



Topic Test: OxfordAQA
International A level Biology
Biological systems and disease

Name: _____

Class: _____

Date: _____

Time: **87 minutes**

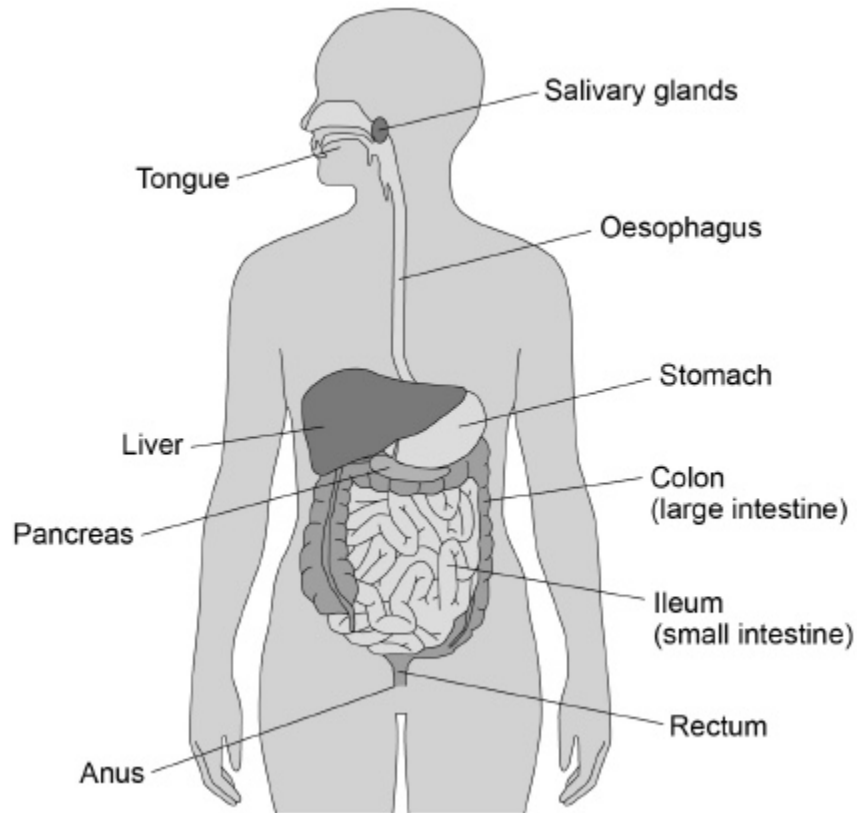
Marks: **71 marks**

Comments:

1

Amylase is a digestive enzyme.

The diagram shows the human digestive system.



(a) Name **two** organs that produce the enzyme amylase.

1. _____

2. _____

(1)

(b) A student carries out an experiment to investigate the action of amylase on starch. Bread contains starch.

Volunteers chew a small piece of bread for 30 seconds. The chewed bread mixed with saliva is collected into a test tube. As a control, a piece of bread is also blended with distilled water and put in a test tube. Both test tubes are heated with Benedict's reagent.

The results are shown in the table.

	Colour after heating with Benedict's reagent
Bread in saliva	Brick red
Bread in distilled water	Pale blue

The student concludes that starch must be directly broken down into glucose by salivary amylase.

Evaluate this conclusion.

(3)

(c) Absorption occurs in the ileum.

Give **three** ways in which the walls of the ileum are adapted for absorption of glucose.

1. _____

2. _____

3. _____

(3)

(Total 7 marks)

2

Cholera is a water-borne disease caused by the intestinal pathogen, *Vibrio cholerae*. The pathogen produces an exotoxin which acts specifically on the epithelial cells of the small intestine causing changes in membrane permeability. Individuals with cholera suffer from severe diarrhoea which may result in death.

(a) Suggest **two** precautions which could be used to prevent the transmission of cholera.

1. _____

2. _____

(1)

S (b) Suggest why the cholera exotoxin is specific to the epithelial cells of the small intestine.

(2)

S (c) The cholera exotoxin affects the movement of ions through the intestinal wall. It causes the loss of chloride ions from the blood into the lumen of the small intestine. This prevents the movement of sodium ions from the lumen of the small intestine into the blood.

(i) Describe how sodium ions normally enter the blood from the cells of the intestinal wall against a concentration gradient.

(2)

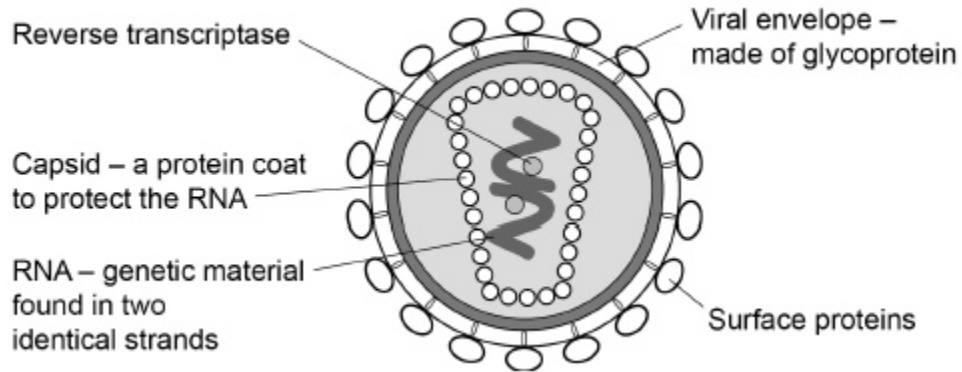
(ii) Use the information provided to explain why individuals with cholera have diarrhoea.

(2)

(Total 7 marks)

3

The diagram below shows the structure of the HIV virus.



(a) HIV is described as a retrovirus.

Give the reason why.

(1)

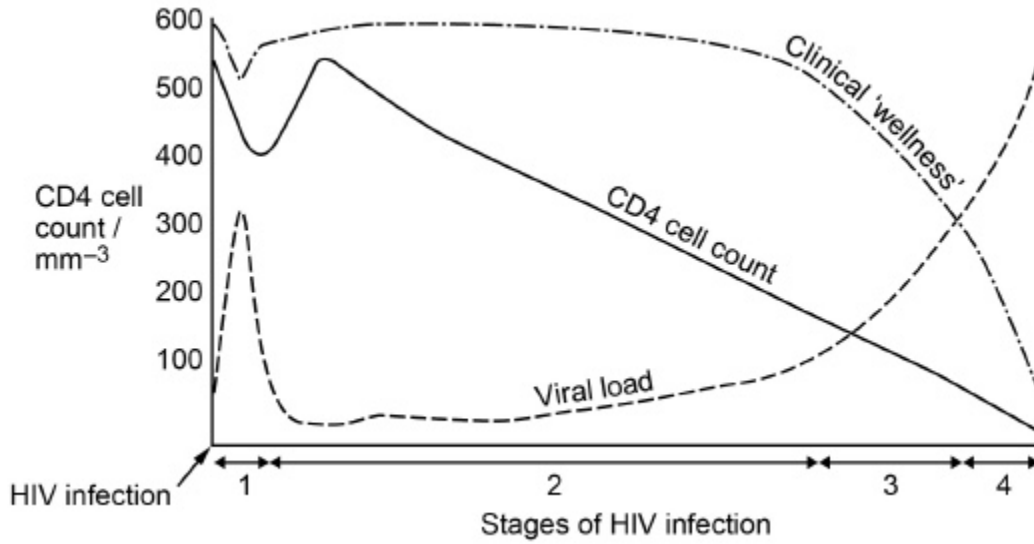
(b) Describe the function of the surface proteins.

(1)

(c) Which type of white blood cell has CD4 receptors on its cell membrane?

(1)

The graph below shows typical progress of an HIV infection. Clinical wellness and viral load are in arbitrary units.



- (d) Describe the effect of HIV on the CD4 cell count through stages 1–2. Use the data in the graph.

(2)

(e) Clinical wellness is a measure of AIDS symptoms.

Explain how HIV reduces the clinical wellness value during stages 3 and 4 in the graph.

(3)

(Total 8 marks)

4

Read the following passage.

Whooping cough is caused by the bacterium *Bordetella pertussis*. The first vaccines for whooping cough contained whole bacterial cells that had been heated for several minutes. Today, most vaccines only contain between one and three parts of the bacterial cells. People given whole-cell vaccines were more likely to develop harmful side effects than the people given the vaccines containing parts of the bacterial cells. Those given whole-cell vaccines produced a greater range of antibodies against the bacterium. 5

There have been suggestions that whooping cough vaccines may not work very well. These suggestions are due to recent reports of large 10 rises in the number of cases of whooping cough. Doctors who examined a group of patients with coughs diagnosed about 17% of them as having whooping cough. Scientists tested the blood of the same group of patients for antibodies against a toxin produced by *Bordetella pertussis*. They concluded that 4% of this group actually had whooping cough. 15

Use the information in the passage and your own knowledge to answer the following questions.

- (a) (i) People given whole-cell vaccines were more likely to develop harmful side effects than the people given the vaccines containing parts of the bacterial cells (lines 4–6).

Suggest reasons why.

(3)

- (ii) People given whole-cell vaccines produced a greater range of antibodies against the bacterium than the people given the vaccines containing parts of the bacterial cells (lines 7–8).

Explain why.

(2)

- (b) The scientists concluded from their test that 4% of patients with long-term coughs actually had whooping cough (line 15).

Explain how they used the results of their test to reach this conclusion.

(3)

- (c) What does the scientists' work suggest about reports of large rises in the number of cases of whooping cough (lines 10–11)?

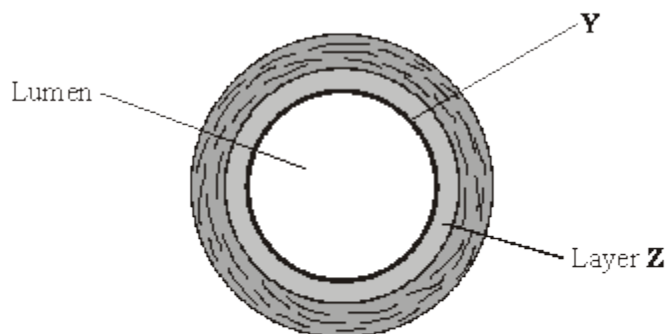
Explain your answer.

(2)

(Total 10 marks)

5

The diagram shows a cross-section of an artery.



Magnification $\times 10$

- (a) Name the layer labelled Y.

(1)

(b) Layer **Z** contains a high proportion of elastic tissue.

Describe the advantage of having elastic tissue in the wall of an artery.

(2)

(c) Calculate the cross-sectional area of the lumen of the artery shown in the diagram. Show your working.

The area of a circle is given by πr^2 , where r is the radius of a circle ($\pi = 3.14$).

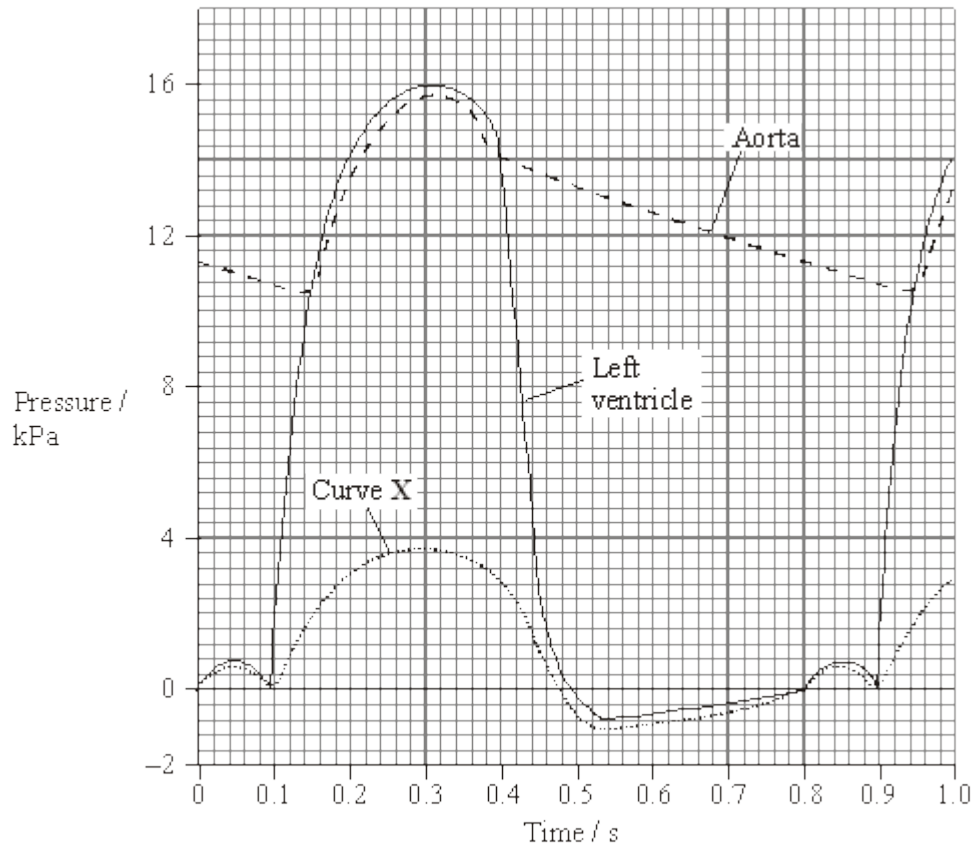
Answer _____ mm²

(3)

(Total 6 marks)

6

The graph shows changes in pressure in different parts of the heart during a period of one second.



(a) (i) At what time do the semilunar valves close?

(1)

(ii) Use the graph to calculate the heart rate in beats per minute.

Show your working.

Answer _____ beats per minute

(1)

- (iii) Use the graph to calculate the total time that blood flows out of the left side of the heart during one minute when beating at this rate. Show your working.

Answer _____ seconds

(1)

- (b) What does curve **X** represent? Explain your answer.

X = _____

Explanation _____

(2)

- (c) The volume of blood pumped out of the left ventricle during one cardiac cycle is called the stroke volume.

The volume of blood pumped out of the left ventricle in one minute is called the cardiac output. It is calculated using the equation

$$\text{Cardiac output} = \text{stroke volume} \times \text{heart rate}$$

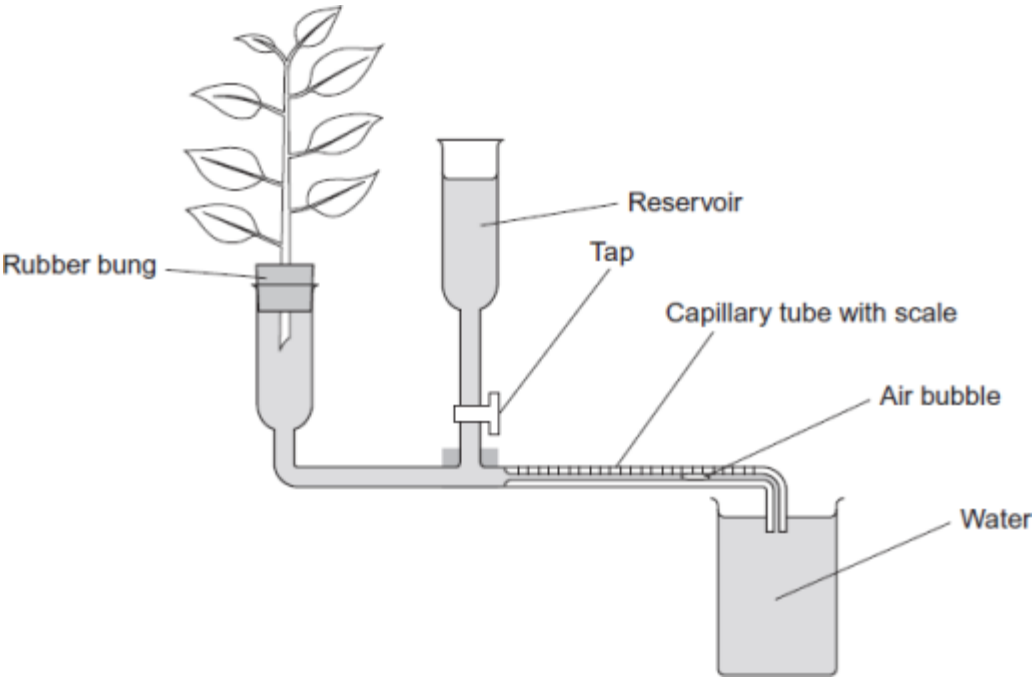
After several months of training, an athlete had the same cardiac output but a lower resting heart rate than before. Explain this change.

(2)

(Total 7 marks)

7

Students investigated the effect of removing leaves from a plant shoot on the rate of water uptake. Each student set up a potometer with a shoot that had eight leaves. All the shoots came from the same plant. The potometer they used is shown in the diagram.



(a) Describe how the students would have returned the air bubble to the start of the capillary tube in this investigation.

(1)

(b) Give **two** precautions the students should have taken when setting up the potometer to obtain reliable measurements of water uptake by the plant shoot.

1. _____

2. _____

(2)

(c) A potometer measures the rate of water uptake rather than the rate of transpiration. Give **two** reasons why the potometer does **not** truly measure the rate of transpiration.

1. _____

2. _____

(2)

(d) The students' results are shown in the table.

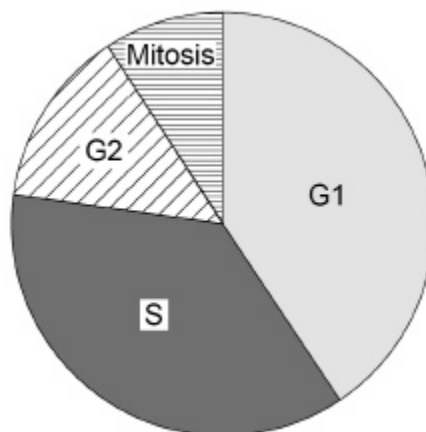
Number of leaves removed from the plant shoot	Mean rate of water uptake / cm^3 per minute
0	0.10
2	0.08
4	0.04
6	0.02
8	0.01

Explain the relationship between the number of leaves removed from the plant shoot and the mean rate of water uptake.

(3)
(Total 8 marks)

8

The cell cycle in a eukaryotic cell is divided into phases as shown in the pie chart.



(a) The whole cell cycle for this cell is completed in 22 hours.

Calculate the time spent in each phase.

Give your answers to the nearest whole hour.

Write your answers in the table.

	G1	S	G2	Mitosis
Sector size / degrees	147	131	49	33
Time / hours				

(2)

(b) Give **two** processes that occur during phase G1.

1. _____

2. _____

(2)

(c) The stages of mitosis in plant cells can be seen with a light microscope by preparing a root tip squash.

To prepare the slide, the root tip is:

- stained with aceto-orcein or toluidine blue
- squashed between a microscope slide and coverslip.

State why the tissue is:

stained _____

squashed _____

(2)

(d) Root tip squashes can be used to calculate the mitotic index of the tissue.

Describe how to:

- collect the data needed
- calculate the mitotic index.

(2)

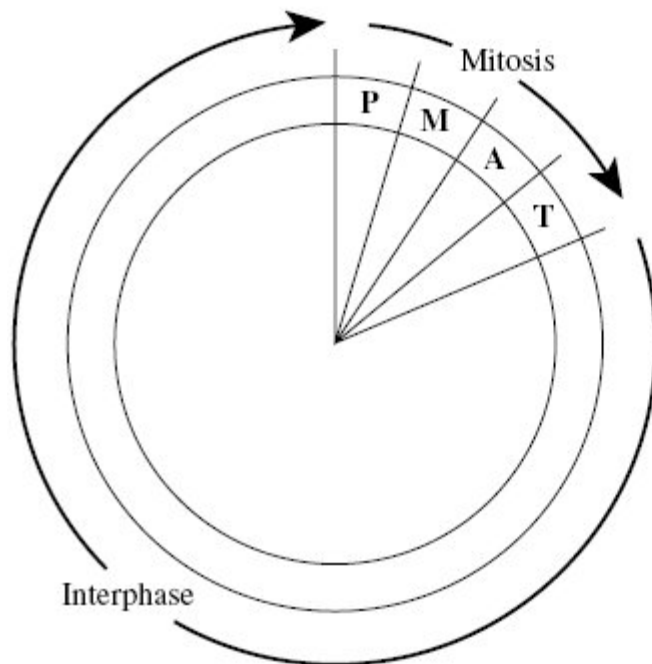
(e) In animal cells the mitotic index could be used to tell the difference between a cancerous tumour and a benign tumour.

Suggest how.

(1)

(Total 9 marks)

9 The diagram shows a cell cycle.



Key

- P** prophase
- M** metaphase
- A** anaphase
- T** telophase

(a) The table shows the number of chromosomes and the mass of DNA in different nuclei.

All the nuclei come from the same animal. Complete this table.

Nucleus	Number of chromosomes	Mass of DNA / arbitrary units
At prophase of mitosis	26	60
At telophase of mitosis		
From a sperm cell		

(4)

(b) If the DNA of the cell is damaged, a protein called p53 stops the cell cycle.

Mutation in the gene for p53 could cause cancer to develop. Explain how.

(3)

(c) Drugs are used to treat cancer. At what phase in the cell cycle would each of the following drugs act?

(i) A drug that prevents DNA replication

(1)

(ii) A drug that prevents spindle fibres shortening

(1)

(Total 9 marks)

Mark schemes

1

- (a) 1. Salivary Glands;
2. Pancreas;

*Both correct for 1 mark
In either order*

1

- (b) 1. (Could be correct as) Benedict's test indicates the chewed bread contains a reducing sugar (which could be glucose);

BUT

2. (The student's conclusion is incorrect because) Glucose is not the only reducing sugar/maltose is also a reducing sugar;

BECAUSE

3. Amylase hydrolyses starch to maltose (a reducing sugar) hence positive test;
Subsumes 2

3

- (c) 1. Villi and/or microvilli provide large/increased surface area;
Accept description, e.g. walls are highly folded

2. Thin walls decrease the diffusion pathway;
Accept description, e.g. blood vessels are near the surface

3. Presence of channel/carrier proteins (for glucose) for facilitated diffusion/active transport/co-transport;

4. Mixing by movement of villi maintains a concentration gradient;
OR
Good blood supply to maintain a concentration gradient;
Accept description, e.g. many capillaries/network of capillaries/blood flows

3 max

[7]

2

- (a) effective water / sewage treatment / prevent water contamination / improved hygiene / vaccination / quarantining of affected area;

(any two)

1

- (b) receptor / proteins on membrane;
complementary shape of exotoxin;

2

- (c) (i) active transport;
using ATP / carrier proteins; 2
- (ii) higher solute concentration / water potential lowered in
small intestine; osmotic loss of water; 2

[7]

3 (a) (Genetic material) RNA used to synthesise DNA;
Reject RNA is converted into DNA 1

(b) To attach to (host/human) cells/receptors/CD4 cells;
Ignore antigen-antibody binding unless qualified 1

(c) Helper-T cells;
Accept T_H cells 1

(d) 1. Overall pattern: Initial decrease then increase/return to normal followed by
decrease; 2

2. Suitable values from graph: Peak 530-550, trough 400;
Accept calculated values, e.g. decreases by 150 2

(e) 1. Replication of HIV/virus/particles/increased viral load / destroys/infected/reduces
number of T (helper) cells/CD4 cells; 3

2. T cells/CD4 cells required for immune response/stimulate B cells;
*Accept antibody production if clearly stated by B /
plasma cells* 3

3. AIDS is a series of (opportunistic) diseases caused by immune system not
working/insufficient T cells/CD4 cells; 3

[8]

4

(a) (i) **(Whole-cell vaccine),**

Accept converse statements for other vaccine

Reject references to the vaccine being alive or the disease reproducing etc

1. Heat(ing) supposed to kill bacteria;
2. Some might be alive / active / viable;
Accept active pathogens present
3. (If so) bacteria could reproduce;
4. Bacterium makes or contains toxin;
5. Toxin might not be affected / all destroyed by heat;
6. Bacteria or toxins attacking / killing person's cells;

3 max

(ii) **(Whole-cell vaccine),**

Ignore references to more / greater antigens unqualified. It is the variety of antigens that matters

1. (Contains) many different / greater range of antigens;
2. Each antigen causes its own immune response / production of / has a specific (type of) antibody;

2

(b) 1. Only patients who had whooping cough have toxin / antibody / immune response;
Accept converse e.g. those without antibody had another disease

2. Toxin is an antigen and is (only) produced by this bacterium;
3. Leading to presence of specific antibody / only 4% had this antibody / 13% did not have antibody;

3

(c) 1. There may not be large rises;

2. Might be the result of wrong diagnosis / reference to difference in figures / 13% diagnosed with whooping cough didn't have it;

Ignore reference to new strains or antigenic variability

2

[10]

5	<p>(a) endothelium / tunica intima (<i>accept endothelial cells</i>);</p>	1
	<p>(b) elastic tissue allows recoil (<i>reject if wording implies a muscle e.g. contract / relax</i>)(<i>ignore expand</i>); maintains blood pressure / constant / smooth blood flow (<i>not increases blood pressure</i>);</p>	2
	<p>(c) measuring radius / 12 mm / 12.5 mm / 1.2 cm / 1.25 cm; correct calculation / $3.14 \times 12 \times 12 = 452$ / $3.14 \times 12.5 \times 12.5 = 490$ / 491; <i>allow for magnification $\div 100 = 4.52$ / 4.9</i>; <i>(allow 1 mark for correct calculation using incorrect radius)</i></p>	3
		[6]
6	<p>(a) (i) 0.4(s);</p>	1
	<p>(ii) $\left\{ \frac{60}{0.8} \right\} = 75$;</p>	1
	<p>(iii) 0.26 (between $0.4 - 0.14$) $\times 75$ (or from (a)(ii)) = 19.5(s) <i>OR</i> 0.25 (between $0.4 - 0.15$) $\times 75$ (or from (a)(ii)) = 18.75(s) <i>(no double penalty)(allow rounding only if working shown)</i></p>	1
	<p>(b) (ii) right ventricle; same pattern / description (as left ventricle) but lower (pressure);</p>	2
	<p>(c) increase in volume / size of ventricles (<i>accept heart</i>) / hypertrophy of heart / increased <u>strength</u> of heart <u>muscle</u> / increased strength of contraction; more blood leaves heart in each contraction / increase in stroke volume;</p>	2
		[7]
7	<p>(a) Open / use tap / add water from reservoir;</p>	1

- (b) 1. Seal joints / ensure airtight / ensure watertight;
Answer must refer to precautions when setting up the apparatus
Ignore: references to keeping other factors constant
2. Cut shoot under water;
3. Cut shoot at a slant;
4. Dry off leaves;
5. Insert into apparatus under water;
6. Ensure no air bubbles are present;
7. Shut tap;
8. Note where bubble is at start / move bubble to the start position;

2 max

- (c) 1. Water used for support / turgidity;
Accept: water used in (the cell's) hydrolysis or condensation (reactions) for one mark. Allow a named example of these reactions
2. Water used in photosynthesis;
3. Water produced in respiration;
4. Apparatus not sealed / 'leaks';

2 max

- (d) As number of leaves are reduced (no mark),
Accept: converse arguments
1. Less surface area / fewer stomata;
3. Less evaporation / transpiration;
4. Less cohesion / tension / pulling (force);

3

[8]

8

(a)

	G1	S	G2	Mitosis
Time / hours	9	8	3	2

2

(b) Protein synthesis;

Allow respiration

Increase in number of organelles/mitochondria/ribosomes;

Growth/increase in size of cell;

2

(c) (Stained) so chromosomes/chromatids can be seen;

(Squashed) to release cells from root tissue/to provide single layer of cell/to spread cells out;

2

(d) 1. Count number of cells in field of view in mitosis/with visible chromosomes AND count total number of cells in field of view;

Allow index expressed as a percentage

2. Divide number of cells in mitosis by total number of cells counted;

If just formula given then only mp2.

2

(e) Cancerous tumours divide more rapidly/have higher mitotic index;

Needs to be comparative

1

[9]

9

(a)

Nucleus	Number of chromosomes	Mass of DNA / arbitrary units
At telophase of mitosis	26;	30;
From a sperm cell	13;	15;

4

(b) Cancer cells often have faulty / damaged DNA;

Protein / p53 faulty / not made;

Cell (with faulty / DNA) divides / completes cell cycle;

Uncontrolled division produces cancer;

p53 refers to the protein so do not accept reference to p53 mutating.

3

(c) (i) Interphase / S phase / synthesis phase;

1

(ii) Anaphase / **A**;

1

[9]