Shape, size and functions of cells

The onion peel and cheek cell slides you observed were temporary slides, using water or some other solution as the mounting medium. Cells come in many shapes and sizes. Some are rectangular, like the onion cells and many other plant cells. Some are irregular, like the cheek cells. Other cells may be disc-shaped, polygonal or spindle-shaped. This variety in shape helps different cells do different jobs.

- Onion cells are epidermal cells that protect the surface of the plant.
- Cheek cells line and protect the inner surface of your mouth.
- Nerve cells, or neurons, are long threadlike cells with branches that carry signals quickly over long distances.
- Muscle cells are thin, elongated and tubular. They can contract (shorten) and relax (lengthen) to bring about movement in the body.
- The cells lining the digestive tract have a variety of shapes. Some are tall and columnar, with tiny folds on their surface that help absorb food. Some of these, called goblet cells, make mucus that protects the inner lining and helps food move smoothly.

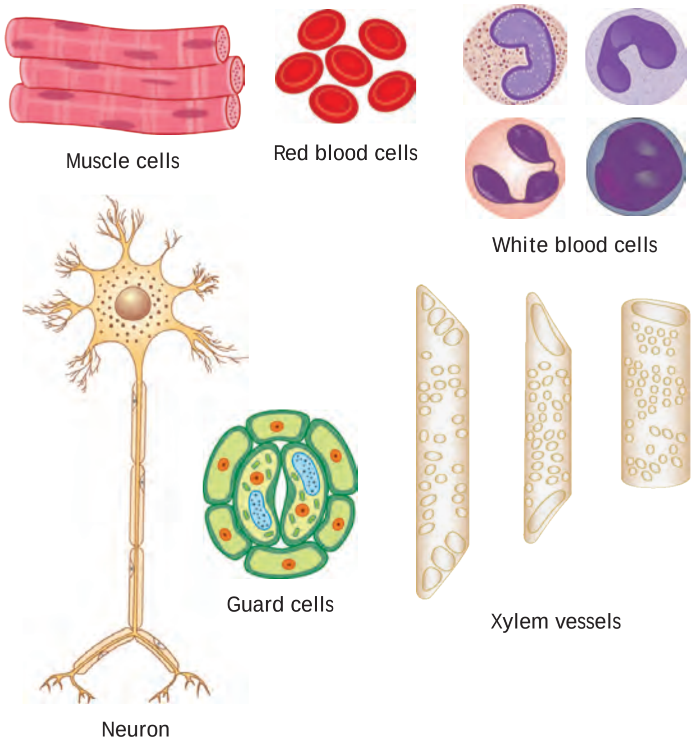


Fig. 1.4 Different types of cells

- In leaves, you can see bean-shaped guard cells that open and close stomatal pores to control gas exchange.
- Xylem vessels in plants are long, hollow tubes that carry water and give strength to stems.

Most cells are too small to be seen with the naked eye. Yet some are large, like the egg of a bird or long fibres in certain plants. The table below lists some cell sizes.

Name	Approximate size	Description
Ostrich egg	About 15 cm long, weighs up to 1.5 kg	Largest cell; egg yolk is a single cell visible to the naked eye
Mycoplasma bacterium	About 0.1 µm (micrometre)	Among the tiniest known living cells
Giraffe's leg neuron	About 2–3 m long	Longest cell; carries signals from the brain and spinal cord to the lower parts of the body

Though cells may look very different, most share the same main parts. These parts are called organelles. Let us learn about them.

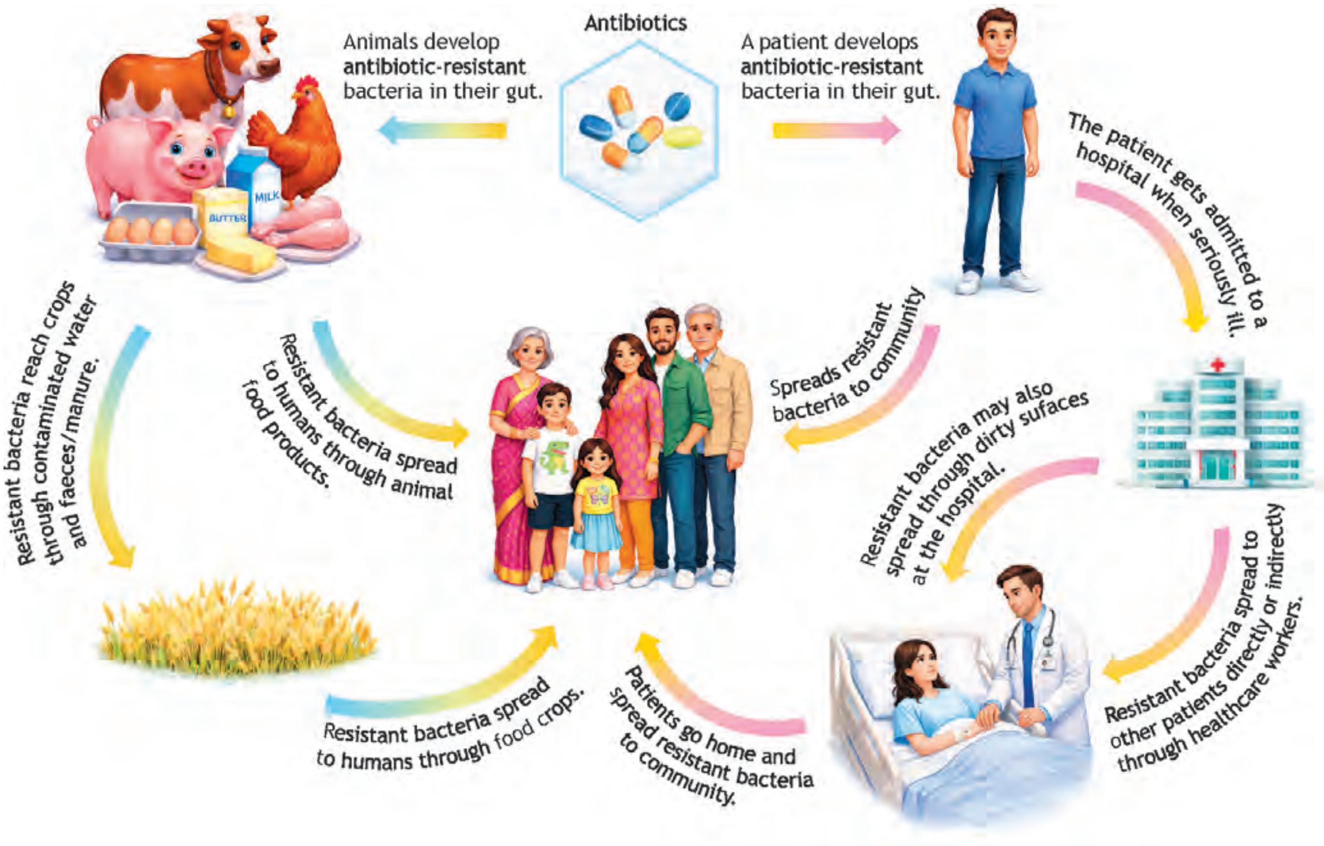


Fig. 2.13 How antibiotic-resistant bacteria spread among people

Noncommunicable Diseases

Noncommunicable diseases do not spread from person to person. You cannot catch diabetes or high blood pressure from a friend. These diseases are caused by factors such as an improper diet, unhealthy lifestyle, old age and the malfunctioning of organs.

Some noncommunicable diseases are deficiency diseases. **A deficiency disease is caused by the lack of a particular nutrient in the diet.** When the whole diet is poor, a person suffers from malnutrition. Children who do not get **enough proteins and carbohydrates** may develop marasmus. Those who do not get **enough proteins** develop kwashiorkor. In marasmus, the body becomes thin, the ribs show and the child looks old and weak. In kwashiorkor, the child has a swollen stomach and ankles, dry and patchy skin, and discoloured hair. **Lack of vitamin D and calcium** causes rickets, in which the bones become soft and bend. **Lack of vitamin C** causes scurvy, with bleeding gums and slow healing of wounds. **Lack of vitamin A** can cause night blindness, and **lack of iron** can cause anaemia, which leads to tiredness and pale skin. **Lack of iodine** in the diet can cause goitre, in which the neck swells due to an enlarged thyroid gland.

Dry cell

A dry cell is a voltaic cell that uses a thick paste as the electrolyte. It comes in a sealed container. It is safer to use and easier to carry than a wet cell.

A zinc–carbon dry cell has a zinc container that acts as the negative terminal and also forms the outer case. A carbon rod is placed at the centre. The metal cap connected to this rod is the positive terminal. A thick paste of ammonium chloride acts as the electrolyte. The top of the cell is sealed.

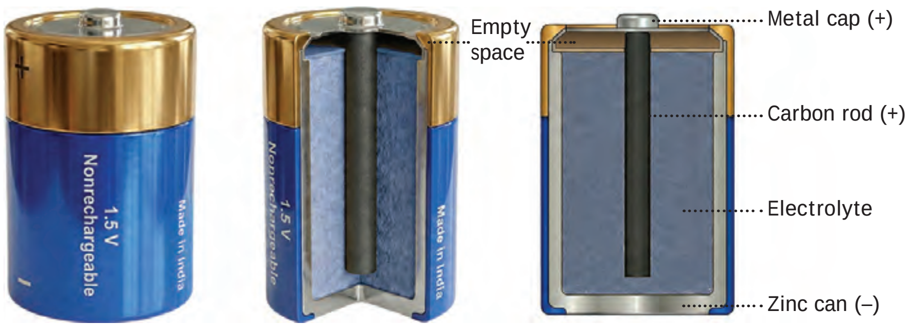


Fig. 3.17 Dry cell

A standard dry cell produces 1.5 volts. It cannot be recharged, so it is thrown away after use.

Rechargeable batteries

A rechargeable battery has several special cells whose chemical changes are reversible by electricity, so they can be recharged and reused. During use (discharge), a chemical reaction produces new substances and electricity in each cell. When the cell becomes weak, current is passed through the cell to charge it. This reverses the reaction. The new substances change back into the original materials. So, the cell is ready to supply electricity again.

A rechargeable battery does not last forever. With each charge–discharge cycle, small changes happen inside, so it becomes weak. But it has a much longer life than a simple cell. That reduces resources needed to make a new cell.

Common rechargeable batteries Lead–acid batteries are used in vehicles, inverters and UPS systems. A lead–acid battery uses dilute sulphuric acid as the electrolyte and lead-based electrodes.

Lithium-ion (Li-ion) batteries are used in phones, laptops, cameras and electric vehicles. A Li-ion battery is named so because lithium ions move between its electrodes. It uses a lithium-salt electrolyte. One electrode is usually graphite. The other electrode is a lithium compound that includes a metal such as nickel, cobalt, manganese or iron.

Fig. 3.18 Rechargeable cells and batteries

Li-ion batteries should be charged only with the correct charger, and they should not be crushed, punctured or heated. Used batteries should be recycled through a proper collection centre instead of being thrown away with household waste.

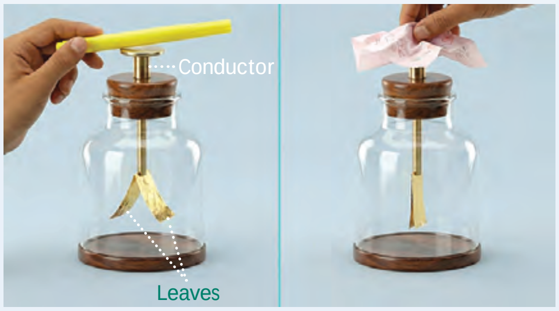
3. Assertion (A) A charged scale is able to pick up bits of paper although gravity pulls them down.
   Reason (R) The electrostatic force on the bits is more than the force of gravity on them.

4. Assertion (A) Among the cubes of the same size, the one that floats with most of its height under the surface of the water is the densest.
   Reason (R) Heavier objects need to displace more water.

GOING FURTHER

Electroscope An electroscope is a device used to detect electric charge. In a simple electroscope, two thin metal foils (leaves) hang from a metal conductor inside a closed glass jar. The jar prevents air currents and moisture from disturbing the leaves.

When a charged object is brought near the top, charges in the conductor rearrange and both leaves get the same type of charge, so they repel and diverge. If another object is brought near, the leaves diverge more if its charge is the same, and they collapse (move towards each other) if its charge is opposite. You can try this by rubbing a plastic straw or pen with paper. If the first charge is known, this comparison tells the nature of the charge on the test object.



Charge of one type makes the leaves diverge. After this, an opposite charge makes them collapse.

SCIENCE ACTION!

DIY electroscope Cut a thin aluminium-foil strip about 10 cm × 1 cm. Make two small slits close together in a piece of chart paper or cardboard. Pass the foil through the slits so that equal lengths hang on both sides as two 'leaves'. Place the chart paper over the mouth of a glass or a clear jar.

Charge a plastic straw or pen by rubbing it with paper. Bring it near the top of the foil. The leaves should diverge. Now bring the paper near the top. The leaves should collapse. Test by rubbing the straw with different materials such as dry hair, wool, silk and synthetic cloth, using the same number of rubs each time. Compare how much the leaves diverge. After each test, touch the foil to discharge it.

Different pairs charge differently, and dry surfaces charge better.

Triboelectric series To predict what happens, scientists use the triboelectric series. Materials higher in the list tend to lose electrons and become positively charged. Materials lower tend to gain electrons and become negative. The farther apart the pair, the stronger the charging.

Simplified triboelectric series (positive → negative)

Glass → human hair → nylon → wool → silk → paper → cotton → wood → rubber → ABS plastic → polythene → PVC

[+ + + neutral – – –]

Examples: Balloon rubbed on hair makes the balloon negative and hair positive. PVC on wool makes PVC negative and wool positive. PVC is the material used in many opaque plastic pens, rulers and pipes.

Liquids Exert Pressure

Liquids exert pressure. Water leaking from a hole in a bucket or a pipe shows that the water inside is exerting pressure.

You might have seen a large water bottle with a tap near the bottom. Water flows out of this tap slowly. The water comes out with more force from the tap in your house. This tap is connected to an overhead tank, which makes the water pressure at the tap greater. The pressure at a point is greater when the water column above it is higher. **The water column at a point in water is the height of water from the point to the surface above.**

Fig. 5.2 Water tanks placed at a height increase the water pressure at the tap.

At a tap in a house, the water column is the height from the tap up to the surface of the water in the overhead tank. This tall water column produces high pressure at the tap.

Pressure inside a liquid

A liquid column presses down with a force equal to its weight. Consider a container with cross-sectional area A filled with a liquid up to height h. The volume of the liquid is Ah. For the same liquid, the density stays the same, so the mass (and weight) of a liquid column at different depths depends on the volume of liquid above it. The pressure (force/area) on the base area A depends on $Ah/A = h$.

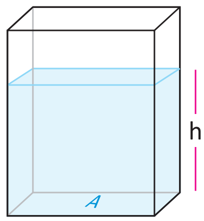


Fig. 5.3

So, for points at different depths in a liquid, the pressure depends on the height of the liquid above the point. It does not depend on the shape of the container or the total amount of liquid in the container.

If two vessels have the same liquid up to the same level, the pressure P at the base is the same. But the force on the base = $F = P \times A$ is greater for the vessel with the larger base area.

DO & DISCOVER

- Take about one metre of flexible transparent tube. Bend it into a U with two arms and fix it to a box with rubber bands. Keep one arm longer. Pour some coloured water into the tube. The water settles at the same level in both arms. This simple U-shaped tube works like a basic manometer used to compare pressure in liquids and gases.
- Dip the longer, free end into water in different containers. As you lower it, the water at the free end presses more on the air in the tube. This air pushes the coloured water, so the levels in the two arms become unequal. The difference in levels (*H* or *h*) indicates the pressure at that depth.
- The taller the water column above the free end, the greater is the difference in levels, which means greater pressure. For the same depth in different containers, the difference in levels is the same. This shows that the pressure depends only on the height of the water column, not on the amount of water in the containers or the shape of the container.

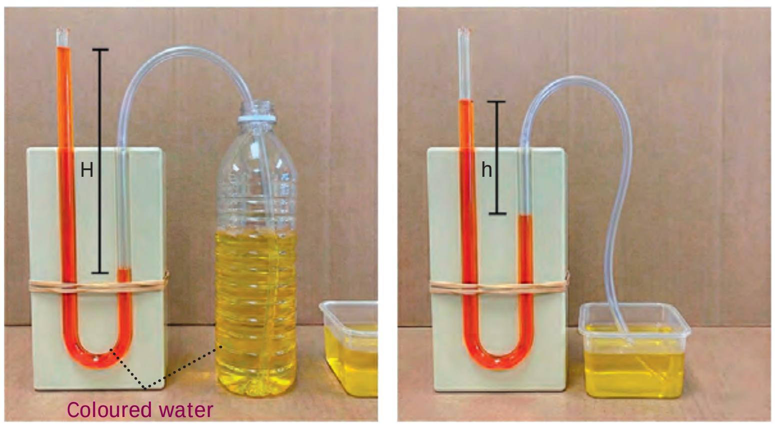


Fig. 5.4 The higher the difference in levels (like *H* or *h*) of the red-coloured water, the higher is the pressure at the free end of the tube dipped in the yellow-coloured water. We find that the pressure at a point in a liquid depends only on the height of the liquid above it.

Mixtures

So far, we have learned about pure substances. But in real life, most things around us are not pure. They are mixtures.

Think about the food you eat and the things you see around yourself. A fruit chaat, a glass of milkshake or a bowl of breakfast cereal are all mixtures of different ingredients. In the same way, soil is also a mixture containing sand, clay, water and bits of organic matter.

A mixture is formed when two or more substances are combined but keep their own properties. Each substance in a mixture is called a component.

- The components of a mixture keep their own properties.
- The components do not react chemically with each other.
- Most mixtures can be separated into their components by physical methods.

Types of Mixtures

Based on their composition, mixtures can be of two types—uniform (homogeneous) and nonuniform (heterogeneous).

Uniform (homogeneous) mixtures These mixtures look the same throughout. Their components are evenly spread out and cannot be seen separately. All solutions are examples of homogeneous mixtures. For example, when you mix sugar and lemon juice in water, everything blends evenly. Each sip tastes the same, and you cannot see or separate the sugar and lemon juice.

Nonuniform (heterogeneous) mixtures These mixtures do not look the same throughout. Their components can be seen separately. Fruit salad is a common example, where you can easily spot the different fruits. Other examples include *poha* or a mixture of dry fruits.

Fig. 6.9 Honey is an example of a uniform mixture. Chaat is an example of a nonuniform mixture.

Is air a mixture?

Air is something we breathe every moment, but have you ever wondered what it really is? **Air is a mixture of gases**. The main gases present in air are nitrogen (about 78%), oxygen (about 21%), carbon dioxide, argon and water vapour. It also contains tiny amounts of other gases. These gases are mixed uniformly, so air is usually a uniform mixture.

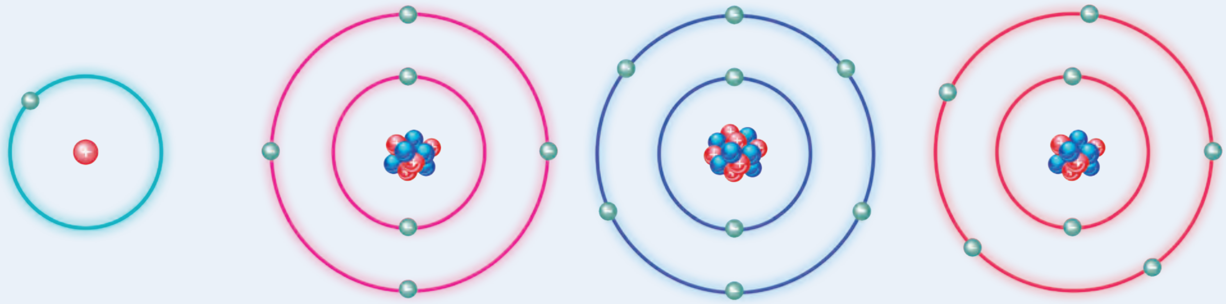
GOING FURTHER

What is inside an atom?

An atom is made up of even smaller particles called electrons, protons and neutrons. These are known as subatomic particles.

Some of these particles have a property called electric charge. There are two types of charges—positive and negative. Particles with the same charge push each other away, while particles with opposite charges pull each other closer.

- Electrons have a negative charge and are very light.
- Protons have a positive charge and are much heavier than electrons.
- Neutrons have no charge and weigh about the same as protons.



Hydrogen atom: 1 electron, 1 proton, 0 neutron

Carbon atom: 6 electrons, 6 protons, 6 neutrons

Oxygen atom: 8 electrons, 8 protons, 8 neutrons

Nitrogen atom: 7 electrons, 7 protons, 7 neutrons

At the centre of an atom is the nucleus. It contains protons and neutrons, so it is positively charged because of the protons. The electrons move very fast around the nucleus. The negative charge of the electrons balances the positive charge of the nucleus. This makes the atom electrically neutral, meaning it has no overall charge.

But what makes one atom different from another? The number of protons in an atom makes it different from all other atoms. This number is called the atomic number.

Also, the sum of the total number of protons and neutrons in an atom is called its mass number.

SCIENCE SUPERHERO

Acharya Kanad

Acharya Kanad was an ancient Indian philosopher who lived around 600 BCE. Long before modern scientists described atoms, he spoke about the idea of *parmanu*, tiny invisible particles that make up everything.

He also stated that these particles could not be divided further and that they combine in different ways to form all kinds of substances. These ideas are described in his famous work, the *Vaisheshika Sutras*.

The Gaseous State

In gases, the constituent particles are packed very loosely and the interparticle force is much weaker than in a liquid. The particles move freely in all directions.

Gases show the following characteristics.

- **Gases have neither a definite shape nor a definite volume.** They spread out to fill any space available.
- **Gases are highly compressible** because there is a lot of space between their particles.

DO & DISCOVER

Let us understand the characteristics of gases better with an activity.

- Take two identical glass jars, an incense stick and a small piece of glass or cardboard.
- Light the incense stick to produce smoke. Hold one jar upside down over the smoke to trap it. Turn the jar upright and cover its mouth with the glass plate or a flat coaster.
- Now place the second jar on top of the first one so their mouths are aligned, and then slowly remove the glass plate.

Fig. 7.8 Smoke spreads freely inside the glass jars.

You will notice that the smoke spreads into the second jar and fills it. This shows that gases spread freely and occupy all available space. Therefore, they do not have a definite shape or volume. This is why gases flow easily, mix with other gases, and fill any container, no matter its shape or size.

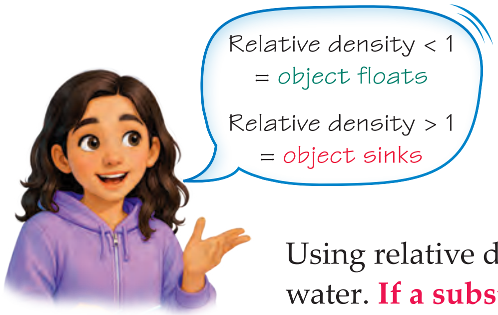
The same activity can also be done using iodine vapour instead of incense smoke. Iodine vapour can be obtained by keeping solid iodine in a closed glass jar for a short period.

Fig. 7.9 Iodine vapour will also spread freely and fill all available space.

Therefore, 10 mL of water has a mass of about 10 g, and 100 mL of water has a mass of about 100 g. This makes it easy to compare the density of water with the density of other liquids and solids.

Now consider an iron nail with a mass of 15.74 g and a volume of 2 cm³. Its density will be

$$\text{Density} = \frac{\text{mass}}{\text{volume}} = \frac{15.74 \text{ g}}{2 \text{ cm}^3} = 7.87 \text{ g/cm}^3.$$



This means iron is about 7.87 times as dense as water. We express this by saying that the relative density of iron is 7.87. Since relative density is a ratio, it has no units.

Relative density (with respect to water) = $\frac{\text{(Density of the substance)}}{\text{(Density of water)}}$

Using relative density, we can predict whether a substance will float or sink in water. **If a substance has a relative density greater than 1, it sinks in water. If its relative density is less than 1, it floats.**

For example,

mass of 1 L packaged mineral water = 1000 g (1 kg),

mass of 1 L of mustard oil = 913 g,

mass of 1 L of honey = 1400 g.

Since honey has more mass for the same volume, it is denser than water, while mustard oil has less mass and is less dense, so it floats on water.

However, relative density is not the only factor that decides whether an object will float or sink. The shape and design of an object also matter because they affect its average density. For example, large iron ships float because their hollow structure traps a lot of air, which lowers the overall average density of the ship to less than that of water. Ice floats because its particles are arranged with more space between them, making ice less dense than liquid water.

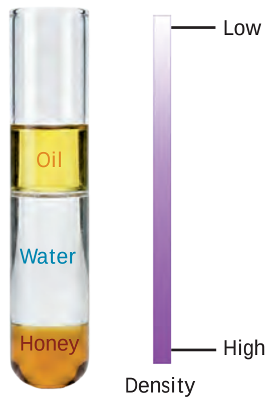


Fig. 8.7

DO & DISCOVER

Let us do an activity to see if we can affect the density of water.

- Put a raw egg in a glass of plain water. It usually sinks because the egg is denser than water.
- Now remove the egg and dissolve common salt in the water, adding it gradually and stirring well. When you place the egg back in the salt water, it may float.

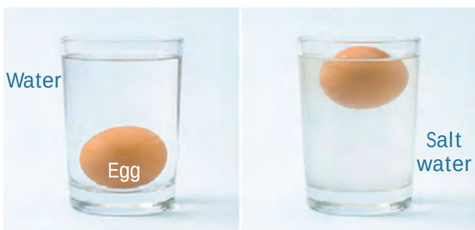


Fig. 8.8 Adding a solute can change the density

This happens because the salt dissolves, increasing the mass of the water without a large increase in volume. As a result, the density of the solution becomes higher than the density of the egg. This shows that adding a solute can change the density of water, which is also why it is easier to float in salty seawater than in freshwater.

Lenses are of two types. A convex lens bulges out and is thicker at the centre than at the edges. A concave lens curves inward and is thinner at the centre than at the edges.

A convex lens is also called a converging lens and a concave lens is also called a diverging lens because of the way they affect a beam of light.

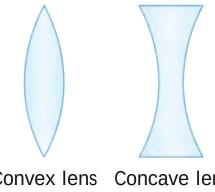


Fig. 9.18 Concave and convex lenses

Parallel beams through lenses and a thin glass slab

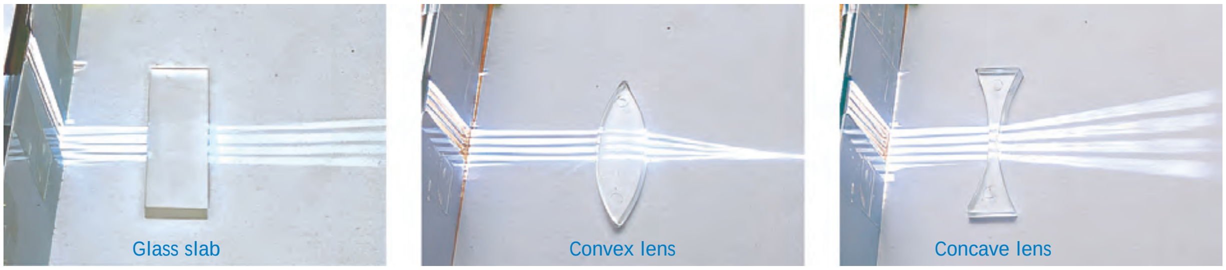


Fig. 9.19 Parallel beams through a thin glass slab and pieces of plastic shaped as lenses

What happens when parallel beams fall on a thin glass slab and on lenses? In the case of a thin glass slab or a thin glass plate, the beams of light emerge parallel. They may be shifted sideways if the incoming light is incident at an angle to the surface. A convex lens makes parallel beams of light converge and meet at a point on the other side of the lens. A concave lens makes parallel beams diverge. If the diverging beams are extended backwards, they seem to meet at a point on the same side of the lens as the incoming beams.

You may think of the principal axis of a lens as an imaginary line passing through the centre of the lens and perpendicular to the lens surface at that centre point. If the parallel beams are parallel to the principal axis of the lens, they meet or seem to meet at the focus (F). This is true for both sides of the lens. So, you have a focus on each side of these lenses. The distance of a focus from the centre of the lens is its focal length.

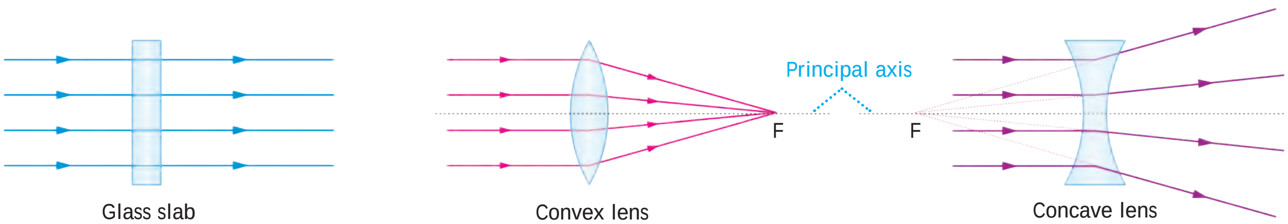


Fig. 9.20 Ray diagrams of parallel beams passing through a thin glass slab, a convex lens and a concave lens

As a convex lens makes parallel beams converge, it can concentrate sunlight to a spot, like a concave mirror.

DO & DISCOVER

- Do this with the help of an adult. You can use a magnifying lens as your convex lens. You can use a ready-made lens holder or make one yourself, as described in the last section of this chapter.
- Focus sunlight onto a thin sheet of paper using your convex lens.
- If focused properly, the focused beam can burn paper. Remember to keep some water handy in case the paper catches fire. Do not look at the sun through the lens.

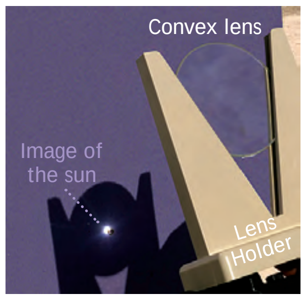


Fig. 9.21 A convex lens focuses sunlight.

8. What kind of mirror is useful for shaving?

9. What is the refraction of light? Give an example from everyday life.

★ 10. What kind of mirror is shown in the picture? Do you think that the image has been altered? Why?

F Answer these in not more than 40 words.

1. Which type of mirror forms a
   a. real and magnified image
   b. virtual and magnified image
   c. real and diminished image
   d. virtual and diminished image

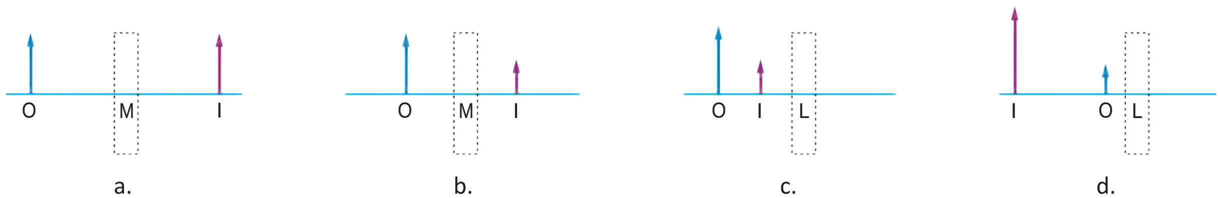
2. Give five uses of concave mirrors and three uses of convex mirrors.

3. Explain why a convex mirror is used as a side-view mirror. It warns: 'Objects in mirror are closer than they appear.' Why?

4. What happens to parallel beams of light incident along the principal axis of a convex lens and a concave lens? Show with a diagram.

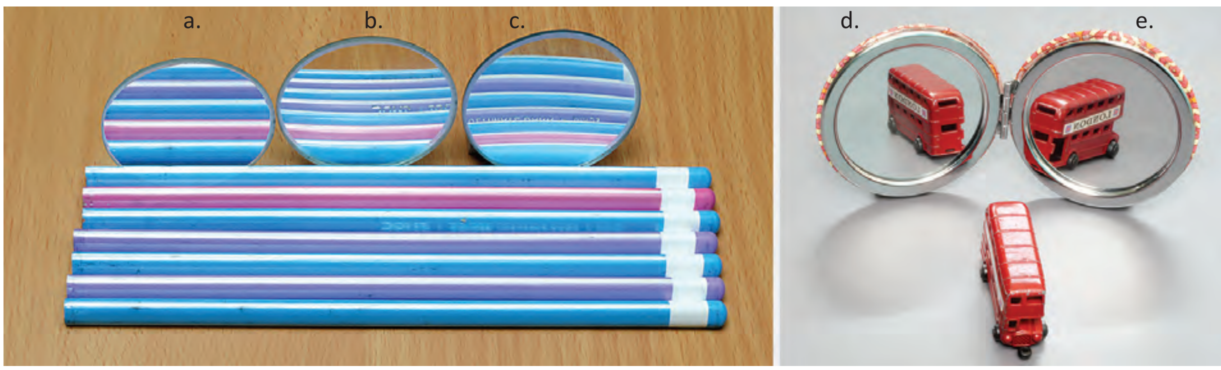
5. What are the different things a lens can do in an optical instrument? Give examples of each.

6. Look at the illustrations. They show an object O and its image I formed by a mirror M or a lens L inside the dotted box. Say what kind of mirror or lens is in the dotted box.



7. Each photo shows a person seen through a lens. Are the lenses the same? If they are not, identify them with reasons.

★ 8. Look carefully at the pictures. Identify the mirrors (look for curved lines too). The picture on the right is that of a compact mirror in which one of the mirrors is a plane mirror.



Predation **Predation is a relationship in which one organism kills and eats another.** The organism that hunts and eats is called a predator. The organism that is killed and eaten is called the prey. Predators include spiders, snakes, tigers, eagles, sharks, and so on. A prey can be a herbivore or a carnivore. One animal can also be both predator and prey. For example, a snake is a predator to a mouse, but a hawk can hunt and eat the snake. Predation helps control the population of prey animals. It also helps remove weak or sick individuals and keeps the ecosystem more balanced.

Fig. 11.12 Brown bears are predators to salmon.

Mutualism **Mutualism is a relationship in which both organisms benefit from each other.** For example, when a bee visits a flower, it gets nectar, and the flower gets pollinated when the bee carries pollen. Mutualism also happens between *Rhizobium* bacteria and leguminous plants such as pea and gram. The bacteria live in root nodules and change nitrogen from air into ammonia. The plant uses this to make proteins. In return, the bacteria get food from the plant.

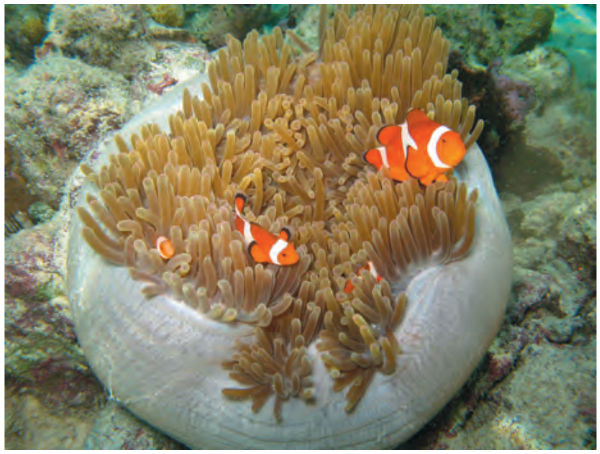


Fig. 11.13 Clownfish and sea anemone benefit from each other.

Lichens show mutualism between an alga and a fungus. The alga makes food, while the fungus provides water, minerals and protection. Clownfish and sea anemones also show mutualism. The fish shelters among the tentacles of the anemone, which sting most predators. A mucus layer on the skin of the clownfish prevents stings , so the fish gets a safe shelter. In return, the clownfish drives away some anemone-eating fish and its waste adds nutrients for the anemone.

Commensalism **Commensalism is a relationship in which one organism benefits and the other is neither helped nor harmed.** The organism that benefits is the commensal. The organism that provides support is the host. Remoras show commensalism in the sea. They attach to large animals such as sharks, whales, rays or turtles. Remoras eat leftover food and sometimes faecal matter. The host also provides transport and protection, but gets no clear benefit.

Fig. 11.14 Orchids are commensals that grow on trees for support, not for food.

Orchids also show commensalism. They grow on tree trunks and branches for support and better

Climate change

Biodiversity loss

Pollution

Fig. 12.11 Triple planetary crisis

Climate change

The long-term change in the earth's temperature, rainfall and weather patterns is called climate change. It is the result of the increase in greenhouse gases in the atmosphere.

We learned that the natural greenhouse effect helps keep our planet warm and livable. The earth also has natural ways to control greenhouse gases. Trees and plants, and even tiny ocean plankton, absorb carbon dioxide as they grow. However, human activities are adding greenhouse gases faster than these natural systems can remove them. Burning fossil fuels like coal and petroleum in vehicles, factories and power plants releases a lot of carbon dioxide. Cutting down forests also reduces the earth's ability to absorb carbon dioxide. When extra greenhouse gases build up, they trap more heat and make the earth warmer than normal. This rise in the earth's average temperature is called global warming.

The effects of climate change can be harmful for plants, animals and humans.

- Even a small increase in temperature can melt glaciers and polar ice, raising the sea levels and flooding low-lying coastal areas.
- It can also make the weather more extreme. In India, it is linked to hotter summers and unpredictable rainfall. Some places suffer from severe floods, while others face droughts. This damages crops and affects our food supply.

Fig. 12.12 The polar ice caps are melting much faster due to global warming.

We all must play our part to reduce climate change. We must reduce our dependence on fossil fuels and shift to cleaner sources of energy. Saving electricity, using public transport, planting more trees and reducing waste also help. Small actions by many people can make a big difference.

Info Flash

Nectar guides are markings on petals that help insects find nectar, like road signs. They can be dots, lines or rings that point towards the centre of the flower. Some guides are visible only in ultraviolet light (UV), so people cannot see them, but bees can. This helps bees reach nectar faster, so they visit more flowers and carry more pollen.

Forget-me-not flowers do a neat trick. The small yellow ring in the centre works as a nectar guide when nectar is available. After the flower has been pollinated, the yellow ring fades to white. This signals to insects that the reward is finished, so they move on to other flowers.

Fertilisation

In flowering plants, fertilisation takes place after pollination. After a pollen grain lands on the stigma, it germinates and forms a long pollen tube. The pollen tube grows down through the style into the ovary and reaches an ovule, usually through an opening called the micropyle. The pollen grain carries two male gametes, which travel through the pollen tube.

One male gamete fuses with the egg cell inside the ovule. This fusion forms a zygote, which divides and develops into an embryo inside the seed. After fertilisation, the ovule becomes the seed and the ovary becomes the fruit. In many flowering plants, the second male gamete fuses with other cells in the ovule to form the food store for the seed.

Post-fertilisation changes After fertilisation, the petals, stamens, stigma and style usually shrivel and fall off. The sepals may also fall off, but in some plants such as cotton and brinjal they remain intact. The embryo lies dormant in the seed until conditions are suitable for germination. It has a radicle, a plumule and one or two cotyledons. The radicle forms the root and the plumule forms the shoot. The young plant uses the food stored in the cotyledons. As the seeds mature, the fruit ripens. Unripe fruits are often green and sour or bitter to discourage animals, while ripe fruits may attract animals that help in seed dispersal.

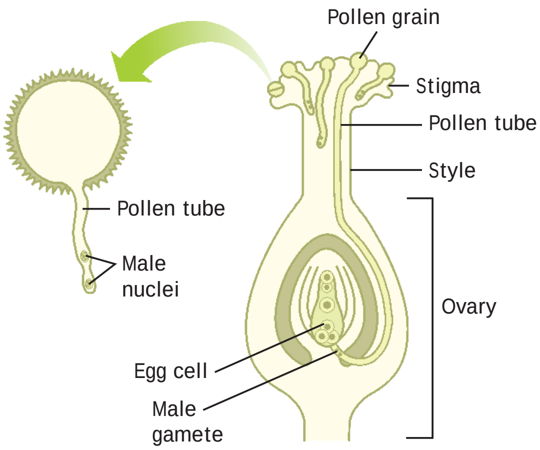


Fig. 13.15 Ovary in longitudinal section, showing the process of fertilisation

Seed dispersal

Many seeds that fall close to the parent plant do not survive. This is because the seedlings have to compete with the parent plant for sunlight, water or minerals. **Seed dispersal is the scattering of seeds away from the parent plant.** It helps seedlings grow in new places. Seeds can be dispersed in the following ways.

- By wind Light seeds with wings or hairs are blown away, like those of drumstick, maple, milkweed, silk cotton, devil's tree and cotton.

Fig. 13.16 A winged maple seed