CHAPTER 15
CARDIOVASCULAR Lectures

Part 1: Heart
Part 2: Heart
Part 3: Vasculature

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Some illustrations are courtesy of McGraw-Hill.
Coronary Arteries

PULMONARY valve

right CORONARY artery

AORTIC valve

left CORONARY artery

PULMONARY Vein

Superior View

Superior VENA CAVA

ANGIOGRAM
CORONARY CIRCULATION: HEART BLOOD SUPPLY

Heart = 0.5% of Body weight- yet accounts for almost 10% of Oxygen demand. **Approx 4% of blood ejects from Left Ventricle and enters one of two coronary arteries (left & right) branching off the aorta.**

Ultimately return for oxygenation via 3 major coronary veins; all empty into:
- Coronary Sinus
- Right Atrium

**Note:** Some minor veins empty into the Coronary sinus or directly to Rt. Atrium.
Coronary Arteries/Veins Circulation

- Aorta
  - Right coronary artery
    - Posterior interventricular artery
      - Ventricular walls
      - Walls of right atrium and right ventricle
  - Left coronary artery
    - Marginal artery
      - Ventricular walls
    - Circumflex artery
      - Walls of left atrium and left ventricle
    - Anterior interventricular artery
      - Ventricular walls
  - Cardiac veins
  - Coronary sinus
  - Right atrium
ISCHEMIA
Blood deficiency (i.e. oxygen) in a branch of the coronary artery; often due to constriction/blockage from an embolus (clot).

ANGINA PECTORIS
Chest pain that often accompanies ischemia.

MYOCARDIAL INFARCTION (MI; Heart Attack)
Death to a portion of the heart due to ischemia.
Blood Flow Schematic

- Systemic capillaries
- Tissue cells
- Superior vena cava
- Alveolus
- Alveolar capillaries
- Pulmonary artery
- Alveolar capillaries
- Pulmonary veins
- Right atrium
- Tricuspid valve
- Pulmonary valve
- Right ventricle
- Inferior vena cava
- Left atrium
- Mitral valve
- Left ventricle
- Aortic valve
- Aorta
- Systemic capillaries
- Tissue cells
Pulmonary Circuit
NERVOUS REGULATION of the HEART

Cardioacceleratory Center in medulla oblongata

Sympathetic nerve fibers leave this (CAC) region:
> spinal cord > Accelerator nerves

Increase in rate/strength of heart beat
by decreasing permeability of K+
or increasing for Na+

Cardioinhibitory Center in medulla oblongata

Parasympathetic nerve fibers leave this (CIC) region:
to heart via Vagus nerve (cranial X)

Decrease in rate/strength of heart beat
by increasing permeability of K+ (hyperpolarization)
Slows heart rate (Parasympathetic)

Increases heart rate (Sympathetic)
NERVOUS REGULATION of the HEART

CONDUCTION  (Intrinsic Regulation)

1. **SINO-ATRIAL NODE**

   located on the posterior wall of rt atrium beneath epicardium; below opening of superior vena cava
   
   • specialized muscle tissue
   • self – exciting cells
   • pacemaker of the heart
   • action potential spreads to:
     
     a) muscle cells in both atria
     b) AV (atrio-ventricular) node
NERVOUS REGULATION of the HEART

CONDUCTION  (Intrinsic Regulation)

2.  AV NODE

located on the floor of right atrium

- Slight delay here to allow for the relaxation of atria before the ventricles contract
- Action potential spreads to the AV bundle
CONDUCTION (Intrinsic Regulation)

3. AV BUNDLE (Bundle of His)
   > through interventricular septum
   > left and right bundle branches

4. BUNDLE BRANCHES
   > carry action potential to.....

5. PURKINJE FIBERS
   > into cells of myocardium
   ventricles contract
NERVOUS CONDUCTION THROUGH THE HEART
1. Mid-to-Late DIASTOLE

Starts with heart in complete relaxation.
Blood pressure in heart is low.
Blood is flowing into and through atria into ventricles.

(Atrial - ventricular)
Av valves open; semilunar exits from ventricles area closed.
Finally, atria contract (ATRIAL SYSTOLE – SA NODES FIRE),
emptying blood remaining (30%) in their chambers to ventricles.
Completed Conduction causes next phase...
Atrial Systole

Pulmonary valve closed

Aortic valve closed

Tricuspid and mitral valves open

Atrial systole

Ventricular diastole

RA

LA

RV

LV
Cardiac Cycle

2. Ventricular Systole (SYSTOLE)

Ventricular contraction
Ventricular pressure increases rapidly.....

- AV valves close. #1 LUB Sound
- Semilunar valves open when pressure inside ventricles > pressure in large arteries leaving heart (pulmonary/aortic).
- Blood rushes out of ventricles. Ventricles begin to relax.
- Semilunar valves now snap shut. #2 DUB Sound (preventing backflow)

Note: During SYSTOLE, the atria are relaxed (Atrial Diastole) and again filling with blood.
Intraventricular Pressure drops...

- When intraventricular pressure drops below the pressure in atria (still filling passively), AV valves are forced open.
- Ventricles again fill with blood, completing the Cardiac Cycle.
Atrial Diastole

- Pulmonary valve open
- Aortic valve open
- Atrial diastole
- Ventricular systole
- Tricuspid and mitral valves closed
Strength of Contraction depends on volume of blood.

**STARLING’S LAW:**
Within physiological limits, the heart pumps all blood that comes to it without allowing excessive damming of the blood in veins.

The more the heart wall is stretched, the greater the force of contraction.

“Heterometric autoregulation” controlled by reflex: called atrial or Bainbridge reflex
Cardiac Output

Amount of blood pumped from left ventricle to aorta per minute.

= STROKE VOLUME \times \text{Beats/minute}

STROKE VOLUME

Amount of blood pumped from left ventricle to aorta per heart beat.

= approximately 70 - 90 ml

Beats/minute

= approximately 75
**AUSCULTATION**  
act of listening to heart sounds

**MURMURS**  
blood flow usually smooth or silent.  
Murmurs = turbulence damaged valves:  
- Stenosis- incomplete opening  
- Insufficiency- incomplete closure
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<thead>
<tr>
<th>Ion Level</th>
<th>Heart Rate</th>
<th>Conditions</th>
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<tbody>
<tr>
<td><strong>K⁺</strong></td>
<td>Increases</td>
<td>Decreases</td>
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<tr>
<td>Decreases</td>
<td>Increases</td>
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<tr>
<td><strong>Na⁺</strong></td>
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<td>Decreases</td>
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<tr>
<td><strong>Ca²⁺</strong></td>
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<td>Decreases</td>
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Heart Rate Factors:

**Temperature**
- Increased temperature > increased heart rate
- Decreased temperature > decreased heart rate

**Gender**
- Male > slightly lower
- Female > slightly higher

**Emotion**
- Fear and anger (epinephrine) > increased rate
- Grief (stimulates CIC) > decreased rate
Cardiovascular System—Interconnections

Integumentary System
Changes in skin blood flow are important in temperature control.

Skeletal System
Bones help control plasma calcium levels.

Muscular System
Blood flow increases to exercising skeletal muscle, delivering oxygen and nutrients and removing wastes. Muscle actions help the blood circulate.

Nervous System
The brain depends on blood flow for survival. The nervous system helps control blood flow and blood pressure.

Endocrine System
Hormones are carried in the bloodstream. Some hormones directly affect the heart and blood vessels.

Lymphatic System
The lymphatic system returns tissue fluids to the bloodstream.

Digestive System
The digestive system breaks down nutrients into forms readily absorbed by the bloodstream.

Respiratory System
The respiratory system oxygenates the blood and removes carbon dioxide. Respiratory movements help the blood circulate.

Urinary System
The kidneys clear the blood of wastes and substances present in excess. The kidneys help control blood pressure and blood volume.

Reproductive System
Blood pressure is important in normal function of the sex organs.
Aortic Aneurysm