CLASS 9 SCIENCE
(EXPLORATION)

CHAPTER 2
CELL : THE BUILDING BLOCK OF LIFE
(PART 2)

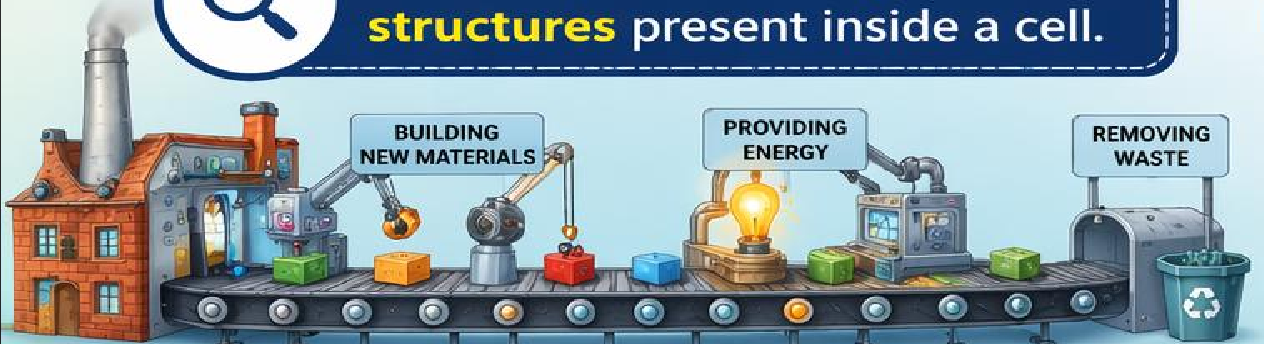
2.3.1 Why do eukaryotic cells need these organelles?

Eukaryotic cells carry out various life processes in different cell organelles independently at the same time.

Cell organelles help in building new materials, removing waste, and providing energy to the cell. They work together to perform all functions of a cell.

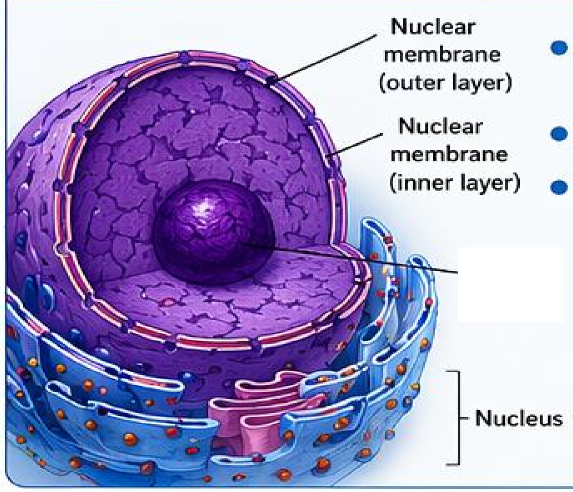
In other words, a cell is like a **tiny living factory**, with each of its part doing a specific job.

Let us explore these **specialised structures** present inside a cell.



NUCLEUS – CONTROL CENTRE OF THE CELL

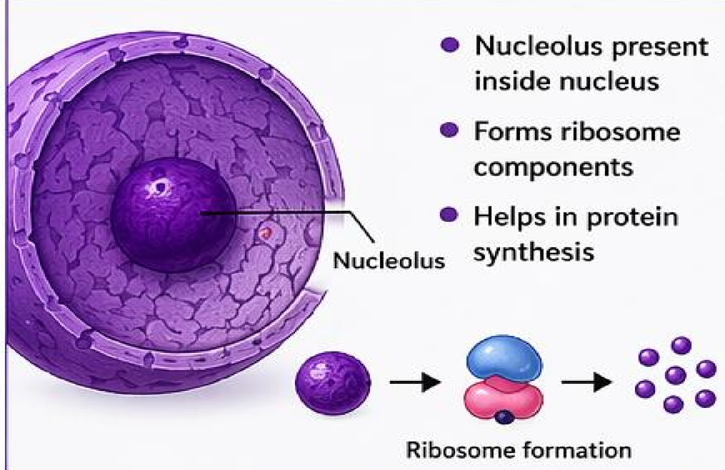
1. STRUCTURE OF NUCLEUS



- Double-layered nuclear membrane
- Nuclear pores present
- Allows exchange of materials

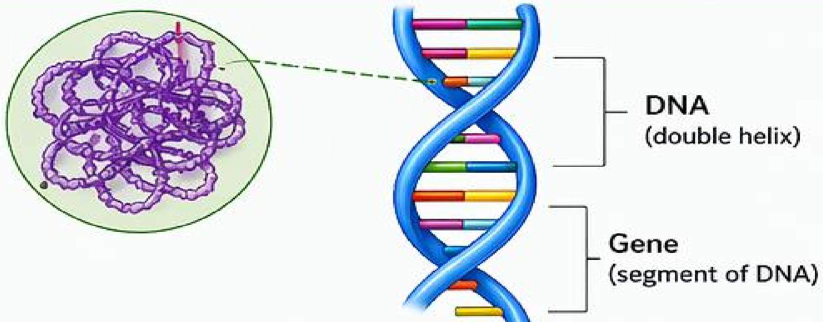
FUNCTION
Controls all cell activities and stores genetic information.

2. NUCLEOLUS & FUNCTION



- Nucleolus present inside nucleus
- Forms ribosome components
- Helps in protein synthesis

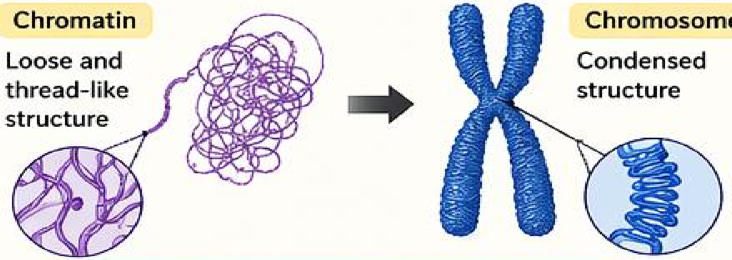
3. GENETIC MATERIAL



- Chromatin present inside nucleus
- Contains DNA and proteins
- DNA carries genetic information

4. CHROMATIN & CHROMOSOMES

Chromatin
Loose and thread-like structure

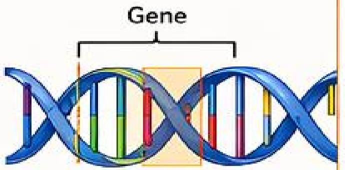


Chromosome
Condensed structure

Chromatin condenses to form chromosomes during cell division and becomes visible.

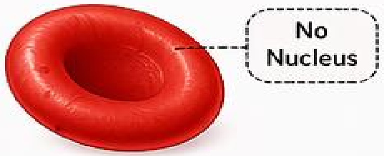
5. GENES

- Functional units of DNA
- Control inheritance of characters



Genes contain instructions for the synthesis of proteins.

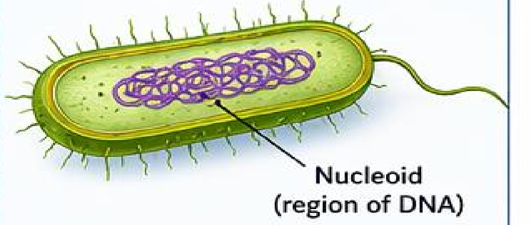
6. SPECIAL CASE – RBCs



- RBCs do not have nucleus
- Carry more oxygen
- Cannot divide or repair

Life span is short (approx. 120 days)

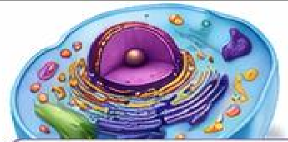
7. PROKARYOTIC CELLS



- Prokaryotic cells lack true nucleus
- DNA present in nucleoid region

KEY TAKEAWAY

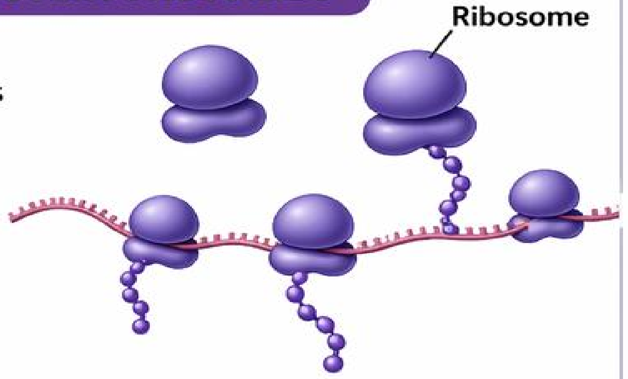
- Nucleus is the control centre of the cell.
- It contains genetic material (DNA).
- Nucleolus helps in ribosome formation.
- Chromatin forms chromosomes during cell division.
- Some cells like RBCs do not have nucleus.
- Prokaryotes have nucleoid instead of nucleus.



RIBOSOMES & ENDOPLASMIC RETICULUM (ER)

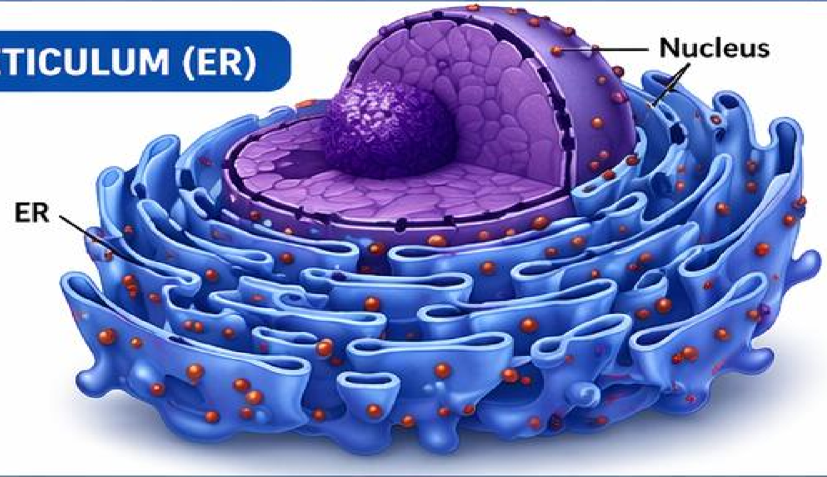
RIBOSOMES – PROTEIN FACTORIES

- Very small cell structures
- Present in cytoplasm or on ER
- Site of protein synthesis
- Help in making proteins

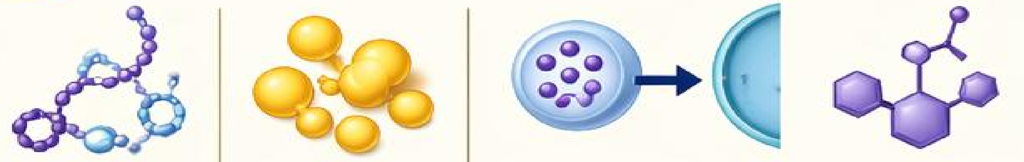


ENDOPLASMIC RETICULUM (ER)

- Large network inside cytoplasm
- Connected to nuclear membrane
- Helps in synthesis and transport



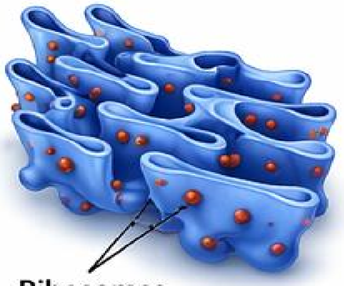
FUNCTIONS OF ER



Protein synthesis | Lipid (fat) synthesis | Transport of materials | Helps in hormone production

ROUGH ENDOPLASMIC RETICULUM (RER)

- Ribosomes attached on surface
- Appears rough
- Involved in protein synthesis
- Helps in protein transport

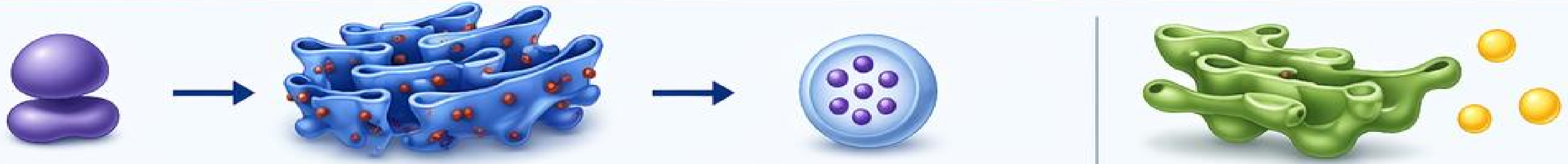


SMOOTH ENDOPLASMIC RETICULUM (SER)

- No ribosomes on surface
- Appears smooth
- Involved in lipid synthesis
- Stores fats and hormones

HOW THEY WORK TOGETHER

Ribosomes make proteins.
RER processes and transports them.
SER makes lipids and stores important molecules.

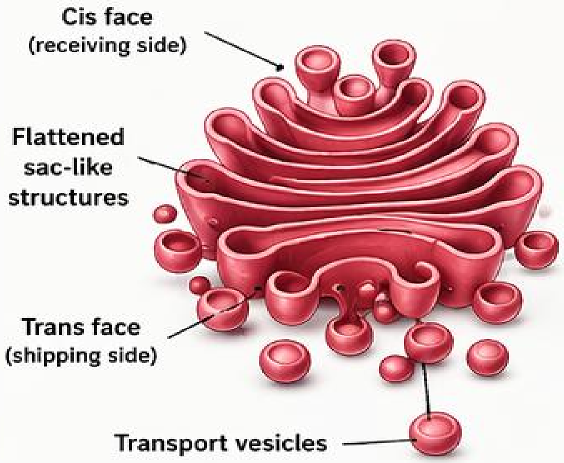


Ribosomes synthesize proteins → RER modifies and transports proteins → Transport vesicles carry proteins to their destination | SER synthesizes lipids, stores fats and hormones

KEY POINT: Ribosomes and ER are essential for the synthesis, modification and transport of proteins, fats and other important molecules in the cell.

GOLGI APPARATUS & LYSOSOMES –
PACKAGING CENTRE & CLEAN-UP SYSTEM

GOLGI APPARATUS – PACKAGING CENTRE



FUNCTIONS

- Modifies proteins and lipids
- Sorts and selects materials
- Packages into vesicles
- Transports materials within or outside the cell

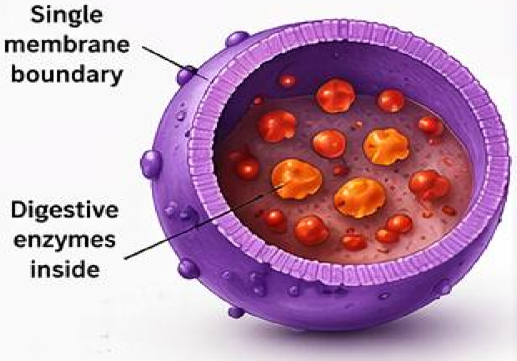
WORKS LIKE

the cell's post office

CONNECTIONS

- Functionally linked to Endoplasmic Reticulum (ER)
- Connected to cell membrane
- Receives proteins and lipids from ER

LYSOSOMES – CLEAN-UP SYSTEM



FUNCTIONS

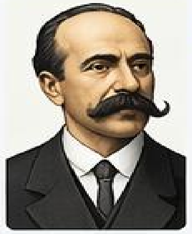
- Breaks down waste materials
- Digests old and damaged organelles
- Breaks down proteins, fats and carbohydrates
- Keeps the cell clean and healthy

HOW LYSOSOMES WORK

RECYCLING ROLE

The products formed after breakdown are released into the cytoplasm and reused in other cellular processes.

MEET A SCIENTIST



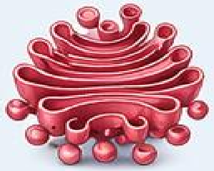
Camillo Golgi discovered the Golgi apparatus in 1898 while studying nerve cells of a barn owl.

Early microscopes could not see it clearly. It was confirmed later using the electron microscope.

THREAD OF CURIOSITY

Human sperm cells contain lysosomal enzymes. These enzymes help break down the outer layer of the egg during fertilisation.

KEY TAKEAWAY



Golgi apparatus modifies, sorts and packages proteins and lipids for transport.

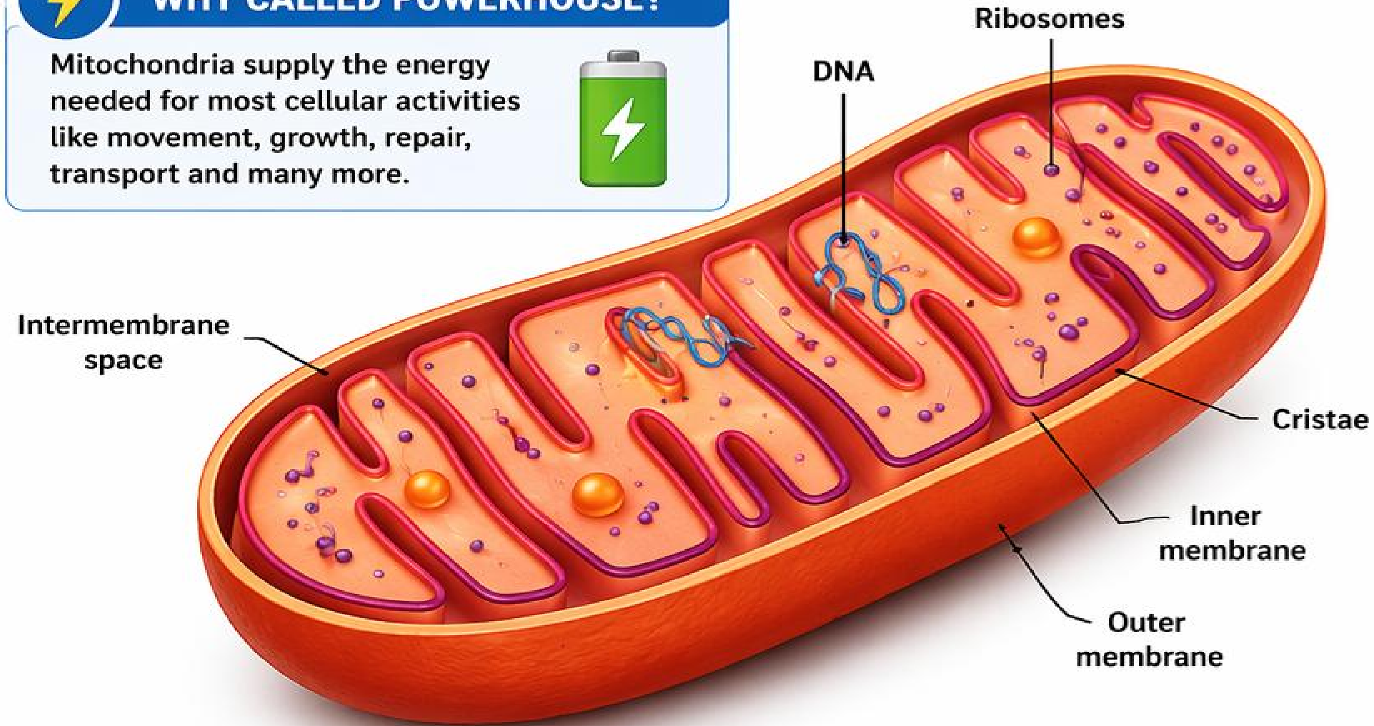
Lysosomes break down waste and damaged parts, keeping the cell clean.

Together, they help the cell function efficiently and stay healthy.

MITOCHONDRIA – THE POWERHOUSE OF THE CELL

WHY CALLED POWERHOUSE?

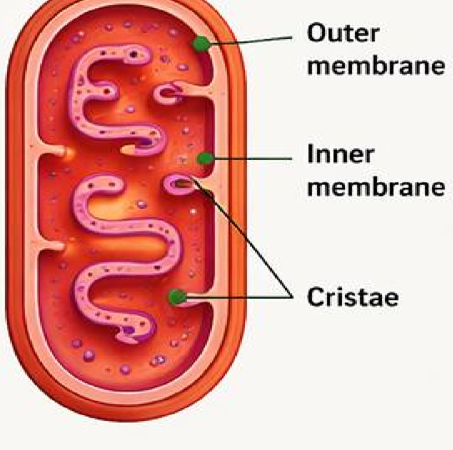
Mitochondria supply the energy needed for most cellular activities like movement, growth, repair, transport and many more.



Structure of a mitochondrion

STRUCTURE

- Mitochondria are surrounded by two membranes.
- Outer membrane – smooth and porous.
- Inner membrane – folded into finger-like projections called cristae.
- Cristae increase the surface area for chemical reactions and facilitate energy production.



FUNCTION

Glucose and other molecules enter mitochondria → Broken down during cellular respiration → Energy is released → Used for all cellular activities

CELLULAR RESPIRATION

Glucose → Mitochondria → Carbon dioxide + Water → Energy (ATP)

ATP – ENERGY CURRENCY OF THE CELL

Adenosine Triphosphate (ATP)

- The energy released is stored in the form of ATP.
- ATP acts as the energy currency of the cell.
- It is used for most cellular activities.

KEY CONCEPT

- Mitochondria break down food molecules to release energy.
- Energy is stored in ATP and used by the cell whenever required.
- Without mitochondria, cellular activities cannot be performed.

PLASTIDS

CENTRE FOR FOOD SYNTHESIS IN PLANT CELLS AND BEYOND

WHAT ARE PLASTIDS?

- Plastids are specialised organelles found in plant cells.
- They help in food synthesis and storage.
- They use sunlight to prepare food by photosynthesis.

CHLOROPLAST – THE PHOTOSYNTHESIS CENTRE

- Green coloured plastid containing chlorophyll.
- Absorbs sunlight energy.
- Site of photosynthesis.
- Converts light energy into chemical energy.

TYPES OF PLASTIDS

CHLOROPLASTS

- Green in colour
- Contain chlorophyll
- Carry out photosynthesis

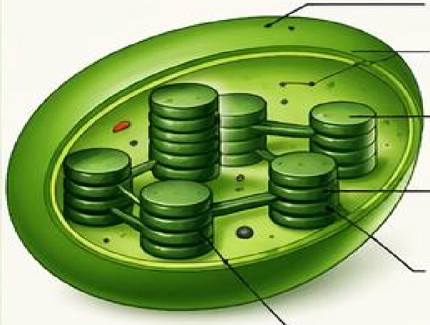
CHROMOPLASTS

- Contain pigments other than chlorophyll
- Give yellow, orange or red colours to flowers and fruits
- Attract pollinators and help in seed dispersal

LEUCOPLASTS

- Colourless plastids
- Store food materials
- Found in non-green parts like roots, tubers and seeds

STRUCTURE OF CHLOROPLAST



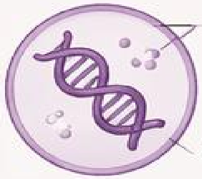
- Surrounded by a double membrane.
- Inner fluid is called stroma.
- Disc-like structures called thylakoids are arranged in stacks called grana.
- Thylakoids contain chlorophyll.
- Large surface area helps in trapping light energy.

FOOD STORAGE

- Sugars formed during photosynthesis are stored in stroma.
- Also stored in the form of starch granules.

SPECIAL FEATURES

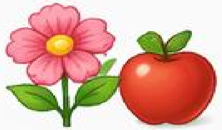
- Plastids have their own DNA and ribosomes.
- They can make some of their own proteins.
- These features are similar to bacteria.



FUNCTIONS OF PLASTIDS

Prepare food by photosynthesis

Store food (starch, oils, proteins)



Provide colours to flowers and fruits

KEY CONCEPT

Plastids are essential for making food, storing food and adding colours.

They help plants survive and grow in their environment.

Without plastids, plants cannot prepare their own food or store energy.

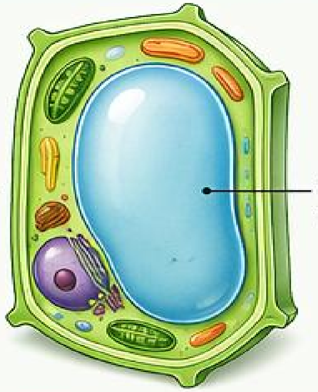
Plastids are vital for plant life and for life on Earth.

VACUOLES – THE ORGANELLES FOR STORAGE AND SUPPORT

Store • Support • Maintain • Protect

WHAT ARE VACUOLES?

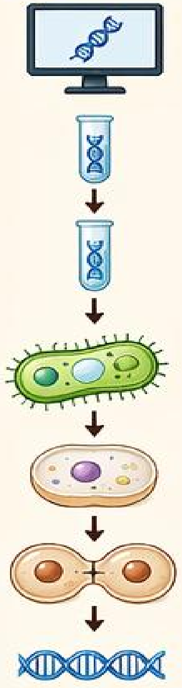
- Membrane-bound spaces present in cells.
- In plant cells, usually one large central vacuole is present.



FUNCTIONS OF VACUOLES

- Store water.
- Store minerals and sugars.
- Store waste materials.
- Help in maintaining cell shape and structure.

THREADS OF CURIOSITY



In 2010, scientist J. Craig Venter and his team made an important discovery in the field of synthetic biology.

They first studied the complete DNA sequence of a simple bacterium called *Mycoplasma mycoides* using a computer programme.

Then, they chemically synthesised (in the laboratory) an exact copy of this DNA.

Next, they took another closely related bacterium and removed its DNA, but kept the rest of the cell (intact).

They inserted the synthetic DNA into this cell.

After this, the cell started to grow and divide, following the instructions from the newly inserted synthetic DNA.

This experiment showed that DNA controls the structure and activities of a cell.

However, scientists did not create a completely new cell from scratch. Only the DNA was synthetic. The other parts of the cell were taken from an already existing living cell.

ROLE IN PLANT CELLS

- The large central vacuole is filled with cell sap.
- Cell sap creates internal pressure (turgor pressure).
- This pressure keeps the plant cell firm and supports the plant.

WILTING EFFECT

- When plant does not get enough water, vacuole loses water.
- Turgor pressure decreases.
- Cells become less firm.
- Plant wilts.

IN ANIMAL CELLS

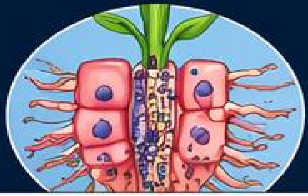
- Vacuoles are present but are usually small in size.
- They are temporary in nature.
- They help in storing water, food and waste materials.

KEY CONCEPT

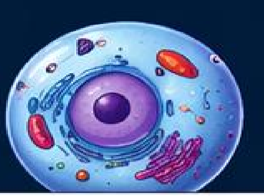
- Vacuoles help in storage and support, essential for plant survival.
- DNA is the control system that directs the cell's structure and activities.

IMPORTANT LEARNING

- DNA controls the structure of the cell.
- DNA controls the activities of the cell.
- Complete cell cannot be created artificially at present.



HOW DO NORMAL CELLS GROW AND DIVIDE?



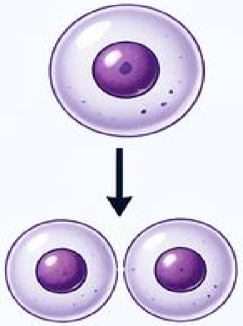
Growth • Repair • Replacement • Continuity of Life

WHY DO CELLS DIVIDE?

- When we get a cut, it heals after a few days.
- When hair falls, new hair grows back.
- This happens because cells in our body can grow and divide.
- They replace old, dead or damaged cells.

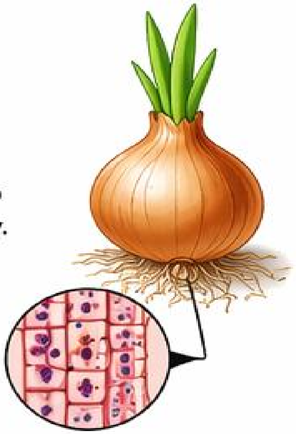
LIMIT OF CELL GROWTH

- Cells grow only up to a certain size.
- After that, they divide to form new cells.
- This helps in growth and repair of the body.



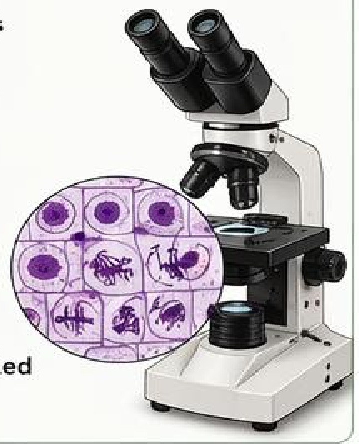
ONION ROOT TIP EXPERIMENT

- Actively growing root tips of onion are used to study cell division.
- Cells at the root tip divide continuously.
- They can be easily observed under a microscope.



OBSERVATION UNDER MICROSCOPE

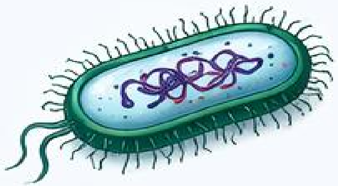
- Onion root tip cells show different stages of division.
- Cells look similar in structure.
- Different cells are in different stages of cell division.
- This process is called cell division.



EVERY DAY, NEW CELLS REPLACE OLD ONES

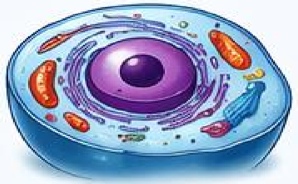
- An estimated hundreds of billions of cells in our body are replaced every day.
- This is almost 1% of the total number of cells in our body.

TYPES OF CELLS DIVISION



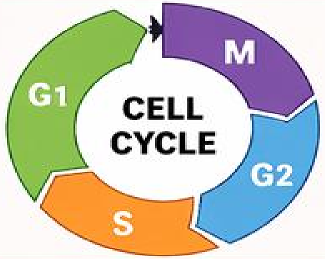
Prokaryotic Cells
(e.g., Bacteria)

- Cell division occurs in both prokaryotic and eukaryotic cells.
- In eukaryotic cells, division is more controlled and organised.



Eukaryotic Cells
(e.g., Plant & Animal Cells)

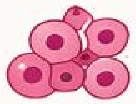
CELL CYCLE – THE ORDERLY PROCESS



- Cell cycle is the organised sequence of events that a cell goes through to grow and divide.
- It includes growth, DNA replication and division.
- It ensures that each new cell receives the correct genetic material.

KEY CONCEPT

Cell division is essential for growth and repair.



It replaces old, dead and damaged cells.

It helps in maintaining health and survival.

It is the basis of life and continuity of organisms.

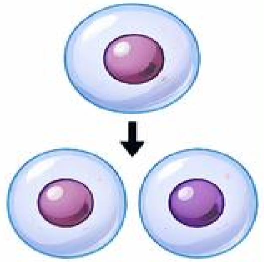
CELL DIVISION

THE PROCESS OF FORMING NEW CELLS FROM PRE-EXISTING CELLS

ESSENTIAL FOR GROWTH, REPAIR AND REPRODUCTION

WHAT IS CELL DIVISION?

- Cell division is the process by which new cells are formed from pre-existing cells.
- It allows living organisms to grow, repair tissues and reproduce.



IMPORTANCE OF CELL DIVISION

Growth
Increase in number of cells leads to growth of the body.

Repair
Damaged cells are replaced by new cells.

Replacement
Old, dead or worn-out cells are replaced.

Reproduction
New organisms are produced through cells.

TYPES OF CELL DIVISION

MITOSIS
Occurs in body cells (somatic cells)

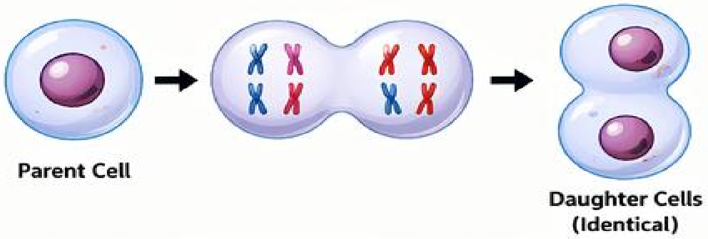
MEIOSIS
Occurs in reproductive cells (germ cells)

MITOSIS – GROWTH AND REPAIR

WHAT IS MITOSIS?

- Type of cell division in body cells.
- One parent cell divides to form two daughter cells.
- The daughter cells are genetically identical to the parent cell.
- Each daughter cell has the same number of chromosomes as the parent cell.

PROCESS OF MITOSIS



FUNCTIONS OF MITOSIS

Growth
Increases the number of cells.

Repair
Heals wounds and replaces damaged tissues.

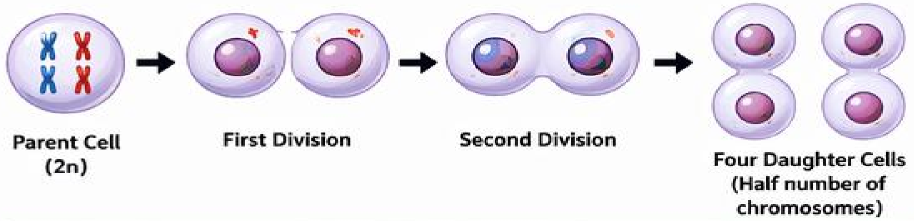
Maintenance
Maintains and renews body cells.

MEIOSIS – REPRODUCTION AND VARIATION

WHAT IS MEIOSIS?

- Type of cell division in reproductive cells.
- One parent cell divides twice to form four daughter cells.
- Daughter cells are genetically different.
- Each daughter cell has half the number of chromosomes as the parent cell.

PROCESS OF MEIOSIS



FEATURES OF MEIOSIS

Two-Step Process
Occurs in two successive divisions.

Creates Variation
Produces genetic variation among individuals.

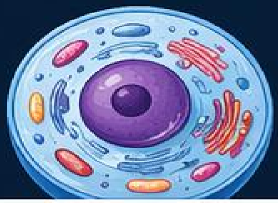
Important for Sexual Reproduction
Forms gametes (sperm and egg cells).

KEY CONCEPT

Mitosis
Helps in growth, repair and maintenance of the body.

Meiosis
Helps in reproduction and creates genetic variation in living organisms.

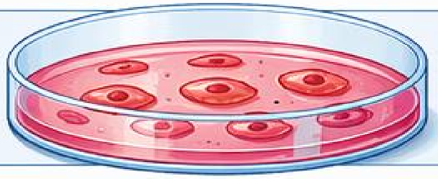
Both mitosis and meiosis are vital processes that ensure continuity of life on Earth.



BRIDGING SCIENCE AND SOCIETY

Cell Biology in Action for a Better Tomorrow

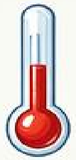
Scientists grow plant and animal cells outside the body in special conditions. This is called **cell culture**.



CELL CULTURE

- Cells are taken from an organism.
- Placed in a nutrient-rich medium.
- Allows cells to grow and multiply.
- Used in a safe and controlled environment.

CONDITIONS REQUIRED



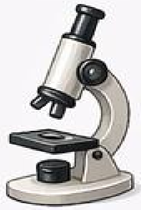
Proper temperature

Suitable pH (acidic/alkaline)

Moisture

Sterile environment

USES OF CELL CULTURE



Study of cell functions

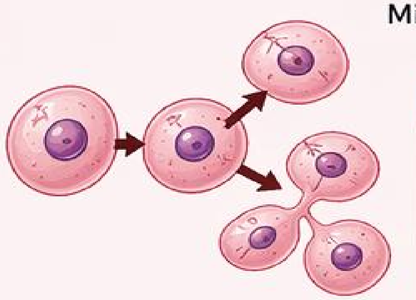
Production of medicines

Vaccine development

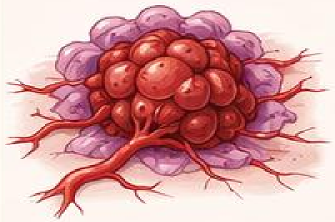
Food and biochemical production

IMPORTANCE OF PROPER AND CONTROLLED CELL DIVISION

Mitosis and meiosis must occur in a proper and controlled manner.
Errors in these processes can lead to various problems.

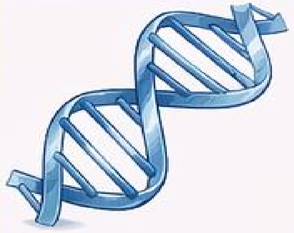


ERRORS IN MITOSIS



- Leads to uncontrolled cell division.
- Can cause tumours and cancer.
- Results in abnormal number of cells.

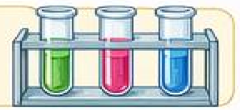
ERRORS IN MEIOSIS



- Leads to genetic disorders.
- May cause developmental problems.
- Can result in early pregnancy loss or reduced fertility.

KEY TAKEAWAY

Cell culture and the proper control of cell division are essential for scientific research, medical advancements, and improving the quality of human life.



MEET A SCIENTIST

Arun Kumar Sharma

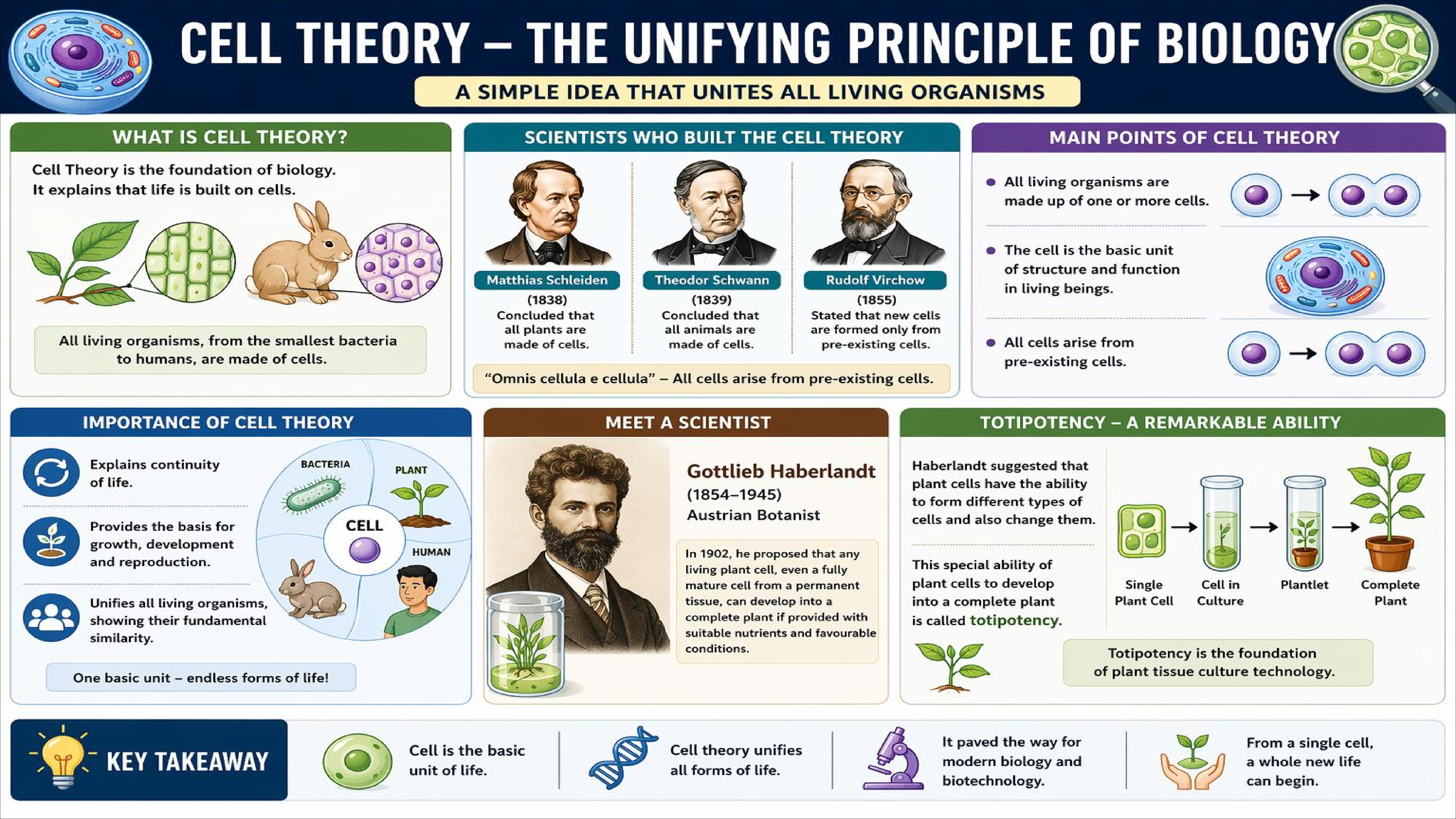
A renowned Indian scientist known for his work on chromosomes.

- Worked in the fields of plant taxonomy, evolution and development.
- Developed many useful laboratory techniques to study chromosomes in plants.
- Received many honours for his contributions to botany.

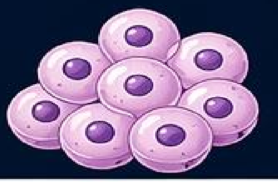
AWARDS AND HONOURS

Shanti Swarup Bhatnagar Award

Padma Bhushan


CELL THEORY – THE UNIFYING PRINCIPLE OF BIOLOGY
A SIMPLE IDEA THAT UNITES ALL LIVING ORGANISMS
WHAT IS CELL THEORY?
Cell Theory is the foundation of biology. It explains that life is built on cells.
All living organisms, from the smallest bacteria to humans, are made of cells.
SCIENTISTS WHO BUILT THE CELL THEORY
Matthias Schleiden
(1838)
Concluded that all plants are made of cells.
Theodor Schwann
(1839)
Concluded that all animals are made of cells.
Rudolf Virchow
(1855)
Stated that new cells are formed only from pre-existing cells.
"Omnis cellula e cellula" – All cells arise from pre-existing cells.
MAIN POINTS OF 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.
IMPORTANCE OF CELL THEORY
Explains continuity of life.
Provides the basis for growth, development and reproduction.
Unifies all living organisms, showing their fundamental similarity.
BACTERIA
PLANT
CELL
HUMAN
One basic unit – endless forms of life!
MEET A SCIENTIST
Gottlieb Haberlandt
(1854–1945)
Austrian Botanist
In 1902, he proposed that any living plant cell, even a fully mature cell from a permanent tissue, can develop into a complete plant if provided with suitable nutrients and favourable conditions.
TOTIPOTENCY – A REMARKABLE ABILITY
Haberlandt suggested that plant cells have the ability to form different types of cells and also change them.
This special ability of plant cells to develop into a complete plant is called totipotency.
Single Plant Cell
Cell in Culture
Plantlet
Complete Plant
Totipotency is the foundation of plant tissue culture technology.
KEY TAKEAWAY
Cell is the basic unit of life.
Cell theory unifies all forms of life.
It paved the way for modern biology and biotechnology.
From a single cell, a whole new life can begin.

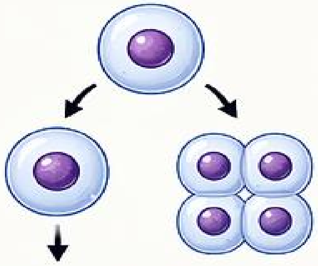
DO CELLS GROW AND REPRODUCE FOREVER?



Control, Balance and Life

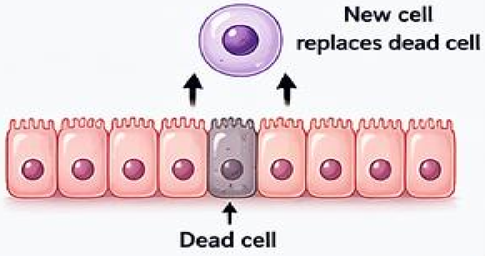
CONTROLLED GROWTH

Cells grow and divide in a controlled way. Each cell has a fixed life span and performs its functions at the right place and time.



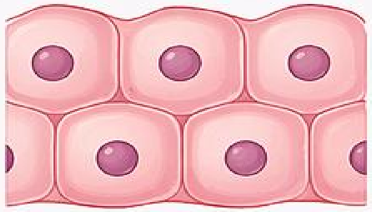
REPLACEMENT OF CELLS

Dead cells are replaced by new cells that take over their functions. This ensures that all body processes continue smoothly.



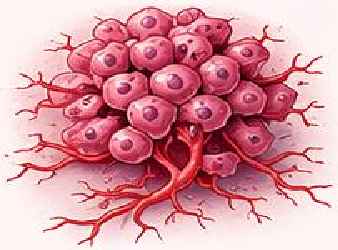
CONTACT INHIBITION

In animal cells, division stops when cells come in contact with neighbouring cells. This prevents overcrowding and helps in organised growth.



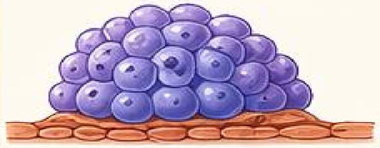
CANCER CELLS – LOSS OF CONTROL

Cancer cells lose control of division. They continue to divide uncontrollably, ignoring contact inhibition. This leads to the formation of tumours.

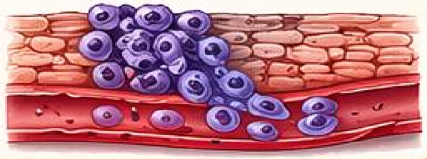


TUMOURS

Benign (Non-cancerous)
Localized growth. Does not spread to other parts.



Malignant (Cancerous)
Invades nearby tissues and can spread to other parts of the body.

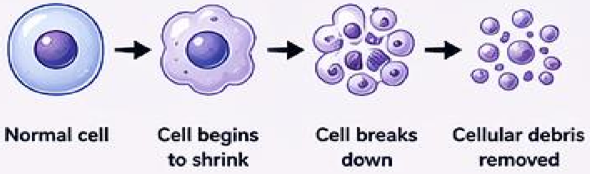


PLANT CELLS – DIFFERENT PATTERN

Plant cells have a rigid cell wall. They do not show contact inhibition and follow a different pattern of growth.

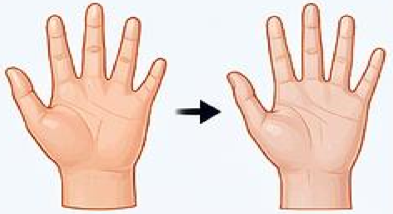
PROGRAMMED CELL DEATH (PCD)

Cells have a natural way of dying in a controlled manner. This process is called Programmed Cell Death (PCD). It is essential for normal development, cellular quality control and immune function.



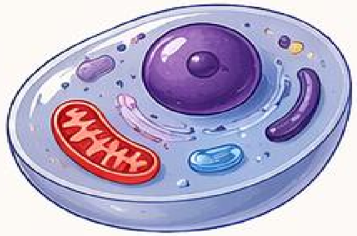
EXAMPLE OF PCD

During development of fingers and toes, cells between the digits die by PCD. This helps in the proper formation of separate digits.



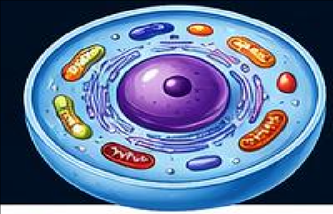
ROLE OF CELLS IN OUR BODY

Cells perform vital functions such as producing energy, synthesising substances, secreting, excreting, forming new cells and maintaining the proper functioning of the body.



KEY TAKEAWAY

- Cell growth and division are tightly controlled.
- Proper control maintains health and balance.
- Loss of control can lead to diseases like cancer.
- PCD helps in normal development and removing unwanted cells.
- Cells are the basic units that keep life running smoothly.



AT A GLANCE – CELL: THE BASIC UNIT OF LIFE

Summary of Key Concepts

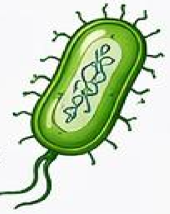
CELL – BASIC UNIT OF LIFE

- Cell is the basic structural and functional unit of all living organisms.
- All life processes occur within cells.

TYPES OF CELLS

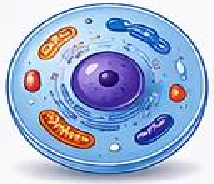
PROKARYOTIC CELLS

- No true nucleus
- DNA present in nucleoid region
- No membrane-bound organelles



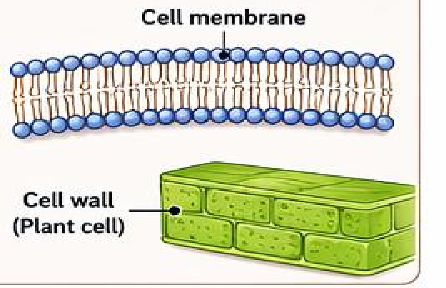
EUKARYOTIC CELLS

- True nucleus present
- Larger and more complex
- Membrane-bound organelles present



CELL COVERING

- Cell membrane present in all cells
- Selectively permeable
- Cell wall present in:
  - Plants
  - Fungi
  - Bacteria



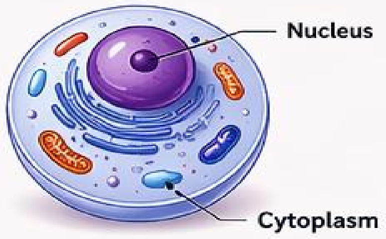
NUCLEUS & CYTOPLASM

NUCLEUS

- Contains chromosomes
- DNA carries genetic information

CYTOPLASM

- Contains organelles
- Each organelle has a specific function



CELL ORGANELLES

- **Nucleus** – Control centre of the cell
- **Endoplasmic Reticulum** – Transport of substances
- **Mitochondria** – Powerhouse of the cell
- **Golgi Apparatus** – Packaging and dispatching
- **Ribosomes** – Protein synthesis
- **Lysosomes** – Digestion and waste removal

PLASTIDS (IN PLANT CELLS)

Chloroplast
Site of photosynthesis

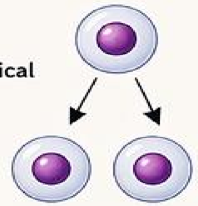
Chromoplast
Gives colour to fruits and flowers

Leucoplast
Stores food (starch, oils, proteins)

CELL DIVISION

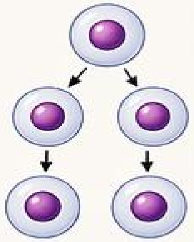
MITOSIS

- One division
- Produces 2 identical daughter cells
- Helps in growth, repair and replacement



MEIOSIS

- Two successive divisions
- Produces 4 daughter cells
- Half the number of chromosomes
- Used in reproduction



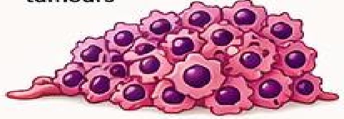
CELL GROWTH & CONTROL

NORMAL CELLS

- Grow in a controlled manner
- Perform specific functions
- Die naturally when no longer needed

CANCER CELLS

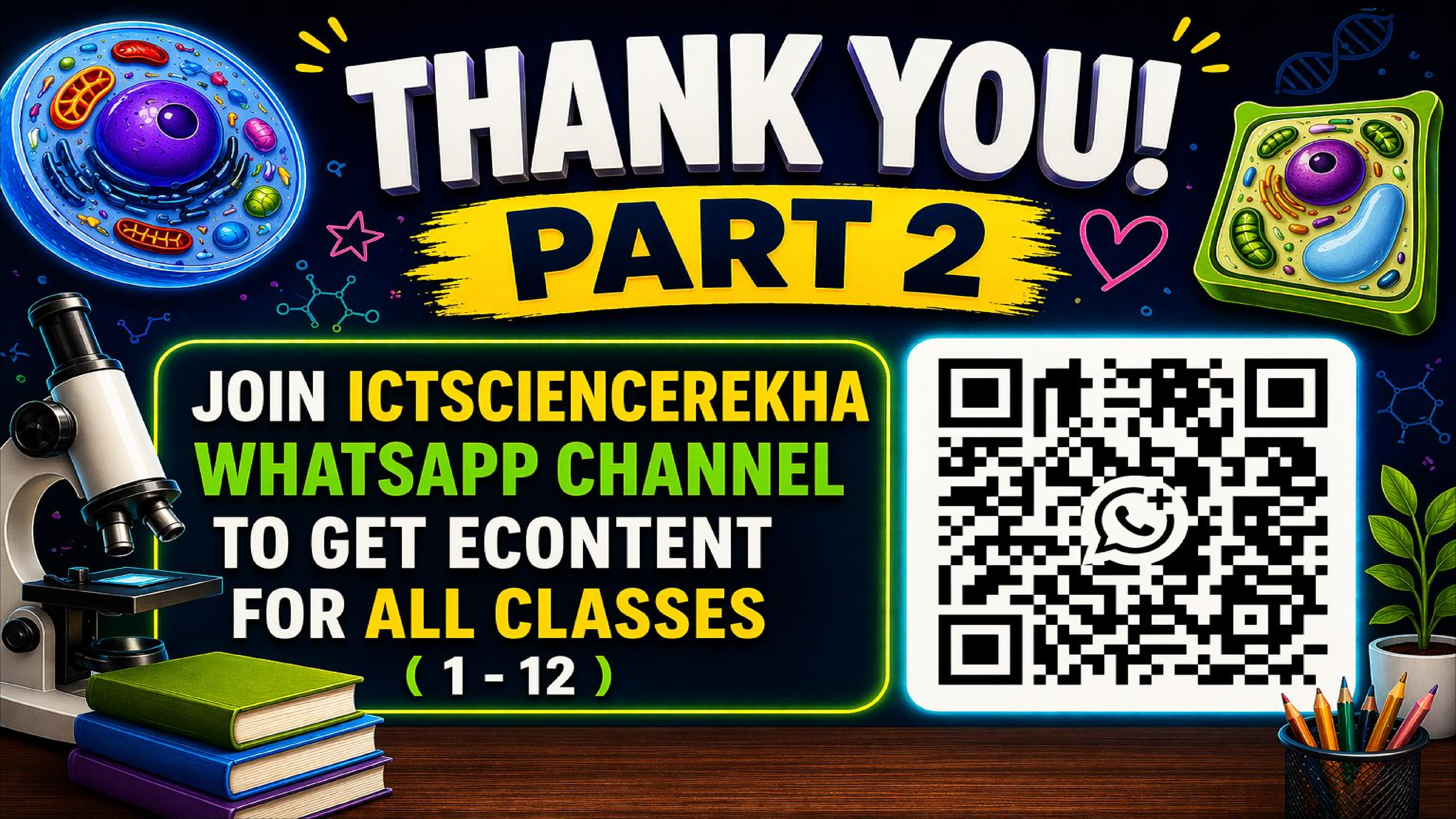
- Lose control of division
- Divide uncontrollably
- Lead to formation of tumours



KEY TAKEAWAY

- Cells are the building blocks of life.
- Cells have specialised structures to perform specific functions.
- Proper control of cell growth and division is essential for healthy life.
- Loss of control can lead to diseases like cancer.

From the tiniest bacteria to the largest trees and animals – all are made of cells.
Understanding cells helps us understand life itself.


THANK YOU!
PART 2
JOIN ICTSCIENCEREKHA
WHATSAPP CHANNEL
TO GET ECONTENT
FOR ALL CLASSES
(1 - 12)


THANK YOU!
PART 2
For Watching!
CELL –
THE BUILDING
BLOCK OF LIFE
SMALL CELLS
BIG
WONDERS!
LIKE
SHARE
SUBSCRIBE
Your Support Means a Lot!