Lab 5 – Electrical & Mechanical Properties of the Frog Heart

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OH: Tuesdays 11-12, Fridays 4-5
2041A SLB

Hey!

- Questions so far?
- General Lab Report Questions?

Lab 5

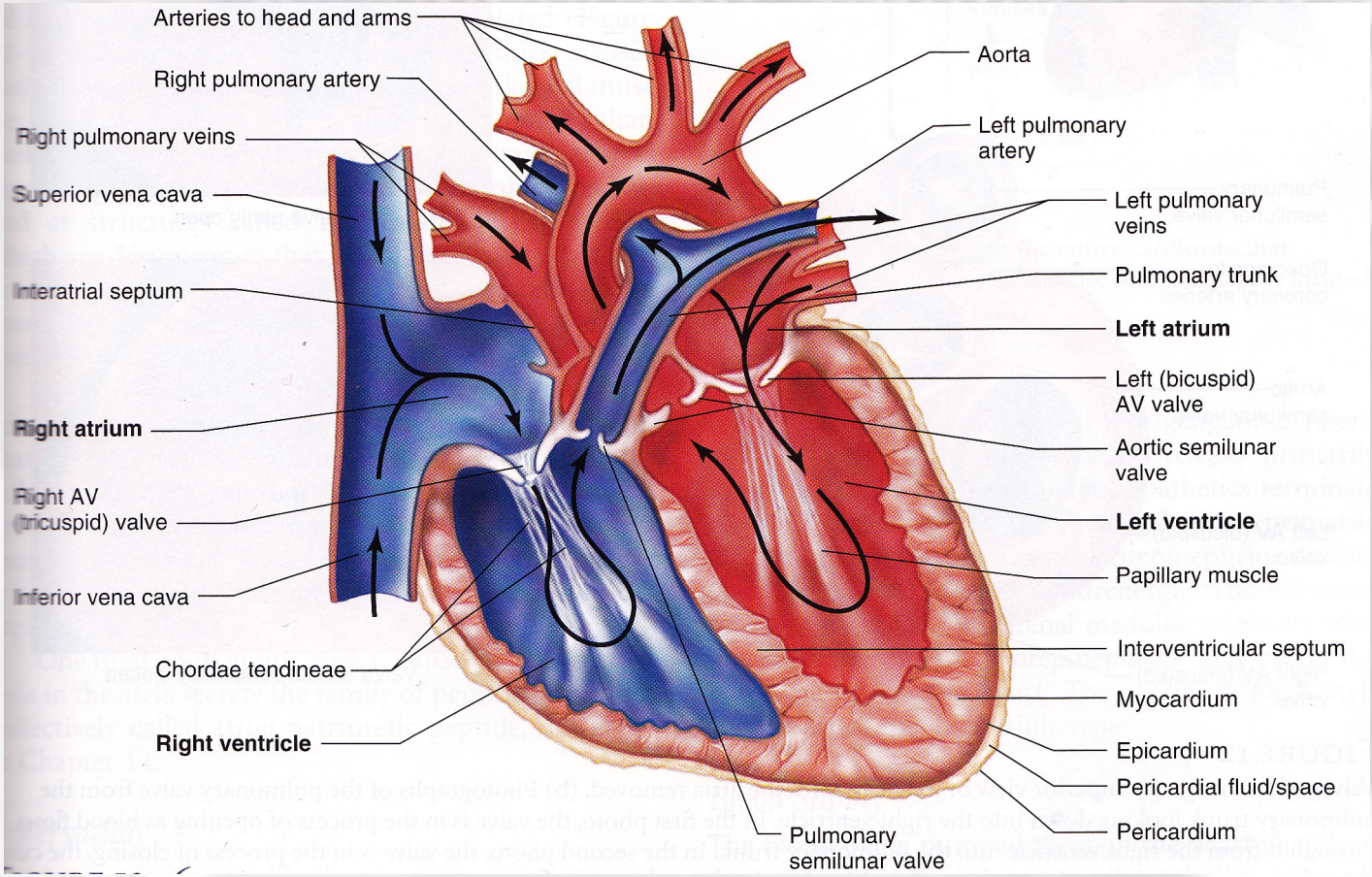
- Record the mechanical and electrical activity of the frog heart
- See if we can elicit a contraction by applying stimulation in early and late diastole.
- Stimulate the vagus nerve to induce bradycardia
- Observe vagal escape

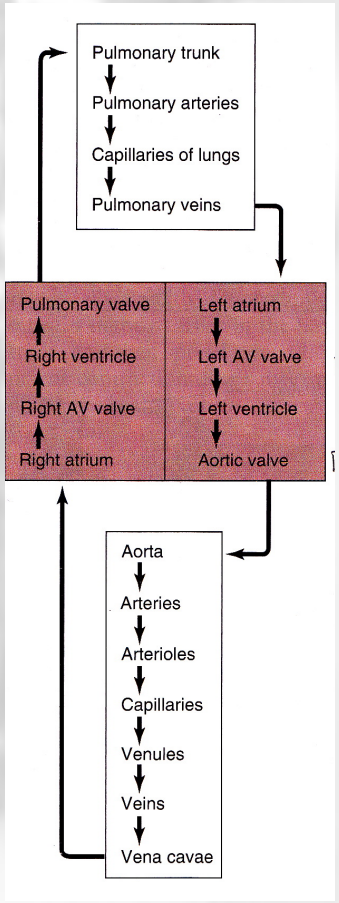
Pop Quiz! (Sort of...)

On the board, diagram the heart and draw arrows indicating the direction of blood flow.

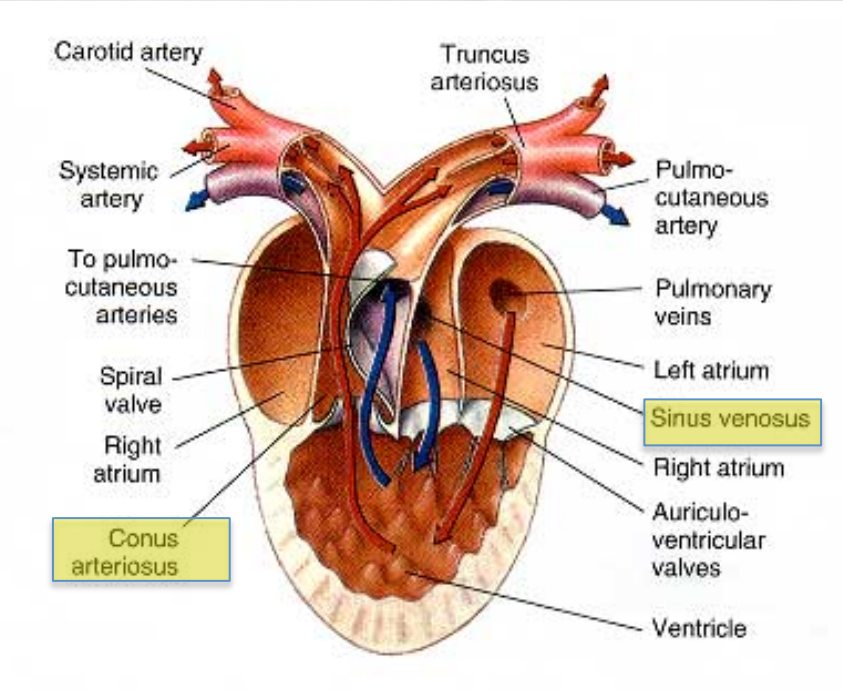
First group to finish (correctly), wins!

The Heart – **Human** Anatomy





The Heart – **Frog** Anatomy



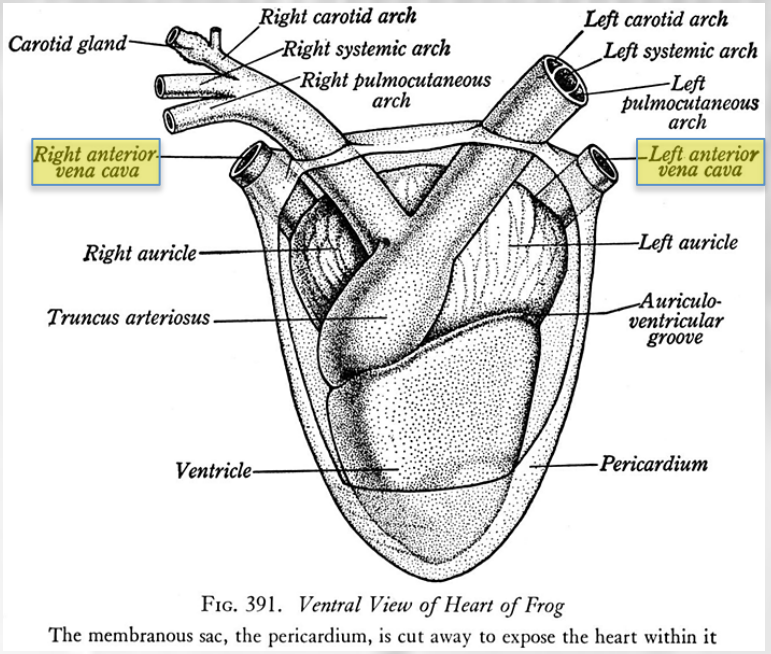
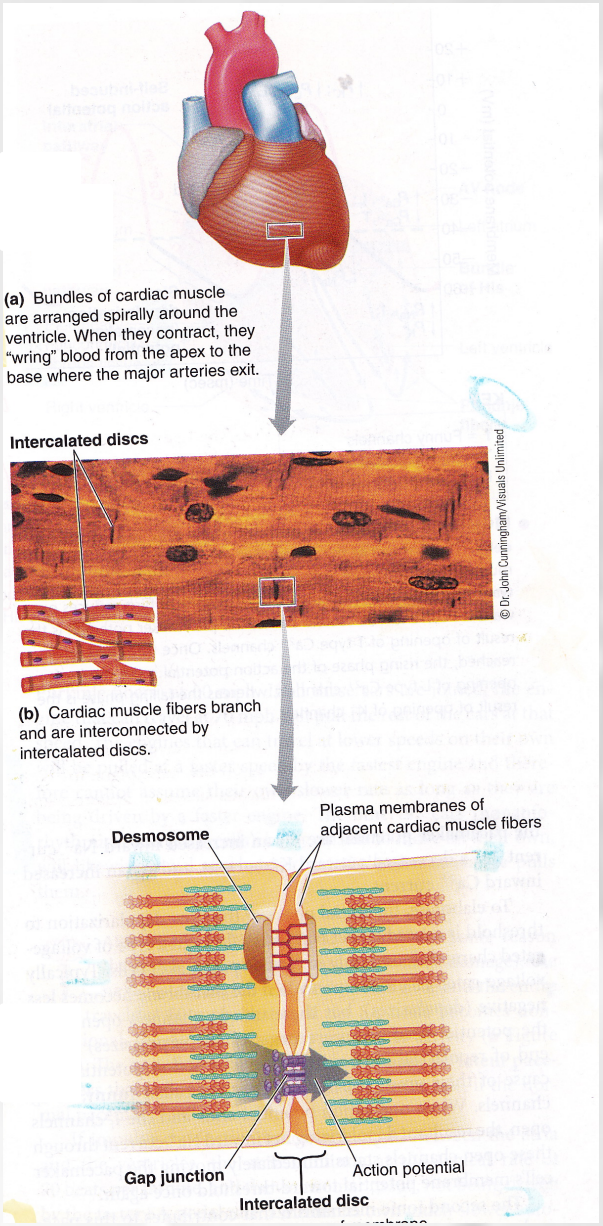


FIG. 391. *Ventral View of Heart of Frog*
The membranous sac, the pericardium, is cut away to expose the heart within it

- Two atria, one ventricle
- Systemic blood empties into the right atrium via the sinus venosus
- No SA node
  - 1° Intrinsic pacemakers are located in the sinus venosus.
- No AV node
  - 2° pacemakers are located in the trabeculae
- No bundle of His
  - Other conduction pathway
- With only one ventricle, how does the frog prevent mixing of O_2 rich and O_2 poor blood?
  - Spongy folds within the ventricular wall (trabeculae) prevents mixing of O_2 rich and O_2 poor blood
  - Spiral valve within conus arteriosus (i.e. aorta) helps direct blood leaving the ventricle

The Heart– Anatomy

The Cardiac Myocyte



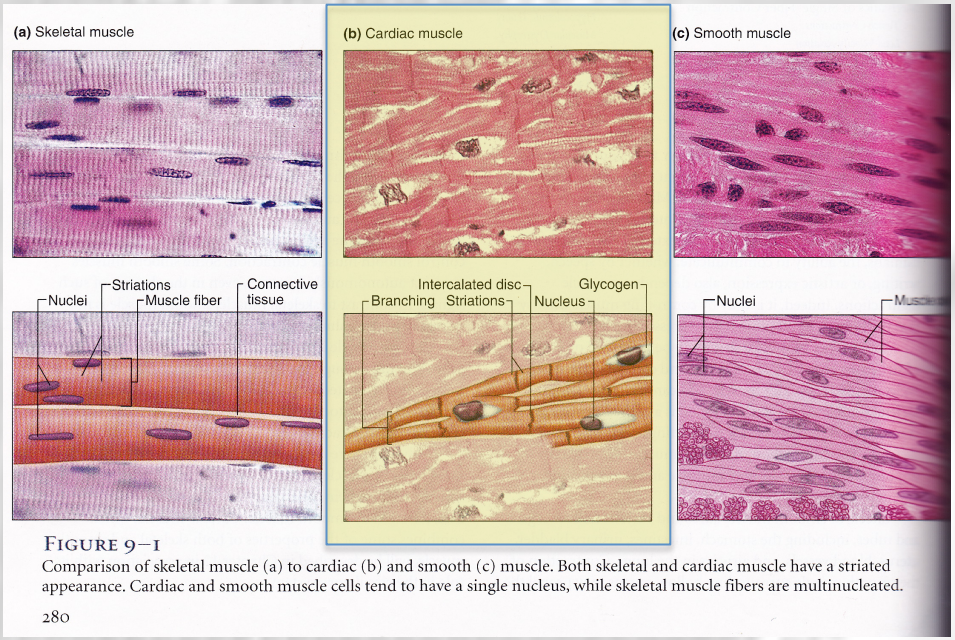


FIGURE 9–1
Comparison of skeletal muscle (a) to cardiac (b) and smooth (c) muscle. Both skeletal and cardiac muscle have a striated appearance. Cardiac and smooth muscle cells tend to have a single nucleus, while skeletal muscle fibers are multinucleated.

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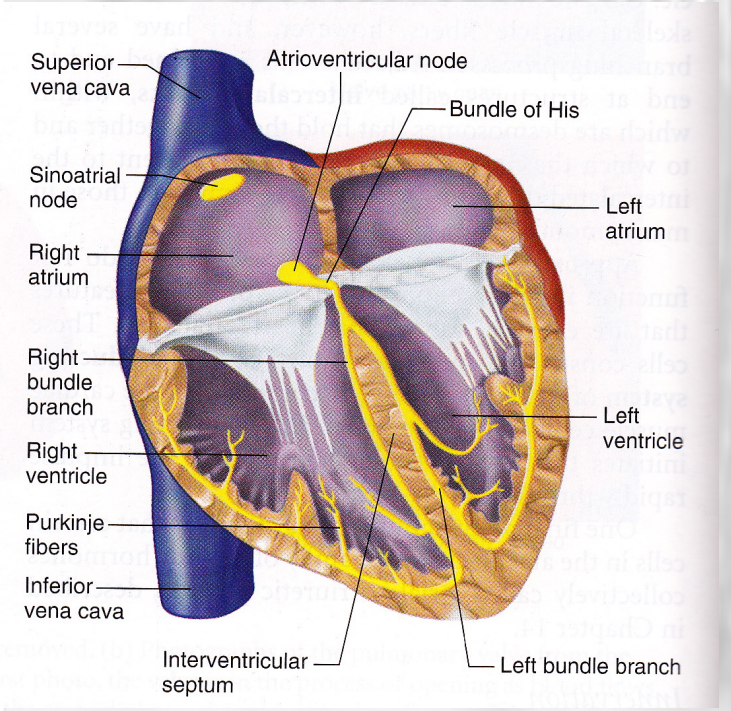
- Skeletal Muscle
  - Striated
  - Multinucleated
- Smooth Muscle
  - Non-striated
  - Single Nuclei
- Cardiac Muscle (some of each!)
  - Striated
  - Single Nuclei

The Heart – Electrical Activity

Sequence of Excitation



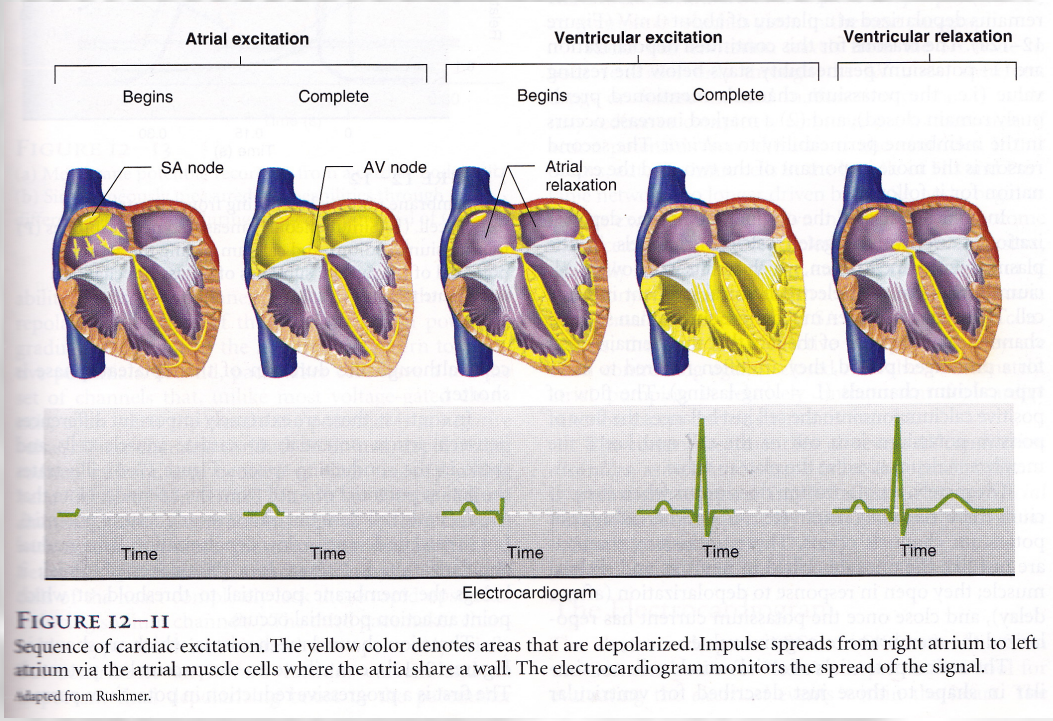
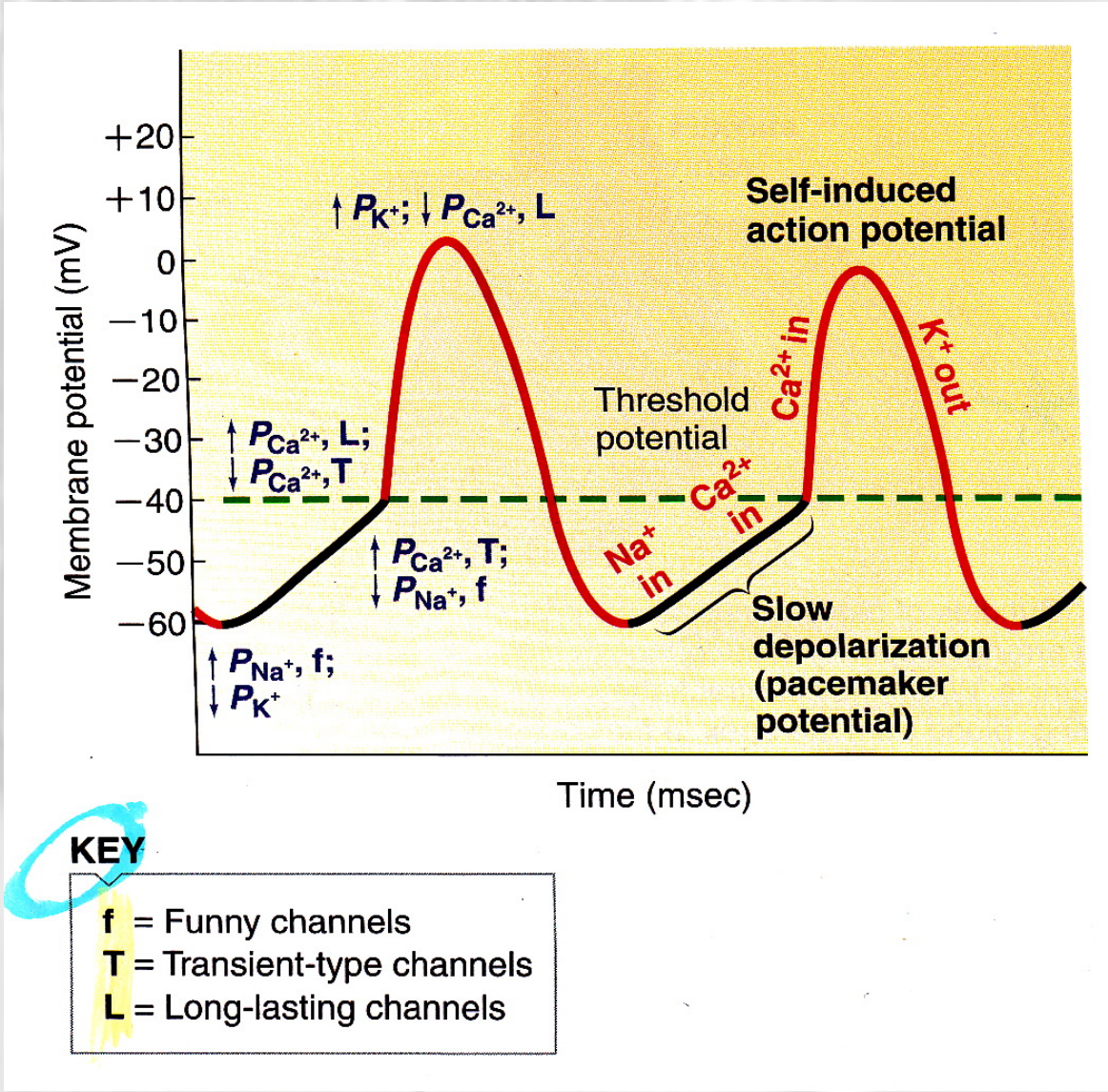


FIGURE 12–11
Sequence of cardiac excitation. The yellow color denotes areas that are depolarized. Impulse spreads from right atrium to left atrium via the atrial muscle cells where the atria share a wall. The electrocardiogram monitors the spread of the signal.
Adapted from Rushmer.

The Heart – Electrical Activity

Pacemaker Potential in SA Node

- Na^+ Funny Channels (I_f)
  - Open at ***negative*** voltages (compared to opening at positive voltages in neurons and other muscle cells)



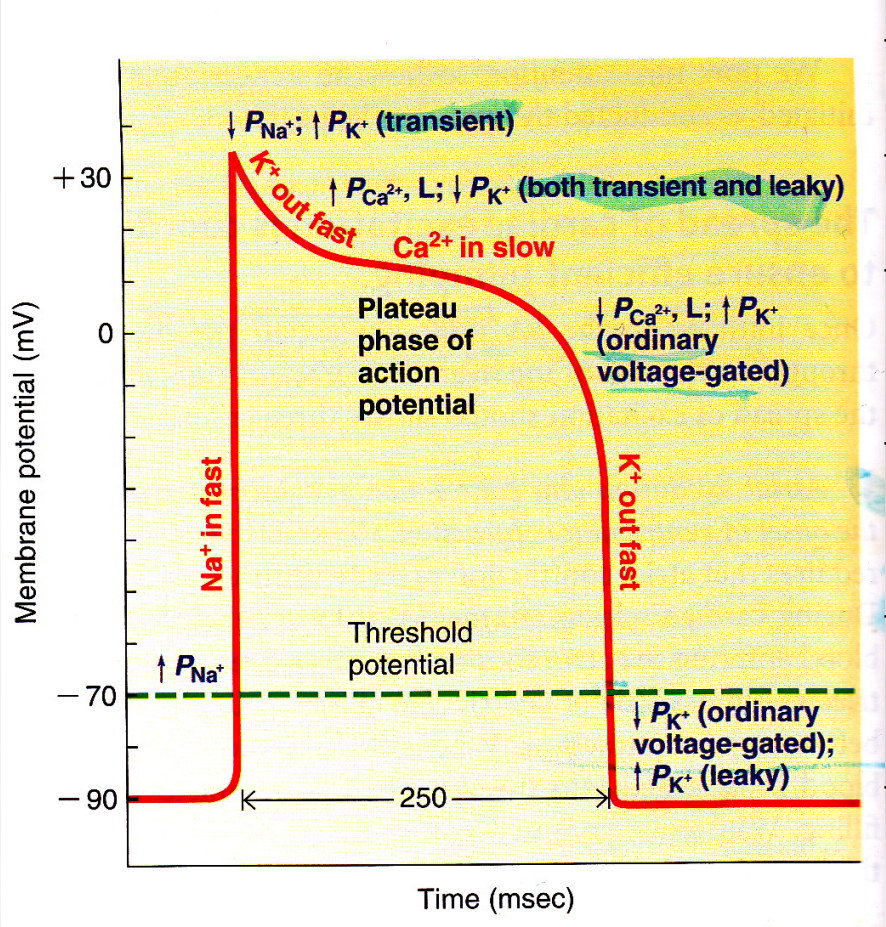
Pop Quiz 2!

Diagram the action potential of a ventricular myocyte. Ignore the detailed channels, only include the direction of ion flow (i.e. K^+ in/out and slow/fast)

First group finished (correctly), wins!

The Heart – Electrical Activity

Ventricular Excitation

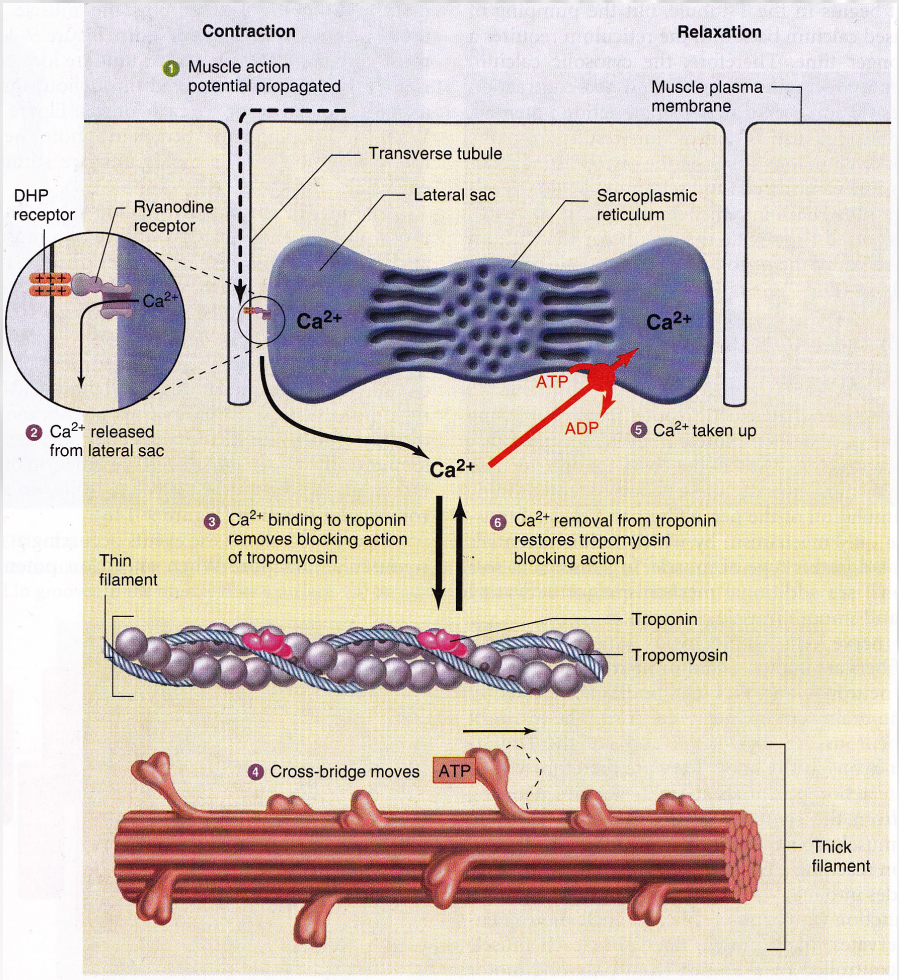


- Resting Potential = -90mv
  - Due to very leaky K^+ channels
- Rising Phase:
  - Na^+ in fast via voltage gated channels
- @ Peak Potential:
  - Na^+ channels close
  - Transient K^+ channels open
- Plateau Phase:
  - Transient and leaky K^+ channels close
  - Slow Ca^{2+} channels open
- Repolarization Phase:
  - Ca^{2+} channels close
  - Ordinary K^+ channels open
- Back @ Resting Potential:
  - Ordinary K^+ channel close
  - Leaky K^+ channels open again

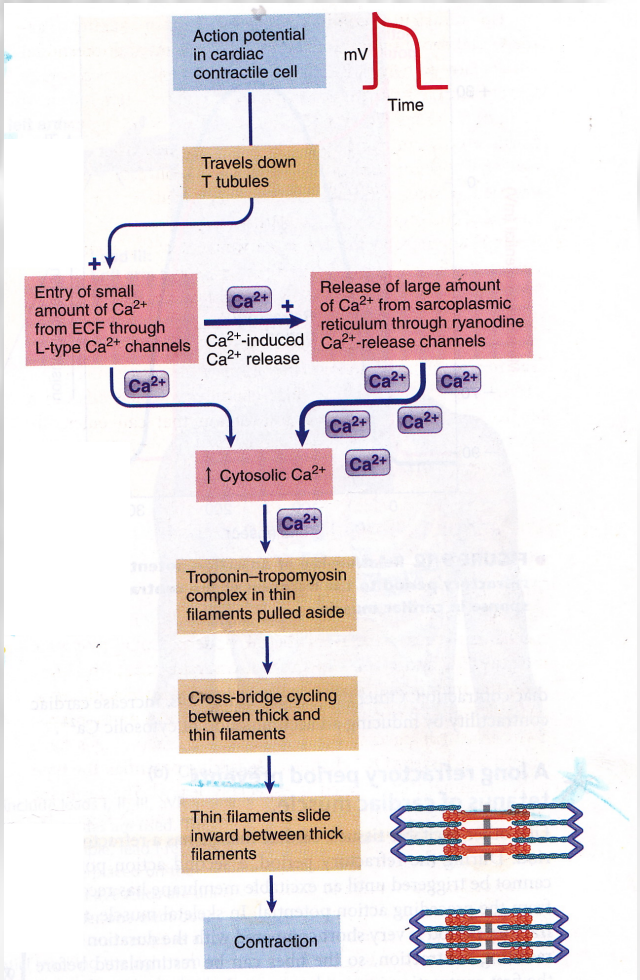
The Heart – Electrical Activity

EC Coupling

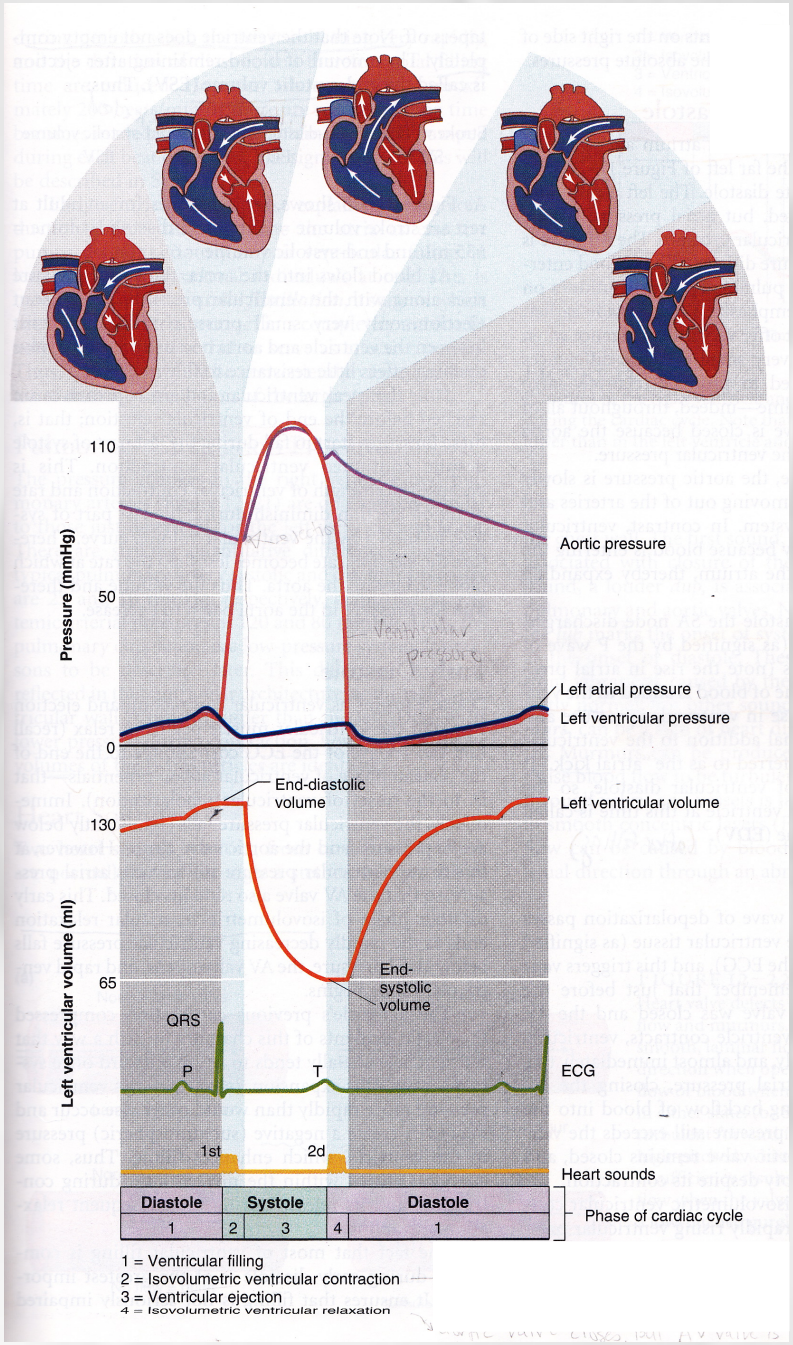
Skeletal Muscle



Cardiac Muscle

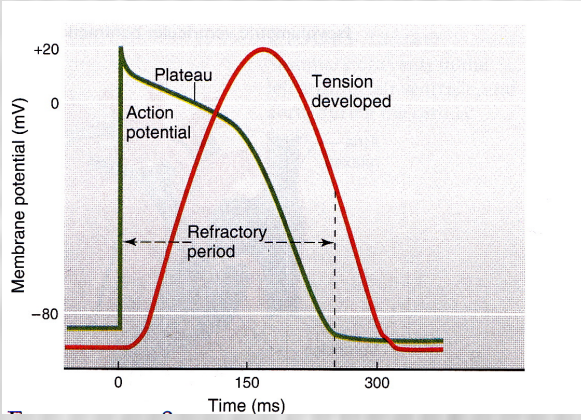


The Heart – Mechanical Activity



The Heart – Electrical & Mechanical Activity

Refractory Period



What would happen if you tried to elicit a contraction at 150 ms?

No contraction!

What would happen if you stimulated the heart at 300 ms?

Contraction!