NEW PLANTS FROM OLD

As well as making seeds which grow into new plants, many plants can reproduce by a process in which part of the plant develops into a new one. This method, called **vegetative reproduction** or **vegetative propagation**, is a type of asexual reproduction, which means it does not involve a male and female sex cell. Some of the different plant parts that can grow into new plants are described here.

Each crocus has grown from a swollen stem called a corm.

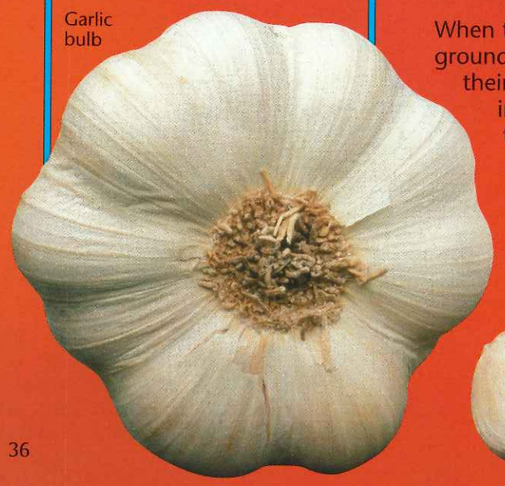
BULBS

Plants such as garlic and tulips grow from bulbs. A **bulb** is a short, thick, underground stem surrounded by scaly leaves that are swollen with food. It stays alive over winter when the rest of the plant has died. Some bulbs can reproduce asexually by sprouting extra bulbs on the side.

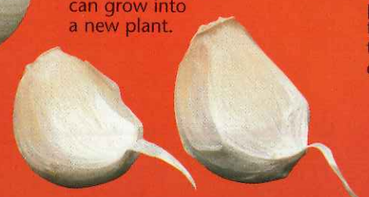
See for yourself

Garlic bulbs are **composite bulbs**. This means that each swollen leaf, called a **clove**, can grow into a garlic plant.

Try planting a few cloves in a pot of potting compost, with the rounded end down. Keep them watered. After about two weeks, shoots of new garlic plants should appear.



Garlic bulb



Each clove of garlic can grow into a new plant.

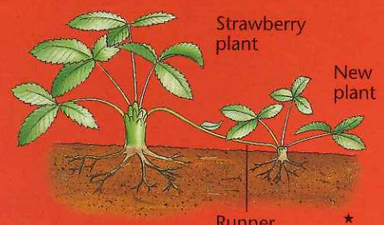
CORMS

A **corm** is a short, thick stem base that is swollen with food. It can sprout extra corms each year.

Crocus corms

RUNNERS

Some plants, such as spider plants and strawberry plants, can reproduce by forming long side shoots called **runners** or **stolons**.



When the runners touch the ground, they develop roots of their own, and start to grow into new plants. At first the new plant is fed by the parent, but once it can live on its own, the runner rots away.

RHIZOMES

Many plants grow from thick stems called **rhizomes** which grow horizontally underground. A rhizome produces roots along its length and also buds from which new shoots grow. Ferns, mint, irises and many grasses are plants that produce rhizomes.

TUBERS

A number of plants produce offspring from swollen underground stems called **tubers**. These develop from shoots which grow into the soil. Food is stored in the tuber. In winter the parent plant dies, but the tubers develop into new plants the following year.

Potato plants produce tubers which grow into new plants.

Potato tuber. This is the part of the plant that you can eat.

Tulips like these grow from bulbs. Each year, market gardens provide thousands of tulips for the flower industry.

SPEED AND QUALITY

Vegetative reproduction produces new plants much more quickly than they can grow from seeds. Also, the new plants are identical to the parent plant. Farmers and market gardeners often make use of a plant's ability to reproduce vegetatively. As well as producing more plants, they know that the new plants will be the same quality as the original plant.

Growers have also developed methods of removing parts from a plant to grow new plants. These are examples of **artificial propagation** as, left to themselves, plants do not usually reproduce in these ways.

Some varieties of fruit, such as this navel orange, do not have seeds. They can only be grown by artificial propagation methods.

TAKING CUTTINGS

One common method of artificial propagation is **cutting**. This involves taking a piece such as a side stem or leaf (known as the cutting) off a plant and planting it in soil where it grows into a new plant. The cutting may need to stand in water for a while to develop new roots before being planted in soil.

Growing a plant from a cutting

A piece of plant is cut from the parent plant.

The cutting is placed in water until roots begin to grow.

The cutting is replanted in soil, where it will grow into a new plant.

African violet plants can be grown from leaf cuttings.

MICROPROPAGATION

Scientists can grow new plants from just a few cells taken from a meristem (growth area) of a plant. The cells are placed on a gel that contains chemicals which make the cells divide. Groups of cells are then moved to a second gel which contains growth chemicals that make the cells grow into shoots. This method, called **micropropagation**, can create hundreds of identical plants from one parent plant.

Internet links

Go to **www.usborne-quicklinks.com** for links to the following Web sites:

Web site 1 Detailed information about natural propagation.

Web site 2 Advanced information about artificial propagation.

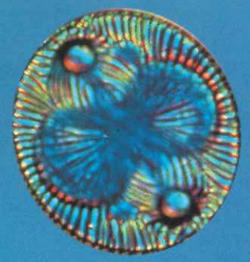
Web site 3 Read about the biology and history of the potato.

Web site 4 Discover the fascinating history of the tulip.

Web site 5 Information on different root vegetables.

WATER PLANTS

Most plants grow on land, but there are also many aquatic plants – plants specially adapted to live in water. These are known as **hydrophytes**. They range from microscopic plants, which are found in groups of several million, to huge flowering plants over a meter across.



This is a microscopic water plant called a diatom.

A WATERY LIFESTYLE

Water plants are either emergent or submergent. **Emergent** plants, such as reed mace, grow well in very wet soils, or in soils which spend a lot of time covered in water. Most or all of their stems and leaves can be seen above the surface of the water.

Reed mace can often be seen growing out of the water by a river bank.

Submergent plants, such as water lilies, grow beneath the surface of the water. However, some of their parts, for instance large leaves, may float on the surface. Unless they are free-floating, their roots, or root-like parts, anchor them to the ground beneath the water.

Free-floating submergent plants, such as duckweed, are not attached to anything. They are found in large numbers in calm, sheltered water.

This duckweed floats freely on the water's surface.

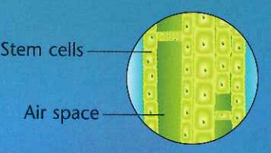
SPECIAL FEATURES

Water-living plants have a number of special features. For instance, most underwater leaves, unlike leaves of other plants, do not have a waxy waterproof coating. This is because the whole leaf surface is needed for exchanging gases between the plant and the water. Many water plants also have very different leaves above and below the surface.

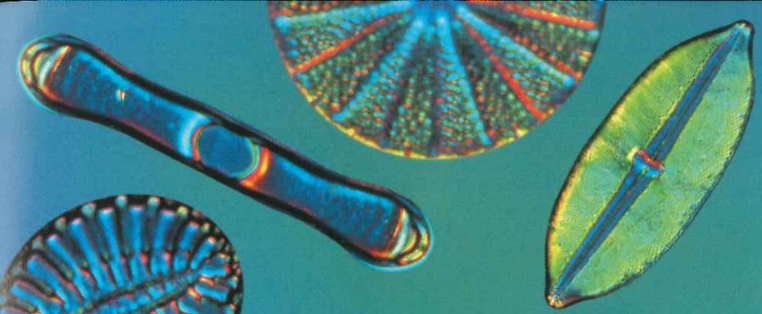
Above the water's surface, water crowfoot has broad, flat leaves.

Under the water, its leaves are thin and finely divided.

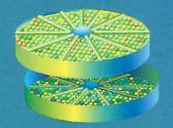
Some submergent plants develop gaps between the cells in their stems and leaves. These gaps trap air which helps the parts to float.



A water lily's stem and roots grow underwater.



Diatoms, like these, are a type of algae.



Each diatom is made up of two halves, which fit together like a lid on a box.

ALGAE

Algae form a large group of plants which have a very simple structure. Most types of algae are found in water, but they can grow in any suitably damp conditions, including in soil, on rocks, and even on living things.

One of the simplest types of algae are microscopic **diatoms**. Most are made up of a single cell, with a hard, glassy case. Each species of diatom has a differently patterned case.

Microscopic algae never have roots, stems or leaves, and don't contain true vascular tissue*. They can reproduce quickly and, like most plants, make their own food using the Sun's energy. Algae are an important source of food for many water creatures.

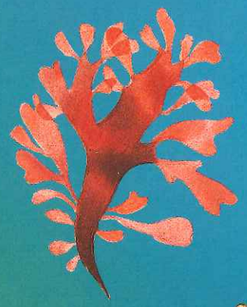
* *Pigments, 19; Vascular tissue, 12.*

SEAWEED

Seaweed is a type of many-celled algae. Most seaweed has root-like **holdfasts** at its base, which anchors it to solid objects, such as rocks. Some have bubble-like **air bladders**, which keep them afloat. A seaweed's leaves, called **fronds**, often contain pigments* which allow them to take in light at different water depths.

Examples of seaweed

Sea lettuce has very thin, crinkled fronds. These darken as the plant ages, because different tiny algae cover their surface.



Edible dulse grows in deep pools. The red pigment in its fronds helps it to capture light underwater.

Knotted wrack has long fronds, which contain pockets of air called air bladders.

STUDYING ALGAE

Scientists study the types and numbers of algae in a water sample to find out how clean it is. Single-celled, freshwater algae called **desmids** are generally found growing in clean water.

Some types of algae, though, reproduce rapidly in water which contains high levels of nitrates (chemicals found in some fertilizers and sewage). This is called **eutrophication**. These algae use up oxygen that other living things in the water need, eventually killing them.

Eutrophication is mostly caused by sewage-dumping and by fertilizer being washed from the soil into the water.

Blue-green algae (called cyanobacteria) are starting to cover this polluted lake.

See for yourself

If you visit the coast, look for seaweed of different colors and textures. You may find it in rock pools, or washed up on the shore. Look for features like air bladders or a holdfast.

Internet links

Go to **www.usborne-quicklinks.com** for links to the following Web sites:

Web site 1 Pictures and information on aquatic plants.

Web site 2 Microscope images of tiny water plants called diatoms and desmids.

Web site 3 Photographs of algae and diatoms.

Web site 4 An illustrated look at aquatic plants.

FIGHTING FOR SURVIVAL

Every living thing in nature struggles to survive. Most plants are threatened by animals and people, as well as by other plants, and may have to live in difficult conditions. Plants survive by adapting to life in different environments, and competing successfully with other living things.

NATURAL SELECTION

Over time, some plants develop features which help them to survive in particular conditions. Plants with helpful features are more likely to survive and reproduce. Plants without these features often die out. This process is called **natural selection**.

COASTAL PLANTS

The seashore is an example of an environment where conditions can be harsh. There is little firm soil or fresh water, and strong, salty winds often blow. Even so, some plants have adapted to life in these surroundings.

For instance, when a sand dune first forms, only grasses grow there. Their roots form a network which helps to bind together the loose, sandy ground, eventually creating a kind of soil that other types of flowering plants can grow in.

Grasses growing on sand dunes help to make the ground firmer.

Shingle beaches are made up of small rock fragments, mixed with sand. Only plants with long or sprawling roots, which hold the plant firmly in the shingle, can live in these areas. Long roots also help the plant to reach supplies of fresh water deep under the ground.

This yucca is a desert plant. It has narrow, tough leaves, which lose little water.

Yellow horned poppies are anchored firmly in the shingle by their long roots.

Areas called **salt marshes** form where a river joins the sea. Their soil is **saline** (salty), which means that most plants are not able to grow in it.

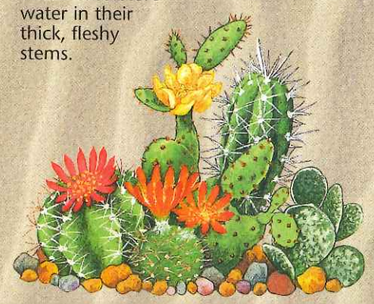
A group of plants known as **halophytes** can survive in saline areas. Some need salt in order to grow. Others are adapted to remove salt from water that they take in. For example, some halophytes have **salt bladders** on the surface of their leaves. These bladders burst to release salt. Other halophytes store the salt in old leaves, which they later shed.

Sea asters grow best in salty conditions.

DESERT PLANTS

Plants which grow in very dry areas, such as deserts, are called **xerophytes**. There are many ways in which they make the most of the limited water supply. For example, some have very small leaves, or needle-like leaves called **spines**, which lose very little water. Most desert plants have specially adapted cells which store water.

These cacti store water in their thick, fleshy stems.



ROCK PLANTS

Plants which live on the surface of rocks are called **lithophytes**. They are mostly found on walls, cliff-faces or mountainsides. Lithophytes usually have special roots which anchor them to rocks.

Mosses are one of the few types of plants that can survive on rocks.

See for yourself

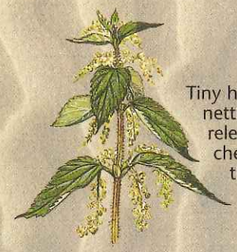
You can easily keep cacti at home. A cactus will grow best in sandy soil with a covering of pebbles. It needs plenty of sunlight, but very little watering. When you water a cactus, you will notice that the water dribbles off its surface. This is because its skin is tough and thick, to keep in as much water as possible. A cactus gets all the water it needs through its roots.

PROTECTION

Plants are constantly under threat from animals that want to eat them. Some plants have special features which protect them from hungry animals and other dangers. These features are known as **protective adaptations**.

Some plants, such as this dog rose, have sharp thorns or prickles which make them difficult for animals to eat.

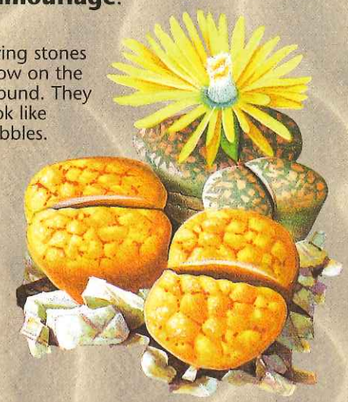
Thorn



Tiny hairs on this nettle's leaves release a stinging chemical when they are touched.

Some types of plants use tricks and disguises to keep themselves safe. For instance, living stone plants have adapted to blend in perfectly with pebbles on the ground. Animals mistake them for real stones, and do not try to eat them. This type of disguise is called **camouflage**.

Living stones grow on the ground. They look like pebbles.

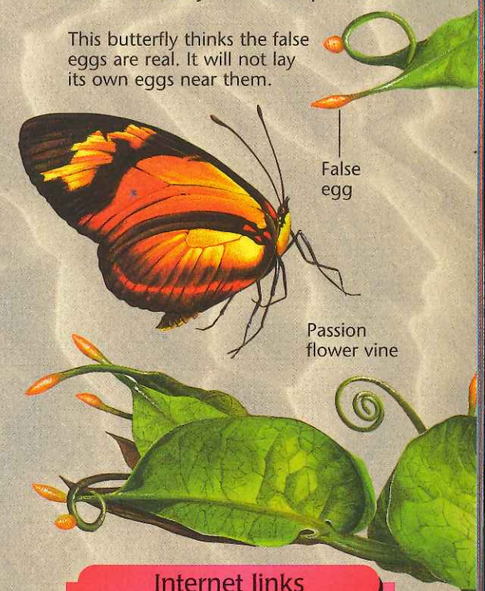


Many plants are damaged by hungry insect grubs, such as caterpillars. These hatch out of eggs laid on the plant's leaves.

Some passion flower vines protect themselves from this threat by developing small growths which look like butterfly eggs. Butterflies are less likely to lay eggs on a plant which looks as if it already has some on it. Only a small number of real eggs are laid on the plant, so it is attacked by few caterpillars.

This butterfly thinks the false eggs are real. It will not lay its own eggs near them.

False egg



Passion flower vine

Internet links

Go to **www.usborne-quicklinks.com** for links to the following Web sites:

Web site 1 Find out how some plants and seeds have adapted to survive in many different places.

Web site 2 Learn about plant survival in the desert.

Web site 3 Play a plant adaptation game and learn about plants around the world.

Web site 4 Find out what rainforests are and how they survive.

Web site 5 Learn about plants in different ecosystems.

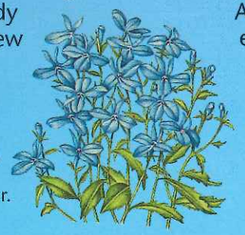
PLANT LIFESTYLES

The way a plant grows and reproduces depends on many things, such as climate, soil and weather conditions. Some plants live in areas where growth is impossible for some parts of the year, so they grow quickly and reproduce many times when conditions are right. Others may grow one year and reproduce the next. Each year in a plant's life is described as a single **growth season**.

These blue daisies are perennials. They bloom year after year.

ANNUALS

Flowering plants that live and die within a single year are called **annuals**. The entire process of growth, flowering and seed production may take place in as little as a few weeks. Annual plants have usually bloomed and died by the end of the summer. Their seeds remain inactive during the winter, ready to grow into new plants when spring comes.



This lobelia grows, flowers and dies within a single year.

BIENNIALS

Some flowering plants take two years to complete their life cycle. They are called **biennials**. During the first year, they grow and store up food. In the second year, the plant grows taller, blooms and produces seeds. After this, the entire plant dies.

Wallflowers grow and store food in one year, then flower and die in the next.

PERENNIALS

Plants that live for many years are called **perennials**. There are two types. **Herbaceous perennials** lose all the parts that are above ground each winter. Their roots become swollen with food and remain inactive until new shoots sprout from them the following spring.

Shrubs and trees are **woody perennials**. They may lose some parts, such as leaves, during the winter, but their stems or trunks stay alive, growing thicker each year.

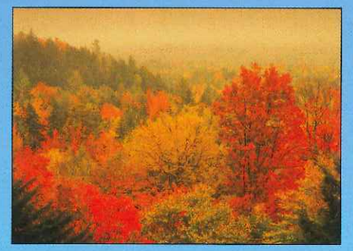
EPHEMERALS

Plants with very short life cycles are called **ephemeral plants**. They are often found where the right growth conditions occur for a limited time, such as in deserts. The plants grow quickly from seeds which have been inactive in the ground. They bloom and produce seeds, which may also then grow, bloom and produce seeds, and so on, until conditions become unsuitable again.

During the brief rainy season, these desert plants have bloomed, creating a carpet of flowers.

TREE LIFESTYLES

Trees can be divided into two categories: deciduous and evergreen. **Deciduous trees** lose their leaves every year. Most deciduous trees have thin, soft leaves that dry out easily. These are shed just before winter, when the temperature drops. If the ground freezes, there is less water available. If deciduous trees kept their leaves at this time, too much precious water would be lost through them.



Leaves on deciduous trees change color before they fall. New leaves grow in spring, when the temperature rises.

In some places, such as grasslands, there are two seasons: rainy and dry. The trees there shed their leaves at the beginning of the dry season, when the moisture level of the soil drops below a certain point. The leaves begin to grow back at the start of the rainy season, when water is available again.

Trees that do not shed their leaves all at once are known as **evergreen**. Unlike deciduous trees, they have tough, waxy leaves, which means they lose less water. They can survive and grow in places where little water is available. Keeping their leaves also means that they can continue to make food during the winter, even though there is less sunlight available.

Conifers such as these have narrow, waxy leaves with a small surface area. Little water is lost through them.

See for yourself

Next time you are in a wooded area, look closely at the trees. See if you can find examples of both deciduous and evergreen trees, and compare the leaves. Deciduous leaves are flat, with thin veins running through them. Evergreen leaves tend to be waxy and pointed.

Internet links

Go to **www.usborne-quicklinks.com** for links to the following Web sites:

Web site 1 Watch a short animated movie about fall leaves.

Web site 2 Images and information about ephemeral desert plants.

Web site 3 Learn all about the life cycle of trees in Californian forests.

Web site 4 Search for annuals and perennials in this online plant guide.

Web site 5 Find out how Christmas trees are grown and harvested.

NATURAL CYCLES

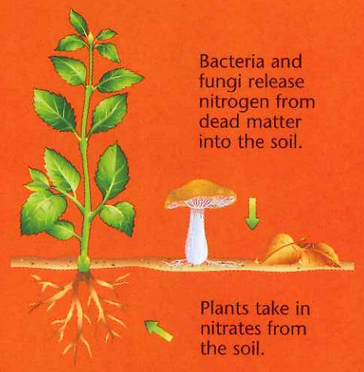
Plants and animals need carbon, nitrogen, oxygen and water to keep them alive. These vital substances are constantly recycled between the air, land and living things, which means that plants and animals need never run out of them. However, natural cycles are easily disturbed, especially by some human activities that release harmful substances into the environment.

Some fungi break down dead matter. This returns vital chemicals to the soil.

THE NITROGEN CYCLE

All living things need **nitrogen** to make essential chemicals called **proteins**. Before plants and animals can use nitrogen, it must be combined with oxygen to form **nitrates**. Lightning forms some nitrates from nitrogen in the air. Certain types of bacteria also form nitrates. They mostly live inside the roots of vegetables called legumes, for example peas and beans.

When a plant or animal dies, fungi and bacteria break it down. This releases nitrogen into the soil as a chemical called **ammonia**. **Nitrogen-fixing bacteria** in the soil change the ammonia into nitrates, which are taken in by plants. Animals gain these nitrates by eating plants, or animals that have eaten plants.



Bacteria and fungi release nitrogen from dead matter into the soil.

Plants take in nitrates from the soil.

THE CARBON CYCLE

All living things need **carbon** to live and grow. Plants obtain it from carbon dioxide in the air. During photosynthesis*, they use carbon dioxide to make food substances called **carbohydrates**.

Plants take in carbon dioxide during the day to help them make food.

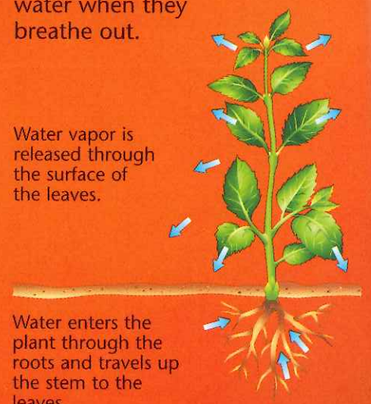
At night, they give out carbon dioxide when food is not being produced.

Inside living things, internal respiration* turns carbohydrates into energy, producing carbon dioxide as waste. Carbon dioxide is also released into the atmosphere when organic matter is burned or broken down in the soil.

THE WATER CYCLE

Water is constantly recycled through the air, rivers and seas. Water that falls as rain drains into rivers, then into the sea. It turns to vapor, forming tiny droplets in the air. These form clouds, and water falls back to Earth as rain.

Plants transpire (release water vapor) through their leaves. Most animals also release water when they breathe out.



Water vapor is released through the surface of the leaves.

Water enters the plant through the roots and travels up the stem to the leaves.

See for yourself

Plants that grow in towns may be harmed by particles of dirt from traffic exhaust. On a dry day, gather a few leaves from trees or bushes growing in a town where there is lots of traffic passing through.

Next, take a damp cloth, and rub the upper surface of the leaves. You may find that a layer of dirt from the polluted air rubs off. This blocks out light that the leaves need to make food for the plant, making it less healthy.

* Internal respiration, 23; Photosynthesis, 22.

UPSET BALANCE

People can upset the balance of natural cycles in various ways. For example, in some parts of the world, forests are burned down to make way for farming or building. Burning releases carbon, which forms carbon dioxide in the air.

The remaining plants do not remove this carbon dioxide fast enough during the process of photosynthesis*, so it builds up in the atmosphere.

The dense layer of carbon dioxide traps the Sun's heat around the Earth, creating what is known as the **greenhouse effect**. This is believed to cause **global warming**, a dangerous increase in the Earth's overall temperature.

Here, a large area of forest is being burned to make way for building and farming. Burning such as this increases the level of carbon dioxide in the atmosphere.

Pollution can also affect the growth patterns of living things. **Lichens** are simple living things made up of a fungus and an alga growing together. In areas with little or no pollution, shrubby lichens may be seen growing on trees. In very polluted areas, there are large amounts of green algae, but no lichens.

Green algae grows on trees in very polluted areas.

Leafy lichens grow on walls. They are found in areas with some pollution.

Shrubby lichens grow on trees in cleaner areas.

PLANTS UNDER THREAT

Some plants are directly threatened by human activities. For instance, golden barrel cacti are now very rare in Mexico, because they have been collected illegally and sold.

Golden barrel cactus

In Wales, seeds from the last tufted saxifrage plants in the country were grown into new plants. These were replanted in the wild to try to save the species from dying out. This was successful, but global warming is once again threatening the cold mountain areas in which they live.

Tufted saxifrage

Internet links

Go to **www.usborne-quicklinks.com** for links to the following Web sites:

Web site 1 Clear, concise explanations of the carbon, nitrogen and water cycles.

Web site 2 Information about acid rain.

Web site 3 Discover fascinating facts about global warming.

Web site 4 All about the ozone layer.

Web site 5 Learn why plants are so important.

Web site 6 All about plant nutrients.

Web site 7 Find out how forests are put in danger.

* Photosynthesis, 22.