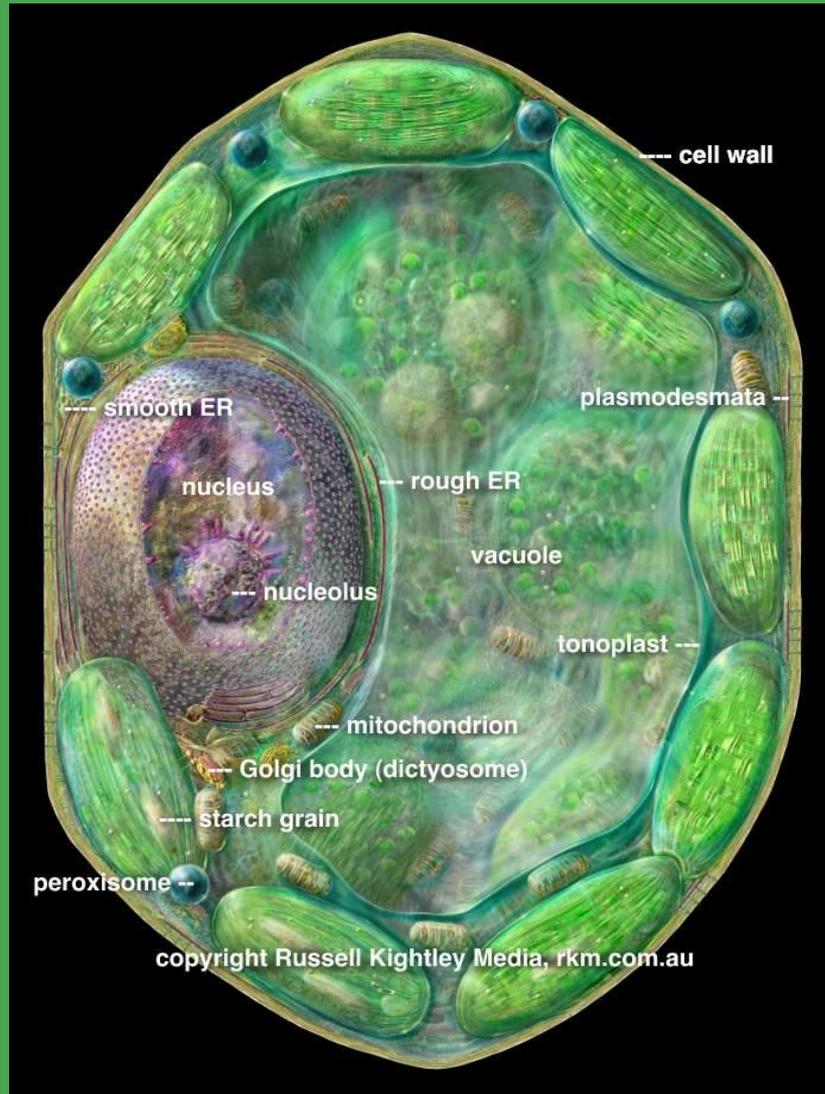


The Plant Cell

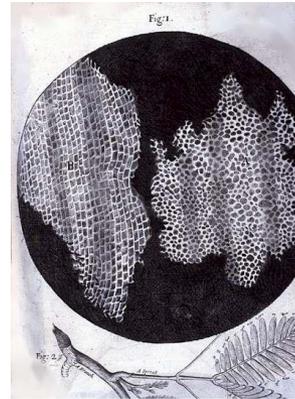


What is Cell?

The cell is the functional basic unit of life. It was discovered by **Robert Hooke** and is the functional unit of all known living organisms. It is the smallest unit of life that is classified as a living thing, and is often called the building block of life.



Robert Hooke
(1635-1703)



Robert Hooke, a 17th C. British physicist, first used the term “cell” to describe the units he observed in a sliver of corky bark.

Unicellular and multicellular

Organisms, such as most bacteria, are **unicellular** (consist of a single cell). All blue green algae, some higher algae (diatoms, Cosmarium, Chlorella, Microcystis, Pinnularia, Haematococcus etc.) and group of protozoa are the good examples of unicellular organisms.

Other organisms, such as humans, are **multicellular** (other group of plants and animals).

Humans have about 100 trillion cells

Schleiden



Schwann

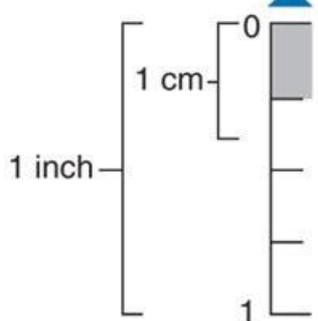
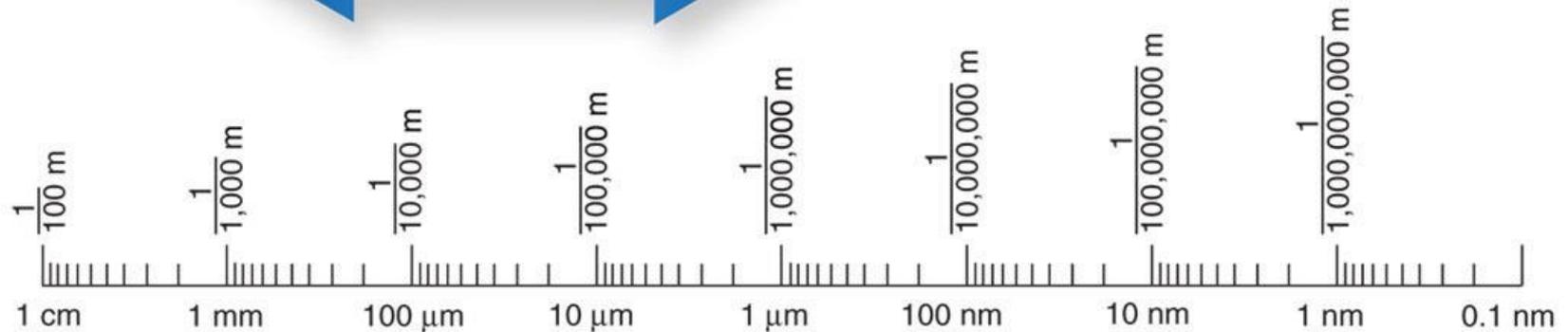


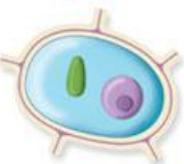
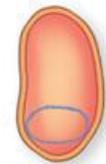
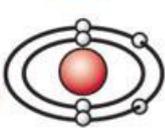
The German biologists Schleiden and Schwann proposed in the 1830s that cells are the structural units of life. This idea has come to be known as the **Cell Theory**.

Cell Theory

1. All organisms are composed of cells.
2. Cells are the smallest living things.
3. Cells arise only from pre-existing cells.

How big is a plant cell?



							
Thickness of a dime	Plant cell	Animal cell	Bacterium	Virus	Globular protein	Small molecule	Atom

A. B. C. D. E.

All cells have certain structures in common.

1. **Genetic material** – in a nucleoid or nucleus
2. **Cytoplasm** – a semifluid matrix
3. **Plasma membrane** – a phospholipid bilayer
4. **Ribosomes**

Cell is basic unit and building blocks of life

Cell "building blocks of life" is the smallest unit of all organisms. The cell was first discovered by Robert Hooke in 1665. The word cell is derived from a Latin word —*cella*” *which means small room.*

Cell is considered as basic biological, structural and functional unit of all living organisms. Cells consist of cytoplasm enclosed within a membrane, which contain many vital macromolecules such as proteins and nucleic acids.

The cell is a unit of biological activity delimited by a semi-permeable membrane and capable of self-reproduction in a medium free of other living systems.

However, exception is observed in viruses because they are capable to self-multiply only using the cellular machinery of other organisms.

Types of Cell

There are two types of cells: **eukaryotic** and **prokaryotic**. Prokaryotic cells are those cells which have nuclear material without nuclear membrane. For ex- bacteria and blue green algae.

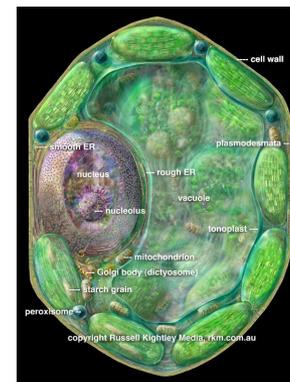
The cell having well- organized nucleus with a nuclear membrane are called eukaryotic cells.

Comparison of Prokaryotic and Eukaryotic Cells

- **Prokaryotic cells:**
- e.g., bacteria
- Relatively simple structure
- Lack nucleus and other membrane-bound organelles
- ca. 1 - 10 μm diam.



- **Eukaryotic cells:**
- e.g., plant & animal cells
- Nucleus and other membrane-bound organelles present
- ca. 100 μm diam.



Prokaryotic Cells

Prokaryotic cells lack a membrane-bound nucleus.

-genetic material is present in the **nucleoid**

Two types of prokaryotes:

- Domain Archaea
- Domain Bacteria

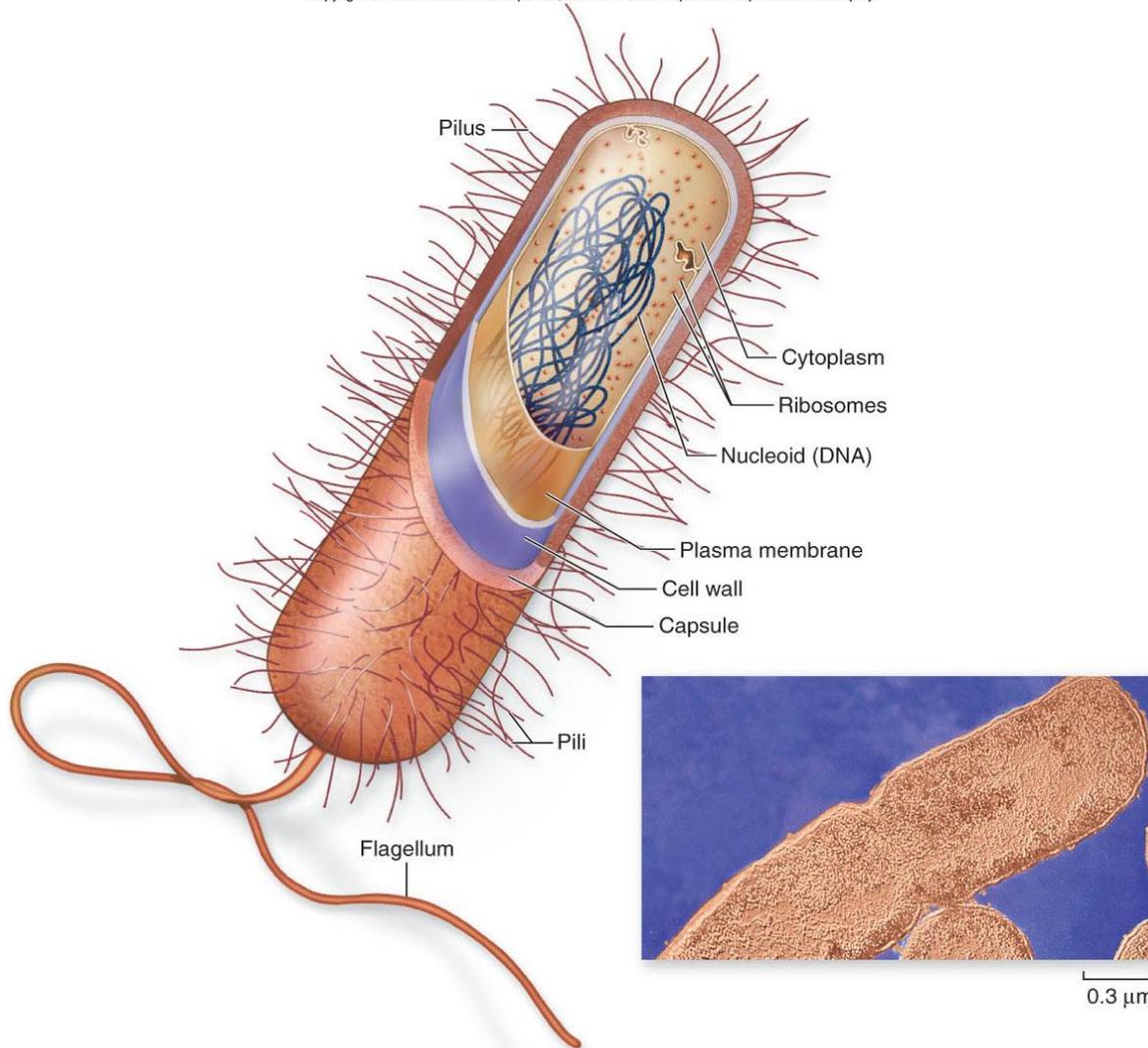
Prokaryotic Cells

Prokaryotic cells possess

- genetic material in the nucleoid
- cytoplasm
- plasma membrane
- cell wall
- ribosomes
- no membrane-bound organelles

Prokaryotic Cells

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Prokaryotic Cells

Prokaryotic cell walls

- protect the cell and maintain cell shape

Bacterial cell walls

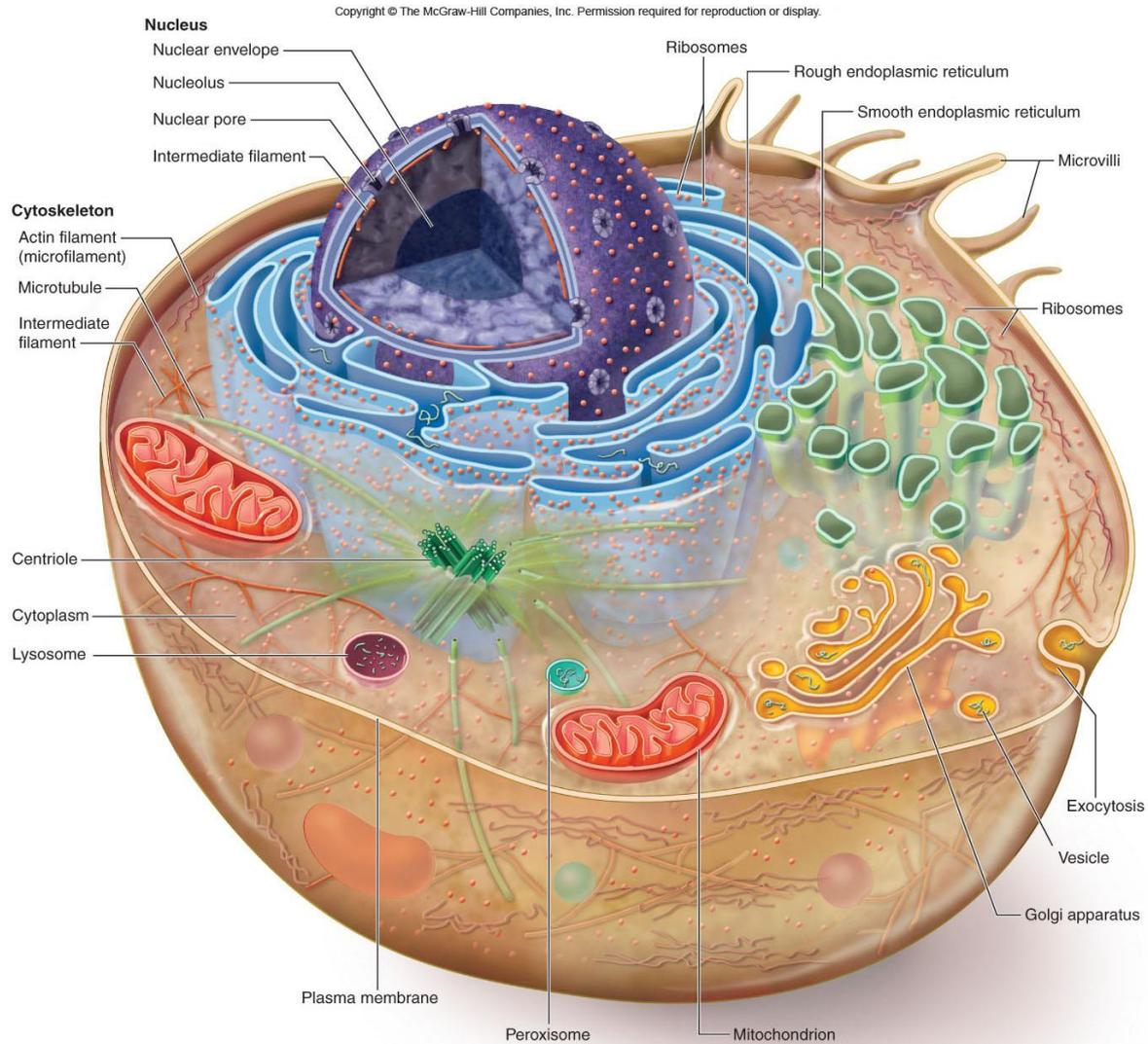
- may be composed of peptidoglycan
- may be **Gram positive** (lots of peptidoglycan) or **Gram negative** (small amount of peptidoglycan)

Eukaryotic Cells

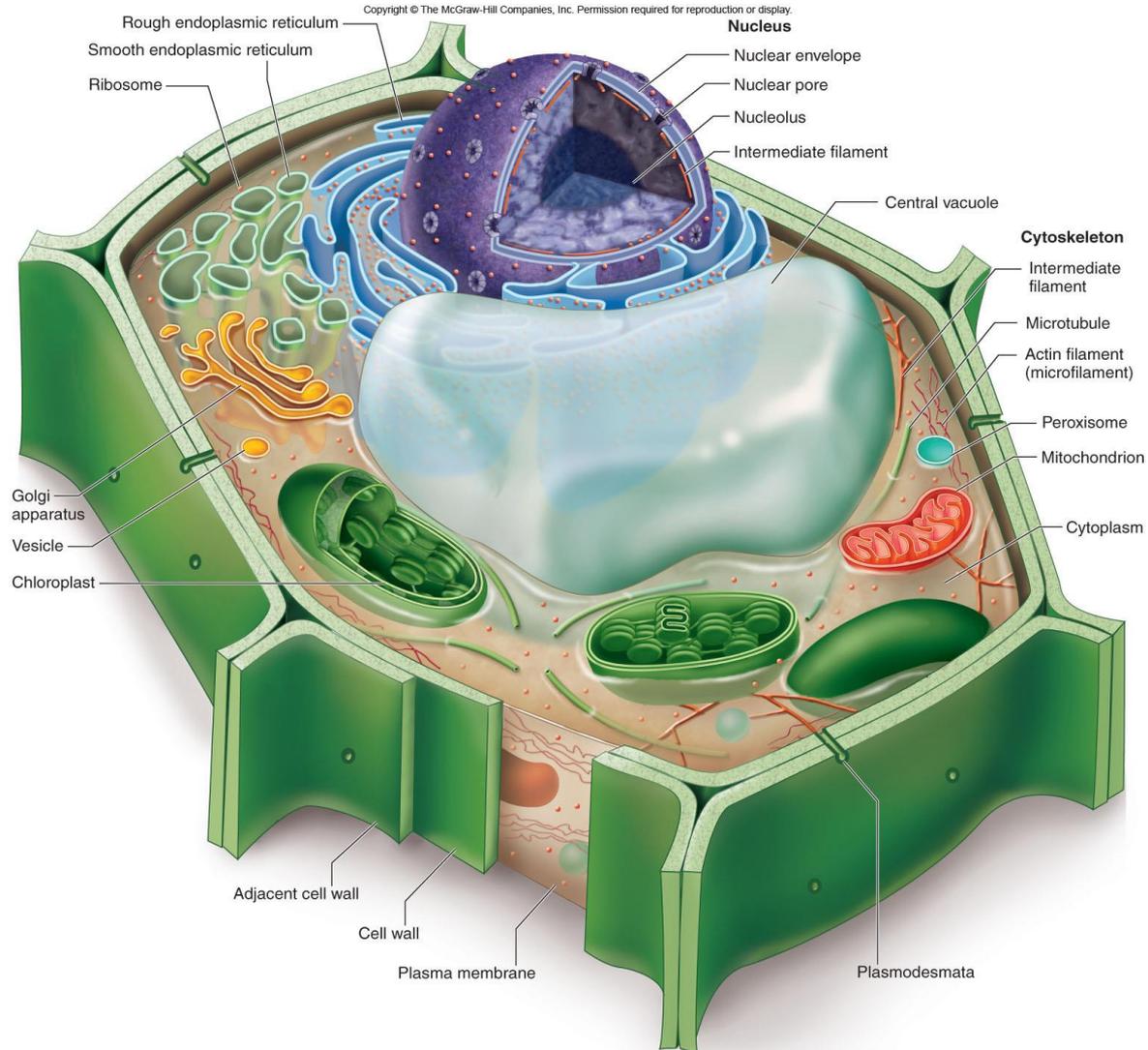
Eukaryotic cells

- possess a membrane-bound nucleus
- are more complex than prokaryotic cells
- compartmentalize many cellular functions within **organelles** and the **endomembrane system**
- possess a **cytoskeleton** for support and to maintain cellular structure

Eukaryotic Cells



Eukaryotic Cells



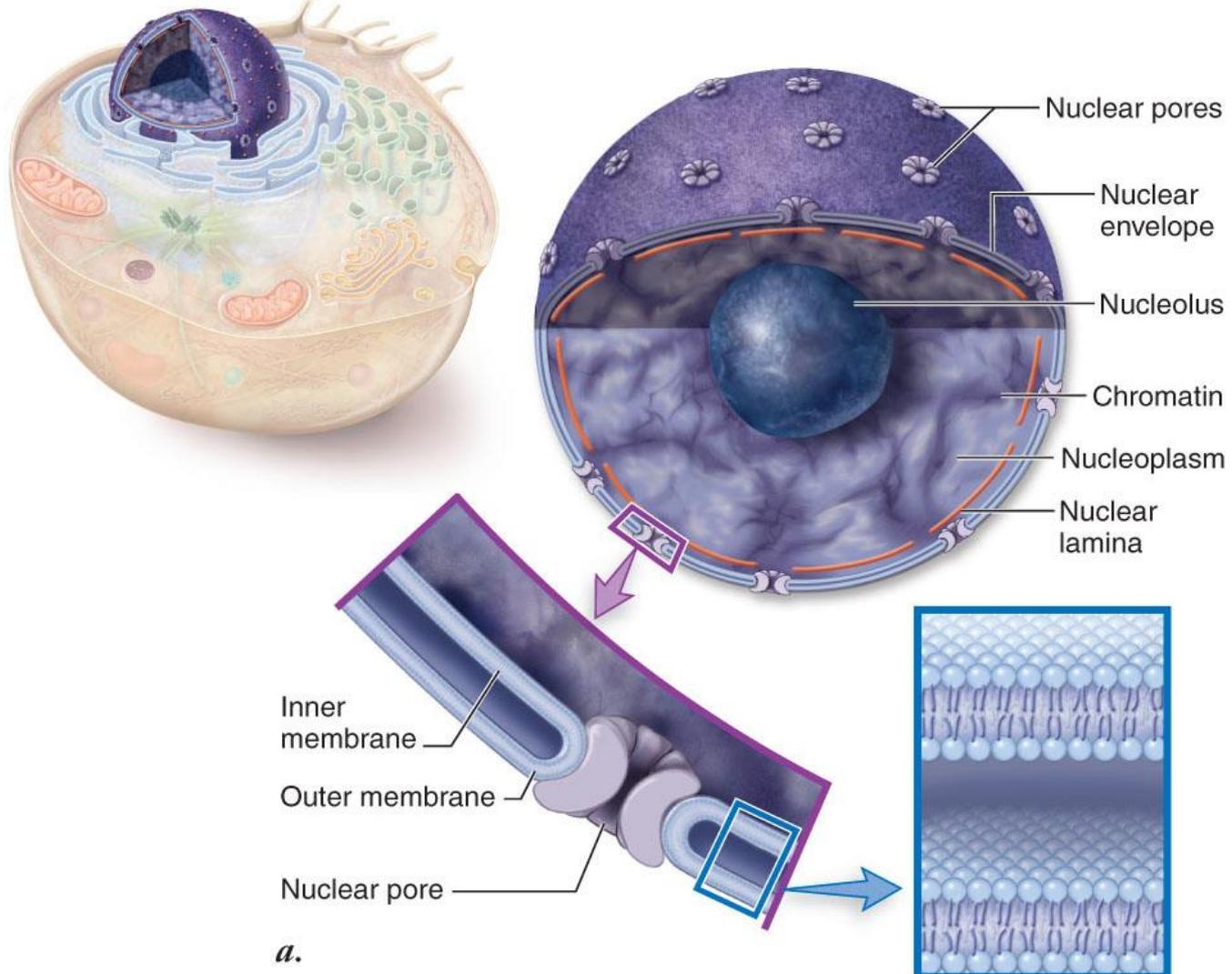
Eukaryotic Cells

Nucleus

- stores the genetic material of the cell in the form of multiple, linear chromosomes
- surrounded by a **nuclear envelope** composed of 2 phospholipid bilayers
- in chromosomes – DNA is organized with proteins to form **chromatin**

Eukaryotic Cells

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Eukaryotic Cells

Ribosomes

- the site of protein synthesis in the cell
- composed of **ribosomal RNA** and proteins
- found within the cytosol of the cytoplasm and attached to internal membranes

Endomembrane System

Endomembrane system

- a series of membranes throughout the cytoplasm

- divides cell into compartments where different cellular functions occur

1. Endoplasmic reticulum

2. Golgi apparatus

3. Lysosomes

Endomembrane System

Rough endoplasmic reticulum (RER)

- membranes that create a network of channels throughout the cytoplasm
- attachment of ribosomes to the membrane gives a rough appearance
- synthesis of proteins to be secreted, sent to lysosomes or plasma membrane

Endomembrane System

Smooth endoplasmic reticulum (SER)

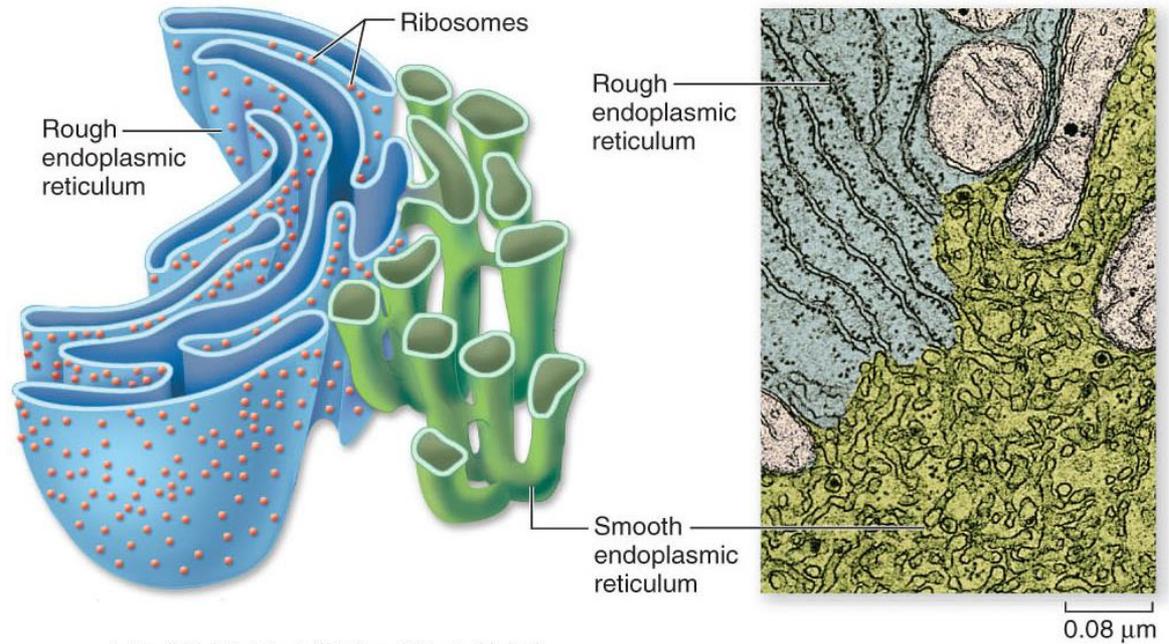
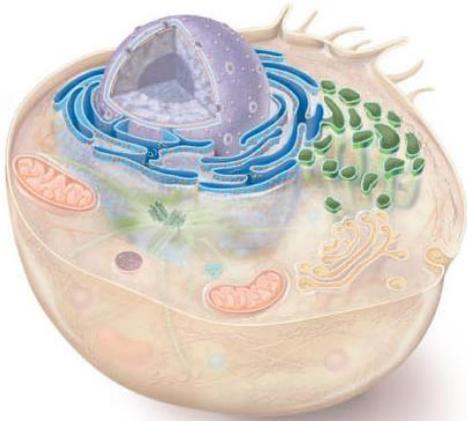
-functions:

- synthesis of membrane lipids

- calcium storage

- detoxification of foreign substances

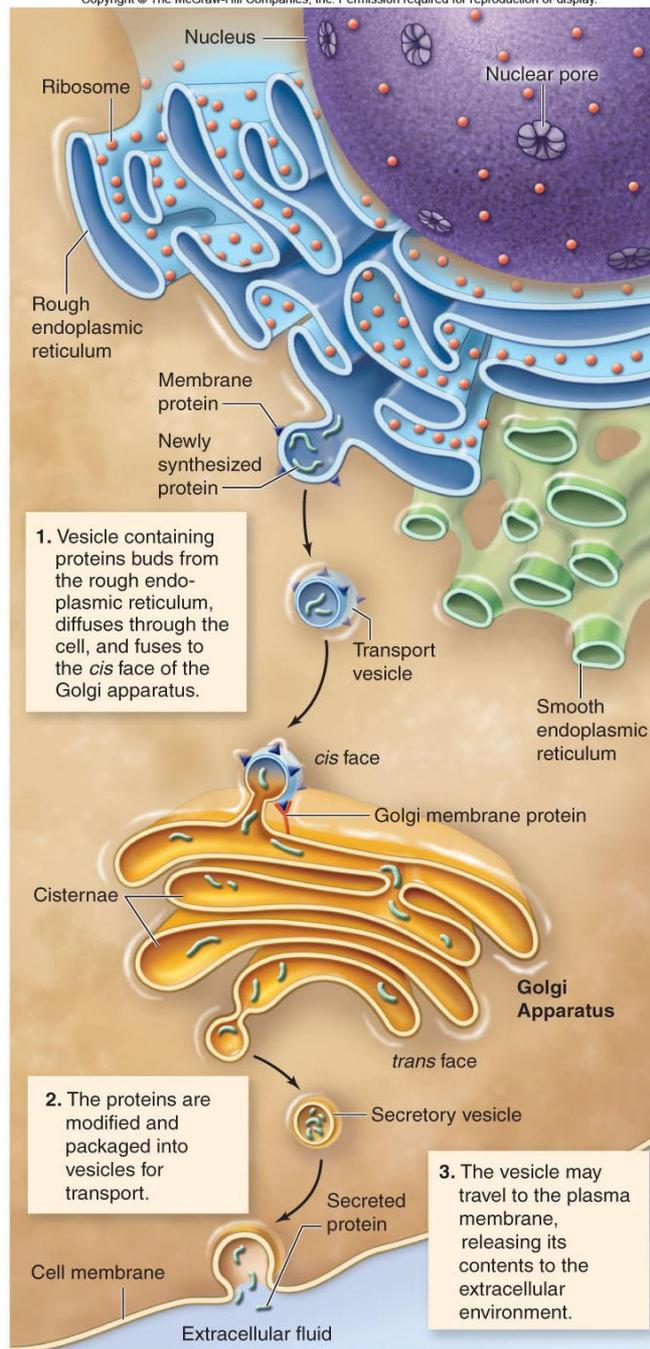
Endomembrane System



Endomembrane System

Golgi apparatus

- flattened stacks of interconnected membranes
- packaging and distribution of materials to different parts of the cell
- synthesis of cell wall components

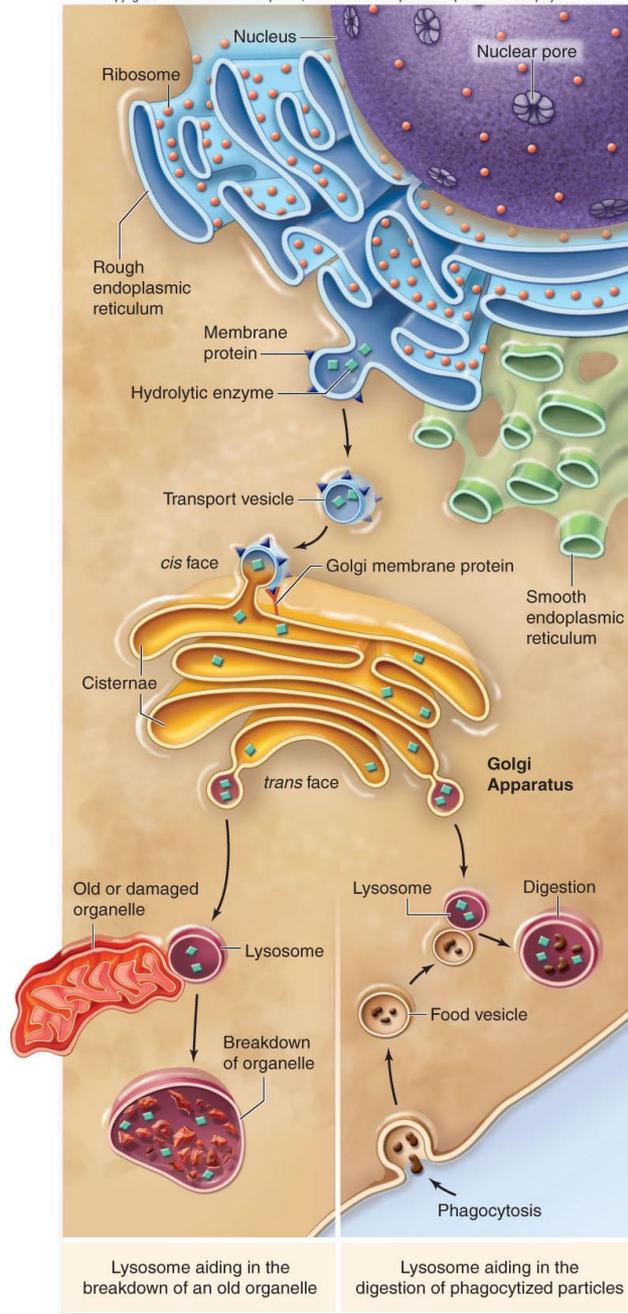


Endomembrane System

Lysosomes

- membrane bound vesicles containing digestive enzymes to break down macromolecules

- destroy cells or foreign matter that the cell has engulfed by phagocytosis



Endomembrane System

Microbodies

- membrane bound vesicles
- contain enzymes
- not part of the endomembrane system
- peroxisomes** contain oxidative enzymes and catalase

Endomembrane System

Vacuoles

- membrane-bound structures with various functions depending on the cell type

There are different types of vacuoles:

- central vacuole** in plant cells
- contractile vacuole of some protists
- vacuoles for storage

Mitochondria

Mitochondria

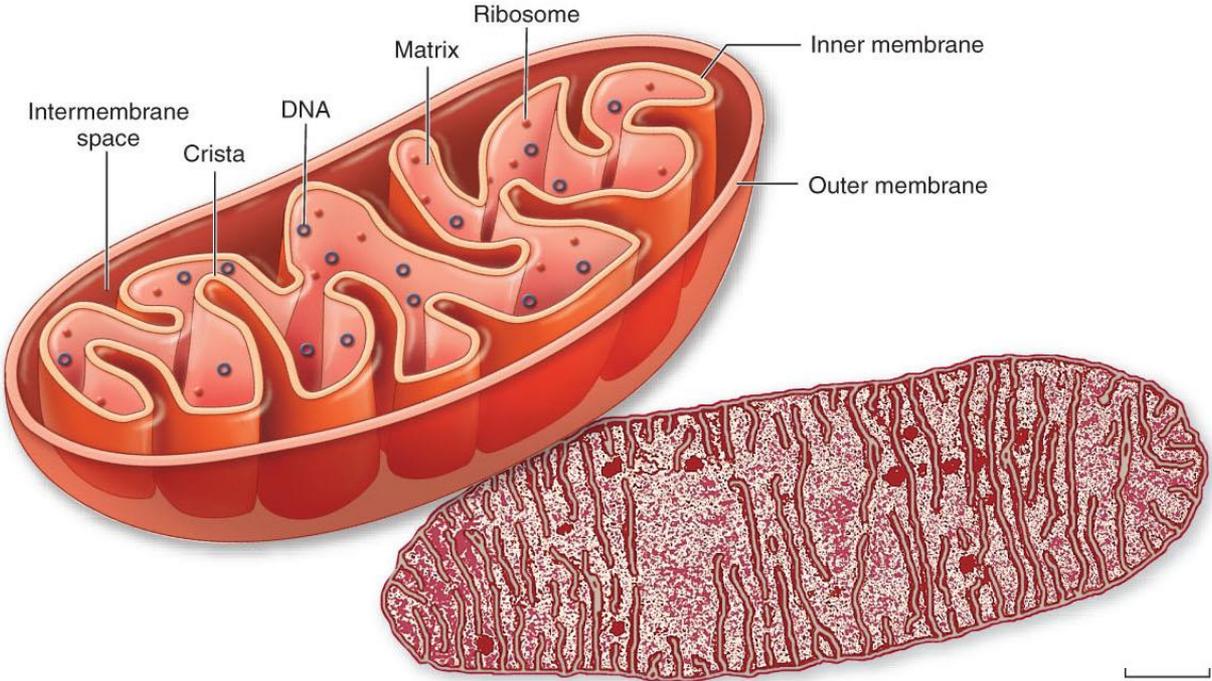
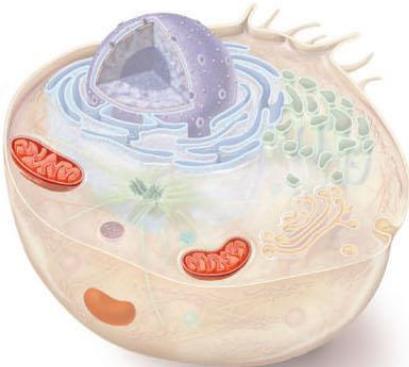
- organelles present in all types of eukaryotic cells
- contain oxidative metabolism enzymes for transferring the energy within macromolecules to ATP (AKA: Cellular Respiration)
- found in all types of eukaryotic cells

Mitochondria

- surrounded by 2 membranes
 - smooth outer membrane
 - folded inner membrane with layers called **cristae**
- matrix** is within the inner membrane
- intermembrane space** is located between the two membranes
- contain their own DNA – mtDNA – maternally inherited – circular plasmid

Mitochondria

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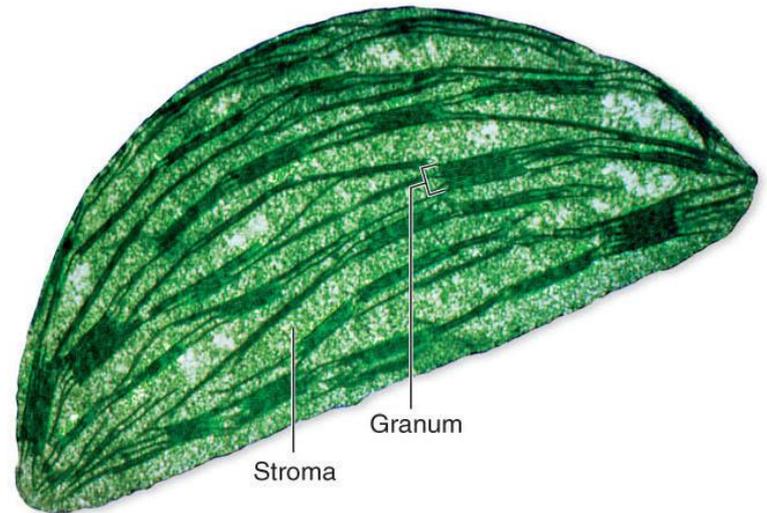
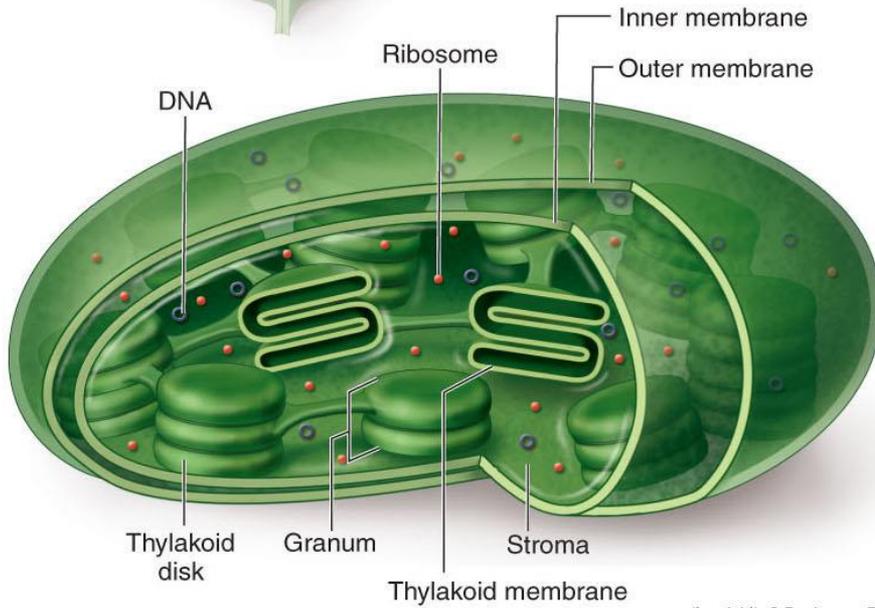
Chloroplasts

Chloroplasts

- organelles present in cells of plants and some other eukaryotes
- contain chlorophyll for photosynthesis
- surrounded by 2 membranes
- thylakoids** are membranous sacs within the inner membrane
- grana** are stacks of thylakoids
- also have own DNA – circular plasmid

Chloroplasts

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1.5 μ m

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Mitochondria & Chloroplasts

Endosymbiosis

- proposal that eukaryotic organelles evolved through a symbiotic relationship
- one cell engulfed a second cell and a symbiotic relationship developed
- mitochondria and chloroplasts are thought to have evolved this way

Mitochondria & Chloroplasts

Much evidence supports this endosymbiosis theory.

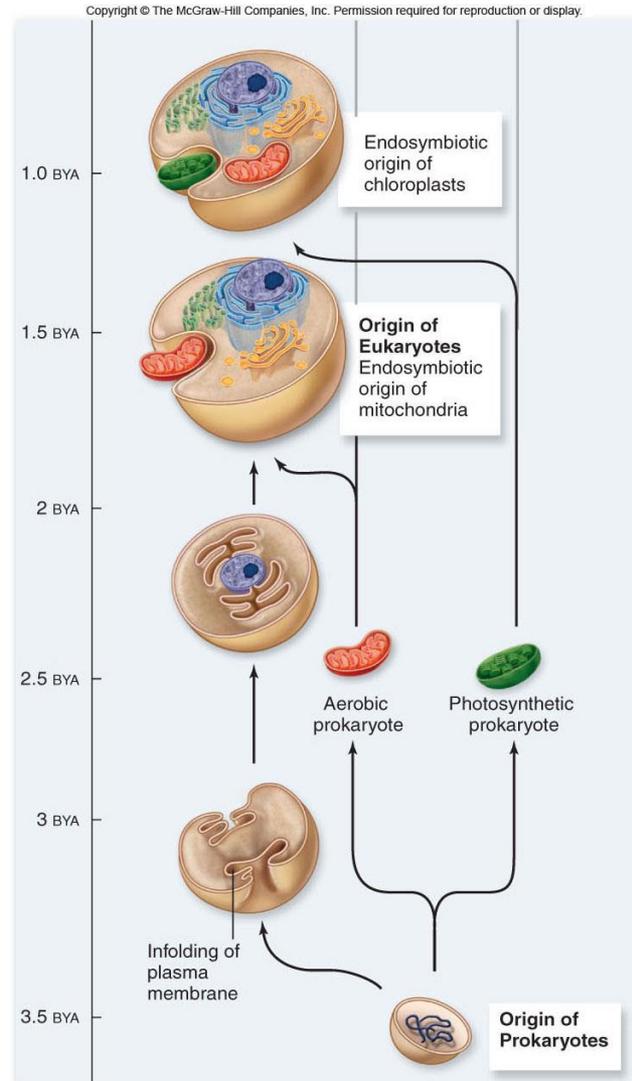
Mitochondria and chloroplasts:

- have 2 membranes
- possess DNA and ribosomes
- are about the size of a prokaryotic cell
- divide by a process similar to bacteria

Endosymbiont Theory

- This theory states that the organelles of eukaryotic cells are the descendants of once free-living prokaryotes that took up residence in a larger cell, establishing a symbiotic relationship.
- This association evolved into the well-studied eukaryotic cell Chloroplasts and mitochondria provide the best examples of this theory. Both organelles resemble free-living prokaryotes.
- In fact, as long ago as the 1880s some biologists observed that chloroplasts of eukaryotic cells resembled cyanobacteria (blue-green algae). Both chloroplasts and mitochondria have structures that are associated with free-living cells. For example, they contain both DNA and ribosomes, which are bacterial in size and nature, allowing them to synthesize some of their own proteins.
- Both chloroplasts and mitochondria can divide to produce new chloroplasts and mitochondria in a manner very similar to prokaryotic cell division. The inner membranes of both organelles closely resemble the plasma membrane of prokaryotes. These features, as well as additional biochemical similarities, provide support for the validity of the Endosymbiont Theory.

Mitochondria & Chloroplasts



Cytoskeleton

Cytoskeleton

- network of protein fibers found in all eukaryotic cells
- supports the shape of the cell
- keeps organelles in fixed locations
- helps move materials within the cell

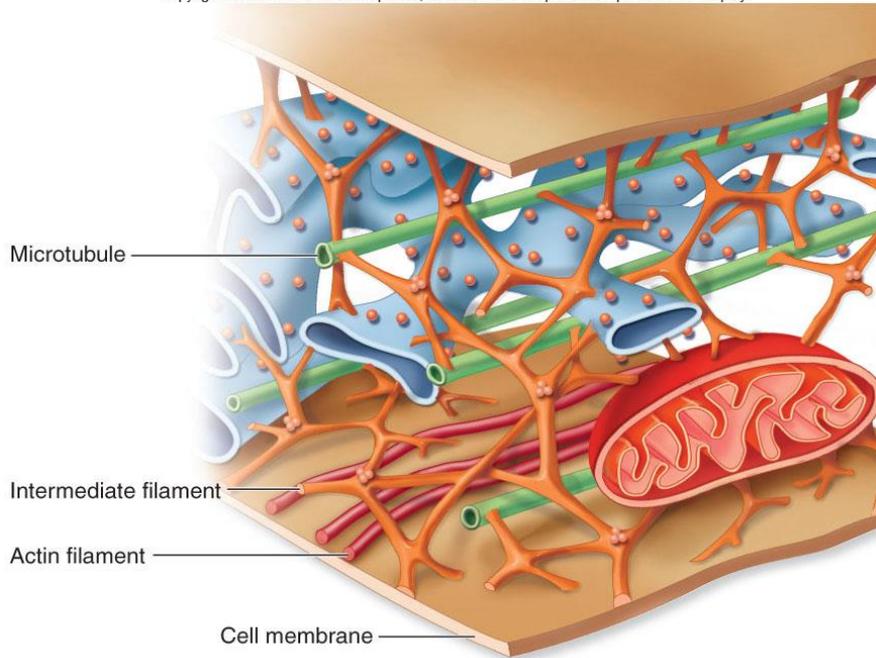
Cytoskeleton

Cytoskeleton fibers include

- actin filaments** – responsible for cellular contractions, crawling, “pinching”
- microtubules** – provide organization to the cell and move materials within the cell
- intermediate filaments** – provide structural stability

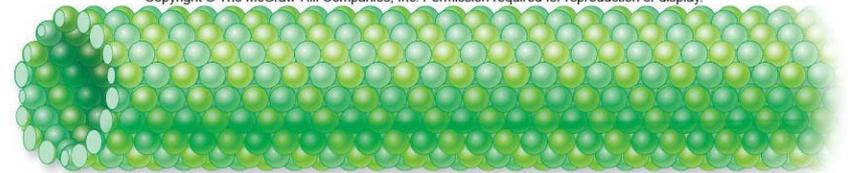
Cytoskeleton

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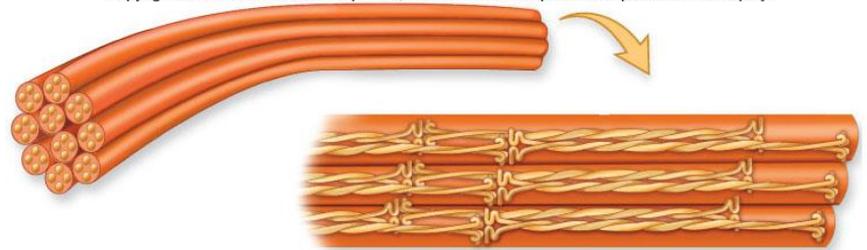
a. Actin filaments

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b. Microtubules

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c. Intermediate filament

Cell Movement

Cell movement takes different forms.

- Crawling is accomplished via actin filaments and the protein **myosin**.

- Flagella** undulate to move a cell.

- Cilia** can be arranged in rows on the surface of a eukaryotic cell to propel a cell forward.

Cell Movement

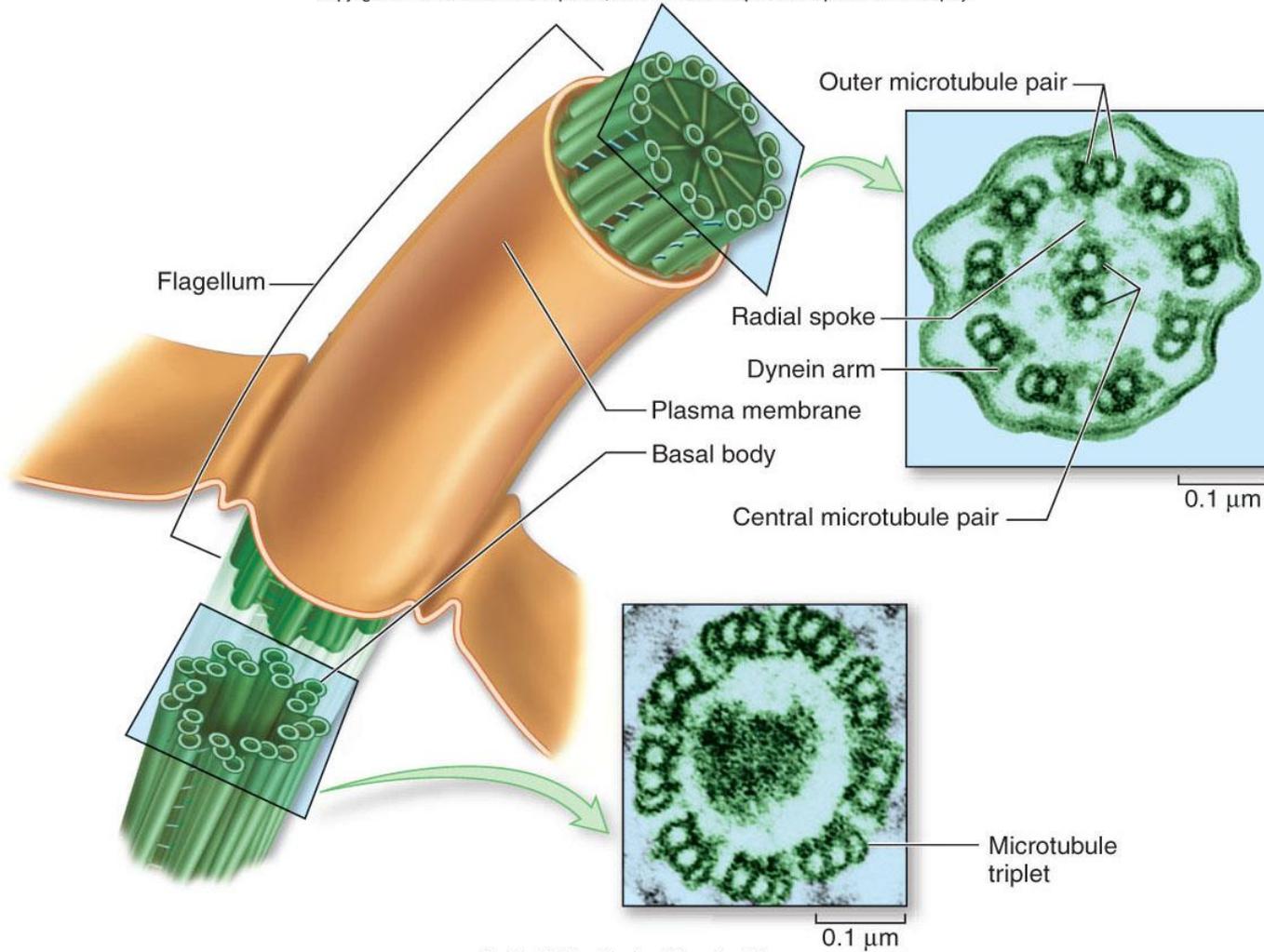
The cilia and flagella of eukaryotic cells have a similar structure:

-**9+2 structure**: 9 pairs of microtubules surrounded by a 2 central microtubules

-Cilia are usually more numerous than flagella on a cell.

Cell Movement

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Extracellular Structures

Extracellular structures include:

- cell walls of plants, fungi, some protists
- extracellular matrix surrounding animal cells

Extracellular Structures

Cell walls

- present surrounding the cells of plants, fungi, and some protists
- the carbohydrates present in the cell wall vary depending on the cell type:
 - plant and protist cell walls - cellulose
 - fungal cell walls - chitin

Extracellular Structures

Extracellular matrix (ECM)

- surrounds animal cells
- composed of glycoproteins and fibrous proteins such as collagen
- may be connected to the cytoplasm via **integrin** proteins present in the plasma membrane

Extracellular Structures

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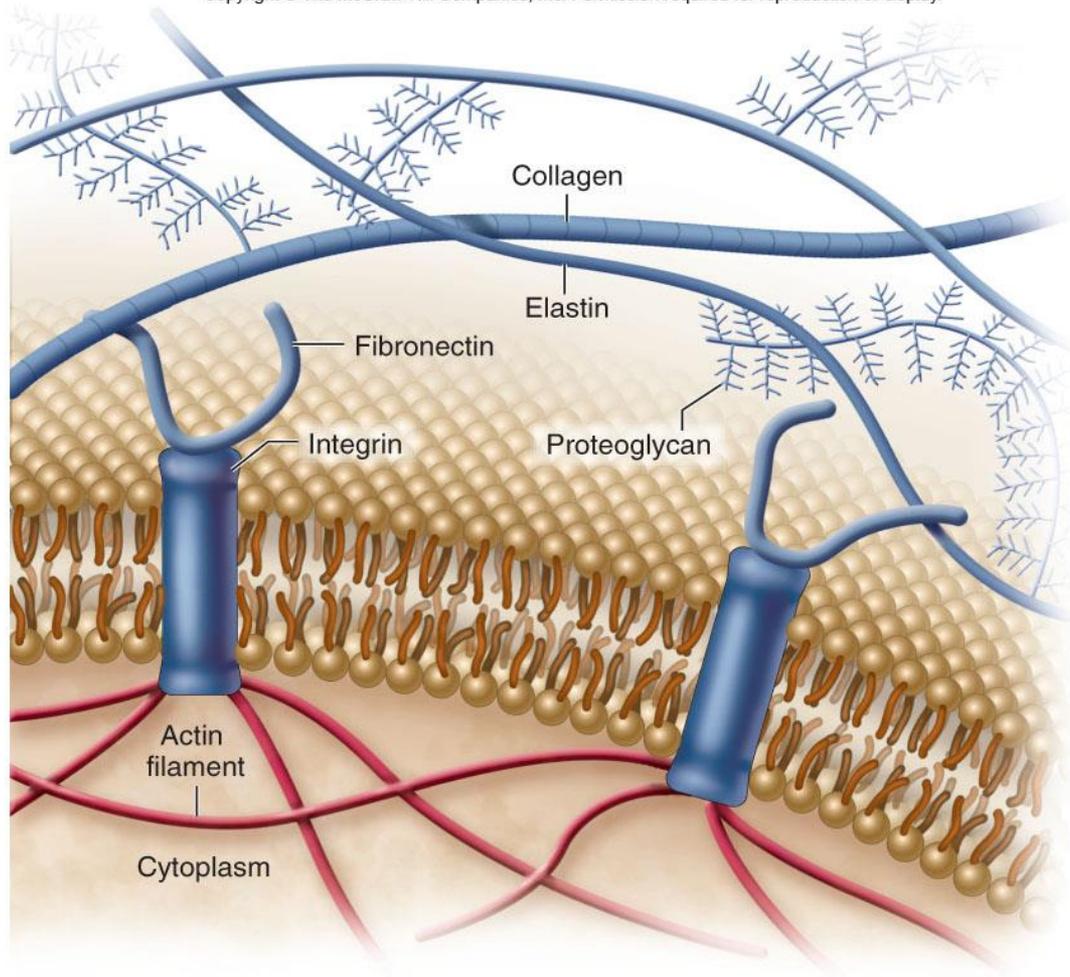


TABLE 4.3**A Comparison of Prokaryotic, Animal, and Plant Cells**

	Prokaryote	Animal	Plant
EXTERIOR STRUCTURES			
Cell wall	Present (protein-polysaccharide)	Absent	Present (cellulose)
Cell membrane	Present	Present	Present
Flagella/cilia	Flagella may be present	May be present (9 + 2 structure)	Absent except in sperm of a few species (9 + 2 structure)

TABLE 4.3**A Comparison of Prokaryotic, Animal, and Plant Cells**

	Prokaryote	Animal	Plant
I N T E R I O R S T R U C T U R E S			
ER	Absent	Usually present	Usually present
Ribosomes	Present	Present	Present
Microtubules	Absent	Present	Present
Centrioles	Absent	Present	Absent
Golgi apparatus	Absent	Present	Present
Nucleus	Absent	Present	Present
Mitochondria	Absent	Present	Present
Chloroplasts	Absent	Absent	Present
Chromosomes	A single circle of DNA	Multiple; DNA–protein complex	Multiple; DNA–protein complex
Lysosomes	Absent	Usually present	Present
Vacuoles	Absent	Absent or small	Usually a large single vacuole

The Plant Cell and their function

Structure	Description	Function
Cell wall	Cellulose fibrils	Support and protection
Plasma membrane	Lipid bilayer with embedded proteins	Regulates passage of materials into and out of cell
Central vacuole	Fluid-filled sac	Storage of various substances
Nucleus	Bounded by nuclear envelope; contains chromatin	Control center of cell; directs protein synthesis and cell reproduction
Nucleolus	Concentrated area of RNA and protein within the nucleus	Ribosome formation
Ribosomes	Assembly of protein and RNA	Protein synthesis
Endoplasmic reticulum	Membranous channels	Transport and protein synthesis (rough ER)
Golgi apparatus	Stack of flattened membranous sacs	Processing and packaging of proteins; secretion
Chloroplast	Double membrane-bound; contains chlorophyll	Photosynthesis
Leucoplast	Colorless plastid	Storage of various materials, especially starch
Chromoplast	Pigmented plastid	Imparts color
Mitochondrion	Double membrane-bound	Cellular respiration
Microbodies	Vesicles	Various metabolic reactions
Cytoskeleton	Microtubules and microfilaments	Cell support and shape
Plasmodesmata	Cytoplasmic bridges	Movement of materials between cells