Introduction of Cells (1)

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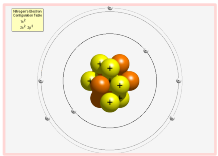
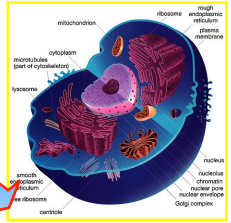
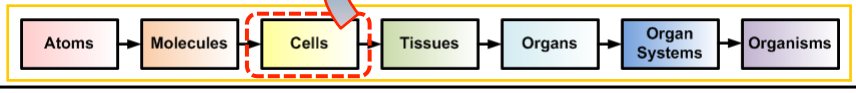
Cells

- Both living and non-living things are composed of molecules made from chemical elements such as C, H, O, and N.
- The organization of these molecules into cells is one feature that distinguishes living things from all other matter.
- The cell is the smallest unit of matter that can carry on all the processes of life.







Cells

- Every living things – from the tiniest bacterium to the largest whale – is made of one or more cells.
- Before the 17th century, no one knew that cells existed, since they are too small to be seen with the naked eye.
- The invention of the microscope enabled Robert Hooke (1665) to see and draw the first “cells”, a word coined by Hooke to describe the cells in a thin slice of cork.

Cell Theory

- The idea that all living things are made of cells was put forward in about 1840 and in 1955 came “Cell Theory” – i.e. “Cells only from other cells” – contradicting the earlier theory of “Spontaneous Generation”.
- ***Cell Theory*** consists of three principles:
  - All living things are composed of **one or more cells**.
  - Cells are the **basic units of structure and function** in an organism.
  - Cells come only from the **replication of existing cells**.

Cell Diversity

- Not all cells are like. Even cells within the same organism show enormous diversity in size, shape, and internal organization.
- Human body contains around 10^{13} to 10^{14} cells of around 300 different cell types, which broadly classify into 4 groups:
  - Muscular
  - Nervous
  - Connective
  - Epithelial
- There are 3 classes of cells in the human body
  - Labile cells: dividing all the time (skin cell)
  - Stable cells: divide when needed (liver)
  - Permanent cells: cannot be replaced (nervous tissue)

Cell Size

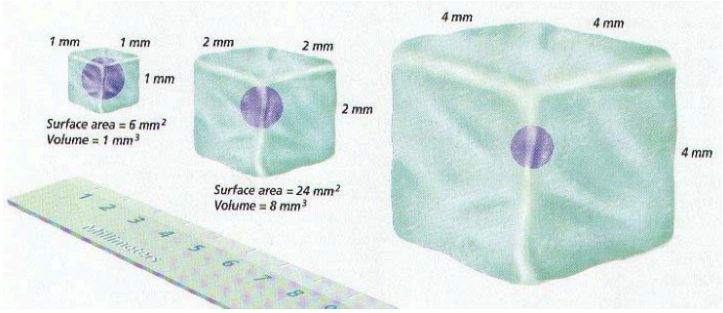
- A few types of cells are large enough to be seen by the unaided eye. The human egg (ovum) is the largest cell in the body, and can (just) be seen without the aid of microscope.
- Most cells are small for two main reasons:
  - The cell's nucleus can only control a certain volume of active cytoplasm.
  - Cells are limited in size by their surface to volume ratio.

    A group of small cells has a relatively large surface area than a single large cell of the same volume. This is important because the nutrients, oxygen, and other materials a cell requires must enter through it surface. As a cell grows larger at some point its surface area becomes too small to allow these materials to enter the cell quickly enough to meet the cell's need.

Cell Size

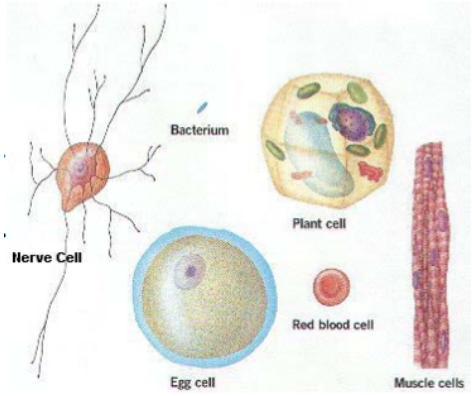
- According to Fick's Law:

  Rate of Diffusion is proportional to (Surface Area x Concentration Difference / Distance)



Cell Shape

- Cells come in a variety of shapes – depending on their function: the neurons from your toes to your head are long and thin; blood cells are rounded disks, so they can flow smoothly.

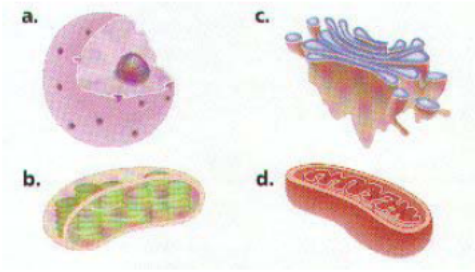


Internal Organization

- Cells contain a variety of internal structures called **organelles**.
- An organelle is a cell component that performs a specific function in the cell.
- Just as the organs of a multicellular organism carry out the organism's life functions, the organelles of a cell maintain the life of the cell.
- There are many different cells; however, there are certain features common to all cells.

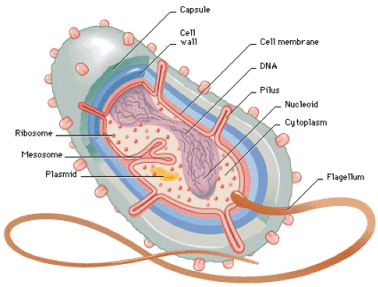
Internal Organization

- The entire cell is surrounded by a thin **cell membrane**. All membrane have the similar thickness and basic structure.
- Organelles often have their own membranes, too – these membranes have a similar structure.
- The **nucleus**, **mitochondria**, and **chloroplasts** all have double membranes, called **envelopes**.

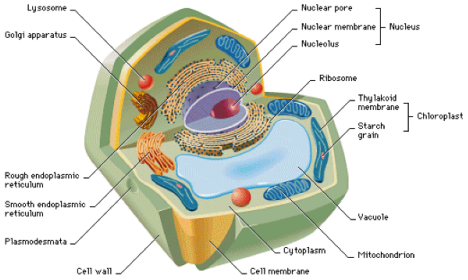


Prokaryotes vs. Eukaryotes

- Organisms whose cells normally contain a nucleus are called **Eukaryotes**; those (generally smaller) organisms whose cells lack a nucleus and have no membrane-bounded organelles are known as **Prokaryotes**.



A Prokaryotic cell (bacterium)



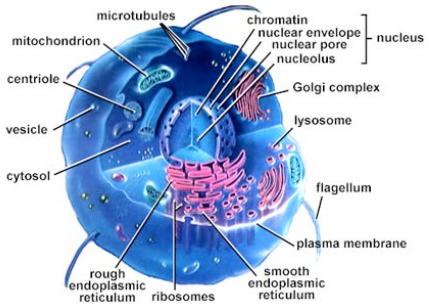
A Eukaryotic cell (plant)

Prokaryotes vs. Eukaryotes

	Prokaryotes	Eukaryotes
Typical organisms	bacteria	Protoctista, fungi, plants, animals
Typical size	~ 1-10 µm	~ 10-100 µm (sperm cells) apart from the tail, are smaller)
Type of nucleus	Nuclear body **No nucleus**	real nucleus with nuclear envelope
DNA	circular (ccc DNA)	linear molecules (chromosomes) with histone proteins
Ribosomes	70S	80S
Cytoplasmatic structure	very few structures	highly structured by membranes and a cytoskeleton
Cell movement	Flagellae/cilia made of flagellin	flagellae and cilia made of tubulin
Mitochondria	none	1 - 100 (though RBC's have none)
Chloroplasts	none	in algae and plants
Organization	usually single cells	single cells, colonies, higher multicellular organisms with specialized cells
Cell division	Binary fission (simple division)	Mitosis (normal cell replication) Meiosis (gamete production)

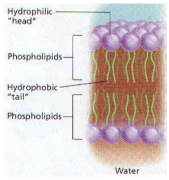
Parts of the Eukaryotic Cell

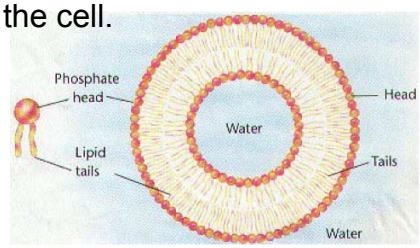
- The structures that make up a Eukaryotic cells are determined by the specific functions carried out by the cell. Thus there is no typical Eukaryotic cell.
- Eukaryotic cells generally have three main components: a cell membrane, a nucleus, and a variety of other organelles.



The Cell Membrane

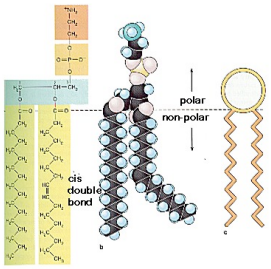
- The cell membrane is a complex barrier separating every cell from its external environment.
- The “selective permeable” membrane regulates what passes into and out of the cell.
- The cell membrane is a fluid mosaic of proteins floating in a phospholipid bilayer.
- The cell membrane functions like a gate, controlling which molecules can enter and leave the cell.





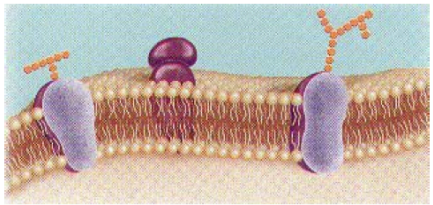
The Cell Membrane

- **Carrier proteins** in or on the membrane are specific, only allowing a small group of very similar molecules through. Many molecules cannot cross at all. For this reason, the cell membrane is said to be **selectively permeable**.
- The rest of the cell membrane is composed of phospholipid molecules. They have only two fatty acid "tails" as one has been replaced by a phosphate group "head".
- **Head** is charged and so polar – hydrophilic.
- **Tail** is not charged and so non-polar – hydrophobic.
- Cell membrane is constantly being formed and broken down in living cells.



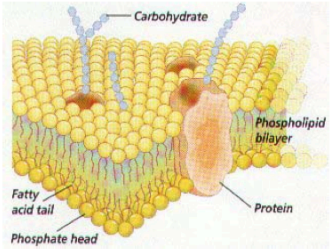
The Cell Membrane

- **Fluid Mosaic Model of Cell Membrane**
  - Membrane are fluid and are rather viscous – like vegetable oil.
  - The molecules of the cell membrane are always in motion, so the phospholipids are able to drift across the membrane, changing places with their neighbor.
  - Proteins, both in and on the membrane, form a mosaic, floating in among phopholipids.
  - The mosaic of proteins in the cell membrane is constantly changing.



The Cell Membrane

MEMBRANE PROTEINS



1. A variety of protein molecules are embedded in the basic phospholipid bilayer.
2. Some proteins are attached to the surface of the cell membrane on both the internal and external surface. These may be hormone receptors, enzymes or cell recognition proteins (or antigens)
3. Other proteins are embedded in the phospholipid bilayer itself. These are often associated with transporting molecules from one side of the membrane to the other and are referred to as **carrier proteins.**
4. Some of these form channels or pores through which certain substances can pass (**facilitated diffusion**), whilst others bind to a substance on one side of the membrane and carry it to the other side of the membrane (**active transport**)
5. Proteins exposed to the cell's external environment often have carbohydrates attached to them which act as antigens (e.g. blood groups A & B – group AB has **both**; group O has **neither**).
6. Some viruses may also bind here too.

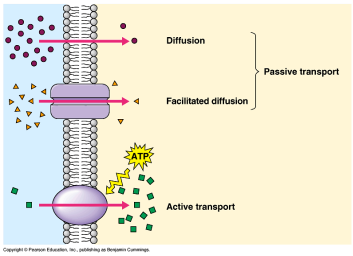
Across Cell Membrane

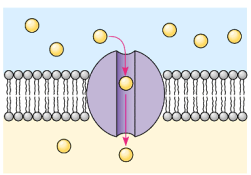
- **Molecules that pass through the membrane easily:**

Hydrophobic molecules (oil soluble)	O_2, N_2
Nonpolar	benzene
Small uncharged Polar molecules	H_2O, Urea, glycerol, CO_2

- **Molecules that don't pass through the membrane easily:**

Large uncharged	Glucose
Polar molecules	Sucrose
Ions (charged)	H^+, Na^+, HCO_3, K^+Ca^{2+}, Cl^-, Mg^{2+}





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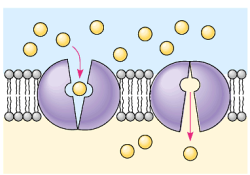

(b)

Across Cell Membrane

- **"Active Transport"** pumps materials across the membrane against the concentration gradient, i.e. from low concentration to high concentration therefore requires energy.