OCR
Oxford Cambridge and RSA

Friday 7 June 2024 – Afternoon

GCSE (9–1) Biology B (Twenty First Century Science)

J257/04 Depth in Biology (Higher Tier)

Time allowed: 1 hour 45 minutes

You must have:
- a ruler (cm/mm)

You can use:
- an HB pencil
- a scientific or graphical calculator

H

J257704

1376030313

Please write clearly in black ink. **Do not write in the barcodes.**

Centre number | | | | | | Candidate number | | | | |

First name(s) _____

Last name _____

INSTRUCTIONS
- Use black ink. You can use an HB pencil, but only for graphs and diagrams.
- Write your answer to each question in the space provided. If you need extra space use the lined pages at the end of this booklet. The question numbers must be clearly shown.
- Answer **all** the questions.
- Where appropriate, your answer should be supported with working. Marks might be given for using a correct method, even if your answer is wrong.

INFORMATION
- The total mark for this paper is **90**.
- The marks for each question are shown in brackets **[ ]**.
- Quality of extended response will be assessed in questions marked with an asterisk (*).
- This document has **20** pages.

ADVICE
- Read each question carefully before you start your answer.

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1 Aerobic and anaerobic cellular respiration take place in human body cells.

(a) Put **one** tick (✓) in each row of the table to describe aerobic and anaerobic respiration in **animal** cells such as human body cells.

	Only aerobic	**Only anaerobic**	**Both aerobic and anaerobic**	**Neither aerobic nor anaerobic**
Is exothermic				
Produces lactic acid				
Requires glucose				
Requires oxygen				

[4]

(b) Complete the sentence about ATP production in respiration.

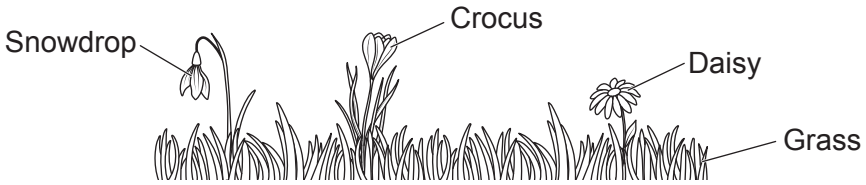
Use words from the list.

more than	**less than**	**equal to**

The amount of ATP produced per molecule of reactant in aerobic respiration is

..... the amount of ATP produced per molecule of reactant in anaerobic respiration. **[1]**

2 The diagram shows some different species of flowers that grow in a field.



A student wants to estimate the total number of snowdrops in the field.

They collect data from six small squares of the field.

Small square	1	2	3	4	5	6
Number of snowdrops	5	8	2	9	0	6

(a)* Describe a method to collect the data in the table.

Include:
- the apparatus needed
- how to use the apparatus on the field
- how to avoid bias in the data.

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..... **[6]**

(b) Use the student's data to calculate the mean number of snowdrops per small square.

Mean number of snowdrops per small square = ... **[2]**

(c) The area of the field is 600 m^2.
The area of each small square is 0.25 m^2.

Calculate the number of small squares that fit in the field.

Number of small squares that fit in the field = ... **[2]**

(d) Estimate the total number of snowdrops in the field.

Use the equation:

total number of snowdrops in the field = mean number of snowdrops per small square × number of small squares that fit in the field

Total number of snowdrops in the field = ... **[1]**

(e) Suggest **one** reason why we can only **estimate** the number of snowdrops in the field from the student's data.

.....

..... **[1]**

(f) The student thinks their estimate is **not** very close to the true number of snowdrops in the field.

Suggest **one** way to improve the data collection to get a better estimate of the number of snowdrops in the field.

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..... **[1]**

3 The heart, blood vessels and blood make up the human circulatory system.

(a) Complete the sentences to describe how substances move between the circulatory system and other organ systems.

Put a (ring) around the correct options.

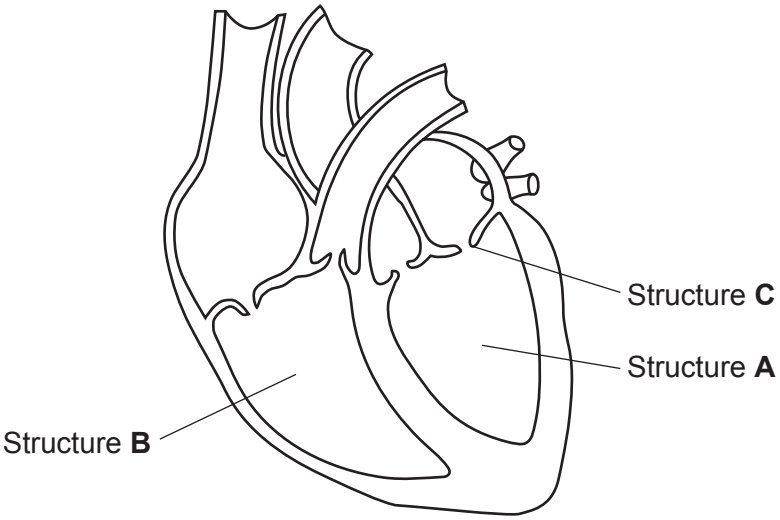
Water and **glucose / oxygen** are taken into the blood from the **digestive / excretory** system.

Carbon dioxide / Oxygen is taken into and **carbon dioxide / oxygen** is taken out of the blood by the gaseous exchange system.

Urea / Glucose is taken out of the blood by the **gaseous exchange / excretory** system.

[3]

(b) The diagram shows a human heart.



(i) Explain why structure **A** has a thicker wall of cardiac muscle than structure **B**.

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..... **[2]**

(ii) Suggest what would happen if structure **C** was faulty.

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..... **[2]**

(c) We feel a pulse in our arteries when our heart beats.

Charlie needs to measure the pulse rate of a person.

The start of his method is:
- press two fingers against an artery in the person's wrist
- keep them there for 20 seconds.

Describe the additional steps Charlie must take to measure and calculate the person's pulse rate in beats per minute.

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..... **[2]**

(d) Charlie tests the effect of exercise on the pulse rate of two people:

- Person **A** is an unfit person.
- Person **B** is a fit person.

During the test, each person pedals as hard as they can on an exercise bike for 5 minutes.

Charlie measures their pulse rate every minute.

(i) What is the factor that Charlie is varying between the two people?

..... **[1]**

(ii) Charlie makes sure that the two people are the same age, sex and ethnicity.

Explain why.

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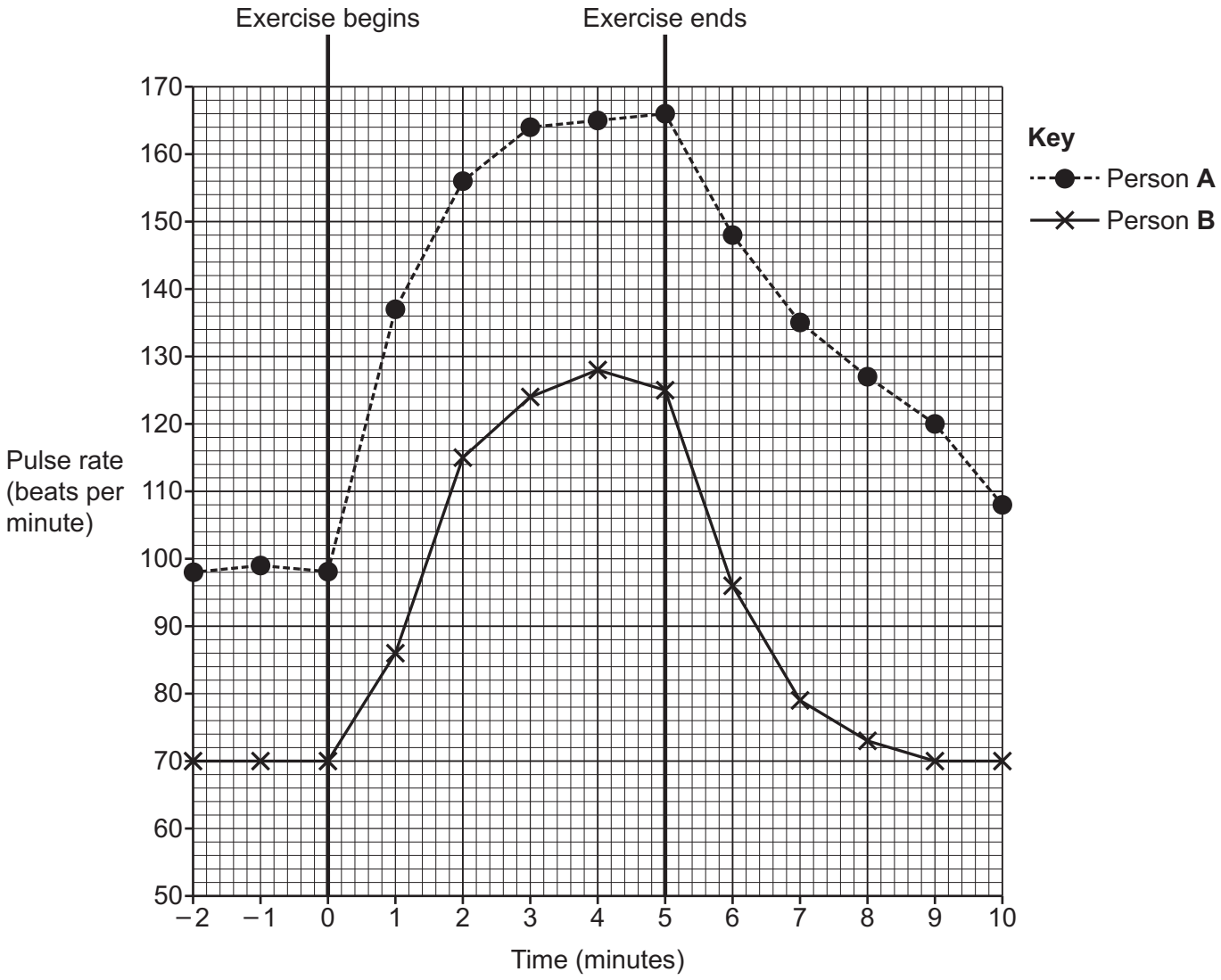
..... **[2]**

(iii) Suggest **one other** factor about the two people that should be the same.

..... **[1]**

The graph shows the pulse rate of each person before, during and after the test.



(e)

(i) Describe what happens to the pulse rate of person **A** during the 5 minutes of exercise.

Include data from the graph in your answer.

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..... **[3]**

(ii) Explain why person **A**'s pulse rate changes during the first minute of exercise.

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..... **[2]**

(iii) Describe **one** way the data in the graph shows person **B** is fitter than person **A**.

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..... **[1]**

4 **Fig. 4.1** shows a complete food chain for a small pond.

Fig. 4.1

phytoplankton → zooplankton → small fish → large fish

(a) Which organism is the source of biomass for all other organisms in the food chain?

..... **[1]**

(b) Explain why phytoplankton are producers.

Use evidence from **Fig. 4.1**.

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..... **[2]**

(c) Explain why zooplankton are **not** producers.

Use evidence from **Fig. 4.1**.

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..... **[2]**

(d) Which statements about the food chain in **Fig. 4.1** are **true** and which are **false**?

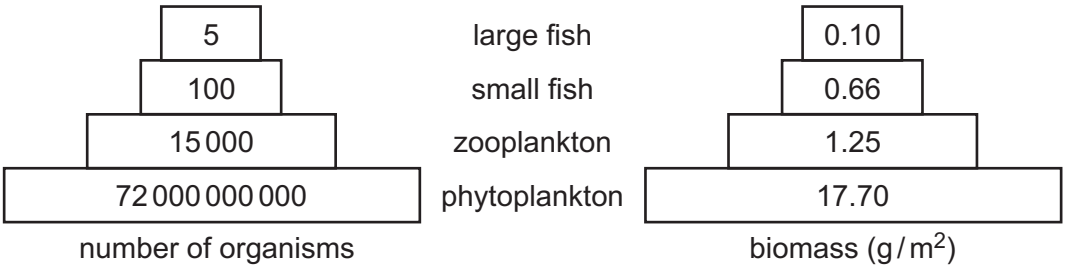
Tick (✓) **one** box in each row.

	True	**False**
Fig. 4.1 shows how many individuals are part of the food chain.		
The food chain has three trophic levels.		
There are four populations of organisms in the food chain.		

[2]

(e) **Fig. 4.2** shows the pyramid of numbers and the pyramid of biomass for the food chain.

Fig. 4.2



(i) Calculate the percentage of the phytoplankton biomass that is transferred to the large fish.

Give your answer to **1** significant figure.

Percentage = ... % **[3]**

(ii)* Explain:

- reasons for the trend in the **biomass** data in **Fig. 4.2**
- why this food chain can only support 5 large fish despite the very large number of phytoplankton.

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..... **[6]**

5 Different methods of contraception can be used to prevent pregnancy.

(a) The effectiveness of different female contraceptive methods is shown in the table.

Method of contraception	Effectiveness (% of pregnancies prevented)		How it is used
	Maximum	During normal use	
Diaphragm/cap	96	71–88	Inserted into the vagina before sex
Hormone pill	99	91	Must be taken daily
Hormone injection	99	94	One injection lasts 8–13 weeks

(i) Why are none of the methods shown guaranteed to prevent pregnancy?

Use data from the table.

.....

..... **[1]**

(ii) Layla has a very busy lifestyle.
She wants an easy to use and reliable method of contraception.

Which method from the table would you recommend for Layla?

Explain your answer.

Method: .....

Explanation: .....

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..... **[2]**

(b) Layla's partner can wear a condom on his penis during sexual intercourse to prevent pregnancy.

Describe **one other** benefit of him wearing a condom during sex.

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..... **[2]**

(c) Complete the sentences to explain how hormones control the menstrual cycle.

Use words from the list.

Adrenaline	**FSH**	**LH**
Oestrogen	**Progesterone**	**Thyroxine**

..... stimulates a follicle containing an egg to mature.

..... causes the uterus lining to thicken.

..... causes the follicle to release the egg.

..... prepares the uterus lining to receive a fertilised egg.

[4]

(d) A hormone contraceptive pill contains progesterone.

Explain why taking this pill helps to prevent pregnancy.

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..... **[3]**

6 Vegetable crops such as peas are grown to help feed the world's population.

(a) Wild pea plants produce only a small number of peas per plant.

Farmers started with wild pea plants and have changed the characteristics of the pea plants they grow. The change happened over many generations of the plants.

The domesticated pea plants that resulted from this process produce more peas per plant.

(i) What process did the farmers use?

Tick (✓) **one** box.

Evolution ☐

Mutation ☐

Natural selection ☐

Selective breeding ☐

[1]

(ii) Suggest **two** advantages of growing domesticated pea plants that produce more peas per plant.

1 .....

.....

2 .....

.....

[2]

(b) Peas can be used to make meat-free versions of foods such as burgers. However, people don't want these burgers to taste of peas.

Some wild pea plants have a gene that produces flavourless peas.

Put statements **A** to **D** in the correct order to describe how scientists used genetic engineering to add this gene to domesticated pea plants.

A Insert the gene into domesticated pea plants.

B Put the flavourless pea gene in a suitable vector.

C Select cells that are modified with the flavourless pea gene.

D Isolate the flavourless pea gene.

Write **one** letter in each box.

[3]

(c) Carbon dioxide in the atmosphere is a greenhouse gas.

Explain benefits to the **environment** of growing genetically engineered peas to make meat-free burgers, rather than farming animals and using meat.

Use ideas about carbon dioxide in your answer.

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..... **[3]**

7 Plants take in substances to help them stay alive.

(a) Complete the table to describe the substances taken into a plant and the processes they are used for.

Substance taken in	Process it is used for in a plant
Water	.....
.....	
Oxygen	.....

[3]

(b) The mass of a plant in the morning is 50 g.

By the evening, the plant has taken up 5 g of water.

(i) Calculate the percentage increase in mass of the plant.

Assume that its mass increased by 5 g.

Percentage increase in mass = ... % **[2]**

(ii) The actual mass of the plant in the evening is 51 g.

Suggest why the mass of the plant only increased by 1 g even though it took up 5 g of water.

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..... **[2]**

(c) Plants take in nitrate and phosphate.

(i) Where do plants get nitrate from?

Tick (✓) **one** box.

- Air ☐
- Carbohydrates ☐
- Mineral ions ☐
- The Sun ☐

[1]

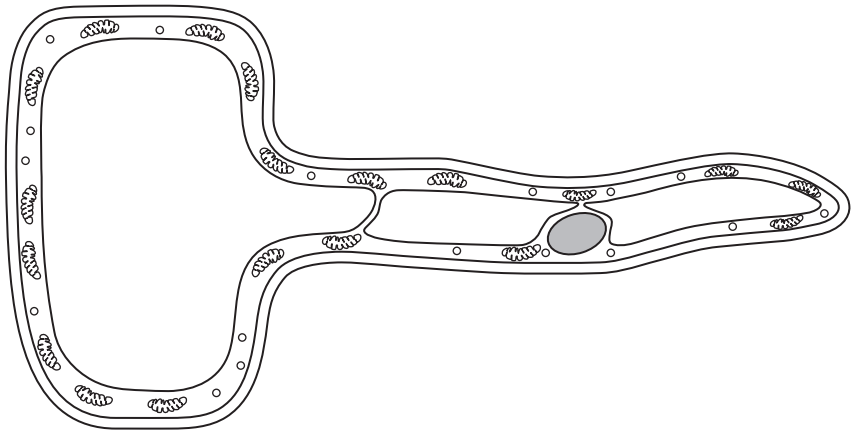
(ii) Draw lines to connect each **substance** to what the substance is **used to make** in a plant.

Substance	Used to make
	Oxygen
Nitrate	Proteins
	Nucleotides
Phosphate	Water
	Glucose

[2]

(d) Plants take in nitrate and water through the cell membrane of root hair cells.

The diagram shows one root hair cell.



Which statement about the cell membrane of a root hair cell is true?

Tick (✓) **one** box.

- It has a small surface area. ☐
- It is an exchange surface. ☐
- It is fully permeable. ☐
- It is part of the xylem. ☐
- It is where translocation takes place. ☐

[1]

(e) Some types of pollution in soil can affect plants.

Some of this pollution stops the mitochondria in the root hair cell from working.

(i) What will happen to the amount of **nitrate** taken into this root hair cell?

Explain your answer.

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..... **[3]**

(ii) What will happen to the amount of **water** taken into this root hair cell?

Explain your answer.

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..... **[2]**

END OF QUESTION PAPER

EXTRA ANSWER SPACE

If you need extra space use these lined pages. You must write the question numbers clearly in the margin.