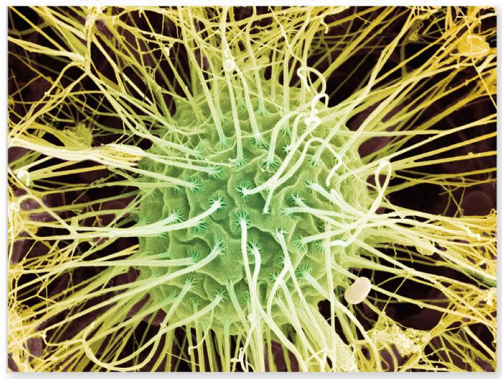
Cell Structure

Chapter 4



Cell Theory

Cell is basic unit of life

Cells discovered in 1665 by Robert Hooke

Early cell studies conducted by
- Mathias Schleiden (1838)
- Theodor Schwann (1839)

Schleiden & Schwann proposed Cell Theory

Cell Theory

Cell Theory

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

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

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Cell Theory

Cell size is limited.

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

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

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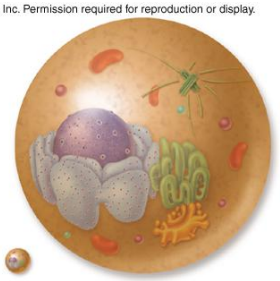
Cell Theory



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

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Cell Theory

Microscopes required to visualize cells

Light microscopes can resolve structures that are 200nm apart

Electron microscopes can resolve structures that are 0.2nm apart.

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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

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Prokaryotic Cells

Prokaryotic cells lack a membrane-bound nucleus

-genetic material is present in **nucleoid**

Two types of prokaryotes:

-archaea

-bacteria

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Prokaryotic Cells

Prokaryotic cells possess

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

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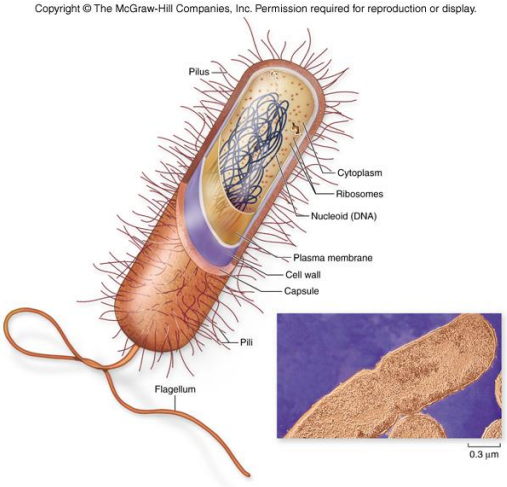
Prokaryotic Cells



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Prokaryotic Cells

Prokaryotic cell walls
-protect cell & maintain cell shape

Bacterial cell walls
-may be composed of peptidoglycan
-may be **Gram positive** or **Gram negative**

Archaean cell walls lack peptidoglycan.

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Prokaryotic Cells

Flagella

-present in some prokaryotic cells
-used for locomotion
-rotary motion propels the cell

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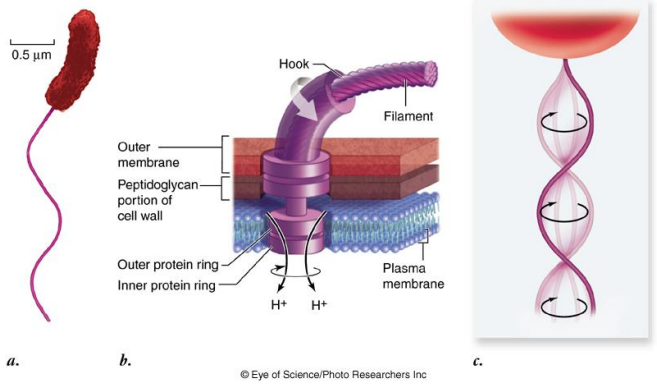
Prokaryotic Cells



Eukaryotic Cells

Eukaryotic cells

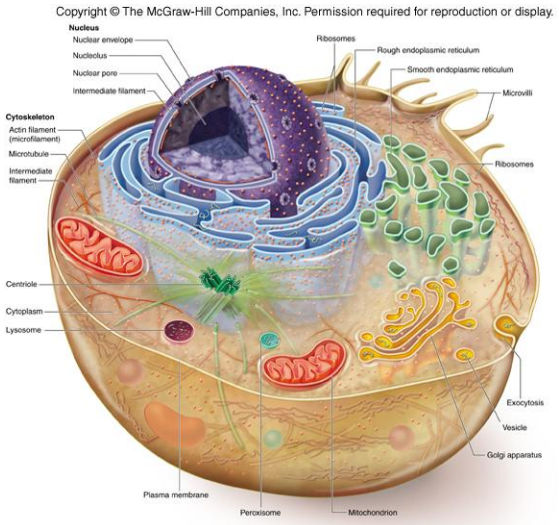
-possess a membrane-bound nucleus

-more complex than prokaryotic cells

-compartmentalize many cellular functions within **organelles** & **endomembrane system**

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

Eukaryotic Cells



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Eukaryotic Cells

Nucleus

-stores genetic material of cell in 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**

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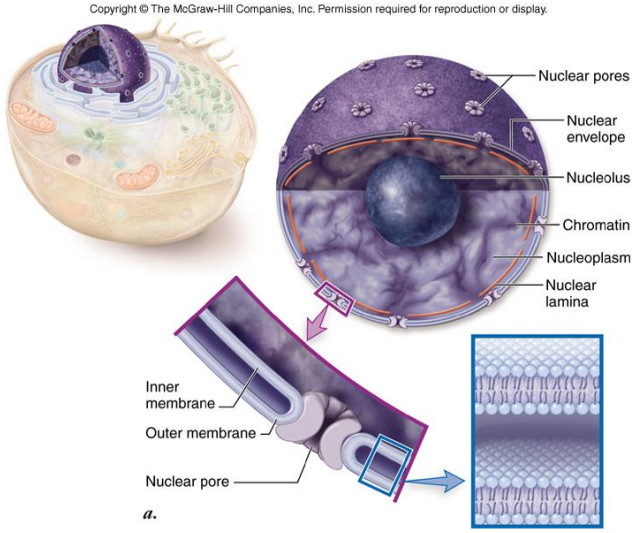
Eukaryotic Cells



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Eukaryotic Cells

Ribosomes

-site of protein synthesis in cell

-composed of **ribosomal RNA** & proteins

-found within cytosol of cytoplasm & attached to internal membranes

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Endomembrane System

Endomembrane system

-a series of membranes throughout cytoplasm

-divides cell into compartments where different cellular functions occur

1. endoplasmic reticulum
2. Golgi apparatus
3. lysosomes

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Endomembrane System

Rough endoplasmic reticulum (RER)

-membranes that create a network of channels throughout cytoplasm

-attachment of ribosomes to membrane gives a rough appearance

-synthesis of proteins to be secreted, sent to lysosomes or plasma membrane

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Endomembrane System

Smooth endoplasmic reticulum (SER)

1) relatively few ribosomes attached

2) functions:

-synthesis of membrane lipids

-calcium storage (e.g. sarcoplasmic recticulum)

-detoxification of foreign substances

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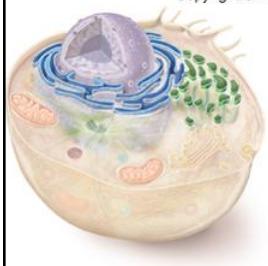
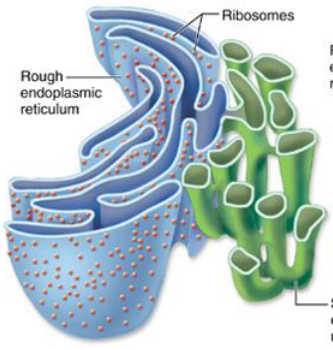
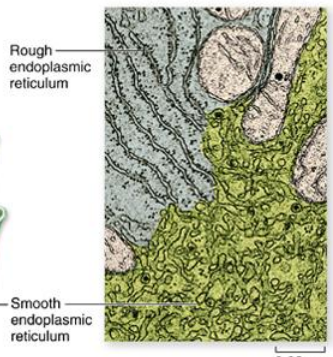
Endomembrane System







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Endomembrane System

Golgi apparatus

-flattened stacks of interconnected membranes

-modification of proteins, packaging, storage & distribution of materials to different parts of cell

-synthesis of cell wall components

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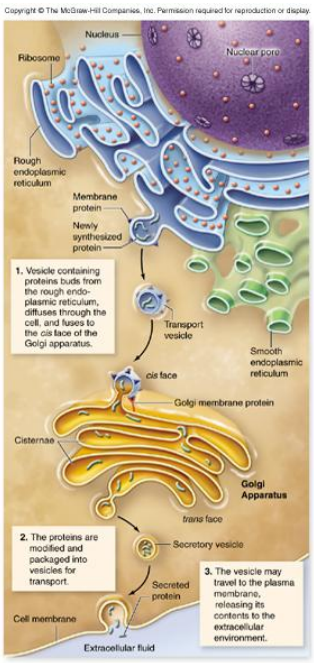

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Endomembrane System

Lysosomes

-membrane bound vesicles containing digestive enzymes to break down macromolecules

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

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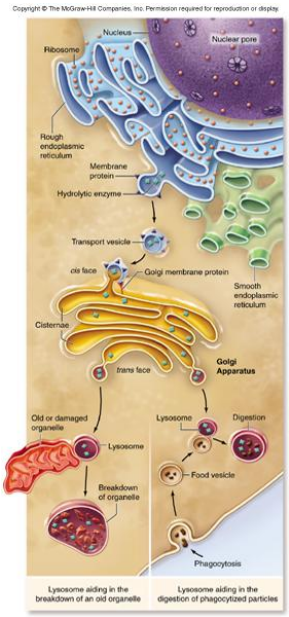

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Endomembrane System

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

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Mitochondria

Mitochondria

-organelles present in all types of eukaryotic cells

-contain oxidative metabolism enzymes for transferring energy within macromolecules to ATP

-found in all types of eukaryotic cells

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Mitochondria

-surrounded by 2 membranes

1) smooth outer membrane

2) folded inner membrane with layers called **cristae**

-**matrix** within inner membrane

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

-contain their own DNA (used a molecular dating markers for evolutionary studies)

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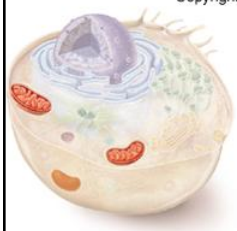
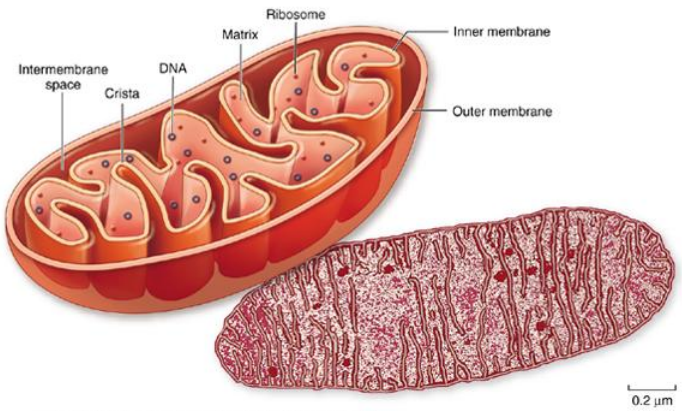
Mitochondria





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Mitochondria

Endosymbiosis

-proposal: eukaryotic organelles evolved through a symbiotic relationship

-one cell engulfed a second cell & a symbiotic relationship developed

-mitochondria thought to have evolved this way

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Mitochondrion

Much evidence supports endosymbiosis theory

Mitochondrion:

-has 2 membranes

-possesses DNA & ribosomes

-about size of a prokaryotic cell

-divide by a process similar to bacteria

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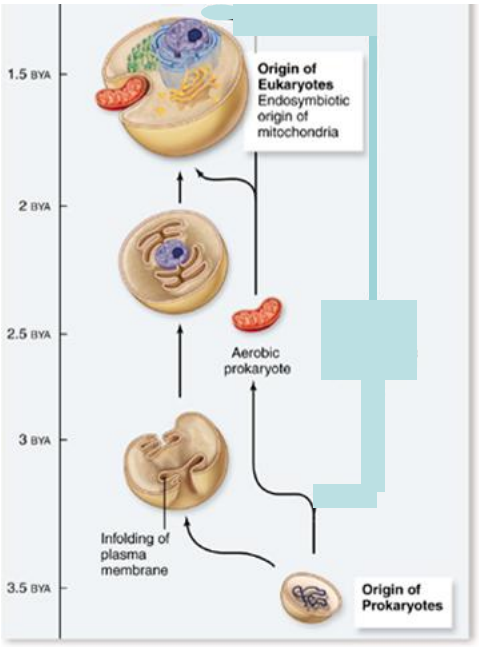
Mitochondrion



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Cytoskeleton

Cytoskeleton

-network of protein fibers found in all eukaryotic cells

-supports cell shape

-keeps organelles in fixed locations

-helps move materials within cell

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Cytoskeleton

Cytoskeleton fibers include

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

-microtubules – provide organization to cell & move materials within cell

-intermediate filaments – provide structural stability

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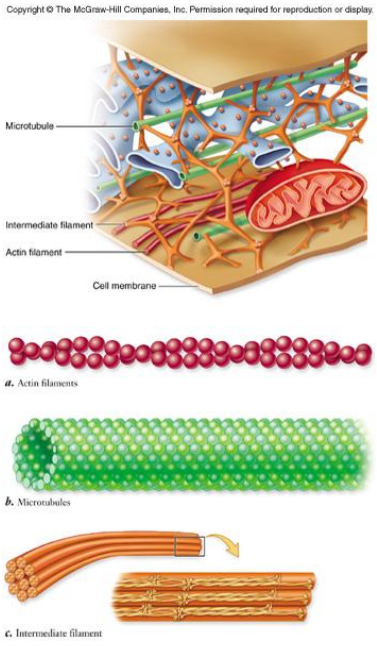
Cytoskeleton



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Cell Movement

Cell movement takes different forms

-Crawling accomplished via actin filaments & protein **myosin**

-**Flagella** undulate to move a cell

-**Cilia** arranged in rows on surface of a eukaryotic cell to propel cell forward

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Cell Movement

Cilia & flagella of eukaryotic cells similar structure

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

-Cilia usually more numerous than flagella on a cell

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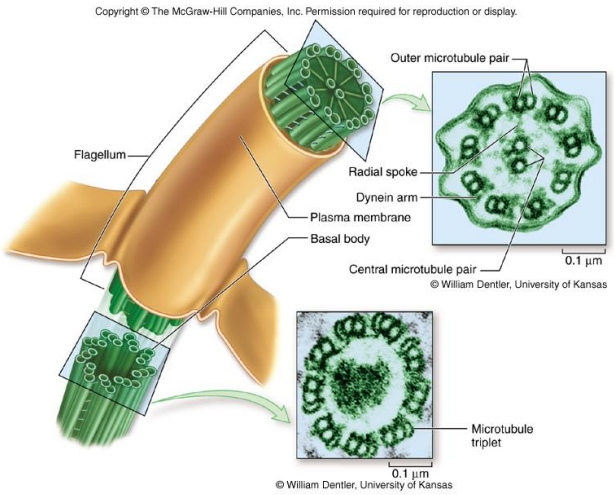
Cell Movement



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Extracellular Structures

Extracellular structures include:

-cell walls of plants, fungi, some **protists**

-**extracellular matrix** surrounding animal cells

Cell walls

-surrounding cells of plants, fungi, & some **protists**

-carbohydrates in cell wall depending on cell type:

-plant & **protist** cell walls - **cellulose**

-fungal cell walls - chitin

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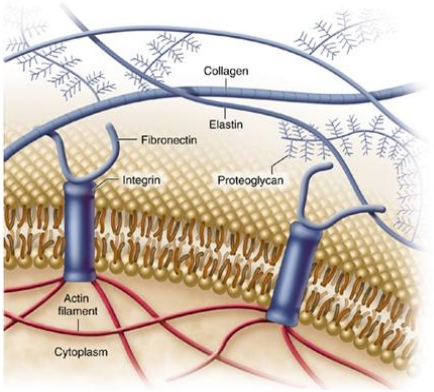
Extracellular Structures



Extracellular matrix (ECM)

-surrounds animal cells

-composed of glycoproteins & fibrous proteins such as collagen

-may be connected to cytoplasm via **integrin** proteins present in plasma membrane

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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)
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

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