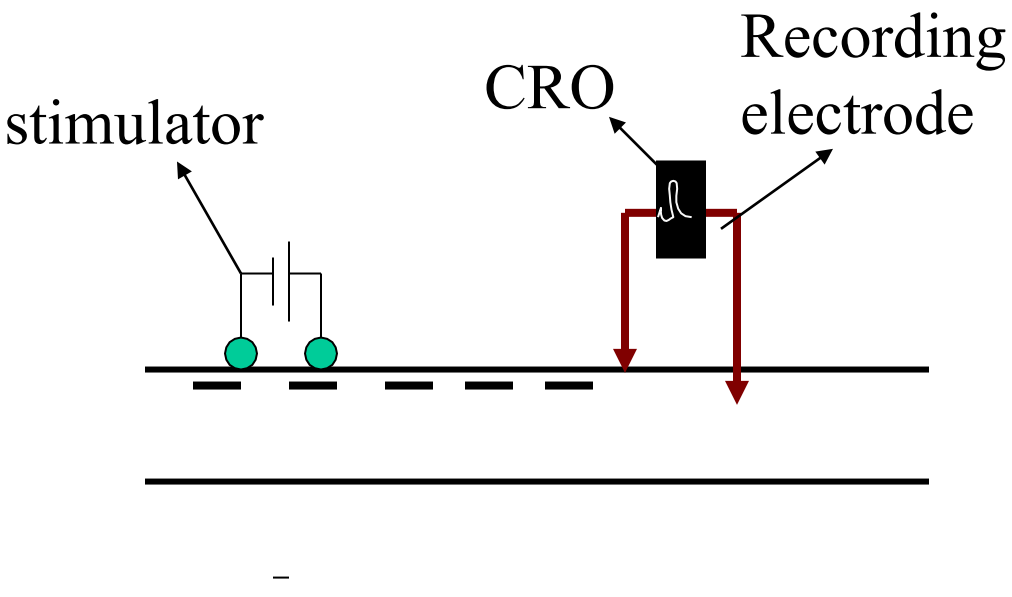
Action potential

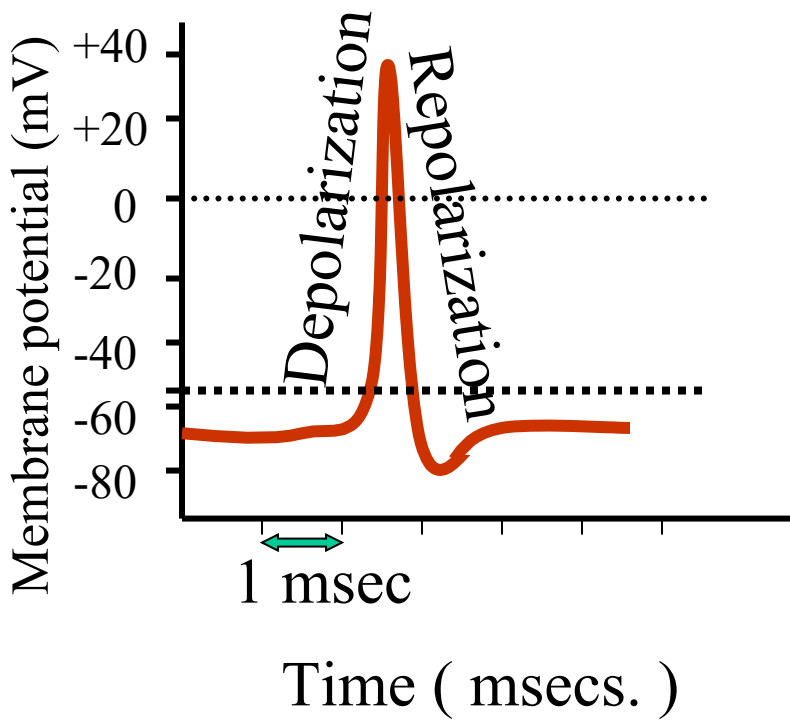
- Action potentials are brief, rapid, large, propogatory changes in membrane potentials produced by application of adequate stimulus to an excitable tissue.

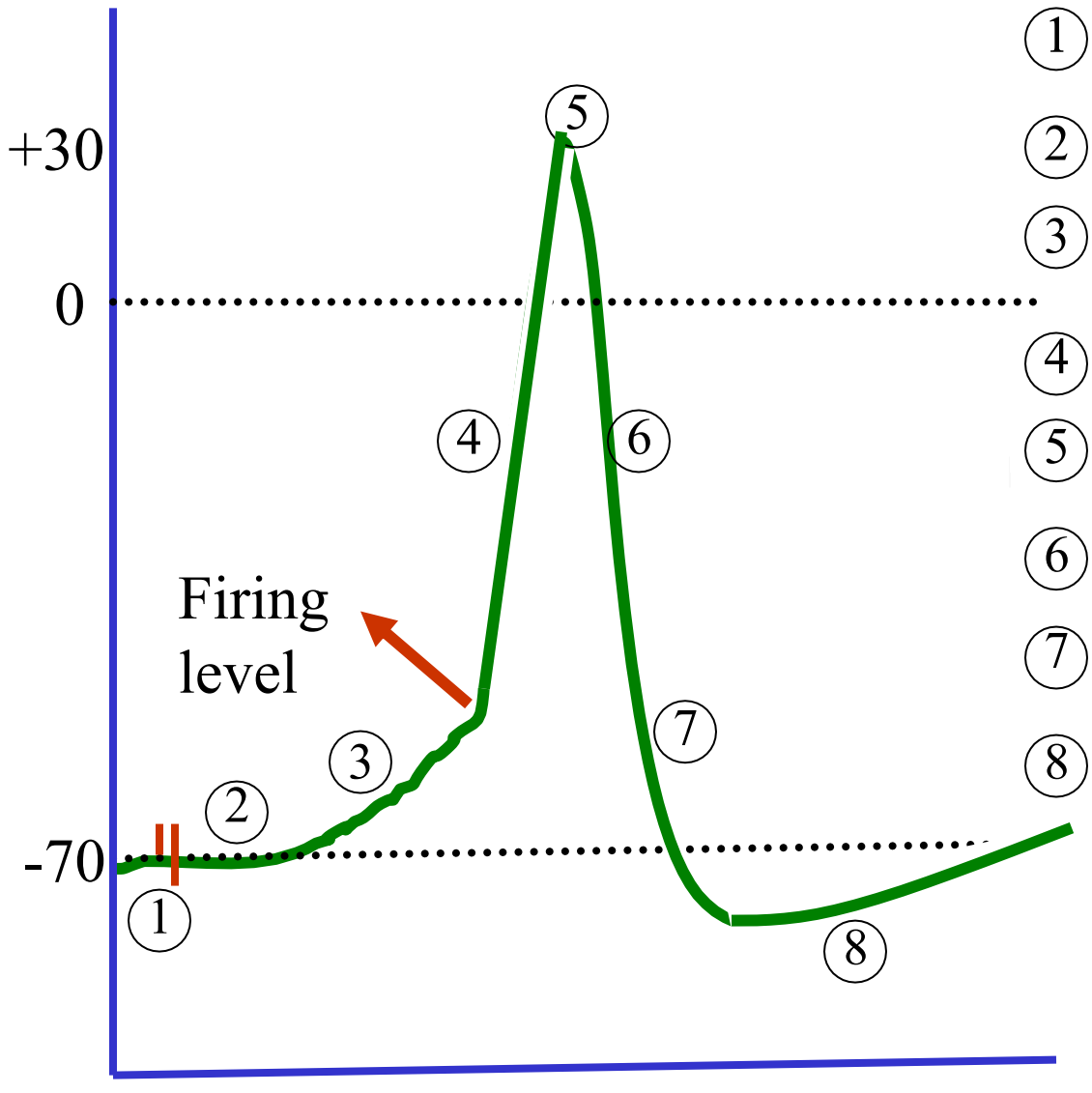
- Action potential = “impulse”

- Changes during AP – Depolarization followed by repolarization of membrane

- Recording of AP in nerve fiber - monophasic







① - Stimulus artifact

② - Latent period

③ - Local potentials

④ - Rapid depolarization

⑤ - Overshoot

⑥ - Rapid repolarization

⑦ - After depolarization

⑧ - after hyperpolarization

Events during A.P. –

1) Stimulus artifact – due to leakage of electric current from stimulating electrode to recording electrode

2) Latent period – It is isoelectric period. Indicates the time taken by the impulse to travel from stim. electrode due to the recording electrode. Duration varies with the distance between two electrodes.

3) Local potential – slow depolarization produced due to opening of Na+ channels

Firing level (threshold potential) – membrane potential at which rapid depolarization begins – which corresponds to 15 mV of depolarization from RMP.(-55mV)

4)Rapid depolarization – due opening of fast voltage gated Na^+ channels which causes entry of Na^+

5) Overshoot – due to Eq_{Na+} is + 60mV.

6) Rapid repolarization – due to closure of voltage gated Na^+ channels and opening of slow voltage gated K^+ channels which increases K^+ exit & stops Na^+ entry.

Afterpotentials –

7) Afterdepolarization – reduced rate of repolarization due to accumulation of K+ on the outer side of membrane.

8) Afterhyperpolarization – due to incomplete closure of K+ channel causing excess efflux of K+.

Membrane potential comes to resting level by Na+ -K+ pump.

Ionic basis of A.P.-

I. Local potentials – partial opening of Na+ channels influx of Na+ along the electrochemical gradient causing slow depolarization

At firing level – rapid opening of activation gates of voltage gated Na-channels.

II. Rapid depolarization – influx of Na^+ causes depolarization which further increases opening of Na channels (positive feedback mechanism)

III.Overshoot – membrane potential becomes +ve because Eq $_{Na+}$ is + 60mV

Peak at +30mV – Na+ entry stops because of closure (of inactivation gates of) Na^+ channels and opening of voltage gated K^+ - channels

IV.Rapid repolarization –increase in K^+ efflux along electrochemical gradient.

V. After potential -

Va) After depolarization –slow repolarization due to reduced rate of efflux of K+ caused by accumulation of +ve charge on outer side, RMP is reached

Vb)After hyperpolarization – K-channels remain open for longer period causing excess efflux of K+ resulting in hyperpolarization

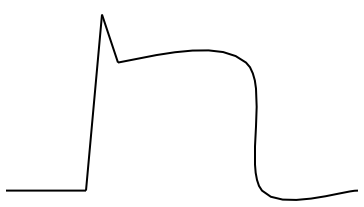
VI. Hyperpolarization is corrected by Na^+-K^+ pump

With each AP very small difference in conc. of Na^+ & K^+ in ICF & ECF.

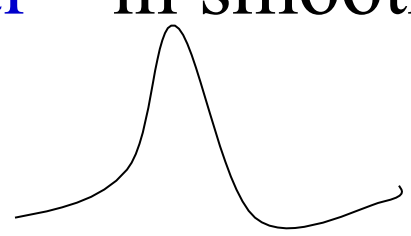
Types of AP –

1 Spike potential- in nerve and skeletal muscle

2 Plateau potential – in cardiac muscle



3 Slow potential – in smooth muscle



Role of Ca++ in A.P. –

Ca++ is a membrane stabilizing factor .

↓Ca++ conc. → early opening of voltage gated Na+ channels → ↑excitability