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AL MUSTAQBAL UNIVERSITY

كلية العلـوم

قســـم الادلة الجنائية

المحاضرة الاولى

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المادة : الخلية The Cell
المرحلة : الاولى
اسم الاستاذ: د.عماد هادي الطائي

A prereview of cell biology

Cell biology is a branch of biology that studies the structure, function, and behaviour of cells.

The **cell** is the basic unit of biology. Every organism consists of multiple cells (**multicellular)** such as humans. or one single cell (**Unicellular)** microorganism, such as bacteria, algae, and fungi.

Cells are constantly changing; they have the capacity to grow, reproduce, and become specialized. In addition, once specialized, they can respond to stimuli and adapt to changes in the environment.

Cell biology started when Robert Hooke in 1665 built a microscope and examined thin slices of cork. He saw a network of tiny boxlike compartments called them as *cells*, from the Latin word ***cellula***, meaning "**little room**."

A few years later, Antonie van Leeuwenhoek, produced small lenses that could magnify objects to almost 300 times their size. He became the first to observe living cells, including blood cells, sperm cells, bacteria, and single-celled organisms (algae and protozoa) found in pond water and reported his observations.

By the 1830s, important optical improvements were made in lens quality and in the *compound microscope,* an instrument in which one lens (the eyepiece) magnifies the image created by a second lens (the objective). This allowed both higher magnification and better resolution. At that point, structures only 1 micrometre (mm) in size could be seen clearly.

The cell theory

By improved lenses, the Scottish botanist **Robert Brown** found that every plant cell contained a rounded structure, which he called a ***nucleus***, a term derived from the Latin word for "kernel." In 1838, his German colleague Matthias Schleiden came to the important conclusion that all plant tissues are composed of cells and that an embryonic plant always arises from a single cell. A year later, German cytologist Theodor Schwann reported similar conclusions concerning animal tissue, thereby, both speculated that plants and animals do not resemble each other structurally (**Why??**). Because plant cell walls form a visible boundary between cells that are readily visible even with a crude microscope, whereas animal cells, which lack cell walls, are much harder to distinguish in a tissue sample.

However, when Schwann examined animal cartilage cells, he saw that they were unlike most other animal cells because they have boundaries that are well defined by thick deposits of collagen fibers. Thus, he became certain of the fundamental similarity between plant and animal tissue. **Accordingly, Schwann postulated in 1839 the cell theory that had two basic principles:**

1. All organisms consist of one or more cells.
2. The cell is the basic unit of structure and function for all organisms.

Less than 20 years later, a third principle was added. This grew out of Brown's original description of nuclei, which Swiss botanist Nägeli extended to include:

observations on the nature of cell division. By 1855 Rudolf Virchow, a German physiologist, concluded that cells arose only by the division of other, pre-existing cells. Virchow encapsulated this conclusion in the now-famous Latin phrase *omnis cellula e cellula*, which in translation becomes the third principle of the modern cell theory:

3. **All cells arise only from pre-existing cells.**

In our world, there are many diversities of cell types around us as illustrated in figure 1

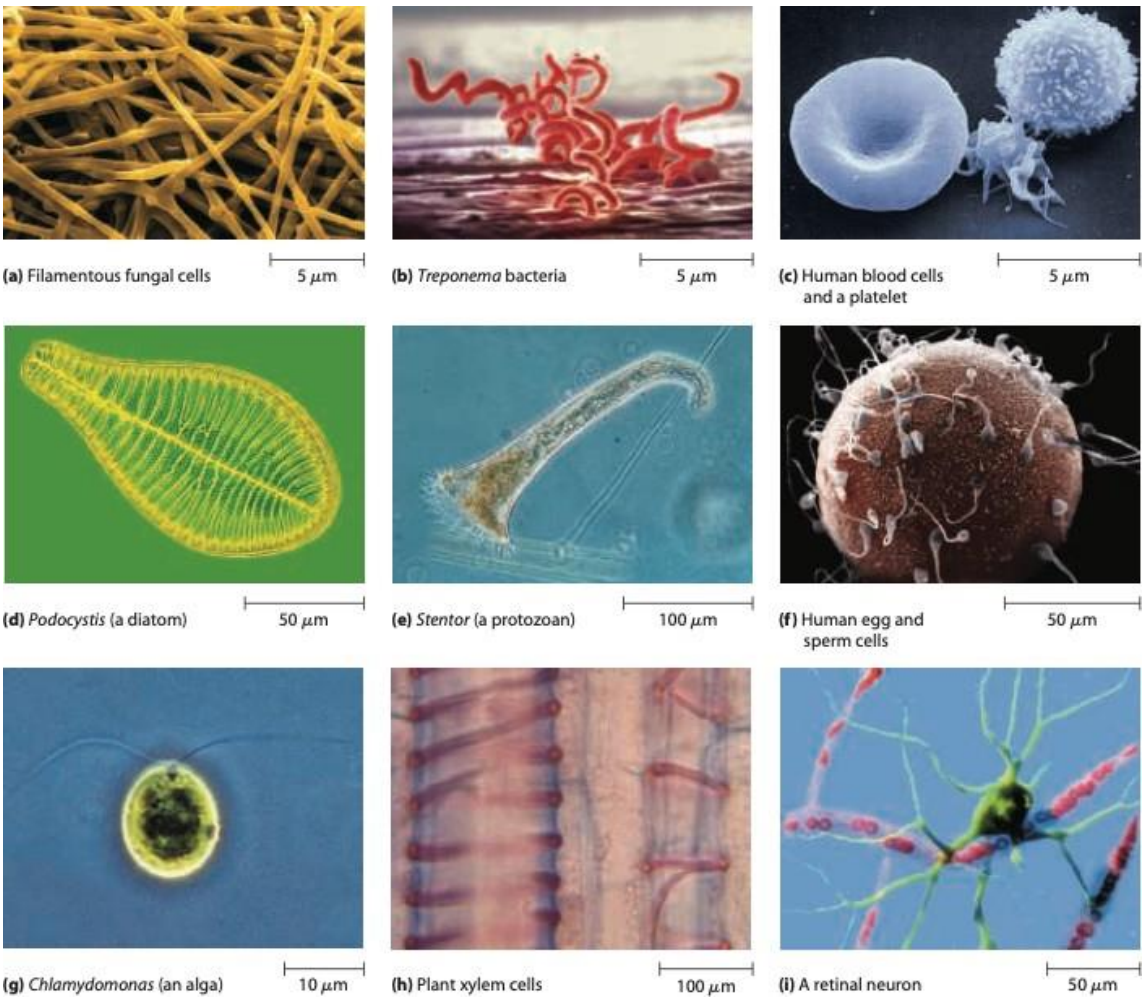

Figure 1: An example of different types of cells.

Cells exist in a wide variety of shapes and sizes, ranging from filamentous fungal cells to spiral-shaped bacteria to the differently shaped cells of the human blood system. Other cells like the two human single-celled gametes, the egg, and the sperm, differ greatly in size and shape.

As in leaves, the green chlorophyll in a *Chlamydomonas* cell shows that these algae carry out photosynthesis. Notice , the cell's shape and structure gives clues about its function. For example, the spiral thickenings in the cell walls of plant xylem tissue give strength to these water-conducting vessels in wood (and the highly branched cells of a human neuron allow it to interact with other neurons.

The modern cell biology

Modern cell biology results from the weaving of three different strands of:

- Cytology
- Biochemistry
- Genetic.

Each of the strands had its own historical origins, and each one makes unique and significant contributions to modern cell biology.

The first of the strands was cytology, which is concerned primarily with cellular structure. **The** electron microscopy **and other** advanced optical techniques **has increased our understanding of cell structure and function.**

The second strand represents the biochemistry by understanding of cellular structure and function.

Prokaryotic cells

Prokaryotic cells are the most primitive cells that does not have a true nucleus or membrane-bound organelles and have simple structural organization. The size of prokaryotic cells ranges between 1 to 10 µm. They include bacteria, viruses, blue-green algae, etc. Prokaryotic cell consists of the following components, as showed in Figure 3:

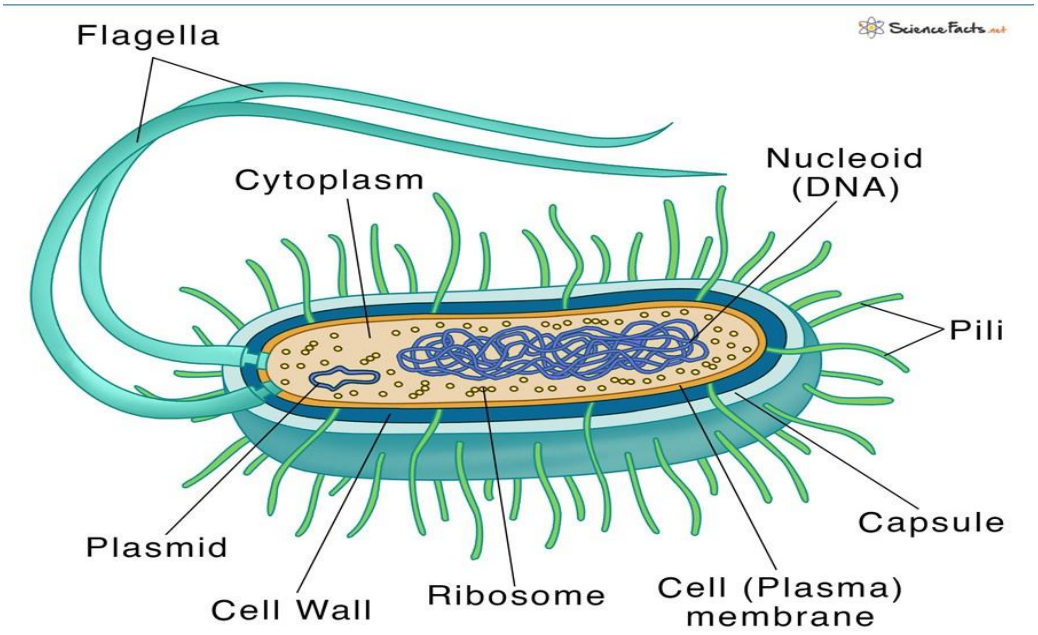

Figure 2: Prokaryotic cell diagram.

A) Outer covering is composed of:

- inner cell or plasma membrane

- middle cell wall and

- outer slimy capsule.

A) **Cytoplasm**: is a gel like substance enclosed within the cell membrane.

Proteins	**Endoplasmic reticulum**
Lipids	**Mitochondria**
glycogen	**Golgi apparatus**
Enzymes and inorganic ions for biosynthetic reactions	**Centrosomes**
Ribosomes , tRNA and mRNA for protein synthesis	**Vacuoles**
Gas vacuoles in some prokaryotic cells	**Lysosomes**
	Microfilaments
	Intermediate filaments
	Microtubules.

B) Nucleoid: Nuclear envelope is absent in prokaryotic cell and the genetic material lies directly into the cytoplasm. Such nuclear material is known as nucleoid. The DNA is not associated with basic histone proteins. It is double stranded, helical and circular.

C) Plasmids: In some prokaryotic cells, in addition to nucleoid, plasmids are also present, which are small circular molecules of DNA (1000 to 30,000 base pairs) that carry genes both for their own replication or encode proteins required by the organism to resist antibiotic and other toxic material. Most plasmids are supercoiled, giving them a condensed, compact form.

D) Flagellum: It is a whip structure found in many bacteria. It is 150Å thick and 10 to 15µm long. It has two main parts: Filament and basal body.

1. Filament: filament extends out of cell into the medium and it is composed of many intertwined spiral chains of the subunits of a protein called flagellin.
2. Basal Body: the basal body attaches the flagellum to the cell and generates the force to rotate it. It has two parts: shaft and hook.

B) Pili: These are short, rod like non-motile processes or fimbriae present on many bacteria. These are formed of pilin protein. They are usually less than 10 nm thick. They help in attachment of bacteria to surfaces or food or to one another. Tubular sex Pili are present in some bacteria.

Bacteria as an examples of prokaryotic cell

Bacteria are single-celled, prokaryotic, simple, unicellular and microscopic microorganism.

Bacterial shapes: there are many different types of bacteria. one way of classifying them is by shape. there are three basic shapes, Figure 4.

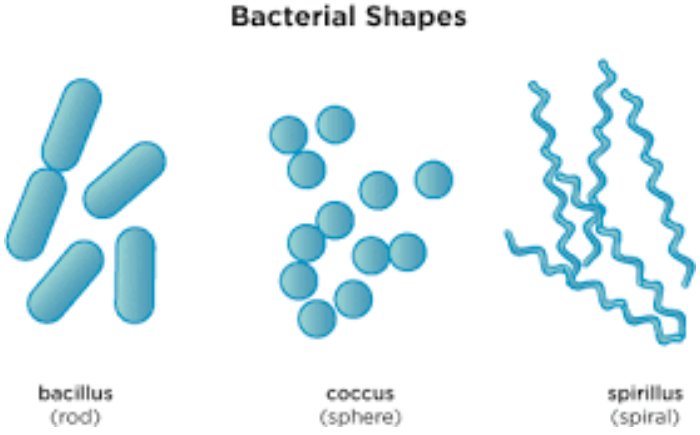

Figure 3: the shapes of bacterial cells

- Spherical: bacteria shaped like a ball are cold cocci and a single bacterium is a coccus such as *Streptococcus* group.

- rod shaped: these are known as bacilli (singular bacillus). Some rod-shape are curved. These are known as vibrio such as *Bacillus anrthracis* (anthrax).

- Spirals: these are known as spirilla (singular spirillus) such as *Helicobacter pylori*. If their coil is very tight, they are known as spirochetes, such as *Treponema pallidum.*

Bacterial feeding: bacteria feed in different ways:

- Heterotrophic bacteria (heterotrophs): they get their energy through consuming organic carbon. Most absorb dead organic material, such as decomposing flesh.
- Autotrophic bacteria (autotrophs): they make their own food either through:
- Photosynthesis, using sun light, water and carbon dioxide.
- Chemosynthesis, using carbon dioxide, water and chemicals, such as ammonia, nitrogen, sulfur and others.

Bacteria that use photosynthesis are called photoautotrophs. Some types sush as cyanobacteria, produce oxygen that played a vital role in creating
the oxygen in the earth's atmosphere.

Bacteria that use chemosynthesis are known as chemoautotrophs. These bacteria are commonly found in ocean and in the roots of legumes such as
beans, peas.

Bacteria habits : bacteria can be found in:

- Soil
- Water

- Animals
- Hot springs

Eukaryotic cells

The general structure of eukaryotic cells

Eukaryotic cells have the following characteristics:

1. Number- In multicellular organisms the numbers of cells are correlated with the body size. **All multicellular organisms begin their life with** a single cell "Zygote" **and then become** multicellular by its mitotic division during development.

2. Shape- A cell may be spherical, oval, disc-like, polygonal, spindle like or irregular. Thus, cells acquire a variety of shapes not only in various organisms

but also in different tissues of the same organism. The shape of cell is correlated with its functions like the shape of muscles and nerve cells are well adapted to their functions. Many factors such as cell functions, age of cell, presence or absence of cell wall, viscosity of cytoplasm etc. are responsible for various shapes of cells.

3. Size- Most of the eukaryotic cells are microscopic and their size ranges between 10 to 100µm. Nerve cells are the longest having the size of their fiber to be of few meters long. **Human cells generally range** from 20 to 30µm.

4. Components of a cell- Three main components of the eukaryotic cells are:

* **Cell membrane**
* **Cytoplasm**
* **Nucleus**

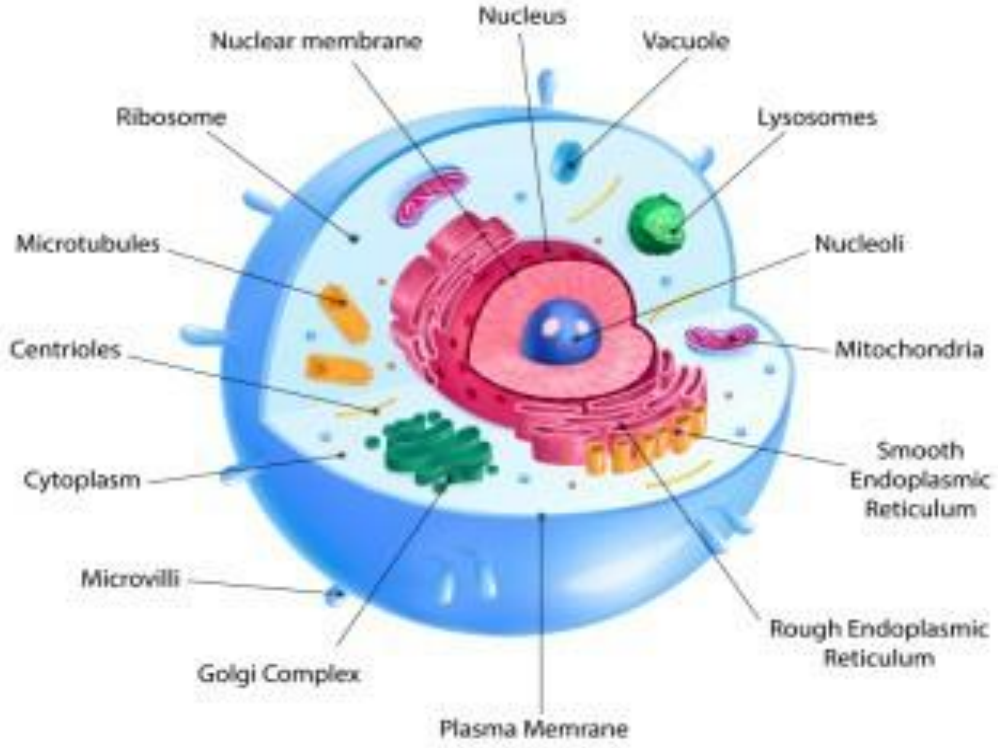

Figure: Components of the cytoplasm in eukaryotic cells