Faculty of Medicine 2012

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PHYSIOLOGY

Sheet

8

Medical Committee
The University of Jordan

Price :

Done by :

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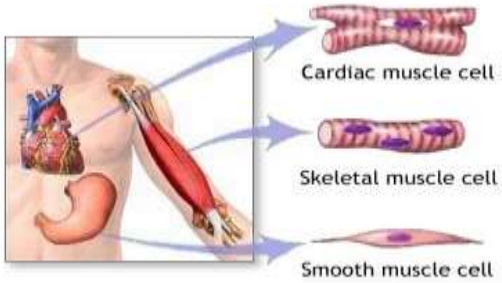
We have three types of muscles in our body:

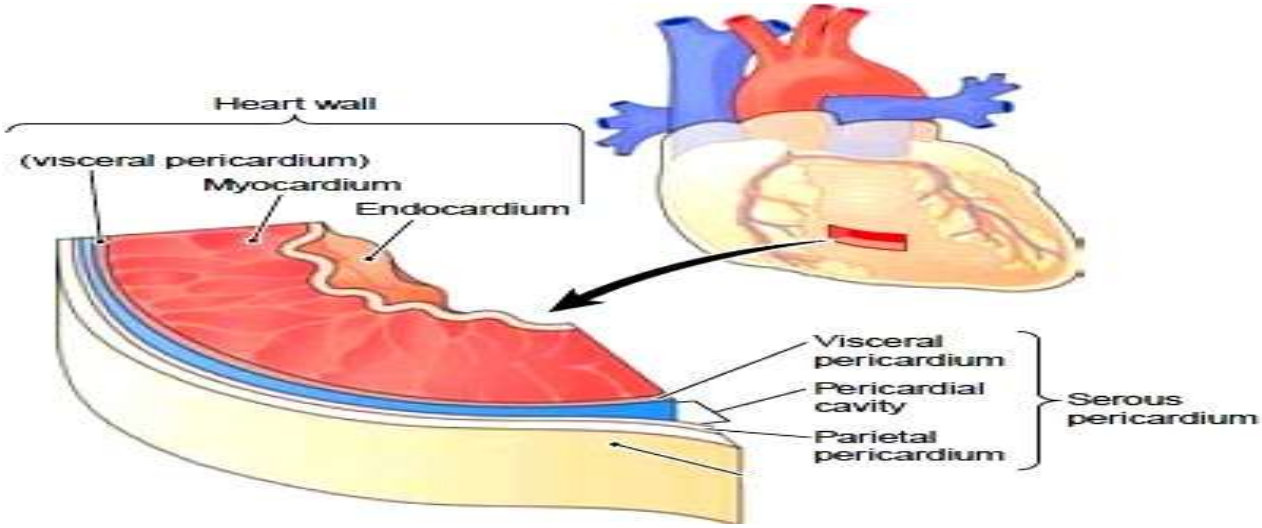
1. ***Skeletal muscles.***
2. ***Cardiac muscle.***
3. ***Smooth muscles.***



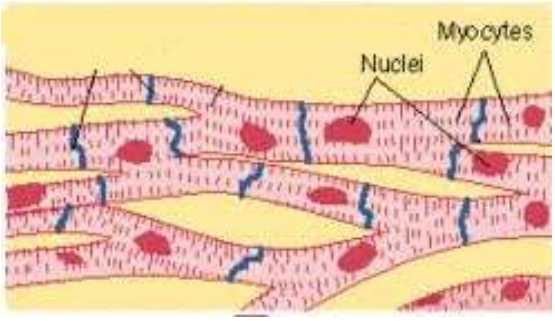
The cardiovascular system consists of : Heart , cardiac vessels.

The wall of the Heart has three layers:

1. ***Endocardium (Inner layer of the heart).***
2. ***Myocardium.***
3. ***Pericardium. (Surrounds the whole heart and has two layers visceral pericardium and parietal pericardium and there's a pericardial cavity between them).***



The cardiac muscle cells are rectangular in shape, and connected with each other through Gap Junctions; which is function is to conduct electricity from one cell to another so they form a low resistance area.



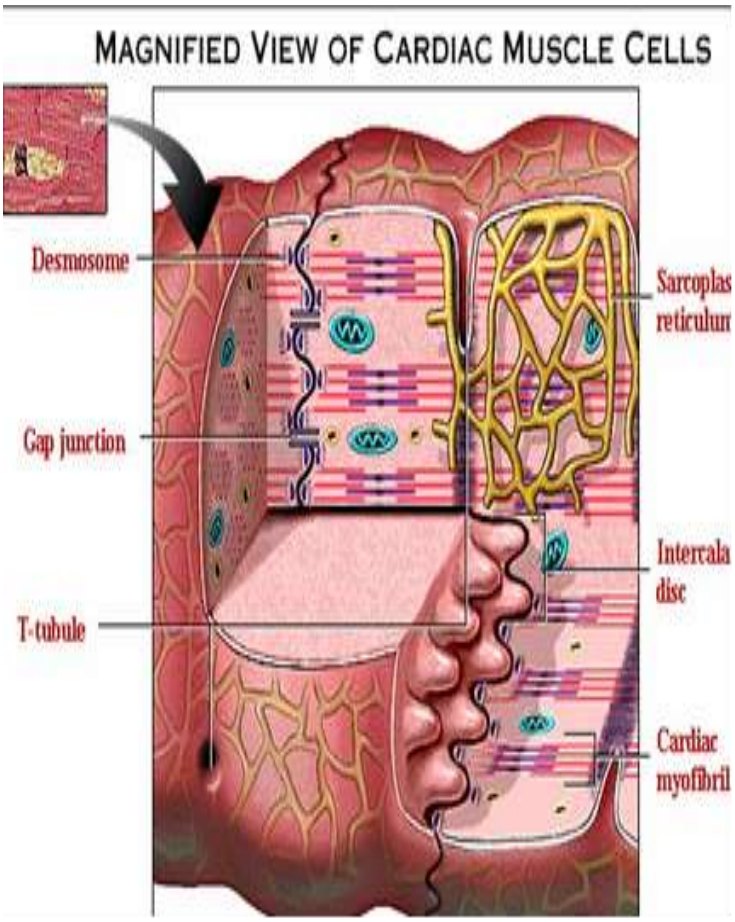
Skeletal muscle doesn't contract unless there's innervation from a nerve (has to be stimulated by impulses) but the Cardiac muscle is able to contract involuntarily, what happen is any change in one cell spreads into all cells at the same time through Gap junction (electrical coupling)

All muscle in the Heart are connected to each other (muscles are interconnected as one unit and this is called Syncytium structure) that's why they receive the action potential at the same time and contract as a one unit. E.g.: ventricles contract to push the blood at the same time as a unit!

Cardiac muscle won't contract or relax (mechanical change) unless there's action potential (electrical change).*electrical change is followed by mechanical change.

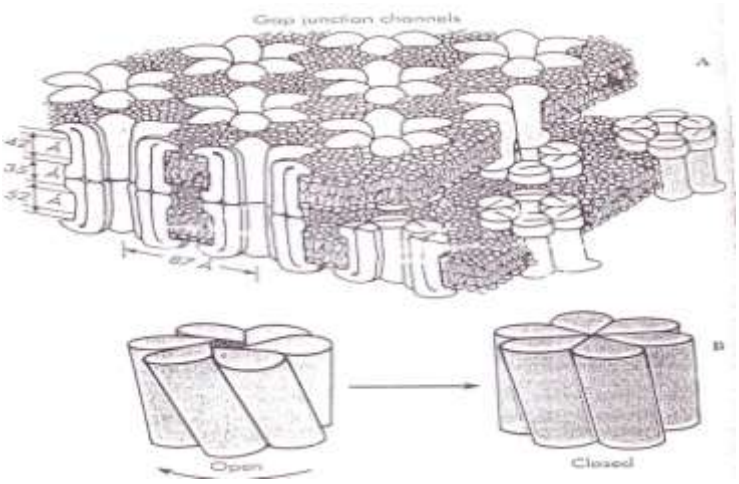
The plasma membrane in the cardiac muscle is called Sarcolemma, the endoplasmic reticulum is called Sarcoplasmic reticulum which is poorly developed (unlike the skeletal muscle where it's well developed to store calcium which means the cardiac muscles need an extra source of calcium from outside to contract) and Sarcoplasm instead of cytoplasm.

Transverse tubules coming from sarcolemma containing the interstitial fluid and inside the sarcoplasm there's myofibrils which are able to contract.



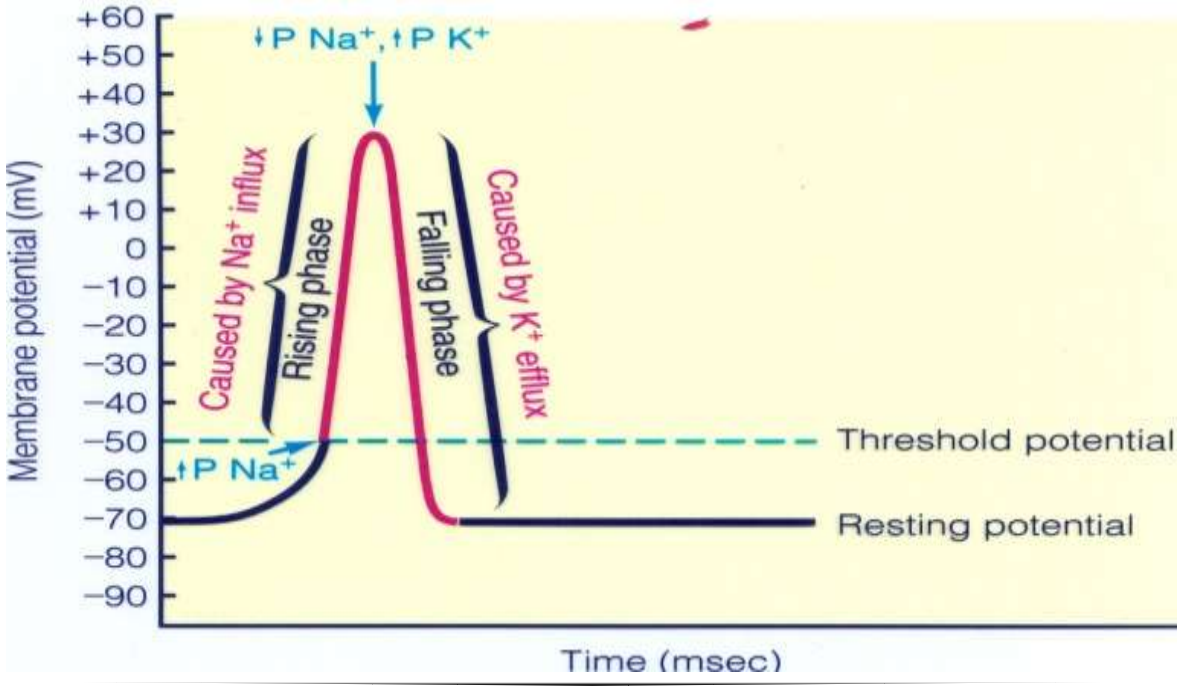
Gap junctions are like voltage gated channels so any change in the voltage they spread to all cell (electrical synapse).

Cardiac cells have lots of mitochondrion as a rich source of energy production, they are also low in nuclei (that's why they don't divide).



Action potential of Skeletal muscle

The resting stage (due to K diffusion) starts at (-70), then there's slow depolarization till it reaches the threshold, there when the firing stage starts (fast depolarization) due to the fast open Na^+ voltage-gated channels to reach (+61 the equilibrium potential for Na^+) but it doesn't get there because other ions are involved, then there's the falling stage (Repolarization) due to opening of K^+ channels, that's all occurs in 10msec.

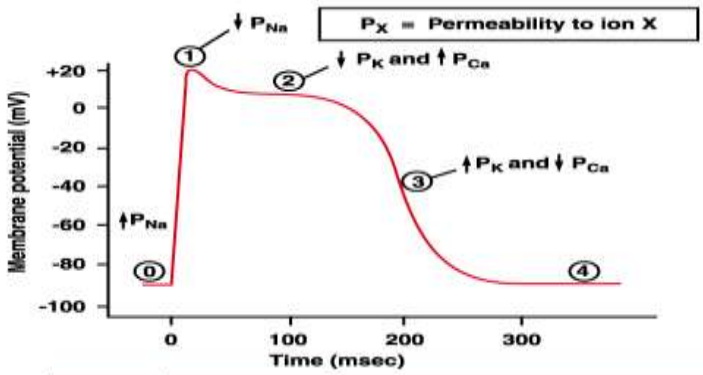


Action potential of Cardiac muscle

- ***The resting membrane potential is more negative (-90).***
- ***Fast depolarization phase which is also due to Na^+ voltage-gated channels. (in this phase there's an increment in the permeability of Na^+ and decrease in the permeability of K^+).***
- ***Partial repolarization (Not in skeletal) is due to the opening of transient, K^+ and Cl^- specialized channels.***
- ***Palteau is due to slow opening of Ca^{2+} , and calcium induces calcium realse from SR and plays the main rule in contraction.***
- ***Repolarization phase is due to opening of K^+ voltage-gated channels.***

Cardiac Muscle action potential

- Phase 0 –Depolarization phase (Na^+ influx)
- Phase 1 partial repolarization (Not in skeletal)
- Phase 2 Plateau (~ depolarization not in skeletal) slow calcium channels
- Phase 3 fast repolarization phase (K^+ repolarization()
- phase 4 resting membrane potential

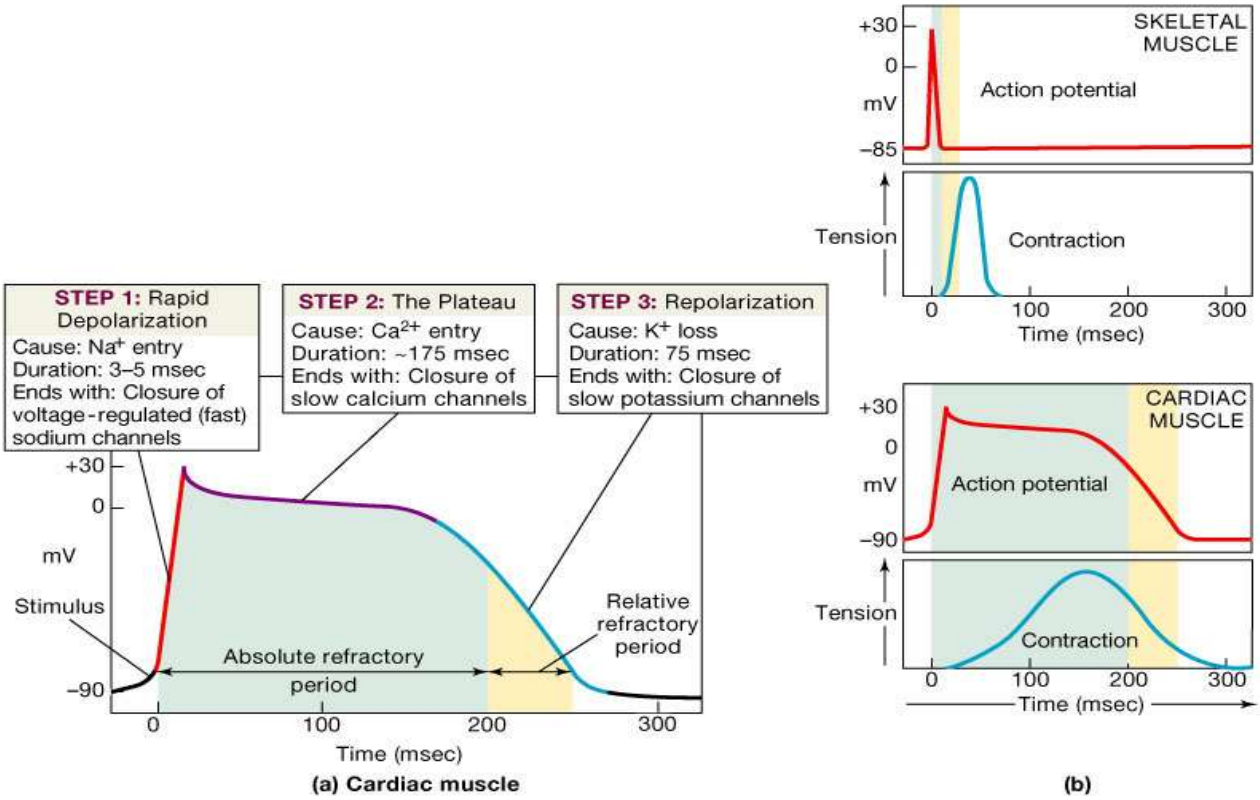


Phase	Membrane channels
0	Na^+ channels open
1	Na^+ channels close
2	Ca^{2+} channels open; fast K^+ channels close
3	Ca^{2+} channels close; slow K^+ channels open
4	Resting potential

In phase 0 there's an increment in permeability of Na^+ and decrease in the permeability of K^2, while in phases 1 and 2 there's an increment for the permeability of Ca^{2+} and there's going to be Calcium influx .

In the skeletal action potential, if there's another STRONG stimuli, another action potential will start in the relative refractory period of the first one (in the last half of the Repolarization phase, before the first potential ends) this is called tetanus(summation of contraction, there's no relaxation).

In the cardiac action potential, there's no tetanus; the muscle contracts and relaxes before any other action potential starts due to the very long action potential of the heart.



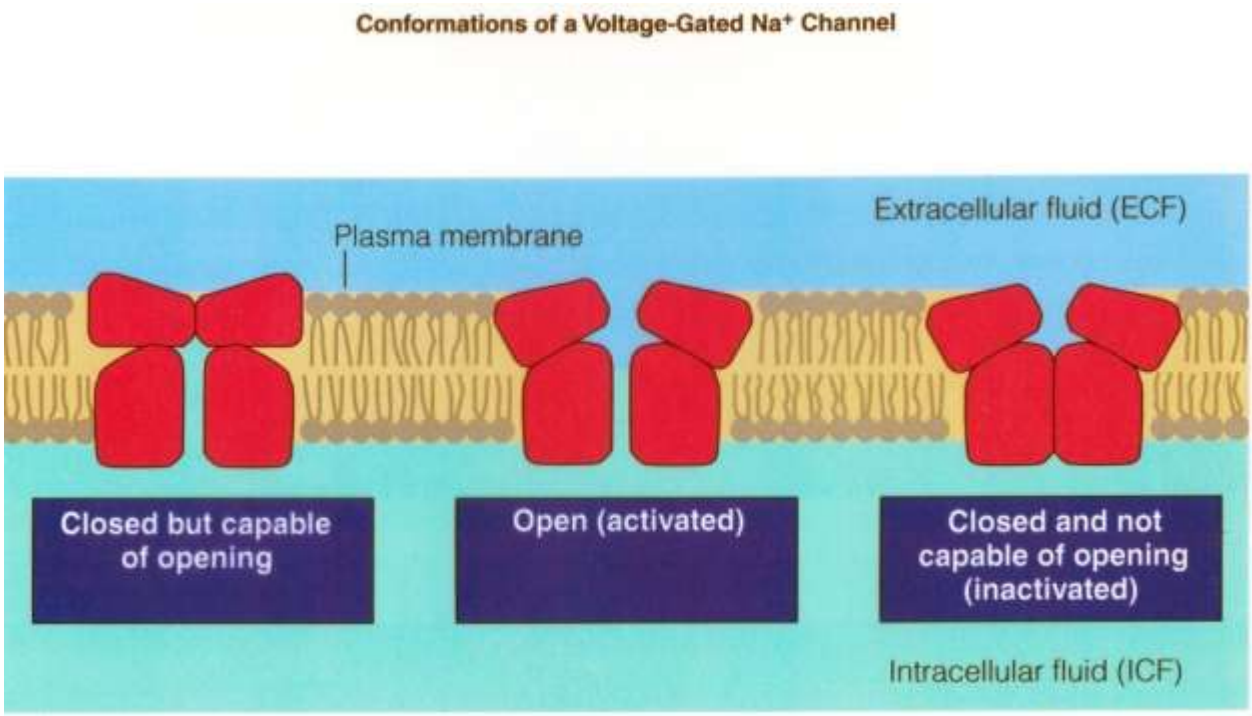
Na+ channels have to gates and Na will enter only when the two gated are open:

1. ***M gate: extracellular, activated (closed during resting phase, fast time constant, opens when the membrane potential becomes less negative)***
2. ***H gate: intracellular, inactivated (open during resting phase, slow time constant, closes when the membrane potential becomes less negative)***

****The Time constant is how much time they need to open***

When the membrane potential becomes less negative the activation gate opens after some time the inactivation gate closes because the threshold is reached and just before the inactivation gate closes Na^+ enter.

After contraction, calcium gets back to the SR or leaves the cell trough Na/Ca exchanger and Ca pump.



Action potential	*phases*	*The resting membrane potential*	*Firing stage*	*Partial depolarization*	*plateau*	*time*
Skeletal muscle	*2 phases*	*-70*	*The same*	*There's no partial depolarization*	*There's no plateau*	*10msec*
Cardiac muscle	*5 phases*	*-90*	*The same*	*There's partial depolarization*	*There's plateau*	*300msec*