Motor unit

- Color index:

Red: important
Green: doctor's notes
Grey: extra information
Pink: found only in female's slides
blue: found only in male's slides

objectives:

By the end of the lecture you will be able to:

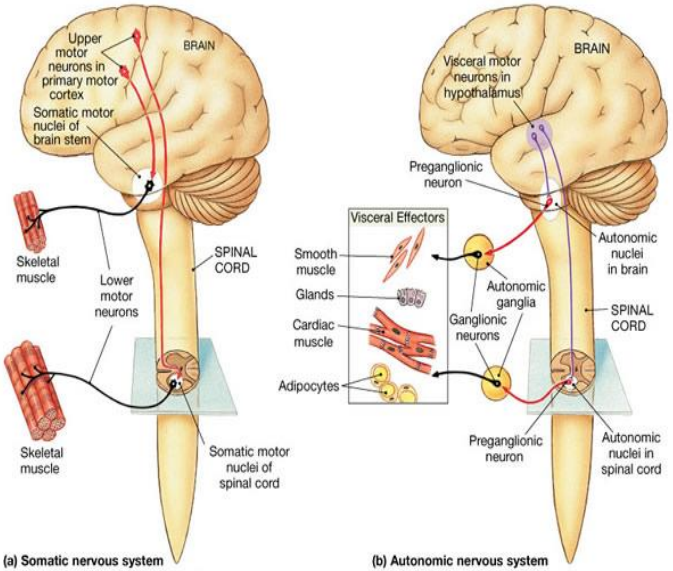
1- Recognise the organization of the nervous system.

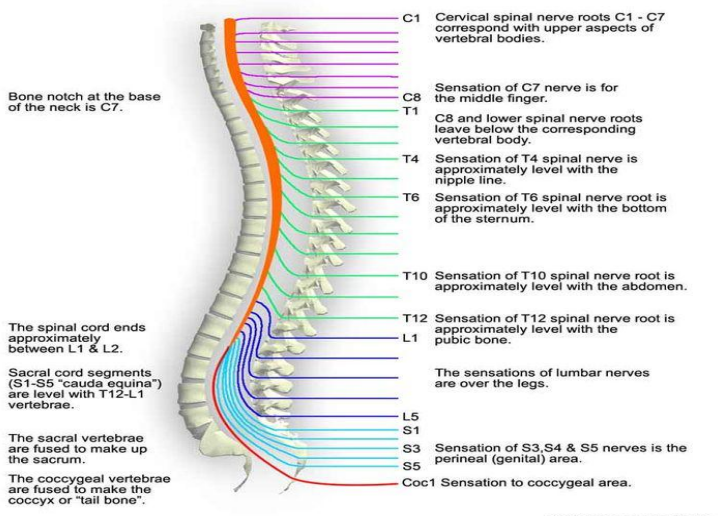
2- Identify the differences between central nervous system (CNS) and the peripheral nervous system (PNS).

3- Discuss the functions and recruitment of the motor unit.

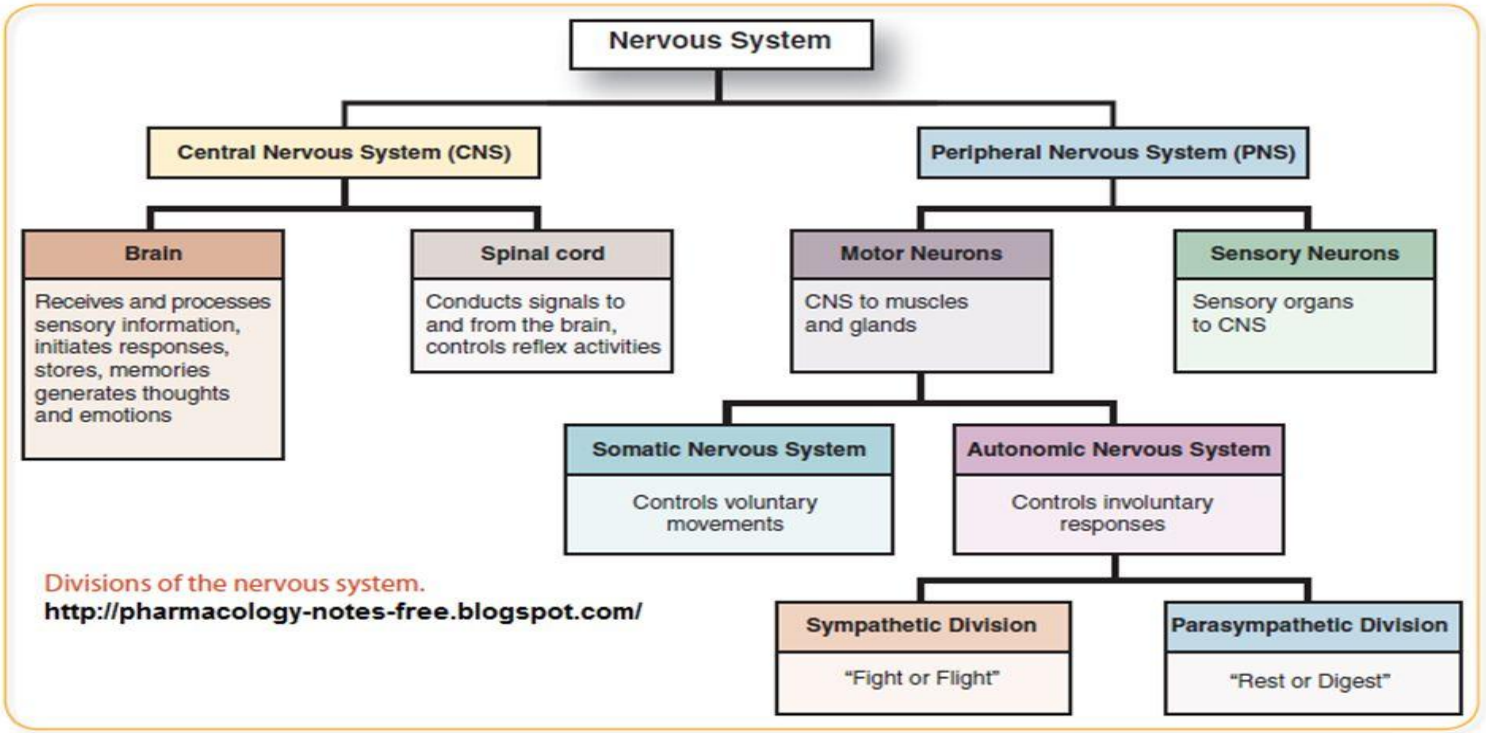
4- Interpret the effect of motor units number on motor action performance.

Organization of nervous system:





This slide was found only in male's lecture



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

Organization of nervous system:

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.
- The CNS consists of :

1. The brain which protected by the skull.

2. The spinal cord which protected by vertebrae.

- Both are enclosed in meninges.

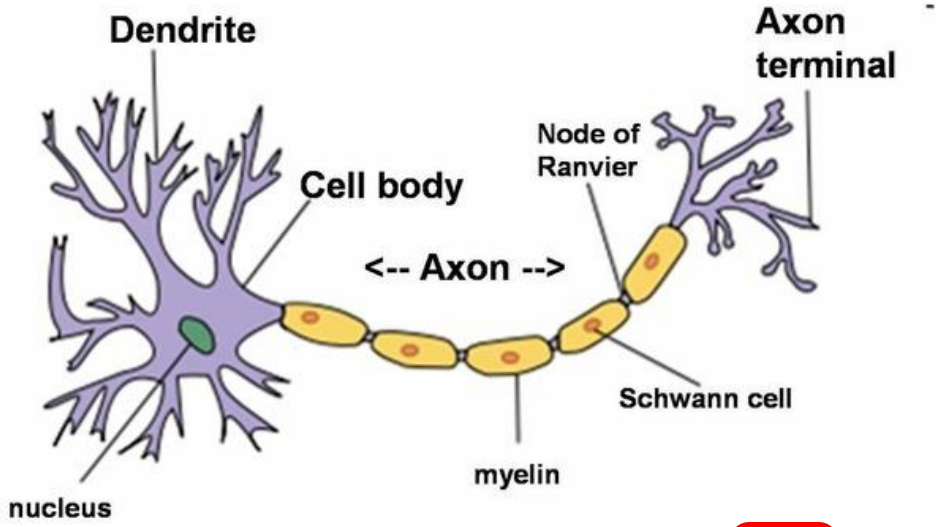
Peripheral Nervous system(PNS): can be divided in terms of function into :

- **Sensory Neurons**: collects information from the various sensors located throughout the body and transmits them to the brain.
- **Motor Neurons**: conducts signals to activate muscle contraction.
  - Skeletal muscle activation is initiated through neural activation.

Neurons

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

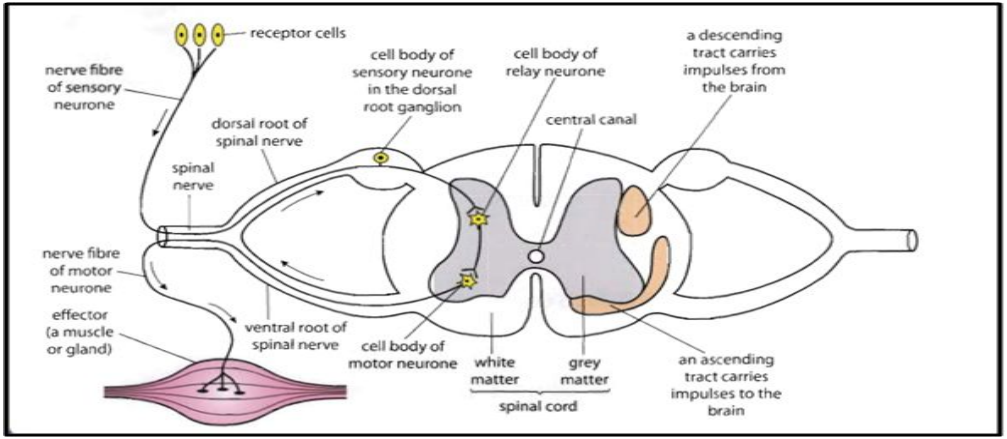
- Cell body:
  - Nucleus
- Dendrite
- Axon:
  - Myelination
  - Node of ranvier
- Axon terminals
- Synaptic bulbs
- Neurotransmitters:
  - Acetylcholine (ACH)

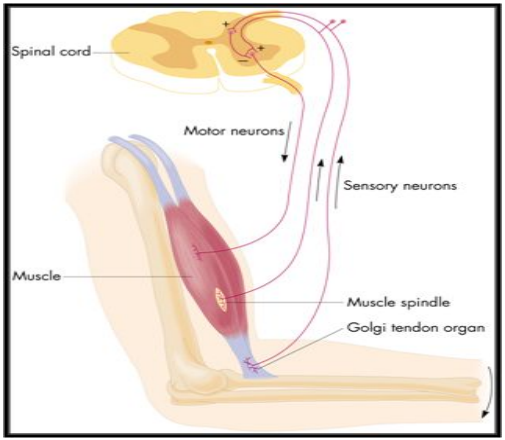


Explanation of anatomical structure of neuron (1:47 mins)

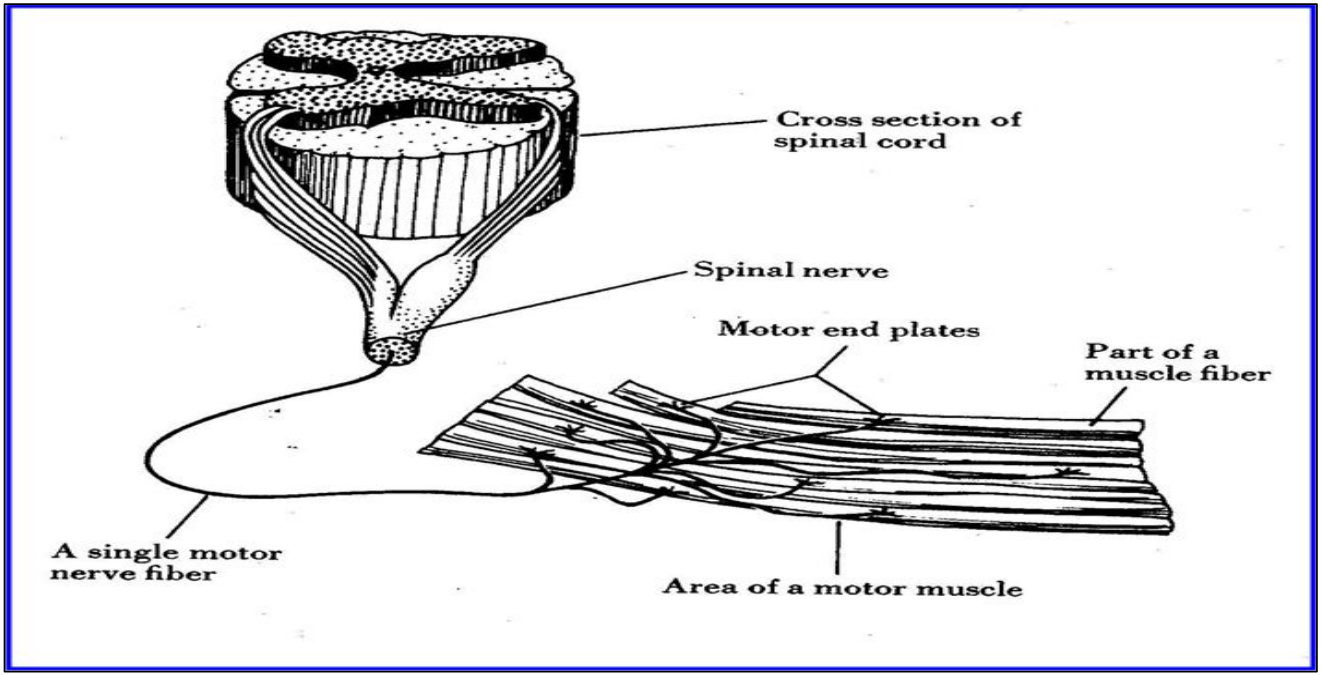
alpha-motor neuron

A nerve is made up of a group of axons of neurons.





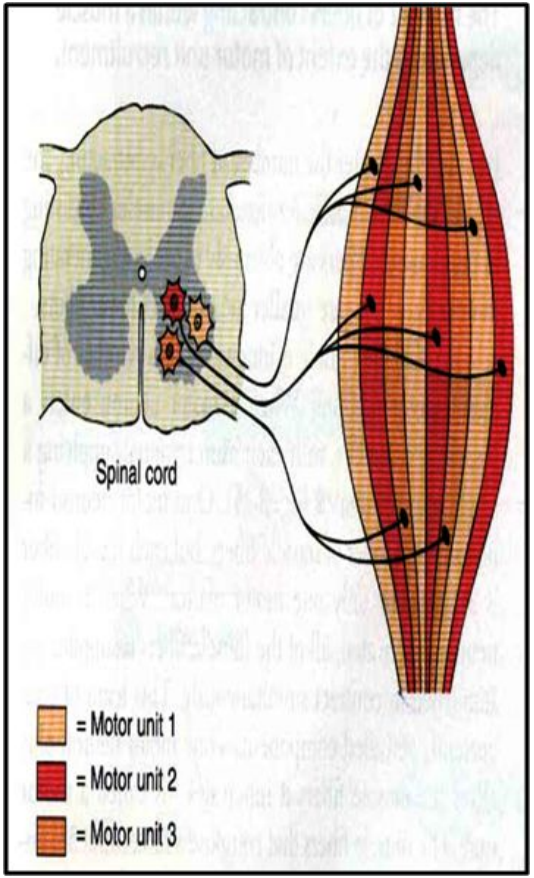
Motor Unit


Cross section of spinal cord
Spinal nerve
Motor end plates
Part of a muscle fiber
A single motor nerve fiber
Area of a motor muscle

What is a Motor Unit ?

- **What is it?** It is the α-motor neuron.
- **Where is α-motor neuron ?** in the anterior horn cell (AHC) and all the muscle fibers it innervates (supplies) تغذيها
- All of these muscle fibers will be of the same type (either fast twitch or slow twitch). الانقباض
  - Slow twitch : have low force & high endurance(تحمل) fast twitch : have high force & low endurance. المعنى باختصار أن الموتر يونت يكون له نوع واحد فقط من الألياف العضلية بينما العضلة نفسها لها تختلف.
- Each muscle consist of a number of motor units.
- When a motor neuron is activated, all the muscle fibers it innervates are stimulated and will contract التوافق الانقباضي لألياف العضلة

Motor unit = motor neuron + their terminal axons + muscle fibers



Motor Unit

The number of muscle fibers in a motor unit innervated by one motor neuron varies

–Gastrocnemius

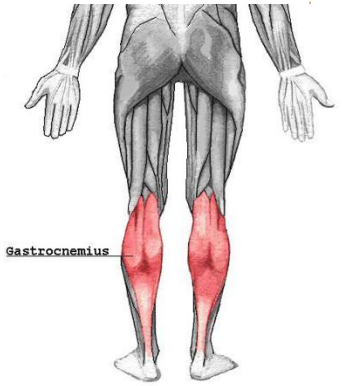
2,000 muscle fibers per motor neuron

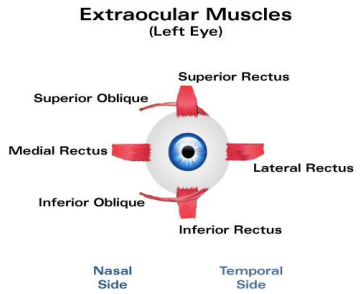
–Extraocular muscles

< 10 muscle fibers per motor neuron

Ratio of muscle fibers to motor neurons

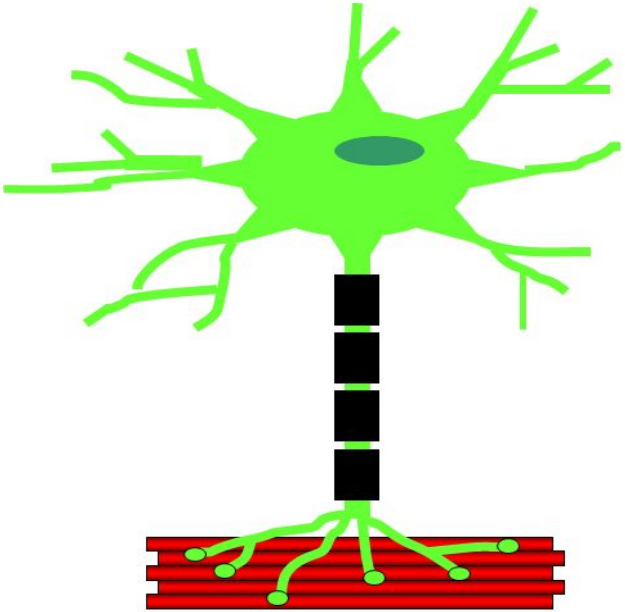
–Affects the precision of movement i.e small number is associated with more precise movements and vice versa.



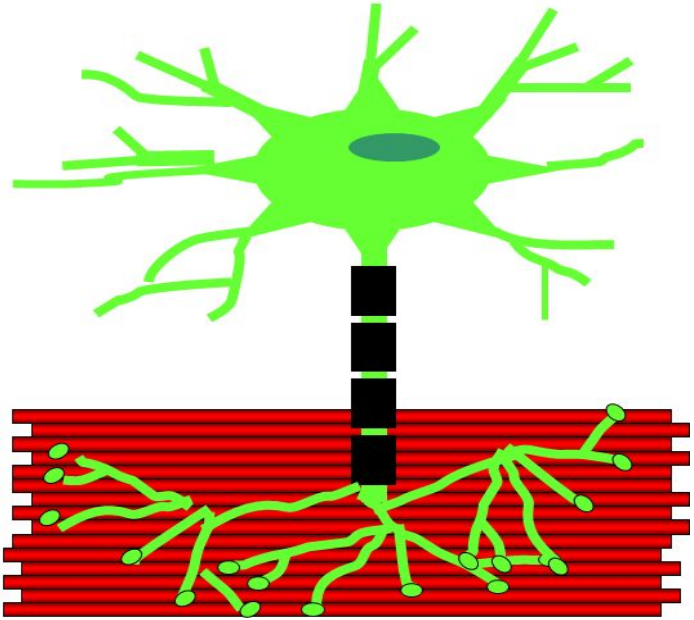


Precision of movement

دقة حركة العضلة



More precise movements
Less strength



Less precise movements
More strength

The Precision (الدقة) 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 can vary”

precise movements muscle consist of a large number of motor units and few muscle fibers in each motor unit

e.g. Hand and eye muscles. **(low ratio of muscle fibers to motor neurons)**

Less precise movements muscles composed of fewer motor units with many fibers per unit

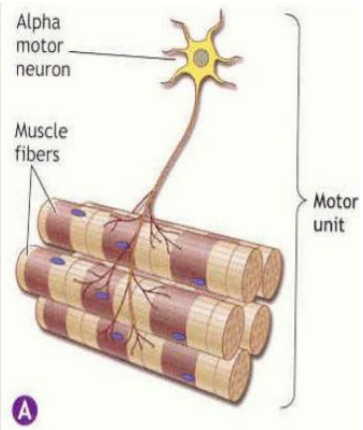
e.g. Trunk muscles. **(High ratio of muscle fibers to motor neurons)**

إذا احتاجت العضلة حركة دقيقة يكون حولها كثير من (motor unit)تكون الحركة دقيقة
وكل (motor unit) ترتبط بعدد قليل من الـ muscle fibers بحيث تستطيع ال motor
unit التحكم الدقيق بهذا العدد القليل من الألياف العصبية

How to increase contraction?

Motor Unit Pool :

The group of motor units supplying a single muscle.



Recruitment of new motor units

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

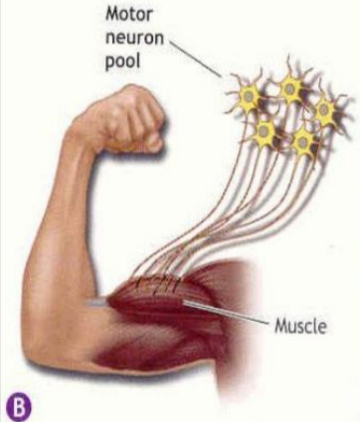
Will be explained in more details next slide

Increasing stimulation frequency (rate coding):

Increasing **frequency** of action potentials (by increasing the impulses of the stimulus) will result in a stronger force of contraction.

اما زيادة ال(action impulse)

أو زيادة عدد (motor units) الفعالة

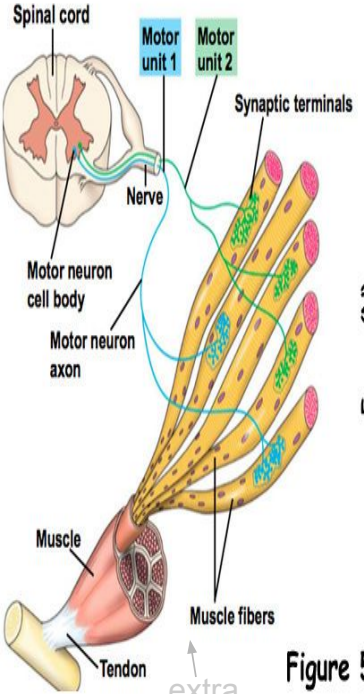


Motor unit recruitment

- 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.

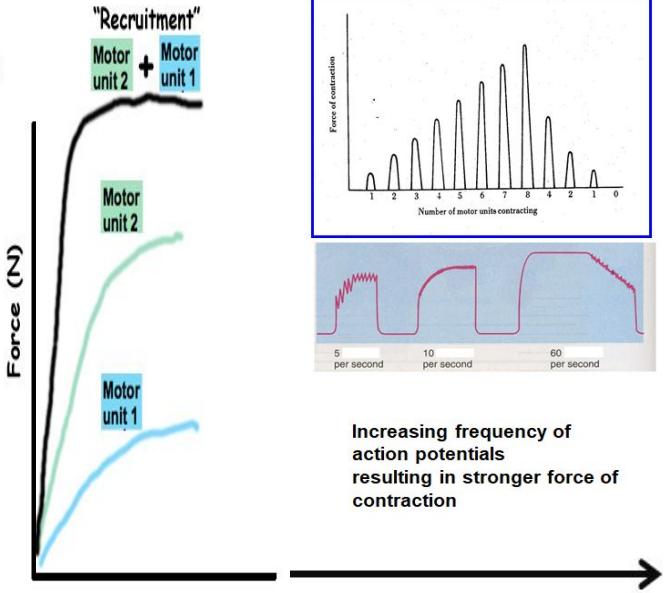
When motor recruitment increase the activated motor unit will increase so the muscle contraction will increase (which result more force)

(1:49)



extra

Figure 5



Increasing frequency of action potentials resulting in stronger force of contraction

cont.

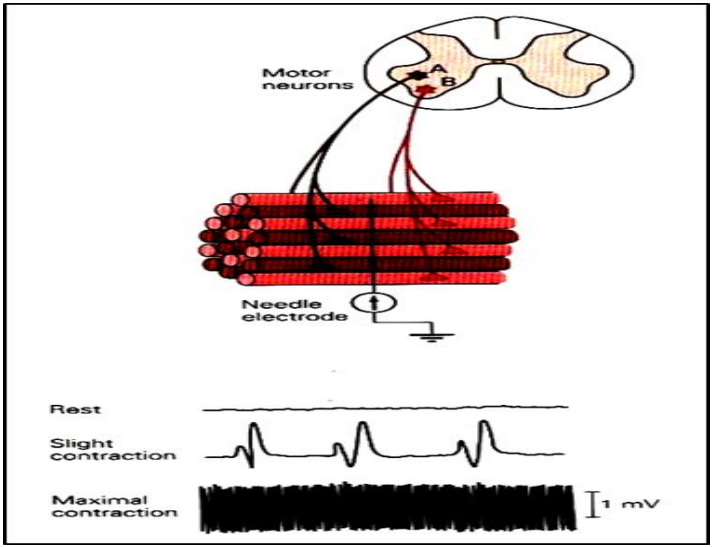
• The higher the motor unit recruitment , the stronger the muscle contraction .

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

(1) **the number of muscle fibers** in the unit .

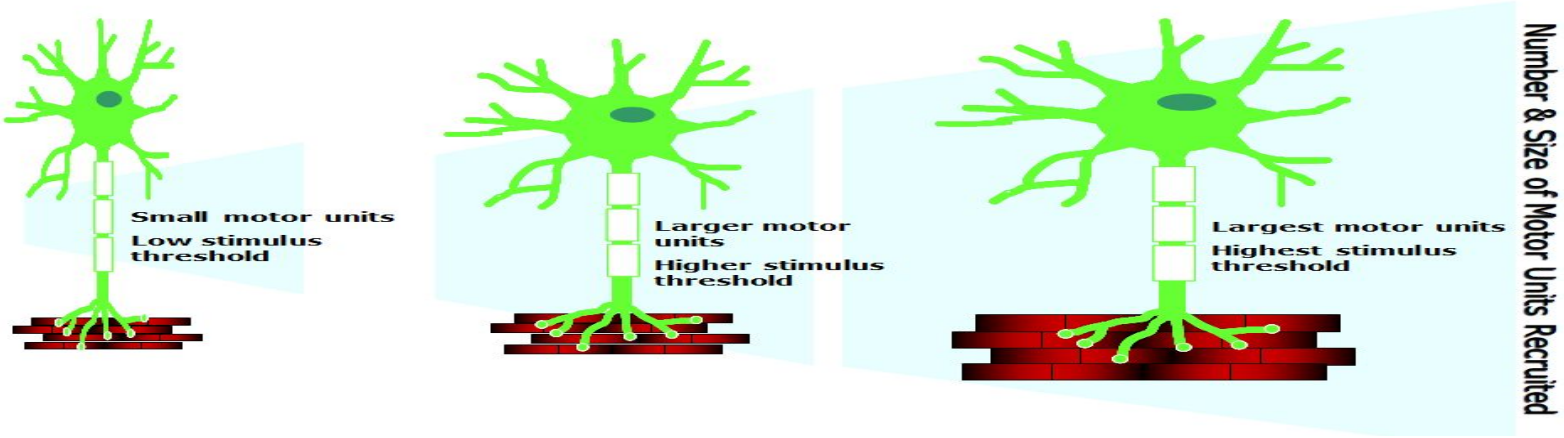
(2) **the frequency** with which the muscle fibers are stimulated by their innervating axon.

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



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 عضلات الأصابع) rely more on rate coding (frequency).

  - Larger muscles of mixed fiber types (ex: deltoid) rely more on recruitment.

All or none 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 (التمييز) a myopathy from neuropathy.

*there’s a lecture about this test

Quiz

MCQ:

1-Nodes of Ranvier are found in :
A-Dendrites.
B-Cell body.
C-Axon.
D-None of them.

2-The location of α-Motor Neuron is in :
A-Anterior horn cell.
B-Posterior horn cell.

3-It is the α-motor neuron in the anterior horn cell AHC and all the muscle fibers it innervates :
A-Sensory Neurons.
B-Interneurons.
C-Motor Unit.
D-Motor Unit Pool.

4-If we have 2000 muscle fibers per motor neuron then the movement will be :
A-Less Precise , With Less Force.
B-Less Precise , With More Force.
C-More Precise , With Less Force.
D-More Precise , With More Force.

5-Small muscles rely more on :
A-Rate Coding
B-Recruitment

6- Muscles that have Less precise movements :
A-Hand muscles.
B-Trunk muscles.
C-eye muscles.
D-A&C.

SAQ :

1-The neuron is comprised of :

A-.....
B-.....
C-.....
D-.....

2-The nervous system can increases force production in two ways :

A-.....
B-.....

3- Describe “all-or-none ” principle

.....

1 : A-Cell body.
B-Dendrites.
C-Axon.
D-Axon terminals.

2 :
A- Recruitment of new motor units.
B-Increasing stimulation frequency (rate coding).

3 : impulse from motor neuron will cause contraction in all muscle fibers it innervates or none.

6-B
5-A
4-B
3-C
2-A
1-C

Female's team:

1. Ahad Algrain
2. Hadeel
3. Maha Alnahdi
4. Majd AlBarrak
5. Rahaf Alshammari
6. Rinad Alghoraiby
7. Munira Alhadlg
8. Sarah AlBlaihed
9. Renad Almogren

Male's team:

1. Saad Alfawzan
2. Mohammed Alswoaiegh
3. Saud Alatawy
4. Saif almeshari

Team Leaders:

Abdulhakim AlOnaiq

Alanoud Salman

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Editing File