

4.1

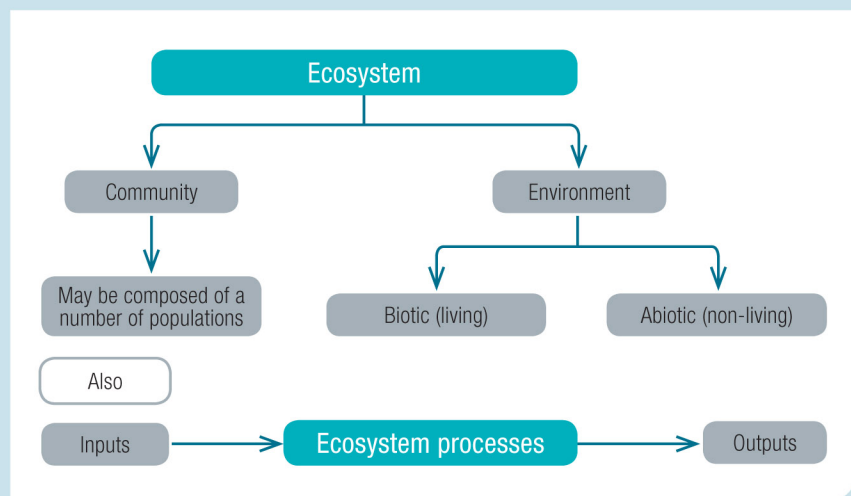
What are ecosystems?

In every community you will find **producers, herbivores, carnivores and decomposers**. Complex interactions happen between these living things. Predators hunt for their food, herbivores are keeping an eye out for carnivores to avoid being eaten, and decomposers slowly break down dead plants and animals. **Non-living (abiotic) factors** are interdependent too. **Energy and matter flows in cycles** as a result of **interactions within ecosystems**.

Dynamic ecosystems

An ecosystem is a **dynamic interactive unit** involving inputs, processes and outputs.

- 1 Work in a small group to identify some of the resources that living organisms require in an ecosystem.
- 2 Categorise each of these resources as biotic (living) or abiotic (non-living).
- 3 Determine the group's understanding of the terms 'dynamic', 'interactive' and 'processes'.



→ Fig 4.4 Definitions of an ecosystem.

Energy and matter in ecosystems

Ecosystems rely on the **movement of energy** from one part to another. **Energy is the ability to do work**. It may be free (for example heat flowing through the air) or locked into the bonds of matter (for example the energy in glucose). **Matter is the building blocks of absolutely everything**, held to other building blocks by 'mortar' in the form of energy. An effective way of distinguishing energy from matter is remembering that we can weigh matter (it has mass) but we cannot weigh energy.

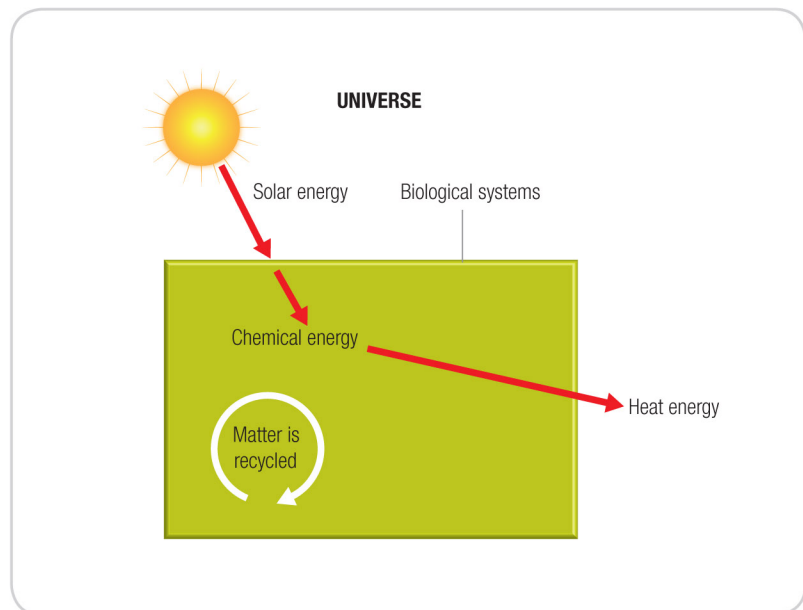
Matter is recycled within ecosystems. It is neither created nor destroyed. **Energy is transferred** through ecosystems. When energy is 'used', it is actually converted into other forms.

Flow of energy

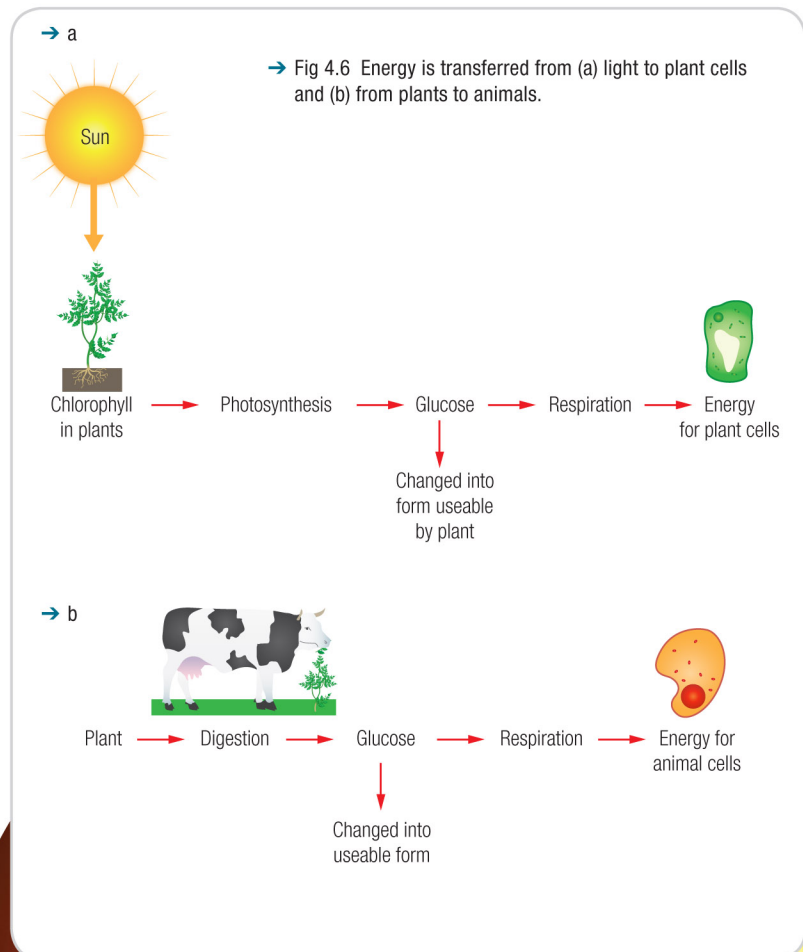
The **first source of energy** in most ecosystems is **solar energy via photosynthesis**. Animals cannot directly use energy from the Sun. Even in caves, and other places where there is no light, the energy may be from dead plants and animals, which obtained their energy originally from the Sun. An exception are the chemosynthetic bacteria on the ocean floor and the craters of volcanoes, which trap the energy from chemicals and chemical reactions occurring under Earth's crust.

Animals obtain their energy from plants and other animals (which have eaten plants), but not all the energy is passed on. Plants use some of the energy themselves, and some of the energy is lost to the atmosphere as heat.

Energy in an ecosystem **flows in only one direction**. Energy is **not recycled** within biological systems (although it is conserved in the universe). Living systems **continuously take in more energy from the Sun**. The energy moves through ecosystems (converted into different forms for work), some of it is lost as heat.



→ Fig 4.5 Energy flow through ecosystems and the recycling of matter.



→ Fig 4.6 Energy is transferred from (a) light to plant cells and (b) from plants to animals.

Energy for work

When we need energy, we often head straight for sugary foods. Although sugars contain energy locked in the bonds of their molecules, this energy cannot be used directly by organisms. They must convert it into other forms.

Many energy transformations keep a living organism alive, functioning and carrying out metabolic processes (chemical reactions that keep cells working). We can describe these processes as the work of living organisms. Some of the types of 'work' performed by living organisms are shown in Table 4.1.

→ Table 4.1 The 'work' of living organisms

Type of work	Examples
Building compounds	All organisms use energy to build and replicate molecules, such as DNA (deoxyribonucleic acid), RNA (ribonucleic acid) and proteins, so that they can manage metabolic processes, grow and pass information on to offspring
Communication inside an organism	Energy is needed for communication within and between cells Electrical and chemical energy are used when nerves transmit information throughout the body
Physical movement	Energy is supplied for physical movement, such as movement of leg or arm muscles or involuntary muscles, such as contraction of the heart, or, in plants, movement towards sunlight
Transport	Energy is required to move substances, such as nutrients and wastes, throughout an organism's body Electrical potential energy is needed to transport materials into and out of cells

..... PRACTIVITY 4.1

Food for thought

What you need: 2 L bottle of water or soft drink, 10 mL and 100 mL measuring cylinders, 4 plastic cups for each organism, dropper

- 1 Work in groups of five to represent five different parts of the food chain: the Sun, native grass (producer), a cricket (herbivore), a wedge-tailed eagle (top consumer), a fungus (decomposer).
 - 2 Use the bottle of water or soft drink to represent the Sun's energy. The total energy available from the Sun is equal to the volume in the bottle (i.e. 2000 mL).
 - 3 Give a cup to each person representing a part of the food chain.
 - 4 Measure and pour 60 mL of water or soft drink into the plant's cup. The plant receives, through photosynthesis, 3% of the solar energy available to it, which gives 60 mL.
 - 5 The herbivore receives 10% of the energy: 10% of 60 mL = 6 mL. Measure out 6 mL from the plant's cup and pour this into the herbivore's cup.
 - 6 The top consumer receives 10% of this energy: 10% of 6 mL = 0.6 mL. Measure out 0.6 mL from the herbivore's cup and pour this into the top consumer's cup.
 - 7 When the top consumer dies, the decomposer will get 10% of its energy: 10% of 0.6 mL = 0.06 mL. Measure out 0.06 mL from the top consumer's cup and pour this into the decomposer's cup.
 - 8 Allow each organism to drink what they have left after the 'energy transfer'.
- Which organism would have been 'most satisfied' by the amount of energy/food it received? Which would have been least satisfied?
 - Explain what has happened to the 1940 mL of 'energy' from the Sun that did not pass into the plant.
 - How much 'energy' did the herbivore receive? How was 90% of that used by the insect (cricket)?
 - Which consumer in the food chain will have to find the most food to gain enough energy to survive? Explain your answer.

Flow of matter

Like energy, matter flows through ecosystems. Plants absorb simple substances such as carbon dioxide, water and minerals and convert them into sugars by photosynthesis. They make other compounds from the sugars, storing them for further use. Animals eating the plants have access to the sugars and other compounds. When plants and animals die, the dead matter is broken down by decomposers to obtain energy. In doing so, they break down the complex chemicals into simple compounds, which are reused by plants, so completing the cycle of matter.

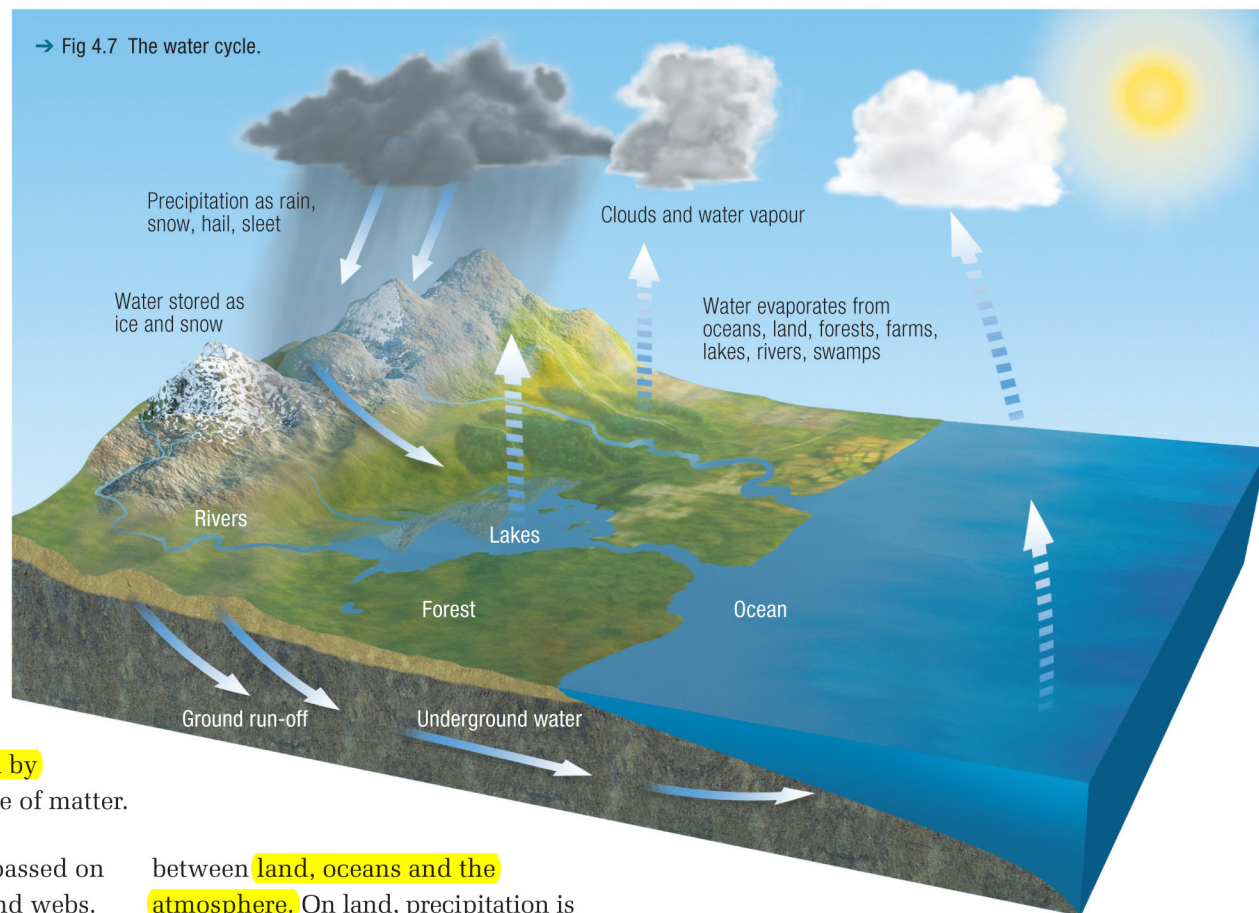
Like energy, not all matter is passed on to organisms in food chains and webs. For example, cellulose in plant cell walls is not digested by some animals and is passed through the body unused. However, matter differs from energy in its flow through ecosystems because matter is recycled.

Cycles of matter

The cycling of matter from the atmosphere or Earth's crust and back again is called a **biogeochemical cycle** (*bio* means 'living'; *geo* means 'earth'). Decomposers are essential to the cycles of matter: they break down dead matter and convert it into simple substances that can be reused by plants.

Water cycle

The global water cycle is driven by heat from the Sun. Three major processes driven by solar heat—precipitation (rain, snow, sleet), evaporation and transpiration from plants—continuously move water



between land, oceans and the atmosphere. On land, precipitation is more than evaporation/transpiration, and the excess water feeds lakes, rivers and groundwater, all of which flow back into the sea.

Humans can alter the water cycle. For example, cutting down rainforests changes the amount of water vapour in the air (due to transpiration), which alters precipitation.

Water is not available equally in all ecosystems. Water that is evaporated from a desert may later fall as rain on a forest thousands of kilometres away. Australia is a good example of this situation: some areas may be in drought and others may have floods, and organisms in ecosystems in both areas may be affected.