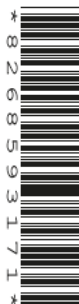


Friday 06 November 2020 – Morning

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

J257/03 Breadth 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 graph calculator



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

Centre number

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Candidate number

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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 [].
- This document has **24** pages.

ADVICE

- Read each question carefully before you start your answer.

BLANK PAGE

PLEASE DO NOT WRITE ON THIS PAGE

Answer **all** the questions.

1 Fig. 1.1 shows three different circulatory systems.

© B Furst, 'The Heart: Pressure Propulsion Pump or Organ of Impendence?', Fig. 8, Journal of Cardiothoracic and Vascular Anesthesia', Vol. 367(6), February 2015. Item removed due to third party copyright restrictions.

Fig. 1.1

(a) Which diagram best represents the **human** circulatory system?

Tick (✓) **one** box.

A ☐

B ☐

C ☐

Give a reason for your answer.

.....

.....

.....

..... [2]

- (b) The human heart has many features that means it is adapted to its function.

For each statement decide which structure's function is described.

Tick (✓) only **one** box in each row.

Function	Structure		
	Heart valve	Cardiac muscle	Heart chambers
Contracts to force blood from atria to ventricles			
Contracts to force blood out of the ventricles through vessels			
Prevents backflow of blood during contractions			
Blood temporarily stored in these small spaces to allow blood to be pumped at a high pressure			

[4]

- (c) Some babies are born with a heart defect known as a 'hole in the heart'. This is where there is a hole between two of the heart's chambers.

Fig. 1.2 shows a normal heart. **Fig. 1.3** shows a heart of a baby with a 'hole in the heart'.

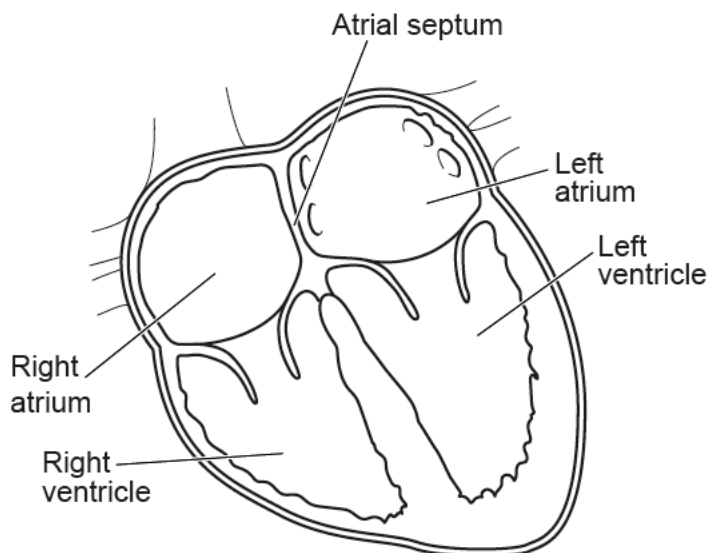


Fig. 1.2

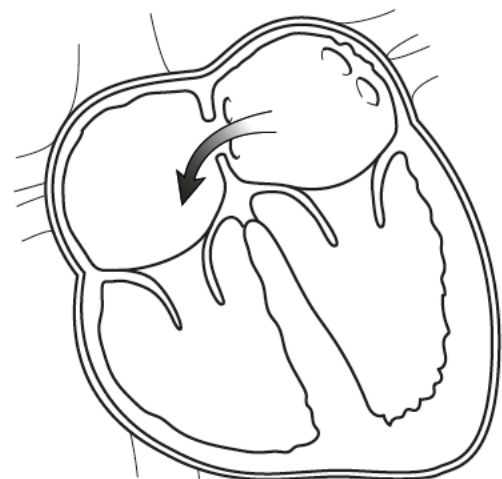


Fig. 1.3

Suggest how the defect in **Fig. 1.3** could affect the baby.

.....

.....

..... [1]

(d) The human circulatory system has three types of blood vessel.

Draw lines to connect the **blood vessel** to the correct description of its **structure** and the explanation of how its structure allows it to carry out its **function**.

Blood vessel	Structure	Function
Arteries	Very thin walls, one cell thick	To withstand the high blood pressure of blood leaving the heart
Capillaries	Very thick walls containing elastic tissue and muscle	They can be squashed to move blood along; backflow of blood is prevented
Veins	Thin walls containing elastic tissue, also contains valves	Allows diffusion of substances into and out of the vessel quickly and easily

[3]

- 2 In the past, humpback whales have been hunted for meat, oil and blubber (fat).

This hunting (known as whaling) caused their numbers to decrease and for humpback whales to be classed as an endangered species.

Whaling was banned in 1986.

The data in the table shows how the estimated number of humpback whales has changed over time.

	Estimated humpback whale population
Before whaling	125 000
Before the ban on whaling in 1986	Less than 5000
2015	24 500

- (a) Explain why scientists can only estimate how many humpback whales there are.

.....
 [1]

- (b) In 2015, humpback whales were removed from the endangered species list.

Do you agree with this decision?

Justify your answer using data from the table.

.....
 [1]

- (c) Current estimates of population size suggest that the number of humpback whales may not be increasing.

Suggest **two** possible reasons for this.

1

 2
 [2]

- (d) In 2018, Japan announced that it will start to hunt whales again.

Use the data in the table to explain why scientists are concerned.

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

- (e) Whales migrate each year to breeding grounds.

On average, the distance travelled is 5000km and they travel at an average speed of 1.6 km per hour.

Calculate how many **days** it will take the whales to reach the breeding grounds.

Use the equation: $\text{time} = \text{distance} \div \text{speed}$

Give your answer to **2** significant figures.

Time in days = ... [3]

3 (a) Pathogens can cause diseases in plants.

Which **two** statements describe **plant** defences against pathogens?

Tick (✓) **two** boxes.

They have a cell wall.

☐

They have platelets.

☐

They have white blood cells.

☐

They produce antibodies.

☐

They produce antimicrobial substances.

☐

[2]

(b) Plants produce hormones. These hormones have different roles.

Draw lines to connect the **plant hormone** to its **role**.

Plant hormone

Role

Auxin

Breaking seed dormancy

Ethene

Ripening of fruit

Gibberellin

Control and co-ordination of plant growth

[2]

(c) Humans also produce hormones.

Name the hormone that lowers the blood sugar level in **humans**.

..... [1]

- 4 Growth in multicellular organisms involves an increase in the number of body cells. New cells are made by mitosis, which is part of the cell cycle.

There are two main phases in the cell cycle.

- (a) The statements in the table describe events in the cell cycle.

For each statement tick (✓) **one** box to show which phase of the cell cycle is being described.

Event in the cell cycle	Takes place in interphase	Takes place in mitosis
Each chromosome is copied.		
The cell grows larger.		
The chromosome copies separate.		
The nucleus divides.		
The number of organelles increases.		

[2]

- (b) Amir is observing the stages of mitosis in cells found in the root tips of garlic.

To prepare his slide he follows this method.

1. Cut a thin section of the root tip.
2. Place on the microscope slide.
3. Add a coverslip.

Describe how Amir would use the light microscope to view his slide.

.....

.....

.....

.....

.....

..... [3]

- (c) When Amir looks at the slide using a light microscope, the chromosomes are still not clear.

Suggest **one** improvement he could make when preparing his slide that will make the chromosomes more visible.

..... [1]

- 5 In many developing countries people rely on rice and corn for their diet. As both these crops are low in nutrients, Vitamin A deficiency is a concern. Deficiency in Vitamin A can cause blindness.

A group of friends are discussing how Vitamin A deficiency in developing countries could be tackled.



Eve

You could give people vitamin supplements or add it to their food.

Carotenoids in plants are converted to Vitamin A in the human body. Therefore you could use selective breeding. Find the rice plants with the most carotenoids and breed them.



Sarah



Alex

The human population is increasing so a solution to the Vitamin A deficiency issue needs to consider this.

You could use genetically engineered crops. These crops can produce 23 times more beta carotene than other crops. Beta carotene is what the body uses to make Vitamin A.



Jamal

- (a) Which method of tackling Vitamin A deficiency in developing countries is the best long-term solution?

Justify your answer.

.....

.....

.....

.....

.....

.....

.....

..... [3]

- (b) What is meant by 'genetic engineering'?

.....

.....

..... [2]

(c) State **one** concern about using genetically engineered crops.

.....

..... [1]

- 6 The partially permeable membrane of the cell allows the reactants of respiration to enter the cell and the products to leave.

(a) Complete the table to explain how each of these substances is transported into or out of cells.

Tick (✓) **one** box in each row.

Substance	Diffusion	Osmosis	Active transport
Carbon dioxide out of the cell			
Oxygen into the cell			
Water out of the cell			

[3]

(b) This image is of a mitochondrion.



(i) What type of microscope would be used to take this image?

..... [1]

(ii) Explain how this type of microscope has increased our understanding of structures such as mitochondria.

.....

 [2]

(iii) Human heart muscle contracts on average 80 times per minute.

Suggest why heart muscle cells contain a large number of mitochondria.

.....
 [1]

- (c) A human liver has a mass of approximately 1.3 kg.

Hepatocytes are one type of cell found in the liver. They make up approximately 75% of the liver mass.

It is estimated that 18% of each hepatocyte is mitochondria.

Calculate the mass of the liver that is made of hepatocyte mitochondria.

Mitochondrial mass of liver = ...kg [2]

7 Onion plants are grown for food.

(a) Onion plants can reproduce sexually or asexually.

Give **one** advantage of using each type of reproduction for growing onions.

Advantage of using **sexual reproduction**

.....

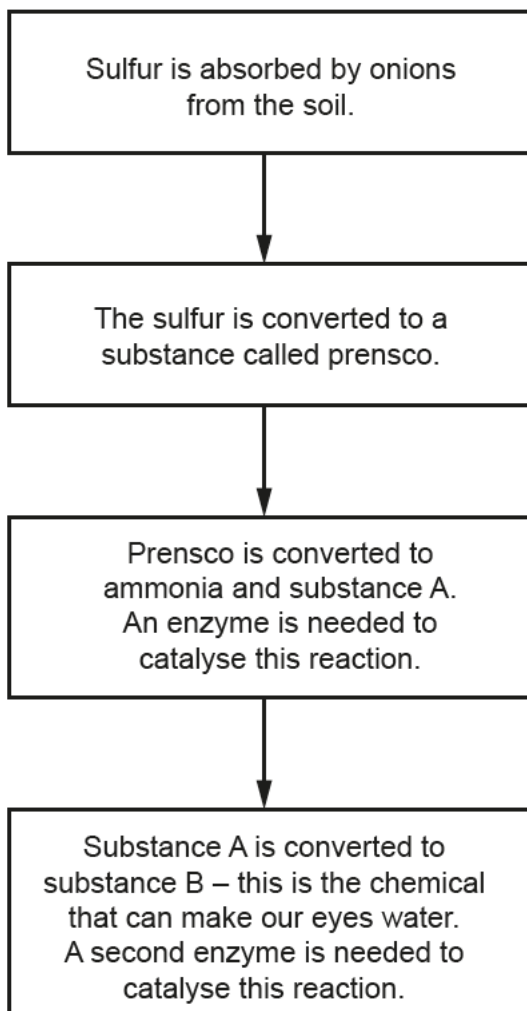
Advantage of using **asexual reproduction**

..... [2]

(b) When an onion is cut during food preparation, it can cause our eyes to water.

Research suggests that this is a result of a chemical that is made by the onion.

The diagram shows how the onion produces this chemical.



- (i) Suggest which type of cell absorbs sulfate mineral ions from the soil.

..... [1]

- (ii) It has been suggested that if you put the onions in freezing cold water or hot water before cutting the onion, it may reduce the quantity of substance B that causes our eyes to water.

Use the information in the diagram and your knowledge of enzymes to suggest why this may work.

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

- (c) Suggest how scientists could produce onions that make our eyes water less.

..... [1]

- 8 (a) The graph shows how temperature can affect the rate of photosynthesis for three different plant types, **A**, **B** and **C**.

Key

— Plant type **A**

---- Plant type **B**

-.- Plant type **C**

© W Yamori, 'Temperature response of photosynthesis in C3, C4, and CAM plants: Temperature acclimation and temperature adaption', Fig. 4, Photosynthesis Research, Vol. 119 (1-2), June 2013. Item removed due to third party copyright restrictions.

- (i) Which **three** conclusions can be drawn from the graph?

Tick (✓) **three** boxes.

All plant types can photosynthesise over the same range of temperatures.

☐

For all plant types, as temperature increases the rate of photosynthesis increases, peaks and then decreases.

☐

The highest rate of photosynthesis for plant type **B** is at 25 °C.

☐

The highest rate of photosynthesis for plant type **C** and **A** is the same.

☐

The lowest rate of photosynthesis for plant type **C** is at 25 °C.

☐

Plant type **C** is less tolerant of high temperatures.

☐

[3]

(ii) Explain why temperature affects the rate of photosynthesis.

.....

.....

..... [2]

(b) Describe the **two** main stages of photosynthesis and the role of chloroplasts in this process.

.....

.....

.....

.....

.....

.....

.....

..... [4]

- 9 Iritis is a condition where the iris of the eye inflames. It usually affects only one eye.

The iris can no longer contract to change the size of the pupil.

- (a) Describe an experiment a doctor could perform to determine if a patient has iritis.

.....

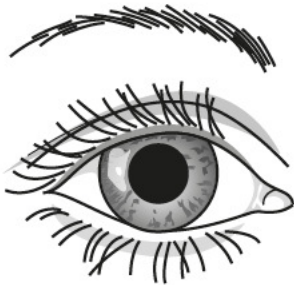
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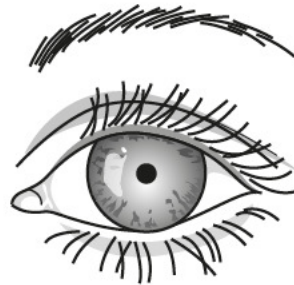
.....

..... [3]

- (b) Fig. 9.1 and Fig. 9.2 show the pupil size of an eye without iritis and an eye with iritis.



Eye **without** iritis
Fig. 9.1



Eye **with** iritis
Fig. 9.2

Calculate the percentage decrease in pupil diameter of the two pupils.

Percentage decrease = ... % [3]

- (c) The optic nerve sends electrical impulses from the retina of the eye to the neurons in the brain.

Explain how nerve cells are adapted to transmit electrical impulses.

.....

.....

.....

.....

..... [3]

..... [3]

Number of confirmed cases of whooping cough

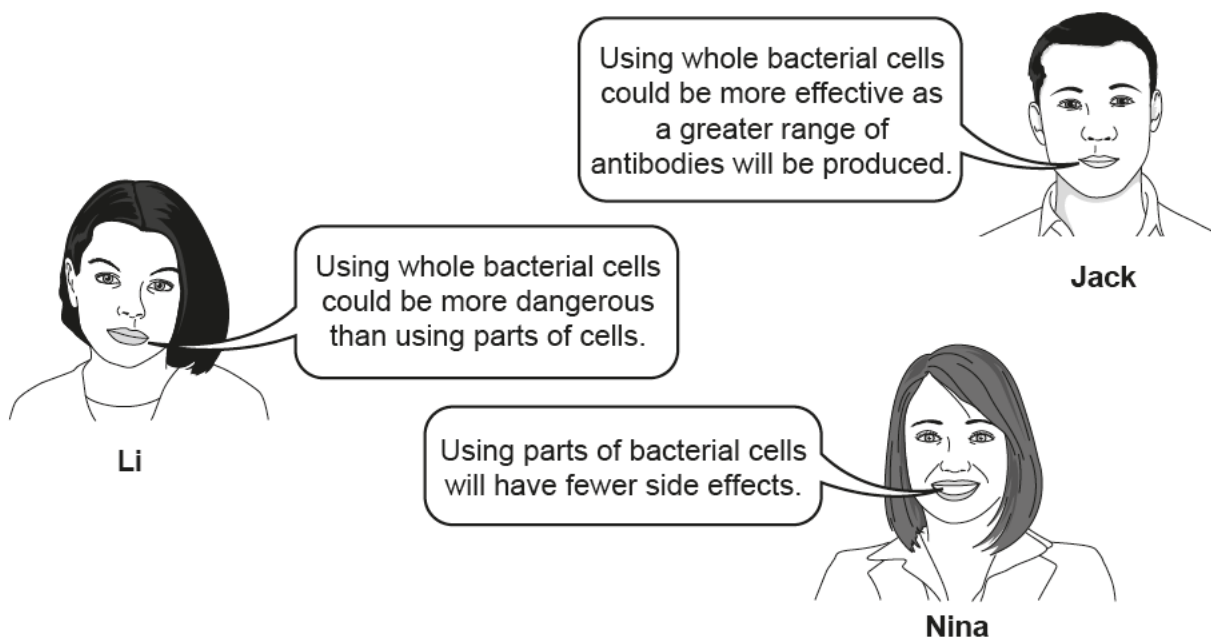
Year	Number of confirmed cases
2007	~500
2008	~800
2009	~600
2010	~300
2011	~1,000
2012	~9,300
2013	~4,500
2014	~3,300
2015	~4,200
2016	~6,000

Year

..... [3]

- (c) The first vaccine for whooping cough contained whole bacterial cells. Today vaccines contain parts of the bacterial cells.

Some friends are discussing the different vaccines for whooping cough.



- (i) Who is suggesting a benefit of using whole bacterial cells?

Tick (✓) **one** box.

Jack	☐
Li	☐
Nina	☐

[1]

- (ii) Who is suggesting a benefit of using parts of bacterial cells?

Tick (✓) **one** box.

Jack	☐
Li	☐
Nina	☐

[1]

- (iii) Why do you think using whole bacterial cells could be more dangerous?

.....

..... [1]

- (d) Scientists are continually developing new drug treatments for diseases. Many tests must be carried out before a new drug is made available for use on humans.

The statements, **A–F**, describe the testing process of a new drug but they are in the wrong order.

Put the statements in the correct order by writing a letter in each box.

One has been done for you.

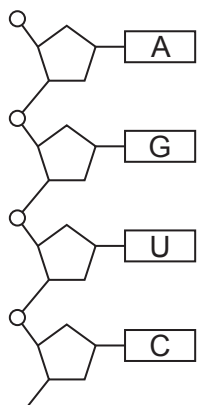
- A** Drugs are tested on animals for safety and effectiveness.
- B** Drugs are tested on a small number of healthy humans to check the drugs are safe to use.
- C** Drugs are tested on a small number of humans with the disease to check for safety and effectiveness.
- D** Drugs are modelled in the lab using computer software.
- E** Drugs are tested on cells and tissues in the lab.
- F** Larger clinical trials are conducted.

		A			
--	--	----------	--	--	--

[3]

- 11 In protein synthesis a section of one strand of DNA is copied and a molecule of mRNA is formed.

The diagram shows a molecule of mRNA.



- (a) Compare the structure of mRNA to the structure of DNA.

.....

.....

.....

..... [2]

- (b) Genetic variants can be found in both coding and non-coding DNA.

Complete the sentences to describe the effect of genetic variants in non-coding DNA.

Use words from the list.

You can use each word once, more than once, or not at all.

base DNA gene genotype

mutation phenotype sugar protein

Some sections of DNA do not code for a

Non-coding DNA controls whether a particular gene is expressed.

If there is a in the non-coding DNA, particular proteins will not be made.

The absence of particular proteins could alter the of the individual. [3]

- 12 (a) Describe how two parents who are at risk of passing on a genetic disease could use modern technology to have a child that is disease-free.

.....

.....

.....

..... [2]

- (b) Some diseases are referred to as sex-linked. XMEN syndrome is a very rare genetic disease which is carried on the X chromosome. It is a recessive disorder.

- (i) XMEN syndrome is caused by a gene mutation.

What is a gene mutation?

.....

..... [1]

- (ii) Is this disease likely to be seen more often in males or females?

Explain your answer.

Use your knowledge of sex determination in your answer.

.....

..... [1]

END OF QUESTION PAPER

[illegible]

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