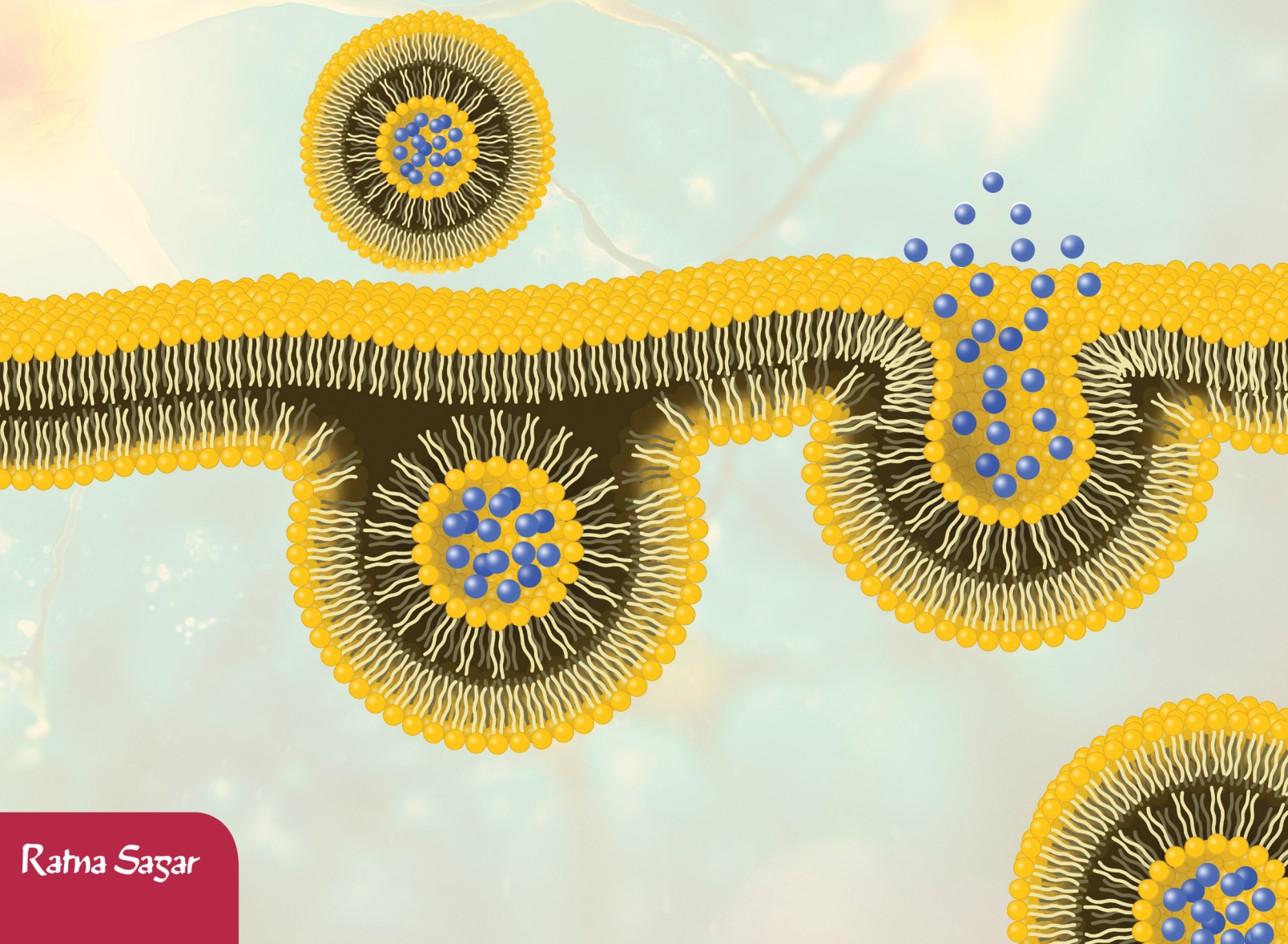


Based on the latest CBSE syllabus

9

# LIVING SCIENCE **BIOLOGY**

D K Rao • J J Kaur



Based on the latest syllabus and guidelines issued  
by the Central Board of Secondary Education (CBSE)

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# LIVING SCIENCE **BIOLOGY**

9

D K Rao • J J Kaur



**Ratna Sagar**

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# Preface

Biology is about understanding how living organisms work. During the last couple of centuries, our knowledge of Biology has grown at a staggering rate. Living Science 'Biology' for Class IX conforms to the latest CBSE syllabus. The book contains all the material which is a part of the core syllabus.

We have written this book to give you a thorough introduction to Biology at the Secondary level. We have presented the various scientific concepts as vital, compelling and meaningful which might otherwise seem dull. Each part of this book has been carefully planned to make it student-friendly and present Biology in an interesting, understandable and enjoyable manner. We have tried to stress the applications of what you are learning so that you can relate the facts to the living world.

## The 'Guided Tour'

Before you start using this book let us familiarize you with its major features.

### Course divided into Themes and Chapters

The book is divided into different chapters. The continuity from one chapter to another is step by step, clear and methodical.

Chapter 1: **Cell: The Structural and Functional Unit of Life**

Chapter 2: **Tissues: The Building Blocks of Life**

Chapter 3: **Diversity in Living Organisms**

Chapter 4: **Why Do We Fall ill**

Chapter 5: **Natural Resources**

Chapter 6: **Improvement in Food Resources**

### Learning Objectives

Learning becomes easy and purposeful if one is aware of the goals and targets of study. Thus, 'Learning Objectives' have been given in the beginning of each chapter to guide the learner about the concepts to be studied step by step. The Learning Objectives also provide an overview of the entire chapter.

### The Text

Learning proceeds from concrete to abstract. One learns about the difficult unknown concepts from simple facts which are quite familiar to him/her. The main text introduces ideas from scratch. A lucid introduction to the chapter has been given to stimulate the interest of the learner in the respective topics. Informal and interactive style has been used throughout the text, which is divided into units and sub-units.

### Self-Test Assignments

Each section is followed by a self-test assignment in the form of 'Check your progress' to reinforce the concept. Each chapter contains several such assignments which students will find valuable to obtain feedback about their progress.

### Text and Illustration Coordination

A large number of figures have been used to enhance effectiveness of the text. Simple and clear illustrations have been designed keeping the needs of the reader in mind. The text and the illustrations together teach the content better and in an interesting manner.

### **Use of Tables, Graphs and Flowcharts**

The tables and graphs used in the text are capable of standing on their own (self-explanatory). In addition, important processes are explained in the form of flowcharts which are in coordination with the text.

### **Feature Boxes**

The feature boxes contain topics of special interest – practical techniques or modern applications of science. Interesting facts related to the topics have been included at appropriate places as box material. These boxes will give you an indepth knowledge to help you understand the concept better.

### **Summary**

The main text of each chapter has been summarized at the end of the chapter which lists the main points of the text. The summary is excellent for revision and to gain an overview of the topics covered in the chapters.

We sincerely hope that this book will meet the aspirations of the students as well as the teachers. Your valuable suggestions for further improvement of the book will be appreciated and gratefully acknowledged.

### **Terminal Exercises**

Terminal exercises at the end of each chapter focus on the application of the subject matter and contain questions which give the opportunity to practice key skills. These exercises provide a full dress rehearsal for examination. They include a variety of questions to facilitate the integration of different concepts taught and test the grasp of the complete chapter. These will be highly helpful for examination purpose and to identify strengths and weaknesses in understanding the concepts.

### **Glossary**

A glossary of technical terms has been provided at the end of the book for quick reference.

We sincerely hope that his book will meet the aspirations of the students as well as the teachers. Your valuable suggestions for further improvement of the book shall be appreciated and gratefully acknowledged.

**D K Rao & J J Kaur**  
Delhi

# Syllabus

## THEME: MATERIALS

(22 Periods)

### UNIT I: MATTER – ITS NATURE AND BEHAVIOUR

Definition of matter; solid, liquid and gas; characteristics – shape, volume, density; change of state – melting (absorption of heat), freezing, evaporation (cooling by evaporation), condensation, sublimation.

**Nature of matter:** Elements, compounds and mixtures. Heterogeneous and homogeneous mixtures, colloids and suspensions.

## THEME: THE WORLD OF THE LIVING

(22 Periods)

### UNIT II: ORGANIZATION IN THE LIVING WORLD

Cell – Basic unit of life: Cell as a basic unit of life; prokaryotic and eukaryotic cells, multicellular organisms; cell membrane and cell wall, cell organelles and cell inclusions; chloroplast, mitochondria, vacuoles, endoplasmic reticulum, Golgi apparatus; nucleus, chromosomes – basic structure, number.

**Tissues, organs, organ system, organism:** Structure and functions of animal and plant tissues (only four types of tissues in animals; meristematic and permanent tissues in plants).

## THEME: MOVING THINGS, PEOPLE AND IDEAS

(36 Periods)

### UNIT III: MOTION, FORCE AND WORK

**Motion:** Distance and displacement, velocity; uniform and non-uniform motion along a straight line; acceleration, distance–time and velocity–time graphs for uniform motion and uniformly accelerated motion, derivation of equations of motion by graphical method; elementary idea of uniform circular motion.

**Force and Newton's laws:** Force and motion, Newton's laws of motion, inertia of a body, inertia and mass, momentum, force and acceleration. Elementary idea of conservation of momentum, action and reaction forces.

**Gravitation:** Gravitation; universal law of gravitation, force of gravitation of the earth (gravity), acceleration due to gravity; mass and weight; free fall.

## THEME: FOOD

(10 Periods)

### UNIT V: FOOD PRODUCTION

Plant and animal breeding and selection for quality improvement and management; use of fertilizers and manures; protection from pests and diseases; organic farming.

## THEME: MATERIALS

(28 Periods)

### UNIT I: MATTER – ITS NATURE AND BEHAVIOUR

**Particle nature, basic units:** Atoms and molecules. Law of constant proportions. Atomic and molecular masses.

**Mole concept:** Relationship of mole to mass of the particles and numbers. Valency. Chemical formula of common compounds.

**Structure of atom:** Electrons, protons and neutrons; isotopes and isobars.

## THEME: THE WORLD OF THE LIVING

(23 Periods)

### UNIT II: ORGANIZATION IN THE LIVING WORLD

**Biological diversity:** Diversity of plants and animals – basic issues in scientific naming, basis of classification. Hierarchy of categories/groups, major groups of plants (salient features) (Bacteria, Thallophyta, Bryophyta, Pteridophyta, Gymnosperms and Angiosperms). Major groups of animals (salient features) (Non-chordates up to phyla and chordates up to classes).

**Health and diseases:** Health and its failure. Infectious and non-infectious diseases, their causes and manifestation. Diseases caused by microbes (virus, bacteria and protozoans) and their prevention, principles of treatment and prevention. Pulse Polio programmes.

## THEME: MOVING THINGS, PEOPLE AND IDEAS

(24 Periods)

### UNIT III: MOTION, FORCE AND WORK

**Floatation:** Thrust and pressure. Archimedes' principle; buoyancy; elementary idea of relative density.

**Work, energy and power:** Work done by a force, energy, power; kinetic and potential energy; law of conservation of energy.

**Sound:** Nature of sound and its propagation in various media, speed of sound, range of hearing in humans; ultrasound; reflection of sound; echo and SONAR.

Structure of the human ear (auditory aspect only).

## THEME: NATURAL RESOURCES

(15 Periods)

### UNIT IV: OUR ENVIRONMENT

**Physical resources:** Air, water, soil.

Air for respiration, for combustion, for moderating temperatures, movements of air and its role in bringing rains across India.

Air, water and soil pollution (brief introduction). Holes in ozone layer and the probable damages.

**Bio-geochemical cycles in nature:** Water, oxygen, carbon and nitrogen.

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“A cell is regarded as the true biological atom.”

— GEORGE HENRY LEWES

## CHAPTER 1

# Cell: The Structural and Functional Unit of Life

### Learning Objectives

After completing this chapter, you will be able to:

- ❖ recognize cell as the basic structural and functional unit of living beings;
- ❖ differentiate between prokaryotic and eukaryotic cells;
- ❖ draw and describe the structural organization of plant and animal cells and state their functions;
- ❖ describe the process by which food and water move from cell to cell and gases get into the cell;
- ❖ list the manner in which the cells of living organisms exchange substances with the external environment and describe the process by which they obtain these substances.

In earlier classes, you have studied that all living beings are composed of cells. **A cell is the structural and functional unit of life.** Any function performed by an organism is the outcome of the activity of the cell. A cell can exist independently on its own and perform all the life processes. Many cells come together to form a tissue and tissues collectively form organs. Thus, every organ in our body is made up of hundreds of thousands of cells.

### ROBERT HOOKE DISCOVERED THE CELL

The invention of microscope helped in the discovery of the cell. **Robert Hooke** (1635–1703) developed a primitive microscope by using two lenses for achieving greater magnification. In such a microscope, the object to be seen was placed on a stage below and light coming from an oil flame was thrown on it by a convex mirror.

Cells were discovered by Robert Hooke in 1665. He observed a thin slice of cork (a substance obtained from

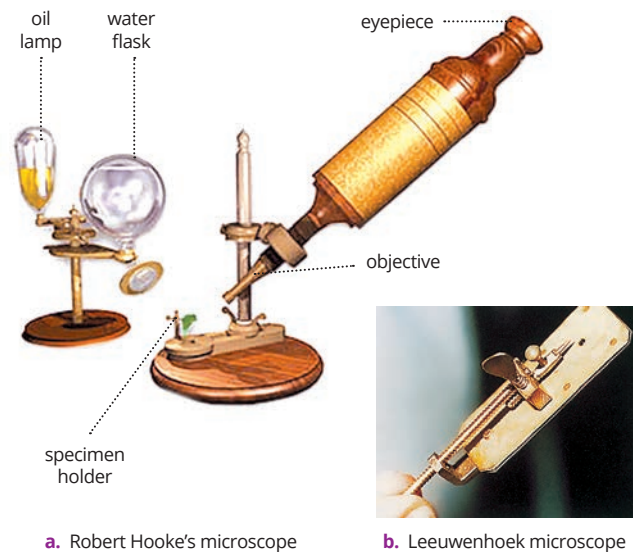


Fig. 1.1

the bark of a tree) under his compound microscope. He observed that the cork slice had a large number of compartments joined together in a honeycomb-like structure. He named these compartments as cells (cell comes from a Latin word *Cella* meaning a compartment or a little room). This was for the first time that anyone had observed that living things consist of separate units called cells.

In 1674, **Anton von Leeuwenhoek** (1632–1723) made further improvements and constructed a simple microscope that could magnify up to 270 times.

### CELL - THE BASIC UNIT OF LIFE

Let us perform the following activity to find out more about cells.

## Activity 1

### To prepare temporary stained mount of onion peel to study epidermal cells

#### You will need

Onion bulb, forceps, watch glass, glass slide, camel hair brush, coverslip, knife, water, razor blade, mounting needle, safranin solution, glycerine and microscope

#### Procedure

- ❖ Take an onion bulb, discard the brown, outer dry scales. With the help of a knife, cut the onion bulb into four pieces. Remove one fleshy scale (Fig. 1.2a).
- ❖ Bend the outer (convex) surface of the fleshy scale towards yourself. Do not break it completely. The two halves remain attached by a thin transparent strip of epidermal peel (Fig. 1.2b).
- ❖ Gently pull the broken end. You will find that the thin transparent layer of epidermis is peeled off easily. Using a pair of forceps, remove the peel (Fig. 1.2c) and place it in a watch glass containing water. This will prevent the peel from getting folded or getting dry.
- ❖ With the help of a blade, cut a square piece of this peel and place it in a drop of water on a clean glass slide with the help of a fine camel hair brush. Make sure that the peel is perfectly flat on the slide.
- ❖ Put a drop of safranin solution on the peel to stain it and leave for 2-3 minutes. Put a drop of glycerine solution over it to prevent it from drying (Fig. 1.2d).
- ❖ With the help of a mounting needle, cover the peel with a coverslip taking care that there are no wrinkles or air bubbles in it (Fig. 1.2e, f).

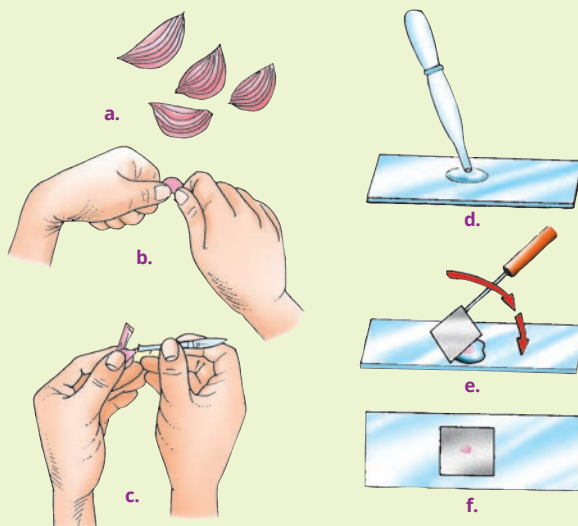


Fig. 1.2 Preparation of a temporary stained mount of onion peel

- ❖ Observe the slide under low power of the microscope. For better details, increase the magnification by observing under high power of the microscope.

#### Observations

While observing the slide under microscope, you will observe that the epidermis is one cell thick. These structures or cells look similar to each other. Each cell has a cell wall, cell membrane, nucleus, cytoplasm and a vacuole.

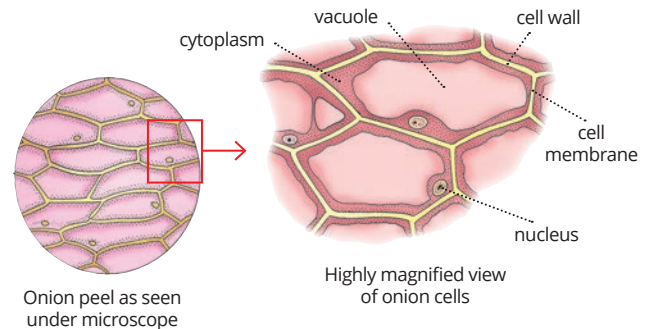


Fig. 1.3 Epidermal cells of onion peel

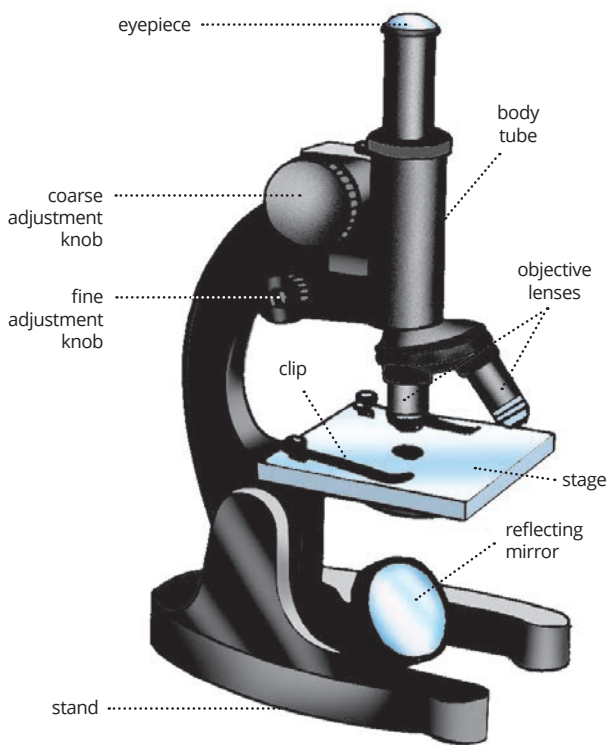
The cells that you observed in the above activity are the basic building units of the onion bulb. The cells of onion peel are linear or rectangular in shape (Fig. 1.3). All the cells are firmly bound together. Like onion, all organisms are made up of cells. Some organisms are made up of one cell while others are made up of many cells.

## MICROSCOPE

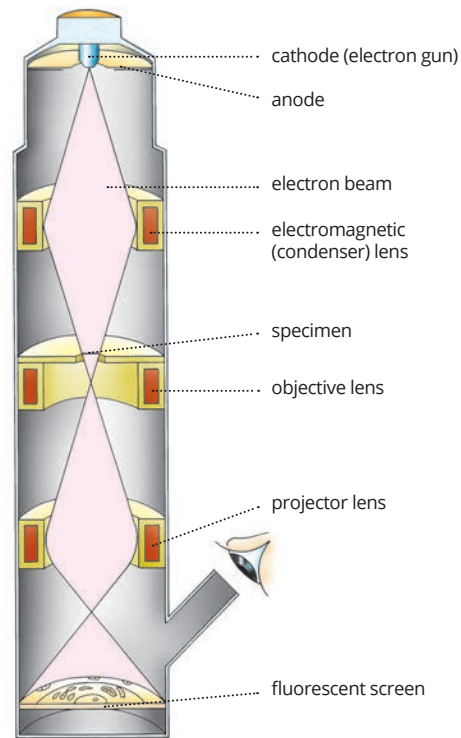
Microscope is an instrument which is used to observe objects that are invisible to the naked eye. For example, plant and animal cells, bacteria, fungi and algae can be observed under a microscope. The two common types of microscopes are compound microscope and electron microscope.

### The compound microscope

The ordinary light or compound or optical microscope used extensively in laboratories these days is a greatly improved design of Hooke's microscope (Fig. 1.4). It consists of two lenses, the eyepiece lens and the objective lens, which are combined to produce a greater magnification. The light microscope has a magnification up to 1500 times, good enough to see cells, larger organelles and bacteria.



**Fig. 1.4** A light microscope



**Fig. 1.5** An electron microscope

### The electron microscope

The electron microscope (EM) has much greater powers of magnification and resolution than those of an optical (light) microscope. An electron microscope can resolve points 1 nm apart. In this microscope, a beam of electrons is passed through the section of

material to produce the image. The electron beam passing through the specimen section is focused by electromagnets and is projected on to a fluorescent screen for direct view or on to a photographic plate for permanent recording. The resulting photograph is called an **electron micrograph**.

### Activity 2

**To prepare temporary stained mount of leaf peels, root tips of onion and peels of onion of different sizes and observe epidermal cells**

#### You will need

*Tradescantia* leaf, onion bulbs of different sizes, onion root tips, forceps, watch glass, glass slide, water, razor blade, iodine solution and microscope

#### Procedure

- ❖ For preparing the temporary stained mounts of peels of onion bulbs of different sizes, follow the steps of activity 1 as given before. Observe different sections under microscope and compare their structures.
- ❖ For preparing the temporary stained mount of leaf peels, take the leaf of *Tradescantia* plant. With a sudden jerk, take out a small segment of peel from the lower surface of leaf. Make a temporary mount of this peel as mentioned in activity 1 and observe under the microscope.

Similarly, you can prepare temporary stained mount of onion root tips to observe epidermal cells.

#### Observations

What do you observe in the above activity? Do all cells look similar with regard to shape and size? Do all cells look similar in terms of structure? Do you observe any difference or similarity among cells from different parts of the plant?

## Inference

Observation	Inference
Do all cells look similar with regard to shape and size?	No, all cells are not similar in shape and size. Some cells are large, some are small. They differ in the shape, size and arrangement.
Do all cells look similar in terms of structure?	No, the cells differ in terms of structure.
Do you find any difference among cells from different parts of the plant?	The cells of different parts of plant body are different in shape, size and structure.
What similarity could you find?	All plant cells have similar basic structure. They have a cell wall, cell membrane (plasma membrane), cytoplasm with cell organelles and a nucleus.

## Activity 3

### To prepare a temporary mount of human cheek cells and observe under a microscope

#### You will need

A clean ice-cream spoon, methylene blue solution, glass slides, water, needle and microscope

#### Procedure

- ❖ Take an ice-cream spoon and gently scrape the inner lining of your cheek. It will collect some viscous transparent material. With the help of a clean needle, transfer this material on a clean glass slide.
- ❖ Add a drop of water to the smear. Also add a drop of methylene blue solution to it. Leave the preparation for about 1 minute. Methylene blue is used to stain the nucleus in a cell.
- ❖ Gently place a coverslip over the material with the help of a needle to avoid entry of air bubbles. Press it gently in between folds of a rough filter paper to remove excess fluid and for uniform distribution of the cells in the mount prepared.
- ❖ Observe under a microscope and find out the structural details of cheek cells.

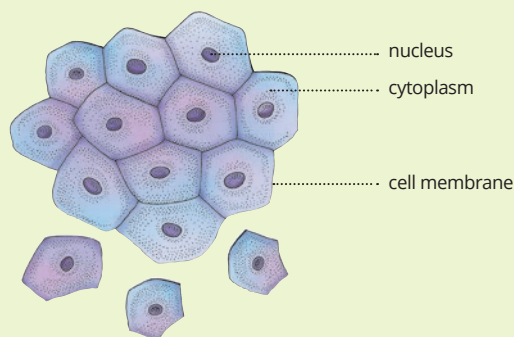


Fig. 1.6 Human cheek cells

#### Observation

What do you observe? What is the shape of the cells you see? Draw it on the observation sheet.

#### Inference

Under high power of a compound microscope, you will observe a darkly stained, oval or spherical dot-like structure near the centre of the cell (Fig. 1.6). This is the nucleus. The nucleus is surrounded by the cytoplasm. The cell membrane forms the boundary of a cell. Similar structures (nucleus) were also found in the onion peel cells. You will also find that there is no large central vacuole or cell wall as observed in onion peel (plant) cells.

### On the basis of above activities we can summarise that:

- ❖ A cell is the structural and functional unit of living beings.
- ❖ It is capable of independent existence and performs essential functions of life.
- ❖ A cell is usually microscopic (i.e. invisible to the naked eye) in nature.
- ❖ It consists of a mass of protoplasm surrounded by a selectively permeable plasma membrane.
- ❖ In an animal cell, the plasma membrane is the only limiting membrane. However, in plant cells, fungi and bacteria, the cell is also surrounded by a cell wall.
- ❖ All organisms start their life as a single cell. Every cell has its own lifespan. The old and worn out cells are continuously replaced by new cells.
- ❖ Many cells collectively form a tissue and many

## Did You Know?

### Some facts about the discovery of cell

The study of cell was impossible without the microscope. **Robert Hooke** was the first one to discover the empty honeycomb-like structures viewed in a thin section of cork with the help of his primitive microscope in 1665. He named these microscopic compartments in the cork as 'cells'. In 1674, **Anton von Leeuwenhoek** discovered the free living cells (protozoa, etc.) in pond water for the first time using his improved microscope. In 1831, **Robert Brown** discovered the nucleus in the cell. In 1839, **Purkinje** coined the term 'protoplasm' for the fluid content of the cell. A German botanist **Matthias Schleiden** (1838) and a British zoologist **Theodore Schwann** (1839) studied a wide variety of plant and animal tissues and proposed the 'cell theory' in 1839. It stated that all organisms are composed of cells. Cell theory was further expanded by **Rudolf Virchow** in 1855 who said that all cells arise from pre-existing cells. It was possible to study the complex structure of the cell and its various organelles with the discovery of electron microscope in 1940.

tissues together form an organ. The organs work together as a system for the purpose of survival.

## CELL THEORY

**Cell theory** was proposed by German botanist Matthias Schleiden (1838) and British zoologist Theodore Schwann (1839). Later on in 1855, Rudolf Virchow, a German physiologist added the phrase *Omnis cellula-e-cellula* meaning all cells arise from pre-existing cells.

- ❖ All living organisms are composed of cells.
- ❖ Cell is the basic structural and functional unit of all living beings.
- ❖ All cells arise from pre-existing cells.
- ❖ The function of an organism is the outcome of the combined activities of the cells.

## Exceptions to cell theory

- ❖ **Viruses** are non-cellular organisms. They do not have nucleus, cytoplasm or enzyme and do not perform any life activity. They can multiply only inside the living host by taking over their machinery.
- ❖ **Bacteria** and **blue-green algae** are not true cells. They do not have nuclear membrane and cell organelles.

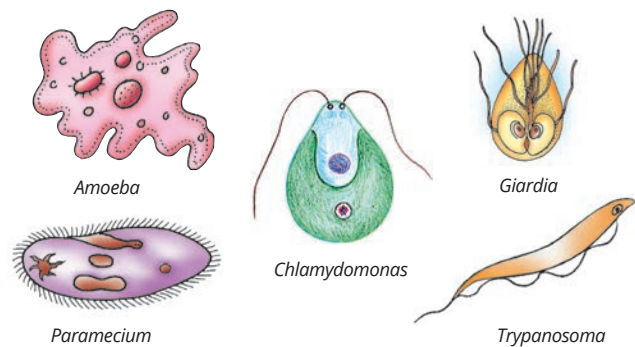


Fig. 1.7 Some unicellular organisms

## UNICELLULAR AND MULTICELLULAR ORGANISMS

On the basis of number of cells, there are basically two types of organisms – unicellular and multicellular.

Unicellular (*uni* means single) organisms are those organisms that are made up of only one cell. For example, *Amoeba*, *Chlamydomonas*, *Euglena*, *Paramecium*, *Trypanosoma* and bacteria are unicellular organisms.

Multicellular (*multi* means many) organisms are those organisms which are made up of many cells that group together to perform many functions of the body. For example, fungi, plants and animals are multicellular organisms. All multicellular organisms have come from a single cell, zygote, through cell division.

## PROKARYOTIC AND EUKARYOTIC CELLS

On the basis of their nuclear organization, cells have been classified into two types:

- ❖ Prokaryotic cells
- ❖ Eukaryotic cells

### Prokaryotic cells

(Gk. *Pro*: before, *karyon*: nucleus)

Prokaryotic cells are single-celled and lack a nuclear membrane. These cells have primitive organization of genetic material. The genetic material is equivalent to a single molecule of a circular DNA. These cells have an undefined nuclear region called nucleoid due to absence of nuclear membrane. These cells lack several cytoplasmic organelles like mitochondria, lysosome, endoplasmic reticulum, chloroplast and nucleolus. Many of the functions of these cells are performed by poorly organized parts of cytoplasm. Bacteria and blue-green algae are examples of prokaryotic cells.

## Eukaryotic cells

(Gk. *Eu*: true, *karyon*: nucleus)

Eukaryotic cells have a well-defined nuclear membrane. In these cells, the genetic material is made of two or more DNA molecules. The nuclear material consists of a linear DNA enclosed in a nuclear membrane. These cells have a well-organized nucleus. These cells have well-developed membrane-bound organelles, such as mitochondria, endoplasmic reticulum, lysosome, chloroplast and nucleolus. Eukaryotic cells occur in plants, animals, fungi and protozoa.

The differences between prokaryotic and eukaryotic cells are given in Table 1.1.

**TABLE 1.1** Differences between prokaryotic and eukaryotic cells

Features	Prokaryotic cell	Eukaryotic cell
size of cell	small in size (1–10 $\mu\text{m}$ ) $1 \mu\text{m} = 10^{-6} \text{ m}$	large in size (5–100 $\mu\text{m}$ )
nucleus	have undefined nuclear region due to absence of nuclear membrane	have well-defined nuclear region surrounded by a nuclear membrane
chromosome	single molecule of circular DNA	more than one chromosome
nucleolus	nucleolus is absent	nucleolus is present
membrane-bound cell organelles	membrane-bound organelles are absent	membrane-bound organelles are present

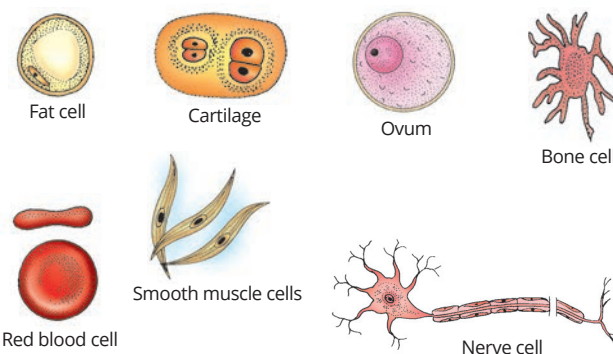
## CELL – SHAPE, SIZE AND FUNCTION

Different organisms have cells of different kind. The shape and size of cells are related to the specific functions performed by the organisms.

### Cell shape

Cells show a great variation in their shapes (Fig. 1.8). Most cells have a definite shape. Cells may be spindle-shaped – muscle cells, elongated – nerve cells, oval – red blood corpuscles, cuboidal – germ cells, branched – osteocytes and so on.

Some cells may not have any definite shape, i.e. they have changing shapes, for example, *Amoeba* and leucocytes (white blood corpuscles).



**Fig. 1.8** Shapes of various cells in the human body

### Cell size

The smallest known cell is *Mycoplasma* or PPLO (Pleuropneumonia-like organism). Its size is 0.1 to 0.5  $\mu\text{m}$  (micrometre).

The bacterial cell is 0.5 to 5  $\mu\text{m}$ , human red blood corpuscles are 7 to 20  $\mu\text{m}$ , human liver and kidney cells are 20 to 30  $\mu\text{m}$  and nerve cells are about 90 to 100  $\mu\text{m}$  in size.

### Cell function – Division of labour

Each cell performs certain basic functions that are characteristics of all living beings. There is a division of labour in multicellular organisms and within a single cell in many cases. This means different parts of the body (organs) perform different functions. This is because each cell has certain specific components within it known as cell organelles. Each cell organelle performs a specific function, such as producing energy, making new materials (proteins, etc.), clearing up the waste material, etc. These organelles together constitute the basic unit, i.e. the cell. A cell is able to perform its functions because of these cell organelles.

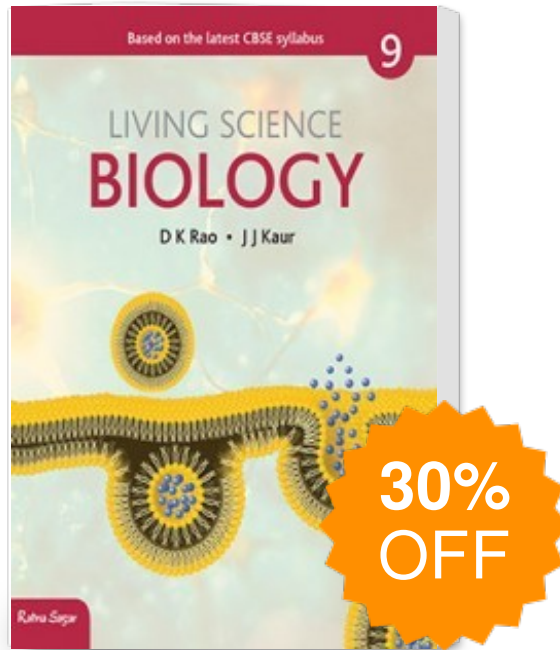
#### Did You Know?

All cells contain same cell organelles, no matter what organism they are found in and what functions they perform.

### STRUCTURAL ORGANIZATION OF A CELL

You have just studied that each cell has special components called cell organelles. Although cells of different organisms differ in structure, cells within the body of a multicellular organism differ in shape, size and functions. In spite of these differences, every cell shows the same basic structure – cell membrane

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