

Electric properties of cardiac muscles

Myocardium has got 2 types of cells

- Contractile tissue (muscles)
- Non- Contractile tissue (auto-rhythmic cells) or conductive tissue.

The Contractile muscles are:

1. Ventricles
2. Atria

Both similar graph shape

Non- Contractile tissue (conductive tissue):

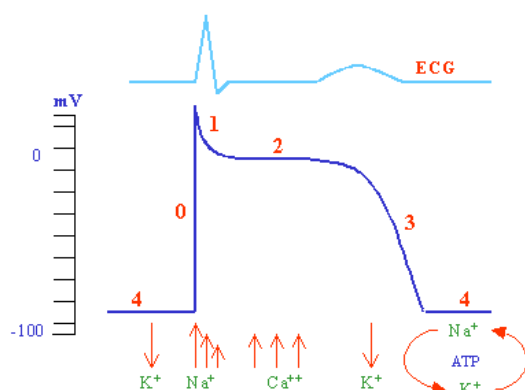
1. SA Node
2. AV Node
3. Bundle of His
4. Bundle of branches
5. Purkinje fibers

They are responsible for rhythmicity (Independent of nerve supply)

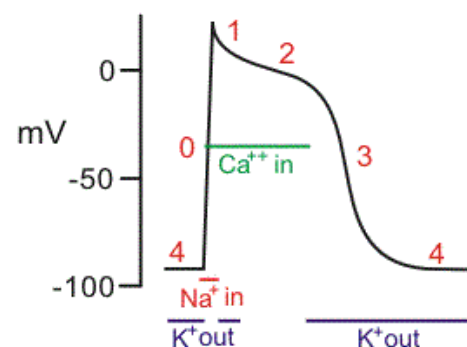
Action potential means depolarization followed by repolarization

The shape of action potential in all nerves is spike-shape but cardiac muscles have got different shape from different parts of heart.

Duration of action potential is from 200 - 250 ms (ventricles)

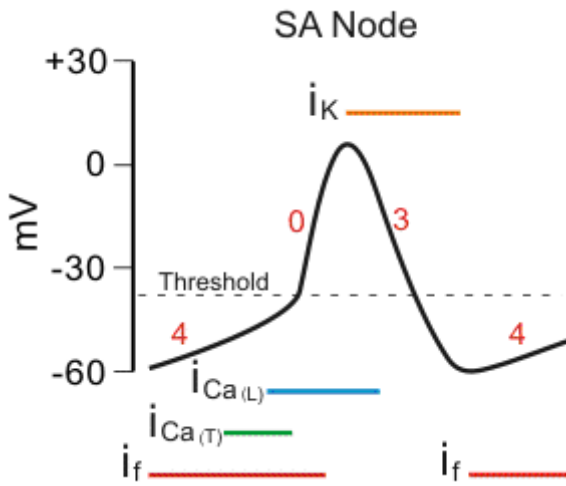


Ventricule action potential
Duration: 250 milliseconds



Atrium action potential
Duration: 100 milliseconds

Cardiac muscle has the longest duration of action potential in purkinje fibers.



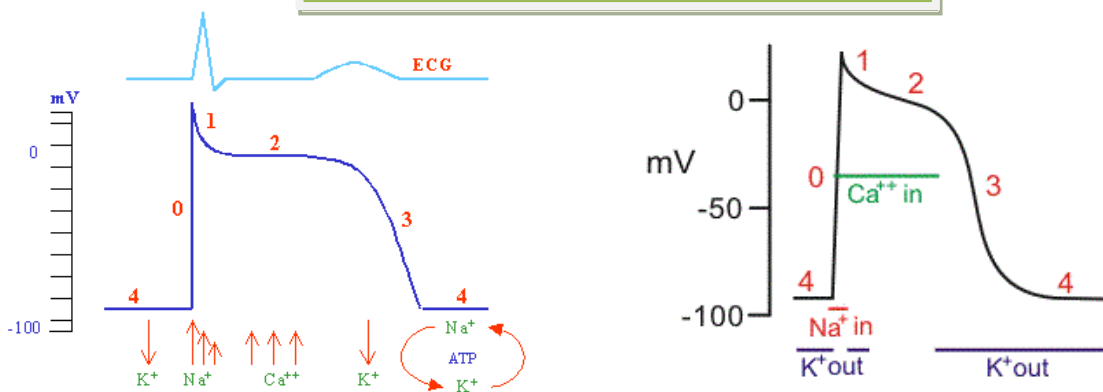
This graph indicates SA, AV nodes action potential

All conductive tissue (non-contractile) have prepotential period (slow depolarization period).

Purkinje fibers has similar graph to the Ventricle (Not atrium) except 2 things which are:

1. Duration of action potential (longer in Purkinje fibers- up to 400 ms).
2. Prepotential period.

Ventricle and Atrium action potential



Have 5 phases:

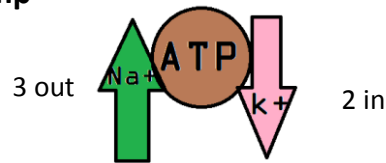
Phase 0: depolarization due to rapid entering of Na^+ ions through fast sodium channels till reach to +30 mv which is the peak of depolarization

Phase 1: early repolarization phase because of transit outflux of K^+ ions (it is very short phase and for very short time too)

Phase 2: called plateau phase (flat phase) because of Ca^{++} entry to the cell (there is **No** potassium entering)

Phase 3: outflux of K^+ ions the cell (K^+ out)

Phase 4: Resting Membrane Potential (RMP) phase because of helping of Na⁺,K⁺ ATP in pump

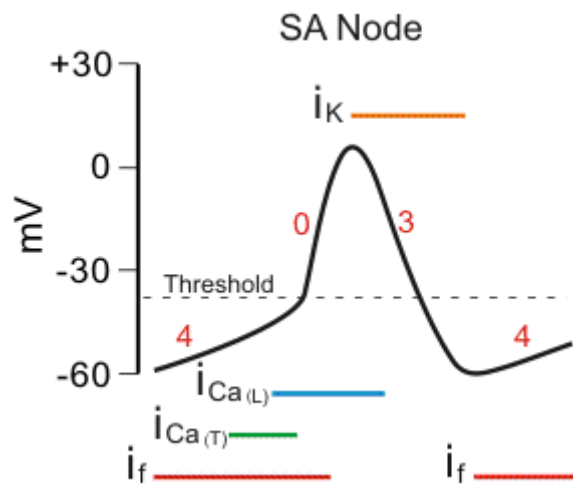


Difference between Ventricle and Atrium action potential	
Atrium	Ventricle
Small duration	Big duration
Short plateau phase	Long plateau phase

- SA node present at the root of SVC.
- AV node present at the mouth of coronary sinus.

Both are located in right atrium

SA and AV nodes action potential



Have 3 phases (no phase 1 & 2).

Phase 0: Ca⁺⁺ entering through Long-action channel (slow not fast as sodium and for that reason you note that it is not vertical line in this phase like Phase 0 in Ventricle and Atrium action potential).

Phase 3: K⁺ ions leaving out the cell (K⁺ out) and it continues to cause hyperpolarization up to -80 (below the RMP which is -60)

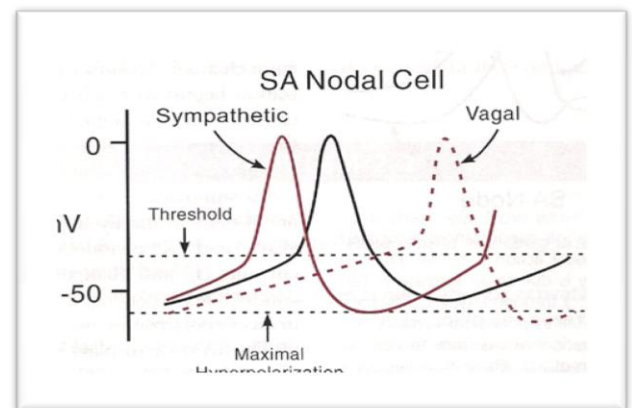
Phase 4: entering Na^+ through funny channels (no K^+ go out) and last third part of this phase sodium will stop and Ca^{++} begins to enter the myocyte through T-channels.

Why it is called funny channel?

Because sodium enters during hyperpolarization

Function of phase 4:

Sympathetic and parasympathetic nervous systems mediate this phase. If SNS activates the heart rate will increase (Tachycardia) then the phase 4 will be more vertical. However, if PNS (vagal nerve) activates the heart rate will decrease (Bradycardia) then the phase 4 becomes more horizontal.



Effect of ANS on SA Node Action Potential

N.B:

1. In SNS, the phase 4 is shorter than PNS.
2. All autorhythmic tissues are not horizontal in phase 4 like Ventricle and Atrium action potential and
3. Phase 4 autorhythmic tissue is known as Prepotential phase, Pacemaker potential phase, Initiator phase or Slow depolarizing potential phase.

Refractory period

Refractory period consists of:

1. Absolute refractory period: second stimulus is not effective in this period (nothing will happen).
2. Relative refractory period: Stronger stimulus can affect and stimulate heart muscles. ARP is very short in skeletal muscle and nerves in contrast with heart muscles which is longer (phase 2). In RRP, Na^+ channels start to close but when we give 2nd strong stimulus it opens.
3. Supra normal period (SNP) is a very sensitive period and if you give a shock in this period, the heart will fibrillate and may die.

