

Introduction to cell biology

CHAPTER (1)

PART (2)

Done by: Abdelhadi Okasha
2nd Sheet

1.3 | Two Fundamentally Different Classes of Cells

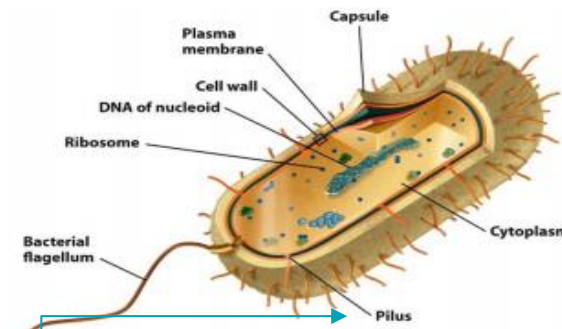
→ After inventing **electronic microscope**, we found that there are **two** types of cells:

1. Prokaryotic cell

→ General information about them:

- They're distinguished by their **size** and the types of organelles they contain.
- both types of cells share an identical genetic language, a common set of metabolic pathways, and many common structural features, because of their common ancestry (*)

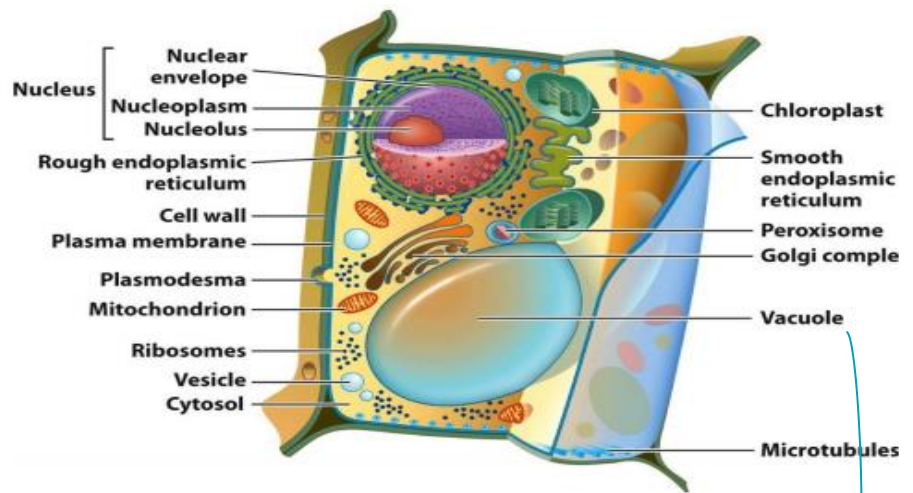
2. Eukaryotic cells



The structure of cells: Bacteria

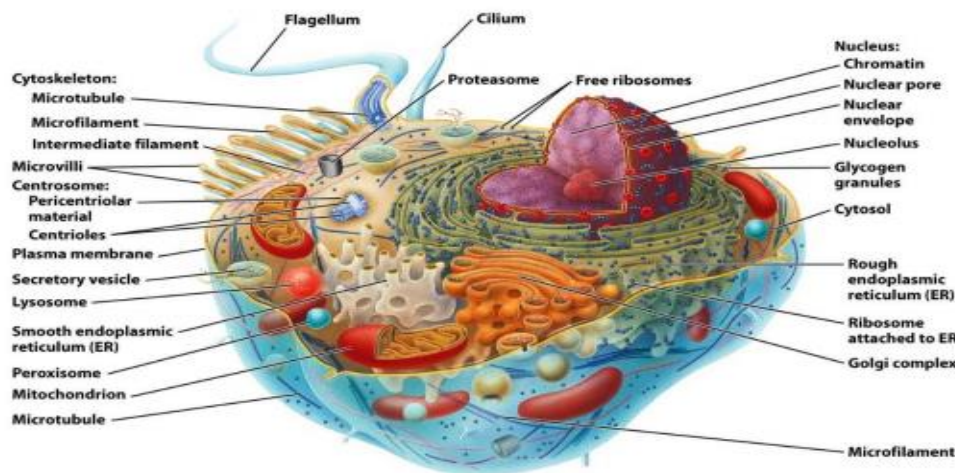
- Pilus: Extension from the plasma membrane that helps for cell-environment interactions

- No cell wall = cell membrane is more dynamic = that helps the cell in it's activities
- No chloroplast
- Contains mitochondria

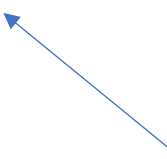


The structure of cells: Plant cell

- Contains one large vacuole: Because of the nature



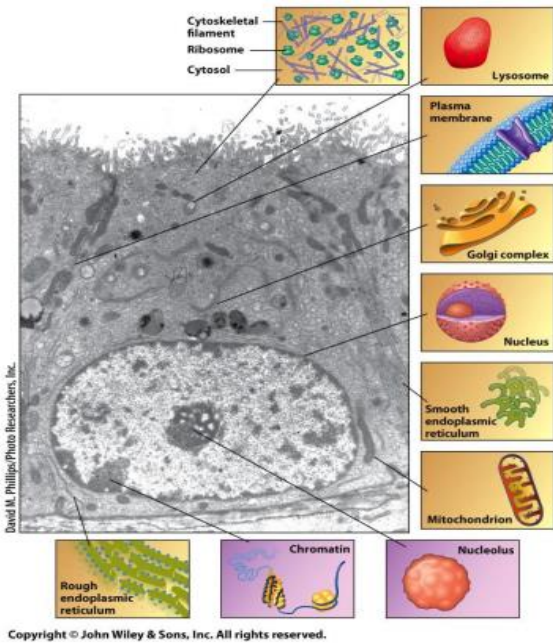
The structure of cells: Animal cell

Differences in green, Similarities in red	Eukaryotic cells	Prokaryotic cells
Time of existing on earth	~ 600 million years	~ 3.7 billion years
Complexity	More complex in structure and function	Relatively simple
Domains الأنواع	Plants + Animals + protists + Fungi	Archaea + Bacteria
Rigid cell wall (protect the cell from bursting)	Exists, It contains cellulose in plants made of starch and glycogen	Exists
Plasma Membrane Note: Phagocytosis and endocytosis can't occur if there is a cell wall 	<ul style="list-style-type: none"> - Exists with similar construction of prokaryotic one's, it serves as a selectively permeable barrier. - The cytoplasmic membranes of eukaryotic cells form a system of interconnecting channels and vesicles that function in the transport of substances from one part of a cell to another, as well as between the inside of the cell and its environment. - Ability to ingest particulate material by enclosure within plasma membrane vesicles (phagocytosis). 	<ul style="list-style-type: none"> - Exists with similar construction of eukaryotic one's, it serves as a selectively permeable barrier. - directed intracytoplasmic communication is less important because of the small size of the cell, where the necessary movement of materials can be accomplished by simple diffusion - Don't have the ability to make phagocytosis
Membrane-bounded Organelles (Function: organization)	<ul style="list-style-type: none"> - Exist (covering endoplasmic reticulum, Golgi complex, lysosomes, endosomes, peroxisomes, and glyoximes) - Not all structures are covered by a membrane, such as: Ribosomes and cytoskeleton system - The cytoplasm near the cell membrane is a region where membrane-bound organelles tend to be absent. 	- Don't exist
Cytoplasm	<ul style="list-style-type: none"> - exist (larger) - contains ribosomes - filled with a great diversity of structures, leaving very little space for the soluble phase of the cytoplasm, the cytosol. 	<ul style="list-style-type: none"> - exist - contains ribosomes - not crowded
Mechanism of photosynthesis	<ul style="list-style-type: none"> - Have the same mechanism as prokaryotes - occurs in green plants - Have a special membrane-bounded organelle (chloroplast) - different enzymes 	<ul style="list-style-type: none"> - Have the same mechanism as eukaryotes - occurs in cyanobacteria by something called thylakoid - Don't Have a special membrane bounded organelle - different enzymes
conservation of chemical energy as ATP (by aerobic respiration)	<ul style="list-style-type: none"> - Exist - Has a specific cytoplasmic organelle for it (mitochondria) in occurs in it's membrane 	<ul style="list-style-type: none"> - Exist - Don't have a specific cytoplasmic organelle for it, it occurs in plasma membrane.

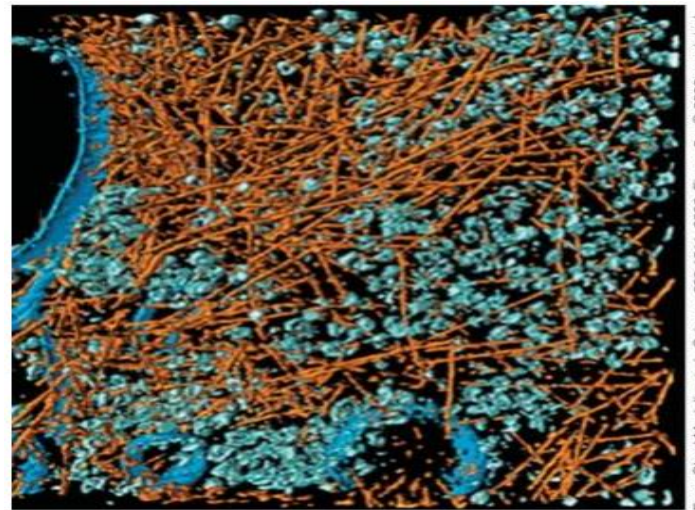
<u>metabolic pathways</u> (e.g. glycolysis, TCA cycle)	-There are shared metabolic pathways (some of them occur in Membrane-bounded organelles)	-There are shared metabolic pathways (e.g. glycolysis, TCA cycle)
<u>Cytoskeleton</u>	- Contain actin and tubulin - Cytoskeletal filaments exist and built of proteins similar to actin and tubulin. - Complex cytoskeletal system (including actin-filaments, intermediate filaments, and microtubules) and associated motor proteins -found in cytoplasm	- Contains actin and tubulin - cytoskeletal filaments have been found in bacteria, but much simpler than the eukaryotic one's -found in cytoplasm
<u>Proteins</u>	More	Less
<u>membrane proteins</u>	- Similar mechanism for synthesizing and inserting	- Similar mechanism for synthesizing and inserting
<u>Proteasomes (protein digesting structures)</u>	- Exist with similar construction of prokaryotic one's (found in most eukaryotes if not all)	- Exist with similar construction of eukaryotic one's (found in archaebacteria)
<u>Ribosomes</u> (non membranous particles that function as "workbenches" on which the proteins of the cell are manufactured)	-Exists and Found in cytoplasm as well as other large macromolecular complexes -similar of prokaryotic one's -differ in size	-Exists and Found in cytoplasm as well as other large macromolecular complexes -similar of eukaryotic one's -differ in size
<u>Packaging of Genetic material</u>	- in a nucleus, which is covered by a doubled membranous nuclear envelope that contains complex pore structures.	- in a nucleoid region
<u>Form of genetic material</u>	- composed of DNA with an identical genetic code compared with eukaryotes - have many complex linear chromosomes made of both DNA and protein that are capable of compacting into mitotic structures	- composed of DNA with an identical genetic code compared with eukaryotes - have a single, circular DNA.
<u>Amount of genetic material</u>	-More - Presence of two copies of genes per cell (diploid), one from each parent	- Less - They contain one copy of their single chromosome
<u>Transcription and translation</u>	-Similar mechanisms for transcription and translation of genetic information, including similar ribosomes -Presence of three different RNA synthesizing enzymes (RNA polymerases) - Transcription occurs in nucleus, and translation occurs in cytosol	-Similar mechanisms for transcription and translation of genetic information, including similar ribosomes -Presence of one RNA synthesizing enzyme that synthesize all RNA's - Transcription occurs in cytosol, and translation occurs in cytosol

<p><u>Cellular reproduction</u></p>	<p>- divide by mitosis (complex process) (needs proteins and microtubules) -Reproduce Sexually, that requires meiosis and fertilization <u>-How</u> each daughter cell receives an equivalent array of genetic material? -Answer: Duplicated chromosomes condense into compact structures that are segregated by an elaborate microtubule containing apparatus. This apparatus, the mitotic spindle, separate chromosomes and allows each daughter cell to receive an equivalent array of genetic material.</p>	<p>- divide by simple fission. - mostly nonsexual organisms, and have no processes comparable to meiosis, gamete formation, or true fertilization -Some are capable of conjugation, in which a piece of DNA is passed to another cell through F pilus. -Prokaryotes are more adept at picking up and incorporating foreign DNA from their environment, which has had considerable impact on microbial evolution (*)</p>
<p><u>Locomotion</u> الحركة</p>	<p>- Done by Flagella , cilia and cytoplasmic movement. (Flagella is different in both form and mechanism of the prokaryotic one's as it's more complex) - Flagella and cilia are Complex - Eukaryotic flagella are much more complex than the simple protein filaments of bacteria, and they generate movement by a different mechanism. -Examples on eukaryotic cells that have flagella: sperm cells and many protists</p>	<p>- Done by flagella which protrudes from the cell and rotates, This rotations exert pressure against the surrounding fluid, propelling the cell through the medium, it's relatively simple. (flagella = thin protein filament) -Examples on prokaryotic cells that have flagella: Helicobacter bacterium that have Multiple flagella for locomotion</p>

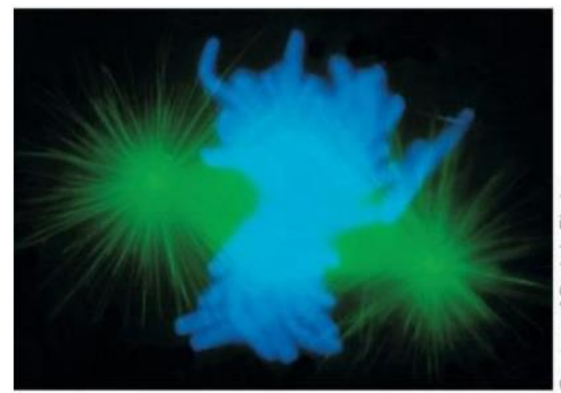
- prokaryotic produced oxygen in early stages of life which was important for the life of next .creatures



Eukaryotic cell structure: Epithelial cell from the male rat reproductive tract

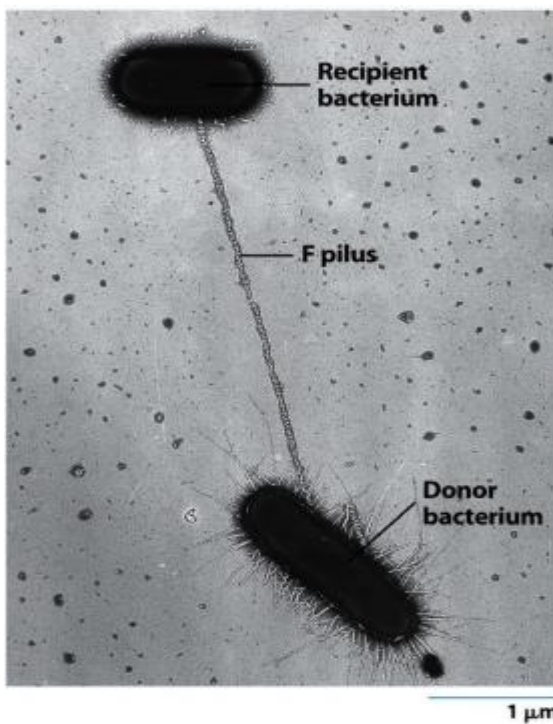


Colorized electron micrograph of a frozen single-celled eukaryote.
Cytoskeleton: Red
Ribosomes: Green
Cell membrane: Blue



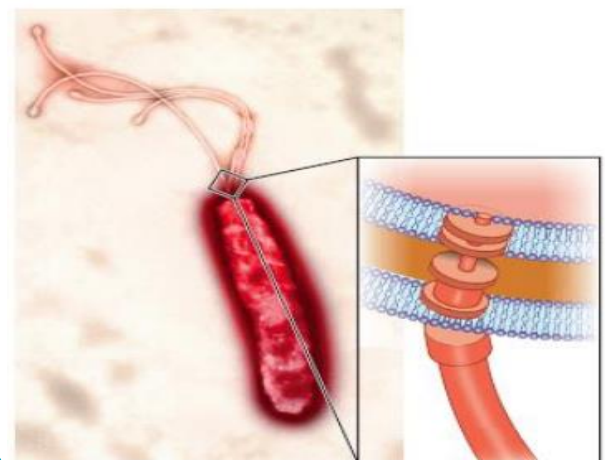
Courtesy of Coniv L. Rieder.

Cell division in eukaryotes
DNA (blue) and microtubules (green) of two daughter cells.



Bacterial conjugation
Sharing of DNA through the F pilus

VERY IMPORTANT



Helicobacter bacterium
Multiple flagella for locomotion

1.4 | Types of Prokaryotic Cells (always unicellular)

- There are two types (domains) of prokaryotic cells:

(1. Archaea) and (2. Bacteria)

1. Archaea: (Archaeobacteria)

- The best known Archaea are **extremophiles (Definition:)** species that live in **extremely inhospitable environments**, such as:

- Methanogens:** Convert CO₂ and H₂ gases into methane (gens: مولدة)
- Halophiles:** Live in extremely salty environments, like the Dead Sea or deep sea brine pools with salinity equivalent to 5M MgCl₂ (halo: ملح) (philes: محب)
- Acidophiles:** Acid-loving prokaryotes that thrive at a pH as low as 0.
- Thermophiles:** Live at very high temperatures. (Thermo: حراري)
- Hyperthermophiles:** Live in the hydrothermal vents of the ocean floor up to a temperature of 121°C, the temperature used to sterilize surgical instruments in an autoclave. (hyper: أعلى من 100)

autoclave: container with very high temperature used for many processes

- Archaea CAN'T cause disease

- Archaea are closer to eukaryotic cells than bacteria

2. Bacteria: (eubacteria)

- Bacteria are present in every conceivable habitat on Earth, even found in rock layers kilometers beneath the Earth's surface.

- This Domain includes the **mycoplasma** (smallest known cells which lack a cell wall)

There are many groups that falls under this domain, one of them is **(cyanobacteria):**

- Lives in polar bear coats
- Cyanobacteria contain arrays of cytoplasmic membranes (thylakoids) that serve as sites of photosynthesis.
- Cyanobacteria gave an oxygen-rich atmosphere, and some are capable of nitrogen fixation (to produce amino acids).



Cyanobacteria: electron micrograph

1.5 | Types of Eukaryotic Cells

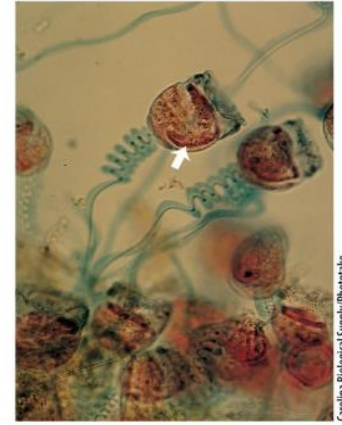
May be unicellular (protists) or multicellular (all other classes include: animals, plants, fungi)

1. Protists: The most complex eukaryotic cells

- The machinery needed for **sensing the environment**, **trapping food**, **expelling excess fluid**, and **evading predators** (الهروب من المفترسات) is found in a single cell.
- They're unicellular, even if they can form colonies (مستعمرات).
- e.g. paramecium, algae, **Vorticella** e.g.2 ameba

These e.g. are heterotrophic, and can make phagocytosis

- Vorticella have a **contractile ribbon in the stalk** and a **large macronucleus that contains multiple copies of its genes**.



Vorticella, a complex ciliated protist

2. animals, plants and fungi:

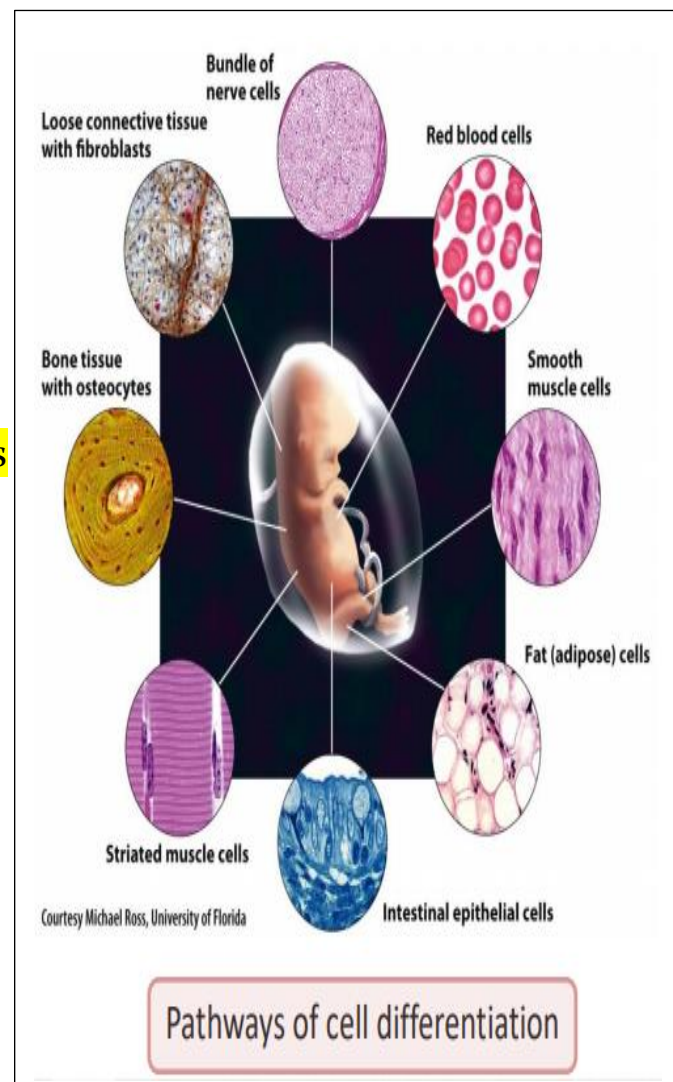
Almost multicellular, and reproduce sexually

-Multicellular eukaryotes have different cell types for different functions.

-Cell differentiation occurs during embryonic development in multicellular organisms.

- The numbers and arrangements of organelles relate to the function and activity of the cell.

- Despite differentiation, cells have many features in common most being composed of the same organelles.



Courtesy Michael Ross, University of Florida

Pathways of cell differentiation

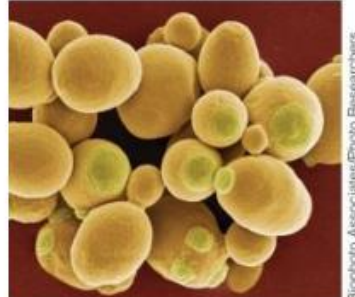
Very important

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اضغط هنا

Model Organisms



(a) *Escherichia coli* (bacterium)



(b) *Saccharomyces* (yeast)



(c) *Arabidopsis* (mustard plant)



(d) *Caenorhabditis elegans* (nematode)



(e) *Drosophila* (fruit fly)



(f) *Mus musculus* (mouse)

الكائنات التي بنستخدمهم للتجارب المخبرية، وعادة دورة حياتهم بتكون قليلة +بنكون عنا صورة كويسة عن بعض صفاتهم

1.6 | The Sizes of Cells and Their Components

Cells are commonly measured in units of **micrometers** ($1 \mu\text{m} = 10^{-6}$ meter) and **nanometers** ($1 \text{nm} = 10^{-9}$ meter).

The cell size is limited:

- 1) By the volume of cytoplasm that can be supported by the genes in the nucleus.
- 2) By the volume of cytoplasm that can be supported by exchange of nutrients.
- 3) By the distance over which substances can efficiently travel through cytoplasm by diffusion.

-However, some eukaryotic cells can be **extremely large**, as the **green alga Acetabularia** is **more than 10 cm long**.

