Bioengineering 3202 Notes
Lecture #8, March 29, 2006
Tina Jovic and Rob MacLeod

Whole Heart Contraction

- Apex rises relative to base (Apex: bottom of heart)
- Atria first, then ventricles
- Twisting motion → ventricles rotate or twist
- Some side to side narrowing

Metrics

- Ejection fraction (percentage of blood that leaves heart at end of diastolic volume) = **(stroke volume)/(end diastolic volume)**
  - Normal range: 56-68% at rest
  - Change in stroke volume during exercise about 8%
  - Cardiac Output (stroke volume / heart rate):
    - Normal: 5liters/min
    - Exercise : 35liters/min

Weighted mean normal values for LVEF at rest were 62.3 +/- 6.1% (ISD) with a lower limit of normal of 50% and for RVEF 52.3 +/- 6.2% (N = 365) with a lower limit of normal of 40%. During exercise, LVEF increased in 475 subjects by +8.0 EF% (range 3-15%), a normal increase being accepted to be greater than or equal to 5% over a normal resting value for both LVEF and RVEF.

Source for this was
1: *Eur Heart J. 1985 Aug;6(8):647-55.*

Contraction happens along long axis
Fibers at the end are in constant direction
Fibers in the middle have different orientation

Atria are very thin

- Have very little coordinated structure
- More random fiber structure

Conduction System

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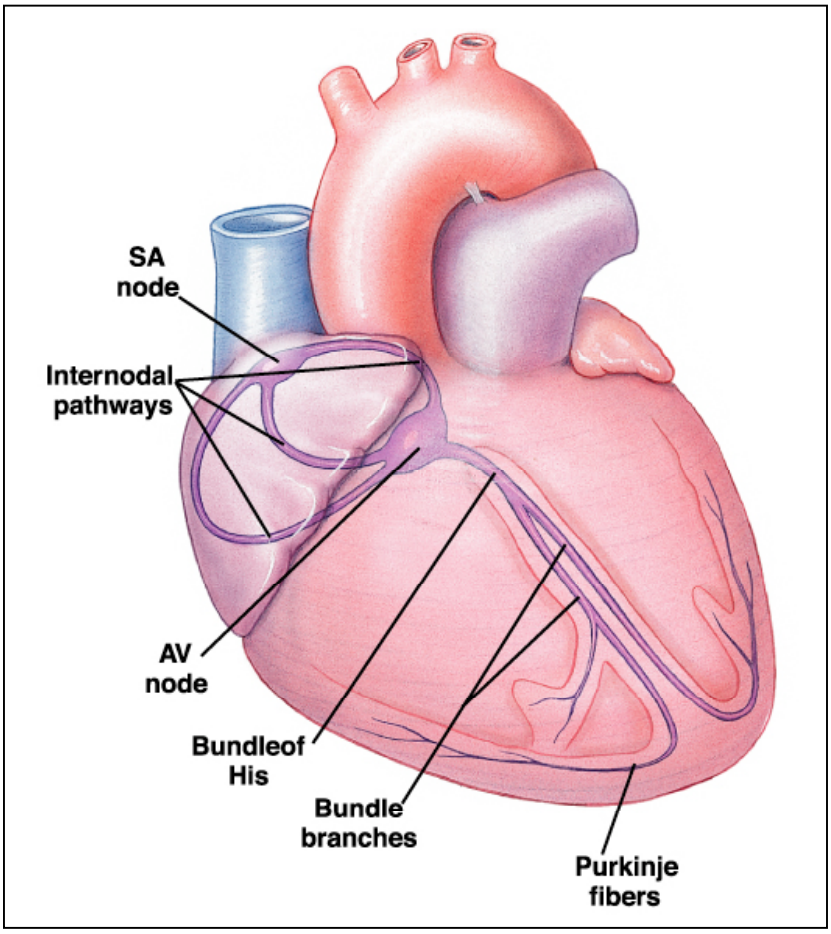
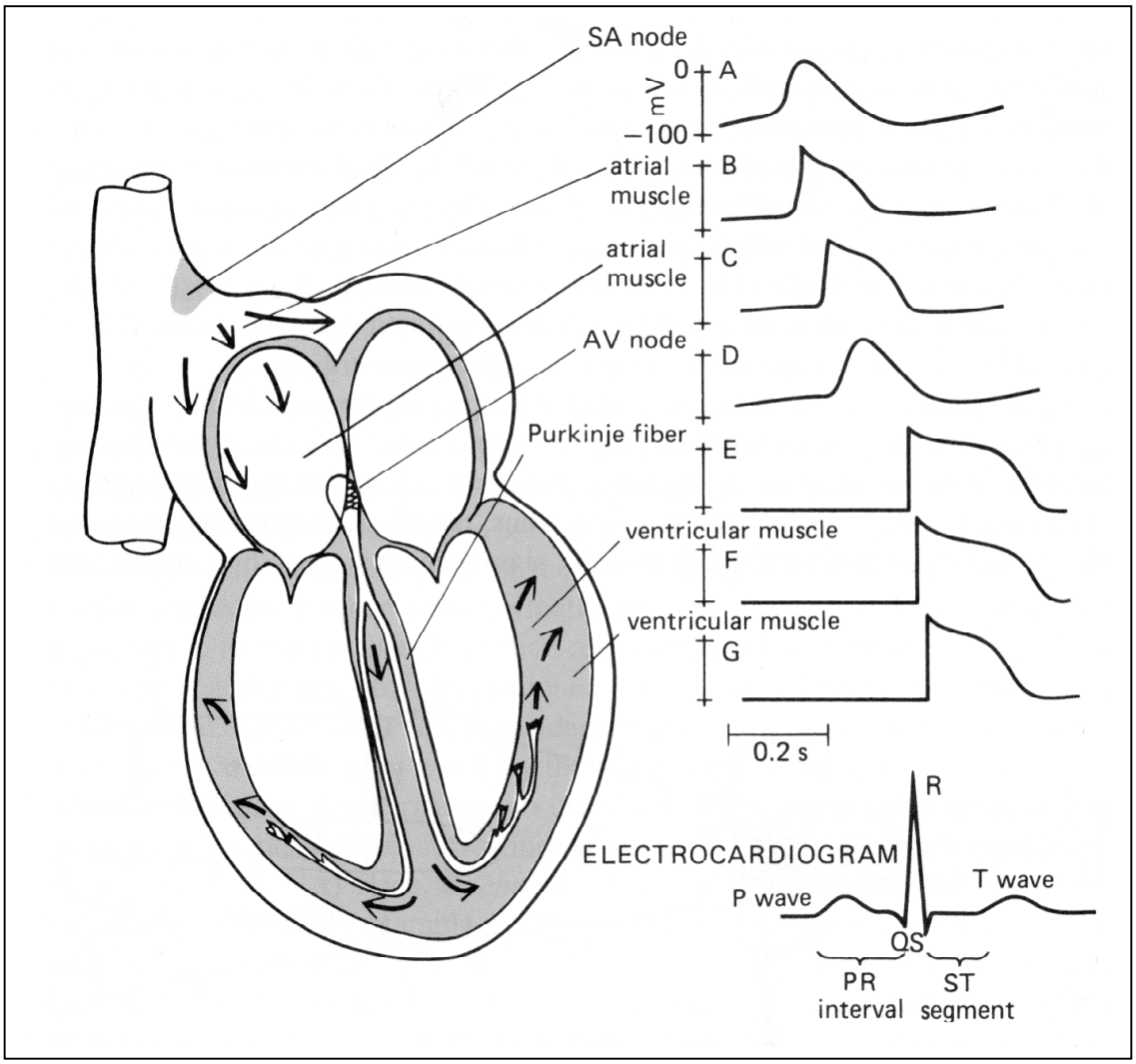
- Bundles conduct through atria: speeds the excitation through the atria
  - Accelerate spread
  - More rapid conduction → contraction



1.) SA Node
   a. Pacemaker
2.) AV Node
   a. Slow conduction, slow propagation
   b. Small cells → higher resistance
   c. Slow dV/dt (Ca2+ current, no Na+)
      i. Propagation Velocity is proportional to ((DdV/dt)/R)^(1/2)
3.) HIS bundle
   a. AV Node picks up signal, delays it, and splits it into two
4.) Right and Left Bundle
5.) Purkinje fibers
   a. Large cells
   b. No T-tubules
   c. No contraction

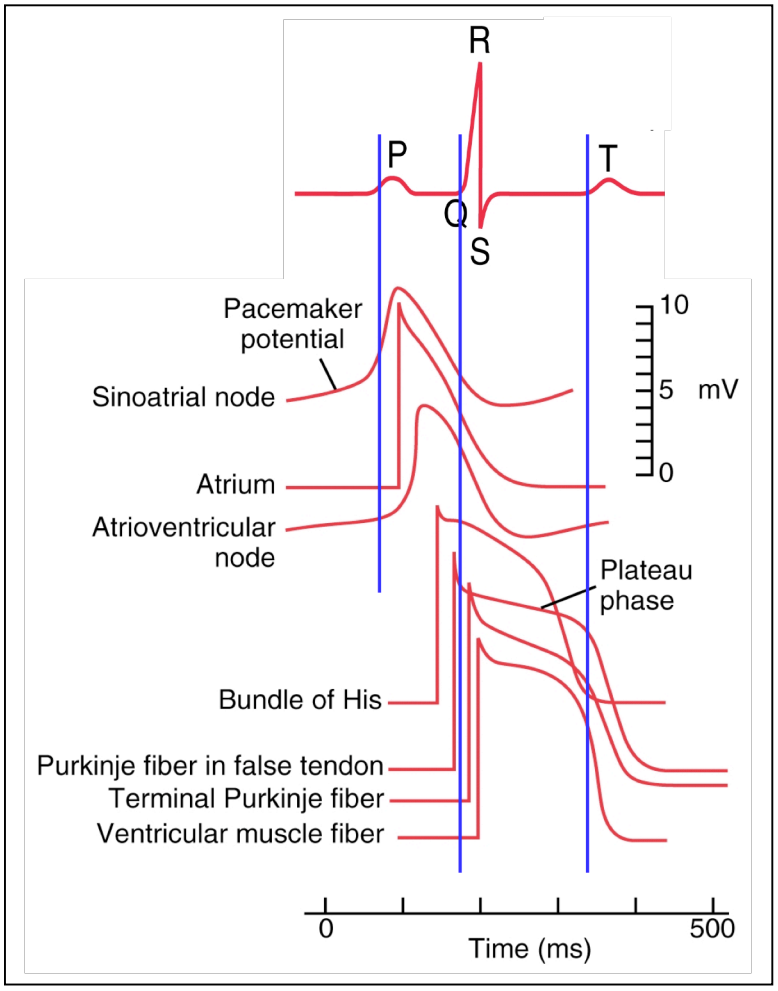
- 3,4,5) Fibers for speed → rapid conduction, high dV/dt, five to ten times faster than ventricular cells
- Excitation start rapidly in the ceptum (due to right and left bundles) → spreads rapidly to apex → then it moves slower outwards
- The whole ceptum forms rigid/stiff support for contractions
    - It isolates the two ventricles so that each can sustain its pressure

The figure below shows the conduction system again with the associated action potentials for each of the specialized conduction system elements.



ECG (EKG)

- Electrocardiogram
  1.) Bioelectric Source
    - Current flowing between cells and then it takes the extracellular path to close the current loop
    - Potential difference within the heart
    - Examples: At resting AP, ECG is equal to zero; at plateau level, ECG is equal to zero



The figure above shows the action potentials from the different parts of the conduction system and the ECG. The figure shows the correspondence between the P wave, QRS complex, and T wave with associated activity at the cellular/tissue level