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.

(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]

(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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.....

.....

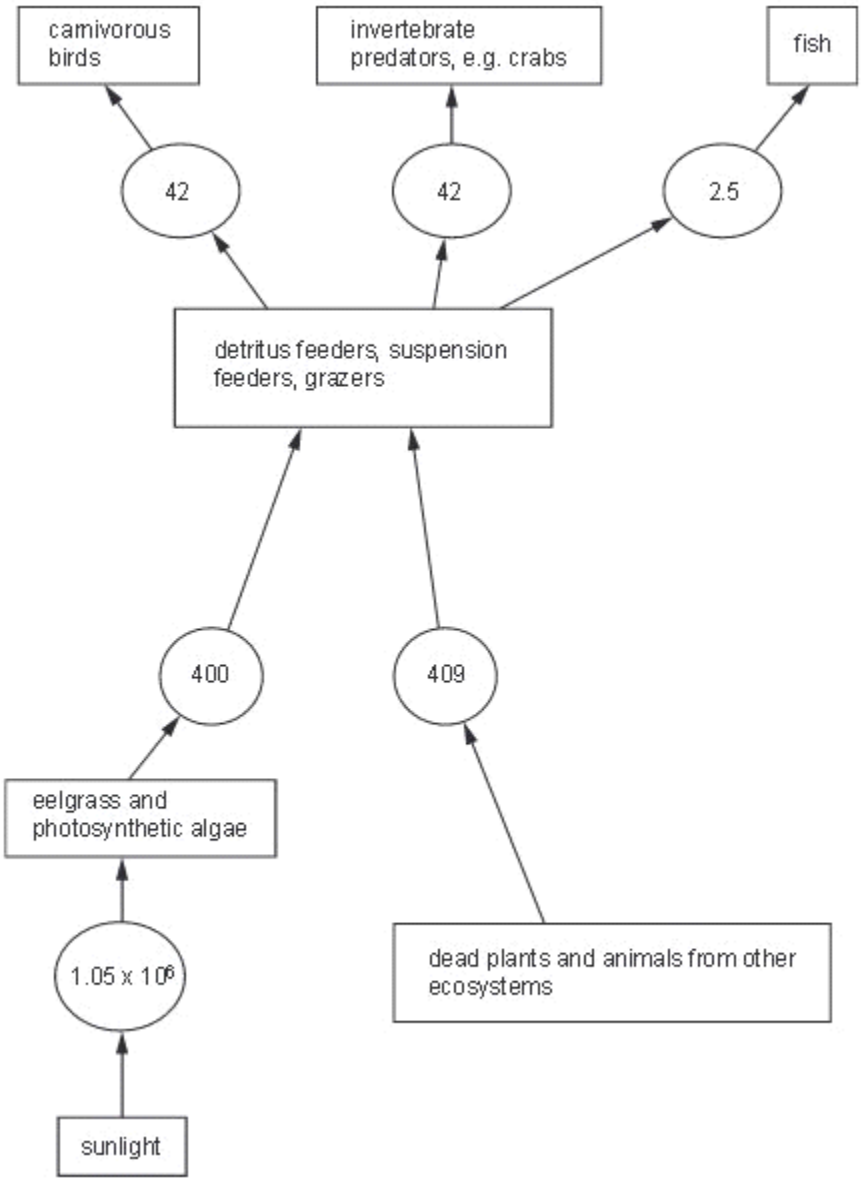
.....[3]

[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 $kJ\ m^{-2}\ yr^{-1}$.


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

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.

.....

.....

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.....

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..... [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.

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.

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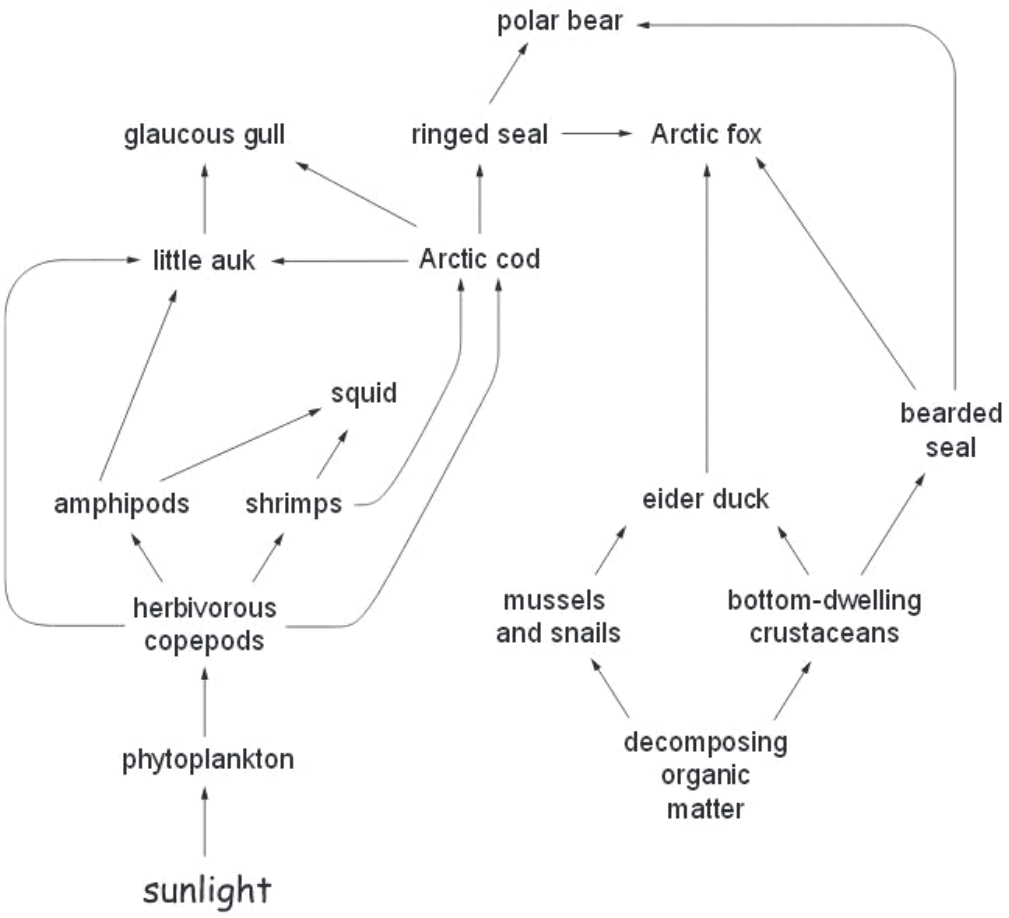
.....[3]

Q4.

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



(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]

(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.

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]

(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.

.....

.....

.....

.....

.....

.....[3]

[Total: 9]

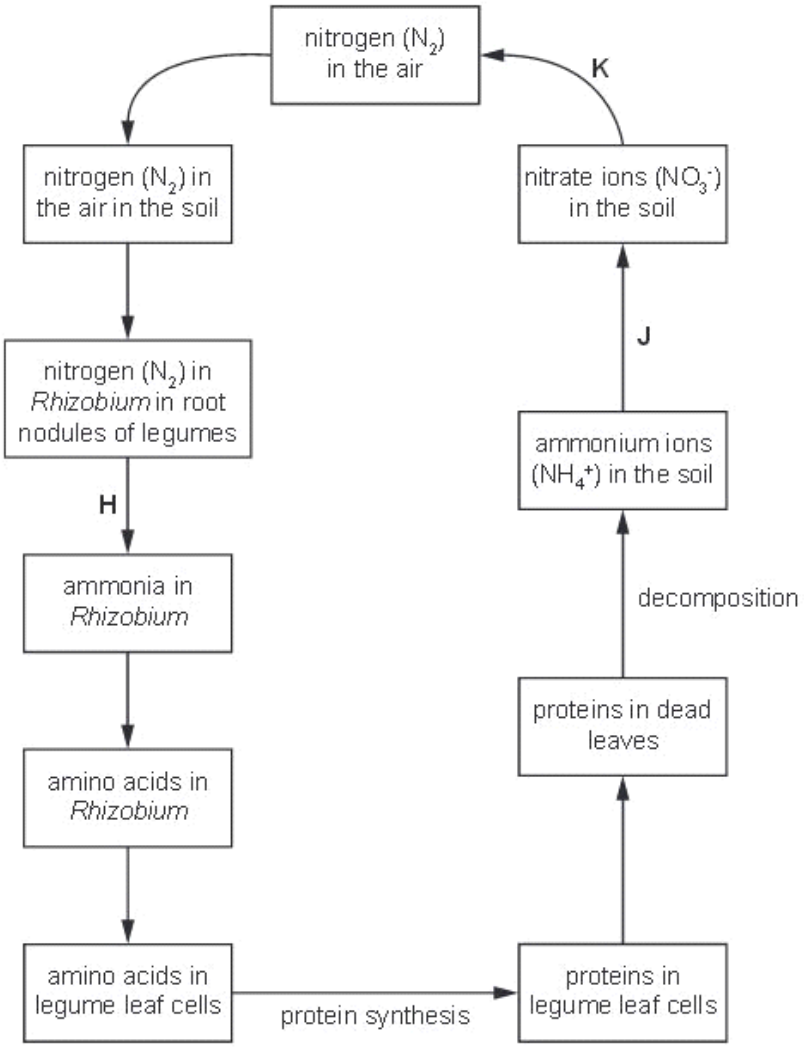
Q6.

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.



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

H .....

J .....

K .....[3]

(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]**

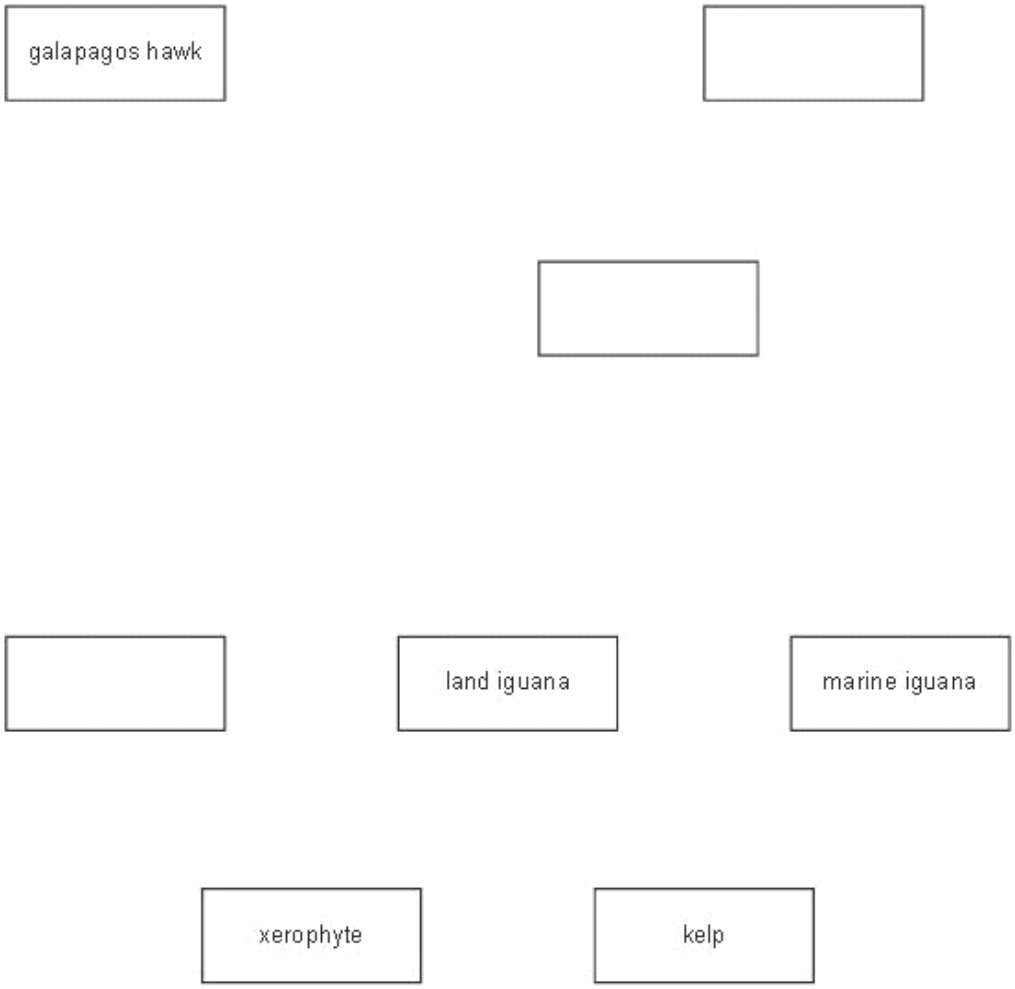


Fig. 6.1

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

.....

.....

.....

.....

.....[3]

[Total: 7]

Q8.

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.

(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.

.....

.....

.....

.....

.....

.....

.....

.....[4]

[Total: 8]

Q10.

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:

Ex

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]

(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.

.....

.....

.....

.....

.....

.....

.....

..... **[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*.

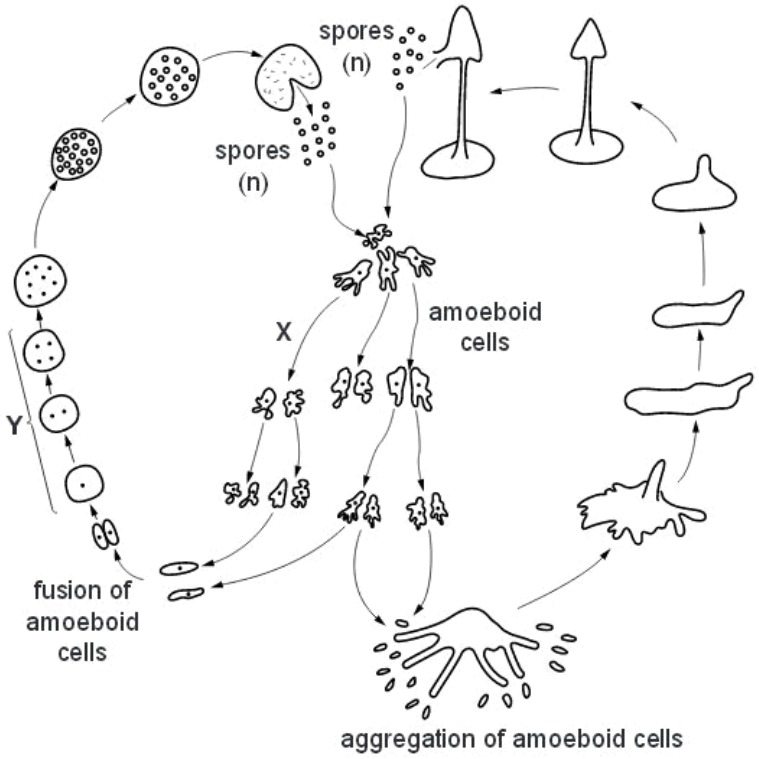


Fig. 5.1

(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]

(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]

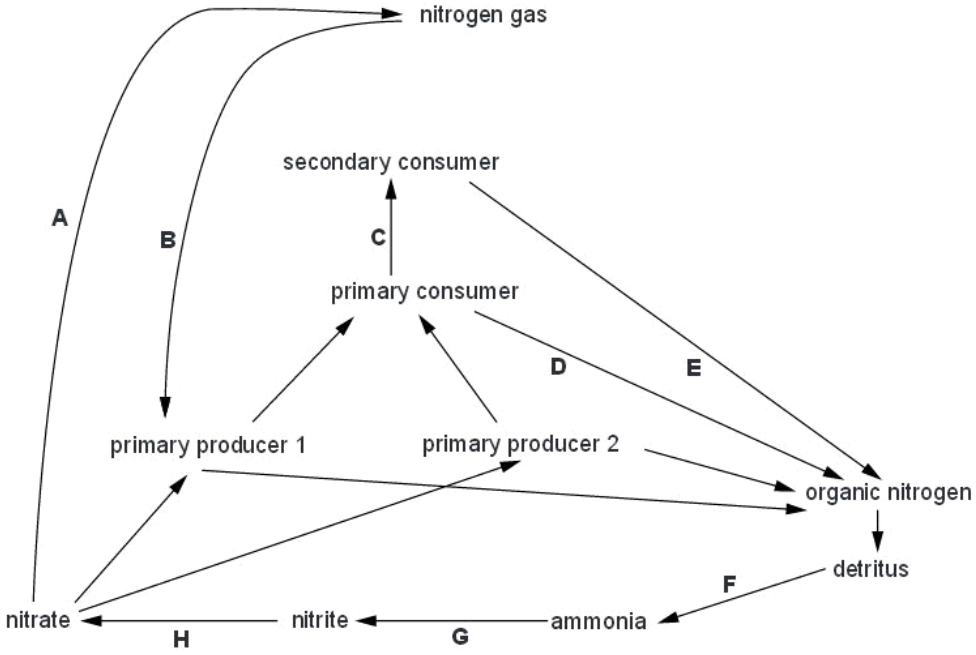
[Total: 8]

Q12.

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]

(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.

(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]

(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.

Exa

(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.

3 Fig. 3.1 shows part of the nitrogen cycle.

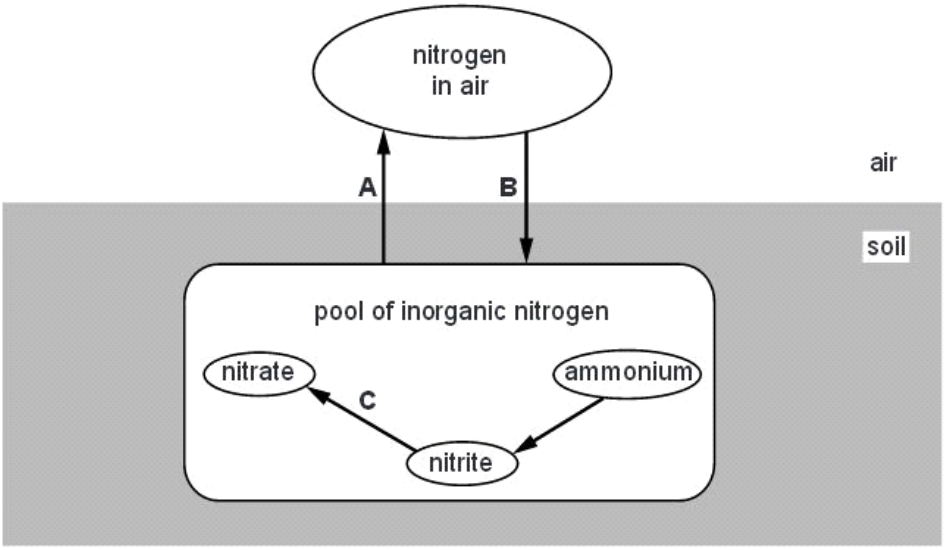


Fig. 3.1

(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]

(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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.....

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.....

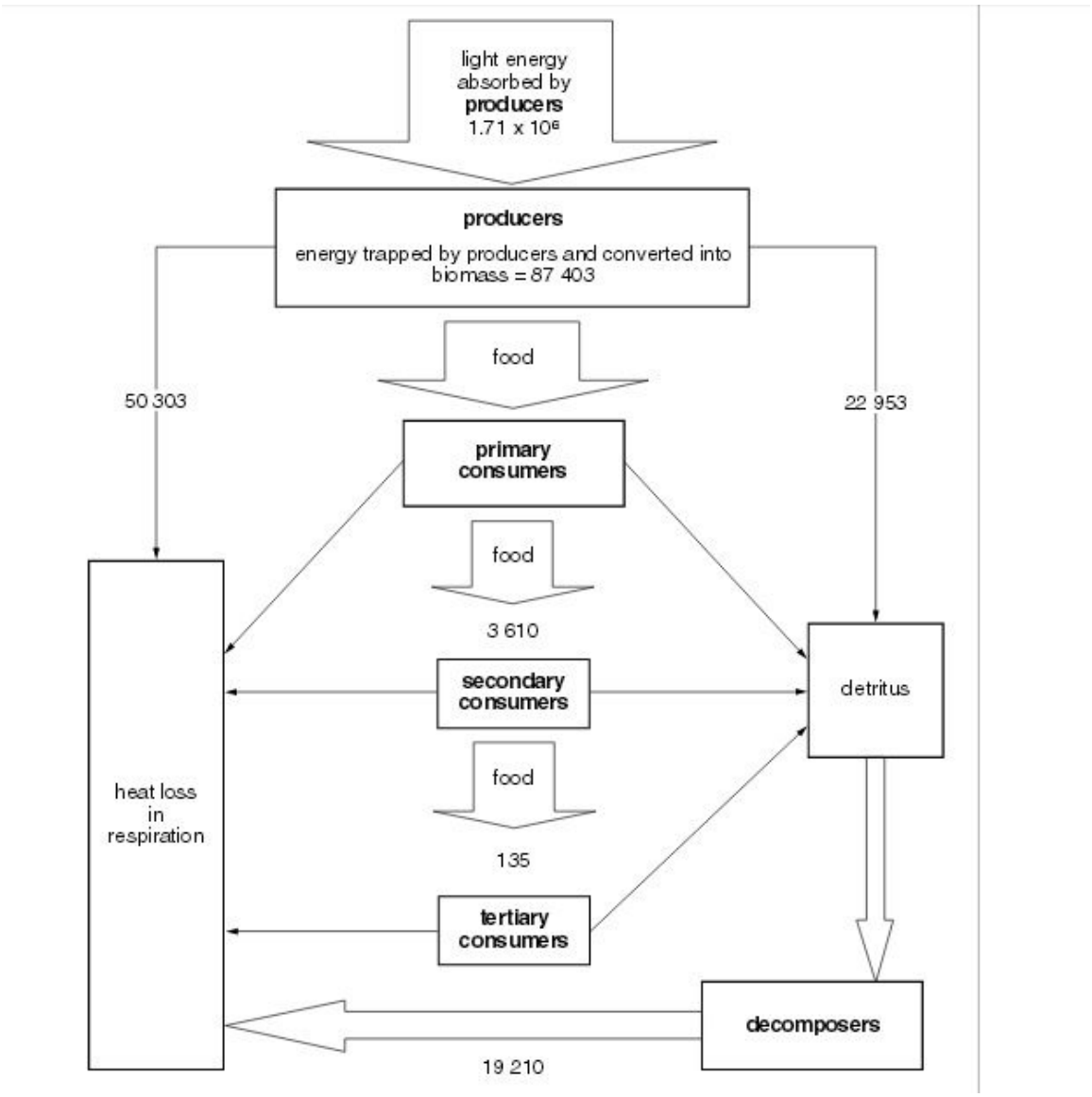
..... [3]

[Total: 11]

Q15.

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

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


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
food
heat loss in respiration
135
tertiary consumers
decomposers
19 210

(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.

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.

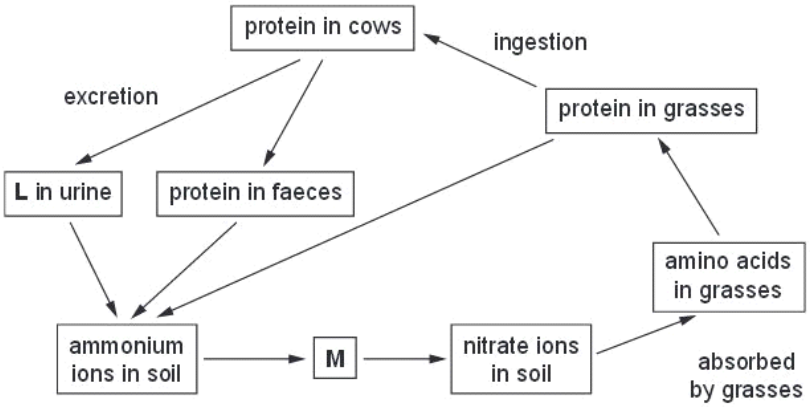


Fig. 3.1

(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]

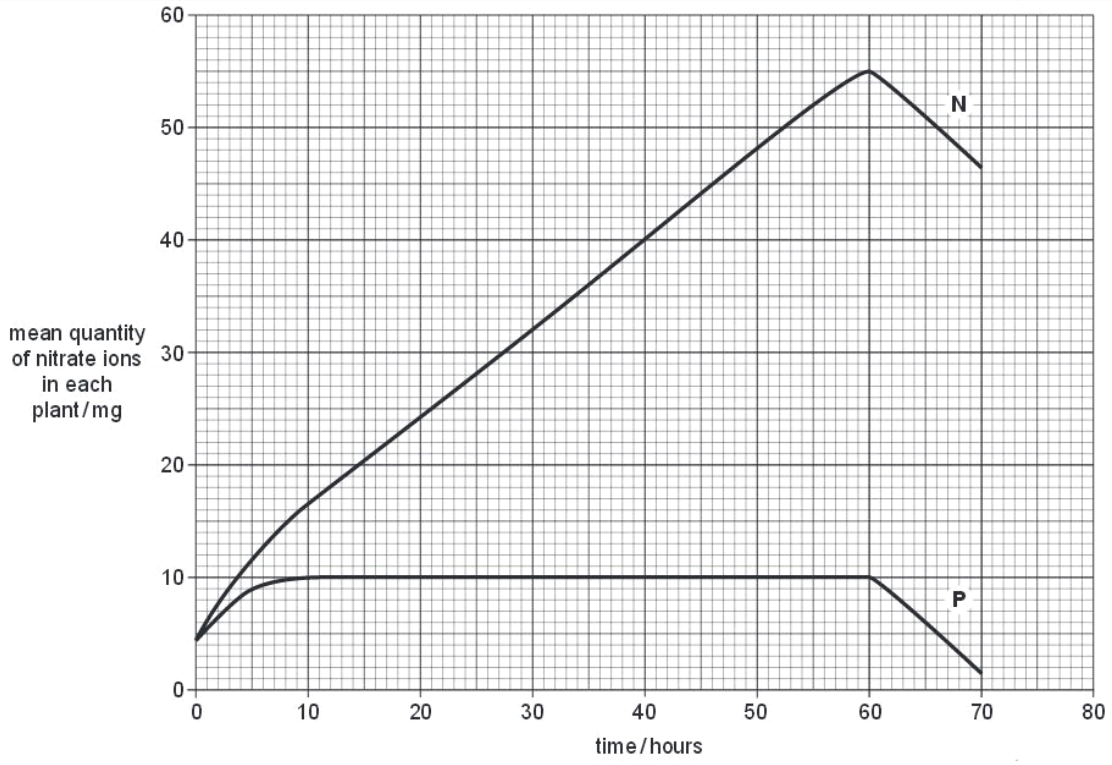
(c) Some young grass plants were grown with their roots in a mineral solution that contained nitrate ions. The plants were divided into two batches, **N** and **P**.

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]

(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.

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]

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.

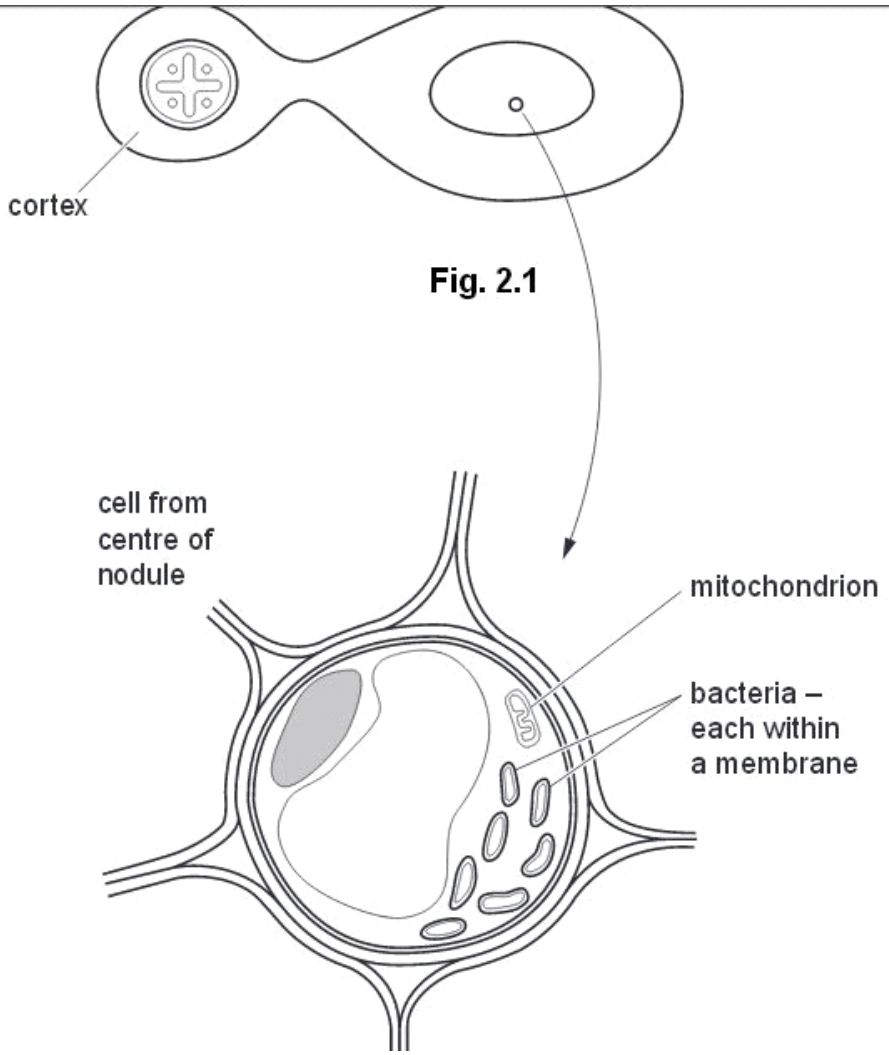


Fig. 2.1

(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]

(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.

.....

.....

.....

.....

.....

.....[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.

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.

.....

.....

.....

.....

.....

.....[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.

.....

.....

.....

.....

.....

.....[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.

.....

.....

.....

.....

.....

.....[3]

[Total: 9]

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.

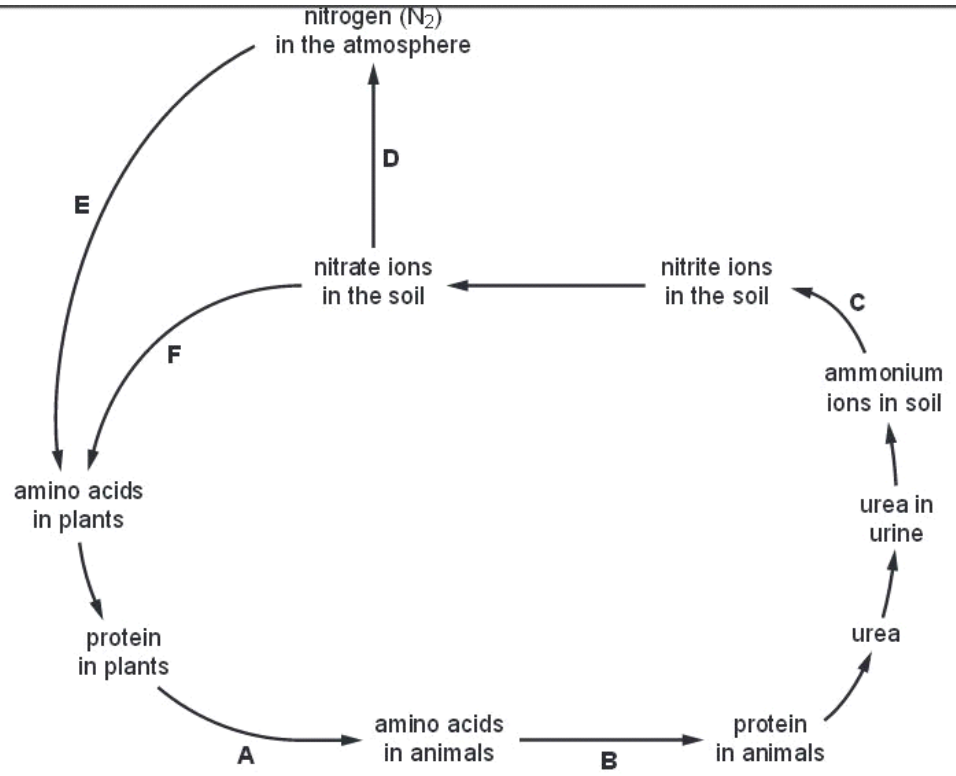


Fig. 6.1

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.

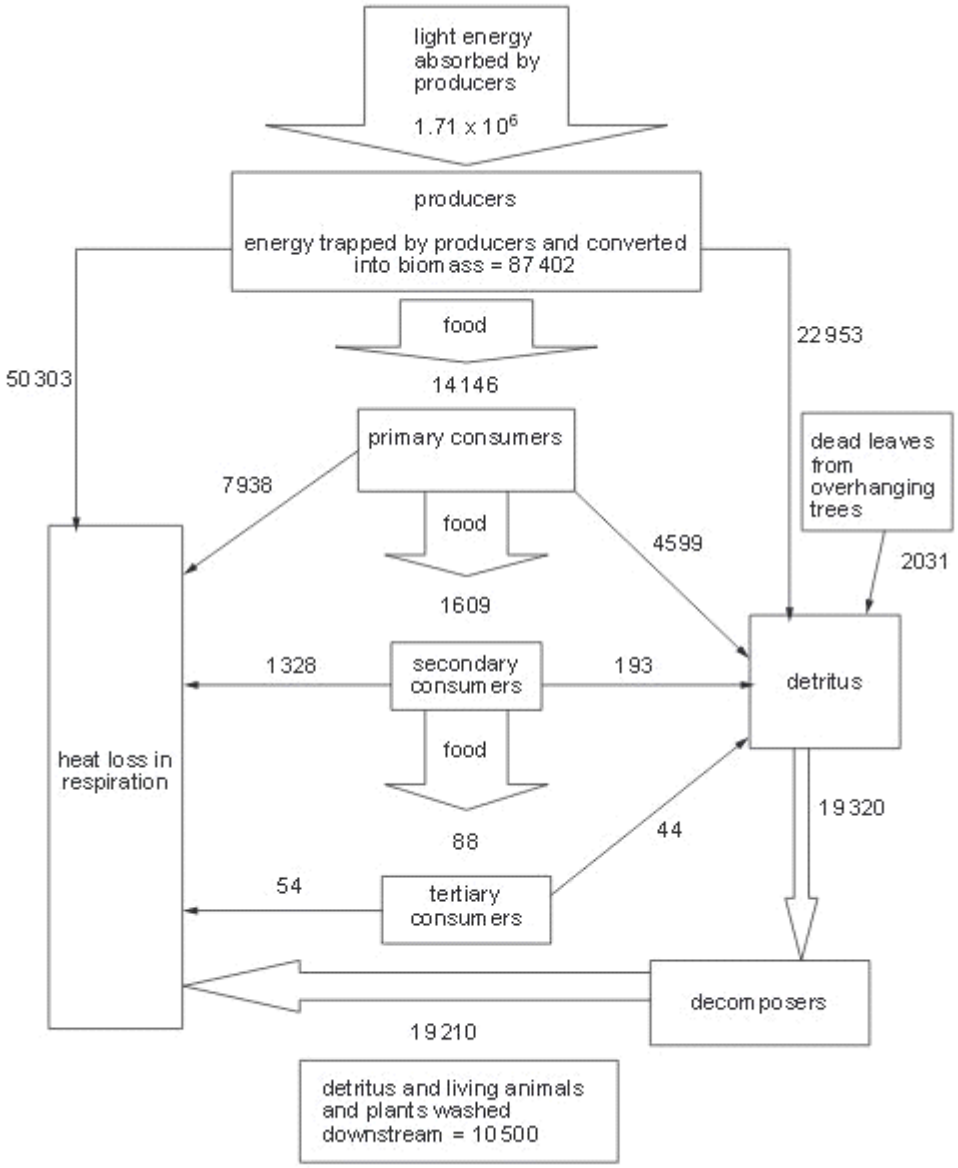

light energy absorbed by producers
1.71 x 10^6
producers
energy trapped by producers and converted into biomass = 87 402
food
14146
50303
22953
primary consumers
7938
food
1609
4599
dead leaves from overhanging trees
2031
heat loss in respiration
1328
secondary consumers
193
detritus
food
88
44
19320
54
tertiary consumers
decomposers
19210
detritus and living animals and plants washed downstream = 10500

Fig. 6.1

(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:

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

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.

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.....[2]

[Total: 9]

Q22.

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

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.....[2]

For Examiner Use

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

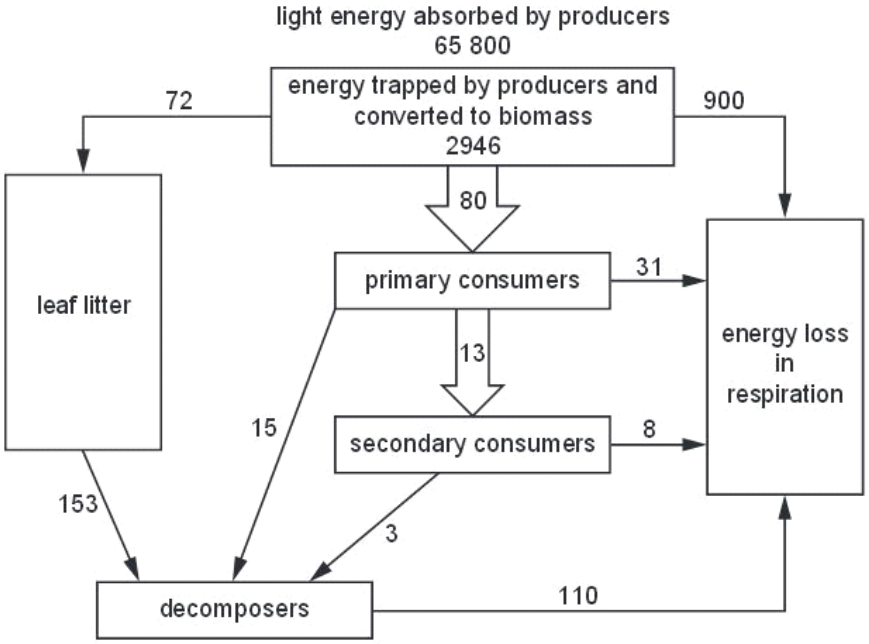

Fig. 6.1

(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]

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

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.....[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]

(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.

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

For Examiner's Use

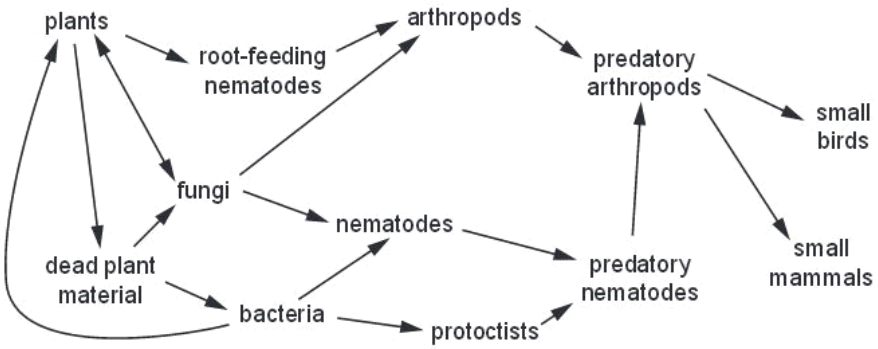

Fig. 6.1

(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.

.....

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.....

.....[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.

.....

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.....[2]

(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".

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.....[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]

(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]

(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.

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.

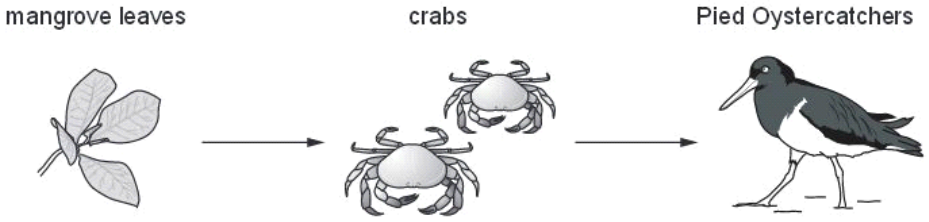

Fig. 6.1

(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]

(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]

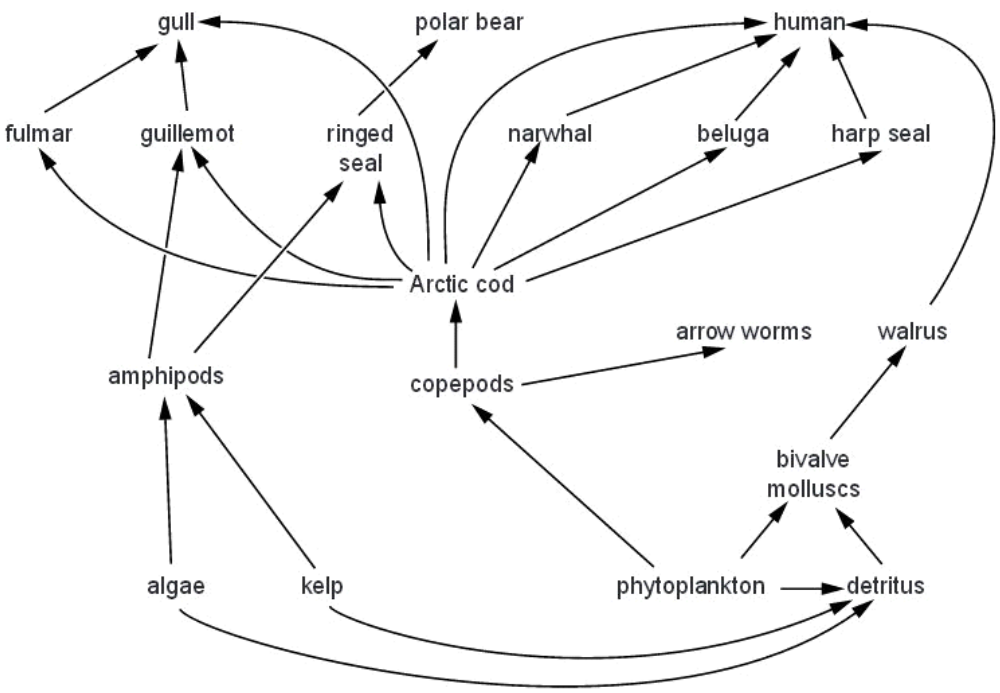
[Total: 10]

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.



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]

(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]

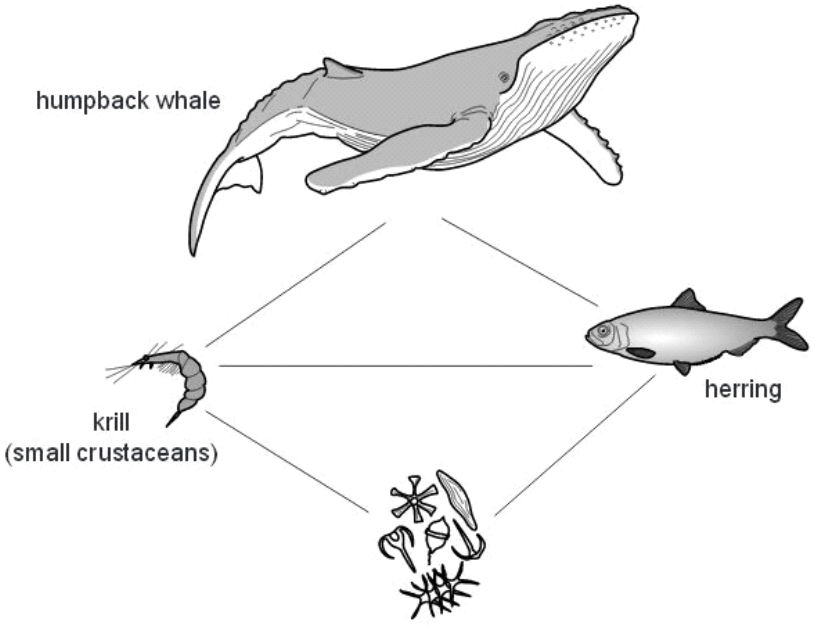
Q.29.

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 36 000 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]

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

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..... [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]

(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.

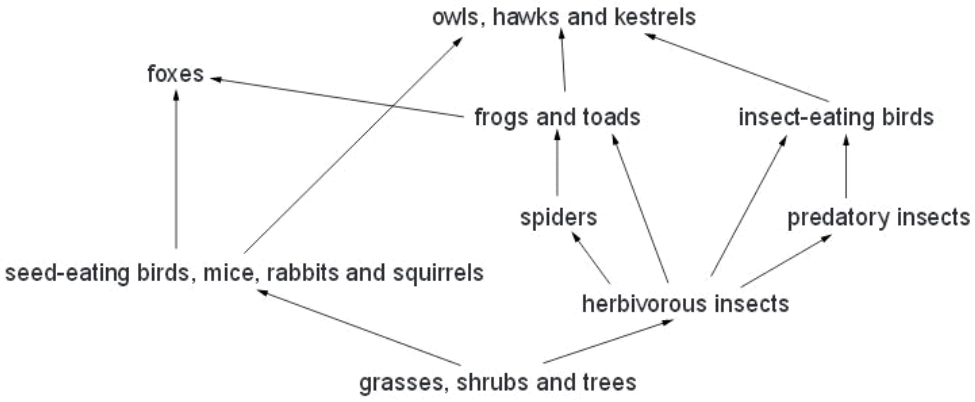

Fig. 6.1

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

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.....[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]

(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]

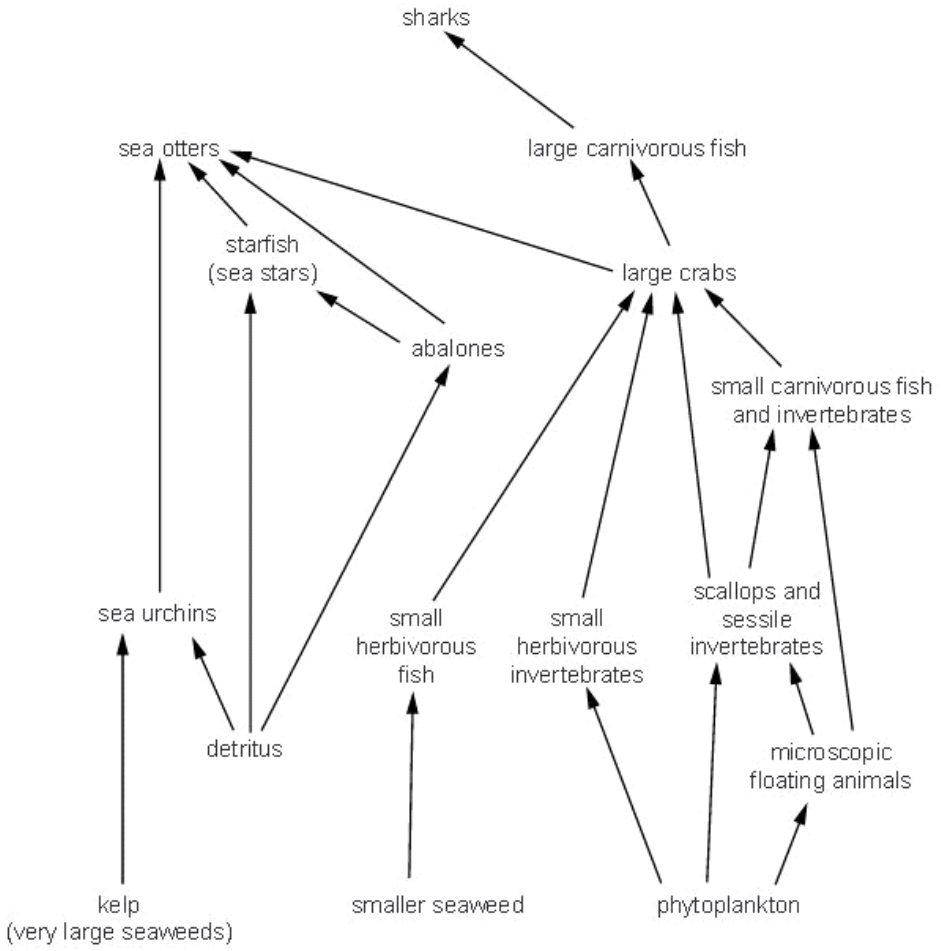
Q31.

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.



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

niche .....

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community .....

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.....[2]

(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.

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]**

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

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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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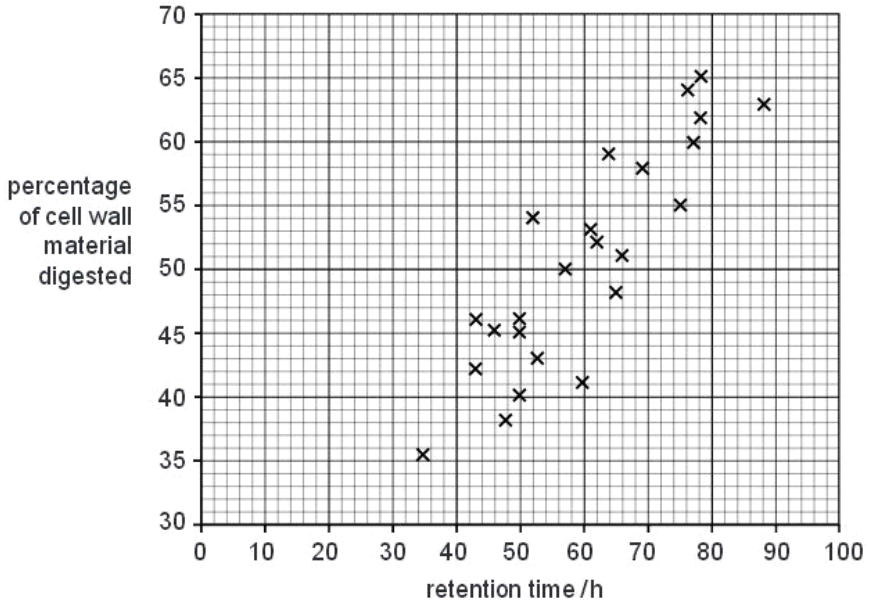
..... [5]

Q34.

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.

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..... [2]