CELL BIOLOGY

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Lecture 2: The Cell 11/10/2021

The **cell** (from Latin *cella*, meaning "small room") is the basic structural, functional, and biological unit of all known organisms.

A cell is the smallest unit of life. Cells are often called the "building blocks of life".

Organisms can be classified as unicellular (consisting of a single cell such as bacteria) or multicellular (including plants and animals).

The number of cells in plants and animals varies from species to species, it has been estimated that humans contain somewhere around 40 trillion (4×10^{13}) cells. The human brain accounting for around 80 billion of these cells.

Cells consist of cytoplasm enclosed within a membrane, which contains many biomolecules such as proteins and nucleic acids. Most plant and animal cells are only visible under a microscope, with dimensions between 1 and 100 micrometres.

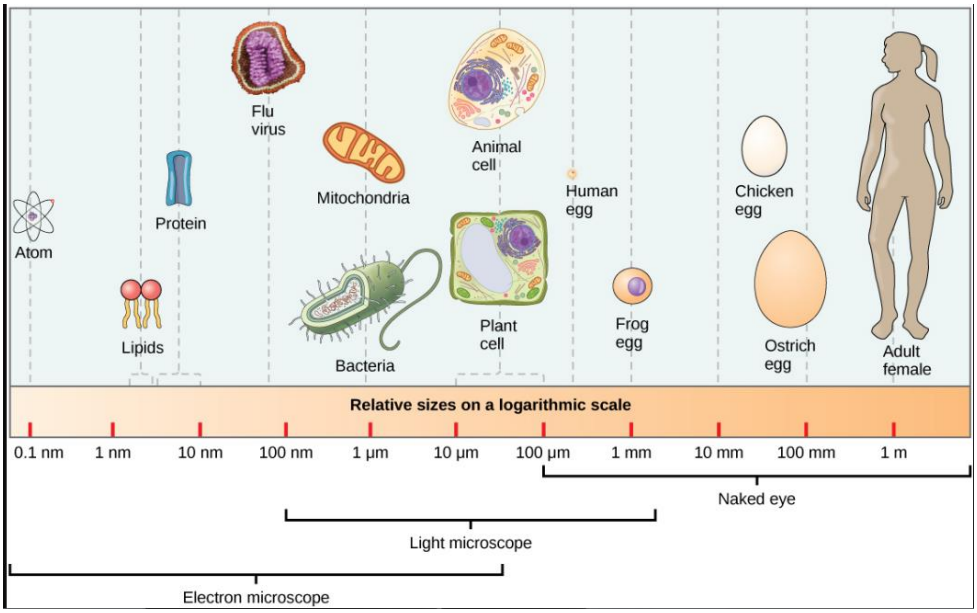
Cell size

At 0.1–5.0 μm in diameter, prokaryotic cells are significantly smaller than eukaryotic cells, which have diameters ranging from 10–100 μm.

The small size of prokaryotes allows ions and organic molecules that enter them to quickly spread to other parts of the cell. Similarly, any wastes produced within a prokaryotic cell can quickly move out.

However, larger eukaryotic cells have evolved different structural adaptations to enhance cellular transport.

In general, cell size is limited because volume increases much more quickly than does cell surface area. As a cell becomes larger, it becomes more and more difficult for the cell to acquire sufficient materials to support the processes inside the cell, because the relative size of the surface area across which materials must be transported declines.



Cell shape

Cells are in various shape and size. It can have the shapes as oval, spherical, rectangular, polygonal, spindle shaped, star shaped, rod-shaped or totally irregular. The shape of cells sometimes vary according to their function.

Cell membrane as well as cell wall maintain shape of any cell. In case of unicellular organisms mostly cells are oval or spherical. But some cells show an unique property related to shapes of cells.

Pleomorphism is a term used in histology and cytopathology to describe variability in the size, shape and staining of cells and/or their nuclei during their life cycle. This property is seen in many bacteria, fungi and in some plant cells.
A specific group of organism have specific shapes of cells. Most bacteria are named according to their shape of cells.
In case of unicellular organisms shapes of the cells is an important criteria of identification.
Also fungal cells are identified with the help of their shape. In case of plants and animals the shapes of cells vary along with the type of tissues.

What all living cells have in common is that they are small 'sacks' composed mostly of water. The 'sacks' are made from a phospholipid bilayer membrane. This membrane is semi-permeable (allowing some things to pass in or out of the cell while blocking others).

So what is in a cell? Cells are 90% fluid (called cytoplasm) which consists of free amino acids, proteins, carbohydrates, fats, and numerous other molecules. The cell environment (i.e., the contents of the cytoplasm and the nucleus, as well as the way the DNA is packed) affect gene expression/regulation, and thus are VERY important aspects of inheritance.

The main component of cells are:-

A- Elements

- 59% Hydrogen (H)
- 24% Oxygen (O)
- 11% Carbon (C)
- 4% Nitrogen (N)
- 2% Others - Phosphorus (P), Sulphur (S), etc.

B- Molecules

- 50% protein
- 15% nucleic acid
- 15% carbohydrates
- 10% lipids
- 10% Other

Cell classification and composition

There are two fundamental classifications of cells: prokaryotic and eukaryotic. eukaryotic, which contain a nucleus, and prokaryotic, which do not. Prokaryotes are single-celled organisms, while eukaryotes can be either single-celled or multicellular.

Prokaryotic cells

Prokaryotes include bacteria and archaea, Prokaryotic cells were the first form of life on Earth. They are simpler and smaller than eukaryotic cells, and lack a nucleus, and other membrane-bound organelles.

The DNA of a prokaryotic cell consists of a single circular chromosome that is in direct contact with the cytoplasm. The nuclear region in the cytoplasm is called the nucleoid. Most prokaryotes are the smallest of all organisms ranging from 0.5 to 2.0 µm in diameter.

The study of eukaryotic cells is typically the main focus of cytologists, whereas prokaryotic cells are the focus of microbiologists.

A prokaryotic cell has three regions:

A- **Cell envelope** – generally consisting of a plasma membrane covered by a cell wall which, for some bacteria, may be further covered by a third layer called a capsule. Though most prokaryotes have both a cell membrane and a cell wall.

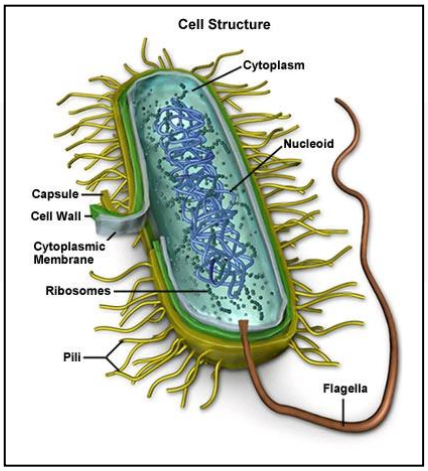
- The envelope gives rigidity to the cell and separates the interior of the cell from its environment, serving as a protective filter.
- The cell wall consists of peptidoglycan in bacteria, and acts as an additional barrier against exterior forces. It also prevents the cell from expanding and bursting (cytolysis) from osmotic pressure due to a hypotonic environment.
- Some eukaryotic cells (plant cells and fungal cells) also have a cell wall.

B- **Cytoplasmic region** consisting of a jelly-like region within the cell in which other cellular components are found

C- **DNA**, the genetic material of the cell;

Prokaryotes can carry extrachromosomal DNA elements called plasmids, which are usually circular.

On the outside, **flagella and pili** project from the cell's surface. These are structures (not present in all prokaryotes) made of proteins that facilitate movement and communication between cells.



Structure of a typical prokaryotic cell

Eukaryotic cells

Either be unicellular or multicellula, and include animal, plant, fungi, and protozoa cells which all contain organelles with various shapes and sizes. These cells are composed of the following organelles:

- **Nucleus**: The genome and genetic information storage for the cell, containing all the DNA organized in the form of chromosomes.
- **Nucleolus**: This structure is within the nucleus, usually dense and spherical in shape. It is the site of ribosomal RNA (rRNA) synthesis, which is needed for ribosomal assembly.
- **Endoplasmic reticulum (ER)**: This functions to synthesize, store, and secrete proteins to the golgi apparatus.
- **Mitochondria**: Production of energy or ATP within the cell.
- **Golgi apparatus**: its function is package, and secrete the proteins to their destination and direct it to the correct place.
- **Lysosome**: The lysosome functions to degrade material brought in, from the outside of the cell or old organelles.

  Autophagy is the process of degradation through lysosomes which occurs when a vesicle buds off from the ER and engulfs the material, then, attaches and fuses with the lysosome to allow the material to be degraded.

- **Ribosomes**: Functions to translate RNA to protein.
- **Cytoskeleton**: This functions to anchor organelles within the cells and make up the structure and stability of the cell.
- **Cell membrane**: The cell membrane can be described as a phospholipid bilayer and is also consisted of lipids and proteins.
- **Centrioles**: Function to produce spindle fibers which are used to separate chromosomes during cell division.

Eukaryotic cells may also be composed of the following molecular components:

- **Chromatin:** This makes up chromosomes and is a mixture of DNA with various proteins.
- **Cilia**: They help to propel substances and can also be used for sensory purposes.

Unique Properties of Plant Cells

Plant Cells have a number of important differences compared to their animal counterparts.

- **Chloroplasts**

  The chloroplasts are an organelle similar to the mitochondria in that they are self reproducing and they are the energy factories of the cell. they are near the large center vacuole.

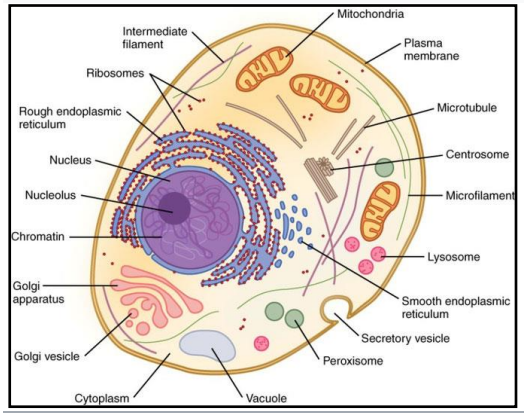
  Chloroplasts capture light energy from the sun and convert it into ATP and sugar. In this way the cell can support itself without food.

- **Vacuoles**

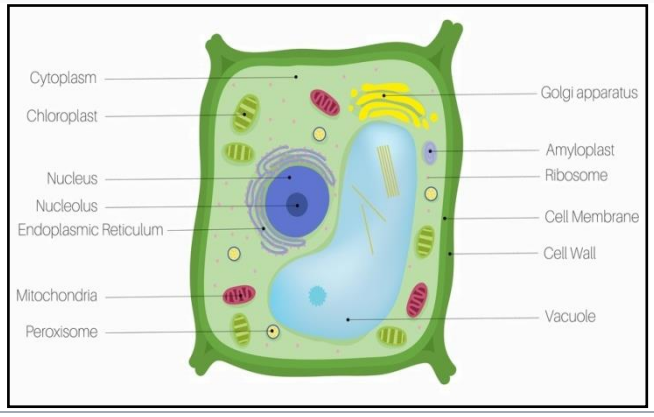
  Plants often have large structures containing water surrounded by a membrane in the center of their cells. These are vacuoles and act as a store of water and food (in seeds. When the plant loses water the vacuoles quickly lose their water, and when plants have a lot of water the vacuoles fill up. In mature plants there is usually one large vacuole in the centre of the cell.

- **Cell walls**

  Plant cells are not flaccid like animal cells,it have a rigid cell wall around them made of fibrils of cellulose embedded in a matrix of several other kinds of polymers such as pectin and lignin. The cellulose molecules are linear and provide the perfect shape for intermolecular hydrogen bonding to produce long, stiff fibrils. It is the cell wall that is primarily responsible for ensuring the cell does not burst in hypotonic surroundings.



Structure of a typical animal cell



Structure of a typical plant cell