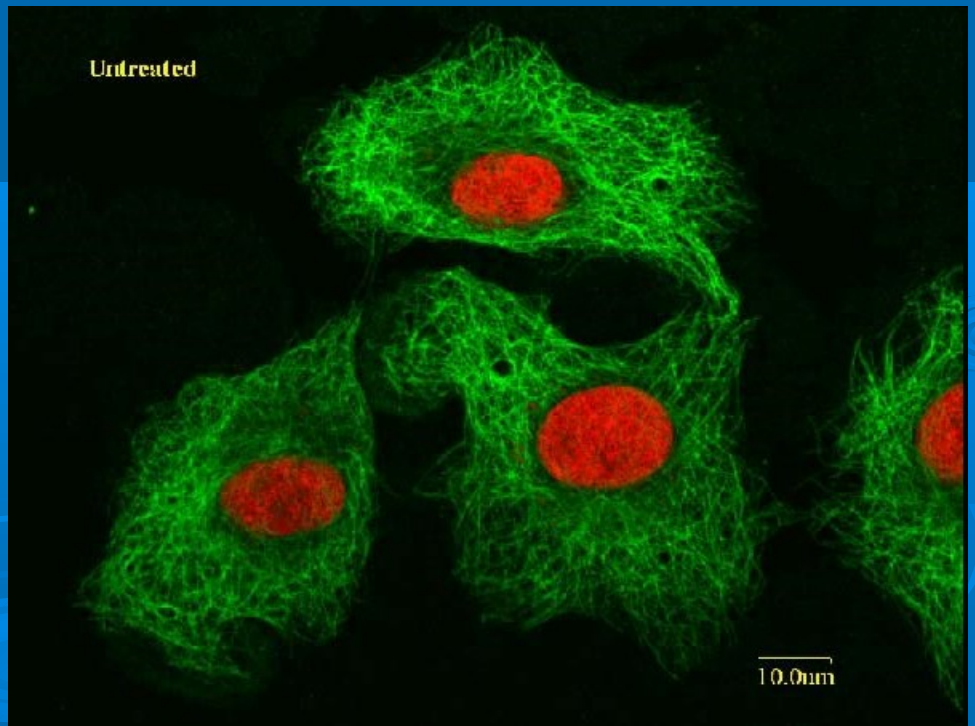
Inside the Dynamic Cell
Chapters 4 & 5

Animalcules and Beasties

- Van Leeuwenhoek was the first to describe small organisms seen through a microscope, which he called animalcules and beasties
- Hooke was the first to sketch and name cells
- We have as many as 100 trillion cells in our body!

The Cell Theory Emerges

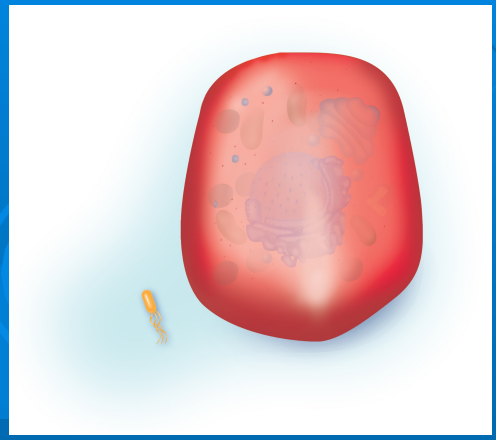
- In 1839, Schleiden and Schwann proposed the basic concepts of the modern **cell theory**
  - All organisms consists of one or more cells
  - Each new cell arises from division of another, preexisting cell



The Basics of Cell Structure

- All cells have a plasma membrane and cytoplasm, and all start out life with DNA
- 2 main types of cells
  - **Eukaryotic cell**
  - Cell interior is divided into functional compartments, including a nucleus

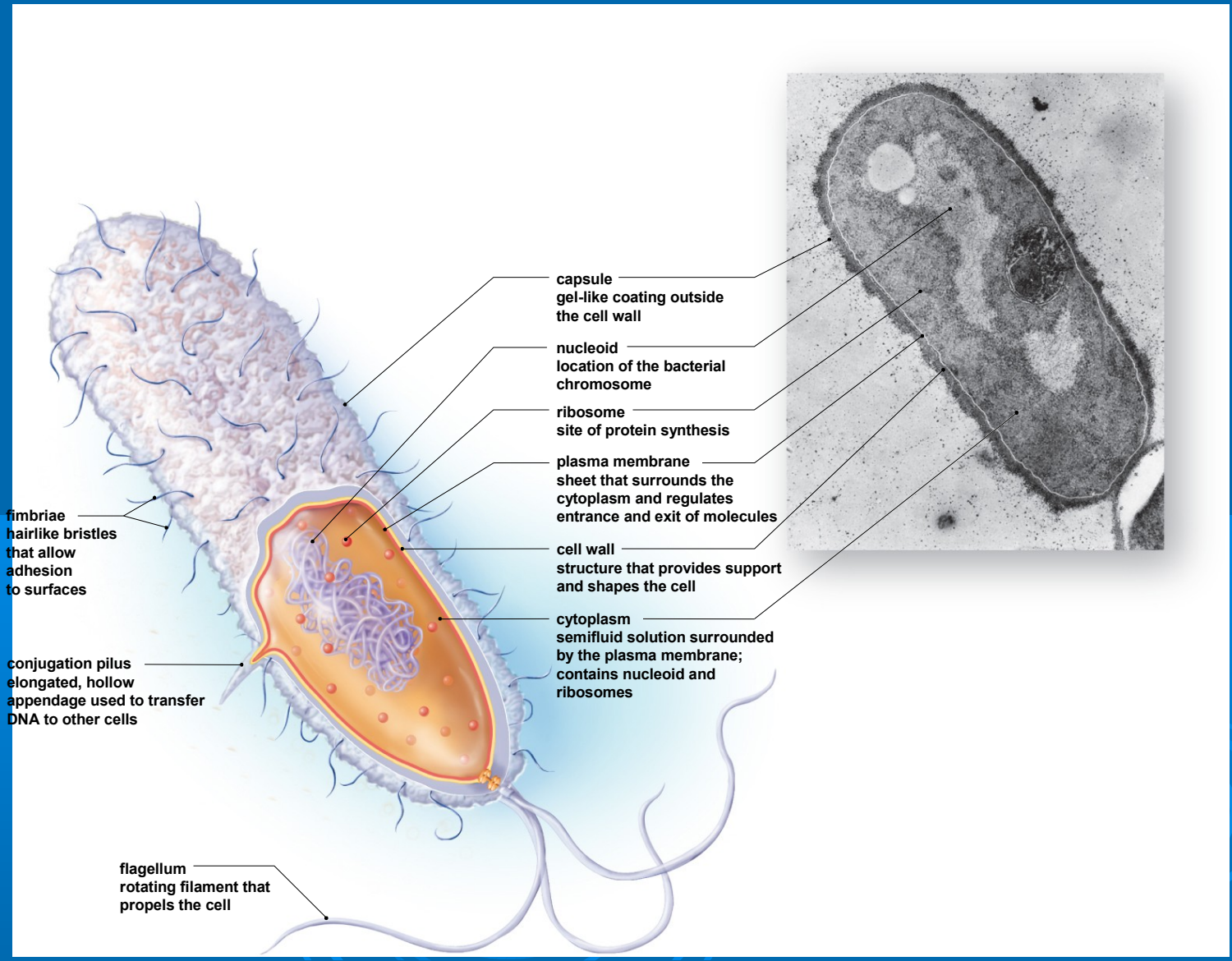
  - **Prokaryotic cell**
  - Small, simple cells without a nucleus
  - DNA in nucleoid region



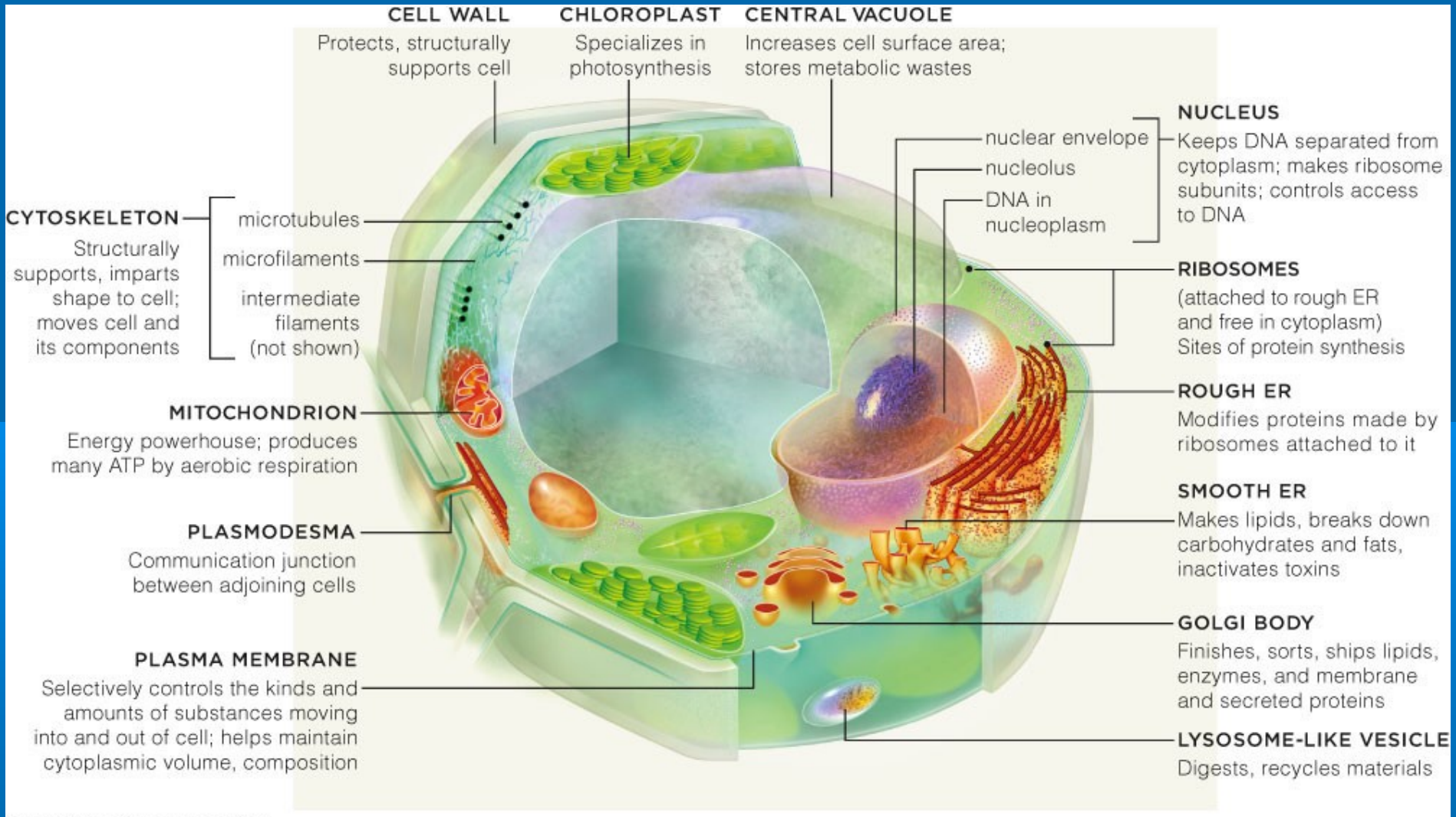
All Cells Have Three Things In Common

- **Plasma membrane**
  - Controls substances passing in and out of the cell
- DNA containing region
  - **Nucleus** in eukaryotic cells
  - **Nucleoid** region in prokaryotic cells
- **Cytoplasm**
  - A semifluid mixture containing cell components

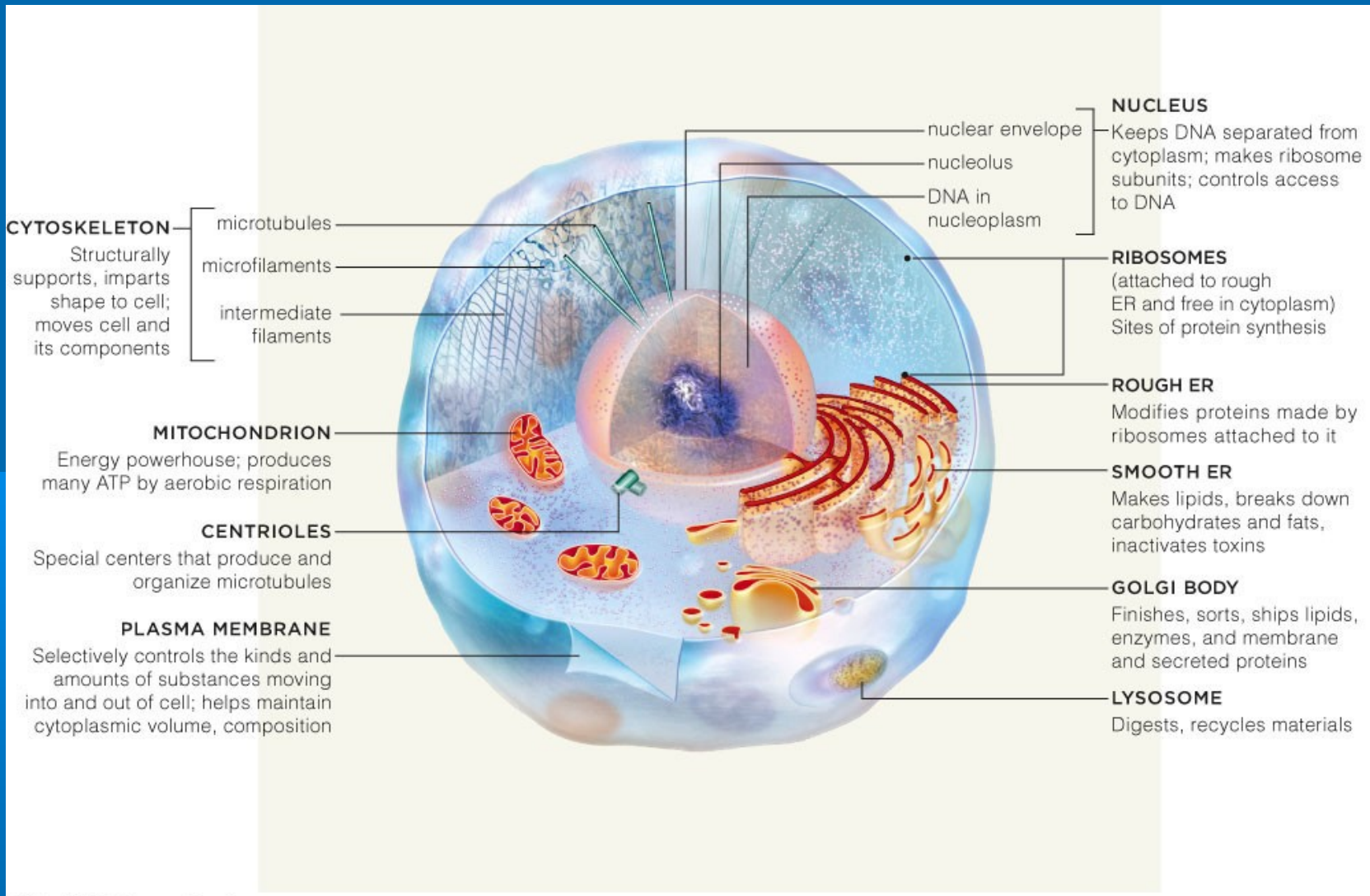
Organisms from the domains Bacteria and Archaea – Prokaryotic cells



Visual Summary of Eukaryotic Cells – Plant Cell



Visual Summary of Eukaryotic Cells – Animal Cell



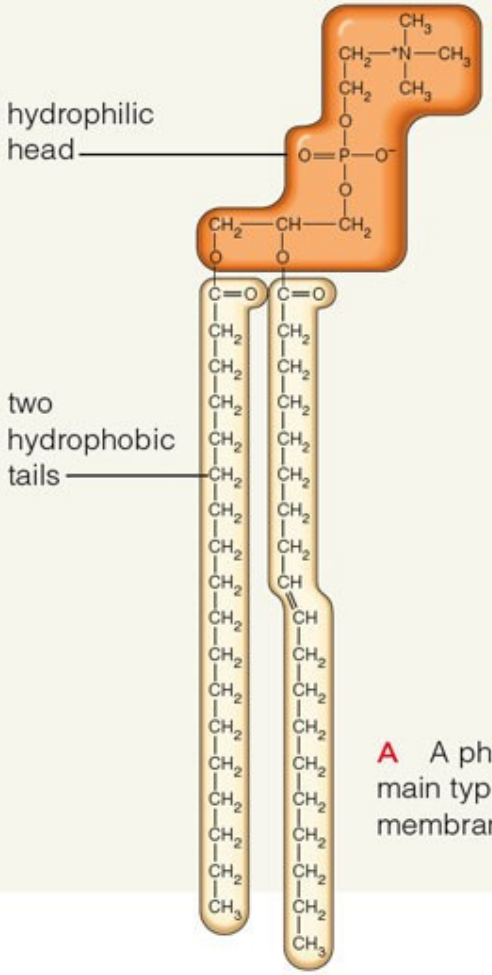
Organization of Cell Membranes

- The basic structure of all cell membranes is the lipid bilayer with many embedded proteins
- A membrane is a continuous, selectively permeable barrier

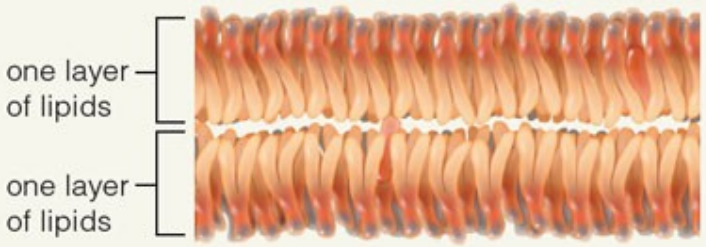
The Lipid Bilayer

- Phospholipid molecules in the plasma membrane have two parts
  - Hydrophilic heads interact with water molecules
  - Hydrophobic tails interact with each other, forming a barrier to hydrophilic molecules

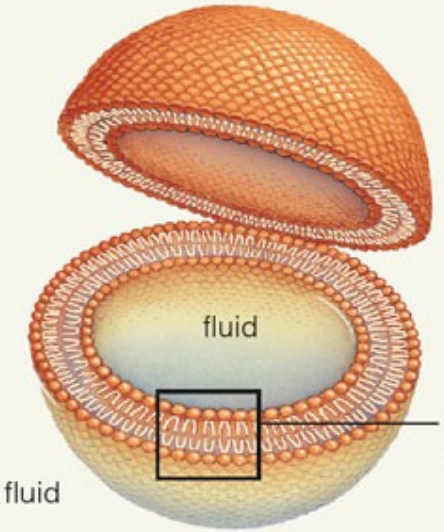
Basic Structure of Cell Membranes



A A phospholipid, the main type of lipid in cell membranes.



B A lipid bilayer has two layers of lipids, the tails of which are sandwiched between the heads. Proteins (not shown) typically intermingle among the lipids.



C The hydrophilic heads of the phospholipids bathe in the watery fluid on both sides of the bilayer.

Animation: Lipid bilayer organization

http://www.youtube.com/v/ULR79TiUj80

The Fluid Mosaic Model

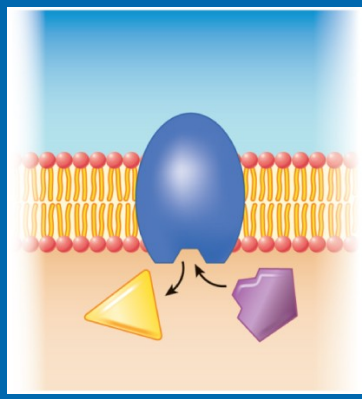
- **Fluid mosaic model**
  - Describes the organization of cell membranes
  - Phospholipids drift and move like a fluid
  - The bilayer is a mosaic mixture of phospholipids, steroids, proteins, and other molecules

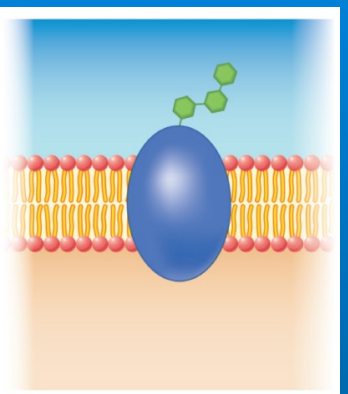
Membrane Proteins

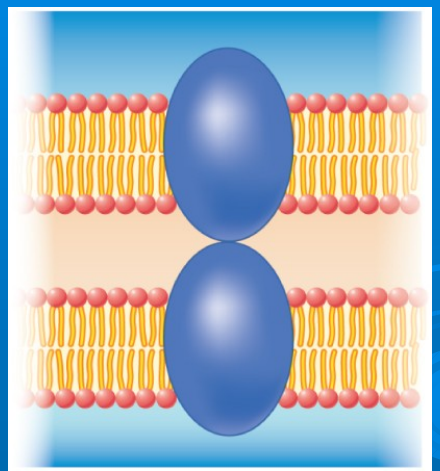
- Cell membrane function begins with the many proteins associated with the lipid bilayer

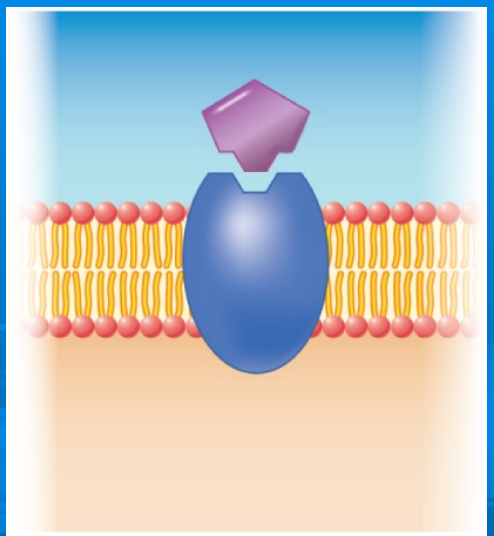
Membrane Proteins

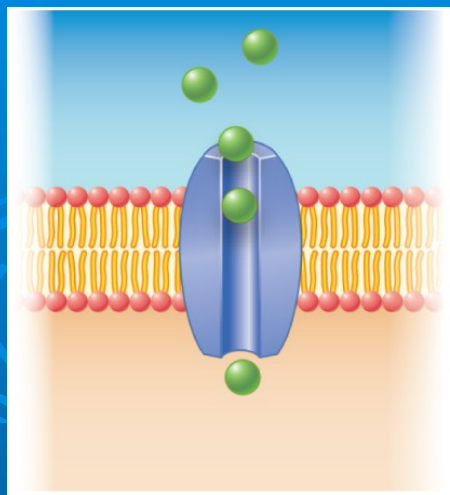
- Each type of protein in a membrane has a special function
  - **Recognition proteins**
  - **Receptor proteins**
  - **Enzymes**
  - **Transport proteins (active and passive)**
  - **Junction proteins**











Cell membranes: animation!

http://www.youtube.com/v/GW0lqf4Fqpg

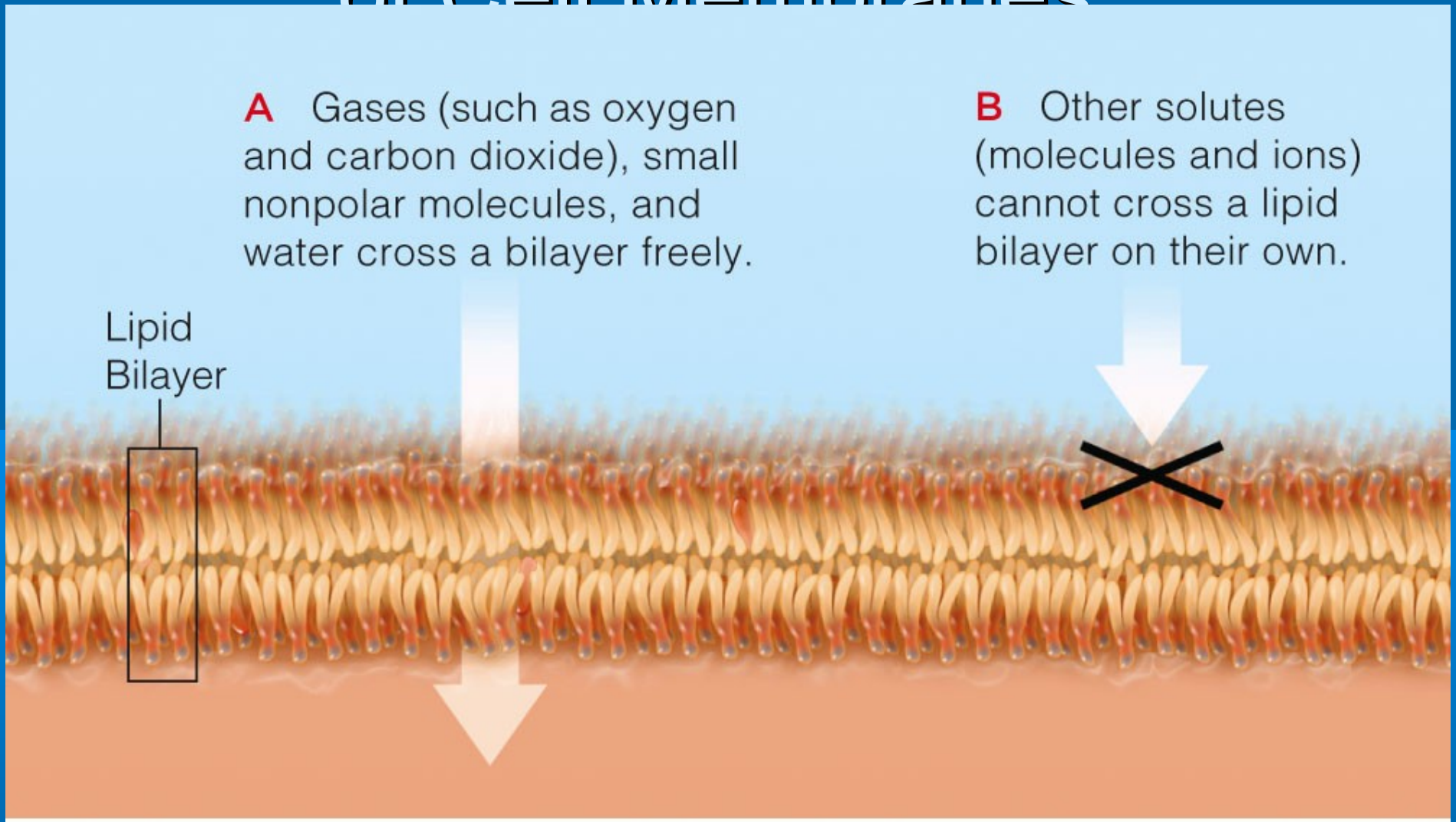
Cell Transport

- Ions and molecules tend to move from one region to another, in response to gradients

- **Concentration gradient**
  - The difference in concentration (# molecules in fluid) between two adjacent regions
  - Molecules move from a region of higher concentration to one of lower concentration

- The cell membrane is selectively permeable

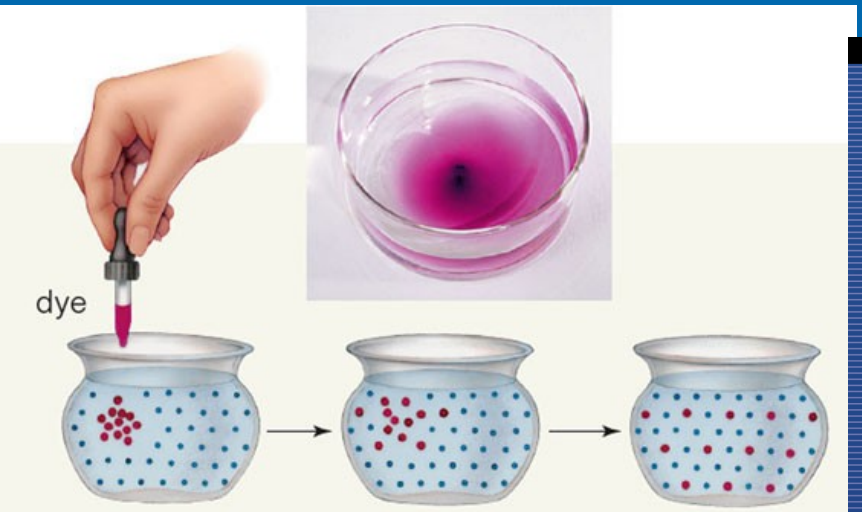
The Selectively Permeable Nature of Cell Membranes



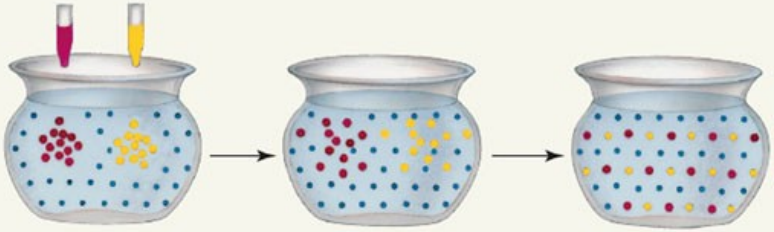
3 Ways To Enter the Membrane

- Passive Transport – higher to lower concentrations, no energy needed
  - Diffusion
  - Facilitated diffusion
- Active Transport – lower to higher concentration, requires energy
- Bulk Transport – independent of gradients, requires energy, large molecules

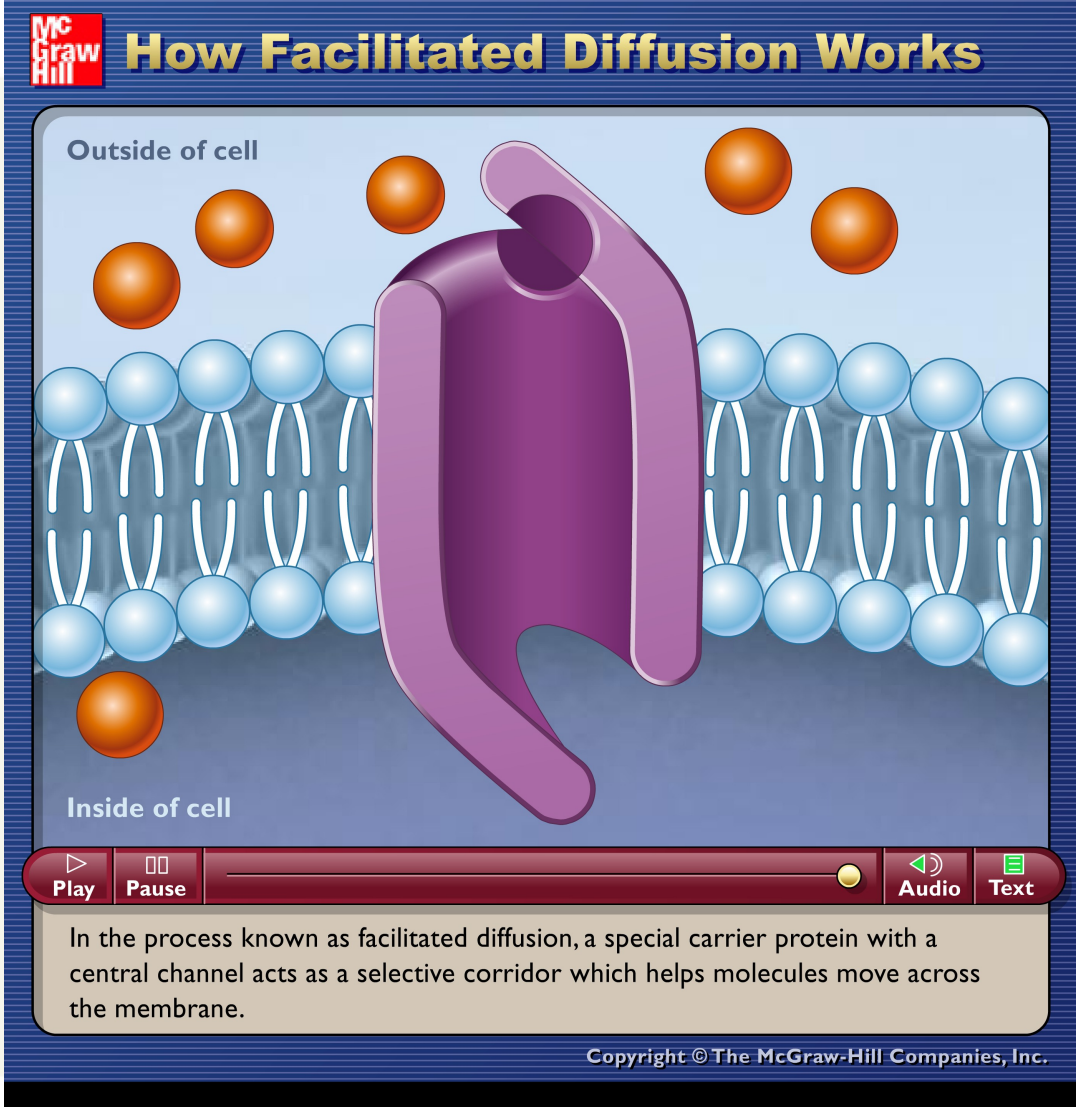
Examples of Diffusion



A Dye is dropped into a bowl of water. The dye molecules diffuse until they are evenly dispersed among the water molecules.

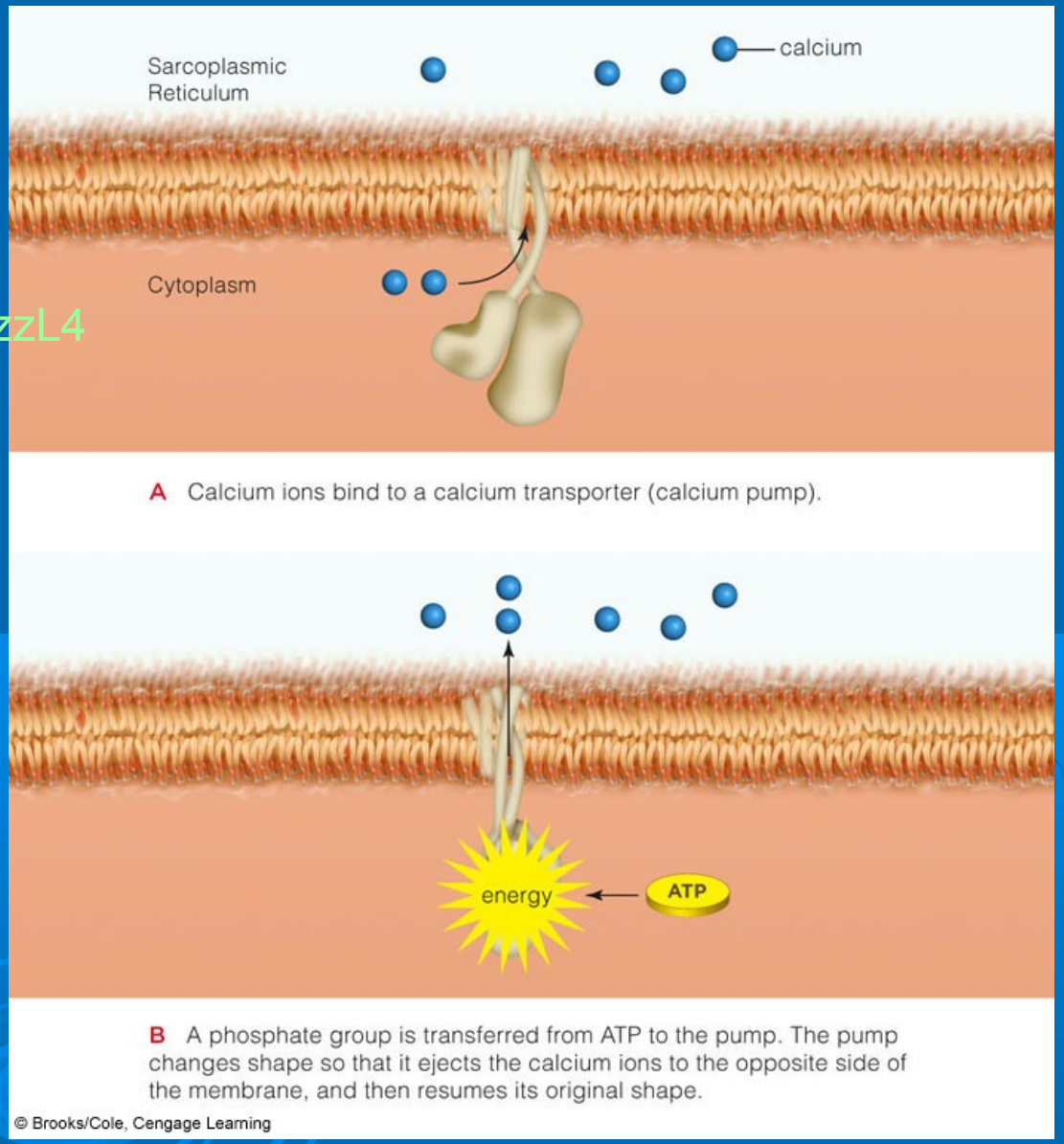


B *Red* dye and *yellow* dye are added to a bowl of water. Each substance moves according to its own concentration gradient until all are evenly dispersed.

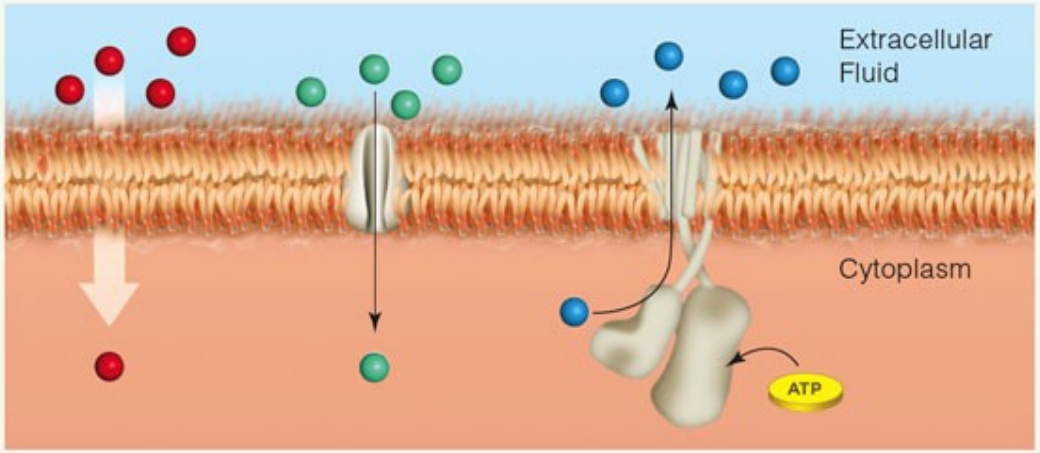


Active Transport: Calcium Pump

http://www.youtube.com/v/STzOiRqzzL4



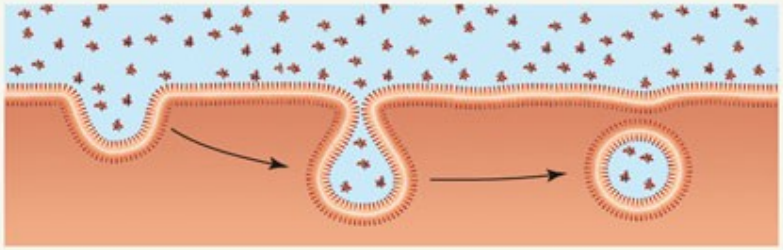
Membrane-Crossing Mechanisms



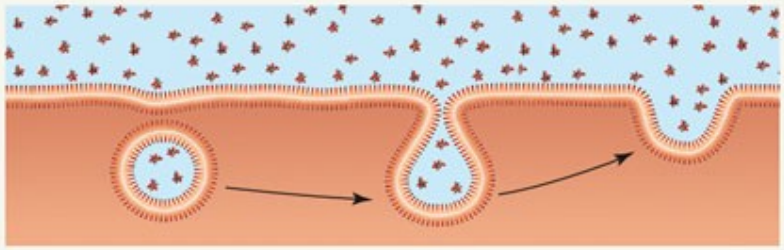
A Diffusion A substance simply diffuses across lipid bilayer.

B Passive Transport A solute moves across bilayer through interior of passive transporter; movement is driven by concentration gradient.

C Active Transport Active transporter uses energy (often, ATP) to pump a solute through bilayer against its concentration gradient.



D Endocytosis Vesicle movement brings substances in bulk into cell.



E Exocytosis Vesicle movement ejects substances in bulk from cell.

Bulk Transport

Bulk Transport - Endocytosis and Exocytosis

- Vesicles take substances in or out of the cell
  - Exocytosis – out of cell
  - Endocytosis – into cell

http://www.youtube.com/v/HndmASfmI8Y

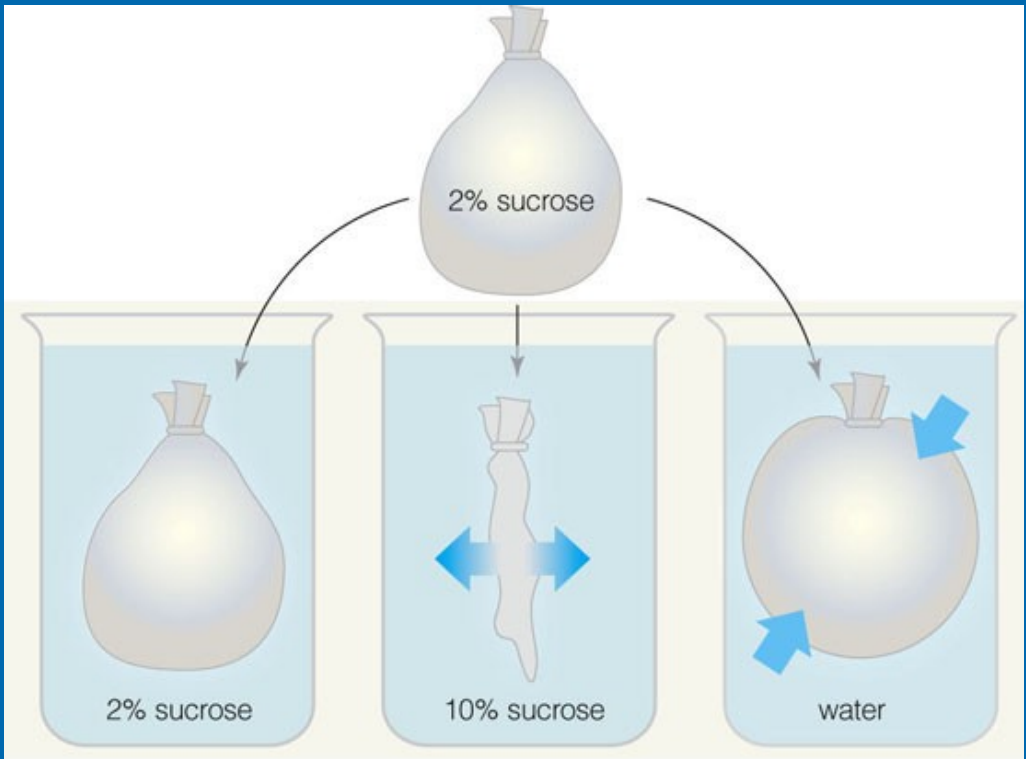
http://www.youtube.com/watch?v=U9pvm_4-bHg&feature=player_embedded

Which Way Will Water Move?

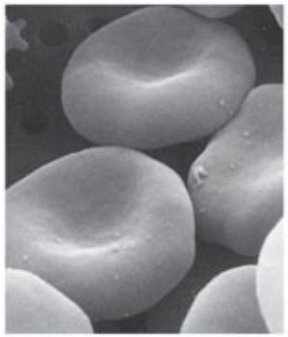
- Water diffuses across cell membranes by osmosis
  - The movement of water down its concentration gradient – from a region of lower solute concentration to a region of higher solute concentration
- Osmosis is driven by tonicity
- **Tonicity**
  - The relative concentrations of solutes in two fluids separated by a selectively permeable membrane

Tonicity

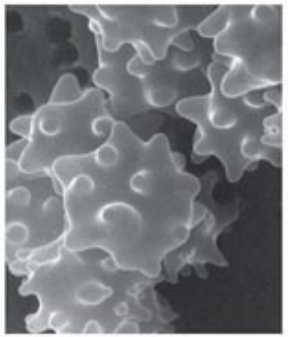
Water moves from a region of lower solute concentration to a region of higher solute concentration



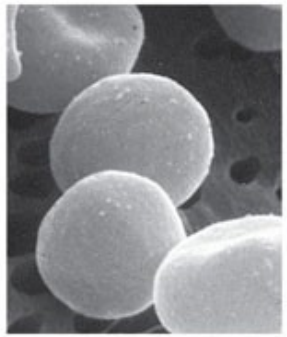
A What happens to a semipermeable membrane bag when it is immersed in an isotonic, a hypertonic, or a hypotonic solution?



B Red blood cells in an isotonic solution do not change in volume.



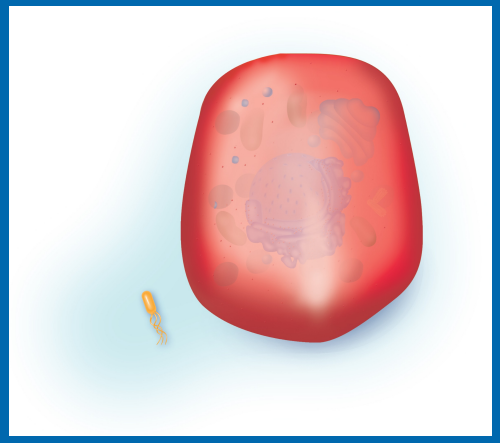
C Red blood cells in a hypertonic solution shrivel because water diffuses out of them.



D Red blood cells in a hypotonic solution swell because water diffuses into them.

Eukaryotic Cells – a closer look

- Eukaryotic organisms
  - Plants
  - Animals
  - Protistans
  - Fungi



- Eukaryotic ("true nucleus") cells carry out much of their metabolism inside membrane-enclosed organelles
- **Organelle**
  - A structure that carries out a specialized function within a cell

Organelles of Eukaryotic Cells

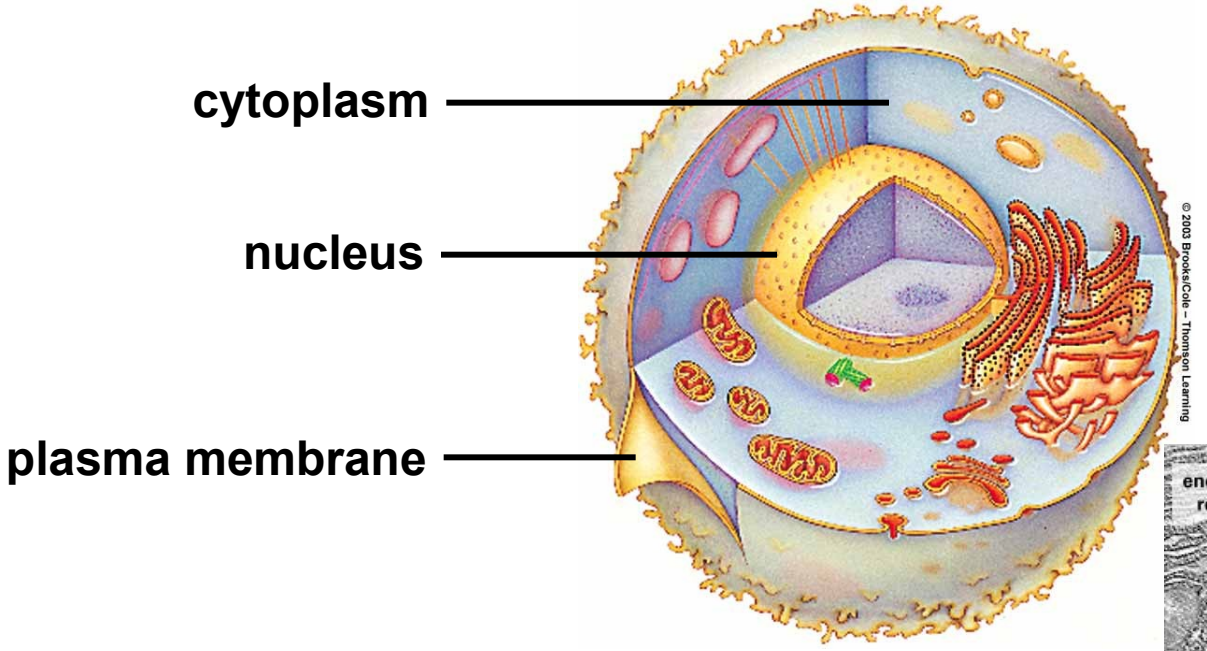
4 categories of organelles:

1. Nucleus and ribosomes
2. Endomembrane system
3. Energy-related
4. Cytoskeleton

1. Nucleus & Ribosomes

- The nucleus keeps eukaryotic DNA away from potentially damaging reactions in the cytoplasm
- The nuclear envelope controls when DNA is accessed

Nucleus


cytoplasm
nucleus
plasma membrane
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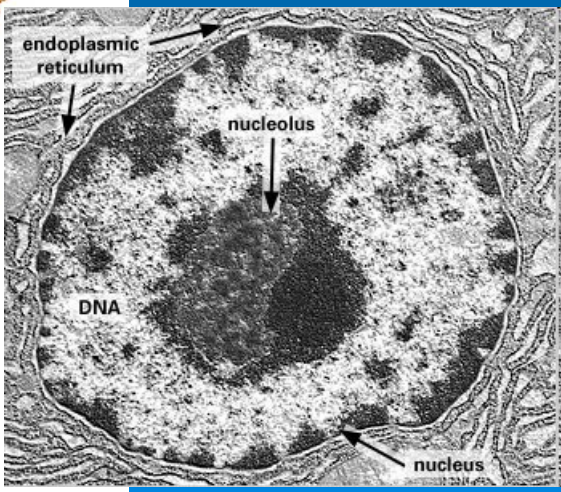
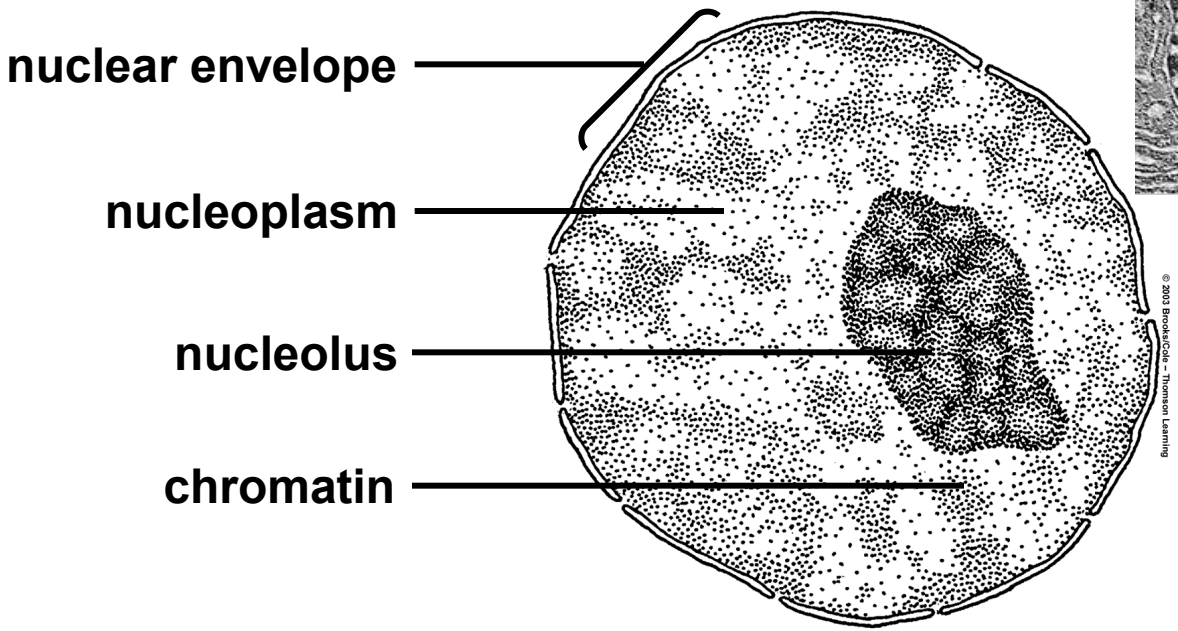

endoplasmic reticulum
nucleolus
DNA
nucleus


nuclear envelope
nucleoplasm
nucleolus
chromatin
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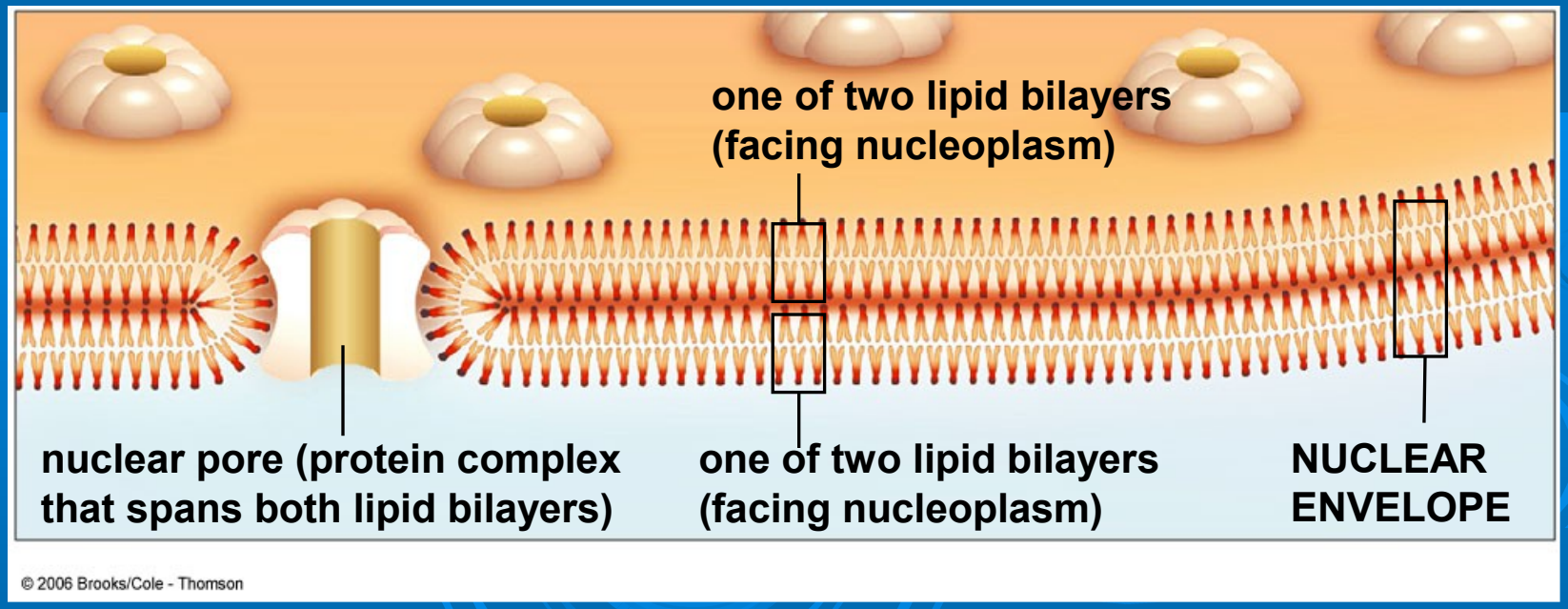
The Nuclear Envelope

- **Nuclear envelope**
  - Two lipid bilayers pressed together as a single membrane surrounding the nucleus
  - Outer bilayer is continuous with the ER
  - Nuclear pores allow certain substances to pass through the membrane



The Nucleoplasm and Nucleolus

- **Nucleoplasm**
  - Viscous fluid inside the nuclear envelope, similar to cytoplasm

- **Nucleolus**
  - A dense region in the nucleus where subunits of **ribosomes** are assembled from proteins and RNA
    - Ribosomes help in making proteins! We'll see more later!!!

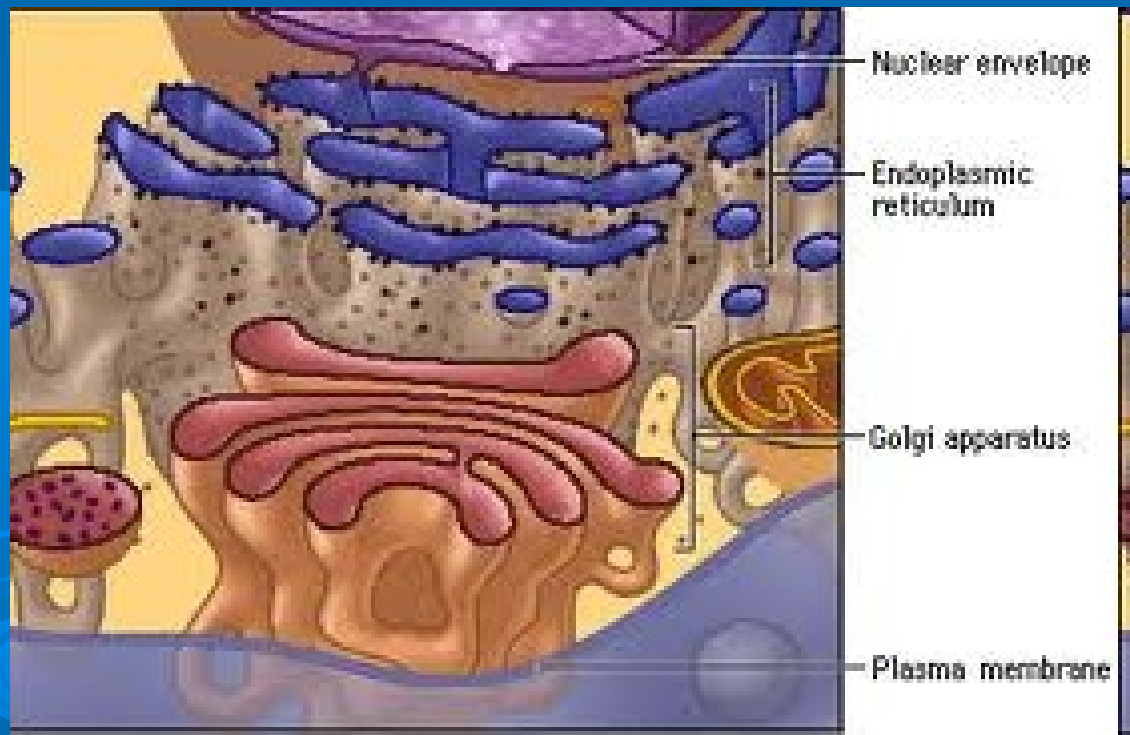
The Chromosomes

- **Chromatin**
  - All DNA and its associated proteins in the nucleus

- **Chromosome**
  - A single DNA molecule with its attached proteins
  - Human body cells have 46 chromosomes

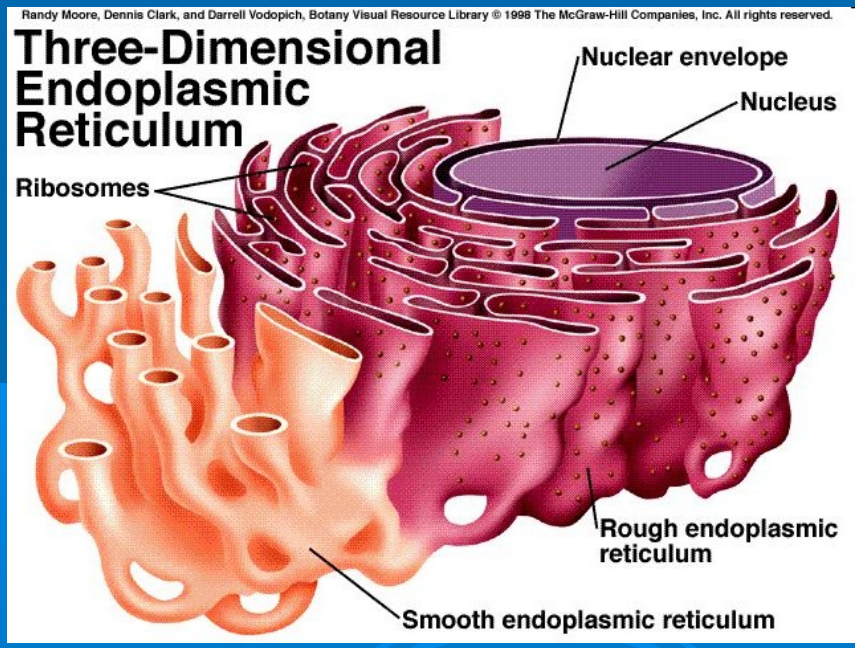
2. The Endomembrane System

- A series of interacting organelles between the nucleus and the plasma membrane
  - Nuclear envelope – already talked about!
  - Endoplasmic reticulum (ER)
  - Golgi apparatus
  - Vesicles



The Endoplasmic Reticulum

- **Endoplasmic reticulum (ER)**
  - An extension of the nuclear envelope that forms a continuous, folded compartment
  - Two kinds of endoplasmic reticulum
    - Rough ER (with ribosomes) that modifies proteins
    - Smooth ER (no ribosomes) makes lipids, breaks down carbohydrates and lipids, detoxifies poisons

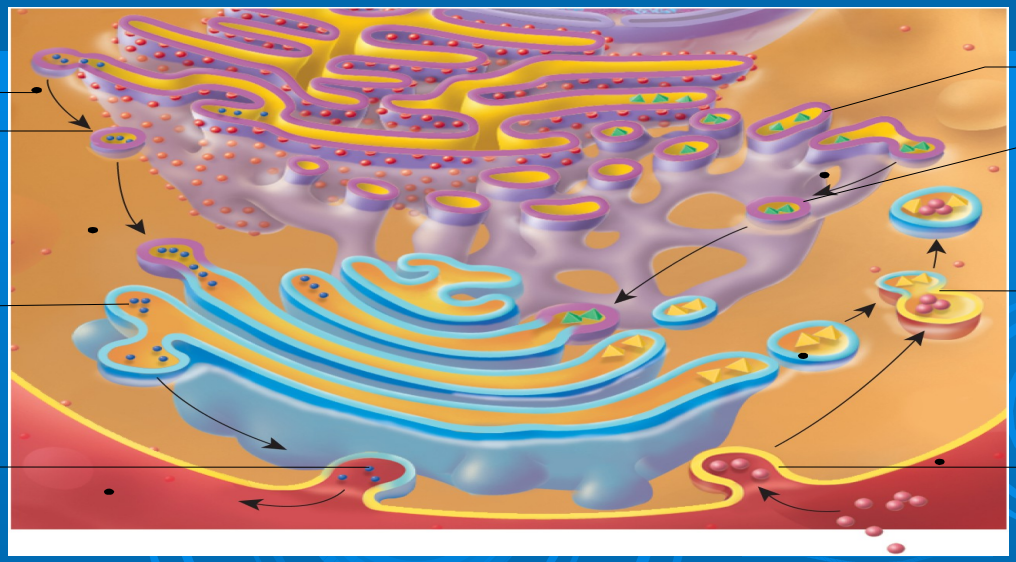


Golgi Apparatus

- A folded membrane containing enzymes that finish polypeptides and lipids delivered by the ER in vesicles
- Packages finished products in vesicles that carry them to the plasma membrane or to lysosomes

Vesicles

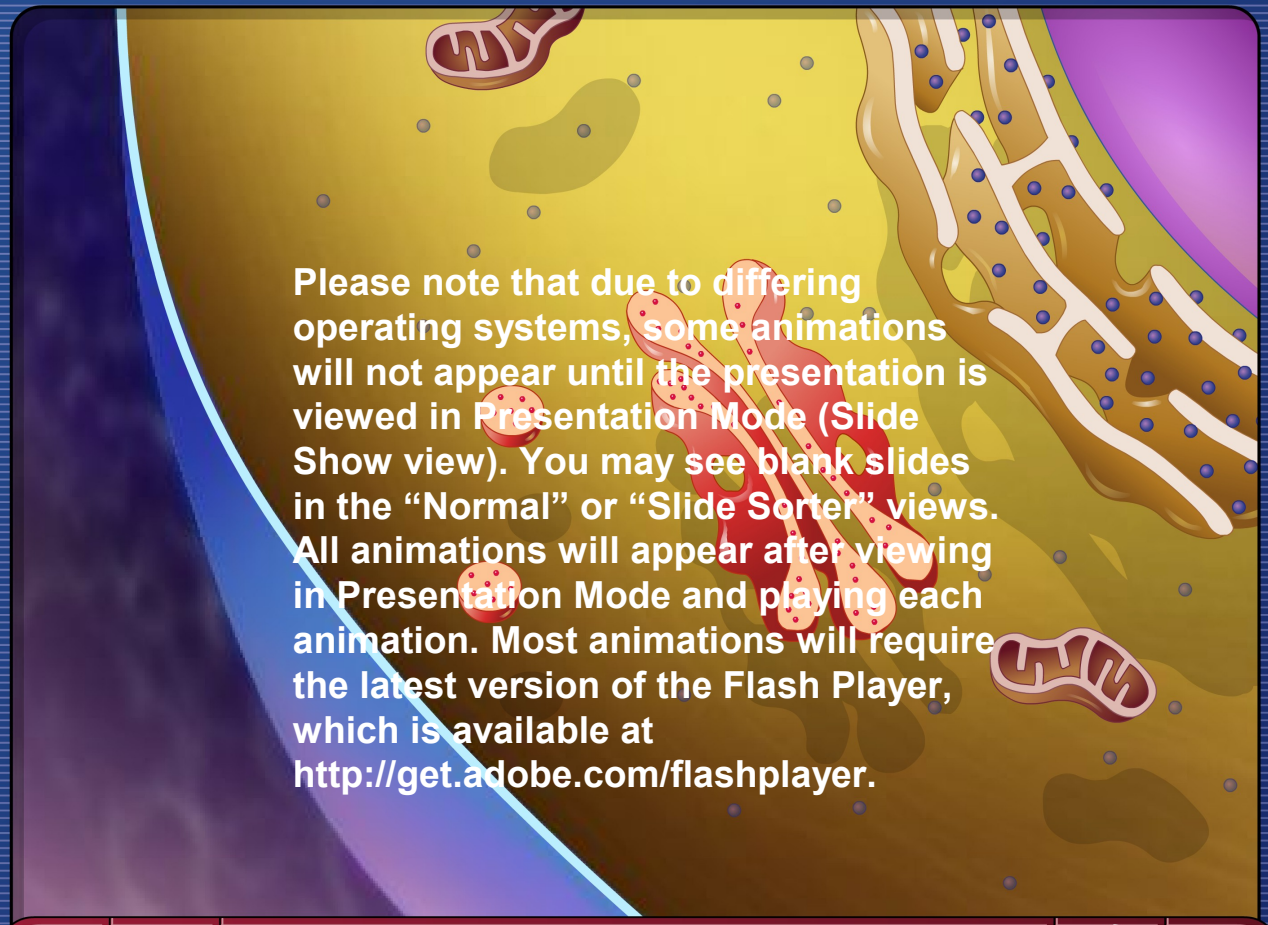
- Small, membrane-enclosed saclike organelles that store or transport substances



Special Types of Vesicles

- **Lysosomes (made in Golgi)**
  - Vesicles that digest molecules or portions of the cell – have digestive enzymes!
- **Peroxisomes**
  - Vesicles containing enzymes that break down hydrogen peroxide, alcohol, and other toxins
- **Vacuoles**
  - Vesicles for waste disposal, storage

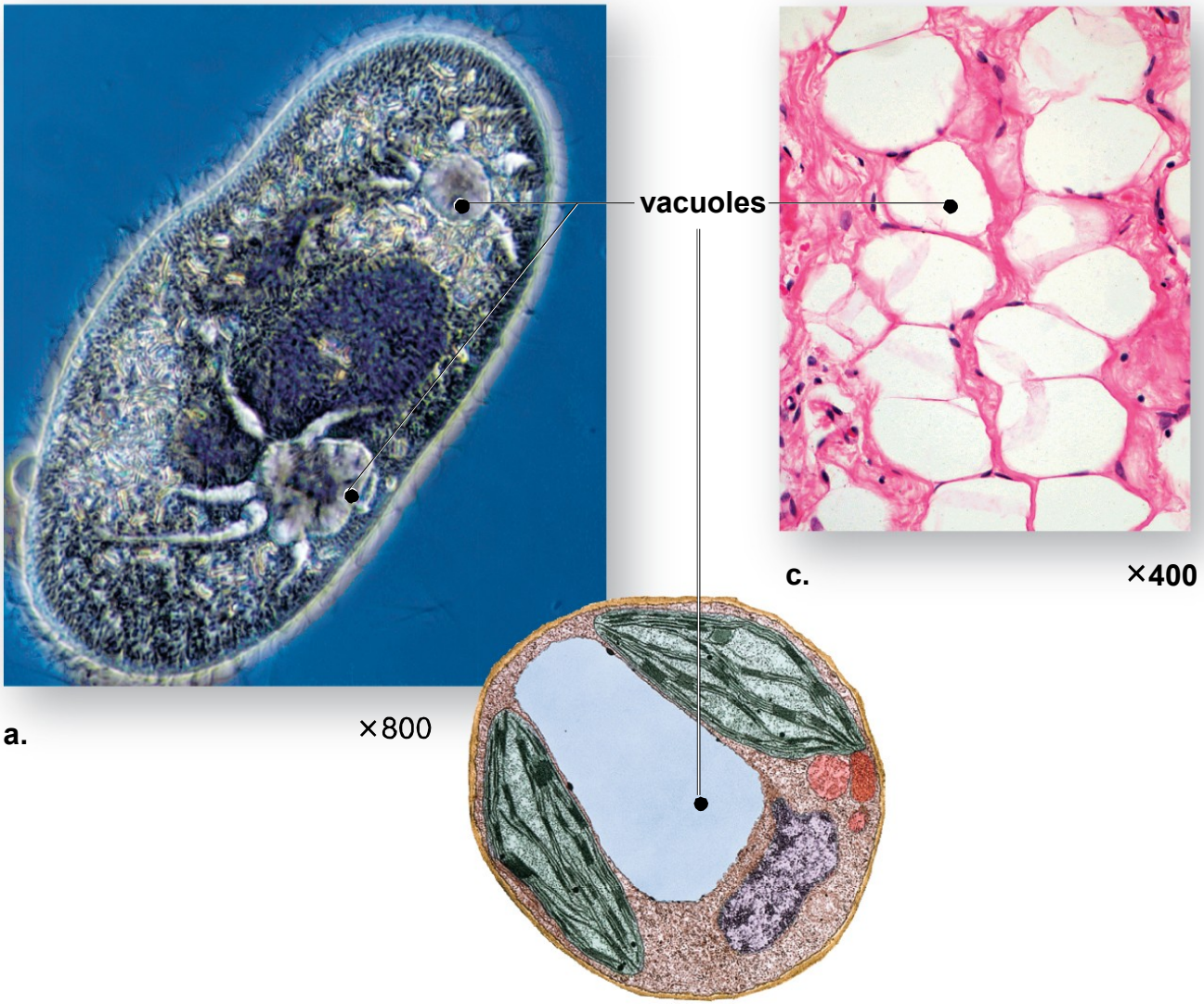
Lysosomes



Play | Pause | Audio | Text

Lysosomes are membrane-bound vesicles that contain hydrolytic enzymes. The hydrolytic enzymes degrade proteins, nucleic acids, lipids, and carbohydrates and are formed in the endoplasmic reticulum.

Vacuoles



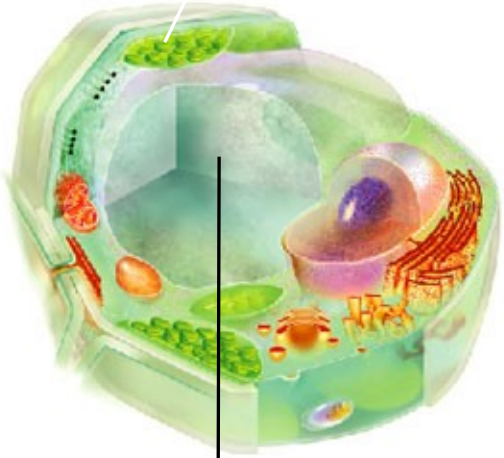
Animation: The Golgi apparatus

http://www.youtube.com/v/cnK7RT1q0bA

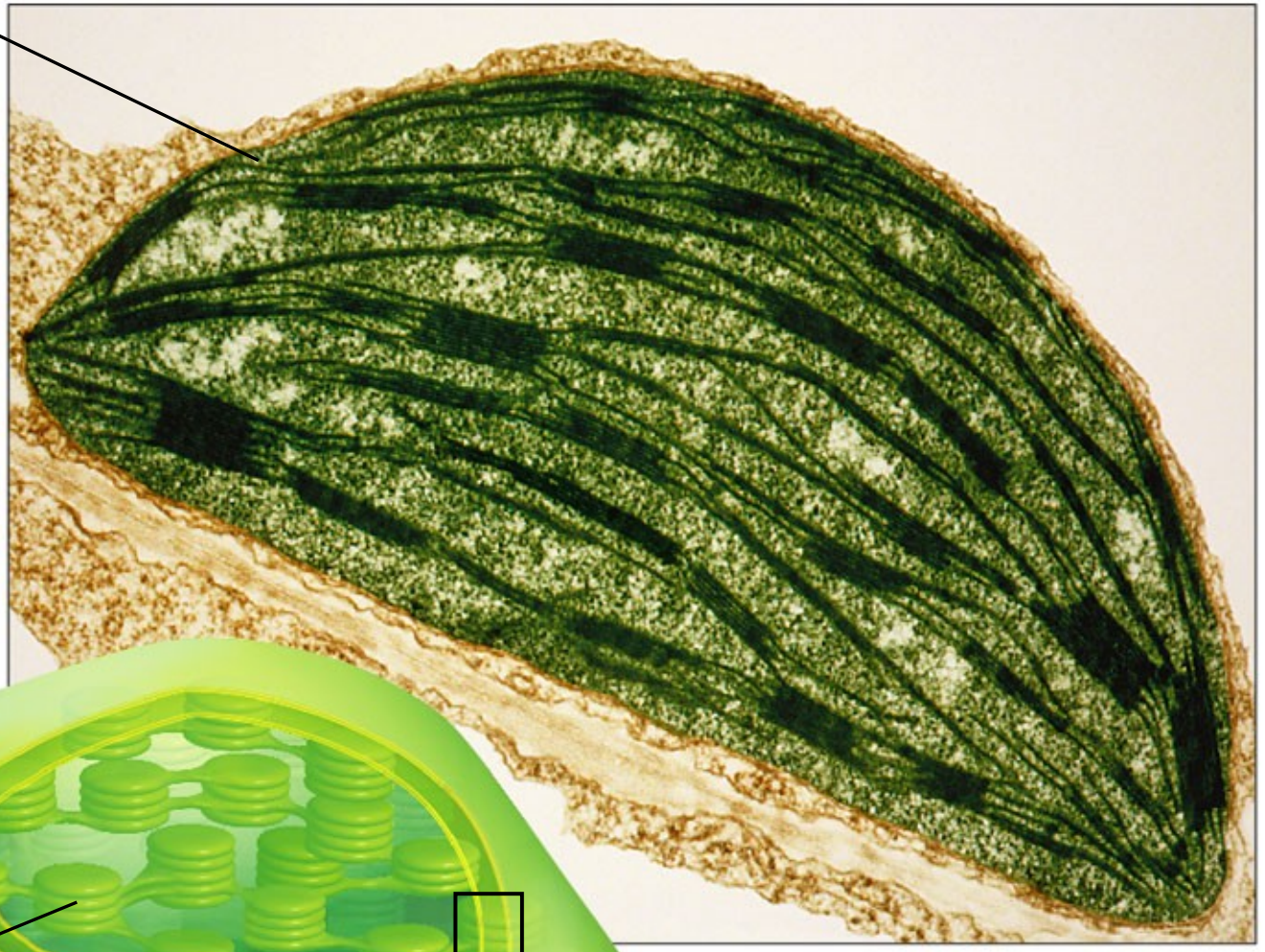
3. Energy-related organelles

- **Chloroplasts** function in photosynthesis in plants and some types of algae
  - Use solar energy to synthesize carbohydrates
- Eukaryotic cells make most of their ATP in **mitochondria**
- Endosymbiosis – chloroplasts and mitochondria have their own DNA and ribosomes

chloroplast in the cytoplasm of a plant cell



central vacuole



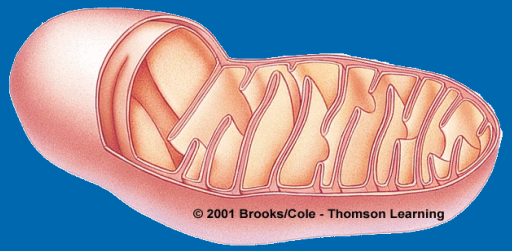
Thylakoid membrane, a much-folded single flattened compartment inside the stroma

two outer membranes

stroma (semifluid interior)

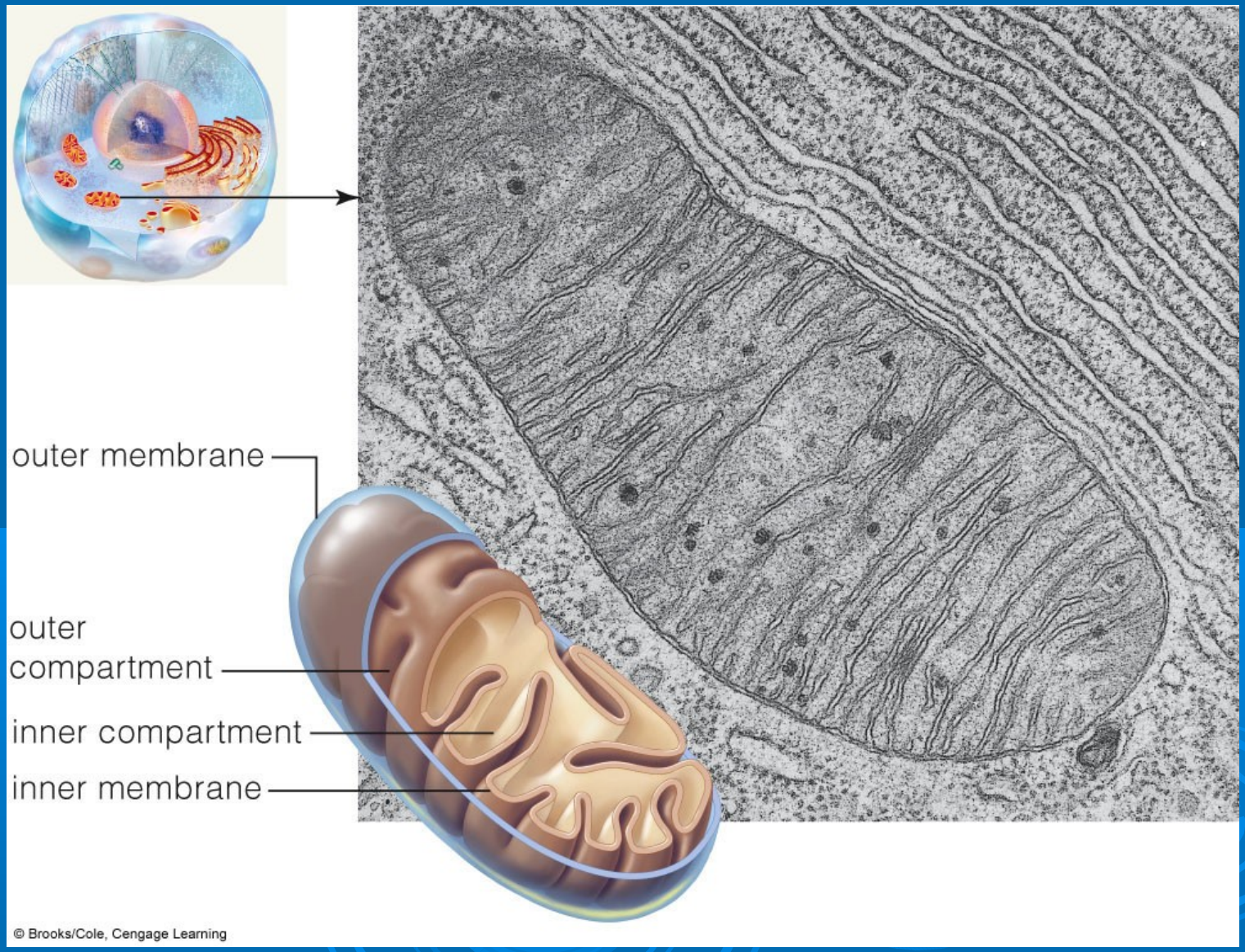
Fig. 4-20, p.65

Mitochondria



- ATP-producing powerhouses!
- Break down carbohydrates to make ATP
- Found in BOTH plants and animals
- These reactions require oxygen, produce carbon dioxide

Mitochondrion

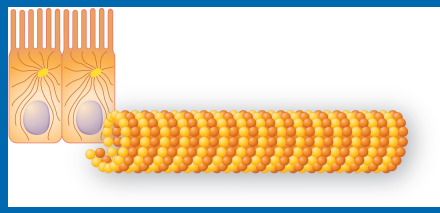


4. Cytoskeleton

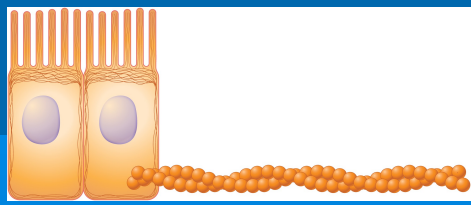
- Eukaryotic cells have a network of interconnected protein filaments and tubules
  - Maintains cell shape
  - Allows cell and organelles to move (with motor proteins

Components of the Cytoskeleton

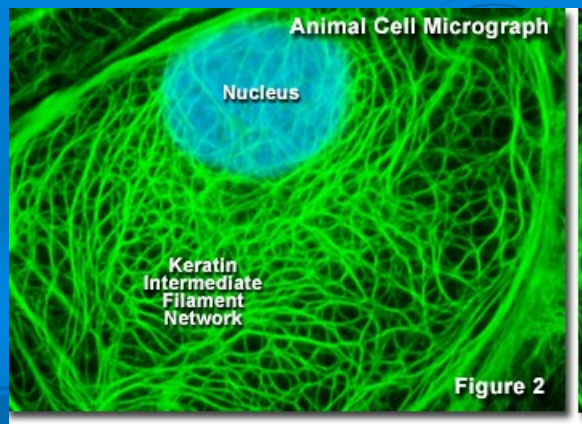
- **Microtubules**
  - Long, hollow cylinders
  - Involved in shape, motility, cell division



- **Actin filaments**
  - Consist mainly of the globular protein actin
  - Take part in movement, formation and maintenance of cell shape

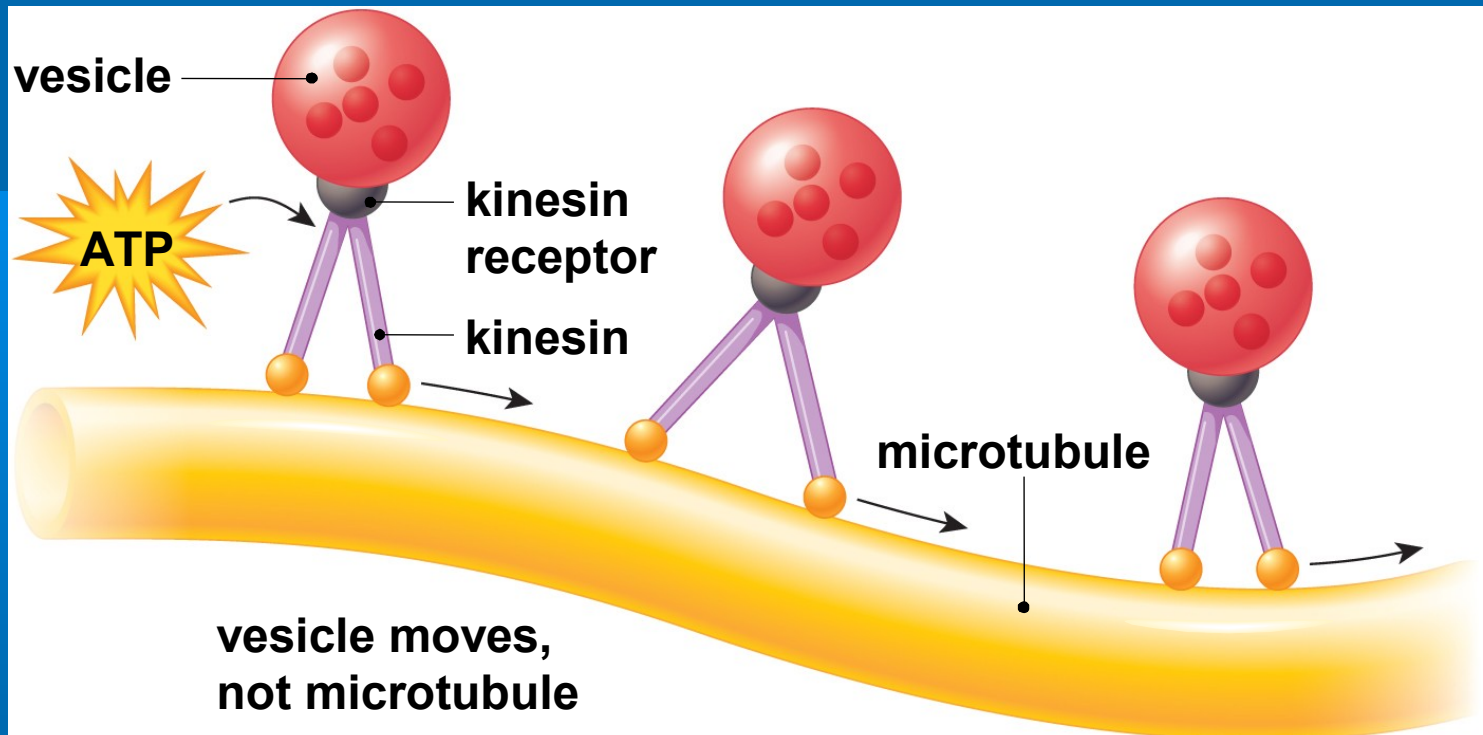


- **Intermediate filaments**
  - Maintain cell and tissue structures
  - ropelike



Motor Proteins

- Myosin
  - Interacts with actin in muscle contraction
- Kinesin and dynein http://www.youtube.com/watch?v=gJ309LfHQ3M
  - Move along microtubules



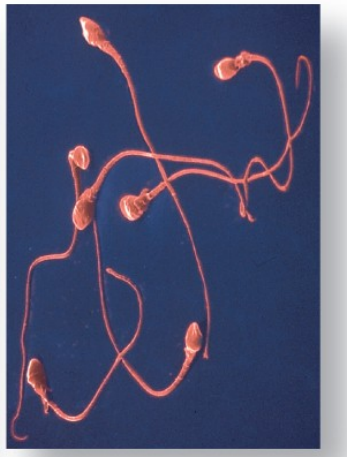
Moving Cells

- Cilia and flagella
- Both made of microtubules
- Cilia shorter and more abundant

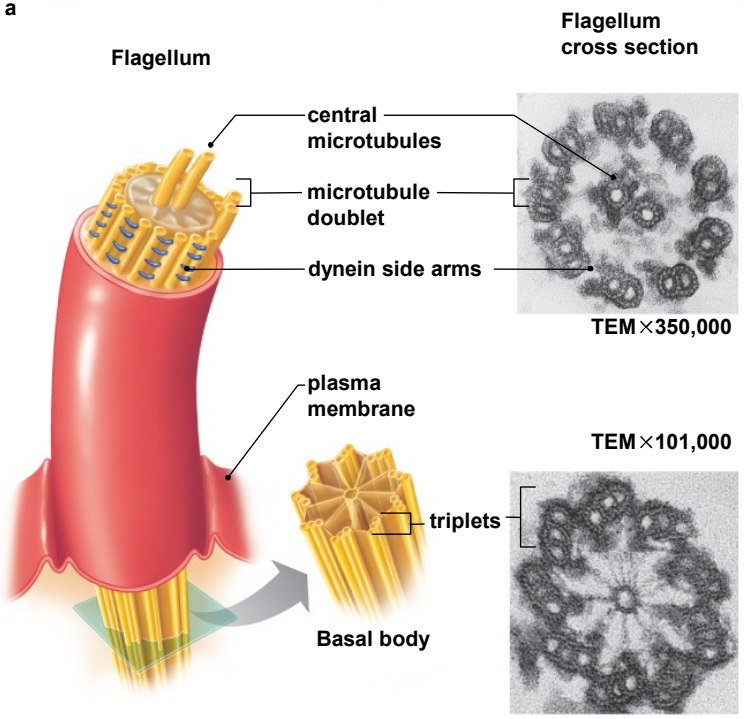
http://www.youtube.com/v/E1L27sUzwQ0

cilia in bronchial wall

a

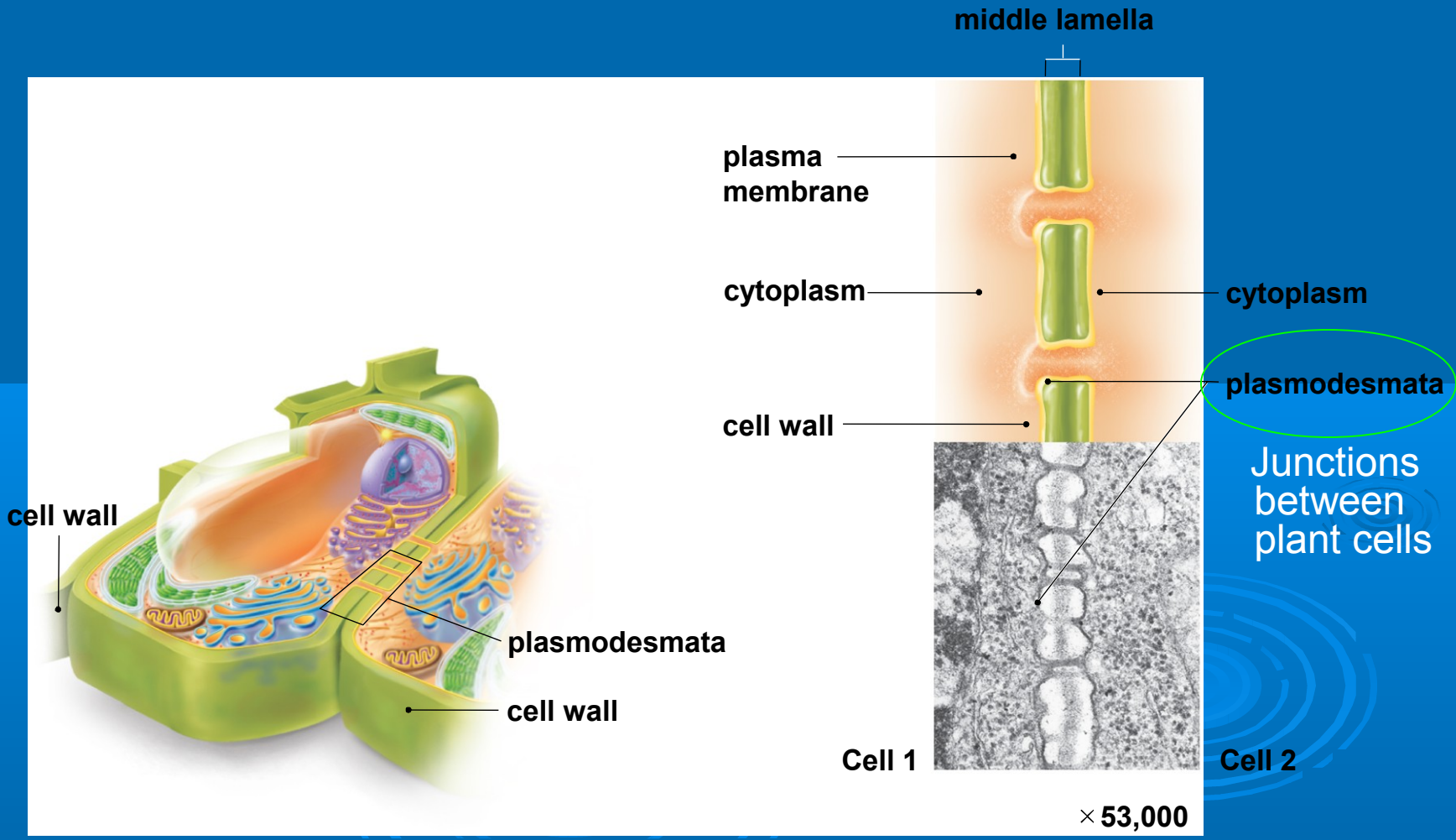


flagella of sperm



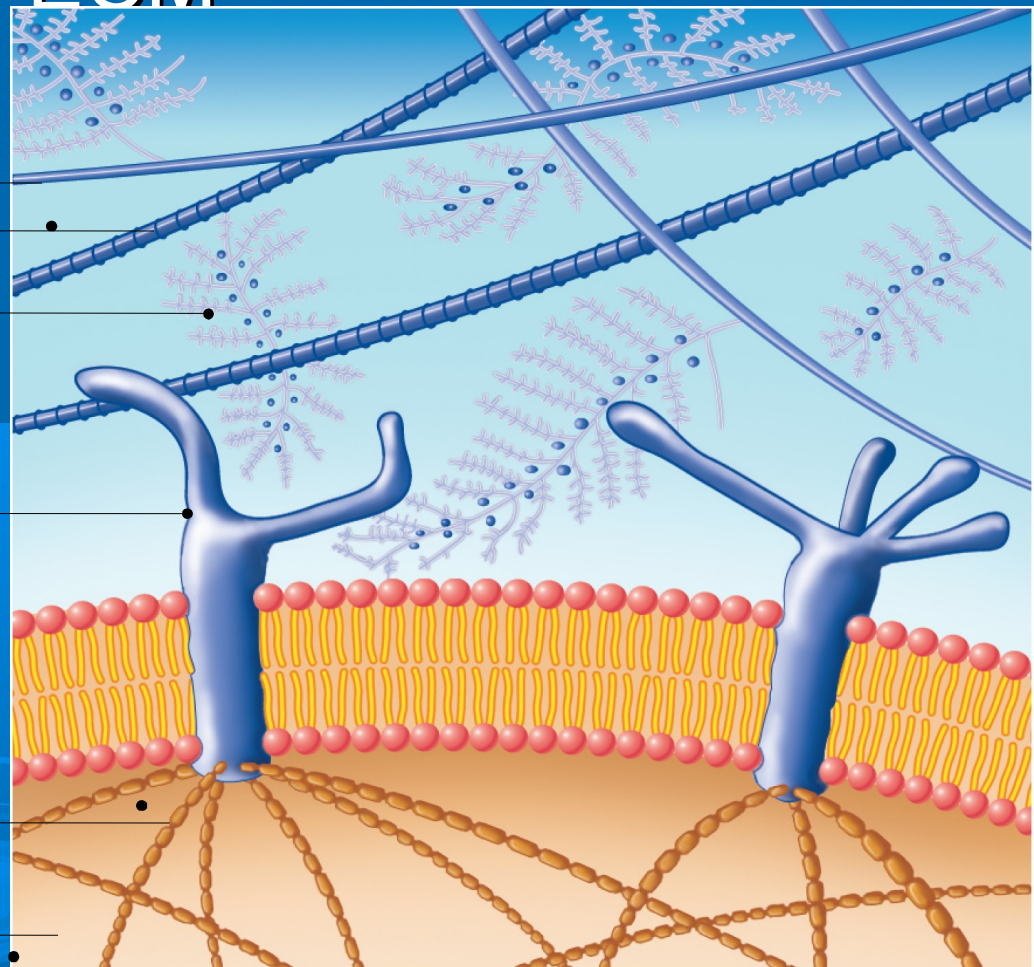
Outside the Eukaryotic Cell - Cell Wall

- Structural component that wraps around the plasma membrane
- Occurs in plants, some fungi, some protistans



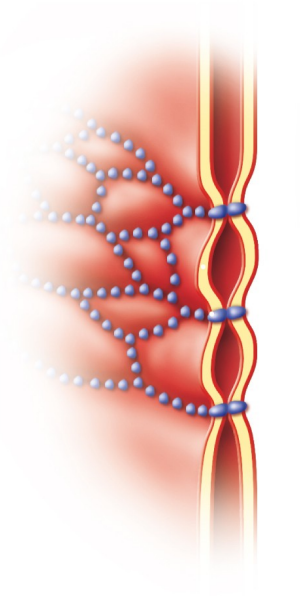
Animal Cells – No cell walls!

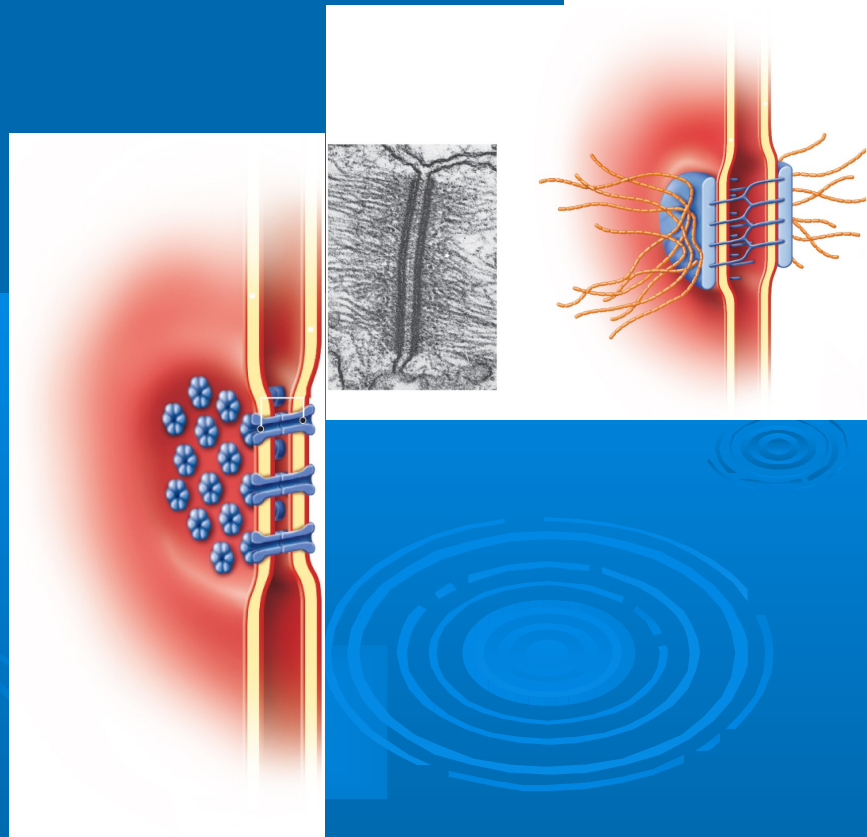
- Some are surrounded by a matrix of fibrous proteins & polysaccharides (called the extracellular matrix) – ECM



Cell Junctions

- Plants
  - Plasmodesmata
- Animals
  - Tight junctions - barriers
  - Adhering junctions – sturdy but flexible
  - Gap junctions – communication between cells





Introducing Prokaryotic Cells

- Bacteria and archaea are the prokaryotes (“before the nucleus”), the smallest and most metabolically diverse forms of life
- Bacteria and archaea are similar in appearance and size, but differ in structure and metabolism

General Prokaryote Body Plan

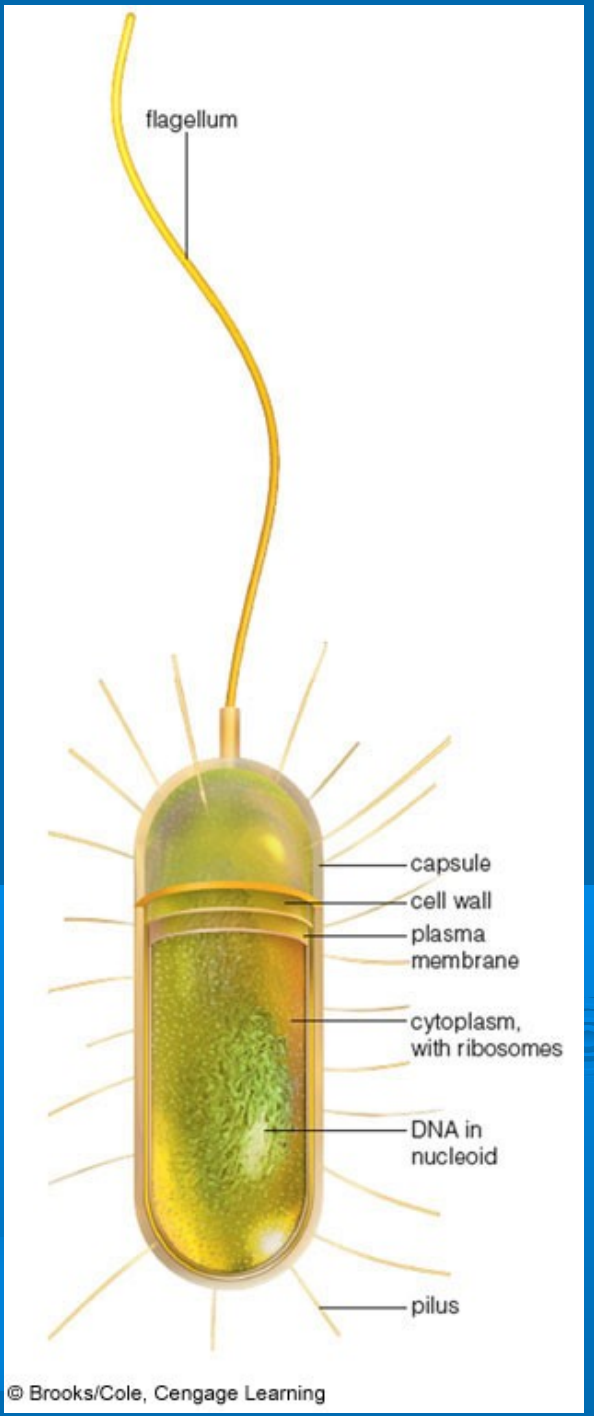
Cell wall surrounds the plasma membrane

- Made of peptidoglycan (in bacteria) or proteins (in archaea) and coated with a sticky **capsule**

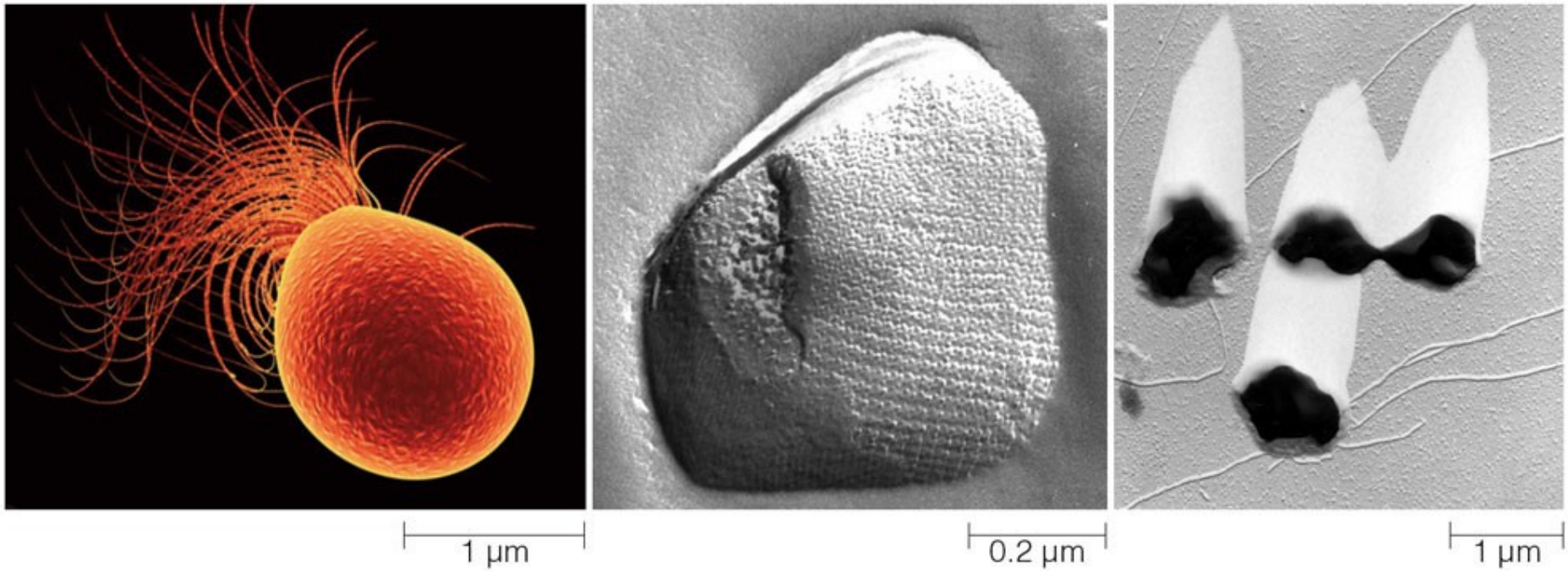
Flagellum for motion

Pili help cells move across surfaces

- Sex pilus aids in sexual reproduction



Archaeans – prokaryotic examples

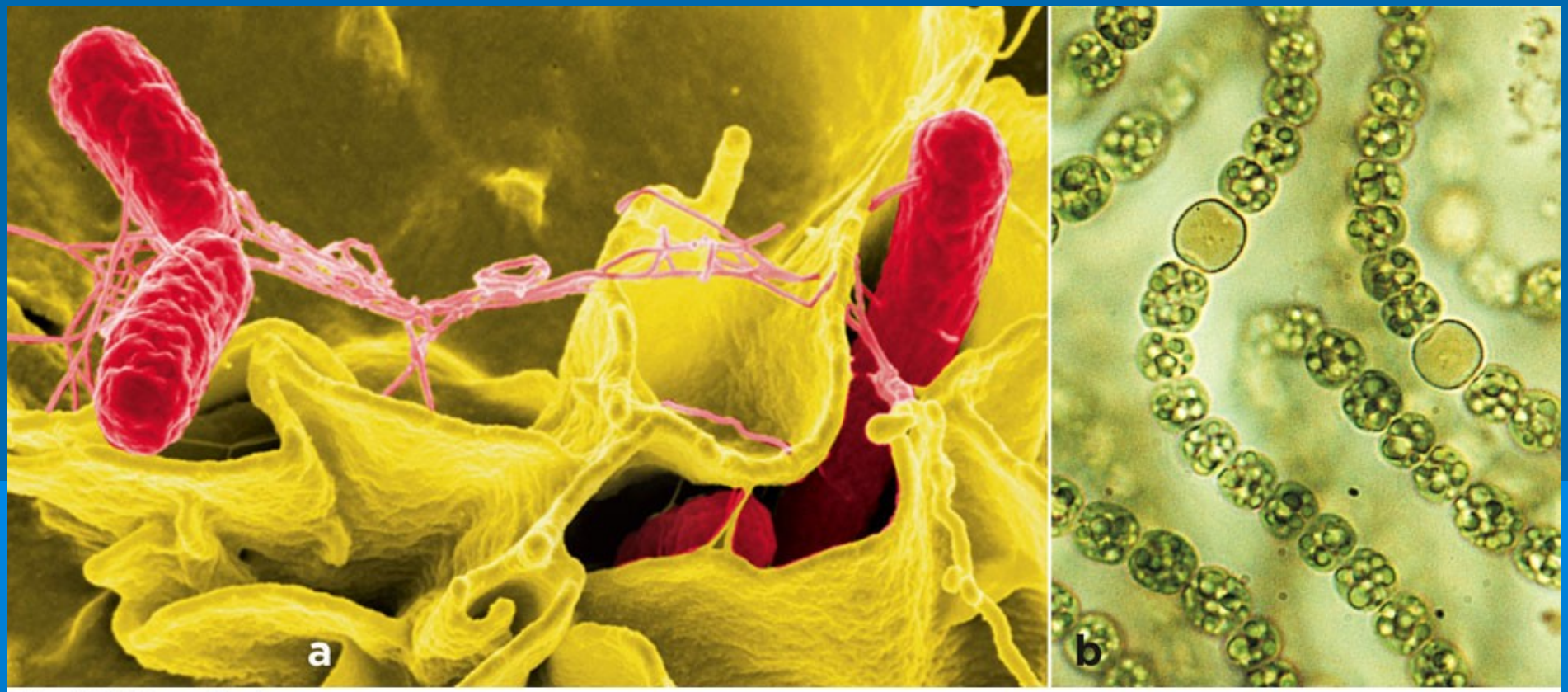


a *Pyrococcus furiosus* was discovered in ocean sediments near an active volcano. It lives best at 100°C (212°F), and it makes a rare kind of enzyme that contains tungsten atoms.

b *Ferroglobus placidus* prefers superheated water spewing from the ocean floor. The unique composition of archaean lipid bilayers keeps these membranes intact at extreme heat and pH.

c *Metallosphaera prunae*, discovered in a smoking pile of ore at a uranium mine, prefers high temperatures and low pH. (*White* shadows are an artifact of electron microscopy.)

Bacteria – more prokaryotic examples!



Key Concepts: Prokaryotic Cells

- *Archaeans and bacteria are prokaryotic cells, which have few, if any, internal membrane-enclosed compartments*
- *In general, they are the smallest and structurally the simplest cells*

Biology Help!

- **Ways to study for my exam:**
  - **Answer the study guide & COME TO ME/USE THE BOOK IF YOU DON'T UNDERSTAND SOMETHING!!! I CAN'T HELP YOU MEMORIZE, BUT I CAN HELP IN YOUR UNDERSTANDING!!!**
  - **Memorize answers/info**
    - **Use flash cards**
    - **Get in groups**
    - **Walk around a pool table**
    - **There aren't any shortcuts!!!**

- **Need help? The Student Success Center offers free tutoring for many De Anza classes. See http://www.deanza.edu/studentsuccess for details.**
- **Writing and Reading Center: ATC 309 408-864-5840**
- **Math, Science and Technology Resource Center:**
- **S-43 408-864-8683**
- **General Subject Tutoring: ATC 305 408-864-8682**
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