OXFORD
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INTERNATIONAL AS
BIOLOGY (9610)

Unit 2 Biological systems and disease

Wednesday 15 May 2019 07:00 GMT Time allowed: 1 hour 30 minutes

Materials
For this paper you must have:
- a ruler with millimetre measurements
- a scientific calculator, which you are expected to use where appropriate.

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- All working must be shown.
- If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The marks for questions are shown in brackets.
- The maximum mark for this paper is 75.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
TOTAL	

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Answer **all** questions in the spaces provided.

0 1 Endopeptidases and exopeptidases are involved in the digestion of proteins in mammals.

0 1 . 1 Describe the action of endopeptidases on a protein.

[2 marks]

0 1 . 2 Describe how the action of endopeptidases increases the rate of action of exopeptidases.

[1 mark]

0 1 . 3 A protein molecule contains 145 amino acids.

How many peptide bonds are there in this protein molecule?

[1 mark]

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The extent to which a protein is digested is called the degree of hydrolysis (DH). The DH value may be calculated from the equation:

$$DH = \frac{\text{Number of peptide bonds hydrolysed}}{\text{Total number of peptide bonds present}} \times 100$$

0 1 . 4 A molecule of the protein described in Question **01.3** is digested. The DH value of the digested protein is 25

Calculate the number of peptide bonds that have been hydrolysed.

[1 mark]

Number of peptide bonds hydrolysed = _____

0 1 . 5 A protein molecule is completely hydrolysed to amino acids.

Give the DH value.

[1 mark]

DH value = _____

6

Turn over for the next question

Do not write outside the box

0 2 Scientists investigate the movement of organic substances through a plant.

This is the method the scientists use:

- surround the leaves at the top of a plant in a sealed glass chamber containing radioactively-labelled carbon dioxide ($^{14}CO_2$) as shown in **Figure 1**
- position an aphid at each of the four points along the length of the stem
- cut the aphid stylets so that the stylets remain attached to the stem as shown in **Figure 2**
- collect and analyse the sap that continues to flow from each stylet and identify radioactive substances.

Figure 1

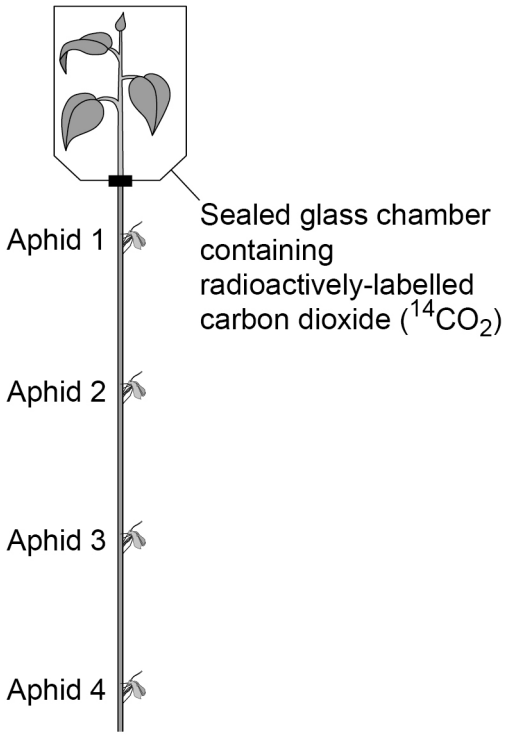

Figure 2

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0 2 . 1 The radioactive carbon is transported as a carbohydrate in the stem.

Suggest the name of this carbohydrate.

[1 mark]

Tick (✓) **one** box.

Cellulose ☐

Ribose ☐

Starch ☐

Sucrose ☐

0 2 . 2 Give the reason why the sap continues to flow from the stylets after the aphids have been removed.

[1 mark]

_____

_____

_____

_____

Question 2 continues on the next page

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The scientists calculated the rate of phloem transport by measuring the time taken for radioactivity to be detected at the different aphid positions along the length of the stem.

Table 1 shows the scientists' results.

Table 1

	Aphid 2	**Aphid 3**	**Aphid 4**
Distance from aphid **1** / cm	20	40	60
Time for radioactive sap to travel from position of aphid **1** / h	1.25	2.40	3.80
Rate of phloem transport from previous aphid position / cm h^{-1}	16.0		14.3

0 2 . 3 Calculate the mean rate of phloem transport.

[2 marks]

Answer = _____ cm h^{-1}

0 2 . 4 Explain what causes the movement of carbohydrate down the stem of the plant.

Use your knowledge of the mass flow hypothesis for the mechanism of translocation in plants.

[4 marks]

_____

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8

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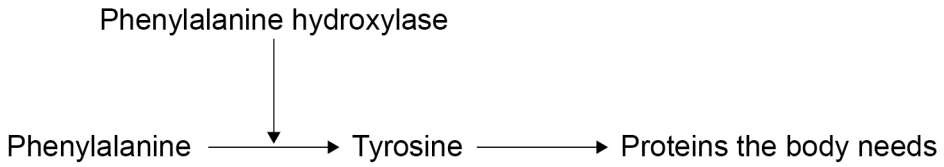
0 3 Phenylalanine is an amino acid found in many foods that contain protein. In most people, phenylalanine is converted to another amino acid, tyrosine, by the following pathway.



People with a disorder called PKU cannot produce the functional enzyme phenylalanine hydroxylase. PKU can cause a build-up of phenylalanine. Too much phenylalanine can cause brain damage.

0 3 . 1 A mutation causes PKU.

What is a mutation?

[1 mark]

0 3 . 2 Describe how a mutation prevents the production of the functional enzyme phenylalanine hydroxylase.

[3 marks]

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Children with PKU are given a diet low in phenylalanine.

0 3 . 3 Give the reason why a low-phenylalanine diet prevents brain damage in children with PKU.

[1 mark]

0 3 . 4 Suggest **one** reason why the diet must contain some phenylalanine.

[1 mark]

A drug called Kuvan has been developed to help patients with PKU. The drug has the ability to improve the activity of the non-functioning enzyme.

0 3 . 5 Suggest how the drug could do this.

[2 marks]

Do not write outside the box

Doctors recommend that the phenylalanine concentration in the blood should not be more than 600 arbitrary units.

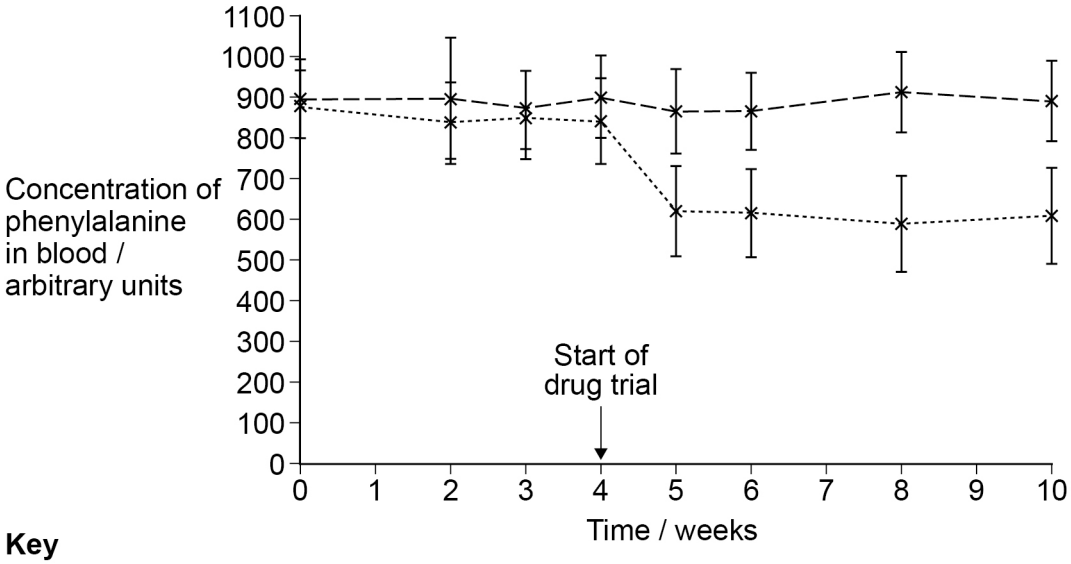
Scientists investigated the effectiveness of Kuvan.

This is the method the scientists use:

- place a large number of patients with PKU randomly into an experimental group or a control group
- give the patients in the experimental group a daily dose of Kuvan
- give the patients in the control group a daily dose of a placebo
- take blood samples at specific time intervals to measure the concentration of phenylalanine.

The results are shown in **Figure 3**.

Figure 3



Key

× Mean — — Control group

I Range ····· Experimental group

0 3 . 6 The scientists concluded that Kuvan is an effective treatment for patients with PKU.

Evaluate this conclusion.

[4 marks]

12

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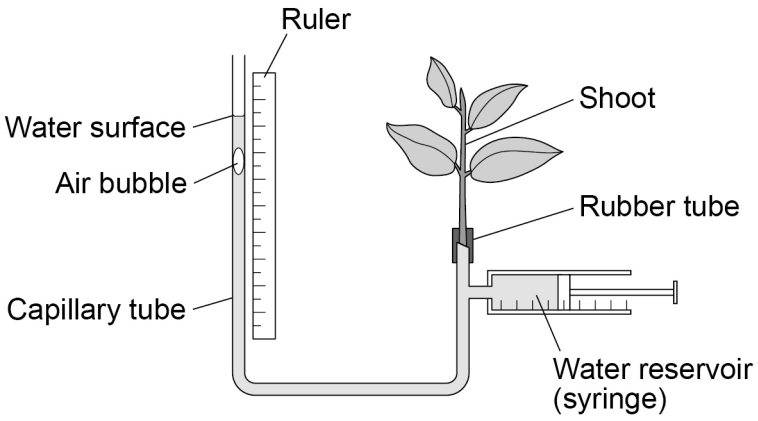
0 4 A student investigates the effect of removing leaves from a plant shoot on the rate of transpiration. The student uses a potometer with a shoot that has four leaves.

Figure 4 shows the potometer the student uses.

Figure 4



0 4 . 1 The student seals the joint between the shoot and the rubber tube with a waterproof jelly.

Give **one** reason why.

[1 mark]

_____

_____

0 4 . 2 The rate of water uptake may not be the same as the rate of transpiration.

Give **two** reasons why.

[2 marks]

1 _____

_____

2 _____

_____

Do not write outside the box

Table 2 shows the student's results.

Table 2

Number of leaves removed from the plant shoot	Mean distance moved by air bubble in 20 minutes / mm
0	8.8
1	5.4
2	3.7
3	2.2
4	0.1

0 4 . 3 Suggest how the reservoir allows the student to take repeat measurements.

[1 mark]

_____

_____

_____

0 4 . 4 The student repeats the measurements in order to calculate a mean.

Suggest **one** other reason why the student takes repeat measurements.

[1 mark]

_____

_____

_____

Question 4 continues on the next page

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0 4 . 5 The diameter of the capillary tube is 1.0 mm

Calculate the rate of water uptake when no leaves are removed from the shoot.

Give your answer in mm^3 per hour and correct to 3 significant figures.

The area of a circle is found using the formula:

$$\text{Area} = \pi r^2 \qquad \text{Use 3.14 for the value of } \pi$$

[3 marks]

Rate = _____ $mm^3\ h^{-1}$

0 4 . 6 Explain the relationship between the number of leaves removed from the plant shoot and the mean distance moved by the air bubble.

[2 marks]

_____

_____

_____

_____

_____

0 4 . 7 Suggest **two** reasons why the results from this experiment may **not** be the same as the rate of water uptake of the same plant growing in natural conditions.

[2 marks]

1 _____

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2 _____

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12

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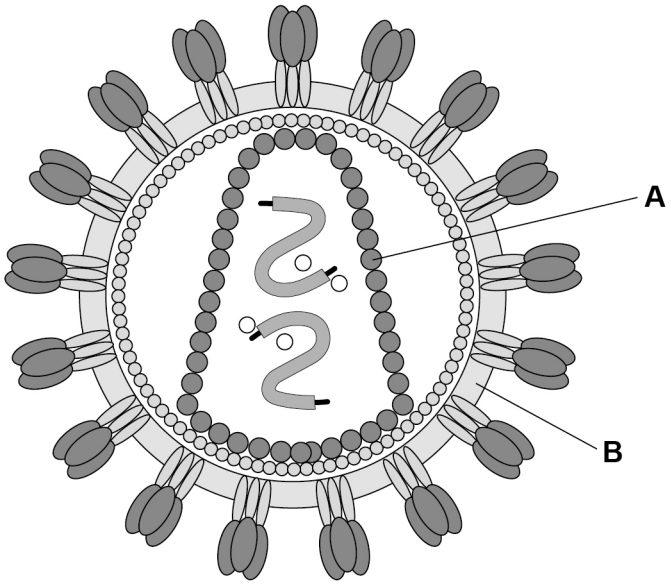
0 5 **Figure 5** below shows the structure of a human immunodeficiency virus (HIV).

Figure 5



0 5 . 1 Name parts **A** and **B**.

[2 marks]

A _____

B _____

Question 5 continues on the next page

Do not write outside the box

0 5 . 2 T-helper cells and HIV both have spherical shapes.

The volume of a sphere can be calculated using the formula:

$$\text{Volume} = \frac{4}{3}\pi r^3$$

Diameter of HIV = 120 nm
Diameter of T-helper cell = 8 μm

Calculate the ratio of the volume of the T-helper cell to the volume of the HIV.

Give your answer in standard form.

[2 marks]

Ratio = _____ :1

0 5 . 3 Give **two** reasons why diseases caused by viruses cannot be treated using antibiotics.

[2 marks]

1 _____

_____

_____

2 _____

_____

_____

Do not write outside the box

0 5 . 4 Drugs can be used for treating HIV.

Suggest how drugs such as integrase inhibitors (INIs) **and** protease inhibitors (PIs) may prevent the onset of AIDS.

[3 marks]

Integrase inhibitors _____

_____

_____

_____

Protease inhibitors _____

_____

_____

_____

9

Turn over for the next question

Do not write outside the box

0 6 Scientists know that nicotine from cigarettes and caffeine in coffee can cause an increase in heart rate.

Scientists investigate the effect of caffeine on heart rate.

This is the method the scientists use:

- select 40 healthy, non-smoking volunteers
- tell the volunteers not to drink anything containing caffeine for 5 days before the start of the investigation
- place the volunteers randomly into two equal-sized groups
- give the volunteers in the test group a capsule containing caffeine at a dose of 5 mg kg^{-1} of body mass
- give the volunteers in the control group a placebo
- measure the resting heart rate of each volunteer at the start of the investigation and after 1 hour.

Table 3 shows the scientists' results.

Table 3

	Mean heart rate / beats per minute	
	Start	**After 1 hour**
Test group given caffeine	72.9	78.8
Control group given placebo	73.5	73.8

0 6 . 1 The mean stroke volume of the volunteers' hearts in the test group was 70 cm^3 at the start of the investigation and was also 70 cm^3 1 hour after receiving caffeine.

Calculate the difference in the mean cardiac output of the test group volunteers after 1 hour.

[1 mark]

Difference = _____ cm^3 min^{-1}

Do not write outside the box

0 6 . 2 Explain why only non-smoking volunteers were chosen for this investigation.

[2 marks]

0 6 . 3 The volunteers in the test group were given 5 mg of caffeine per kilogram body mass.

Explain why the scientists gave each volunteer the same dose of caffeine per kilogram body mass.

[2 marks]

0 6 . 4 The scientists decided to use a control group for this investigation.

Give **one** reason why.

[1 mark]

Question 6 continues on the next page

Do not write outside the box

The scientists use a statistical test to determine if there is a significant difference in the mean heart rates of the volunteers in the two groups after 1 hour.

0 6 . 5 Suggest a statistical test the scientists could use.

Give the reason for your answer.

[2 marks]

Statistical test _____

Reason _____

_____

_____

_____

0 6 . 6 The scientists obtain a value, P=0.03

The scientists conclude that caffeine causes an increase in heart rate.

Evaluate the scientists' conclusion.

Use the result of the statistical test and information from **Table 3**.

[3 marks]

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11

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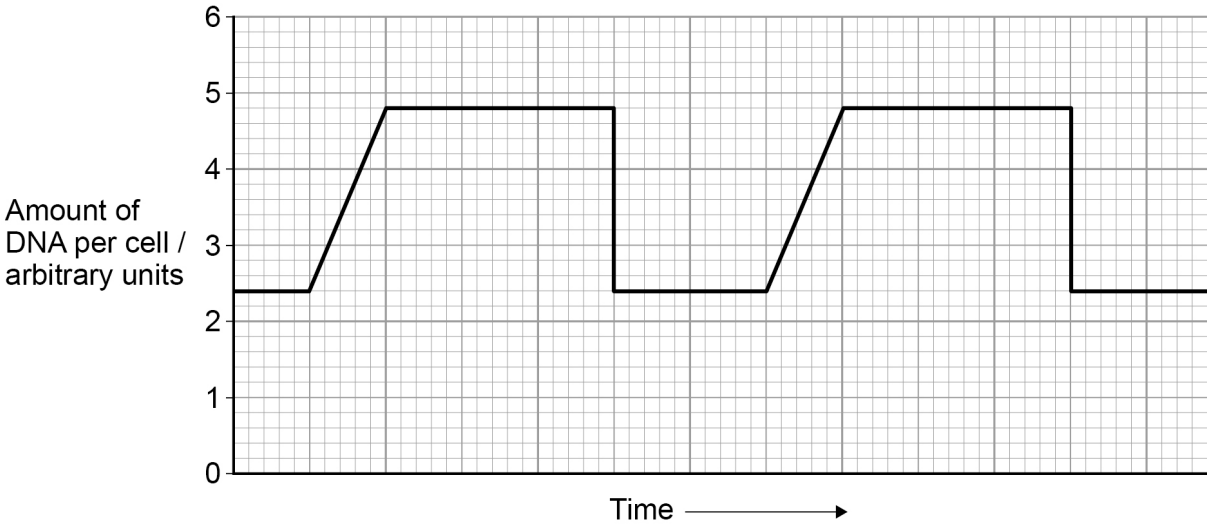
0 7 A student investigates cell division in tissue from the root tip of a plant.

0 7 . 1 Describe how the student makes a temporary mount of this root tissue to observe cells in different stages of the cell cycle using an optical (light) microscope.

[4 marks]

Figure 6 shows how the amount of DNA per cell changes during two successive cell cycles.

Figure 6



0 7 . 2 In the cell cycle, interphase is divided into three sub-phases: G1, S and G2.

On **Figure 6**, label the start and the end of **one** S-phase.

[1 mark]

Question 7 continues on the next page

Do not write outside the box

0 7 . 3 The student observes cells at different stages in the cell cycle.

Table 4 shows the student's results.

Calculate the percentage of cells with visible chromosomes.

Give your answer correct to the nearest whole number.

[2 marks]

Table 4

Stage in the cell cycle	**Number of cells**
Interphase	208
Prophase	74
Metaphase	6
Anaphase	5
Telophase	7

Answer = _____ %

7

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0 8 Cholera is a disease that causes severe diarrhoea.

Diarrhoea causes the loss of large amounts of fluid from the body.

0 8 . 1 Explain how vaccination can protect people from cholera.

[6 marks]

Question 8 continues on the next page

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0 8 . 2 Doctors treat cholera with oral rehydration solutions (ORS).

Describe:
- the contents of an oral rehydration solution
- how ORS can stop diarrhoea.

[4 marks]

10

END OF QUESTIONS

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