What are excitable tissues?

- They are capable of generating electrochemical impulses and transmitting them along the membrane

Excitable Tissues?

- The term **excitability** refers to an ability of a *tissues to receive stimuli and respond to that stimuli.*
  - ✓ Excitable tissues **respond** to various **stimuli** by rapidly *changing their resting membrane potentials* ***and*** *generating electrochemical impulses (action potential).*
- The stimuli can be **electrical**, **chemical**, **mechanical** or **thermal**.
- There are two types of excitable tissues:
  - ✓ Nerve
  - ✓ Muscle

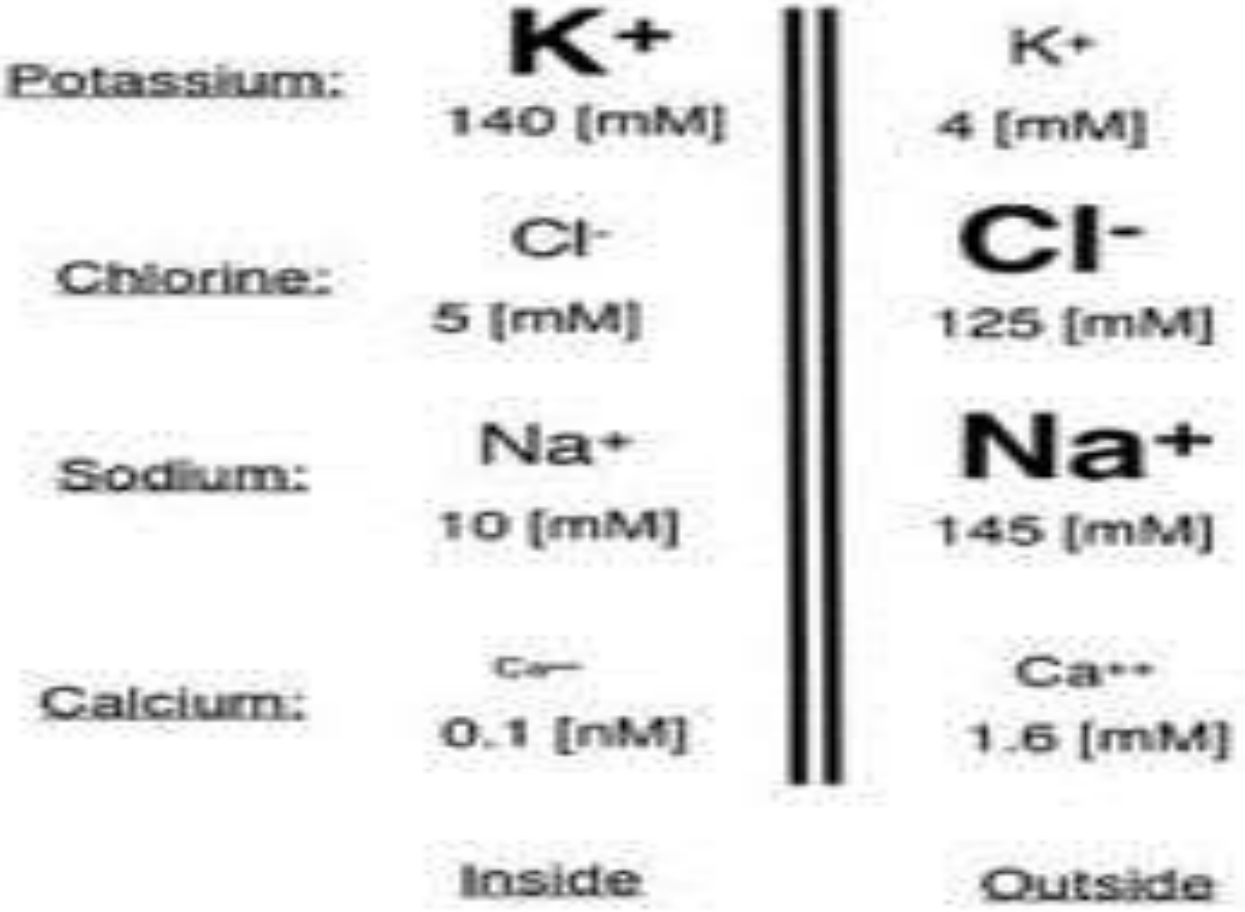
Properties of excitable tissues:

1. Ion distribution across cell membrane: the intracellular fluid contain high concentration of K and large organic anion A.

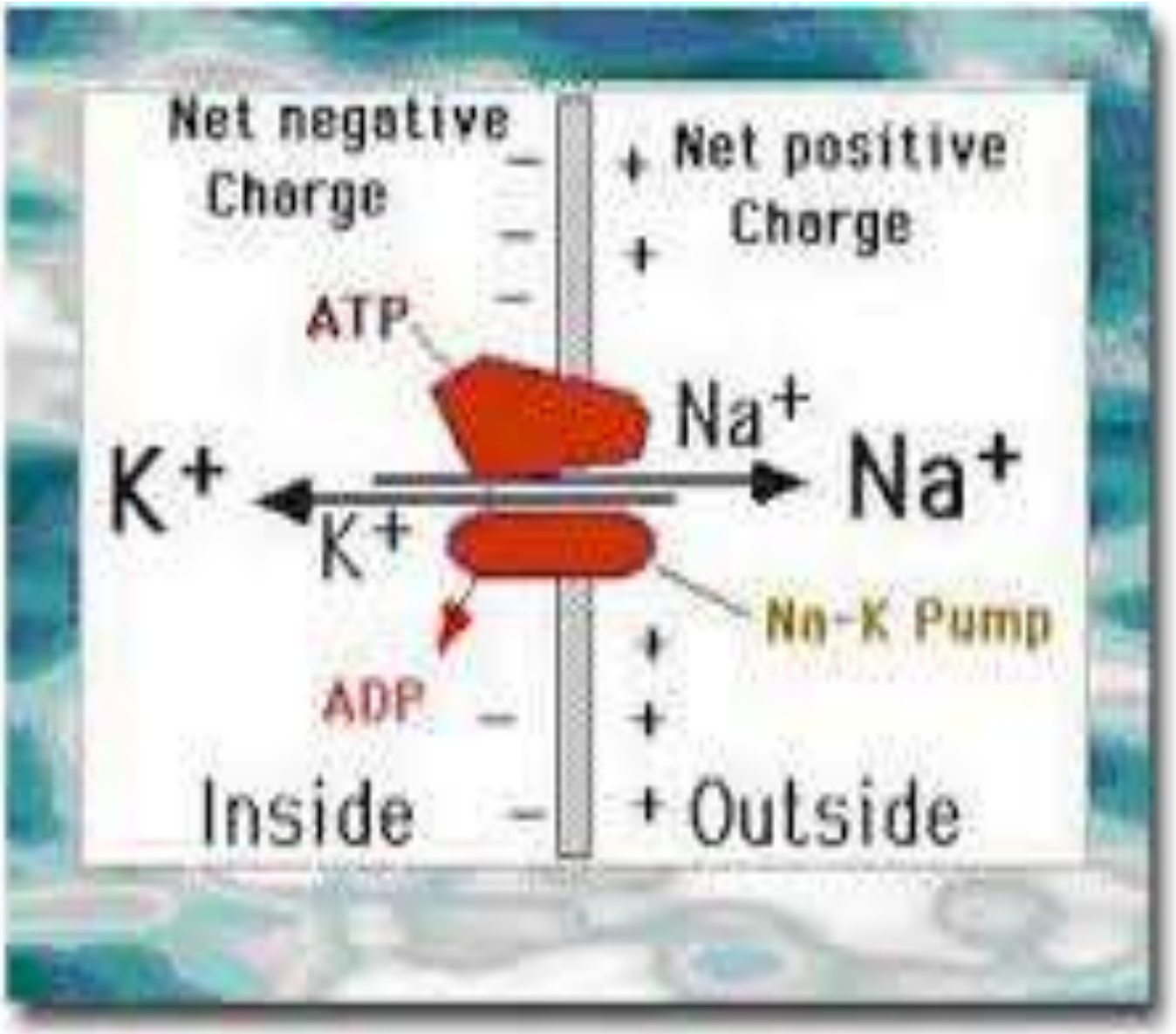
The extra cellular fluid contain high conc. Of Na and Cl.

mMol/L	intra	extra
Na	15	150
K	150	5.5
CL	9	125

properties of excitable tissues



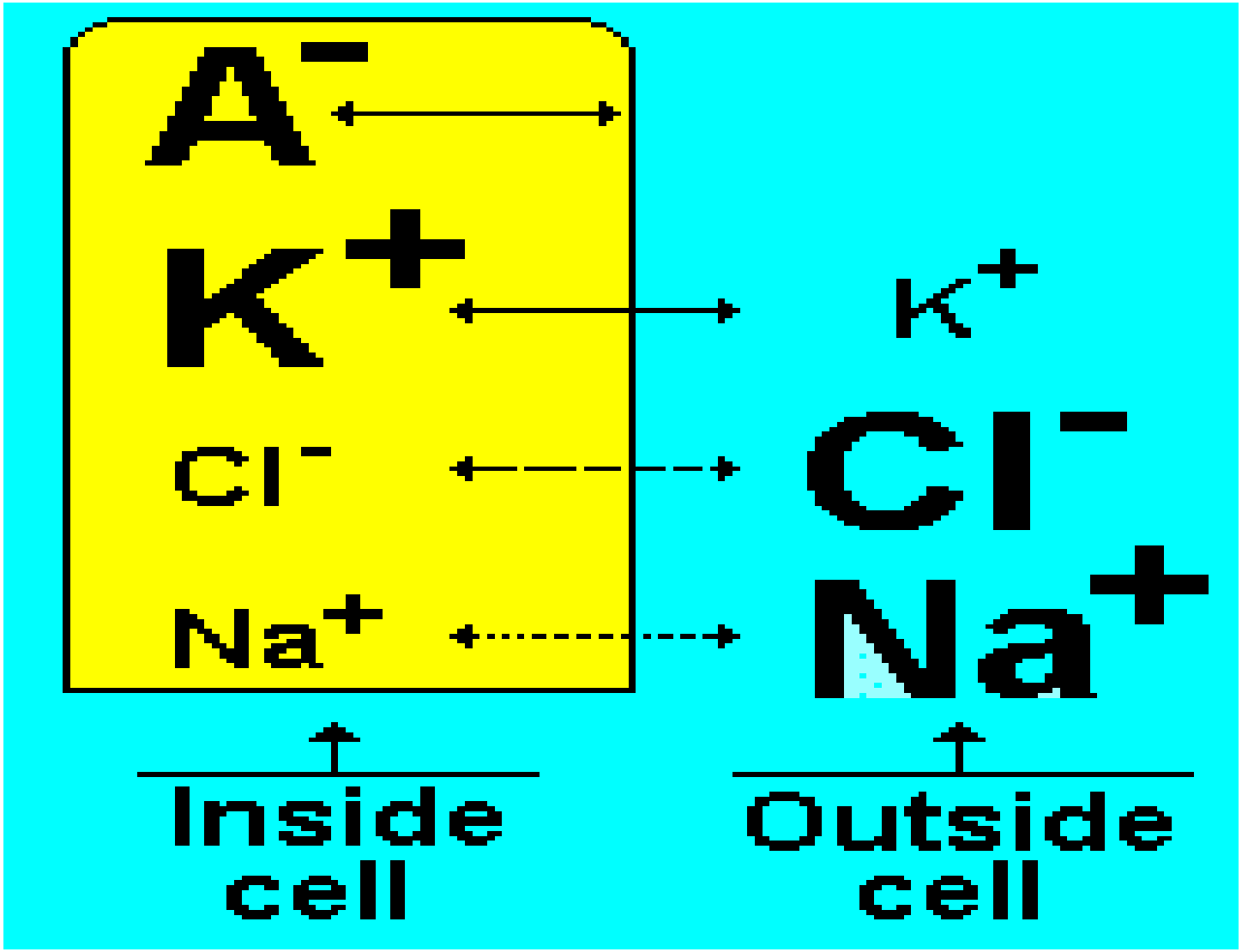
2.Membrane potential: the inside the cell is negative Out side the cell is positive. This is called resting membrane.


Net negative Charge
Net positive Charge
ATP
Na+
K+
Na+
K+
Na-K Pump
ADP
Inside
Outside

3.Membrane impermeability to cellular protein and other organic negative ion while the membrane is permeable to Na,K,CL, but in different degree.

Factors affected the permeability:

1. Size of ion.
2. Charge of ion.
3. Ion concentration.


A⁻
K⁺
Cl⁻
Na⁺
K⁺
Cl⁻
Na⁺
Inside cell
Outside cell

Action potential:

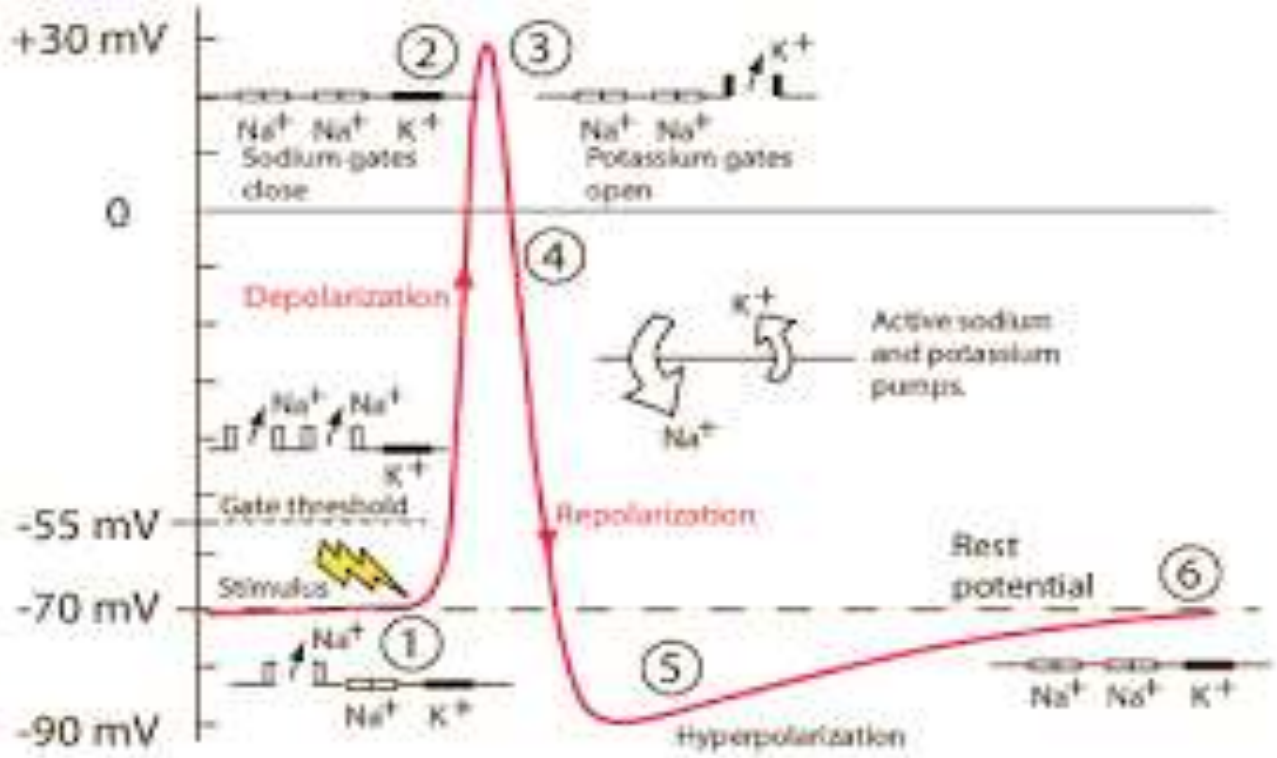
Electro and chemical changes occur in the plasma membrane of excitable tissues (nerve and muscle).

Stages of action potential:

1.Resting stage: K ion out flux by concentration gradient=K ion influx by electric potential.

2.Threshold: minimum stimulus lead to response resulted from continuous and slow influx of Na.

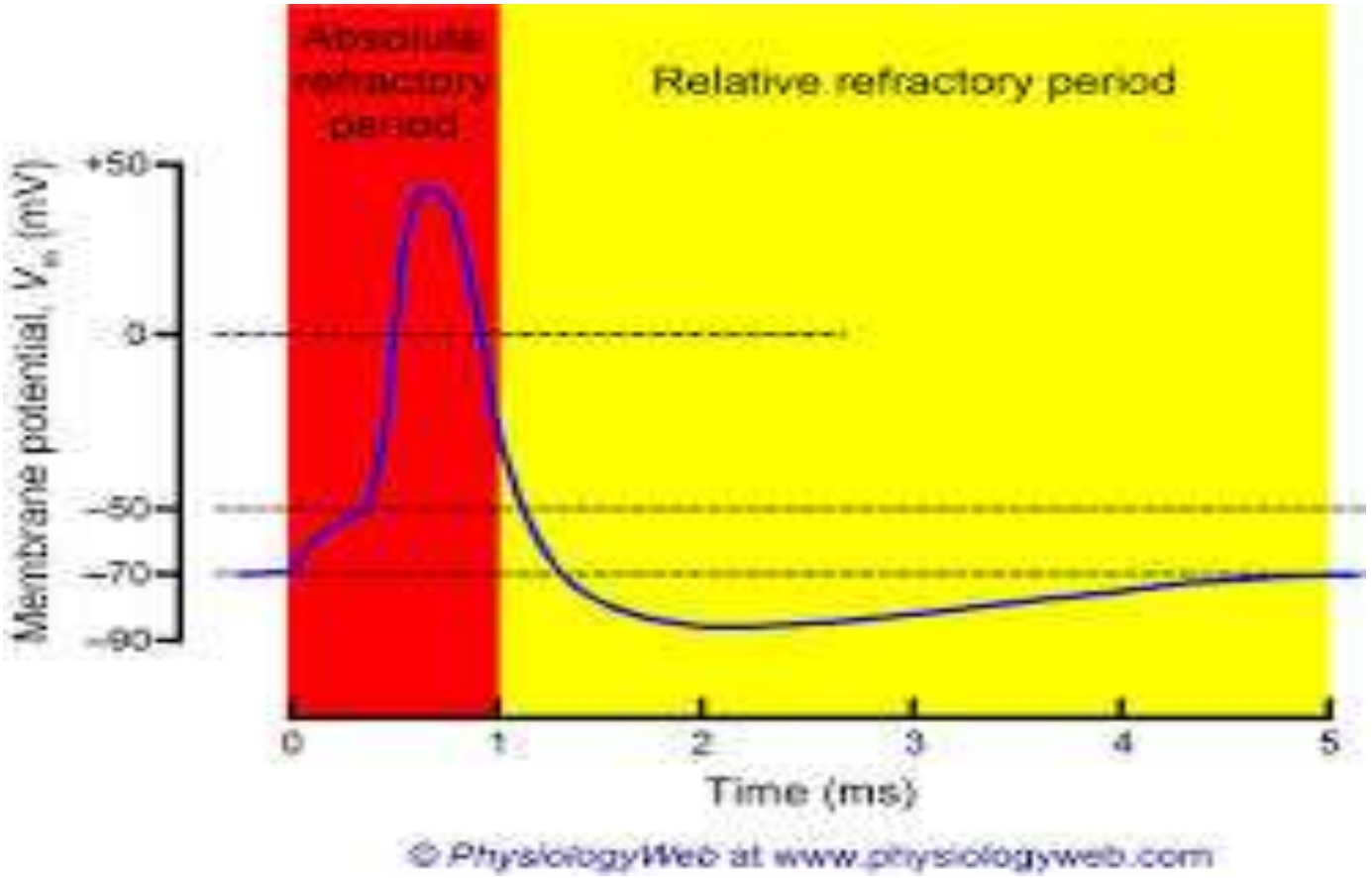
3.Depolarization: rapid influx of Na ion.
4.Spike:maximum level of membrane potential.
5.Repolarization: rapid out flux of Na and influx of K.
6.Hyperpolarization.continous influx of K.


+30 mV
0
-55 mV
-70 mV
-90 mV
2
3
Na+ Na+ K+
Sodium gates close
Na+ Na+
Potassium gates open
K+
4
Depolarization
K+
Active sodium and potassium pumps
Na+
Na+ Na+
K+
Gate threshold
Repolarization
Stimulus
Rest potential
6
Na+
1
Na+ K+
5
Hyperpolarization
Na+ Na+ K+

Periods of action potential:

1.Absolute refractory period: if we increase the strength of stimulus their will be no response because all Na ion channel activated.

2.Relative refractory period: if we increase the strength of stimulus there will get response because some of Na ion channel is inactivated.


Absolute refractory period
Relative refractory period
Membrane potential, V_m (mV)
+50
0
−50
−70
−90
0
1
2
3
4
5
Time (ms)
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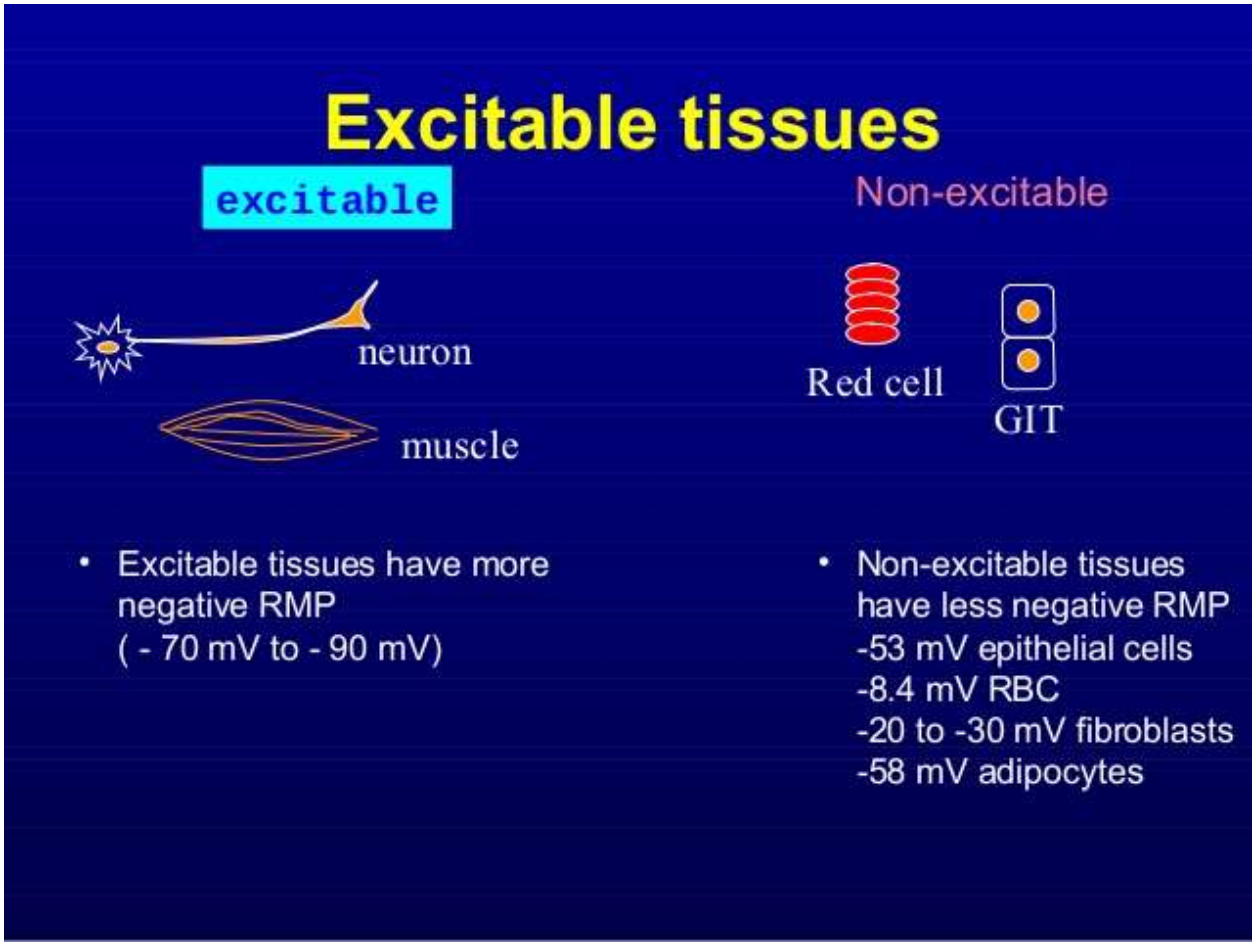
All or Non law:

any stimulus =or above threshold lead to action potential.

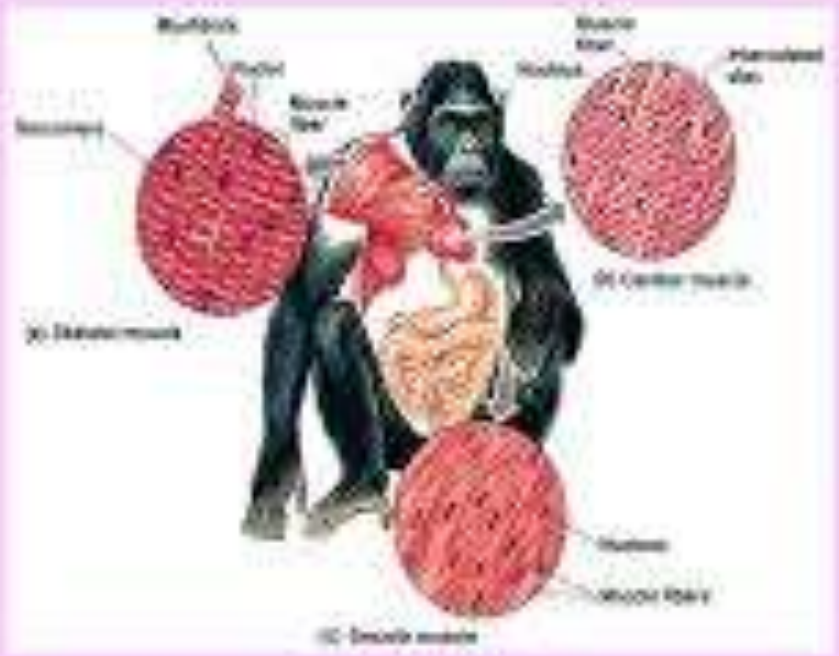
But increase the strength of stimulus not lead to increase the spike of action potential.

types of excitable tissues



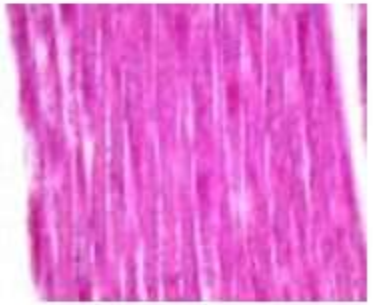
Muscle Tissue

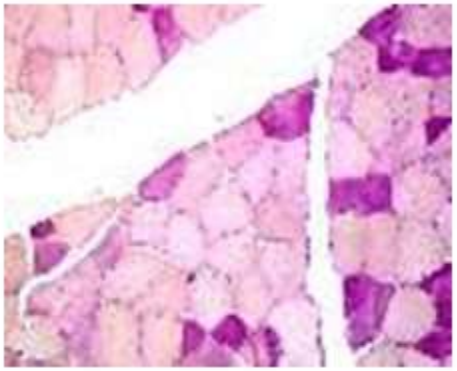
- Most abundant type in animals
- Long, excitable cells capable of contraction
- Contain contractile microfilaments
  - actin and myosin



MUSCLE TISSUE

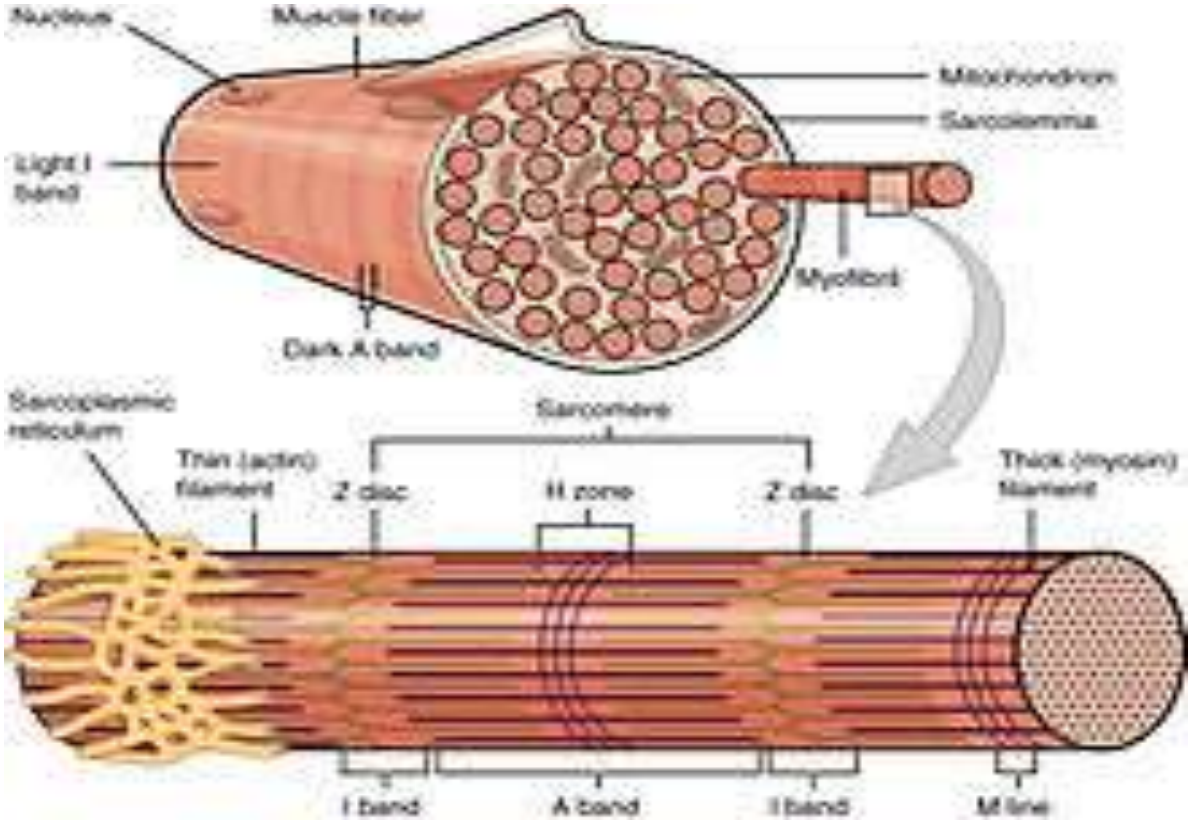
- – has the ability to contract and move the body
- Muscle is an excitable tissue, meaning that it can be stimulated mechanically, chemically or electrically to produce an action potential
- **Smooth, skeletal ,or cardiac**
  - Vol vs. Invol

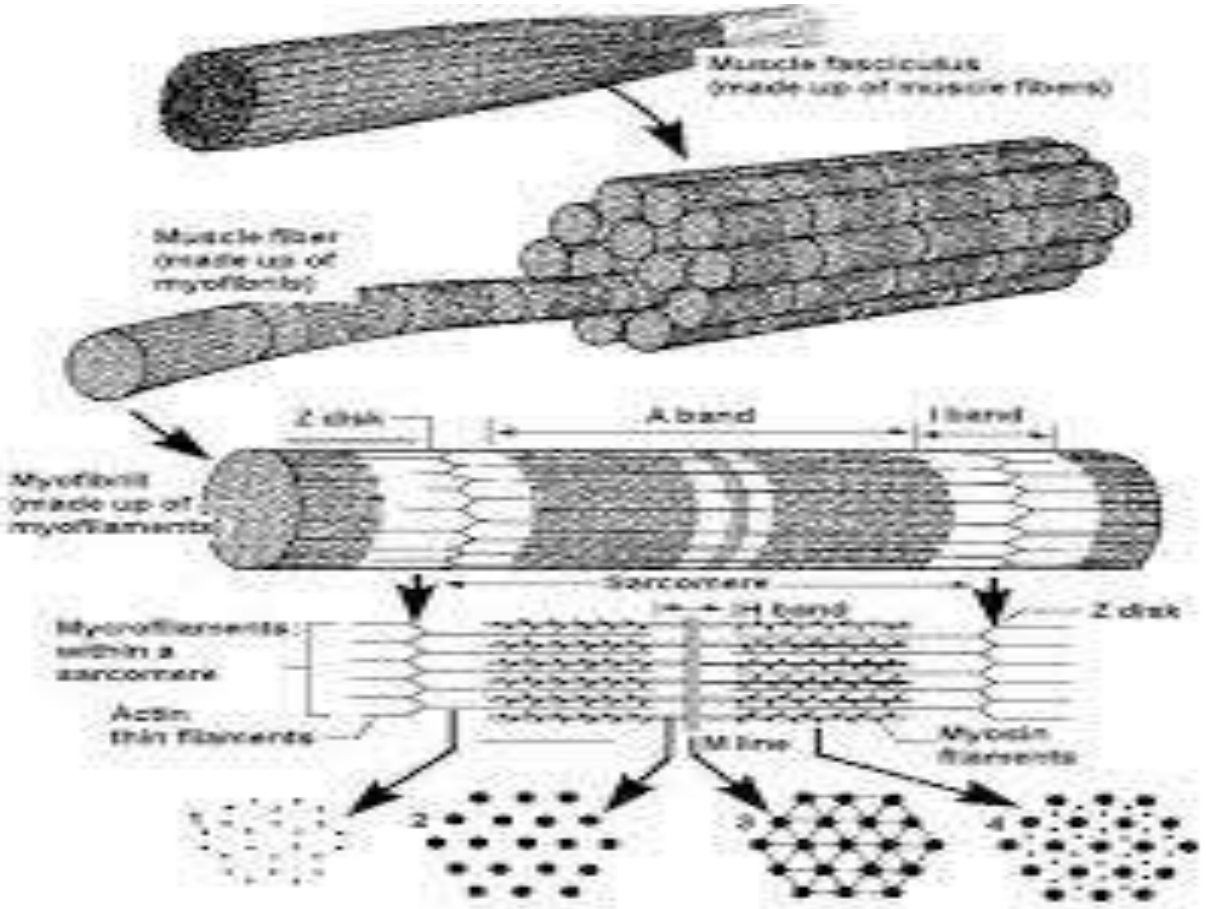




structure of muscle

sarcomer is the basic functional unit of muscle




Muscle fascicullus
(made up of muscle fibers)
Muscle fiber
(made up of
myofibrils)
Z disk
A band
I band
Myofibril
(made up of
myofilaments)
Sarcomere
H band
Z disk
Myofilaments
within a
sarcomere
Actin
thin filaments
M line
Myosin
filaments
1
2
3
4

CONTRACTILE PROTEINS

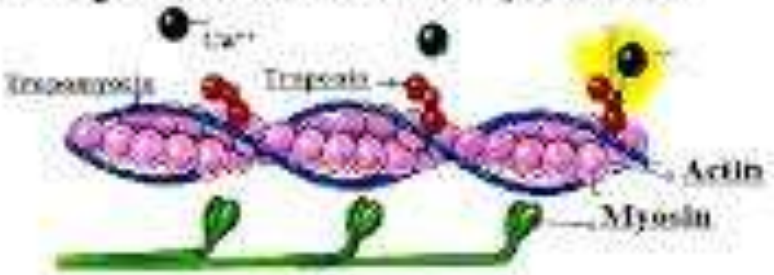
1. THIN FILAMENT

- Has 3 parts;

i) **ACTIN PROTEIN**
(i.e. the main molecule of this filament).
FUNCTION: Binds to myosin head of thick filament.

ii) **TROPONIN**
FUNCTION: Regulatory function by binding to Ca^{2+}

iii) **TROPOMYOSIN**
FUNCTION: Has a regulatory function by blocking/unblocking the binding site of actin to the myosin head



CONTRACTILE PROTEINS

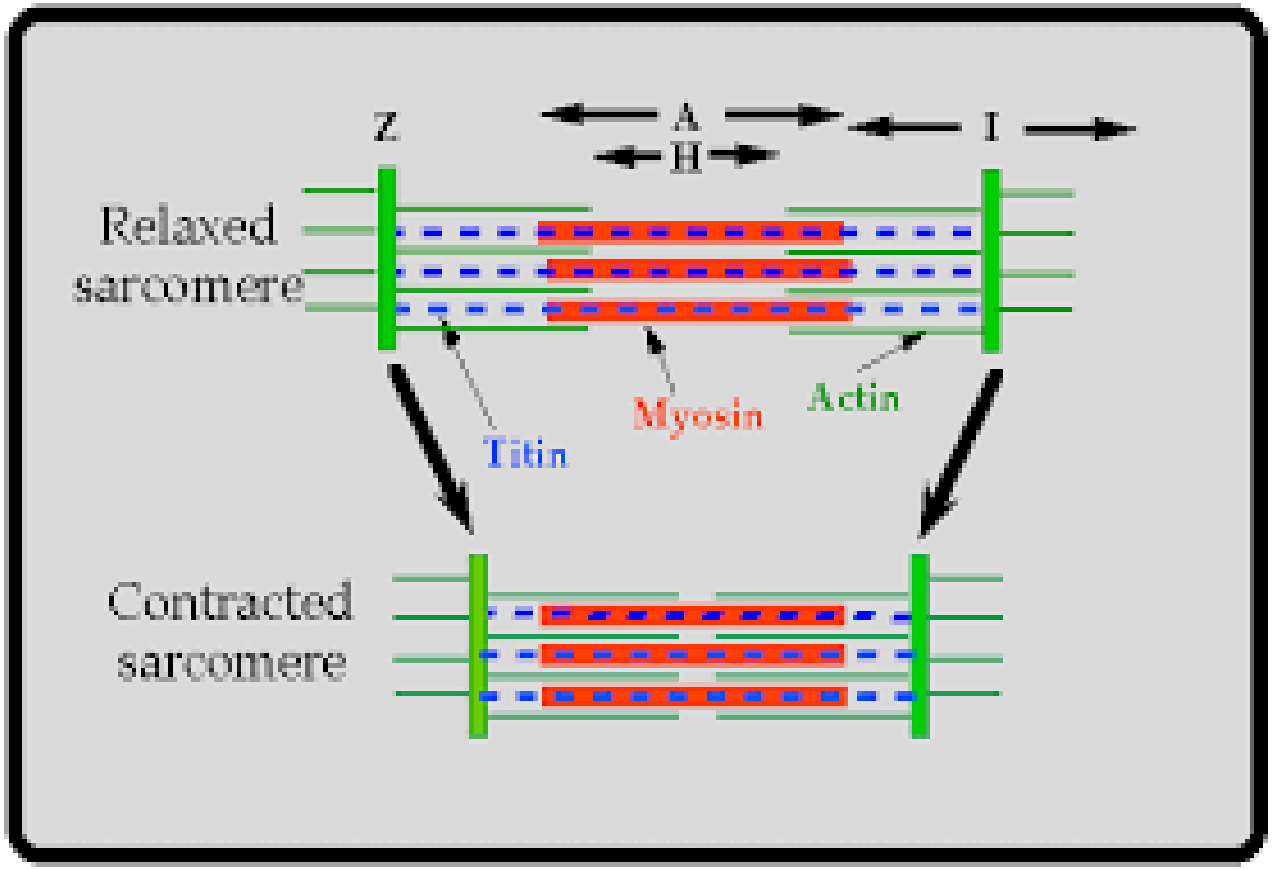
2. THICK FILAMENT

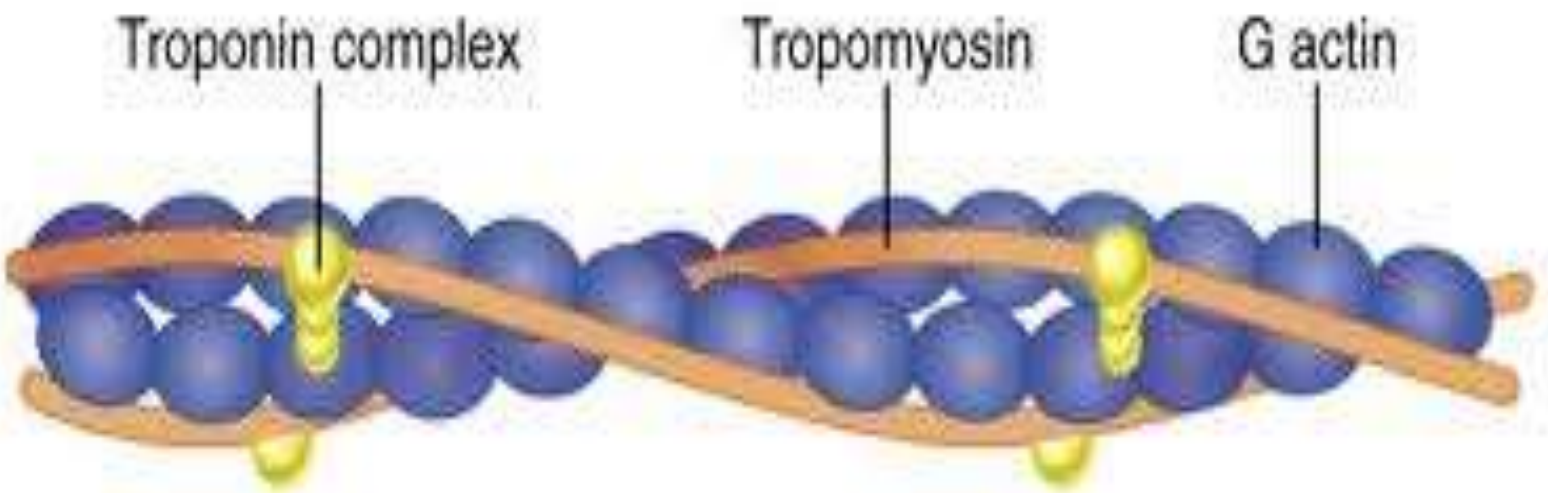
- Thick filament: composed of structural protein, myosin.

- has 2 main parts

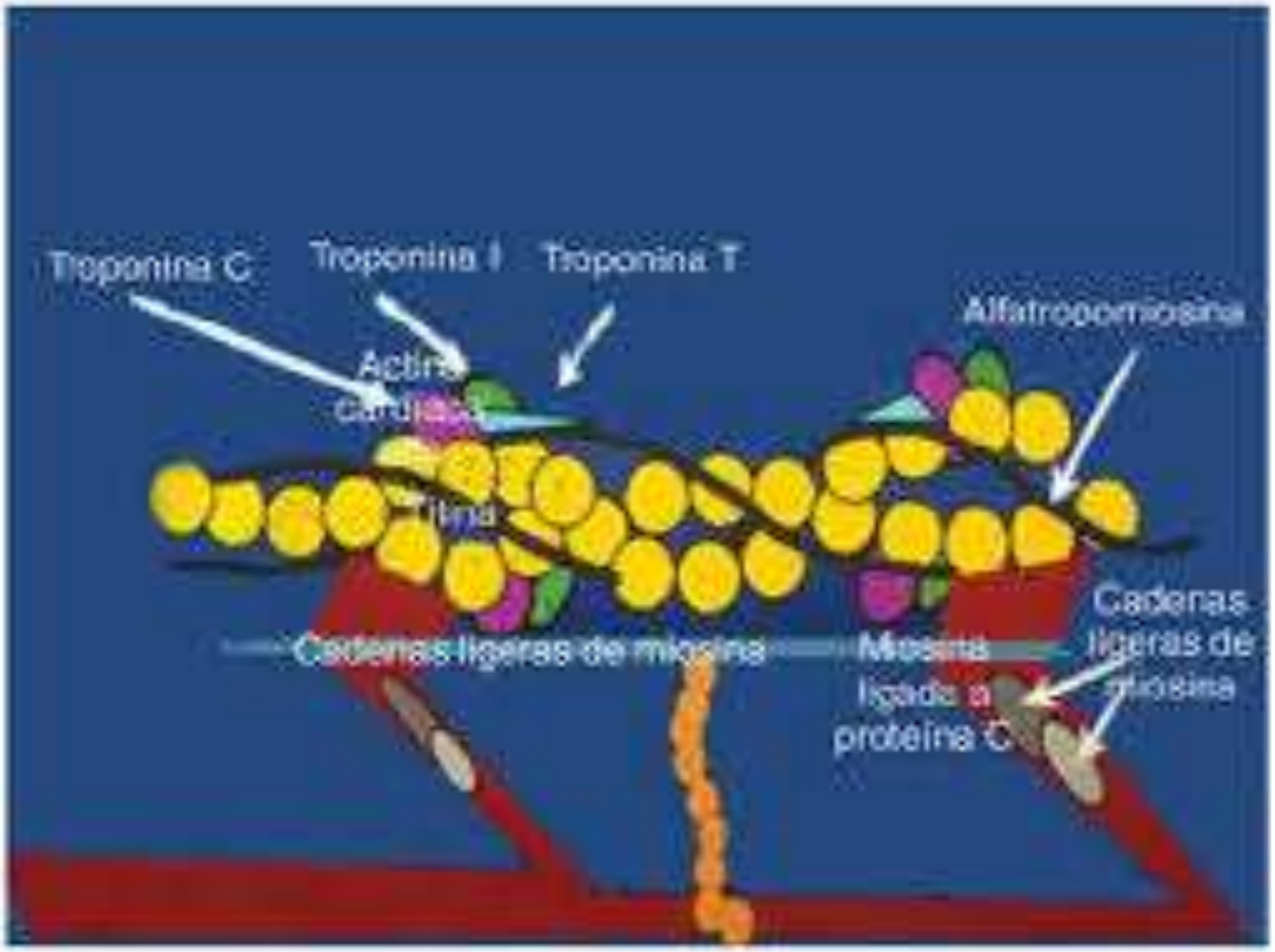
i) Myosin head – possesses actin binding site and ATPase activity.

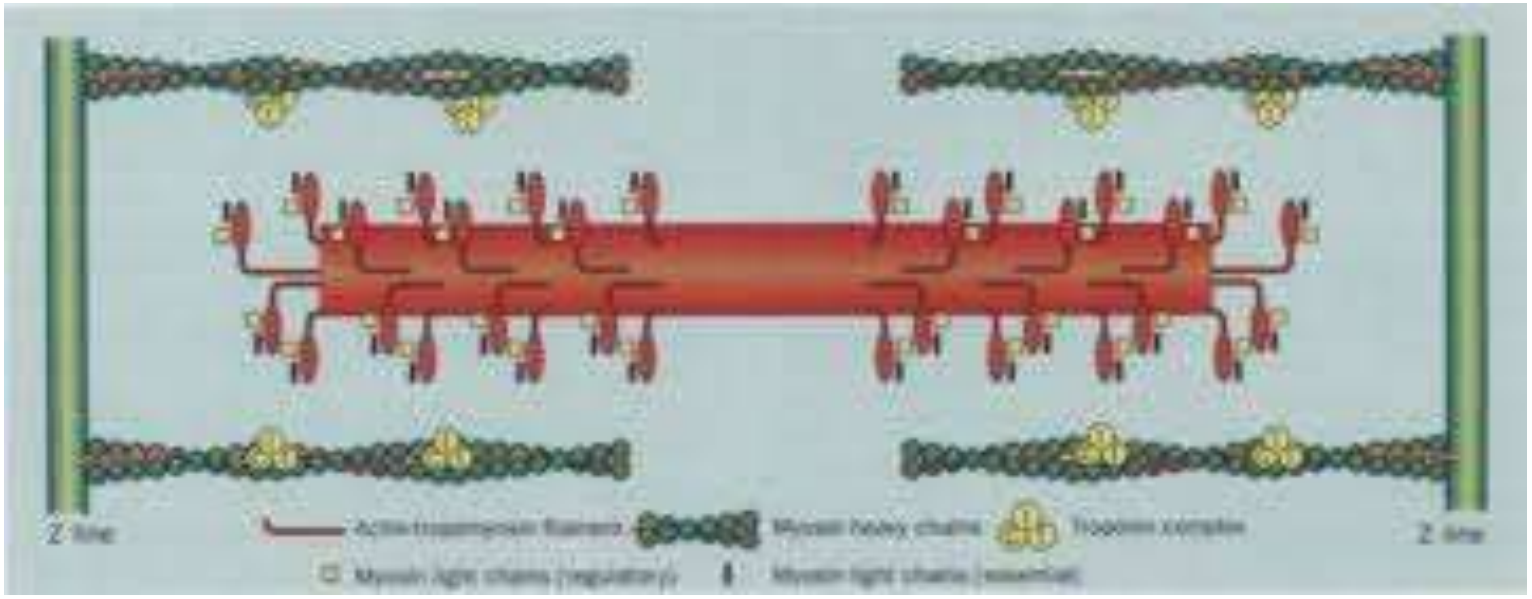
ii) Myosin tail– forms the shaft of thick bands.


Z
A
H
I
Relaxed
sarcomere
Titin
Myosin
Actin
Contracted
sarcomere



(c) Portion of a thin filament


Troponina C
Troponina I
Troponina T
Alfatropomiosina
Actina
Miosina
Cadenas ligeras de miosina
Miosina ligada a proteína C
Cadenas ligeras de miosina

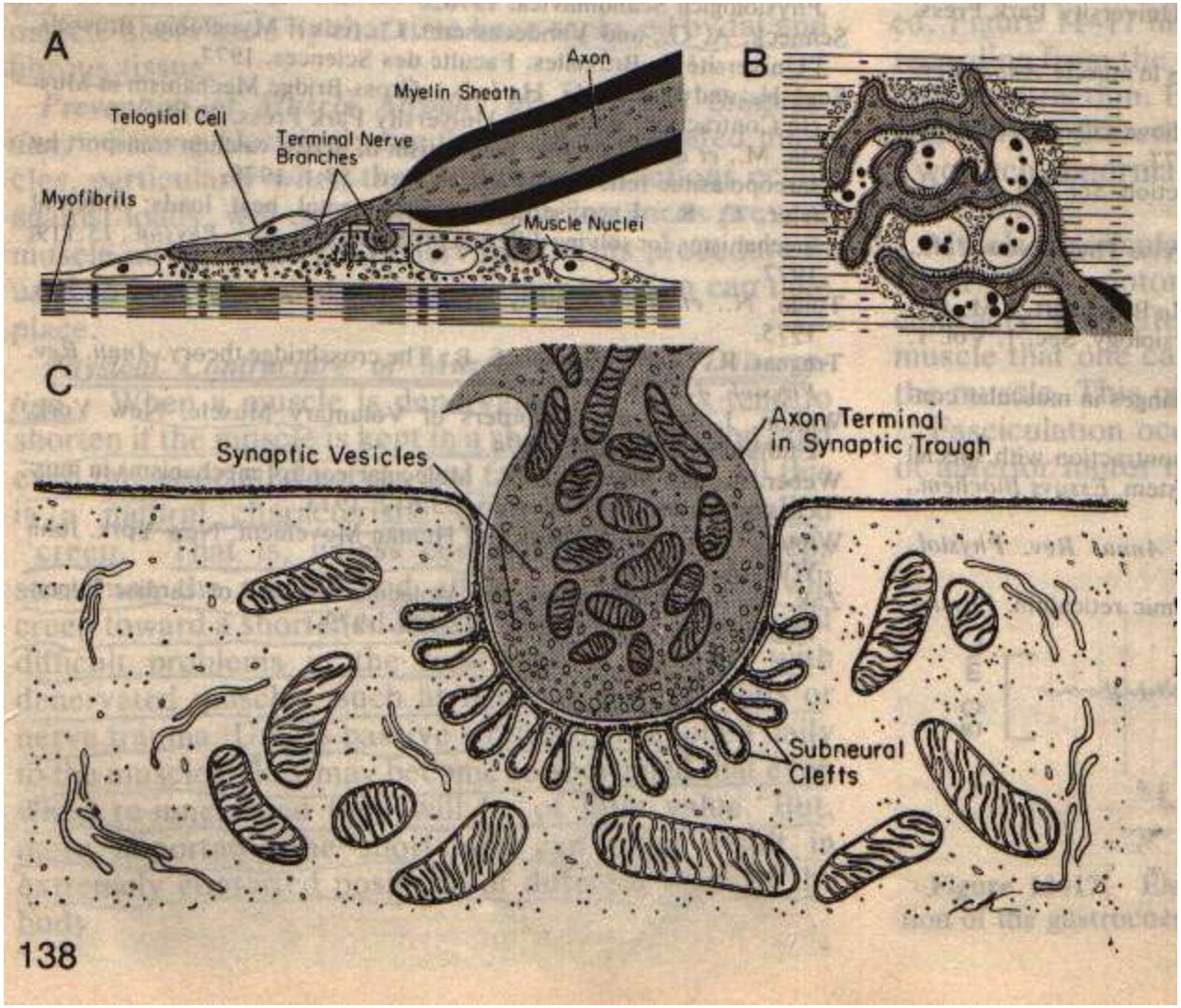

Z line
Z line

Sarcotubular system:

Include:

1. **T system :invagenation of plasma membrane, its function for rapid transmission of action potential to all fibrils.**
2. **2. sarco plasmic reticulum: sac concert with calcium movement and muscle metabolism.**

Myo neuronl junction: **The skeletal muscle fiber innervated by motor nerve which loss its myelin sheath in its end and branched to end feet which has vesicles contain (Ach) acetylcholine .**

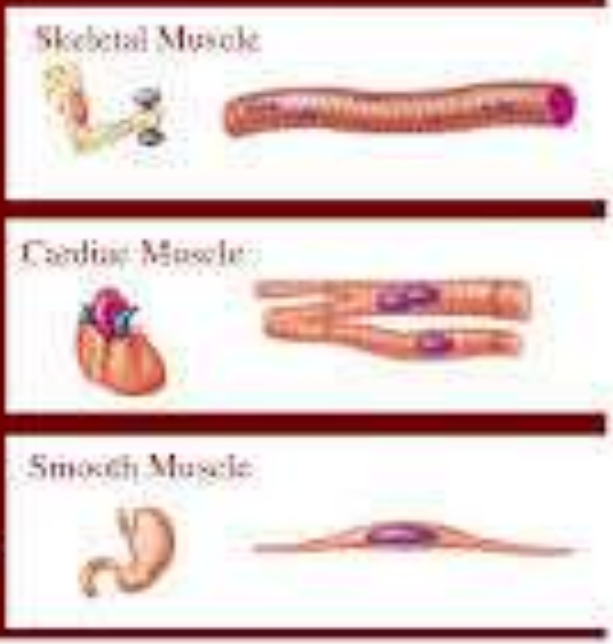

A
Axon
Myelin Sheath
Teloglial Cell
Terminal Nerve Branches
Myofibrils
Muscle Nuclei
B
C
Synaptic Vesicles
Axon Terminal in Synaptic Trough
Subneural Clefts

Types of Muscle Contractions

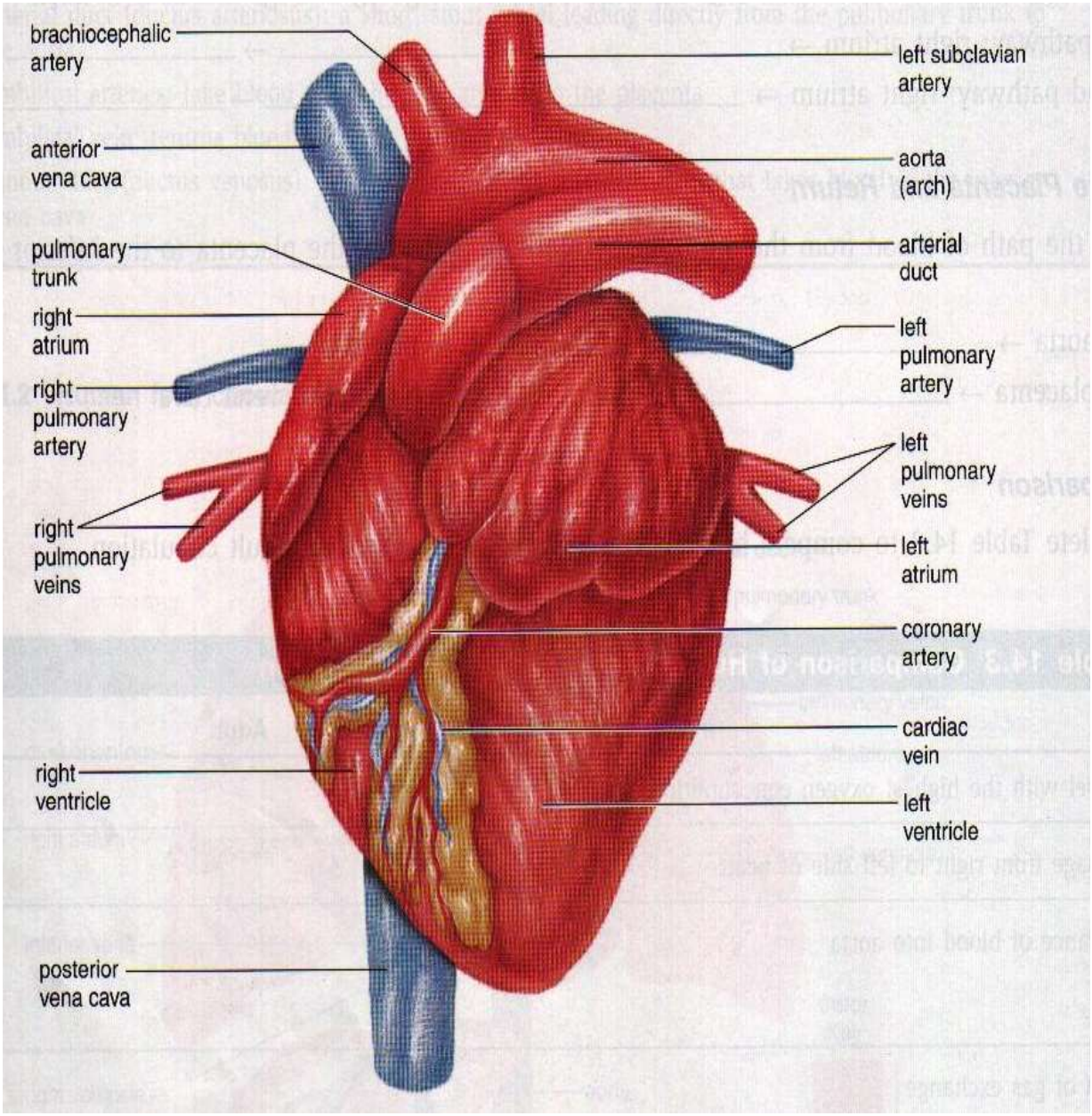
- **Isometric**: no change in length of muscle but tension increases during contraction
  - Postural muscles of body ex: muscles hold spine erect while person is sitting or standing
- **Isotonic**: change in length but tension constant
  ex: writing using computer keyboard
  - **Concentric**: tension is so great it overcomes opposing resistance and muscle shortens
    ex: raising of a weight during a bicep curl.
  - **Eccentric**: tension maintained but muscle lengthens
    ex: person slowly lowers a heavy weight
- **Muscle tone**: constant tension by muscles for long periods of time

Muscle tissue types

- Skeletal
  - Striated
  - Elongated cells
  - Multinucleated cells
  - Voluntary
- Cardiac (Heart)
  - Striated
  - Branched cells
  - 1-3 central nuclei
  - Involuntary
- Smooth
  - Nonstriated
  - Single central nucleus
  - Involuntary



Cardiac muscle :

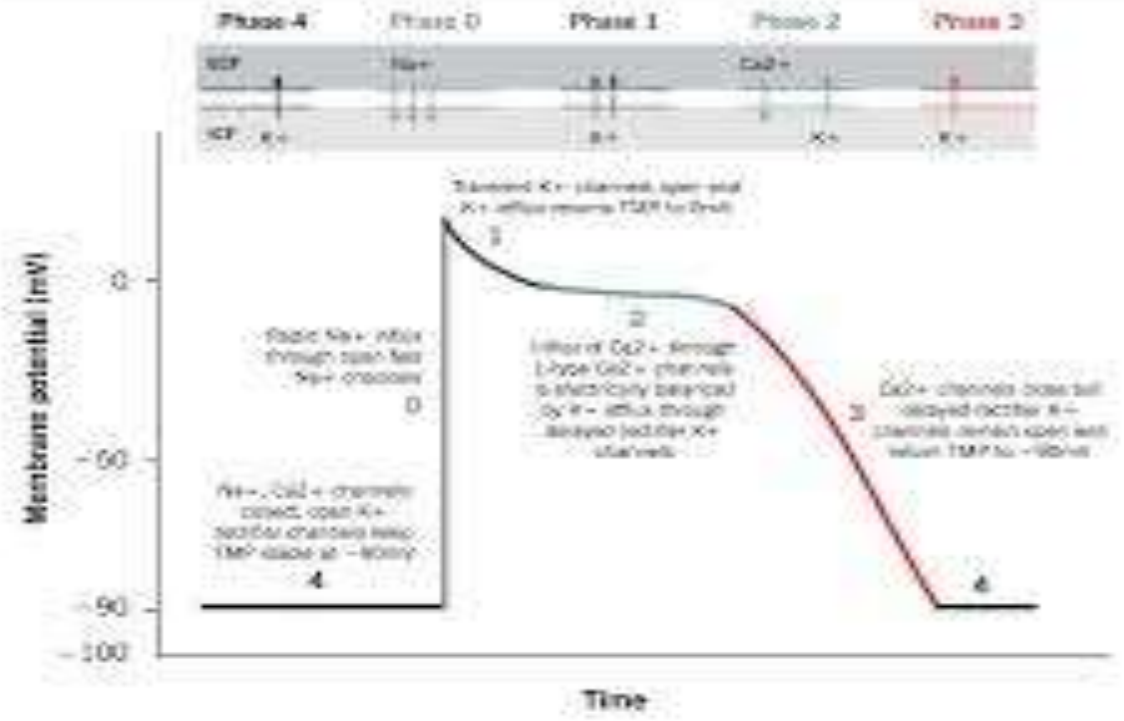


Action potential of heart muscle (cardiac muscle):

1. Resting stage.
2. Depolarization.
3. spike.
4. Plateau
5. Repolarization.

Note :plateau result from slow and continuous input of calcium ion.

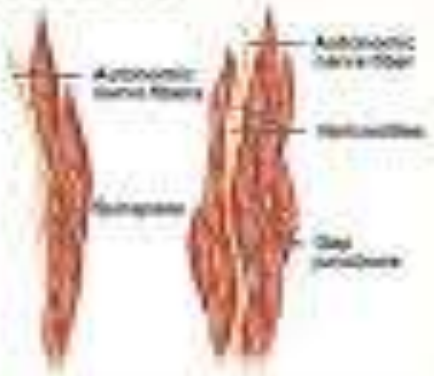
Action potential of cardiac muscles




Pacemaker Action Potential
Phase 0
Ca4+4(T)
K+
PREPOTENTIAL
Phase 3
Phase 4

Types of Smooth Muscle

- Multiunit smooth muscle
  - in largest arteries, iris, pulmonary air passages, arrector pili muscles
  - terminal nerve branches synapse on individual myocytes in a motor unit
  - independent contraction



- Single-unit smooth muscle
  - in most blood vessels & viscera as circular & longitudinal muscle layers
  - electrically coupled by gap junctions
  - large number of cells contract as a unit

Types of Ordinary Body Movements

- Flexion
  - Decreases the angle of the joint
  - Brings two bones closer together
  - Typical of hinge joints like knee and elbow
- Extension
  - Opposite of flexion
  - Increases angle between two bones