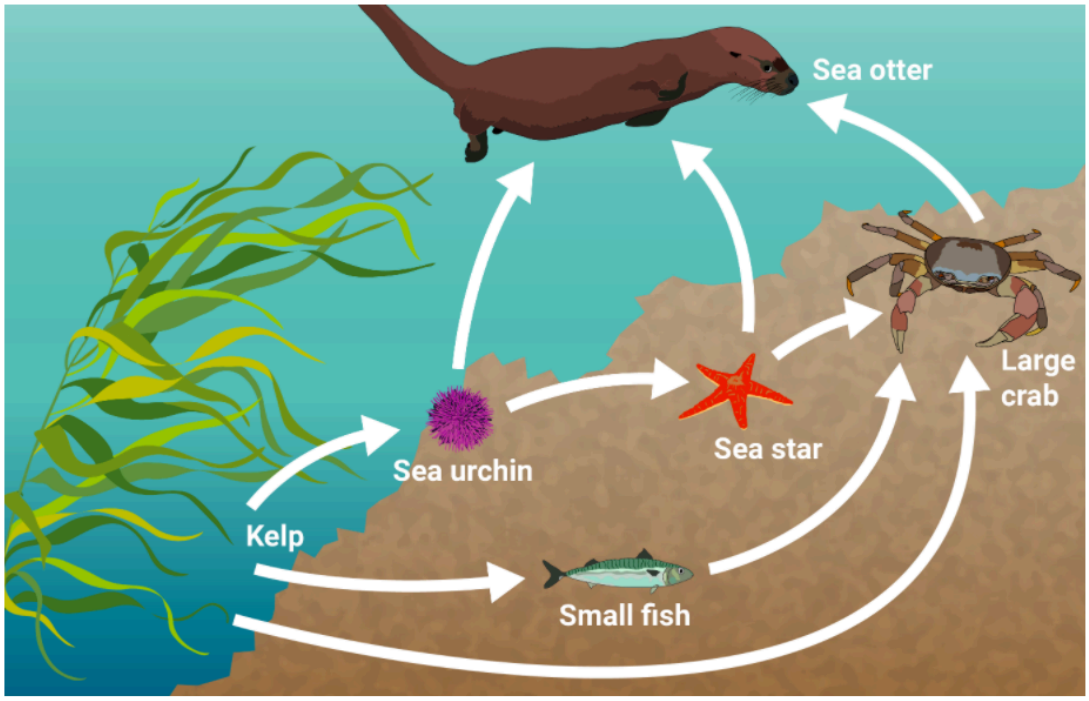
The food web below shows the feeding relationships in a marine ecosystem.



Question 1a (1 mark)

Identify a primary consumer in the food web.

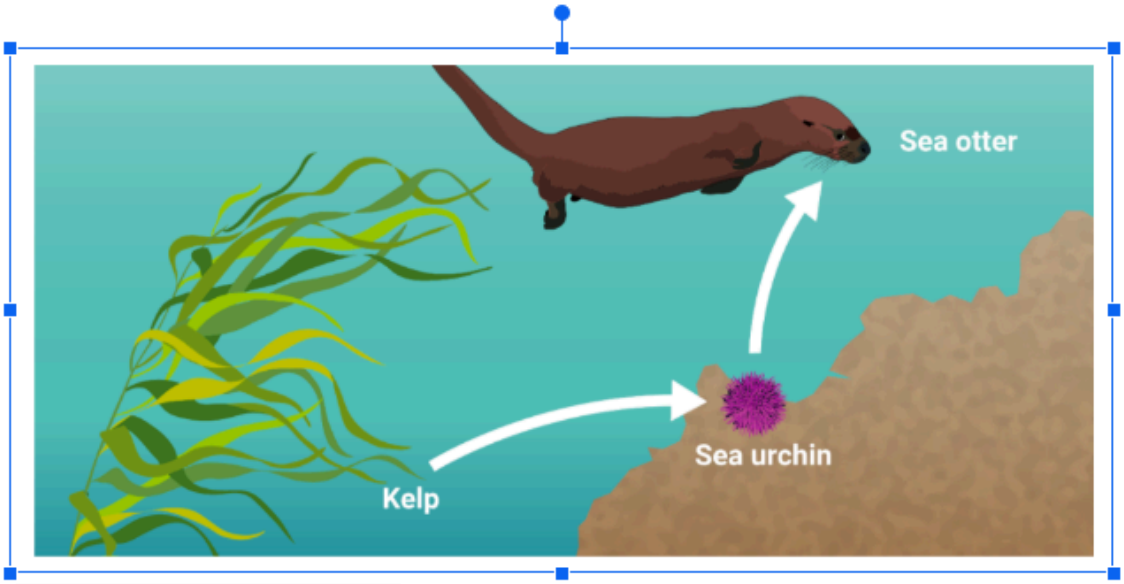
B I U x_2 x^2 Ω Σ Styles

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.

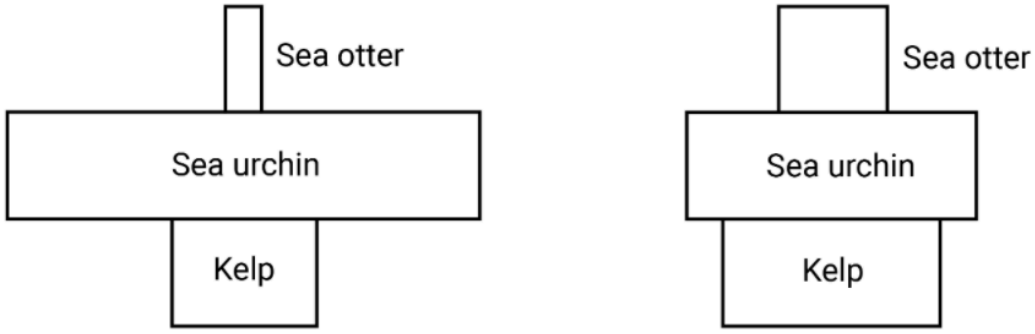


Until the 1950s, sea otters were killed and hunted for their fur; this had a dramatic impact on this ecosystem. Following a ban on hunting in the 1970s, the sea otter population started to increase.

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)

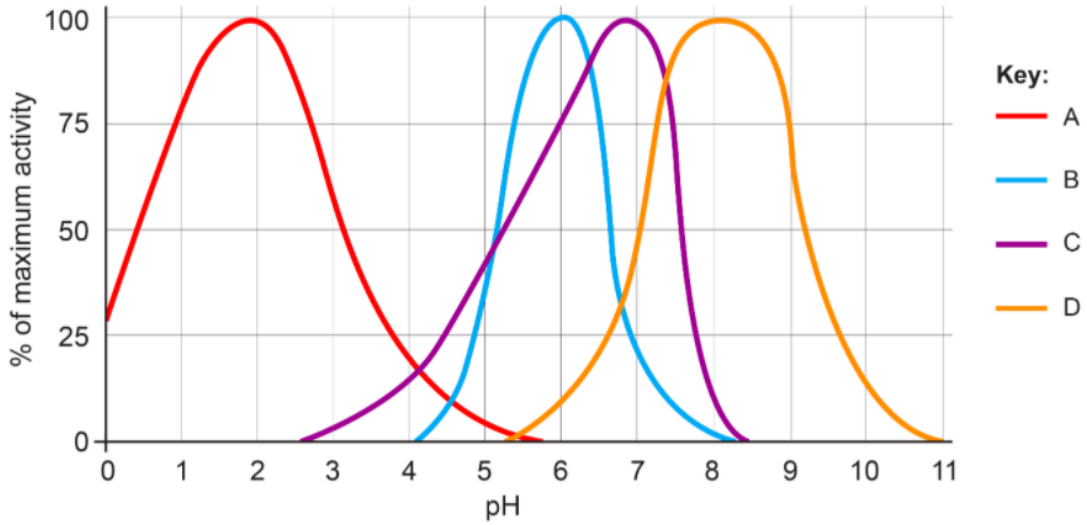
Question 2a (1 mark)

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.

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)

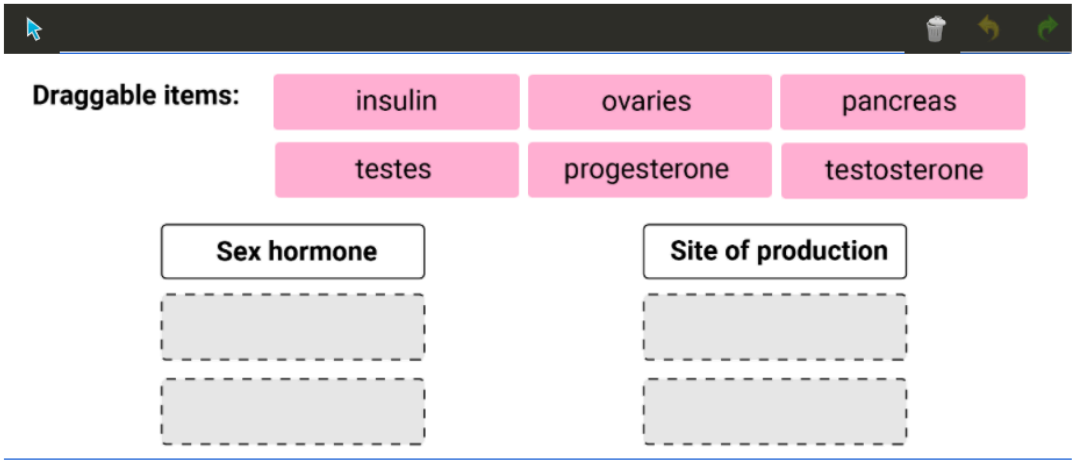
The products of digestion must enter the blood to be transported around the body. **Outline** the process through which the products of digestion enter the bloodstream. You should use scientific terminology in your answer.

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)

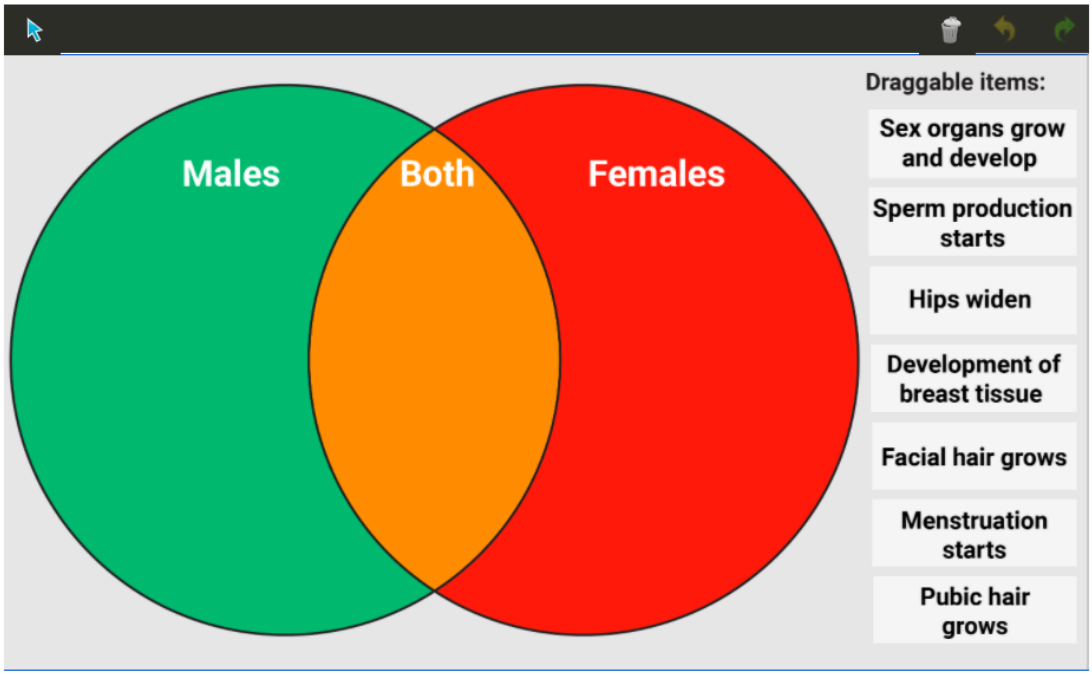
Question 3a (2 marks)

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



Question 3b (2 marks)

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



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.

Question 3d (3 marks)

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

Question 4 (13 marks)

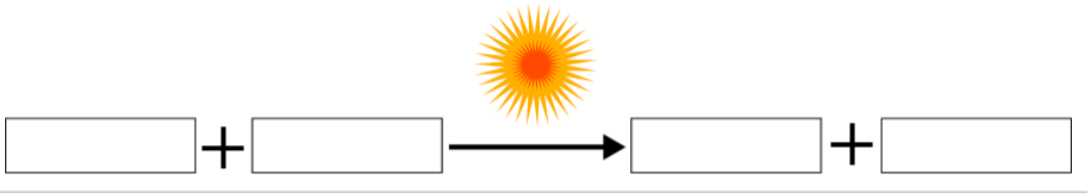
Climate change is one of the biggest current issues facing humanity. Human actions have caused atmospheric carbon dioxide (CO_2) concentration to increase, which has led to a rise in average global temperatures.

Question 4a (1 mark)

Plants use sunlight to convert CO_2 to glucose using a process called photosynthesis.

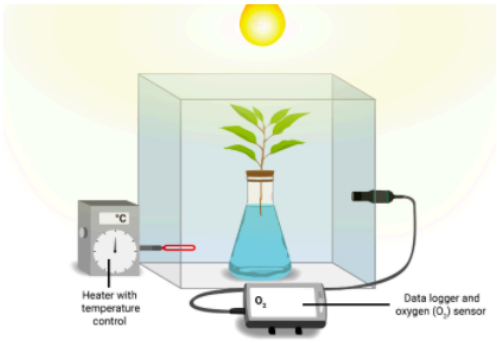
Select words to complete the word equation for photosynthesis.

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

Styles

Dependent variable

Styles

Question 4c (3 marks)

Formulate a hypothesis for this investigation.

If

Then

Because

Question 4d (2 marks)

The student conducted the experiment and collected the data below.

Temperature	Concentration of O_2 after 10 minutes / 10^3 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 4e (1 mark)

State one improvement to the **presentation** of the student's data table in part (d).

B I U x_2 x^2 Ω Σ Styles

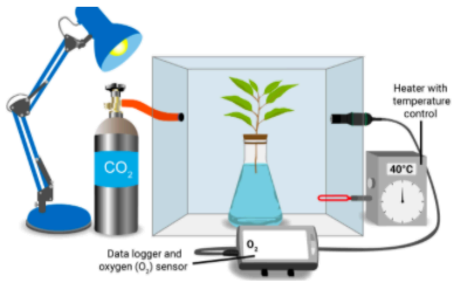
Question 4f (2 marks)

The student predicted that, as temperature increases, the O_2 concentration decreases.

Use the results in part (d) to **comment** on the validity of this prediction.

Question 5 (14 marks)

A student tested the effect of carbon dioxide (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°C and a CO_2 regulator to adjust the level of CO_2.
4. Carry out the experiment with CO_2 concentrations of 0.05%, 0.10% and 0.15%.
5. Measure the concentration of O_2 in ppm after 10 minutes.
6. Use the concentration of 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°C.

Question 5c (4 marks)

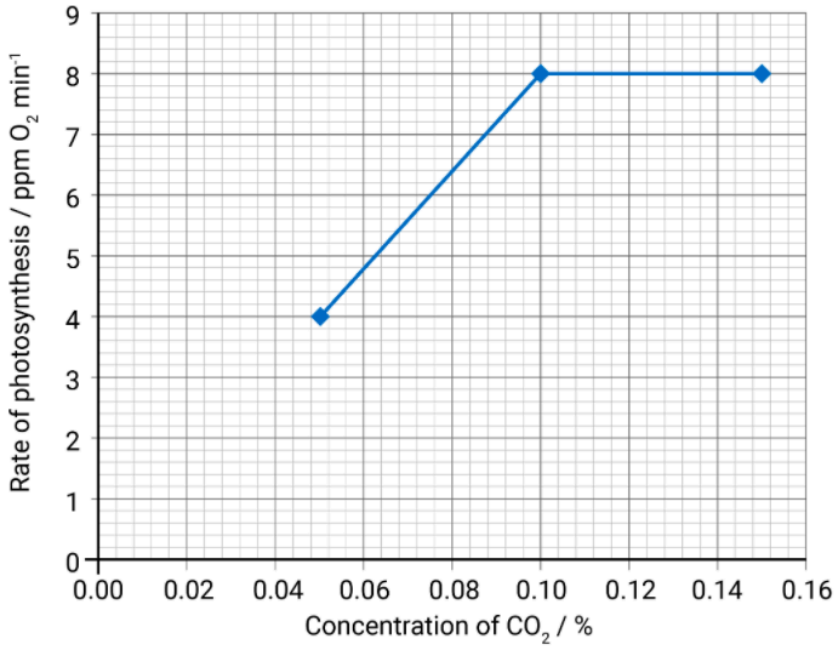
The student's laboratory partner read through the method. They said that the method would not give sufficient data to test the effect of changing CO_2 concentration on the rate of photosynthesis.

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.



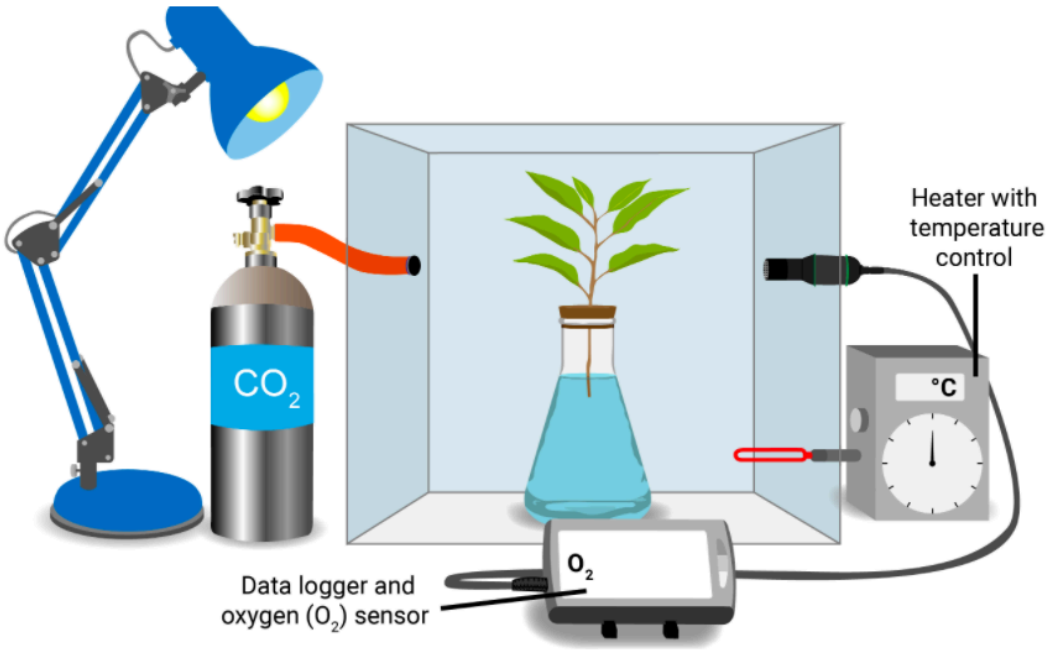
Using data from the graph and scientific reasoning, **explain** the results of this experiment.

Question 5e (1 mark)

Suggest how the students could increase the rate of photosynthesis beyond 8 ppm O_2 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^{-2}	Yield with pesticide / kg m^{-2}
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)

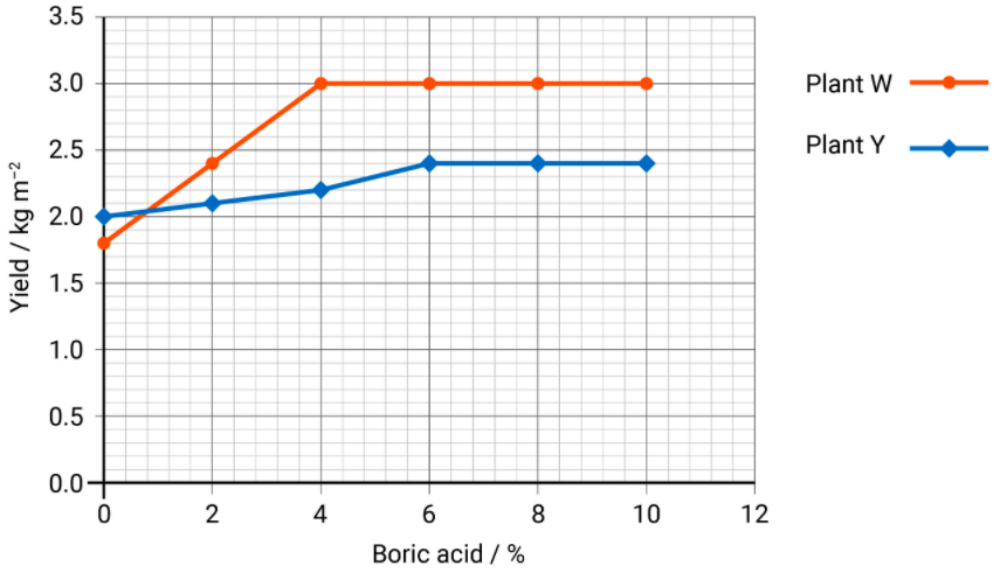
In some species, the use of pesticide did not have a large impact on yield. **Suggest** a reason for this observation.

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.

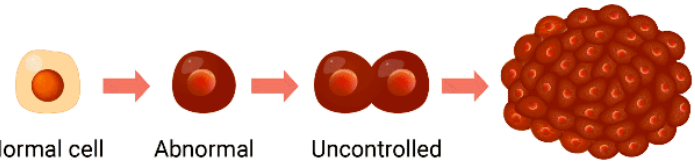
This media is interactive

Click on the blue arrow to view the images.

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

Normal cell → Mitosis → Healthy body tissue

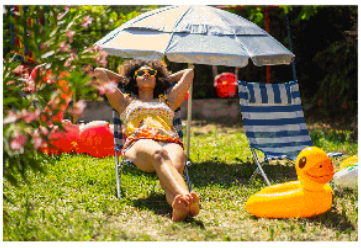
Tumours are formed when cells grow and divide uncontrollably.

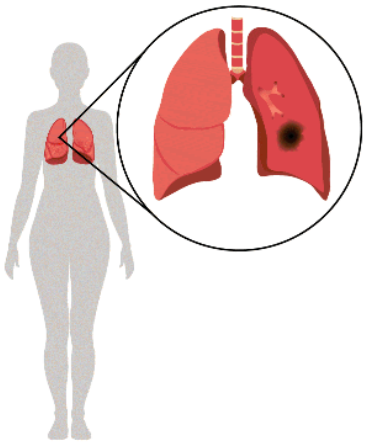


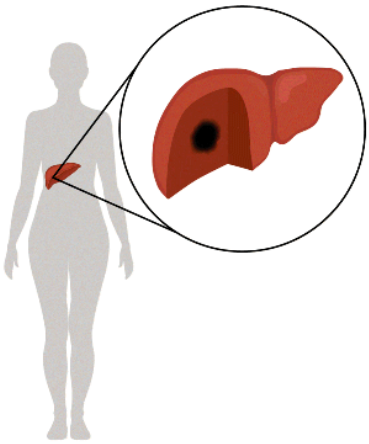
Normal cell → Abnormal genetic changes → Uncontrolled mitosis → Tumour

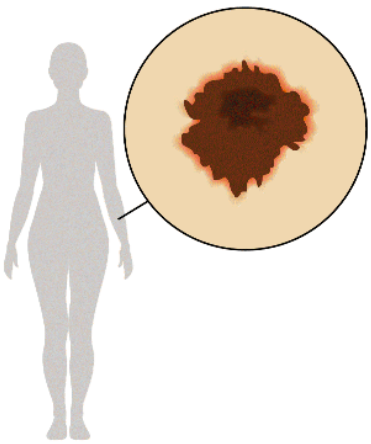
Scroll down to continue

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



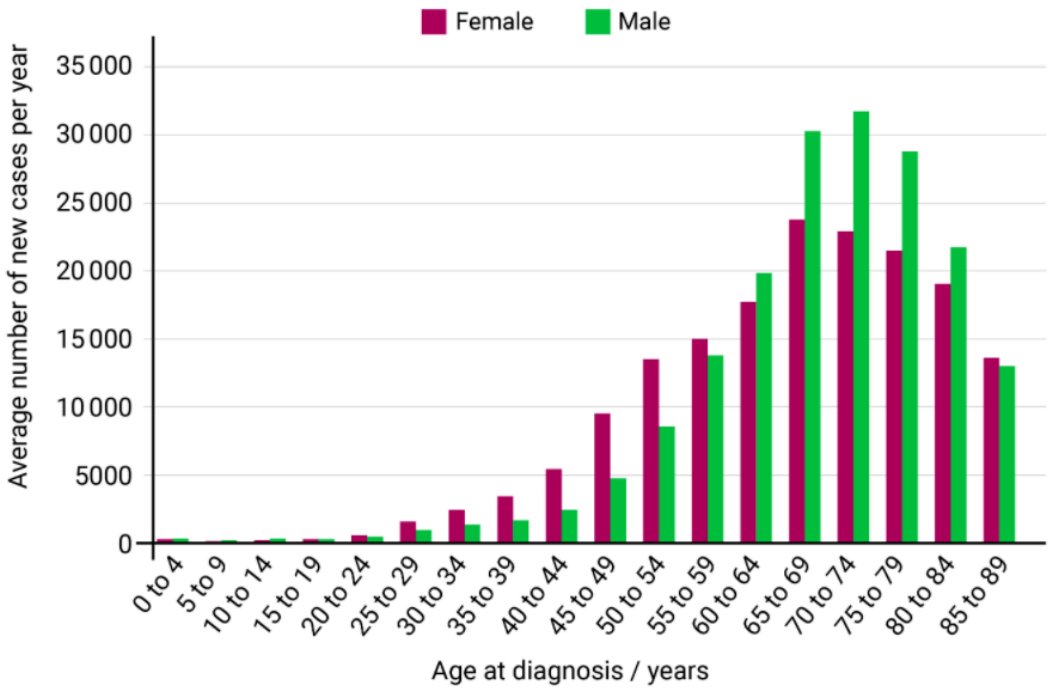






Question 8a (2 marks)

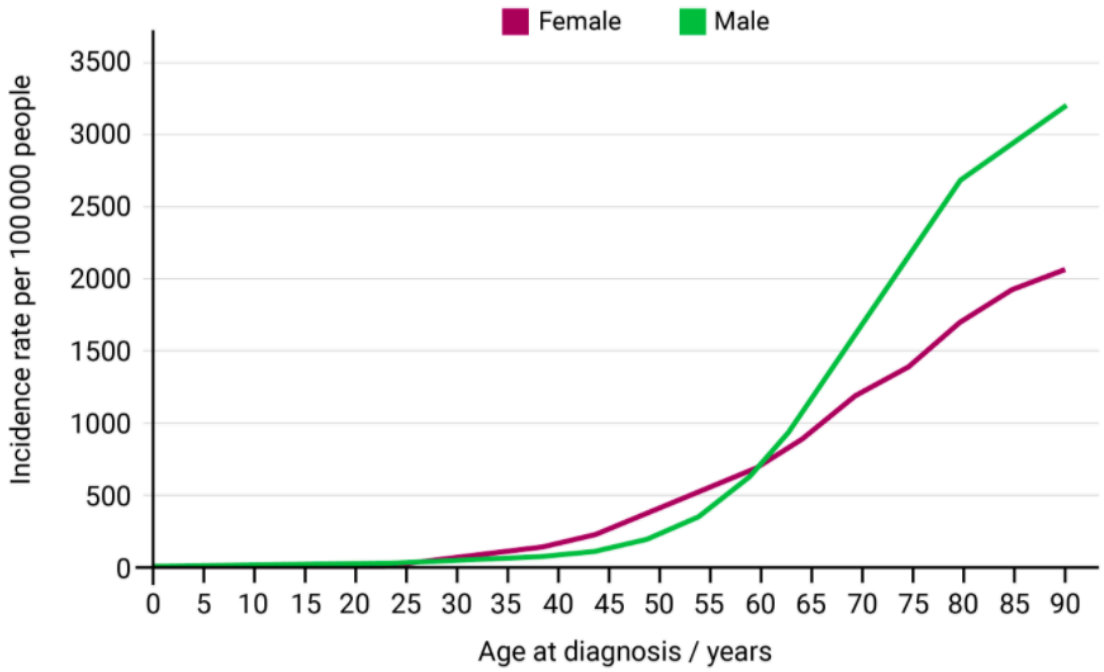
The graph below shows the number of new cases of cancer per year in females and males in the UK in 2016–2018.



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?

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.

MODEL ANSWERS FOR CRITERIA B

To design an investigation to test how changing light intensity affects the rate of photosynthesis using the provided equipment:

Independent Variable (IV): Light Intensity (measured in lux)

Dependent Variable (DV): Rate of Photosynthesis (measured in units per time)

Control Variables (CV):

Temperature: Controlled using the Heater with Temperature Control to maintain a constant temperature, as temperature can affect the rate of photosynthesis.

Carbon Dioxide (CO_2) Concentration: Maintained at a constant level using a CO_2 source, as CO_2 availability also influences photosynthesis.

Equipment Needed:

Heater with Temperature Control

CO_2 source

Data logger

Oxygen (O2) sensor

Testable Hypothesis:

"If the light intensity increases, then the rate of photosynthesis will also increase due to the greater availability of light energy for the process."

Method:

Set up the experimental chamber with the plant and the necessary equipment.

Control and maintain a constant temperature using the Heater with Temperature Control.

Ensure a constant supply of CO2 using the CO2 source.

Gradually adjust the light intensity using the provided equipment while monitoring the rate of photosynthesis.

Measure and record the rate of photosynthesis at different light intensities using the Data logger and Oxygen (O2) sensor.

Repeat the experiment multiple times to ensure reliability and collect sufficient data points.

This method will allow you to investigate how changing light intensity affects the rate of photosynthesis while controlling for temperature and CO2 concentration.

MODEL ANSWER FOR CRITERIA D

In the context of healthcare, personalized medicine represents a significant advancement in tailoring treatments to individual patients based on their genetic makeup. Traditionally, treatment decisions have been based on standard combinations of drugs and doses derived from broad clinical trials. While these standard treatments are effective for many patients with a specific disease, genetic variations among individuals can lead to varied responses to these treatments.

Personalized healthcare utilizes DNA sequencing to analyze a patient's genetic information before determining the most suitable treatment. By identifying specific

genetic markers and variations, healthcare providers can predict how individual patients will respond to different drugs and doses. This personalized approach offers several medical benefits for both individuals and society at large.

(A) Medical Benefits: Personalized healthcare can lead to more precise and effective treatments for patients. By understanding how an individual's genetic makeup influences their response to treatment, healthcare providers can optimize therapy, reduce the risk of incorrect treatment, minimize adverse effects, and improve patient outcomes. This tailored approach can potentially enhance treatment success rates and overall patient well-being.

(B) Economic Considerations: Moving towards personalized healthcare can have economic implications. While initial costs associated with DNA sequencing and personalized treatments may be higher, the long-term benefits include potential cost savings by avoiding ineffective treatments, reducing hospitalizations due to adverse reactions, and improving overall healthcare efficiency. Additionally, advancements in DNA sequencing technology can lead to cost reductions over time.

(C) Ethical Considerations: The shift towards personalized medicine raises ethical considerations regarding the ownership and access to genetic data. Questions arise about who owns the sequencing data, how it should be used, and who should have access to this sensitive information. Ethical guidelines and regulations are essential to ensure patient privacy, informed consent, and fair distribution of benefits from genetic data analysis.

(D) Concluding Appraisal: In conclusion, personalized healthcare offers promising opportunities to revolutionize disease treatment by leveraging genetic information to tailor therapies for individual patients. While it presents medical benefits such as improved treatment efficacy and patient outcomes, economic considerations and ethical dilemmas must be carefully addressed. The transition from standard treatments to personalized medicine requires ongoing advancements in DNA sequencing technology, regulatory frameworks, and ethical guidelines to maximize its potential benefits while safeguarding patient rights and privacy.