

Organization of the Nervous System

and Motor unit BY

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Lecture2:- Organization of the Nervous System

Objectives:-

At the end of this lecture the student should be able to:-

- Diagnose what is the organization of the Nervous System**
- Appreciate differences between both central nervous system (CNS) & peripheral nervous system (PNS)**
- Identify motor unit**
- know the function & recruitment of motor unit**
- Appreciate effect of motor units number on action performance**

Organization of the Nervous System

The nervous system is divided into the

- 1- central nervous system (CNS)
- 2-peripheral nervous system (PNS)

1- Central nervous system (CNS)

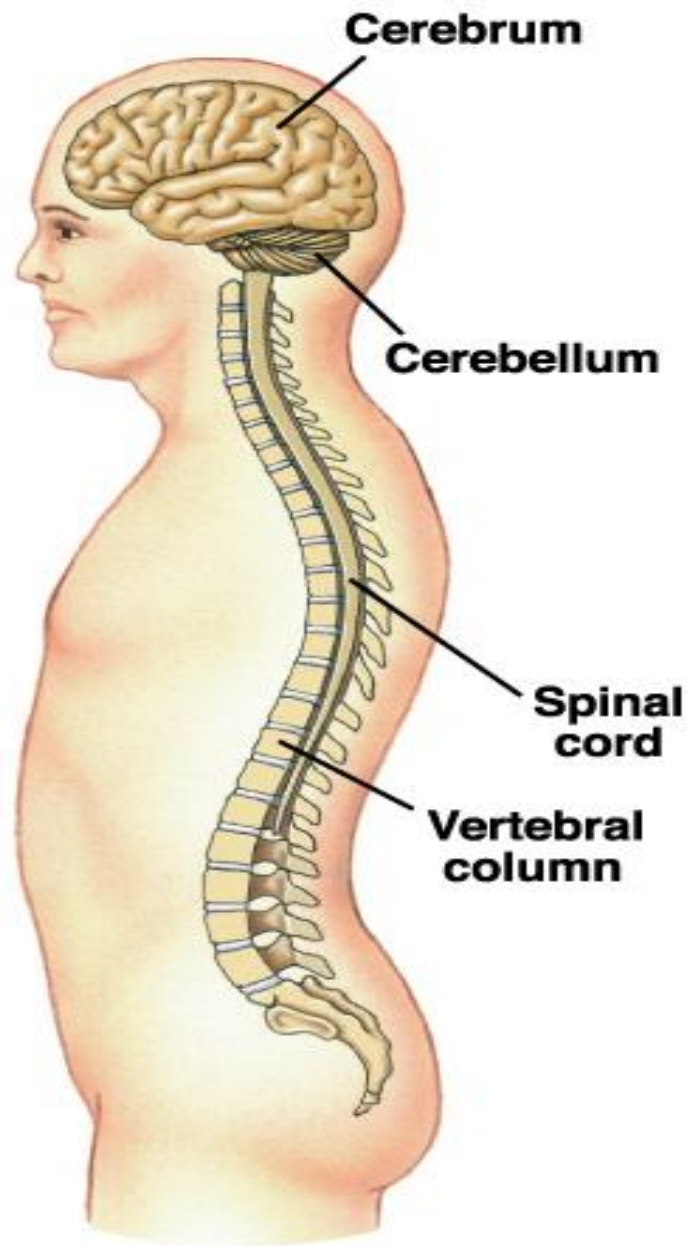
- It is the part of the nervous system that integrates the sensory information that it receives from diff parts of body , and coordinates the activity of all parts of the body .

;It consists of:-

1- the brain

2-the spinal cord.

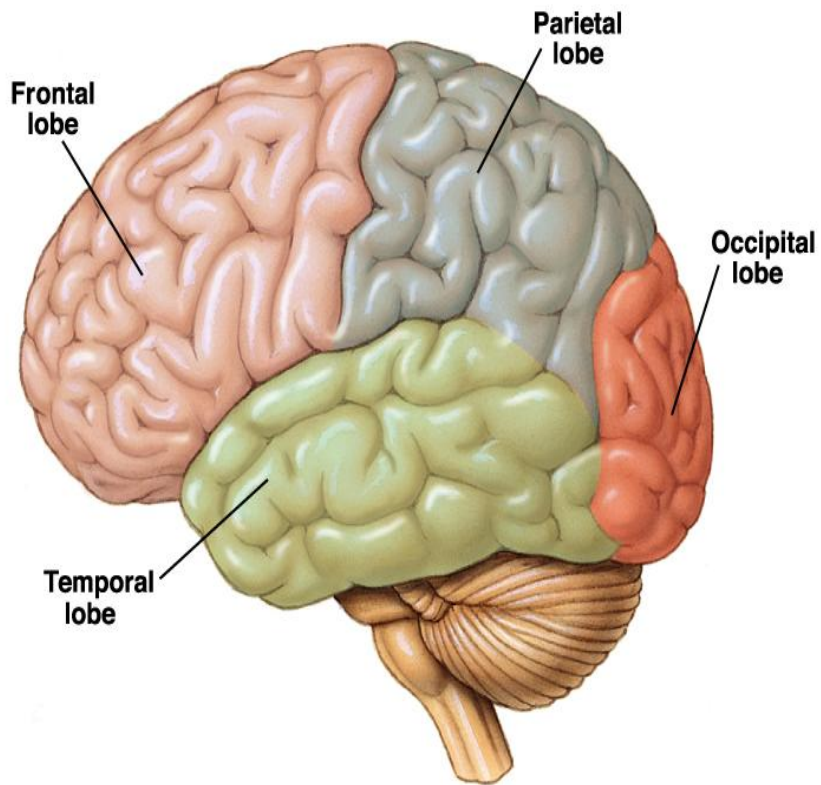
-the brain is protected by the skull, while the spinal cord is protected by the vertebrae, and both are enclosed in the meninges



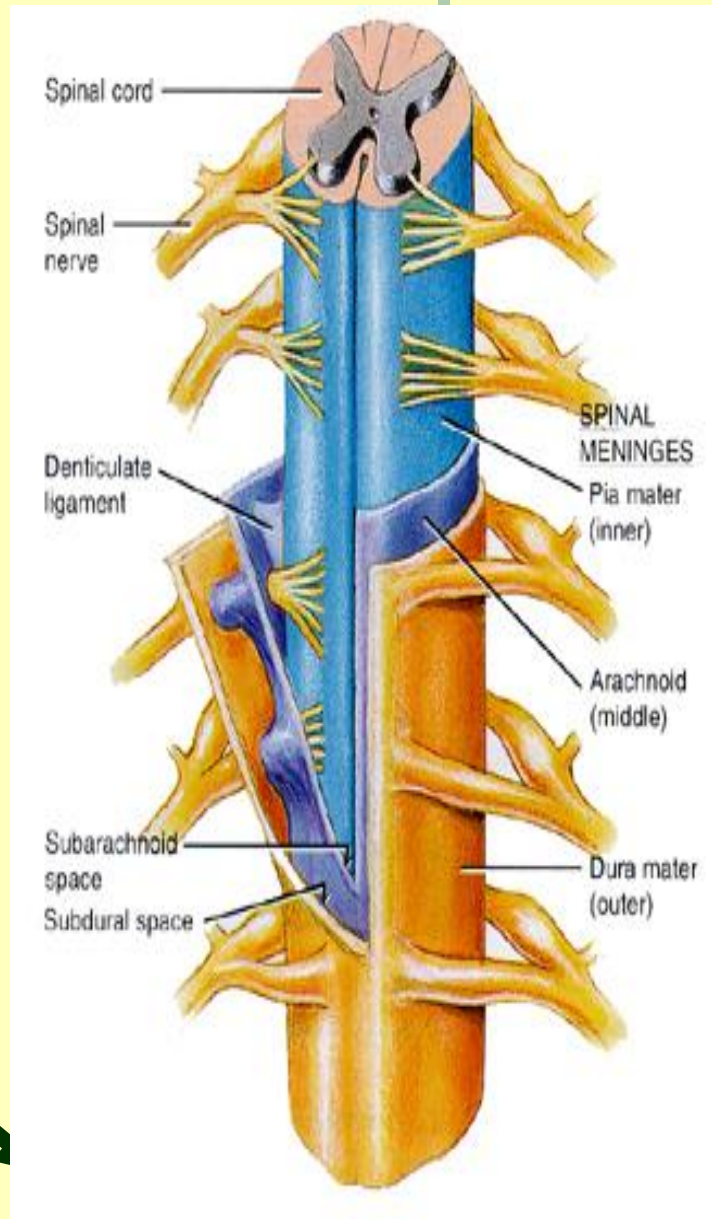
- Brain:

- - Two cerebral hemispheres connected together
- - Each hemisphere consists of frontal, parietal, temporal & occipital lobes
- - Cerebral cortex has sulci & gyri to increase brain surface area
- - Deep white matter has groups of nuclei as basal ganglia and others
- - Brain stem
- - cerebellum

- Spinal cord:-
- - Consists of H- shape grey matter formed of neurons(nerve cells)(dorsal horn has sensory neurons& ventral horn has motor neurons)
- - Surrounded by white matter of nerve fibers(tracts)

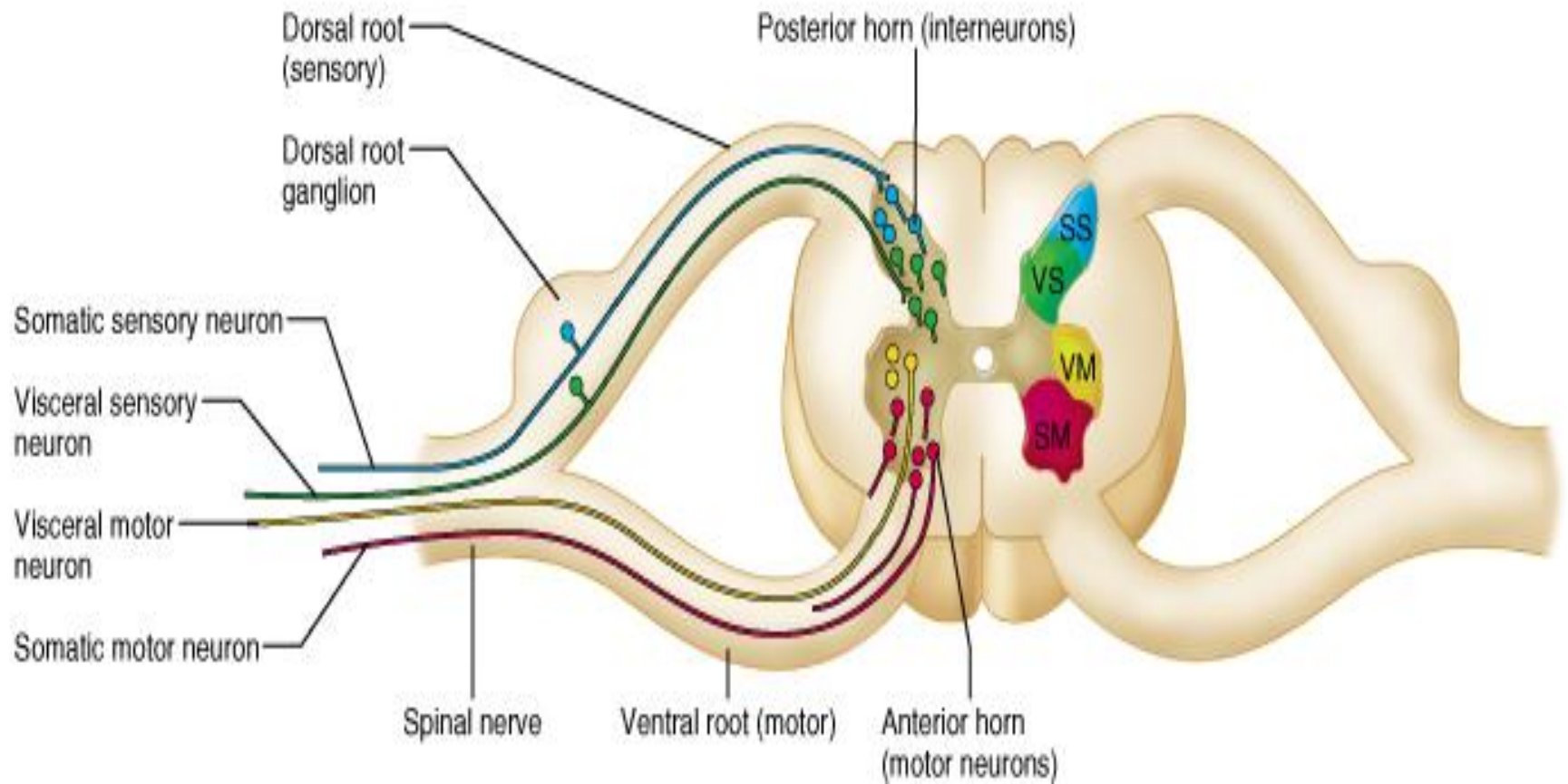


Where's the insula?

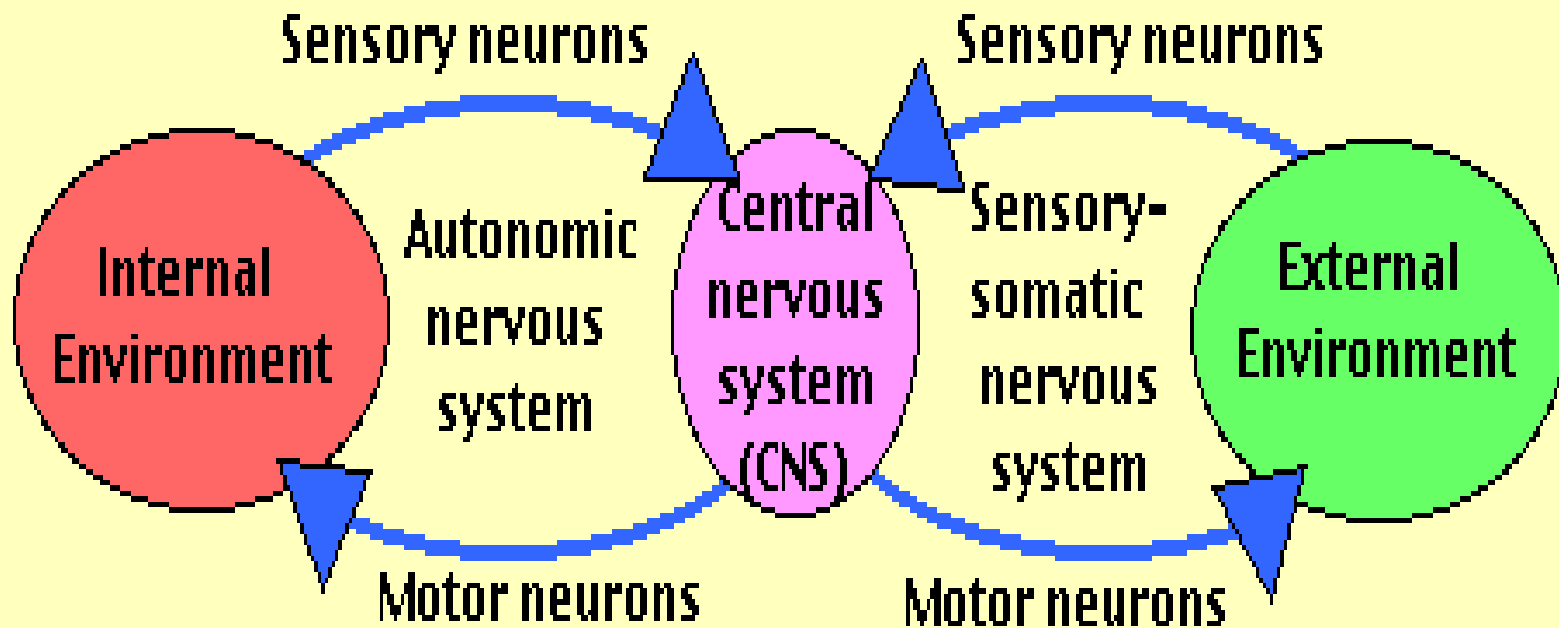


What's the name of this region

ed?



- **The peripheral nervous system is subdivided into the :-**
- **1-sensory-somatic nervous system**
- **2- autonomic nervous system**



- **A-Sensory-somatic nervous system**

- - The actions of the Sensory-Somatic nervous system **are largely voluntary** ارادية
- The Sensory-Somatic Nervous System is concerned with all our conscious awareness of the external environment and all our motor activity to cope with it
- Operate through the sensory-somatic division of the PNS.
- **The sensory-somatic system consists of**
- 1-12 pairs of cranial nerves (control function of head & neck)
- 2- 31 pairs of spinal nerves.
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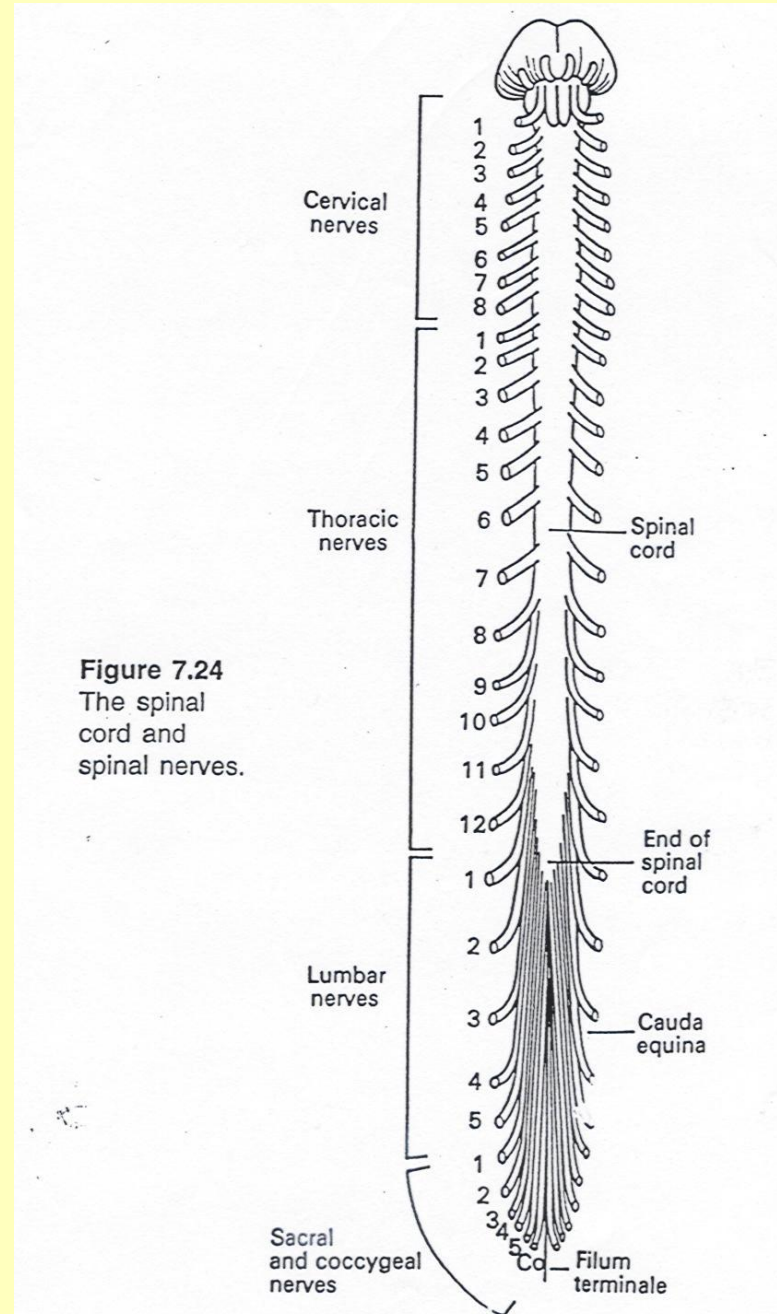
1-SPINAL NERVES:-

- Spinal nerves take their origins from the spinal cord.

-In humans, there are **31** pairs of spinal nerves: **8** cervical, **12** thoracic, **5** lumbar, **5** sacral and **1** coccygeal.

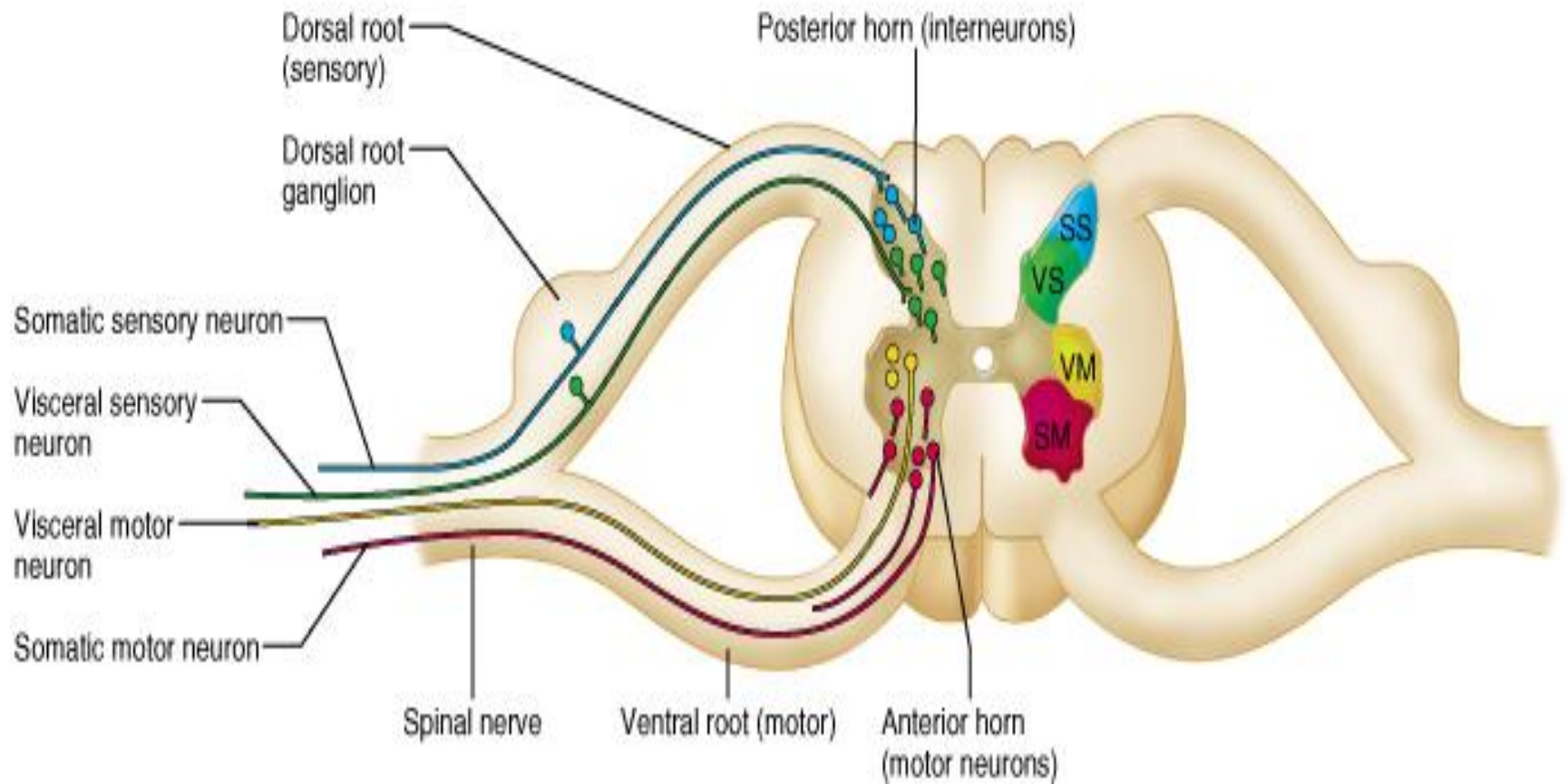
-They control the functions of all parts of body except head & neck.

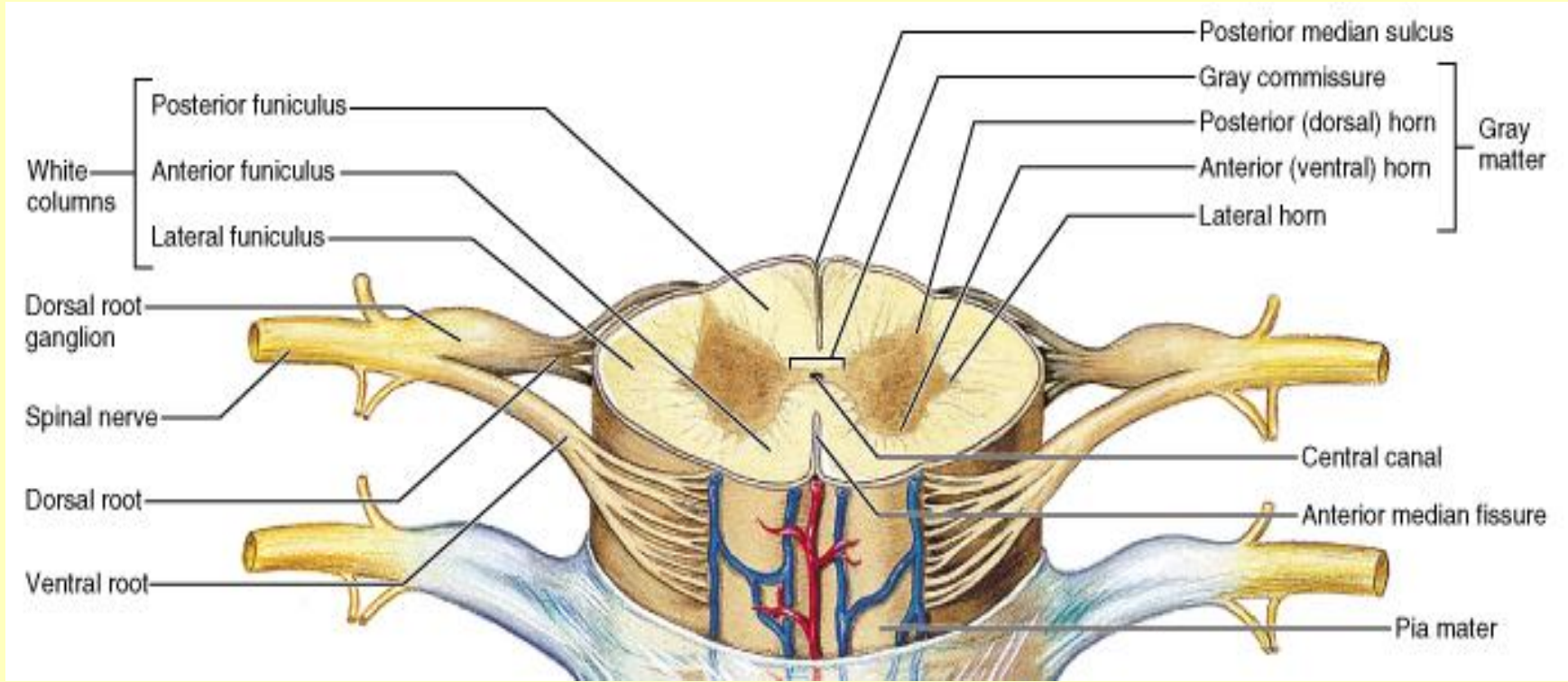
- All of the spinal nerves are "mixed"; that is, they contain both sensory and motor neurons.(pass in dorsal & ventral root)



- **The sensory neurons are afferent neurons which relay nerve impulses toward the central nervous system.
- Sensory neurons running from stimulus receptors that inform the CNS about all types of sensations.
- (pass in the dorsal root)

- **The motor neurons are efferent neurons which relay nerve impulses away from the central nervous system to periphery (skeletal muscles , or gland) to take action.
- (pass in the ventral root)
-





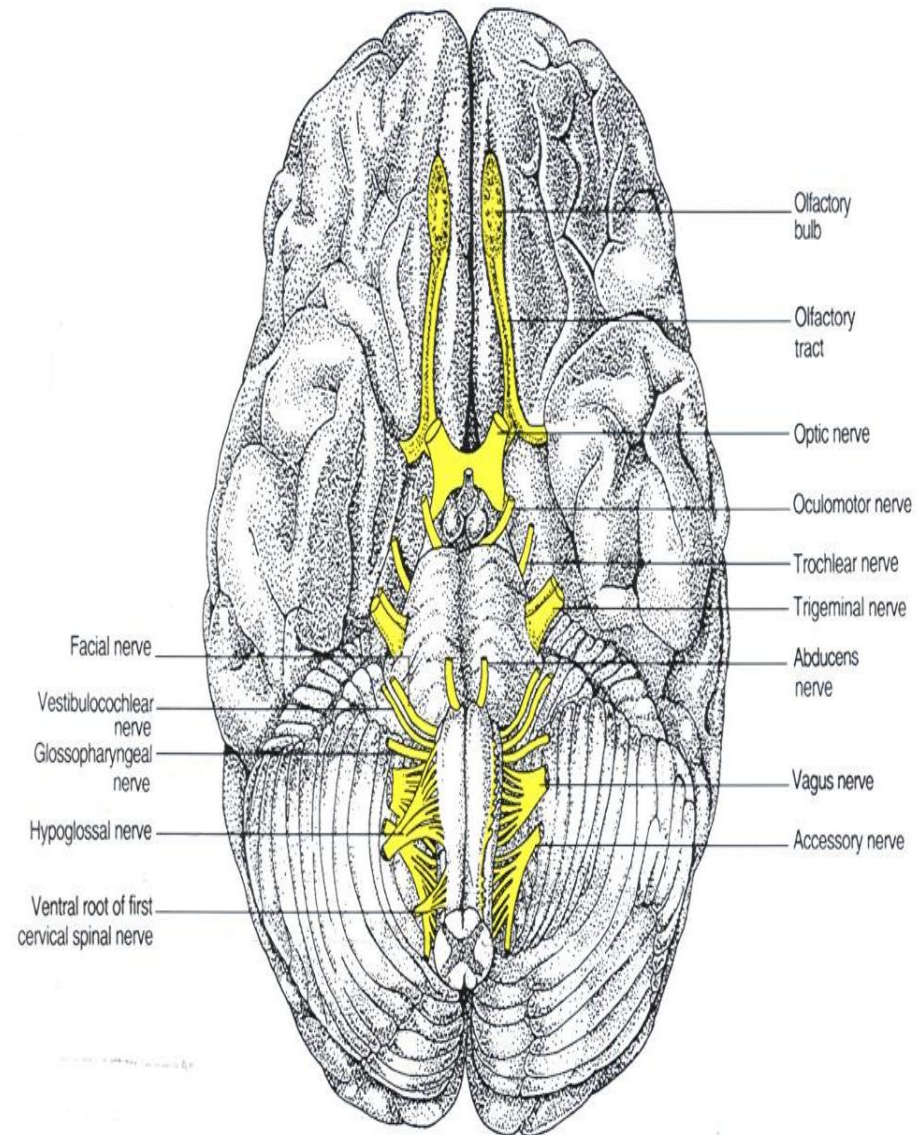
2-CRANIAL NERVES:-

- 12 PAIR

- Ten out of the twelve cranial nerves originate from the brainstem nuclei

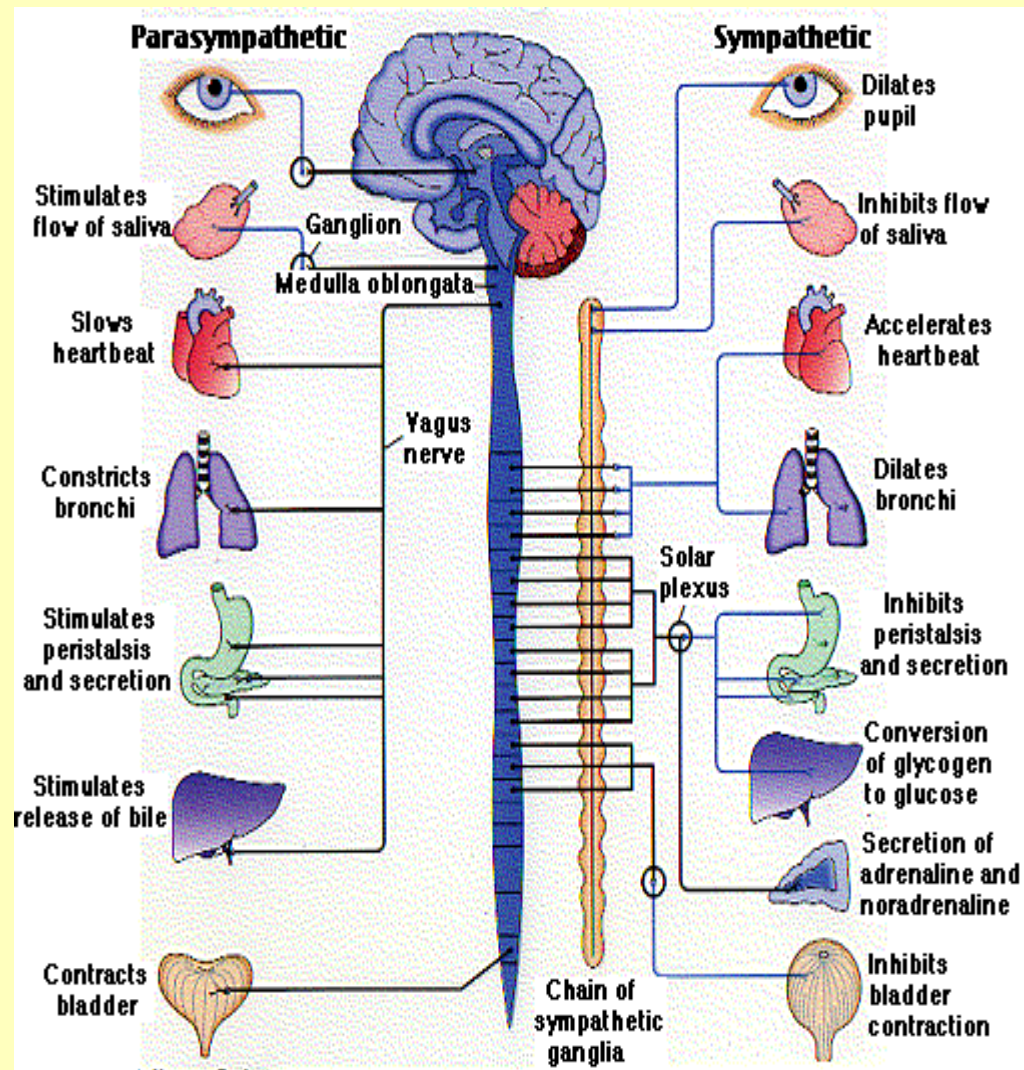
-The nuclei of cranial nerves I and II lie in the forebrain and thalamus

-_mainly control the functions of all structures of the head with some exceptions.



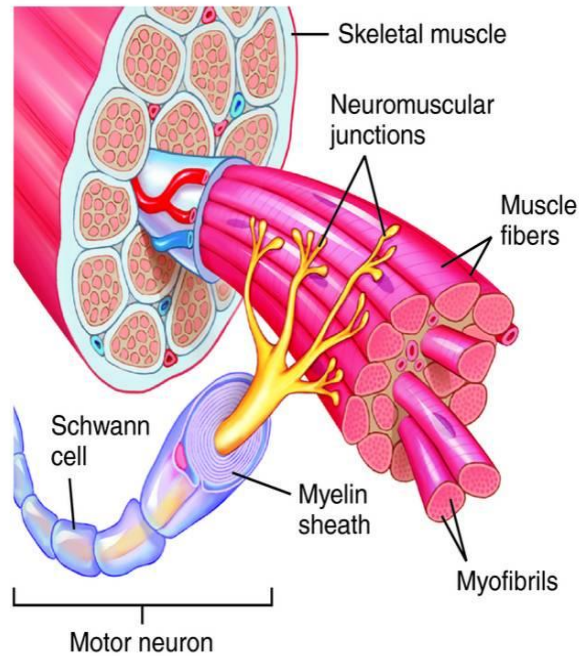
- **B-The Autonomic Nervous System**

- The autonomic nervous system consists of neurons that run between the central nervous system (especially the hypothalamus and medulla oblongata) and various internal organs such as the:
 - heart
 - lungs
 - viscera
 - glands (both exocrine and endocrine)
- -It is responsible for monitoring conditions in the internal environment and bringing about appropriate changes in them.
- -The contraction of both smooth muscle and cardiac muscle is controlled by the autonomic system.
- -The actions of the autonomic nervous system are largely involuntary (in contrast to those of the sensory-somatic system).
- The first, the preganglionic neurons, arise in the CNS and run to a ganglion in the body.
- Here they synapse يشبك with postganglionic neurons, which run to the effector organ (cardiac muscle, smooth muscle, or a gland).
- -The autonomic nervous system has two subdivisions, the
 - 1-sympathetic nervous system and the
 - 2-parasympathetic nervous system.



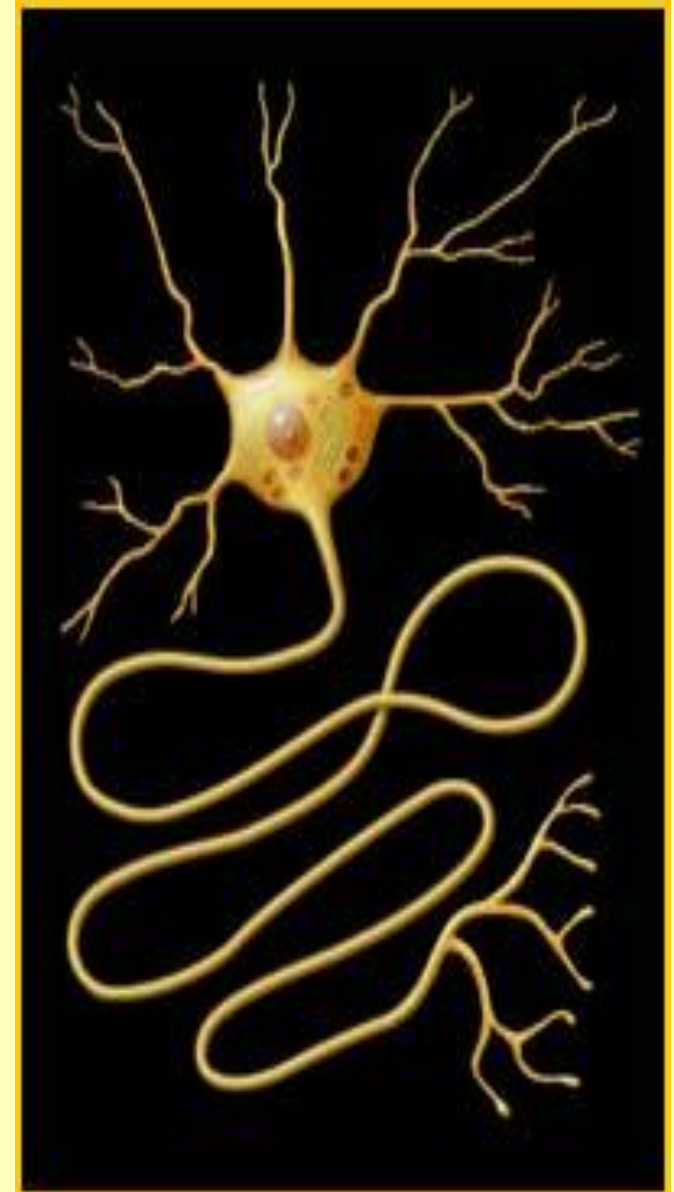
Motor unit

وحدة حركية



- **Neuron:-**

- **-DIF;-unit of function of the central nervous system, Either sensory or motor**
- **Motor neuron is mostly anterior horn cell in the spinal cord supply skeletal muscle**
- **Parts of motor neuron & function of each part:**
- **1- Soma (cell body)**
- **2-Dendrites التشعبات carry nerve impulses from surroundings to the soma**
- **3 Axon hillock بروز at which nerve impulses begin & pass in one direction from soma to the axon(nerve fiber) then to axon terminal.**
- **4-Axon and axon terminal end on skeletal muscle via neuromuscular junction**
- Nerve cell axons are very thin, about 1 micrometer. However, they are extraordinarily long. For many motor neurons the axon is over a meter long, extending from the spinal column to a muscle cell.



Motor unit

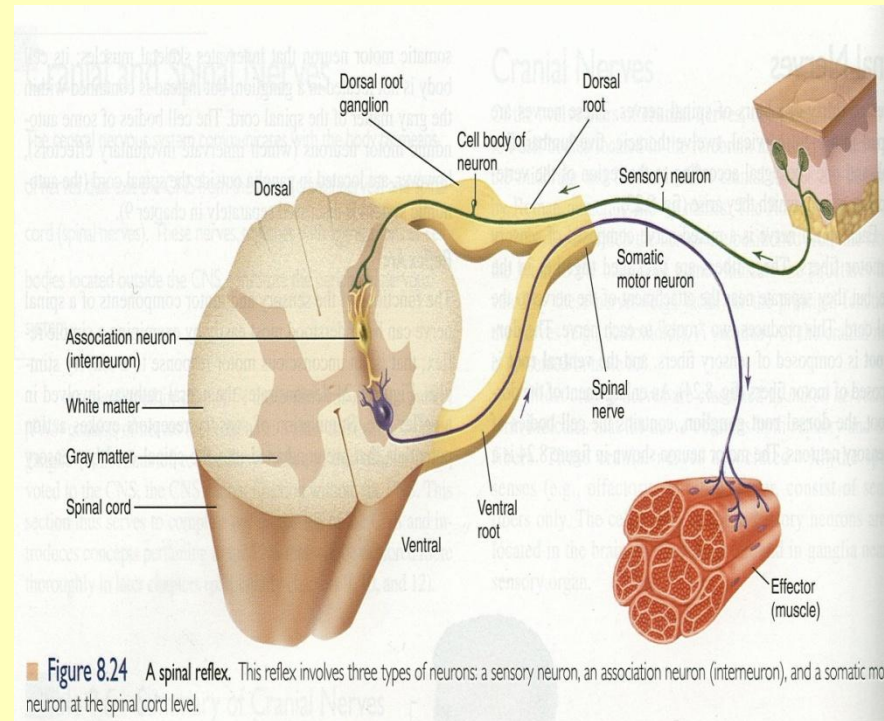
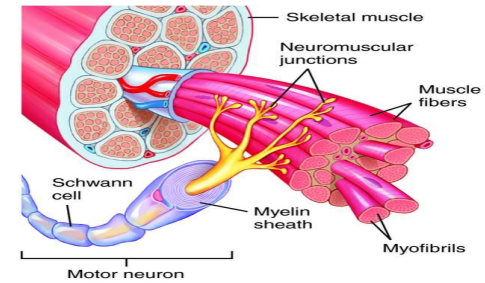
A motor unit is a single α -motor neuron and all of the corresponding muscle fibers it innervates (supplied with it)

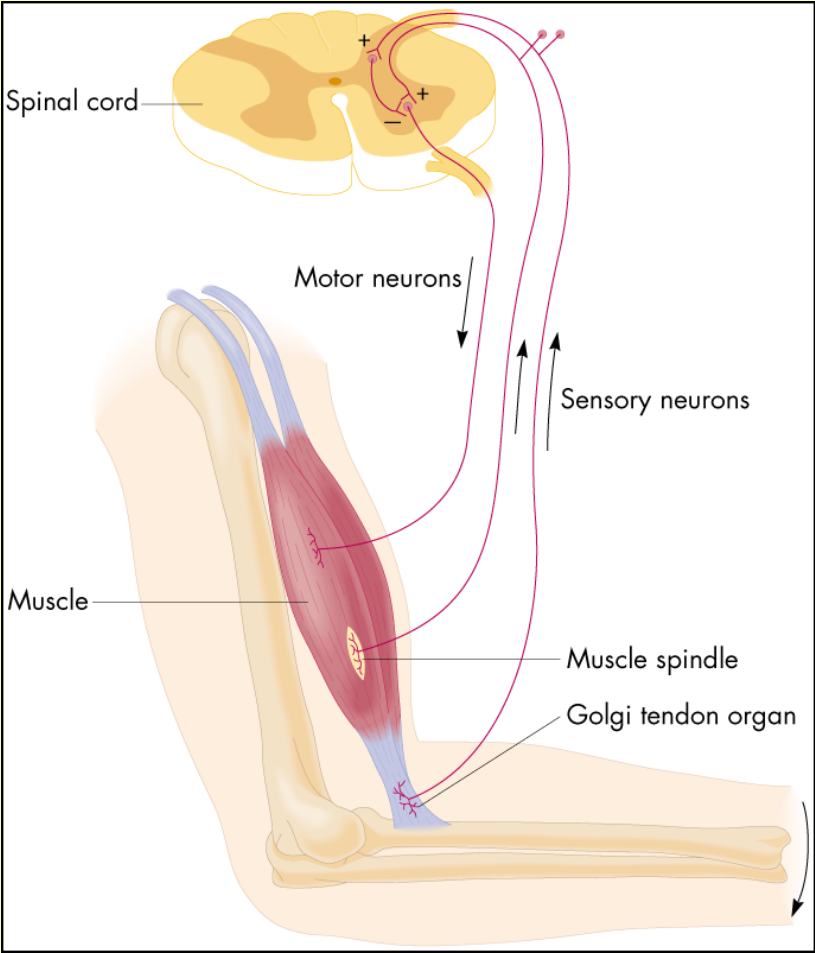
all of these muscle fibers will be of the same type (either fast twitch or slow twitch-انتفاض).

-When a motor unit is activated, all of its muscle fibers contract.

Groups of motor units often work together to coordinate the contractions of a single muscle

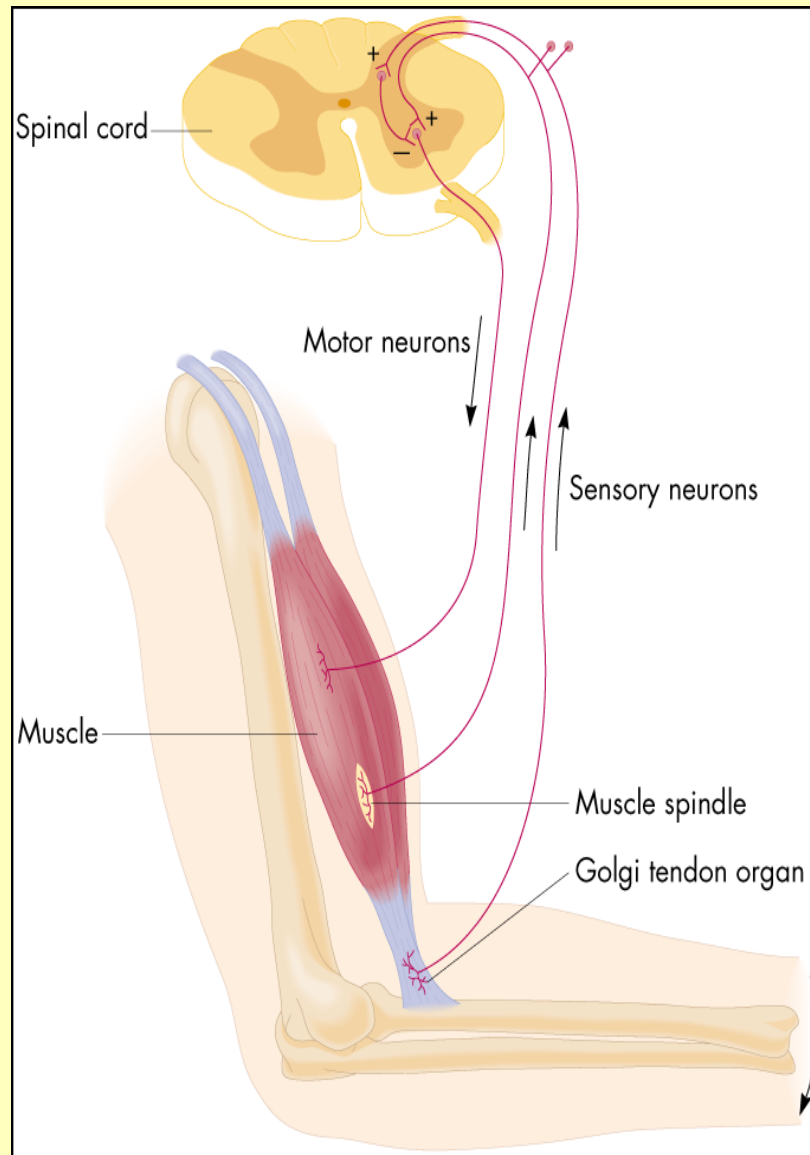
-all of the motor units that subserve a single muscle are considered a motor unit pool.





- The number of muscle fibers within each motor unit can vary:
- - Fine movements الحركات الدقيقة / need motor units have small number of muscle fibers
 - Gross movements الحركات الجسيمة / need motor units have large number of muscle fibers
- -Thigh muscles can have a thousand fibers in each motor unit
- - A single motor unit for a muscle like the gastrocnemius (calf) muscle (for gross movements) may include 1000-2000 muscle fibers
- - A single motor unit for eye muscle controlling eye movements (fine movements) may trigger fewer than 10 muscle fibers

- -In general, the number of muscle fibers innervated by a motor unit is a function of a muscle's need for refined motion.
- - The smaller the motor unit, the more precise **دقيق** the action of the muscle.
- -Muscles requiring more refined motion are innervated by motor units that **synapse** with fewer muscle fibers.
- In medical **electrodiagnostic testing** for a patient with muscle **weakness**, careful analysis of the motor unit action potential (MUAP) size, shape, and recruitment pattern can help in distinguishing a **myopathy** **مرض عضلى** from a **neuropathy** **مرض فى الاعصاب**



• Motor unit recruitment التوظيف

- Motor unit recruitment is the progressive activation of a muscle by successive recruitment of contractile units (motor units) to accomplish increasing gradations of contractile strength.
-
- - All muscles consist of a number of motor units each one has its own muscle fibers belonging to it.
- -When a motor neuron is activated, all of the muscle fibers innervated by this motor neuron are stimulated and contract.
- The activation of **one motor neuron** will result in **a weak muscle contraction**.
- The activation of **of more motor neurons** will result in more muscle fibers being activated, and therefore **a stronger muscle contraction**
- -.
- Motor unit recruitment is a measure of how many motor neurons are activated in a particular muscle, and therefore is a measure of how many muscle fibers of that muscle are activated.
- The higher the recruitment the stronger the muscle contraction will be

Rate coding of muscle force

The force of muscle contraction produced by a single motor unit is determined in part by:-

- 1- the number of muscle fibers in the unit.
- 2- the frequency of nerve impulses **نبضات عصبية** with which the muscle fibers are stimulated by their innervating axon.

--The rate at which the nerve impulses arrive is known as **the motor unit firing rate** and may vary from:-

- 1- frequencies **low enough** to produce a **series of single twitch** contractions
- 2- frequencies **high enough** to produce **a fused tetanic contraction**. **انقباض تقلصي**
مدموج (contraction without relaxation)

-- In general, the motor unit firing rate (firing of nerve impulses) of each individual motor unit increases with increasing muscular effort until a maximum rate is reached.