



CLASS 9 SCIENCE — CHAPTER 2



CELL: THE BUILDING BLOCK OF LIFE



Based on the New *Exploration* Science Textbook | 2026–27 Curriculum



Chapter Overview

Every living organism is made up of **cells**.

From a tiny bacterium 🦠 to a huge tree 🌳 and from a fish 🐟 to a human being 🧑, cells form the basic level at which life exists.

Some organisms consist of only **one cell** and are called **unicellular organisms**.

Others consist of **many cells** and are called **multicellular organisms**.

In multicellular organisms:

Cells → Tissues → Organs → Organ Systems → Organism

For example:



Nasal pores + nasal cavity + trachea + lungs → Respiratory system

Even when cells become organised into tissues and organs, the cell remains the **fundamental structural and functional unit of life**.



1. What Is a Cell?

A **cell** is the basic structural and functional unit of life.

♦ Structural unit

All living organisms are made up of cells.

◆ Functional unit

Cells perform the activities necessary for life.

Cells can:

- 🍴 Obtain and use materials.
- ⚡ Release and use energy.
- 🧪 Produce substances.
- 🗑️ Remove waste.
- 📡 Respond to their surroundings.
- 🔄 Grow and divide.
- 🗣️ Communicate with other cells.

★ **Remember:** The cell is the basic **structural and functional unit of life**.

2. Unicellular and Multicellular Organisms

Unicellular Organisms

Organisms made up of **one cell** are called unicellular organisms.

Examples:

- 🦠 Bacteria
- 🍞 Yeast

A single cell performs all necessary life processes.

Multicellular Organisms

Organisms made up of **many cells** are called multicellular organisms.

Examples:

- 🌱 Plants

- 🐟 Fish
- 🐦 Birds
- 👤 Humans

Different cells become specialised for different functions.

Organisation:

Cells → Tissues → Organs → Organ Systems → Organism

3. Where Did Cells Come From?

Scientists widely accept that life originated in water.

Some researchers suggest that early life may have originated in small water pools with changing environmental conditions rather than directly in oceans.

Puga Valley, Ladakh

The textbook discusses the hot springs of **Puga Valley in Ladakh**.

These hot springs have temperatures close to the boiling point of water even though Ladakh has a cold climate.

They contain heat-loving bacteria called **thermophiles**.

Scientists from the **Birbal Sahni Institute of Palaeosciences, Lucknow**, studied these hot springs and found rapid formation of calcium carbonate around them.

These deposits may have:

- 🛡️ Protected early organic molecules.
- ☢️ Reduced exposure to harmful radiation.
- 🧪 Protected molecules from extreme conditions.
- 🚢 Contributed to the formation of an early protective membrane.

This provides an interesting connection between the study of cells and the possible early environments in which life developed.



4. How Do We Study Cells?

Most cells are too small to be seen clearly with the unaided human eye.

Limit of Resolution of Human Eye

The human eye can distinguish two points separated by approximately:

0.1 mm

at the near point of vision, about **25 cm** from the eye.

If two points are closer than this, they may appear as one point.

This ability is called the **limit of resolution**.



5. Why Do We Need a Microscope?

Cells are usually much smaller than the resolution limit of the human eye.

Therefore, scientists use microscopes to:

-  Magnify cells.
 -  Observe cell structures.
 -  Study organelles.
 -  Estimate cell size.
 -  Study structures that cannot be seen with the naked eye.
-



6. Robert Hooke and the Discovery of Cells

In **1665**, English scientist **Robert Hooke** observed a thin slice of cork using a microscope that he designed himself.

His microscope could provide approximately **200–300× magnification**.

He observed many small box-like compartments in the cork.

He called these compartments:

“Cells”

The name "cell" therefore came from Hooke's observation of the tiny compartments in cork.

★ **Exam Point:** Robert Hooke first observed and named "cells" in 1665 while studying cork.



7. Light Microscope

School laboratories commonly use **light microscopes**.

They use visible light and lenses to magnify objects.

A light microscope contains:

- 👁 Eyepiece
- 🔍 Objective lens
- 🪄 Stage
- ⚙ Coarse adjustment knob
- 🎯 Fine adjustment knob
- 🪞 Mirror/light source
- 🖐 Handle
- 🧱 Base
- 🧪 Body tube

Different objective lenses, such as **10×** and **40×**, can provide different levels of magnification.



8. Magnification and Resolution

Three important features of microscopes are:



Magnification

Makes the object appear larger.



Resolution

Measures how clearly two close objects can be distinguished.

Contrast

Difference in brightness between different parts of an object.

 **Important:** A very high magnification is not useful if the image is not clear. Resolution is essential for seeing fine details.

9. Electron Microscope

Electron microscopes are much more powerful than ordinary light microscopes.

Instead of visible light, they use a **beam of electrons**.

They can reveal very fine details of cell structures at the **nanometre scale**.

Nanometre

1 nanometre = one-billionth of a metre

Electron microscopes therefore allow scientists to explore structures much smaller than those visible with a light microscope.

10. Estimating the Size of a Cell

The textbook gives an activity to estimate the size of an onion peel cell.

Step1

Measure the diameter of the microscope's field of view using a transparent ruler.

Suppose it is:

5 mm

Step2

Convert millimetres to micrometres.

$$1 \text{ mm} = 1000 \text{ }\mu\text{m}$$

Therefore:

$$5 \text{ mm} = 5000 \text{ }\mu\text{m}$$

Step 3

Place an onion peel slide under the microscope.

Count the number of cells visible along the diameter.

Suppose:

25 cells are visible.

Step 4

Use:

$$\text{Estimated size of one cell} = \text{Diameter of field of view} \div \text{Number of cells}$$

Therefore:

$$= 5000 \text{ }\mu\text{m} \div 25$$

$$= 200 \text{ }\mu\text{m}$$

✓ Estimated size of one onion cell = 200 μm



11. Total Magnification

The total magnification of a microscope depends on:

Eyepiece magnification $\times$ Objective magnification

For example:

Eyepiece = **10 $\times$**

Objective = **10 $\times$**

Therefore:

Total magnification = $10 \times 10 = 100\times$

An object will appear approximately 100 times larger.



12. Structure of a Cell

Most cells have three basic components:

1 Plasma Membrane

A selectively permeable boundary around the cell.

2 Cytoplasm

A semi-fluid, jelly-like substance inside the cell.

3 Nucleus

A prominent structure containing genetic information in eukaryotic cells.

The cytoplasm also contains specialised structures called:



Cell Organelles

Each organelle performs particular functions.



13. Cell Membrane — Universal Feature of a Cell

The **cell membrane**, also called the **plasma membrane**, is a thin boundary surrounding the cell.

It:

-  Protects the cell contents.
-  Separates the cell from its surroundings.
-  Controls movement of substances.

-  Helps cells interact with their surroundings.

Selectively Permeable

The cell membrane is **selectively permeable**.

This means:

It allows some substances to pass through while preventing others from passing through.



14. Osmosis

The movement of water through a selectively permeable membrane is called:

Osmosis

Water moves from an area having:

More water + less solute

towards an area having:

Less water + more solute

until the concentrations become equal.



15. Potato Experiment — Understanding Osmosis

The textbook demonstrates osmosis using potato pieces.



Beaker A

Potato piece placed in:



Plain water

Beaker B

Potato piece placed in:

 20% salt solution

After some time:

Beaker A

 Potato swells.

Beaker B

 Potato shrinks.

Why?

Water moves through the selectively permeable cell membrane.

In plain water, water enters the potato cells.

In concentrated salt solution, water moves out of the cells.

Therefore:

Water movement through a selectively permeable membrane = Osmosis

16. Diffusion vs Osmosis

Diffusion

Diffusion is the net movement of particles from:

Higher concentration → Lower concentration

It can occur even without a membrane.

Osmosis

Osmosis is the movement of:

Water

through a:

Selectively permeable membrane



Easy Memory Trick

Diffusion → particles

Osmosis → water + selectively permeable membrane



17. Isotonic, Hypotonic and Hypertonic Solutions



Isotonic Solution

Solute concentration outside the cell:

= Solute concentration inside the cell

There is no net movement of water.



Hypotonic Solution

Solute concentration outside:

< Solute concentration inside

Water tends to move **into the cell**.

The cell may swell.



Hypertonic Solution

Solute concentration outside:

> Solute concentration inside

Water tends to move **out of the cell**.

The cell may shrink.

★ Remember

Hypotonic → **Water enters**

Hypertonic → **Water leaves**

Isotonic → **Balanced**

18. Structure of Cell Membrane

The cell membrane is extremely thin, approximately:

7–10 nm thick

It is mainly made of:

-  Lipids
-  Proteins

The **fluid-mosaic model** explains its structure.

19. Fluid-Mosaic Model

The cell membrane contains a:

Lipid Bilayer

It has two layers of lipid molecules.

The:

 Water-attracting heads face outward.

 Water-repelling tails face inward.

Proteins are embedded within the lipid bilayer.

Why "fluid"?

The molecules can move sideways, flip and rotate.

Why "mosaic"?

Different proteins are arranged within the lipid bilayer like pieces of a mosaic.

Functions of Membrane Proteins

They act like **gatekeepers** and help control movement of substances across the membrane.



20. Cell Wall

Plant, fungal and bacterial cells have an additional layer outside the cell membrane called the:

Cell Wall

The cell wall provides:

-  Protection.
-  Structural support.
-  Rigidity.
-  Shape.
-  Mechanical strength.

Plant cells need this rigid structure because plants generally remain fixed in one place and must withstand environmental stresses such as wind and rain.



21. Cell Wall in Plants

Plant cell walls help:

- Keep leaves firm.
- Maintain the shape of cells.
- Keep plants upright.

- Provide structural strength.

The plant cell wall is primarily made of:

Cellulose

Cellulose is a carbohydrate made from many glucose units linked together.

22. Cell Wall and Water Movement

The cell wall is **permeable**.

Water and some dissolved minerals can pass through it.

However, the cell membrane remains selectively permeable.

When a plant cell is placed in a concentrated sugar solution:

 Water leaves the cell by osmosis.

The rigid cell wall prevents the whole cell from collapsing.

Instead:

Cell membrane pulls away from the cell wall

while the inner contents shrink.

23. Plant Cell vs Animal Cell — Cell Wall

Plant Cell

Has:

- ☒ Cell membrane
- ☒ Cell wall

Animal Cell

Has:

 Cell membrane

 Cell wall

Therefore, animal cells can change shape more easily.



24. Prokaryotic and Eukaryotic Cells

Cells are broadly classified into:



Prokaryotic Cells

and



Eukaryotic Cells



25. Prokaryotic Cells

Prokaryotic cells do **not** have a well-defined nucleus.

Their genetic material is located in a region called the:

Nucleoid

They also lack membrane-bound organelles.

Example:



Bacteria

Typical size:

1–10 μm

Most prokaryotic organisms are unicellular.



26. Eukaryotic Cells

Eukaryotic cells have:

-  A well-defined nucleus.
-  Membrane-bound organelles.
-  DNA enclosed within the nucleus.

Examples:



Plant cells



Animal cells

Typical size:

10–100 μm

Eukaryotic organisms may be unicellular or multicellular.



27. Prokaryotic vs Eukaryotic Cells

Feature	 Prokaryotic	 Eukaryotic
Nucleus	 No true nucleus	 Well-defined nucleus
Genetic region	Nucleoid	Nucleus
Membrane-bound organelles	 Absent	 Present
Typical size	1–10 μm	10–100 μm
Organisation	Usually unicellular	Unicellular or multicellular
Example	Bacteria	Plants, animals



28. Cytoskeleton

Eukaryotic cells contain a network of fine fibres called the:

Cytoskeleton

It helps:

-  Provide structural support.
-  Maintain cell shape.
-  Enable internal transport.
-  Support cell movement.

It is visible as a separate structure mainly with an electron microscope.



29. Viruses, Viroids and Prions

The textbook also introduces some **acellular infectious agents**.



Viruses

Contain:

- Genetic material.
- Protein coat.



Viroids

Contain genetic material but lack a protein coat.



Prions

Are misfolded proteins and lack genetic material.

These are not made up of cells.



30. Cell as a Tiny Living Factory

Eukaryotic cells contain specialised organelles.

Each organelle performs particular jobs.

A cell can therefore be compared with a:

Tiny living factory

Different departments perform different functions.

For example:

 Nucleus → Instructions

 ER → Manufacturing and transport

 Golgi apparatus → Packaging

 Mitochondria → Energy

 Lysosomes → Cleaning

 Chloroplast → Food production

 Vacuole → Storage and support

31. Nucleus — House of Coded Instructions

The **nucleus** contains the genetic information of a eukaryotic cell.

It is surrounded by a:

Double-layered nuclear membrane

The nuclear membrane contains pores through which materials can move between the nucleus and cytoplasm.

Chromosomes

The nucleus contains **chromosomes**.

Chromosomes contain:

DNA + Associated Proteins

DNA contains genetic information.

Genes

Functional segments of DNA are called:

Genes

Genes carry information related to inherited characteristics.



32. Chromatin and Chromosomes

In a non-dividing cell:

DNA exists as:

Chromatin

Chromatin appears as a thread-like, tangled material.

When a cell prepares to divide:

Chromatin → Condenses → Chromosomes

Chromosomes become clearly visible during cell division.



33. Nucleolus

The nucleus contains a dense round structure called the:

Nucleolus

The nucleolus is involved in the synthesis of **ribosomal subunits**.

These subunits move into the cytoplasm and combine to form ribosomes.

34. Special Case — Human Red Blood Cells

Mature human red blood cells (**RBCs**) do not have a nucleus.

They are called:

Enucleate cells

The absence of a nucleus gives more space for:

Haemoglobin

This allows RBCs to carry more oxygen.

However, because mature RBCs lack a nucleus:

-  They cannot divide.
-  They have limited ability to repair themselves.

Their lifespan is approximately:

120 days

35. Nucleoid

Prokaryotic cells do not have a membrane-bound nucleus.

Their genetic material is mainly present as a single circular DNA molecule associated with proteins.

The region containing this DNA is called:

Nucleoid



36. Ribosomes — Protein Factories

Ribosomes are tiny structures found:

- Freely in the cytoplasm, or
- Attached to the endoplasmic reticulum.

Main function:



Protein synthesis

★ **Remember:** Ribosome = Protein factory



37. Endoplasmic Reticulum — Manufacturing Factory

The **Endoplasmic Reticulum (ER)** is a network spread through the cytoplasm.

It is continuous with the outer membrane of the nuclear envelope.

The ER helps in:

-  Synthesis of proteins.
-  Synthesis of lipids.
-  Transport of materials.
-  Synthesis of some hormones in specialised cells.

There are two major types:



Rough ER (RER)

Has ribosomes attached to its surface.

Mainly involved in:

- Protein synthesis.
- Protein secretion.

Smooth ER (SER)

Does not have ribosomes.

It is involved in:

- Lipid synthesis.
- Lipid storage.
- Hormone synthesis.

Easy Trick

RER → Ribosomes

SER → Smooth, no ribosomes

38. Golgi Apparatus — Packaging and Shipping Centre

The Golgi apparatus consists of stacks of flattened, sac-like structures.

It is functionally connected with:

- ER
- Cell membrane
- Other organelles

Functions:

 Modifies proteins and lipids.

 Sorts materials.

 Packages them into vesicles.

 Helps transport substances.

 Helps in lysosome formation.

Easy Memory

Golgi = Packaging + Sorting + Shipping

39. Lysosomes — Clean-Up System

Lysosomes are single-membrane-bound sacs containing enzymes.

They help break down:

- Unwanted proteins.
- Carbohydrates.
- Fats.
- Damaged cell components.
- Worn-out organelles.

The breakdown products may be released into the cytoplasm and reused.

Easy Memory

Lysosome = Cell's clean-up system

40. Mitochondria — Powerhouse of the Cell

Mitochondria are often called:

Powerhouses of the cell 

They supply energy needed for most cellular activities.

Mitochondria have:

- Outer membrane.
- Inner membrane.
- Cristae.

 **Cristae**

The inner membrane is folded into finger-like projections called **cristae**.

Cristae increase the surface area available for chemical reactions.



41. ATP — Energy Currency

Inside mitochondria, glucose and other molecules are broken down during:

Cellular respiration

Energy is released and stored in a molecule called:

ATP — Adenosine Triphosphate

ATP acts as the:



Energy currency of the cell

It provides energy for many cellular activities.



42. Plastids

Plastids are special organelles found in plant cells.

They are involved in:

- 🌞 Food synthesis.
- 🍲 Food storage.
- 🎨 Colour production.

Important types include:

1. 🌿 Chloroplasts
 2. 🌈 Chromoplasts
 3. ⚪ Leucoplasts
-

43. Chloroplasts

Chloroplasts contain the green pigment:

Chlorophyll

Chlorophyll absorbs sunlight.

Chloroplasts are the sites of:

Photosynthesis

They have:

- Outer membrane.
 - Inner membrane.
 - Stroma.
 - Chlorophyll-containing structures.
-

44. Chromoplasts

Chromoplasts contain pigments other than chlorophyll.

They are responsible for many bright colours in:

-  Flowers
-  Fruits
-  Some plant parts

Their pigments may be:

- Yellow
- Orange
- Red

These colours can help attract:

 Pollinators

and

 Fruit-eating animals that assist in seed dispersal.

45. Leucoplasts

Leucoplasts are colourless plastids.

They mainly function in:

Food storage

They can store:

- Starch.
- Oils.
- Proteins.

For example, some leucoplasts in potato and taro cells store starch.

46. Chloroplast vs Chromoplast vs Leucoplast

Plastid	Main Feature	Function
 Chloroplast	Contains chlorophyll	Photosynthesis
 Chromoplast	Contains coloured pigments	Produces bright colours
 Leucoplast	Colourless	Stores food

47. Vacuoles — Storage and Support

A mature plant cell usually contains:

One large central vacuole

The vacuole is surrounded by a selectively permeable membrane.

It contains a watery fluid called:

Cell sap

The vacuole stores:

-  Water.
 -  Minerals.
 -  Sugars.
 -  Waste materials.
-

48. Vacuoles and Plant Rigidity

Vacuoles help maintain pressure inside plant cells.

When the vacuole contains enough water:

 Cell becomes firm.

When a plant lacks water:

 Vacuole loses water.

 Cell becomes less firm.

 Plant becomes:

Wilted

Therefore, vacuoles help plants maintain firmness and support.

49. Mitochondria and Plastids Have Their Own DNA

An interesting feature of mitochondria and plastids is that they contain:

-  Their own DNA.
-  Their own ribosomes.

Therefore, they can make some of their own proteins.

Their similarities with certain bacteria suggest an evolutionary relationship with ancient single-celled organisms.

50. Synthetic Biology — J. Craig Venter

In 2010, scientist **J. Craig Venter** and his team carried out an important experiment in synthetic biology.

They:

1.  Studied the complete DNA sequence of *Mycoplasma mycoides*.
2.  Used computer-based methods to study the sequence.
3.  Chemically synthesised a copy of the DNA.
4.  Removed DNA from another related bacterial cell.
5.  Inserted the synthetic DNA into that cell.
6.  The cell then grew and divided according to the instructions in the inserted DNA.

★ Important conclusion

The experiment showed that:

DNA controls the structure and activities of a cell.

However, scientists did **not** create an entire cell from non-living materials.

Only the DNA was synthetic; other cell components came from an existing living cell.

51. How Do Normal Cells Grow and Divide?

Our bodies constantly replace old or damaged cells.

For example:

 A cut on the skin heals.

 Hair grows again.

These processes occur because cells:

Grow → Divide → Produce new cells

Cells cannot simply keep increasing in size indefinitely.

Instead, growth of an organism largely occurs through an increase in the **number of cells**.



52. Cell Division



Definition

Cell division is the process by which new cells are formed from pre-existing cells.

Cell division is important for:



Growth



Repair



Replacement of old cells



Asexual reproduction



Sexual reproduction

There are two major types:

1 Mitosis

2 Meiosis



53. Mitosis

Mitosis is the most common type of cell division.

It helps in:

-  Growth.

-  Repair.
-  Replacement.
-  Maintenance.
-  Asexual reproduction.

Result of Mitosis

One parent cell produces:

Two genetically identical daughter cells

Each daughter cell receives:

- Same genetic information.
- Same number of chromosomes as the parent cell.

Easy Memory

MITOSIS → 2 identical cells

54. Why Is Mitosis Important?

Imagine a cut on your skin.

Damaged cells need to be replaced.

Mitosis produces new cells that can replace damaged or dead cells.

Similarly, growth from childhood to adulthood requires repeated cell division.

55. Meiosis

Meiosis is a special type of cell division that produces:

Gametes

Gametes are reproductive cells.

In humans:

🧑 Sperm are produced in the testes.

🧑 Eggs are produced in the ovaries.

In plants, meiosis is involved in the formation of reproductive cells through structures such as:

🌻 Anthers

🌸 Ovaries

56. Result of Meiosis

One parent cell undergoes **two successive divisions**.

The result is:

Four daughter cells

Each has:

Half the chromosome number of the parent cell

57. Why Is Meiosis Important?

Meiosis is important for:

- 🧬 Sexual reproduction.
- 🌈 Genetic variation.
- 👤 Producing gametes.
- 🌍 Diversity among organisms.

Children resemble their parents but are not exactly identical because sexual reproduction creates variation.

58. Mitosis vs Meiosis

Feature	🌟 Mitosis	🧬 Meiosis
Number of divisions	1	2
Daughter cells	2	4
Chromosome number	Same as parent	Half of parent
Genetic similarity	Generally identical	Genetically varied
Main role	Growth, repair, maintenance	Sexual reproduction
Gametes produced?	❌ No	✅ Yes

★ Super Easy Memory

MITOSIS → 2 same

MEIOSIS → 4 half



59. Cell Culture

Scientists can grow plant and animal cells outside the body under suitable conditions.

This is called:

Cell Culture

Cells are placed in a:

🥄 Nutrient-rich medium

and maintained under appropriate:

- 🌡 Temperature
- 🧪 pH conditions
- 💧 Moisture
- 🧫 Sterile conditions

Applications

Cell culture is useful for:

-  Studying cells.
 -  Producing medicines.
 -  Producing vaccines.
 -  Producing biochemicals.
 -  Developing certain food-related products.
-

60. Errors in Cell Division

Cell division must be properly controlled.

Errors in:

Mitosis

may lead to:

- Uncontrolled cell division.
- Tumour formation.
- Abnormal chromosome numbers.

Meiosis

may lead to:

- Genetic disorders.
 - Developmental problems.
 - Reduced fertility.
 - Early pregnancy loss.
-

61. Cancer Cells

Normal cells:

 Grow in a controlled manner.

 Divide when required.

 Stop dividing when appropriate.

 Eventually die when no longer needed.

Cancer cells can lose this control.

They may:

 **Divide uncontrollably**

This can result in:

Tumours

Some tumours may be benign, while cancerous tumours can invade nearby tissues and spread to other parts of the body.

62. Contact Inhibition

In many normal animal cells, cell division usually stops when cells come into contact with neighbouring cells.

This process is called:

Contact inhibition

Cancer cells can lose this control and continue dividing.

 **What about plants?**

Plant cells have rigid cell walls and follow a different pattern of growth. They do not show contact inhibition in the same way as many animal cells.

63. Programmed Cell Death

Cells also have natural mechanisms for controlled death.

Programmed Cell Death (PCD)

is a genetically regulated and organised process of selective cell destruction.

It is important for:

-  Normal development.
-  Cellular quality control.
-  Immune function.

Example

During development of an embryo, programmed cell death removes cells between developing fingers.

Without this process, the fingers could remain connected, producing webbed hands.



64. Meet the Scientist — Arun Kumar Sharma

Professor Arun Kumar Sharma was an Indian scientist known for his work on:



Chromosomes



Plant taxonomy



Evolution



Plant development

He developed useful laboratory methods for studying chromosomes in plants.

He received several honours, including:



Shanti Swarup Bhatnagar Award



Padma Bhushan

His work contributed significantly to the study of chromosomes and plant biology.



65. Totipotency

The chapter also introduces the idea of:

Totipotency

In 1902, Austrian botanist **Gottlieb Haberlandt** proposed that a living plant cell can potentially develop into a complete plant when provided with suitable nutrients and favourable conditions.

This special ability of plant cells is called:

Totipotency

Haberlandt's ideas helped lay the foundation for:

Plant Tissue Culture Technology

66. Cell Theory

The **Cell Theory** is one of the most important unifying principles in biology.

Matthias Schleiden — 1838

He proposed that:

All plants are made up of cells.

Theodor Schwann — 1839

He concluded that:

Animals are also made up of cells.

Rudolf Virchow — 1855

He added the important idea that:

New cells arise from pre-existing cells.

67. Classical Cell Theory

The classical Cell Theory states:

1

 All living organisms are made up of one or more cells.

2

 The cell is the basic unit of structure and function in living organisms.

3

 All cells arise from pre-existing cells.

★ Why is Cell Theory Important?

It provides a common principle that connects living organisms ranging from:

 Bacteria

to

 Humans



68. Do Cells Live Forever?

No. Cells have a definite life span.

Normal cells:

 Grow.

 Divide.

 Perform their functions.

 Eventually die.

Dead cells are replaced by new cells.

The balance between cell growth, division and death is important for healthy organisms.



69. Organisation of Cells in Living Organisms

The organisation of multicellular organisms can be represented as:



Cell



Tissue



Organ



Organ System



Organism

Example

Muscle cells → Muscle tissue → Heart → Circulatory system → Human

This demonstrates how specialised cells work together to form complex organisms.



70. Important Differences



Cell Membrane vs Cell Wall

Cell Membrane

Cell Wall

Thin

Rigid

Present in all cells	Present in plants, fungi and bacteria
Selectively permeable	Permeable
Controls movement of substances	Provides support and rigidity
Made mainly of lipids and proteins	Plant cell wall mainly cellulose

RER vs **SER**

RER	SER
Ribosomes present	Ribosomes absent
Looks rough	Looks smooth
Protein synthesis	Lipid synthesis
Protein secretion	Lipid/hormone-related functions

Chloroplast vs **Chromoplast**

Chloroplast	Chromoplast
Contains chlorophyll	Contains other pigments
Green	Often yellow, orange or red
Photosynthesis	Colour production
Absorbs light	Helps produce attractive colours

71. Important Organelles at a Glance

 **Organelle**

 **Main Function**

 Nucleus	Stores genetic information; controls cell activities
--	--

 Ribosome	Protein synthesis
 RER	Protein synthesis and transport
 SER	Lipid synthesis and storage
 Golgi apparatus	Modification, sorting and packaging
 Lysosome	Breakdown of waste and damaged components
 Mitochondria	Energy production
 Chloroplast	Photosynthesis
 Chromoplast	Colour pigments
 Leucoplast	Food storage
 Vacuole	Storage and support
 Cell membrane	Controls movement of substances
 Cell wall	Support, rigidity and protection

72. Key Terms

 Term	 Meaning
 Cell	Basic structural and functional unit of life
 Unicellular	Made of one cell
 Multicellular	Made of many cells
 Microscope	Instrument used to magnify small objects
 Resolution	Ability to distinguish two close objects clearly
 Magnification	Enlargement of an object's apparent size
 Cell membrane	Selectively permeable boundary of a cell

 Osmosis	Movement of water through a selectively permeable membrane
 Diffusion	Movement of particles from higher to lower concentration
 Cell wall	Rigid outer covering outside the membrane in plants, fungi and bacteria
 Prokaryote	Cell without a membrane-bound nucleus
 Eukaryote	Cell with a membrane-bound nucleus
 Nucleoid	Region containing genetic material in a prokaryotic cell
 Organelle	Specialised structure performing a specific cell function
 Gene	Functional segment of DNA
 ATP	Molecule that acts as cellular energy currency
 Mitosis	Division producing two genetically identical daughter cells
 Meiosis	Division producing four cells with half the chromosome number
 Tumour	Abnormal mass formed by uncontrolled cell growth
 Totipotency	Ability of a plant cell to develop into a complete plant under suitable conditions



73. Important Exam Questions

Q1. Why is the cell called the structural and functional unit of life?

Answer:

All living organisms are made up of cells, making the cell the basic structural unit. Cells also perform essential life processes, making them the functional units of life.

Q2. What is the limit of resolution of the human eye?

Answer:

The human eye can distinguish two points separated by approximately **0.1 mm** at the near point of vision.

Q3. Who discovered cells?

Answer:

Robert Hooke observed and named cells in **1665** while examining a thin slice of cork using a microscope.

Q4. What is osmosis?

Answer:

Osmosis is the movement of water through a selectively permeable membrane from a region of higher water concentration and lower solute concentration towards a region of lower water concentration and higher solute concentration.

Q5. Differentiate between diffusion and osmosis.

Answer:

Diffusion: Movement of particles from higher concentration to lower concentration.

Osmosis: Movement of water through a selectively permeable membrane.

Q6. Why do plant cells have a cell wall?

Answer:

The cell wall provides rigidity, support and protection. It helps plants maintain their shape and remain upright and protects cells from environmental stresses.

Q7. What is the difference between prokaryotic and eukaryotic cells?

Answer:

Prokaryotic cells lack a well-defined membrane-bound nucleus and membrane-bound organelles. Eukaryotic cells have a well-defined nucleus and several membrane-bound organelles.

Q8. What is the function of mitochondria?

Answer:

Mitochondria release energy from food during cellular respiration and store much of the released energy in ATP.

Q9. What is the function of ribosomes?

Answer:

Ribosomes are the sites of protein synthesis.

Q10. What is the function of the Golgi apparatus?

Answer:

The Golgi apparatus modifies, sorts and packages proteins and lipids for transport, secretion or other cellular functions.

Q11. What is mitosis?

Answer:

Mitosis is a type of cell division in which one parent cell produces two genetically identical daughter cells having the same chromosome number as the parent cell.

Q12. What is meiosis?

Answer:

Meiosis is a two-step cell division process that produces four daughter cells, each having half the chromosome number of the parent cell. It is important for sexual reproduction and genetic diversity.

Q13. What is Cell Theory?

Answer:

The classical Cell Theory states that:

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

74. Competency-Based Question

Situation

Two similar potato pieces are placed in:

 Beaker A → Plain water

 Beaker B → Concentrated salt solution

After one hour:

 A becomes swollen.

 B becomes smaller.

Questions

1. Which process causes these changes?

 Osmosis.

2. Why does the potato in water swell?

 Water moves into the cells through the selectively permeable membrane.

3. Why does the potato in concentrated salt solution shrink?

 Water moves out of the cells into the concentrated solution.

4. What does this experiment demonstrate?

 It demonstrates the movement of water through a selectively permeable membrane.

75. Another Competency-Based Question

Situation

A student observes a cell that has:

- No well-defined nucleus.
- No membrane-bound organelles.
- Genetic material located in a nucleoid region.

Answer:

The cell is a:

 **Prokaryotic cell**

76. Think Like a Scientist

 **What would happen if mitochondria were removed from a eukaryotic cell?**

Mitochondria are major sites of energy release.

Without mitochondria, the cell would have a severe shortage of energy for many cellular activities.

Therefore, many important cellular processes would be affected.

77. What Would Happen If Skin Cells Divided by Meiosis?

Skin cells normally divide by **mitosis**.

Mitosis produces daughter cells with the same chromosome number.

If skin cells underwent meiosis instead:

- They would produce cells with half the chromosome number.
- Normal growth and repair would be disrupted.
- Wound healing would not occur normally.

Therefore, mitosis is essential for normal growth and repair.

78. Chapter at a Glance

CELL



CELL MEMBRANE

Controls movement of substances



ORGANELLES

Perform specialised functions



NUCLEUS

Contains genetic information



MITOCHONDRIA

Release energy



RIBOSOMES

Make proteins



GOLGI

Packages and sorts materials



LYSOSOMES

Break down unwanted materials



CHLOROPLAST

Photosynthesis



VACUOLE

Storage and support



CELL DIVISION

Mitosis + Meiosis



GROWTH + REPAIR + REPRODUCTION

79. Quick Revision

- ★ Cells are the basic structural and functional units of life.
- ★ Robert Hooke observed and named cells in 1665.
- ★ The human eye has a resolution limit of about 0.1 mm.
- ★ Microscopes allow us to observe cells.

- ★ Electron microscopes can reveal structures at the nanometre scale.
 - ★ The cell membrane is selectively permeable.
 - ★ Osmosis is the movement of water through a selectively permeable membrane.
 - ★ Diffusion is the movement of particles from higher to lower concentration.
 - ★ Plant, fungal and bacterial cells have a cell wall outside the cell membrane.
 - ★ Prokaryotic cells lack a membrane-bound nucleus.
 - ★ Eukaryotic cells have a well-defined nucleus and membrane-bound organelles.
 - ★ The nucleus contains chromosomes made of DNA and associated proteins.
 - ★ Genes are functional segments of DNA.
 - ★ Ribosomes make proteins.
 - ★ Mitochondria release energy and produce ATP.
 - ★ Chloroplasts perform photosynthesis.
 - ★ Chromoplasts provide colour.
 - ★ Leucoplasts store food.
 - ★ Vacuoles store substances and help provide support.
 - ★ Mitosis produces two genetically identical daughter cells.
 - ★ Meiosis produces four daughter cells with half the chromosome number.
 - ★ Cell division is important for growth, repair and reproduction.
 - ★ Uncontrolled cell division can result in tumours.
 - ★ Cell Theory explains the fundamental importance of cells in living organisms.
-



80. SUPER QUICK MEMORY TRICKS



Organelles

Nucleus → Instructions 🧠

Ribosome → Protein 🧪

Mitochondria → Energy ⚡

Golgi → Packaging 📦

Lysosome → Cleaning 🧹

Chloroplast → Food 🌿

Vacuole → Storage 💧

🧠 Cell Division

MITOSIS → 2 identical cells

MEIOSIS → 4 cells + half chromosomes

🧠 Solutions

Hypotonic → Water enters 💧 ⬆️

Hypertonic → Water leaves 💧 ⬆️

Isotonic → Balanced ⚖️

🌟 FINAL TAKEAWAY

The cell may be microscopic 🧫, but it performs an enormous number of activities.

Every living organism depends on cells for:

- 🌱 Growth
- ⚡ Energy
- 🧪 Chemical activities
- 🛡️ Protection
- 🔄 Repair

 Reproduction
 Communication

 **The cell is the basic structural and functional unit of life, and understanding cells helps us understand life itself.**