



Physiology Team 432



First Lecture: Motor Unit

DONE BY:

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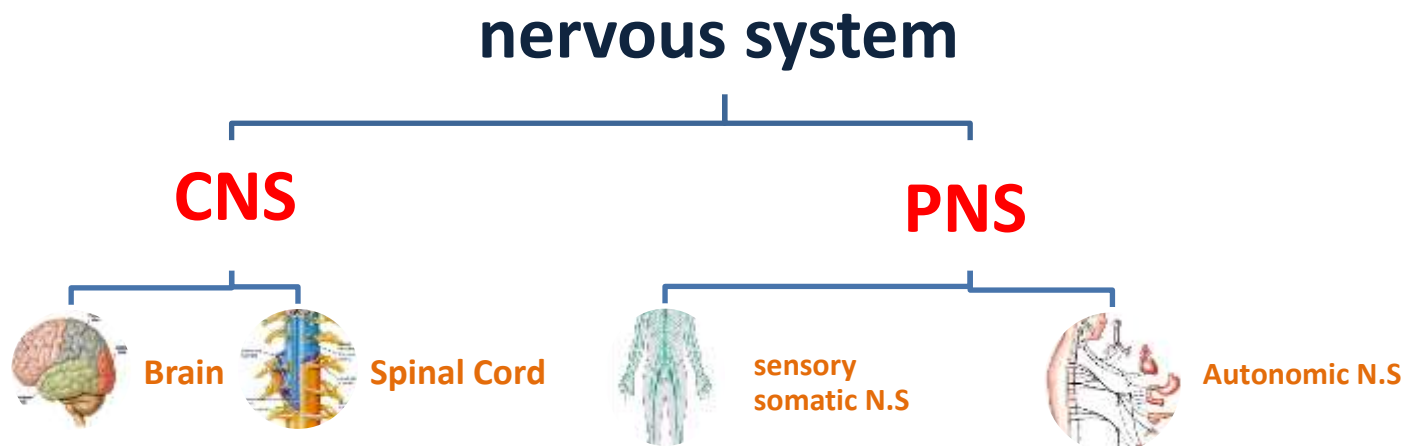
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Objective of the lecture

- Diagnose what is the organization of the nervous system.
- Appreciate differences between both CNS & PNS.
- Identify motor unit.
- Know the function & recruitment of motor unit.
- Appreciate effect of motor unit's number on action performance.



A- central nervous system (CNS):

- It is the part of the nervous system

that integrates the sensory information

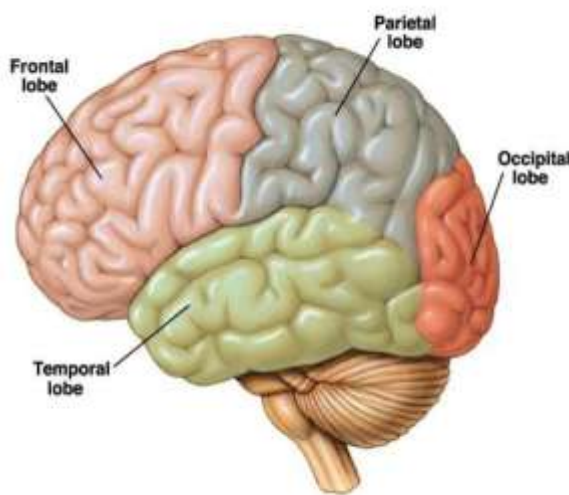
that it receives from different parts of body,

and coordinates the activity of all

parts of the body. & it consist of:

رد الفعل اما
يكون: حركي او
افرازات من
الأعضاء الداخلية.

1- BRAIN:



-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

- - the brain is protected by the skull

& enclosed in the meninges.

- - it consist of:

1- Two cerebral hemispheres connected

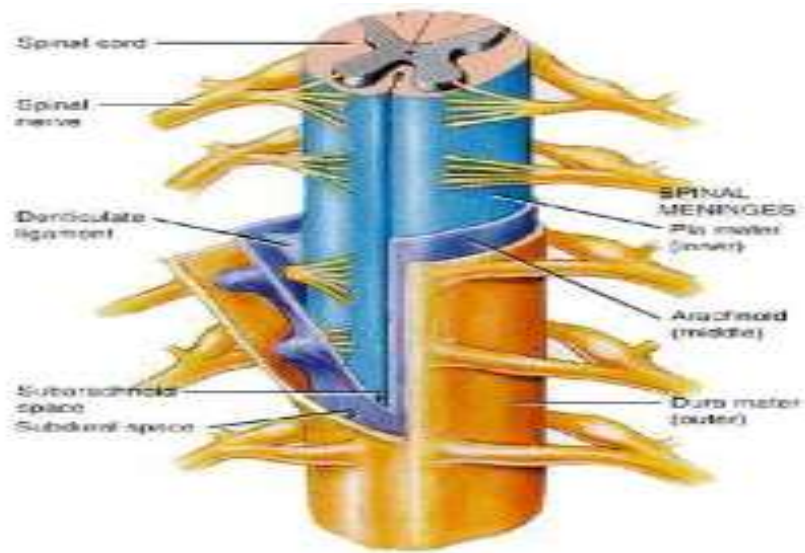
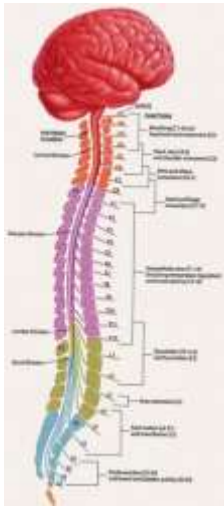
together by **corpus callosum**.

2- Brain stem

Midbrain, pons & medulla

3- cerebellum

2- SPINAL CORD:

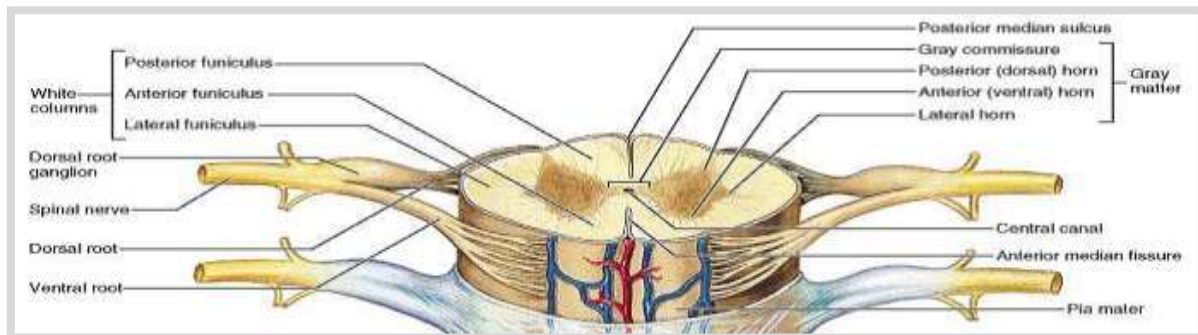


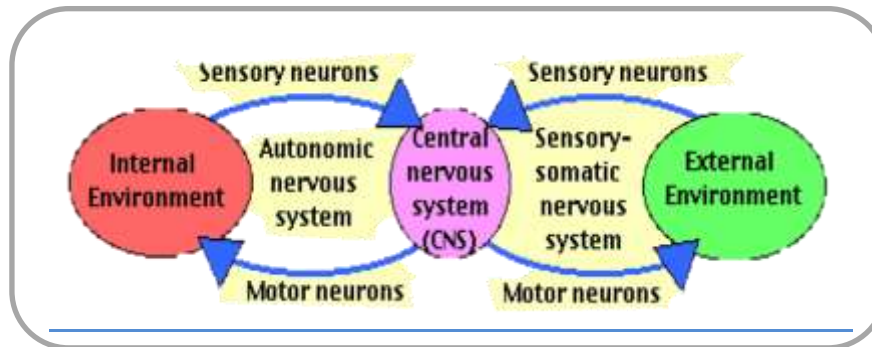
- - spinal cord is protected by the vertebrae & enclosed in the meninges as the brain.
- - it consist of:

1-H- shape grey matter formed of neurons(nerve cells).

2- dorsal horn has sensory neurons& ventral horn has motor neurons).

3-Surrounded by white matter of nerve fibers(tracts).





B-peripheral nervous system (PNS):

1-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.
- All has sensory afferent (ascending) & motor efferent (descendant).
- The sensory-somatic system ***consists of:***
 - ✓ 12 pairs of cranial nerves (control function of head & neck).
 - ❖ **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 & neck with some exceptions.
 - ✓ 31 pairs of spinal nerves:
 - ❖ **Spinal nerve** take their origins from the spinal cord.
 - ❖ In humans, there are **31 pairs** of spinal nerves:

▪ Cervical	➡	8
▪ Thoracic	➡	12
▪ Lumba	➡	5
▪ Sacral	➡	5
▪ coccygeal	➡	1
 - ❖ 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).

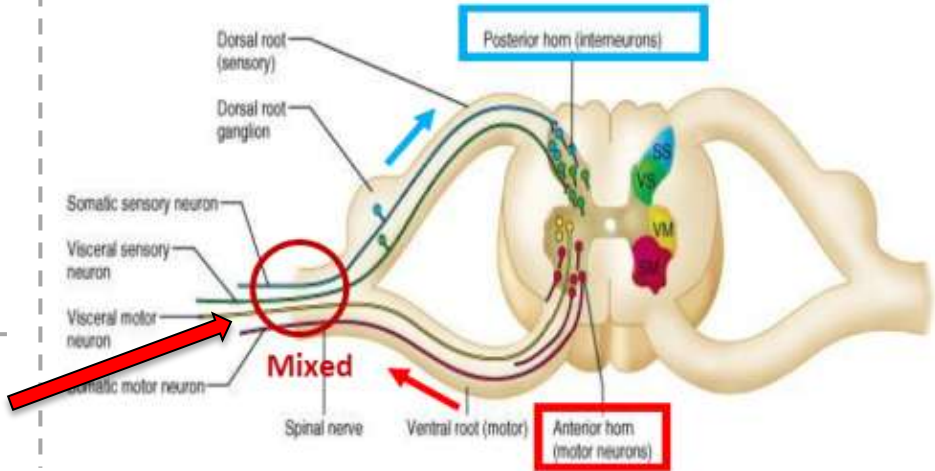
Dorsal horn -sensory:

مسؤول عن الاحساس بحيث يستقبل المعلومات الحسية ويوصلها للدماغ.

Ventral horn - motor:

ينقل الأوامر من الدماغ وتوصلها للموتور نيورون والموتور نيورون بدورها توصلها للسكيليتال مسل في الجسم.

يوجد منطقة في السباينل تيرف يلتقي السينسوري والموتور مع بعض ويصير فيه ميكسد تيرف.



-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.(pain,touch....etc)

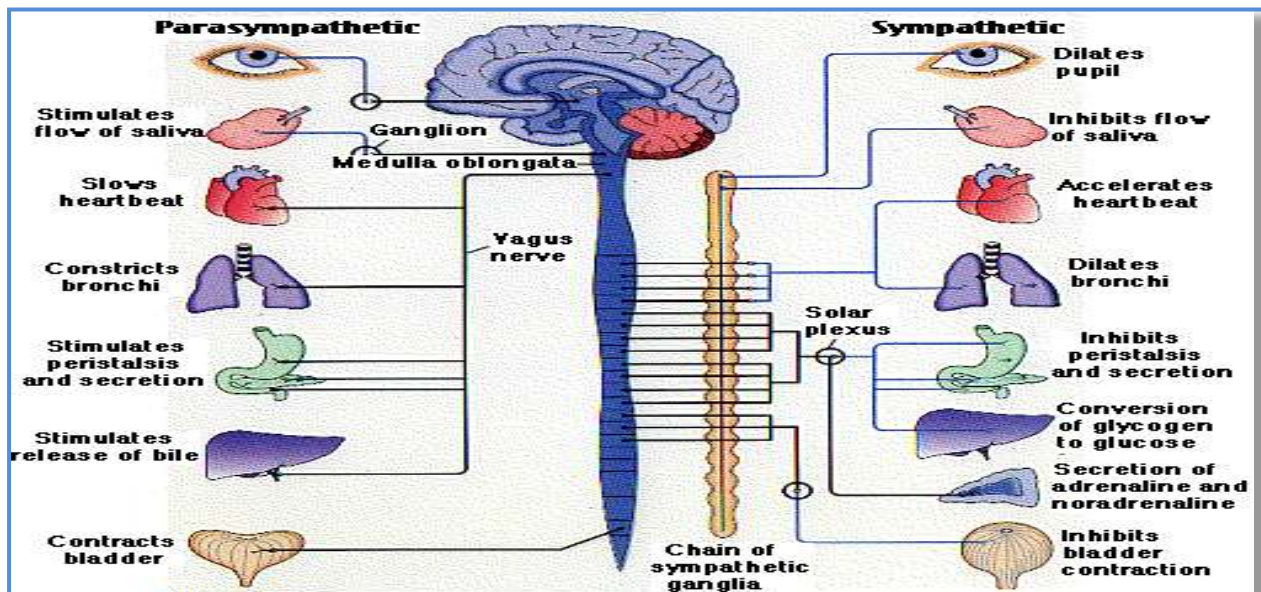
-(pass in the dorsal root).

-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-Autonomic nervous system:

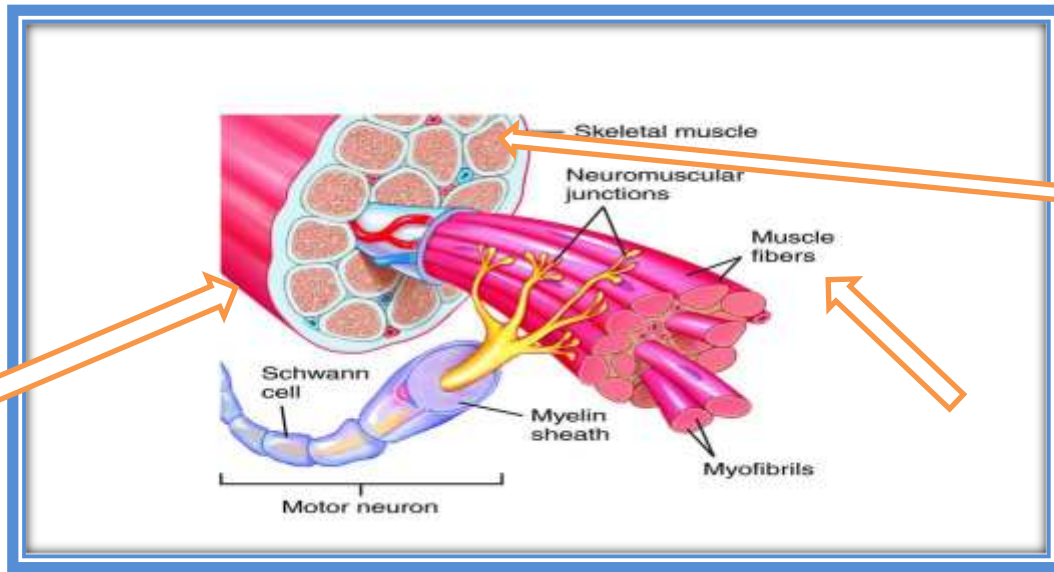
- The autonomic nervous system consists of neurons that run between the central nervous system (especially the hypothalamus and medulla oblongata) and various internal organs such as the:
 - ✓ Heart.
 - ✓ Lungs.
 - ✓ Viscera.
 - ✓ glands (both **exocrine** and **endocrine**).



- 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**:
 - ✓ **sympathetic nervous system.**
 - ✓ **parasympathetic nervous system.**

The doctor said the most important thing we have to know here is that the actions of the autonomic N.S are largely **INVOLUNTARY**.

Motor Unit



Neuron:

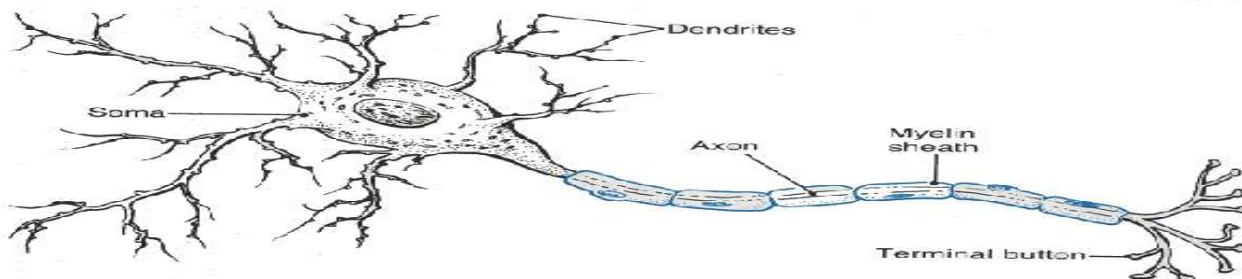
Is the Unit of function of the central nervous system, either sensory or motor.

- Motor neuron is mostly anterior horn cell in the spinal cord supply skeletal muscle.
- Parts of motor neuron & function of each part:
 - ✓ **Soma (cell body).**
 - ✓ **Dendrites** التشعبات carry nerve impulses from surroundings to the soma.
 - ✓ **Axon hillock** بروز at which nerve impulses begin & pass in one direction from soma to the axon(nerve fiber) then to axon terminal.
 - ✓ **Axon and axon terminal end** on skeletal muscle via neuromuscular junction.

مكان نشوء كل المؤثرات العصبية.

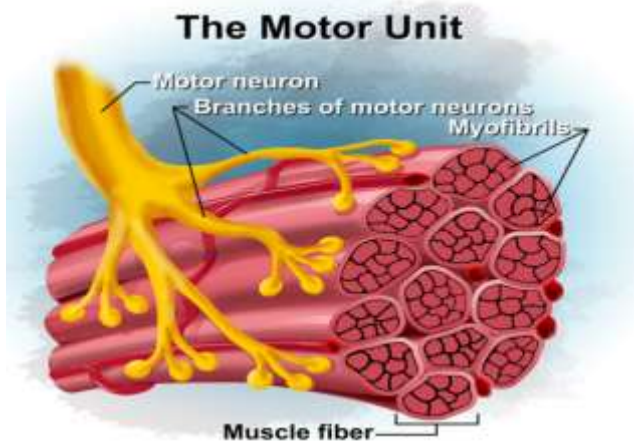
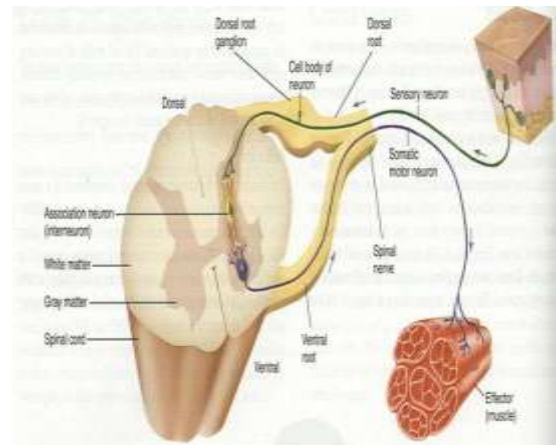
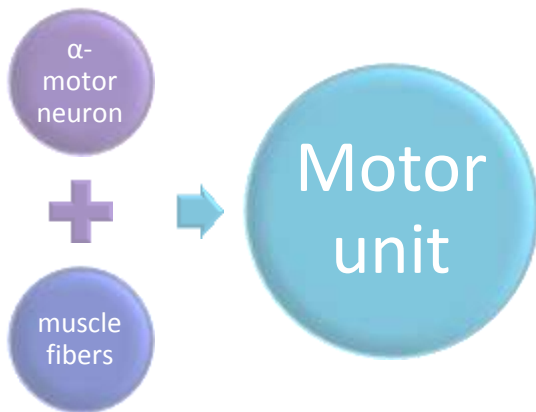
مكان التقاء نهاية العصب مع العضلة.

- 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 fibers 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 sub serve تفيد a single muscle are considered a motor unit pool.
- One Nerve is supplies group of muscle fibers , but Each branch of the nerve is supply only one Muscle fiber..



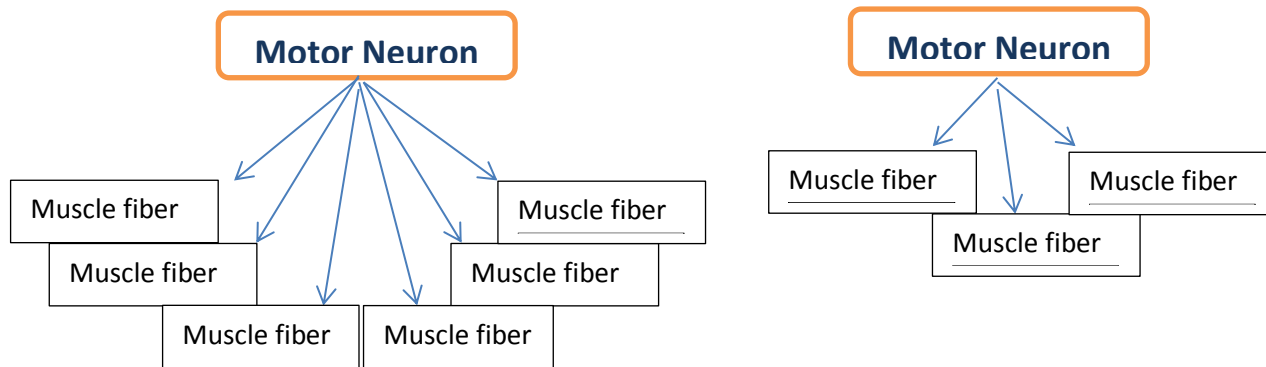
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- كل موتور نيورون طالع من السباينل كورد يروح للمسل فايبر اللي يغذيها.
- كل عضلة لها ملايين من الموتور نيورون تغذيها، لأن العضلة لها ملايين من المسل فايبرز.
- المسل فايبر اللي داخله في تركيب الموتور يونيت لازم يكونوا من نفس النوع.
- لما يصير اكتيفيشن لموتور يونيت (اللي هو عبارة عن موتور نيورون مع النيرف مع العضلة) المسل فايبر يصير لها كونتراكشن.

- اذا صار اكتيفيشن لازم الموتور يونيت يسوي الكونتراكشن لكل المسل فايبر- يعني ماينفع يصير كونتراكشن لشوية مسل فايبر والباقي ما يوصلهم شي (: ، فلازم يوصل لكل المسل فايبر عشان يصير بيست كونتراكشن

The number of muscle fibers within each motor unit can vary:

- **Fine movements:** need motor units have **small** number of muscle fibers.
- **Gross movements:** need motor units have **large** number of muscle fibers.



E.X: A single motor unit for eye muscle controlling eye movements (**fine movements**) may trigger fewer than 10 muscle fibers.

E.X: A single motor unit for a muscle like the gastrocnemius (calf) muscle (**gross movements**) may include 1000-2000 muscle fibers.

- Thigh muscles can have a thousand fibers in each motor unit.
- 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 number of muscle fibers in 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** electro diagnostic 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 (motor unit) will result in a weak muscle contraction.
- The activation of more motor neurons (multiple motor units) 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.**

The most important

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 عصبية نبضات 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. موج انقباض تقلصي (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.