PEARSON EDEXCEL A-LEVEL BIOLOGY A · 9BN0

# BIOLOGY



## EXAM QUESTION PACK

### TOPIC 5: ON THE WILD SIDE

| SCORE | PERCENTAGE |
| --- | --- |
| /394 | % |

STEMUP

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Q1.

Ebola haemorrhagic fever is a life-threatening disease caused by the Ebola virus.

(a) Explain why antibiotics are not used to treat Ebola haemorrhagic fever.

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(b) Some of the blood plasma of individuals who have survived infection with Ebola can be collected. This can be used in the treatment of individuals currently infected with Ebola.

Explain why the blood plasma from survivors can be used to treat new cases of Ebola infection.

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(c) A study of the 2014 Ebola outbreak in Sierra Leone found that the Ebola virus was evolving rapidly.

Explain why the evolution of the virus might reduce the effectiveness of any vaccine being developed.

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**(Total for question = 9 marks)**

Q2.

The photograph shows heather, *Calluna vulgaris*, a plant that grows on moorland.



© C016/7131/Science Photo Library

In an investigation into the net primary productivity of heather, all the vegetation on an area of two different moorlands, A and B, was removed by burning. The dry biomass, in g $m^{-2}$, was then measured each year for a period of 20 years.

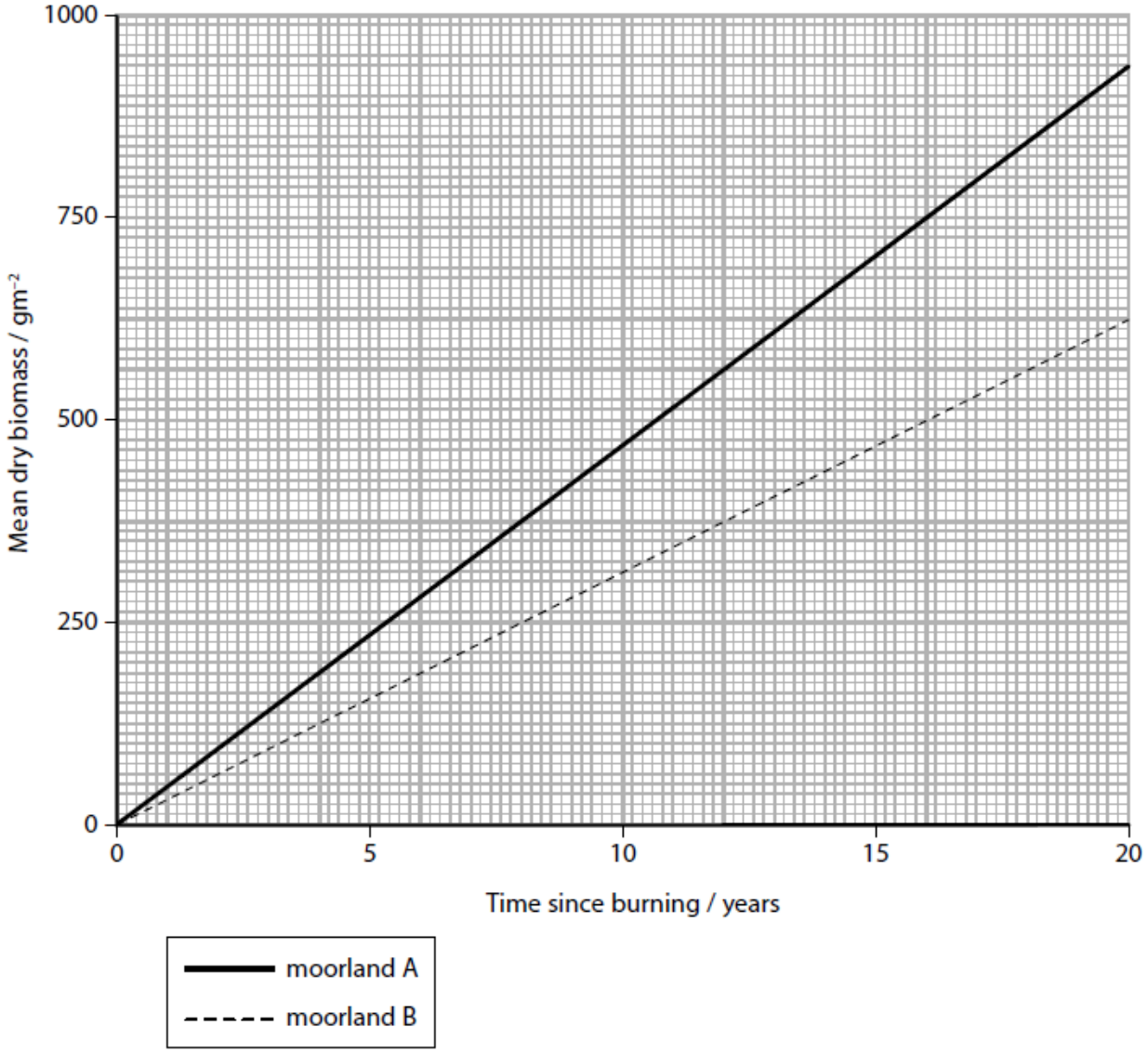
(a) Give an equation that shows the relationship between gross primary productivity, net primary productivity and respiration.

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(b) The graph shows the change in the mean dry biomass of the heather plants during the 20 year period.




(i) Describe a method that could be used to obtain the mean dry biomass of the heather plants in year 20.

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(ii) The total solar radiation reaching moorland A was 3 144 000 kJ $m^{-2}$ $yr^{-1}$. Each gram of dry heather contains 22.186 kJ.

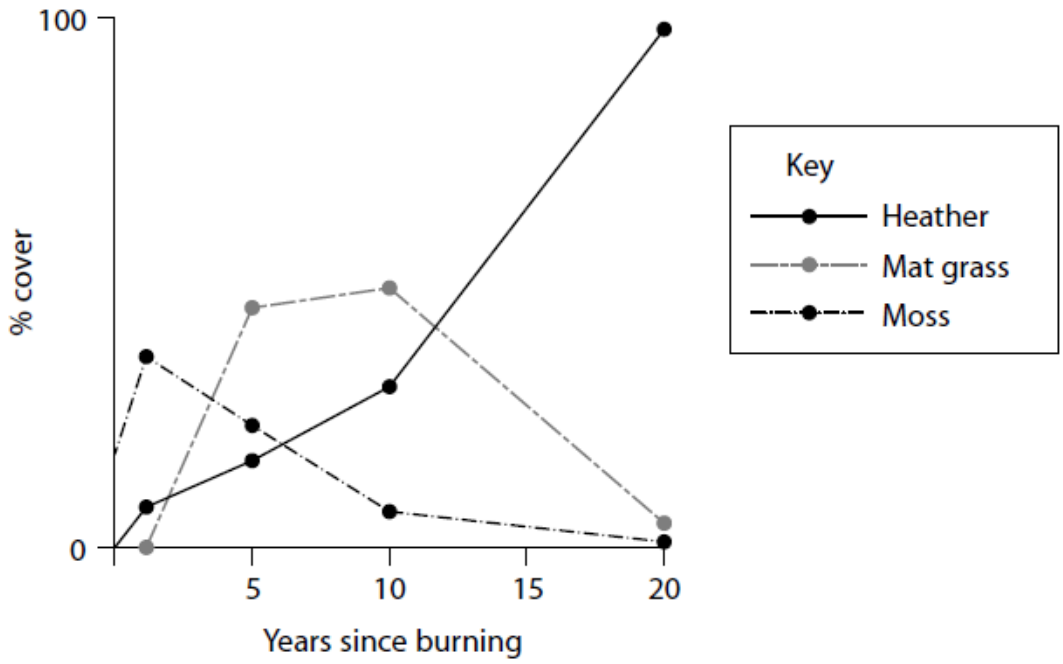
Calculate the percentage efficiency of heather plants from moorland **A** at converting solar radiation into dry biomass.

**(2)**

Answer .....

(iii) After the burning of the moorland, a process of succession occurred.

The following information shows some of the changes found over the 20 years.




Analyse the data to explain the changes shown.

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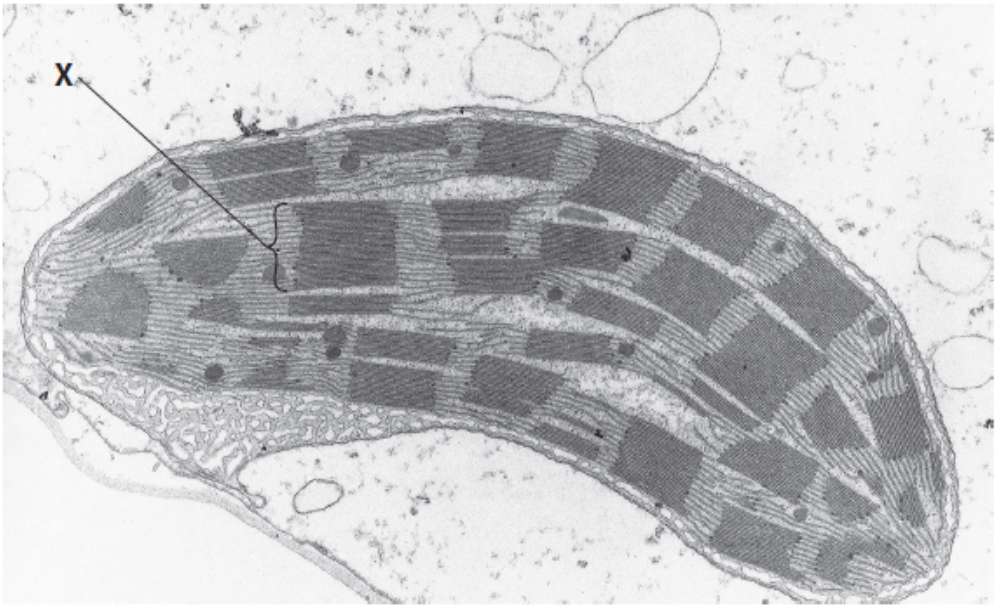
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**(Total for question = 8 marks)**

Q3.

Eukaryotic cells contain membrane-bound organelles.

The photograph, obtained using an electron microscope, shows an organelle.




(Source: © Science History Images/Alamy Stock Photo)

(i) Label a part of this organelle where carbon fixation occurs.

**(1)**

(ii) Give the name of the component labelled X.

**(1)**

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(iii) Describe how the structure of a membrane in the part labelled X is related to its function.

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(iv) Describe how GP is produced by carbon fixation in this organelle.

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**(Total for question = 7 marks)**

Q4.

The scientific article you have studied is adapted from an article from '*The Scientist*'.

Use the information from the scientific article and your own knowledge to answer the following questions.

Explain how cyanobacteria evolved to 'handle high temperatures' (paragraphs 14 and 15).

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Q5.

Scientists have studied behavioural, anatomical and genetic variation in elephants.

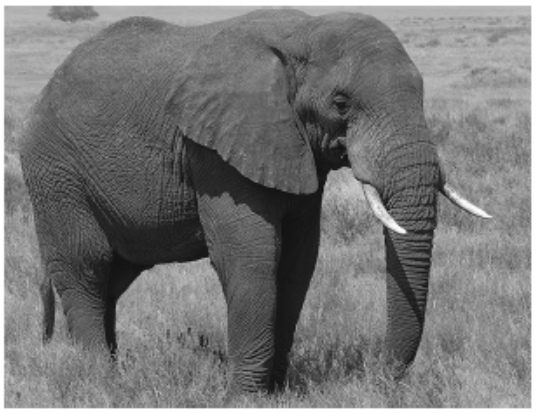
The table shows some information about two populations of African elephants.

| Population | Location | Feeding behaviour | Anatomical differences |
|---|---|---|---|
| Forest elephant | tropical forest of central and West Africa | feeds on leaves and fruits of high-growing plants such as shrubs and trees | • lower jaw longer and narrower<br>• tusks straighter and downward facing<br>• overall a much smaller size |
| Savannah elephant | African savannah | feeds on grass and leaves of low-growing shrubs | • lower jaw shorter and wider<br>• tusks more curved and upward facing<br>• overall a larger size |

The photographs show elephants from the two populations.



Forest elephant



Savannah elephant

DNA samples were collected from these two populations of elephants.

Scientists have concluded that the forest elephant and the savannah elephant are two different species.

* (i) Analyse the data and the information provided to comment on the validity of this conclusion.

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(ii) Explain how two species of African elephant could evolve from a common ancestor.

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**(Total for question = 9 marks)**

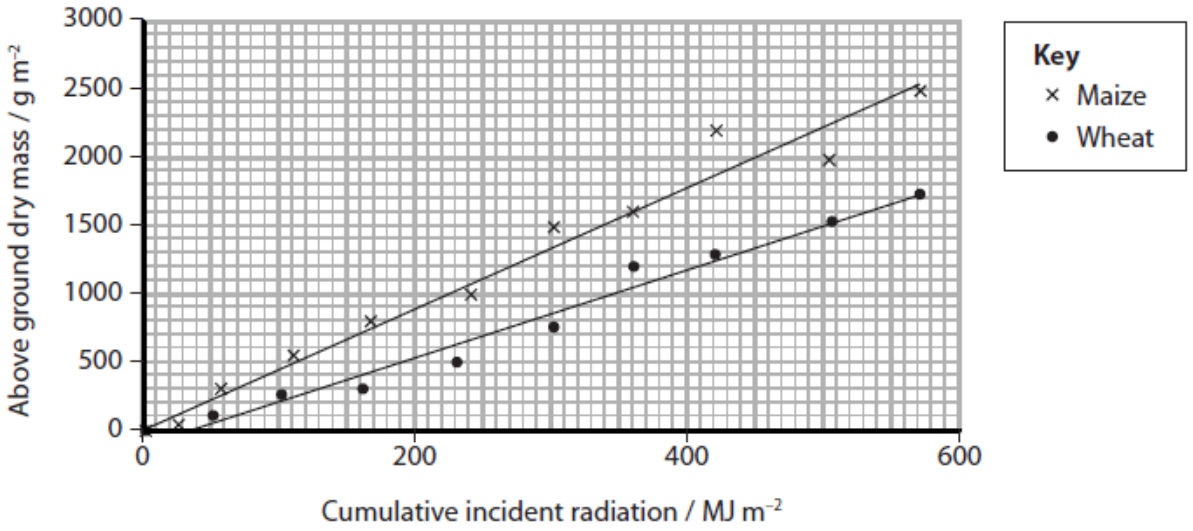
Q6.

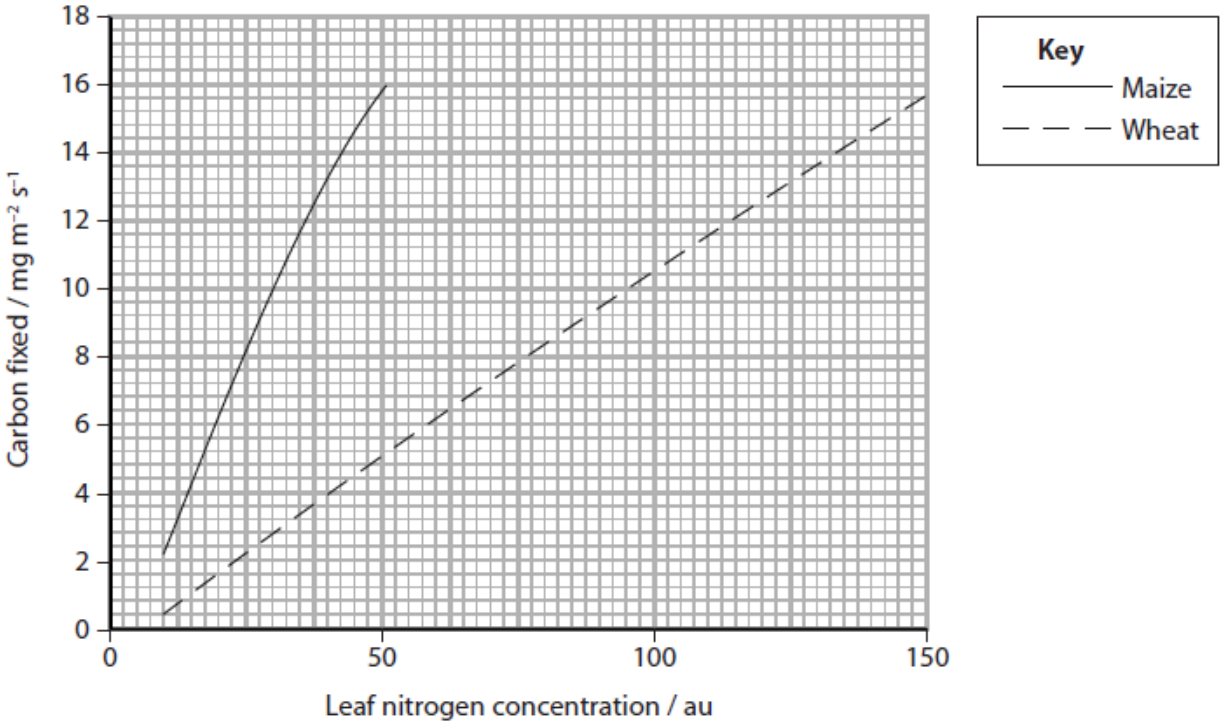
Wheat and maize are used as biofuel crops.

Scientists have investigated the effect of incident radiation and leaf nitrogen concentration on the growth of wheat and maize.

Incident radiation is a measure of the useful light energy hitting the plant.
Leaf nitrogen concentration is a measure of the availability of nitrogen in the soil.

The results of these investigations are shown in the graphs.




(i) Scientists calculated the dry mass produced per MJ of incident radiation for wheat. This is shown in the table.

| Plant | Above ground dry mass / g $MJ^{-1}$ |
|---|---|
| Wheat | 3.25 |

Calculate the above ground dry mass produced per MJ of incident radiation for maize.

**(2)**

Answer ..... g $MJ^{-1}$

(ii) Analyse the information provided about maize and wheat to determine which crop should be used for the production of biofuels.

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(iii) Sugar cane crops are also being grown for the production of biofuel.



Devise an experiment to investigate the effect of light intensity on the above ground dry mass of sugar cane crops grown in a field.

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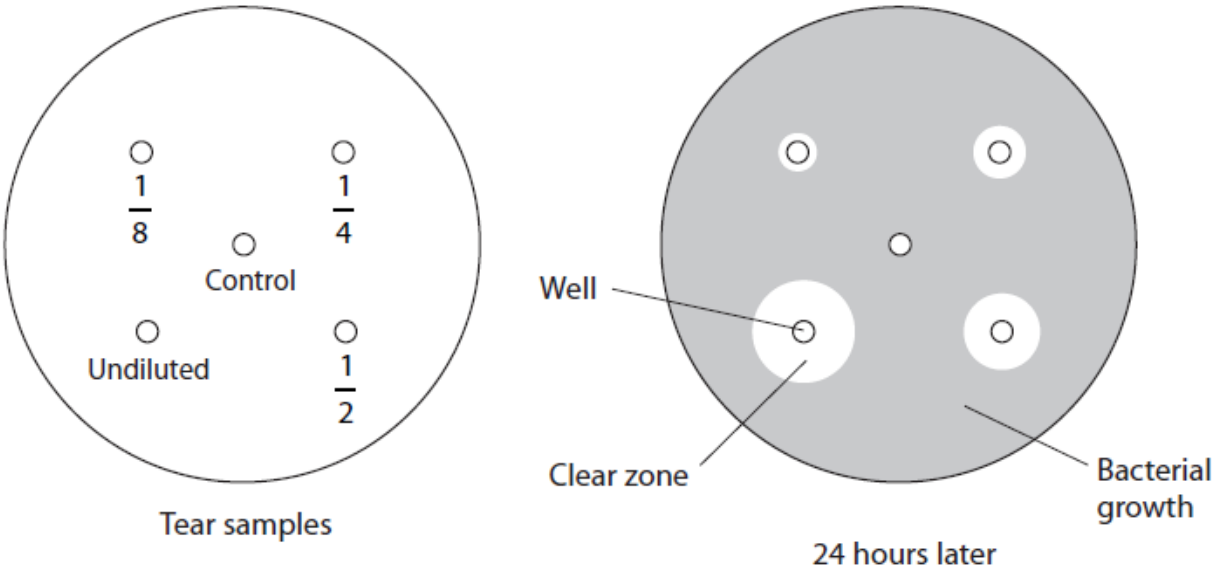
Q7.

Lysozyme is one component of the non-specific response to infection.

A student investigated the activity of lysozyme in tears.

A suspension of bacteria was mixed with molten agar and poured into a Petri dish. After the agar had solidified, wells were cut and different dilutions of tear sample were placed in the wells.

After 24 hours the Petri dish was inspected.




Explain how the student could adapt the investigation to study the effect of pH on the activity of lysozyme.

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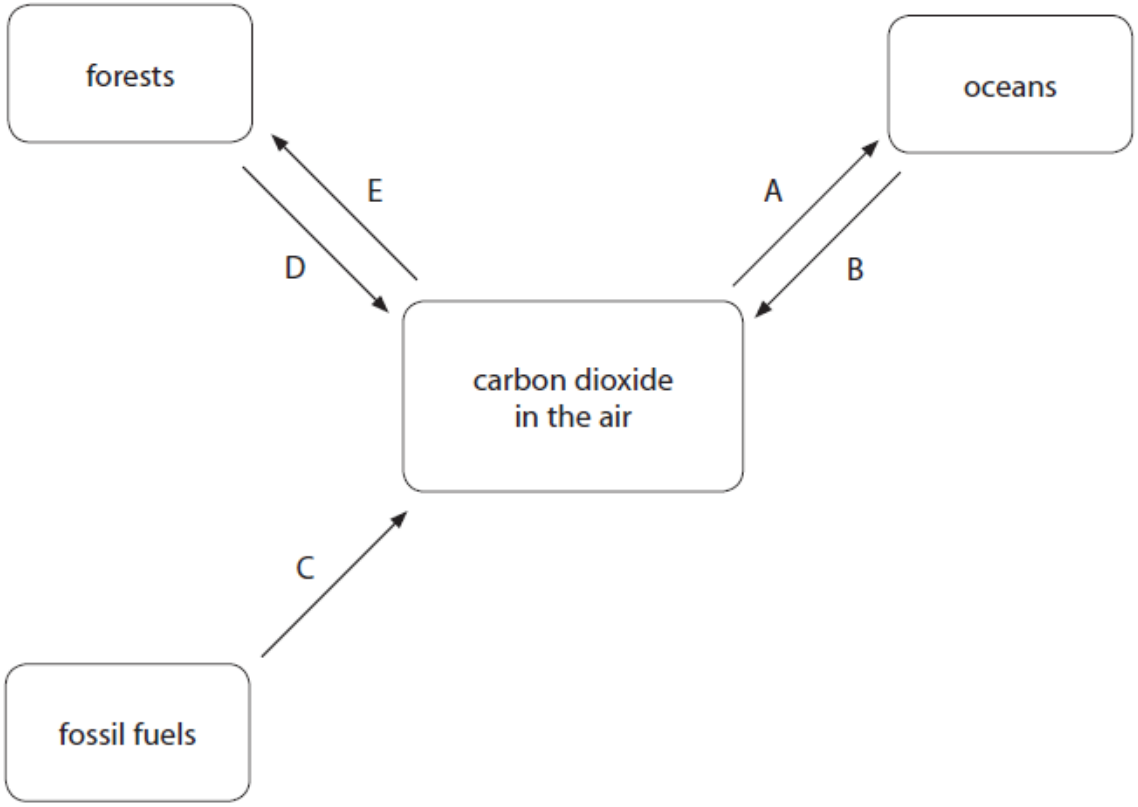
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Q8.

The diagram below shows part of the carbon cycle. The processes A, B, C, D and E, transfer carbon.




Explain how carbon dioxide is removed from the air into the oceans by process A.

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Q9.

The earthworm, (*Lumbricus terrestris*), feeds on dead organic matter found in soil.



Soil pH is one of the abiotic factors that affects the population size of earthworms.

The populations of earthworms in fields with either acidic soil or alkaline soil have been investigated.

The results of this investigation are summarised in the table.

| Sample | Earthworms in field with acidic soil | | Earthworms in field with alkaline soil | |
|---|---|---|---|---|
| | Number per square metre | Mass per square metre / g $m^{-2}$ | Number per square metre | Mass per square metre / g $m^{-2}$ |
| 1 | 80 | 184 | 723 | 1 164 |
| 2 | 59 | 110 | 1 613 | 1 968 |
| 3 | 106 | 253 | 354 | 439 |
| 4 | 31 | 70 | 728 | 961 |
| 5 | 121 | 238 | 214 | 233 |
| 6 | 75 | 139 | 874 | 1 739 |
| 7 | 97 | 149 | 668 | 1 096 |
| 8 | 138 | 309 | 121 | 213 |
| 9 | 63 | 95 | 791 | 1 455 |
| 10 | 63 | 84 | 497 | 736 |
| Total | 833 | 1 631 | 6 583 | 10 004 |

Explain how differences between the mass of earthworms in these two soils could be shown to be statistically significant.

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**(Total for question = 3 marks)**

Q10.

The scientific article you have studied is adapted from several sources.

Use the information from the scientific article and your own knowledge to answer the following questions.

Probiotics include live bacteria that are ingested for health benefits.

Explain how probiotics may regulate food cravings (paragraphs 18, 19 and 20).

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**(Total for question = 3 marks)**

Q11.

Tropical rainforests play a role in maintaining biodiversity and in storing carbon.

Explain how reforestation of tropical rainforests can be used to minimise climate change.

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**(Total for question = 3 marks)**

Q12.

Trypsin is an enzyme found in many groups of living organisms.

Trypsin specifically acts on a polypeptide to form amino acids.

Trypsin molecules from vertebrates, but not other animals, have a calcium ion binding site.

Explain how this calcium ion binding site could have evolved in vertebrates.

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**(Total for question = 3 marks)**

Q13.

Explain how these two species of snake could have arisen from a common ancestor.

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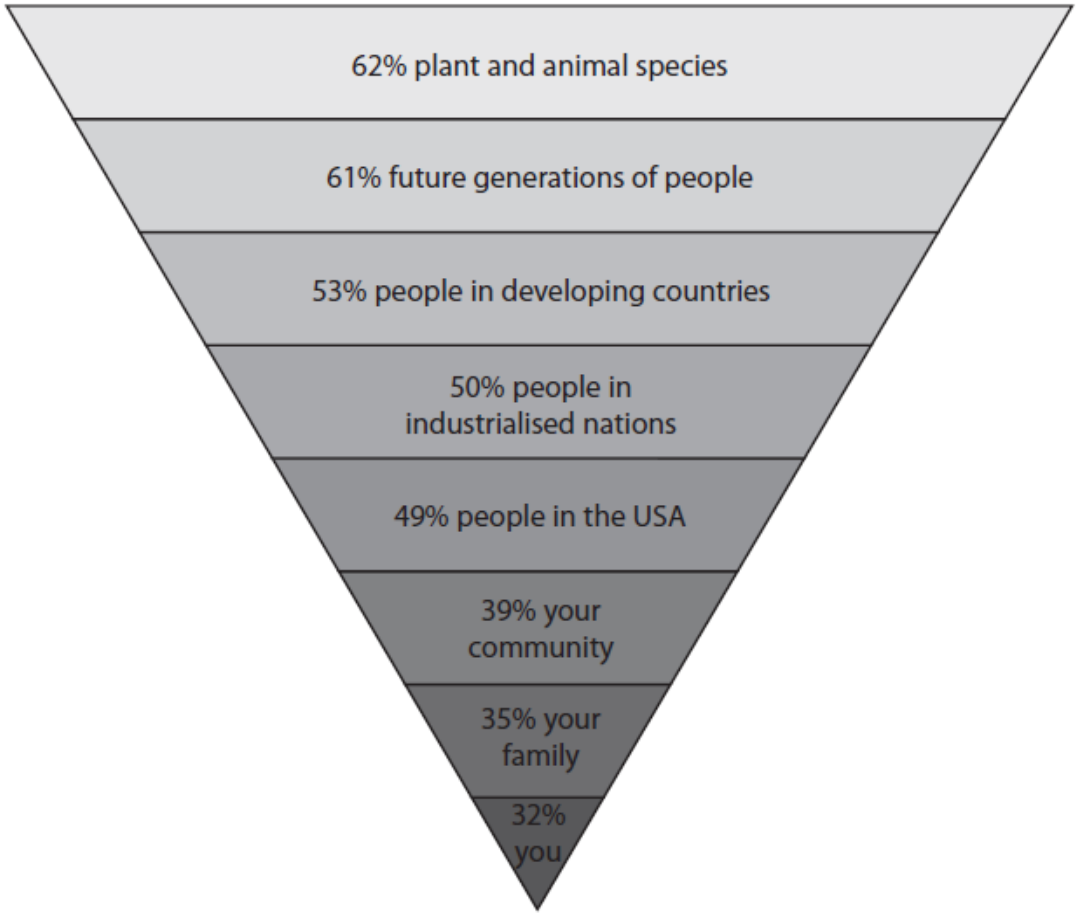
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Q14.

A survey was conducted in the USA to find out what harm people thought global warming could have.

The people were asked if they thought global warming could harm the eight groups shown in the diagram.

The diagram below shows the percentage of people who thought each group would be harmed.




Explain the meaning of the term **global warming**.

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Q15.

In some commercial glasshouses, the concentration of carbon dioxide in the atmosphere is increased.

Explain why this increase in carbon dioxide concentration affects the growth of plants in glasshouses.

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**(Total for question = 3 marks)**

Q16.

The Intergovernmental Panel on Climate Change (IPCC) has issued the following statement:

"Human influence on the climate system is clear, and recent anthropogenic emissions of greenhouse gases are the highest in history. Recent climate changes have had widespread impacts on human and natural systems."

(a) Explain why anthropogenic emissions of greenhouse gases are affecting the climate.

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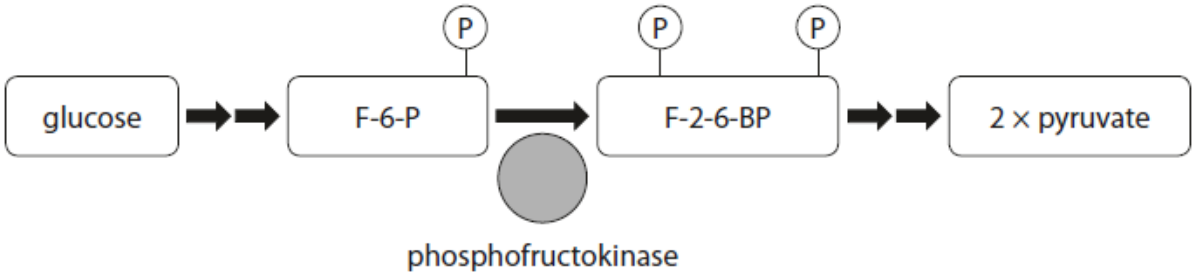
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**(Total for question = 3 marks)**

Q17.

Phosphofructokinase is an enzyme that uses ATP to convert fructose-6-phosphate (F-6-P) into fructose-2,6-bisphosphate (F-2,6-BP).

The conversion of F-6-P by this enzyme is a rate-determining step in glycolysis. This is shown in the diagram.




(i) Explain why ATP is required for this reaction.

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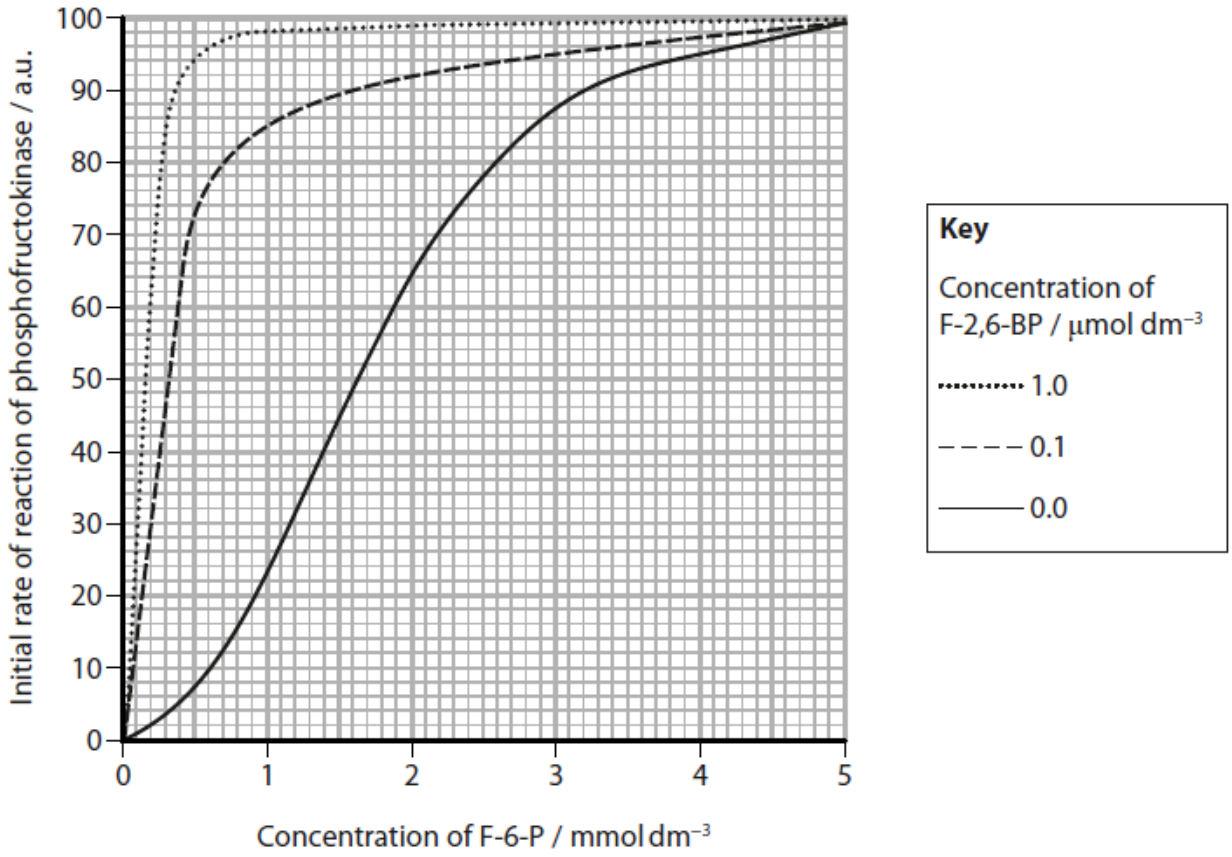
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The effect of substrate concentration on the initial rate of reaction of phosphofructokinase was investigated.

This investigation was repeated with the addition of two concentrations of F-2,6-BP.

The graph shows the results of this investigation.




Comment on the effects of F-6-P and F-2,6-BP concentrations on the rate of glycolysis.

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**(Total for question = 6 marks)**

Q18.

Explain why the value for GPP is lower than the light energy available to the ecosystem.

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**(Total for question = 3 marks)**

Q19.

A new species of mosquito has evolved in the tunnels of the London Underground. These mosquitoes are believed to be the descendants of bird-biting mosquitoes which colonised the tunnels 100 hundred years ago. The mosquitoes now feed on rats, mice and human beings instead of birds.

(a) Place a cross in the box next to the best definition of a species.

**(1)**

☒ **A** individuals can interbreed to produce fertile offspring

☒ **B** individuals can interbreed to produce hybrid offspring

☒ **C** individuals can interbreed to produce sterile offspring

☒ **D** individuals can interbreed to produce offspring

(b) Explain how this species of mosquito may have evolved.

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**(Total for question = 6 marks)**

Q20.

DCMU is a herbicide that can disrupt one of the carrier proteins in the electron transport chain of chloroplasts.

A student carried out an investigation to study the effect of DCMU concentration on the Hill reaction.

The student ground up some spinach leaves in an isolation mixture containing sucrose solution at a concentration of 0.4 mol $dm^{-3}$. The mixture was filtered and then spun in a centrifuge. The chloroplasts were extracted.

These chloroplasts were divided equally into eight different tubes containing a solution of distilled water, DCPIP and a buffer.

A small volume of DCMU was added to each tube and the time taken for the blue DCPIP to decolourise was recorded.

(a) (i) Explain why the isolation mixture contained sucrose at a concentration of 0.4 mol $dm^{-3}$ rather than at a concentration of 0.8 mol $dm^{-3}$.

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(ii) The isolation mixture had a temperature of 4 $^{\circ}$C and pH of 7.

Explain why this temperature and pH are appropriate.

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| Concentration of DCMU / μmol dm$^{-3}$ | Rate of colour change / $\times 10^{-4}$ s$^{-1}$ |
|---|---|
| 0 | 23.5 |
| 1 | 12.5 |
| 2 | 6.3 |
| 3 | 4.2 |
| 4 | 3.2 |
| 5 | 2.6 |
| 6 | 2.2 |
| 7 | 2.3 |

(i) Analyse the data to deduce a null hypothesis for this investigation.

**(1)**

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(ii) The student started to analyse the data using a statistical test, called the Spearman's rank correlation coefficient ($r_s$), to see if there was a correlation.

Complete the table by filling in the empty boxes.

**(1)**

| Concentration of DCMU / mol dm$^{-3}$ | Concentration ranked ($R_1$) | Rate of colour change / $10^{-4}$ s$^{-1}$ | Rate ranked ($R_2$) | Difference in ranks d ($R_1$–$R_2$) | Difference squared $d^2$ |
|---|---|---|---|---|---|
| 0 | 1 | 23.5 | 8 | | |
| 1 | 2 | 12.5 | 7 | 5 | 25 |
| 2 | 3 | 6.3 | 6 | 3 | 9 |
| 3 | 4 | 4.2 | 5 | 1 | 1 |
| 4 | 5 | 3.2 | 4 | 1 | 1 |
| 5 | 6 | 2.6 | 3 | 3 | 9 |
| 6 | 7 | 2.2 | 1 | 6 | 36 |
| 7 | 8 | 2.3 | 2 | 6 | 36 |

(iii) Calculate $r_s$ by using the equation.

$$r_s = 1 - \frac{6\Sigma d^2}{n(n^2-1)}$$

Where $\Sigma(d^2)$ is the sum of all the values for $d^2$ and n is the number of pairs of data.

**(3)**

$r_s$ = .....

(iv) The table shows some of the critical values for the Spearman's rank correlation coefficient.

| Number of pairs of data ($n$) | $p$ value | | | |
|---|---|---|---|---|
| | 0.10 | 0.05 | 0.02 | 0.01 |
| 6 | 0.829 | 0.866 | 0.943 | 1.000 |
| 8 | 0.643 | 0.786 | 0.833 | 0.881 |
| 10 | 0.564 | 0.648 | 0.746 | 0.794 |
| 12 | 0.506 | 0.591 | 0.712 | 0.777 |
| 14 | 0.456 | 0.544 | 0.645 | 0.715 |
| 16 | 0.425 | 0.506 | 0.601 | 0.665 |
| 18 | 0.399 | 0.475 | 0.564 | 0.625 |

Explain the outcome of the statistical test.

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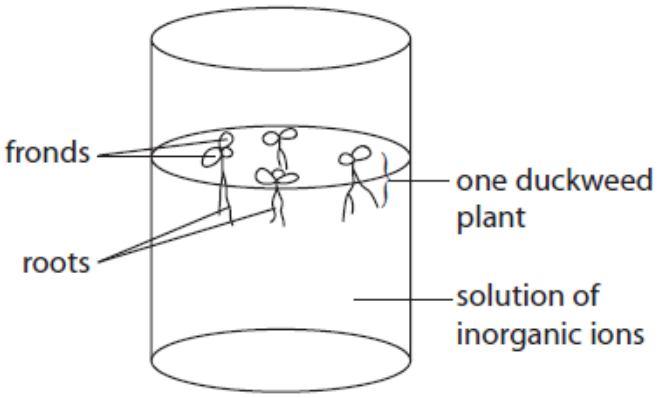
**(Total for question = 13 marks)**

Q21.

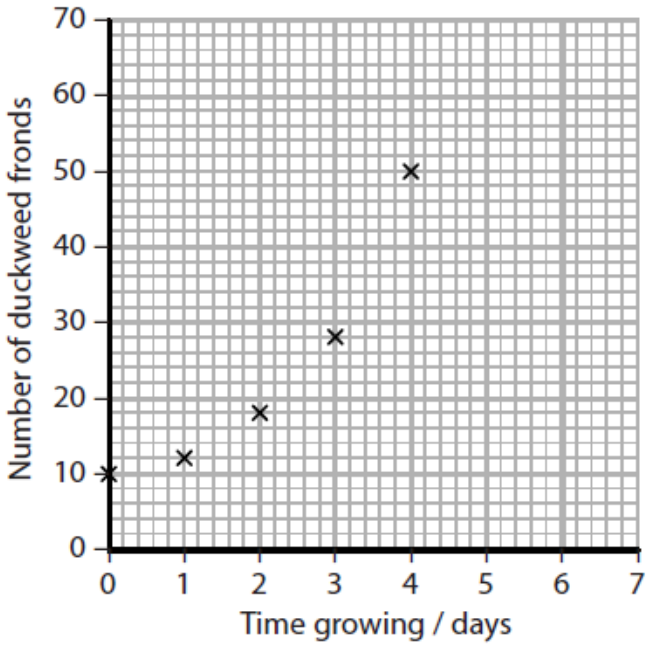
Duckweed is a small plant that floats on the surface of water. It could be a source of animal feed as it grows very quickly. Duckweed absorbs dissolved inorganic ions and this decreases water pollution.

Duckweed grows by producing more fronds, which then separate into new plants.

The diagram below shows some duckweed growing in a beaker containing a solution of inorganic ions.




The graph below shows the growth of duckweed over a four-day period.




(i) Explain what the solution should contain for the optimum growth of duckweed.

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(ii) Explain how the information in this graph could be used to estimate the increase in growth after a further six days.

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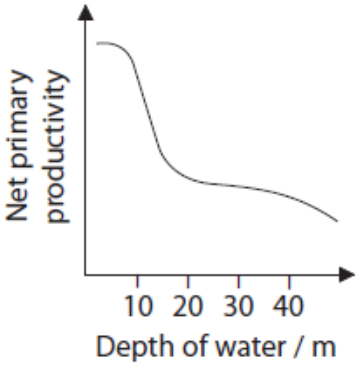
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Q22.

The graph below shows how the depth of water in a freshwater lake affects the net primary productivity (NPP).




Suggest an explanation for the effect of depth of water on the NPP in this freshwater lake.

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Q23.

The pigment content of mountain plants can be affected by various environmental factors. These factors include altitude (height up a mountain), exposure to ultraviolet radiation (UV-B) and temperature.

These pigments include chlorophyll, found in chloroplasts, and flavonoids that are found in sap vacuoles.

Flavonoids can protect plants from ultraviolet radiation (UV-B) that can damage DNA.

The altitude at which a plant grows on a mountain affects its flavonoid content.

Devise a procedure to show that an increase in altitude increases the flavonoid content of one species of plant found growing on a mountain.

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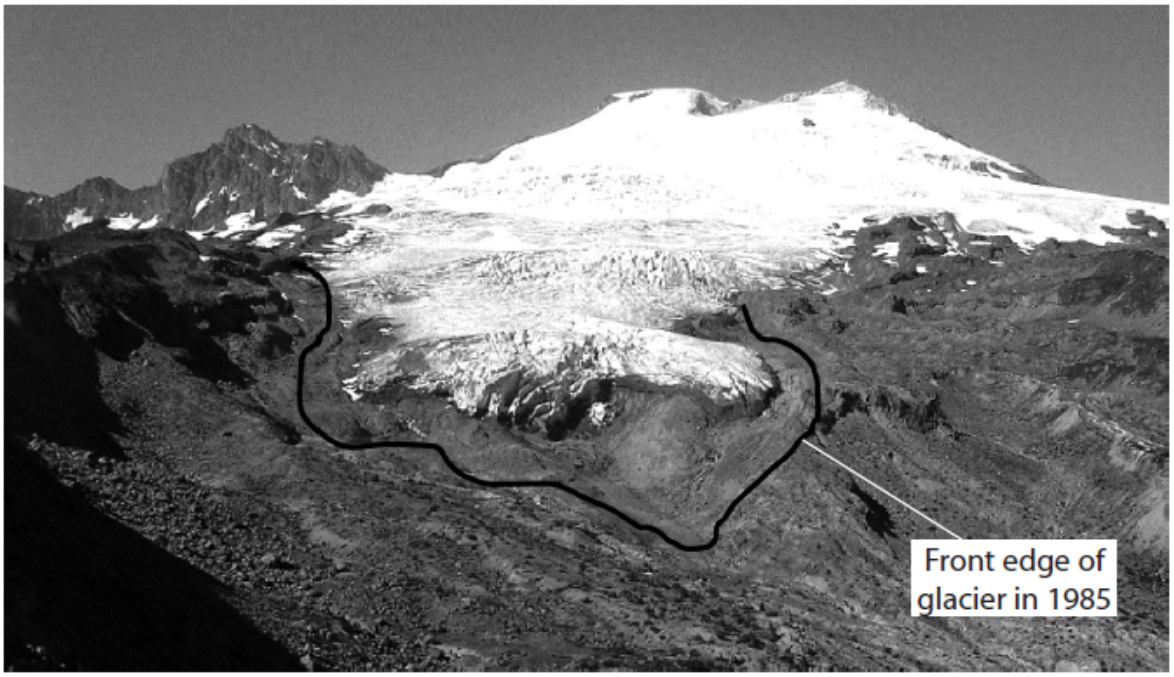
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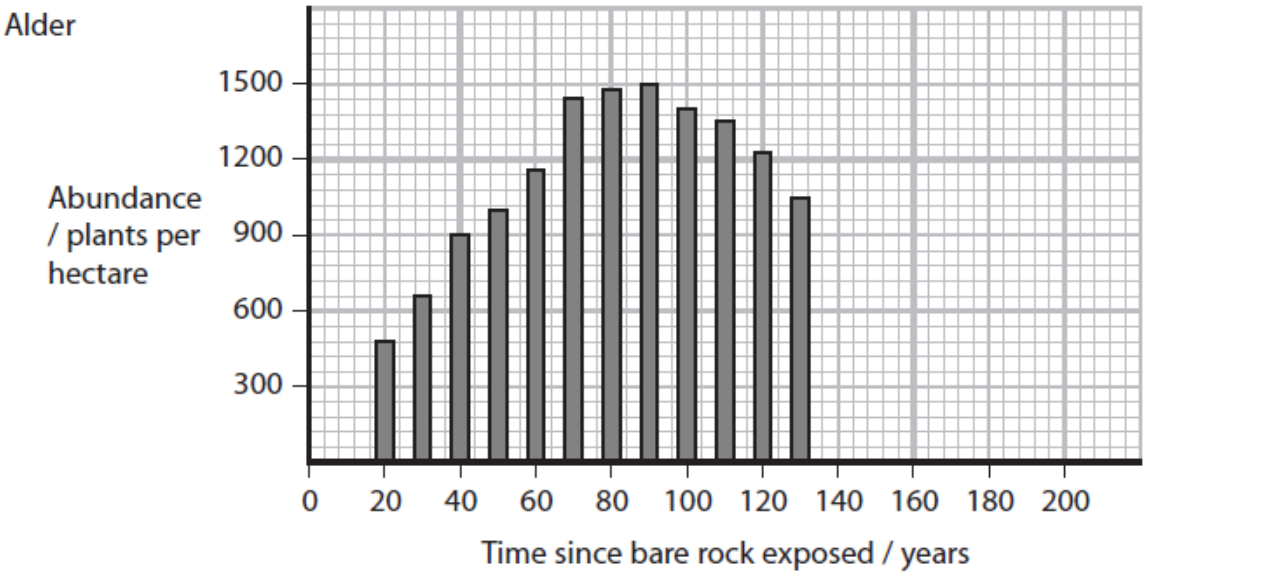
Q24.

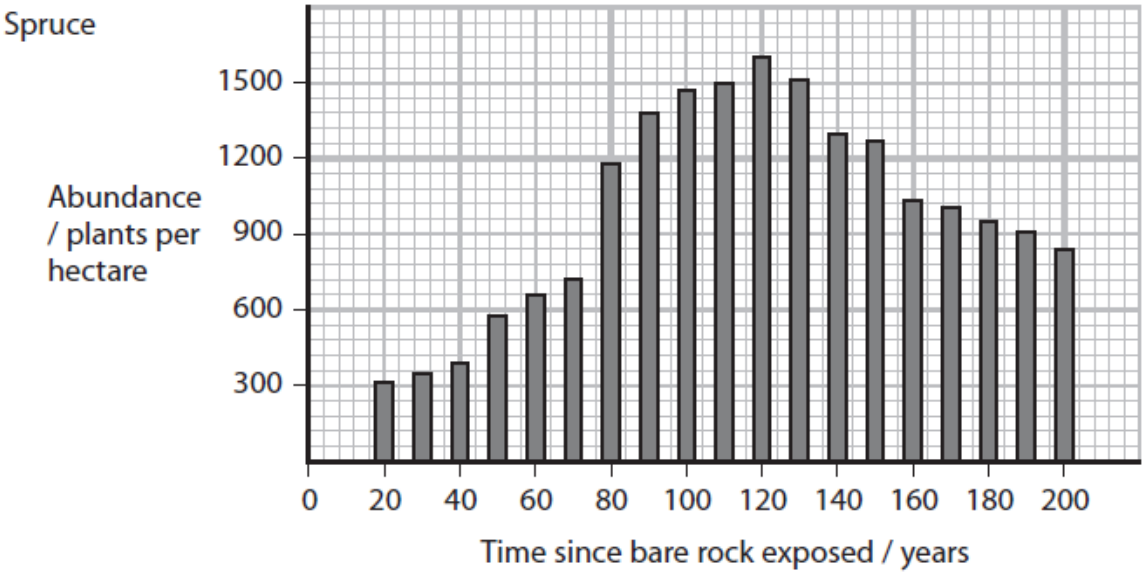
The photograph shows a glacier at the top of a mountain.
Glaciers in many areas of the world are retreating (reducing in size).
The line on the photograph shows the position of the front edge of the glacier in 1985.

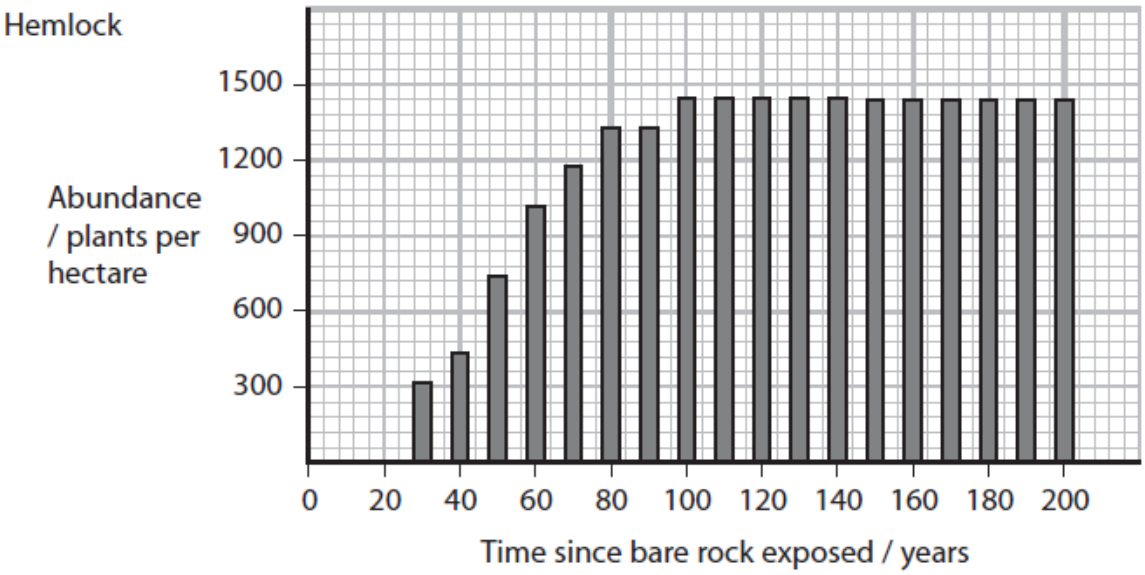



Bare rock is exposed as the glacier retreats. Two hundred years ago, bare rock was exposed after a glacier retreated. A study has been made of the long-term changes in vegetation on that area of rock after the retreat of the glacier.

The graphs show the abundance of three species of tree since the bare rock was exposed as the glacier retreated. The abundance of each species was measured every ten years for 200 years.




Comment on the changes in the abundance of these three species over 200 years.

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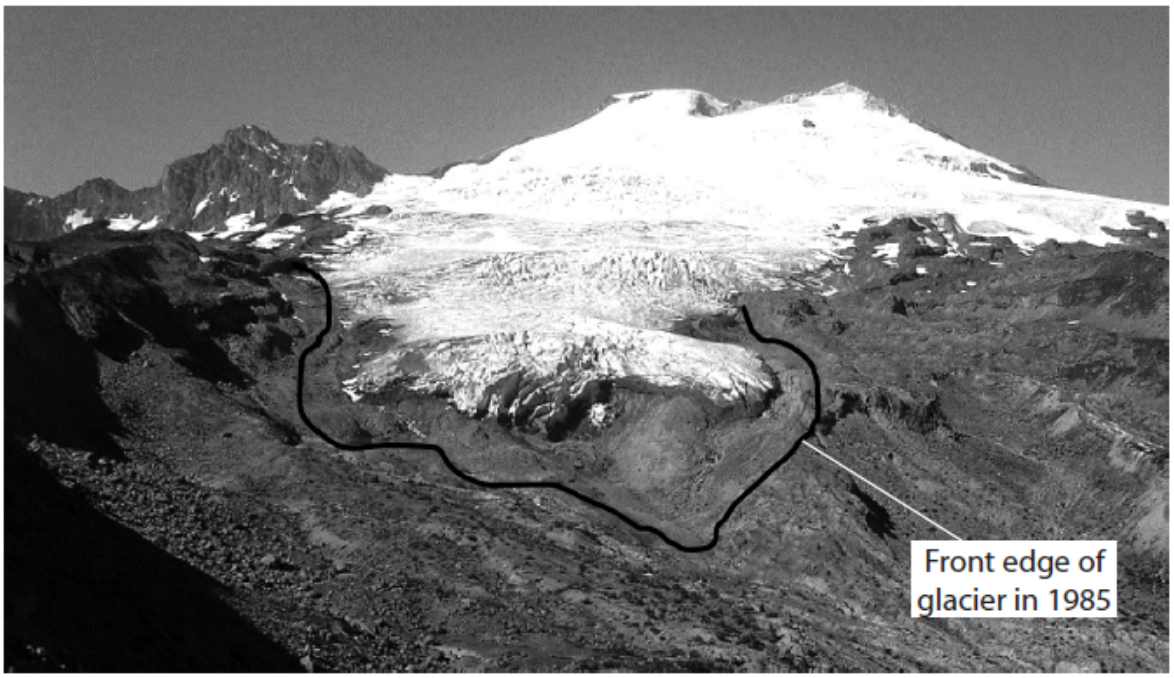
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**(Total for question = 4 marks)**

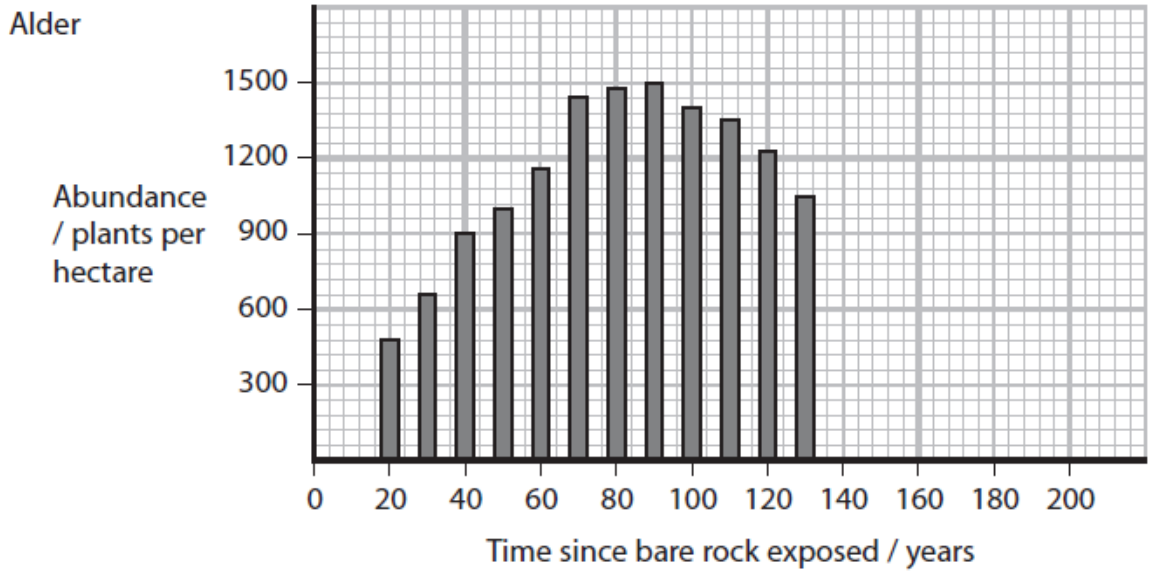
Q25.

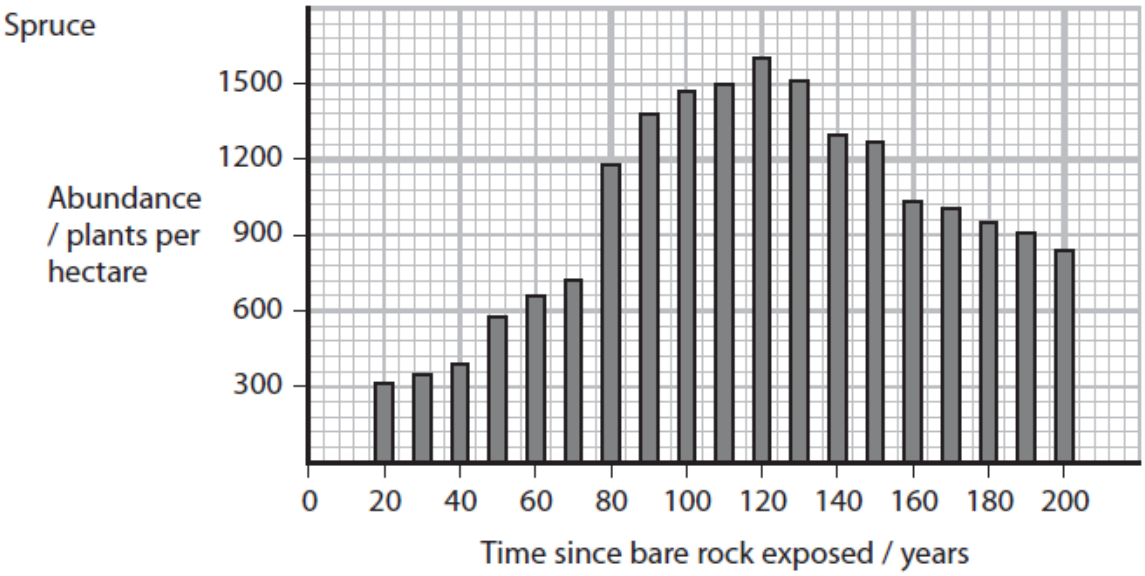
The photograph shows a glacier at the top of a mountain.
Glaciers in many areas of the world are retreating (reducing in size).
The line on the photograph shows the position of the front edge of the glacier in 1985.

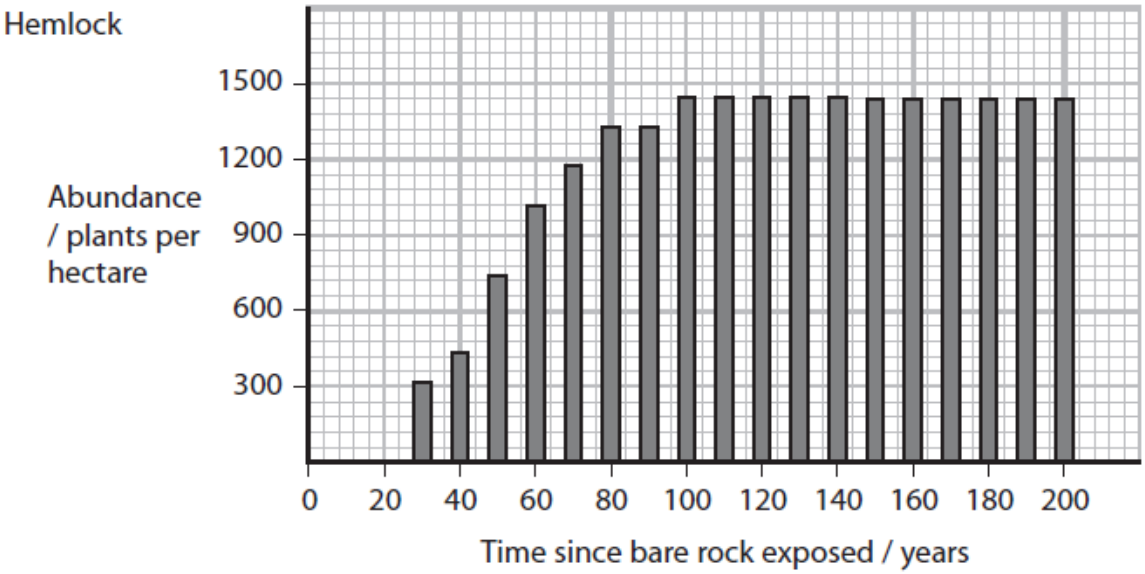



Bare rock is exposed as the glacier retreats. Two hundred years ago, bare rock was exposed after a glacier retreated. A study has been made of the long-term changes in vegetation on that area of rock after the retreat of the glacier.

The graphs show the abundance of three species of tree since the bare rock was exposed as the glacier retreated. The abundance of each species was measured every ten years for 200 years.






Explain what happened to the bare rock to allow the growth of these trees.

**(3)**

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Q1.

Global warming can affect abiotic factors that determine the distribution of organisms.

The presence of sodium chloride in soil is an abiotic factor that affects the germination of seeds.

The effects of sodium chloride solution and gibberellin on the germination of rice seeds have been investigated.

Gibberellin regulates developmental processes in plants.

Fifty seeds were placed in each of three Petri dishes containing different solutions.

The seeds were incubated for 96 hours and the number that germinated in each Petri dish was counted.

| Treatment | Solution | Number of seeds germinating |
|---|---|---|
| Control | Distilled water | 48 |
| Sodium chloride | 120 mmol $dm^{-3}$ of sodium chloride | 33 |
| Sodium chloride and gibberellin | 120 mmol $dm^{-3}$ sodium chloride and 50 µmol $dm^{-3}$ gibberellin | 45 |

(i) Give a null hypothesis for this experiment.

**(1)**

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(ii) Calculate the chi-squared ($X^2$) value for these results, using the formula provided.

**(3)**

$$\chi^2 = \sum \frac{(O - E)^2}{E}$$

Answer .....

(iii) In a second experiment, using the same three treatments, the chi-squared ($X^2$) value was found to be 6.635.

The table gives the critical values for the chi-squared ($X^2$) test at different probability levels.

| Degrees of freedom | Probability level | | |
|---|---|---|---|
| | 0.05 | 0.01 | 0.001 |
| 1 | 3.841 | 6.635 | 10.83 |
| 2 | 5.991 | 9.210 | 13.82 |
| 3 | 7.815 | 11.34 | 16.27 |
| 4 | 9.488 | 13.28 | 18.47 |

Deduce the statistical significance of the results of the second experiment.

**(2)**

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**(Total for question = 6 marks)**

Q2. The Sylt-Rømø Wadden Sea, shown in the diagram below, has a high gross primary productivity (GPP) which is monitored constantly.

The Sylt-Rømø Wadden Sea is protected from the North Sea by an island.

There are no large rivers flowing into the Sylt-Rømø Wadden Sea.




(a) Explain the meaning of the term **gross primary productivity (GPP)**.

**(2)**

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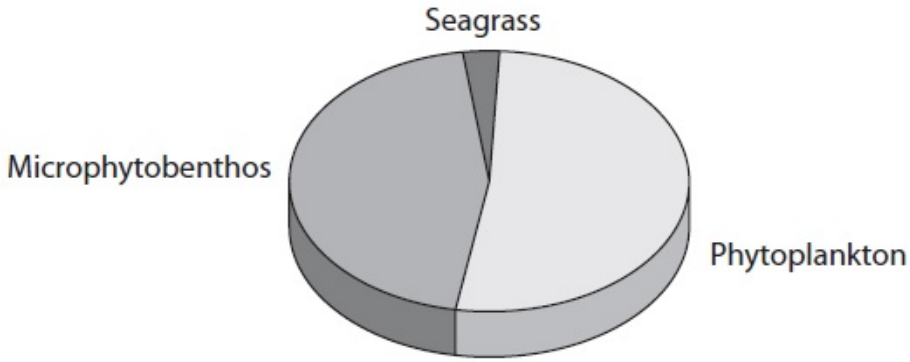
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(b) Seagrass, microphytobenthos and phytoplankton are the producers found in the Sylt-Rømø Wadden Sea.

The chart below shows the distribution of GPP between these producers.




(i) Using the chart, describe the distribution of GPP in this sea.

**(2)**

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(ii) The total GPP for this sea is $840 \times 10^6$ kJ $m^{-2}$ $y^{-1}$.

Explain how GPP for the phytoplankton could be calculated.

**(2)**

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(iii) Suggest why GPP for this sea is very high.

**(2)**

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(c) Explain why net primary productivity (NPP) is lower than GPP.

**(2)**

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**(Total for Question = 10 marks)**

Q3.

Anthropogenic activities are contributing to global warming.

Scientists from the IPCC (Intergovernmental Panel on Climate Change) say that changes to diet can have a major impact on greenhouse gas emissions. The method of farming affects the level of impact.

The Paris Agreement of 2015 committed countries to reduce carbon emissions.

The table shows the mass of greenhouse gas released in the production of one serving of a variety of sources of protein.

| Source of protein | Mass of greenhouse gas released in the production of one serving of the protein / kg |
|---|---|
| Beef | 7.0 |
| Lamb | 5.0 |
| Chicken | 2.5 |
| Cheese | 2.0 |
| Tofu (from soya beans) | 1.0 |
| Nuts | 0.5 |

(i) Explain why a diet based on plant protein produces lower greenhouse gas emissions than a

diet based on animal protein.

**(3)**

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(ii) Beef cattle are traditionally reared by grazing on natural pastures (grassland).

In recent years, large areas of rainforest have been cleared to produce beef.

Explain why the farming of beef cattle on deforested land produces more greenhouse gas emissions than from those reared on natural pastures.

**(3)**

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**(Total for question = 6 marks)**

Q4.

The scientific article you have studied is adapted from *Scientific American*.

Use the information from the scientific article and your own knowledge to answer the following question.

Describe how the effects of 'competitive release' could be demonstrated (paragraphs 18 and 19).

**(4)**

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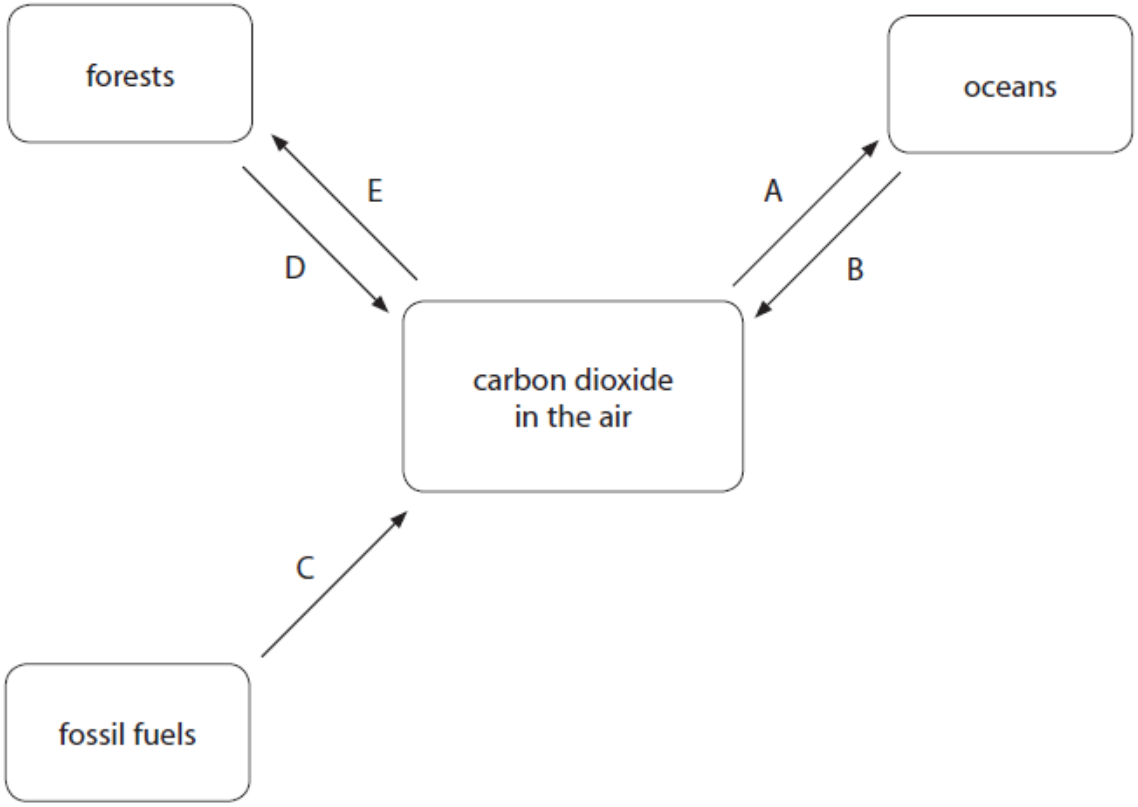
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**(Total for question = 4 marks)**

Q5.

The diagram below shows part of the carbon cycle. The processes A, B, C, D and E, transfer carbon.




Place a cross ☒ in the box next to the reaction in process E that uses carbon dioxide.

**(1)**

☒ **A** light-dependent reaction

☒ **B** light-independent reaction

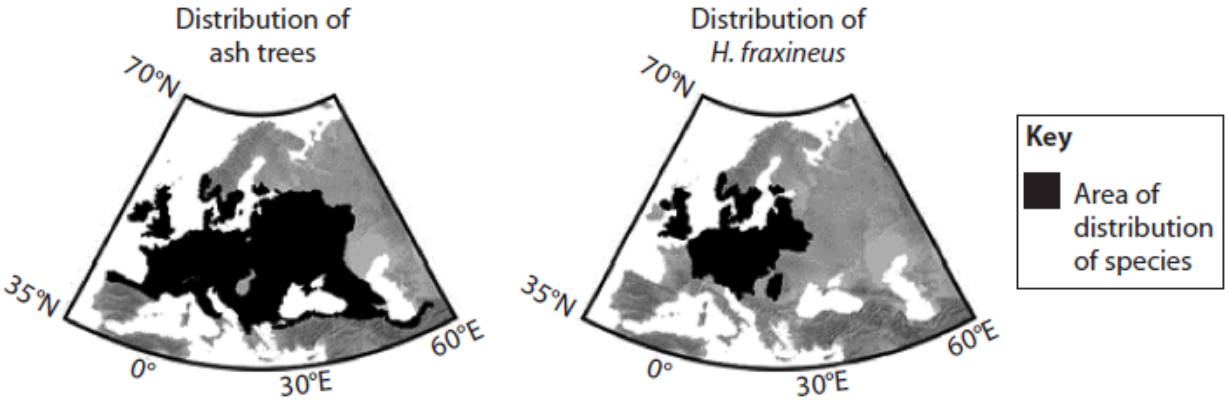
☒ **C** photolysis

☒ **D** photophosphorylation

Q6.

*Hymenoscyphus fraxineus* (*H. fraxineus*) is the fungus that causes ash dieback. This disease usually kills all the ash trees that it infects.

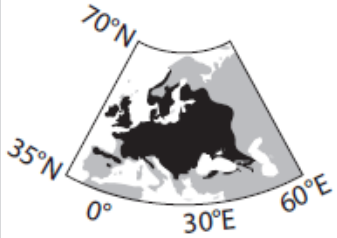
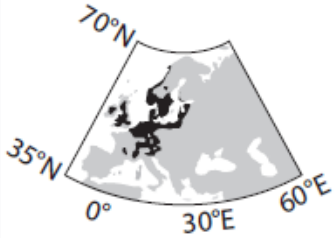
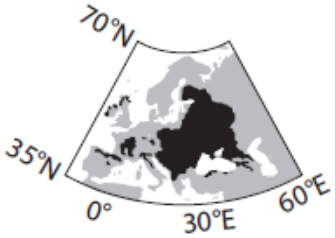
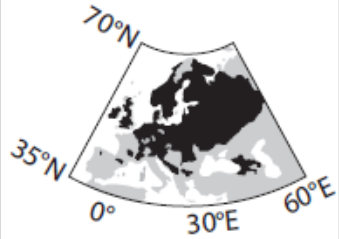
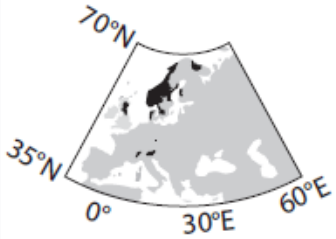
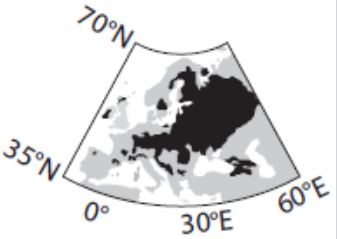
The diagrams show the distribution of ash trees and *H. fraxineus* in 2007.




In 2007 the mean atmospheric carbon dioxide concentration was 398 ppm.

Models have been used to predict the effect of increasing atmospheric carbon dioxide concentration on the distribution of ash trees and *H. fraxineus*.

The table shows these predictions.

| Concentration $CO_2$ / ppm | Predicted region suitable for ash trees | Predicted region suitable for *H. fraxineus* | Predicted distribution of ash trees |
|---|---|---|---|
| 430 |  |  |  |
| 1080 |  |  |  |

(i) Which of the following is an abiotic factor that should be considered in the model?

**(1)**

☒ **A** ash tree resistance to *H. fraxineus*

☒ **B** *H. fraxineus* pathogens

☒ **C** humidity

☒ **D** ocean pH

(ii) Which of the following could be caused by an increase in atmospheric carbon dioxide from 398 ppm to 1080 ppm?

**(1)**

☒ **A** decreased photosynthesis

☒ **B** global warming

☒ **C** increased plant respiration

☒ **D** ozone depletion

(iii) Analyse the data to explain the predicted effect of climate change on the distribution of ash trees.

**(5)**

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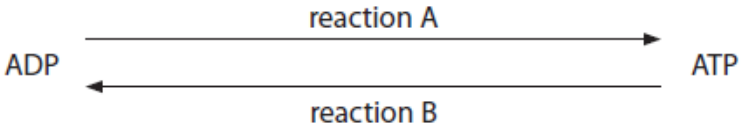
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**(Total for question = 7 marks)**

Q7.

Phagocytosis requires a source of energy in the form of ATP.

The diagram below shows the relationship between ATP and ADP.



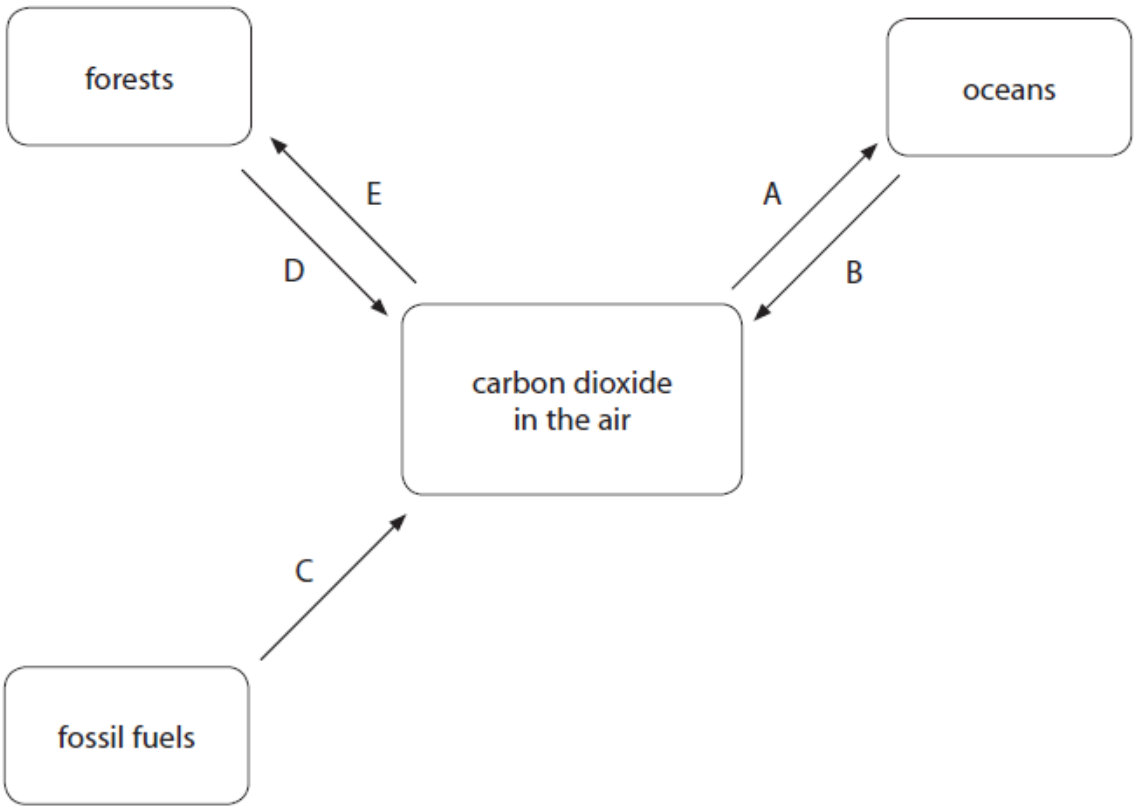

Place a cross ☒ in the box next to the name of reaction A and reaction B.

**(2)**

| Reaction | Name of reaction | | | | |
|---|---|---|---|---|---|
| | autolysis | decarboxylation | hydrolysis | phosphorylation | polymerisation |
| A | ☐ | ☐ | ☐ | ☐ | ☐ |
| B | ☐ | ☐ | ☐ | ☐ | ☐ |

Q8.

The diagram below shows part of the carbon cycle. The processes A, B, C, D and E, transfer carbon.




Place a cross ☒ in the box next to the gases produced by process C.

**(1)**

☒ **A** carbon dioxide and methane

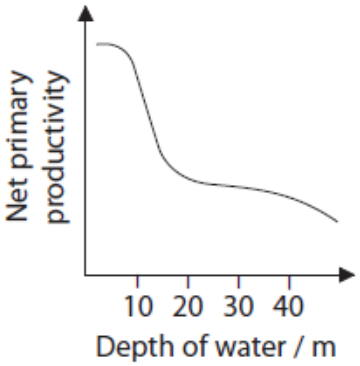
☒ **B** carbon dioxide and water vapour

☒ **C** carbon dioxide, methane and water vapour

☒ **D** carbon dioxide, oxygen and water vapour

Q9.

The graph below shows how the depth of water in a freshwater lake affects the net primary productivity (NPP).




Place a cross ☒ in the box next to the units that should appear on the *y*-axis of this graph.

**(1)**

☒ **A** kg

☒ **B** kJ m$^{-}$1

☒ **C** kJ m$^{-2}$ year$^{-1}$

☒ **D** kg m$^{-1}$ year$^{-1}$

Q10.

**Answer the questions with a cross in the boxes you think are correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.**

Photosynthetic plants use light as a source of energy for the synthesis of organic molecules. Photosynthesis is a two-stage process.

The light-dependent reactions take place in the chloroplast.

(i) Which of the following describes where, in the chloroplast, the light-dependent reactions take place?

**(1)**

- ☒ **A** cristae
- ☒ **B** matrix
- ☒ **C** stroma
- ☒ **D** thylakoids

(ii) Which of the following are the products of the light-dependent reactions?

**(1)**

- ☒ **A** carbon dioxide and reduced NADP
- ☒ **B** glucose and oxygen
- ☒ **C** reduced NAD, ATP and oxygen
- ☒ **D** reduced NADP, ATP and oxygen

(iii) Which of the following is the source of the hydrogen produced by the light-dependent reactions?

**(1)**

- ☒ **A** glucose
- ☒ **B** reduced NAD
- ☒ **C** reduced NADP
- ☒ **D** water

**(Total for question = 3 marks)**

Q11.

The golden snub-nosed monkey (*Rhinopithecus roxellana*) is endemic to high mountainous

regions of China.

This endangered species of monkey feeds on seeds.

Golden snub-nosed monkeys live in areas with very cold winters.

The seeds in their diet contain lipids and carbohydrates.

Climate change is reducing seed production by plants in their habitat.

Discuss the impact of climate change on the monkey population.

**(4)**

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**(Total for question = 4 marks)**

Q12.

The coffee husks, shown in the photograph, are a waste product of coffee plantations.

Composting has been suggested as an environmentally friendly way of decomposing these coffee husks.



The effect of adding cow dung to coffee husks, before they are composted, has been investigated.

The table shows the percentages of organic carbon and nitrogen in two compost heaps at the start of composting and after 90 days.

| | Husks alone | | Husks with added cow dung | |
|---|---|---|---|---|
| Days composting | 0 | 90 | 0 | 90 |
| Organic carbon (%) | 54.50 | 41.70 | 48.10 | 35.40 |
| Nitrogen (%) | 1.84 | 2.31 | 2.76 | 3.19 |

* The changes in the compost heaps are due to the activity of decomposers and other organisms.

Devise an investigation to determine the effect of the carbon to nitrogen ratio on the succession of species in these compost heaps.

**(6)**

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**(Total for question = 6 marks)**

Q13.

Glycolysis is inhibited by acidic conditions.

Devise an investigation to determine the effect of acidic conditions on the initial rate of reaction of phosphofructokinase.

**(4)**

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**(Total for question = 4 marks)**

Q14.

The scientific article you have studied is adapted from *The Biologist*.

Use the information from the scientific article and your own knowledge to answer the following question.

Human cells can be grown in monolayers using tissue culture (Figure 1).

Devise a procedure to investigate the effect of temperature on the growth rate of a monolayer of human cells.

**(5)**

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**(Total for question = 5 marks)**

Q15.

A student investigated the light-dependent reactions of photosynthesis in spinach leaves.

The leaves were cut into pieces and ground in a cold solution of sucrose and a buffer.

The mixture was filtered and centrifuged. The liquid in the tube was poured off and kept in an ice water bath.

The pellet at the bottom of the tube was suspended by mixing with fresh sucrose and buffer and stored in an ice water bath.

Four tubes were then set up as follows:

| Tube | Liquid poured off after centrifuging / $cm^3$ | Resuspended pellet / $cm^3$ | Sucrose and buffer solution / $cm^3$ |
|---|---|---|---|
| 1 | – | 0.5 | – |
| 2 | – | – | 0.5 |
| 3 | – | 0.5 | – |
| 4 | 0.5 | – | – |

The tubes had 5 $cm^3$ of DCPIP added to them. Tube 3 was kept in the dark and the others kept in the light.

After twenty minutes, the colour in each tube was recorded. The results are shown in the table below.

| Tube | Colour in tube |
|---|---|
| 1 | pale green |
| 2 | blue |
| 3 | blue |
| 4 | blue |

(a) (i) Give **two** reasons why a cold solution containing sucrose and a buffer was used in this investigation.

**(2)**

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(ii) Give a reason why tube 3 was used in this investigation.

**(1)**

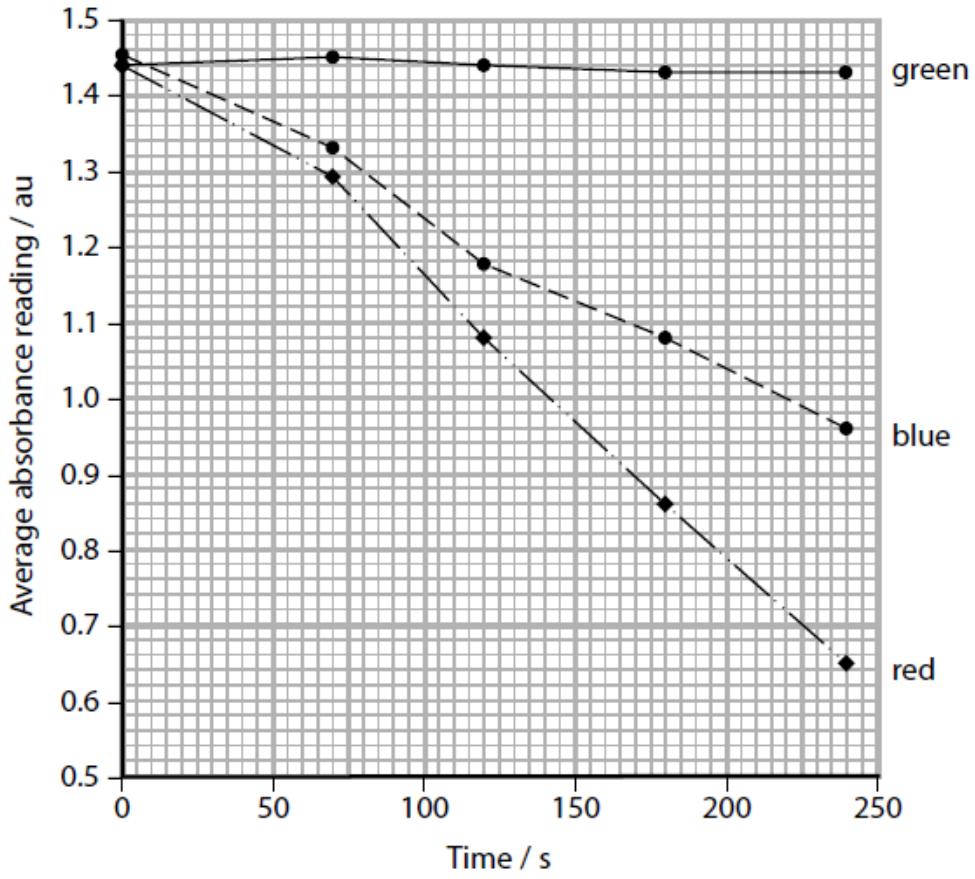
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(iii) In another investigation, the student wanted to determine the effect of different wavelengths of light on the light-dependent stage of photosynthesis.

The student modified her first investigation to obtain results.

The graph shows the results of her modified investigation.




Explain how the student modified the practical procedure of the first investigation to enable these results to be obtained.

**(4)**

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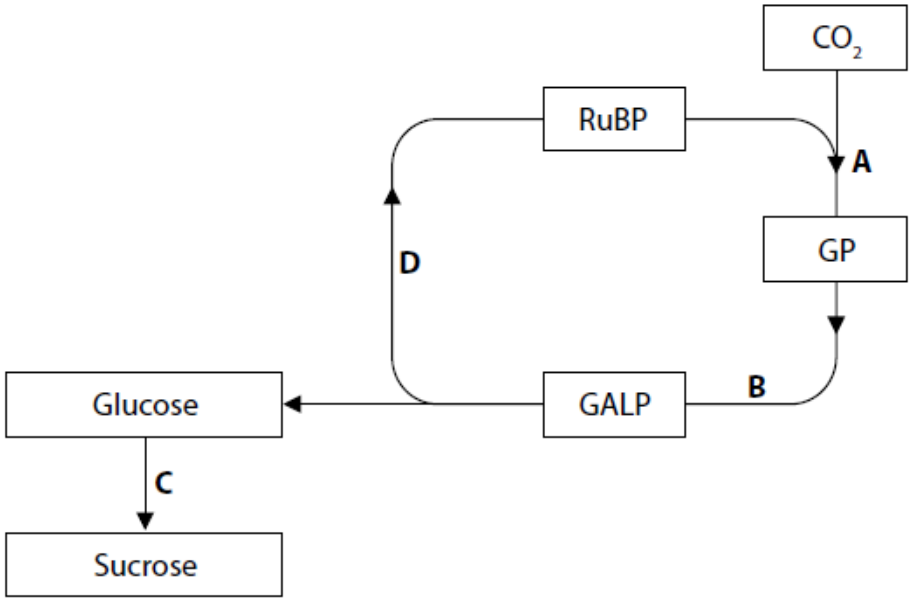
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(b) The diagram shows part of the Calvin cycle (light-independent reactions) of photosynthesis.




Place a cross in the box which indicates the correct stage (A – D) for the following statements.

(i) The stage which involves a condensation reaction and fructose.

**(1)**

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(ii) The stage where the enzyme RUBISCO is involved.

**(1)**

☒ **A**

☒ **B**

☒ **C**

☒ **D**

**(Total for question = 9 marks)**

Q16.

A student investigated the effect of salt concentration on the growth of one species of brine shrimp.

The student placed 100 shrimp eggs in a beaker containing $1dm^3$ of 3% salt solution. Three days after the eggs hatched, 10 shrimps were collected and their lengths measured. Seven days after hatching, another 10 shrimps were collected and their lengths measured.

The procedure was repeated using a 5% salt solution. All other variables were kept constant.

The results are shown in the table.

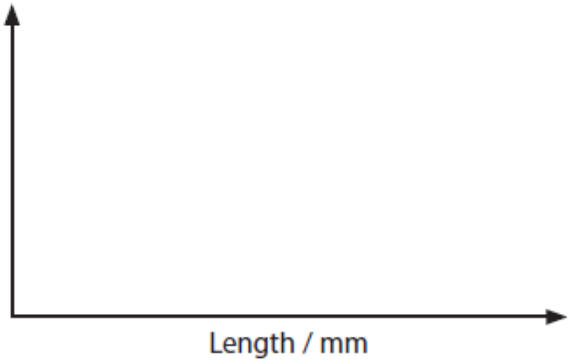
| Specimen number | Length of specimen in 3% salt solution / mm | | Length of specimen in 5% salt solution / mm | |
|---|---|---|---|---|
| | 3 days after hatching | 7 days after hatching | 3 days after hatching | 7 days after hatching |
| 1 | 0.75 | 1.00 | 0.75 | 0.98 |
| 2 | 0.78 | 1.25 | 0.73 | 0.95 |
| 3 | 0.66 | 1.10 | 0.61 | 0.93 |
| 4 | 0.73 | 1.03 | 0.63 | 0.83 |
| 5 | 0.85 | 1.15 | 0.53 | 0.98 |
| 6 | 0.78 | 1.08 | 0.60 | 1.08 |
| 7 | 0.90 | 1.13 | 0.52 | 0.95 |
| 8 | 0.90 | 1.05 | 0.81 | 1.03 |
| 9 | 0.80 | 1.18 | 0.58 | 0.88 |
| 10 | 0.85 | 1.05 | 0.68 | 0.88 |
| Mean | 0.800 | 1.102 | | 0.949 |

The student carried out a statistical test to see if there was a significant difference between the mean lengths of brine shrimps in these two salt solutions. The student used the 7 days after hatching data.

The student selected the *t*-test because the data are normally distributed.

(i) Draw a line on the graph to show a normal distribution for a population of brine shrimp.

**(1)**




(ii) Complete the table by filling in the missing value for specimen 7 and then calculate the value for $\Sigma x_1^2$.

**(1)**

| Specimen number (n) | 3% salt solution | | 5% salt solution | |
|---|---|---|---|---|
| | Length of specimen ($x_1$) | Square of length of specimen ($x_1^2$) | Length of specimen ($x_2$) | Square of length of specimen ($x_2^2$) |
| 1 | 1.00 | 1.000 | 0.98 | 0.960 |
| 2 | 1.25 | 1.563 | 0.95 | 0.903 |
| 3 | 1.10 | 1.210 | 0.93 | 0.865 |
| 4 | 1.03 | 1.061 | 0.83 | 0.689 |
| 5 | 1.15 | 1.323 | 0.98 | 0.960 |
| 6 | 1.08 | 1.166 | 1.08 | 1.166 |
| 7 | 1.13 | ..... | 0.95 | 0.903 |
| 8 | 1.05 | 1.103 | 1.03 | 1.061 |
| 9 | 1.18 | 1.392 | 0.88 | 0.774 |
| 10 | 1.05 | 1.103 | 0.88 | 0.774 |
| | | | | |
| Sum ($\sum$) | $\sum x_1 = 11.020$ | $\sum x_1^2 =$ ..... | $\sum x_2 = 9.490$ | $\sum x_2^2 = 9.055$ |
| Mean | $\bar{x}_1 = 1.102$ | | $\bar{x}_2 = 0.949$ | |

(iii) The variances are used in the calculation of a *t*-value.

The variance for the 3% salt solution $S_1^2 = 0.0059$.

Calculate the variance for the 5% salt solution $(S_2^2)$ using the formula

$$S_2^2 = \frac{\sum x_2^2 - \frac{(\sum x_2)^2}{n}}{n-1}$$

n = the number of specimens

**(2)**

$S_2^2$ .....

(iv) Calculate the *t*-value using the formula.

Give your answer to an appropriate number of significant figures.

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$$

**(3)**

*t* = .....

(v) The calculated *t*-value is greater than the critical value at $p = 0.05$.

Describe what this result indicates about the effect of salt concentration on the length of brine shrimp.

**(2)**

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**(Total for question = 9 marks)**

Q17.

The pigment content of mountain plants can be affected by various environmental factors. These factors include altitude (height up a mountain), exposure to ultraviolet radiation (UV-B) and temperature.

These pigments include chlorophyll, found in chloroplasts, and flavonoids that are found in sap

vacuoles.

Flavonoids can protect plants from ultraviolet radiation (UV-B) that can damage DNA.

State the location of chlorophyll in a chloroplast.

**(1)**

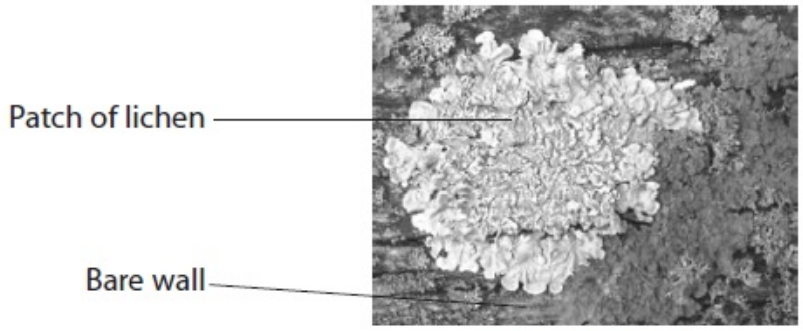
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**(Total for question = 1 mark)**

Q18. Lichen consists of two organisms, an alga and a fungus, growing together. The alga photosynthesises producing carbohydrate for the two organisms and the fungus absorbs and retains water so that the lichen does not dry out.

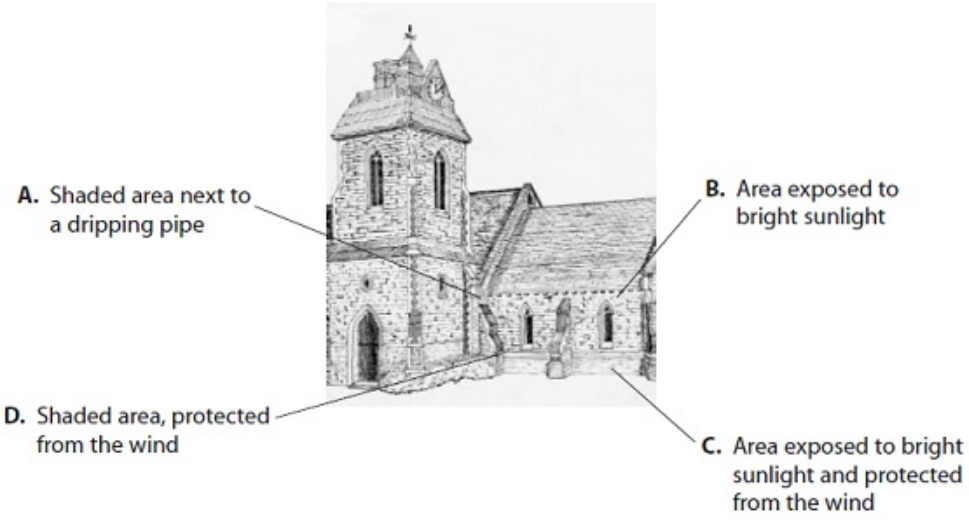
The photograph below shows a patch of lichen growing on a wall.




Magnification ×1

Algae and fungi are eukaryotic organisms.

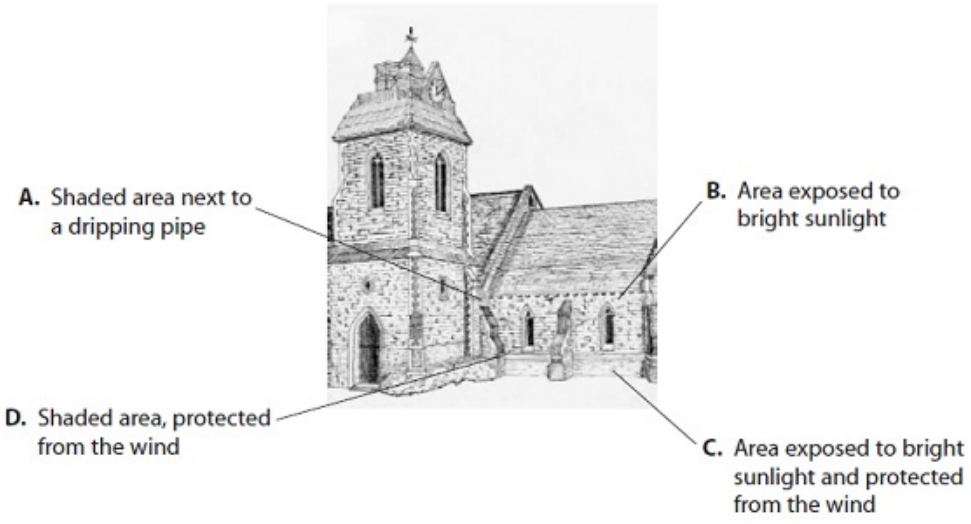
(a) Place a cross



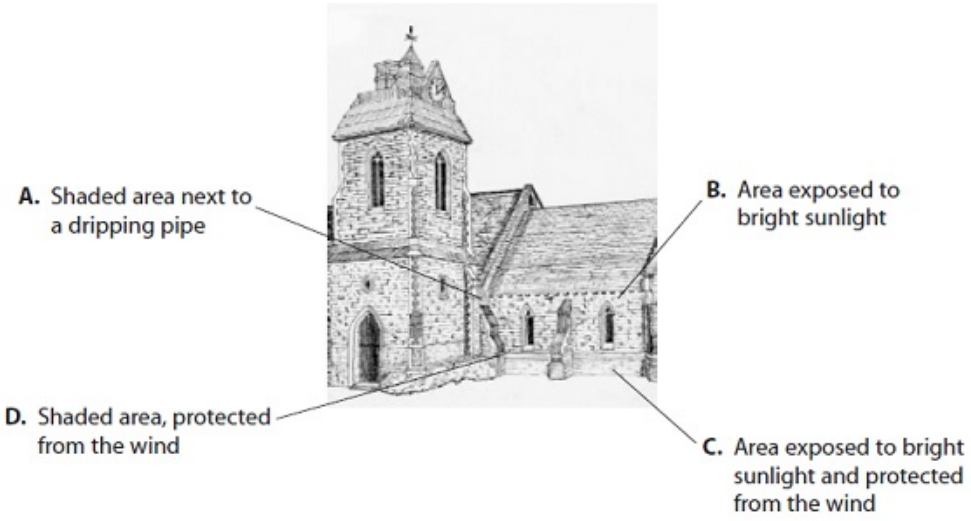

in the box

next to the names of cell structures that would be used to classify algae and fungi as eukaryotic organisms.

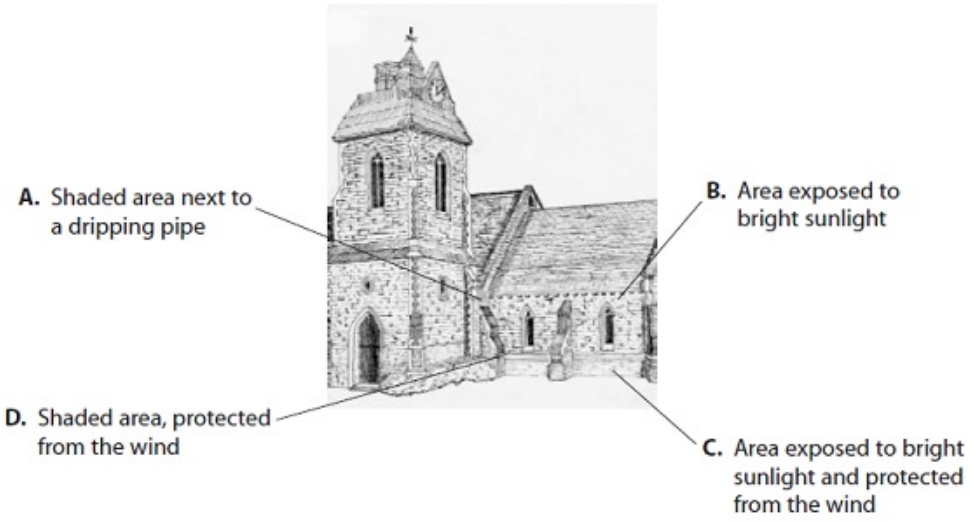
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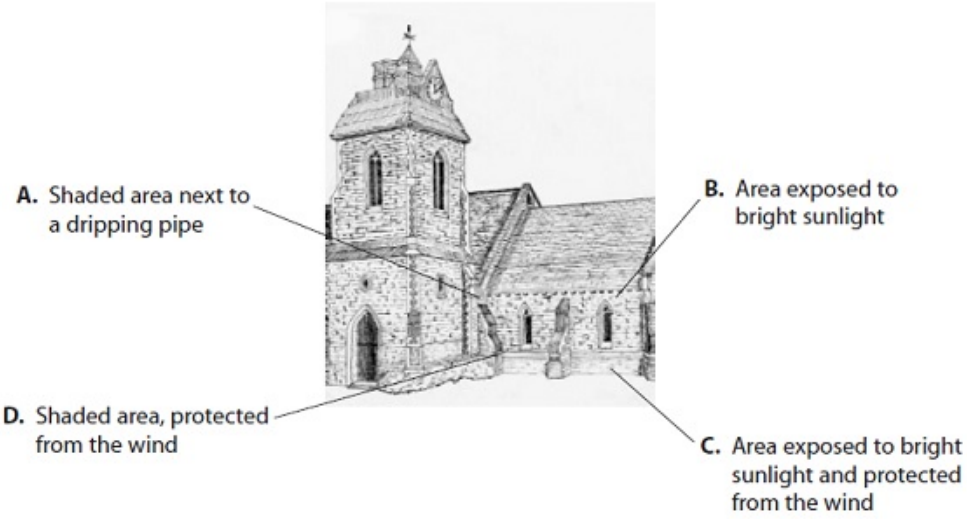

**A** cytoplasm and large (80S) ribosomes




**B** cytoplasm and small (70S) ribosomes

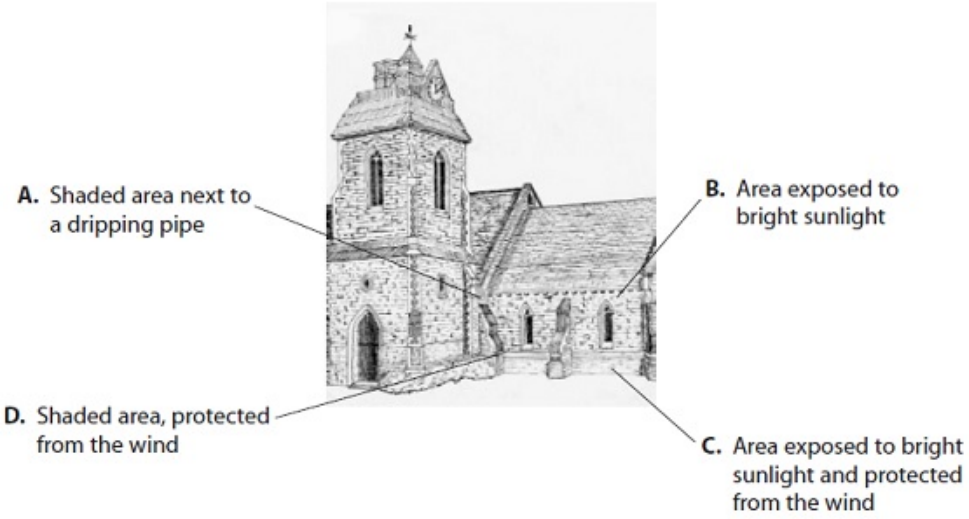



**C** nucleus and large (80S) ribosomes



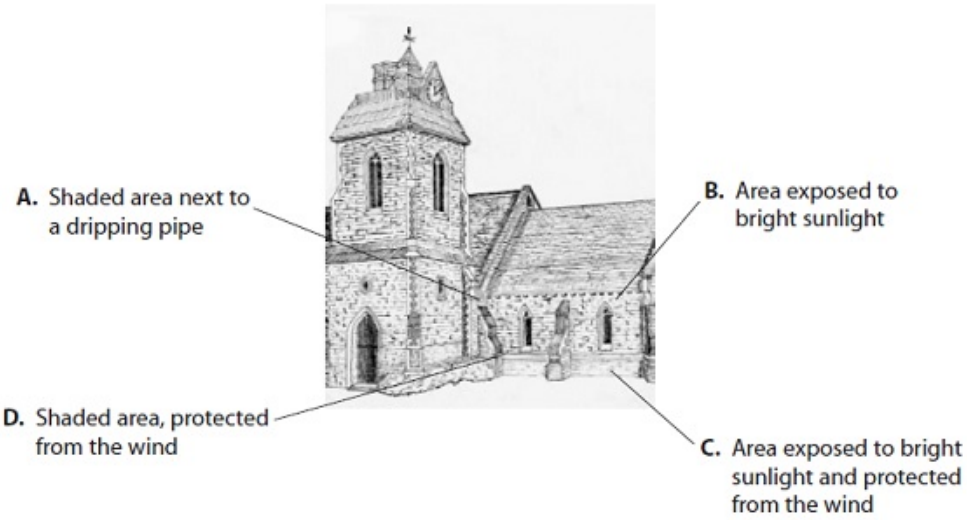

**D** nucleus and small (70S) ribosomes

(b) Place a cross

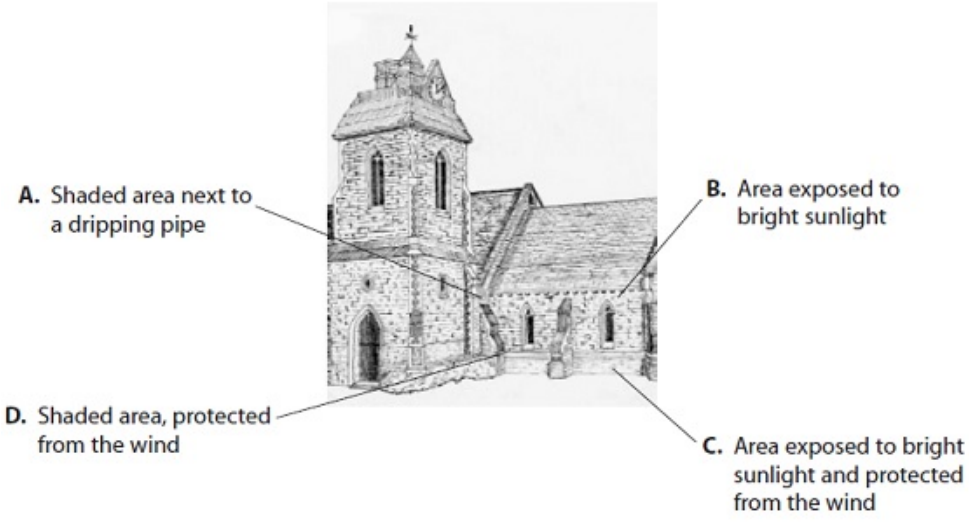



in the box next to one difference in cell structure between these two eukaryotic organisms.

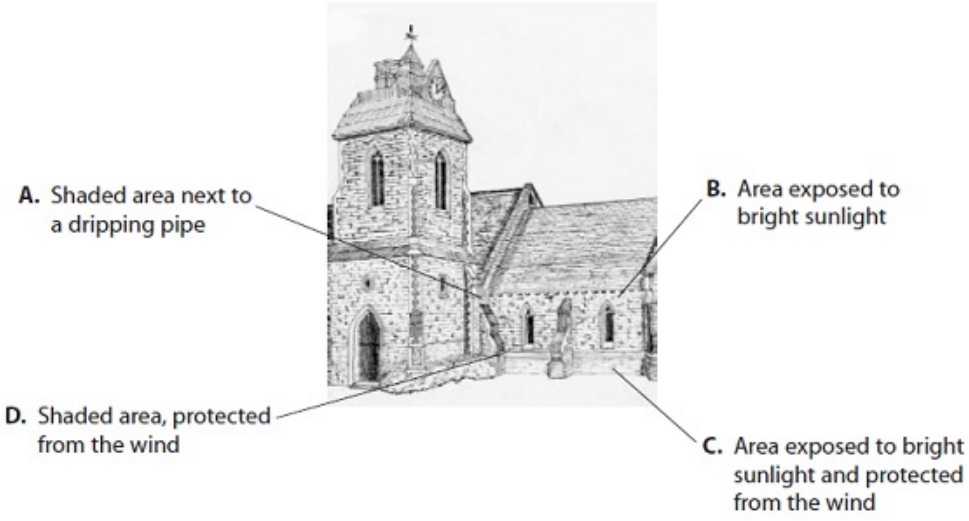
**(1)**



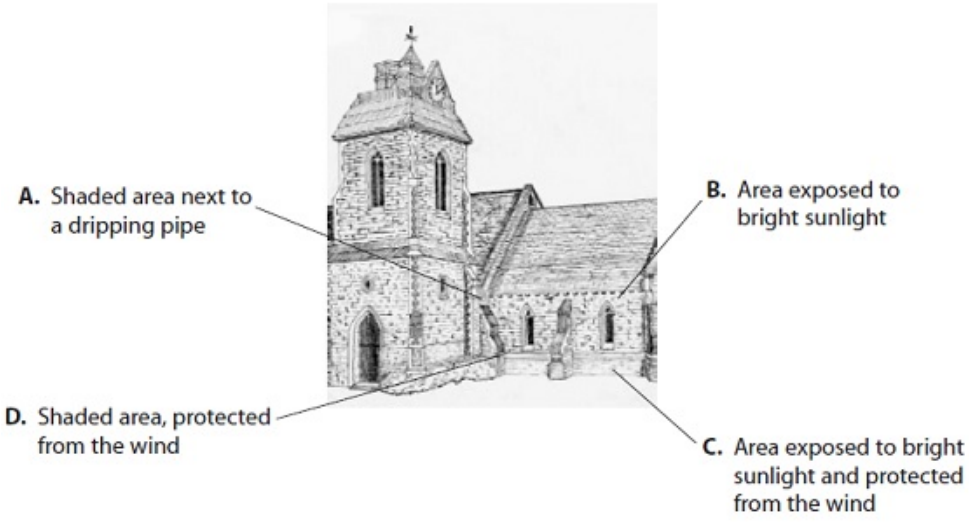

**A** algae have chloroplasts, fungi do not




**B** algae have circular DNA, fungi have linear DNA




**C** fungi have chloroplasts, algae do not




**D** fungi have circular DNA, algae have linear DNA

(c) Lichens can reproduce sexually and asexually. Sexual reproduction involves meiosis and asexual reproduction involves mitosis.

Suggest advantages to lichens of being able to reproduce both sexually and asexually.

**(2)**

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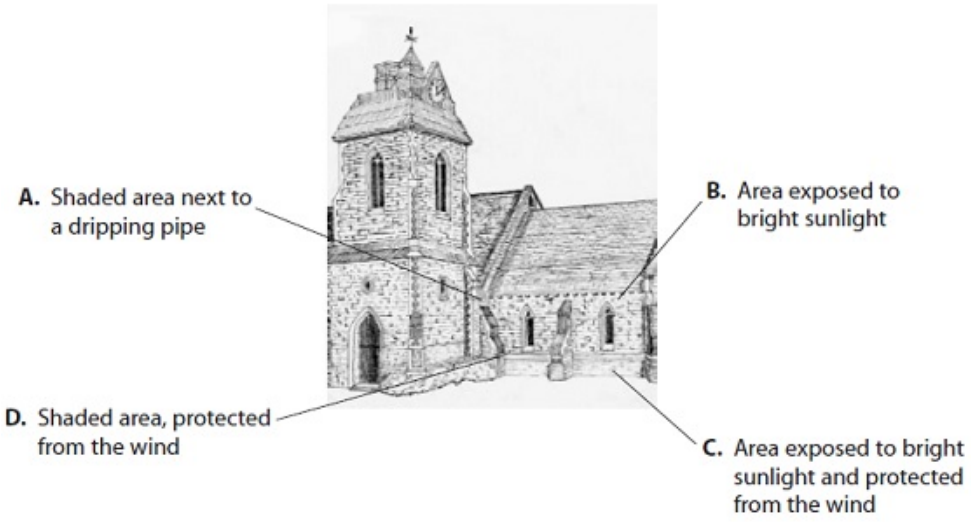
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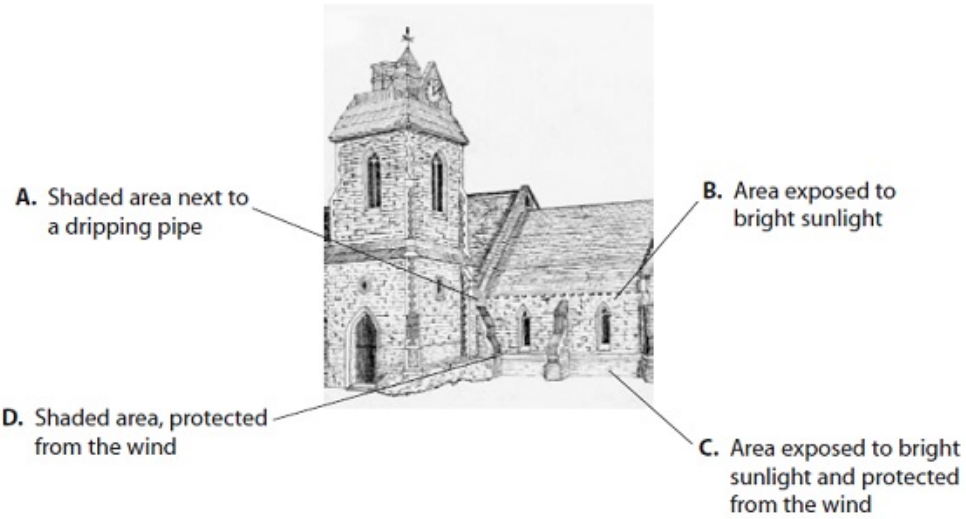
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(d) The diagram below shows the conditions at four positions, A, B, C and D, on a building.

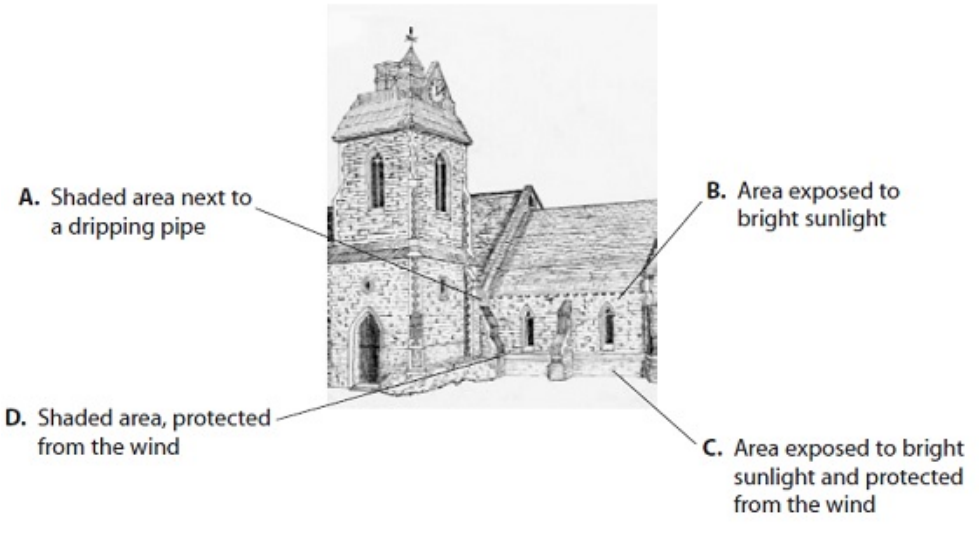



(i) Place a cross

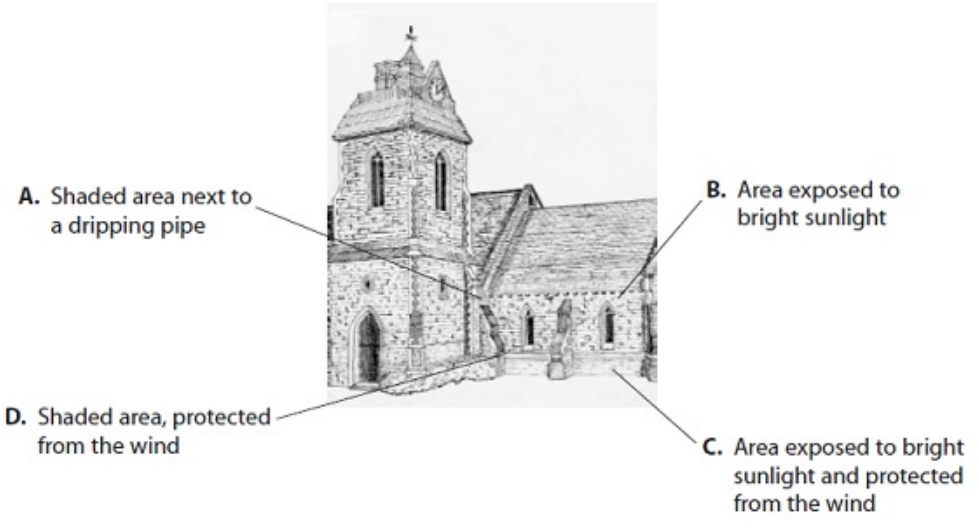



in the box next to the position where the lichen is likely to be most abundant.

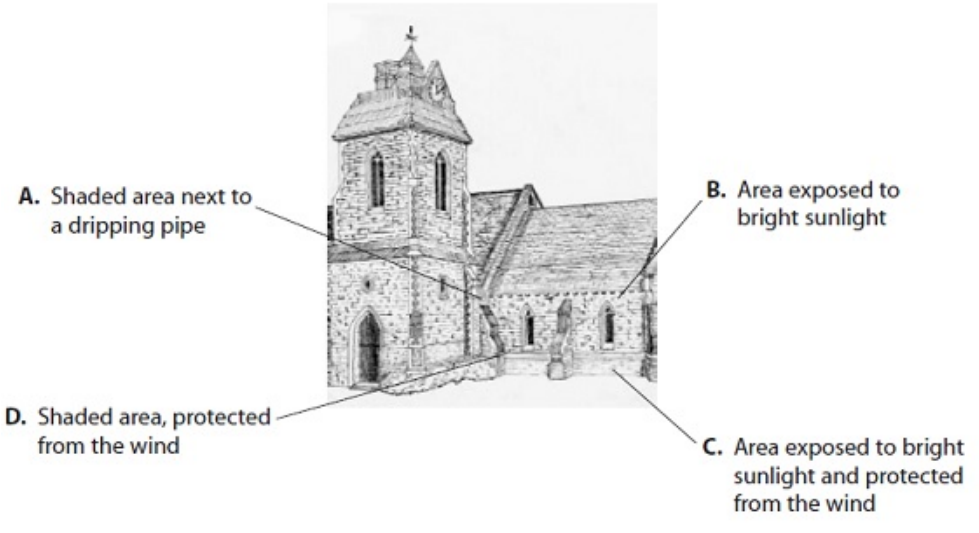
**(1)**


A. Shaded area next to a dripping pipe
B. Area exposed to bright sunlight
D. Shaded area, protected from the wind
C. Area exposed to bright sunlight and protected from the wind

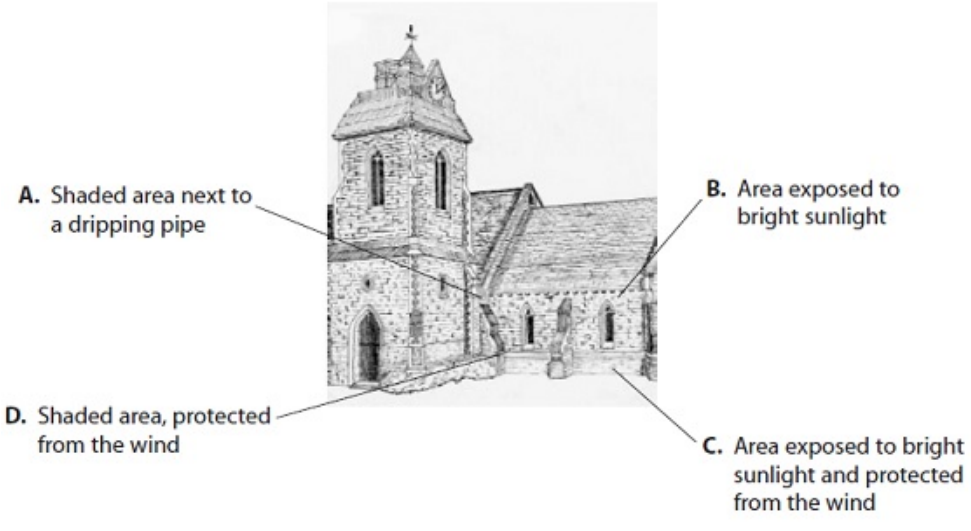
**A**


A. Shaded area next to a dripping pipe
B. Area exposed to bright sunlight
D. Shaded area, protected from the wind
C. Area exposed to bright sunlight and protected from the wind

**B**


A. Shaded area next to a dripping pipe
B. Area exposed to bright sunlight
D. Shaded area, protected from the wind
C. Area exposed to bright sunlight and protected from the wind

**C**




**D**

(ii) The abundance of lichen on the walls of this building can be measured by determining the percentage cover of lichen.

Suggest how the percentage cover of lichen could be determined.

**(3)**

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(iii) Explain how light intensity could be measured at the surface of the wall.

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(iv) Suggest how the data collected could be used to show whether there is a relationship between the abundance of lichen and light intensity.

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**(Total for Question = 13 marks)**

Q19.

Madagascar is an island rich in biodiversity.

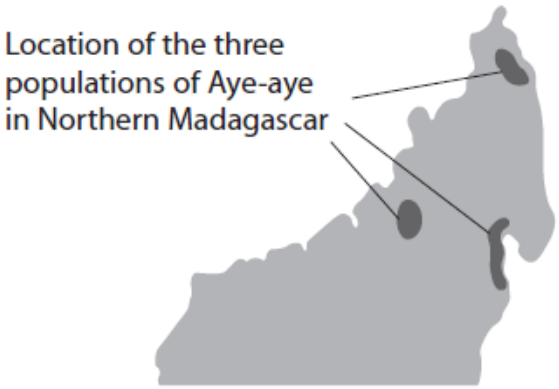
Lemurs are a diverse group of primates endemic to Madagascar.

Scientist suggest there may be as many as 100 different species of lemur.

One species of lemur, the Aye-aye, is found throughout the forests of Northern Madagascar.

Deforestation is taking place in this part of Madagascar.

Scientists have identified three separate populations of Aye-aye in this area, as shown on the map.




Explain how these three populations could become distinct species.

**(3)**

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Q20.

The scientific article you have studied is adapted from several sources.

Use the information from the scientific article and your own knowledge to answer the following questions.

Name one process that would have validated Pettersson's paper before it was published in the journal known as the Proceedings of the National Academy of Science (paragraph 58).

**(1)**

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**(Total for question = 1 mark)**

Q21.

The scientific article you have studied is adapted from *Scientific American*.

Use the information from the scientific article and your own knowledge to answer the following question.

Explain why natural selection took place in Darwin's Galapagos finches (paragraph 3).

**(3)**

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**(Total for question = 3 marks)**

Q22.

During the civil war in Mozambique, from 1977 to 1992, 90% of the African elephants were killed for the ivory in their tusks.

Since 1992, the elephant population in Mozambique has increased.

The photograph shows a group of elephants in Mozambique.




© ALEXANDER JOE/Staff/Getty Images

A study of an elephant population in Mozambique was carried out in 2017.

The elephants studied were all born before 1992.

The table shows the number of elephants with and without tusks.

| Elephants | Number of elephants |
|---|---|
| with tusks | 98 |
| without tusks | 102 |

In most African elephant populations, 2% to 4% of elephants do not grow tusks.

(i) Explain why the percentage of elephants without tusks in Mozambique will probably increase in the future.

**(3)**

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(ii) Describe how the Hardy-Weinberg equation can be used to provide evidence for changes in the elephant population in Mozambique.

**(2)**

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**(Total for question = 5 marks)**

Q23.

Climate change has been linked to the release of carbon dioxide from some power stations.

Net primary productivity (NPP) is a measure of the increase in biomass of a plant.

Explain why respiration affects the production of biomass.

**(2)**

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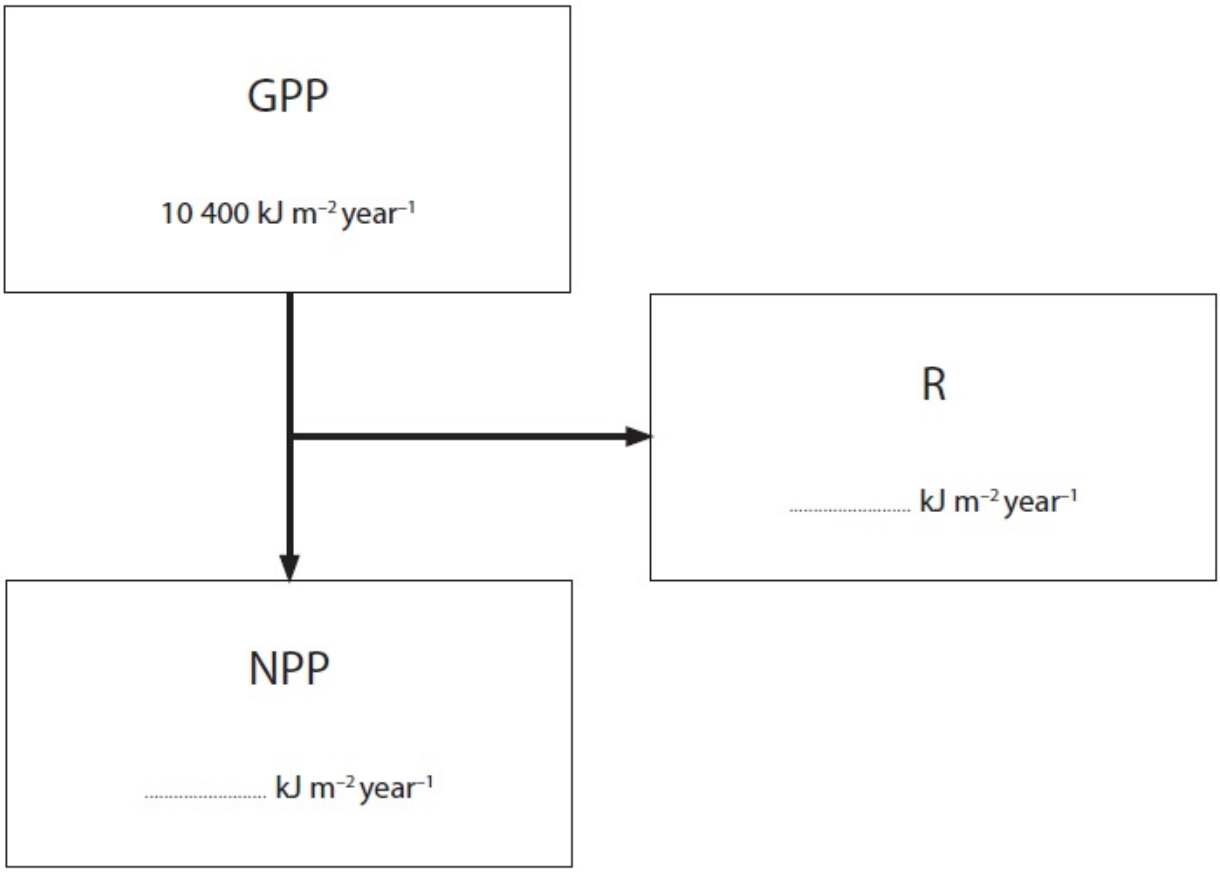
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**(Total for question = 2 marks)**

Q24. Farmers find it helpful to know the productivity of their land.

The diagram below shows the relationship between GPP (gross primary productivity), NPP (net primary productivity) and R (plant respiration) for an area of grassland.




(a) The efficiency of the transfer of energy from GPP to NPP for this grassland is 45%.

(i) Calculate the values for NPP and R. Write your answers in the diagram above.

**(2)**

(ii) Using the information given, explain the relationship between GPP and NPP.

**(3)**

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(b) Suggest why NPP values would be of use to a farmer who wanted to use this land for cattle.

**(3)**

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(c) The units (kJ $m^{-2}$ $year^{-1}$) used in the diagram show a rate of energy production. Suggest why this is more useful than measurements of biomass in the grassland on a particular day.

**(2)**

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**(Total for Question = 10 marks)**

Q25.

There are two main types of woodland in the UK. One consists of broadleaved deciduous trees, the other contains coniferous trees that have needle-like leaves.

In a study of two woodlands, 11 species of plant were found in a deciduous woodland and 4 different species in a coniferous woodland.

The table shows the other data recorded in this study.

| Factor | Deciduous woodland | Coniferous woodland |
|---|---|---|
| Mean light intensity 10 cm above soil level / lux | 1075 | 543 |
| Mean pH of soil | 7 | 5 |
| Mean air temperature 10 cm above soil level / °C | 18 | 18 |
| Mean soil moisture content (%) | 45 | 47 |

Assess the reasons for the differences in the number of species between these two types of woodland.

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**(Total for question = 4 marks)**

Q1.

The scientific article you have studied is adapted from an article from '*The Scientist*'.

Use the information from the scientific article and your own knowledge to answer the following questions.

Explain why the 'anaerobic oxidation of methane' could be a 'key climate regulator' (paragraph 2).

**(3)**

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**(Total for question = 3 marks)**

Q2.

The genomes of some species of cichlid fish have been sequenced and analysed.

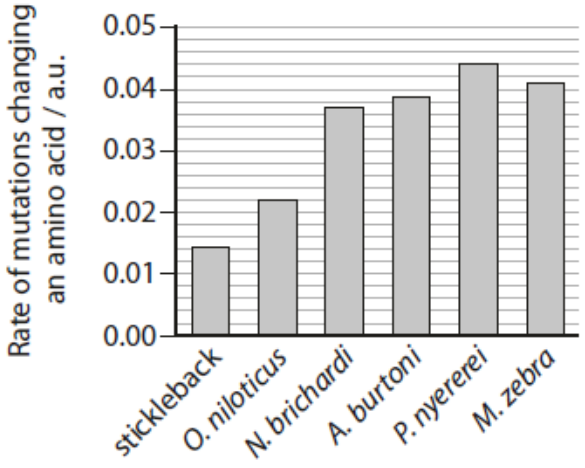
The data collected included:

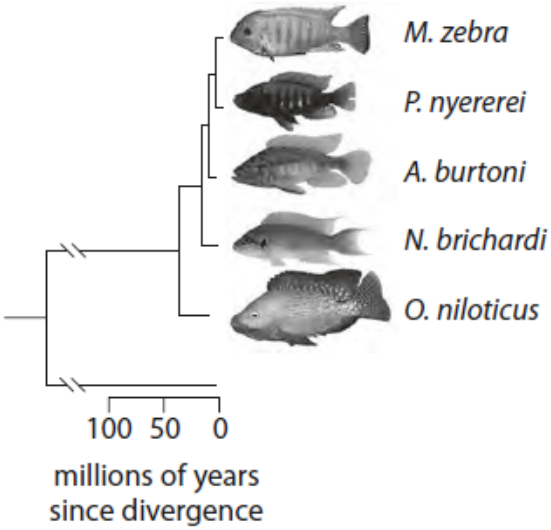
- the rate at which genes have been duplicated to produce additional copies of genes on a chromosome
- the frequency of mutations in transcription factor binding sites
- the rate of mutations that result in a change of an amino acid in a protein.

This information was used to produce a phylogenetic tree.

A comparison was made with a stickleback, which is a slowly evolving fish.

| Speed of evolution | Fish | Rate of gene duplication / a.u. | Number of mutations in transcription factor binding sites (compared to *O. niloticus*) |
|---|---|---|---|
| Rapidly evolving cichlid fish | *O. niloticus* | 45 | 0 |
| | *N. brichardi* | 45 | 214 |
| | *A. burtoni* | 55 | 140 |
| | *P. nyererei* | 45 | 129 |
| | *M. zebra* | 60 | 142 |
| Slowly evolving fish | stickleback | 10 | 0 |




Phylogenetic tree

Analyse all the data provided to discuss how several species of cichlid fish have evolved over a short period of time.

**(9)**

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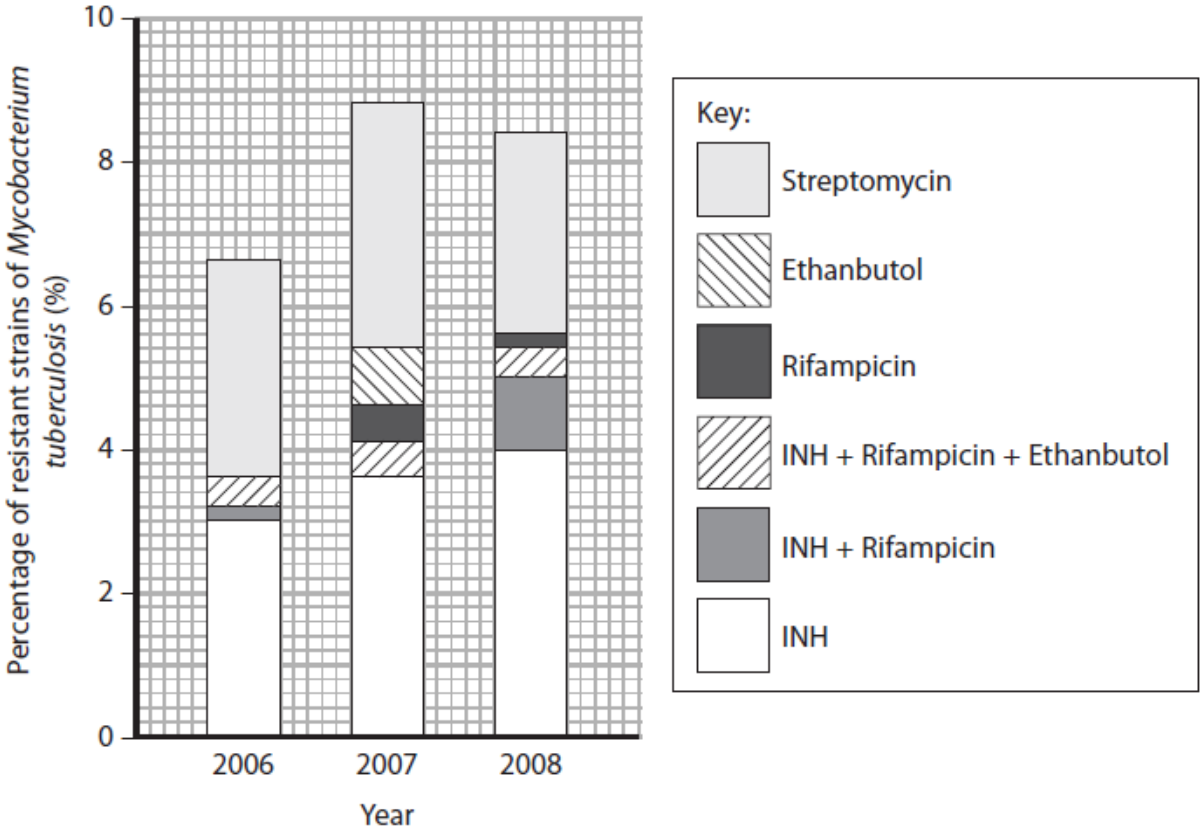
**(Total for question = 9 marks)**

Q3.

Treating *Mycobacterium tuberculosis* infections can be a problem, as the bacteria are resistant to many antibiotics.

There are many strains of *Mycobacterium tuberculosis*. Different strains are resistant to different antibiotics or combinations of antibiotics.

The chart below shows the percentage of resistant strains of *Mycobacterium tuberculosis* to six different antibiotics, or combinations of antibiotics, in 2006, 2007 and 2008.




(i) Using the information in the graph, compare the types of antibiotics and combinations of antibiotics that the *Mycobacterium tuberculosis* are resistant to in 2006 with 2007.

**(3)**

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(ii) The percentage of strains of *Mycobacterium tuberculosis* resistant to the antibiotic INH has increased during these three years.

Suggest how natural selection could have resulted in this increase.

**(3)**

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(iii) Suggest how hospitals could prevent an increase in the percentage of strains of *Mycobacterium tuberculosis* resistant to antibiotics.

**(2)**

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Q4.

Crustose coralline algae are a group of photosynthetic red algae that play an important role in the formation of coral reefs.

These algae deposit calcium carbonate in their cell walls to form encrusting and rock-like structures.

(a) (i) Write an expression that describes net productivity.

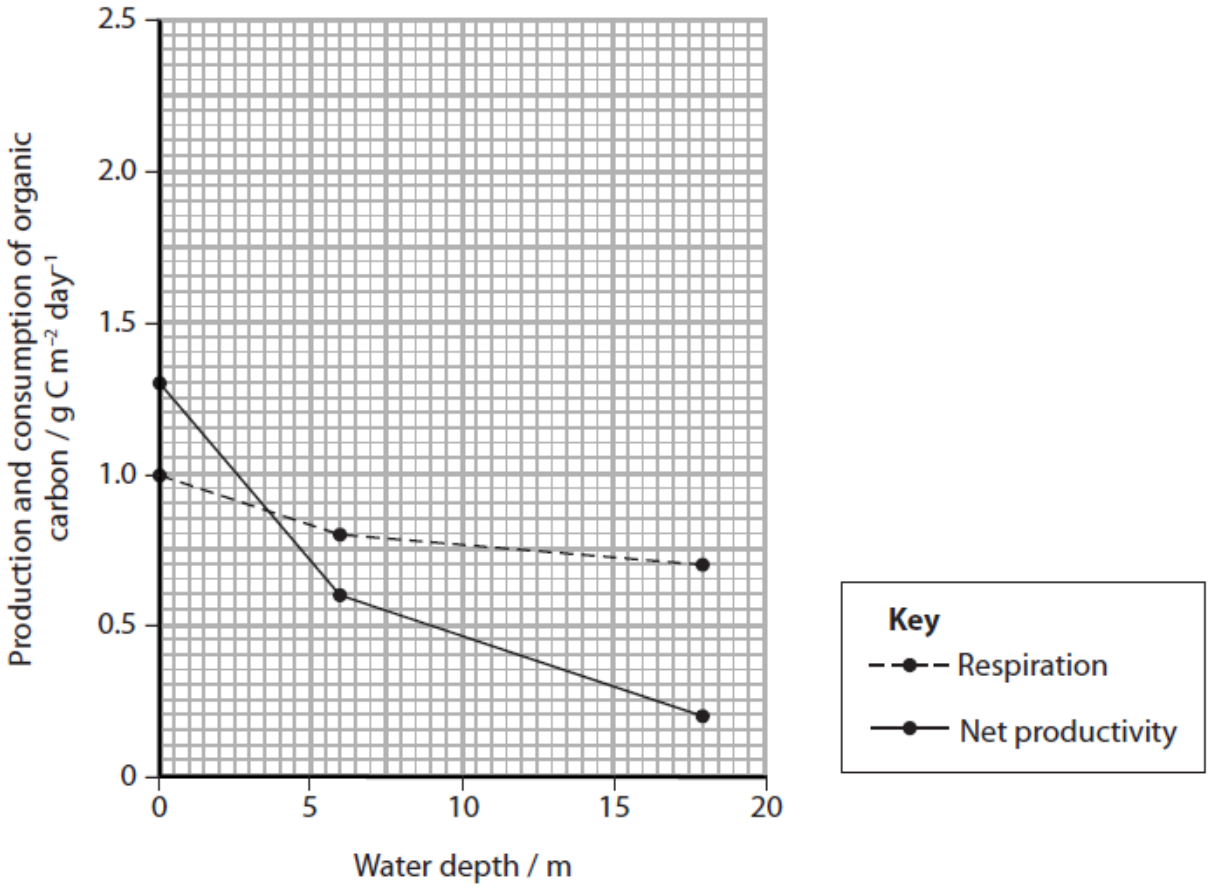
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**(1)**

(ii) The graph shows net productivity and respiration for one species of crustose coralline algae found at different water depths.




On the graph, plot the gross productivity for this species.

**(1)**

(iii) Analyse the data to explain the effect of water depth on net productivity.

**(3)**

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*(b) Scientists investigated the effect of water temperature and carbon dioxide concentration on the growth of one species of crustose coralline algae.

The growth was measured by recording the percentage cover of the algae on a surface.

The results of this investigation are shown in the table.

| Growth conditions | | Percentage cover (%) |
|---|---|---|
| Temperature / °C | $CO_2$ concentration / ppm | |
| 17 | 400 | 100 |
| 17 | 700 | 70 |
| 20 | 400 | 100 |
| 20 | 700 | 35 |

The normal temperature and carbon dioxide concentration in the natural habitat of this species are 17°C and 400 ppm $CO_2$.

Analyse the data in the graph and the table to assess the possible impact of the continued burning of fossil fuels on crustose coralline algae.

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**(Total for question = 11 marks)**

Q5.

Anthropogenic activities are contributing to global warming.

Scientists from the IPCC (Intergovernmental Panel on Climate Change) say that changes to diet can have a major impact on greenhouse gas emissions. The method of farming affects the level of impact.

The Paris Agreement of 2015 committed countries to reduce carbon emissions.

How many of the following statements about global warming are correct?

**(1)**

- global warming is caused by a reduction in greenhouse gases
- deforestation may contribute to global warming
- global warming is leading to the melting of sea ice
- global warming may lead to a change in rainfall patterns
- global warming is affecting only the ice caps

☒ **A** 2

☒ **B** 3

☒ **C** 4

☒ **D** 5

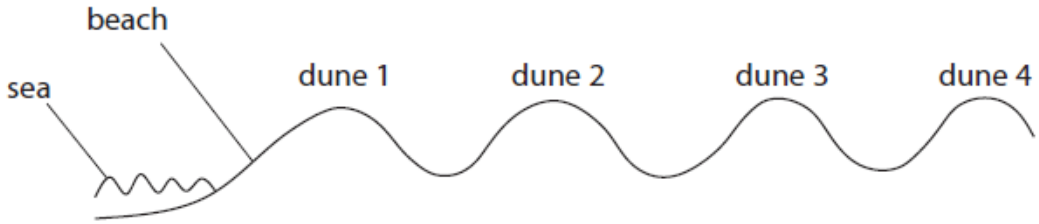
**(Total for question = 1 mark)**

Q6.

Sand dunes are a habitat that can often be found by the edge of the sea.

An investigation was carried out to study the variety of plant species found on sand dunes.

Four adjacent sand dunes from the sea to further inland were selected, as shown in the diagram.




Each species of plant present on dune 1 was recorded along with the total number of each species of plant present. This was repeated for dunes 2, 3 and 4 and the results are shown in the table.

| Plant species | Number of each plant species present | | | |
|---|---|---|---|---|
| | dune 1 | dune 2 | dune 3 | dune 4 |
| A | 169 | 9 | 0 | 0 |
| B | 5 | 123 | 19 | 0 |
| C | 0 | 0 | 126 | 182 |
| D | 1 | 44 | 0 | 0 |
| E | 0 | 0 | 5 | 2 |
| F | 0 | 0 | 20 | 10 |
| G | 0 | 0 | 86 | 35 |
| H | 0 | 0 | 0 | 62 |
| I | 0 | 0 | 32 | 17 |
| J | 0 | 0 | 0 | 119 |

Devise a procedure that you could use to find out if the percentage cover of species B is different on the tops of dunes than in between the dunes.

**(5)**

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Q7.

Scientists are concerned that climate change may be affecting the Arctic environment and the polar bears that live there.

Birds, such as barnacle geese, use the land on Spitsbergen as nesting sites.

Polar bears usually hunt for seals from sea ice. They have also been seen feeding on eggs from barnacle geese nests.

Assess the relationship between the presence of sea ice and the number of eggs taken by polar bears since 2000.

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**(Total for question = 4 marks)**

Q8.

Lipids and carbohydrates are found in both plants and animals.

The carbohydrate content of vegetables ranges from 3 to 35%. However, meat contains little to no carbohydrate. Milk is the only food source from animals that contains a significant amount of carbohydrate.

Although plant material contains a higher proportion of carbohydrate than animal tissues, it has been claimed that carbohydrates are more important to animals than they are to plants.

Assess the relative importance of carbohydrates to plants and animals.

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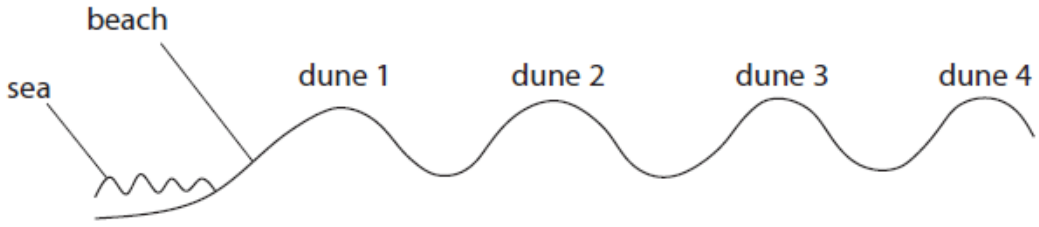
**(Total for question = 9 marks)**

Q9.

Sand dunes are a habitat that can often be found by the edge of the sea.

An investigation was carried out to study the variety of plant species found on sand dunes.

Four adjacent sand dunes from the sea to further inland were selected, as shown in the diagram.




Each species of plant present on dune 1 was recorded along with the total number of each species of plant present. This was repeated for dunes 2, 3 and 4 and the results are shown in the table.

| Plant species | Number of each plant species present | | | |
|---|---|---|---|---|
| | dune 1 | dune 2 | dune 3 | dune 4 |
| A | 169 | 9 | 0 | 0 |
| B | 5 | 123 | 19 | 0 |
| C | 0 | 0 | 126 | 182 |
| D | 1 | 44 | 0 | 0 |
| E | 0 | 0 | 5 | 2 |
| F | 0 | 0 | 20 | 10 |
| G | 0 | 0 | 86 | 35 |
| H | 0 | 0 | 0 | 62 |
| I | 0 | 0 | 32 | 17 |
| J | 0 | 0 | 0 | 119 |

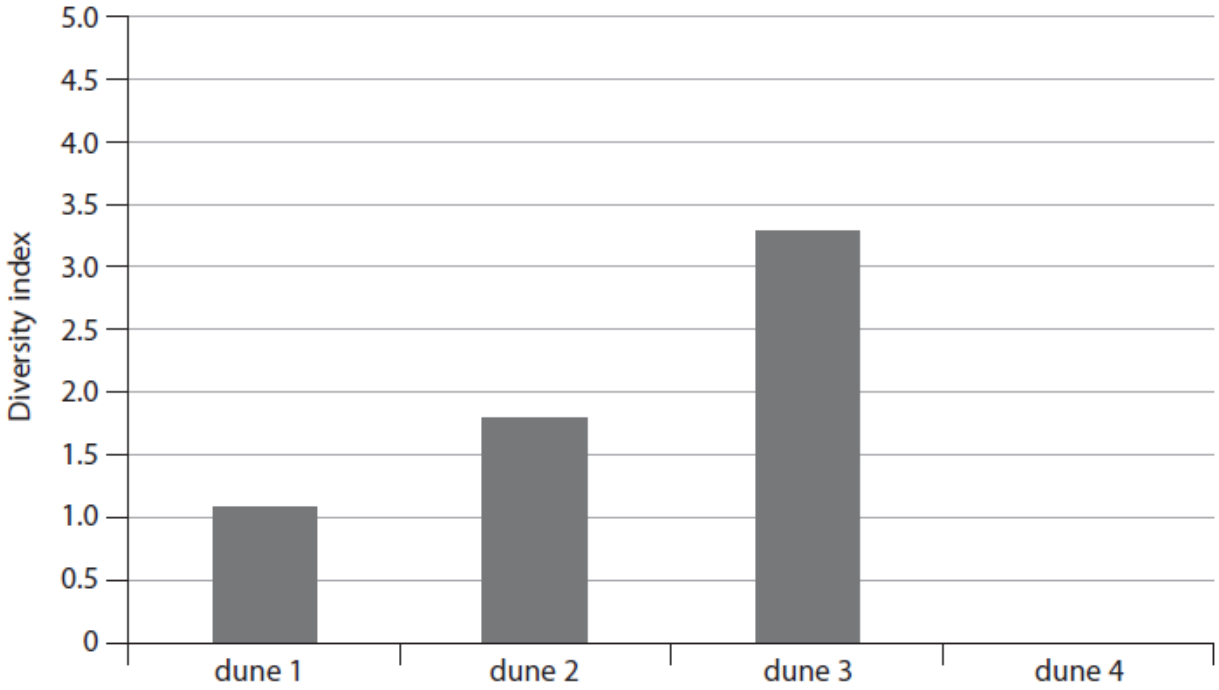
(i) The diversity index was calculated for dunes 1, 2 and 3 using this equation.

$$\text{Diversity index } (D) = \frac{N(N-1)}{\Sigma n(n-1)}$$

Where $N$ is the total number of all individuals of all species in each dune. Use the table and diversity index equation to calculate the diversity index for dune 4.

Plot your answer on the bar chart.

**(3)**




(ii) Explain how the data demonstrate the process of succession.

**(5)**

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Q10. The carbon cycle describes the movement of carbon within an ecosystem.

In this cycle, carbon neutral processes do not change the concentration of carbon dioxide in the atmosphere.

The table below shows the main sources and combustion products of some fuels.

| Fuel | Main sources | Main combustion products |
|---|---|---|
| Biodiesel | Oils from crops such as soya beans, rape seeds, palm seeds | Carbon dioxide and water vapour |
| Ethanol | Fermented sugars from crops such as sugar cane, sugar beet | Carbon dioxide and water vapour |
| Hydrogen | Catalysis of methane from fossil deposits or biogas generation using waste biomass | Water vapour |
| Methane | Extracted from fossil deposits or biogas generation using waste biomass | Carbon dioxide and water vapour |
| Propane | Refining of crude oil from fossil deposits | Carbon dioxide and water vapour |

(a) Place a cross ☒ in the box next to the names of the four fuels, shown in the table, that could be considered to be biofuels.

**(1)**

☒ **A** biodiesel, ethanol, hydrogen, methane

☒ **B** biodiesel, ethanol, hydrogen, propane

☒ **C** biodiesel, ethanol, methane, propane

☒ **D** biodiesel, hydrogen, methane, propane

*(b) Large areas of land may need to be cleared in order to produce biofuels. This might involve deforestation.

Discuss why the production of biofuels may not be carbon neutral.

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(c) Explain how the combustion products, from the burning of fuels, may lead to global warming.

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**(Total for Question = 10 marks)**

Q11.

First generation biofuels are made from sugars and vegetable oils found in food crops.

(a) Some countries are replacing small percentages of petrol and diesel with first generation biofuels to reduce the effect of greenhouse gases on global warming.

(i) Place a cross ☒ in the box next to a pair of greenhouse gases.

**(1)**

☒ **A** carbon dioxide and methane

☒ **B** carbon dioxide and carbon monoxide

☒ **C** carbon monoxide and nitrogen

☒ **D** methane and nitrogen

(ii) Suggest why using first generation biofuels instead of petrol and diesel could reduce global warming.

**(3)**

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(b) Second generation biofuels are now being developed. These will use non-food parts of crops that contain the polymers cellulose and lignin.

Bacteria can be used to synthesise ethanol from these polymers. However, enzyme treatment is necessary before the bacteria can use these polymers.

(i) Name a part of a plant stem that would contain these polymers.

**(1)**

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(ii) Suggest why cellulose has to be treated with enzymes before the bacteria can use it as an energy source.

**(2)**

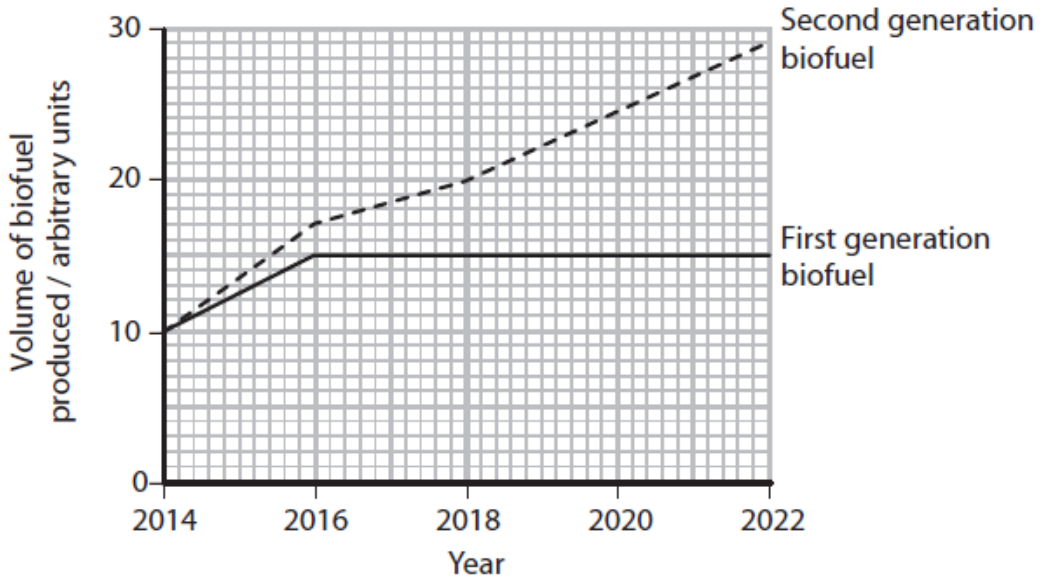
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(c) The graph below shows how the global production of first generation and second generation biofuels could change in the future.




Using the information in the graph, describe the expected changes in the production of first generation and second generation biofuels. Suggest reasons for these changes.

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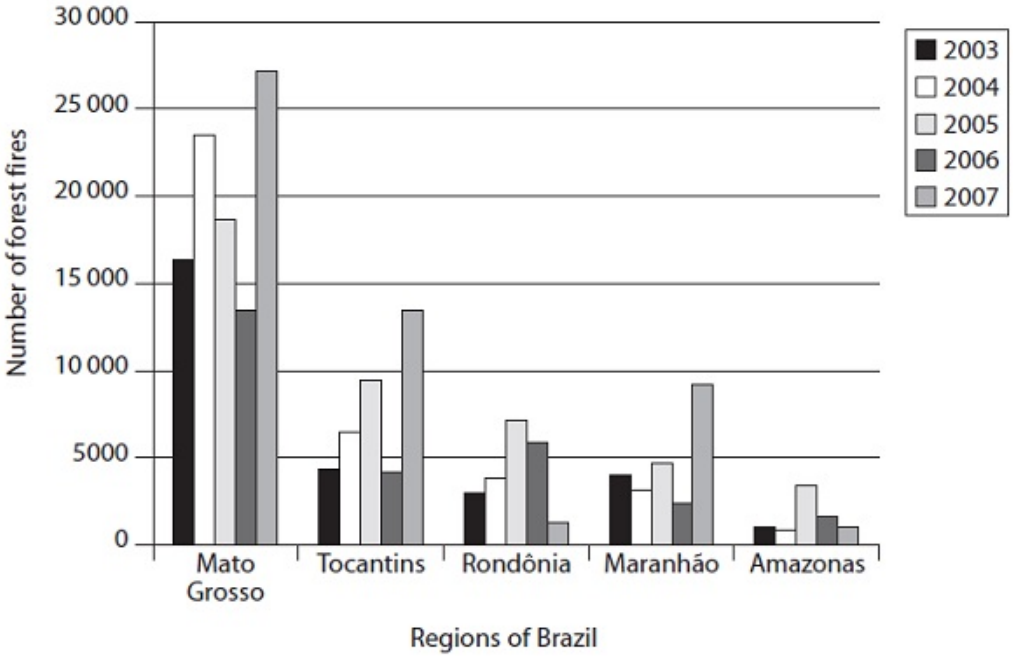
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**(Total for question = 11 marks)**

Q12. Global warming is a worldwide problem that affects climate and the environment.

(a) The graph below shows the number of forest fires in five regions of Brazil, for 2003 to 2007.




(i) Place a cross ☒ in the box next to the best conclusion that can be drawn from these results about the number of forest fires in Brazil.

**(1)**

☒ **A** The number of forest fires has generally decreased

☒ **B** The number of forest fires has generally increased

☒ **C** The number of forest fires in Mato Grosso each year is always higher than in other areas

☒ **D** There are no clear trends

*(ii) Explain how forest fires may lead to global warming.

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(b) (i) Explain why the use of biofuels may help to reduce global warming.

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(ii) Explain **one** disadvantage of using biofuels to reduce global warming.

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**(Total for Question = 11 marks)**

Q13.

Biofuels are being developed to reduce the effect of greenhouse gases on global warming.

(a) The list below shows some of the gases found in the atmosphere:

- carbon dioxide
- helium
- methane

- nitrogen
- oxygen

Place a cross ☒ in the box next to the number of greenhouse gases in this list.

**(1)**

☒ **A** 1

☒ **B** 2

☒ **C** 3

☒ **D** 4

(b) Biofuels are produced from crop plants.

Bioethanols are produced from carbohydrates, such as corn starch and sugar.

Biodiesels are produced from lipids, such as soybean oil and rapeseed oil.

(i) Describe the structure of lipids.

**(2)**

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(ii) The table below gives some information about the **production** of biofuels from four different crop plants.

| Crop plant | Carbon dioxide emissions from the production of biofuels / kg per MJ of energy produced | Level of resources used in production of biofuels | | |
|---|---|---|---|---|
| | | water | fertilisers | pesticides |
| Corn | 81 to 85 | High | High | High |
| Sugar cane | 4 to 12 | Medium to low | High | Medium |
| Soy | 49 | High | Low to medium | Medium |
| Rape | 37 | High | Medium | Medium |

Using the information in the table, discuss the advantages of producing biodiesels instead of bioethanols.

**(3)**

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(iii) Fertilisers contain inorganic ions. Name **three** inorganic ions that could be contained in the fertilisers and explain how these would improve the yield of the crop plants.

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**(Total for question = 10 marks)**

Q14.

Forests are important habitats.

The effect of cutting down trees on the number of bird species observed in two different forest habitats was investigated.

(i) Give two biotic factors, other than cutting down trees, that could affect the number of bird species observed in a forest.

**(2)**

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(ii) Some of the results of the investigation are shown in the table.

| Forest | Number of bird species in areas of the forest where no trees are cut down | Number of bird species in areas of the forest where some trees are cut down |
|---|---|---|
| A | 35 | 19 |
| B | 16 | 10 |

Calculate the Chi-squared value ($\chi^2$) for forest B using the formula shown.

$$\chi^2 = \sum \frac{(O - E)^2}{E}$$

**(3)**

Answer .....

(iii) The table gives some critical values for the Chi-squared test.

| Probability level | Critical value |
|---|---|
| 0.05 | 3.84 |
| 0.01 | 6.64 |
| 0.001 | 10.83 |

The Chi-squared value for forest A is 4.74.

Deduce the effect of some trees being cut down on the number of species of birds in these two forests.

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**(Total for question = 7 marks)**

Q15.

Anthropogenic climate change is linked to an increase in carbon dioxide in the atmosphere.

The World Meteorological Association recorded carbon dioxide levels of 405 ppm in 2017.

This is an increase of 46% since 1817.

Calculate the level of carbon dioxide in 1817.

**(2)**

..... ppm

**(Total for question = 2 marks)**

Q16.

A student investigated the effect of salt concentration on the growth of one species of brine shrimp.

The student placed 100 shrimp eggs in a beaker containing 1dm$^3$ of 3% salt solution. Three days after the eggs hatched, 10 shrimps were collected and their lengths measured. Seven days after hatching, another 10 shrimps were collected and their lengths measured.

The procedure was repeated using a 5% salt solution. All other variables were kept constant.

The results are shown in the table.

| Specimen number | Length of specimen in 3% salt solution / mm | | Length of specimen in 5% salt solution / mm | |
|---|---|---|---|---|
| | 3 days after hatching | 7 days after hatching | 3 days after hatching | 7 days after hatching |
| 1 | 0.75 | 1.00 | 0.75 | 0.98 |
| 2 | 0.78 | 1.25 | 0.73 | 0.95 |
| 3 | 0.66 | 1.10 | 0.61 | 0.93 |
| 4 | 0.73 | 1.03 | 0.63 | 0.83 |
| 5 | 0.85 | 1.15 | 0.53 | 0.98 |
| 6 | 0.78 | 1.08 | 0.60 | 1.08 |
| 7 | 0.90 | 1.13 | 0.52 | 0.95 |
| 8 | 0.90 | 1.05 | 0.81 | 1.03 |
| 9 | 0.80 | 1.18 | 0.58 | 0.88 |
| 10 | 0.85 | 1.05 | 0.68 | 0.88 |
| Mean | 0.800 | 1.102 | | 0.949 |

(i) Calculate the mean length of shrimp three days after hatching in the 5% salt solution. Give your answer to an appropriate number of significant figures.

**(1)**

Answer ..... mm

(ii) Explain how these data can be used to show the effect of salt concentration on the rate of growth of brine shrimps.

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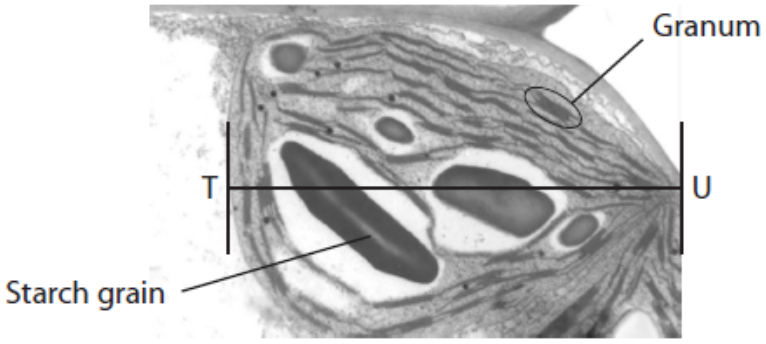
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**(Total for question = 3 marks)**

Q17.

Photosynthesis is a process that occurs in all green plants.

The electron micrograph shows part of a chloroplast in a plant cell.




(i) The labelled starch grain in the chloroplast is 2.2 µm long.

Calculate the width of this chloroplast between T and U.

**(2)**

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(ii) Explain the relationship between the structure and functions of a granum in photosynthesis.

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**(Total for question = 5 marks)**

Q18.

The scientific article you have studied is adapted from an article from '*The Scientist*'.

Use the information from the scientific article and your own knowledge to answer the following questions.

State what is meant by the phrase 'fix carbon into biomass' (paragraph 4).

**(2)**

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**(Total for question = 2 marks)**

Q19.

Climate change has been linked to the release of carbon dioxide from some power stations.

Some power stations burn wood chips instead of fossil fuels to produce electricity.

The photograph shows wood chips at a power station.



© Mr. Amarin Jitnathum/Shutterstock

It is thought that burning wood chips is more beneficial to the environment because in the long term it does not add carbon dioxide to the atmosphere.

Explain why burning wood chips does not increase carbon dioxide to the atmosphere in the long term.

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**(Total for question = 4 marks)**

Q20.

Climate change has been correlated with changing atmospheric carbon dioxide levels.

Scientists measured the productivity of two types of forest and recorded the mass of carbon taken up per square metre per year (gC $m^{-2}$ $y^{-1}$).

The table shows data on the mean net primary productivity (NPP) and mean gross primary productivity (GPP) of these two types of forest.

| Type of forest | Mean NPP / gC $m^{-2}$ $y^{-1}$ | Mean GPP / gC $m^{-2}$ $y^{-1}$ | Ratio of NPP to GPP |
|---|---|---|---|
| Boreal | 322 | 1013 | 0.32 |
| Temperate deciduous | 1301 | 2165 | 0.60 |

(i) Calculate the percentage increase in mass of carbon released due to respiration by temperate deciduous forests compared with that by boreal forests.

**(3)**

..... %

(ii) The ratio of net primary productivity to gross primary productivity is a measure of the ability of forests to transfer carbon from the atmosphere into biomass.

Scientists concluded that temperate deciduous forests would reduce levels of carbon dioxide in the atmosphere more than boreal forests.

Justify this conclusion.

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**(Total for question = 6 marks)**

Q21.

**Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.**

Climate change has been linked to the release of carbon dioxide from some power stations.

The main reason that carbon dioxide acts as a greenhouse gas is because it

**(1)**

☒ **A** absorbs infrared radiation reflected by the surface of the Earth

☒ **B** absorbs ultraviolet radiation reflected by the surface of the Earth

☒ **C** reflects infrared radiation absorbed by the surface of the Earth

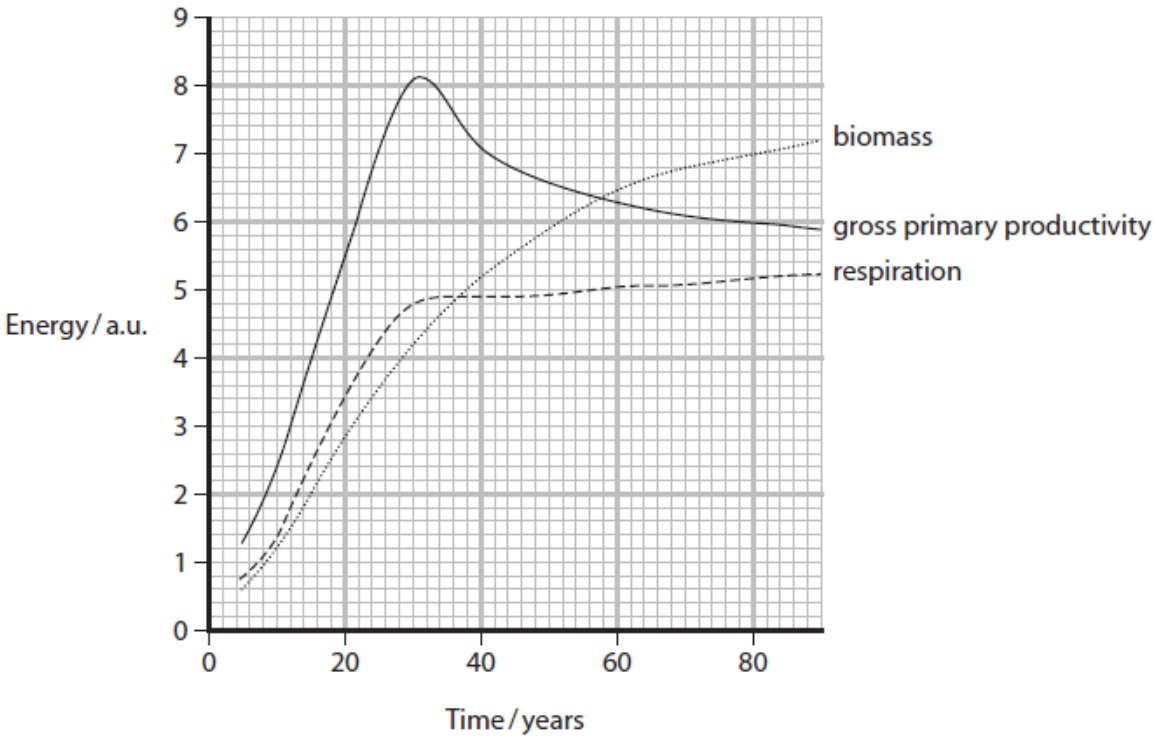
☒ **D** reflects ultraviolet radiation absorbed by the Earth's atmosphere

**(Total for question = 1 mark)**

Q22.

Eukaryotic cells contain membrane-bound organelles.

The graph shows the changes in biomass, gross primary productivity and the energy used in respiration during succession from grassland to mature forest.




(i) Add shading to the graph to show the area that represents net primary productivity.

**(1)**

(ii) Describe what is meant by the term succession.

**(2)**

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(iii) Deduce the effect of succession on the level of carbon dioxide in the atmosphere.

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**(Total for question = 6 marks)**

Q23.

Some plants are adapted to grow in shady conditions.

A study was carried out to compare the effect of growing in different light intensities on rates of photosynthesis of plants.

The plants are rated for levels of shade tolerance.

Plant seedlings of nine species were grown in either 25% or 5% of full sunlight. All other abiotic factors were controlled.

These seedlings were grown for six weeks and then exposed to full sunlight for 15 minutes. The rate of photosynthesis was measured during the exposure to full light.

The table shows the results of this investigation for four species of plant.

| Species | Shade tolerance | Rate of photosynthesis / a.u. | |
|---|---|---|---|
| | | Seedlings grown in 25% of full sunlight | Seedlings grown in 5% of full sunlight |
| A | Intolerant | 410 | 415 |
| B | Intermediate | 300 | 275 |
| C | Tolerant | 180 | 210 |
| D | Very tolerant | 150 | 215 |

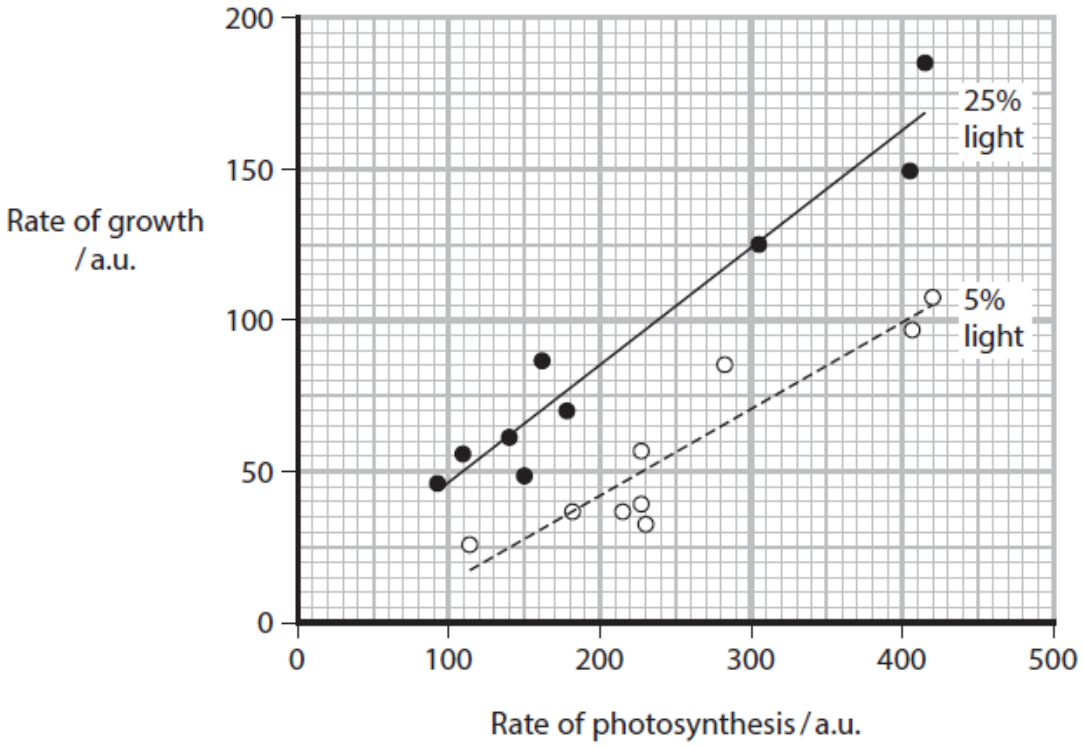
(i) Determine which species had the greatest percentage change in rate of photosynthesis when grown in lower light intensities.

**(2)**

..... Answer

(ii) The rate of growth for all nine species of plant was also measured.

The graph shows the effects of the rate of photosynthesis on the rate of growth of these plants.




Explain the effect of light intensity during the first six weeks of growth on the growth rate of these species of plant.

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**(Total for question = 6 marks)**

Q24.

Some plants are adapted to grow in shady conditions.

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| A | Intolerant | 410 | 415 |
| B | Intermediate | 300 | 275 |
| C | Tolerant | 180 | 210 |
| D | Very tolerant | 150 | 215 |

* Differences in the rate of photosynthesis may be due to the light-dependent reactions in chloroplasts.

Devise an investigation to compare the rate of the light-dependent reaction in shade tolerant and shade intolerant plants grown at different light intensities.

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**(Total for question = 6 marks)**

Q25.

Climate change has been linked to the release of carbon dioxide from some power stations.

Name the plant organelle that fixes carbon dioxide from the atmosphere.

**(1)**

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**(Total for question = 1 mark)**

Q1.