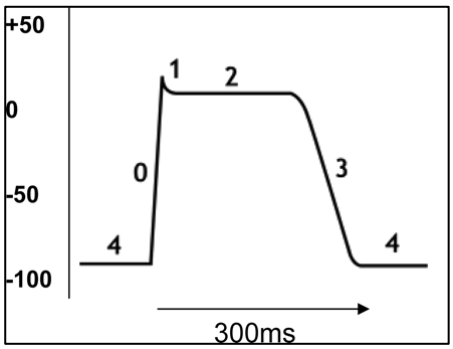
Q23 Describe the ionic events associated with a ventricular cardiac action potential (80% of marks). Outline how the action potential relates with the mechanical events of the cardiac cycle (20% marks) (Sept 2010)

There are 5 phases of the ventricular cardiac action potential:



http://ceaccp.oxfordjournals.org/content/7/3/85/F2.expansion

- **PHASE 0** - When stimulated by an action potential in an adjacent cell, voltage-gated sodium channels open rapidly and sodium moves into the cell. When the cell membrane reaches the cardiac threshold potential of -65mV, a positive feedback mechanism causes cell permeability to Na to increase dramatically, and the cell depolarizes to the sodium equilibrium potential of ~35mV

- **PHASE 1** – represents an initial repolarisation caused by the closing of fast Na channels and the opening of a transient outward K channel

- **PHASE 2** - A plateau occurs owing to the inward movement of Ca^{2+} through L-type Ca^{2+} channels which opened during depolarization, when the membrane depolarized to about -40mV. This offsets the action of K channels to maintain depolarisation (Ca^{2+} in, K+ out). There is also a Na/Ca exchanger which pumps out 3 Na for every 1 Ca. During this time no further depolarisation is possible, this represents the absolute refractory period (approx. 200msec)

- **PHASE 3** - L-type Ca^{2+} channels close and K efflux causes repolarization. It is now possible to cause another depolarization with a supramaximal stimulus, although the force of the contraction will be diminished. This is the relative refractory period (50msec).

- **PHASE 4 –** resting membrane potential (-90 mV), resulting from the activity of the Na/K ATPase pump which creates a negative intracellular potential because of the exchange of three sodium ions for only two potassium ions.

MECHANICAL EVENTS

- Phases 0 and 1 relate to rapid depolarisation of the ventricular muscle mass (the QRS complex of the ECG)
- Ventricular contraction starts at the peak of the R wave (corresponding to the start of the isovolumetric phase of the pressure-volume loop). The ventricle remains depolarised (ie; in a contracting state) until the start of the T wave (phase 3 of the action potential) when repolarisation begins
- The end of the T wave is related to ventricular relaxation and the return of the myocyte to resting membrane potential (phase 4)