



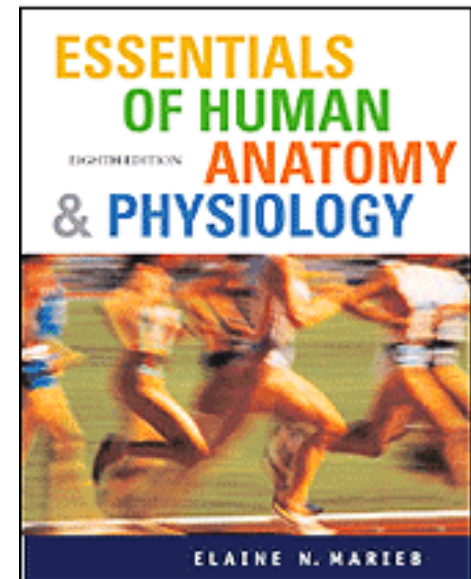
# Human Anatomy and Physiology

CLS 224

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## **Lecture 2:**

# **Cells, Tissues, and body fluids**

# CELLS

A cell is the smallest working unit of all living things that is capable of performing life functions.

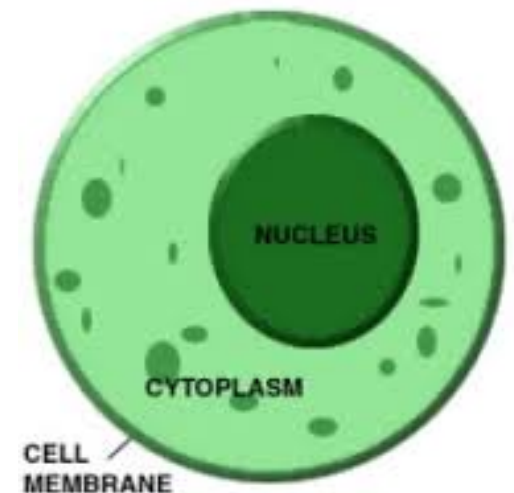
All living things are made up of cells.

1. Anatomy and physiology of a generalized cell.

# 1. Anatomy and physiology of a generalized cell.

In general, all cells have 3 main structures:

- A) Nucleus,
- B) Cytoplasm
- C) Plasma membrane.



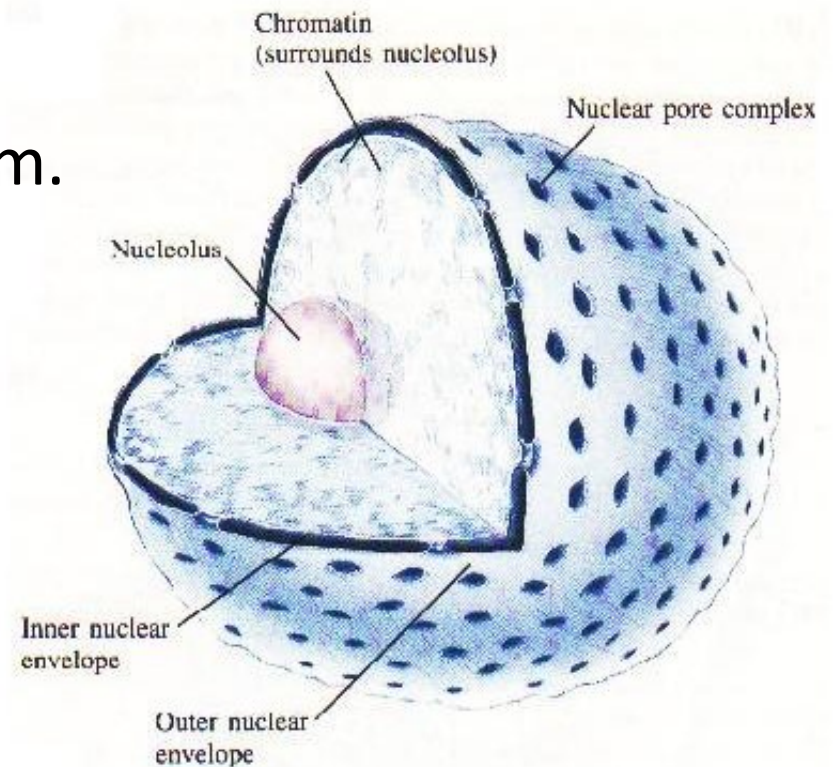


## A) Nucleus

- “The control center”; directs cell activities (how?)
- Has three regions:

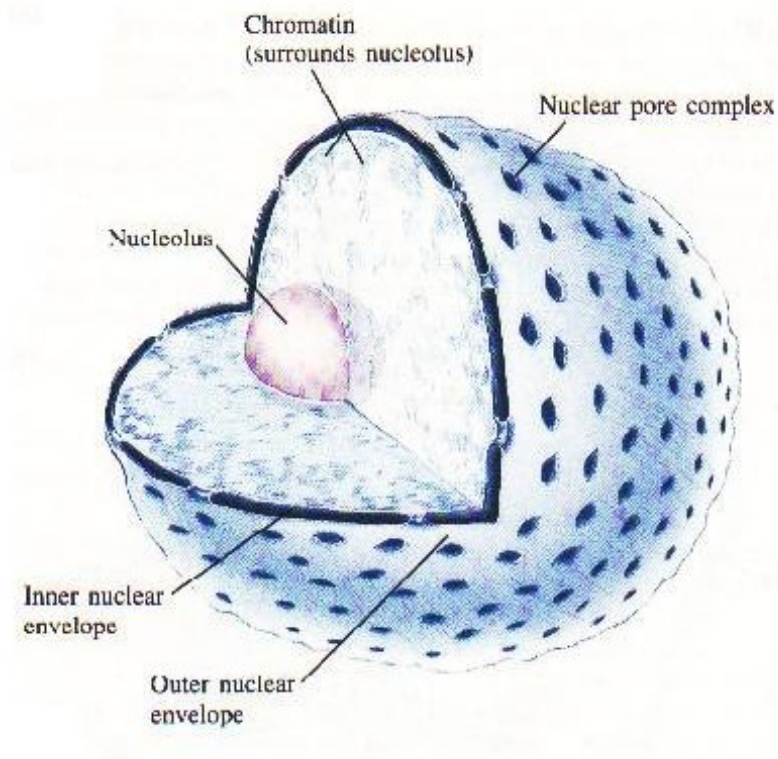
# Nuclear Membrane

- Surrounds the nucleus; separating it from the cytoplasm.
- Made of two layers.
- Nuclear pores: Openings allow material to enter and leave nucleus selectively.



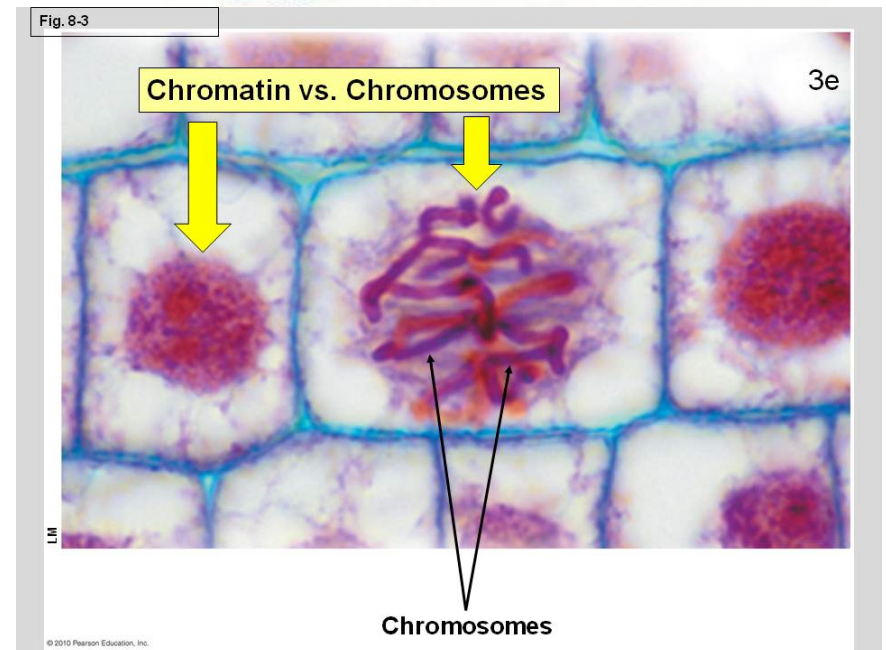
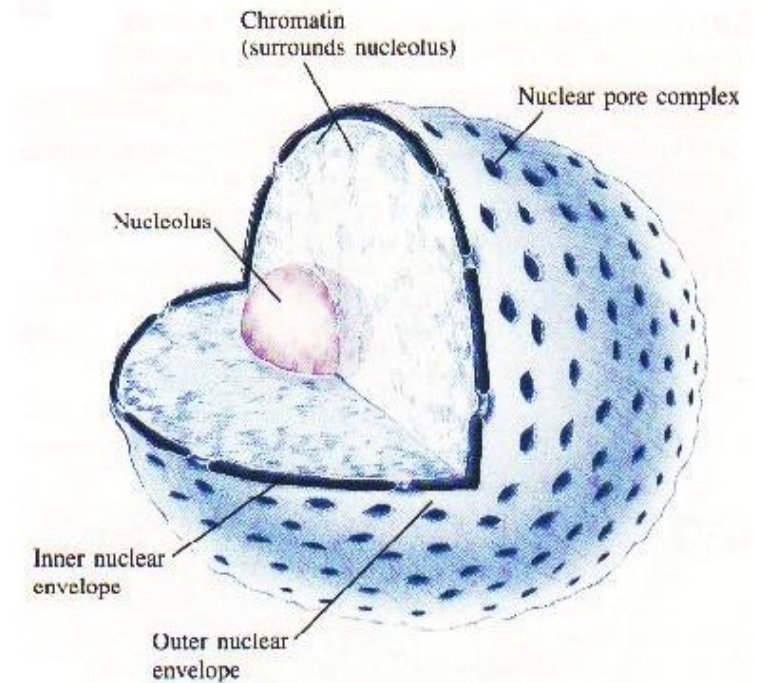
# Nucleolus

- Inside nucleus.
- Site where ribosomes are assembled.



# Chromatin

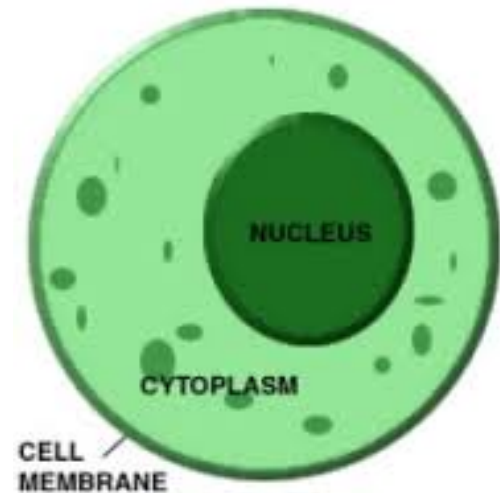
- When cell isn't dividing, its DNA forms a loose network of threads called chromatin that is scattered throughout the nucleus.
- When a cell is dividing, chromatin condense to form rodlike bodies called chromosomes.



## B) Plasma membrane

All cells are surrounded by a plasma membrane.

a) Structure –  
composed of proteins, phospholipid bilayer and cholesterol arranged in a fluid mosaic pattern.

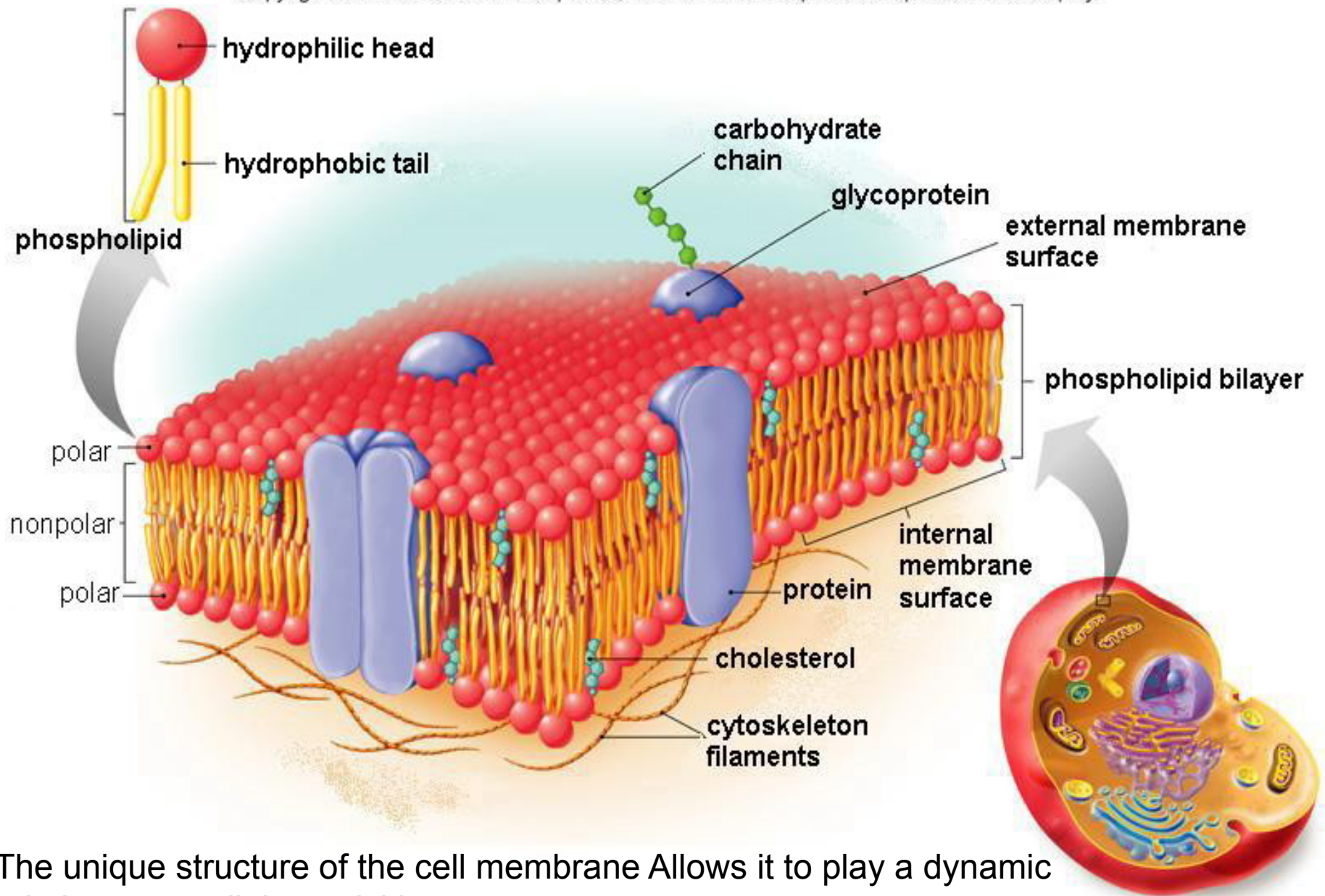


b) Functions

- ❖ Gives the cell its integrity.
- ❖ **Selectively permeable** boundary between the cell and the external environment (regulates what comes in and goes out).

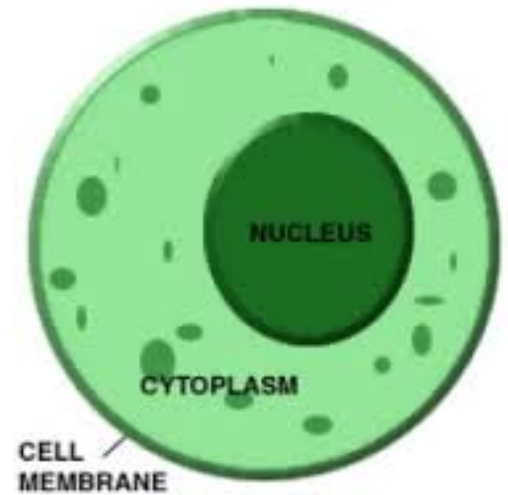


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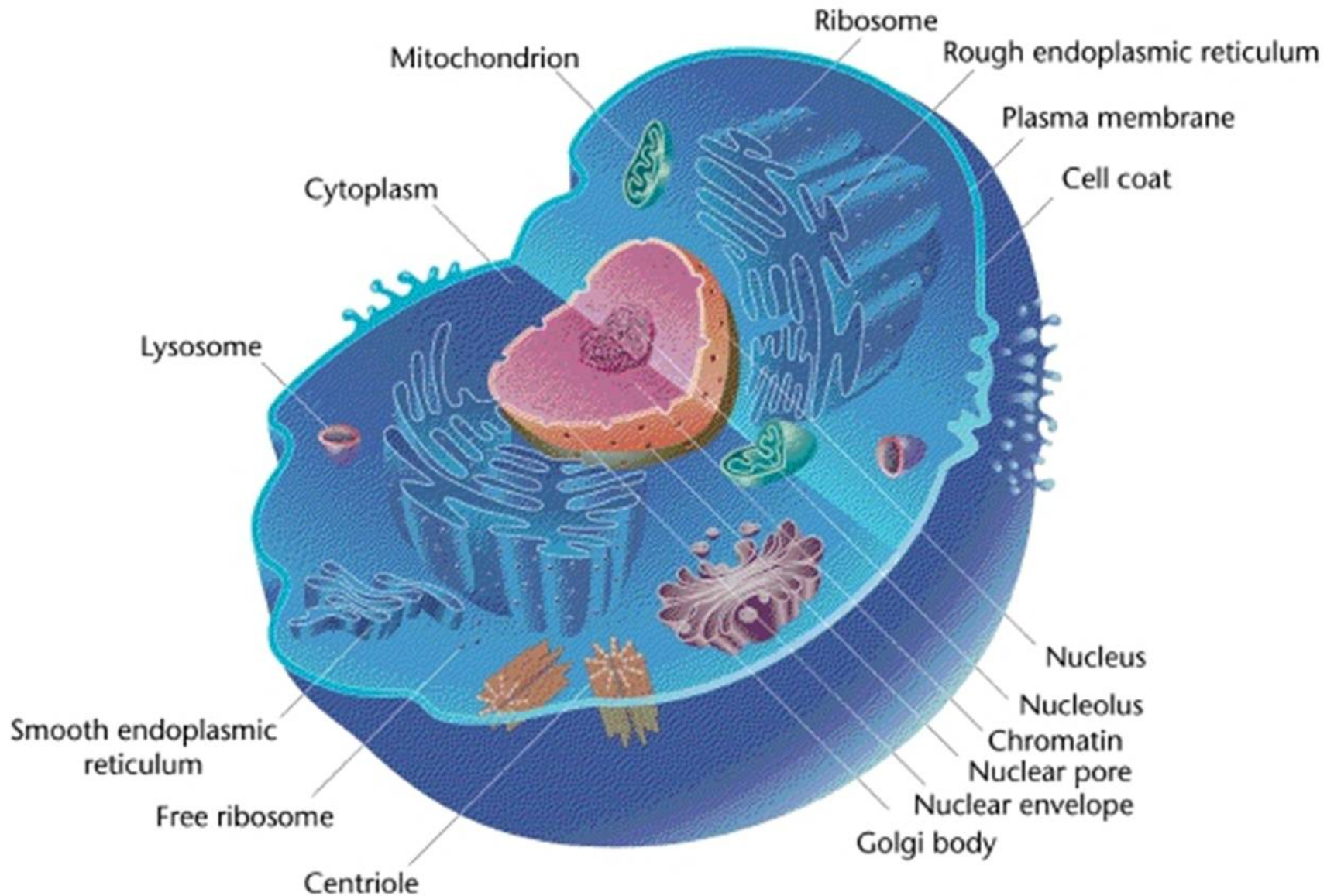
The unique structure of the cell membrane Allows it to play a dynamic role in many cellular activities.

## C) Cytoplasm



- It is the factory area.
- Has 3 major elements:
  - 1) Cytosol: makes up about 70% of the cell volume.  
Semitransparent fluid composed of water mostly.
  - 2) Organelles.
  - 3) Inclusions: are not functional units e.g. melanin seen in hair and skin cells, crystals..
- The fluid in the nucleus are called the **nucleoplasm**

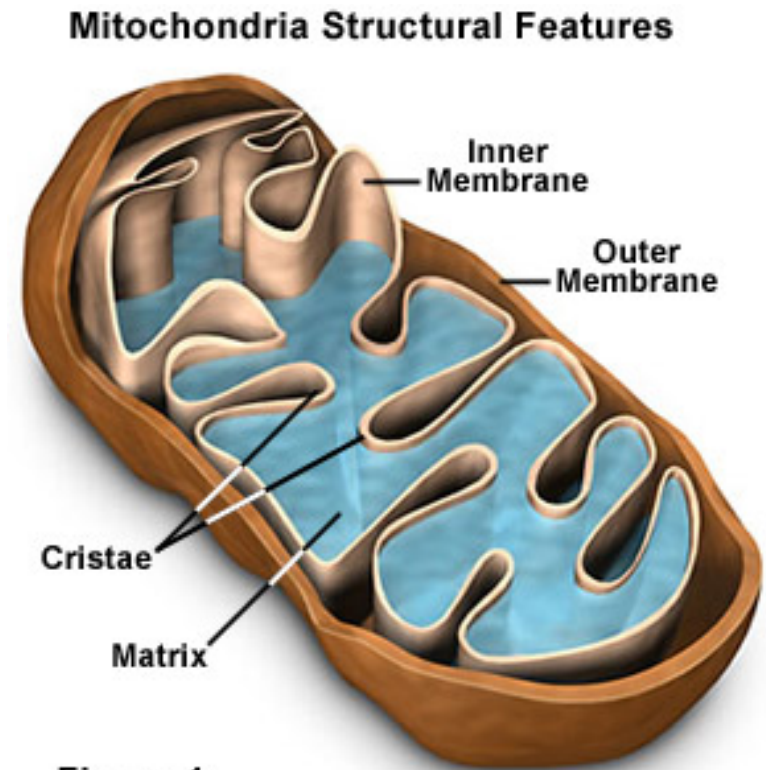
# Organelles





# Mitochondria

- Mitochondria are known as the “powerhouses” of the cell.
- It takes in nutrients, breaks them down, and creates energy (ATP) for the cell.
- It has outer membrane, an inner membrane, cristae and matrix.
- Their number varies from cell to cell.



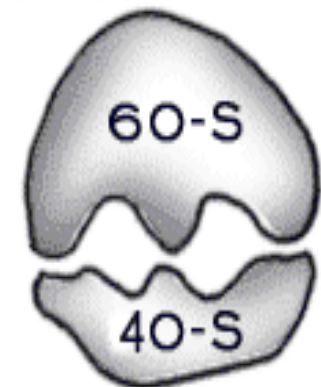
**Figure 1**

# Ribosomes

- **Ribosomes** are the “protein builders” or the “protein **synthesizers**” of the cell. Each cell contains thousands.
- Found floating in the cell making proteins that will be used inside the cell. Other ribosomes are found on the endoplasmic reticulum
- Made of two subunits-  
60-S (large) and 40-S (small).



RIBOSOME SUBUNITS

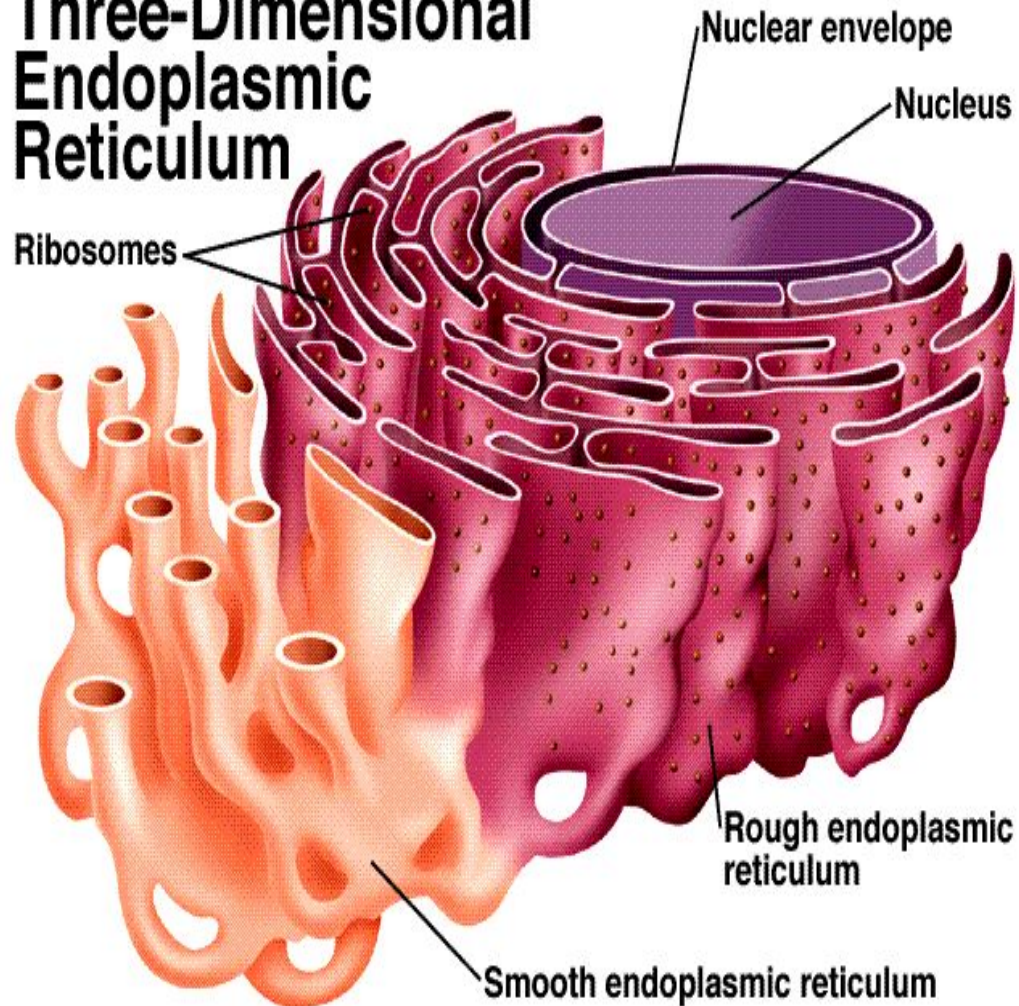


TWO SUBUNITS

# Endoplasmic Reticulum

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## Three-Dimensional Endoplasmic Reticulum



- Is a system of fluid Cisterns (canals) that coil and twist held together by the cytoskeleton.
- Functions as a **"minicirculatory system"**.  
(carries substances from one part of the cell to another).

## Classified into two types:

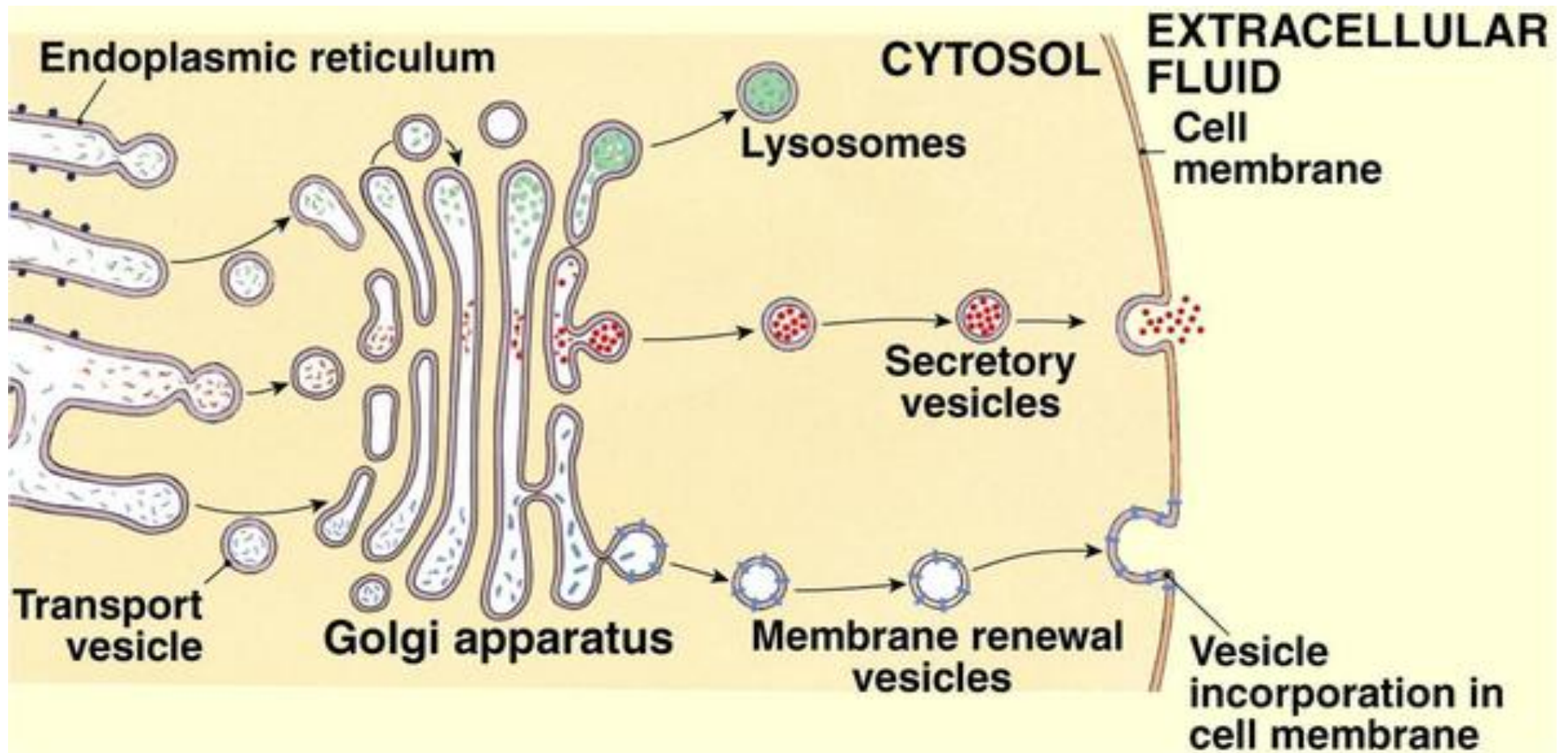
### ❖ Rough endoplasmic reticulum (RER):

- Studded with ribosomes.
- They are very important in the synthesis and packaging of proteins.
- The proteins made by ribosomes are dispatched to other areas of the cell in transport vesicles.

### ❖ Smooth endoplasmic reticulum (SER):

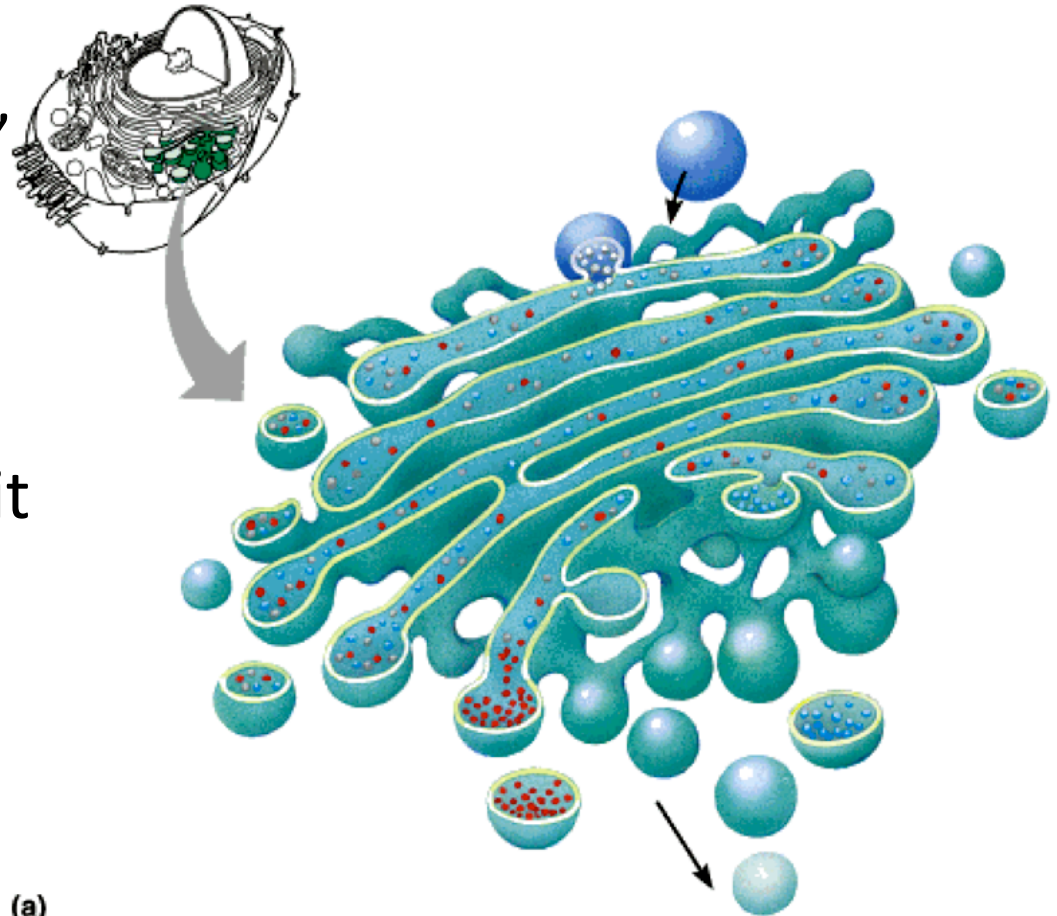
- lacks ribosomes.
- It functions in lipid metabolism and detoxification of drugs.

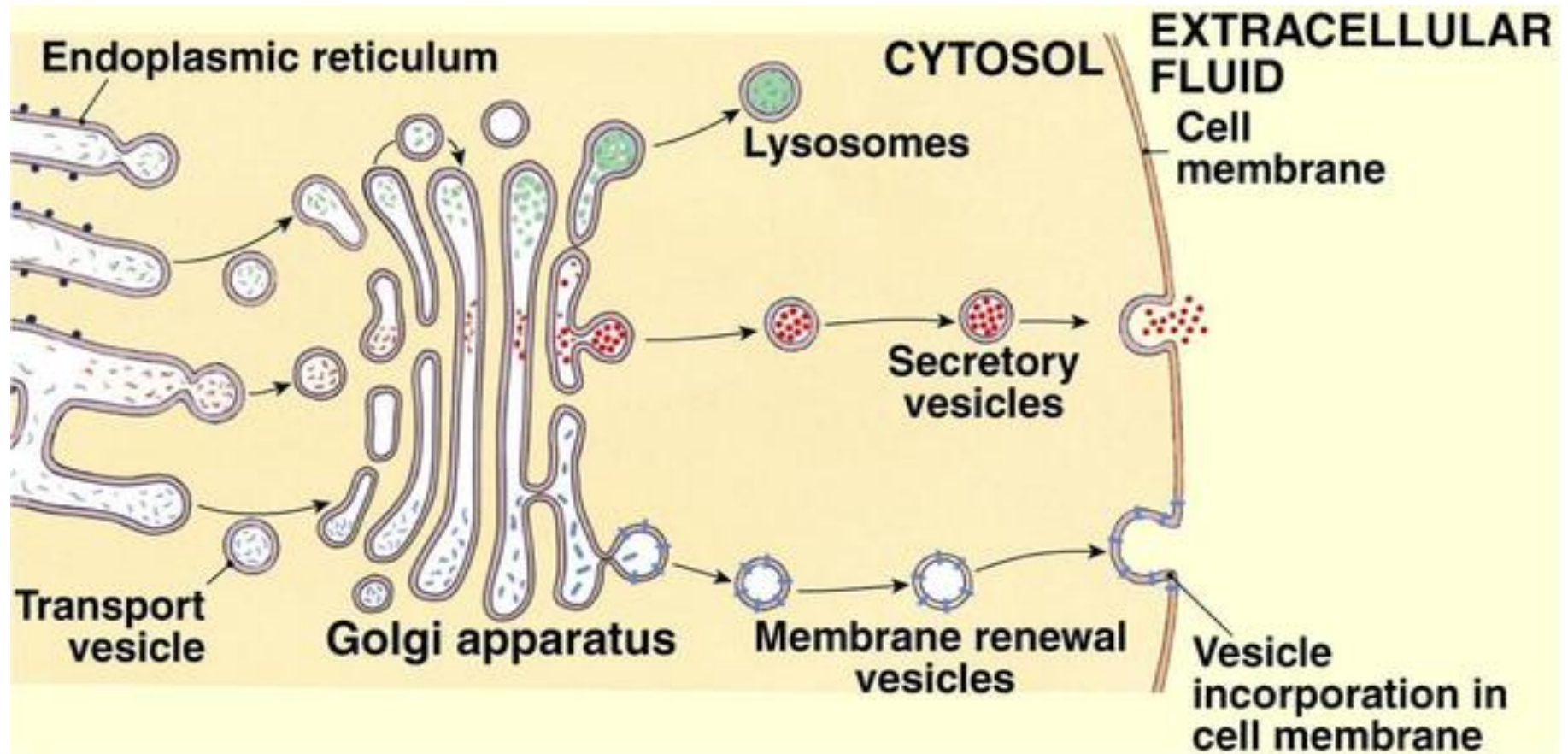




# Golgi apparatus

- The Golgi complex works closely with the rough ER.
- It is the “**traffic director**” for cellular proteins; its major function is to further process and modify proteins sent to it by RER via transport vesicles. The product is then packaged within vesicles which leave the golgi apparatus and goes to various destinations.





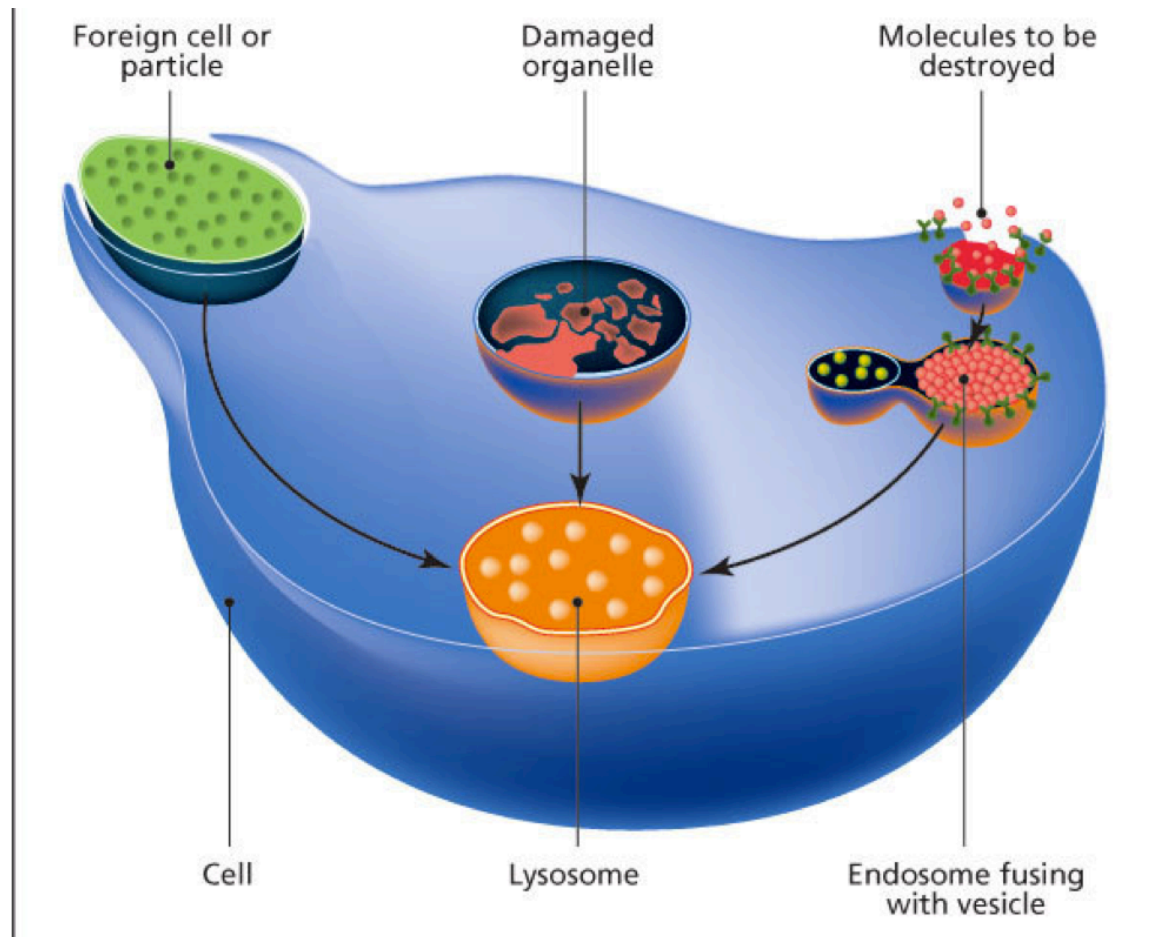
- 1) Golgi vesicle containing proteins to be secreted becomes a secretory vesicle which fuse to the plasma membrane and eject the contents to the outside of the cell.
- 2) Golgi vesicle containing membrane components become a membrane renewal vesicles which fuse with plasma membrane to become part of the membrane.
- 3) Golgi vesicle containing digestive enzymes become a lysosome that remain in the cell.



# Lysosome

- It is the cell's “demolition site”; lysosomal enzymes can digest nonusable cell structures and most foreign substances.

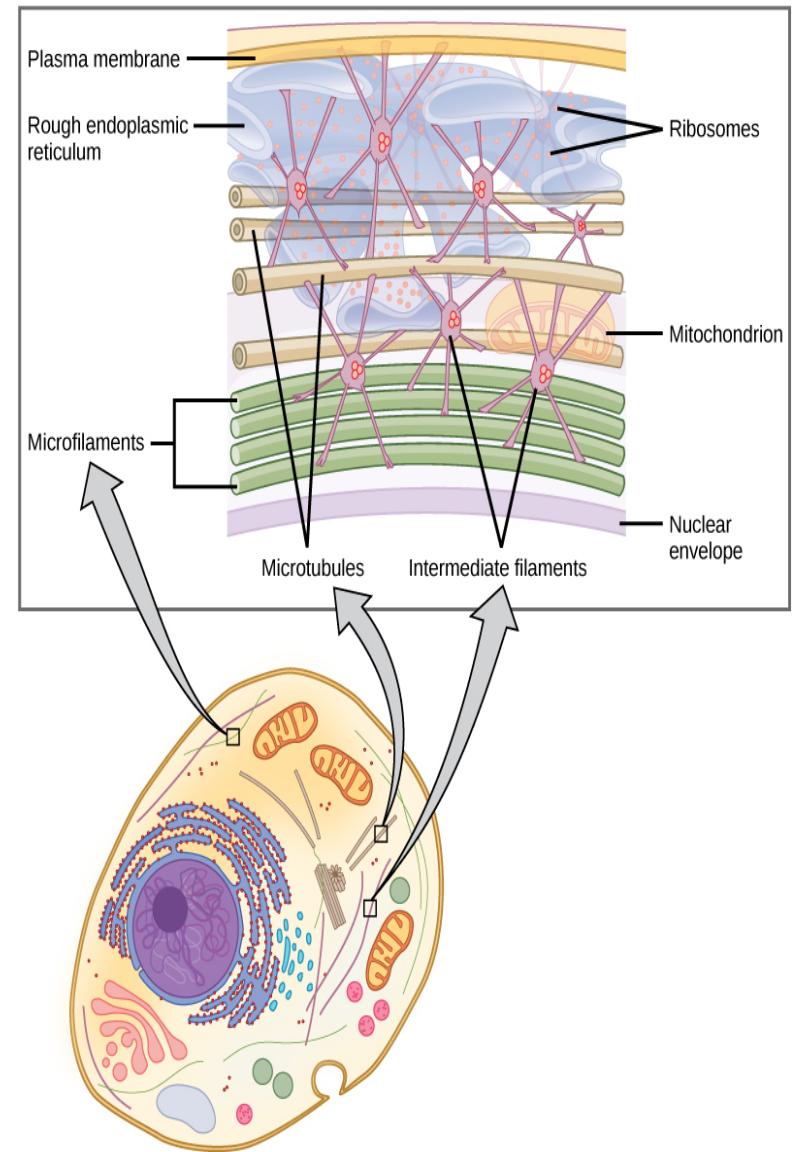
Abundant in  
WBC that  
engulf bacteria





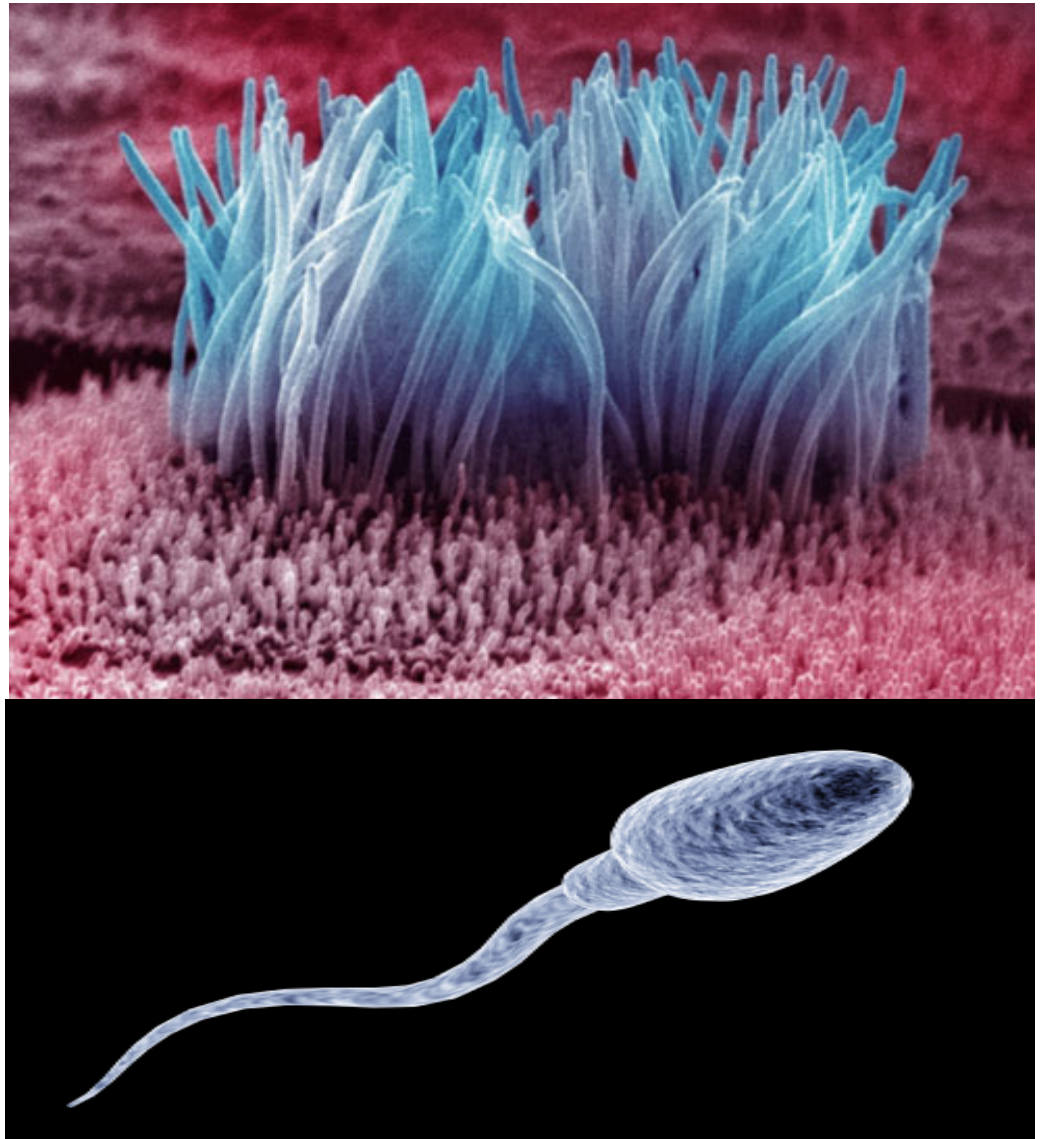
# Cytoskeleton

- The cytoskeleton is a network of protein structures extends through out the cytoplasm. Act as the cell's “**bone and muscles**”;
- Determines cell shape, support organelles.
- Mediates movement by helping the cell move in its environment and mediating the movement of the cell's organelle.
- Cytoskeleton is made of: microfilaments, intermediate filaments, and microtubules.



# Cilia, Flagella

- Cilia: Move substance along the cell surface  
E.g. ciliated cells of the respiratory system lining move mucus up and away from the lungs.
- The only flagellated cell in human is the sperm.

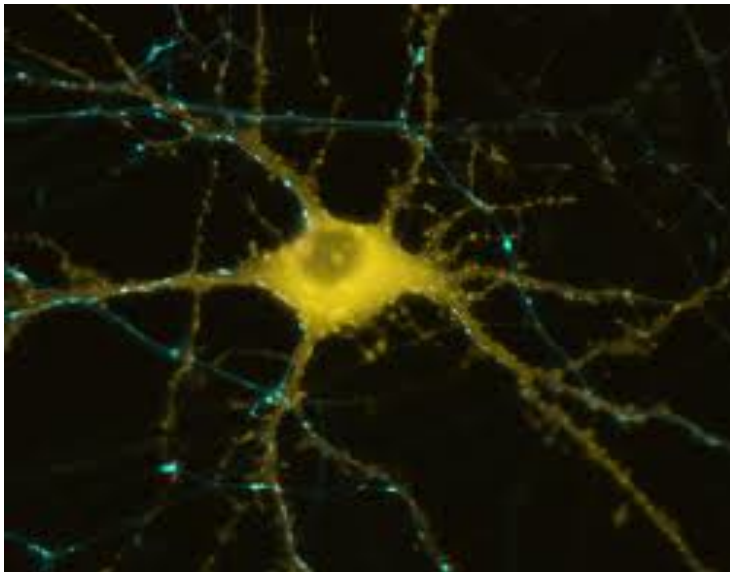
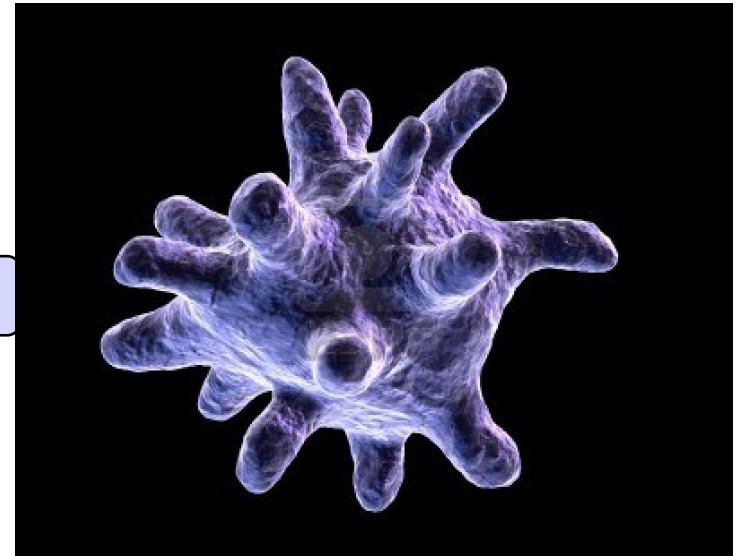


# Cell diversity



Fat cell

macrophage



Nerve Cell

Sperm, oocyte



# 1. Anatomy and physiology of a generalized cell.

- Define cell, organelle, and inclusion.
- Identify the three major cell regions.
- List the structures of the nucleus and explain the function of each.
- Describe organelles and discuss the major function of each.

# Body Tissues

## Four Basic Kinds of Tissues

- Epithelial Tissue (covering).
- Connective Tissue (support).
- Muscle Tissue (movement).
- Nervous Tissue (control).



- Histology:  
The study of tissues.

#### Four types of tissue



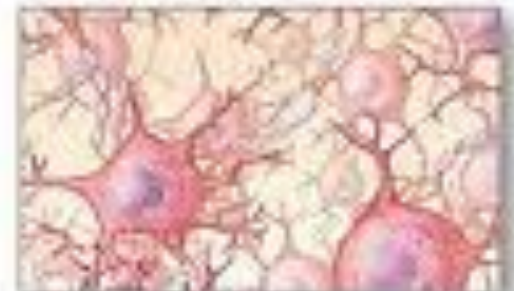
Connective tissue



Epithelial tissue



Muscle tissue


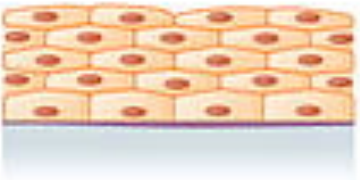







Nervous tissue

Groups of similar cells which perform a common function.

# Epithelial Tissue

- Is the lining, covering and glandular tissue of the body.

	Simple	Stratified
Squamous	 <p>Simple squamous epithelium</p>	 <p>Stratified squamous epithelium</p>
Cuboidal	 <p>Simple cuboidal epithelium</p>	 <p>Stratified cuboidal epithelium</p>
Columnar	 <p>Simple columnar epithelium</p>	 <p>Stratified columnar epithelium</p>
		 <p>Pseudostratified columnar epithelium</p>

- Epithelial Tissue Locations:
  - Covers all body surface, and organs inside the body cavities.
  - Lines the cavities, tubes, ducts and blood vessels inside the body.
  - Forms various glands in the body.

# Epithelial Tissue

## Functions:

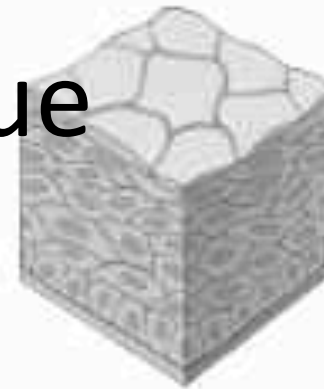
### Simple squamous

- Lines blood vessels and air sacs of lungs
- Permits exchange of nutrients, wastes, and gases



### Stratified squamous

- Outer layer of skin, mouth, vagina
- Protects against abrasion, drying out, infection



### Simple cuboidal

- Lines kidney tubules and glands
- Secretes and reabsorbs water and small molecules



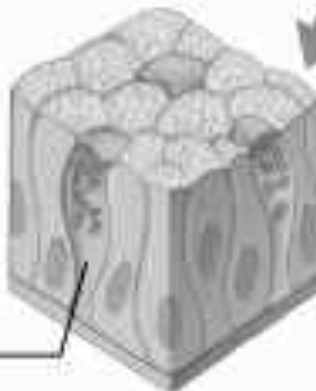
### Stratified cuboidal

- Lines ducts of sweat glands
- Secretes water and ions



### Simple columnar

- Lines most digestive organs
- Absorbs nutrients, produces mucus



### Stratified columnar

- Lines epididymus, mammary glands, larynx
- Secretes mucus



Goblet cell

Basement membrane

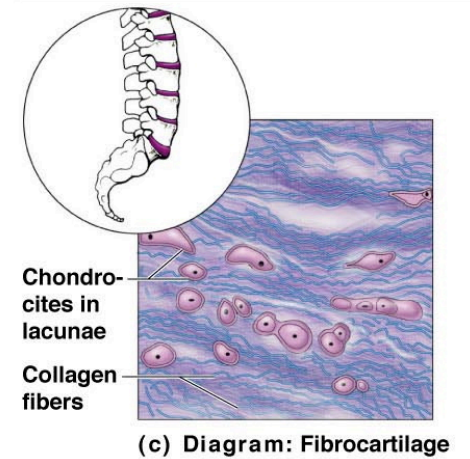
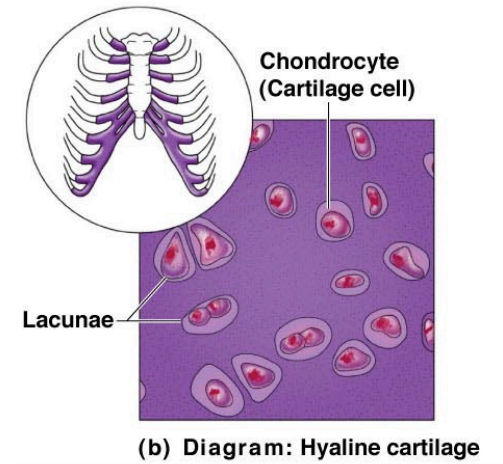
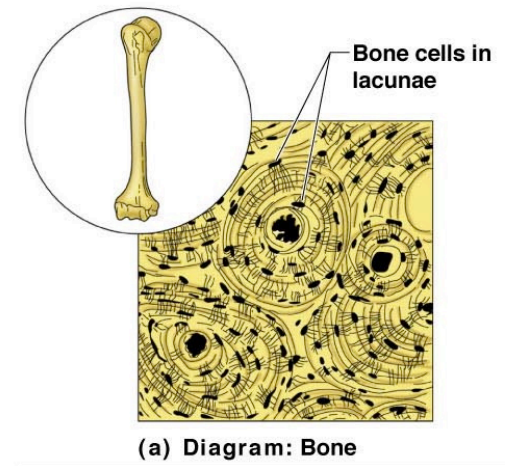
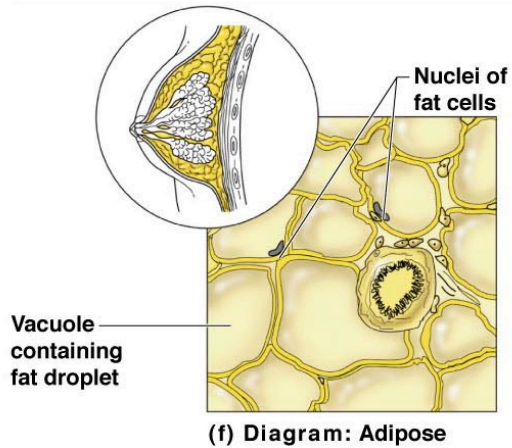
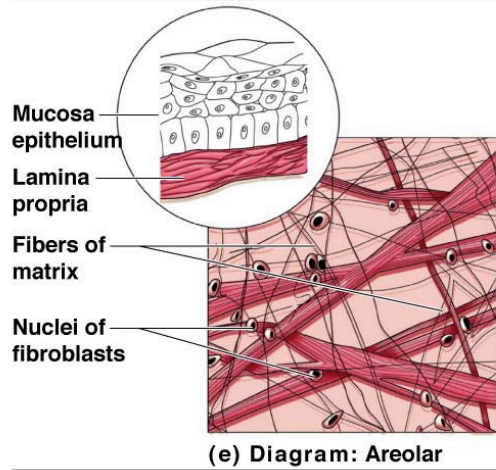
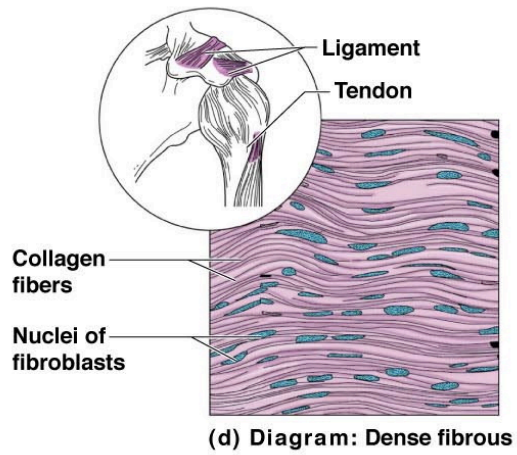


# Connective Tissue

- Connective Tissue:
  - Most abundant & widely distributed tissue
- Connective Tissue Functions:
  - Connects, binds and supports structures.
  - Protects & cushions organs and tissues,
  - Insulation (fat)
  - Transports substances (blood).

# Types of connective tissue:

- Dense connective tissue (tendons, ligaments)
- Loose connective tissue (reticular, adipose, areolar)
- Cartilage (elastic, fibro, hyaline)
- Bone
- Blood

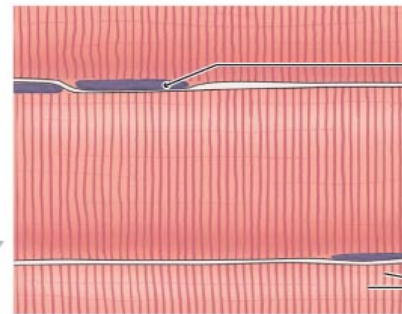
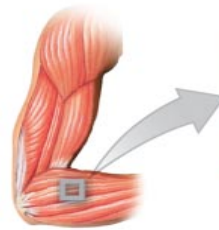


# Muscle Tissue

- Muscle Tissue: Specialized to contract to produce movement.
- Muscle Tissue Functions:
  - Movement.
  - Maintains posture.
  - Produces heat.
  - Facial expressions.
  - Pumps blood.
  - Peristalsis.

# 3 kinds of muscle cells:

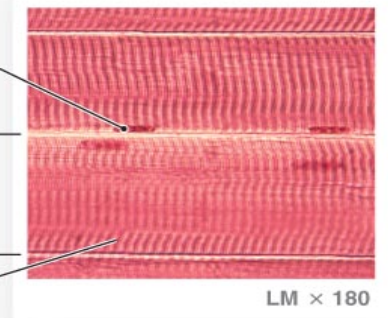
## The structure and function of the three types of muscle tissue



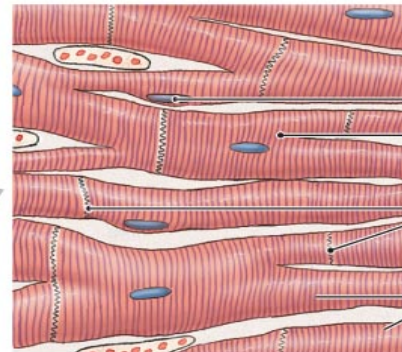
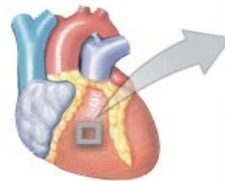
Nuclei

Muscle fiber

Striations



**Skeletal muscles move or stabilize the position of the skeleton; guard entrances and exits to the digestive, respiratory, and urinary tracts; generate heat; and protect internal organs.**

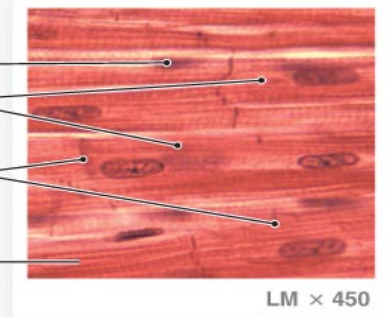


Nucleus

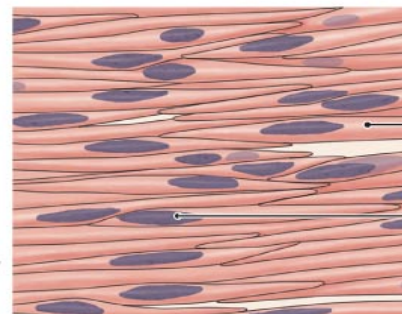
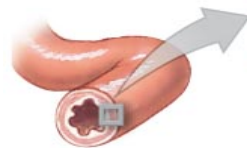
Cardiac muscle cells

Intercalated discs

Striations

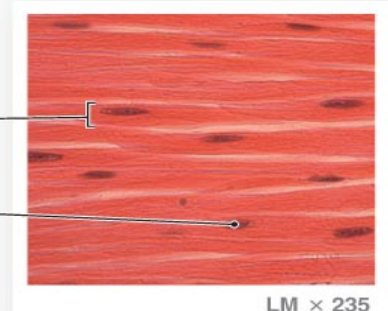


**Cardiac muscle moves blood and maintains blood pressure.**



Smooth muscle cell

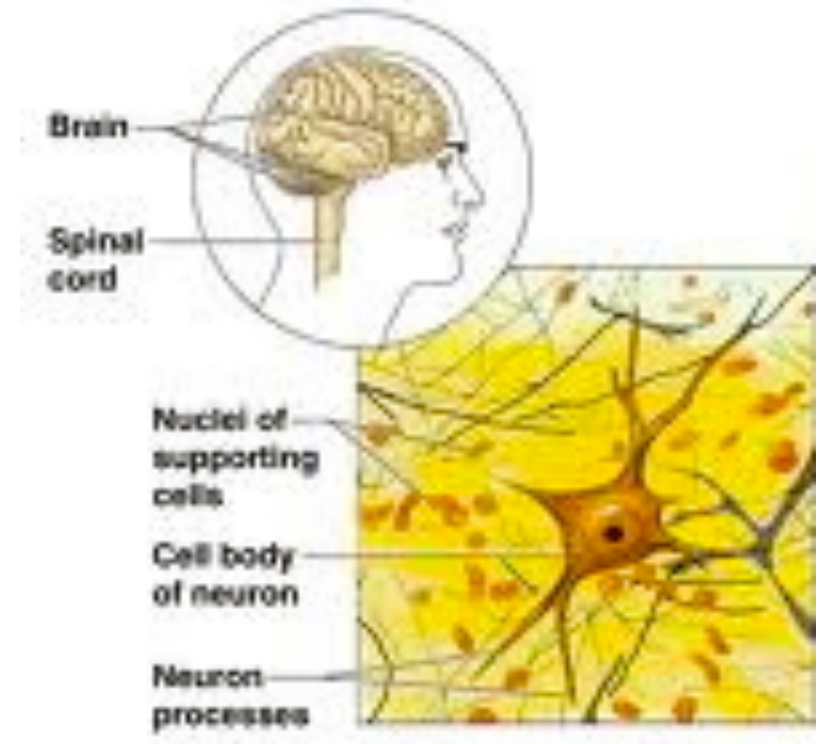
Nucleus



**Smooth muscle moves food, urine, and reproductive tract secretions; controls diameter of respiratory passageways and regulates diameter of blood vessels.**

# Nervous Tissue

- Nervous Tissue:
  - neurons and supporting cells form the brain, spinal cord and nerves





# Body Tissues

## Objective:

- Name the four major tissue types and their chief subcategories.
- Explain how the four major tissue types differ structurally and functionally.
- Give the main locations of the various tissue types in the body.

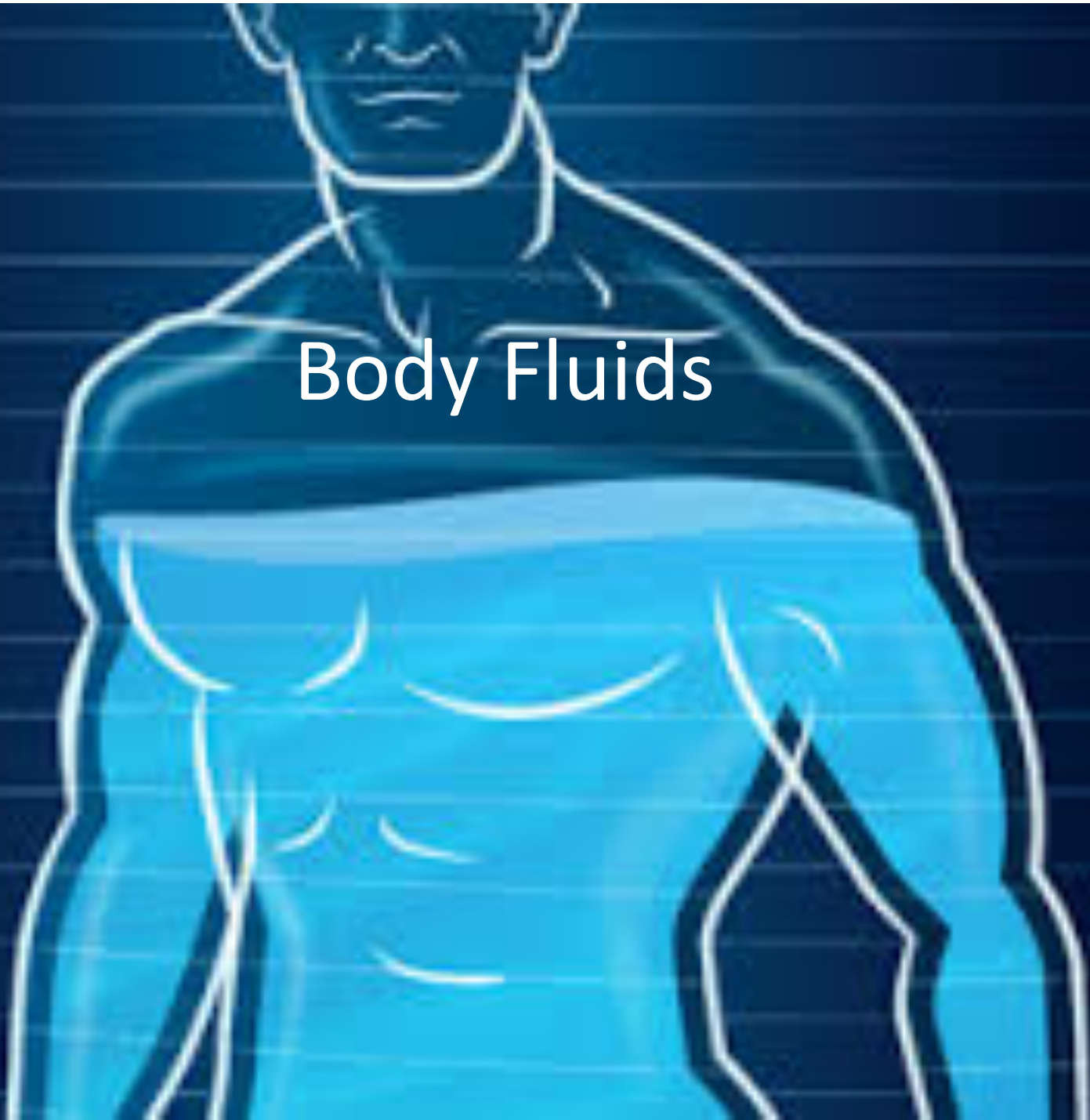
# Assignment

- list the similarities and differences between an Eukaryotic and a Prokaryotic cell in a well organized schedule.

(e.g. size, cell membrane, nucleus, organelle...  
ect)



# Body Fluids



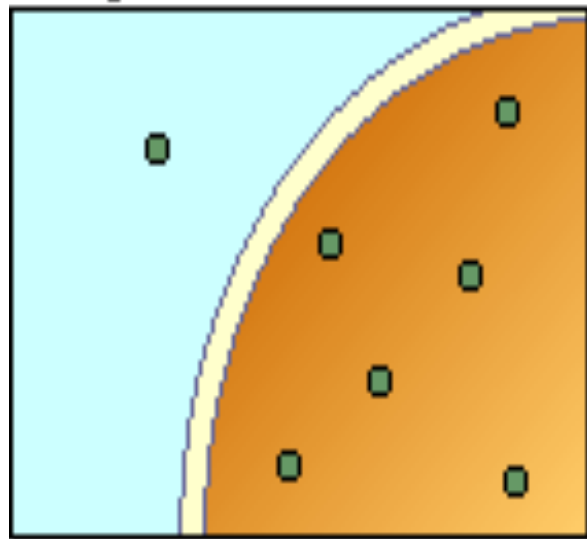
# Solutions

- **Solutions are made of solute and a solvent**
- **Solvent** - The liquid into which the solute is dissolved. E.g. water
- **Solute** - Substance that is dissolved or put into the solvent. E.g. oxygen, sugar..ect

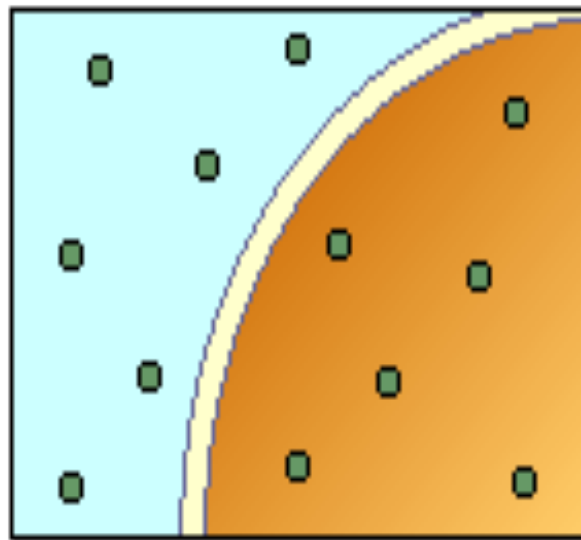
# Solutions

- **Hypotonic Solution** - One solution has a lower concentration of solute than another.
- **Hypertonic Solution** - one solution has a higher concentration of solute than another.
- **Isotonic Solution** - both solutions have same concentrations of solute.

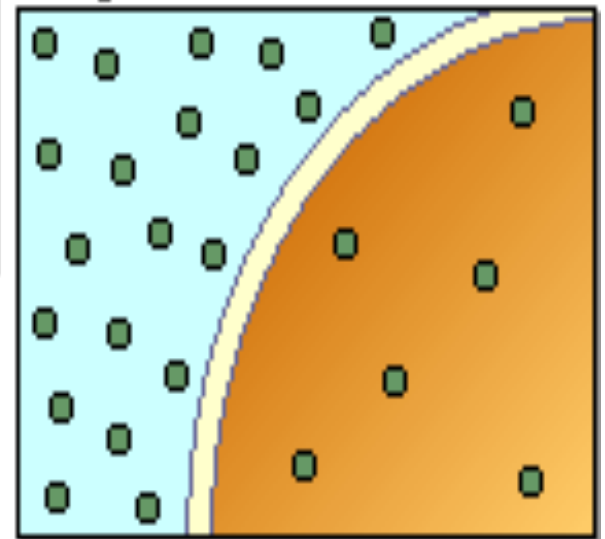
Hypotonic solution



Isotonic solution



Hypertonic solution



# Methods of Transport Across Plasma Membranes

- **Plasma membrane is Selectively permeable.**  
(regulates what comes in and goes out of the cell).
- Movement of substances through plasma membrane happens in two ways:

1) Passive transport

2) Active transport



# Passive transport

- Substances are transported across the plasma membrane without any energy consumption.

**-Diffusion**

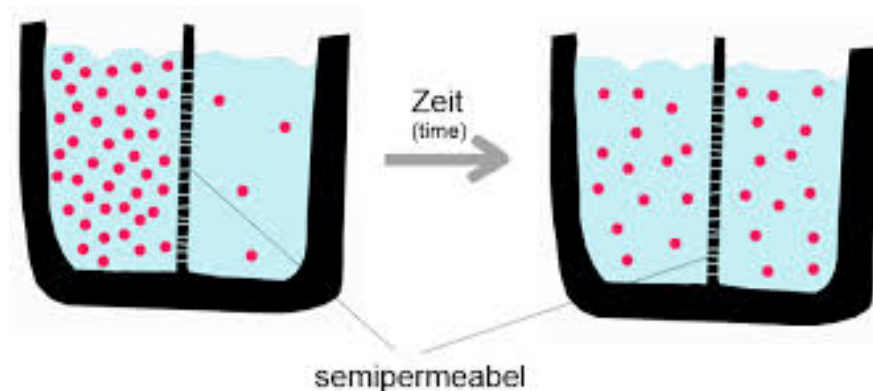
**-Facilitated diffusion**

**-Osmosis**

**-Filtration**

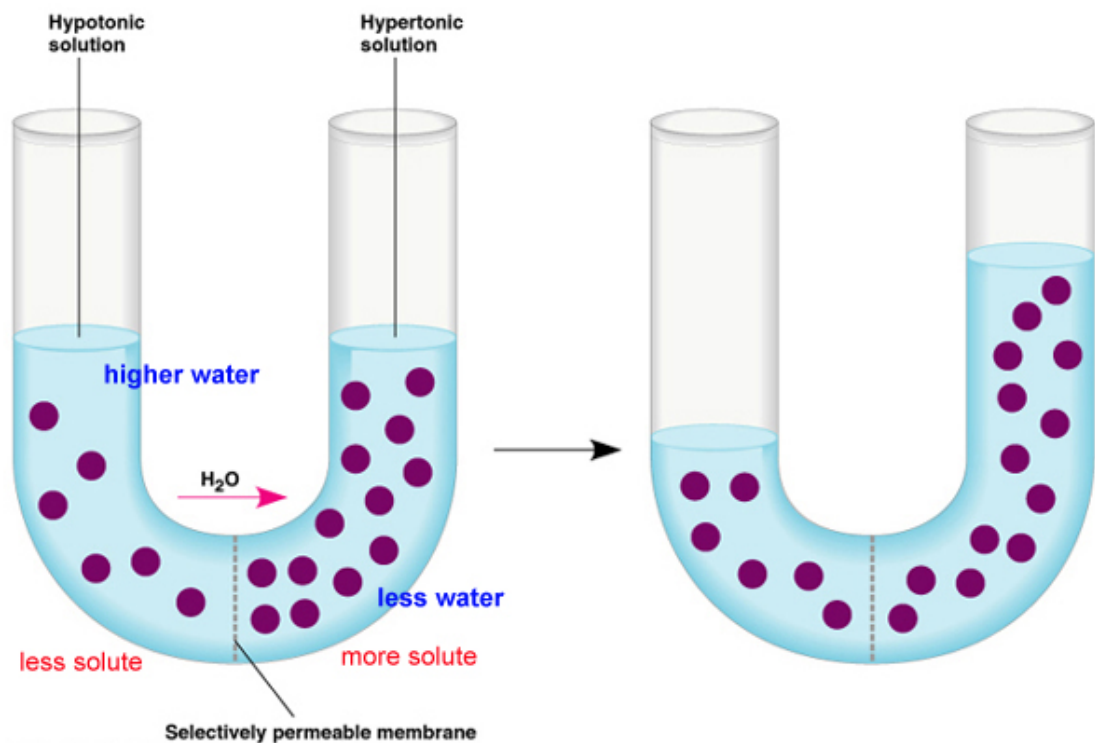
# Diffusion

- **Movement of molecules from an area of high concentration to an area of low concentration until equilibrium is reached.**
- Molecules have to be small or lipid-soluble
- E.g. small ions,  $O_2$ ,  $CO_2$ , fat soluble vitamins.



# Osmosis

- Movement of water from an area of high water concentration to an area of low concentration.



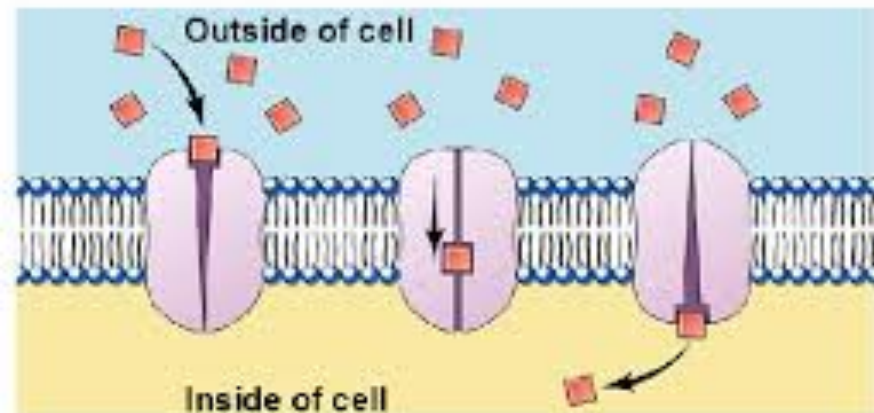
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# Facilitated diffusion

- A protein carrier is used to transport a molecule from an area of high concentration to an area of low concentration.
- Molecules are large and lipid-insoluble.
- e.g. Glucose

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## Facilitated Diffusion

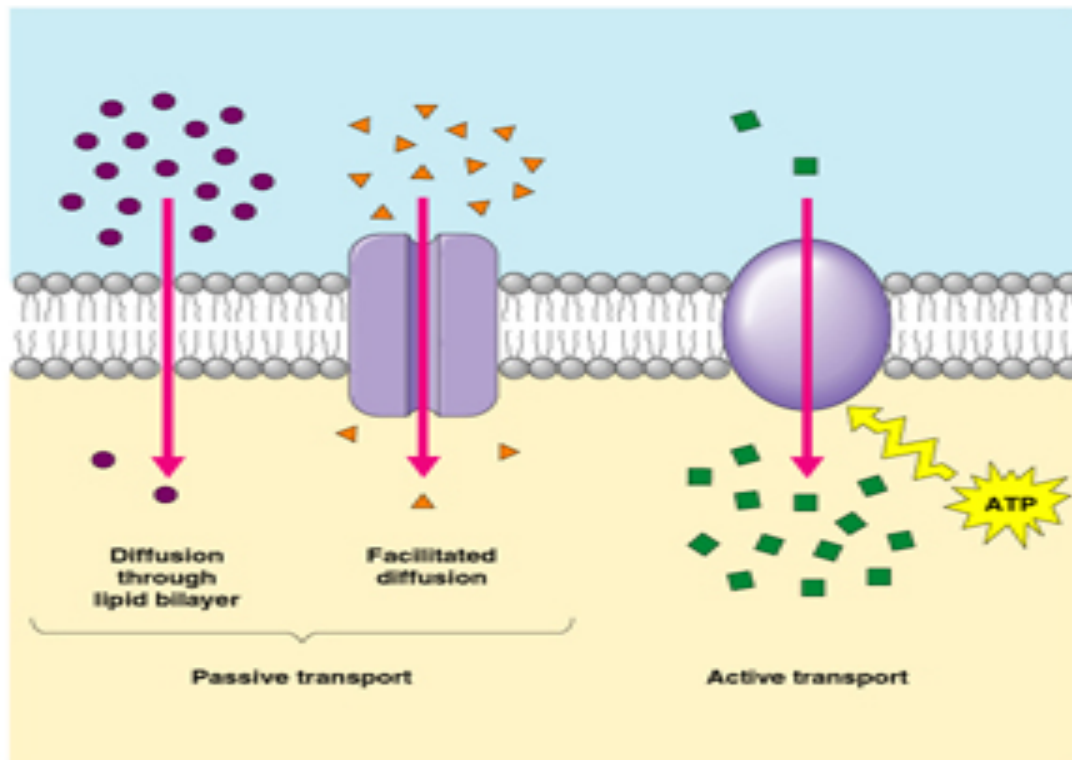


# Filtration

- Water and solutes are forced through the plasma membrane by hydrostatic pressure.
- Water and solutes travel from higher pressure area to lower pressure area.
- Only blood cells and proteins are too large to pass through the membrane by filtration.
- E.g. at kidney and arterial end of capillaries



- Passive transport allows cells to get water, oxygen and other small molecules that they need. It also allows the cell to get rid of waste such as carbon dioxide.



# Active transport

- The cell provides **ATP** to transport molecules across the plasma membrane from low concentration to high concentration.

- 3 Kinds:

Solute Pump

Endocytosis

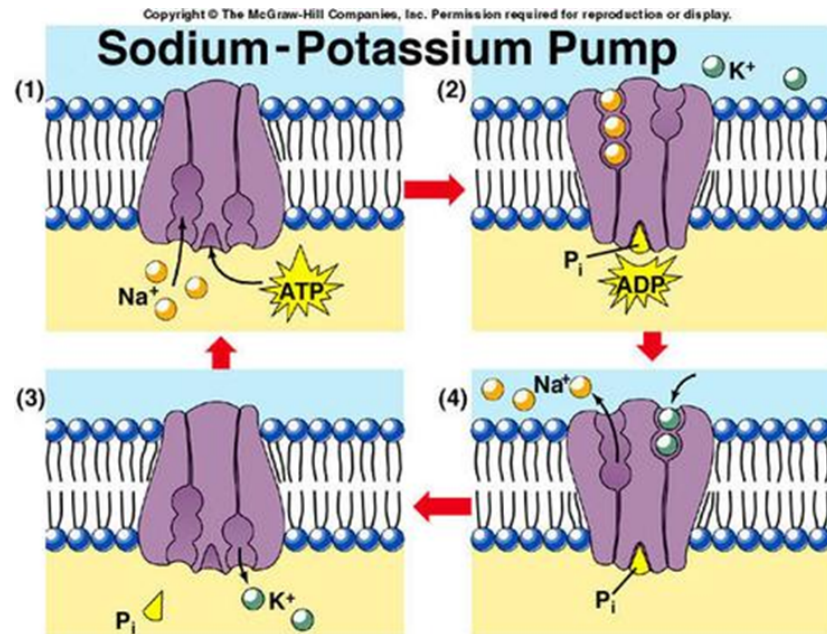
Exocytosis

# Solute Pumps

- Most ions are transported by solute Pumps.
  - Solute pumping requires
    1. carrier protein
    2. ATP
    3. ATPase enzyme that breaks ATP to release energy.
- E.g. The sodium-potassium pump is absolutely necessary for transmission of impulses by the nerve cell.

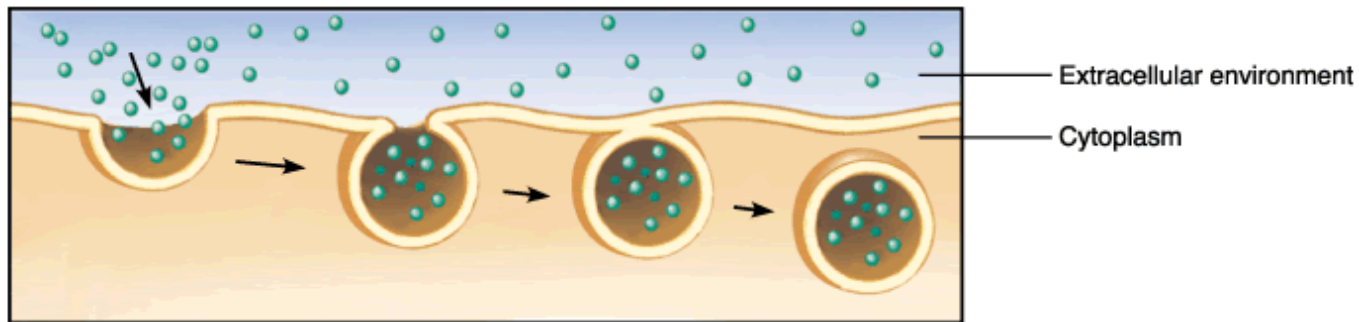
## Example of active transport: sodium-potassium pump in nerve cells

Sodium ions are kept at low concentrations inside the cell and potassium ions are at higher concentrations. Outside the cell, it is the opposite. When a nerve message is sent, the ions pass across the membrane to send the message. After the message has passed, the ions must be actively transported back to their starting positions across the membrane.



# Endocytosis

- When a cell actively takes large molecules into itself by folding the plasma membrane inward, forming a vesicle.

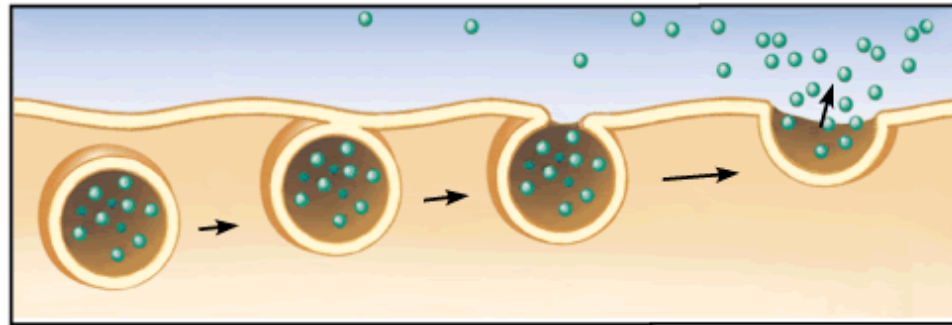


Source: <http://kenpitts.net/bio/images/endocytosis.gif>



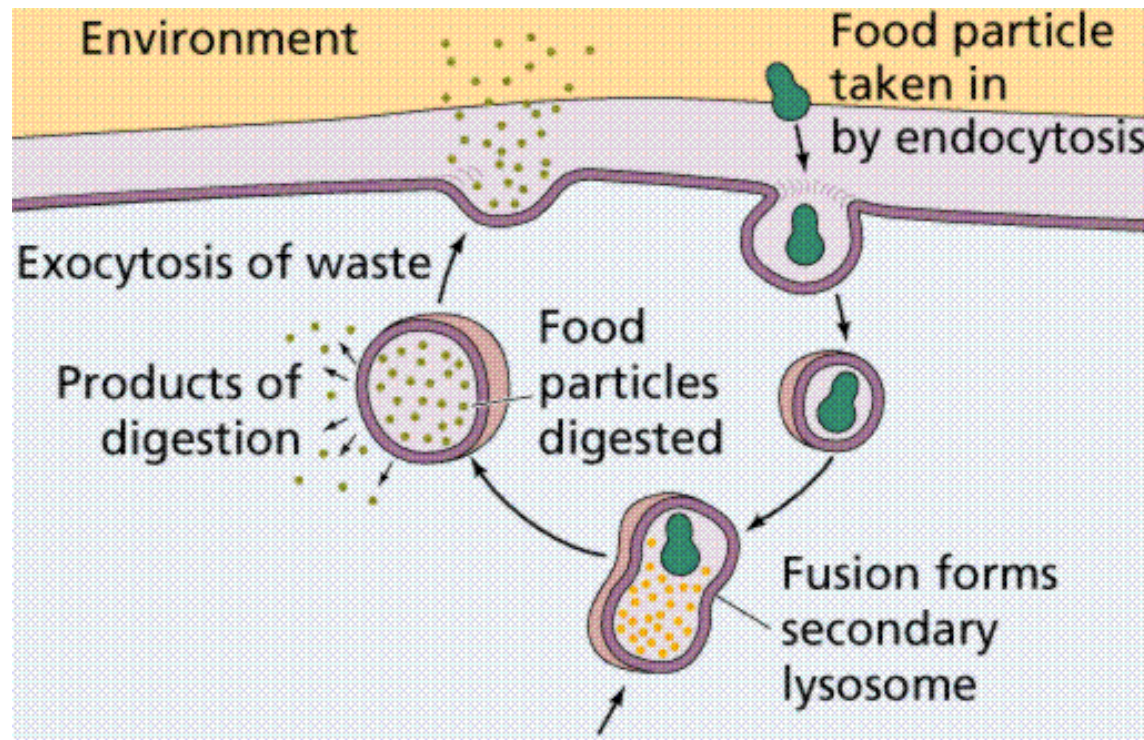
# Exocytosis

- When a cell actively releases large molecules by folding the plasma membrane outward, forming a vesicle.



Source: <http://kenpitts.net/bio/images/exocytosis.gif>

- **Endocytosis and Exocytosis** is the mechanism by which very large molecules (such as food and wastes) get into and out of the cell

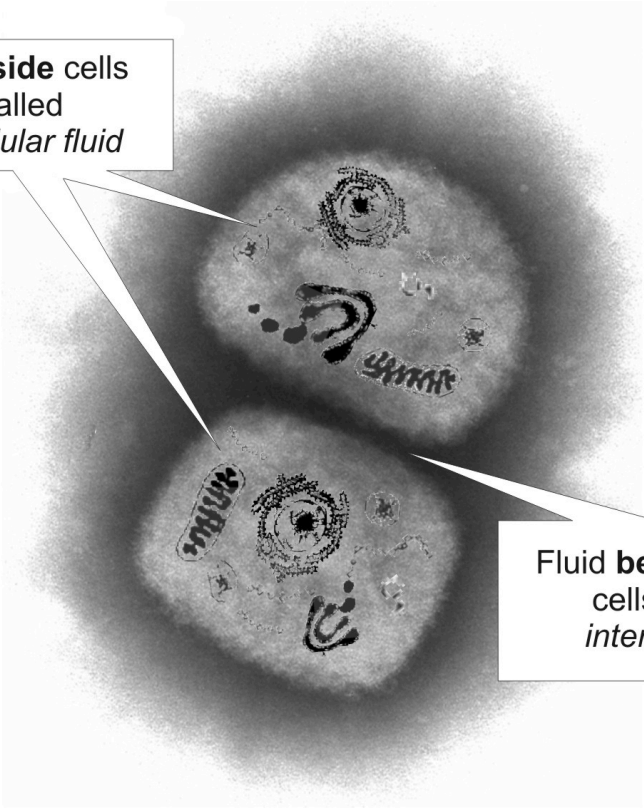
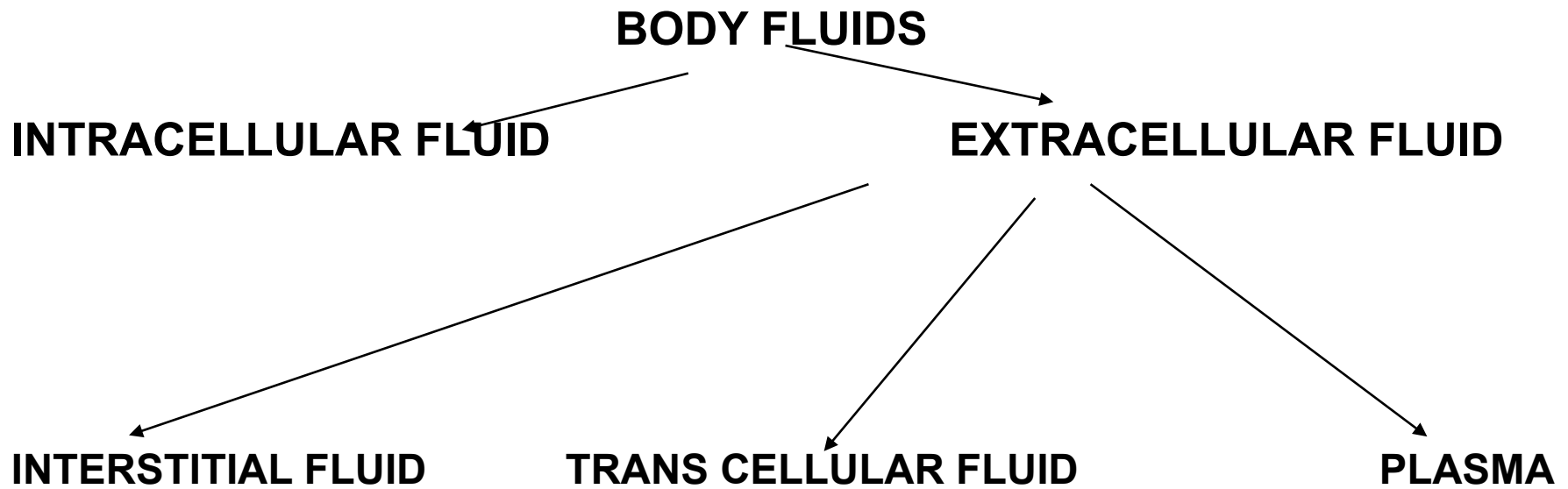


Food is moved into the cell by Endocytosis

Wastes are moved out of the cell by Exocytosis

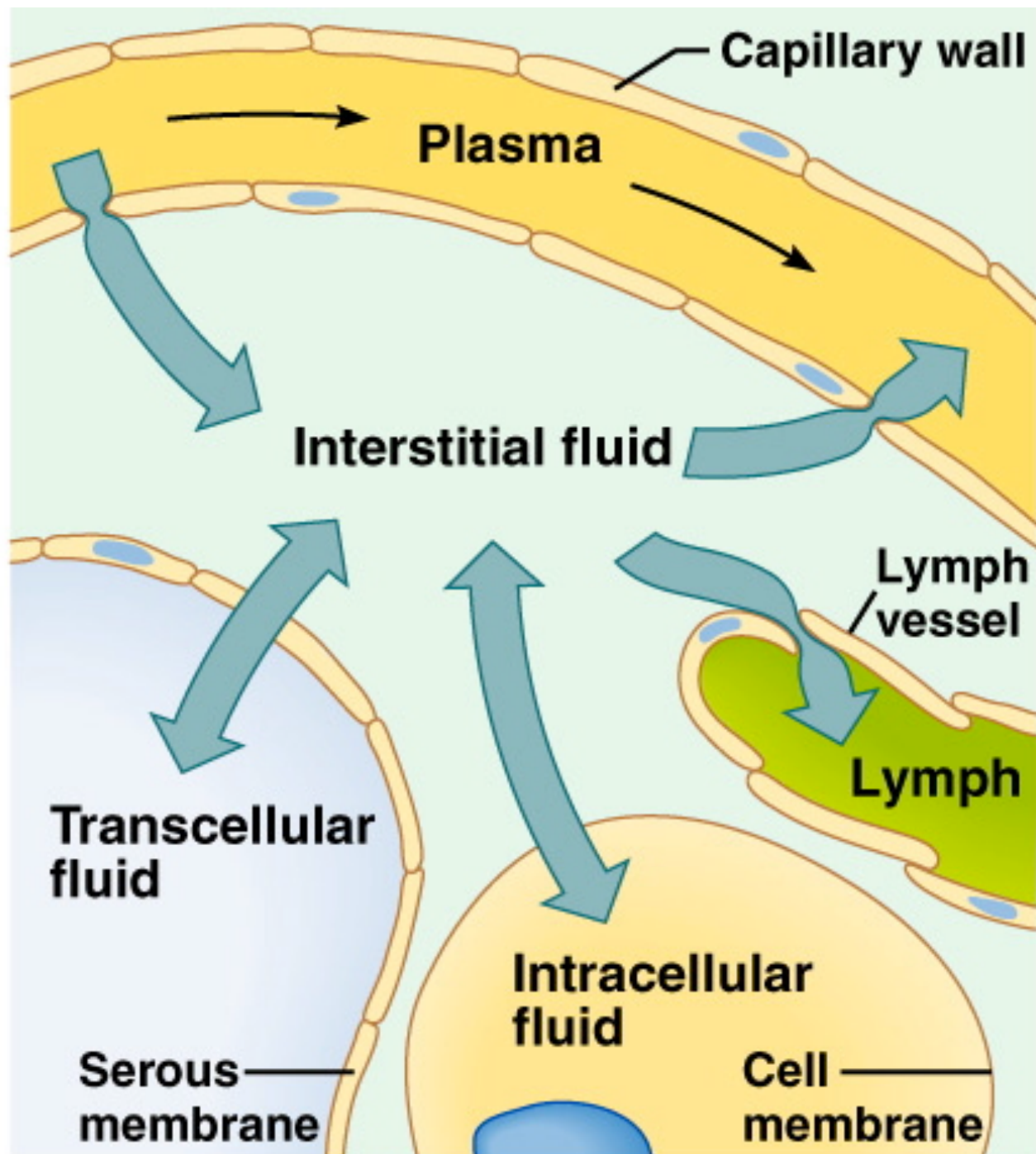
# Body fluids

- The main fluid in the body is water.
- 60-70% of total body weight is water.
- Water is distributed in Two main compartments separated from each other by cell membranes.
- ❖ The intracellular compartment
- ❖ The extracellular compartment consists of the
  - Interstitial Fluid (between and around cells)
  - Plasma (inside blood vessels).
  - transcellular Fluid (water contained within epith lined spaces)



Fluid **inside** cells  
is called  
*intracellular fluid*

Fluid **between** tissue  
cells is called  
*interstitial fluid*





## Extracellular fluid (ECF)

**Extracellular fluid**-It is all body fluid outside the cells.

It has high sodium (Na) concentration and low potassium (K) conc.

It is poorer in proteins, as compared to intracellular fluid

The ECF is divided into several smaller compartments:

--- Interstitial fluid, tissue fluid-

It is the main component of the ECF.

It is a solution that bathes and surrounds the cells.

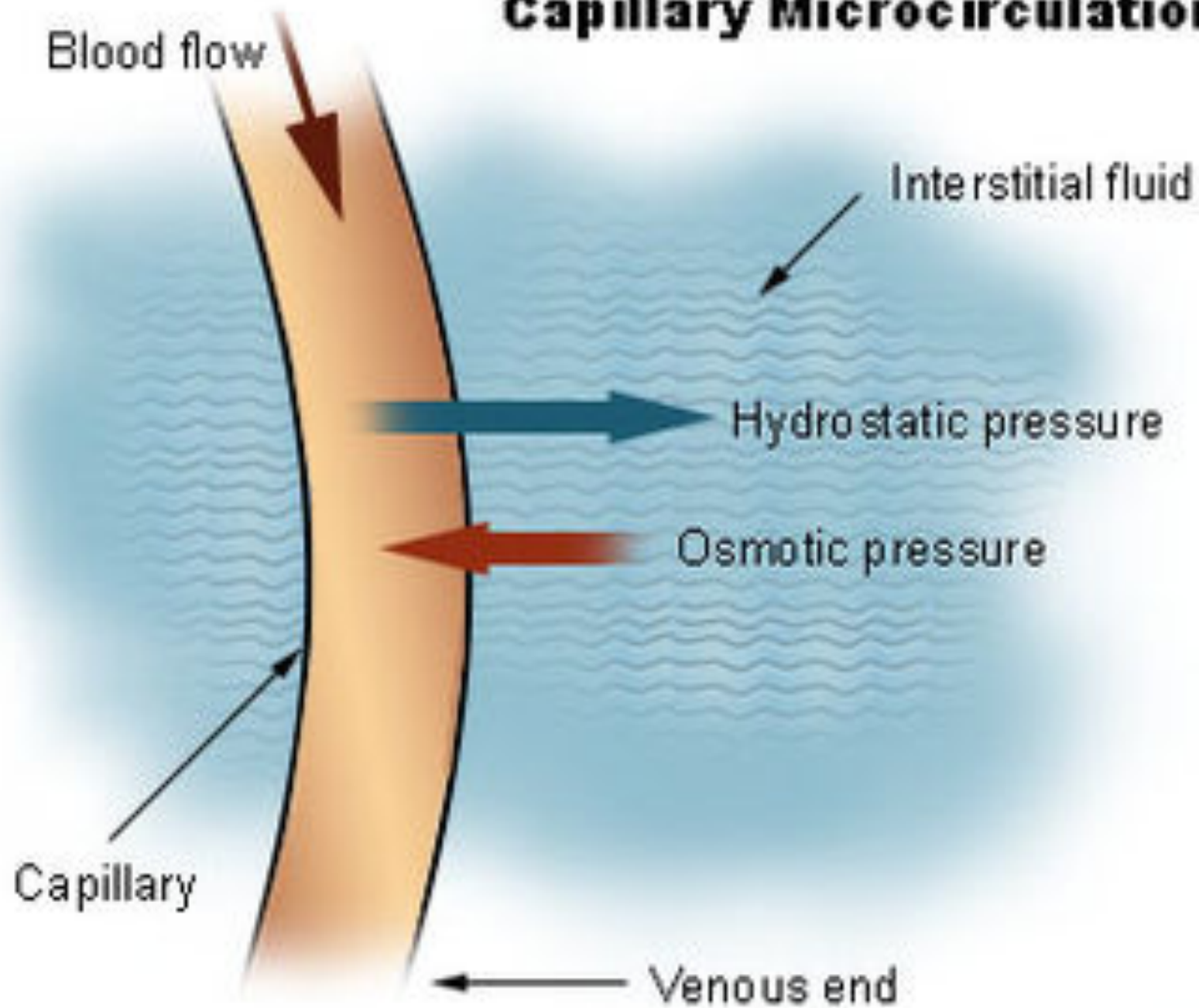
Formation:

Hydrostatic Pressure is generated from the heart pushing the fluid out of the capillaries. The buildup of solutes induce osmoses: Water passes from a high concentration (of water) outside the vessels to a low concentration inside the vessels.

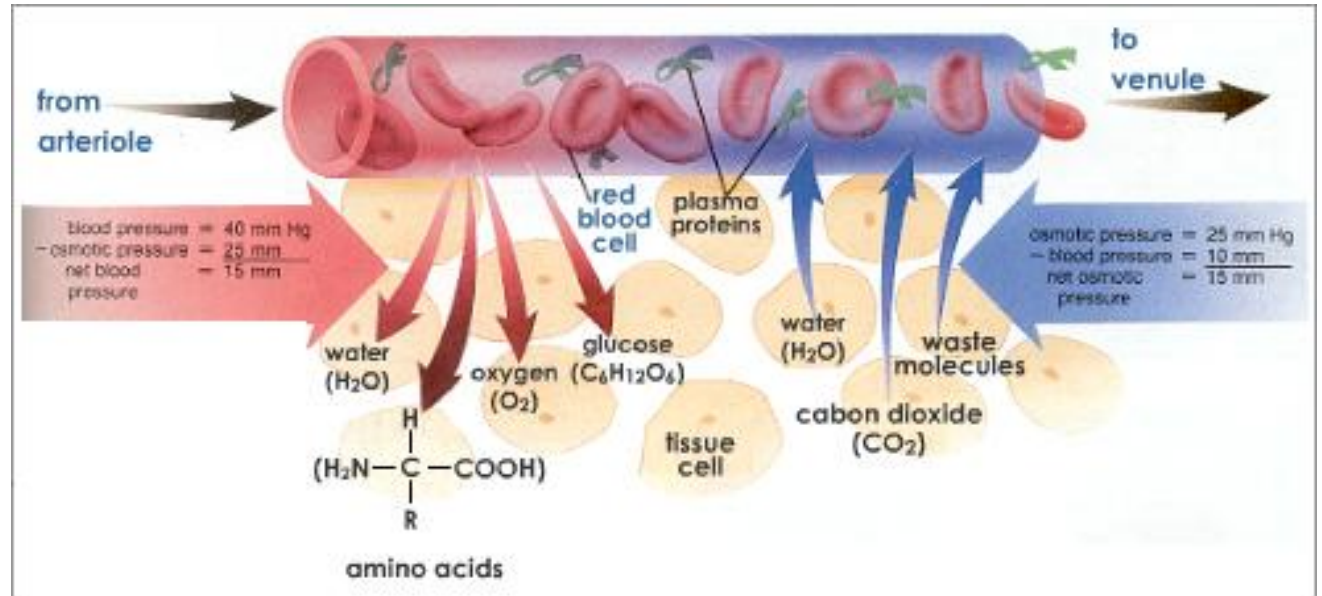
To prevent build up of tissue fluid, the fluid can also rejoin the blood by the help of the lymphatic system.

Function: deliver material to the cells, intracellular communication and removal of metabolic waste.

## Capillary Microcirculation



# Composition



- Water (solvent), glucose, fatty acids, amino acids-nutrients, hormones, as well as waste products from the cell and gases ( $O_2$ ,  $CO_2$ ), vitamins, salts ions.
- Contains some types of WBC which help fight infections.
- RBC, platelets, plasma proteins cannot pass through capillary walls.

--- **Plasma**- liquid part of blood in which blood cells are suspended. It makes up about 55% of total blood volume.

Blood plasma contains exactly what **Interstitial fluid contains**. (These substances can be transported from the blood capillaries to the interstitial fluid to the cells and back again by passive and active transport)  
**It also contains RBC, platelets, and plasma proteins.**

---**Transcellular fluid**- is the portion body fluid contained within epithelial lined spaces. It is the smallest component of extracellular fluid.

## **Intracellular fluid (ICF)- Cytosol-**

It is fluid present inside the cell. Approximately 60-65% of body water is contained within the cells.

it is the matrix in which cellular organelles are suspended, and chemical reactions take place.

the intracellular compartment remains in the osmotic equilibrium with the ECF under ordinary circumstances.

contains dissolved ions, small molecules, and large water-soluble molecules (such as proteins).

Intracellular fluid is high in K and low in Na.



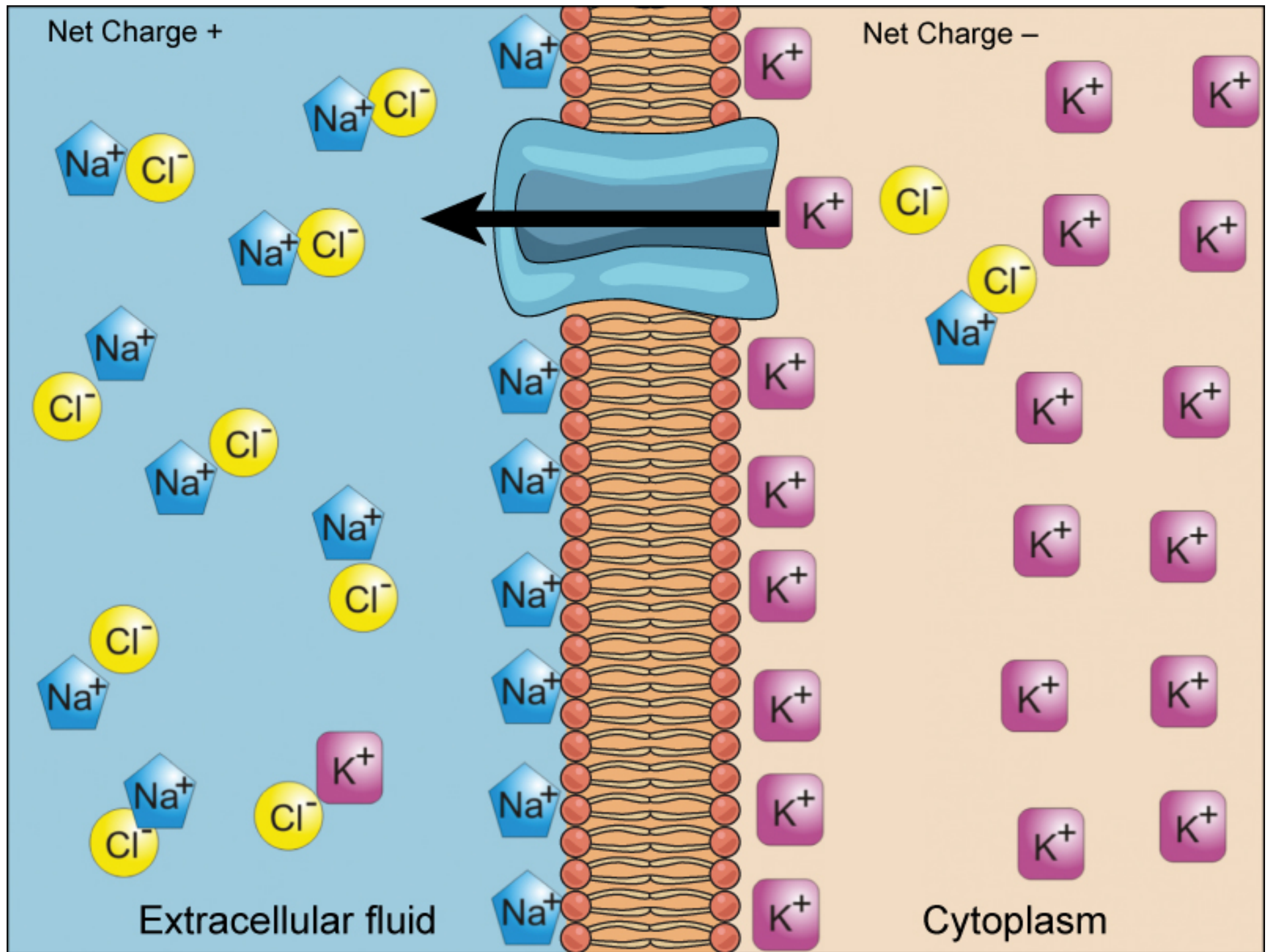
# Electrolytes

are minerals in your blood and other body fluids that carry an electric charge.

- Electrolytes affect the amount of water in your body, the acidity of your blood (pH), your muscle function, and other important processes. You lose electrolytes when you sweat. You must replace them by drinking fluids.
- Common electrolytes include:
  - Calcium
  - Chloride
  - Magnesium
  - Phosphorous
  - Potassium
  - Sodium
- Sodium chloride is found mostly in extracellular fluid, while potassium and phosphate are the main ions in the intracellular fluid.

# Movement of body fluid

- The exchange of interstitial and intracellular fluid is controlled mainly by the presence of the electrolytes  $\text{Na}^+$  and  $\text{K}^+$ .
- Potassium is the chief intracellular cation (+) and sodium is the chief extracellular cation.
- Because the osmotic pressure of the interstitial fluid and the ICF are generally equal, water typically does not enter or leave the cell.
- A change in the concentration of either electrolyte will cause water to move into or out of the cell via osmosis. A drop in potassium will cause fluid to leave the cell while a drop in sodium will cause fluid to enter the cell.



# objectives

- Define selective permeability, diffusion, osmosis, active transport, passive transport, solute pumping, exocytosis, endocytosis, hypertonic, isotonic, and hypotonic solution..ect
- Describe the structure of the plasma membrane, and explain how molecules have various transport methods to pass through the membrane.