# Cell biology
## Chapter I: General

### I/ Notions
Cell biology is a discipline of Life Sciences, which studies cells and their organelles, the vital processes that take place in them as well as the mechanisms allowing their survival, without forgetting the main characteristic of the living cell, namely: death.

### Historical
Animals and plants, no matter how complex their organization, consist of only a small number of elements (cells) that repeat in each of them.
The cells cannot be observed with the naked eye due to their very small size. The beginnings of cell biology are closely linked to the discovery of the optical microscope at the end of the sixteenth (16th) century which activated research on microscopic objects.
From this time the history of cell biology can be summarized as follows:
**In 1665: Robert HOOKE** observing cork cups with a rudimentary microscope with a single lens (actually dead plant cells) proposes, for the first time, the term cell (small room) the smallest structural unit of life.

**In 1674 Antony Van Leeuwenhok** described several living microorganisms (protists, bacteria) and highlighted certain intracellular elements.
**1839: Theodor Schwann** discovered that plants and animals are all made of cells, concluding that the cell is the common unit of structure and development, which founded the **CELL THEORY**.

### Principles of cell theory
1. Cells are the fundamental units of life
2. All organisms are composed of one or more cells
3. All cells come from pre-existing cells by division

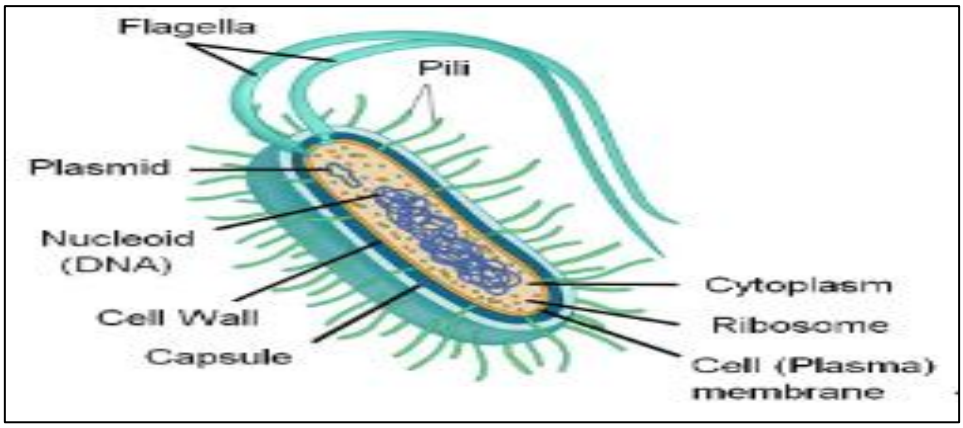
### Cellular organization
A group of cells gives a Tissue
Tissues = Organ
Organs = System
Systems= Organism

## Cell types
Two main types of cells are recognized:
**1.Prokaryotic cells** (identified with bacteria)
Cells that do not have a nucleus visible under a microscope: DNA is not surrounded by a membrane.
**2, Eukaryotic cells** (all animal and plant organisms)

Cells with a nucleus, a compartment separated from the rest of the cellular contents, which contains DNA. Both types of cellular organisms, prokaryotes and eukaryotes, have a common single-celled ancestor called proto-cell or progenote which is a prokaryotic organism.
Attention viruses, or akaryotes, are elements (and not cells) that have neither nuclei nor cytoplasm and can only reproduce by parasitizing a host cell.

## 1.Prokaryotic cells

Prokaryotes (from Greek, the word pro means: before and karyon: nucleus) are Unicellulars. Their genetic material is free in the cytoplasm, not limited by a nuclear envelope; It forms a nucleoide.




### The Bacterial Cell

When we look at bacteria under a microscope, we realize that they can have different shapes. They can live grouped in colonies or isolated.

Some are spherical in shape: these are the shells (or **cocci**).
If these shells are grouped in chain, they are **streptococci.**
If they gather in clusters like a bunch of grapes, they are **staphylococci.**
If they are free but grouped by two, they are **diplococci.**
Others form a kind of rods: these are the **bacilli.**
Finally, some can be spiral-shaped: **spirillas**

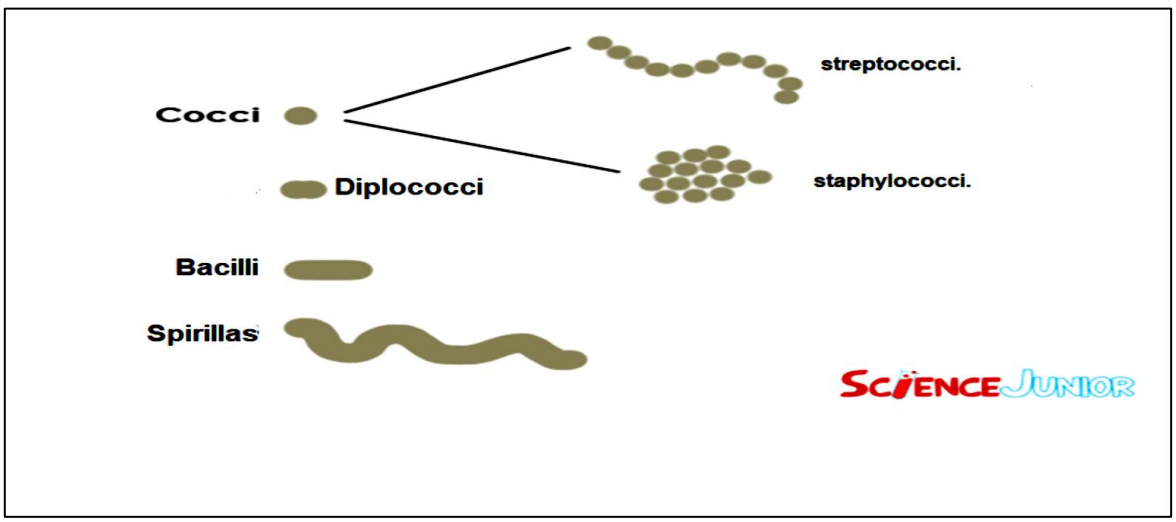
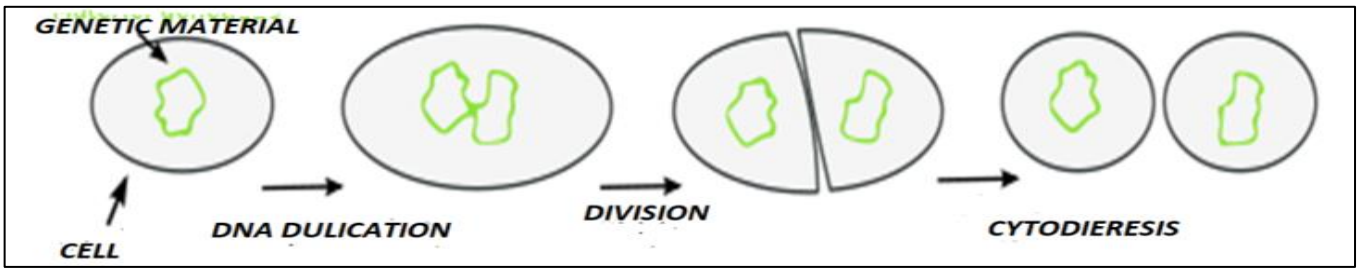



**Diagram showing the different forms of bacteria**

They are characterized by a small size (1 to 10 µm) and a mode of reproduction by **splitting (strangulation)**



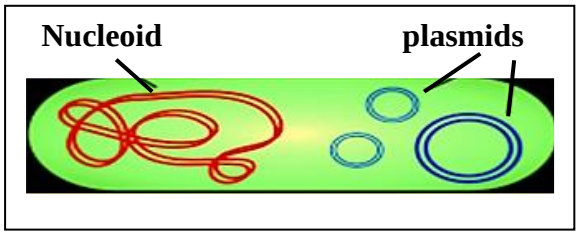

## Structure of a bacterial cell

The bacterial cell consists of constant (essential) structures present in all bacterial species and inconstant (facultative) structures present in only a few species

### 1. Constant (essential) structures

**1.Nuclear material or nucleoid** is made up of a single circular DNA molecule representing the bacterial chromosome.

**2. The plasmids** are extrachromosomal DNA fragments that are circular and localized in the cytoplasm. Their replication is independent of that of the bacterial chromosome.
A plasmid can be present in multiple copies in a single bacterial cell. Plasmids encode the synthesis of different enzymes, thus conferring special characteristics on the bacterium that possesses them, such as the ability to use certain substrates or resistance to antibiotics.
Plasmids are transmissible to other bacteria




**2.The plasma membrane** is composed, like that of eukaryotes, of lipids and proteins in different percentages. It differs from it in the absence of cholesterol and the lack of carbohydrates. The plasma membrane is responsible for the transport of nutrients.

**4.homogeneous cytoplasm,** bounded by a plasma membrane, which contains soluble RNAs (messenger RNA and transfer RNA), and ribosomal RNA.

**5.Ribosomes** are often grouped into clusters or polyribosomes.

**6.The wall (parietis, which means wall)** is 20 to 80 nm thick and externally limits the bacteria and determines its shape. It controls exchanges with the outside environment and also plays a protective role (a bacterium that does not have a wall dies).

### 2. Inconstant (facultative) structures

**1, The capsule**, of variable thickness (0.2 to several µm), is highlighted by light microscopy, by staining with Indian ink. When it exists, it covers the wall and thus represents the outermost structure.
The capsule is often polysaccharide and sometimes polypeptide. Its presence is a sign of virulence because it protects the bacteria from phagocytosis.

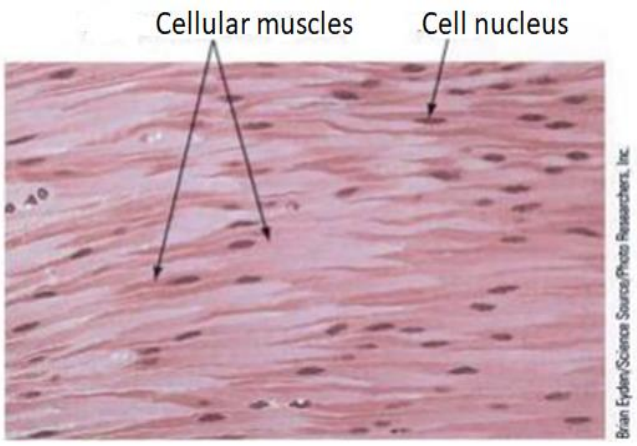
**2, Mesosomes** are an invagination of the plasma membrane, on which bacterial DNA is attached, present exclusively in aerobic bacteria.
Mesosomes contain the enzymes of the respiratory chain, thus ensuring the function of mitochondria absent in bacterial cells

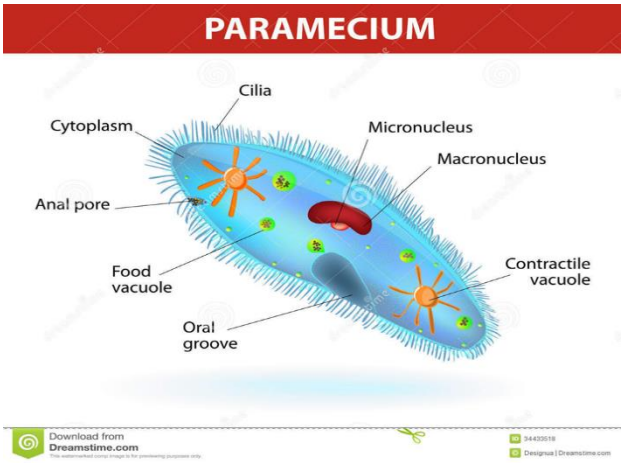
**3, The flagellum**, a mobile membrane expansion whose number (1 to 8) and positions vary according to the bacterial species.

**4, The pilis (hairs) (cilia)** shorter than the flagella are membrane expansions visible only under an electron microscope. They are useful for adhesion to substrates and particularly to mucous membranes.

## 2, Eukaryotic cells

Eukaryotes correspond to multicellular organisms or (=) protozoa (animals, plants, fungi) whose cells are grouped into epithelial, muscular, connective, supportive [cartilaginous, bone], nervous tissues in animals




As well as some unicellular eukaryotes or(=) **Metazoans** often able to move (Amoebas, Paramecium, yeasts, algae, protists).

## Structure of a eukaryotic cell

All plant or animal tissues are made up of small units: cells
There are nearly 200 different types of cells known in the human body of different eukaryotic type. Each type serves a specific function. These cell types vary according to:
size, shape, type of tissue, type of organ, function(s), ability to divide...

**Constituents of a eukaryotic cell**

The eukaryotic cell is bounded by the plasma membrane, contains a nucleus and cytoplasmic organelles.

**Cytoplasmic membrane:** separates the cell from the environment + allows exchanges with the extracellular environment

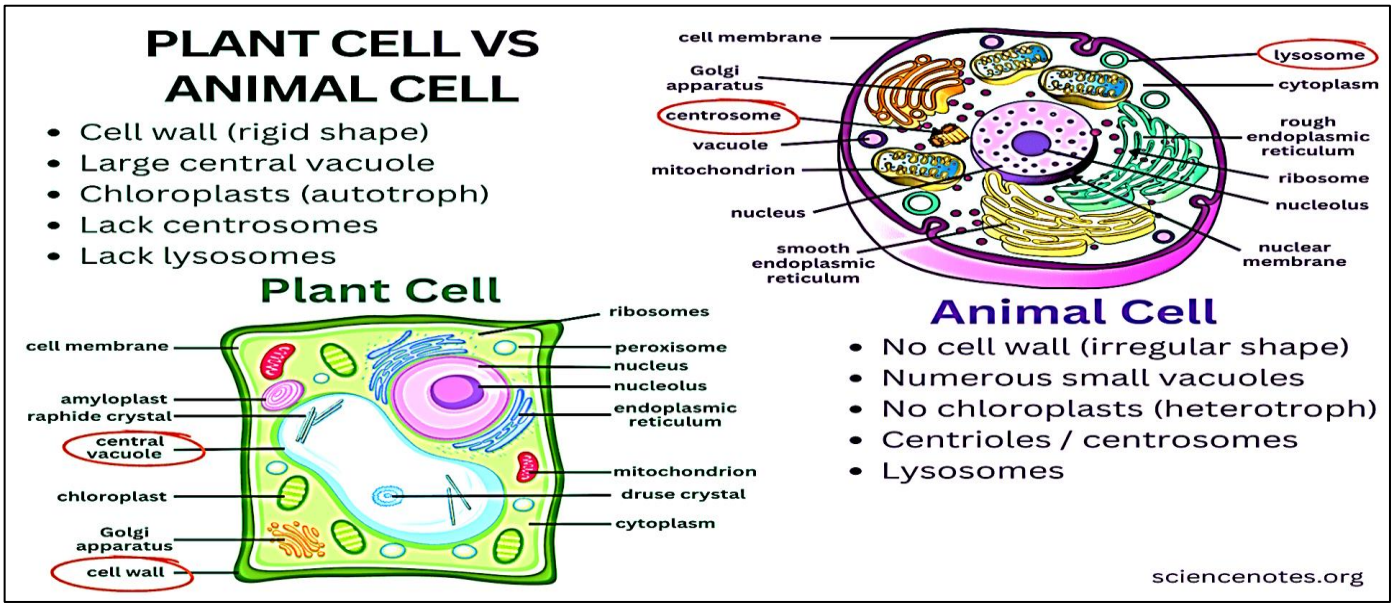
**The cytoplasm is composed of protoplasm and hyaloplasm:**

**Protoplasm** refers to cellular organelles: the cytoskeleton, the endomembrane system (the endoplasmic reticulum, the Golgi apparatus, lysosomes, etc.), the mitochondria, the ribosomes, and the nucleus (the nuclear envelope, the chromatin and the nucleolus).

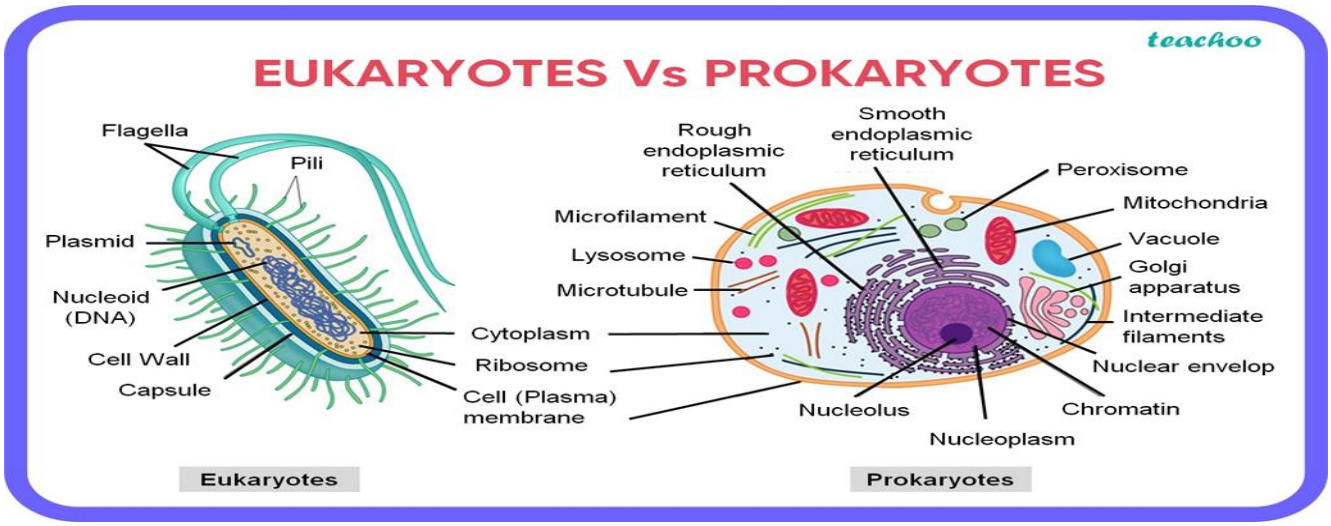
**The hyaloplasm** corresponds to the medium in which all these organelles are immersed

## Comparison between animal and plant cells

Animal cells resemble plant cells in many ways. However, there are differences. They are located in particular at the level of organelles present in animal or plant cells.




## Comparison between Eukarytes and Prokaryotes



## Comparison table between eukaryote and prokaryote

| Characteristic | Prokaryotic cell | Eukaryotic cell |
|---|---|---|
| Size of cell | Typically 0.2-2.0µm in diameter | Typically 10-100 µm in diameter |
| Example | Bacteria and Archaea | Animals and Plants |
| Nucleus | Absent | Present |
| Membrane-enclosed organelles | Absent | Present; examples include lysosomes, Golgi complex, endoplasmic reticulum, mitochondria & chloroplasts |
| Flagella | Consist of two protein building blocks | Complex; consist of multiple microtubules |
| Cell wall | Usually present; chemically complex | Only in plant cells and fungi (chemically simpler) |
| Plasma membrane with steroid | Usually no | Yes |
| Cytoplasm | No cytosketeton or cytoplasmic streaming | Cytoskeleton; cytoplasmic streaming |
| Ribosomes | Smaller | Larger |
| Cell division | Binary fission | Mitosis |
| Number of chromosomes | One, but not true chromosome | More than one |
| Sexual reproduction | No meiosis; transfer of DNA fragments only (conjugation) | Involves meiosis |

Prokaryotic cells, as well as eukaryotic cells, are covered with the plasma membrane, which is located on top of the cell membrane or mucous capsule. Despite of its relative simplicity, prokaryotes are typically independent cells. Table 4.1 presents the major differences between prokaryotic and eukaryotic cells.

## Viruses

The term virus means poison in Latin. Viruses are agents of a large number of diseases, from the mildest to the most severe, affecting all living things, prokaryotes and eukaryotes.

A virus is usually specific to a living species called a host species.

Apart from the host, the virus is an inert particle that has no metabolism of its own, no capacity for replication, and consequently no possibility of autonomous evolution. So, it's not cells.

Viruses are visualized by electron microscopy in the infected cell (host cell) and are called virions.