Cell Theory

Class 9 Biology · Chapter: The Fundamental Unit of Life
🎬 **Video explanation (PrayogX reel):** https://www.instagram.com/reel/DfCiNf3HYJB/

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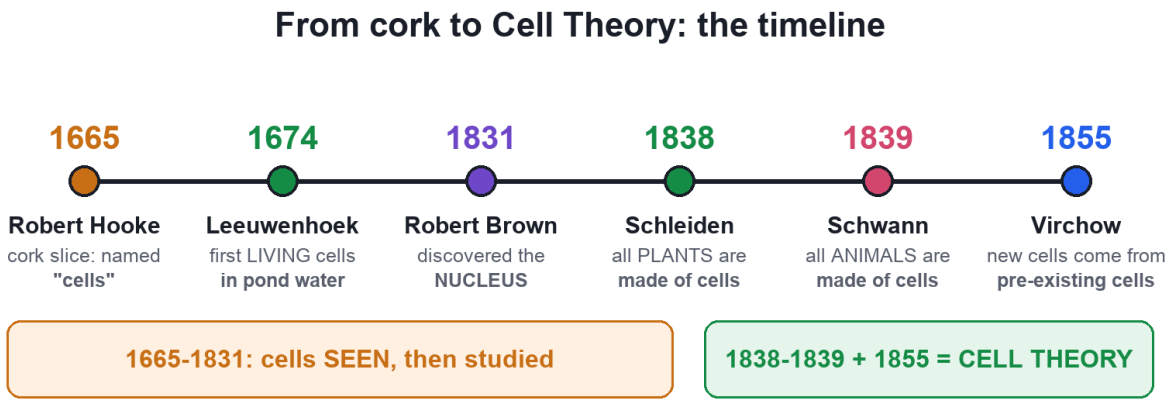
1. The big question

Your body has about **37 trillion** cells (3.7×10^{13}, a scientific estimate). A mango leaf, a mushroom, an earthworm and a bacterium are all made of cells too. But how do we *know* that every living thing is built from cells? The answer is the **Cell Theory**, one of the basic ideas of biology. It was put together by three scientists between 1838 and 1855.

2. Key definitions

Term	Meaning
Cell	The smallest structural and functional unit of a living organism; the smallest unit that can carry out all life processes.
Cell Theory	The theory that all living organisms are made of cells, the cell is the basic unit of life, and all cells arise from pre-existing cells.
Unicellular organism	An organism made of a single cell that does every job of life (e.g. *Amoeba*, *Paramecium*, *Chlamydomonas*, bacteria).
Multicellular organism	An organism made of many cells that share the work (e.g. fungi, plants, animals, humans).
Structural unit	The building block: the body is *built* from cells, like a wall is built from bricks.
Functional unit	The working unit: every life activity (respiration, nutrition, excretion) actually *happens* inside cells.

3. How Cell Theory was built, step by step



Step 1: Cells are seen (1665–1831). Robert Hooke saw tiny boxes in cork and named them "cells" (1665). Leeuwenhoek saw the first *living* free cells in pond water (1674). Robert Brown discovered the **nucleus** (1831). People could now see cells, but nobody had said that *all* life is made of them.



Matthias Schleiden
botanist, 1838



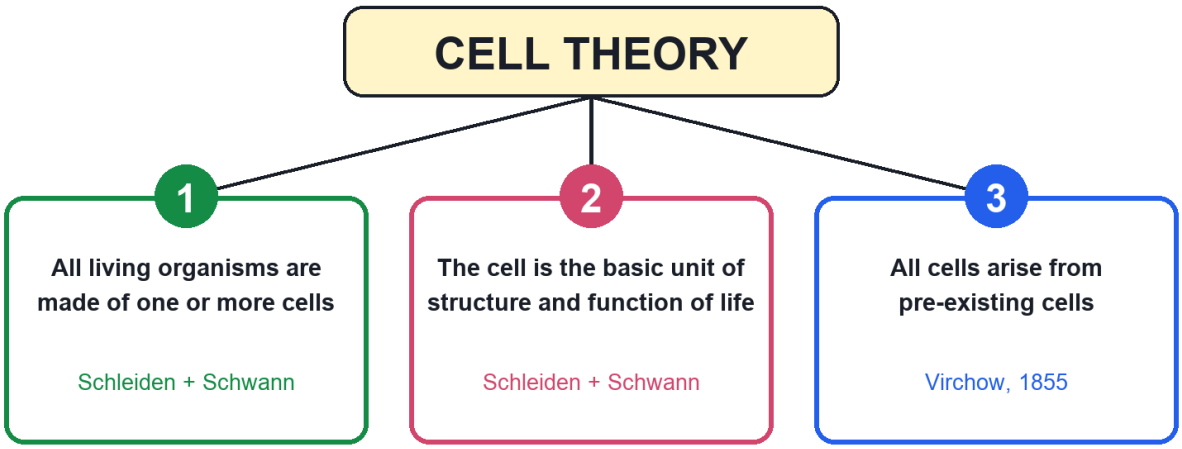
Theodor Schwann
zoologist, 1839



Rudolf Virchow
physician, 1855

Step 2: Plants (1838). The German botanist **Matthias Schleiden** studied many plant parts under the microscope and concluded: **all plants are made of cells.**
Step 3: Animals (1839). The German zoologist **Theodor Schwann** found that animal tissues are also made of cells and concluded: **all animals are made of cells, and the cell is the basic unit of life.** Together Schleiden and Schwann proposed the **Cell Theory**.
Step 4: The missing piece (1855). Schleiden and Schwann could not explain where new cells come from. **Rudolf Virchow** showed that new cells are formed only by the division of existing cells: **"Omnis cellula e cellula": all cells arise from pre-existing cells.** This completed the theory.

4. The three postulates of Cell Theory



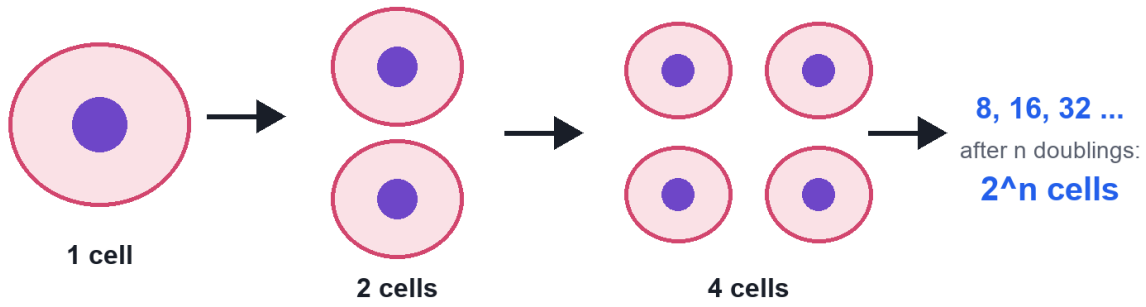
Exception to remember: VIRUSES are not made of cells (they are acellular).

Virchow's Latin phrase: "Omnis cellula e cellula" (every cell from a cell).

#	Postulate	Given by	What it means
1	**All living organisms are made of one or more cells.**	Schleiden (1838) + Schwann (1839)	No living thing exists without cells; an *Amoeba* is one cell, you are trillions.
2	**The cell is the basic structural and functional unit of life.**	Schleiden + Schwann	Cells are both the bricks and the workers of the body.
3	**All cells arise from pre-existing cells.**	Virchow (1855)	A new cell never forms from non-living matter; it comes from the division of an older cell.

5. Postulate 3 in action: cell division

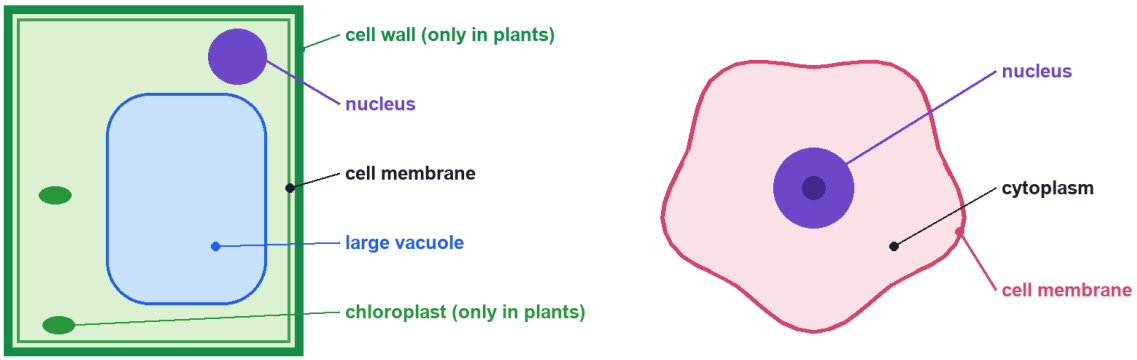
Postulate 3: every new cell comes from an existing cell



One cell divides into 2, then 4, then 8, 16, 32 and so on. **After n rounds of division: number of cells = 2^n** (if every cell divides each time). This is how you grew from **one cell** (the zygote) into about 37 trillion cells.

6. What Schleiden and Schwann compared

What Schleiden and Schwann saw: plant cell vs animal cell



Feature	Plant cell	Animal cell
Cell wall	Present (made of cellulose)	Absent
Cell membrane, nucleus, cytoplasm	Present	Present
Vacuole	One large central vacuole	Small or absent
Plastids (chloroplasts)	Present	Absent
Shape	Fixed, usually rectangular	Irregular or rounded

Different in detail, but **both are cells**. This common plan is exactly why one theory covers both

kingdoms.

7. Analogy and examples

- **Analogy: a building of bricks.** A house is made of bricks (structure). Now imagine every brick is also a tiny worker that breathes, eats and cleans (function). That is a cell: structural *and* functional unit.
- **Unicellular examples:** *Amoeba*, *Paramecium*, *Chlamydomonas*, bacteria; one cell does everything.
- **Multicellular examples:** mango tree, mushroom, earthworm, human; cells divide the work (nerve cells carry messages, muscle cells contract, red blood cells carry oxygen).
- **Everyday proof of postulate 3:** a cut on your skin heals because nearby skin cells divide and make new cells.

8. Exceptions and limits (important for exams)

- **Viruses** are not made of cells (they are **acellular**). They show life only inside a host cell, so they do not fit postulate 1.
- Cell Theory does **not** explain how the **very first cell** on Earth was formed.
- Schleiden and Schwann's original idea that new cells form from non-living material was **wrong**; Virchow corrected it.

9. Solved examples

Solved example 1. A bacterium divides once every 20 minutes. Starting with one bacterium, how many will there be after 2 hours (assuming every cell divides each time)?
Solution: Number of divisions n = 120 min ÷ 20 min = 6. Number of cells = $2^n = 2^6$ = **64 bacteria**. (This uses postulate 3: each new cell comes from an existing cell.)
Solved example 2. A student says, "Muscle is a tissue, so the tissue is the basic unit of life." Is the student right?
Solution: No. A tissue is a group of cells. The smallest unit that can carry out life processes on its own is the **cell** (an *Amoeba* lives as a single cell). So the cell, not the tissue, is the basic unit (postulate 2).

10. Key takeaways

- Cell Theory: Schleiden (plants, 1838) + Schwann (animals, 1839) + Virchow (cells from cells, 1855).
- **Three postulates:** all organisms are made of cells; the cell is the basic structural and functional unit; all cells arise from pre-existing cells.
- Virchow: **"Omnis cellula e cellula"**.
- After n divisions: **2^n** cells.
- Exception: **viruses** are acellular.

Practice questions (CBSE style)

Q1 (MCQ). Who proposed that all cells arise from pre-existing cells?
(a) Robert Hooke (b) Matthias Schleiden (c) Rudolf Virchow (d) Robert Brown
Q2 (MCQ). Which of the following does NOT fit the Cell Theory?
(a) *Amoeba* (b) Virus (c) Mushroom (d) Bacterium
Q3 (Short answer, 2 marks). State the three postulates of the Cell Theory.
Q4 (Short answer, 2 marks). Why is the cell called both the *structural* and the *functional* unit of life?
Q5 (Short answer, 2 marks). Name the two scientists who proposed the Cell Theory and state what each one studied.
Q6 (Numerical, 3 marks). A yeast cell divides once every 90 minutes. Starting from one cell, how many cells will there be after 6 hours? After how many hours will there first be more than 1000 cells?
Q7 (Application, 3 marks). A wound on your hand heals in a few days. Explain this using the Cell Theory.
Q8 (Diagram based, 3 marks). Draw a neat labelled diagram of a plant cell and an animal cell. Write two differences that you can see in your diagrams.
Q9 (Case based, 4 marks). In 1838 Schleiden studied plant tissues and in 1839 Schwann studied animal tissues. Both found cells everywhere. But they believed new cells could form from non-living fluid. In 1855 Virchow showed this was wrong.
(a) What common conclusion did Schleiden and Schwann reach? (1)
(b) What was wrong in their idea about new cells? (1)
(c) State Virchow's correction in one line. (1)
(d) Give one limitation of the Cell Theory. (1)

Answer key with worked solutions

A1. (c) Rudolf Virchow, 1855 ("Omnis cellula e cellula").
A2. (b) Virus. Viruses are acellular (not made of cells), so they do not fit postulate 1.
A3. (i) All living organisms are made of one or more cells. (ii) The cell is the basic structural and functional unit of life. (iii) All cells arise from pre-existing cells.
A4. *Structural:* every organism is built from cells, like a wall from bricks. *Functional:* all life processes (respiration, nutrition, excretion, reproduction) take place inside cells; a single cell like *Amoeba* can carry out all of them.
A5. Matthias Schleiden, a botanist, studied **plants** (1838). Theodor Schwann, a zoologist, studied **animals** (1839).
A6. Number of divisions in 6 h: n = 360 min ÷ 90 min = 4. Cells = 2^4 = **16 cells**.
For more than 1000 cells: 2^9 = 512 < 1000 and 2^{10} = 1024 > 1000, so 10 divisions are needed. Time = 10 × 90 min = 900 min = **15 hours**.
A7. Postulate 3 says all cells arise from pre-existing cells. The healthy skin cells around the wound divide again and again; the new cells fill the gap, so the wound heals. New cells are never made from non-living material.
A8. Diagram as in Section 6. Plant cell labels: cell wall, cell membrane, nucleus, cytoplasm, large vacuole, chloroplast. Animal cell labels: cell membrane, nucleus, cytoplasm. Differences:

(i) the plant cell has a cell wall, the animal cell does not; (ii) the plant cell has a large central vacuole (and chloroplasts), the animal cell has small or no vacuoles (and no chloroplasts).
A9. (a) All plants and animals are made of cells; the cell is the basic unit of life. (b) They thought new cells could form from non-living material. (c) "Omnis cellula e cellula": all cells arise from pre-existing cells. (d) Either: it does not explain the origin of the first cell, or viruses (acellular) do not fit it.