University of Anbar
College of Education for Pure Science
Department of Biology
Zoology>>>>>>> First Class
Dr. Haidar K. Al-Salman

Introduction to Zoology

Biology

Bilology: The term biology is derived from the Greek word βίος, bios, "life" and the suffix "study of." The Latin-language form of the term first appeared in 1736 when Swedish scientist Carl Linnaeus (Carl von Linné) used biologi in his Bibliotheca botanica.

- **Zoology** or **animal biology:** is the branch of biology that studies the animal kingdom, including the structure, embryology, evolution, classification, habits, and distribution of all animals, both living and extinct, and how they interact with their ecosystems.
- **Zoology** – the study of animals, including classification, physiology, development, evolution and behaviour……

1) Morphology - is the field of biology that studies the form and structure of organisms and their specific structural features.

2) Histology is the field of biology that studies the microanatomy of cells, tissues, and organs as seen through a microscope. It examines the correlation between structure and function.

3) Cytology (Cell biology) is the field of biology that studies the cell as a complete unit, and the molecular and chemical interactions that occur within a living cell. This is done on both the microscopic and molecular levels, for single-celled organisms such as bacteria as well as the specialized cells in multicellular organisms such as humans.

4) Physiology – is the field of biology that studies the functions and mechanisms occurring in living organisms.

5) Embryology – the study of the development of embryo (from fecundation to birth).

6) Genetics – the study of genes and heredity

7) Ecology – the study of the interactions of living organisms with one another and with the non-living elements of their environment.

8) Taxonomy - Scientific classification in zoology, is a method by which zoologists group and categorize organisms by biological type, such as genus or species.

9) Anatomy - is the field of biology that studies the organisms structures. It considers the forms of macroscopic structures such as organs and organ systems. It focuses on how organs and organ systems work together in the bodies of humans and animals, in addition to how they work independently.

Comparative anatomy – the study of evolution of species through similarities and differences in their anatomy.

10) Molecular biology – is the field of biology that studies the composition, structure and interactions of cellular molecules – such as nucleic acids and proteins

11) Endocrinology - is the field of biology that studies the endocrine system in the human body. This is a system of glands which secrete hormones. Hormones are chemicals which affect the actions of different organ systems in the body. Examples include thyroid hormone, growth hormone, and insulin.

12) Paleontology – the study of fossils and sometimes geographic evidence of prehistoric life.

Characteristics of Life

Characteristics of Life

Nutrition

Egestion ، Absorption ، Digestion ، Ingestion

Heterotrophic organisms

Autotrophic organisms

Characteristics of Life

Growth

Growth

- Grow occurs as the result of **cell division and cell enlargement**
- **Cell division** is the formation of two cells from a **preexisting cell**
- New cells enlarge as they mature
- When a cell grows to a size where its **surface area isn't big enough for its volume**, the cell divides

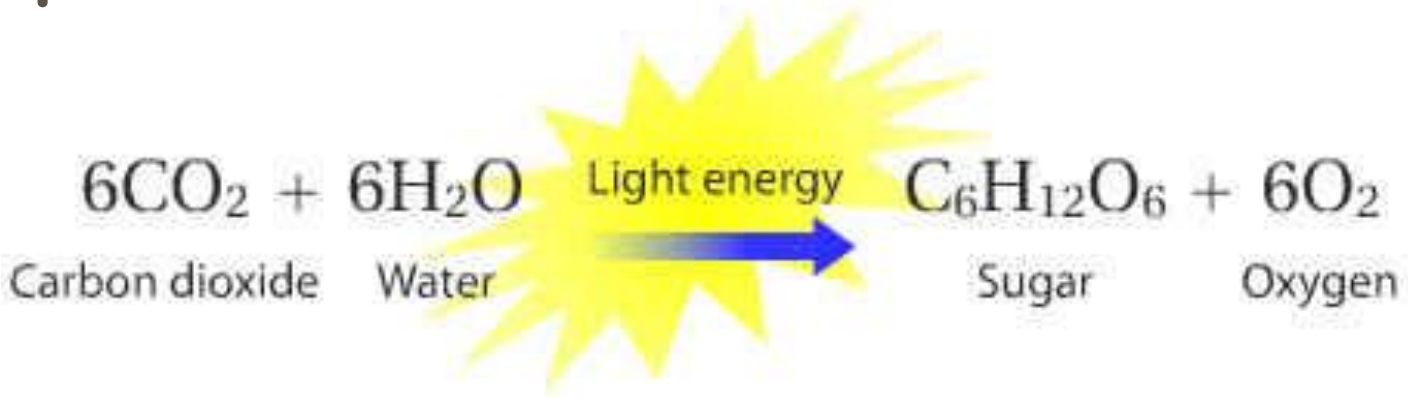
Metabolism

Catabolism

Anabolism

Energy Use

- Use energy in a process called **metabolism**
  - ***Sum of all chemical processes***
- Require energy to maintain their molecular and cellular organization, grow and reproduce



Characteristics of Life

Movement

Locomotion

flagella- pseudopodia –cilia

Characteristics of Life خصائص الحياة

Respiration

External respiration

Internal respiration (Cellular respiration)

Enzymes .

Characteristics of Life

Excretion

Secretion

Characteristics of Life خصائص الحياة

Irritability (Responsiveness)

Responsiveness

- **Respond to stimuli** in the external environment
- Detect and respond to changes in **light, heat, sound and chemical and mechanical contact**
- Coordinates it's responses

Characteristics of Life خصائص الحياة

Reproduction

Asexual…….

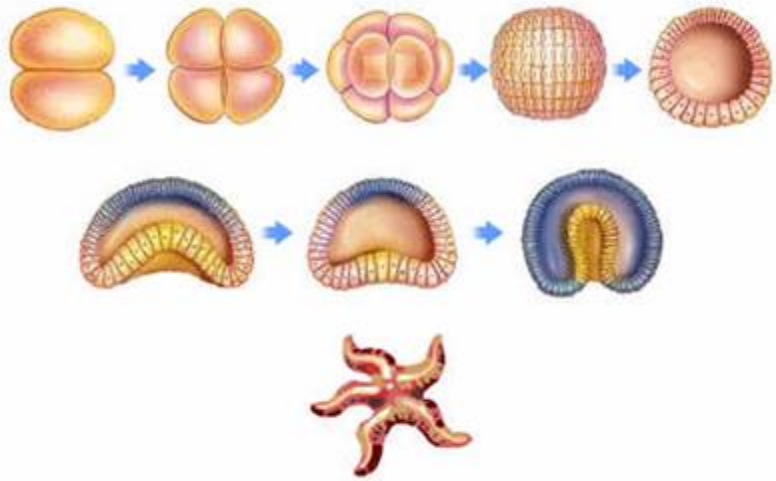
Sexual …….

Reproduction

- All species have the **ability to reproduce**
  - **Not essential to survival of individual** but is essential for continuation of a species

Development

- The process by which an adult organism arise is called **development**
  - Repeated cell divisions and **cell differentiation**



Characteristics of Life

Evolve and Adaption

Evolve

- Ability to adapt to their environment through the process of **evolution**
- **Favorable characteristics** are selected for and passed on to offspring
- Called **adaptations**
- Driven by **natural selection** or **"survival of the fittest"**

Homeostasis

- Maintain **stable internal conditions**
- **Temperature, pH, etc.**

Asking a Question

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The Cell

The basic unit of life

Cell History

- ***Cytology-*** study of cells
- 1665 English Scientist Robert Hooke
- Used a microscope to examine cork (plant)
- Hooke called what he saw "Cells"

Robert Hooke
(1635-1703)

Cell History

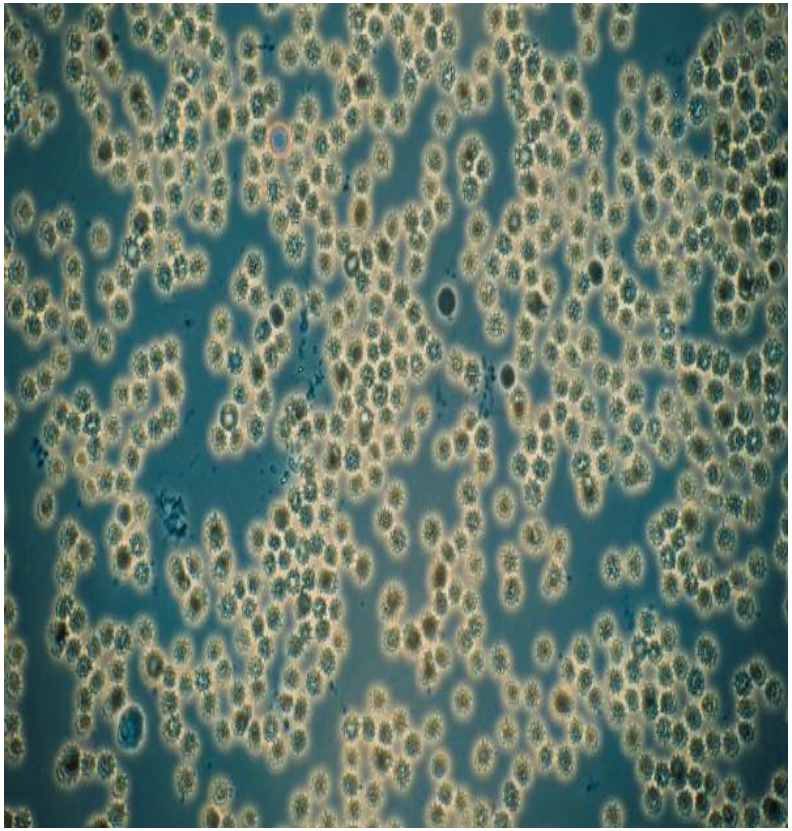
- Robert Brown
  - discovered the nucleus in 1833.
- Matthias Schleiden
  - German Botanist Matthias Schleiden
  - 1838
  - ALL PLANTS "ARE COMPOSED OF CELLS".
- Theodor Schwann
  - Also in 1838,
  - discovered that animals were made of cells

Cell History

- Rudolf Virchow
  - 1855, German Physician
  - " THAT CELLS ONLY COME FROM OTHER CELLS".
- His statement debunked "**Theory of Spontaneous Generation"**

Cell Theory

- The COMBINED work of Schleiden, and Schwann make up the modern **CELL THEORY**.



The Cell Theory states that:

1. All living things are composed of a cell or cells.

2. Cells are the basic unit of life.

3. All cells come from preexisting cells.

Explain: Cell Diversity

- Cells within the same organism show Enormous Diversity in:
  - Size
  - Shape
  - Internal Organization

- **Unicellular organisms**
- **Multicellular organisms**

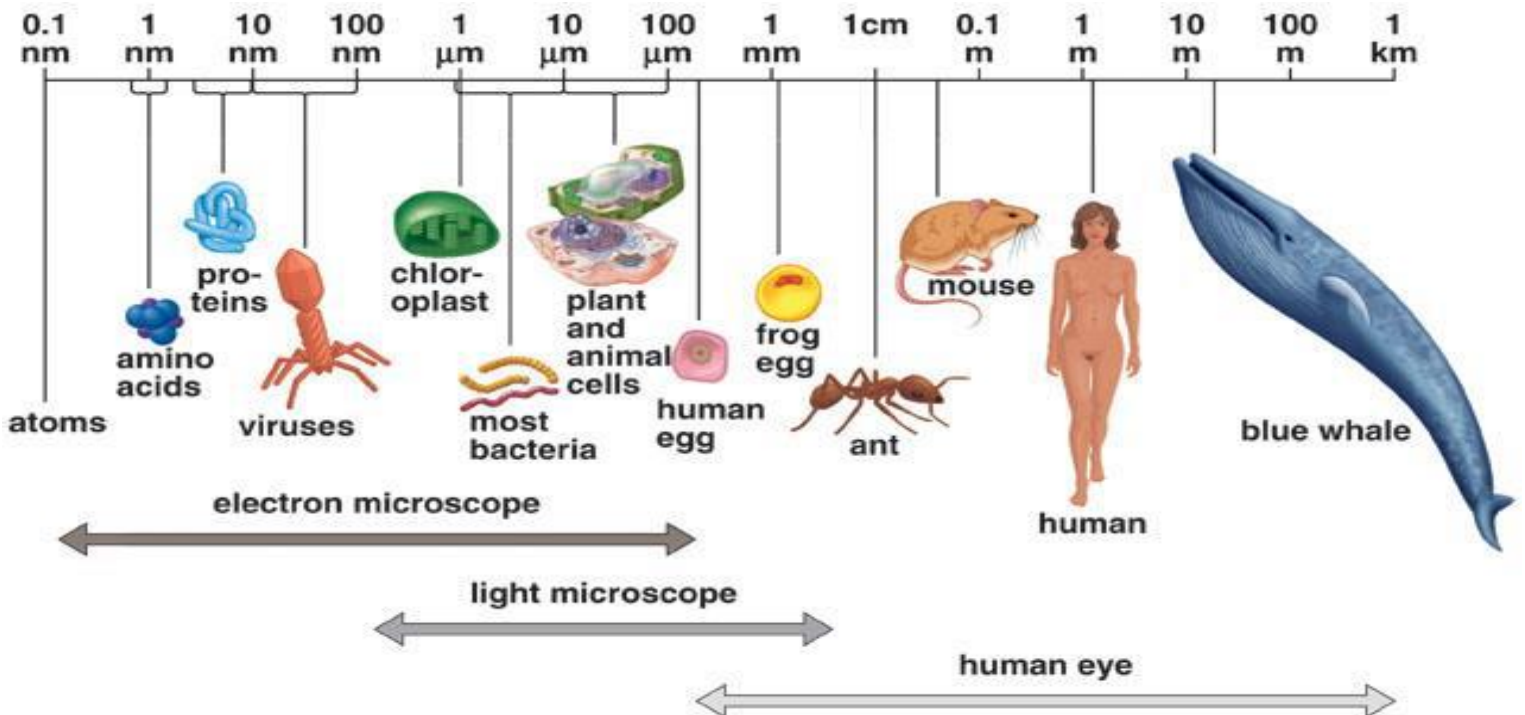
Cell zise

1 Micrometer (µm) = 0.001 Millimeters (mm)

1 Millimeter (mm) = 0.1 Centimeter (cm)

1. Cell Size

- Female Egg - largest cell in the human body; seen without the aid of a microscope
- Most cells are visible only with a microscope.

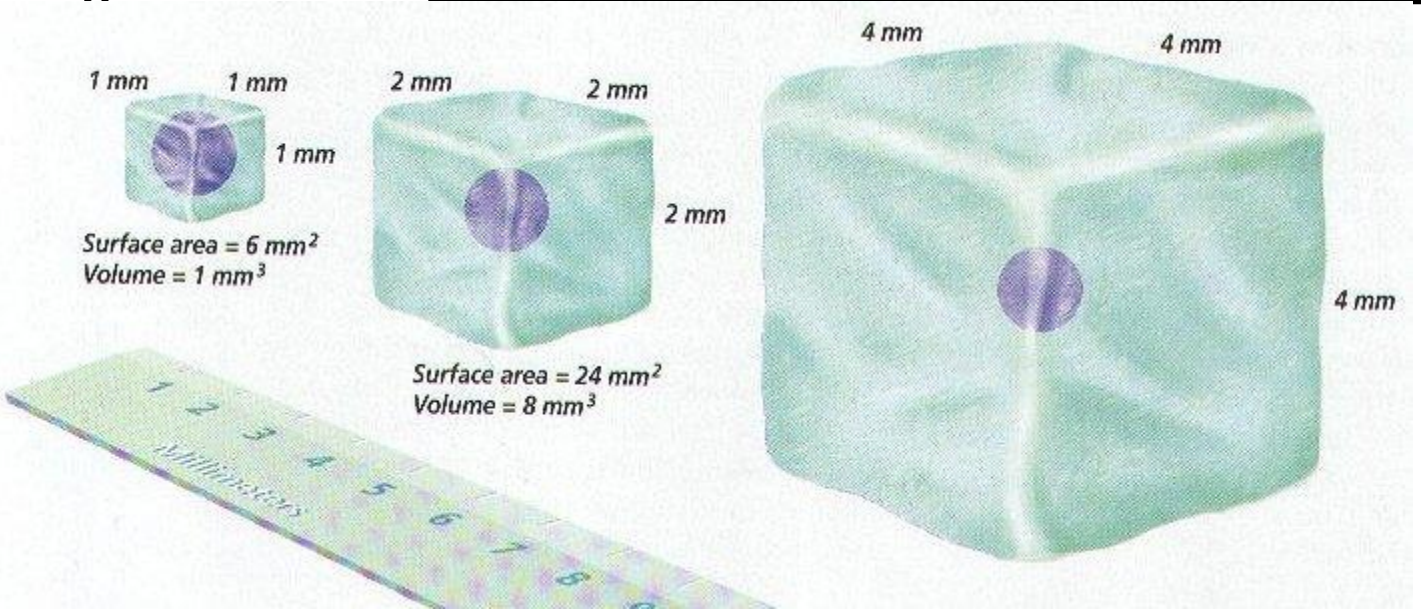


Cells are small for 2 Reasons

Reason 1:

- Limited in size by the RATIO between their Outer Surface Area and Their Volume.

  A small cell has more SURFACE AREA than a large cell for a GIVEN VOLUME OF CYTOPLASM.



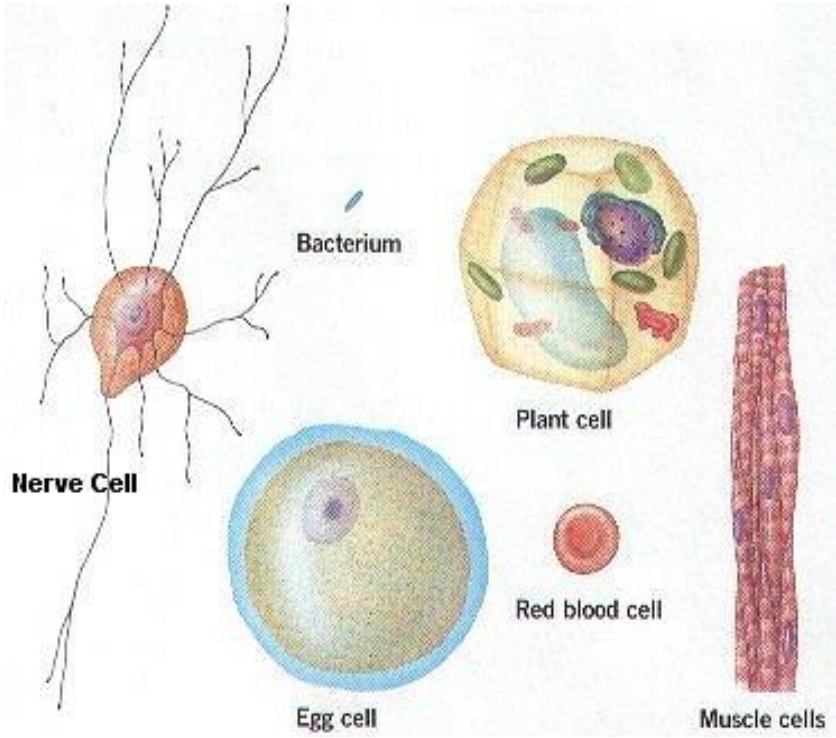
Cells are Small

Reason 2:

- THE CELL'S NUCLEUS (THE BRAIN) CAN ONLY CONTROL A CERTAIN AMOUNT OF LIVING, ACTIVE CYTOPLASM.

2. Cell Shapes

- Diversity of form reflects a diversity of function.
- **THE SHAPE OF A CELL DEPENDS ON ITS FUNCTION.**



2. Cell Shapes

Flattened shape squamous shape

..... Cuboidal shape

..... Columnar shape

..... Discoidal shape

..... Spherical shape

..... Spindle shape

..... Elongated shape

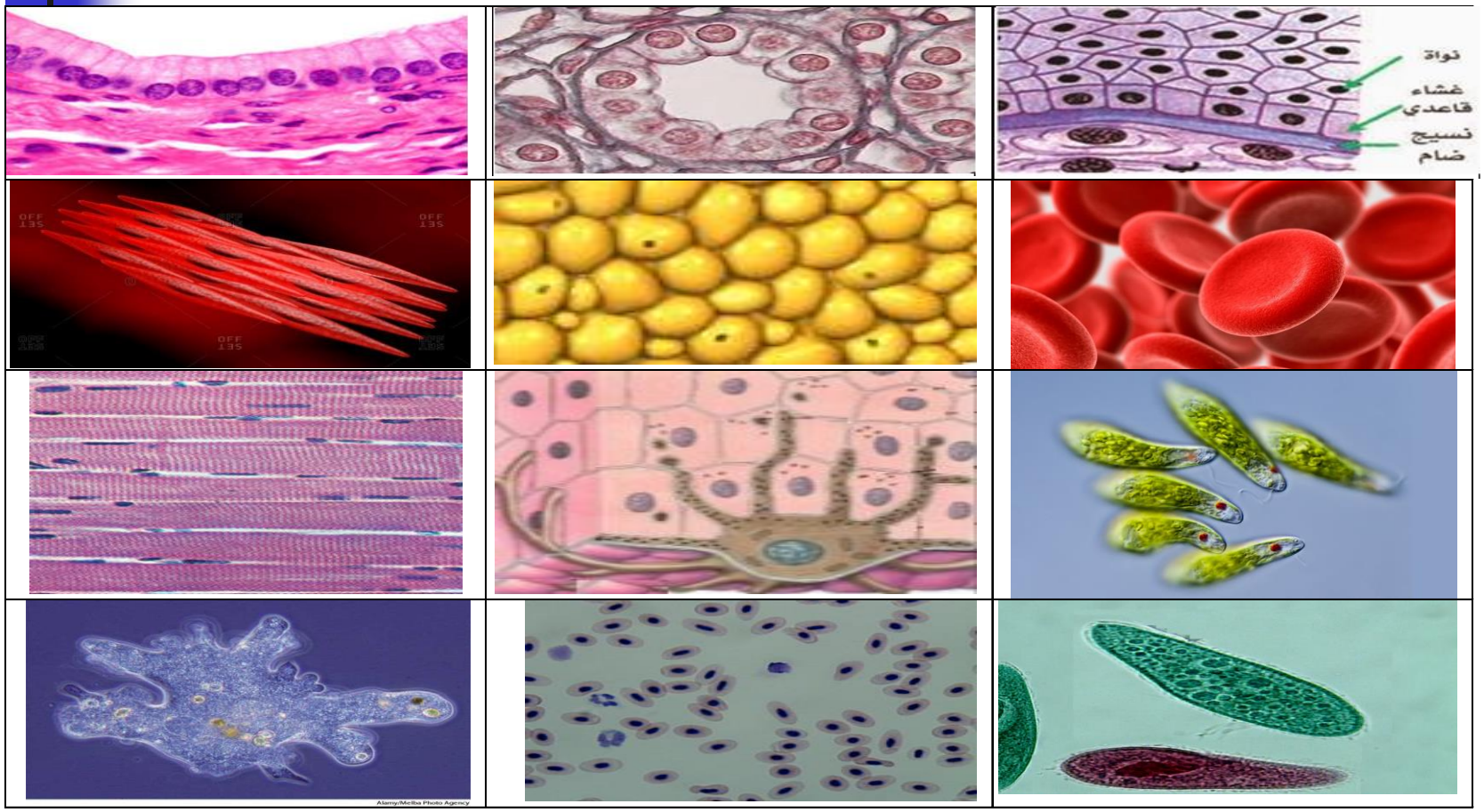
..... **Oval shape**

..... Branched shape

……. (Irregular shape) Ameboid shape

…….Cylendrical shape

2. Cell Shapes



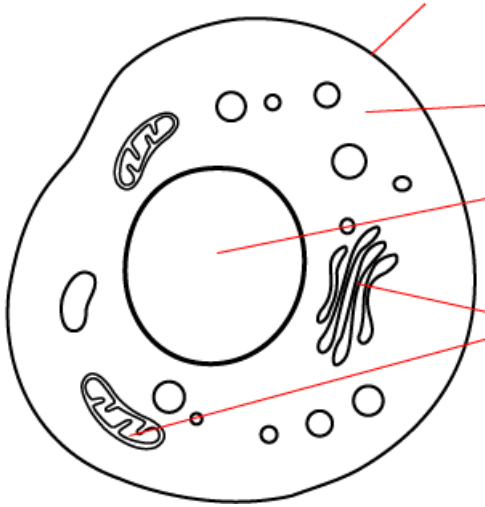
3. Internal Organization

Cell membrane

Cytoplasm

Prokaryotic Cell

Eukaryotic Cell



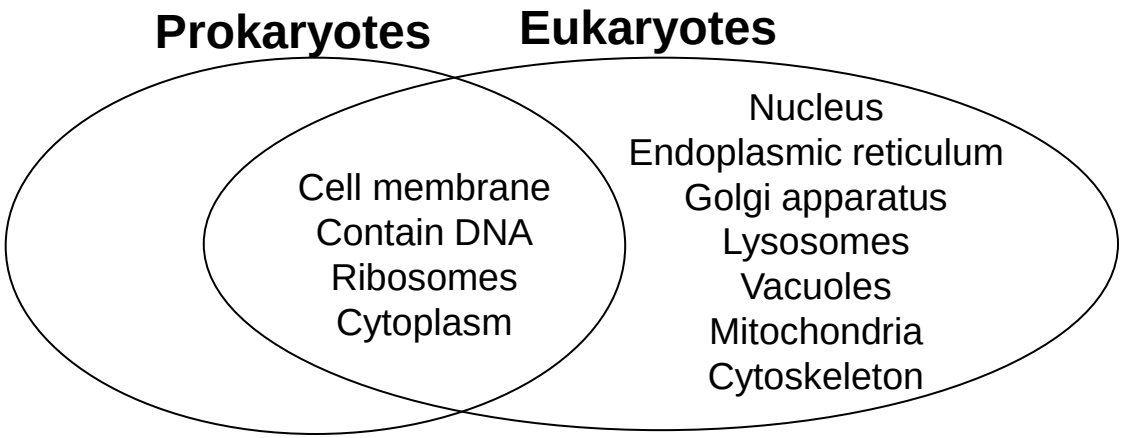
Prokaryotic Cell & Eukaryotic Cell

Characteristic	Prokaryote	Eukaryote
Typical organism	Bacteria, Mycoplasma, Blue-green bacteria, Archaea	Protists, Fungi, Plants, Animals
Organization	Usually single cells	Single cells, colonies, higher multicellular organisms with specialized cells
Size	1-10 µm	10-100µm
Nuclear Envelope	Absent	Present
Type of nucleus	Nucleoid region, no true nucleus	True nucleus with double membrane
DNA	Circular usually	Linear molecules (chromosomes) with histone proteins
Chromosomes	Single chromosome	Multiple (more than one chromosome)
RNA / protein synthesis	Coupled in the cytoplasm	RNA synthesis in the nucleus Protein synthesis in the cytoplasm
Membrane	Cell membrane	Cell membrane and membrane-bound organelles
Cytoplasmic structure	Very few structures	Highly structured by endomembranes and a cytoskeleton

Prokaryotic Cell & Eukaryotic Cell

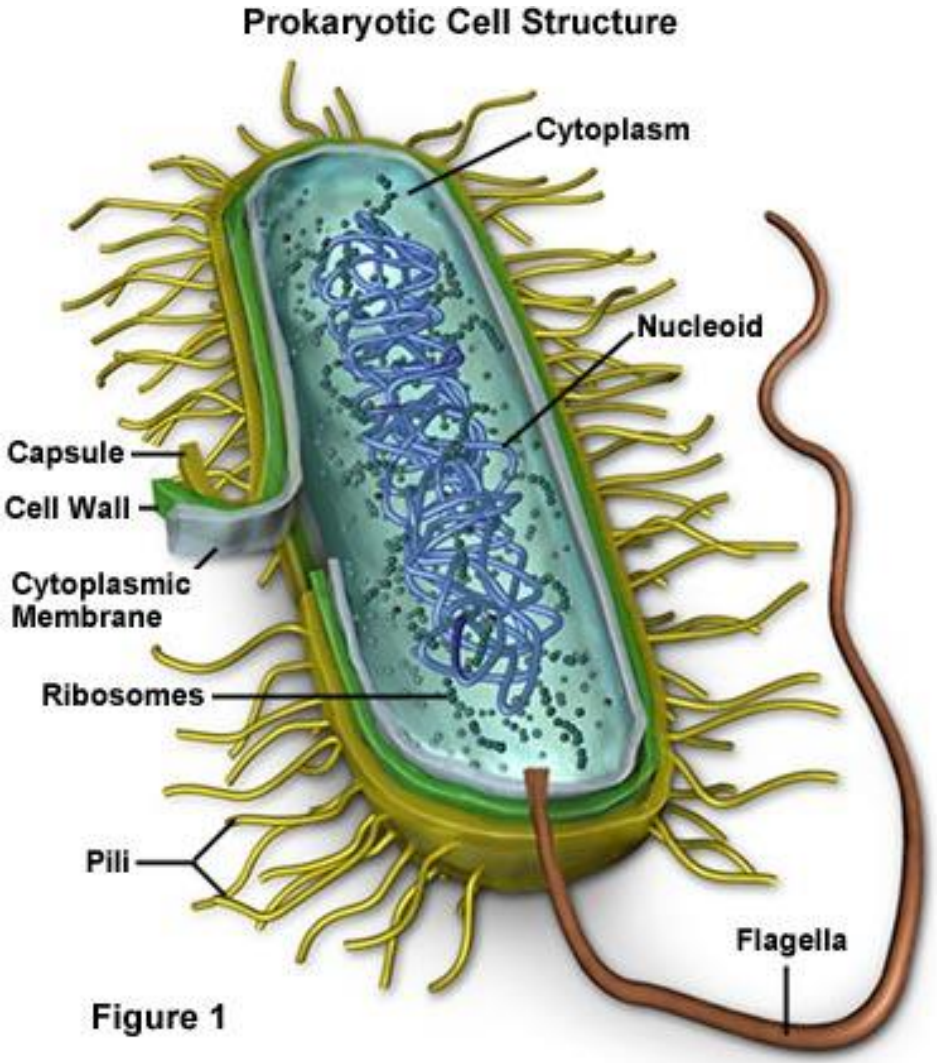
Characteristic	Prokaryote	Eukaryote
Golgi apparatus	Absent	Present
Endoplasmic reticulum		
Mitochondria		
Lysosomes		
Ribosomes	Relatively small 70S (two subunits: 50S and 30S)	Relatively large 80S (two subunits: 40S and 60S)
Cell movement	Flagella (lack microtubules and made of flagellin)	Flagella and cilia containing microtubules; lamellipodia and filopodia containing actin
Cell division	Binary fission (simple division)	Mitosis (fission or budding); Meiosis
Chlorophyll (Plant cell)	Not in chloroplasts	Present in chloroplasts (algae and plants)

Compare and Contrast



Prokaryotic Examples

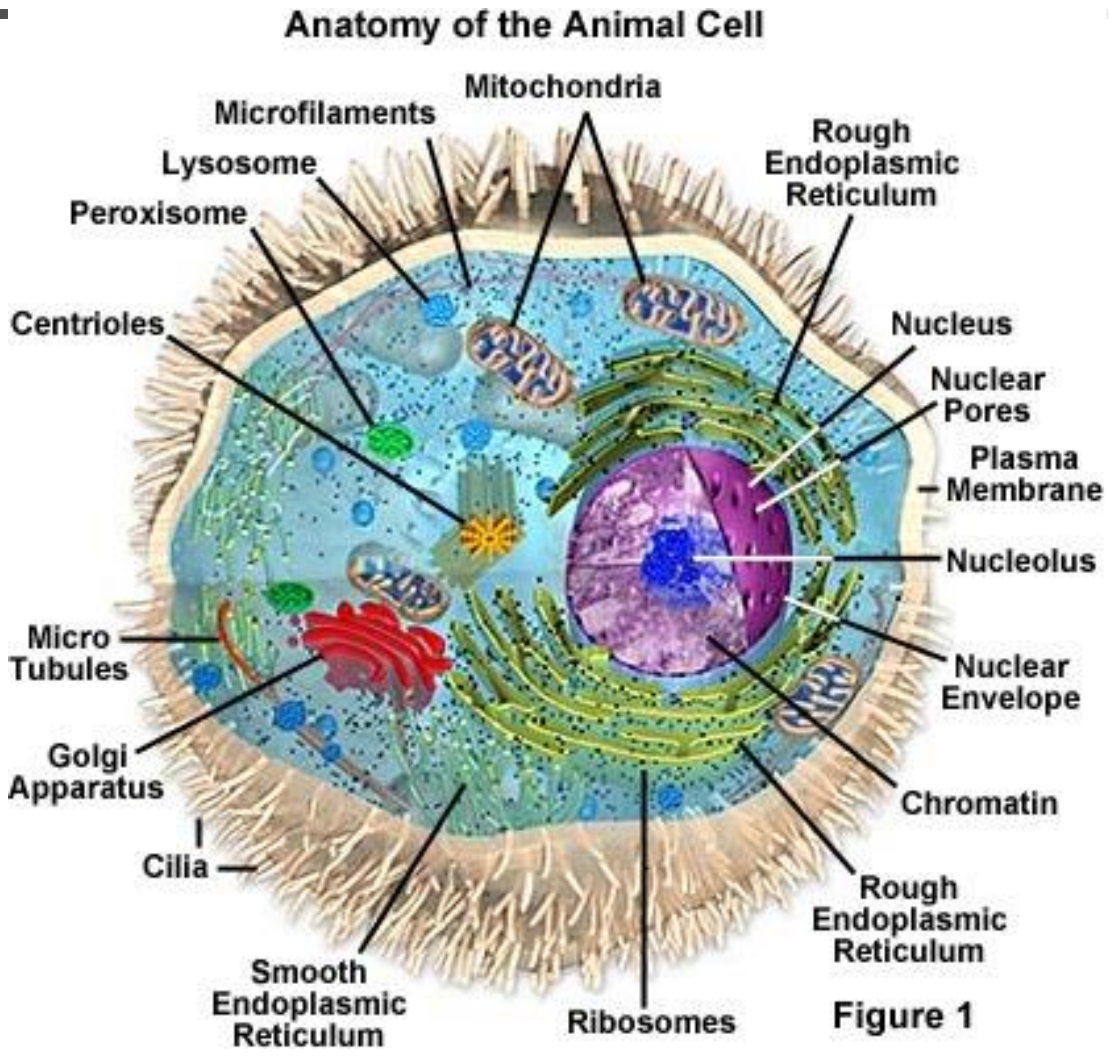
ONLY Bacteria

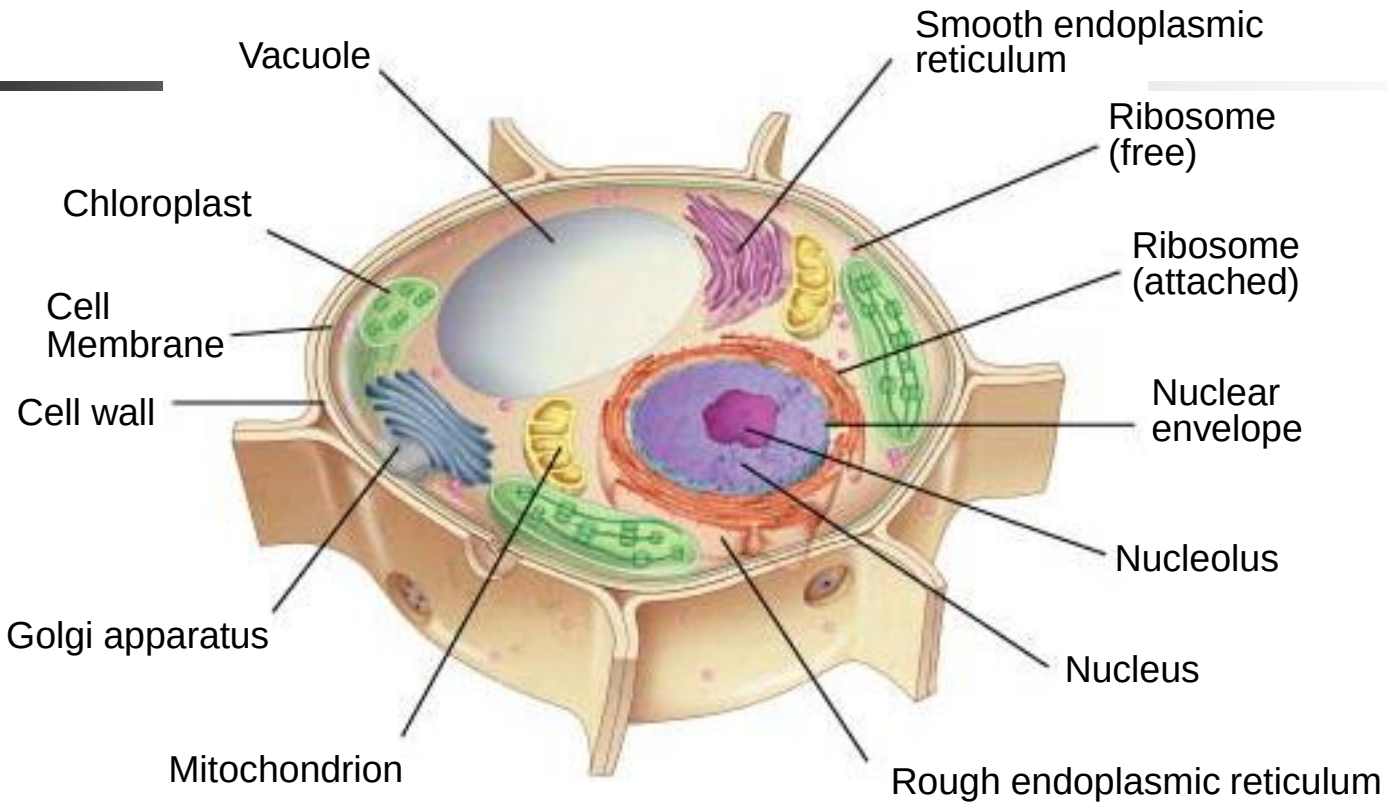


EUKARYOTIC CELLS

Two Kinds:
Plant and Animal

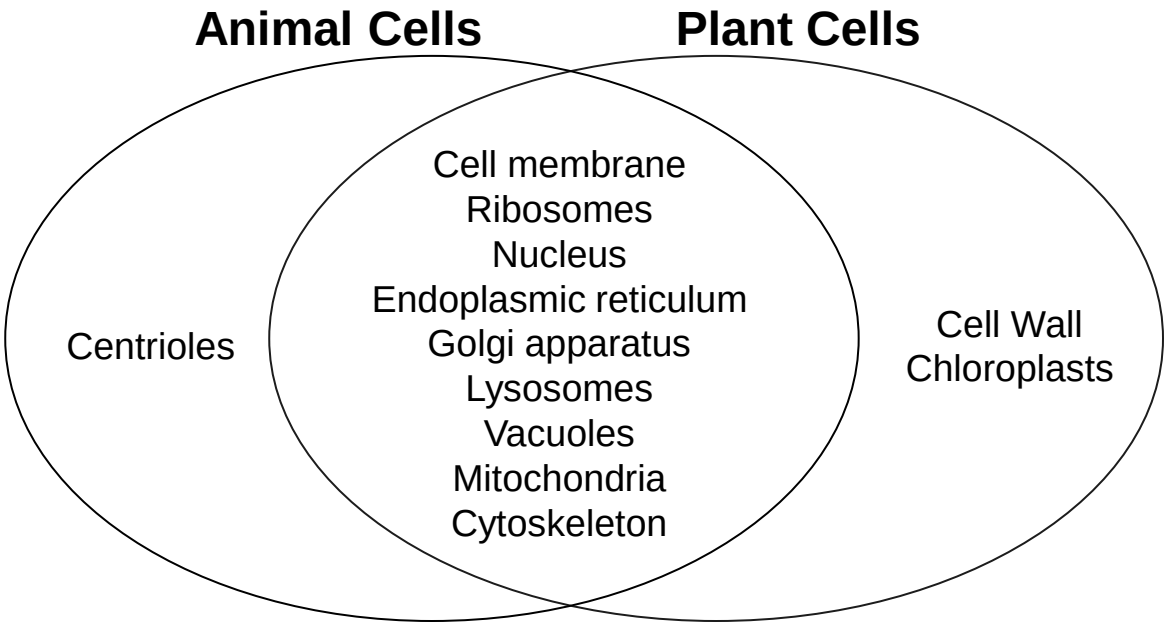
Eukaryotic Example



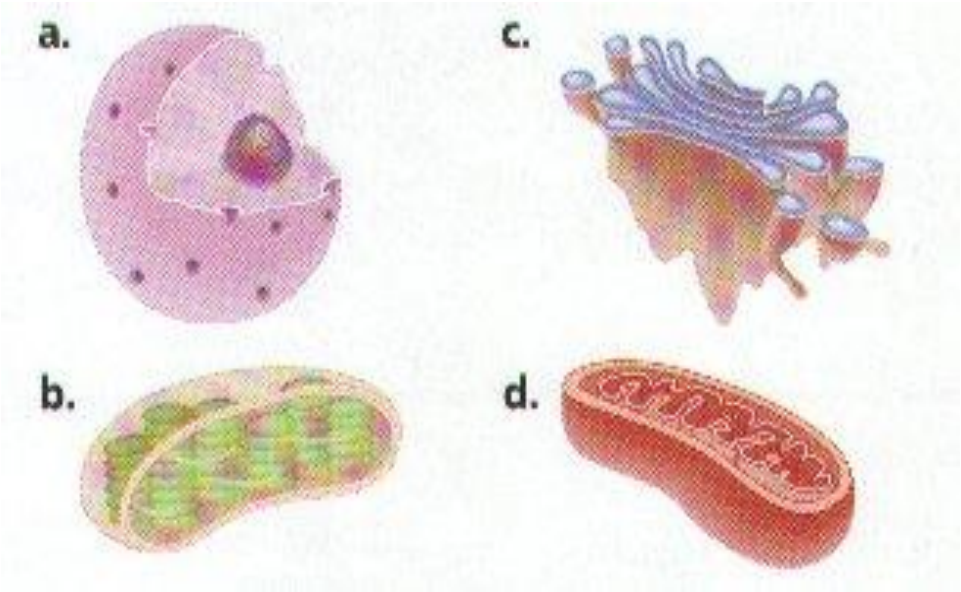

Vacuole
Smooth endoplasmic reticulum
Ribosome (free)
Chloroplast
Ribosome (attached)
Cell Membrane
Cell wall
Nuclear envelope
Nucleolus
Golgi apparatus
Nucleus
Mitochondrion
Rough endoplasmic reticulum

Plant Cell

Compare and Contrast



Internal Organization



- Cells contain **<u>ORGANELLES</u>**.
- Cell Components that PERFORMS SPECIFIC FUNCTIONS FOR THE CELL.

Cellular Organelles

- **The Plasma membrane**
  - The boundary of the cell.
  - Composed of three distinct layers.
  - Two layers of fat and one layer of protein.

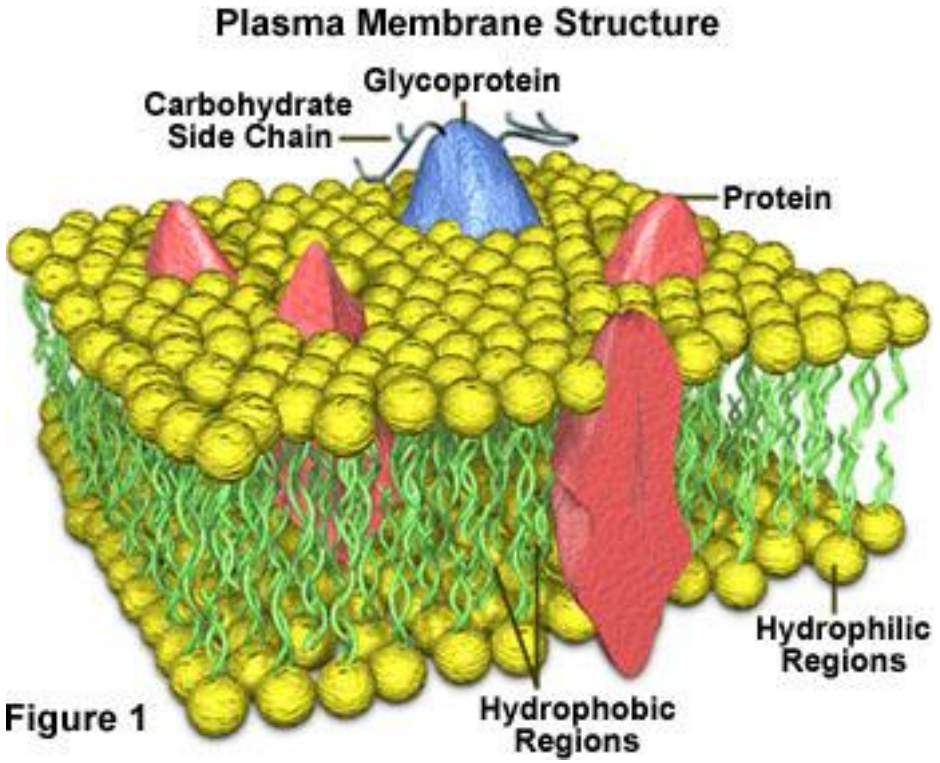


Figure 1

The Nucleus

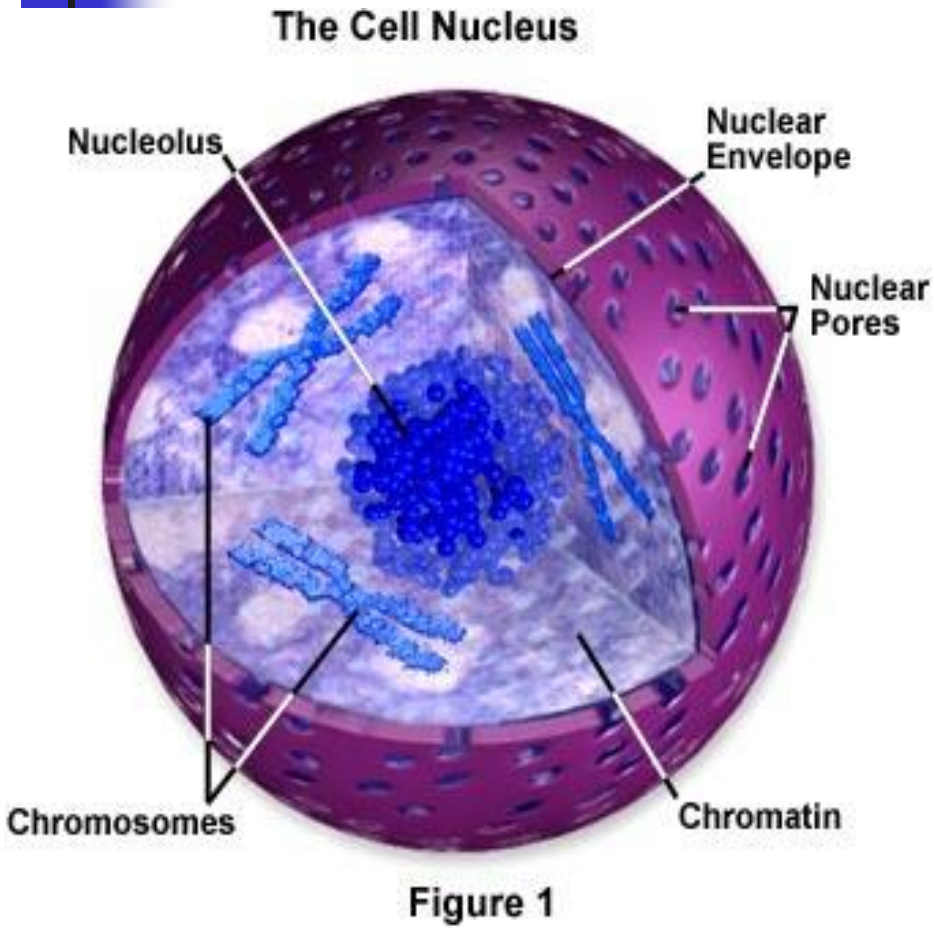
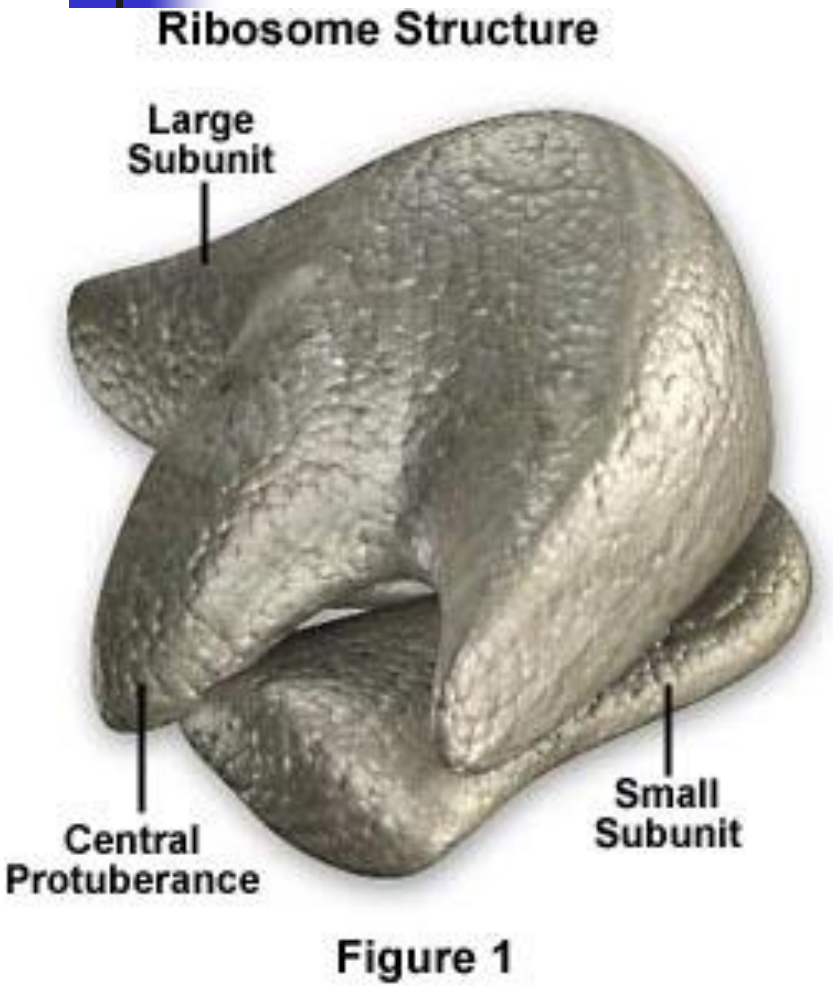


Figure 1

- Brain of Cell
- Bordered by a porous membrane - nuclear envelope.
- Contains thin fibers of DNA and protein called Chromatin.
- Rod Shaped Chromosomes
- Contains a small round nucleolus
  - produces ribosomal RNA which makes ribosomes.

Ribosomes



- Small **non-membrane** bound organelles.
- Contain two sub units
- Site of protein synthesis.
- Protein factory of the cell
- Either free floating or attached to the Endoplasmic Reticulum.

Endoplasmic Reticulum

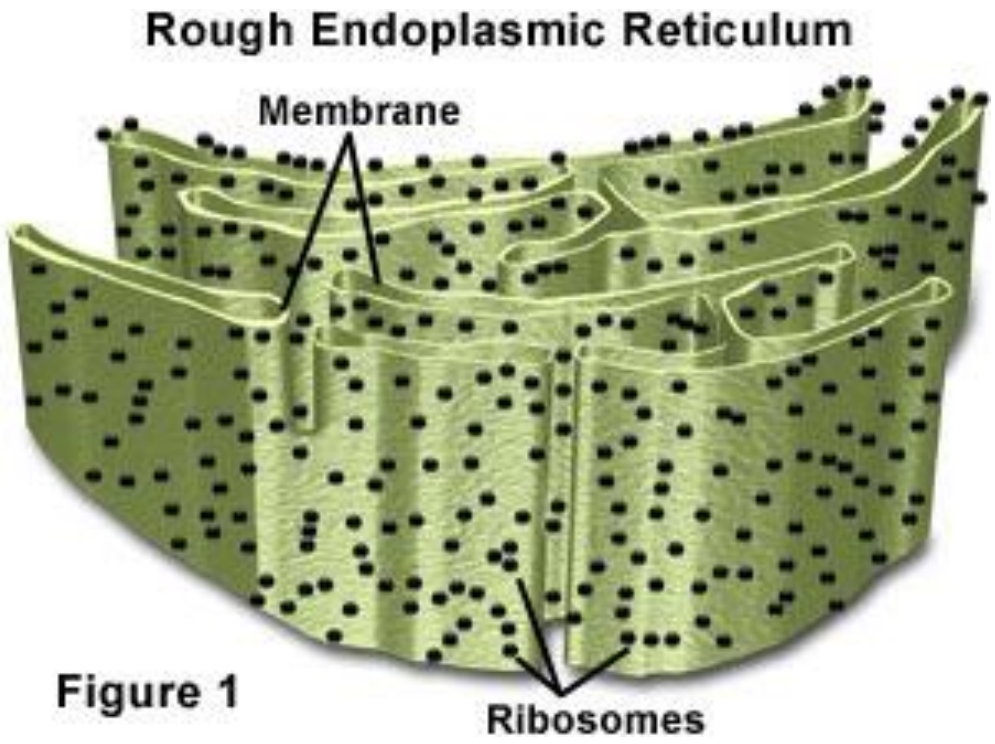


Figure 1

- Complex network of transport channels.
- Two types:

1. **Smooth**- ribosome free and functions in poison detoxification.
2. **Rough** - contains ribosomes and releases newly made protein from the cell.

Golgi Apparatus

- A series of flattened sacs that modifies, packages, stores, and transports materials out of the cell.
- Works with the ribosomes and Endoplasmic Reticulum.

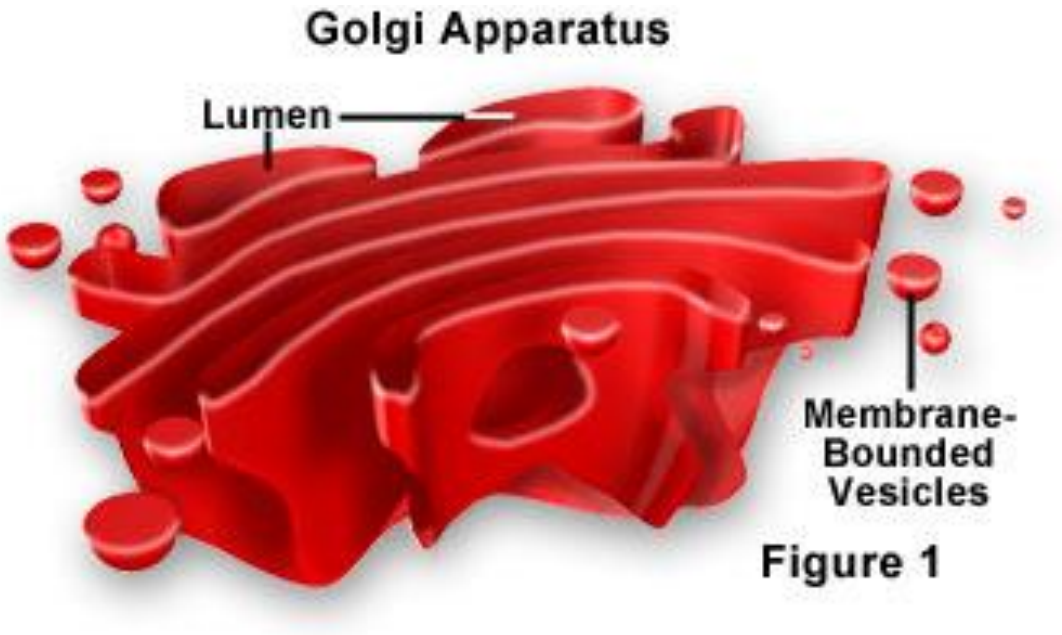
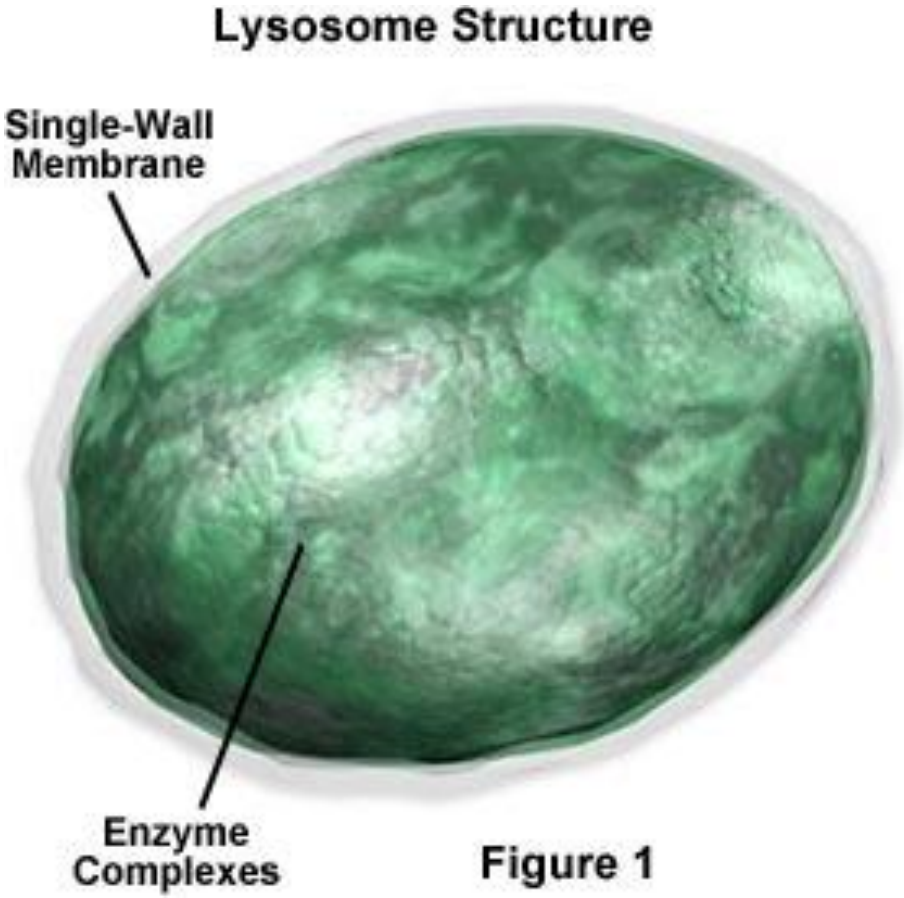


Figure 1

Lysosomes



- Recycling Center
  - Recycle cellular debris
- Membrane bound organelle containing a variety of enzymes.
- Internal pH is 5.
- Help digest food particles inside or out side the cell.

Centrioles

- Found **only** in animal cells
- Paired organelles found together near the nucleus, at right angles to each other.
- Role in building cilia and flagella
- Play a role in cellular reproduction

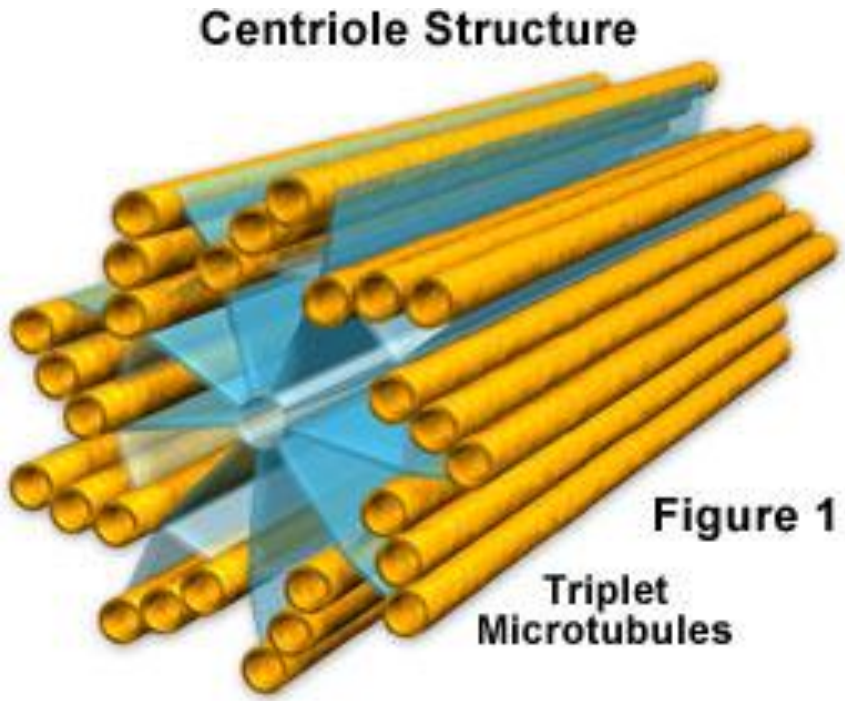
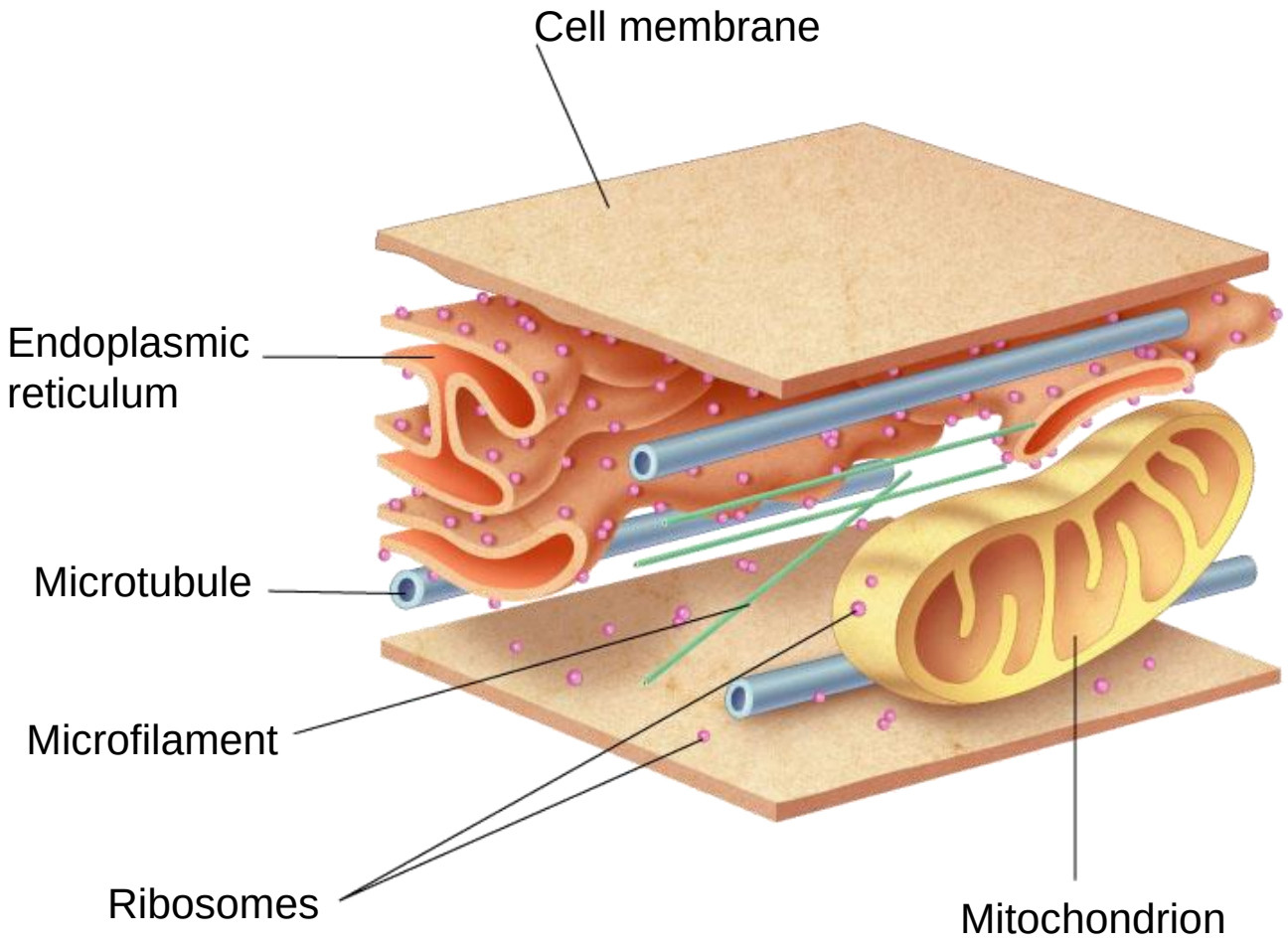


Figure 1

Cytoskeleton

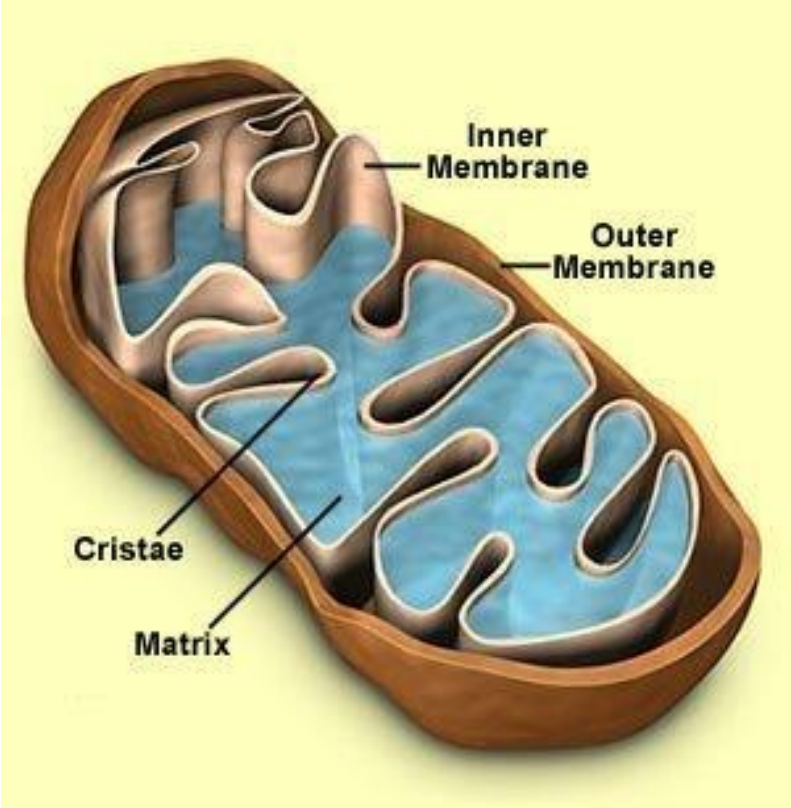


Cytoskeleton

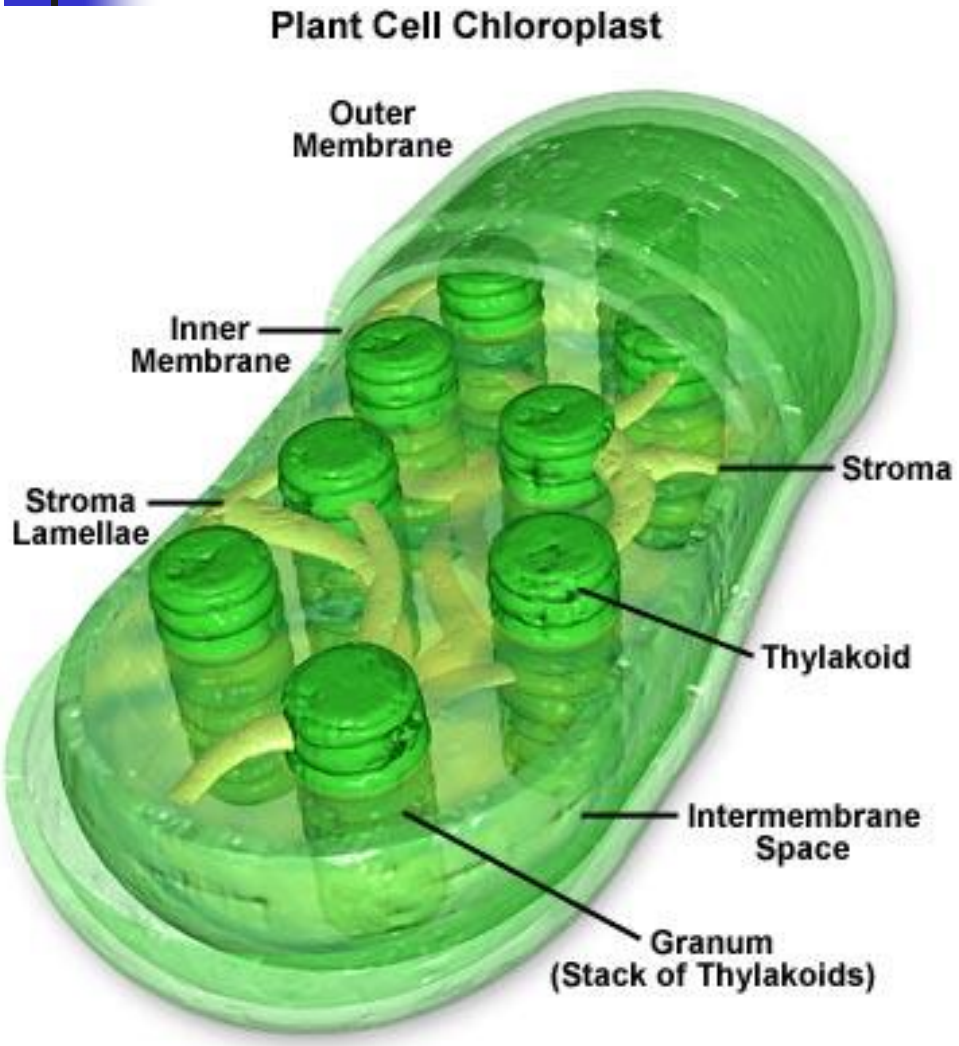
- Framework of the cell
- Contains small microfilaments and larger microtubules.
- They support the cell, giving it its shape and help with the movement of its organelles.

Mitochondrion

- Double Membranous
- It's the size of a bacterium
- Contains its own DNA; mDNA
- Produces high energy compound ATP



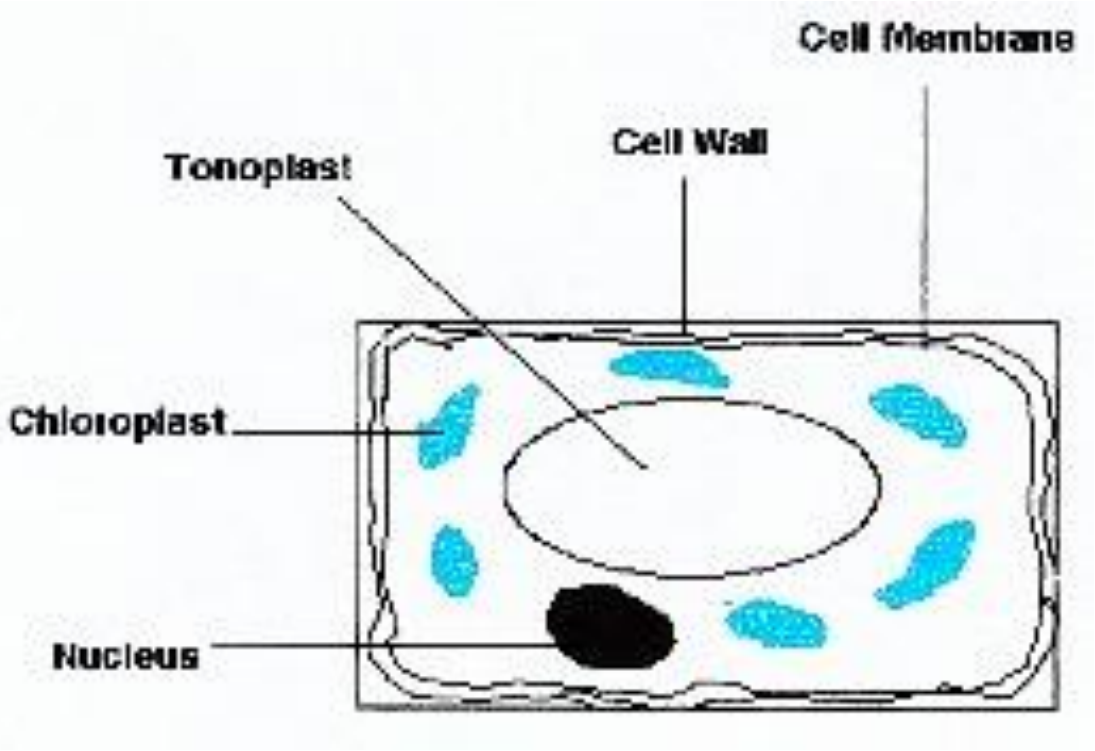
The Chloroplast



- Double membrane
- Center section contains grana
- Thylakoid (coins) make up the grana.
- Stroma - gel-like material surrounding grana
- Found in plants and algae.

The Vacuole

- Sacs that help in food digestion or helping the cell maintain its water balance.
- Found mostly in plants and protists



Cell Wall

- Extra structure surrounding its plasma membrane in plants, algae, fungi, and bacteria.
- Cellulose – Plants
- Chitin – Fungi
- Peptidoglycan - Bacteria

Review

A. The Discovery of the Cell
    1. Robert Hooke
    2. The Cell Theory
B. Exploring Cell Diversity
    1. Size
    2. Shape
    3. Internal Organization
C. Two types of cells
    1. Prokaryote
    2. Eukaryote

Cell Types (Review)

Eukaryotic

1. Contains a nucleus and other membrane bound organelles.
2. Rod shaped chromosomes
3. Found in all kingdoms except the Eubacteria and Archaebacteria

Prokaryotic

1. Does not contain a nucleus or other membrane bound organelles.
2. Circular chromosome
3. Found only in the Eubacteria and Archaebacteria Kingdoms

Elaborate

- **Modeling the Animal Cell**
- You will create a cellular game. By following the procedure, you will create a closed circuit using a battery, wires, paper spreaders, and an LED light that will turn on when they match up the organelle with its correct function

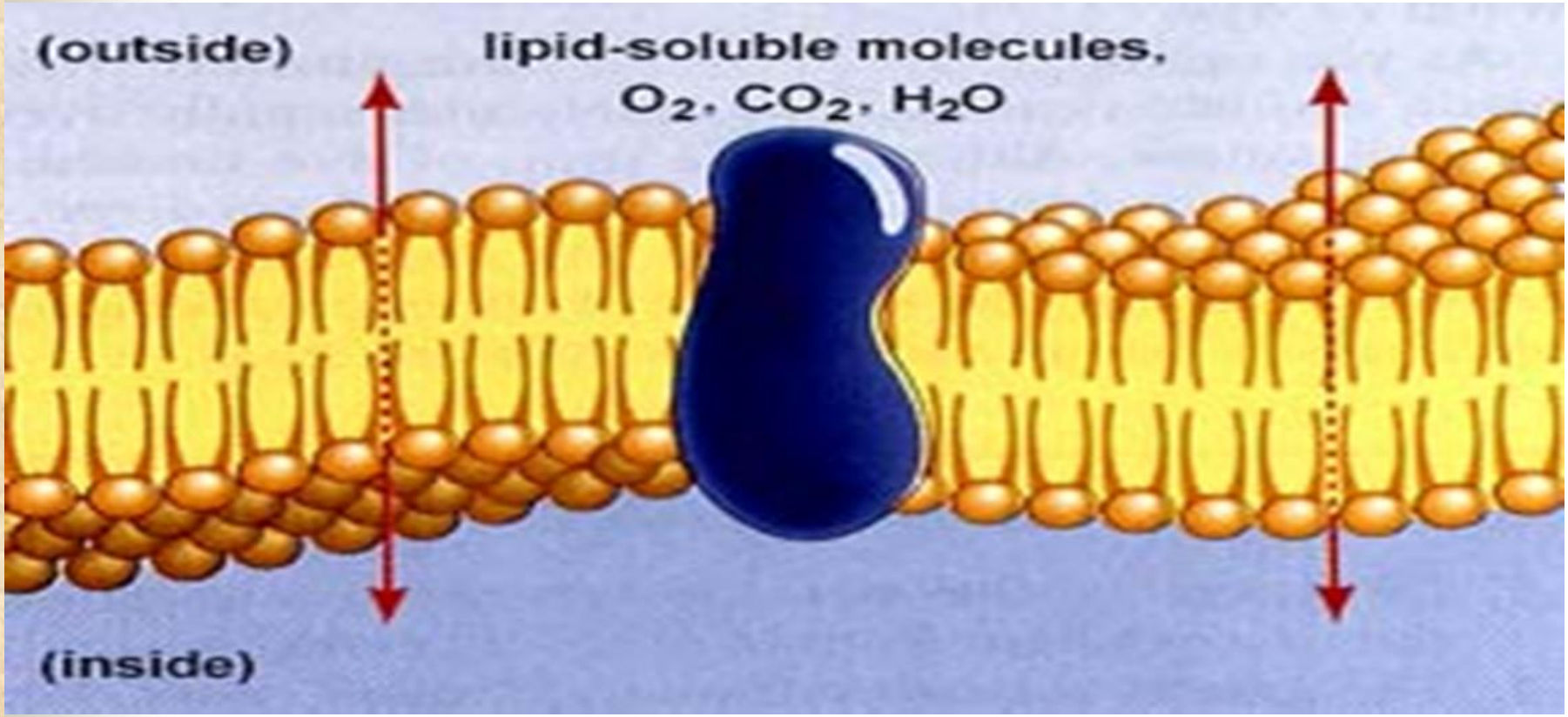
Evaluate

- The students will create an edible cell model and correctly identify the location and function of at least 8 organelles.
- The students will correctly match at least 10 organelles with their function, using the animal and plant cell model.
- The students will draw and label both a prokaryotic and a eukaryotic cell. Pass/Fail
- The students will complete a Venn diagram comparing both prokaryotic and eukaryotic cells showing at least two differences.

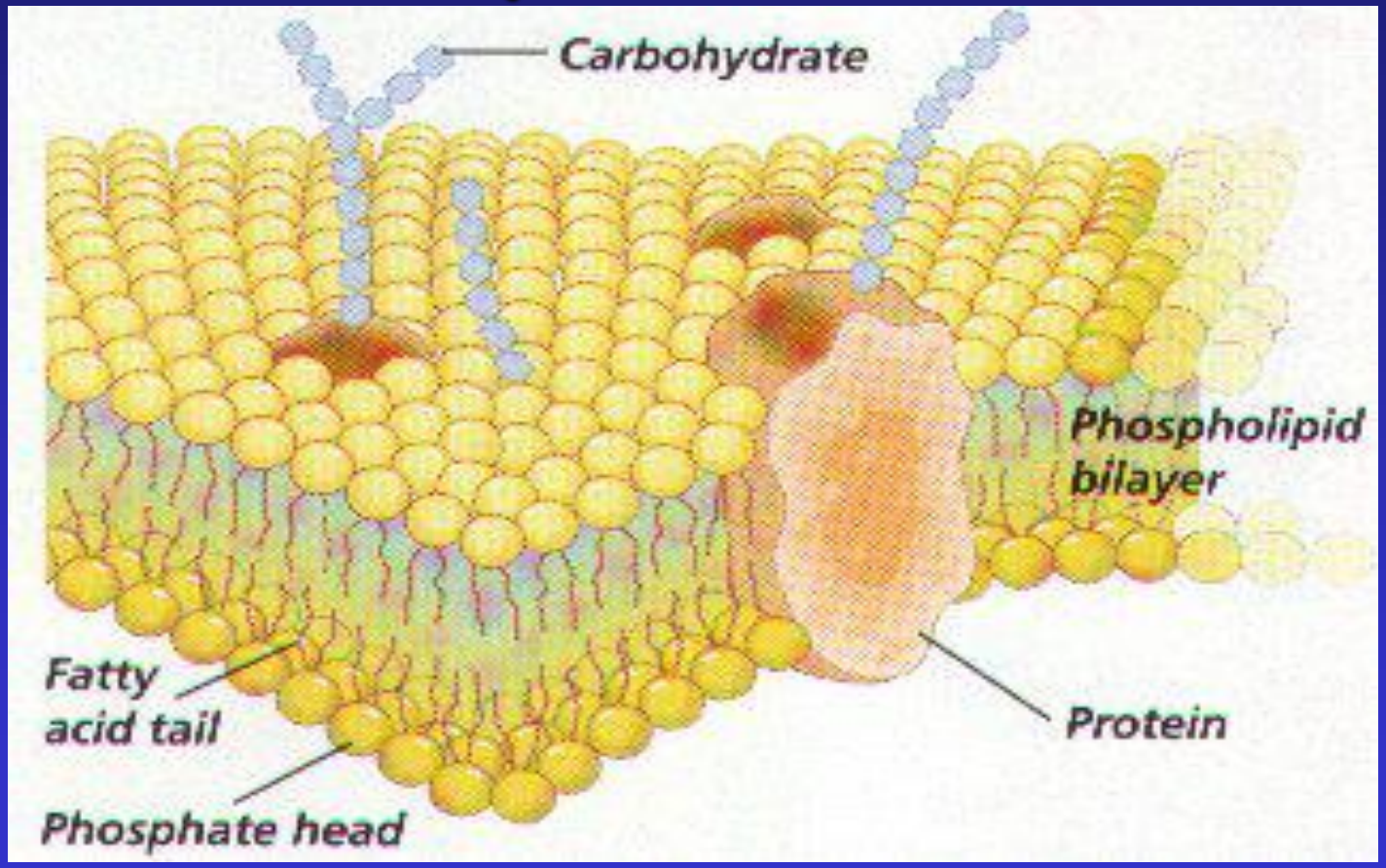
Asking a Question

Dr. Haidar K. Al-Salman

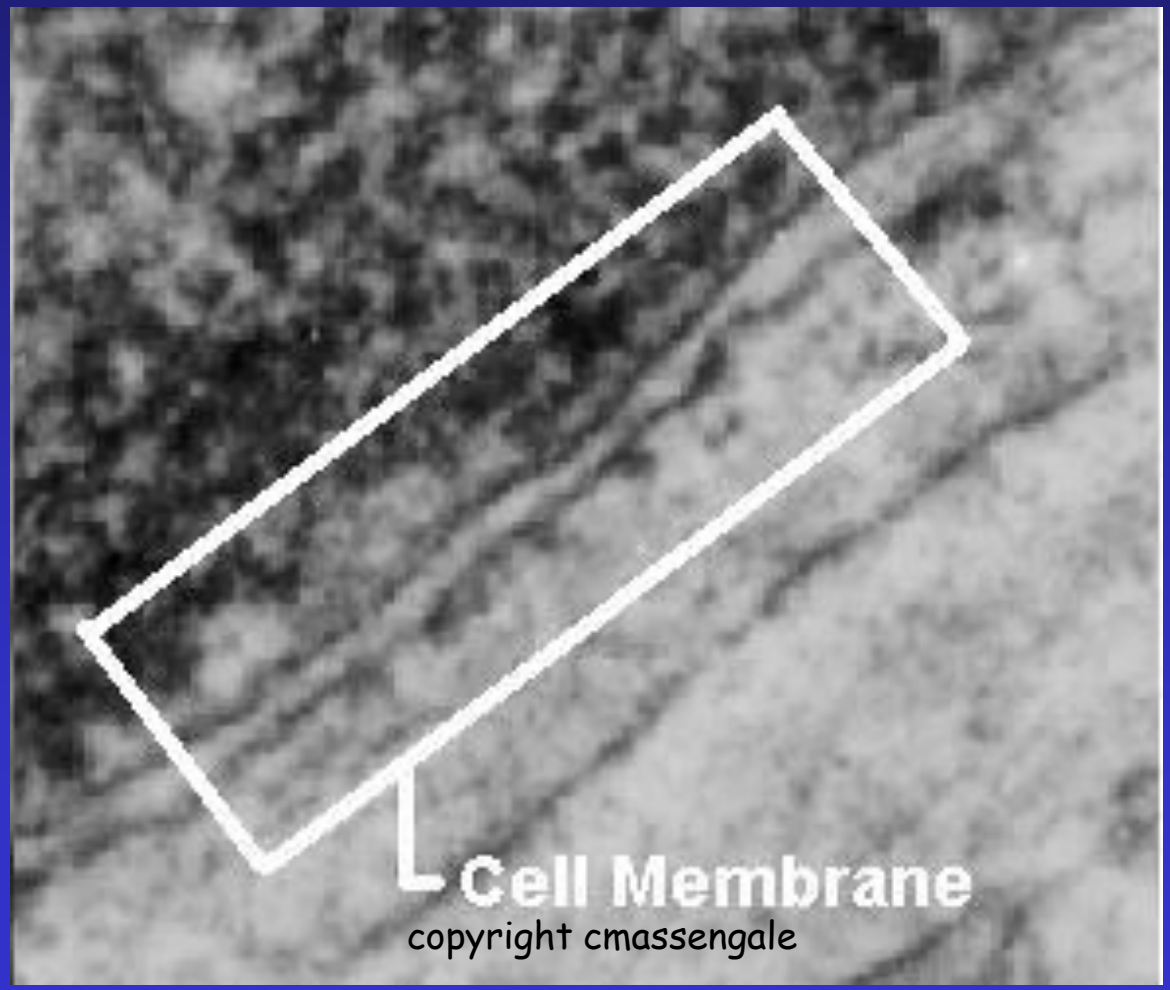
The Plasma Membrane



The Plasma Membrane
Gateway to the Cell



Photograph of a Cell Membrane



Cell Membrane

The cell membrane is flexible and allows a unicellular organism to move

Homeostasis

- **Balanced** internal condition of cells
- Also called *equilibrium*
- **Maintained by plasma membrane** controlling what enters & leaves the cell

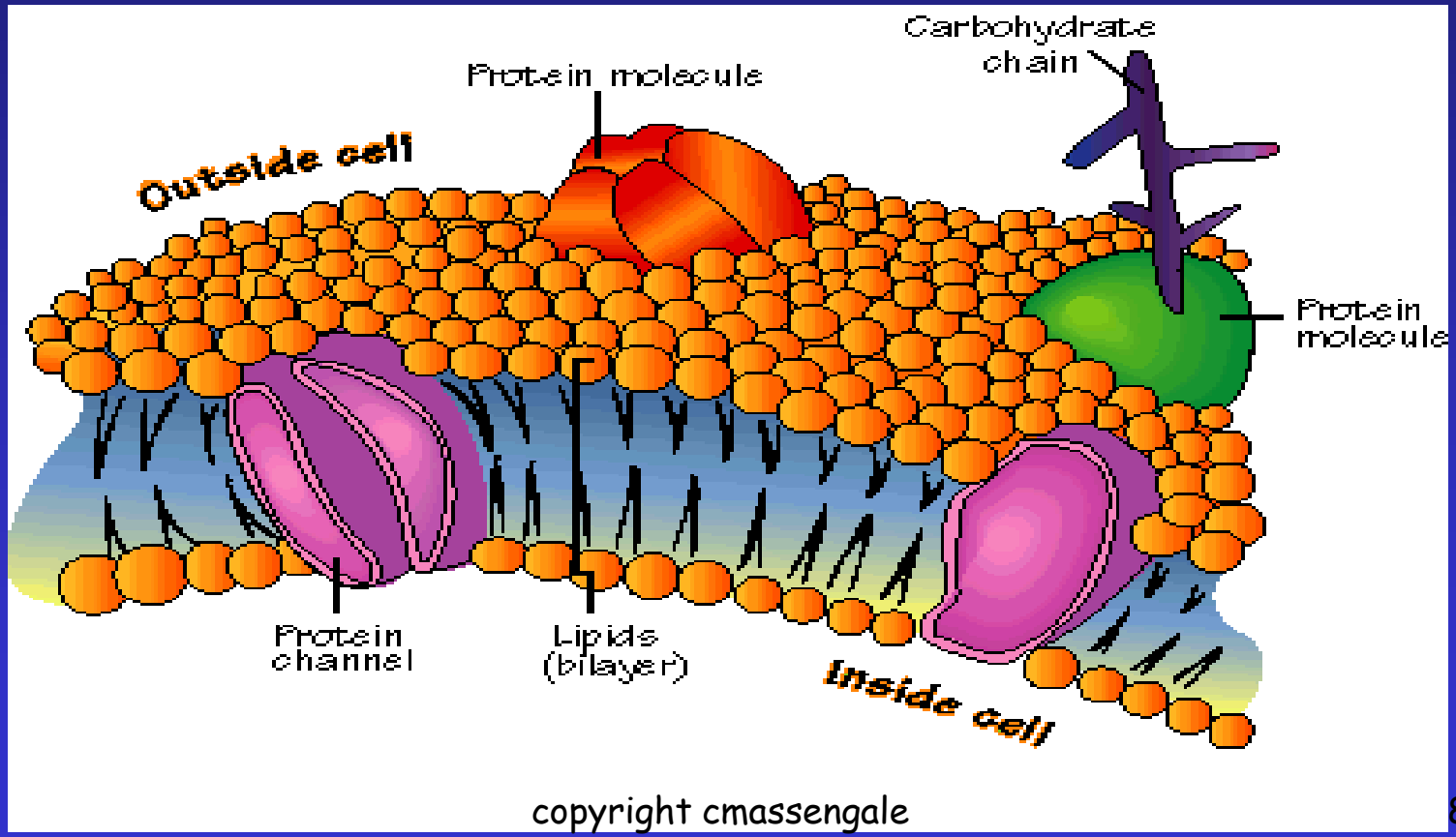
Functions of Plasma Membrane

- ✓ Protective barrier
- ✓ Regulate transport in & out of cell (selectively permeable)
- ✓ Allow cell recognition
- ✓ Provide anchoring sites for filaments of cytoskeleton

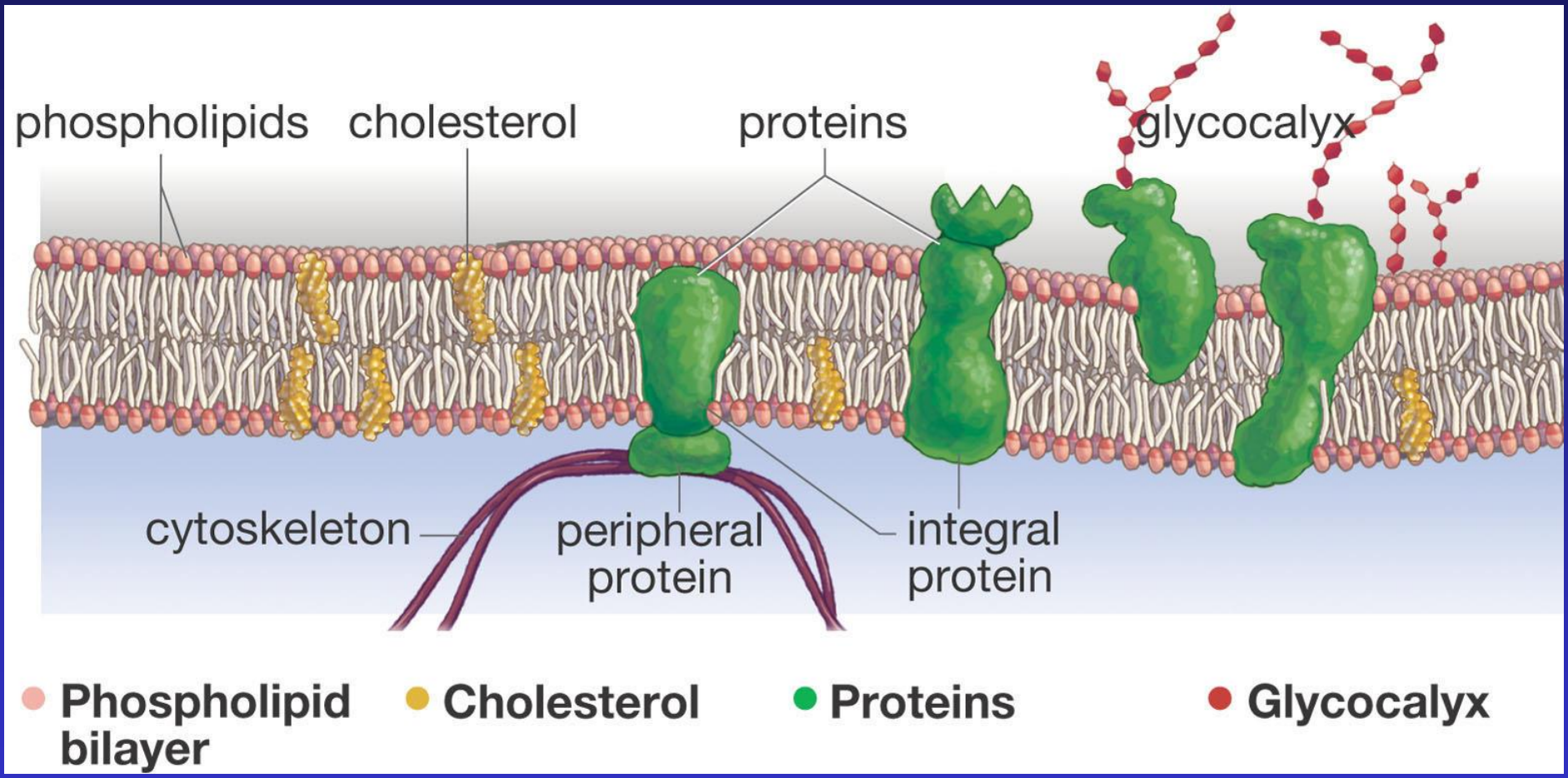
Functions of Plasma Membrane

- ✓ Provide a binding site for enzymes
- ✓ Interlocking surfaces bind cells together (junctions)
- ✓Contains the cytoplasm (fluid in cell)

Structure of the Cell Membrane



Membrane Components

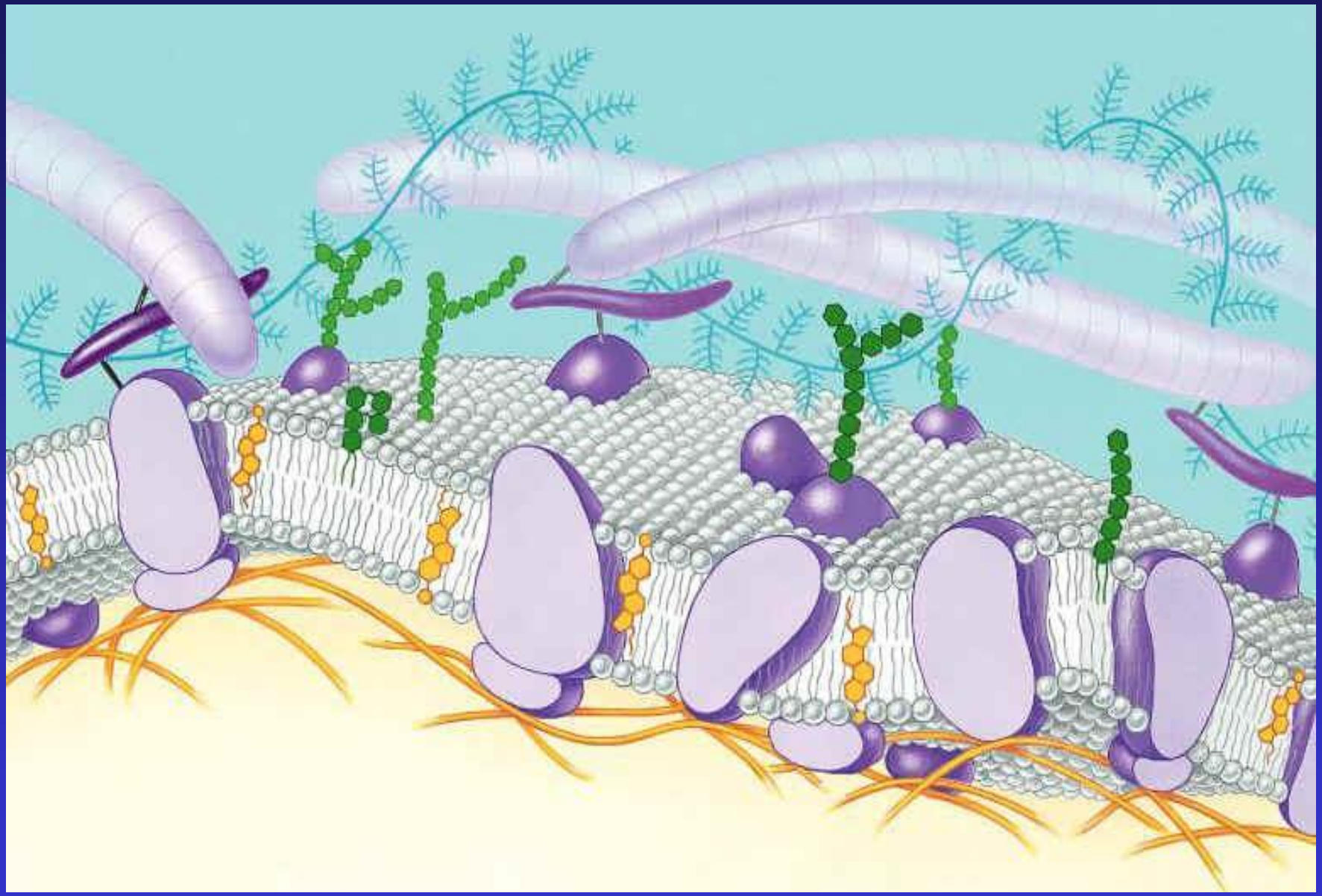


Phospholipids

Cholesterol

Proteins (peripheral and integral)

Carbohydrates (glucose)

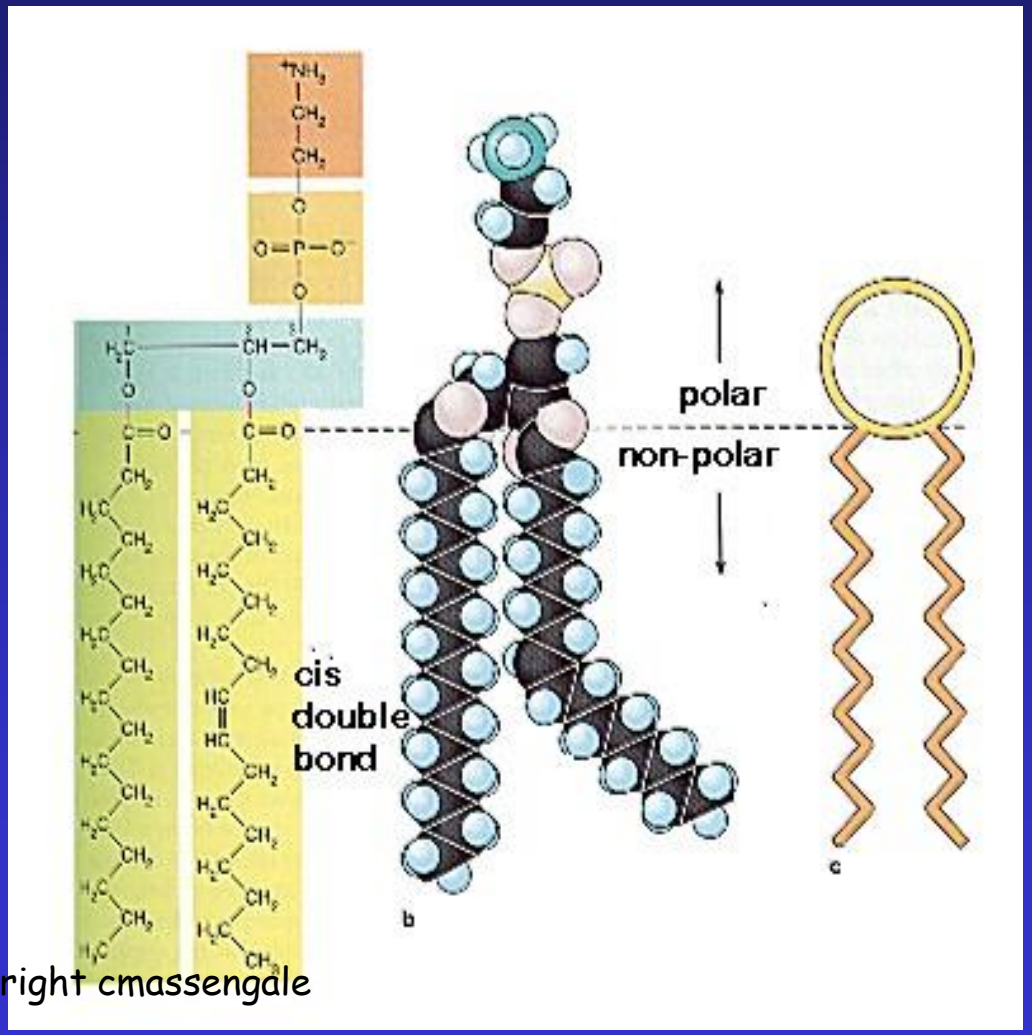


Phospholipids

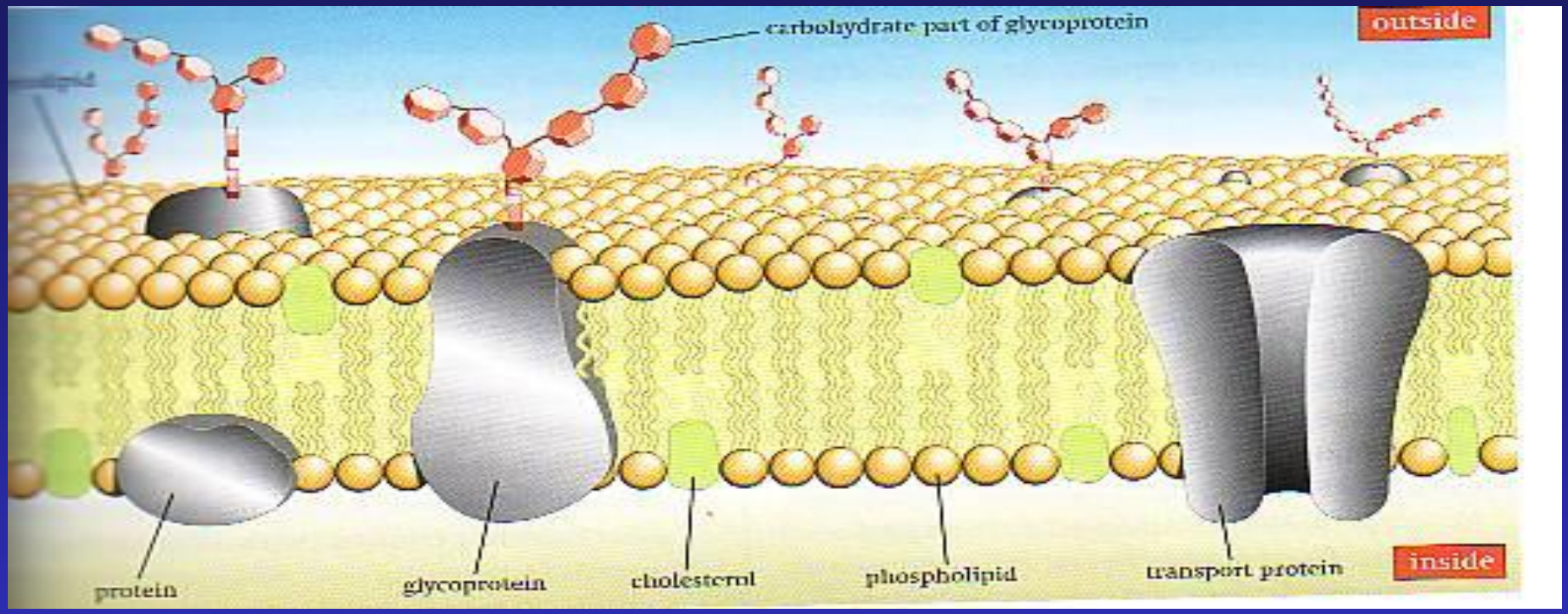
Make up the cell membrane

Contains 2 fatty acid chains that are nonpolar

Head is polar & contains a $-PO_4$ group & glycerol



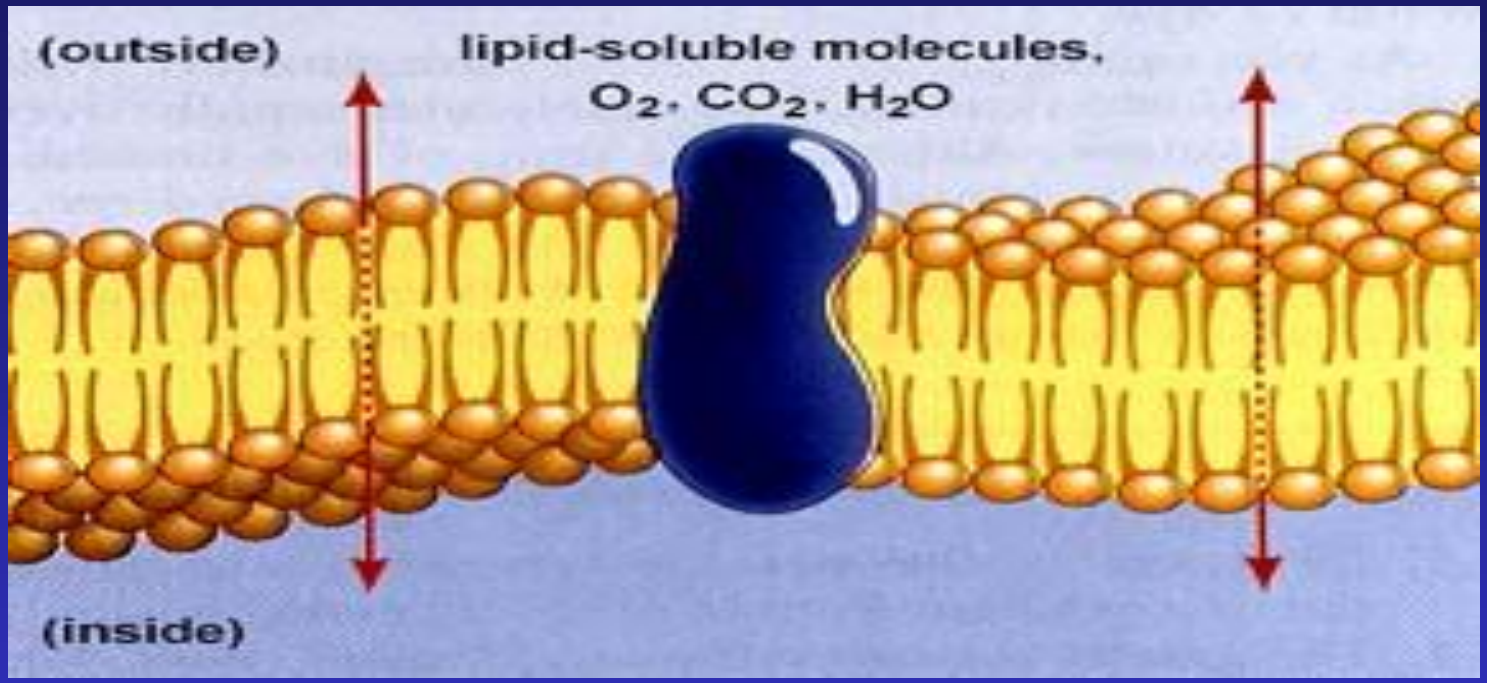
FLUID MOSAIC MODEL



FLUID- because individual phospholipids and proteins can move side-to-side within the layer, like it's a liquid.

MOSAIC- because of the pattern produced by the scattered protein molecules when the membrane is viewed from above.

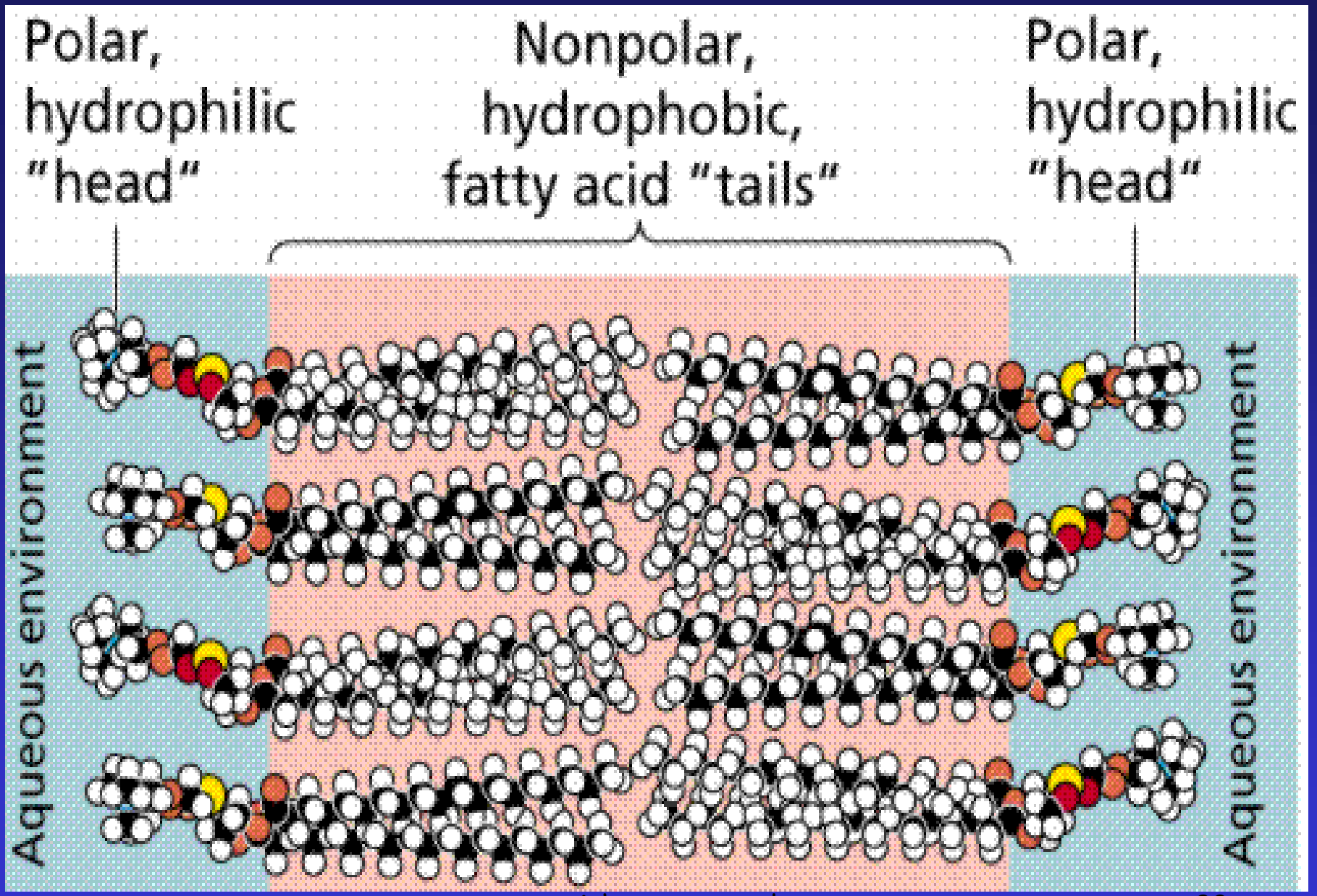
Cell Membrane



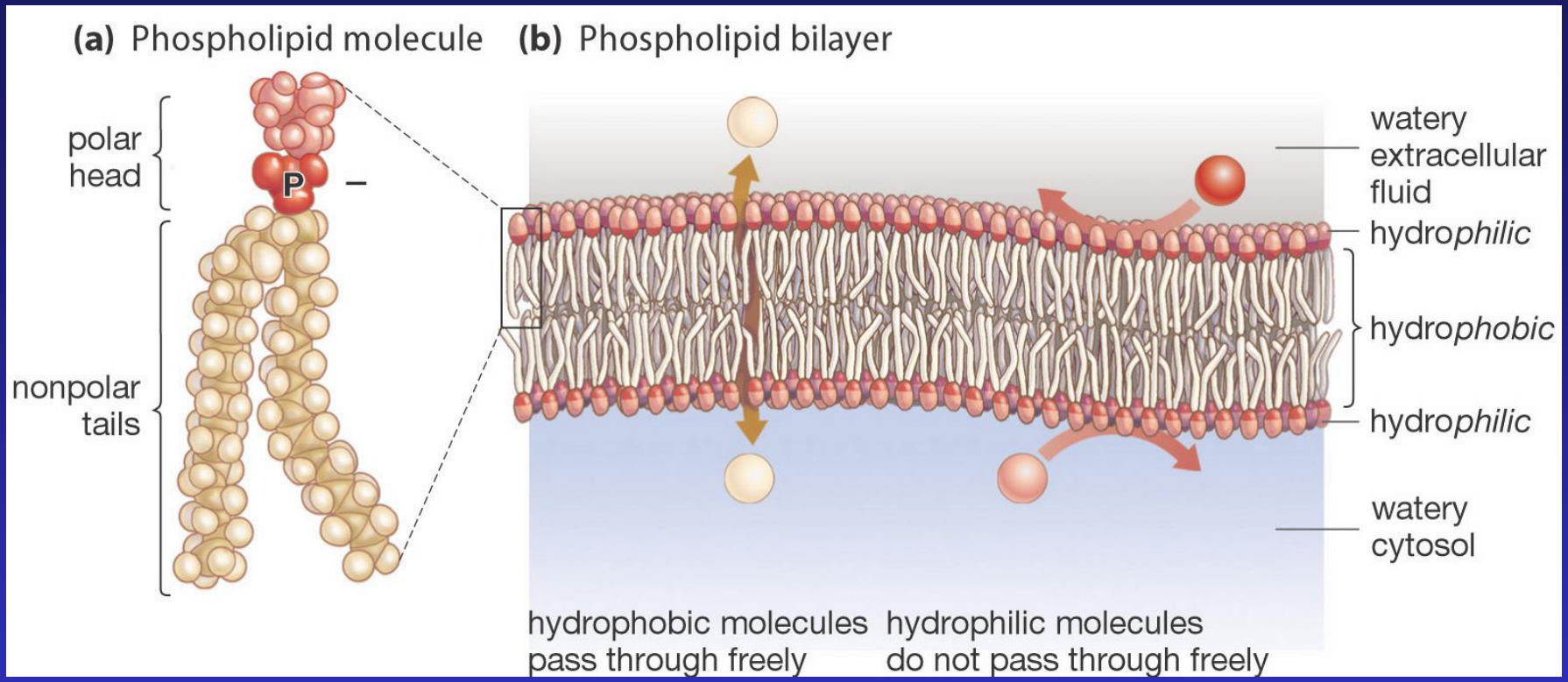
Polar heads are **hydrophilic** "water loving"

Nonpolar tails are **hydrophobic** "water fearing"

Makes membrane **"Selective"** in what crosses



Cell Membrane

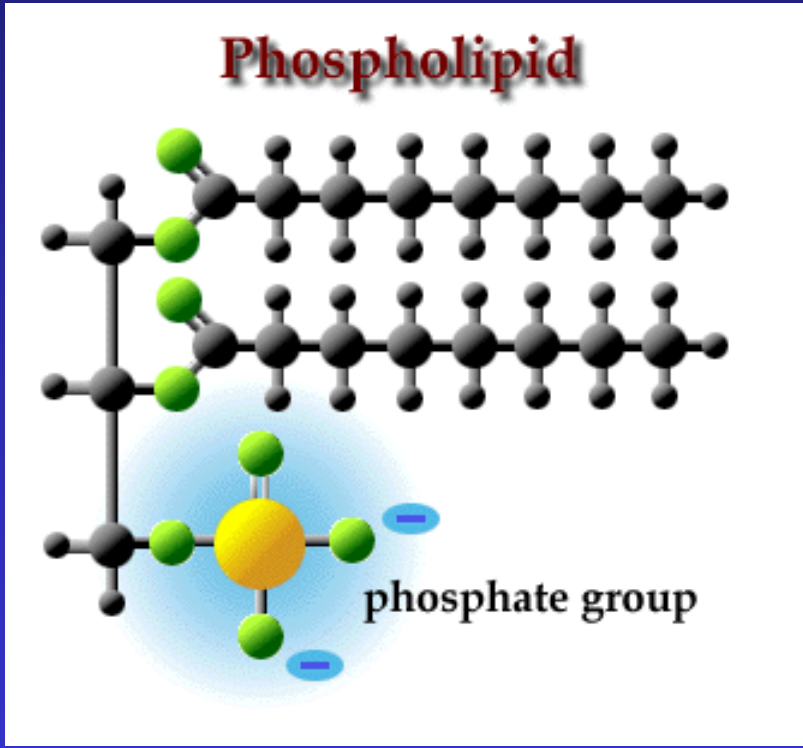


The cell membrane is made of 2 layers of phospholipids called the lipid bilayer

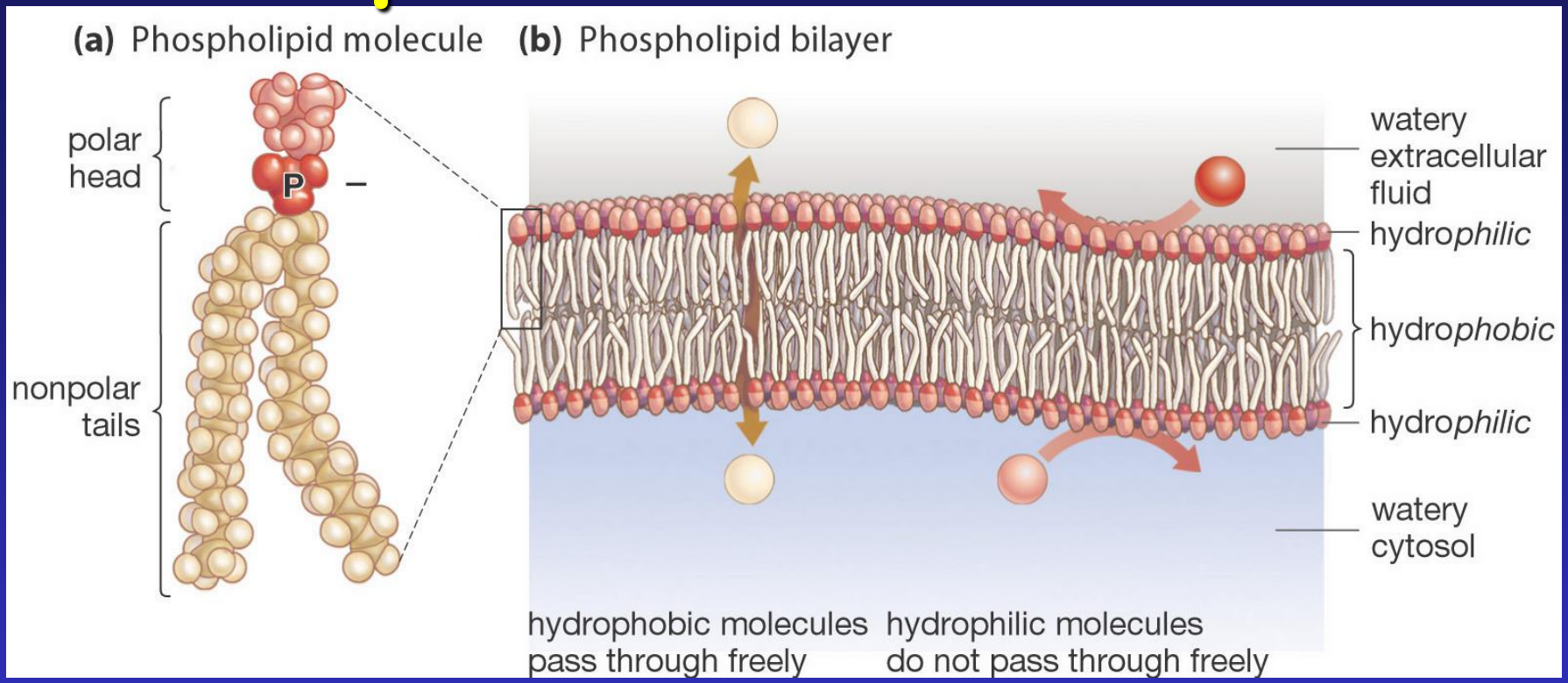
Hydrophobic molecules pass easily; hydrophilic DO NOT

Solubility

- Materials that are soluble in lipids can pass through the cell membrane easily



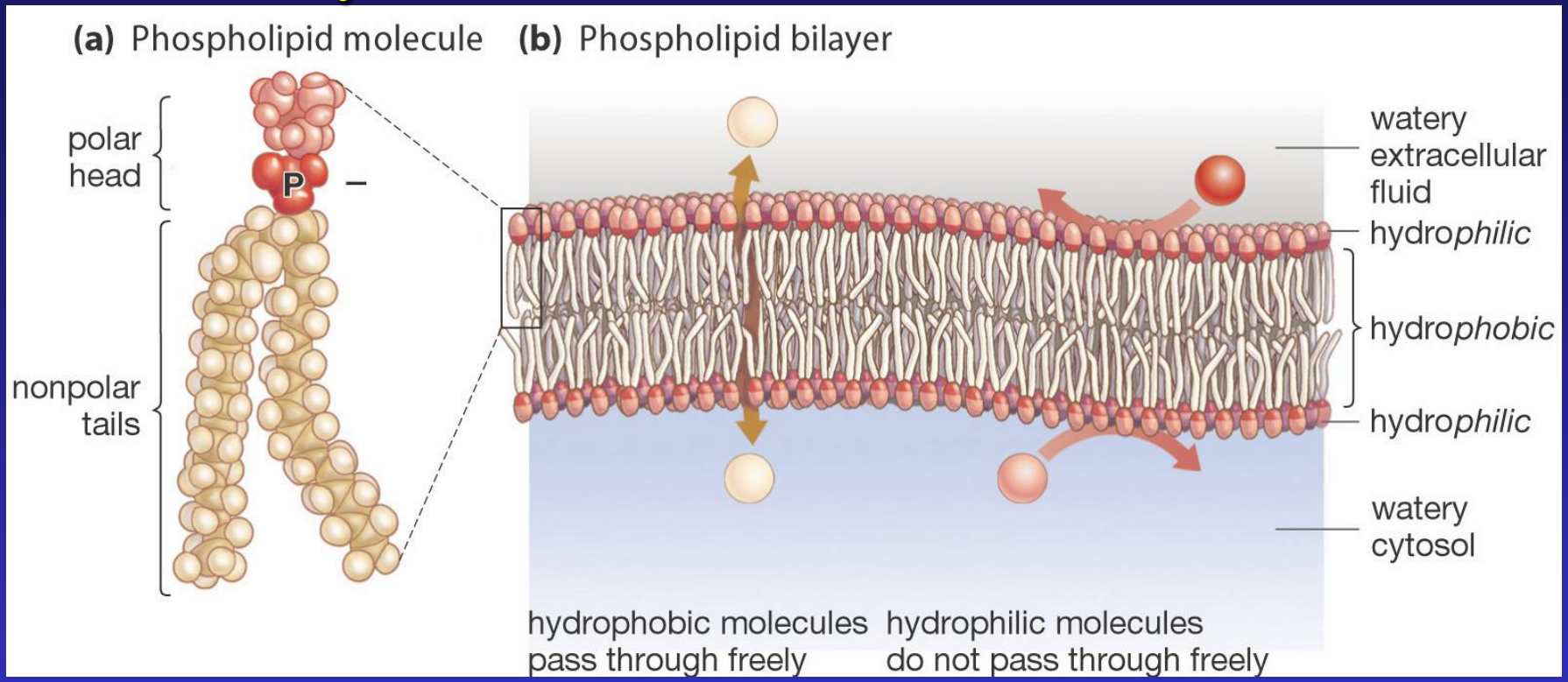
Semipermeable Membrane



Small molecules and larger hydrophobic molecules move through easily.

e.g. O_2, CO_2, H_2O

Semipermeable Membrane

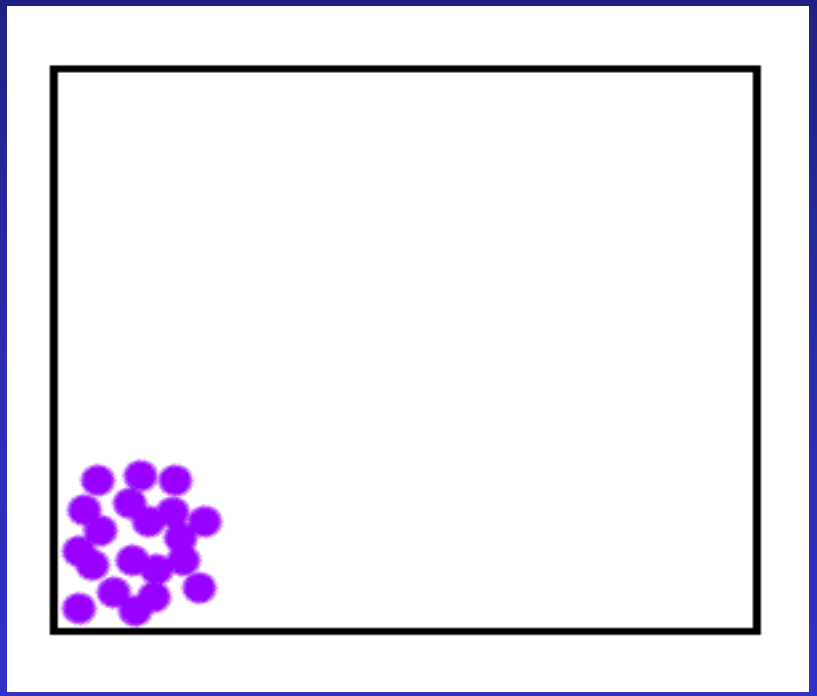


Ions, hydrophilic molecules larger than water, and large molecules such as proteins do not move through the membrane on their own.

Types of Transport Across Cell Membranes

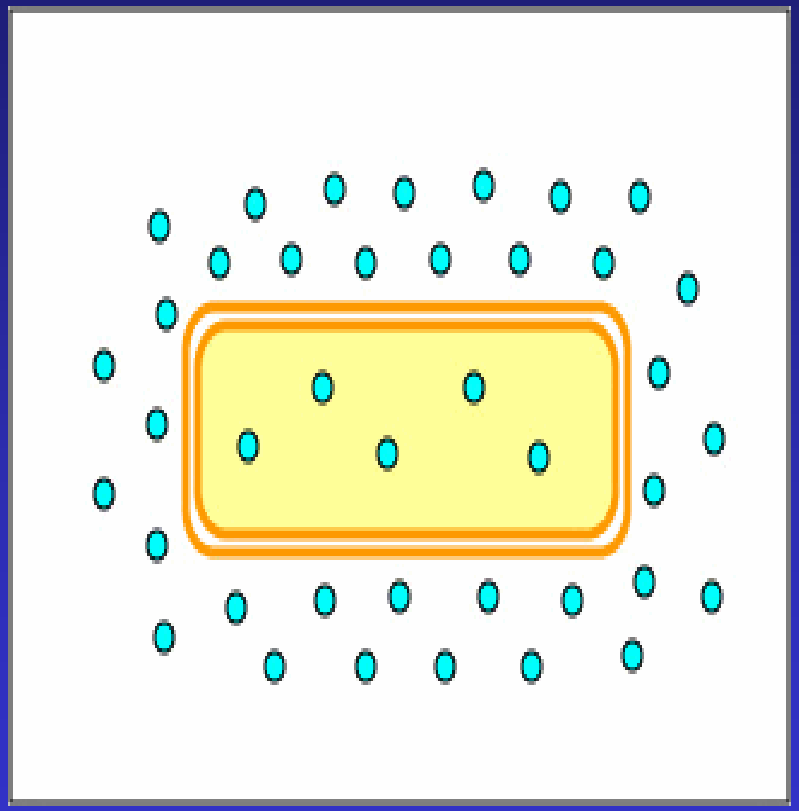
Simple Diffusion

- Requires NO energy
- Molecules move from area of HIGH to LOW concentration

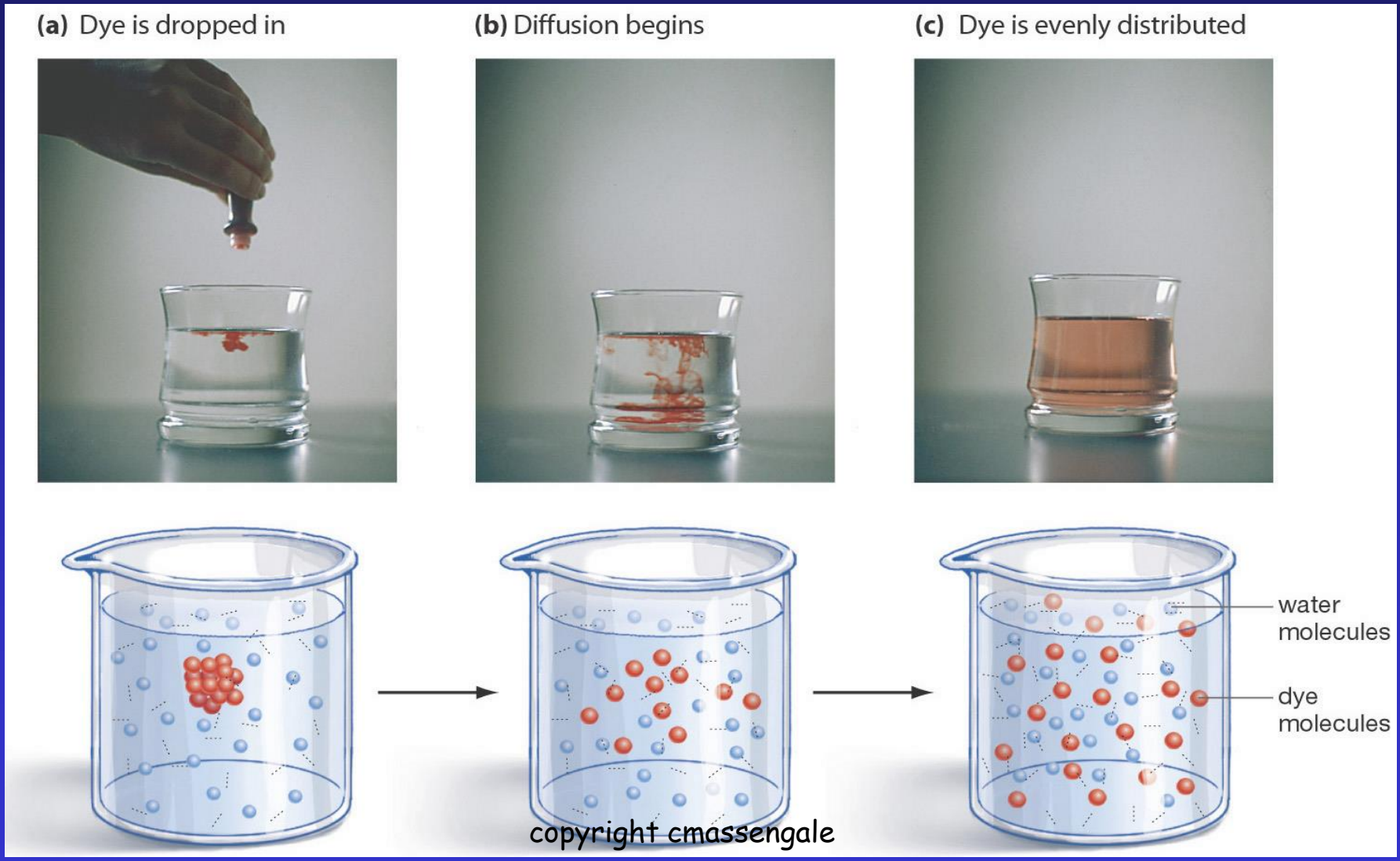


DIFFUSION

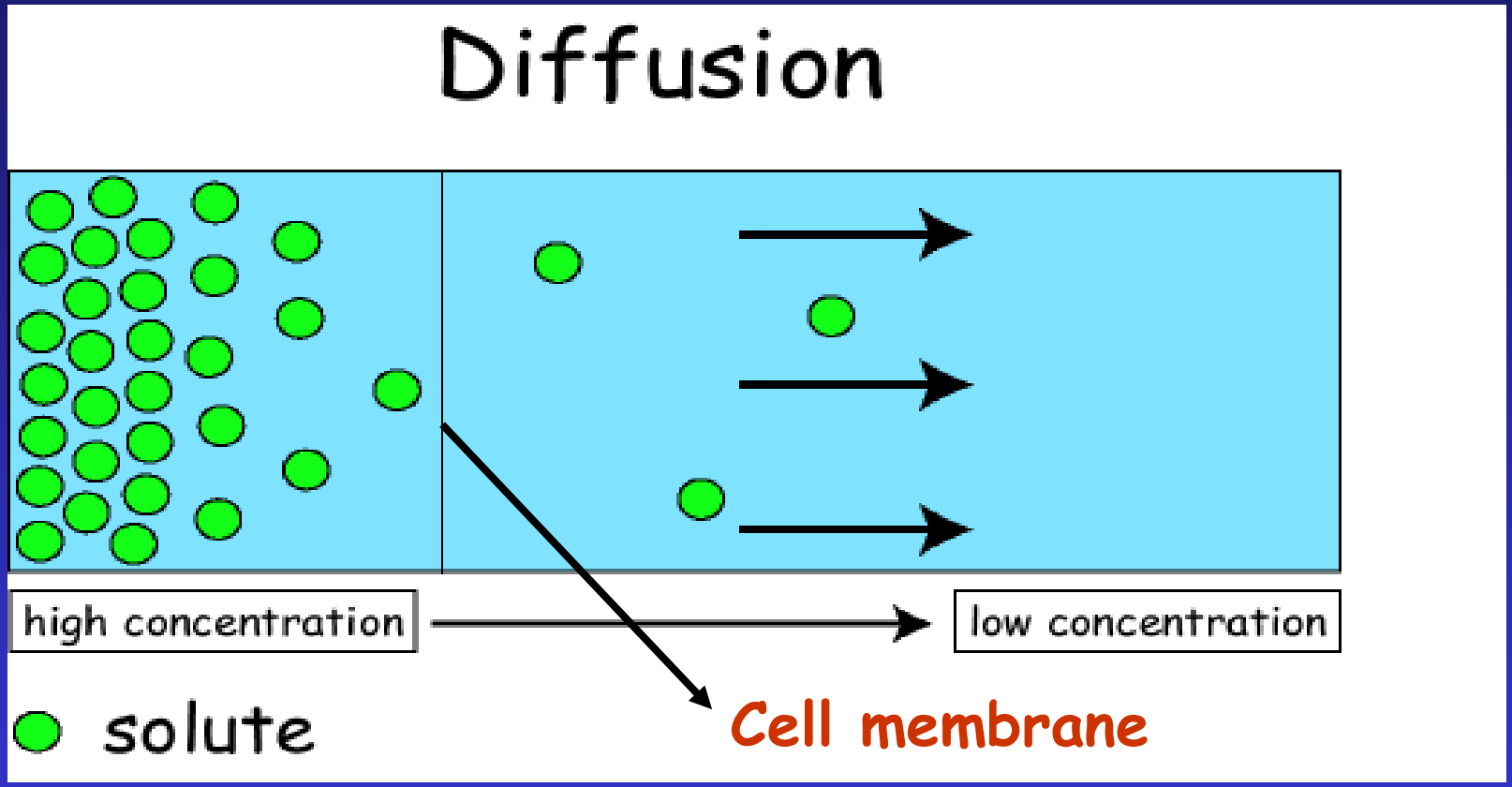
Diffusion is a PASSIVE process which means no energy is used to make the molecules move, they have a natural KINETIC ENERGY



Diffusion of Liquids



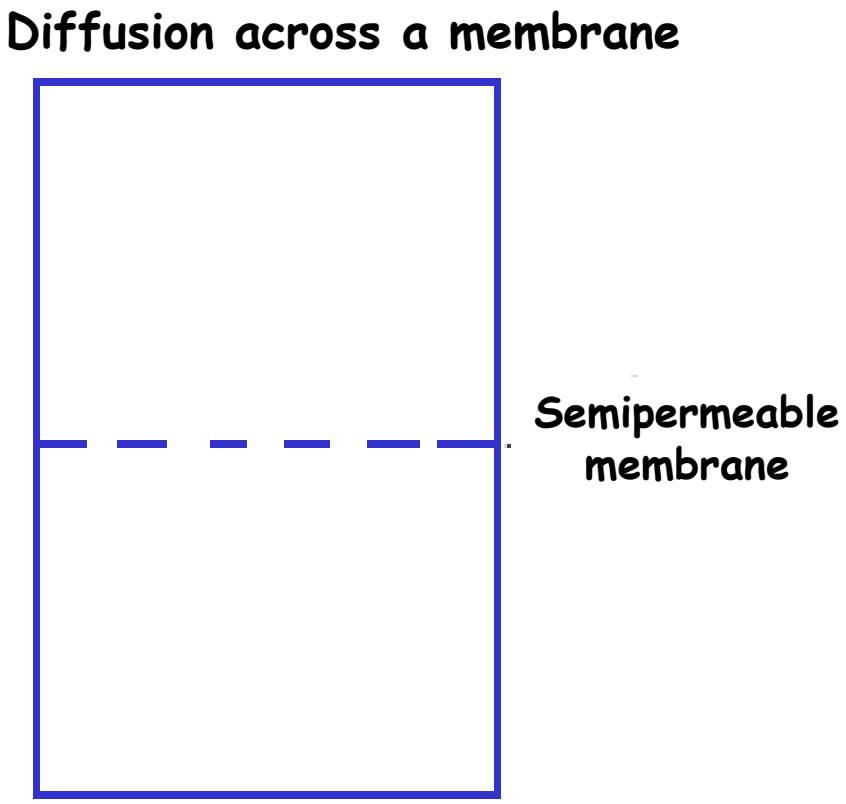
Diffusion through a Membrane



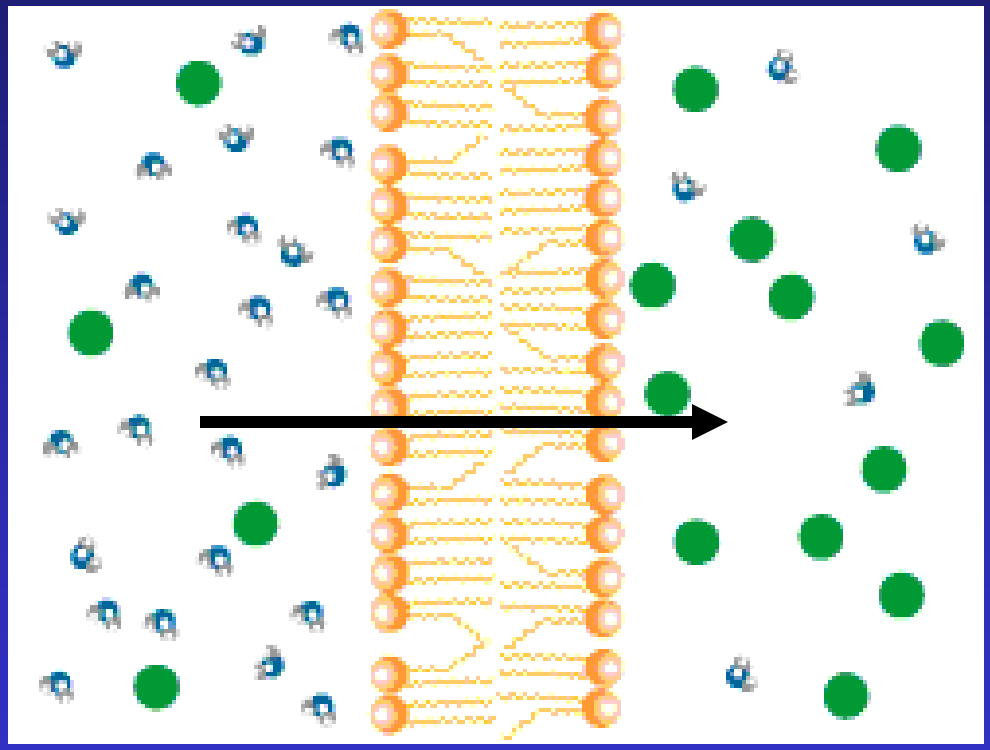
Solute moves DOWN concentration gradient (HIGH to LOW)

Osmosis

- Diffusion of water across a membrane
- Moves from HIGH water potential (low solute) to LOW water potential (high solute)



Diffusion of H_2O Across A Membrane

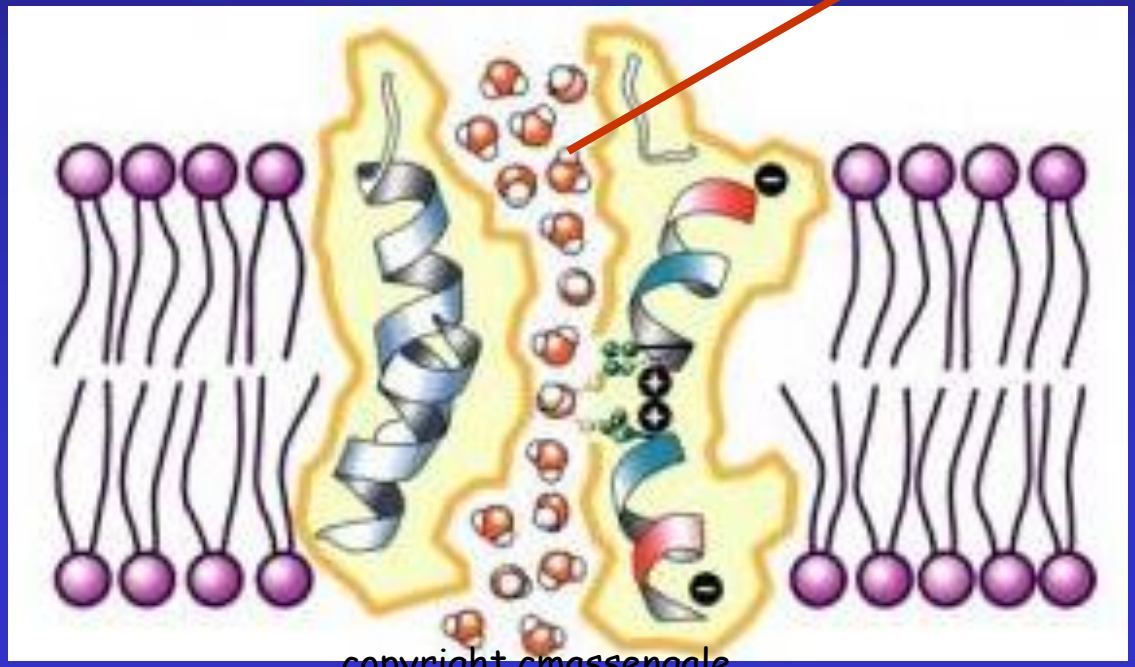


High H_2O potential
Low solute concentration

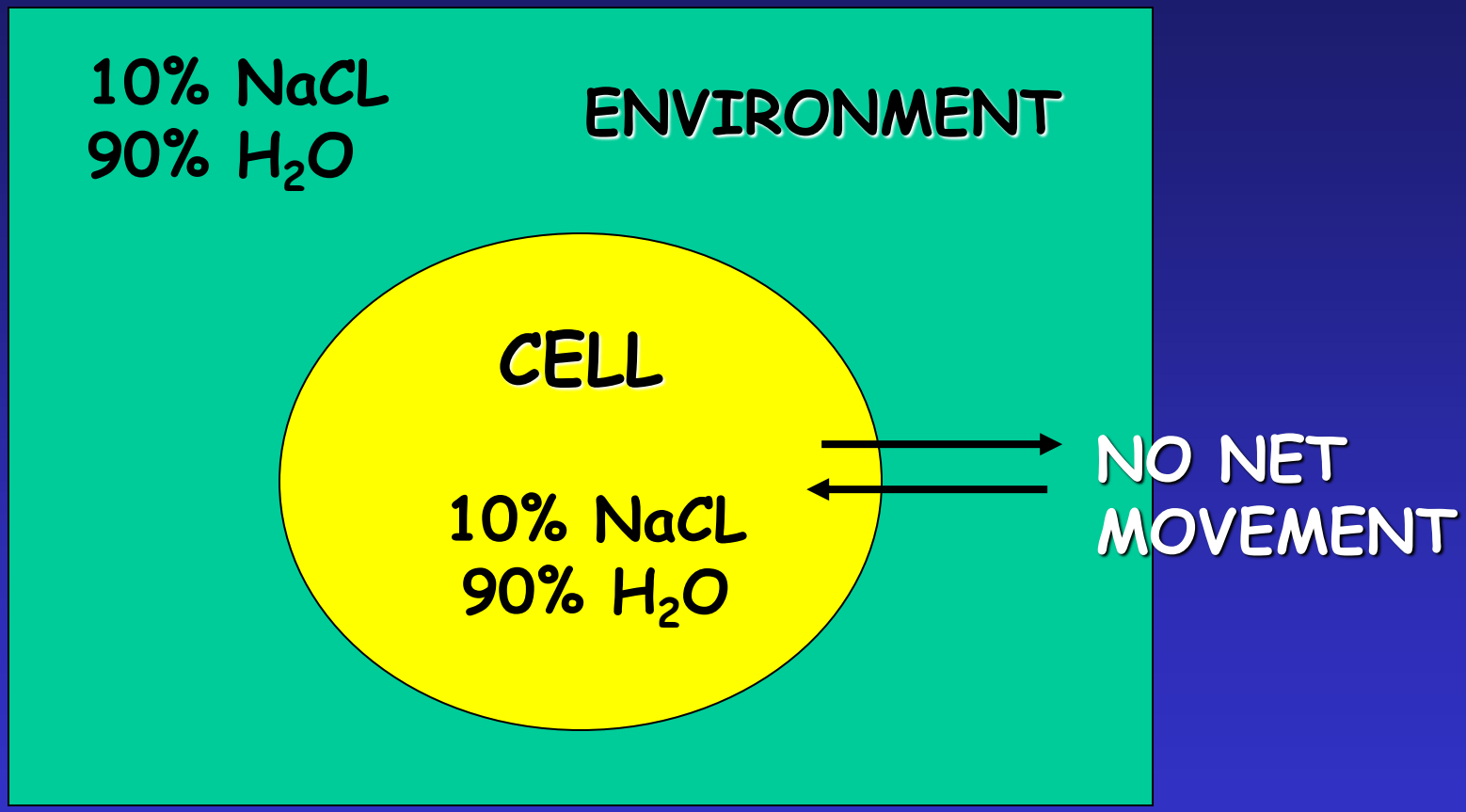
Low H_2O potential
High solute concentration

Aquaporins

- Water Channels
- Protein pores used during OSMOSIS



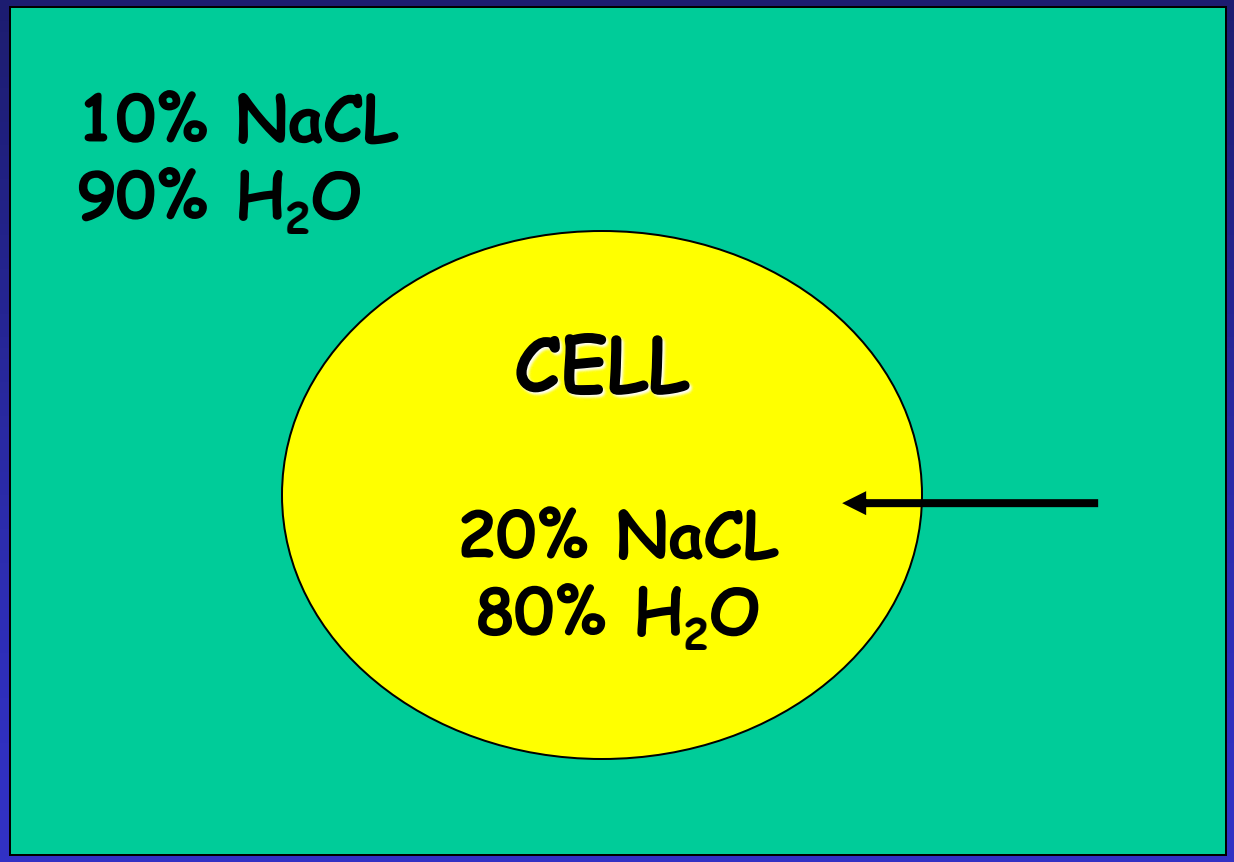
Cell in Isotonic Solution



What is the direction of water movement?

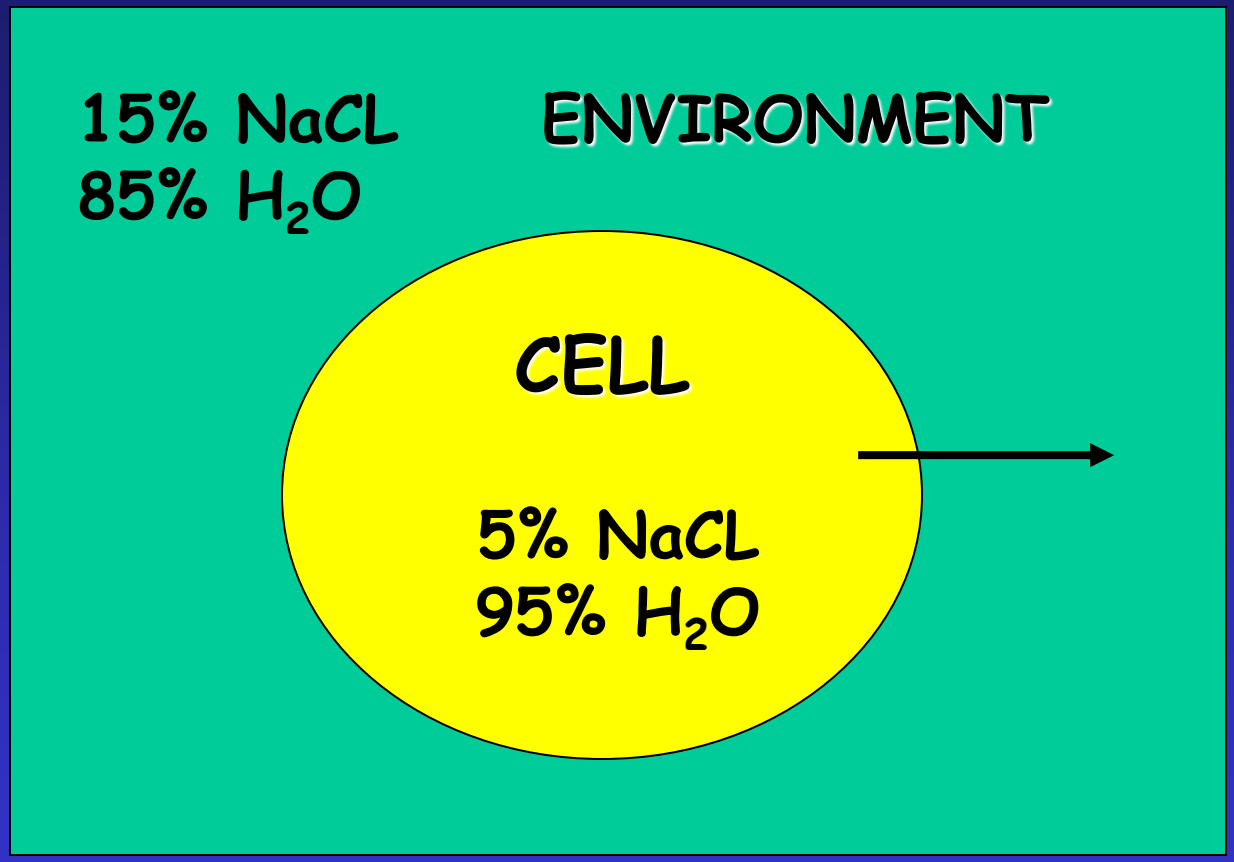
The cell is at _____equilibrium_____.

Cell in Hypotonic Solution



What is the direction of water movement?

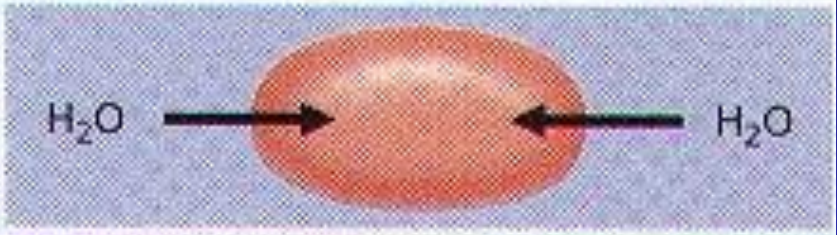
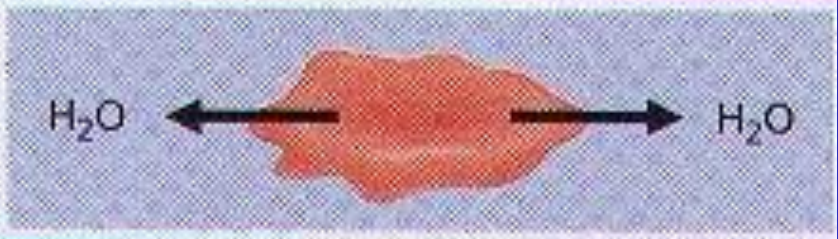
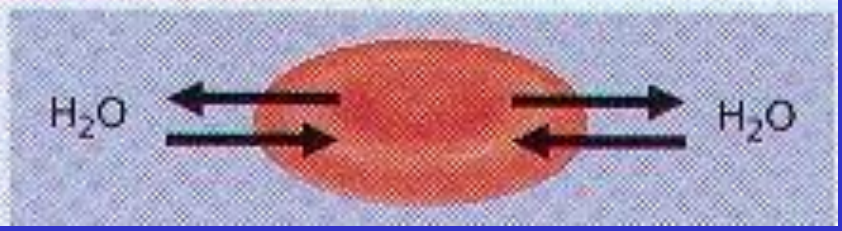
Cell in Hypertonic Solution

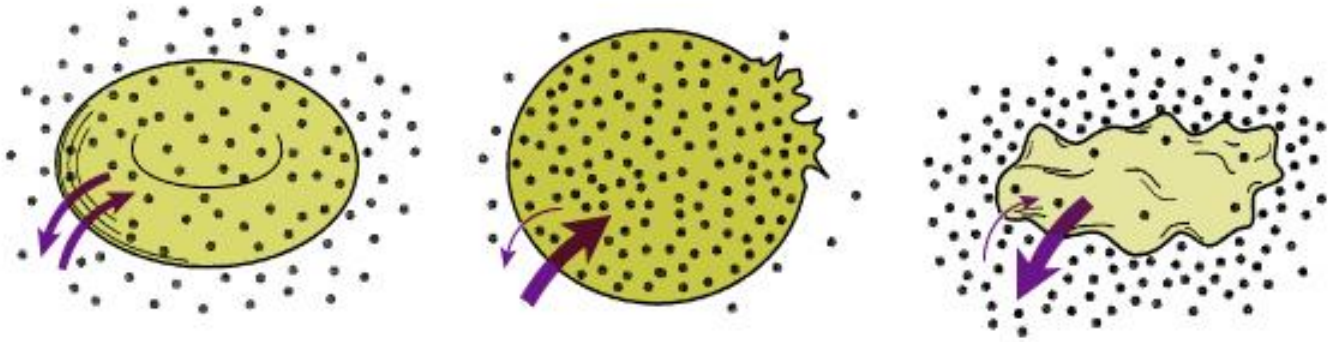


What is the direction of water movement?

Cells in Solutions

TABLE 5-1 Direction of Osmosis

Condition	Net movement of water	
External solution is hypotonic to cytosol	into the cell	
External solution is hypertonic to cytosol	out of the cell	
External solution is isotonic to cytosol	none	



Isotonic Solution

↓

NO NET MOVEMENT OF H_2O (equal amounts entering & leaving)

Hypotonic Solution

↓

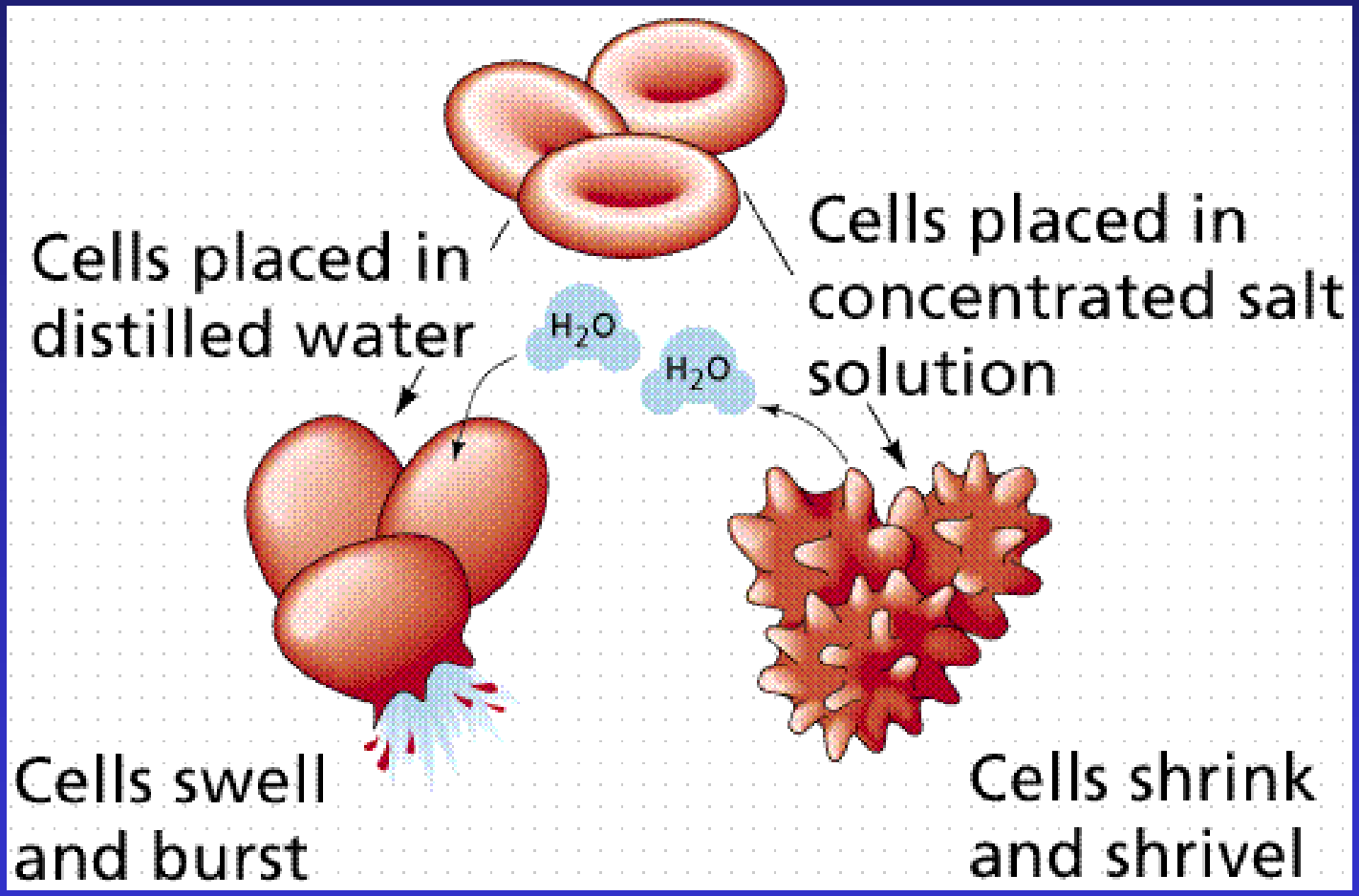
CYTOLYSIS

Hypertonic Solution

↓

PLASMOLYSIS

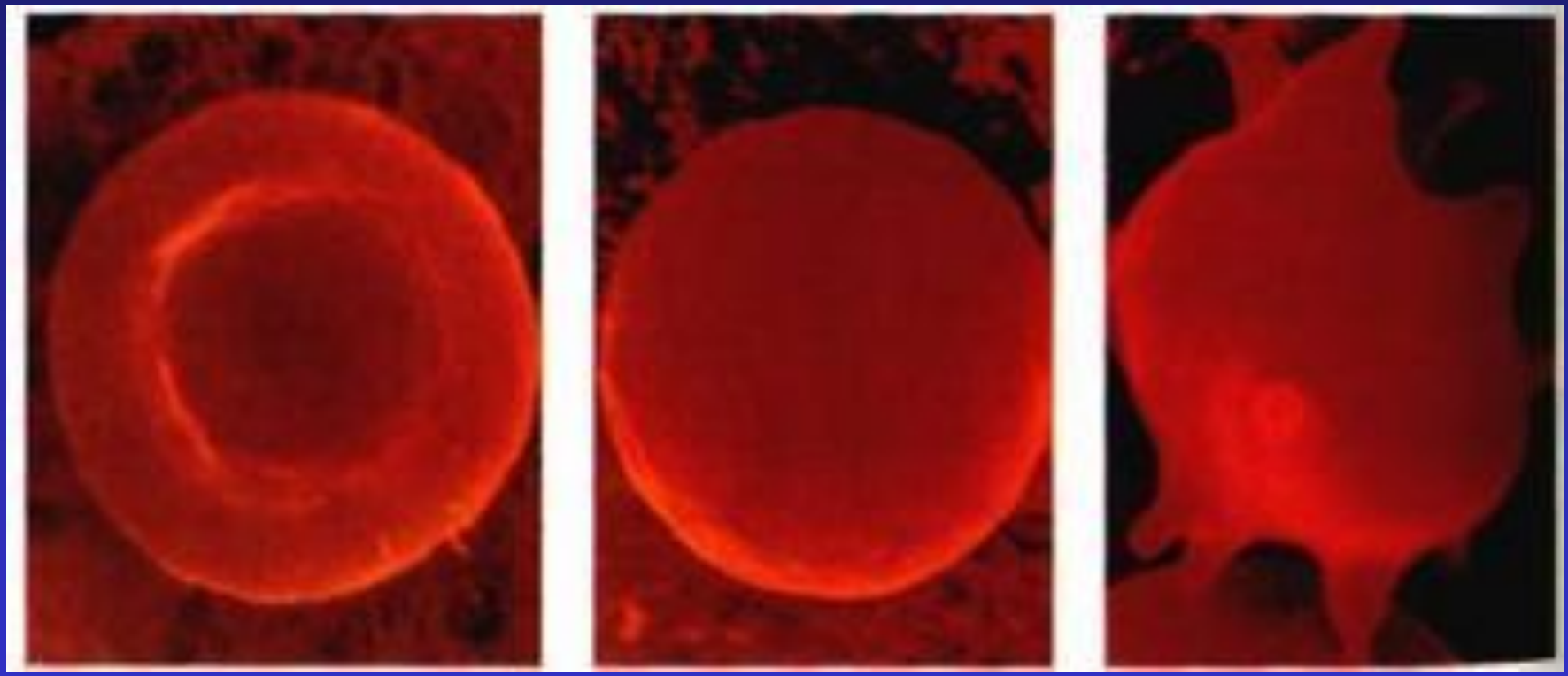
Cytolysis & Plasmolysis



Cytolysis

Plasmolysis

Osmosis in Red Blood Cells

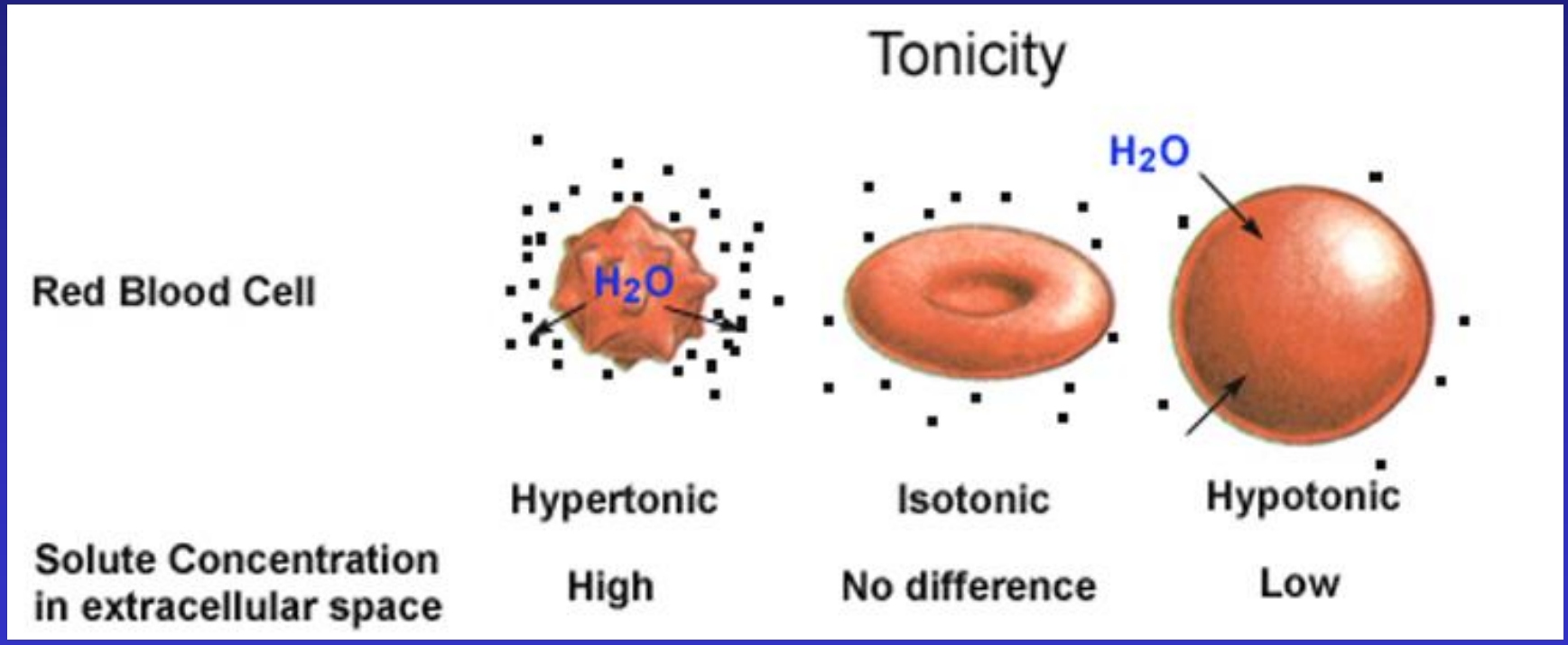


Isotonic

Hypotonic

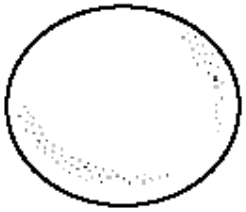
Hypertonic

What Happens to Blood Cells?



STRUCTURES AND FUNCTIONS The drawings below show the appearance of a red blood cell and a plant cell in isotonic, hypotonic, and hypertonic environments. Label each environment in the spaces provided.

RED BLOOD CELL

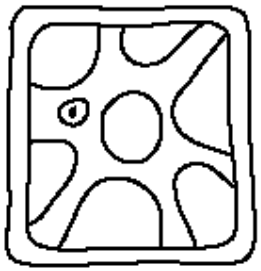


a **hypotonic**

b **hypertonic**

c **isotonic**

PLANT CELL



d **hypertonic**

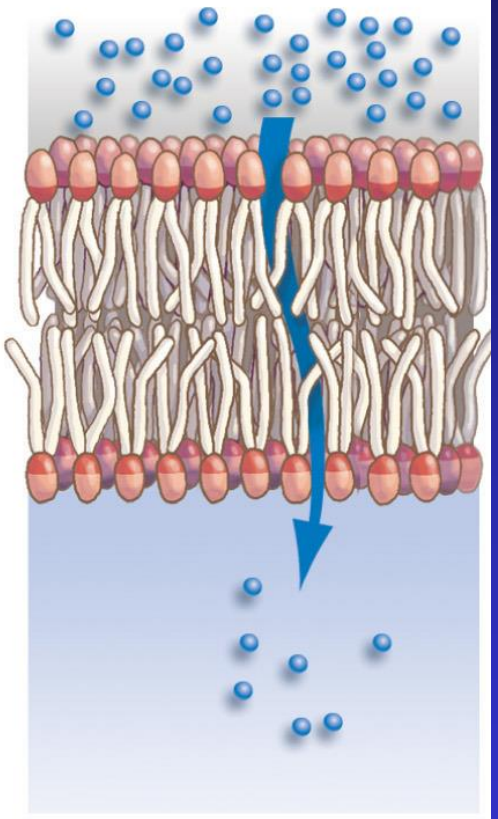
e **isotonic**

f **hypotonic**

Three Forms of Transport Across the Membrane

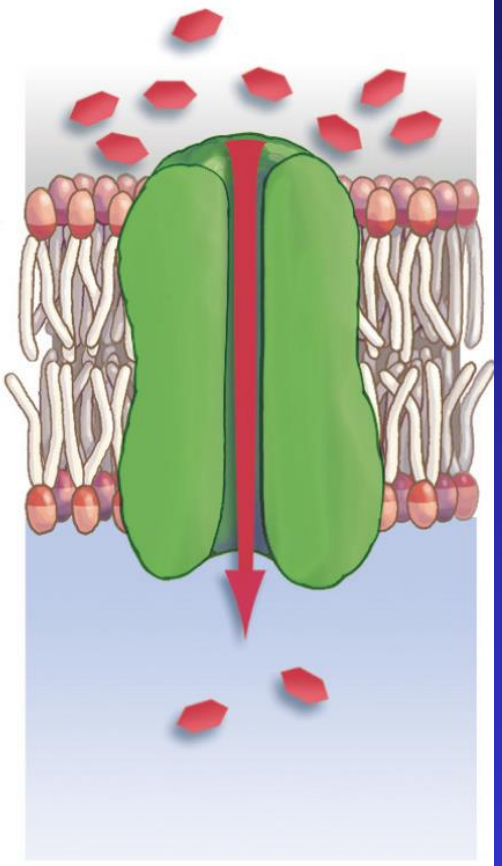
Passive transport

simple diffusion



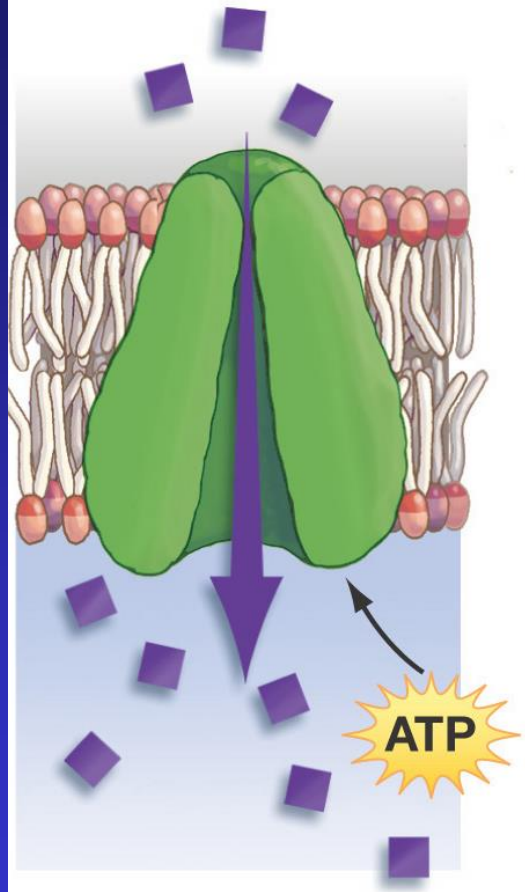
Materials move down their concentration gradient through the phospholipid bilayer.

facilitated diffusion

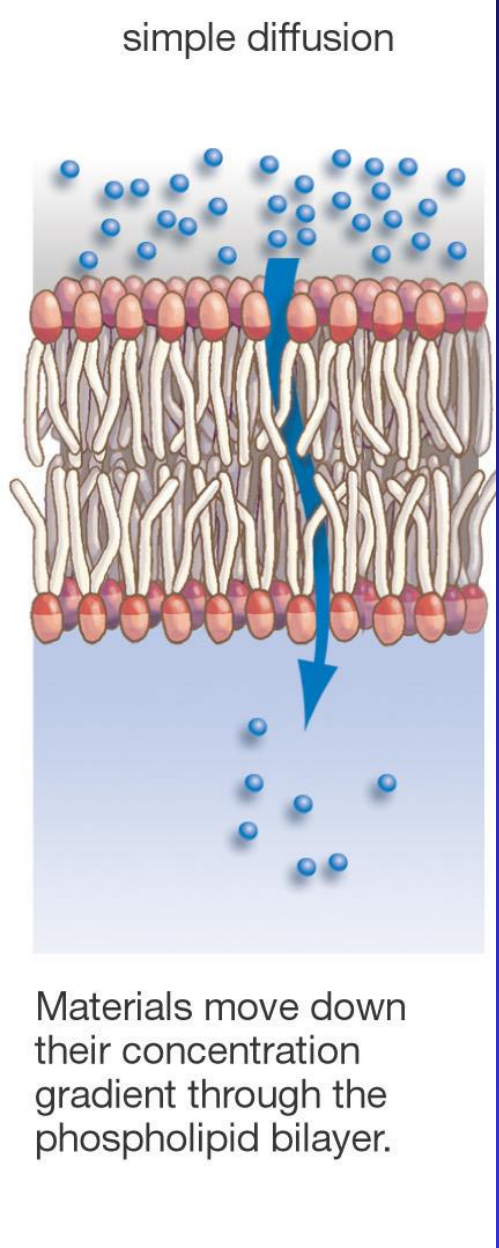


The passage of materials is aided both by a concentration gradient and by a transport protein.

Active transport



Molecules again move through a transport protein, but now energy must be expended to move them against their concentration gradient.

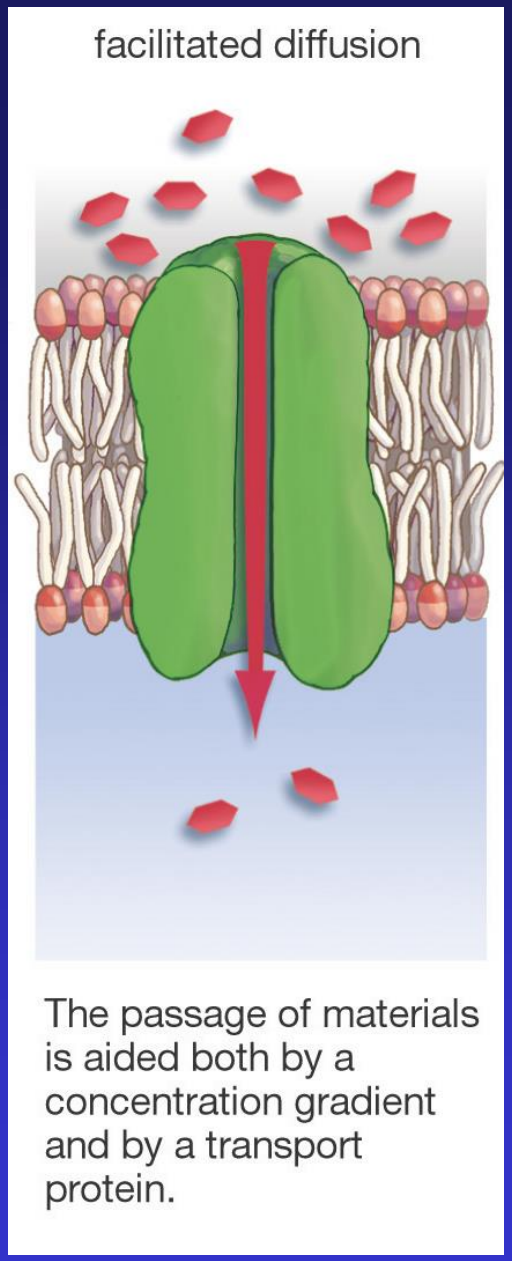


Materials move down their concentration gradient through the phospholipid bilayer.

Passive Transport

Simple Diffusion

- Doesn't require energy
- Moves high to low concentration
- Example: Oxygen or water diffusing into a cell and carbon dioxide diffusing out.



The passage of materials is aided both by a concentration gradient and by a transport protein.

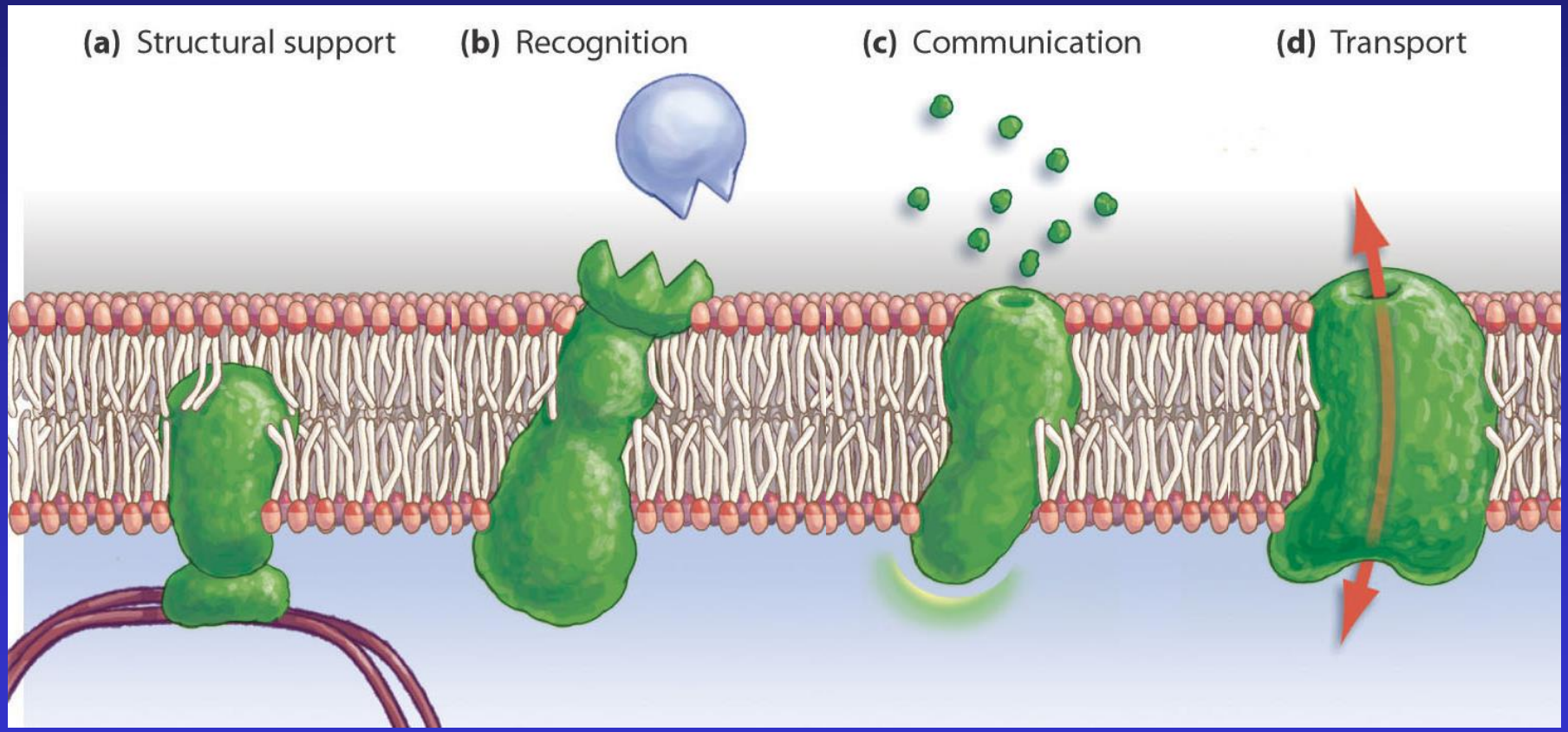
Passive Transport

Facilitated diffusion

- Doesn't require energy
- Uses transport proteins to move high to low concentration

Examples: Glucose or amino acids moving from blood into a cell.

Proteins Are Critical to Membrane Function

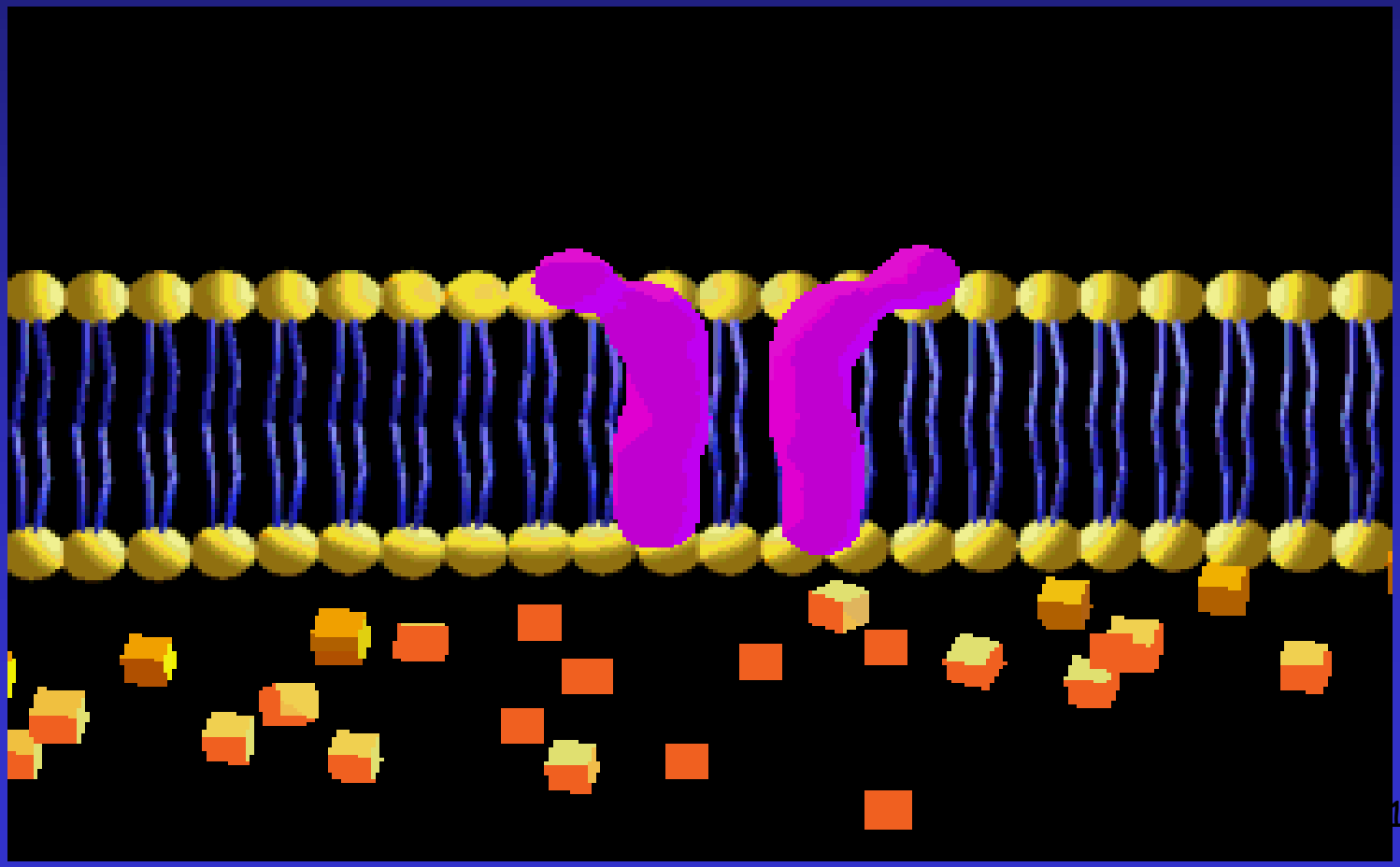


Types of Transport Proteins

- Channel proteins are embedded in the cell membrane & have a pore for materials to cross
- Carrier proteins can change shape to move material from one side of the membrane to the other

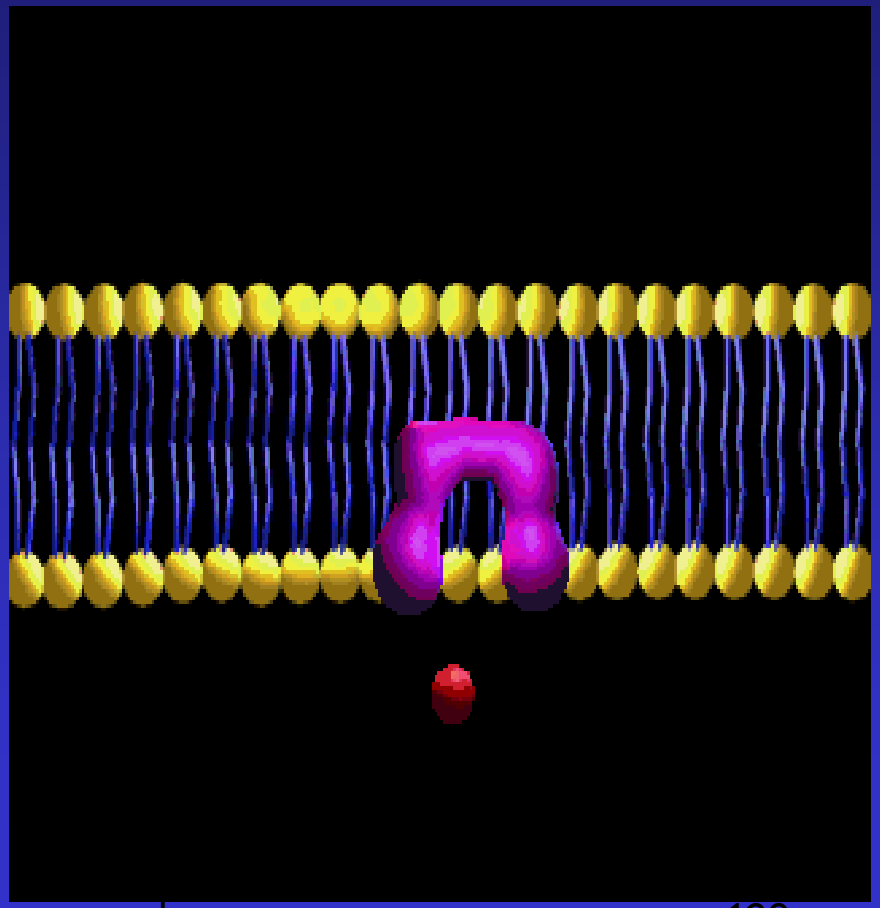
Facilitated Diffusion

Molecules will randomly move through the pores in Channel Proteins.



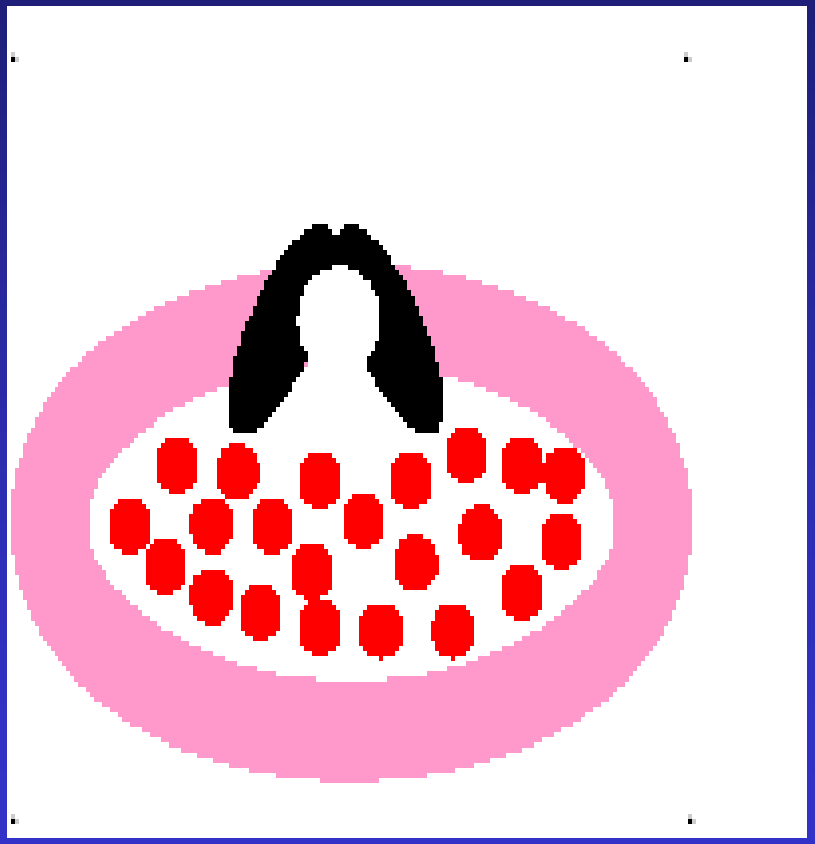
Facilitated Diffusion

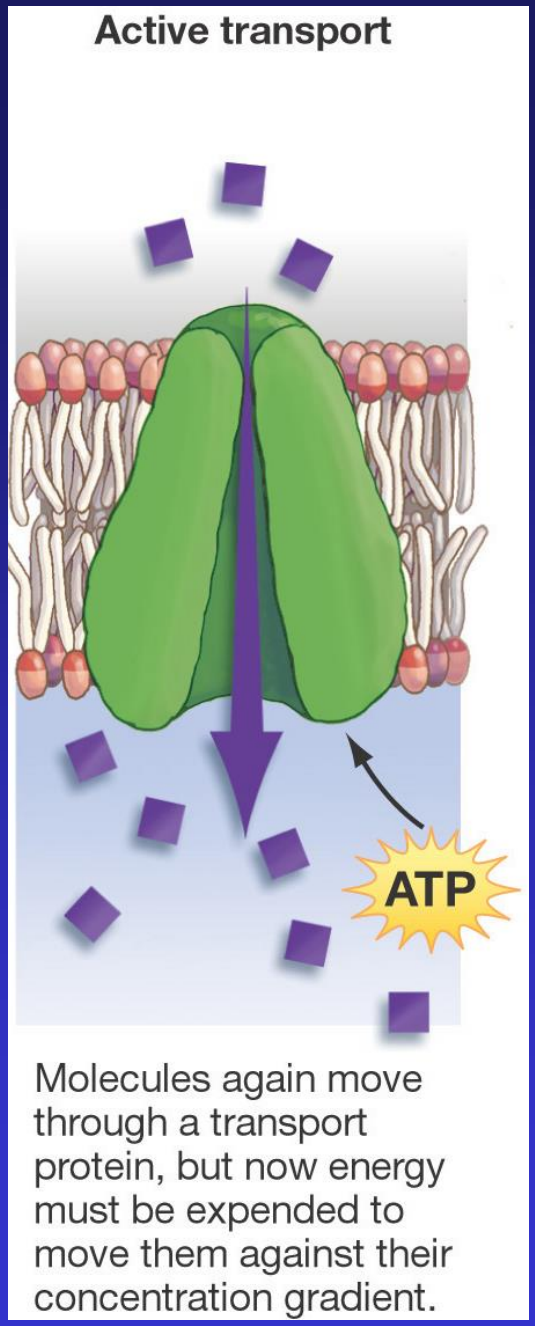
- Some Carrier proteins do not extend through the membrane.
- They bond and drag molecules through the lipid bilayer and release them on the opposite side.



Carrier Proteins

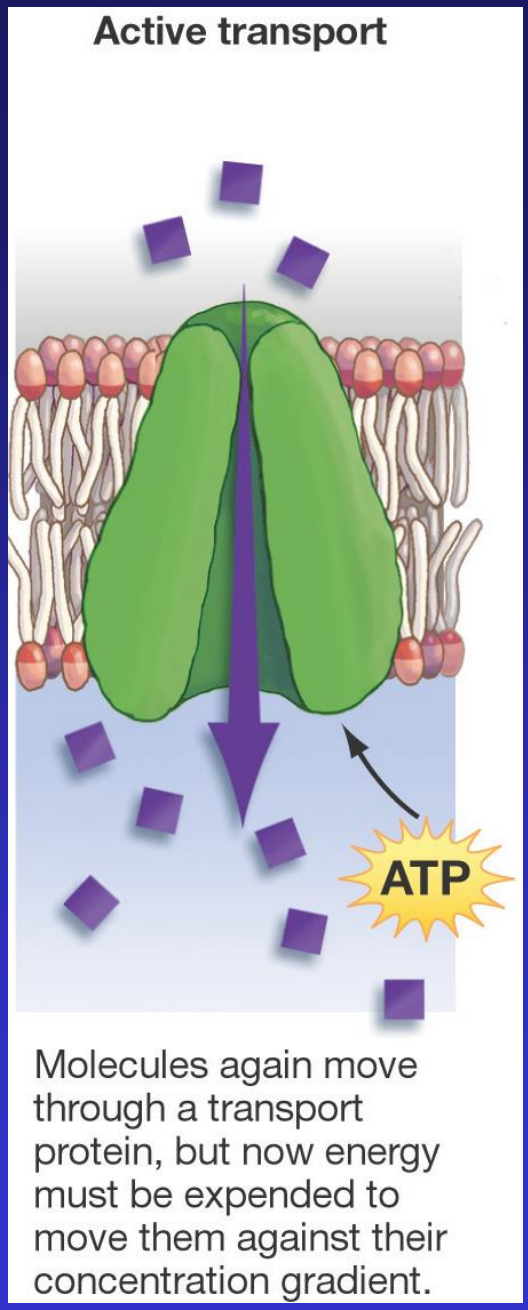
- Other carrier proteins change shape to move materials across the cell membrane





Active Transport

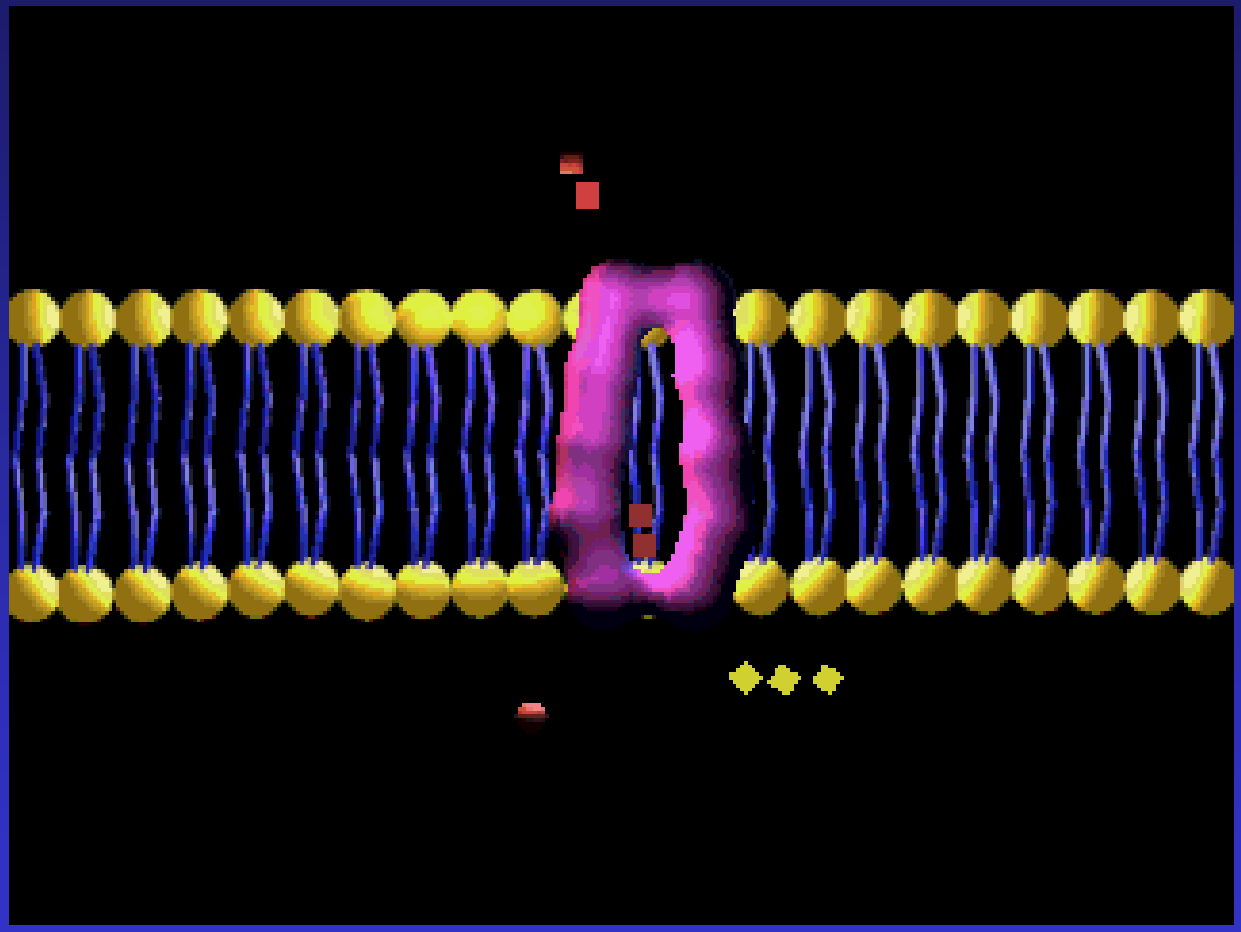
- Requires energy or ATP
- Moves materials from LOW to HIGH concentration
- AGAINST concentration gradient



Active transport

- Examples: Pumping Na^+ (sodium ions) out and K^+ (potassium ions) in against strong concentration gradients.
- Called Na+-K+ Pump

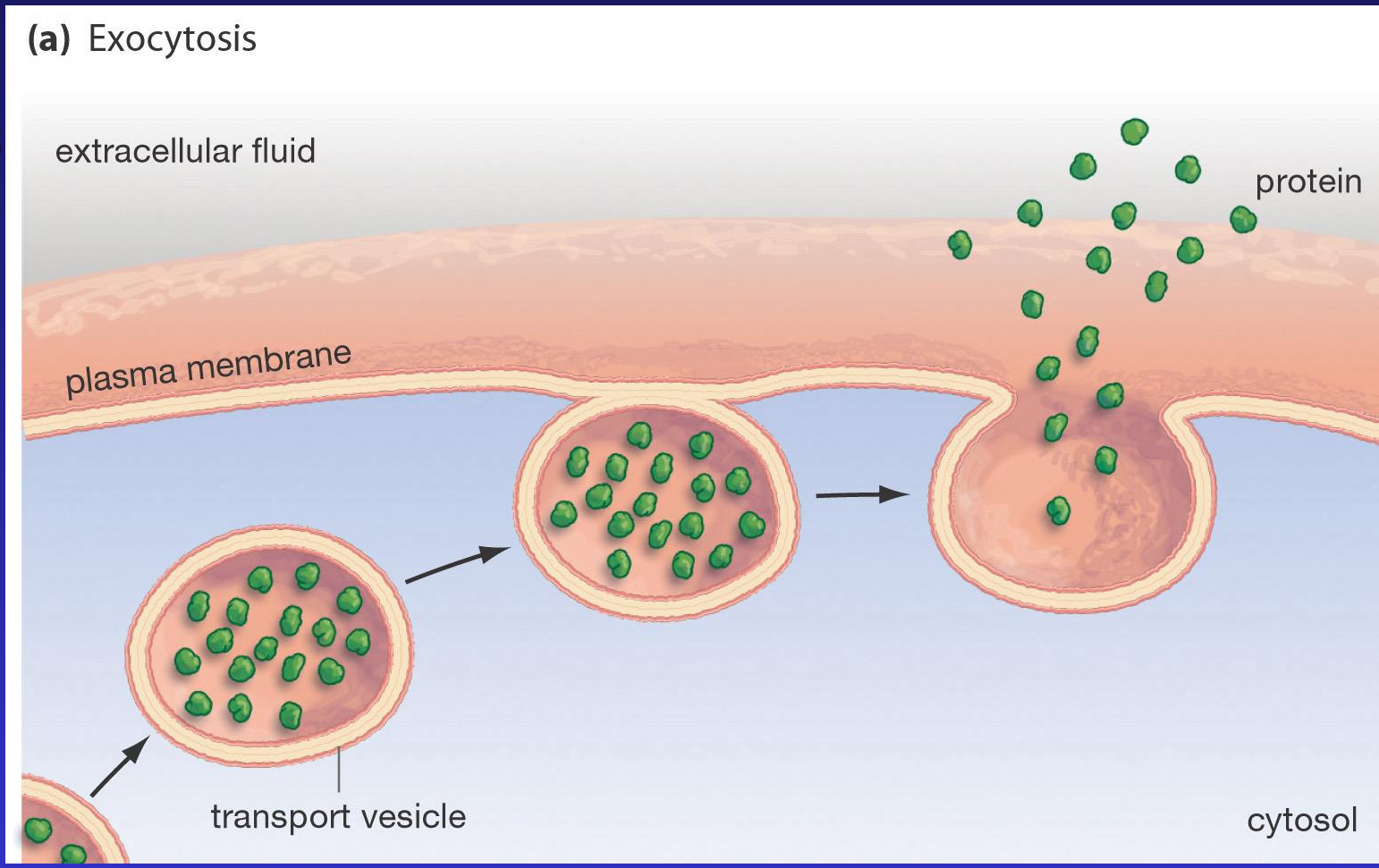
Sodium-Potassium Pump



3 Na+ pumped in for every 2 K+ pumped out; creates a membrane potential

Moving the "Big Stuff"

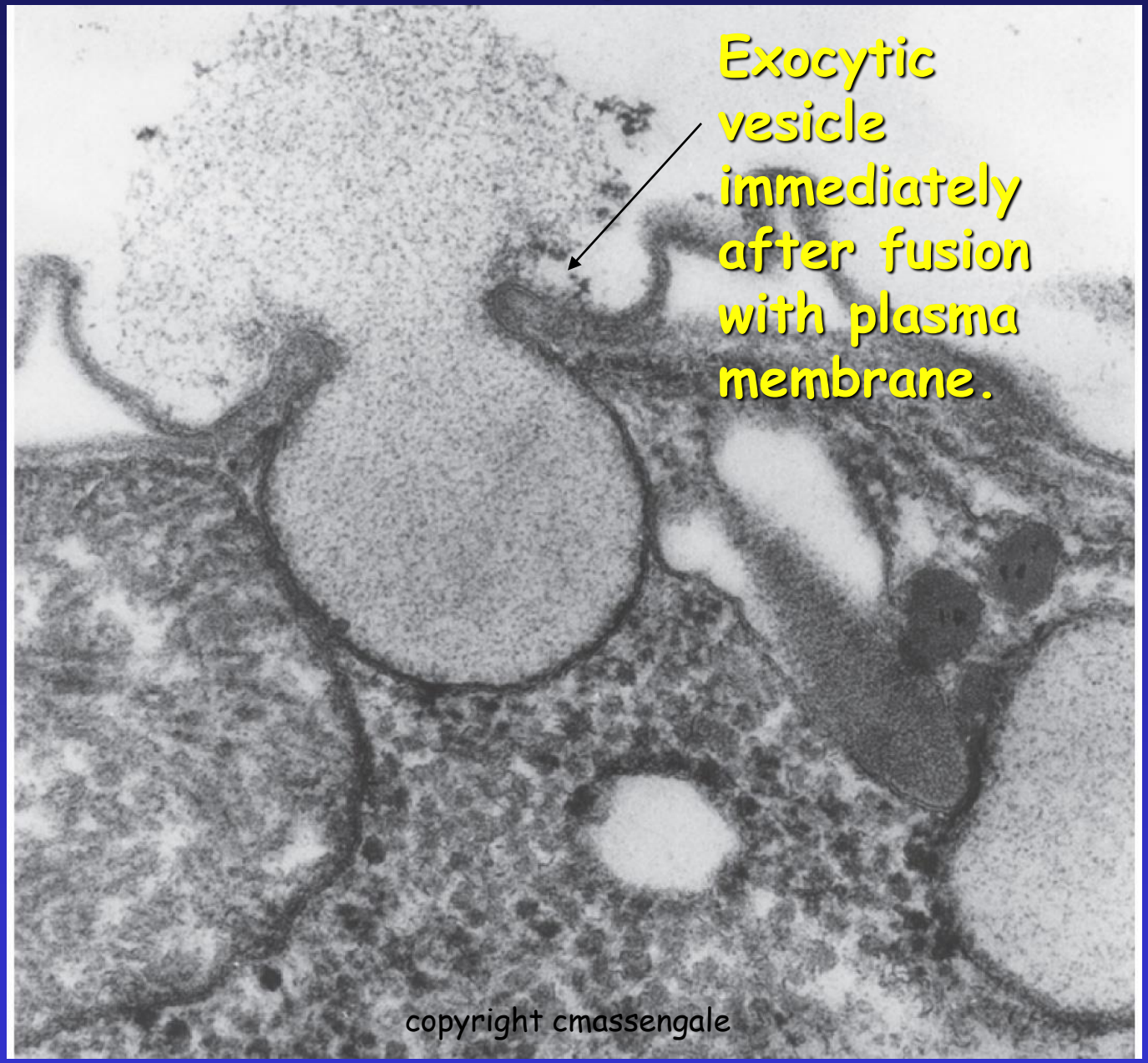
Exocytosis - moving things out.



Molecules are **moved out** of the cell by **vesicles** that **fuse** with the plasma membrane.

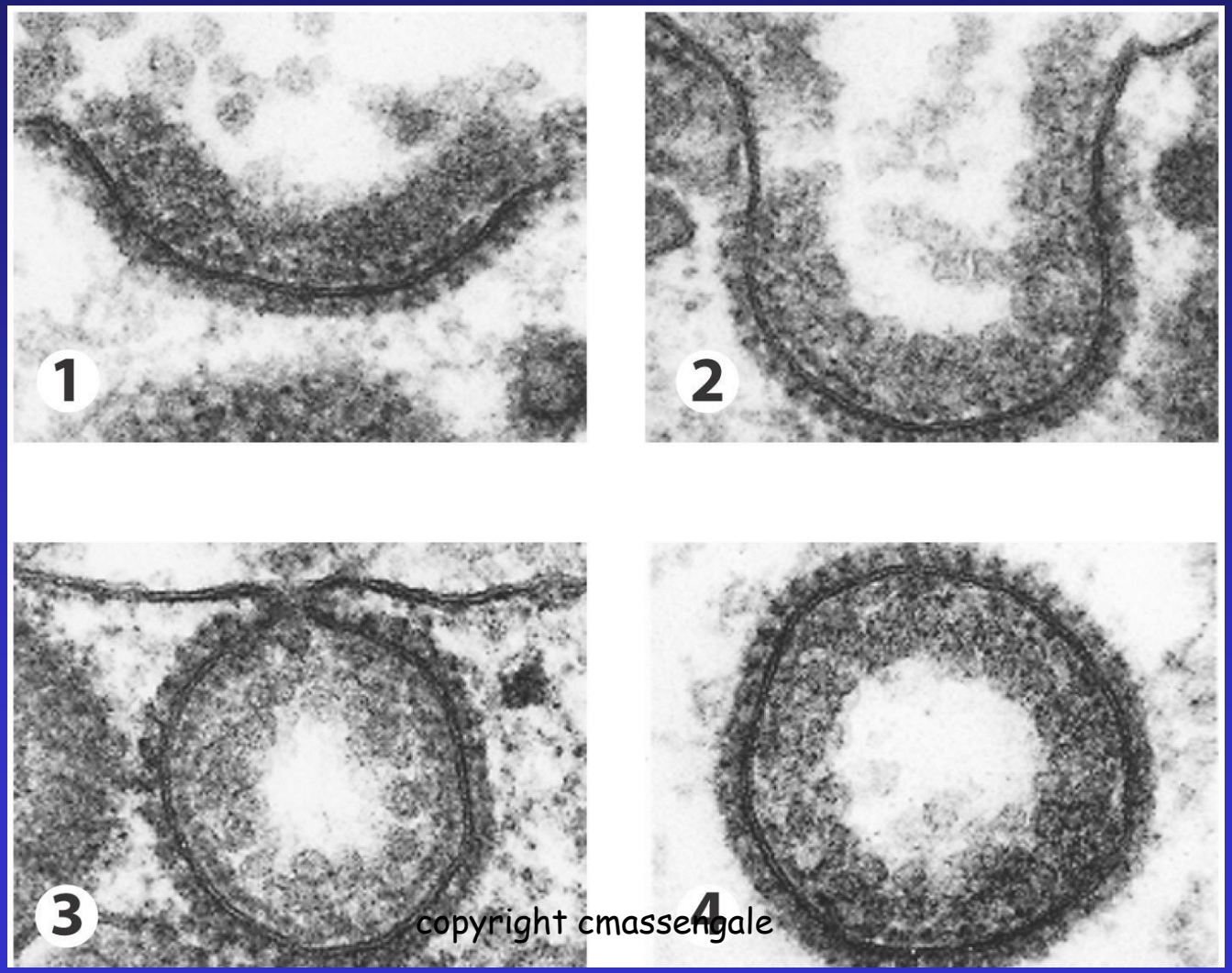
This is how many **hormones** are secreted and how **nerve cells** communicate with one another.

Exocytosis

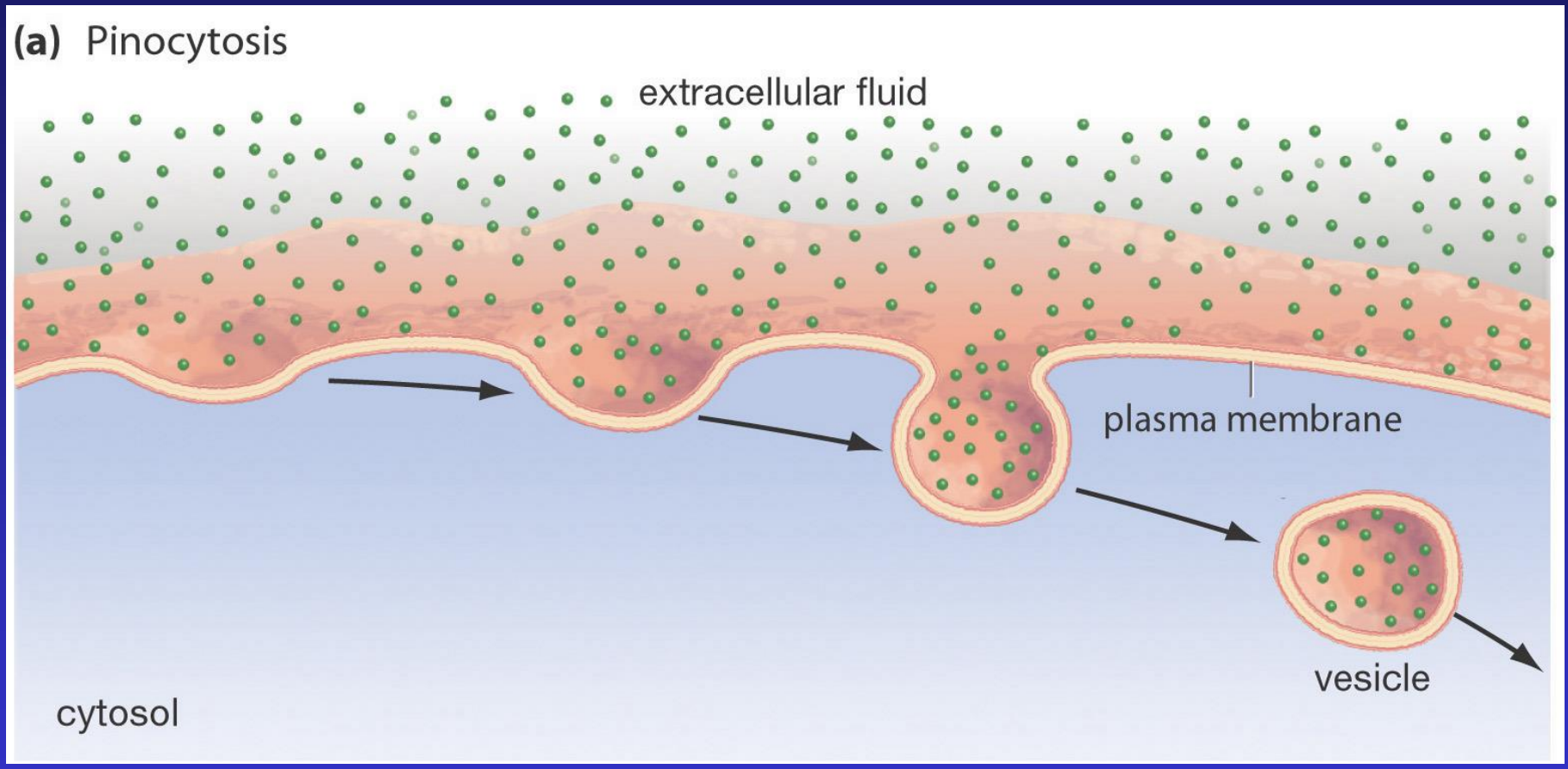

Exocytic vesicle immediately after fusion with plasma membrane.
copyright cmassengale

Moving the "Big Stuff"

Large molecules move materials into the cell by one of three forms of endocytosis.



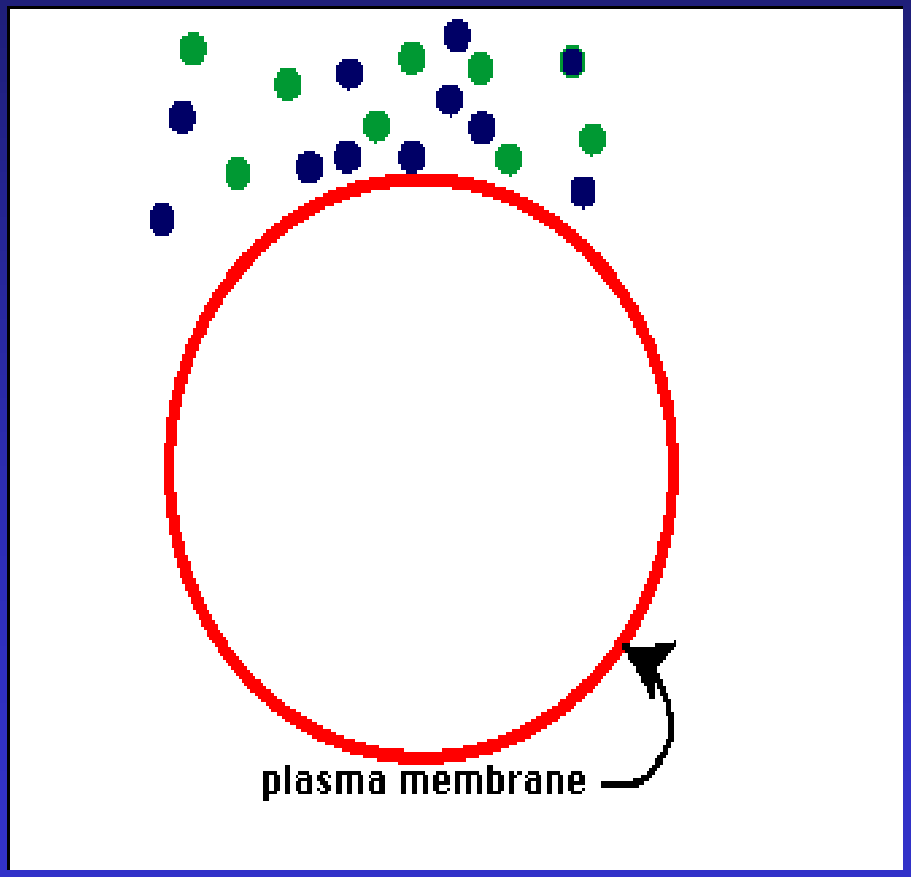
Pinocytosis



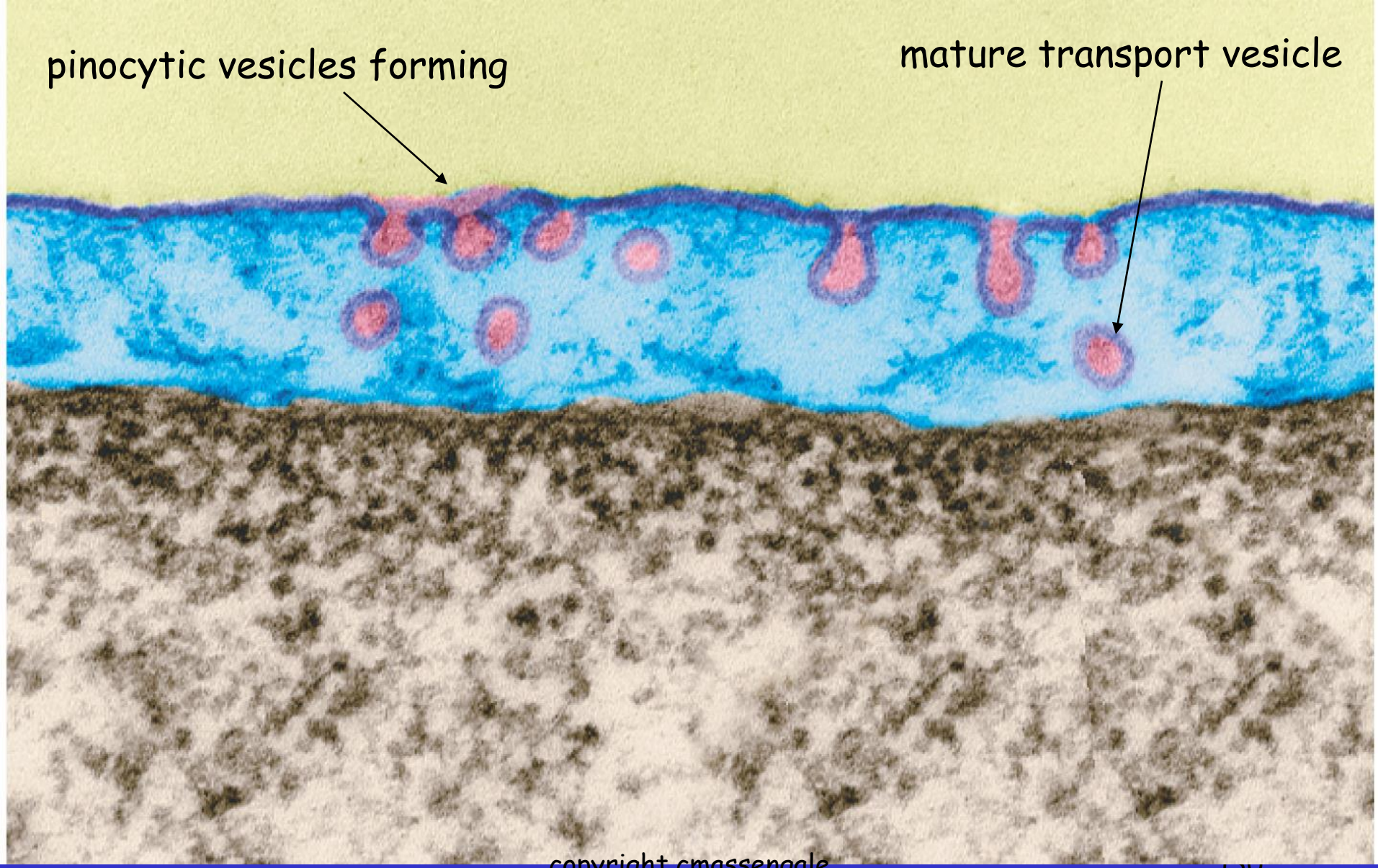
Most **common** form of endocytosis.
Takes in **dissolved** molecules as a vesicle.

Pinocytosis

- Cell forms an invagination
- Materials dissolve in water to be brought into cell
- Called "Cell Drinking"

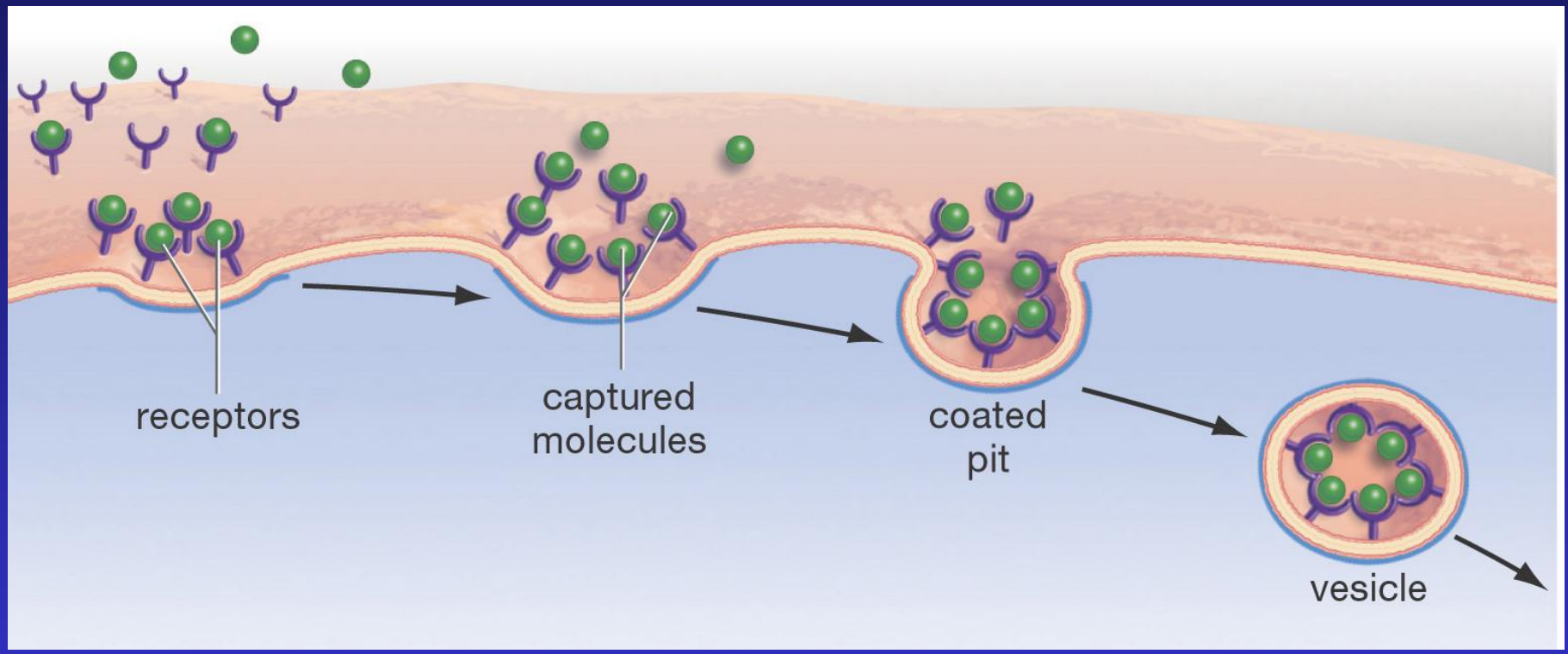


Example of Pinocytosis



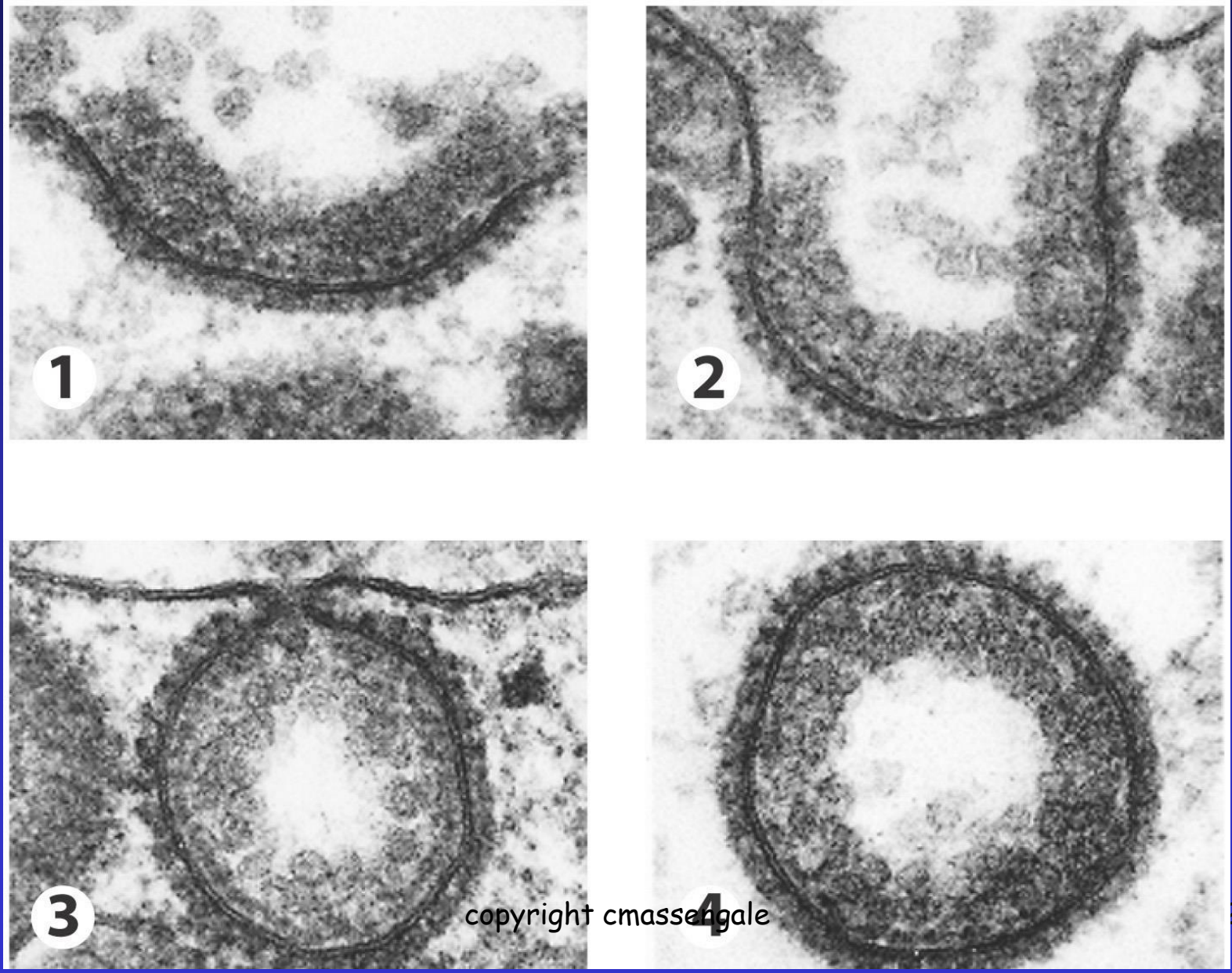
Transport across a capillary cell (blue).

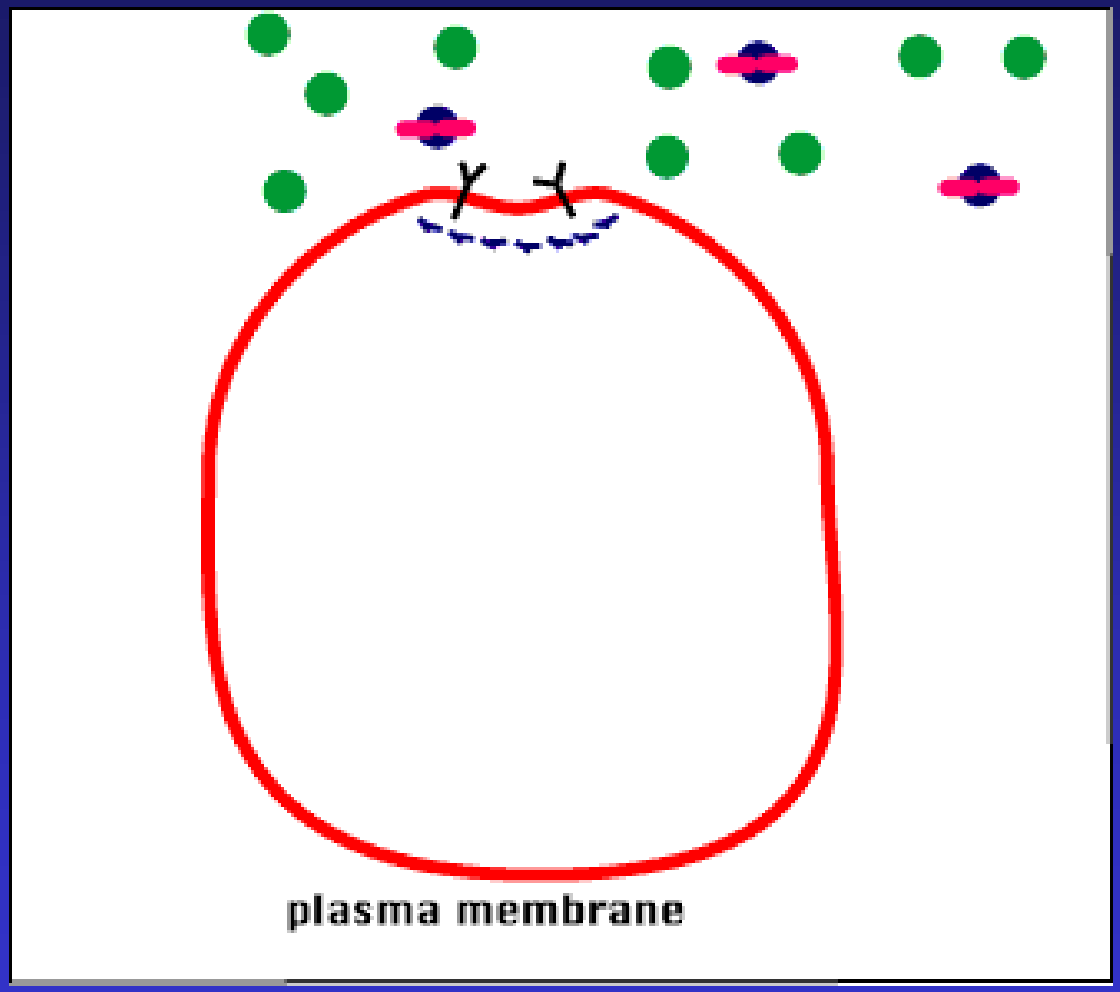
Receptor-Mediated Endocytosis



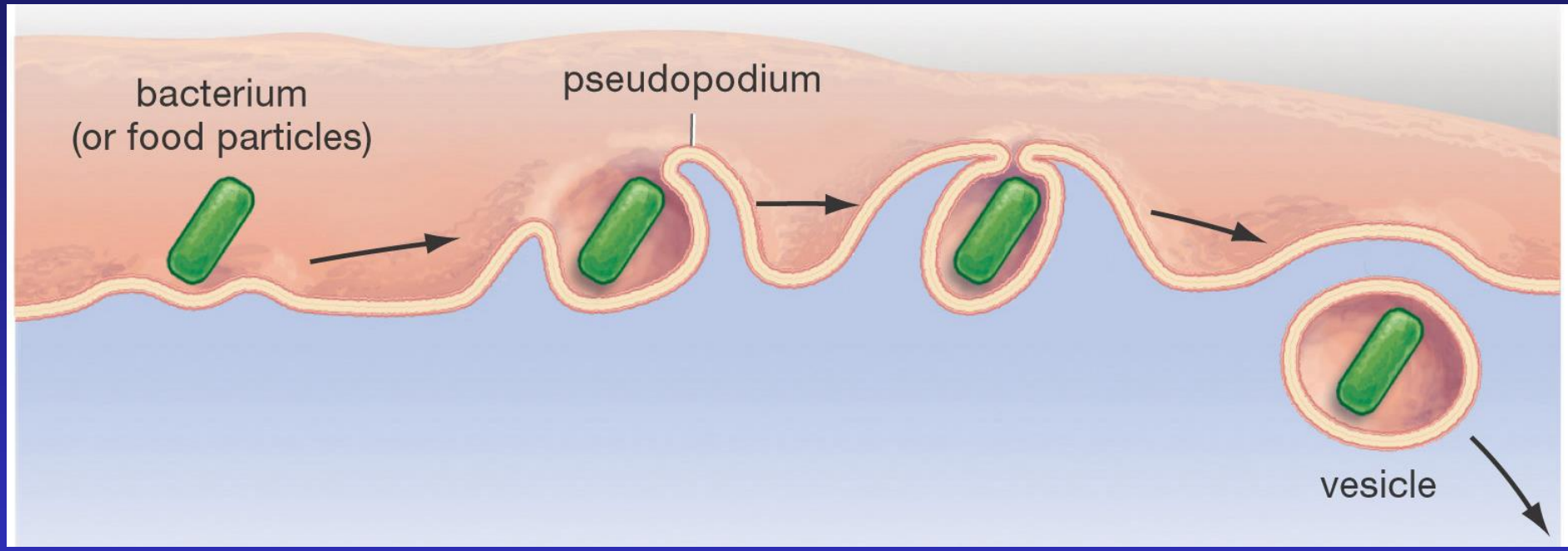
Some integral proteins have receptors on their surface to recognize & take in hormones, cholesterol, etc.

Receptor-Mediated Endocytosis



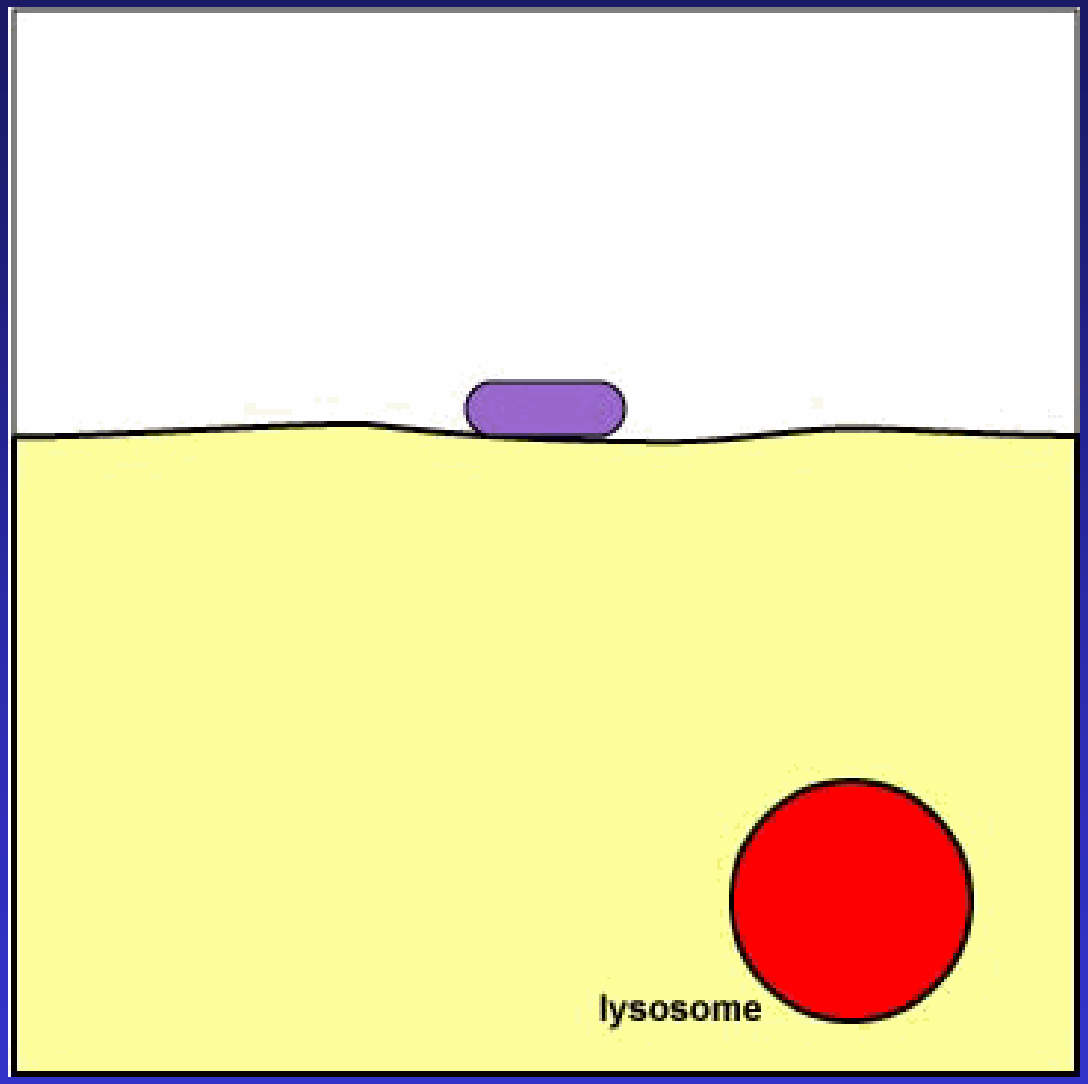


Endocytosis – Phagocytosis

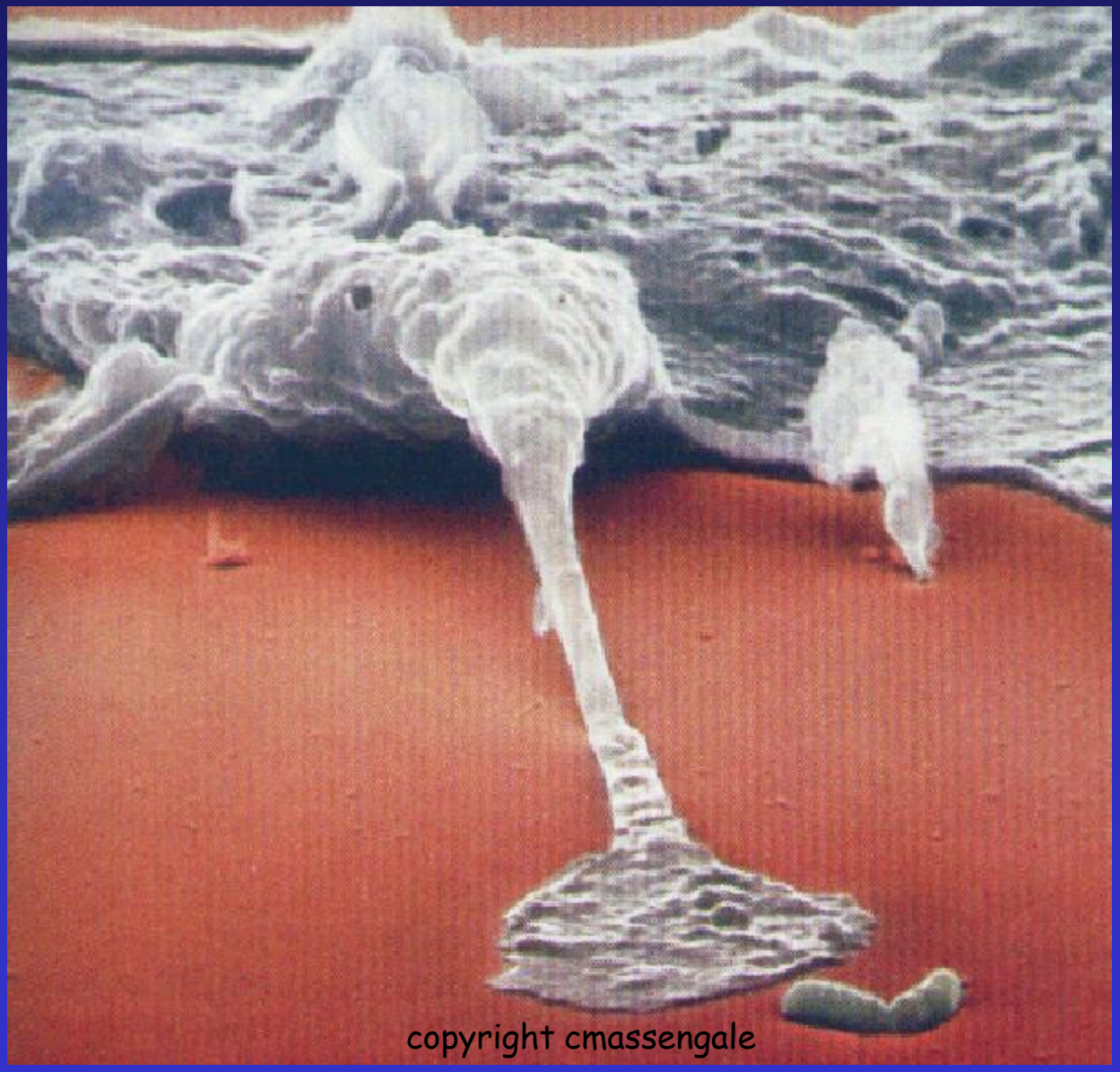


Used to **engulf large particles** such as food, **bacteria**, etc. into vesicles

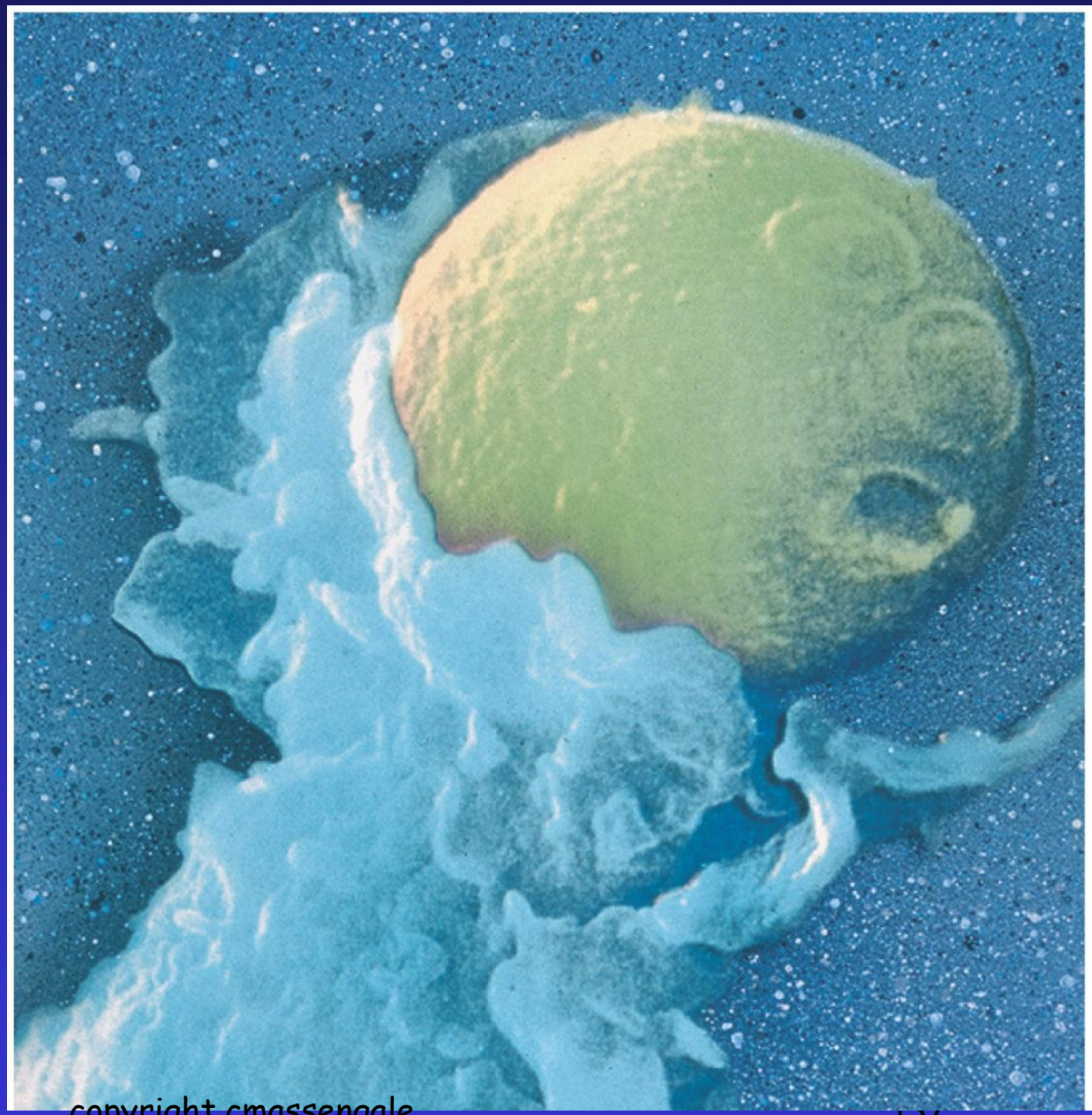
Called **"Cell Eating"**



Phagocytosis About to Occur

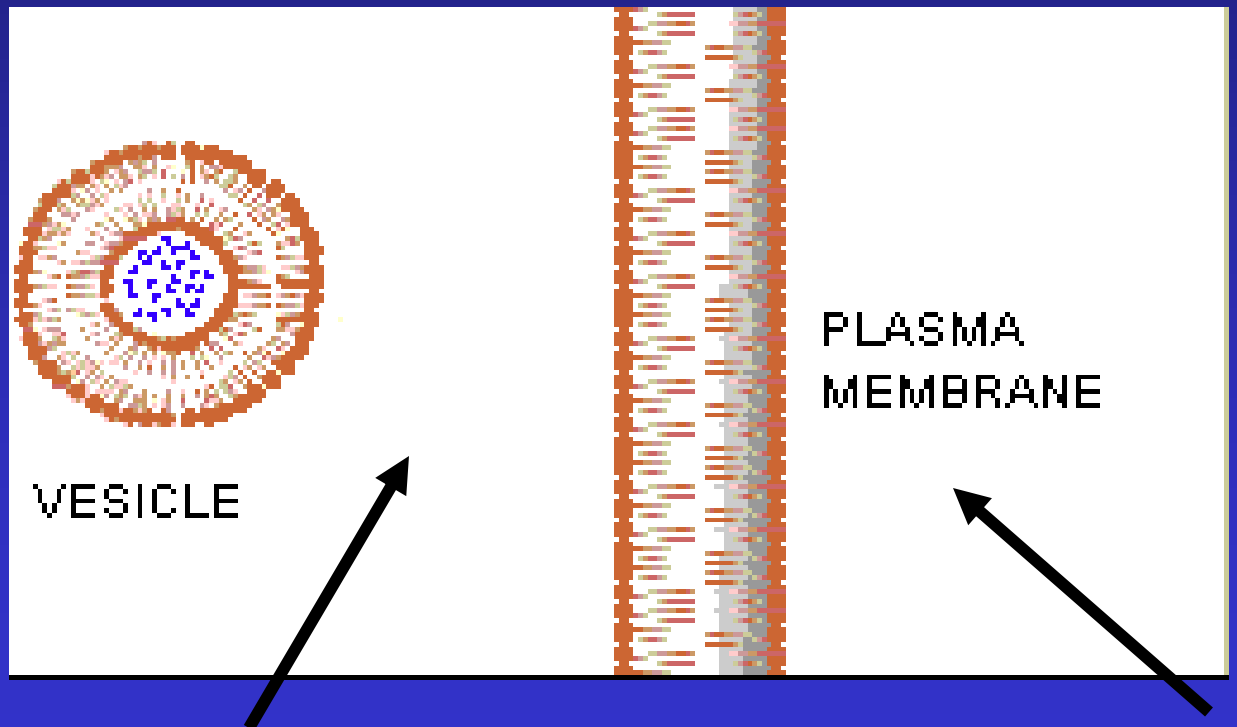


Phagocytosis - Capture of a **Yeast** Cell (yellow) by Membrane Extensions of an **Immune System Cell** (blue)



Exocytosis

The opposite of endocytosis is exocytosis. **Large molecules** that are manufactured in the cell are **released** through the cell membrane.



Asking a Question