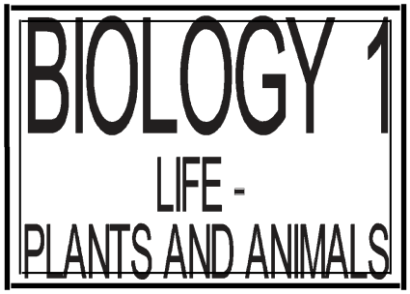
CONTENTS

NB Some spellings of scientific terms may vary - words are sometimes used in their internationally accepted format.



By Harry Jivenmukta

WHAT IS BIOLOGY?

1

Biology may be defined as:

an area of learning that deals with all of the physicochemical aspects of life.

Because biology is such a broad subject, it is subdivided into separate branches for convenience of study. Despite apparent differences, all the subdivisions are interrelated by basic principles.

Biology is often approached today on the basis of levels that deal with fundamental units of life. At the level of molecular biology, for example, life is regarded as a manifestation of chemical and energy transformations that occur among the many chemical constituents that comprise an organism.

Cell biology, the study of the fundamental unit of structure and function in a living organism, may be said to have begun in the 17th century, with the invention of the compound microscope. Before that, the individual organism was studied as a whole. Population biology deals with groups or populations of organisms that inhabit a given area or region. Included at this level are studies of the roles that specific kinds of plants and animals play in the complex and self-perpetuating interrelationships that exist between the living and non-living world, as well as studies of the built-in controls that maintain these relationships naturally.

In another way of classification, a field of biology may be especially concerned with the investigation of one kind of living thing. These can include:

- Botany, the study of plants;
- Zoology, the study of animals;
- Ornithology, the study of birds;
- Ichthyology, the study of fishes;
- Mycology, the study of fungi;
- Microbiology, the study of micro-organisms;
- Protozoology, the study of one-celled animals;
- Herpetology, the study of amphibians and reptiles;
- Entomology, the study of insects;
- Physical anthropology, the study of humans.

CLASSIFICATION

2

Classification means putting things into groups. Classifications are important for several reasons:

- Dividing up a large subject area into smaller sections,
- Being able to look at particular sections in greater detail,
- Being able to find distinct parts of a subject and link it with other areas by size, date, age, common factors, etc.

The first person to classify living things into groups using scientific methods was a Swedish naturalist called Linneaus. He divided living things into species, and identified 12,000. Today, scientists have identified more than 1.5 million types of organism. A species is identified as:

A group of similar organisms which can interbreed successfully with one another and produce fertile young.

In Biology classification starts with:

- Very large groups called **Kingdoms**.
- Kingdoms are divided into smaller groups; **Phyla** for animals and **Divisions** for plants.
- The groups are then divided into **Class** and then into **Order**.
- After that is **Family**, **Genus** and **Species**.

Questions...

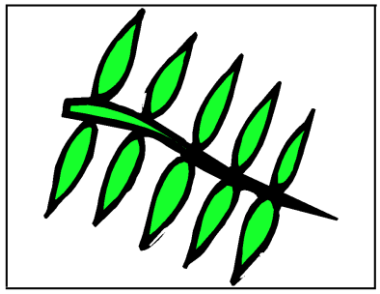
1. What does classification mean?
2. Why is classification an important scientific method?
3. What is a species?
4. Write a short biography of Linneaus.

CLASSIFICATION OF PLANTS

Algae - These plants have no proper roots, leaves or stems. They live in water, or in very wet places.

Mosses - These have simple stems and leaves. The roots are hair like, and reproduction is achieved through spores.

Ferns - These have roots, leaves, and a system for transporting nutrients and water around the plant. These also reproduce through spores.

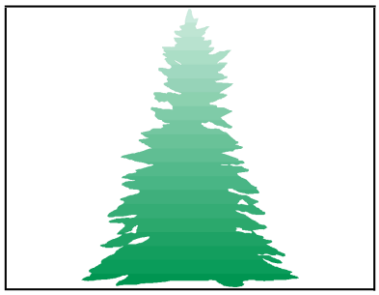


Questions...

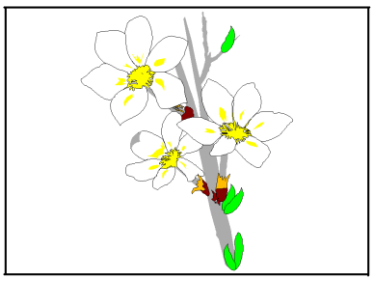
1. Draw a picture of algae in the blank box above.
2. Write a short sentence each on the characteristics of the three types of plants listed above.
3. Compare and contrast the qualities of the three types of plants.
4. Find out about and list the names of other plants which are; algae, mosses, or ferns.

CLASSIFICATION OF PLANTS

Conifers - These have roots, leaves, and stems. They can transport food and water around the plant and reproduce through seeds which grow inside a cone.



Flowering Plants - These have roots, stems, and leaves and can transport food and water throughout the plant. Reproduction is through seeds which grow inside a fruit and which develop from the ovary in the flower.



Questions...

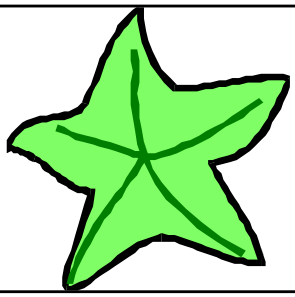
1. Draw a picture of a cone like the one in the picture above and label its main features. Explain the main function of the cone.
2. Write a short sentence each on the characteristics of the two types of plants listed above.
3. Compare and contrast the qualities of the two types of plants.
4. Find out about and list the names of other plants which fall into these two categories.

CLASSIFICATION OF ANIMALS
SOFT BODIED

Coelenterates (Jellyfish) - These animals have a soft jelly like body, and one opening which is surrounded by tentacles.

Annelids (worms) - Their bodies are made up of segments and form into a long thin body

Starfish - this group also includes sea urchin types of animals. Starfish have five 'arms' which gives them their name. The next group, **Molluscs** are similar. These have a muscular foot for movement. They may have a soft or hard body.

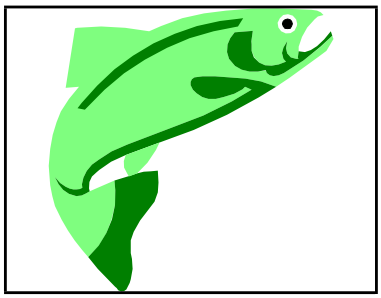


Questions...

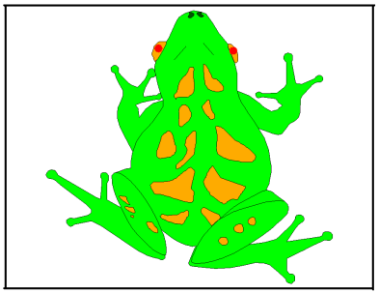
1. Draw a picture of a Coelenterate, (jellyfish), in the blank box above.
2. Draw a detailed picture of an Annelid, (worm), in the box above and explain how it achieves movement.
3. Write a short sentence each on the characteristics of the four types of animals listed above.
4. Compare and contrast the qualities of the four types of animals.
5. Find out about and list the names of other animals which fall into these four categories.
6. What is a mollusc?

CLASSIFICATION OF ANIMALS
SOFT BODIED

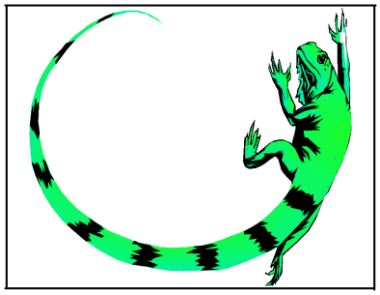
Fish - Use gills to breathe in water. Their bodies are covered with scales and they have fins to allow easy movement. Fish reproduce by laying soft shelled eggs.



Amphibians - They have four legs, live on land, but return to water to lay eggs. Their young also grow up in water before moving to land to live.



Reptiles - These have dry scaly skin. They can live either in water or on land and reproduce by laying eggs.

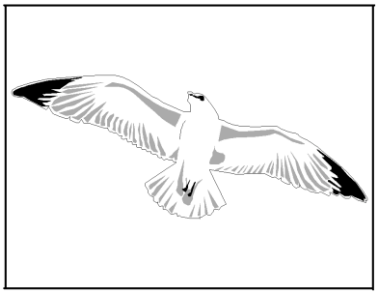


Questions...

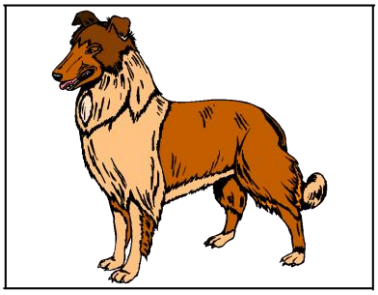
1. Draw a picture of another reptile, other than the one shown above.
2. Write a short description each on the characteristics of the three types of animals listed above.
3. Compare and contrast the qualities of the three types of animals.
4. Find out about and list the names of other animals which fall into these three categories.

CLASSIFICATION OF ANIMALS WITH A BACKBONE

Birds - They are covered with feathers and have two legs and two wings. They reproduce by laying hard shelled eggs. Not all birds can fly.



Mammals - Their bodies are covered to a greater or lesser degree with fur or hair. They reproduce their young inside the body and their young are nourished after birth by mammary glands in the female.



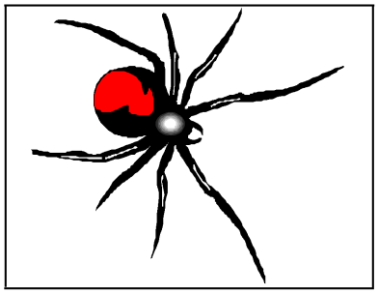
Questions...

1. Write a short description each on the characteristics of the two types of animals listed above.
2. Compare and contrast the qualities of the two types of animals.
3. Find out about and list the names of other animals which fall into these two categories.

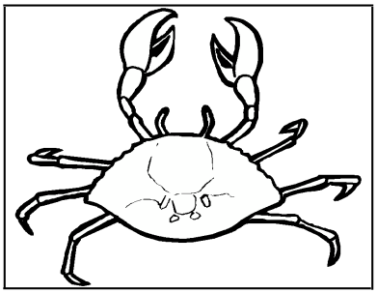
ARTHROPODS

Insects - They have six legs, a pair of antennae, and usually a pair of wings

Spiders - Their body is divided into two parts and they have eight legs.



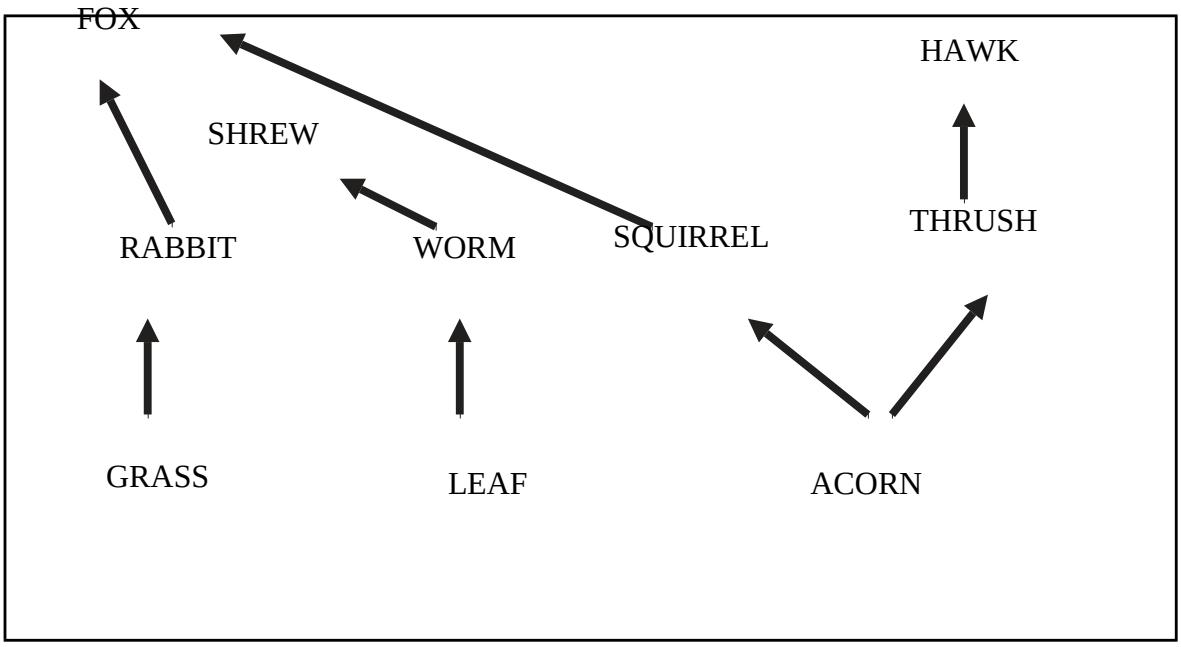
Crustaceans - This group varies greatly. Generally, they have a hard outside skeleton and eight or more legs. The next group, **Myriapods** are multi-segmented and have legs attached to each segment. An example of these is a centipede.



Questions...

1. Draw a picture of a Myriapod.
2. Write a short description each on the characteristics of the four types of animals listed above.
3. Compare and contrast the qualities of the four types of animals.
4. Find out about and list the names of other animals which fall into these categories.

A WOODLAND FOOD WEB



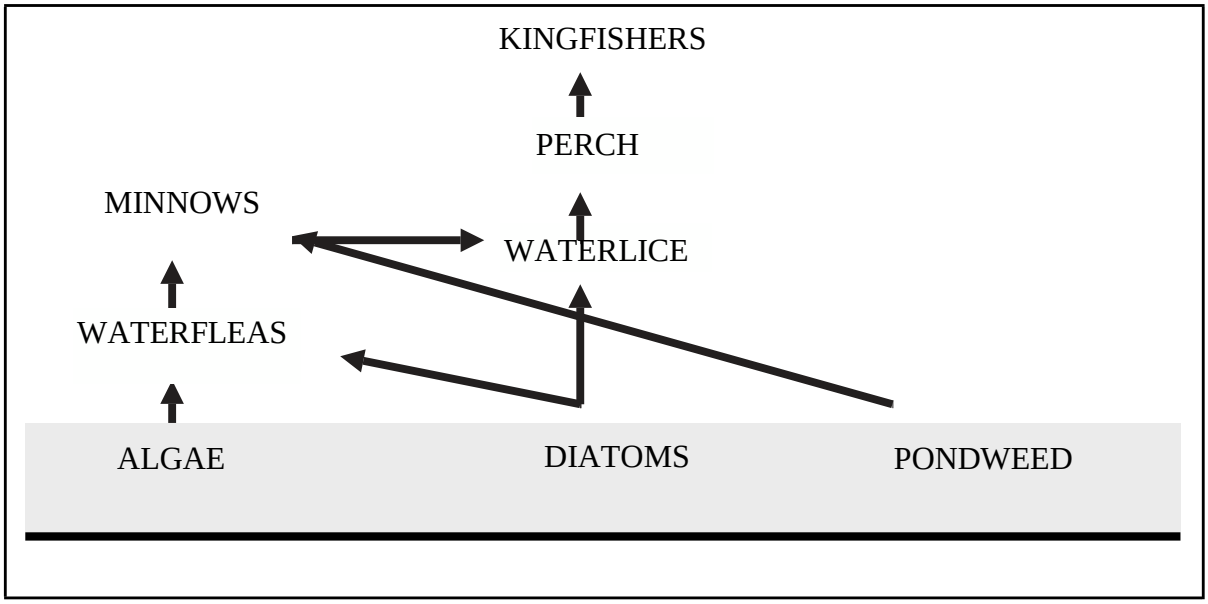
A food web describes the relationship in the food chain between plants and animals, and between prey and predator. Food webs are a good way to understand how all living things rely on each other and how habitats work. The illustration above shows a woodland food web. It is by no means exhaustive and you can easily add to it.

It is easy to see, from the illustration above, that the grass is eaten by the rabbit, which is itself food for the fox. Similarly, acorns are eaten by thrushes who are then a food source for the hawk. Food webs are a very easy way to follow the sequence of the food chain, but they differ depending on the habitat and the types of plants and animals present.

Questions...

1. What is a food web?
2. What purpose does studying a food web have in our understanding of biology?
3. Think of other ways in which this type of information could be shown and easily understood.

A POND FOOD WEB



The illustration above shows a section of a pond food web. The plants and small creatures which live in the water are consumed by the small insects which live around the surface. They are then consumed by larger insects and fish. The fish are eaten by birds.

Within a food web, any changes which occur in the populations of one plant or animal affects the whole web in either a positive or negative way. For example, if there were no algae or small water creatures, the larger surface living insects would have no food and would either die out or reduce considerably. This would have a direct impact on the food available to the fish and so on, up the food chain.

If, on the other hand, there was an abundance of algae and water living creatures, the predators further up the food chain would have more to eat and therefore would probably increase in number. Whilst this might increase numbers temporarily, they would decrease again because more predators would mean less food for them each. In this way a balance is created.

Pollution and other human interference often affects food webs adversely and sometimes leads to a wipeout of habitats, plants and animals.

Questions...

1. What is the relationship between plants and animals in any food web?
2. How does this relationship differ between a woodland and a pond food web?
3. Draw a sea or ocean food web.

PREDATOR AND PREY

Predators are any animal which hunts for and eats other (usually smaller) animals. Often, we think of predators as lions, tigers, and eagles, but in fact many smaller animals are also predators, like foxes and wild cats. Predators often have very keen senses which have developed through necessity in order to be able to capture prey.

Prey is any animal which is hunted by another. Usually we think of prey like Thompson's Gazelles, in the African wild, or rabbits hunted by foxes. Prey can, however, be one of the smaller predators being hunted by a larger predator. Some animals are both prey and predator, hunting for smaller animals themselves and then being hunted by larger animals.

According the Darwin's theory of evolution there is a direct link between the development of prey and predators. Both develop together, as prey become faster or cleverer, predators also have to increase their abilities in order to be able to capture their food. In this way a balance is maintained where both prey and predator continue to survive by becoming better and better.

Make a list of predators, prey, and animals which are both.

PREDATOR	**PREY**	**BOTH**

Questions...

1. What is a predator? Find out about and write a paragraph on a predator.

2. What is Prey? Write about the characteristics of one animal which is considered to be a prey animal.

3. Can animals be both predator and prey? Give examples.

NATURAL SELECTION

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Charles Darwin was a British naturalist who lived from 1809-1882. He was fascinated by plants and animals and travelled around the world in a ship, (the Beagle), studying the different types of animal and plant species. He thought that all living things developed as a result of a process of slow and gradual evolution. Many people of the time thought that God had put all living things on the Earth. Darwin's theory, however, shocked these people.

Darwin believed that all living things started out as simple organisms which developed as a result of circumstances and needs. In this way, some organisms developed into sea living, others land living, etc. Some organisms developed into plants, others into animals.

Darwin also thought that in every species it was inevitable that the strongest would survive. With severe competition for food and resources the weaker members of a species would not be able to compete and their contribution to the furtherance of the species would end. The strongest would also be the best at winning the reproductive race and the next generation would therefore be a little bit stronger and better than the generation before.

There are two main ideas that Darwin believed in:

- **Survival of the Fittest** - Animals struggle to survive. The fittest will usually win.
- **Natural Selection** - The fittest will also win the reproductive race and produce a better generation of the species each time.

Survival of the fittest does not mean that the biggest will always survive. It might be that a combination of abilities is required and the members of the species with that particular combination of abilities will be more likely to survive best.

Questions...

1. Write a short biography of Charles Darwin.
2. Write a paragraph each explaining what is meant by:
   - Survival of the Fittest,
   - Natural Selection.
3. How did Darwin's theory of evolution differ from traditional beliefs of his time?

THE CARBON CYCLE - AND CYCLES IN NATURE

The Carbon Cycle is the **circulation of carbon in various forms through nature**.

Carbon is a constituent of all organic compounds, many of which are essential to life on Earth. The source of the carbon found in living matter is carbon dioxide in the air or dissolved in water. Algae and green plants are the chief agents of carbon dioxide fixation through the process of photosynthesis, through which carbon dioxide and water are converted into simple carbohydrates. These compounds are used by the plants to carry on metabolism, the excess being stored as fats and polysaccharides. The stored products are then eaten by consumer animals, including humans, which convert them into other forms. All animals return carbon dioxide directly to the atmosphere as a by-product of their respiration. The carbon present in animal wastes and in the bodies of all organisms is released as carbon dioxide by decay or decomposition

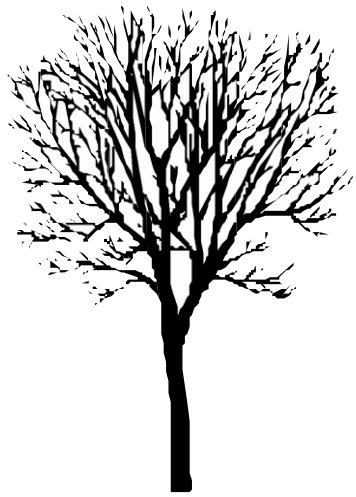
The remains of organisms, has accumulated in the Earth's crust as fossil fuels (e.g., coal, gas, and petroleum), limestone, and coral. The carbon of fossil fuels, removed from the cycle in prehistoric time, is now being released in vast amounts as carbon dioxide through industrial and agricultural processes.

A cycle in biology means any process which completes a circle and continues. An example is the life cycle of any animal where the new born animal develops and grows, eventually reproducing, creating new young, and then getting old and dying. There are many important cycles in nature which are concerned with chemicals. The Carbon Cycle is one, as is the Nitrogen Cycle. These are important because they allow us to understand how we depend on the environment around us to survive. Just as with the food web, if one or more parts are changed, there is likely to be an impact on other parts of the connected web.

Questions...

1. What is the Carbon cycle?
2. Draw an illustration to show how the Carbon cycle works.
3. Find out about the Nitrogen cycle. Write a paragraph explaining how it works, and draw an illustration to aid understanding.

RECYCLING IN NATURE



The Sun's energy is captured by leaves

Some trees lose their leaves in Autumn

Small animals and fungi feed on leaf litter

Nurtrients from decayed leaves return to the soil

Plants take up nutrients with water through their roots. Growth includes new leaves.

Questions...

1. Write a short paragraph each on the stages listed above, starting with 'The Sun's energy...', and working around clockwise. Explain how and why each stage occurs.
2. Write a paragraph each on the 4 seasons and explain how they contribute to recycling in nature.

POLLUTION - AIR

Air pollution involves the release into the atmosphere of:

- gases,
- finely divided solids,
- finely dispersed liquid aerosols.

These become pollution when rates of release exceed the capacity of the atmosphere to dissipate them or to dispose of them through incorporation into solid or liquid layers of the biosphere.

Air pollution results from a variety of causes, not all of which are within human control:

- Dust storms in desert areas. Dust blown from the Sahara has been detected in West Indian islands.
- Smoke from forest and grass fires contributes to chemical and particulate pollution of the air.
- The discovery of pesticides in Antarctica, where they have never been used, suggests the extent to which aerial transport can carry pollutants from one place to another.
- Probably the most important natural source of air pollution is volcanic activity, which at times pours great amounts of ash and toxic fumes into the atmosphere. The eruptions of volcanoes have been related to measurable climatic changes.

Air pollution may affect humans directly, causing a smarting of the eyes or coughing. More indirectly, the effects of air pollution are experienced at considerable distances from the source, as, for example, the fallout of lead from car exhausts, which has been observed in the oceans and on the Greenland ice sheet. Still less directly experienced are the possible effects of air pollution on global climates.

Questions...

1. What is air pollution?
2. List the natural causes of air pollution.
3. List the main causes of air pollution which can be attributed to humans.
4. What effect does air pollution have on living things?
5. How can air pollution be reduced?

POLLUTION - WATER

16

Water pollution occurs when substances that become dissolved or suspended in the water of rivers, seas, etc., accumulate to the extent that they interfere with the functioning of aquatic ecosystems. Under normal circumstances, inorganic substances are widely spread and have little or no effect on life within the bodies of water into which they are released; organic materials are broken down by bacteria or other organisms and converted into a form in which they are useful to aquatic life. But, if the capacity of a body of water to dissolve, disperse, or recycle is exceeded, all additional substances or forms of energy become pollutants.

Pollution may begin when:

- Soil erosion adds silt as a pollutant.
- The use of chemical fertilizers, pesticides, or other materials on watershed lands is an additional factor contributing to water pollution.
- Industries located along waterways downstream contribute a number of chemical pollutants.
- Cities and towns contribute their loads of sewage and other urban wastes.

When organic matter exceeds the capacity of those microorganisms in water that break it down and recycle it, the excess of nutrients encourages rapid growth of algae. When they die, the remains of the dead algae add further to the organic wastes already in the water; eventually, the water becomes deficient in oxygen. Organisms that do not require oxygen to live then attack the organic wastes, releasing gases such as methane and hydrogen sulphide, which are harmful to the oxygen-requiring forms of life. The result is a foul-smelling, waste-filled body of water, a situation that has already occurred in such places as the Baltic Sea and is a growing problem in freshwater lakes of Europe and North America. The process by which a lake or any other body of water changes from a clean, clear condition, with a relatively low concentration of dissolved nutrients and a balanced aquatic community, to a nutrient-rich, algae-filled body and then to an oxygen-deficient, waste-filled condition is known as **accelerated eutrophication**.

Questions...

1. What is water pollution?
2. List the main causes of water pollution which can be attributed to humans.
3. What effect does water pollution have on living things which:
   - live in water,
   - do not live in water but are part of the food chain involving water plants and animals?
4. How can water pollution be reduced?

POLLUTION - LAND

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Land pollution involves the deposition on land of solid wastes including:

- used cars,
- cans,
- bottles,
- plastic containers,
- paper.

Many of these cannot be broken down quickly or, in some instances, cannot be broken down at all by the action of organic or inorganic forces. The term **biodegradable** is used to describe those materials that can be decomposed and recycled by biological action. When such materials become concentrated within any one area, they interfere with organic life.

Methods of disposal other than recycling include:

- ocean dumping, which creates water pollution and destroys marine habitats,
- landfill, which often requires the availability of low-lying ground and frequently involves the destruction of marshland or swamps that have high biological value,
- burning, which increases air pollution.

Obviously, none of these methods is entirely satisfactory, although using landfill to create artificial landscapes, which then are covered with soil and planted with various kinds of vegetation, is a possibility. It is the great quantity of debris produced by urban communities, more so than a shortage of raw materials, that forces the development of more effective means for recycling wastes. Land pollution also involves the accumulation on land of substances in dispersed solid or liquid form that are injurious to life. This has been particularly noticeable with those chemicals (e.g., DDT) that are spread for the purpose of exterminating pests but then accumulate to the extent that they can do damage to many other forms of life.

Questions...

1. What is land pollution?
2. List the main causes of land pollution which can be attributed to humans.
3. What effect could land pollution have on living things? Give examples.
4. How can land pollution be reduced?

FOOD

18

Food serves three major functions:

- it generates energy for growth, maintenance, and activity;
- supplies the reducing agents that help to make enzymes, which carry out cellular processes;
- provides the materials for cell building.

Organisms, plants and animals have different nutritional needs:

- Some organisms (such as green plants) are **autotrophic**, requiring only inorganic nutrients,
- Others (such as fungi) are **heterotrophic**, requiring both inorganic and organic substances.
- Green plants are **lithotrophic** (deriving reducing agents from such inorganic sources as water), In addition, they are **phototrophic** (they get their energy for life processes from light),
- Animals are **organotrophic** (deriving reducing agents from ingested organic compounds). Animals are also **chemotrophic** (they get their energy from ingested chemicals).

The essential human nutrients are proteins, minerals, and vitamins.

- **Proteins** are broken down during digestion into amino acids, which are used for tissue building, as transmitters of genetic information, and for energy.
- **Minerals** are important in a number of body processes. For example, Iron is used in the blood to make haemoglobin; Calcium is crucial to the growth of bones and teeth.
- **Vitamins** can be divided into two categories: water-soluble vitamins (the B vitamins and vitamin C) and fat-soluble vitamins (A, D, E, and K).

Questions...

1. What are the main functions of food?
2. Write a paragraph each on the needs of the following in humans:
   - Proteins,
   - Minerals,
   - Vitamins.

PHOTOSYNTHESIS IN PLANTS

19

Photosynthesis, which means **putting together with light**, is the process by which green plants and certain other organisms transform light energy into chemical energy. During photosynthesis in green plants, light energy is captured and used to convert water, carbon dioxide, and minerals into oxygen and energy-rich organic compounds.

Without photosynthesis, the replenishment of the Earth's fundamental food supply would halt, and the planet would become devoid of oxygen. During photosynthesis the radiant energy from the sun is harnessed and converted to the chemical energy stored in green plants and certain bacteria. Animals and humans eat the green plants and turn them into energy which can be used for life and other processes.

All life forms require energy to survive. The energy we use all comes from the Sun in the first instance and is then turned into energy which we can use in different ways. Plants use the Sun's energy and turn it into usable nutrients through photosynthesis. The plant can then use this energy to grow and produce fruits and complete its own reproductive requirements. Animals eat the plants and turn that energy into essential proteins, carbohydrates and other types which can be used by the animal for it to grow.

The basic chemical reaction of photosynthesis is:

Light Energy + Carbon Dioxide + Water = Chemical Energy + Oxygen

Questions...

1. What is photosynthesis?
2. What part does photosynthesis play in the food chain?
3. Compare how animals turn food into usable energy with the processes used by plants.

COMMON CHARACTERISTICS OF ALL LIVING THINGS

20

All living things have certain things in common. It is useful to remember these when studying biology because it reminds us of the similarities and essential functions of a living thing, whether it be a plant or a person. In very simple terms living things can be studied by learning about the following common traits:

- **NUTRITION** - All living things need food. Nutrients in the food give energy for other functions to take place.
- **GROWTH** - All living things grow. This is usually to become larger, and the growth also usually produces a more complicated and advanced structure.
- **MOVEMENT** - Animals and humans move their whole bodies whilst other living things may be capable of moving only certain parts of their structure. Obvious movement in animals can be compared to more subtle movement in plants and small organisms.
- **RESPIRATION** - All living things need to extract energy from the food they consume. Part of this process usually involves taking in oxygen and expelling carbon dioxide.
- **EXCRETION** - All living things need to remove waste during the living process. Waste is often not only surplus to requirement but potentially dangerous if not excreted because it may become poisonous, (think of the acids in human digestion etc.).
- **REPRODUCTION** - The fundamental and basic instinct of all living things is to reproduce. Lifespans for some organisms can be as little as a few minutes and all their energy is spent on reproduction. On the other hand, humans may live for about 100 years, and reproduction, whilst being very important, is not the only activity of advanced living things.
- **SENSITIVITY** - All living things need to know about their surroundings and know how to maximise the food and nutrient intake among other things. Sensitivity in plants, for instance, can be seen in the movement of a plant towards the sun.

Questions...

1. Taking each of the listed points above compare human behaviour with that of plants.