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FREE EBOOK

SCIENCE PROJECTS AND KITS

Biology Models Guide

Make the heart, lungs, kidney, eye, cell and more, and explain them well

INSIDE THIS BOOK

- Before you start
- Plant and animal cells
- The human heart
- The lungs and the digestive system
- The kidney and the nephron
- ...and 6 more chapters, practice questions and a glossary

Beginner

Students of class 4 to 12

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+91 97116 99511

Biology Models Guide

Step-by-step guides to fourteen classic biology models, from plant and animal cells, the heart and the balloon lung model to the kidney, eye, ear, brain, skeleton and DNA. Each model comes with the science, a materials list, numbered steps, the labels you must get right and the viva questions examiners ask, plus tips on safe materials and display.

WHO IT IS FOR	Students of class 4 to 12
LEVEL	Beginner
SUBJECT AREA	Science projects and kits
WHAT IS INSIDE	11 chapters, practice questions with answers, and a glossary

HOW TO USE IT

Read one chapter at a time and try the examples as you go: on a computer, at your workbench or in your notebook. The boxes give tips, safety points and short activities. When you finish, test yourself with the practice questions and check your answers at the end. Words you may not know are explained in the glossary.



Gurukul Technicals Institute

A-10, Chief Commissioner Colony, opposite Rana Pratap Bagh, Delhi 110007

Phone 011 2721 1512 · Mobile and WhatsApp +91 97116 99511

engineergurukul@yahoo.co.in · engineergurukul.com

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Before you start

A biology model is a large, clear copy of something that is too small, too hidden or too complicated to see easily: a cell, a heart, a nephron. A good model teaches. Someone who looks at it should understand how that part of a living thing works.

Judges and teachers usually look for four things:

- 1. Correct science.** Every part is in the right place and the right shape.
- 2. Correct labels.** Every name is spelt correctly and points to the right part.
- 3. Neat work.** Clean edges, steady colours and a model that does not fall apart.
- 4. Your explanation.** You can say what each part does, in your own words.

Each model in this book is set out the same way: **the science, you need, how to make it, labels and viva questions.** A **viva** is a short spoken test in which the examiner asks you questions about your work.

Safe materials

Material	Good for
Modelling clay or play dough	Organs, cell parts, bones
Thermocol sheets and balls	Bases, the eye, cells
Cardboard and chart paper	Skeletons, flowers, food chains
Foam sheets	Petals, leaves, membranes
Pipe cleaners, wool, straws	Blood vessels, tubes, nerves, DNA
Balloons and plastic bottles	Lungs, eardrum, working parts
Poster colours and white glue	Painting and joining

SAFETY

An adult should handle cutters, hot glue guns and thermocol cutters. A hot-wire thermocol cutter gives off fumes, so it is used only by an adult, near an open window. Never use poisonous plants such as oleander (kaner) or datura in a model, and wash your hands after handling any plant.

Getting the science right

- Check every part against your textbook before you paint it.
- Make a rough sketch first and mark each label on it.
- Diagrams of the body are drawn as if the person is **facing you**. So the heart's left side appears on **your right**. This catches many students out.

EXAMPLE

Ishaan from Jaipur made a heart model for ₹ 150. He spent ₹ 60 on modelling clay in red and blue, ₹ 30 on straws and pipe cleaners, ₹ 40 on a thermocol base and ₹ 20 on label paper. The rest came from home.

REMEMBER

A small, accurate model beats a big, wrong one. Examiners notice a misplaced label much faster than they notice size.

CHAPTER 2

Plant and animal cells

The science

A **cell** is the smallest unit of life. Every plant and animal is made of cells, most of them too small to see without a microscope. In 1665, Robert Hooke looked at a thin slice of cork under his microscope and saw tiny box-like spaces. He called them cells, from a word meaning small rooms.

Plant cells and animal cells share many parts, but plant cells have a few extra ones.

Part	What it does	Plant cell	Animal cell
Cell wall	Stiff outer layer that gives shape and support	Yes	No
Cell membrane	Thin layer that controls what enters and leaves	Yes	Yes
Cytoplasm	Jelly-like fluid in which the other parts float	Yes	Yes
Nucleus	Controls the cell and holds the genetic information	Yes	Yes
Mitochondria	Release energy from food; the cell's powerhouse	Yes	Yes
Chloroplasts	Contain green chlorophyll and make food	Yes	No
Vacuole	Stores water and other substances	One large central	Small, if any

You need

A shoebox lid, a round thermocol plate, modelling clay in five colours, beads, toothpicks and label flags.

How to make it

- 1. Plant cell:** use the shoebox lid. Its stiff sides are the cell wall. Plant cells are roughly box-shaped, so this suits them.
- 2.** Line the inside edge with a thin strip of yellow clay for the cell membrane.
- 3.** Fill the base with light-coloured clay for the cytoplasm.
- 4.** Make a large, flat, light blue shape for the central vacuole. It should take up much of the cell and push the other parts to the sides.
- 5.** Add a round nucleus with a darker dot inside (the **nucleolus**), green oval chloroplasts and orange mitochondria with a wavy line drawn inside.
- 6. Animal cell:** use the round thermocol plate. Animal cells have no wall, so make an irregular round outline with the membrane strip.

7. Add cytoplasm, a nucleus in the middle, mitochondria and a few small vacuoles. Leave out chloroplasts.

Labels

Cell wall, cell membrane, cytoplasm, nucleus, nucleolus, mitochondria, chloroplast and vacuole.

TIP

Show the two cells side by side on one board, with a table beneath listing the differences. Examiners love a clear comparison.

Viva questions

- Why do plant cells need a cell wall? It gives them shape and support, so a plant can stand upright.
- Which part is called the powerhouse of the cell? The mitochondria, because they release energy from food.
- Why are leaves green? Their cells contain chloroplasts, which hold the green pigment chlorophyll.

CHAPTER 3

The human heart

The science

The heart is a muscular pump about the size of your fist. It sits in the chest between the two lungs, a little to the left. It has four **chambers**: two upper ones called **atria** (one is an atrium) and two lower ones called **ventricles**.

The right side pumps blood to the lungs to pick up oxygen. The left side pumps that oxygen-rich blood to the whole body. Blood therefore passes through the heart twice in each full trip round the body. This is called **double circulation**. Flaps called **valves** let blood flow in one direction only.

The path of blood

1. Blood from the body, low in oxygen, enters the right atrium through two large veins, the **vena cava**.
2. It passes through a valve into the right ventricle.
3. The right ventricle pumps it through the **pulmonary artery** to the lungs.
4. In the lungs it gives up carbon dioxide and takes in oxygen.
5. The **pulmonary veins** bring it back to the left atrium.
6. It passes through a valve into the left ventricle.
7. The left ventricle pumps it into the **aorta**, the largest artery, which carries it to the whole body.

You need

A thermocol base, red and blue clay, red and blue straws or pipe cleaners, white chart paper for labels, and toothpicks.

How to make it

1. Shape a heart about 12 cm tall from clay. Mark a line down the middle with a toothpick, and a cross line to show the four chambers.
2. Colour the right side (on **your left** as you face it) blue, and the left side red.
3. Make the left ventricle's wall visibly thicker than the right's. It pumps blood to the whole body, so it needs the most muscle.
4. Push in blue straws for the vena cava and pulmonary artery, and red ones for the pulmonary veins and aorta. Bend the aorta into an arch over the top.
5. Draw small arrows on paper strips to show the direction of flow, and stick them along the vessels.

Labels

Right atrium, left atrium, right ventricle, left ventricle, vena cava, pulmonary artery, pulmonary veins, aorta and valves.

REMEMBER

Blue for blood low in oxygen and red for blood rich in oxygen is only a colour code. Real blood is always red, though blood low in oxygen is a darker red.

TRY THIS

Fill a soft plastic bottle with red water and push a straw through a hole in its cap. Squeeze and release it in a steady rhythm. Each squeeze is like a heartbeat pushing blood out into an artery.

Viva questions

- Why is the wall of the left ventricle the thickest? It pumps blood to the whole body, which needs the greatest force.
- Which artery carries blood low in oxygen? The pulmonary artery, which takes blood from the heart to the lungs.
- What do valves do? They stop blood from flowing backwards.
- How often does the heart beat? About 70 times a minute in an adult at rest. It beats faster during exercise.

CHAPTER 4

The lungs and the digestive system

The balloon lung model

The science: We breathe using a sheet of muscle under the lungs called the **diaphragm**. When it moves down, the space in the chest gets bigger, the air pressure inside falls, and air rushes into the lungs. When it moves up, the space gets smaller and air is pushed out. Inside the lungs, millions of tiny air sacs called **alveoli** pass oxygen into the blood and take carbon dioxide out.

You need: a clear plastic bottle, a Y-shaped connector or two straws and a short wider straw, three balloons, clay, tape and scissors.

1. An adult cuts the bottom off the bottle.
2. Join two straws to one wider straw with tape or a Y connector, making an upside-down Y. The single stem is the **trachea** (windpipe), and the two arms are the **bronchi**.
3. Tie a small balloon to the end of each arm. These are the lungs.

4. Put the Y into the bottle through the open bottom, so the single straw pokes out of the bottle's mouth and the balloons hang inside. Seal the mouth around the straw with clay so no air leaks.
5. Cut the neck off the third balloon. Stretch the rest over the open bottom of the bottle and tape it tightly. This is the diaphragm.
6. Pull the diaphragm balloon gently down. The lung balloons fill. Push it up, and they shrink.

REMEMBER

Every model has limits, and saying so impresses examiners. Real lungs are spongy, not hollow bags. A real diaphragm is dome-shaped and flattens when it contracts, and the ribs also move when we breathe.

The digestive system

The science: Digestion is the breaking down of food into substances small enough to pass into the blood. Food travels along a long tube, the **alimentary canal**, from mouth to anus.

Part	Its job
Mouth	Teeth chew food; saliva starts breaking down starch
Oesophagus (food pipe)	Squeezes food down to the stomach
Stomach	Churns food with acid and digestive juices
Liver	Makes bile, which helps digest fats; the largest gland
Pancreas	Makes digestive juices for the small intestine
Small intestine	Finishes digestion; tiny finger-like villi absorb food into the blood
Large intestine	Absorbs water from the leftover material
Rectum and anus	Store and remove waste

You need: a large cardboard sheet with a body outline, clay, a long thin rubber tube or thick wool, and paints.

1. Draw the body outline and paint it a light skin colour.
2. Make the mouth, oesophagus and a J-shaped stomach from clay.
3. Coil a long tube tightly in the middle of the belly for the small intestine. It is the longest part of the canal, so use plenty of tube.
4. Frame it with a wider tube for the large intestine: up the body's right side (your left), across the top and down the other side.
5. Add a large brown liver above the stomach on the body's right side (your left), with the green gall bladder tucked under it, and the pancreas below the stomach.

TRY THIS

Chew a small piece of plain chapati for a full minute without swallowing. It starts to taste slightly sweet, because saliva is breaking starch into sugar.

Viva questions

- What makes air enter the lungs? The diaphragm moves down, the chest space grows and the air pressure inside falls.
- Where is most food absorbed? In the small intestine, through the villi.

CHAPTER 5

The kidney and the nephron

The science

Our two kidneys clean the blood. They are bean-shaped, about the size of a fist, and sit at the back of the belly, one on each side of the backbone, partly sheltered by the lowest ribs. They remove wastes, especially **urea**, along with extra water and salts. Together these make **urine**.

The path of urine is: **kidneys** → **ureters** → **urinary bladder** → **urethra**. The **renal artery** brings blood to each kidney, and the **renal vein** carries cleaned blood away.

If you cut a kidney in half lengthwise, you see three regions: the outer **cortex**, the inner **medulla** and the hollow **pelvis**, which collects urine and leads into the ureter.

The nephron

Each kidney has about a million tiny filters called **nephrons**. A nephron works in two stages:

1. **Filtration:** blood enters a tight knot of tiny blood vessels called the **glomerulus**. Water, salts, glucose and urea are pushed out of the blood into a cup around it, called **Bowman's capsule**.
2. **Reabsorption:** the liquid flows along a long, twisted tube. Useful substances, such as glucose, most of the water and some salts, are taken back into the blood. What is left, the urine, drains into a **collecting duct**.

The tube has three parts in order: the first coiled tube, a long U-shaped **loop of Henle**, and a second coiled tube.

You need

Brown and pink clay, red and blue pipe cleaners, yellow wool, a thermocol base and label flags.

How to make it

1. **Urinary system:** make two bean-shaped kidneys and place them on the base. Add yellow wool ureters running down to a balloon-shaped bladder, and a short urethra below it.
2. Add a red pipe cleaner (renal artery) and a blue one (renal vein) to each kidney.
3. **Kidney section:** beside it, make a large half kidney. Use dark brown clay for the cortex, lighter cone shapes for the medulla, and a pale funnel shape for the pelvis.
4. **Nephron:** on the other side, bend a yellow pipe cleaner into a cup (Bowman's capsule), a coil, a long U (loop of Henle), a second coil and finally a straight collecting duct.
5. Twist a red pipe cleaner into a small ball inside the cup for the glomerulus.

Labels

Kidney, ureter, urinary bladder, urethra, renal artery, renal vein, cortex, medulla, pelvis, glomerulus, Bowman's capsule, loop of Henle and collecting duct.

DID YOU KNOW

When kidneys fail, a **dialysis** machine can clean the blood instead. Blood flows out of the body, through a filter that removes wastes, and back again.

Viva questions

- What is the working unit of the kidney? The nephron.
- What is the main waste in urine? Urea.
- What happens in the glomerulus? Filtration: water and small dissolved substances are pushed out of the blood into Bowman's capsule.

CHAPTER 6

The eye and the ear

The human eye

The science: Light enters through the clear **cornea** and passes through the **pupil**, the black opening in the middle. The coloured **iris** around it makes the pupil smaller in bright light and larger in dim light. The **lens** focuses the light onto the **retina**, a layer at the back covered with light-sensitive cells. The image on the retina is upside down. The **optic nerve** carries signals to the brain, which turns the picture the right way up. Where the optic nerve leaves the eye there are no light-sensitive cells. This is the **blind spot**.

You need: a large thermocol ball cut in half by an adult, paints and clay, and for the working model a magnifying glass and a sheet of tracing paper.

1. Paint the outside of the half ball white for the tough outer coat, the **sclera**.
2. On the cut face, show the parts in cross-section: a clear bulge at the front for the cornea, a coloured ring for the iris, a clay lens behind it, and a red layer lining the back for the retina.
3. Add a thick yellow pipe cleaner leaving the back for the optic nerve.

Working model: stand in a dim room facing a bright window. Hold the magnifying glass up towards the window, and hold the tracing paper behind it. Move the paper slowly closer or farther until a sharp picture of the window appears on it. The picture is upside down, just like the image on your retina. The lens plays the part of the eye's lens, and the paper plays the retina.

SAFETY

Never point a lens or your eye model at the sun. A lens focuses sunlight to a hot spot that can burn paper, skin and eyes.

The human ear

The science: The outer ear collects sound and funnels it down the ear canal to the **eardrum**, which vibrates. Three tiny bones in the middle ear, the **hammer**, **anvil** and **stirrup**, pass the vibrations on and make them stronger. The stirrup is the smallest bone in the body. The vibrations reach the snail-shaped **cochlea**, where tiny hair cells turn them into nerve signals. The **auditory nerve** carries these to the brain. The **semicircular canals** beside the cochlea help us balance.

1. On a thermocol base, model the outer ear and the canal in clay.
2. Stretch a piece of balloon over the end of the canal for the eardrum.
3. Add three small clay bones, then a coiled cochlea and three loops for the semicircular canals.
4. Run a yellow pipe cleaner from the cochlea for the auditory nerve.

TRY THIS

Stretch a balloon tightly over an empty tin and sprinkle a few grains of rice on top. Tap a steel plate loudly with a spoon near it. The rice jumps, because sound waves make the balloon vibrate, just as they make your eardrum vibrate.

Viva questions

- What controls the size of the pupil? The iris.
- What kind of image forms on the retina? An upside-down image. The brain turns it the right way up.
- Which is the smallest bone in the body? The stirrup, in the middle ear.

The brain and the skeleton

The brain

The science: The brain is the control centre of the body. It is protected by the skull and cushioned by fluid. It has three main parts:

Part	Where it is	What it does
Cerebrum	Large, folded, upper part	Thinking, memory, speech, the senses and the movements we choose to make
Cerebellum	Small, at the back, below the cerebrum	Balance, posture and smooth, coordinated movement
Medulla	Brain stem, joining the spinal cord	Breathing, heartbeat, swallowing and other actions we do not have to think about

The cerebrum has two halves. The left half controls the right side of the body, and the right half controls the left side.

How to make it:

1. Shape a large dome from pink clay for the cerebrum. Draw a deep groove down the middle for the two halves.
2. Roll thin clay worms and press them on in wavy lines to show the folds.
3. Add a smaller, finely lined cerebellum at the lower back, in a different shade.
4. Attach a short stem for the medulla, joining a long white pipe cleaner for the spinal cord.

The skeleton

The science: An adult human skeleton has 206 bones. A newborn baby has more, but some of them join together as the child grows. The skeleton gives the body its shape, protects soft organs, lets us move with the help of muscles, and makes blood cells in the bone marrow.

Joint	How it moves	Example
Ball and socket	In all directions	Shoulder, hip
Hinge	Back and forth, like a door	Elbow, knee
Pivot	Turns round	Where the neck joins the head
Fixed	Does not move	Bones of the skull

You need: thick white card, a pencil, scissors, split pins (paper fasteners) and a black chart sheet.

1. Draw the bones on card: skull, rib cage, backbone, pelvis, and upper and lower arms and legs.
2. An adult helps cut them out.
3. Join them with split pins at the shoulders, elbows, hips and knees, so these joints really move.
4. Mount the skeleton on the black chart and label the main bones.

Labels

Skull, backbone, ribs, collarbone, shoulder blade, pelvis, humerus, radius, ulna, femur, tibia and fibula.

DID YOU KNOW

The femur, the thigh bone, is the longest and strongest bone in the body. There are 12 pairs of ribs.

Viva questions

- Which part of the brain controls balance? The cerebellum.
- Which part controls breathing and heartbeat? The medulla.
- Name a hinge joint and a ball and socket joint. Elbow or knee; shoulder or hip.

The DNA double helix

The science

DNA (deoxyribonucleic acid) is the substance that carries the instructions for building and running a living thing. It is found in the nucleus of almost every cell. A section of DNA that carries the instructions for one feature is called a **gene**.

A DNA molecule looks like a ladder twisted into a spiral. This shape is called a **double helix**.

- The two sides of the ladder are made of sugar and phosphate, joined in a chain.
- The rungs are pairs of chemical **bases**. There are four bases: adenine (A), thymine (T), guanine (G) and cytosine (C).
- The bases always pair the same way: **A with T**, and **G with C**.

In 1953, James Watson and Francis Crick described this structure. Their work drew on X-ray photographs of DNA made by Rosalind Franklin.

You need

Two long pipe cleaners for the sides, more pipe cleaners cut into 6 cm pieces for the rungs, beads in four colours that fit on a pipe cleaner, a thermocol base and two wooden skewers.

How to make it

1. Choose a colour for each base, for example red for A, blue for T, green for G and yellow for C.
2. Make each rung by threading two beads that pair correctly onto a 6 cm piece: red with blue, or green with yellow.
3. Make about 14 rungs, mixing the order of the pairs.
4. Lay the two long pipe cleaners side by side and twist the ends of each rung round them, about 2 cm apart, to make a straight ladder.
5. Hold the bottom still and gently turn the top **anticlockwise**, as you look down on it from above. Seen from the side, the strands at the front should now run from lower left to upper right, like the stroke /.

6. Stand the helix between two skewers in the base.

REMEMBER

Natural DNA is a **right-handed** helix: it twists the same way as the thread of an ordinary screw. A model twisted the wrong way is a common mistake, and a sharp examiner will spot it. In real DNA, one full turn holds about ten base pairs.

TRY THIS

Write a short sequence on one side of your model, for example A, T, T, G, C, A. Ask a friend to work out the bases on the other side. The answer is T, A, A, C, G, T.

Viva questions

- Which bases pair together? Adenine with thymine, and guanine with cytosine.
- What are the sides of the ladder made of? Sugar and phosphate.
- What is a gene? A section of DNA that carries the instructions for one feature.

CHAPTER 9

Flowers and photosynthesis

Parts of a flower

The science: A flower is the part of a plant that makes seeds.

Part	What it does
Sepals	Green leaf-like parts that protect the bud
Petals	Coloured parts that attract insects
Stamen (male part)	Made of a thin filament topped by an anther , which makes pollen
Pistil (female part)	Made of a sticky stigma that catches pollen, a stalk called the style , and the ovary , which holds the ovules

When pollen reaches the stigma, this is **pollination**. After **fertilisation**, the ovary grows into a fruit and the ovules become seeds.

How to make it:

1. Use a china rose (gudhal) as your guide. Its parts are large and easy to see.
2. Cut five large petals from red foam sheet and five sepals from green.
3. Make the ovary from green clay at the centre, and the style as a pipe cleaner rising from it.
4. In a china rose, the stamens are joined into a tube around the style, with anthers dotted along its upper part. Copy this with small yellow beads glued around the pipe cleaner.
5. Add five small red clay knobs at the very top for the stigma.

TIP

Dissect a real china rose too. Lay each part on white card, cover it with clear tape and label it. Shown beside your model, it proves your labels are correct.

Photosynthesis

The science: Green plants make their own food by **photosynthesis**. Using the energy of sunlight, captured by chlorophyll, they combine carbon dioxide from the air with water to make glucose, a sugar, and they give out oxygen.

carbon dioxide + water → glucose + oxygen (in sunlight, with chlorophyll)

Experiment: plants give out oxygen. Put a few sprigs of hydrilla, a water plant sold in aquarium shops, in a wide glass bowl of water with a pinch of baking soda, which adds carbon dioxide. Cover the plant with an upside-down glass funnel. Fill a test tube with water and turn it upside down over the stem of the funnel, keeping its mouth under the water. Keep it in bright sunlight. Bubbles of oxygen rise and collect in the tube. Move the bowl into shade and count the bubbles each minute: fewer bubbles appear.

Experiment: leaves need light to make starch. Keep a potted plant in a dark cupboard for two days so its leaves use up their starch. Cover part of one leaf with a strip of black paper on both sides and leave the plant in sunlight for a day. A teacher then tests the leaf with iodine. The uncovered part turns blue-black, showing starch. The covered part does not.

SAFETY

The leaf test needs alcohol to remove the green colour. Alcohol catches fire easily, so it is heated only in a water bath and only by a teacher.

Viva questions

- What are the male and female parts of a flower? The stamen and the pistil.
- Which gas do plants give out in photosynthesis? Oxygen.

CHAPTER 10

Germination and food chains

The germination experiment

The science: Germination is the sprouting of a seed into a young plant. A seed needs water, air and a suitable temperature to germinate. Most seeds do not need light for this.

You need: four small jars, cotton wool, a handful of moong or chana seeds, water that an adult has boiled and cooled, a little oil and labels.

1. **Jar A:** seeds on dry cotton.
2. **Jar B:** seeds on moist cotton, kept moist every day.
3. **Jar C:** seeds completely under the boiled, cooled water, with a thin layer of oil on top to keep air out.
4. **Jar D:** seeds on moist cotton, kept in a refrigerator.
5. Keep jars A, B and C at room temperature, and check all four every day for five days.

Jar	Has water?	Has air?	Warm enough?	Result
A	No	Yes	Yes	No germination
B	Yes	Yes	Yes	Germinates

Jar	Has water?	Has air?	Warm enough?	Result
C	Yes	No	Yes	No germination, though the seeds may swell
D	Yes	Yes	No	Little or no germination

In jar B, look for the parts of the young plant. The first root is the **radicle** and the first shoot is the **plumule**. The two fat halves of a moong seed are the **cotyledons**, or seed leaves, which feed the young plant until it can make its own food.

EXAMPLE

Meera from Nagpur started her jars on a Monday. By Wednesday, every seed in jar B had a white radicle about 1 cm long. Jar A looked unchanged. She recorded the radicle lengths in a table each day and drew a line graph for her report.

Food chains

The science: A **food chain** shows who eats whom, and so how energy passes from one living thing to the next.

- **Producers**, the green plants, make their own food using sunlight.
- **Herbivores** eat plants. **Carnivores** eat other animals.
- **Decomposers**, such as bacteria and fungi, break down dead plants and animals and return their nutrients to the soil.

An example from an Indian field: grass → grasshopper → frog → snake → eagle.

At each step, most of the energy is used up in living, and only a small part, often given as about a tenth, passes to the next animal. That is why food chains are short.

How to make it:

1. Draw or print each living thing on a card circle.
2. Join the cards with arrows that point **from the food to the eater**: from grass to grasshopper, never the other way.
3. For a food web, show how one animal eats several foods. The frog eats insects, and the snake also eats rats.

4. Add a mushroom card off to one side, labelled decomposer, with arrows reaching it from every card.

REMEMBER

The arrow shows the direction of energy flow. Getting it backwards is the most common mistake in food chain models.

CHAPTER 11

Labelling, display and the viva

Labels that help

- Print labels or write them in neat capital letters, large enough to read from a metre away.
- Use thin black lines or toothpick flags that touch the part exactly. Lines should never cross each other.
- Keep labels on the outside of the model, arranged in a neat column where possible.
- Give a **colour key** when colour carries meaning, such as red and blue blood.
- Check every spelling. Common mistakes are oesophagus, mitochondria, alveoli, glomerulus and cerebellum.

A display that teaches

Set out your table in a clear order:

1. A title in large letters at the top.
2. The model in the centre.
3. A chart on one side showing how it works, using a numbered sequence or a flow of arrows.
4. A small card listing the materials and the limits of your model.

If your model has a working part, such as the balloon lungs or the eardrum drum, practise showing it until it works every time.

TIP

Carry your model on a flat board, inside a box packed with crumpled newspaper. Bring spare clay, glue and labels for repairs at the venue.

Facing the viva

Prepare a 30-second explanation for each model: what it shows, how the real part works, and one interesting fact. Then practise answering questions out loud with a friend or a family member.

EXAMPLE

Kabir from Kolkata explained his heart model like this: "This is the human heart, seen from the front. Blood from the body enters the right atrium and is pumped to the lungs for oxygen. It returns to the left side, and the thick left ventricle pumps it to the whole body through the aorta. The valves keep it flowing one way."

If you do not know an answer, say so honestly, then say what you do know about the topic. Examiners respect honesty far more than a guess presented as fact.

CHECK YOURSELF

Practice questions

1. Name two parts found in plant cells but not in animal cells.
2. Which organelle is called the powerhouse of the cell, and why?
3. Who first used the word "cell", and what was he looking at?
4. Write the path of blood from the vena cava to the aorta.
5. Why does the heart's left side appear on the viewer's right in a diagram?
6. Which blood vessel carries blood low in oxygen away from the heart?
7. In the balloon lung model, what do the balloons, the straws and the stretched balloon at the bottom stand for?
8. Give one limitation of the balloon lung model.

9. Where in the digestive system is most digested food absorbed?
10. Why does chapati start to taste sweet when you chew it for a long time?
11. Write the path of urine from the kidneys out of the body.
12. Name the two stages by which a nephron makes urine.
13. What is the blind spot of the eye?
14. Why is the image on the retina not seen upside down?
15. Name the three small bones of the middle ear.
16. Which part of the brain controls balance and coordination?
17. How many bones does an adult human skeleton have?
18. Give one example each of a hinge joint and a pivot joint.
19. Which base pairs with guanine in DNA?
20. Which way does a correct DNA model twist?
21. Name the male and female parts of a flower.
22. Why is a pinch of baking soda added to the water in the hydrilla experiment?
23. What three conditions does a seed need to germinate?
24. Which way should the arrows point in a food chain?
25. What is the job of decomposers?

ANSWER KEY

Answers

1. The cell wall and chloroplasts. Plant cells also have one large central vacuole.
2. The mitochondria, because they release energy from food.
3. Robert Hooke, in 1665. He was looking at a thin slice of cork under a microscope.
4. Vena cava → right atrium → right ventricle → pulmonary artery → lungs → pulmonary veins → left atrium → left ventricle → aorta.
5. Diagrams show the body as if the person is facing you, so their left is on your right.

6. The pulmonary artery, which carries it to the lungs.
7. The balloons are the lungs, the straws are the trachea and bronchi, and the stretched balloon is the diaphragm.
8. Any one: real lungs are spongy, not hollow; the real diaphragm is dome-shaped; the ribs also move in real breathing.
9. In the small intestine, through the villi.
10. Saliva starts breaking down starch into sugar.
11. Kidneys → ureters → urinary bladder → urethra.
12. Filtration (in the glomerulus and Bowman's capsule) and reabsorption (along the tubule).
13. The point where the optic nerve leaves the eye. It has no light-sensitive cells, so no image forms there.
14. The brain turns the picture the right way up.
15. The hammer, the anvil and the stirrup.
16. The cerebellum.
17. 206.
18. Hinge: the elbow or the knee. Pivot: where the neck joins the head.
19. Cytosine.
20. It is a right-handed helix, twisting the same way as the thread of an ordinary screw. Seen from the side, the front strands run from lower left to upper right.
21. The stamen is the male part, and the pistil is the female part.
22. It adds carbon dioxide to the water, which the plant needs for photosynthesis.
23. Water, air and a suitable temperature.
24. From the food to the eater, which is the direction of energy flow.
25. They break down dead plants and animals and return nutrients to the soil.

WORD LIST

Glossary

Alveoli

tiny air sacs in the lungs where oxygen enters the blood.

Atrium

one of the two upper chambers of the heart; the plural is atria.

Cell

the smallest unit of life.

Chlorophyll

the green substance in leaves that captures sunlight for photosynthesis.

Cochlea

the snail-shaped part of the inner ear that turns vibrations into nerve signals.

Cotyledon

a seed leaf, which stores food for the young plant.

Diaphragm

the sheet of muscle below the lungs that helps us breathe.

DNA

the substance in cells that carries the instructions for building and running a living thing.

Double circulation

blood passing through the heart twice in each full trip round the body.

Food chain

a series showing which living thing eats which, and how energy passes along.

Gene

a section of DNA that carries the instructions for one feature.

Germination

the sprouting of a seed into a young plant.

Glomerulus

a knot of tiny blood vessels in a nephron where blood is filtered.

Nephron

one of the tiny filtering units of the kidney.

Photosynthesis

the process by which green plants make food from carbon dioxide and water using sunlight.

Pollination

the transfer of pollen from an anther to a stigma.

Producer

a living thing, such as a green plant, that makes its own food.

Radicle

the first root that grows from a seed.

Retina

the light-sensitive layer at the back of the eye.

Valve

a flap that lets blood flow in one direction only.

Ventricle

one of the two lower, pumping chambers of the heart.

Villi

tiny finger-like folds in the small intestine that absorb digested food.

Viva

a short spoken test in which an examiner asks about your work.



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CONTACT

Head office: A-10, Chief Commissioner Colony, opposite Rana Pratap Bagh, Delhi 110007

Phone: 011 2721 1512 · **Mobile and WhatsApp:** +91 97116 99511

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