The Cell

The basic unit of life

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Cell History

- ***Cytology-*** study of cells
- 1665 English Scientist Robert Hooke used a microscope to examine cork (plant).
- Hooke called what he saw "Cells"

Robert Hooke
(1635-1703)

Cell History

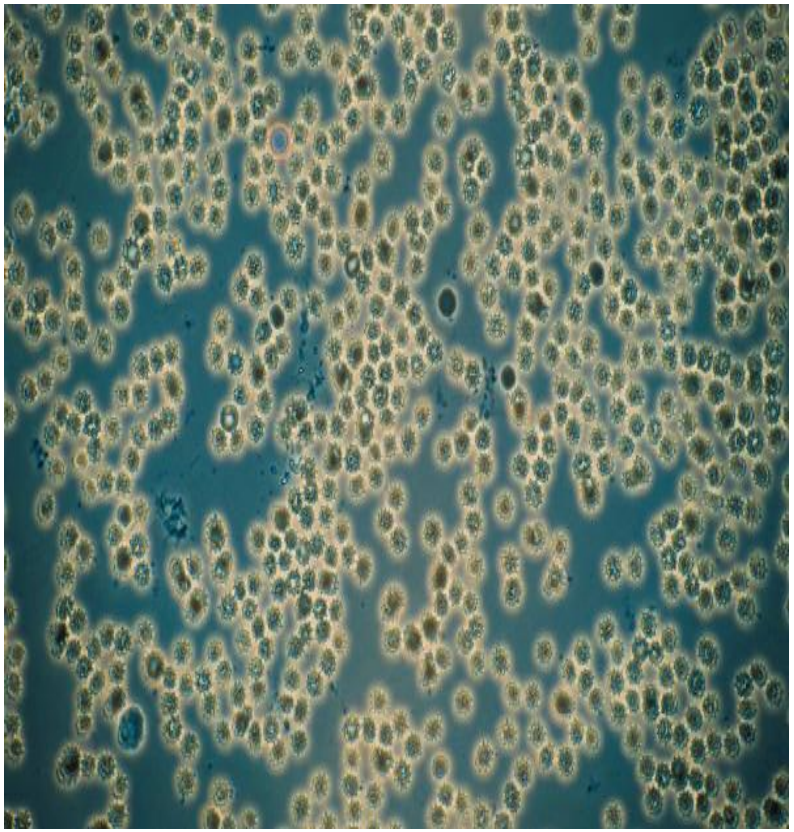
- Robert Brown
  - **discovered the nucleus in 1833.**
- Matthias Schleiden
  - German Botanist Matthias Schleiden
  - 1838
  - **ALL PLANTS "ARE COMPOSED OF CELLS".**
- Theodor Schwann
  - Also in 1838,
  - **discovered that animals were made of cells**

Cell History

- Rudolf Virchow
  - 1855, German Physician
  - **" THAT CELLS ONLY COME FROM OTHER CELLS".**

Cell Theory

- The COMBINED work of Schleiden, Schwann, and Virchow make up the modern **CELL THEORY**.



The Cell Theory states that:

1. All living things are composed of a cell or cells.

2. Cells are the basic unit of life.

3. All cells come from preexisting cells.

Cell Diversity

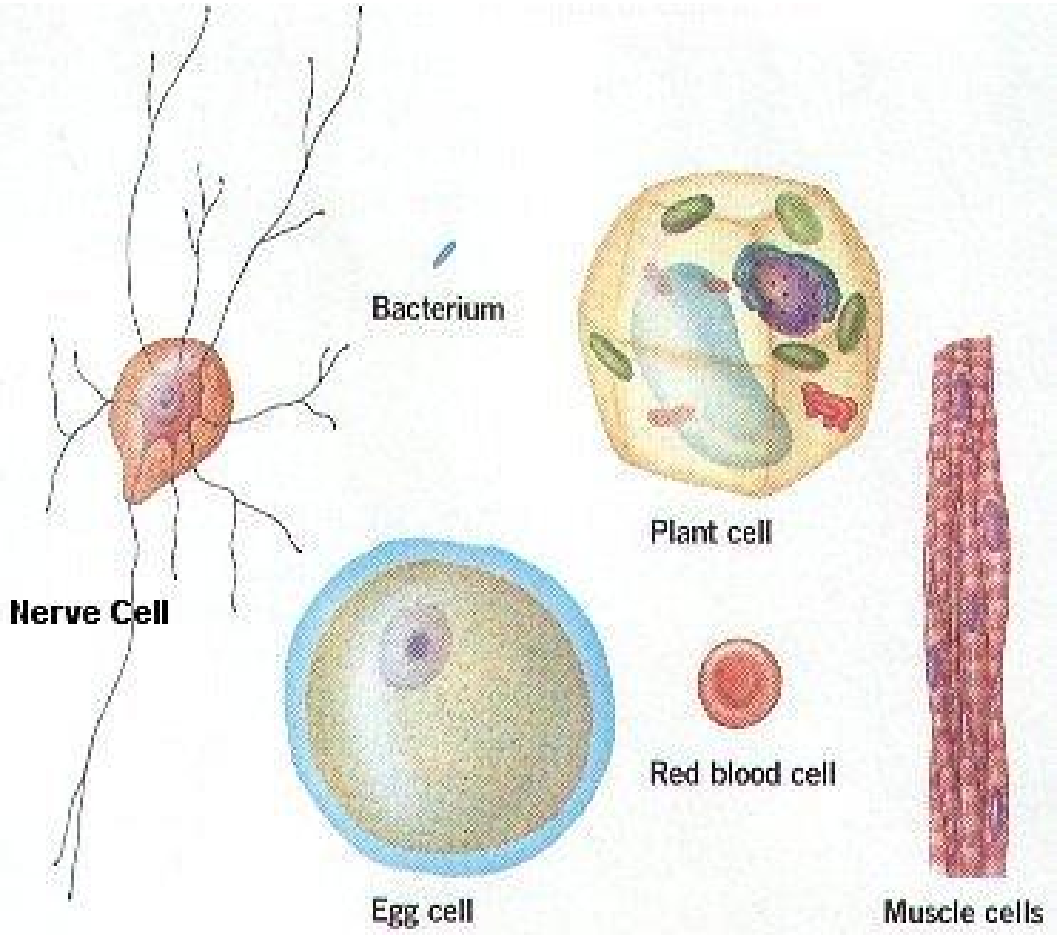
- Cells within the same organism show Enormous Diversity in:
  - Size
  - Shape
  - Internal Organization

1. Cell Size

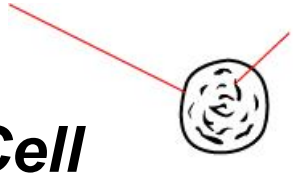
- Female Egg - largest cell in the human body; seen without the aid of a microscope
- Most cells are visible only with a microscope.

2. Cell Shape

- Diversity of form reflects a diversity of function.
- **THE SHAPE OF A CELL DEPENDS ON ITS FUNCTION.**

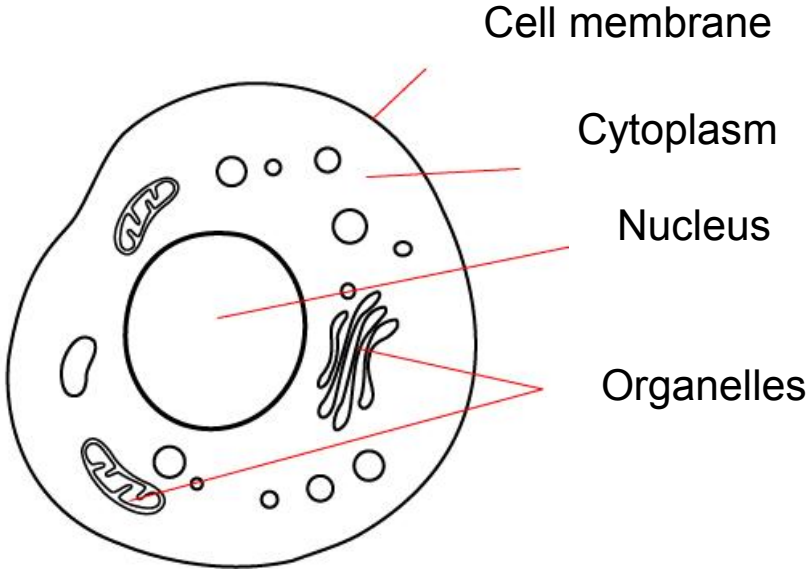


3. Internal Organization



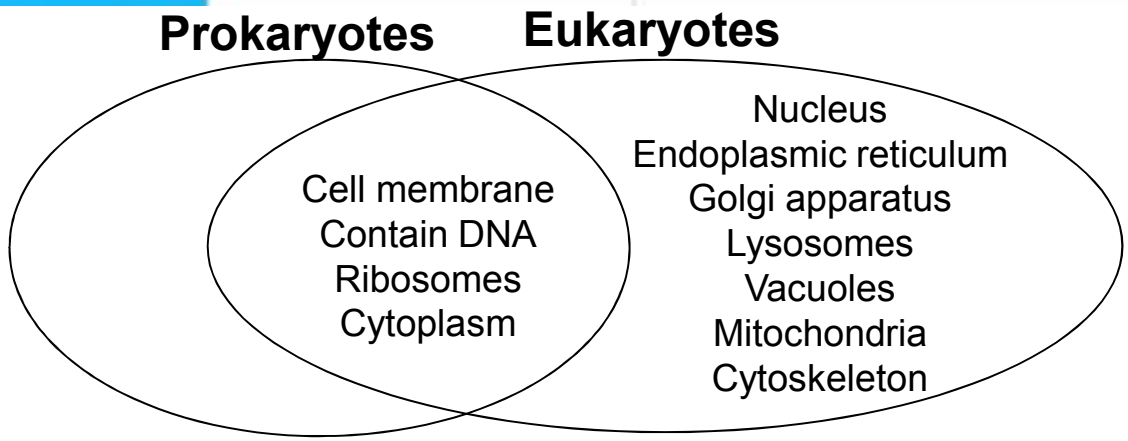
Prokaryotic Cell

Eukaryotic Cell



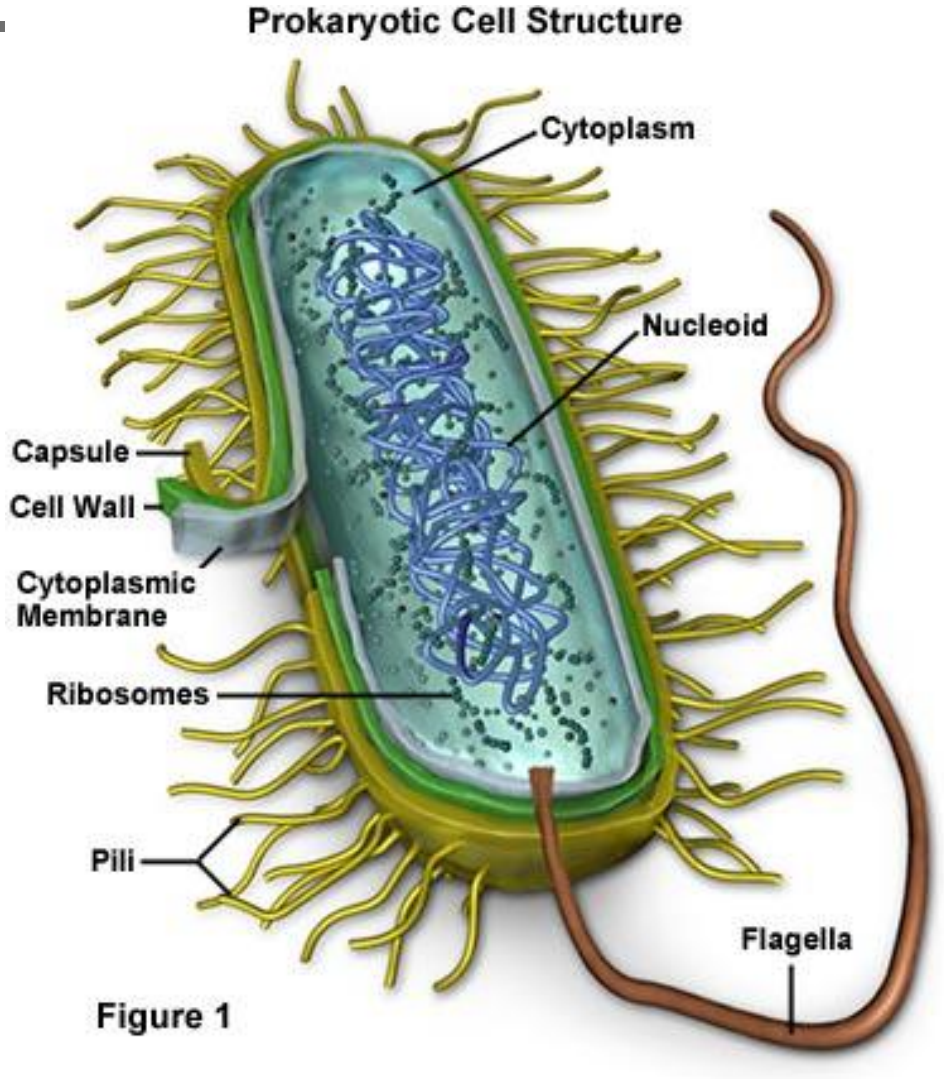
Compare and Contrast

Feature	Prokaryote	Eukaryote
Size	Small about 0.5 micrometers	Up to 40 micrometers
Genetic material	Circular DNA (in cytoplasm)	DNA in form of linear chromosomes (in nucleus)
Organelles	Few present, none membrane bound	Many organelles: •Double membranes e.g.: nucleus, mitochondria & chloroplasts •Single membrane e.g.: GA, ER & lysosomes
Cell walls	Rigid formed from glycoproteins (mainly murein)	•Fungi: rigid, formed from polysaccharide, chitin. •Plant: rigid, formed from polysaccharides. E.g.: cellulose. •Animals no cell wall
Ribosome's	70s	80s



Prokaryotic Examples

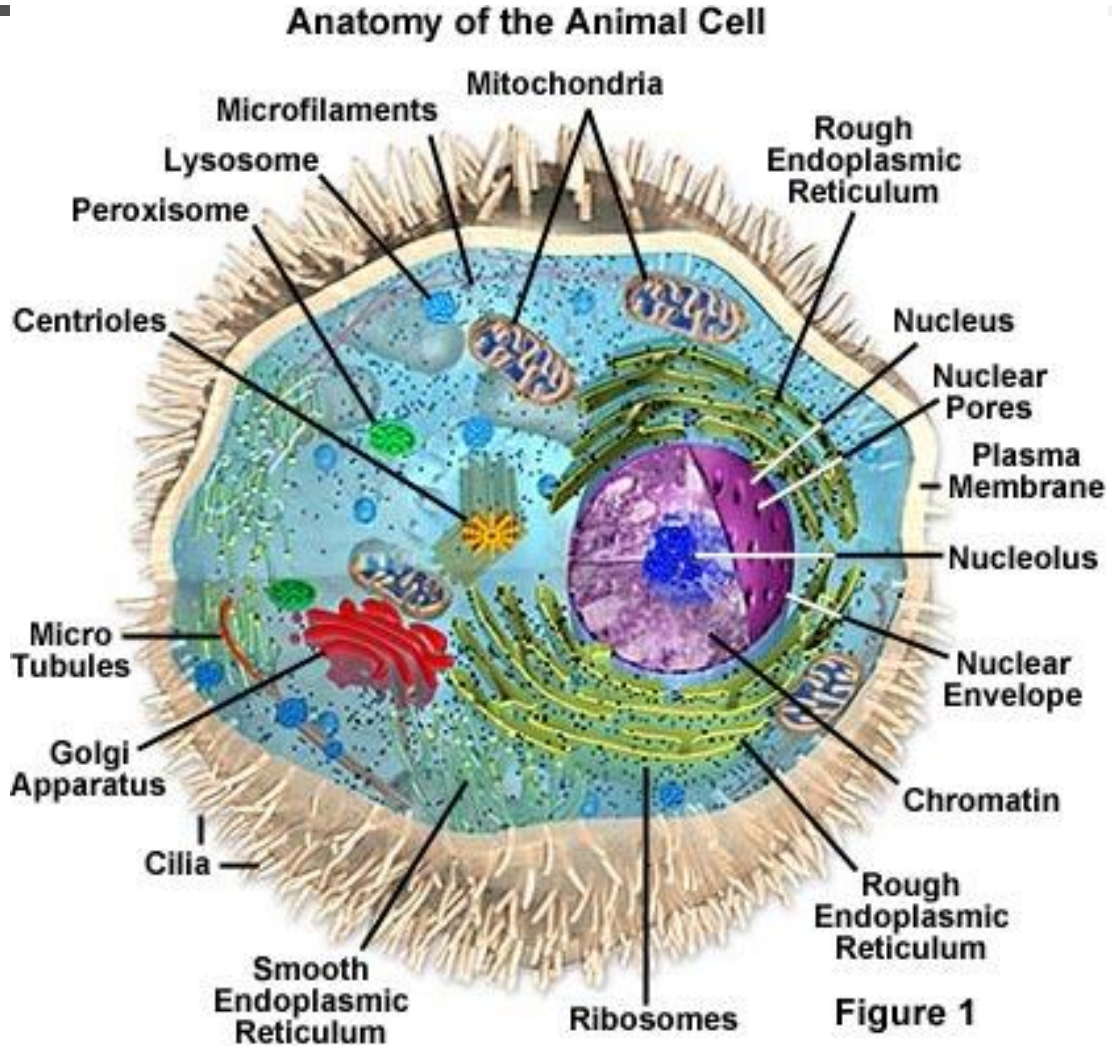
ONLY Bacteria

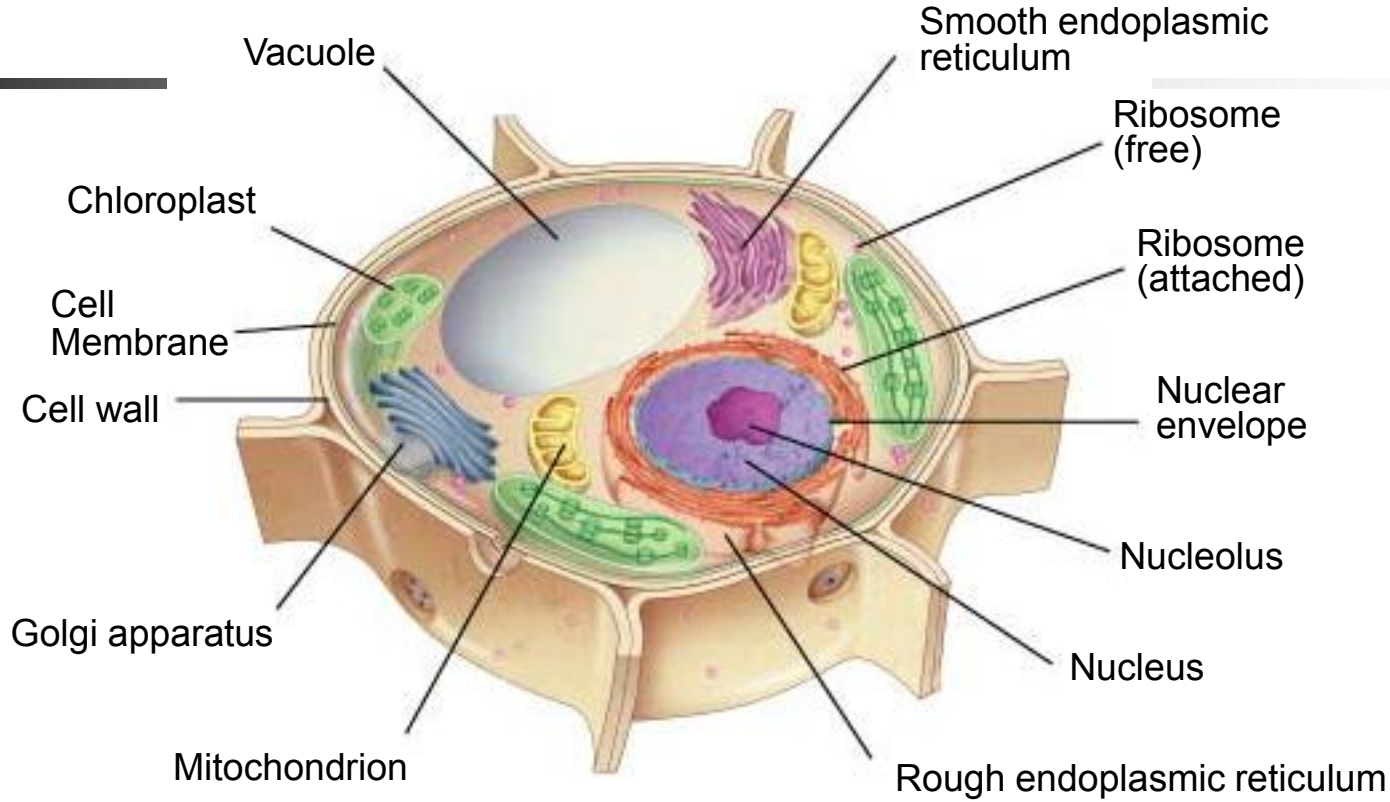


EUKARYOTIC CELLS

Two Kinds:
Plant and Animal

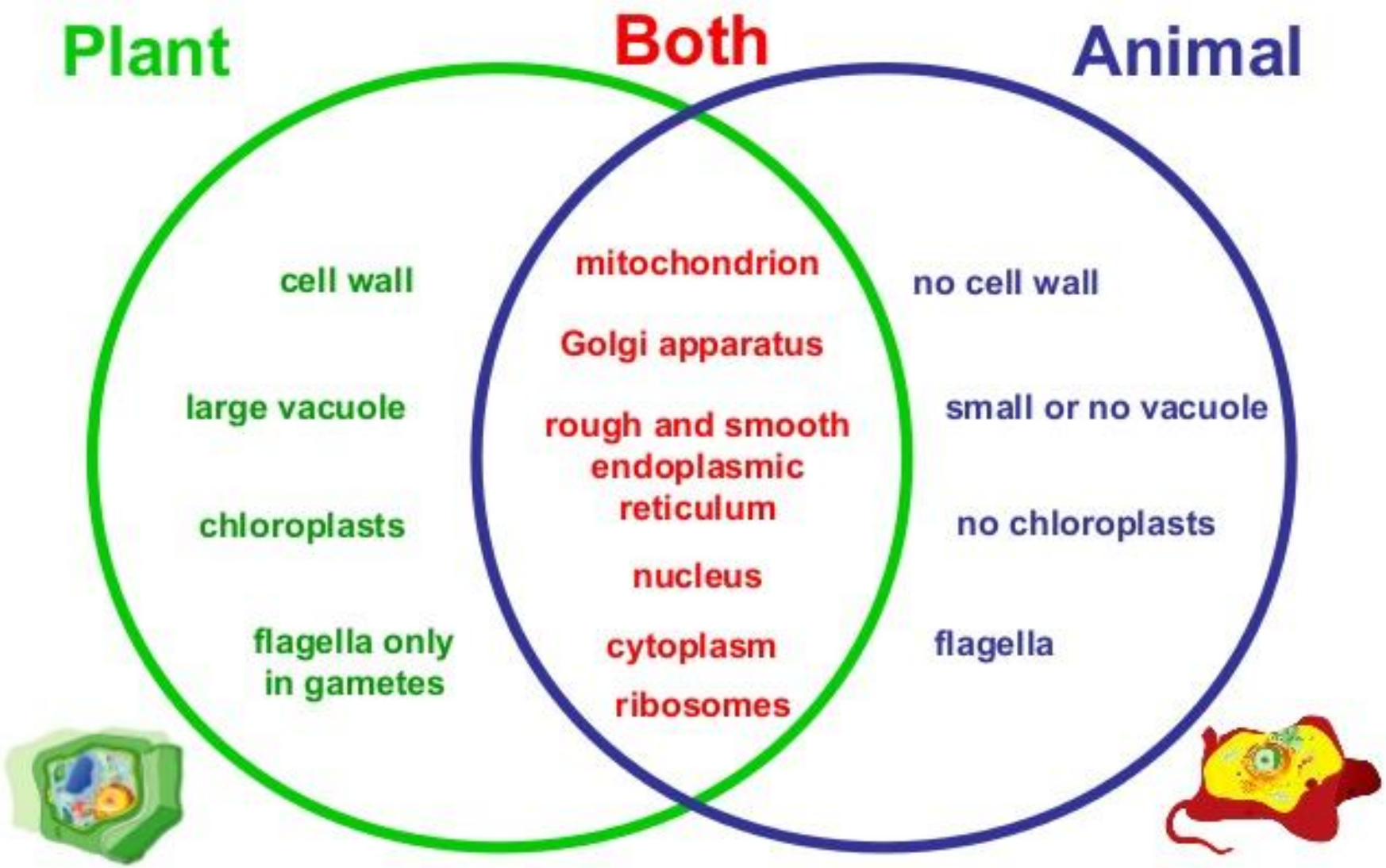
Eukaryotic Example



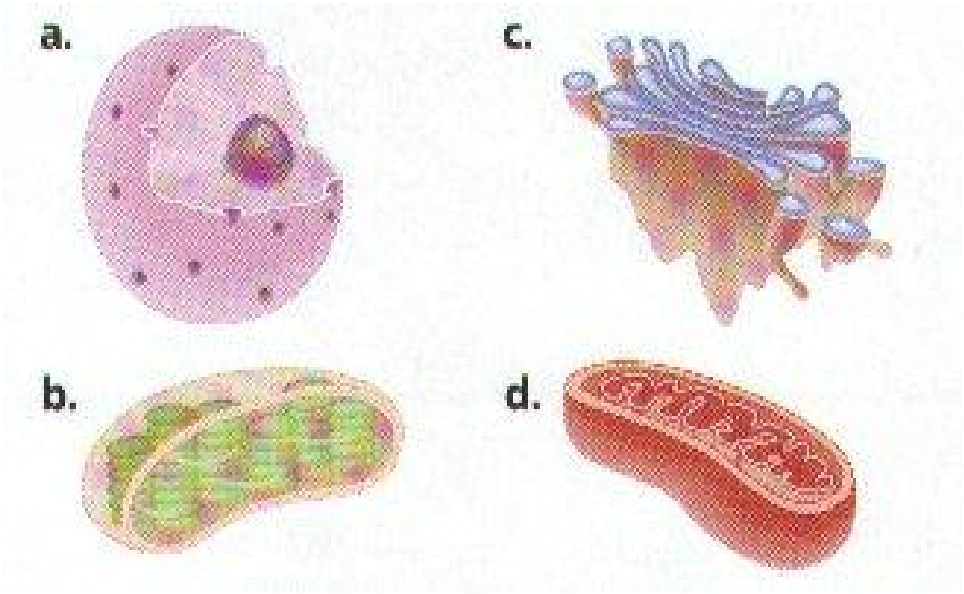

Vacuole
Smooth endoplasmic reticulum
Ribosome (free)
Chloroplast
Ribosome (attached)
Cell Membrane
Nuclear envelope
Cell wall
Nucleolus
Golgi apparatus
Nucleus
Mitochondrion
Rough endoplasmic reticulum

Plant Cell

Compare and Contrast



Internal Organization



- Cells contain **ORGANELLES**.
- Cell Components that PERFORMS SPECIFIC FUNCTIONS FOR THE CELL.

Cellular Organelles

- **The Plasma membrane**
  - The boundary of the cell.
  - Composed of three distinct layers.
  - Two layers of fat and one layer of protein.

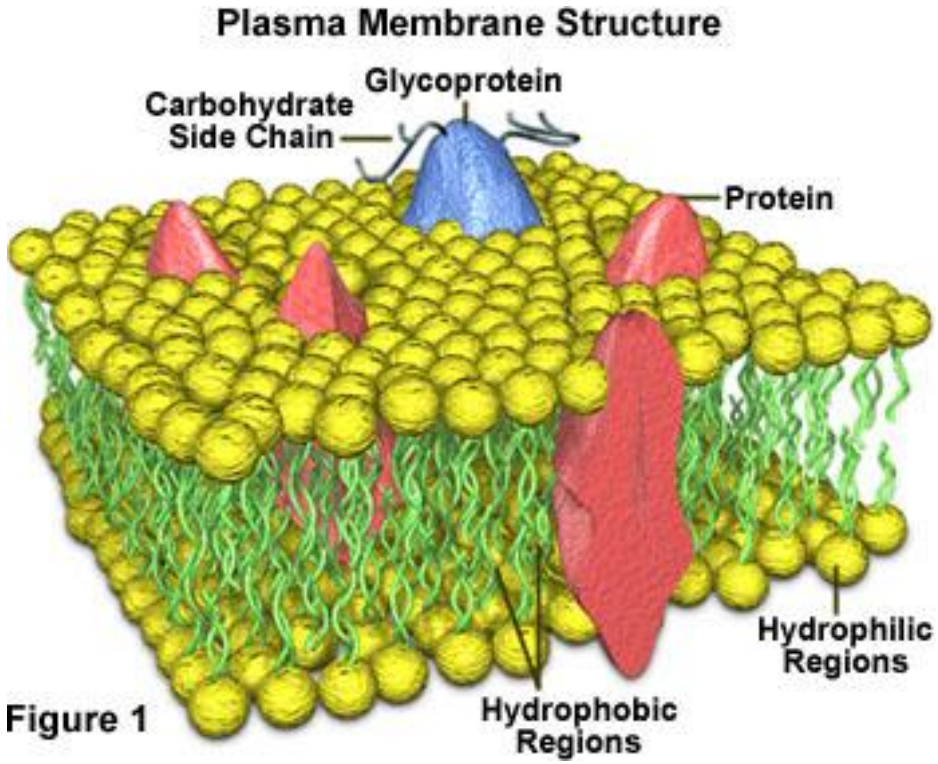


Figure 1

The Nucleus

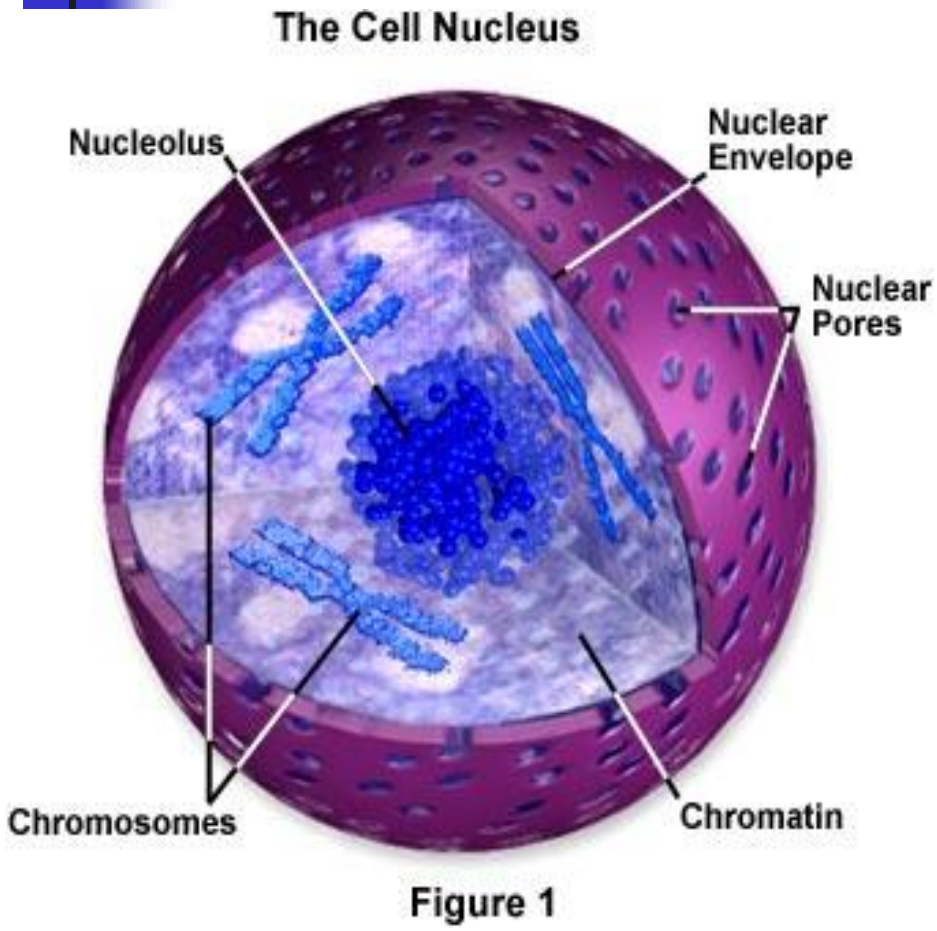


Figure 1

- Brain of Cell
- Bordered by a porous membrane - nuclear envelope.
- Contains thin fibers of DNA and protein called Chromatin.
- Rod Shaped Chromosomes
- Contains a small round nucleolus
- produces ribosomal RNA

Ribosomes

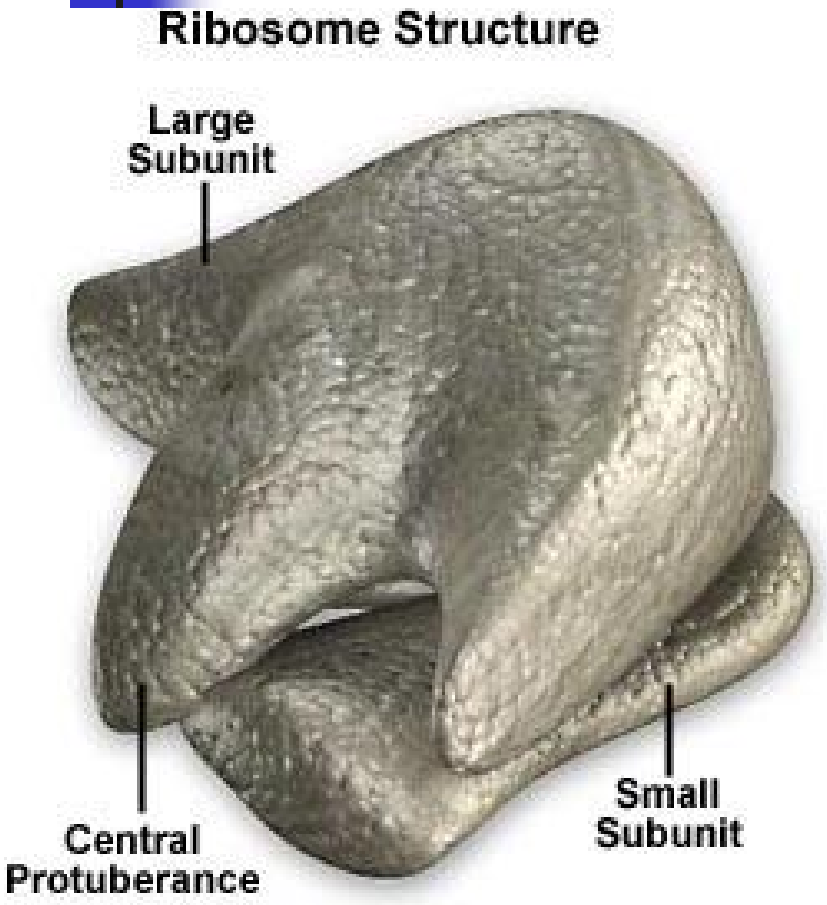


Figure 1

- Small **non-membrane** bound organelles.
- Contain two sub units
- Site of protein synthesis.
- Protein factory of the cell
- Either free floating or attached to the Endoplasmic Reticulum.

Endoplasmic Reticulum

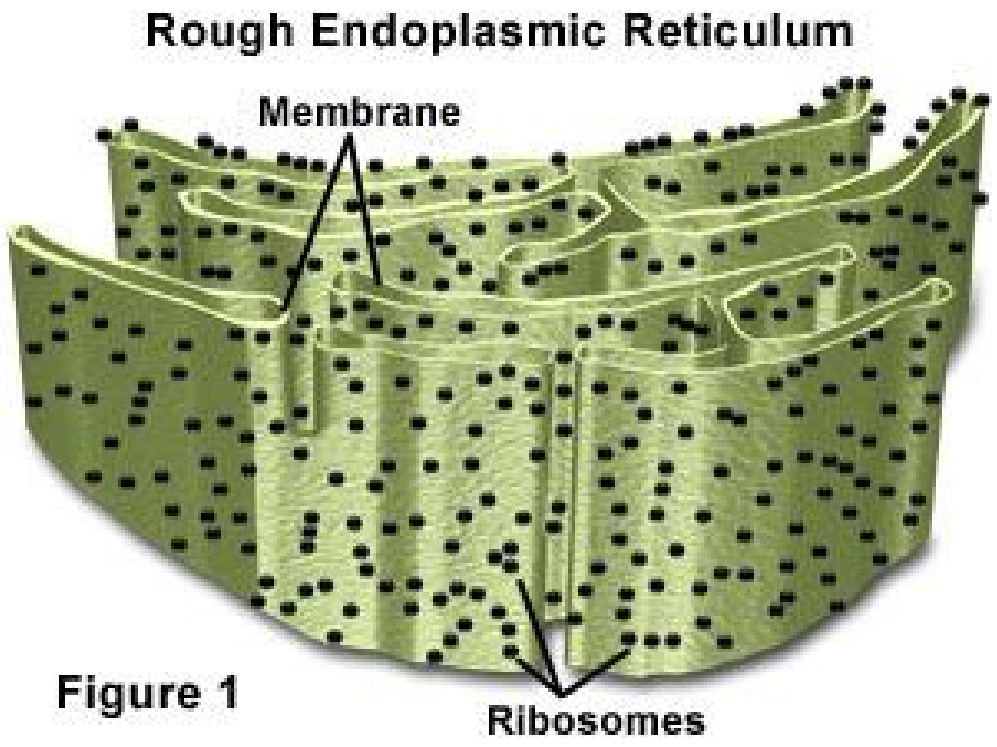


Figure 1

- Complex network of transport channels.
- Two types:

1. **Smooth**- ribosome free and functions in poison detoxification.
2. **Rough** - contains ribosomes and releases newly made protein from the cell.

Golgi Apparatus

- A series of flattened sacs that modifies, packages, stores, and transports materials out of the cell.

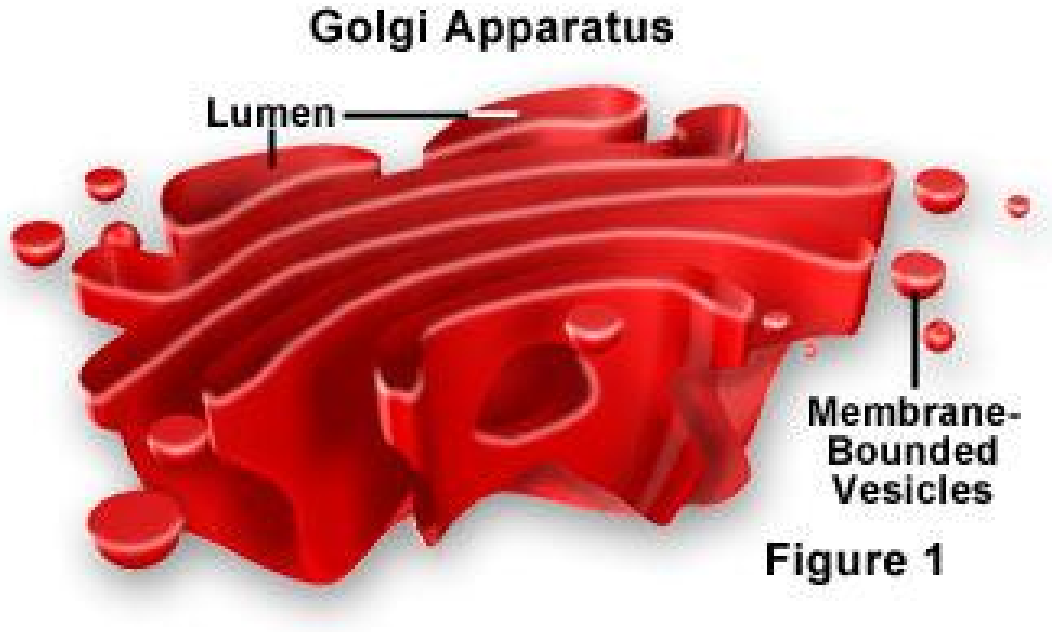


Figure 1

Lysosomes

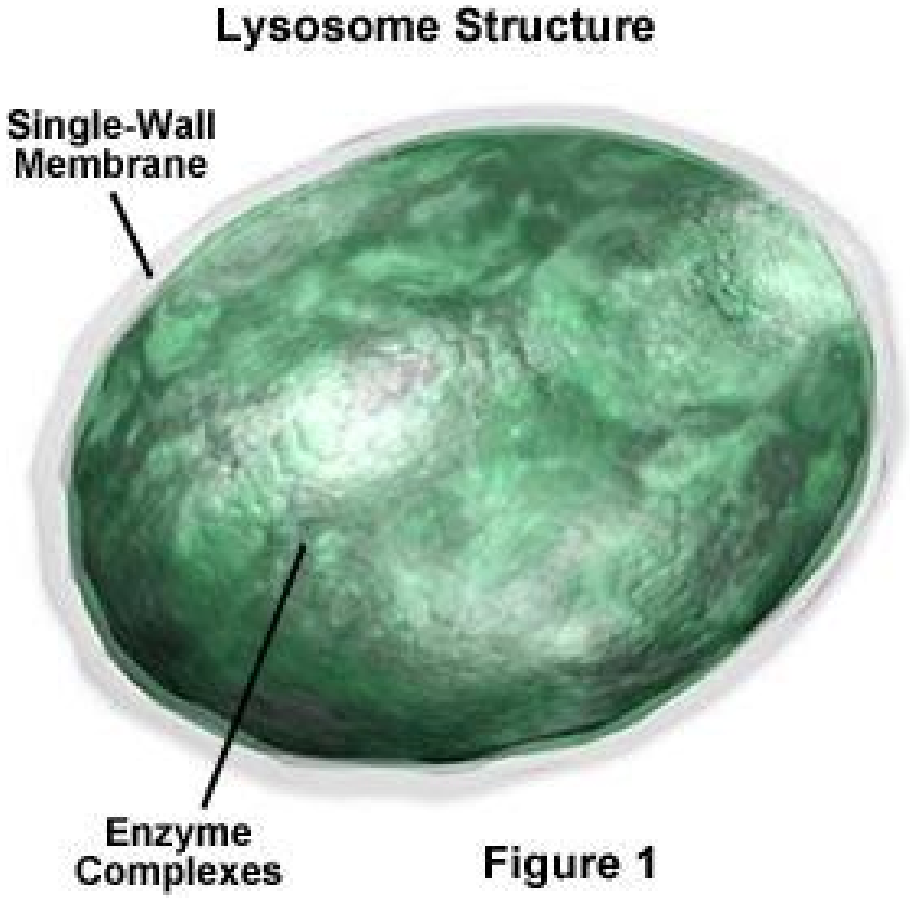
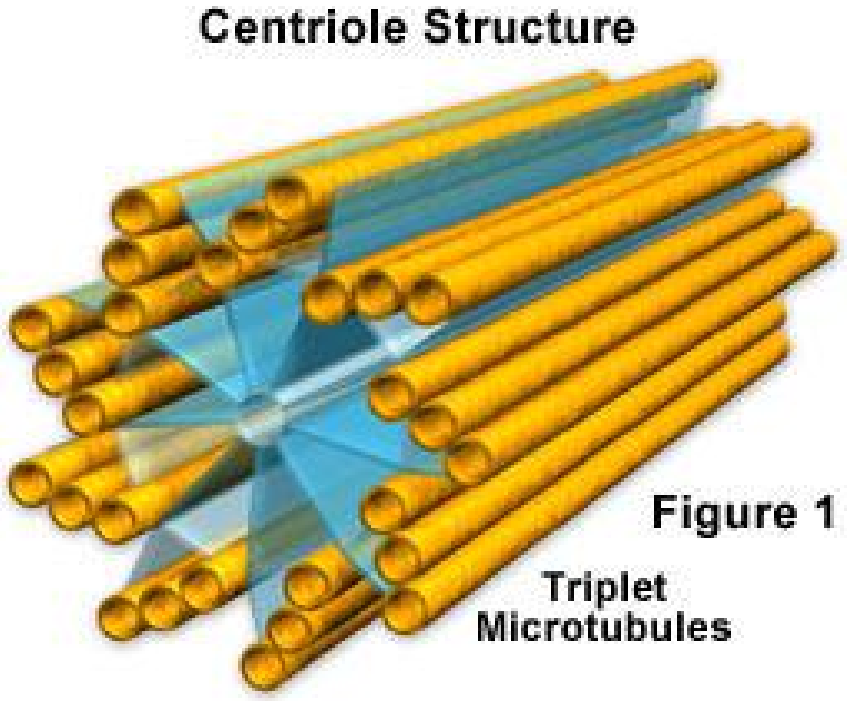


Figure 1

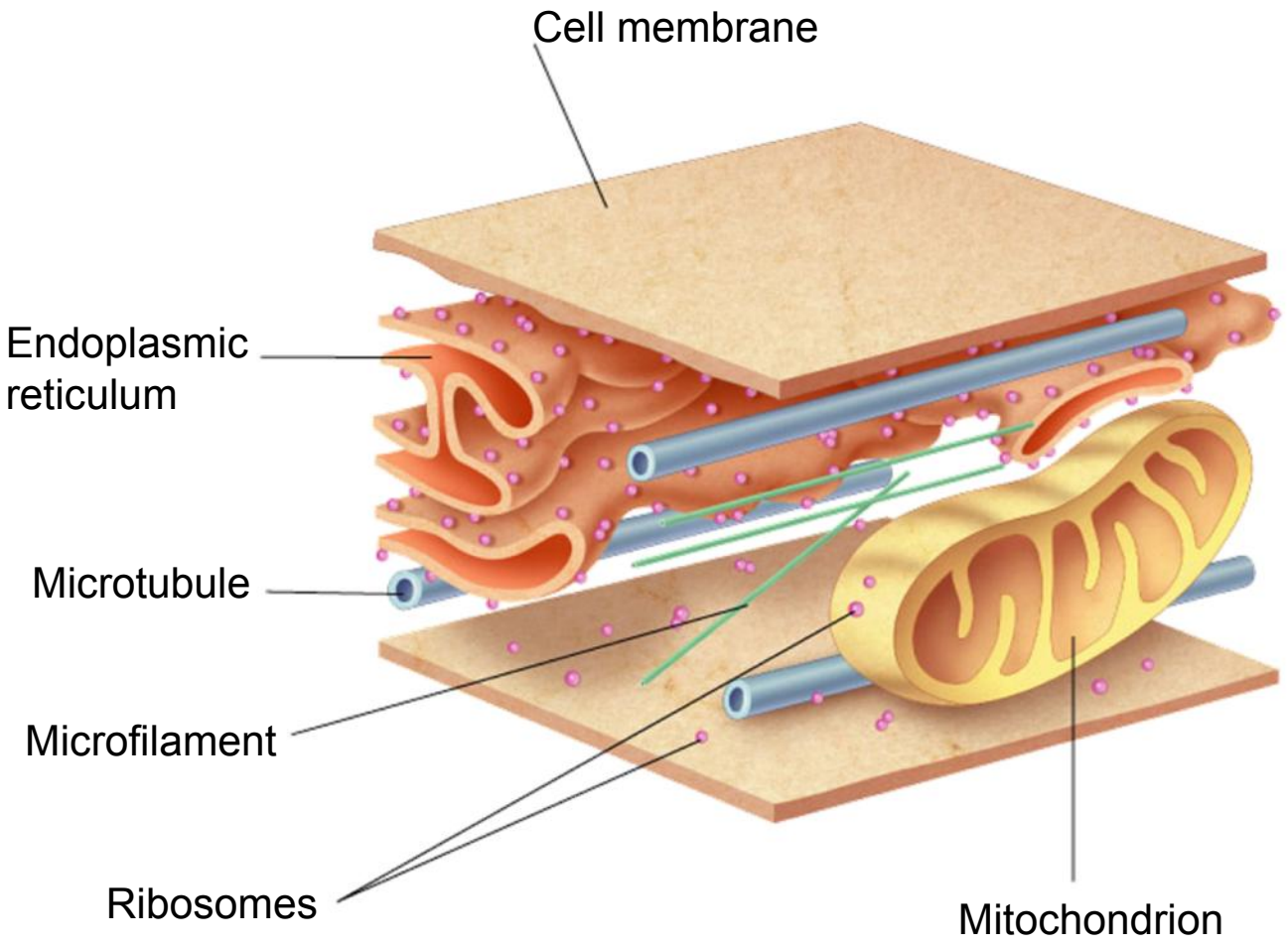
- Recycling Center
- Membrane bound organelle containing a variety of enzymes.
- Internal pH is 5.
- Help digest food particles inside or out side the cell.

Centrioles

- Found **only** in animal cells
- Paired organelles found together near the nucleus, at right angles to each other.
- Role in building cilia and flagella
- Play a role in cellular reproduction



Cytoskeleton

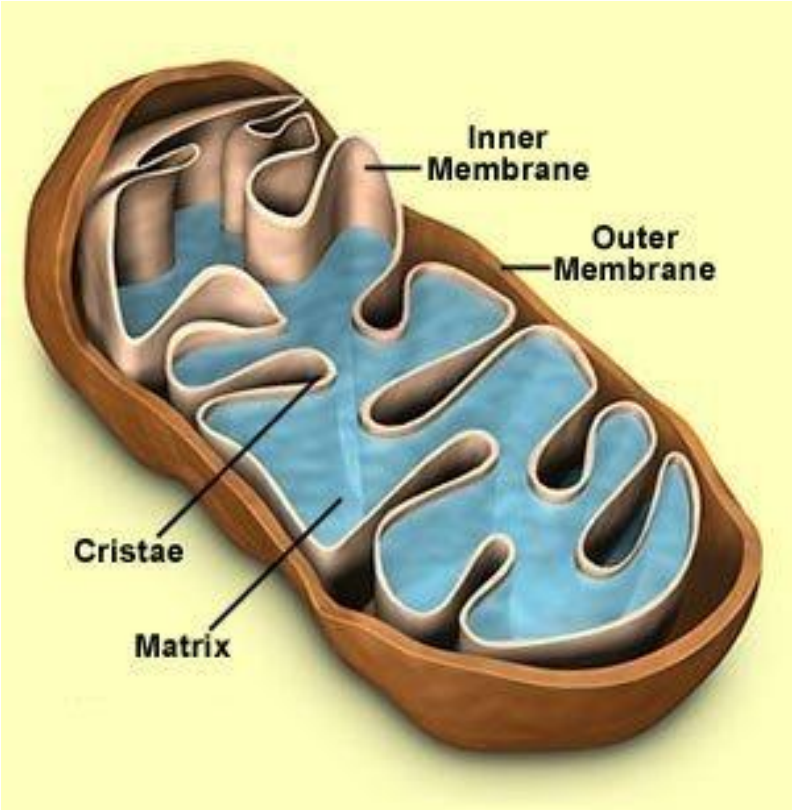


Cytoskeleton

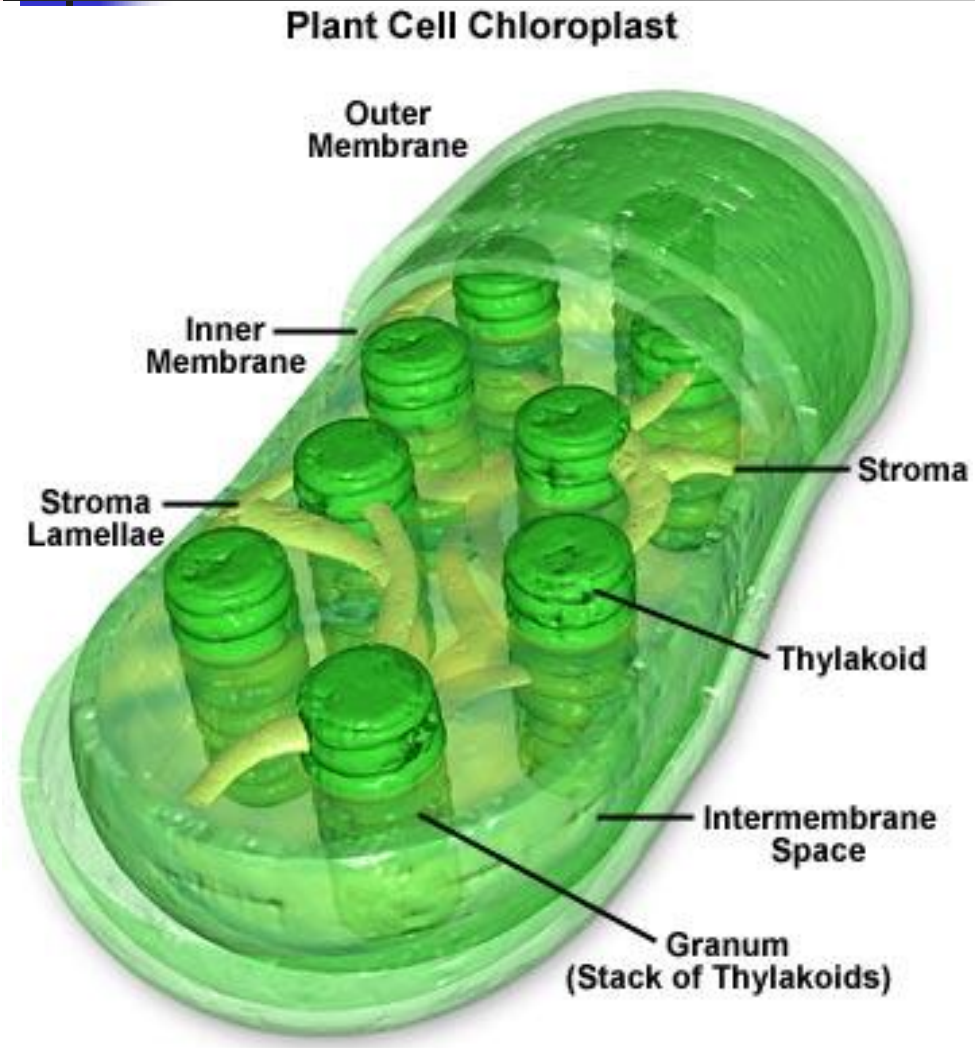
- Framework of the cell
- Contains small microfilaments and larger microtubules.
- They support the cell, giving it its shape and help with the movement of its organelles.

Mitochondrion

- Double Membranous
- It's the size of a bacterium
- Contains its own DNA; mDNA
- Produces high energy compound ATP



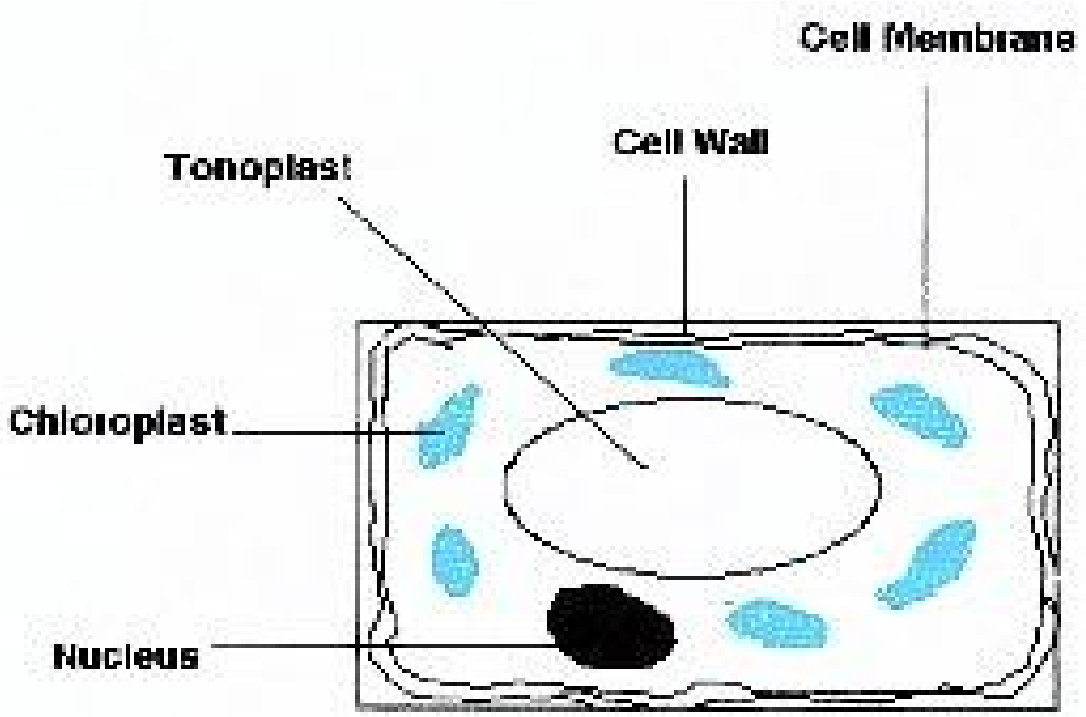
The Chloroplast



- Double membrane
- Center section contains grana
- Thylakoid (coins) make up the grana.
- Stroma - gel-like material surrounding grana
- Found in plants and algae.

The Vacuole

- Sacs that help in food digestion or helping the cell maintain its water balance.
- Found mostly in plants and protists



Cell Wall

- Extra structure surrounding its plasma membrane in plants, algae, fungi, and bacteria.
- Cellulose – Plants
- Chitin – Fungi
- Peptidoglycan - Bacteria

Molecule Movement & Cells

- Passive Transport
- Active Transport
- Endocytosis
  (phagocytosis & pinocytosis)
- Exocytosis

Getting through cell membrane

- Passive transport
  - No energy needed
  - Movement down concentration gradient
- Active transport
  - Movement against concentration gradient
    - low $\rightarrow$ high
  - requires ATP

Types of Passive Transport

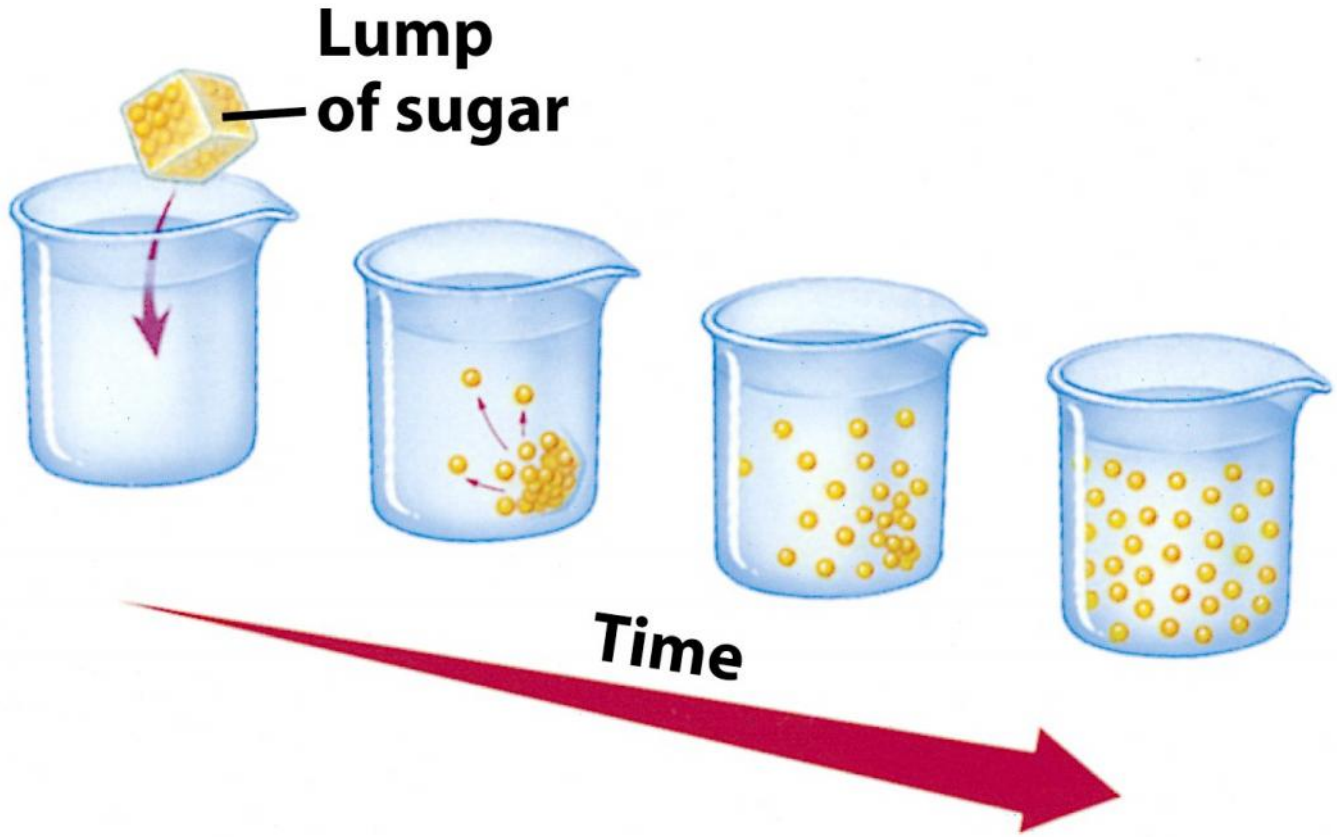
1. Diffusion

2. Osmosis

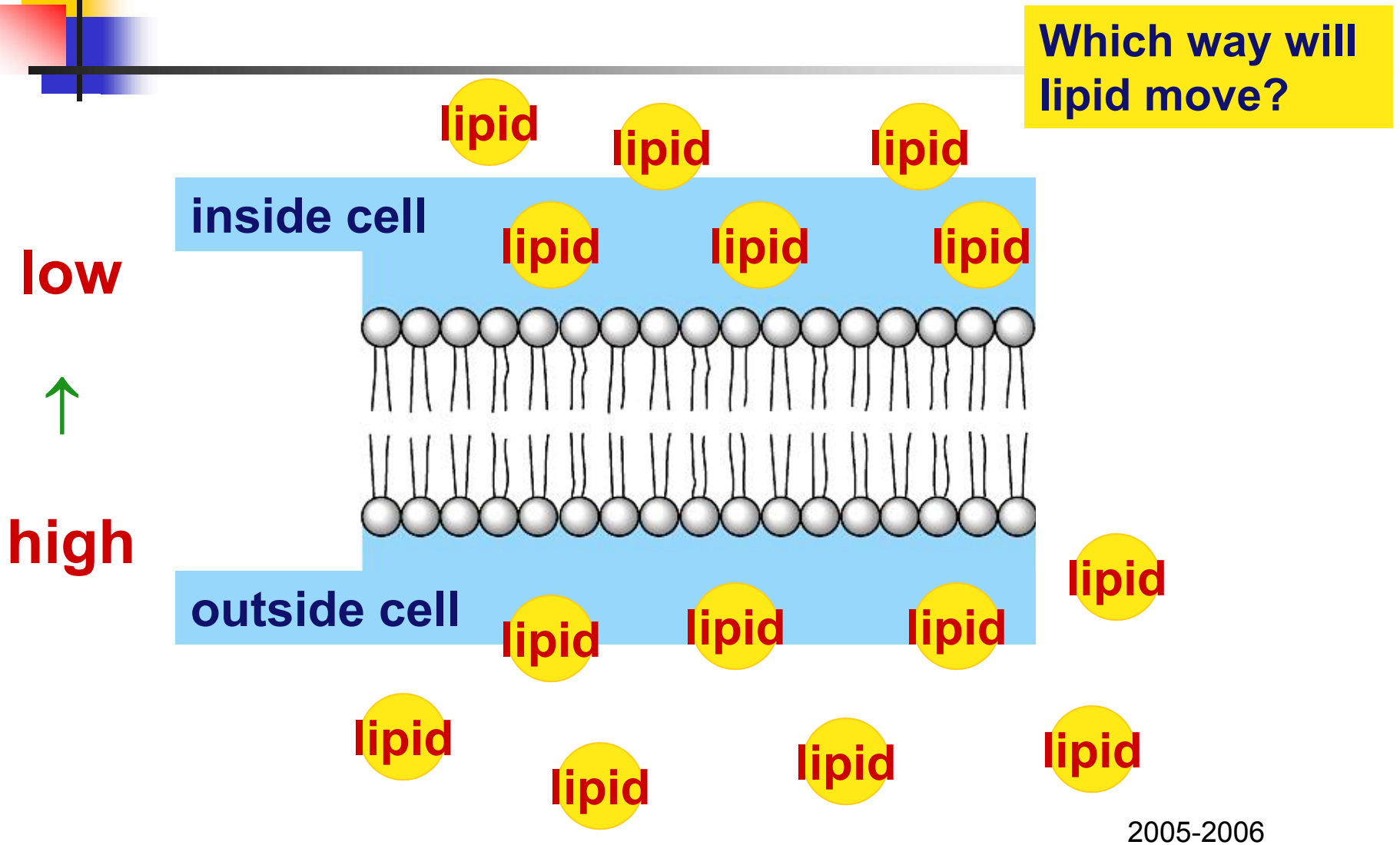
3. Facilitated diffusion

Diffusion

- Molecules move to equalize concentration



Simple diffusion across membrane

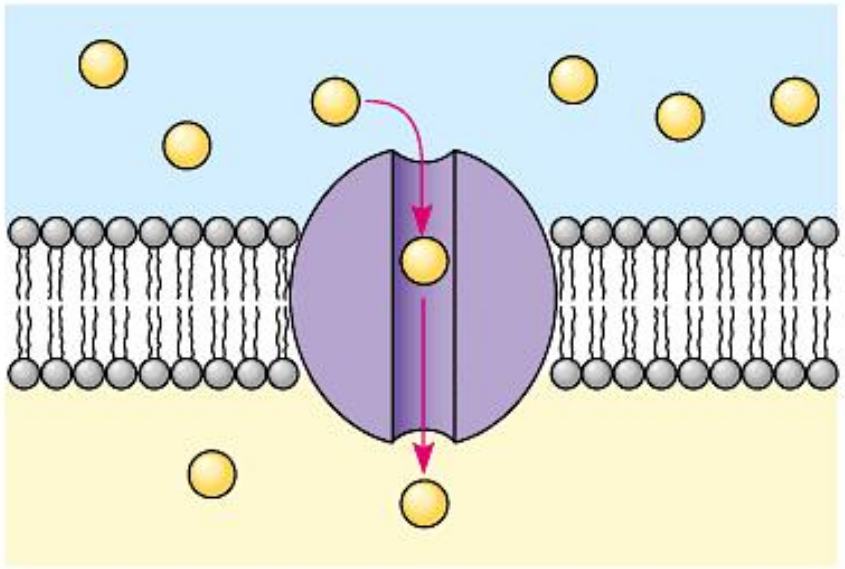


Osmosis

- Special form of diffusion
- Fluid flows from lower solute concentration
- Often involves movement of water
  - Into cell
  - Out of cell

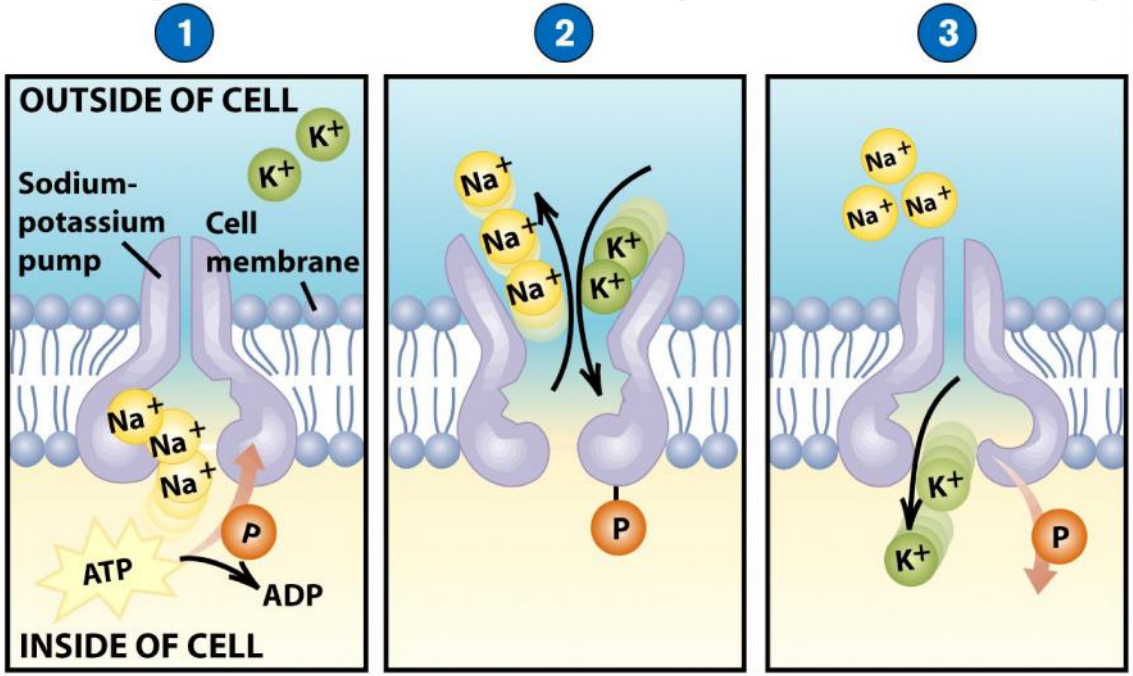
Facilitated diffusion

- Move from HIGH to LOW concentration through a protein channel
  - passive transport
  - no energy needed
  - facilitated = with help

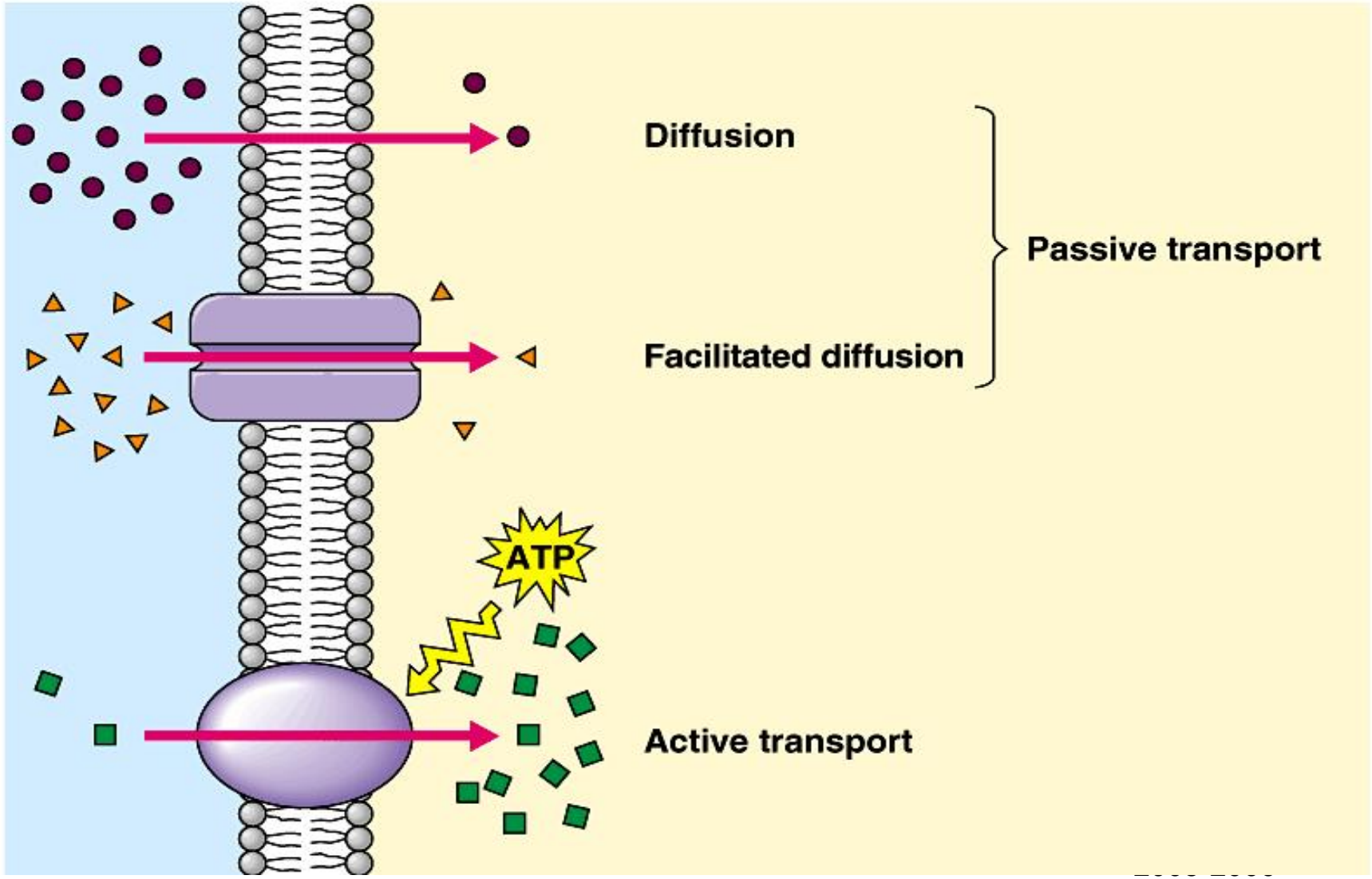


Active Transport

- Molecular movement
- Requires energy (against gradient)
- Example is sodium-potassium pump

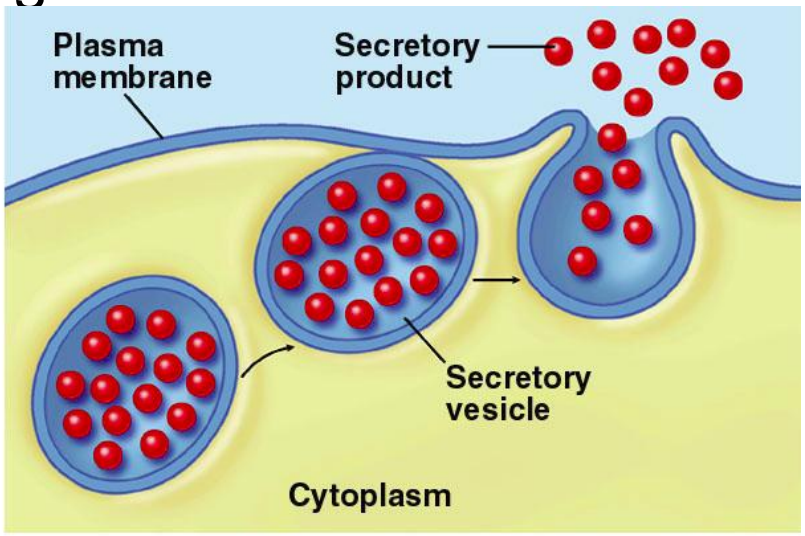


Transport summary



How about large molecules?

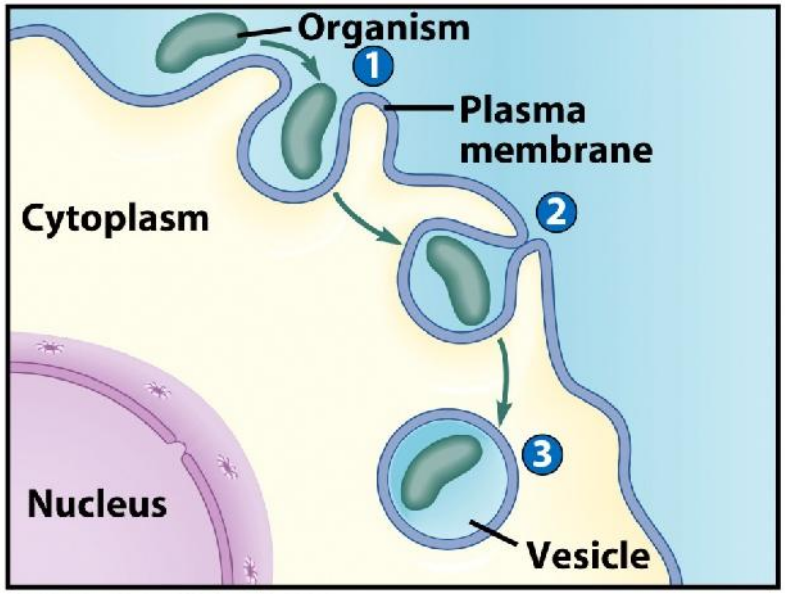
- Moving large molecules into & out of cell requires ATP!
  - through vesicles & vacuoles
  - endocytosis
    - phagocytosis = “cellular eating”
    - pinocytosis = “cellular drinki
    - receptor-mediated endocytosis
  - exocytosis



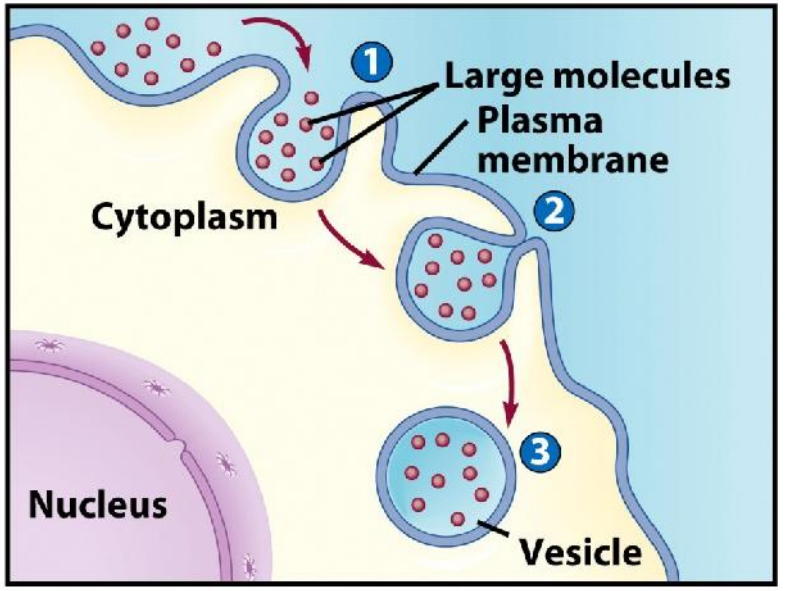
exocytosis

Process of Endocytosis

- Plasma membrane surrounds material
- Edges of membrane meet
- Membranes fuse to form vesicle



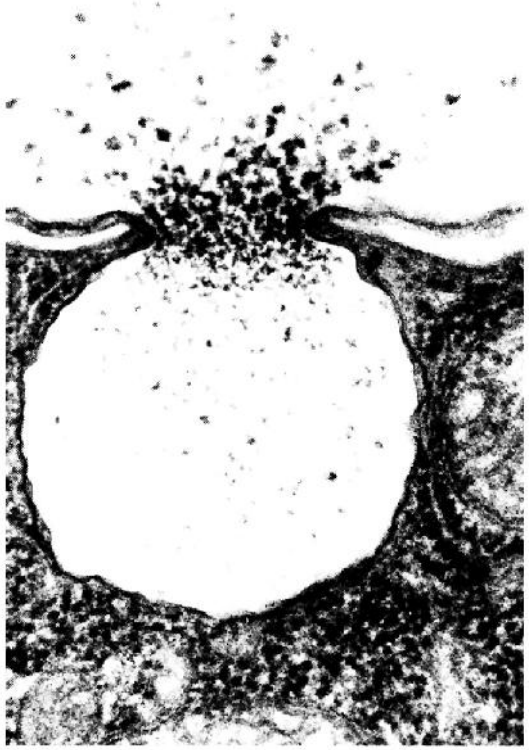
PHAGOCYTOSIS



PINOCYTOSIS

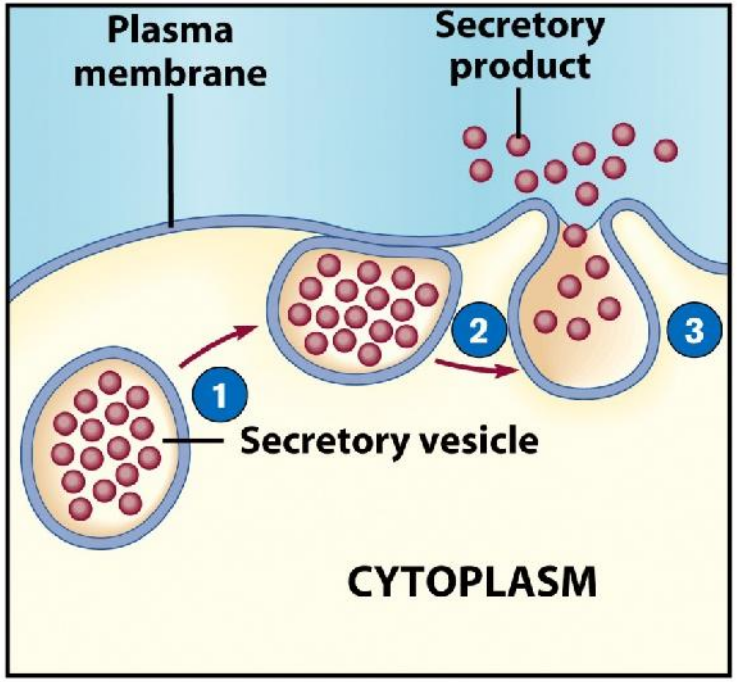
Exocytosis

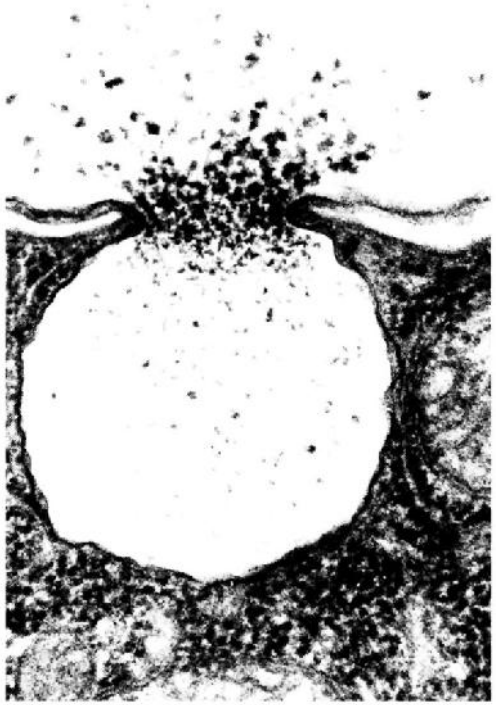
- Reverse of endocytosis
- Cell discharges material



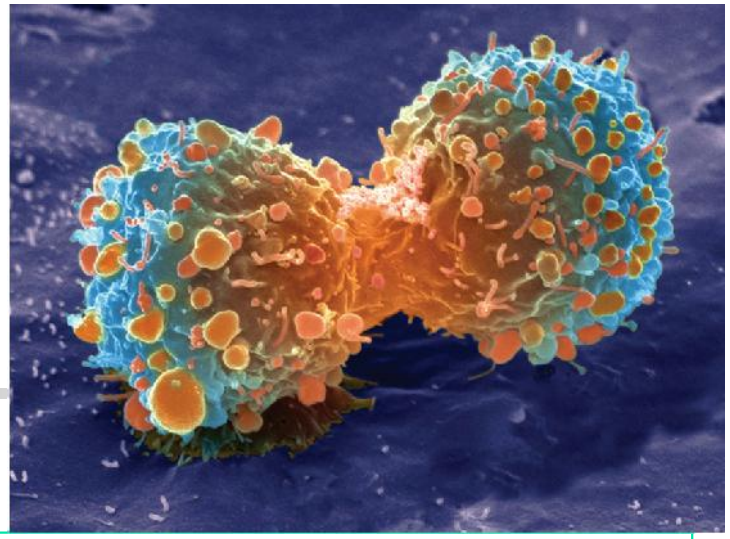
Exocytosis

- Vesicle moves to cell surface
- Membrane of vesicle fuses
- Materials expelled





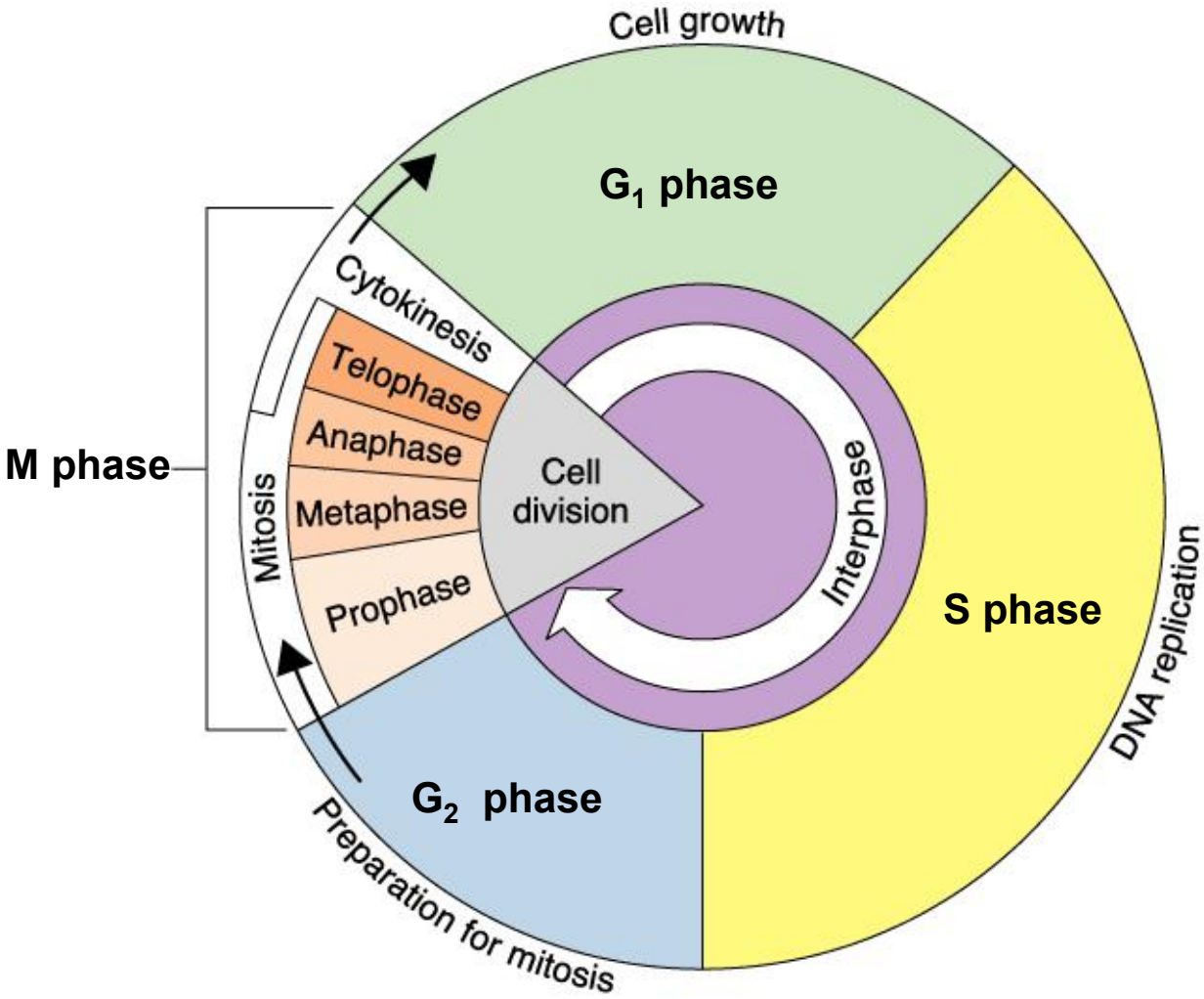
Cell Cycle
(mitosis, cytokinesis)



- The cell cycle is the “life cycle” or reproductive cycle of a cell. It includes the **replication** of the genetic material and other components of the cell, division of the nucleus **(mitosis)** , and division of the cytoplasm **(cytokinesis).**

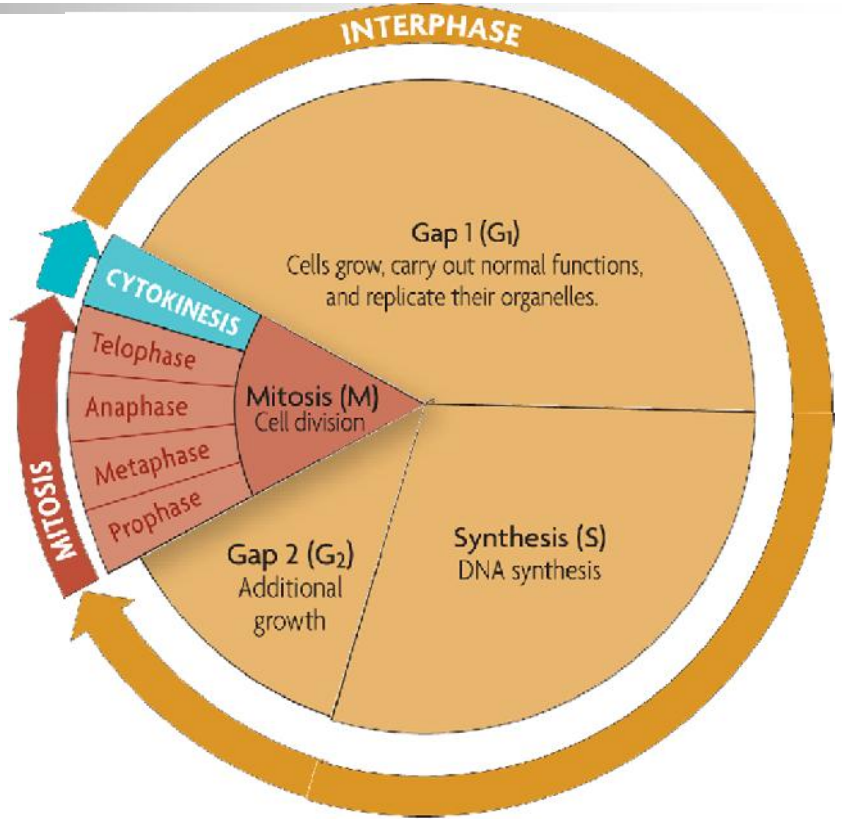
The cell cycle has four main stages.

The cell cycle is a regular pattern of growth, DNA replication, and cell division.



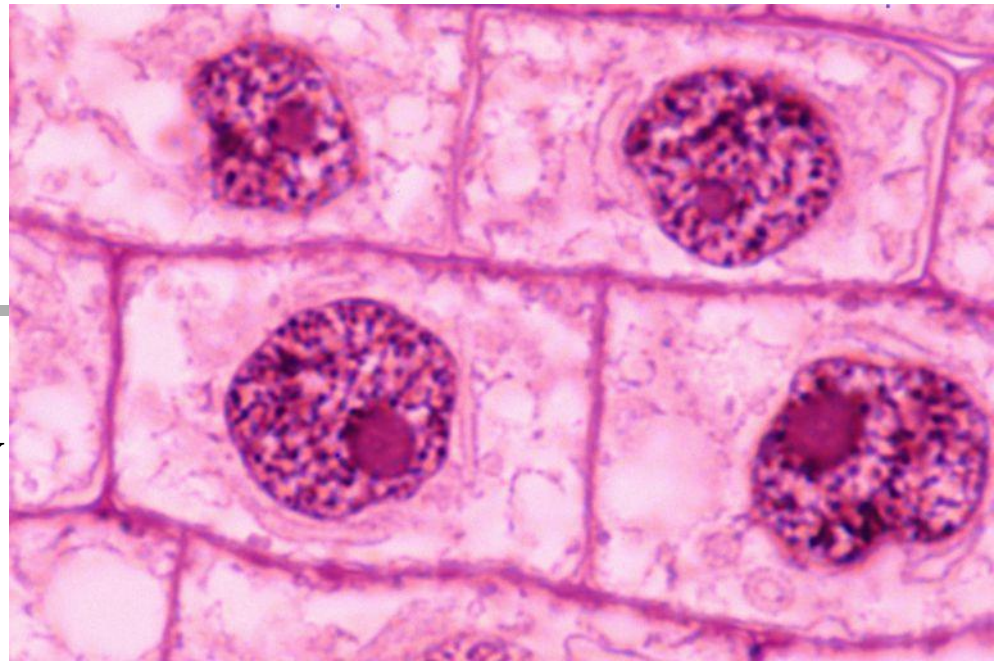
The main stages of the cell cycle are gap 1, synthesis, gap 2, and mitosis.

- Gap 1 (G_1): cell growth and normal functions
- DNA synthesis (S): copies DNA
- Gap 2 (G_2): additional growth (chromatids become replicated chromosomes)
- Mitosis (M): includes division of the cell nucleus (mitosis) and division of the cell cytoplasm (cytokinesis)



- Mitosis occurs only if the cell is large enough and the DNA undamaged.

Interphase



Cells spend the majority of their cell cycle in interphase.

The purpose of interphase is for cell growth.

By the end of interphase a cell has two full sets of DNA (chromosomes) and is large enough to begin the division process.

Mitosis

The purpose of mitosis is cell division: making two cells out of one.

- Each cell has to have its own cytoplasm and DNA.

- The DNA is replicated in interphase when two chromosome strands became four strands (two strands per chromatid).

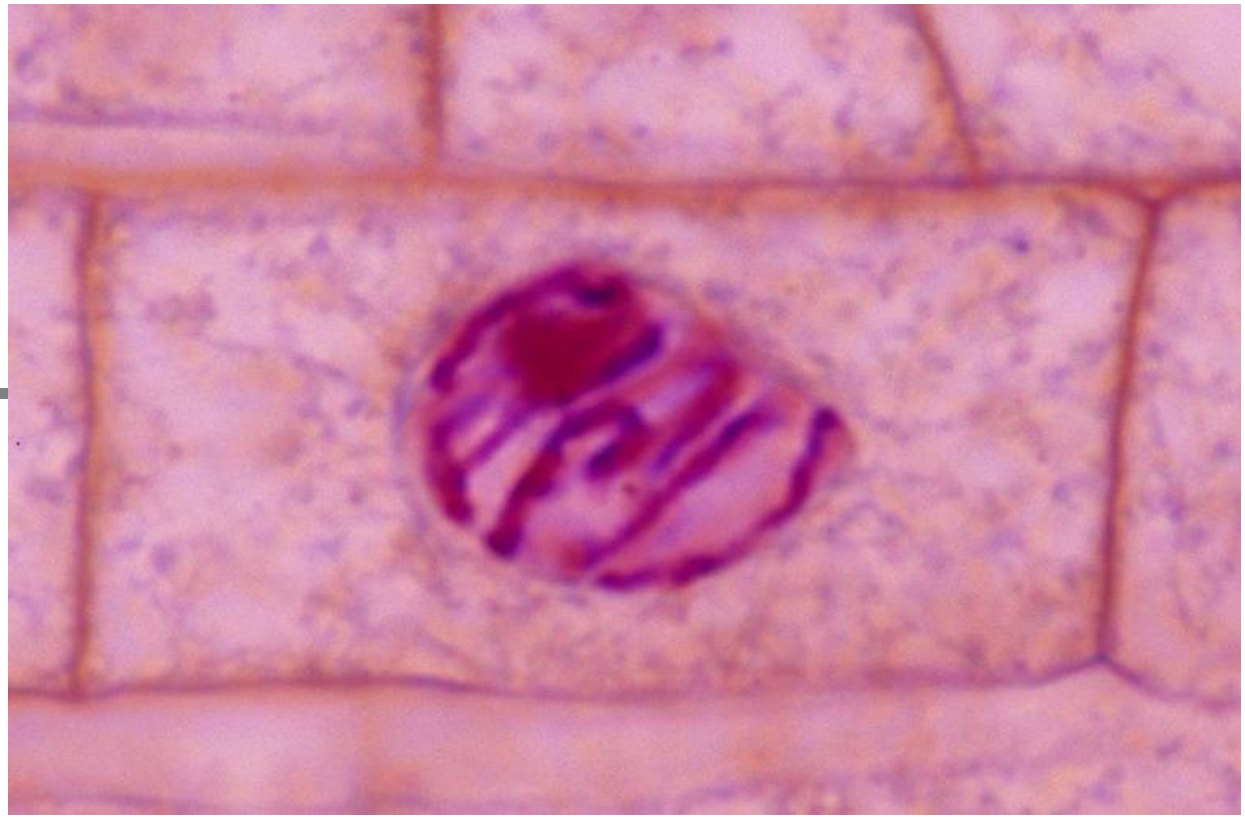
- In mitosis the four strands (two sister chromatid) have to break apart so that each new cell only has one double-stranded chromosome.
- Two sister chromatids together make a chromosome

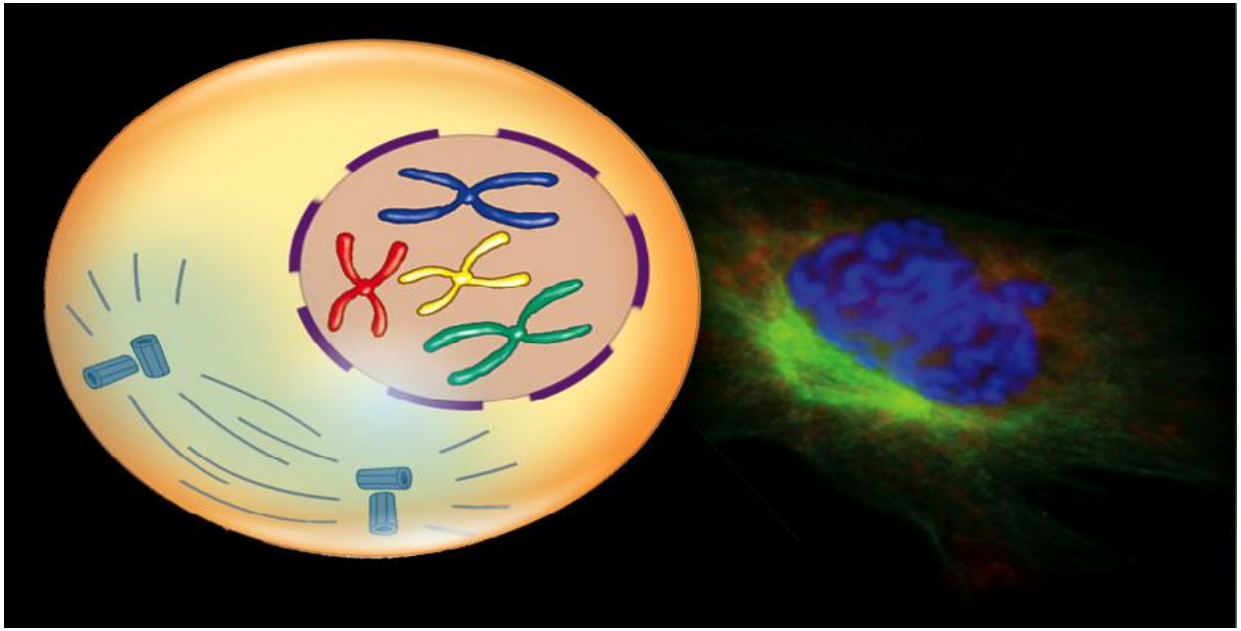
Prophase is characterized by four events:

1. Chromosomes condense and are more visible.
2. The nuclear membrane (envelope) disappears.
3. Centrioles have separated and taken positions on the opposite poles of the cell.
4. Spindle fibers form and radiate toward the center of the cell.

Prophase

During prophase, chromosomes condense and spindle fibers form.

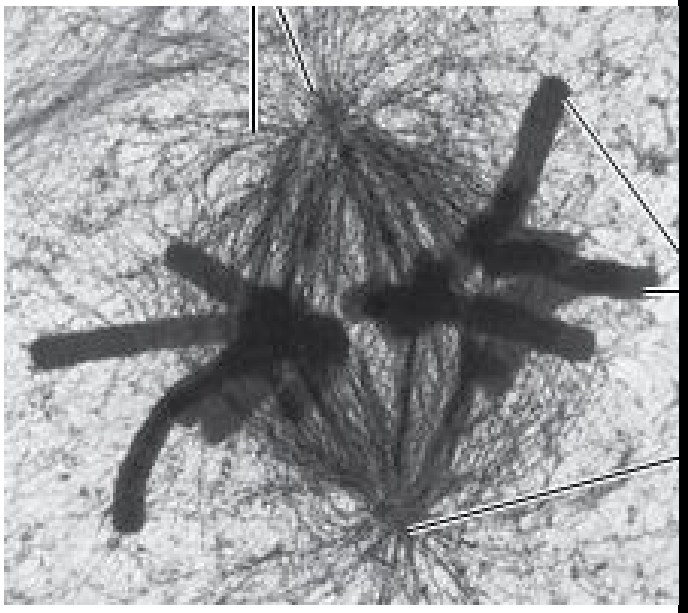


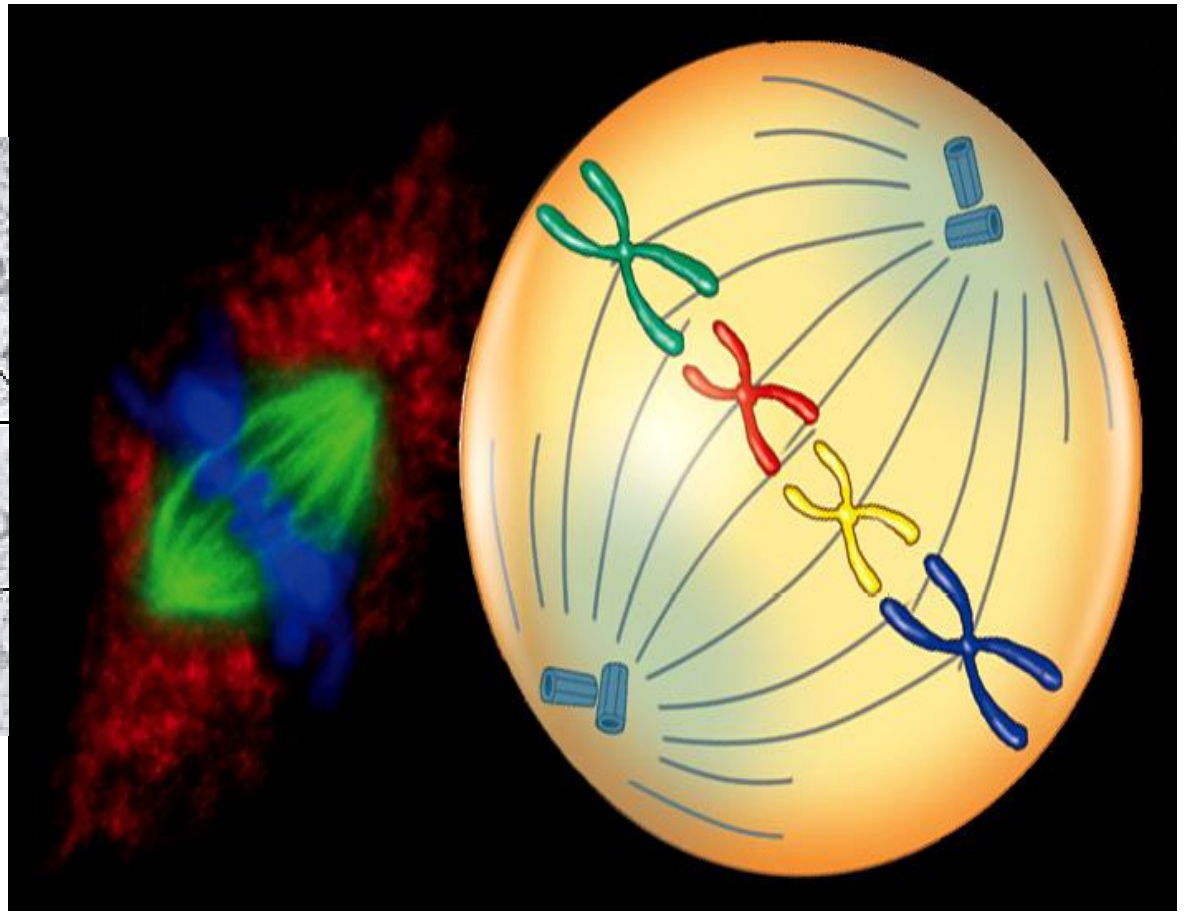


Metaphase (the shortest phase of mitosis) is characterized by two events:

1. Chromosomes line up across the middle of the cell.
2. Spindle fibers connect the centromere of each sister chromatid to the poles of the cell.

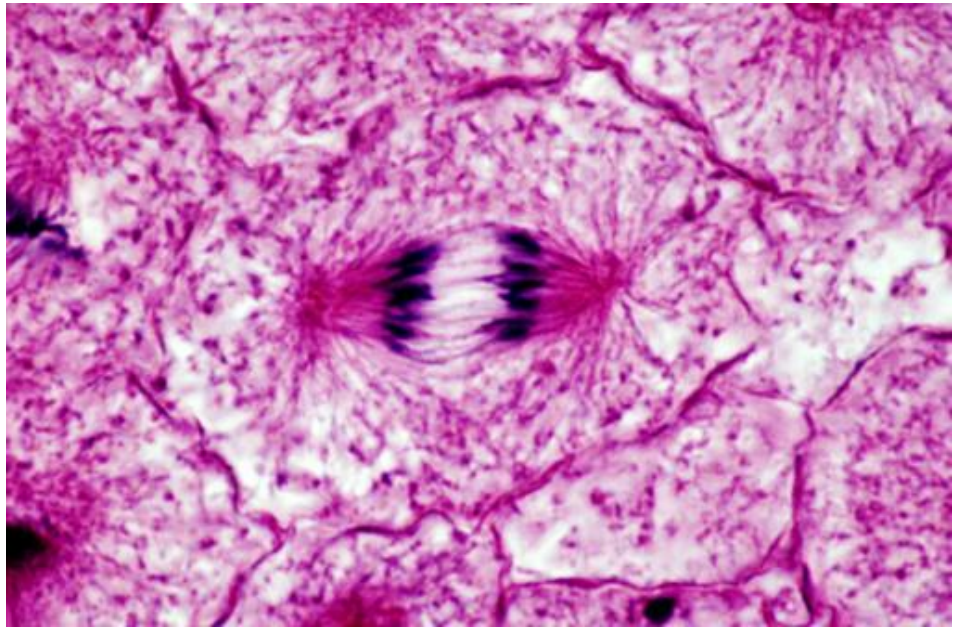
– During metaphase, chromosomes line up in the middle of the cell.



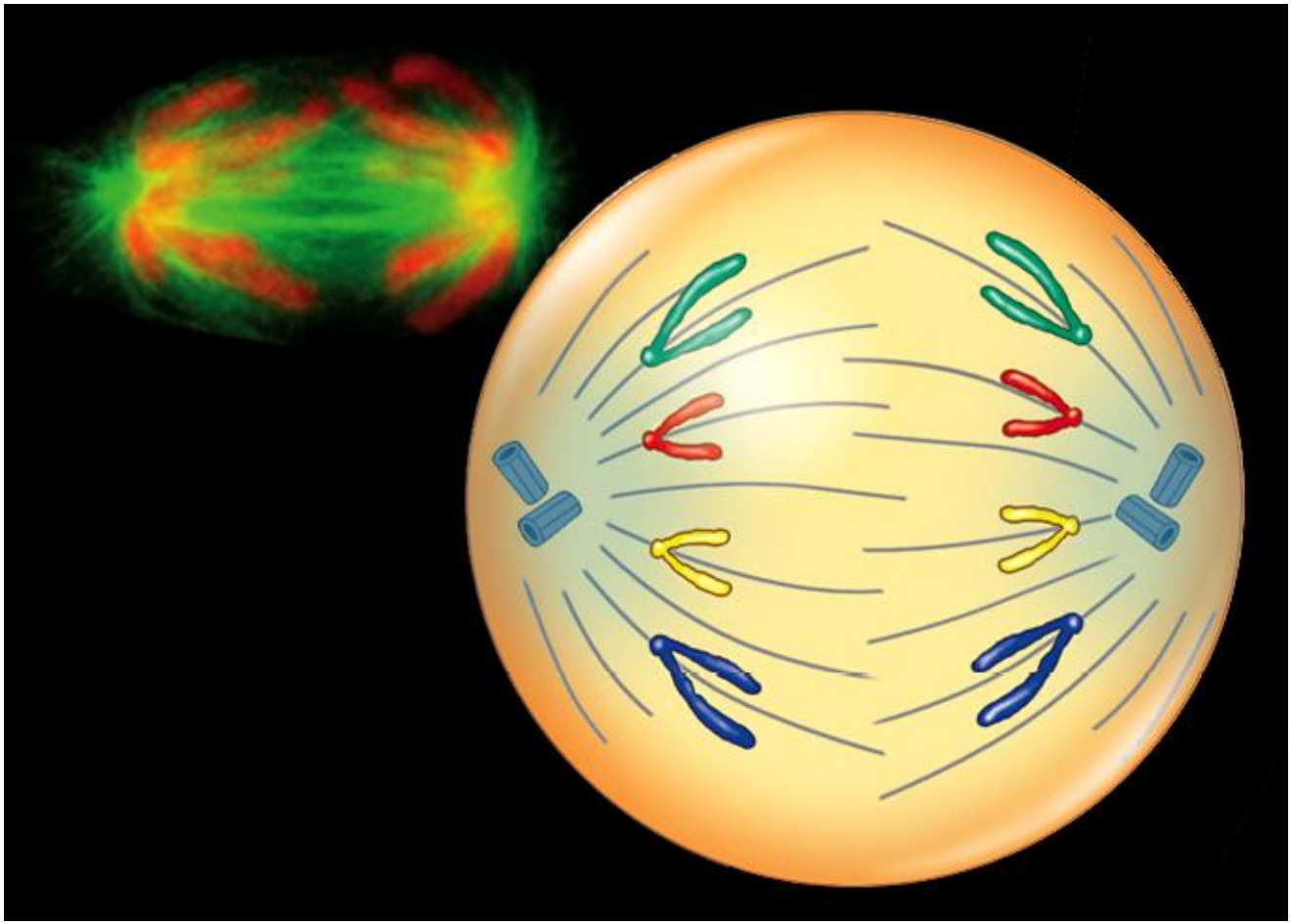


Anaphase is characterized by three events:

1. Centromeres that join the sister chromatids split.
2. Sister chromatids separate becoming individual chromosomes.
3. Separated chromatids move to opposite poles of the cell.

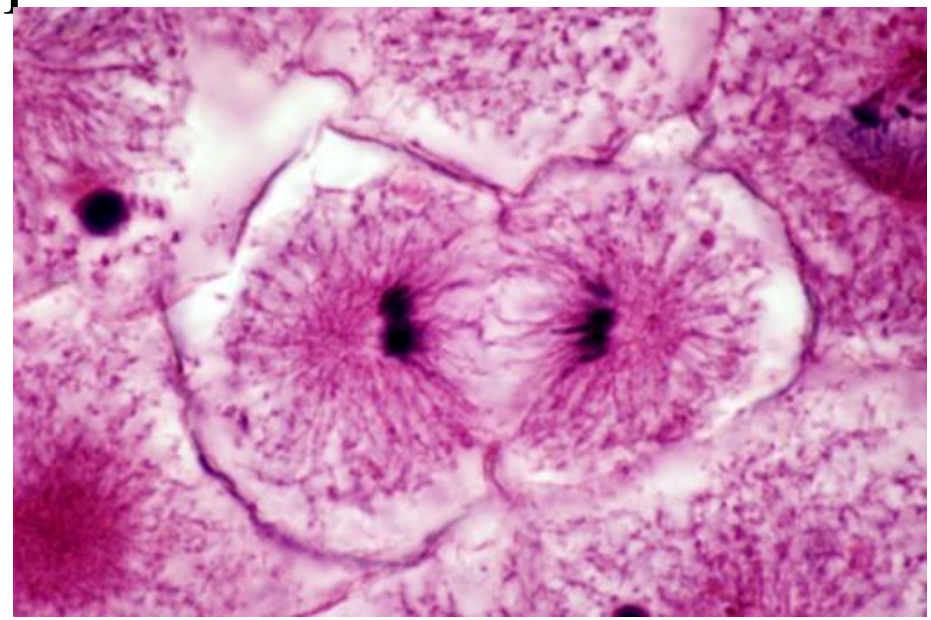


– During anaphase, sister chromatids separate to opposite sides of the cell.

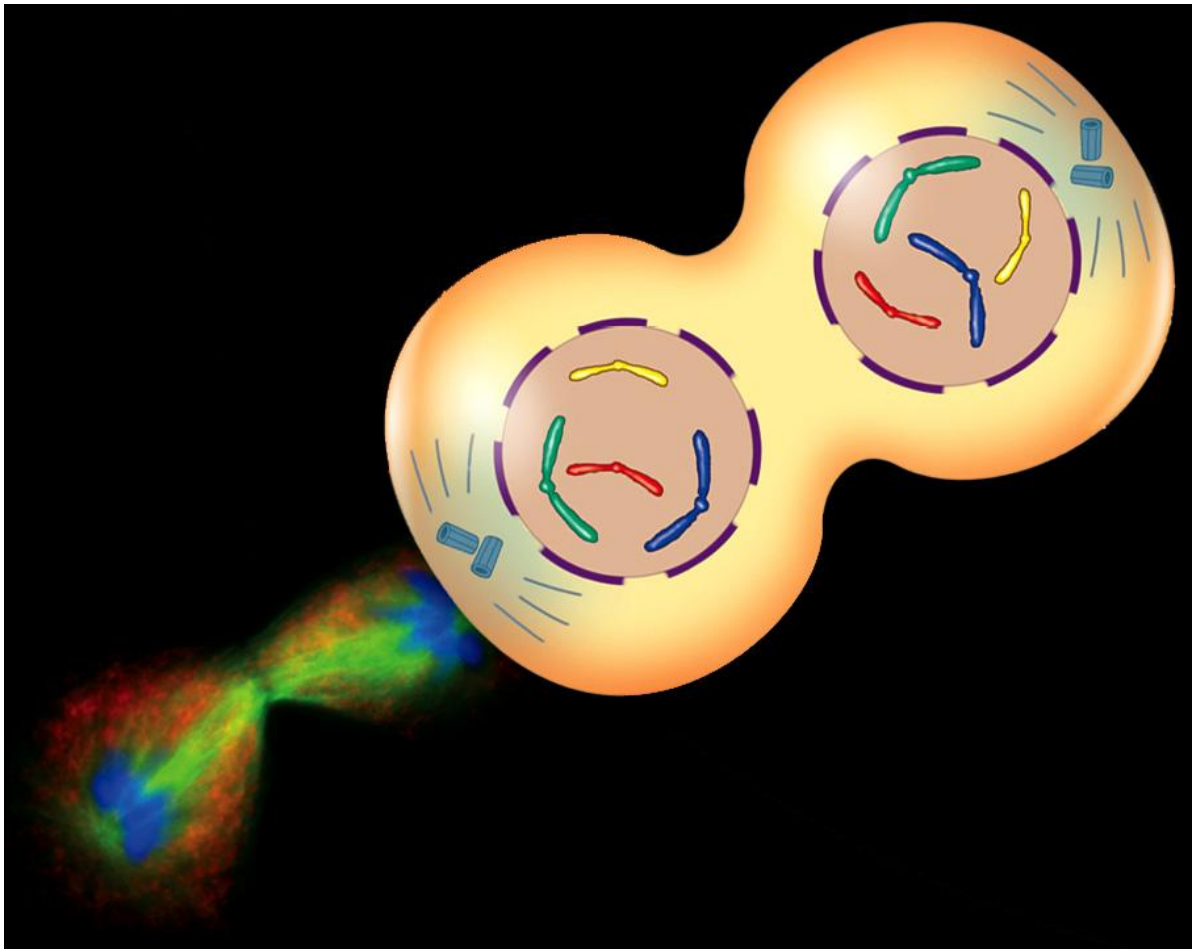


Telophase (the last phase of mitosis) consists of four events:

1. Chromosomes (each consisting of a single chromatid) uncoil.
2. A nuclear envelope forms around the chromosomes at each pole of the cell.
3. Spindle fibers break down and dissolve.
4. Cytokinesis begins.



– During telophase, the new nuclei form and chromosomes begin to uncoil.



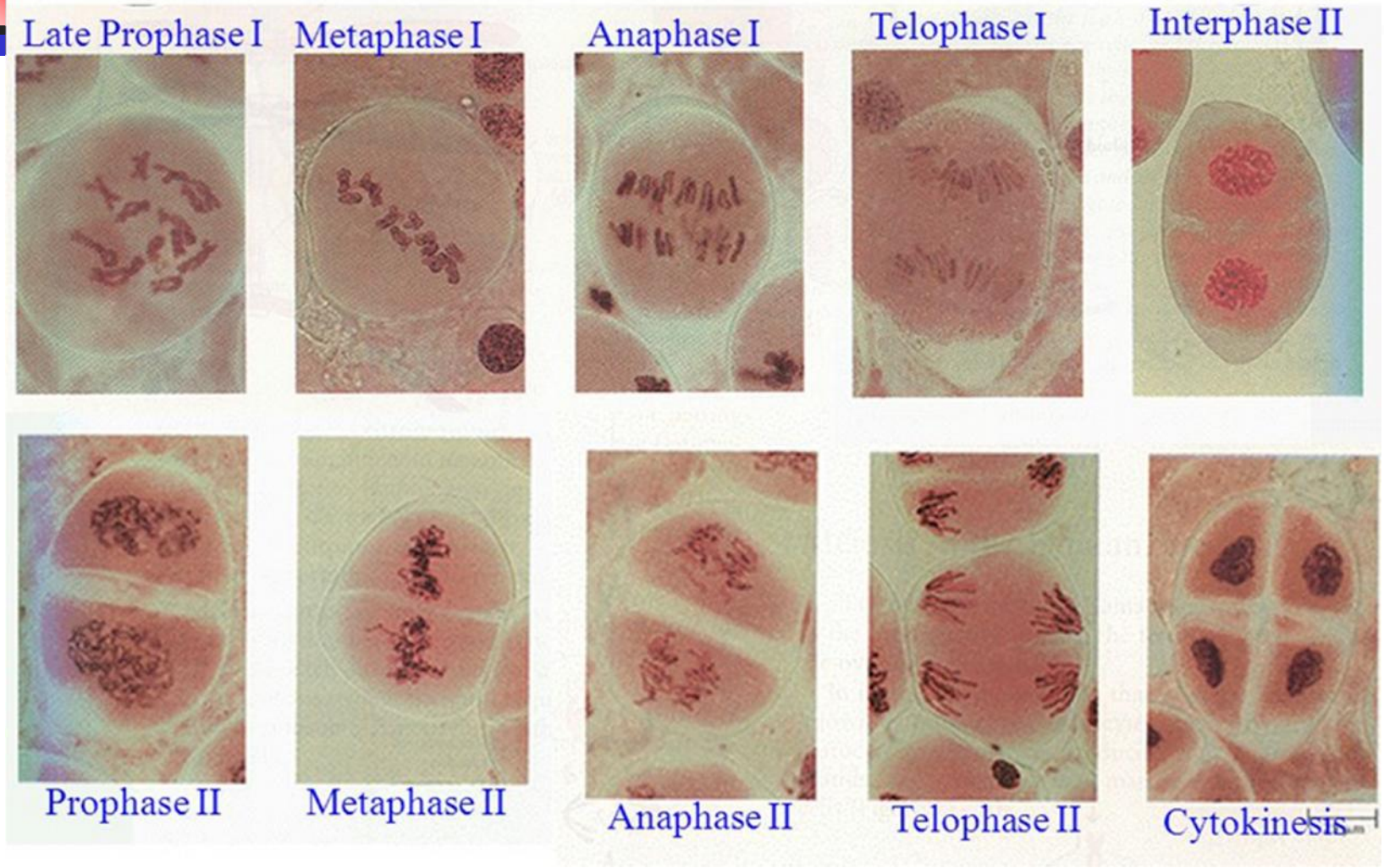
Cytokinesis

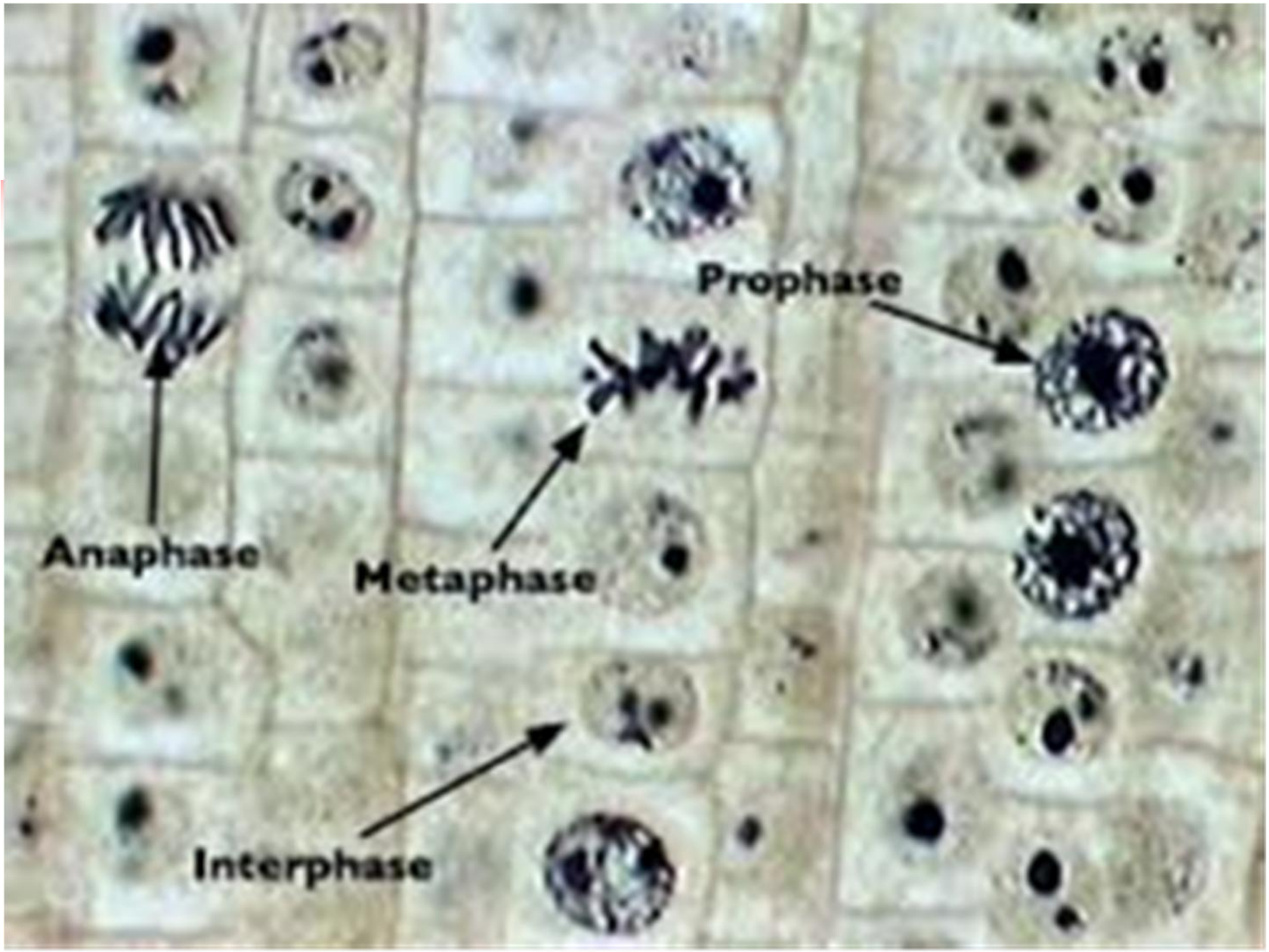
- Cytokinesis is the division of the cytoplasm into two individual cells.

Real Pictures

Pictures adopted from:

http://www.micro.utexas.edu/courses/levin/bio304/genetics/celldiv.html




Prophase
Anaphase
Metaphase
Interphase