Physiology Of The Motor Unit

Great video will help you understand the lecture

http://www.youtube.com/watch?v=hzXVe4RS8-A

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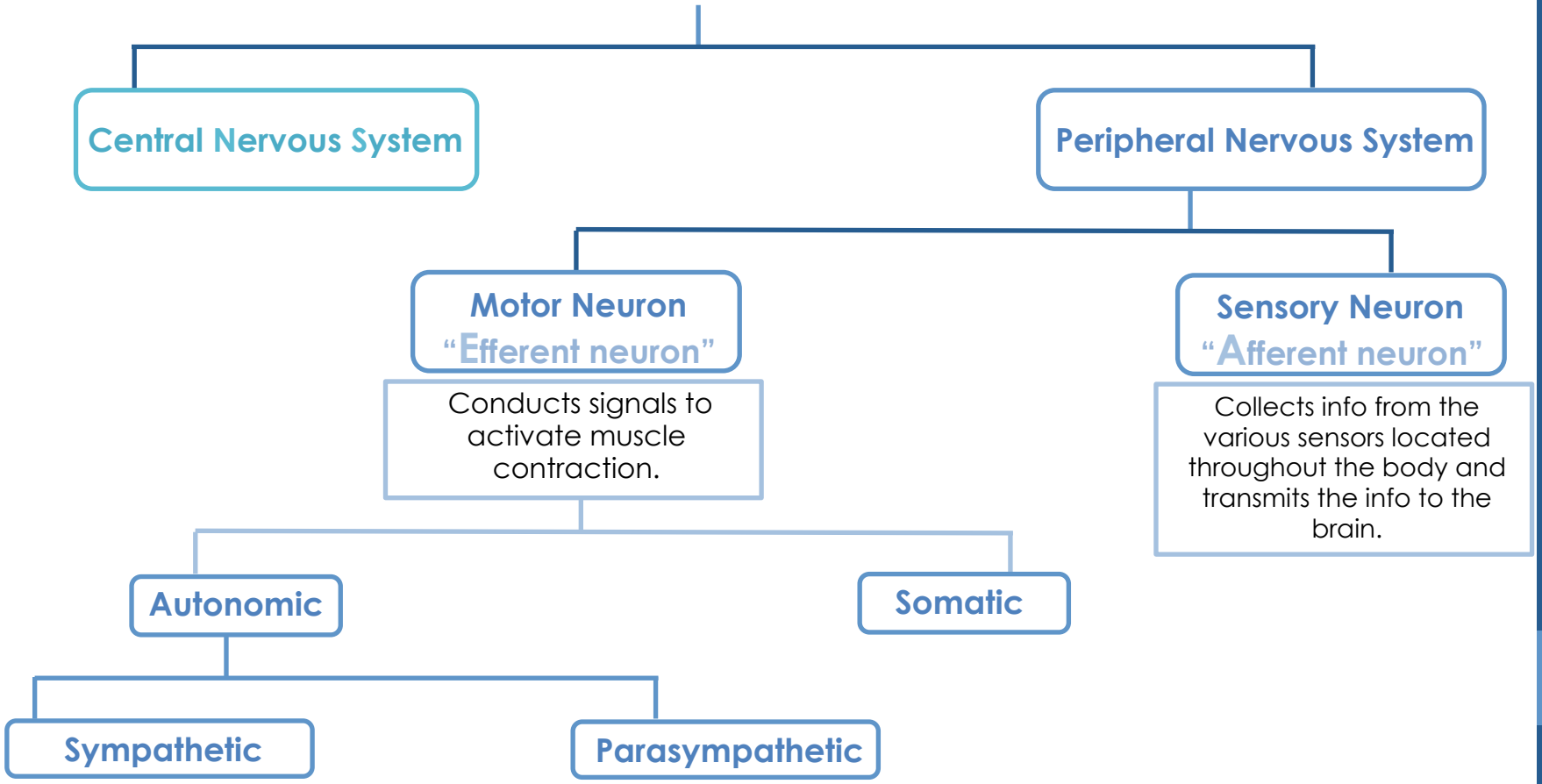
- Important
- Further Explanation

Physiology Team 434
contact us : physiology434@gmial.com

Objectives

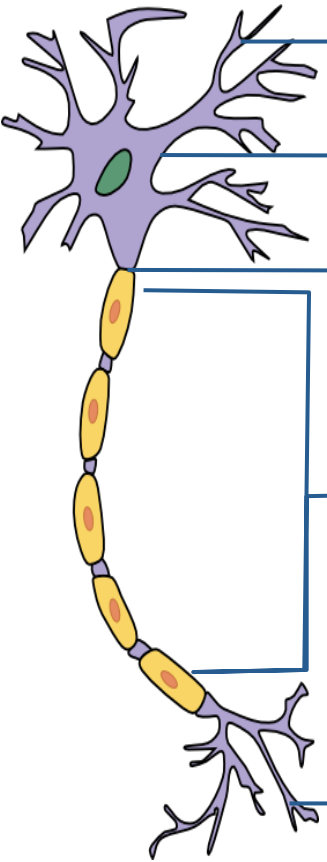
- Recognise the organization of the Nervous System.
- Appreciate differences between central nervous system (CNS) & peripheral nervous system (PNS).
- Understand the function & the recruitment of the motor unit

Nervous System



This slide is taken form RMP lecture

Neuron (Unit of function of CNS)



Dendrites (receive impulses, Carry them from surroundings to soma)

Soma (cell body)

Axon Hillock

Axon

Axon Terminal

Histological classification

Myelin Sheath:
-Formed by Schwann cell which deposits Sphingomyelin
-**Node of ranvier:** is the space between each myelin which allows the impulses to pass

Function:
-Insulator.
-Increase conduction velocity.
- Conserve energy for axon.

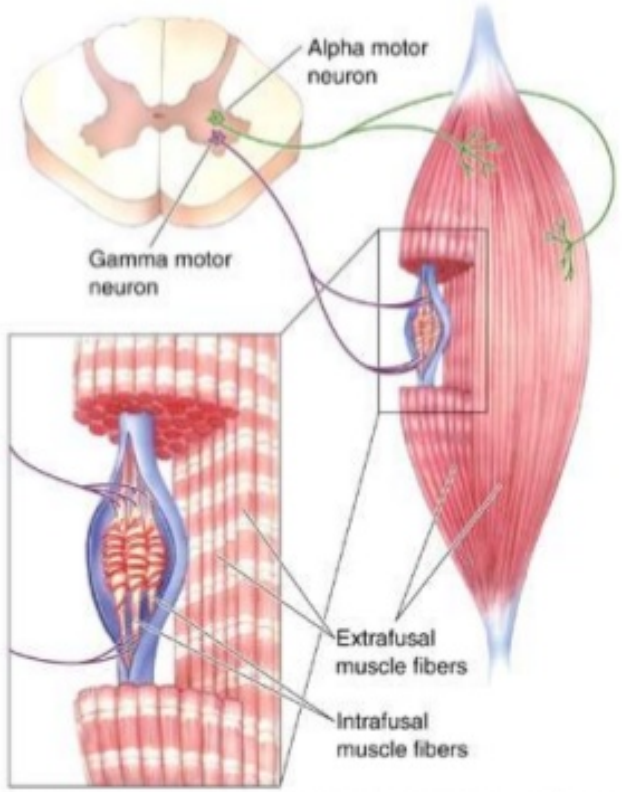
Type C:
-Postganglionic autonomic
-Pain Fibers

Additional slide

- **Motor neurons are divided into two groups :**

1- **Alpha motor neurons** innervate **extrafusal fibers** , the highly contracting fibers that supply the muscle with its power .

2- **Gamma motor neurons** innervate **intrafusal fibers** , which contract only slightly , its function is not to provide force to the muscle rather keep the muscle spindle taut .



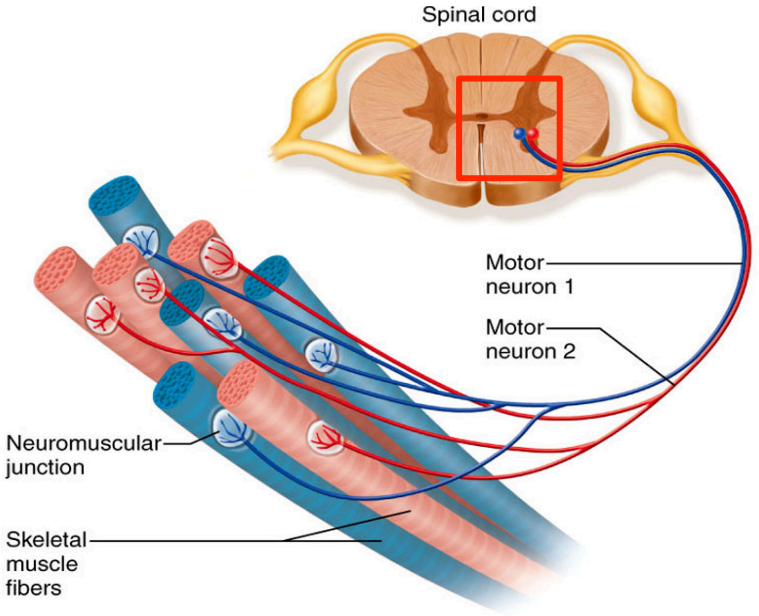
The Motor Unit

*It is the α-motor neuron in the (Anterior horn cell , AHC) and all the muscle fibers it innervates (supplies)

*All of these muscle fibers will be of the same type (either fast twitch or slow twitch)

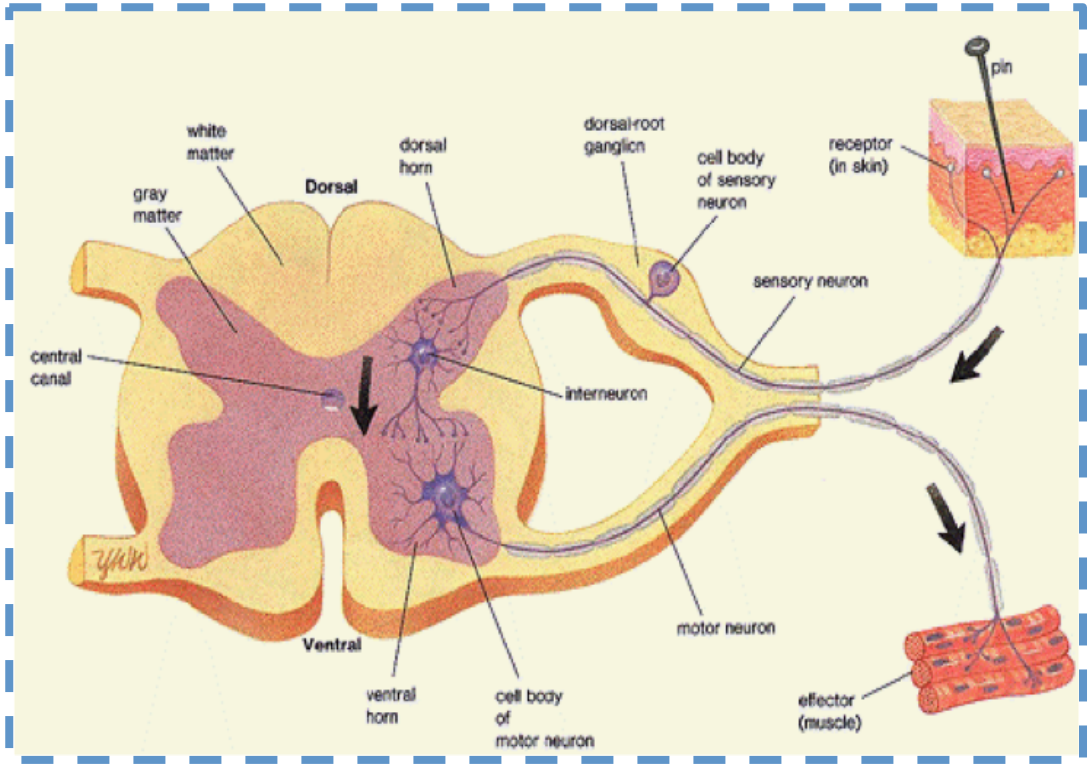
*Each muscle consists of a number of motor units.

*When a motor neuron is activated, all the muscle fibers innervated by that motor neuron are stimulated and contract.



Each nerve supplies the same muscle fibers,
(each nerve differs depending on the type of muscle it supplies) either fast or slow in contraction.

α-Motor Neuron In The Anterior (ventral) Horn Cell



Remimber: A **nerve** is made of a group of axons of neurons

The Motor Unit

* **The number of muscle fibers in a motor unit (innervated by 1 motor neuron) varies**
* **Ratio of muscle fibers to motor neurons, affects the precision of movement.**

For example :

-Gastrocnemius

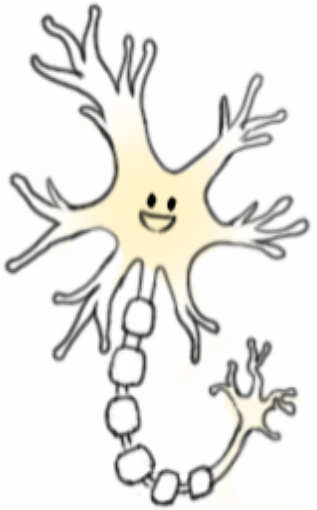
2,000 muscle fibers per motor neuron

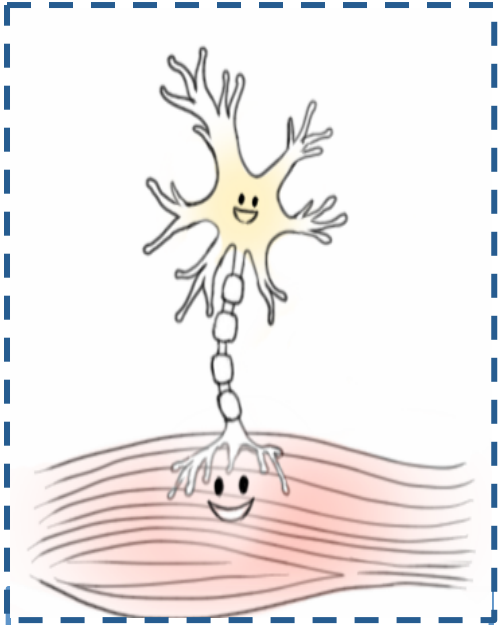
Less precise and larger movement

-Extraocular muscles

<10 muscle fibers per motor neuron

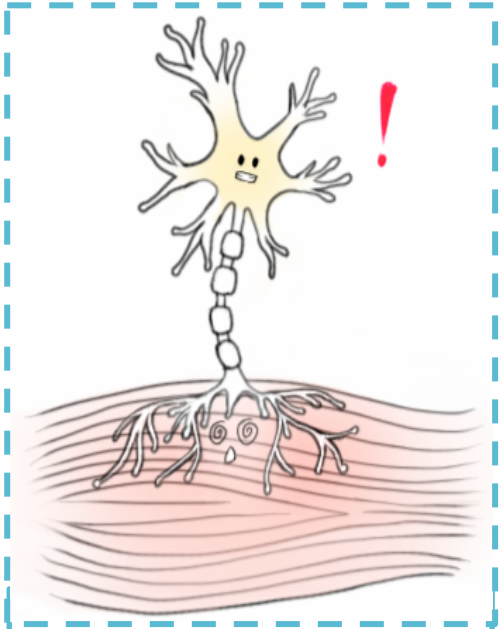
More precise and fine control





More precise movements

-Large number of Motor Units.
-Few muscle fibers.



Less precise movements

-Fewer Motor Units.
-Many muscle fibers.

Muscles needed to perform **precise movements generally consist of a **large** number of motor units and **few** muscle fibers per motor unit .

e.g **Hand and eye muscles.**

****Less precise movements** are carried out by muscles composed of **fewer** motor units with **many** fibers per motor unit

e.g **Trunk muscles**

*Groups of motor units often work together to help the contractions of a single muscle.

* The group of motor units supplying a single muscle are ***Motor Unit Pool***

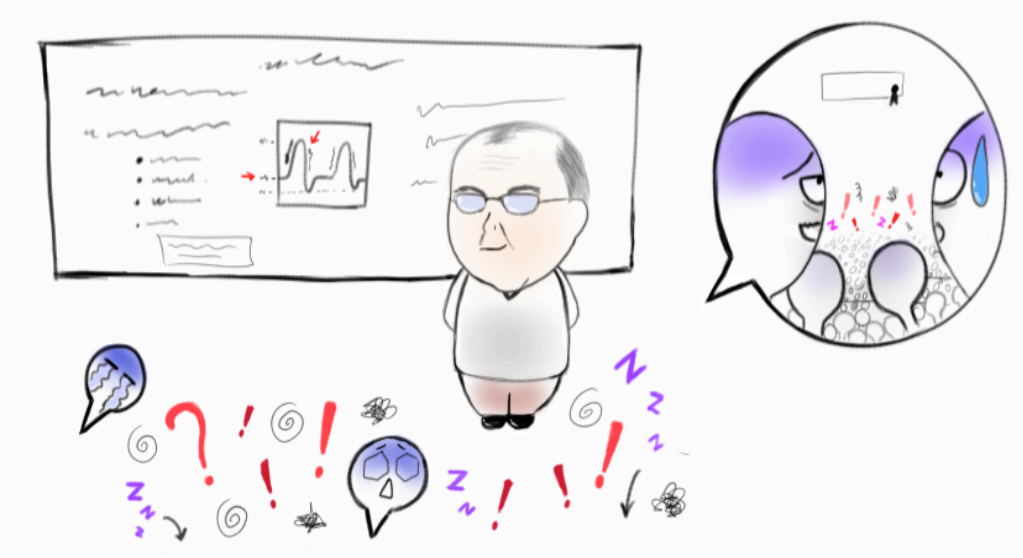
- The two ways the nervous system increases force production:

2.increasing stimulation frequency (rate coding) ; increase the discharge

1.recruitment of new motor units

-The activation of **one** motor neuron will result in a weak muscle contraction.

- The activation of **more** motor neurons will result in more muscle fibers being activated, and therefore a stronger muscle contraction.



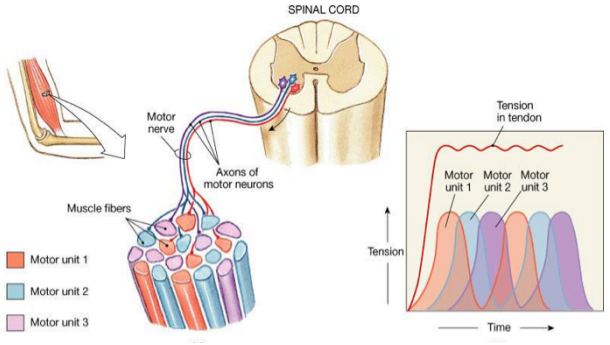
1- Motor Unit Recruitment

It is the progressive activation of a muscle by successive recruitment of **contractile units** (motor units) to accomplish increasing degrees of **contractile strength** (force).

The force produced by a single motor unit is determined by :

The **number** of muscle fibers in the unit .

The more motor neurons the more muscle fibers the stronger the contraction .



The stimulation **frequency** of muscle fibers by their innervating axon.
- Motor unit firing rate **(Rate coding)** -

** Slow rate of Anterior Horn cells (AHCs) firing leads to weak contraction .
** Fast rate of Anterior Horn cells (AHCs) firing leads to strong contraction .

Generally , this allows a 2 to 4 fold change in force .

Recruitment VS Rate coding

Larger muscles of mixed fiber types rely more on **recruitment** .
Ex: Deltoid

Small muscles rely more on rate **coding** .
Ex: First Dorsal Interosseous

N.B
-The size of the recruited motor unit.

- the smaller the motor unit the lower the force required during movement (threshold)

- The larger the motor unit the higher the force required during movement (threshold)

N.B
Motor units follow " all-or-none" principle

Impulse from motor neuron will cause contraction in all muscle fibers it innervates or none .

Electromyography
" was discussed in details in nerve conduction studies and EMG lecture "

An electrodiagnostic test for a patient with weakness, careful analysis of the motor unit action potential size , shape and recruitment pattern can help distinguishing a myopathy from a neuropathy .

MCQs

1.Comparing between two muscles A and B, The ratio of muscle fibers to motor neurons of muscle A is 10 muscle fibers/one neuron. and the ratio of muscle fibers to motor neurons of muscle B is 19 muscle fibers/one neuron . which of these statement is correct :

A- Muscle B is more precise than A
B- Muscle A is more precise than B
C- The two muscles have the same precision
D- The information given isn't enough

2. The nervous system increases the force production by:
A- Increase the stimulation frequency.
B- Recruitment of new motor units.
C- A and B

3- The higher the motor unit recruitment the stronger the muscle contraction will be:
A- True
B-False

Answers:
1. B
2. C
3. A

Done By:

- Suhail Alghamdi
- Moath Aleisa
- Sara Almubrik
- Amirah Mansouur
- Manal Alhamdan
- Nouf Alharbi
- Nouf Almasoud
- Rasha Bassas
- Wajda Alhouthli