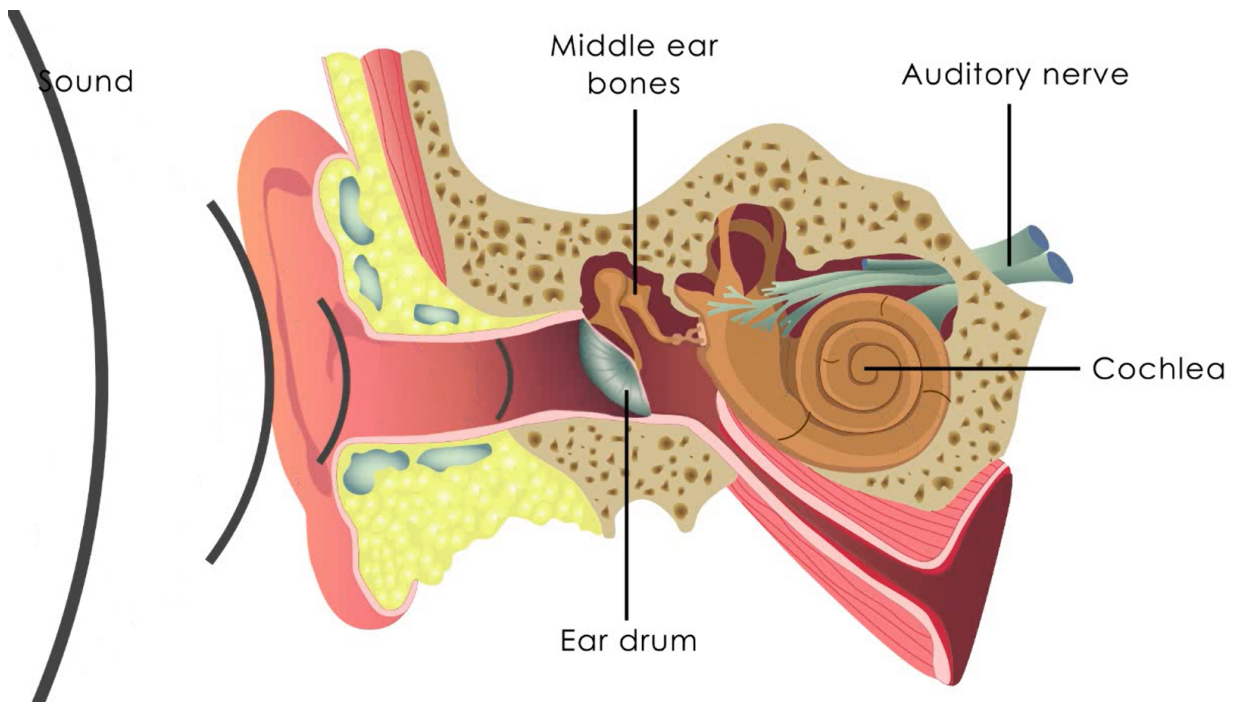




**Question 1** (15 marks)

The nervous system and sensory organs work together to provide information about our environment. The animation below shows the ear, which is the sensory organ responsible for hearing.





**Question 1a** (2 marks)

**State two** other human senses apart from hearing.



**Question 1b** (1 mark)

**Select** the type of cell that can detect a stimulus and generate nerve signals.

- palisade
- receptor
- muscle
- stem



**Question 1c** (2 marks)

**Outline** the route of a signal through the nervous system.



**Question 1d** (1 mark)

In the ear, hair cells respond to vibrations and generate nerve signals. Using the animation above, **identify** the part of the ear where hair cells should be located.

**Question 1e** (4 marks)

Loud noises, including loud music, cause damage to hair cells which results in gradual hearing loss. Damaged or dead hair cells cannot be replaced through cell division so the hearing loss is permanent.

**State** the names of the two different types of cell division and **list** two differences.



**Type of cell division 1**

Name

**Type of cell division 2**

Name

Loss of hearing can also be observed in young children. This loss of hearing can be caused by events during birth, it can develop later in life or it can be inherited. During birth, for example, an extended shortage in oxygen supply can damage hair cells while muscle cells are not affected.



**Question 1f** (2 marks)

**State** the metabolic process that allows muscle cells to produce energy in the absence of oxygen.

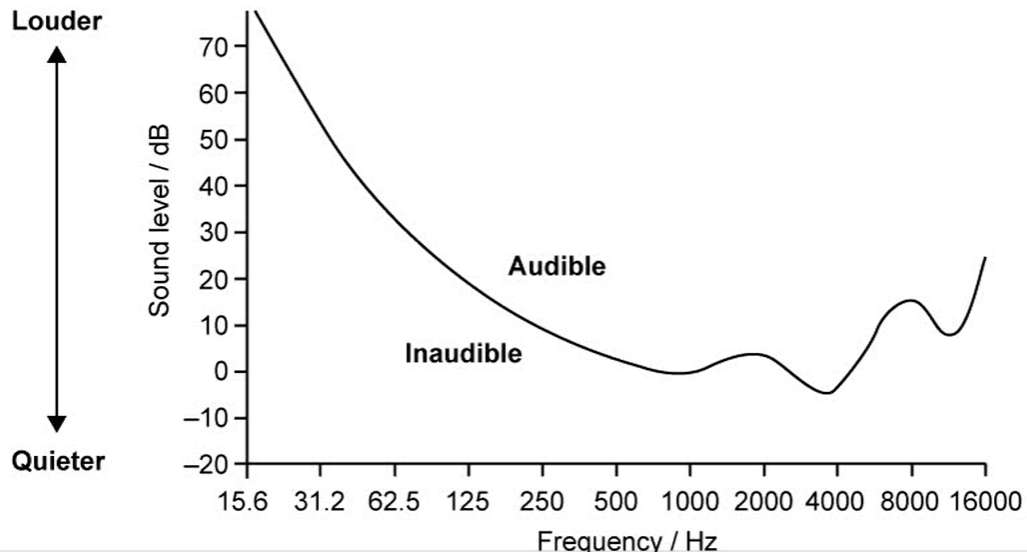


**Question 1g** (3 marks)

**Suggest** how a breakdown in the body's oxygen supply system could lead to a permanent loss of hearing.

Question 2 (9 marks)

The graph below shows the range of frequencies that an average 20-year-old human can hear.



Question 2a (1 mark)

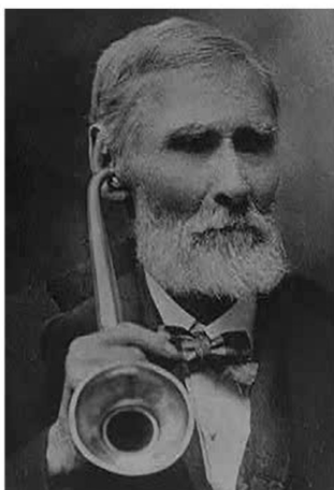
Use the graph to **state** the frequency at which an average 20-year-old human can hear the quietest sound.



Question 2b (2 marks)

Over time many devices have been used to assist humans with loss of hearing.

All of the hearing aids below aim to increase the loudness of the sound entering the ear.



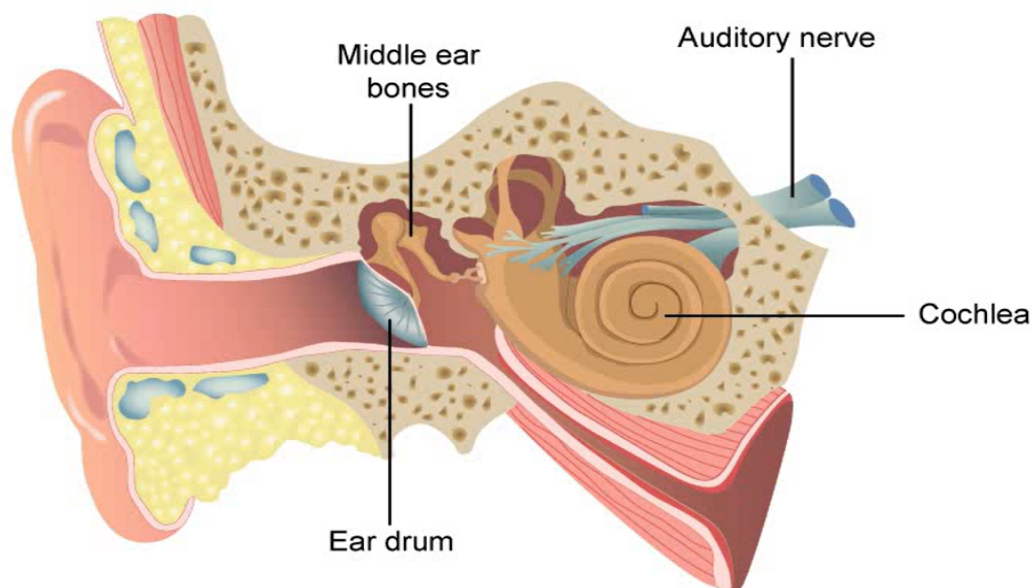
"Trumpet" (1800s)



Amplifier (1950s)



Behind-the-ear device (2000s)



Considering the function of the ear, **describe** an advantage and a disadvantage of amplifying the sound entering the ear.

Advantage

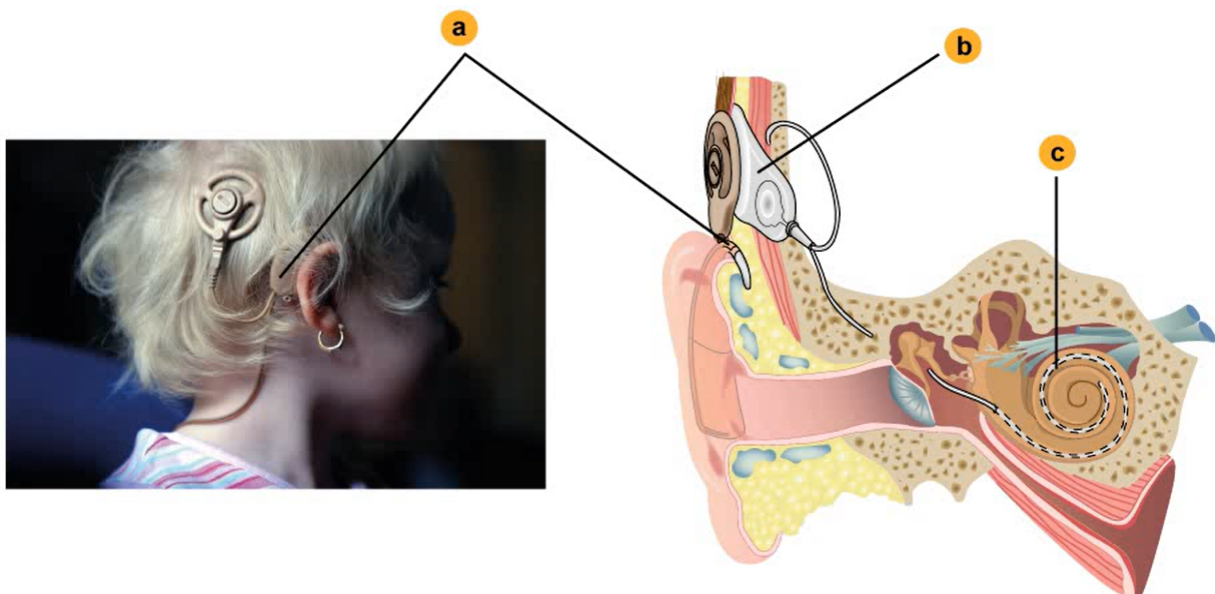
Disadvantage



Question 2c (2 marks)

Recently a different type of hearing aid was developed called the cochlear implant. The complex technology in a cochlear implant means that the total cost is 10 to 20 times higher than that of external, behind-the-ear hearing devices.

The cochlear implant consists of a microphone and a processor (a) mounted outside the head and the actual implant, located under the skin (b) and partly inside the cochlea (c).



Use the image above to **suggest** what kind of stimulus part (c) of the cochlear implant needs to generate for a person to detect a sound. **Justify** your answer.



**Question 2e** (2 marks)

**Suggest** an advantage and a disadvantage of cochlear implants.

Advantage

Disadvantage



**Question 2e** (2 marks)

**Suggest** an advantage and a disadvantage of cochlear implants.

Advantage

Disadvantage

**Question 3 (7 marks)**

Several genes have been discovered that are known to be responsible for hearing loss in humans.

**Question 3a (2 marks)**

Parents with normal hearing have a child with genetically determined hearing loss. **Deduce** and **justify** whether this characteristic is controlled by a dominant allele (**H**) or a recessive allele (**h**).

**B** *I* ← → U  $\times_2$   $\times^e$   $\frac{1}{2}$   $\frac{3}{4}$   $\frac{1}{4}$   $\Omega$   $\Sigma$   
Styles ▾

**Question 3b (3 marks)**

**Use** the symbols **H** and **h** to show the genetic information (allele combination) of the parents and child in part (a).

Mother	Father	Child

Reset

**Question 3c (2 marks)**

Gene PAX3 is one of the genes that control hearing. The normal form of PAX3 is recessive (symbol **a**, normal hearing). The mutated form of PAX3 is dominant (symbol **A**, hearing loss).

**Explain** why a person with hearing loss possessing two dominant alleles for this characteristic (genotype **AA**) would only have children with hearing loss.

**B** *I* ← → U  $\times_2$   $\times^e$   $\frac{1}{2}$   $\frac{3}{4}$   $\frac{1}{4}$   $\Omega$   $\Sigma$  Styles ▾

**Question 4** (9 marks)

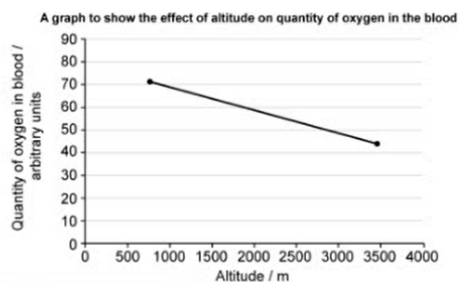
In 2011, a group of international students took part in a run in Bolivia. The runners started at a lower altitude (700 m above sea level) and finished at a higher altitude (3500 m above sea level). As altitude increases, the available oxygen in the air decreases.

During the run, scientists monitored many factors to study how altitude impacts the human body.

**Question 4a** (1 mark)

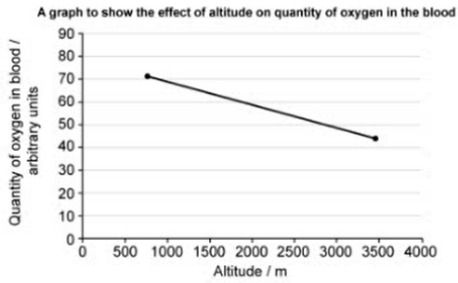
**State** the name of the blood cell responsible for transporting oxygen.

The scientists conducted one trial of an investigation during the run. As one of the runners moved from lower to higher altitude, the scientists measured the quantity of oxygen in his blood. The results are shown in the graph below.



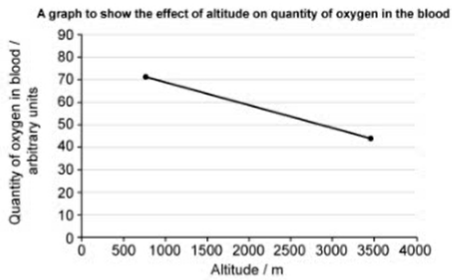
**Question 4b** (1 mark)

**Suggest** a research question that could be investigated by this experiment.



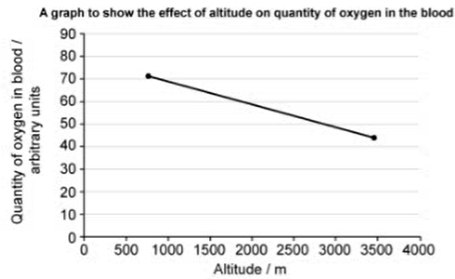
**Question 4c** (1 mark)

**State** one weakness in the data shown on the graph.



**Question 4d** (1 mark)

Using the graph, **state** the relationship between altitude and quantity of oxygen in the blood.



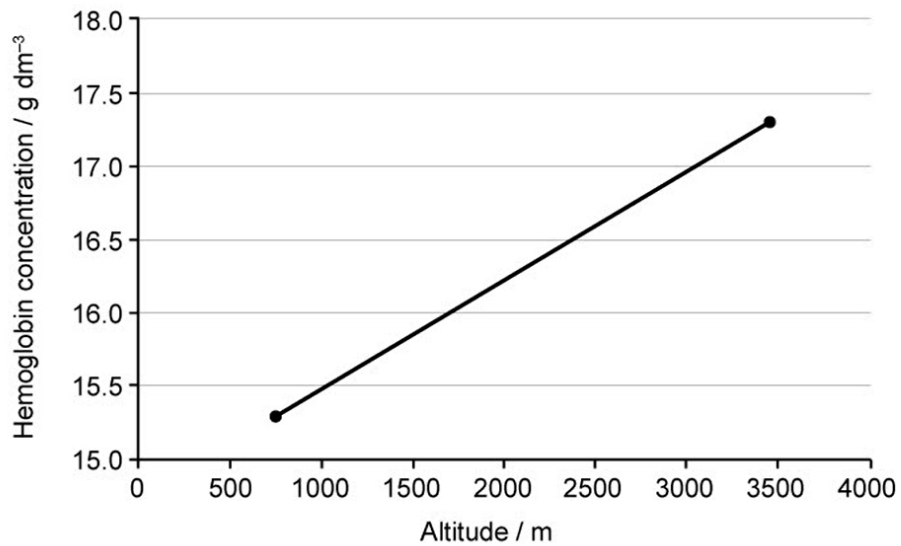
Question 4e (1 mark)

Using the graph, **predict** the quantity of oxygen in the blood at sea level.

Question 4f (4 marks)

Hemoglobin is the molecule that transports oxygen in the blood around the body. A graph of hemoglobin concentration in the blood against altitude is shown below.

A graph to show the effect of altitude on hemoglobin concentration in the blood



The percentage decrease in oxygen available in the air between an altitude of 700 m and 3500 m is 45 %. However the percentage decrease in the quantity of oxygen in the blood is only 34 % over the same increase in altitude.

**Explain** how the change in hemoglobin concentration in the blood is involved in homeostasis.



**Question 5** (13 marks)

During the run, the blood oxygen saturation and heart rates of five students were measured at three different altitudes.



**Question 5a** (4 marks)

**Identify** the independent variable, dependent variable and two control variables that should be considered in this investigation.



Independent variable

Dependent variable

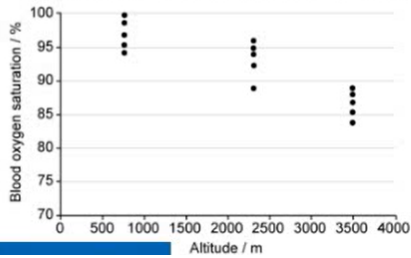


**Question 5b** (3 marks)

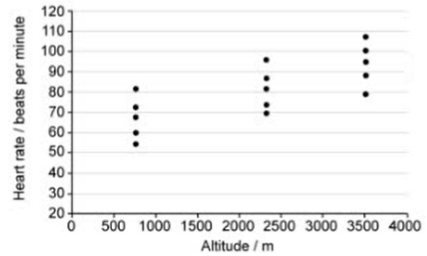
The measurements are shown in the graphs below. Blood oxygen saturation shows the actual quantity of oxygen in the blood compared to the maximum quantity of oxygen that could be carried. 100 % saturation means that the blood carries as much oxygen as possible.



A graph to show the effect of altitude on blood oxygen saturation



A graph to show the effect of altitude on heart rate



**Interpret** the trends in the data shown in the graphs and **explain** the effect on the body shown by the results from this investigation.



**Question 5c** (4 marks)

**Suggest** two improvements that could be made to this investigation. **Justify** your answers.



**Improvement 1**

What you would change

**Improvement 2**

What you would change



**Question 5d** (2 marks)

**Suggest** an extension for this investigation. **Justify** your answer.

**Extension**

What you would change

**Question 6** (19 marks)

The pika is a small mammal that lives in the mountains. A team of scientists was interested in studying whether groups of pikas had adjusted to living at different altitudes. The aim of the research was to determine whether body mass was related to altitude. The scientists identified isolated groups of pikas living at different altitudes and determined the mean body mass of each group.



©

**Question 6a** (4 marks)

**Suggest** and **justify** two control variables that should be considered for this experiment.



Control variable 1

Control variable 2



**Question 6b** (1 mark)

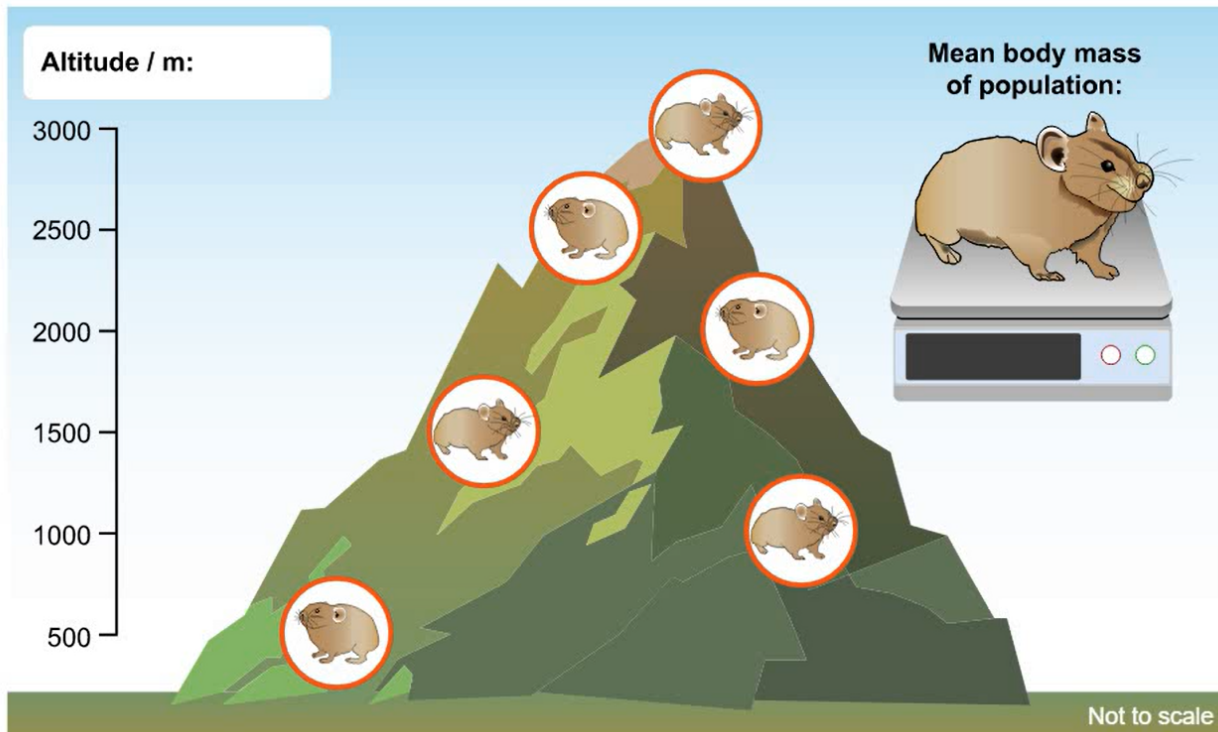
**State** how many individuals in each group should be sampled to collect a sufficient amount of reliable data.



**Question 6c** (4 marks)

This media is interactive

Click on the image of each pika to display mean body mass data.



**Design** a data table and collect data using the tool above. You should include headings in your table.



Reset

**Question 6d** (3 marks)

**Calculate** the percentage increase in mean body mass between the groups living at the lowest altitude and the highest altitude. Give your answer to an appropriate number of significant figures.

Rich text editor toolbar with buttons 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), and Unlink (Σ). Below the toolbar is a "Styles" dropdown menu and a "Paste" icon.

**Question 6e** (2 marks)

The hypothesis for this investigation was that groups of pikas living at higher altitudes will have a higher mean body mass in order to adjust to conditions at higher altitudes.

**Outline** whether or not the data from this experiment support the hypothesis.

**Justify** your answer.

Rich text editor toolbar with buttons 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), and Unlink (Σ). Below the toolbar is a "Styles" dropdown menu and a "Paste" icon.

**Question 6f** (5 marks)

The scientists asked if natural selection led to the change in mean body mass in the groups of pikas living on this mountain.

**Evaluate** whether the method of this investigation is appropriate to answer the question the researchers asked. In your answer you should identify strengths and weaknesses of the method. Use scientific knowledge and understanding to give a concluding appraisal.

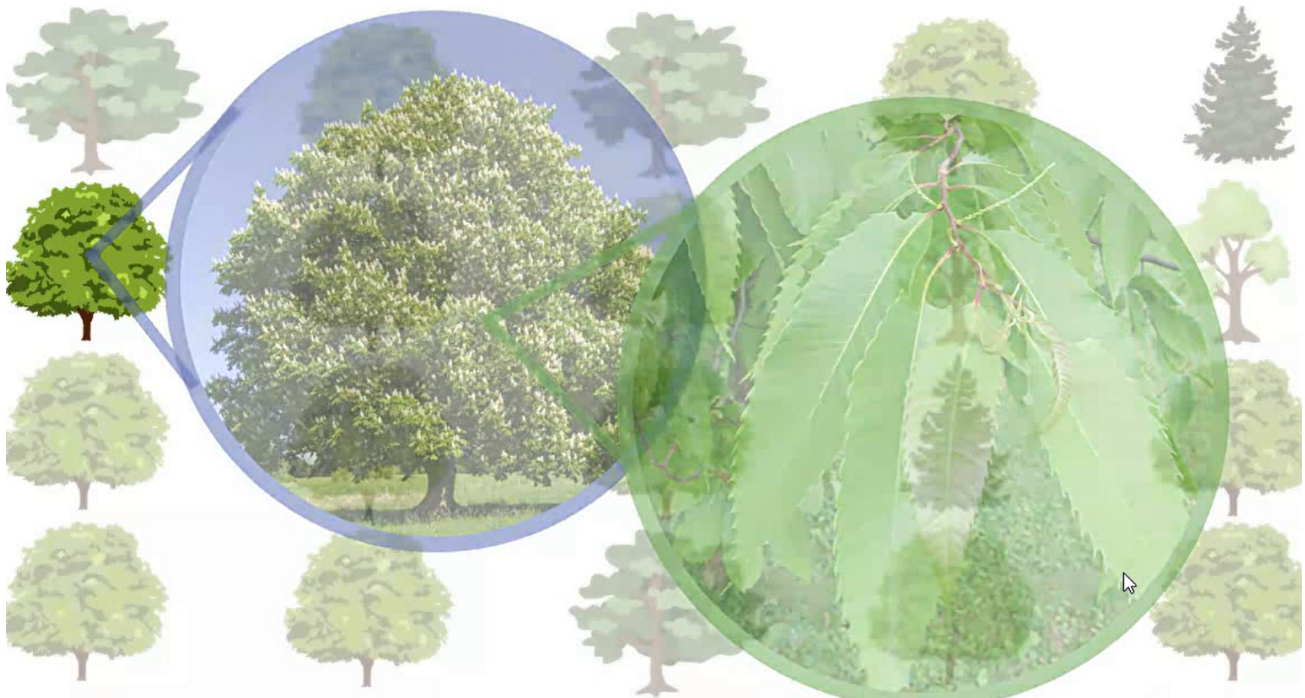
Rich text editor toolbar with buttons for Bold (B), Italic (I), Undo, Redo, Underline (U), Subscript (x<sub>2</sub>), Superscript (x<sup>2</sup>), Bulleted List, Numbered List, Link (Ω), and Unlink (Σ). Below the toolbar is a "Styles" dropdown menu and a "Paste" icon.

Question 7 (21 marks)

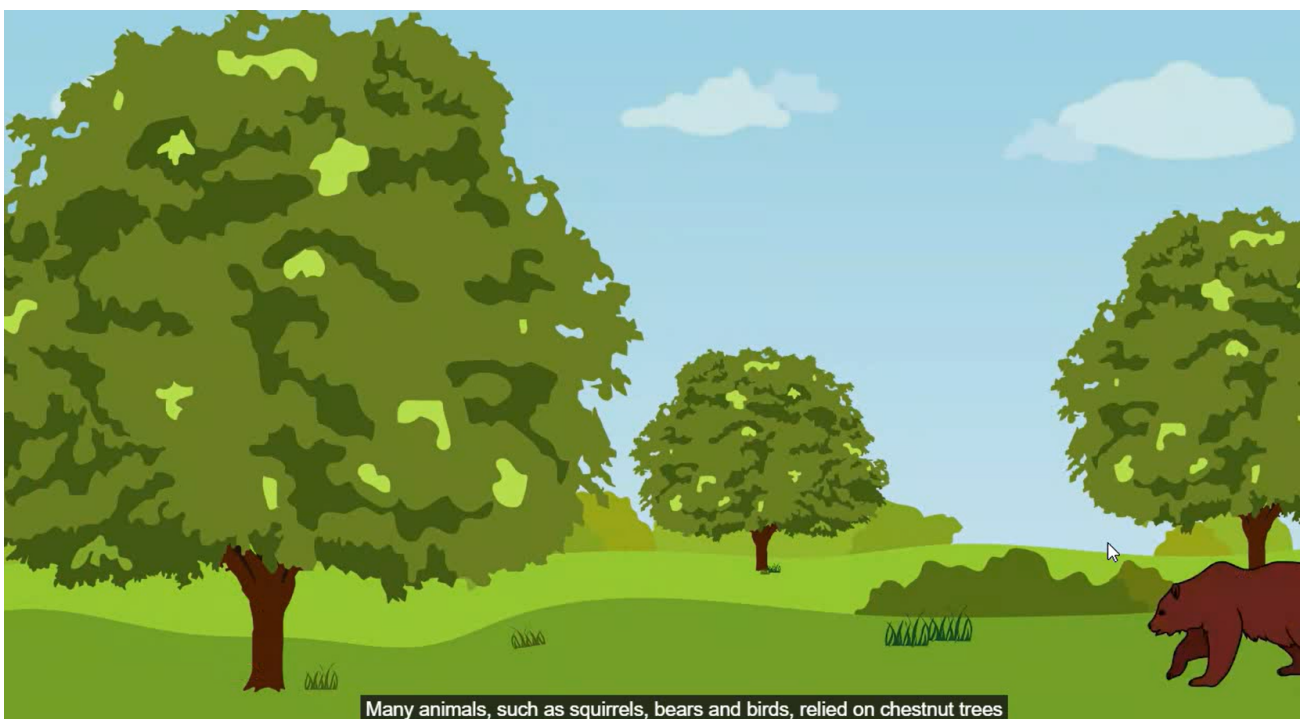
The human body adjusts to changes in the environment. This is known as acclimatization. Some acclimatizations may allow athletes to improve their performance. Athletes sometimes train at high altitudes before they compete at lower altitudes as they think that training at high altitude might give them a competitive advantage.

**Design** an investigation to study the relationship between training at high altitude and performance in athletes. In your answer you should:

- outline a suitable physical activity
- explain the problem to be studied
- formulate a testable hypothesis with a scientific explanation
- identify relevant variables
- describe how to measure and manipulate these variables in your method
- list any safety considerations
- outline any ethical concerns about investigations using humans.

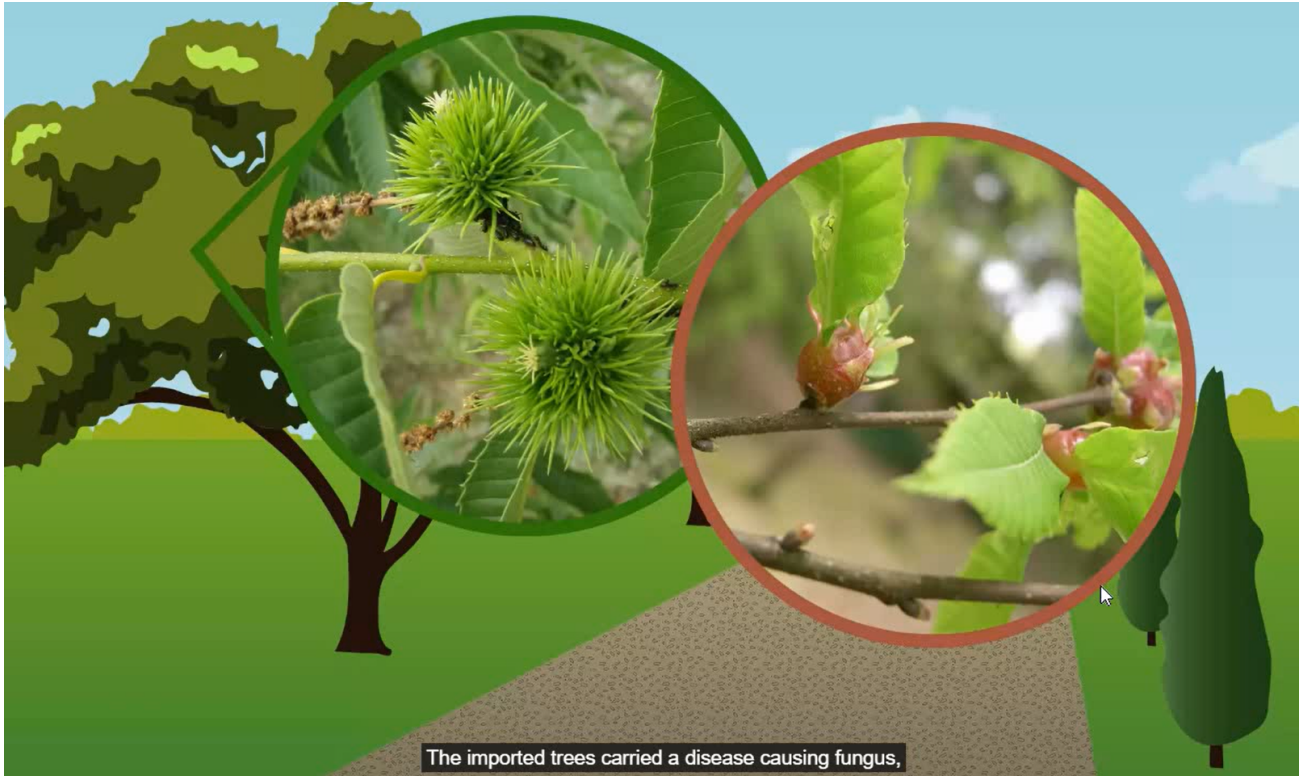


the American chestnut tree that is native to North America.



Many animals, such as squirrels, bears and birds, relied on chestnut trees





The imported trees carried a disease causing fungus,



The Japanese chestnut trees had evolved resistance to the fungus,





**Question 8a** (1 mark)

Using information from the video, **state** which **organism** caused American chestnut trees to die.



**Question 8b** (2 marks)

**Outline** the specific human action that caused the organism you named in part (a) to be introduced into North America.



**Question 8c** (3 marks)



Using scientific language, **outline** the effect of the damage on the transport processes in the diseased trees.





Question 8d (2 marks)

State one similarity and one difference between genetic engineering and selective breeding.



Similarity

Difference



Question 8e (4 marks)

Describe how biotechnology is used to create disease resistant American chestnut trees.



Question 8f (15 marks)

Using the information from this project and your wider MYP knowledge, **discuss** and **evaluate** the possible implications of changing the genome of American chestnut trees. In your answer you should include:

- the advantages of introducing a new genetic variant
- the disadvantages of introducing a new genetic variant
- an environmental impact of introducing a new genetic variant
- an economic impact of introducing a new genetic variant
- an appraisal of the arguments you have discussed.

**B** *I* | ← → | U  $x_2$   $x^2$  |  $\int$   $\sum$  |  $\Omega$   $\Sigma$  | Styles ▾ |