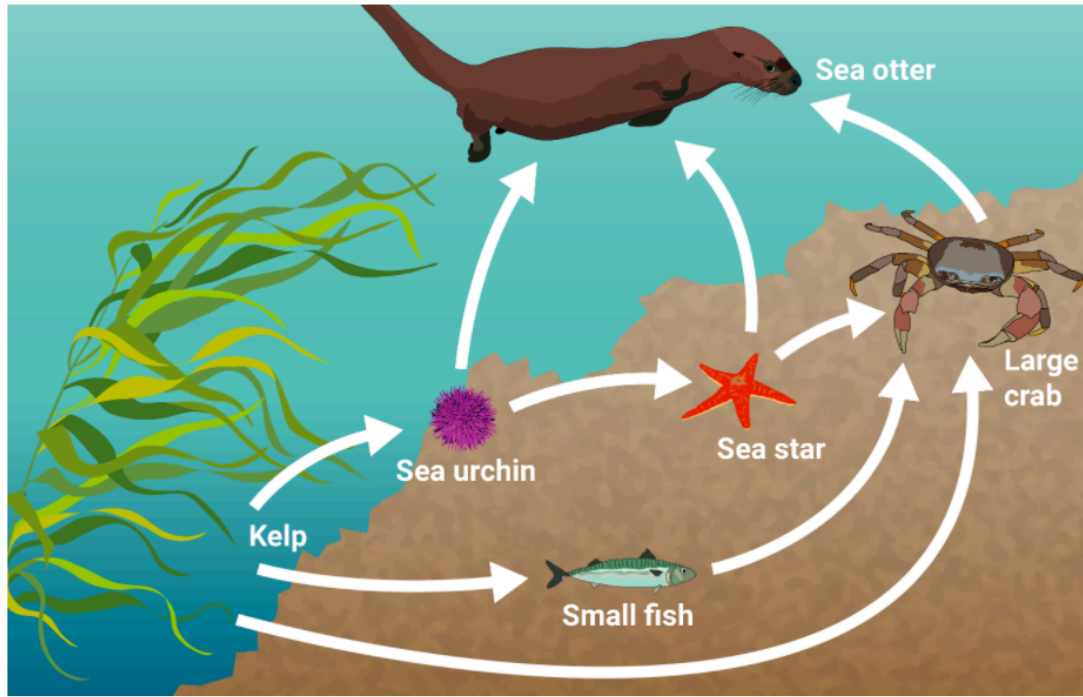


The food web below shows the feeding relationships in a marine ecosystem.



Question 1a (1 mark)

**Identify** a primary consumer in the food web.

Rich text editor toolbar with icons for Bold (B), Italic (I), Undo, Redo, Underline (U), Subscript (x<sub>2</sub>), Superscript (x<sup>2</sup>), Bulleted list, Numbered list, Link (Ω), Unlink (Σ), Styles dropdown, and a mobile device icon.



Question 1b (2 marks)

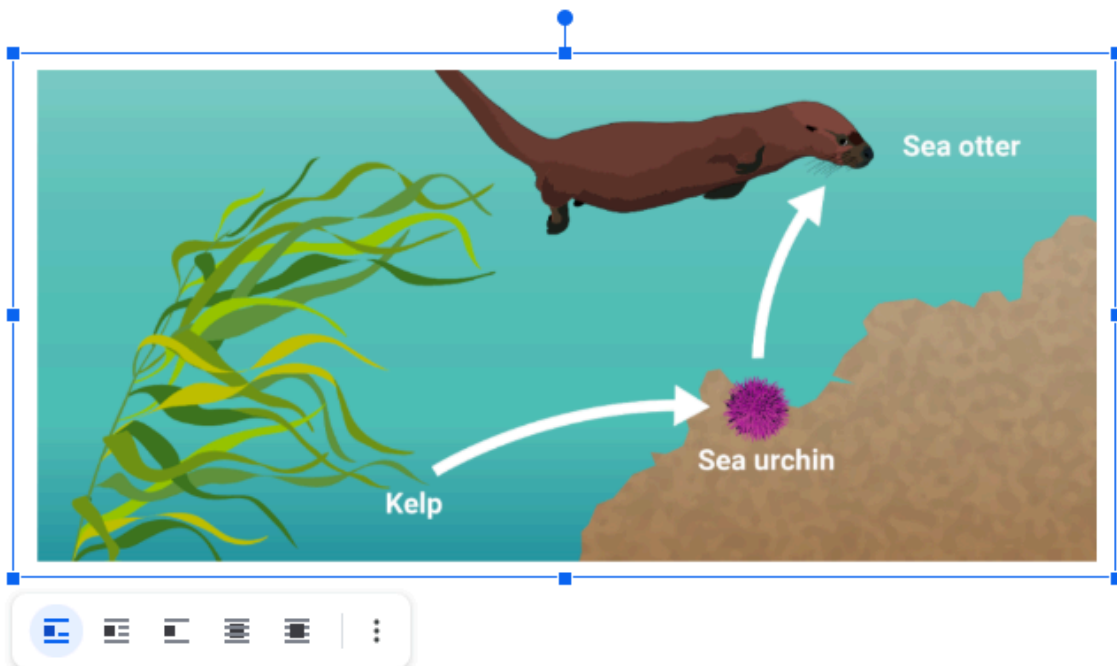
**Outline** why all food chains in a food web must start with a producer.

---



Question 1c (1 mark)

One of the food chains in this food web is shown below.



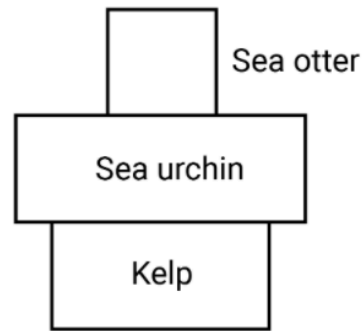
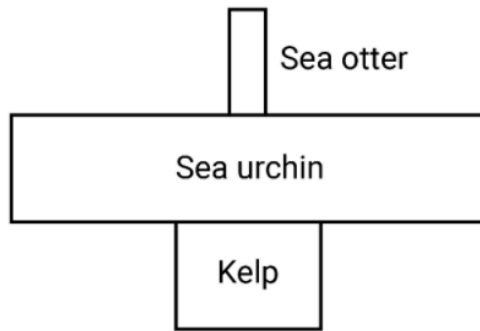
Until the 1950s, sea otters were killed and hunted for their fur; this had a dramatic impact on this ecosystem. Following a ban on hunting in the 1970s, the sea otter population started to increase.

**Suggest** another human action that could have caused the sea otter population to increase.



Question 1d (4 marks)

The following diagrams are pyramids of numbers from the food chain in part (c). The pyramid on the left shows the ecosystem in 1957; the pyramid on the right shows the ecosystem today.



Using the diagrams, **explain** the effect of the growing sea otter population on the populations of sea urchins and kelp.



Question 2 (10 marks)



Question 2a (1 mark)

To be healthy, humans need a balanced diet containing a mixture of nutrients. The body uses proteins for growth and repair. **State** a nutrient that is used as a source of energy under normal circumstances.

Rich text editor toolbar with icons for Bold (B), Italic (I), Undo, Redo, Underline (U), Subscript (x<sub>2</sub>), Superscript (x<sup>2</sup>), Bulleted list, Numbered list, Link (Ω), Unlink (Σ), Styles dropdown, and a document icon.

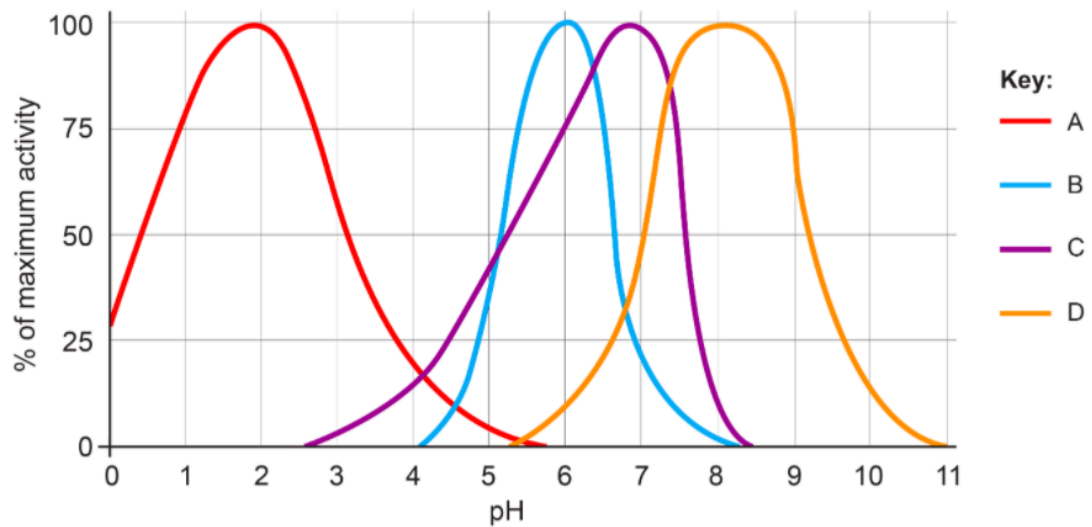


Question 2b (1 mark)

Proteases are enzymes in the stomach that begin to digest proteins. **Select** what is produced when proteins are digested.



Cells in the stomach lining produce hydrochloric acid. The graph below shows the activity of four different enzymes. **Select** the enzyme that digests protein in the stomach. **Justify** your answer.



- A
- B
- C
- D



Question 2d (2 marks)

The products of digestion must enter the blood to be transported around the body. **Outline** the process through which the products of digestion enter the bloodstream. You should use scientific terminology in your answer.



In addition to the products of digestion, other molecules are present in the bloodstream. **Explain** how red blood cells are adapted to transport gases around the body.



Question 3 (9 marks)



Question 3a (2 marks)

The reproductive system is controlled by hormones. **Select** the correct items to complete the diagram below.



Draggable items:

insulin

ovaries

pancreas

testes

progesterone

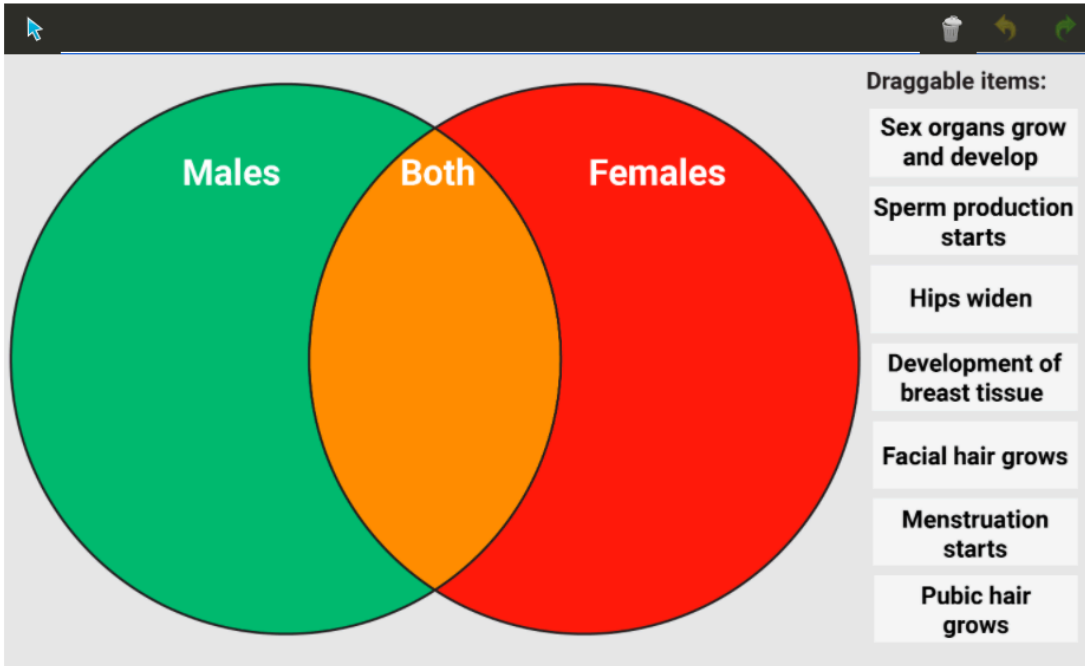
testosterone

Sex hormone

Site of production

**Question 3b** (2 marks)

Sex hormones are responsible for the changes during puberty. **Select** the correct location for each change in the diagram below.



A Venn diagram with two overlapping circles. The left circle is green and labeled "Males". The right circle is red and labeled "Females". The overlapping area in the center is orange and labeled "Both". To the right of the diagram is a list of "Draggable items":

- Sex organs grow and develop
- Sperm production starts
- Hips widen
- Development of breast tissue
- Facial hair grows
- Menstruation starts
- Pubic hair grows



**Question 3c** (2 marks)

Sperm are formed in the testes through meiosis. Human body cells contain 46 chromosomes, but sex cells contain 23. **Outline** why there are fewer chromosomes in sex cells.

**B** *I* ← → U  $x_0$   $x^2$   $\sum$   $\Omega$   $\Sigma$  Styles -



**Question 3d** (3 marks)

Using your knowledge of sex chromosomes X and Y, **explain** why sperm determine whether offspring will be male or female.

**B** *I* ← → U  $x_0$   $x^2$   $\sum$   $\Omega$   $\Sigma$  Styles -

Question 4 (13 marks)

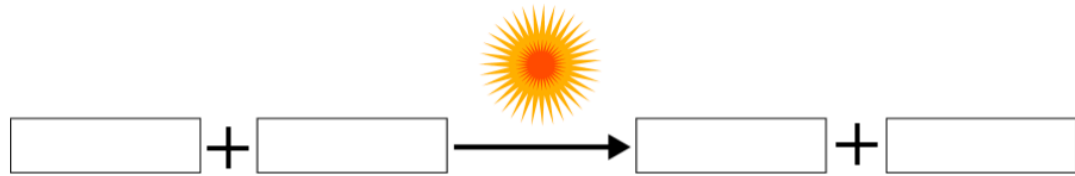
Climate change is one of the biggest current issues facing humanity. Human actions have caused atmospheric carbon dioxide (CO<sub>2</sub>) concentration to increase, which has led to a rise in average global temperatures.

Question 4a (1 mark)

Plants use sunlight to convert CO<sub>2</sub> to glucose using a process called photosynthesis.

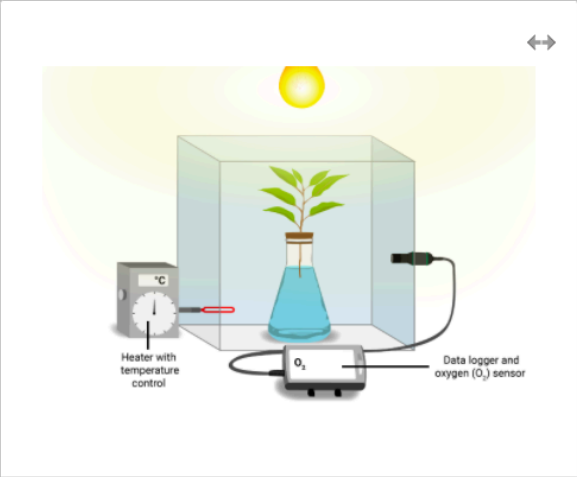
Select words to complete the word equation for photosynthesis.

Draggable items: Oxygen Glucose Water Carbon dioxide



**Question 4b** (4 marks)

A student decided to test the effect of temperature on photosynthesis. The experiment they conducted is shown below.



**Identify** the variables in this investigation.

Independent variable

**B** *I* ← → U  $x_2$   $x^2$   $\frac{1}{x}$   $\frac{1}{x^2}$   $\Omega$   $\Sigma$

Styles ▾

Dependent variable

**B** *I* ← → U  $x_2$   $x^2$   $\frac{1}{x}$   $\frac{1}{x^2}$   $\Omega$   $\Sigma$

Styles ▾



Question 4c (3 marks)

**Formulate** a hypothesis for this investigation.

If

**B** *I* ← → U  $x_e$   $x^e$   $\frac{1}{2}$   $\frac{3}{2}$   $\Omega$   $\Sigma$  Styles -

Then

**B** *I* ← → U  $x_e$   $x^e$   $\frac{1}{2}$   $\frac{3}{2}$   $\Omega$   $\Sigma$  Styles -

Because



Question 4d (2 marks)

The student conducted the experiment and collected the data below.

Temperature	Concentration of O <sub>2</sub> after 10 minutes / 10 <sup>3</sup> ppm*			
	Trial 1	Trial 2	Trial 3	Average
20	219	217	218	218
40	262	261	259	
60	201	200	202	201

\*ppm: parts per million, a unit for measuring small concentrations

**Calculate** the missing average and add it to the table, giving your answer to an appropriate degree of accuracy.



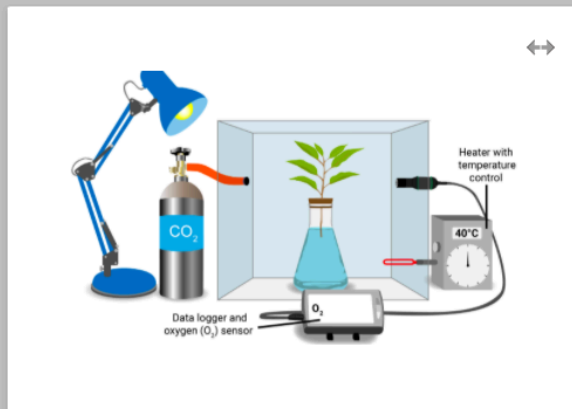




### Question 5 (14 marks)



A student tested the effect of carbon dioxide ( $\text{CO}_2$ ) concentration on the rate of photosynthesis, using the following method.



1. Using a knife, cut the base of the plant stem.
2. Place the plant stem in a flask filled with water.
3. Place the flask with the plant stem in a closed container with a heater set to  $40^\circ\text{C}$  and a  $\text{CO}_2$  regulator to adjust the level of  $\text{CO}_2$ .
4. Carry out the experiment with  $\text{CO}_2$  concentrations of 0.05%, 0.10% and 0.15%.
5. Measure the concentration of  $\text{O}_2$  in ppm after 10 minutes.
6. Use the concentration of  $\text{O}_2$  data to calculate the rate of photosynthesis.



### Question 5a (2 marks)

The method does not contain details of how control variables should be monitored. **State** two extra details that should be added to the method to make it repeatable.



### Question 5b (2 marks)

**Suggest** two reasons for setting the heater at  $40^\circ\text{C}$ .





**Question 5c** (4 marks)

The student's laboratory partner read through the method. They said that the method would not give sufficient data to test the effect of changing CO<sub>2</sub> concentration on the rate of photosynthesis.

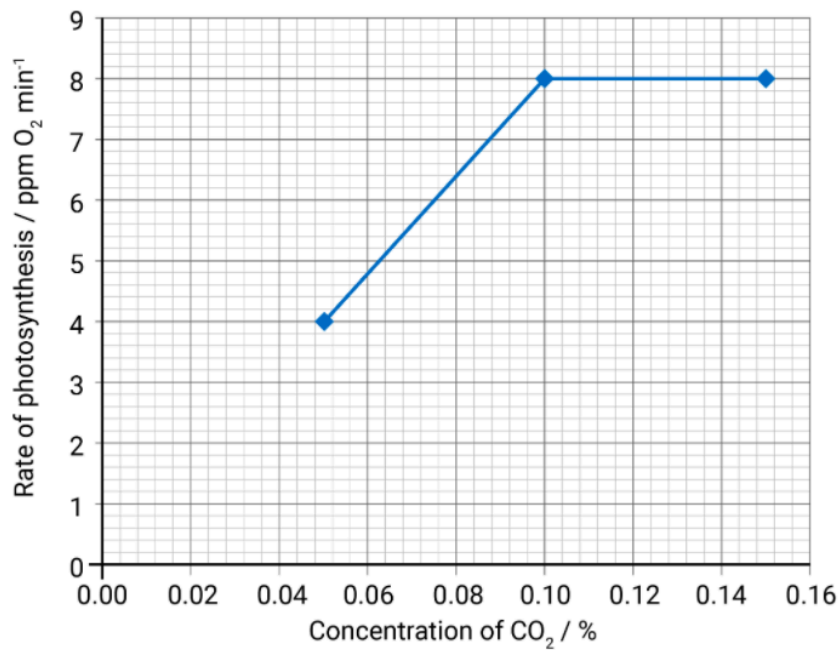
**Suggest** and **justify** two improvements to the data collection to give sufficient data.

Improvement 1 and justification



**Question 5d** (5 marks)

The students used their data to calculate the rate of photosynthesis and plotted the graph below.



Using data from the graph and scientific reasoning, **explain** the results of this experiment.



Question 5e (1 mark)

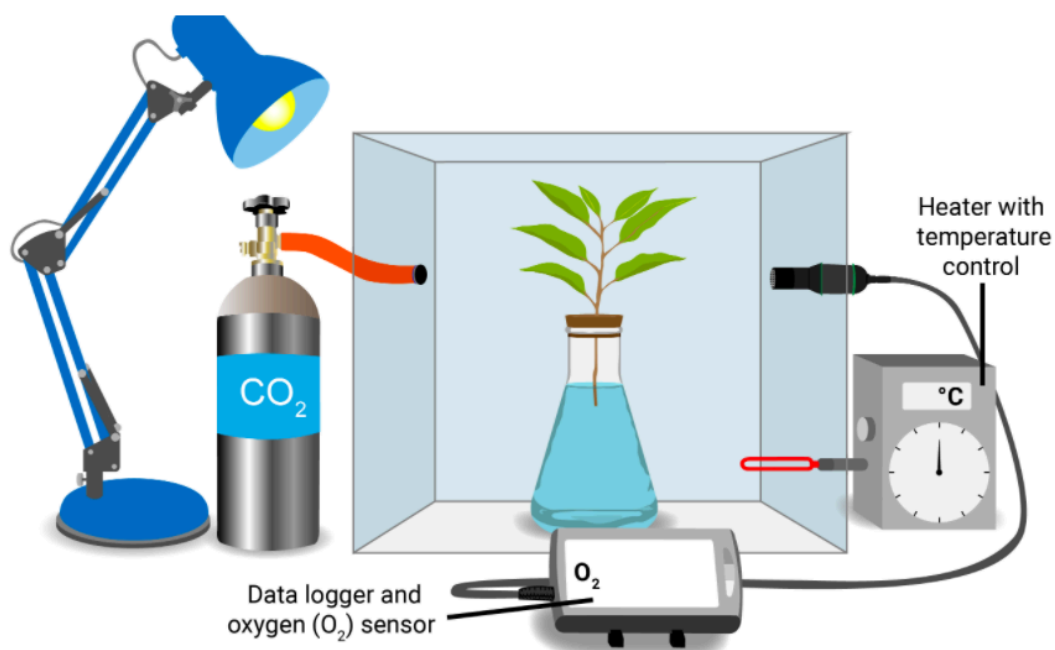
**Suggest** how the students could increase the rate of photosynthesis beyond  $8 \text{ ppm O}_2 \text{ min}^{-1}$ .



Question 6 (15 marks)



The students wanted to extend their knowledge of photosynthesis.



**Design** an investigation to test how changing light intensity affects the rate of photosynthesis. You are provided with the equipment above and standard laboratory equipment. In your answer, you should include:

- the independent variable, dependent variable and two control variables
- a testable hypothesis
- details of any additional equipment you would need
- details of how to manipulate, measure or monitor the variables
- details of the method to collect sufficient data.



### Question 7 (7 marks)



In addition to maximizing plant growth through photosynthesis, the yield of plant crops can be increased using pesticides. Pesticides are compounds used in farming to kill plant pests.

The table below shows the results from experiments testing the impact of using the pesticide boric acid on the yield of different plant species. The experiment was conducted in a greenhouse with constant environmental conditions and concentration of pesticide.

Plant species	Yield without pesticide / kg m <sup>-2</sup>	Yield with pesticide / kg m <sup>-2</sup>
W	1.8	3.0
X	1.9	2.0
Y	2.0	2.4
Z	1.0	1.2

Reset



### Question 7a (1 mark)

**Identify** the plant species that has the highest yield when grown using pesticide.



### Question 7b (1 mark)

In some species, the use of pesticide did not have a large impact on yield. **Suggest** a reason for this observation.

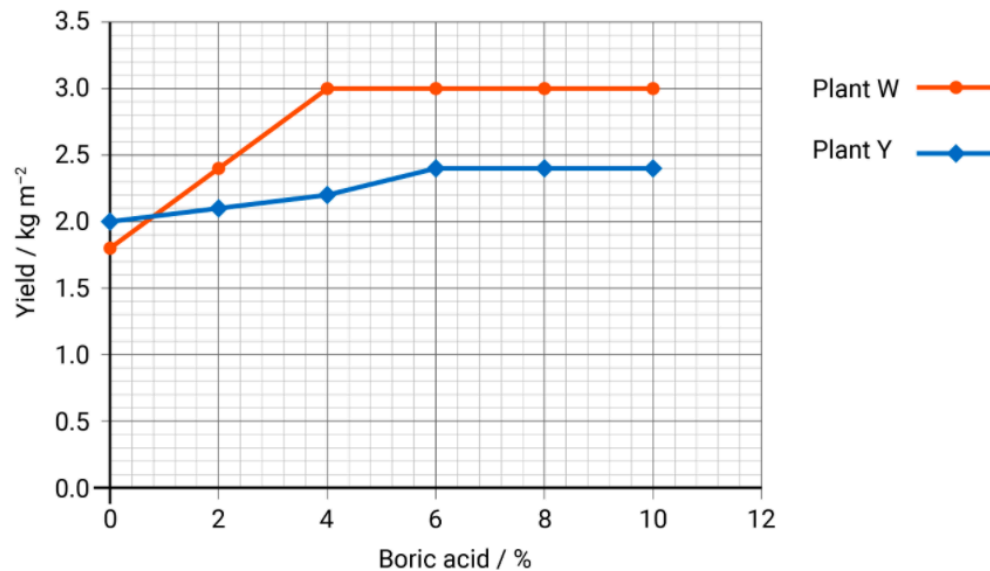


### Question 7c (1 mark)

**State** the reason for conducting these experiments inside a greenhouse.

Question 7d (2 marks)

A farmer who grows species W and Y decided to find the lowest possible concentration of boric acid needed to maximize yield. They conducted an experiment on different plots of land to determine the impact on yield. The graph below shows how yield changes for different concentrations of boric acid.



**Identify** the minimum concentration of boric acid that the farmer should use to maximize the yield of plants W and Y.

Question 7e (2 marks)

The farmer wants to grow both species on the same farm. **Identify** the minimum concentration of boric acid they should use. **Justify** your answer.

Question 8 (10 marks)

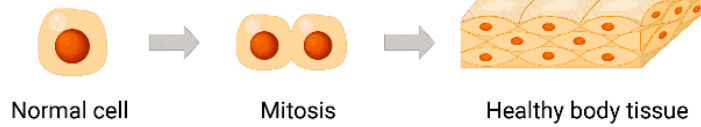
A disease is a disorder that affects an organism's body, organs, tissues or cells. Diseases can be caused by pathogens; they can be inherited or they can develop due to changes in normal body processes.

This media is interactive

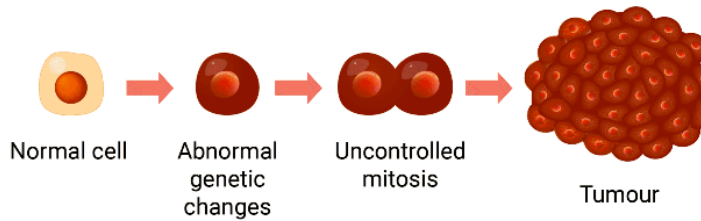
Click on the blue arrow to view the images.



In healthy organisms, cells divide by mitosis to grow and replace old or damaged cells.

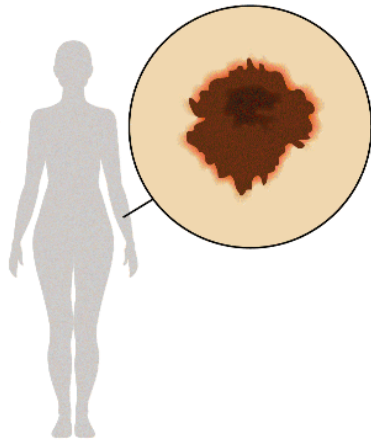
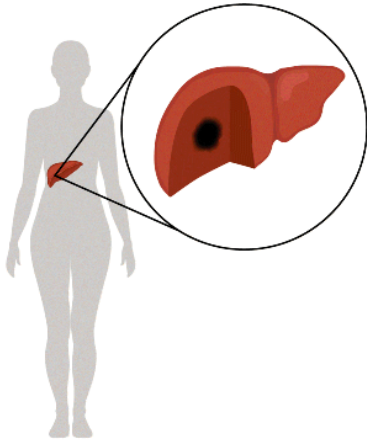
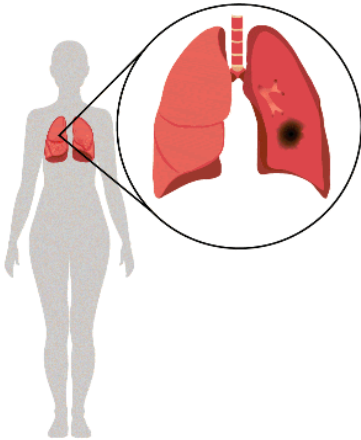


Tumours are formed when cells grow and divide uncontrollably.



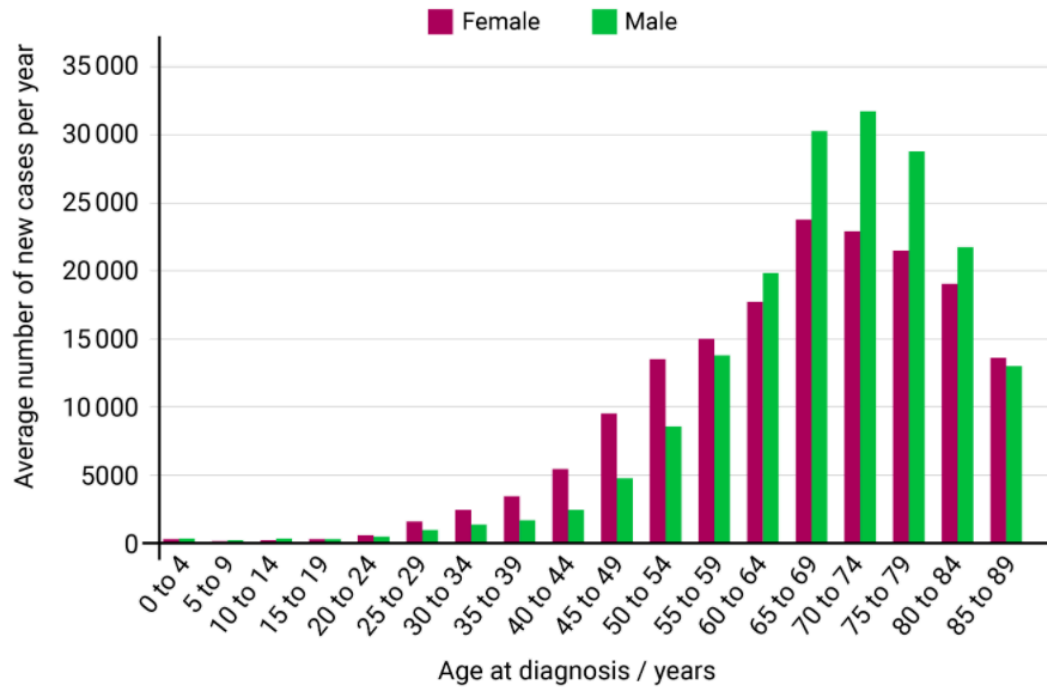
Scroll down to continue

Certain behaviours such as smoking, alcohol intake and sun exposure increase the risk of certain cancers developing:



Question 8a (2 marks)

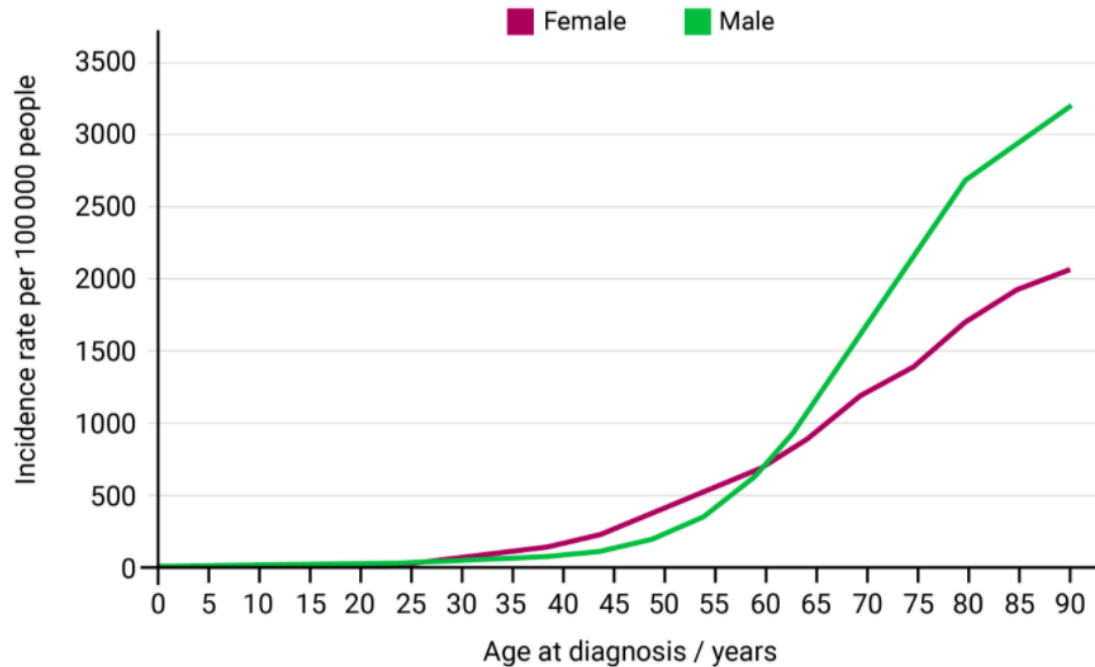
The graph below shows the number of new cases of cancer per year in females and males in the UK in 2016–2018.



Using the graph, **state** one similarity and one difference in the trends in new cancer cases per year for females and males.

**Question 8b** (2 marks)

The data can also be presented as the number of cases per 100 000 people. This is known as the incidence rate.



©

**Suggest** and **justify** why the incidence rates for both males and females increase with age.

**Question 8c** (6 marks)

A student claims that spending time in the sun is good for health. **Discuss** and **evaluate** the student's claim. In your answer, you should include:

- health benefits that support the student's claim
- health concerns that do not support the student's claim
- a concluding statement with advice for minimizing the health concerns.



Question 9 (14 marks)



Developments in science and technology have allowed for personalization of medicine so that patients can be prescribed the most effective treatment. The video below gives an overview of personalized medicine.



One aspect of healthcare involves prescribing the most effective treatment.

Currently, most standard combinations of drugs and their doses are based on evidence gained from clinical trials. The drug and dose are effective for most patients with a specific disease.

However, differences in genetic material between individuals mean that not all patients respond in the same way to standard treatments.

In personalized medicine, DNA sequencing is used to study a patient's genetic material before deciding on a treatment.

DNA sequencing can be used to determine which version of a disease a patient has. This information can be used to predict how individual patients will respond to different drugs and doses.

Personalized medicine has the potential to reduce incorrect treatment and to save valuable resources. Improvement of DNA sequencing methods will speed up this process and reduce the cost.

The move from standard treatments to personalized medicine is a huge task.

It is not yet possible to treat all diseases in this way and approval processes for new drugs vary across the world.

Decisions need to be made about an individual's genetic information. Who owns the sequencing data and who should have access?

When should sequencing be done?

Should we use data to confirm diagnoses, or could we use it to look for potential issues before a person gets ill?

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**Discuss** and **evaluate** the use of personalized healthcare in the treatment of diseases. In your answer, you should include:

- medical benefits of personalized healthcare for an individual and wider society
- economic considerations in moving to personalized healthcare
- ethical considerations
- a concluding appraisal with justification.