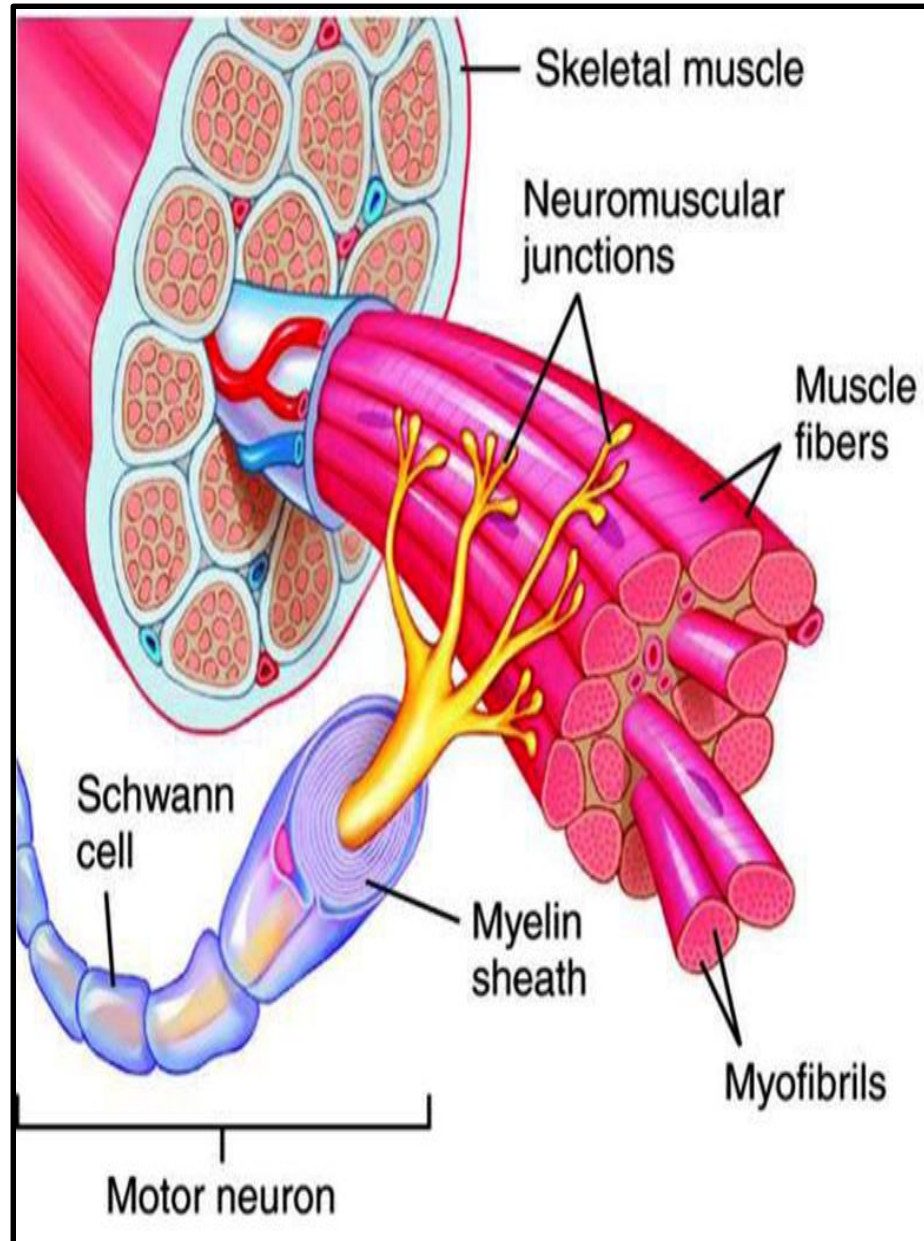


# Motor Unit

Dr. Salah Elmalik  
MBBS, PhD

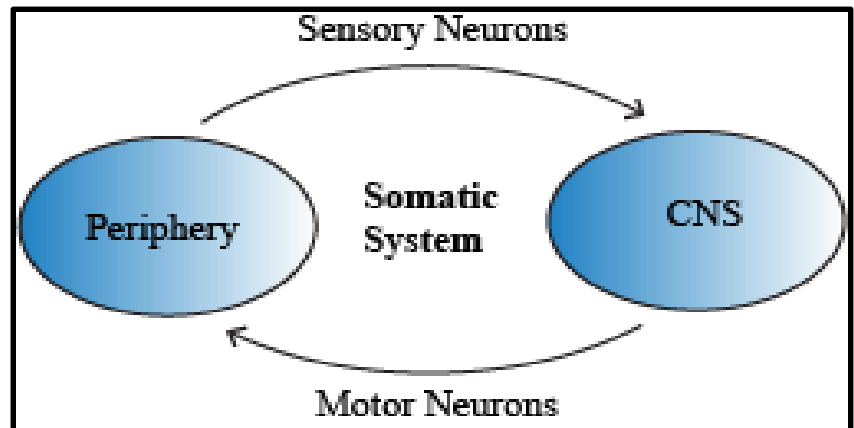
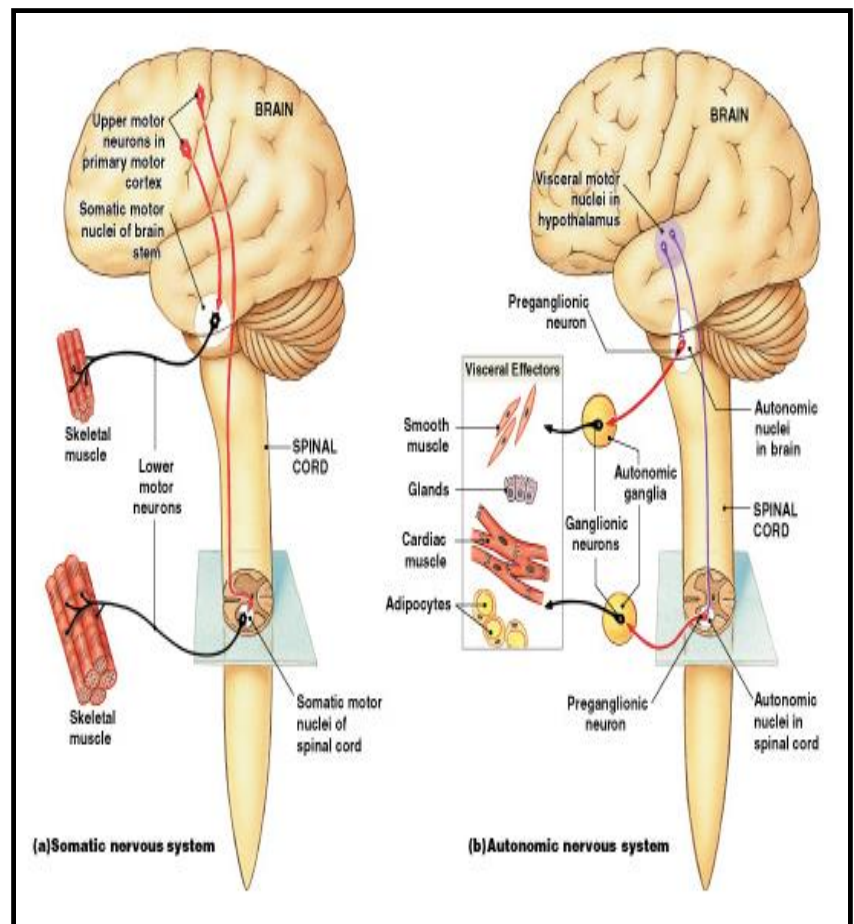
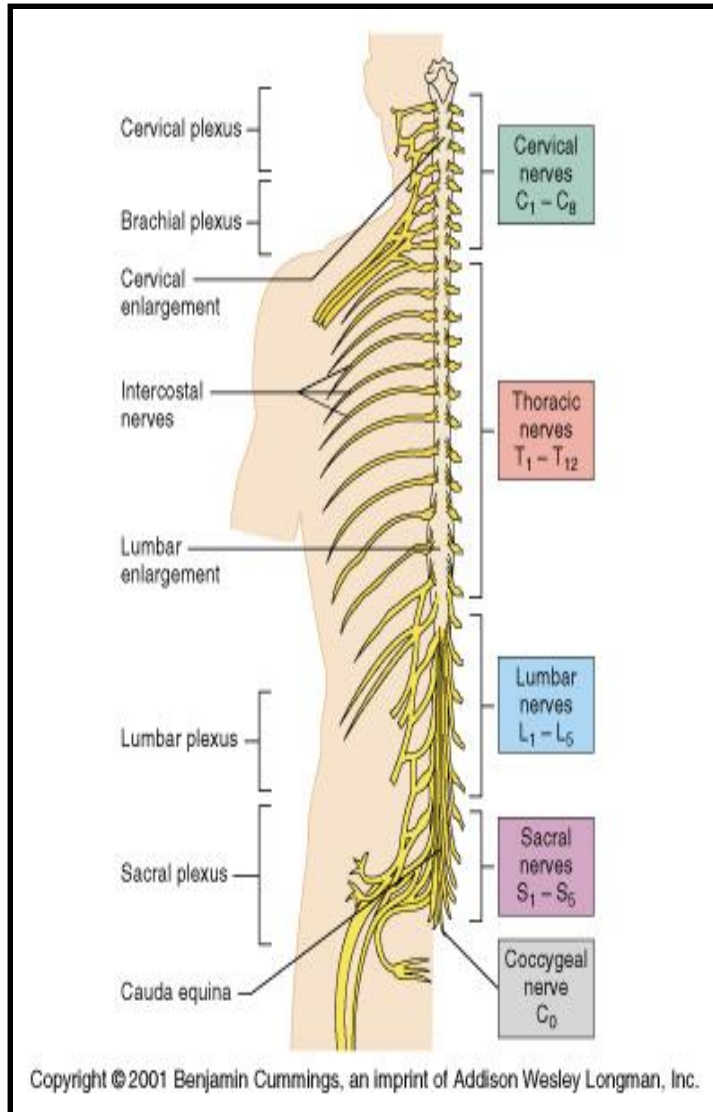


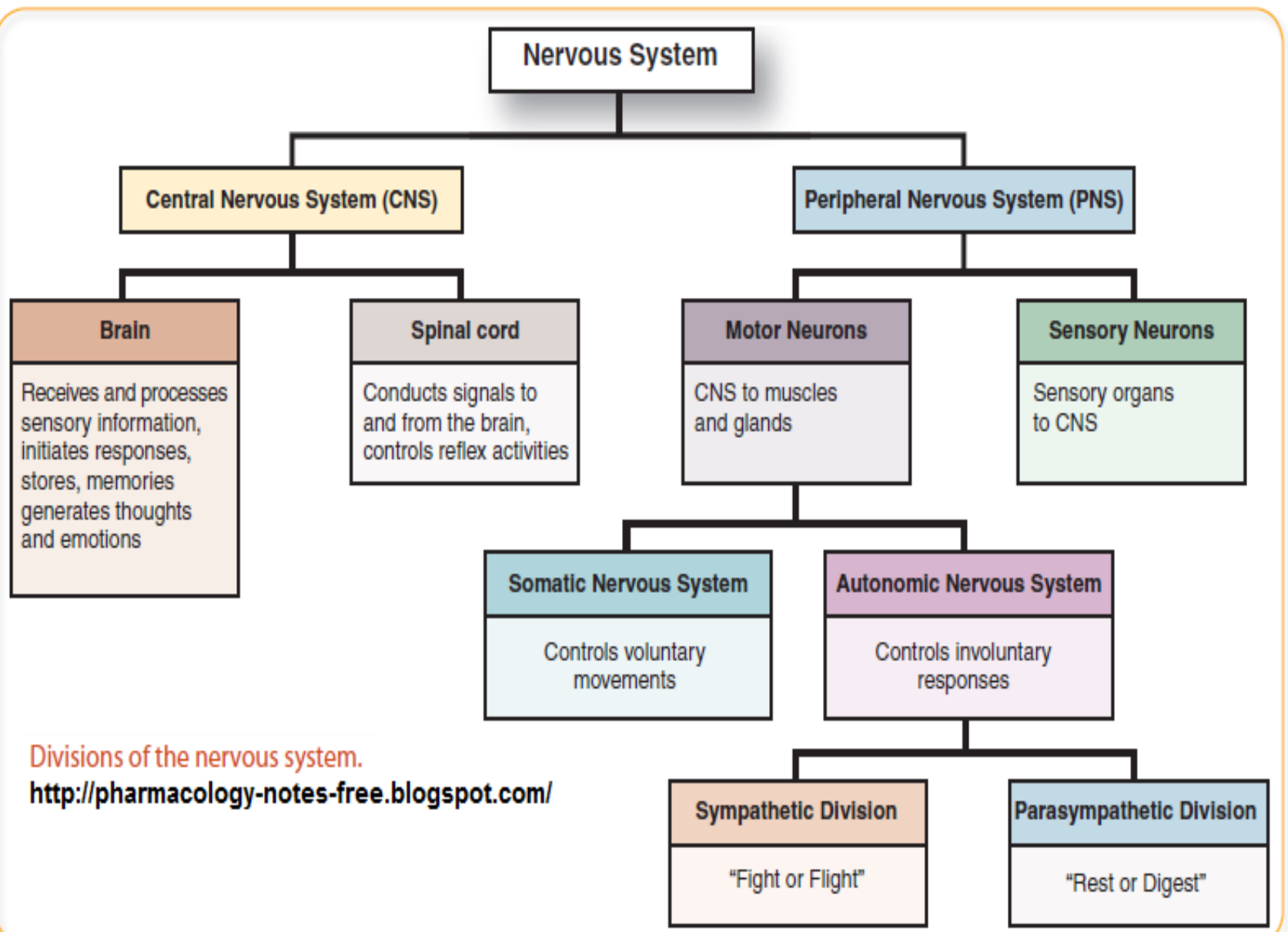
# Objectives

At the end of this lecture you should be able to:

- ❑ Recognise the organization of the Nervous System
- ❑ Identify the differences between central nervous system (CNS) & peripheral nervous system (PNS)
- ❑ Understand the function & the recruitment of the motor unit. Appreciate effect of motor units number on motor action performance

# Organization of Nervous System





Divisions of the nervous system.  
<http://pharmacology-notes-free.blogspot.com/>

# Nerve-Muscle Interaction

- The nervous system can be divided into central (CNS) and peripheral (PNS)
- It can also be divided in terms of function: motor and sensory activity
- **Sensory Neurons** : collects info from the various sensors located throughout the body and transmits the info to the brain
- **Motor Neurons** : conducts signals to activate muscle contraction
- Skeletal muscle activation is initiated through neural activation

# Organization of the Nervous System

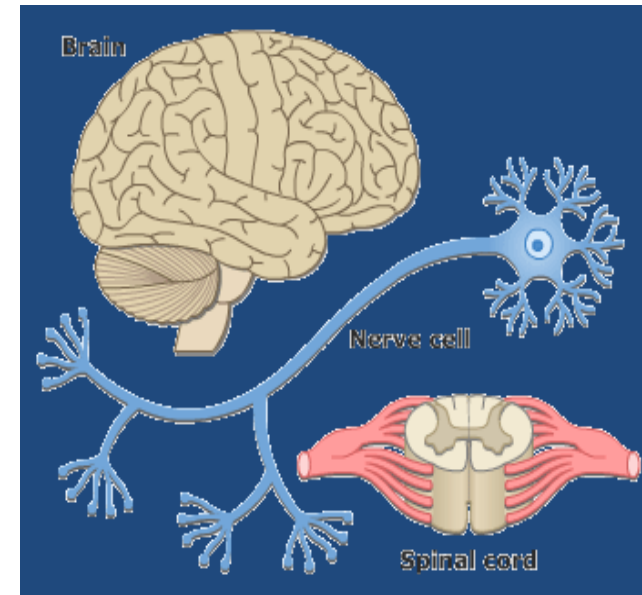
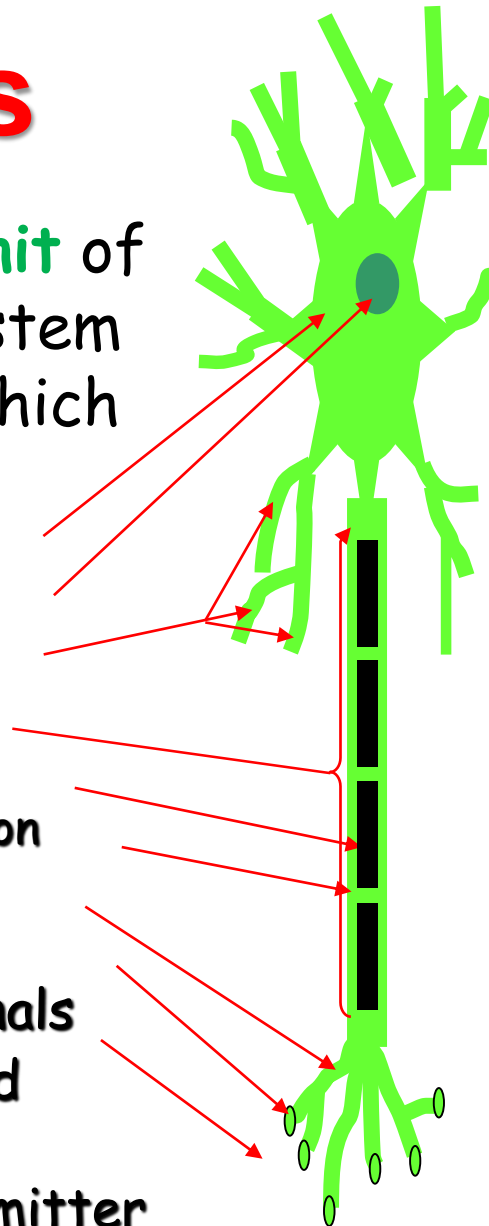
## 1- Central nervous system (CNS)

- It is the part 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 :-
  - The brain
  - 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

# Neurons

The building unit of the nervous system is the neuron which has

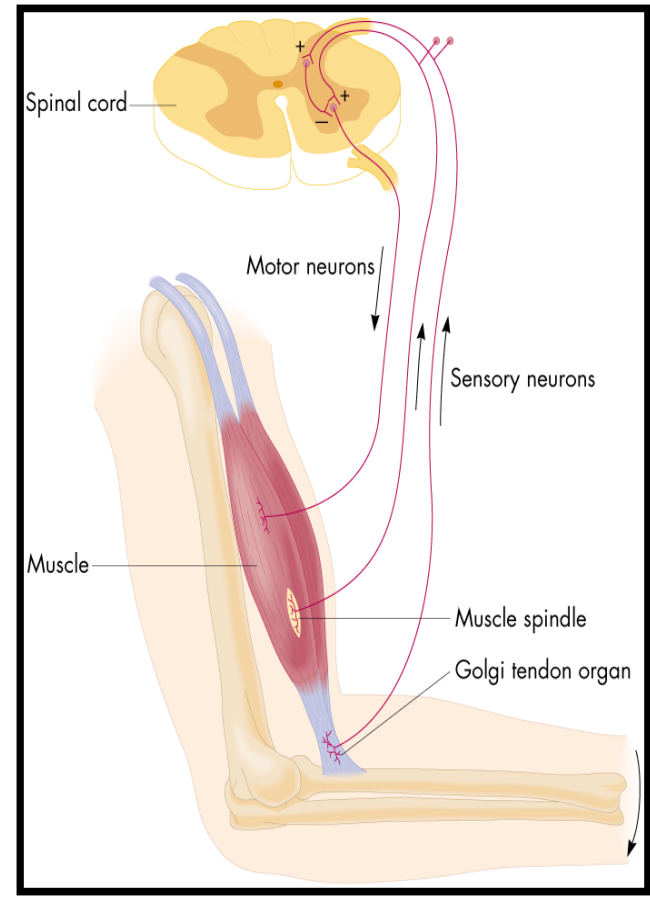
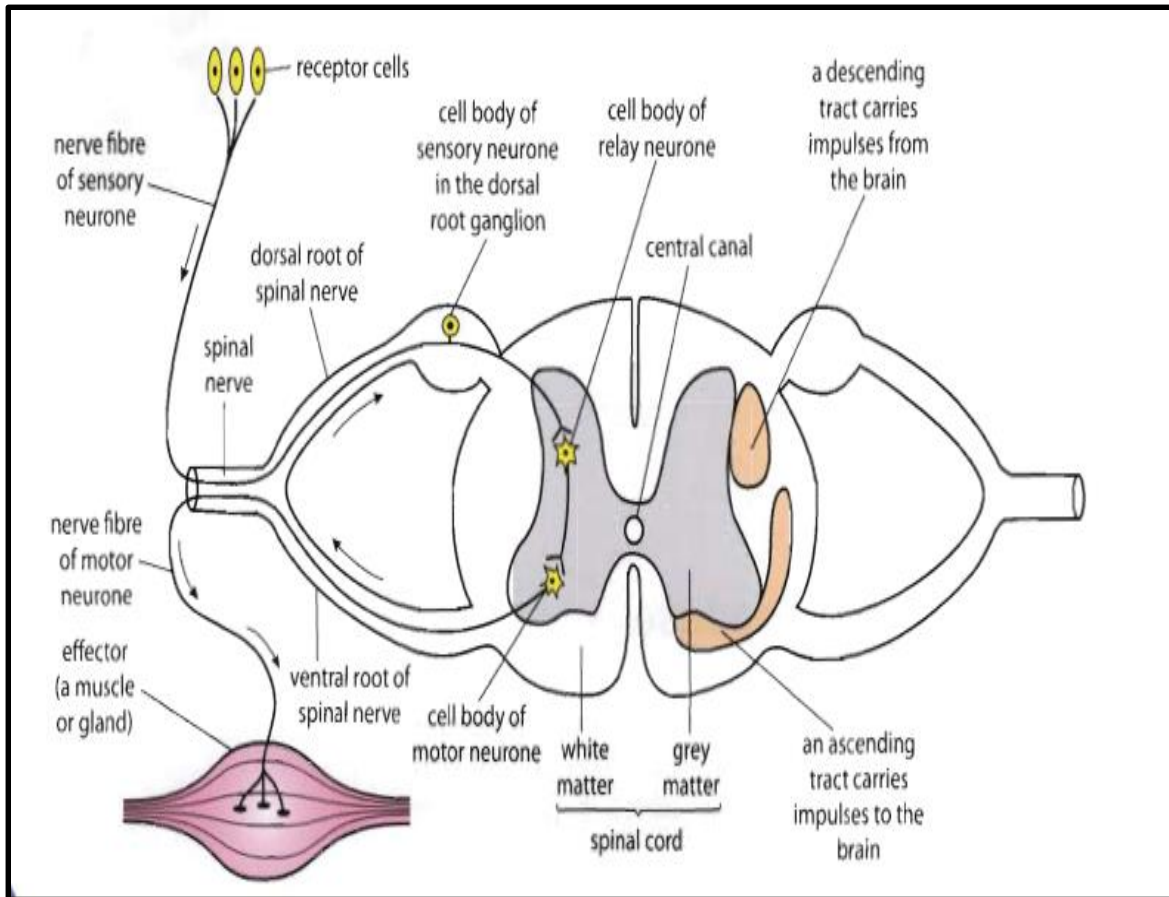
- Cell body
  - Nucleus
- Dendrites
- Axon
  - Myelination
  - Nodes of Ranvier
- Axon terminals
- Synaptic end bulbs
- Neurotransmitter
  - Acetylcholine (ACH)





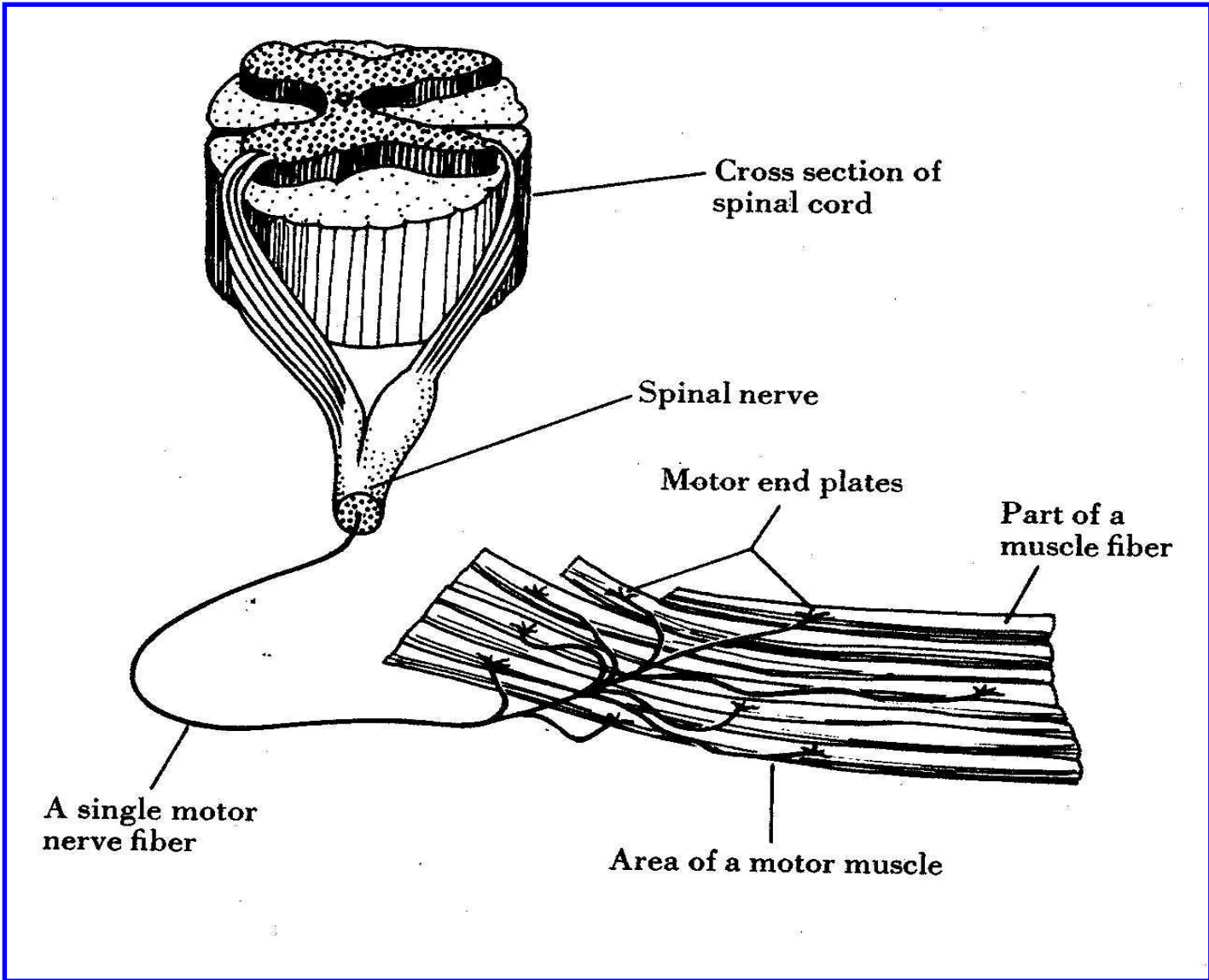
# $\alpha$ -motor neuron in the anterior horn cell

A nerve is made of a group of axons of neurons



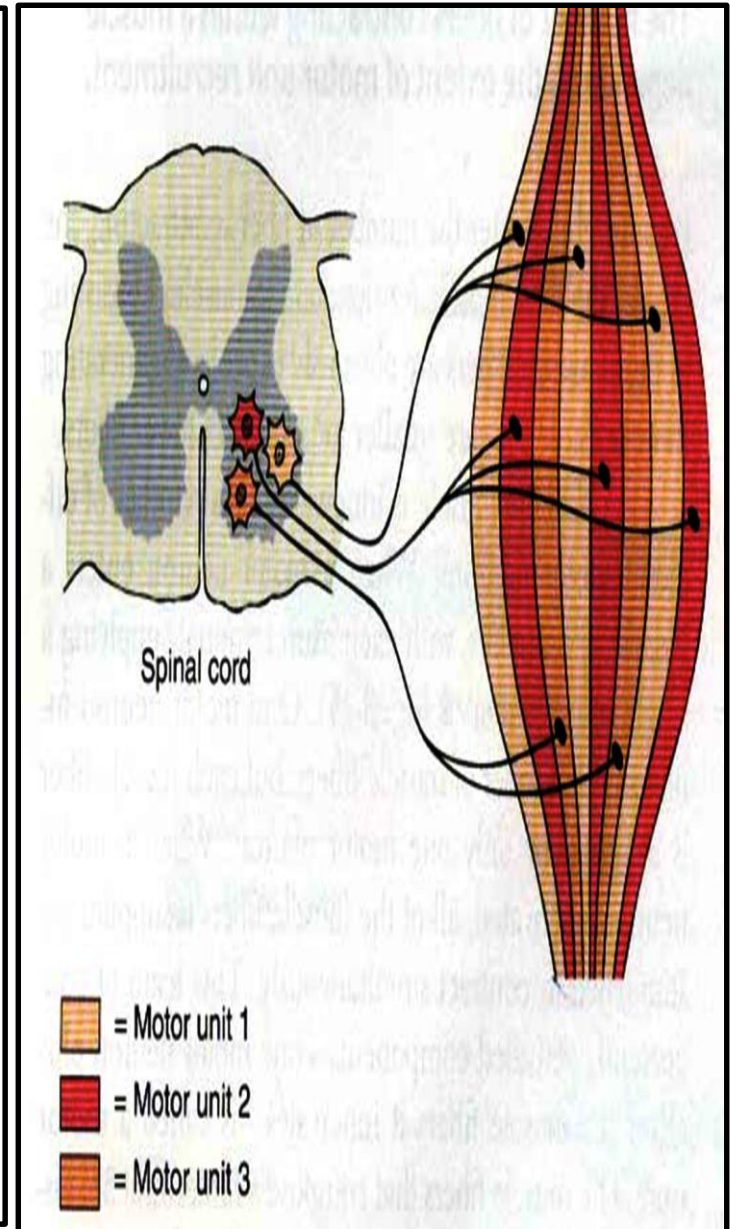


# Motor Unit



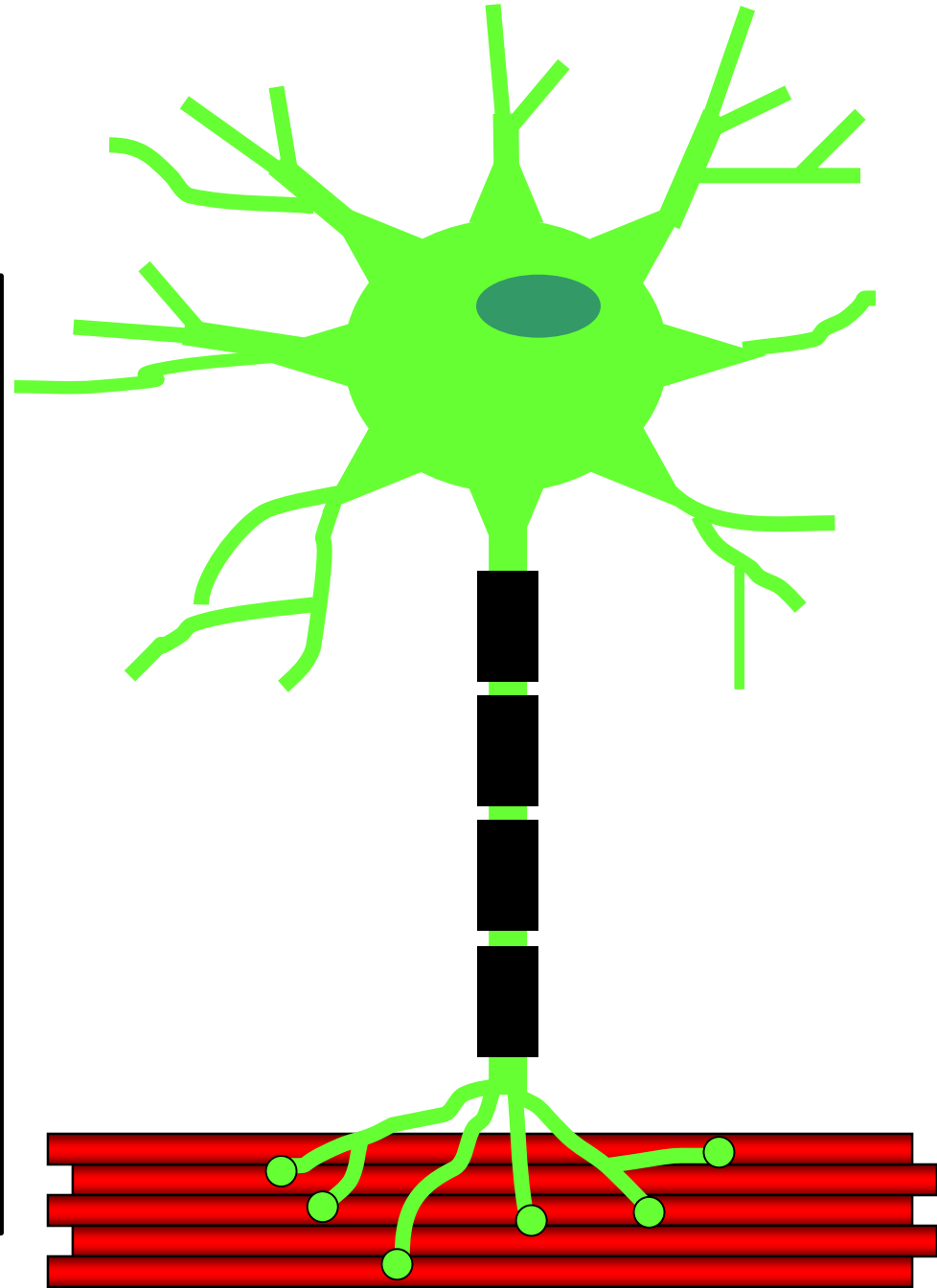
# What is a Motor Unit ?

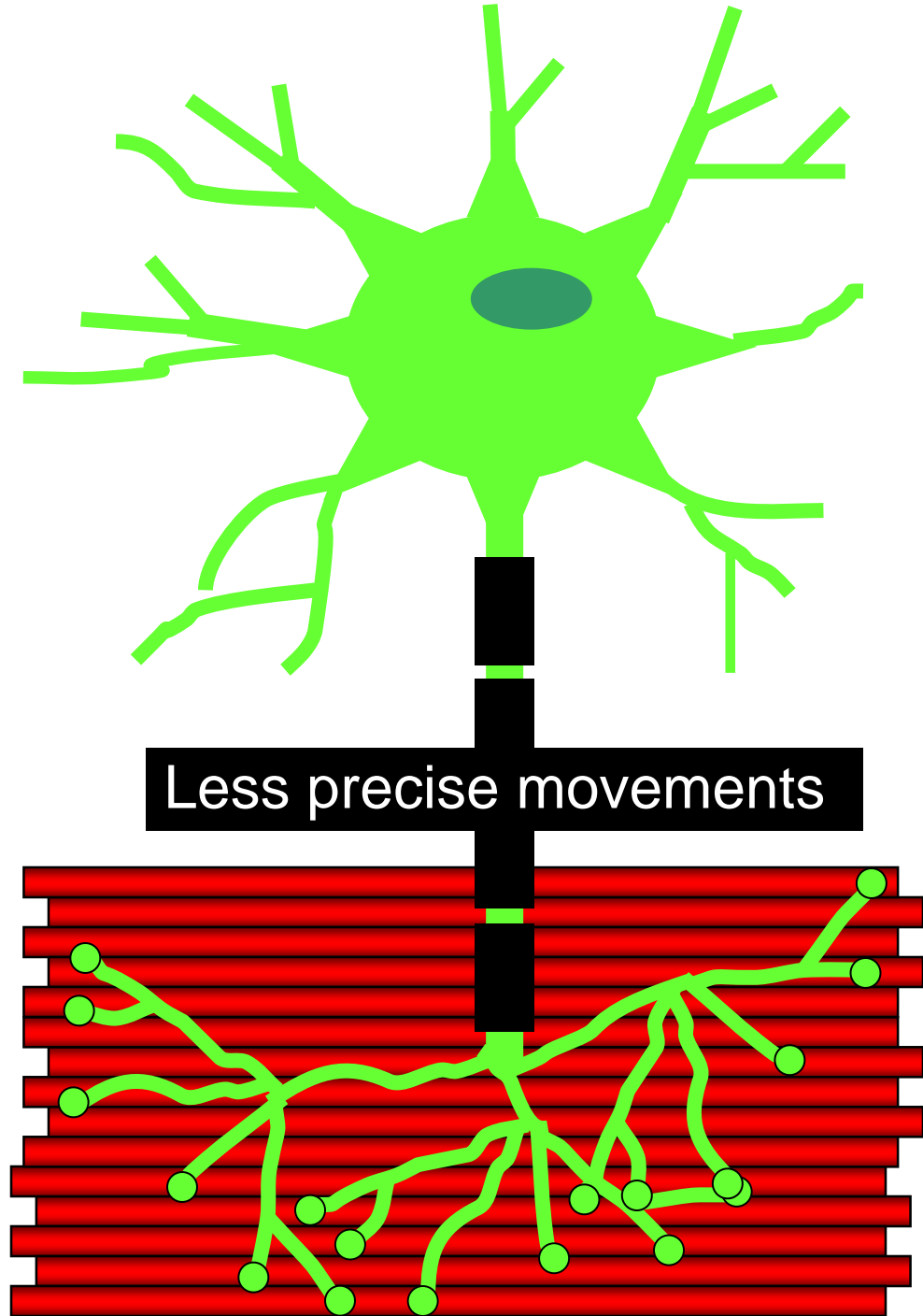
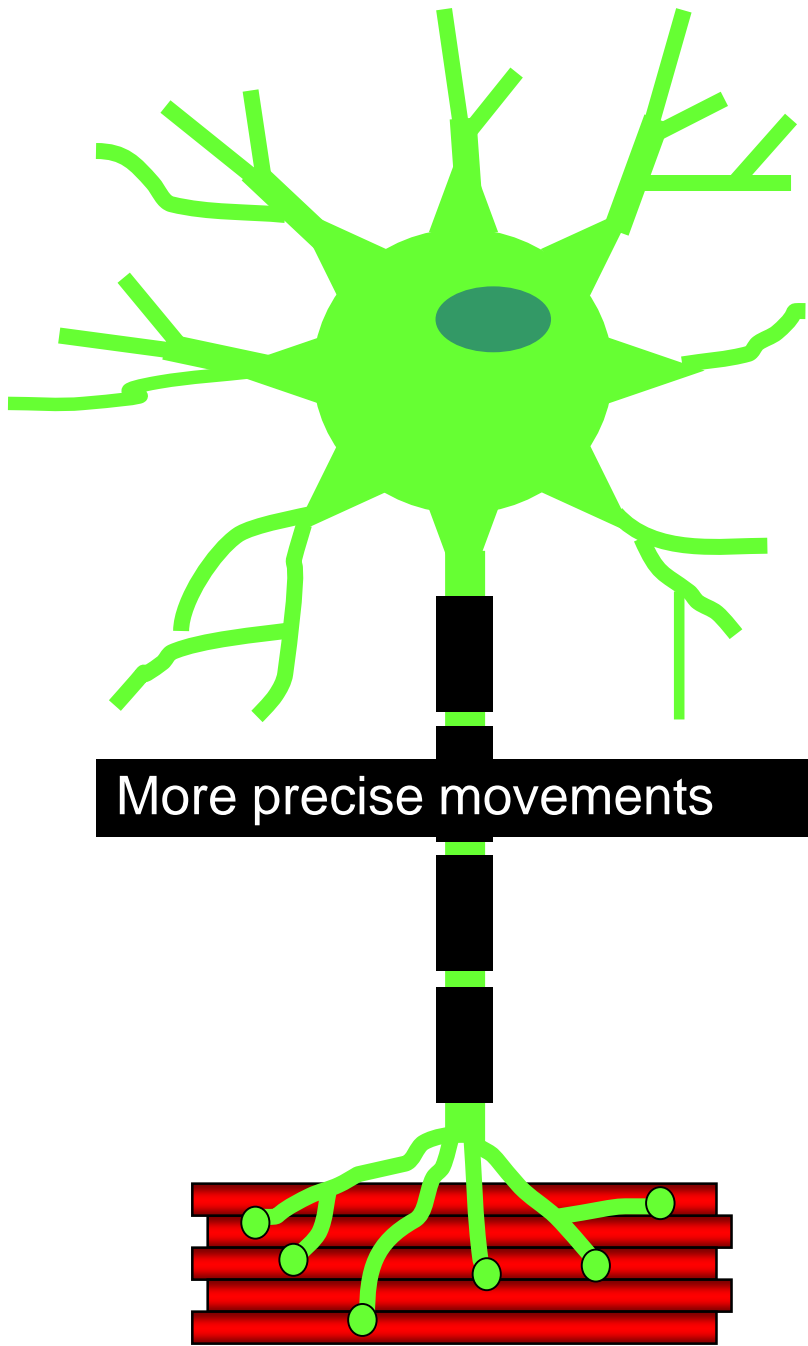
- It is the  $\alpha$ -motor neuron in the anterior horn cell , AHC ) and all the muscle fibers it innervates (supplies)
- All of these muscle fibers will be of the same type (either fast twitch or slow twitch)
- Each muscles consist of a number of motor units.
- When a motor neuron is activated, all of the muscle fibers innervated by the motor neuron are stimulated and contract.



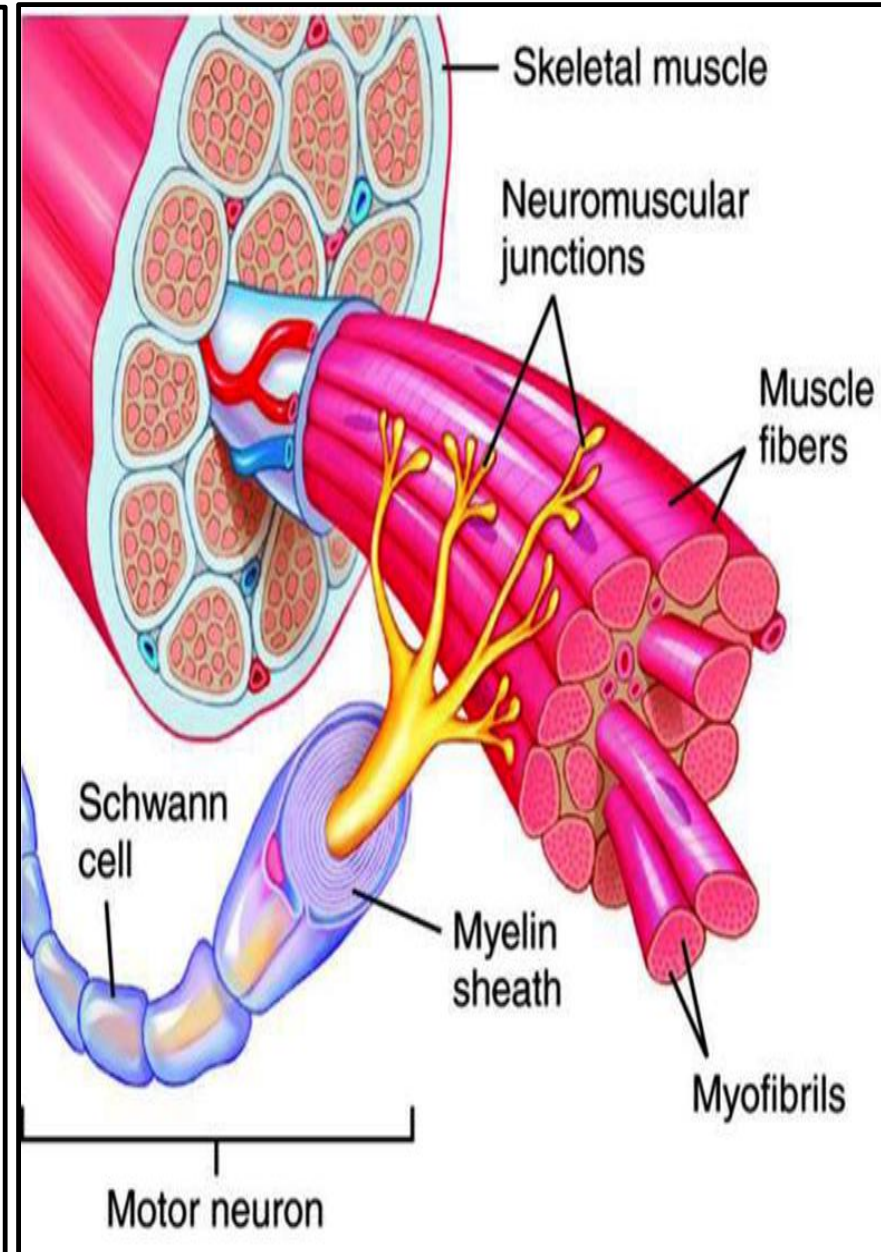
# Motor Unit

- The number of muscle fibers in a motor unit (innervated by 1 motor neuron) varies
  - Gastrocnemius
    - 2,000 muscle fibers per motor neuron
  - Extraocular muscles
    - < 10 muscle fibers per motor neuron
- Ratio of muscle fibers to motor neurons
  - Affects the precision of movement





- Groups of motor units often work together to help the contractions of a single muscle .
- The number of muscle fibers within each motor unit can vary.
- Muscles needed to perform **precise movements** generally consist of a large number of motor units and few muscle fibers in each 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 unit e.g Trunk muscles

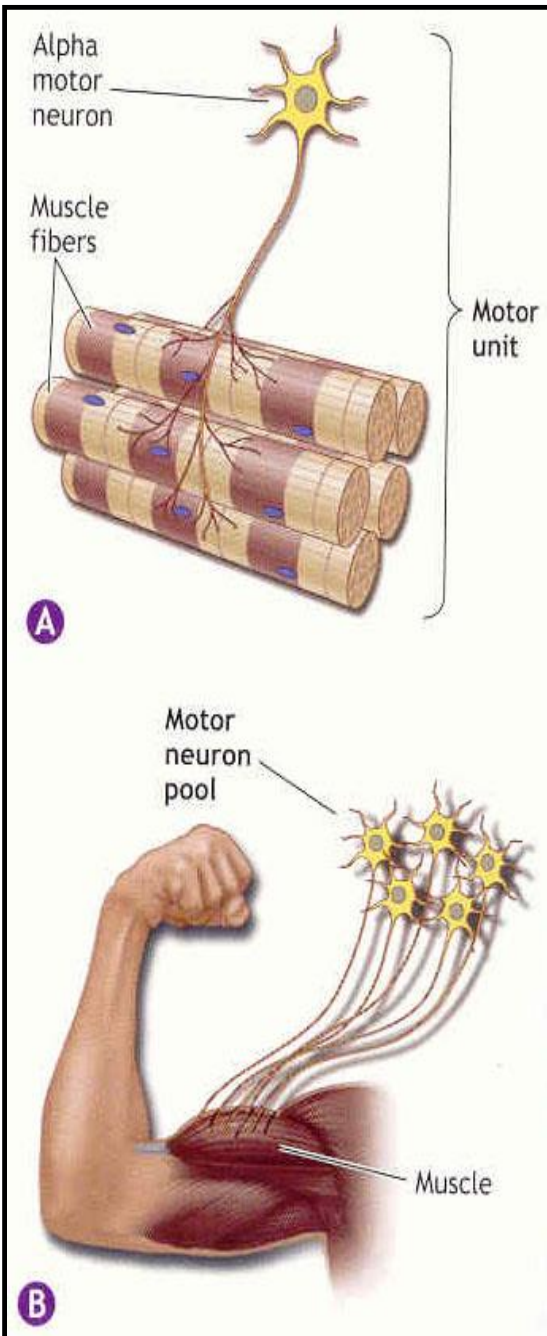




## Motor unit recruitment:

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

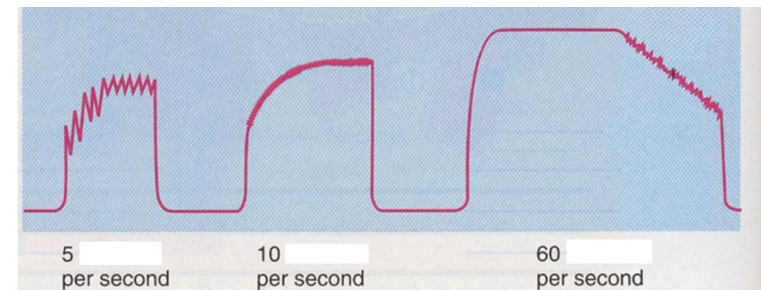
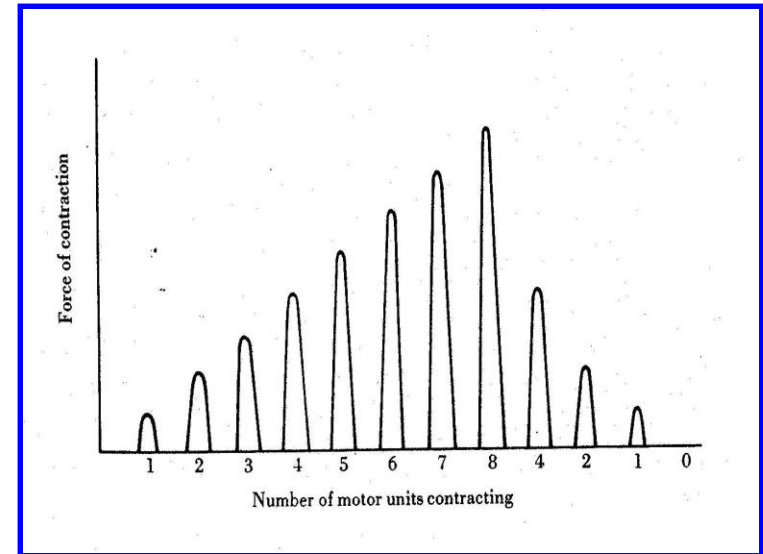
- The two ways the nervous system increases force production is through
  - \*\*recruitment of new motor units
  - \*\*increasing stimulation frequency (rate coding).
- The activation of one motor neuron will result in a weak muscle contraction.
- The activation of more motor neurons will result in more muscle fibers being activated, and therefore a stronger muscle contraction.





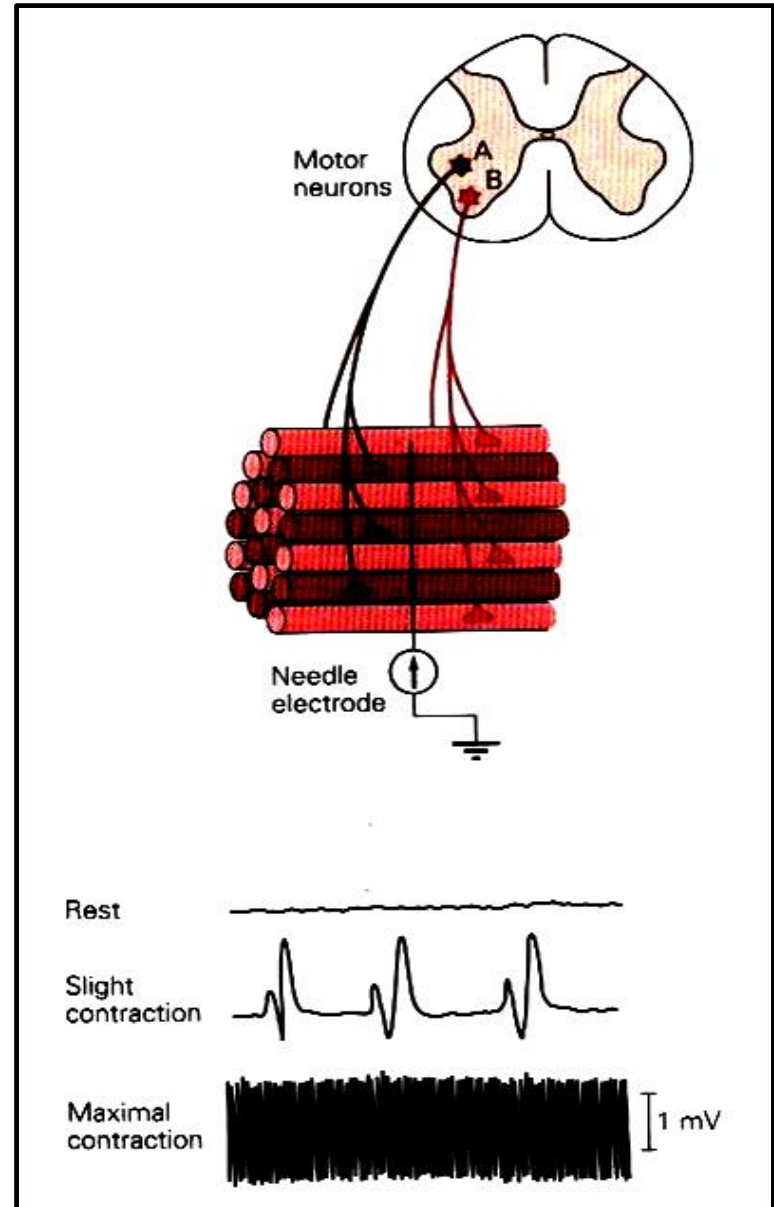
# Motor unit recruitment

- Recruitment of motor units is the progressive activation of a muscle by successive recruitment of contractile units (motor units) to accomplish increasing degrees of contractile strength ( force ).
- When the AHC fires at slow rates , motor unit potentials (MUPs) will be at slow rate & the force of muscle contraction is weak
- If AHCs fire at very fast rates → fast MUPs → stronger contraction



Increasing frequency of action potentials resulting in stronger force of contraction

- The higher the motor unit recruitment , the stronger the muscle contraction .
- The force produced by a single motor unit is determined by →
- (1) the number of muscle fibers in the unit , &
- (2) the frequency with which the muscle fibers are stimulated by their innervating axon.
- Generally, this allows a 2 to 4-fold change in force.

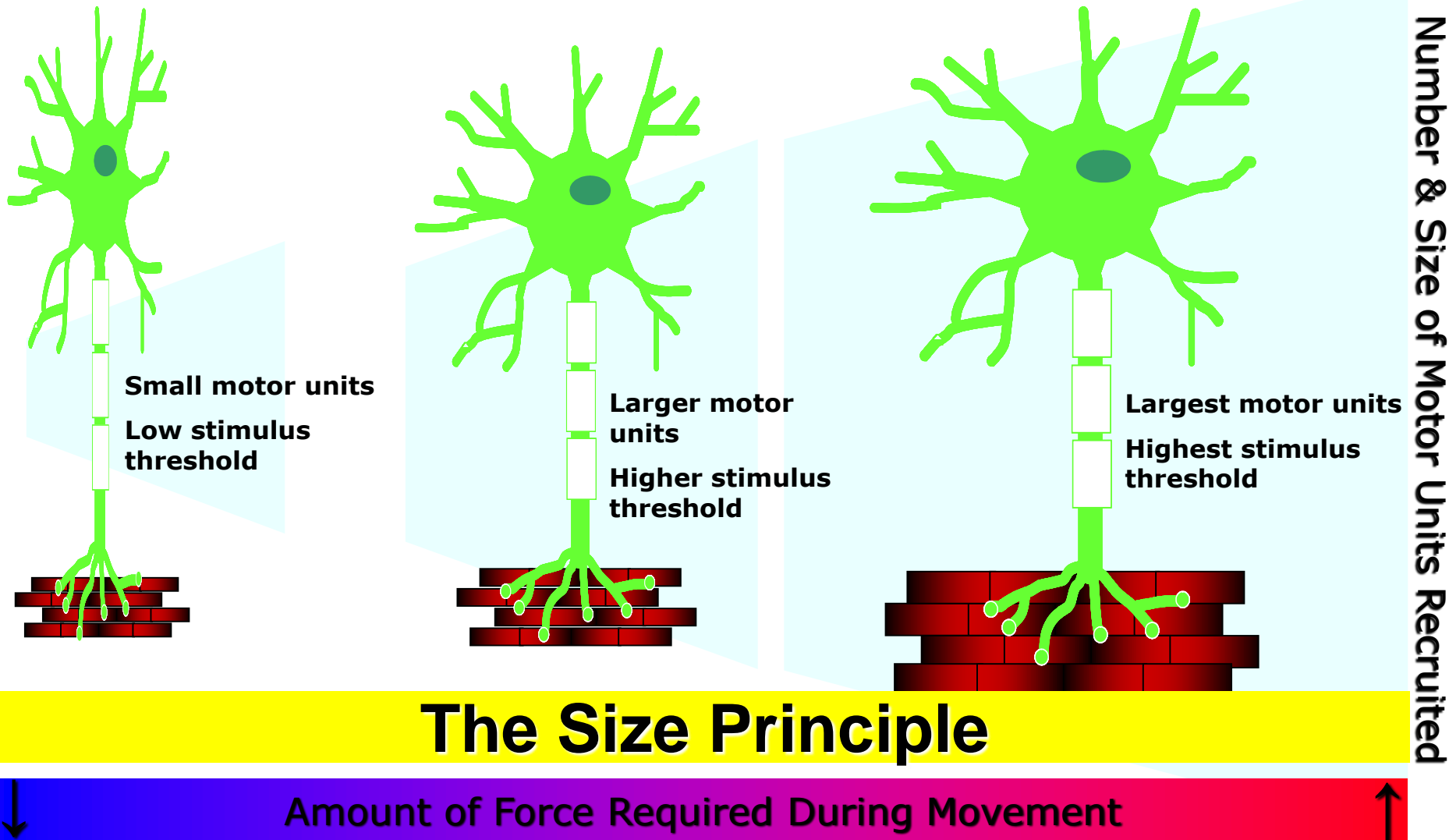


# Size Principle

- When CNS send a weak signal to contract muscle , the smaller motor units of the muscle stimulated first.
- Then with increase the strength of signals larger and larger motor units begins to be excited

# Recruitment

- Varying the number of motor units activated.



# Rate Coding

- **Rate coding refers to the motor unit firing rate.**
  - Active motor units can discharge at higher frequencies to generate greater tensions.
- **Recruitment versus rate coding**
  - Smaller muscles (ex: first dorsal interosseous) rely more on rate coding.
  - Larger muscles of mixed fiber types (ex: deltoid) rely more on recruitment.

# All or non role

- Motor Units Follows “all-or-none” principle - impulse from motor neuron will cause contraction in all muscle fibers it innervates or none
- In an electrodiagnostic testing (EMG , electromyography) for a patient with weakness, careful analysis of the motor unit action potential (MUAP) size, shape, and recruitment pattern can help in distinguishing a myopathy from neuropathy.



THANK YOU