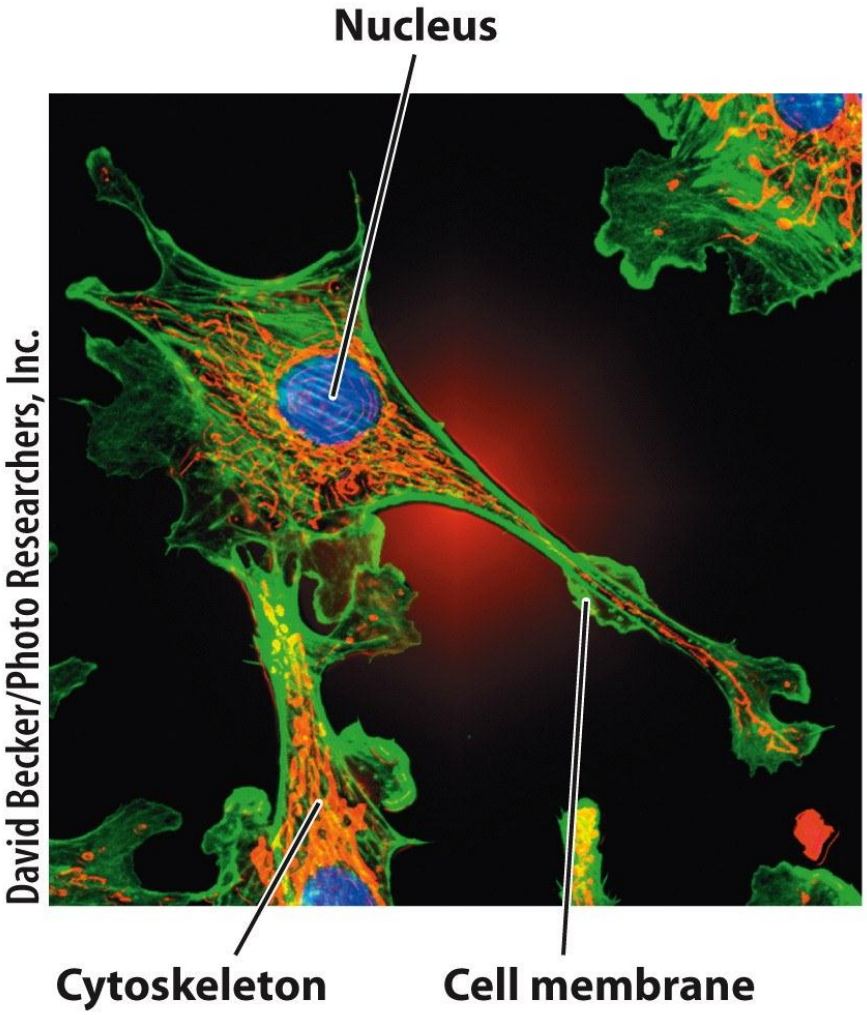
Chapter 3
Lecture 5,6

Cells: Cellular Organization

Cells are the Building Blocks of Life

- **Cells are highly organized and dynamic**
  - The human body contains trillions of cells
  - Cells differ in both shape and size
- **The study of cells is called cytology**

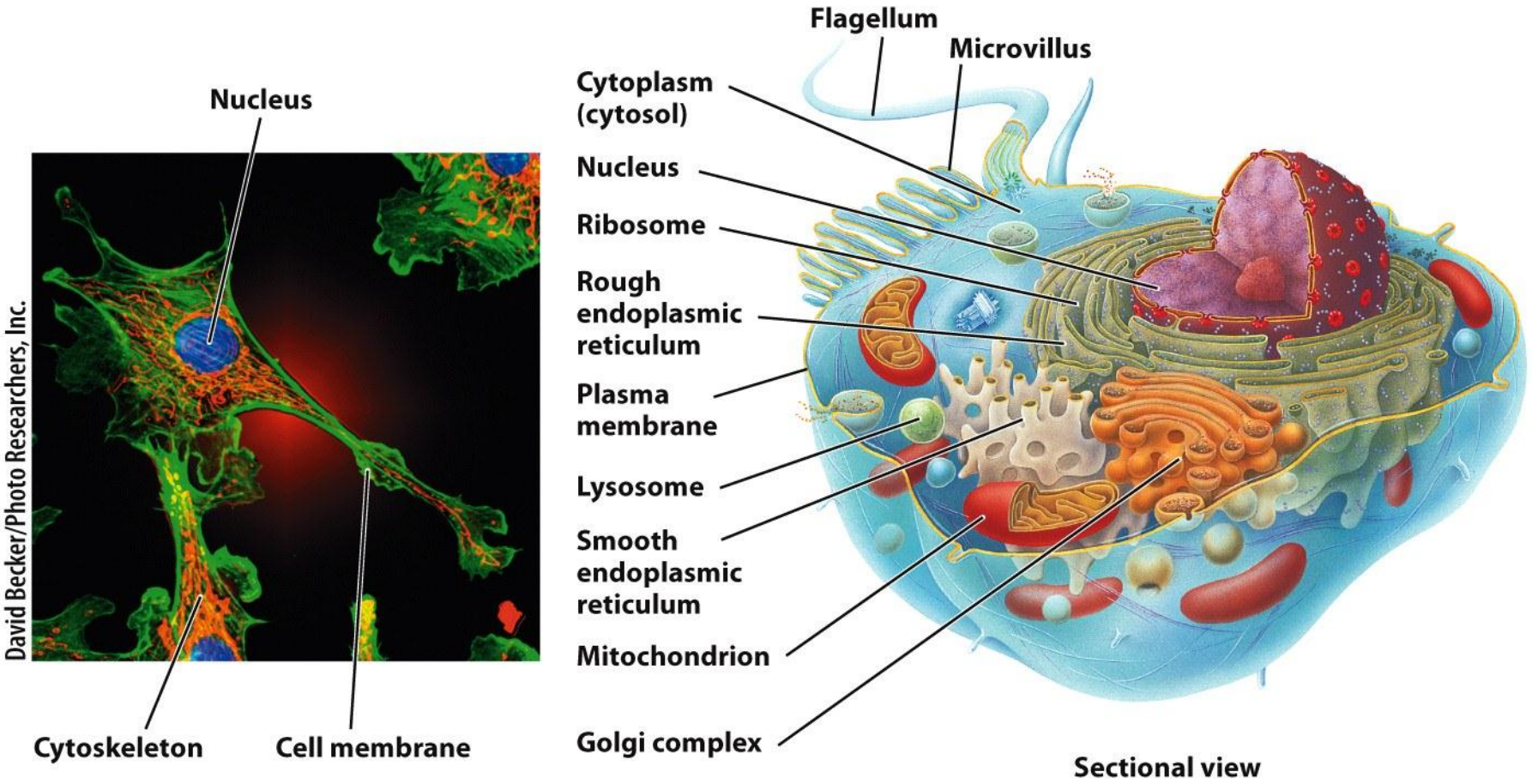


All Cells Have Similar Characteristics

- **Current cell theory holds:**
  - All living things are composed of cells
  - All cells arise from preexisting cells through cell division
  - Cells contain hereditary material, which they pass to daughter cells during cell division
  - The chemical composition of all cells is quite similar
  - The metabolic processes associated with life occur within cells

The Cell is a Highly Organized Structure That Has Three Basic Parts

- **A barrier called the *plasma membrane (or cell membrane)***
  - Plant cells and bacteria have a cell wall next to their plasma membrane
- **An area where the cell's *genetic material* is stored**
  - A nucleus in animal and plant cells
  - A nucleoid in bacterial cells
- **A fluid called *cytosol***
  - Found between plasma membrane and nucleus
  - Filled with organelles, each with a function vital to the life of the cell

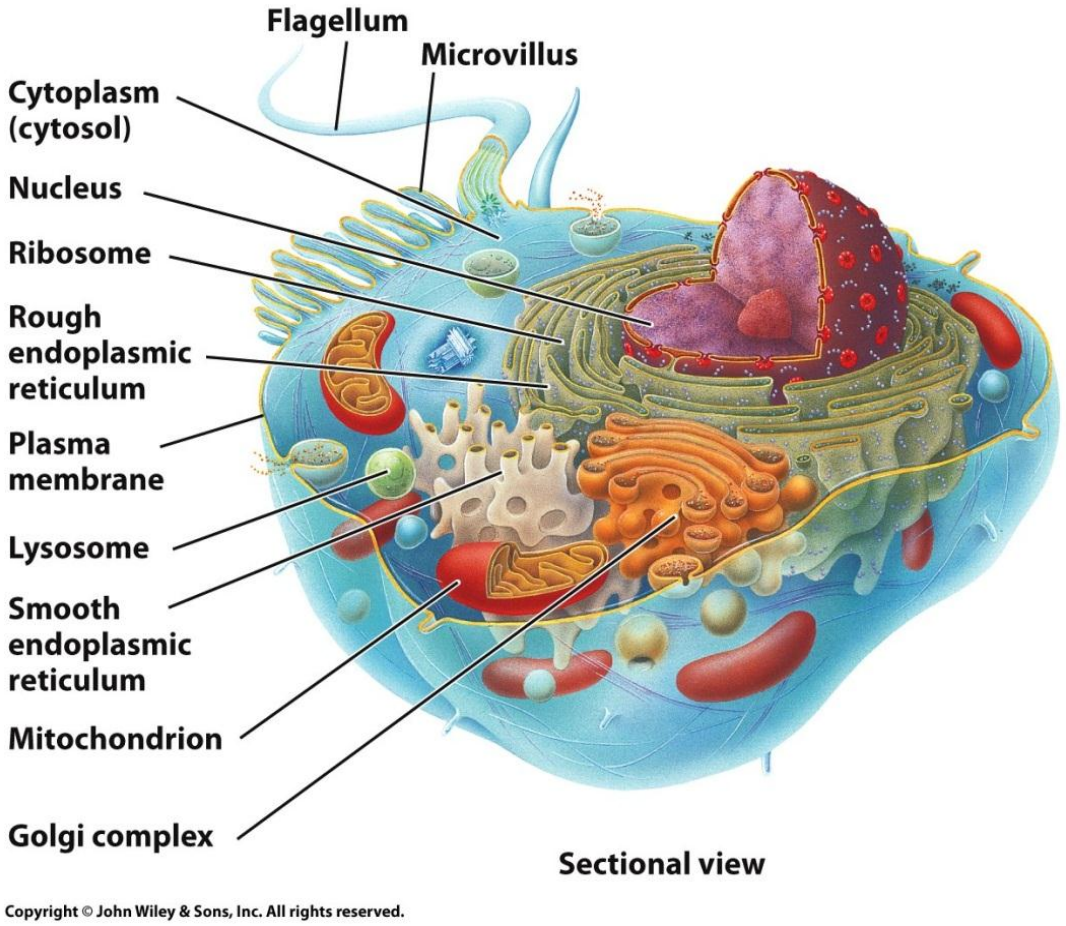


Early Life Forms were Prokaryotic

- **Millions of years ago, prokaryotic cells adapted to the extreme environments of early Earth**
- **Today, they survive as bacteria and *Archaebacteria***
- **Prokaryotic cells have no internal membrane-bound organelles**
  - Although they have genetic material, they have *no nucleus*
    - Their genetic material is confined to the *nucleoid region* in their cytoplasm
  - They contain ribosomes
    - These permit prokaryotic cells to produce the proteins they require for life

Eukaryotic Cells Have a Nucleus and Membrane-Bound Organelles

- **Plant, animal, and fungal cells are eukaryotic**

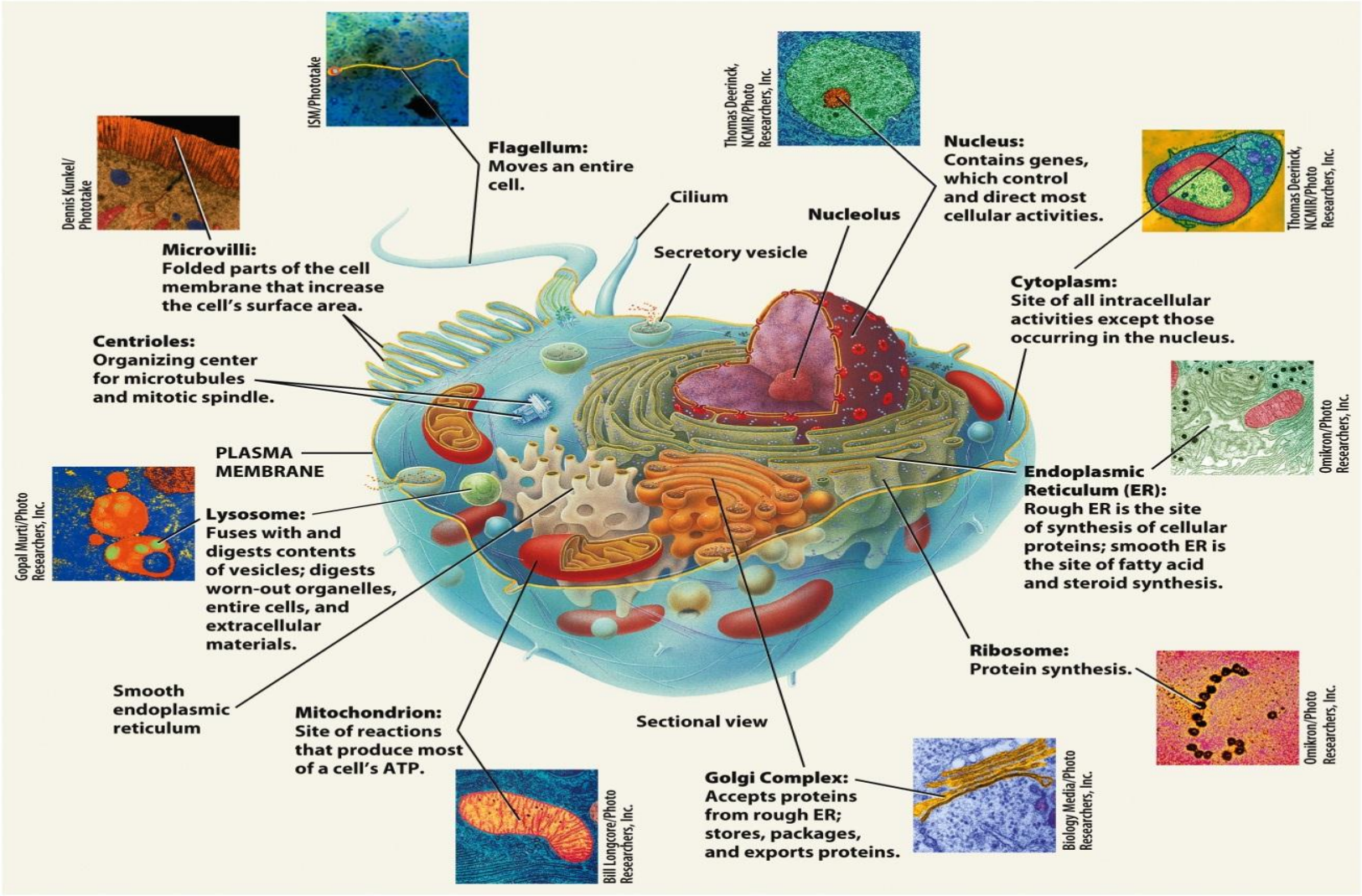


Plant Cells

- **Plant cells have most of the same organelles as animal cells**
- **Plant cells also have additional organelles that are not found in animal cells**
  - The **cell wall** lies next to the plasma membrane to provide structural stability to the cell
  - The **central vacuole** maintains cell pressure (turgor)
    - The central vacuole consists of water and nutrients
  - **Chloroplasts** produce sugars through the process of *photosynthesis*
    - The sugars contain energy which is used by the plants as nutrients
    - The sugars (with their energy) also are passed on to the organisms that eat the plants

The Components of a Cell are Called Organelles

- **Each organelle plays a role in regulating the life and death of cells**



Cytoskeleton

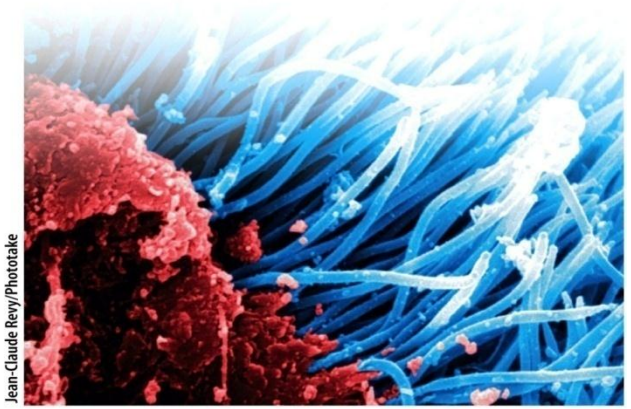
- **The *cytosol* is a highly organized "chemical soup" complete with a support structure called the *cytoskeleton***
- **The *cytoskeleton* provides**
  - Shape and structural support for the cell
  - A scaffold for suspending and moving organelles within the cell
- **The cytoskeleton continuously changes shape**
  - Forming and breaking down and reforming
  - Giving cells a plasticity, or fluidity, that allows them to change shape or move organelles quickly

The Cytoskeleton is Composed of Three Types of Filamentous Proteins

- **All three types of cytoskeleton contribute to cell shape – but each also has its own specific function**
  - **Microfilaments**
    - Long filaments constructed of ***actin*** protein subunits
    - Responsible for cellular locomotion and muscle contractions
    - Establish the basic shape and strength of the cell
  - **Intermediate filaments**
    - Strong cables of protein subunits
      - Protein type depends on type of intermediate filament
    - Stronger than microfilaments - protect cells from mechanical stresses
  - **Microtubules**
    - Long tiny tubules made of ***tubulin*** protein subunits
    - Are instrumental in chromosome movement during cell division
    - Also used as tracks for organelle movement

Flagella and Cilia

- **Flagella are single, long, whip-like structures that propel the cell forward**
  - The only human cell that moves by flagellum is the *sperm*
- **Cilia are shorter extensions that look like hairs or eyelashes**
  - Cilia line the upper respiratory tract, moving mucus upward and sweeping out debris and pathogens
  - Cilia also line the fallopian tubes, moving the egg from the ovary to the uterus



Cilia and Flagella

- **Structure (9+2)**

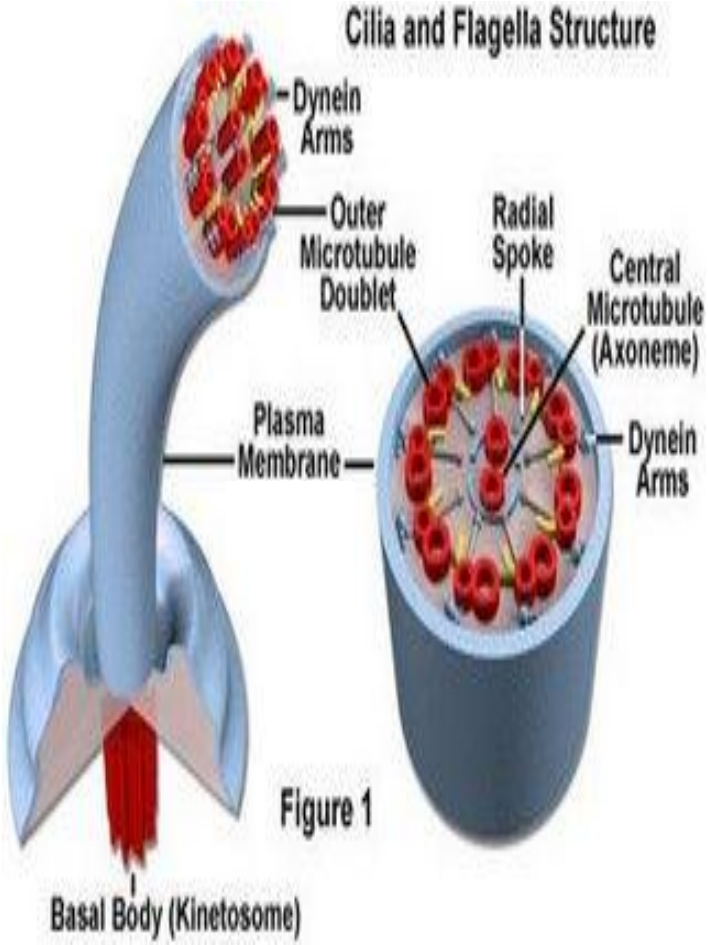
  1- A cylindrical array of

  9 pairs evenly-spaced microtubules

  2- 2 single microtubules run up through the center of the bundle

  3- The entire assembly is sheathed in a membrane

  4- A motor protein called *dynein*, which drives the bending movements of a cilium or flagellum



Centrioles

- Cellular structure that is composed of nine triplet microtubles and forms the asters during mitosis
- Divides in a perpendicular from during mitosis
- Centrioles form cilia and flagella.

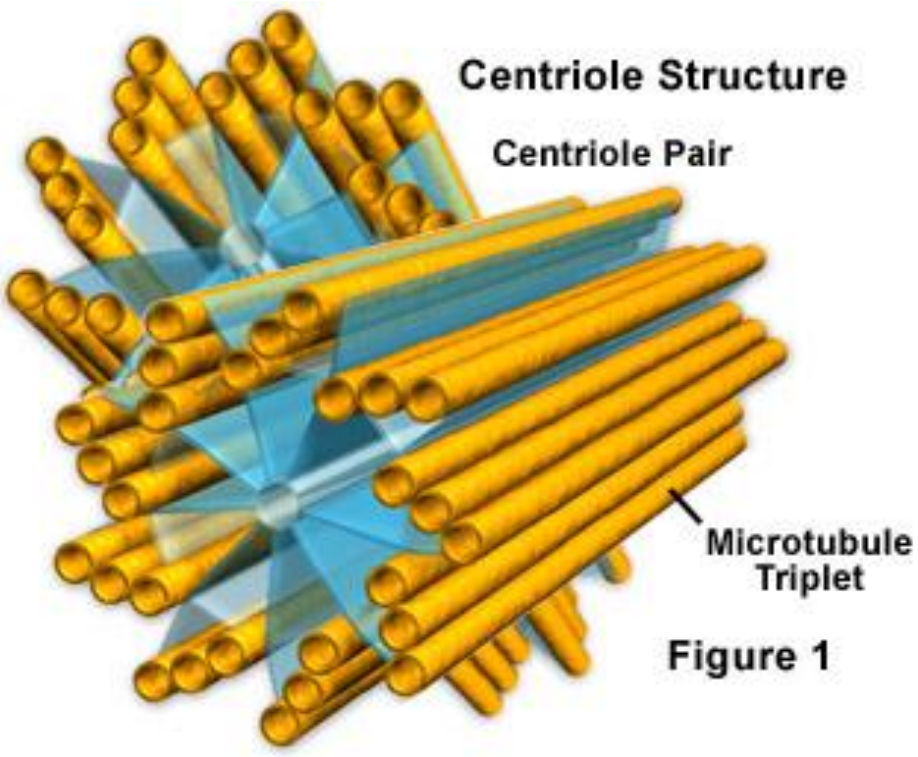
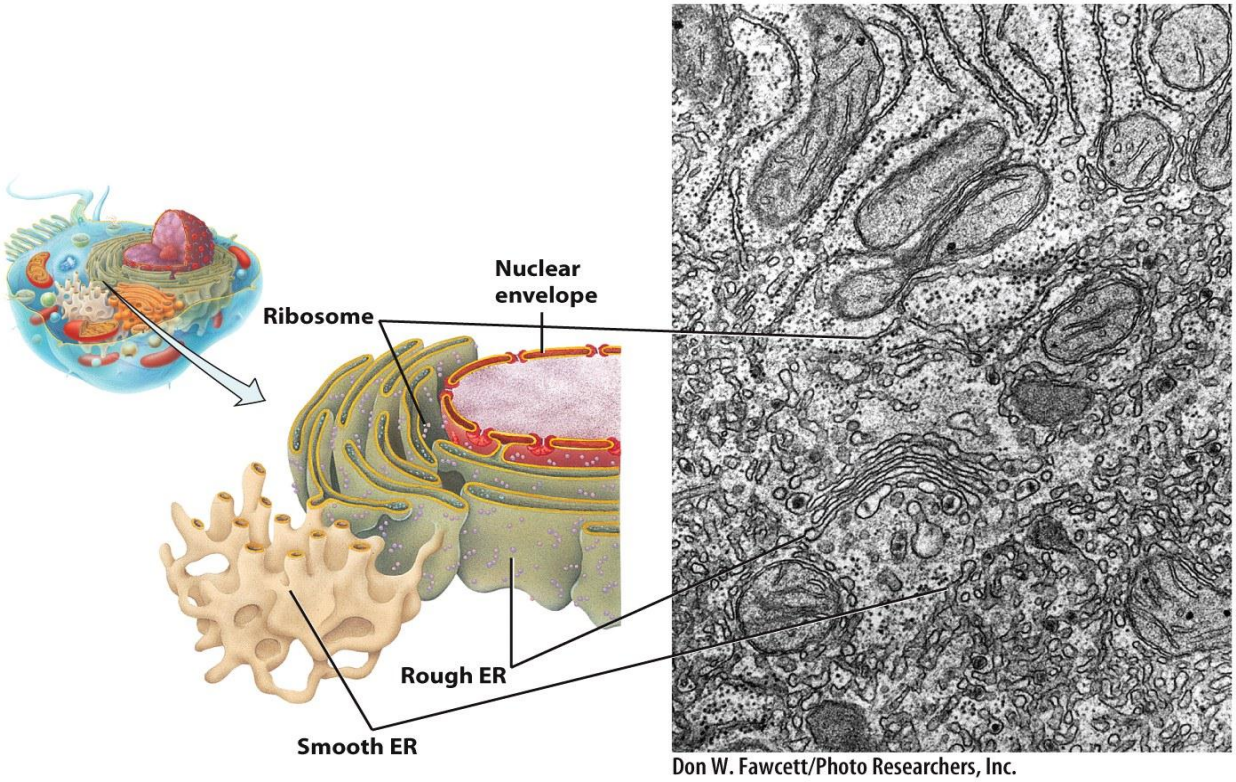


Figure 1

The Endoplasmic Reticulum

- Endoplasmic reticulum or ER (literally “within fluid network”)
- The membranes of the ER are directly connected to the double membrane surrounding the cell nucleus



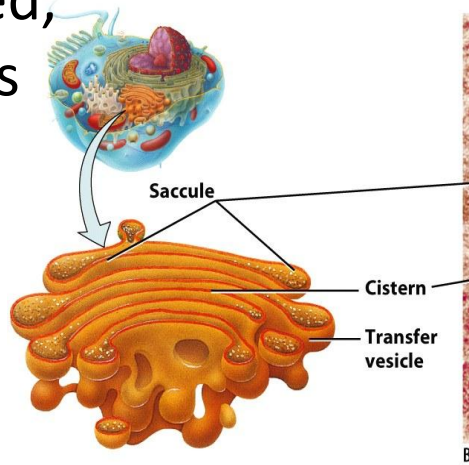
Humans Have Two Types of Endoplasmic Reticulum

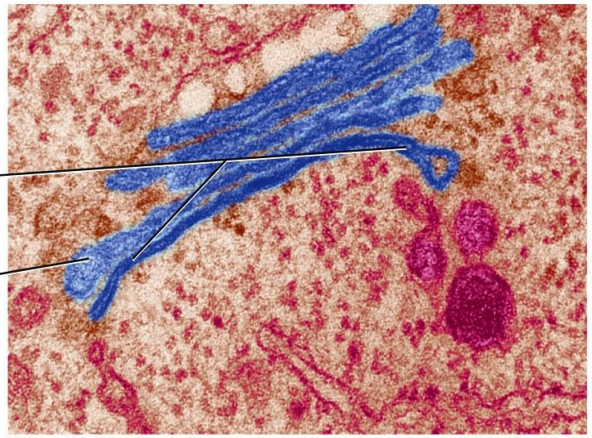
- **Rough endoplasmic reticulum (RER)**
  - Processing and sorting area for *proteins* synthesized by the ribosomes that stud its outer membrane
  - Ribosomes are small nonmembrane-bound organelles composed of protein and ribosomal RNA that function as protein factories
    - Synthesize proteins that may be incorporated into other organelles or into the plasma membrane
- **Smooth endoplasmic reticulum (SER)**
  - Responsible for the synthesis of *fatty acids and steroid hormones*
  - SER has no attached ribosomes
- **Both SER and RER produce vesicles filled with product ready for the next step in processing**
  - Vesicles usually move substances from to the cell membrane for exocytosis
  - Or to the Golgi complex for further packaging

The Golgi Complex is Involved with Processing Proteins and Fatty Acids

- **The Golgi complex, or Golgi apparatus, is found near the end of the SER that is farthest from the nucleus**
- **Resembles a stack of pancakes called saccules**

- *Saccules* are slightly curved, with concave and convex faces
  Concave portions face the ER; convex portions face plasma membrane
  - *Vesicles* are found at the edges of these saccules
  Vesicles that leave the Golgi complex migrate all over the cell





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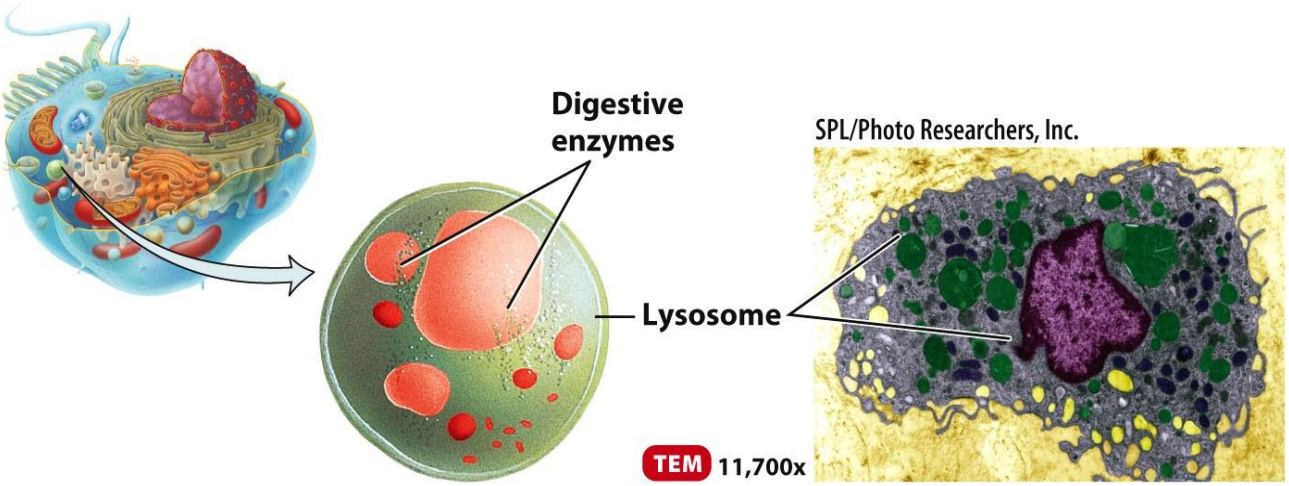
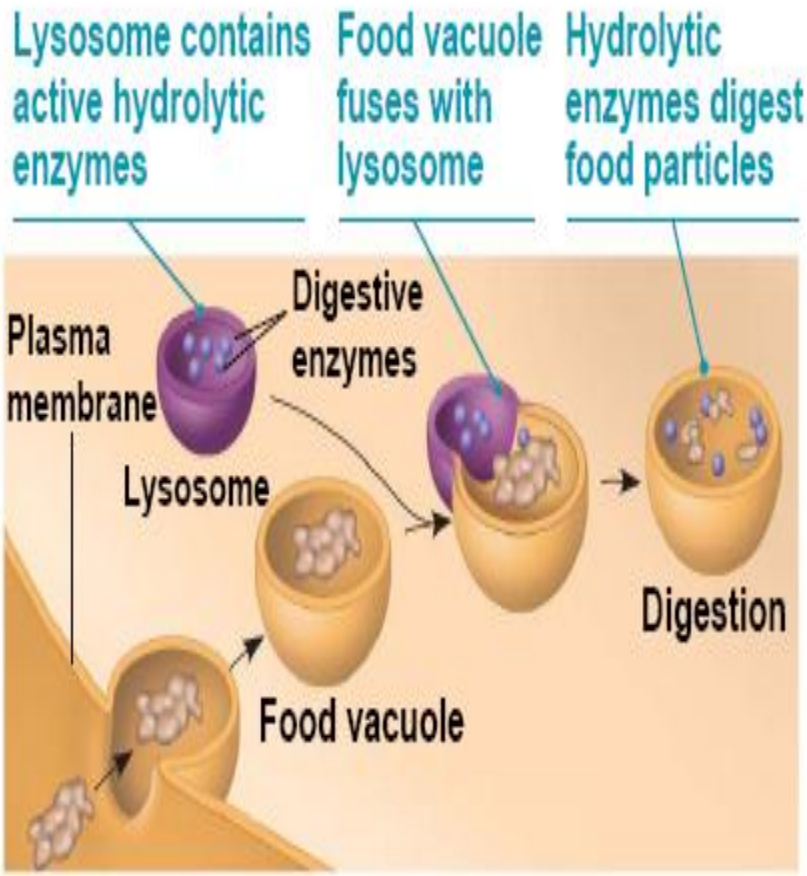
Lysosomes are Chemical Packages that Contain Hydrolytic Enzymes

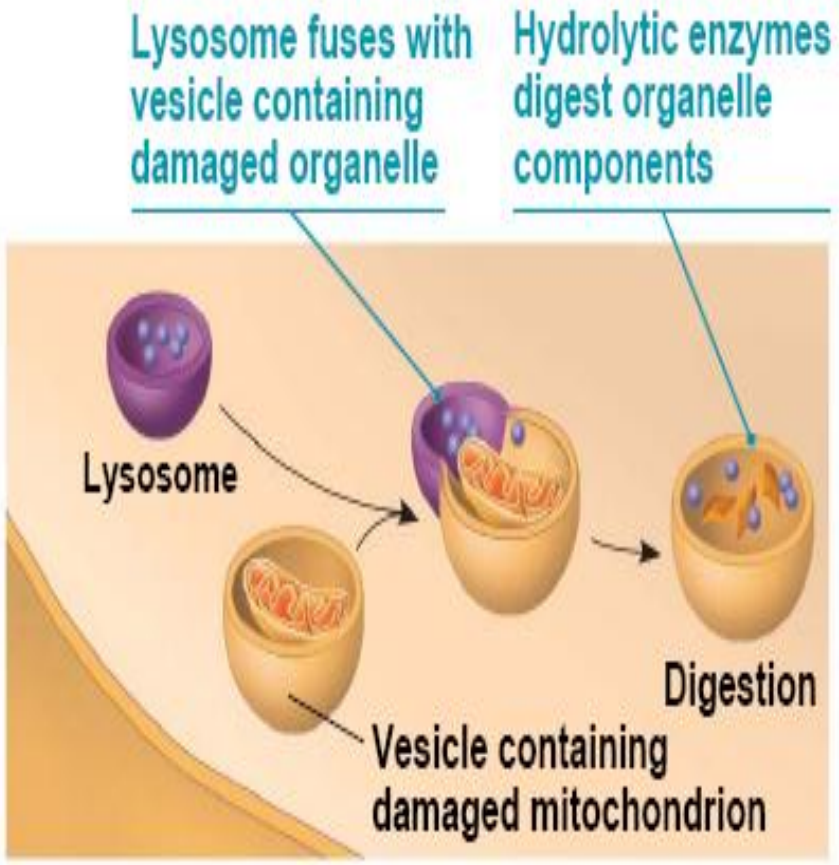
- **Produced by the *Golgi complex***
- **When a lysosome** (*lyse* means to break open or break apart) **fuses with an endocytotic vesicle, it pours its contents into the vesicle**
  - The *hydrolytic enzymes* break down the vesicle's contents
  - Phagocytosed bacteria are routinely destroyed in the body by lysosomal activity



Phagocytosis and autophagy



(a) Phagocytosis: lysosome digesting food

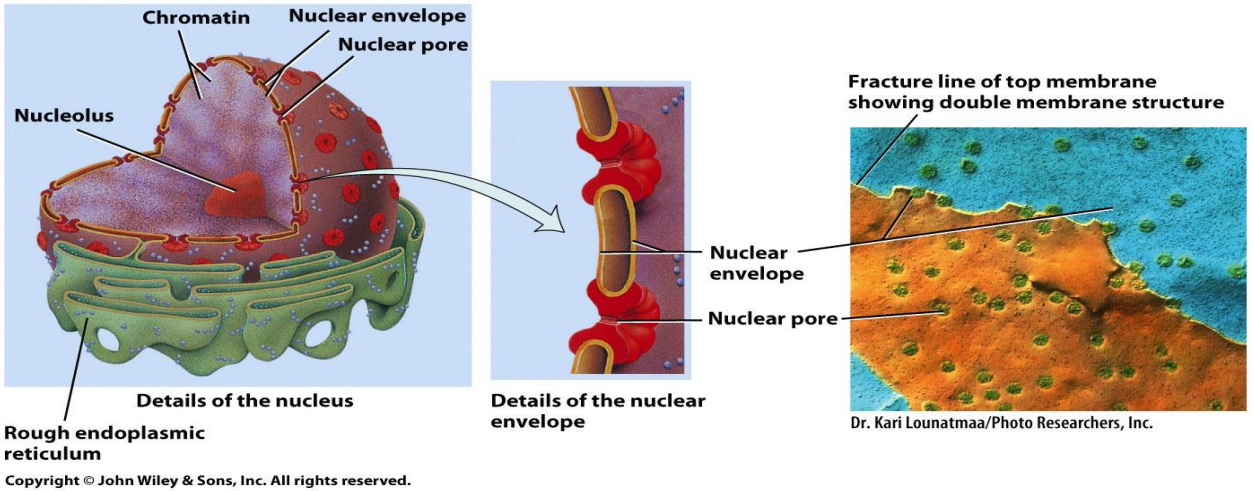


(b) Autophagy: lysosome breaking down damaged organelle

The Nucleus Contains a Cell's Genetic Library

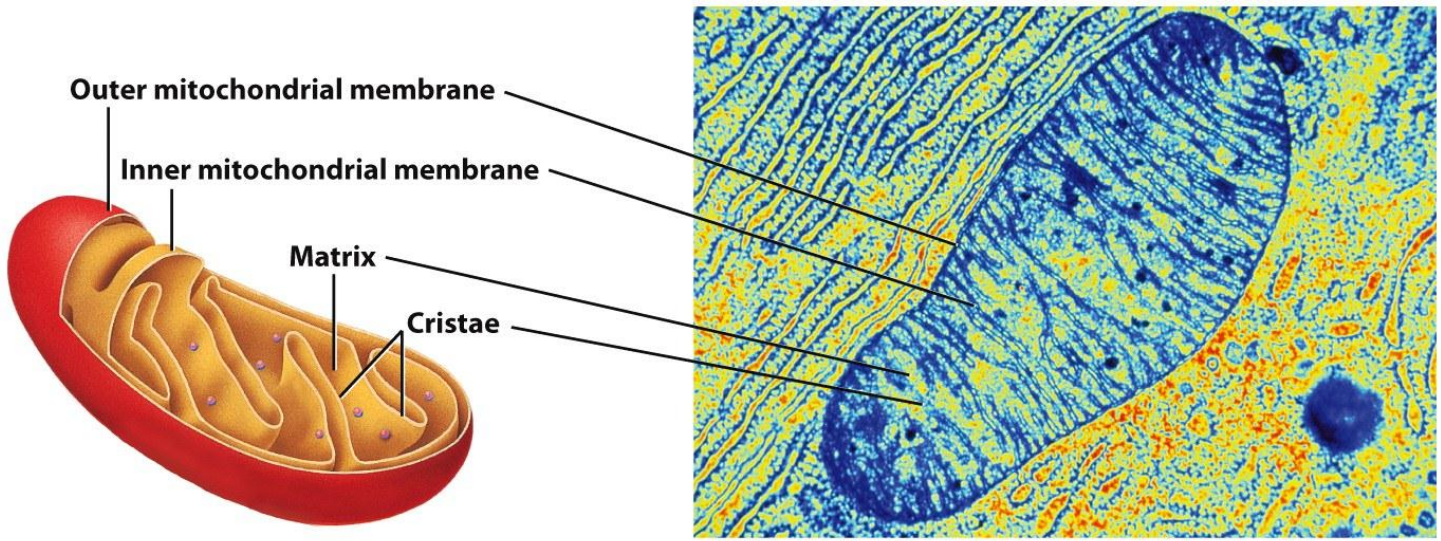
- **Usually the largest organelle in a eukaryotic cell**
- **It is covered by two phospholipid bilayers, called the *nuclear envelope***
  - The envelope is punctuated by *nuclear pores*, which allow molecules to enter and exit the nucleus
  - The small size of the nuclear pores prevents the *genetic material* (DNA) from leaving the nucleus

Nucleolus : Organelle in eukaryotic cell nucleus that produces *ribosomes* .



Mitochondria Convert Nutrients into Usable Energy in the Form of ATP

- **Have a smooth outer membrane and a folded inner membrane (cristae)**
- **Mitochondria require oxygen, and produce carbon dioxide in their endless production of ATP**
  - Cellular respiration



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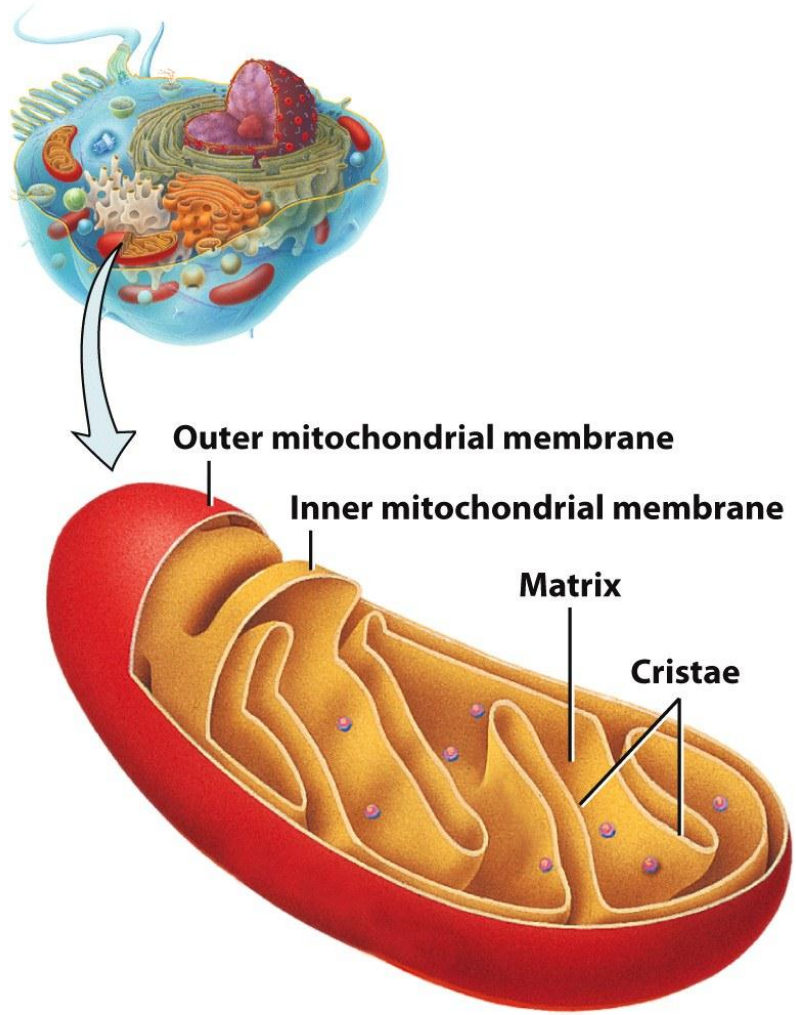
Cellular Respiration Occurs in Four Steps



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