

Please write clearly in block capitals.

Centre number

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Candidate number

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Surname StemUp Model Solution

Forename(s) _____

Candidate signature _____

I declare this is my own work.

INTERNATIONAL AS BIOLOGY (9610)

Unit 2 Biological Systems and Disease

Time allowed: 1 hour 30 minutes

Materials

For this paper you must have:

- a ruler with millimetre measurements
- a scientific calculator, which you are expected to use where appropriate.

Instructions

- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).
- All working must be shown.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information

- The marks for questions are shown in brackets.
- The maximum mark for this paper is 75.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
TOTAL	



Answer **all** questions in the spaces provided.

0 1

Some species of bacteria are resistant to antibiotics. These bacteria can continue to divide even when antibiotics have been used.

0 1 . 1

Describe how bacteria divide by binary fission.

[2 marks]

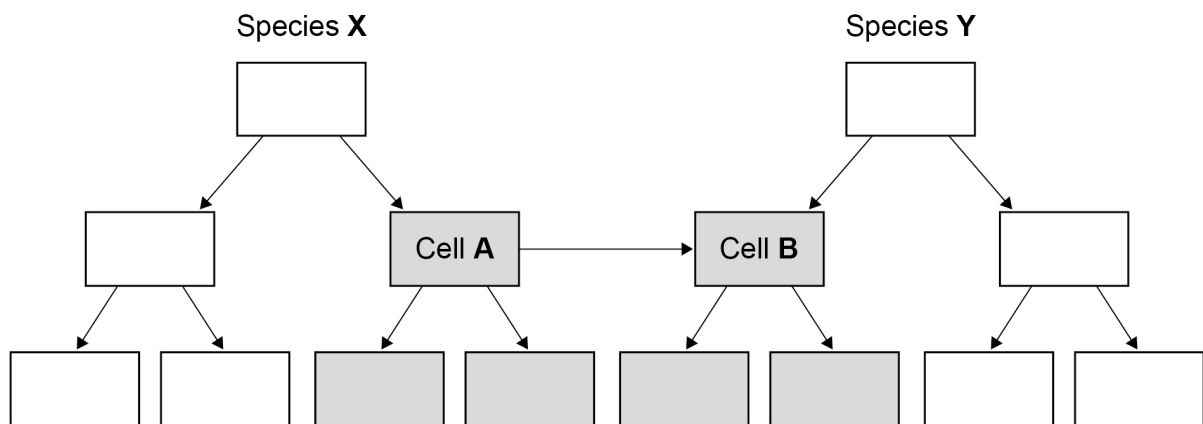
The circular DNA (and the plasmids) replicate.

The cell membrane grows inwards and a new cell wall is made, so the cytoplasm divides to produce two daughter cells.

Each daughter cell receives one copy of the circular DNA and a variable number of plasmids.

Figure 1 shows two species of bacteria (**X** and **Y**) and the number of cells after two divisions. The shaded bacteria are resistant to a type of antibiotic.

Figure 1



Cell **A** was the first cell to become resistant to this type of antibiotic.

0 1 . 2

Suggest what caused cell **A** to become resistant.

[1 mark]

A (random) mutation in its DNA.



0 1 . 3

Explain how cell **B** gained resistance to this antibiotic from cell **A**.**[3 marks]***By horizontal transmission (horizontal gene transfer).**The gene for antibiotic resistance is on a plasmid (DNA) in cell A.**A copy of the plasmid is passed from cell A to cell B by conjugation,
through a conjugation tube (pilus) joining the two cells.*

0 1 . 4

Species **X** and **Y** divide every 20 minutes.Calculate the total number of resistant bacteria after cells **A** and **B** had been dividing for 3 hours.**[2 marks]***3 hours = 180 min, $180 \div 20 = 9$ divisions**each cell gives $2^9 = 512$ resistant bacteria**A + B: $2 \times 512 = 1024$* Total number of antibiotic-resistant bacteria = 1024

8

Turn over for the next question**Turn over ►**

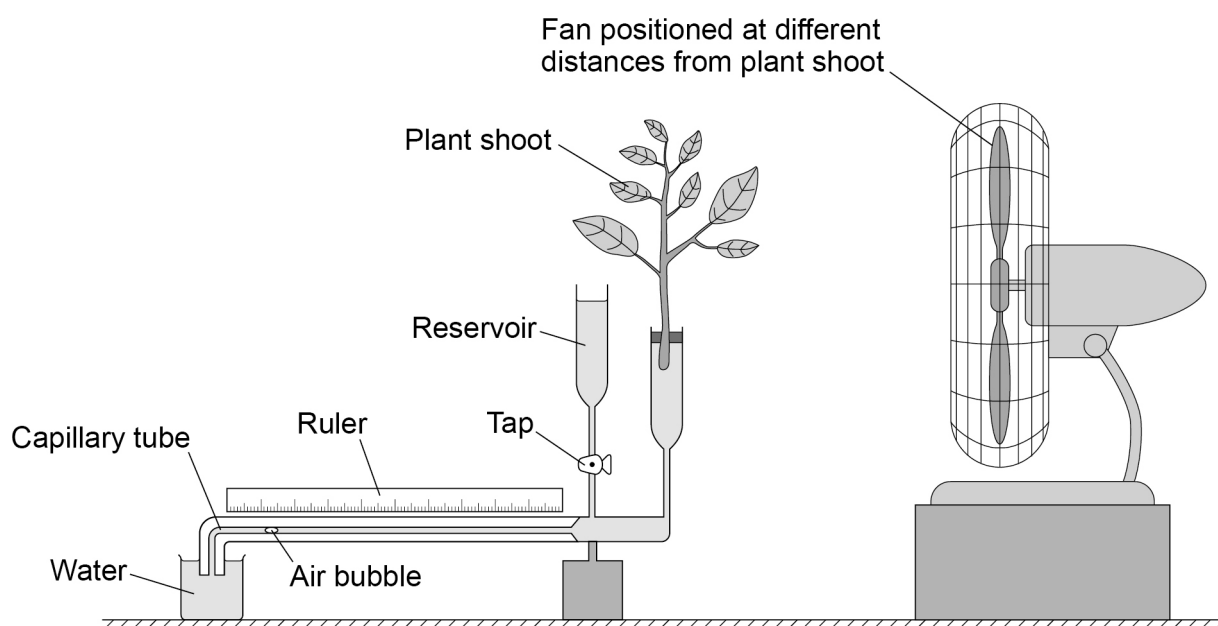
0 2

A student investigates the effect of wind speed on the rate of water uptake by a plant shoot.

The student places a fan at different distances from a potometer to create different wind speeds.

Figure 2 shows the equipment the student uses.

Figure 2



0 2 . 1

Give **two** environmental factors the student should keep constant during this investigation.

[2 marks]

- 1 *Light intensity*
- 2 *(Air) temperature (also humidity)*

0 2 . 2

The student cuts the shoot under water and also positions it in the potometer under water.

Give **two** other precautions the student should take when setting up a potometer to get an accurate measurement of water uptake.

[2 marks]

- 1 *Make sure all joints are sealed (airtight and watertight).*
- 2 *Make sure there are no air bubbles, and the leaves are dry.*



Table 1 shows the student's results from this experiment.

Table 1

Distance between the plant shoot and the fan / cm	Rate of water uptake / $\text{mm}^3 \text{ hour}^{-1}$
20	776.4
40	718.3
60	702.6
80	686.9
100	682.2

0 2 . 3

The rate of water uptake was calculated using the distance the air bubble moved through the capillary tube in 5 minutes.

The diameter of the capillary tube was 1.0 mm

When the fan was positioned 20 cm away from the plant shoot, calculate the distance the air bubble moved in 5 minutes.

Give your answer in mm and correct to 2 significant figures.

The area of a circle is found using the formula:

Area = πr^2 Use 3.14 for the value of π

[3 marks]

$$\text{volume in 5 min} = 776.4 \div 12 = 64.7 \text{ mm}^3$$

$$\text{area of tube} = 3.14 \times 0.5^2 = 0.785 \text{ mm}^2$$

$$\text{distance} = 64.7 \div 0.785 = 82.42 \text{ mm}$$

$$(= 776.4 \times 4 \div (12 \times 3.14))$$

Distance = 82 mm

Turn over ►



0 2 . 4

Explain the results shown in **Table 1** (on page 5).

[3 marks]

The closer the fan is to the plant shoot, the faster the air movement (wind speed), so more water vapour (moist air) is removed from around the stomata and leaves.

This increases the water potential gradient between the air spaces in the leaf and the air outside.

So there is more evaporation and diffusion of water vapour out of the leaf (more transpiration), so the rate of water uptake increases.

0 2 . 5

The student wants to compare these results with those of other students to find out if they are similar.

To compare the results, give **one** additional measurement all the students in the group should take.

[1 mark]

The total surface area of all the leaves on the plant shoot.

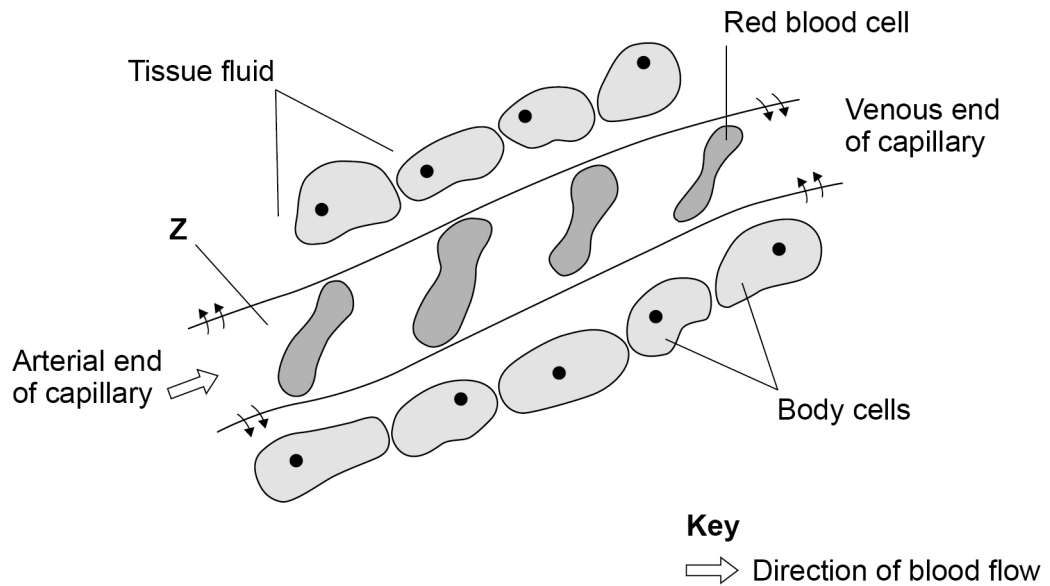


0 3

In humans, substances move out of the capillaries to form tissue fluid.

Figure 3 shows a capillary and some of the surrounding cells.

Figure 3



0 3

1

Name the fluid found at point **Z**.

[1 mark]

(Blood) plasma

0 3

2

Give **two** ways the composition of fluid at point **Z** is different from tissue fluid.

[2 marks]

- 1 *Fluid Z has more (larger) proteins.*
- 2 *Fluid Z has more glucose and oxygen, and less carbon dioxide.*

Question 3 continues on the next page

Turn over ►



0 3 . 3

Tissue fluid is formed at the arterial end of the blood capillary.

Describe how some tissue fluid is returned to the circulatory system at the venous end of the capillary.

[4 marks]

At the venous end of the capillary the hydrostatic pressure in the capillary is lower (lower than in the tissue fluid).

Large plasma proteins stay in the blood, so the water potential in the capillary is lower (more negative) than in the tissue fluid.

So water moves back into the capillary by osmosis, down a water potential gradient.

7



0 4

A student investigates the different stages of the cell cycle in the roots of onion plants.

As part of the method, the student:

- places a root tip onto a microscope slide
- adds two drops of a stain
- positions a cover slip on top of the root tip
- presses downwards on the cover slip.

0 4 . 1

Explain why the student:

[3 marks]

uses tissue only from the tip of the onion root *This is where the dividing cells are found (meristem), so mitosis is occurring; there are no dividing cells further from the tip.*

adds a stain *Chromosomes are not visible without a stain, so it lets you distinguish the chromosomes (chromatids).*

presses downwards on the cover slip. *To get a single thin layer of cells (spread out), so light passes through and the cells and nuclei are visible.*

0 4 . 2

The student uses an optical microscope to identify and count cells in different stages of the cell cycle.

When counting cells with the optical microscope, explain **two** precautions the student should take to make sure the results are valid.

[4 marks]

1 *Examine a large number of fields of view (at least 10) and many cells.*

This ensures a representative sample of cells.

2 *Use a counting grid (eyepiece graticule) and count cells in each square in order.*

This ensures that cells are not counted more than once.

Turn over ►



Table 2 shows the results the student recorded.

Table 2

Stage	Number of cells
Interphase	110
Prophase	12
Metaphase	11
Anaphase	5
Telophase	12

0 4 . 3 The student recorded five cells in anaphase.

Describe the appearance of a cell in anaphase.

[1 mark]

*The cell contains two groups of V-shaped chromatids (chromosomes)
being pulled to opposite poles.*

0 4 . 4 One cell cycle of the root tissue studied takes 16 hours.

The number of cells at each stage is proportional to the time spent at that stage.

Calculate the number of minutes these root cells are in anaphase.

Use information from **Table 2**.

[2 marks]

$$\text{total cells} = 110 + 12 + 11 + 5 + 12 = 150$$

$$16 \text{ h} = 16 \times 60 = 960 \text{ min}$$

$$(5 \div 150) \times 960 = 32$$

32 minutes



0 4 . 5

Another student completes the same experiment using root tissue from the same variety of onion plant.

The two students get different results.

Give **two** possible reasons for the different results.

[2 marks]

1 *Chance: the field of view chosen may not be representative of the rest of the root tip.*

2 *Genetic differences between the plants (or different age of root tip).*

12

Turn over for the next question

Turn over ►



0 5 . 1

The aorta takes oxygenated blood away from the heart.

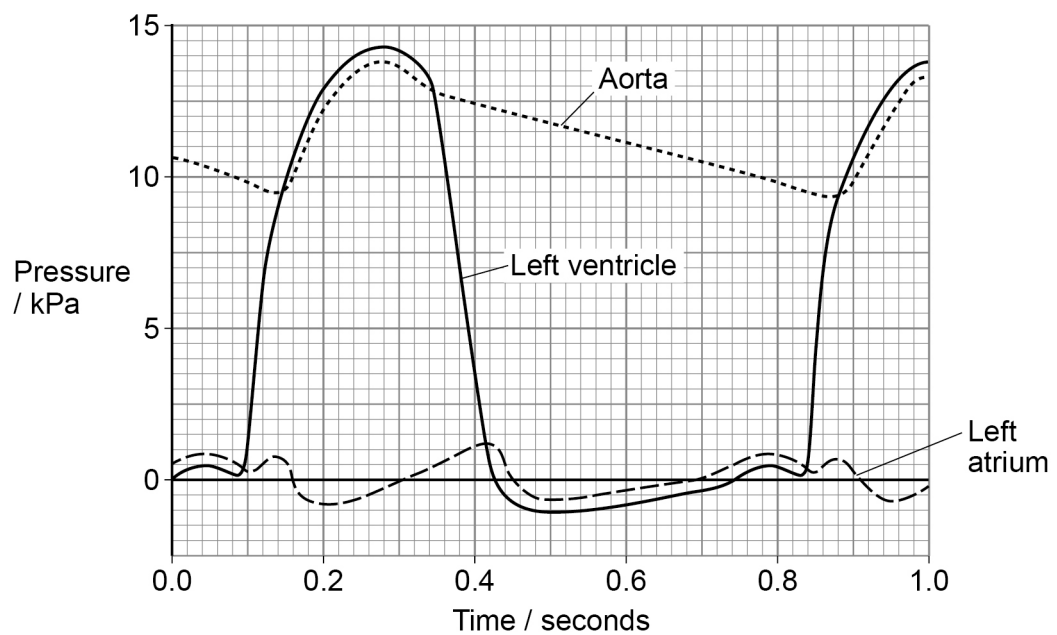
Describe **two** ways that the structure of the aorta is related to its function.

[2 marks]

- 1 *Thick wall (with collagen) withstands high blood pressure and stops the aorta bursting.*
- 2 *Elastic tissue allows stretching and recoil, which smooths out blood flow and maintains pressure.*

Figure 4 shows the pressure changes in the left side of the heart.

Figure 4



Use information from **Figure 4** to answer the following questions.

0 5 . 2 Calculate the heart rate in beats per minute.

Give your answer to the nearest whole number.

[1 mark]

$$\text{one cycle} = 0.84 - 0.10 = 0.74 \text{ s}$$

$$60 \div 0.74 = 81.08$$

81 beats per minute

0 5 . 3 Calculate the length of time that the muscle of the left ventricle would be contracting within a 24-hour period.

Assume the heart rate stayed constant during this time.

Give your answer in hours, to the nearest hour.

[2 marks]

$$\text{one contraction} = 0.34 - 0.15 = 0.19 \text{ s}$$

$$0.19 \div 0.74 \times 24 = 6.16 \text{ hours}$$

$$(0.19 \times 81 \times 60 \times 24 \div 3600 = 6.156)$$

6 hours

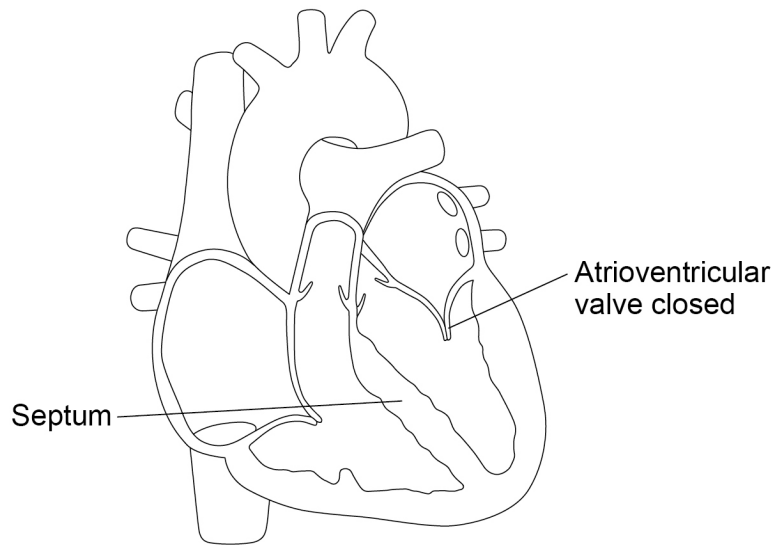
Question 5 continues on the next page

Turn over ►



Figure 5 shows a section through the human heart during one stage of the cardiac cycle.

Figure 5



0 5 . 4

At 0.2 seconds in the cardiac cycle shown in **Figure 4** (on page 12), blood is leaving the left ventricle.

Use information from **Figure 4** and **Figure 5** to explain what causes blood to leave the left ventricle at this time.

[3 marks]

At 0.2 s the muscle in the wall of the left ventricle is contracting, causing a high pressure in the ventricle (13 kPa), higher than in the aorta.

So the semilunar (aortic) valve is forced open and blood flows into the aorta.

The atrioventricular valve is closed by the high pressure in the left ventricle (higher than in the atrium), so blood cannot flow back into the atrium.



0 5 . 5

Some babies are born with a hole in the septum between the left ventricle and the right ventricle.

Babies with a hole in the septum of the heart transport less oxygen around the body.

Suggest why.

[2 marks]

*Oxygenated blood flows from the left ventricle into the right ventricle,
mixing oxygenated and deoxygenated blood.*

*So a lower volume of oxygenated blood leaves the left ventricle into the
aorta, at a lower pressure, so less oxygen is carried in the blood in the
aorta.*

10

Turn over for the next question

Turn over ►



06.1

Describe how HIV replicates after the virus enters a human cell.

[6 marks]

Reverse transcriptase uses the viral RNA as a template to make a single-stranded DNA copy.

DNA polymerase then makes this into double-stranded viral DNA.

Integrase enables the viral DNA to be integrated (inserted) into the host cell DNA.

The viral DNA is transcribed to make new viral RNA (copies of the HIV genome) and mRNA.

The viral DNA is used to make new HIV proteins (capsid proteins and enzymes), which are made at the host cell ribosomes.

The new viruses are assembled and bud out, acquiring their lipid envelope from the plasma membrane of the infected cell.

06.2

Some people are resistant to infection by HIV. These people have a mutation in the gene that codes for the proteins on the surface of CD4 helper T cells.

Suggest how people with this mutation may be resistant to HIV infection.

[3 marks]

The mutation causes a different sequence of amino acids (primary structure) in the receptor proteins, so a change in their tertiary structure (shape).

So the receptor is no longer complementary to the virus attachment proteins, so HIV cannot bind to the CD4 cell.

So the viral RNA (contents) cannot enter the cell.

9



07.1

Explain how a mutation of a tumour suppressor gene can cause a tumour.

[2 marks]

The mutation inactivates the tumour suppressor gene, so it can no longer slow down (control) cell division.

So the rate of cell division (mitosis) is too rapid and uncontrolled, and the cells continue to divide, forming a tumour.

07.2

Some tumours are benign and some tumours are malignant.

Which statement is **not** true of malignant tumours?**[1 mark]**Tick (✓) **one** box.

More likely to be life-threatening

☐

More likely to grow projections into surrounding tissue

☐

More likely to grow slowly

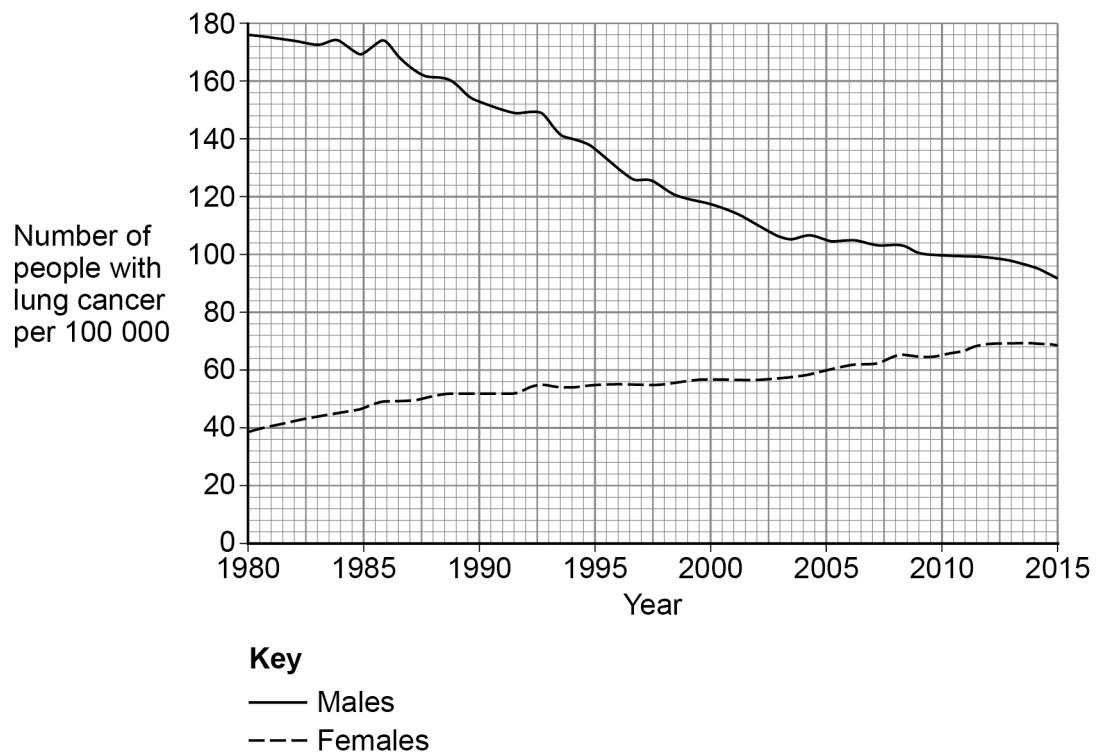
☒

More likely to occur again after treatment

☐**Question 7 continues on the next page****Turn over ►**

Figure 6 shows the numbers of males and females with lung cancer in the UK between 1980 and 2015.

Figure 6



0 7 . 3

Describe how the numbers of males and females with lung cancer have changed between 1980 and 2015.

Use information from **Figure 6**.

[2 marks]

The number of males with lung cancer has decreased (from 176 to 92 per 100 000) and the number of females has increased (from 40 to 69 per 100 000).

There is a larger change in males: a sharp decrease until 2003 then a more gradual decrease, while females increase slowly.



Table 3 shows the mean survival rates for males and females diagnosed with lung cancer in 2015 in the UK.

Table 3

	Mean survival rate after 2015 diagnosis / % $\pm$ SE		
	1 year	Estimated	
		5 years	10 years
Males	30.4 $\pm$ 0.3	8.4 $\pm$ 0.9	4.0 $\pm$ 1.2
Females	35.1 $\pm$ 0.3	11.6 $\pm$ 1.0	6.5 $\pm$ 1.9

0 7 . 4

Table 3 shows that females with lung cancer are expected to survive longer than males with lung cancer.

Are the survival rates for females **significantly** greater than the survival rates for males?

Give evidence from **Table 3** in your answer.

[3 marks]

Yes for 1 year and 5 years: the survival rates of females are significantly higher than males after 1 year and 5 years.

This is because the standard errors do not overlap (30.1 to 30.7 vs 34.8 to 35.4, and 7.5 to 9.3 vs 10.6 to 12.6).

No for 10 years: there is no significant difference, as the standard errors overlap (2.8 to 5.2 vs 4.6 to 8.4), so the difference could be due to chance.

8

Turn over for the next question

Turn over ►



08.1

Describe how:

- carbohydrates are digested in the human body
- the products of carbohydrate digestion are absorbed.

[5 marks]

Digestion: salivary amylase in the mouth and pancreatic amylase in the small intestine convert starch to maltose.

Maltase (a membrane-bound disaccharidase on the epithelial cells of the ileum) converts maltose to glucose; sucrase and lactase hydrolyse sucrose and lactose.

These are hydrolysis reactions, which break the glycosidic bonds.

Absorption: sodium ions are actively transported out of the epithelial cell into the blood.

This maintains a low concentration of sodium ions in the epithelial cell, so a sodium ion concentration gradient between the lumen and the epithelial cell.

Glucose moves into the epithelial cell by co-transport with sodium ions, via a co-transport (carrier) protein.

Glucose then moves out of the epithelial cell into the blood by facilitated diffusion.



0 8 . 2

Describe the mass flow hypothesis for the movement of carbohydrates in plants.

[5 marks]

At the source (leaves), sucrose is actively transported into the phloem sieve tube elements by companion cells (co-transport with H^+ ions).

This lowers the water potential in the sieve tube, so water enters from the xylem by osmosis.

This produces a high hydrostatic pressure at the source end of the sieve tube.

At the sink (roots, storage tissue), sucrose is removed and used for respiration or stored (as starch), so water leaves by osmosis and the pressure is lower.

So there is a hydrostatic pressure gradient from source to sink.

This causes mass flow of the sucrose solution through the sieve tubes towards the sink.

10

END OF QUESTIONS

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