The objectives

1-To understand the different type of muscles in human body

2- Learn the different function, shape and structures

3- Give an example for each type of muscle tissue

3- Muscle Tissue

Muscle tissue, the third basic tissue type with epithelia, connective tissues, and nervous tissue, is composed of cells that optimize the universal cell property of contractility. As in all cells, actinmicrofilaments and associated proteins generate the forces necessary for the muscle contraction. Essentially all muscle cells are of mesodermal origin and differentiate by a gradual process of cell lengthening with abundant synthesis of the myofibrillar proteins actin and myosin. Three types of muscle tissue can be distinguished on the basis of morphologic and functional characteristics:

■ Skeletal muscle contains bundles of very long, multinucleated cells with cross-striations. Their contraction is quick, forceful, and usually under voluntary control.

■ Cardiac muscle also has cross-striations and is composed of elongated, often branched cells bound to one another at structures called intercalated discs that are unique to cardiac muscle. Contraction is involuntary, vigorous, and rhythmic.

■ Smooth muscle consists of collections of fusiform cells that lack striations and have slow, involuntary contractions.

There are basic similarities among the three muscle types:

• They are all mesodermally derived and are elongated parallel to their axis of contraction.

• they possess numerous mitochondria to accommodate their high energy requirements.

• All contain contractile elements known as myofilaments, in the form of actin and myosin, as well as additional contractile-associated proteins

1- Skeletal Muscle: (or striated) muscle consists of muscle fibers, which are long, cylindrical multinucleated cells with diameters of 10 to 100 μm. Elongated nuclei are found peripherally just under the sarcolemma, a characteristic nuclear location unique to skeletal muscle fibers/cells. Longitudinally sectioned skeletal muscle fibers show cross striations of alternating light and dark bands. The dark bands are called A bands and the light bands are called I band. In the TEM, each I band is seen to be bisected by a dark transverse line, the Z disc (Ger. zwischen, between). The repetitive functional subunit of the contractile apparatus, the sarcomere, extends from Z disc to Z disc and is about 2.5 μm long in resting muscle.

There are three types of skeletal muscle fibers: red, white, and intermediate depending on their contraction velocities, mitochondrial content, and types of enzymes the cell contains.

Muscle Type	Myoglobin Content	Mitochondrial Population	Enzyme Content	ATP Generation	Contraction Characteristics
Red (slow)	High	Abundant	High in oxidative enzymes, low ATPase	Oxidative phosphorylation	Slow and repetitive; not easily fatigued
Intermediate	Intermediate	Intermediate	Intermediate-oxidative enzymes and ATPase	Oxidative phosphorylation and anaerobic glycolysis	Fast but not easily fatigued
White (fast)	Low	Sparse	Low oxidative enzymes; high ATPase and phosphorylases	Anaerobic glycolysis	Fast and easily fatigued

2- **Smooth Muscle:** Smooth muscle is specialized for slow, steady contraction and is controlled by a variety of involuntary mechanisms. Fibers of smooth muscle (also called visceral muscle) are elongated, tapering, and nonstriated cells, each of which is enclosed by a thin basal lamina and a fine network of reticular fibers, the **endomysium**. Smooth muscle cells may range in length from 20 μm in small blood vessels to 500 μm in the pregnant uterus. Each cell has a single long nucleus located in the center of the cell's central, broadest part.

3- **Cardiac Muscle:**.

Cardiac muscle cells have central nuclei and myofibrils that are less dense and less well-organized than those of skeletal muscle. Also, the cells are often branched. Mature cardiac muscle cells are approximately 15 μm in diameter and from 85 to 100 μm in length. They exhibit a cross-striated banding pattern comparable to that of skeletal muscle. Unlike multinucleated skeletal muscle, however, each cardiac muscle cell possesses only one (or two) centrally located, pale-staining nuclei. Surrounding the muscle cells is a delicate sheath of endomysium with a rich capillary network. A unique and distinguishing characteristic of

cardiac muscle is the presence of dark-staining transverse lines (Intercalated disk) that cross the chains of cardiac cells at irregular intervals where the cells join. These intercalated discs represent the interface between adjacent muscle cells and contain many junctional complexes.

Characteristics	Skeletal Muscle	Smooth Muscle	Cardiac Muscle
Location	Generally attached to skeleton	Generally in hollow viscera, iris, blood vessels	Myocardium, major blood vessels as they enter or leave the heart.
Shape	Long, cylindrical parallel fibers	Short, spindle-shaped	Branched and blunt ended
Striations	Yes	No	Yes
Number and location of nucleus	Numerous, peripherally	Single, central	One or two, central
T tubules	Present at A-I junctions	No—but caveolae	Present at Z discs
Sarcoplasmic reticulum (SR)	Complex surrounds myofilaments forming meshwork. Forms triads with T tubules	Some smooth SR but poorly developed	Less developed than in skeletal muscle; forms diads with T tubules
Gap junctions	No	Yes	Yes—within intercalated discs
Control of contraction	Voluntary	Involuntary	Involuntary
Sarcomere	Yes	No	Yes
Regeneration	Restrictive	Extensive	Perhaps some limited
Histological distinction	Multiple striations and numerous peripherally located nuclei	No striations, central nucleus	Intercalated discs

MEDICAL APPLICATION

Myasthenia gravis is an autoimmune disorder that involves circulating antibodies against proteins of acetylcholine receptors. Antibody binding to the antigenic sites interferes with acetylcholine activation of their receptors, leading to intermittent periods of skeletal muscle weakness.

As the body attempts to correct the condition, junctional folds of sarcolemma with affected receptors are internalized, digested by lysosomes, and replaced by newly formed receptors. These receptors, however, are again made unresponsive to acetylcholine by similar antibodies, and the disease follows a progressive course. The extraocular muscles of the eyes are commonly the first affected.

The objectives

1-Understand how the nervous system is divided and the types of cells that are found in nervous tissue

2-Know the anatomy of a neuron and the structural and functional types of neurons

3- Classify the neuron according to the number of processes extending from the cell body

4- Numerate the spinal cord parts?

4-Nervous Tissue:

The human nervous system, by far the most complex system in the body, is formed by a network of many billion nerve cells (neurons) , all assisted by many more supporting cells called glial cells. Each neuron has hundreds of interconnections with other neurons, forming a very complex system for processing information and generating responses.

The nervous system has two major divisions:

- Central nervous system (CNS) , consisting of the brain and spinal cord
- Peripheral nervous system (PNS), composed of the cranial, spinal, and peripheral nerves conducting impulses to and from the CNS (sensory and motor nerves, respectively) and ganglia that are small groups of nerve cells outside the CNS.

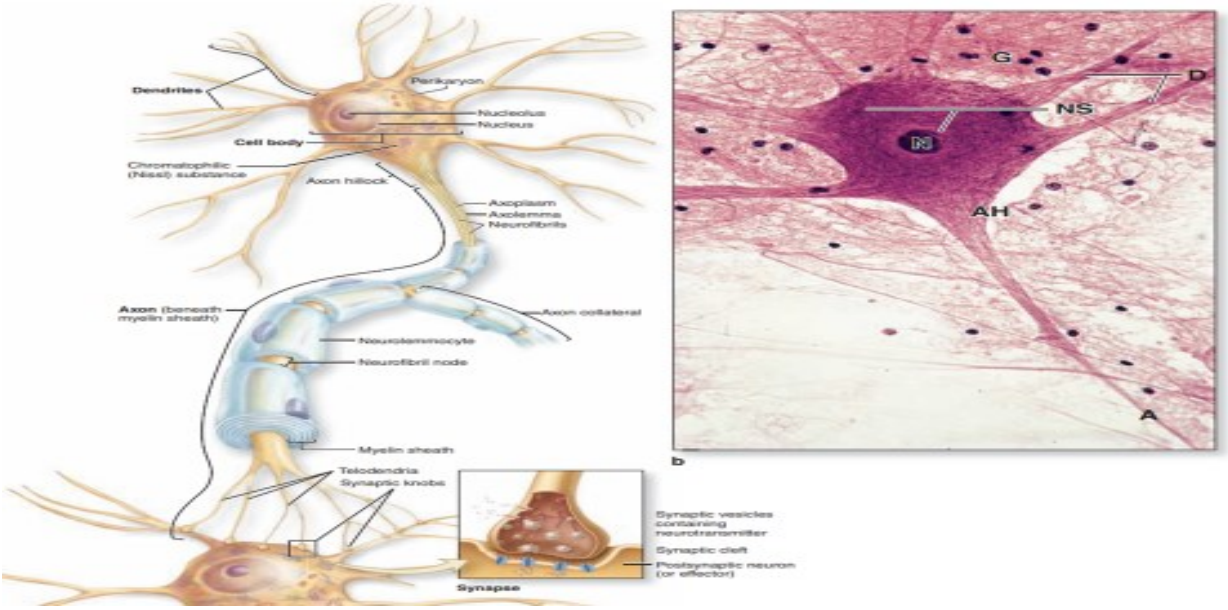
Cells of Nerve Tissue :The nervous tissue develops from the outer embryonic layer, The two major classes of cells that make up the nervous tissue are nerve cells **neurons (**the functional and structural units) which usually show numerous long processes and supporting cells **glia** which have short processes, support and protect

neurons, and participate in many neural activities, neural nutrition, and defense of cells in the CNS.

1-NEURONS The functional unit in both the CNS and PNS is the neuron or nerve cell. Some neuronal components have special names, such as "neurolemma" for the cell membrane. It contains the nucleus and surrounding cytoplasm ,most nerve cells have a spherical, unusually large, with a prominent nucleolus, Bi-nuclear nerve cells are sometimes seen in sympathetic and sensory ganglia.

Most neurons consist of three main parts:

1-The cell body, or perikaryon, which contains the nucleus and most of the cell's organelles. Cell bodies often contain a highly developed rough ER organized into aggregates of parallel cisternae. In the cytoplasm between the cisternae are numerous polyribosomes, suggesting that these cells synthesize both structural proteins and proteins for transport and secretion. RER and free ribosomes appear under the light microscope as clumps of basophilic material called chromatophilic substance (often called Nissl bodies)



2- The dendrites, which are the numerous elongated processes extending from the perikaryon and specialized to receive stimuli from other neurons at unique sites called synapses.

3-The axon (Gr. axon, axis), which is a single long process ending at synapses specialized to generate and conduct nerve impulses to other cells (nerve, muscle, and gland cells). Axons may also receive information from other neurons, information that mainly modifies the transmission of action potentials to those neurons. Neurons and their processes are extremely variable in size and shape. Cell bodies can be very large, measuring up to 150 μm in diameter.

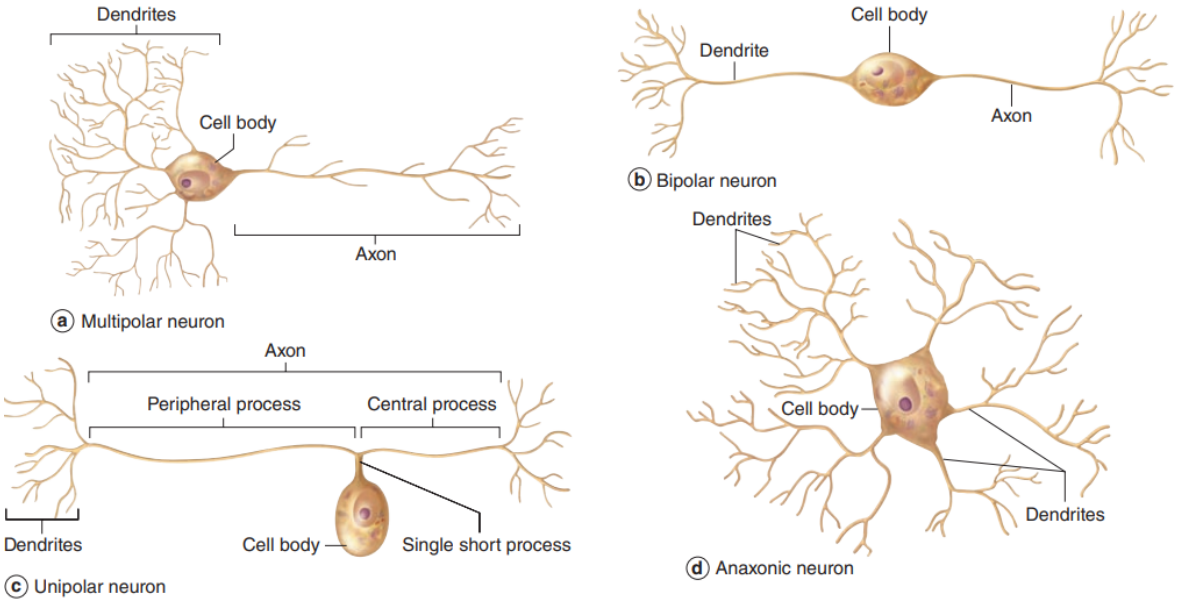
Neurons can be classified according to the number of processes extending from the cell body to:

■ Multipolar neurons, which have one axon and two or more dendrites

■ Bipolar neurons, with one dendrite and one axon

■ Unipolar or pseudounipolar neurons, which have a single process that bifurcates close to the perikaryon, with the longer branch extending to a peripheral ending and the other toward the CNS.

■ Anaxonic neurons, with many dendrites but no true axon, do not produce action potentials, but regulate electrical changes of adjacent neurons.



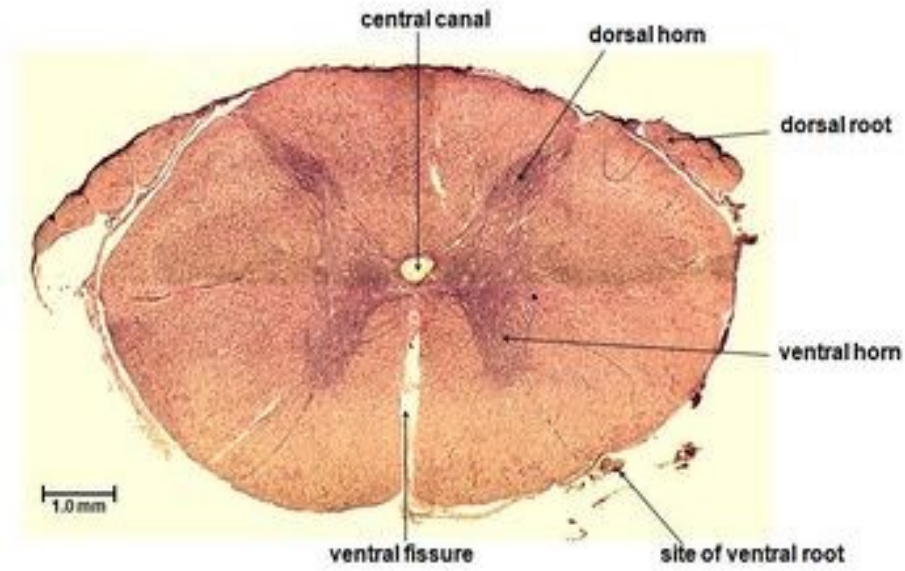
2-Glial cells : support neuronal survival and activities, and are ten times more abundant in the mammalian brain than the neurons. Like neurons, most glial cells develop ***from progenitor cells*** of the embryonic neural plate. In the CNS glial cells surround both the neuronal cell bodies, which are often larger than glial cells, and the processes of axons and dendrites occupying the spaces between neurons. Glial cells substitute for cells of connective tissue in some respects, ***supporting neurons and creating a microenvironment immediately around those cells that is optimal for neuronal activity.***

Spinal Cord:

The spinal cord is composed of two discrete parts; the white matter, which is the outer part of the cord and the grey matter, which is the inner portion of the cord. The white matter is given this name due to its appearance in unfixed histological specimens in which the white nature of the tissue is caused by the myelination of ascending and descending nerve fibers. The grey matter is also named after its unfixed histological

appearance and contains the cell bodies of neurons as well as nerve fibers.

Within the spinal cord the grey matter forms an H-shape where the ***ventral horns of the H are broader than the dorsal horns. The ventral horns of the grey matter contain the cell bodies of motor neurons whilst the dorsal horns contain sensory neurons where the cell bodies are found in the dorsal root ganglia.***



MEDICAL APPLICATION

Alzheimer disease, a common type of dementia in the elderly, affects both neuronal perikaryon and synapses within the cerebrum. Functional defects are due to neurofibrillary tangles, which are accumulations of tau protein associated with microtubules of the neuronal perikaryon and axon hillock regions, and neritic plaques, which are dense aggregates of β-amyloid protein that form around the outside of these neuronal regions.