# BIOLOGY

## Introduction to biology:

**Biology is the science that studies living organisms and their interactions with one another and their environments.**

**Biology is very broad and includes many branches and sub disciplines. Examples include molecular biology, microbiology, neurobiology, zoology, and botany, among others.**

**The Chemical Foundation Of Life:**

**Elements in various combinations comprise all matter, including living things. Some of the most abundant elements in living organisms include carbon, hydrogen, nitrogen, oxygen, sulfur, and phosphorus. These form the nucleic acids, proteins, carbohydrates, and lipids that are the fundamental components of living matter.**

**The four elements common to all living organisms are: oxygen (O), carbon (C), hydrogen (H), and nitrogen (N).**

Table 1. Approximate Percentage of Elements in Living Organisms (Humans) Compared to the Non-living World

| Element | Life (Humans) | Atmosphere | Earth's Crust |
|---|---|---|---|
| Oxygen (O) | %65 | %21 | %46 |
| Carbon (C) | %18 | trace | trace |
| Hydrogen (H) | %10 | trace | %0.1 |
| Nitrogen (N) | %3 | %78 | trace |

**All living organisms share several key properties such as:**

**1. Order.**

**2. Sensitivity or Response to Stimuli.**

**3. Reproduction.**

**4. Growth and Development.**

**5. Regulation.**

**6. Homeostasis.**

**7. Energy Processing.**

## 1. Order

**Organisms are highly organized, coordinated structures that consist of one or more cells. Even very simple, single-celled organisms are remarkably complex: inside each cell, atoms make up molecules; these in turn make up cell organelles and other cellular inclusions. In multicellular organisms ,similar cells form tissues. Tissues, in turn, collaborate to make organs (body structures with a distinct function). Organs work together to form organ systems.**

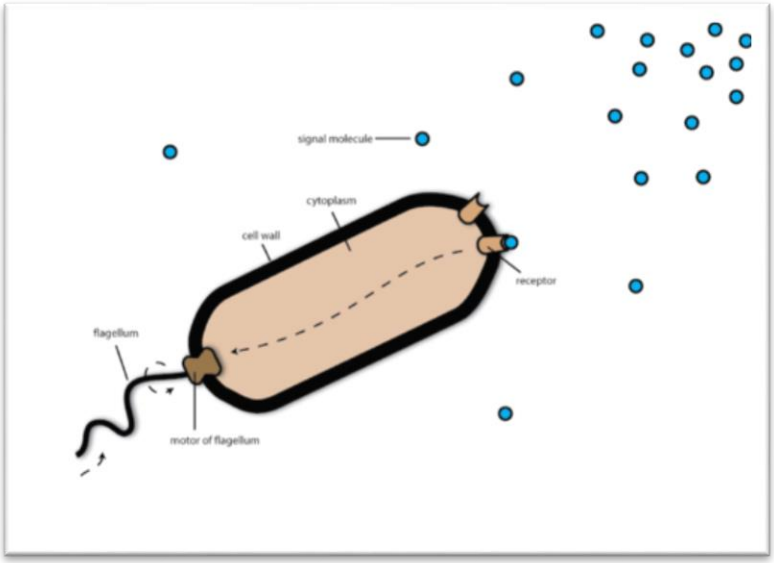
## 2. Sensitivity or Response to Stimuli

**Organisms respond to diverse stimuli. For example, plants can bend toward a source of light, climb on fences and walls, or respond to touch .Movement toward a stimulus is considered a positive response, while movement away from a stimulus is considered a negative response**

### Movement

- A **taxis** is a more or less automatic, *oriented* movement toward or away from a stimulus.
- Examples of taxis in animals include:
  - Phototaxis = movement toward/away from light
  - Phonotaxis = …sound
  - Chemotaxis = …a chemical
  - Anemotaxis = …wind
  - Trophotaxis = …food
  - Geotaxis = …earth or gravity
  - Magnetotaxis = …a magnetic direction
  - Klinotaxis = …a slope
  - Rheotaxis = …water currents

**Even tiny bacteria can move toward or away from chemicals (a process called *chemotaxis) or light (phototaxis).***




### 3. Reproduction

**Single-celled organisms reproduce by first duplicating their DNA, and then dividing it equally as the cell prepares to divide to form two new cells.**

**Multicellular organisms often produce specialized reproductive germline cells that will form new individuals. When reproduction occurs, genes containing DNA are passed along to an organism‘s offspring. These genes ensure that the offspring will belong to the same species and will have similar characteristics, such as size and shape.**

### 4. Growth and Development

**Organisms grow and develop following specific instructions coded for by their genes. These genes provide instructions that will direct cellular growth and development, ensuring that a species‘ young will grow up to exhibit many of the same characteristics as its parents.**

### 5. Regulation

**Even the smallest organisms are complex and require multiple regulatory mechanisms to coordinate internal functions, respond to stimuli, and cope with environmental stresses.**

**Two examples of internal functions regulated in an organism are nutrient transport and blood flow.**

## 6. Homeostasis

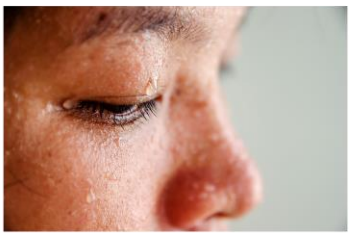
**In order to function properly, cells need to have appropriate conditions such as proper temperature, pH, and appropriate concentration of diverse chemicals. These conditions may, however, change from one moment to the next.**

**Organisms are able to maintain internal conditions within a narrow range almost constantly, despite environmental changes, through homeostasis.**

**Homeostasis (literally, —steady state):The ability of an organism to maintain constant internal conditions.**

**Polar bears and other mammals living in ice-covered regions maintain their body temperature by generating heat and reducing heat loss through thick fur and a dense layer of fat under their skin.**

**perspiration in humans**



**panting in dogs**

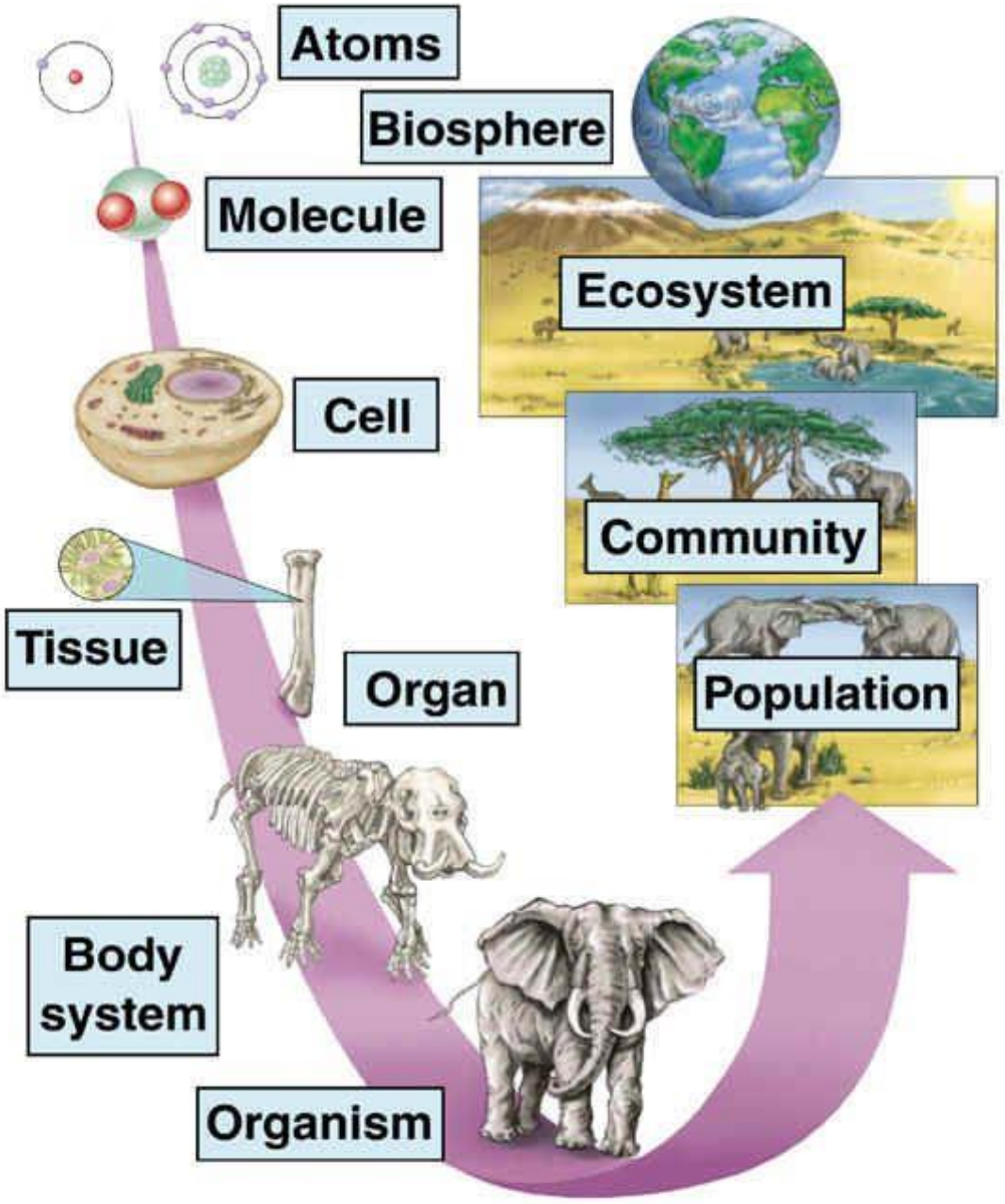
## 7. Energy Processing

**All organisms use a source of energy for their metabolic activities. Some organisms capture energy from the sun and convert it into chemical energy in food; others use chemical energy in molecules they take in as food.**

**Levels of Organization of Living Things:**

**Living things are highly organized parts of a hierarchy that includes atoms, molecules, organelles, cells, tissues, organs, and organ systems. Organisms, in turn, are grouped as populations, communities, ecosystems, and the biosphere.**

Raven/Berg, Environment, 3/e
Figure 4.1

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**BIOLOGICAL MACROMOLECULES**

**Food provides the body with the nutrients it needs to survive. Many of these critical nutrients are biological macromolecules, or large molecules, necessary for life.**

**These macromolecules (polymers) are built from different combinations of smaller organic molecules (monomers).**

**There are four major classes of biological macromolecules (carbohydrates, lipids, proteins, and nucleic acids); is an important cell component and performs a wide array of functions.**

**Some proteins types and functions:**

| Type | Examples | Functions |
|---|---|---|
| Digestive Enzymes | Amylase, lipase, pepsin, trypsin | Help in digestion of food by catabolizing nutrients into monomeric units |
| Transport | Hemoglobin, albumin | Carry substances in the blood or lymph throughout the body |
| Structural | Actin, tubulin, keratin | Construct different structures, like the cytoskeleton |
| Hormones | Insulin, thyroxine | Coordinate the activity of different body systems |
| Defense | Immunoglobulins | Protect the body from foreign pathogens |
| Contractile | Actin, myosin | Effect muscle contraction |
| Storage | Legume storage proteins, egg white (albumin) | Provide nourishment in early development of the embryo and the seedling |

## Dehydration Synthesis

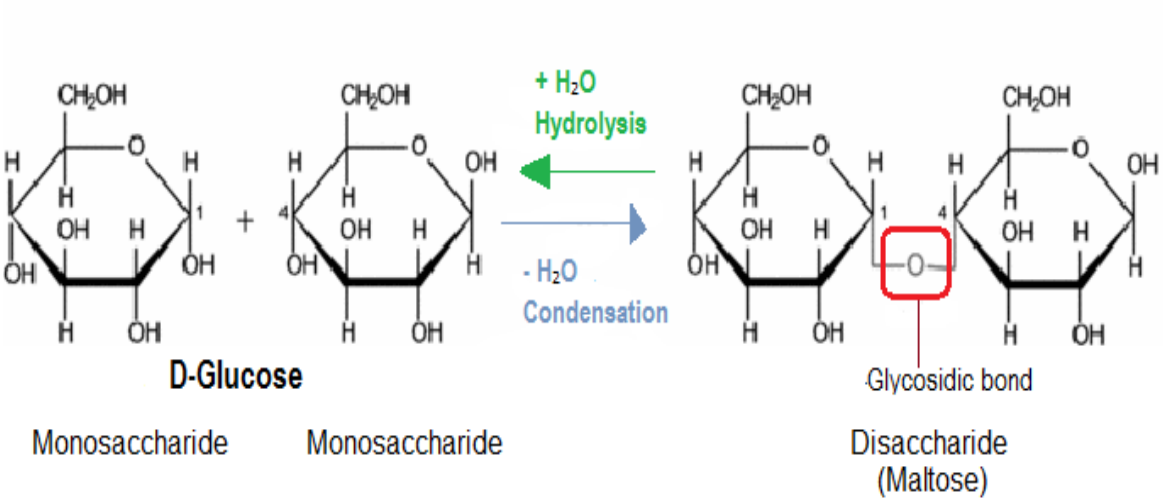
**Most macromolecules are made from single subunits, or building blocks, called monomers.**

**The monomers combine with each other using covalent bonds to form larger molecules known as polymers .**

**In doing so, monomers release water molecules as byproducts. This type of reaction is known as dehydration synthesis, which means to put together while losing water.**

## Hydrolysis

**Polymers are broken down into monomers in a process known as hydrolysis, which means to split water, a reaction in which a water molecule is used during the breakdown . During these reactions, the polymer is broken into two components: one part gains a hydrogen atom (H+) and the other gains a hydroxyl molecule (OH–) from a split water molecule.**

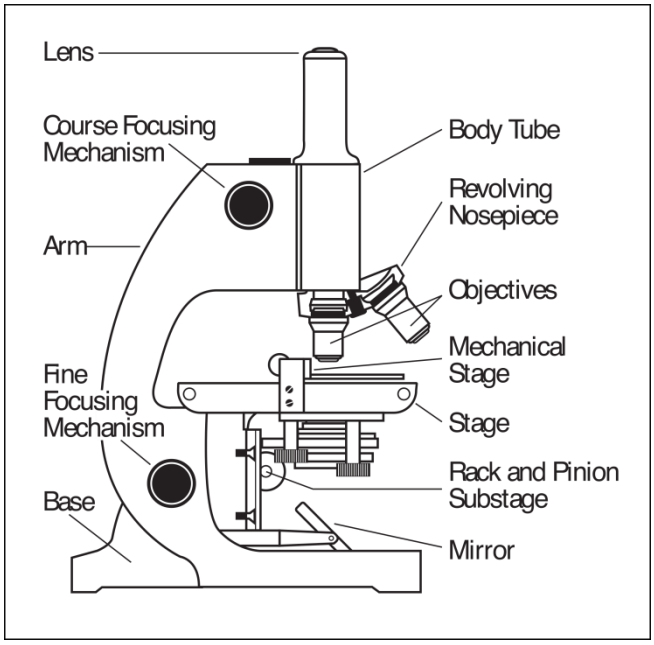


# CYTOLOGY

**We all know that the Animal cell is a unit of composition and function in living organisms, and the cell is linked to the discovery of the microscope , which invented by (Levinhock in 1591).**

**Anthony Levinhock became more involved in science and with his new improved microscope was able to see things that no man had ever seen before. He saw bacteria, yeast, blood cells and many tiny animals swimming about in a drop of water.**

**Microscopes (micro = small )(scope = to look at) A microscope is an instrument that magnifies an object.**




**CELL STRUCTURE:**

**A cell is the smallest unit of a living thing. A living thing, whether made of one cell (like bacteria) or many cells (like a human), is called an organism. Thus, cells are the basic building blocks of all organisms. Cells vary in size. With few exceptions, individual cells cannot be seen with the naked eye, so scientists use microscopes to study them.**

**Cell Theory:**

**botanist Matthias Schleiden and zoologist Theodor Schwann were studying tissues and proposed the unified cell theory, which states that:**

**-All living things are composed of one or more cells.**

**-The cell is the basic unit of life.**

**-New cells arise from existing cells.**

**The basic structure of the cell:**

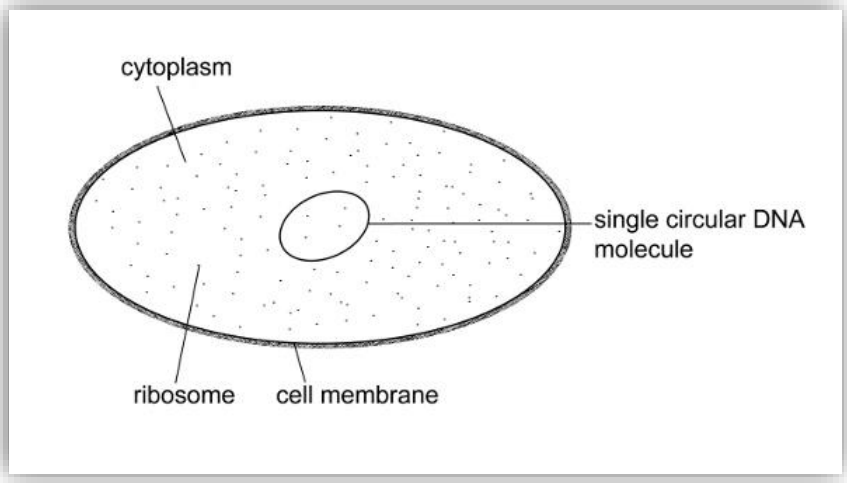
**All cells share four common components:**

**1- A plasma membrane, an outer covering that separates the cell‘s interior from its surrounding environment.**

**2- Cytoplasm, consisting of a jelly-like cytosol within the cell in which other cellular components are found.**

**3- DNA, the genetic material of the cell.**

**4- Ribosomes, which synthesize proteins.**

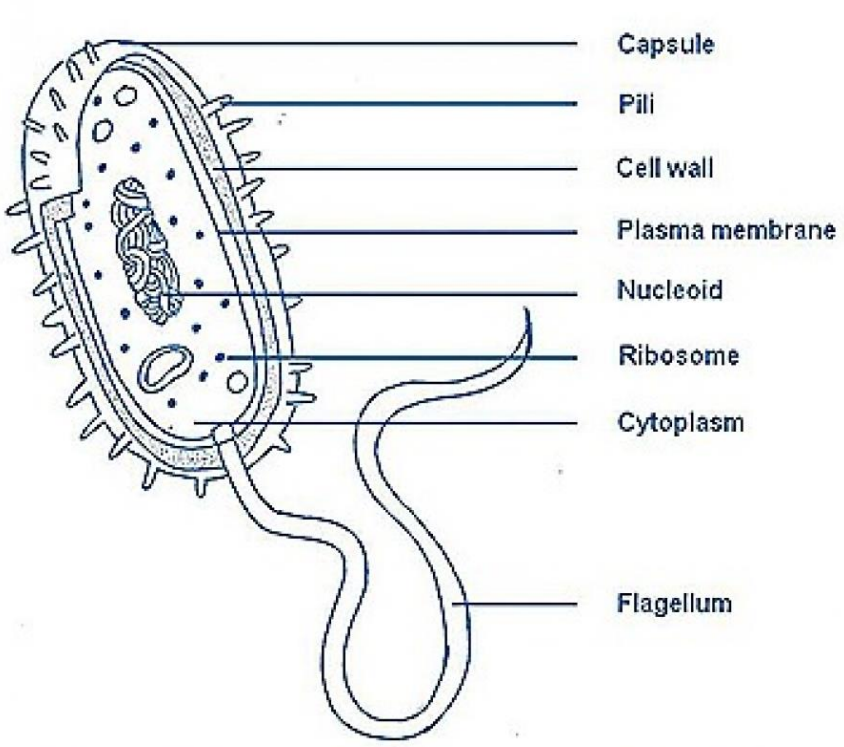



**Main types of cells:**

**1 - Eukaryotic cells.  2 - Prokaryotic cells.**

## Prokaryotic Cells

**A prokaryote is a simple, mostly single-celled (unicellular) organism that lacks a nucleus, or any other membrane-bound organelle.Prokaryotic DNA is found in a central part of the cell the nucleoid.**




**PROKARYOTIC CELL**

**Most prokaryotes have a peptidoglycan cell wall and many have a polysaccharide capsule.**

**The cell wall acts as an extra layer of protection, helps the cell maintain its shape, and prevents dehydration.**

**The capsule enables the cell to attach to surfaces in its environment.**

**Some prokaryotes have flagella, pili. Flagella are used for locomotion. Pili are used to exchange genetic material during a type of reproduction called conjugation.**

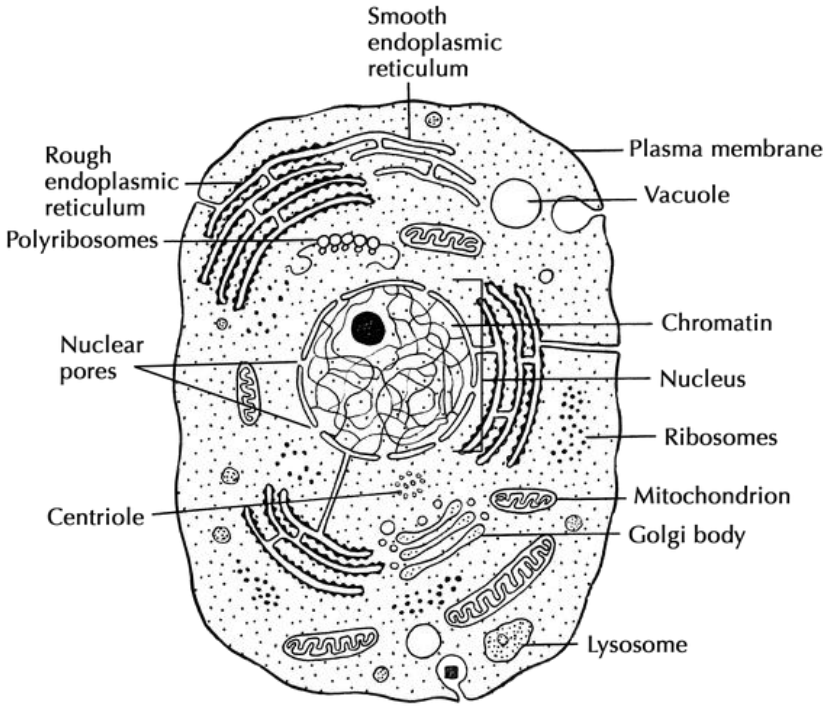
## Eukaryotic Cells

**Unlike prokaryotic cells, eukaryotic cells have:**

**1) a membrane-bound nucleus; 2) numerous membrane-bound organelles such as the endoplasmic reticulum, Golgi apparatus, chloroplasts, mitochondria, and others; and 3) several, rod-shaped chromosomes.**

**Because a eukaryotic cell‘s nucleus is surrounded by a membrane, it is often said to have a —true nucleus.**

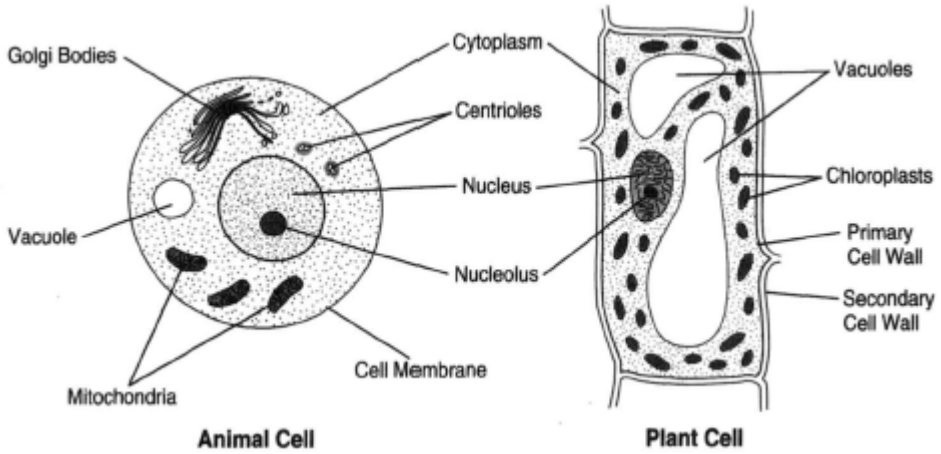
**At this point, it should be clear to you that eukaryotic cells have a more complex structure than prokaryotic cells.**




**Eukaryotic Cells**

| Eukaryotic cells | Prokaryotic cells |
|---|---|
| True nucleus surrounded | No true nucleus |
| Endoplasmic reticulum present | No Endoplasmic reticulum or associated organelles such as Golgi apparatus |
| Membrane bounded organelles such as mitochondria | No Membrane bounded organelles |
| Large (80S) ribosome attached to endoplasmic reticulum | Small(70S) ribosome scattered in cytoplasma |
| If present flagella have (9+2) arrangement of microtubules | If present flagella are made of single microtubule |
| Cell wall if present made of cellulose | Cell wall containing peptidoglycan |
| Cells are large typically 10-100 µm | Cells are small typically 0.3-5µm |

## Animals cell compared whit Plant cell:

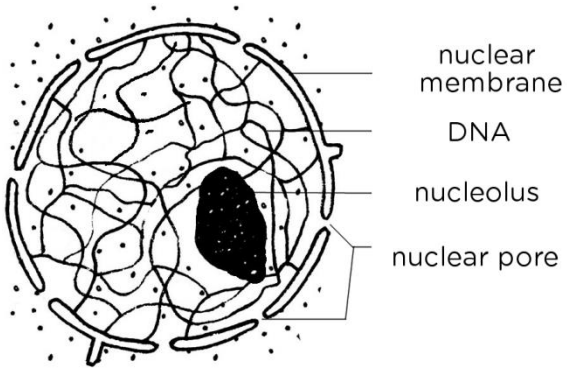



| Animal cell | Plant cell |
|---|---|
| No cell wall | Cell wall |
| One or more small vacuoles | Large vacuole to store water |
| Can't make their own food | Can make their food by photosynthesis |
| Centrioles | No centrioles |
| No plastids or chloroplasts | plastids / chloroplasts |
| Often have cilia or flagella | Flagella may found only in gametes |
| | |
| Plasma membrane | Plasma membrane |
| Cytoplasm | Cytoplasm |
| Mitochondrion | Mitochondrion |
| Golgi apparatus | Golgi apparatus |
| ER | ER |
| Nucleus/DNA | Nucleus/DNA |
| ribosome | ribosome |

# Cell components

**Nucleus:**

**Usually spherical in shape, large-sized. Surrounded by a nuclear envelope and it is composed of two layers of membranes separated by a distance of 20-40 nm. The Merges of the two layers in many places to form a nuclear pores. The genetic material DNA exists in the form of filaments .**




**Functions of nucleus**:

**1 - Contains the genetic material inherited from one cell to another by division.**

**2 - Regulate the activity of the cell.**

**Cytoplasm:**

**Is part of the cell material, which is located between the cell membrane and the nucleus. Consists of about 80% water and 15% as proteins, it also contains fats, sugars , and mineral salts 5%.**

**Cytoplasm is the medium in which the chemical reactions occur within several structures surrounded by membranes called organelles, each of which is specific functions.**

**Cytoplasm functions:**

**1- Most of the important activities of the cell occur in the cytoplasm. Cytoplasm contains molecules such as enzymes which are responsible for breaking down waste and also aid in metabolic activity.**

**2- Cytoplasm is responsible for giving a cell its shape. It helps to fill out the cell and keeps organelles in their place. Without cytoplasm, the cell would be deflated and materials would not be able to pass easily from one organelle to another.**

**Mitochondria:**

**Considered among the largest cell organelles in size, It is a rod organelles, or spherical surrounded by a double membrane bends inward forming folds called criste. The cavity of the mitochondria fill by thick liquid called matrix, contains some enzymes that are involved in the chemical processes in the Krebs cycle and cellular respiration.**

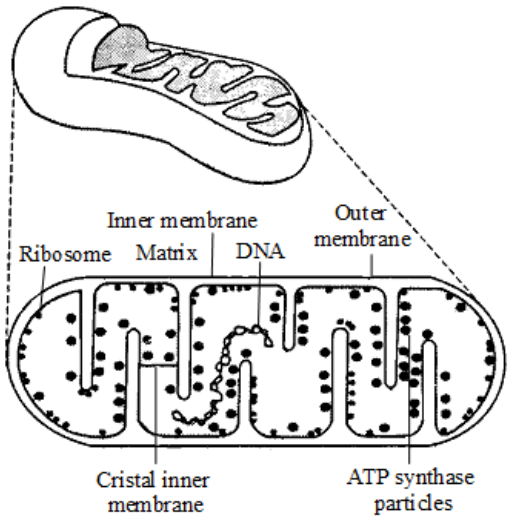



**Figure : MITOCHONDRIA**

**Function of Mitochondria: Is the place that it is made up the energy ( ATP).**

**-The greater the need for the cell to power the greater the number and size of mitochondria.**

**- Contain mitochondrial DNA on its own which is capable of**

**self-cleavage.**

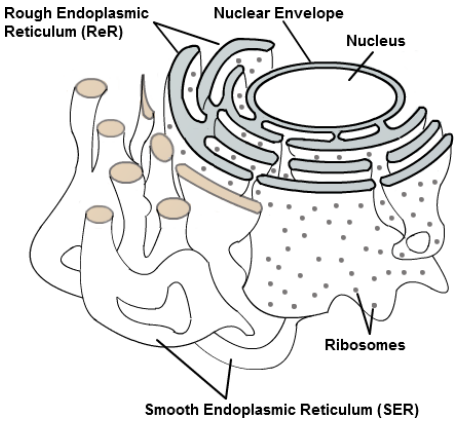
**Endoplasmic reticulum :**

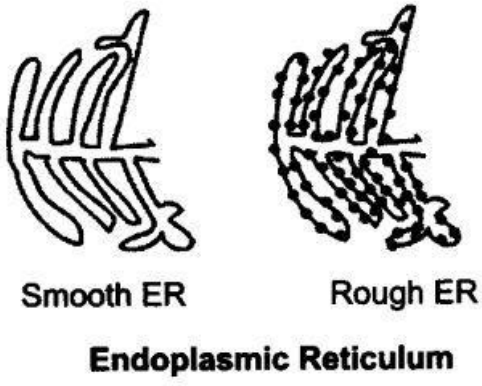
**The endoplasmic reticulum is a multifold membranous structure within eukaryotic cells which plays a major role in the synthesis of the complex molecules required by the cell and the organism .**

**There are two types of endoplasmic reticulum, rough endoplasmic reticulum (RER) and smooth endoplasmic reticulum (SER) ,both types present in animal and plant cells, the two types of ER separate entities and are not joined together.**

**Cells specializing in the production of proteins will tend to have larger amount of rough ER whilst cells producing lipids (fat) and steroids hormones will have a greater amount of smooth ER.**

**Often the membranes of these structures are lined with ribosomes on their outer surfaces, giving them a rough appearance. These parts are called the rough endoplasmic reticulum to contrast them with the smooth where there are no attached ribosomes.**




**Endoplasmic Reticulum**

**Main functions of the the (Rough and Smooth):**

**- Rough ER synthesis of the proteins and modification of some proteins that are produced by the ribosomes.**

**- Smooth ER plays a major role in synthesizing lipids such as phospholipids and cholesterol. In the reproductive organs, smooth ER in the cells produces the steroid hormones testosterone and estrogen.**

**Ribosome:**

**Ribosomes are consists of two units, one large and the other small and do not unite only when the synthesis of numerous peptides (protein).**

**There are large numbers of the ribosomes in the cells that create proteins because it is the only place where the amino acids is created .**

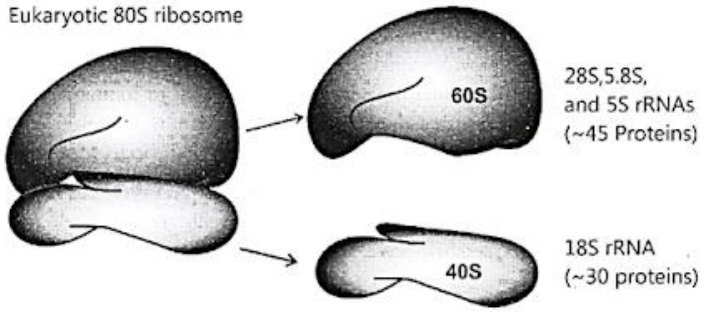



Figure 1.18: Ribosome structure in eukaryotes

**Golgi apparatus:**

**A Golgi complex is composed of flat sacs known as cisternae, and associated small hollow spheres of membrane called vesicles .**

**The Golgi complex or Golgi apparatus is responsible for manufacturing, warehousing, and shipping certain cellular products, particularly those from the endoplasmic reticulum (ER).**

**Depending on the type of cell, there can be just a few complexes or there can be hundreds. Cells that specialize in secreting various substances typically have a high number of Golgi complexes.**

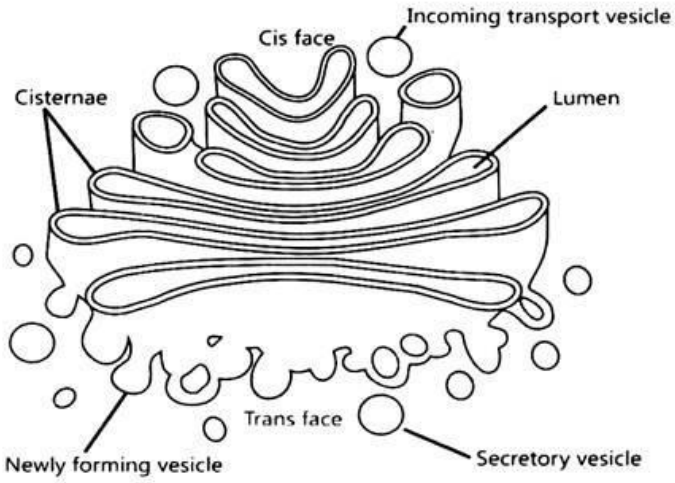
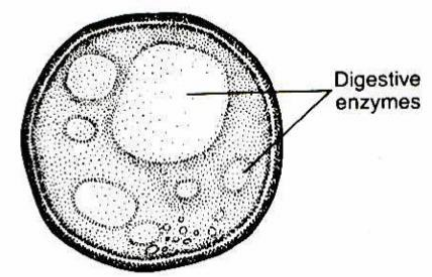


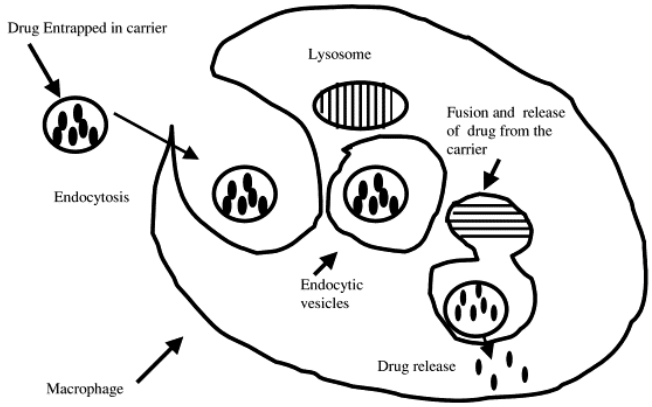

**Figure 1.20:** Golgi complex structure

**The Lysosomes:**

**Small vesicles are formed in the Golgi apparatus, contain enzymes analyst of carbohydrates and protein and fatty acids. Lysosomes are also found in most plant and animal cells, especially in the animals cells which are phagocytic, these are cells which carry out the process of phagocytosis. Lysosomes are formed by inclusion of digestive enzymes such as proteases and lipases.**




**Lysosomes**




**It is very important that enzymes contained within lysosomes are isolated from the rest of the cell inside the lysosomes membrane, otherwise their release would result in self digestion of the cell for instance disease called (rheumatoid arthritis) where the cartilage of joints is attacked by lysosmes enzymes.**

**Peroxisomes:**

**These vesicles contain enzymes crash organic compounds such as hydrogen peroxide and then the decomposition of this toxic compound to water and oxygen.**

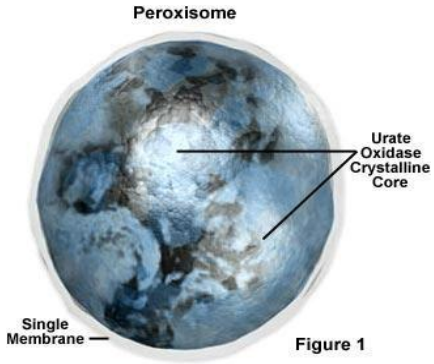


Figure 1

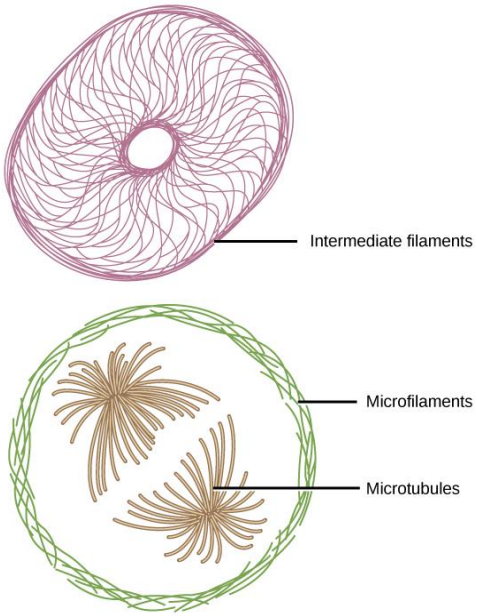
**The cytoskeleton:**

**The cytoskeleton has three different types of protein elements. From narrowest to widest, they are:**

**-Microfilaments.**

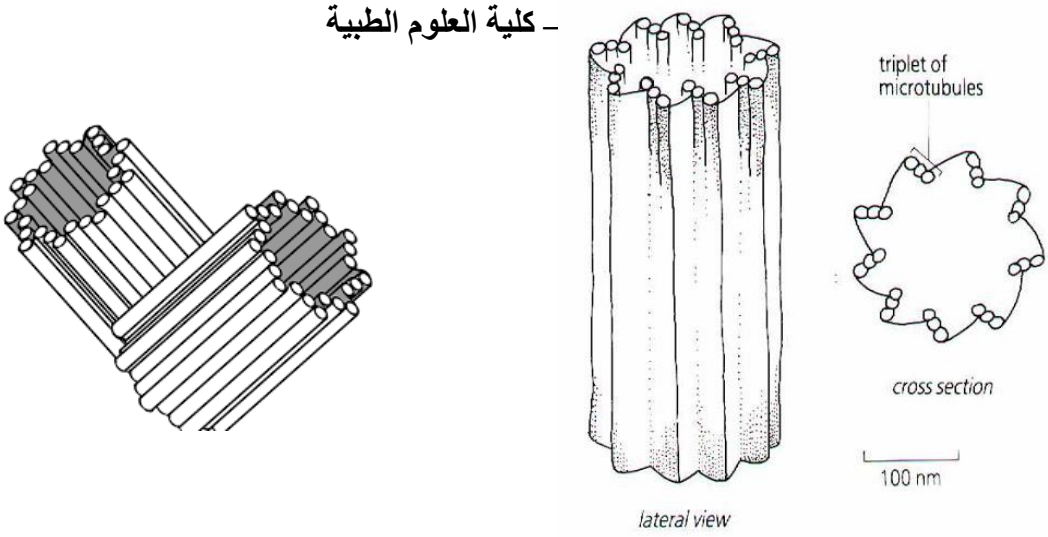
**-Intermediate filaments.**

**-Microtubules.**




**Centrioles:**

**Centrioles are small hollow cylindrical organelles, present in pairs in animal cells. Each centriole is made up of nine triplets of microtubules . During cell division the centrioles replicate themselves and migrate to the opposite poles of the cell. They are thought to have a role in the formation of the spindle fibers which are also made of microtubules.**




**Cilia and flagella:**

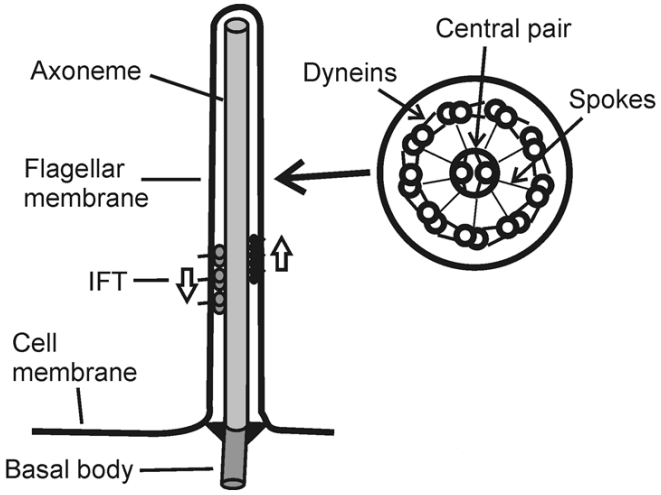
**They are thin cytoplasmic threads projecting from the surface of the cell also containing microtubules they are similar in structure ,but flagella are longer about 100µm compared with 5-10µm for cilia and fewer in number then the cilia.**

**Cilia are present in large numbers on the surface of some cells such as epithelia lining the trachea, their function is to beat backswords and forwards in one direction.**

**The flagella normally move the whole cell or organism as in case of the tail of the sperm cells which is a single flagellum.**

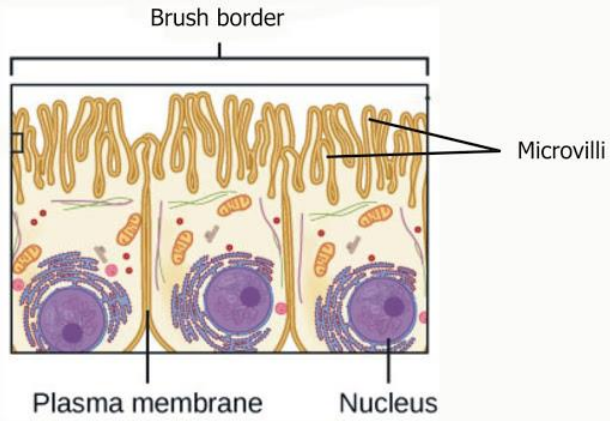
**Cilia and flagella both contain a characteristic arrangement of nine outer pairs of microtubules and two central ones this is called (9+2) arrangement and probably responsible for producing the beating movements.**

Conserved structures in 9 + 2 organelles (cilia/flagella)



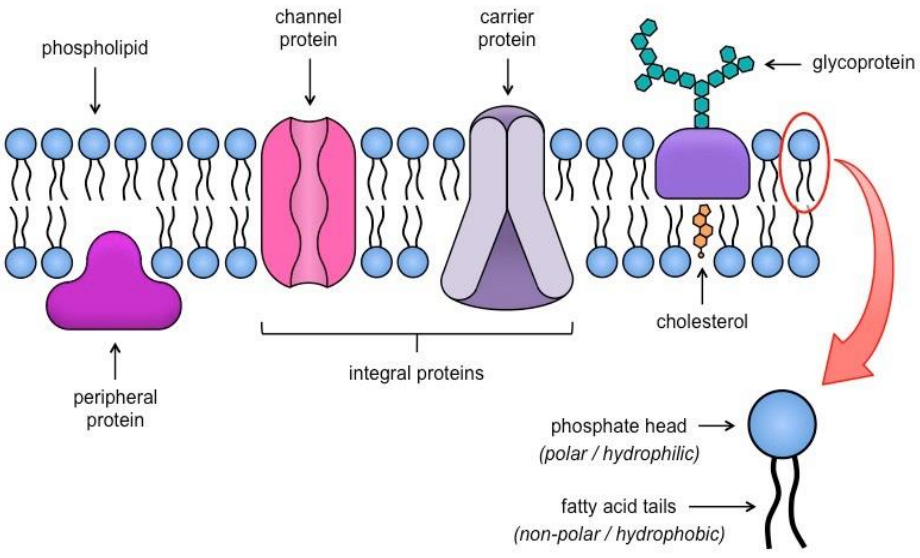
**Microvilli:**

**Microvilli are the finger like projections present on the outer surface of the cell, the function of microvillia is to greatly increase the surface area of cells allowing the increased absorption of materials for example in the small intestine, the microvilli of the epithelium allow a faster uptake of the products of digestion .**




**Plasma Membrane:**

**All membranes have a similar structure ,including the outer cell membrane or the cell surface membrane of both prokaryotic and eukaryotic cells and membranes around organelles in eukaryotic.Some organelles have single membrane (Golgi apparatus) ,but the others have a double membrane (nucleus, mitochondria). Membranes are composed of phospholipids with proteins scattered amongst them. The plasma membrane is selectively permeable.**



**-Phospholipids in the cell membrane :**

**Phospholipids are molecules which are made up of phosphate (heads) and fatty acid (tail).Phosphate is attracted to water and described as hydrophilic(water loving). The phosphate heads turn toward solution (water). fatty acid are repelled by water and are called hydrophobic (water hating). The hydrophobic fatty acids tails turn away from solutions (water).**

**-Proteins in cell membrane**:

**There are proteins floating in the cell membrane between the phospholipids, the two main function of the proteins is to provide support and stability in the fluid structural ,and transport of molecules across membrane. Types of the proteins in cell membrane:**

**a. Transport proteins.**

**b. Channel proteins.**

**c. Receptors.**

**d. Carrier proteins.**

**e. Enzymatic.**

**f. Recognition proteins.**

**-Glycoprotein and Glycolipids:**

**A polysaccharide chain may be attached to a protein, forms a glycoprotein.polysaccharide attached to phospholipid, forms a glycolipid. The polysaccharide is always on the outside of the cell surface membrane. glycoprotein and glycolipid are involved in cell to cell recognition ,enabling cells of similar type to group together to form a tissue . The varying carbohydrate chains emerging from the cell surface membrane of the red blood cells are responsible for producing the different type blood group A ,B, AB ,and O. Some glycoprotein and glycolipid act as receptor sites.**

# The cell cycle

**Multiplication:**

1- essential feature of embryonic development.

2-for growth and replacement of dead cells.

The chromosomes within the nuclei of cells carry genetic information that controls the development and functioning of various cells and tissues and , therefore, of the body as a whole.

**The cell cycle**: is a series of events within the cell that prepare the cell for dividing into two daughter cells.The cell cycle is divided into two major events :interphase, a long period of time during which the cell increase its size and content and replicates its genetic material, and mitosis, a shorter period of time during which the cell divides its nucleus and cytoplasm, giving rise to two daughter cells.

**Interphase:**

Interphase is subdivided into three phases:

(a) G1 (gap) phase, when the synthesis of macromolecules essential for DNA duplication begins. The centrioles begin to duplicate themselves.

(b) S (synthetic) phase, when the DNA is duplicated.

(c) G2 (gap) phase, when the cell prepare for mitosis.

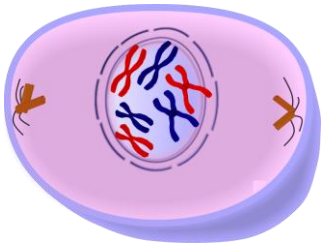
**Mitosis:**

Mitosis is the process of cell division that results in the formation of two identical daughtercells.

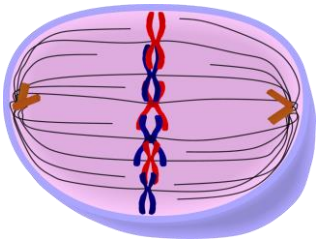
-The nuclear material is divided in a process called Karyokinesis, followed by division of the cytoplasm, called Cytokinesis.

The process of mitosis divided into four distinct stages :

Prophase



Metaphase



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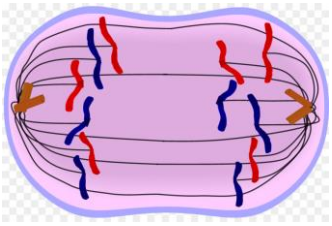
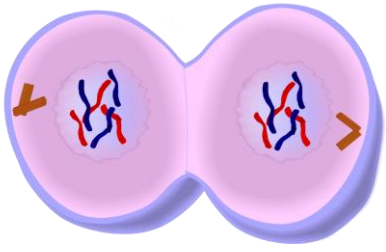
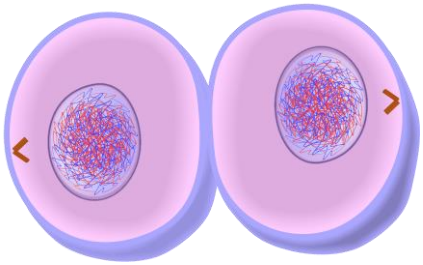


Telophase

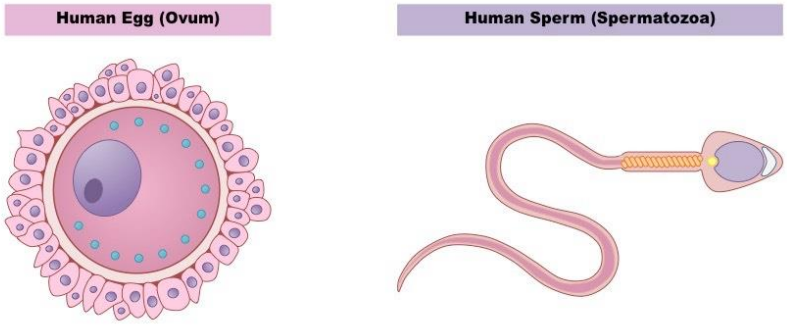


Cytokinesis



**Meiosis:**

Meiosis is a special type of cell division resulting in formation of gametes (spermatozoa or ova) whose chromosome number has been reduced from the diploid (2n) to the haploid (1n) number.




**This process has two crucial results:**

1. Reduction in the number of chromosomes from the diploid (2n) to the haploid (1n) number, ensuring that each gamete carries the haploid amount of DNA and the haploid number of chromosomes.

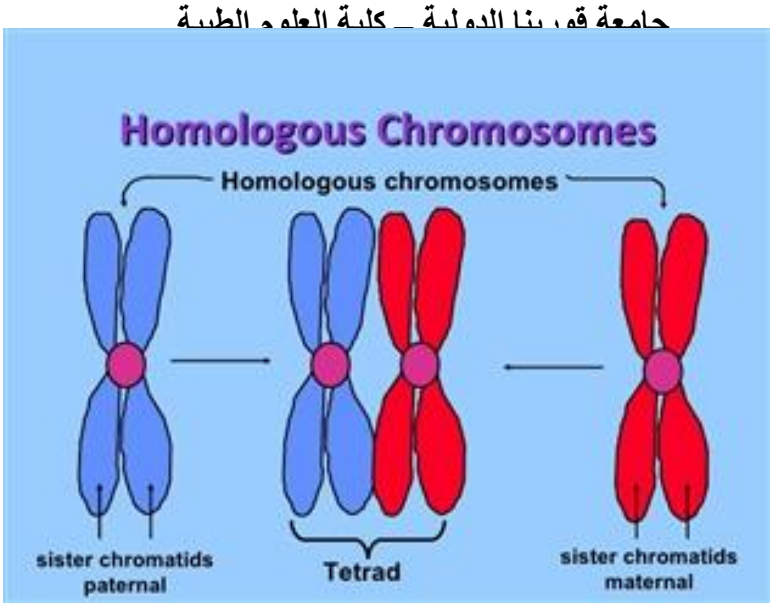
2. Recombination of genes, ensuring genetic variability and diversity of the gene pool.

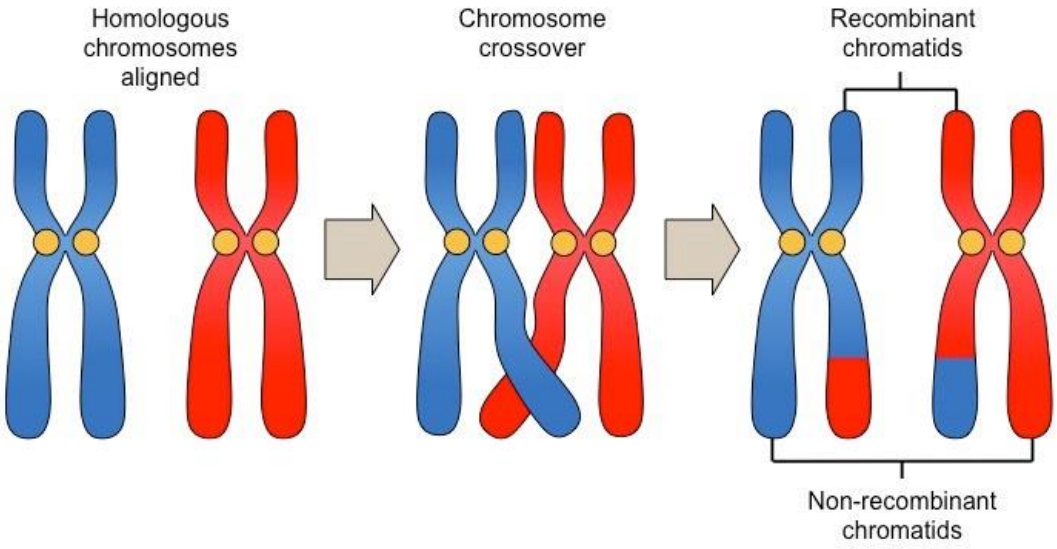
**Meiosis I:**

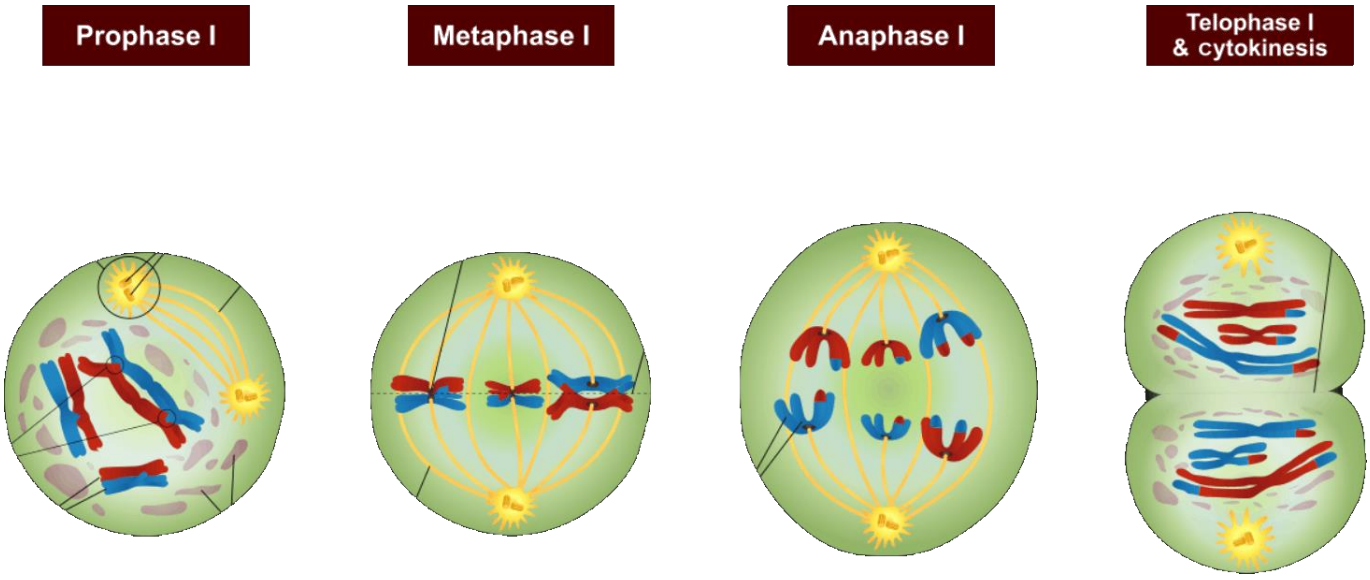
Reductional division separates the homologous pairs of chromosomes, thus reducing the number from diploid (2n) to haploid (1n).

In gametogenesis, when the germ cells are in the S phase of the cell cycle preceding meiosis, The amount of DNA is doubled to 4n but the chromosome number remains at 2n (46 chromosomes).

In the prophase of meiosis I homologous pairs of chromosomes approximate each other, lining up and make synapses , forming a tetrad. chiasmata (crossing over sites) are formed random exchange of genetic material occurs between homologous chromosomes.


Homologous Chromosomes
Homologous chromosomes
sister chromatids paternal
Tetrad
sister chromatids maternal


Homologous chromosomes aligned
Chromosome crossover
Recombinant chromatids
Non-recombinant chromatids

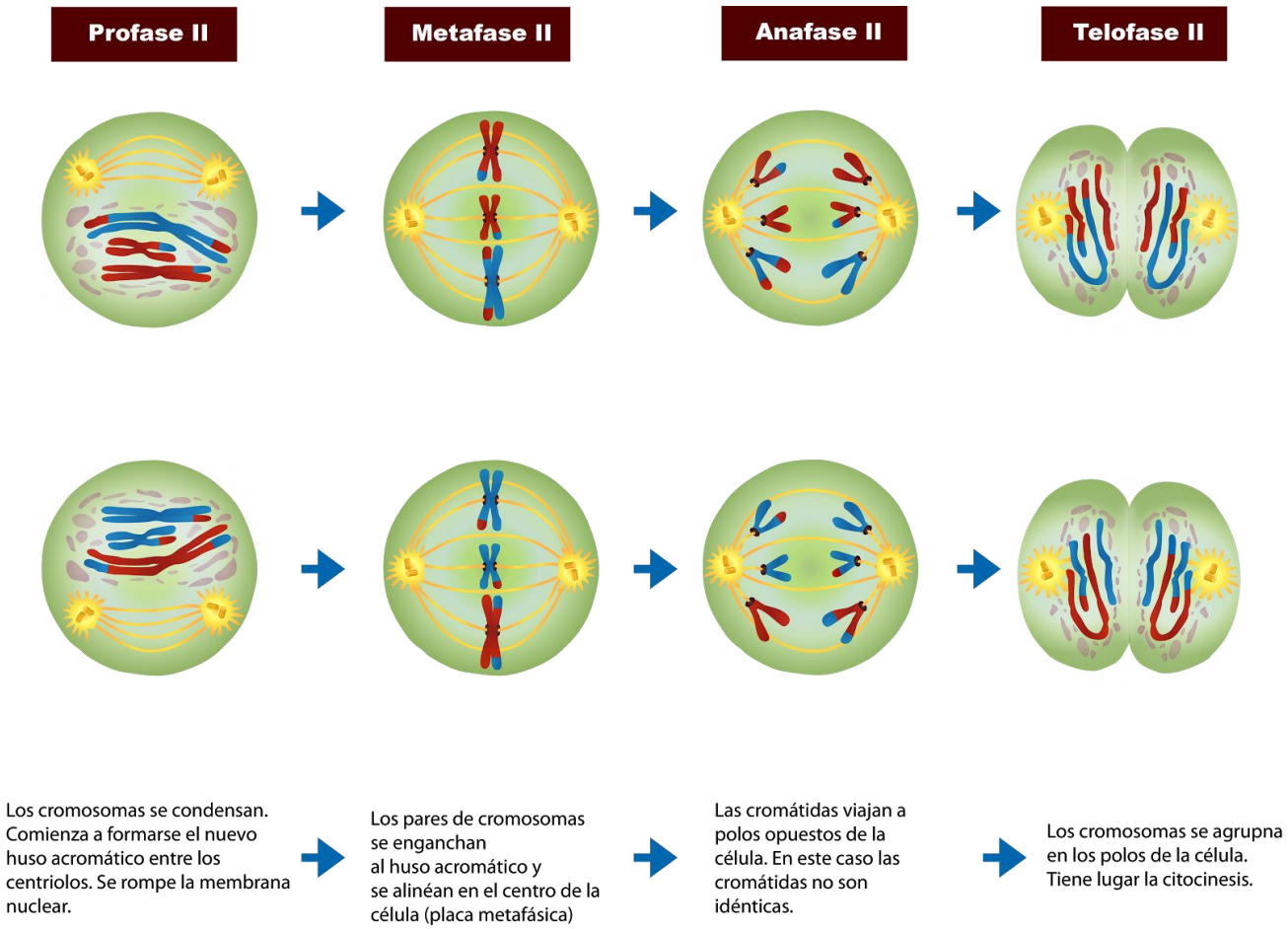

Prophase I
Metaphase I
Anaphase I
Telophase I & cytokinesis

**Meiosis II:**

is not preceded by S phase (without DNA synthesis). It is very similar to mitosis resulting in a total of four daughter cells from the original diploid germ cell.

Each of the four cells contains a haploid amount of DNA and a haploid chromosome number.

The haploid number of chromosome and are genetically distinct because of reshuffling of the chromosomes and crossing over. Thus, every gametes contains its own unique genetic complement.



# Embryology

is the branch of biology that studies the prenatal development of gametes (sex cells), fertilization, and development of embryos and fetuses.

**Gametogenesis:**

Gametogenesis is arbitrarily designated as the first stage of embryonic development. Gametogenesis is defined as the process of formation of respective gametes( sperm and ova) in respective gonads. It involves Spermatogenesis and Oogenesis.
The female gamete is usually non-mobile, larger and nutrient filled cell, the ovum or egg. The male gamete is usually small and mobile sex cell, the Spermatozoon or sperm.
Both classes of gametes, spermatozoon and ova make an equal contribution to the nucleus of the Zygote. It is said that egg and sperm possess the „information" that is needed to build a new organism in the encoded form. The decoding or reading of the information is equivalent to the process of ontogenetic development transformation of zygote into new adult individual.

**Spermatogenesis:**

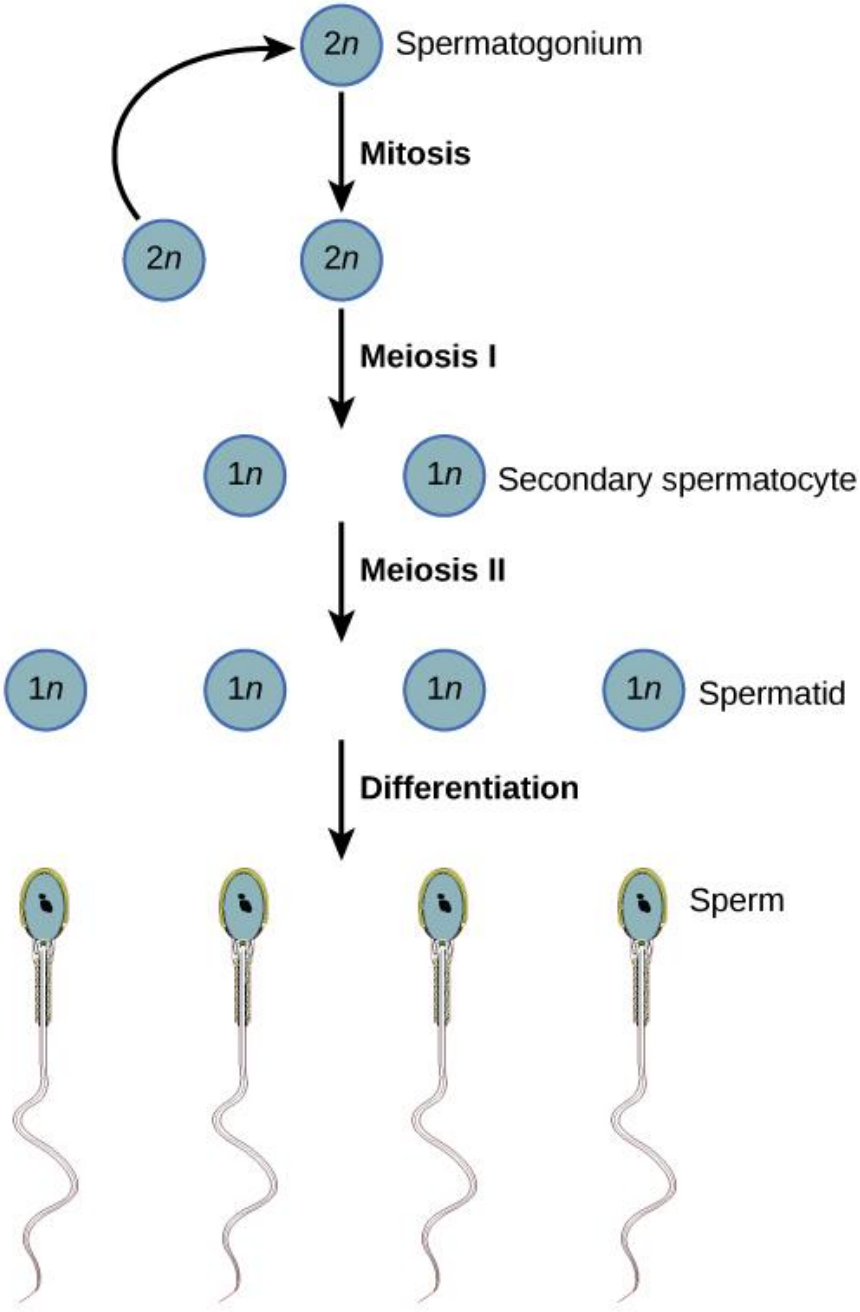
**i) Multiplication phase:** the germinal epithelium of seminiferous tubules produce primodial germ cell. These cell multiplies repeatedly by mitosis to produce large number of spermatogonia.
**ii) Growth or Maturation phase:** The spermatogonia undergoes maturation. It is a diploid cell. After maturation spermatogonia is known as Sperm mother cell because it will eventually develop into the mature sperm.
**iii) Meiotic phase:** Duplication of homologous chromosome in sperm mother cell occur and become ready for meiosis. First meiotic division produce two Primary spermatocyte with haploid number of chromosome. The first meiotic division separates the homologous chromosomes from each parent. The second meiotic division of each primary spermatocytes occur resulting altogether of 4 haploid secondary

spermatocytes. The secondary spermatocytes after maturation is known as spermatids. Each Spermatids goes on metamorphosis into sperm by the process of Spermiogenesis.

**Spermiogenesis:**

Sperm is a motile male gamete with head, neck and tail. During Metamorphosis of spermatids into sperm, following changes occurs

- Spermatids elongates and its Nucleus.
-Cytoplasm extended to develop Flagella.
-Golgi body produces Acrosome.
- Mitochondria aggregate to form super mitochondria around base of flagella, providing energy for sperm motility.
-By tubulobular process, sertoli cell phagocytose the sheded cytoplasm.

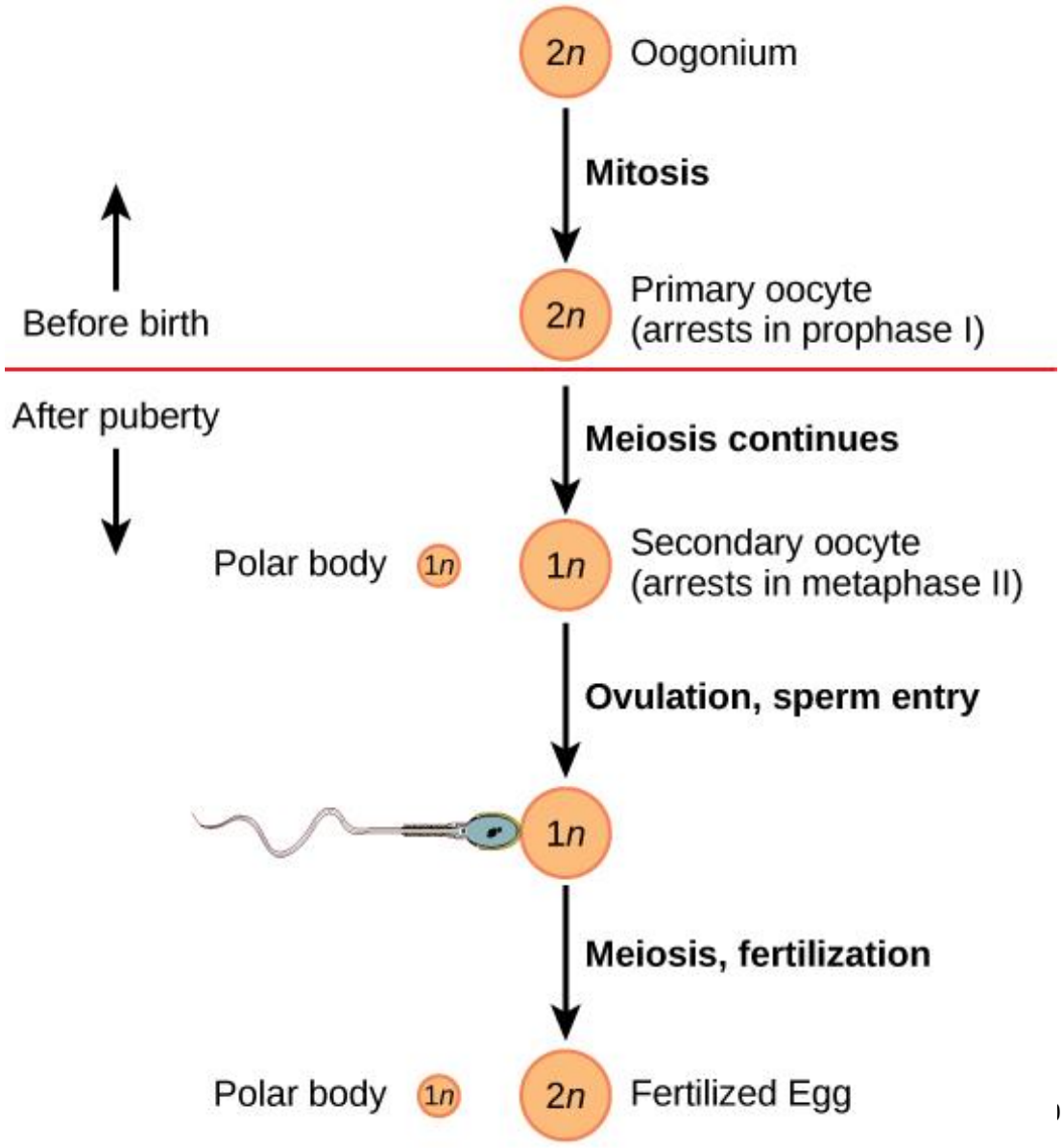


**Oogenesis**

**i) Multiplication:** The initial phase of Oogenesis starts during fetal stage. The primary germ cell, Oogonia develop from stem cell by mitosis cell division. In adult ovaries, primordial follicle contains a primary oocyte. Primary oocyte is also known as ova mother cell, which eventually produce ova.

**ii) Growth or maturation phase:** the Oogonia undergoes maturation. It is a diploid cell. Mature Oogonia is knownas primary oocytes, which undergoes meiosis, howerer, meiosis stopped at Prophase-I.

**iii) Meiotic phase:** Completion of meiosis-I produces a secondary oocyte and a polar body. The second meiosis division os Secondary Oocyte occur with unequal distribution of cytoplaswm producing large egg and a small second polar body. Eventually 1 egg and 3 polar bodies are produced.



# Tissues

- 200 distinctly different types of cells composing the human body.

- A tissue is a functional collection of cells and associated intercellular material that is specialized to carry out a specific role.

- Groups of these tissues are assembled in various organizational and functional arrangements into organs.

**The four basic tissues types:**

1-epithelium tissue.

2-connective tissue.

3-muscle tissue.

4-nervous tissue.

**Epithelium Tissue:**

The outer surface of the body and the luminal surface of cavities within the body are lined by one or more layers of cells that completely cover them. Epithelia also line the ducts and Secretory elements of glands.

**General Features of Epithelium Tissue:**

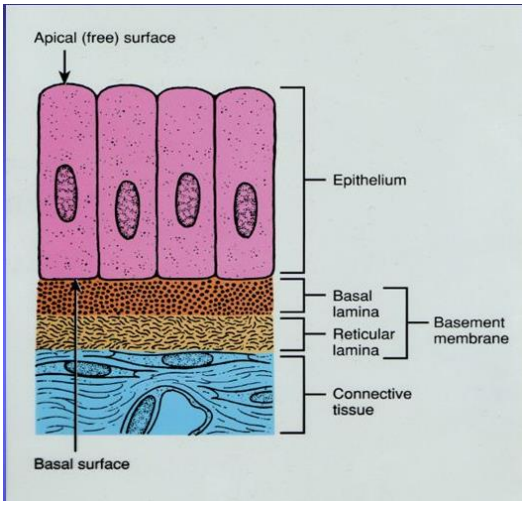
1. All surfaces in the body are covered or lined by an epithelium; excluding the joint cavities ; therefore, serve as barrier membranes to separate the organism from various external and internal environments.
2. Epithelia rests on a basement membrane.
3. Epithelia are generally avascular; so nourishment of an epithelium occurs by diffusion from the underlying connective tissue vasculature.

4. Epithelial tissue possess a remarkable capability for renewal and regeneration.

5. The cells are compactly arranged on a thin, structureless basement membrane.

6. Due to the compact arrangement, intercellular spaces are usually absent .

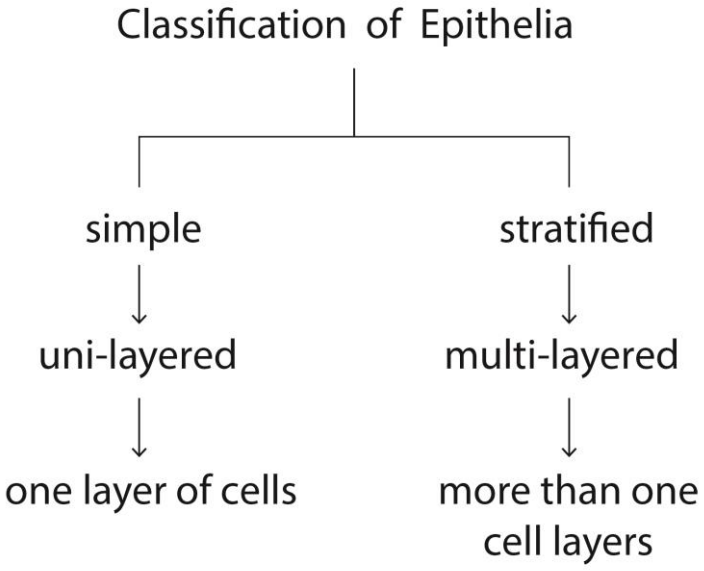
7. Epithelia are diverse in origin; they are derived from all three primary germ layers (ectoderm, mesoderm, and endoderm).




**Epithelial function:**

protection, lubrication, secretion, sensory, digestion, absorption, transduction, and reproduction.

**Classification of Epithelium Tissues:**

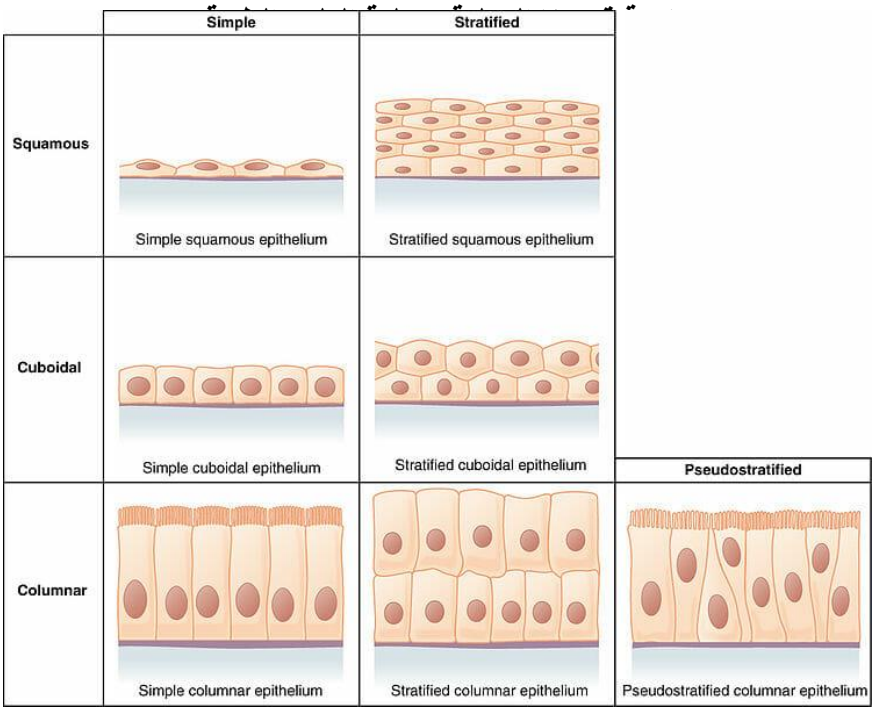


**Simple epithelia:**

(1) In some epithelia the cells are flattened, their height being very little as compared to their width. Such an epithelium is called a simple squamous epithelium.
**Locations :** glandular ducts of small caliber, lining the pleural, pericardial, and peritoneal cavities (mesothelium); lining the cardiovascular and lymph channels (endothelium); respiratory bronchioles and alveoli of the lungs, Bowman's capsule in the kidney .
(2) When the height and width of the cells of the epithelium are or less equal (i.e., they look like squares in section) it is described as simple cuboidal epithelium.
**Locations :** ducts of many glands, lining certain kidneys tubules, rete testis, and covering the free surface of the ovary.
(3) When the height of the cells of the epithelium is distinctly greater than their width, it is described as a simple columnar epithelium.
**Locations :** much of digestive tract (stomach, intestine, gall-bladder), portions of female reproductive tract (oviduct and uterus).
(4) The fourth variety is termed pseudostratified columaner epithelium ; despite an apparently stratified appearance, all cells rest on the basement membrane.
**Locations :** large portion of the respiratory passages, Eustachian tube, and portions of the male and female urethra.

**stratified epithelia:**

there are two or more layers of cells, only the basal (lowermost) layer of cells rests on the basement membrane. According to the shape of the surface (outermost) layer of cells, a stratified squamous, stratified cuboidal, or stratified columnar epithelium can be distinguished. A fourth variety of stratified epithelia is termed transitional epithelium . Originally, this epithelium was termed transitional because it was considered to be an intermediate between stratified squamous and stratified columnar. The appearance of this epithelium varies tremendously depending on whether it is in its contracted or expanded state .
Locations: limited to lining some portions of the urinary tract, namely , the renal pelvis , ureters and urinary bladder.

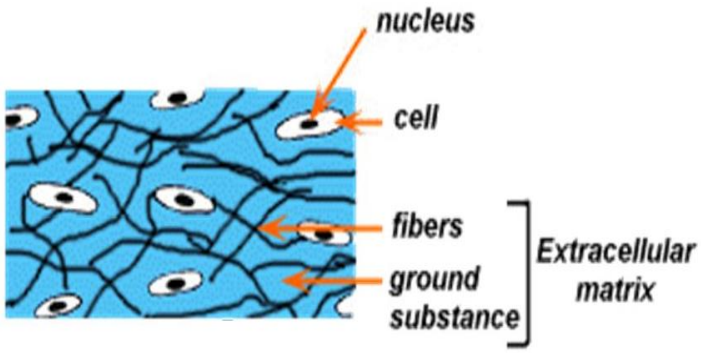



**Connective tissues:**

The term connective tissue is applied to a tissue that fills the interstices between more specialized elements; serves to hold them together and support them.

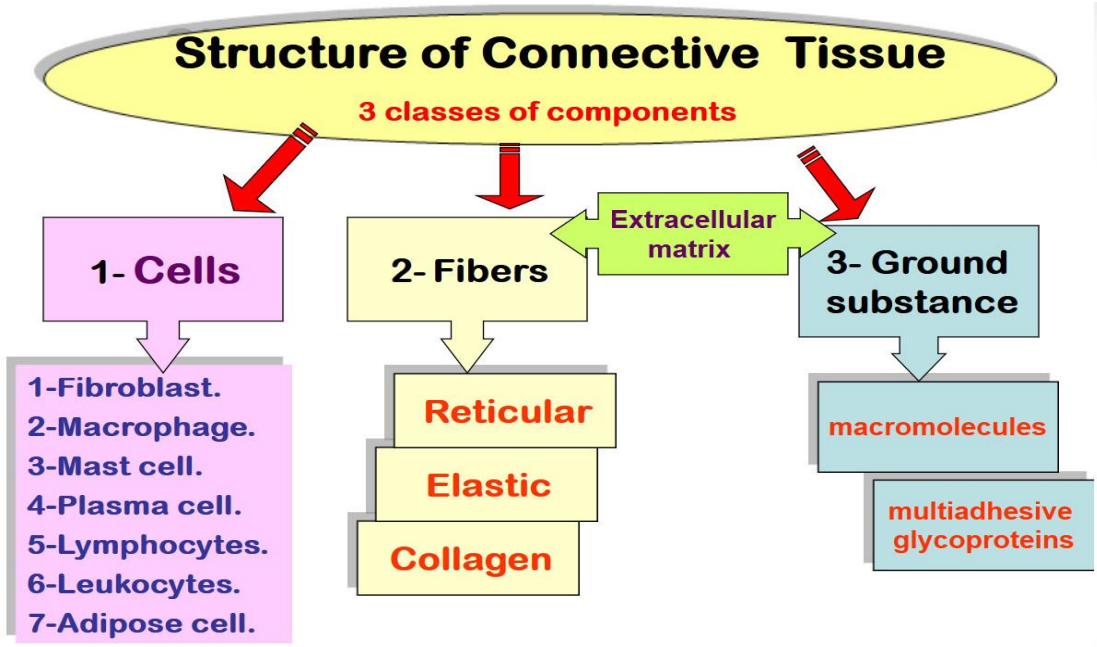
**General Features of connective Tissue:**

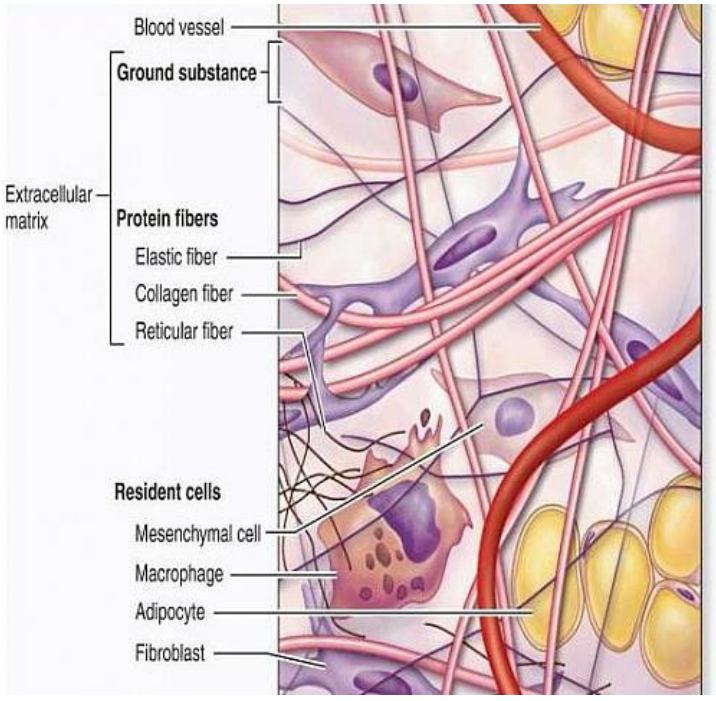
1. Most connective tissues originate from mesoderm, middle germ layer of the embryonic tissue.
2. Connective tissues are responsible for providing and maintaining form in the body and also provide a matrix that connect and binds the cells and organs and ultimately gives support to the body.
3. Structurally, connective tissue is formed by three classes of components: cells, fibers, and ground substance.
4. Unlike the other tissues (epithelium, muscle, and nerve), which are formed mainly by cells, the major constituent of connective tissue is the extracellular matrix.



**Functions of Connective Tissue:**

1. Providing structural support.
2. Serving as a medium for exchange.
3. Aiding in the defense and protection of the body.
4. Forming a site for storage of fat.

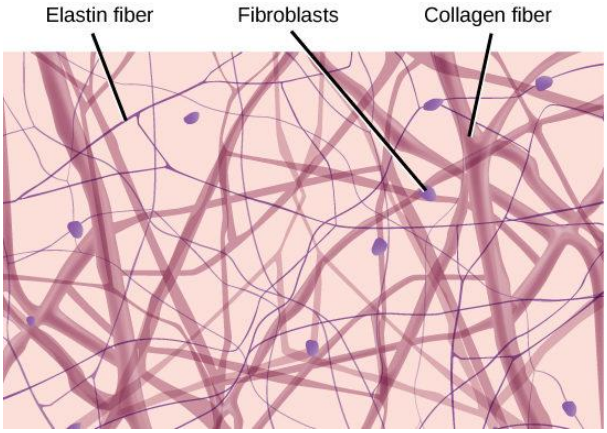


**Types of connective tissues:**

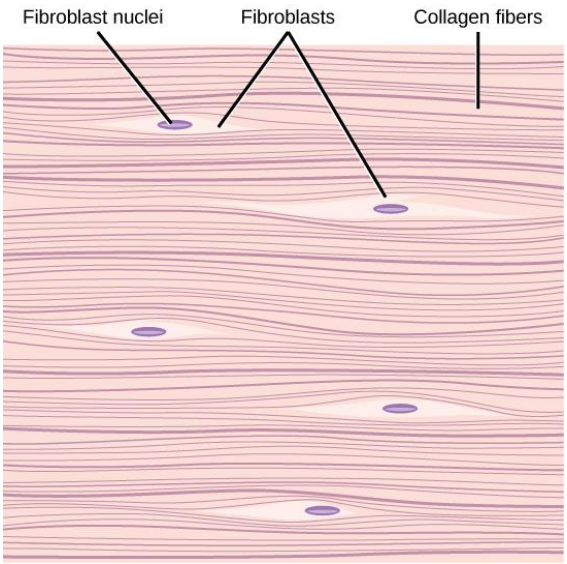
**Loose/Areolar Connective Tissue:**

has a sampling of all of the components of a connective tissue. loose connective tissue has some fibroblasts; macrophages are present as well. Collagen fibers are relatively wide and stain a light pink, while elastic fibers are thin and stain dark blue to black. The space between the formed elements of the tissue is filled with the matrix. Loose connective tissue is found around every blood vessel and helps to keep the vessel in place. The tissue is also found around and between most body organs.



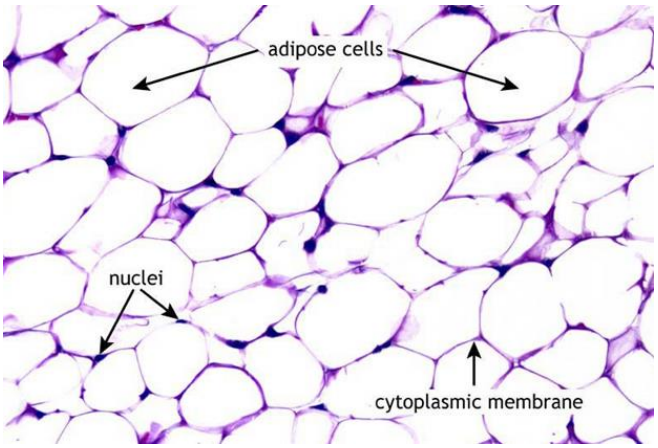

**Fibrous Connective Tissue:**

Fibrous connective tissues contain large amounts of collagen fibers and few cells or matrix material. The fibers can be arranged irregularly or regularly with the strands lined up in parallel. Irregularly arranged fibrous connective tissues are found in areas of the body where stress occurs from all directions, such as the dermis of the skin.



**Adipose Tissue:**

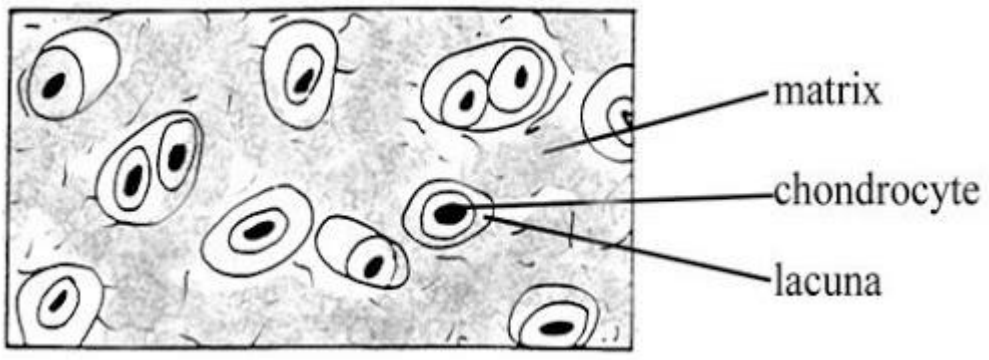
Adipose tissue, or fat tissue, is considered a connective tissue even though it does not have fibroblasts or a real matrix and only has a few fibers. Adipose tissue is made up of cells called adipocytes that collect and store fat in the form of triglycerides, for energy metabolism. Adipose tissues additionally serve as insulation to help maintain body temperatures ,and they function as cushioning against damage to body organs.




**Specialized connective tissue:**

cartilage, bone, and blood are specialized connective tissues.

**(a). Cartilage**:
possesses cells called chondrocytes, which occupy small cavities called lacunae within the extracellular matrix they secreted The substance of cartilage is neither vascularized nor supplied with nerves or lymphatic vessels; however, the cells receive their nourishment from blood vessels of surrounding connective tissue by diffusion through the matrix.



**Types of Cartilage:**

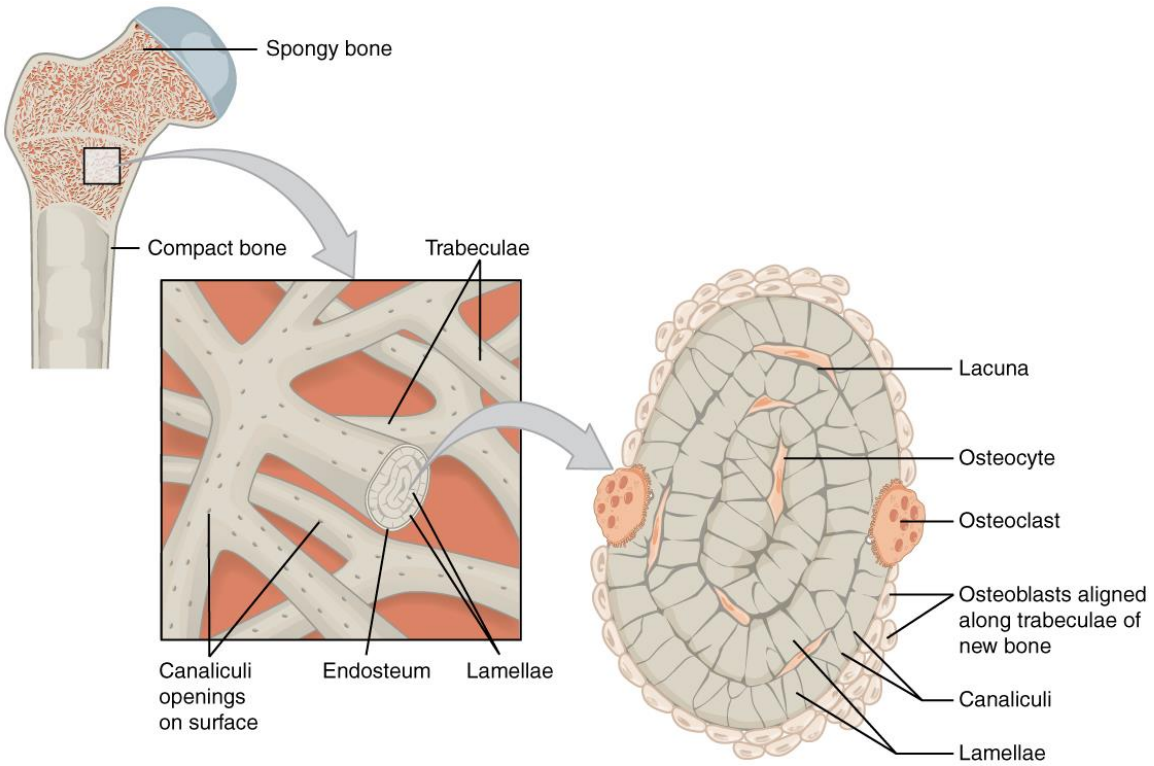
1. Hyaline cartilage.

2. Elastic cartilage.

3. Fibrocartilage.

**(b). Bone :**
is the primary structural framework for support and protection of the organs of the body, including the brain and spinal cord and lungs bone is composed of cells lying in an extracellular matrix that has become calcified. The cells of bone include osteoprogenitor cells, which differentiate into osteoblasts. Osteoblasts are responsible for secreting the matrix. When these cells are surrounded by matrix , they become osteocytes, and occupy by lacunae. Osteoclast which are multinucleated giant cells involved in the resorption and remodeling of bone tissue.

**Types of Bone:**
Gross observation of bone in cross section shows dense areas with-out cavities corresponding to compact bone, and areas with numerous interconnecting cavities corresponding cancellous (spongy) bone.

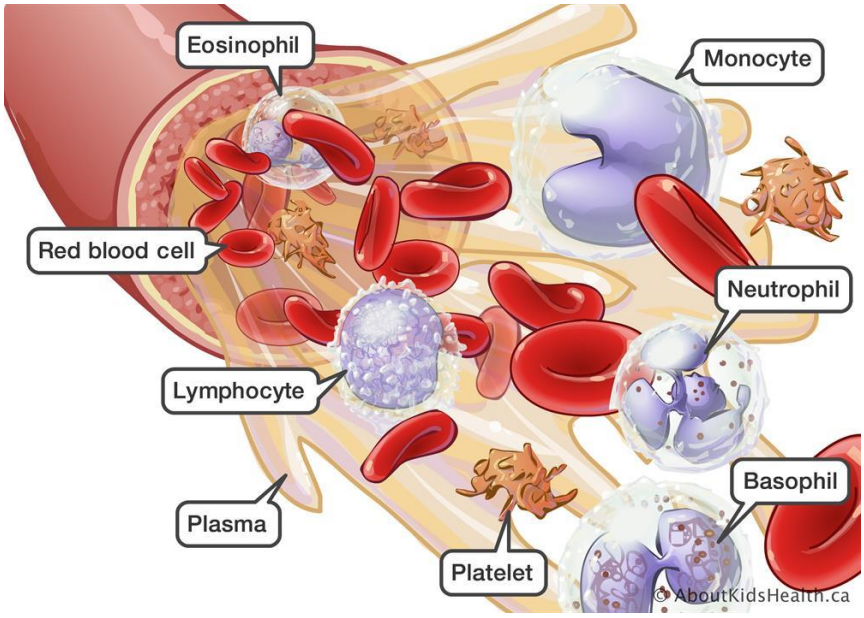


**(c). Blood:**

Blood is a specialized connective tissue composed of formed elements– Red blood cells ( RBCs; erythrocytes), White blood cells (WBCs; leukocytes), and Platelets (Thrombocytes). suspended in a fluid component (the extracellular matrix), known as plasma.

**Blood components:**

1-Plasma.
2- Erythrocytes (red blood cells).
2. Leukocytes (white blood cells).
3. Platelets (Thrombocytes).



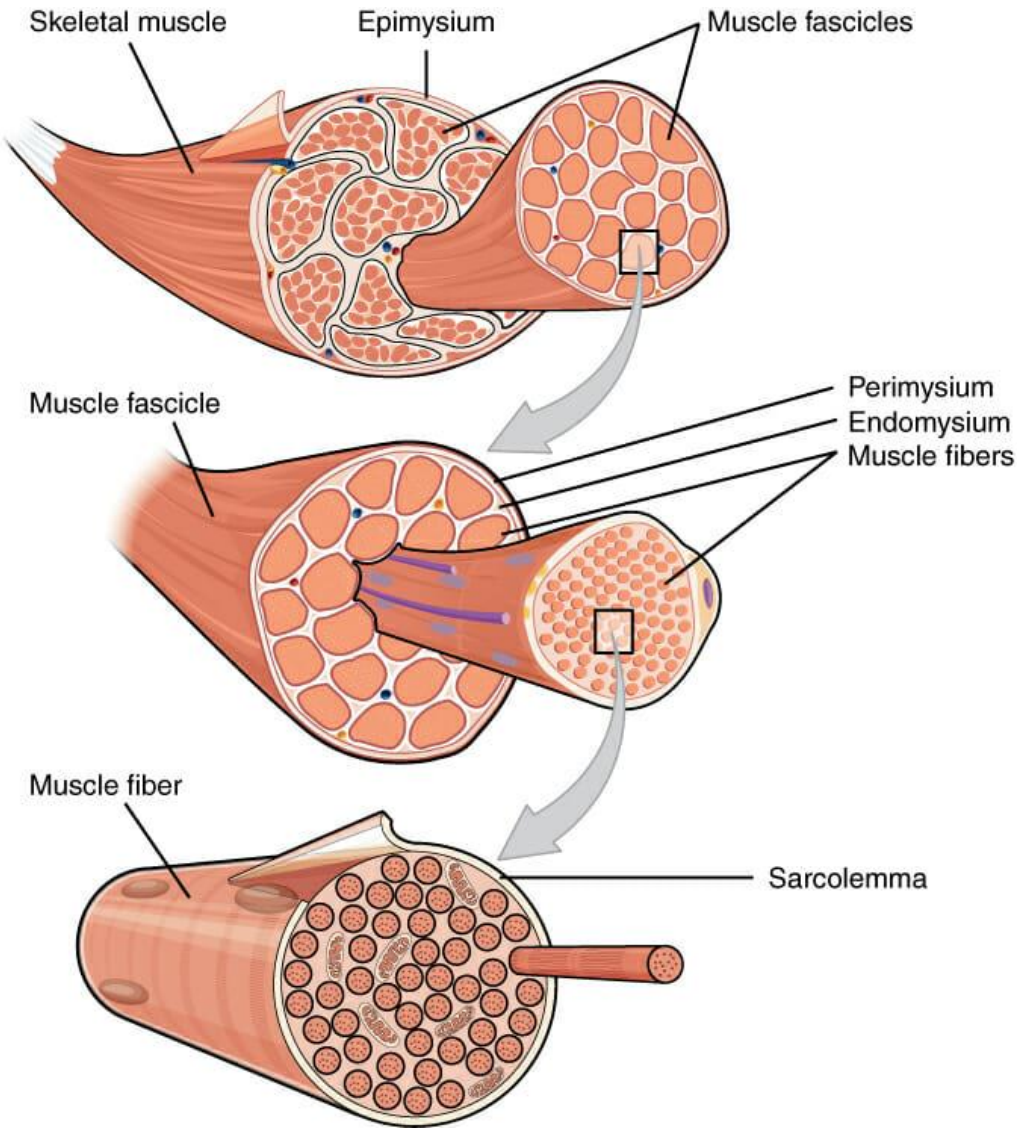

**Muscular tissue:**

Although many cells of multicellular organisms have limited contractile abilities, it is the capability of muscle cells, which are specialized for contraction, that permits animals to move.

**General features of muscular tissue:**

1. Muscle tissue is composed of differentiated cells containing contractile proteins.
2. Most muscle cells are of mesodermal origin.
3. Muscle tissue is made up basically of cells that are called muscle fibers.

4. Unique terms are often used to describe the components of muscle cells. Thus, muscle cell membrane is referred to as sarcolemma; the cytoplasm, as sarcoplasm; the smooth endoplasmic reticulum, as sarcoplasmic reticulum.
5. Cells of muscle are elongated and are called either striated muscle cells or smooth muscle cells, depending on the respective presence or absence of a regularly repeated arrangement of myofibrillar contractile proteins, myofilaments.
6. Striated muscle cells display characteristic alternations of light and dark cross-bands, which are absent in smooth muscle.
7. There are two types of striated muscle : skeletal, accounting for most of the voluntary muscle mass of the body, and involuntary cardiac, limited almost exclusively to the heart. The third type is unstriated, smooth muscle cells are located in the walls of blood vessels and the viscera as well as in the dermis of skin.



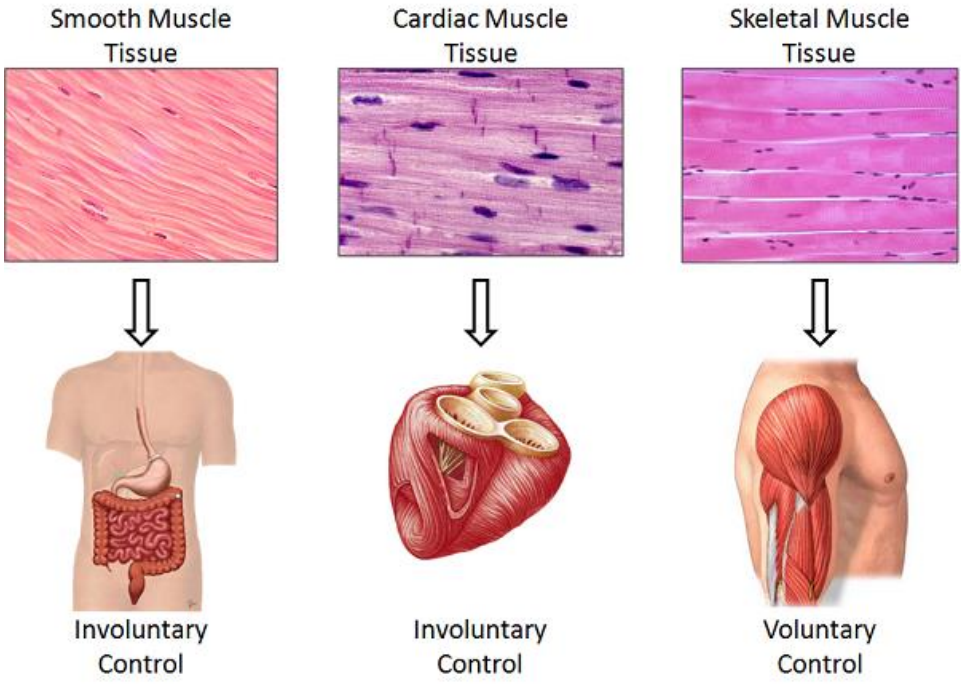
**Types of muscle:**

There are three types of muscles :

(a). Skeletal muscle : is composed of long, cylindrical, not branched muscle fiber, and
multinucleated cells that undergo voluntary contraction to facilitate movement of the body .

(b). Cardiac muscle: is composed of long, branched muscle fiber with a single, large, oval,
centrally placed nucleus, nonvoluntary striated muscle limited to the heart.

(c). Smooth muscle: is composed of short, spindle-shaped muscle fiber, with a centrally placed
nucleus, it is not under voluntary control, and found in the walls of a hollow viscera.



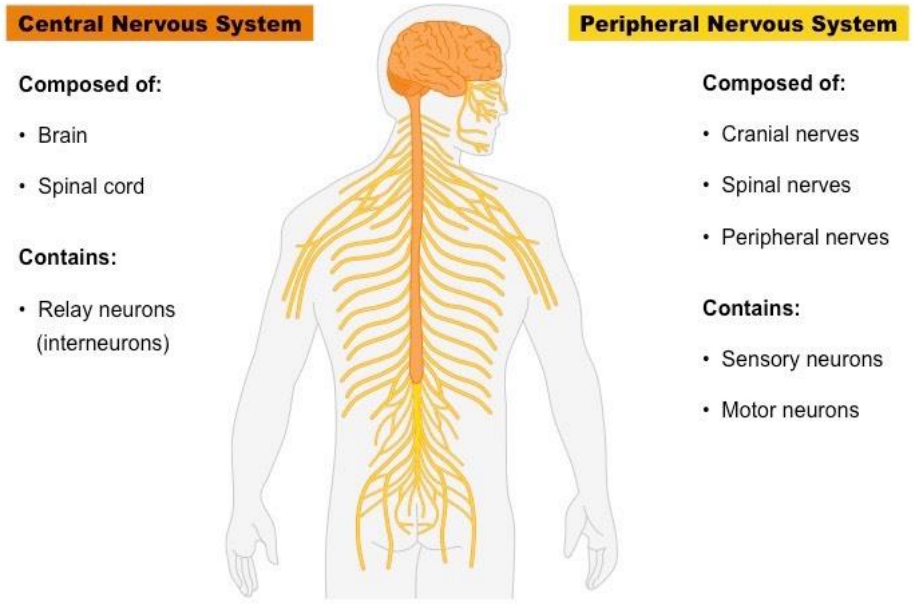

**Nervous tissue:**

Nervous tissue, composed of as many as a trillion neurons with multitudes of interconnections, forms the complex system of neuronal communication within the body.

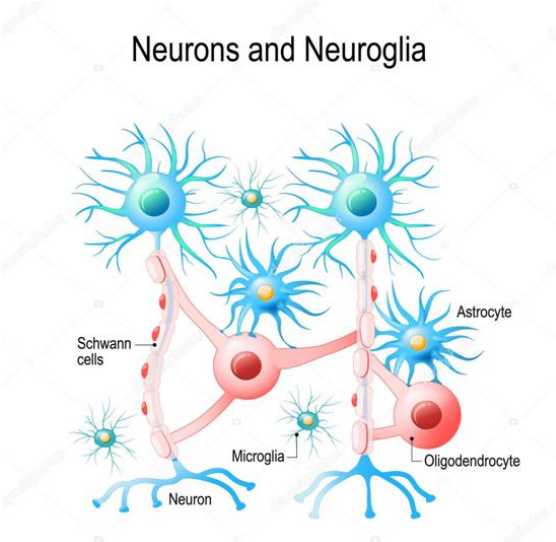
**General features of nervous tissue:**

1. The nervous system develops from the ectoderm.

2. The specialized cells that constitute the functional units of the nervous system are called neurons.
3. The nervous system is organized anatomically into the central nervous system (CNS), which comprise the brain and spinal cord, and the peripheral nervous system (PNS), which include cranial nerves, emanating from the brain; spinal nerves, emanating from the spinal cord.
4. Within the CNS, neurons are supported by a special kind of connective tissue that is called neuroglia; while within PNS, the supporting cells is called schwann cells.




**Cells of the nervous system:**
The cells of the nervous system are divided into two categories : neurons, which are responsible for the receptive, integrative, and motor functions of the nervous system; and neruroglia cells, which support and protect neurons.



# Energy and Metabolism

**flow of energy:**

Energy exists in many forms, such as heat, light, chemical energy, and electrical energy. Energy is the ability to bring about change or to do work. Energy flows through ecosystems in one direction, typically from the Sun, through photosynthetic organisms including green plants and algae, to herbivores to carnivores and decomposers.

Green plants and algae are called Autotrophs or producer organisms, as they capture solar energy to make sugars (chemical energy) in the process of photosynthesis. consumers use the producer organisms as their source of food (chemical energy).

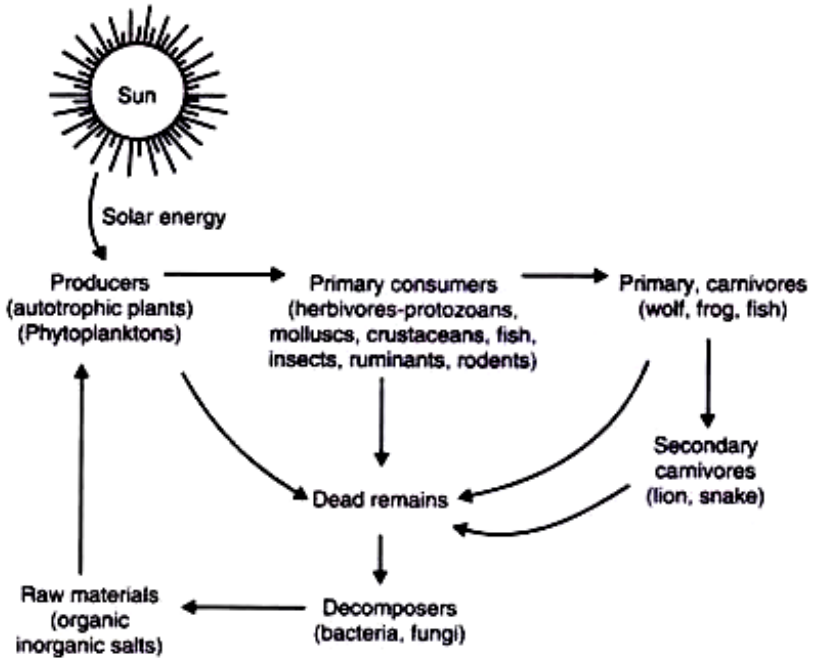



**Fig. 3.7.** Flow of energy at different levels of ecosystem.

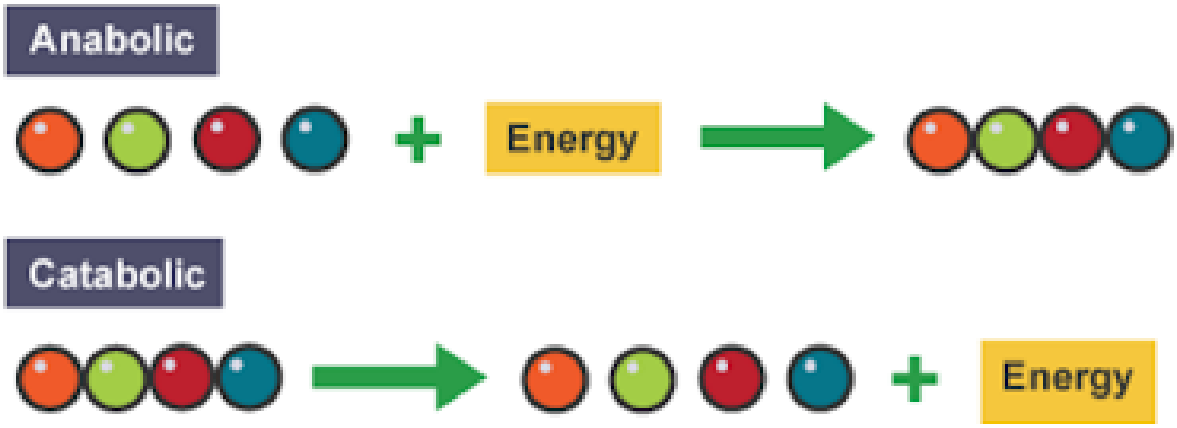
**Energy:**

Energy has been defined as the capacity to do work. Energy exists in two forms potential and kinetic.

**kinetic** energy is the energy of objects in motion.

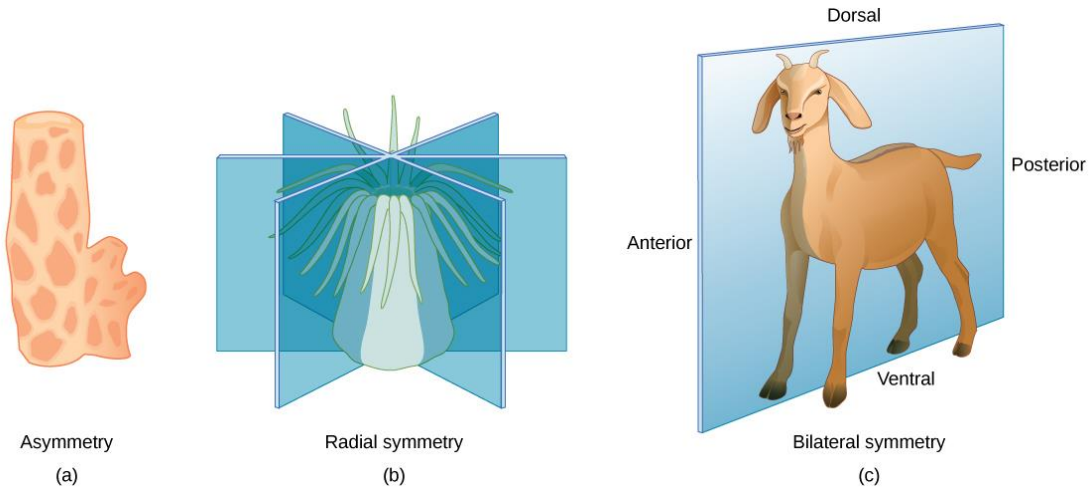
**potential** energy stored in molecular bonds and can be release when they are breakdown.

Cells perform the functions of life through various chemical reactions. A cell‘s metabolism refers to the chemical reactions that take place within it. There are metabolic reactions that involve the breaking down of complex chemicals into simpler ones, such as the breakdown of large macromolecules. This process is referred to as catabolism, and such reactions are associated with a release of energy. On the other end of the spectrum, anabolism refers to metabolic processes that build complex molecules out of simpler ones, such as the synthesis of macromolecules. Anabolic processes require energy. Glucose synthesis and glucose breakdown are examples of anabolic and catabolic pathways, respectively.



# Body Plans

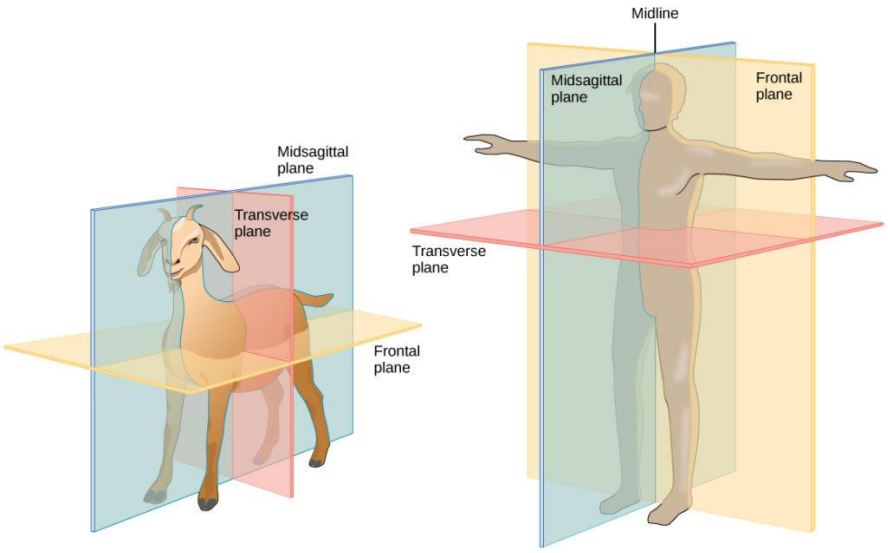
Animal body plans follow set patterns related to symmetry. They are asymmetrical, radial, orbilateral. **Asymmetrical** animals are animals with no pattern or symmetry; an example of an asymmetrical animal is a sponge. Radial symmetry, describes when an animal has an up-and-down orientation: any plane cut along its longitudinal axis through the organism produces equal halves, but not a definite right or left side. This plan is found mostly in aquatic animals, especially organisms that attach themselves to a base, like a rock or a boat, and extract their food from the surrounding water as it flows around the organism. Bilateral symmetry is illustrated in the same figure by a goat. The goat also has an upper and lower component to it, but a plane cut from front to back separates the animal into definite right and left sides. Additional terms used when describing positions in the body are anterior (front), posterior (rear), dorsal (toward the back), and ventral (toward the stomach). Bilateral symmetry is found in both land-based and aquatic animals; it enables a high level of mobility.




**Animal Body Planes and Cavities:**

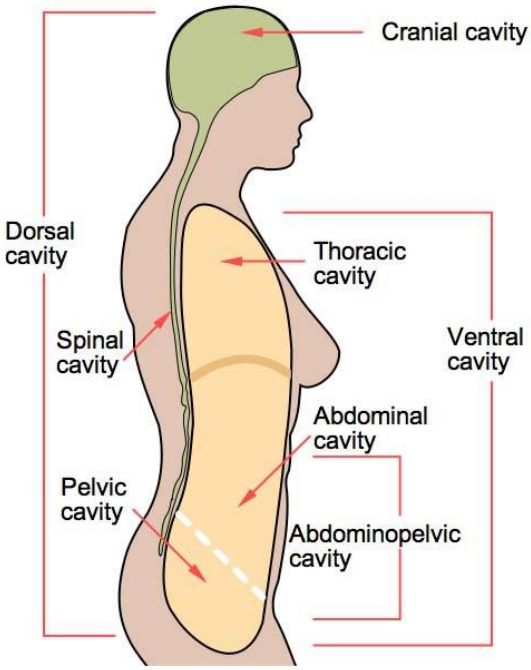
A standing vertebrate animal can be divided by several planes. A **sagittal plane** divides the body into right and left portions. A **midsagittal plane** divides the body exactly in the middle, making two equal right and left halves. A **frontal plane** (also called a coronal plane) separates the front from the back. A **transverse plane** (or, horizontal plane) divides the animal into upper and lower portions. This is sometimes called a cross

section, and, if the transverse cut is at an angle, it is called an oblique plane. these planes on a goat (a four-legged animal) and a human being.




These planes on a goat (a four-legged animal) and a human being.

Vertebrate animals have a number of defined body cavities. Two of these are major cavities that contain smaller cavities within them. The **dorsal cavity** contains the cranial and the vertebral (or spinal) cavities. The **ventral cavity** contains the thoracic cavity, which in turn contains the pleural cavity around the lungs and the pericardial cavity, which surrounds the heart. The ventral cavity also contains the abdominopelvic cavity, which can be separated into the abdominal and the pelvic cavities.

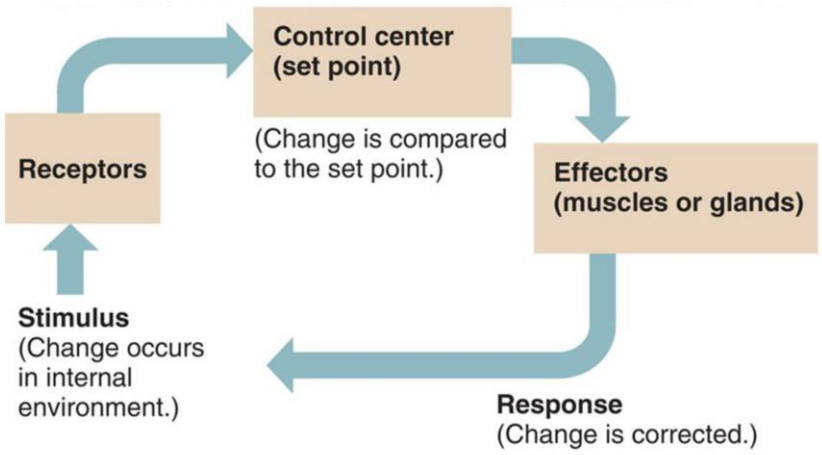


# Homeostasis

Animal organs and organ systems constantly adjust to internal and external changes through a process called homeostasis (steady state). These changes might be in the level of glucose or calcium in blood or in external temperatures. **Homeostasis** means to maintain dynamic equilibrium in the body. It is dynamic because it is constantly adjusting to the changes that the body's systems encounter. It is equilibrium because body functions are kept within specific ranges. Even an animal that is apparently inactive is maintaining this homeostatic equilibrium.

**Control of Homeostasis:**

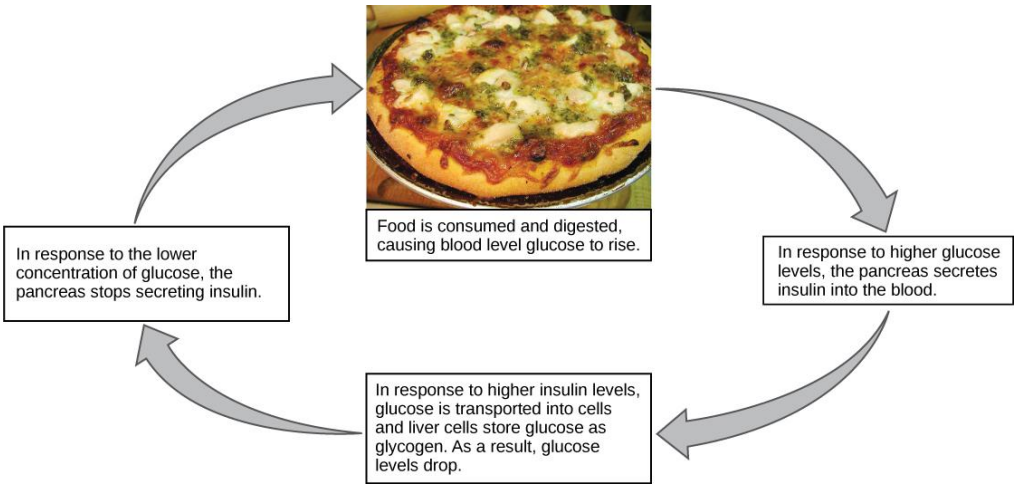
When a change occurs in an animal's environment, an adjustment must be made. The receptor senses the change in the environment, then sends a signal to the control center (in most cases, the brain) which in turn generates a response that is signaled to an effector. The effector is a muscle (that contracts or relaxes) or a gland that secretes. Homeostatsis is maintained by negative feedback loops. Positive feedback loops actually push the organism further out of homeostasis, but may be necessary for life to occur. Homeostasis is controlled by the nervous and endocrine system of mammals.




**Negative Feedback Mechanisms:**

Any homeostatic process that changes the direction of the stimulus is a **negative feedback loop**. It may either increase or decrease the stimulus,

but the stimulus is not allowed to continue as it did before the receptor sensed it.




**Positive Feedback Loop:**

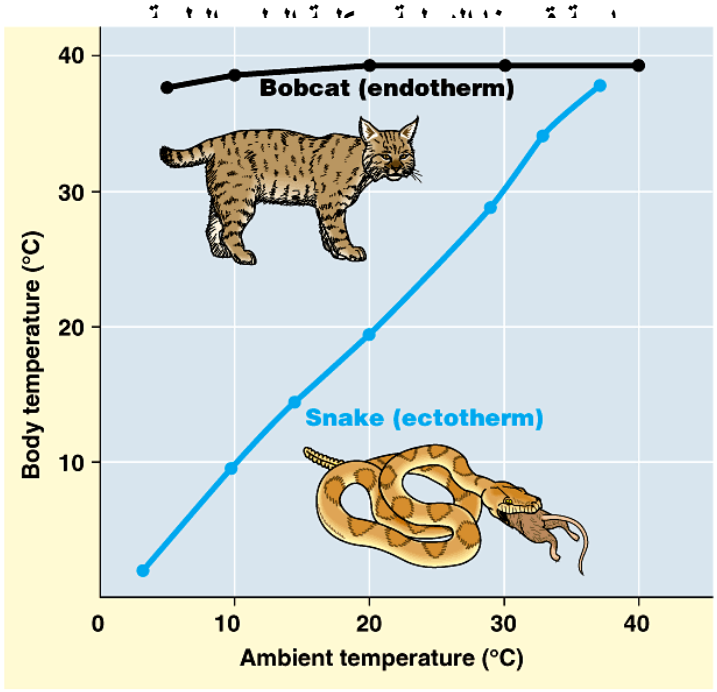
A **positive feedback loop** maintains the direction of the stimulus, possibly accelerating it. Few examples of positive feedback loops exist in animal bodies, but one is found in the cascade of chemical reactions that result in blood clotting, or coagulation.

## Thermoregulation

**Endotherms and Ectotherms**

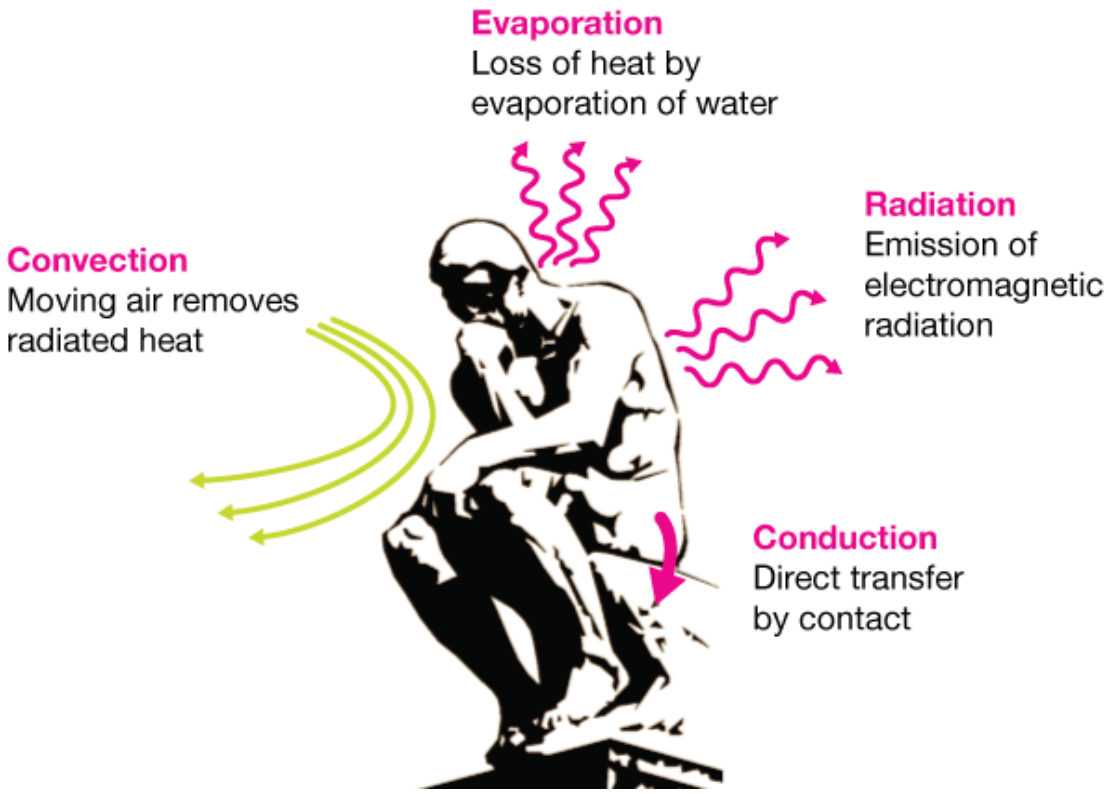
Animals can be divided into two groups: some maintain a constant body temperature in the face of differing environmental temperatures, while others have a body temperature that is the same as their environment and thus varies with the environment. Animals that do not control their body temperature are ectotherms. This group has been called cold blooded, but the term may not apply to an animal in the desert with a very warm body temperature.

Endotherms are animals that rely on internal sources for body temperature but which can exhibit extremes in temperature. These animals are able to maintain a level of activity at cooler temperature, which an ectotherm cannot due to differing enzyme levels of activity.





Heat can be exchanged between an animal and its environment through four mechanisms:
radiation, evaporation, convection, and conduction



# THE CIRCULATORY SYSTEM

# THE CARDIOVASCULAR and the LYMPHATIC SYSTEM

Most of the cells in the human body are not in direct contact with the external environment, so rely on the circulatory system to act as a transport service for them. Two fluids move through the circulatory system: blood and lymph.
The blood, heart, and blood vessels form the Cardiovascular System. The lymph, lymph nodes and lymph vessels form the Lymphatic System. The Cardiovascular System and the Lymphatic System collectively make up the Circulatory System.

1. Vertebrates have a closed circulatory system, meaning the blood is repeatedly cycled throughout the body inside a system of pipes.
2. blood was pumped out of the heart and into the tissues through one type of vessel and back to the heart through another type of vessel. The blood, in other words, moved in a closed cycle through the body.
3. Blood is the body‘s internal transportation system. Pumped by the heart, blood travels through a network of blood vessels, carrying nutrients (O2, glucose) and hormones to the cells and removing waste products (CO2. urea) from the cells of our bodies.
1. Arteries-carry blood away from the heart. These branch until they become microscopic capillaries. Carbon dioxide and wastes can pass into capillaries by diffusion. Nutrients diffuse out of capillaries into body tissues.
2. Capillaries lead to Veins, which carry deoxygenated blood back to the heart. This blood is then pumped to the lungs where it picks up oxygen. The oxygenated blood is then returned to the heart for dispersal to the body.

**BLOOD:**

- Is the only fluid tissue in the human body. Is a form of connective tissue. It is sticky and red in color because it contains red blood cells. It contains living cells and fluid.
- Blood is pushed through the body by the pumping action of the heart.

**CHARACTERISTICS OF BLOOD**:

A. It is classified as being a type of connective tissue since blood contains the 3 elements of connective tissue:

1. Cells
2. Matrix-the liquid portion of blood.
3. Fibers-mostly protein fibers such as fibrin. These provide support to blood. These also play a role in blood clotting.

B. It has a salty, metallic taste. This is due to the presence of iron.

C. Blood‘s color depends on the amount of oxygen it is carrying (Scarlet red blood is oxygen rich; whereas, dark red blood is low in oxygen).

D. Blood has a greater density than water.

E. Blood is slightly alkaline, with a Ph between 7.35 and 7.45.

F. It maintains a temperature around 100.4 degree F (38 degrees C). This is slightly higher than normal body temperature.

**FUNCTIONS OF BLOOD**:

A. Distribution: which includes:

1. Carrying oxygen from the lungs to body tissues.
2. Delivering nutrients and water to body tissues.
3. Transporting metabolic wastes from body tissues to sites of elimination, e.g.CO2 is carried to the lungs and nitrogen wastes to the kidneys.

B. Regulation: The regulatory functions of blood include: Maintaining normal body temperature by blood. It does this by absorbing and distributing heat throughout the body and to the skin where heat loss can occur.
C. Protection: this includes:
1. Preventing blood loss-platelets and blood proteins aid in clot formation which stops blood loss.
2. Fighting and preventing infection-antibodies and leukocytes are involved in fighting and preventing infection.

**COMPOSITION OF BLOOD:**

Blood is composed of 2 Primary Components:
1. Plasma-the liquid matrix of blood.
2. Formed Elements-blood cells and cell fragments. These are suspended in plasma.

**BLOOD PLASMA:**

The liquid portion of blood.
Plasma is a straw-colored, sticky fluid. Is Composed of:
1. Water: accounts for over 90% of total plasma volume. Water serves as a dissolving and suspending medium for blood solutes. It is also involved in absorbing heat and heat transfers.
2. Plasma Proteins: account for 8% of total plasma volume.

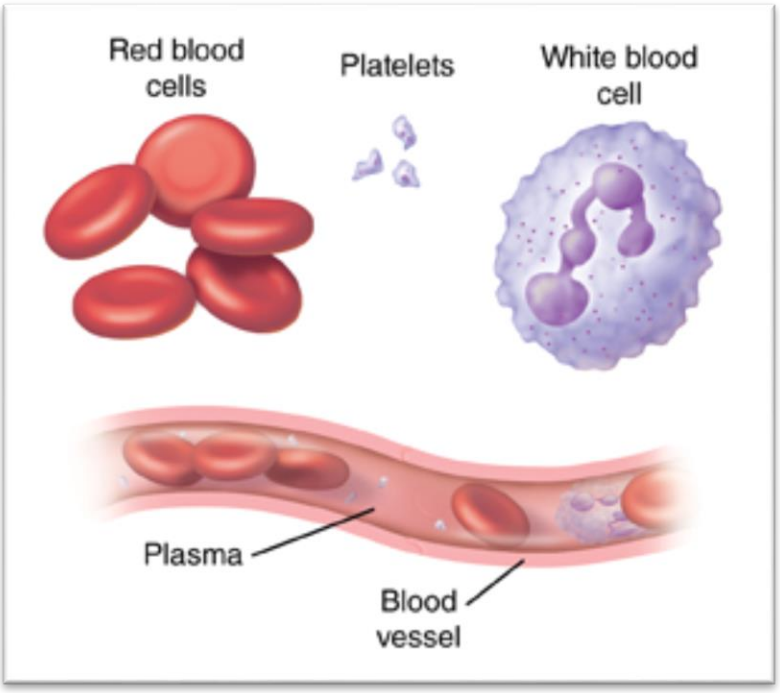
**FORMED ELEMENTS:**

Formed Elements in Human Blood:

1. Erythrocytes

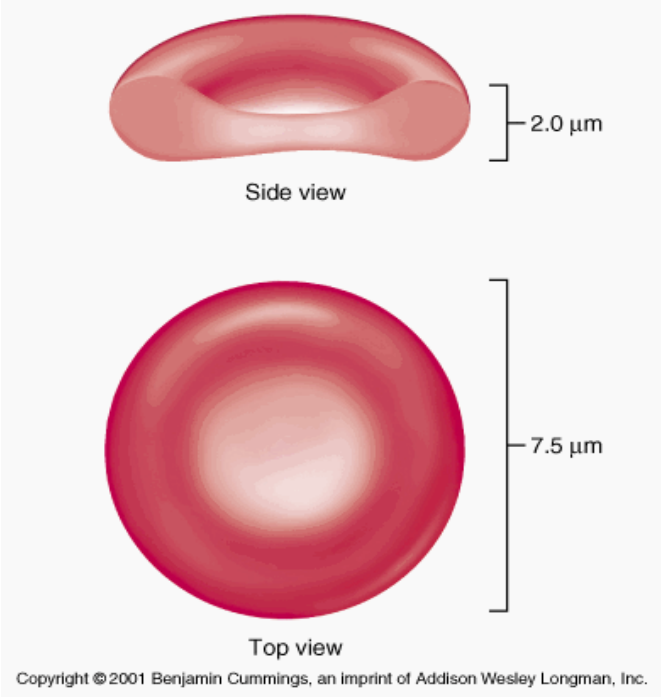
2. Leukocytes

3. Thrombocytes




**Erythrocytes-Red Blood Cells**:

1. Erythrocytes are small (7.5 micrometers in diameter), biconcave discs with depressed centers.
2. Cellular Structure of Erythrocytes: are bound by a true cellular membrane, and they lack a nucleus and they do not contain cellular organelles. Erythrocytes contain Hemoglobin (Hb).
3. Erythrocytes contribute greatly to blood viscosity.
4. Erythrocytes transport oxygen and carbon dioxide through the body. Much of the oxygen is carried by hemoglobin which is stored in erythrocytes.
5. Hemoglobin: transports most of the oxygen through the body. It can also carry carbon dioxide.




**Leukocytes -white blood cells:**

a. They are complete cells-leukocytes contain a nucleus and organelles.

b. They can divide to reproduce.

c. Leukocytes help fight disease and they protect us from damage by bacteria, viruses, parasites, toxins and tumor cells.

Whenever an infection occurs, the body increases its leukocyte production.

**Leukocytes are Classified into 2 Major Categories:**

a. Granulocytes: contain membrane-bound cytoplasmic granules.

b. Agranulocytes: do not contain membrane-bound cytoplasmic granules.

**Types of Granulocytes:**

1) Neutrophils

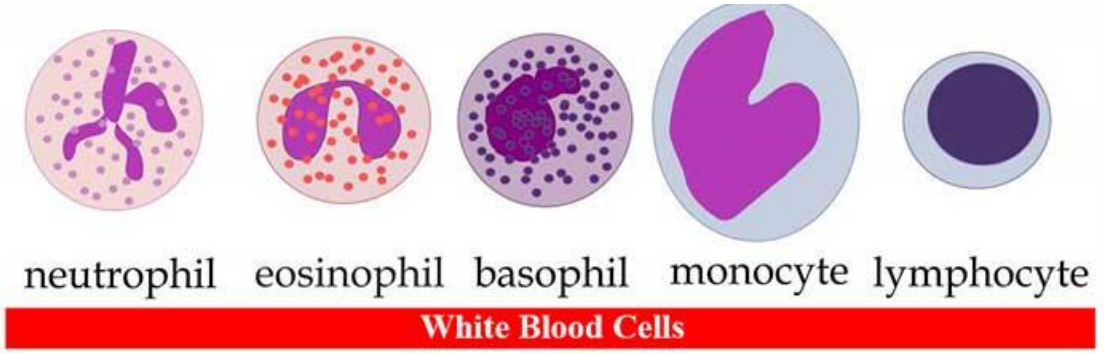
2) Eosinophils

3) Basophils

**Types of Agranulocytes:**

1) Lymphocytes:

2) Monocytes




**Thrombocytes (Platelets):**

are cell fragments, not true cells.
1. Platelets contain many small, purple-staining granules. These granules contain chemicals that are involved in blood clotting. The chemicals include: serotonin, Ca+, ATP, enzymes, and clot factors.
2. Platelets begin forming clots when blood vessels are broken. They stick to the damaged site to form a plug which stops blood loss.
3. They live for only about 10 days if they are not involved in clot formation.
4. Platelet formation-is regulated by the hormone thrombopoietin.

# Immune system

The body has a system of cells – the immune system – that has the ability to distinguish "self" (the organism's own molecules) from "nonself" (foreign substances). This system has the ability to neutralize or inactivate foreign molecules (such as molecules present in viruses, bacteria, and parasites) and destroy microorganisms or other cells (virus-infected cells, cells of transplanted organs, and cancer cells).

**What is the immune system?**
Biological mechanism for identifying and destroying pathogens within a larger organism.
Pathogens: agents that cause disease such as , bacteria, viruses, fungi, and worms, etc.

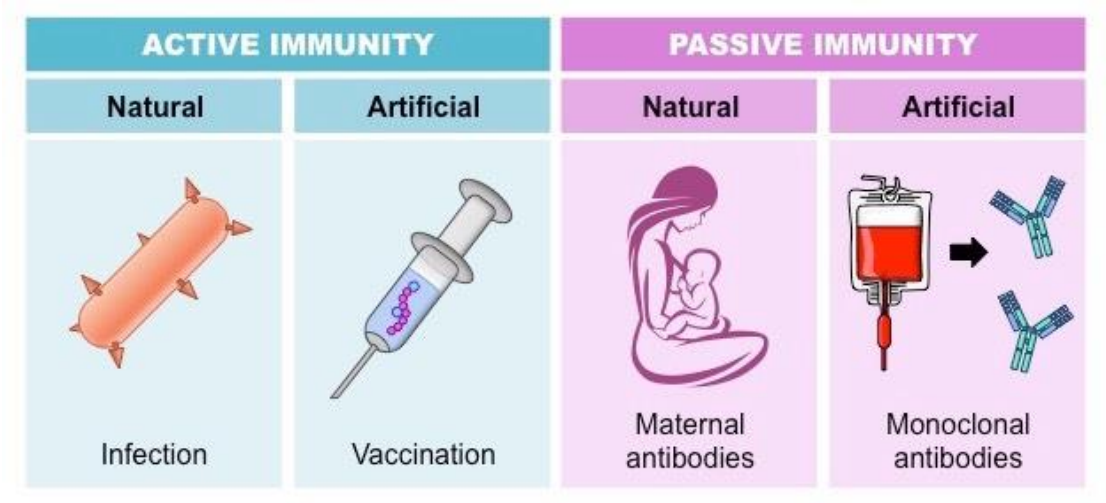
**TYPES OF IMMUNITY :**
**Passive Immunity:**
1. Antibodies from another person or animal that can be injected or transfused.
2. Called passive because the individual did not create the antibodies, but instead received pre-formed antibodies.
3. Protection is effective, but duration is short lived and no memory is created.
4. Examples of passive immunity are maternal antibodies (trans-placental and breast milk) and injected antibodies "sera" (e.g., rabies and tetanus immune globulins).

**Active Immunity:**
When the body is exposed to a foreign substance the cells of the immune system -actively- respond such as (vaccine) -

person exposed to -weakened- antigens. Active immunity is further divided into categories:

**1. Innate Immunity :**protective mechanisms we are born with.

**2. Adaptive Immunity :**cell mediated immunity and humoral immunity.

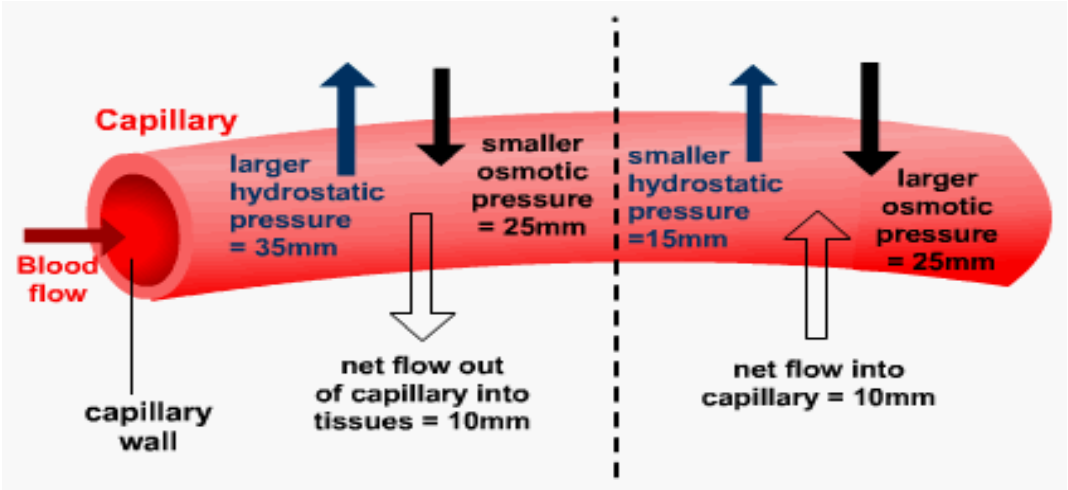


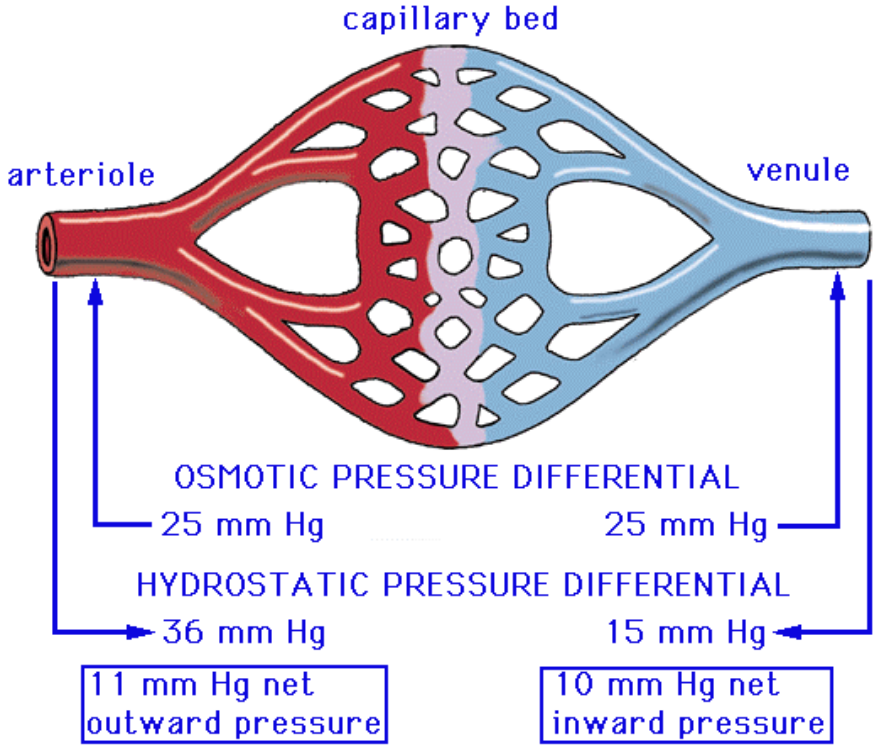

The immune system provides the second and third lines of defense against invading pathogens. The first line of defense is epithelial barrier, namely skin and mucosa, once this physical barrier is breached by a cut or abrasion, or even if foreign substances are able to penetrated, the intact barrier, the second and the third lines of defense may become activated; these are the innate and the adaptive immune system.

# Tissue Fluid And The Lymphatic System

1. As blood passes through the capillaries, about 10% of its fluid leaks into the surrounding tissues. This is known as tissue fluid.
2. This fluid carries chemicals such as glucose and hormones to the cells of the body that are not next to the capillary, and removes waste products, such as urea and CO2.
3. The mechanism of fluid formation is:
a) The high blood pressure (hydrostatic pressure) at the arteriole end of the capillary bed is much greater than the solute potential (osmotic pressure) of the surrounding cells. Thus fluid is forced out of the capillary.
b) at the venous end of the capillary bed, the blood pressure (hydrostatic pressure) is low,
whilst the solute potential (osmotic pressure) of the blood is much stronger, since the blood is more concentrated. [The proteins in the blood are generally too big to leave the capillaries, whilst the blood cells (and their proteins) all remain behind]. This causes some water to be returned to the blood in the capillaries by osmosis.
c) The overall effect is to ensure that the tissue fluid is constantly on the move and so every cell in the body receives a fresh supply of nutrients.
4. Not all of the fluid forced out of the capillaries is returned by osmosis, and a network of vessels known as the lymphatic system collects this excess fluid and returns it to the circulatory system.
5. This fluid ( lymph ) flows through wider and wider vessels which contain valves to ensure a one-way flow, before it is returned to the blood in the vena cava, just outside the right atrium (where blood pressure is lowest).
6. The lymphatic system has no pump, so lymph must be moved through vessels by the squeezing of skeletal muscles.

7. These lymph vessels pass through small bean-shaped enlargements (organs) called lymph nodes, which produce one type of white blood cell (lymphocytes) which are an important source of antibodies and help us to fight infection.
Examples of lymph organs are the tonsils, the appendix, the spleen and the thymus gland.



**Functions of Lymphatic System**

**fluid recovery**

◦ fluid continually filters from the blood capillaries into the tissue spaces

**immunity**

◦ excess filtered fluid picks up foreign cells and chemicals from the tissues

**lipid absorption**

◦lacteals in small intestine absorb dietary lipids that are not absorbed by the blood capillaries

# The Respiratory System

The respiratory system provides for gas exchange, intake of oxygen and elimination of carbon dioxide, whereas the cardiovascular system transports these gases in the blood between the lungs and the body‘s cells.

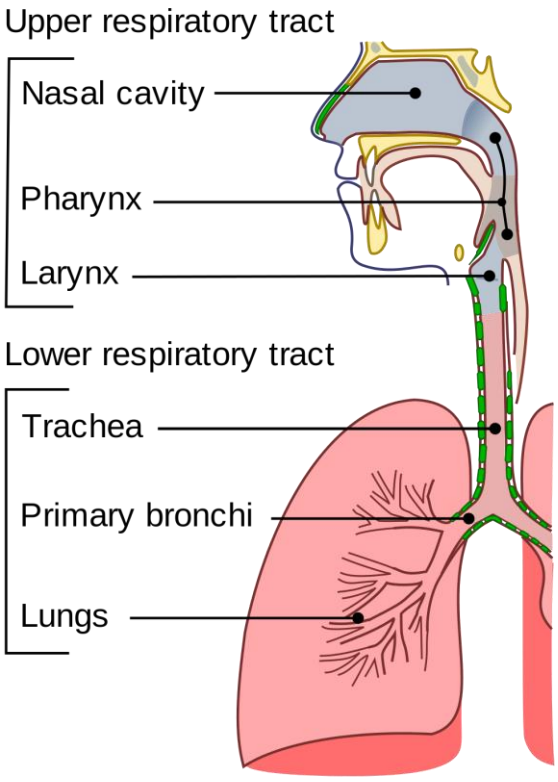
**In addition to functioning in gas exchange, the respiratory system also:**

1. Regulates blood pH
2. Contains receptors for smell
3. Filters inspired air
4. Produces sound
5. Eliminates some water vapor and heat in exhaled air

**Anatomy of Respiratory System :**

1.The **upper respiratory system** includes: nose , pharynx and larynx.

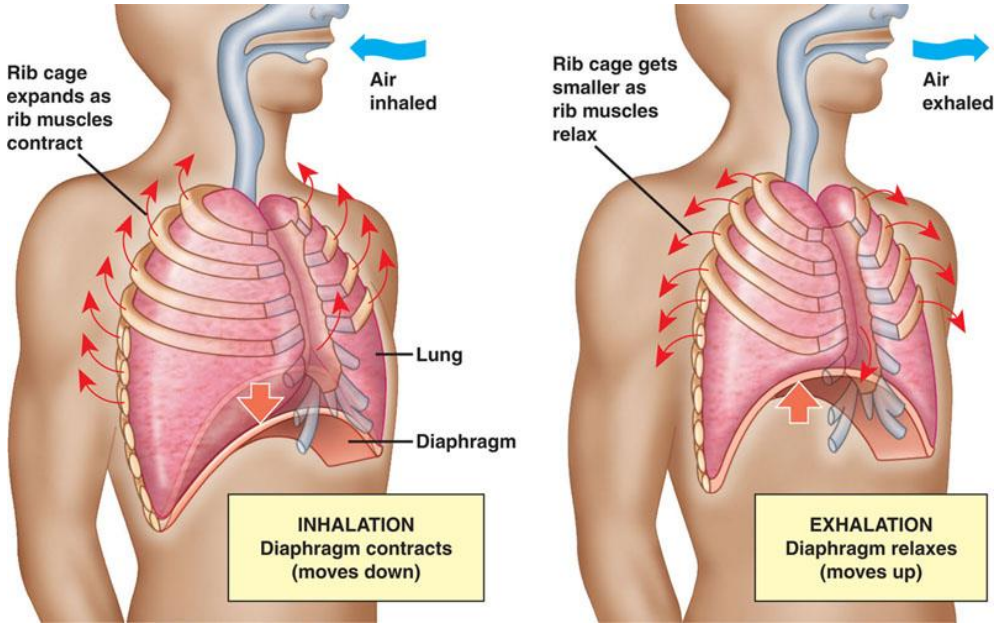
2. The **lower respiratory system** includes: trachea, bronchi and lungs.



The exchange of gases between the atmosphere, blood, and cells is called **respiration**; it consists of three major processes:
-**pulmonary ventilation** or breathing, which includes inspiration and expiration of air between the lungs and the atmosphere
- **external (pulmonary) respiration**, the exchange of gases between the air spaces in the lungs and the blood in pulmonary capillaries; the blood gains O2 and loses CO2.
- **internal (tissue) respiration,** the exchange of gases between the blood in systemic capillaries and the body‘s cells; the blood loses O2 and gains CO2

**Inspiration:**
a. Inspiration (inhalation) is the process of moving air into the lungs.
b. It occurs when air pressure within the alveoli of the lungs, called alveolar pressure, is lower than atmospheric pressure.
c. It is achieved by expanding the lungs, a process which increases the volume of the lungs and therefore decreases the air pressure within the lungs below atmospheric pressure.
**The major inspiratory muscles are:**
a. diaphragm (the most important inspiratory muscle)
b. external intercostals.

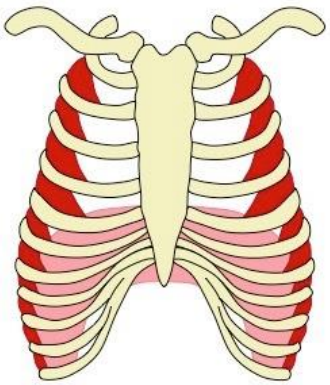
**Expiration:**
a. Expiration (exhalation) is the process of moving air out of the lungs.
b. It occurs when air pressure in the lungs is greater than atmospheric pressure.
c. Unlike inspiration, normal expiration is a passive process since no muscular contractions are involved.
d. It is achieved by relaxation of the inspiratory muscles.




**Muscles of Inspiration**

**Core Muscles**

- External intercostals
  *(contracts to elevate ribs)*
- Diaphragm
  *(contracts to expand thoracic cavity)*

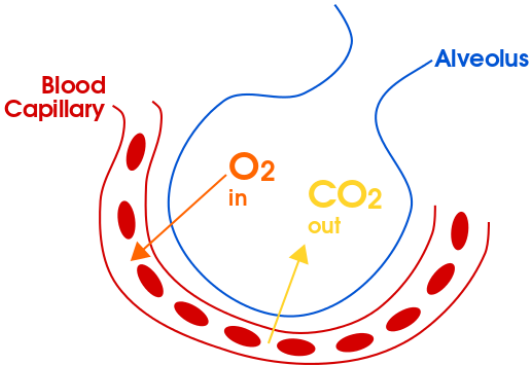


**Muscles of Expiration**

**Core Muscles**

- Internal intercostals
  *(contracts to pull ribs down)*
- Diaphragm
  *(relaxes to reduce thoracic cavity)*

-Diffusion of gases through the respiratory membrane proceeds from where a gas is at high pp to low pp.



# The Digestive System

Vertebrates have evolved more complex digestive systems to adapt to their dietary needs. Some animals have a single stomach, while others have multi-chambered stomachs. Birds have developed a digestive system adapted to eating unmasticated food.

**Functions of the Digestive System:**

**Digestion:**
Mechanical digestion –muscular movement of the digestive tract (mainly in the oral cavity and stomach) physically break down food into smaller particles .
chemical digestion –hydrolysis reactions aided by enzymes(mainly in the stomach and small intestine) chemically break down food particles into nutrient molecules , small enough to be absorbed .
**Secretion**–enzymes and digestive fluids secreted by the digestive tract and its accessory organs facilitate chemical digestion .
**Absorption**–passage of the end –products (nutrients) of chemical digestion from the digestive tract into blood or lymph for distribution to tissue cells .
**Elimination**–undigested material will be released through the rectum and anus by defecation.

**Organization of The Digestive System**
Organs of the digestive system are divided into 2 main group : the gastrointestinal tract (GI tract) and accessory structures .

GI tract is a continuous tube extending through the ventral cavity from the mouth to the anus –it consists of the mouth , oral cavity , oropharynx , esophagus, stomach, small intestine, large intestine, rectum , and anus .
Accessory structures include the teeth, tongue (in oral cavity), salivary glands, liver, gallbladder , and pancreas

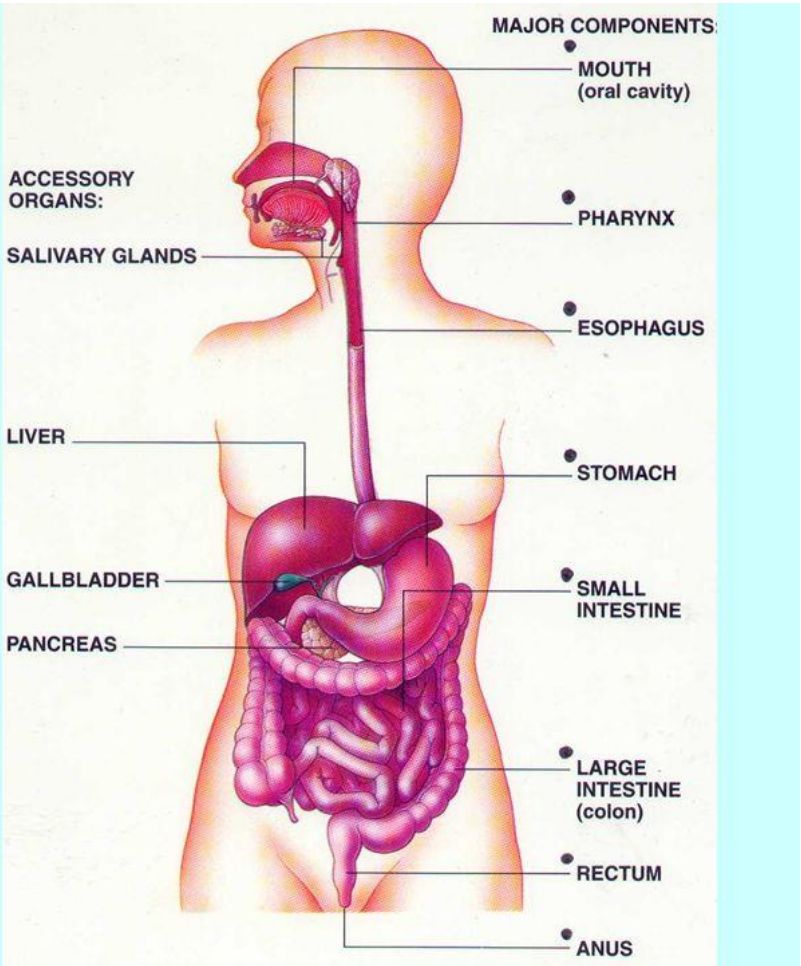
# Digestive System

## Gastrointestinal Tract

1. Mouth
2. Pharynx
3. Esophagus
4. Stomach
5. Small Intestine
6. Large Intestine

## Accessory Structures

1. Teeth
2. Tongue
3. Salivary Glands
4. Liver
5. Gallbladder
6. Pancreas



# Nervous System

The nervous system is the body‘s control center and communications network.

**Functions of the Nervous System:**

The human nervous system serves 3 broad functions:

**A. Sensory**

The nervous system senses changes within the body and in the outside environment.

**B. Integrative**

The nervous system interprets the changes and determines the appropriate response based on past experiences, reflexes, and current conditions.

**C. Motor**

The nervous system responds to the interpretation by initiating action in the form of muscular contractions or glandular secretions.

**Organization of the Nervous System:**

The nervous system can be divided into 2 principle divisions: The CNS and PNS

*A.* ***Central Nervous System (Brain and Spinal Cord):***

-This is the control center for the entire nervous system.

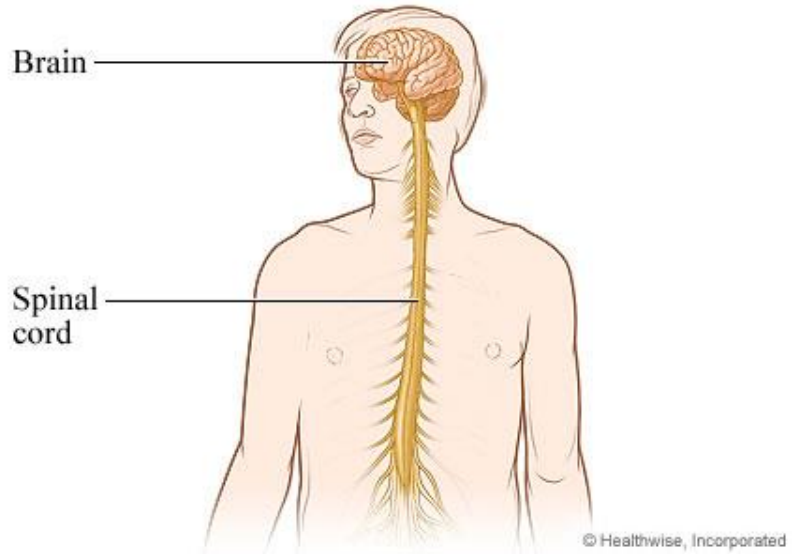
-It consists of the brain and spinal cord.

-All body sensations must be relayed from receptors to the CNS if they are to be interpreted and acted on.

-All of the nerve impulses that stimulate muscles to contract and glands to secrete must also originate in the CNS.

-Thus, we say the CNS integrates and coordinates sensory data and motor commands.

-The CNS is also the part of the nervous system that is involved in ―higher‖ functions such as intelligence, memory, and emotion.



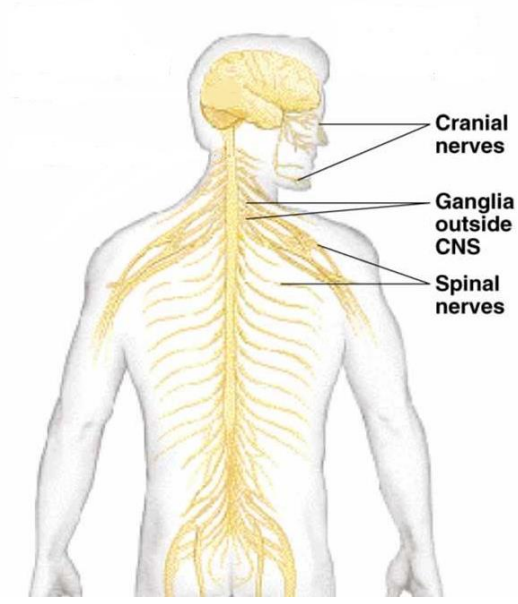

*B.* ***Peripheral Nervous System (Cranial Nerves, Spinal Nerves, and Ganglia):***

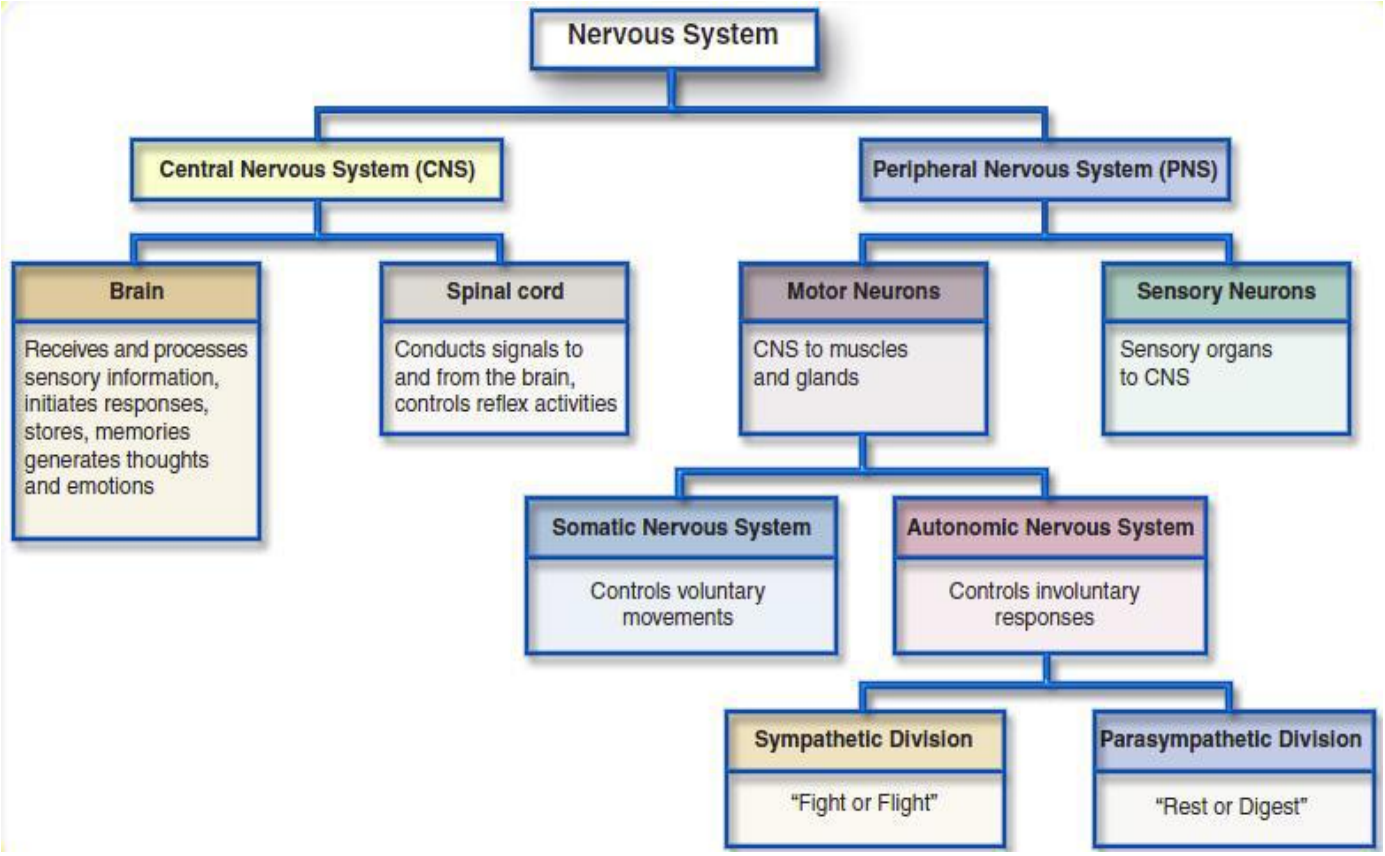
The PNS is made up of cranial nerves, spinal nerves, and ganglia. They connect the brain and spinal cord with receptors, muscles, and glands.

**Cranial nerves** carry signals to and from the brain

**Spinal nerves** carry signals to and from the spinal cord

**Ganglia** are areas in the PNS where the cell bodies of neurons are clustered.




Nervous System
Central Nervous System (CNS)
Peripheral Nervous System (PNS)
Brain
Receives and processes sensory information, initiates responses, stores, memories generates thoughts and emotions
Spinal cord
Conducts signals to and from the brain, controls reflex activities
Motor Neurons
CNS to muscles and glands
Sensory Neurons
Sensory organs to CNS
Somatic Nervous System
Controls voluntary movements
Autonomic Nervous System
Controls involuntary responses
Sympathetic Division
"Fight or Flight"
Parasympathetic Division
"Rest or Digest"

# Muscular System

**Functions of muscle tissue:**

- Movement
- Maintenance of posture
- Joint stabilization
- Heat generation

**Characteristics of muscle**

1- Contractility
- able to shorten in length
- Shortening generates pulling force

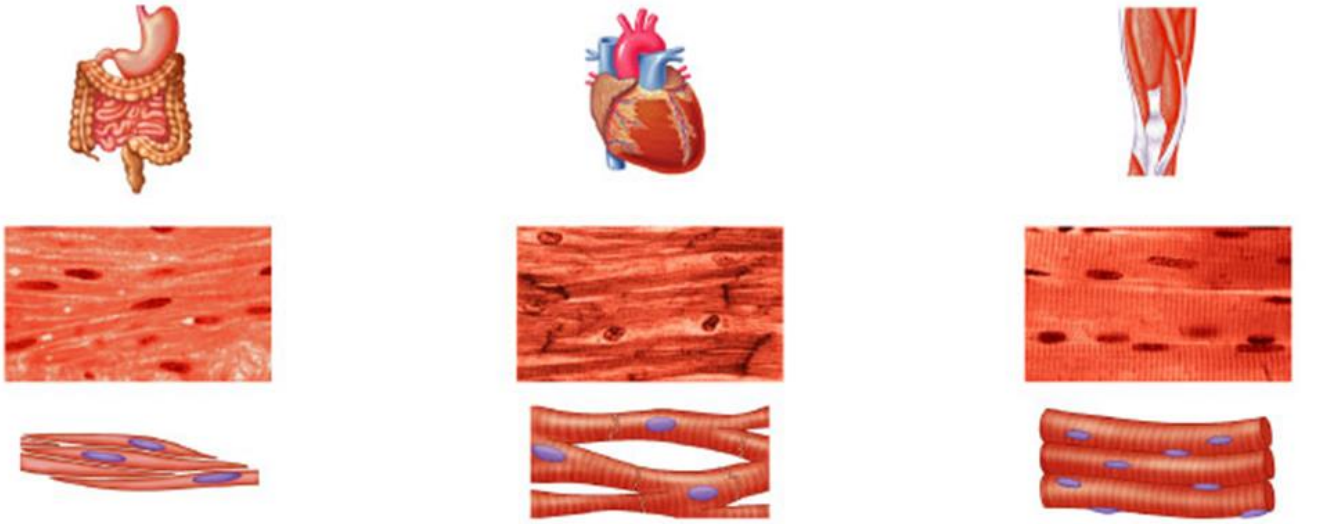
2- Excitability
- Nerve fibers cause electrical impulse to travel
- Response to stimuli

3- Extensibility
- Stretch with contraction of an opposing muscle (stretched when pulled)

4- Elasticity
- Recoils passively after being stretched
- Tends to return to original shape and length after contraction or extension

## Types of muscle:





**Smooth muscle**
- has spindle-shaped, nonstriated uninucleated fibers.
- occurs in walls of internal organs.
- is involuntary.

**Cardiac muscle**
- has striated, branched, uninucleated fibers.
- occurs in walls of heart.
- is involuntary.

**Skeletal muscle**
- has striated, tubular, multinucleated fibers.
- is usually attached to skeleton.
- is voluntary.

# EXCRETORY SYSTEM

EXCRETION: The process of removal of metabolic wastes from the body.

Osmoregulation: The process by which living organisms maintain an osmotic pressure in the body by regulating the amount of water and salts.

**Kinds of wastes excreted :**

- Nitrogenous wastes: These are the major waste products formed during the breakdown of extra amino acids and nucleic acids.
- Non- nitrogenous wastes: oxalic acid and lactic acid.
- Excess chemicals: like drugs, vitamins, hormones, cholesterol etc.
- Bile pigments: like bilirubin and biliverdin.
- Carbon dioxide
- Excess water.

**The route of excretion:**

- Lungs: excrete carbon dioxide and water vapor.
- Skin: excretes metabolic wastes in perspiration (water, salt, and urea).
- Liver: produced urea.
- Kidneys: filter metabolic wastes (water, salt, and urea) from blood.

**The Human Excretory System:**

The urinary system is made-up of the **kidneys**, **Ureters**, **Bladder**, and **Urethra**. The **Nephron**, an evolutionary modification of the nephridium, is the kidney's functional unit. Waste is filtered from the blood and collected as urine in each kidney. Urine leaves the kidneys by ureters, and collects in the bladder. The bladder can distend to store urine that eventually leaves through the urethra.

**Functions of kidneys**

- Removal of waste products
- Maintaining water balance.
- Elimination of excess water soluble substances.
- Regulation of salts content.
- Maintenance of pH.
- Regulation of blood pressure.

# THE ENDOCRINE SYSTEM

An animal‘s endocrine system controls body processes through the production, secretion, and regulation of hormones, which serve as chemical —messengers functioning in cellular and organ activity and, ultimately, maintaining the body‘s homeostasis.

The endocrine system plays a role in growth, metabolism, and sexual development.

## How Hormones Work:

Hormones mediate changes in target cells by binding to specific Hormone receptors.

In up-regulation, the number of receptors increases in response to rising hormone levels, making the cell more sensitive to the hormone and allowing for more cellular activity.

When the number of receptors decreases in response to rising hormone levels, called down-regulation, cellular activity is reduced.

Hormones can mediate changes directly by binding to intracellular hormone receptors and modulating gene transcription, or indirectly by binding to cell surface receptors and stimulating signaling pathways.

## The Structure of DNA

Watson and Crick‘s ( 1950 ) they construct a model of DNA
DNA is a very regular polymer of nucleotides:
1.Each nucleotide subunit contains a nitrogenous base which may be one of burines ( Adenine or Guanine ) or one of pyrimidines ( Thymine or Cytocine ). Each base is covalently linked to five-carbon sugar deoxyribose, which is covalently bonded to phosphate group.
2.The back bone of each single DNA chain is forming by alternating sugar and phosphate groups, joined by covalent phosphodiester linkages. Each phosphate group is attached to the 5‘carbon of one deoxyribose and to 3‘ carbone of the neighboring deoxyribose.
3. Each DNA molecule is composed of two polynucleotide chains that associate as double helix. The two chains are antiparallel( meaning they run in opposite directions ) at each end of the DNA molecule one chain has exposed 5‘ deoxyribose carbon ( the 5, end ) and the other has exposed 3‘ deoxyribose carbon ( the 3‘ end ) .
The two chains of helix are held together by hydrogen bonding between specific base pairs Adenine ( A ) forms two hydrogen bonds with Thymine ( T ) Guanine ( G ) forms three hydrogen bonds with Cytocine ( C ). Chargaff ‗s rules A= T and G =C ( complementary base pair ). Because the two stands of DNA are held together by complementry base-pairing, it is possible to predict the base sequence of one strand if one knows the base sequence of the other strand.

# Biology Laboratory

# Compound Microscope Parts

A high power or compound microscope achieves higher levels of magnification than a stereo or low power microscope. It is used to view smaller specimens such as cell structures which cannot be seen at lower levels of magnification. Essentially, a compound microscope consists of structural and optical components. However, within these two basic systems, there are some essential components that every microscopist should know and understand. These key microscope parts are illustrated and explained below.

**STRUCTURAL COMPONENTS**

The three basic, structural components of a compound microscope are the head, base and arm.

- **Head/Body** houses the optical parts in the upper part of the microscope.
- **Base** of the microscope supports the microscope and houses the illuminator.
- **Arm** connects to the base and supports the microscope head. It is also used to carry the microscope.

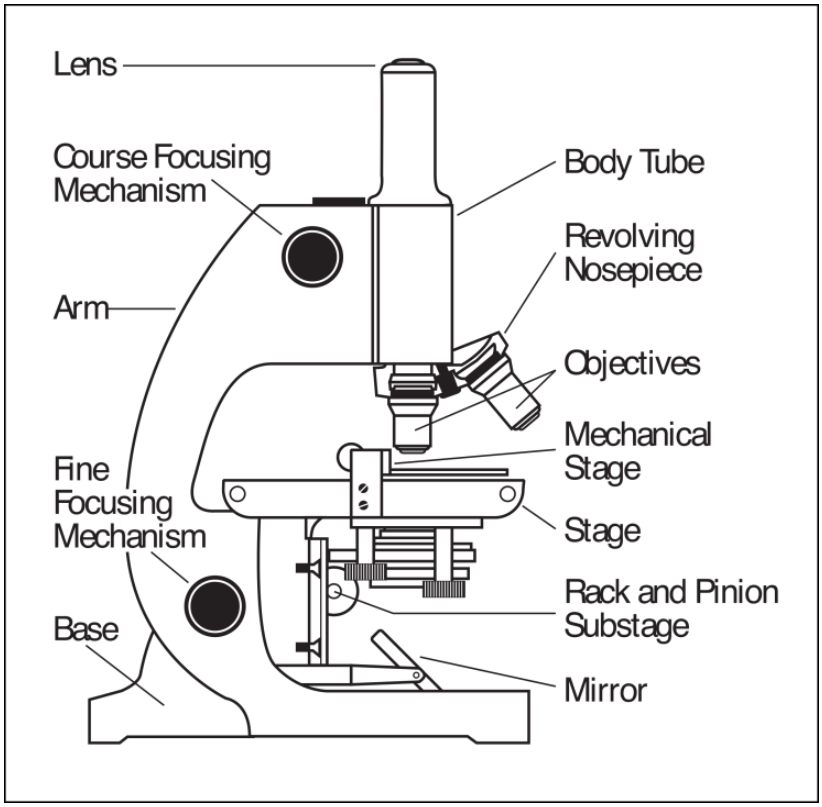
When carrying a compound microscope always take care to lift it by both the arm and base, simultaneously.

There are two optical systems in a compound microscope: Eyepiece Lenses and Objective Lenses:

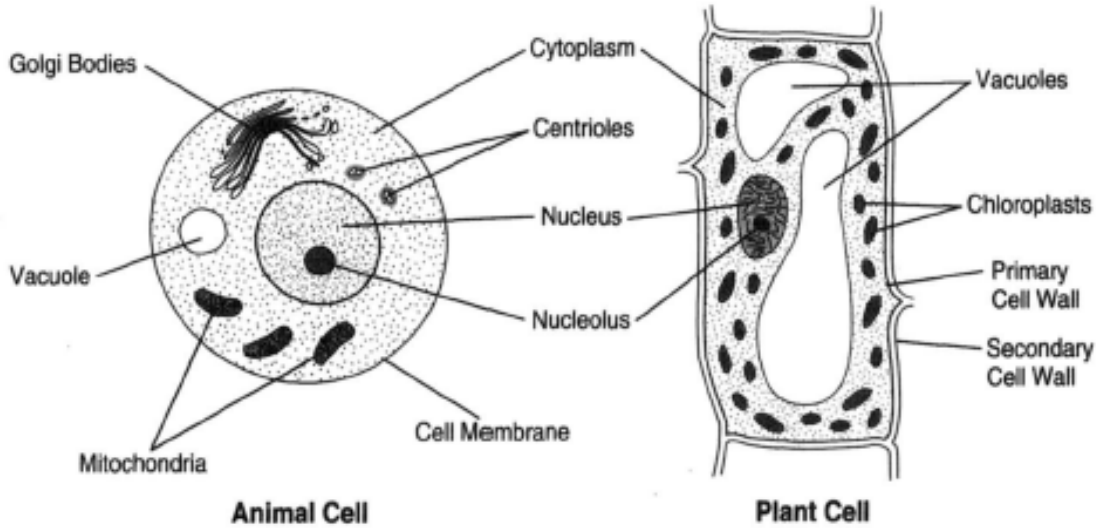
**Eyepiece or Ocular** is what you look through at the top of the microscope. Typically, standard eyepieces have a magnifying power of 10x. Optional eyepieces of varying powers are available, typically from 5x-30x.

**Eyepiece Tube** holds the eyepieces in place above the objective lens. Binocular microscope heads typically incorporate a diopter adjustment ring that allows for the possible inconsistencies of our eyesight in one or both eyes. The monocular (single eye usage) microscope does not need a diopter. Binocular microscopes also swivel (Interpupillary Adjustment) to allow for different distances between the eyes of different individuals.

**Objective Lenses** are the primary optical lenses on a microscope. They range from 4x-100x and typically, include, three, four or five on lens on most microscopes. Objectives can be forward or rear-facing.
**Nosepiece** houses the objectives. The objectives are exposed and are mounted on a rotating turret so that different objectives can be conveniently selected. Standard objectives include 4x, 10x, 40x and 100x although different power objectives are available.
**Coarse and Fine Focus knobs** are used to focus the microscope. Increasingly, they are coaxial knobs - that is to say they are built on the same axis with the fine focus knob on the outside. Coaxial focus knobs are more convenient since the viewer does not have to grope for a different knob.
**Stage** is where the specimen to be viewed is placed. A mechanical stage is used when working at higher magnifications where delicate movements of the specimen slide are required.
**Stage Clips** are used when there is no mechanical stage. The viewer is required to move the slide manually to view different sections of the specimen.
**Aperture** is the hole in the stage through which the base (transmitted) light reaches the stage.
**Illuminator** is the light source for a microscope, typically located in the base of the microscope. Most light microscopes use low voltage, halogen bulbs with continuous variable lighting control located within the base.
**Condenser** is used to collect and focus the light from the illuminator on to the specimen. It is located under the stage often in conjunction with an iris diaphragm.
**Iris Diaphragm** controls the amount of light reaching the specimen. It is located above the condenser and below the stage. Most high quality microscopes include an Abbe condenser with an iris diaphragm. Combined, they control both the focus and quantity of light applied to the specimen.
**Condenser Focus Knob** moves the condenser up or down to control the lighting focus on the specimen.


Lens
Course Focusing Mechanism
Arm
Fine Focusing Mechanism
Base
Body Tube
Revolving Nosepiece
Objectives
Mechanical Stage
Stage
Rack and Pinion
Substage
Mirror

# Animals cell compared whit Plant cell

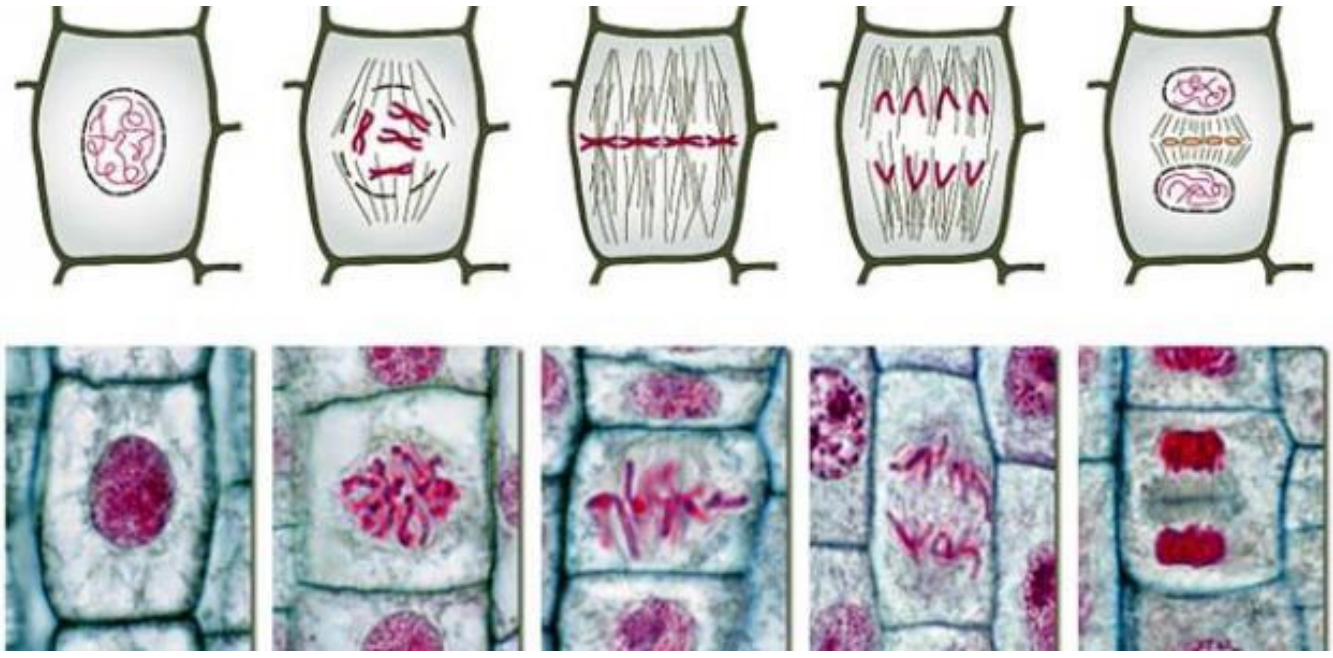



| Animal cell | Plant cell |
|---|---|
| No cell wall | Cell wall |
| One or more small vacuoles | Large vacuole to store water |
| Can't make their own food | Can make their food by photosynthesis |
| Centrioles | No centrioles |
| No plastids or chloroplasts | plastids / chloroplasts |
| Often have cilia or flagella | Flagella may found only in gametes |
| | |
| Plasma membrane | Plasma membrane |
| Cytoplasm | Cytoplasm |
| Mitochondrion | Mitochondrion |
| Golgi apparatus | Golgi apparatus |
| ER | ER |
| Nucleus/DNA | Nucleus/DNA |
| ribosome | ribosome |

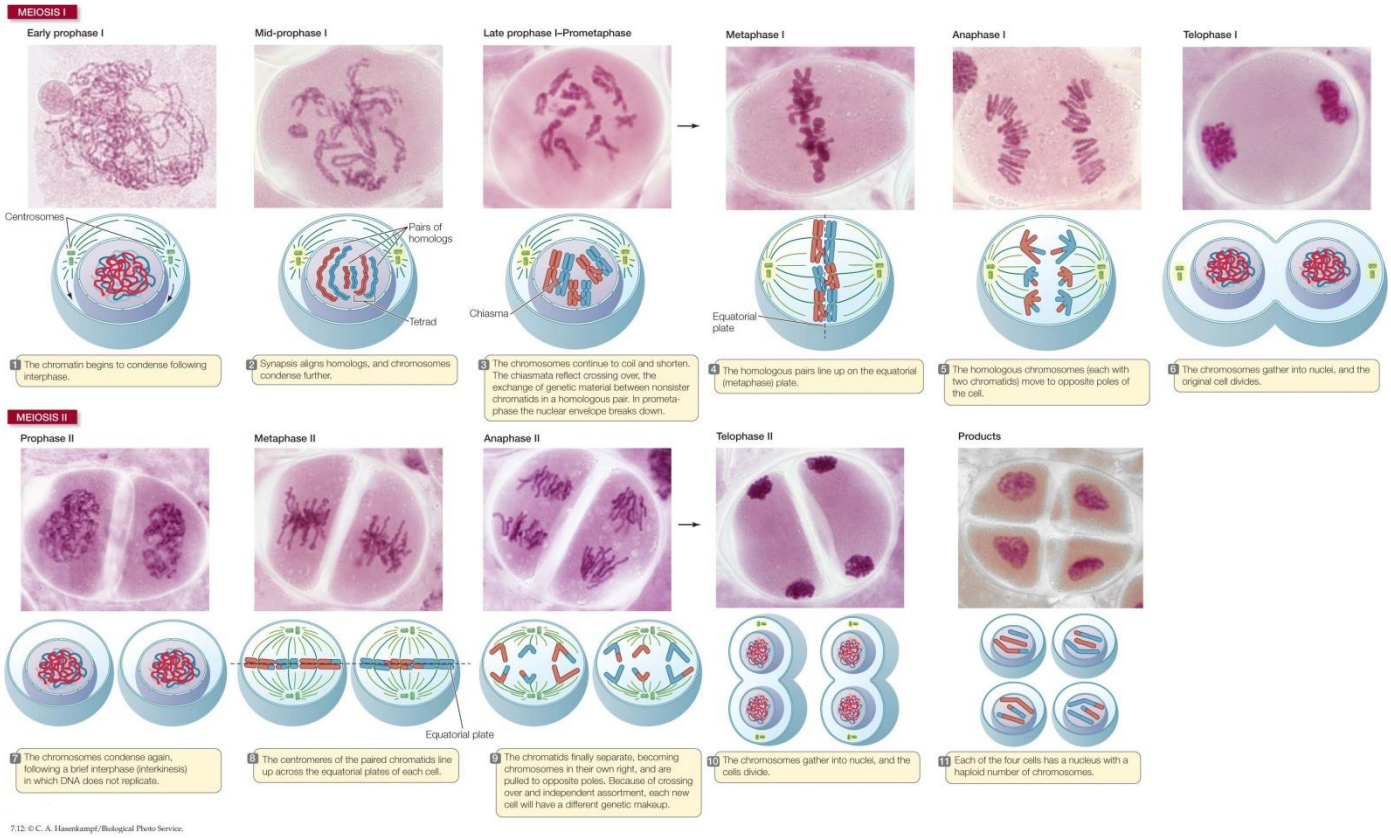
## The process of Mitosis compared whit Meiosis

| Mitosis | meiosis |
|---|---|
| 1-create 2 new cells. | 1-create 4 new cells. |
| 2-diploid new cells. | 2-haploid new cells. |
| 3-homologous chromosome pairs. | 3-no homologous chromosome pairs. |
| 4-create body cells. | 4-create gametes(sperm/ova). |
| 5-no segregations. | 5-segregated chromosomes. |
| 6-ending human cells have 46 chromosome. | 6-ending human cells have 23 chromosome. |

# Mitosis



# Meiosis




7.12. © C. A. Hasenkampf/Biological Photo Service.

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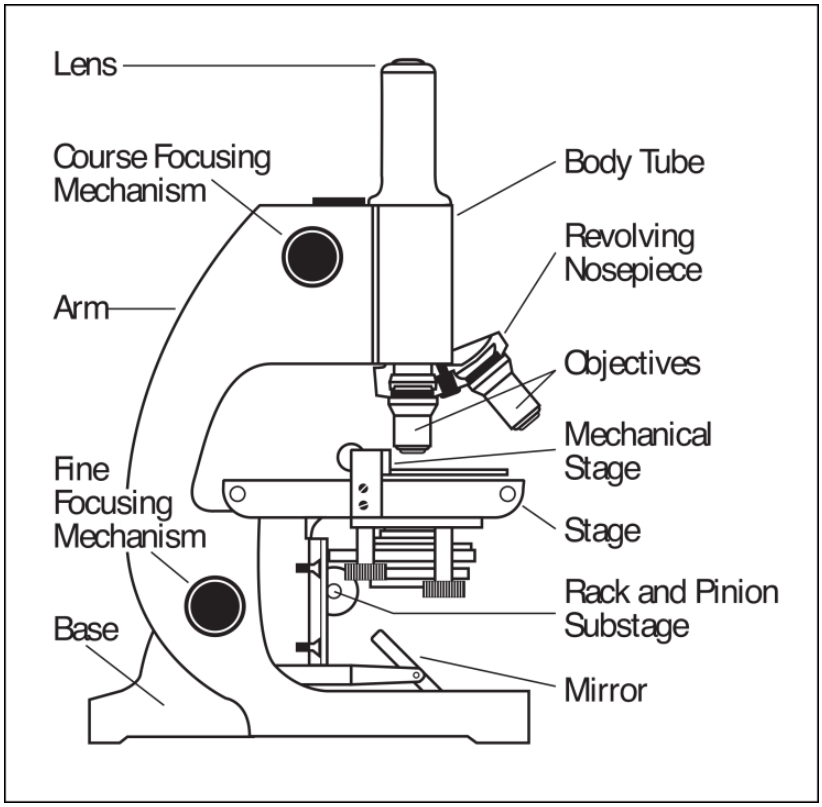
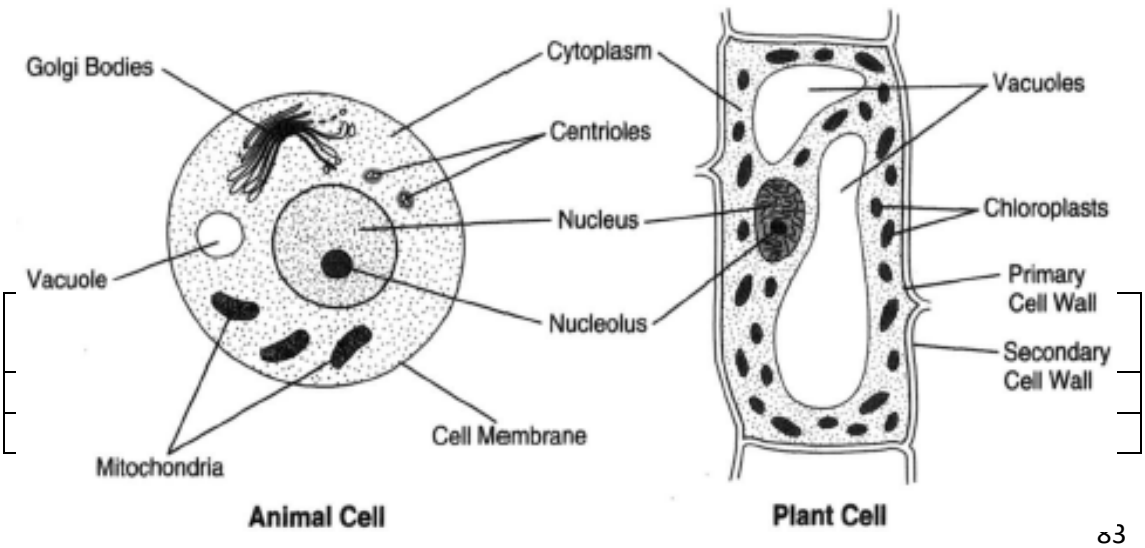



**Animals cell compared whit Plant cell**



| | |
|---|---|
| **Can't make their own food** | **Can make their food by photosynthesis** |
| **Centrioles** | **No centrioles** |
| **No plastids or chloroplasts** | **plastids / chloroplasts** |
| **Often have cilia or flagella** | **Flagella may found only in gametes** |
| | |
| **Plasma membrane** | **Plasma membrane** |
| **Cytoplasm** | **Cytoplasm** |
| **Mitochondrion** | **Mitochondrion** |
| **Golgi apparatus** | **Golgi apparatus** |
| **ER** | **ER** |
| **Nucleus/DNA** | **Nucleus/DNA** |
| **ribosome** | **ribosome** |

**The process of Mitosis compared whit Meiosis**

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|---|---|
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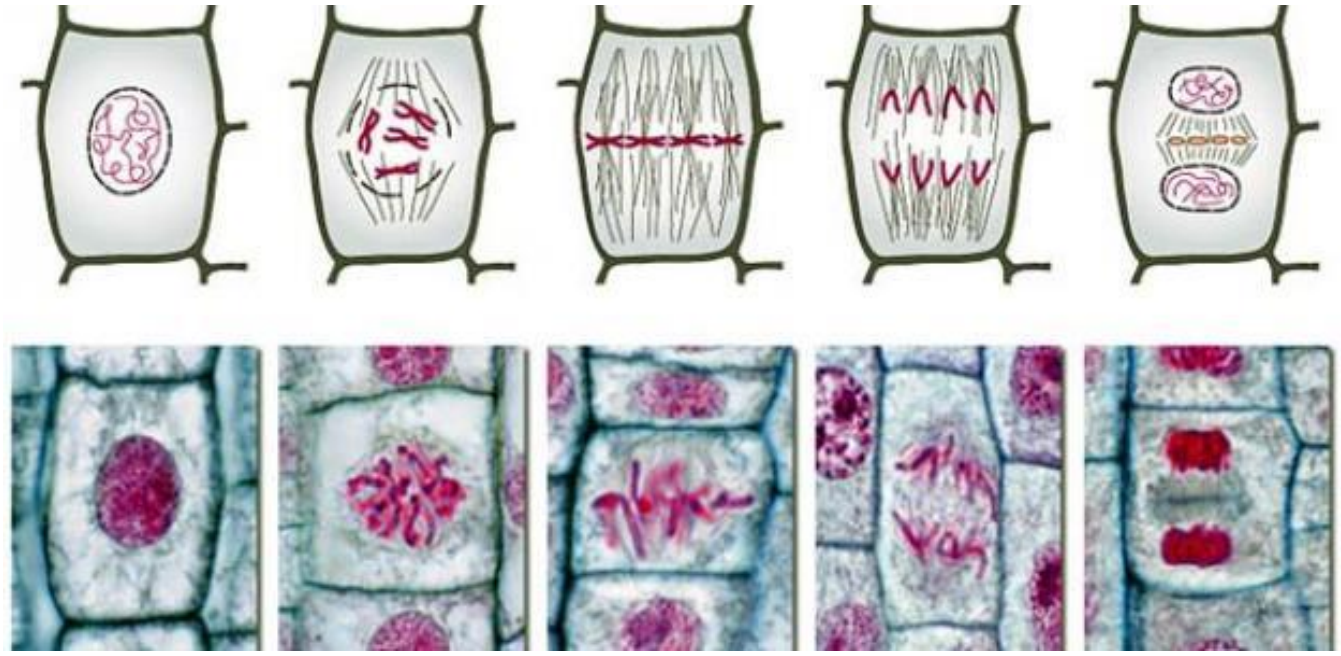
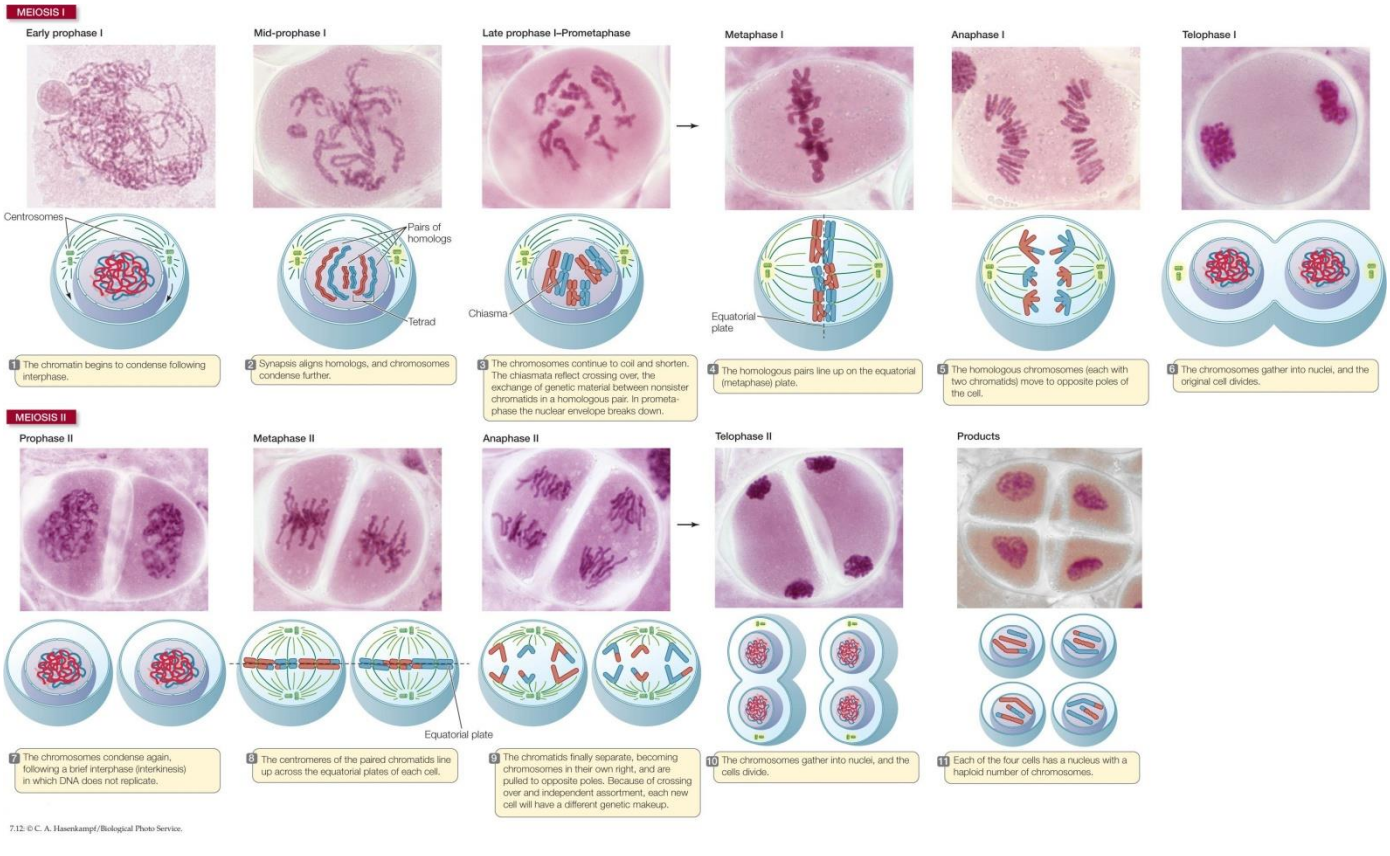
**Mitosis**




MEIOSIS I
Early prophase I
Mid-prophase I
Late prophase I–Prometaphase
Metaphase I
Anaphase I
Telophase I
Centrosomes
Pairs of homologs
Tetrad
Chiasma
Equatorial plate
1 The chromatin begins to condense following interphase.
2 Synapsis aligns homologs, and chromosomes condense further.
3 The chromosomes continue to coil and shorten. The chiasmata reflect crossing over, the exchange of genetic material between nonsister chromatids in a homologous pair. In prometaphase the nuclear envelope breaks down.
4 The homologous pairs line up on the equatorial (metaphase) plate.
5 The homologous chromosomes (each with two chromatids) move to opposite poles of the cell.
6 The chromosomes gather into nuclei, and the original cell divides.
MEIOSIS II
Prophase II
Metaphase II
Anaphase II
Telophase II
Products
Equatorial plate
7 The chromosomes condense again, following a brief interphase (interkinesis) in which DNA does not replicate.
8 The centromeres of the paired chromatids line up across the equatorial plates of each cell.
9 The chromatids finally separate, becoming chromosomes in their own right, and are pulled to opposite poles. Because of crossing over and independent assortment, each new cell will have a different genetic makeup.
10 The chromosomes gather into nuclei, and the cells divide.
11 Each of the four cells has a nucleus with a haploid number of chromosomes.
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