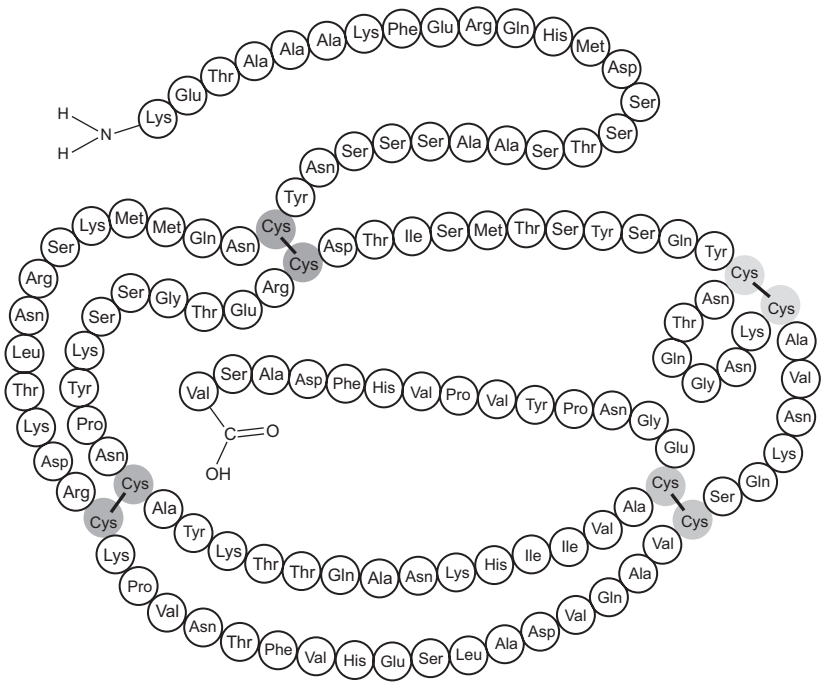
1 Enzymes, messenger RNA (mRNA) and transfer RNA (tRNA) are involved in the synthesis of proteins.

(a) The diagram below represents the structure of an enzyme.
Each circle represents an amino acid.



(i) An enzyme is a protein and has a primary structure.
Explain the meaning of the term **primary structure**.

(2)

.....

.....

.....

.....

.....

.....

(ii) Using the diagram and your own knowledge of enzymes, explain the importance of the primary structure of an enzyme to its function.

(5)

(b) Describe the roles of messenger RNA (mRNA) and transfer RNA (tRNA) in protein synthesis.

(i) Messenger RNA

(3)

(ii) Transfer RNA

(3)

(Total for Question 1 = 13 marks)

2 The Atlantic tomcod is a fish found in the rivers of North America.

The photograph below shows an Atlantic tomcod.

Magnification $\times 1$

Atlantic tomcod in the Hudson River are able to survive high levels of polychlorinated biphenyls (PCBs). PCBs enter the water from industrial processes.

One group of scientists identified a mutation in the DNA of these fish. They found that the AHR2 gene had six bases missing. This mutation was rarely found in Atlantic tomcod in the unpolluted St. Lawrence River.

(a) Suggest how scientists in other countries learnt of these findings.

(2)

*(b) (i) Describe how the DNA and protein of Atlantic tomcod from the Hudson River could be compared with the DNA and protein of Atlantic tomcod from the St. Lawrence River.

(6)

(ii) Suggest **one** similarity in the DNA of the Atlantic tomcod from these two rivers.

Give an explanation for your answer.

(2)

(iii) Suggest **one** difference in the protein of the Atlantic tomcod from these two rivers.

Give an explanation for your answer.

(2)

(Total for Question 2 = 12 marks)

3 (a) Read through the following passage on the blood clotting process, then write on the dotted lines the most appropriate word or words to complete the passage.

(5)

The blood clotting process starts when cell fragments called ..... release molecules of ..... . These molecules are ..... which catalyse the conversion of ..... into ..... , in the presence of calcium ions. As a result, fibrinogen is converted into fibrin and blood cells are trapped to form the clot.

(b) Fibrinogen and fibrin are both proteins.

A protein consists of a chain of amino acids joined together by bonds.

(i) In the space below, draw a diagram to show the structure of an amino acid.

(3)

(ii) Name the covalent bond that joins the amino acids into a chain.

(1)

.....

(iii) Suggest **two** differences between fibrinogen and fibrin.

(2)

1 .....

.....

.....

2 .....

.....

.....

(Total for Question 3 = 11 marks)

4 Cystic fibrosis is a genetic disease caused by mutations in the CFTR gene.
This disease can be classified according to the effect of the different gene mutations on the CFTR protein.

The table below shows the classification of cystic fibrosis.

Class	Effect on the CFTR protein
I	CFTR protein is not synthesised.
II	CFTR protein is mis-folded and is not found in the correct location.
III	CFTR protein is mis-folded and is found in the correct location, but does not function properly.
IV	CFTR protein has a faulty opening.
V	CFTR protein is synthesised in smaller quantities than normal.
VI	CFTR protein breaks down quickly after it is synthesised.

(a) For class I cystic fibrosis, suggest how a mutation in the CFTR gene could result in no CFTR protein being synthesised.

(2)

(b) Class II cystic fibrosis results from the CFTR protein being located in the wrong place.

Describe the correct location for the CFTR protein.

(2)

(c) The mutation causing class III cystic fibrosis results in a change in the primary structure of the CFTR protein.

Explain why this would result in the CFTR protein being mis-folded.

(2)

(d) For class IV cystic fibrosis, explain why a faulty opening of the CFTR protein would affect the functioning of this protein.

(2)

(e) For a person with class V cystic fibrosis, describe the effect of having smaller quantities of CFTR protein.

(2)

(f) For class VI cystic fibrosis, suggest how the CFTR protein is broken down.

(2)

(Total for Question 4 = 12 marks)