

Chapter 2: The Invisible Living World: Beyond Our Naked Eye

1. Introduction to the Invisible World

- **The Concept of Lenses:** The human eye can only see objects above a certain size, which kept many tiny things unknown for a long time. Early people discovered that a curved piece of glass, shaped like a lentil seed (thick in the middle and thin at the edges), could magnify objects, and they named it a "lens".
- **Robert Hooke and the Cell:** In 1665, scientist Robert Hooke published a book called *Micrographia* containing detailed drawings of tiny objects seen through a microscope that magnified things 200 to 300 times. While looking at a thin slice of cork, he observed empty spaces resembling a honeycomb and named each small space a "cell," using the term for the first time in science to describe the basic unit of life.
- **Antonie van Leeuwenhoek:** In the 1660s, this Dutch scientist built better lenses and more useful microscopes. He was the first to clearly describe living things like bacteria and blood cells, earning him the title "Father of Microbiology".
- **Definition of Organisms:** All living beings, whether plants or animals of various shapes, sizes, and colors, are called organisms.

2. What Is a Cell?

- **The Cell:** All living beings are made up of cells, which act as the basic building blocks of life.
- **Plant Cells (Onion Peel Activity):** When a thin, transparent layer of an onion bulb is peeled, stained with safranin (a red-colored stain), and viewed under a microscope, it reveals nearly rectangular structures closely arranged without any space between them, resembling a brick wall.
- **Animal Cells (Cheek Cell Activity):** When the inside of a human cheek is scraped, stained with methylene blue, and observed, the cells appear as polygon-shaped structures that form a protective inner lining in the mouth.

Key Components of a Cell:

- **Cell Membrane:** The porous outer layer that encloses the cell, separates it from other cells, and controls the entry of essential materials and the exit of waste.
- **Nucleus:** A round, membrane-covered structure in the middle of the cell that regulates all cellular activities and growth.
- **Cytoplasm:** The jelly-like space between the cell membrane and the nucleus. It contains compounds like carbohydrates, proteins, fats, and mineral salts, and is where most life processes take place.

Special Structures in Plant Cells:

- **Cell Wall:** An extra outer layer outside the cell membrane that provides rigidity and strength to plants, making their cells compact and firm.
- **Plastids (e.g., Chloroplasts):** Tiny rod-shaped structures found in plant cells. Chloroplasts contain green chlorophyll for photosynthesis, while other plastids help in storing substances.
- **Vacuoles:** Large, empty-looking spaces in plant cells that store important substances, help eliminate waste, and maintain the cell's shape and strength. Animal cells generally lack vacuoles, or have very small ones to store water-dissolved substances.

3. Variation in Shape and Structure of Cells

- Cells vary vastly in shape (e.g., rectangular, elongated, oval, tube-like) and number depending on the organism and the specific function the cell must perform.
- **Muscle Cells:** Thin, flexible, and spindle-shaped, allowing them to contract and relax in a wave-like manner (e.g., pushing food down the food pipe or churning food in the stomach).
- **Nerve Cells (Neurons):** Long, elongated, and branched structures designed to quickly carry messages to and from different parts of the body.

4. Levels of Organisation in Living Organisms

- The body of a living organism is organized in a complex hierarchy:
 1. **Cell:** The basic unit of life.
 2. **Tissue:** A group of similar cells working together.
 3. **Organ:** Different tissues organized to perform a specific task (e.g., stomach).
 4. **Organ System:** Several organs working together to perform a major body function (e.g., digestive system).
 5. **Organism:** All organ systems combined into a complete living being.
- **Multicellular Organisms:** Organisms like plants and animals are made of many cells. Their life begins with a single cell—the 'egg'—which repeatedly divides to form the complete organism.
 - *Fun Fact:* The yolk of an ostrich egg is a single cell (the largest known cell in the living world), measuring 130 mm to 170 mm in diameter.

5. What Are Microorganisms?

- **Definition:** Tiny living creatures that cannot be seen with the naked eye are called microorganisms or microbes. They require a microscope (which magnifies 100 to 400 times) to be observed.
- They can be **unicellular** (single-celled like bacteria and Amoeba) or **multicellular** (many-celled like some fungi and algae).
- **Types of Microorganisms:**
 - **Protozoa:** E.g., *Amoeba* (single cell, irregular shape) and *Paramecium* (uses specialized structures to move).
 - **Algae:** E.g., single-celled or multicellular green branched filaments containing chlorophyll.
 - **Fungi:** E.g., Bread mould (sac-like structures) and general Mould (brush-like filaments), which lack chlorophyll.
 - **Bacteria:** Found in spherical, comma, spiral, or rod shapes, sometimes featuring hair-like projections.
- **Viruses:** Microscopic, acellular entities that only multiply when they enter a living host cell (plant, animal, or bacterial), often causing diseases.

6. How Are We Connected to Microbes?

- Microbes are incredibly diverse and exist everywhere: in water, soil, air, inside our bodies (like gut bacteria aiding digestion), and in extreme environments (hot springs and snow).

A. Cleaning the Environment (Decomposition)

- Microorganisms like bacteria and fungi act on dead plants, fallen leaves, and animal waste, breaking down complex substances into simpler, nutrient-rich natural manure in a process called **decomposition**. This recycles nutrients back to the soil.
- **Biogas:** In oxygen-free environments, bacteria decompose plant and household waste, releasing a mixture of gases called biogas (primarily carbon dioxide and methane), which is used as fuel for cooking, heating, and running vehicles.
- *Scientific Fact:* In 1971, scientist Ananda Mohan Chakrabarty developed a special bacterium capable of breaking down oil spills to combat pollution, earning a patent for it in 1980.

- *Historical Heritage:* Ancient Indian texts like the Vedas and Atharvaveda mention 'Krimi', referring to tiny visible and invisible entities and their beneficial/harmful effects.

B. Microorganisms and Food

- **Yeast (Fungus):** Yeast respires and breaks down food in warm conditions, releasing carbon dioxide gas. These gas bubbles make dough (for breads and cakes) soft and fluffy. Yeast also produces a small amount of alcohol, altering the dough's smell.
- **Lactobacillus (Bacteria):** This bacterium feeds on lactose (sugar in milk), multiplies in warm conditions, and ferments the milk. It produces lactic acid, which curdles the milk and makes the resulting curd sour. It is also used to ferment idli, dosa, and bhatura batter.
- *Note on Food Preservation:* Food items left out rot due to microbe infection. Pickles and murabbas don't rot because the high concentration of added salt or sugar acts as a preservative, preventing microbe growth.

C. Agriculture and Nitrogen Fixation

- **Rhizobium (Bacteria):** These bacteria live in swollen root nodules of legume plants (like beans, peas, and lentils). They trap nitrogen from the air and convert it into a form useful for plants, naturally increasing soil fertility without chemical fertilizers.

D. Amazing Microalgae

- Microalgae are microscopic plant-like organisms (e.g., *Spirulina*, *Chlorella*, Diatoms) that live in water, soil, and air.
- They perform photosynthesis, releasing oxygen and producing more than half of the Earth's oxygen supply. They also clean water and are used to make biofuel.
- *Spirulina* is known as a "superfood" as it is rich in protein (over 60% of its body weight) and Vitamin B12. It can be farmed easily in water tanks.

7. Distinguishing Cellular Features

- All organisms are made of cells, but different kingdoms have structural variations:
 - **Fungi:** Their cells have a cell membrane and a cell wall, but they do not have chloroplasts and cannot photosynthesize.
 - **Bacteria:** They do not have a well-defined nucleus or a nuclear membrane; instead, they contain a region called a **nucleoid**.

- To observe these highly complex subcellular components, scientists use an **electron microscope**, which magnifies a cell about 1,000,000 (ten lakh) times.