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CHAPTER NOTES

Cell: The Building Block of Life Class 9 Notes | CBSE Science Chapter 2

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Your teacher for Cell: The Building Bl...



Hi, I am **Ira**. I teach this syllabus all day, so **Cell: The Building Block of Life** is very much my home ground.

Ask me anything from this chapter. A concept, a numerical, or that one doubt you did not want to raise in class. Pick one to start:

Explain Cell: The Building Block of Life simply

What can the board exam ask?

Most important formulas

Quiz me on this chapter

Ask Ira anything...



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Cell: The Building Block of Life Class 9 Notes | CBSE Science Chapter 2

Cell: The Building Block of Life is Chapter 2 of CBSE Class 9 Science (Exploration, 2026-27). It starts with a simple fact: every living organism, from a single bacterium to a neem tree, is made of cells. The chapter then shows how cells are studied with light and electron microscopes, how the cell membrane and cell wall control what enters and leaves a cell, how prokaryotic and eukaryotic cells differ, what each organelle does, how cells divide by mitosis and meiosis, and what the Cell Theory states.

School exams test this chapter through definitions (osmosis, selectively permeable membrane, nucleoid), comparisons (prokaryotic and eukaryotic cells, cell membrane and cell wall, mitosis and meiosis, RER and SER), labelled cell diagrams, and experiment-based questions built on the potato, Rhoen leaf and onion root tip activities. The same ideas return in Class 10 life processes and heredity, so a clear picture of the cell

Quick Answer - Cell: The Building

The cell is the basic unit of structure and function. It is smaller than about 0.1 mm, so cells are seen with a microscope. All cells have a selectively permeable **cell membrane** (cell wall in plants, fungi and bacteria also have a **cell wall**). Prokaryotic cells have a nucleoid and no nucleus. Eukaryotic cells have a true nucleus and organelles such as mitochondria, chloroplasts, plastids and vacuoles. **Mitosis** gives two daughter cells with half the chromosomes, and all cells arise from one cell.



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All Key Terms at a Glance

Term	Meaning
Limit of resolution of the eye	About 0.1 mm: the smallest gap at which two points, seen from about 25 cm, still look separate
Cell membrane (plasma membrane)	Thin, selectively permeable boundary of every cell, made of lipids and proteins
Osmosis	Diffusion of water across a selectively permeable membrane, from dilute to concentrated solution
Cell wall	Rigid but permeable layer outside the cell membrane in plants (cellulose), fungi and bacteria
Prokaryotic cell	No well-defined nucleus or membrane-bound organelles
Eukaryotic cell	Well-defined nucleus and membrane-bound organelles
Mitochondria	Powerhouse of the cell; stores and generates energy in the form of ATP
Plastids	Chloroplasts (green), chromoplasts (colored), and leucoplasts (colorless)
Mitosis	One parent cell divides to form two daughter cells
Meiosis	Two divisions of a cell resulting in four daughter cells, each with half the genetic material of the parent cell
Cell Theory	All organisms are made of cells; cells arise from pre-existing cells



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Key Concepts

1. The Cell as the Unit of Life, and How We Study It

The chapter opens with the origin of life. Life probably began in water, possibly in small pools such as hot springs. The Puga Valley hot springs in Ladakh, nearly at the boiling point of water, host heat-loving unicellular bacteria called **thermophiles**, and calcium carbonate deposits around such springs may have helped form the first protective membrane, the barrier that defines a cell.

All living organisms are made up of cells. The cell is the basic level at which life exists.

- **Unicellular** organisms consist of one cell, for example bacteria and yeast.
- **Multicellular** organisms, such as plants, fish, birds and humans, are made of millions of cells that work together.

Levels of organisation: a group of similar Different tissues are organised into an **org system**. For example, the nasal pores, nas respiratory system.

Why we need a microscope

Draw two tiny dots on paper and move the from about 25 cm (the near point of the h as separate; closer than that, they look like **of the human eye**, 0.1 mm. A cell is usually biologists rely on lenses.

A convex lens, or a combination of lenses object so that it appears larger. This is the

- **Robert Hooke** was the first person to ol microscope capable of about 200 to 30 box-like compartments and named ther
- **Light microscopes** in school laboratorie example 10X and 40X) for better magni textbook are the eyepiece, body tube, c objective lens, handle, stage, mirror and



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- **Electron microscopes** use a **beam of electrons** instead of light. They produce highly magnified images and show cell structure at the nanometre scale. A nanometre is one-billionth of a metre. A picture of the lower surface of a Colocasia leaf taken with a **Scanning Electron Microscope** shows its stomata clearly.

Estimating the size of a cell (Activity 2.1)

Measure the diameter of the field of view with a transparent millimetre ruler on the stage, convert it to micrometres ($1 \text{ mm} = 1000 \text{ }\mu\text{m}$), then count the onion peel cells lying in a straight line across the same diameter. Estimated size of one cell = diameter of the field in μm / number of cells along the diameter.

With 25 cells across a $5000 \text{ }\mu\text{m}$ field, one onion cell is $5000/25 = 200 \text{ }\mu\text{m}$.

Total magnification depends on the magnifying power of both the eyepiece and the objective lens. With a 10X eyepiece and a 10X objective, the total magnification is $10 \times 10 = 100\text{X}$, so a $200 \text{ }\mu\text{m}$ cell appears 100 times larger.

Microscopes have been improved through **contrast** (the difference in brightness between

2. The Cell Membrane and Osmosis

Cells in tissues and organs must interact with their environment. Many interactions happen at the cell boundary. Cells respond to their environment through the cell membrane.

The **cell membrane**, also called the **plasma membrane**, and protects its contents. It defines the inner boundary of cells. It is **selectively permeable**: it allows some substances to pass in and out of the cell.

Activity 2.2: Potato pieces in water

A potato is cut into two pieces of roughly equal size. One piece is placed in Beaker A with plain water; the other into Beaker B with a sugar solution. After about an hour, both are weighed again.



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Beaker	Liquid	Observation	Weight
A	Plain water	Potato piece swells	Increases
B	20 per cent salt or sugar solution	Potato piece shrinks	Decreases

Reason: the cell membrane lets water move in and out of the cell but does not let the salt or sugar molecules through. 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 the concentrations become equal. In Beaker A water enters the potato cells; in Beaker B water leaves them.

Diffusion and osmosis

- **Diffusion** is the net movement of particles from a higher to a lower concentration. It happens because of a concentration difference, called a **concentration gradient**, and it occurs even without a membrane (dye spreading in water).
- **Osmosis** is the diffusion of water across a semi-permeable membrane. Water from the soil enters root cells by osmosis.

Cells in solutions of different strengths

Type of outside solution	Solute concentration compared with inside
Isotonic	Outside = inside
Hypotonic	Outside < inside
Hypertonic	Outside > inside

Structure of the membrane: the fluid mosaic model

The cell membrane is extremely thin, about 7.5 nm (millionths of a metre) thick (about 1/100th of a mm). It is made of **lipids (fats) and proteins**.

- It has a **lipid bilayer**: two layers of phospholipids. The hydrophilic heads face outwards and water-repelling tails face inwards.
- The molecules can move sideways, flip and rotate within the membrane. Hence it is **fluid**.



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- Proteins in the membrane act like **gatekeepers** that help substances pass through.
- The molecules are arranged like tiles in a mosaic, so it is called the **mosaic** model.

3. The Cell Wall: Plant Cells versus Animal Cells

All living cells communicate with their surroundings through the cell membrane. However, cells of **plants, fungi and bacteria** have an additional layer outside the cell membrane, called the **cell wall**.

Activity 2.3: Onion or Rhoeo peel and cheek cells

- A thin peel of an onion leaf or a Rhoeo (Cradle lily) leaf is mounted with **safranin** stain. Cheek cells, scraped gently from the inside of the cheek with a cotton swab or the blunt end of a toothpick, are spread on a slide with a drop of water and a few drops of **methylene blue** stain.
- Onion and Rhoeo peel cells are **box-shaped and regularly arranged**. Cheek cells are **irregularly arranged**.

Why plants need a cell wall

Plants generally cannot move from place to place. They face stresses like wind and rain. The cell wall:

- gives strength and helps leaves and flowers stand upright,
- helps plants stay upright,
- is **rigid but permeable**: water and some minerals pass through the selective permeability of the cell membrane from the soil.

In concentrated sugar solution a plant cell loses water and shrinks. Only the inner content shrinks. The **cell wall**. The chapter describes this without n... cells, with no wall, shrink as a whole.

Without a rigid wall, animal cells can change shape. This affects the structure and working of animal tissues.

Composition: the plant cell wall is mainly made of cellulose, a chain of glucose units linked together. Cellulose in plants and bacteria also have cell walls for protection.



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Basis	Cell membrane	Cell wall
Present in	All cells	Plants, fungi and bacteria only
Permeability	Selectively permeable	Permeable
Nature	Thin, flexible, fluid	Rigid
Made of	Lipids and proteins	Mainly cellulose (in plants)

4. Prokaryotic and Eukaryotic Cells

Most cells have three basic parts:

- a selectively permeable membrane called the **plasma membrane**
- a semi-fluid, jelly-like substance called **cytoplasm**
- a prominent **nucleus**.

Besides the nucleus, the cytoplasm contains various organelles which are visible only with an electron microscope.

A **bacterial cell** lacks a well-defined nucleus (it is not surrounded by their own membranes). Such cells are called **prokaryotes** (eu = true, karyon = nucleus). Most cellular activities in them take place in the **cytoplasm**. They have a **single circular molecule** associated with a **nucleoid**.

Plant and animal cells have a well-defined nucleus. They are **eukaryotic** (eu = true, karyon = nucleus).

Table 2.1 filled in: bacterial, plant and animal cells



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Cell structure	Bacterial cell	Plant cell	Animal cell
Cell membrane	Present	Present	Present
Cell wall	Present	Present	Absent
Cytoplasm	Present	Present	Present
Well-defined nucleus (genetic material enclosed by a membrane)	Absent	Present	Present
Primitive nucleus or nucleoid (genetic material without a membrane)	Present	Absent	Absent
Membrane-bound organelles	Absent	Present	Present

Table 2.2: Prokaryotic versus eukaryotic cells

Characteristic	Prokaryotic cell
Primitive nucleus (nucleoid)	Present
Diameter of a typical cell	1 to 10 µm
Number of cells in an organism	Usually unicellular
Membrane-bound organelles	Absent
Membrane-bound nucleus	Absent

Other parts of the cytoplasm

- **Cytoskeleton:** in eukaryotic cells, a network of protein fibers that maintains cell shape, and enables cell movement. It is a separate entity only under an electron microscope.
- **Cell inclusions:** stored materials in the cytoplasm, such as calcium oxalate or silica (in some plant cells).

Acellular agents



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Viruses, viroids and prions are acellular (they are not cells) infectious agents, too small to be seen under a light microscope.

- **Viruses:** some genetic material with a protein coat.
- **Viroids:** genetic material with no protein coat around it.
- **Prions:** misfolded proteins that lack genetic material.

5. Cell Organelles: A Living Factory

Eukaryotic cells carry out different life processes in different organelles, independently and at the same time. Organelles build new materials, remove waste and provide energy, and they work together. A cell is like a tiny living factory in which each part does a specific job.

Nucleus: house of coded instructions

- Covered by a **double-layered nuclear membrane** between the nucleus and the cytoplasm.
- The **nucleolus** is a dense round body in the nucleus. These subunits move out to the cytoplasm to form a ribosome.
- The nucleus contains **chromosomes**, which are about to divide. Chromosomes are made of DNA and proteins, and they carry information for the next generation.
- Functional segments of DNA are called **genes**.
- In a non-dividing cell, DNA is part of the **chromatin** structures. When the cell is about to divide, the DNA condenses into chromosomes.

Cells without a nucleus: mature human red blood cells (erythrocytes). This leaves more space for haemoglobin. Without a nucleus they cannot repair or divide themselves.

Evidence that DNA controls the cell: in 1952, Alfred Hershey and Martha Chase made copy of the DNA of the bacterium *M. lysogenicus*. They removed their own DNA had been removed. The cell grew normally. The DNA was synthetic; the rest of the cell came from the bacterium.

Ribosomes: the protein factories



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Tiny structures present either freely in the cytoplasm or attached to the endoplasmic reticulum. Ribosomes are the **sites of protein synthesis**.

Endoplasmic reticulum (ER): manufacturing factory

A large organelle that spreads like a network in the cytoplasm and is continuous with the outer membrane of the nuclear envelope. It plays a key role in making and transporting proteins, fats (lipids) and some hormones. Its structure varies with the cell's function.

Basis	Rough ER (RER)	Smooth ER (SER)
Structure	Ribosomes attached to its surface, so it looks rough under an electron microscope	No ribosomes on its surface, so it looks smooth
Main function	Protein synthesis and protein secretion (e.g. pancreatic gland cells)	Synthesis and storage of fats and hormones

Golgi apparatus: packaging and shipping

Stacks of flattened, sac-like structures. It is continuous with other organelles. Like the cell's post office, it packages proteins into **vesicles** for transport, secretion or lysosomes. Named after the Italian scientist **Camillo Golgi** in the nerve cells.

The secretion pathway: RER (proteins made) → packaged → vesicles → cell membrane → outside the cell

Lysosomes: the clean-up system

Single membrane-bound sacs filled with enzymes that break down carbohydrates, fats and even damaged parts of the cytoplasm and may be reused. Human sperm uses lysosomes to break down the outer layer of the egg during fertilisation.

Mitochondria: the powerhouse of the cell

- Each mitochondrion has **two membranes**. The inner membrane is folded into finger-like projections called cristae, which increase the surface area for chemical reactions and the production of ATP.
- Glucose and other molecules are broken down in the mitochondria to release energy.



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- The energy is stored as **ATP (adenosine triphosphate)**, the **energy currency** of the cell, used for most cellular activities.

Plastids: food synthesis and storage in plant cells

Plants make food by photosynthesis. The green pigment **chlorophyll**, present in **chloroplasts**, absorbs sunlight. Chloroplasts are double-membrane-bound, like mitochondria. Inside is a semi-fluid substance, the **stroma**, which contains disc-shaped membrane structures holding chlorophyll. Sugars made in photosynthesis are stored in the stroma along with starch granules.

Plastid	Pigment	Function or example
Chloroplast	Chlorophyll (green)	Photosynthesis; temporary food storage
Chromoplast (chroma = colour)	Yellow, orange or red pigments	Colour of flower petals and fruits; attracts
Leucoplast (leukos = white)	None (colourless)	

Mitochondria and plastids resemble certain animals, so they can make some of their own proteins, like such single-celled organisms.

Vacuoles: storage and support

- A mature plant cell usually has **one large central vacuole** with a permeable membrane and filled with a watery solution.
- It stores water, minerals, sugars and waste products.
- By holding a lot of water it keeps pressure high. If a plant gets too little water, vacuoles lose water and the plant wilts.
- Animal cells sometimes have vacuoles, but they are much smaller than those in plant cells.

6. Cell Division: Mitosis and Meiosis

A cut on the skin heals and fallen hair grows back. Old, dead or damaged cells. Cells can grow only up to a certain size, so the body grows mainly by cell division.



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because cells **divide** to form new cells. Every day an estimated hundreds of billions of cells in our body are replaced, almost 1 per cent of the total.

Activity 2.5: Onion root tip

Roots grown from an onion bulb over water for 5 to 6 days are cut (2 to 3 cm), fixed in **aceto-alcohol** (glacial acetic acid : ethanol :: 1 : 3) for 24 hours and kept in 70 per cent ethanol. A root tip is softened with dilute hydrochloric acid, stained with **aceto-carmin**, warmed gently, squashed under a coverslip and observed.

Observation: root tip cells look different from one another because the growing tip divides continuously and its cells are caught at different stages of division.

Cell division is the process by which new cells form from pre-existing cells. It lets organisms grow, repair damaged tissues and reproduce. Some cells, such as skin cells, divide continuously to replace cells lost regularly. Both prokaryotic and eukaryotic cells divide, but eukaryotic cells divide in a more controlled, orderly way through **mitosis** and **meiosis**.

Mitosis

Every human begins as a single fertilised egg cell. This cell divides to form two identical cells. Mitosis is the **most common** type of cell division. It produces **identical daughter cells**, each with the same genetic material as the parent. It is important for normal **growth**, repair and replacement of cells.

Meiosis

Meiosis produces **gametes** and occurs only in the **testes** (sperm) in animals, and the **anthers** and **ovaries** (egg cells) in plants.

- The parent cell divides **twice**, one division after the other.
- In the **first division** the cell divides into two cells, each with half the DNA of the parent cell. The cell is **reduced to half**.
- The **second division** is similar to mitosis. Each of the two cells divides into two more cells.
- Each gamete has half the DNA of the parent cell. The original chromosome number is **reduced**.
- Meiosis creates **variation**, which is why offspring are not identical to the parent.



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Basis	Mitosis	Meiosis
Number of divisions	One	Two, one after the other
Daughter cells	Two	Four
Chromosome number	Same as parent	Half of parent
Genetic make-up	Identical to parent	Creates variation
Purpose	Growth, repair, maintenance, asexual reproduction	Gametes for sexual reproduction; genetic diversity

When division goes wrong: errors in mitosis can lead to uncontrolled cell division, forming **tumours**, and to an abnormal number of chromosomes. Errors in meiosis can lead to gametes with an abnormal number of chromosomes, which may cause **genetic disorders**, which may cause physical features, and faulty meiosis may also cause

7. The Cell Theory, Cell Life Span and Cell Division

In 1838 the German botanist **Matthias Schleiden** and in 1839 the German zoologist **Theodor Schwann** proposed the **Cell Theory**. **Rudolf Virchow** added that new cells form only from pre-existing cells.

According to the classical **Cell Theory**:

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

The theory unifies all biology, from bacteria to humans, and explains cell division.

Totipotency: Haberlandt proposed that an undifferentiated cell, under certain conditions, can develop into a complete organism. This laid the foundation of **Pluripotency**.



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Do cells live forever?

Cells grow and divide in a controlled way, stay in the right place, do their work and eventually die when no longer needed. New cells replace them. Every cell has a **definite life span**. Problems arise if cells do not die when they should, or die too early.

- **Contact inhibition:** in many animal cells, division usually stops when the cells come in contact with neighbouring cells.
- **Cancer cells** lose this control and keep dividing uncontrollably, forming **tumours**. Tumours may be **benign** or **malignant**. Cancerous tumours can invade nearby tissues and spread to other parts of the body to form new tumours.
- **Plant cells** do not show contact inhibition because of their rigid cell walls, and they follow a different pattern of growth.
- **Programmed Cell Death (PCD)** is a genetically regulated, organised process of selective cell destruction, needed for normal development, cellular quality control and immune function. In an embryo, PCD removes the cells between digits. If it didn't, we would have webbed hands.



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Formula and Reaction Sheet

Quantity	Relation	Example from the chapter
Unit conversion	$1 \text{ mm} = 1000 \text{ }\mu\text{m}$	$5 \text{ mm} = 5 \times 1000 = 5000 \text{ }\mu\text{m}$
Nanometre	$1 \text{ nm} = \text{one-billionth of a metre} = 0.000001 \text{ mm}$	Membrane thickness 7 to 10 nm
Estimated cell size	Diameter of field of view (μm) / number of cells along the diameter	$5000 \text{ }\mu\text{m} / 25 = 200 \text{ }\mu\text{m}$
Total magnification	Magnifying power of eyepiece $\times$ magnifying power of objective	$10\text{X} \times 10\text{X} = 100\text{X}$
Typical cell diameter	Prokaryotic 1 to 10 μm Eukaryotic 10 to 100 μm	
Meiosis count	1 parent cell $\rightarrow$ 4 daughter cells with half the chromosomes	
Cellular respiration	Glucose broken down to release energy stored as ATP	



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Important Definitions

- **Limit of resolution of the human eye:** the minimum distance (about 25 cm) at which two points can be seen as separate.
- **Cell membrane (plasma membrane):** the thin layer that surrounds a cell, protects its contents and defines its shape.
- **Diffusion:** the net movement of particles from an area of higher concentration to an area of lower concentration.
- **Osmosis:** the diffusion of water across a semi-permeable membrane from a dilute solution to a concentrated solution.

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- **Cell wall:** the rigid, permeable outer covering outside the cell membrane in plant, fungal and bacterial cells; mainly cellulose in plants.
- **Prokaryotic cell:** a cell without a well-defined nucleus and without membrane-bound organelles.
- **Eukaryotic cell:** a cell with a well-defined nucleus and membrane-bound organelles.
- **Nucleoid:** the region of a prokaryotic cell containing its genetic material, with no membrane around it.
- **Chromosome:** a rod-shaped structure of DNA and specific proteins, visible when the cell is about to divide, that carries hereditary information.
- **ATP:** adenosine triphosphate, the molecule in which energy from cellular respiration is stored; the energy currency of the cell.
- **Mitosis:** cell division that forms two genetically identical daughter cells from one parent cell.
- **Meiosis:** a two-step cell division in reproductive organs that forms four gametes, each with half the number of chromosomes.
- **Contact inhibition:** the stopping of cell division when cells are in contact with neighbouring cells.
- **Totipotency:** the ability of a living plant to grow into a new plant under suitable conditions.
- **Programmed Cell Death (PCD):** a gene-controlled process of cell destruction.



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Solved Examples (NCERT)

Example 1: Estimating the size of a cell

Question: The field of view of a microscope is 5 mm in diameter. The eyepiece and the objective lenses are both 10X magnifying. How large it appears.

Solution:

1. Convert the field to micrometres: 5 mm = 5000 μm
2. Size of one cell = $5000 \mu\text{m} / 25 = 200 \mu\text{m}$
3. Total magnification = $10 \times 10 = 100\text{X}$, so the cell appears 100 times larger than its actual size.

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Example 2: Potato pieces in water and salt solution (Activity 2.2)

Question: Why does the potato piece in plain water gain weight while the piece in 20 per cent salt solution loses weight? Why must both pieces be of roughly equal size and weighed first (Pause and Ponder 3)?

Solution: Water moves by osmosis towards the side with more solute: into the cells from plain water, out of the cells into the 20 per cent salt solution, while the membrane blocks the salt. Equal sizes make the two pieces comparable, and the initial weights are needed to calculate the change in weight, which is the measured result.

Example 3: Revise, Reflect, Refine Question 2

Question: 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 into Cell X and moved out of Cell Y through the membrane. (iii) Water moved into Cell X and out of Cell Y through the membrane by osmosis in both cells.

Solution: (iii). Pure water is hypotonic, so water moves into Cell X. The concentrated salt solution is hypertonic, so water leaves Y. Options (i), (ii) are incorrect as the membrane blocks the salt and osmosis is only for water.

Example 4: Revise, Reflect, Refine Question 1

Question: Indicate the presence or absence of the following organelles in a plant cell: Chromosome, Nucleus, Mitochondria, Golgi apparatus, Vacuole.



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Structure	Bacterial cell	Animal cell	Reason
Chromosome	Present as one circular DNA molecule with proteins, lying in the nucleoid	Present	Bacterial DNA has no nucleus around it; animal chromosomes lie inside the nucleus
Nucleus	Absent	Present	Prokaryotes have only a nucleoid
Mitochondria	Absent	Present	Membrane-bound organelle
Golgi complex	Absent	Present	Membrane-bound organelle
Chromoplasts	Absent		

Example 5: Revise, Reflect, Refine

Question: Four scooped potato cups stand in a beaker of water. Cup A has no sugar, Cup B has one teaspoon sugar, Cup C has one teaspoon sugar. (i) Explain why water gathers in B and C. Why is Cup A necessary for this experiment? (ii) Explain the hollowed portions of Cups A and D.

Solution:

- (i) In B and C the sugar or salt dissolves in the water. The beaker water is dilute. The potato cells are in a hypertonic solution, so water moves by osmosis from the beaker into the potato cells.
- (ii) Cup A is the **control**. It is the same as the other cups because of the same reason. Cup A stands in water.
- (iii) Cup A has no solute inside, so there is no osmosis. Cup D has solute, but boiling kills the potato cells, so the semi-permeable membranes and osmosis do not occur.



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Example 6: Revise, Reflect, Refine Question 8 (carrots)

Question: A researcher placed one carrot in plain water and another of similar size in concentrated salt solution for 24 hours. (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?

Solution:

1. (i) Hypothesis: water moves into or out of plant cells by osmosis depending on the concentration of the surrounding solution.
2. (ii) Weigh each carrot before and after, keep all other conditions the same, and repeat with several carrots or solutions of different strengths.
3. (iii) In plain water, water enters the cells; the vacuoles stay full, pressure inside the cells keeps them firm, and the carrot is crunchy. In salt solution, water leaves the cells by osmosis; the vacuoles lose water, the cells become limp when short of water.



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Example 7: Revise, Reflect, Refine

Question: The cell membrane of a cell is r help in the synthesis of cell membrane? W synthesis to the cell membrane.

Solution:

1. Proteins are made by **ribosomes** on the
2. Lipids (fats) are made by the **smooth E**
3. They travel in vesicles to the **Golgi appa**
4. Vesicles from the Golgi apparatus carry

Path: RER (proteins) and SER (lipids) → ve
In the labelled diagram, draw the nucleus, small round vesicles and the membrane, v

Example 8: Counting cells in mitosis

Question: A cell of an organism has 8 chr
chromosomes per cell after one mitosis? (b) After mitosis? (c) After two such gametes fuse.



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Solution:

1. (a) Mitosis: 2 daughter cells, each with 8 chromosomes, identical to the parent.
2. (b) Meiosis: the first division gives 2 cells with 4 chromosomes each; the second division, like mitosis, splits each into 2. Result: 4 gametes, each with 4 chromosomes.
3. (c) Fertilisation: $4 + 4 = 8$, the original number is restored.

The same reasoning answers Question 15, "What would happen if gametes are formed by mitotic divisions?": gametes would carry the full number, so the fused cell would have double the number (16 here), and the number would keep doubling every generation.

Competency-Based Questions (with answers)

1. Case-based: Pickles and sharbat (Cell: The Building Block of Life)

A farmer, Deepa, sold only one-fourth of her produce as pickles, murabbas and sharbat by adding salt and sugar to pieces of fruit and their juices, and stored them in glass bottles.

(i) Which scientific concept has the farmer used to preserve her produce?
Osmosis. High salt or sugar makes a strong solution.

(ii) How does the addition of high concentration of salt or sugar prevent the growth of spoilage-causing microorganisms?
Microorganisms have far more solute than their cells. Water cannot grow or multiply, so the food does not spoil.

(iii) Suggest a healthy recipe of this kind of sharbat.
Store in clean, dry glass bottles.

(iv) What are the scientific values addressed in this case?
Security and income from agro-processing.

2. Assertion-Reason

Assertion (A): A Rhoeo leaf cell placed in a solution of high sugar concentration.

Reason (R): The rigid cell wall maintains the shape of the cell.



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Answer: (a) Both A and R are true, and R correctly explains A. Only the membrane and contents shrink away from the wall.

3. Assertion-Reason

Assertion (A): Mature human red blood cells live only about 120 days. **Reason (R):** They have no nucleus, so they cannot repair or divide themselves.

Answer: (a) Both A and R are true, and R correctly explains A.

4. Assertion-Reason

Assertion (A): Bacteria are eukaryotic organisms. **Reason (R):** The genetic material of bacteria lies in a nucleoid without a membrane around it.

Answer: (d) A is false, R is true. Having a nucleoid and no membrane-bound organelles makes bacteria prokaryotic.

5. Source-based: Contact inhibition Question 13, first part)

"In many animal cells, cell division usually stops when cells are in contact with each other. However, cancer cells lose this contact inhibition and continue to divide, leading to the formation of tumours."

(a) Which phenomenon inhibits the formation of tumours?

(b) Why do plant cells not show this phenomenon? pattern of growth, and the chapter states that plant cells have a cell wall.

(c) Name the two kinds of tumour. Benign tumours are confined to the tissues and spread to other parts of the body.

6. Reasoning: One giant mitochondrion

Question: Instead of many small ones, why do some cells have one giant mitochondrion? How does this relate to the concept of surface area to volume ratio?

Answer: Energy production depends on the surface area of the inner membrane. This is why the inner membrane is folded into cristae, providing a large total surface area than one giant mitochondrion. The cristae are distributed throughout the cytoplasm close to where energy is needed.



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7. Competency MCQ: Revise, Reflect, Refine Question 11

Question: 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: (ii). The chapter gives the SER's role as the synthesis and storage of fats and hormones; cellulose is not an SER product. Ribosomes make proteins, and lysosome enzymes break down unwanted material.

8. Competency MCQ: Revise, Reflect, Refine Question 4

Question: Which of the following option(s) of the pairs of cell organelles are correctly placed under the given categories (present in the plant cells, absent in the animal cells)? (i) Leucoplast, Cell wall (ii) Mitochondria, Ribosome (iii) Cell wall, Golgi apparatus (iv) Lysosome, Endoplasmic reticulum

Answer: (i). Leucoplasts are present in plant cells, while Mitochondria, Ribosomes, the Golgi apparatus and the Endoplasmic reticulum are present in both plant and animal cells.

Important Questions for

1-Mark Questions

1. Who first observed cells, and in what?
2. What is the limit of resolution of the human eye?
3. Which organelle is called the powerhouse of the cell?
4. Which of the following pairs of cell organelles are present in both plant and animal cells?
(i) Mitochondria, Nucleus (ii) Mitochondria, Golgi body (iii) Mitochondria, Nucleus (iv) Mitochondria, Golgi body
5. What are functional segments of DNA called?

2-Mark Questions

1. Differentiate between cell membrane and nuclear envelope.
Cell membrane is selectively permeable: it lets some substances pass and some not. Nuclear envelope is completely permeable: water and some dissolved substances pass freely.



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2. **Differentiate between RER and SER (structure).** RER has ribosomes attached to its surface and looks rough under an electron microscope. SER has no ribosomes on its surface and looks smooth.
3. **Differentiate between chloroplasts and chromoplasts (pigments).** Chloroplasts contain the green pigment chlorophyll, which absorbs sunlight for photosynthesis. Chromoplasts contain yellow, orange or red pigments that colour flowers and fruits.
4. **What outcome do you expect, if all the mitochondria are removed from a eukaryotic cell?**
The cell cannot carry out cellular respiration, so it cannot make ATP. Without energy most cellular activities stop, and the cell would eventually die.

3-Mark Questions

1. **Give three differences between prokaryotic and eukaryotic cells.** (1) Prokaryotic: genetic material in a nucleoid with no membrane; eukaryotic: membrane-bound nucleus. (2) Prokaryotic: no membrane-bound organelles; eukaryotic: several membrane-bound organelles. (3) Prokaryotic: typical diameter 1 to 10 μm , unicellular or multicellular.
2. **Explain the fluid-mosaic model of the cell membrane.** The phospholipid bilayer has water-attracting heads outwards and w... it. The molecules can move sideways, f... so it is a mosaic. Proteins act as gateke...
3. **Two students, Renu and Rohit, were ha... that all parts of the plants, even roots, the statement and told her that plastid underground and do not need to perfo... answer.** Renu. Rohit assumes that plast... colourless leucoplasts, which store star... green parts such as roots still contain le... storing leucoplasts in potato and taro, u...



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5-Mark Questions

1. **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.**

Similarities: both are bounded by two membranes; both have their own DNA and ribosomes, so both can make some of their own proteins; both deal with energy in the cell; both resemble certain bacteria, suggesting a shared evolutionary history.

Differences: mitochondria occur in plant and animal cells, chloroplasts only in plant cells. The inner mitochondrial membrane is folded into cristae; a chloroplast contains a semi-fluid stroma with disc-shaped membrane structures holding chlorophyll. Mitochondria break down glucose in cellular respiration and store the energy as ATP; chloroplasts absorb light and make sugars by photosynthesis, storing them in the stroma with starch granules.

2. **Describe mitosis and meiosis and compare them. What happens if either goes wrong?**

Mitosis: one division of a body cell gives two genetically identical daughter cells with the same DNA and chromosome number; it serves growth, repair, maintenance and asexual reproduction. Meiosis: in reproductive cells, the first division halves the chromosome number, and the second division separates the sister chromatids, resulting in four daughter cells, each with half the chromosomes, leading to genetic variation.

Errors in mitosis can cause uncontrolled cell division, leading to cancer. Errors in meiosis can lead to gametes with abnormal chromosome numbers, resulting in reduced fertility.



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Common Mistakes and Explanations

1. **Mistake:** writing that salt or sugar move only. The solute stays put because the water moves.
2. **Mistake:** mixing up hypotonic and hypertonic compared with the cell. Hypertonic outside, hypotonic inside.
3. **Mistake:** calling the cell wall selectively permeable. The cell membrane is selectively permeable.
4. **Mistake:** writing that only plant cells have cell walls; animal cells do not.
5. **Mistake:** saying bacteria have no genetic material. They have a circular molecule in the nucleoid; they also have plasmids.

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6. **Mistake:** saying plastids occur only in green parts. **Fix:** leucoplasts and chromoplasts occur in non-green parts; white or underground storage tissues still contain plastids.
7. **Mistake:** writing “meiosis gives two cells” or “mitosis halves the chromosomes”. **Fix:** mitosis: 2 identical cells, same number. Meiosis: 2 divisions, 4 gametes, half the number.
8. **Mistake:** saying chromosomes are always visible in the nucleus. **Fix:** in a non-dividing cell the DNA is in thread-like chromatin; chromosomes become visible only when the cell is about to divide.
9. **Mistake:** adding total magnification ($10X + 10X = 20X$). **Fix:** multiply the powers of the eyepiece and the objective: $10X \times 10X = 100X$.
10. **Tip:** in “differentiate” questions, answer only on the basis given in brackets (permeability, structure, pigments) and write the point for both items, ideally in a two-column table.

Quick Revision Points

- The cell is the basic structural and functional unit of life.
- Cells → tissues → organs → organ systems (e.g., heart, lungs, kidney, brain, stomach, intestines, skin, etc. form the respiratory system).
- Robert Hooke saw cells in cork in 1665.
- Cell size = field diameter in μm / cells across the field of view.
- The cell membrane (plasma membrane) is made of phospholipids and proteins.
- Diffusion: net movement from higher to lower concentration across a selectively permeable membrane.
- Hypotonic outside: cell swells. Hypertonic outside: cell shrinks.
- Plants, fungi and bacteria have a cell wall.
- In concentrated sugar solution plant cells become plasmolysed; cheek cells shrink.
- Prokaryotic: nucleoid, no membrane-bound organelles, 10 to 100 μm .
- Nucleus: double membrane with pores; DNA becomes chromosomes before division.



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- Ribosomes make proteins; RER makes and secretes proteins; SER makes and stores fats and hormones.
- Golgi apparatus modifies, sorts and packages into vesicles; first seen by Camillo Golgi in 1898.
- Mitochondria: two membranes, cristae, cellular respiration, ATP.
- Plastids: chloroplast (chlorophyll, stroma), chromoplast (colour), leucoplast (storage). Mitochondria and plastids have their own DNA and ribosomes.
- Mature plant cells have one large central vacuole full of cell sap; loss of water causes wilting.
- Mitosis: 2 identical daughter cells. Meiosis: 2 divisions, 4 gametes with half the chromosomes; fertilisation restores the number.
- Cell Theory: Schleiden 1838, Schwann 1839, Virchow 1855. Totipotency: Haberlandt 1902. Contact inhibition stops division in many animal cells; cancer cells lose it.

Weightage and Exam Pattern

Class 9 has no board exam. This chapter is important for internal assessment (term and annual papers), and the NCERT source chapter with a strong practical side, so questions are based on the experiments and the activities.

Question type	
MCQ and one-word	Organelle and cell theory, Hooke and cell
Assertion-Reason	Cell wall and cell theory, eukaryote, cell
Short answer	Differentiate between chloroplast and
Long answer	Mitochondria and potato osmotic
Case-based and experiment-based	Potato piece and shariat



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Practise a labelled plant cell and animal cell diagram. This chapter is the foundation for Class 10 boards, where life processes and heredity build on cells, DNA and gametes.



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