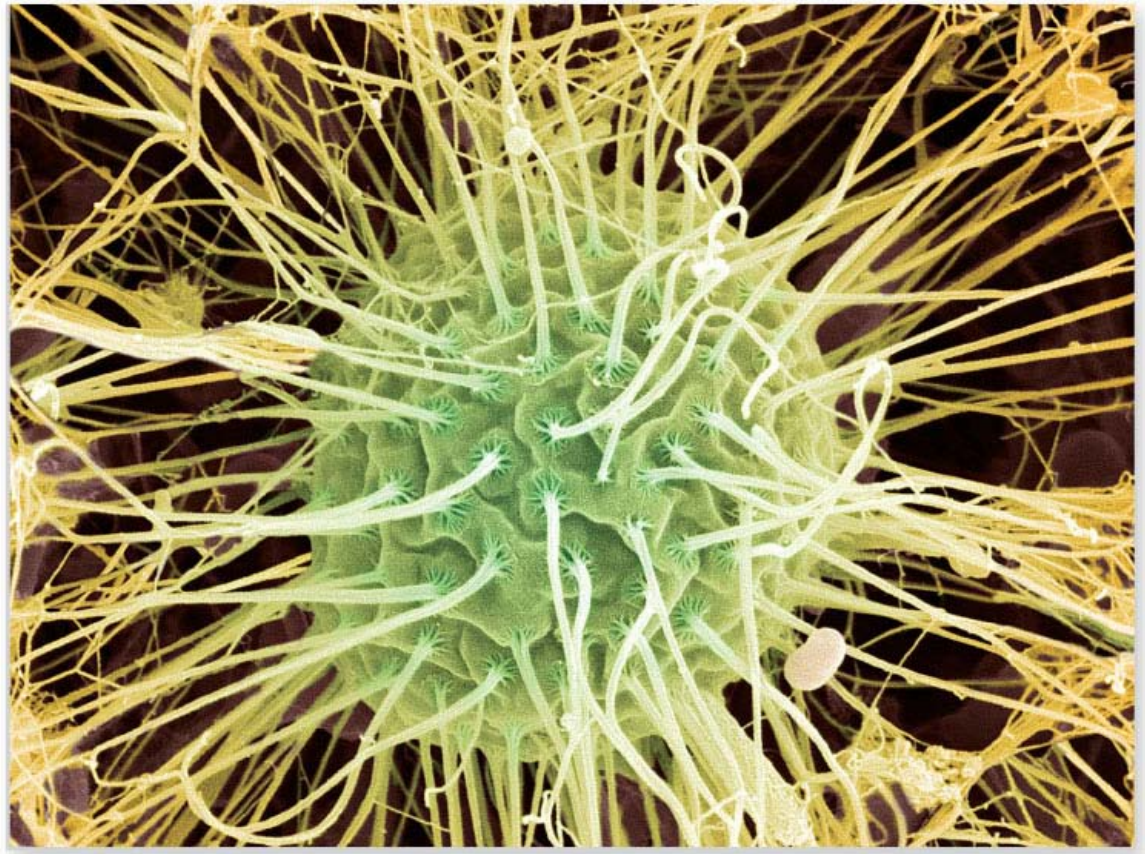
Cell Structure

Chapter 4



Cell Theory

Cells were discovered in 1665 by Robert Hooke.

Early studies of cells were conducted by

- Mathias Schleiden (1838)
- Theodor Schwann (1839)

Schleiden and Schwann proposed the Cell Theory.

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.

All cells today represent a continuous line of descent from the first living cells.

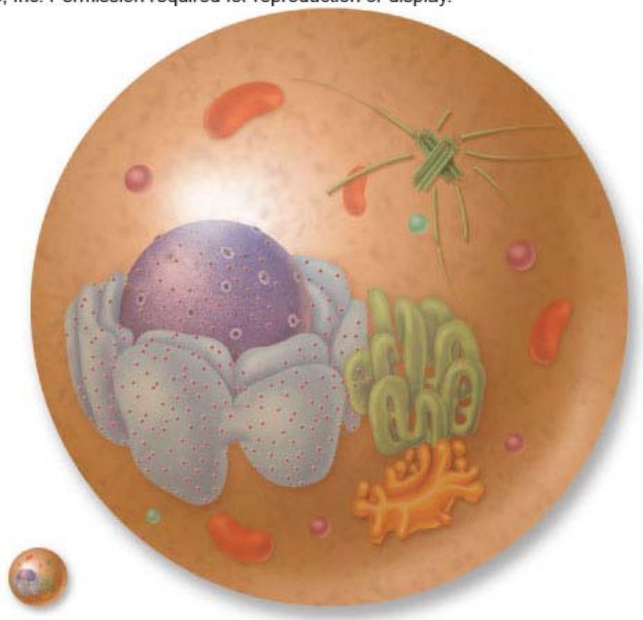
Cell Theory

Cell size is limited.

-As cell size increases, it takes longer for material to diffuse from the cell membrane to the interior of the cell.

Surface area-to-volume ratio: as a cell increases in size, the volume increases 10x faster than the surface area

Cell Theory



Cell radius (r)	1 unit	10 unit
Surface area ($4\pi r^2$)	12.57 unit^2	1257 unit^2
Volume ($\frac{4}{3}\pi r^3$)	4.189 unit^3	4189 unit^3
Surface Area / Volume	3	0.3

Cell Theory

Microscopes are required to visualize cells.

Light microscopes can resolve structures that are 200nm apart.

Electron microscopes can resolve structures that are 0.2nm apart.

Cell Theory

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

Prokaryotic Cells

Prokaryotic cells lack a membrane-bound nucleus.

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

Two types of prokaryotes:

-archaea

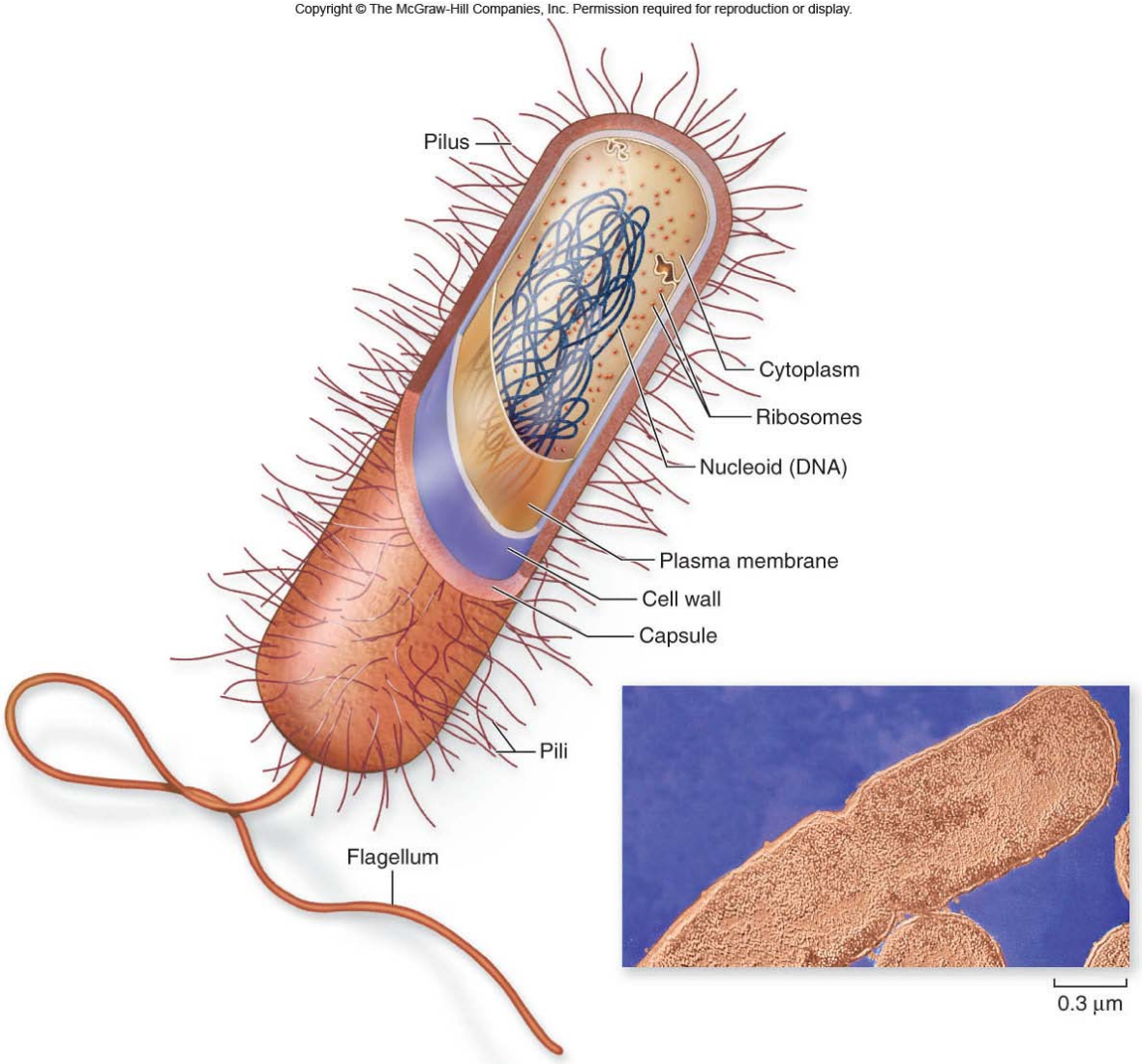
-bacteria

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** or **Gram negative**

Archaean cell walls lack peptidoglycan.

Prokaryotic Cells

Flagella

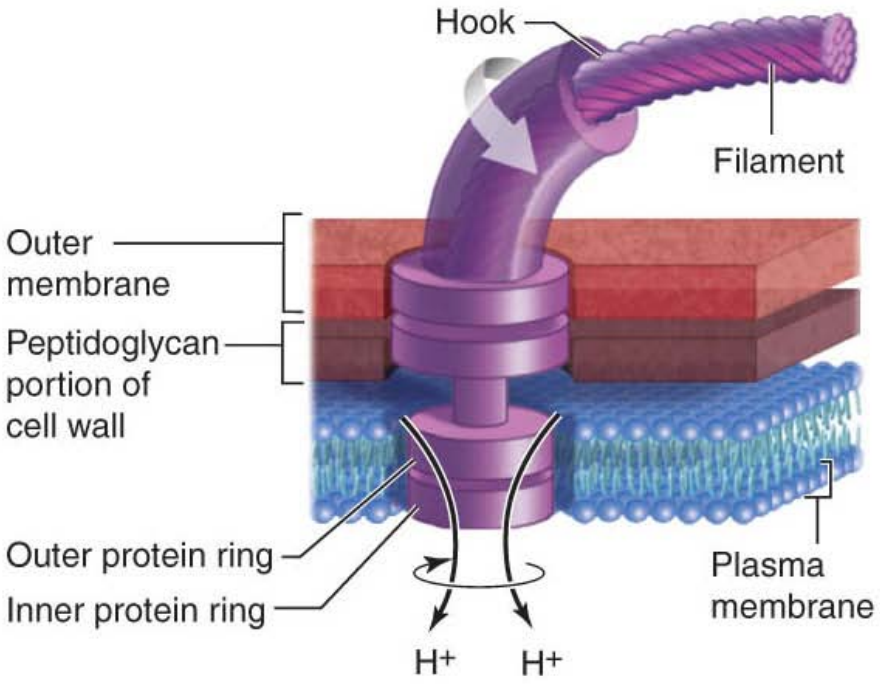
-present in some prokaryotic cells

-used for locomotion

-rotary motion propels the cell

Prokaryotic Cells

a.



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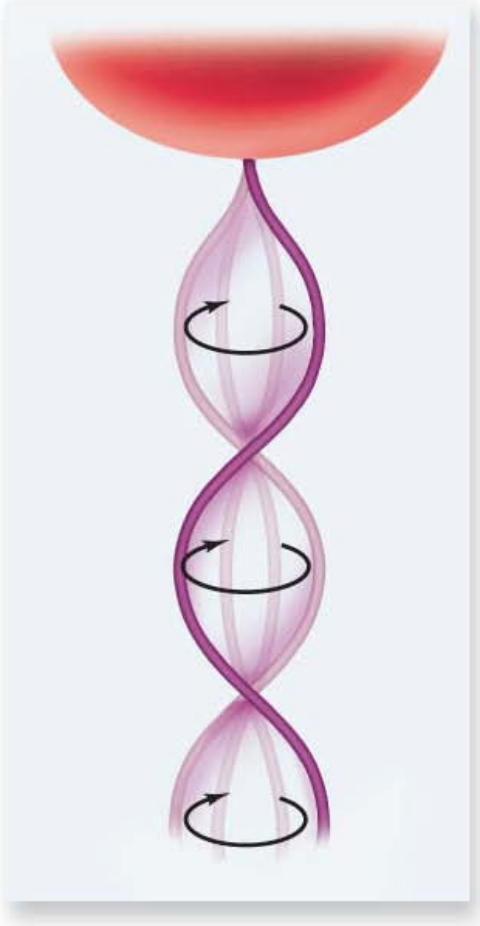


c.

Eukaryotic Cells

Eukaryotic cells

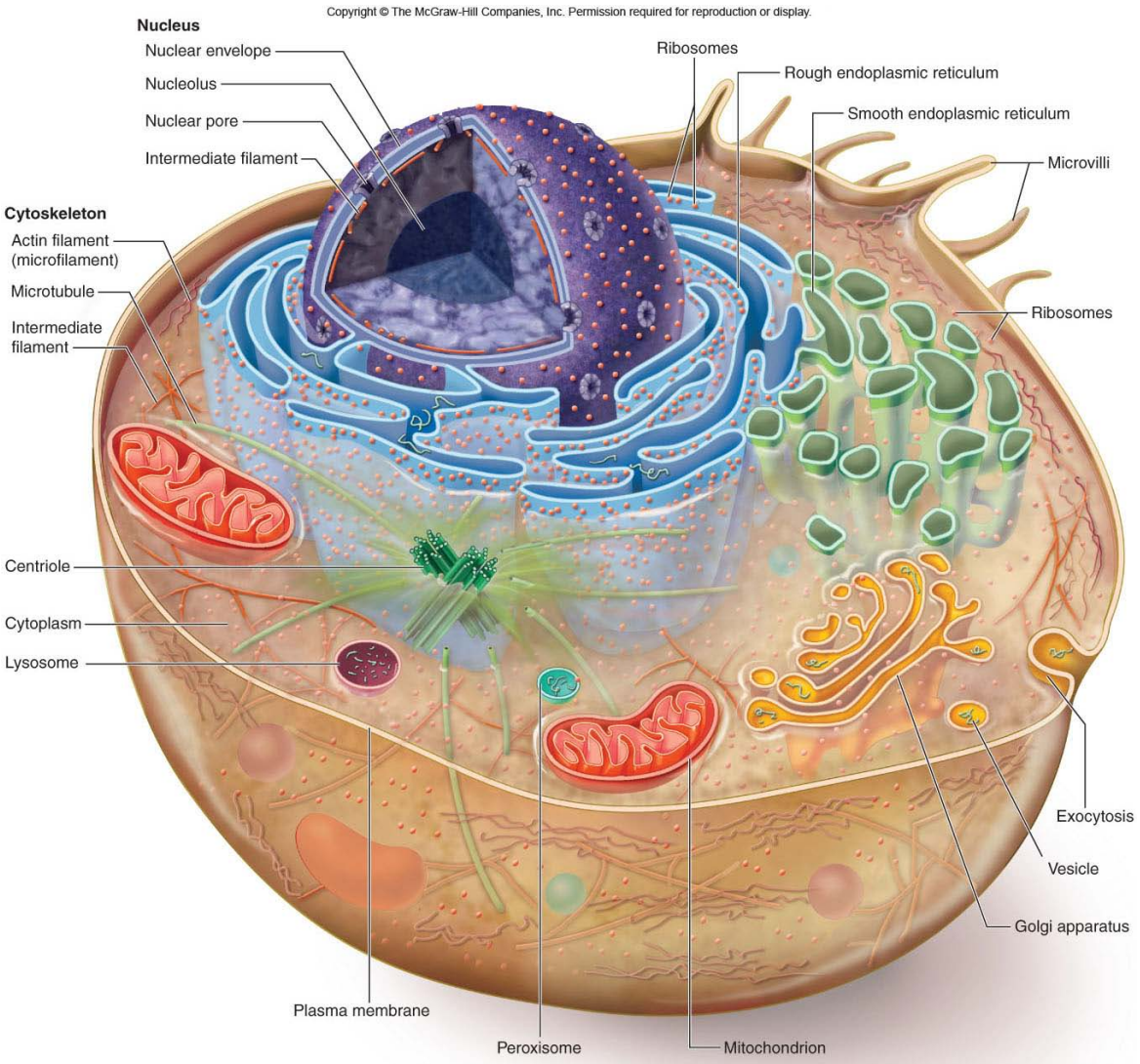
-possess a membrane-bound nucleus

-are more complex than prokaryotic cells

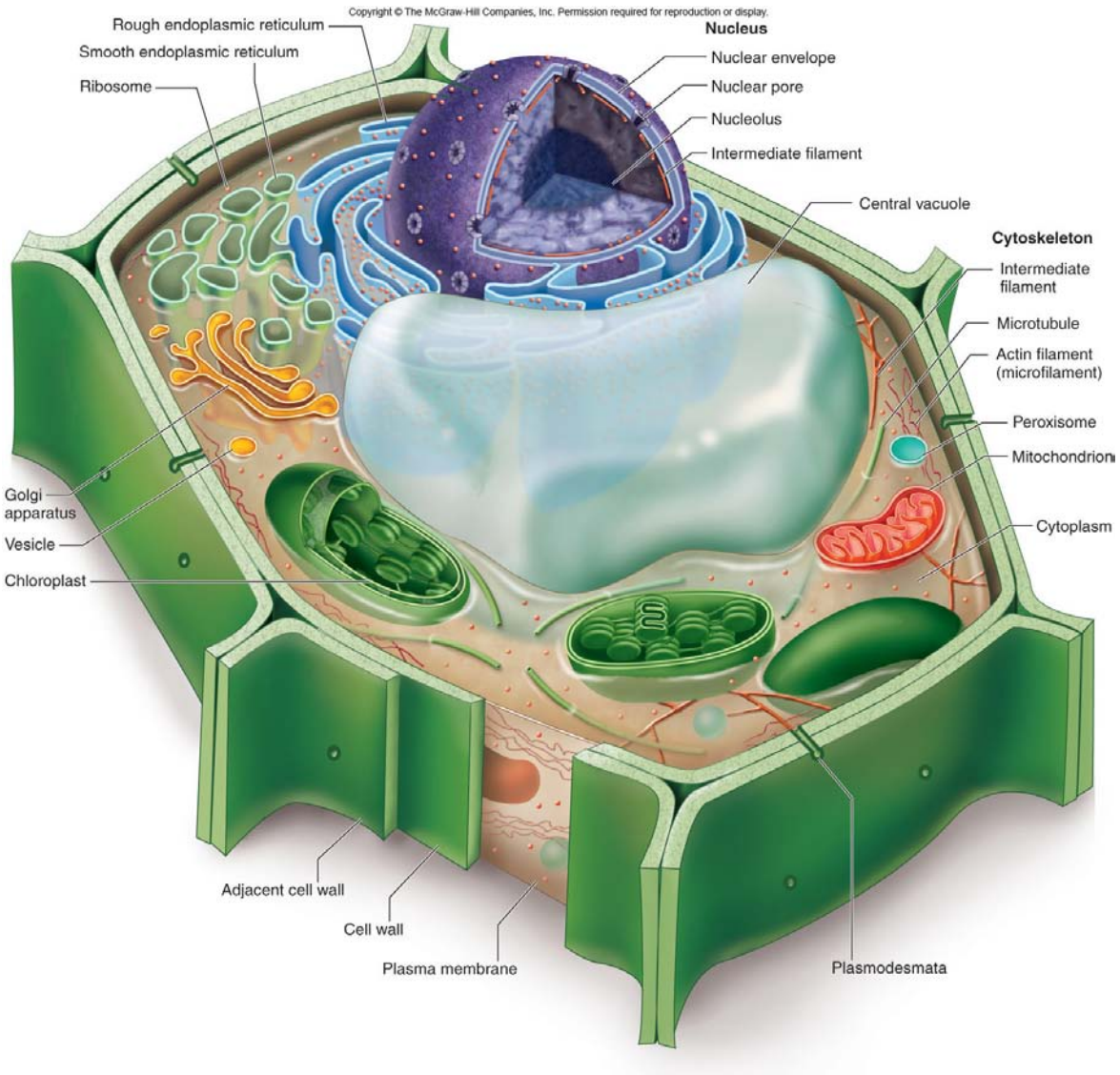
-compartmentalize many cellular functions within **organelles** and the **endomembrane system**

-possess a **cytoskeleton** for support and to maintain cellular structure

Eukaryotic Cells



Eukaryotic Cells



Eukaryotic Cells

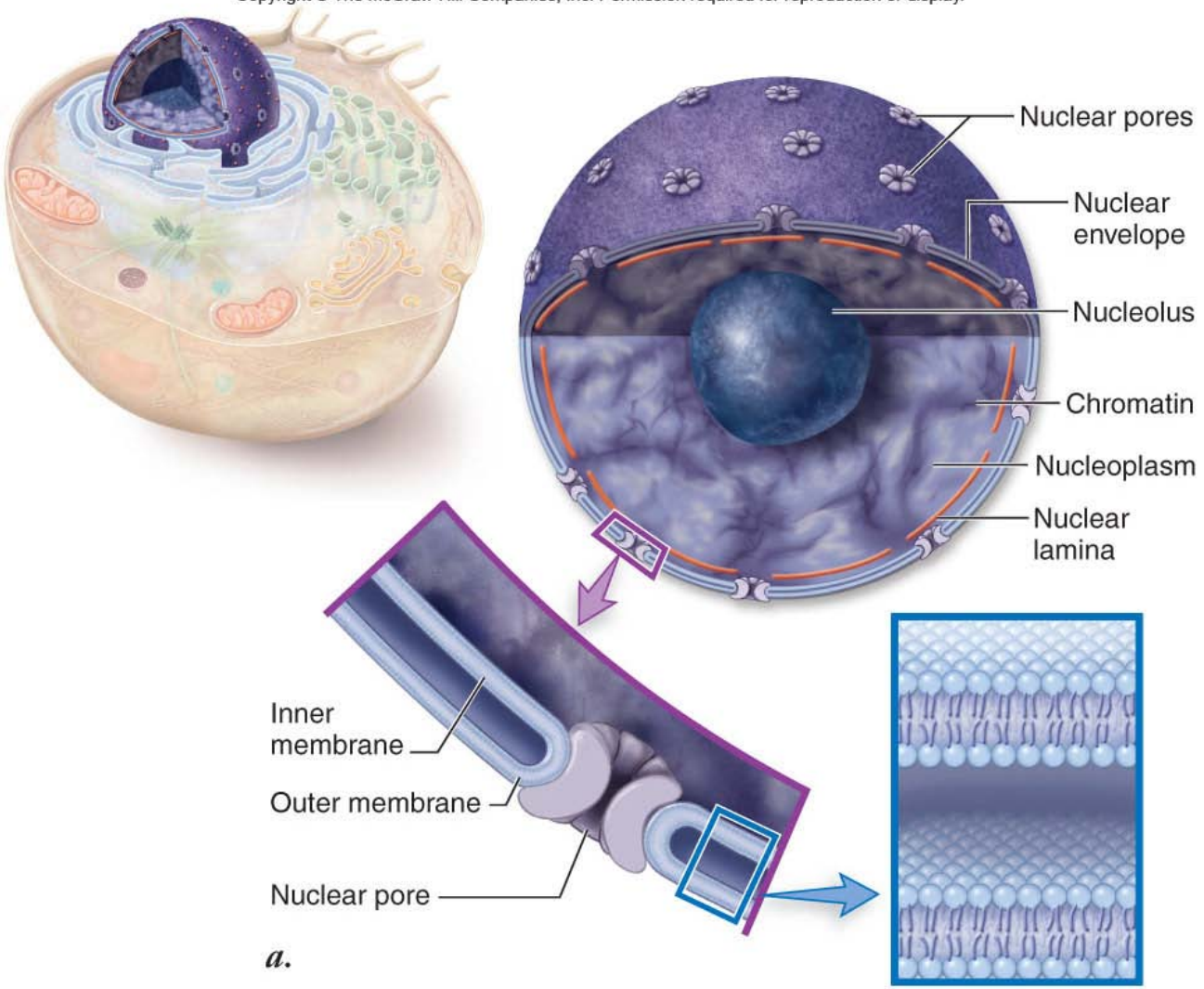
Nucleus

-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



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)

-relatively few ribosomes attached

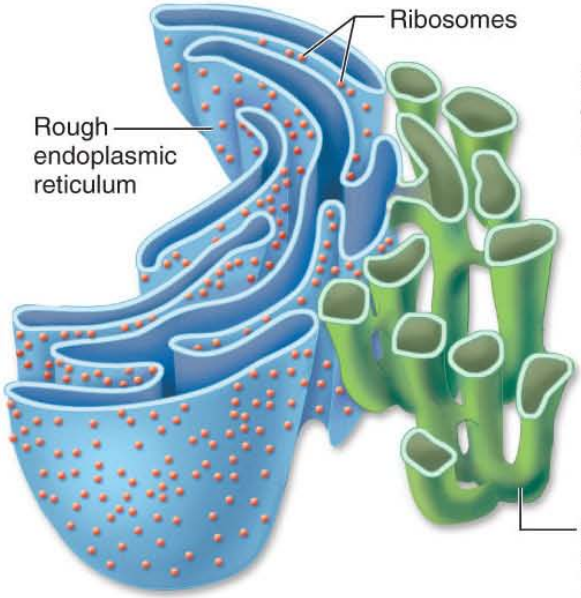
-functions:

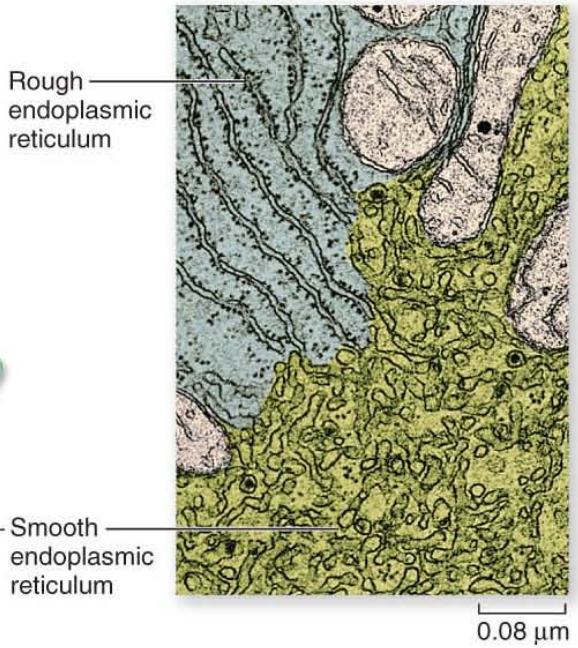
-synthesis of membrane lipids

-calcium storage

-detoxification of foreign substances

Endomembrane System





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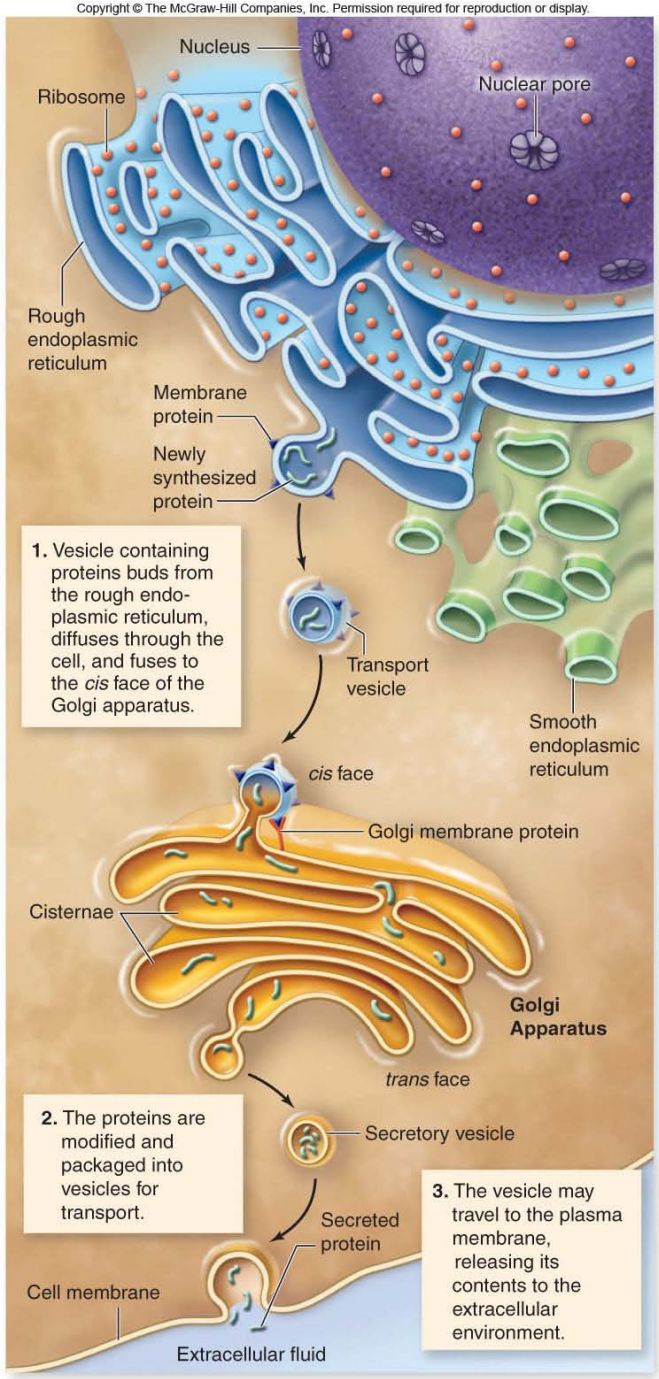
Endomembrane System

Golgi apparatus

-flattened stacks of interconnected membranes

-packaging and distribution of materials to different parts of the cell

-synthesis of cell wall components

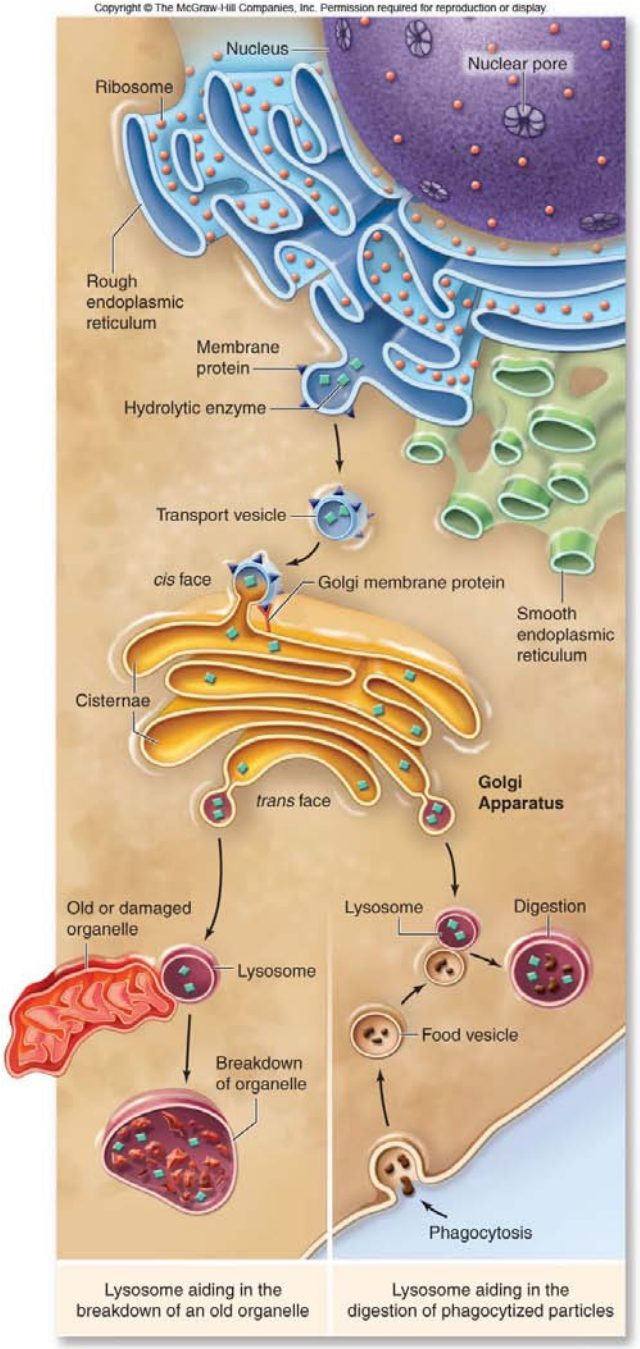


Endomembrane System

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

-**glyoxysomes** in plants contain enzymes for converting fats to carbohydrates

-**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

-found in all types of eukaryotic cells

Mitochondria

-surrounded by 2 membranes

  -smooth outer membrane

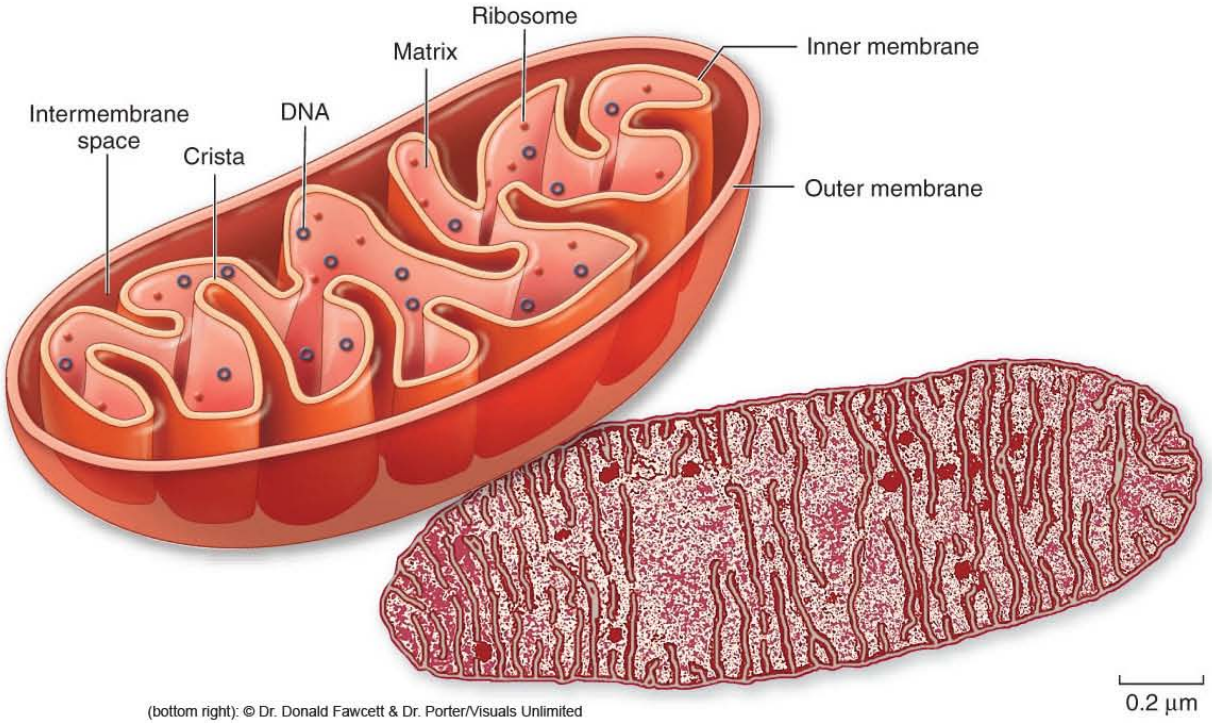
  -folded inner membrane with layers called **cristae**

-**matrix** is within the inner membrane

-**intermembrane space** is located between the two membranes

-contain their own DNA

Mitochondria



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Chloroplasts

Chloroplasts

-organelles present in cells of plants and some other eukaryotes

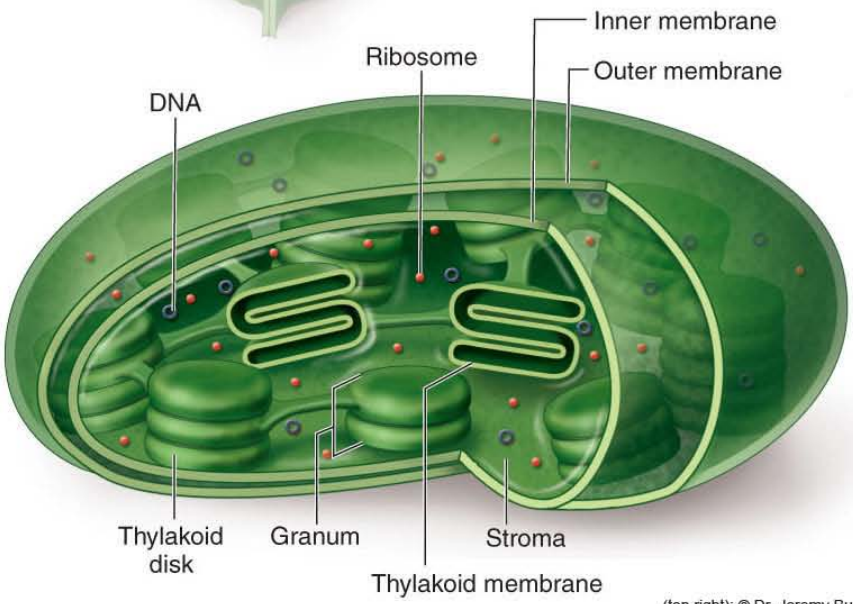
-contain chlorophyll for photosynthesis

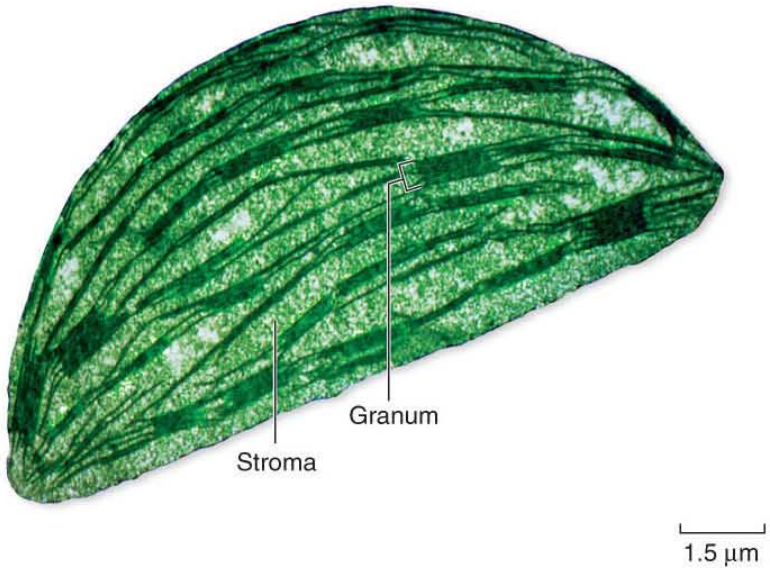
-surrounded by 2 membranes

-**thylakoids** are membranous sacs within the inner membrane

-**grana** are stacks of thylakoids

Chloroplasts





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:

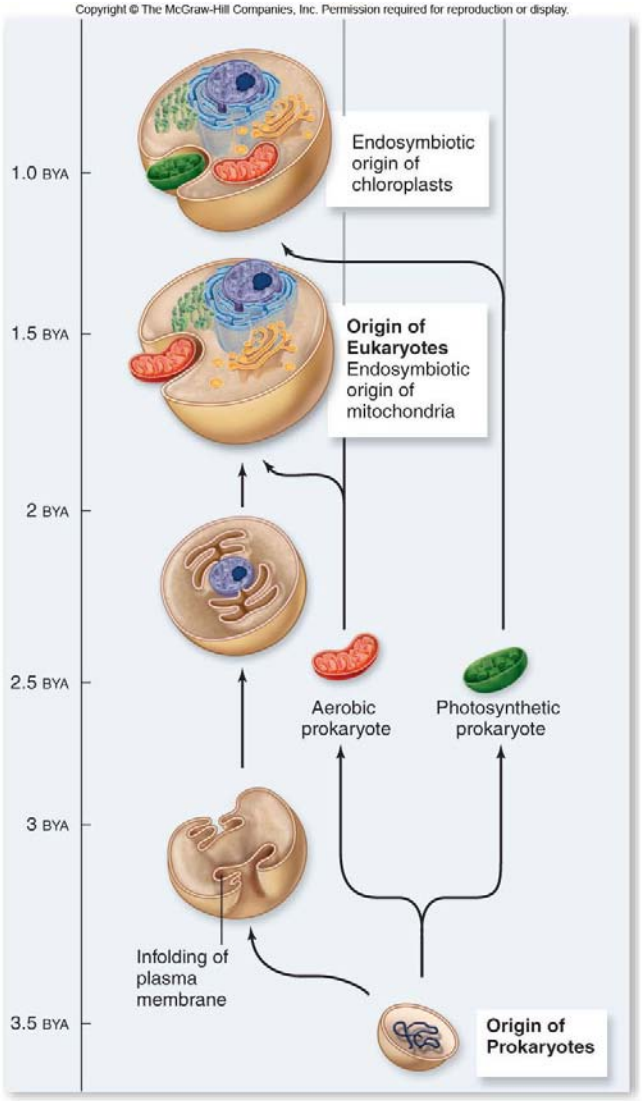
-have 2 membranes

-possess DNA and ribosomes

-are about the size of a prokaryotic cell

-divide by a process similar to bacteria

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

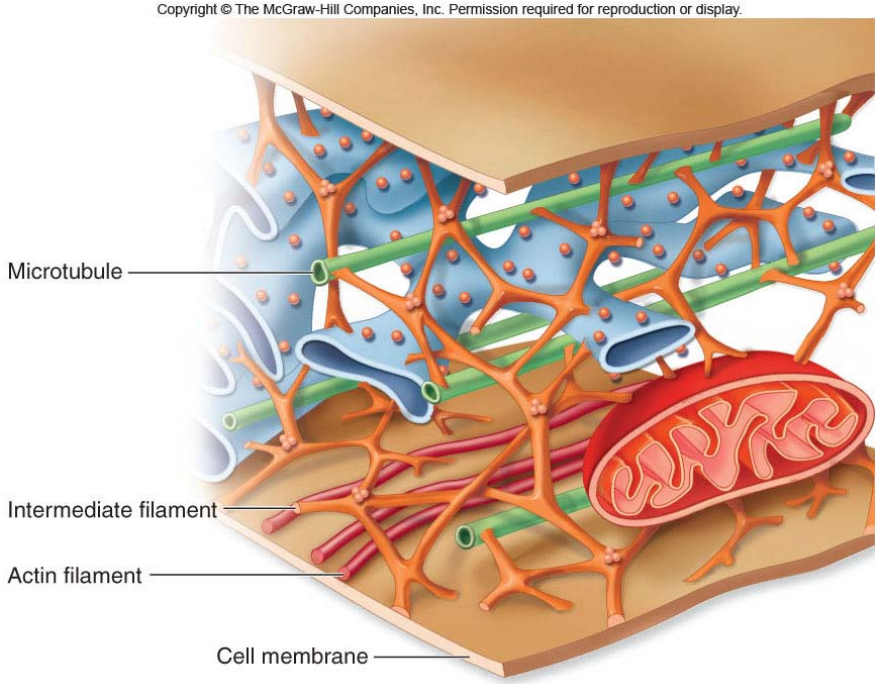
Cytoskeleton fibers include

-actin filaments – responsible for cellular contractions, crawling, “pinching”

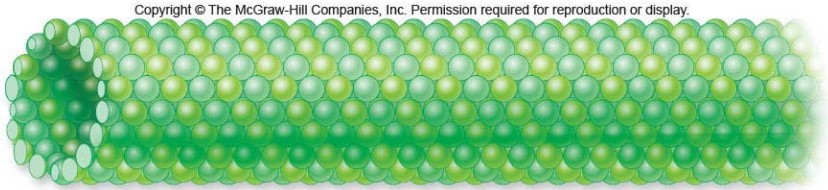
-microtubules – provide organization to the cell and move materials within the cell

-intermediate filaments – provide structural stability

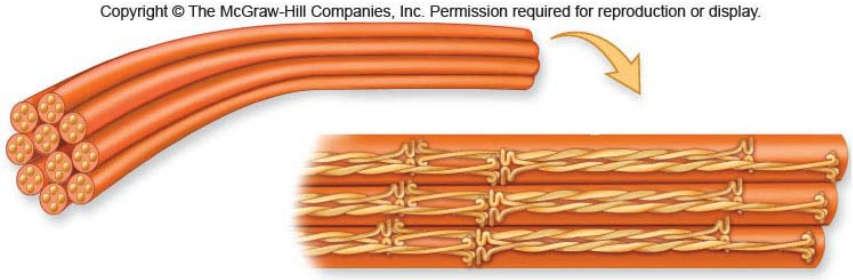
Cytoskeleton



a. Actin filaments



b. Microtubules



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.

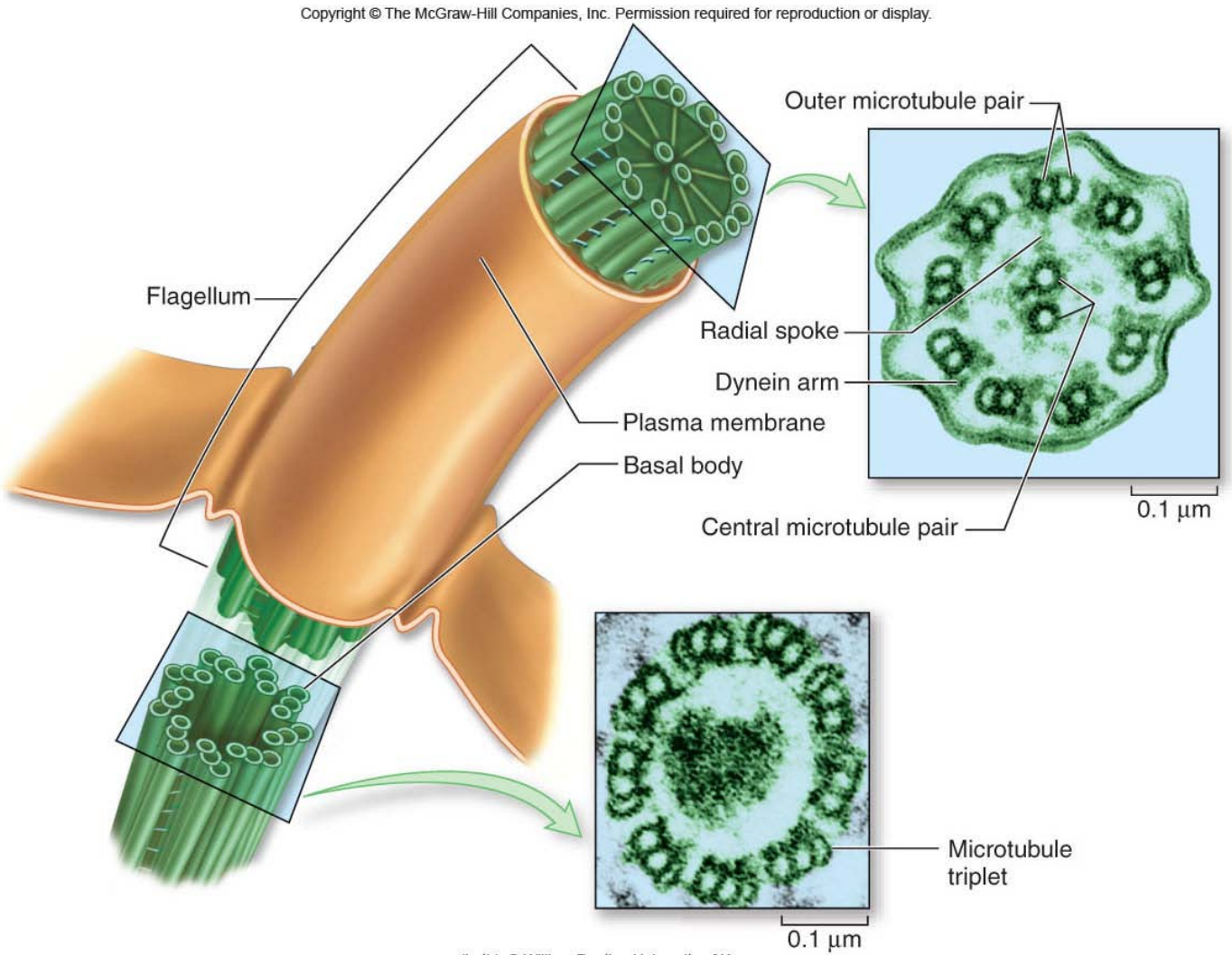
Cell Movement

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



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

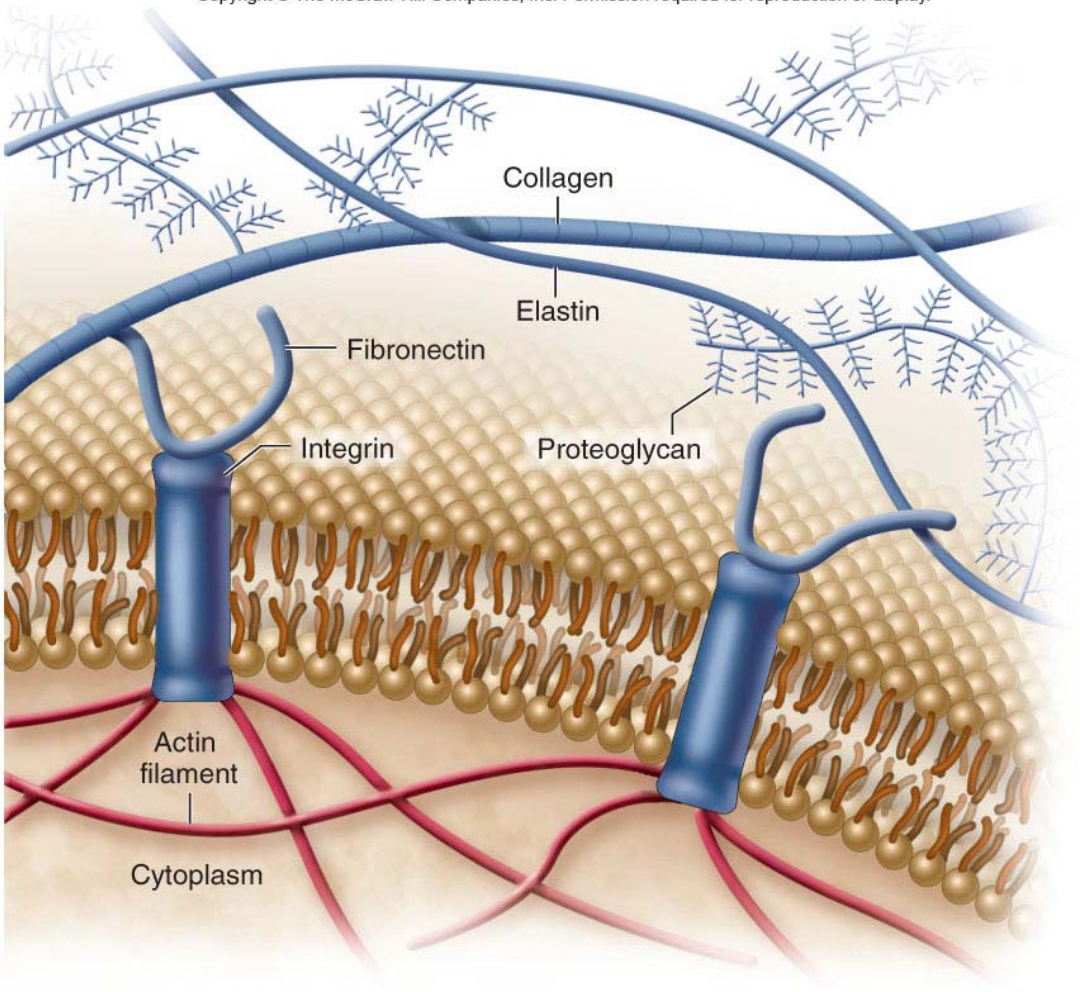


TABLE 4.3 A Comparison of Prokaryotic, Animal, and Plant Cells

	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
INTERIOR STRUCTURES			
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