Properties of Cardiac muscle (Part 1)

Properties of cardiac muscle

Properties of the cardiac muscle:

I. Excitability: The ability to respond to a stimulus of adequate strength and duration (i.e. threshold or more) by generating a propagated action potential

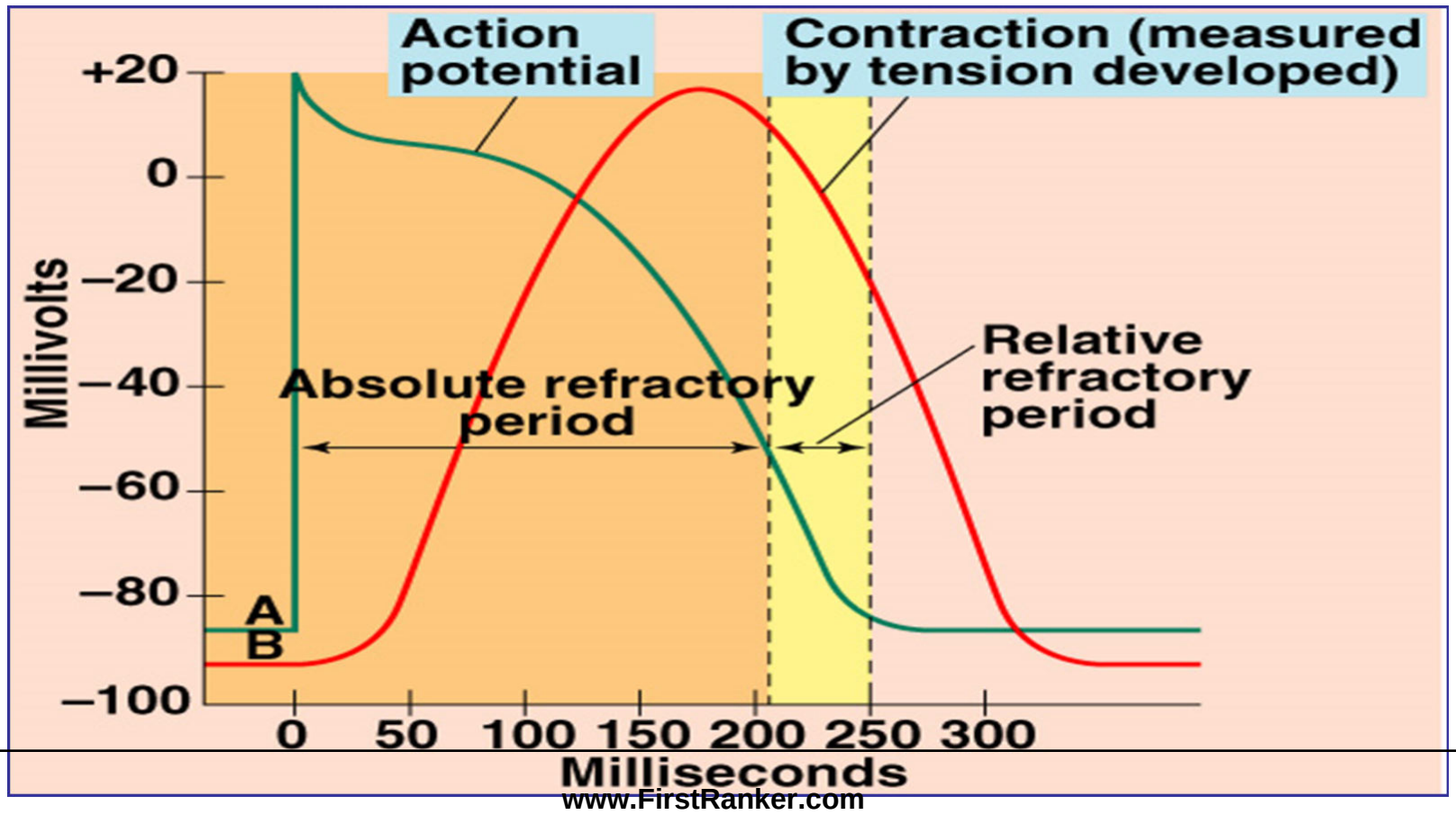
II. Conductivity: The ability to conduct excitation through the cardiac tissue

III. Contractility: The ability to contract in response to stimulation

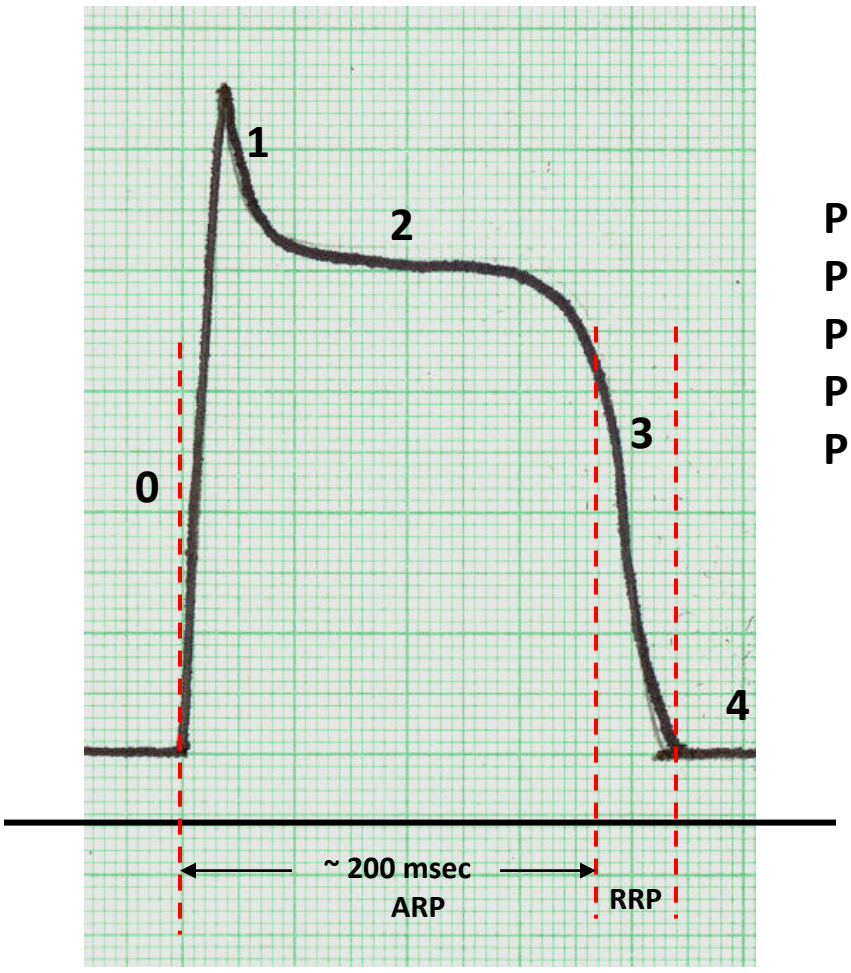
IV. Auto-Rhythmicity: The ability to initiate a heart beat continuously and regularly without external stimulation

Refractory Period

Excitability changes during the action potential

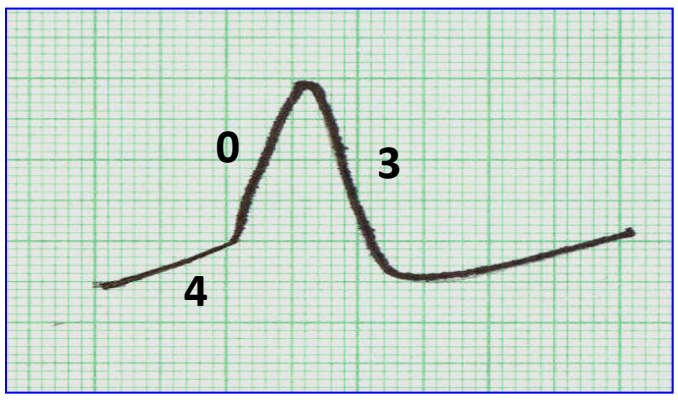


Phases of action potential in ventricles/SA node)



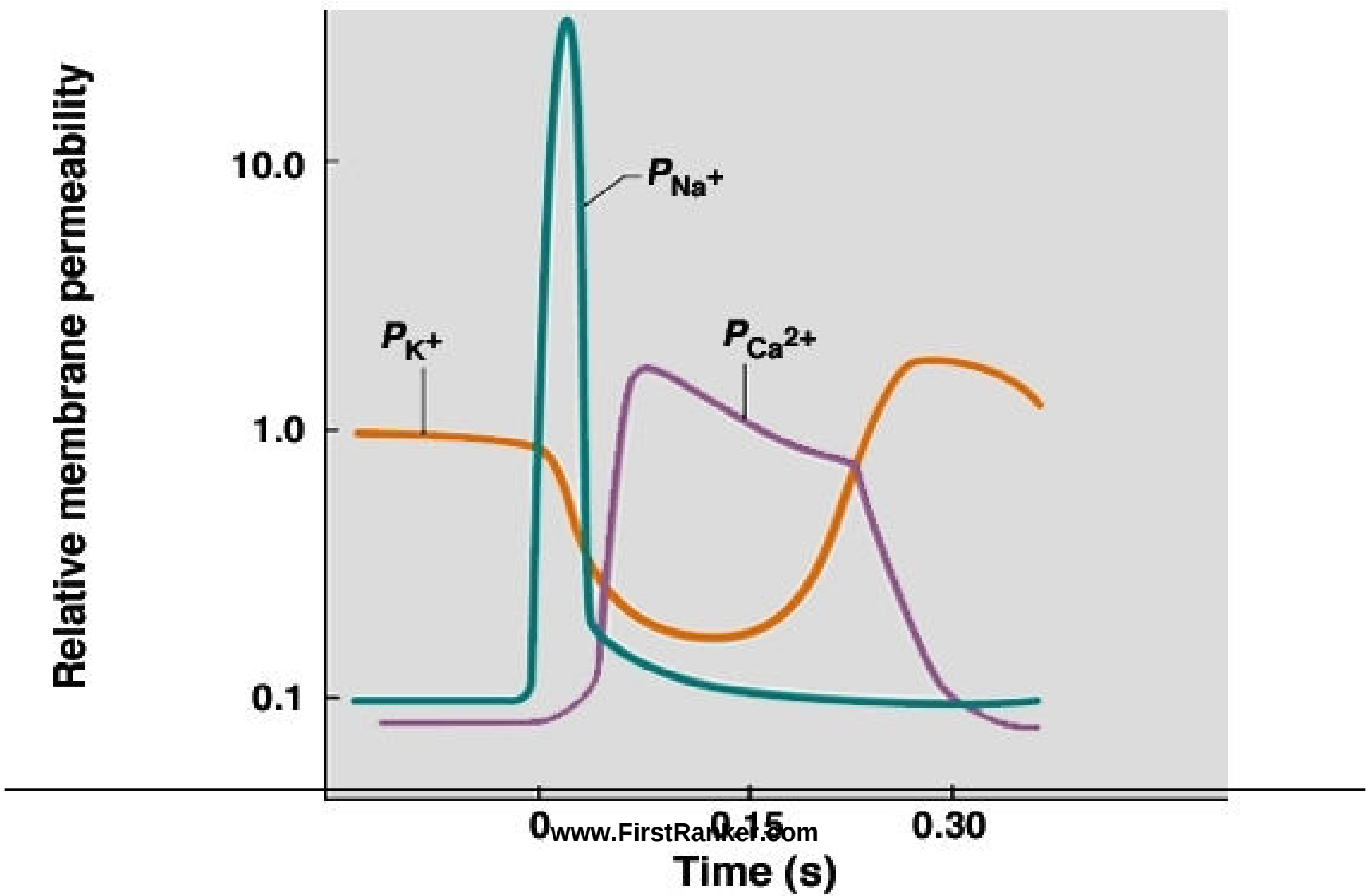
Phase 0 = depolarization
Phase 1 = early repolarization
Phase 2 = Plateau potential
Phase 3 = repolarization
Phase 4 = resting state of polarization

SA node

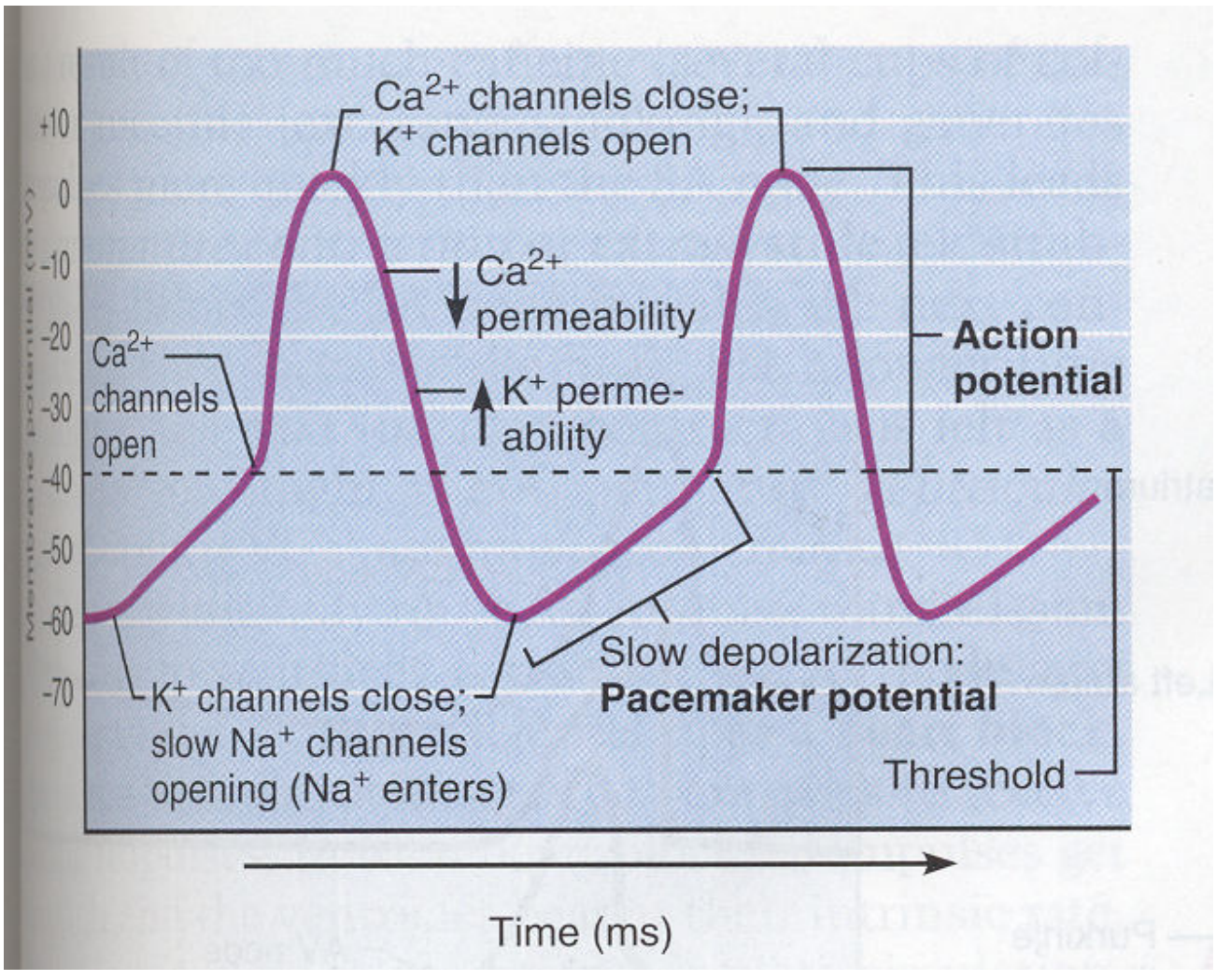


ARP = absolute refractory period
RRP = relative refractory period

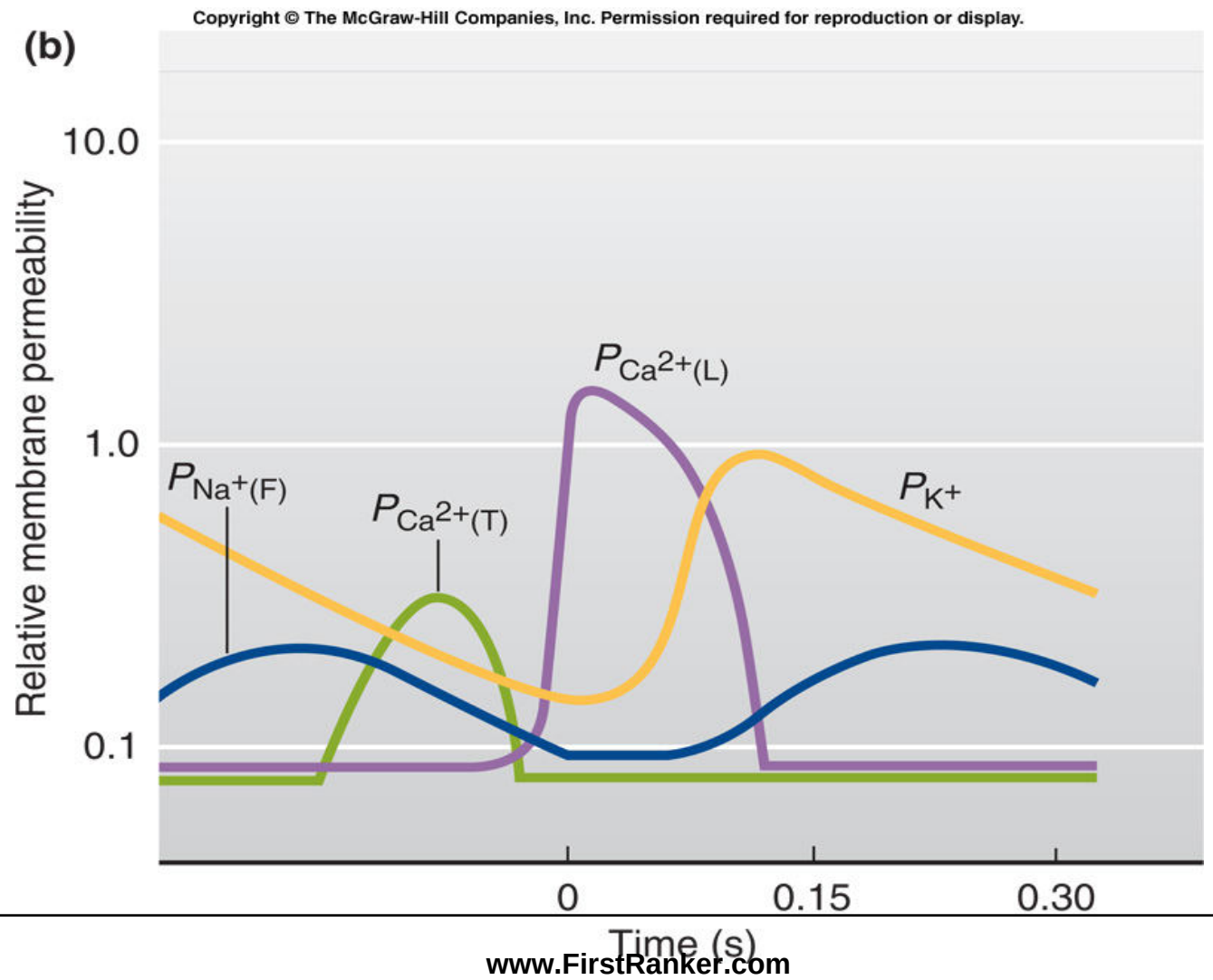
Relative Permeabilities During Action Potential



Pacemaker Potential

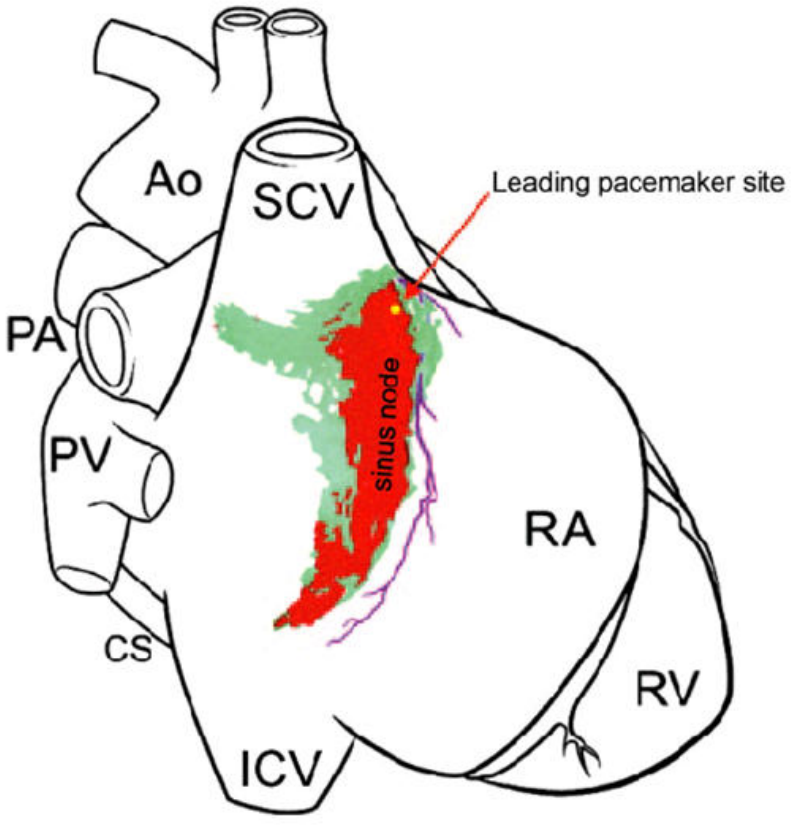


Channels responsible for pacemaker potential



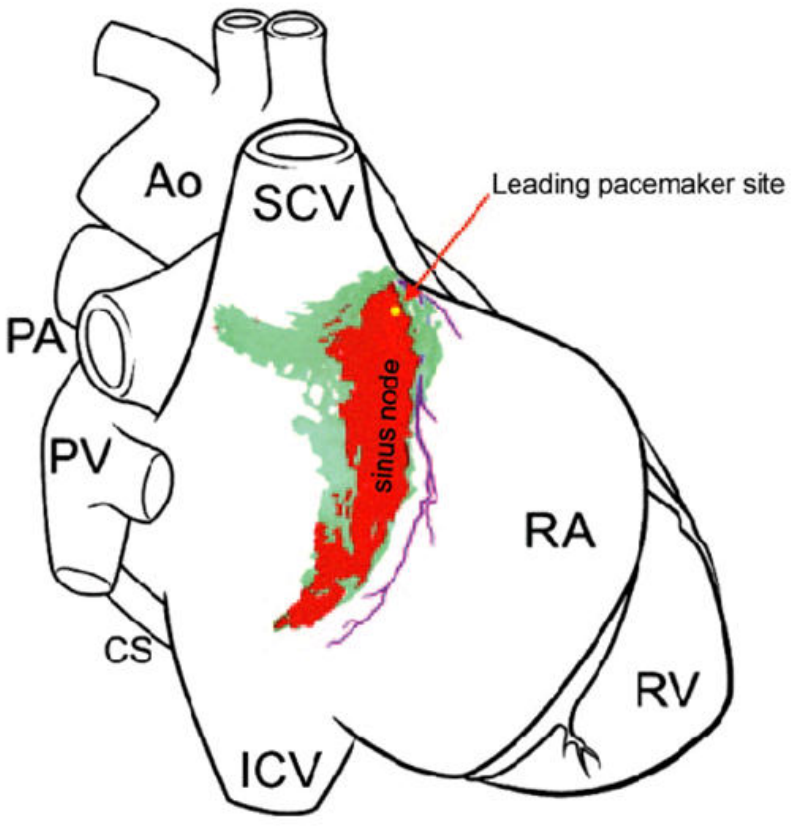
Pacemaker of the heart: SA- node

- Small, ellipsoid strip about 3mm wide, 15 mm long, and 1mm thick
- Located in the superior postero-lateral wall of the right atrium immediately below and slightly lateral to the opening of the superior venacava



Pacemaker of the heart: SA- node

- Contains the P- cells, which are actual pacemaker cells
- Unstable RMP and spontaneous depolarization
- Has the fastest rhythm: 90 impulses/min



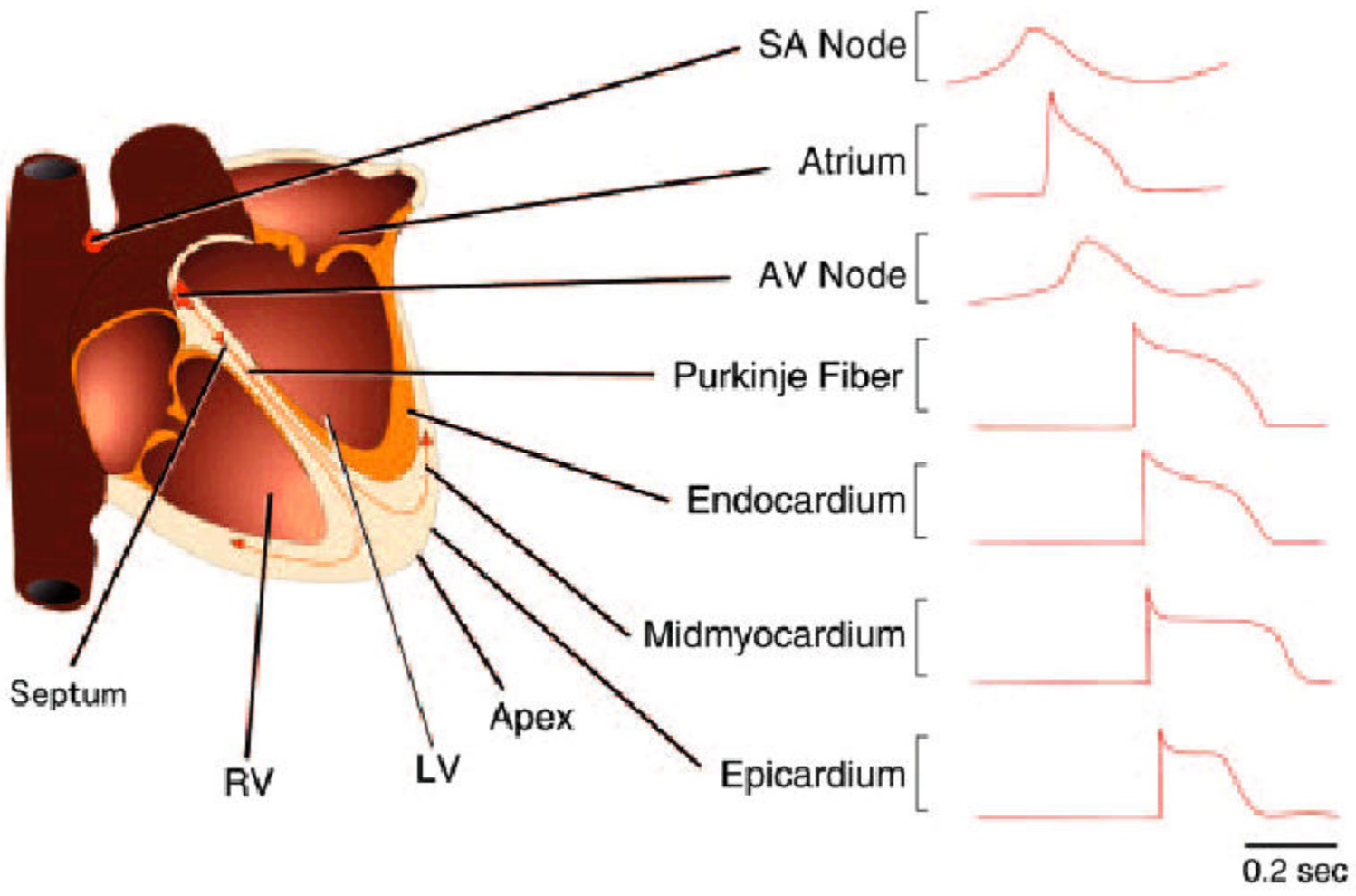
Rate of generation of AP at different sites of the heart

RATE (impulses/min)	SITE
100	SA node
40 - 60	AV node
20 - 35	AV bundle, bundle branches,& Purkinje fibres

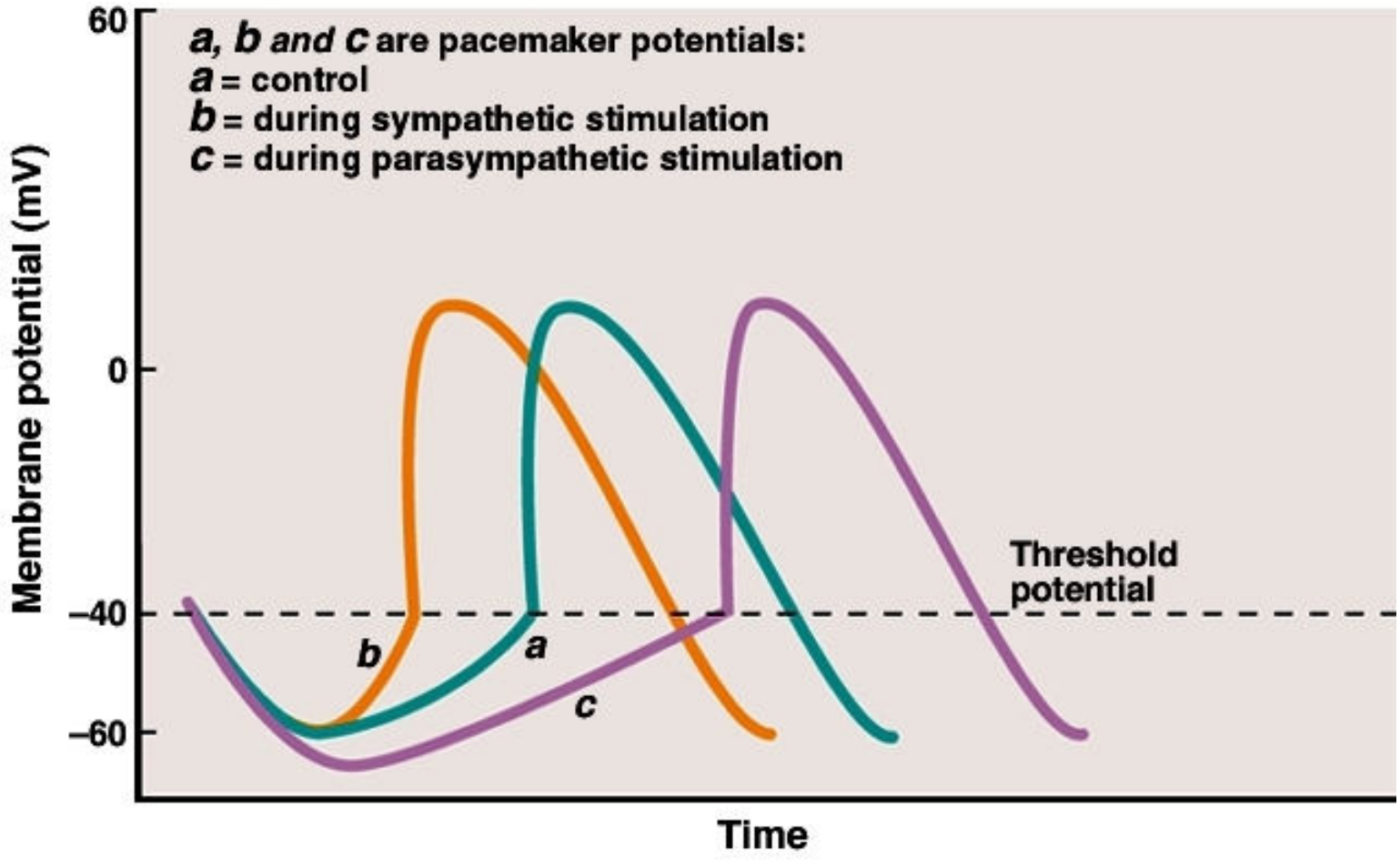
ANS and hormones modify the timing and strength of each heart beat but do not establish the fundamental rhythm

vagal tone controls SA- node to become 70 impulses/min

Action potential in different regions of the heart

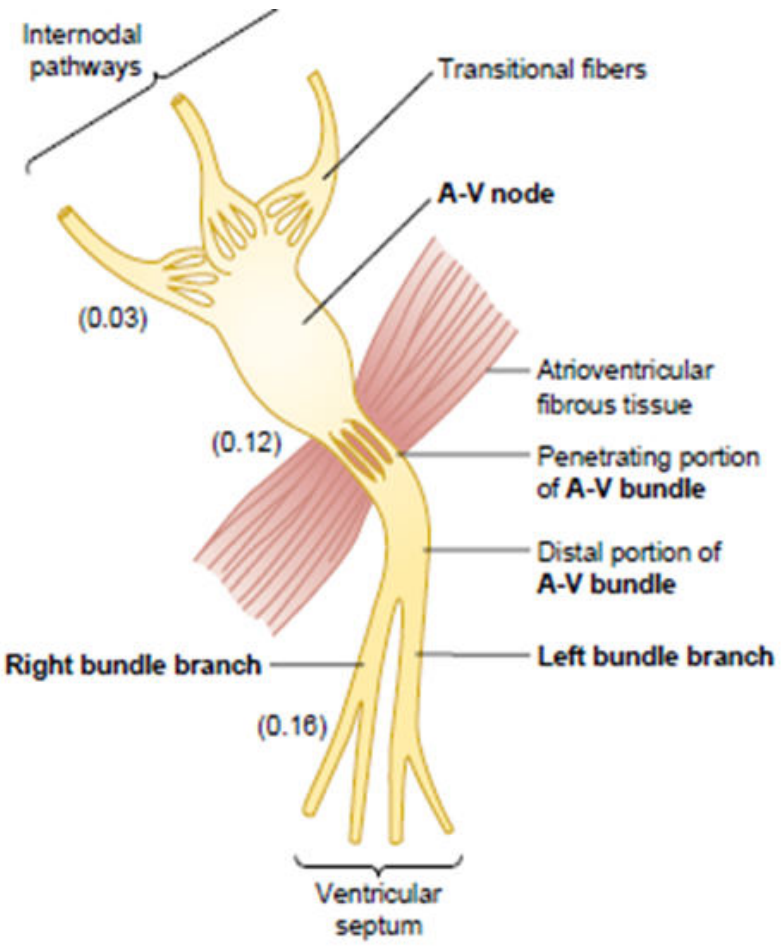


Effect of ANS



Conductivity:

- Inter-nodal Pathway
  - Anterior internodal bundle of Bachman
  - Middle internodal bundle of Wenkebach
  - Posterior internodal bundle of Thoral



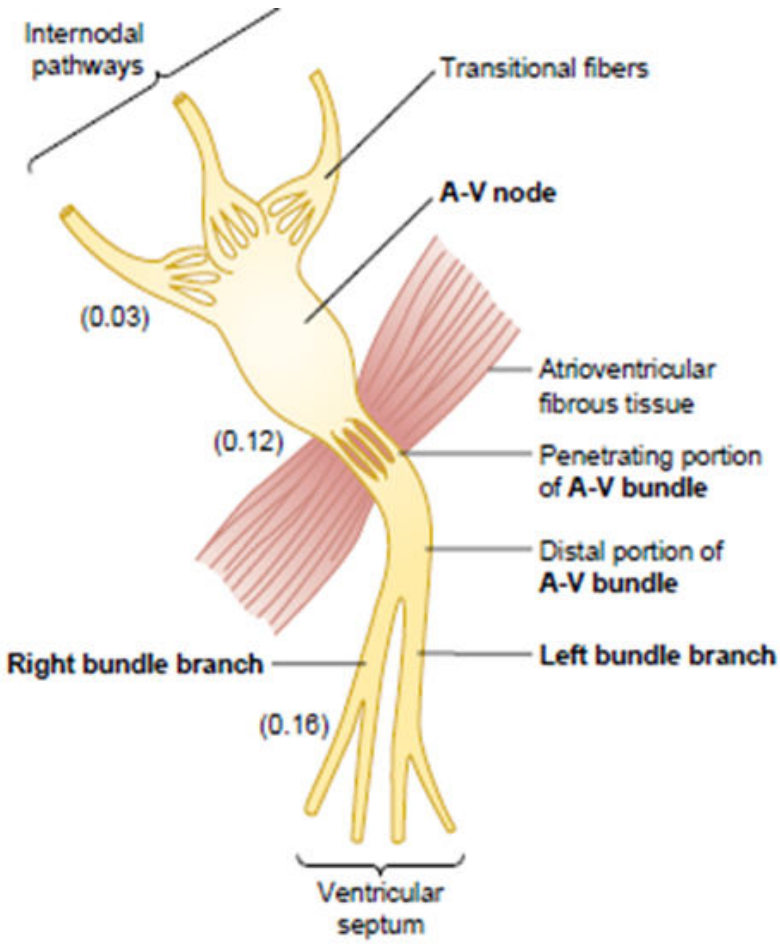
Conduction velocities in different regions of heart

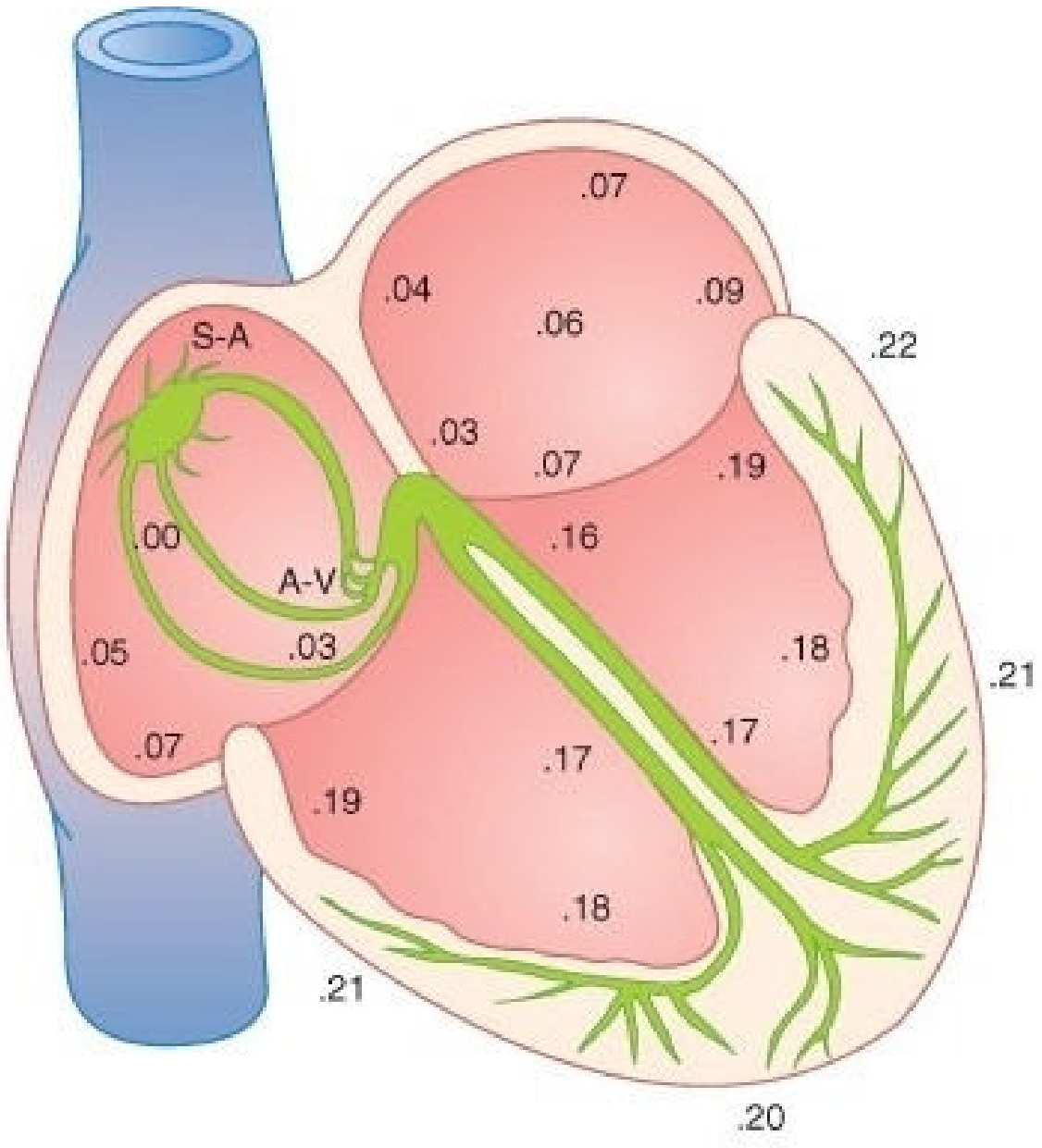
Region of heart	Speed of spread
Atria	0.5 m/sec
Inter-nodal fibers	1 m/sec
AV node	0.05 m/sec
Bundle of His	2 m/sec
Purkinje fibers	4 m/sec
Ventricles	1 m/sec

Due to differences in gap junction properties

Time of impulse arrival at different regions of the heart

Regions	Time
SA node	0.00 sec
AV node	0.03 sec
Bundle of His	0.12 sec
Ventricular septum	0.16 sec
Endocardium	0.17 - 0.19 sec
Epicardium	0.21 – 0.22 sec





Exercises

What is the normal total delay of the cardiac impulse in the A-V node and the A-V bundle system?

Conduction velocity is least in ……and maximum in …….

Channels involved in prepotential are ……

Why cardiac muscle can not be tetanized ?