The Challenges of Size (H)

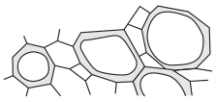
1. Which diagram shows cells that swell, creating an opening during daylight conditions?

A

B

C

D



Your answer ☐ **[1]**

2. Which row shows the correct direction of blood flow through a double circulatory system?

A	left side of heart	→	body organs	→	right side of heart	→	lungs
B	left side of heart	→	lungs	→	right side of heart	→	body organs
C	right side of heart	→	body organs	→	lungs	→	left side of heart
D	right side of heart	→	lungs	→	body	→	left side of heart

Your answer ☐ **[1]**

3. How is sugar transported around a plant?

A Upwards in phloem
B Upwards in xylem
C Upwards and downwards in phloem
D Upwards and downwards in xylem

Your answer ☐ **[1]**

4. The surface area of a single red blood cell is 1.5×10^{-4} mm^2.

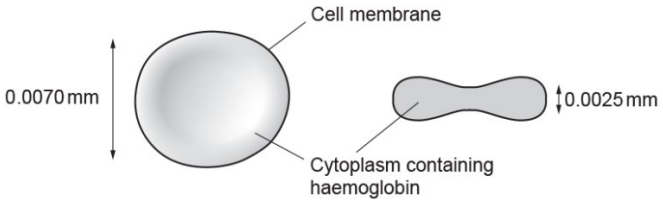
The volume is 1×10^{-7} mm^3.

What is the surface area to volume ratio of a red blood cell?

A 0.0015 : 1
B 0.7 : 1
C 1.5 : 1
D 1500 : 1

Your answer ☐ **[1]**

5. The diagram shows a red blood cell.



	Distance oxygen travels to get to haemoglobin from blood plasma	Surface area to volume ratio	Nucleus present
A	Large	Small	Yes
B	Short	Large	Yes
C	Short	Large	No
D	Large	Large	No

Which row in the table shows how red blood cells are adapted for transport of oxygen?

Your answer ☐ **[1]**

6. Sieve plates are structures found in plants.

What is their location and function?

A Found in phloem and allow movement of sucrose
B Found in phloem and allow movement of water
C Found in xylem and allow movement of sucrose
D Found in xylem and allow movement of water

Your answer ☐ **[1]**

7. A student uses a simple potometer to study the effect of different temperatures on the cut shoot of a plant.

What does the potometer actually measure?

A Volume of water evaporating from the leaves of the shoot
B Volume of water produced by respiration in the shoot
C Volume of water taken up by the shoot
D Volume of water used in photosynthesis in the shoot

Your answer ☐ **[1]**

8. Hypercholesterolemia (HC) is the result of a mutation in the genome. It is caused by a dominant allele on chromosome 19. The mutation involved causes a change in the DNA nucleotides.

People with HC are more likely to develop heart disease. **Fig. 21.1** shows the heart of a person who has heart disease.

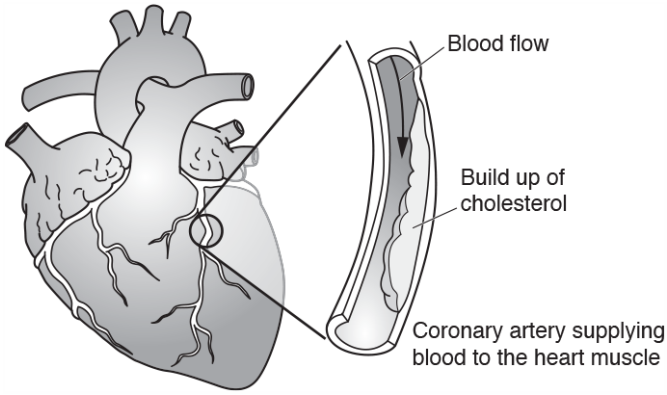


Fig. 21.1

The LDL receptor protein is found on the cell membrane of liver cells. The receptor picks up cholesterol from the blood and transports it into the liver cell. Inside the liver cell the cholesterol is broken down or used.

Explain why people who have the mutation in the allele for the LDL receptor are much more likely to develop heart disease.

[6]

9 (a). Fanconi anaemia is a genetic disorder. It results in the bone marrow being destroyed. This causes a decrease in the numbers of red blood cells, white blood cells and platelets.

Explain **two** possible symptoms of Fanconi anaemia.

1 ---

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2 ---

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[2]

(b). Table 19.1 shows normal ranges for blood components in people **without** Fanconi anaemia.

Blood component	Number per mm^3
red blood cell	$4.5 – 6.5 \times 10^6$
white blood cell	$6.0 – 16.0 \times 10^3$
platelet	$1.5 – 4.0 \times 10^5$

Table 19.1

i. Suggest why there is such a wide range of white blood cell numbers.

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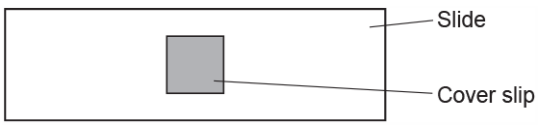
[2]

ii. The diagram shows a microscope slide containing blood from a patient.



The square cover slip is 10 mm wide and the thickness of the blood underneath is 0.001 mm.

Calculate the volume of blood under the cover slip.

Volume of blood = ... mm^3 **[1]**

iii. Under the cover slip are 1000 white blood cells.

Does the blood sample provide evidence that the patient has Fanconi anaemia?

Use **Table 19.1** and your answer to part **(ii)** to justify your answer.

---**[3]**

(c). There are many different genetic disorders that can affect blood cells. Details of three of these are found in **Table 19.2**.

Name of disorder	Cause of disorder	Symptom
D-B anaemia	dominant allele	low red blood cell numbers
S-D syndrome	recessive allele	low white blood cell numbers
Fanconi anaemia	recessive allele	small numbers of all blood cells

Table 19.2

A blood smear from another patient shows that he has 3×10^6 red blood cells per mm^3 of blood. Neither of his parents have a blood disorder.

Use **Table 19.1** and **Table 19.2** to explain which blood disorder the patient could have.

Name of disorder

Explanation

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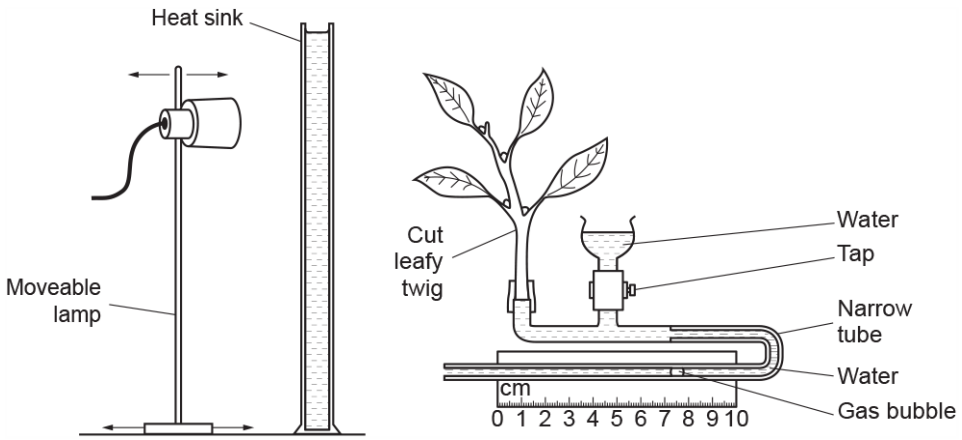
[3]

10 (a). The diagram shows a simple potometer.

The apparatus can be used to investigate the effect of light intensity on transpiration rates.



i. Describe what happens during transpiration.

---**[2]**

ii. Describe how the apparatus can be used to investigate the effect of light on transpiration rates.

---**[3]**

iii. The heat sink is a transparent tube of cold water.

Explain why a heat sink is used in this experiment.

---**[2]**

(b). The table shows the results from using the potometer.

Distance of potometer from the light (cm)	Distance gas bubble moved in one minute (mm)		
	Trial 1	Trial 2	Trial 3
10	70	74	72
20	73	75	71
30	52	49	51
40	42	30	31
50	12	14	13

i. The mean distance the gas bubble moved along the tube at 10 cm from the light was 72 mm.

The diameter of the narrow tube was 1 mm.

Calculate the volume of water taken up by the plant.

Use the equation: volume = $\pi r^2 l$
where r is the radius of the tube and *l* is the distance the bubble moves
$\pi = 3.14$

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

Volume of water = ... mm^3 / minute **[3]**

ii. Identify the anomalous reading in their recorded results and suggest a possible reason for this.

_____

_____ **[2]**

iii. How should the scientists deal with this anomalous reading when they process the data?

_____

_____ **[1]**

iv. The scientists described their results for **20 cm** as 73 ± 2.
Explain why they did this.

_____

_____ **[2]**

11 (a). In a condition called sickle cell anaemia, the red blood cells can change shape. This reduces the amount of oxygen getting to cells in the body.

Fig. 16.2 shows a red blood cell and a sickled red blood cell.

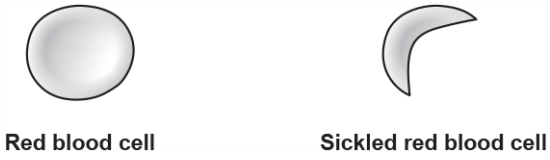


Fig. 16.2

Explain why sickle cell anaemia reduces the amount of oxygen getting to cells in the body.

---**[2]**

(b). Some students investigate the effect of the surface area : volume ratio on the rate of diffusion in animal cells.

They use hydrochloric acid and gelatine cubes that have been stained blue using a pH indicator solution. The indicator will turn red in acidic conditions.

They put different sized cubes into 3 different test tubes of hydrochloric acid and time how long it takes for the cubes to completely change to red.

Fig. 16.1 shows the apparatus they use.

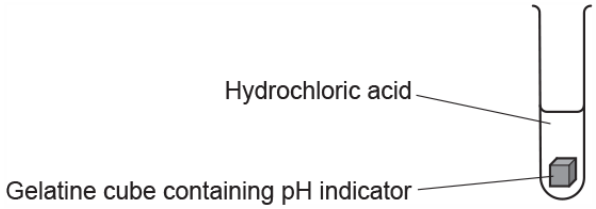


Fig. 16.1

The table shows the students' results.

Length of each side of the cube (mm)	surface area : volume ratio	Time to completely change colour (seconds)
2	.....	32
4	3 : 2	61
6	1 : 1	170

i. Calculate the surface area : volume ratio for the cube with sides of 2 mm.

surface area : volume ratio = ... **[2]**

ii. What conclusion can be made about the effect of surface area : volume ratio on the rate of diffusion?

---**[1]**

iii. Emphysema causes some of the walls of alveoli in the lungs to break down. This produces a smaller number of larger air sacs.

Use the results to explain the effect of emphysema on oxygen diffusing into the blood.

---**[2]**

12 (a). Rats are a major pest in many areas of the world. They can reduce food security and spread diseases.

Warfarin is a chemical that is used as a rat poison. It stops the correct functioning of platelets in the blood.

Explain why warfarin can be used as a rat poison.

---**[2]**

(b). In 1958, some rats were found that were resistant to warfarin. They did not die, even when fed with large amounts of the poison. Scientists found that the resistance was due to dominant allele **R**.

Two resistant rats can mate and produce non-resistant rats.

Draw a genetic diagram below to show how these non-resistant rats can be produced.

[3]

(c). When scientists studied the resistant rats they found that there were two different types.

Homozygous rats are resistant to warfarin but need to eat 20 times more vitamin K.

Heterozygous rats are resistant to warfarin but only need slightly increased amounts of vitamin K.

The scientists found that the non-resistant rats never died out completely.

Explain why.

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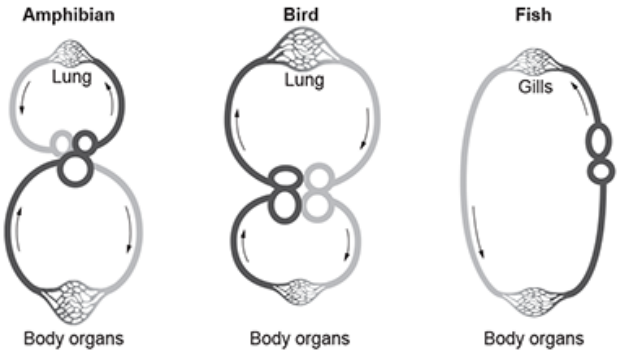
_____ **[2]**

13 (a). Look at the diagrams of the circulation systems in an amphibian, bird and fish.



Which of these has a circulatory system most similar to humans?

Tick (✓) **one** box.

Amphibian ☐

Bird ☐

Fish ☐

Explain your choice.

_____

_____

_____

_____

_____

_____ **[3]**

(b). Scientists investigate how exercise affects blood flow to different organs in the body.

This is their method.

- Ask a healthy person to sit in a room at 20 °C
- Measure the blood flow to different organs in the person's body
- Repeat this with the person exercising at a constant speed on a treadmill in the same room.

The table shows the scientists' results.

Organ	Rate of blood flow (ml per minute)	
	Sitting	**Doing exercise**
Brain	750	750
Heart muscle	250	1000
Muscles	1200	22 000
Skin	500	600
Other organs	3100	650
Total	**5800**	**25 000**

i. By how many times has the **total** blood flow increased by doing exercise?

Give your answer to the **nearest whole number.**

Number of times the total blood flow has increased =

_____ **[2]**

ii. The table shows that blood flow to other organs has decreased by nearly 5 times when a person is **doing exercise**.

The blood flow to the muscles has increased by more than eighteen times.

Explain these changes to blood flow rate.

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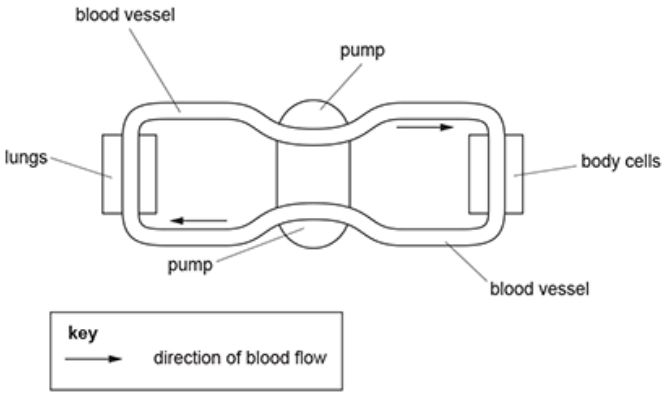
_____ **[2]**

(c). Look at the diagram. It represents the human circulatory system.



Describe how the diagram shows that humans have a double circulatory system.

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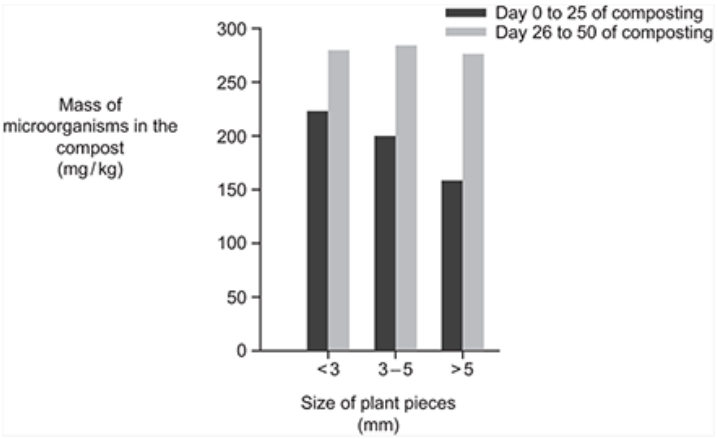
[2]

14. This machine helps shred plants for a compost heap.

The machine can shred plants into three different sizes.

This graph is in the instruction booklet for the machine.



The size of the plant pieces has an effect on the number of microorganisms in the

compost.

Suggest why.

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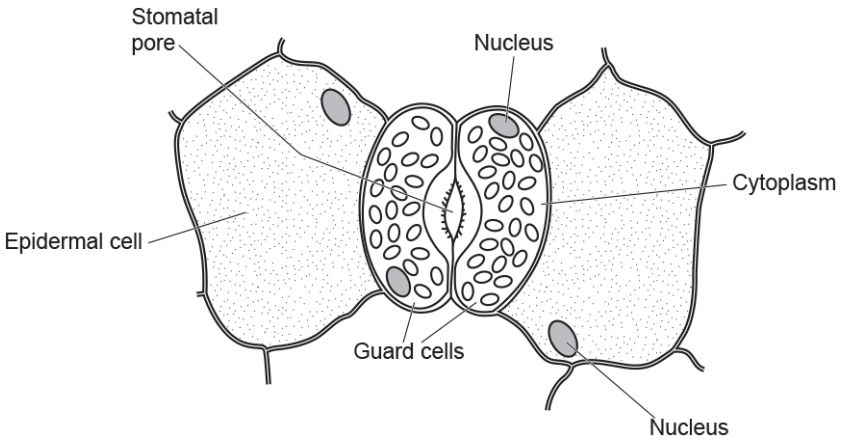
_____

_____

_____ **[2]**

15 (a).

The diagram shows structures on the surface of a leaf.



i. Photosynthesis occurs in the guard cells but not the epidermal cells.

Explain why this is important in the control of the rate of transpiration in the plant.

_____

_____

_____

_____

_____

_____ **[4]**

ii. Explain why guard cells are an example of specialised cells.

_____

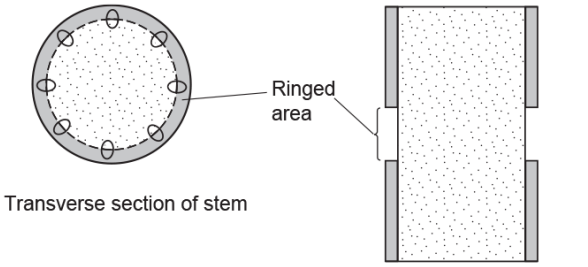
_____

_____

_____ **[2]**

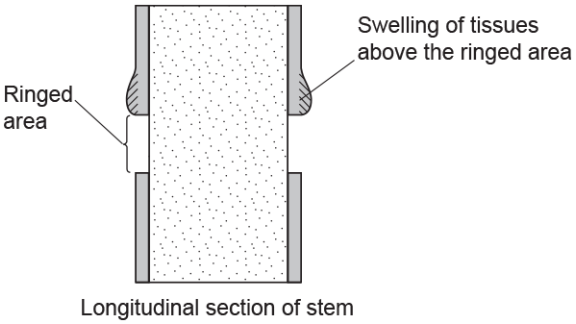
(b). An experiment was done to look at the effect of ringing on a tree trunk. Ringing removes a strip of plant tissue from around the stem of the tree.

The diagram shows where the stem is ringed.



The results were recorded after one week.

The diagram shows the results.



What conclusions can be made about the results?

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_____ **[3]**

END OF QUESTION PAPER