

By : Dr. Arslan
NOVA CSS Academy

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مَوْلَاهُ الرَّحْمَنِ الرَّحِيمِ

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NOVA CSS Academy

GENERAL SCIENCE

CELL BIOLOGY



*Dr. Arslan Luqman
House Physician
Ayub Teaching Hospital,
Abbottabad*

CELL

- A cell is the smallest unit of life that can replicate independently.
- Cells are often called the "building blocks of life".
- The study of cells is called cell biology.
- Most are microscopic
- Cells emerged on Earth at least 3.5 billion years ago.

DISCOVERY OF CELLS

- Robert Hooke
(1674)
 - Observed sliver of cork
 - Saw “row of empty boxes”
 - Coined the term cell



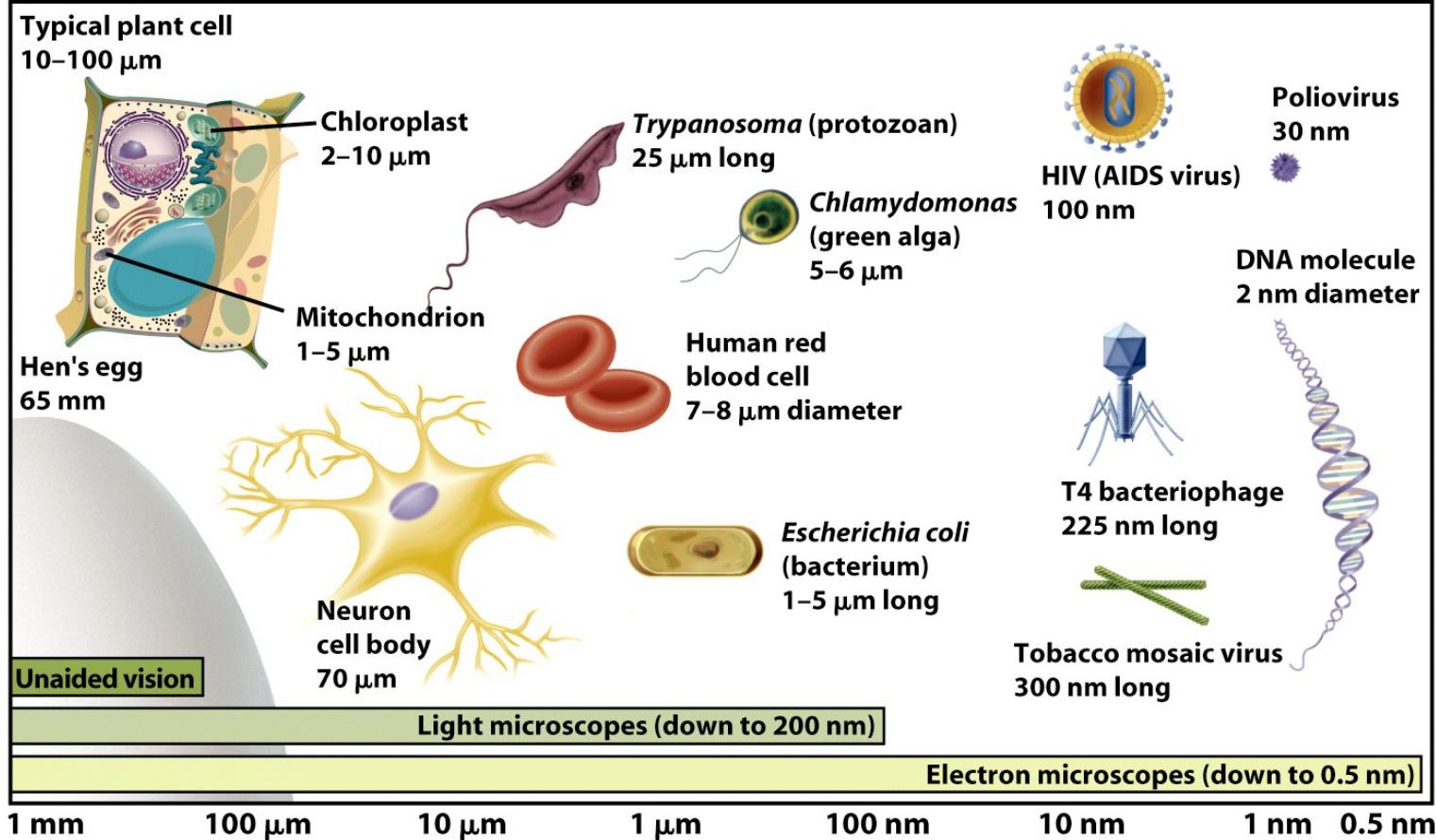
CELL THEORY

- (1839) Theodor Schwann & Matthias Schleiden
 - “ all living things are made of cells”
- (50 yrs. later) Rudolf Virchow
 - “all cells come from cells”

PRINCIPLES OF CELL THEORY

- All living things are made of cells
- Smallest living unit of structure and function of all organisms is the cell
- All cells arise from preexisting cells
(this principle discarded the idea of spontaneous generation)

CELL SIZE

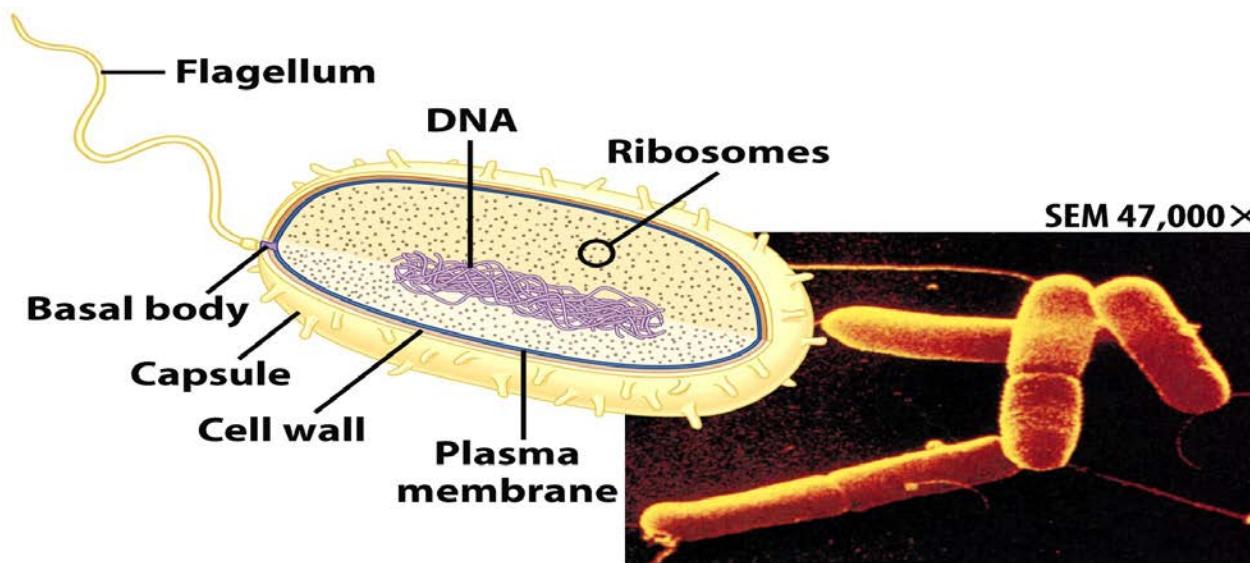


TYPES OF CELL

- PROKARYOTIC CELLS
- EUKARYOTIC CELLS

PROKARYOTIC CELLS

- First cell type on earth
- Cell type of Bacteria and Archaea

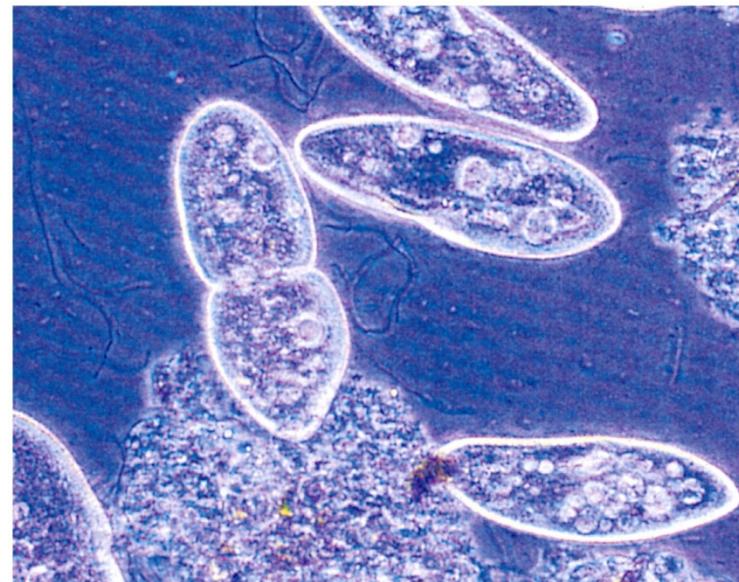


PROKARYOTIC CELLS

- No membrane bound nucleus
- Nucleoid = region of DNA concentration
- Organelles not bound by membranes

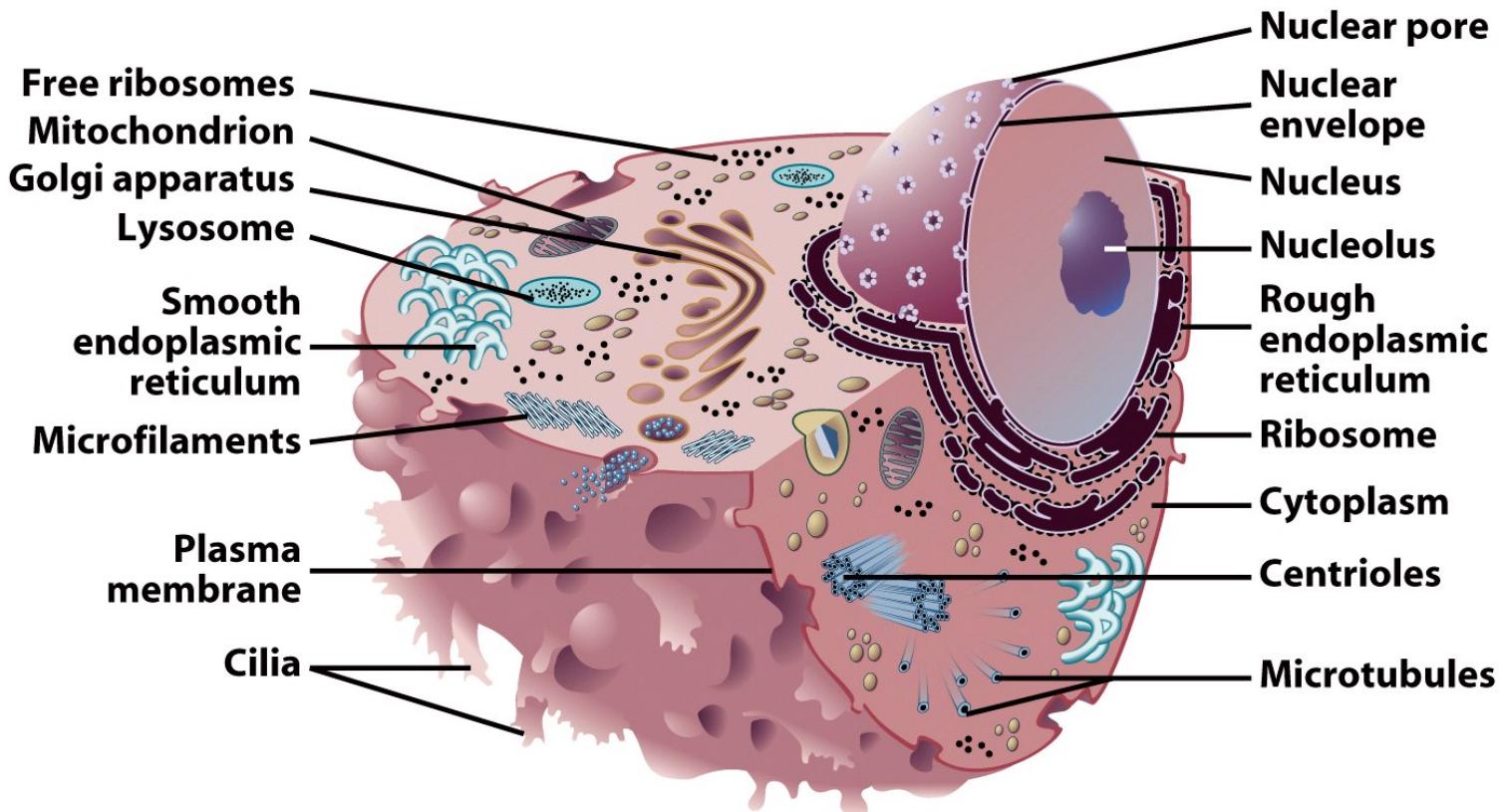
EUKARYOTIC CELLS

- Nucleus bound by membrane
- Include fungi, protists, plant, and animal cells
- Possess many organelles

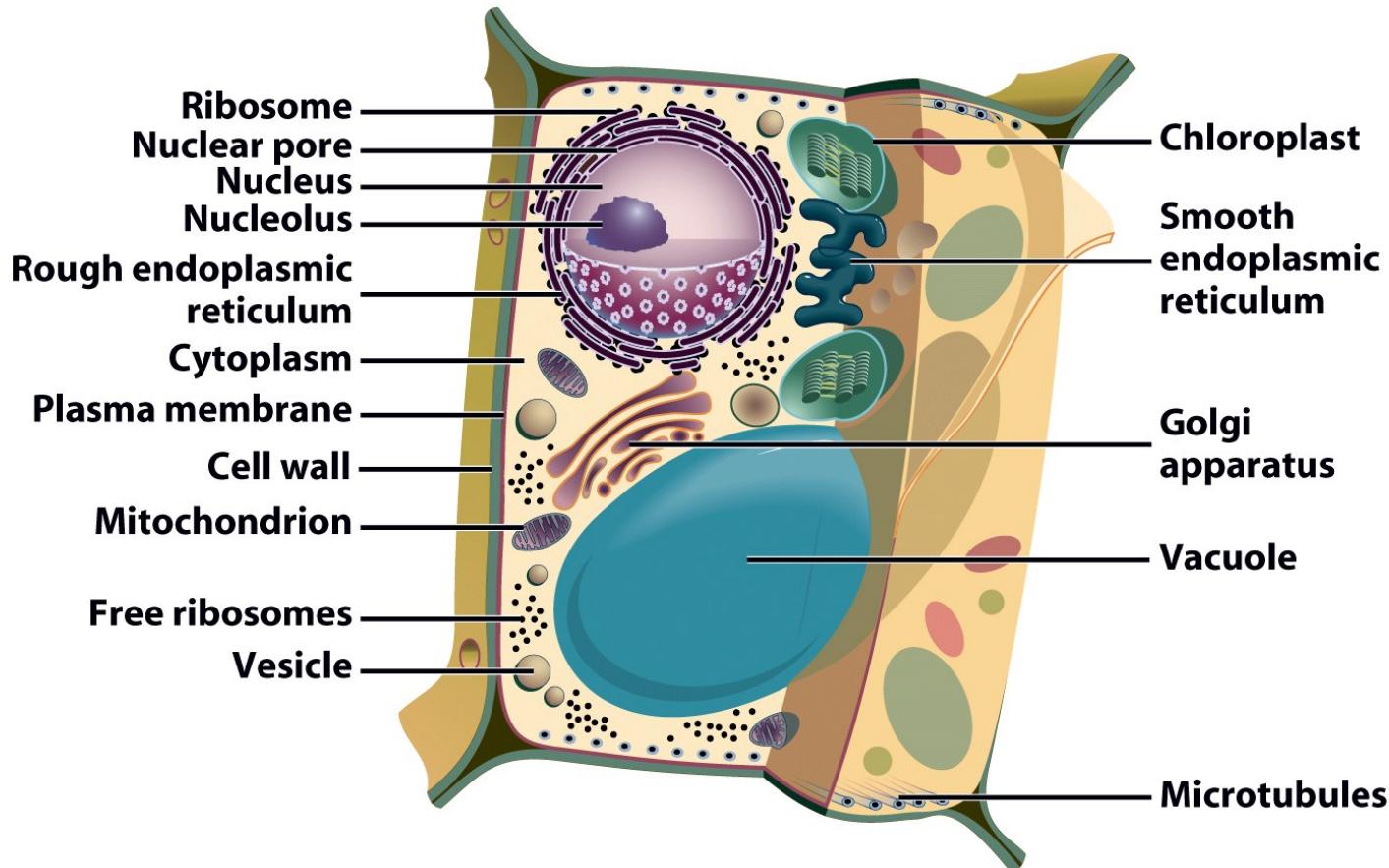


● Protozoan

REPRESENTATIVE ANIMAL CELL



REPRESENTATIVE PLANT CELL



ORGANELLES

- Cellular machinery
- Two general kinds
 - Derived from membranes
 - Bacteria-like organelles

CELL WALL

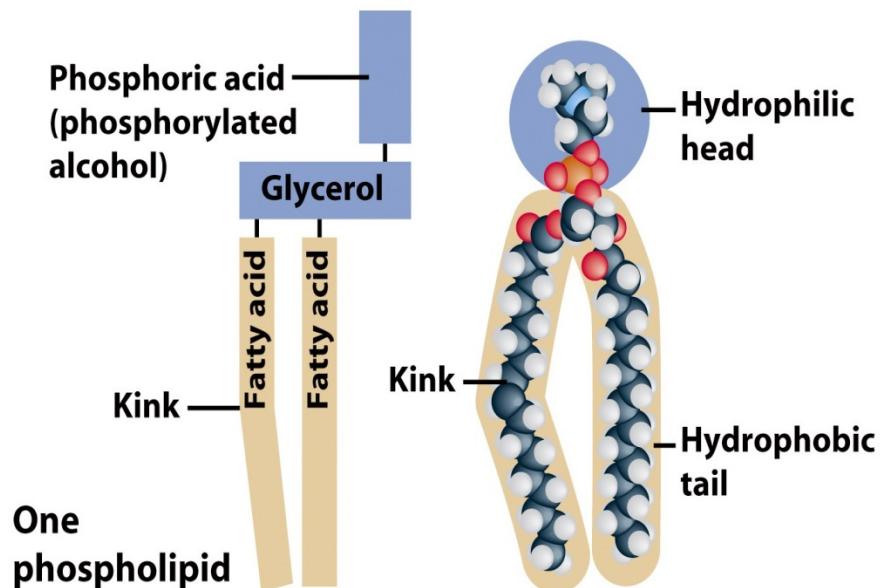
- It is not found in every cell but whenever it is present it is found as outermost covering of the cell.
- It's found in plants(contains cellulose), fungi(contains chitin) and bacterial(contains peptidoglycan) cells.
- The cell wall acts to protect the cell mechanically and chemically from its environment, and is an additional layer of protection to the cell membrane.

PLASMA MEMBRANE

- In animals, the plasma membrane is the outer boundary of the cell, while in plants and prokaryotes it is usually covered by a cell wall
- Separate a cell from its surrounding environment and is mostly from a double layer of phospholipids (partly hydrophobic and partly hydrophilic).Called a phospholipid bilayer
- Embedded within this membrane is a variety of protein molecules that act as channels and pumps that move different molecules into and out of the cell.
- Cell surface membranes also contain receptor proteins that allow cells to detect external signaling molecules such as hormones.

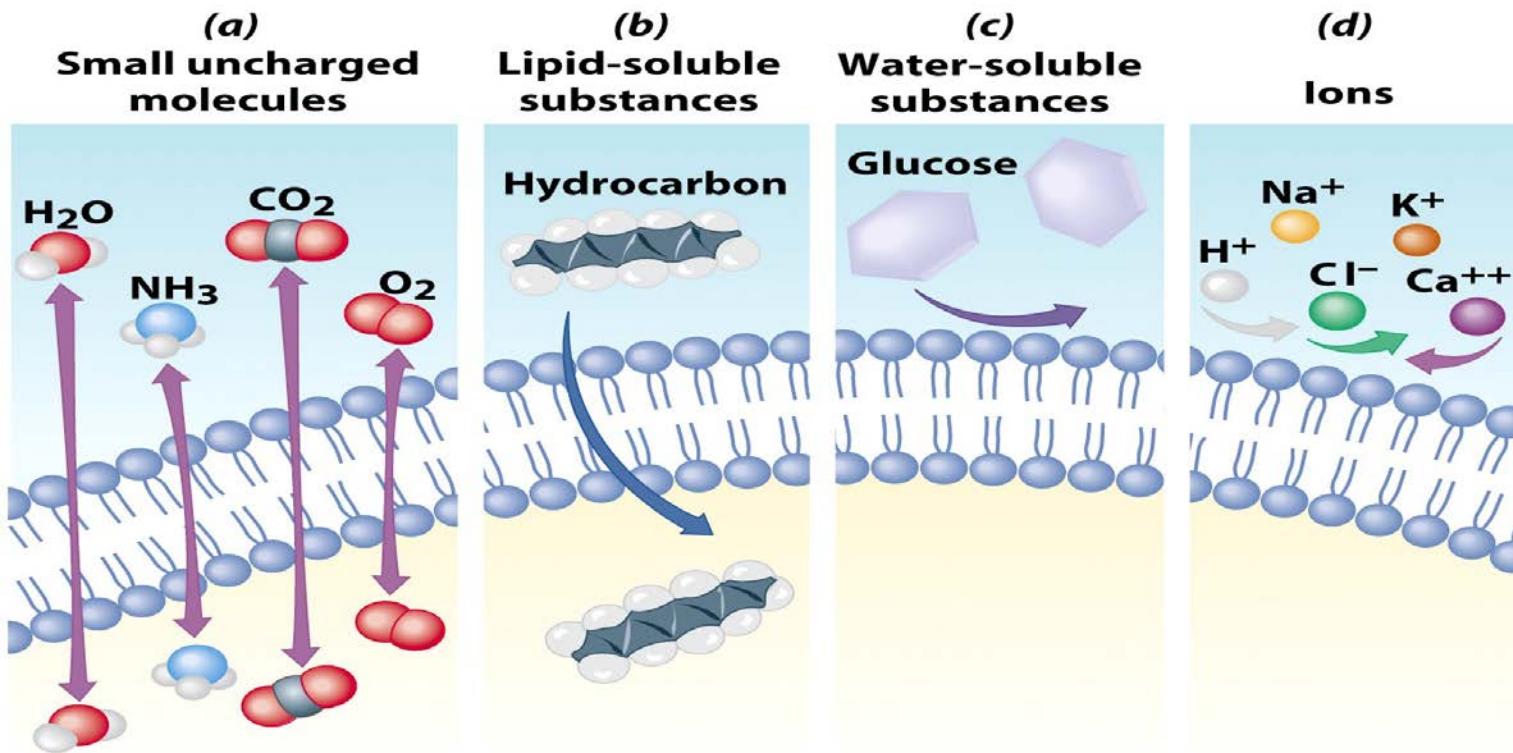
PHOSPHOLIPIDS

- Polar
 - Hydrophylic head
 - Hydrophobic tail
- Interacts with water



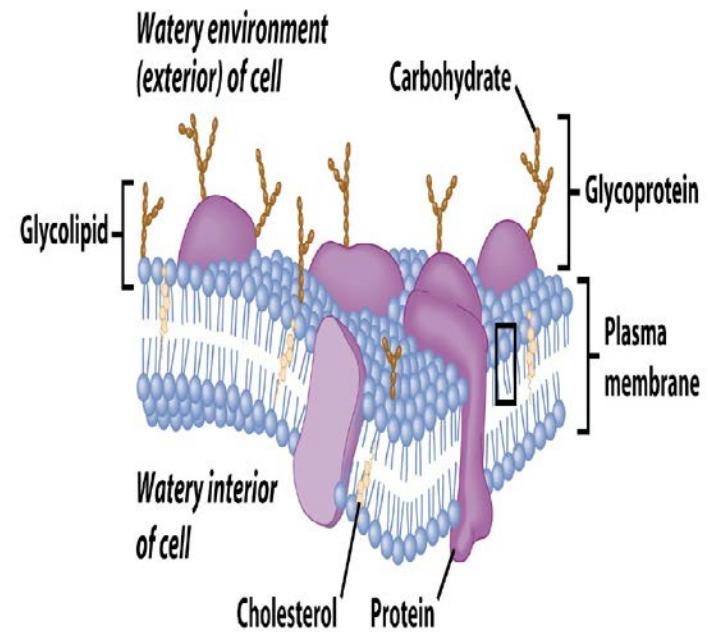
MOVEMENT ACROSS THE PLASMA MEMBRANE

- A few molecules move freely
 - Water, Carbon dioxide, Ammonia, Oxygen
- Carrier proteins transport some molecules
 - Proteins embedded in lipid bilayer
 - Fluid mosaic model – describes fluid nature of a lipid bilayer with proteins



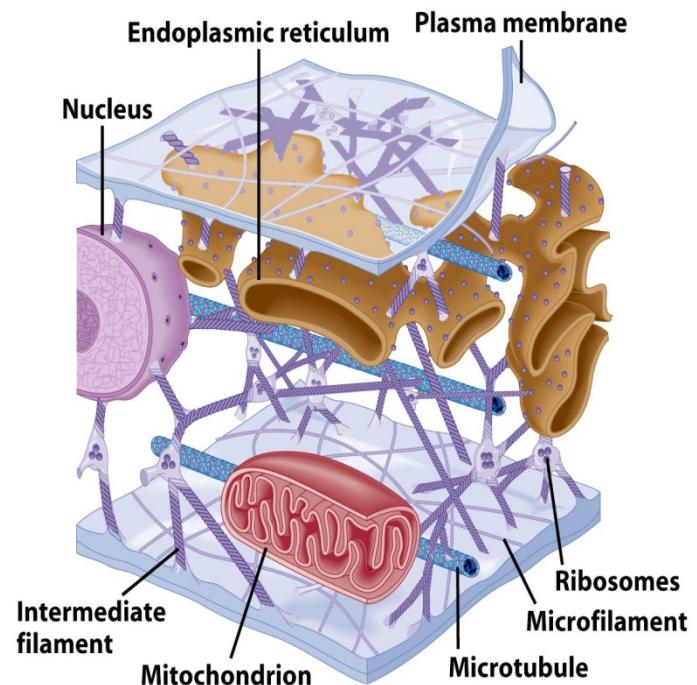
MEMBRANE PROTEINS

1. Channels or transporters
 - Move molecules in one direction
2. Receptors
 - Recognize certain chemicals
3. Glycoproteins
 - Identify cell type
4. Enzymes
 - Catalyze production of substances



CYTOPLASM

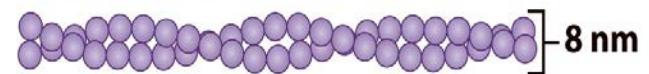
- Viscous fluid containing organelles
- Components of cytoplasm
 - Interconnected filaments & fibers
 - Fluid = cytosol
 - Organelles (not nucleus)
 - storage substances



CYTOSKELETON

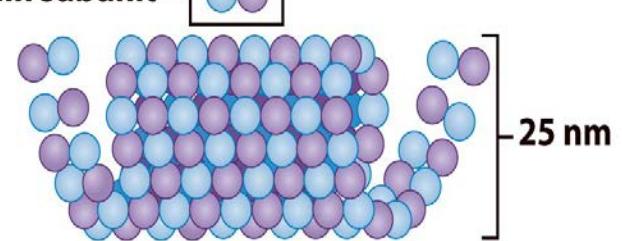
- Filaments & fibers
- Made of 3 fiber types
 - Microfilaments
 - Microtubules
 - Intermediate filaments
- 3 functions:
 - mechanical support
 - anchor organelles
 - help move substances

(a) Microfilament



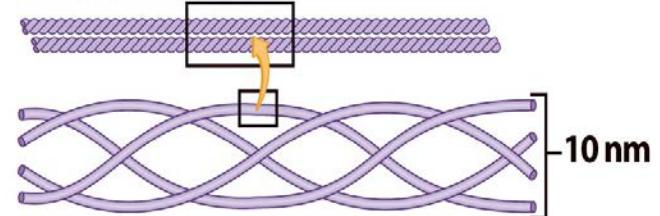
(b) Microtubule

Protein subunit —



(c) Intermediate filament

Threadlike unit



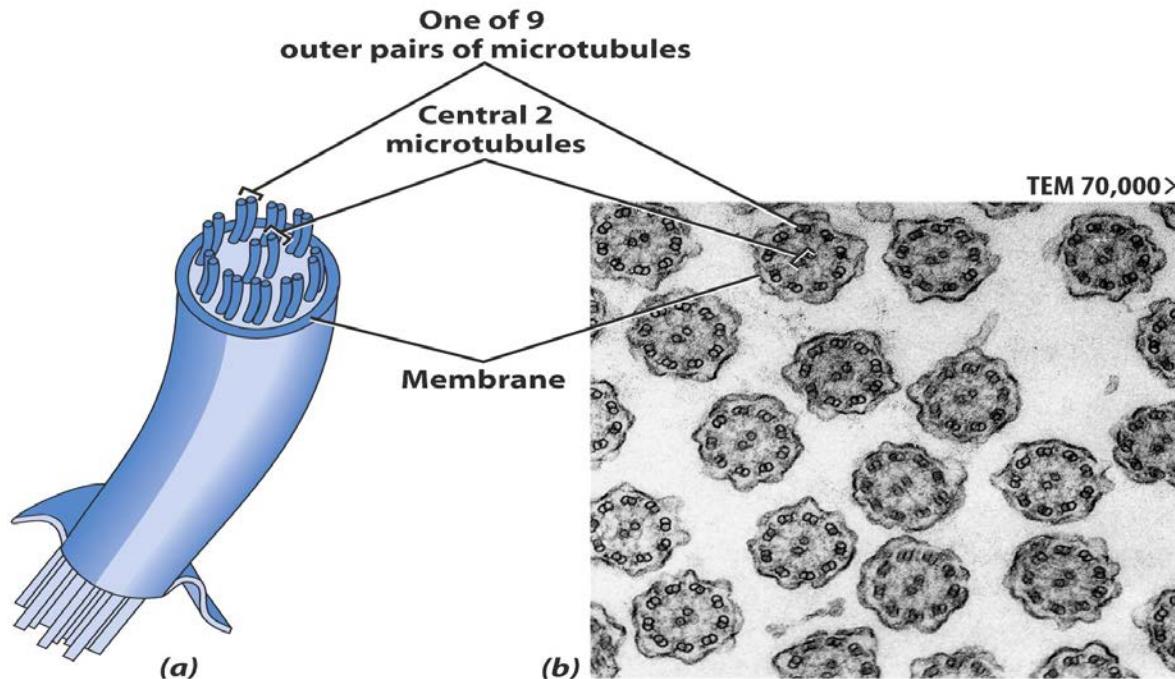
CILIA & FLAGELLA

- Provide motility
- Cilia
 - Short
 - Used to move substances outside human cells
- Flagella
 - Whip-like extensions
 - Found on sperm cells
- Basal bodies like centrioles



CILIA & FLAGELLA STRUCTURE

- Bundles of microtubules
- With plasma membrane



CENTRIOLES

- Pairs of microtubular structures
- Play a role in cell division

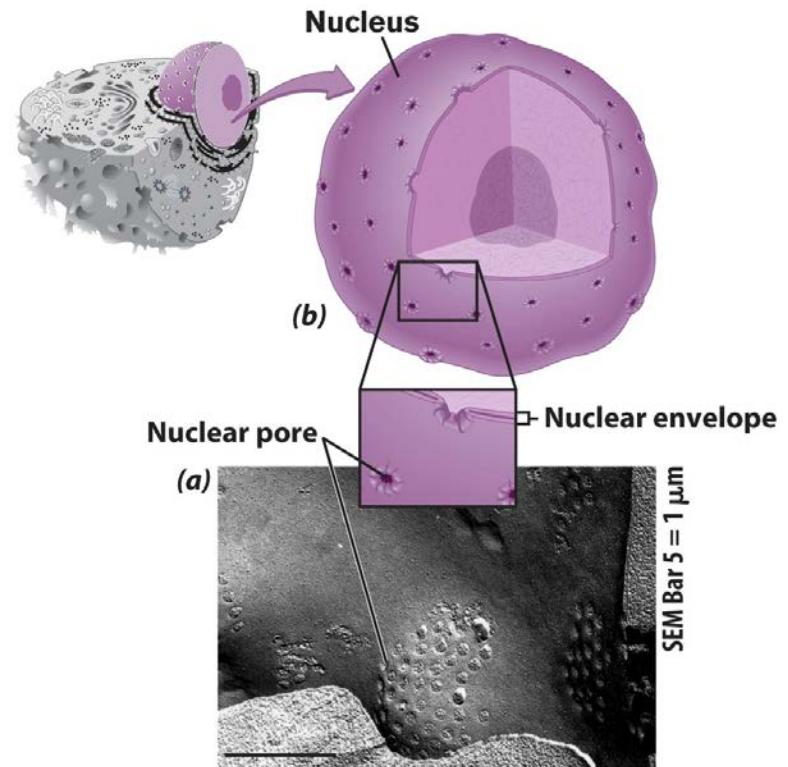


MEMBRANOUS ORGANELLES

- Functional components within cytoplasm
- Bound by membranes

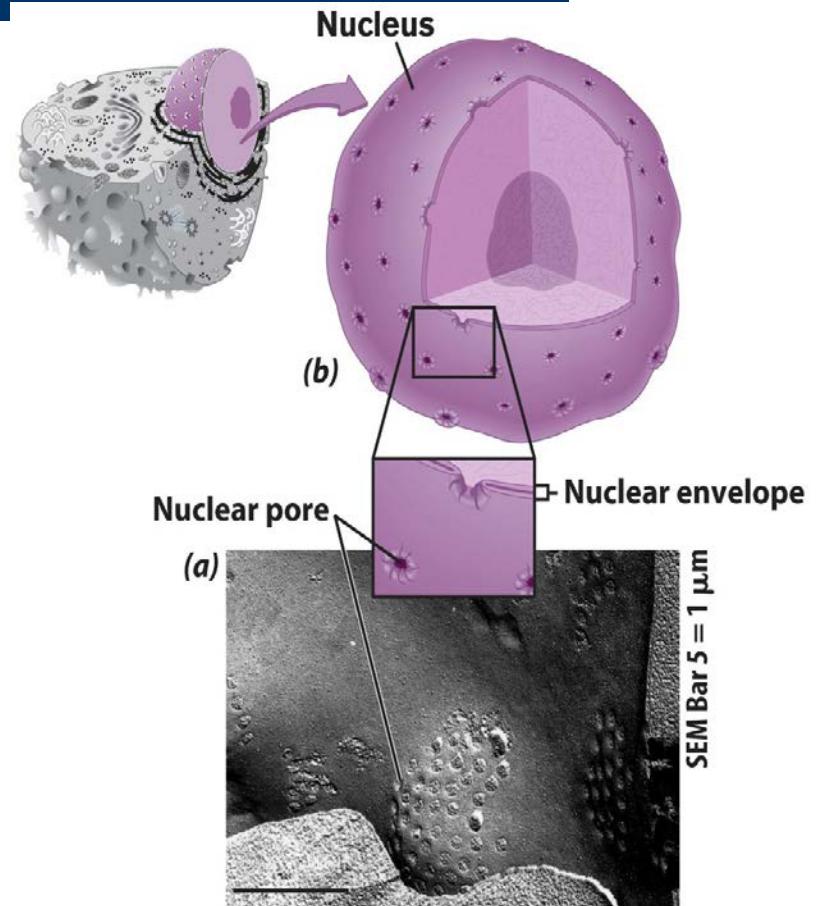
NUCLEUS

- Control center of cell
- Double membrane
- Contains
 - Chromosomes
 - Nucleolus



NUCLEAR ENVELOPE

- Separates nucleus from rest of cell
- Double membrane
- Has pores

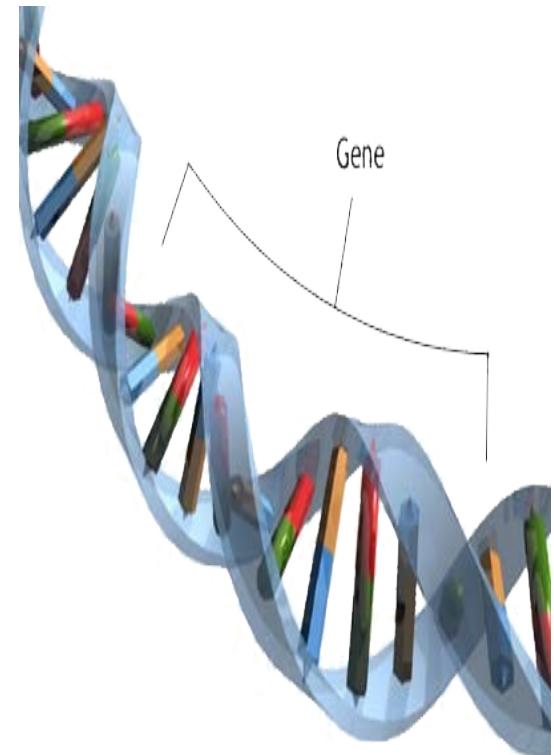


NUCLEOTIDE

- **Nucleotides** are organic molecules that serve as the monomers, or subunits, of nucleic acids like DNA and RNA
- The building blocks of nucleic acids, nucleotides are composed of a nitrogenous base, a five-carbon sugar (ribose or deoxyribose), and at least one phosphate group

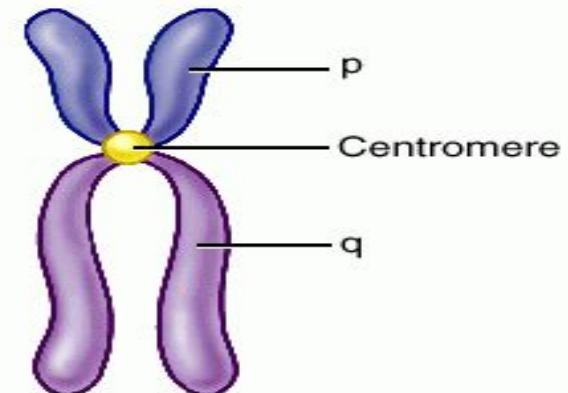
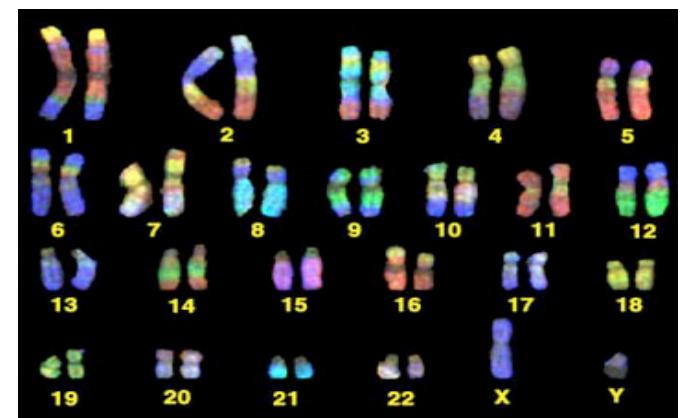
GENE

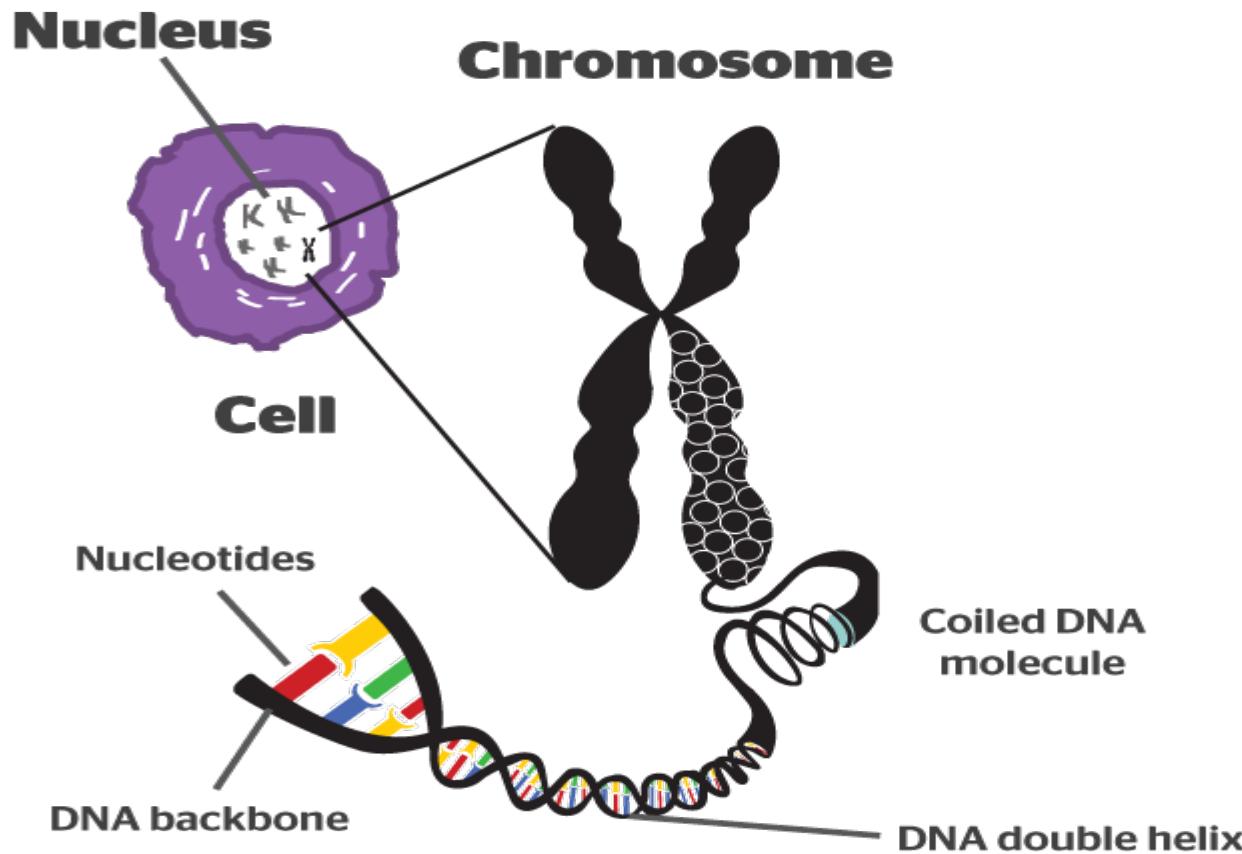
- A distinct sequence of nucleotides forming part of a chromosome, the order of which determines the type of protein to be synthesized.
- E.g. AUG is a start codon for Methionine and UGG for Tryptophan



CHROMOSOME

- A **chromosome** is a packaged and organized structure containing most of the DNA.
- DNA + Histones = Chromosome

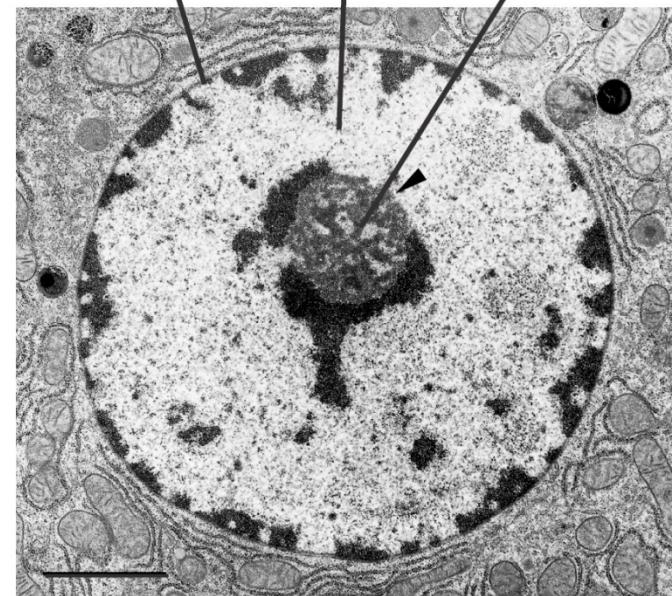




NUCLEOLUS

- Most cells have 2 or more
- Directs synthesis of RNA
- Forms ribosomes

Nuclear membrane Nucleus Nucleolus

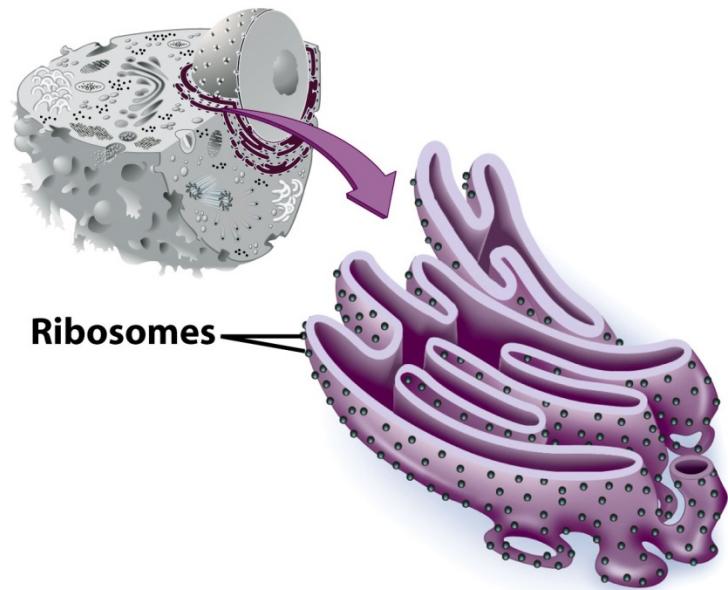


ENDOPLASMIC RETICULUM

- Helps move substances within cells
- Network of interconnected membranes
- Two types
 - Rough endoplasmic reticulum
 - Smooth endoplasmic reticulum

ROUGH ENDOPLASMIC RETICULUM

- Ribosomes attached to surface
 - Manufacture proteins
 - Not all ribosomes are attached to rough ER
- May modify proteins from ribosomes

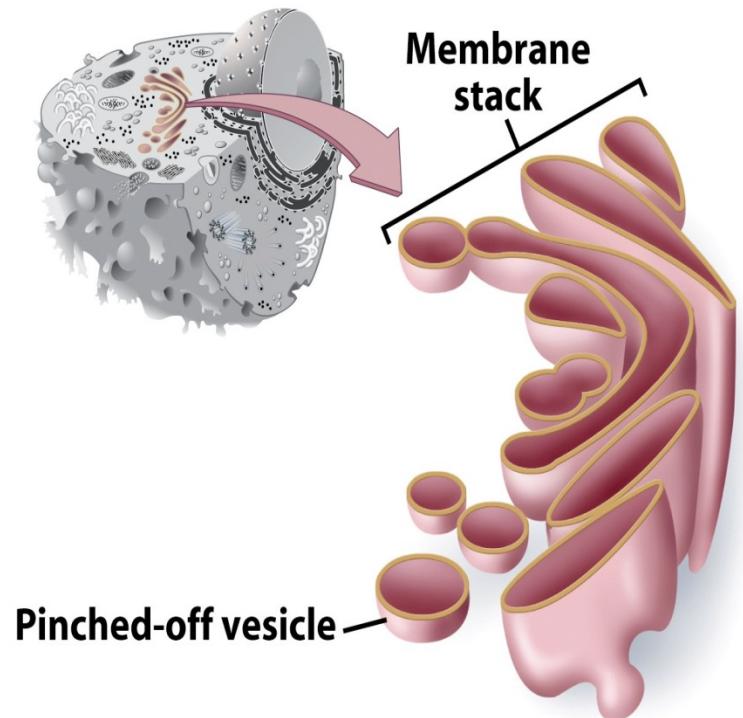


SMOOTH ENDOPLASMIC RETICULUM

- No attached ribosomes
- Has enzymes that help build molecules
 - Carbohydrates
 - Lipids
 - Detoxification of drugs

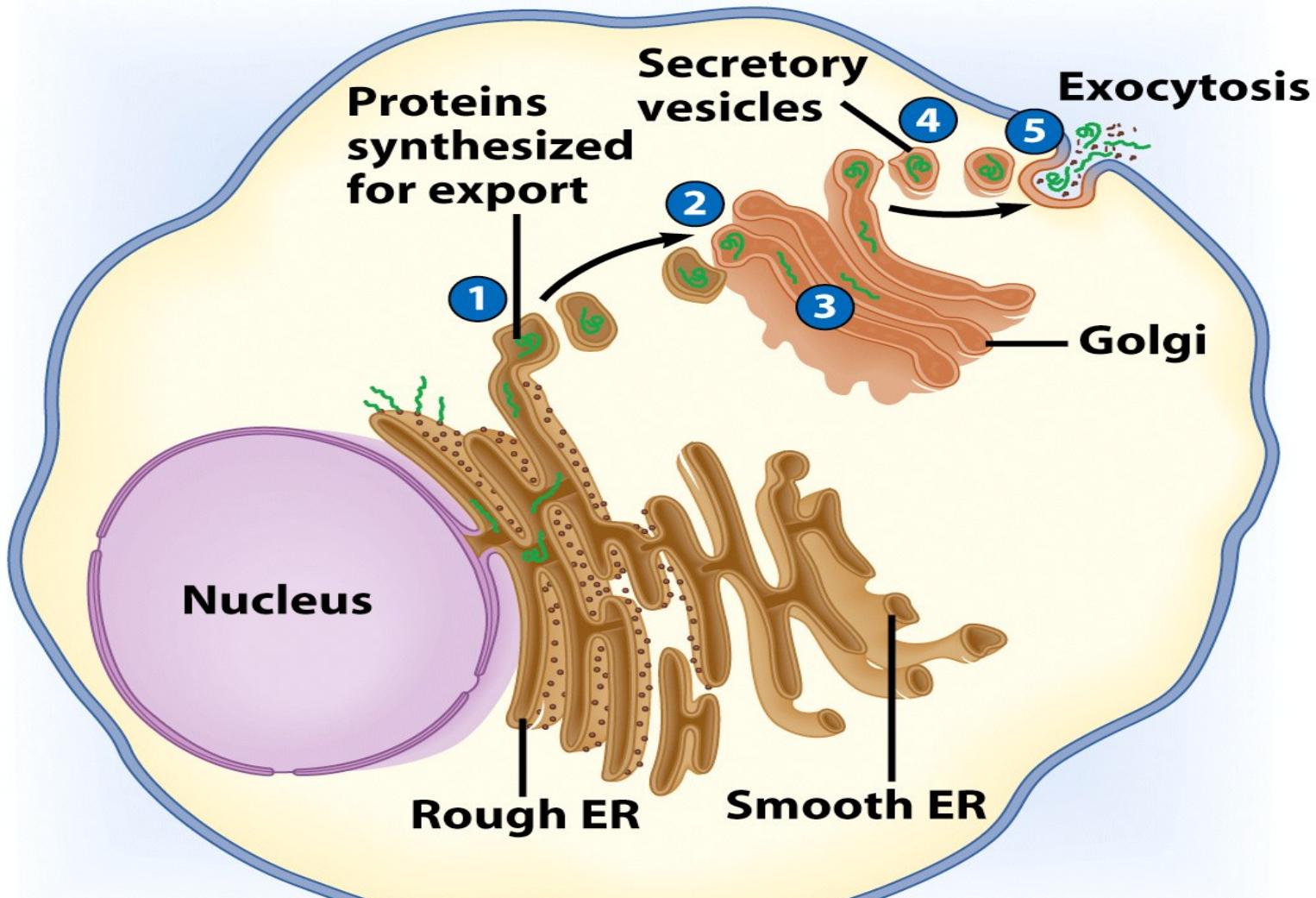
GOLGI APPARATUS

- Involved in synthesis of plant cell wall
- Packaging & shipping station of cell



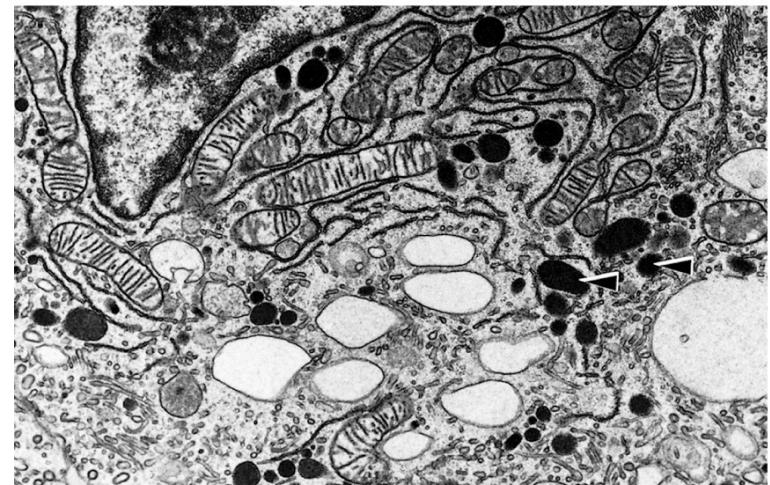
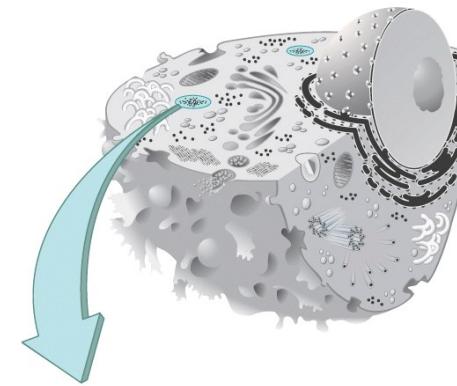
GOLGI APPARATUS FUNCTION

1. Molecules come in vesicles
2. Vesicles fuse with Golgi membrane
3. Molecules may be modified by Golgi
4. Molecules pinched-off in separate vesicle
5. Vesicle leaves Golgi apparatus
6. Vesicles may combine with plasma membrane
to secrete contents



LYSOSOMES

- Contain digestive enzymes
- Functions
 - Aid in cell renewal
 - Break down old cell parts
 - Digests invaders



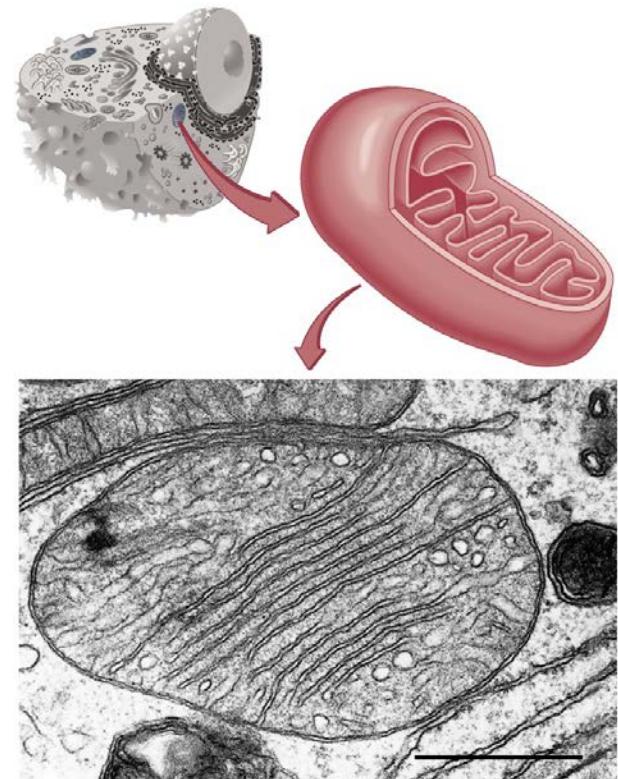
VACUOLES

- Membrane bound storage sacs
- More common in plants than animals
- Contents
 - Water
 - Food
 - wastes



MITOCHONDRIA

- Have their own DNA
- Bound by double membrane
- Break down fuel molecules (cellular respiration)
 - Glucose
 - Fatty acids
- Release energy
 - ATP



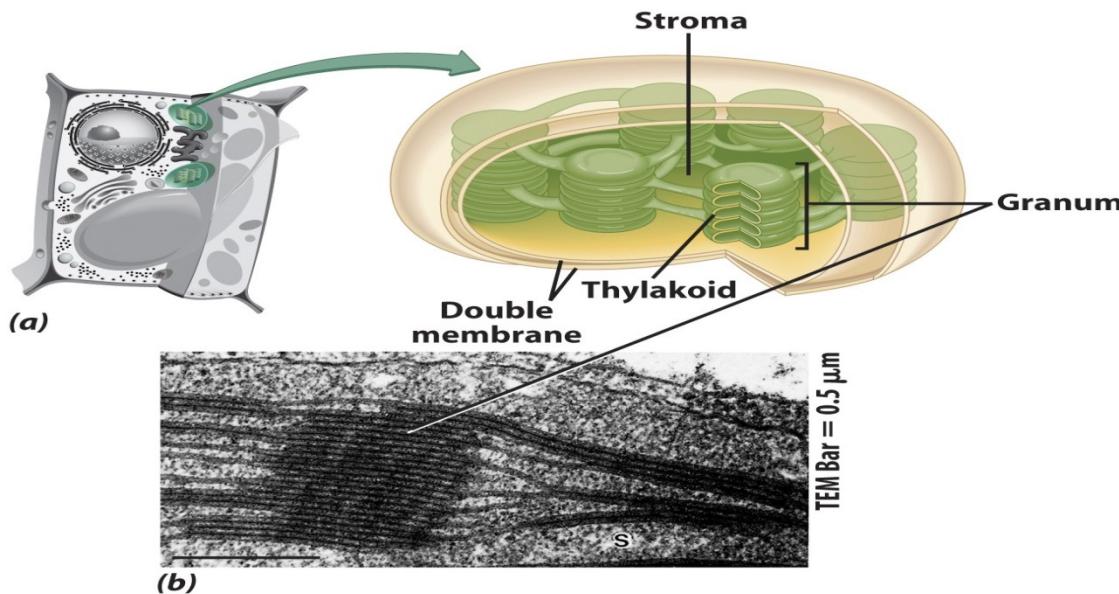
FUNCTIONS OF MITOCHONDRIA

The main function of mitochondria in aerobic cells is the **production of energy by synthesis of ATP**. However, mitochondria also have many other functions, including e.g.:

- Processing and storage of calcium ions (Ca^{2+}).
- Apoptosis, i.e. the process of programmed cell death
- Regulation of cellular metabolism
- Synthesis of certain steroids

CHLOROPLASTS

- Derived from photosynthetic bacteria
- Solar energy capturing organelle



PHOTOSYNTHESIS

- Takes place in the chloroplast
- Makes cellular food – glucose

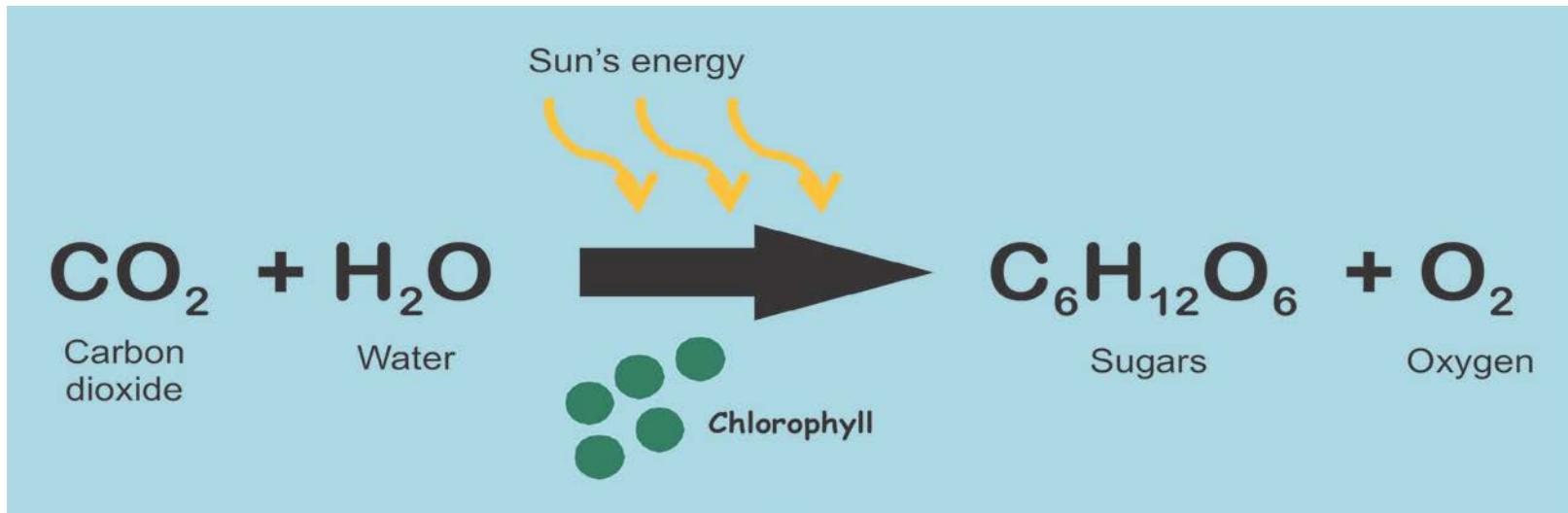


TABLE 5.2

A Comparison of Bacterial, Animal, and Plant Cells

	Bacterium	Animal	Plant
Exterior Structures			
Cell wall	Present (protein polysaccharide)	Absent	Present (cellulose)
Plasma membrane	Present	Present	Present
Flagella (cilia)	Sometimes present	Sometimes present	Sperm of a few species possess flagella
Interior Structures and Organelles			
Endoplasmic reticulum	Absent	Usually present	Usually 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 naked DNA	Multiple units, DNA associated with protein	Multiple units, DNA associated with protein
Ribosomes	Present	Present	Present
Lysosomes	Absent	Present	Present
Vacuoles	Absent	Absent or small	Usually a large single vacuole in mature cell

CELL PROCESSES

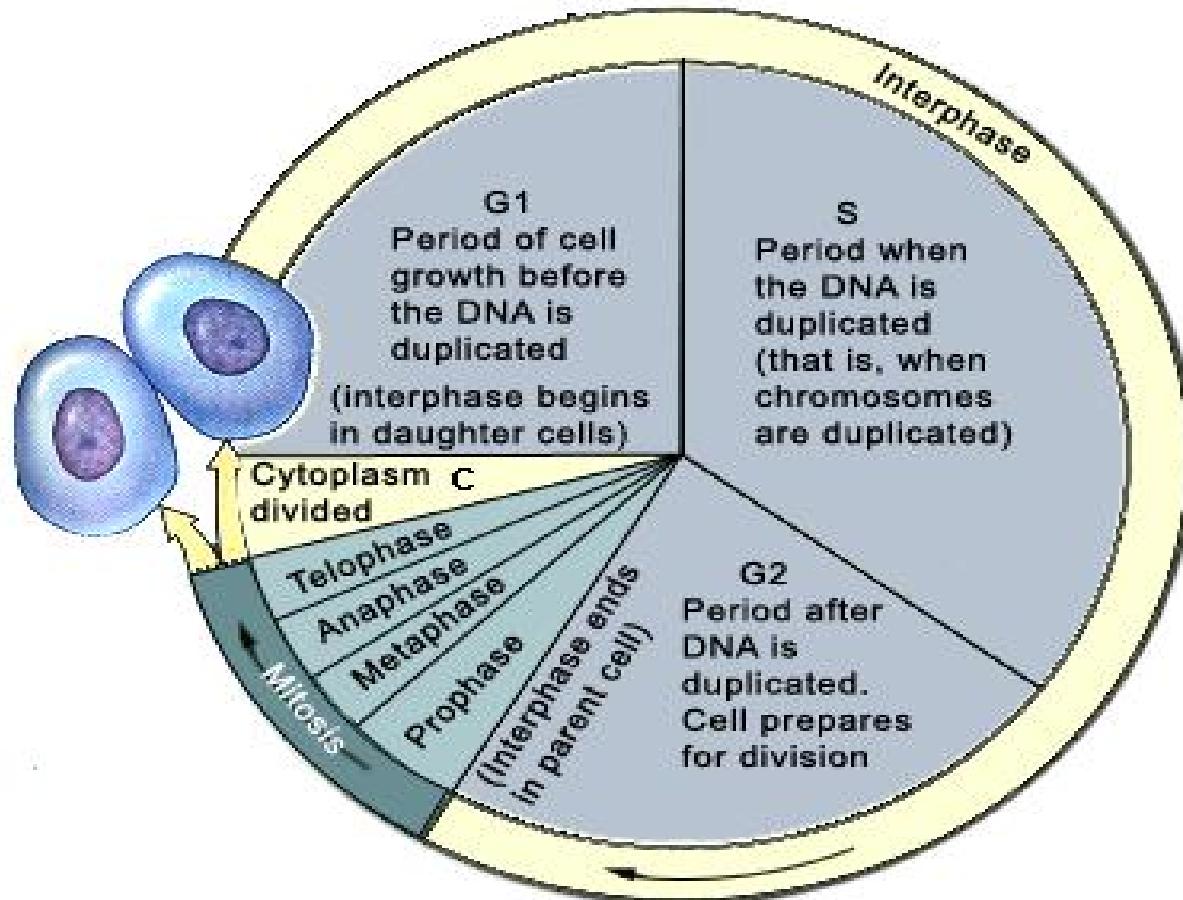
CELL PROCESSES

- Cell Division
- Protein Synthesis

CELL DIVISION

Cell division is the process by which a *parent cell* divides into two or more *daughter cells*. Cell division usually occurs as part of a larger cell cycle

CELL CYCLE



MITOSIS AND MEIOSIS

There are two distinct types of cell division

- **Mitosis:**
-division of **somatic** (body) cells

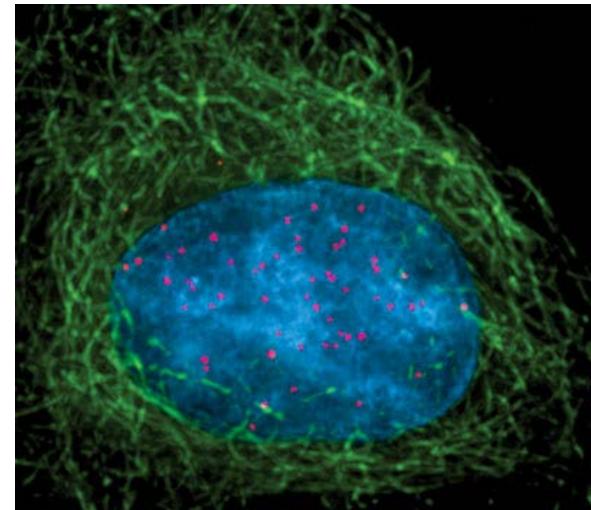
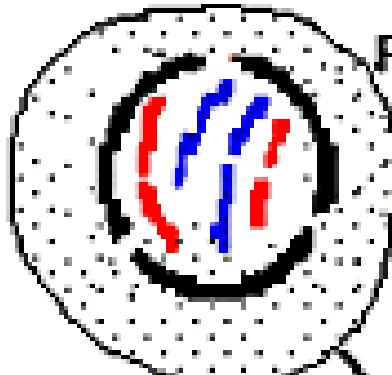
- **Meiosis**
-division of gametes (sex cells)

Mitosis

- Interphase
- Prophase
- Metaphase
- Anaphase
- Telophase

Interphase

- **Interesting** things happen!
 1. Cell preparing to divide
 2. Genetic material doubles

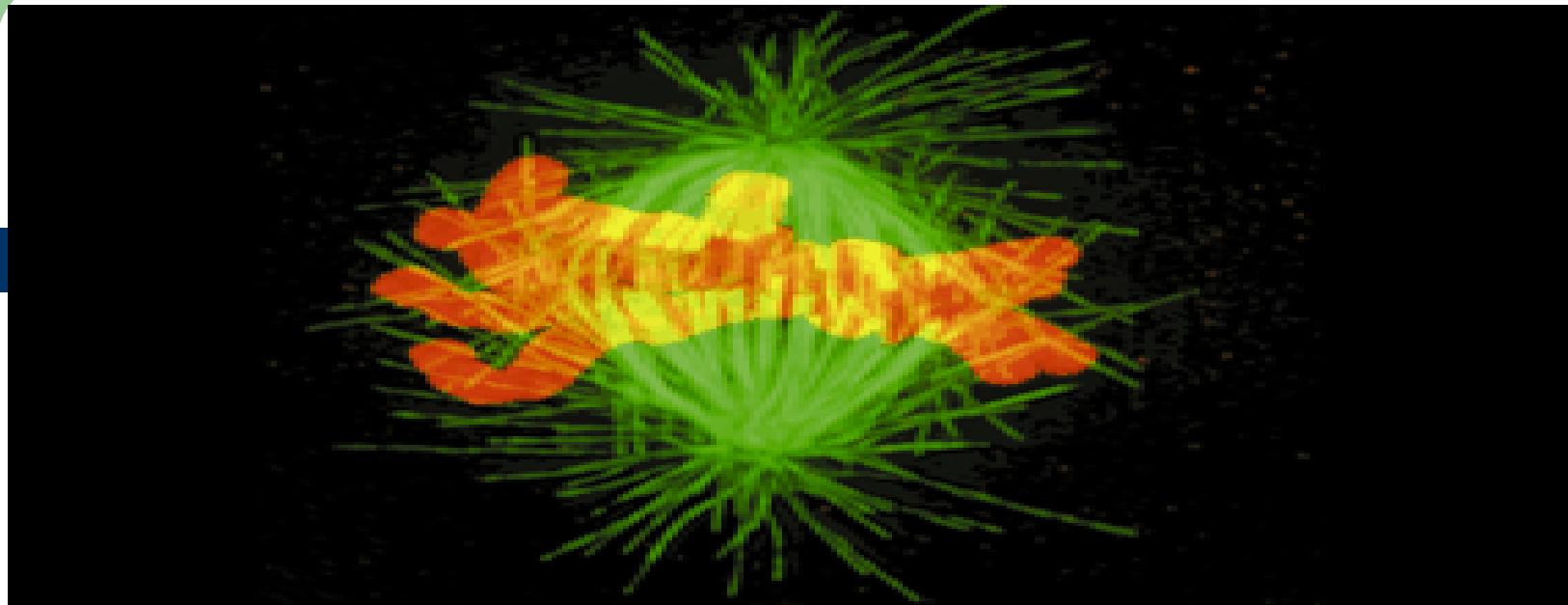


Prophase

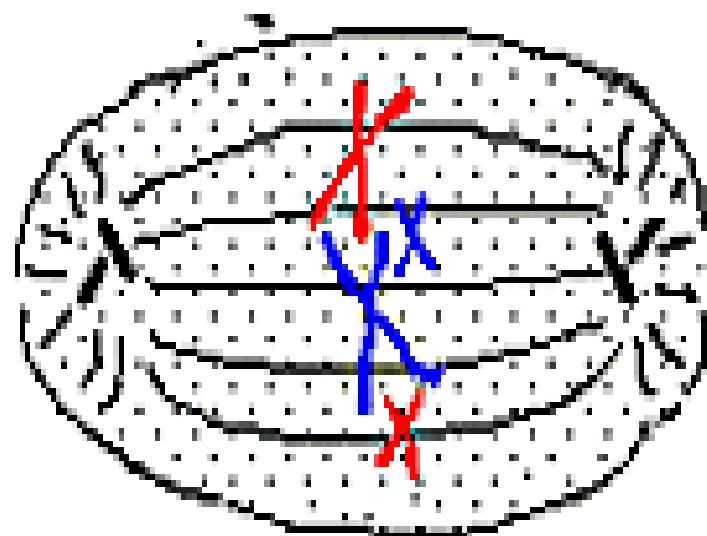
- Chromosome **pair up!**
- 1. Chromosomes thicken and shorten
 - become visible
 - 2 chromatids joined by a centromere**
- 2. **Centrioles** move to the opposite sides of the nucleus
- 3. **Nucleolus** disappears
- 4. Nuclear membrane disintegrate

Metaphase

- Chromosomes **meet in the middle!**
- 1. Chromosomes arrange at **equator** of cell
- 2. Become attached to **spindle fibres** by **centromeres**
- 3. **Homologous chromosomes do not associate**

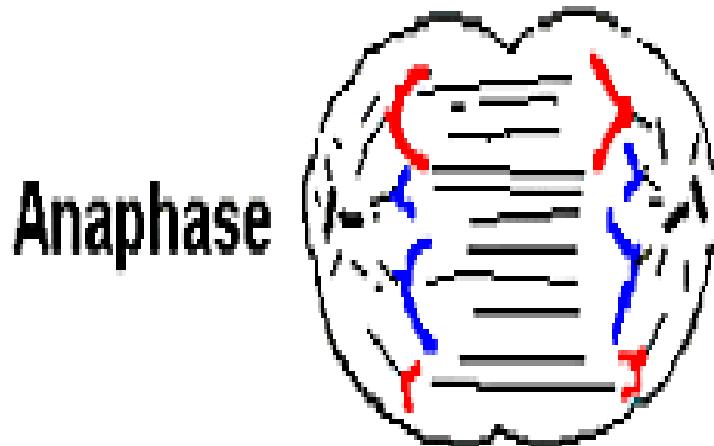


Metaphase

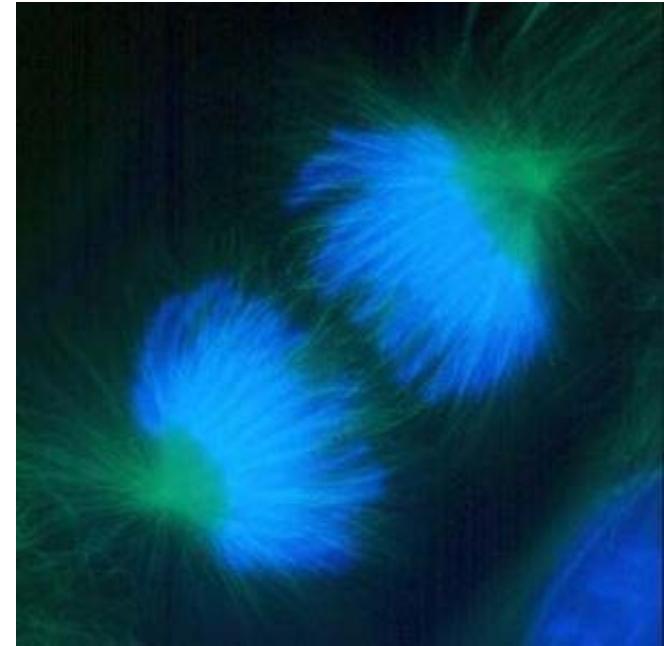


Anaphase

- Chromosomes get pulled **apart**
- 1. Spindle fibres contract pulling chromatids to the opposite poles of the cell



Anaphase

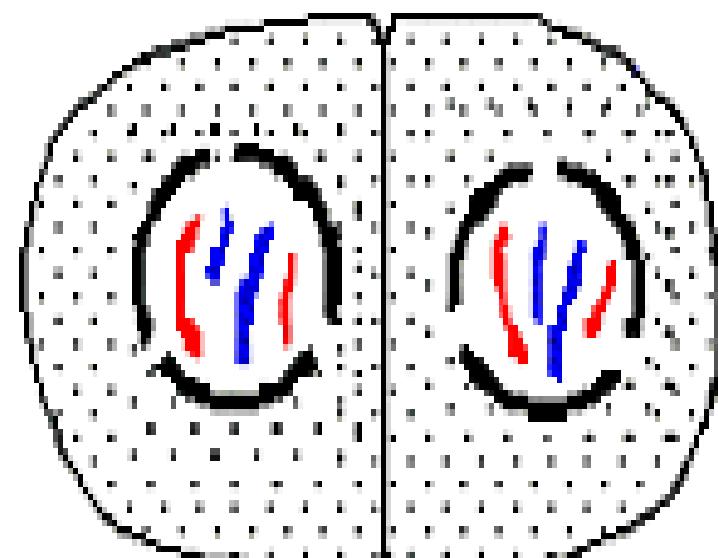


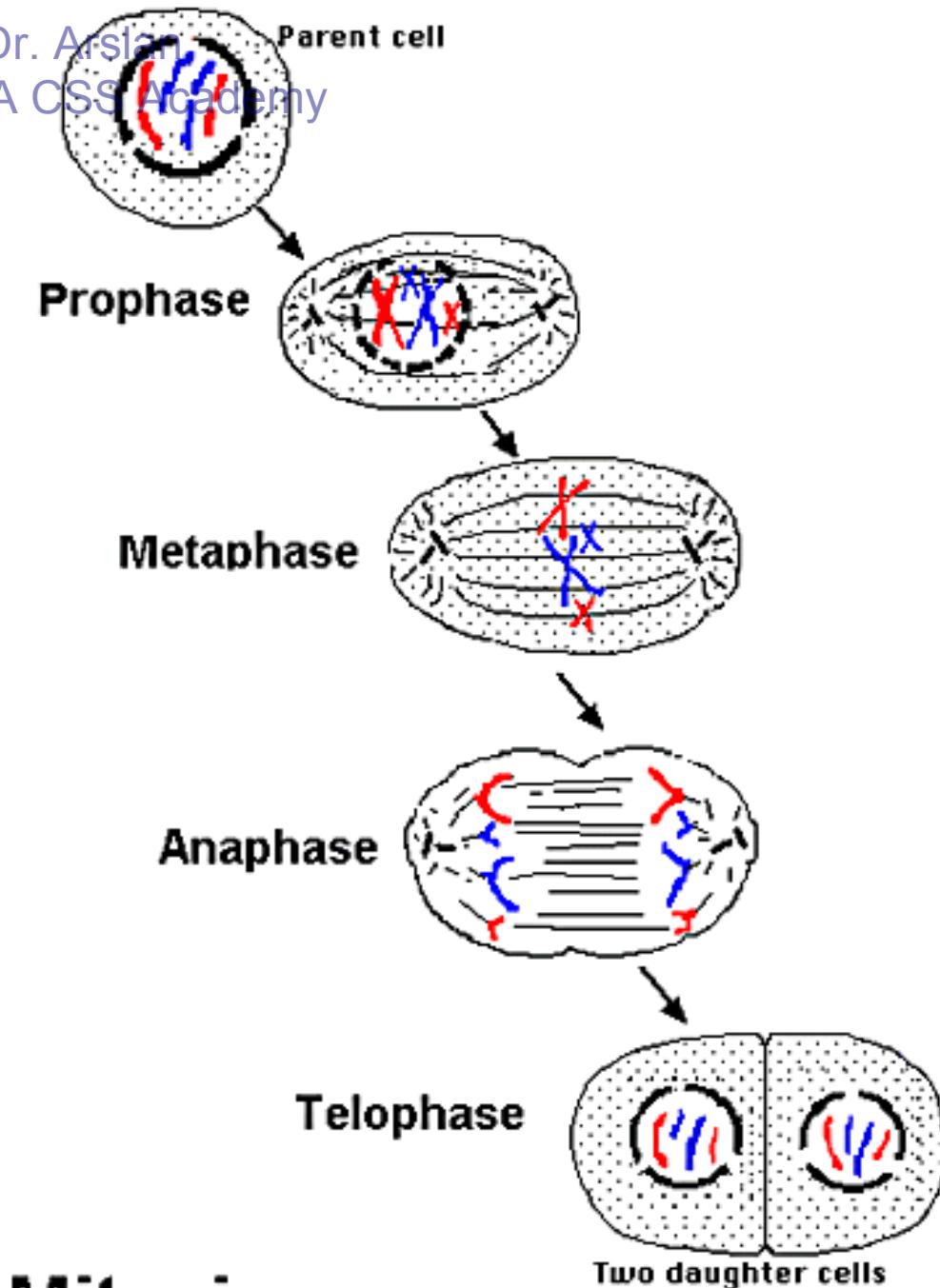
Telophase

- Now there are **two!**
 1. Chromosomes uncoil
 2. Spindle fibres disintegrate
 3. Centrioles replicate
 4. Nuclear membrane forms
 5. Cell divides



Telophase





Mitosis

MEIOSIS

- 4 daughter cells produced
- Each daughter cell has half the chromosomes of the parent
- 2 sets of cell division involved

PROTEIN SYNTHESIS

- Cells are capable of synthesizing new proteins from amino acid building blocks based on information encoded in DNA/RNA.

- Protein synthesis generally consists of two major steps
 - TRANSCRIPTION
 - TRANSLATION

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THE END