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EDEXCEL AS UNIT 1

1 Tay-Sachs disease is a genetic disorder.

(a) A couple without Tay-Sachs disease are expecting their second child. Their first child died from the disease.

Use a genetic diagram to determine the probability of their second child having Tay-Sachs disease.

(2)

Answer .....

(b) Tay-Sachs disease can be detected during pregnancy.

Name the prenatal test that could be used to detect Tay-Sachs disease at 11 weeks of pregnancy.

(1)

.....

(c) Explain why this couple may choose not to have this test.

(3)

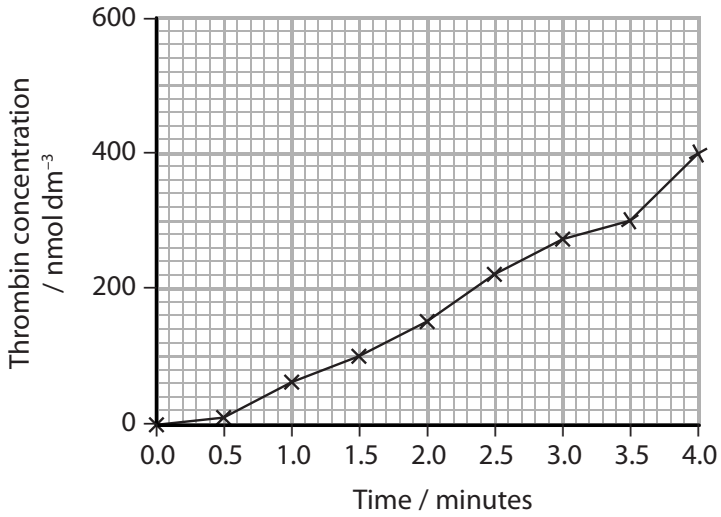
(Total for Question 1 = 6 marks)

2 The photograph shows the tropical rattlesnake, *Crotalus durissus terrificus*.

This snake produces a toxin called convulxin (CVX), which activates platelets leading to blood clotting.

(a) The effect of CVX on the rate of thrombin production was investigated.

The graph shows the concentration of thrombin in a sample of blood treated with CVX.



(i) Calculate the rate of thrombin production during the last two minutes of this investigation.

(2)

Answer .....

(ii) State and justify a suitable control for this investigation.

(2)

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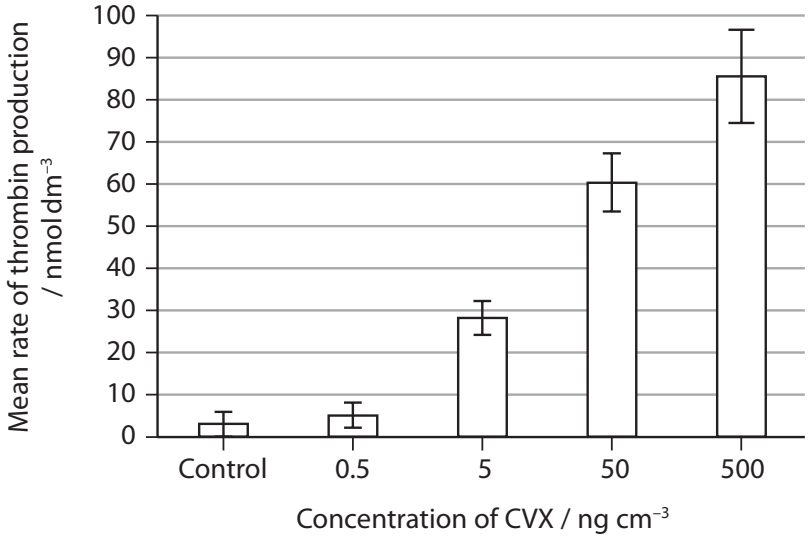
(b) The effect of four different concentrations of CVX on thrombin production was investigated.

The graph shows the results of this investigation, with bars showing the standard deviation.



Analyse the data to assess the effect of CVX on the rate of blood clotting.

(5)

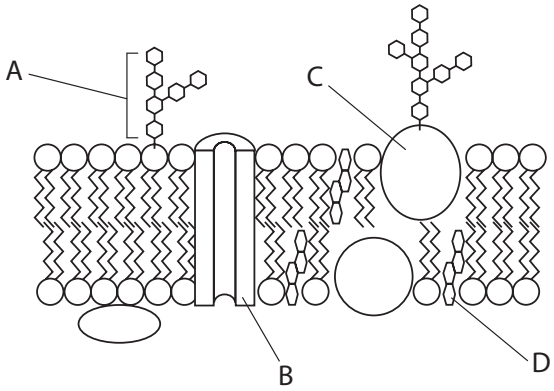
(c) Haemophilia is a disease that affects blood clotting. People with haemophilia are sometimes given a protein called factor VIII. Factor VIII is an enzyme that is involved in the process of blood clotting.

Explain how a change in the primary structure of factor VIII could cause difficulties with blood clotting.

(4)

(Total for Question 2 = 13 marks)

3 The diagram shows part of a cell surface membrane.



(a) (i) Which of the molecules labelled in the diagram is a glycoprotein?

(1)

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(ii) Describe the function of carrier proteins in a cell surface membrane.

(4)

(b) Anthocyanins are purple pigments found in the cells of red cabbage leaves.

A student investigated the following hypothesis:

'The permeability of cell membranes in a red cabbage leaf is affected by the age of the plant.'

Devise an investigation the student could use to test this hypothesis and collect valid data.

(4)

(Total for Question 3 = 9 marks)

4 Cardiovascular disease (CVD) is a major cause of death in developed countries.

(a) A high body mass index (BMI) and diabetes are two risk factors for CVD.

(i) Which of the following is another risk factor for CVD?

(1)

- ☒ **A** high blood pressure
- ☒ **B** low blood cholesterol
- ☒ **C** low salt intake
- ☒ **D** using statins

(ii) A woman is 154 cm tall and has a mass of 61 kg. Her body mass index is calculated using the following formula.

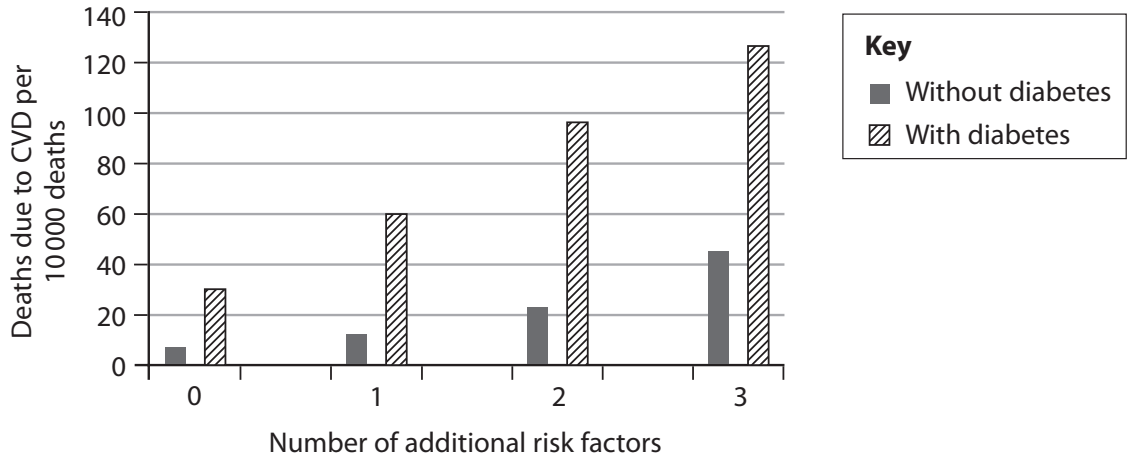
$$\text{BMI} = \frac{\text{mass in kilograms}}{(\text{height in metres})^2}$$

Calculate her BMI to one decimal place.

(2)

Answer .....

(iii) The graph shows the effect of additional risk factors on deaths due to CVD for people with and without diabetes.



Identify the effect of the number of additional risk factors on deaths due to CVD for people with and without diabetes.

(2)

(b) It is possible to reduce the risk of CVD by taking medication or changing diet.

Explain the role of antihypertensive drugs in reducing the risk of atherosclerosis.

(4)

(Total for Question 4 = 9 marks)

5 Muscle cells contain globular and fibrous proteins.

(a) Compare and contrast the molecular structures of globular and fibrous proteins.

(4)

(b) Describe the roles of transcription and translation in the synthesis of a globular protein by a muscle cell.

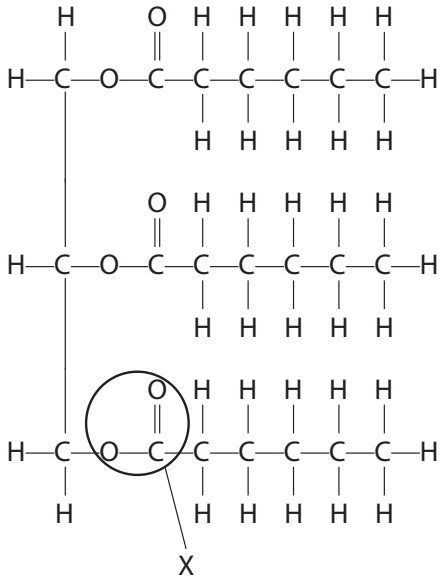
(5)

(Total for Question 5 = 9 marks)

6 Hydrolytic enzymes are released by organs in the digestive system.

(a) Cells in the pancreas and small intestine synthesise lipase. Lipase hydrolyses lipids in food.

The diagram shows a triglyceride molecule.



(i) Which of the following is the name of the bond labelled X?

(1)

☒ **A** ester bond

☒ **B** glycosidic bond

☒ **C** hydrogen bond

☒ **D** phosphodiester bond

(ii) Name the process by which enzymes leave the cells of the pancreas and small intestine.

(1)

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(iii) Explain why the pH in the small intestine would change after lipase hydrolyses lipids.

(2)

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(b) The triglyceride in the diagram can combine with protein to form a lipoprotein.

Explain the effect that large quantities of this lipoprotein would have on blood cholesterol levels.

(4)

(c) Glycogen and starch can be hydrolysed by enzymes.

Which row shows the correct features of the structure of glycogen?

(1)

☒ **A**	1,4-glycosidic bonds only	branched
☒ **B**	1,6-glycosidic bonds only	unbranched
☒ **C**	1,4-glycosidic bonds and 1,6-glycosidic bonds	branched
☒ **D**	1,4-glycosidic bonds and 1,6-glycosidic bonds	unbranched

(d) Starch contains two different molecules, amylose and amylopectin. The percentage of each molecule found in starch varies depending on its source.

The effect of amylose content on the hydrolysis of starch from different sources by enzymes was investigated.

Source of starch	**Amylose content (%)**	**Percentage of starch hydrolysed after 4 hours (%)**
Cassava	20.0	51.9
Peruvian carrot	18.7	54.2
Potato	28.9	39.6
Yellow maize	35.8	37.5

(i) Calculate the ratio of amylose to amylopectin in cassava. Give your answer in simplest form.

(1)

Answer .....

(ii) Explain the relationship between the composition of the starch and the rate of hydrolysis by enzymes.

(4)

(Total for Question 6 = 14 marks)

7 DNA is a double-stranded molecule. During transcription, the antisense and sense strands are separated.

Part of the antisense strand, with base sequence TACGCTGAC, is transcribed.

(a) (i) State where transcription occurs in an animal cell.

(1)

.....

(ii) Which row shows the correct sequence for the complementary sense strand and the mRNA produced in transcription?

(1)

		Sense strand	mRNA
☒	**A**	ATGCGACTG	ATGCGACTG
☒	**B**	TACGCTGAC	AUGCGACUG
☒	**C**	TACGCTGAC	ATGCGACTG
☒	**D**	ATGCGACTG	AUGCGACUG

(b) A human gene is 27 000 base pairs long. In this section of double-stranded DNA there are 4050 nucleotides containing the base cytosine.

(i) State what is meant by the term gene.

(1)

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(ii) How many nucleotides in this gene contain the base adenine?

(1)

☒ **A** 9000

☒ **B** 18000

☒ **C** 22950

☒ **D** 45900

(c) Mutations to DNA can affect the structure of proteins produced in the cell.

Removing one base from a DNA sequence will affect the primary structure of a protein.

Changing one base for another may not affect the primary structure of a protein.

Explain why these two types of mutation have different effects on protein structure.

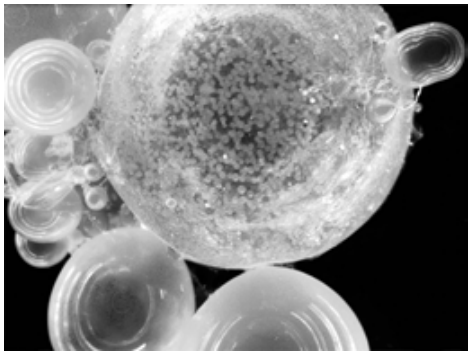
(4)

(Total for Question 7 = 8 marks)

8 All organisms exchange gases with their environment.

(a) Sailor's eyeball (*Valonia ventricosa*) is a single-celled, spherical organism.

One of these organisms can have a diameter of 1 cm to 4 cm.



The table shows the diameter, surface area and volume of different *Valonia ventricosa* cells.

Diameter / cm	1	2	4
Surface area / cm^2	3.14	12.57	50.27
Volume / cm^3	0.52	4.19	

(i) The volume of a sphere can be calculated using the following equation.

$$V = \frac{4\pi r^3}{3}$$

What is the volume of a cell with a diameter of 4 cm?

(1)

☒ **A** 33.51 cm^2

☒ **B** 33.51 cm^3

☒ **C** 268.08 cm^2

☒ **D** 268.08 cm^3

(ii) Describe why single-celled organisms, such as *Valonia ventricosa*, do not need a specialised gas exchange surface.

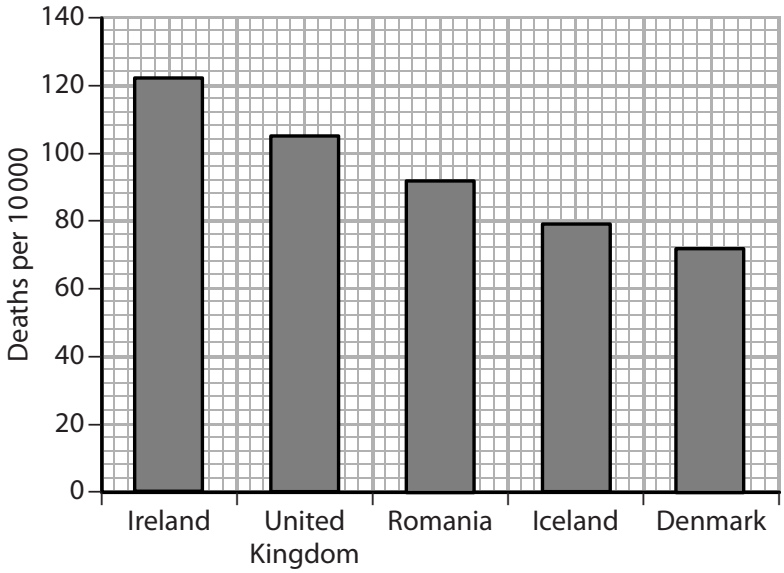
(2)

(b) Mammalian lungs are adapted for rapid gas exchange.

Explain how the structure of the human lungs enables rapid gas exchange.

(4)

(c) The graph shows the death rates due to diseases of the respiratory system in some countries.



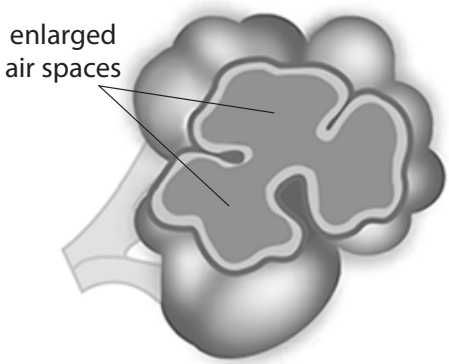
Calculate the probability of dying from a disease of the respiratory system in the United Kingdom.

(2)

Answer .....

(d) Emphysema is a disease of the respiratory system that affects the structure of the lungs.

Lung without emphysema



Lung with emphysema

Explain why people with emphysema are given air with a higher concentration of oxygen than atmospheric air.

(2)

(Total for Question 2 = 11 marks)

9 Blood plasma contains glucose dissolved in water. Glucose is a polar molecule that is taken up by muscle cells and used in the synthesis of glycogen.

(a) Explain why water is a good solvent.

(2)

(b) Describe how glucose enters muscle cells through the cell membrane.

(2)

(c) The ratio of glucose to glycogen inside a cell can affect the uptake of water by the cell. This results in a change in cell mass.

Cells with different ratios of glucose to glycogen were placed in tissue fluid and the percentage change in cell mass was recorded.

Ratio of glucose to glycogen	Percentage change in cell mass (%)
100:0	25.0
80:20	16.5
60:40	4.0
40:60	0.0
20:80	0.0

Analyse the data to explain the effect of these ratios on the percentage change in cell mass.

(3)

(d) Glucose is used in the synthesis of glycogen in muscle cells.

(i) Describe the formation of glycogen from glucose.

(2)

(ii) Describe how the structure of glycogen is related to its function as a storage molecule.

(2)

(Total for Question 3 = 11 marks)

10 Brilliant cresyl blue (BCB) can be used to stain red blood cells. When red blood cells are immersed in a solution of BCB, they take up all the stain and leave the surrounding solution colourless.

The effect of temperature on the uptake of BCB by red blood cells was investigated.

The table shows the results of the investigation.

Temperature / °C	Percentage of stained cells (%)	Colour of solution surrounding red blood cells
10	100	colourless
20	100	colourless
30	100	colourless
40	97	colourless
50	81	pale blue
60	17	blue

It was concluded that the cells were taking up the BCB stain by active transport.

(a) Which component of the cell surface membrane is involved in this process?

(1)

☒ **A** carrier protein

☒ **B** channel protein

☒ **C** cholesterol

☒ **D** glycolipid

(b) Analyse the data to justify the conclusion of this investigation.

(3)

(c) Explain **one** way in which this investigation could be improved.

(2)

(Total for Question 4 = 6 marks)

11 The food we eat contains carbohydrates, lipids and proteins.

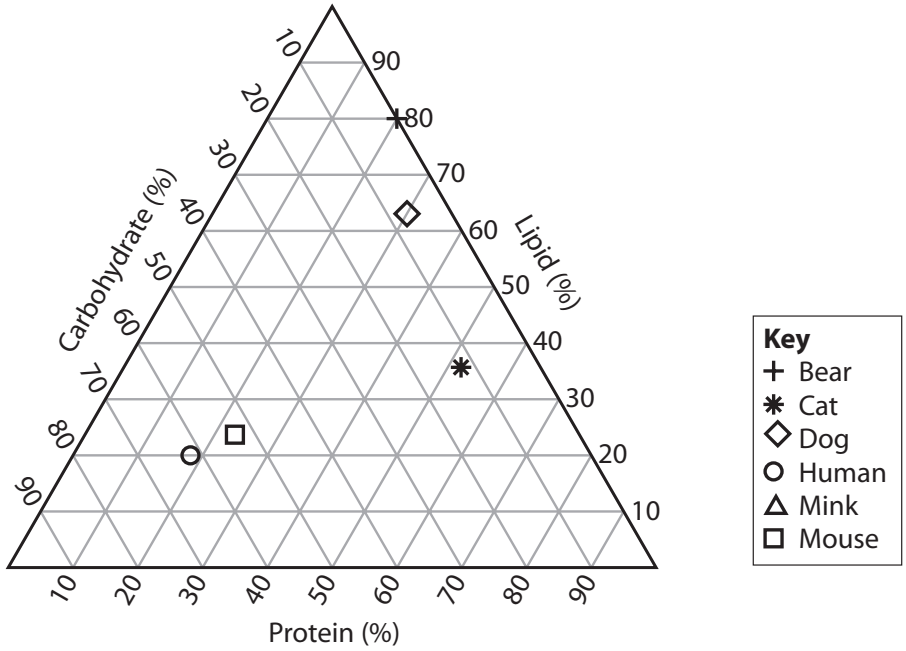
(a) Which of the following contains nitrogen atoms?

(1)

- ☒ **A** carbohydrate
- ☒ **B** glycogen
- ☒ **C** lipid
- ☒ **D** protein

(b) Mammals have diets containing different proportions of carbohydrates, lipids and proteins.

The diagram shows the composition of the average diet of some mammals.



(i) The diet of a dog contains 6% carbohydrate, 64% lipid and 30% protein. This is shown on the diagram as a diamond.

The diet of a mink contains 15% carbohydrate, 50% lipid and 35% protein.

Plot this on the diagram.

(1)

(ii) Which mammal will have a diet containing food with the highest proportion of ester bonds?

(1)

☒ **A** bear

☒ **B** cat

☒ **C** human

☒ **D** mouse

(c) Carbohydrates, lipids and proteins can be used as sources of energy.

The table shows the average daily energy requirements for boys and girls aged 13 to 18.

Age / years	Daily energy requirement / kJ	
	Boys	Girls
13	10 090	9292
14	10 989	9789
15	11 787	9990
16	12 389	10 090
17	12 886	10 291
18	13 187	10 291

(i) Calculate the percentage increase in the average daily energy requirements for boys aged 17 compared with their energy requirements aged 13.

(2)

Answer ..... %

(ii) Many foods are labelled in kilocalories (kcal). One calorie is equal to 4.18 joules.

Which of the following is the average energy requirements for girls aged 13 in kilocalories (kcal)?

(1)

☒ **A** 2.223 kcal

☒ **B** 222.3 kcal

☒ **C** 2223 kcal

☒ **D** 2 223 000 kcal

(iii) State what will happen to the additional energy if an individual takes in more energy than is required.

(1)

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.....

*(d) People with cystic fibrosis require a higher energy diet than people without cystic fibrosis. They are also more likely to develop problems in the pancreas.

Men with cystic fibrosis are less likely to be able to release sperm.

Discuss why a person with cystic fibrosis could have these symptoms.

(6)

(Total for Question 5 = 13 marks)

12 Atherosclerosis is more likely to occur in arteries due to the higher blood pressure in these blood vessels.

(a) Explain how the structure of an artery wall is adapted both to withstand and to maintain high blood pressure.

(3)

(b) A person with very high blood pressure has an increased risk of developing atherosclerosis.

(i) Describe how very high blood pressure could result in atherosclerosis.

(3)

(ii) Explain how atherosclerosis in one part of an artery could increase the likelihood of it developing in another part of the same artery.

(2)

(iii) A haemorrhagic stroke occurs when a blood vessel in the brain bursts.

Which of the following would be the least helpful in reducing damage from this type of stroke?

(1)

- ☒ **A** anticoagulant
- ☒ **B** antihypertensive
- ☒ **C** statins
- ☒ **D** thrombin

(Total for Question 6 = 9 marks)

13 DNA is a polymer made from monomers called nucleotides.

(a) Describe how nucleotides join together to form DNA.

(2)

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(b) Different theories for DNA replication have been suggested. Figure 1 illustrates two of these theories.

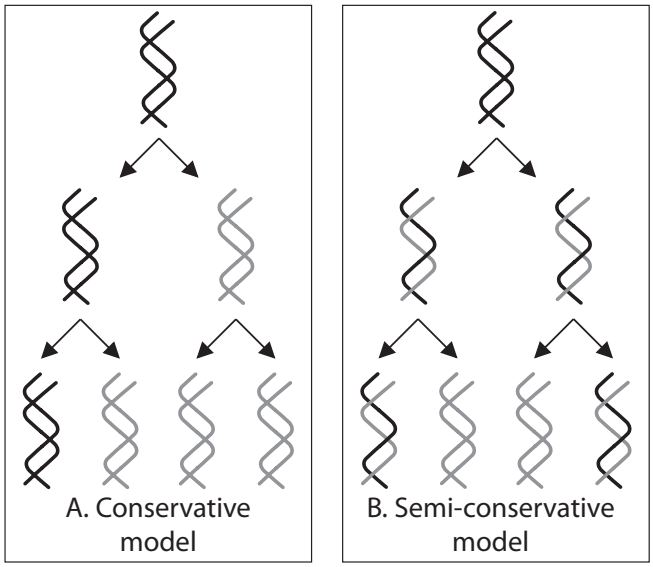


Figure 1

Meselson and Stahl carried out experiments to test these theories for DNA replication.

Figure 2 shows the results from one of their experiments.

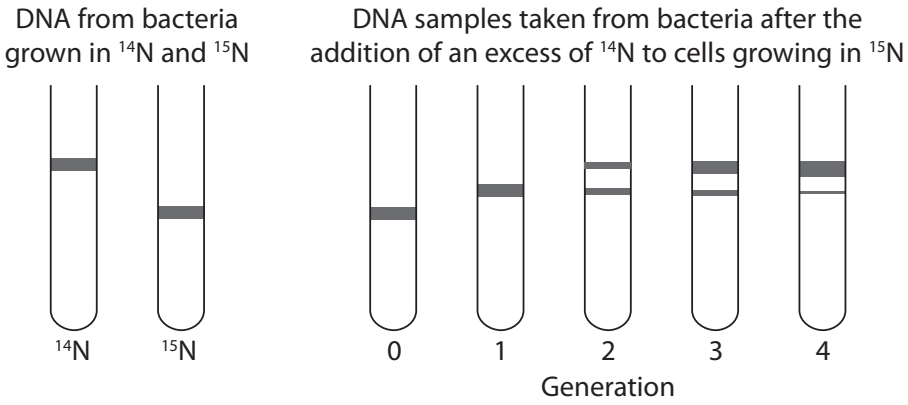
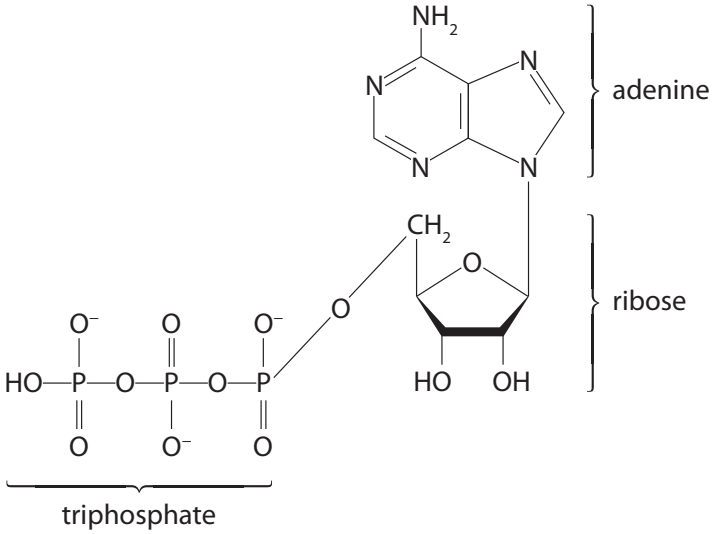


Figure 2

Analyse the data to explain why Meselson and Stahl accepted one of the models for DNA replication and rejected the other.

(4)

(c) The diagram shows the structure of ATP.



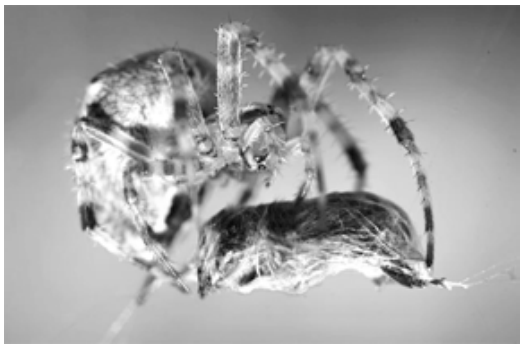
Compare and contrast the structure of ATP and a DNA nucleotide.

(3)

(Total for Question 7 = 9 marks)

14 Spiders inject a mixture of digestive enzymes into the body of their prey and feed on the products of this digestion.

The photograph shows a spider with its prey.



(a) State why enzymes are described as biological catalysts.

(1)

(b) One of the enzymes injected into the prey is called arazyme. Arazyme is a protease enzyme that can break down collagen.

(i) Compare and contrast the molecular structure of collagen and an enzyme such as arazyme.

(4)

(ii) The hydrolysis of collagen results in a decrease in pH. The indicator phenolphthalein is pink at pH 8 and becomes colourless at lower pH values.

Devise an investigation to determine the effect of arazyme concentration on the rate of hydrolysis of collagen.

(4)

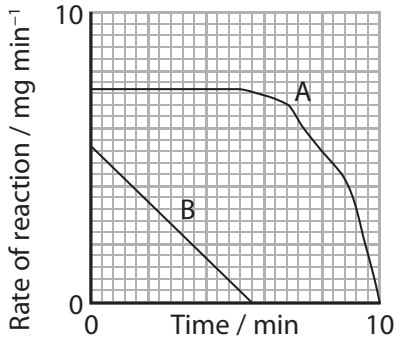
(c) The effect of substrate concentration on the rate of an enzyme reaction was investigated.

Two substrate solutions, A and B, were used. Solution A had a higher concentration than solution B. The optimum pH for the enzyme was pH 7.

The product lowered the pH of the solution.

The rate of reaction was determined at 1-minute intervals for 10 minutes.

The graph shows the results of this investigation.



It was concluded that the product reduces the activity of the enzyme.

Comment on the validity of this conclusion.

(4)

(Total for Question 8 = 13 marks)