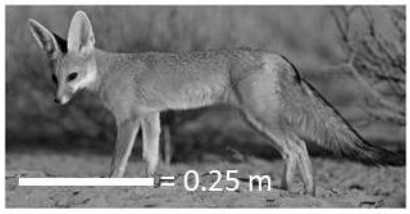
1. Review the structure of eukaryotic and prokaryotic cells and the design and function of the light and electron microscopes over the summer break.

2. Complete the exam questions below in preparation for September.

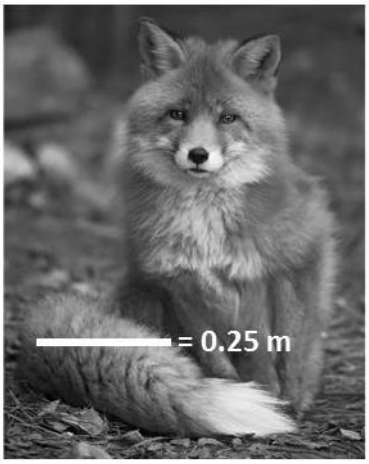
1. The pictures show four foxes from different parts of the world.

Which fox has the largest surface area:volume ratio?

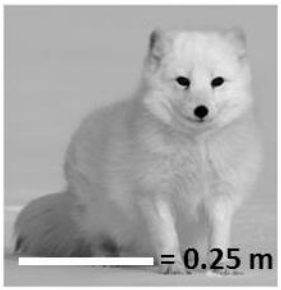


A

B



C

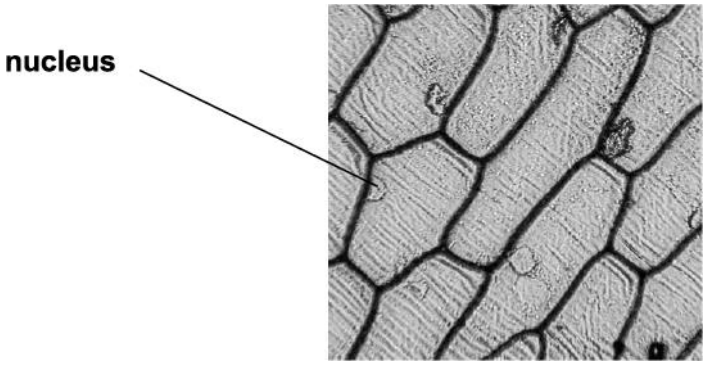


D

Your answer ☐

[1]

2(a). Look at the image below of some onion cells.



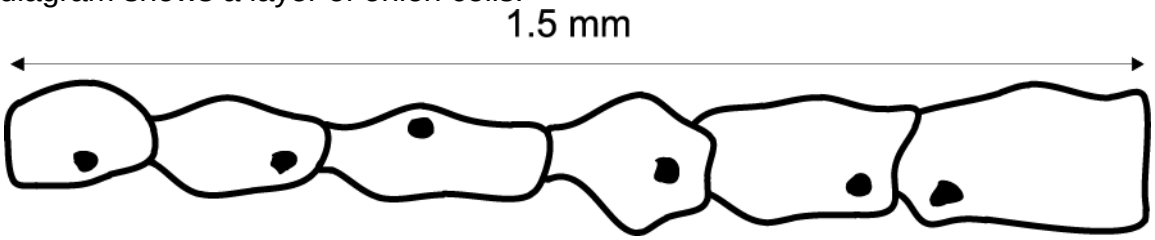
i. Explain how the contents of the nucleus allow it to carry out its function.

[2]

ii. Explain why there are **no** chloroplasts in these onion cells.

[2]

(b). The diagram shows a layer of onion cells.



The actual length of the layer is 1.5 mm.

Calculate the average length of one onion cell.

answer = ... mm **[2]**

(c). A student thinks that using the highest magnification of a microscope is always best.

Explain why this may **not** be true.

[2]

(d). A student prepares onion cell slides to view under a microscope.

Put the stages in the correct order by writing the numbers **1** to **5** in the boxes.

	add a drop of iodine solution
	cut the onion in to pieces
	peel off a thin layer of onion tissue
	put on a cover slip
	put the onion tissue on a slide

[2]

(e). Explain why the iodine solution is used.

.....

.....

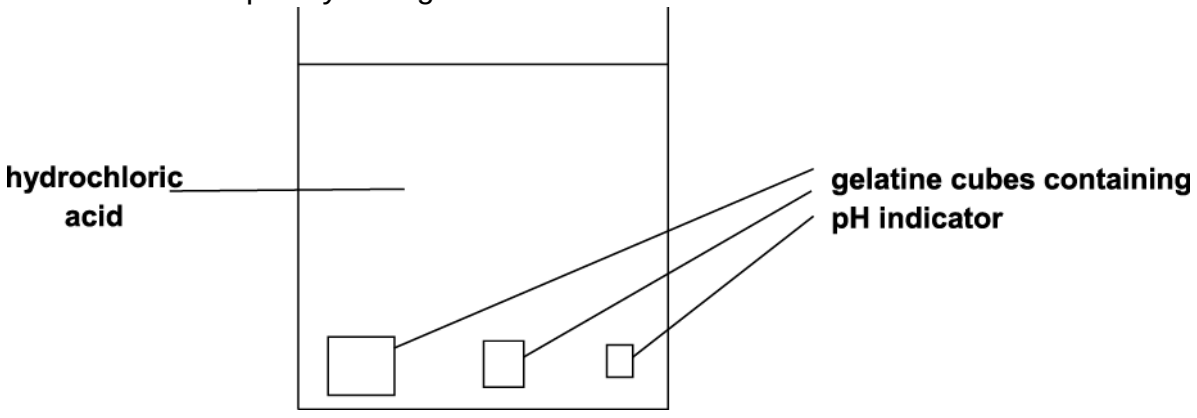
.....

[2]

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

They use hydrochloric acid and gelatine cubes stained blue with pH indicator.

They put different sized cubes into a beaker of hydrochloric acid and time how long it takes for the cubes to completely change colour.



The table shows their results.

length of 1 side of cube (cm)	surface area:volume ratio (cm^{-1})	time to completely change colour in seconds
1	.....	132

2	3	328
3	2	673

i. Calculate the surface area:volume ratio for the cube with sides of 1 cm.

answer = ... **cm^{-1}** **[1**

ii. Calculate the rate of colour change for each of the three cubes.

Write your answers in the table below.

Show your answers in standard form.

length of 1 side of cube (cm)	**rate of colour change (s^{-1})**
1	.....
2	.....
3	.....

iii.

iv. **[2]**

v. Use the results and your calculations in parts **(i)** and **(ii)**

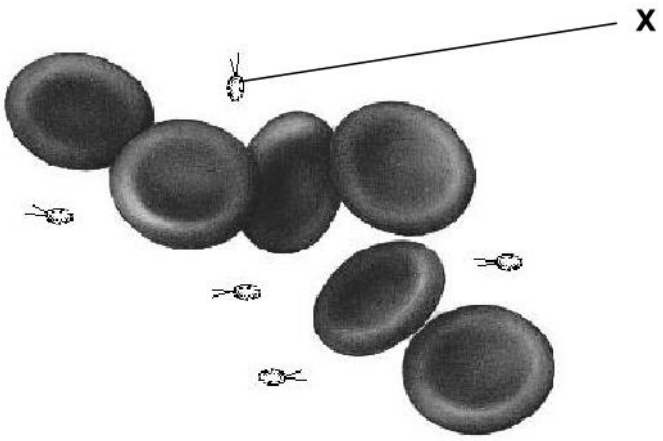
Explain why most single celled organisms do **not** need a transport system (e.g. the circulatory system of multi cellular organisms).

[2]

4. Probash is ill and is having tests in hospital. The doctors took a sample of blood from Probash.

They looked at the specimen under a light microscope.

This is a picture of what they saw.



From this picture, the doctors decide that Probash's illness is caused by bacteria (labelled X).

i. Why do the doctors not think that the structures labelled **X** are viruses?

[1]

ii. What equipment could the doctors use to get a clearer image to confirm their ideas?

[1]

5. Which does **not** contain DNA?

A. cell membrane
B. chromosome
C. nucleus
D. plasmid

Your answer ☐

[1]

6. The diameter of a human egg cell is 120µm.
What is the diameter in mm?
1µm = 1×10^{-3}mm.

A. 1.2×10^{-1}
B. 1.2×10^{-2}
C. 1.2×10^{-3}
D. 1.2×10^{-4}

Your answer

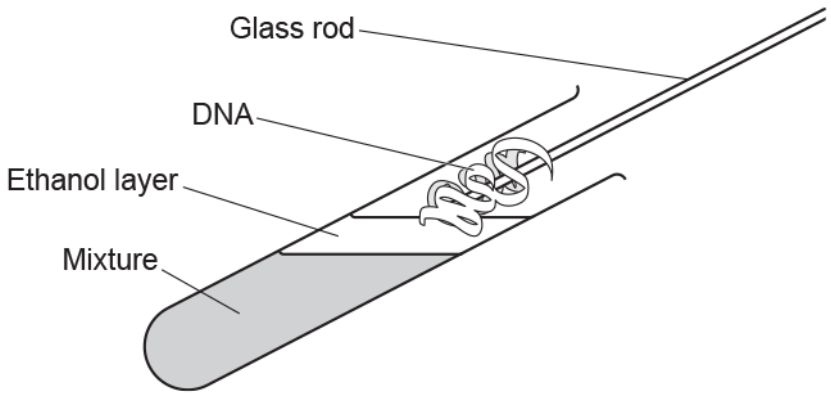
[1]

7. Students investigate how to extract DNA from peas.

Stage 1:

- Chill 10 cm^3 of ethanol. Keep it on ice throughout the method for use in stage 2.
- Make a thick 'soup' by blending 100 cm3 of peas with salt and cold water. Blend for 15 seconds in an electric blender.
- Strain the 'soup' through a mesh strainer and collect the liquid part in a beaker.
- Add 30 cm^3 of washing-up liquid and swirl to mix.
- Let the mixture settle for 510 minutes in a water bath at 60°C.

Stage 2 isolates the DNA.



- Pour the mixture collected from stage **1** into a test tube until a third full. Add protease enzymes to the test tube.
- Slowly pour cold ethanol at an angle of 45° into the tube. Ethanol will float on top.
- DNA is soluble in water, but salted DNA does not dissolve in ethanol and will form white clumps where the water and ethanol layers meet.
- Twirl a glass rod and the DNA will collect on the rod.
- Dry the sample on a pre-weighed filter paper and measure the mass of product.

Look at the table. It shows the results from the two groups of students in the investigation.

Type of water bath used	**Mass of DNA collected (mg)**			
	Test 1	**Test 2**	**Test 3**	**Mean**
Beaker of water and Bunsen burner				22.9
Electric	33.6	32.3	32.3	.....

i. Calculate the mean mass collected in the investigation using the electric water bath.

Give your answer to **1** decimal place.

Answer = ... mg **[2]**

ii. The range of the three test readings for the beaker of water and Bunsen burner was 3.4.

Does the evidence support using an electric water bath instead of a beaker of water and Bunsen burner?

Explain your answer.

.....

.....

.....

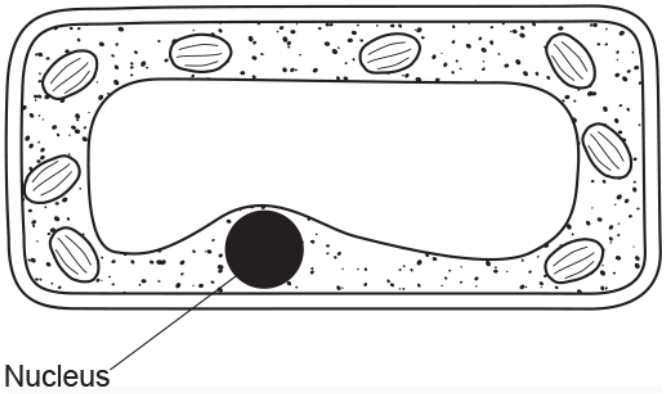
[2]

Which of these structures is found in eukaryotic but **not** prokaryotic cells?

A Cell wall
B Cytoplasm
C Nucleus
D Plasmid

Your answer ☐ **[1]**

9. Look at the diagram showing a plant cell.

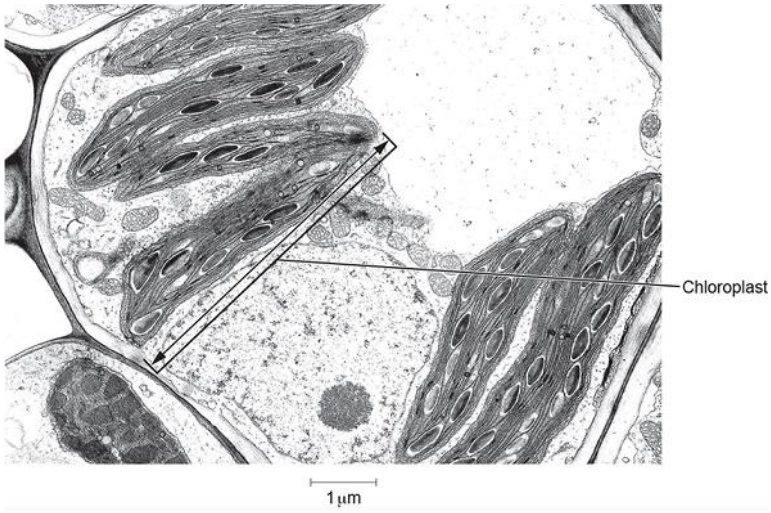


i. The diameter of the nucleus in the diagram is 10 millimetres. The actual size of the nucleus is 10 **micrometres.**

Calculate the magnification of the diagram.

Answer = ... × **[2]**

ii. Look at the picture of part of a plant cell.



Use the arrow on the picture and the scale to estimate the length of the chloroplast.

Answer = ... µm **[1]**

10. The microscope used by the student has an eyepiece lens with a magnification of 10×.

Which objective lens would give an image magnification of 200×?

A 10×
B 20×
C 30×
D 200×

Your answer ☐ **[1]**

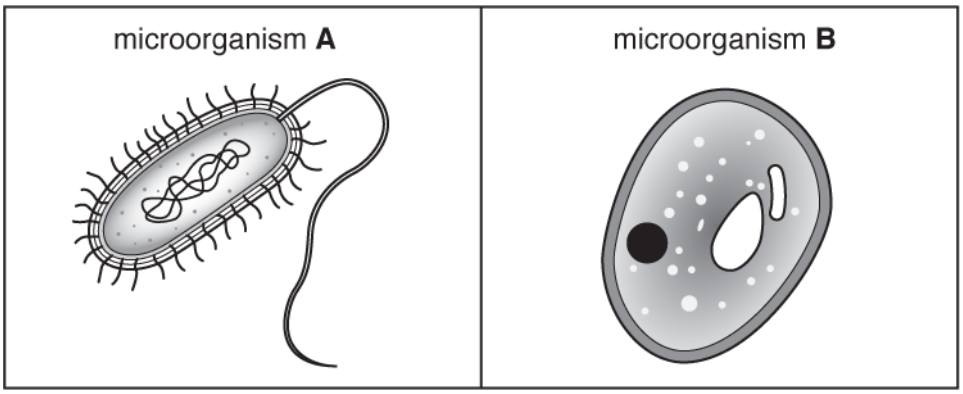
11. A student uses a microscope to look at plant cells on a slide.

Which of these methods should they use first?

A Highest power objective lens and focus moving the lens away from the slide
B Highest power objective lens and focus moving the lens towards the slide
C Lowest power objective lens and focus moving the lens away from the slide
D Lowest power objective lens and focus moving the lens towards the slide

Your answer ☐ **[1]**

12. Look at the diagrams of two different microorganisms.



One of the microorganisms is yeast and one is a bacterium.

Which is a bacterium? Choose from **A** or **B**

Write down **two** reasons for your answer.

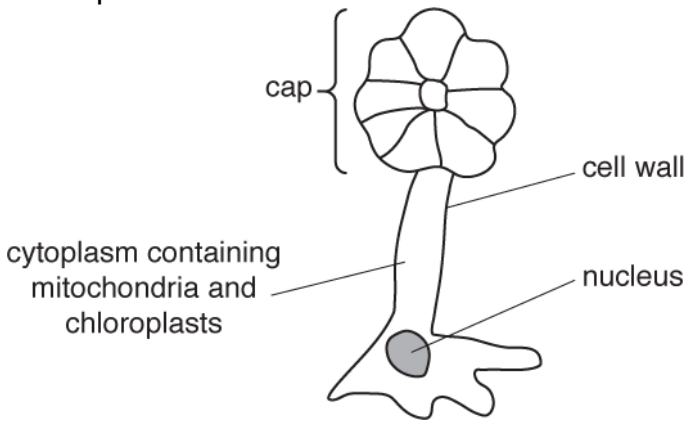
1 ---

2 ---

[2]

13. *Acetabularia* is a unicellular organism that lives in the sea.

It has rather an unusual shape.



i. Write down **two** features shown in the diagram of *Acetabularia* that tell you that it is **not** a bacterium.

1 ---

2 --- [2

ii.

iii. *Acetabularia* is one of the largest unicellular organisms.

To be larger, organisms need to be multicellular.

What is an advantage of being larger and multicellular?

Put a tick (✓) next to the **correct** answer.

Some genes can be lost from some cells. ☐

Both aerobic and anaerobic respiration can occur. ☐

Cells are able to differentiate and specialise. ☐

Organisms are able to clone themselves. ☐

[1

v. To become multicellular, specialised organ systems may be needed.

Write down **one** of these systems and explain why it is needed.

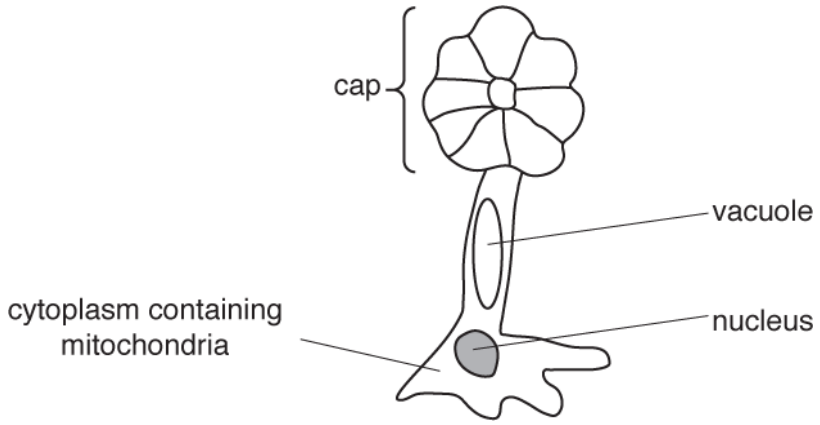
---

[1]

---

14. *Acetabularia* is a single-celled organism that lives in the sea.

It has rather an unusual shape.



Draw lines to join each **structure** in *Acetabularia* to its **job**.

structure	job
vacuole	contain chromosomes
mitochondria	support
nucleus	respiration

[2]

15. A student uses a microscope.

The magnification on the eyepiece lens is ×10.

The magnification on the objective lens is ×4.

What is the total magnification?

A. 2.5
B. 6
C. 14
D. 40

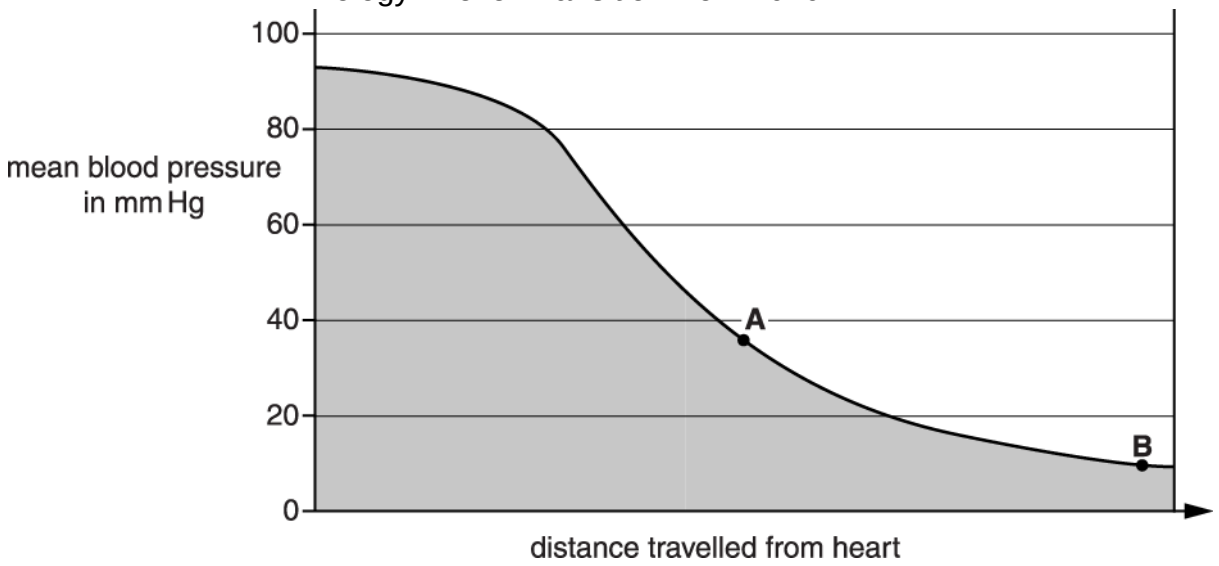
Your answer ☐

[1]

16. This question is about circulation.

Look at the graph.

It shows the changes in pressure as blood leaves the heart and passes through blood vessels.



i. Blood leaving the heart has a pressure of 93 mm Hg.

The blood pressure drops by 84 mm Hg.

Calculate the percentage drop in blood pressure.

percentage drop in blood pressure .....%

[1]

ii. Use the graph to name the type of blood vessels at point **A** and point **B**.

blood vessel at point **A** .....

blood vessel at point **B** .....

[2]

17. Blood contains cells.

One type of cell is a red blood cell.

i. Red blood cells are adapted for their job by being very small.

Explain why this helps them do their job.

[1]

ii. Haemoglobin is found in red blood cells.

Haemoglobin is a protein made in the cytoplasm.

Red blood cells start off life with a nucleus.

The gene for haemoglobin is **only** found in the nucleus.

Explain how it is possible that haemoglobin can be made in the cytoplasm.

[2]

iii. Haemoglobin is important in transporting oxygen.

Describe how haemoglobin transports oxygen from the lungs to the body cells.

[2]

18. During exercise, the rate of blood flow to different parts of the body changes.

Look at the table.

	Rate of blood flow in ml per minute	
Part of body	**At rest**	**During exercise**
digestive system	1350	600
kidneys	1100	600
muscles	1000	12500
brain	700	750
skin	300	1900
heart muscle	200	750
other	350	400
Total blood flow to the body	5000	17500

The rate of blood flow to the lungs is always the same as the total rate of blood flow shown in the table. Suggest why.

[1]

19. The table shows some information about three types of mammal.

Mammal	Metabolic rate	Surface area of one red blood cell in arbitrary units	Volume of one red blood cell in arbitrary units	Surface area to volume ratio of red blood cells
Mouse	1.0	91	52	1.75
Rabbit	1.5	114	70	1.63
Shrew	7.5	60	24	

i. Calculate the surface area to volume ratio of red blood cells for the shrew.

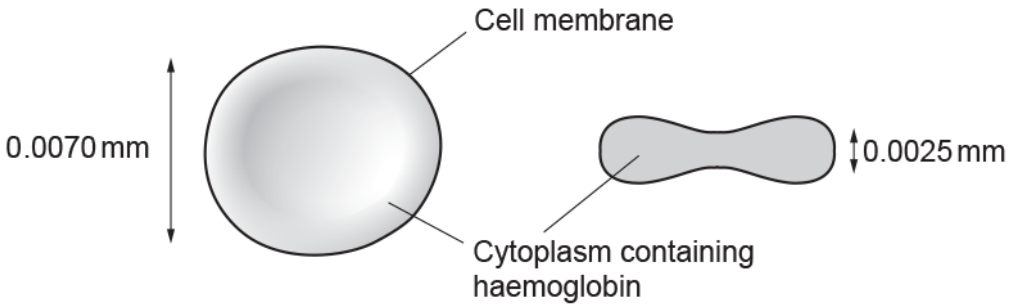
answer = ... **[1**

ii. Explain how the shrew manages to maintain its metabolic rate.

Use your calculation in part **(b)(i)** and information from the table in your answer.

[3]

20. 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]**

21. 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]**

22. About 1 in 10 000 people has a condition called situs inversus.

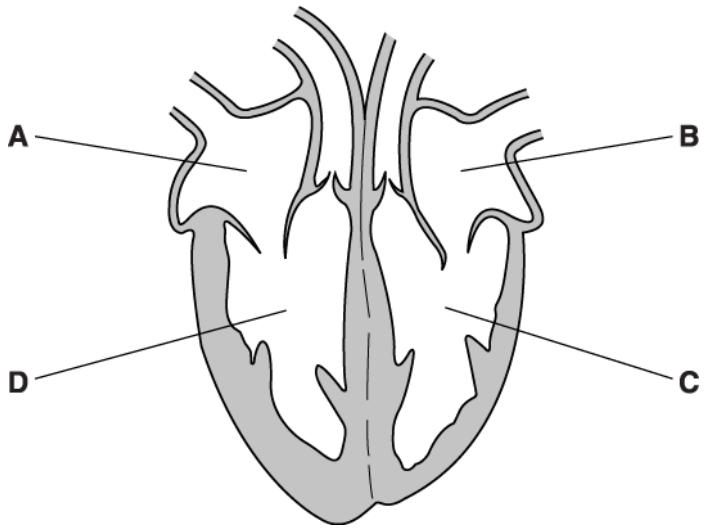
People with this condition have **their organs reversed** so they are a '**mirror image**' of the usual arrangement.

For most people with situs inversus, there are no harmful effects on their health.

However, doctors need to know if someone has the condition if they are going to

successfully treat them if they are ill or injured.

The diagram shows the heart from someone with situs inversus, viewed from the front.



i. Look at the diagram of the heart. Which part pumps blood **around the body**?

Choose from **A**, **B**, **C** or **D**, and explain your choice.

[2]

ii. If someone with situs inversus needs a heart transplant, then a normal heart can be used.

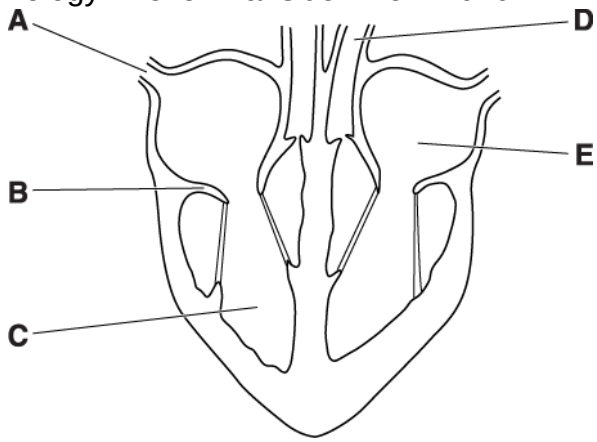
The procedure will be very similar to a normal heart transplant but there will need to be some differences.

Suggest how the procedure will be different.

Explain your answer.

[2]

23. Look at the diagram of a human heart.



Write the letter **A** to **E** next to the correct name of each part of the heart.

name of part	letter
aorta	
left atrium	
right ventricle	
tricuspid valve	
vena cava	

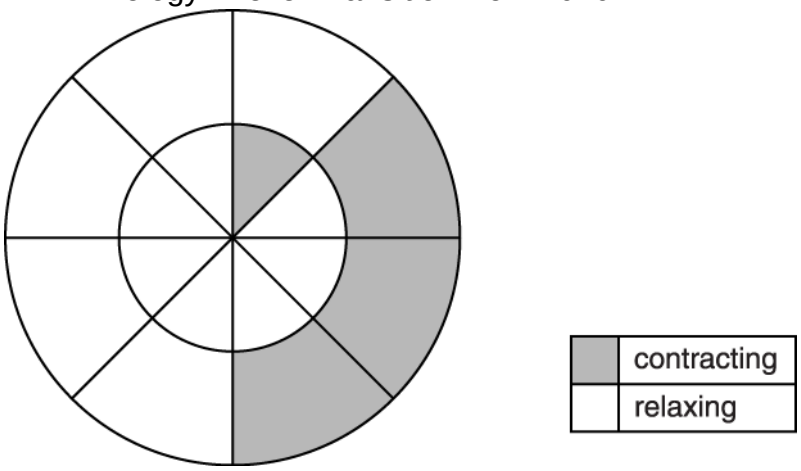
[2]

24. Dicky is visiting the hospital to have his heart checked.

The doctor produces this diagram showing one complete cycle of Dicky's heart.

The inner circle shows what is happening in the atria and the outer circle shows what is happening in the ventricles.

The whole cycle lasts for 0.64 seconds.



i. For how long do the atria contract during one cycle of Dicky's heart?

answer ..... seconds **[1**

ii. The longer a contraction lasts, the greater the pressure that can be generated by the heart.

Explain how and why the contraction time of the ventricles is different from the contraction time for the atria.

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[2]

25. The valves inside someone's heart can become damaged.

How can damaged heart valves affect a person's circulatory system?

---

[2]

END OF QUESTION paper

Mark scheme

Question			Answer/Indicative content	Marks	Guidance
1			A	1	
			Total	**1**	
2	a	i	contains genes / genetic material / DNA (1)	1	
		i	controls cell (functions) (1)	1	**allow** protein synthesis
		ii	(onion cells) do not photosynthesize (1)	1	
		ii	(because) they are underground / in the dark (1)	1	
	b		0.25 (mm) (2)	2	**allow** 1.5 ÷ 6
	c		more difficult to focus (1)	1	
			smaller field of view (1)	1	
	d		4 1 2 5 3 all correct = 2 one out of sequence = 1	2	
	e		as a stain (1)	1	
			so can see organelles (1)	1	**allow** to increase contrast
			Total	**12**	
3		i	6:1	1	
		ii	7.6×10^{-3} 3.0×10^{-3} 1.5×10^{-3} correct calculation of 1 / time (1)	1	
		ii	answer in standard form (1)	1	
		iii	Comment on the rate of colour change / smaller block changed faster (1)	1	**ORA**
		iii	Diffusion alone is sufficient in smaller organisms / smaller organisms have a larger surface area to volume ratio / diffusion alone may not be effective in multi cellular organisms (may require circulatory system) (1)	1	
			Total	**5**	
4		i	structure X is too big to be a virus	1	**allow** viruses cannot be seen with a light microscope
		ii	use an electron microscope (1)	1	

			Total	**2**	
5			A	1	
			Total	**1**	
6			A	1	
			Total	**1**	
7		i	**First check answer on answer line** **If answer = 33.1 (mg) award 2 marks** $\frac{99.2}{3}$ **OR** 33.067 / 33.07✓	**2** **(AO 1.2)** **(AO 2.2)**	**Examiner's Comments** The majority of candidates could correctly calculate the mean mass and give the answer to one decimal place. A small but significant number only gained one mark as they quoted too many decimal places.
		ii	(yes because) idea that there is a greater mean / yield / mass produced (of DNA) ✓ there is less range/variation in results ✓	**2** **(AO 2 × 3.1b)**	**ALLOW** ECF **ALLOW** examples of data from table to indicate less range/variability **Examiner's Comments** There were many correct references to the differences in the ranges of readings, although in some cases the range for the water bath was incorrectly calculated. Fewer candidates commented on the differences between the mean mass of DNA obtained.
			Total	**4**	
8			C ✓	**1 (AO 1.1)**	
			Total	**1**	
9		i	**First check answer on answer line** **If answer = 1000 (x) award 2 marks** $\frac{10}{0.01}$ ✓ 1000 (x) ✓	**2** **(AO 1.2)** **(AO 2.2)**	**Examiner's Comments** This question assessed their AO1.2 mathematical and AO2.2 practical skills. Some candidates correctly gave 1000 and scored 2 marks. However, the working out of nearly all candidates indicated that there was little understanding of the calculation required, as single marks were very rare. The most common incorrect response was 100.

		ii	5(µm)	**1** **(AO 2.2)**	**ALLOW** +/− 1 µm tolerance **Examiner's Comments** The question assesses AO2.2. A significant number of candidates were able to get the correct answer within tolerance. The most common error was to just measure the length of the chloroplast to 7.5 and fail to use the scale measurement to adjust the estimate.
			Total	**3**	
10			B ✓	**1** (**AO** 2.2)	**Examiner's Comments** The question assessed AO2.2 mathematical and practical skills needed for using a microscope. Most candidates were able to calculate the correct magnification for the objective lens. The most common distractor chosen by candidates was 200x. This indicates these candidates seemed unaware of the combined magnification power of the eyepiece and objective lenses to the overall magnification which the question was assessing.
			Total	**1**	
11			C ✓	**1** (**AO** 2.2)	**Examiner's Comments** The question assessed AO2.2 practical skills needed for using a microscope. Candidates did not demonstrate an awareness of skills in using a microscope. Few candidates identified the correct response. All distractors were seen in significant numbers. This is clearly an area where candidates could develop application of skills in a practical situation.
			Total	**1**	
12			(A) has a flagellum (1) does not have a nucleus (1)	2	**If answer B then no marks** **ignore** tail **allow** has DNA in the cytoplasm / DNA in a loop
			Total	**2**	

13		i	**any two from:** has a nucleus ora (1) has mitochondria ora (1) has chloroplasts ora (1)	2	**not** cell wall **not** cytoplasm **not** cap
		ii	some genes can be lost from some cells: ☐ both aerobic and anaerobic respiration can occur: ☐ cells are able to differentiate and specialise: ✓ organisms are able to clone themselves: ☐	1	more than one answer = 0
		iii	nervous or hormone system to communicate between cells / transport or circulation or cardiovascular system to carry nutrients / oxygen / blood / CO_2 around the organism excretory or gas exchange system to exchange materials with the surroundings (1)	1	**ignore** named organs e.g. kidney / heart etc. for system **allow** explained alternative systems e.g. respiratory system / reproductive / digestive
			Total	**4**	
14			vacuole — contain chromosomes mitochondria — support nucleus — respiration	2	all three correct = 2 marks one or two correct = 1 mark
			Total	**2**	
15			D	1	
			Total	**1**	
16		i	90 (%) (1)	1	**allow** 90.32258 or correct rounding **Examiner's Comments** About half the candidates correctly calculated the percentage drop in pressure as 90%. The common error was to convert 9/93 to a percentage.
		ii	vessel at A = capillary (1) vessel at B = vein (1)	2	**allow** capillary bed / arteriole **ignore** small artery allow venule / named vein e.g. vena cava **Examiner's Comments** Many candidates could not identify either the vessel at A as a capillary, nor the one at B as a vein. A minority correctly identified both. The most common error was to identify A as an artery.
			Total	**3**	

17		i	provides a large surface area to volume ratio (1)	1	**allow** large SA / V **allow** squeeze through capillaries **ignore** arteries / veins / vessels **Examiner's Comments** Many candidates gained credit for the idea that red blood cells can squeeze through capillaries. Only a very small number gained the mark for a large surface area to volume ratio. The most common errors were 'more of them can travel in blood vessels' or 'they can travel faster'.
		ii	**any two from:** DNA codes for mRNA (1) mRNA moves (from nucleus) to cytoplasm (1) (mRNA passed to) ribosomes in cytoplasm (to make haemoglobin / protein) (1)	2	**Examiner's Comments** This question did differentiate and only a few candidates knew about mRNA and the ribosomes in the cytoplasm. There were many vague, incorrect answers stating that 'the cytoplasm is where chemical reactions take place' or 'the nucleus is in the cytoplasm'.
		iii	(haemoglobin combines with oxygen to form) oxyhaemoglobin (in lungs) (1) reverse reaction / breakdown of oxyhaemoglobin happens in tissues / cells to release oxygen (1)	2	**allow** oxyhaemoglobin dissociates releasing oxygen **Examiner's Comments** The majority of answers failed to mention oxyhaemoglobin at all, even though candidates did state that oxygen combined with haemoglobin. Most attempts at the second marking point simply stated that, in the tissues, oxygen passed / diffused into the cells, with no reference to any reverse reaction or release from the combined molecule.
			Total	**5**	
18			idea that **all** the blood goes through the lungs (1)	1	**allow** all the blood needs oxygenating **?Examiner's Comments?**? Some candidates failed to realise that all blood has to go through the lungs. They reverted to more superficial responses.
			Total	**1**	
19		i	2.5 (1)	1	

		ii	the shrew needs / uses lots of oxygen (1) shrew red blood cell has a large surface area to volume ratio (1) this means that it can pick up / release oxygen **quickly** (1)	3	**ignore** references to shrew's body surface area to volume ratio **ignore** pick up more oxygen
			Total	**4**	
20			C ✓	**1 (AO 1.1)**	**Examiner's Comments** This question was the most accessible question in section A, with most candidates correctly answering C.
			Total	**1**	
21			D ✓	**1 (AO 2.2)**	
			Total	**1**	
22		i	D (1) it has a thick(er) wall / muscle OR it should be C but the heart is reversed (1)	2	2nd mark is dependent on the 1st **allow** more muscular **Examiner's Comments** Many candidates made links between D and a thicker muscle wall. There was, however, still evidence of some confusion over what each part of the heart does.
		ii	idea that heart would need to be turned round / placed back to front (1) to allow connection to the correct blood vessels (1)	2	**allow** put the heart in face down / flipped over / reversed / inverted **allow** idea that would need to extend / reach the blood vessels to the heart (1) to allow them to reach the correct chambers (1) arteries / veins need to be swapped around (1) **Examiner's Comments** Some candidates struggled with the applied nature of this question. Most who scored did so for the idea of putting it in back to front. Fewer got the mark for linking up the correct blood vessels.
			Total	**4**	

23			<table><tr><th>name</th><th></th><th>part</th></tr><tr><td>aorta</td><td></td><td>D</td></tr><tr><td>left atrium</td><td></td><td>E</td></tr><tr><td>right ventricle</td><td></td><td>C</td></tr><tr><td>tricuspid valve</td><td></td><td>B</td></tr><tr><td>vena cava</td><td></td><td>A</td></tr></table>	2	3 or 4 correct (1) less than 3 correct (0) **Examiner's Comments** The parts of the heart were quite well known but all combinations were seen. The most common error was to reverse boxes 1 and 5. This illustrates that many candidates are still not aware that diagrams are mirror images of the body to identify right and left sides.
			Total	**2**	
24		i	0.08 (1)	1	**?Examiner's Comments?**? Most candidates correctly gave 0.08 seconds. Common incorrect answers included 0.04 and 0.16.
		ii	contraction of ventricles is longer / 0.24 v 0.08 (1) need to pump blood further / to the body (1)	2	**allow** atria only need to pump the blood into the ventricles / do not need to pump as far (1) **ignore** to generate a higher pressure **?Examiner's Comments?**? Most candidates gained at least one mark and many gained both. One common incorrect answer was that while the ventricles pump blood to the body, the atria pump it to the lungs.
			Total	**3**	
25			reduces effective blood circulation / blood could fall back into heart / backflow would happen (1) pressure is not maintained / reduces pressure (1)	2	**ignore** references to oxygenated / deoxygenated **ignore** less blood but **allow** less blood pumped around body **ignore** job of valves e.g. valves stop backflow **allow** not enough pressure to push blood around **allow** oedema / idea of fluid building up in tissues / lungs **ignore** references to higher pressure e.g. inside heart **Examiner's Comments** Most candidates gained at least 1 mark, usually for explaining that damaged valves could lead to backflow. A small minority gained both marks, usually for adding that blood pressure would fall. Some candidates seemed to confuse damaged valves with a 'hole in the heart' and wrote about oxygenated and deoxygenated blood mixing.
			Total	**2**	