PEARSON EDEXCEL A-LEVEL BIOLOGY A · 9BN0

BIOLOGY



EXAM QUESTION PACK

TOPIC 4: BIODIVERSITY AND NATURAL RESOURCES

SCORE	PERCENTAGE
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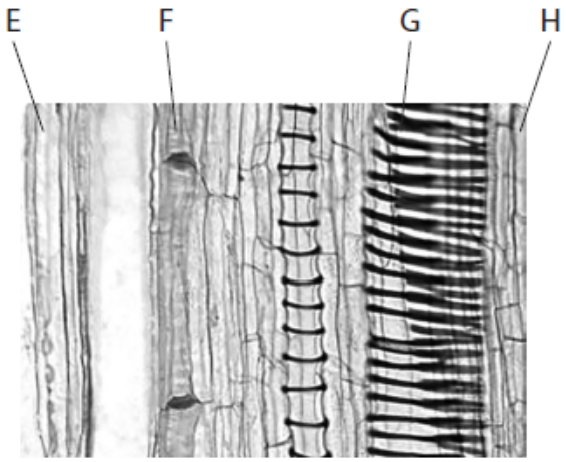
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Q1.

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 ☒.

The stems of plants contain tissues involved in transport and in support.

The photograph shows a longitudinal section through one plant stem.



Cell image library - image ID 38928

(i) Which labelled structure in the photograph contains lignin?

(1)

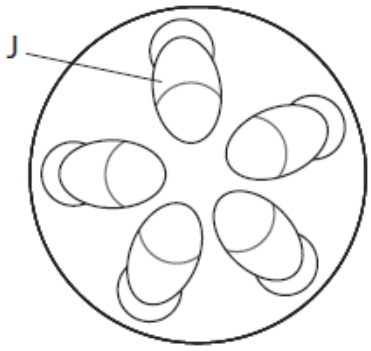
☒ **A** E

☒ **B** F

☒ **C** G

☒ **D** H

(ii) The diagram shows a transverse section through a plant stem.



Which of the labelled structures in the photograph is located in the area labelled J in the diagram?

(1)

☒ **A** E

☒ **B** F

☒ **C** G

☒ **D** H

(Total for question = 2 marks)

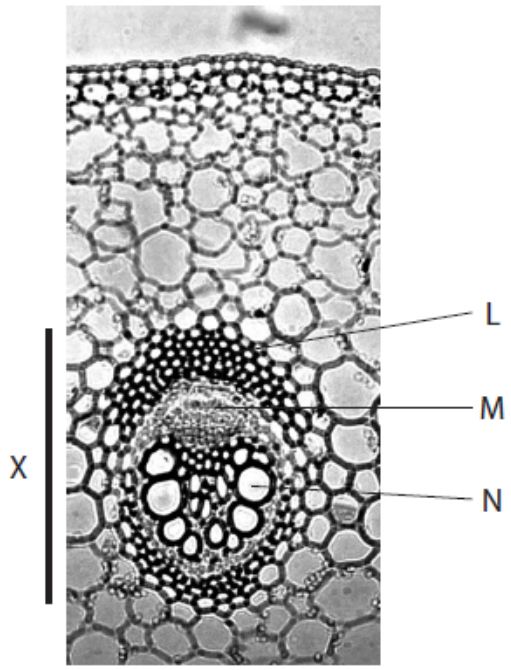
Q2.

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 ☒.

The stems of plants contain tissues involved in transport and in support.

The photograph shows a cross section of part of the stem of a plant.

Fibres can be extracted from stems similar to this one and used instead of fibres produced from oil-based plastics.



John Bebbington FRPS Science and Plants for schools – https://www.saps.org.uk

(i) The part of the stem labelled L contains

(1)

☒ **A** phloem that transports organic solutes

☒ **B** sclerenchyma fibres that provide support

☒ **C** sieve tubes that transport water

☒ **D** xylem vessels that transport water and mineral ions

(ii) The part of the stem labelled M contains

(1)

☒ **A** phloem that transports organic solutes

☒ **B** sclerenchyma fibres that transport water

☒ **C** sieve tubes that synthesise organic solutes

☒ **D** xylem vessels that transport water and mineral ions

(iii) The structure labelled N is a

(1)

☒ **A** part of the phloem that transports water

☒ **B** sclerenchyma fibre that provides support

☒ **C** sieve tube that transports organic solutes

☒ **D** xylem vessel that transports water and mineral ions

(iv) The line labelled X on the photograph represents the width of the vascular bundle.

The actual width of the vascular bundle is 320 µm.

Calculate the magnification of the image.

(3)

Answer .....

(Total for question = 6 marks)

Q3.

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 ☒.

Electron microscopes have enabled scientists to view the ultrastructure of cells.

(i) Which of the following structures is found in animal cells?

(1)

☒ **A** amyloplast

☒ **B** chloroplast

☒ **C** mesosome

☒ **D** ribosome

(ii) Which of the following structures is found only in plant cells?

(1)

☒ **A** amyloplast

☒ **B** Golgi apparatus

☒ **C** mesosome

☒ **D** vacuole

(iii) Which of the following structures is found in both animal and plant cells?

(1)

☒ **A** amyloplast

☒ **B** cell wall

☒ **C** pili

☒ **D** smooth endoplasmic reticulum

(Total for question = 3 marks)

Q4.

The arctic ground squirrel (*Spermophilus parryii*) lives in Alaska. It has small ears, a cylindrical body and a shorter tail than other species of ground squirrel.

The arctic ground squirrel can survive cold winters by hibernating for up to eight months per year. When hibernating, arctic ground squirrels use stored fat supplies as an energy source.



www.sciencephoto.com

Which combination of adaptations shown by the arctic ground squirrel have been described?

(1)

☒ **A** anatomical and behavioural only

☒ **B** anatomical and physiological only

☒ **C** anatomical, behavioural and physiological

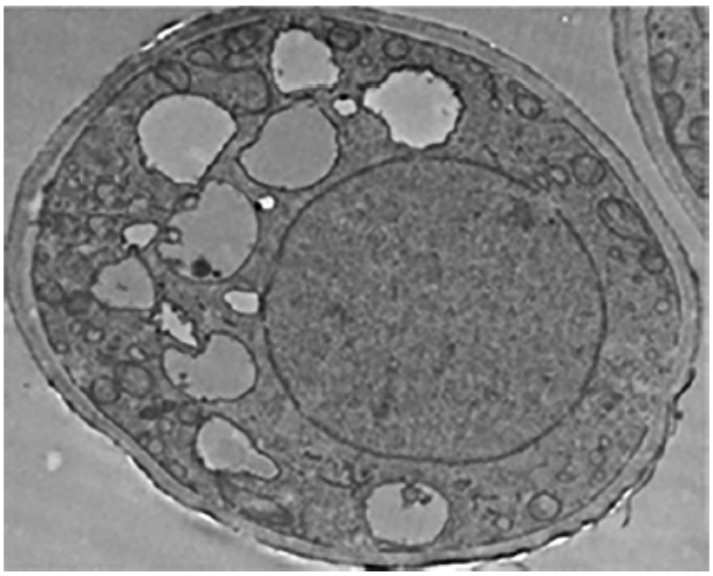
☒ **D** behavioural and physiological only

(Total for question = 1 mark)

Q5.

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

The electron micrograph shows a section through a fungal cell.



Magnification ×1000

To which group do fungi belong?

(1)

- ☒ **A** Archaea
- ☒ **B** Eukaryota
- ☒ **C** Prokaryota
- ☒ **D** Viruses

(Total for question = 1 mark)

Q6.

Plants can respond to and use light.

The photograph shows a seedling starting to grow from a germinating seed.



(a) Explain why the seedling needs a supply of magnesium ions.

(2)

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(Total for question = 2 marks)

Q7.

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.

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(Total for question = 5 marks)

Q8.

Wildlife conservation can involve keeping animals in zoos as well as protecting habitats.

Describe the roles that zoos play in animal conservation.

(3)

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(Total for question = 3 marks)

Q9.

An experiment was carried out to investigate mineral deficiencies on the growth of seedlings.

The effects of two mineral deficiencies on two different species of plant were investigated.

Test tubes were half filled with an aqueous gel containing a mineral solution without calcium ions. Seeds of rice or fenugreek were placed separately in these test tubes.

These test tubes were placed by a window for two weeks to allow the seeds to germinate and the seedlings to grow.

This was repeated using test tubes containing mineral solution without magnesium ions.

A control should have been used in this investigation.

(i) Which of the following would be a suitable control?

(1)

☒ **A** complete mineral ion solution

☒ **B** distilled water

☒ **C** dry gel

☒ **D** tap water

(ii) In this investigation a control would have improved

(1)

☒ **A** accuracy

☒ **B** precision

☒

C repeatability

☒ **D** validity

(iii) The table gives some properties of rice seeds and fenugreek seeds.

Property of seeds	Rice	Fenugreek
Number per g	200	500
Calcium ion content / mg $100g^{-1}$	21	176
Magnesium ion content / mg $100g^{-1}$	177	191

The calcium content of one fenugreek seed was calculated to be 3.52 µg.

Calculate the calcium content of one rice seed.

(3)

Answer ..... µg

(iv) After two weeks, the seedlings of both rice and fenugreek grown in both solutions had green leaves.

The rice seedlings grown in mineral ion solution without calcium ions were shorter than the rice seedlings grown in mineral solution without magnesium ions.

The fenugreek seedlings grown in mineral ions solution without calcium ions grew to normal height.

Explain what is shown by these observations.

(3)

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Q10.

Mineral ions are required for plant growth.

(i) Nitrate ions are required for the synthesis of

(1)

☒ **A** amino acids

☒ **B** cellulose

☒ **C** starch

☒ **D** sucrose

(ii) Phosphate ions are required for the synthesis of

(1)

☒ **A** cellulose

☒ **B** chlorophyll

☒ **C** nucleic acids

☒ **D** sucrose

(iii) Magnesium ions are present in the structure of

(1)

☒ **A** amino acids

☒ **B** cellulose

☒ **C** chlorophyll

☒ **D** starch

(Total for question = 3 marks)

Q11.

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.

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(Total for question = 5 marks)

Q12.

The modern bread wheat plant (*Triticum aestivum*) has been developed from other plant species that have different genomes.

Three species of plant and their genomes are shown in the images.



Triticum aestivum
Genomes A, B and D

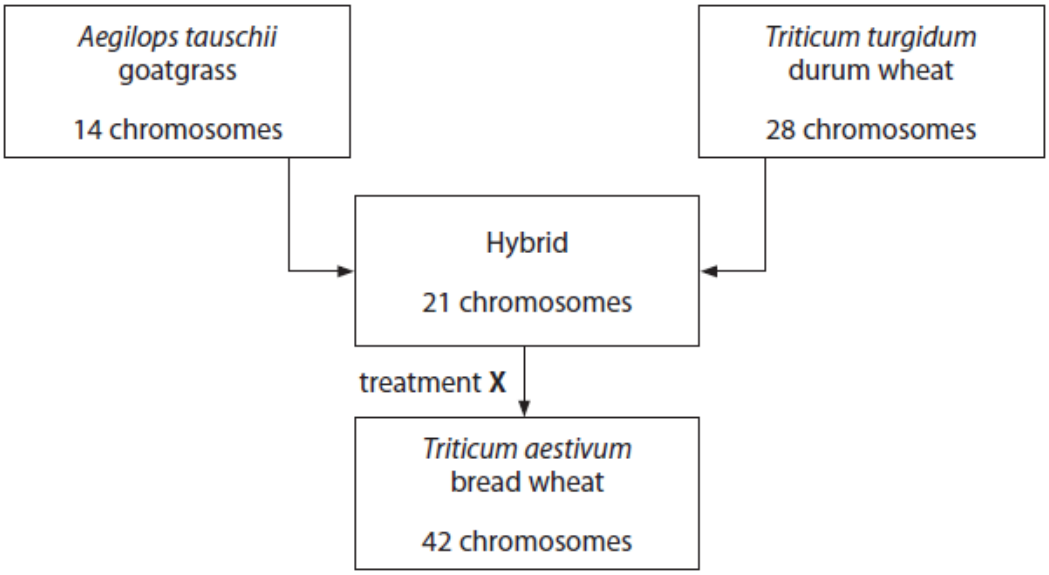


Triticum turgidum
Genomes A and B



Aegilops tauschii
Genome D

The diagram shows how chromosomes from different species have combined to produce the bread wheat species used to produce flour.



Which row in the table shows the number of chromosomes in cells from these different plant species?

(1)

	A. tauschii gamete	*T. turgidum* leaf cell	*T. aestivum* gamete
☒ **A**	7	14	42
☒ **B**	7	28	21
☒ **C**	14	28	42
☒ **D**	14	14	21

(Total for question = 1 mark)

Q13.

The polar bear, *Ursus maritimus*, preys on seals and fish. Polar bears are adapted to live in cold Arctic regions.



Polar bear
Magnification ×0.04

A recent study has shown that all polar bears are descended from populations that diverged from the Irish brown bear, *Ursus arctos*, approximately 120 000 years ago.

In this study, DNA from modern polar bears, the remains of historic polar bears and the remains of Irish brown bears was analysed.

(a) The first part of the study involved the amplification of DNA to give large enough samples for analysis.

(i) Describe how small samples of DNA can be amplified.

(4)

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(ii) Name **one** technique that could be used to analyse the amplified DNA samples.

(1)

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(b) Suggest how the scientists who conducted the study had their results accepted by other scientists.

(2)

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(c) Suggest how each of the following may have contributed towards the divergence of polar bears and Irish brown bears into two separate species.

(i) Separation of the Arctic and Irish regions by sea

(2)

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(ii) Genetic mutation

(2)

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(Total for question = 11 marks)

Q14.

Wasps are insects that live in groups.

One species of wasp (*Vespula germanica*) has been shown to knock its body repeatedly against

a hard surface. This signals the presence and quality of food to other wasps.

When threatened by another animal, it may use its stinger to inject a venom to protect itself.



bugguide.net

Phospholipase in the venom of wasps can cause allergic reactions.
Phospholipase can affect the Golgi apparatus in cells.

(i) Give two functions of the Golgi apparatus.

(2)

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(ii) A three-phase protocol will be used when developing the phospholipase inhibitor as a new drug.

Explain the purpose of each phase of this protocol for a phospholipase inhibitor.

(3)

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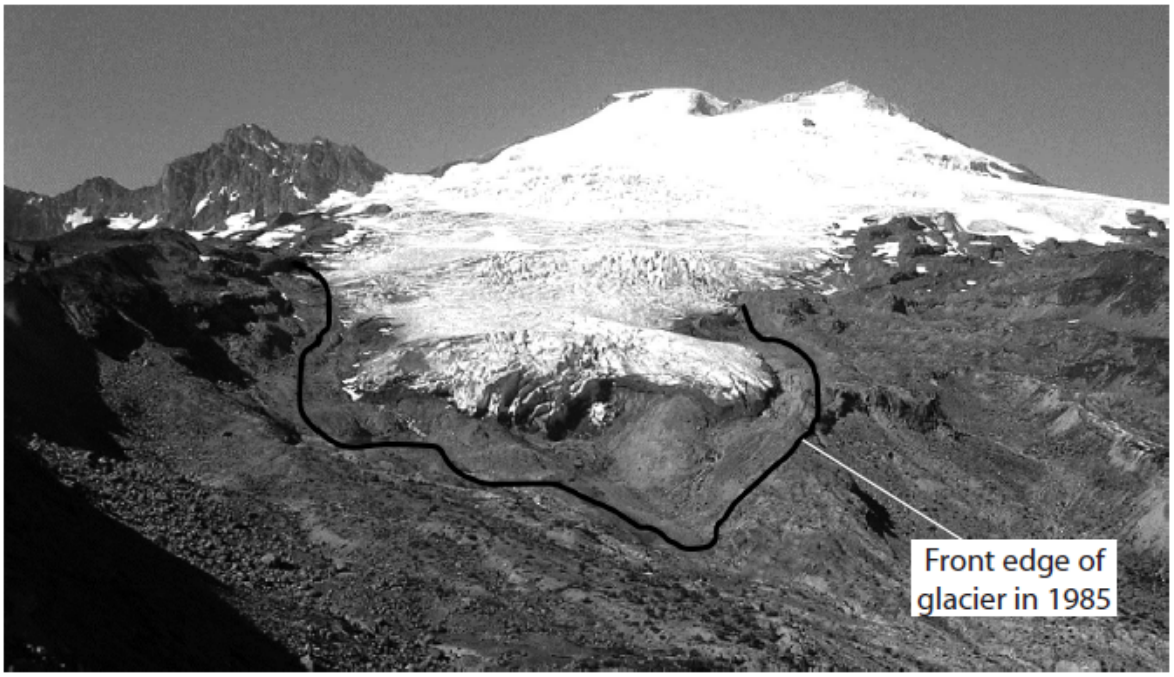
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(Total for question = 5 marks)

Q15.

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.

Plants such as lupin are often found in the early stages of glacial retreat. Lupin plants have nodules on their roots containing nitrogen-fixing bacteria that convert atmospheric nitrogen to ammonium ions. Plants can use ammonium ions as a source of nitrogen.

Explain why lupin plants are able to grow in the early stages of glacial retreat.

(3)

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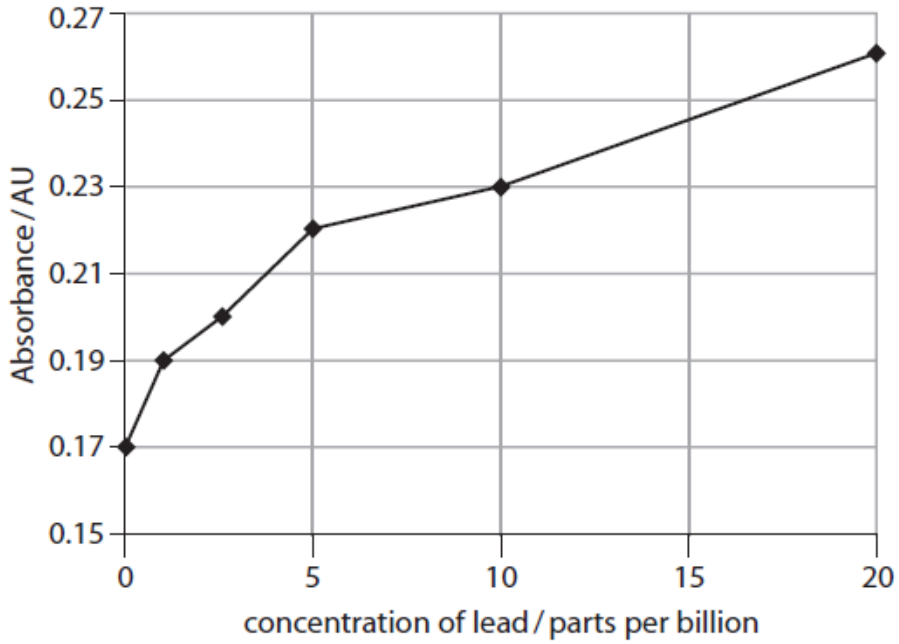
(Total for question = 3 marks)

Q16.

Lead is a toxic metal that can affect the structure of proteins. Lead affects protein in a similar way to changing pH.

Beetroot vacuoles contain a pigment. The absorbance of a solution is proportional to the concentration of the pigment in the solution.

The graph shows the results of a scientific investigation to study the effect of increasing lead concentration on the permeability of the membranes of beetroot cells.



(a) State the name of the membrane that surrounds the vacuole in beetroot cells.

(1)

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(b) Calculate the difference in percentage increase in absorbance between the lead concentration of 0-10 parts per billion and 10-20 parts per billion.

(3)

Answer ..... %

(c) (i) Explain the effect of lead on membrane permeability in beetroot cells.

(2)

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(ii) Devise an investigation to determine whether pH has a similar effect to lead on the permeability of the membranes of beetroot cells.

(4)

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(Total for question = 10 marks)

Q17.

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.

The table shows some of the species of plant growing underneath the trees in a deciduous woodland.

Species	Number of individuals of each species (n)	n(n – 1)
Woodrush	2	
Holly	8	
Bramble	1	
Yorkshire fog	9	
Sedge	3	

(i) Complete the table to show n(n – 1) for each species of plant.

(1)

(ii) Calculate the diversity index (D) using the data in the table.

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

(2)

Answer .....

(Total for question = 3 marks)

Q18.

A student carried out an investigation to compare the antibacterial effect of a garlic extract with that of three antibiotics, all at the same concentration.

(a) (i) To obtain the extract, a clove of garlic was cut into lots of small pieces and soaked in 0.1% ethanol for a long time.

Explain why this is an effective method of extraction.

(2)

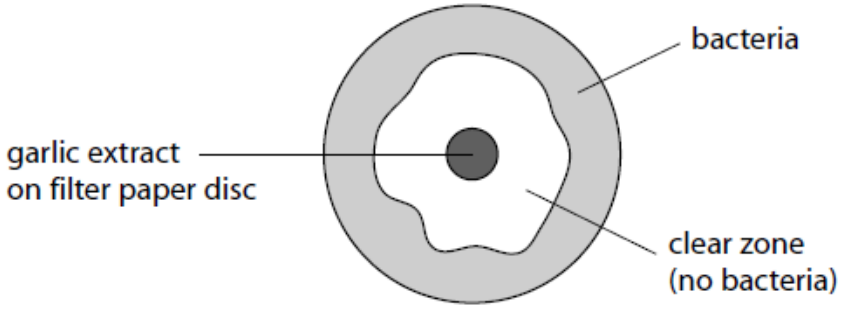
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(ii) The diagram shows the effect of the garlic extract on bacteria growing on an agar plate.



The area of the clear zone was calculated by assuming it is a circle and estimating the diameter. The estimate made was 4.3 cm.

Calculate the estimated area of the clear zone.

(2)

Answer .....

(b) The results of the investigation are shown in the table.

Sample number	Estimated area of clear zone / mm²			
	Antibiotics			Plant extract
	Chloramphenicol	Tetracycline	Streptomycin	Garlic
1	28	16	15	20
2	26	19	13	28
3	29	11	14	18
4	28	21	12	25
5	26	7	14	27
6	29	11	15	26
7	22	8	9	25
8	25	21	14	25
9	29	10	12	29
Mean	27	14	13	25
Standard deviation	2.37	5.54	1.90	3.60

These data were analysed using *t*-tests.

(i) Several statistical tests were available to the student to analyse these data, including the *t* -test, Chi squared and the correlation coefficient.

Explain why the *t*-test was chosen to analyse these data, rather than the other two tests.

(3)

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(ii) Calculate the *t* value for the data to compare garlic with chloramphenicol, using the formula:

$$t = \frac{\left|\overline{x}^1 - \overline{x}^2\right|}{\sqrt{\left(\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}\right)}}$$

(3)

Answer .....

(iii) The table shows the critical values of *t* with 16 degrees of freedom.

Significance level (p)	0.20	0.10	0.05	0.01	0.001
Critical value of *t*	1.34	1.75	2.12	2.92	4.02

Use your value of *t* to test the validity of a stated null hypothesis.

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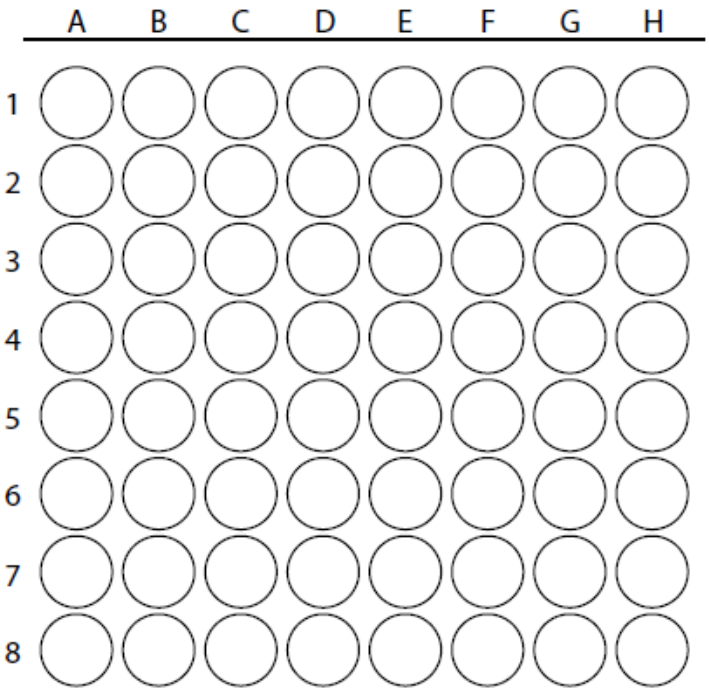
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(c) The size of the clear zone depends on variables other than the antibacterial properties of the substances used, such as size and solubility of the antimicrobial molecules in the extract.

A new method was developed in which the minimum concentration of extract that causes inhibition of bacterial growth (Minimum Inhibitory Concentration, MIC), was found.

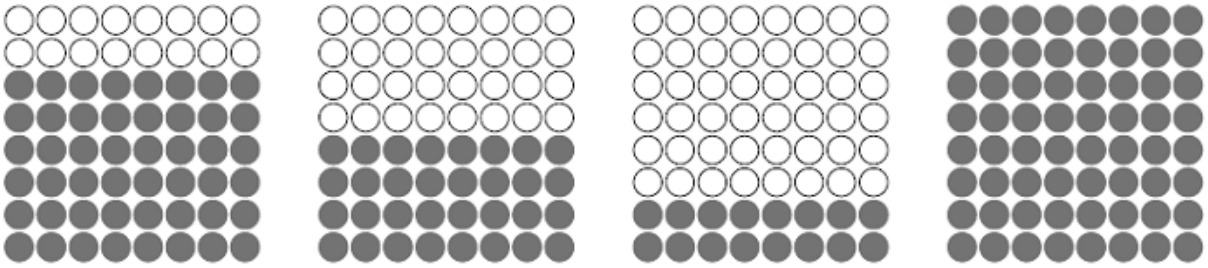
Samples of extract, bacteria (*E. coli*) and a respiration indicator were placed in a micro-titre tray.



1 = 4%
2 = 2%
3 = 1%
4 = 0.5%
5 = 0.25%
6 = 0.125%
7 = 0.0625%
8 = 0.0%

concentration of extract

The diagrams show the results obtained. The tubes are black when respiration occurs and clear when no respiration occurs.



(i) Analyse the data to explain the results of this experiment.

(2)

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(ii) Give **two** changes that can be made to the procedure to get a more accurate measure of MIC.

(2)

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(iii) It was concluded that plant extracts inhibit respiration of bacteria. This conclusion may not be valid because the investigation has limitations.

Describe how the investigation could be modified to reduce the effect of two named limitations.

(2)

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(Total for question = 20 marks)

Q19.

A number of seed banks have been set up around the world.

When a seed bank receives new seeds, it processes them in several ways.
The processes can include the following stages:

- washing the seeds with disinfectant
- allowing the seeds to dry.

Explain the advantages of these two stages.

(3)

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(Total for question = 3 marks)

Q20.

A number of seed banks have been set up around the world.

The processed seeds are stored at minus 20 °C. At intervals, samples of seeds are removed from storage and tested for viability.

If at least 75% of the seeds in the sample germinate, the remaining seeds are described as viable.

The diagram shows a container with many seeds in it.



Sunflower Seeds
mass of 1000 seeds = 50 g

A sample of 3 g of seeds was removed from this container. These seeds were given optimum conditions for germination.

However, only 48 seeds germinated.

Determine whether the remaining seeds in the container are viable or not.

(3)

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(Total for question = 3 marks)

Q21. The group of birds, known as warblers, contains many species which are very similar in external appearance.

Two of these species, the chiffchaff, *Phylloscopus collybita*, and the willow warbler, *Phylloscopus trochilus*, are so similar that many experts can identify them only by listening to their individually-characteristic songs.
These songs are used during breeding to mark territory and attract mates.

The photographs below show these two warblers.



Chiffchaff Willow warbler

Magnification × 0.75

(a) Although chiffchaffs and willow warblers are often found at the same time in the same woodlands, they do not interbreed.

(i) Suggest why successful interbreeding between chiffchaffs and willow warblers would make some scientists doubt their classification as separate species.

(3)

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(ii) Suggest reasons why the two species do not interbreed.

(3)

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(b) Records show that very little change in the appearance of chiffchaffs and willow warblers has occurred during the last two hundred years.

Suggest why the rate of change in the appearance of these two species is relatively slow.

(3)

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(Total for Question = 9 marks)

Q22. The group of birds, known as warblers, contains many species which are very similar in external appearance.

The chiffchaff, *Phylloscopus collybita*, and the willow warbler, *Phylloscopus trochilus* are two species of warbler.

These warblers are so similar that many experts can identify them only by listening to their characteristic songs. Their songs are used during breeding to mark territory and attract mates.

The photographs below show these two warblers.



Chiffchaff



Willow warbler

Magnification × 0.75

(a) Explain the meaning of the term **species**.

(1)

(b) Suggest how these two types of warbler became separate species.

(4)

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(c) Suggest why these two species of warbler are so similar in external appearance.

(3)

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(Total for Question = 8 marks)

Q23.

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.

Another measure of diversity is species richness.

(i) Species richness is the number of

(1)

☒ **A** different alleles in one species

☒ **B** different species in one area

☒ **C** individuals of one species in one area

☒ **D** individuals of one species in different habitats

(ii) Devise an investigation to compare species richness of the plants growing

under the trees in a deciduous woodland with that of a coniferous woodland.

(5)

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(Total for question = 6 marks)

Q24.

A study of the genetics of grass snakes has led to the identification of a new species

of grass snake in the UK.

The barred grass snake was thought to be a variation of the common grass snake, *Natrix natrix*.

However, the barred grass snake, *Natrix helvetica*, has been found to be a different species.

Both types of grass snake are normally found in lowland regions in the south of England. The snakes can be more than a metre long, are found near water and eat mainly amphibians such as frogs and newts.

The common grass snake is olive green with a bright yellow collar.

The barred grass snake, shown in the photograph, is grey with black markings.



State what is meant by the term species.

(1)

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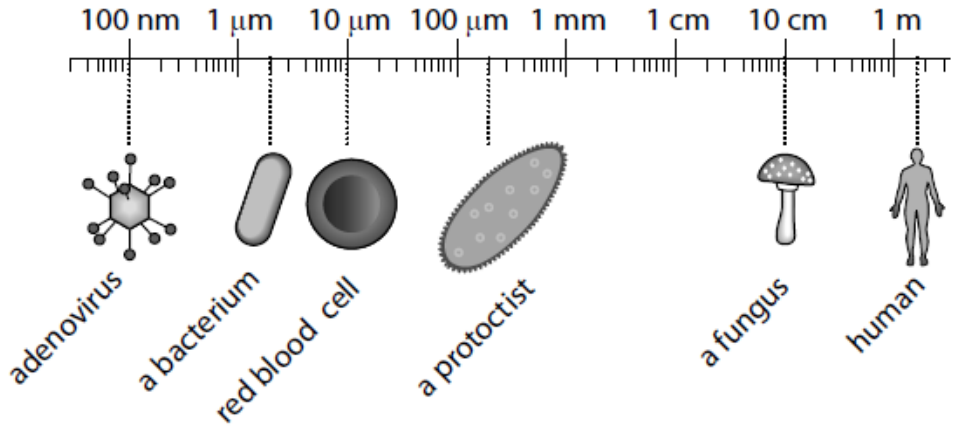
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(Total for question = 1 mark)

Q25.

The diagram compares the size of some microbes with that of a human and a human cell.



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(a) Which of the following belong to the domain Eukaryota?

(1)

☒ **A** adenovirus, bacterium and protoctist

☒ **B** human, bacterium and red blood cell

☒ **C** human, red blood cell and protoctist

☒ **D** adenovirus, fungus and human

(b) Which of the following do **not** have a nucleus?

(1)

☒ **A** bacterium and protoctist

☒ **B** bacterium and red blood cell

☒ **C** fungus and adenovirus

☒ **D** protoctist and adenovirus

(c) Which of the following shows how many times bigger the bacterium is than the adenovirus?

(1)

☒ **A** 45 times

☒ **B** 22 times

☒ **C** 2 times

☒ **D** 10 times

(d) State **one** way in which the structure of a virus is different from that of a bacterium.

(1)

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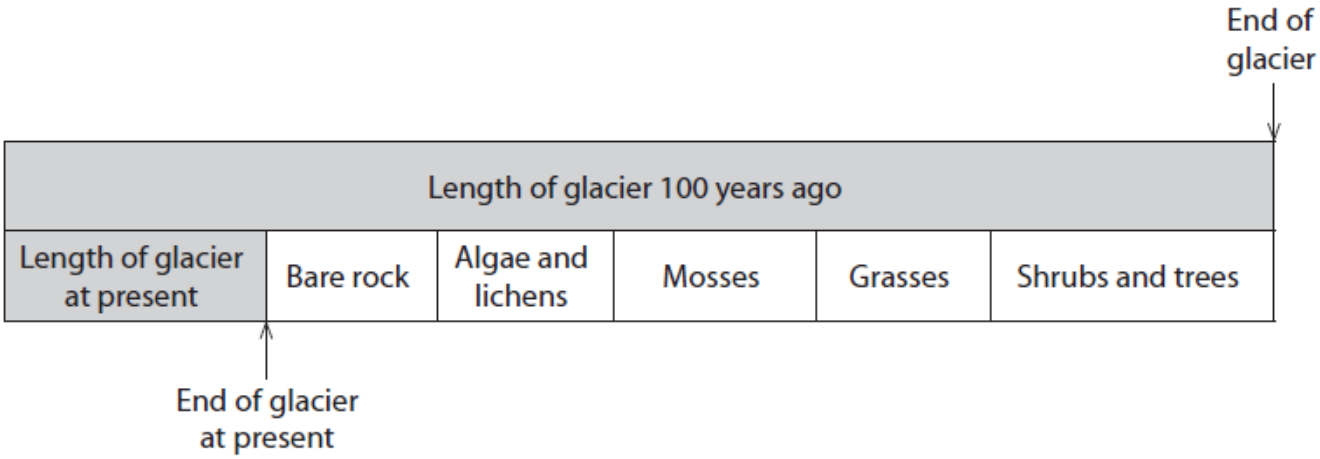
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(Total for question = 4 marks)

Q26.

Glaciers are long, large masses of ice that formed thousands of years ago. As a result of warmer climates, more ice is melting. This is reducing the length of the glaciers. As a result, bare rock that was once covered by the glacier becomes exposed.

The diagram below shows the length of a glacier 100 years ago and the glacier at present. It also shows what is now found in a transect taken from where the front edge of the glacier is at present.



(a) Using the information in the diagram, describe and explain the changes in the distribution of organisms with distance from the front edge of this glacier.

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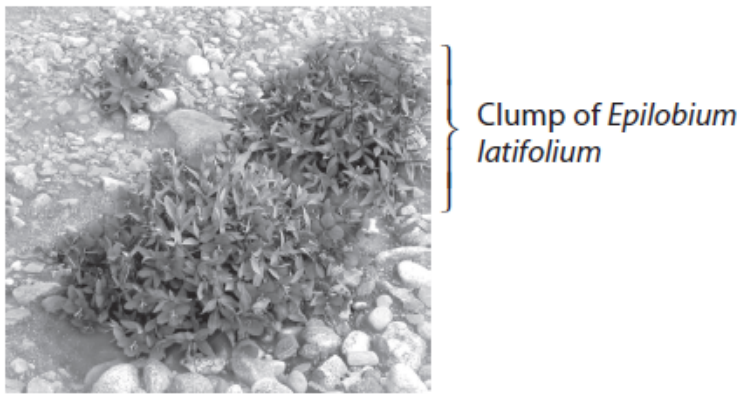
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(b) *Epilobium latifolium* is a plant that occupies a niche in an area once covered by this glacier. It is a short flowering plant that grows in clumps.

The photograph below shows three clumps of *Epilobium latifolium*.



Magnification ×0.2

(i) Explain what is meant by the term **niche**, using the plant *Epilobium latifolium* as an example.

(3)

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(ii) Describe how to carry out a study of the distribution of *Epilobium latifolium* from the front edge of this glacier.

(4)

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(iii) Suggest **one** abiotic factor that might affect the abundance of *Epilobium latifolium* and describe how this factor could be measured.

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(Total for question = 13 marks)

Q27.

Frogs are ectothermic animals. This means that their body temperature will vary as the environmental temperature varies.

(a) Explain why body temperature affects the rate of development of animals.

(3)

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(b) Several species of the frog genus, *Rana*, can be found in North America. Many of these

species inhabit areas within a range of latitudes from the colder north to the warmer south.

The table below shows data for four of these species, *R. clamitans*, *R. palustris*, *R. pipiens* and *R. sylvatica*.

Species	Body temperature of frog / °C			
	Lower lethal, below which frog dies	Minimum to start development	Maximum to complete development	Upper lethal, above which frog dies
R. clamitans	10.0	11.0	35.0	37.0
R. palustris	5.0	7.0	30.0	31.0
R. pipiens	3.0	6.0	28.0	30.0
R. sylvatica	0.0	2.0	24.0	25.0

Using the information, suggest why the lower and upper lethal temperatures limit the range of latitudes inhabited by each species of frog.

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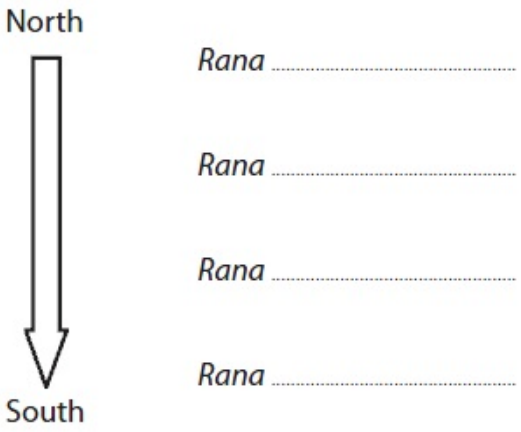
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(c) Complete the species names in the diagram below to show the most likely distribution of *Rana* from north to south.

(2)



(d) Populations of the different species overlap on the boundaries of each latitude range.

Suggest why interbreeding does not take place between these populations.

(3)

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(e) Suggest how global warming may affect the distribution of these species of Rana in North America.

(3)

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(Total for question = 13 marks)

Q28.

Plant fibres and oil-based plastics have both been used to make ropes.

Ropes used in climbing need to have high tensile strength.

State what is meant by the term **tensile strength**.

(1)

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(Total for question = 1 mark)

Q29.

There are many reasons why humans may lose muscle mass.

Two known causes are hip replacement surgery and some genetically inherited conditions.

Muscular dystrophy (MD) is a range of genetically inherited conditions in which a loss of muscle mass can occur.

Limb-girdle muscular dystrophy (LGMD2A) is a rare type of MD. Only six people per million have this
recessive condition.

In 2018 there were 66.5 million people in the UK.

(i) Calculate the number of people in the UK who are carriers of LGMD2A using the Hardy-Weinberg equation.

(3)

$$p^2 + 2pq + q^2 = 1$$

Answer .....

(ii) In the human population, the frequency of the allele for LGMD2A may change from one generation to the next.

Explain why the frequency of this allele may change from one generation to the next.

(3)

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(Total for question = 6 marks)

Q30.

Plant fibres and oil-based plastics have both been used to make ropes.

Tissues that contain lignin provide strength to plant fibres.

Describe the positions in the stem of those tissues that contain lignin.

(2)

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(Total for question = 2 marks)

Q1.

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

Information on biodiversity has been collected from various rainforest habitats in Madagascar.

(i) Describe what needs to be measured in order to compare the biodiversity of two rainforests.

(2)

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(ii) The biodiversity of the land area of Earth has been estimated.

The table shows information on the number of species of plants and vertebrate animals in the rainforests of Madagascar and for the land area of Earth.

Region	Plants		Vertebrate animals		Land area / km²
	Number of known species	Number of known endemic species	Number of known species	Number of known endemic species	
Madagascar	12 000	9704	987	771	59 300
Land area of the Earth	300 000	300 000	27 300	27 300	149 000 000

Analyse the data to determine the importance of the rainforests of Madagascar in maintaining biodiversity on Earth.

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(Total for question = 5 marks)

Q2.

The decomposition of leaves depends on the content of the leaves, the presence of certain microorganisms and a number of abiotic factors.

Leaves consist of a number of organic molecules, including lignin and cellulose.

(a) Place a cross ☒ in the box next to the groups of microorganisms that all cause decomposition.

(1)

☒ **A** bacteria and fungi

☒ **B** bacteria and viruses

☒ **C** fungi and viruses

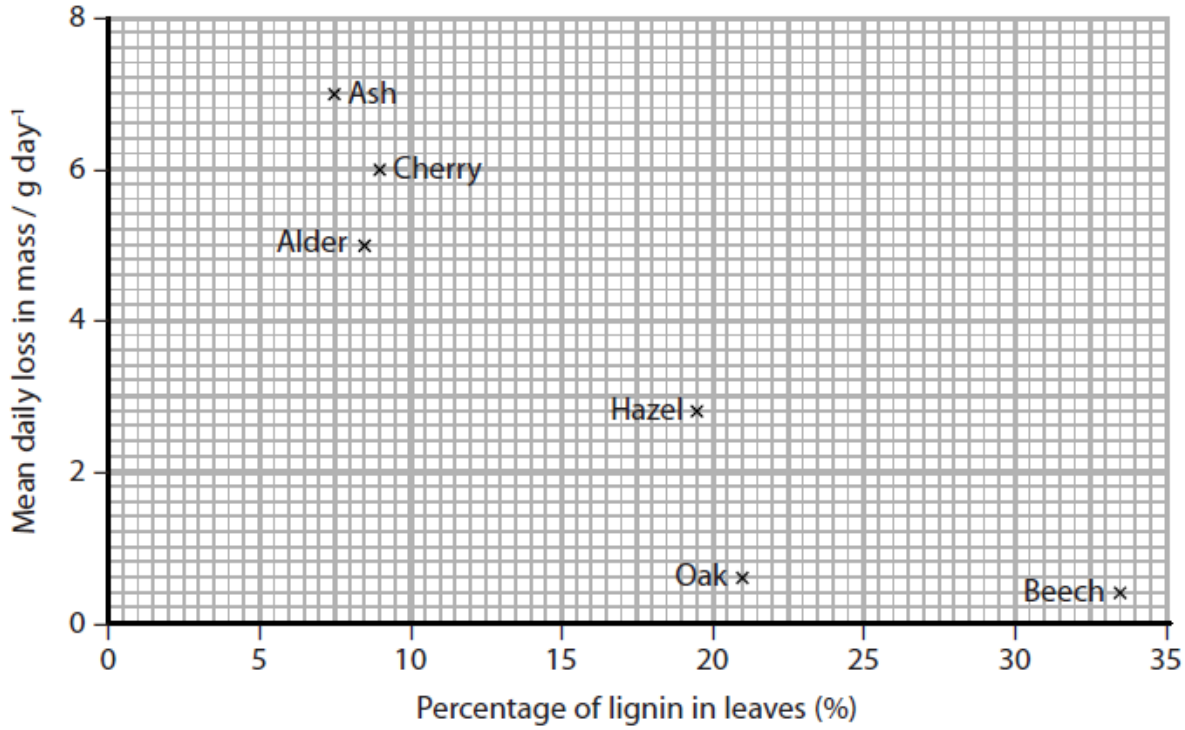
☒ **D** bacteria, fungi and viruses

(b) An investigation was carried out into the effect of lignin content on the decomposition of leaves from different types of tree.

The lignin content of leaves from an ash tree was determined. A pile of ash leaves was collected and weighed. The leaves were left for 40 days and reweighed. The mean daily loss in mass was calculated.

This was repeated for leaves from five other species of tree. All six piles of leaves had the same starting mass.

The results of this investigation are shown in the graph below.



(i) A student made the following conclusions from the data.

Beech leaves decompose faster than cherry leaves.
Microorganisms are needed for the decomposition of these leaves.
There is a causal relationship between lignin content and decomposition.

Place a cross ☒ in the box next to the number of correct conclusions made by the student.

(1)

☐ **A** none

☐ **B** one

☐ **C** two

☐ **D** three

(ii) Place a cross ☒ in the box next to the term that completes the following statement.

Each pile of leaves had the same mass to ensure the investigation was

(1)

☐ **A** accurate

☐ **B** precise

☐ **C** reliable

☐ **D** valid

(iii) Suggest what happens to the cellulose in these leaves during decomposition.

(4)

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(iv) The student repeated this investigation on sycamore leaves.

Explain why it would be necessary to keep the temperature of this investigation the same as the original.

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(Total for question = 11 marks)

Q3.

Anabolic steroids and testosterone have been used as performance-enhancing drugs by some athletes. These drugs can increase muscle mass and strength.

An investigation was carried out to assess the effect of doses of testosterone on muscle size.

A group of men was randomised into four groups: A, B, C and D. Groups A and B were given a placebo. Groups C and D were both given doses of testosterone. Groups A and C had no exercise training. Groups B and D were given exercise training.

The cross-sectional area of the triceps muscle of each individual was measured at the start of the investigation and after 10 weeks.

The results are shown in the table.

Muscle	Mean cross-sectional area of muscle / mm^2 ± SD			
	Group A Placebo without exercise	Group B Placebo with exercise	Group C Testosterone without exercise	Group D Testosterone with exercise
Triceps – at the start	3621 ± 213	4052 ± 262	3579 ± 260	3483 ± 217
Triceps after 10 weeks	3539 ± 226	4109 ± 230	4003 ± 229	3984 ± 239

(i) Deduce the effect of testosterone on the size of the triceps muscle.

(2)

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(ii) The purpose of the placebo is to

(1)

☒ **A** increase the accuracy of the measurements

☒ **B** increase the reproducibility of the data

☒ **C** show that exercise has an effect

☒ **D** show that testosterone has an effect

(Total for question = 3 marks)

Q4.

The scientific article you have studied is adapted from *National Geographic*.

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

State what is meant by the term endemic (paragraph 35).

(1)

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(Total for question = 1 mark)

Q5.

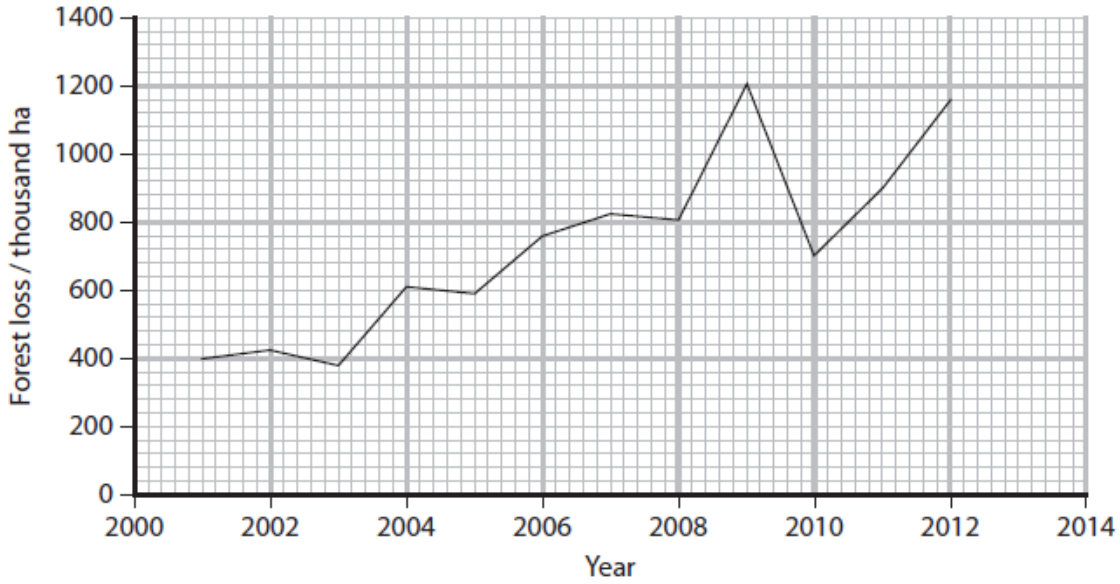
The photograph shows an orangutan. These animals inhabit the forests of Borneo and Sumatra.



The orangutan population in Borneo decreased by 60% between 1950 and 2010.

This has been linked to loss of habitat. Deforestation has resulted in the loss of natural habitat.

The graph shows the area of forest loss in Borneo from 2001 to 2012.



(2)

(i) Calculate the mean rate at which forest was lost between 2010 and 2012.

Answer .....

*(ii) Land use has changed over time in Borneo, with areas of forest being removed due to logging. The land may then be used for planting oil palms, which are not a suitable habitat for orangutans.

The following comments refer to other issues concerning the conservation of orangutans in Borneo.

- Over the past 100 years, 80% of suitable habitat for orangutans has been lost.
- Only 2% of the remaining forest suitable as orangutan habitat is protected.
- From 1999 to 2015, the orangutan population decreased by 50%.
- Captive-bred orangutans may spread human diseases into wild populations.
- When captive-bred orangutans are released, their offspring often die young because the

females have not learnt parenting behaviour from older individuals.

- Large numbers of orangutans are hunted in Borneo, even though they are a protected animal.

It has been stated that habitat protection is more important than captive breeding programmes for the conservation of orangutans in Borneo.

Evaluate this statement.

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(Total for question = 8 marks)

Q6.

Photosynthesis is a process that occurs in all green plants.

Describe how starch is formed from the products of the light-independent reactions of photosynthesis.

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(Total for question = 4 marks)

Q7.

The largest blood vessels in the body are the aorta and the vena cava.

In some individuals, the wall of the aorta splits. This can result in rapid blood loss and death.

It has been suggested that this splitting is a result of a loss of tensile strength in the wall of the aorta.

Describe how the tensile strength of the aorta wall can be determined.

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(Total for question = 3 marks)

Q8.

The effects of these plant extracts were tested on pathogenic bacteria. It was found that each extract had an effect on its own, but the effect was greater when used together.

Devise a procedure that scientists may have used to measure the effects of these extracts on pathogenic bacteria.

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(Total for question = 4 marks)

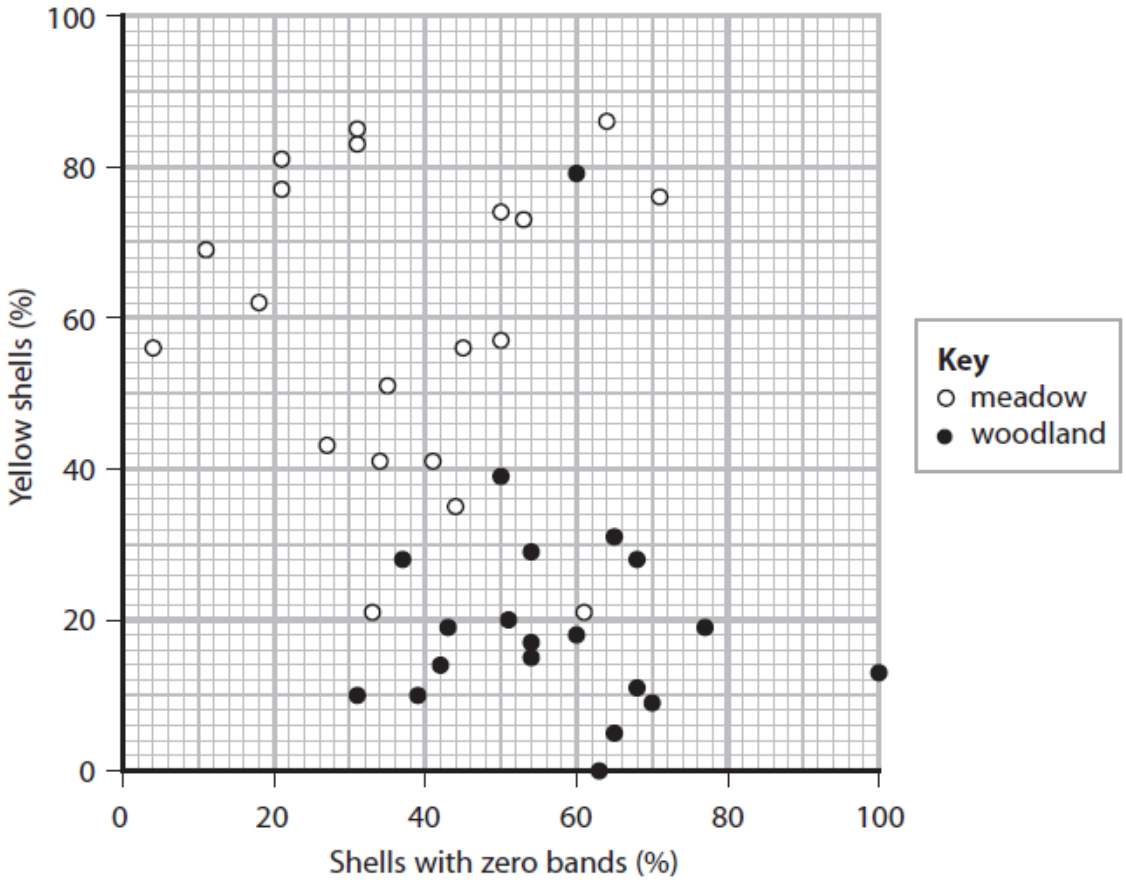
Q9.

The shells of the banded snail can have from zero to five black bands.

The populations of banded snails in 20 meadow habitats and 20 woodland

habitats were investigated.

At each location the percentage of snails with yellow shells was recorded. The percentage of snails with shells with zero bands was also recorded.



(i) Explain the importance of the different shell patterns in these two habitats.

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(ii) Explain how a statistical test could be used to determine if the number of shells with zero bands is significantly different in these two habitats.

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(Total for question = 5 marks)

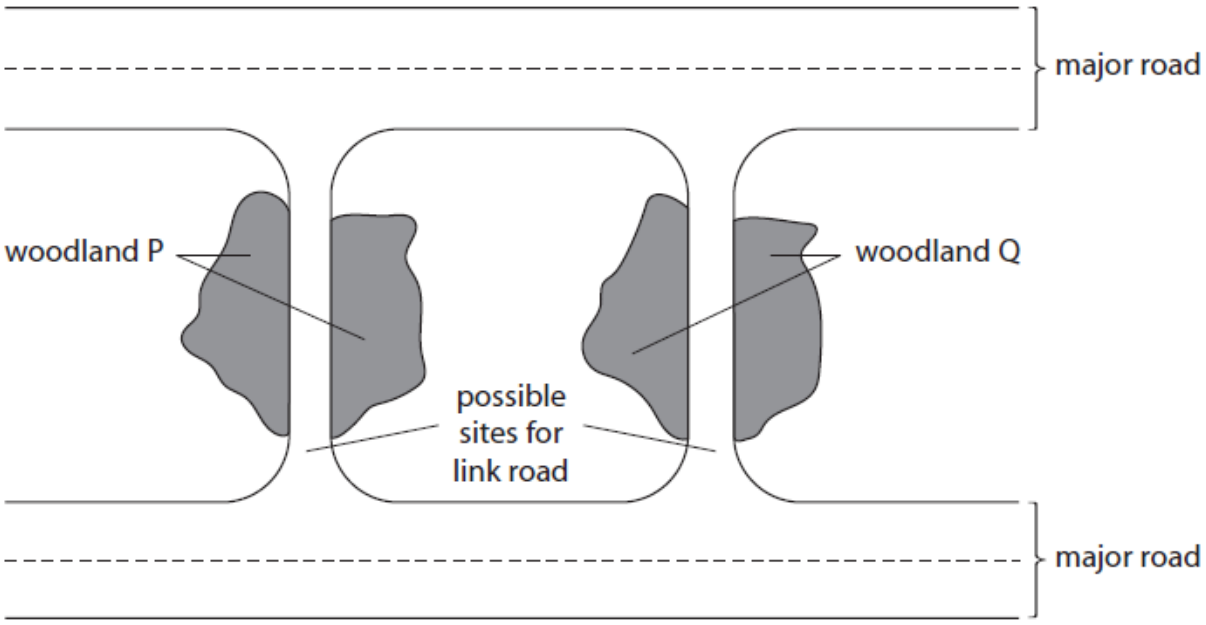
Q10.

Wildlife conservation can involve keeping animals in zoos as well as protecting habitats.

Habitats can be destroyed by road building.

A link road is planned to connect two major roads.

The diagram shows the two possible sites for the link road and two woodland habitats.



(1)

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(ii) To decide which of the two link roads should be built, studies of the biodiversity of woodlands P and Q need to be carried out.

Discuss what information needs to be collected from the two woodlands to make a decision about the site of the link road.

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(Total for question = 5 marks)

Q11.

Plant fibres and oil-based plastics have both been used to make ropes.

Climbing ropes can be made from manila (a plant fibre) or nylon (an oil-based plastic). Various factors affect the tensile strength of these ropes, including diameter and storage conditions.

The table shows the effect of rope diameter on tensile strength.

Diameter of rope / mm	Tensile strength / kN	
	Manila rope	Nylon rope
6	2.4	7.5
8	4.2	12.1
10	5.7	16.3
12	10.6	28.4

It is claimed that the ideal storage conditions for rope are 18 °C and 60% relative humidity.

Devise a valid investigation to determine the effect of storage temperature on the tensile strength of manila rope and nylon rope.

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(Total for question = 4 marks)

Q12.

A population of white-tailed deer *Odocoileus virginianus* was introduced from North America into Finland in 1934. There were four females and one male. The population has since increased rapidly.

A study in 2012 compared the genetic diversity of the population in Finland with the population in North America.

The table shows the heterozygosity index for each population of white-tailed deer.

Heterozygosity index for Finland population	Heterozygosity index for North American population
0.692	0.742

Climate change may affect the habitat of both populations of deer.

Explain which population is more likely to adapt to changing conditions.

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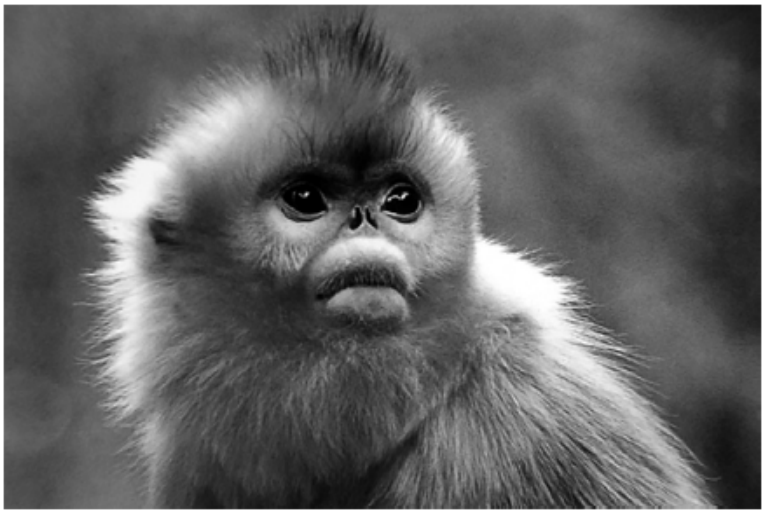
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(Total for question = 4 marks)

Q13.

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

This endangered species of monkey feeds on seeds.



State what is meant by the term endemic.

(1)

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(Total for question = 1 mark)

Q14.

Some marine snails produce chemicals called conotoxins. These chemicals paralyse the prey of these snails by interfering with the conduction of nerve impulses to muscles.

Conotoxins can be modified to produce painkillers.

The effects of conotoxins on the nervous system were first demonstrated in experiments involving animals.

These experiments were involved in the development of painkillers from conotoxins.

(i) Describe the ethical issues concerning the use of animals in this research.

(2)

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(ii) After testing on animals, painkillers undergo three-phased testing.

In an investigation testing the effectiveness of a painkiller produced from conotoxin, the new painkiller was tested on a group of healthy volunteers.

Explain the reasons for this stage in the testing of the painkiller.

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Q15.

Seed banks store seeds to conserve different varieties of plants.

Seeds are stored for long periods of time in conditions that allow them to be germinated when required.

An investigation was carried out to study the effect of storage time on wheat seeds of two different varieties.

Wheat seeds of one variety, P, were collected and divided into six groups, each with the same number of seeds. Each group of seeds was stored in an atmosphere of 80% humidity at a temperature of 42 °C.

Each group was stored in these conditions for different lengths of time. One group of seeds was germinated immediately after collection. This was the control group.

After storage, the seeds were planted in suitable conditions to allow germination. The number of seeds that germinated was found and the mean percentage germination calculated.

This was repeated using wheat seeds of a different variety, Q.

All other variables were kept constant.

The results are shown in the table.

Storage time / hours	Mean percentage germination (%)	
	Wheat variety P	Wheat variety Q
0 (control)	97	99
24	96	99
48	95	98
72	94	81
96	60	66
120	57	63

(i) Describe the effect of storage time on the germination of seeds for these two varieties of wheat.

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(ii) Explain how the results for the control were useful in this investigation.

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(Total for question = 5 marks)

Q16.

The modern bread wheat plant (*Triticum aestivum*) has been developed from other plant species that have different genomes.

Three species of plant and their genomes are shown in the images.



Triticum aestivum
Genomes A, B and D

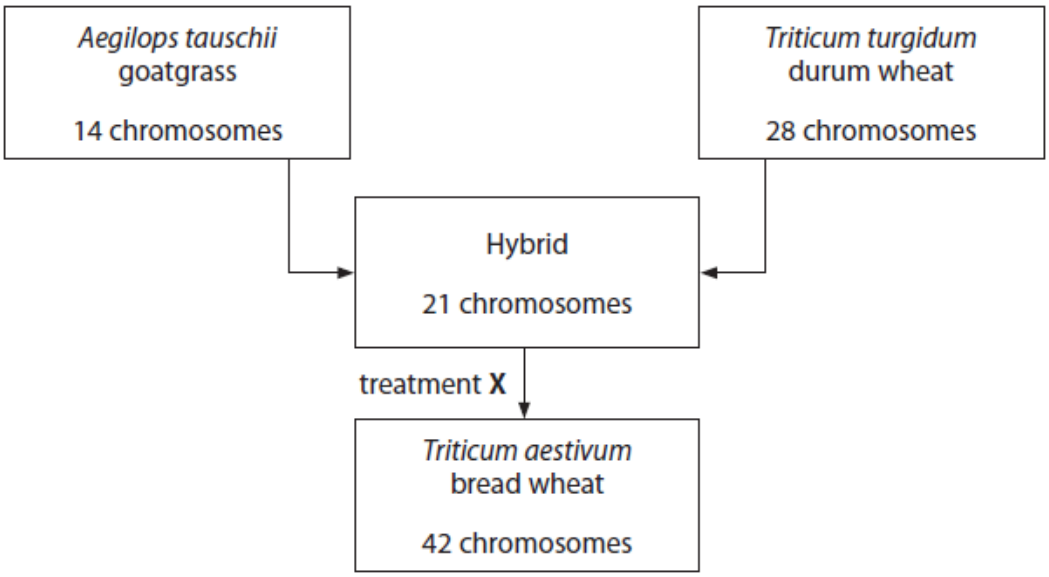


Triticum turgidum
Genomes A and B



Aegilops tauschii
Genome D

The diagram shows how chromosomes from different species have combined to produce the bread wheat species used to produce flour.



* New varieties of plants with desirable combinations of characteristics can be produced using the methods shown in the table.

Method	Example
Formation of hybrids	In wheat, genome D includes genes for a tolerance of harsh conditions and genome A promotes large starch stores in seeds.
Genetic modification	Production of specific molecules in plant cells.
Selective breeding	Plants with desired characteristics can be used for breeding to produce plants with combinations of desired characteristics.

Evaluate the risks and benefits of producing varieties of plants using these methods.

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(Total for question = 6 marks)

Q17.

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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(Total for question = 5 marks)

Q18.

The scientific article you have studied is adapted from *National Geographic*.

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

Dengue is a disease caused by a virus carried by *Aedes aegypti*.

Using CRISPR and a gene drive, it may be possible to stop the reproduction of *Aedes aegypti* mosquitoes (paragraphs 20 and 21).

Explain why stopping the reproduction of this species of mosquito might not stop the spread of this disease.

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(Total for question = 3 marks)

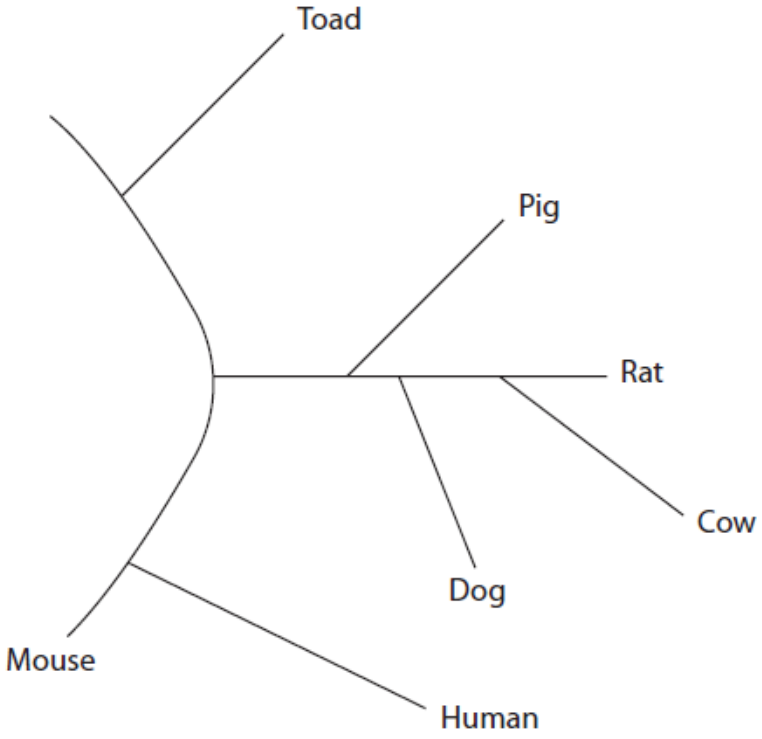
Q19.

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

Trypsin specifically acts on a polypeptide to form amino acids.

The primary structures of trypsin molecules from different species have been used to produce a phylogenetic tree for trypsin.

Each branch of the following phylogenetic diagram represents trypsin from a different species.



Explain how the primary structure of trypsin molecules can be used to produce a phylogenetic tree.

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(Total for question = 3 marks)

Q20.

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

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(Total for question = 4 marks)

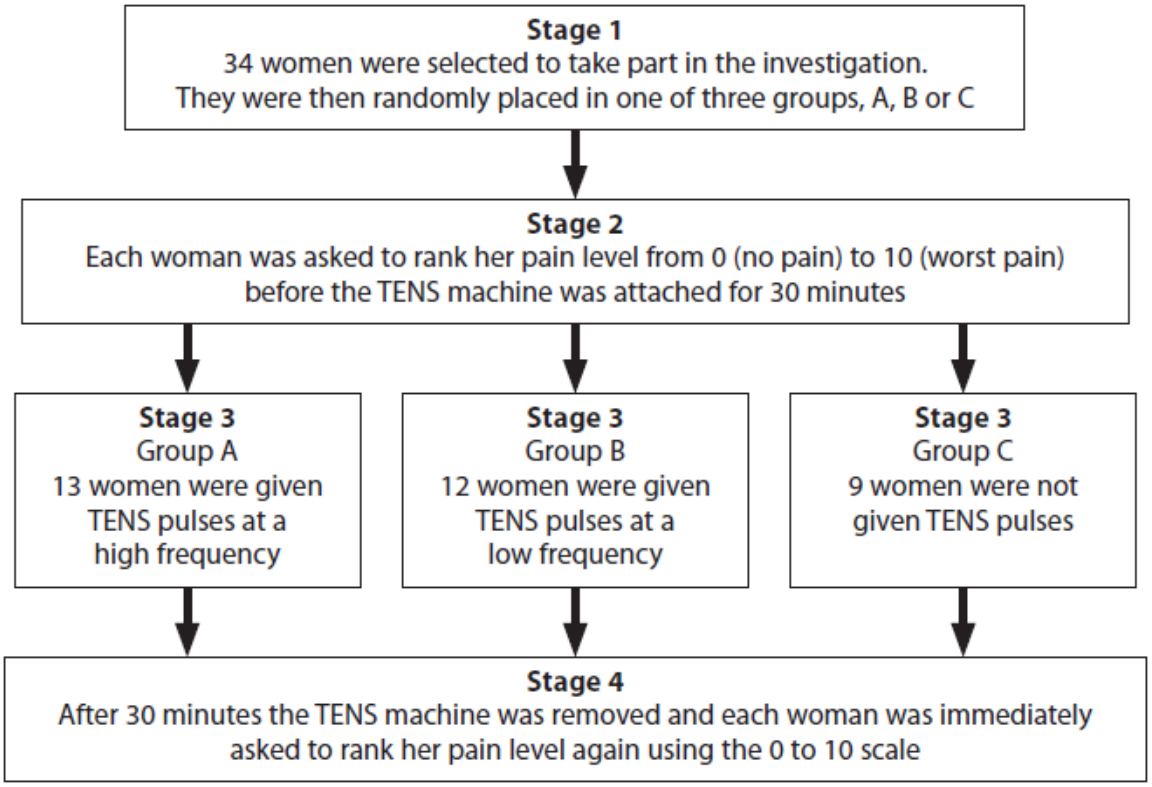
Q21.

Some women need to have surgery to aid childbirth. This can lead to pain after surgery.

A TENS (transcutaneous electrical nerve stimulation) machine releases regular pulses of electricity onto the skin surface and can be used in pain relief.

An investigation was carried out to study whether the frequency of the pulses from a TENS machine could help these women with their pain relief.

The diagram shows how the investigation was carried out.



Explain why group C was included in this investigation.

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(Total for question = 2 marks)

Q22.

Sepsis is a bacterial infection in the bloodstream. Sepsis can cause tissue death in limbs. This may require parts of a limb to be removed (amputation).

Open wounds can become infected by bacteria, leading to sepsis.

Explain why bacteria are able to multiply in the bloodstream when they enter the body.

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(Total for question = 3 marks)

Q23.

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.

Explain why genetically modified bacteria delivering drugs 'to the exact tissue in the body where they're needed and nowhere else' would decrease side effects (paragraph 34).

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(Total for question = 2 marks)

Q24.

The modern bread wheat plant (*Triticum aestivum*) has been developed from other plant species that have different genomes.

Three species of plant and their genomes are shown in the images.



Triticum aestivum
Genomes A, B and D

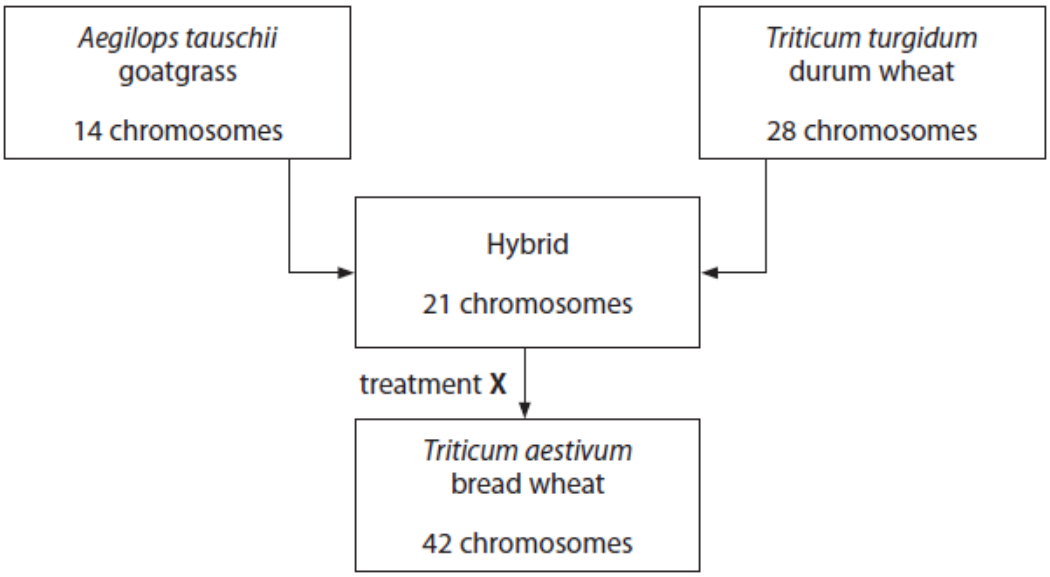


Triticum turgidum
Genomes A and B



Aegilops tauschii
Genome D

The diagram shows how chromosomes from different species have combined to produce the bread wheat species used to produce flour.



Explain why the hybrid plant cannot produce haploid gametes.

(2)

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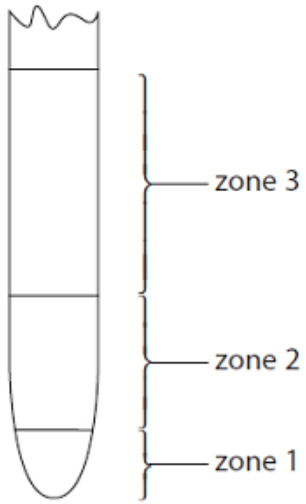
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(Total for question = 2 marks)

Q25.

The diagram shows three different zones found in a plant root.



In zone 3, some of the cells differentiate to give rise to phloem sieve tube elements and others differentiate
into phloem companion cells.

(i) Explain how genetically identical cells in zone 3 can differentiate to give rise to different tissues.

(3)

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(ii) The student also hypothesised that the cells in zone 1 would be smaller in size

than the cells that had differentiated into xylem vessels in zone 3.

The student prepared microscope slides of sections from zones 1 and 3.

Explain how the student could compare the sizes of cells in zone 1 with the sizes of xylem vessels in zone 3.

(3)

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(Total for question = 6 marks)

Q26.

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.

(5)

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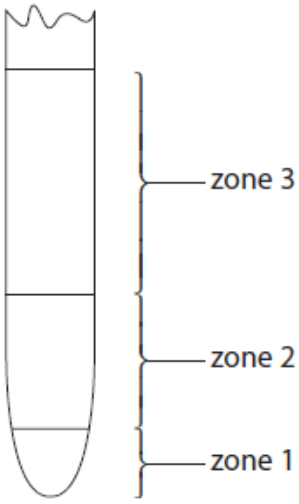
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(Total for question = 6 marks)

Q27.

The diagram shows three different zones found in a plant root.



In zone 2, the plant cells elongate due to a change in their cellulose cell walls.

(i) Cellulose and amylopectin are polymers of hexose sugars.

State one difference between the hexose in cellulose and the hexose in amylopectin.

(1)

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(ii) The cellulose molecules form microfibrils.

Name the bond between adjacent cellulose molecules in a cellulose microfibril.

(1)

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(Total for question = 2 marks)

Q28.

A population of white-tailed deer *Odocoileus virginianus* was introduced from North America into Finland in 1934. There were four females and one male. The population has since increased rapidly.

A study in 2012 compared the genetic diversity of the population in Finland with the population in North America.

Ten genes were compared from 72 deer in each population. The allele richness (number of alleles in the population) of each gene was measured.

A χ^2 test was carried out to compare the two populations.

(i) The null hypothesis for this investigation is

(1)

☒ **A** the allele richness in the population from Finland is higher than the USA.

☒ **B** the allele richness in the population from the USA is higher than Finland.

☒ **C** the population in the USA is more genetically diverse than the population in Finland.

☒ **D** there is no difference in allele richness between the two populations.

(ii) The values from the population in the USA can be taken as the expected values and a χ^2 test can be carried out.

Gene	Allele richness (Finland population) X (observed)	Allele richness (USA population) Y (expected)	X – Y	$(X - Y)^2$	$(X - Y)^2 / Y$
1	6	14	8	64	4.57
2	4	5	1	1	0.2
3	7	13	6	36	2.77
4	7	15	8	64	4.27
5	6	6	0	0	0
6	8	12	4	16	1.33
7	2	3	1	1	0.33
8	4	4	0	0	0
9	4	9			
10	3	4			

Complete the table to calculate the χ^2 value, using the formula

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

(3)

Answer .....

(iii) The table shows the critical values of chi-squared at different levels of probability.

Degrees of freedom	Probability	
	p=0.10	p=0.05
1	2.706	3.841
2	4.605	5.991
3	6.251	7.815
4	7.779	9.488
5	9.236	11.070
6	10.645	12.592
7	12.017	14.067
8	13.362	15.507
9	14.684	16.919
10	15.987	18.307

Deduce the effect of a small founder population on the allele richness in the population of white-tailed deer in Finland.

(3)

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(Total for question = 7 marks)

Q29.

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

The presence of tusks is controlled by a single gene. The allele for tusks is known to be dominant.

The frequency of alleles in a population can be determined using the Hardy-Weinberg equation.

Calculate the frequency of the dominant and recessive alleles in this population.
Give your answer to 2 decimal places.

(3)

Frequency of the dominant allele .....

Frequency of the recessive allele .....

(Total for question = 3 marks)

Q30.

The scientific article you have studied is adapted from *National Geographic*.

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

Explain how two populations of mosquito could be shown to belong to different species (paragraph 4).

(2)

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(Total for question = 2 marks)

Q1.

Wasps are insects that live in groups.

One species of wasp (*Vespula germanica*) has been shown to knock its body repeatedly against a hard surface. This signals the presence and quality of food to other wasps.

When threatened by another animal, it may use its stinger to inject a venom to protect itself.



bugguide.net

Complete the table by giving the name of the type of adaptation.

(2)

Description of adaptation	Type of adaptation shown by the wasp
knocking its body to signal food	
the stinger	

(Total for question = 2 marks)

Q2.

Plant fibres and oil-based plastics have both been used to make ropes.

Describe one advantage and one disadvantage of using ropes made from plant fibres rather than ropes made from oil-based plastics.

(2)

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(Total for question = 2 marks)

Q3.

In the 18th century, William Withering trialled the use of an extract of foxglove plants to treat a heart condition.

Give **four** reasons why a contemporary drug testing protocol is an improvement on the trial used by William Withering.

(4)

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(Total for question = 4 marks)

Q4.

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 ☒.

Moving a limb involves the interaction of muscles, tendons and ligaments.

Tendons and ligaments are important structures in elbow and knee joints.

(i) Which of the following identifies the structures that join bones to bones in an elbow joint?

(1)

☒ **A** ligaments only

☒ **B** ligaments and tendons

☒ **C** tendons only

☒ **D** neither ligaments nor tendons

(ii) One type of joint injury is a torn ligament. This may be treated by adding a piece of tendon to the ligament. This is because after a period of time, the tendon tissue changes and responds in the same way as a ligament.

Which of the rows in the table correctly describe the changes in this piece of tendon?

(1)

Row	Piece of tendon shows a change in its	The change is
1	genotype	an anatomical adaptation
2	genotype	a physiological adaptation
3	phenotype	an anatomical adaptation
4	phenotype	a physiological adaptation

☒ **A** row 1 only

☒ **B** row 3 only

☒ **C** rows 1 and 2

☒ **D** rows 3 and 4

*(iii) The photograph shows athletes competing in the modern triathlon.



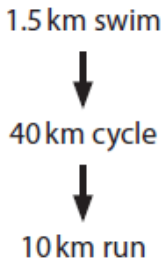
© Gonzalo Arroyo Moreno/Stringer

The modern triathlon involves three sports: swimming, cycling and running.

An investigation was carried out to compare the level of demand on the body of these three sports during a triathlon.

The investigation involved 12 athletes who were all males of the same age.

Each athlete carried out the triathlon as shown in the flow diagram. There was no rest period between each sport.



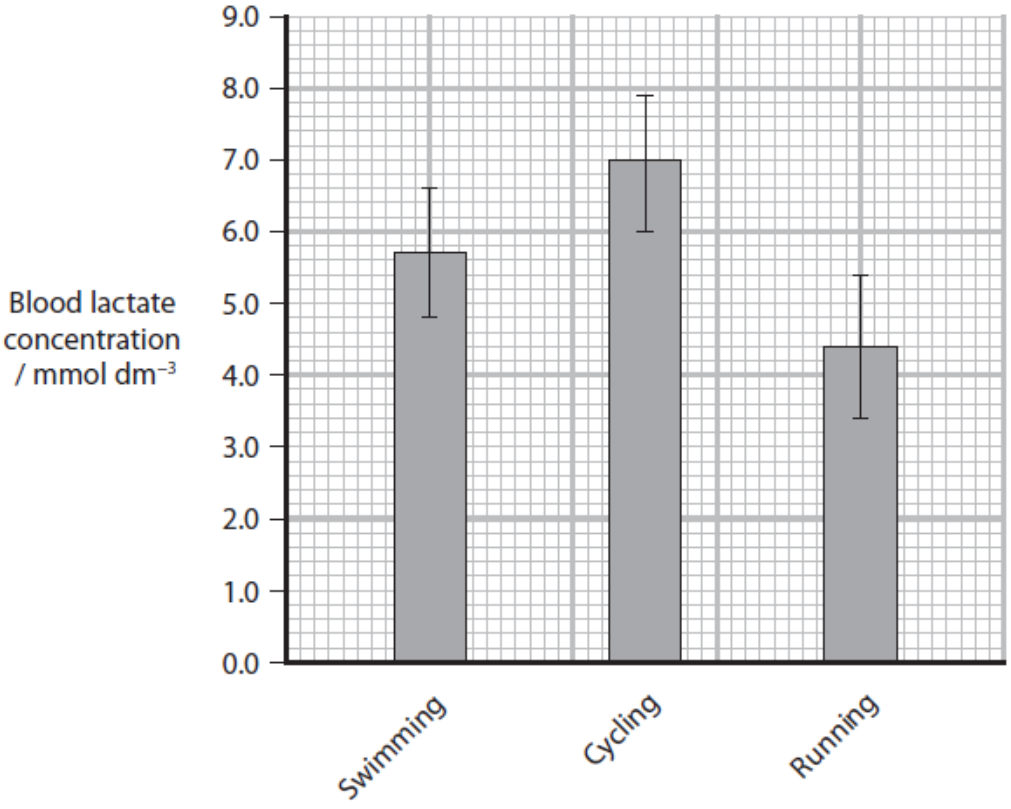
The heart rate for each athlete was measured as they completed each sport.

The mean heart rate for each sport was then calculated and is shown in the table.

Sport	Mean heart rate / bpm
Swimming	163
Cycling	165
Running	159

The blood lactate level for each athlete was also measured as they completed each sport. Means for lactate level after each sport were calculated.

The results are shown in the graph.



It was concluded that cycling was the most demanding of the three triathlon sports. This was followed by swimming and then running.

Evaluate the validity of this conclusion.

(6)

(Total for question = 8 marks)

Q5.

Anabolic steroids stimulate muscle development.

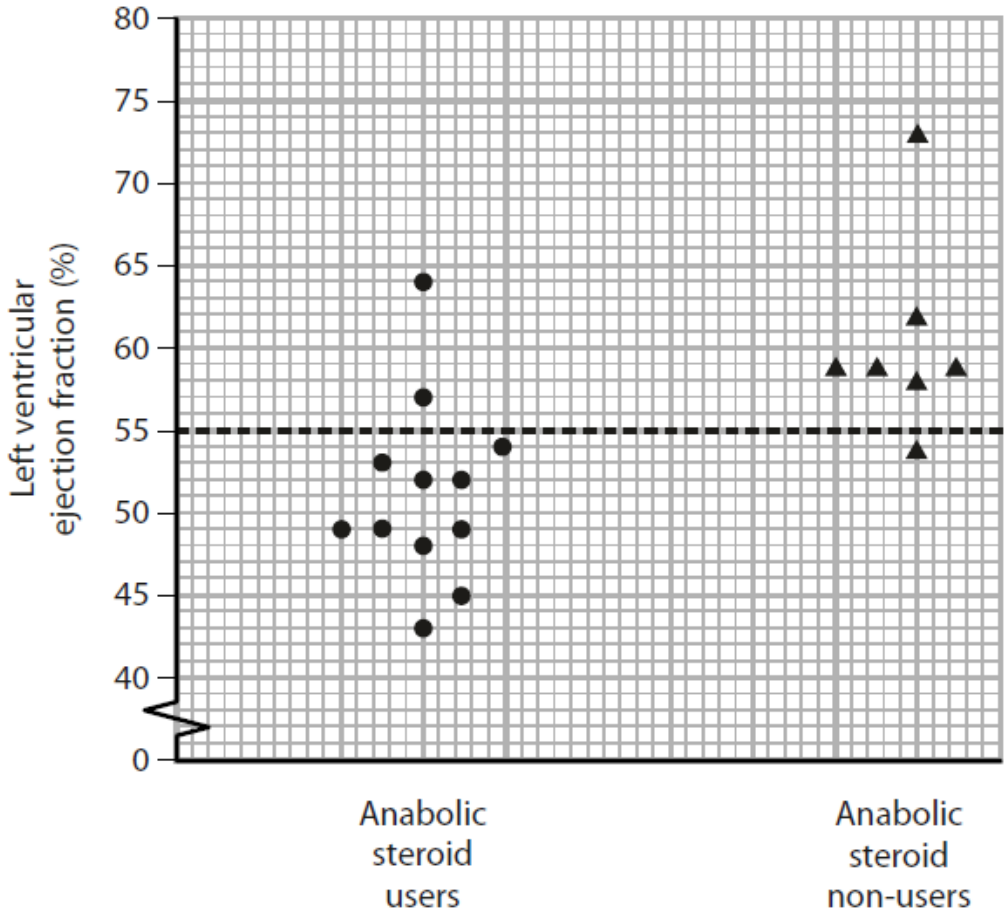
Some athletes use anabolic steroids in an attempt to improve their performance.

The effect of long-term anabolic steroid use on heart function has been investigated.

The left ventricular ejection fraction is the percentage of blood that leaves the left ventricle when it contracts.

The left ventricular ejection fraction for a healthy heart should be greater than 55%.

The results of a small study are shown in the graph.



(i) Analyse the data to determine the effect of anabolic steroid use on heart function.

(2)

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(ii) Some drugs used to treat cancer have also been shown to reduce the ventricular ejection fraction.

Describe how the safe dose of a cancer drug could be determined.

(3)

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(Total for question = 5 marks)

Q6.

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

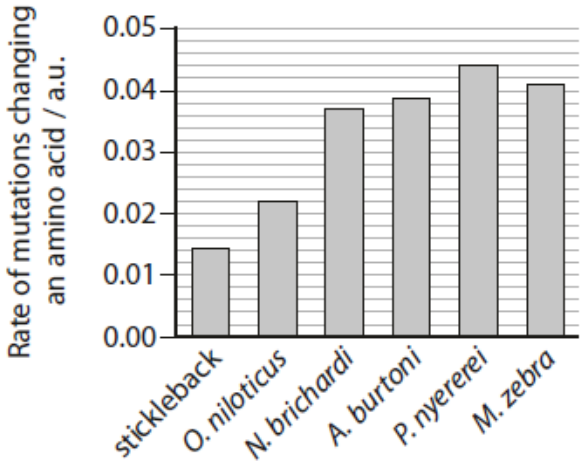
chromosome

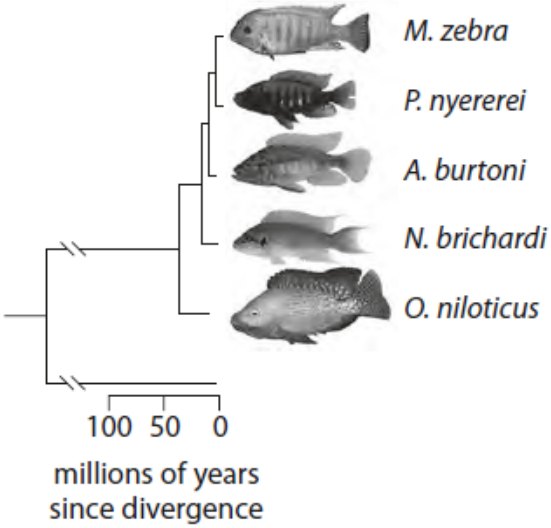
- the frequency of mutations in transcription factor binding sites
- the rate of mutations that result in a change of an amino acid in a protein.

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.

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(Total for question = 9 marks)

Q7.

Tuberculosis (TB) is an infectious disease caused by mycobacteria.

Individuals infected with M. tuberculosis can be treated with antibiotics.

Four of the antibiotics used to treat TB are shown in the table.

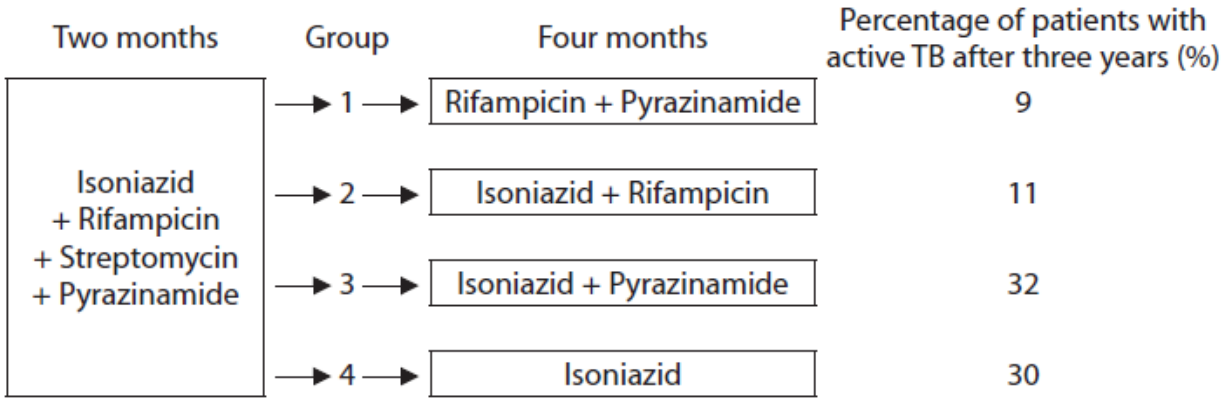
Antibiotic	Mechanism of action
Isoniazid	Inhibits the synthesis of a fatty acid needed to make bacterial cell walls
Rifampicin	Inhibits bacterial RNA polymerase
Streptomycin	Binds to bacterial ribosomes to prevent the binding of tRNA
Pyrazinamide	Not yet known, but not the same mechanisms as the other three antibiotics

In one clinical trial lasting six months, the effect of treating TB with these antibiotics was investigated.

All patients were treated with all four antibiotics for two months. Then they were treated with different pairs of antibiotics or isoniazid alone for a further four months.

All patients were free of any signs of active TB at the end of the clinical trial.

The design of the trial and the percentage of these patients with TB three years after the trial ended are shown in the diagram.



Analyse the data to comment on the effectiveness of these antibiotics for the treatment of TB.

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(Total for question = 6 marks)

Q8.

In a drug trial, people with a heart condition were given one of three drug treatments. The table shows the recorded improvement in their condition for each of the three treatments.

Treatment	Concentration of drug / mg	Recorded improvement / arbitrary units
1	0	18.8
2	400	24.8
3	600	30.9

It was concluded that the drug treatment improved the condition of the patients.

Analyse the data to comment on this conclusion.

(3)

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(Total for question = 3 marks)

Q9.

Extracts of the plant St John's wort have also been used to treat depression.

A double blind trial compared the effectiveness of treating depression using a SSRI, an extract of St John's wort, and a placebo.

Depression was measured using the Hamilton Rating Scale for Depression (HRSD).
The higher the HRSD score the greater the depression.

The table shows the results of this trial.

Time / weeks	HRSD score		
	SSRI	St John's wort	Placebo
0	16	16	17
1	14	15	15
2	13	14	12
3	12	13	12
4	10	13	12
5	9	12	11
6	8	12	11
7	7	11	12
8	6	12	12

(i) State what is meant by the term **double blind**.

(1)

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(ii) Analyse the data in the table to compare the effectiveness of these three treatments for depression.

(3)

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(iii) Double blind trials give scientists confidence in the results collected.

Explain **two** ways the design of this trial could be improved in order to increase confidence in the results.

(4)

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(Total for question = 8 marks)

Q10.

The photograph shows a plant called lantana (*Lantana camara*).



(Source: © Peter Vrabel/Alamy Stock Photo)

The leaves of lantana contain chemicals known to have antimicrobial properties.

The antimicrobial activity of lantana leaf extracts prepared using three different solvents, A, B and C, was compared.

Fresh lantana leaves were dried and powdered. The dried leaf material was mixed with the solvent and then the extract was purified and dried.

The mass of extract obtained from 5 g of powdered leaf, using each solvent, was measured.

Solvent used	Mean mass of extract ± SD / μg
A	501.3 ± 3.5
B	721.3 ± 1.5
C	245.6 ± 4.0

The mass of dried and powdered lantana leaves is 10.5% of the mass of fresh leaves.

Calculate the mass of fresh leaves needed to produce 1 mg of extract using solvent A.

Give your answer to three significant figures.

(2)

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(Total for question = 2 marks)

Q11.

The photograph shows a plant called lantana (*Lantana camara*).



(Source: © Peter Vrabel/Alamy Stock Photo)

The leaves of lantana contain chemicals known to have antimicrobial properties.

The antimicrobial activity of lantana leaf extracts prepared using three different solvents, A, B and C, was compared.

Fresh lantana leaves were dried and powdered. The dried leaf material was mixed with the solvent and then the extract was purified and dried.

The mass of extract obtained from 5 g of powdered leaf, using each solvent, was measured.

Solvent used	Mean mass of extract ± SD / μg
A	501.3 ± 3.5
B	721.3 ± 1.5
C	245.6 ± 4.0

The antimicrobial properties of the extracts produced using these solvents are shown in the table.

Solvent used to prepare extract	Dry mass of extract / μg	Bacteria tested	
		Klebsiella pneumoniae (Gram negative)	*Micrococcus luteus* (Gram positive)
		Mean diameter of the zone of inhibition / mm	
A	5.0	8.3	7.1
	10.0	10.5	7.0
B	5.0	14.5	12.2
	10.0	18.1	18.0

(i) Deduce the effect of using different solvents on the effectiveness of the extracts against these two bacteria.

(2)

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(ii) Devise a method that could be used to collect the data in the table.

(4)

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(Total for question = 6 marks)

Q12.

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.

(9)

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(Total for question = 9 marks)

Q13.

All known organisms can be placed into one of the three domains of life.

The table shows some information about the three different domains.

Feature	Archaea	Bacteria	Eukaryota
DNA is circular	Yes	Yes	No
DNA is single-stranded	No	.....	No
Growth inhibited by the antibiotic streptomycin	No	Yes	No
Name of the link between fatty acids and glycerol in lipids	Ether	Ester	Ester
Presence of cell wall	Some	Yes	.....
Methionine required for starting protein synthesis	Yes	No	Yes
Transcription factors required for transcription	Yes	No	Yes

Complete the table to show the features in Bacteria and in Eukaryota.

(2)

(Total for question = 2 marks)

Q14.

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 • tusks straighter and downward facing • overall a much smaller size
Savannah elephant	African savannah	feeds on grass and leaves of low-growing shrubs	• lower jaw shorter and wider • tusks more curved and upward facing • 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.

One of the genes showing variation was the GBA gene. The table shows the frequency of the alleles of the GBA gene in the two populations.

GBA allele	Frequency of allele in the elephant population	
	Savannah elephant	Forest elephant
J	0.05	0.43
K	0.00	0.57
L	0.95	0.00

(i) State what is meant by the term **allele**.

(1)

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(ii) Use the Hardy-Weinberg equation to show that more than 50% of the forest elephant population are homozygous for the GBA gene.

(3)

Answer .....

(Total for question = 4 marks)

Q15.

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.

(i) State what is meant by the term **endemic**.

(1)

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(ii) Describe what is meant by **biodiversity**.

(2)

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(iii) Explain how the biodiversity of lemurs in two different parts of Madagascar could be compared.

(3)

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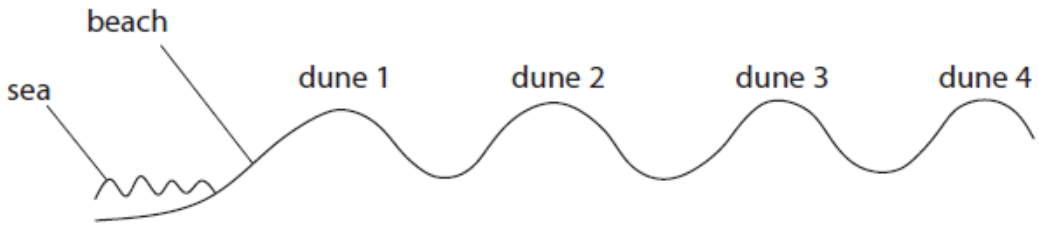
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Q16.

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

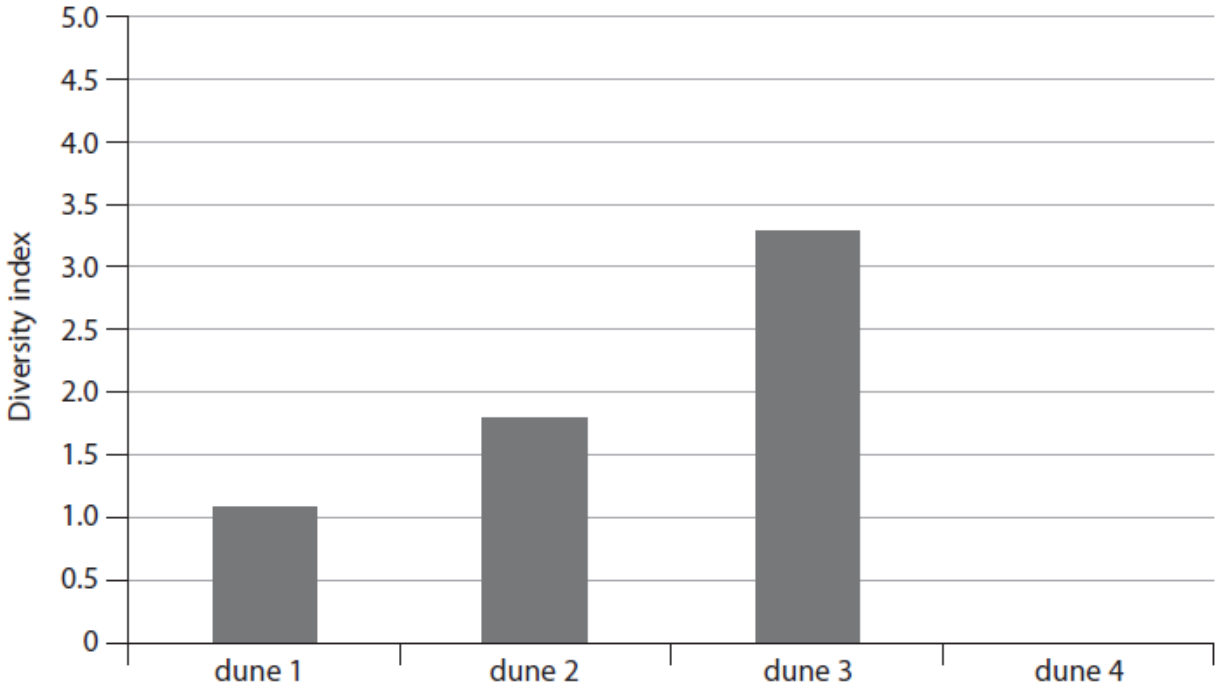
(i) The diversity index was calculated for dunes 1, 2 and 3 using this equation.

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

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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Q17.

A biodiversity hotspot is a region that is both highly diverse and threatened with destruction.

Biodiversity hotspots have at least 1500 endemic plant species.

These hotspots have lost at least 70% of their natural vegetation.

Explain how protection of these hotspots can affect global biodiversity.

(2)

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(Total for question = 2 marks)

Q18.

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.

(4)

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(Total for question = 10 marks)

Q19.

*Biological farming aims to reduce the use of fertilisers to add minerals to the soil.

The following is some information on biological farming.

- Biological farming makes use of products containing fungi that can be added to soil to improve soil life.
- Soil life is essential for converting nutrients into a plant-available form.
- Fungi form a network around the roots of plants to trap water and aid absorption of mineral ions.
- Some fungi provide protection from pathogens.

Devise a procedure, using wheat seedlings, to compare the effects of a biological farming product with the use of a chemical fertiliser on the growth of plants.

(Total for question = 6 marks)

Q20.

A biodiversity hotspot is a region that is both highly diverse and threatened with destruction.

Biodiversity can be measured by the number of

(1)

☒ **A** different genes in a population.

☒ **B** different species in a habitat.

☒ **C** homozygotes in a habitat.

☒ **D** individuals in a population.

(Total for question = 1 mark)

Q21.

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 (χ^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.

(2)

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(Total for question = 7 marks)

Q22.

The photograph shows an orangutan. These animals inhabit the forests of Borneo and Sumatra.



They are critically endangered, largely due to habitat loss and hunting.

Managed breeding programmes in zoos are an important factor in the conservation of the orangutan.

Explain how breeding programmes in zoos maintain the genetic diversity of captive populations.

(3)

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(Total for question = 3 marks)

Q23.

All mammals have an internal skeleton that includes bone and cartilage. Bones contain calcium ions.

In humans, calcium ions are important for structure as part of bone material. These ions are also involved in physiological processes in soft tissue. Soft tissue is non-bony material.

The table shows some data relating to humans.

mean mass of an adult	80 kg
mean percentage of body mass that is bone	4%
mean mass of calcium ions per adult	1000 g
mean percentage of calcium ions present in soft tissue	1%

(i) Calculate the calcium ion concentration in the soft tissue of a human.

(3)

..... $\mu g\ g^{-1}$

*(ii) Calcium ions are also found in the tissue of plants.

The calcium ion concentration in one species of plant has been measured.

It was found to be 170 $\mu g\ g^{-1}$ of plant tissue.

A student made the conclusion that:

Calcium ions are more important in the tissue of plants than in animals.

Evaluate this conclusion.

(6)

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(Total for question = 9 marks)

Q24.

Cystic fibrosis is a genetically inherited condition.

A couple who are both carriers for the condition have a 25% chance of having a baby with cystic fibrosis. In the UK, 1 in 2500 babies born have cystic fibrosis.

Use the Hardy-Weinberg equation to calculate the probability of babies born in the UK being carriers for cystic fibrosis.

(3)

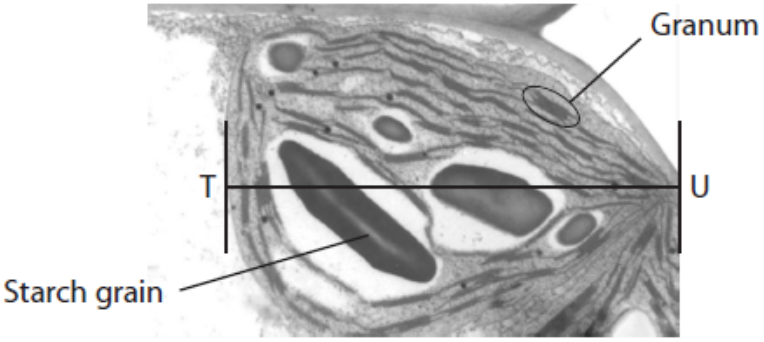
Answer .....

(Total for question = 3 marks)

Q25.

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.

(3)

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(Total for question = 5 marks)

Q26.

(i) A study compared the diversity of species at different places on a shore.
On the upper shore the following data were obtained.

Species	Number of individuals found
Pelvetia canaliculata	10
Enteromorpha sp.	3
Patella vulgata	3
Littorina littorea	15
Gibbula sp.	14
Lichens	15

Calculate an index of diversity (D) for this site using the formula below.

(3)

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

n = total number of organisms of a particular species

N = total number of organisms of all species

Answer .....

(ii) On the middle shore the index was found to be 7.74 with a total individual count of 37.

Comment on the relationship between diversity and the total number of individuals on these two parts of the shore.

(2)

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(Total for question = 5 marks)

Q27.

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 ☒.

Farmers grow wheat plants to produce grain that is used to make flour. Farmers can use modern technology to monitor the mass and the moisture content of the grain in a field. Wheat can be sold at a higher price when it has a lower moisture content.

The table shows some data recorded from a field of wheat.

Plot number	Moisture content of grains (%)	Mass of wheat grains / tonnes per Ha
1	0.57	0.759
2	0.58	0.523
3	0.67	4.243
4	0.94	1.954
5	1.64	1.417
6	1.93	1.170
7	2.27	1.321
8	2.53	6.289
9	4.96	3.809
10	10.36	3.404
mean		2.489

(i) Which of the following describes the relationship between the mass of wheat grain and the moisture content of the wheat grain?

(1)

☒ **A** inverse correlation

☒ **B** negative correlation

☒ **C** no correlation

☒ **D** positive correlation

(ii) Calculate the standard deviation for the mass of wheat using the formula

$$s = \sqrt{\frac{\Sigma(x - \bar{x})^2}{n - 1}}$$

(3)

Answer .....

(Total for question = 4 marks)

Q28.

All known organisms can be placed into one of the three domains of life.

The table shows some information about the three different domains.

Feature	Archaea	Bacteria	Eukaryota
DNA is circular	Yes	Yes	No
DNA is single-stranded	No	.....	No
Growth inhibited by the antibiotic streptomycin	No	Yes	No
Name of the link between fatty acids and glycerol in lipids	Ether	Ester	Ester
Presence of cell wall	Some	Yes	.....
Methionine required for starting protein synthesis	Yes	No	Yes
Transcription factors required for transcription	Yes	No	Yes

Explain how the information in the table can be used to show that the Archaea are more closely related to the Eukaryota than to the Bacteria.

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(Total for question = 3 marks)

Q29.

Ebola virus disease (EVD) is a rare and deadly disease most commonly found in Africa. Following a severe outbreak in 2014, in which 11 000 people died, work has been underway to develop a vaccine.

The vaccine is still undergoing clinical trials, but was given approval for use in recent Ebola outbreaks.

(i) Describe how clinical trials of a vaccine would be conducted.

(3)

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(ii) The Ebola vaccine was given to health workers and immediate family of those with the disease.

Justify the use of this vaccine, even though the clinical trials had not been completed.

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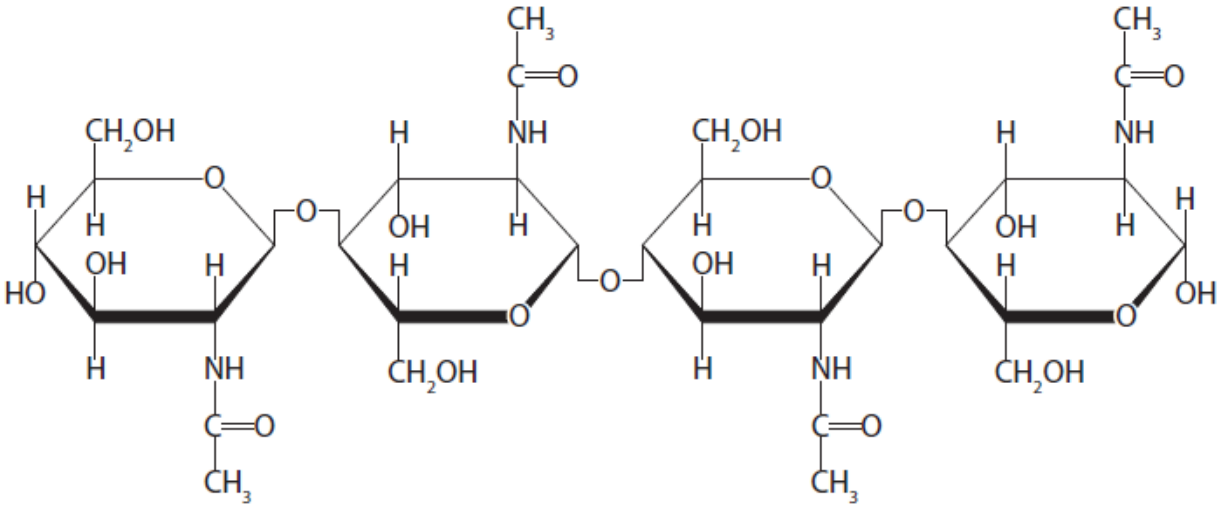
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(Total for question = 7 marks)

Q30.

The diagram shows part of a molecule of chitin, a modified polysaccharide found in fungal cell walls.



Compare and contrast the structure of chitin with that of a cellulose molecule.

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(Total for question = 3 marks)