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SOLUTIONS BOOK

CLASS 9

Science · Exploration

CHAPTER 2

Cell: The Building Block of Life

Complete Questions and Activities Solutions

In-text Questions | Revise, Reflect, Refine | The Journey Beyond

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Every question is followed by its answer. Question numbers above are clickable and the PDF bookmarks panel lets you jump to any exercise set or question. Figures are reproduced from the NCERT textbook (© NCERT) for educational use.

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2.1

CLASS 9 SCIENCE · CHAPTER 2

In-text Questions

Solutions · 36 questions

Directions (Questions 1–36): These are the questions and activities that appear inside the chapter (Think It Over, Activities, Pause and Ponder, What if …, Threads of Curiosity and Ready to Go Beyond), numbered in the order in which they appear. Where an activity needs a practical result, the expected observation is given with the explanation; you may add your own observations.

QUESTION 1 *Think It Over · p. 8*

Where does a cell come from?

ANSWER

Every cell today comes from a pre-existing cell, but the very first cells arose in water, long ago, when life originated on the early Earth.

a Origin of the first cells

- It is widely accepted among scientists that **life originated in water**. Some researchers believe it may have begun in small water pools with changing environmental conditions rather than in the oceans.
- Hot springs are examples of such environments. The hot springs of **Puga Valley in Ladakh** stay at nearly the boiling point of water even in a cold climate. Their conditions seem similar to those on the early Earth about 3.5 billion years ago, and they are home to heat-loving, unicellular bacteria called **thermophiles**.
- Scientists of the Birbal Sahni Institute of Palaeosciences, Lucknow, found that **calcium carbonate** forms rapidly around these springs. Such deposits may have protected early organic molecules from harmful radiation and extreme conditions, and may have helped in forming the first protective **membrane**, the barrier that defines a cell.

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b Origin of cells today

In 1855, Rudolf Virchow stated that **new cells are formed only from pre-existing cells**. Cells grow and then divide to form new cells; this is how the cells of our body are replaced and how the body grows.

> **Therefore, the first cells arose in water, and every cell since then has arisen from a pre-existing cell.**

QUESTION 2 *Think It Over · p. 8*

How have technological interventions facilitated the creation of new knowledge in understanding the world beyond the naked eye?

ANSWER

The human eye cannot see anything smaller than about 0.1 mm. Tools such as microscopes extended our vision and revealed the structure of cells.

a Technologies and what they revealed

Technology	How it created new knowledge
Hooke's self-designed microscope (1665, about 200–300X)	Showed small box-like compartments in a thin slice of cork, which he named 'cells'.
Light microscope (e.g. 10X and 40X objective lenses)	Lets us see the structure of cells such as onion peel and cheek cells in school laboratories.
Electron microscope	Uses a beam of electrons instead of light and shows cell structure at the nanometre scale; it also confirmed the Golgi apparatus decades after its first observation.
Staining techniques	Stains such as safranin, methylene blue and aceto-carmine increase contrast so that parts of cells become visible.
Computer programming and DNA synthesis	In 2010 J. Craig Venter's team studied the DNA sequence of *Mycoplasma mycoides* on a computer and synthesised a copy of it, showing that DNA controls the structure and activities of a cell.
Cell culture	Growing cells outside the body helps in studying how cells work and in making medicines and vaccines.

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Over the years, scientists improved the microscope in three main features: **resolution** (clarity), **contrast** and **magnification**.

Therefore, better instruments and techniques have let us study cells, organelles and DNA that lie far beyond the unaided eye.

QUESTION 3 *Think It Over · p. 8*

How is the cell the structural and functional unit of life?

ANSWER

All living organisms are made of cells, and all life processes are carried out by cells. So the cell is both the building unit and the working unit of life.

a Structural unit

- Some organisms, such as bacteria and yeast, consist of only one cell (unicellular). Others, such as plants, fish, birds and humans, are made up of millions of cells (multicellular).
- Similar cells performing similar functions form **tissues**; tissues form **organs**; organs work together as **organ systems**. Even then, the cell remains the fundamental unit of structure.
- Every cell is bounded by a cell membrane and contains cytoplasm and genetic material (a nucleus in eukaryotic cells, a nucleoid in prokaryotic cells), along with organelles in eukaryotes.

b Functional unit

- Cells produce energy, synthesise and secrete substances, divide to form new cells and work together to maintain the proper functioning of the body.
- Each organelle does a specific job, so a cell works like a tiny living factory. Cells also exchange materials and respond to their surroundings through the cell membrane.

c Cell Theory

- All living organisms are made up of one or more cells.
- The cell is the basic unit of structure and function in living beings.
- All cells arise from pre-existing cells.

Therefore, the cell is the basic structural and functional unit of all living organisms.

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QUESTION 4 *Think It Over · p. 8*

How does a cell multiply?

ANSWER

A cell multiplies by cell division, in which a pre-existing cell forms new cells. There are two major types: mitosis and meiosis.

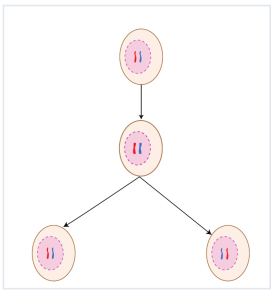

Fig. 2.18: Mitosis produces two genetically identical daughter cells

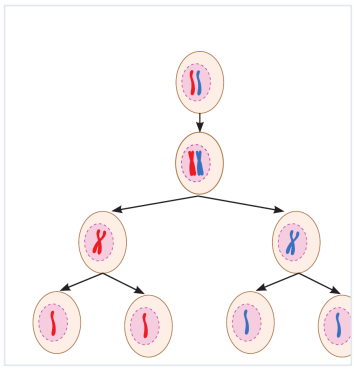

Fig. 2.19: Meiosis is a two-step process that produces four gametes

a Comparison of mitosis and meiosis

Point	Mitosis	Meiosis
Number of divisions	One	Two, one after the other
Daughter cells formed	Two, genetically identical to the parent cell	Four, with half the number of chromosomes
Where it occurs	Body cells (the most common type of cell division)	Only in cells of reproductive organs (testes, ovaries, anthers)
Importance	Normal growth, repair, maintenance and asexual reproduction	Sexual reproduction; produces gametes and creates genetic diversity

In eukaryotic cells, division takes place in an orderly, controlled way called the **cell cycle**. When gametes from two individuals fuse during fertilisation, the original chromosome number is restored.

Therefore, cells multiply by mitosis (two identical cells) and meiosis (four cells with half the chromosomes).

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QUESTION 5 *p. 9*

What do we call the ability of the human eye to see two very close objects as separate and distinct?

ANSWER

This ability is called the resolution of the eye. The smallest separation at which two points can still be seen as distinct is its limit of resolution, which is 0.1 mm for the human eye.

a Understanding the limit of resolution

- Imagine two tiny dots drawn on paper. As they are brought closer, a point comes when they can no longer be seen as separate.
- When viewed from about 25 cm (the near point of the human eye), two points about **0.1 mm** apart can be seen as distinct; if they are closer, they look like a single point.
- A cell is usually too small to be seen by the unaided eye (Fig. 2.1), so we need magnifying instruments to study it.

Therefore, the limit of resolution of the human eye is 0.1 mm.

QUESTION 6 *p. 9*

How have cell biologists studied the structure and function of cells that are much smaller than the limit of resolution of the human eye?

ANSWER

Cell biologists use instruments that magnify objects, mainly the light microscope and the electron microscope.

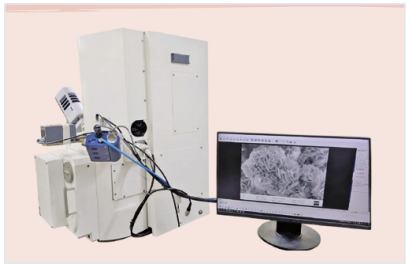

Fig. 2.3: An electron microscope

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a Magnifying instruments

- A **convex lens**, or a combination of lenses (an objective lens and an eyepiece), magnifies an object and makes it appear larger.
- In school laboratories, **light microscopes** use different objective lenses (for example 10X and 40X) to give better magnification and resolution under visible light.
- **Electron microscopes** use a beam of electrons instead of light and show cell structure at the nanometre scale (1 nm is one-billionth of a metre) with remarkable clarity.
- Improvements in resolution, contrast and magnification have made the microscope a powerful tool for studying cells.

Therefore, microscopes made it possible to see cells and their parts, which are smaller than 0.1 mm.

QUESTION 7 *p. 10*

Explore different parts of a microscope (Fig. 2.2) in your school laboratory and use it to observe fine structures of various materials. Under the microscope, you will see a magnified image of an object. Can you estimate its actual size?

ANSWER

Yes. The actual size can be estimated by comparing the object with a known length, as done in Activity 2.1 (next question). First learn the parts of the microscope.

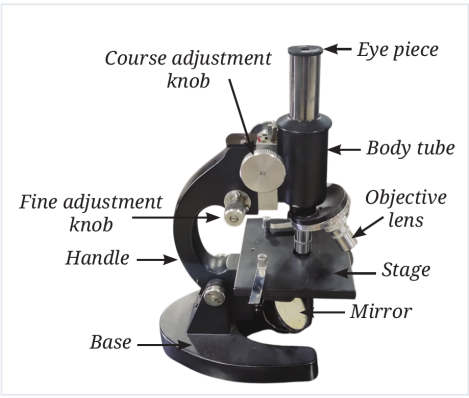

Fig. 2.2: Structure of a light microscope

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a Parts of a light microscope and their use

Part	Use
Eye piece	The lens through which we look; it magnifies the image formed by the objective lens
Body tube	Holds the eyepiece and the objective lens at the correct distance
Objective lens	Lens close to the object (e.g. 10X, 40X) that gives the first magnified image
Stage	Platform on which the slide is placed
Mirror	Directs light on to the slide
Coarse and fine adjustment knobs	Move the lens or stage to bring the object into focus; the fine knob gives a sharp image
Handle and base	Handle is used to hold the microscope; the base supports it

b Estimating the actual size

Measure the diameter of the field of view with a ruler, count the cells along that diameter, and divide: **size of one cell = diameter of the field of view ÷ number of cells along the diameter**.

> **Therefore, the actual size of an object seen under a microscope can be estimated from the field of view.**

QUESTION 8 *Activity 2.1 · p. 10*

Let us estimate the size of a cell.

ANSWER

Use a ruler to find the diameter of the field of view, then count the onion peel cells along that diameter and divide. The worked example in the chapter gives 200 µm.

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a Procedure and observations

1. Place a transparent ruler with millimetre markings on the stage, focus on it and measure the diameter of the circular field of view in mm.
2. Convert the diameter into micrometres using 1 mm = 1000 µm.
3. Replace the ruler with an onion peel slide, focus, and count the cells present along the diameter of the field in one straight line.
4. Calculate the size of the cell.

b Worked example from the chapter

Quantity	Value
Diameter of the visible field	5 mm = 5 × 1000 = 5000 µm
Number of cells along the diameter	25
Estimated size of an onion peel cell	**Diameter of field in µm ÷ number of cells = 5000 µm ÷ 25 = 200 µm**

Your own values will differ with the microscope and slide, but the method and formula remain the same.

Therefore, in the example, the onion peel cell is about 200 µm in size.

QUESTION 9 *p. 10*

If the estimated size of an onion peel cell is 200 µm, how much does a light microscope magnify this cell?

ANSWER

Total magnification = magnifying power of the eyepiece × magnifying power of the objective lens. With 10X and 10X it is 100X.

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a Calculation

- Eyepiece = 10X and objective lens = 10X.
- Total magnification = 10 × 10 = **100X**.
- So a cell of estimated size 200 µm appears **100 times larger**. With a 40X objective and a 10X eyepiece, the magnification would be 40 × 10 = 400X.

Therefore, the light microscope magnifies the cell 100 times (100X) in this case.

QUESTION 10 *p. 11*

How does the structure of the cell membrane in the cells of alveoli control the movement of substances across it?

ANSWER

The cell membrane is selectively permeable: its lipid bilayer with embedded proteins lets some substances pass and blocks others.

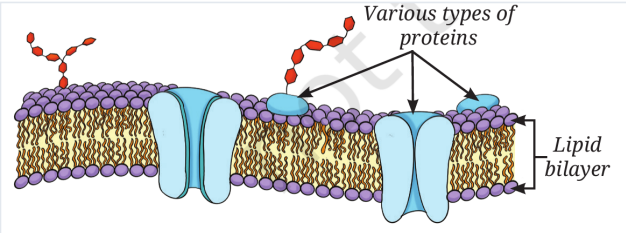

Fig. 2.7: Structure of a cell membrane

a Structure of the membrane

- The membrane is extremely thin (about 7 to 10 nm), so substances have only a very short distance to cross.
- It has a **lipid bilayer** (two layers of fat molecules with water-attracting heads outwards and water-repelling tails inwards) with **proteins** embedded in it (fluid-mosaic model).
- Proteins act like **gatekeepers** in helping substances pass through.

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b In the alveoli

Oxygen and carbon dioxide move across the membranes of alveolar cells by diffusion, from a region of higher concentration to a region of lower concentration. The thin, selectively permeable membrane lets these gases pass, while it controls and blocks the passage of other substances.

Therefore, the thin lipid bilayer with protein gatekeepers controls which substances cross the membrane of alveolar cells.

QUESTION 11 *Activity 2.2 · p. 11*

Let us experiment. Cut a potato into two equal pieces, weigh them, place one in plain water (Beaker A) and the other in 20 per cent salt or sugar solution (Beaker B) for about an hour, and weigh again. What do you observe? What do you infer? What do you expect in terms of changes in their weight?

ANSWER

The potato piece in Beaker A swells and gains weight; the piece in Beaker B shrinks and loses weight. This is due to osmosis.

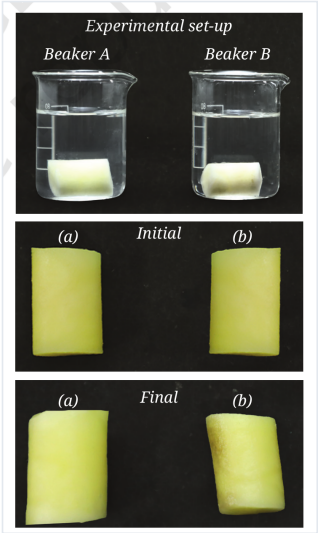

Fig. 2.5: Experimental set-up, and initial and final states of potato pieces in (a) plain water, and (b) 20 per cent salt solution

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a Observations

Beaker	Liquid	Observation	Change in weight
A	Plain water	Potato piece swells	Final weight is more than initial weight (increase)
B	20 per cent salt or sugar solution	Potato piece shrinks	Final weight is less than initial weight (decrease)

b Inference

- The cell membrane allows water to move in and out of the cell but not the salt or sugar molecules.
- Water moves from an area with more water and less solute (dilute solution) to an area with less water and more solute (concentrated solution) until concentrations become equal. This movement of water through a selectively permeable membrane is **osmosis**.
- In Beaker A, water enters the potato cells, so the piece swells. In Beaker B, water leaves the cells, so the piece shrinks.

Therefore, a potato piece gains weight in plain water and loses weight in concentrated solution because of osmosis.

QUESTION 12 *What if ... · p. 12*

What if mung bean seeds are kept in a concentrated solution after soaking in water for 12 hours? What will happen to them?

ANSWER

The seeds will lose water and shrink (shrivel), because water moves out of the swollen seed cells by osmosis.

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a **Reasoning**

- After soaking in water for 12 hours, the seeds are swollen because their cells have taken in water.
- A concentrated solution has more solute and less water than the inside of the seed cells, so the solution is **hypertonic** to them.
- Water moves out of the cells through their selectively permeable membranes, from the region of less solute to the region of more solute, until the concentrations become equal. The seeds therefore shrink and become wrinkled.

Therefore, mung bean seeds placed in a concentrated solution will shrink as they lose water.

QUESTION 13 *What if ... · p. 12*

What if a cell is kept in salt or sugar solutions of different concentrations?

ANSWER

The effect depends on whether the solution outside is isotonic, hypotonic or hypertonic compared with the cell's contents.

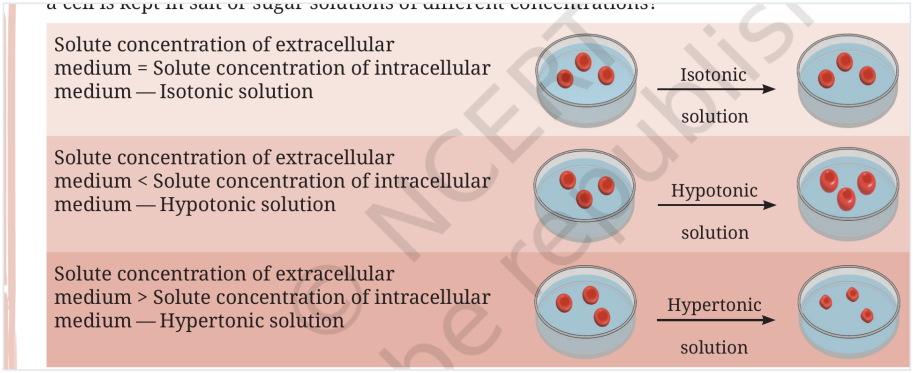

Fig. 2.6: Effect of solutions of different concentrations on a cell

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a Three possibilities

Solution	Solute concentration outside	Movement of water	Effect on the cell
Isotonic	Equal to that inside the cell	No net movement	Cell remains the same size
Hypotonic	Less than that inside the cell	Water moves into the cell	Cell swells
Hypertonic	More than that inside the cell	Water moves out of the cell	Cell shrinks

A plant cell has a rigid cell wall, so in a hypotonic solution it does not burst, and in a hypertonic solution the cell membrane pulls away from the cell wall while the outer shape stays the same.

Therefore, a cell swells in a hypotonic solution, shrinks in a hypertonic solution and stays unchanged in an isotonic solution.

QUESTION 14 *p. 13*

What do you think is the necessity of the cell wall in plant, fungi and bacterial cells?

ANSWER

The cell wall is an additional layer outside the cell membrane that gives shape, support and protection to these cells.

a Why the cell wall is needed

- Plants cannot move from place to place, so they need a rigid structure to withstand environmental stresses like wind and rain.
- It helps leaves and flowers remain firm, helps plants maintain their shape and stay upright.
- Although rigid, the wall is **permeable**: water and some dissolved minerals pass through it, which helps roots absorb water and nutrients.
- It keeps the shape of a plant cell even when water is lost by osmosis.
- In fungi and bacteria the cell wall provides protection and structural support. The plant cell wall is mainly made of **cellulose**.

Therefore, the cell wall gives rigidity, shape and protection to plant, fungal and bacterial cells.

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QUESTION 15 *Activity 2.3 · p. 13*

Let us investigate. Prepare slides of an onion (or *Rhoeo*) leaf peel and of cheek cells and observe them. Why do you think the shape and arrangement differ? Then put 20 per cent sugar solution on both and observe after half an hour.

ANSWER

Onion peel (or Rhoeo) cells are box-shaped and regularly arranged, whereas cheek cells are irregularly arranged. In sugar solution, plant cell contents shrink inside an unchanged outline, while cheek cells shrink considerably.

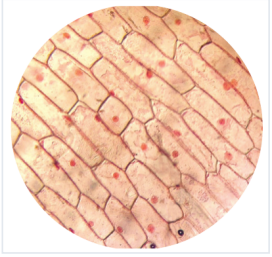

Fig. 2.8(a): Onion peel cells

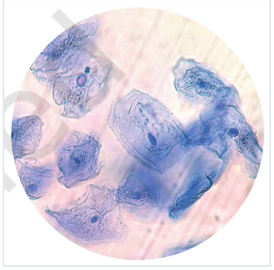

Fig. 2.8(b): Human cheek cells

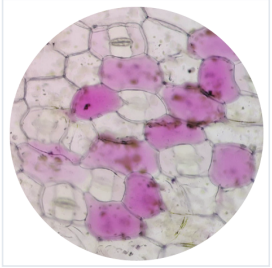

Fig. 2.9(a): Cradle lily leaf peel cells in water

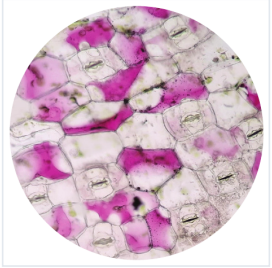

Fig. 2.9(b): Cradle lily leaf peel cells in 20 per cent sugar solution

a Why the shapes differ

Plant cells have a rigid **cell wall** outside the cell membrane, which gives them a fixed box-like shape and a regular arrangement. Animal cells such as cheek cells have no cell wall, so they are flexible and irregularly arranged.

b In 20 per cent sugar solution

- **Plant cells:** they lose water by osmosis. The boundaries (cell wall) remain the same, but the inner content shrinks as the cell membrane pulls away from the wall, so the space between the inner and outer boundaries increases (Fig. 2.9a and b).
- **Cheek cells:** having no cell wall, they lose water and shrink considerably.

Therefore, the cell wall keeps the shape of plant cells, while animal cells without it change shape and shrink.

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QUESTION 16 *Pause and Ponder 1 · p. 14*

What argument would you give for the necessity of a cell wall in plants usually fixed in one place versus in animals usually moving from one place to the other?

ANSWER

Plants stay fixed in one place and must bear wind and rain, so they need a rigid cell wall; animals move, so they need flexible cells.

Point	Plants (usually fixed)	Animals (usually moving)
Environmental stress	Cannot move away from wind or rain, so need a strong, rigid structure	Can move away from harsh conditions
Cell covering	Cell wall outside the cell membrane	No cell wall; only a cell membrane
Role	Keeps leaves and flowers firm, maintains shape and keeps the plant upright	Flexible cells can change shape, which supports movement and functioning of tissues

Therefore, a rigid cell wall suits fixed plants, while flexible cells suit moving animals.

QUESTION 17 *Pause and Ponder 2 · p. 14*

What consequences would you predict for a plant cell if its cell wall were to become as flexible as a cell membrane?

ANSWER

The plant cell would lose its fixed shape and firmness, and the plant would be unable to stay upright.

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- The cell could no longer keep its shape or resist wind and rain, so leaves and flowers would droop.
- Plant parts would not remain firm and upright.
- The cell could change shape or shrink freely when water is lost by osmosis, since there would be no rigid wall to hold the outline.

Therefore, a flexible wall would make plants limp and unable to support themselves.

QUESTION 18 *Pause and Ponder 3 · p. 14*

Why is it important to cut the two potato pieces in roughly equal size and measure their initial weight before placing them in different liquids?

ANSWER

It makes the experiment a fair comparison, so that any change in the pieces is due only to the liquid they are placed in.

- Pieces of equal size start under the same conditions, so differences in the final result can be attributed only to plain water versus salt or sugar solution.
- The **initial weight** is needed to calculate the change: difference = final weight − initial weight. Without it we could not tell whether a piece gained or lost water.

Therefore, equal size and the initial weight keep the test fair and allow the change to be measured.

QUESTION 19 *Activity 2.4 · pp. 14–15*

Let us study. Study the diagrams of a bacterial cell, a plant cell and an animal cell (Fig. 2.10a, b and c), observe the different structures present in each of them, and record your observations in Table 2.1.

ANSWER

Table 2.1 completed from Fig. 2.10. The bacterial cell is prokaryotic; the plant and animal cells are eukaryotic.

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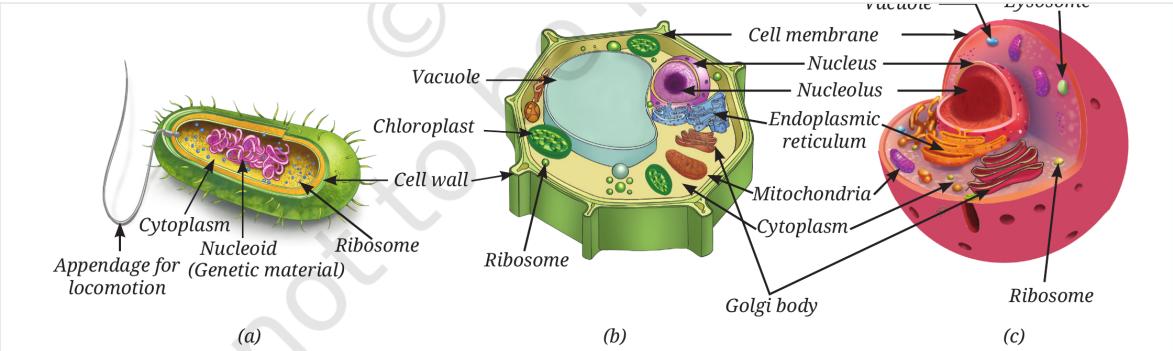

Fig. 2.10: (a) A typical bacterial cell, (b) a typical plant cell, and (c) a typical animal cell

a Table 2.1 completed

S. No.	Cell structures	Bacterial cell	Plant cell	Animal cell
1.	Cell membrane	Present	Present	Present
2.	Cell wall	Present	Present	Absent
3.	Cytoplasm	Present	Present	Present
4.	Well-defined nucleus (genetic material enclosed by a membrane)	Absent	Present	Present
5.	Primitive nucleus or nucleoid (genetic material without membrane around it)	Present	Absent	Absent
6.	Membrane-bound organelles	Absent	Present	Present

Therefore, all cells have a membrane and cytoplasm; the cell wall is absent only in animal cells.

QUESTION 20 *p. 15*

Which of the cells given in Fig. 2.10 fall under the categories of prokaryotic and eukaryotic cells?

ANSWER

The bacterial cell (Fig. 2.10a) is prokaryotic. The plant cell (Fig. 2.10b) and the animal cell (Fig. 2.10c) are eukaryotic.

Cell	Category	Reason
(a) Bacterial cell	Prokaryotic	No well-defined nucleus; genetic material lies in the nucleoid; no membrane-bound organelles

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Cell	Category	Reason
(b) Plant cell	Eukaryotic	Well-defined nucleus and several membrane-bound organelles
(c) Animal cell	Eukaryotic	Well-defined nucleus and several membrane-bound organelles

Pro means primitive and *eu* means true; *karyon* means nucleus. Prokaryotic cells are usually 1 to 10 µm and usually unicellular, whereas eukaryotic cells are 10 to 100 µm and can be unicellular or multicellular.

Therefore, bacterial cells are prokaryotic, while plant and animal cells are eukaryotic.

QUESTION 21 *p. 16*

Why do eukaryotic cells need these organelles?

ANSWER

Eukaryotic cells carry out various life processes at the same time, so organelles let each process go on independently in its own compartment.

a Work divided among organelles

Organelle	Function
Nucleus	House of coded instructions: contains chromosomes with DNA (genes)
Ribosomes	Sites of protein synthesis, the protein factories
Endoplasmic reticulum	Synthesis and transport of proteins, fats (lipids) and some hormones
Golgi apparatus	Modifies, sorts and packages proteins and lipids into vesicles
Lysosomes	Break down unwanted material and damaged parts; the clean-up system
Mitochondria	Release energy from glucose and store it as ATP; the powerhouse of the cell
Plastids (plants)	Food synthesis and storage
Vacuoles	Storage of water, minerals, sugars and wastes; support

Therefore, organelles help in building new materials, removing waste and providing energy, so a cell works like a tiny living factory.

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QUESTION 22 *Threads of Curiosity · p. 16*

Do you know any other cells without a nucleus?

ANSWER

Yes. Besides mature red blood cells, prokaryotic cells have no well-defined nucleus, and some specialised plant cells lose their nucleus at maturity.

- **Mature red blood cells (RBCs)** of humans are enucleate; the absence of a nucleus gives more space for haemoglobin, but they cannot repair or divide and live for about 120 days.
- **Bacterial cells** do not have a well-defined nucleus. Their DNA lies in a region called the nucleoid.
- **Sieve tube cells** of the phloem in flowering plants lose their nucleus when mature.

Therefore, cells without a well-defined or any nucleus include mature RBCs and bacterial cells.

QUESTION 23 *p. 17*

Cells produce waste materials and damaged, worn-out organelles during their activities. How does the cell prevent these wastes from accumulating inside it?

ANSWER

Lysosomes clean the cell by breaking down wastes and damaged parts with their enzymes.

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- Lysosomes are single membrane-bound sacs filled with **enzymes**.
- The enzymes break down unwanted proteins, carbohydrates, fats and even damaged parts of the cell, keeping it clean and healthy.
- The products formed by the breakdown are released into the cytoplasm, where they may be reused in other cellular processes.
- Lysosomal enzymes of sperm cells also help break down the outer layer of the egg during fertilisation.

Therefore, lysosomes act as the clean-up system of the cell.

QUESTION 24 *p. 18*

Where do plants synthesise their food and obtain energy for cellular activities?

ANSWER

Plants make food in plastids called chloroplasts and release energy from that food in mitochondria.

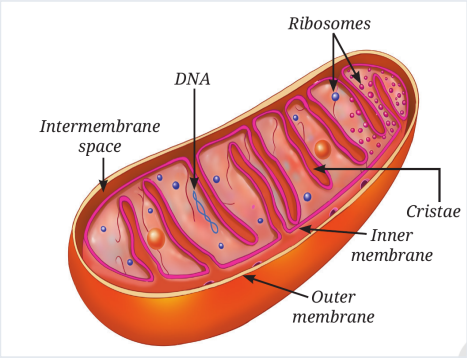


Fig. 2.14: Structure of a mitochondrion

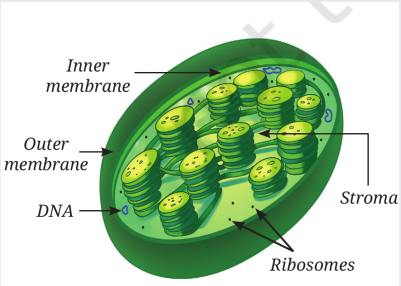


Fig. 2.15: Structure of a chloroplast

a Food synthesis

Plants use special organelles called **plastids** for food synthesis and storage. Green pigment **chlorophyll** in the **chloroplast** absorbs sunlight; sugars made by photosynthesis are stored in the stroma along with starch granules.

NCERT ARCHIVE

b Energy for cellular activities

In **mitochondria**, glucose and other molecules are broken down in cellular respiration to release energy, which is stored as **ATP** and used for most cellular activities.

Therefore, chloroplasts make the food, and mitochondria release energy from it for the cell.

QUESTION 25 *p. 19*

Are there any other plastids in plant cells that contain pigments other than the green pigments? How do flowers, fruits and vegetables acquire varied colours?

ANSWER

Yes. Chromoplasts contain yellow, orange or red pigments and give bright colours to flowers and fruits; colourless plastids called leucoplasts store food.

Plastid	Pigment	Role and example
Chloroplast	Green chlorophyll	Photosynthesis in green parts such as leaves
Chromoplast	Pigments other than chlorophyll (yellow, orange, red)	Bright colours of flower petals and fruits; the colours attract pollinators and fruit-eating animals that help in seed dispersal
Leucoplast	No pigment (colourless)	Store food such as starch, oils or proteins, e.g. starch in potato and taro (*Colocasia*) cells

Therefore, chromoplasts give flowers and fruits their varied colours.

QUESTION 26 *p. 19*

Where are water, minerals and waste materials stored in the cell? Why do plants look wilted when they do not get enough water?

ANSWER

They are stored in vacuoles. Plants wilt when the large central vacuole loses water.

NCERT ARCHIVE

a Vacuoles

- A mature plant cell usually has one **large central vacuole**, surrounded by a single selectively permeable membrane and filled with **cell sap**.
- It stores water, minerals, sugars and waste materials. Animal cells sometimes have smaller vacuoles for temporary storage.

b Wilting

The vacuole stores water and so maintains pressure inside the cell, which keeps the plant cell firm. When the plant does not get enough water, the vacuole loses water, the cells become less firm and the plant wilts.

Therefore, vacuoles store materials and keep cells firm; loss of water from them makes plants wilt.

QUESTION 27 *Pause and Ponder 4 · p. 19*

Do white flowers contain any pigment? Give reasons.

ANSWER

White flowers do not contain a coloured pigment; their plastids are colourless.

- The bright colours of flowers come from the yellow, orange or red pigments of **chromoplasts**.
- White petals have colourless plastids (leucoplasts) instead of chromoplasts, so no coloured pigment absorbs visible light and they appear white.

Therefore, white flowers lack coloured pigments.

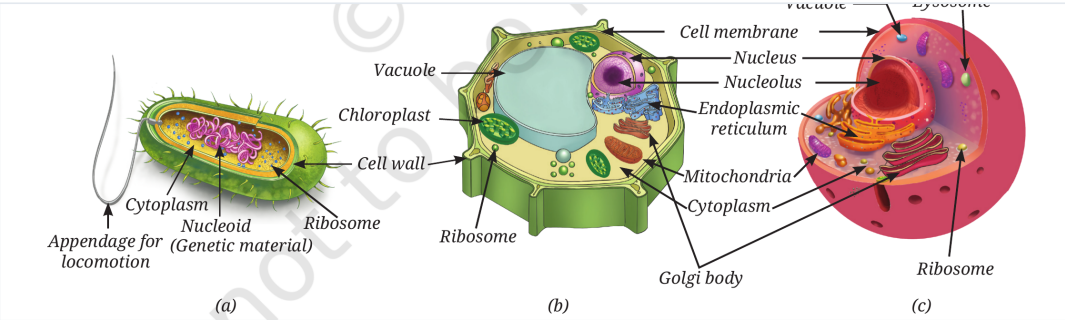
NCERT ARCHIVE

QUESTION 28 *Pause and Ponder 5 · p. 19*

Draw a well-labelled schematic diagram of a plant or an animal cell using these clues: (i) Nucleus appears as a dark and round body inside the cell. (ii) ER spreads like a network of extended nuclear envelope. (iii) Mitochondria and chloroplasts are rod shaped. You may refer to Fig. 2.10.

ANSWER

Draw the cell outline first, then add the parts as per the clues. Fig. 2.10b (plant) and 2.10c (animal) show the expected result.



Refer to Fig. 2.10(b) plant cell and (c) animal cell

a Steps to draw a plant cell

1. Draw a rectangular outline for the **cell wall** and a thin line just inside it for the **cell membrane**.
2. Draw a dark, round **nucleus** with a small **nucleolus** inside it.
3. Draw the **ER** as a network of folded tubes spreading out from the nuclear envelope.
4. Add rod-shaped **mitochondria** and **chloroplasts**, a **Golgi apparatus** (stack of flattened sacs), **ribosomes** (dots) and a large central **vacuole**.
5. Label all parts with straight lines. For an animal cell, omit the cell wall, chloroplasts and large vacuole, and add lysosomes.

Therefore, a labelled diagram should show the cell outline, nucleus, ER, Golgi apparatus, mitochondria and, in a plant cell, the chloroplasts and vacuole.

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QUESTION 29 *Activity 2.5 · pp. 20–21*

Let us enhance our skills. Study freshly growing root tips of onion. What do you observe? Do you observe the cells of the onion root tip? Are they similar in structure? Do you find any structural differences in these cells? If yes, why is it so?

ANSWER

The root tip cells are not all alike. They show different structures because the cells of a growing root tip divide continuously and are at different stages of cell division.

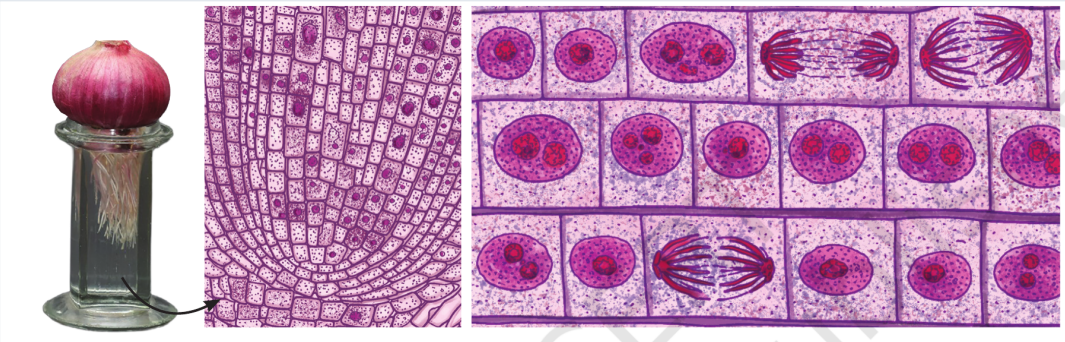

Fig. 2.17: Different stages of cell division in onion root tip cells

a Steps and their purpose

Step	Purpose
Grow roots of an onion bulb in water for 5–6 days	Obtain freshly growing root tips
Place 2–3 cm root tips in aceto-alcohol for 24 hours, then in 70 per cent ethanol	Preservation of the root tips
Put a drop of dilute HCl for 10–15 minutes	Softens the tissue
Add 2–3 drops of aceto-carmine and warm gently	Stains the cells so that structures are visible
Cut the tip, add a coverslip and gently squash it	Spreads the cells on the slide for observation

b Observation

Under the microscope the cells look different from one another: they exhibit different structures corresponding to different stages of **cell division**.

Therefore, differences among root tip cells are due to continuous cell division at different stages.

NCERT ARCHIVE

QUESTION 30 *p. 21*

Can you identify which stage comes first during cell division?

ANSWER

The stage in which the cell has an intact round nucleus and chromosomes are not yet visible as rods comes first, before division begins.

- In a non-dividing cell, the DNA is present as chromatin, seen as an entangled mass of thread-like structures inside the nucleus.
- When the cell is about to divide, the chromatin organises itself into rod-shaped **chromosomes**, which become visible. So the cells with an intact nucleus come first and those with visible chromosomes come later in Fig. 2.17.
- The chapter notes that the detailed stages of cell division will be learnt in higher grades.

Therefore, the cell with an undivided nucleus and no visible chromosomes is the first stage.

QUESTION 31 *Pause and Ponder 6 · p. 22*

Instead of many small ones, why does a cell not have a single giant mitochondrion? How does this relate to the concept of surface area?

ANSWER

Many small mitochondria give a much larger total surface area for their volume than one giant mitochondrion would.

- Energy production takes place on the folded **inner membrane** (cristae), so more membrane surface means more energy production.
- For the same total volume, many small structures have a larger total surface area than one big one, so more materials can be exchanged and more reactions can occur.
- Small mitochondria can also be spread through the cytoplasm, close to the places that need energy.

Therefore, many small mitochondria provide a greater surface area for energy production than a single giant one.

NCERT ARCHIVE

QUESTION 32 *Pause and Ponder 7 · p. 22*

If the skin cells start dividing by meiosis instead of mitosis, what do you think will happen to a cut on the skin?

ANSWER

The cut would not heal properly, because meiosis does not produce identical, fully functional skin cells.

- Healing needs new skin cells identical to the old ones, which **mitosis** provides (two identical daughter cells with the same number of chromosomes).
- Meiosis gives four cells with **half** the number of chromosomes, which cannot work as normal skin cells.
- So the damaged tissue would not be replaced properly.

Therefore, skin cells must divide by mitosis for a cut to heal.

QUESTION 33 *p. 22*

What happens if meiosis and mitosis do not happen properly?

ANSWER

Any error in these processes can lead to various problems in the body of an organism.

Process	Result of errors
Mitosis	Uncontrolled cell divisions, leading to the formation of tumours, and an abnormal number of chromosomes in body cells
Meiosis	Genetic disorders, which may be associated with developmental problems or distinctive physical features; also early pregnancy loss or reduced fertility

Therefore, mitosis and meiosis must occur in a proper and controlled manner.

NCERT ARCHIVE

QUESTION 34 *p. 23*

Do cells grow and reproduce forever? (Do cells live forever, or do they die?)

ANSWER

No. Every cell has a definite life span; cells grow and divide in a controlled way and eventually die when they are no longer needed.

- Dead cells are replaced by new cells that carry out the same function. If cells do not die when they should, or die too early, problems arise in the body.
- Every day an estimated hundreds of billions of cells in our body are replaced, almost 1 per cent of the total.
- In many animal cells, division usually stops when cells come in contact with neighbouring cells; this is **contact inhibition**. Cancer cells lose this control and keep dividing uncontrollably, forming **tumours**.
- Plant cells do not show contact inhibition because of their rigid cell walls and follow a different pattern of growth.

Therefore, cells do not live forever; they grow, divide, function and die in a controlled way.

QUESTION 35 *Ready to Go Beyond · p. 23*

How do cells monitor their growth to maintain a balance? Explore different ways by which cells maintain themselves.

ANSWER

Cells keep a balance by controlled growth and division, contact inhibition and programmed cell death.

NCERT ARCHIVE

- **Controlled division and definite life span:** cells grow and divide in a controlled way, stay in the right place, carry out their functions and die when no longer needed.
- **Contact inhibition:** division stops in many animal cells when they touch neighbouring cells.
- **Programmed Cell Death (PCD):** a genetically regulated, organised process of selective cell destruction, essential for normal development, cellular quality control and immune function. For example, PCD removes cells between the digits of an embryo to form fingers; without it we would have webbed hands.
- **Cleaning up:** lysosomes break down damaged parts of the cell.

Therefore, controlled division, contact inhibition and programmed cell death keep cell numbers in balance.

QUESTION 36 *Threads of Curiosity · p. 23*

How do cancer cells grow and spread?

ANSWER

Cancer cells grow and divide uncontrollably, form tumours, and can invade nearby tissues and spread to other parts of the body.

- Normal cells grow, age and die in a controlled manner. Sometimes this system breaks down and abnormal cells start growing and dividing uncontrollably.
- This results in tumours, which may be **benign** or **malignant**.
- Cancerous tumours can invade nearby tissues and even spread to other parts of the body to form new tumours.

Therefore, cancer is the result of cells that lose control over their growth and division.

NCERT ARCHIVE

2.2

CLASS 9 SCIENCE · CHAPTER 2

Revise, Reflect, Refine

Solutions · 16 questions

Directions (Questions 1–16): These are the questions of Revise, Reflect, Refine at the end of the chapter (pages 24–27). Each question is reproduced in full and answered step by step; the correct option is given where options are provided.

QUESTION 1

Differentiate between the following pairs of terms based on the clues given in parentheses: (i) Cell membrane and cell wall (permeability) (ii) RER and SER (structure) (iii) Chloroplasts and chromoplasts (pigments)

ANSWER

Each pair is compared below on the clue given in the question.

a Cell membrane and cell wall (permeability)

Cell membrane	Cell wall
Selectively permeable: allows some substances to pass while blocking others	Permeable: water and some dissolved minerals pass through it freely, although it is rigid

b RER and SER (structure)

Rough ER (RER)	Smooth ER (SER)
Has ribosomes attached to its surface, so it looks rough under an electron microscope	Has no ribosomes on its surface, so it looks smooth
Mainly involved in protein synthesis and secretion	Involved in synthesis and storage of fats and hormones

NCERT ARCHIVE

c Chloroplasts and chromoplasts (pigments)

Chloroplasts	Chromoplasts
Contain the green pigment chlorophyll; take part in photosynthesis	Contain pigments other than chlorophyll (yellow, orange or red); give bright colours to flowers and fruits

Therefore, the pairs differ in permeability, in presence of ribosomes, and in the type of pigment.

QUESTION 2

Two similar animal cells are placed in two different solutions: Cell X is placed in pure water. Cell Y is placed in a concentrated salt solution. Cells are observed after some time. Cell X swells, and Cell Y shrinks. Which statement provides the correct explanation for the above observations? (i) Salt molecules moved into Cell Y, causing it to shrink. (ii) Water moved into Cell X and more water moved out of Cell Y than the salt solution entered in it. (iii) Water moved into Cell X and moved out of Cell Y through the cell membrane. (iv) Solute movement caused osmosis in both cells.

ANSWER

The correct answer is option (iii): water moved into Cell X and moved out of Cell Y through the cell membrane.

a Reasoning

- Pure water is **hypotonic** to Cell X, so water moves into it by osmosis and it swells.
- A concentrated salt solution is **hypertonic** to Cell Y, so water moves out of it through the cell membrane and it shrinks.

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b Why the other options are wrong

- (i) The membrane does not allow salt molecules to enter, so shrinking is not caused by salt moving in.
- (ii) This also assumes that salt solution entered Cell Y, which does not happen.
- (iv) Osmosis is the movement of **water** across a selectively permeable membrane, not movement of solute.

Therefore, the correct option is (iii).

QUESTION 3

Look at the diagram of a cell in Fig. 2.20. Identify the parts labelled from (a) to (g) and correctly match them with their functions given below: (i) Controlling all the activities of a cell. (ii) Site of cellular respiration. (iii) Storage organelle that also provides rigidity to the cell. (iv) Separates the cell contents from surroundings. (v) Provides structural rigidity to the cell. (vi) Packs and stores materials received from ER. (vii) Helps in manufacturing food.

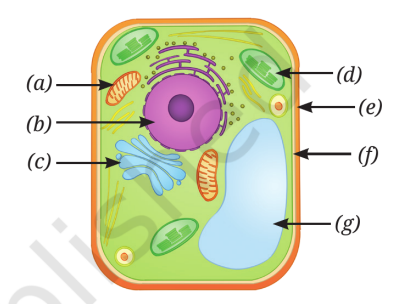

Fig. 2.20

ANSWER

Fig. 2.20 shows a plant cell. Each label is identified and matched with its function below.

Label	Part	Function
(a)	Mitochondrion	(ii) Site of cellular respiration
(b)	Nucleus	(i) Controlling all the activities of a cell
(c)	Golgi apparatus	(vi) Packs and stores materials received from ER
(d)	Chloroplast	(vii) Helps in manufacturing food

NCERT ARCHIVE

Label	Part	Function
(e)	Cell wall	(v) Provides structural rigidity to the cell
(f)	Cell membrane	(iv) Separates the cell contents from surroundings
(g)	Vacuole	(iii) Storage organelle that also provides rigidity to the cell

The vacuole stores water and keeps the cell firm by maintaining pressure inside it, while the cell wall lies outside the cell membrane and gives rigidity to the cell.

Therefore, (a) mitochondrion, (b) nucleus, (c) Golgi apparatus, (d) chloroplast, (e) cell wall, (f) cell membrane and (g) vacuole.

QUESTION 4

Which of the following option(s) of the pairs of cell organelles are correctly placed under the given categories? (Table: Option | Present in the plant cells | Absent in the animal cells)

ANSWER

Only option (i) is correct.

Option	Present in plant cells	Absent in animal cells	Verdict
(i)	Leucoplast: present in plant cells	Cell wall: absent in animal cells	**Correct**
(ii)	Mitochondria: present in plant cells	Ribosome: present in animal cells too	Incorrect
(iii)	Cell wall: present in plant cells	Golgi apparatus: present in animal cells too	Incorrect
(iv)	Lysosome: shown in the animal cell in Fig. 2.10	Endoplasmic reticulum: present in animal cells too	Incorrect

Therefore, only option (i) places both organelles correctly.

NCERT ARCHIVE

QUESTION 5

Two students, Renu and Rohit, were having a discussion on the plastids. Renu emphasised that all parts of the plants, even roots, contain plastids. However, Rohit did not agree with the statement and told her that plastids are absent in plant roots since the roots are underground and do not need to perform photosynthesis. Who is correct? Justify your answer.

ANSWER

Renu is correct. Plastids are present in the cells of all parts of a plant, including roots, although root cells do not contain chloroplasts.

a **Justification**

- Plastids are not only for photosynthesis. **Leucoplasts** are colourless plastids that store food such as starch, oils or proteins; for example, some leucoplasts in potato and taro cells store starch. Root cells have such plastids.
- **Chromoplasts** give colour to some plant parts, so plastids can be present in other coloured parts too.
- Rohit is right only in saying that roots do not perform photosynthesis, so they have no chlorophyll-bearing chloroplasts; but this does not mean plastids are absent.

Therefore, Renu is correct: plastids, such as leucoplasts, are present in roots too.

QUESTION 6

Mitochondria and chloroplasts are two important organelles in a plant cell. Discuss how these two organelles are structurally and functionally similar to each other, and different from each other.

ANSWER

Both are double-membrane-bound organelles that convert energy and have their own DNA, but they do different jobs.

NCERT ARCHIVE

a Similarities

- Both are surrounded by **two membranes** (an outer and an inner membrane).
- Both have their own **DNA and ribosomes**, so they can make some of their own proteins; this suggests a shared evolutionary history with certain single-celled bacteria.
- Both are involved in energy changes of the cell.

b Differences

Point	Mitochondria	Chloroplasts
Found in	Plant and animal cells	Plant cells (green parts)
Inner structure	Inner membrane folded into cristae	Semi-fluid stroma with disc-shaped membrane structures containing chlorophyll
Pigment	No pigment	Green pigment chlorophyll
Function	Cellular respiration: break down glucose to release energy stored as ATP	Photosynthesis: absorb light energy and synthesise food (sugars, starch)

Therefore, they are similar in structure and origin but differ in the function: energy release versus food synthesis.

QUESTION 7

Which of the following pairs of cell organelles contains DNA? (i) Chloroplasts, Ribosomes (ii) Mitochondria, Nucleus (iii) Golgi bodies, Ribosomes (iv) Nucleus, Lysosomes

ANSWER

The correct answer is option (ii): Mitochondria and Nucleus.

- The nucleus contains chromosomes made of DNA and proteins.
- Mitochondria (like plastids) have their own DNA and ribosomes.
- Ribosomes, Golgi bodies and lysosomes do not contain DNA, so options (i), (iii) and (iv) are wrong; chloroplasts do have DNA but ribosomes do not.

Therefore, option (ii), mitochondria and nucleus, is correct.

NCERT ARCHIVE

QUESTION 8

A researcher carried out an experiment in which she took two carrots of similar size. She placed one carrot in plain water and the other carrot in concentrated salt solution (Fig. 2.21). After 24 hours she recorded her observations. (i) What hypothesis does she want to test through this experiment? (ii) What would you suggest for the improvement of this experiment? (iii) Why does the carrot in plain water stay stiff and crunchy, but the carrot in concentrated salt solution become rubbery and limp?

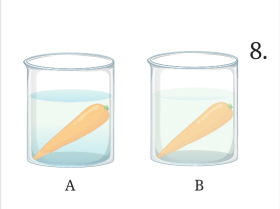

Fig. 2.21: Experimental set-up having carrot (a) in plain water, and (b) in salt solution

ANSWER

The experiment tests how the concentration of the surrounding solution affects the movement of water in and out of carrot cells.

a Hypothesis

Carrot cells gain water by osmosis when placed in plain water and lose water when placed in a concentrated salt solution; that is, the direction of water movement depends on the concentration of the surrounding solution.

b Improvements

- Measure the initial and final **weight** (or length) of each carrot so that the change is recorded in numbers, not only by feel.
- Use several carrots of the same size for each solution and take an average (repeat the experiment).
- Keep the volume of liquid, temperature and time the same, and try different salt concentrations to find the one at which the carrot does not change.

NCERT ARCHIVE

c Explanation

- In plain water (hypotonic) water enters the carrot cells by osmosis; the cells become firm and the cell wall prevents bursting, so the carrot stays stiff and crunchy.
- In concentrated salt solution (hypertonic) water leaves the cells through the cell membrane, the cells lose firmness, and the carrot becomes rubbery and limp.

Therefore, osmosis makes the carrot firm in water and limp in concentrated salt solution.

QUESTION 9

Indicate the presence or absence of the following structures in bacterial and animal cells: Chromosome, Nucleus, Mitochondria, Golgi complex, Chromoplasts.

ANSWER

The bacterial cell is prokaryotic and the animal cell is eukaryotic, which decides the entries below.

Structures in a cell	Bacterial cell	Animal cell
Chromosome	Present (single circular DNA molecule in the nucleoid)	Present (in the nucleus)
Nucleus	Absent (only a nucleoid)	Present
Mitochondria	Absent	Present
Golgi complex	Absent	Present
Chromoplasts	Absent	Absent

Therefore, bacterial cells lack a nucleus, mitochondria and Golgi complex, and animal cells lack chromoplasts.

NCERT ARCHIVE

QUESTION 10

Carry out the following experiment: Take four peeled potato halves and scoop each one out to make potato cups. One of these potato cups should be made from a boiled potato. Place each of the potato cups in a beaker containing water (Fig. 2.22). Now, set up the experiment as follows: (a) Keep Cup A empty. (b) Add one teaspoon sugar in Cup B. (c) Add one teaspoon salt in Cup C. (d) Add one teaspoon sugar in the boiled potato in Cup D. Observe the four potato cups at least two hours and answer: (i) Explain why water gathers in the hollowed portion of Cup B and Cup C. (ii) Why is Cup A necessary for this experiment? (iii) Explain why water does not gather in the hollowed portions of Cups A and D.

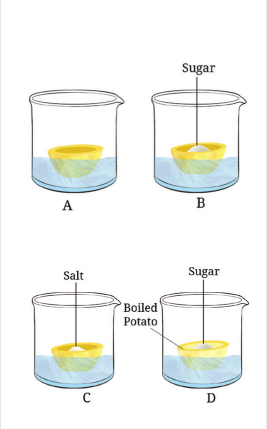

Fig. 2.22: Experimental set-up

ANSWER

Water gathers in Cups B and C by osmosis, but not in Cups A and D.

a Observations

Cup	Contents	Water in the hollow?
A	Empty (fresh potato)	No
B	Sugar (fresh potato)	Yes
C	Salt (fresh potato)	Yes
D	Sugar (boiled potato)	No

NCERT ARCHIVE

b (i) Water in Cups B and C

The hollow contains concentrated sugar or salt, while the water in the beaker is dilute. Water moves through the selectively permeable membranes of the living potato cells from the beaker, which has more water, into the hollow, which has less water and more solute. This is **osmosis**, so water collects in the hollow.

c (ii) Need for Cup A

Cup A is the **control**. It shows that water does not gather in a cup by itself, so the water in Cups B and C is due to the sugar or salt.

d (iii) No water in Cups A and D

- Cup A has no solute, so there is no concentration difference and no net movement of water into the hollow.
- Cup D is made of boiled potato; boiling kills the cells and destroys the selectively permeable membrane, so osmosis cannot take place.

Therefore, water collects only where living cells with selectively permeable membranes face a concentrated solute.

QUESTION 11

Identify the pair that incorrectly matches the cell organelle with its function. (i) Ribosome — Protein synthesis (ii) SER — Lipid and cellulose synthesis (iii) Lysosome — Digestion of foreign agents

ANSWER

The incorrect pair is (ii): SER — Lipid and cellulose synthesis.

- Smooth ER is involved in the **synthesis and storage of fats (lipids) and hormones**; it is not the organelle that makes cellulose.
- (i) Ribosomes are the sites of protein synthesis, so this pair is correct.
- (iii) Lysosomes are sacs of enzymes that break down unwanted material, so this pair is correctly matched.

Therefore, pair (ii) is incorrect.

NCERT ARCHIVE

QUESTION 12

What outcome do you expect, if all the mitochondria are removed from a eukaryotic cell?

ANSWER

The cell would run short of energy and could not survive for long.

- Mitochondria release energy from glucose in cellular respiration and store it as **ATP**, which is used for most cellular activities.
- Without them, ATP supply would fall sharply, so energy-requiring activities such as synthesis of substances, transport and cell division would slow down or stop.
- The cell would become weak and eventually die.

Therefore, removing all mitochondria would cut the energy supply and the cell would die.

QUESTION 13

Which phenomenon inhibits the formation of tumors in the human body? Can plants also develop tumors? Explain.

ANSWER

Contact inhibition checks tumour formation in animal cells. Plants can also develop tumours.

a Contact inhibition

In many animal cells, cell division usually stops when cells come in contact with neighbouring cells. This is **contact inhibition**. Cancer cells lose this control, keep dividing uncontrollably and form tumours.

NCERT ARCHIVE

b Tumours in plants

Yes, plants can also develop tumours. Because of their rigid cell walls, plant cells do not show contact inhibition and follow a different pattern of growth, so uncontrolled growths can form (for example, crown gall caused by the bacterium *Agrobacterium tumefaciens*).

Therefore, contact inhibition prevents tumours in animals, while plants, lacking it, can also develop tumours.

QUESTION 14

The cell membrane of a cell is made up of proteins and lipids. Which cell organelles help in the synthesis of cell membrane? Write the path of these compounds from their site of synthesis to the cell membrane and show this through a labelled diagram.

ANSWER

Ribosomes and the endoplasmic reticulum make the proteins and lipids, and the Golgi apparatus packages them for the membrane.

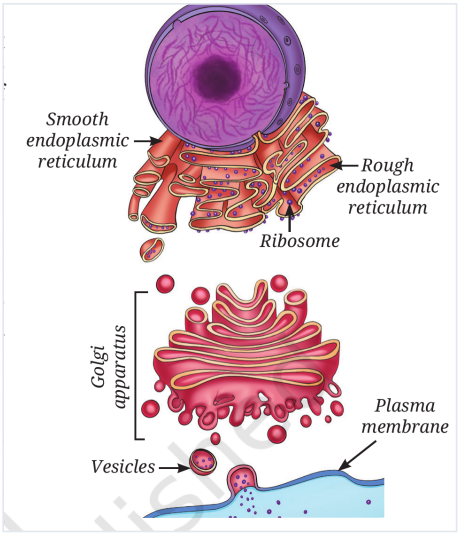

Fig. 2.13: Endoplasmic reticulum and Golgi apparatus: pathway for protein processing and secretion

a Organelles involved

- **Ribosomes** attached to the rough ER synthesise proteins.
- The **smooth ER** synthesises lipids (fats).
- The **Golgi apparatus** modifies, sorts and packages proteins and lipids into **vesicles**.

NCERT ARCHIVE

b Path to the cell membrane

Stage	Site	What happens
1	Ribosomes on rough ER	Proteins are made
2	Smooth ER	Lipids are made
3	Golgi apparatus	Proteins and lipids are modified, sorted and packed into vesicles
4	Vesicles	Carry the material to the plasma membrane
5	Plasma membrane	Vesicles fuse with the membrane and add to it

Therefore, the path is: ribosomes / ER → Golgi apparatus → vesicles → cell (plasma) membrane.

QUESTION 15

What would happen if gametes are formed by mitotic divisions?

ANSWER

The chromosome number would double in every generation, and offspring would not show variations.

- Mitosis gives cells with the **same** number of chromosomes as the parent cell, whereas meiosis halves the number.
- If gametes had the full number, fertilisation would double the chromosome number in the zygote, and this would keep doubling in each generation.
- Meiosis creates variations and diversity among organisms; gametes formed by mitosis would be identical copies, so children would not show variation from their parents.

Therefore, gametes must be formed by meiosis to keep the chromosome number constant and to create diversity.

NCERT ARCHIVE

QUESTION 16

A farmer, Deepa, was very happy with the harvest of amla (Indian Gooseberry) and lemons on her farm. However, she could sell only one-fourth of the produce in the local market. She turned perishable produce into profitable products such as pickles, murabbas and sharbat by adding appropriate amounts of salt, sugar, or jaggery to small pieces of fruit and their juices, stored in small glass bottles. Based on the passage answer: (i) Which scientific concept has the farmer applied in the preservation of the farm produce? (ii) How does the addition of high concentrations of salt and sugar create an environment that prevents the growth of spoilage-causing bacteria and fungi? (iii) Suggest a healthy recipe of this kind for food preservation. (iv) What are the scientific values addressed in this case?

ANSWER

Deepa has applied the concept of osmosis: salt and sugar make the surroundings hypertonic to microorganisms.

a (i) Scientific concept

Osmosis, the movement of water across a selectively permeable membrane from a dilute to a concentrated solution.

b (ii) Prevention of spoilage

- Salt, sugar or jaggery in high concentration makes the surroundings of bacterial and fungal cells **hypertonic**.
- Water moves out of their cells by osmosis, so the cells shrink and lose water, and cannot grow or multiply. This prevents spoilage and extends shelf life.

c (iii) A healthy recipe: amla murabba with jaggery

1. Wash 500 g amla, prick with a fork and steam until soft; cool and remove the seeds if desired.
2. Make a thick syrup with about 400 g jaggery and a little water; add a pinch of cardamom powder.
3. Add the amla pieces to the syrup and simmer gently until it is absorbed. Cool completely.
4. Store in clean, dry, sterilised glass bottles.

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d (iv) Scientific values

- Applying scientific knowledge (osmosis) to solve an everyday problem and reduce post-harvest wastage.
- Respect for traditional methods that are scientifically sound, and a sustainable approach that supports food security.
- Entrepreneurship and use of local resources to boost the local economy.

Therefore, osmosis explains why salt, sugar and jaggery preserve food, and the practice shows scientific values in daily life.

NCERT ARCHIVE

2.3

CLASS 9 SCIENCE · CHAPTER 2

The Journey Beyond

Solutions · 5 questions

Directions (Questions 1–5): These are the activities of The Journey Beyond and the question of The Quest Continues at the end of the chapter (page 27). Most are projects, so a plan and model answers are given; add your own work and observations.

QUESTION 1 *The Journey Beyond · p. 27*

Use selected software or digital tools to create animations or simulations of cell division and share them in the class.

ANSWER

This is a project. A simple plan and the points to be shown are given.

a **Plan**

1. Choose mitosis or meiosis and note its steps from Fig. 2.18 or 2.19.
2. Draw a storyboard: one cell with its chromosomes, then the cell dividing into two (mitosis) or into four cells with half the chromosomes (meiosis).
3. Build the animation with any presentation software or a free animation tool, adding captions to each step.
4. Check accuracy: mitosis gives **two identical** daughter cells; meiosis gives **four** cells with **half** the chromosomes.
5. Present it in class and explain each stage.

Therefore, a good simulation shows the correct number and type of daughter cells.

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QUESTION 2 *The Journey Beyond · p. 27*

Create a model of any type of a ‘synthetic cell’ using low-cost eco-friendly material.

ANSWER

This is a model-making activity. A suggested material list is given; use whatever you have locally.

Cell part	Material that can represent it
Cell membrane / outline	Cardboard or clay base, or a thin cloth border
Cytoplasm	Coloured jelly or agar (or a clay base)
Nucleus	A clay ball or a large seed
Mitochondria	Small beans or rolled paper
Ribosomes	Mustard seeds or sago pearls
Golgi apparatus / ER	Folded paper strips or jute thread

Label each part and add a card saying the model is a ‘synthetic cell’. Remember that in the 2010 experiment only the DNA was synthetic; the other parts of the cell were taken from an existing living cell.

Therefore, a good model is labelled, low-cost and eco-friendly.

QUESTION 3 *The Journey Beyond · p. 27*

Build a mitosis or meiosis model with your classmates for your science project or exhibition. How did teamwork contribute to the success of the activity? Did this activity change your perspective or understanding of the cell division topic in any way? If so, explain how?

ANSWER

The model-building steps are given with sample reflections; write your own experience in your answer.

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a Steps

- Make cells of clay or paper and use coloured threads or pipe cleaners as chromosomes.
- Show each stage in order, for mitosis (one division, two identical cells) or meiosis (two divisions, four cells with half the chromosomes).

b Sample reflections

- **Teamwork:** tasks were divided (making cells, chromosomes, labels and explaining), and classmates corrected each other's mistakes, so the model was more accurate and finished sooner.
- **Understanding:** building the model showed clearly that chromosome number stays the same in mitosis but is halved in meiosis, which is easier to remember than reading about it.

Therefore, teamwork and hands-on modelling make the idea of cell division clearer.

QUESTION 4 *The Journey Beyond · p. 27*

Develop a *nukkad natak* for community awareness in simple dialogues about the different functions of cell organelles.

ANSWER

A short sample script is given; it can be extended or acted out in your own words.

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a Sample script: “Our Busy Cell”

- **Sutradhar:** Friends, our body is made of cells, and every cell is like a small factory. Meet the workers!
- **Nucleus:** I am the manager. I keep the coded instructions, the DNA, and control all the work.
- **Ribosome:** I make proteins, the protein factory!
- **ER and Golgi:** We make, pack and send things: the ER makes and carries, the Golgi packs and posts them like a post office.
- **Mitochondria:** I am the powerhouse; I give energy to everyone.
- **Lysosome:** I clean up the waste and old parts.
- **Sutradhar:** When every part does its job, the cell, and we, stay healthy. Take care of your cells!

Therefore, the play shows that each organelle has a specific job in the cell.

QUESTION 5 *The Quest Continues ... · p. 27*

What is the future of the development of synthetic cells using non-living chemicals? If a synthetic cell is developed, what may be the related ethical issues?

ANSWER

Synthetic cells may help in medicine and research, but they also raise safety and ethical questions.

a Possible future

- Helps understand what a cell needs for life, since J. Craig Venter’s team in 2010 showed that DNA controls a cell’s structure and activities.
- May lead to useful products such as medicines and vaccines. At present, scientists have not made a completely new cell from scratch; only the DNA was synthetic.

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b Ethical issues

- **Safety:** harm to people or the environment if such cells escape or behave in unexpected ways.
- **Misuse:** possible use for harmful purposes.
- **Moral questions:** whether humans should create or alter life.
- **Fairness:** who owns and gets the benefits; the need for rules and public discussion.

Therefore, synthetic cells promise benefits but need careful rules and ethical thinking.

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