1st semester Histology Dr. Ramzi
2nd stage

Histology is the microscopic study of the structure of biological tissues using special staining techniques combined with light and electron microscopy.

Cytology is the study of the structural components of the cell.

Histology is the study of the integration of cells to form tissues and organs.

Cell : The cell is the basic structural unit of the tissues and organs of the body.

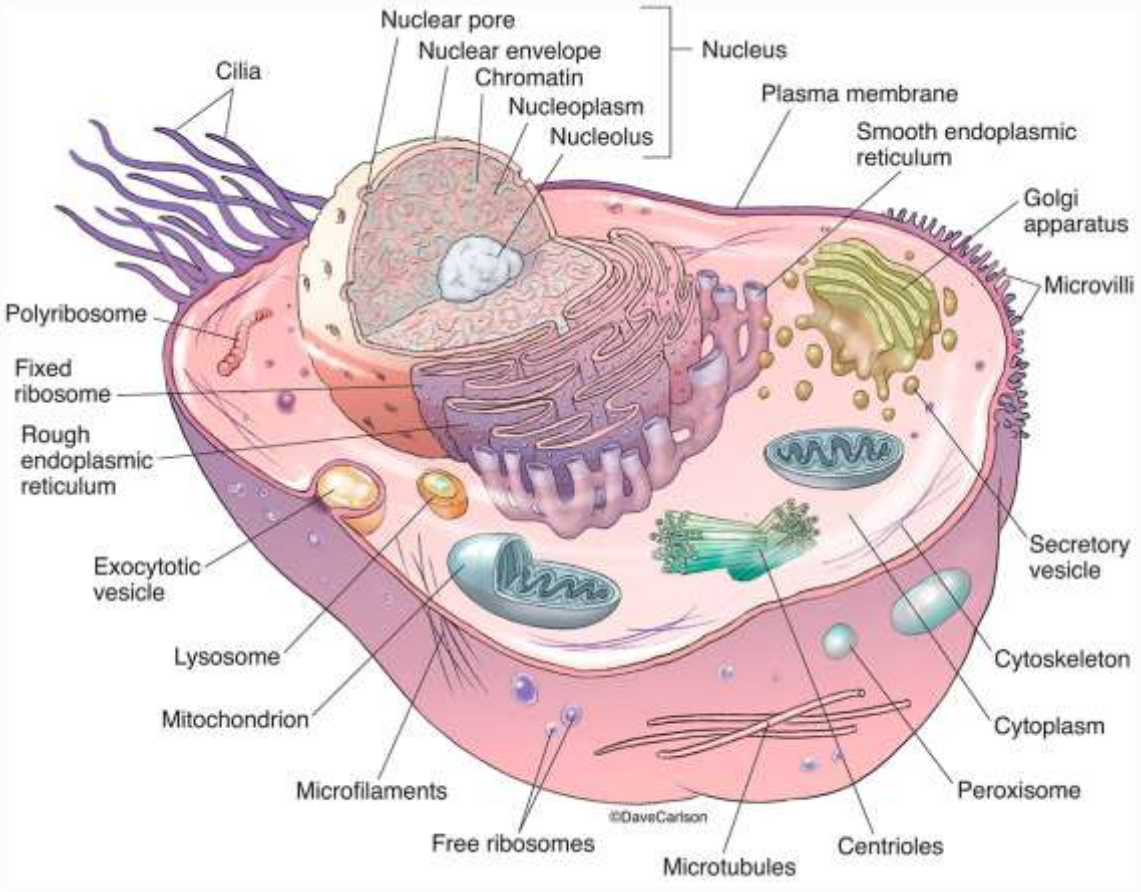
Various cell shapes include spherical, stellate, spindle, polyhedral, squamous, cuboidal or columnar.

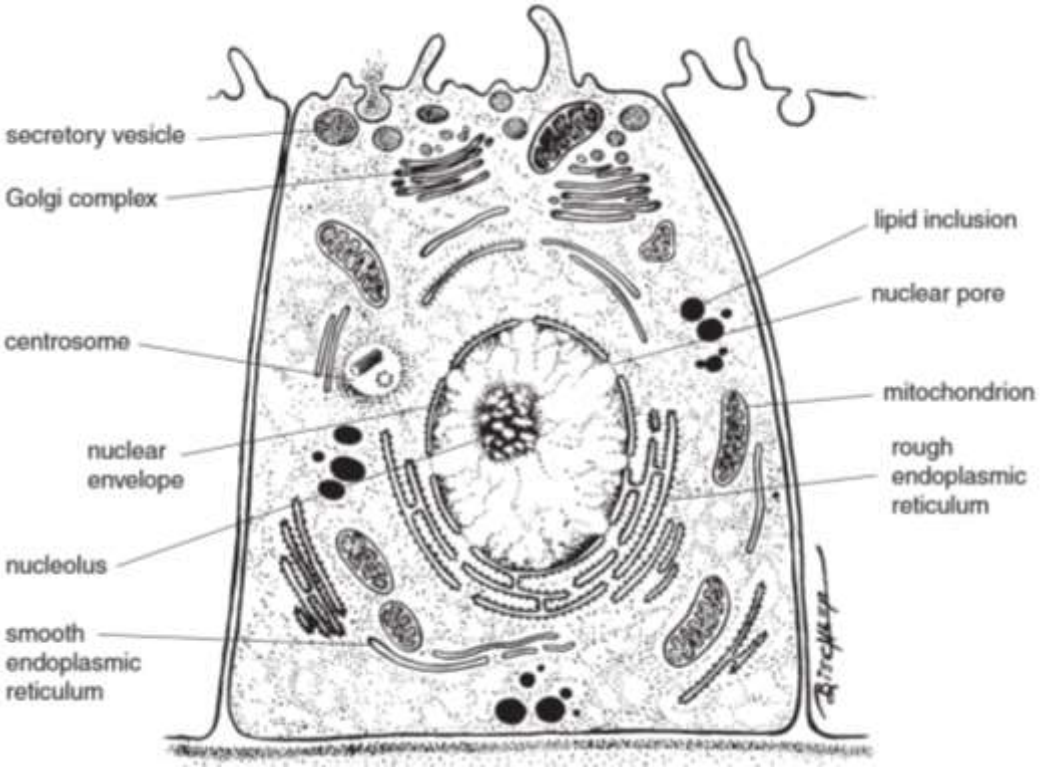
Cell sizes range from a single micrometre to several centimetres in diameter.

Comparison between Eukaryotic cell and Prokaryotic cell

Characters	Eukaryotic Cell	Prokaryotic Cell
Nucleus	Present	Absent
Number of chromosomes	More than one	One--but not true chromosome: Plasmids
Cell Type	Usually multicellular	Usually unicellular
True Membrane bound Nucleus	Present	Absent
Example	Animals and Plants	Bacteria
Genetic Recombination	Meiosis and fusion of gametes	Partial, undirectional transfers DNA
Microtubules	Present	Absent or rare
Endoplasmic reticulum	Present	Absent
Mitochondria	Present	Absent
Ribosomes	larger	smaller
Vesicles	Present	Present
Golgi apparatus	Present	Absent
Vacuoles	Present	Present
Cell size	10-100um	1-10um

Diagram of animal cell

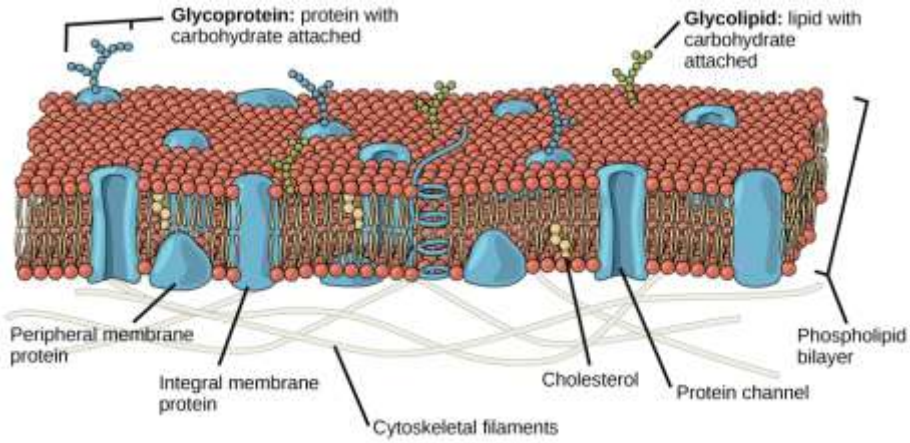


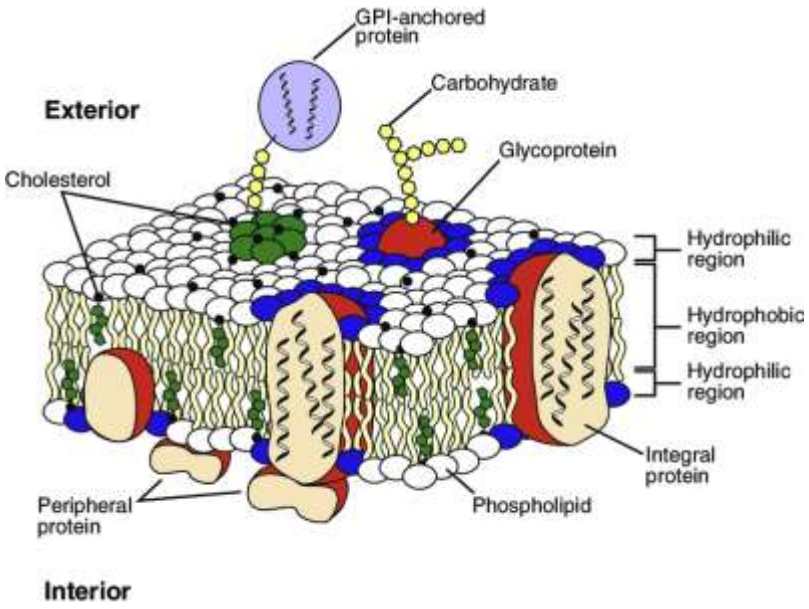


Cell Membrane

Each cell in the body is bounded by a cell membrane (plasmalemma) which provides a barrier and controls movement of substances into and out of the cell.

1. The cell membrane is a lipid bilayer with embedded proteins.
2. Integral proteins are tightly bound within the membrane and often extend across it as transmembrane proteins.
3. These transmembrane proteins frequently form ion channels or carrier proteins that transport molecules across the cell membrane.
4. Peripheral proteins, located on the cytoplasmic surface of the cell membrane, are more loosely bound to other membrane proteins or lipids.
5. A glycocalyx, comprised of carbohydrates on the outer surface of the cell membrane, functions in cell recognition, adhesion, absorption and antigenicity.





1. More than one nucleus can be present in a cell.

2. Within this spherical structure, deoxyribonucleic acid (DNA) is transcribed and ribonucleic acid (RNA) is synthesized.

3. The surrounding nuclear envelope is formed by two adjacent bilaminar lipid membranes with embedded proteins.

4. Scattered nuclear pores, which perforate the envelope, regulate passage of substances between the cytoplasm and the nucleus. Chromatin, primarily comprised of DNA, is located within the nucleus.

5. The inert form of chromatin, heterochromatin, stains intensely while euchromatin, which is actively involved in protein production, stains lightly.

6. Nuclear chromatin condenses to form chromosomes during cell division.

7. Within the nucleus is the nucleolus that is the site of rRNA synthesis.

8. The number and size of cell nucleoli are related to the amount of protein synthesis occurring within the cell.

Cytoplasm

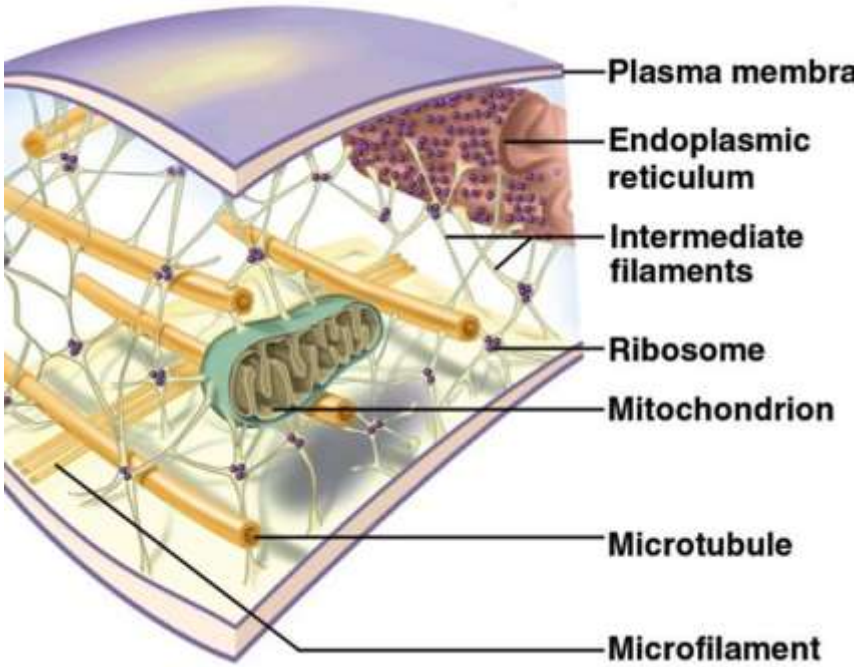
The cytoplasm, which surrounds the nucleus and the organelles of the cell,

varies in composition of water, protein, carbohydrates and salts.

A cytoskeleton of

1. Microfilaments
2. Intermediate filaments
3. microtubules

These above provides structure for cell shape and movement



The cell organelles are:

Golgi bodies, endoplasmic reticulum, lysosomes, peroxisomes, microtubules, filaments, chloroplast.

The cell inclusions are:

pigment granules, fat droplets, secretory products, glycogen, lipids and crystalline inclusions.

Cell organelles Function

Nucleus It stores genetic material (DNA or RNA) of the cell. Mitochondrion It involves in energy production.

Golgi apparatus It involves in protein modification and export.

Endoplasmic Reticulum (ER) It involves in lipid production, protein production, and detoxification.

Lysosomes It contains various hydrolytic enzymes (recycling and security).

Chloroplast It involves in photosynthesis (glucose production).

Cytoskeleton It provides cell stability and helps in movement.

Microtubules It helps in cell movement.

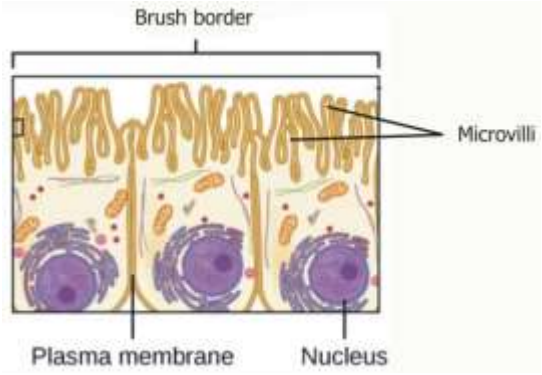
Intermediate Filaments It provides structural stability to the nuclear envelope.

Microfilaments It helps in cell movement.

***Cell organelles are living structure of the cell while cell inclusions are non living material of the cell. Cell organelles form metabolic machinery of the cell while cell inclusions are products of metabolism.

Cell surface modifications:

1. **Microvilli** are finger like projections of the cell membrane that increase the surface area of absorptive cells located in the lining of digestive tract.

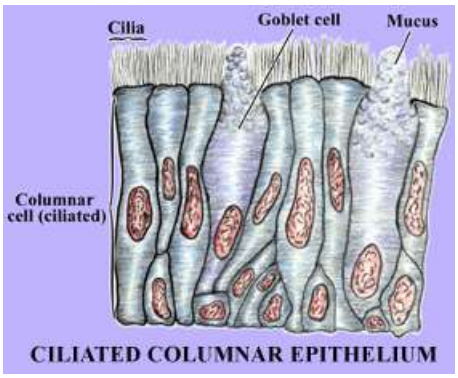


2. **Microfilaments** constitute the core structure of the microvilli.

3. **Stereocilia** represents a long variant of microvilli, limited to the epididymis and ear

*****Both microvilli and stereocilia are nonmotile.

4. **Ciliated cells** have numerous, 2- to 10-µm long motile cilia, which are on the cell surface. In the respiratory tract, cilia transport mucus and particles in an oral direction.



5. **Flagellated cells**, like spermatozoa, normally have a single flagellum. The structure of cilia and flagella is very similar . Both cilia and flagella are delimited by the cell membrane and contain a central region (axoneme).

6. Another cilium-like structure, the **kinocilium**, is found in the ear.

Cell Cycle

The cell cycle of dividing cells includes **interphase**, **mitosis**, and **cytokinesis**.

During interphase, the cell undergoes growth and synthesis of DNA and RNA.

1. Interphase is divided into **Gap1**, **S** and **Gap2** phases.

2. Mitosis are: **prophase**, **prometaphase**, **metaphase**, **anaphase**, and **telophase**.

3. Cytokinesis, or division of the cell cytoplasm, results in two daughter cells.

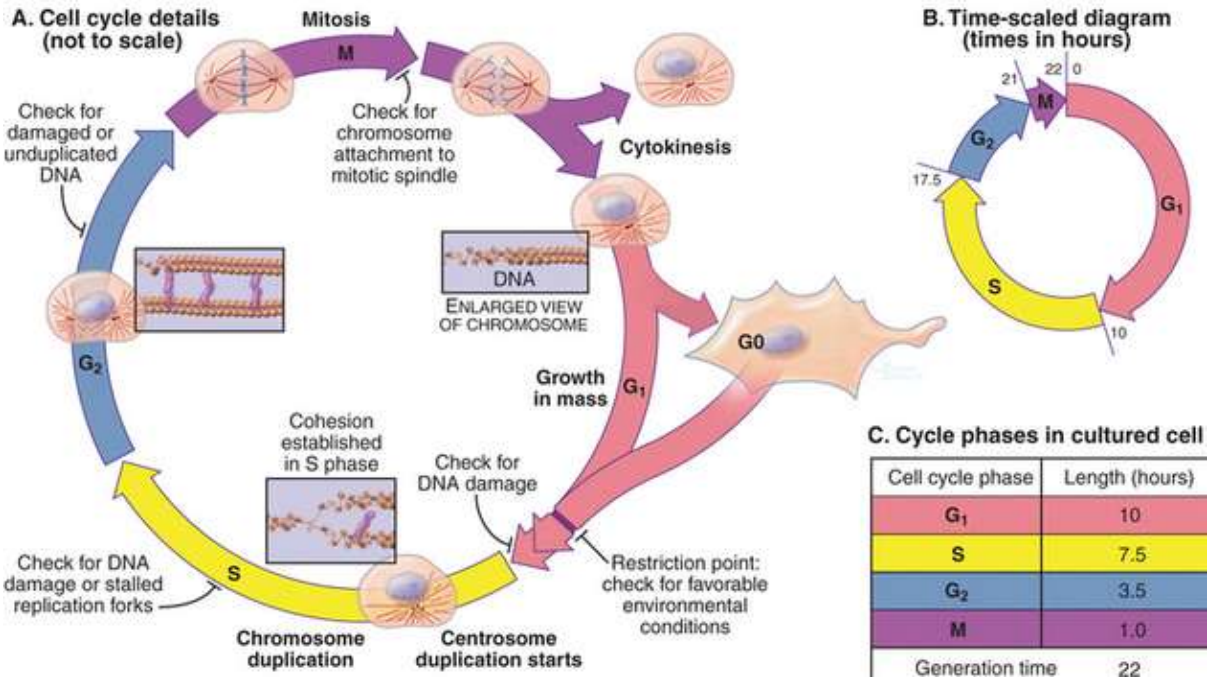
***Reduction of chromosome numbers to half the diploid state occurs during **meiosis**. * **Apoptosis** is programmed cell death.

***Most cells in the body are capable of division, but some cells, such as neurons, do not divide once cellular maturity is reached.

***The cycle of dividing cells includes interphase, mitosis and cytokinesis.

***Initiation of the cell cycle is governed by proteins known as cyclins and associated cyclin-dependent kinases (CDKs).

Diagram of cell Cycle



C. Cycle phases in cultured cell

Cell cycle phase	Length (hours)
G_1	10
S	7.5
G_2	3.5
M	1.0
Generation time	22

The Cell Cycle are:

1. **Interphase**:

During interphase, the cell undergoes growth, RNA synthesis, and DNA synthesis.

A. **Gap 1** (G1) of interphase is the time period when proteins necessary for DNA replication and enzymes are synthesized. As a result of this synthesis, the cell increases in size.

B. The cell continues into **S phase** during which nucleoproteins and histones are assembled into DNA. DNA is replicated into pairs of chromosomes in preparation for future cell division. The chromosomal pairs are comprised of two sister chromatids joined at a centromere.

C. During **Gap 2** (G2) phase, the RNA and proteins needed for cell division are synthesized.

2. Mitosis

Mitosis is the segregation of chromosomes and the formation of two separate nuclei within a dividing cell.

A. **The prophase** portion of mitosis begins with

   a. appearance of condensed chromosomes and the dispersion of the nucleolus.

   b. In the cytoplasm, the cytoskeleton of the cell disassembles followed by the formation of the mitotic spindle.

   c. Two centrosomes, comprised of centrioles and matrix, are the anchor points for the microtubules of the mitotic spindle apparatus.

B. **Prometaphase,** the nuclear envelope disappears as prometaphase begins. Kinetochores on the centromere of each chromosome attach to the microtubules of the mitotic spindle and tension is exerted on the chromosome.

C. **Metaphase,** the chromosomes are aligned on the equatorial plane of the dividing cell by the paired microtubules.

D. **Anaphase,** sister chromatids separate quickly during anaphase. The resulting individual chromatids migrate to opposite poles of the cell.

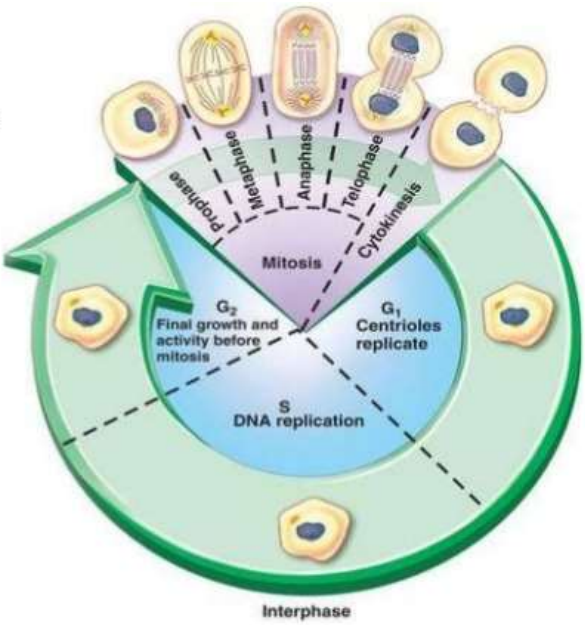
E. **Telephase,** the nuclear envelopes and nucleoli of the new cells begin to reappear during telophase. Kinetochore microtubules disappear and chromosomes uncoil to form heterochromatin and euchromatin.

3 stages of cell cycle:

Interphase

Mitosis (division of nuclear material)

Cytokinesis (division of cytoplasm)



3. Cytokinesis

a. **During late anaphase, a cleavage furrow forms in the plasma membrane at the site where the cell will divide.**

b. **At the end of telophase, the cell undergoes cytokinesis resulting in two separate but identical daughter cells.**