Energy and change

A project funded by the Nuffield Foundation

Theme D

Life

Theme D - Life

What is this theme about?

This theme is rather different from most of the other themes, in that the activities are spread across a wide range of levels. The earlier activities can be done by children lower down in the school, even in Y7, while the later activities are intended for Key Stage 4. The theme is concerned essentially with the concentration of substances in living things and in the environment, and with how these concentrations are maintained.

A statue is a structure which does not change much from one day to the next because nothing much tends to happen to it. A human being is also a structure, and it is kept much the same from day to day, but only by continual activity to maintain its structure. All livings things need a constant flow of matter and energy through them, from and to the surroundings, if they are to continue their existence. Many different kinds of changes are involved - the 'spreading out' and 'bunching together' of substances, mixing and 'unmixing', building up and breaking down of molecules, energy flows and temperature differences, energy being stored and released through the 'splitting' and 'joining' of particles.

In this theme, the focus will be on perhaps the most essential feature amongst these changes - how the amounts of substances in organisms and the environment change through processes of 'spreading out' and 'bunching together'. Initially, the activities are concerned with the flow of *water* through living things - water is a clear case of a flow through an organism (mostly being chemically unchanged). Later activities look at flows of other substances through living things.

The activities

D1 Water and life

D2 Keeping a balance

D3 Getting out of balance

D4 Spreading and bunching in living things

D5 Pollution

D6 Using a concentration difference

D7 Keeping a concentration difference going

Activity D1 - Water and life

The activity introduces the idea of a 'steady state', and that living things 'keep a balance' by a flow of water through them.

Sheet 1 can be used as an OHP for class discussion and as a pupil activity she It forms the focus for a series of tasks:

a) introduction to the situations involving containers of water shown on the sheet
b) an activity in which pupils match 'a lake', 'a plant' and 'a human' to these situations
c) a series of practical tasks concerned with evaporation in a plant and a human
d) the activity in (b) repeated by pupils, thinking about it in the light of the practical tasks.

a) Demonstration of these situations and class discussion to introduce the idea of a 'steady state'.

Situation 1 can be illustrated by a plastic drinks bottle with water in it - no water goes in or out, and the level does not change.

Situation 2 is worth most of the discussion at this point. It can be illustrated by a plastic drinks bottle with a tube connected to a tap going in at the top, and a tube leading from the bottom going into the sink. Pupils should be asked to think about questions such as 'What happens when the tube at the bottom is blocked?', 'What happens when the tap is turned off?', 'When water is going in and out, why does the level stay the same?', 'How is this similar to situation 1?', 'How is it different?'.

Situation 3 would need to be left a long time, but pupils can be told that if the bottle does not have a cap on it, the level will slowly go down - 'Why?'.

Situation 4 again cannot be convincingly demonstrated, but should be discussed and comparisons should be made with situation 2 - 'How is this similar to situation 2?', 'How is it different?'.

b) Pupils can now think about the activity on Sheet 1 in which they match 'a lake', 'a plant' and 'a human' to these situations. This is intended at this stage as a stimulus to discussion - the 'correct' answers need not be discussed until after the series of practical tasks. Note that all 3 have similarities with situation 4, since they all lose water by evaporation; a lake and a human both have similarities with situation 2 since water may flow from them (a river from a lake and urine from a human).

c) A selection of activities could be undertaken from this series of practical tasks which show evaporation from plants and humans:

- looking at pores in skin using a binocular microscope to see sweat forming and evaporating
- blowing onto a cold surface or through a cooled U-tube to condense water in breath
- tying a plastic bag around a hand and leaving
- tying a plastic bag around the leaves of a plant and leaving

Activity D5 - Pollution

Pollution is an important example of a 'spreading out' change. Some pollutants are hazardous because they are able to 'bunch together' in living things.

Pollution is a 'spreading out' change which 'just happens by itself'. Once a pollutant has been released it starts to spread out and become less concentrated, so although it has become less harmful it affects more of the environment. It is difficult to deal with pollution after it has been released since it is impossible to get all the pollution to 'bunch together' in one place where it could be dealt with. This is not a change which 'just happens by itself'. However, some pollution does become more concentrated and therefore more hazardous by accumulating in living things.

For the first task, pupils need sheets 1 and 2 in which they identify 'spreading out' and 'bunching together' kinds of changes involving pollution in a piece of text. The second task is to show these changes on a diagram.

Answers

'Spreading out'

- carbon monoxide from cars into air
- sulphur dioxide and oxides of nitrogen from cars
- sulphur dioxide and oxides of nitrogen from power stations and factories
- untreated sewage into rivers and seas
- nitrates from fertilisers into streams and rivers
- lead from leaded petrol into air
- mercury and cadmium from factories into sea

'Bunching together'

- carbon monoxide combines with red blood cells
- sulphur dioxide dissolves and falls as acid rain
- lead accumulates in brain tissue
- mercury and cadmium accumulate in fish
- mercury and cadmium accumulate in humans that eat fish

Sheet 3 is an additional task about DDT in which pupils are asked to identify the same kinds of changes.

- potometer to show water movement through plant
- using a balance to measure weight loss in plant cutting
- using dry cobalt chloride paper on human skin and on leaves

d) Pupils re-visit the task that they did in part (b) in the light of these practical experiences.

Activity D2 - Keeping a balance

The activity relates the flow of water into and out of a living thing to ideas of 'bunching together' and 'spreading out'.

Living things can be thought of as a 'concentration of water' which need to be actively maintained - the water tends to 'spread out' by evaporation, so there need to be mechanisms for making water 'bunch together' to replace the water lost. This activity provides an opportunity for pupils to write in their own words what is happening to water in a plant and the human body, emphasising the idea that the amount of water stays about the same because the amount of water going in is the same as the amount leaving.

This might be a useful opportunity to relate these ideas to the water cycle. The amount of water in a lake stays about the same because the amount going in is about the same as the amount going out. But this also applies to rivers, the sea, water in the land, clouds and so on. So, while in one sense everything is changing since water is going around a cycle, in another sense, things stay the same. This is a natural cycle, but artificial water cycles could be made. On a long journey in a spacecraft, water could be re-cycled, and over a period of time one human might drink a greater quantity of water than the total amount on board. Water that had 'spread out' by evaporation would need to be made to 'bunch together' (by cooling it) and water in urine would need to be 'unmixed'.

Activity D3 - Getting out of balance

The activity looks at some of the factors which affect the rate of evaporation from a plant and from a human.

If the amount of water going into a plant is about the same as that going out by evaporation, then the plant is 'keeping a balance' - the amount of water in the plant stays about the same. However, if the amount evaporating increases, then the plant may 'get out of balance' and start to wilt. A similar thing applies to a human - if we lose water faster than we take it in, then we start to feel thirsty.

An activity in a previous theme (C8/2 'Evaporation: speeding it up and slowing it down') was concerned with the factors that affect the rate of evaporation. It would be worth having a class discussion about these ideas in order to help them make predictions in this activity. They should

be encouraged to use the ideas here about 'helping water to spread out' when they are thinking about their explanations.

Answers:

1 a) on a hot day
b) on a windy day
c) on a dry day

2 a) in a warm room
b) on a windy day
c) while having a run
d) travelling in a car with the windows open

It may be useful to have a potometer set up during this activity in order to show water flow through a plant. One difficulty which pupils may have with understanding the flow of water through a human is that the amount of sweat on the skin is not an indicator of how much water is being lost by evaporation. Thus, if we were travelling on a hot day in a car with the windows closed, we would become 'sweaty' - with the windows open, we would have less sweat on our skin because it would evaporate faster (and we would become thirsty quicker).

Activity D4 - Spreading and bunching in living things

This activity extends the earlier ideas of the 'spreading out' and 'bunching together' of water to include a wider range of substances and processes.

Sheet 1 is intended as an OHP to be used for class discussion. The difficult point here is that *growing* is a *'bunching together'* change. It seems natural to think of changes such as a fish getting bigger or hair getting longer as 'spreading out' changes. But the point is to focus on what is happening to the *substances* involved. This point should be discussed explicitly with pupils. So, a fish growing bigger is a 'bunching together' change since it needs to bring together substances which are spread out in the sea. Another example would be a human child growing into an adult - getting substances needed for growth from food is a 'bunching together' change. For example, we eat a loaf of bread which has been made from wheat which has been growing on a large area of land.

(With older pupils, this could lead to a more quantitative discussion. In comparison with the land, the sea is a 'desert' with dissolved minerals and organic matter being in a very low concentration. We should not expect life in the oceans to be as 'concentrated' as life on the land, with fewer top predators in the sea (e.g. sharks) compared to the land (e.g. foxes).)

Sheet 2 is an activity for pupils, in which they categorise a number of changes in living things as examples of 'spreading out' or 'bunching together'. Again, it should be emphasised to pupils that the focus is on looking at what is happening to the *substances* involved.

Answers:

'Spreading out' - A, C, D, G
'Bunching together' - B, E, F, H, I

Activity D6 - Using a concentration difference

Substances tend to go from where they are more concentrated to where they are less concentrated. This can happen between an organism and its surroundings or within an organism.

Sheet 1 is an OHP which illustrates three ways in which substances may travel due to a concentration difference - from a living thing to its surroundings, from the surroundings to a living thing, and within a living thing. Substances 'spreading out' because of a concentration difference are dealt with in a number of activities in other themes (see, for example, A2 'Pictures of mixing' and F6 'Spreading out and mixing').

Sheet 2 is the pupil activity. Pupils are asked to identify what kind of change is happening in each situation and to match it to one of three pictures showing substances going from a living thing to its surroundings, from the surroundings to a living thing, and spreading out within a living thing.

The idea of substances spreading out because of a concentration difference includes water as well as other substances. Thus, water tends to go from a concentrated to a dilute salt solution, because water is more 'concentrated' in the 'dilute salt solution'. Some membranes allow solute to pass through them, some allow solvent, and some allow both. Fundamentally, diffusion across a membrane and osmosis are the same kind of process - in the former, a solute passes from a high concentration to a low, while in the latter a solvent (water) passes from a high concentration (of solvent) to a low.

For small organisms, and individual cells, concentration differences are sufficient to drive the movement of substances. However, for big organisms, it is necessary to actively pump substances around. This is essentially like stirring some sugar in water to make it dissolve quicker - it speeds up a change which would otherwise happen by itself (see A3 'Dissolving - speeding it up'). For example, in a human, oxygen is made to spread around the body by the heart pumping blood, and in a tree, mineral salts are carried from the roots through the xylem (a process which is driven by a 'spreading out' change - evaporation of water from the leaves).

Answers:

1 B E G K 2 A C F H I 3 D J L

Note that some of these changes (for example A and I) seem counter-intuitive. Thus, digested food passing from the intestine into the bloodstream, might appear to be a case of a substance spreading out within an organism, rather than substance entering the organism from the surroundings. A useful way of thinking about this is that humans have 'roots' in the same way as plants, but unlike a plant, by carrying these inside us we are able to move around.

Situation 'L' is less straightforward than the others, since both urea and water pass from the blood into the Bowman's capsule. In a kidney machine (or dialysis machine), however, only the

urea and other impurities pass from the blood into the dialysate, and this would be worth discussing. To stop substances needed by the body also passing out, the dialysate is made up with the same concentration of sugar and salts in it as in the blood. With no concentration difference, there is no flow of these substances.

Activity D7 - Keeping a concentration difference going

If substances go from a region of high to low concentration, then the concentration difference will disappear. Concentration differences need to be actively maintained.

In the previous activity the focus was on concentration differences which drive change. Because substances tend to spread out, these differences tend to disappear unless they are kept in being. Livings things need to strive actively to maintain these concentration differences. In order to do this, substances need to be removed or introduced, either by chemical reaction or by physically 'pumping' the substances in or out.

Sheet 1 is an OHP which introduces these ideas. In the example here, a concentration difference (lower inside than outside) is maintained by 'pumping' a substance out. Exactly the same would apply if the substance were removed by chemical reaction. (One important example of 'pumping out', though it is not mentioned in the pupil activity, is the difference in concentration of sodium and potassium ions inside and outside a nerve cell, actively maintained by pumping sodium ions out of the cell and potassium ions in. An example of removing a substance by chemical reaction is the using up of oxygen in muscle tissue due to respiration.) The process would be similar (with the concentration higher inside than outside) if a substance were 'pumped' in or introduced by chemical reaction.

Sheet 2 is the pupil activity. There are three parts to this. The first part is about identifying concentration differences. The second part is about how concentration differences are maintained in a living thing. The third part is about how living things can maintain concentration differences in the environment.

Answers:

1 In three of these pairs the concentration is higher in the organism than its surroundings (a - water in a camel, b - calcium in a shellfish, d - carbon in a plant). In two of these pairs, the concentration is lower in the organism (c - salt in a fish, e- silicon in a plant). In one pair (f) the concentration in one part (bone) is higher than another part (muscle).

2 a) The concentration of oxygen is higher in the air in the lungs than in the blood supply to the lungs, and oxygen passes from the air to the blood supply. (In fact, this is not the only thing going on. As well as being driven by a concentration difference, it is also driven by going 'downhill' in energy when oxygen molecules are grabbed by - i.e. bond to - the haemoglobin.) The concentration difference is kept going because fresh air is taken into the lungs, and oxygenated blood is constantly pumped away from the lungs.

b) The concentration of carbon dioxide is higher in the blood supply to the lungs than in the air in the lungs, and carbon dioxide passes from the blood supply to the air. The concentration difference is kept going because the air is expelled from the lungs, and blood containing the carbon dioxide is constantly pumped through the capillaries in the lungs.

c) The concentration of oxygen is higher in the blood supply to the muscles than in the muscle tissue, and oxygen passes from the blood to the muscle tissue. (In fact, the oxyhaemoglobin must split, and since this is 'uphill' in energy, this change must be driven by the concentration difference.) The concentration difference is kept going because oxygen is used up in the muscles, and oxygenated blood is constantly pumped through the blood capillaries.

d) The concentration of carbon dioxide is higher in the muscle tissue than in the blood supply to the muscles, and carbon dioxide passes from the muscle tissue to the blood. The concentration difference is kept going because carbon dioxide is produced in the muscles, and blood containing the carbon dioxide is constantly pumped away.

3 a) Organic matter containing carbon would react with the oxygen in the air producing large amounts of carbon dioxide. Carbon dioxide is constantly produced by respiration, but its concentration in the atmosphere is kept low by the photosynthetic activity of plants.

b) Without the activity of plants, all the oxygen in the air would oxidise organic and inorganic matter. Oxygen first appeared in large quantities in the Earth's atmosphere about 2 billion years ago when bacteria evolved which obtained the hydrogen needed for the synthesis of organic compounds by splitting molecules of water. Before they evolved, the sulphur bacteria obtained hydrogen by splitting hydrogen sulphide, and there were only trace amounts of oxygen in the atmosphere.

c) Salts are constantly being washed into the sea by the action of rain on rocks. These salts are taken up by organisms and are deposited when the organisms die and sink to the sea bed. For example, limestone is formed by the deposition of calcium carbonate in this way.

Whether organisms are involved in removing salt (sodium chloride) from the sea is more speculative - it has been suggested that microbes are involved in the formation of lagoons in which sea water evaporates leaving solid salt thus removing it from the sea. (It is interesting to note that the salinity of the blood of mammals and most fish, whether living in the sea or in fresh water, is about the same, and considerably lower than the salinity of the sea. For animals that live in the sea this concentration difference must be maintained - they need to do work to pump water in against the osmotic pressure. If the concentration of the sea were only a little higher, then they would not be able to work hard enough to do this and they would die.)

Water and life

What do you have in common with a lake and a plant?

A lake is made of water. A plant is mainly made of water. About three-quarters of your body is made up of water.

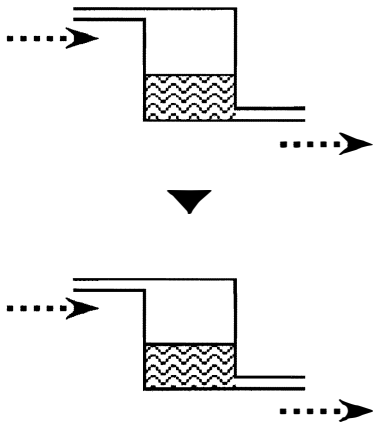
The pictures below show situations involving containers of water. Which do you think is most like:

A a lake
B a plant
C you

1

water in a sealed container

2

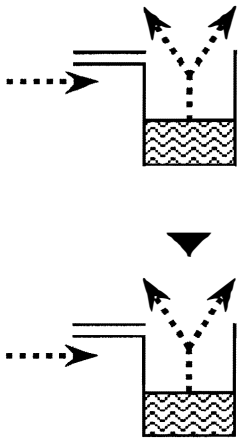


water flows in and out of container

3

water evaporates

4



water flows in to replace the water which evaporates

Keeping a balance

Sheet 1

Here are some changes. Tick the boxes you think describe what happens in each change.	Is the water 'spreading out' or is it 'bunching together'? 'spreading out'  'bunching together' 
A water evaporates from a lake	❑ ❑
B water vapour forms rain, which falls into rivers and lakes	❑ ❑
C water evaporates from the leaves of a plant	❑ ❑
D a plant takes in water through its roots	❑ ❑
E a human loses water by sweating	❑ ❑
F a human drinks some water	❑ ❑

1 Circle the correct words:

Water goes [into / out of] a lake because of evaporation. Water goes [into / out of] a lake because of rain.

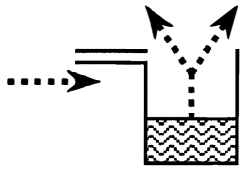
The amount of water in a lake [always gets bigger / stays about the same / always gets smaller]. This is because the amount of water going [in / out] is [more / about the same / less] as the amount going [in / out].

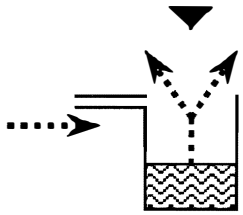
2 Now write your own explanation of what happens to water a) in a plant b) in your body.

Getting out of balance

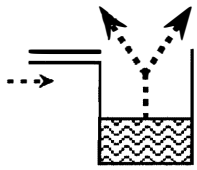
When does a plant wilt? When do we feel thirsty?

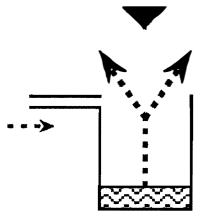
Living things lose water by evaporation. They need to take in water to 'keep a balance'.





If they do not take in enough water, they will 'get out of balance'.





Questions

1 When a plant does not get enough water, it wilts. When will this happen faster? Circle the correct answers.

a)	on a hot day	OR	on a cold day
b)	on a windy day	OR	on a still day
c)	on a wet day	OR	on a dry day

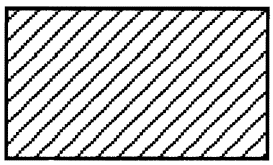
2 When we do not have enough to drink, we feel thirsty. When will this happen faster? Circle the correct answers.

a)	in a cold room	OR	in a warm room
b)	on a windy day	OR	on a still day
c)	while having a run	OR	while resting in a chair
d)	travelling in a car with the windows closed	OR	travelling in a car with the windows open

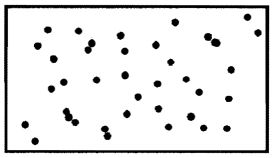
3 Explain your answers to these questions.

Spreading and bunching in living things

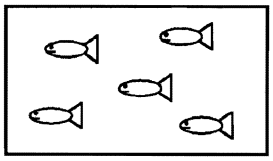
Life in the sea



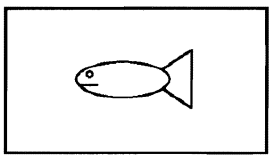
The sea contains many substances dissolved in it.



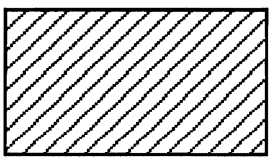
There are lots of very tiny plants in the sea, called plankton. They form from the substances dissolved in the sea.



Small fish eat the plankton and grow.

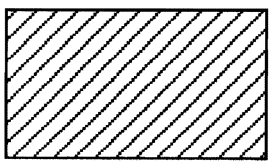


Large fish eat the small fish.

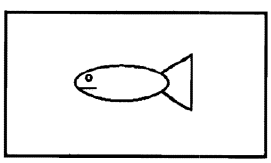


The large fish eventually die and decay. The substances in their bodies dissolve in the sea.

Bunching together

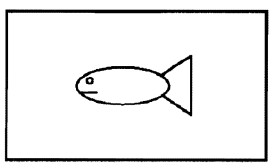


A fish is formed from the substances dissolved in the sea.

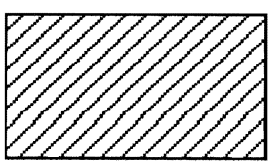


These substances need to bunch together to form the fish.

Spreading out



The fish dies and decays.



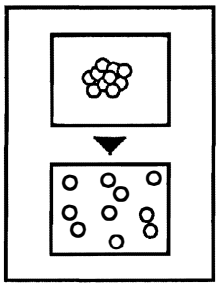
The substances spread out into the sea.

Spreading and bunching in living things

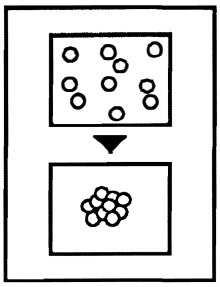
Sheet 2

1 Think about the changes below. For each change, decide whether substances are 'spreading out' or 'bunching together'.

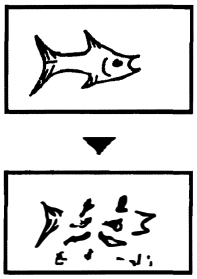
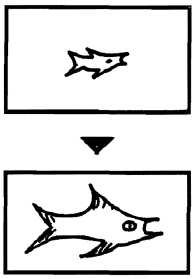
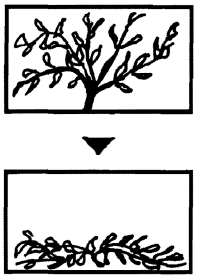
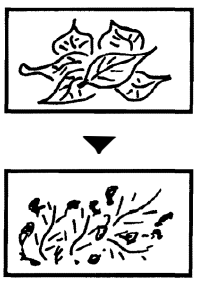
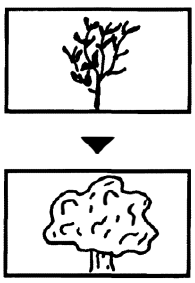
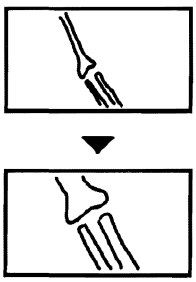
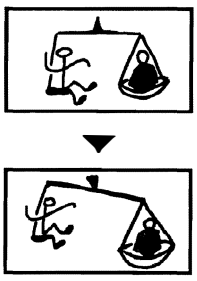
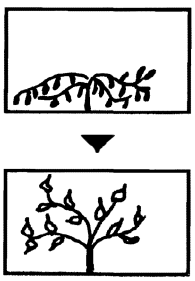
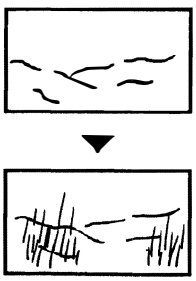
'spreading out'



'bunching together'



2 For some examples, explain why you made your choice.

A  a fish dies and decays	**B**  a fish grows	**C**  a plant wilts
D  in autumn, the leaves fall from a tree and decay	**E**  a tree grows	**F**  a baby's bones grow
G  an athlete weighs less after running a race	**H**  a wilting plant is watered	**I**  grass starts to grow on some waste ground

Pollution

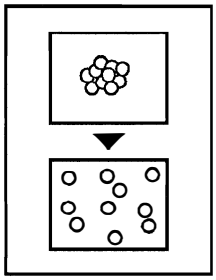
Sheet 1

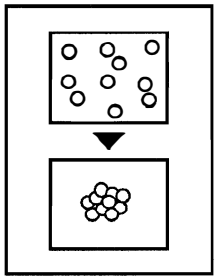
Pollution means anything that we do not want where we do not want it Once pollutants have been released, they *spread out* into the environment. As they spread out, they become *less concentrated.* So, they may become less harmful, but they also affect more of the environment. Some pollutants may be destroyed naturally before they do much harm. Others may persist, causing a lot of damage by becoming *concentrated* in livings things.

1 Read the text on sheet 2. Underline changes where pollutants are spreading out or becoming more concentrated. Then match them to one of the following two pictures.

'spreading out'

pollutants being released into the air and the water system

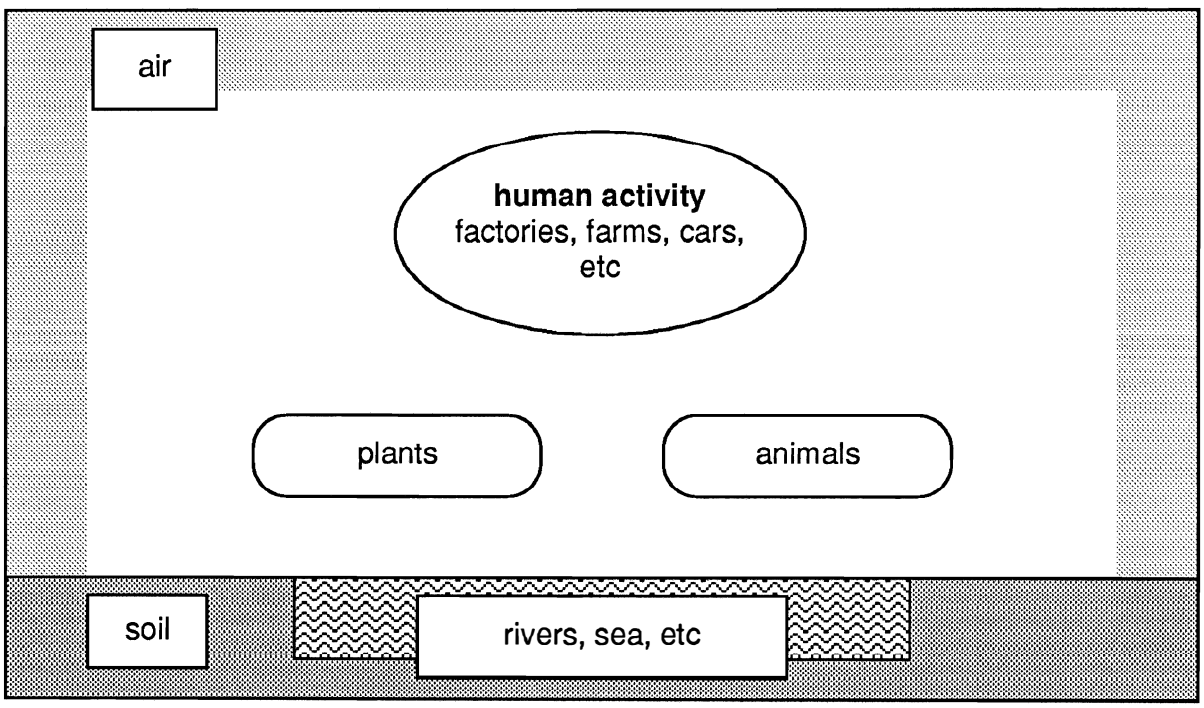




'bunching together'

pollutants being absorbed and becoming more concentrated

2 Substances are continually recycled in nature - between air, water and soil, plants and animals. Draw arrows on this picture showing how pollutants can enter these cycles.



How does pollution affect living things?

Cars produce carbon monoxide gas which spreads out into the air. Carbon monoxide can combine with our red blood cells, reducing the amount of oxygen our blood can carry. In the upper atmosphere, carbon monoxide is oxidised to carbon dioxide. Car exhausts also release other gases into the air, such as sulphur dioxide and oxides of nitrogen. These gases are also produced by burning fossil fuels in power stations and factories. These gases dissolve in water in the atmosphere, and fall to the ground as 'acid rain'. Acid rain can damage buildings and forests.

Some pollutants are *biodegradable,* which means that they are broken down by living things. For example, untreated sewage from humans and farm animals often finds it way into rivers and the sea. Sewage is rich in nitrates, which are needed by plants to grow - some plants can grow very rapidly in water polluted by sewage, using up oxygen and killing off fish and other plant life. Nitrates also get into the water system from the soil - they are used as fertilisers on farms, and rain dissolves them, causing them to 'run off' into streams and rivers.

Some pollutants, such as metal compounds, are *non-biodegradable.* Lead is released into the air from cars using leaded petrol. We breathe in this lead, and it accumulates in brain tissue, which can cause brain damage or death at high concentrations. Some factories release poisonous metals, such as mercury and cadmium into the sea. These can accumulate in plants and fish, and can be passed along food chains (when one organism eats another). These poisonous metals can also accumulate in the tissues of humans who eat these fish, causing serious diseases.

DDT and pollution

Read the following, and then answer the two questions below:

DDT is an insecticide - it kills insects. People first started making and using DDT about 50 years ago, but it is now banned in many parts of the world. It is very effective in controlling many pests (eg malarial mosquitoes), but it has caused other problems.

DDT can be applied to fields of crops from an aircraft. The fine mist falls to the ground and spreads over a wide area. From here, it can be washed out of the soil, and enter rivers and lakes. There may be only a small amount of DDT in a lake, but it can become concentrated in the body fat of fish.

For example, Clear Lake in California was treated with DDT. This was to get rid of the midges (insects). The DDT was diluted by the water in the lake, so the concentration was quite low. However, the concentration of DDT in the plankton (tiny animals in the lake) was 250 times bigger. The concentration of DDT increased up the food chain. In the sunfish in the lake, the level of DDT was 12 thousand times higher. In the grebes (birds) which fed on the fish, the level was 80 thousand times higher. These grebes failed to make any eggs that hatched.

Much DDT has travelled away from the regions where it was used. It is now found everywhere in the world. It has even been found in the body fat of Antarctic penguins, even though DDT has never been used there.

a) List some examples in which DDT becomes *more spread out.*

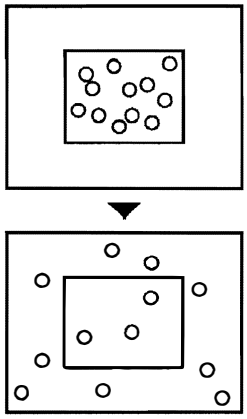
b) List some examples in which DDT becomes *more concentrated.*

Using a concentration difference

1 Living things get rid of waste

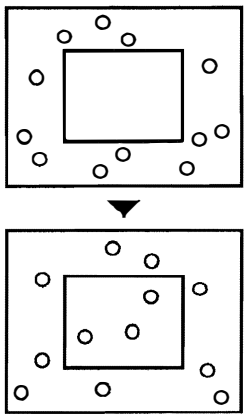
Living things produce waste substances. These waste substances tend to go from where there is a lot (inside the living thing) to where there is not (in the surroundings).

Some substances which are needed by living things, such as water, also tend to escape like this.



2 Living things need new substances

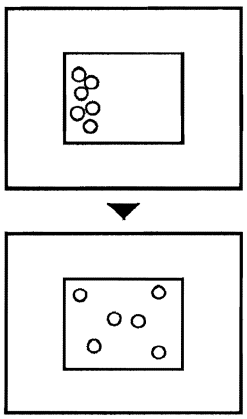
Living things need new substances from the surroundings. Often, these substances are more concentrated in the surroundings than they are in the living thing. They tend to go from where there is a lot (in the surroundings) to where there is not (inside the living thing).



3 Moving substances around in living things

Substances spread out inside living things because of concentration differences. This can help to get substances to where they are needed.

In large plants and animals, using only concentration differences takes too long. So, substances also need help to make them spread out (for example, the heart pumps blood around).

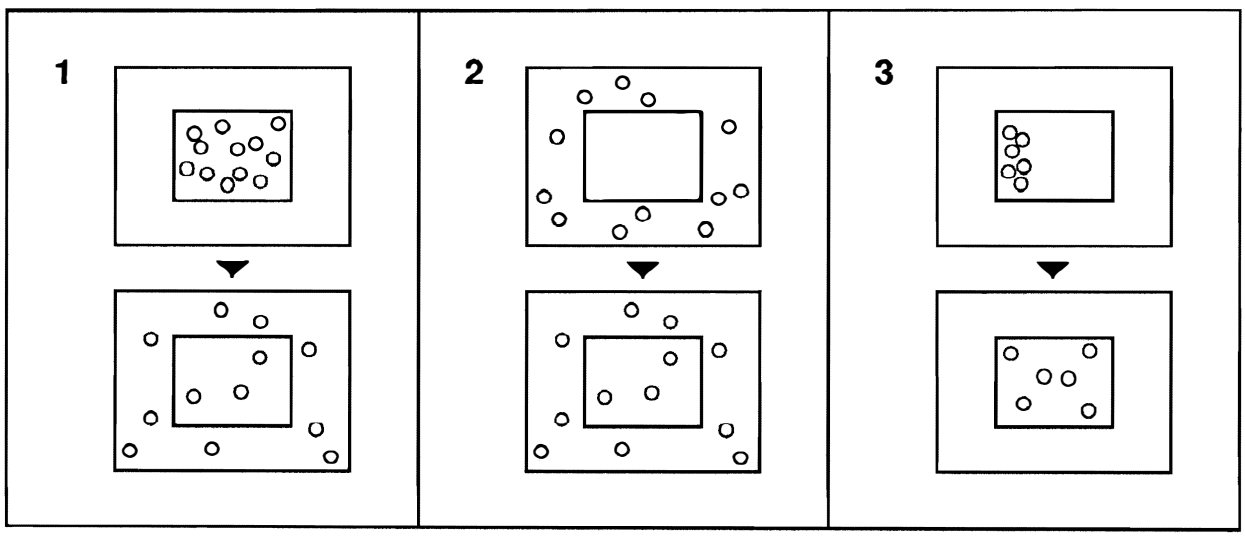


Using a concentration difference

Sheet 2

Substances often move from one place to another because of a concentration difference. Below are some different changes. All of them are about substances moving from where there is a lot to where there is not. Match each one to the picture you think best represents the change. The pictures show substances moving out of, into, and around living things.

A In human lungs, oxygen travels from the air into the bloodstream.	**B** Water in the leaf of a plant evaporates from the stomata into the air.
C During the day, plants take in carbon dioxide from the air. The carbon dioxide goes through the stomata into the leaves.	**D** Human cells get the glucose they need from nearby blood capilliaries.
E In human lungs, carbon dioxide travels from the bloodstream into the air.	**F** As water flows over the gills of a fish, dissolved oxygen in the sea passes into the blood of the fish.
G During the day, plants release oxygen into the air. The oxygen travels from the leaves through the stomata into the air.	**H** Water in the soil passes into the root hairs of plants.
I Digested food passes from the intestine into the bloodstream.	**J** Carbon dioxide produced in human cells passes into the blood and is carried away.
K As water flows over the gills of a fish, carbon dioxide in the blood of the fish passes into the sea.	**L** In the kidney, urea passes from the blood into the fluid in the Bowman's capsule.

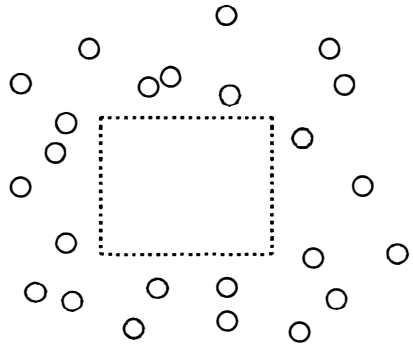


Keeping a concentration difference going

A Substance X - a concentration difference

Imagine a 'leaky' container surrounded by 'substance X', which can pass through the walls of the container. At the start there is a concentration difference - X is more concentrated outside the container than inside.

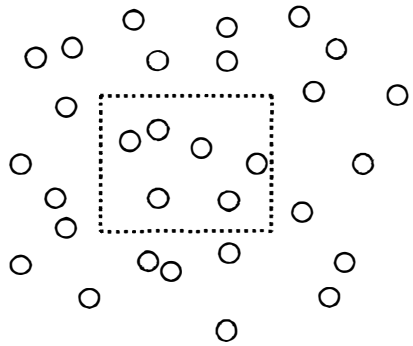
What will happen?



B The concentration difference disappears

Substances tend to go from from where there is a lot to where there is not. So, X passes from outside the container to inside. The concentration difference disappears.

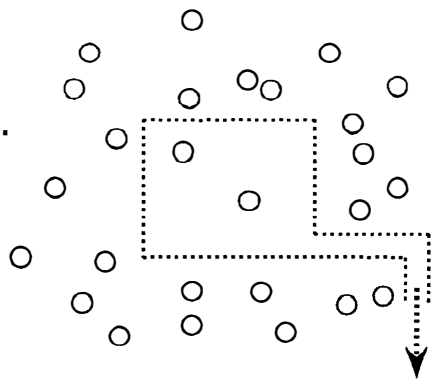
Could you re-create the concentration difference?



C Creating a concentration difference

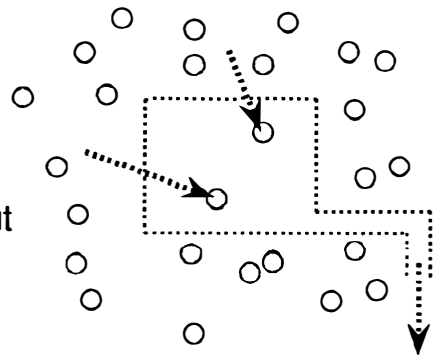
You could re-create the concentration difference, if you could 'pump' X out of the container in some way.

What will happen now?



D Keeping a concentration difference going

As soon as you start pumping, the concentration inside drops and becomes less than outside. So, more X will pass into the container from outside. You can keep the concentration difference going, but you must *carry on pumping all the time.*



Keeping a concentration difference going

Sheet 2

Living things make themselves from substances they get from their surroundings. But the concentrations of these substances are different inside and outside the organism. To stay alive, living things must keep concentration differences going.

1 For each of these pairs, which has the higher concentration?

a)	water in a camel	water in the desert
b)	calcium in a shellfish	calcium in the sea
c)	salt in a fish	salt in the sea
d)	carbon in a plant (as starch, cellulose, etc)	carbon in the air (as carbon dioxide)
e)	silicon in a plant	silicon in the soil
f)	calcium in human bone	calcium in human muscle tissue

2 For each of these pairs, which has the higher concentration? Which direction does the substance go? How is the concentration difference kept going?

a)	oxygen in air in lungs	oxygen in blood supply to lungs
b)	carbon dioxide in air in lungs	carbon dioxide in blood supply to lungs
c)	oxygen in muscle tissue	oxygen in blood supply to muscles
d)	carbon dioxide in muscle tissue	carbon dioxide in blood supply to muscles

3 Living things are affected by the environent, but they also affect it themselves. They keep concentration differences going; without life, the chemical composition of the atmosphere and the oceans, for example, would be very different.

Can you explain why these changes would happen if there were no living things?

a) There would be much more carbon dioxide in the air.

b) The amount of oxygen in the air would drop to almost nothing.

c) The concentration of salts in the sea would increase.