Introduction

1 Matter, energy and living things

1.1 What are living and non-living things?

Look around you. Try to identify which are the living things, or **organisms**, and which are the non-living things. What do the living things have in common? For example, they are all made of living material, need food and can move parts of themselves. They do their activities on their own. They can also reproduce to make new organisms like themselves.

Let us examine the **characteristics** of living things.

Nutrition

Nutrition is the process of making or eating of food. Food is the fuel needed by living things for all their activities.

Plants can make their own food from simple substances – carbon dioxide, water and mineral salts. Plants contain **chlorophyll** that allows them to carry out **photosynthesis**. They trap energy from the sun and build it into food.

Animals cannot make their own food. They have to take in foods that already contain trapped energy. They eat plants, or animals that have eaten plants.

Respiration

Respiration is the release of energy from food inside all living cells. Carbon dioxide and water are also produced.

Respiration is similar to burning: the combination of oxygen with a fuel to release energy. However, in living things, respiration makes use of special substances called **enzymes** and can happen without high temperatures.

Excretion

Excretion is the removal of wastes made by the activities of living cells. A living thing is a bit like a chemical factory, with lots of chemical reactions going on in the cells all the time. Some of these reactions produce wastes that could be harmful.
Note: getting rid of faeces is not part of excretion, as the wastes are only undigested materials.

Irritability

Irritability is being able to *sense* (be aware of) changes in the environment called **stimuli**. Living things have to react (respond) appropriately to stimuli in order to stay alive.

Plants usually respond slowly to stimuli. For example, roots grow towards water, or sunflowers turn towards the light. A few plants, such as the sensitive plant, respond quickly to touch by closing their leaves.

Animals usually have special sense organs to pick up stimuli, and muscles so they can move quickly to search for food, or to escape their enemies.

Objectives

- Identify the seven characteristics of living things.
- Describe briefly what you understand by each characteristic.

Activity

Living and non-living things

1 Look carefully at the photograph. Make a list of all the things you can see.

2 Make a table in your Exercise book, with two columns labelled 'Living things' and 'Non-living things'. Write the names of the things in the correct columns.

3 Look at your completed tables with a friend. Discuss any differences that you notice.

- Here is a way to remember the characteristics of living things.

REMINDeR!

Respiration
Excretion
Movement
Irritability
Nutrition
Development and growth
Reproduction

(a) Fish

(b) Sunflowers facing the sun

Movement

Movement happens inside all living things. Organisms can also move parts of themselves.

Movement in a plant is usually very slow and is brought about by growth. An exception is the sensitive plant: this can quickly close its leaves when they are touched.

Most animals can move from place to place: this is called **locomotion**. Locomotion is important, for example, for animals to find their food.

Development and growth

Living things grow if they make or eat more food than is needed for their activities. Growth is an increase in mass, length or width. **Development** is the process by which the organism gets more cells and becomes more complicated.

Reproduction

Reproduction means making more of the same kind. The new organisms can later live separately.

Organisms need to grow and develop before they can reproduce. They have to become **mature**. Usually two organisms are needed; for example, many plants make flowers with pollen and eggs, and animals make sperm and eggs. These are examples of **sexual reproduction**.

Other organisms can reproduce on their own by a part growing out and becoming a new organism. We call this **asexual reproduction** (pages 132–5).

Questions

1 What do we mean by (a) a living thing and (b) a non-living thing? Give an example of each.
2 What are the seven characteristics of living things? How is a non-living thing, such as a car, different from a living thing for each characteristic?
3 How do fish and sunflowers carry out the characteristics of living things?

Did you know?

- Organisms can live in the coldest places near the poles and the hottest places near underground volcanoes.
- A blue whale grows from a single cell less than 1 mg in mass to a one year old of 26 tonnes.
- The giant redwood, General Sherman, is the largest living thing. Its diameter is 11 m. Cars can drive through a hole in its trunk.

Key ideas

Use these words to fill in the spaces as you write the sentences in your Exercise book.

respond **excrete** **respire** **nutrition** **reproduce** **move** **develop**

Every day living things have to make or eat food. We call this _____ . Plants make their own food but animals need to _____ in order to find theirs. All living things also sense and _____ to changes in their environment. They all _____ to release energy and _____ to get rid of waste products. As they grow and _____ they can _____ to make new living things.

1.2 What are the units of measurement?

A system of measurement

There is a system of measurement that is used by most of the nations of the world. The system is called the Système International d'Unités, or SI (metric) system, and its units are meant to replace all other types of measurement. These measurements include measurements of mass, length (distance), time, force, pressure, energy, temperature and electricity.

The table below gives the different types of measurements, with their units and symbols, which you are likely to find in science texts. These units have been adopted by all scientists and are essential for accuracy in the recording, transfer and interpretation of data.

SI units

Measurement	Quantity	Standard unit	Symbol
length, mass and time	length	metre	m
	area	square metre	m^2
	volume	cubic metre	m^3
	mass	kilogram	kg
	density	kilogram per cubic metre	kg/m^3
	time	second	s
	frequency	hertz (= per second)	Hz
force and pressure	force	newton	N
	weight	newton	N
	moment of force	newton metre	N m
	pressure	pascal (= newton per square metre)	Pa
energy and heat	energy	joule	J
	work	joule (= newton metre)	J
	power	watt	W
	temperature	degree Celsius	°C
	absolute temperature	Kelvin	K
electricity	electric current	ampere	A
	electromotive force	volt	V
	potential difference	volt	V
	resistance	ohm	Ω
	electrical energy	joule	J

Objectives

- Identify the common SI units and what they are used to measure.
- Describe the use of prefixes for large and small measurements.

Using prefixes

A **prefix** is a small word that can be added in front of the standard unit, to increase or decrease its value for very large or very small numbers.

Numbers are expressed as powers of ten. For example, one hundred is ten to the power two (or ten squared): $100 = 10 \times 10 = 10^2$.

Increase in value

For example, the term 'kilo' is used with metre to derive the term 'kilometre'. Since kilo stands for 1000, a kilometre is one thousand metres ($1000 = 10 \times 10 \times 10$, or 10^3).

The table below gives a few examples of the powers of ten of large numbers and shows how the prefixes are used.

Multiple	Prefix	Symbol	Example
10^9	giga	G	gigawatt
10^6	mega	M	megajoule
10^3	kilo	k	kilometre

Decrease in value

One metre can be divided into smaller units, for example into one thousand parts, each of which is called a millimetre. The prefix 'milli' means that the particular unit to which it is attached is divided by one thousand.

$$\frac{1}{1000} = \frac{1}{10 \times 10 \times 10} = 10^{-3}$$

This table gives a few examples of the powers of ten for smaller numbers and shows how the prefixes are used.

Multiple	Prefix	Symbol	Example
10^{-1}	deci	d	decimetre
10^{-2}	centi	c	centimetre
10^{-3}	milli	m	millimetre
10^{-6}	micro	μ	micrometre
10^{-9}	nano	n	nanosecond

Common derived units

The common multiples (larger and smaller) derived from SI units are shown in the table below.

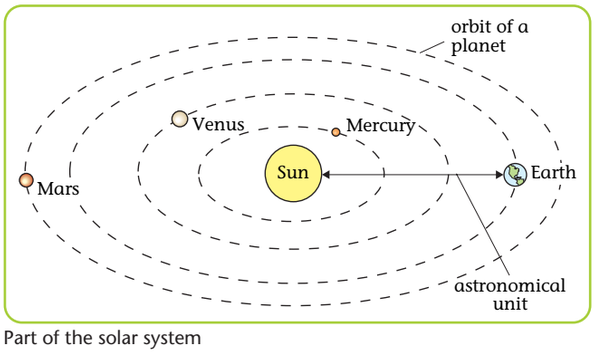
Quantity	SI unit and symbol	Common derived units
Length	metre m	km, dm, cm, mm, μm, nm
Area	square metre m^2	cm^2, mm^2
Volume	cubic metre cm^3	litre (dm^3), cm^3, mm^3, ml
Mass	kilogram kg	g, mg, μg
Weight	newton N	kN
Time	second s	minute, hour, day, week, month, year
Energy	joule J	kJ, MJ
Pressure	pascal Pa	kPa, MPa

Note: in science, weight is a force and therefore measured in newtons, and not in kilograms or grams.

Measuring very, very large distances

To measure distances in space, astronomers use:

- the light-year (the distance that light travels in a year) = 9.45×10^{15} km
- the astronomical unit (AU: the average distance of the Earth from the Sun) = 149.6×10^6 km.



Part of the solar system

Are there other measurements we use?

A visit to the local grocery store or market will soon show that many things are still sold in pounds and pints. Tailors still use inches, cloth may be sold in yards and gallons of paint can be bought from the hardware store. Racehorses still run furlongs, weather reports often give wind speeds in miles per hour and ships travel in knots.

While these units are no longer taught in our schools, they remain part of our everyday experience, and we still need to know how they relate to the SI units we use in science, as shown below.

Unit	How used in everyday life	Metric equivalent
Inch	Length measure	2.54 cm
Foot	Length measure	30.48 cm
Yard	Length measure	0.9144 m
Furlong	Length/distance measure	201.18 m
Mile	Length/distance measure	1.6093 km
Mile per hour	Speed measure	1.61 km/h
Knot	Speed measure	1.85 km/h
Pint (US)	Volume measure	0.473 dm^3
Gallon (US)	Volume measure	3.79 dm^3
Gallon (Imperial)	Volume measure	4.55 dm^3
Ounce	Weight/mass measure	28.38 g
Pound	Weight/mass measure	0.454 kg
Pound/square inch	Pressure measure	7.038 kPa
Ton	Weight/mass measure	1016.05 kg

Questions

1. Choose five quantities (such as length), and give the SI unit and a common derived unit.
2. What is the meaning of each of these prefixes: kilo, milli, centi, micro and mega?
3. What are the scientific units for (a) mass and (b) weight? How are they confused in everyday life?

Key ideas

Use these numbers and words to fill in the spaces as you write the sentences in your Exercise book.

10^{-3} SI light-year 10^3 prefixes 10^{-2} AU pounds

The _____ system is used by scientists. The _____ units can be made larger or smaller by using _____ . Some _____ for these measurements are: kilo (_____), centi (_____) and milli (_____). For very large distances, astronomers use the _____ (astronomical unit) and the _____ . Non-metric units, such as _____ and stones, are still used to measure weight.

1.3 How are living things built up?

Activity

Matter and energy

1 Look around you. Find things made of living and non-living matter. Also identify forms of energy that you know are there because they have some effect, e.g. the energy of moving air blowing some leaves.

2 Copy this table into your Exercise book. Fill in other examples in the columns.

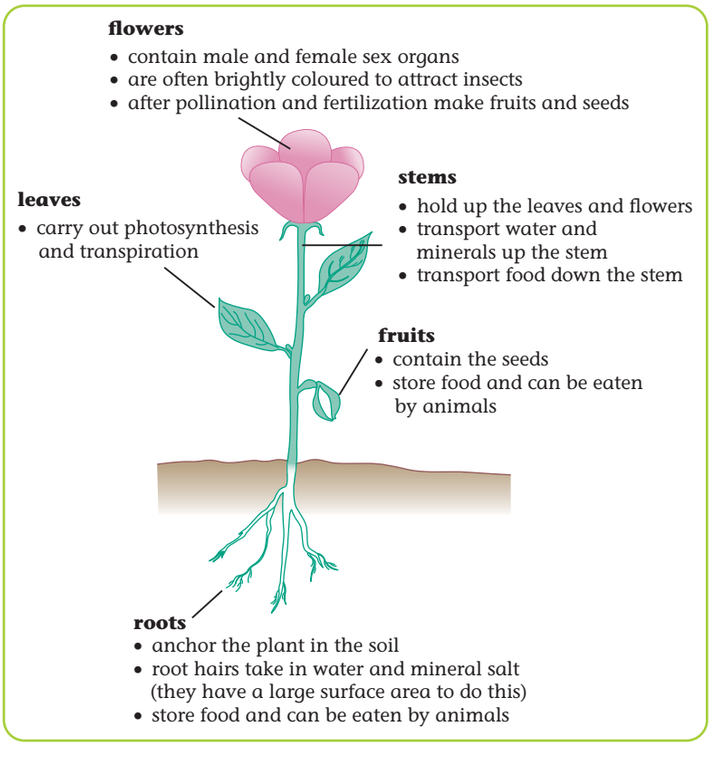
Matter (material, things with mass)		**Energy** (ability to do work of some kind)
Living things	Non-living things	
Yourself	Your desk	Sound from a CD
Birds	Your clothes	Warmth from the Sun
Flowers	Clouds	

What are the organs in a flowering plant?

The organs of a flowering plant are the:

- flowers
- fruits
- leaves
- stems
- roots

Every living cell in a plant can carry out respiration, but the different parts of the plant have different functions.



Objectives

- Define cell, tissue, organ, organ system and organism.
- List the functions of some organs and organ systems in a flowering plant and a mammal.

How are organisms built up?

Cells (pages 44–5) are the building blocks of living things, in a similar way that bricks are used in a house. Cells are built into tissues, tissues into organs, organs into systems and systems into the whole organism.

Questions

1 Why are cells called 'building blocks'?

2 How are tissues and organs (a) similar and (b) different?

3 Which organs are important for transport in (a) flowering plants and (b) humans?

What does it mean?

Cell The building block of living things.

Tissue A group of similar cells working together with a certain function, e.g. plant epidermis, a muscle.

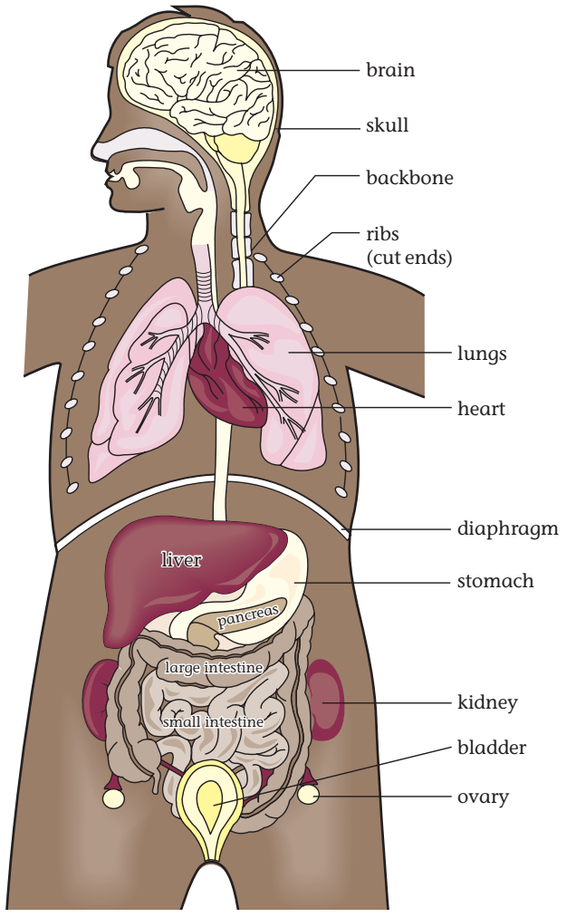
Organ Different tissues working together with certain functions, e.g. a leaf, the heart.

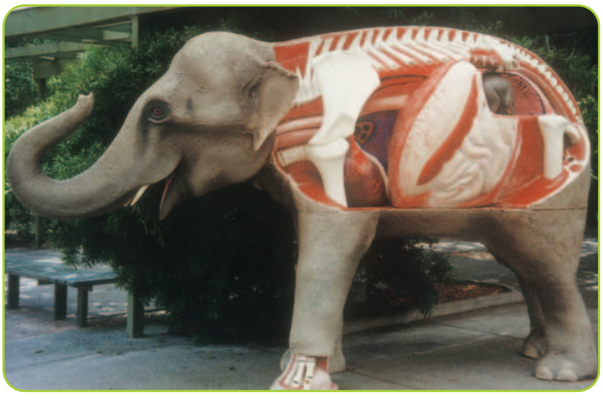
Organ system Several organs working together to carry out major activities, e.g. transport systems.

Organism The whole plant or animal.

Cells → Tissues → Organs
↓
Organ systems
↓
Organism

What are the organs and systems in a mammal?





Systems	Functions and main organs
Digestive system	Digests and absorbs food: alimentary canal, liver, pancreas
Respiratory system	Takes in O_2 and gets rid of CO_2: windpipe, lungs, ribs, diaphragm
Excretory system	Removes waste materials made in the body: kidneys, bladder, liver
Circulatory system	Transports materials around body: heart, blood vessels
Reproductive system	Produces offspring: ovary, uterus; testes, penis
Nervous system	Controls and coordinates body: brain, spinal cord, nerves
Endocrine system	Controls growth rates and some reactions: glands, hormones
Skeletal system	Supports and protects body organs: backbone, skull, limb bones
Muscle system	Allows movement of the body: muscles arranged in pairs

Key ideas

Use these words to fill in the spaces as you write the sentences in your Exercise book.

different **digestive** **similar** **reproductive** **organs** **respiratory**

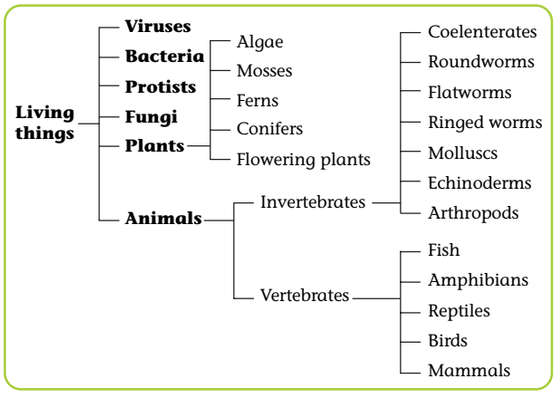
A tissue is built up of _____ cells working together. An organ is made up of _____ tissues working together. Several _____ work together to make each organ system. In animals the _____ system is important for breaking down food, the _____ system controls the exchange of gases, and the _____ system produces offspring.

1.4 Who's who among living things?

How do we classify living things?

'To classify' is to put things into groups. These groups are then split into smaller groups. Each group has features in common and is different from other groups. Some important features we use are:

- size: microscopic, or can be seen with the naked eye
- unicellular (one cell) or multicellular (many cells)
- seeds or no seeds
- number of limbs
- kind of body covering
- flowers or no flowers
- backbone or not
- lays eggs or not



Groups of living things

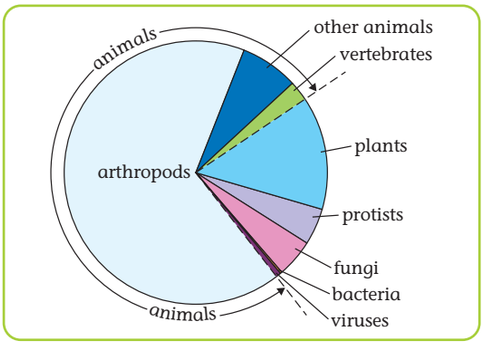
How are plants and animals different?

Look at the photographs and talk about how plants and animals are different. Then read the table below and check if you were right.

Objectives

- Describe plant and animal features.
- Identify the characteristics of the most important groups.

Number of limbs	Examples of animals
0	Molluscs, echinoderms
4	Amphibians, reptiles, birds, mammals
6	Insects
8	Spiders
2 per segment	Centipedes
4 per segment	Millipedes



The proportions of different groups of living things

A plant	An animal
Uses simple substances to make its own food.	Feeds on complex food substances containing trapped chemical energy.
Has chlorophyll and can carry out photosynthesis.	Does not have chlorophyll and cannot photosynthesize.
Does not digest food.	Has structures to digest food.
Is usually rooted in the ground.	Is not rooted in the ground.
Does not move from place to place.	Moves around to get food and to escape enemies.
Has no nerve or muscle cells.	Has nerves and muscle cells.
Does not have special sense organs.	Has special sense organs.

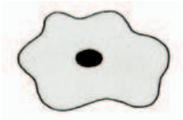
Viruses About 100 nm, seen only with electron microscope, no cell structure, can only reproduce inside living organisms.

Tobacco mosaic disease virus

Influenza virus

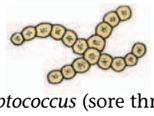
Protists About 10 µm–1 mm, some seen with low power, single-celled, with nucleus. Plant-like with chlorophyll, or animal-like.

Plant-like: diatom

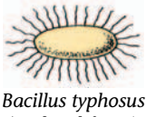


Animal-like: *Entamoeba*

Bacteria About 0.001 mm, seen under high power, single-celled or joined in chains, no nuclei.



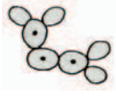
Streptococcus (sore throat)



Bacillus typhosus (typhoid fever)

Vibrio (cholera)

Fungi About 5 µm–20 cm, mostly many-celled with nuclei. No chlorophyll.



Yeast

Pin mould on a banana

Mushroom

Plants

Small to very large, visible to the naked eye (i.e. without a microscope), many-celled with nuclei, chlorophyll, mostly stationary and rooted in the ground.

Non-flowering plants Do not have flowers.

Algae About 5 mm–100 cm, mostly small, no roots, stems or leaves. Threads or divided sheets.

Spirogyra green threads

Sargassum brown seaweed

Mosses About 5 mm–15 cm, simple roots, stems and leaves, reproduce by spores.

Moss 'leaves'

Spore case

Ferns About 5 cm–10 cm, small to tree-like, roots, stems and leaves, reproduce by spores.

Fern

Spore cases

Tree fern

Conifers About 5 m–30 m, mainly tree-like, roots, stems and leaves, reproduce by seeds inside cones.

Pine tree

Cone

Flowering plants 5 cm–30 m, small to tree-like, roots, stems and leaves, reproduce by seeds inside flowers.

Monocotyledons

Narrow leaves with parallel veins.
Bunch of small roots (fibrous roots).
One seed leaf (cotyledon) in seed.

Grass

Banana

Coconut palm

Dicotyledons

Broad leaves with branching veins.
Main (tap) root with many branches.
Two seed leaves (cotyledons) in seed.

Balsam

Hibiscus

Mango tree