

Biomedical
Science

Molecular
Genetics



BME 380 | Fall 2026-2027

Human Biology 1

Cell Structure & Function



Free Session

A+ is more than just a platform



[Academy Website](#)



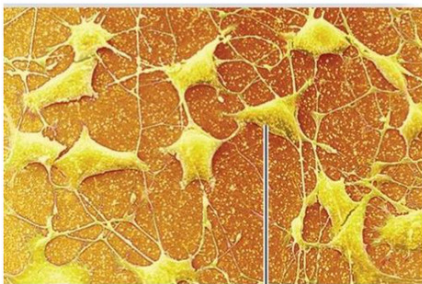
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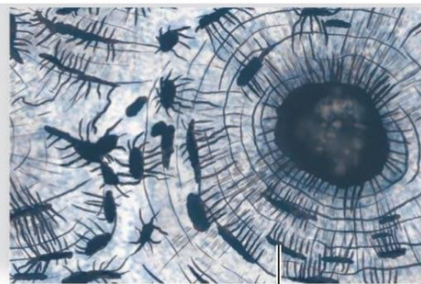
The Cell Theory

Cell — the **basic unit of life.**

- 1 All living things are made up of **cells**.
- 2 New cells arise only from **preexisting cells**.
- 3 Cells **vary in structure and function**.



nerve cell



osteocyte



red blood cell

blood vessel



Cell Size

Cells are small because of their **surface-area-to-volume ratio.**

- Smaller cells have a **larger amount of surface area** compared to the volume.
- An increase in surface area allows for more nutrients to pass into the cell and more wastes to exit the cell.
- There is a **limit** to how large a cell can be while remaining efficient and metabolically active.

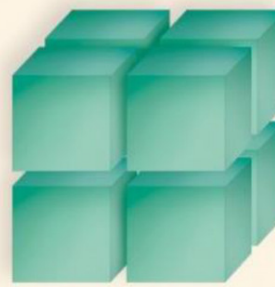


Surface-Area-to-Volume Ratio

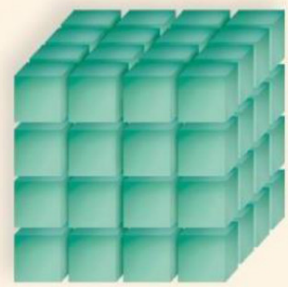
Dividing one large cube into many small cubes keeps the **volume the same** but **multiplies the surface area**.



One
4-cm cube



Eight
2-cm cubes



Sixty-four
1-cm cubes

MEASUREMENT	ONE 4-CM CUBE	EIGHT 2-CM CUBES	SIXTY-FOUR 1-CM CUBES
Total surface area	96 cm ²	192 cm ²	384 cm ²
Total volume	64 cm ³	64 cm ³	64 cm ³
Surface area : volume per cube	1.5 : 1	3 : 1	6 : 1

HOW EACH ROW IS CALCULATED

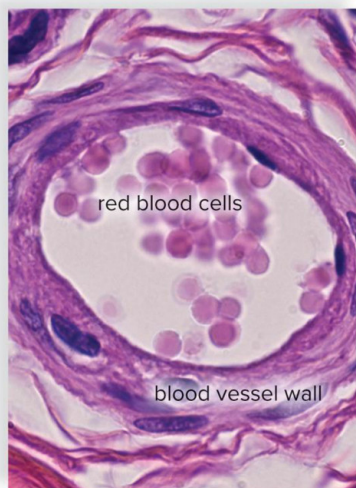
- **Total surface area** = height × width × number of sides × number of cubes.
- **Total volume** = height × width × length × number of cubes.
- **Volume per cube** = surface area ÷ volume.



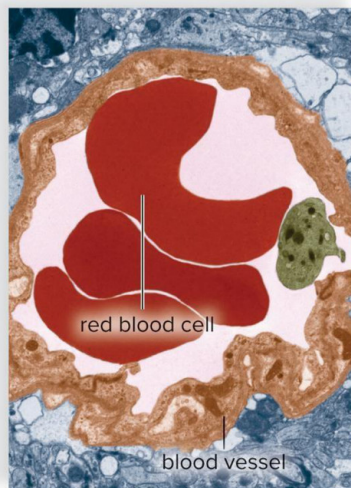
Microscopy

Resolution of the image varies among different types of microscopes.

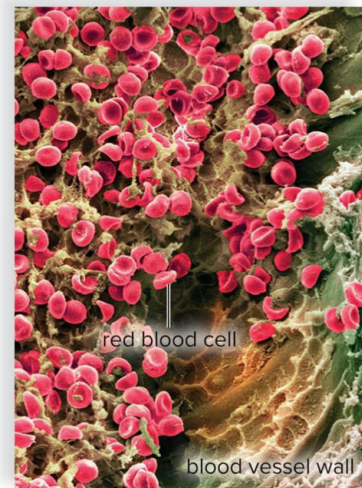
MICROSCOPE	IMAGE	HOW IT VIEWS THE SPECIMEN	SPECIMENS
1. Compound light	—	Uses glass lenses and light beams; lower magnification than other microscopes	Can view live specimens
2. Transmission electron	2-D	Uses a stream of electrons; the eye cannot see the image — it must be projected onto a screen	High magnification, no live specimens
3. Scanning electron	3-D	Uses a beam of electrons to view surface structures of specimens	High magnification, no live specimens



a. Light micrograph 250×



b. Transmission electron micrograph 4,000×

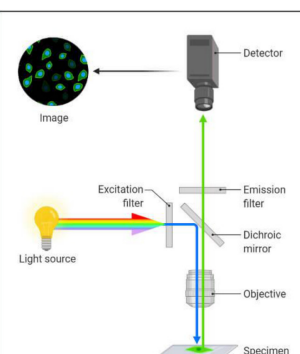


c. Scanning electron micrograph

Micrographs of human red blood cells.

4. FLUORESCENCE MICROSCOPY

Fluorescence Microscopy





How Cells Are Organized

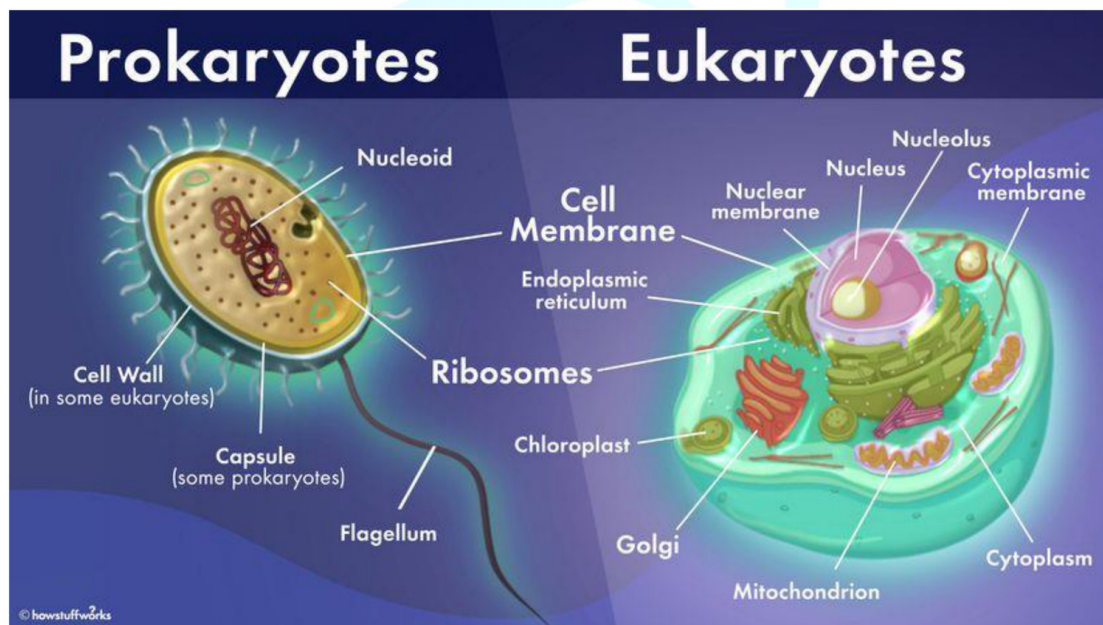
Cells are classified into **two categories**: **prokaryotes** and **eukaryotes**.

Prokaryotic cells

- Lack a nucleus.
- Include two groups of bacteria: **eubacteria** and **archaeobacteria**.

Eukaryotic cells

- Have a nucleus.
- Include **animals, plants, fungi, protists**.



Features Shared by All Cells

A plasma membrane

- Surrounds the cell.
- Made of a phospholipid bilayer that is **selectively permeable** — it regulates what enters and leaves the cell.

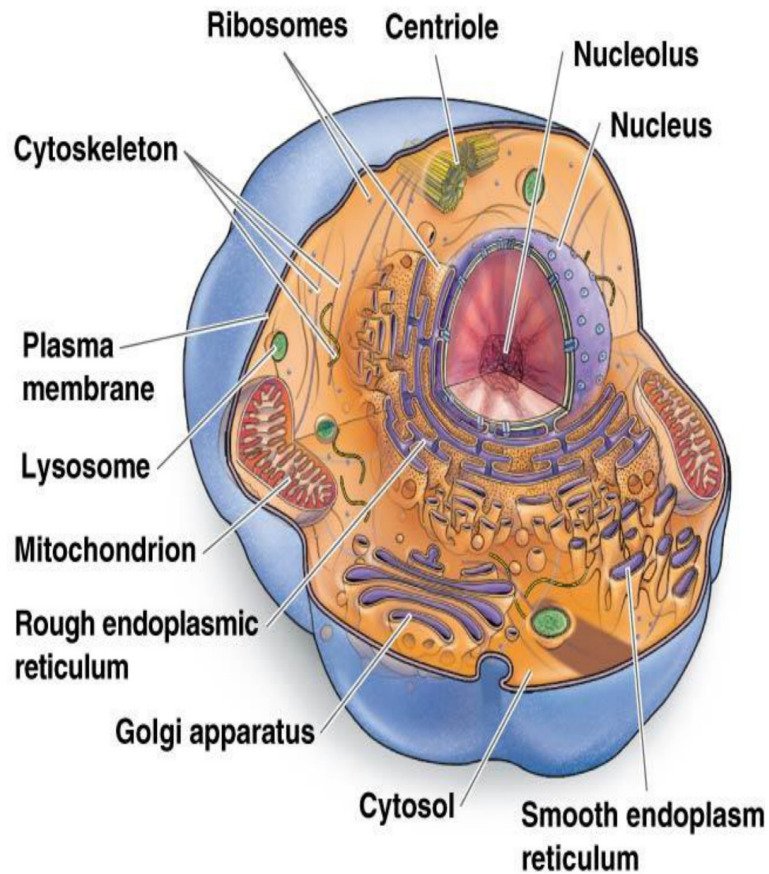
A cytoplasm

- The **semifluid substance** inside the cell.
- Includes **organelles** — internal compartments with specialized functions.

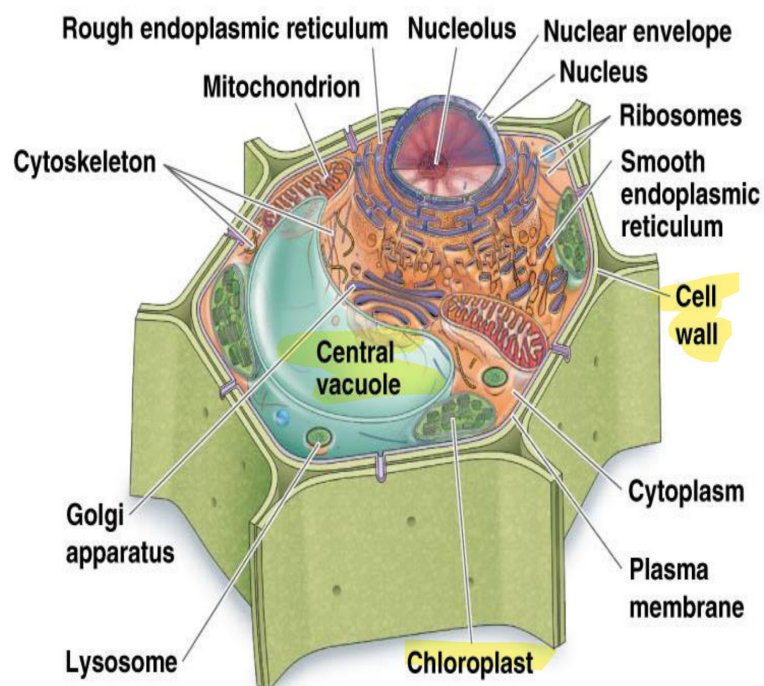


The Typical Eukaryotic Cell

(a) Animal cell



(b) Plant cell



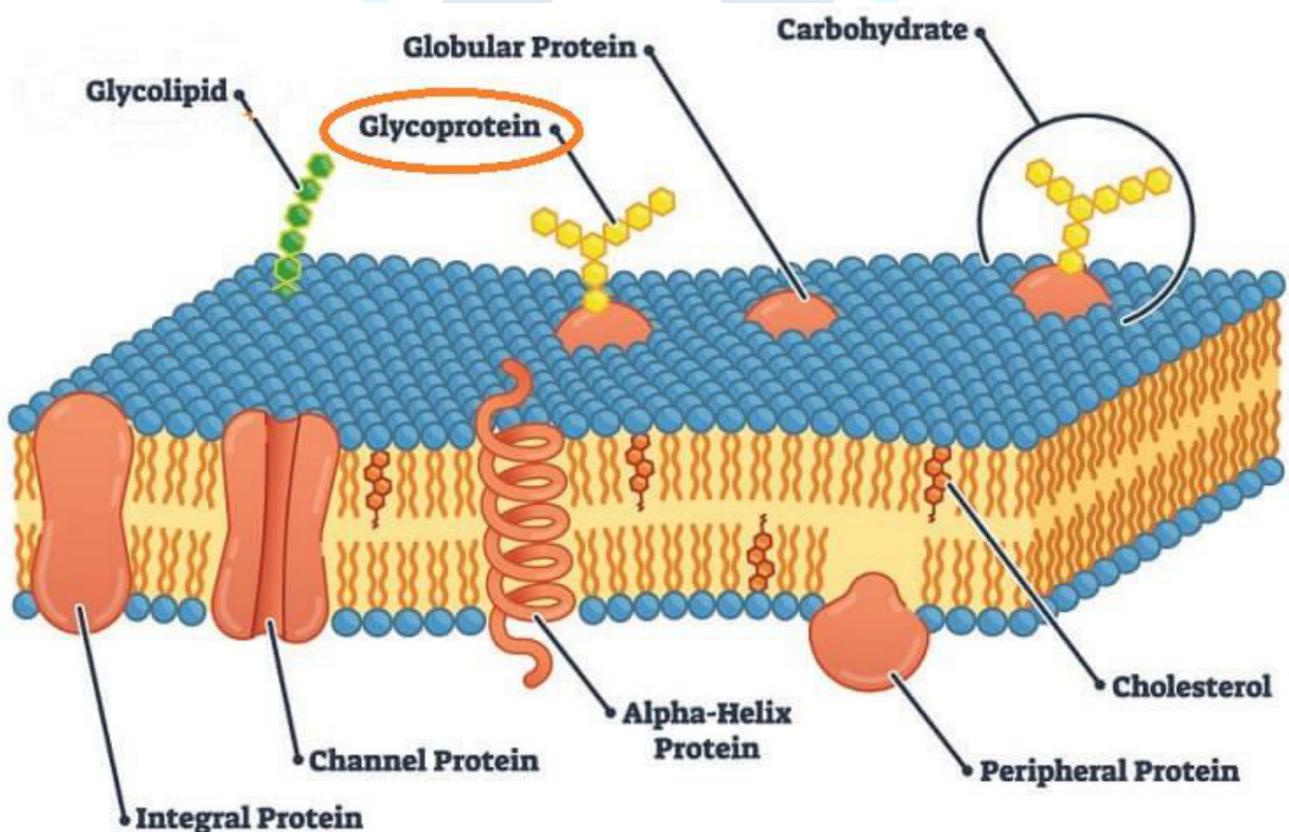
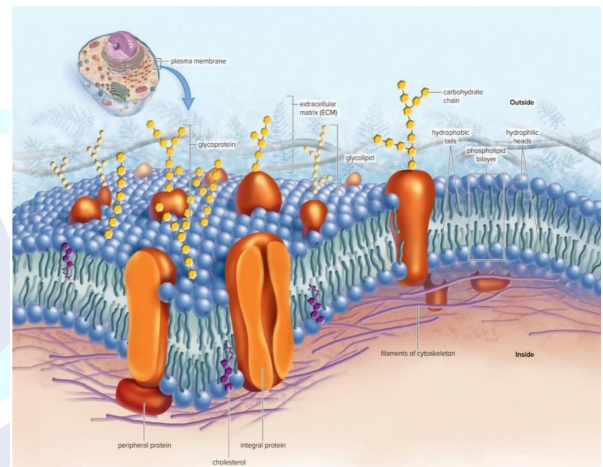


The Plasma Membrane

A **phospholipid bilayer** with proteins that are attached and embedded.

- **Hydrophilic heads** face the cytoplasm and extracellular fluid.
- **Hydrophobic tails** face inward.

- Contains **cholesterol** for support.
- **Glycoproteins** and **glycolipids** — carbohydrate chains attached to proteins and lipids.
- They identify the cell as **"self"** or **"foreign"** and act as **receptors**.

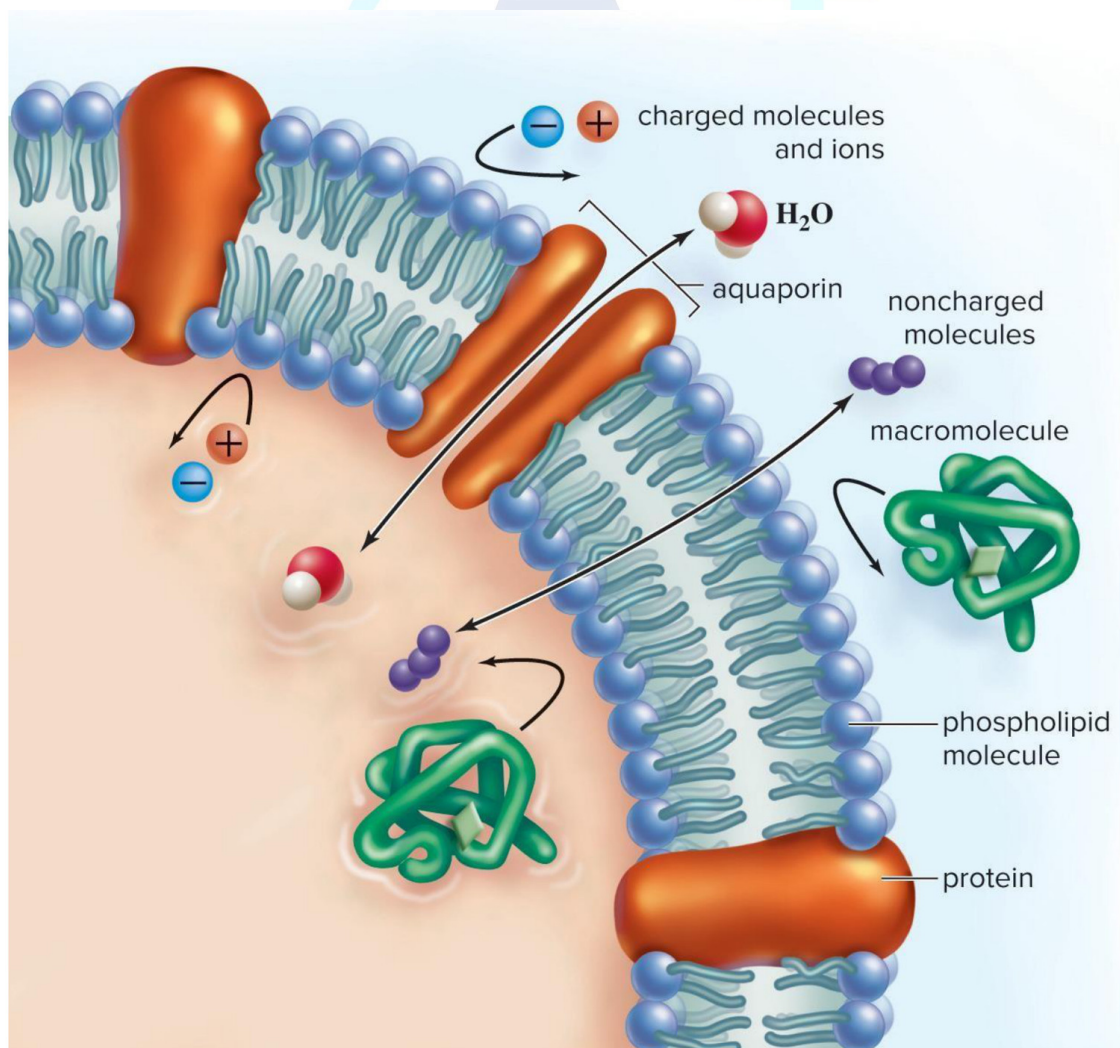




Selective Permeability

Some membrane proteins act as **channels** — they allow some things in while keeping other substances out.

- **Small, hydrophobic substances** pass freely through the phospholipid bilayer.
e.g. gases like oxygen and carbon dioxide.
- **Ions and large molecules** need help passing through.
- Water can cross the membrane by passing through channels called **aquaporins**.





Ways Substances Cross the Membrane

Diffusion

Osmosis

Facilitated diffusion

Active transport

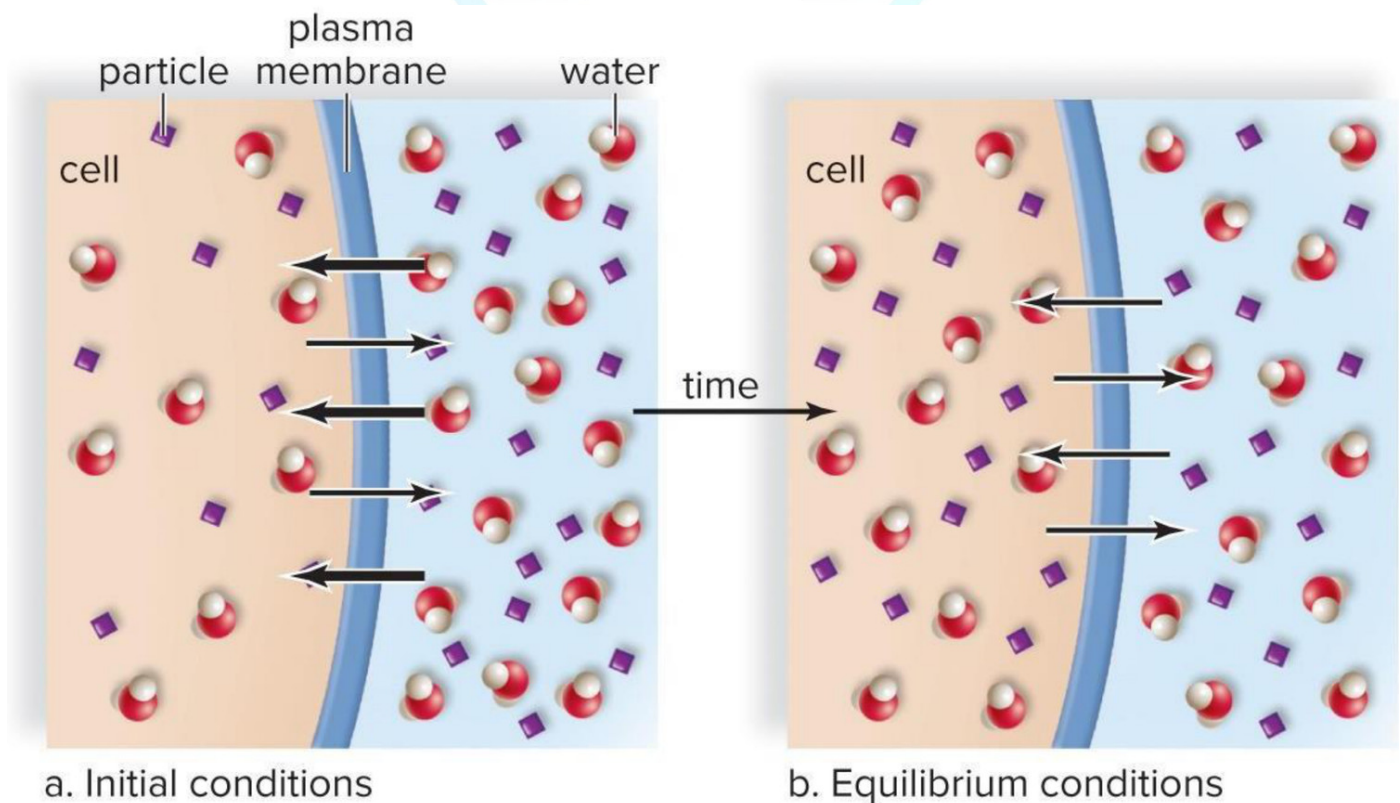
Endocytosis & exocytosis



Diffusion

The **random movement of molecules** from a higher concentration to a lower concentration — until they are equally distributed.

- **Passive** movement; **no energy is required**.
- Molecules move in both directions, but the **net movement** is from high to low concentration.
- At **equilibrium**, the same number of molecules move in and out of the cell.





Osmosis

The **diffusion of water molecules**; from high to low water concentration. **Osmotic pressure** drives osmosis.

Isotonic

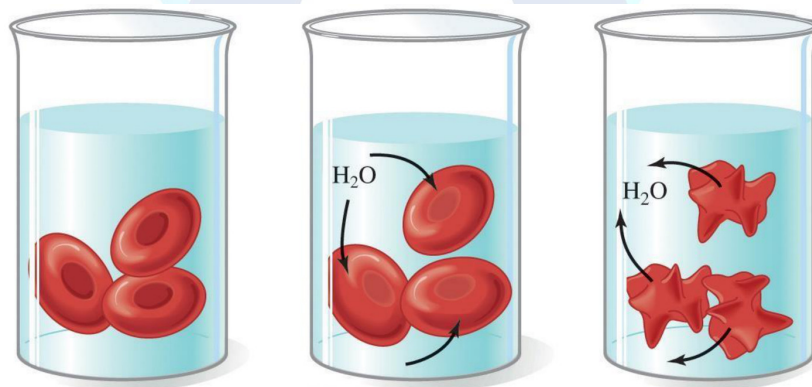
- Normally body fluids are isotonic to cells.
- The same concentration of impermeable solutes.
- **Cells do not change in size.**

Hypotonic

- Hypotonic solutions have **fewer solutes**.
- Cells **swell** and can burst (**lysis**).

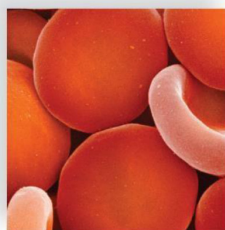
Hypertonic

- Hypertonic solutions have **more solutes**.
- Cells **shrink** (**crenation**).



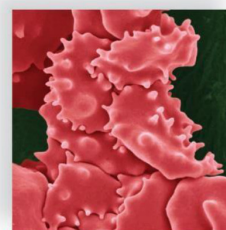
4,300x

a. Isotonic solution
(same solute concentration as in cell)



4,300x

b. Hypotonic solution
(lower solute concentration than in cell)



4,000x

c. Hypertonic solution
(higher solute concentration than in cell)

a. Isotonic · **b.** Hypotonic · **c.** Hypertonic solution.



Facilitated Transport

The transport of molecules across the plasma membrane from **higher to lower concentration** via a protein carrier.

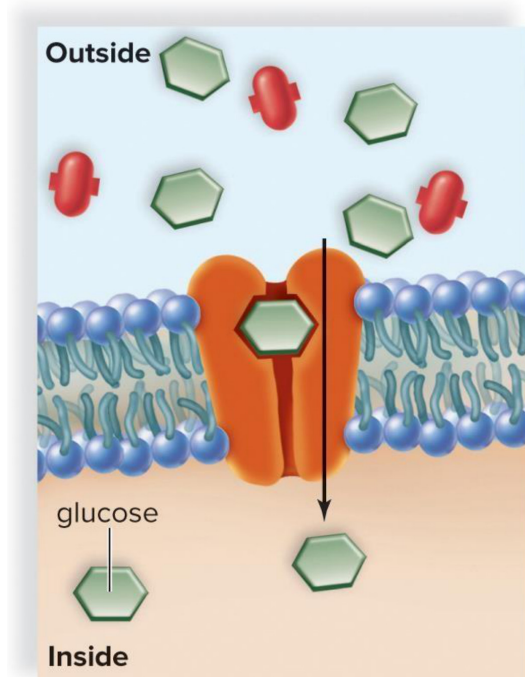
- **Passive transport** — no energy required.
- Protein transporters are **very specific** and only move certain molecules.



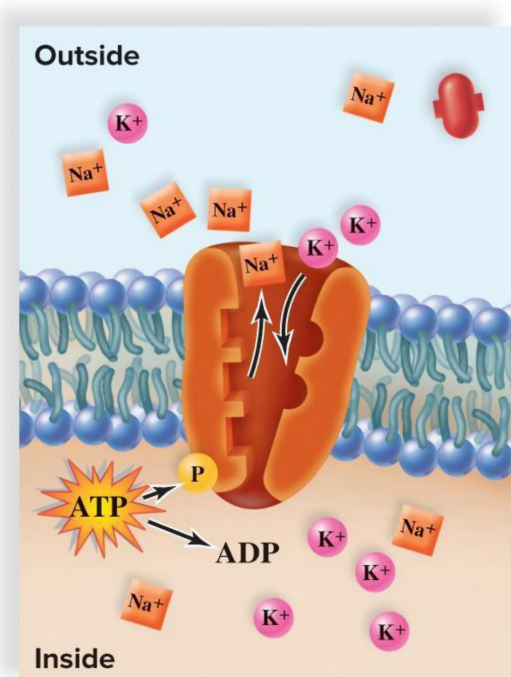
Active Transport

The movement of molecules from a **lower to higher concentration**.

- Uses **ATP** as energy.
- Requires a protein carrier, which is often called a **pump**.



Facilitated transport of glucose



The sodium-potassium pump



Bulk Transport

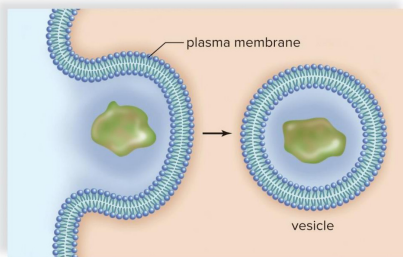
Cells use **bulk transport** to move large molecules across the membrane.

ENDOCYTOSIS

Transports molecules or cells **into** the cell via invagination of the plasma membrane to form a **vesicle**.

Phagocytosis

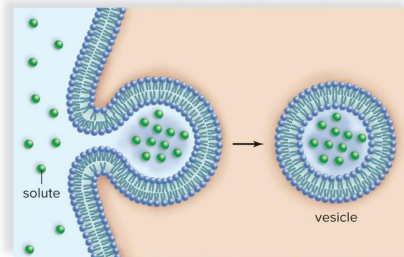
- Endocytosis of pathogens (that is, bacteria) by white blood cells.



a. Phagocytosis

Pinocytosis

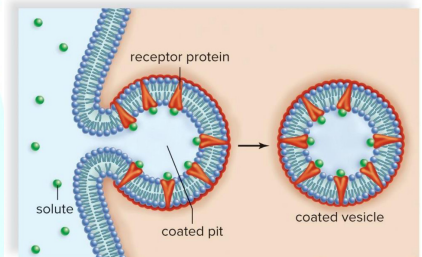
- Endocytosis of fluid with small particles.



b. Pinocytosis

Receptor-mediated

- Particles first bind to receptors in the plasma membrane; this initiates endocytosis.



c. Receptor-mediated endocytosis

EXOCYTOSIS

Transports molecules **outside** the cell via the fusion of a vesicle with the plasma membrane — **sort of like reverse endocytosis**.

