

1 The circulatory system contains arteries and veins.

(a) (i) Describe how the structure of an artery is different from the structure of a vein.

(2)

(ii) A comparison is made between blood taken from an artery in the leg and blood taken from a vein in the leg.

Give **two** differences in the composition of the blood.

1. _____

2. _____

(2)

(b) During operations patients can lose a lot of blood. Patients often need blood transfusions to keep them alive.

The text shows information about a new artificial blood product.

Sea worms give hope for people in need of blood transfusions

Scientists have carried out a five-year trial using a new artificial blood product. The scientists have used a protein from sea worms to create the new artificial blood and the results from the trial are very positive. Thousands of sea worms can be grown and collected.

During the trial, mice were given blood transfusions of the artificial blood. The bodies of the mice tolerated the artificial blood and the artificial blood did not cause any side effects.

Suggest **two** possible advantages of using the new artificial blood, instead of using human blood for a transfusion in humans.

1. _____

2. _____

(2)

(Total 6 marks)

2

Fresh milk is a mixture of compounds including lipid, protein and about 5% lactose sugar.

Lactose must be digested by the enzyme lactase, before the products can be absorbed.

Lactase can be added to fresh milk to pre-digest the lactose. This makes 'lactose-free' milk, which is suitable for people who do not produce enough lactase of their own.

A student investigated the effect of changing pH and temperature on the digestion of lactose in milk.

The results are shown in **Tables 1** and **2**.

Table 1
Effect of pH

pH	Time taken to digest lactose in minutes
4.0	20
5.0	18
6.0	13
7.0	7
8.0	5
9.0	6

Table 2
Effect of temperature

Temperature in °C	Time taken to digest lactose in minutes
25	20
30	14
35	11
40	6
45	29
50	No digestion

(a) The label on a carton of lactose-free milk states:

'Lactase is normally produced in the stomach of mammals.'

The results in **Table 1** suggest that this statement is **not** true.

Explain how.

(2)

(b) Explain, as fully as you can, the results shown in **Table 2** .

(3)

(c) Bile is produced in the liver and is released into the small intestine.

Bile helps the digestion of lipid in the milk.

Describe how.

(2)

(Total 7 marks)

3 Drugs are used to treat cardiovascular diseases (diseases of the heart and blood vessels).

(a) What is a drug?

(1)

(b) People can be treated for cardiovascular diseases with statins or aspirin.

Information about these two drugs is given in the table.

STATINS	ASPIRIN
<p>Statins are only available on prescription from doctors.</p> <p>In studies, 30 000 patients were monitored over several years. Statins were found to reduce the rate of non-fatal heart attacks by about 30%.</p> <p>Approximately 0.1% of the patients suffered serious muscle damage and 0.01% suffered kidney failure.</p> <p>Statins reduce blood cholesterol which builds up in the walls of blood vessels. The cost of treating patients with statins can vary between £150 and £500 per year, depending on the type of cardiovascular disease being treated.</p>	<p>Aspirin can be bought over the counter. Treatment with aspirin costs up to £15 per year.</p> <p>In a study of 1000 patients, aspirin was found to cause bleeding of the stomach in around 0.5% of patients and there was a slightly increased risk of poor blood clotting at cuts.</p> <p>There was a slightly increased risk of damage to the blood vessels in the brain in older patients.</p> <p>Aspirin was found to reduce the risk of non-fatal heart attacks by 31%.</p>

4

Plants exchange substances with the environment.

- (a) Plant roots absorb water mainly by osmosis.
Plant roots absorb ions mainly by active transport.

Explain why roots need to use the two different methods to absorb water and ions.

(4)

- (b) What is meant by the *transpiration stream*?

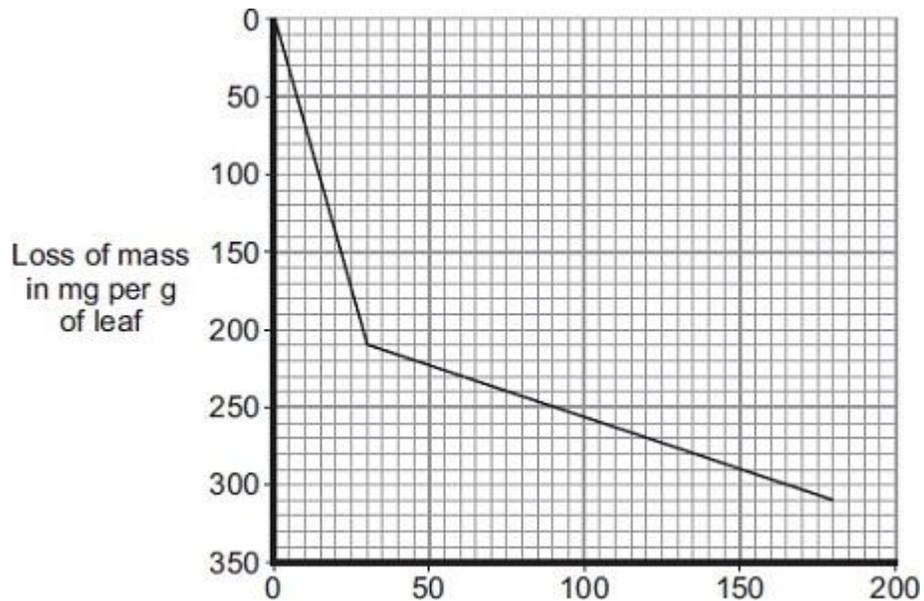
(3)

(c) Students investigated the loss of water vapour from leaves.

The students:

- cut some leaves off a plant
- measured the mass of these leaves every 30 minutes for 180 minutes.

The graph shows the students' results.



- (i) The rate of mass loss in the first 30 minutes was 7 milligrams per gram of leaf per minute.

Calculate the rate of mass loss between 30 minutes and 180 minutes.

Rate of mass loss = _____ milligrams per gram of leaf per minute

(2)

- (ii) The rate of mass loss between 0 and 30 minutes was very different from the rate of mass loss between 30 and 180 minutes.

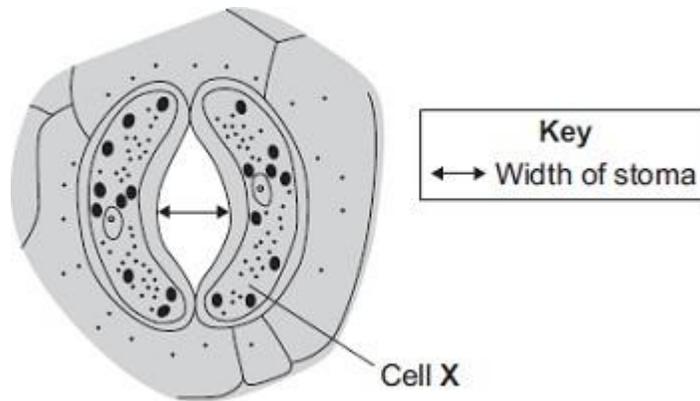
Suggest an explanation for the difference between the two rates.

(2)

(Total 11 marks)

5

Plant leaves have many stomata.
The diagram shows a stoma.



(a) Name cell X _____

(1)

(b) The table shows the mean widths of the stomata at different times of the day for two different species of plant.
Species **A** grows in hot, dry deserts.
Species **B** grows in the UK.

	Time of day in hours	Mean width of stomata as a percentage of their maximum width	
		Species A	Species B
Dark	0	95	5
	2	86	5
	4	52	6
Light	6	6	40
	8	4	92
	10	2	98
	12	1	100
	14	0	100
	16	1	96
	18	5	54
Dark	20	86	6
	22	93	5
	24	95	5

The data in the table show that species **A** is better adapted than species **B** to living in hot, dry deserts.

Explain how.

(4)

(Total 5 marks)

6

The leaves of most plants have stomata.

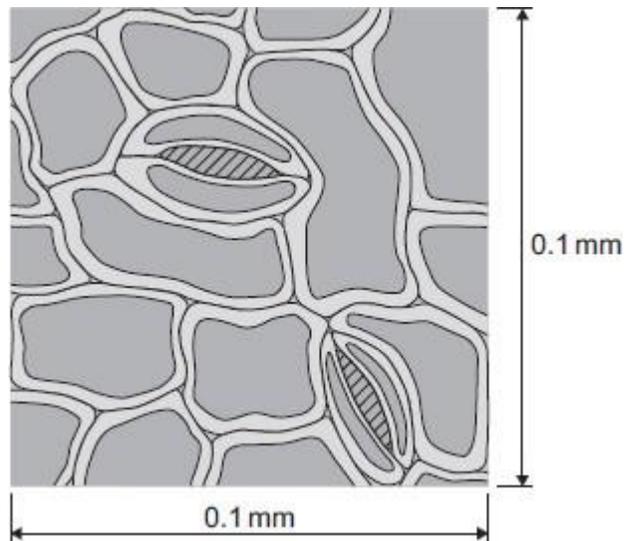
(a) (i) Name the cells which control the size of the stomata.

(1)

(ii) Give **one** function of stomata.

(1)

(b) The image below shows part of the surface of a leaf.



The length and width of this piece of leaf surface are both 0.1 mm.

(i) Calculate the number of stomata per mm^2 of this leaf surface.

_____ per mm^2

(2)

(ii) A different plant species has 400 stomata per mm^2 of leaf surface.

Having a large number of stomata per mm^2 of leaf surface can be a disadvantage to a plant.

Give **one** disadvantage.

(1)

(c) A student investigated the loss of water from plant leaves.

The student did the following:

- Step 1: took ten leaves from a plant
- Step 2: weighed all ten leaves
- Step 3: hung the leaves up in a classroom for 4 days
- Step 4: weighed all ten leaves again
- Step 5: calculated the mass of water lost by the leaves
- Step 6: repeated steps 1 to 5 with grease spread on the upper surfaces of the leaves
- Step 7: repeated steps 1 to 5 with grease spread on both the upper and lower surfaces of the leaves.

All the leaves were taken from the same type of plant.

The table below shows the student's results.

Treatment of leaves	Mass of water the leaves lost in g
No grease was used on the leaves	0.98
Grease on upper surfaces of the leaves	0.86
Grease on upper and lower surfaces of the leaves	0.01

(i) What mass of water was lost in 4 days through the upper surfaces of the leaves?

Mass = _____g

(1)

- (ii) Very little water was lost when the lower surfaces of the leaves were covered in grease.

Explain why.

(3)

(Total 9 marks)

7

Blood is part of the circulatory system.

- (a) (i) Give **one** function of white blood cells.

(1)

- (ii) Which of the following is a feature of platelets?

Tick (✓) **one** box.

They have a nucleus.

They contain haemoglobin.

They are small fragments of cells.

(1)

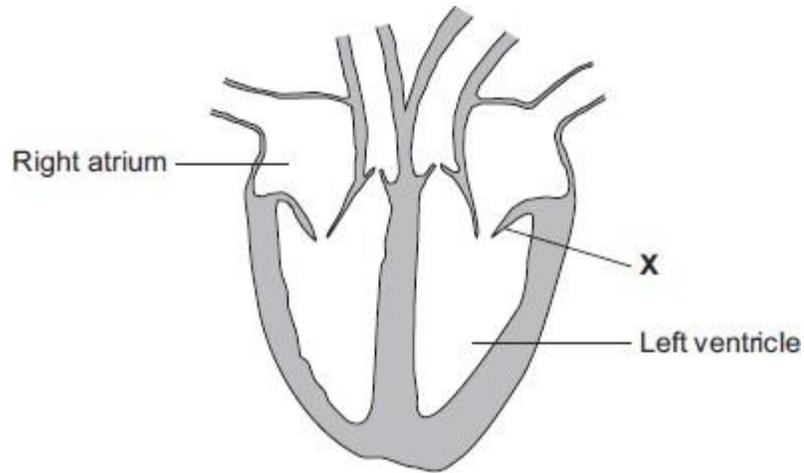
- (b) Urea is transported by the blood plasma from where it is made to where the urea is excreted.

Complete the following sentence.

Blood plasma carries urea from where it is made in the _____
to the _____ where the urea is removed from the blood.

(2)

- (c) The illustration shows a section through the human heart.



Structure **X** is a valve. If valve **X** stops working, it may need to be replaced.

A scientist is designing a new heart valve. The scientist knows that the valve must be the correct size to fit in the heart.

Suggest **two** other factors the scientist needs to consider so that the newly designed valve works effectively in the heart.

(2)

(Total 6 marks)

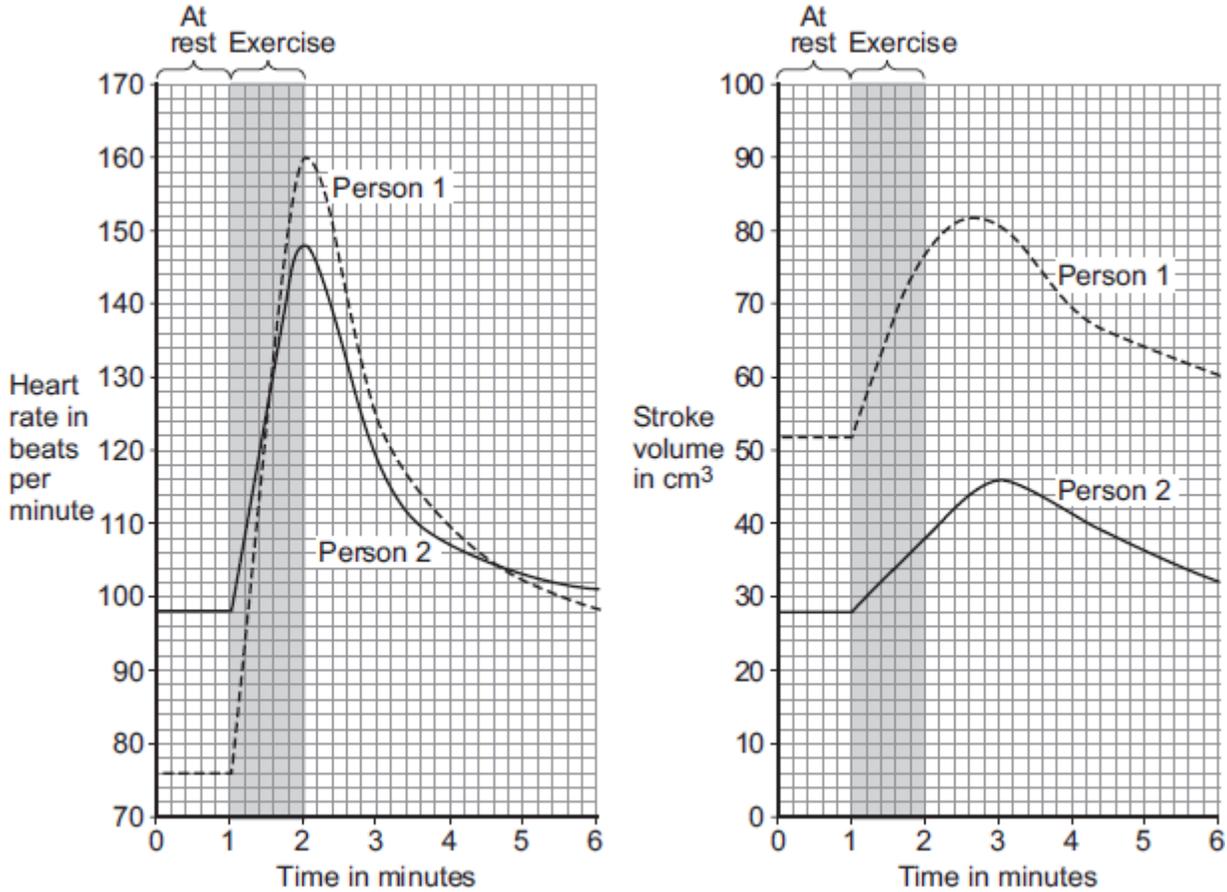
8

During exercise, the heart beats faster and with greater force.

The 'heart rate' is the number of times the heart beats each minute. The volume of blood that travels out of the heart each time the heart beats is called the 'stroke volume'.

In an investigation, **Person 1** and **Person 2** ran as fast as they could for 1 minute. Scientists measured the heart rates and stroke volumes of **Person 1** and **Person 2** at rest, during the exercise and after the exercise.

The graph below shows the scientists' results.



(a) The 'cardiac output' is the volume of blood sent from the heart to the muscles each minute.

$$\text{Cardiac output} = \text{Heart rate} \times \text{Stroke volume}$$

At the end of the exercise, **Person 1's** cardiac output = $160 \times 77 = 12\,320 \text{ cm}^3$ per minute.

Use information from the figure above to complete the following calculation of **Person 2's** cardiac output at the end of the exercise.

At the end of the exercise:

Person 2's heart rate = _____ beats per minute

Person 2's stroke volume = _____ cm^3

Person 2's cardiac output = _____ cm^3 per minute

(3)

Mark schemes

- 1** (a) (i) doesn't have valves
allow veins have valves 1
- has a thicker wall **or** thicker layer of muscle
allow has a smaller lumen
ignore references to elastic (in walls) 1
- (ii) any **two** from:
- (artery has) more oxygen
 - (artery has) more glucose
allow (artery has) more amino acids / fatty acids
 - (artery has) less carbon dioxide
 - (artery has) less lactic acid
ignore urea
ignore reference to pressure
accept converse for veins if veins is clearly stated 2
- (b) any **two** from:
- no rejection
allow no tissue matching required
 - abundant supply
 - low risk of infection
allow named example ie HIV, CJD
 - longer shelf life
allow less space needed for storage
ignore side effects 2
- 2** (a) stomach is acidic / has low pH
allow any pH below 7
ignore stomach is not alkaline 1
- lactase works best / well in alkali / high pH / neutral / non-acidic conditions
allow any pH of 7 and above
accept works slowly in acid conditions
*allow figures from table with a **comparison***
ignore reference to temperature 1
- [6]**

(b) any **three** from:

- (below 40(°C)) increase in temperature increases rate / speed of reaction
- reference to molecules moving faster / colliding faster / harder / more collisions
- enzyme optimum / works best at 40°C
allow value(s) in range 36 – 44
ignore body temperature unless qualified
- high temperatures (above 40°C) / 45°C / 50°C enzyme denatured
*allow synonyms for denaturation, but do **not** allow 'killed'*
*denaturation at high and low temperature does **not** gain this mark*
ignore references to time / pH

3

(c) any **two** from:

- acid neutralised or conditions made neutral / alkali
accept bile is alkaline
- (allow) emulsification / greater surface area (of lipid / fat)
allow description of emulsification eg fat broken down / broken up
into droplets
*do **not** accept idea of chemical breakdown*
- lipase / enzymes (in small intestine) work more effectively / better
allow better for enzymes
ignore reference to other named enzymes

2

[7]

3

(a) (substance / chemical) that affects body chemistry / chemical reactions in the body

1

(b) statin / aspirin / neither recommended

no mark, may be implied. If no recommendation or implication, max 4 marks

answers should be comparative

any **five** from:

•argued evaluation in favour of aspirin or statin or neither

answers could include reference to

*accept converse for statins / aspirin but **not** as advantage of one **and** disadvantage of other*

for statins:

- more people in studies
- so data / findings more repeatable
accept reliable for repeatable
ignore accurate / precise
- reduces cholesterol but aspirin doesn't
allow reduces cholesterol but no evidence about aspirin
- aspirin (may) causes bleeding / poor clotting but statins do not
allow aspirin causes bleeding / poor clotting but no evidence about statins
- smaller (total) percentage suffer side-effects
- monitored by doctor, aspirins not for

aspirin:

- cheaper
- can be bought over the counter rather than prescribed
- statins cause serious damage / muscle damage / kidney failure but aspirins do not

similarities:

- both have similar effect on reducing (non-fatal) heart attacks
- incidence of side-effects low in both
allow (for aspirin) higher reduction of risk of heart attack

5

[6]

4

(a) solution in soil is more dilute (than in root cells)

concentration of water higher in the soil (than in root cells)

1

so water moves from the dilute to the more concentrated region

*so water moves down (its) concentration gradient **or** water moves from a high concentration of water to a lower concentration*

1

concentration of ions in soil less (than that in root cells)

1

so energy needed to move ions

or

ions are moved against concentration gradient

the direction of the concentration gradient must be expressed clearly

accept correct reference to water potential or to concentrations of water

1

(b) any **three** from:

- movement of water from roots / root hairs (up stem)
- via xylem
- to the leaves
- (water) evaporates
- via stomata

3

(c) (i) 0.67/0.7

accept 0.66, 0.6666666... or $\frac{2}{3}$ or 0.6

*correct answer gains **2** marks with or without working*

*if answer incorrect allow evidence of $\frac{100}{150}$ for **1** mark*

*do **not** accept 0.6 or 0.70*

2

(ii) during the first 30 minutes

any **one** from:

- it was warmer
- it was windier
- it was less humid
- there was more water (vapour) in the leaves

1

so there was more evaporation

ignore 'water loss'

or

stomata open during first 30 minutes **or** closed after 30 minutes (1)

so faster (rate of) evaporation in first 30 min **or** reducing (rate of) evaporation after 30 min (1)

1

[11]

5 (a) guard cell

ignore stoma / stomata

1

(b) Species A:

allow converse points for species B

stomata open in dark / at night **or** close in light / in day

1

stomata closed during warm(est) period **or** open when cool(er)

1

heat (energy) / warmth increases evaporation / transpiration

must give explicit link between heat and transpiration

1

reduces water loss / evaporation / transpiration

ignore photosynthesis

1

[5]

6 (a) (i) guard (cells)

allow phonetic spelling

1

(ii) any **one** from:

ignore reference to cells

- allow carbon dioxide to enter

*allow control loss / evaporation of water **or** control transpiration rate*

- allow oxygen to leave.

allow 'gaseous exchange'

1

(b) (i) 200

correct answer gains 2 marks with or without working

allow 1 mark for $0.1 \times 0.1 = 0.01$ (mm²)

2

(ii) more / a lot of / increased water loss
allow plant more likely to wilt (in hot / dry conditions)

1

(c) (i) 0.12

1

(ii) the lower surface has most stomata

1

stomata are now covered / blocked (by grease)

1

so water cannot escape / evaporate from the stomata

ignore waterproof

to gain credit stomata must be mentioned at least once

1

[9]

7 (a) (i) defence against **or** destroy pathogens / bacteria / viruses / microorganisms
do not allow 'destroy disease'
accept engulf pathogen / bacteria / viruses / microorganism
accept phagocytosis
accept produce antibodies / antitoxins
allow immune response

1

(ii) they are small fragments of cells

1

(b) liver

in this order only

1

kidney(s)

1

(c) any **two** from:

- that it doesn't cause an immune response **or** isn't rejected / damaged by white blood cells
- whether it is a long lasting material / doesn't decompose / corrode / inert
- if it is strong (to withstand pressure)
- it will open at the right pressure
- that it doesn't cause clotting
- that it doesn't leak **or** it prevents backflow
- non toxic

ignore correct size

2

[6]

8

(a) 5624

allow 2 marks for:

• correct HR = 148 **and** correct SV = 38 plus wrong answer / no answer

or

• only one value correct **and** ecf for answer

allow 1 mark for:

• incorrect values **and** ecf for answer

or

• only one value correct

3

(b) (i) **Person 2** has low(er) stroke volume / SV / described
eg **Person 2** pumps out smaller volume each beat
do **not** allow **Person 2** has lower heart rate

1

(ii) **Person 1** sends more blood (to muscles / body / lungs)

1

(which) supplies (more) oxygen

1

(and) supplies (more) glucose

1

(faster rate of) respiration **or** transfers (more) energy for use

ignore aerobic / anaerobic

allow (more) energy release

allow aerobic respiration transfers / releases more energy (than anaerobic)

*do **not** allow makes (more) energy*

1

removes (more) CO₂ / lactic acid / heat

allow less oxygen debt

or less lactic acid made

or (more) muscle contraction / less muscle fatigue

if no other mark awarded,

allow person 1 is fitter (than person 2) for max 1 mark

1

[9]