1 The efficiency of energy transfer between trophic levels limits the number of organisms in a particular ecosystem.

(a) Outline how the **percentage efficiency** of energy transfer between producers and herbivores can be estimated.

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

(b) One way that humans try to maximise food production is to manipulate the transfer of energy through ecosystems.

A number of methods can be used to increase energy transfer through agricultural ecosystems and other food production systems.

These methods include:

A artificial selection

B recombinant DNA technology

C growing microorganisms in a fermenter

D use of immobilised enzymes

E control of plant physiology with synthetic plant hormones

F manipulation of the nitrogen cycle.

Using the letters **A** – **F**, select the **most suitable** method that could be used to achieve each of the aims shown in the table below.

You may select each letter more than once.

Aim	**Letter**
improving soil that is low in nutrients for the growing of wheat	
preventing the spoilage of fruits after picking	
reducing the impact of a fungal disease on yields from cucumber plants	
producing strawberry plants that grow quicker and fruit earlier	
making sugar syrup from waste starch	
producing large amounts of a fungus for food	

[6]

(c) Some animal pests compete with humans for food.

Some examples of pest behaviour are described below. These include examples of innate (instinctive) and learned behaviours.

Name each **specific** type of innate or learned behaviour described in the table below.

Description	**Name of innate or learned behaviour**
Sparrows initially fly away from fruit bushes on which shiny CDs are hung, particularly when the CDs move in the wind.	
After a few days the sparrows start visiting the fruit bushes again, and do not fly away even when the CDs move.	
Carrot flies move towards chemicals released by carrot plants.	
Raccoons learn to remove lids from containers of grain in a barn.	
A line of young chicks follow their mother into a cornfield.	

[5]

[Total: 15]

2 Fig. 4.1 shows some notes that a gardener pinned to his notice board to remind him of jobs to do.

Each is based upon a different biological principle.

A Pin any trailing blackberry shoots onto the soil so that they grow roots and form new plants.

B Remove the tops of chilli plants to encourage bushy growth.

C Leave vegetable waste in a well-aerated container for six months to make compost to add minerals to soil.

D Sow a leguminous crop like clover in bare soil in the autumn, and dig this crop into the soil in the spring to add nitrates.

E Save seeds from the biggest pumpkin grown, and plant these seeds next year, hoping to get a better crop.

F Dip cut stems of rosemary plants in rooting powder before planting them in soil.

G Bring carnivorous ladybirds into the greenhouse to reduce the numbers of plant-eating pests.

H Encourage pollinating insects by growing flowers with a strong sweet smell near crop plants.

Fig. 4.1

(a) Match the notes, **A** to **H**, with the biological principles on which they are based.

Write the correct letter next to the description of each principle.

Biological principle	**Letter**
artificial selection	.....
predator-prey interaction	.....
apical dominance	.....
nitrogen fixation	.....
reproductive cloning	.....
positive chemotaxis	.....
decomposition	.....
use of plant hormones	.....

[8]

(b) Four **other** procedures associated with growing or storing crops are described in Table 4.1 below.

Name a biological process that is slowed down or stopped by each procedure.

Procedure	Biological process slowed down or stopped
storing apples at a low temperature of 5° C	
removing weeds from a vegetable garden	
placing seedlings so they are lit from all sides equally	
removing elm suckers and self-sown tree seedlings from farmland	

Table 4.1 **[4]**

(c) Suggest **three** ways that farmers can maximise the efficiency of the transfer of energy up food chains from **primary consumers** to humans.

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..... **[3]**

[Total: 15]

3 Earthworms are abundant in fertile soil where they play an important role in the transfer of energy in the ecosystem. An example of a food chain involving earthworms is shown in Fig. 8.1.

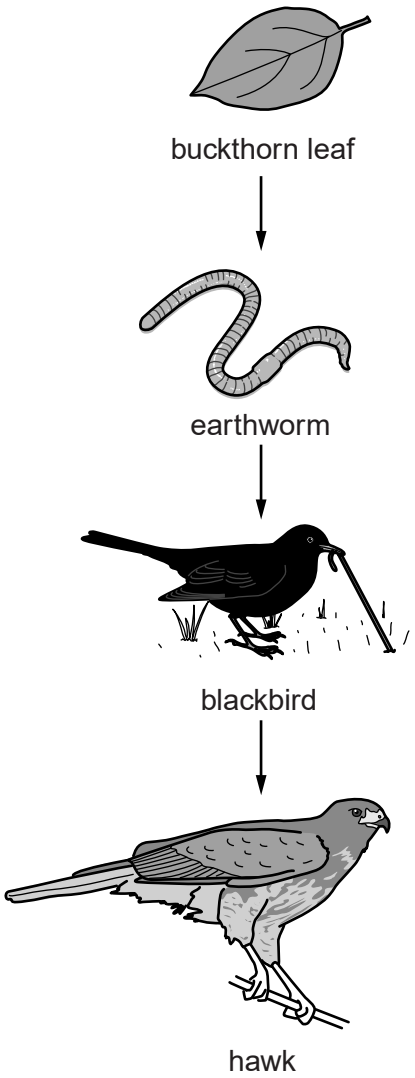

Fig. 8.1

(a) Define the following terms:

producer .....

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consumer .....

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trophic level .....

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[3]

(b) One way of measuring the abundance of earthworms is as follows:

- place quadrat frames of known area onto the ground
- pour a chemical solution onto the soil to cause the earthworms to come up to the surface
- wait and then count the earthworms.

Researchers used this technique in 2004 and 2006 to compare the abundance of earthworms in four areas of soil:

- soil underneath buckthorn plants
- soil underneath honeysuckle plants
- bare soil after the removal of buckthorn plants
- bare soil after the removal of honeysuckle plants.

The results are shown in Fig. 8.2.

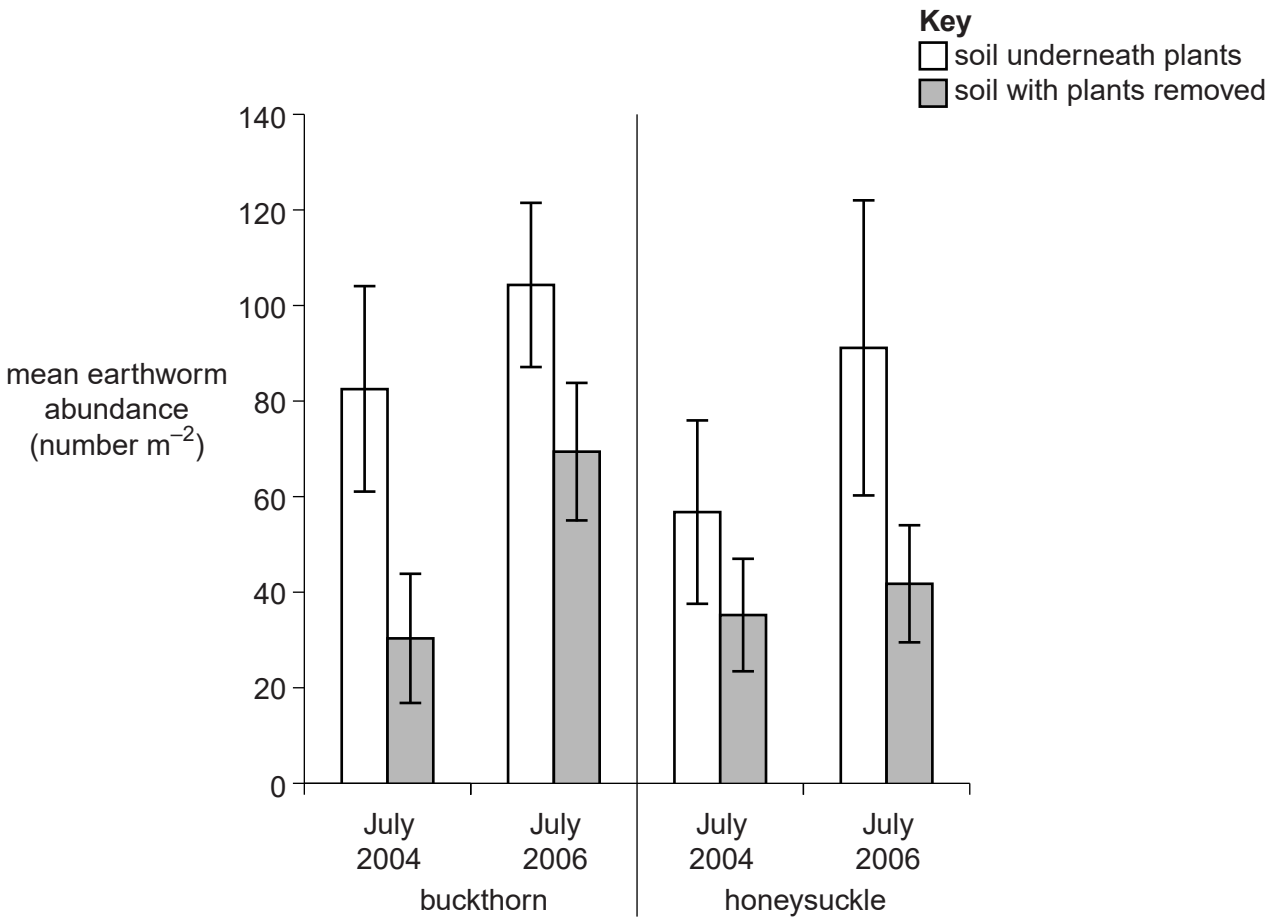

Fig. 8.2

(i) Suggest **two** variables which the researchers should have controlled in order to make the results comparable.

1 .....

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2 .....

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[2]

(ii) Evaluate, with reference to the error bars in Fig. 8.2, whether the data show a valid difference in the abundance of earthworms between the 'soil underneath honeysuckle' and 'soil with honeysuckle removed' sites for July 2004.

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..... **[2]**

(iii) Ecosystems can be described as dynamic.

State **two** pieces of evidence from Fig. 8.2 that show that the ecosystem is dynamic.

1 .....

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2 .....

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[2]

[Total: 9]

4 Peat bogs are large areas of waterlogged land that support a specialised community of plants. Peat bogs take thousands of years to form.

Fig. 5.1 lists the main stages in the formation of a peat bog.

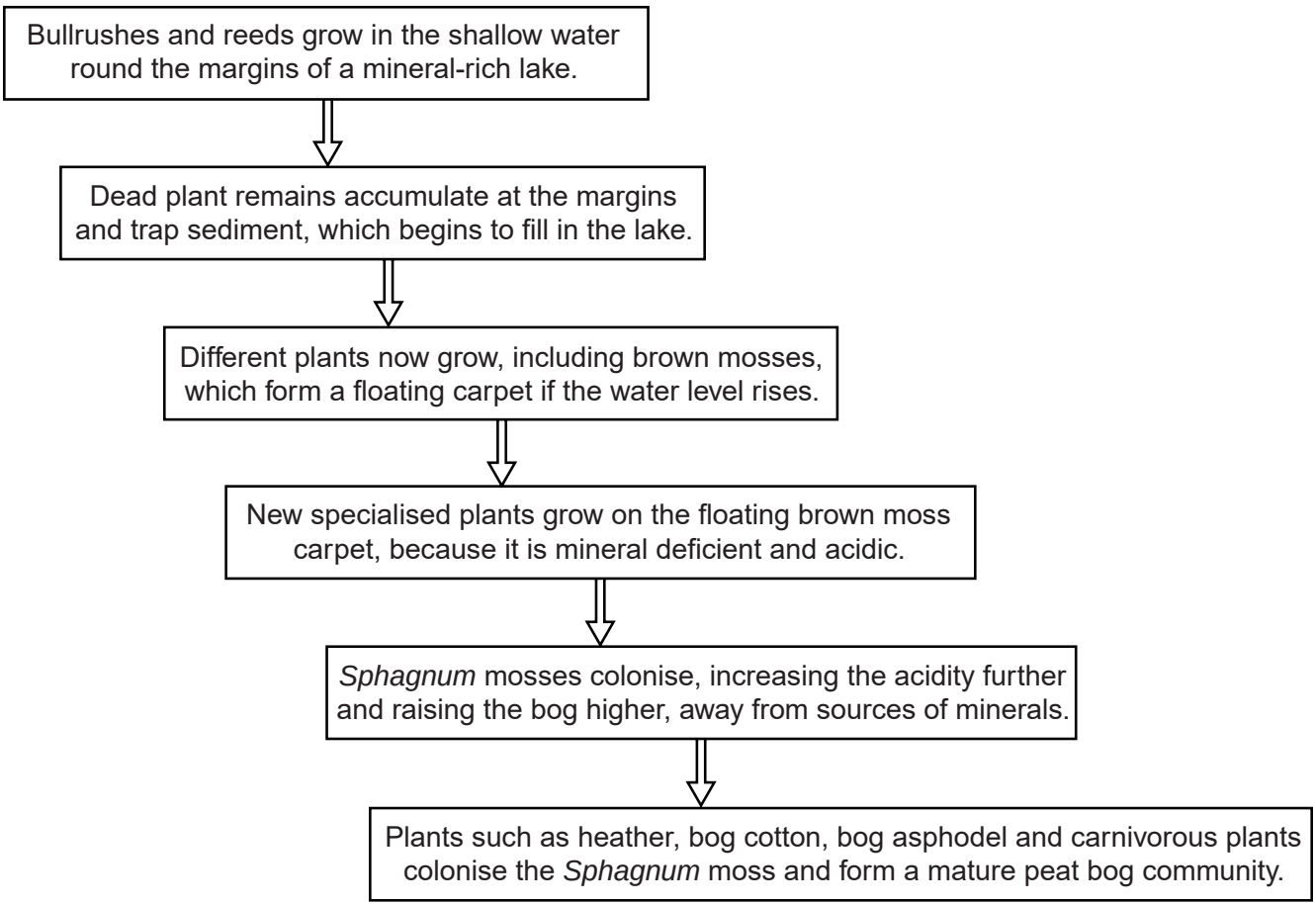

Fig. 5.1

(a) (i) Name the process summarised in Fig. 5.1 that changes a lake community into a peat bog community.

..... **[1]**

(ii) Using Fig. 5.1, list **two abiotic** factors that play a role in determining what species of plant can grow in an area.

1 .....

2 ..... **[2]**

(b) Most of the minerals in a peat bog are held within the living plants at all times, **not** in the soil.

- Plants like bog cotton and bog asphodel recycle the minerals they contain.
- The leaves of these plants turn orange as the chlorophyll within them is broken down.
- Minerals such as magnesium ions are transported from the leaves to the plants' roots for storage.

Describe **one** similarity and **two** differences in mineral recycling in a peat bog and in a **deciduous forest**.

similarity .....

.....

differences .....

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..... **[3]**

(c) In Ireland in 2002, two well-preserved Iron Age human bodies were found in peat bogs. Despite having been dead for over two thousand years, the bodies had not decomposed. They still had skin, hair and muscle.

Suggest why these bodies had not decomposed.

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..... **[2]**

(d) Suggest **two** reasons why the large scale removal of peat from bogs for use in gardens is discouraged by conservation groups.

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[Total: 10]