CARDIOVASCULAR ANA-PHY: A REVIEW

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http://www.youtube.com/AtYourSIRvice

HEART as an ORGAN

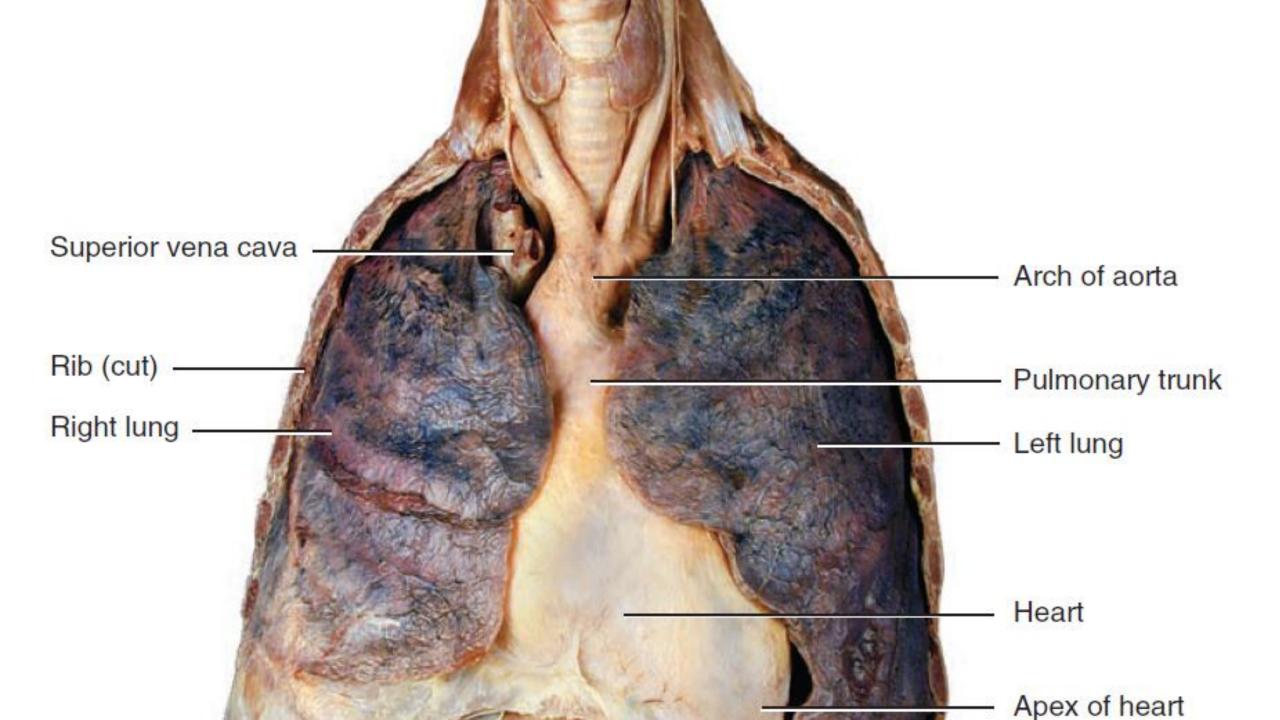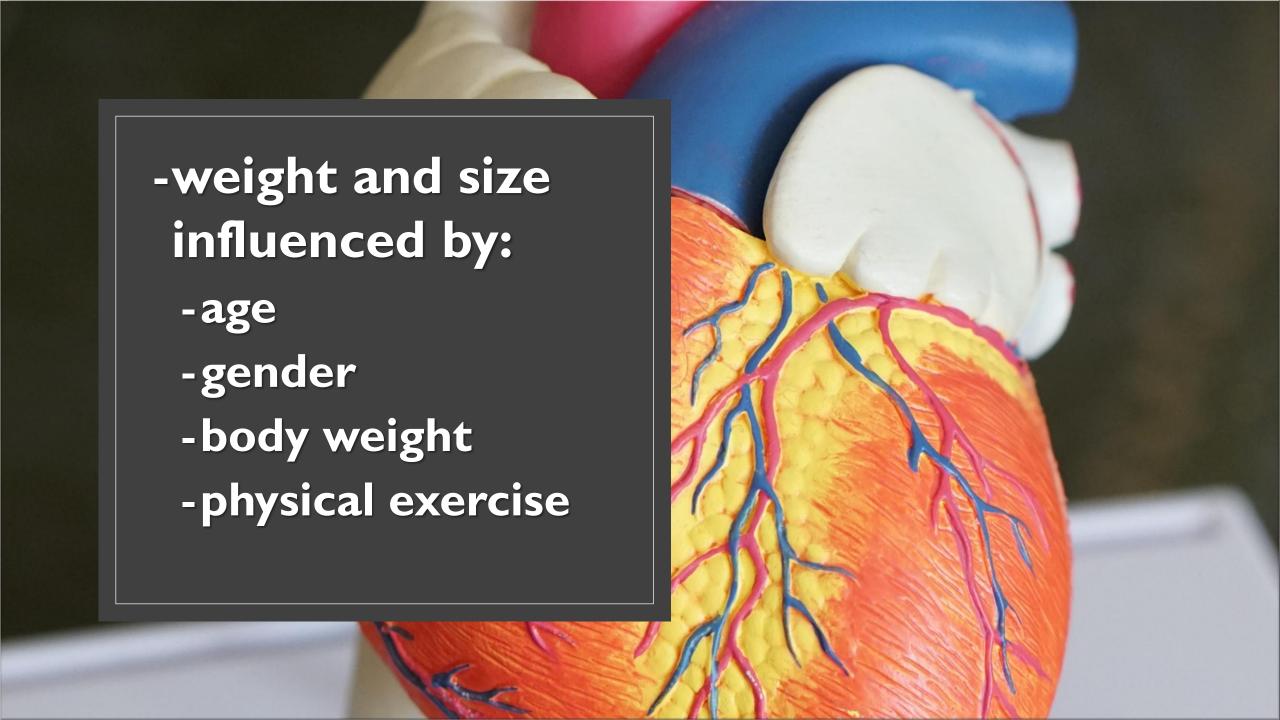-hollow, muscular

-location: mediastinum, resting on the diaphragm

LOCATION OF THE HEART

lies in the **mediastinum**

about two-thirds of the mass of the heart lies to the left of the body's midline

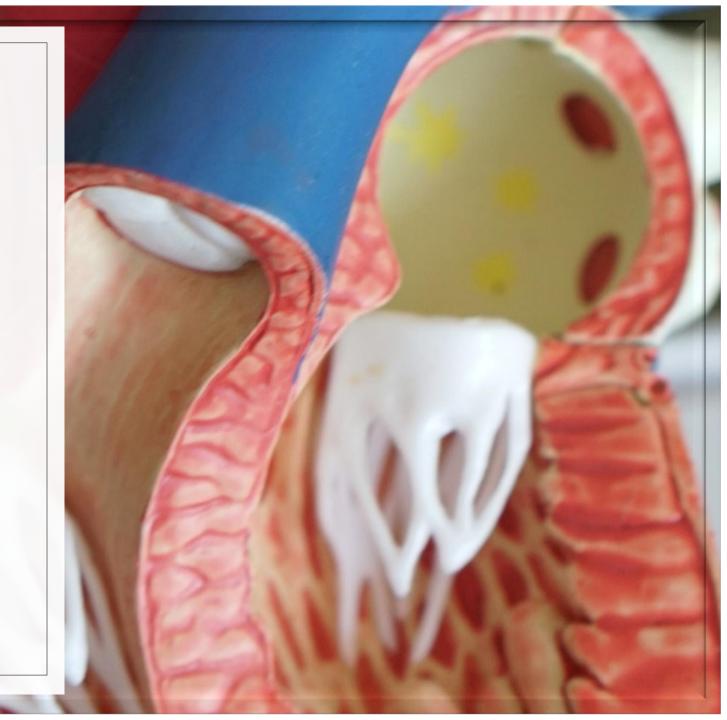Its **apex** is the pointed, inferior part; its **base** is the broad, superior part.

Superior vena cava

Rib (cut)

Right lung

Arch of aorta

Pulmonary trunk

Left lung

Heart

Apex of heart

-weight and size influenced by:
 -age
 -gender
 -body weight
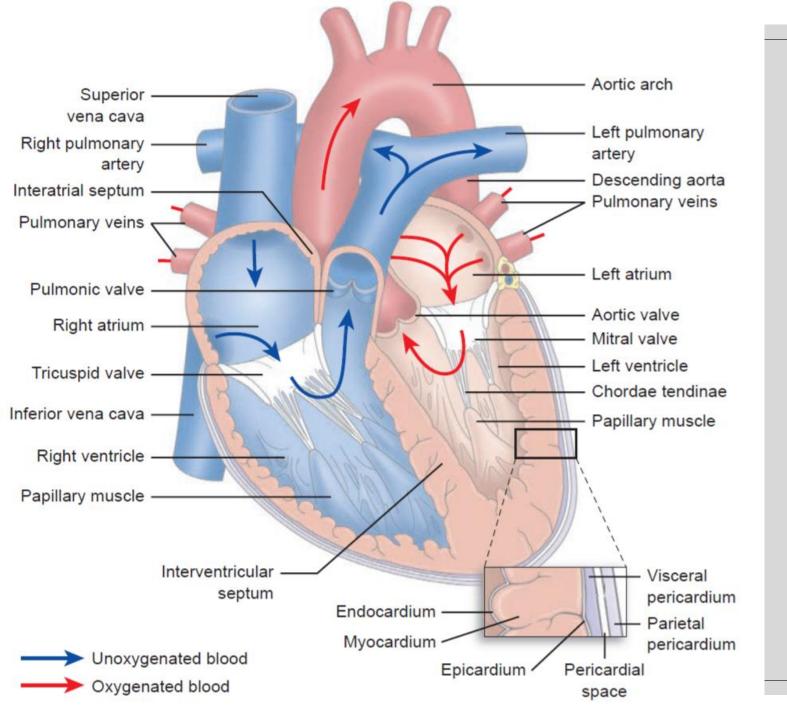 -physical exercise

HEART WALL

- **Three Layers:**
  - Endocardium
  - Myocardium
  - Epicardium

HEART WALL

- **Encased by the pericardium**
  - Fibrous
  - Serous
    - *Visceral*
    - *Parietal*

Pericardial fluid:
-20 ml
-lubrication
-friction reduction
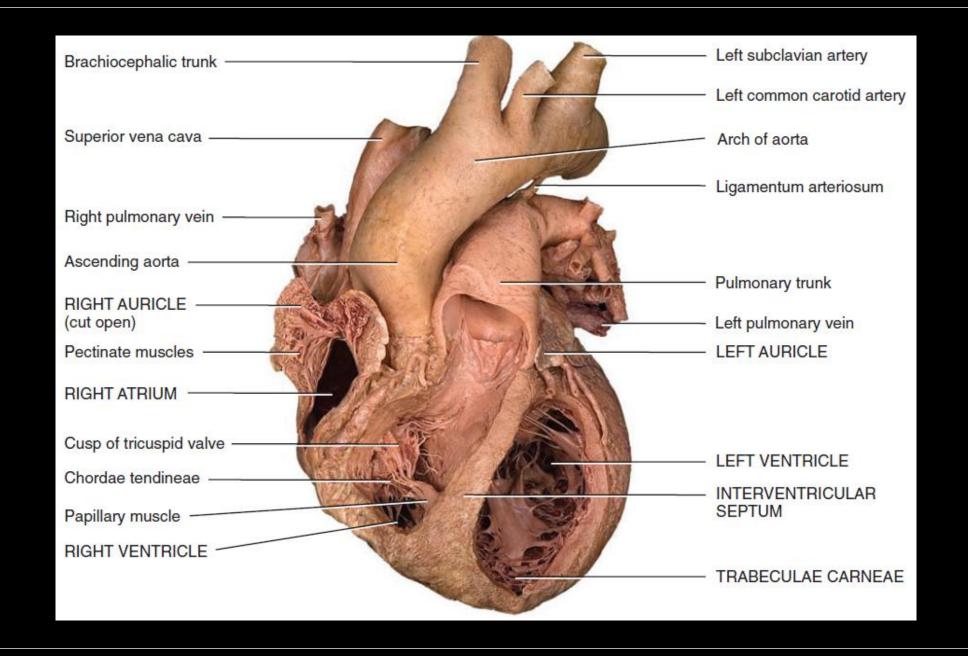
HEART VALVES
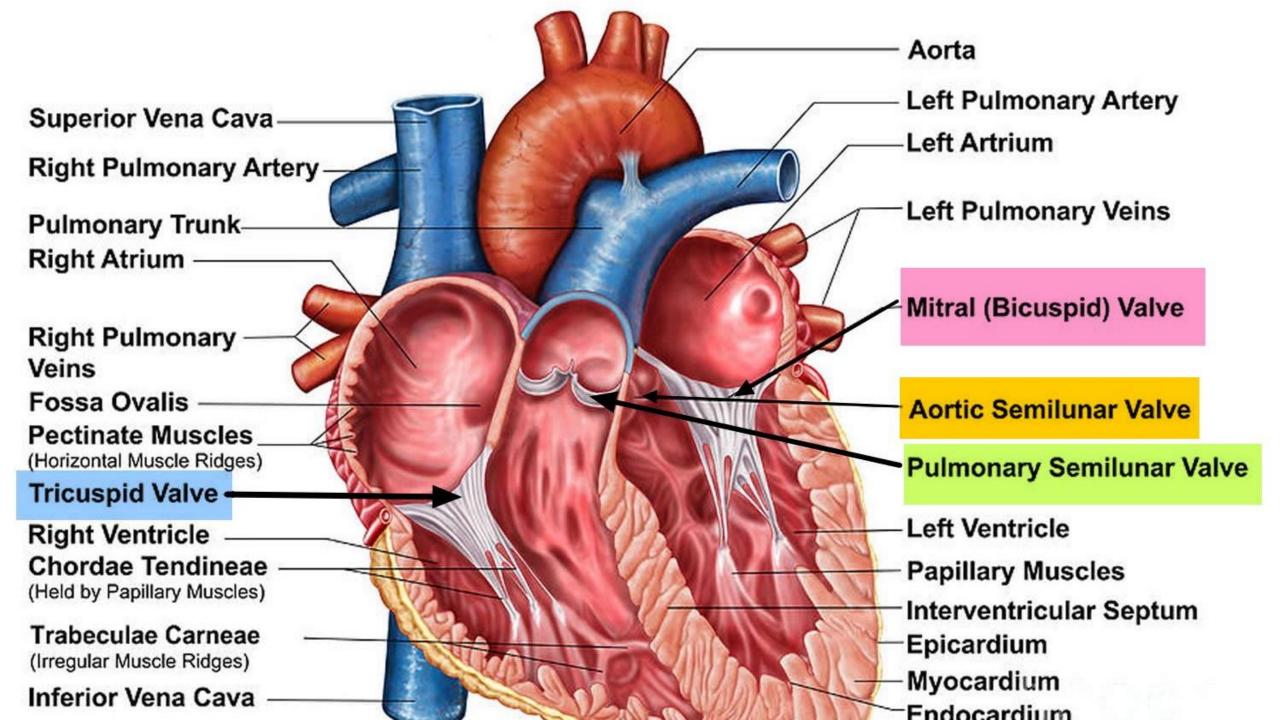
Atrioventricular

- Tricuspid valve
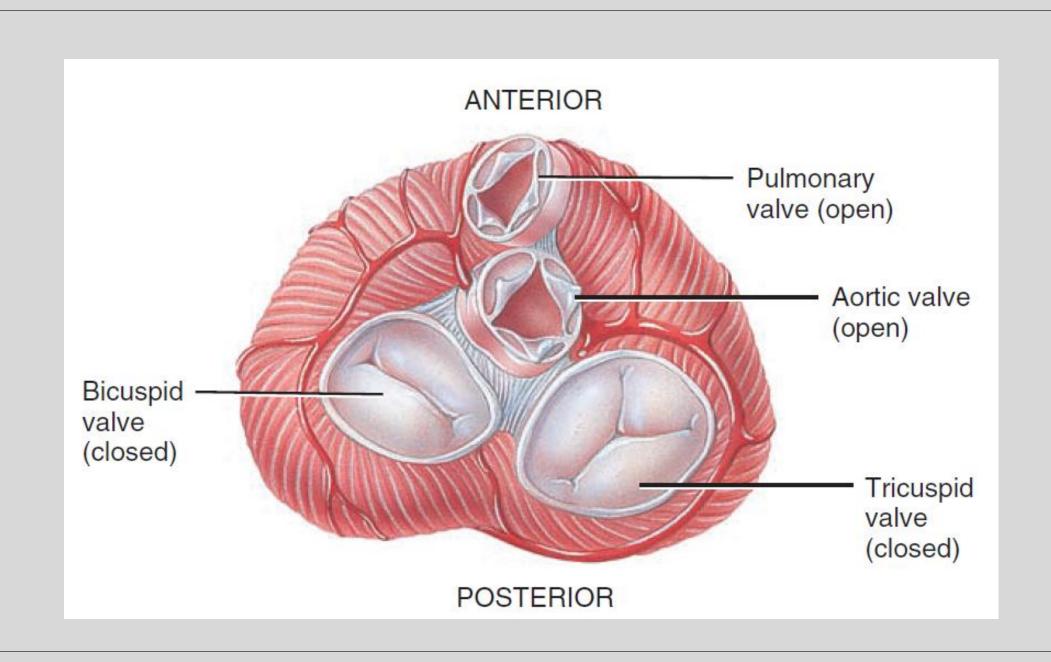- Bicuspid valve (mitral valve)

Semilunar

- Pulmonary valve
- Aortic valve

ANTERIOR

Pulmonary valve (open)

Aortic valve (open)

Bicuspid valve (closed)

Tricuspid valve (closed)

POSTERIOR

Aorta

Left Pulmonary Artery

Left Artrium

Left Pulmonary Veins

Mitral (Bicuspid) Valve

Aortic Semilunar Valve

Pulmonary Semilunar Valve

Left Ventricle

Papillary Muscles

Interventricular Septum

Epicardium

Myocardium

Endocardium

Superior Vena Cava

Right Pulmonary Artery

Pulmonary Trunk

Right Atrium

Right Pulmonary Veins

Fossa Ovalis

Pectinate Muscles
(Horizontal Muscle Ridges)

Tricuspid Valve

Right Ventricle

Chordae Tendineae
(Held by Papillary Muscles)

Trabeculae Carneae
(Irregular Muscle Ridges)

Inferior Vena Cava

REVIEW OF ELECTRO-PHYSIOLOGY

- The **cardiac conduction system** generates and transmits electrical impulses that stimulate contraction of the myocardium.
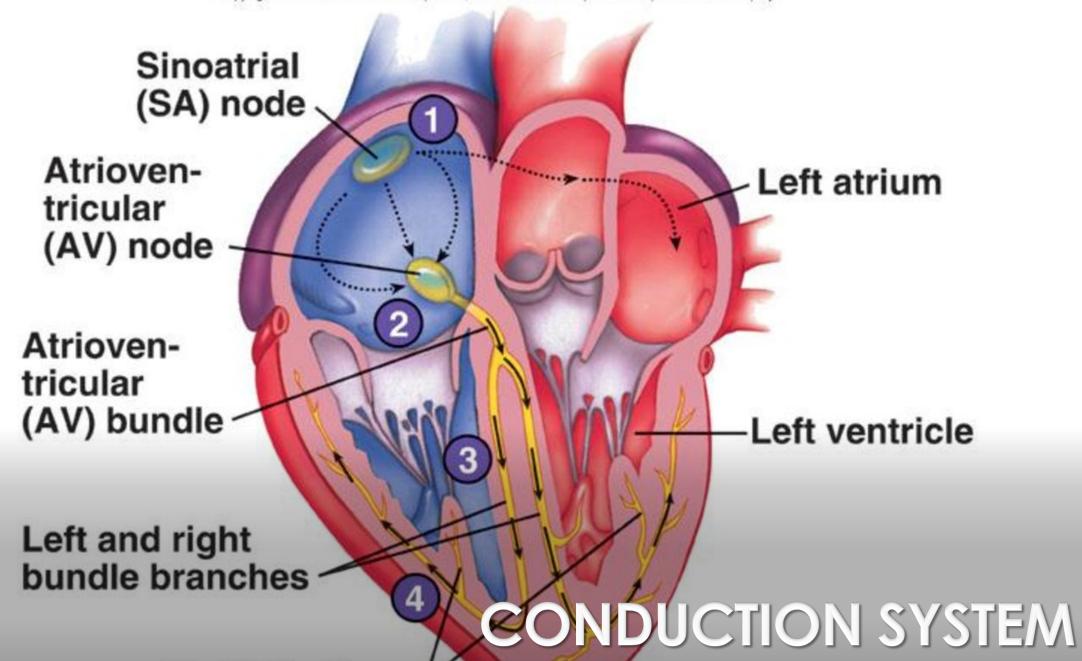- Sequence of Contraction:
  - *1. Atria*
  - *2. Ventricles*

CHARACTERISTICS OF ELECTRIC CELLS

Automaticity:
"initiation"

Excitability:
"response"

Conductivity:
"transmission"

Sinoatrial (SA) node

Atrioven-tricular (AV) node

Atrioven-tricular (AV) bundle

Left and right bundle branches

Left atrium

Left ventricle

1

2

3

4

CONDUCTION SYSTEM

CONDUCTION SYSTEM

PACEMAKER SITE	RATE
SA node	60 – 100 bpm
AV junction	40 - 60 bpm
Bundle branches	30 – 40 bpm
Purkinje network	30 – 40 bpm

CARDIAC ACTION POTENTIAL: A REVIEW

Pre-contraction (resting or polarized state):

- **Na⁺** = primary extracellular cation
- **K⁺** = primary intracellular cation
- **Intracellular compartment** = negatively charged
- **Extracellular compartment** = positively charged

CARDIAC ACTION POTENTIAL: A REVIEW

PHASES OF ACTION POTENTIAL (0 to 4)
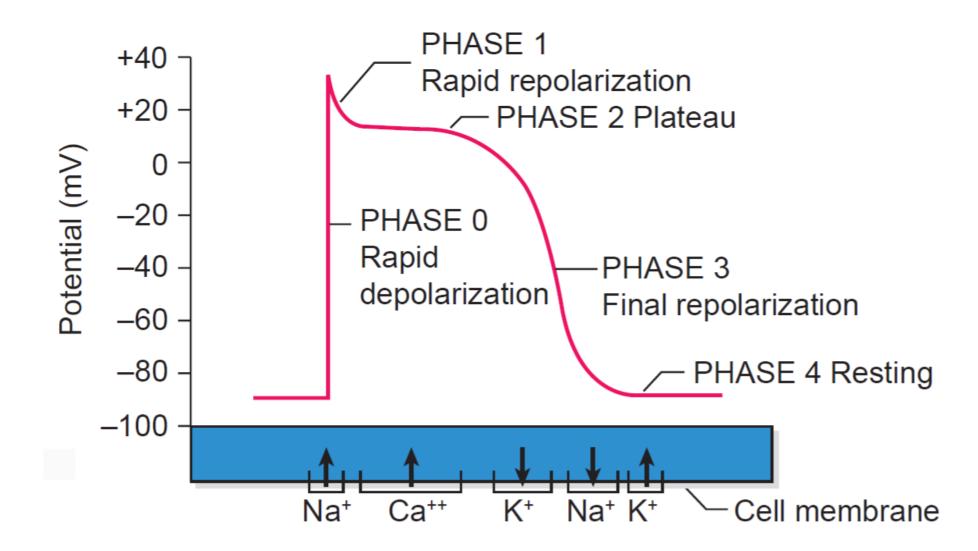
- **Phase 0:** rapid depolarization
  - Na+ influx into the cells (myocytes)
  - Ca++ influx into the nodal cells (SA, AV)

CARDIAC ACTION POTENTIAL: A REVIEW

PHASES OF ACTION POTENTIAL (0 to 4)

- **Phase 1:** early repolarization
  - K+ exits the intracellular compartment

CARDIAC ACTION POTENTIAL: A REVIEW

PHASES OF ACTION POTENTIAL (0 to 4)

- **Phase 2:** plateau phase
  - Slowing down of repolarization
  - Ca++ enters the intracellular compartment

CARDIAC ACTION POTENTIAL: A REVIEW

PHASES OF ACTION POTENTIAL (0 to 4)

- **Phase 3:** final repolarization
  - Completed repolarization
  - Cell returns to its resting state

CARDIAC ACTION POTENTIAL: A REVIEW

PHASES OF ACTION POTENTIAL (0 to 4)

○ **Phase 4:** resting phase
  ○ Cell has returned to its pre-contraction state
  ○ Phase before the next depolarization

HEMODYNAMICS

REMEMBER!

1. Pressure gradient causes blood to flow.
2. Chamber pressures cause valves to either open or close.
   - High ventricular pressure (systole)= closure of AV valves, opening of SL valves
   - Low ventricular pressure (diastole)= closure of SL valves, opening of AV valves

CARDIAC CYCLE

- Consists of:
  - *Atrial systole-Ventricular diastole*
  - *Atrial diastole-Ventricular systole*
  - *Relaxation Period*

ATRIAL SYSTOLE

⏱ **Lasts about 0.1 sec**

〰 **Caused by atrial dep.**

🩸 **Atria force blood through open AV valves**

✔ **Contributes 25 mL in addition to the 105 mL already in the ventricles**

➤ *EDV = 130 mL*

Atrial Systole

Pulmonary valve closed

Aortic valve closed

RA

LA

Atrial systole

Tricuspid and bicuspid valves open

LV

RV

Ventricular diastole

(a)

VENTRICULAR SYSTOLE

⏱ **Lasts about 0.3 sec**

∿ **Caused by ventricular dep.**

♥ **Ventricles push blood against AV valves, causing them to close**

💉 **LV (RV) ejects 70 mL of blood into the aorta (PA)**

✓ *ESV = 60 mL*

Atrial Diastole

Pulmonary valve open

Aortic valve open

Atrial diastole

Ventricular systole

Tricuspid and bicuspid valves closed

(b)

VENTRICULAR DIASTOLE

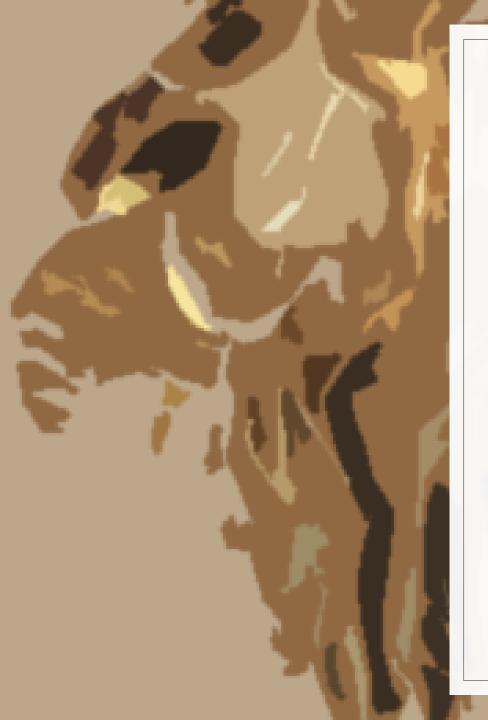Caused by ventricular rep.

Lasts for 0.4 sec

- **Cardiac output (CO)**
  - Amount of blood pumped by each side (ventricle) of the heart in one minute
- **Stroke volume (SV)**
  - Volume of blood pumped by each ventricle in one contraction (each heartbeat)
  - Usually remains relatively constant
  - About 70 mL of blood is pumped out of the left ventricle with each heartbeat
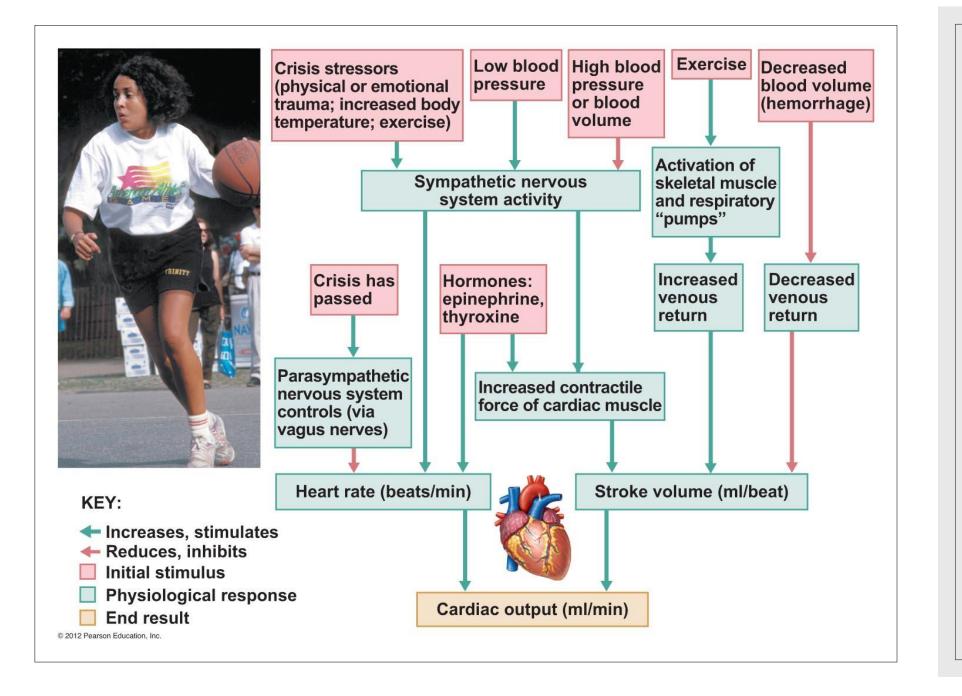
- **CO = HR × SV**
- CO = HR (75 bpm) × SV (70 bpm)
- CO = 5250 mL/min
- **Starling's law of the heart**—the more the cardiac muscle is stretched, the stronger the contraction
- Changing heart rate is the most common way to change cardiac output

Crisis stressors (physical or emotional trauma; increased body temperature; exercise)

Low blood pressure

High blood pressure or blood volume

Exercise

Decreased blood volume (hemorrhage)

Sympathetic nervous system activity

Activation of skeletal muscle and respiratory "pumps"

Crisis has passed

Hormones: epinephrine, thyroxine

Increased venous return

Decreased venous return

Parasympathetic nervous system controls (via vagus nerves)

Increased contractile force of cardiac muscle

Heart rate (beats/min)

Stroke volume (ml/beat)

Cardiac output (ml/min)

KEY:
- Increases, stimulates
- Reduces, inhibits
- Initial stimulus
- Physiological response
- End result

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Figure 11.9