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Chapter 6

A Tour of the Cell

PowerPoint® Lecture Presentations for

Biology

Eighth Edition

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Lectures by Chris Romero, updated by Erin Barley with contributions from Joan Sharp

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Overview: The Fundamental Units of Life

- All organisms are made of cells
- The cell is the simplest collection of matter that can live
- Cell structure is correlated to cellular function
- All cells are related by their descent from earlier cells

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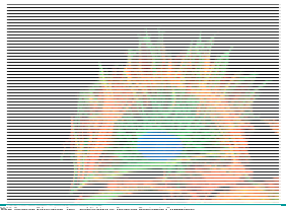
Concept 6.1: To study cells, biologists use microscopes and the tools of biochemistry

- Though usually too small to be seen by the unaided eye, cells can be complex



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Prokaryotic vs. Eukaryotic Cells

	Prokaryotes	Eukaryotes
Includes what?		
# cells		
Location of DNA		
# of chromosomes		
Has membrane-bound organelle?		
Contains ribosomes?		
Is surrounded by a plasma membrane?		
Has a cell wall?		
Size range		

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Prokaryotic vs. Eukaryotic cells

The basic unit of every organism is either prokaryotic or eukaryotic cells

- Prokaryotes include Bacteria and Archaea
- Eukaryotes include Protists, Fungi, Animals and Plants

Basic features of all cells

- Plasma membrane
- Semifluid substance called **cytosol**
- Double-stranded DNA, RNA and proteins

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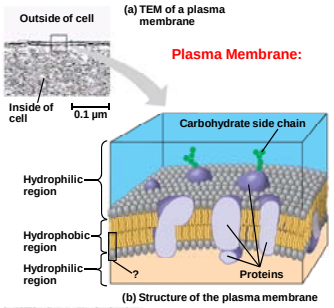
Fig. 6-7



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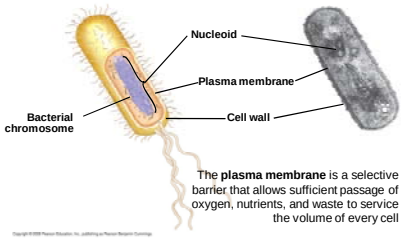
Prokaryotes:
Cytoplasm bound by plasma membrane, no organelles
No nucleus, DNA in an unbound region called the nucleoid



The **plasma membrane** is a selective barrier that allows sufficient passage of oxygen, nutrients, and waste to service the volume of every cell

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- **Eukaryotic cells are generally much larger than prokaryotic cells**
- **Eukaryotic cells are also characterized by having stuff prokaryotes don't have:**
  - Membrane-bound organelles
  - Cytoskeleton
  - Compartmentalized function

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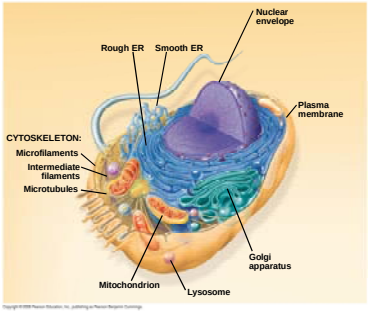

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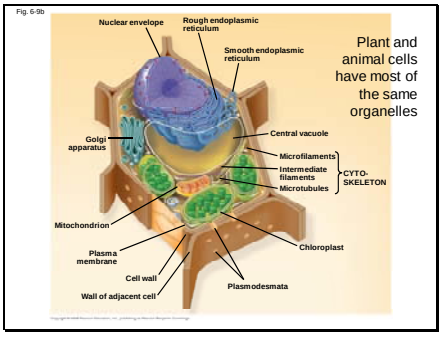

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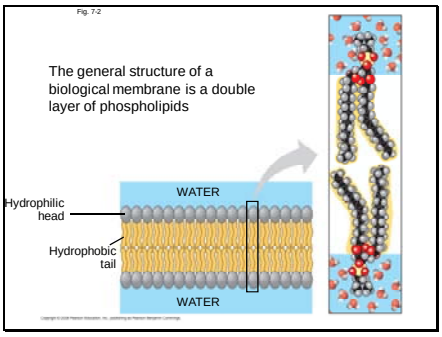

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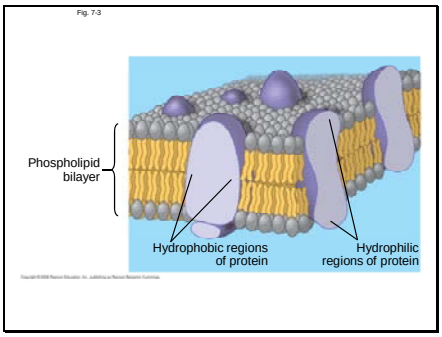

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How does the cell get all of these hydrophobic molecules to their appropriate locations –

right through the middle of an aqueous environment?!

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The endomembrane system allows containment and movement of hydrophobic and dangerous materials

- Components of the **endomembrane system**:
  - Nuclear envelope
  - Endoplasmic reticulum
  - Golgi apparatus
  - Lysosomes
  - Vacuoles
  - Plasma membrane
- These components can be bridged by **vesicles**

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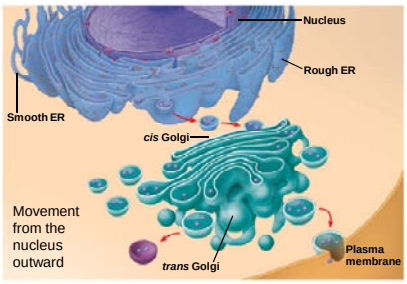
Fig. 6-16-3



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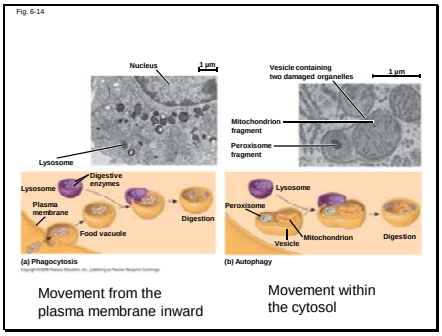

Movement from the plasma membrane inward

Movement within the cytosol

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How do we move stuff around in eukaryotic cells?

- The **cytoskeleton** is a network of fibers extending throughout the cytoplasm
- It interacts with **motor proteins** to produce motility
- Inside the cell, vesicles can travel along "monorails" provided by the cytoskeleton

(The cytoskeleton also does other stuff: giving support to the cell, anchoring cell parts and attaching cells to their extracellular environment, among others....)

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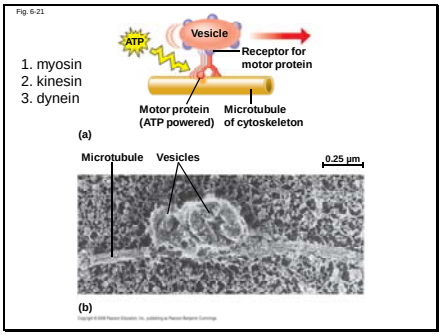

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Table 6-1a

Property	Microtubules (Tubulin Polymers)
Structure	Hollow tubes, wall consists of 13 columns of tubulin molecules
Diameter	25 nm with 15-nm lumen
Protein subunits	Tubulin
Main functions	Maintenance of cell shape Cell motility Chromosome movements in cell division Organelle movements

Molecular Motors: Dynein and Kinesin

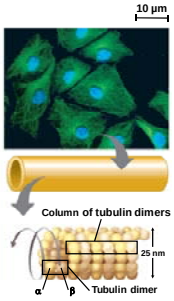

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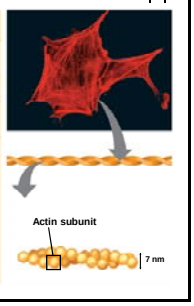
Table 6-1b

Property	Microfilaments (Actin Filaments)
Structure	Two intertwined strands of actin
Diameter	7 nm
Protein subunits	Actin
Main functions	Maintenance of cell shape Changes in cell shape Muscle contraction Cytoplasmic streaming Cell motility Cell division

Molecular Motor: Myosin



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Outward Flow

- The Nucleus-Endoplasmic Reticulum Complex builds complex membranes and prepares material for secretion
- The Golgi Apparatus modifies those membrane components and materials into their finished form
- Membrane-bound Vesicles allow transport between organelles and Plasma Membrane

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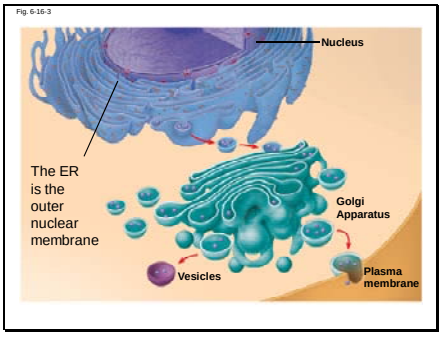

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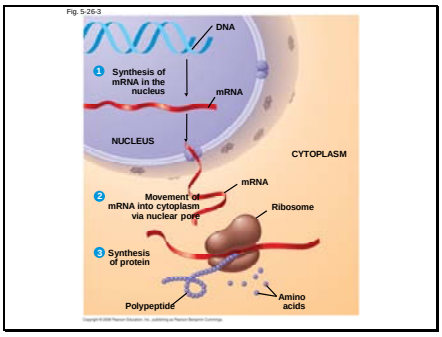

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Ribosomes: Protein Factories

- **Ribosomes** are particles made of ribosomal RNA and protein
- Ribosomes carry out protein synthesis for two purposes:
  - Free ribosomes make cytosolic proteins

    Can you name some? _____
  - Bound ribosomes make proteins for the endomembrane system and secretion

    Can you name some? _____

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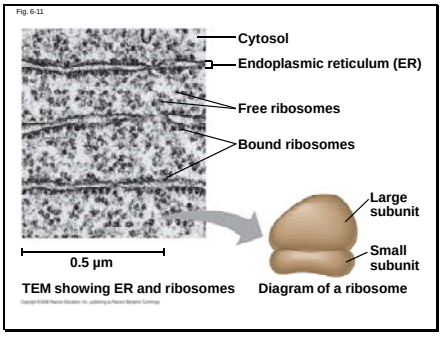

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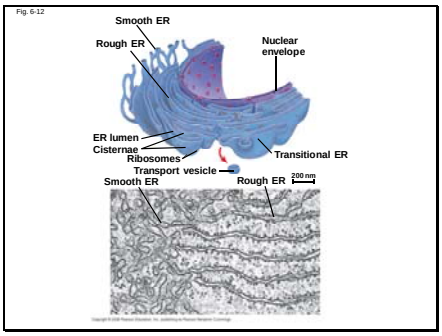

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Functions of the ER

The ER is a membrane factory for the cell

- Synthesizes lipids
- Synthesizes endomembrane and secreted proteins
- Puts them together in a "first draft" and makes vesicles

- It also: Metabolizes carbohydrates
  Detoxifies poison
  Stores calcium

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Functions of the Golgi Apparatus

- The **Golgi apparatus** creates the "final draft"
  - Modifies products of the ER
  - Manufactures certain macromolecules
  - Sorts and packages materials into transport vesicles

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Fig. 6-13

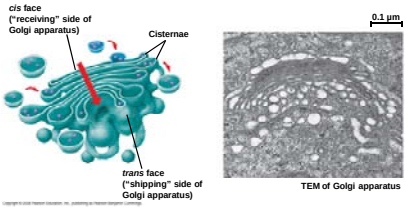

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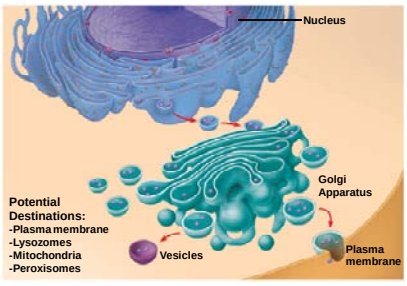
Fig. 6-16-3



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Inward and Internal Flow

- Some types of cell can engulf another cell by **phagocytosis**; this forms a food vacuole
- A lysosome fuses with the food vacuole and digests the molecules
- Lysosomes also use enzymes to recycle the cell's own organelles and macromolecules, a process called autophagy

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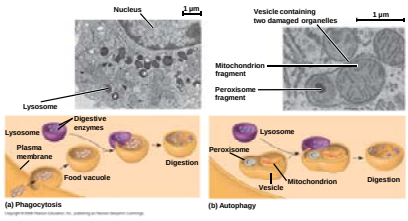
Fig. 6-14



Movement from the plasma membrane inward

Movement within the cytosol

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- **lysosome** is a membranous sac of hydrolytic enzymes that can digest macromolecules
- Lysosomal enzymes can hydrolyze proteins, fats, polysaccharides, and nucleic acids

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Three More Important Membrane Compartments

1. Vacuoles: Diverse Maintenance Compartments

- A plant cell or fungal cell may have one or several vacuoles
- **Food vacuoles** are formed by phagocytosis
- **Contractile vacuoles**, found in many freshwater protists, pump excess water out of cells
- **Central vacuoles**, found in many mature plant cells, hold organic compounds and water

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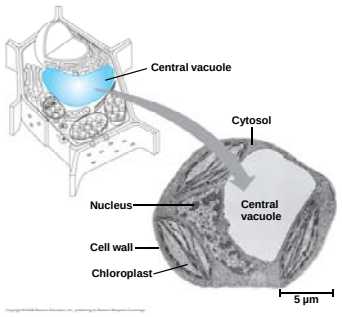
Fig. 6-15



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2. Mitochondria and chloroplasts

- **Mitochondria** are the sites of cellular respiration, a metabolic process that generates ATP
- **Chloroplasts**, found in plants and algae, are the sites of photosynthesis

Mitochondria and chloroplasts

- Are partially separate from the endomembrane system
- Have a double membrane
- Have proteins made by free ribosomes
- Contain their own DNA

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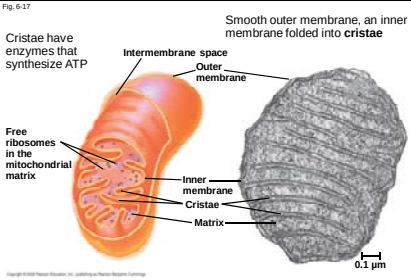
Fig. 6-17



Some steps of cellular respiration occur in the mitochondrial matrix

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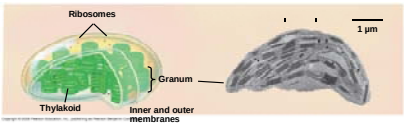
Fig. 6-18

Capture of Light Energy

The chloroplast is a member of a family of organelles called **plastids**

Chloroplasts contain the green pigment chlorophyll, as well as enzymes and other molecules that function in photosynthesis

Chloroplasts are found in leaves and other green organs of plants and in algae



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3. Peroxisomes: Oxidation

- Peroxisomes are specialized metabolic compartments bounded by a single membrane
- Peroxisomes produce hydrogen peroxide and convert it to water
- Oxygen is used to break down different types of molecules
- What do you know about singlet oxygen?

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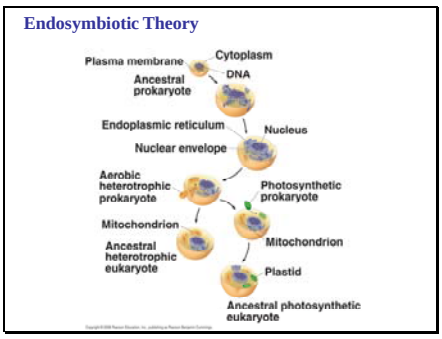

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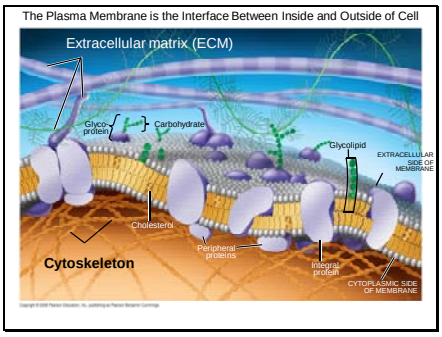

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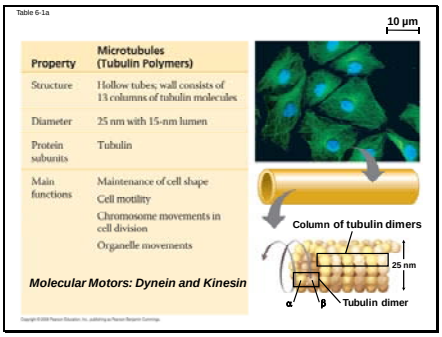

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Table 6-1b

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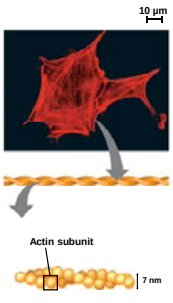

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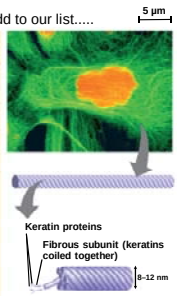
Table 6-1c

One last component to add to our list.....

Property	Intermediate Filaments
Structure	Fibrous proteins supercoiled into thicker cables
Diameter	8–12 nm
Protein subunits	One of several different proteins of the keratin family
Main functions	Maintenance of cell shape Anchorage of nucleus and certain other organelles Formation of nuclear lamina

No Molecular Motors



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Intermediate Filaments form the Underlying Structure for the Rest of the Cytoskeleton

- Intermediate filaments are more permanent than microtubules and microfilaments
- They surround the nucleus and extend to all parts of the cell
- They provide long-term support for cell shape and fix organelles in place
- They provide tracks for moving microtubules and microfilaments around
- A second set of intermediate filaments do the same things for the inside of the nucleus

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Microtubule-organizing centers allow "point-and-shoot" repositioning of microtubules

A. Centrosomes and Centrioles

- In many cells, microtubules grow out from a **centrosome** near the nucleus
- In animal cells, the centrosome has a pair of **centrioles**, each with nine triplets of microtubules arranged in a ring

- **B. Basal Bodies**
  - anchors cilium and flagellum
  - **dynein**, which drives the bending movements of a cilium or flagellum

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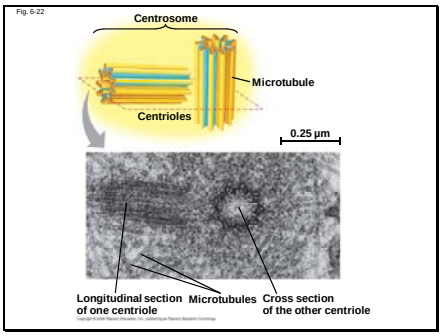

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The Steps to Long-Distance Transport in the Cell

1. Break down the old microtubules
2. Move the centriole where you need it, "point"
3. Build new microtubules towards a new destination, "shoot"
4. Use molecular motors to send material to that destination

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Microfilaments Have Lots of Jobs To Do (and some pretty fancy names.....)

- ***Actin tracks*** use myosin motors to move materials short distances inside the cell
- ***Stress fibers*** bear tension, resist pulling forces
- ***The cortex*** just inside the plasma membrane supports the cell's shape
- ***Actin bundles*** make up the core of microvilli
- ***Actin treadmills*** form the basis for cell migration
- ***Thin filaments*** work with myosin to contract muscle cells
- ***Purse strings*** of actin separate the daughter cells during cell division

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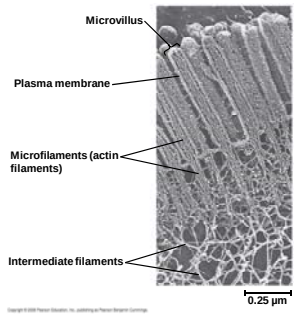
Fig. 6-26



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Cells Use the Area Outside Their Plasma Membranes to Build Protections and Connections to Other Cells

- Most cells synthesize and secrete materials that are external to the plasma membrane
- These extracellular structures include:
  - Cell walls of plants
  - The extracellular matrix (ECM) of animal cells
  - Intercellular junctions

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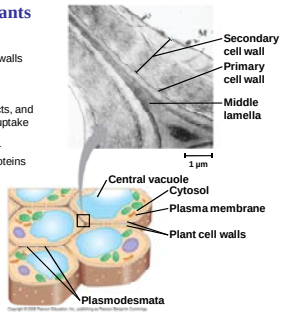
Fig. 6-28

Cell Walls of Plants

- Prokaryotes, fungi and some protists have cell walls
- Thicker than the PM
- Maintains shape, protects, and prevents excess water uptake
- Made of cellulose, other polysaccharides and proteins



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The Extracellular Matrix (ECM) of Animal Cells

- Animal cells lack cell walls but are covered by an elaborate **extracellular matrix (ECM)**
- Functions of the ECM:
  - Support
  - Adhesion
  - Movement
  - Regulation

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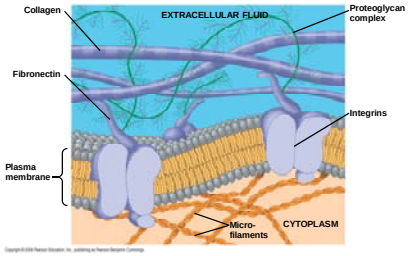
Fig. 6-30a



Glycoproteins (collagen, proteoglycans, fibronectin) bind integrin proteins in plasma membrane

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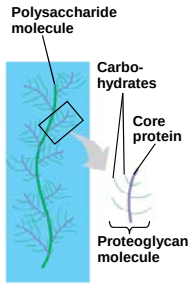
Fig. 6-30b



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Intercellular Junctions

- Neighboring cells in tissues, organs, or organ systems often adhere, interact, and communicate through direct physical contact
- Intercellular junctions facilitate this contact
- There are several types of intercellular junctions
  - Plasmodesmata
  - Tight junctions
  - Desmosomes
  - Gap junctions

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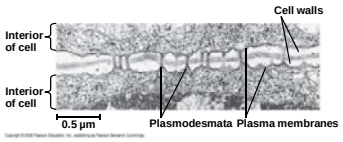
Fig. 6-31

Plasmodesmata in Plant Cells



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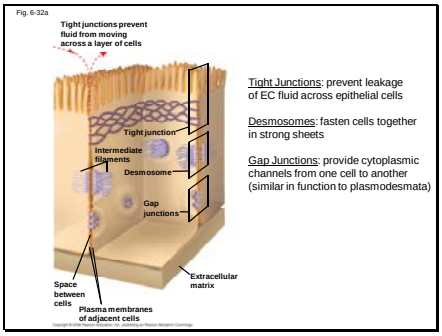

Tight Junctions: prevent leakage of EC fluid across epithelial cells

Desmosomes: fasten cells together in strong sheets

Gap Junctions: provide cytoplasmic channels from one cell to another (similar in function to plasmodesmata)

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You should now be able to:

1. Distinguish between the following pairs of terms: prokaryotic and eukaryotic cell; free and bound ribosomes; smooth and rough ER
2. Describe the structure and function of the components of the endomembrane system
3. Briefly explain the role of mitochondria, chloroplasts, and peroxisomes
4. Describe the functions of the cytoskeleton

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5. Compare the structure and functions of microtubules, microfilaments, and intermediate filaments
6. Explain how the ultrastructure of cilia and flagella relate to their functions
7. Describe the structure of a plant cell wall
8. Describe the structure and roles of the extracellular matrix in animal cells
9. Describe four different intercellular junctions