# Lectures of Histology

## (1st Stage)
## First Semester 2024-2025

## Anatomy and Histology Department

By

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# The Cell

## Introduction

The basic morphological and functional unit of all unicellular and multicellular organisms, which represents the lowest level of structure capable to perform all the activities/manifestations of life independently as a dynamic system such as (growth, movement, secretion, excretion, etc.) and independent cellular reproduction, which dependents on DNA that contains the hereditary information necessary for regulating cell functions and for transmitting information to the next generation of cells.

Science that concerns with the study of cell structure, function, reproduction, type, specialization, its organelles, and heredity is called **Cell Biology** or **Cytology.**

The term **"cell"** was used for the first time in 1665 by Robert Hooke, who observed structure of cork with simple microscope, then by Leeuwenhoek, and during this period Cytology started to form as a separate biological science. In 1838 Schleiden and Schwann formulated the cell theory in which they appointed plant and animal cells as elementary constituents of all living organisms. In 1855 Virchow revised cell theory and summarized it into three general points:

**1.** The Cell is the basic functional and structural unit of all life.

**2.** All living things are composed of cells, cell parts, or cell products.

**3.** All cells come from pre-existing cells.

Improvement of light microscopy and then electron microscopy helped to a more understanding of the cells structure. In general, all cells are composed of nucleus, cytoplasm, and cytoplasmic membrane. In some cells at their differentiation some components should be reduced or disappeared as the presence of organelles is dependent on cell type. According to the organization of nucleus and other structures, we can distinguish Prokaryotic (Fig. 1) from Eukaryotic cells (Fig. 2).

**Comparison between prokaryotic and eukaryotic cells**

| No. | Features | Prokaryotic cells | Eukaryotic cells |
|---|---|---|---|
| 1 | Nuclear envelope | absent, missing | present, existing |
| 2 | Chromosomes | Single | Numerous |
| 3 | Nucleolus | absent, missing | present, existing |
| 4 | Ribosomes | 70S | 80S |
| 5 | Endoplasmic reticulum | absent, missing | present, existing |
| 6 | Mitochondria | absent, but there are respiratory enzymes in cell membrane | present, existing |
| 7 | Chloroplasts | absent, but -if any- there are photosynthesis enzymes in cell membrane | present in plant cells |
| 8 | Cell division | binary fission | direct and indirect division |
| 9 | Cell wall | non-cellulosic | cellulosic only in plants |

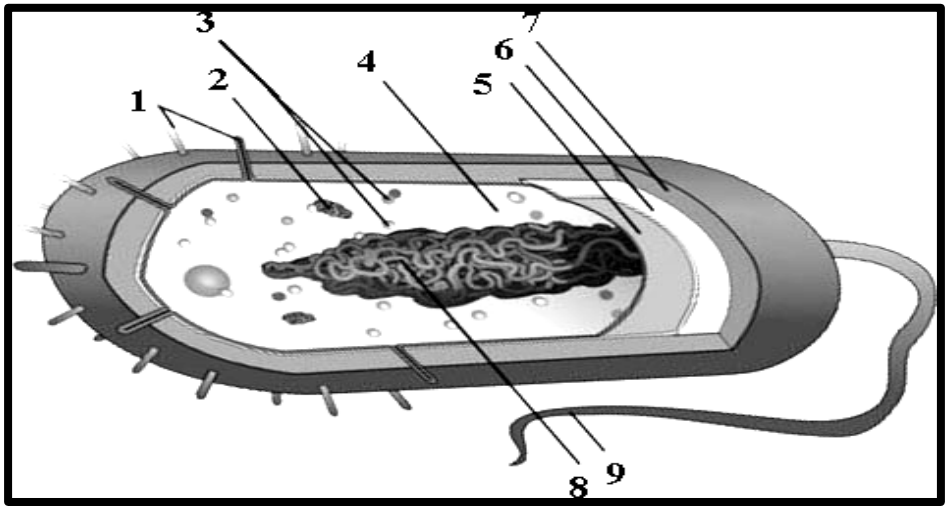



**Fig.1: Morphology of Prokaryotic cell (1–pili; 2–plasmid; 3–ribosomes; 4–cytoplasm;5–plasma membrane; 6–cell wall; 7–capsule; 8–nukleoid; 9–flagellum).**

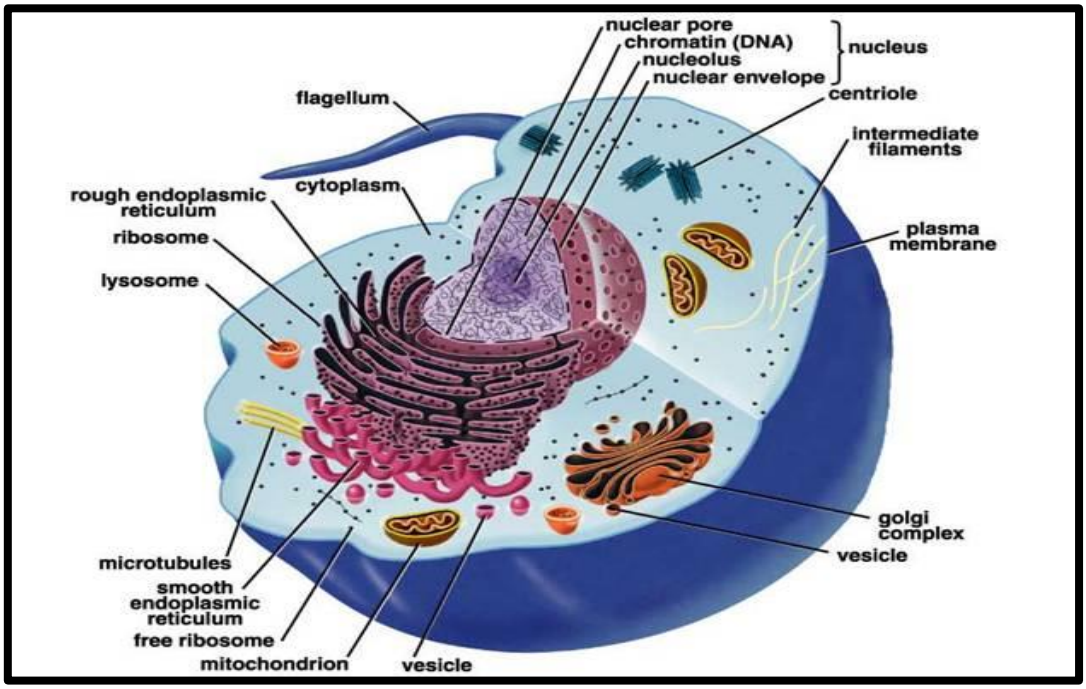



**Fig. 2: Morphology of Eukaryotic cell.**

## Common Features of Cells

Cells vary in size and shape, which depends on the type of organism. Despite these differences most cells have basic general properties in common:

**1-** Cell has metabolic mechanisms that enables it to obtain energy from the environment, such as Photosynthesis in plant cells, and from catabolism/breaking down nutrients to simpler chemicals metabolite, as in animal cells.

**2-** Ability of cell to use this energy for supporting and perpetuating its life, such as the movement of cell components from one part to another within the cell. Ability to transfer materials to/from the cell. Ability of cell to convert molecules from one form to another to replace the lost compounds for growth and production.

**3-** Possesses genetic material in form of DNA.

**4-** Has protective external surface regulated its relationship with the environment.

## Shape and Size of Cells

Shape and size of cells is genetically determined and related to their location and function. Cells vary in **size**, they are affected by the ratio of genetic to cytoplasmic material, surface area to cell volume, as well as the rate of activities that they carry out. While the **shape** of cell depends on the function, surface tension, viscosity of protoplasm, mechanical pressure of the neighboring cells. Generally, cells have fixed shape, with some exceptions, such as WBCs which variable in shape.

## Shape of Cells

The basic cell shape is **spherical** (e.g., human oocyte, leukocytes) and other shapes are derived from it (Fig. 3) like:

**1.** biconcave (discoid): disc-shaped (e.g., human erythrocytes).

**2.** squamous: thin, flat, scaly (e.g., epithelial cells of skin or esophagus).

**3.** cuboidal: squarish- looking (e.g., epithelium of ovary).

**4.** columnar: taller than wide (e.g., epithelial cells of small intestine).

**5.** polygonal: irregular angular shapes, multiple sides (e.g., hepatocytes).

**6.** spindle: thick in middle, tapered toward the ends (e.g., smooth muscles).

**7.** ovoid: round to oval (e.g., plasma cell).

**8.** cylindrical (fibrous): thread-like (e.g., skeletal, cardiac muscles).

**9.** multi-polar (e.g., neurons, astrocytes).

**10.** pear (e.g., Purkinje cells).

**11.** pyramidal (e.g., pyramidal neurons).

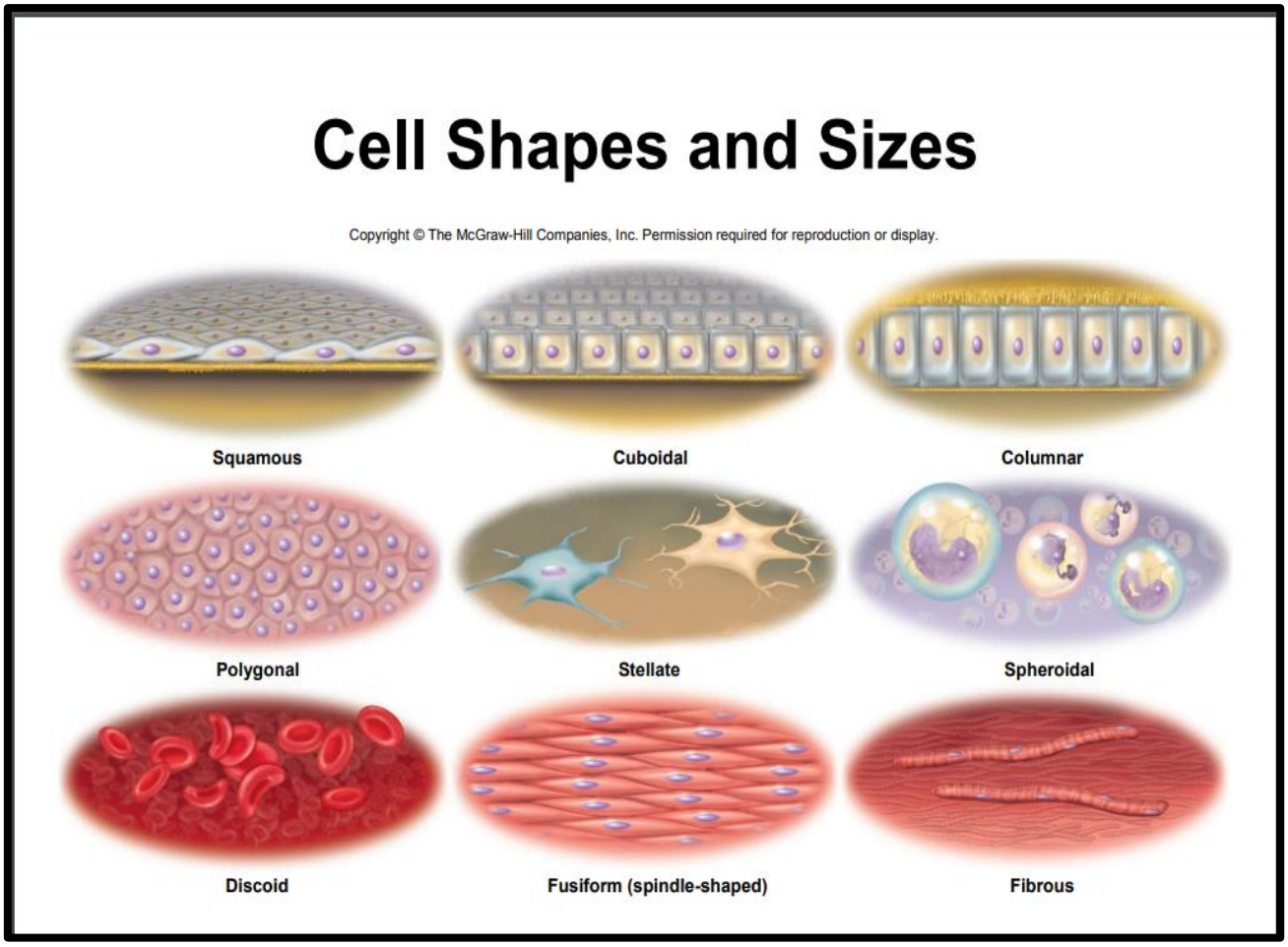
**12.** amoebic (e.g., macrophage).

Cells may have different projections, for example: protoplasmic projections (e.g., neurons, fibroblasts); cilia and microvilli (e.g., cells of the small intestine, respiratory tract, and uterus); flagellum (e.g., sperm).

**Note:** A cell's shape can appear different if viewed in a different type of section (longitudinal vs. cross section).

## Size of Cells

- small, which reach size to 7μm or 10μm (e.g., erythrocytes, lymphocytes).
- middle, their size varied from (10-30)μm (e.g., plasmatic cells, chondrocytes). Most of cells in human tissues are of this size.
- big, with size over 30 μm (human ova, motoric neurons).


Cell Shapes and Sizes
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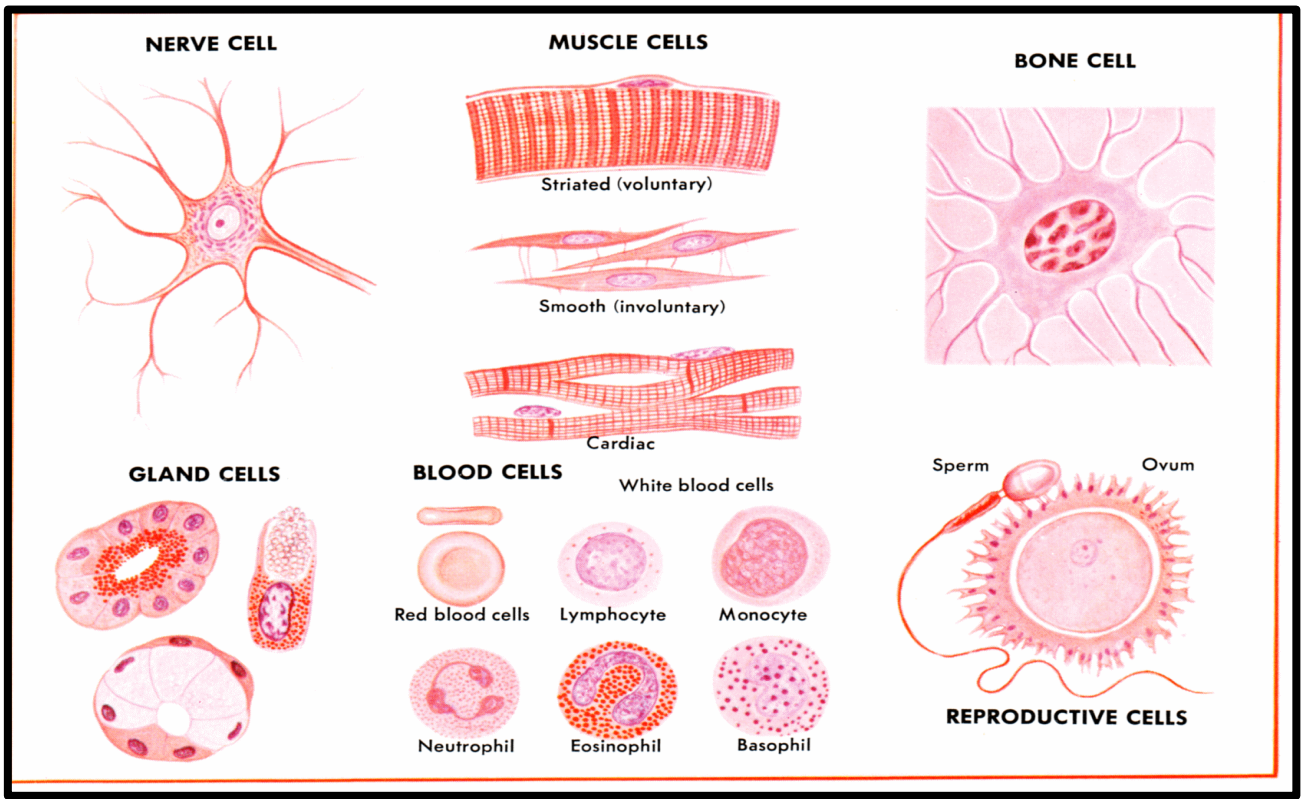
Squamous
Cuboidal
Columnar
Polygonal
Stellate
Spheroidal
Discoid
Fusiform (spindle-shaped)
Fibrous


NERVE CELL
MUSCLE CELLS
Striated (voluntary)
Smooth (involuntary)
Cardiac
BONE CELL
GLAND CELLS
BLOOD CELLS
White blood cells
Red blood cells
Lymphocyte
Monocyte
Neutrophil
Eosinophil
Basophil
Sperm
Ovum
REPRODUCTIVE CELLS

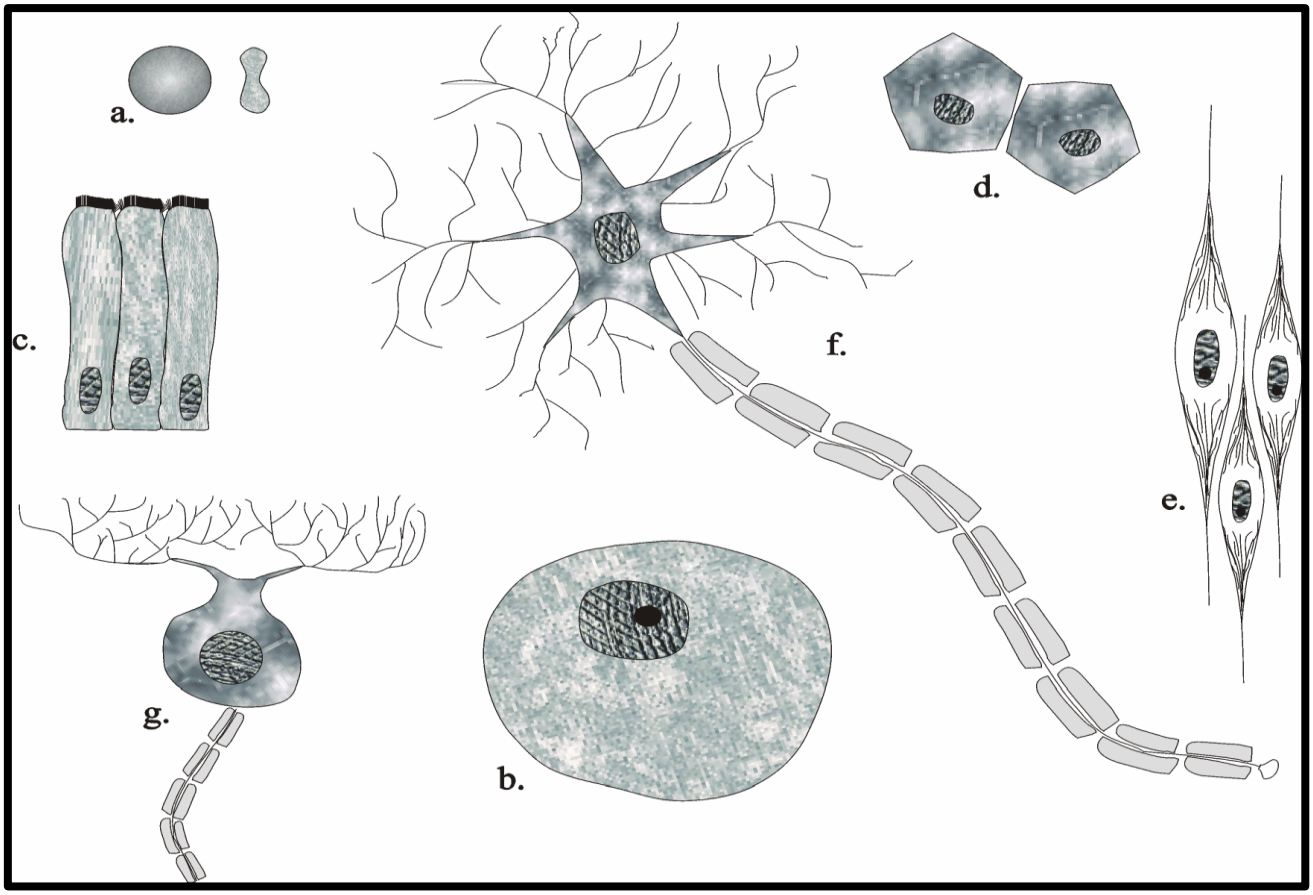



**Fig. 3: Morphology of cells (a. biconcave discoid– human erythrocyte; b. spherical cell– oocyte; c. columnar– enterocytes; d. polygonal cells– hepatocytes; e. spindle– smooth muscles; f. multipolar– neurons; g. pear– Purkinje cells.**