



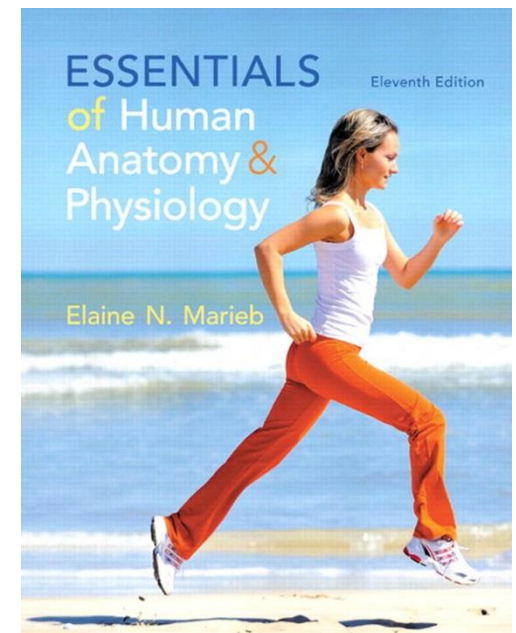
Human Anatomy and Physiology

CLS 224

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Lecture 2:

Cells, Tissues, and body fluids (Chapter 3)

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 their functions.
- Describe organelles and recognize their functions.

CELLS

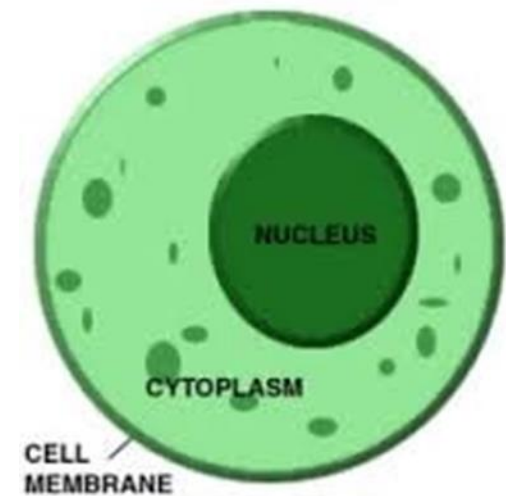
A cell is the smallest working unit of all living things that is capable of performing life functions.

All living things are made up of cells.

1. Anatomy and physiology of a generalized cell.

Cells are not all the same yet in general, all cells have 3 main structures:

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

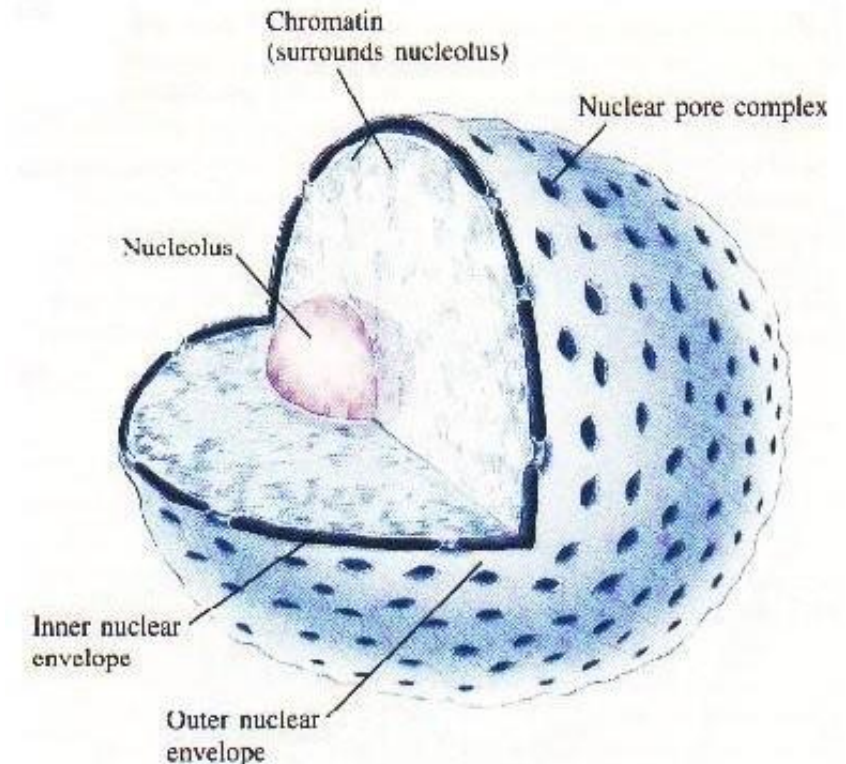


A) Nucleus

- “The control center” (how?)
The genetic material, or *deoxyribonucleic acid (DNA)*,
- Has three regions:
 - **Nuclear Membrane/envelope**
 - **Nucleolus/ Nucleoli**
 - **Chromatin**

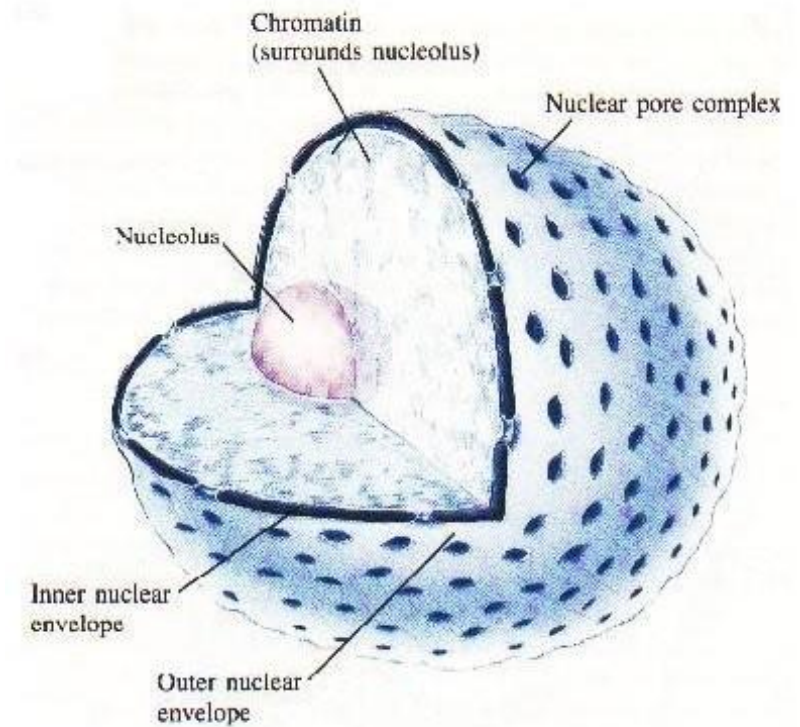
Nuclear Membrane/envelope

- Surrounds the nucleus; separating it from the cytoplasm.
- Made of two layers.
- Contains nuclear pores: Openings allow exchange of material with the rest of the cell.
- It encloses a jellylike fluid called *nucleoplasm* in which other nuclear elements are suspended.



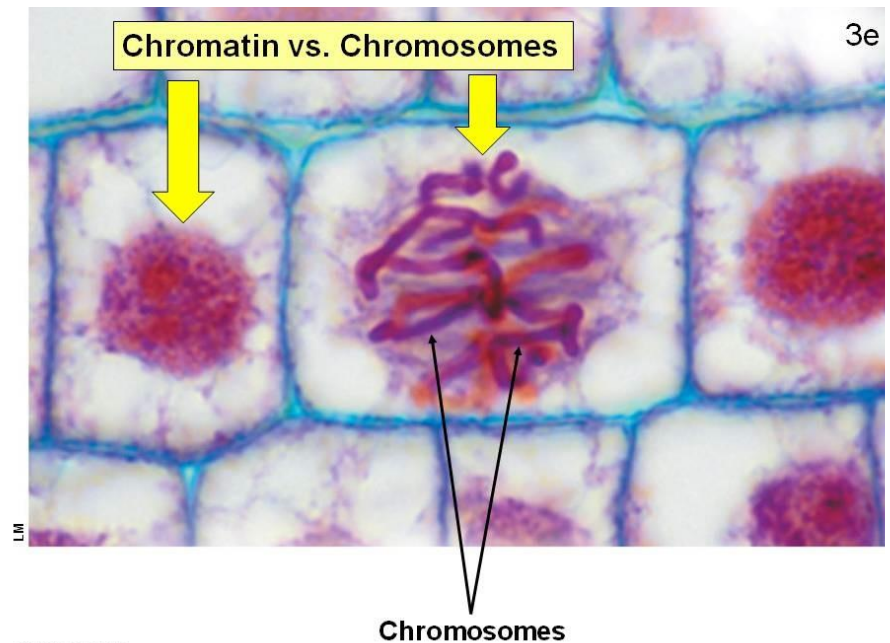
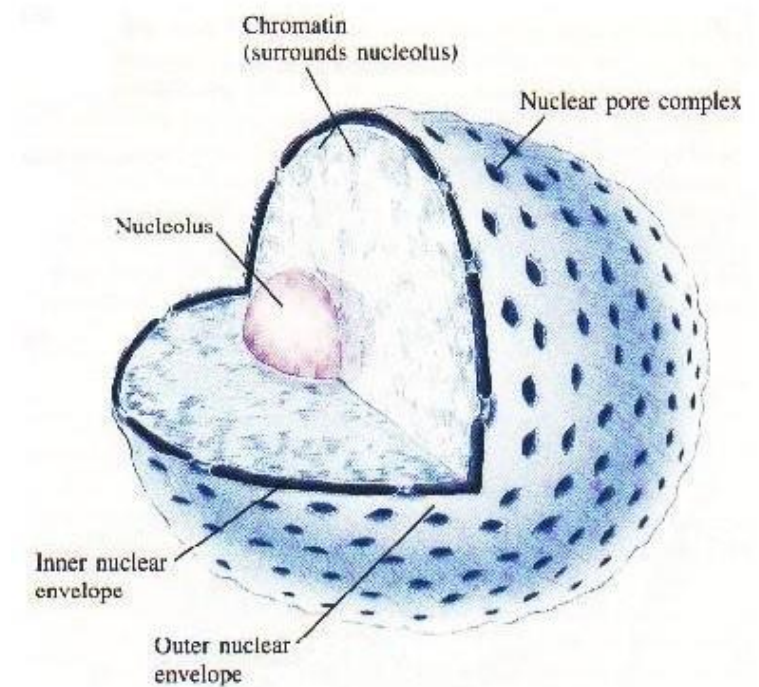
Nucleolus/ Nucleoli

- dark staining, round bodies.
- Could be one or more Inside nucleus.
- Site of Ribosomes production and assembly.



Chromatin

- Made of DNA + Proteins
- 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

also called cell membrane

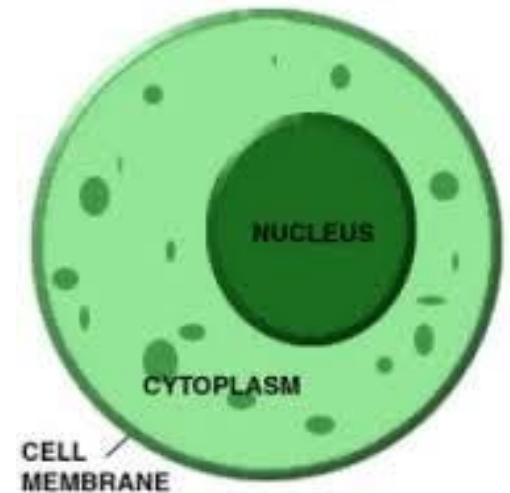
All cells are surrounded by a plasma membrane.

a) Structure

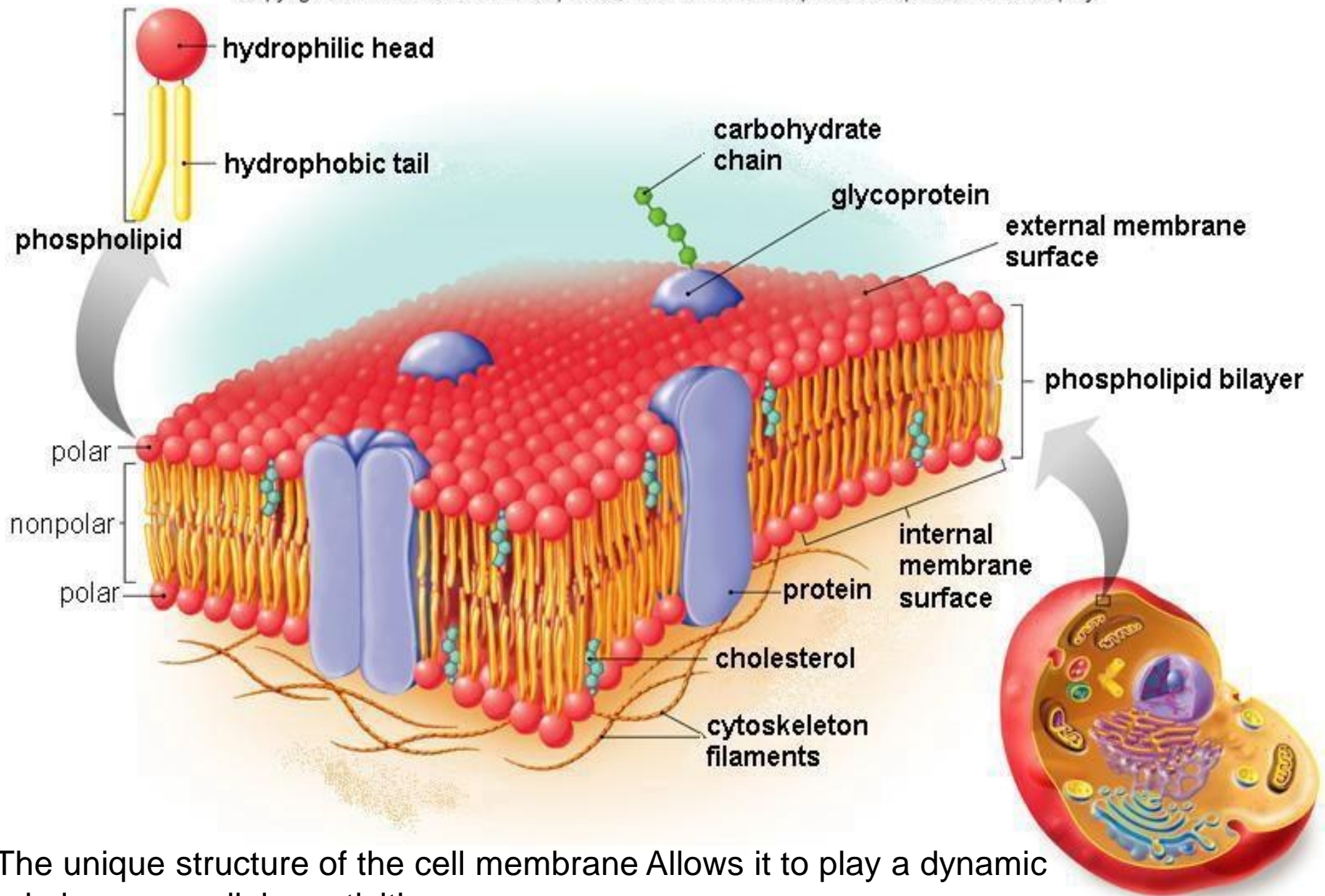
composed of proteins, phospholipid bilayer, cholesterol, glycoprotein and glycolipids arranged in a fluid mosaic pattern.

b) Function

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



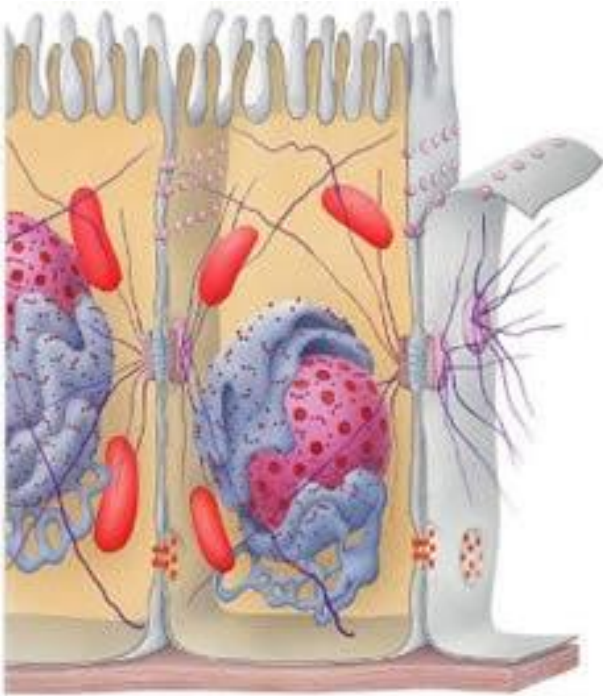
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The unique structure of the cell membrane Allows it to play a dynamic role in many cellular activities.

Specialization of the plasma membrane

- Microvilli

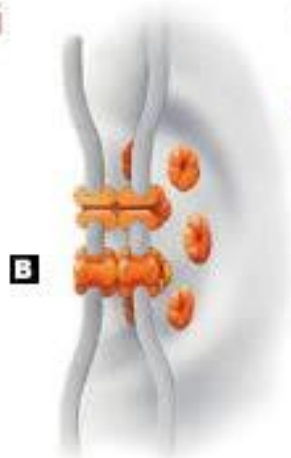


- Membrane junctions:

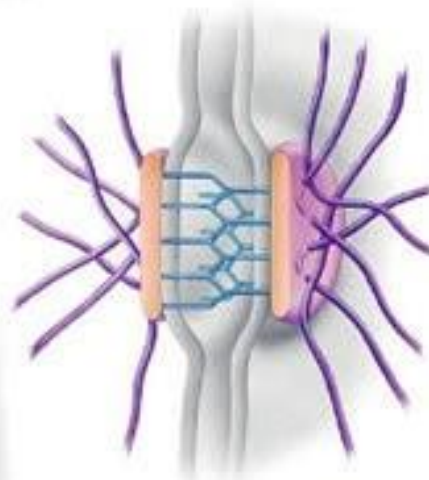
- Tight junctions
- Desmosomes
- Gap junctions



A

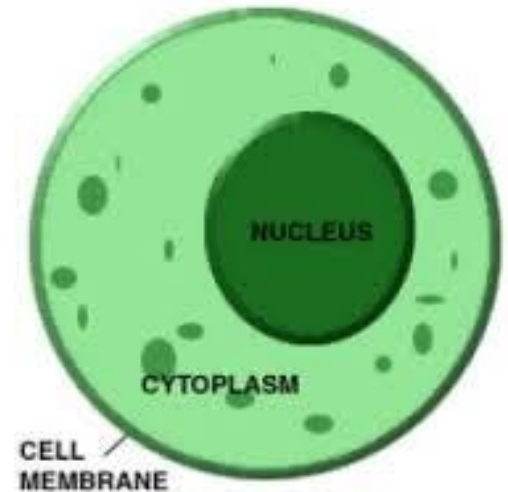


B



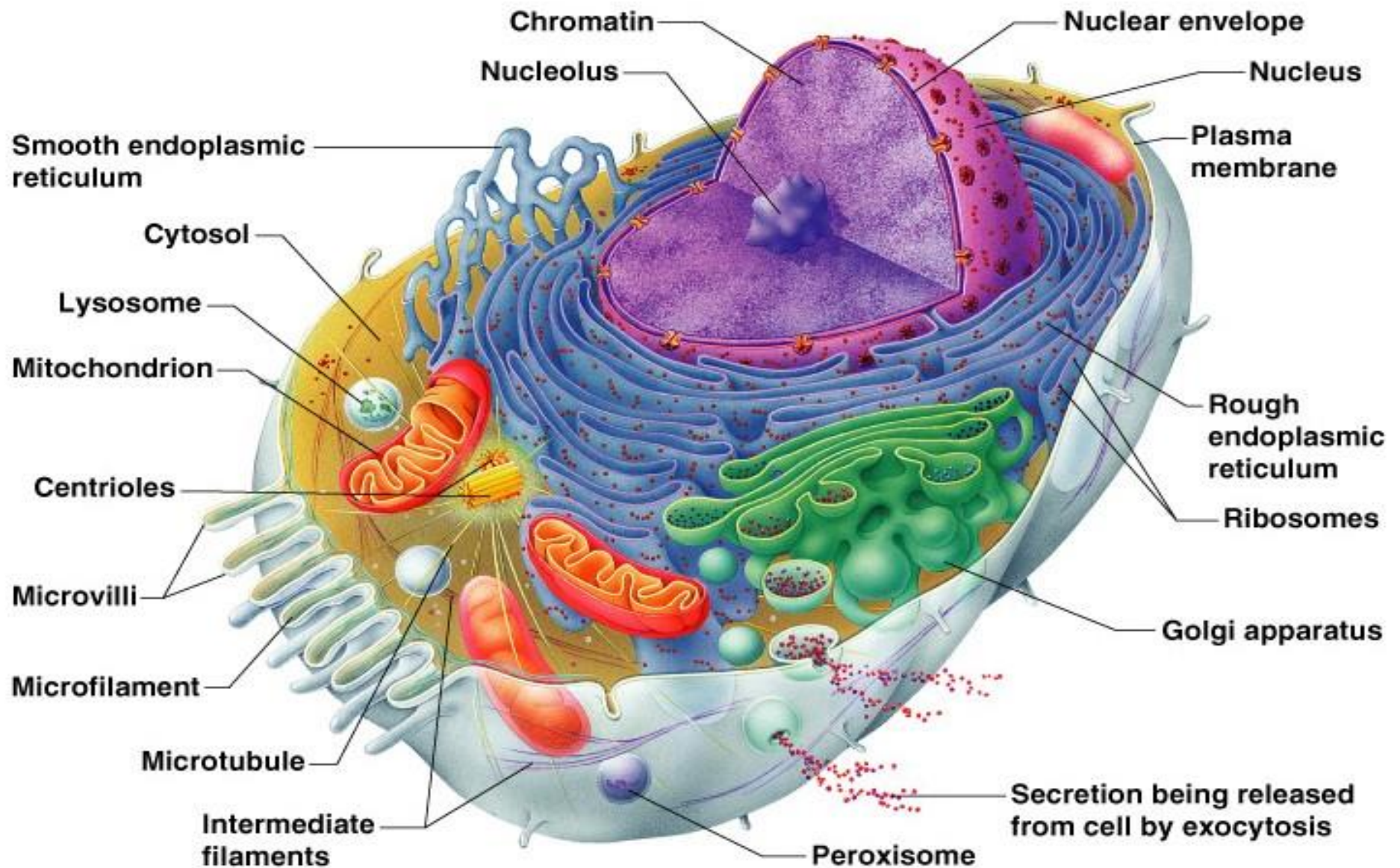
C

C) Cytoplasm



- It is the “factory area”.
- Has 3 major elements:
 - 1) Cytosol: makes up about 70% of the cell volume. Semi-transparent fluid composed of water mostly.
 - 2) Organelles.
 - 3) Inclusions: nonliving components of the cell that do not possess metabolic activity and are not bounded by membranes. The most common inclusions are glycogen, lipid droplets, crystals and pigments (store house).
- 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 using oxygen, and creates energy (ATP) to provide Cellular Energy.
- It has outer membrane, an inner membrane, cristae and matrix.
- Their number varies from cell to cell .

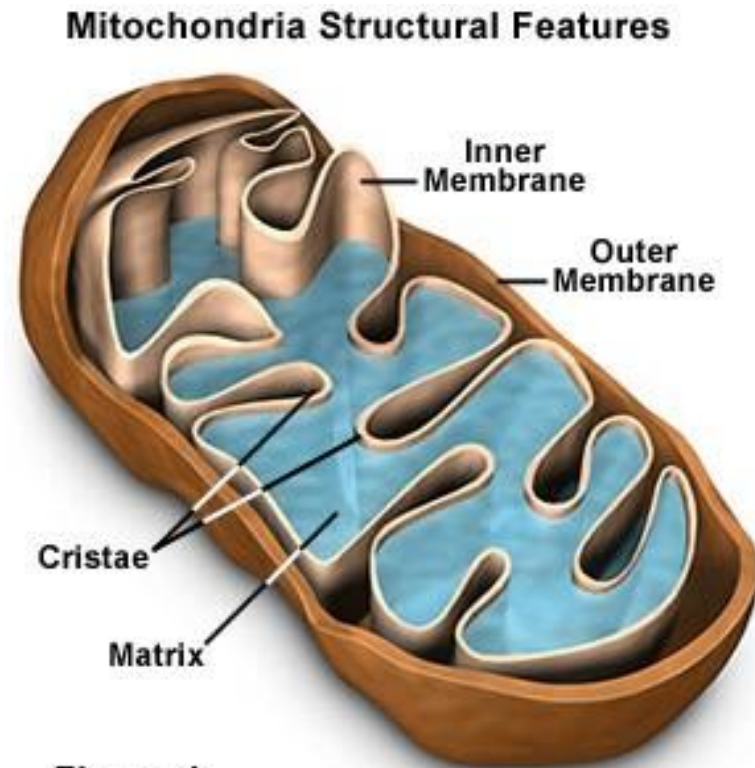


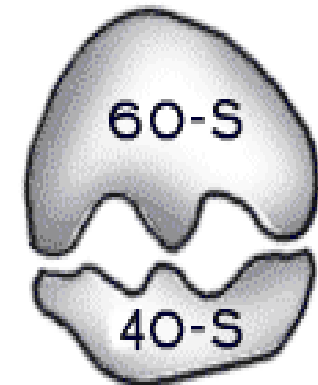
Figure 1

Ribosomes

- **Ribosomes** are the “protein builders” or the “protein **synthesizers**” of the cell.
- Each cell contains thousands.
- Found floating in the cytoplasm or attached to the Endoplasmic reticulum.
- Made of two subunits–
60-S (large) and 40-S (small).



RIBOSOME SUBUNITS

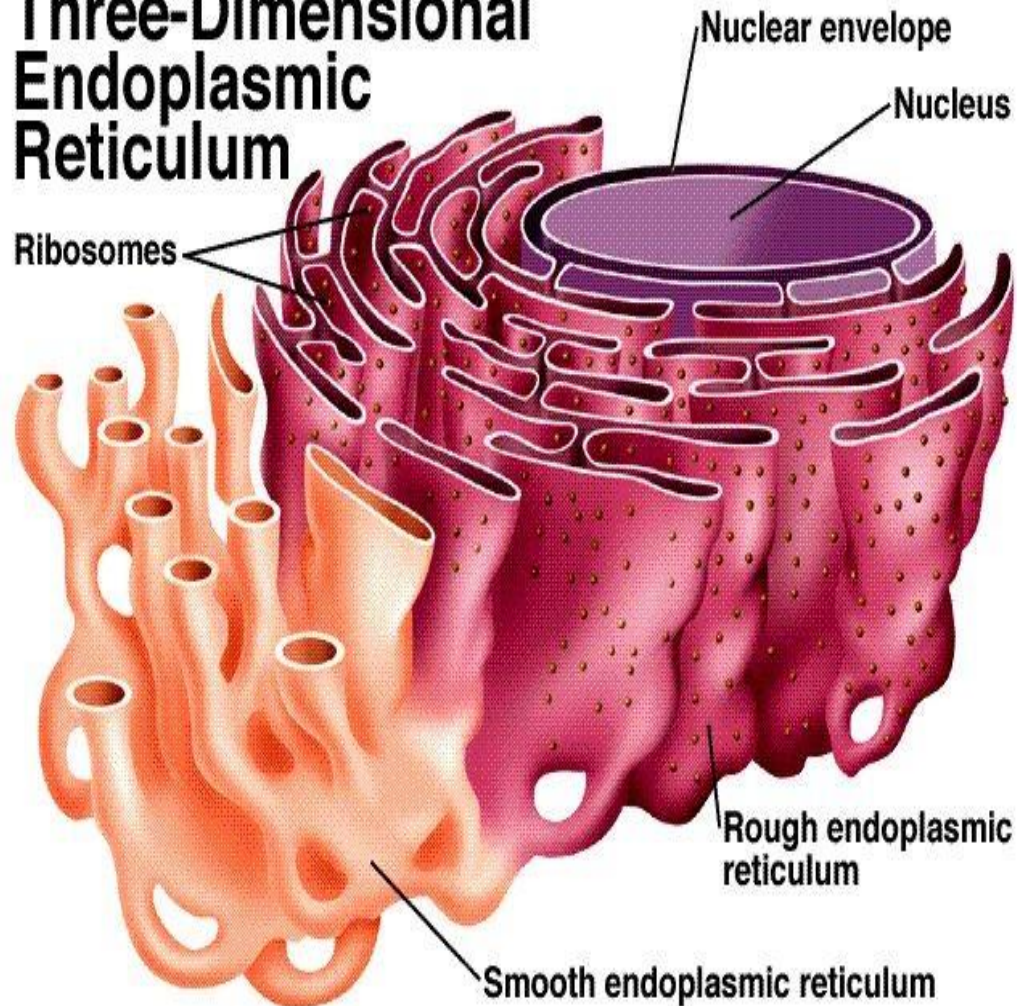


TWO SUBUNITS

Endoplasmic Reticulum

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Three-Dimensional Endoplasmic Reticulum



- Is a system of fluid-filled tubules (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.

- The proteins made by Ribosomes migrate into the tubules and then are dispatched to other areas of the cell in transport vesicles.

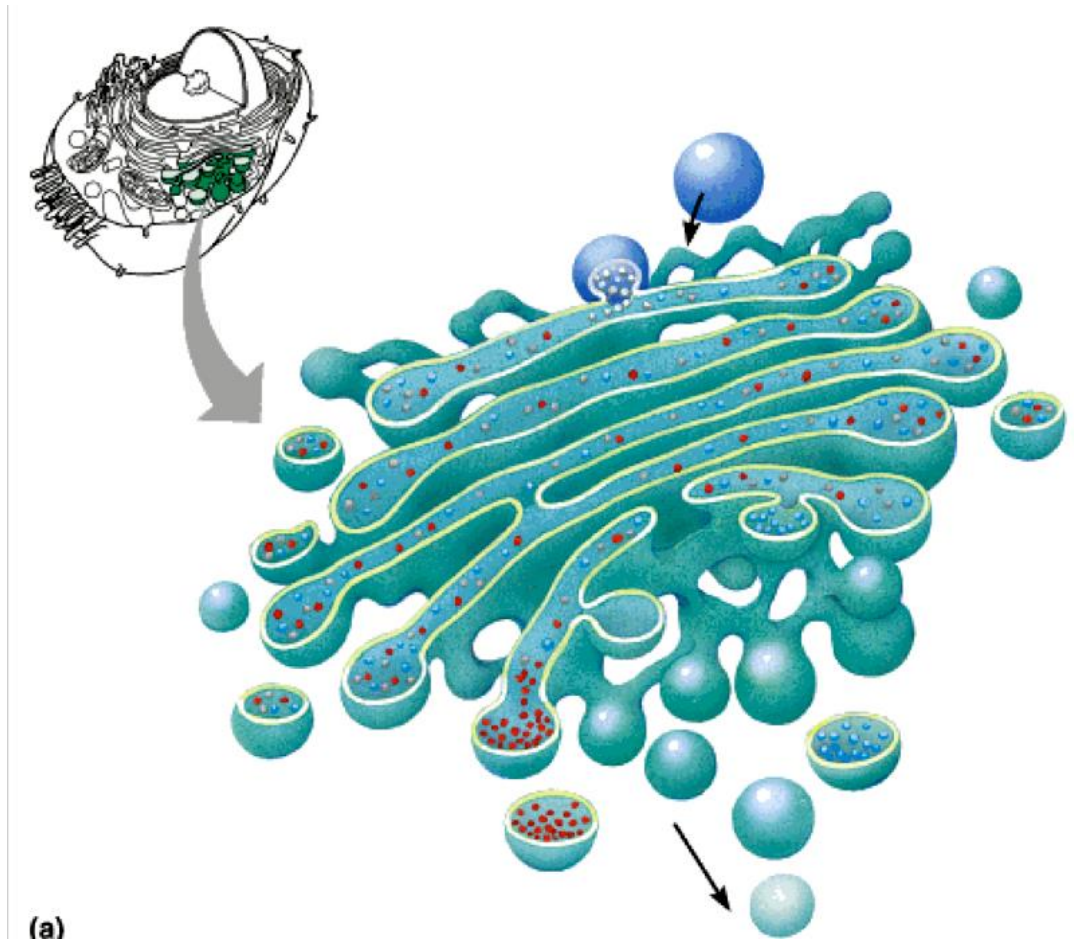
❖ Smooth endoplasmic Reticulum (SER):

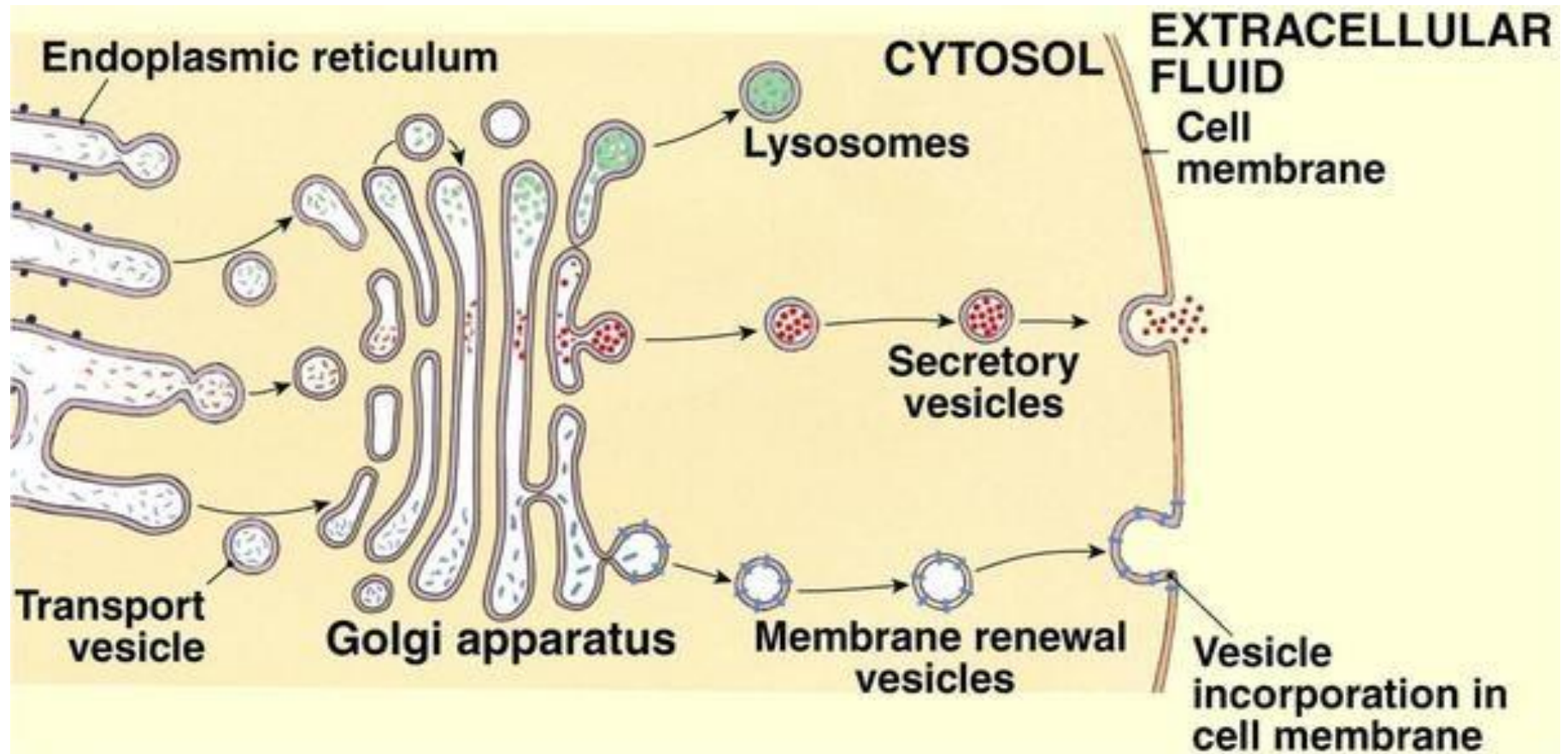
- Lacks ribosomes.

- It functions in lipid metabolism and detoxification of drugs.

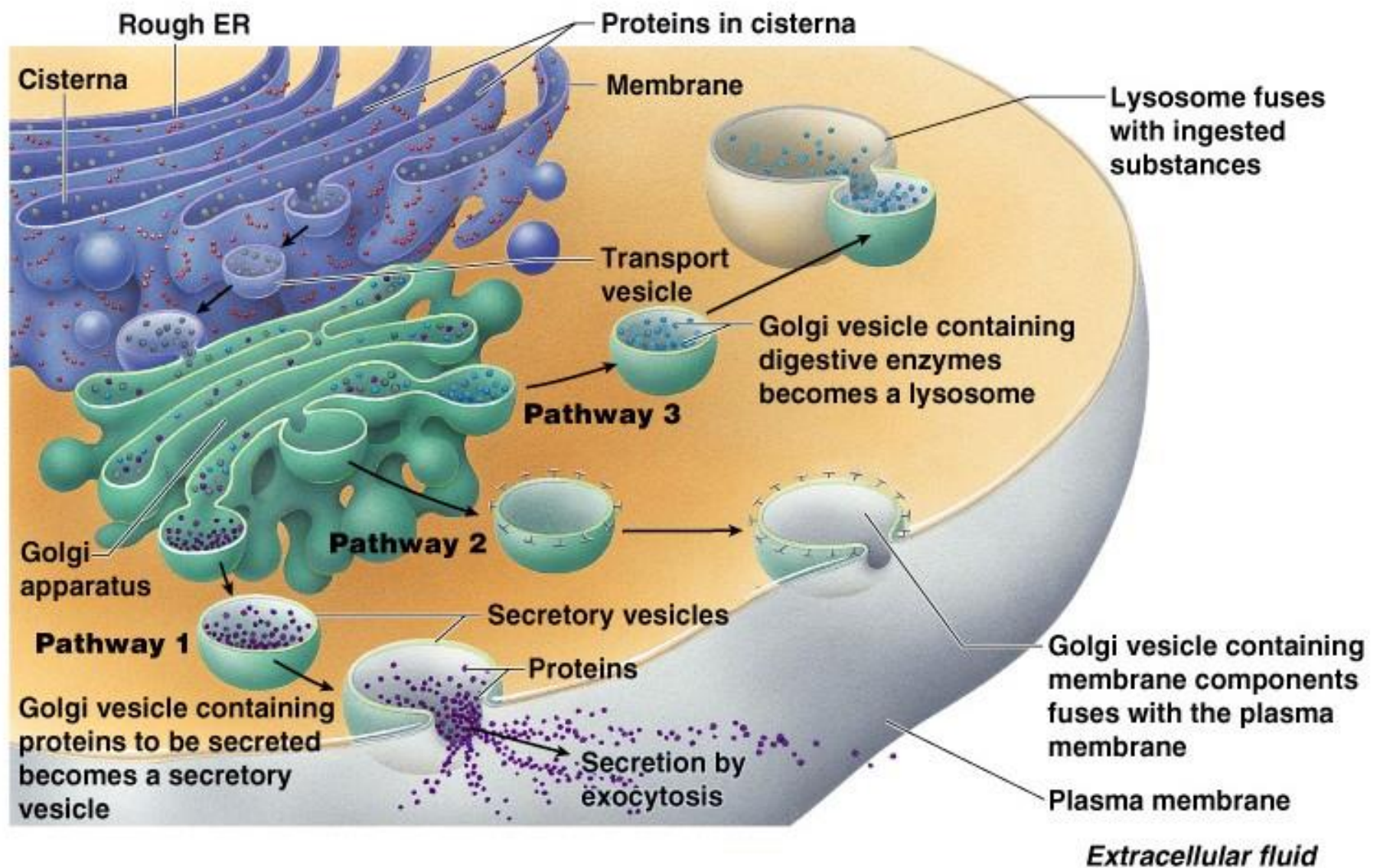
Golgi apparatus

- 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.





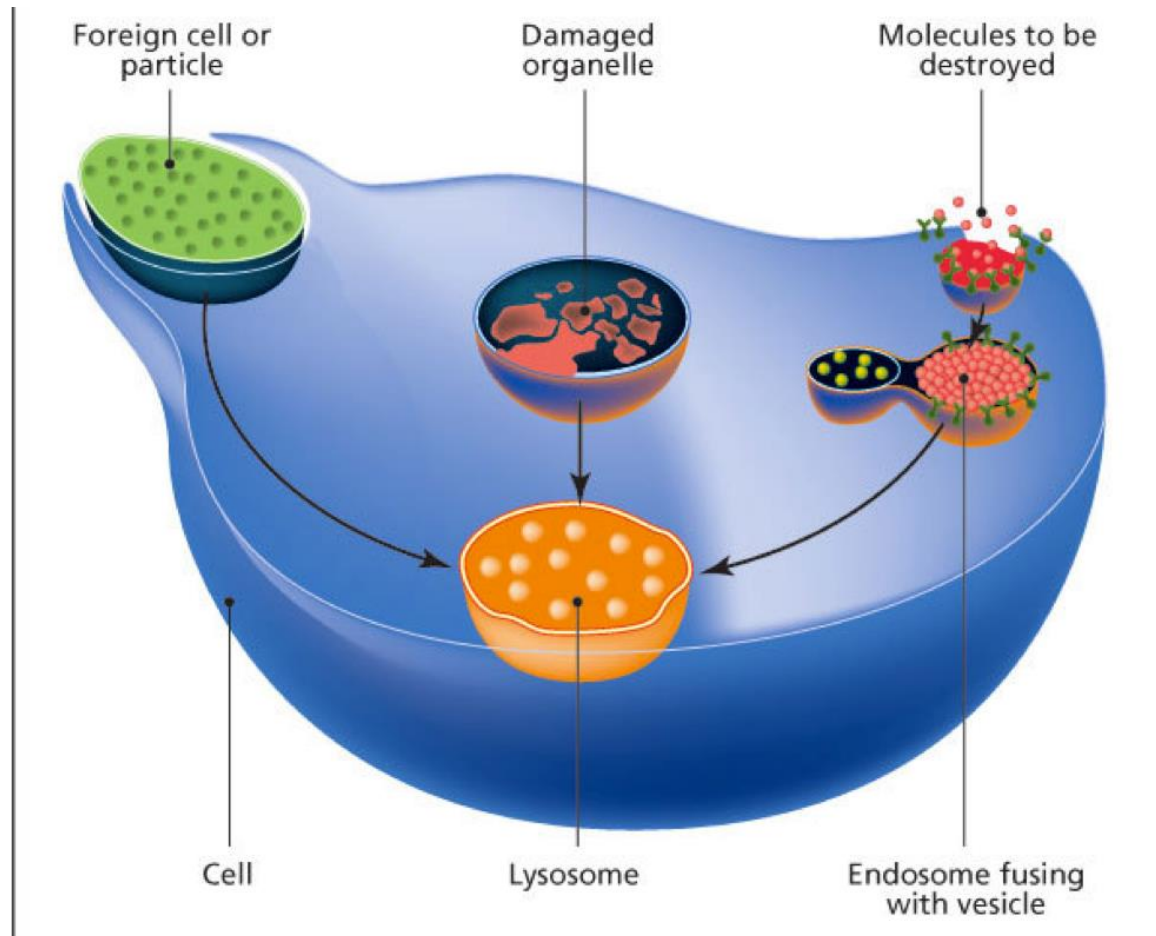
- 1) Golgi vesicle containing proteins to be secreted becomes a secretory vesicle which fuse to the plasma membrane and eject the contents to the outside of the cell.
- 2) Golgi vesicle containing membrane components become a membrane renewal vesicles which fuse with plasma membrane to become part of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



Lysosome

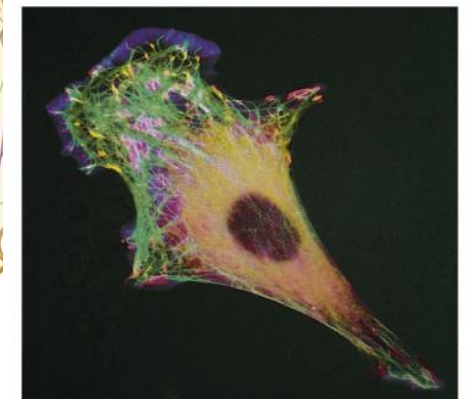
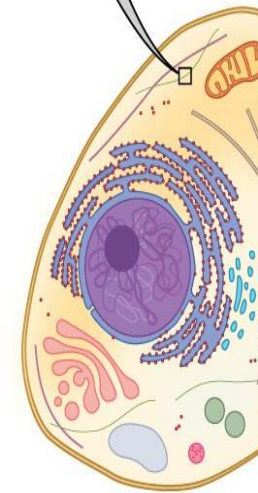
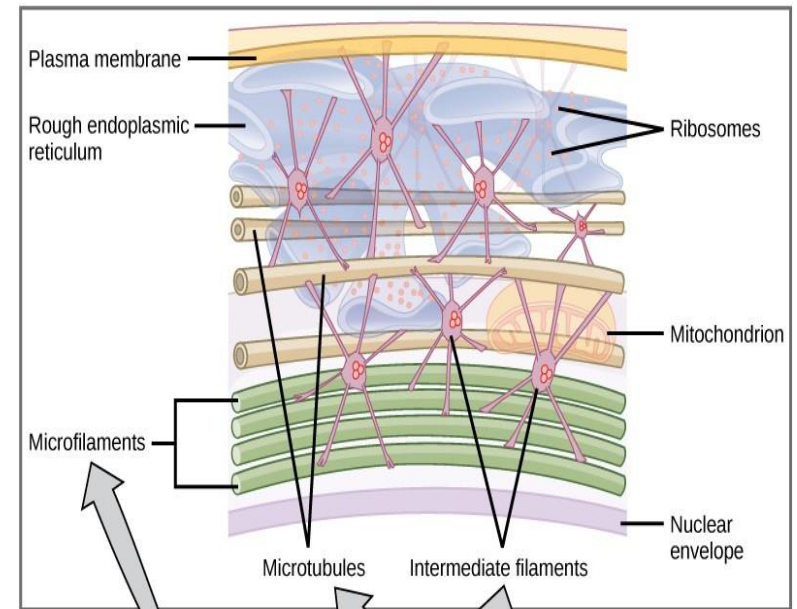
- It is the cell's "breakdown bodies" or demolition sites. contains enzymes that can digest non-usable cell structures and most foreign substances.

Abundant in ?



Cytoskeleton

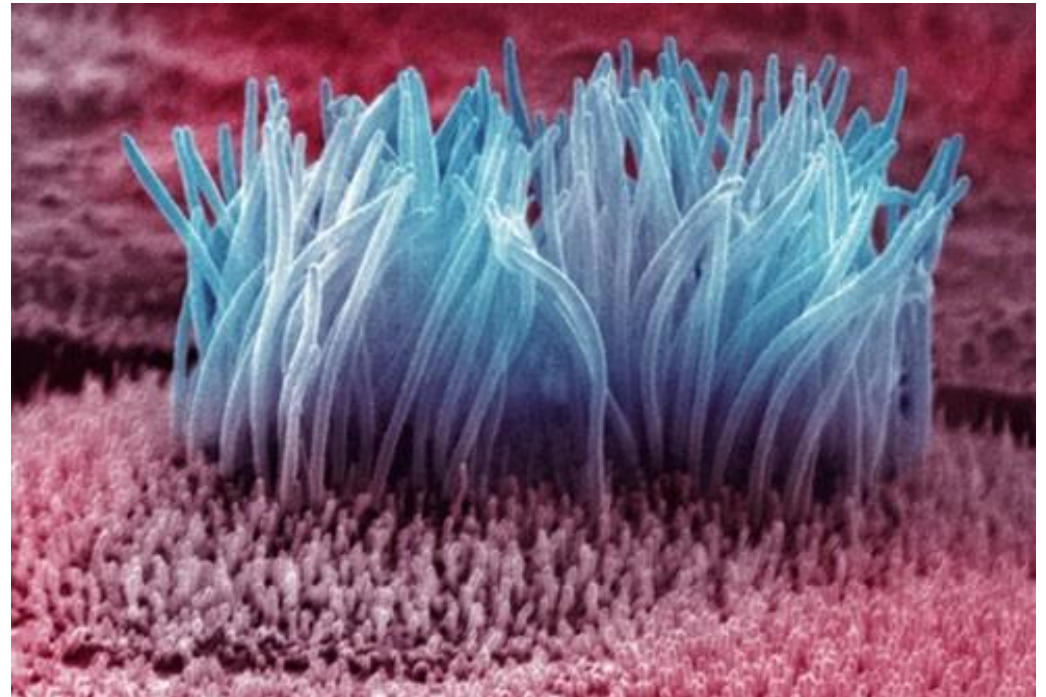
- The cytoskeleton is a network of protein structures extends through out the cytoplasm providing the cell with an internal framework.
- Act as the cell's “**bone and muscles**”;
- Determines cell shape, support organelles.
- Cytoskeleton is made of: microfilaments, intermediate filaments, and microtubules.



(a)

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.



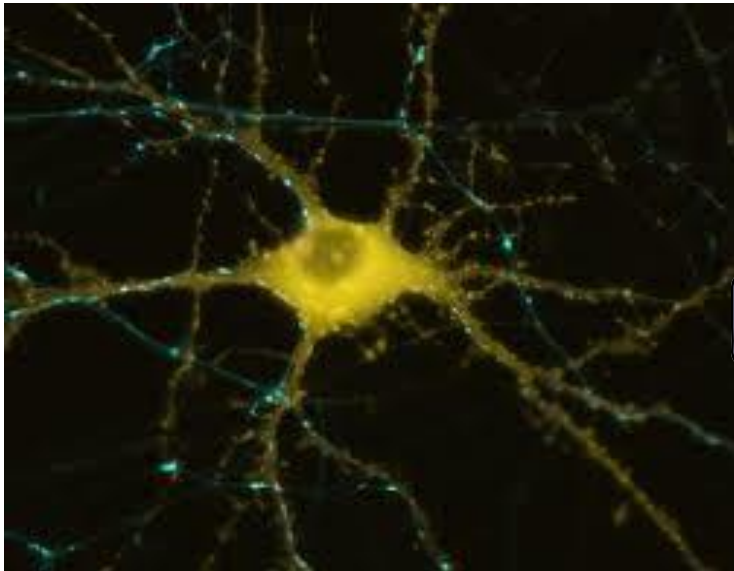
Cell diversity



Fat cell

macrophage

RBC



Nerve Cell

Sperm, oocyte



Cell Diversity

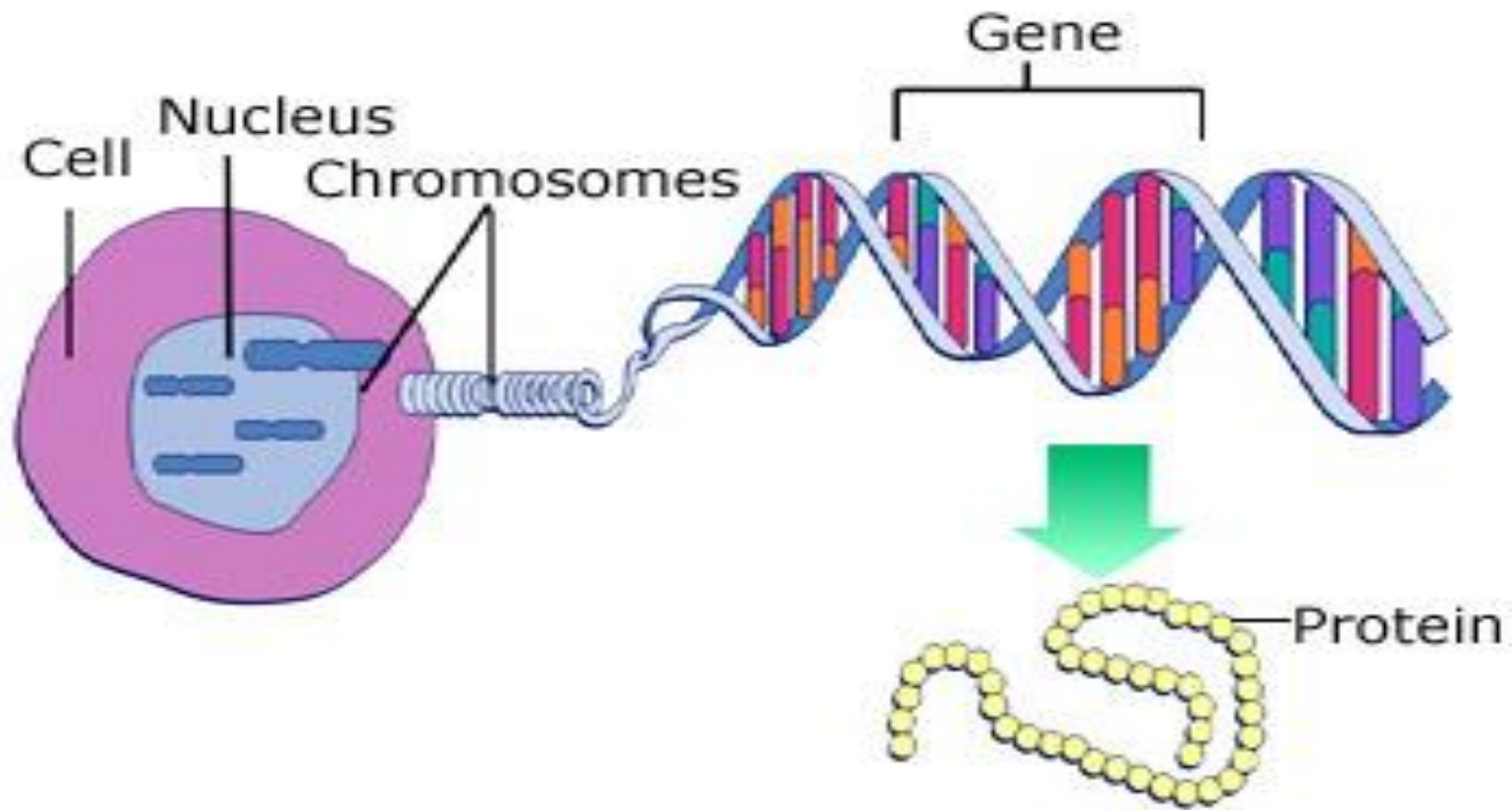
- Connect your body.
- Covers body organs.
- Movement.
- Store nutrients.
- Fighting disease.
- Store information and control function.
- Reproduction.

P74

Examples

The Origin of Life

The central dogma of molecular biology



The Origin of Life

What is a chromosome?

In the nucleus of each cell, the DNA molecule is packaged into thread-like structures called chromosomes.

Deoxyribonucleic acid (DNA);

is the hereditary material in humans and almost all other organisms. Almost every cell in a person's body has the same DNA.

Most DNA is located in the cell nucleus (where it is called nuclear DNA), but a small amount of DNA can also be found in the mitochondria (where it is called mitochondrial DNA or mtDNA).

The information in DNA is stored as a code made up of four chemical bases: adenine (A), guanine (G), cytosine (C), and thymine (T) to make up genes.

The Origin of Life

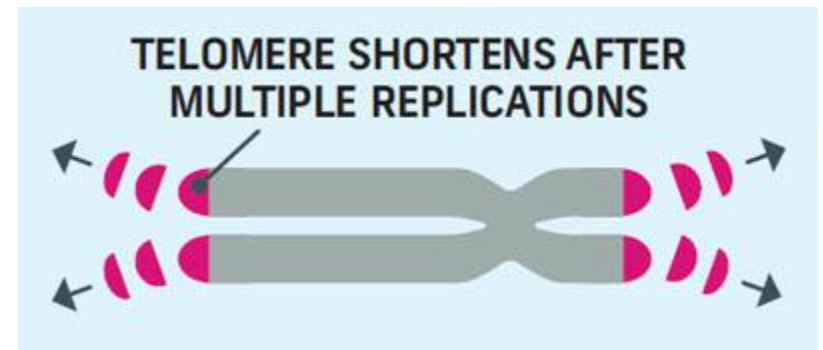
Telomeres:

A telomere is a region of repetitive nucleotide sequences at each end of a chromatid.

They are the caps at the end of each strand of DNA that protect our genetic data, make it possible for cells to divide.

Each time a cell divides, the telomeres get shorter. When they get too short, the cell can no longer divide; and it dies by a process called apoptosis.

This shortening process is associated with aging, cancer, and a higher risk of death.



Body Fluids



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.

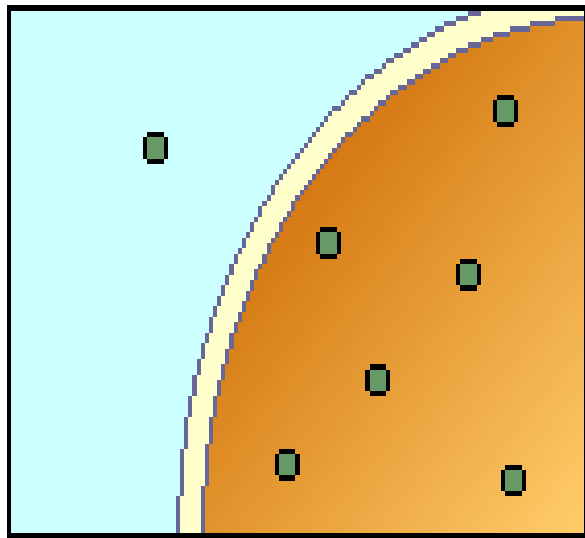
Solutions

- **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

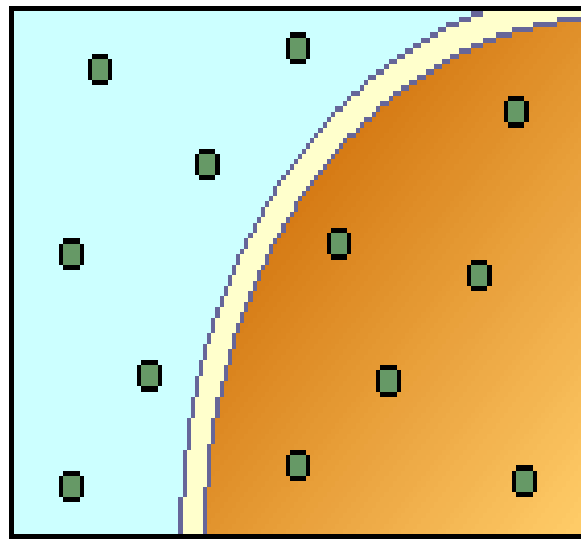
Solutions

- **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.

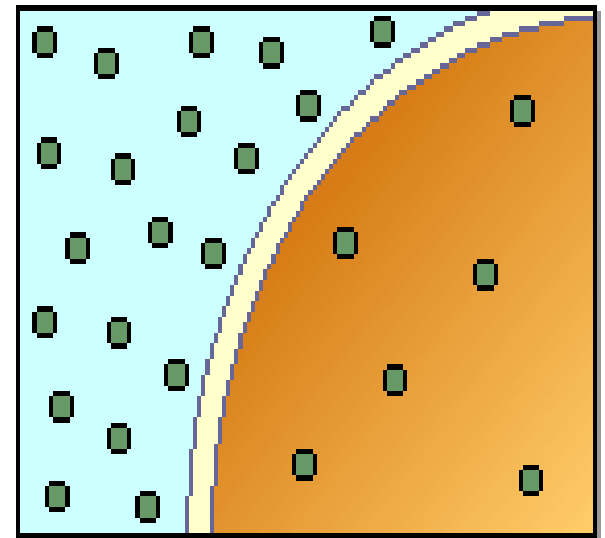
Hypotonic solution



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.

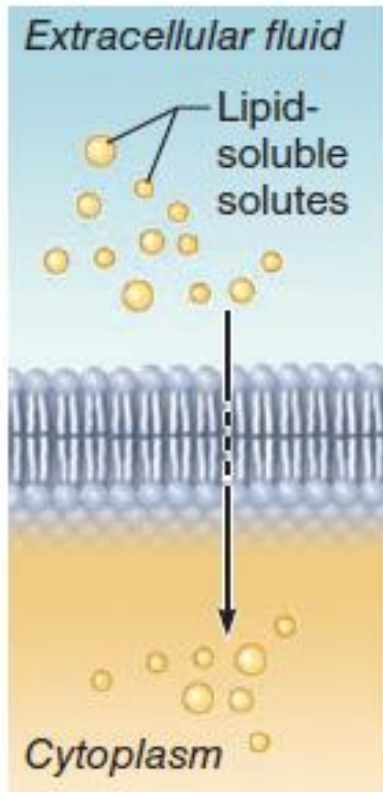
-Diffusion

-Facilitated diffusion

-Osmosis

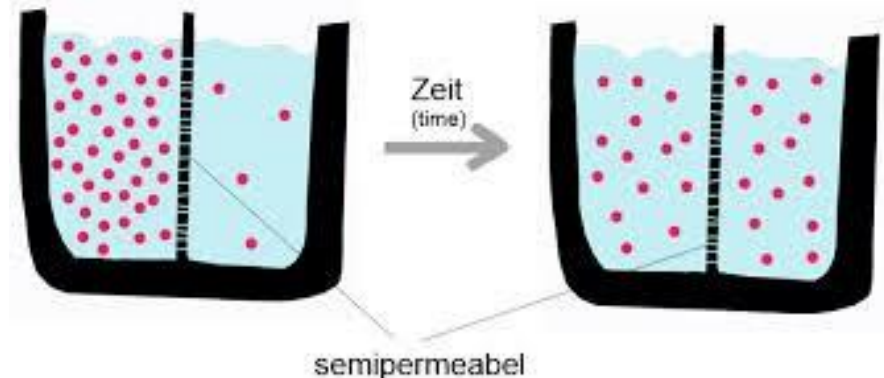
-Filtration

Diffusion



(a) Simple diffusion of fat-soluble molecules directly through the phospholipid bilayer

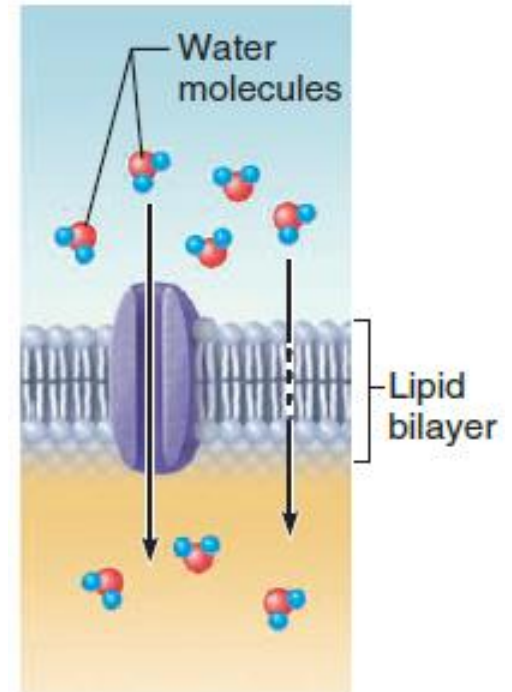
- Movement of molecules from an area of high concentration to an area of low concentration until equilibrium is reached.
- Molecules have to be small or lipid-soluble
- E.g. small ions, O_2 , CO_2 , fat soluble vitamins.



Osmosis

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

It passes through special pores called *aquaporins* (“water pores”) created by the proteins in the membrane.



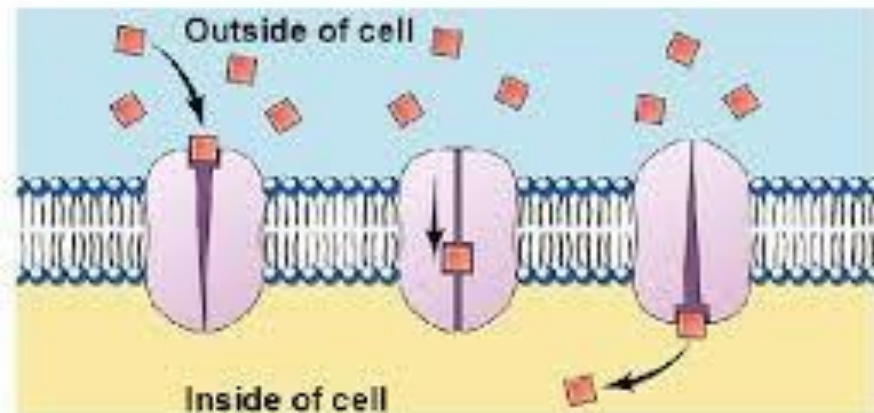
(d) Osmosis, diffusion of water through a specific channel protein (aquaporin) or through the lipid bilayer

Facilitated diffusion

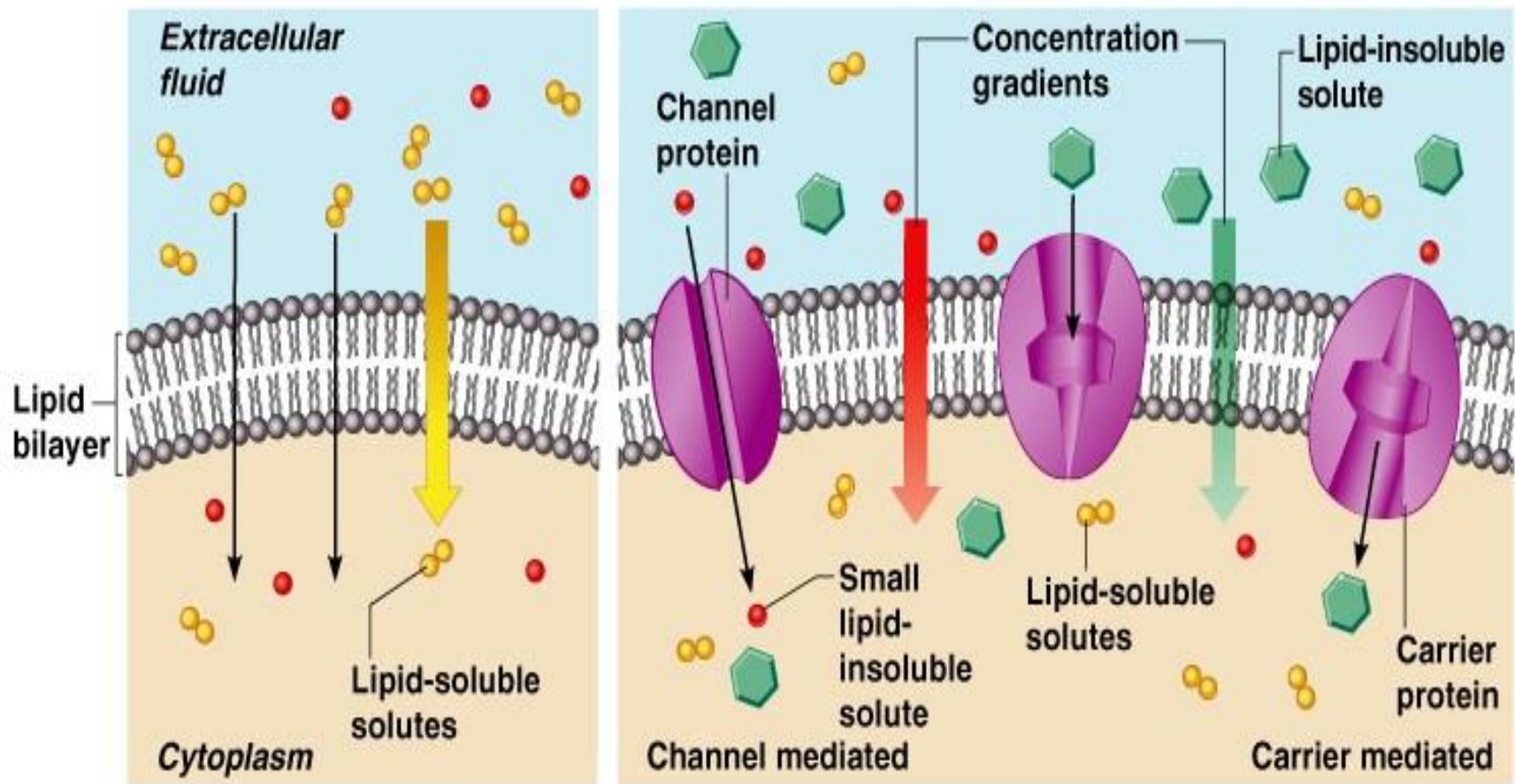
- A protein carrier is used to transport a molecule from an area of high concentration to an area of low concentration.
- Molecules are large and lipid-insoluble.
- e.g. Glucose

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Facilitated Diffusion



Ways of Diffusion through the Plasma Membrane

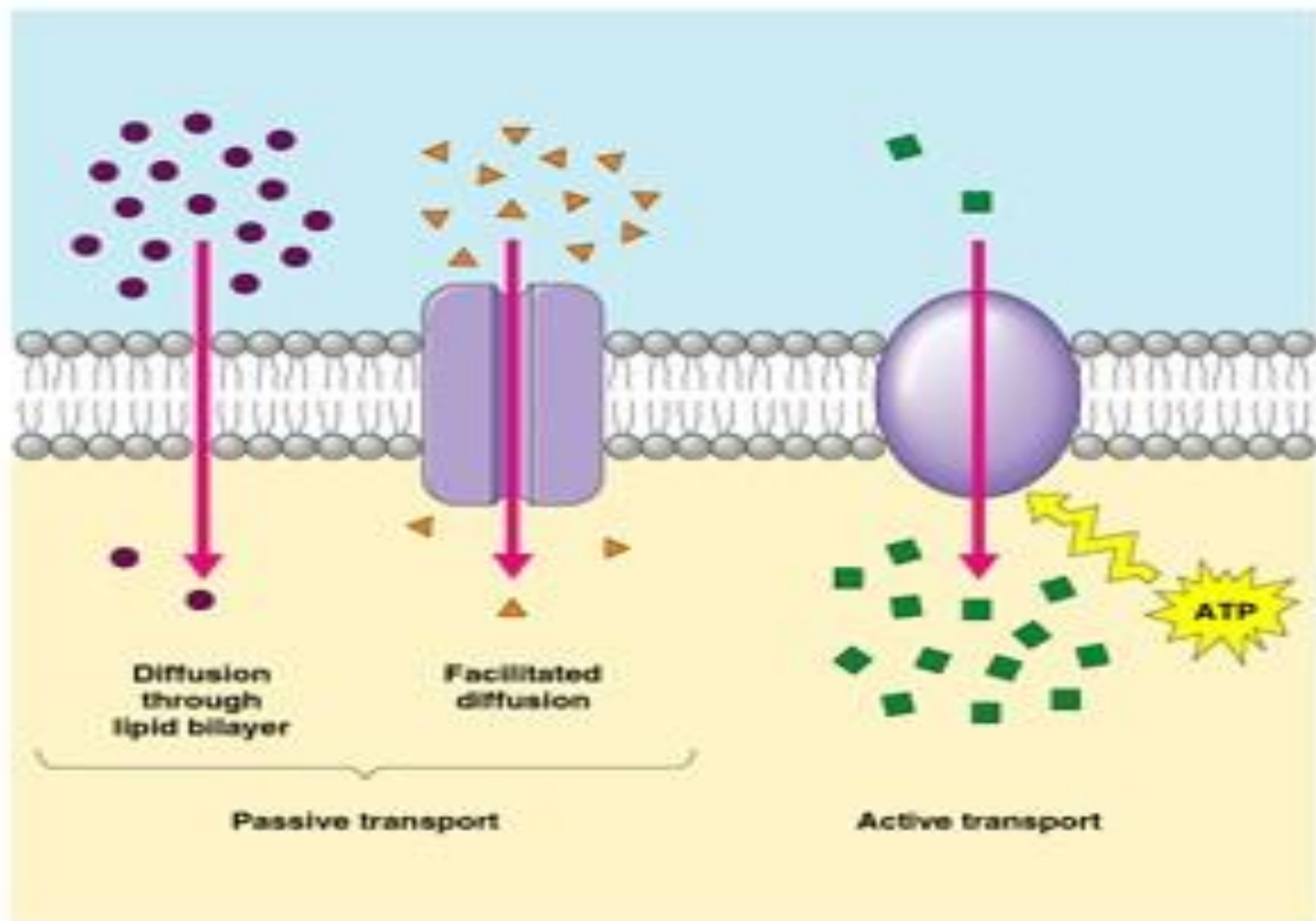


(a) Simple diffusion

(b) Facilitated diffusion

Filtration

- Water and solutes are forced through the plasma membrane by hydrostatic pressure.
 - Solute-containing fluid is pushed from a high pressure area to a lower pressure area
- Only blood cells and proteins are too large to pass through the membrane by filtration.
- E.g. water and small solutes filter out of the capillaries into the kidney tubules because the blood pressure in the capillaries is greater than the fluid pressure in the tubules.



Active transport

- The cell provides **ATP** to transport molecules that are unable to pass by passive transport.
 - They may be too large.
 - They may not be able to dissolve in the fat core of the membrane.
 - They may have to move against a concentration gradient (from low concentration to high concentration).

2 Kinds:

- Solute pumping
- Bulk transport (Vesicular transport)

Solute Pumping

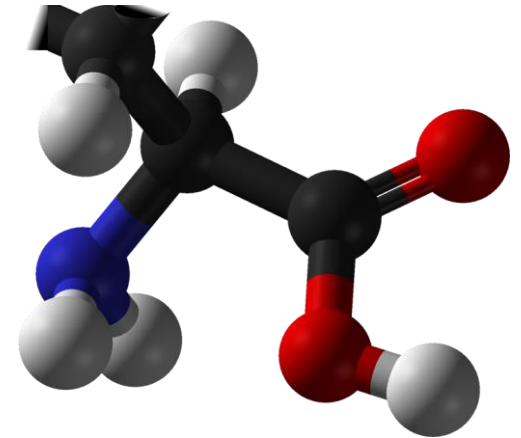
- Most ions and amino acids transported by solute Pumps.

- Solute pumping requires

1. carrier protein

2. ATP

3. ATPase enzyme that breaks ATP to release energy.

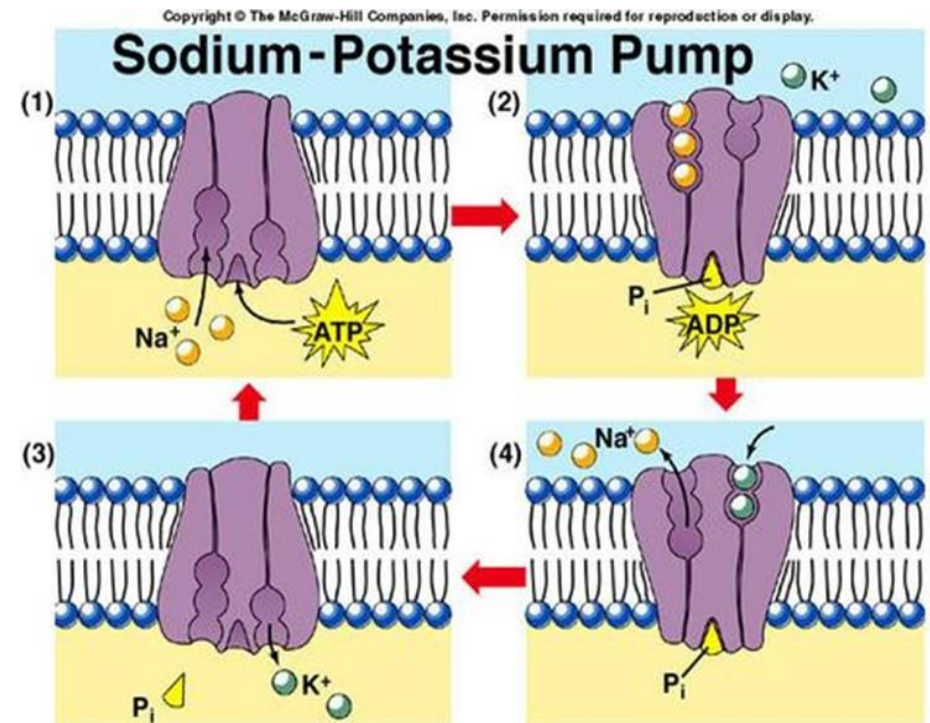


E.g. The sodium-potassium pump: is absolutely necessary for transmission of impulses by the nerve cells.

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

Sodium ions are moved out of cells by solute pumps. There are more sodium ions outside the cells than inside, so they tend to remain in the cell unless the cell uses ATP to force them out.

Likewise, there are more potassium ions inside cells than outside, and potassium ions that leak out of cells must be actively pumped back inside.



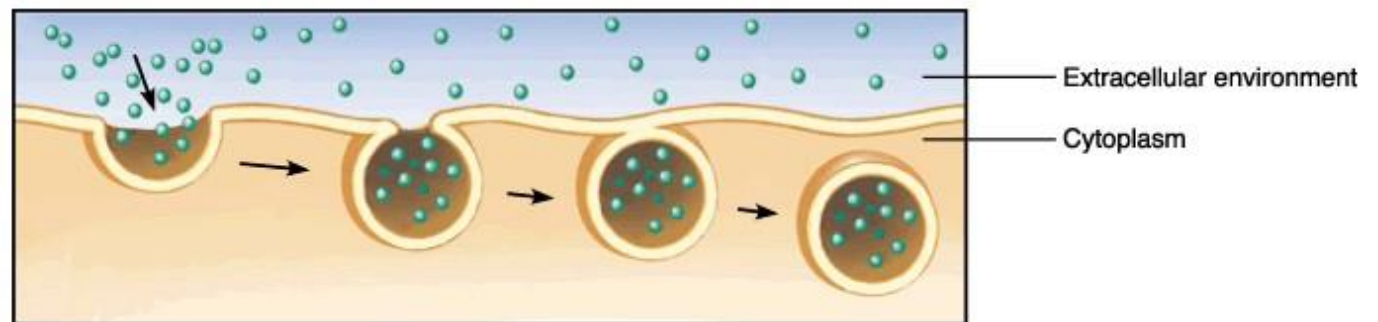
Bulk transport (Vesicular transport):

A) Endocytosis

- Extracellular substances are engulfed by being enclosed in a membranous vesicle.

– Types of endocytosis

- **Phagocytosis** – cell eating > by specialized cells for body protection.
- **Pinocytosis** – cell drinking > routine activity of most cells.

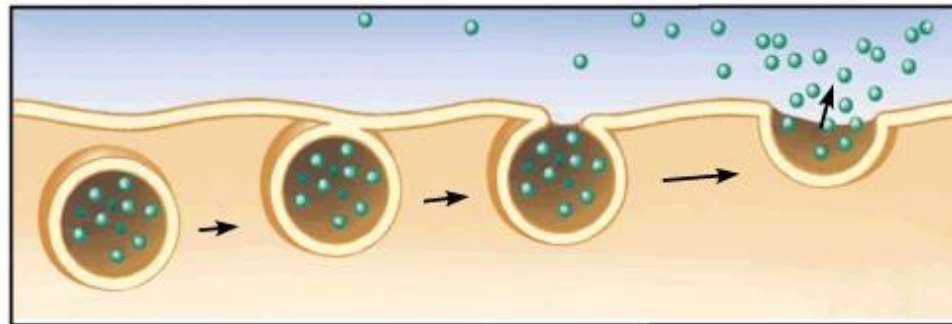


Receptor-mediated endocytosis

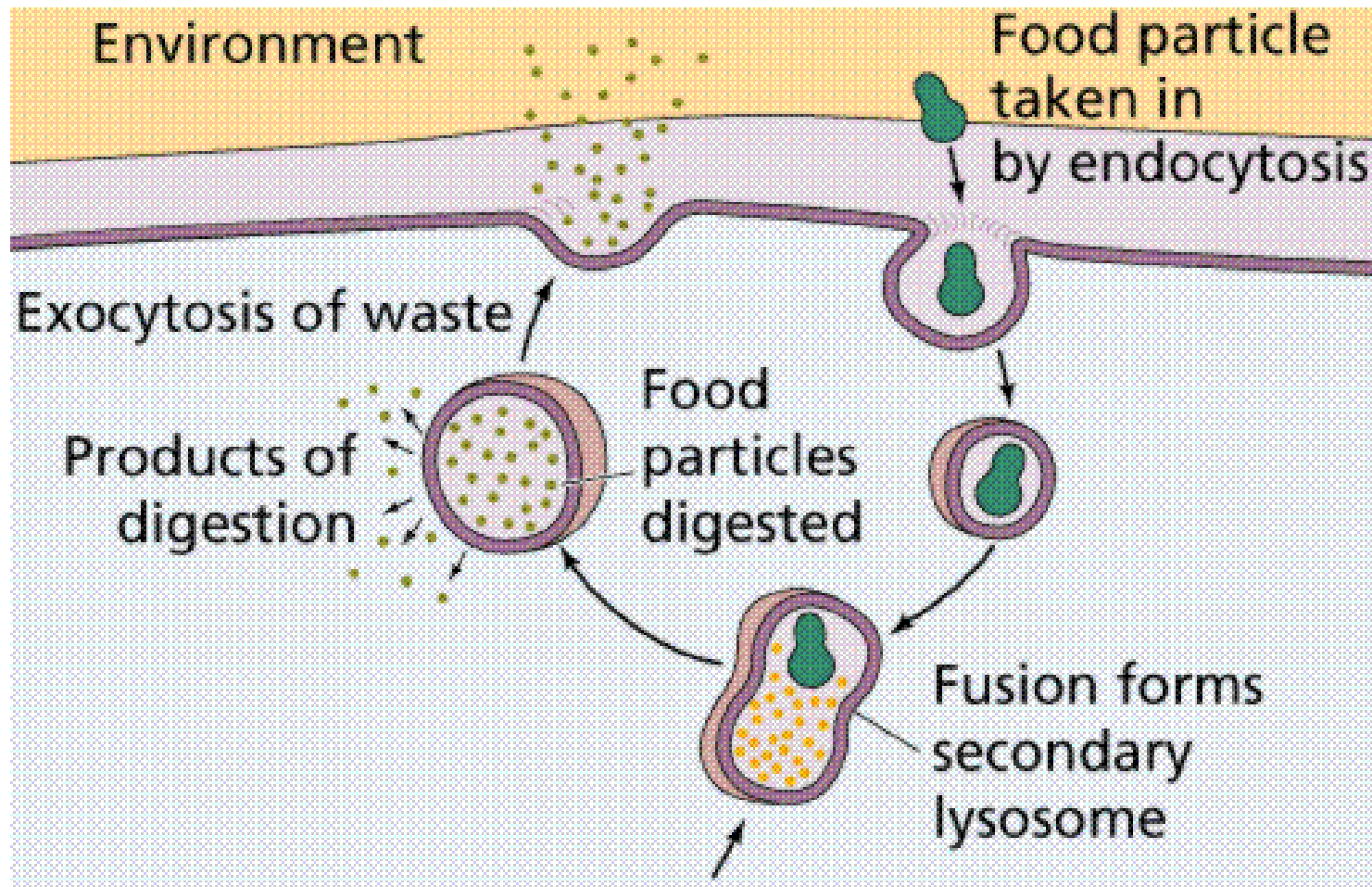
- cellular mechanism for taking up specific target Molecules.
- In this process, receptor proteins on the plasma membrane bind only with certain substances.
- target molecules are internalized in a vesicle.
- Highly specific endocytosis.
- Substances taken in by receptor mediated endocytosis include: enzymes, some hormones, cholesterol, and iron.
- flu viruses also use this route to enter and attack our cells.

B) Exocytosis

- Moves materials out of the cell
- Material is carried in a membranous vesicle
- Vesicle migrates to plasma membrane
- Vesicle combines with plasma membrane
- Material is emptied to the outside
- Process mediated by SNARE protein family.



- **Endocytosis and Exocytosis**



Body fluids

- The main fluid in the body is water.
- Water is distributed in Two main compartments separated from each other by cell membranes.
- ❖ The intracellular fluid
- ❖ The extracellular fluid consists of:
 - Interstitial Fluid
 - Plasma
 - Transcellular Fluid

$TBW = 0.6 \times \text{Body weight}$

Total Body Water (TBW)
(70Kg man)
42 litres

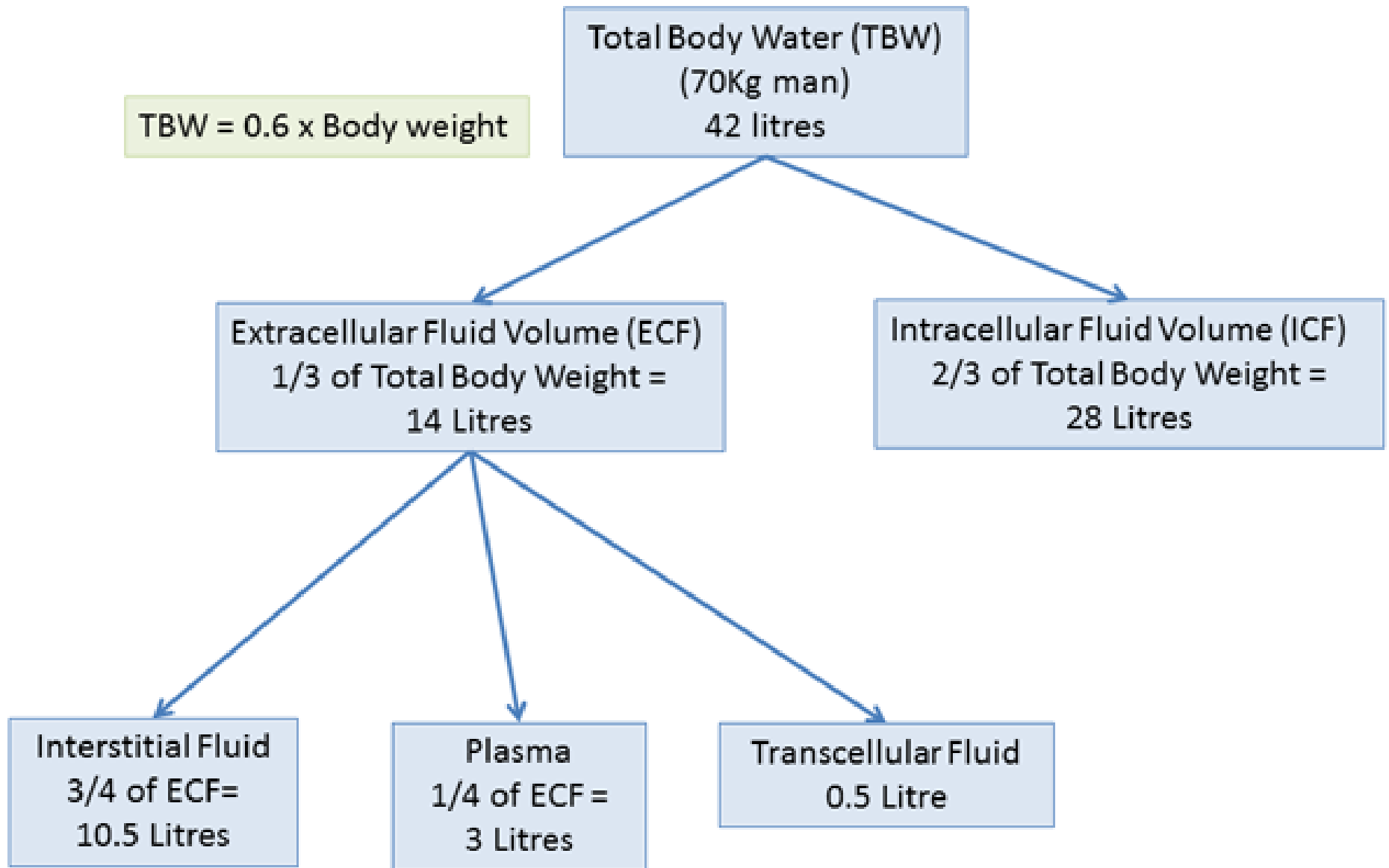
Extracellular Fluid Volume (ECF)
 $\frac{1}{3}$ of Total Body Weight =
14 Litres

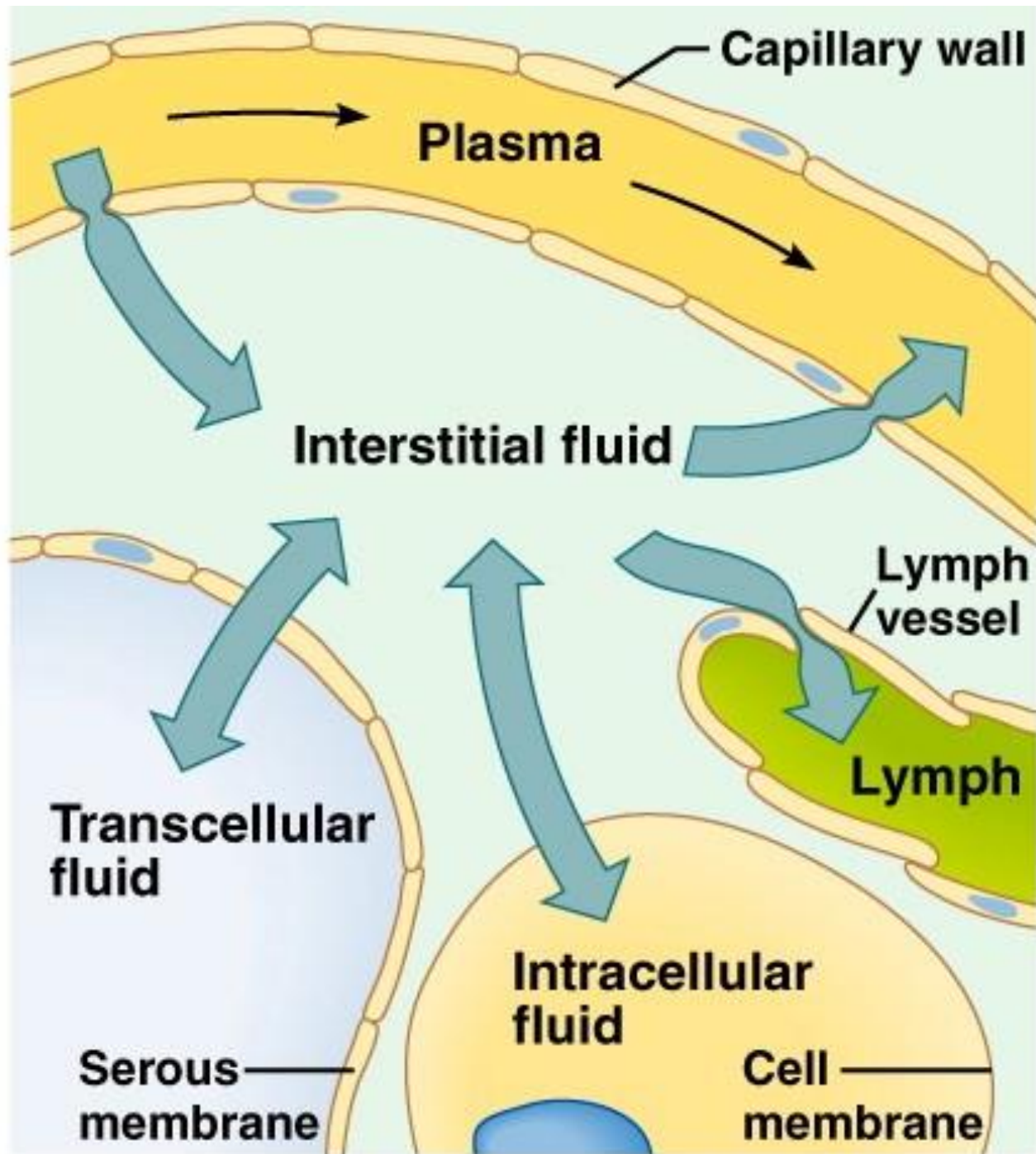
Intracellular Fluid Volume (ICF)
 $\frac{2}{3}$ of Total Body Weight =
28 Litres

Interstitial Fluid
 $\frac{3}{4}$ of ECF =
10.5 Litres

Plasma
 $\frac{1}{4}$ of ECF =
3 Litres

Transcellular Fluid
0.5 Litre





Extracellular fluid (ECF)

Extracellular fluid—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

Interstitial Fluid

Formation of ECF :

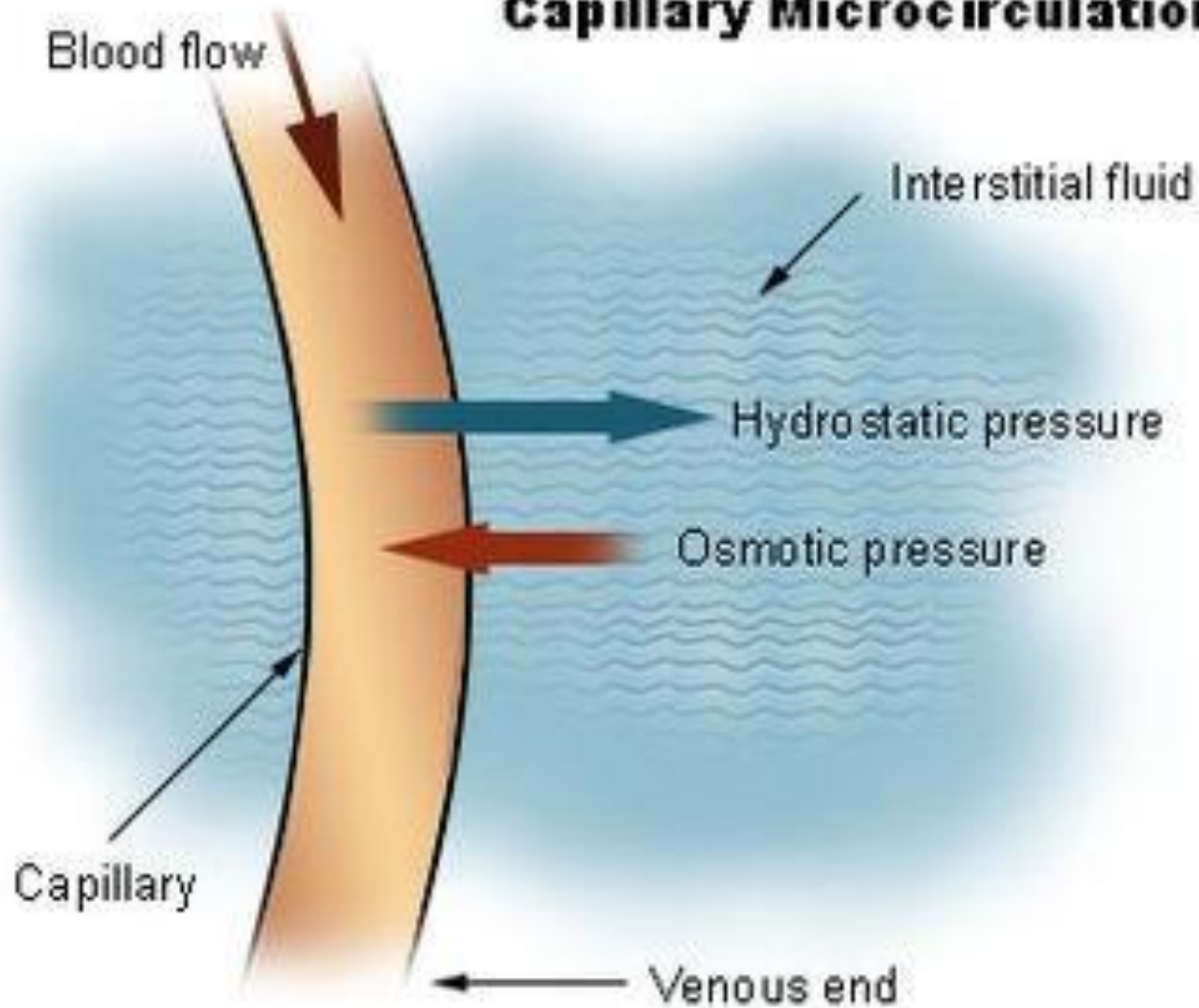
Hydrostatic Pressure is generated from the heart pushing the fluid out of the capillaries.

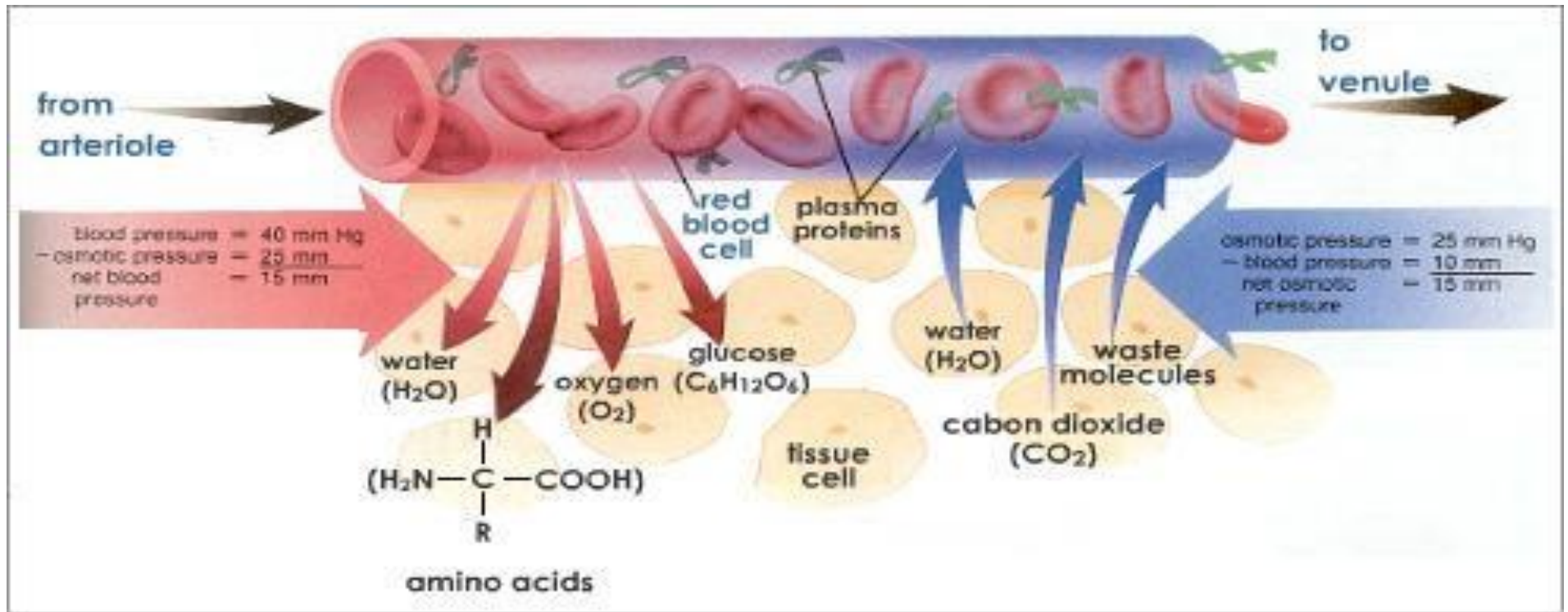
How does this fluid rejoin the blood?

- 1) The buildup of solutes in BV induce **osmosis**: Water passes from a high conc. (of water) outside the BV to a low conc. inside the BV.
- 2) The fluid can also rejoin the blood by the help of the lymphatic system.

ECF Function: Deliver material to the cells (intracellular communication) and removal of metabolic waste.

Capillary Microcirculation





Composition:

- Water, glucose, fatty acids, amino acids, nutrients, hormones, waste products from the cells, 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.

- Blood plasma contains exactly what interstitial fluid contains in addition to RBC, platelets, and plasma proteins.

—Transcellular fluid— is the portion of body fluid contained within epithelial lined spaces.

- It is the smallest component of extracellular fluid.

Intracellular fluid (ICF)

- It is fluid present inside the cell where cellular organelles are suspended and chemical reactions take place
- Composed of both Nucleoplasm and the cytosol
- 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^+ .

Movement of body fluid

- The exchange of interstitial and intracellular fluid is controlled mainly by the presence of the electrolytes Na^+ and K^+ .
- Potassium is the chief intracellular cation and sodium is the chief interstitial 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.

Body Tissues

Objectives:

- 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.

Body Tissues:

Groups of similar cells that perform a common function

Four Basic Kinds of Tissues

Four types of tissue

(support)



Connective tissue

(covering)



Epithelial tissue

(movement)



Muscle tissue

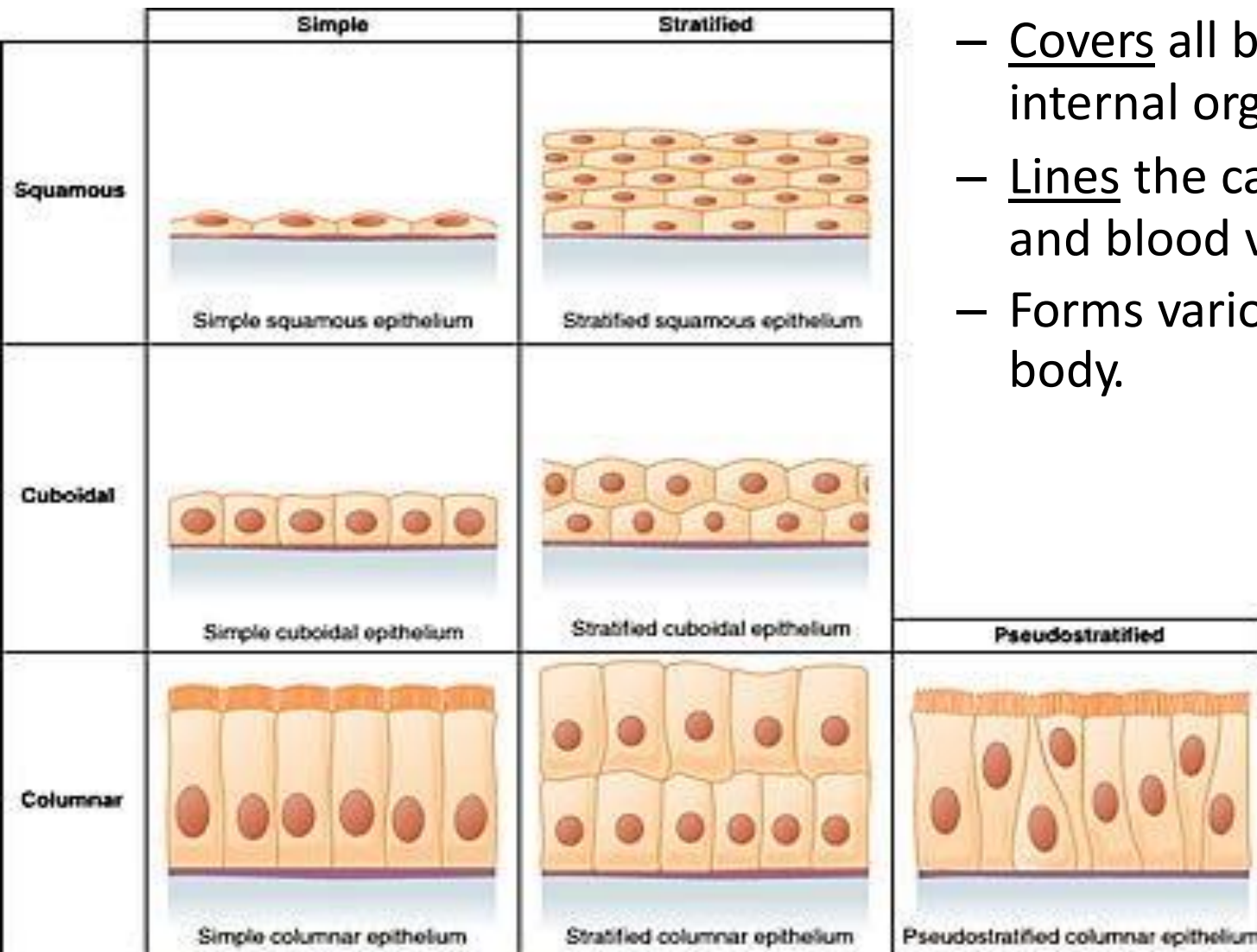
(control)



Nervous tissue

Epithelial Tissue

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



*Function:

- Protection
- Absorption
- Filtration
- Secretion

Epithelial Tissue functions

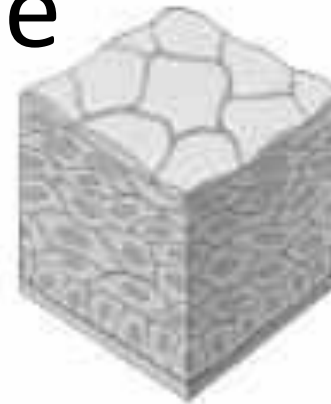
Simple squamous

- 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



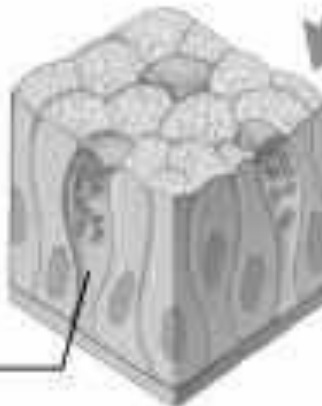
Stratified cuboidal

- Lines ducts of sweat glands
- Secretes water and ions



Simple columnar

- Lines most digestive organs
- Absorbs nutrients, produces mucus



Goblet cell

Stratified columnar

- Lines epididymus, mammary glands, larynx
- Secretes mucus

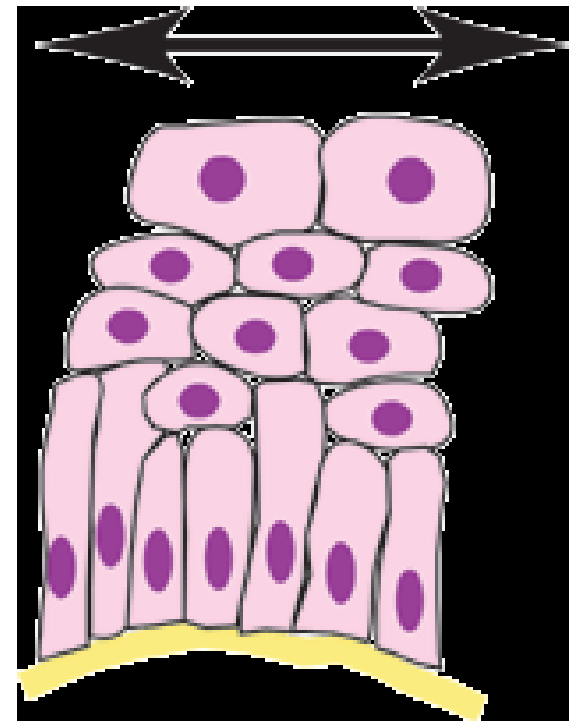


Basement membrane

Transitional epithelium

is a highly modified, stratified squamous epithelium that forms the lining of only a few organs—the Urinary bladder, the ureters, and part of the urethra.

- All these organs are subject to considerable stretching.
- Cells of the basal layer are cuboidal or columnar;
- the organ is not stretched, the membrane is many-layered, and the superficial cells are rounded. When the organ is distended with urine, the epithelium thins, and the surface cells flatten and become squamous-like.
- This allows the ureter wall to stretch as a greater volume of urine flows through that tube-like organ. In the bladder, it allows more urine to be stored.

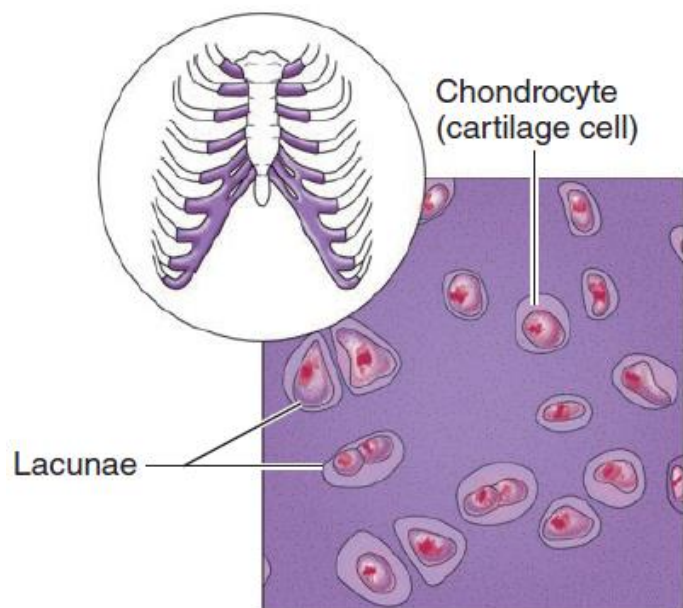


Connective Tissue

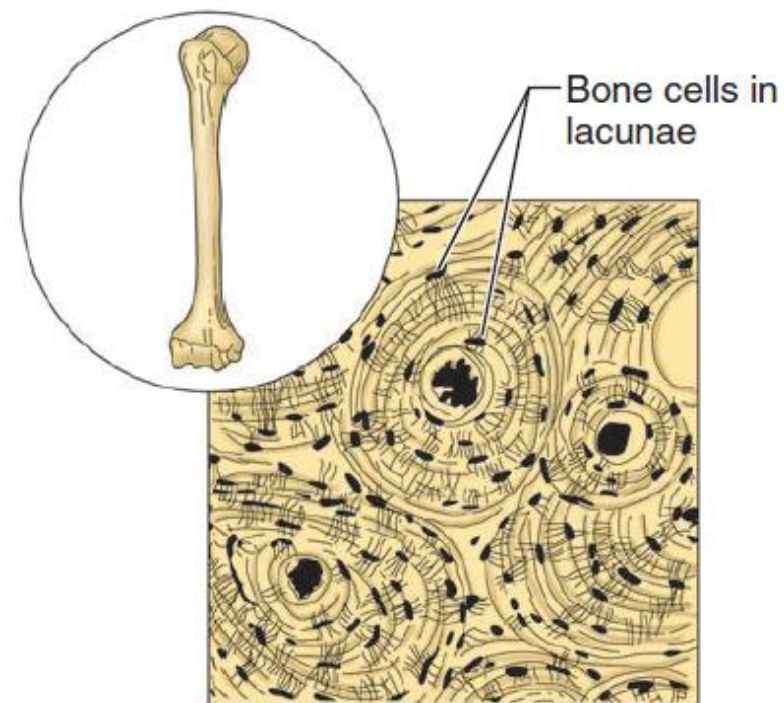
Most abundant & widely distributed tissue.



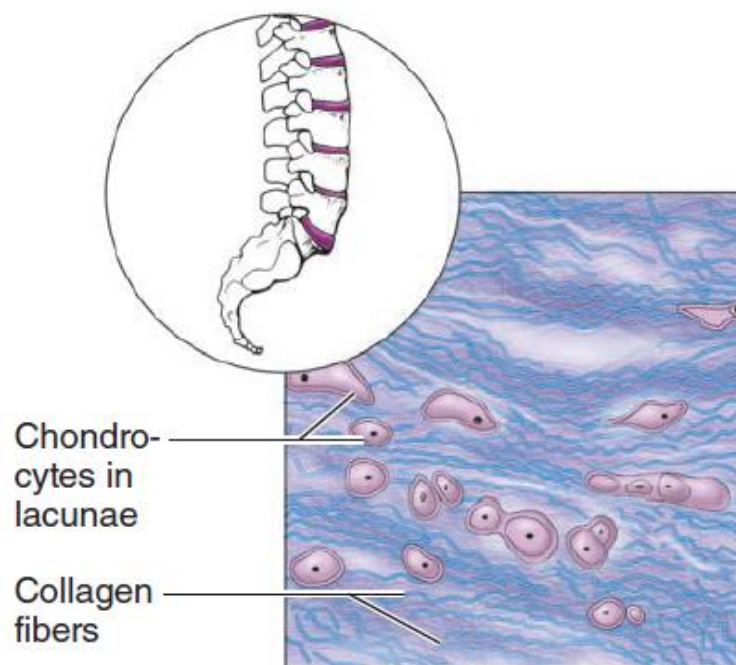
- Types of connective tissue:
 - Dense connective tissue (tendons, ligaments)
 - Loose connective tissue (Reticular, adipose, areolar)
 - Cartilages (elastic, fibro, hyaline)
 - Bone
 - Blood
- Connective Tissue Functions:
 - Connects, binds body tissue together.
 - Protection
 - Supports and cushions organs.
 - insulation and storage (fat)
 - Transports substances (blood).



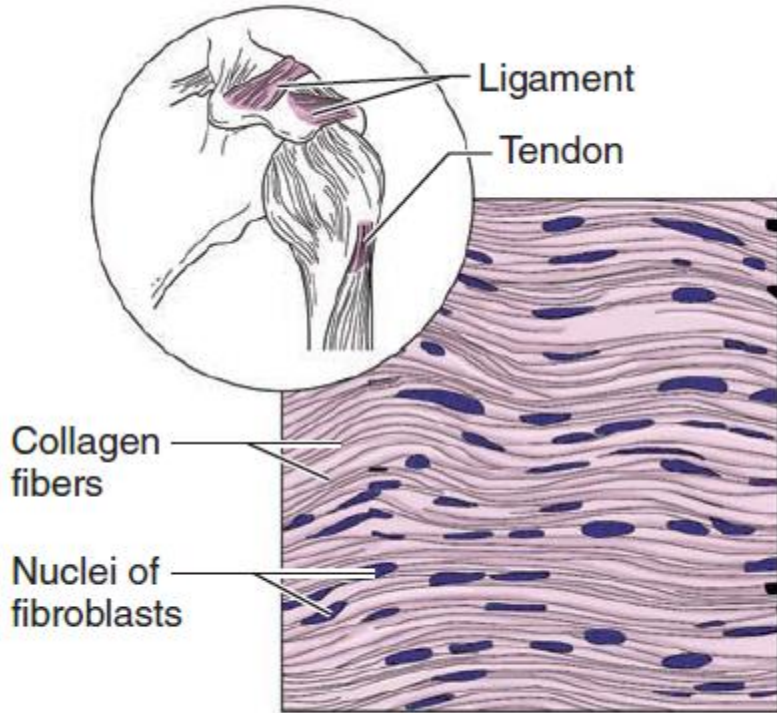
(b) Diagram: Hyaline cartilage



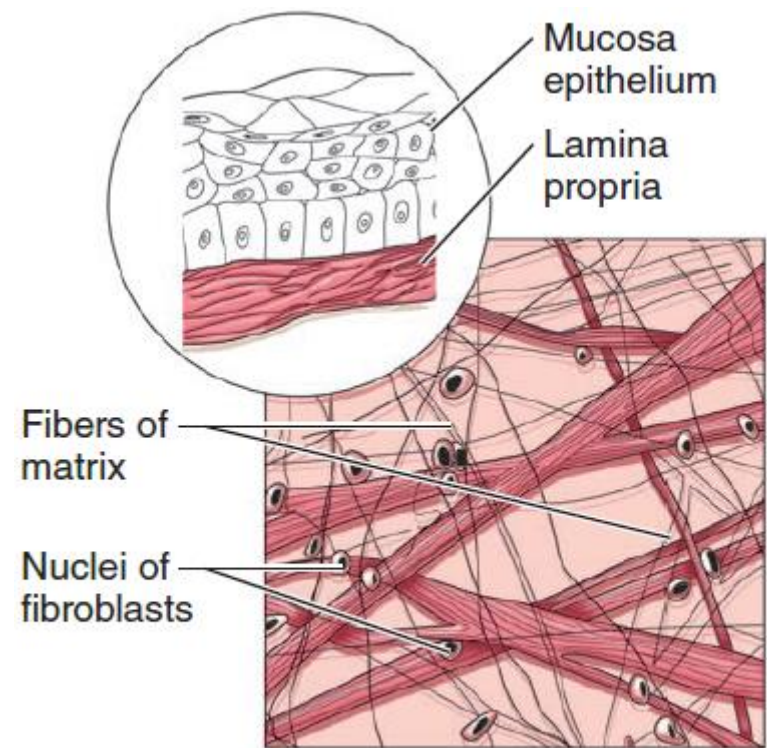
(a) Diagram: Bone



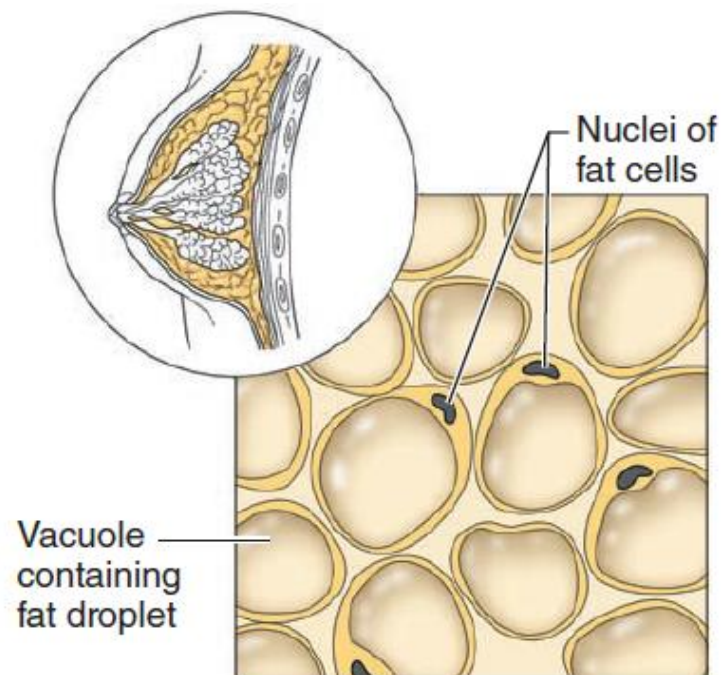
(c) Diagram: Fibrocartilage



(d) Diagram: Dense fibrous

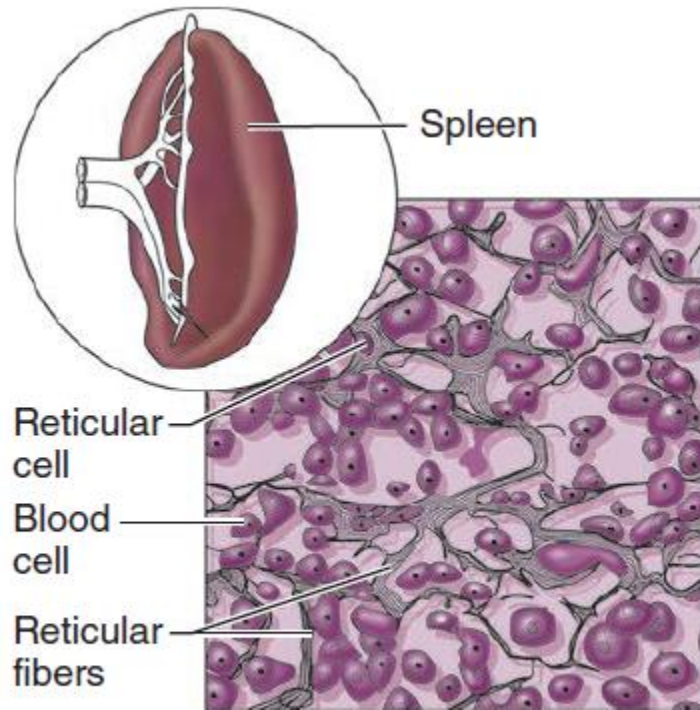


(e) Diagram: Areolar

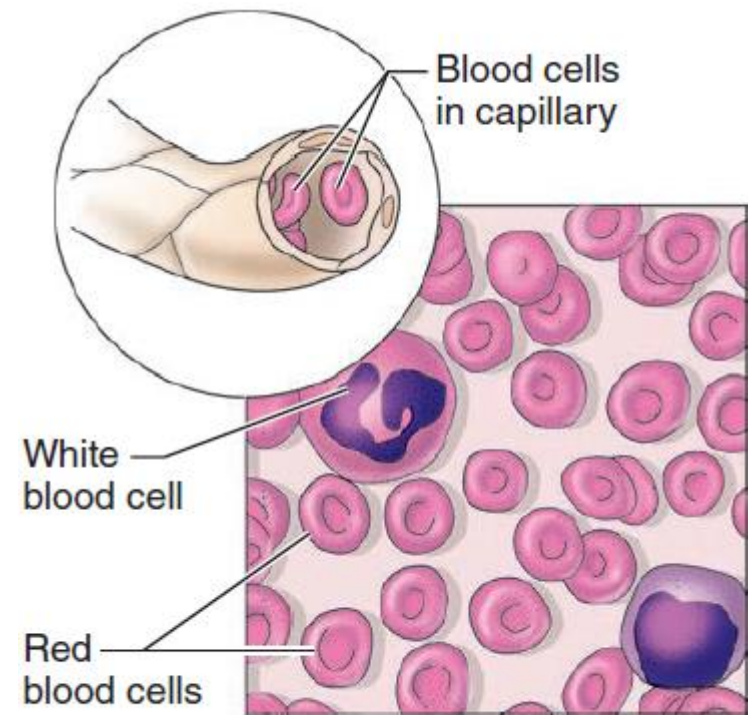


(f) Diagram: Adipose

V



(g) Diagram: Reticular

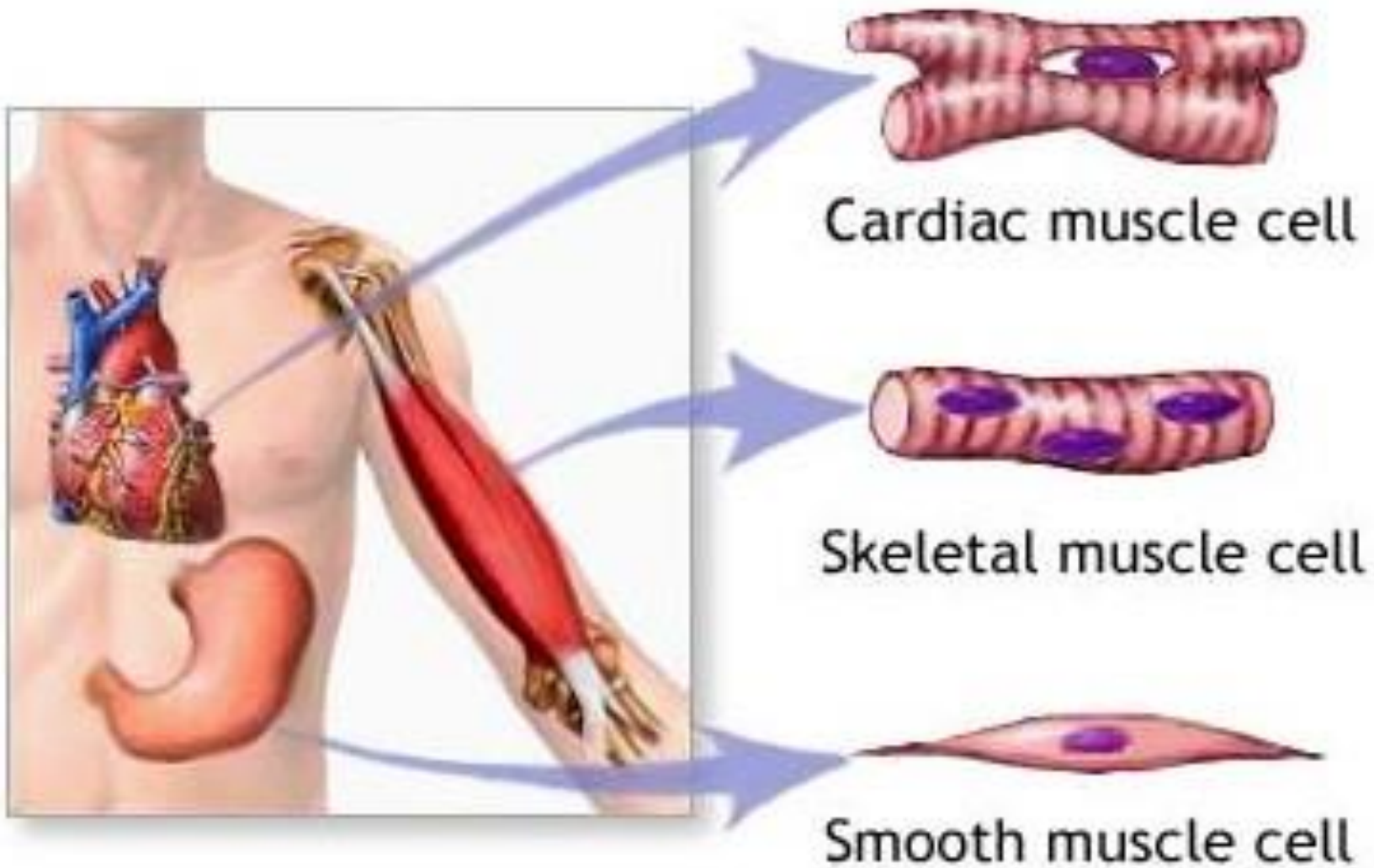


(h) Diagram: Blood

Muscle Tissue

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

3 kinds of muscle cells:



Nervous Tissue

- Sends messages throughout the body by conducting electrical impulses
- The brain and spinal cord are control centers
- The neuron is the basic unit
- Neuroglia; A special group of supporting cells insulate, support, and protect the delicate neurons.

