CAMBRIDGE INTERNATIONAL AS & A LEVEL BIOLOGY · 9700

BIOLOGY



EXAM QUESTION PACK

18 CLASSIFICATION, BIODIVERSITY AND CONSERVATION

SCORE	PERCENTAGE
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Chapter 16

Biodiversity, classification and conservation

16.1 Biodiversity

1617. 9700_s15_qp_11 Q: 39

In an ecosystem, at which stage is most energy lost?

A sunlight → trophic level 1

B trophic level 1 → trophic level 2

C trophic level 2 → trophic level 3

D trophic level 3 → trophic level 4

1618. 9700_s15_qp_11 Q: 40

Two species of animal are found in the same area of forest and grassland. In the spring and summer they eat the same plant food. However, in the autumn and winter one eats nuts in the forest and the other eats roots on the grassland.

Both species are preyed upon by the same predator. Numbers of root-eating animals are reduced most by this, but they recover faster since they reproduce faster.

What can be concluded about these two species of animals?

1 They are part of the same community.

2 They are at different trophic levels.

3 They occupy different habitats.

4 They have different niches.

A 1, 2 and 4 **B** 2, 3 and 4 **C** 1 and 2 only **D** 1 and 4 only

---

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1619. 9700_w15_qp_11 Q: 38

A tree carries out photosynthesis and provides organic compounds for other organisms in a forest.

It takes carbon dioxide from the atmosphere and returns oxygen to the atmosphere.

It takes water from the soil into its roots and its leaves lose water to the atmosphere.

Many other organisms live in the tree.

Which term describes the tree?

A population

B community

C ecosystem

D trophic level

16.2 Conservation

1620. 9700_s15_qp_11 Q: 38

Which soil would have the smallest number of denitrifying bacteria?

A compressed agricultural soil

B poorly drained forest soil

C water-logged clay soil

D well-aerated garden soil

Chapter 14

Biodiversity, classification and conservation

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14.1 Biodiversity

244. 9700_s15_qp_22 Q: 6

(a) Sentences **(i)** and **(ii)** are extracted from longer definitions of ecological terms. Each has one or more missing words.

Complete **(i)** and **(ii)** using the correct terms chosen from the list below.

a population	**a community**	**an ecosystem**
a niche	**a habitat**	**trophic level**
producers	**organisms**	**consumers**

(i) ..... is the particular location and type of local environment occupied by ..... or organism, characterised by its physical features or by its dominant ..... . [3]

(ii) ..... is the functional role or place of a species of organism within ..... . [2]

(b) Only a small proportion of the light energy striking the leaves of producers becomes converted to chemical energy. The proportion that is converted is known as the photosynthetic efficiency (PE).

(i) Outline the possible reasons why a large proportion of light energy striking the leaves of plants is **not** converted into chemical energy.

.....

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.....

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.....

.....

.....

.....

.....[3]

(ii) Most crops have a PE of 1% to 4%. Sugar cane, an important crop plant for food production and for the production of biofuel, has a PE of 7% to 8%.

Suggest the advantages of growing crops with high PE for food production or for biofuel.

.....

.....

.....[2]

(iii) Fertilisers containing nitrate are added to improve or maintain yield of crops such as sugar cane.

Name two organic compounds containing nitrogen that are made by plants and state one function of each in plant growth.

organic compound 1 .....

function .....

.....

organic compound 2 .....

function .....

.....

.....[2]

[Total: 12]

14.2 Conservation

245. 9700_s15_qp_23 Q: 6

In the oceans, parts of the nitrogen cycle involve different bacteria from those that are involved on the land.

A bacterium found in oceans is *Nitrococcus mobilis*, which carries out the following step in the nitrogen cycle:

$$NO_2^- \longrightarrow NO_3^-$$

nitrite nitrate

(a) (i) Name the stage in the nitrogen cycle in which this step occurs.

.....[1]

(ii) Describe how nitrogen in nitrate can be returned to the atmosphere in the form of nitrogen gas.

.....

.....

.....

.....

.....[2]

(b) Phytoplankton are microscopic photosynthetic organisms that are the main producers in ocean ecosystems. Their habitat is the upper layers of the oceans where sunlight can penetrate through the water.

Define the terms:

(i) ecosystem

.....

.....

.....[2]

(ii) producer

.....

.....

.....[1]

(iii) habitat.

.....

.....

.....[1]

[Total: 7]

Q1.

2 Food webs in hot deserts are much simpler than those of other areas, such as temperate woodlands or coral reefs. The physical conditions in deserts are so extreme that few organisms can survive. However, there are plants and animals that have special adaptations to withstand big changes in temperature and lack of rainfall. Desert plants provide shade and food for herbivorous animals, such as insects, lizards and rodents. Snakes, scorpions and spiders feed on the herbivores. Animals such as the fennec fox and hawks feed as top carnivores.

Use

(a) State the term that best describes each of the following.

(i) Organisms, such as desert plants, that form the first trophic level in a food web.

term .....[1]

(ii) All the fennec foxes living in one area at the same time.

term .....[1]

(iii) All the different species that inhabit a desert at the same time.

term .....[1]

(iv) A natural unit, such as a desert, consisting of all the living organisms and the physical environment interacting together to give a stable system.

term .....[1]

(v) Herbivorous animals, such as lizards and rodents, which are prey for carnivores.

term .....[1]

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(b) Using information from the passage, explain the term *habitat*.

.....

.....

.....

.....[2]

(c) Explain how the **leaves** of desert plants may be adapted for survival in areas with little rainfall.

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.....[3]

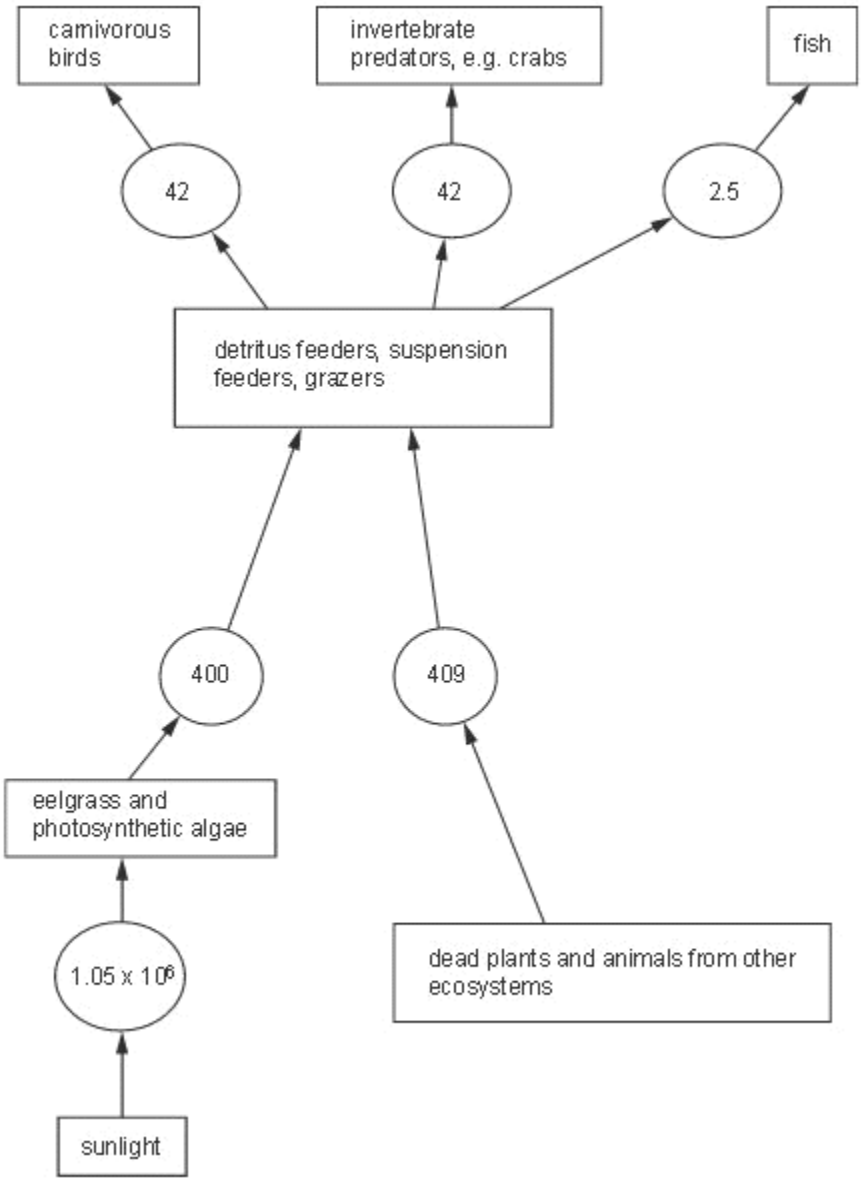
[Total: 10]

Q.2.

5 The eelgrass, *Zostera*, is a marine plant that forms dense vegetation in shallow coastal waters. The primary consumers in this ecosystem eat the eelgrass and the photosynthetic algae that grow on its surface.

Fig. 5.1 shows the flow of energy through an eelgrass ecosystem. The figures in circles represent the energy transfer in $kJ\ m^{-2}\ yr^{-1}$.

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carnivorous birds
invertebrate predators, e.g. crabs
fish
42
42
2.5
detritus feeders, suspension feeders, grazers
400
409
eelgrass and photosynthetic algae
1.05 x 10^6
dead plants and animals from other ecosystems
sunlight

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Examiner's Use

(a) Calculate the percentage of energy transferred from primary consumers to the secondary consumers in the ecosystem shown in Fig. 5.1. Show your working and express your answer to the nearest whole number.

Answer ..... [2]

(b) Explain why little of the energy present in producers is transferred to the secondary consumers.

.....

.....

.....

.....

.....

.....

.....

..... [4]

(c) Dead plants contain nitrogen in the form of proteins. These are decomposed by bacteria.

Outline how bacteria convert nitrogen in these proteins to a form that may be taken up by living plants.

.....

.....

.....

..... [2]

[Total: 8]

Q.3.

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5 Some bacteria that are found in soils contain the enzyme urease.

Urease catalyses the hydrolysis of urea to form ammonia and carbon dioxide:

$$\text{urea} + \text{water} \longrightarrow \text{carbon dioxide} + \text{ammonia}$$

Some fertilisers added to soils to help crop growth contain urea. Although some crop plants can absorb ammonium ions, most obtain their source of nitrogen as nitrate ions.

(a) Describe how urea from fertilisers becomes available to plants as nitrate ions.

.....

.....

.....

.....

.....

.....[3]

Q4.

6 Fig. 6.1 shows some feeding relationships in an Arctic ecosystem.

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(a) Using the information shown in Fig. 6.1,

(i) name **two** organisms that are feeding as secondary consumers;

.....

..... [1]

(ii) explain why it is difficult to assign some organisms to trophic levels.

.....

.....

..... [2]

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(b) The efficiency of energy transfer through a trophic level is calculated by comparing the energy available to that trophic level with the energy available to the next trophic level.

It has been estimated that the efficiency of energy transfer by herbivorous copepods is about 17%.

State two factors that are likely to influence the efficiency of energy transfer by herbivorous copepods.

1 .....

.....

2 .....

..... [2]

[Total: 5]

Q5.

2 (a) The table below gives some terms that are used in ecology and their definitions.

Complete the table.

term	definition
ecosystem	all the organisms and the physical factors that influence them in an area, such as a forest
	a place where an organism lives
community	
	role of organism in an ecosystem
	all the organisms of the same species in an ecosystem at the same time

[4]

Fig. 2.1 shows a three-toed sloth, *Bradypus variegatus*, that lives in forest ecosystems in Central America. The sloths living in these forests form part of the community. Sloths feed mainly on the leaves of many different tree species that grow in the under canopy in the forest. These leaves are rich in cellulose, which is digested by bacteria and other microorganisms in the stomachs of sloths. The main predators of sloths are jaguars, harpy eagles, snakes and humans.

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Fig. 2.1

(b) With reference to the information above,

(i) state the trophic level occupied by the sloth in the food chain;

.....[1]

(ii) suggest **one** advantage to the sloth of having bacteria and other microorganisms in its stomach;

.....

.....[1]

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(iii) suggest why there are few predators, such as jaguars and harpy eagles, in the forest ecosystem even though there are many producers, such as trees.

.....

.....

.....

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.....[3]

[Total: 9]

Q6.

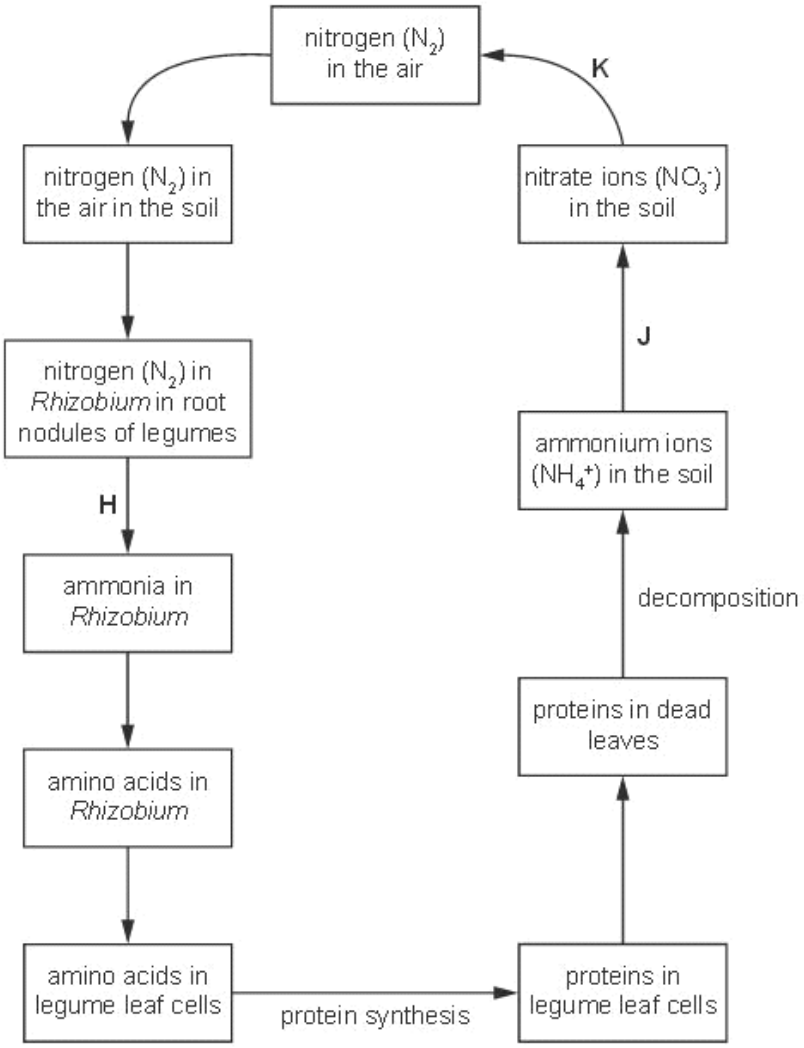
6 Many species of legume grow in nitrate-deficient soils in the tropics. Some of these are large trees such as the flamboyant tree, *Delonix regia*.

Bacteria of the genus *Rhizobium* live inside swellings along the roots of legumes. These swellings are known as root nodules.

A student followed the cycling of nitrogen in an area with many flamboyant trees.

Fig. 6.1 summarises the flow of nitrogen in the area.

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(a) Name the processes that occur at **H**, **J** and **K**.

H .....

J .....

K .....[3]

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(b) Suggest the advantages gained by legumes of having *Rhizobium* living in their roots.

.....

.....

.....

.....

.....[2]

[Total: 5]

Q7.

6 When investigating ecosystems, food chains and food webs are constructed.

Read the passage below about trophic relationships on one of the Galapagos Islands.

> *Marine iguanas feed on kelp, which grows attached to rocks in shallow waters. Kelp is a photosynthetic organism. Further inland, xerophytes are grazed upon by land iguanas. A great diversity of herbivorous insects, including many species of short-horned grasshoppers, feed on the xerophytes. An analysis of the gut contents of lava lizards reveals that these insects are prey for the lizards. The lizards are preyed upon by Galapagos snakes. The snakes also hunt grasshoppers and newly hatched iguanas. The Galapagos hawk has a varied diet and catches animals such as Galapagos snakes, short-horned grasshoppers, small lava lizards and newly hatched iguanas.*

(a) Complete Fig. 6.1 to make a food web by:

- filling in the blank boxes with the names of the organisms
- adding arrows to show the direction of energy flow between all the different links in the food web. [4]

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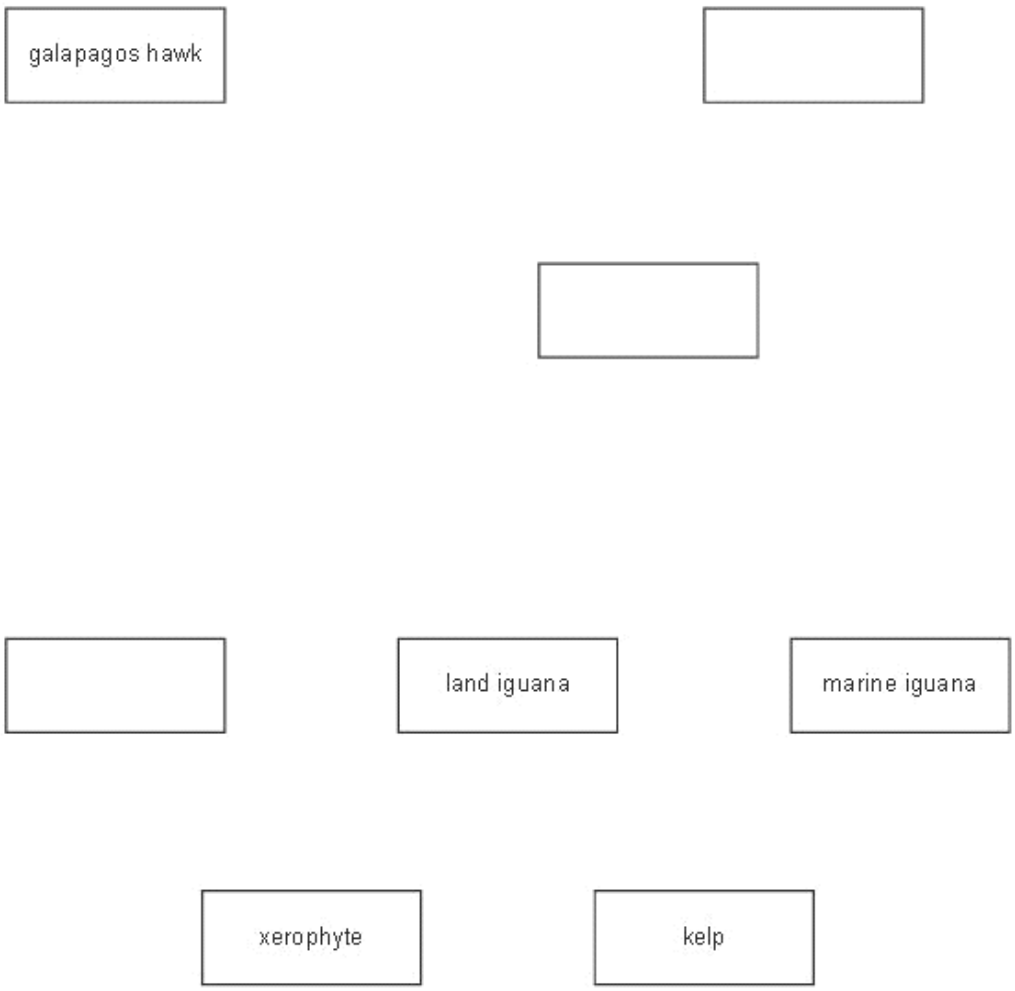


Fig. 6.1

(b) State which of the organisms in Fig. 6.1 are the producers. Explain your choice.

.....

.....

.....

.....

.....[3]

[Total: 7]

Q8.

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5 **(a)** Some bacteria, such as *Rhizobium*, carry out nitrogen fixation, which is an important process in the nitrogen cycle.

Explain what is meant by the term *nitrogen fixation*.

.....

.....

.....

.....[3]

(b) An important enzyme in the nitrogen cycle is urease, which catalyses the hydrolysis of urea to ammonia. This reaction is shown below:

$$(NH_2)_2CO + H_2O \xrightarrow{\text{urease}} 2NH_3 + CO_2$$

(i) State the name of this process in the nitrogen cycle.

.....[1]

(ii) Explain the importance of this process in making nitrogen from animals available for uptake by plants.

.....

.....

.....

.....[2]

Q9.

2 Read the passage below. Parts of the passage are in **bold type**. These are examples of ecological terms and are labelled **A** to **F**.

A class of students carried out an ecological study of **a defined area of seashore (A)** in Brittany, France. One group decided to study a **rockpool (B)** and recorded information such as the **oxygen concentration and temperature of the seawater (C)**. After investigating **all the different living organisms (D)** present in the rockpool, the students decided to study in more detail the **group of limpets, *Patella vulgata* (E)**. They collected information about the **role of the limpets within the rockpool, including interactions with other organisms (F)**. For example, limpets grazed on green seaweeds, while the shore crab, *Carcinus maenas*, fed on small limpets.

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(a) State the correct letter, **A** to **F**, from the passage above that corresponds to each of the ecological terms below.

habitat	
ecosystem	
abiotic component	
ecological niche	
population	
community	

[4]

(b) State the trophic levels to which each of the organisms named in the passage belong **and** outline the energy losses that occur in the food chain.

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.....

.....

.....

.....

.....

.....

.....[4]

[Total: 8]

Q10.

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6 In anaerobic soil, bacteria, such as *Pseudomonas stutzeri*, can use nitrate ions (NO_3^-) as a source of oxygen for their respiration. The word equation below summarises the process:

glucose + nitrate $\longrightarrow$ water + carbon dioxide + nitrogen

(a) (i) State the name of this process in the nitrogen cycle.

..... [1]

(ii) In agriculture, this reaction can be undesirable. Explain why.

.....

.....

.....

..... [2]

High concentrations of nitrate ions in drinking water obtained from rivers and lakes can be toxic, especially to infants. These nitrate ions enter rivers and lakes dissolved in water which drains from the soil.

(b) (i) Name the process, carried out by soil bacteria, which produces nitrate ions.

..... [1]

(ii) Suggest how bacteria, such as *Pseudomonas stutzeri*, can be used in the process of purifying water for drinking.

.....

.....

.....

..... [2]

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(c) In recent years there has been an increase in flooding of agricultural land worldwide.

Explain why crop yields are often significantly reduced even after the flood water has drained away.

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.....

.....

.....

.....

.....

.....

..... [4]

[Total: 10]

For Examiner Use

Q11.

5 The slime mould, *Dictyostelium discoideum*, is a eukaryote and a decomposer of protein-rich material.

Fig. 5.1 shows the life cycle of *D. discoideum*.

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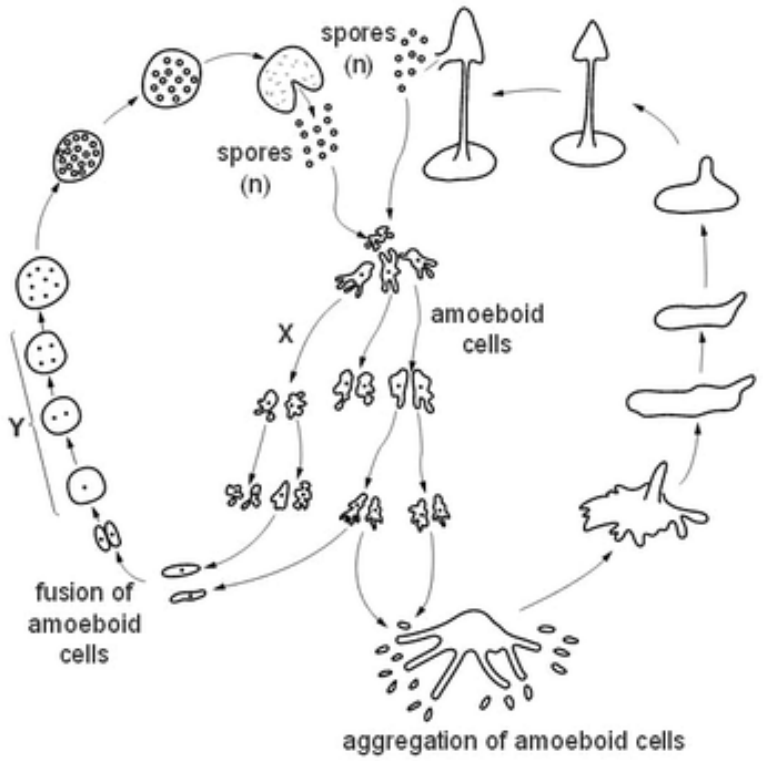


Fig. 5.1

(a) State the type of nuclear division that occurs at **X** and at **Y**.

X .....

Y .....[1]

(b) State what is meant by the term *reduction division* **and** explain why this division is necessary in a life cycle, such as that shown in Fig. 5.1.

.....

.....

.....

.....

.....[2]

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(c) The amoeboid cells of *D. discoideum* feed on protein-rich material and break it down to form ammonium ions (NH_4^+). The cell membranes of *D. discoideum* have transporter proteins that are responsible for the excretion of ammonium ions.

Ex

Describe what happens to the ammonium ions excreted by *D. discoideum* into the soil.

.....

.....

.....

.....

.....

.....[3]

(d) Suggest why a transporter protein is required for the removal of ammonium ions from *D. discoideum*.

.....

.....

.....

.....

.....[2]

[Total: 8]

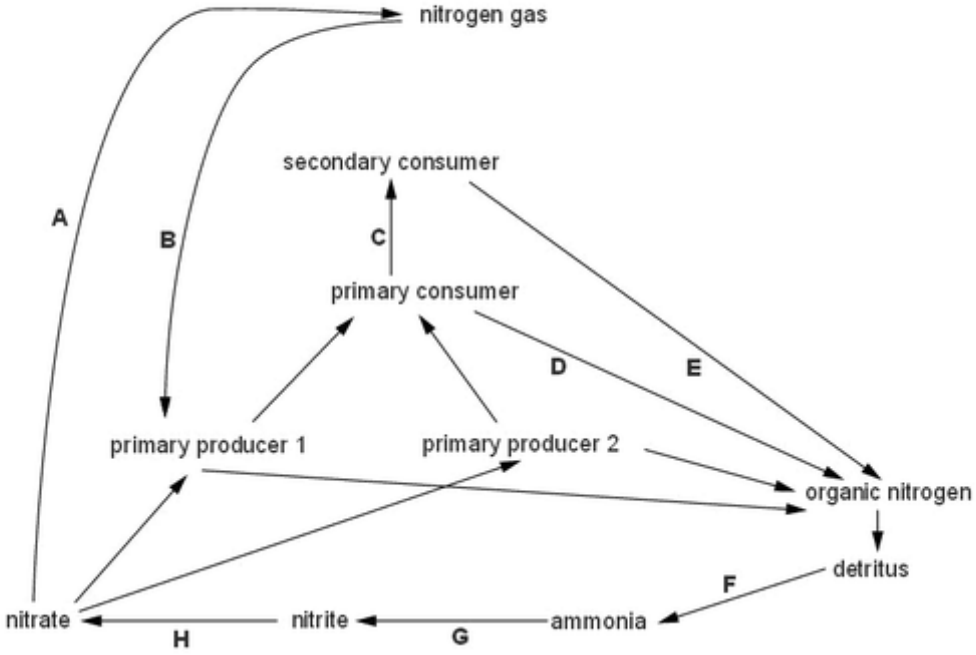
Q12.

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6 Microorganisms play an important role in the cycling of nitrogen in ecosystems.

For Examiner Use

Fig. 6.1 is a diagram of a nitrogen cycle.



(a) Read the information below about four different species of soil bacteria. In the box provided, write the appropriate letter that matches each microorganism to its corresponding stage in the nitrogen cycle in Fig. 6.1.

- *Nitrosomonas europaea* is an ammonia-oxidising bacterium.
- *Bacillus cereus* is a denitrifying bacterium.
- *Azospirillum lipoferum* lives in the roots of some cereals and grasses and supplies fixed nitrogen to plants.
- *Streptomyces coelicolor* is a bacterium that secretes powerful hydrolases to break down compounds such as proteins and cellulose.

[4]

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(b) Some fungi form beneficial associations with plant roots. They enable the plant to increase the uptake of nutrients, such as phosphates, which are not readily available to the plants from the soil.

Suggest how increasing phosphate ion uptake will lead to increased plant growth.

.....

.....

.....

.....

.....

.....

.....[3]

[Total: 7]

Q13.

6 Read the following passage.

> Catfish are a commercially important species of freshwater fish used as a human food source. In the wild, catfish are found in all types of large freshwater habitats, such as rivers, lakes and reservoirs. In North America, they are often maintained in catfish ponds, which are artificially constructed habitats. Each pond functions as a self-sustaining ecosystem with its own community of organisms. Catfish feed on living and dead fish, amphibians, insects and even dead mammals found on the bottom of the pond. Different species of phytoplankton are always present in these ponds. They are small organisms found suspended in the water and they are essential for the growth of all the other pond organisms.

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(a) With reference to the passage:

(i) state the meaning of the terms *habitat* and *community*

habitat

.....

.....

.....

community

.....

.....

.....[4]

(ii) name the producer in the pond ecosystem

.....[1]

(iii) describe the features of producers.

.....

.....

.....

.....

.....[3]

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(b) Studies on the energy efficiency of raising catfish in ponds have shown that only 15–20% of the energy taken in by the catfish population in their food is used to increase their total biomass.

(i) Explain why only some of the energy taken in by the catfish is used to increase biomass.

.....

.....

.....

.....

.....

.....[3]

(ii) In the wild, only about 10% of the energy taken in by the catfish in their food is used to increase biomass.

Suggest why this percentage is lower in the wild than in the pond.

.....

.....

.....[1]

[Total: 12]

Q14.

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3 Fig. 3.1 shows part of the nitrogen cycle.

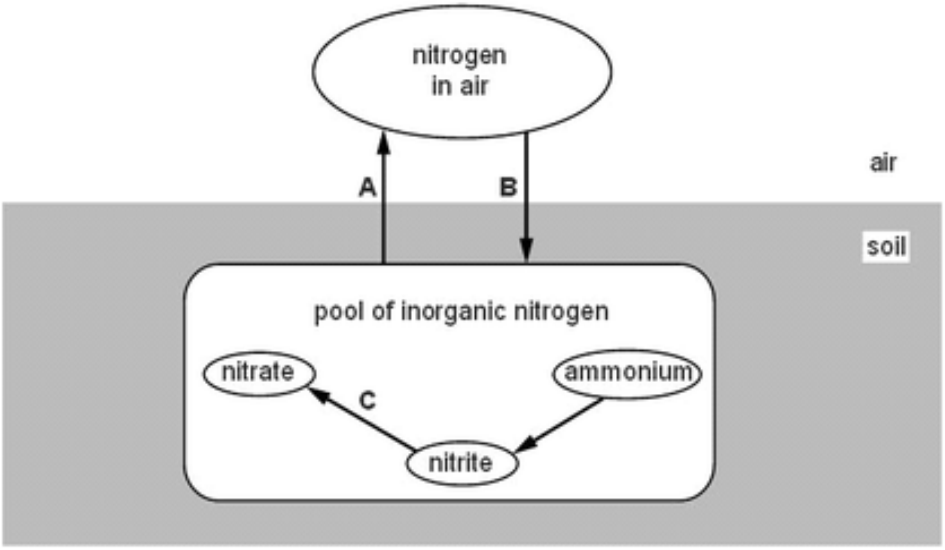


Fig. 3.1

(a) (i) Name processes **A**, **B** and **C**.

A .....

B .....

C .....

[3]

(ii) Dead animal and plant material can also contribute to the pool of inorganic nitrogen in soil.

Describe how this happens.

.....

.....

.....

.....

.....

.....

..... [3]

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(b) Other inorganic substances, such as phosphate, are cycled entirely within the soil.

(i) State **one** use for phosphate and **one** use for nitrate in organisms.

phosphate .....

nitrate .....

[2]

(ii) Nitrogen and phosphate are both cycled more rapidly in ecosystems where there are high rates of growth within trophic levels and high rates of energy flow between trophic levels.

With reference to the use of **both** nitrogen and phosphate in organisms, explain this statement.

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..... [3]

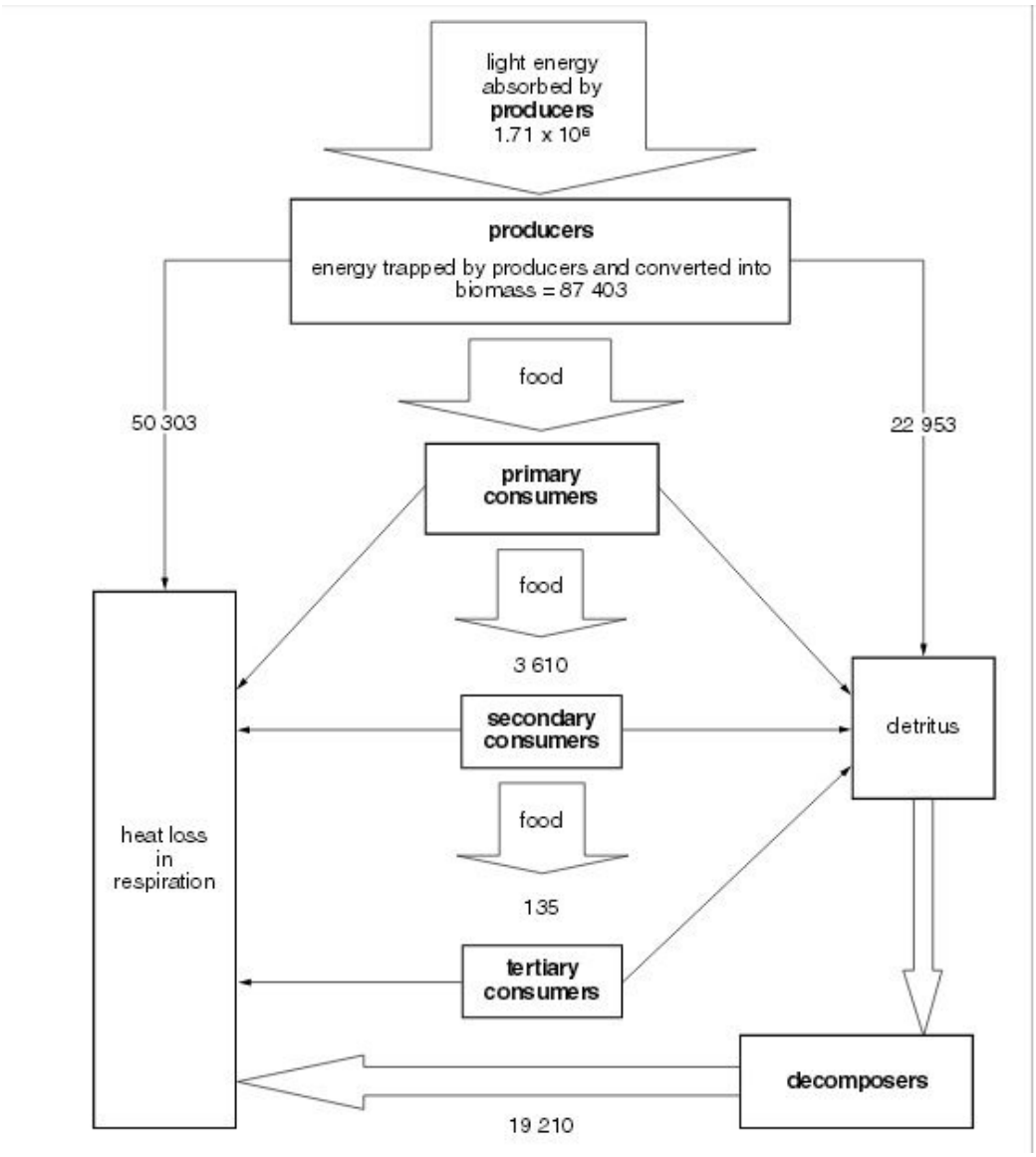
[Total: 11]

Q15.

2 Fig. 2.1 shows the flow of energy through an ecosystem.

All the figures are in kJ m^{-2} $year^{-1}$.

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light energy absorbed by producers 1.71 x 10⁶
producers
energy trapped by producers and converted into biomass = 87 403
food
50 303
22 953
primary consumers
food
3 610
secondary consumers
detritus
heat loss in respiration
food
135
tertiary consumers
decomposers
19 210

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(a) Calculate how much energy is available to the primary consumers in this ecosystem.

.....[1]

(b) The efficiency of energy transfer between trophic levels is calculated by comparing the energy available to a trophic level with the energy available to the next trophic level. Between secondary and tertiary consumers, this is calculated as follows.

$$\frac{\text{energy available to tertiary consumers}}{\text{energy available to secondary consumers}} \times 100\ \%$$

Use the formula above to calculate the efficiency of energy transfer between the secondary consumers and the tertiary consumers in this ecosystem.

.....

.....

.....[1]

(c) In some food webs, individual consumer species feed at different trophic levels.

With reference to Fig. 2.1, explain an advantage of this for these consumer species.

.....

.....

.....[2]

(d) Explain the role of decomposers in the cycling of carbon and nitrogen in ecosystems.

.....

.....

.....

.....

.....

.....[4]

[Total: 8]

Q16.

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3 **(a)** Complete the table below by describing **one** role in living organisms for each of the ions listed.

ion	role in living organisms
calcium	
iron	
potassium	

[3]

(b) Fig. 3.1 shows part of the nitrogen cycle in a field grazed by cows.

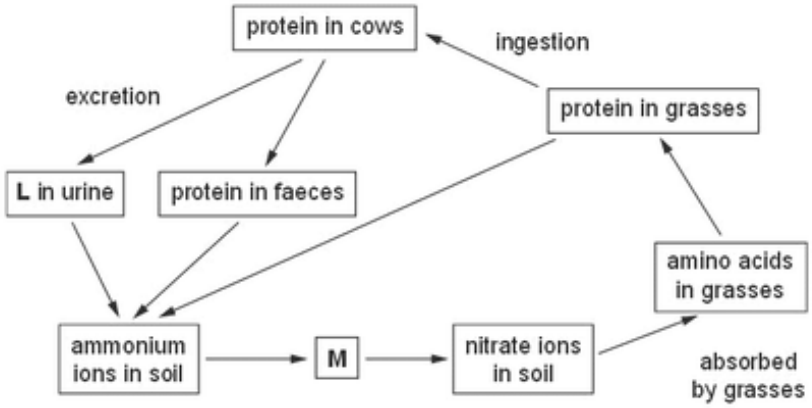


Fig. 3.1

(i) Name substances **L** and **M**.

L .....

M .....[2]

(ii) Name the process by which ammonium ions are converted to nitrate ions in the nitrogen cycle.

.....[1]

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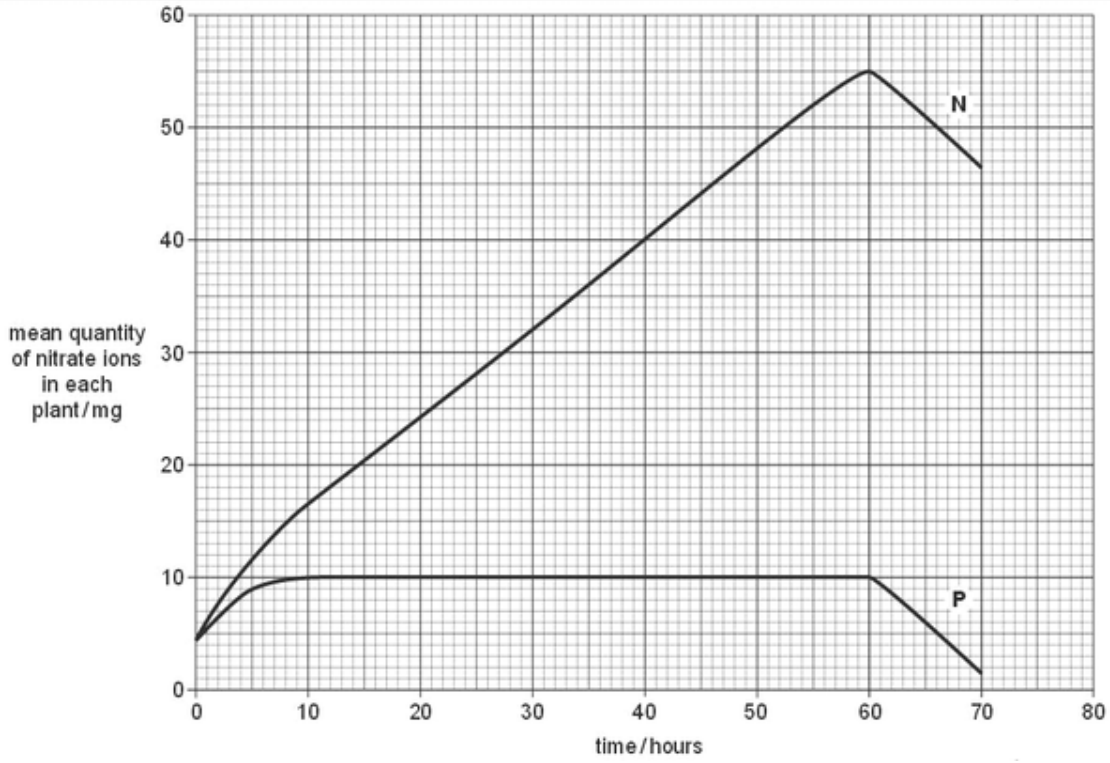
(c) Some young grass plants were grown with their roots in a mineral solution that contained nitrate ions. The plants were divided into two batches, **N** and **P**.

Cyanide, which inhibits aerobic respiration, was added to the solution given to the plants in batch **P**.

The quantity of nitrate ions in the plants was determined at regular intervals for 70 hours.

After 60 hours, the mineral solution was replaced by distilled water.

The results are shown in Fig. 3.2.



Using the data in Fig. 3.2,

(i) calculate the rate of absorption of nitrate ions in batch **N** between 40 and 60 hours. Show your working.

Answer = ... mg per hour [2]

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(ii) explain why the absorption of nitrate ions by the plants in batch **N** differs from that in batch **P**;

.....

.....

.....

.....

.....

.....

.....

.....[4]

(iii) explain why the mean quantity of nitrate ions in **both** batches of plants decreased after 60 hours.

.....

.....

.....

.....[2]

[Total : 14]

Q17.

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1 Fig. 1.1 is a photograph taken at low tide in a mangrove swamp in Mozambique.



Fig. 1.1

The photograph shows a hermit crab surrounded by the pneumatophores ('breathing roots') of mangrove trees. The hermit crabs live inside the shells of dead molluscs. Large birds, such as Goliath herons, feed on the hermit crabs. The vertical pneumatophores are an adaptation to the soil in the swampy, coastal environment that contains very little oxygen. They are exposed to the air at low tide. The soil has a very high salt content as the sea often covers the area. Some bacteria are able to grow deep in the rich organic mud where the oxygen concentration is very low.

(a) Listed below are eight ecological terms that can be applied to the mangrove swamp and the organisms that live there.
Use **only** the information given above to match each organism with the most appropriate term from the list. You may use each letter once, more than once or not at all.

mangrove trees	
all the organisms in the mangrove swamp	
bacteria deep in the mud	
all the hermit crabs in the swamp	

A primary consumer
B population
C community
D niche
E secondary consumer
F ecosystem
G decomposer
H producer [4]

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Use

(b) Explain how the cells in the roots of mangrove trees obtain sufficient oxygen and water in this extreme environment.

oxygen .....

.....

.....

.....

water .....

.....

.....

.....

.....[5]

[Total: 9]

Q18.

C

2 Fig. 2.1 shows a transverse section of a root nodule of a legume. Fig. 2.2 is a drawing of a cell from the centre of the nodule made from an electron micrograph.

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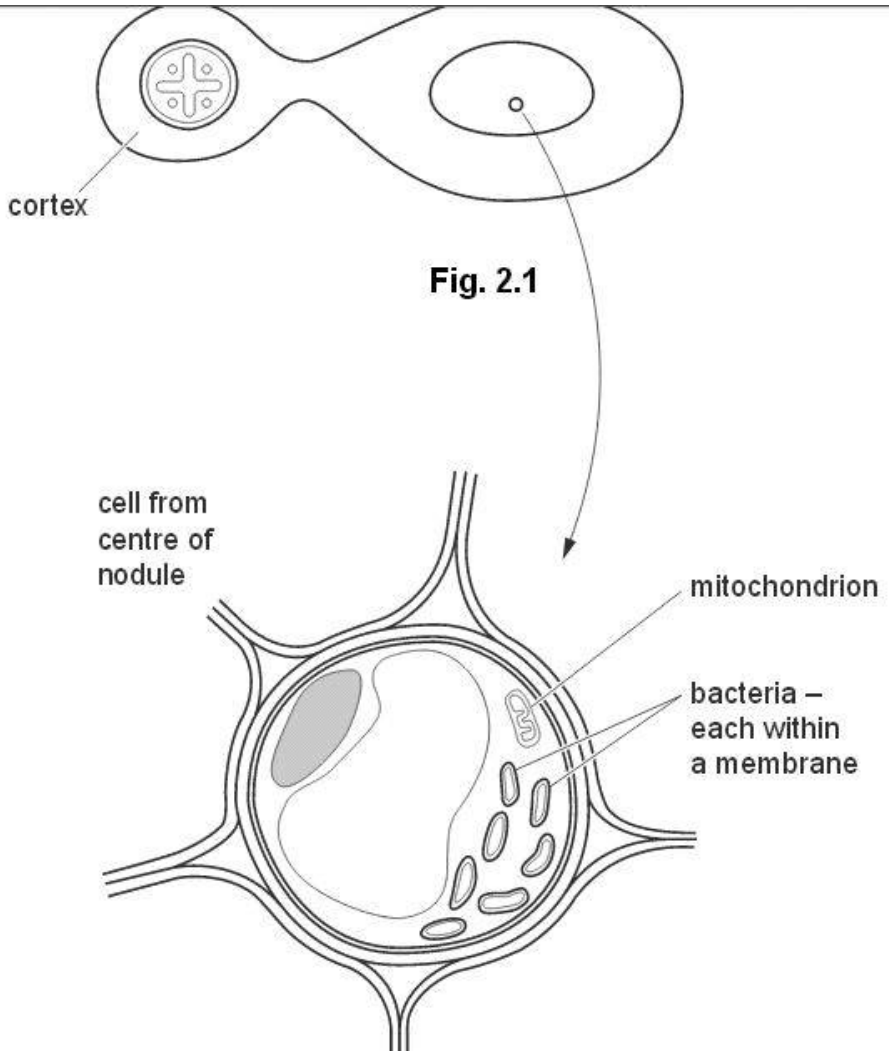


Fig. 2.1

(a) Name three structures that are present in cells in the cortex of the root that are not present in bacterial cells.

1 .....

2 .....

3 .....[3]

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(b) Explain the advantages of studying cell structure with an electron microscope rather than with a light microscope.

.....

.....

.....

.....[2]

(c) Describe the role of *Rhizobium* in the root nodule.

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.....[3]

(d) Cells in the centre of the root nodule have a high concentration of the pigment, leghaemoglobin. This combines with oxygen in much the same way as haemoglobin in mammals. Leghaemoglobin is responsible for maintaining anaerobic conditions around the bacteria in the nodules. Leghaemoglobin is not found in the roots of other plants.

The base sequence in the gene that codes for the β polypeptide of mammalian haemoglobin is similar to that for leghaemoglobin.

Suggest why this is so.

.....

.....

.....

.....[2]

[Total: 10]

Q19.

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6 **(a)** An ecosystem may be as small as a pond or as large as a forest. Some scientists consider that the whole biosphere is an ecosystem.

Give a detailed definition of the term *ecosystem*. You may use **another** example in your answer.

.....

.....

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.....[3]

(b) In 1978, the American ecologist Paul Colinvaux published a book of essays with the title 'Why Big Fierce Animals are Rare'.

Explain why 'big, fierce animals' are rare in ecosystems.

.....

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.....[3]

(c) Many tropical islands have nitrogen-deficient soils. Leguminous trees, such as Royal Poinciana, *Delonix regia*, grow well in such conditions.

Explain why leguminous plants grow well in these conditions.

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.....

.....

.....

.....

.....[3]

[Total: 9]

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Q20.

6 The element nitrogen is present in many biological molecules, such as amino acids, proteins and nucleotides.

Fig. 6.1 shows part of the nitrogen cycle.

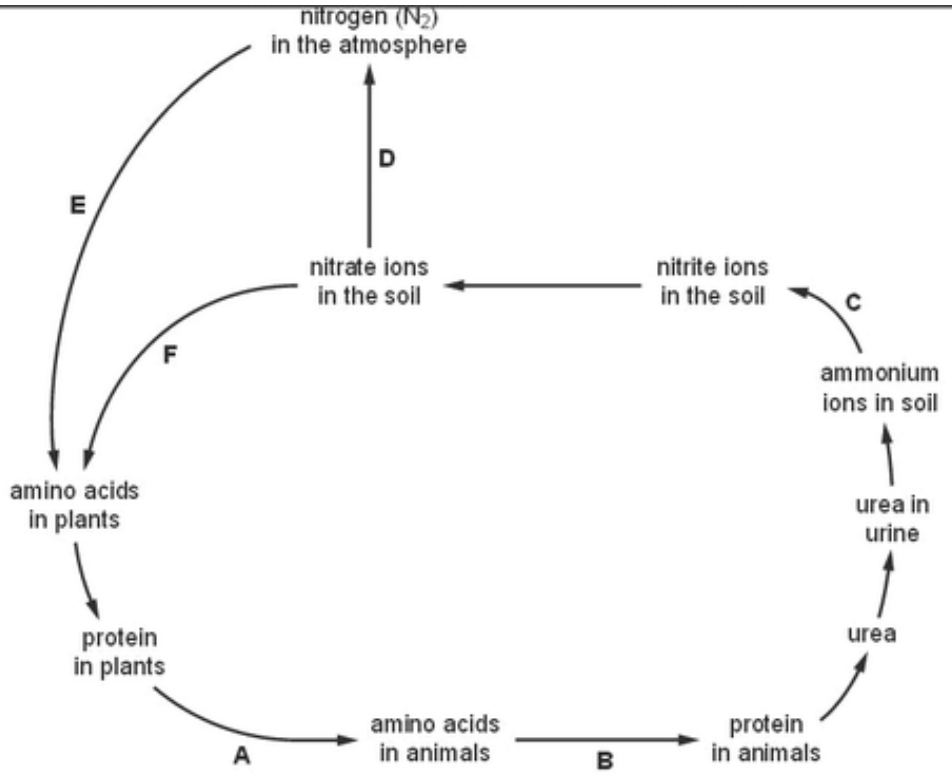


Fig. 6.1

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The statements 1 to 10 are processes that occur during the nitrogen cycle.

For Examiner's Use

For each of the stages **B** to **F** shown on Fig. 6.1, select the appropriate description from the list of statements and write it in the box provided.

Write only **one** number in each box.

The first one (**A**) has been selected and completed for you.

1 digestion by primary consumers

2 amino acid synthesis in plants

3 protein synthesis in primary consumers

4 nitrification

5 decomposition

6 nitrogen fixation

7 excretion

8 deamination in primary consumers

9 denitrification

10 deamination by bacteria and fungi

A	1
B	.....
C	.....
D	.....
E	.....
F	.....

[Total: 5]

Q21.

6 **(a)** **Explain what is meant by the term ecosystem.**

.....

.....

.....

.....[2]

Fig. 6.1 shows the energy flow through a river ecosystem.

All the figures are in kJ m^{-2} per year.

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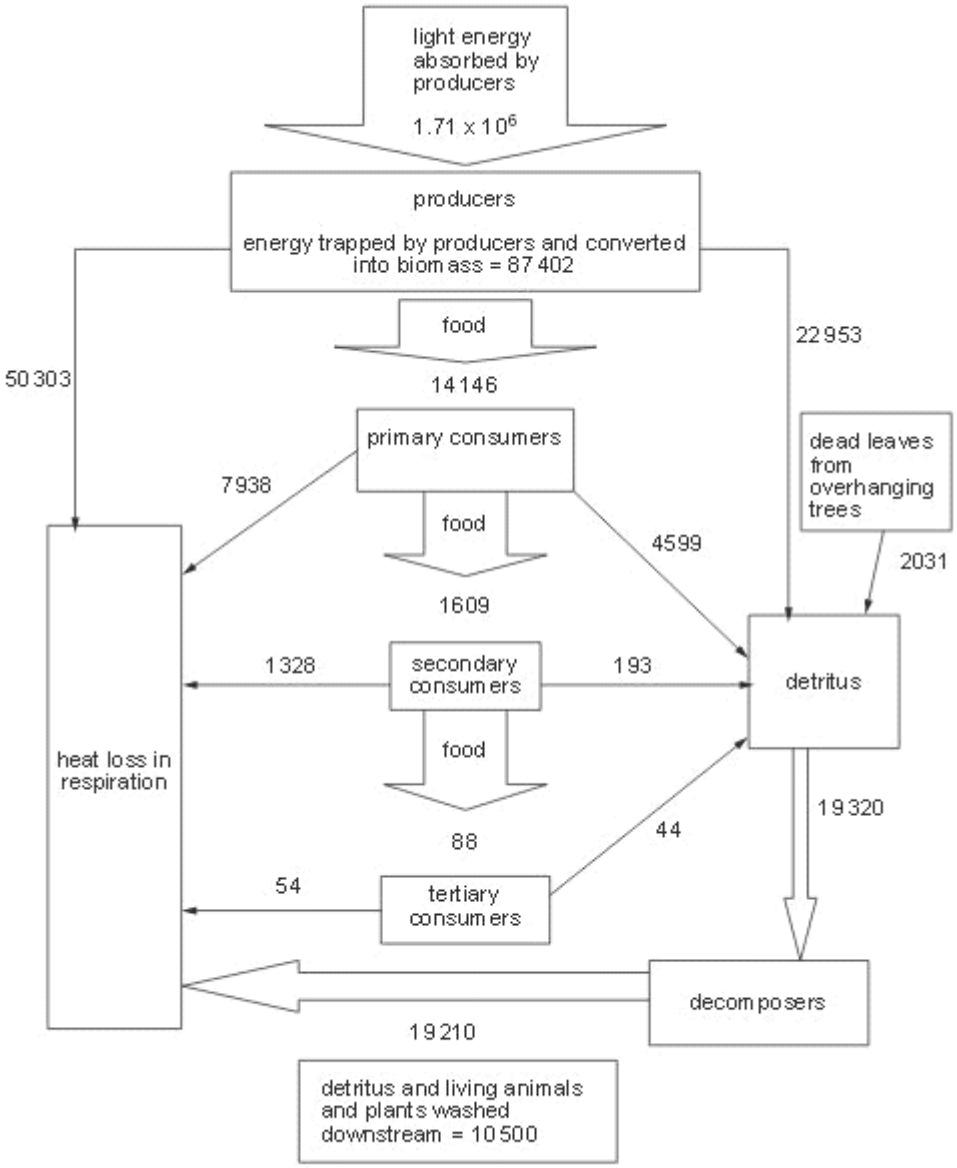


Fig. 6.1

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(b) The efficiency of energy transfer between trophic levels is calculated by comparing the energy available to a trophic level with the energy available to the next trophic level. Between secondary and tertiary consumers, this is calculated as follows:

$$\frac{\text{energy available to tertiary consumers}}{\text{energy available to secondary consumers}} \times 100\%$$

Calculate the efficiency of energy transfer between secondary and tertiary consumers in the river ecosystem.

Express your answer to the nearest 0.1%.

Show your working.

Answer .....% [2]

(c) Explain why the energy efficiency between secondary and tertiary consumers is greater than that between producers and primary consumers.

.....

.....

.....

.....

.....

.....

.....[3]

(d) Describe the roles of decomposers in recycling nitrogen.

.....

.....

.....

.....

.....[2]

[Total: 9]

Q22.

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6 **(a)** Explain what is meant by the term *community*.

.....

.....

.....

.....[2]

For Examiner Use

Fig. 6.1 shows the flow of energy through a woodland. All figures are in kJm^{-2} per week.

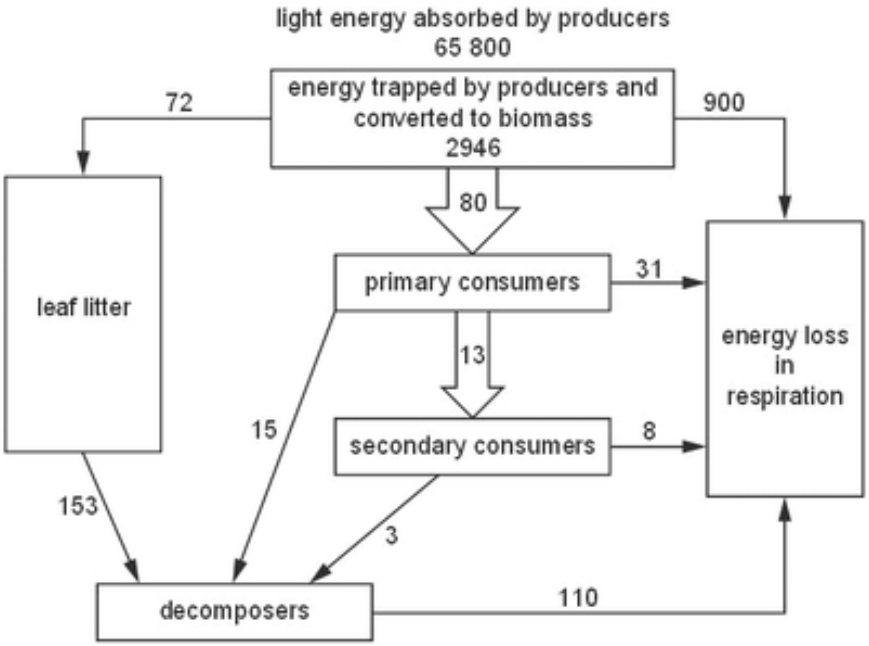


Fig. 6.1

(b) (i) Calculate the energy trapped by the producers and converted to biomass as a percentage of the light energy absorbed.

Express your answer to the nearest 0.1%.

Show your working.

Answer .....% [2]

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(ii) Suggest, in terms of energy flow, why there are no tertiary consumers in the woodland.

.....

.....

.....

.....[2]

(iii) Leaf litter is composed of dead leaves and twigs. The total energy in the leaf litter was 15899 kJm^{-2} but only 153 kJm^{-2} per week is transferred to decomposers. When animal wastes rich in nitrogen were mixed with the leaf litter the energy flow to decomposers increased significantly.

Suggest why the addition of animal wastes rich in nitrogen increased the energy flow to decomposers.

.....

.....

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.....

.....

.....[3]

[Total: 9]

Q23.

1 (a) Complete the passage with the most appropriate term.

Within each ecosystem there is a ..... of organisms that interact with each other and with their environment. Each species fills a particular ..... within the ecosystem. Feeding relationships in food webs are an example of the interactions species have with each other. In old field ecosystems in North America, producers, such as blue grass, provide energy for grazing animals. These animals form the .... in the food chain. [3]

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(b) Very little of the energy consumed by grazing animals is available to carnivores.

State two reasons why this is so.

1. .....

.....

2. .....

.....[2]

[Total: 5]

Q24.

5 State the term that applies to each of the descriptions **(a)** to **(e)**.

(a) Storage polysaccharide in animals made of chains of 1,4 linked α-glucose with 1,6 linkages forming branches.

..... [1]

(b) A plant that has adaptations to enable it to live in areas where water is in short supply.

..... [1]

(c) Any cell containing one complete set of chromosomes.

..... [1]

(d) The name of the trophic level to which photosynthetic organisms belong.

..... [1]

(e) A process carried out by bacteria that involves the conversion of atmospheric nitrogen into nitrogenous compounds that can be used directly by plants.

..... [1]

[Total: 5]

Q.25.

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6 Fig. 6.1 shows the directions of **nutrient flow** in a soil food web.

For Examiner's Use

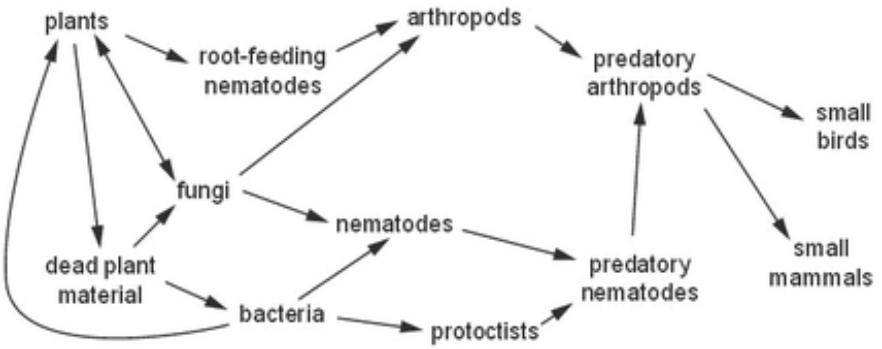


Fig. 6.1

(a) (i) Magnesium is an example of a nutrient required by organisms.
State **one** role of magnesium in organisms.

.....[1]

(ii) State, in terms of **nutrient flow**, the significance of the double-headed arrow between plants and fungi.

.....

.....

.....

.....[2]

(b) The small birds shown in Fig. 6.1 are preyed upon by larger birds.

(i) State which trophic level these larger birds occupy.

.....[1]

(ii) Some large animals feed on more than one trophic level.
Suggest why this is so.

.....

.....

.....

.....[2]

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(c) Communities of organisms, in soil habitats, have been described by biologists as "the driving force for the environment".

(i) Define the terms

community .....

.....

habitat .....

.....[2]

(ii) Suggest what is meant by the term "driving force for the environment".

.....

.....

.....

.....

.....

.....[3]

[Total: 11]

Q.26.

3 *Azotobacter vinelandii* is a bacterium found in the soil that is able to fix atmospheric nitrogen. One feature of nitrogen-fixing bacteria is the ability to synthesise the enzyme nitrogenase, a molybdenum- and iron-containing, protein complex.

(a) (i) Molybdenum is a mineral ion found in the soil solution. It enters the cell as molybdate ions, through membrane transport proteins. The proteins have the ability to bind to, and hydrolyse, ATP.

Name **and** describe the mechanism of transport of molybdate ions into the cell.

.....

.....

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.....

.....

.....[3]

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(ii) State the structures in the bacterial cell where the protein components of nitrogenase are synthesised.

.....[1]

(iii) Part of the equation for the reaction that is catalysed by nitrogenase in *A. vinelandii* is shown below.

Complete the equation by naming the product of the reaction.

$$\text{atmospheric nitrogen } (N_2) \xrightarrow[\text{ATP and hydrogen}]{\text{nitrogenase}} \text{.....}$$

[1]

(b) Table 3.1 shows the various types of nitrogen fixation that occur throughout the world and gives estimates of the mass of atmospheric nitrogen fixed in a year.

Table 3.1

type of nitrogen fixation		mass of nitrogen fixed / $\times 10^9$ kg yr^{-1}
non-biological	Haber process	50
	combustion	20
	lightning	10
biological	agricultural land	90
	non-agricultural land	50
	sea	35

(i) Using data from Table 3.1, calculate the percentage of nitrogen fixation carried out worldwide by nitrogen-fixing organisms, such as *A. vinelandii*, in **agricultural land**.

Show your working and express your answer to the nearest whole number.

answer .....% [2]

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(ii) Explain why the proportion of nitrogen gas in the atmosphere remains stable at 78%, even though nitrogen fixation removes nitrogen gas from the atmosphere.

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.....[2]

(c) Describe **and** explain the benefits to humans of the presence of nitrogen-fixing bacteria, such as *A. vinelandii*, in agricultural land.

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.....[3]

[Total: 12]

Q.27.

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6 (a) State the term for each of the following:

(i) all organisms of the same species living in a defined area at a particular time.

..... [1]

(ii) the interaction of all living organisms with each other and their non-living environment in a self-contained location

..... [1]

(iii) the process of converting nitrate ions in soil to nitrogen gas in the atmosphere.

..... [1]

Mangroves are trees which grow on tropical coastlines in salt water.

Fig. 6.1 shows part of a food chain from a mangrove area.

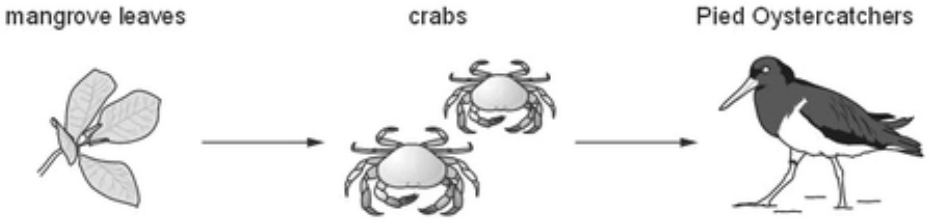


Fig. 6.1

(b) (i) Name the trophic level of the Pied Oystercatchers.

..... [1]

(ii) Explain why the energy taken in by the crabs is not all available to the Pied Oystercatchers.

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..... [2]

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(c) The crabs in Fig. 6.1 also feed on mangrove leaves that have fallen to the ground. The leaves which are not eaten supply a source of nitrogen for the mangrove trees.

Explain how nitrogen from compounds in the dead leaves is made available to the growing plants.

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..... [4]

[Total: 10]

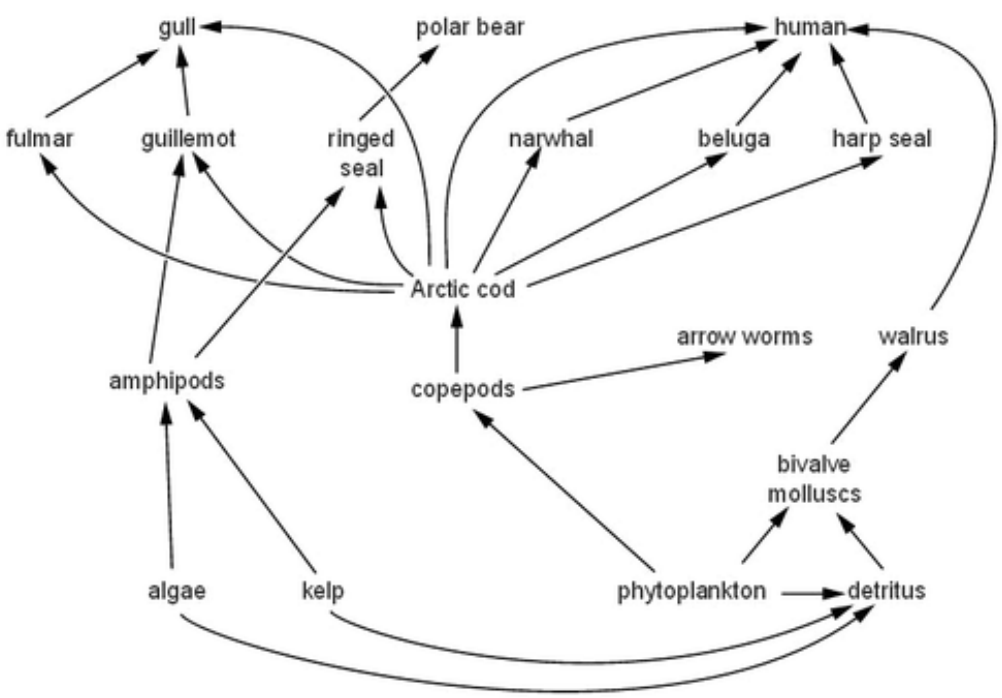
Q.28.

4 Lancaster Sound in the Canadian Arctic is a very productive marine environment and supports large populations of sea birds and marine mammals.

Studies of the area have shown the importance of Arctic cod, *Boreogadus saida*, in the flow of energy to marine birds, such as guillemots and fulmars, and marine mammals, such as narwhals and belugas. Arctic cod forms the main, or only, source of food for many such animals.

The flow of energy through the food web in Lancaster Sound is shown in Fig. 4.1.

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Note: detritus is dead and decaying matter

Fig. 4.1

(a) Name the trophic levels occupied by the following organisms in the food web in Fig. 4.1:

kelp .....

arrow worms .....

narwhals. .....[3]

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(b) The population of polar bears in the Lancaster Sound area is quite small in comparison to populations of animals that feed on Arctic cod.

For Examiner's Use

Using **only** the information shown in Fig. 4.1, explain why the population of polar bears is small.

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.....[4]

(c) Populations of many fish species are under threat of extinction as a result of over-fishing.

Explain the likely consequences of over-fishing of Arctic cod.

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.....[3]

[Total: 10]

Q.29.

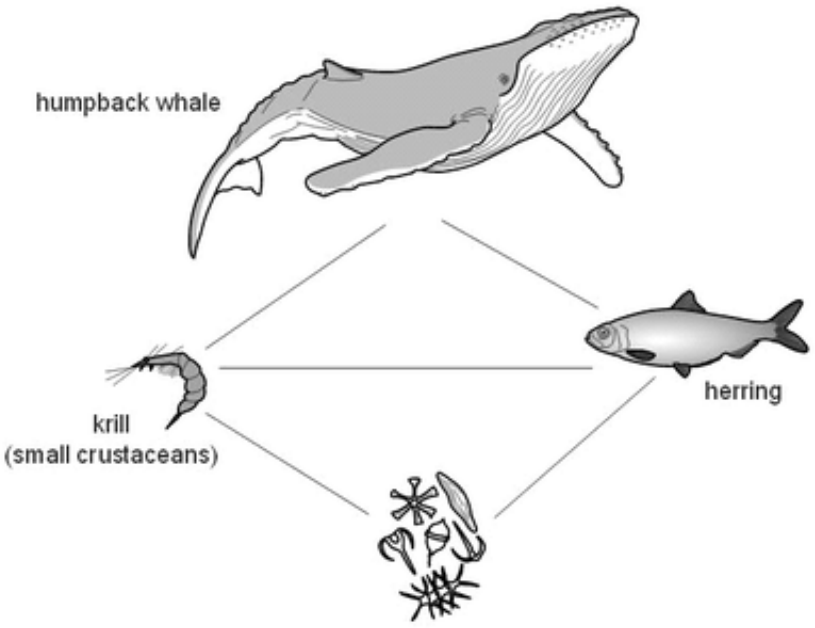
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3 The humpback whale, *Megaptera novaeangliae*, is one of the world's largest aquatic mammals. It can grow to a length of up to 15 metres and a mass of up to 36000 kg. A large proportion of the mass of a humpback whale is a very thick layer of fat-filled cells stored under the skin, called blubber.

The humpback whales are seasonal feeders. They feed in polar regions during the summer and then migrate to warmer temperate and tropical waters to mate and have their young during the polar winter.

(a) One reason that the humpback whale has managed to reach its enormous size is because it is a member of a simple food web. Fig. 3.1 is an example of such a food web.

(a) One reason that the humpback whale has managed to reach its enormous size is because it is a member of a simple food web. Fig. 3.1 is an example of such a food web.



not drawn to scale

(i) The humpback whale is a carnivore, feeding on krill and herring. The herring feed on krill.

Add **arrow heads** to the lines drawn on Fig. 3.1 to show the direction of energy flow in the food web. [1]

(ii) State the trophic level to which the humpback whale belongs.

..... [1]

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(iii) In terms of energy transfer, explain how the humpback whale is able to reach such a large size.

.....

.....

.....

.....

.....

..... [3]

(b) The thickness of blubber in humpback whales decreases during the non-feeding season and increases during the feeding season.

Suggest explanations for this observation.

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..... [2]

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(c) Describe the roles of water as an environment for organisms, such as those shown in Fig. 3.1.

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..... [3]

[Total: 10]

Q30.

6 A woodland ecosystem was investigated and a food web was constructed. This food web is shown in Fig. 6.1.

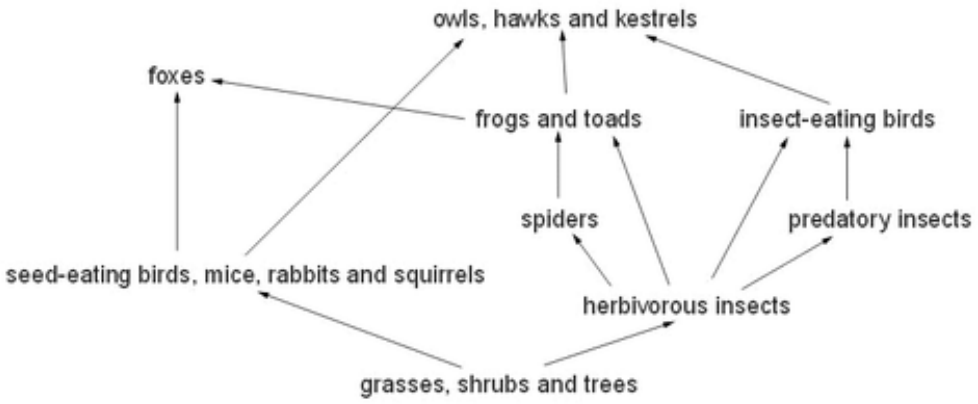


Fig. 6.1

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(a) State the meaning of the term *ecosystem*.

.....

.....

.....[2]

(b) Name one group of organisms from Fig. 6.1 that are:

(i) producers

.....[1]

(ii) **only** secondary consumers.

.....[1]

(c) Explain why only a small percentage of the energy present at each trophic level is available to the organisms at the next level.

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.....[3]

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(d) Fig. 6.1 shows the flow of energy but not the cycling of nutrients in the ecosystem.

Outline what happens to the nitrogen-containing compounds in the organisms at the top of the food web.

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.....[3]

[Total: 10]

Q31.

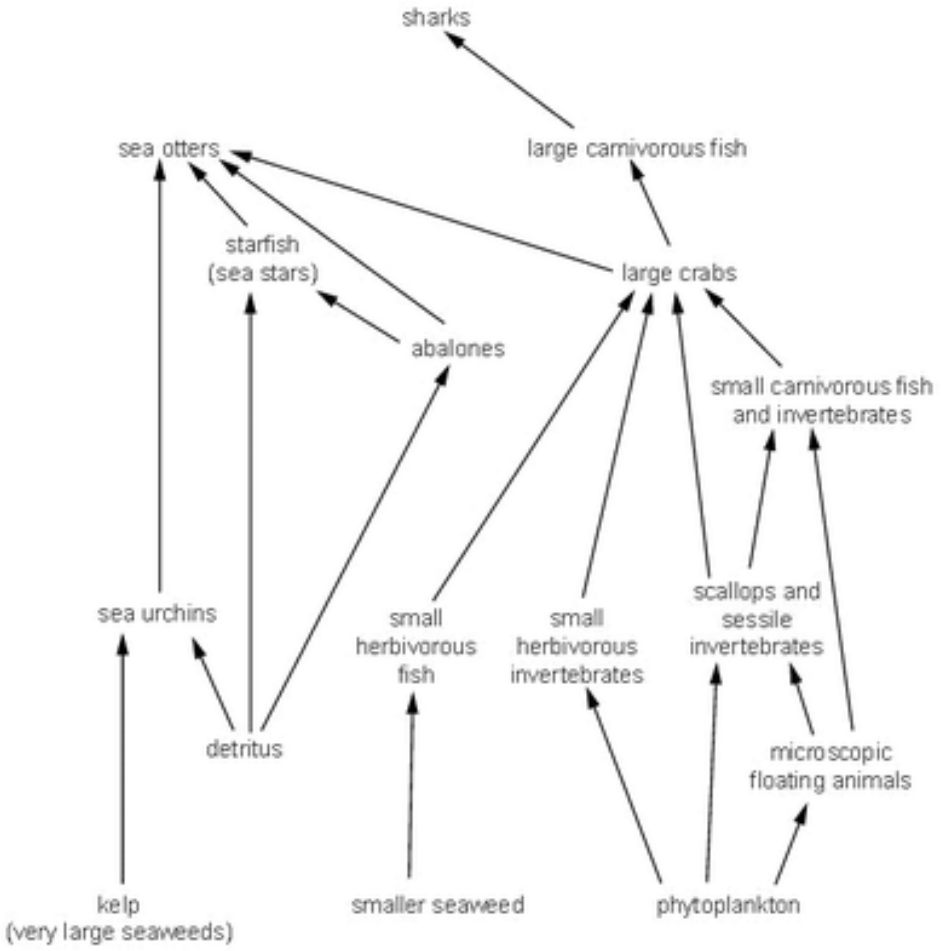
6 In some ecosystems, certain species fulfil important roles in maintaining biodiversity in communities. These species are often known as keystone species.

The sea otter, *Enhydra lutris*, is found in waters of the northern and eastern coasts of the Pacific, where it occupies a niche as a predator. These coastal waters are rich in kelp communities. Kelp are very large seaweeds that form 'underwater forests'.

In the 19th century the sea otter was hunted for its fur, with the result that populations decreased. A consequence of this reduction in numbers was the disappearance of much of the kelp. Conservation measures in the 20th century restored the numbers of sea otters.

Fig. 6.1 shows the food web for this ecosystem.

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(a) Explain the meaning of the terms *niche* and *community*.

niche .....

.....

.....

.....

community .....

.....

.....

.....[2]

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(b) With reference to the food web in Fig. 6.1, suggest why sea otters are considered to be a keystone species.

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.....[4]

(c) Suggest how the efficiency of energy transfer from kelp to sea urchins could be determined.

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.....[3]

[Total: 9]

Q32.

5 Read the following passage.

The three-toed sloth, *Bradypus variegatus*, is a very slow-moving mammal found in Central and South America that spends most of its life living in trees.

The thick, long grey fur of the sloth in Fig. 5.1 has a green appearance. Individual hairs of the sloth have grooves in them where water can collect.

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Research has shown that the green colour is due to the presence of algae living on the sloth's fur, the most common species being *Trichophilus welckeri*. Algae are eukaryotic, photosynthetic organisms.

Many other species of non-photosynthetic eukaryotes, both unicellular and multicellular, have been found living on the sloth's fur. These include different species of roundworms, insects and saprotrophic fungi.

(a) Explain the ecological terms *population* and *community*, **using examples given in the passage**.

population .....

.....

.....

community .....

.....

.....**[4]**

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(b) Suggest why the sloth and its fur can be described as a small ecosystem.

.....

.....

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.....

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.....

.....

.....[3]

[Total: 7]

Q33.

2 **(a)** Bacteria in root nodules of leguminous plants carry out nitrogen fixation.

For Examin Use

Describe how nitrogen that is available to these bacteria can eventually become part of animal protein.

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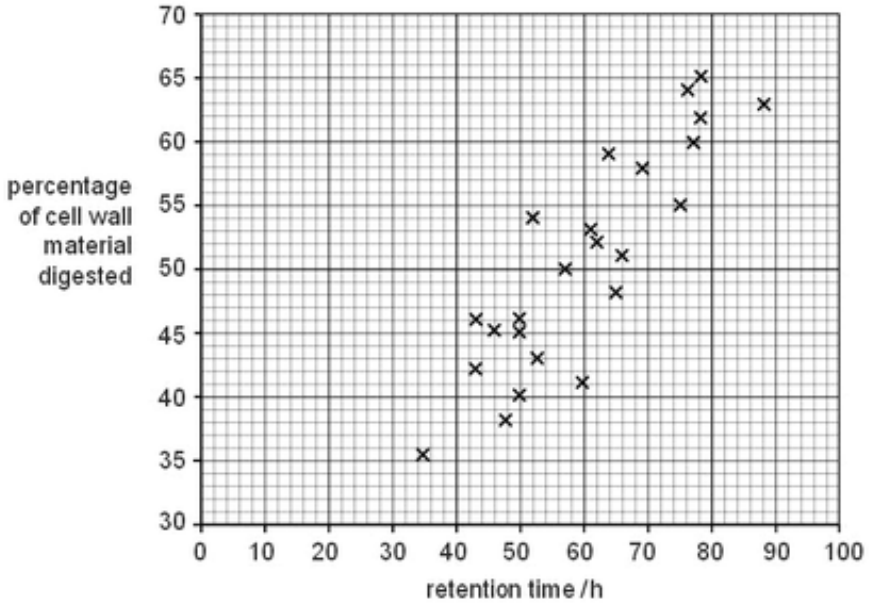
..... [5]

Q34.

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Animals do not have the ability to produce enzymes to digest cellulose. Most herbivores have bacteria in their digestive systems that can digest cellulose.

Fig. 5.1 shows the results of a study on 24 different herbivores. The percentage of cell wall material that was digested by each animal was determined. The time taken for the plant material to pass through the digestive system, the retention time, was also recorded.



(ii) Explain, in terms of energy flow in ecosystems, the importance of the results in Fig. 5.1.

.....

.....

.....

.....

..... [2]

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Q1.

1 The western lowland gorilla, *Gorilla gorilla*, has become an endangered species although it has no known enemies, except humans. Gorillas are herbivorous, feeding on fruit, shoots, tree bark and leaves. Fig. 1.1 shows a western lowland gorilla.



Fig. 1.1

(a) Suggest three reasons why the western lowland gorilla has become an endangered species.

1. .....

.....

2. .....

.....

3. .....

.....[3]

(b) **(i)** Explain how captive breeding programmes in zoos may help in the protection of endangered species, such as the western lowland gorilla.

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.....[3]

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(ii) State two disadvantages of captive breeding programmes.

1. .....

.....

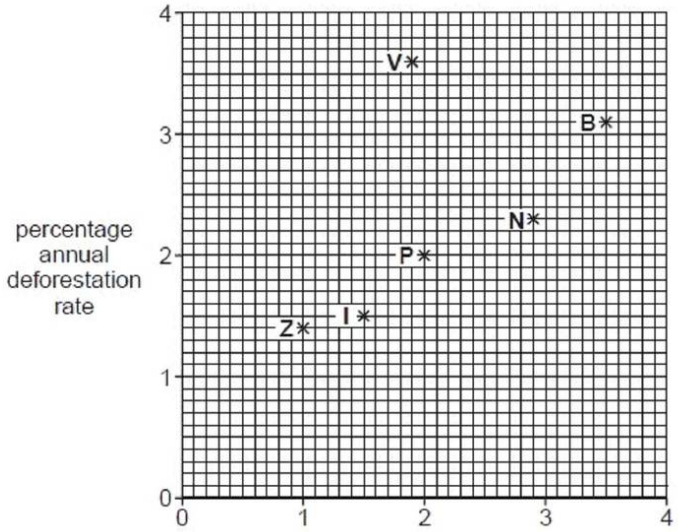
2. .....

.....[2]

[Total: 8]

Q2.

1 **(a)** Fig. 1.1 shows the relationship between annual deforestation rates and annual human population growth for six countries.



B – Burundi
I – Indonesia
N – Nigeria
P – Philippines
V – Vietnam
Z – Zimbabwe

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Describe the relationship shown in Fig. 1.1.

.....

.....

.....

.....[2]

(b) Over half of the species of plants and animals comprising the biodiversity of the Earth are thought to exist in tropical rainforests.

(i) Explain the meaning of the term *biodiversity*.

.....

.....

.....[2]

(ii) Explain the economic reasons for maintaining biodiversity.

.....

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.....

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.....

.....

.....[4]

[Total: 8]

Q3.

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3 **(a)** The African elephant, *Loxodonta africana*, is a large herbivorous mammal which eats tree leaves. It has the longest gestation period of any land mammal and normally produces one offspring at a time. Its habitat is mainly savannah. B

Suggest how human activities have caused the African elephant to become endangered.

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..... [3]

(b) The meerkat, *Suricata suricatta*, also lives in the savannah of southern Africa. It is a carnivorous mammal and feeds on insects, worms, snails and other invertebrates. It grows up to 30 cm in length and lives in large family groups in burrows.

Fig. 3.1 shows a meerkat.



Fig. 3.1

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With reference to the information given, suggest why the meerkat is less likely than the elephant to become endangered.

.....

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..... [3]

[Total: 6]

Q4.

1 The flatback turtle, *Natator depressus*, is an endangered species that nests on northern Australian beaches.

Fig. 1.1 shows a flatback turtle.

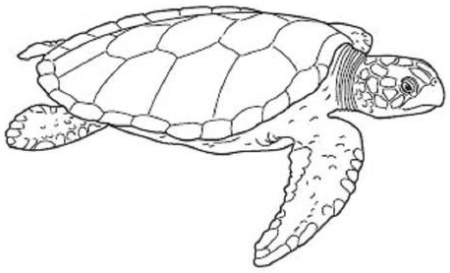


Fig. 1.1

Each female lays approximately 50 eggs per nest, which is a smaller number than all other species of marine turtle. The eggs are buried in the sand and when the hatchlings emerge each has a mass of approximately 43 g. Unlike most marine turtles, flatback turtles spend most of their time in coastal waters. This is where they feed and mate.

Fig. 1.2 shows the numbers of female flatback turtles nesting on a beach in northern Australia between 1993 and 2002.

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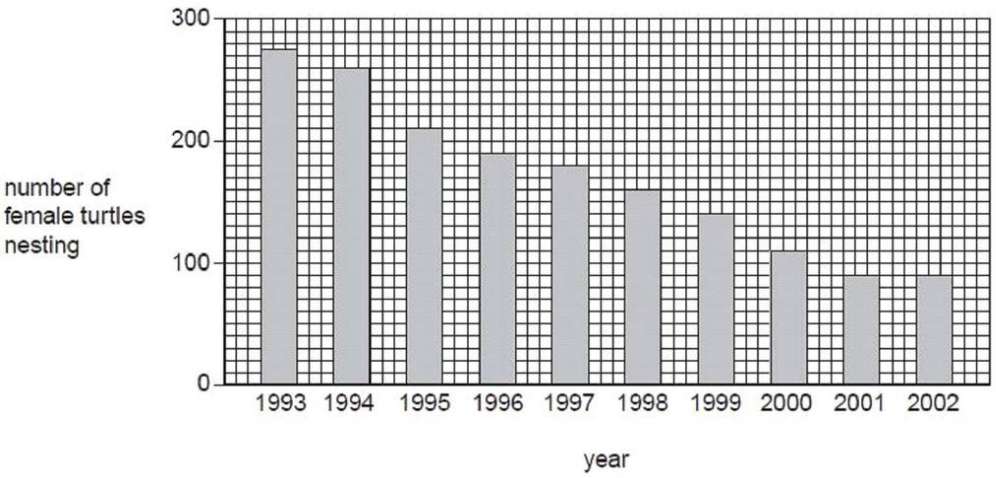


Fig. 1.2

(a) Calculate the mean **rate** of decrease in the numbers of females nesting between 1993 and 2002.

Show all the steps in your calculation.

Answer..... [2]

(b) Suggest ways in which the flatback turtle could be protected.

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.....

..... [5]

[Total: 7]

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Q5.

1 The American crocodile, *Crocodylus acutus*, was classified as an endangered species by the USA in 1975. It is found in estuarine regions of southern Florida.

Fig. 1.1 shows an American crocodile.



Fig. 1.1

The salinity of the water was thought to play a part in the distribution of the American crocodile.

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Fig. 1.2 shows the number of American crocodile nest sites in areas with water of varying salinity in southern Florida.

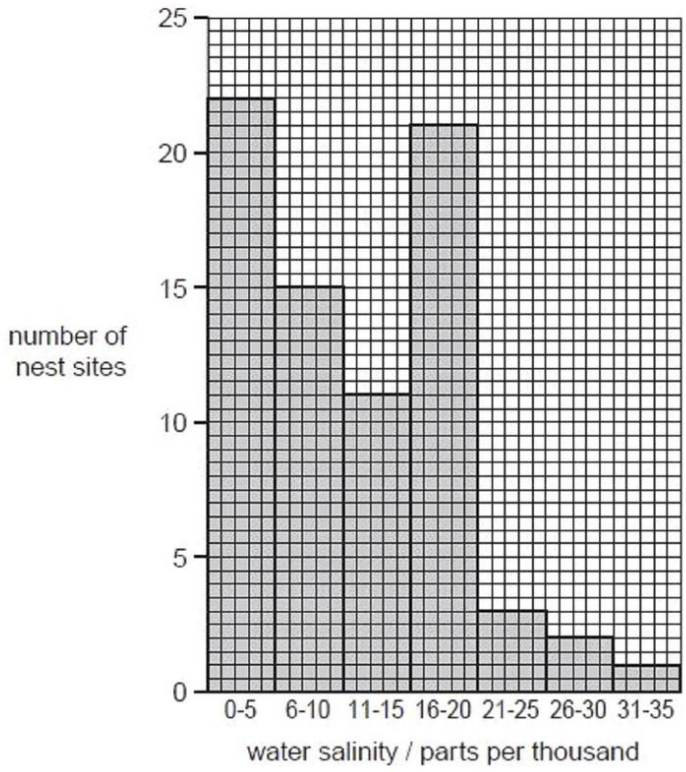


Fig. 1.2

(a) Describe the results shown in Fig. 1.2.

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..... [3]

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(b) Much conservation work has been done in the Everglades National Park in Florida, which is a large wetland area. As a result the number of nest sites has increased from 8 in 1975 to 31 in 2000. This has led to a rise in the number of crocodiles.

(i) Calculate the percentage increase in nest sites between 1975 and 2000.

Show your working.

answer ..... % [2]

(ii) Suggest two reasons why the population of crocodiles in the Everglades National Park has increased.

1. .....

.....

2. .....

..... [2]

[Total: 7]

Q6.

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1 The polar bear, *Ursus maritimus*, lives in the Arctic regions of the USA, Canada, Norway and Russia. Polar bears move across the Arctic ice sheet to hunt prey such as seals.

Fig. 1.1 shows a polar bear.



Fig. 1.1

The area over which the Arctic ice sheet extends varies throughout the year.

Fig. 1.2 shows the variation in the extent of the Arctic ice sheet for the months of July to November for the years 1979 and 2009.

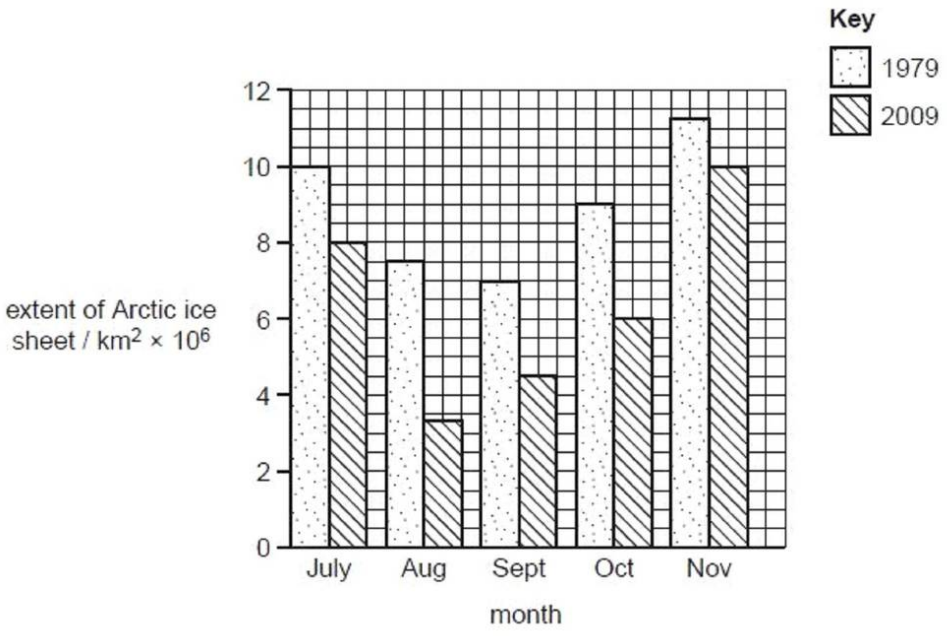


Fig. 1.2

STEMUP.CO.UK

(a) Calculate the percentage reduction in the area over which the ice sheet extends between 1979 and 2009 **for the month of September**.

Give your answer to the **nearest whole number**.

Show your working.

answer ..... % [2]

(b) In 2008 the government of the USA classified *U. maritimus* as an endangered species because it is under threat of extinction.

Suggest what has caused *U. maritimus* to have become endangered.

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..... [3]

(c) *U. maritimus* is a eukaryote. Beneficial bacteria, which are prokaryotic cells, live in the gut of *U. maritimus*.

State three differences between the cells of *U. maritimus* and its gut bacteria.

1. .....

2. .....

3. ..... [3]

[Total: 8]

Q7.

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1 The natterjack toad, *Bufo calamita*, is an endangered amphibian species in the UK. It comes out of hibernation in April and breeds in pools by sand dunes along parts of the UK coast. A young natterjack toad will take about 10 weeks to develop from a fertilised egg. A natterjack toad feeds at night, by running at its prey, mainly insects and worms, on the sand dunes.

Fig. 1.1 shows a natterjack toad.



Fig. 1.1

(a) Suggest what may have caused the natterjack toad to become an endangered species in the UK.

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.....[3]

(b) Fig. 1.2 shows the number of adult natterjack toads counted from 1989 to 1997 in one area of the UK.

Ex

STEMUP.CO.UK

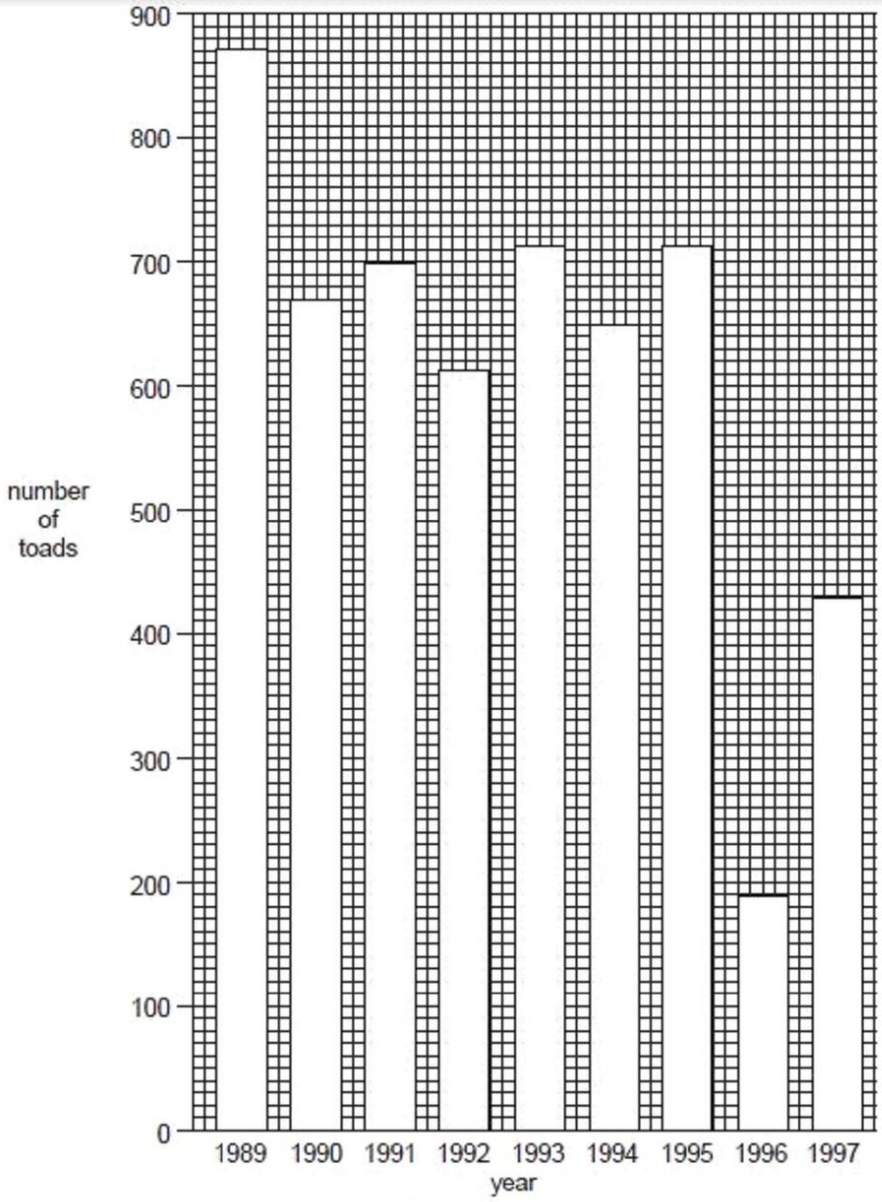


Fig. 1.2

Calculate the mean annual number of adult natterjack toads counted from 1989 to 1997.

Give your answer to the **nearest whole number**.

Show your working.

answer ..... [2]

STEMUP.CO.UK

(c) The natterjack toad is heterotrophic.

Exa

(i) Explain what is meant by heterotrophic.

.....

.....

.....

.....[2]

(ii) Name two kingdoms that are exclusively heterotrophic.

1. .....

2. .....[1]

(d) Each year the International Union for the Conservation of Nature and Natural Resources (IUCN) publishes a list of endangered species called the Red List. The Red List has a very high proportion of vertebrates compared to invertebrates.

Suggest **one** reason **why** the Red List has many more vertebrates than invertebrates.

.....

.....[1]

[Total: 9]

Q8.

STEMUP.CO.UK

6 **(a)** The plant *Rafflesia arnoldii*, which grows in the jungles of South East Asia, is noted for producing the largest flower of all plants.

- The flower is reddish-brown and can grow up to one metre in diameter.
- The flower gives off a smell similar to rotting flesh to attract flies, which then pollinate it.

Fig. 6.1 shows a flower of *R. arnoldii*.



Fig. 6.1

R. arnoldii is classified as an endangered species.

Suggest why *R. arnoldii* has become an endangered species.

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.....[3]

STEMUP.CO.UK

(b) (i) Explain the meaning of the term *biodiversity*.

For Examiner Use

.....

.....[1]

(ii) Suggest reasons for maintaining **plant** biodiversity.

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.....[4]

[Total: 8]

Q9.

STEMUP.CO.UK

6 **(a)** The Millennium Seed Bank is located in the UK. So far it has successfully stored seeds from 10% of the world's wild plant species.

For Examiner's Use

(i) Suggest the benefits to humans of conserving plant species.

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.....[3]

(ii) In the wild, seeds may be subjected to conditions that can be hostile to successful germination and growth.

Suggest how the seeds should be stored in the seed bank to keep them viable for future use.

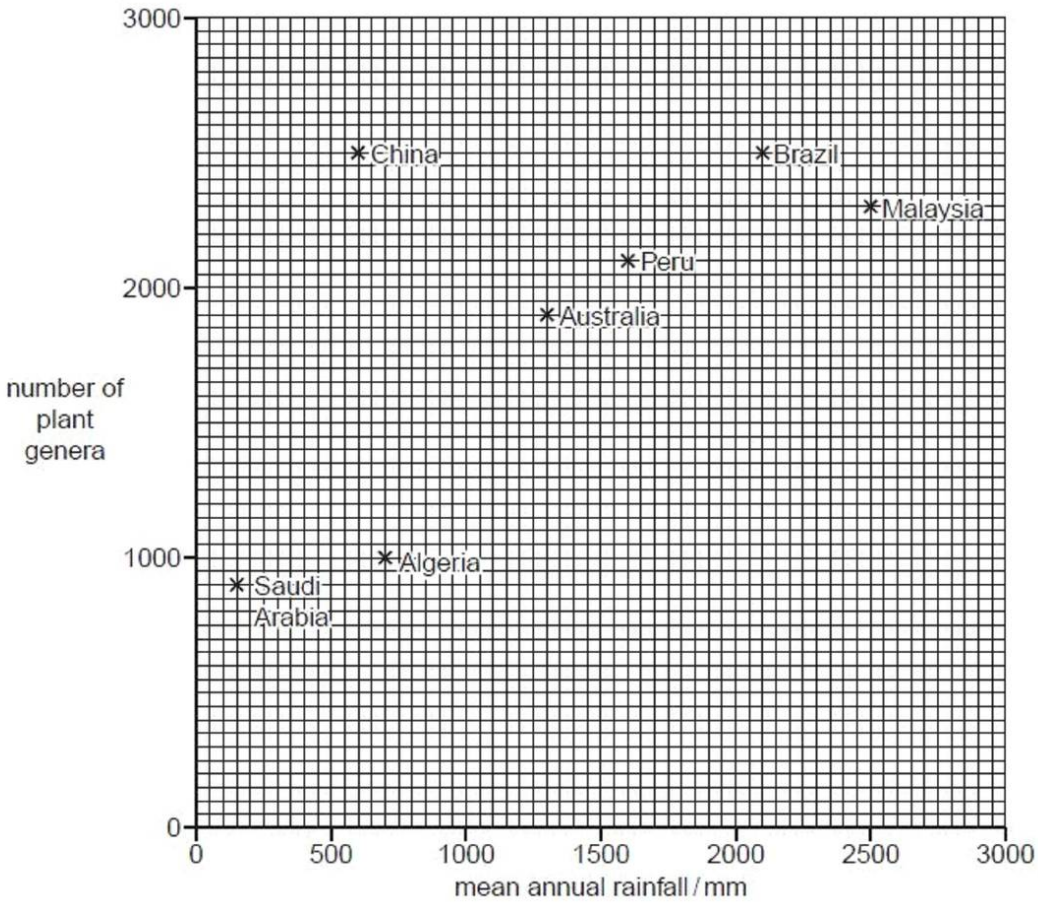
.....

.....[1]

(b) Plant biodiversity varies throughout the world and is dependent on many factors, particularly climate.

Fig. 6.1 shows the relationship between the number of plant genera and the mean annual rainfall in seven countries.

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(i) Describe the relationship between the number of plant genera and the mean annual rainfall in these seven countries.

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.....[2]

(ii) Suggest what other climatic factors, apart from rainfall, affect plant biodiversity.

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.....[2]

[Total: 8]

Q10.

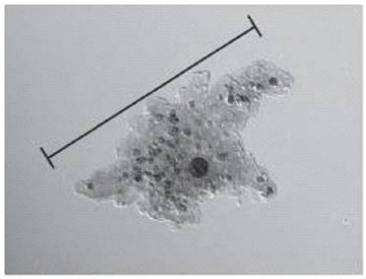
STEMUP.CO.UK

1 Fig. 1.1 shows two unicellular organisms, **P** and **R**. These organisms are members of **different** kingdoms.



X 20 000

P



X 2 000

R

Fig. 1.1

(a) Calculate the actual sizes, in µm, of **P** and **R**, as shown by the lines on Fig. 1.1.

Show your working.

P ..... µm

R ..... µm [3]

(b) Identify the kingdom to which each organism belongs. Write your answers in the table below. [1]

(c) Complete the table by listing five features which distinguish **P** from **R**.

One has been completed for you. [5]

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	unicell P	unicell R
kingdom	.....	.....
features	1 cell wall present	cell wall absent
	2	....
	3	....
	4	....
	5	....
	6	....

[Total: 9]

Q11.

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Use

2 Fig. 2.1 shows part of a tropical rainforest.

Tropical rainforests have a high biodiversity.

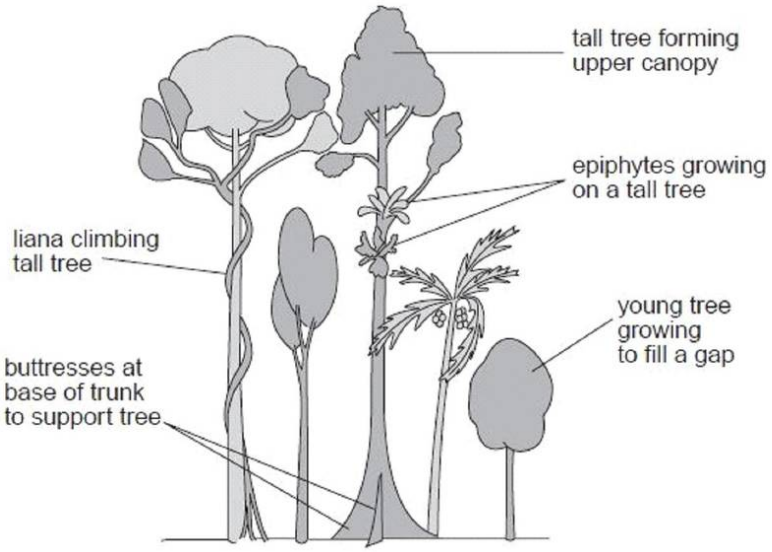


Fig. 2.1

(a) Explain what is meant by *biodiversity*.

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..... [3]

Exar

(b) Suggest why tropical rainforests have a high biodiversity of animal species.

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..... [2]

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(c) Discuss why it is important to maintain biodiversity.

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..... [4]

[Total: 9]

Q12.

1 The African hunting dog, *Lycaon pictus*, is a carnivore which hunts in packs in areas of East Africa.

Fig. 1.1 shows an African hunting dog.



Fig. 1.1

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(a) The African hunting dog has cells that are eukaryotic while bacteria have cells that are prokaryotic.

Describe the differences between eukaryotic and prokaryotic cells **with respect to their DNA**.

.....

.....

.....[2]

(b) In some parts of East Africa *L. pictus* is becoming an endangered species.

Suggest reasons why *L. pictus* is becoming an endangered species.

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.....[3]

(c) One way of protecting *L. pictus* is to create conservation areas.

Describe two **other** methods of conserving endangered species such as *L. pictus*.

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.....[2]

[Total: 7]

Q13.

STEMUP.CO.UK

1 **(a)** The squirrel monkey, *Saimiri sciureus*, of Costa Rica has become an endangered species.

Fig. 1.1 shows a squirrel monkey.



Fig. 1.1

Explain what is meant by the term *endangered species*.

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.....[2]

(b) Discuss possible ways in which the squirrel monkey could be protected.

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.....[4]

[Total: 6]

Q14.

STEMUP.CO.UK

1 All living organisms are divided into five kingdoms.

The table below lists some features possessed by living organisms and some processes that they carry out.

Place a tick or a cross in the table to indicate the presence or absence of the feature or process in any or all members of the kingdom.

The first row has been done for you.

feature or process	kingdom				
	Prokaryotae	Protoctista	Fungi	Plantae	Animalia
80s ribosomes	✗	✓	✓	✓	✓
cell walls contain chitin					
circular DNA					
endoplasmic reticulum					
most species unicellular					
autotrophic					
heterotrophic					

[6]

[Total: 6]

Q15.

STEMUP.CO.UK

1 The Great Lakes, in North America, lie between the USA and Canada. A survey of birds of the Lake Ontario area has shown the relative abundance of birds between 1995 and 2005.

Table 1.1 shows the feeding habits and the relative change in numbers of some of the birds in the survey.

Table 1.1

name	feeding habit	percentage change in numbers between 1995 and 2005
mallard *Anas platyrhynchos*	amphibia, plants	+10.0
tree swallow *Tachycineta bicolor*	flying insects	−6.2
blue-winged teal *Anas discors*	aquatic insects, molluscs, plants	−12.3
pied-billed grebe *Podilymbus podiceps*	amphibia, aquatic insects, fish	−15.9
black tern *Chlidonias niger*	aquatic insects, fish, flying insects	−18.7

(a) Using the information in Table 1.1 suggest reasons for the changes in numbers of these birds.

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..... [4]

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(b) An ecosystem that has a wide range of species has a high biodiversity.

Explain the benefits of maintaining biodiversity.

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..... [4]

[Total: 8]

Q16.

1 **(a)** A 50-year study of marine animal biodiversity in the coastal waters of Canada was carried out.

The percentage decrease in the number of marine animal species between 1950 and 2000 is shown in Fig. 1.1.

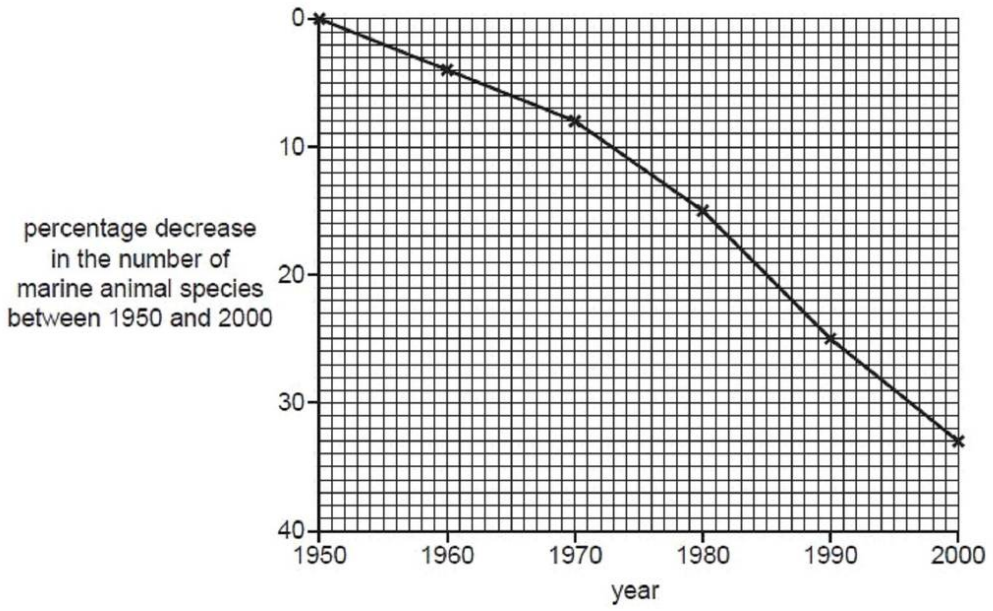


Fig. 1.1

STEMUP.CO.UK

Suggest explanations for the decrease in the number of marine animal species between 1950 and 2000.

.....

.....

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.....

..... [3]

(b) Explain what is meant by the term *biodiversity*.

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..... [2]

(c) Discuss the benefits of maintaining the biodiversity of a marine ecosystem, such as that in the coastal waters of Canada.

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..... [3]

[Total: 8]

Q17.

STEMUP.CO.UK

1 The Ethiopian wolf, *Canis simensis*, is a member of the Canidae family of carnivores.

Fig. 1.1 shows an Ethiopian wolf.



Fig. 1.1

(a) Ethiopian wolves evolved from an ancestor similar to the grey wolf that crossed into Northern Africa from Europe about 100 000 years ago.

They live in the alpine grasslands and heathlands at, or above, 3000 m altitude in Ethiopia.

State the most likely type of speciation that led to the evolution of the Ethiopian wolf.

.....[1]

(b) A population of Ethiopian wolves is called a pack.

Heterozygosity has been found to be low in all of the packs of Ethiopian wolves that have been studied.

Suggest why the heterozygosity may be low in Ethiopian wolf packs.

.....

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.....[2]

STEMUP.CO.UK

(c) The Ethiopian wolf is classified as an endangered species by the International Union for the Conservation of Nature and Natural Resources (IUCN). It publishes an annual list of endangered species called the Red List.

For Examiner Use

Complete Table 1.1 to summarise four of the main reasons, with further explanation, as to why the Ethiopian wolf has become an endangered species.

Table 1.1

reason	explanation
	an activity that accompanies human expansion and reduces the size of the wolf habitat
rabies, a lethal viral disease of wolves	
	a human activity to control wolves, considered to be pests
	the result of wolves breeding with domestic dogs

[4]

(d) According to the Red List, the number of endangered mammal species in 2007 was 349 and in 2008 was 448.

Calculate the percentage increase in endangered mammal species between 2007 and 2008.

Give your answer to the **nearest whole number.**

Show your working.

answer .....% [2]

[Total: 9]

Q18.

STEMUP.CO.UK

1 The Bengal Tiger, *Panthera tigris tigris*, is an endangered mammalian species of Southern Asia. It lives mostly in a forest habitat.

Fig. 1.1 shows a Bengal Tiger.



Fig. 1.1

(a) Table 1.1 shows the relationship between available forest habitat and Bengal Tiger numbers between 1970 and 2010.

Table 1.1

year	forest habitat remaining compared to 1970 (%)	Bengal Tiger numbers
1970	100	37 000
1980	79	27 000
1990	42	12 000
2000	26	3 600
2010	18	1 400

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Calculate the percentage decrease in the number of Bengal Tigers between 1970 and 2010.
Give your answer to the **nearest whole number**.

answer ..... % [2]

(b) Suggest methods to conserve the Bengal Tiger.

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.....[4]

(c) The Bengal Tiger belongs to the kingdom Animalia. State **two** differences between members of the kingdom Animalia and the kingdom Plantae.

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.....[2]

[Total: 8]

Q19.

STEMUP.CO.UK

7 Corals are simple marine animals and usually exist in colonies of thousands of individuals.

Fo
Exami
Us

Fig. 7.1 shows a coral colony.



Fig. 7.1

Corals absorb calcium carbonate from the sea to build their skeletons, which help to form large coral reefs. Coral reefs provide a home for about 25% of known fish species and have the highest biodiversity of any marine ecosystem.

(a) Corals, although they are animals, are sometimes mistaken for members of the plant kingdom.

State **two** ways in which corals differ from plants.

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.....[2]

(b) Outline what is meant by the term *ecosystem*.

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.....[2]

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(c) Coral reefs are at risk of damage due to human activities. All the coral reefs in three regions were classified as being at low, medium or high risk of damage.

Table 7.1 shows the areas of coral reef at risk of damage in these three regions.

Table 7.1

region	area of coral reef at risk of damage / 1000 km^2			percentage of coral reef at high risk of damage
	low	medium	high	
Caribbean Sea	9	8	7	29
Indian Ocean	20	15	10	
Pacific Ocean	60	30	9	

(i) Complete Table 7.1, giving your answers **to the nearest whole number**. [1]

(ii) Suggest how human activities could damage coral reefs.

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.....[3]

[Total: 8]

Q20.

8 **(a)** The tiger, *Panthera tigris*, is classified as an endangered species by the International Union for the Conservation of Nature and Natural Resources (IUCN). The IUCN publishes an annual list of endangered species called the Red List.

Fig. 8.1 shows the number of tigers in the wild between 1900 and 2010.

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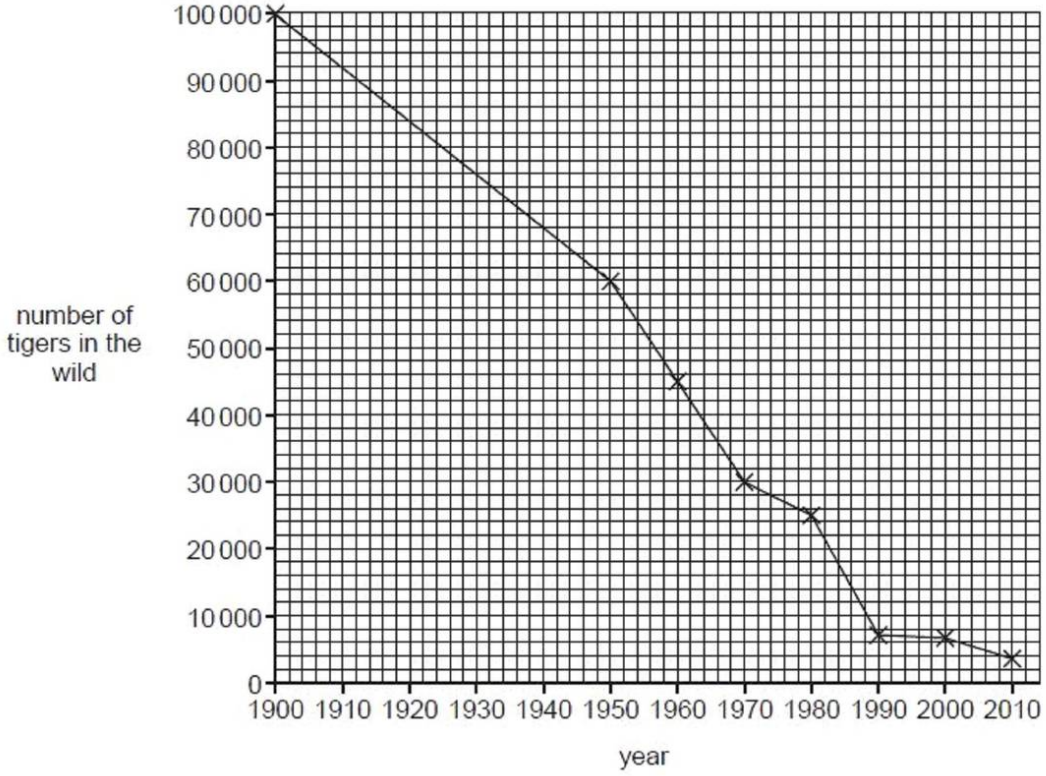


Fig. 8.1

Calculate the overall rate of decrease in number of tigers between 1900 and 2010.

Give your answer to the **nearest whole number**.

answer ..... tigers per year [2]

STEMUP.CO.UK

(b) Describe the reasons why a **named** species has become endangered.

Ex

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.....[4]

[Total: 6]

Q21.

8 The Atlantic cod, *Gadus morhua*, is fished for food.

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Exam
Us

(a) Fig. 8.1 shows the size of the stocks of Atlantic cod between 1968 and 2000.

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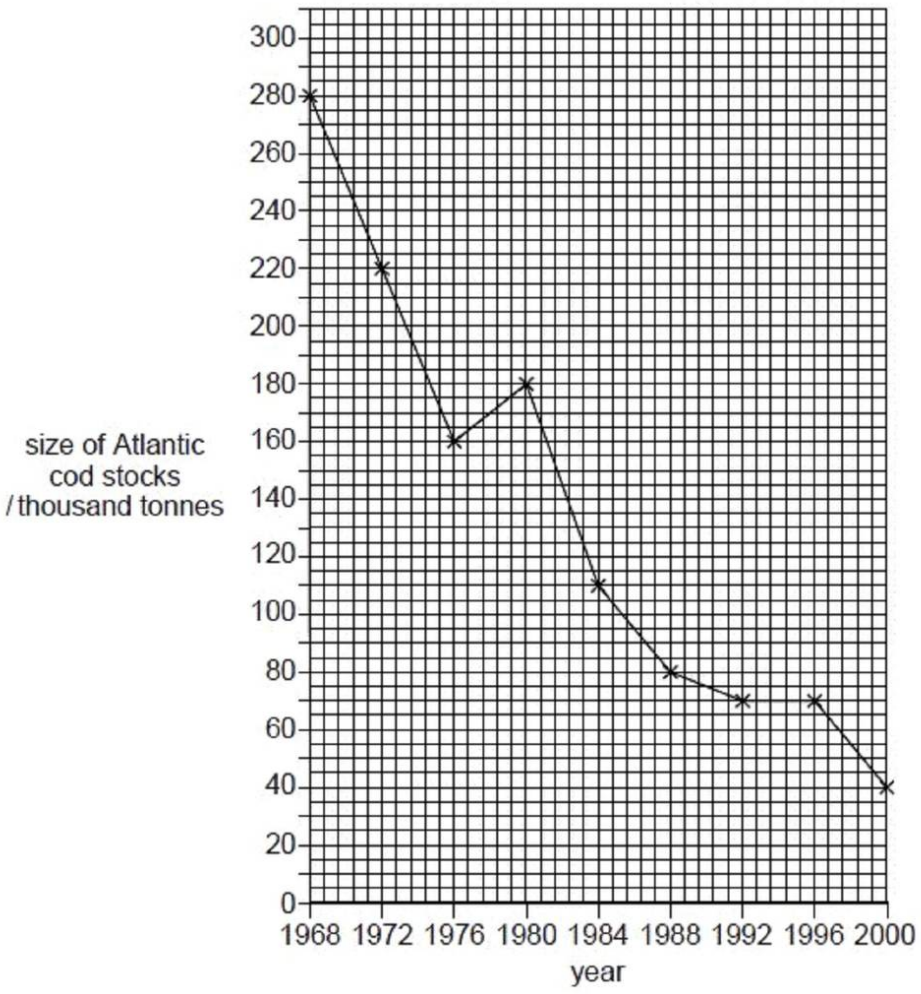


Fig. 8.1

Calculate the overall rate of decrease in size of the stocks of Atlantic cod between 1968 and 2000.

answer ..... tonnes per year [2]

STEMUP.CO.UK

(b) Suggest how the stocks of Atlantic cod may be increased.

Exa

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.....[3]

[Total: 5]

Q22.

7 The Venus fly trap, *Dionaea muscipula*, is a carnivorous plant. It has traps which catch insects.

Each trap consists of a pair of modified leaves joined by a midrib of hinge cells. The modified leaves have touch-sensitive hairs. If two hairs are touched within 20 seconds, or the same hair is touched twice in rapid succession, the trap closes.

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(a) Explain how touching the hairs results in closure of the trap.

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..... [5]

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(b) *D. muscipula* grows naturally in a small region in eastern USA. Fires that destroy much of the vegetation occur in this region. Three sites in this region where there had been fires were identified and investigated.

- Site 1 had experienced a fire 2 years before.
- Site 2 had experienced a fire 10 years before.
- Site 3 had experienced a fire 30 years before.

Preliminary observations suggested that over the course of time following a fire, the biodiversity of plants had increased. However, the abundance of Venus fly trap plants had decreased and so had the light intensity available to them. There was also a decrease in the nitrogen that the plants absorbed from insects as a proportion of all the nitrogen they obtained from their environment.

Name an ecological or statistical method to measure:

(i) the abundance of *D. muscipula* at each site

..... [1]

(ii) plant biodiversity at each site

..... [1]

(iii) the strength of the relationship between light intensity and the proportion of nitrogen absorbed from insects, after taking measurements from a large number of plants.

..... [1]

[Total: 8]

Q23.

STEMUP.CO.UK

4 **(a)** List three reasons why it is important to conserve endangered plant species.

1. .....

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2. .....

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3. .....

.....[3]

(b) The tree *Vatica guangxiensis* is an endangered species. Only three wild populations exist, all in south-western China. Conservation of this species began in the 1980s. Conservation methods included attempts to preserve the habitat of the wild populations and the establishment of a fourth population in the Xishuangbanna Tropical Botanical Garden.

In 2002, the genetic diversity of each of the four populations was assessed. This was done by testing samples of DNA from a number of individuals.

- Twenty different regions of DNA were investigated, using electrophoresis.
- For each population, the percentage of samples that showed differences in the DNA structure, shown by different bands on the DNA 'fingerprint', was calculated.
- This figure was recorded as the percentage of polymorphic bands.

The greater the percentage of polymorphic bands, the greater the genetic diversity in the population.

Table 4.1 shows the results.

Table 4.1

population	number of individual plants sampled	percentage of polymorphic bands
wild population **A**	27	38.53
wild population **B**	30	31.60
wild population **C**	10	27.27
population in the botanic garden	28	30.74

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(i) With reference to Table 4.1, compare the genetic diversity of the population of *V. guangxiensis* in the botanic garden with the genetic diversity of the three wild populations.

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.....[2]

(ii) Suggest explanations for the relatively low percentage of polymorphic bands recorded in wild population **C**.

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.....[2]

(iii) Explain why high genetic diversity is important for a species.

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.....[2]

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(iv) The Xishuangbanna Tropical Botanical Garden is located only tens of kilometres from the habitats of the wild populations of *V. guangxiensis*.
Suggest how this may help with the long-term conservation of this species.

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.....[2]

(c) Seed banks also have an important role in the conservation of endangered plant species.

(i) Explain why storing seeds may be a more successful method of conservation than maintaining a population of growing plants.

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.....[2]

(ii) Suggest why a sample of each type of seed stored in a seed bank is germinated every few years.

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.....[2]

[Total: 15]

Q24.

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2 The endangered Californian condor, *Gymnogyps californianus*, is the largest flying bird in North America. Condors feed on dead bodies of large mammals, such as cattle and deer. Fig. 2.1 shows the Californian condor.



Fig. 2.1

The population of these condors fell to just 22 in 1982 and this led to the California Condor Recovery Program (CCRP), a captive breeding programme, being set up in different zoos in the United States and Mexico.

Owing to the success of the captive breeding programme there are now over 300 condors. Many of these have been released as part of the programme.

(a) Outline the advantages of captive breeding programmes such as CCRP.

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.....[4]

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(b) Suggest why animals in captive breeding programmes may not always breed successfully.

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.....[2]

(c) When animals that have been bred in captivity are released, their survival rate is low.

Suggest **two** reasons why many of these animals are unable to survive in the wild.

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.....

.....[2]

(d) Bullets containing lead are commonly used by hunters. Hunting for pleasure means that hunters often leave the killed animals, such as deer, bears and antelopes, in the area where they have been shot.

Suggest why this is a threat, rather than an advantage, to the Californian condor.

.....

.....

.....

.....[1]

[Total: 9]

Q25.

STEMUP.CO.UK

1 **(a)** Describe what is meant by the term *biodiversity.*

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.....

..... [2]

(b) Explain why tropical rainforest is considered to have a very high **ecological** importance.

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..... [3]

In Mexico, coffee is an important crop. Coffee trees grow well in areas in which tropical rainforest is found and so the planting of coffee plantations frequently means that rainforest is destroyed.

Table 1.1 shows four different coffee-growing systems that are used in Mexico and also the results of a survey into the number of different bird species found in each system.

(c) With reference to Table 1.1,

(i) explain the reasons for the pattern shown by the numbers of bird species in systems **A**, **B**, **C** and **D**;

.....

.....

..... [2]

(ii) suggest reasons for the greater yield of coffee from system **D** than from system **A**;

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..... [2]

(iii) suggest why more pesticides are used in system **D** than in the other systems.

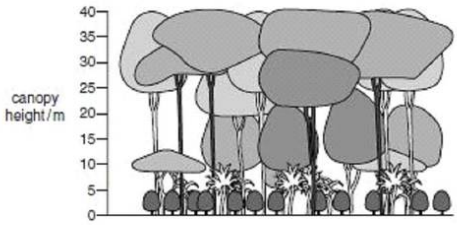
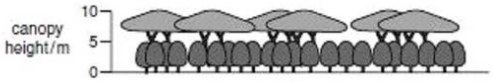
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..... [2]

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Table 1.1

coffee-growing system		mean total number of bird species per unit area
A traditional polyculture or 'coffee garden' 	coffee and many other useful species grown beneath the original forest trees	184
B commercial polyculture 	original forest trees removed and replaced with a mixture of other tall trees such as rubber; coffee and other crops grown beneath them	106
C shaded monoculture 	original forest trees removed and replaced with a single species of leguminous trees; only coffee trees grown beneath them	50
D unshaded monoculture 	original forest trees removed; coffee trees grown alone	9

increasing fertiliser and pesticide use and increase in yield of coffee

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(d) In the shaded monoculture system, system **C**, the shade is usually provided by a single species of the leguminous tree *Inga*. This tree has nodules containing *Rhizobium* on its roots.

Explain why coffee trees grown in this system require much lower inputs of fertiliser than when grown in the unshaded monoculture system, system **D**.

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..... [2]

(e) With reference to Table 1.1 and your own knowledge of the conservation of tropical rainforest, describe **international** measures that could be taken to conserve biodiversity in the coffee-growing areas of Mexico.

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..... [2]

[Total: 15]

Section B

1.

9 **(a)** Explain the need to maintain biodiversity in an ecosystem such as a tropical rainforest. [7]

(b) Discuss the advantages and the disadvantages of captive breeding programmes for mammals. [8]

[Total: 15]

2.

9 **(a)** It has been stated that the kingdom Protoctista can be described as a very diverse group of organisms that share only a few common features.

Discuss the ways in which members of the kingdom Protoctista are similar to each other and ways in which they differ. [7]

(b) With reference to any **named** species of plant or animal, explain why this species is considered to be endangered **and** outline the reasons that have caused it to become endangered. [8]

[Total: 15]

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3.

9 (a) Describe the main features of an organism belonging to the **plant** kingdom. [8]

(b) Describe the methods used to conserve endangered **animal** species. [7]

[Total: 15]

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1. Nov/2018/Paper_41/No.1

The Bali starling, *Leucopsar rothschildi*, is found on the island of Bali, Indonesia.

Fig. 1.1 shows a Bali starling.



Fig. 1.1

(a) The International Union for Conservation of Nature (IUCN) is the world's largest global environmental organisation. The IUCN Red List of Threatened Species™ evaluates the conservation status of plant and animal species.

The Bali starling is categorised as critically endangered on the IUCN Red List, which means that it is nearly extinct in the wild.

The Bali starling is protected by Indonesian law and trapping of the birds for sale as pets is illegal. In 2001 there were only six Bali starlings in the wild and about 1000 in captivity.

(i) Suggest reasons, other than the trapping of the birds for sale as pets, for the very low numbers of Bali starlings in the wild.

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(ii) Describe the roles zoos can take in the protection of the Bali starling.

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(b) Explain the consequences on genetic biodiversity of having a wild population of just six birds.

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..... [4]

[Total: 9]

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2. Nov/2018/Paper_41/No.9

(a) Outline the characteristic features of organisms in the domain Bacteria. [8]

(b) Describe the role of botanic gardens in the protection of endangered species. [7]

[Total: 15]

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1. Nov/2019/Paper_41/No.9

(a) Compare the characteristic features of members of the kingdoms Fungi and Animalia. [7]

(b) Discuss the methods used in breeding programmes for endangered mammal species **and** outline the problems that may occur with these programmes. [8]

[Total: 15]

2. Nov/2019/Paper_42/No.9

(a) Compare the characteristic features of members of the kingdoms Fungi and Animalia. [7]

(b) Discuss the methods used in breeding programmes for endangered mammal species **and** outline the problems that may occur with these programmes. [8]

[Total: 15]

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3. Nov/2019/Paper_43/No.9(a, b)

(a) Viruses are not included in the three domain classification system as they have different features from most organisms.

Describe the features of viruses. [8]

(b) Non-governmental organisations play a role in **global** conservation.

Discuss how **two** global non-governmental organisations contribute to conservation. [7]

[Total: 15]

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4. June/2019/Paper_41/No.8

Table 8.1 shows the total number of plant species, the total number of insect species and the number of habitats in three areas, **A**, **B** and **C**.

Table 8.1

area	total number of plant species	total number of insect species	number of habitats
A	6	5	1
B	15	23	4
C	362	70	12

(a) Identify the area with the highest biodiversity.

Give reasons for your choice of area.

area .....

reasons .....

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..... [3]

(b) Identify the area that is likely to be affected the most if the environment changes.

Give a reason for your choice of area.

area .....

reason .....

.....

[1]

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(c) State **one** reason why it is important to conserve biodiversity in **all** three areas.

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..... [1]

[Total: 5]

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5. June/2019/Paper_42/No.2(a, b)

(a) Fig. 1.1 is an electron micrograph showing a cross-section of a myelinated neurone.

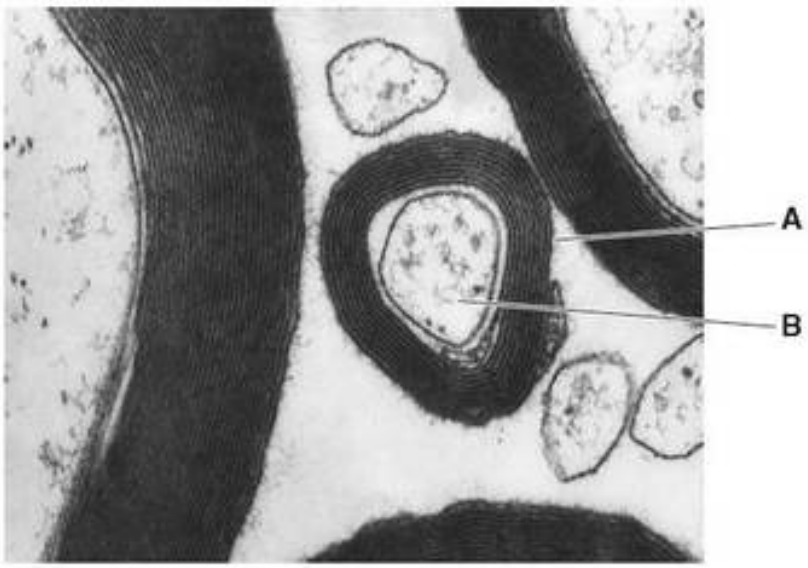


Fig. 1.1

Name **A** and **B**.

A .....

B .....

[2]

(b) Explain what is meant by saltatory conduction **and** describe its effect on the transmission of a nerve impulse.

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..... [3]

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6. June/2019/Paper_42/No.7

(a) Define the term *ecosystem*.

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..... [3]

(b) State the term used to describe:

the functional role of a species within an ecosystem

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a reproductively isolated group of organisms that interbreed to produce fertile offspring

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physical factors in the environment such as temperature and soil pH.

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[3]

[Total: 6]

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7. June/2019/Paper_42/No.9(b)

(b) Outline how degraded habitats may be restored, with reference to named examples. [7]

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8. June/2019/Paper_43/No.7

The passage below outlines one method used by a student to estimate the population size of an animal species.

Complete the passage by using the most appropriate scientific term or terms.

A student estimated the population size of an animal species using the mark-release-..... technique. This can only be used for ..... animals such as mice.

The student caught a sample of mice using humane traps. The student then marked the mice in a way that did not ..... them. For example, the mark did not make them more visible to potential ..... . The student released the marked mice and left enough time for them to randomly ..... with the population.

The student then caught a second sample of mice and noted the numbers of marked and unmarked mice.

The student estimated the population size by multiplying the number of mice in the first sample by the number in the second sample, then dividing by the number of ..... mice in the second sample.

[6]

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9. Feb/2019/Paper_42/No.7

(a) Explain what is meant by the term *biodiversity*.

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..... [3]

(b) Simpson's Index of Diversity (D) is a method of assessing biodiversity.

The formula for Simpson's Index of Diversity is:

$$D = 1 - \left(\Sigma\left(\frac{n}{N}\right)^2\right)$$

n = number of individuals of each species present in the sample
N = total number of all individuals of all species

(i) In an investigation of biodiversity in a pond, samples of pond animals were removed using sampling nets. The species of each animal was identified and the number of individuals of each species was recorded.

Table 8.1 shows the results of the investigation.

Calculate Simpson's Index of Diversity by completing Table 8.1 in the spaces provided. Record your values to three decimal places.

Write the value for Simpson's Index of Diversity on the dotted line. Record your value to three decimal places.

Table 8.1

species	number	$\frac{n}{N}$	$\left(\frac{n}{N}\right)^2$
Rana temporaria	10	0.042	0.002
Leucorrhinia dubia	35	0.148	0.022
Hydrometra stagnorum	50	0.212	0.045
Lymnaea stagnalis	44	0.186	0.035
Gammarus pulex	97		
total	236		

Simpson's Index of Diversity (D) = ...

[3]

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(ii) Explain what this value for Simpson's Index of Diversity shows about the diversity of the pond.

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..... [2]

[Total: 8]

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1. Nov/2021/Paper_41/No.3

Ecological surveys are conducted before conservation decisions are made. For example, surveys can be carried out before deciding whether to reintroduce a species to its former habitat.

(a) Outline how an ecological survey can measure the biodiversity of a terrestrial habitat.

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(b) Table 3.1 lists some mammal species that became extinct in Great Britain or were introduced into Great Britain in the last 12400 years.

The reasons for each extinction or introduction and the time of each event are shown.

Table 3.1

species	number of years before present time	event	reason
arctic fox	12400	extinction	climate change
sheep	5400	introduction	farming
house mouse	3500	introduction	accidental
lynx	1500	extinction	hunting
fallow deer	900	introduction	food
South American coypu	86	introduction	fur
South American coypu	33	extinction	conservation culling

With reference to Table 3.1, state **and** explain the factors that have had a negative impact on biodiversity in Great Britain.

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..... [4]

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(c) Non-governmental and government organisations are working together to reintroduce a lynx population to its former habitat in a remote part of Great Britain. Lynx are predatory big cats.

Fig. 3.1 shows a lynx.



Fig. 3.1

Suggest the factors that need to be considered by organisations to successfully reintroduce and restore a breeding population of lynx in Great Britain.

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..... [5]

[Total: 13]

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2. Nov/2021/Paper_42/No.4

(a) Genome-wide association studies find links between single nucleotide polymorphisms (SNPs) and phenotypic features such as human diseases. SNPs are points on the DNA that vary in the population because of DNA base substitutions.

A genome-wide association study investigates the effect of genetic variation on a disease. A large number of people with the disease and a large number of healthy control individuals provide DNA. Microarray chips are used to identify the genotype of each individual at many SNPs.

The Wellcome Trust Case Control Consortium (WTCCC) study was an important genome-wide association study.

- The study used a microarray chip that identified each person's genotype at 500 000 different SNPs.
- The study looked for links between SNPs and 7 different diseases.
- For each disease, 2000 people with the disease were tested.
- Their results were compared with the results of 3000 healthy control individuals.

(i) Outline how microarrays are used in the analysis of genomes.

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..... [4]

(ii) Explain why bioinformatics was important to the WTCCC study.

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..... [2]

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(b) Fig. 4.1 summarises results for three diseases in the WTCCC study. The 22 human autosomes and the X chromosome (chromosome 23) are shown.

Chromosome locations with SNPs that are associated with a disease at a statistically significant level (greater than 5 arbitrary units) are shown in black.

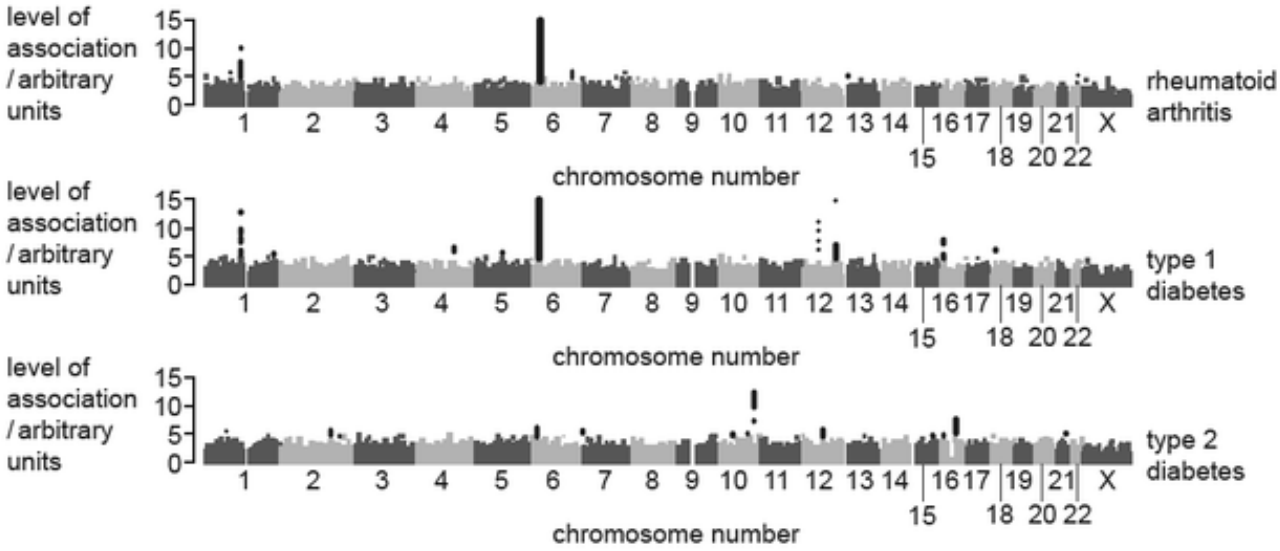


Fig. 4.1

(i) Identify the chromosomes that contain SNPs that have a high level of association with **both** rheumatoid arthritis and Type 1 diabetes.

..... [1]

(ii) With reference to Fig. 4.1, compare the genetic basis of the three diseases.

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..... [2]

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(c) Individuals can choose to have their DNA analysed on a microarray chip to predict their risk of developing different diseases.

Outline the social **and** ethical considerations of this type of DNA analysis.

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..... [3]

[Total: 12]

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1. June/2022/Paper_41/No.1(a)

(a) The golden mantella, *Mantella aurantiaca*, is a small terrestrial frog found in Madagascar.

Fig. 1.1 shows a golden mantella.



Fig. 1.1

(i) Name the domain and kingdom to which the golden mantella belongs.

domain .....

kingdom .....

[2]

(ii) The skin of the golden mantella is brightly coloured and contains a toxin.

Suggest a benefit to the frog of being brightly coloured.

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..... [1]

2. June/2022/Paper_41/No.8

(a) Over the past 200 years, many species of animals and plants have become extinct.

Fig. 8.1 shows the changes between the years 1800 and 2000 in:

- the number of species becoming extinct
- the size of the world human population.

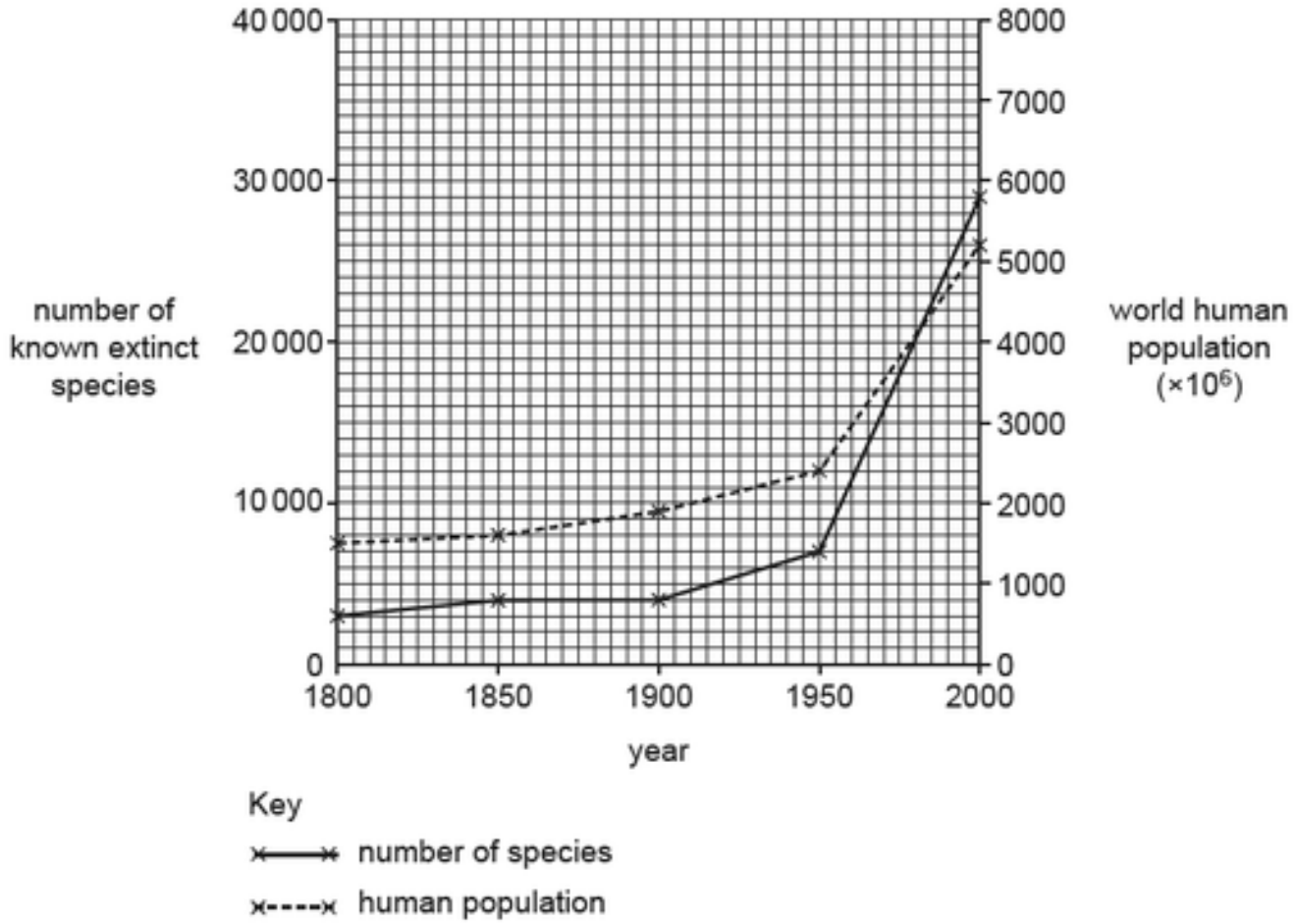


Fig. 8.1

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(i) It has been suggested that there is a correlation between the number of species becoming extinct and the size of the world human population.

Suggest reasons for this possible correlation.

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..... [3]

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(ii) Calculate the rate of species extinction per year between 1950 and 2000.

Show your working.

answer = ... [2]

(b) Extinction of animal and plant species reduces biodiversity.

Explain why it is important to maintain biodiversity.

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[Total:12]

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3. June/2022/Paper_42/No.7

The bacterium, *Escherichia coli*, can use glucose or disaccharides, such as lactose, in its metabolism. Lactose needs to be hydrolysed by the enzyme β-galactosidase to form glucose and galactose, which can then be used by *E. coli*.

The production of β-galactosidase is controlled by a length of DNA called the *lac* operon.

(a) Fig. 7.1 shows the *lac* operon when lactose is **absent**.

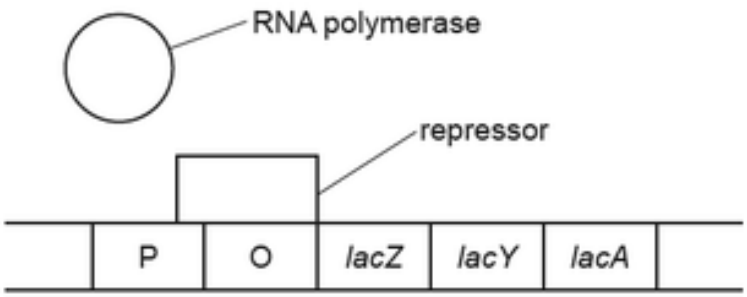


Fig. 7.1

On Fig. 7.2, draw the positions of RNA polymerase and the repressor molecule when lactose is **present**.

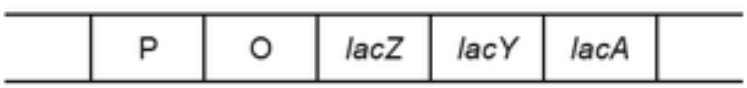


Fig. 7.2 [2]

(b) The protein coded for by *lacY* is not involved in the control of gene expression.

(i) Name the type of gene represented by *lacY*.

..... [1]

(ii) Name the protein product coded for by *lacY* **and** state the precise role of this protein.

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..... [2]

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(c) In an investigation into the growth of *E. coli*, a sample of the bacterium was grown in a medium that contained limited concentrations of glucose and lactose. The population size of *E. coli* was measured at regular intervals.

Fig. 7.3 shows the population growth curve obtained for this investigation.

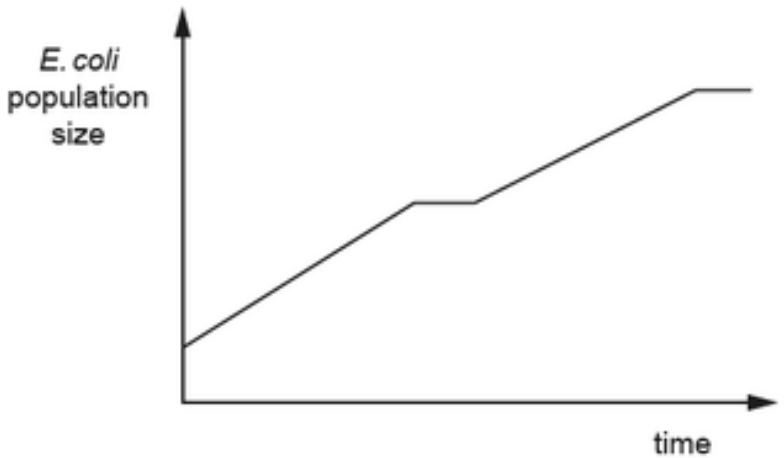


Fig. 7.3

Describe **and** suggest explanations for the population growth curve shown in Fig. 7.3.

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..... [4]

[Total: 9]

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4. June/2022/Paper_43/No.8

(a) The Malayan tapir, *Tapirus indicus*, lives in the rainforest of South East Asia.

Fig. 8.1 shows a Malayan tapir and her calf.



Fig. 8.1

On the International Union for the Conservation of Nature (IUCN) Red List of Threatened Species, the Malayan tapir is categorised as endangered and could become extinct. One problem is the illegal trade in the Malayan tapir.

Apart from illegal trading, suggest **and** explain reasons why the Malayan tapir has become endangered and could become extinct.

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..... [2]

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(b) The trade in Malayan tapirs is regulated by the Convention on International Trade in Endangered Species (CITES).

Suggest ways by which CITES attempts to regulate the trade in wild fauna and flora.

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..... [3]

(c) Many endangered species, such as the Malayan tapir, are protected in zoos.

Outline the role of zoos in the conservation of endangered species.

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..... [4]

[Total: 9]

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1. Nov/2022/Paper_41/No.1

The wild Bactrian camel, *Camelus ferus*, lives only in the desert regions of Mongolia and northern China.

Fig. 1.1 shows a wild Bactrian camel.



Fig. 1.1

(a) The wild Bactrian camel is at risk of extinction in the wild and is categorised as critically endangered by the International Union for Conservation of Nature (IUCN). There are only 950 wild Bactrian camels left in their natural habitat.

Suggest reasons why the wild Bactrian camel has become critically endangered.

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..... [2]

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(b) Outline the role of the IUCN.

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..... [3]

(c) Some zoos use assisted reproduction techniques, such as embryo transfer, in their captive breeding programmes for endangered species. Embryo transfer has resulted in domesticated dromedary camels giving birth to wild Bactrian camel calves.

Describe the procedure of embryo transfer in a mammal such as a camel.

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..... [4]

[Total: 9]

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1. March/2023/Paper_ 9700/42/No.10

(a) The passage in Fig. 10.1 is about biodiversity.

Complete the passage by using the most appropriate scientific terms.

Biodiversity within an area can be assessed at different levels, including the species diversity, genetic diversity and ecological diversity.

Species diversity can be assessed by determining the number of different species and the relative ..... of different species in a given area. From this information, species diversity can be estimated using ..... index of diversity.

Organisms of the same species can show much genetic diversity even though they share the same ..... . This is because they can have different combinations of ..... .

The greater the genetic diversity, the greater the ability of a species to ..... to a changing environment.

Ecological diversity is a measure of the number and range of different ecosystems and ..... within a given area.

Fig. 10.1

[6]

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(b) The International Union for Conservation of Nature (IUCN) Red List of Threatened Species is updated regularly.

Table 10.1 shows the numbers of endangered animal species counted every three years between 2007 and 2019.

Table 10.1

year	number of endangered species
2007	7851
2010	9618
2013	11212
2016	12630
2019	14234

(i) Calculate the rate of increase in the number of endangered species between 2007 and 2019.

Show your working.

Give your answer to the nearest whole number.

rate of increase = ... per year
[2]

(ii) More species of fish were listed as endangered in 2019 than species of mammals.

Suggest reasons why more fish species than mammal species are endangered.

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..... [4]

[Total: 12]

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2. June/2023/Paper_ 9700/41/No.2

The natural **ecosystem** on Hawadax Island in Alaska was disrupted in the 1780s when brown rats, *Rattus norvegicus*, swam to the island from a sinking ship and then rapidly increased their population size.

The rats occupied a new **niche** on the island as predators. The rats ate the eggs and chicks of birds such as the black oystercatcher, *Haematopus bachmani*, and the glaucous-winged gull, *Larus glaucescens*. These birds make nests, lay eggs and rear their chicks on the beaches of the island.

(a) Define the terms ecosystem and niche.

(i) ecosystem

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..... [2]

(ii) niche

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..... [1]

Conservation ecologists carried out a project to try to restore the natural ecosystem of Hawadax Island. In 2008, they removed all rats from the island.

Before removing the rats, the ecologists measured the abundance of birds, invertebrates and seaweeds on eight of the island's beaches. Seaweeds are large algae that grow attached to rocks on the beach. The ecologists repeated these measurements in 2013 and in 2019, so that they could calculate the percentage change in abundance from 2008.

(b) To measure the abundance of invertebrates and seaweeds, the ecologists used this method:

- They laid 30 m tapes from high-tide mark to low-tide mark on the beach.
- They placed quadrats at 5 metre intervals next to the tapes.
- They took a photograph of each quadrat.
- They analysed the photographs to calculate the percentage cover of seaweeds and the percentage cover of invertebrates such as mussels and sea snails.

(i) State the name of the sampling technique used.

..... [1]

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(ii) Biodiversity can be assessed at a number of different levels.

Identify the levels of biodiversity:

- that were assessed by this sampling technique
- that were **not** assessed by this sampling technique.

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..... [3]

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(c) Table 2.1 shows the percentage change in abundance of some of the seaweeds, invertebrates and birds found on the beaches of Hawadax Island.

Table 2.1

organism	percentage change from 2008 to 2013	percentage change from 2008 to 2019
seaweeds	+2	+49
mussel, *Mytilus*	–94	–99
sea snail, *Littorina*	–47	–91
black oystercatcher, *Haematopus bachmani*	+400	+800
glaucous-winged gull, *Larus glaucescens*	+126	+191

(i) Use Table 2.1 to state the **genus** name of **one** organism that has **increased** in abundance.

..... [1]

(ii) Seaweeds were once thought to be plants but are now classified in the kingdom Protoctista.

Outline the features of the kingdom Protoctista that are shown by **seaweeds**.

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..... [2]

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(d) To evaluate the success of the Hawadax Island restoration project, the ecologists obtained data from other islands near to Hadawax Island.

- Some islands had never been occupied by rats (rat-free islands) and had a healthy ecosystem.
- Some islands were still occupied by rats (rat-occupied islands) and had a disrupted ecosystem.

Table 2.2 shows the percentage differences in the abundance of organisms in rat-free islands compared with rat-occupied islands.

Table 2.2

organism	percentage difference in rat-free islands compared to rat-occupied islands
seaweeds	+68
mussel, *Mytilus*	–97
sea snail, *Littorina*	–83
black oystercatcher, *Haematopus bachmani*	+883
glaucous-winged gull, *Larus glaucescens*	+914

With reference to Table 2.1 and Table 2.2, suggest **and** explain how removing rats has restored the ecosystem on Hawadax Island.

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..... [4]

[Total: 14]

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3. June/2023/Paper_ 9700/42/No.5

(a) Warfarin is a poison used to kill rats. Some rats are resistant to warfarin and can survive the effects of the poison. Warfarin resistance is due to a mutant dominant allele at a single gene locus.

Researchers investigated the population of brown rats on a large island where there are no predators of rats. On this island, warfarin is used to try to control the rat population.

The researchers found that 40% of the population of rats was resistant to warfarin.

(i) Use Hardy–Weinberg equation 1 and equation 2 to calculate the percentage of the population of rats on the island that is heterozygous for warfarin resistance.

equation 1 $p + q = 1$

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

Show your working.

answer ..... % [3]

(ii) In natural populations, it is usual to find that only some of the conditions of the Hardy–Weinberg principle are met.

Suggest **and** explain which of the conditions of the Hardy–Weinberg principle are most likely to be met for the island population of brown rats.

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(b) Dominant advantageous alleles and recessive advantageous alleles both naturally occur in populations.

Explain why, when a new **dominant** advantageous allele occurs, its frequency increases more quickly in the population than when a new **recessive** advantageous allele occurs.

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..... [3]

[Total: 10]

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4. June/2023/Paper_ 9700/42/No.10

(a) Many zoos around the world are involved in captive breeding programmes for endangered species.

Outline the role of zoos in the conservation of endangered species, **other than** captive breeding programmes.

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..... [3]

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(b) Chester Zoo, in the United Kingdom, controls the European captive breeding programme for the eastern black rhinoceros, *Diceros bicornis michaeli*.

Fig. 10.1 shows an eastern black rhinoceros.

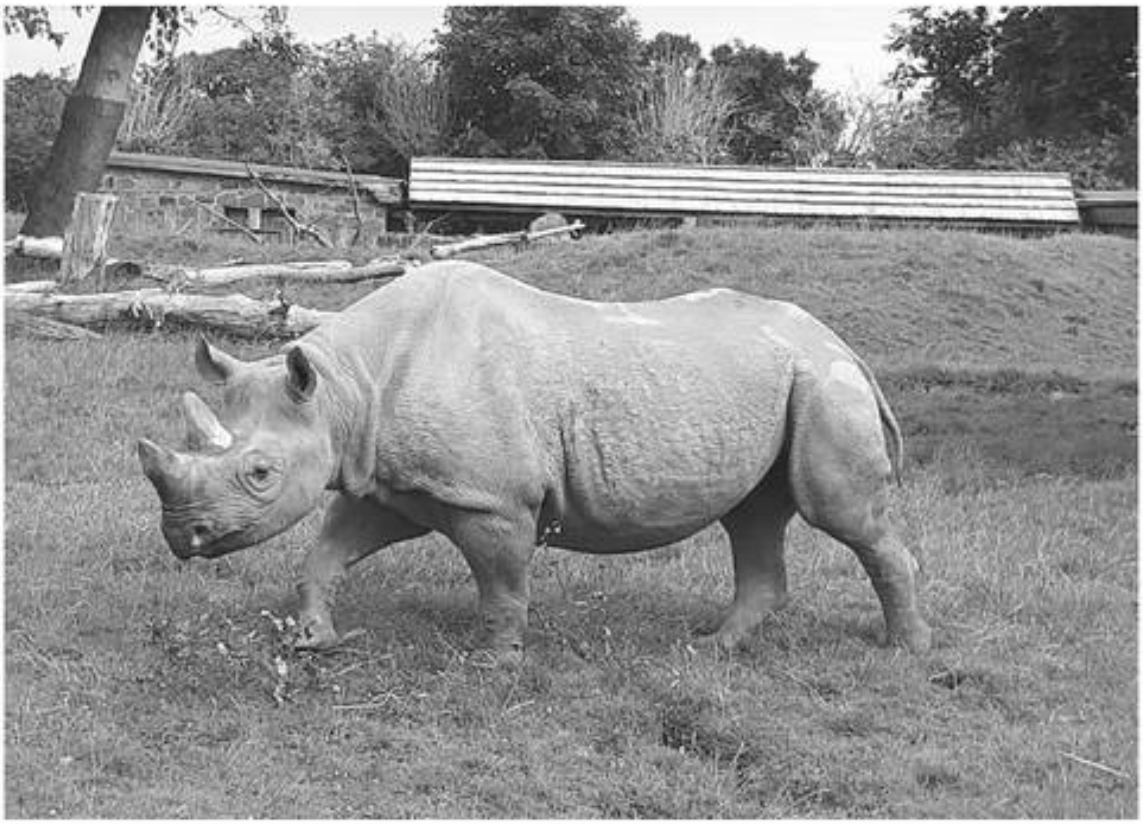


Fig. 10.1

In the captive breeding programme for the eastern black rhinoceros, 15.8% of females breed each year while in the wild 23.7% of females breed each year.

Suggest reasons why fewer females breed in captivity than in the wild.

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..... [4]

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(c) Sometimes assisted reproduction is used in captive breeding programmes for the eastern black rhinoceros.

Fig. 10.2 outlines the process of IVF that is used in these programmes.

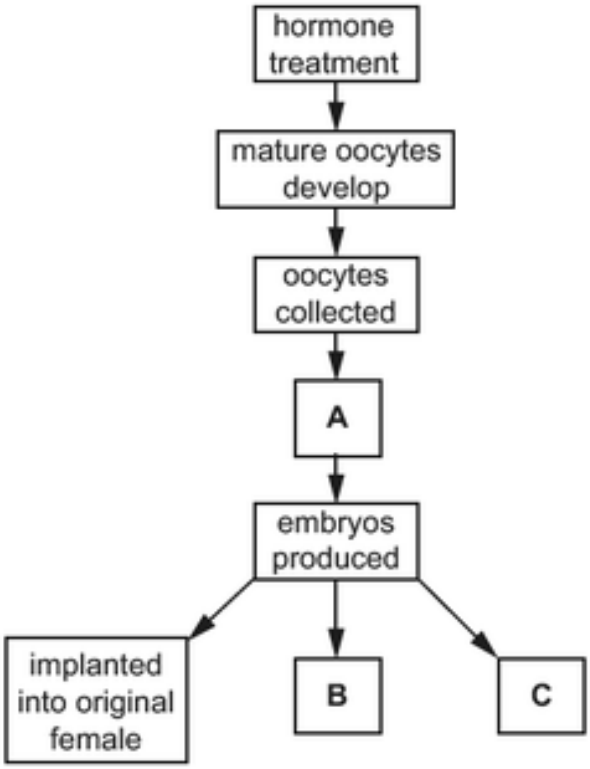


Fig. 10.2

Outline:

- the event **A** that occurs in the production of the embryos
- the **two** other possible outcomes, **B** and **C**, for the embryos that have been produced.

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..... [3]

[Total: 10]

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5. June/2023/Paper_ 9700/43/No.10

(a) The moose, *Alces alces*, is a large member of the deer family. It lives in temperate forests in North America and northern Europe, where snow is present for large parts of the year.

Fig. 10.1 shows an adult male moose feeding in a lake.



Fig. 10.1

The moose feeds on a plant in the lake called watermilfoil, *Myriophyllum aquaticum*.

The moose and the watermilfoil belong to the domain Eukarya, which includes the kingdoms Animalia and Plantae.

Describe the main differences between the kingdom Animalia and the kingdom Plantae.

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(b) Measurements of the surface temperature of land and oceans can be taken from locations around the world. The mean global surface temperature for land and ocean combined can be calculated for a fixed time period.

Scientists calculated:

- the mean global temperature for the twentieth century
- the mean global temperature for each decade (ten years) from 1880 to 2020.

The mean temperature for each decade was compared to the mean for the twentieth century. For each decade, the difference in temperature was calculated.

The calculated differences are shown in Fig. 10.2.

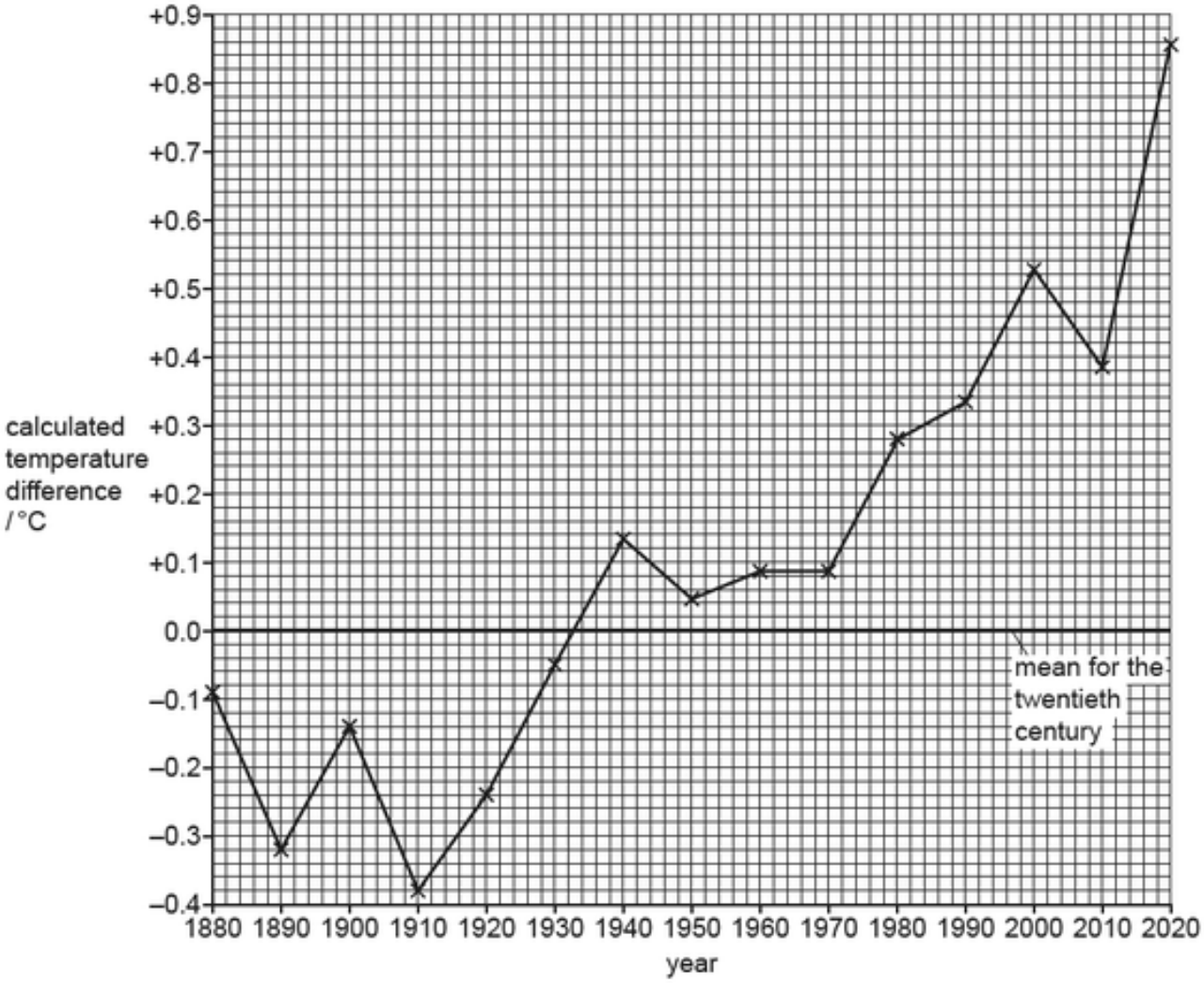


Fig. 10.2

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(i) Calculate the rate of increase in temperature per **decade** between 1980 and 2020.

Show your working.

Write your answer to **two** decimal places.

answer ..... °C per decade [2]

(ii) Moose populations have decreased in North America since 1980.

Suggest **and** explain reasons for the decrease in moose populations.

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[Total: 9]

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1. Nov/2023/Paper_9700/41/No.2

Biodiversity can be assessed at three different levels. One of these is the genetic variation within each species.

(a) Outline **two** other levels at which biodiversity can be measured.

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..... [2]

To calculate the genetic variation that exists within a species, scientists:

- obtain DNA sequences from many individuals of one species
- count the number of nucleotides that differ when the sequences of two individuals are compared
- repeat this with different pairs of individuals.

This allows scientists to calculate the **mean** number of differences at every nucleotide position along the sequence (mean number of nucleotide differences per site).

(b) Explain why scientists use databases and computers to calculate the mean number of nucleotide differences per site.

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(c) Table 2.1 shows the mean number of nucleotide differences per site of some species.

Table 2.1

species	mean number of nucleotide differences per site
Drosophila melanogaster, fruit fly	0.0087
Anopheles gambiae, mosquito vector of malaria	0.0301
Plasmodium falciparum, malarial pathogen	0.0015
Zea mays, wild maize	0.0139

(i) State the **genus** name of the species that shows the most genetic variation.

..... [1]

(ii) State how many kingdoms of organisms are represented in Table 2.1.

..... [1]

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(d) Genetic variation is considered important in the conservation of species. Low genetic variation is assumed to decrease the chance of the long-term survival of a species.

(i) Give reasons why low genetic variation may decrease the long-term survival of a species.

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Fig. 2.1 shows how the International Union for the Conservation of Nature (IUCN) categorises species according to their conservation status.

Common species with the lowest conservation status (least risk of extinction) are categorised as Least Concern (LC).

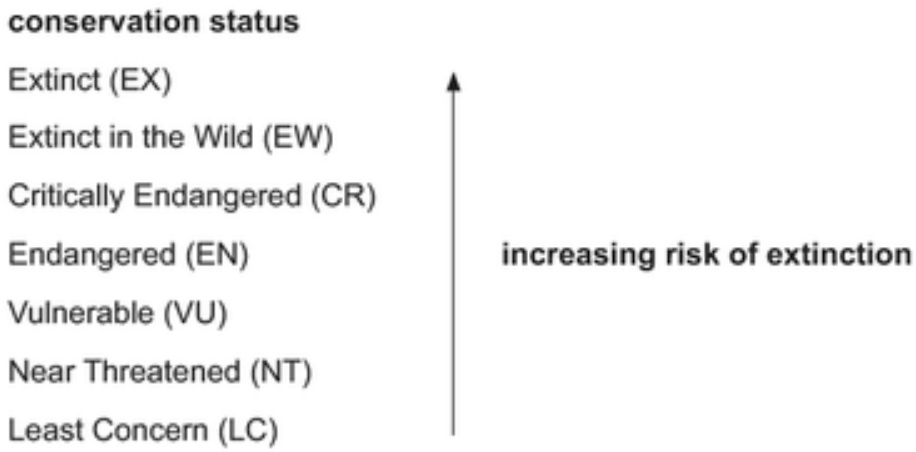


Fig. 2.1

(ii) Question **2(d)** states that 'low genetic variation is assumed to decrease the chance of the long-term survival of a species'.

Predict the relationship between genetic variation and conservation status if this assumption is true.

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..... [1]

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Fig. 2.2 shows the mean number of nucleotide differences per site of some species and sub-species of mammal and their conservation status.

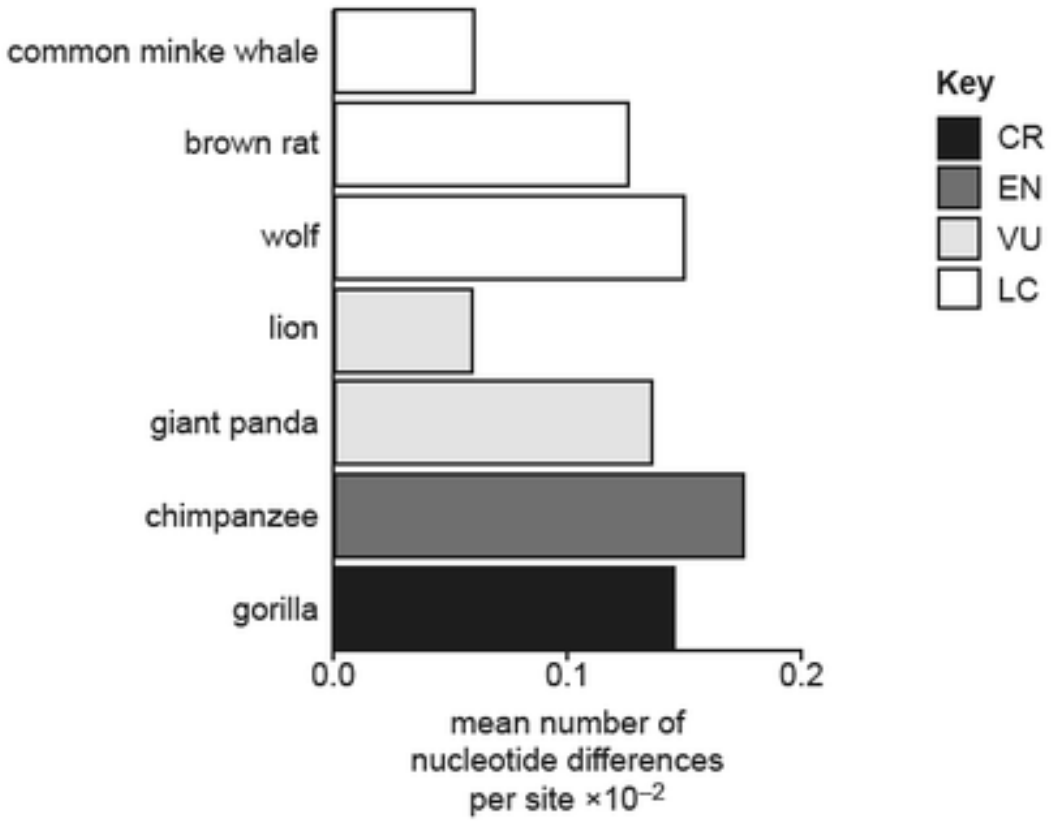


Fig. 2.2

(iii) Assess whether the data in Fig. 2.2 provide support for the prediction you made in **2(d)(ii)**.

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..... [3]

[Total: 14]

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2. Nov/2023/Paper_9700/41/No.3

There are more than 600 plant species in the genus *Ipomoea*. Many species are grown for their attractive flowers, and some species are used as crop plants.

(a) Fig. 3.1 shows *Ipomoea purpurea*, the common morning glory.



Fig. 3.1

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The gene that determines flower colour in *I. purpurea* has two alleles:

- a dominant allele that results in purple flowers
- a recessive allele that results in red flowers.

A student recorded the flower colour of all the *I. purpurea* plants in a field.

The student recorded 660 plants with purple flowers and 440 plants with red flowers.

Assuming the Hardy-Weinberg principle applies to this population, calculate the number of plants in the field that are heterozygous.

Use the equations:

$p + q = 1$

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

Show your working and give your answer to the nearest whole number.

number of heterozygous plants ..... [3]

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(b) The Japanese morning glory, *I. nil*, has over 20 different flower colour phenotypes, including shades of blue, purple, red and pink.

The flower colour of *I. nil* is controlled by at least four genes. The flower colour can change gradually after the flowers open each morning and can change with fluctuations in the carbon dioxide concentration of the surrounding air.

A student concluded that the flower colour phenotype in *I. nil* shows continuous variation.

Suggest **two** reasons why the student made this conclusion.

1 .....

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2 .....

..... [2]

(c) Scientists investigated the response of stomata to changing carbon dioxide (CO_2) concentrations in the beach morning glory, *I. pes-caprae*.

The scientists placed *I. pes-caprae* plants in chambers. They measured the width of open stomata (stomatal apertures) after the plants had been exposed to different CO_2 concentrations for 40 minutes. Light intensity and temperature were kept constant.

The relationship between CO_2 concentration and the mean width of stomatal apertures is shown in Fig. 3.2.

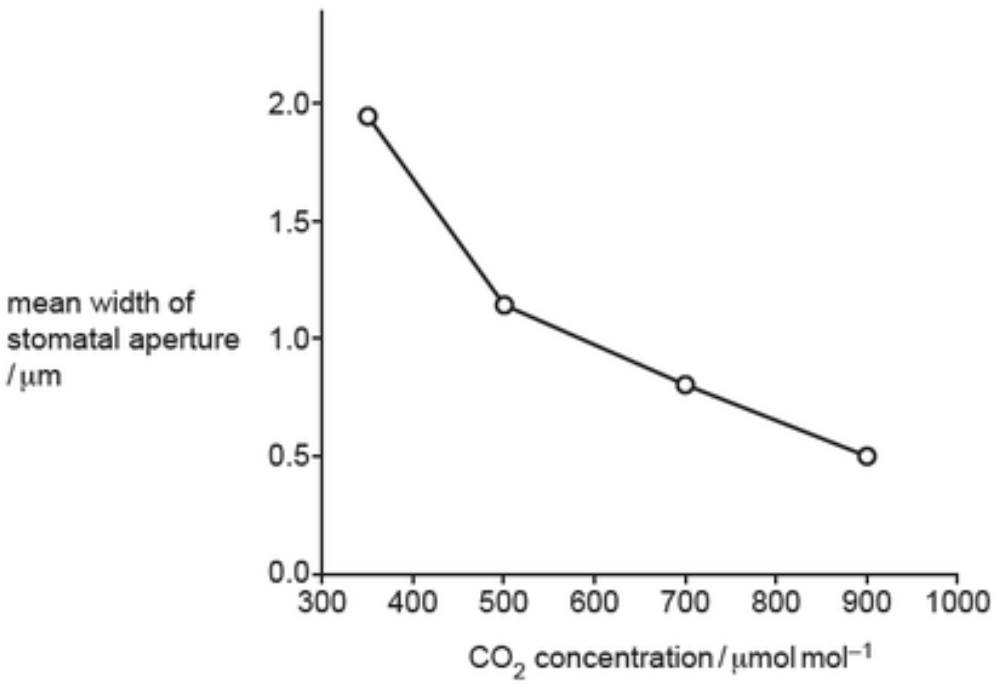


Fig. 3.2

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(i) In 2016, a study measured the atmospheric CO_2 concentration as 400 μmol mol^{-1}.

In the future, climate change may reduce water availability and increase atmospheric CO_2 concentrations in some habitats.

Suggest how the stomatal response shown in Fig. 3.2 would allow *I. pes-caprae* to survive the effects of climate change.

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..... [2]

(ii) Under certain conditions, the closure of stomata is controlled by abscisic acid.

Describe how abscisic acid causes the closure of stomata.

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..... [4]

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(d) Scientists are researching whether abscisic acid can be used in crop treatment to increase yield. Evidence suggests that abscisic acid modifies the effect of auxin on elongation growth in plants.

(i) Scientists investigated the effect of different concentrations of abscisic acid on root elongation in seedlings of thale cress, *Arabidopsis thaliana*.

The seedlings were divided into four groups:

- a control group (0.0 μmol abscisic acid)
- three experimental groups, each treated with a different concentration of abscisic acid: 0.1 μmol, 1.0 μmol, or 10.0 μmol.

For each group of seedlings, root length was measured for six days during treatment. The rate of root elongation was calculated each day.

The results are shown in Fig. 3.3.

Key

● control (no abscisic acid)

⊙ 0.1 μmol of abscisic acid

× 1.0 μmol of abscisic acid

△ 10.0 μmol of abscisic acid

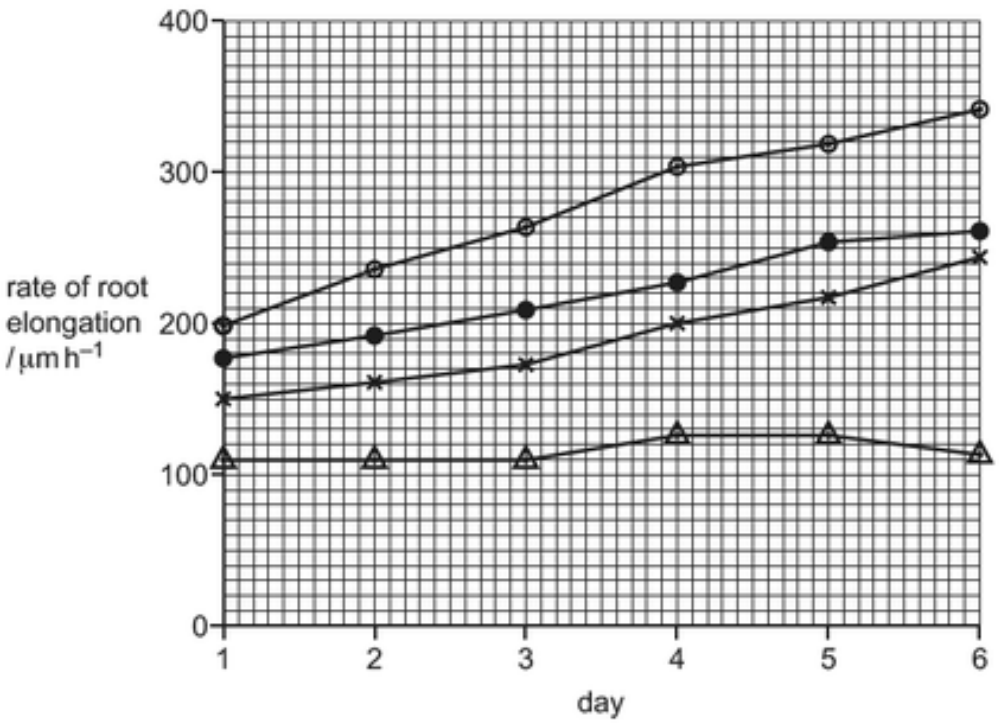


Fig. 3.3

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With reference to Fig. 3.3, describe the effect of treatment with abscisic acid on the rate of root elongation.

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(ii) The passage outlines the role of auxin in elongation growth in plants.

Complete the passage by using the most appropriate scientific terms.

The binding of auxin to receptors causes ..... to be pumped into cell walls.

This activates proteins called expansins, which disrupt the links between

..... microfibrils. The cell walls are then able to expand.

[2]

[Total: 16]

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3. Nov/2023/Paper_9700/41/No.9

Green lacewings are a family of insects with more than 1300 species.

The common green lacewing, *Chrysoperla carnea*, is shown in Fig. 9.1.

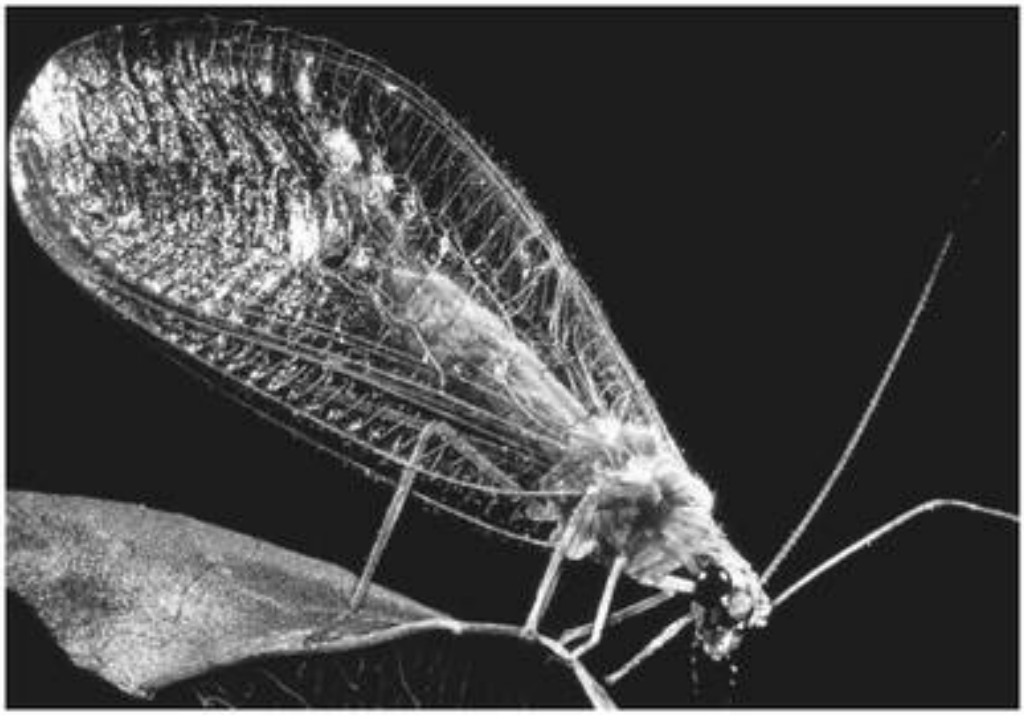


Fig. 9.1

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(a) Green lacewings have sense organs, known as tympanal organs, that detect sound.

The tympanal organ of green lacewings has evolved to detect the high frequency sounds that bats make when they are hunting. Bats eat green lacewings.

When a green lacewing senses the presence of a bat, it moves away or closes its wings in flight to escape.

(i) Outline how the tympanal organ of green lacewings could have evolved by natural selection.

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(ii) When high frequency sound is detected, the receptor cells in the tympanal organ stimulate the transmission of impulses in sensory neurones.

Describe the sequence of events that results in an action potential in a sensory neurone.

The first event in the sequence has been given for you.

Calcium ions enter the cytoplasm of the receptor cell .....

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..... [4]

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(b) Two species of green lacewing, *C. carnea* and *C. downesi*, evolved from a common ancestor.

The two species have populations with overlapping distributions in parts of North America.

Table 9.1 shows a comparison of the characteristics of overlapping populations of the two species.

Table 9.1

characteristic	*C. carnea*	*C. downesi*
breeding months	June to September	April to May
courtship song	song with a regular rhythm	song with no regular rhythm
colour	light green	dark green

Suggest how speciation occurred to produce the two different species of green lacewing.

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[Total: 10]

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4. Nov/2023/Paper_9700/42/No.10

(a) The passage outlines one method of estimating the size of an animal population.

Complete the passage by using the most appropriate scientific terms.

The size of a population of animals can be estimated using the mark-release-recapture method. A sample of animals is captured using a humane (harmless) trap and is counted. The animals are marked using a method that does not harm them. This can be done using a small tag or ..... . The marked animals are released into the area where they were captured. Time is allowed for the marked animals to mix into the population. This period of time must be short so that emigration, immigration, migration or ..... do not occur.

A second sample of animals is then captured and the number of marked and unmarked animals is counted. The population size can be estimated using the ..... Index. For reliability, the method should be ..... .

[4]

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(b) Himalayan balsam, *Impatiens glandulifera*, is an annual plant native to Pakistan, India and Nepal. It was first introduced into the United Kingdom (UK) in 1839 because of its attractive flowers. Individual plants can produce thousands of mature seeds. These can be dispersed for long distances when the capsules that contain the seeds burst.

Fig. 10.1 shows Himalayan balsam growing in a woodland.



Fig. 10.1

Himalayan balsam has now become established in the UK. It is listed as an invasive alien species and attempts are being made to eradicate (remove) the plant.

Not all alien plant species are considered to be invasive.

Suggest why Himalayan balsam has been listed as an invasive alien species in the UK.

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[Total: 8]

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