BIOLOGY MIND

Edexcel

A-Level

BIOLOGY

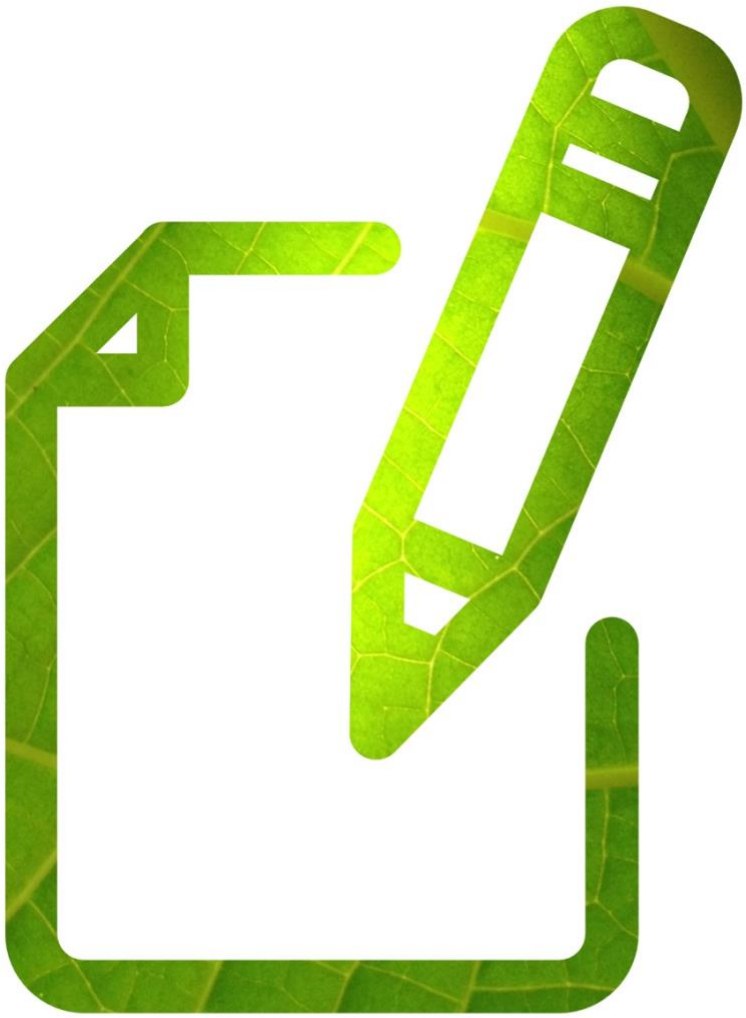
Biological Molecules

DNA & Protein Synthesis 6

Time allowed

54 minutes

QUESTION PAPER



Score	Percentage
/45	%

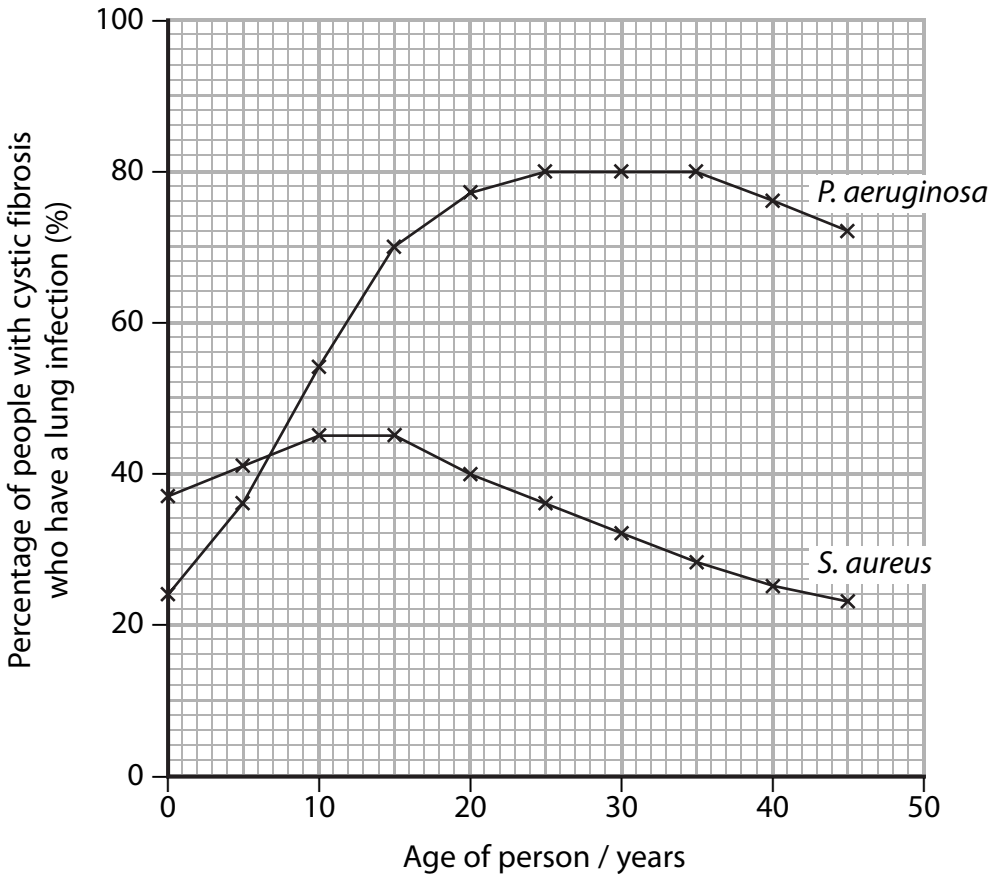
1 Cystic fibrosis is a genetic disease that can affect many body systems, including the respiratory system.

*(a) Explain how a gene mutation causes a build up of mucus in the respiratory system of a person with cystic fibrosis.

(5)

(b) Lung infections can be caused by bacteria such as *P. aeruginosa* and *S. aureus*. People with cystic fibrosis may develop these lung infections.

The graph below shows the relationship between the percentage of people with cystic fibrosis who have a lung infection and the age of the person.



(i) Suggest why people with cystic fibrosis are more likely to suffer from these lung infections than people without cystic fibrosis.

(2)

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(ii) Using the information in the graph, describe the relationship between the age of a person and the incidence of a lung infection due to *P. aeruginosa*.

(3)

(iii) Using the information in the graph, give **two** differences between the percentages of people with infections due to *P. aeruginosa* and infections due to *S. aureus*.

(2)

1 .....

2 .....

(Total for Question 1 = 12 marks)

2 Protein synthesis in cells involves molecules of DNA and RNA.

(a) The table below describes some features of the molecular structure of DNA and RNA. Place a tick (✓) in the box next to each statement to show whether it applies to DNA only, RNA only or to both DNA and RNA.

(2)

Description	DNA only	RNA only	Both DNA and RNA
Polymer formed from a single strand of nucleotides			
Pentose present in the nucleotides			
Adenine, cytosine, guanine and thymine present			
Nucleotides linked by phosphodiester bonds			

(b) The diagram below shows the sequence of the **last** six amino acids in a protein molecule.

The tRNA anticodon that corresponds to each amino acid is also shown.

amino acids	Alanine	Glutamine	Glycine	Asparagine	Proline	Valine
tRNA anticodon	CGA	GUU	CCA	UUA	GGA	CAA

Using this information, explain how each of the following processes leads to the synthesis of this sequence of amino acids.

(i) The formation of mRNA during transcription in the nucleus

(3)

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(ii) The translation of mRNA into the sequence of amino acids in a ribosome

(3)

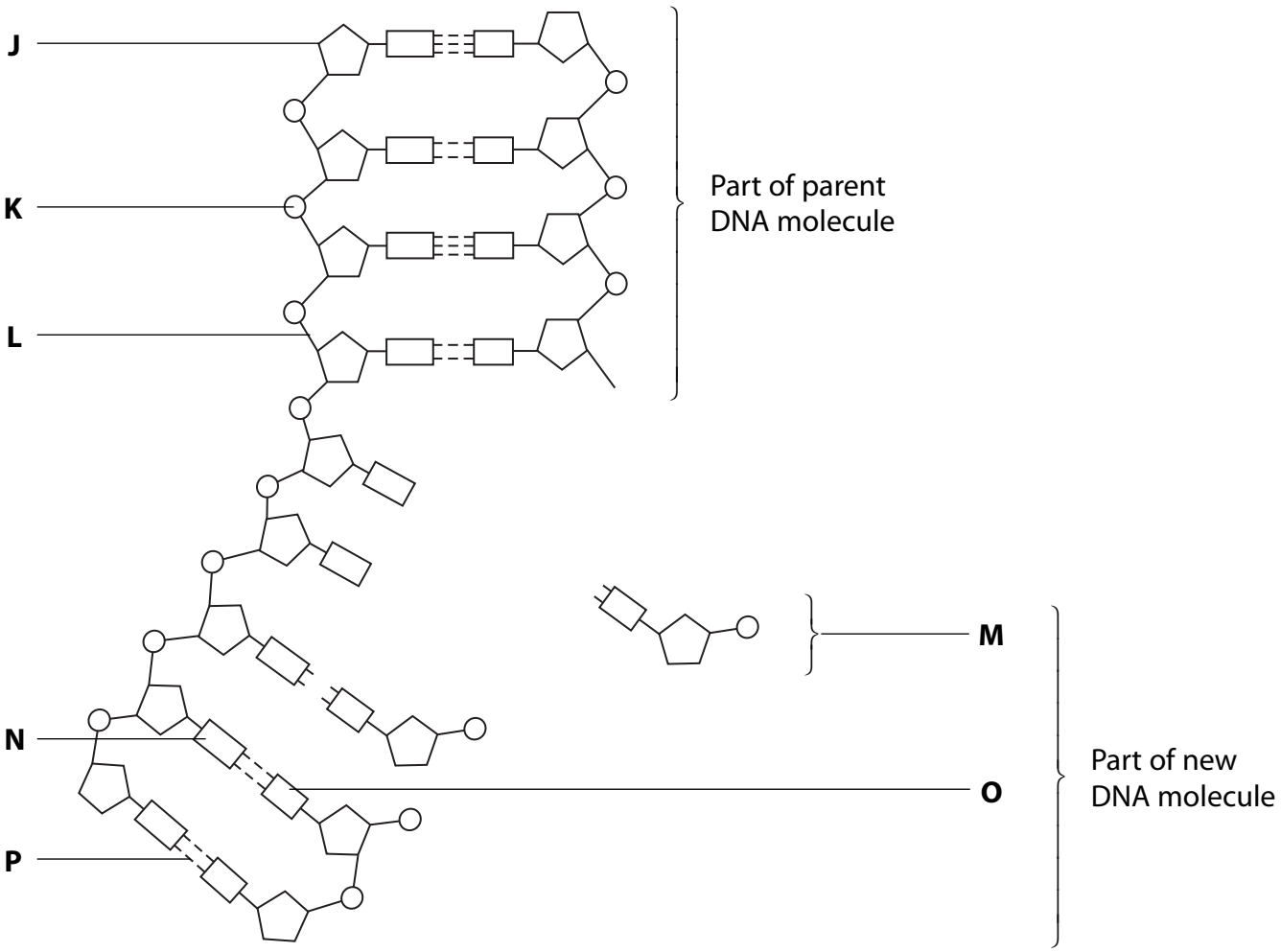
(c) Suggest why the final triplet of nucleotides, on the strand of mRNA involved in the synthesis of this sequence of amino acids, did not correspond with any anticodon on tRNA.

(2)

(Total for Question 2 = 10 marks)

3 DNA is a very important molecule in living organisms as it carries the genetic code that controls all characteristics. When a cell divides, the DNA molecule replicates so that each resulting daughter cell is genetically identical to the original parent cell.

The diagram below shows part of this process of DNA replication.



For each of the statements below, put a cross in the box that corresponds to the correct statement about DNA structure or DNA replication.

(a) The structure labelled **J** is

(1)

- ☒ **A** ribose
- ☒ **B** α glucose
- ☒ **C** β glucose
- ☒ **D** deoxyribose

(b) The structure labelled **K** is a

(1)

- ☒ **A** phosphate group
- ☒ **B** phosphorus atom
- ☒ **C** sulphate group
- ☒ **D** potassium atom

(c) The bond labelled **L** is a

(1)

- ☒ **A** peptide bond
- ☒ **B** phosphodiester bond
- ☒ **C** hydrogen bond
- ☒ **D** glycosidic bond

(d) The structure labelled **M** is a

(1)

- ☒ **A** polynucleotide
- ☒ **B** mononucleotide
- ☒ **C** polypeptide
- ☒ **D** mononucleoside

(e) If the base labelled **N** on the parent DNA molecule is adenine, the base labelled **O** on the new DNA molecule is

(1)

- ☒ **A** uracil
- ☒ **B** guanine
- ☒ **C** thymine
- ☒ **D** cytosine

(f) The bond labelled **P** is a

(1)

- ☒ **A** peptide bond
- ☒ **B** phosphodiester bond
- ☒ **C** hydrogen bond
- ☒ **D** glycosidic bond

(Total for Question 3 = 6 marks)

4 Read through the following passage on protein synthesis, then write on the dotted lines the most appropriate word or words to complete the passage.

(6)

Protein synthesis involves two stages. The first stage is ..... and takes place in the nucleus of the cell. During this stage, a molecule called ..... is made using the antisense DNA strand as a template.

The second stage, known as ..... , takes place in the cytoplasm of the cell on structures called ..... . During this stage, ... molecules enable the amino acids attached to them to line up in the correct order. The amino acids are joined together by the formation of ..... bonds.

(Total for Question 4 = 6 marks)

5 The bases in a gene code for the synthesis of a protein. Gene mutations can influence the metabolism of an organism.

(a) (i) The diagram below shows the bases on the template strand of DNA in the part of a gene that codes for a short sequence of amino acids in an enzyme.

A A C T A G T T G G C A A G T G G T C A C

Each of the following statements is about this sequence of bases. For each statement, place a cross ☒ in the appropriate box to show whether it is true or false.

(3)

Statement	True	False
This sequence of bases could be used as a template during translation	☒	☒
A strand of mRNA could be synthesised using this sequence	☒	☒
This sequence codes for 7 amino acids during protein synthesis	☒	☒

(ii) Name and describe the structures where the polypeptide chain of this enzyme would be synthesised.

(2)

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(b) *Chlamydomonas* is a single-celled photosynthetic organism that lives in well-illuminated ponds. In populations of *Chlamydomonas*, a gene mutation occasionally occurs. This mutation enables *Chlamydomonas* to take in organic compounds produced by other organisms and use them as a source of energy.

(i) Explain what is meant by the term **gene mutation**.

(2)

(ii) A population of *Chlamydomonas* was found in a pond in the centre of a developing forest of fast-growing trees. Suggest how the allele frequency for this mutation could change as the forest develops. Give reasons for your answer.

(4)

(Total for Question 5 = 11 marks)