Muscular tissue

Muscle is a soft tissue that is highly specialized for the production of tension which results in the generation of force. Muscle cells, or myocytes, contain myofibrils comprised of actin and myosin myofilaments. Numerous myocytes make up muscle tissue.

Terms to know and identify

Sarcolemma - plasma membrane covering each muscle cell.

Sarcoplasm - muscle cell cytoplasm.

Thick filaments – contractile protein myosin molecules. Thin filaments slide over thick filaments

Thin filaments – contractile protein actin molecules
(f and G actin) also contains the regulatory proteins tropomyosin and troponin.
Elastic filaments - keep thick and thin filaments aligned over one another for proper contraction to occur

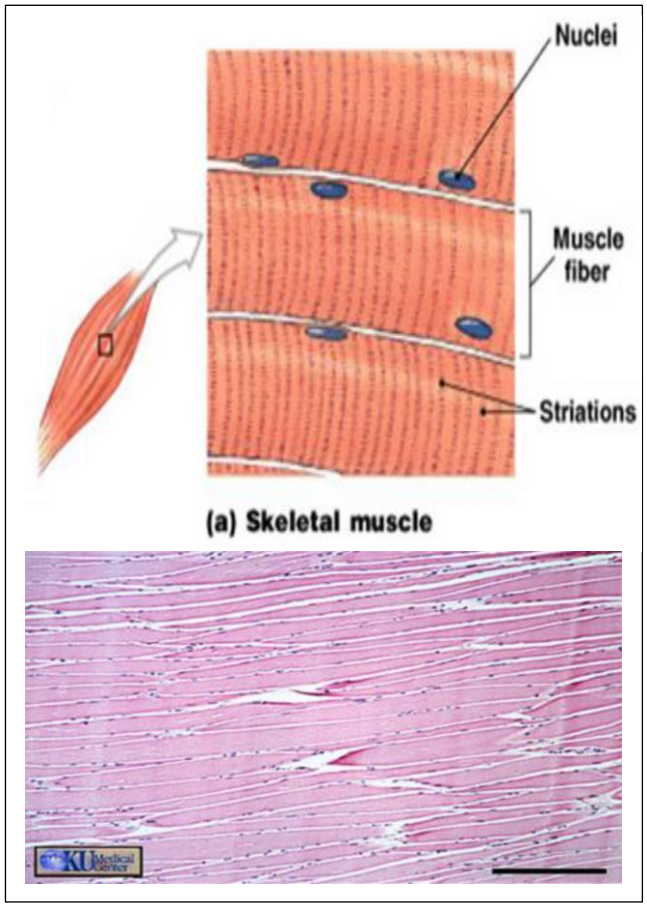
Types of Muscle Tissue

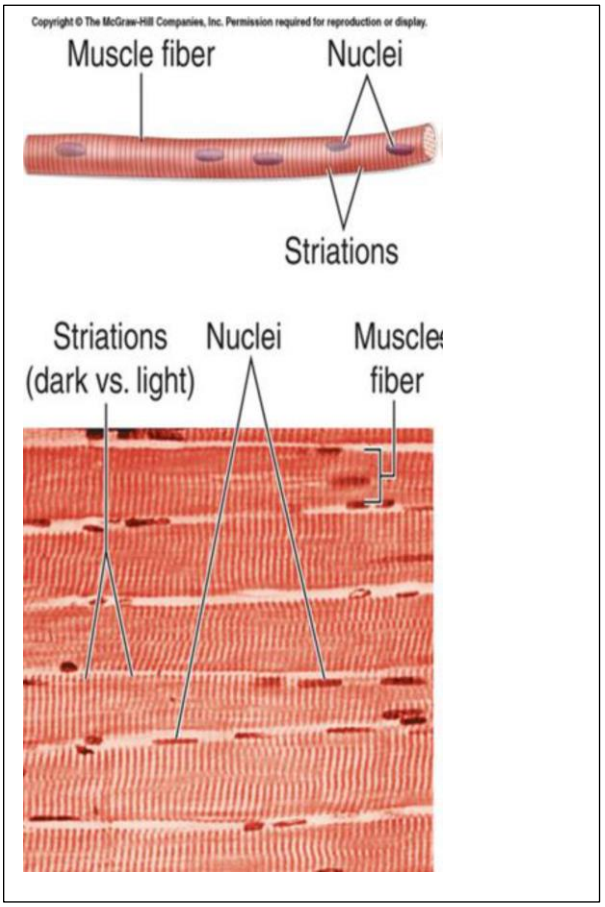
Muscle tissue can be classified functionally, voluntary or involuntary and morphologically, striated or non-striated and number of nuclei. Voluntary refers to whether the muscle is under conscious control, striation refers to the presence of visible banding within myocytes which occurs due to organization of myofibrils to produce a constant direction of tension.

By applying the above classifications it is possible to describe three forms of muscle tissue which perform the wide range of functions described.

Skeletal Muscle

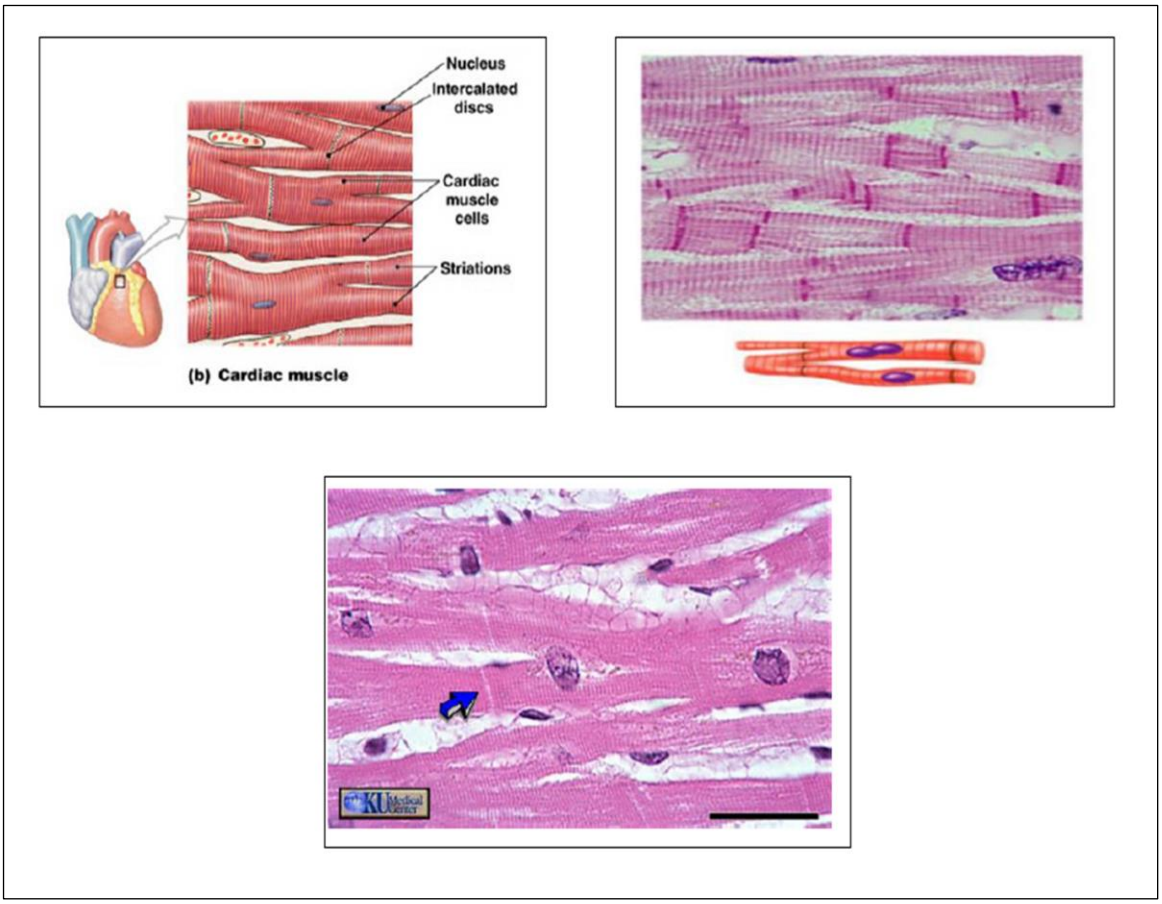
Skeletal muscle mainly attaches to the skeletal system via tendons to maintain posture and control movement. Skeletal muscle is under voluntary control. Morphologically skeletal myocytes are elongated and tubular and appear striated with multiple peripheral nuclei.





Cardiac Muscle Tissue

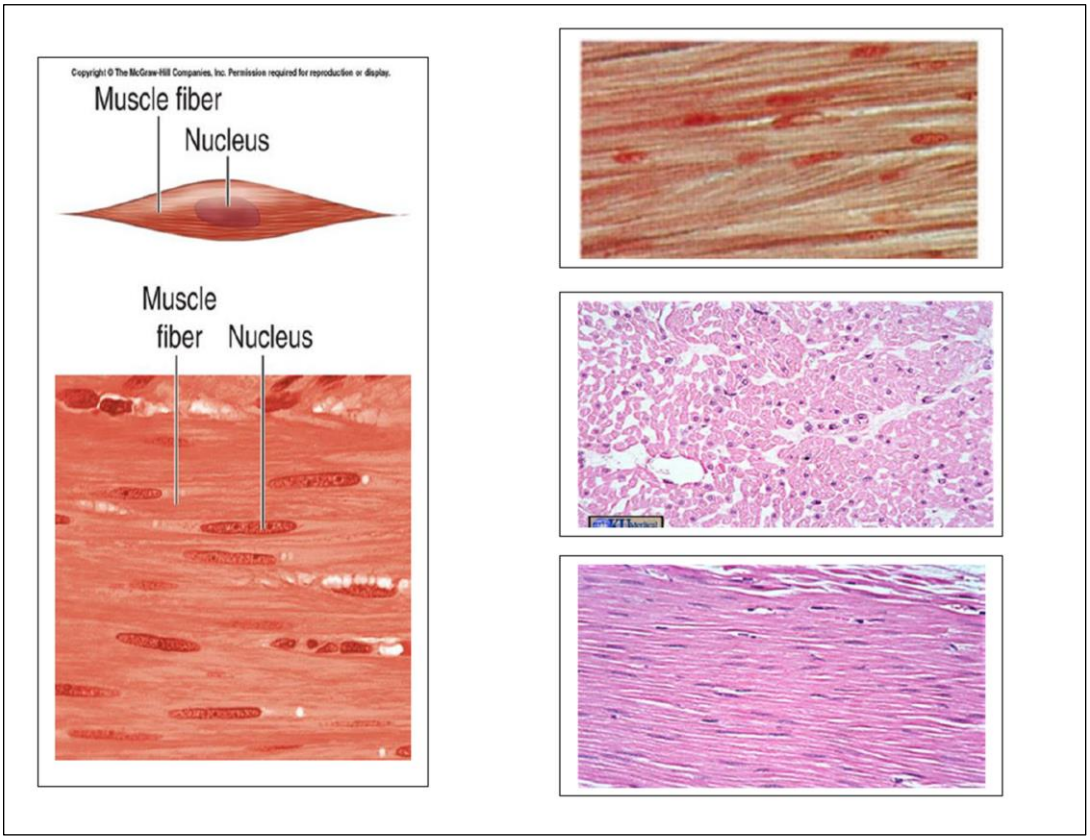
Cardiac muscle tissue is found only in the heart. As with skeletal muscle cardiac muscle is striated, however it is not consciously controlled and so is involuntary. Cardiac muscle can be further differentiated from skeletal muscle by the presence of intercalated discs which control the synchronized contraction of cardiac tissues. Cardiac myocytes (cardiocytes) are shorter than skeletal equivalents and contain only one or two centrally located nuclei.



Smooth Muscle Tissue

Smooth muscle tissue is found associated with numerous hollow organs and tissue systems such as the digestive system or respiratory system. It plays an important role in the regulation of flow in such tissues for example aiding the movement of food through the digestive system via peristalsis.

Smooth muscle is non-striated, although it contains the same myofilaments they are just organized differently, and involuntary. Smooth muscle myocytes are spindle shaped with a single centrally located nucleus.

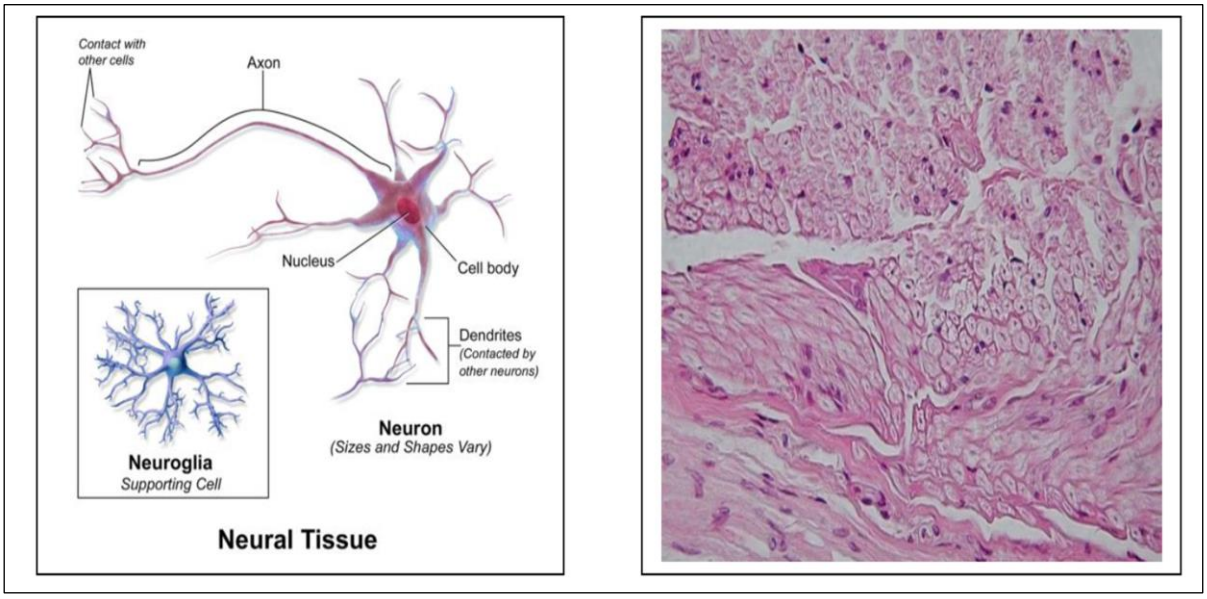


Muscle Type	Striated?	# of nuclei	Voluntary or Involuntary
Skeletal	Yes	Multi-nucleated	Voluntary
Cardiac	Yes	Single Nucleus	Involuntary
Smooth	No	Single Nucleus	Involuntary

NERVOUS TISSUE

Nervous tissue, also called **neural tissue** or **nerve tissue**, is the main tissue component of the nervous system. The nervous system regulates and controls bodily functions and activity and it consists of two parts: **the central nervous system (CNS)** comprising the brain and spinal cord, and **the peripheral nervous system (PNS)** comprising the branching peripheral nerves.

Nervous tissue cells is grouped into two main categories: neurons and neuroglia. Neurons transmit electrical impulses, while neuroglia do not; neuroglia have many other functions including provide nutrients, assist the propagation of the nerve impulse as well as supporting and protecting neurons.



Structure

Nervous tissue is composed of neurons, also called nerve cells, and neuroglial cells. Four types of neuroglia found in the centeral nerve system (CNS) are astrocytes, microglial cells, ependymal cells and oligodendrocytes. Two types of neuroglia found in the peripheral nerve system (PNS) are satellite cells and Schwann cells.

Neuroglia in the CNS

There are four types of neuroglia found within the central nervous system:

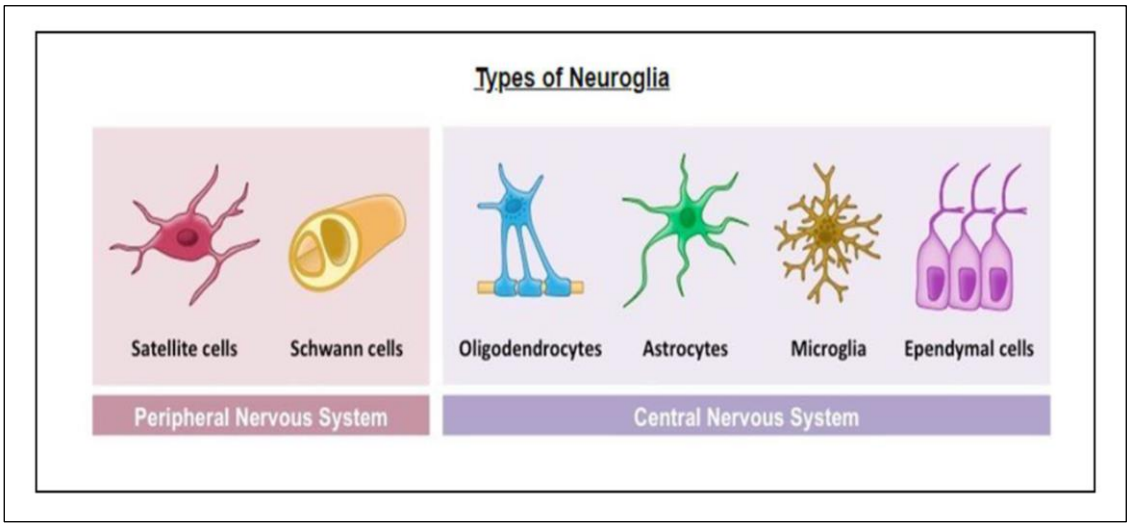
- Astrocytes – maintain the blood brain barrier and preserve the chemical environment by recycling ions and neurotransmitters

- Oligodendrocytes – myelinate axons in the central nervous system and provide an overall structural framework
- Ependymal cells – line ventricles (brain) and central canal (spine) and are involved in the production of cerebrospinal fluid
- Microglia – remove cell debris, wastes and pathogens via phagocytosis.

Neuroglia in the PNS

There are two types of neuroglia found within the peripheral nervous system:

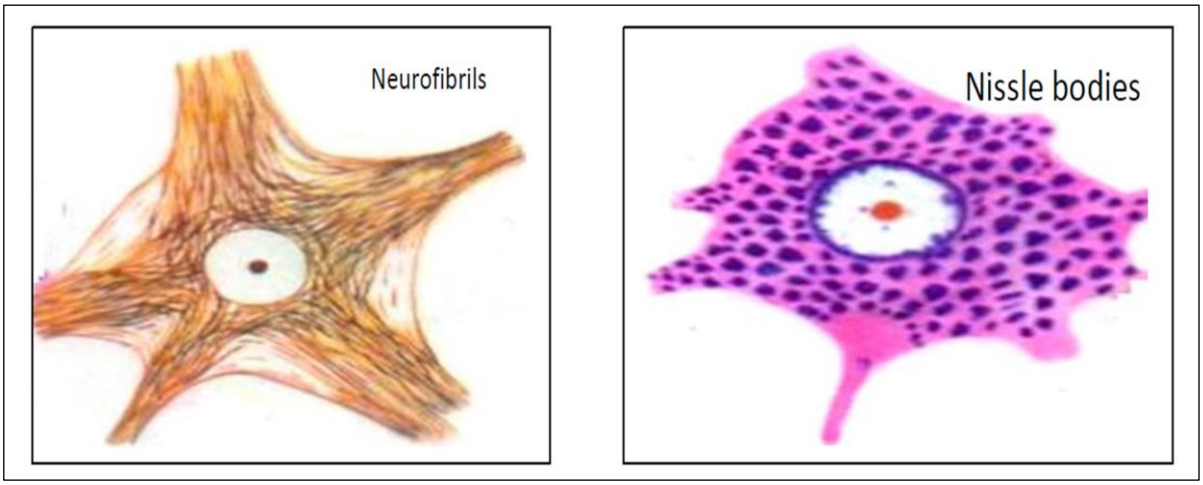
- Schwann cells – myelinate axons in the peripheral nervous system
- Satellite cells – regulate nutrient and neurotransmitter levels around neurons in ganglia

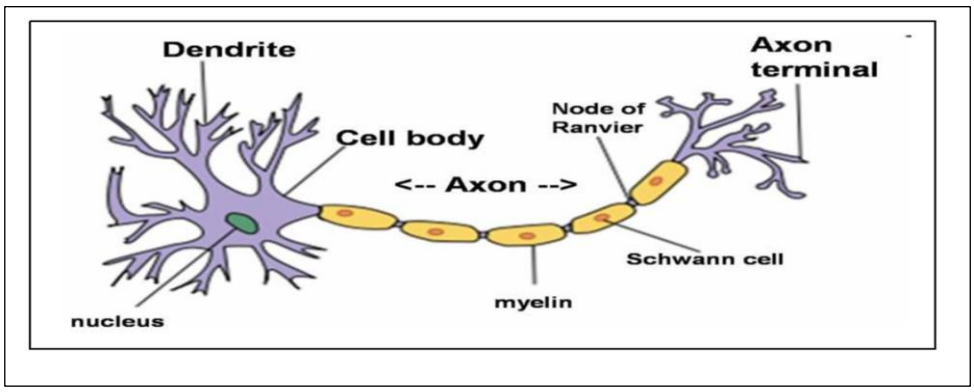


Components

Neurons are cells with specialized features that allow them to receive and facilitate nerve impulses, or action potentials, across their membrane to the next neuron. They possess a large cell body (soma){ perikaryon contain nucleus}, with cell projections called dendrites and an axon. Dendrites are thin, branching projections that receive electrochemical signaling (neurotransmitters) to create a change in voltage in the cell. Axons are long projections that carry the action potential away from the cell body toward the next neuron. The bulb-like end of the axon, called the axon terminal (nerve ending), is separated from the dendrite of the following neuron by a small gap called a synaptic cleft.

Cell body has:
1- Nucleus with large nucleolus.
2- Neurofibrils are present in the perikaryon, dendrites and axon and are unique to neurons. = "Skeleton" of the neurons
3- "Nissl bodies" (chromophilic substance) large clumps of basophilic material around the nucleus, Function – protein synthesis (neurotransmitters).





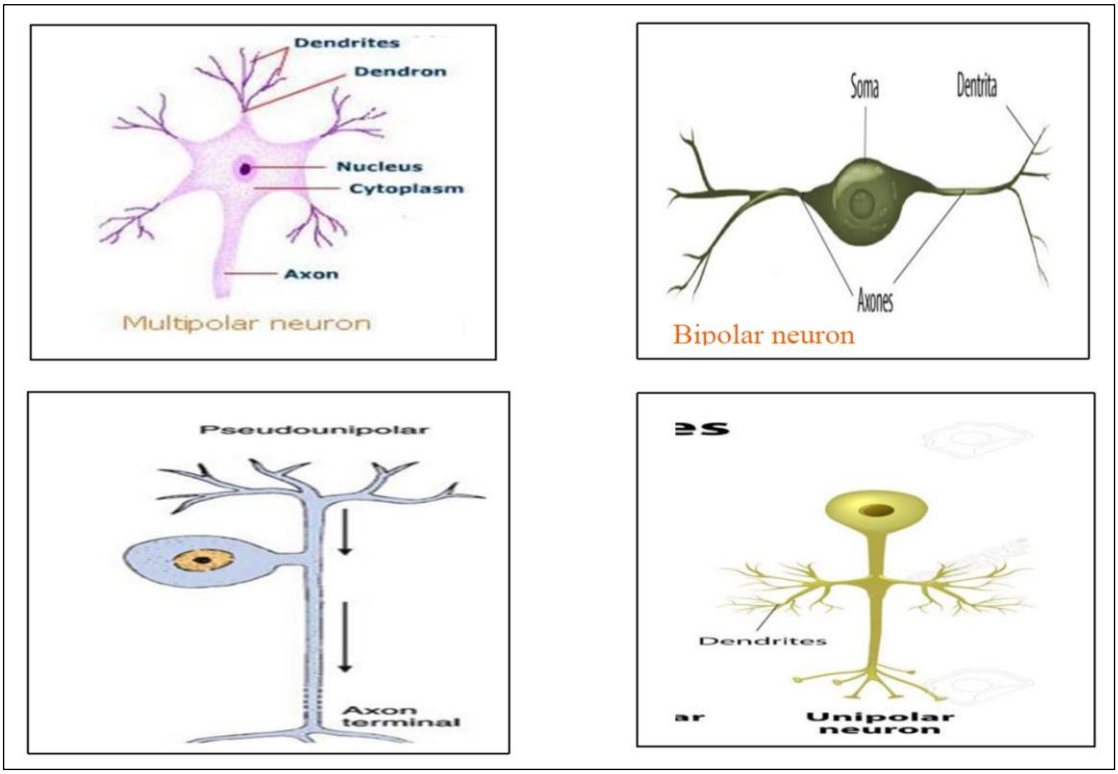
Neurons are classified both functionally and structurally. Structural classification:

 Multipolar neurons: Have 3 or more processes coming off the soma (cell body). They are the major neuron type in the CNS.

 Bipolar neurons: Sensory neurons that have two processes coming off the soma, one dendrite and one axon

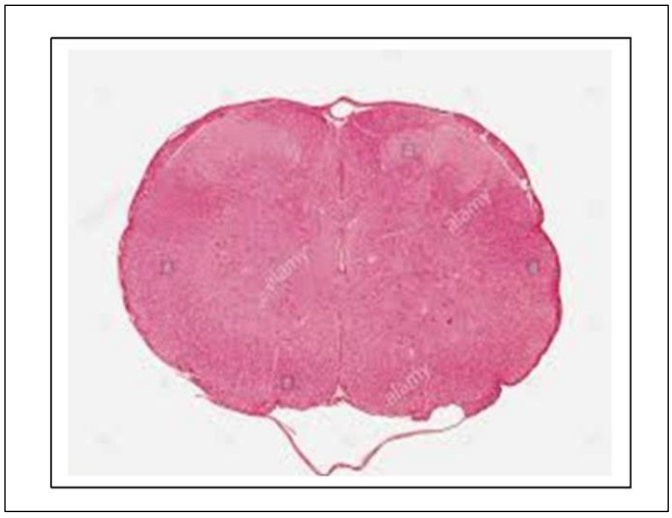
 Pseudounipolar neurons: Sensory neurons that have one process that splits into two branches, forming the axon and dendrite

 Unipolar brush cells: Are have a single short dendrite terminating in a brush-like tuft of dendrioles. These are found in the granular layer of the cerebellum.



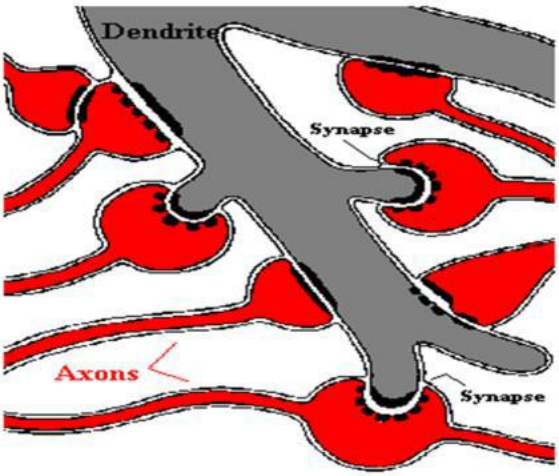
Spinal cord

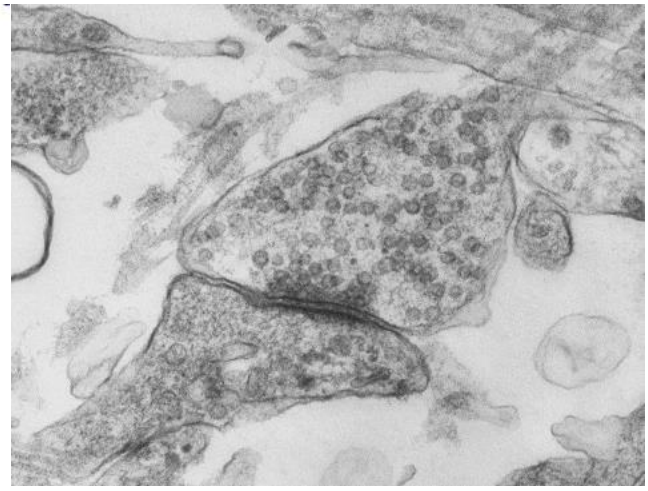
The **spinal cord** is a long, thin, tubular structure made up of nervous tissue, that extends from the medulla oblongata in the brainstem to the lumbar region of the vertebral column. It encloses the central canal of the spinal cord that contains cerebrospinal fluid. The brain and spinal cord together make up the central nervous system (CNS).



Synapse

The specialized region of contact between 2 neurons. This structure permits a neuron (or nerve cell) to pass an electrical or chemical signal to another neuron or to the target effector cell.





function of nerve tissue

The function of nervous tissue is to form the communication network of the nervous system by conducting electric signals across tissue.

cell division

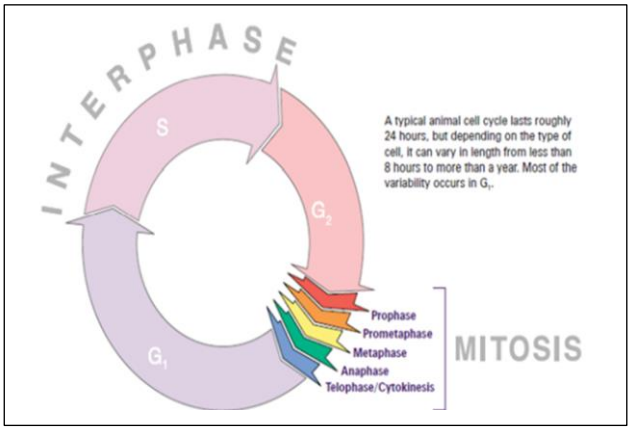
(mitosis and meiosis)

Cell division is the basis of individual growth, development, and reproduction, it is the process by which a living cell proliferates from one cell to two cells. The cells before division are called mother cells, and the new cells formed after division are called daughter cells. Generally, it includes two steps: nuclear division and cytokinesis.

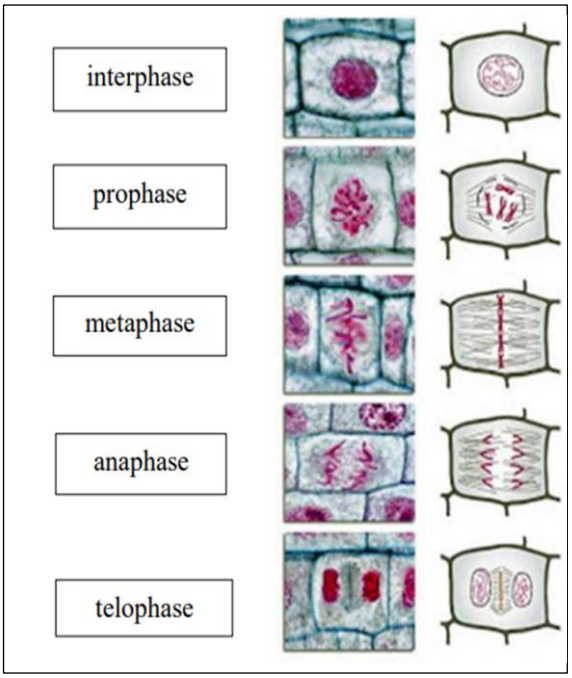
Cell division is the process by which a parent cell divides into two or more daughter cells. Cell division usually occurs as part of a larger cell cycle. In eukaryotes, there are two distinct types of cell division: mitosis, whereby each daughter cell is genetically identical to the parent cell , and a reproductive cell division, whereby the number of chromosomes in the daughter cells is reduced by half to produce haploid gametes (meiosis).

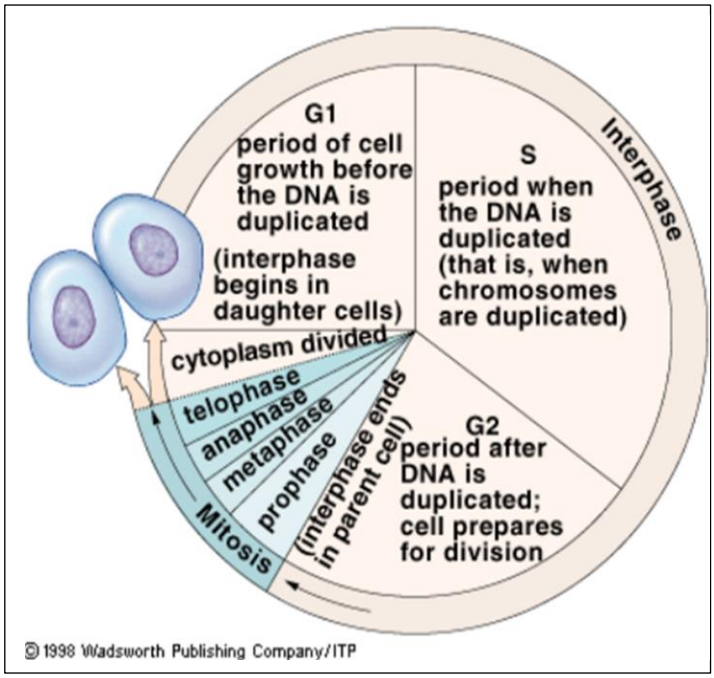
The cell cycle begins when the cell is produced by mitosis and runs until the cell undergoes its own mitosis and splits in two. The cycle is divided into distinct phases: G1 (gap 1), S (synthesis), G2 (gap 2), and M (mitosis). The time (phases G1 through G2) is known as interphase.

During interphase the chromosomes (the genetic material) are copied, and cells typically double in size. While this is happening, cells continue to do their jobs. In contrast, most of these activities cease during mitosis while the cell focuses on dividing but not all cells in an organ undergo mitosis at the same time. While one cell divides, its neighbors work to keep the body functioning.



Mitosis is essentially a duplication process that replicates chromosomes and produces two genetically identical "daughter" cells from a single "parent" cell. Mitosis has the following phases: prophase, metaphase, anaphase, telophase and cytokinesis.





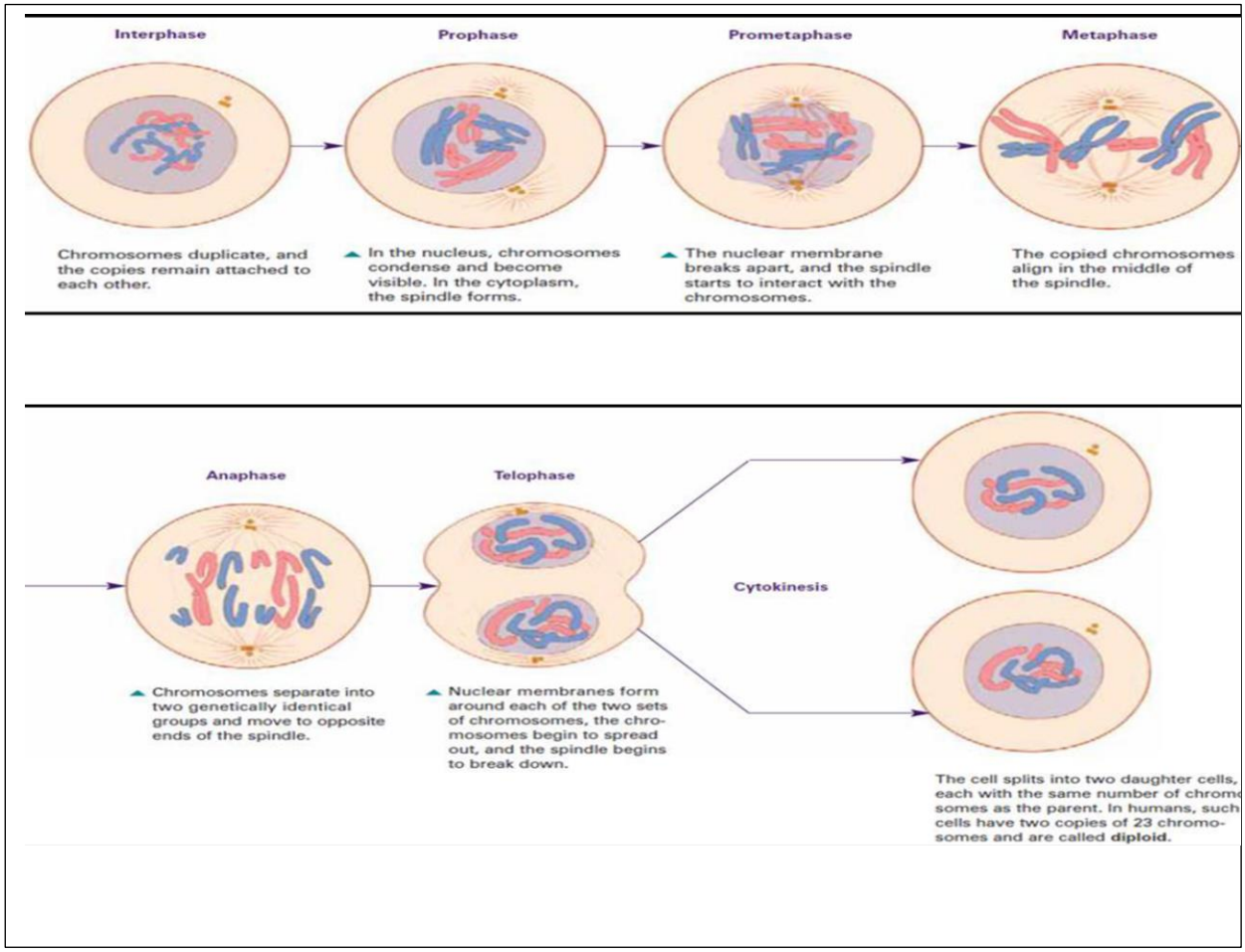
Prophase: Chromatin in the nucleus begins to condense and becomes visible in the light microscope as chromosomes. The nuclear membrane dissolves. Microtubules attach at the kinetochores and the chromosomes begin moving.

Metaphase: Spindle fibers align the chromosomes along the middle of the cell nucleus. This line is referred to as the metaphase plate. This organization helps to ensure that in the next phase, when the chromosomes are separated, each new nucleus will receive one copy of each chromosome.

Anaphase: The paired chromosomes separate at the kinetochores and move to opposite sides of the cell. Motion results from a combination of kinetochore movement along the spindle microtubules and through the physical interaction of polar microtubules.

Telophase: New membranes form around the daughter nuclei while thechromosomes disperse.

The first phases do the job of splitting the nucleus and its duplicated genetic information in two, while in the final step **cytokinesis**; the entire cell is split into two identical daughter cells. Mitosis is essential for growth, repair and replacement. The primary goal of mitosis is to make sure that each daughter cell gets one copy of each chromosome. Other cellular components, like ribosomes and mitochondria, also are divided between the two daughter cells. For simplicity, the following illustrated cells with only six chromosomes.



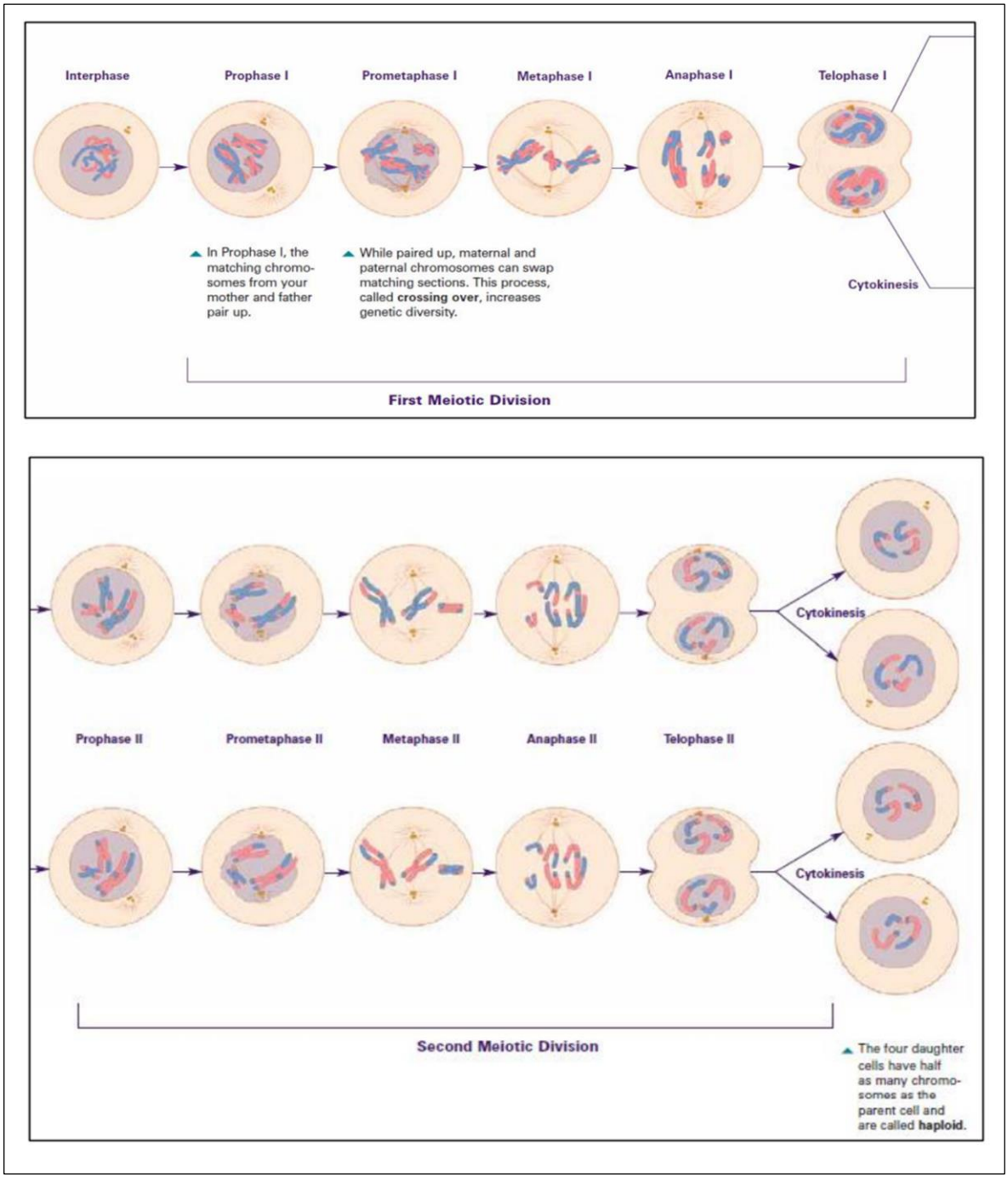
Meiosis: sex, heredity, and survival

Meiosis is a special type of cell division that occurs in sexually reproducing organisms. Nearly all multicellular organisms reproduce sexually by the fusion of an egg and a sperm. The new cell (a zygote) has a full contingent of 23 pairs of chromosomes. But what about its parent cells, the sperm and egg??? If the egg and sperm each had 23 chromosome pairs, their union would result in a zygote with 46 pairs (double the usual number). Theoretically, this cell would then grow into a person with 46 pairs of chromosomes per cell (rather than the usual 23 pairs). Subsequent generations would have even more chromosomes per cell. Clearly, this is not what actually happens. Even early cell biologists realized that there must be a way to cut in half the number of chromosomes in egg and sperm cells. To accomplish that task, meiosis occur. In preparation for meiosis, the chromosomes are copied once, just as for mitosis, but instead of one cell division, there are two. The result is four daughter cells, each containing 23 individual chromosomes rather than 23 pairs. Generating daughter cells are distinct from one another and from the original parent cell.

Meiosis is divided into phases just like mitosis, and although the phases have the same names. Also, since there are two cell divisions in meiosis, each phase is followed by an I or II, indicating to which division it belongs.

Phases of meiosis

Meiosis is used to make sperm and egg cells. During meiosis, cell's chromosomes are copied once, but the cell divides twice. For simplicity, we have illustrated cells with only three pair of chromosomes.


Interphase
Prophase I
Prometaphase I
Metaphase I
Anaphase I
Telophase I
Cytokinesis
In Prophase I, the matching chromosomes from your mother and father pair up.
While paired up, maternal and paternal chromosomes can swap matching sections. This process, called crossing over, increases genetic diversity.
First Meiotic Division
Cytokinesis
Prophase II
Prometaphase II
Metaphase II
Anaphase II
Telophase II
Cytokinesis
Second Meiotic Division
The four daughter cells have half as many chromosomes as the parent cell and are called haploid.

Item	Mitosis	Meiosis
Definition	A process of asexual reproduction in which the cell divides in two producing a replica, with an equal number of chromosomes in each resulting diploid cell.	A type of cellular reproduction in which the number of chromosomes are reduced by half through the separation of homologous chromosomes, producing four haploid cells
Function	Cellular Reproduction & general growth and repair of the body	sexual reproduction
Type of Reproduction	Asexual	Sexual
Genetically	identical	Different
Crossing Over	No, crossing over cannot occur.	Yes, mixing of chromosomes can occur.
Number of Divisions	1	2
Number of Daughter Cells produced	2 diploid cells	4 haploid cells
Chromosome Number	Remains the same	Reduced by half
Steps	The steps of mitosis are Interphase, Prophase, Metaphase, Anaphase, Telophase and Cytokinesis	The steps of meiosis are Interphase, Prophase I, Metaphase I, Anaphase I, Telophase I, Prophase II, Metaphase II, Anaphase II and Telophase II.
Creates	Makes everything other than sex cells	Sex cells only: Female egg cells or Male sperm cells
Discovered by	Walther Flemming	Oscar Hertwig