1. Lipids, polysaccharides, nucleic acids and proteins are all macromolecules.

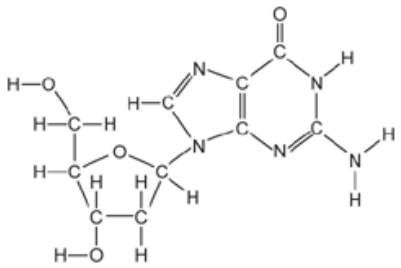
Which statement about macromolecules is correct?

A All macromolecules are formed in hydrolysis reactions.
B Lipids are not polymers, but polysaccharides, nucleic acids and proteins are polymers.
C Lipids are polymers of fatty acids and glycerol.
D Macromolecules all consist of repeating units of monomers.

Your answer ☐ **[1]**

2(a). Phosphodiester bonds are formed during DNA replication.

The diagram shows a molecule of deoxyguanosine, which consists of deoxyribose bonded to guanine.



Draw **two** circles **on the diagram** around the two parts of the molecule that bond to phosphate when phosphodiester bonds form in DNA.

[2]

(b). Outline why cellular respiration is necessary in cells that are carrying out DNA replication.

---**[1]**

3(a). Describe how a polynucleotide is formed from its monomers.

---**[1]**

(b). DNA has a double helix structure made from polynucleotides.

DNA is replicated during interphase of the eukaryotic cell cycle.

i. The enzyme helicase is active during DNA replication.

Describe the action of helicase.

[2]

ii. DNA replication conserves genetic information with accuracy.

Explain how errors may occur during DNA replication.

[2]

(c). Students use this method to extract DNA from the fruit of a strawberry plant:

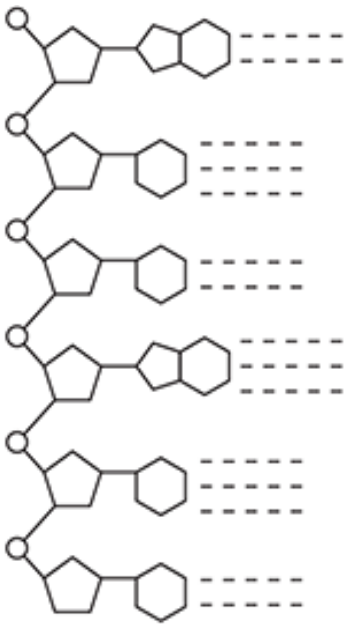
- Take a fruit from a strawberry plant and crush it using a mortar and pestle.
- Add salt to the crushed strawberry fruit mixture.
- Add an enzyme to the mixture.
- Add ethanol to the mixture.

Evaluate whether the method used by the students would successfully extract DNA.

[4]

4. Enzymes that catalyse the removal of CH_3 groups from cytosine bases in DNA are called TET enzymes. The rate of transcription increases when CH_3 groups are removed from DNA.

The diagram shows a section of one strand of DNA.



Key

- - - = hydrogen bonds formed with base in the other strand

i. Label a phosphodiester bond **in the diagram above** with the letter '**P**'.

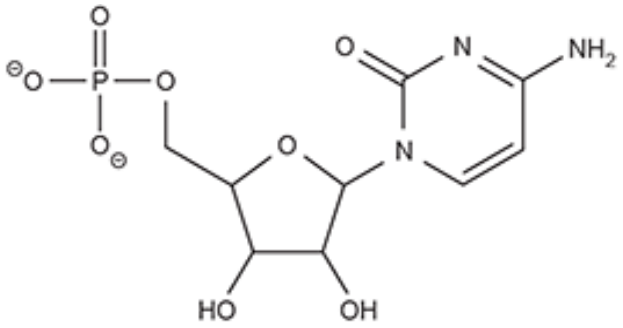
[1]

ii. TET enzymes remove CH_3 groups from a cytosine base only when it is next to a guanine base in the same DNA strand.

Identify a cytosine base that could have CH_3 removed by TET by adding the letter '**T**' to a base **in the diagram above**.

[1]

5. Which nucleotide is shown in the diagram?



A DNA nucleotide with a purine base
B DNA nucleotide with a pyrimidine base
C RNA nucleotide with a purine base
D RNA nucleotide with a pyrimidine base

Your answer ☐ **[1]**

6. Which statement is a correct description of the structure of ADP?

A A pyrimidine is part of its structure.
B It contains deoxyribose.
C It is a nucleotide.
D One phosphate group is present.

Your answer ☐ **[1]**

7. State the roles of DNA polymerase and helicase in cells.

DNA polymerase _____

_____

Helicase _____

_____ **[2]**

8. Mutations in genes coding for proteins in the cytoskeleton have been associated with several diseases of the nervous system, including neurodegenerative disorders.

i. Give **three** functions of the cytoskeleton.

1 _____

_____

2 _____

_____

3 _____

_____ **[3]**

ii. Suggest how a mutation in cytoskeleton genes could cause a disease of the nervous system.

_____

_____

_____

_____

_____ **[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. DNA must be extracted from cells before it can be analysed.

The sentences describe how DNA is extracted from a sample of tissue.

Complete the sentences using the most appropriate words or phrases.

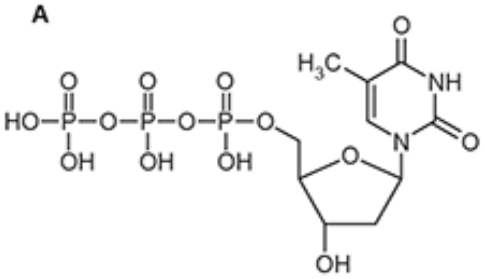
Detergent is used to break down ..... . Proteins, such as histones, surrounding DNA can be hydrolysed by the addition of

..... . The DNA is precipitated from solution by adding ..... .

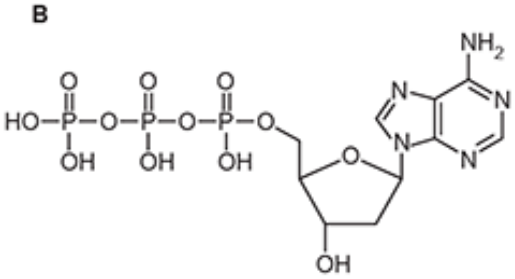
[3]

11. Which structure shows ATP?

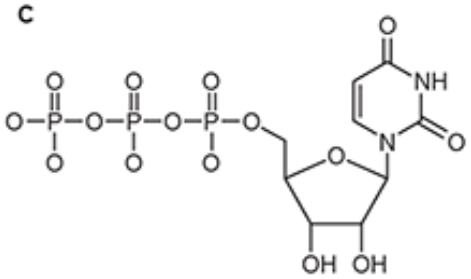
A



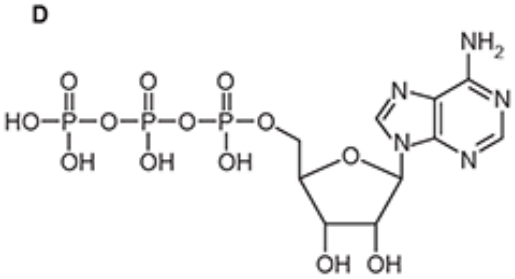
B



C



D



Your answer ☐ **[1]**

12. 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.

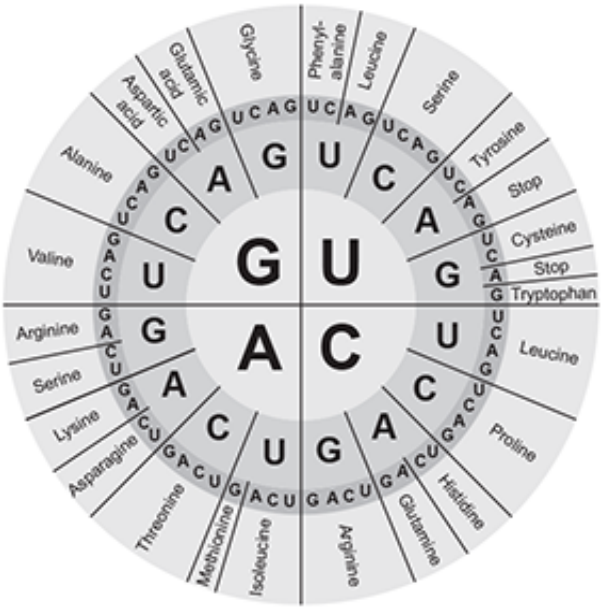


Fig. 16.3

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.

13(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.

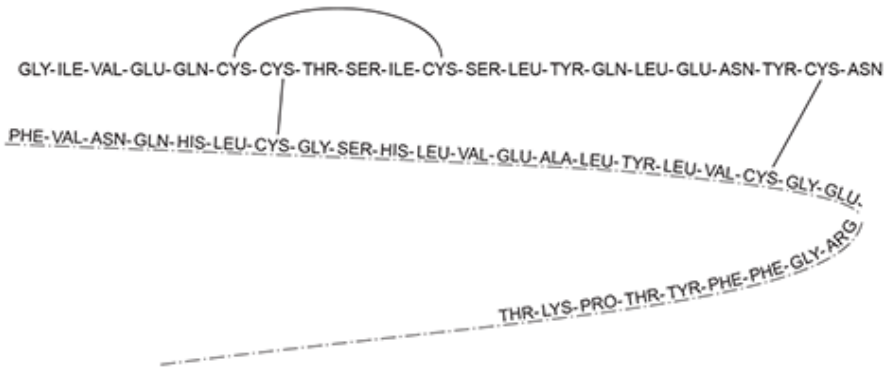


Fig. 21.1

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

---**[2]**

(b). 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**.

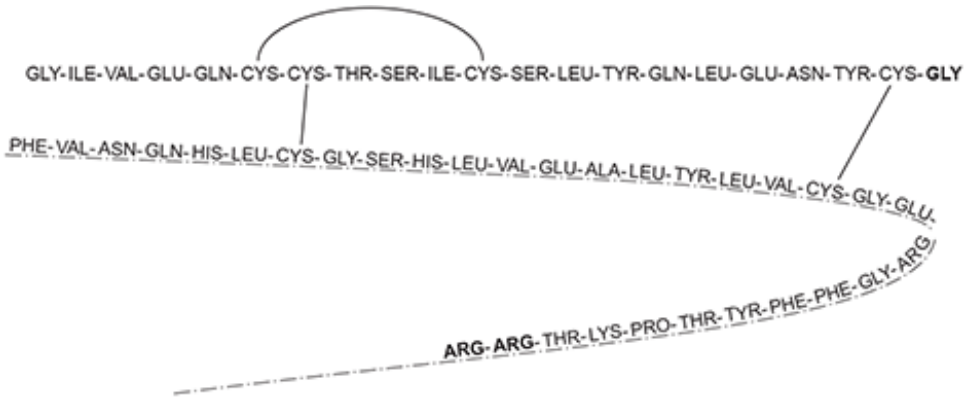


Fig. 21.3

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.

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]

iii. 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]**

14. The following passage has four key terms missing, which are names of molecules involved in protein synthesis.

The enzyme .....**1**..... joins nucleotides together to make a copy of the gene. This makes the molecule .....**2**....., which leaves through the nuclear pore to bind to an organelle that is made of protein and .....**3**..... The amino acids are assembled here when .....**4**..... brings the specific amino acid to be joined to the polypeptide.

Which row gives the correct names of these missing molecules?

	1	2	3	4
A	DNA polymerase	(t)RNA	(m)RNA	(r)RNA
B	RNA polymerase	(m)RNA	(r)RNA	(t)RNA
C	RNA polymerase	(m)RNA	(t)RNA	(r)RNA
D	RNA polymerase	(r)RNA	(t)RNA	(m)RNA

Your answer ☐ **[1]**

15. Researchers have calculated that the probability of bacterial DNA having a mutation is 1 / 333 in a single division.

A gene has DNA that codes for amino acids and is called coding DNA. The rest of the DNA in a genome has base sequences that do not code for amino acids and is called non-coding DNA.

Bacterial genome studies have shown that the average proportion of a bacterial genome that has non-coding DNA is 3 / 25.

What is the probability of a dividing bacterium having a mutation in a gene that codes for a protein in a single division?

A 1 / 2775
B 22 / 8325
C 1024 / 8325
D 7351 / 8325

Your answer ☐ **[1]**

16. Restriction endonucleases are a group of enzymes that carry out hydrolysis reactions that cut long DNA molecules into shorter lengths.

Which of the options describes how restriction endonucleases carry out hydrolysis reactions on a DNA molecule?

A They break the glycosidic bond between a ribose and a phosphate group.
B They break the hydrogen bonds between nitrogenous bases.
C They break the phosphodiester bond between a deoxyribose and a phosphate group.
D They break the phosphodiester bond between a ribose and a phosphate group.

Your answer ☐ **[1]**

END OF QUESTION PAPER