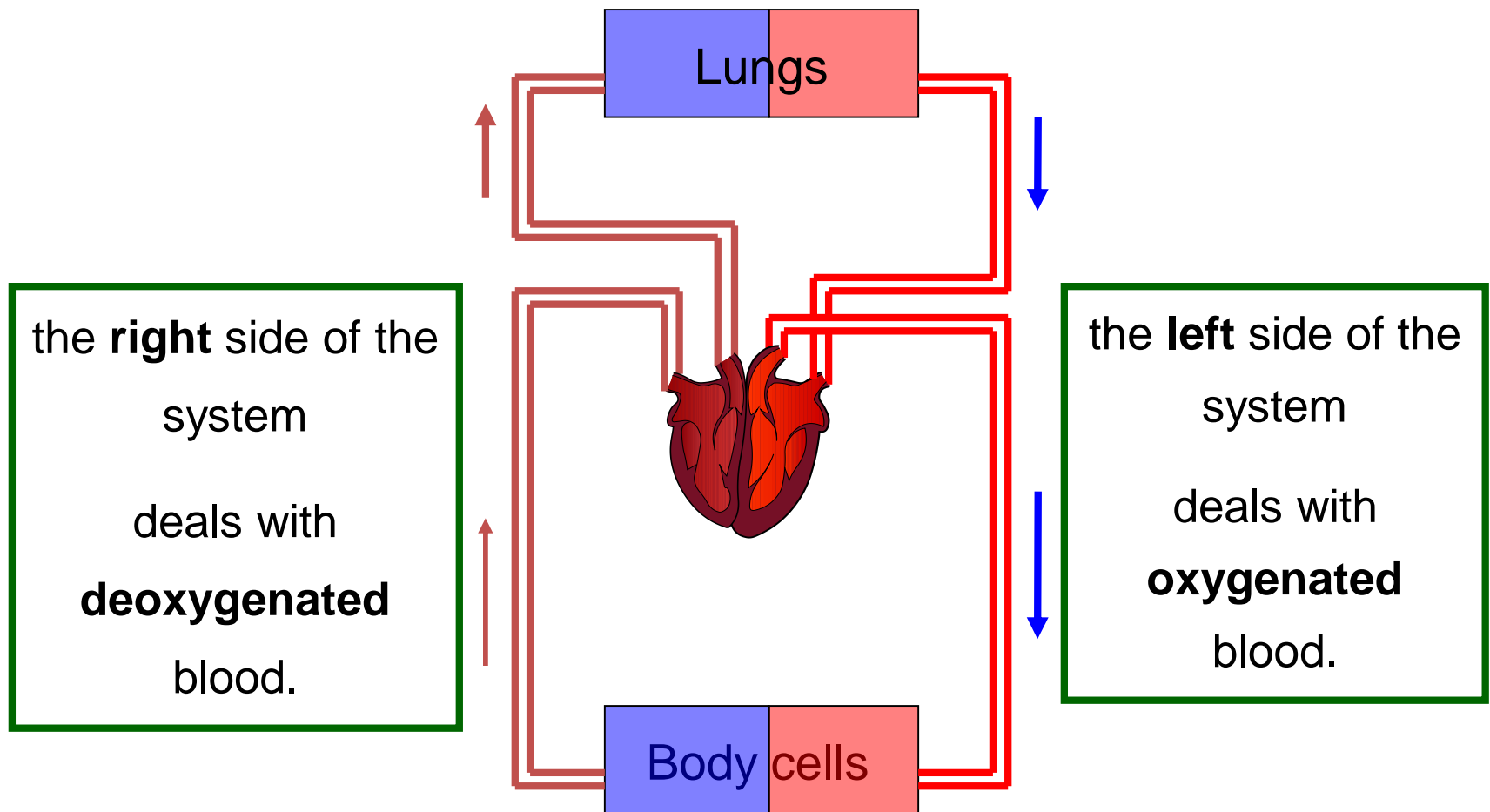


# Biofluidics

## Part 2

Blood- Mechanical systems of the  
heart, Blood pressure

# Double circulatory system



# Circulation

- Pulmonary circuit

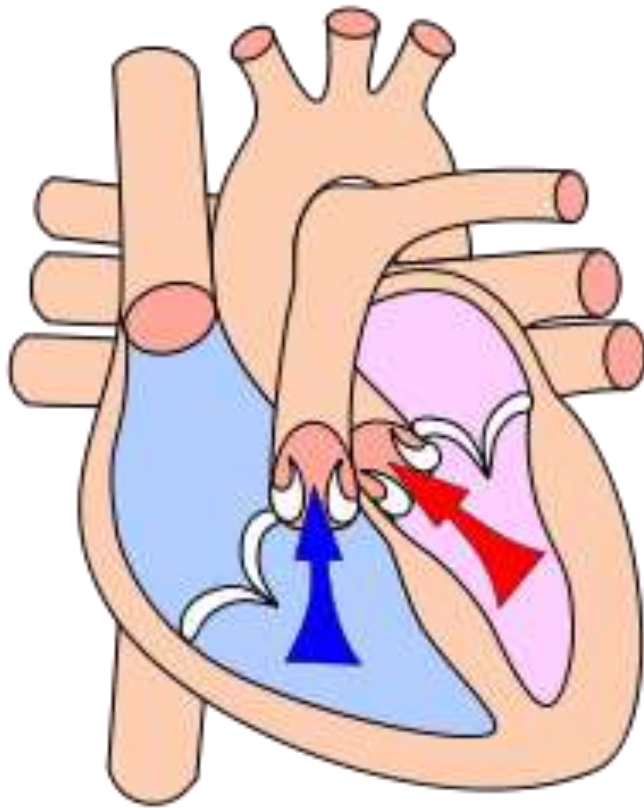
right atrium → right ventricle → pulmonary artery  
trunk → pulmonary arteries → lungs →  
pulmonary veins → heart (left atrium)

- Systemic circuit

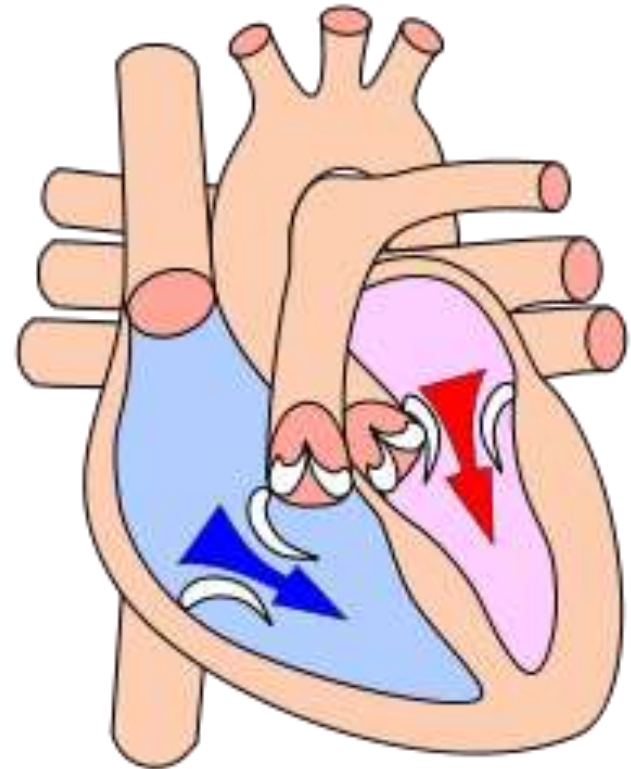
left atrium → left ventricle → aorta → arteries →  
arterioles → capillaries → venules → veins →  
vena cava → heart (right atrium)

# The Heart : Eternal Pump

- The Heart : Eternal Pump
- An electro-mechanical system
- Weighs 11 ounces (size of fist)
- Pumps 2,000 gallons of blood
- Beats 100,000 times/day 2.5 billion times in lifetime

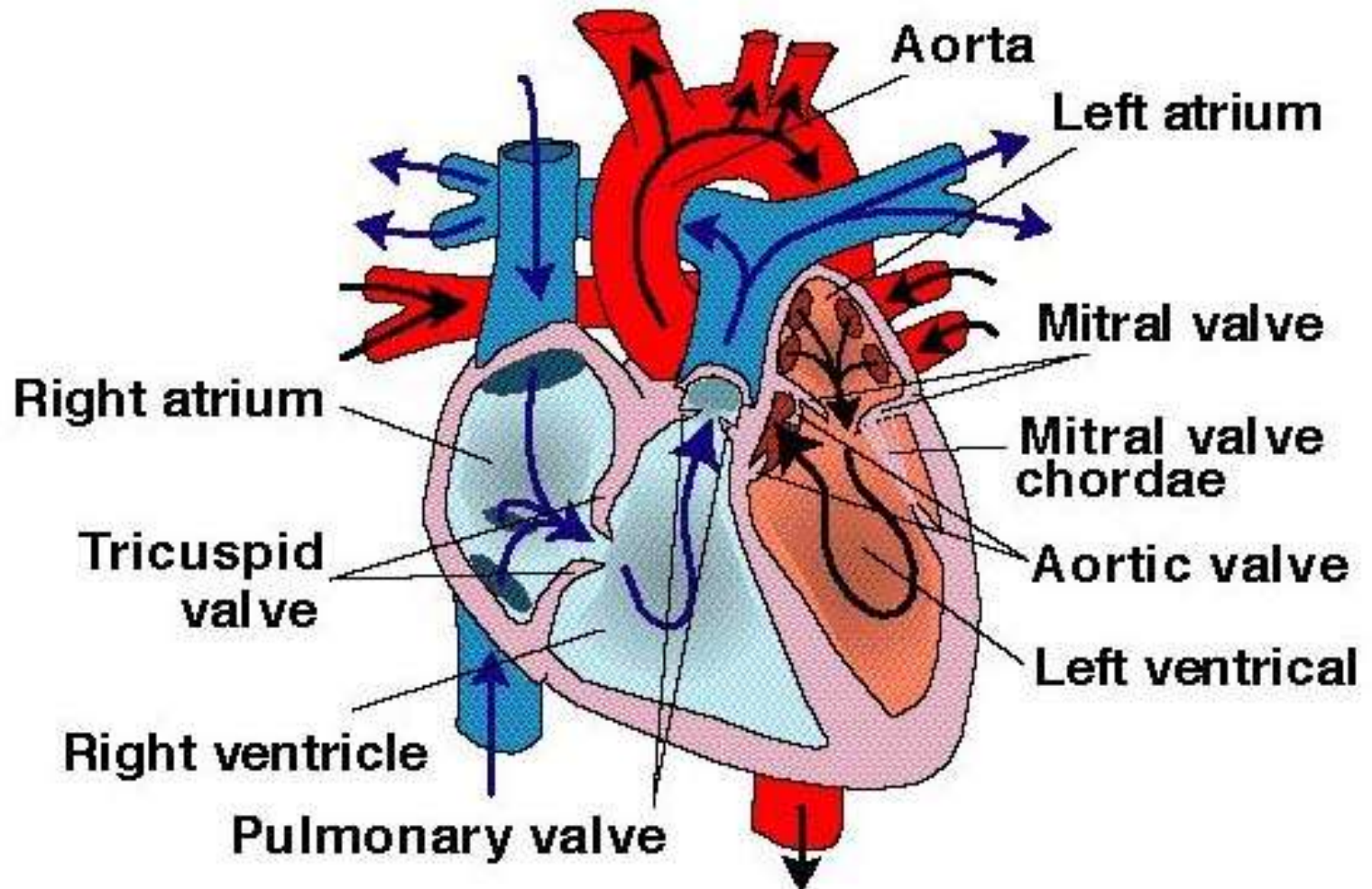


**Systole**



**Diastole**

# Heart Chambers and Valves



HEART and VALVES

# The Heart: *Heart Sounds*

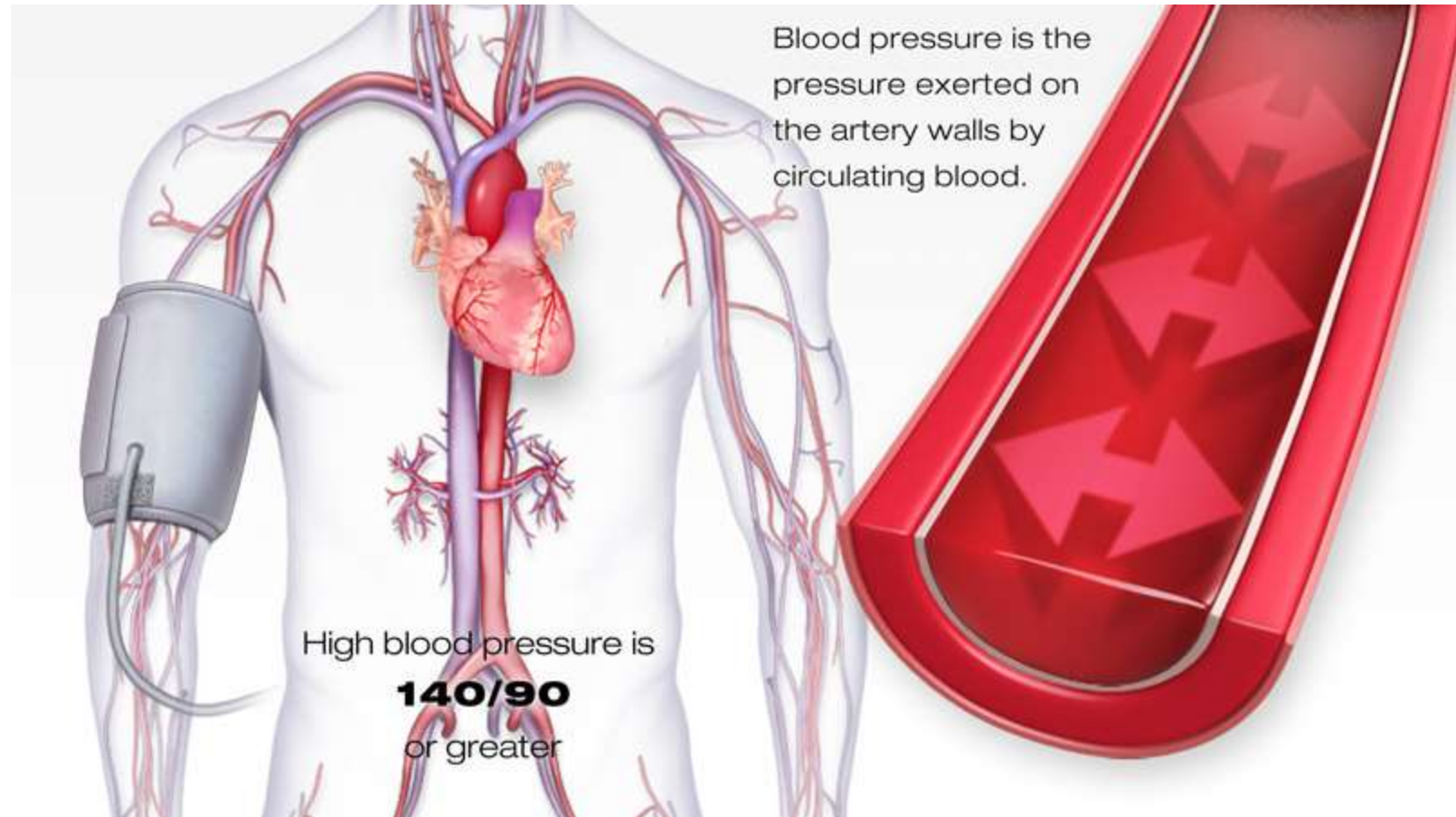
- One cardiac cycle – two heart sounds (lubb and dubb) when valves in the heart snap shut
  - Lubb – First sound
    - When the ventricles contract, the tricuspid and bicuspid valves snap shut
  - Dubb – Second sound
    - When the atria contract and the pulmonary and aortic valves snap shut

**Cardiac output** – the volume of blood pumped from each ventricle per minute:

$$\begin{array}{ccccc} \text{CO} & = & \text{SV} & \times & \text{HR} \\ \text{cardiac output} & = & \text{stroke volume} & \times & \text{heart rate} \\ (\text{ml/minute}) & & (\text{ml/beat}) & & (\text{beats/min}) \end{array}$$

- a. Average heart rate = 70 bpm
- b. Average stroke volume = 70–80 ml/beat
- c. Average cardiac output = 5,500 ml/minute





Blood pressure is the pressure exerted on the artery walls by circulating blood.

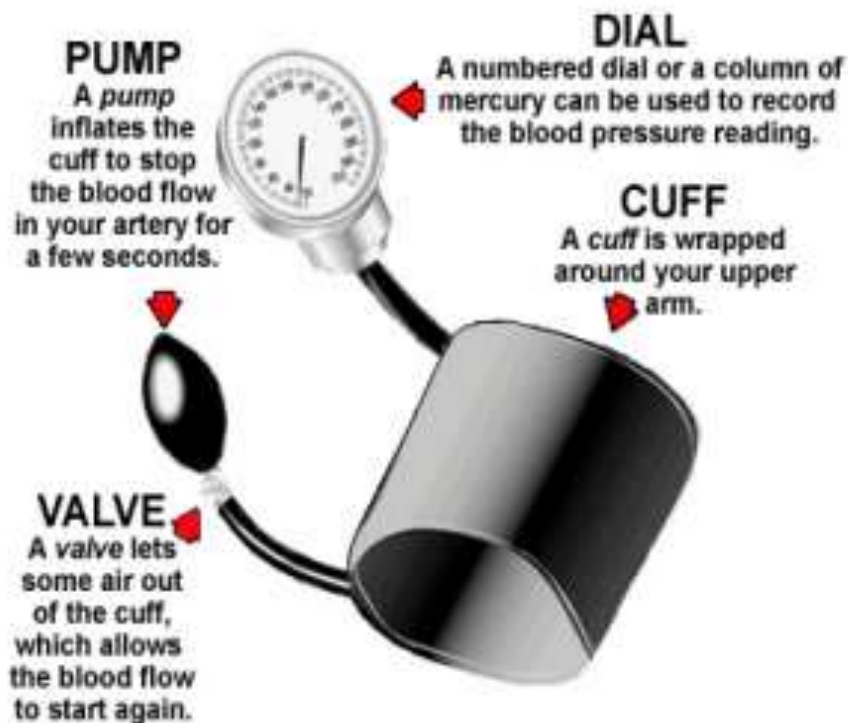
High blood pressure is  
**140/90**  
or greater

# Blood Pressure

- **Blood pressure** is one of the vital signs, along with respiratory rate, heart rate, oxygen saturation, and body temperature.

# Blood Pressure

- The blood pressure of blood vessels is related to the total cross-sectional area
- Capillary blood pressure is low because of large total cross-sectional area.
- Artery blood pressure is high because of small total cross-sectional area
- Sphygmomanometer



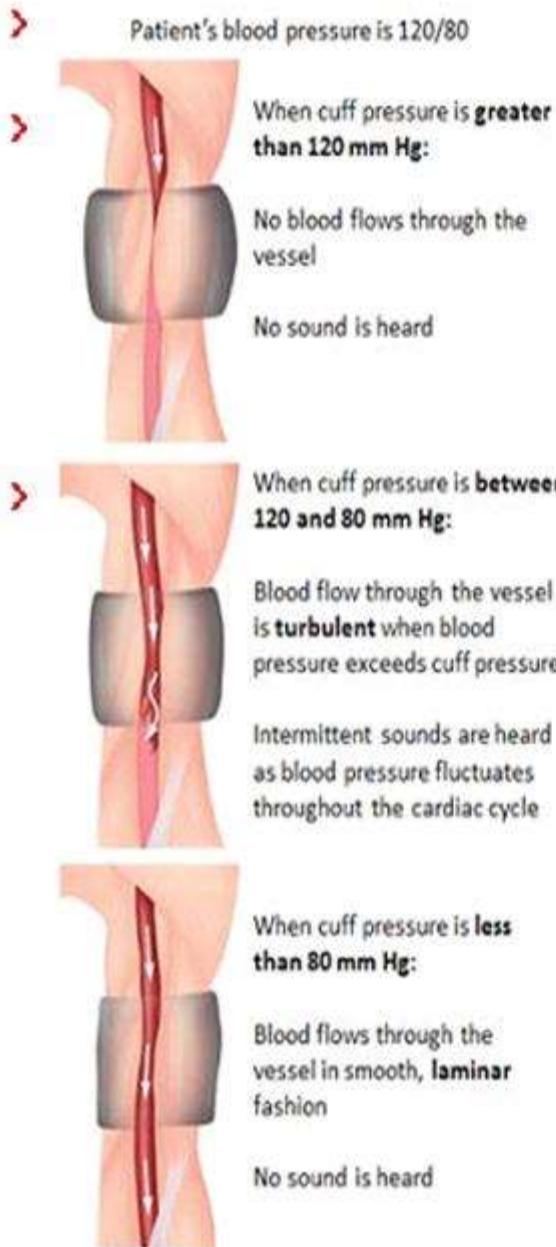
**STETHOSCOPE**  
A stethoscope is used to hear the sound of blood rushing back through the artery. The first thumping sound is the systolic blood pressure. When the thumping sound is no longer heard, that's the diastolic pressure.



# Blood Pressure

- When blood pressure is taken, the cuff is wrapped around the upper portion of the arm and pumped with air until blood flow in the artery is blocked.
- As the pressure in the cuff is relaxed, 2 numbers are recorded.
  - **Systolic pressure**- the first number taken, is the force felt in the arteries when the ventricles contract.
  - **Diastolic pressure**- the second number taken, is the force of the blood on the arteries when the ventricles relax.

## Measurement of BP



Blood pressure cuff is inflated above systolic pressure, occluding the artery. As cuff pressure is lowered, the blood will flow only when systolic pressure is above cuff pressure, producing the sounds of Korotkoff.

- Named after Dr. Nikolai Korotkoff, a Russian physician who described them in 1905.

**Korotkoff sounds** will be heard until cuff pressure equals diastolic pressure, causing the sounds to disappear



# Blood Pressure Stages

Blood Pressure Category	Systolic mm Hg (upper #)		Diastolic mm Hg (lower #)
Normal	less than 120	and	less than 80
Elevated	120-129	and	less than 80
High Blood Pressure (Hypertension) Stage 1	130-139	or	80-89
High Blood Pressure (Hypertension) Stage 2	140 or higher	or	90 or higher
Hypertensive Crisis (Seek Emergency Care)	higher than 180	and/or	higher than 120

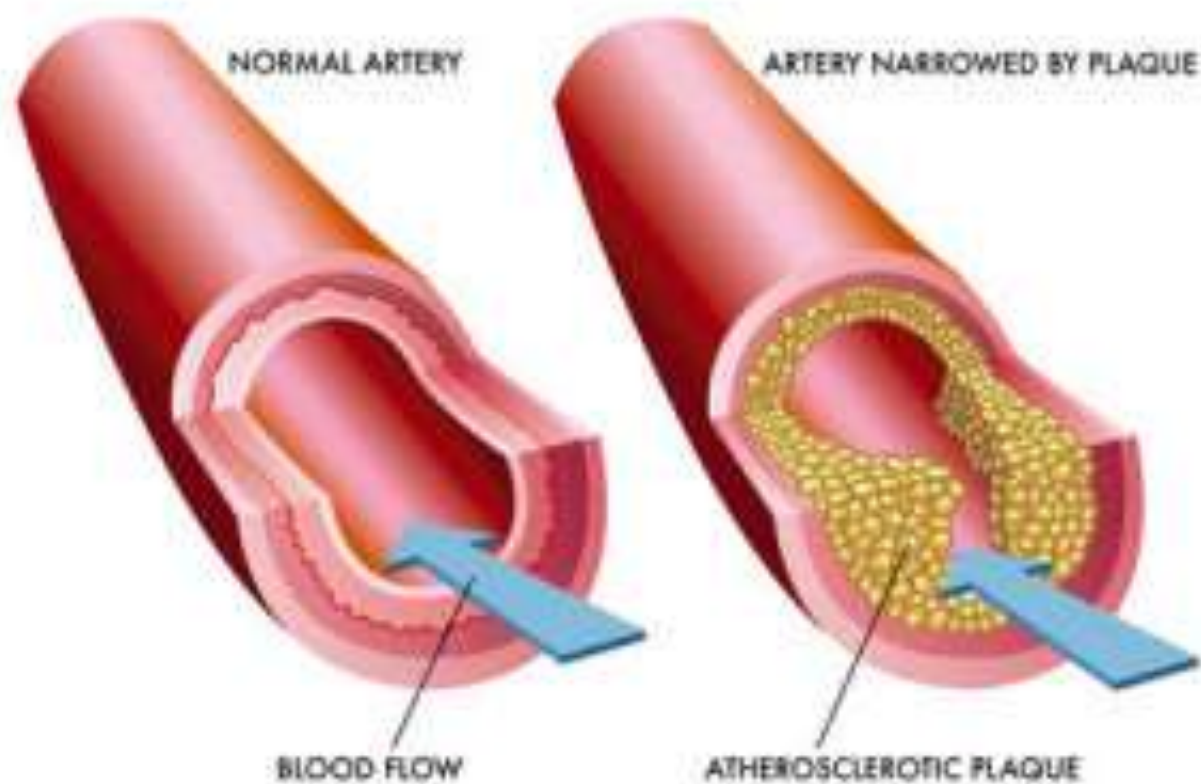
Source: American Heart Association

# Hypertension

- **Hypertension** (HTN or HT), also known as high blood pressure (HBP), is a long-term medical condition in which the blood pressure in the arteries is persistently elevated.
- High blood pressure usually does not cause symptoms.

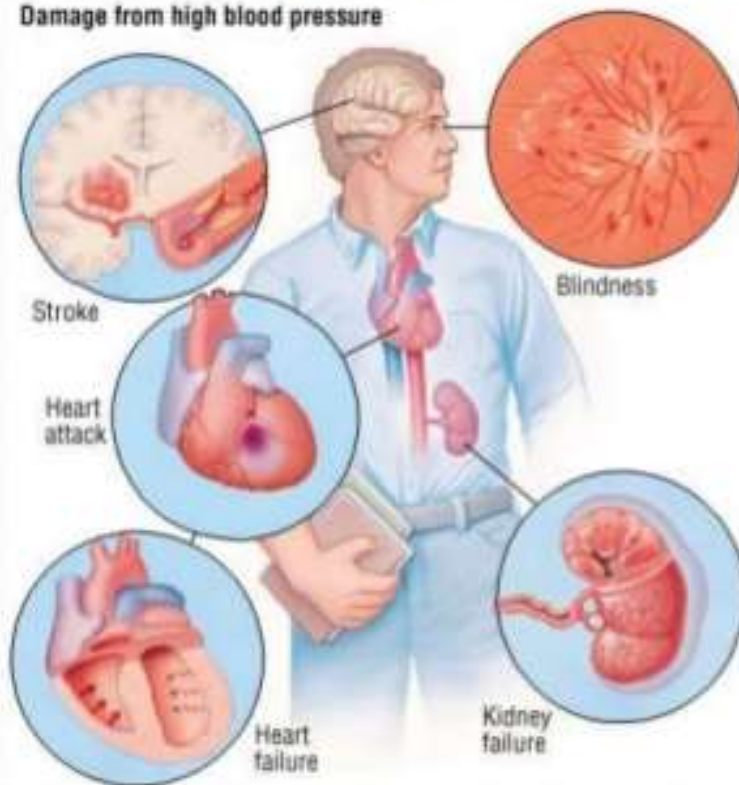


## ATHEROSCLEROSIS



# Symptoms/ Diagnosing

## Damage from high blood pressure



There are no true symptoms of high blood pressure; however, some individuals may get headaches, shortness of breath and nosebleeds. These symptoms may or may not be caused directly by the heart condition.

**Normal blood pressure** -Your blood pressure is normal if it's below 120/80 mm Hg.

**Prehypertension**- Prehypertension is a systolic pressure ranging from 120 to 139 mm Hg or a diastolic pressure ranging from 80 to 89 mm Hg. Prehypertension tends to get worse over time.

**Stage 1 hypertension**- Stage 1 hypertension is a systolic pressure ranging from 140 to 159 mm Hg or a diastolic pressure ranging from 90 to 99 mm Hg.

**Stage 2 hypertension**- More severe hypertension, stage 2 hypertension is a systolic pressure of 160 mm Hg or higher or a diastolic pressure of 100 mm Hg or higher.

High blood pressure (hypertension). (n.d.). Retrieved November 27, 2015, from <http://www.mayoclinic.org/diseases-conditions/high-blood-pressure/basics/definition/con-20019580>

Main complications of persistent  
**High blood pressure**

**Brain:**

- Cerebrovascular accident (*strokes*)
- Hypertensive encephalopathy:
  - *confusion*
  - *headache*
  - *convulsion*

**Blood:**

- Elevated sugar levels

**Retina of eye:**

- Hypertensive retinopathy

**Heart:**

- Myocardial infarction (*heart attack*)
- Hypertensive cardiomyopathy: *heart failure*

**Kidneys:**

- Hypertensive nephropathy: *chronic renal failure*

