



# ADVANCED ASSESSMENT Cardiovascular System

# ADVANCED ASSESSMENT Cardiovascular System

## **AUTHORS**

### **Mike Muir AEMCA, ACP, BHSc**

Paramedic Program Manager  
Grey-Bruce-Huron Paramedic Base Hospital  
Grey Bruce Health Services, Owen Sound

### **Kevin McNab AEMCA, ACP**

Quality Assurance Manager  
Huron County EMS

## **REVIEWERS/CONTRIBUTORS**

### **Rob Theriault EMCA, RCT(Adv.), CCP(F)**

Peel Region Base Hospital

### **Donna L. Smith AEMCA, ACP**

Hamilton Base Hospital

### **Tim Dodd, AEMCA, ACP**

Hamilton Base Hospital

## **References – Emergency Medicine**

# Cardiovascular System

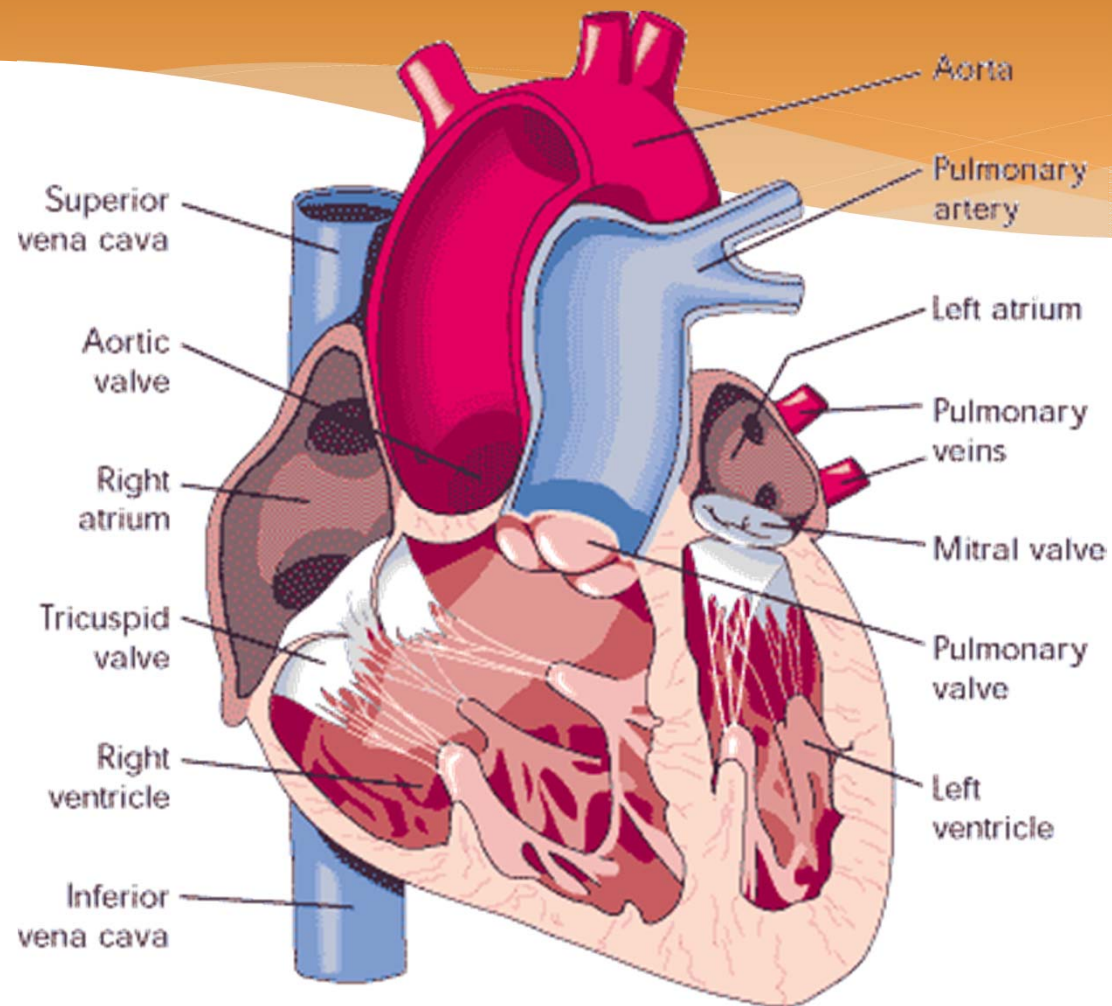
## CONSISTS OF:

- ◆ Heart (pump)
- ◆ Arteries and veins (container)
- ◆ Capillaries (site nutrient, gas exchange)

# Functions

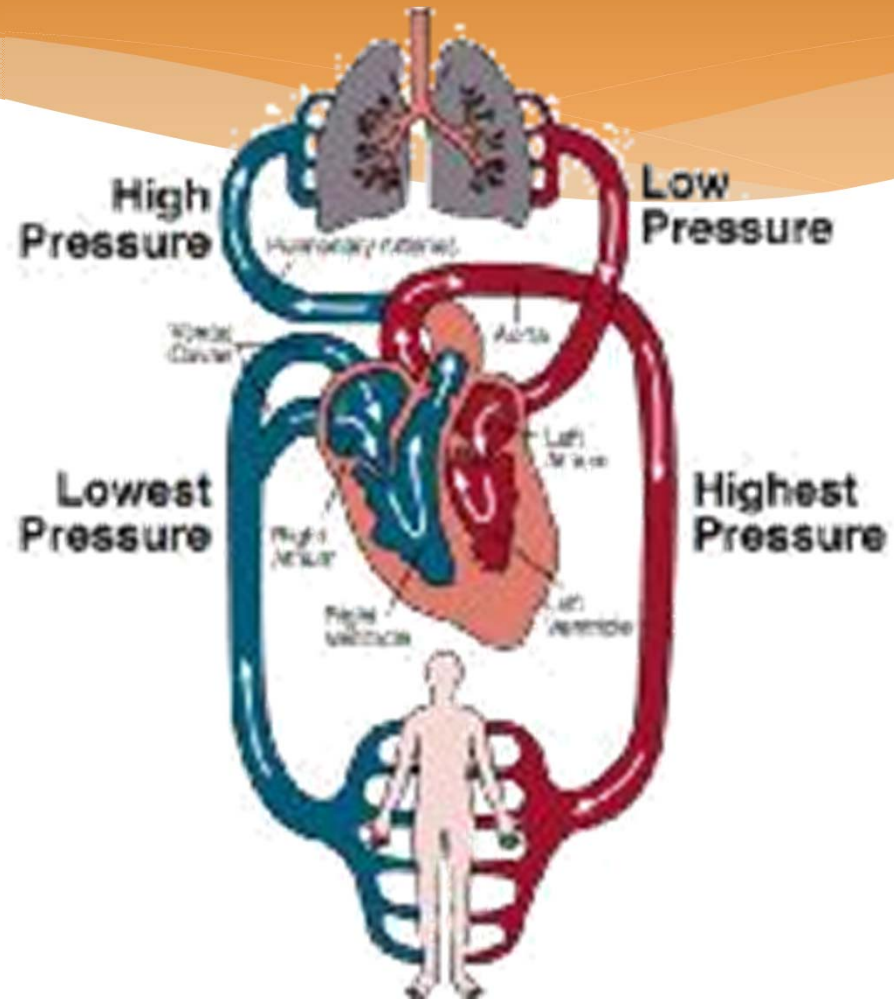
- ◆ Transportation of oxygen and other nutrients to the cells
- ◆ Removal of carbon dioxide and wastes
- ◆ Distributes hormones
- ◆ Control heat transfer

# Heart Anatomy

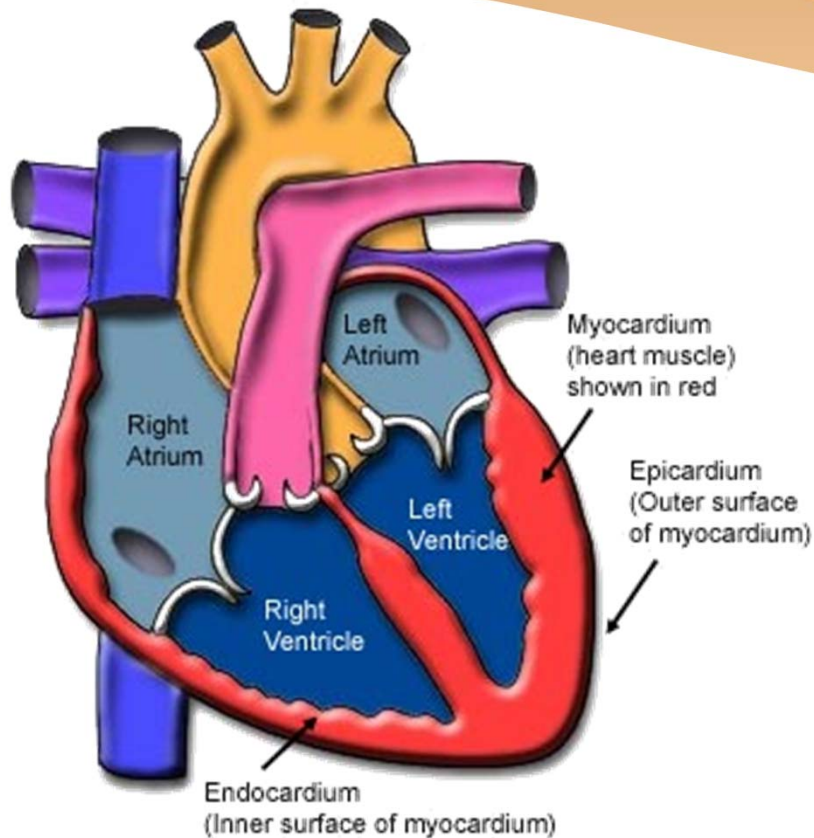


# Heart Anatomy

- ◆ Left Ventricle
  - ◆ High Pressure
  - ◆ More Muscle
  - ◆ Systemic
- ◆ Right Ventricle
  - ◆ Low Pressure
  - ◆ Less Muscle
  - ◆ Pulmonary



# Heart Anatomy



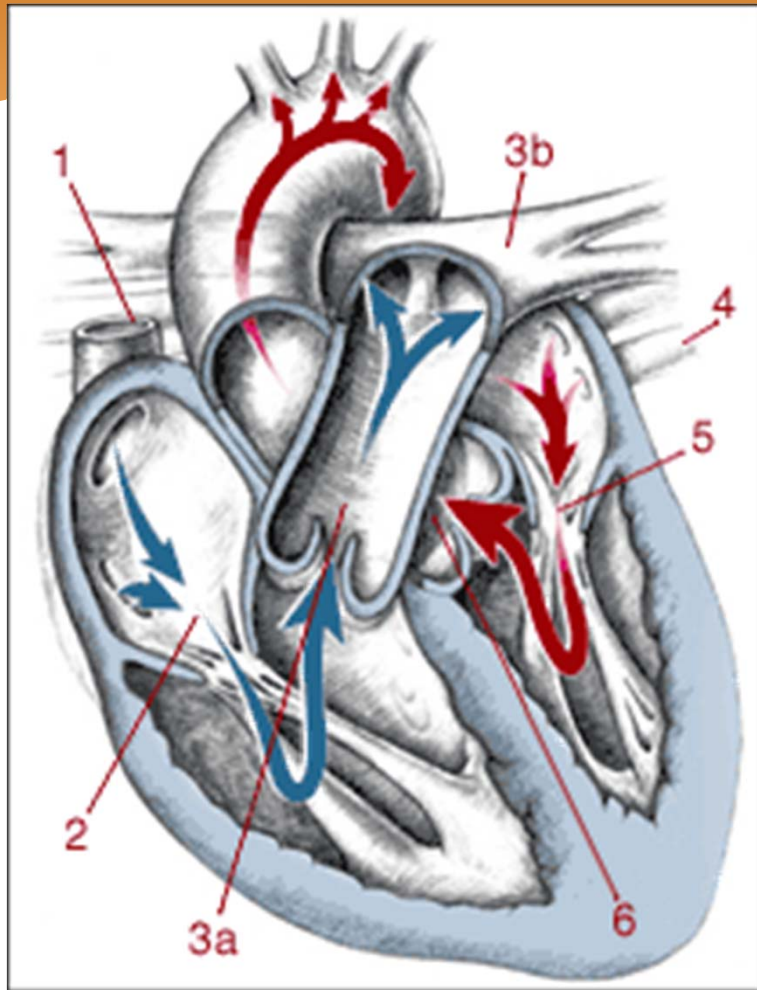
- ◆ Three Layers
  - ◆ Endocardium
  - ◆ Myocardium
  - ◆ Epicardium

# Heart Physiology

- ◆ Automaticity
  - ◆ All myocardial cells can generate an electrical impulse
- ◆ Conductivity
  - ◆ Intercalated discs
- ◆ Contractility
  - ◆ Functional syncytium



# Blood Flow

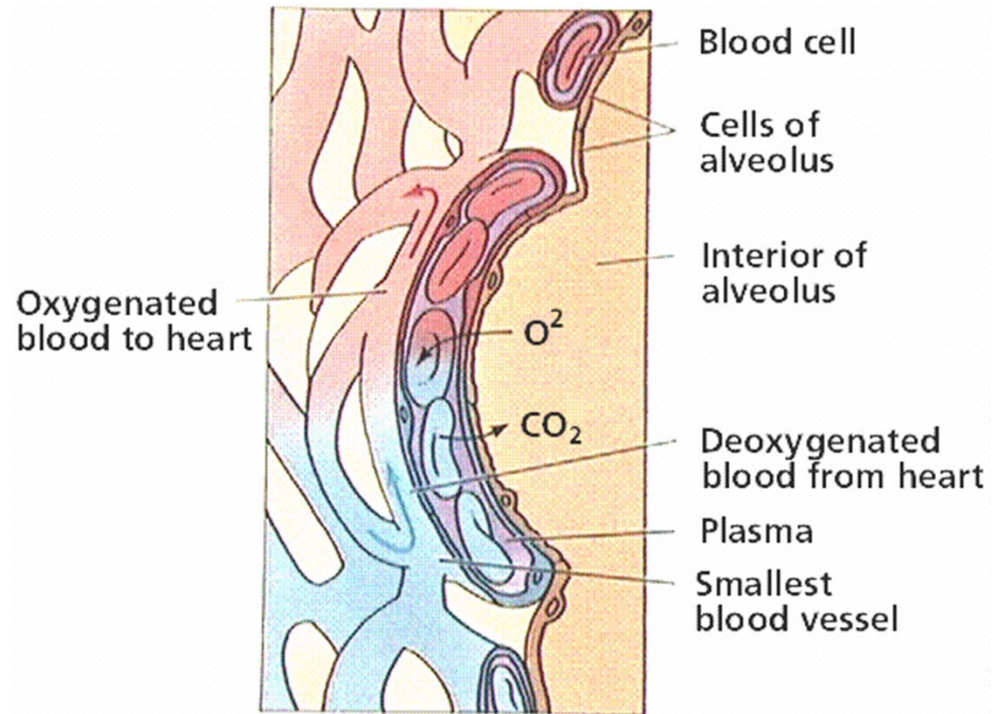
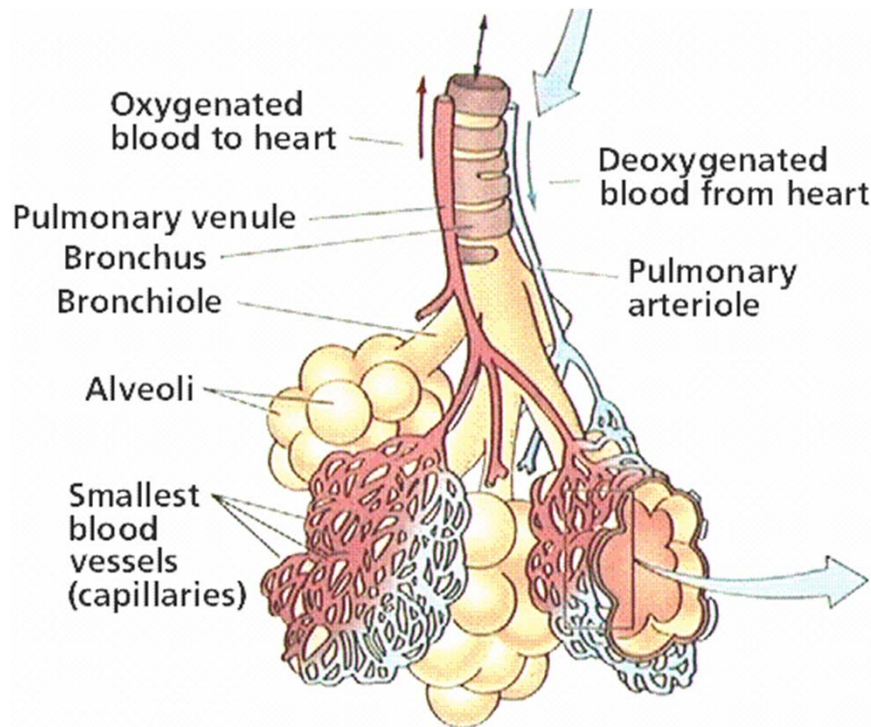


BLOOD FLOW THROUGH THE HEART

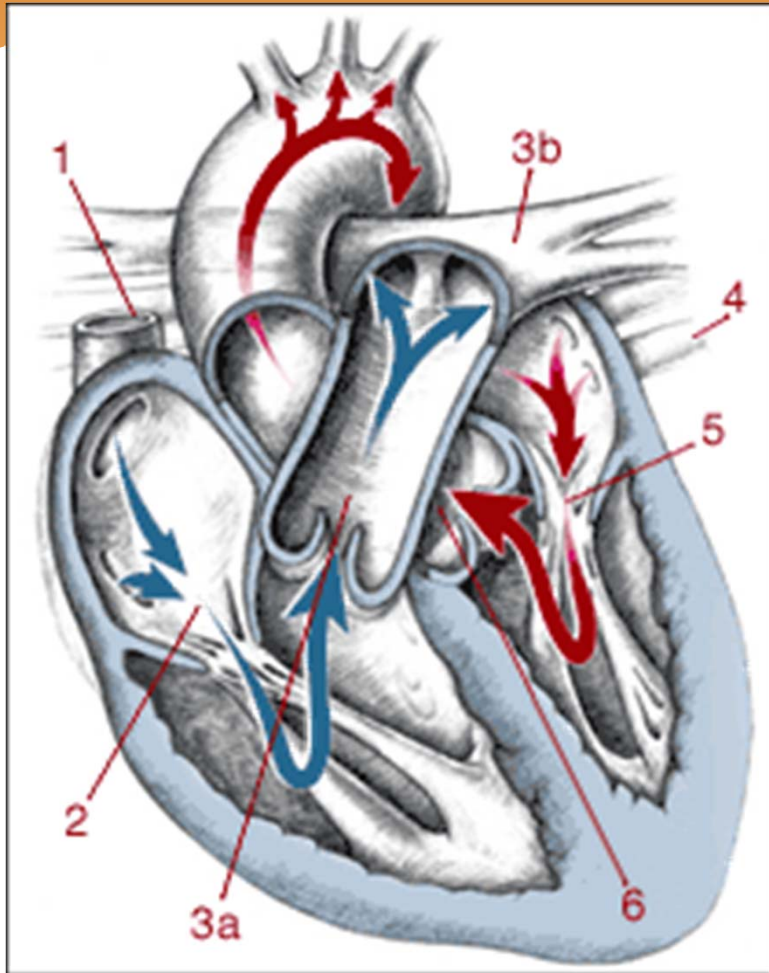
1. Right atria via vena cava
2. Tricuspid valve into right ventricle
3. a) Pulmonic valve to pulmonary artery
4. b) Right and left pulmonary arteries

# Blood Flow

## 4. Pulmonary arterioles to capillaries = gas exchange



# Blood Flow



BLOOD FLOW THROUGH THE HEART

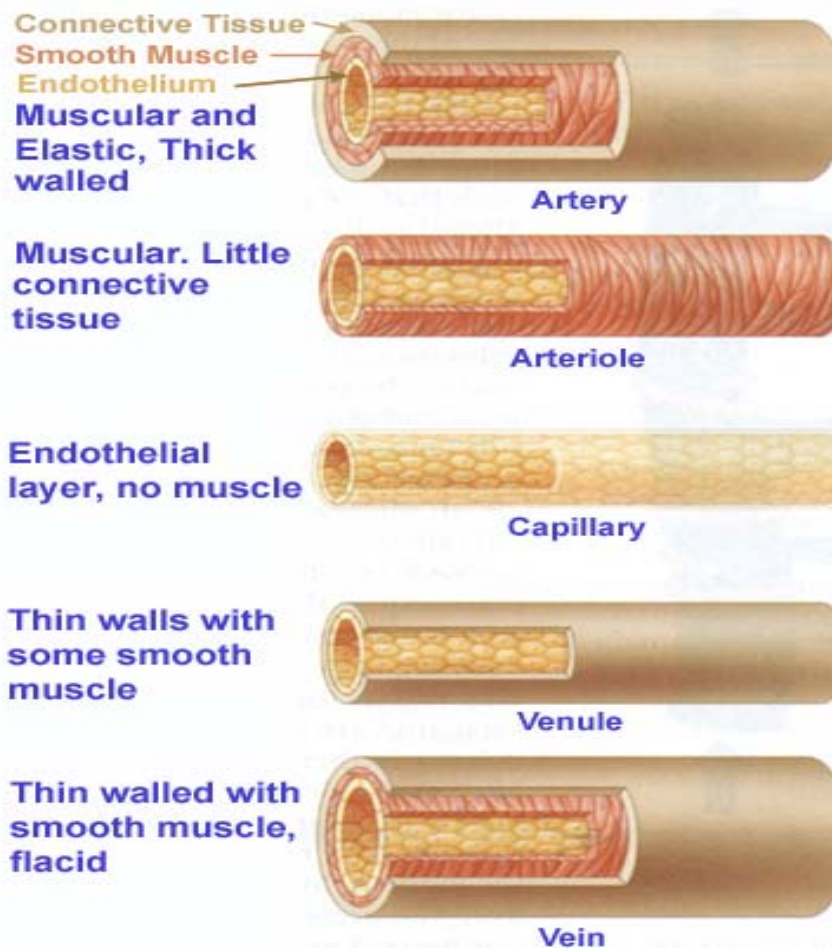
4. Left atrium via pulmonary veins
5. Mitral valve to left ventricle
6. Aortic valve to aorta



# Arteries & Veins

- ◆ Arteries
- ◆ Arterioles
- ◆ Capillaries
- ◆ Venules
- ◆ Veins

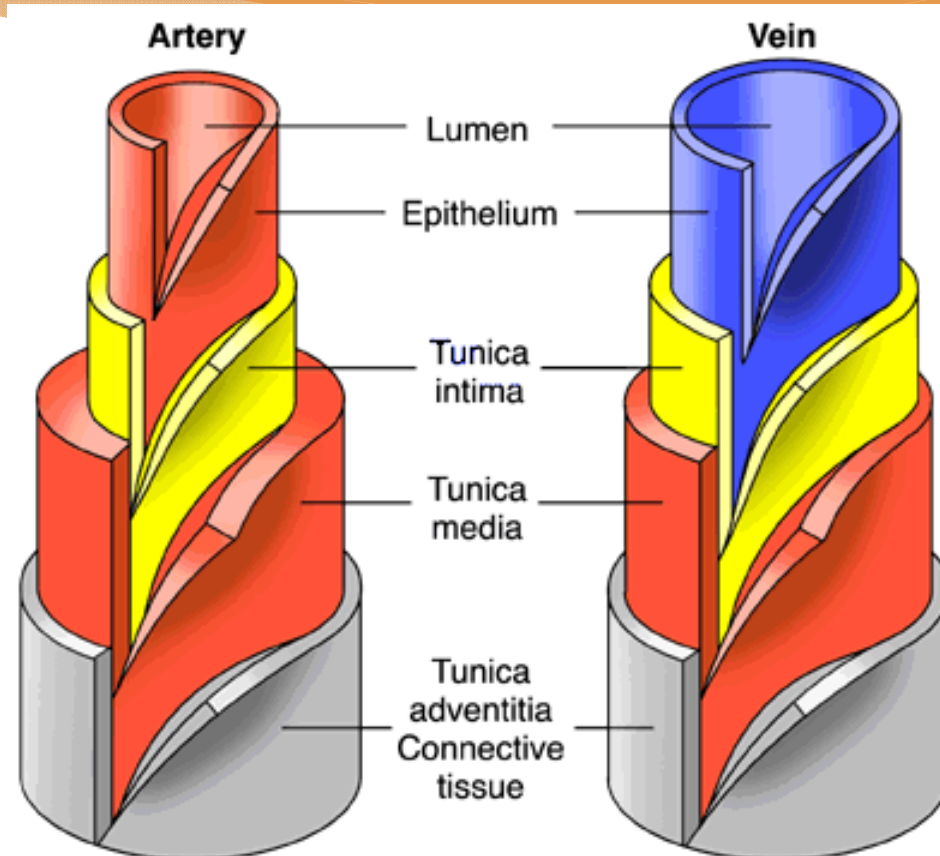
## Vessel Characteristics



# Arteries & Veins

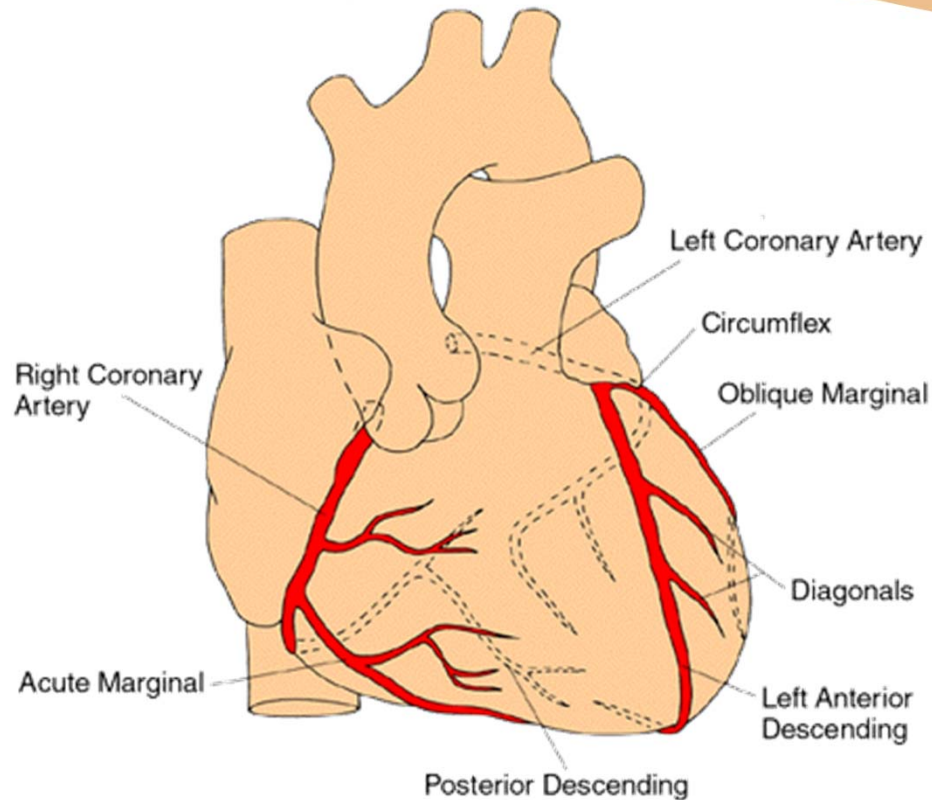
## Three Layers

- ◆ Intima
- ◆ Media
- ◆ Adventitia



# Coronary Arteries

Coronary Arteries of the Heart



- ◆ Left
  - ◆ Main
    - ◆ Left Anterior descending
    - ◆ Circumflex
  - ◆ Right
    - ◆ RCA
    - ◆ Marginal
    - ◆ Posterior Descending

# Lead Groups

<b>I</b>	<b>aVR</b>	<b>V1</b>	<b>V4</b>
<b>II</b>	<b>aVL</b>	<b>V2</b>	<b>V5</b>
<b>III</b>	<b>aVF</b>	<b>V3</b>	<b>V6</b>

Limb Leads

Chest Leads

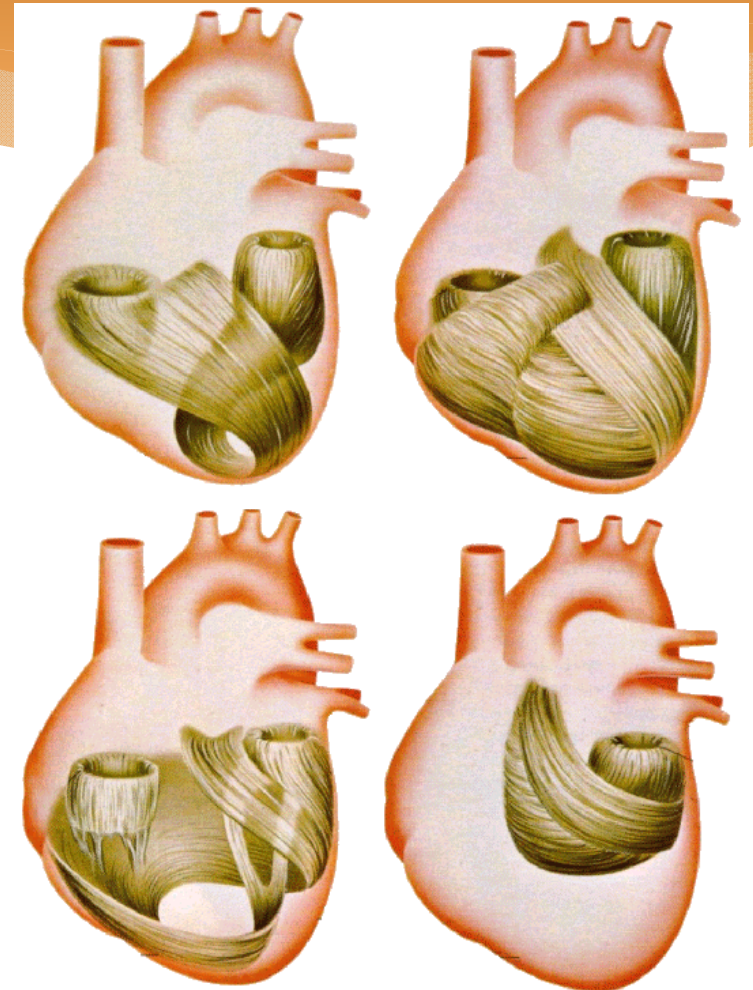
# Neuromuscular Electrophysiology

- ◆ Contractility
- ◆ Conductivity
- ◆ Automaticity



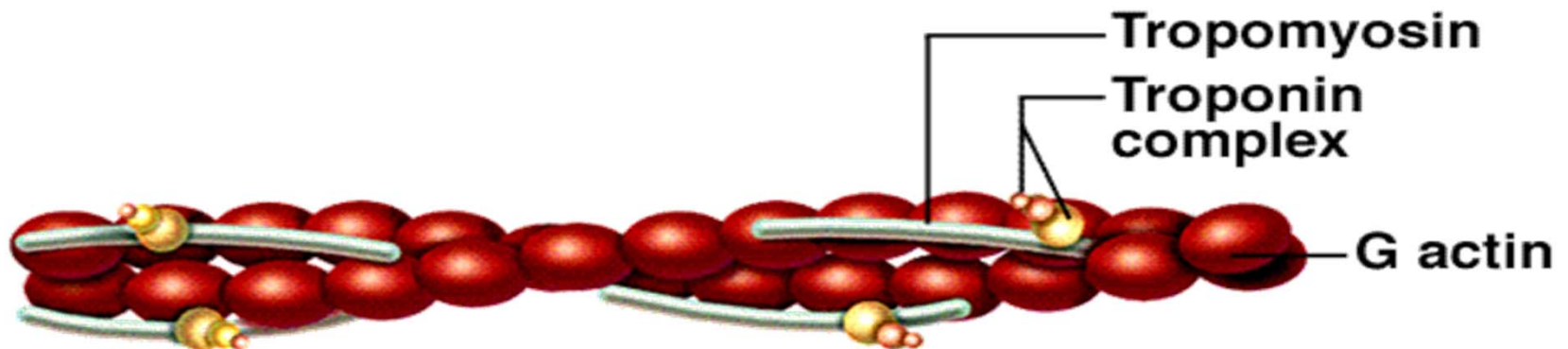
# Contractility

- ◆ Contractility
  - ◆ Similar to skeletal muscle
  - ◆ Interwoven muscle fibers



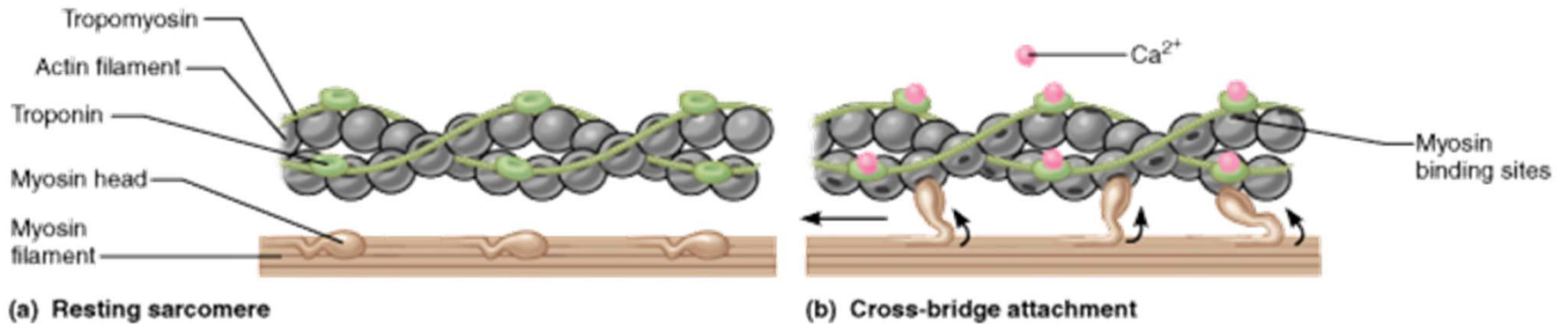
# Contractility

- ◆ Muscle Fiber
  - ◆ Thin Filament
    - ◆ Actin Molecule
      - ◆ Troponin
      - ◆ Tropomyacin



# Contractility

## ◆ Muscle Contraction



◆  $Ca^{2+}$  =



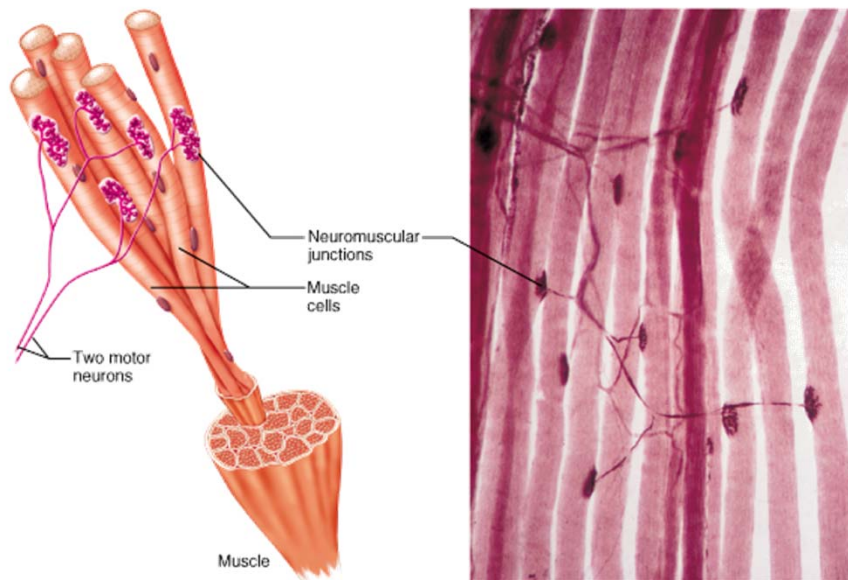
◆ Troponin =



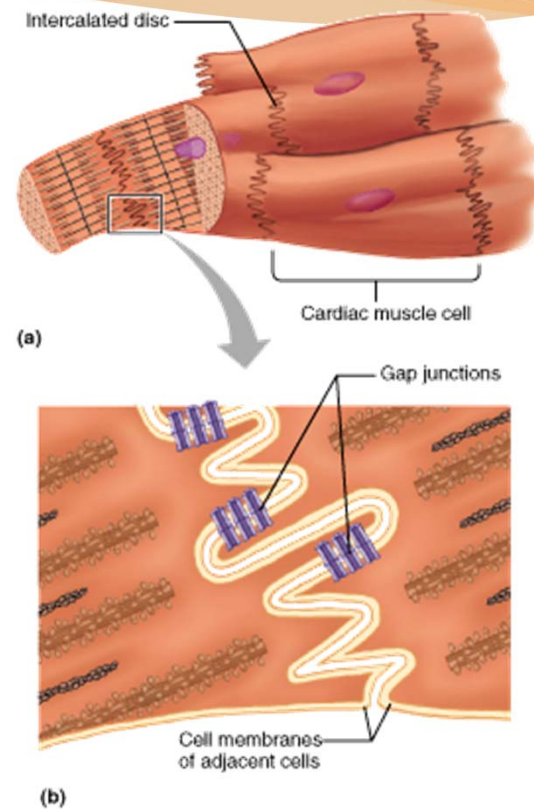
◆ Tropomyocin =



# Contractility



(a)  
Copyright © 2001 Benjamin Cummings, an imprint of Addison Wesley Longman, Inc.



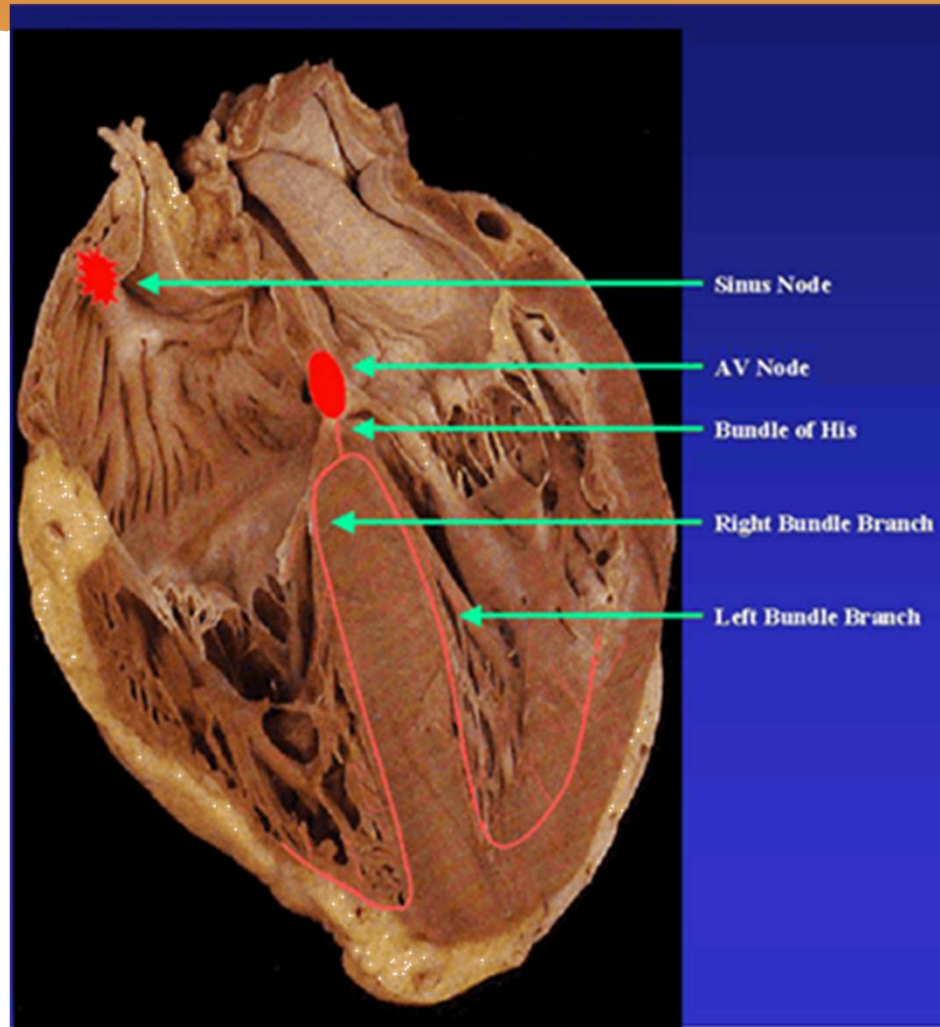
(b)  
Copyright © 2001 Benjamin Cummings, an imprint of Addison Wesley Longman, Inc.

# Conductivity

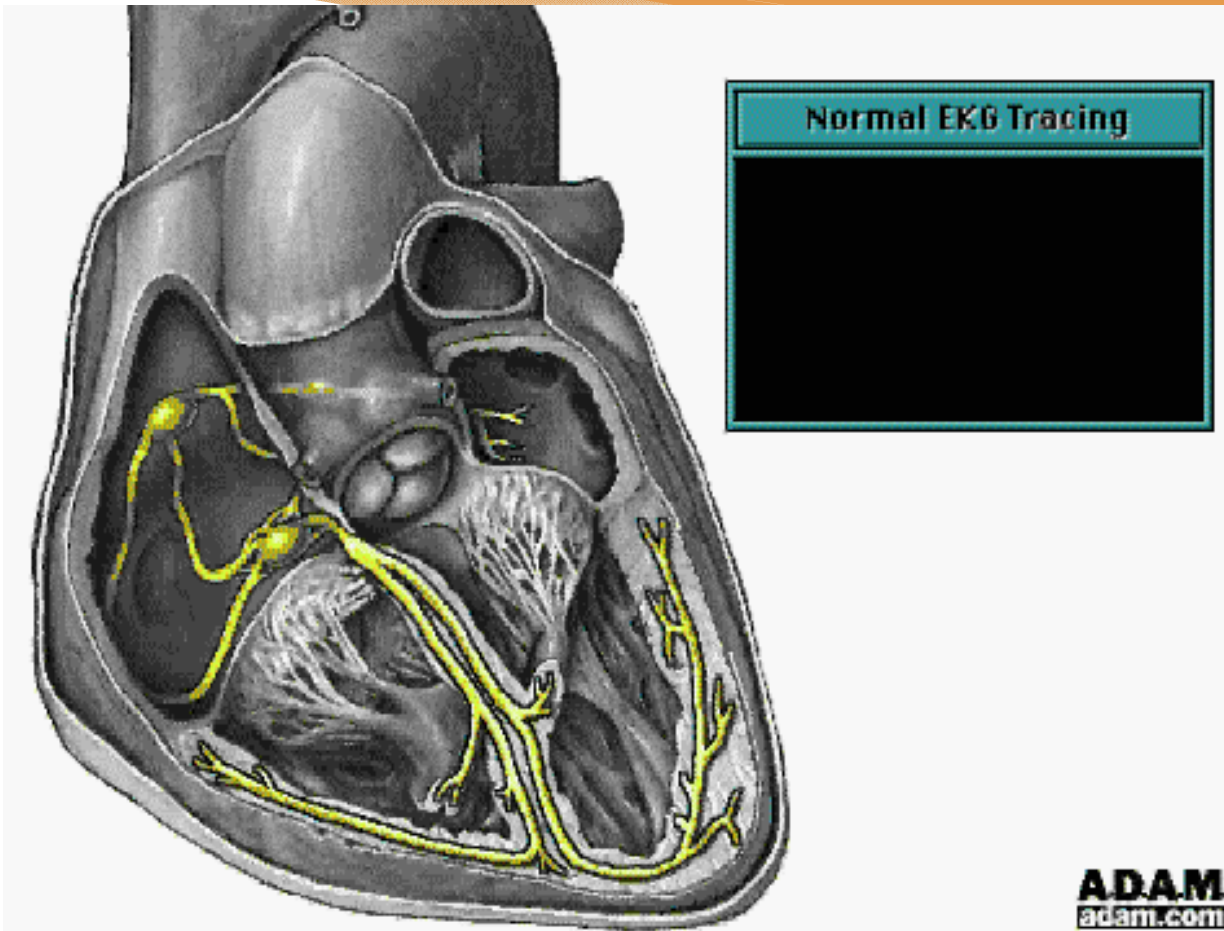
- ◆ Specialized tissues conduct electrical impulses
  - ◆ SA Node
  - ◆ Intra-atrial pathways
  - ◆ AV Node
  - ◆ Bundle of His
  - ◆ Lt and Rt Bundle Branches
  - ◆ Purkinje Fibers



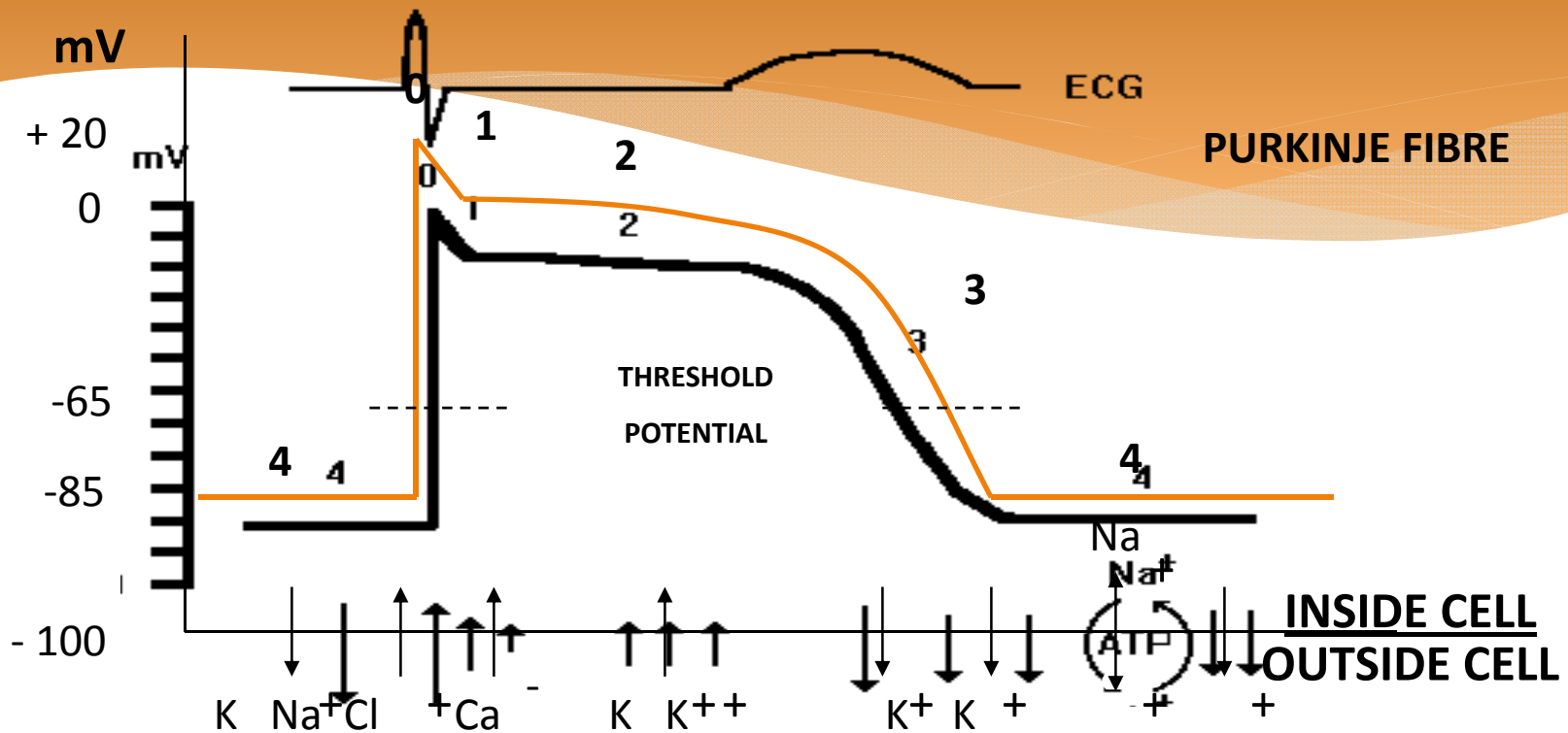
# Conduction System



# Cardiac Conduction



# Action Potential



Phase 0: Rapid Depolarization

Phase 3: Relative Refractory Period

Phase 1: Early Repolarization

Phase 4: Resting Membrane Potential

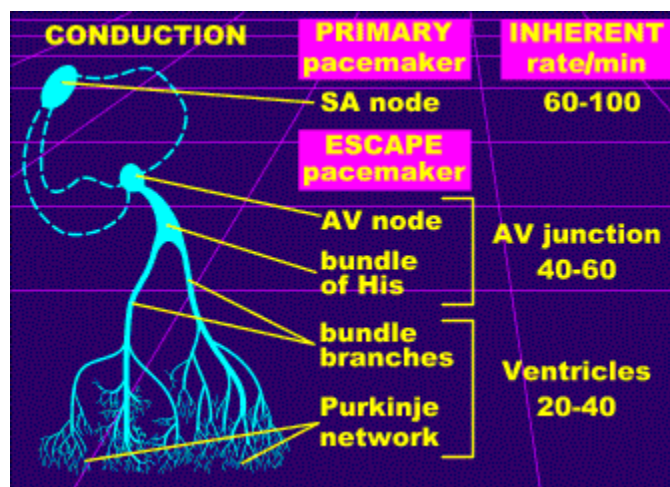
Phase 2: Plateau ( Absolute Refractory Period)



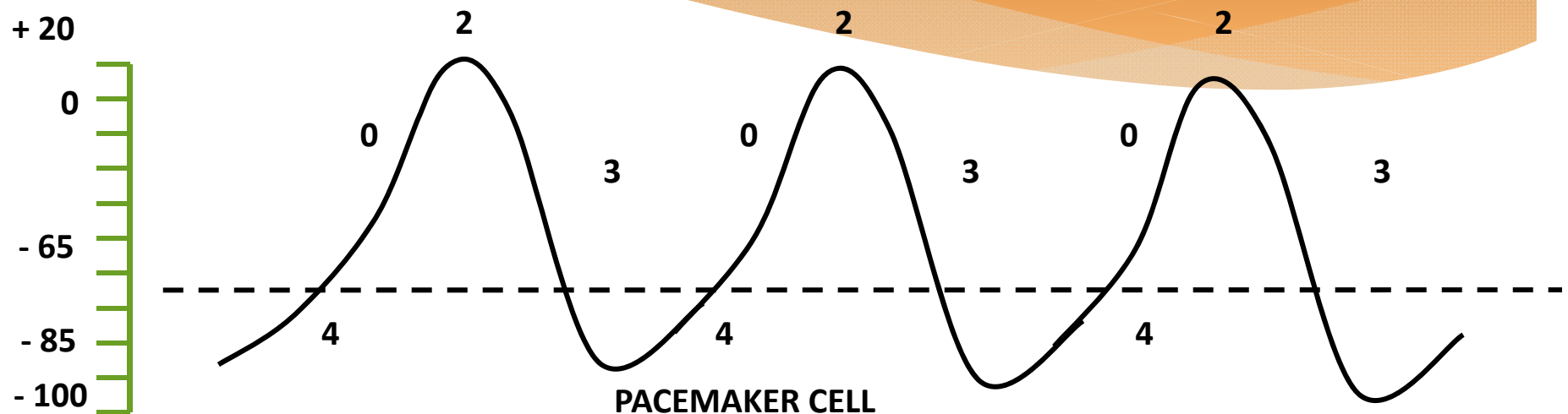
# Automaticity

- ◆ Inherent ability of all myocardial cells to spontaneously depolarize
  - ◆ Primary Pacemaker - SA Node
    - ◆ Secondary – AV Node, Bundle of His, Bundle Branches, Purkinje Fibers
    - ◆ Under stress all other cells can generate an impulse

# Pacemaker Sites



# SA Node



**Phase 0: Depolarization**

**Phase 1: Does not Apply**

**Phase 2: Plateau ( Absolute Refractory Period)**

**Phase 3: Relative Refractory Period**

**Phase 4: Spontaneous Phase 4 Rise**

# Cardiac Output

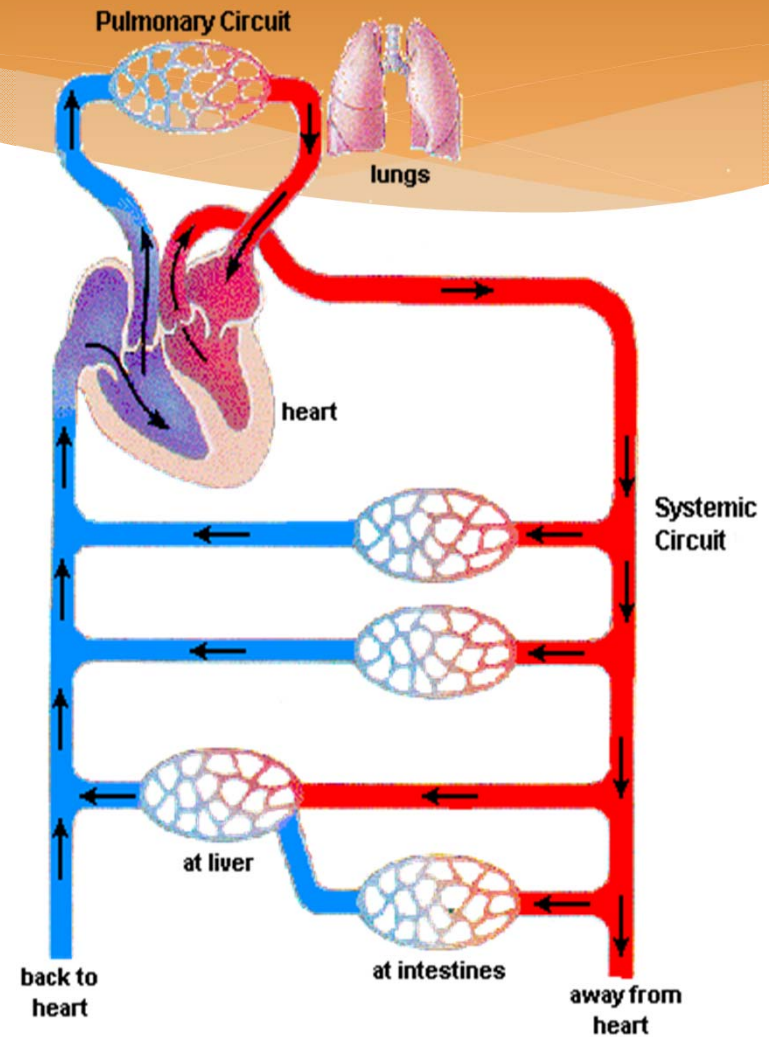
$$\text{Cardiac Output} = \text{Heart Rate} \times \text{Stroke Volume}$$

# Cardiac Function Control

- ◆ Intrinsic
  - ◆ Preload
- ◆ Extrinsic
  - ◆ ANS
  - ◆ Electrolytes
  - ◆ Temperature
  - ◆ Humoral/Chemical

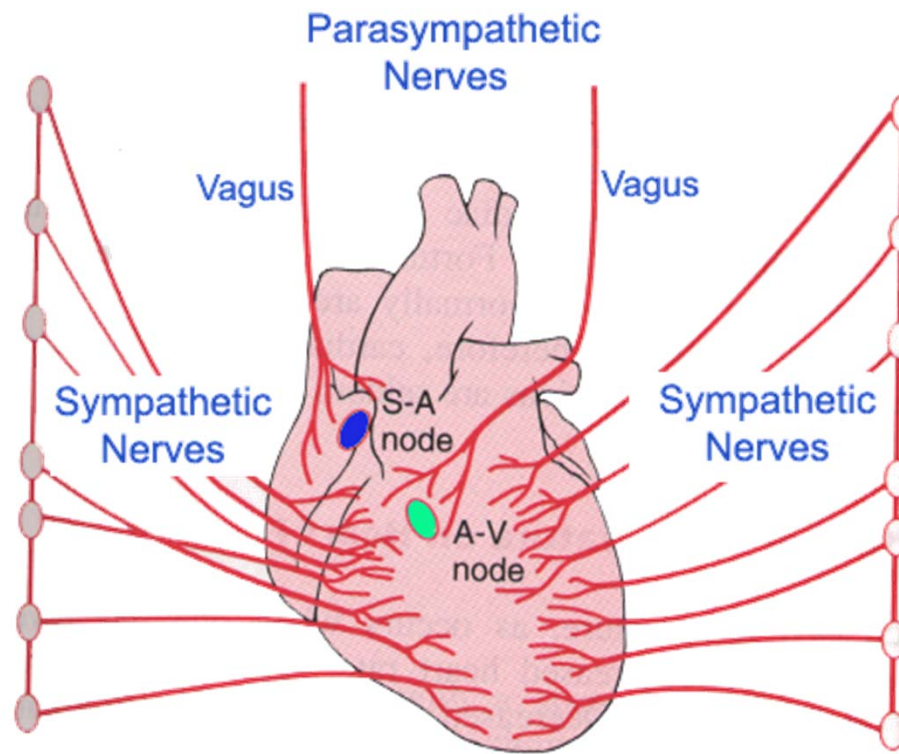
# Intrinsic

- ◆ Preload
  - ◆ Venous return to Heart
  - ◆ 70 % blood volume
  - ◆ Low Pressure



# Extrinsic influences on CO

- ◆ Autonomic Nervous System



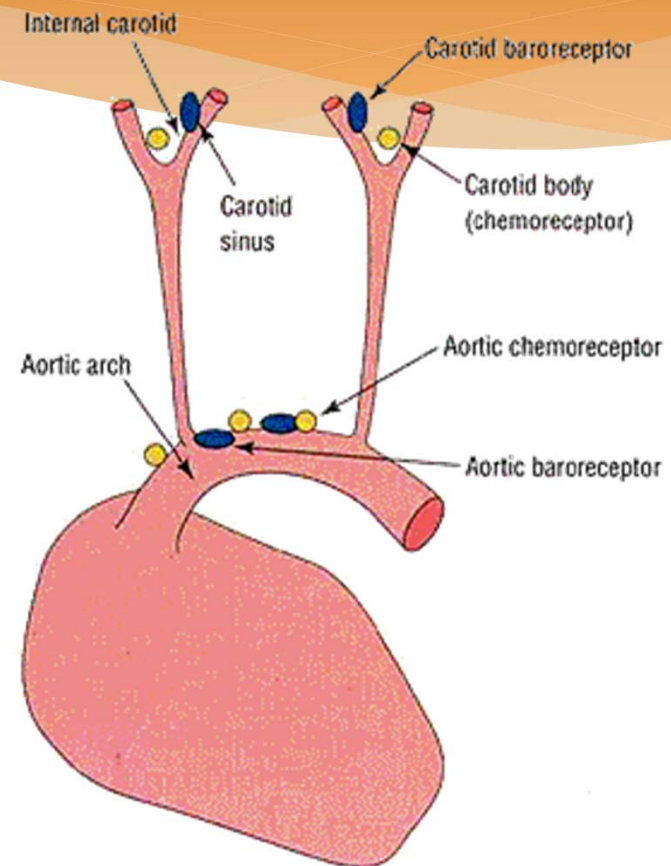
# Extrinsic influences on CO

- ◆ Electrolytes
  - ◆  $K^+$  - Increase will decrease rate and force
  - ◆  $Na^+$  - Increase will decrease force
  - ◆  $Ca^{++}$  - Increase will increase force
- ◆ Temperature
  - ◆ Low - Decreased rate
  - ◆ Hi - Increased rate, Increased force
- ◆ Humoral/Chemical
  - ◆ Catecholamines – increase rate and force
  - ◆ ADH – increased secretion increases preload
  - ◆ Acids – increases in acids decreases function



# Blood Pressure Control

- ◆ Rapid
  - ◆ ANS
    - ◆ Baroreceptors
    - ◆ Chemoreceptors



# Blood Pressure Control

- ◆ Intermediate
  - ◆ Renin/Angiotensin
  - ◆ ADH
- ◆ Slow
  - ◆ Kidneys

# Heart Sounds “lub dub”

## Lub

- ◆ closing of A-V valves
- ◆  $S_1$

## Dub

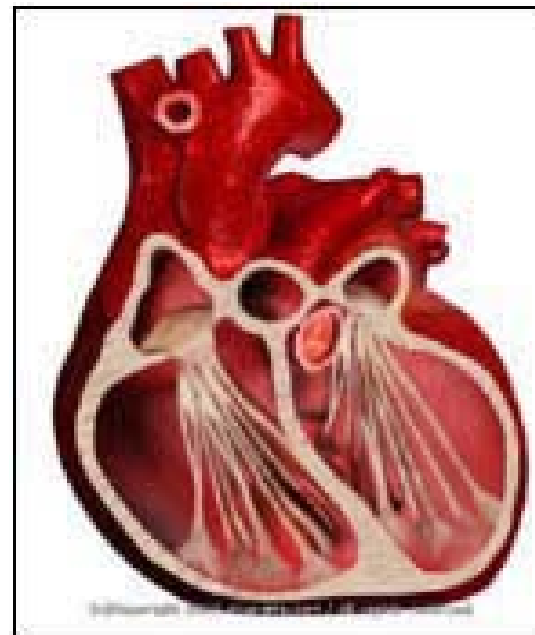
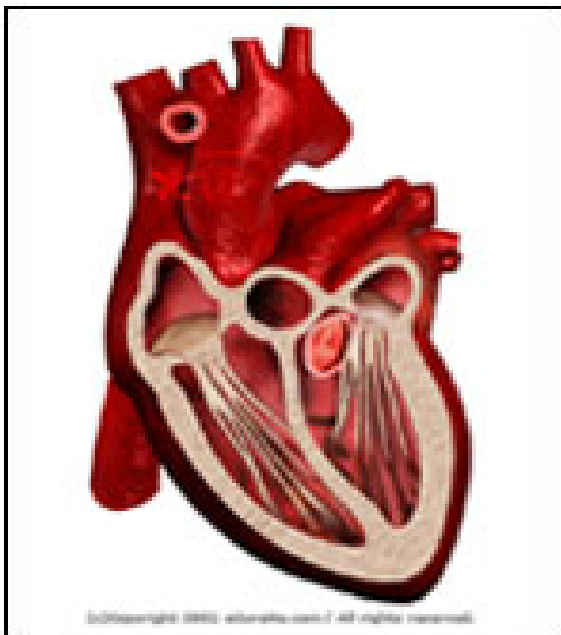
- ◆ Closing of aortic and Pulmonic valves
- ◆  $S_2$

# Heart Failure

- ◆ When the heart is unable to pump the volume it receives it is said to be in failure
  - ◆ Right Sided
  - ◆ Left Sided

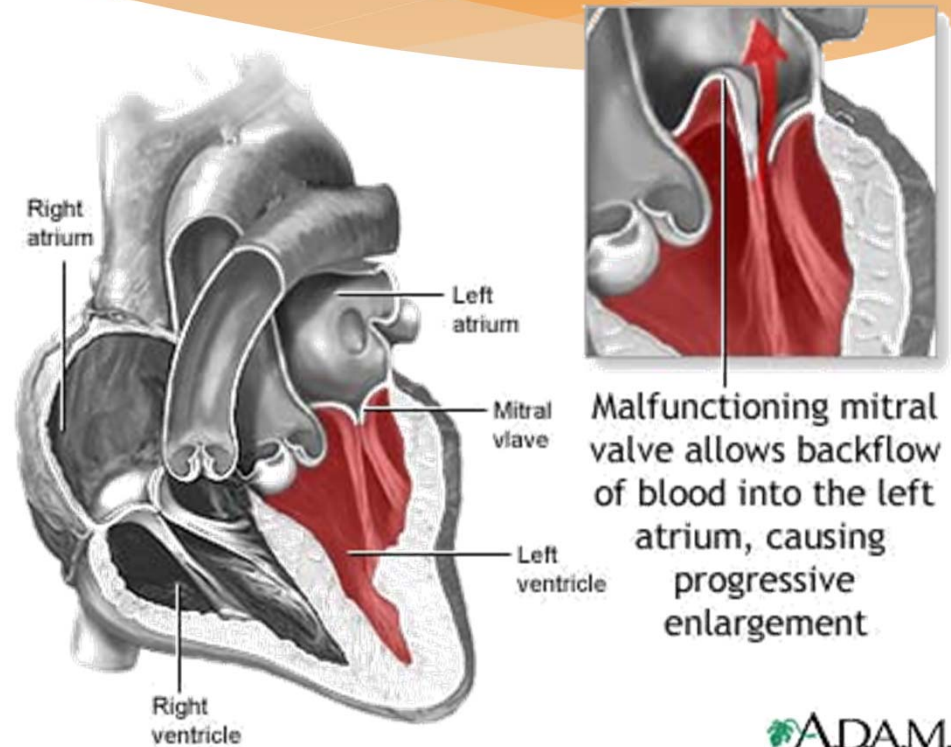
# Heart Failure

- ◆ Causes
  - ◆ Pump Failure



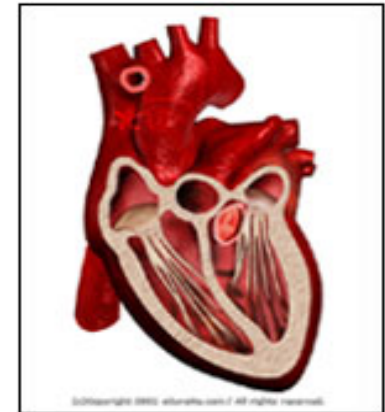
# Heart Failure

- ◆ Causes
  - ◆ Cardiac ischemia
  - ◆ Hypertensive event
  - ◆ Rate related
    - ◆ Tachycardia
    - ◆ Bradycardia
  - ◆ Valvular disease
    - ◆ Prolapse
    - ◆ Rupture



# Heart Failure

- ◆ Acute Right Sided Failure
  - ◆ associated with acute inferior wall MI
  - ◆ hypotension
  - ◆ normal to slow heart rate
  - ◆ JVD
  - ◆ chest clear
- ◆ Treatment: fluid resuscitation



Note: NTG contraindicated for HR < 60 and/or SBP < 100 mmHg

# Heart Failure

- ◆ Volume overload
  - ◆ inappropriate fluid resuscitation
  - ◆ diligent monitoring of respiratory status required when administering IV fluids

Note: Auscultate chest q 250 ml in adults - q 100 ml in Paeds



# CATEGORIZING FAILURE

- \* **Left** or **Right** sided heart failure
- \* **Forward** or **Backward** ventricular failure
  - \* Backward failure is secondary to elevated systemic venous pressures.
  - \* Forward ventricular failure is secondary to left ventricle failure and reduced flow into the aorta and systemic circulation

# LV BACKWARD EFFECTS

Decreased emptying of the left ventricle



Increased volume and end-diastolic pressure in the left ventricle



Increased volume (pressure) in the left atrium



Increased volume in pulmonary veins



# LV BACKWARD EFFECTS cont'd.

Increased volume in pulmonary capillary bed = increased hydrostatic pressure



Transudation of fluid from capillaries to alveoli



Rapid filling of alveolar spaces



*Pulmonary edema*

# LV FORWARD EFFECTS

Decreased cardiac output



Decreased perfusion of tissues of body



Decreased blood flow to kidneys and glands



Increased reabsorption of sodium and water and  
vasoconstriction



## LV FORWARD EFFECTS cont'd.

Increased secretion of sodium and water-retaining hormones



Increased extracellular fluid volume



Increased total blood volume and increased systemic blood pressure

# RV BACKWARD EFFECTS

Decreased emptying of the right ventricle



Increased volume and end-diastolic pressure in the right ventricle



Increased volume (pressure) in right atrium



Increased volume and pressure in the great veins



## RV **BACKWARD** EFFECTS cont'd.

Increased volume in the systemic venous circulation



Increased volume in distensible organs  
(hepatomegaly, splenomegaly)



Increased pressures at capillary line



Peripheral, dependant edema and serous infusion

# RV FORWARD EFFECTS

Decreased volume from the RV to the lungs



Decreased return to the left atrium and subsequent  
decreased cardiac output



All the forward effects of left heart failure



# Well Done!

Ontario Base Hospital Group  
Self-directed Education Program