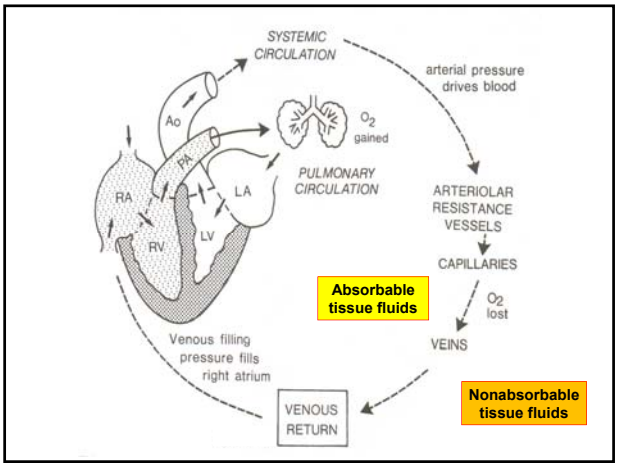
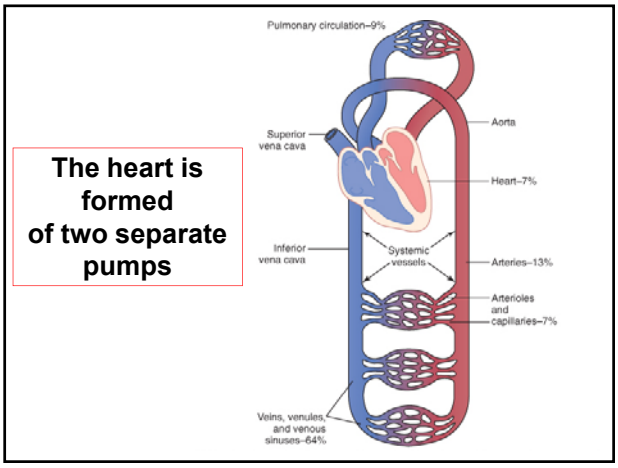
Cardiac Properties (1)

PHYSIOLOGY DEPARTMENT
CAIRO UNIVERSITY

2010-2011

بسم الله الرحمن الرحيم





2- All are the functions of the atrium EXCEPT:

a- A blood reservoir.

b- Atrial systole is followed by ventricular systole

c- Pump the blood to the ventricle.

d- Contracts weakly to help move the blood into the ventricle.

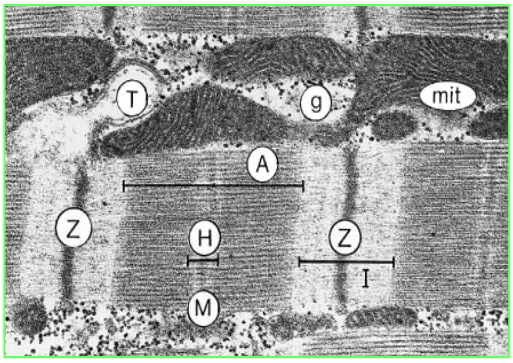
1- Cardiac Valves:

a- Prevent backflow of blood from the ventricles to the atria during diastole.

b- The cusps of the semilunar valves attached to the papillary muscles

c- The cusps of the AV valves pulled inward toward the ventricles during systole.

d- Normally allow flow of some blood to the atria during ventricular systole.



Sarcomere

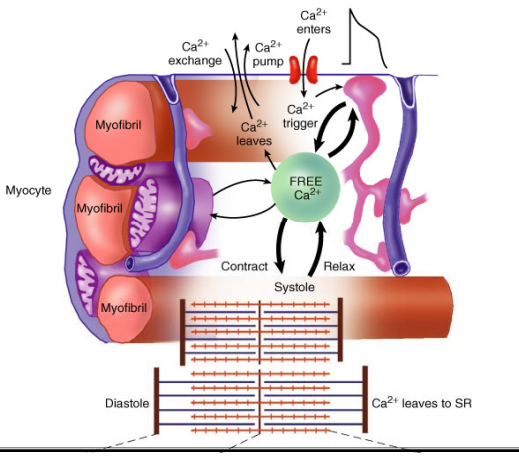
3- All the following belong to papillary muscle EXCEPT:

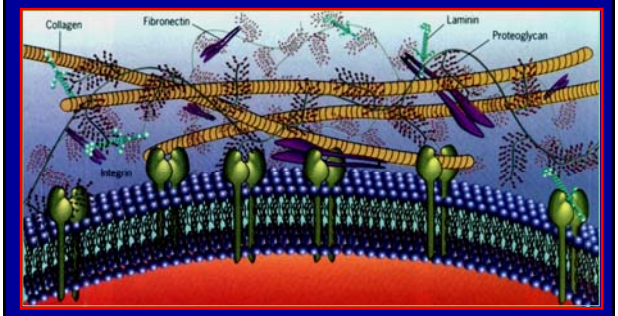
a- Attached to the cusps of the A-V valves by cordae tendineae

b- Contract when ventricular walls contract

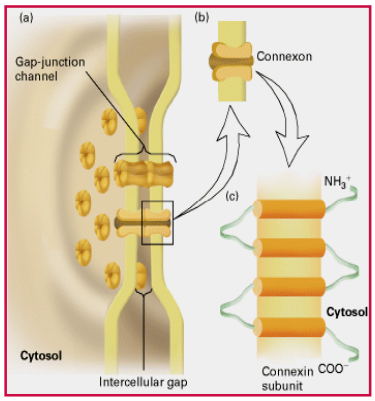
c- Pull the cusps of the valves inward

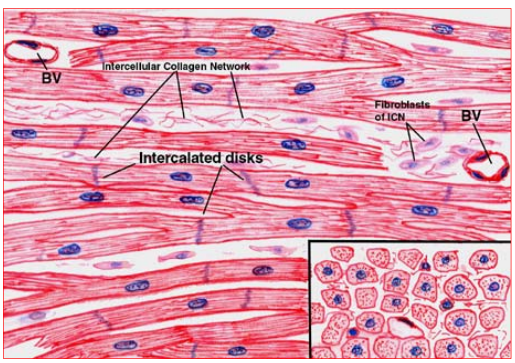
d- When the AV valves are pulled inward the atrial pressure increases rapidly.

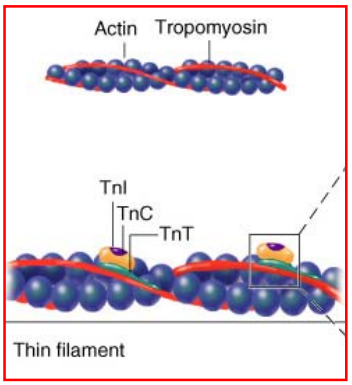


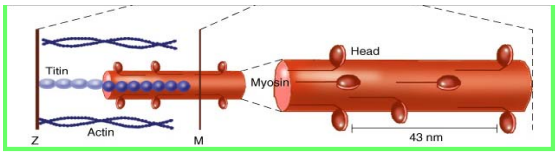


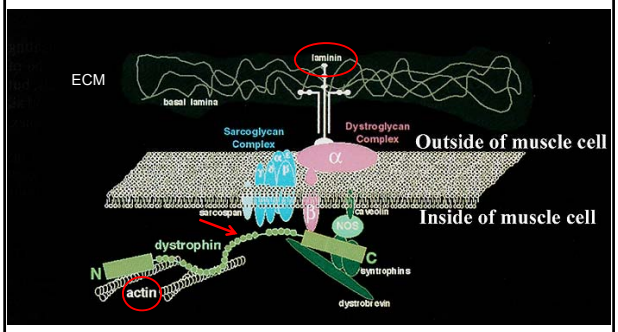
Schematic diagram of extracellular matrix (ECM)

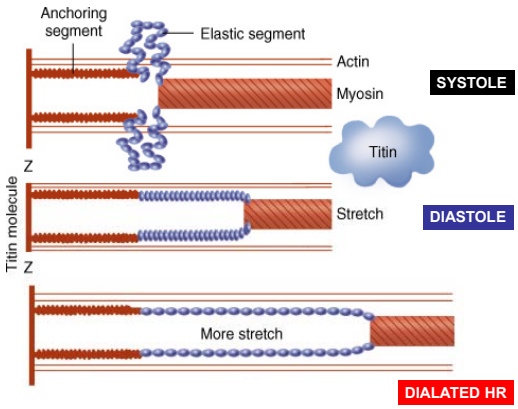












5- All are the functions of the intercalated disks EXCEPT:

a- Connect two adjacent cardiac cells.

b- Provide strong union between fibers.

c- Connect actin filaments of adjacent cells at M lines.

d- Contain gap junctions that allow electrical continuity between cardiac cells.

4- Cardiac cells:

a- Represent 90 % of the total volume of the heart.

b- Are rich in mitochondria (30% of cell volume) as in skeletal muscle.

c- Contain sarcoplasmic reticulum which takes up Ca2+ during contraction cycle.

d- They function as a syncytium.

7- Dystrophin:

a- A rod like structure connects the actin filaments of two adjacent cardiac cells.

b- Connects actin with extracelular matrix.

c- Helps platelets adhesion.

d- When dysfunctioned the connection between cardiac cells becomes slow.

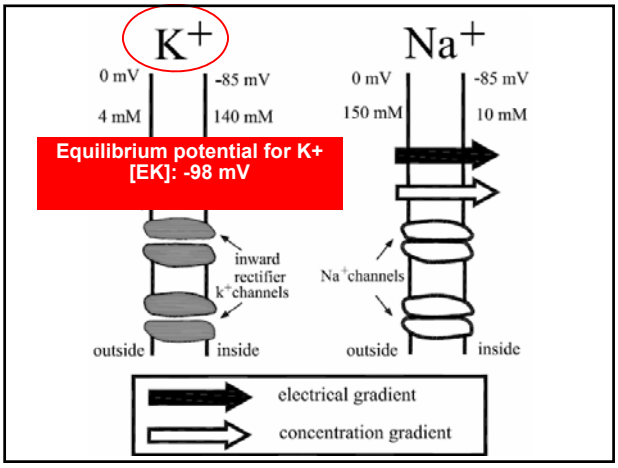
6- Cardiac gap junctions:

a- Composed of several ligand-gated channels permeable to ions.

b- Largely distributed in AV node.

c- Are Low-resistance intercellular junctions.

d- Are little in Purkinje fibers.



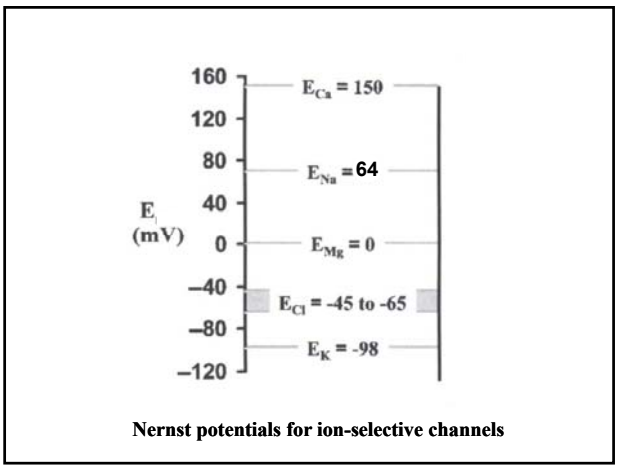
8- Titin:

a- Very large elongated stiff protein.

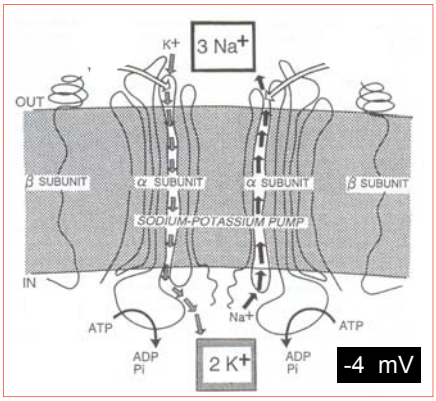
b- Binds actin to the Z line.

c- Keeps myosin thick filaments centered in the sarcomere.

d- When dysfunctioned the heart is dialated abnormally in systole.

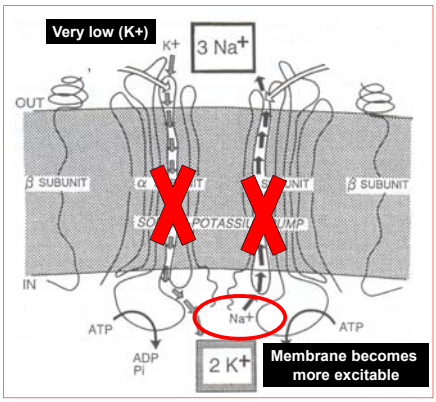


Nernst potentials for ion-selective channels

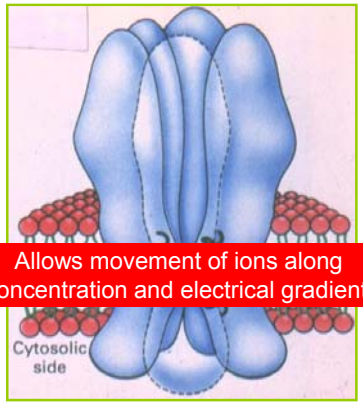


Na, K-ATPase Pump

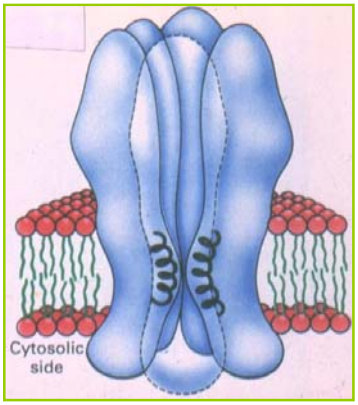
ION CHANNELS



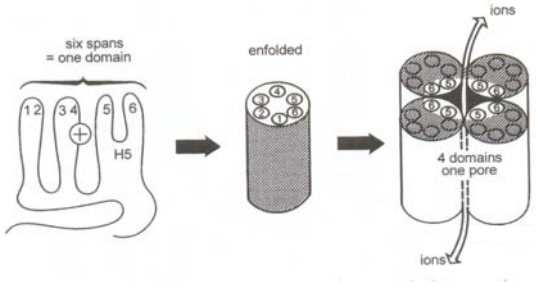
Na, K-ATPase Pump



Ion channel, Intrinsic membrane protein

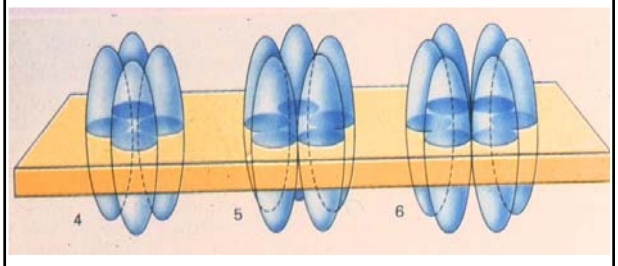


Ion channel, Intrinsic membrane protein

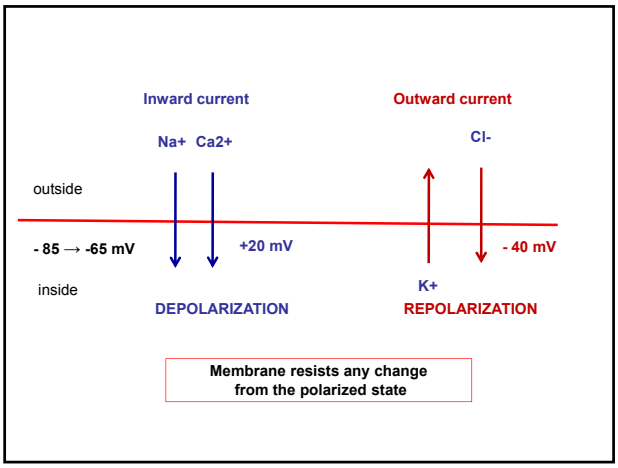


Voltage-gated Na+ and Ca++ channels

Voltage-gated ion channel | Ligand-gated ion channel | Gap-junction



Topology of various intrinsic membrane proteins

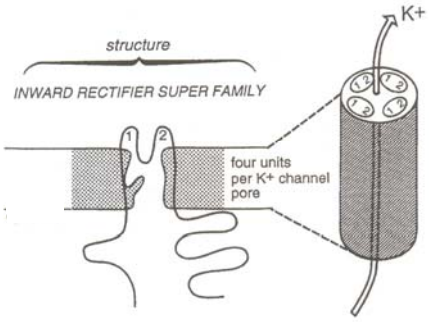


- **Inward current:**
- **Outward current:**

Inward rectifying K+ (IRK) channel

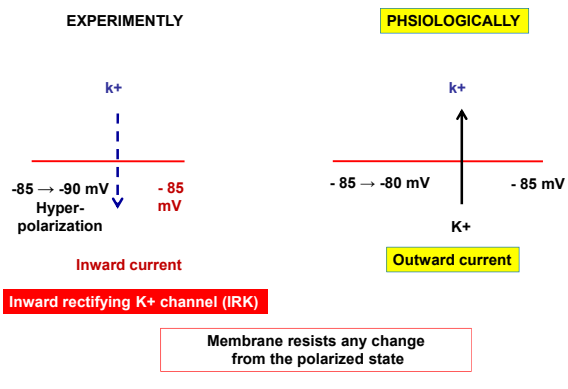
- **Allows K+ leaks out along its concent. gradient**
- **Does not inactivate with time**
- **Rectification:**
  - Favors ion movement in one direction than the other.
  - Specific character for potassium channels

Inward Rectifying K channel (IRK)



Inward rectifying K+ (IRK) channel

- **Allows K+ leaks out along its concent. gradient**
- **Does not inactivate with time**
- **Rectification:**
  - Favors ion movement in one direction than the other.
  - Specific character for potassium channels
- **Experimentally at MP < -85 mV (-90 mV):**
  - Membrane **resists** any change from the polarized state
  - The channel conducts inward current
  - The channel is **named** inward rectifying
- **Physiologically it causes outward current (Kr1)**



10- The cardiac resting membrane potential (RMP):

a- The delayed rectifying potassium channels are responsible for establishing the RMP.

b- At both low and high K+ concentrations, the membrane becomes less excitable.

c- Is about -85 mV in the ordinary cardiac cells.

d- When extracellular K+ ions is decreased to very low levels, the Na-K pump is enhanced.

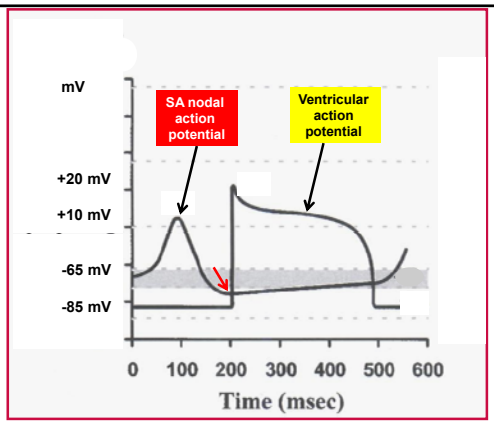
9- The resting cardiac cell membrane:

a- Is primarily permeable to K^+ ions.

b- Has resting membrane potential - 65 mV.

c- Favors inward movement of K^+ ions at -85 mV.

d. Influenced by extra-cellular Na+ ion concentration.



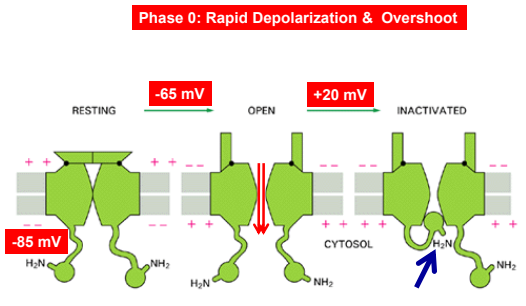
11- The inwardly rectifying K^+ channels:

a- Responsible for establishing the resting membrane potential at -100 mV.

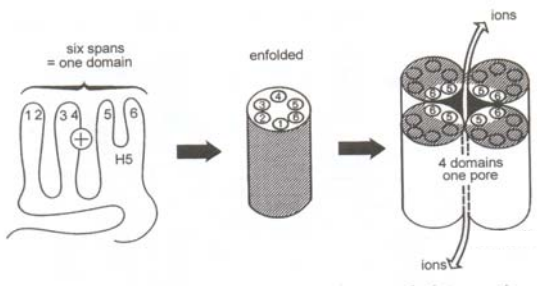
b- Favor inward movements of K^+ ions at membrane potential -65 mV.

c- Inactivate with time.

d- Conduct outward current physiologically.

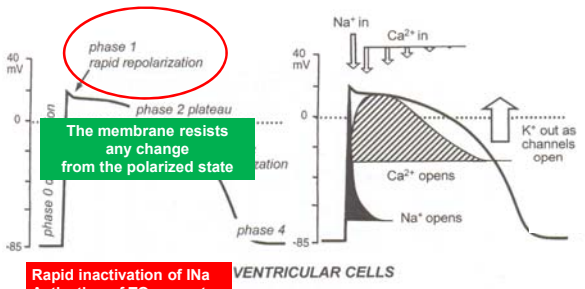


Na channel opening (activation) & closing (inactivation)



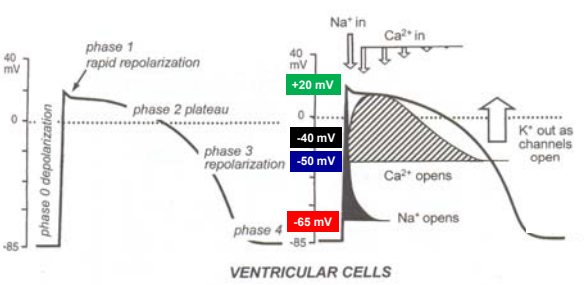
Voltage-gated sodium channel

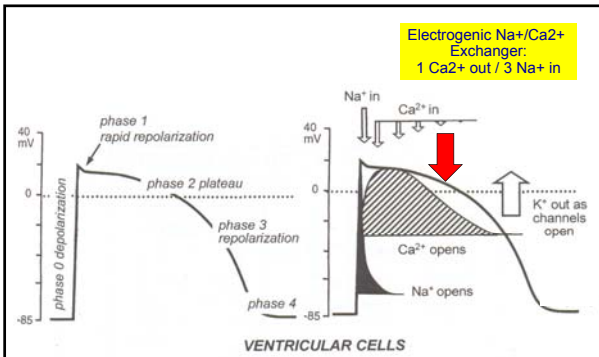
Phase 1: Early Rapid Repolarization

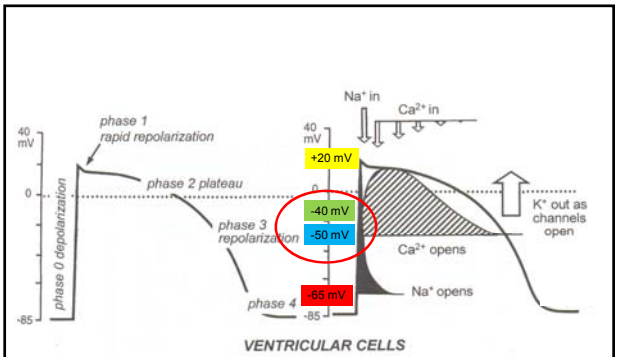


The membrane resists any change from the polarized state

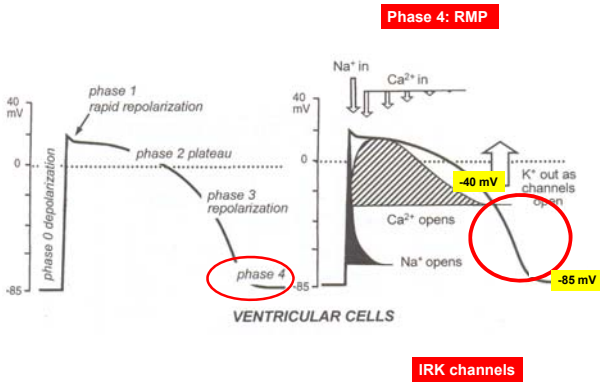
Rapid inactivation of INa
Activation of TO current:
- Efflux of K+
- Influx of Cl-





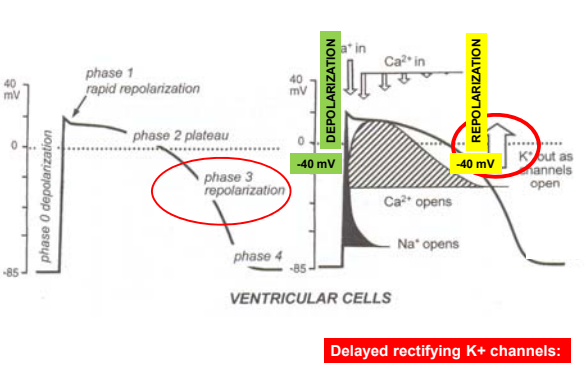


Phase 4: RMP

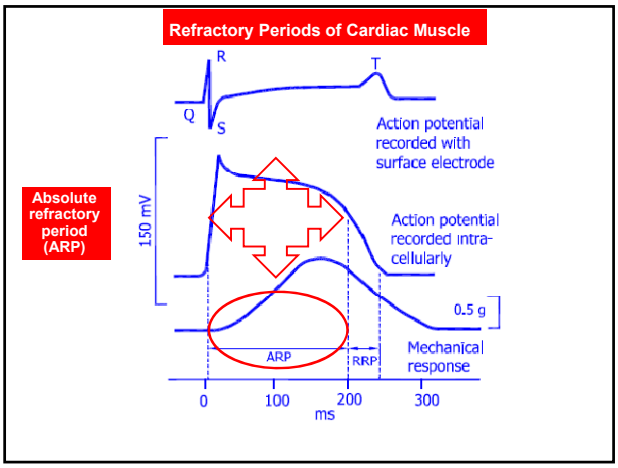


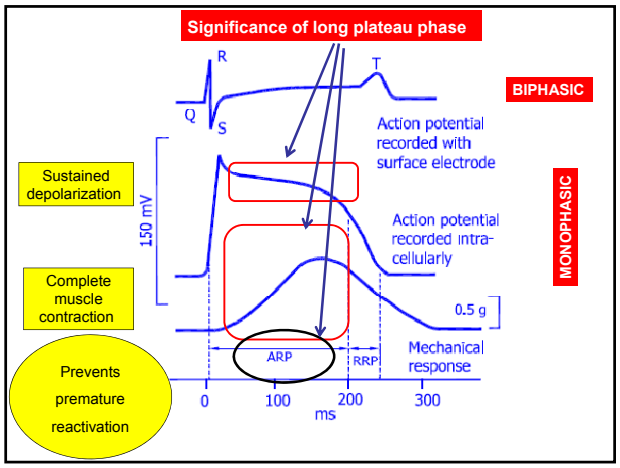
IRK channels

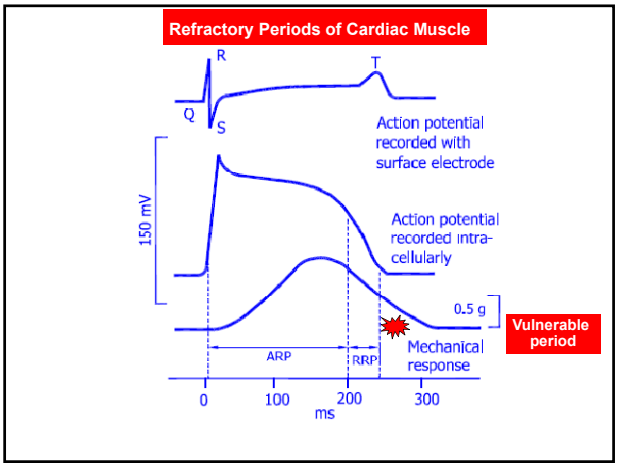
Phase 3: Repolarization

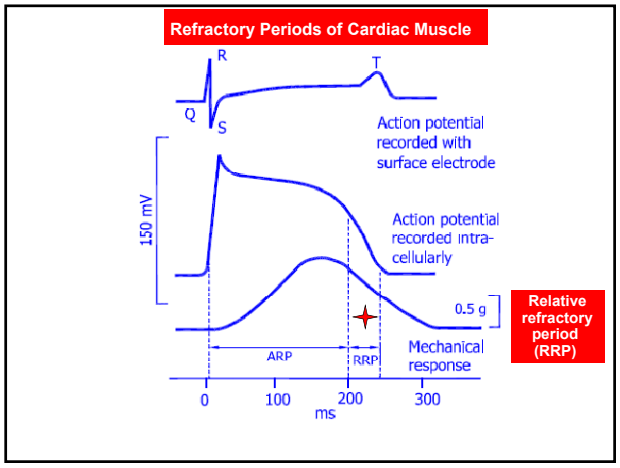


Delayed rectifying K+ channels:









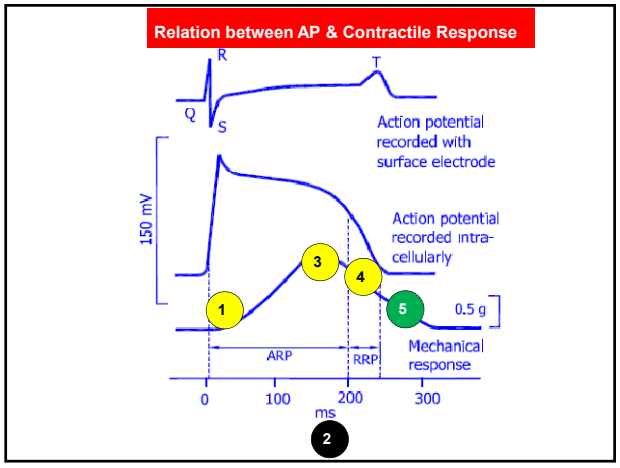
12- Regarding "cardiac action potential" all the followings are correct EXCEPT:

a- Transient depolarization-repolarization.

b- At threshold voltage, the membrane becomes primarily permeable K+ ions.

c- The membrane resists any change from the polarized state.

d- Has long duration from 200 to 300 msec.



13- The cardiac fast voltage- gated Na^+ channels:

a- Conduct inward current (INa) that responsible for slow action potential upstroke.

b- INa depolarizes the membrane to levels of activation of inward Ca2+ & outward K+ currents.

c- Quickly depolarize the membrane to +47 mV.

d- Blocked by dihydropyridines "DHP".

14- All the following cause the first rapid repolarization of cardiac ventricle EXCEPT:

a- Rapid inactivation of INa

b- Transient efflux of K+

c- Transient influx of Cl-

d- Rapid influx of Ca+.

15- Regarding "the plateau of ventricular action potential" all are correct EXCEPT:

a- Unique to cardiac cell.

b- Provides sustained depolarization and contraction needed to empty the heart.

c- Prevents premature activation.

d- Maintained by balance between inward Na^+ current and outward K^+ current.

16- Regarding "L- type Ca2+ current (Ica-L)" all are correct EXCEPT :

a- Ligand operated current.

b- Blocked by dihydropyridines (DHP).

c- Induces Ca^{2+} release from SR.

d- Inactivated very slowly.

17- The terminal part of cardiac plateau is prolonged by:

a- Electrogenic Na-K ATPase pump.

b- Ca2+-induced Ca2+ release.

c- Spontaneous diastolic depolarization.

d- Electrogenic Na+/Ca2+ exchanger.

18- Delayed outward rectifier K^+ channels:

a- Repolarizes the cell back to - 85 mV.

b- Voltage operated channels deactivated at +10 mV.

c- Activated during the early rapid repolarization.

d- Activated during the plateau phase competing with the inward Ca2+ current.

20- The contractile response of the cardiac muscle:

a- Lasts 2 times the action potential.

b- Begins just with the start of depolarization.

c- Systole reaches its maximum by the end of plateau.

d- The 2nd half of diastole coincides with the late rapid phase of re-polarization.

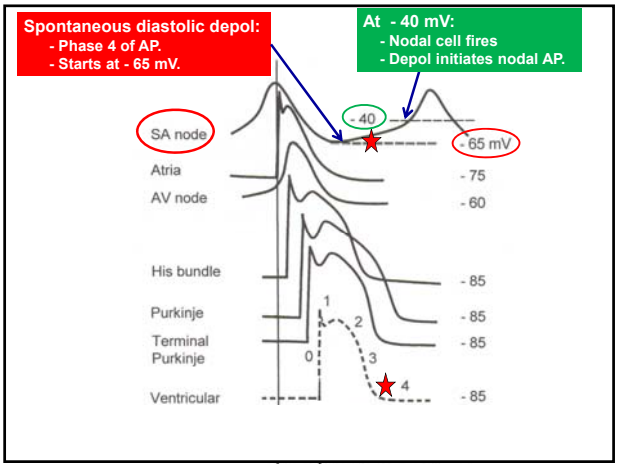
19- Regarding the refractory period (RP) of cardiac muscle:

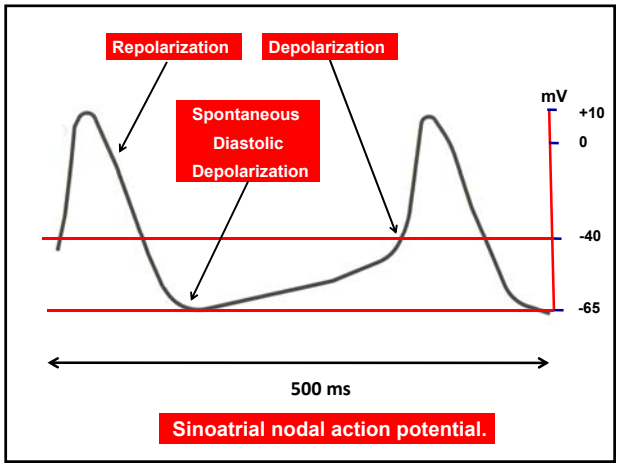
a-Tetanus can not occur because absolute RP occupies part of systole.

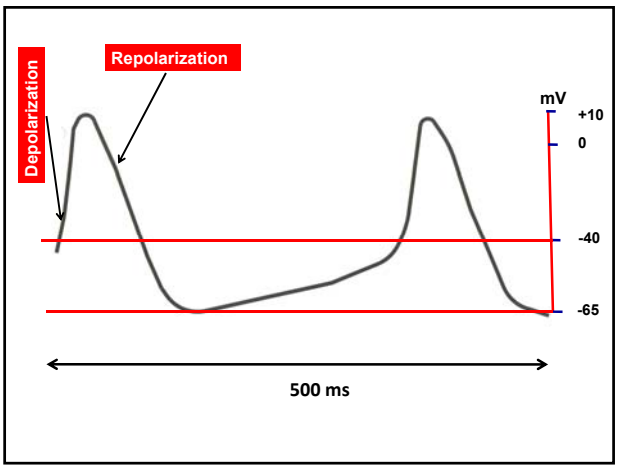
b- Extra-systole occurs after diastole.

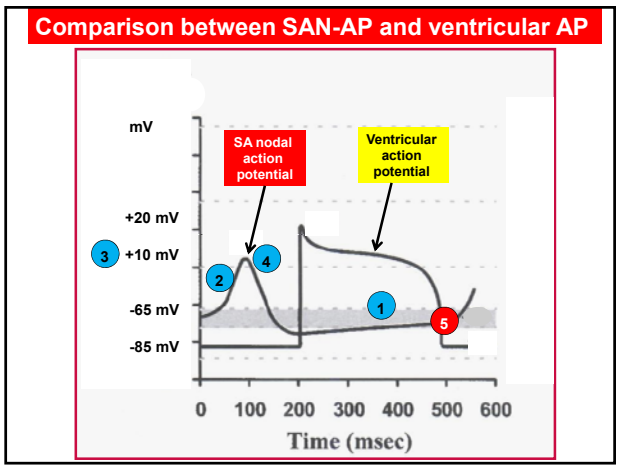
c- Fatal ventricular fibrillation may occur during 1st half of diastole.

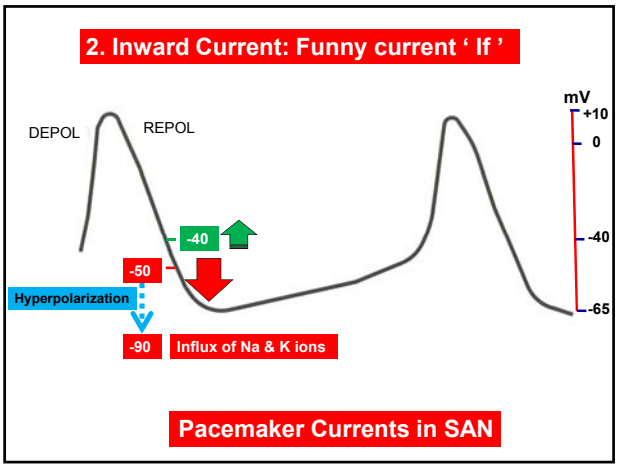
d- Vulnerable period is a critical period coincides with the 2nd half of diastole.

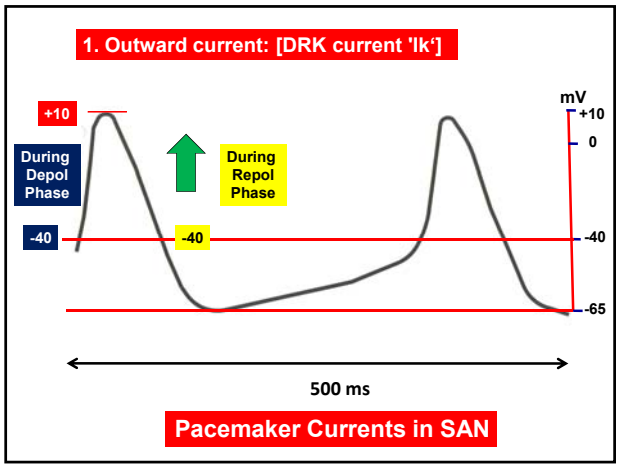


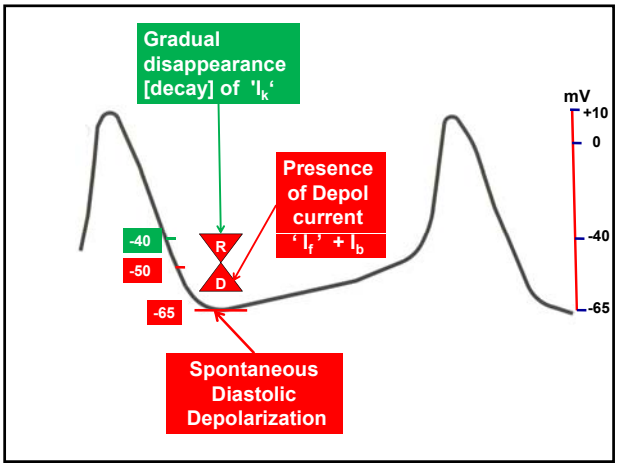


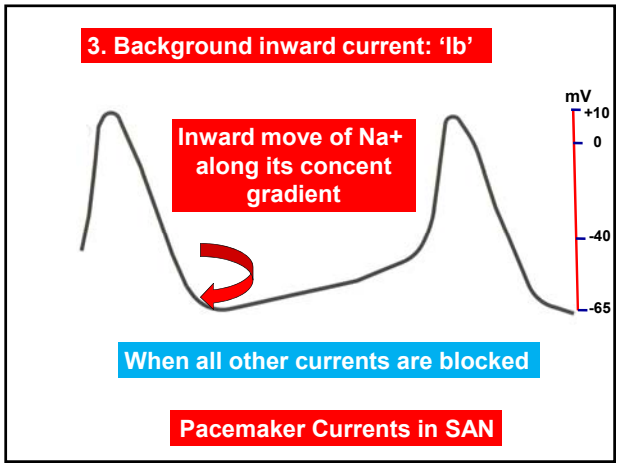






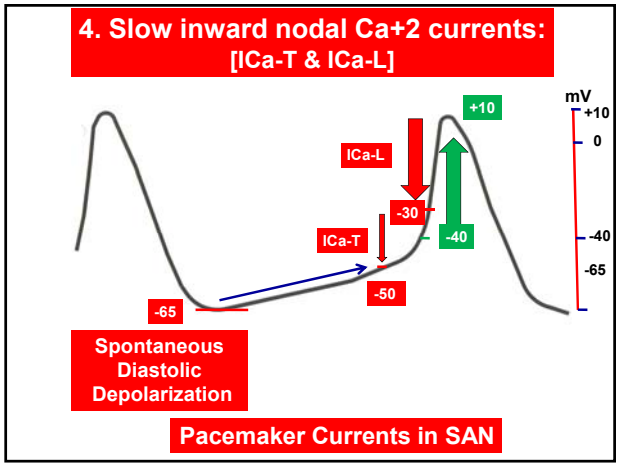


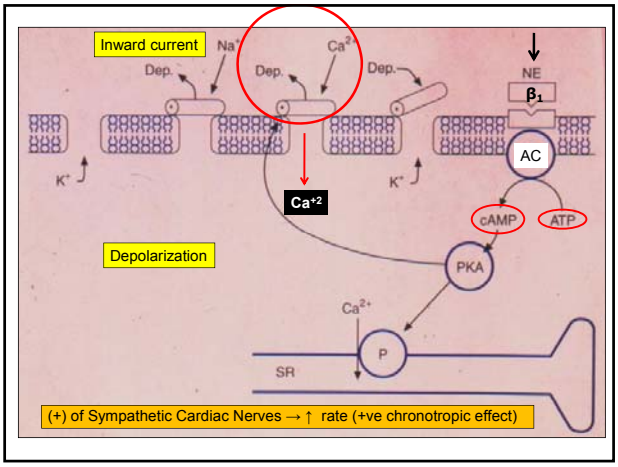


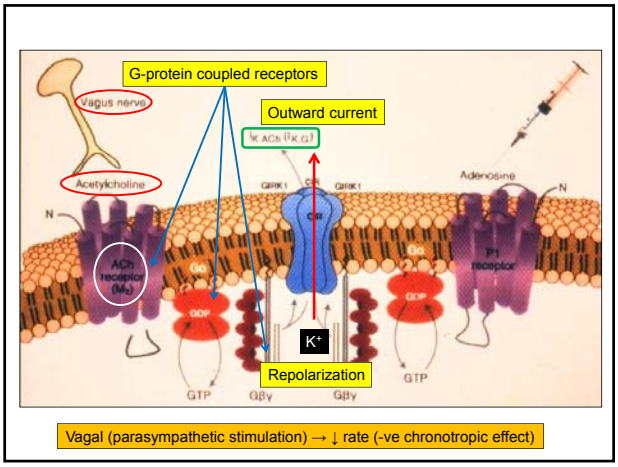


Autonomic Control of SAN

- (+) of Vagal (Parasympathetic) Fibers to SAN:
- (+) of Sympathetic Cardiac Nerves:







22- Nodal action potential:

a- Has rapid upstroke because of presence of fast sodium current (INa).

b- There is no plateau because of rapid onset of potassium-dependent repolarization.

c- At - 40 mV nodal cells fire and depolarization initiates the nodal action potential.

d- Has an apex up to 20 mV.

21- The sinoatrial (SA) node tissue:

a- Characterized by spontaneous systolic depolarization.

b- Initiates repetitive contractions.

c- The spontaneous depolarization starts at -65 mV.

d- Has stable resting membrane potential.

24- All are the pacemaker currents in SAN EXCEPT:

a- Inward rectifying K+ current 'Ik1' .

b- Inward funny current ' If '.

c- Background inward current (Ib).

d- Slow inward nodal calcium currents.

23- All are the characters of SAN action potential EXCEPT:

a- Unstable resting membrane potential.

b- Slow upstroke.

c- Occurrence of spontaneous diastolic depolarization at – 65 mV .

d- Balance between depolarization & repolarization at +10 mV.

26- Regarding the slow inward nodal calcium currents all the following are correct EXCEPT:

a- Are essential for SA nodal pacemaker activity.

b- Explain the slowly rising depolarization phase of the action potential.

c- The transient T type Ca2+ channels open first.

d- They overcome the outward potassium current at +10 mV

25- The inward funny current ' If ' of the SAN:

a- Activated at the apex of the action potential.

b- Is due to influx of both Na+ & K+ ions through a specific ion channel.

c- Remains when all other currents are blocked.

d- Is due to the spontaneous inward movement of Na+ ions along its concentration gradient.

28- The SAN is the normal pace-maker of the HR because of the following EXCEPT:

a- Is more rapid than other parts of the conduction system.

b- Discharges at a rate from 90 to 105 /min.

c- Is slowed by the tonic vagal discharge.

d- Has no circadian rhythm.

27- Pacemaker currents:

a- Present in all the conductive system.

b- When blocked there are "latent pace-maker" in Purkinje fibers.

c- Disappeared in denervated heart.

d- Present only in the SA node.

30- Sympathetic nerve stimulation to the HR:

a- Has +ve chronotropic effect.

b- Increases intracellular cGMP via B_1 receptors.

c- Increases the rapidity of repolarization.

d- Facilitates opening of T-type Ca2+ channels.

29- Vagal nerve stimulation to the heart:

a- Decreases the heart rate (+ve chronotropic effect).

b- Decreases the K+ conductance of the nodal tissue.

c- Hyperpolarizes the membrane.

d- Increases the conductance of the membrane to chloride ions.

THANK YOU

31- All the followings have +ve chronotropic effects EXCEPT:

a- Most types of fever.

b- Administration of digitalis.

c- Atropine.

d- Beta-1 adrenergic stimulation.