Life on Earth

Energy in Ecosystems

Unit 3 Life on Earth

Sub Topic 1 – Energy in Ecosystems

a	Food chains/webs and energy loss
b	Pyramid of numbers, biomass and energy
c	Nitrogen Cycle
d	Interspecific Competition
e	Intraspecific Competition

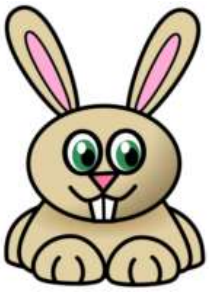
Learning Outcomes – Energy in an Ecosystem

- To describe the role of producers and consumers in food webs and food chains;
- To describe how energy flows in food webs and food chains;
- To describe what happens to energy as it moves along a food chain.

Activity 1 - Food Chains

A food chain is a simple diagram showing the feeding relationship between organisms in a habitat. Energy is transferred in the form of chemical energy in food from **plants to animals** and then to other animals. We use **arrows** to show the **direction of energy flow** in a food chain.

A green plant **(producer)** can be eaten by a herbivore. The herbivore is called the **primary consumer**. The herbivore in turn can be eaten by a carnivore. The carnivore is called a **secondary consumer**


Green Plant
PRODUCER

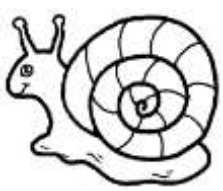
Rabbit
PRIMARY
CONSUMER
(HERBIVORE)

Fox
SECONDARY
CONSUMER
(CARNIVORE)

1. Write the heading "**Food Chains**" in your jotter

2. Use the organisms in the diagrams below to make a food chain





3. On your food chain **label** the producer, primary consumer and secondary consumer.

4. Copy and complete these sentences:

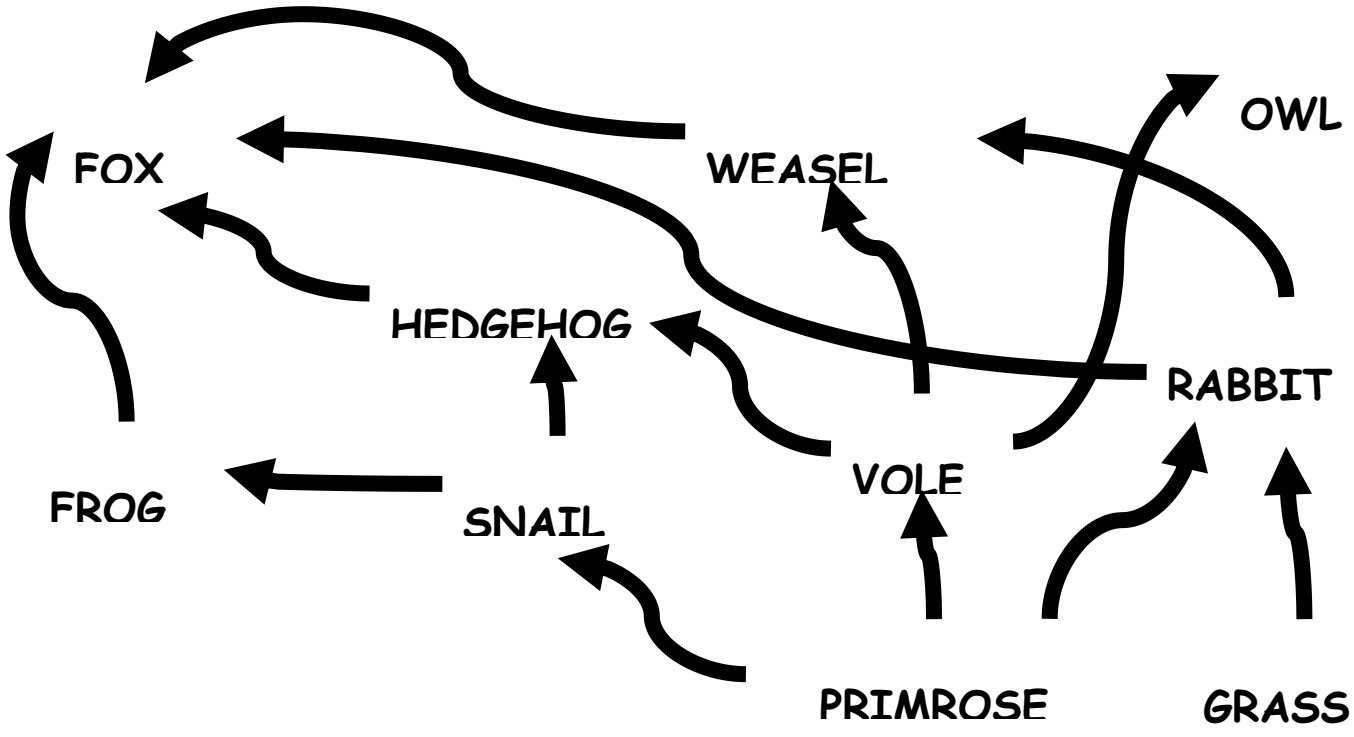
a) The green plant gets its energy from the _____.
b) The bird gets its energy from the _____.
c) The snail gets its energy from the _____.

5. What do the arrows in a food chain represent?

Activity 2 - Food Webs

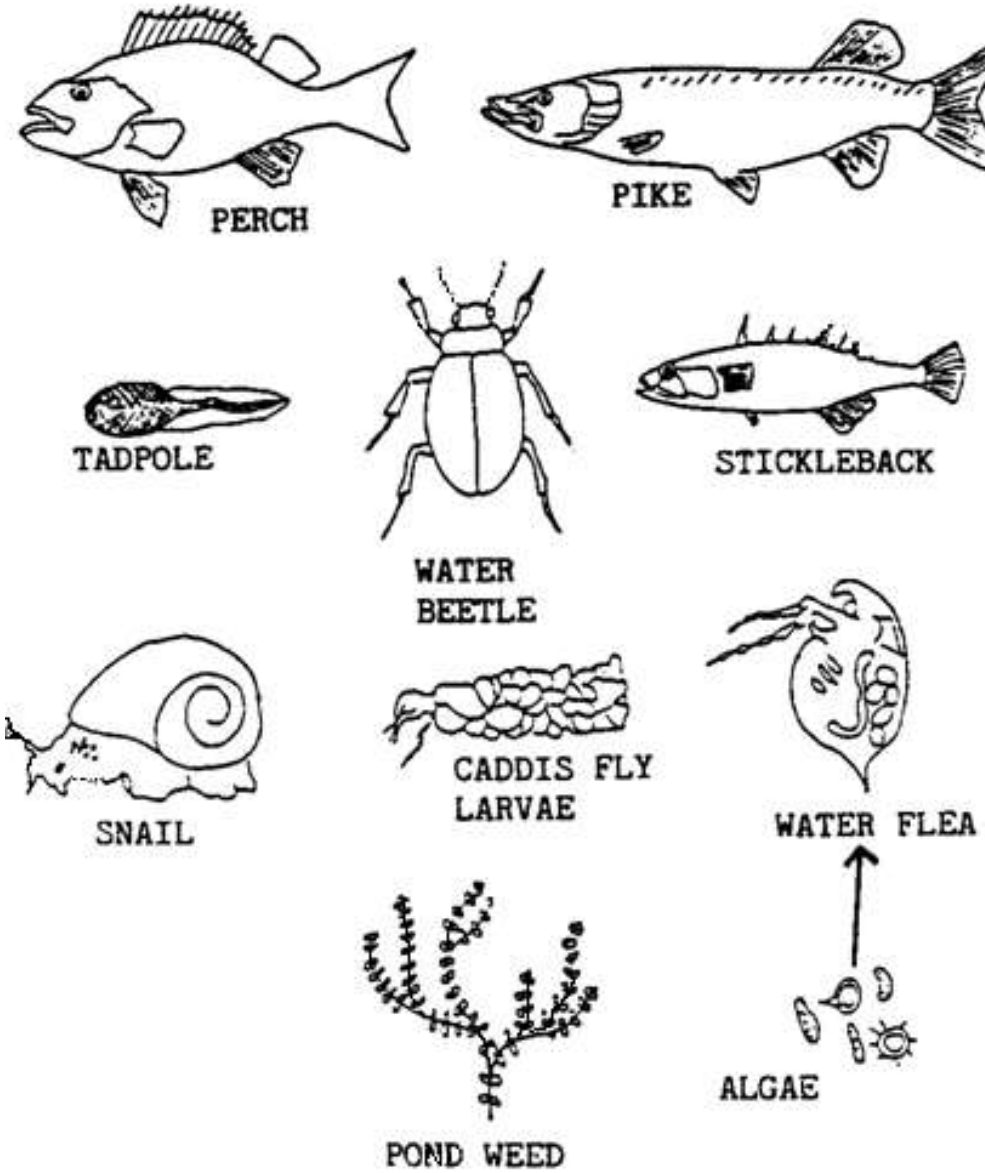
Feeding relationships are more complicated than food chains suggest. Food chains interconnect at many points. This interconnection of food chains is called a **food web**.

In the example shown, Voles eat Primrose Plants, while they are eaten themselves by Hedgehogs, Weasels and Owls.



1. Write the heading "**Food Webs**" into your jotter.
2. Copy the diagram below of a fresh water loch food web into your jotter.

   (Handy Hint – make it big and set out the names only in the same position as they appear in the diagram below)
3. Using the consumers food table, on page 6, connect the organisms using arrows to show the flow of energy.



Consumers Food Table	
Consumer	**Food**
Water Flea	Algae
Caddis Fly Larvae	Pond Weed, Algae
Snail	Pond Weed, Algae
Stickleback	Water Flea
Water Beetle	Water Flea, Caddis Fly Larvae, Tadpole
Tadpole	Pond Weed
Perch	Tadpole, Water Beetle
Pike	Perch, Water Beetle, Stickleback, Tadpole

Activity 3 - Energy Loss in food chains

Not all the energy available at each step in a food chain is passed on to the next step. Most of the energy is lost.

Oak Leaf → Caterpillar → Shrew → Badger

Remember the arrows represent the **direction of energy flow** in a food chain.

Some of the energy present in the leaf passes out of the caterpillar in **undigested food material (waste).**

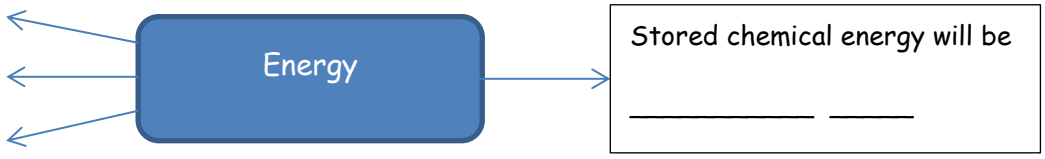
The caterpillar uses some of the energy it gets from the leaf to **move** and **produce heat.**

The rest of the energy the caterpillar gets from the leaf is **stored as chemical energy** in the body of the caterpillar.

Only this energy is available to the next animal in the chain.

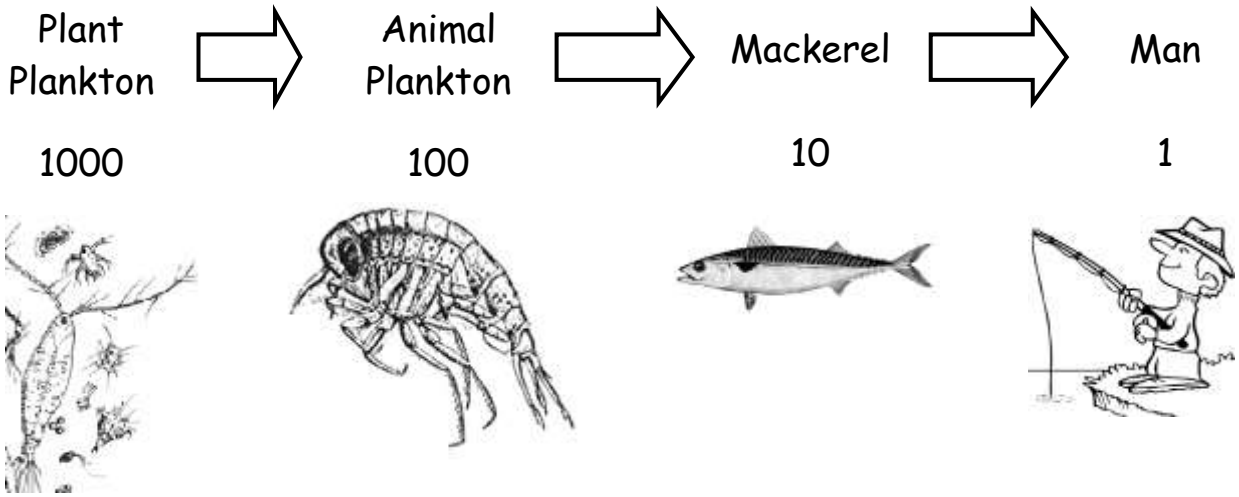
Read the passage above regarding energy in a caterpillar and answer the questions below.

1. If a blackbird eats the caterpillar what energy would be passed on to the blackbird?
2. What energy would not be passed on to the blackbird?
3. Copy and complete the diagram below to show the 3 ways energy can be lost and passed on in a food chain.



Activity 4 - How much energy is lost?

An energy study was carried out on a marine food chain. It was calculated that the plant plankton contained 1000 units of energy, Animal Plankton 100 units, Mackerel had 10 units and Man 1 unit.



1. Copy the food chain into your jotter and answer questions 2 - 5
2. What percentage of energy was passed on at each transfer?
3. State the percentage energy loss at each transfer?
4. Are organisms efficient at turning their food into body material? Explain why.
5. Which of the following food chains would supply more energy to man (and give a reason for your answer)

Grain ⇨ Chicken ⇨ Man

Grain ⇨ Man

Success Criteria: I can

- Identify producers and consumers in a food chain.
- State the arrows in a food chain/web indicate the direction of energy flow.
- State 3 ways in which energy can be lost from a food web.
- State that energy passed on in a food web is in the form of chemical energy.

Learning Outcomes – Pyramids

- To investigate the terms pyramid of numbers, biomass and energy.

Activity 5 – Pyramid of Numbers

A **pyramid of numbers** shows the relative number of organisms at each stage of a food chain.

Green Plants ⇨ Slug ⇨ Frog ⇨ Fox

Large numbers Of small organisms

Small numbers of large organisms

The diagrams below show 2 examples of a pyramid of numbers.

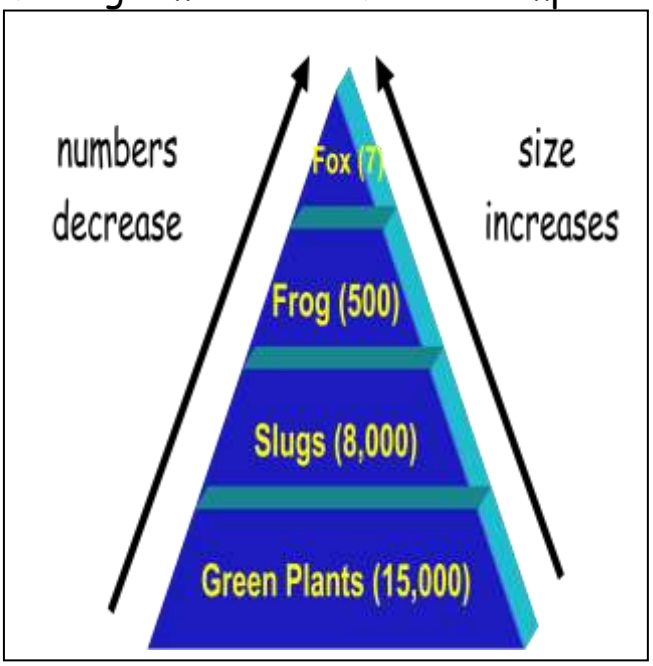


Figure 1.1

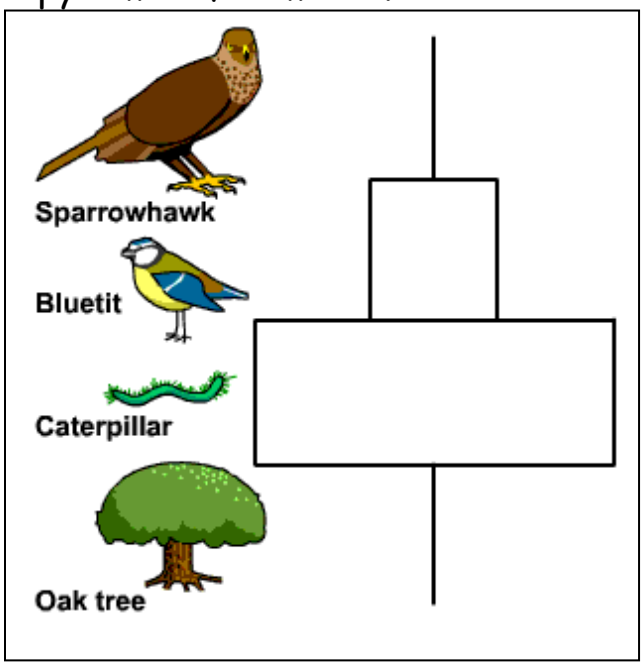


Figure 1.2

They are diagrams showing food chains. The producer is at the bottom and the consumers above. Looking at figure 1.1 only, answer the following question.

1. What do you notice about the number and size of the organisms as you go up the pyramid?

2. Using the information in the following table, construct the most likely **food chain** then make a **pyramid of numbers** to scale

(Handy Hint... 10 organisms = 1cm)

Organism	Number present in food chain
Snail	80
Pike	10
Algae	100
Perch	40

3. Copy and complete the following statement

As you move along a food chain, the number of organisms _____ and the size of organisms _____ . A pyramid of _____ shows the _____ _____ of organisms at each stage of a _____ _____

Sometimes, the diagram will not be a true pyramid. See figure 1.2, Oak tree example showing a single large producer.

Activity 6 – Pyramid of Biomass

Often, a **pyramid of biomass** is a better diagram to use. A pyramid of biomass shows the **total mass** of organisms at each stage of a food chain.

In general, all producers have a higher biomass than the primary consumer, so a pyramid will always be produced.

1. Copy the heading "**PYRAMID OF BIOMASS"** in your jotter.

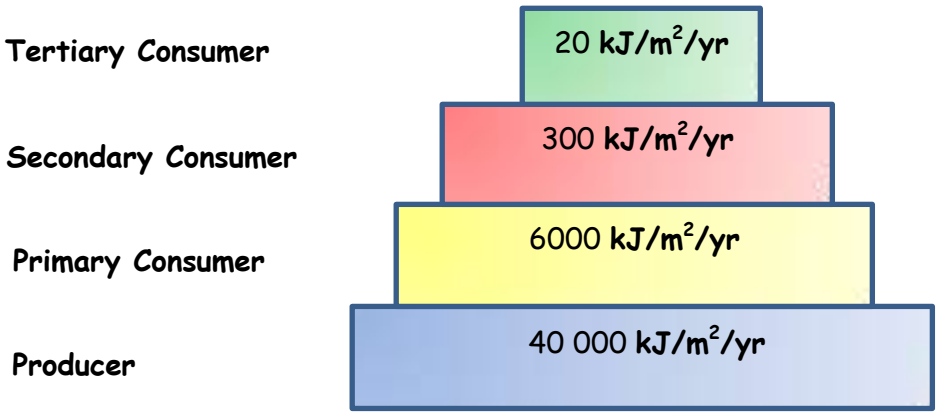
2. Copy and complete the following statement:

A pyramid of _____ shows the _____ _____ of organisms at each stage of a food chain. As you move along a food chain, the biomass of each organism at that level is always _____. A pyramid of Biomass gives us a more _____ idea of the quantity of animal and plant material at each level.

Activity 7 – Pyramid of Energy

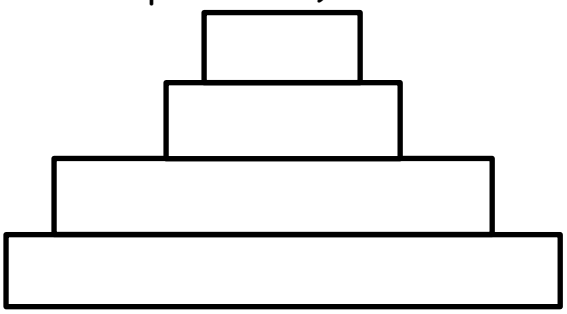
Pyramids of energy represent the flow of **energy** through each level of a food chain.

Energy pyramids are constructed using **energy values** *(kJ)* determined from a **given area** *(m^2)* over a specified **period of time** *(yr)* for each level of a food chain and therefore take in account of differences in an ecosystem over the year.



Energy pyramids, however, **do not show** what happens to <u>all the **energy**</u> at each level of the food chain; they do not include energy used by **decomposers**.

1. Write the heading "**Pyramid of Energy**" into your jotter.
2. Copy the diagram below into your jotter and calculate the energy value at each level of the pyramid and add to your diagrams. (**<u>handy hint</u>**: remember what percentage of energy is generally passed on)



(a) For area 1, the energy value for the producer was 322 120 **kJ/m²/yr**

(b) For area 2, the energy value for the secondary consumer was 299 **kJ/m²/yr**

Success Criteria: I can

- Represent food chains in an ecosystem as a pyramid of numbers, biomass and energy.

Learning Outcomes – Competition

- To investigate the effects of competition between organisms of different species and of the same species.

Competition occurs when 2 or more organisms of the same or different species need the **same resource**.

Activity 8 - Interspecific Competition

Interspecific competition occurs when organisms of 2 or more different species compete for the same resources.

Find the Competition

- Collect a set of animal fact cards
- Read the information on the cards
- Sort the cards into sets showing animals which would compete with each other (make sure you understand what they are competing for).
- **Copy and complete** the following table into your jotter.

Animal 1	Animal 2	Resource competed for

- In your group, come up with 2 more examples of Interspecific competition.

Activity 9 - Intraspecific Competition

1. Write the above heading and the passage below into your jotter.

Intraspecific competition occurs when organisms of **the same** species compete for **exactly** the same resources.

From the previous activity it was concluded that organisms compete for a number of resources. Watch **BBC clip 7120** and identify another resource that animals of the same species compete for.

2. Copy and complete the following table:

Resources Animals compete for	Resources Plants compete for

Activity 10 – Effect of extreme competition

1. Watch the following clip and then copy and complete the following passage into your jotter under the above heading.

- **http://www.twigonglow.com/films/invading-plant-species-1185/ (OR)**
- **http://www.twigonglow.com/films/invading-animal-species-the-cane-toad-1235/**

Introducing a new species to an ecosystem where it was not previously found can have _____ effects on native species. The biodiversity will be _____ as some species will _____ _____. This is due to extreme _____ for the same _____. For example, the red squirrel and the _____ _____, or the brown trout and rainbow trout.

2. Give another example of how an introduced species has affected a native species

Success Criteria: I can

- State that competition occurs when organisms have a need for the same resource and describe differences between Interspecific and Intraspecific competition. I can describe some effects of competition.

Learning Outcomes – Nitrogen in Ecosystems

- To find out about the importance of nutrient cycling in an ecosystem.
- To describe the different stages in the nitrogen cycle.

Nutrient Cycling

It is important that chemical elements 'locked up' in the bodies of dead animals and plants are recycled. Decomposers, mainly bacteria and fungi, release nutrients from the dead bodies and waste material of animals and plants into the soil. These nutrients are then used by plants which return them into the food web. The **NITROGEN CYCLE** is an example of this recycling.

Activity 11 – Nitrogen Cycle

1. Write the heading "Nitrogen Cycle" into your jotter.

Nitrogen is a chemical element which is needed to make **protein** in plants.

The protein in dead animals and plants, or their waste material, is converted into **ammonia**. This is done by ***decomposer bacteria*** and fungi which eat the protein and produce **ammonia** as their waste product.

Nitrifying bacteria convert this **ammonia** into **nitrites**, and another similar type of bacteria converts **nitrites** into **nitrates**.

Plant roots absorb nitrates and use the nitrates to make their protein.

Animals eat some of the plants to make their protein. This basic cycle happens continuously in the soil.

Some bacteria, which are known as ***denitrifying bacteria***, use up soil **nitrate** by converting it to **nitrogen gas**.

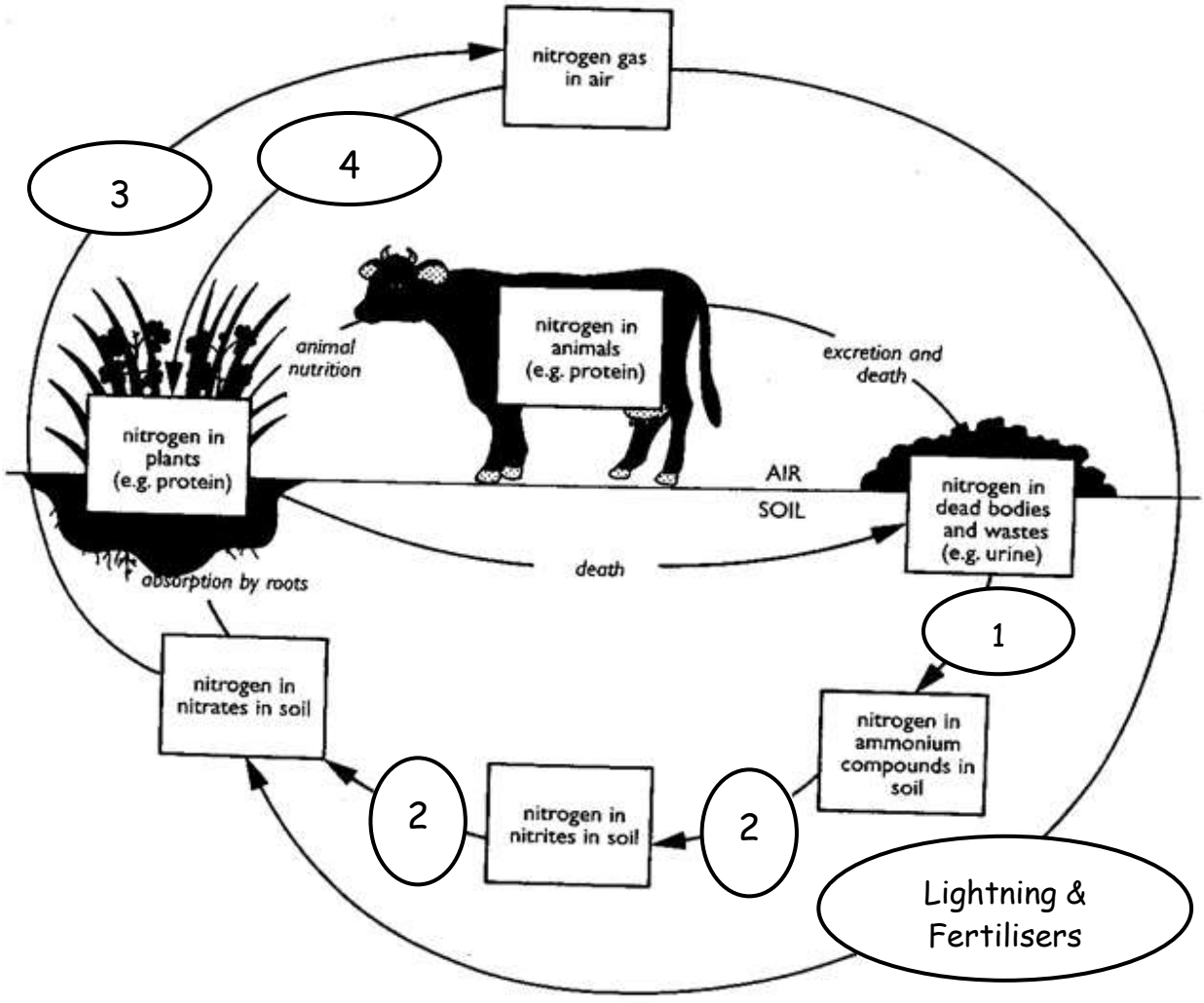
Some (leguminous) plants, such as peas and clover, have ***nitrogen-fixing bacteria*** in root nodules which take **nitrogen gas** from the air to make **nitrates** which the plant then uses to make protein.

Humans make **fertilisers** from nitrogen gas. They are an artificial method of adding **nitrates** to the soil.

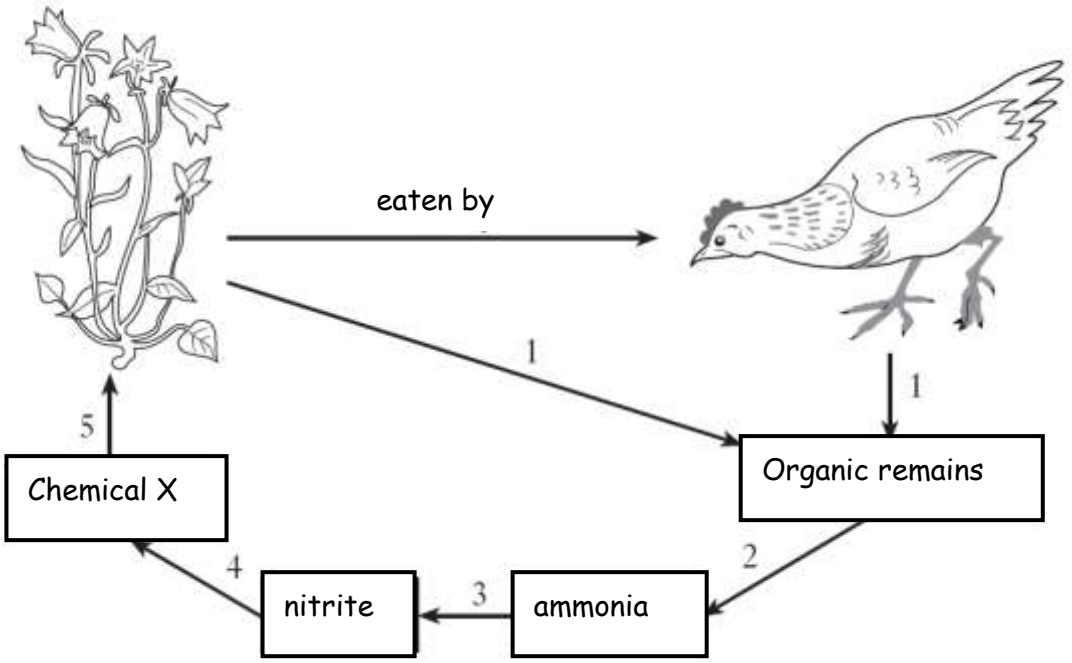
2. Now **copy and complete** the following table using the information from the passage.

Position in Diagram	Type of Bacteria	Function of the Bacteria
1		Breaks down dead organisms and _____ material to _____
2		Converts Ammonia to _____ Converts _____ to _____
3		Uses up soil nitrate and converts it to nitrogen _____
4	Nitrogen _____	Bacteria in _____ _____ take nitrogen gas from the air to make _____

3. Collect a diagram of the nitrogen cycle and complete using the information given and add in an arrow to show how fertilisers can contribute to the nitrogen cycle.



4. The diagram shows some of the stages in the nitrogen cycle.



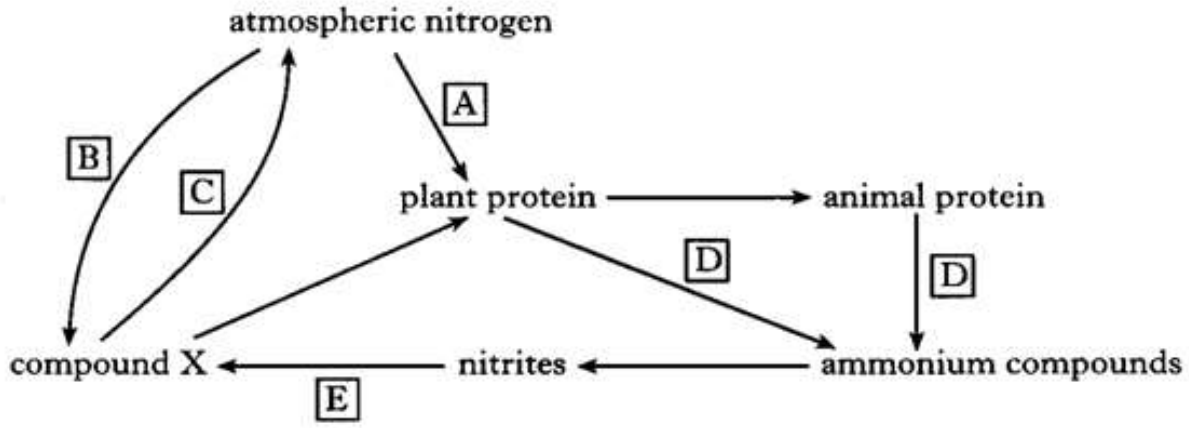
a) **Copy** and **complete** the table by giving a number from the diagram to match each of the named stages.

Stage	Number
Absorption	
Death	
Nitrification	
Decomposition	

b) Name chemical X.

c) Name the type of organism responsible for Stage 3.

5 The diagram shows part of the nitrogen cycle.



a) Use letters from the diagram to **copy** and **complete** the following table about some of the events of the nitrogen cycle

Event	Letter
Death and decay	
Action by denitrifying bacteria	
Lightning	

b) **Explain** why event A can take place in some plants such as clover, peas and beans, but not in others

c) **Name** compound X

Success Criteria: I can

- Explain the importance of nutrient cycles to the organisms of an ecosystem.
- Describe the sequence of processes in the nitrogen cycle.