Notes for the

Cardiovascular System

Anatomy & Physiology

2017

Mr. Johnson

I. Overview of the Cardiovascular System

A. Major function: transportation
   1. O_2, nutrients, wastes, hormones, etc.
   2. Uses blood to carry things

B. Three major components: **heart, vessels, blood**

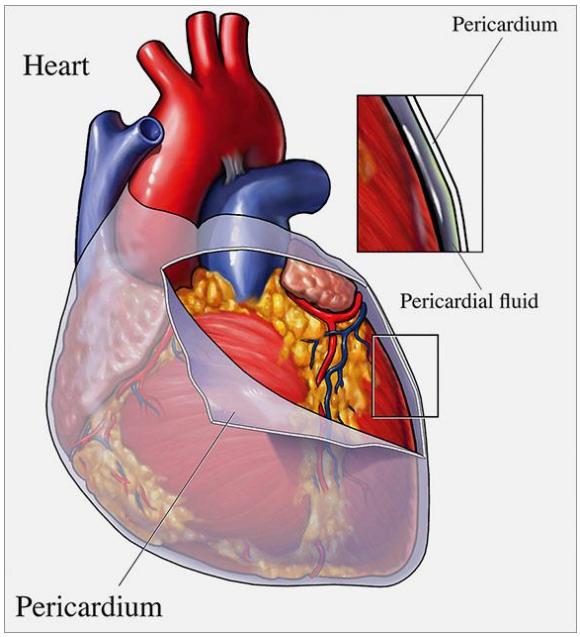
II. Heart

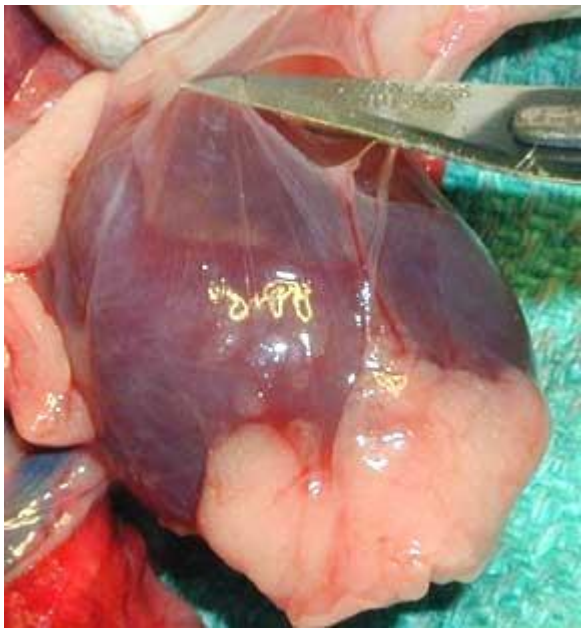
A. One-pound, fist-sized muscular pump with one-way valves.

B. Pumps about 4,000 gallons of blood daily.

C. Inferior (pointy) end called the “apex”; superior (blunt) end called the “base”.

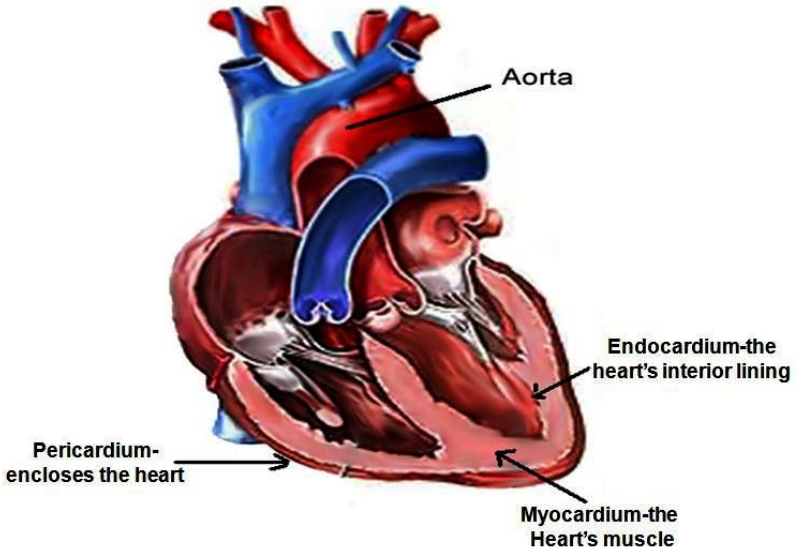
D. Covered with two layers of pericardium with fluid in between (lubrication).





E. Heart walls made of three layers:

1. Epicardium – outside layer
2. Myocardium – middle layer (cardiac muscle)
3. Endocardium – inside lining



F. Four hollow chambers (2 atria & 2 ventricles)

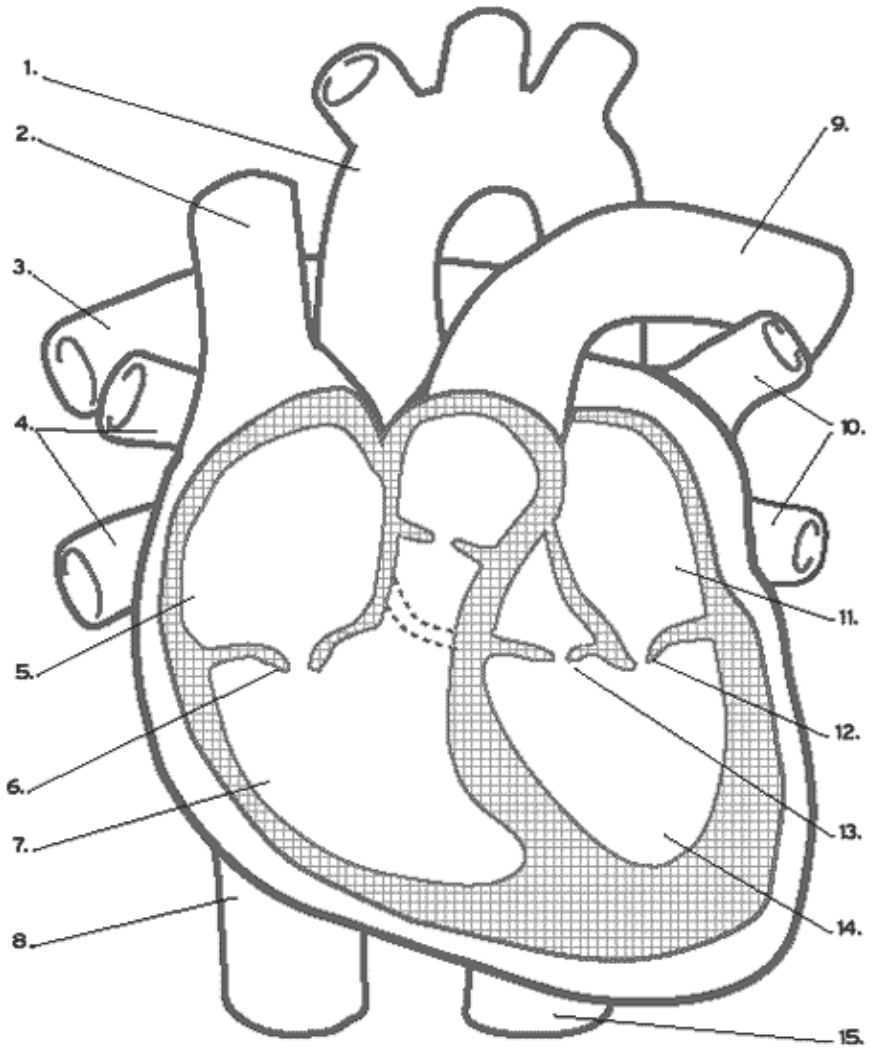
1. **Atria** – receiving chambers (not muscular)
2. **Ventricles** – sending chambers (muscular)

3. **Right A&V** – pulmonary circulation
   a. **Receive O_2**-poor blood from body.
   b. **Sends O_2**-poor blood to lungs to get O_2.

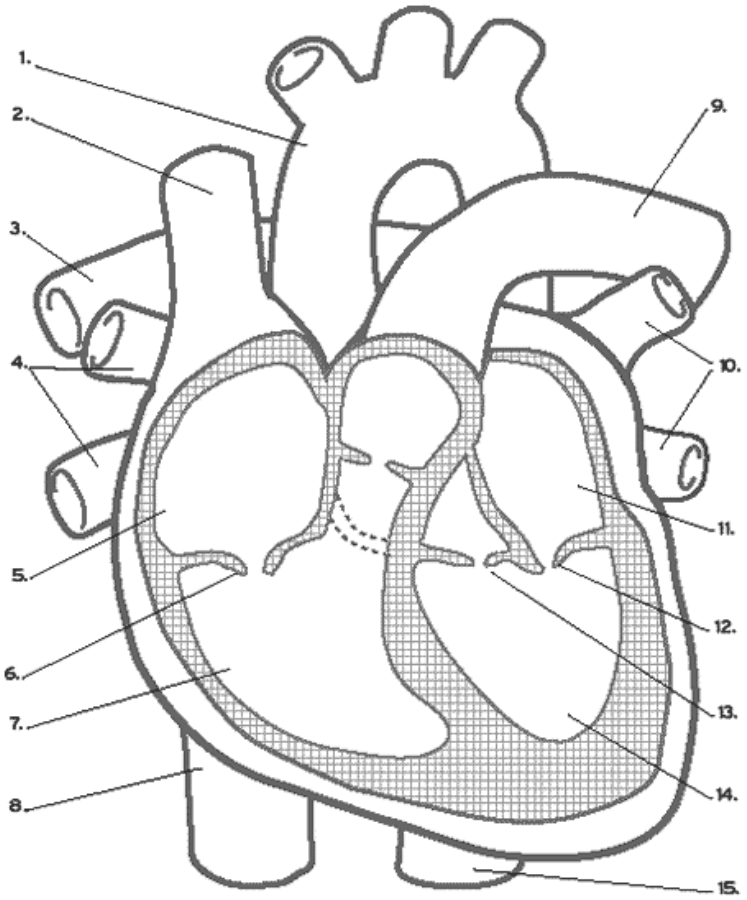
4. **Left A&V** – systemic circulation
   a. Receive O_2-rich blood from lungs.
   b. Sends O_2-rich blood to body.

III. Blood Flow through the Heart

A. Pulmonary Circulation (RA → RV → PA → lungs → PV)



B. Systemic Circulation (LA → LV → aorta → body → VC)



Assn:

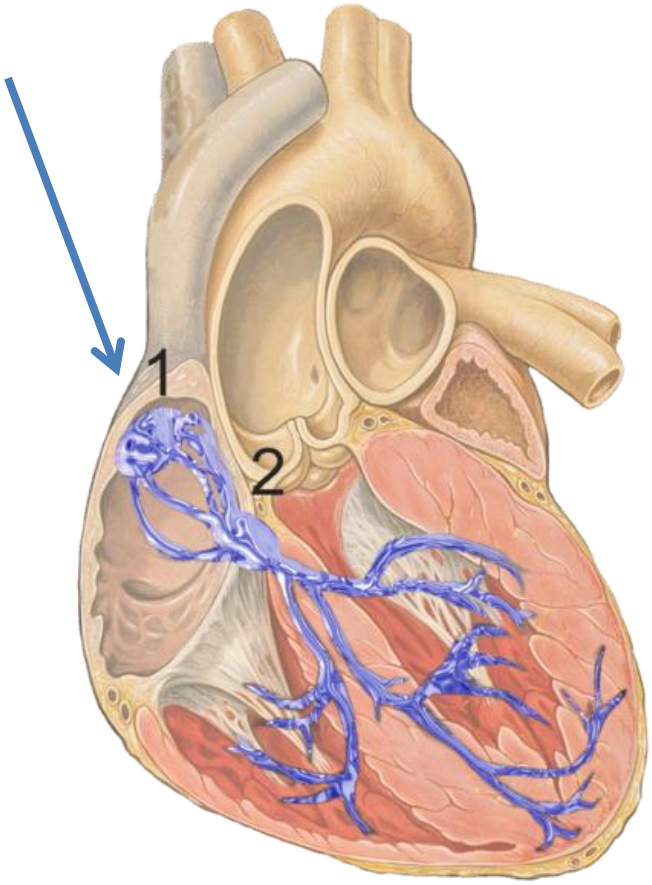
- p.348-349 Short Answer Essay #4-7
- Make a simplified drawing of the path that a drop of blood takes from the Left Atrium to the Right Atrium. Differentiate the pulmonary from systemic circuits with different colors.

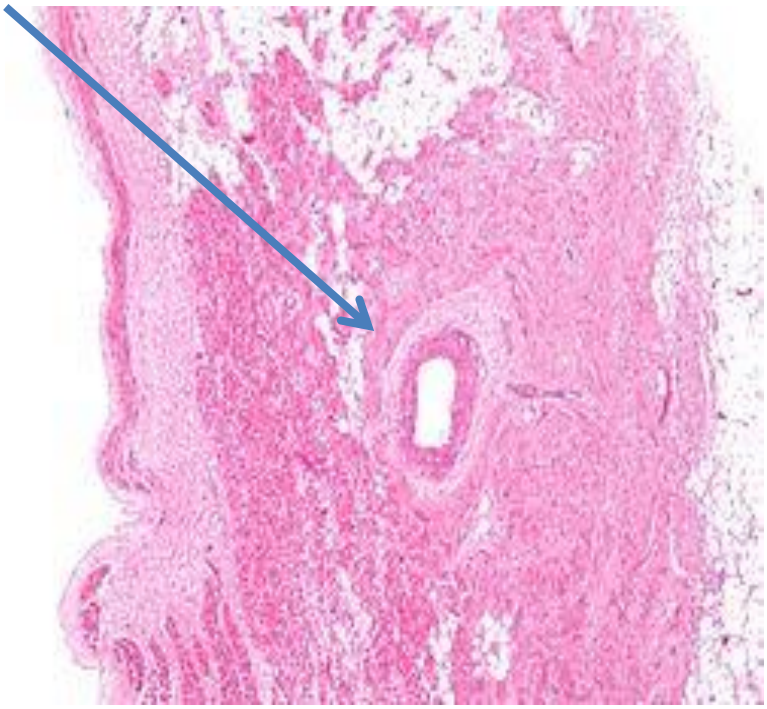
IV. Heart Stimulation & Sounds

A. Cardiac muscle can contract on its own without any stimulation, but needs to be synchronized.

B. Two systems control heart activity:

1. Intrinsic Conduction System
   a. Special tissue makes heart contraction in one-way wave (atria → ventricles)
   b. Sets pace at 75 bpm
   c. Sinoatrial (SA) node
      - Creates initial impulse of heartbeat
      - Our natural "pacemaker"
      - In right atrium of heart



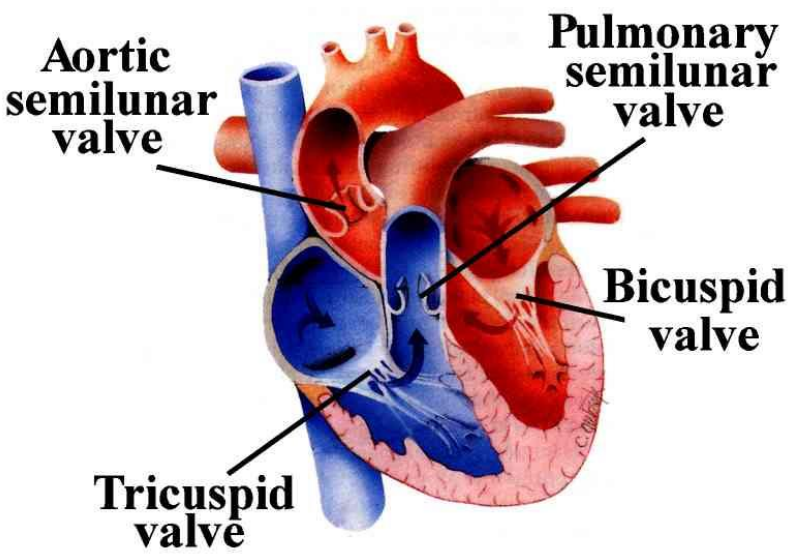


2. Brain Control

*brain acts like brakes / accelerator to modify basic rhythm set by ICS depending on body needs.

C. Heart Sounds

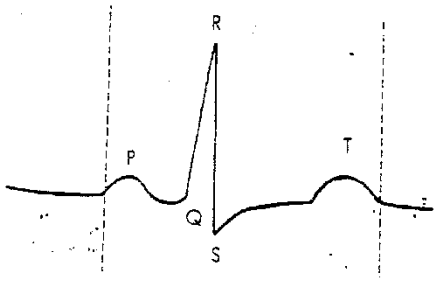
1. Cardiac cycle = one complete heartbeat (~0.8sec)
   a. Contraction of ventricle = systole (top number)
   b. Relaxation of ventricle = diastole (bottom number)
2. Beat makes "LUB-DUP" sound from valves closing
   a. "LUB" = closing of tricuspid & bicuspid valves
      (from atria to ventricles so quieter)
   b. "DUP"= closing of aortic & pulmonary semilunar valves.
      (from ventricles to lungs or whole body so louder)



   c. Leaky valves let some blood flow backward, making a gurgling sound called a "heart murmur".

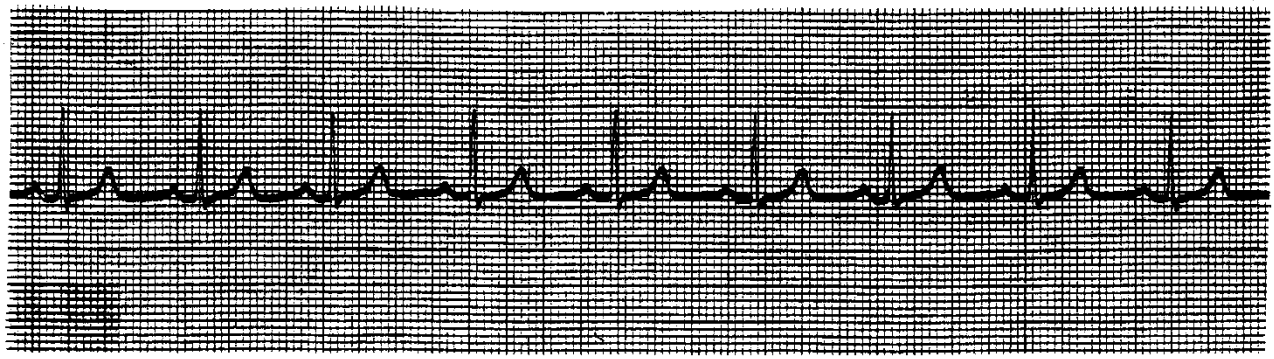
V. Reading Electrocardiogram (EKG / ECG) Strips (3:04-3:24)

Each phase of the cardiac cycle produces a specific wave in the ECG complex.



One cardiac cycle

Normal Sinus Rythym



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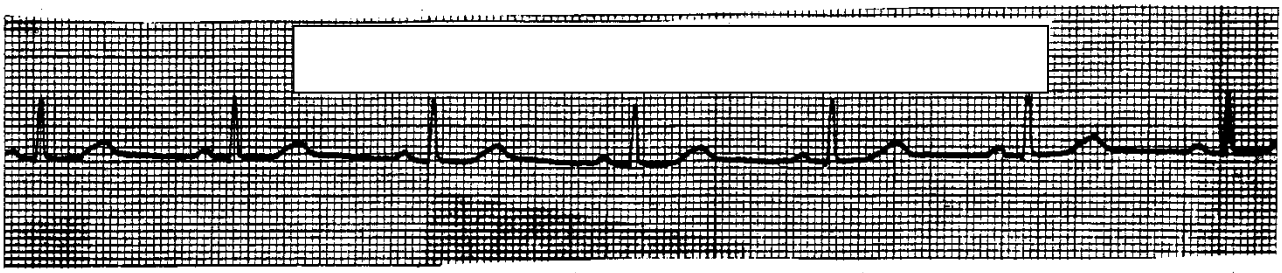

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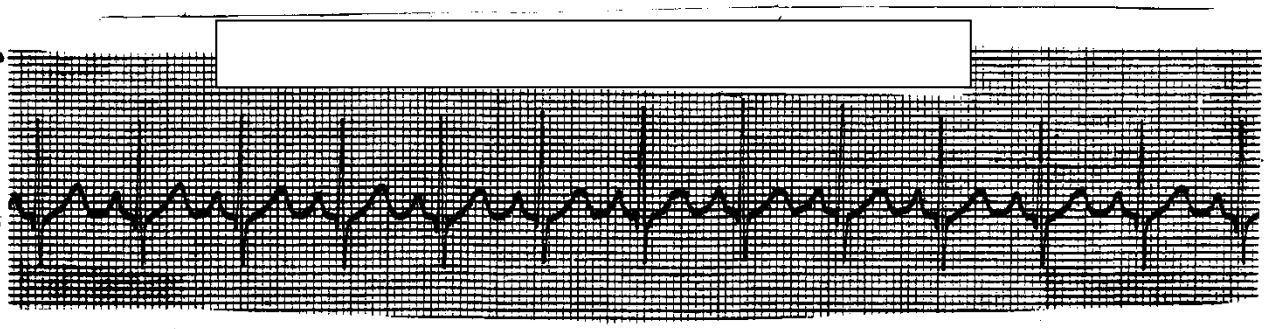

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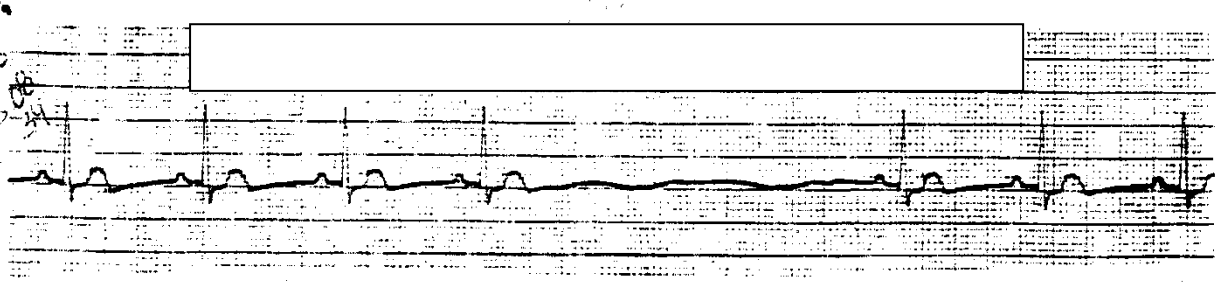

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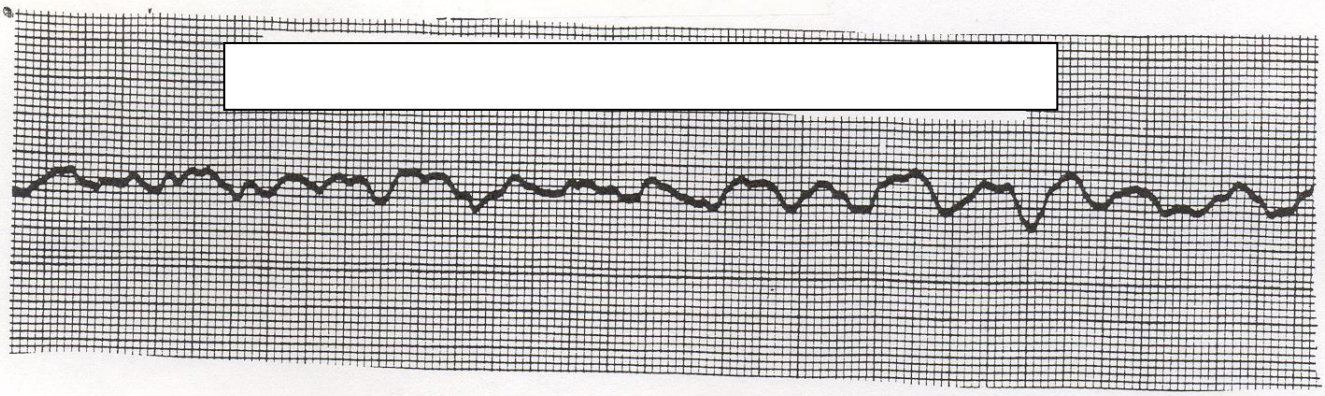

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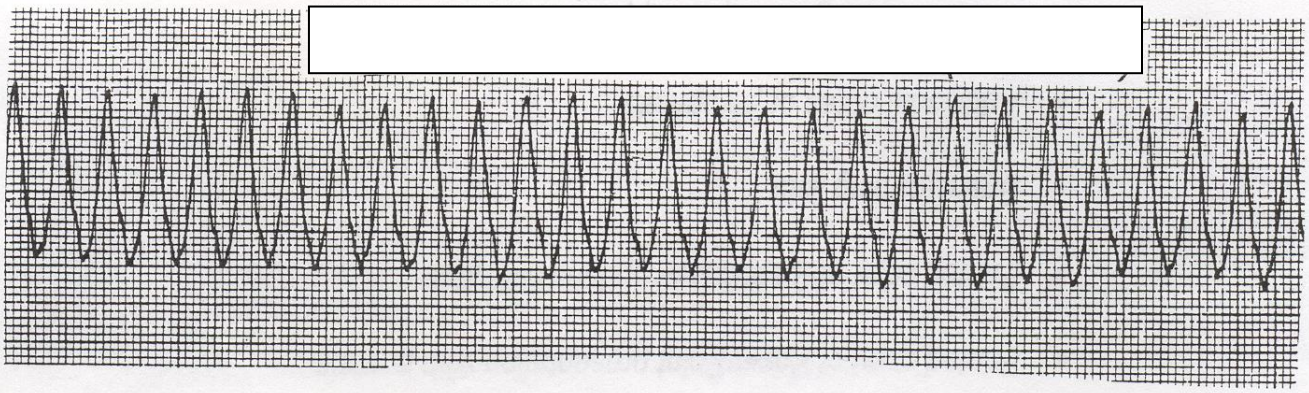

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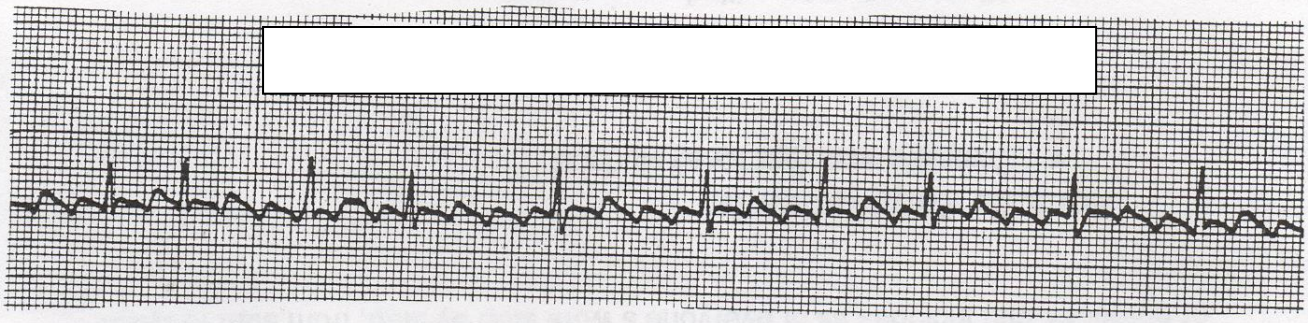

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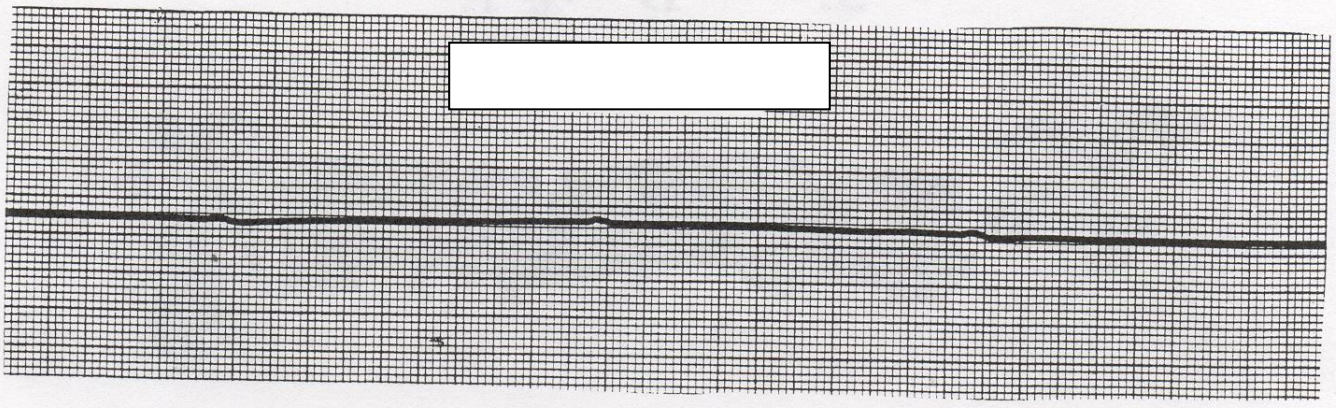


Assignment for Tuesday 3/17:

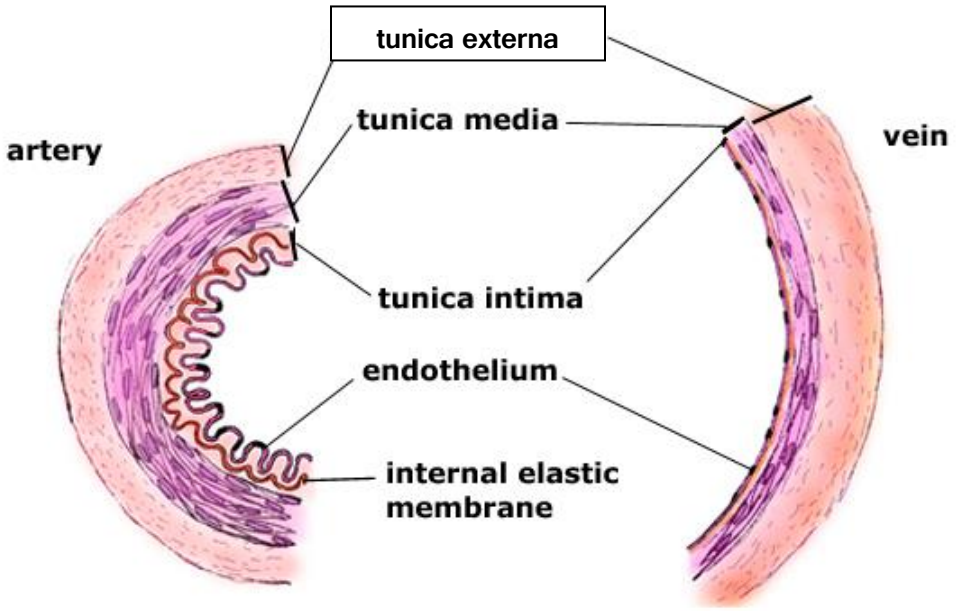
- Find three abnormal heart sounds. For each, describe how it sounds and the cause of it. Yes, you may use “murmur” as one of your three.

- Explain how a defibrillator works.

VI. Blood Vessels

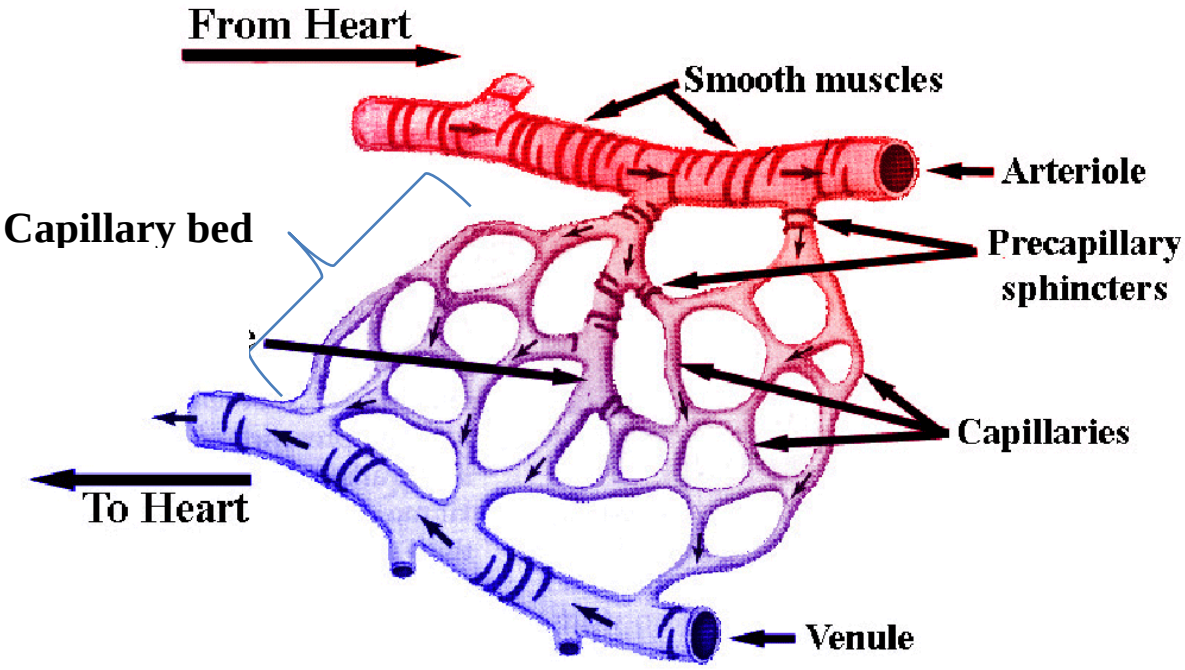
A. Vessel walls made of 3 layers:

1. Tunica intima – slick inner layer.
2. Tunica media – middle layer of smooth muscle.
    - Dilation – vessel open up larger
    - Constriction – vessel squeezes smaller
3. Tunica externa – outer layer of fibrous connective tissue for protection.



B. Arteries - vessels that carry blood ***away*** from heart.
   1. Oxygen-rich blood (except for pulmonary artery).
   2. Arterioles – smaller arteries.
   3. Capillaries – smallest vessels where gas exchange happens between blood and body cells.

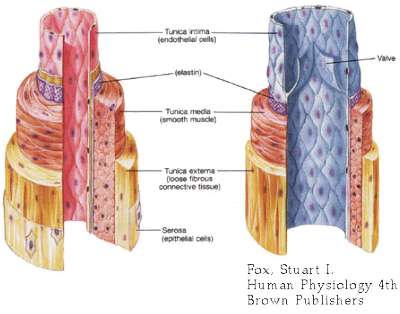
C. Veins – vessels that carry blood ***back*** to the heart.
   1. Oxygen-poor blood (except for pulmonary vein).
   2. Venules – small veins that drain capillaries.



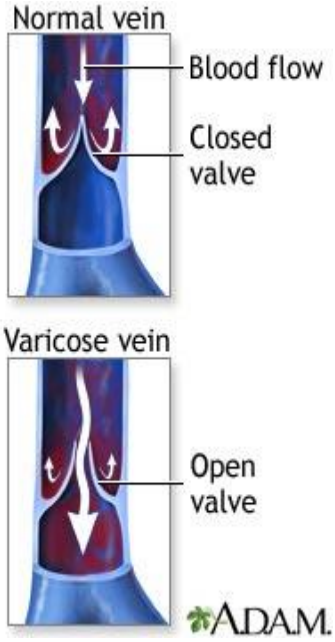
D. Differences between arteries and veins:

1. Arterial blood is under more pressure than venous blood.
   *Arteries spurt, veins ooze.
2. The walls of arteries are thicker than the walls of veins.
3. Veins have valves that prevent backflow.
   *less pressure because farther from heart
   *against gravity
   *common site of blood clots
4. “Arteries pump, veins dump”

artery vein



Fox, Stuart I.
Human Physiology 4th
Brown Publishers



VII. Blood

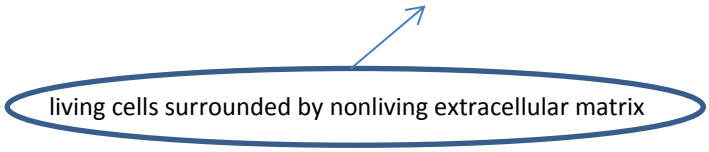
A. The vehicle that the cardiovascular system uses to transport materials throughout the body:

- Gases
- Nutrients
- Wastes
- Heat

B. Physical characteristics:

1. Scarlet (O_2-rich/arteries) to dull red (O_2-poor/veins)
2. Heavier and 5x thicker than water
3. Narrow pH range: 7.35-7.45
4. 100.4°F (warmer than body)
5. 5-6 liters (8% of total body weight)

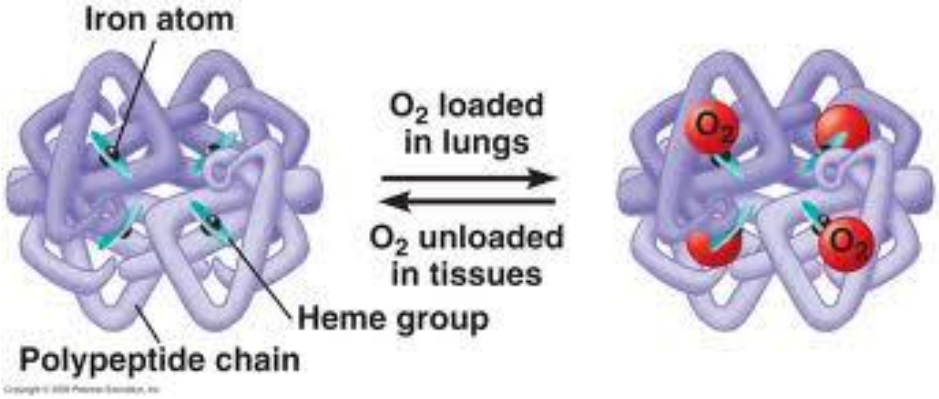
C. Considered to be <u>connective tissue</u>.



D. Major Components:

1. Plasma (the nonliving extracellular matrix)
    a. 90% water
    b. 100's of things dissolved in it
    c. Plasma proteins:
        - Albumin – keeps correct amount of water in the blood
        - Antibodies – protection from pathogens
        - Clotting proteins – control blood loss

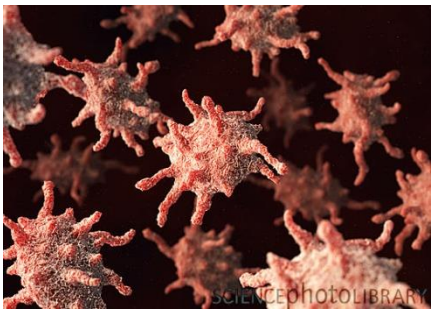
2. Formed Elements (the living cells in the plasma)
    a. Erythrocytes (RBC's)
        - the most abundant F.E.
        - last about 120 days
        - no nucleus
        - carry O_2 on hemoglobin (a protein with iron)



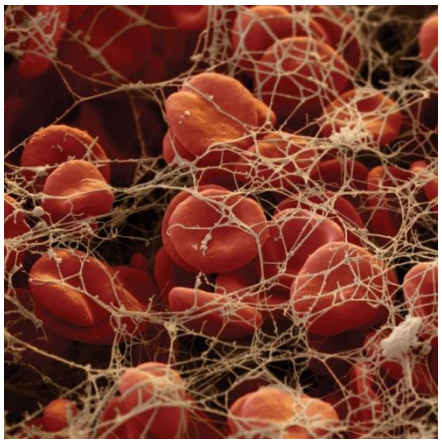
b. Leucocytes (WBC's)

- Fight disease
- Respond to chemicals given off by infected tissue
- Leukocytosis – elevated WBC count which indicates disease or infection.

c. Platelets



- Irregular-shaped cell fragments.
- Hemostasis (blood clotting):



  - Cling to ruptured tunica intima of vessel (usually very smooth but rough when injured)
  - Plug causes vessel to spasm and constrict
  - Protein "fibrin" forms which traps RBC's to make clot
  - Usually takes 3-6 minutes

E. Blood Typing

*Antigens – molecular “name tags” on the surface of RBC’s which are recognized by antibodies.

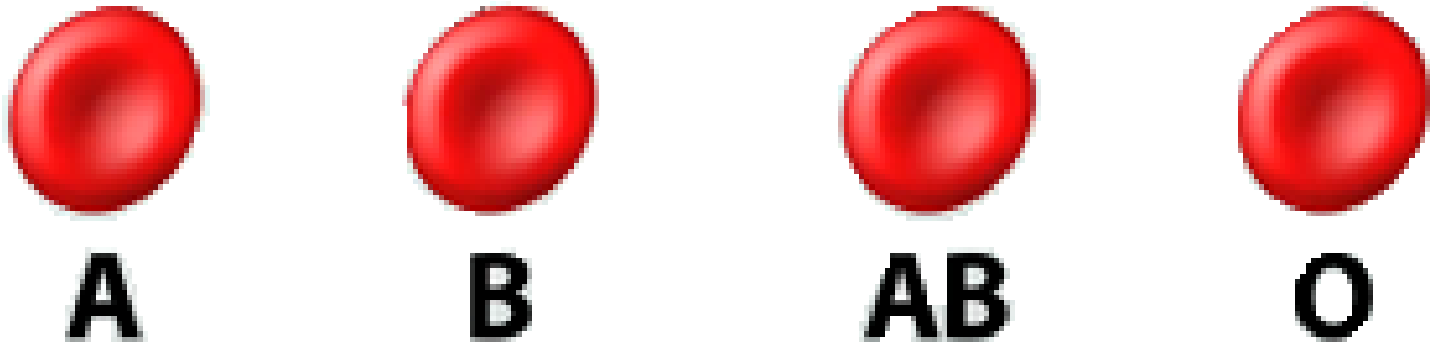
*Antibodies – cells in the immune system which destroy RBC’s with matching antigens.

Two “factors” *(genes, actually)* determine blood type:

- The ABO factor and the…
- Rh factor

1. The ABO-factor

Blood Type	Antigen	Antibody
A	A	B
B	B	A
AB	A &B	none
O	none	A & B



So……..

Type A destroys _____ but can receive from_____

Type B destroys _____ but can receive from_____

Type AB destroys _____ but can receive from_____

Type O destroys _____ but can receive from_____

The “Universal Donor” is type _____

and

The “Universal Receiver” is type _____

2. The Rh-factor

Rh-factor	Rh-antigen on surface of RBC	Rh-antibody on surface of RBC
Rh^{+}	yes	no
Rh^{--}	no	sometimes

Rh^{+} Rh^{--}

So……..

Type Rh^{+} destroys _____ and can receive from_____

Type Rh^{--} destroys _____ and can receive from_____

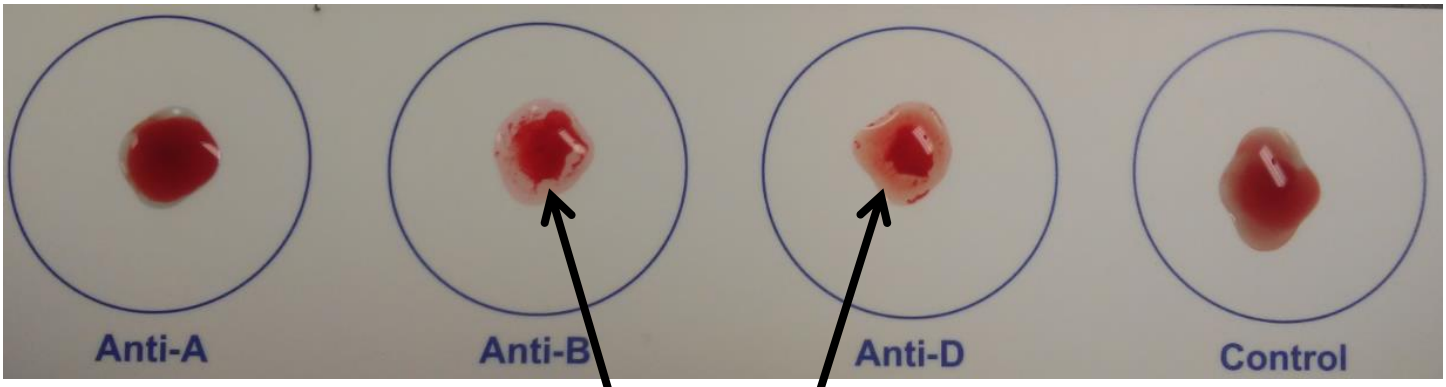
(look up Erythroblastosis fetalis)

Considering both the ABO-factor and the Rh-factor…

The “Ultimate Universal Donor” is type _____

and

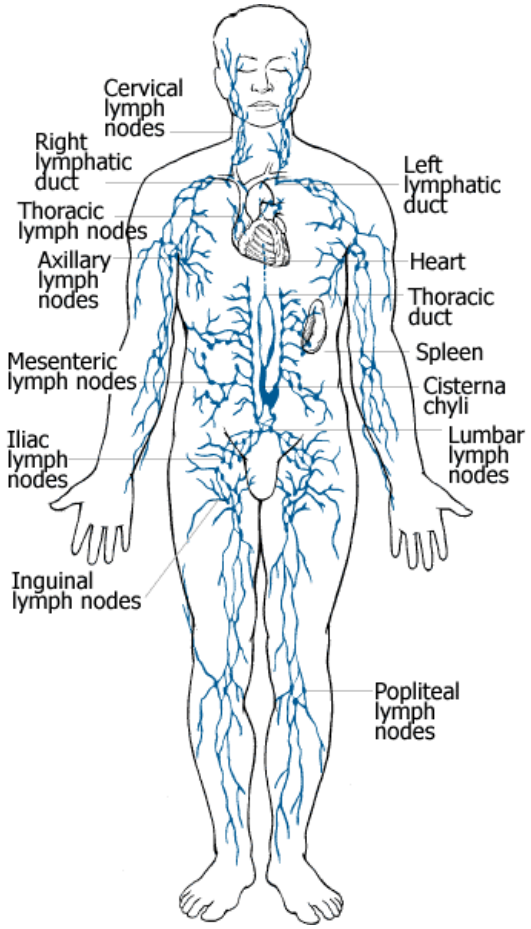
The “Ultimate Universal Receiver” is type _____



B-pos

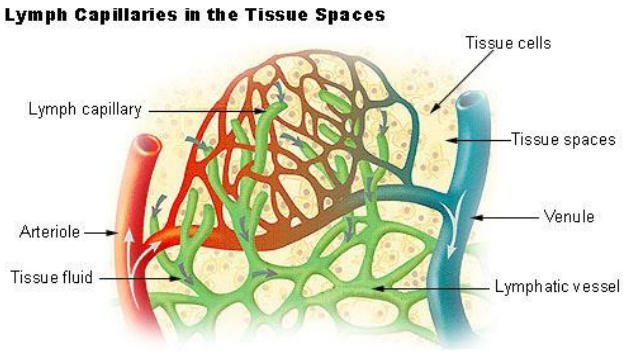
Blood type	Percent of Americans with this type
O+	37%
O–	6
A+	34
A–	6
B+	10
B–	2
AB+	4
AB–	1

VII. Lymphatic System (ch12)



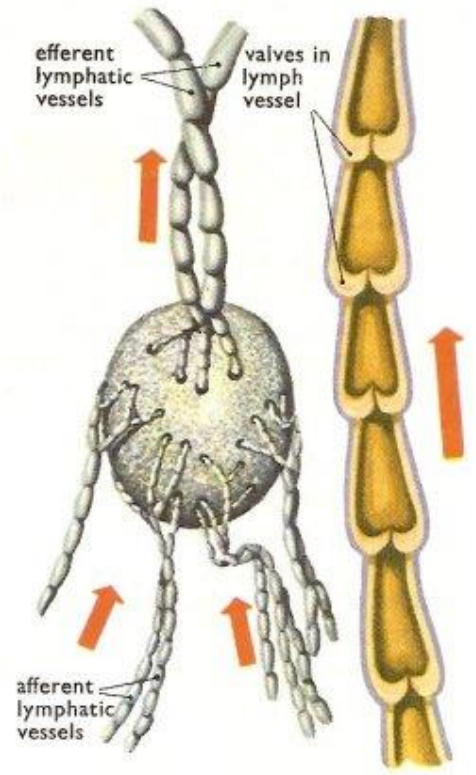
A. Two major functions
   1. Immunity (houses many infection-fighting cells)
   2. Returns fluid lost from blood back to the heart.
      *Up to 3 liters of watery fluid called "lymph" leaks through the blood vessels into the surrounding tissues every day.

B. Two basic parts to this system:
   Lymphatic Vessels
   a. One-way system of capillaries that take fluid from tissues back to the heart (via subclavian veins).



   b. Very permeable to fluid called "lymph".

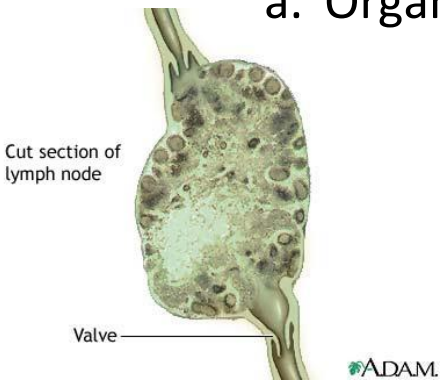
c. Lymph pumped back to heart by "milking" action of skeletal muscles.

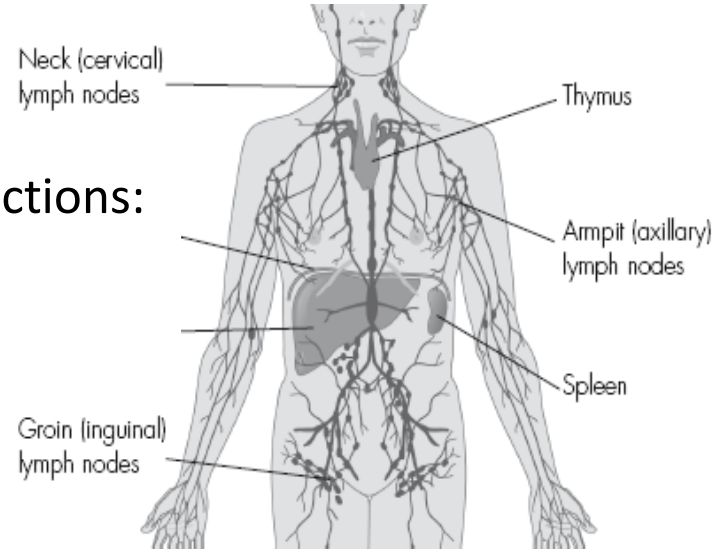


2. Lymphoid Organs

a. Organs with Immunity functions:

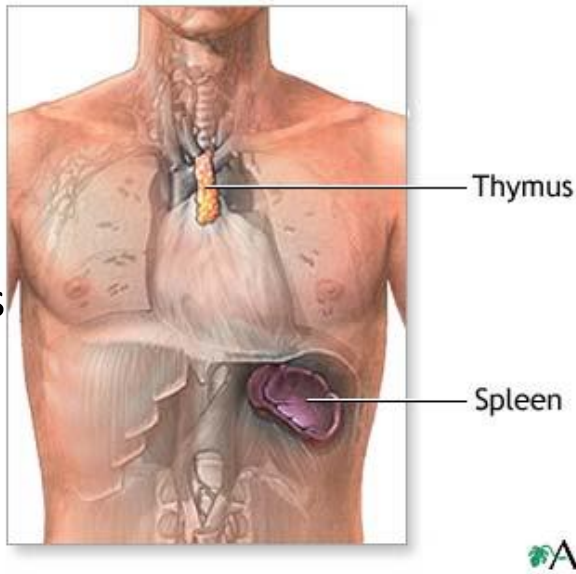
- lymph nodes
- thymus gland
- tonsils





b. Cardiovascular functions:

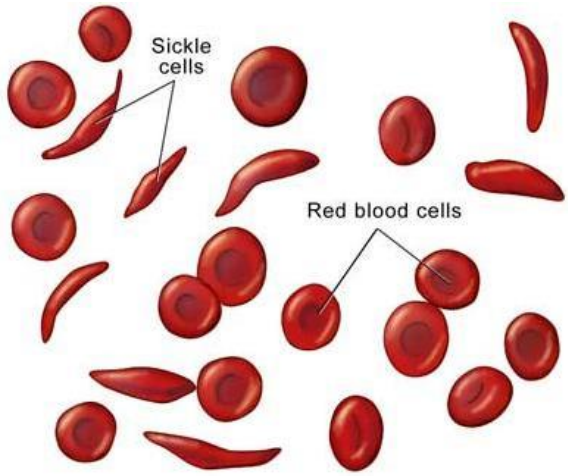
- Spleen
  - filters blood
  - destroys worn-out RBC's
  - recycles iron
  - stores platelets
  - blood reservoir



VIII. Cardiovascular System Disorders

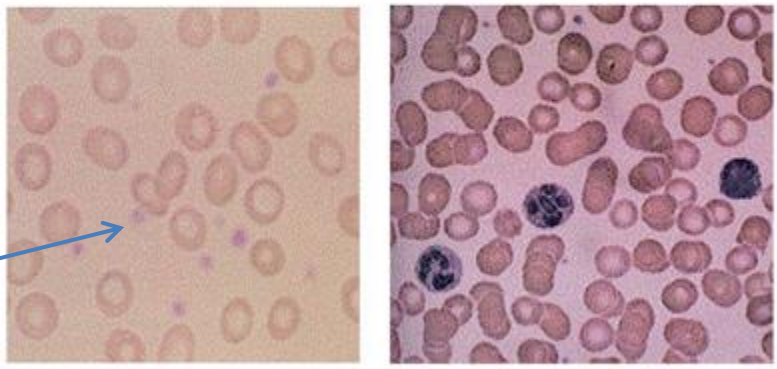
A. Anemia – blood does not carry enough oxygen.

1. Sickle Cell Anemia – misshaped RBC's



2. Iron Deficient Anemia – not enough Fe to carry O_2

Smaller & Paler

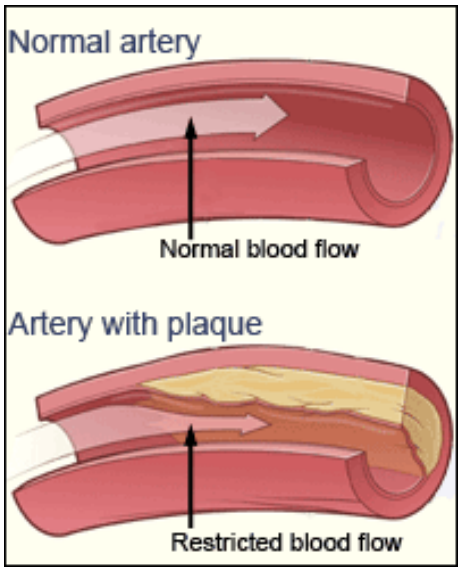


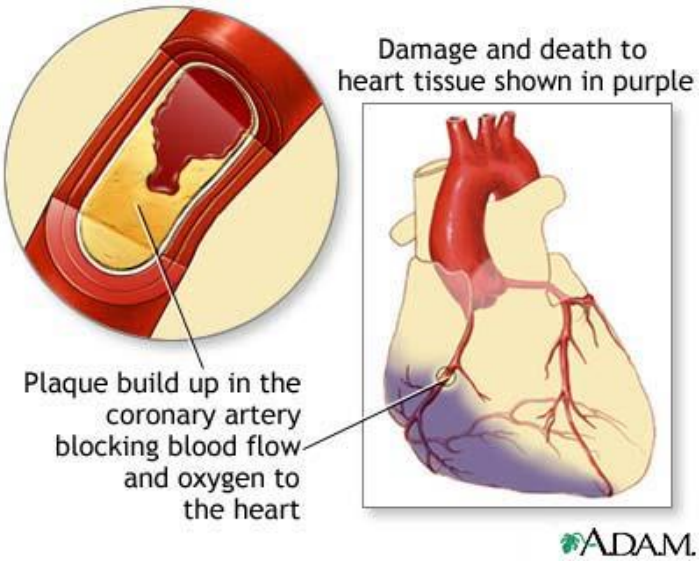
anemia

normal blood

B. Arteriosclerosis

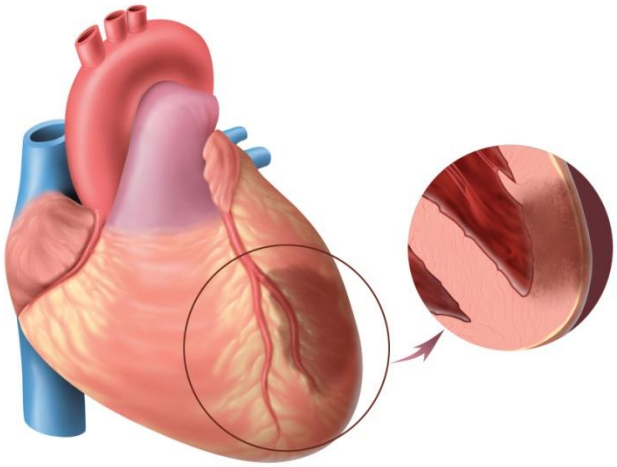
1. Thickening and toughening of artery wall.
2. Usually caused by build-up of fats (called “plaque”) from high blood cholesterol levels.
3. Reduced blood supply can result in heart attack.

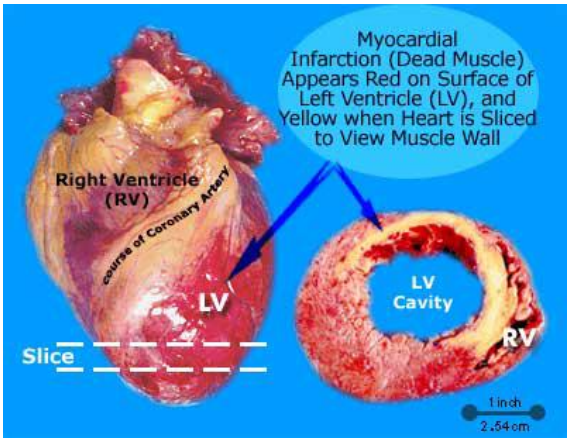




C. Heart Attack (myocardial infarction)

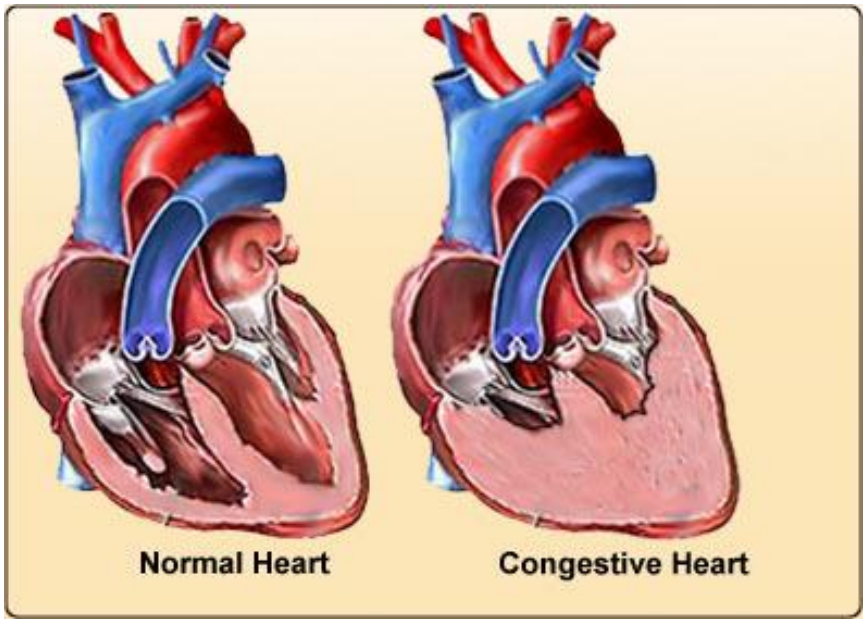
1. Blood supply to heart is blocked.
2. Cardiac muscle cells that die off are not replaced.





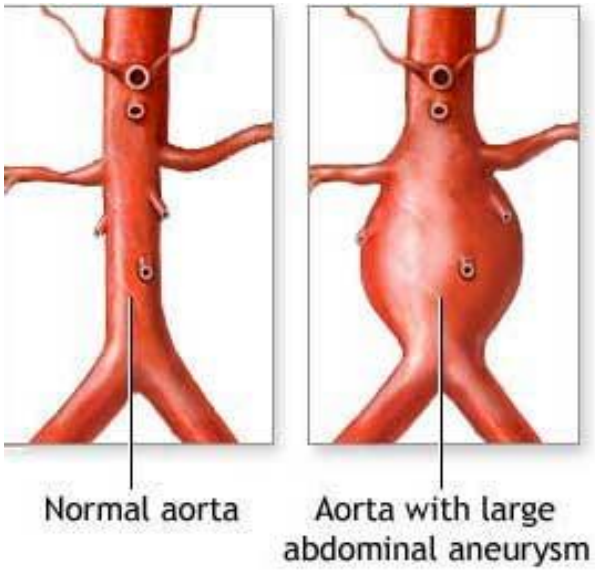
D. Congestive Heart Failure

1. Heart is too weak to deliver adequate blood to body.
2. Infections, toxins, high BP can weaken heart.



E. Aneurysm

1. Bulge in blood vessel.
2. No symptoms until burst, then catastrophic.



F. Edema – blocked lymph vessels

IX. Vital Signs – measurements of health including
- Respiratory Rate
- Body Temperature
- Arterial Pulse } *cardio*
- Blood Pressure } *functions*

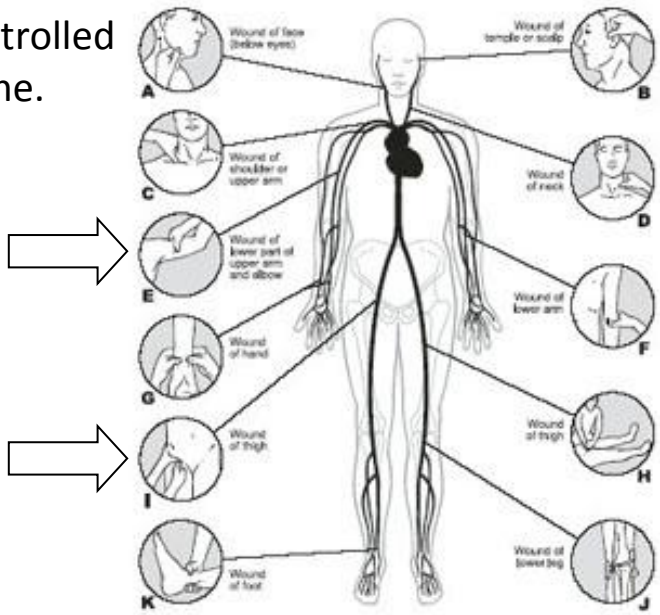
A. Arterial Pulse

1. Expansion of arterial wall during systole.

newborn (0-3 months old)	infants (3 — 6 months)	infants (6 — 12 months)	children (1 — 10 years)	children over 10 years & adults, including seniors	well-trained adult athletes

2. Also function as pressure points.

Where blood flow can be controlled by pressing artery against bone.



B. Blood Pressure

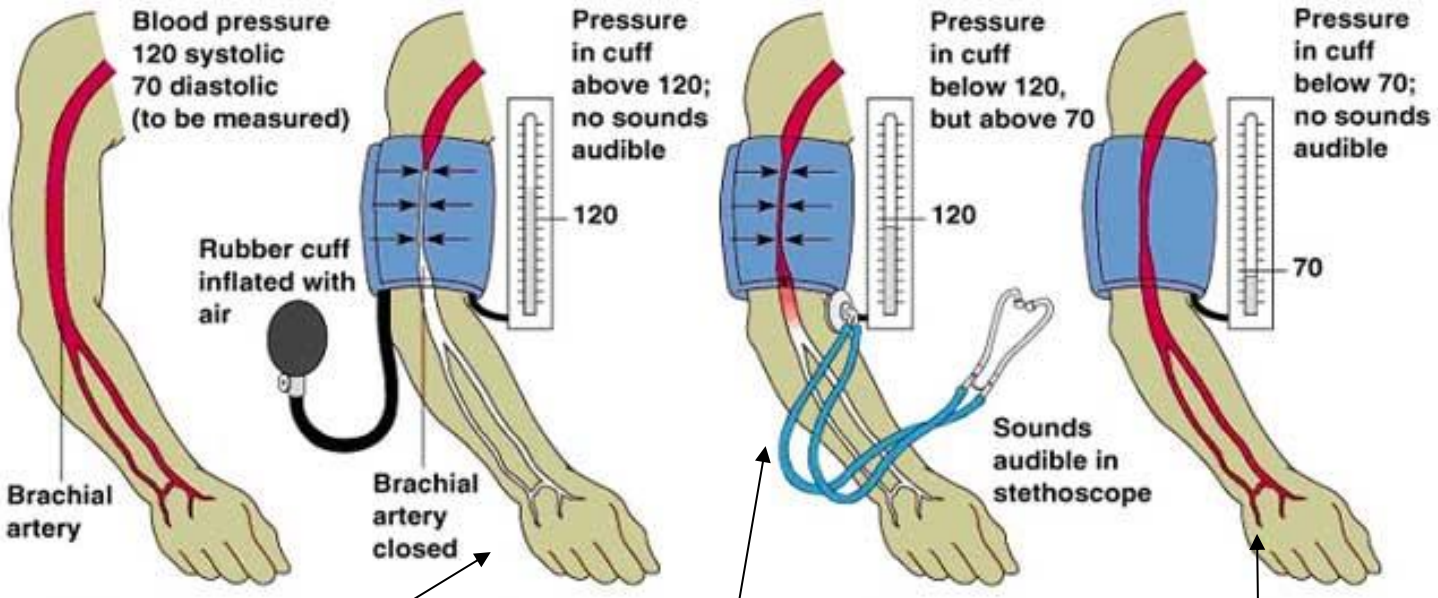
1. Exerted against arterial walls.
2. Includes two measurements
   a. Systolic Pressure
      - When ventricles are contracted
      - Higher pressure (~120mmHg)

   b. Diastolic Pressure
      - When ventricles are relaxed
      - Lower pressure (~80mmHg)

written as sys/dia

(*ex: 120/80)*

3. Measuring Blood Pressure (procedure & sounds)



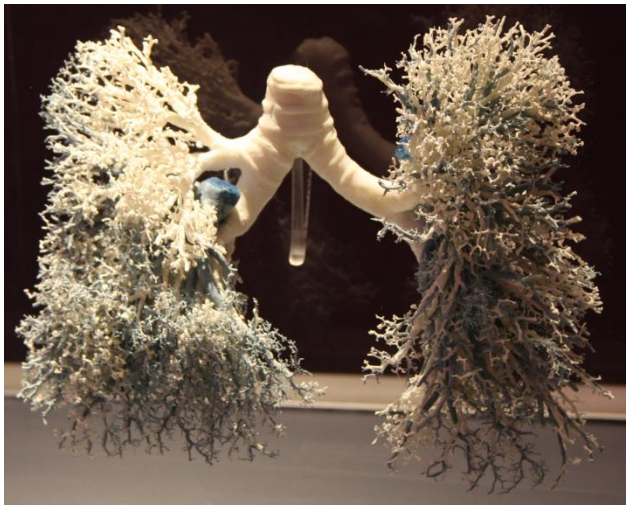
Inflate cuff until no pulse is heard below the cuff. This should be above 120mmHg. Artery is now completely pinched closed.

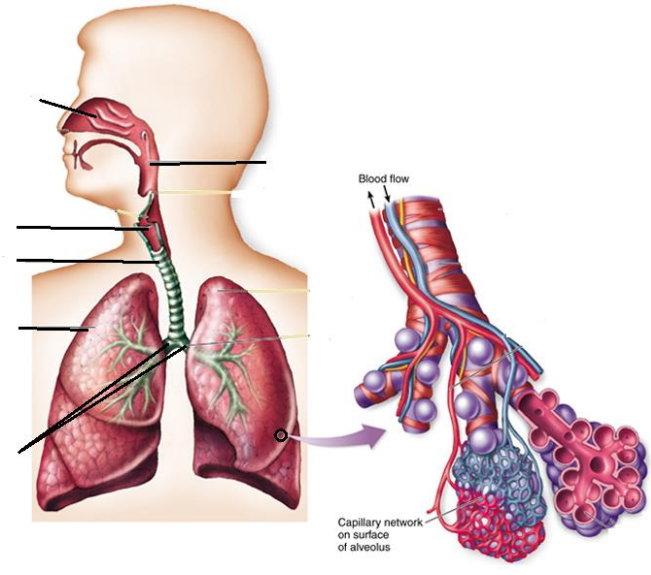
While listening for a pulse, slowly release the air from the cuff until a pulse is heard. This is the blood starting to flow through the artery under high pressure. Record this value as the systolic (contracted heart) pressure.

Continue to release pressure from the cuff until no pulse is heard. Record this value. It shows where the diastolic (relaxed heart) pressure begins, which is too low-pressure to be heard.

Notes for the RESPIRATORY SYSTEM

STRUCTURES IN THE RESPIRATORY SYSTEM	**FUNCTIONS** OF THE RESPIRATORY SYSTEM	HOW THIS SYSTEM HELPS OUR BODIES MAINTAIN **HOMEOSTASIS**

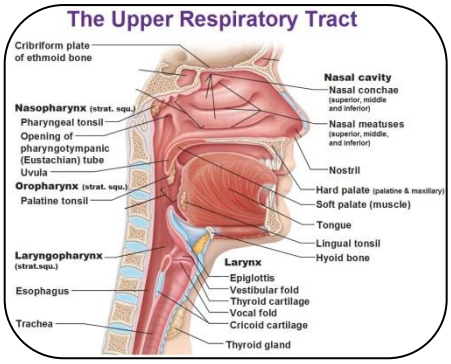




STRUCTURES IN THE RESPIRATORY SYSTEM	**FUNCTIONS** OF THIS SYSTEM	HOW THIS SYSTEM HELPS OUR BODIES MAINTAIN **HOMEOSTASIS**
Nose *Cleans & warms incoming air **Pharynx** *Passage for both food & air **Larynx** *vocal cords **Trachea** *tube for air passage to lungs **Bronchi** *separate tubes that lead to lungs **Lungs/Alveoli** *where gas exchange happens with blood	Respiration: The process by which O_2 and CO_2 are exchanged between the body's cells, the blood, and the air in the lungs.	Maintaining the proper balance of CO_2 and O_2 so the body's cells can function.

I. Respiratory System divided into TWO "tracts" (Upper & Lower)

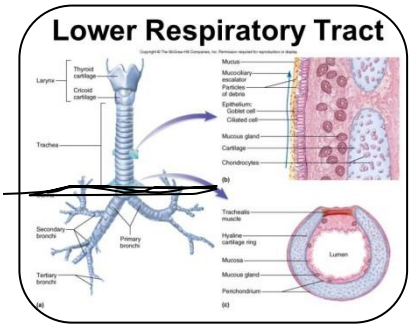
A. Upper Respiratory Tract (structures ABOVE thoracic cavity)



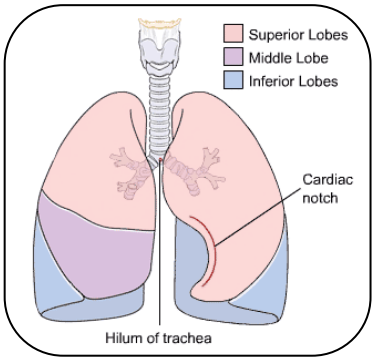
1. Nose
2. Pharynx
3. Larynx
4. Trachea
   - Supported by C-shaped cartilage

B. Lower Respiratory Tract (structures WITHIN thoracic cavity)

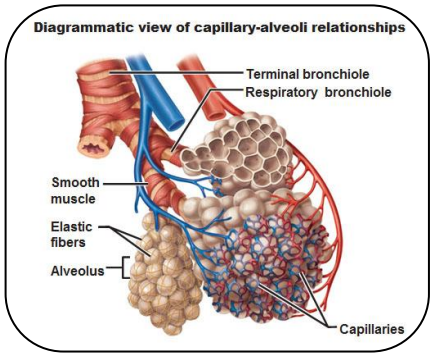
1. Primary Bronchi
2. Bronchials → Bronchioles → Alveolar Ducts
   - Series of tubes that branch smaller & smaller
   - Referred to as the "respiratory tree"



3. Lungs
   - Superior "Apex" and inferior "Base"



   - 2 lobes on left & 3 lobes on right
   - Double layer of lining ("pleura") with fluid between
     - Allows lungs to slide against rib cage
     - Causes them to stick to thoracic cavity wall
   - Alveoli
     - Small air sacs where gas exchange happens
     - Surrounded by a cobweb of wee capillaries
     - About 300 million of 'em for a total surface area of 70-80 m^2 of gas exchange



II. Pulmonary Ventilation *(aka: "Breathing")*

A. Inspiration *(aka: "Inhaling")*

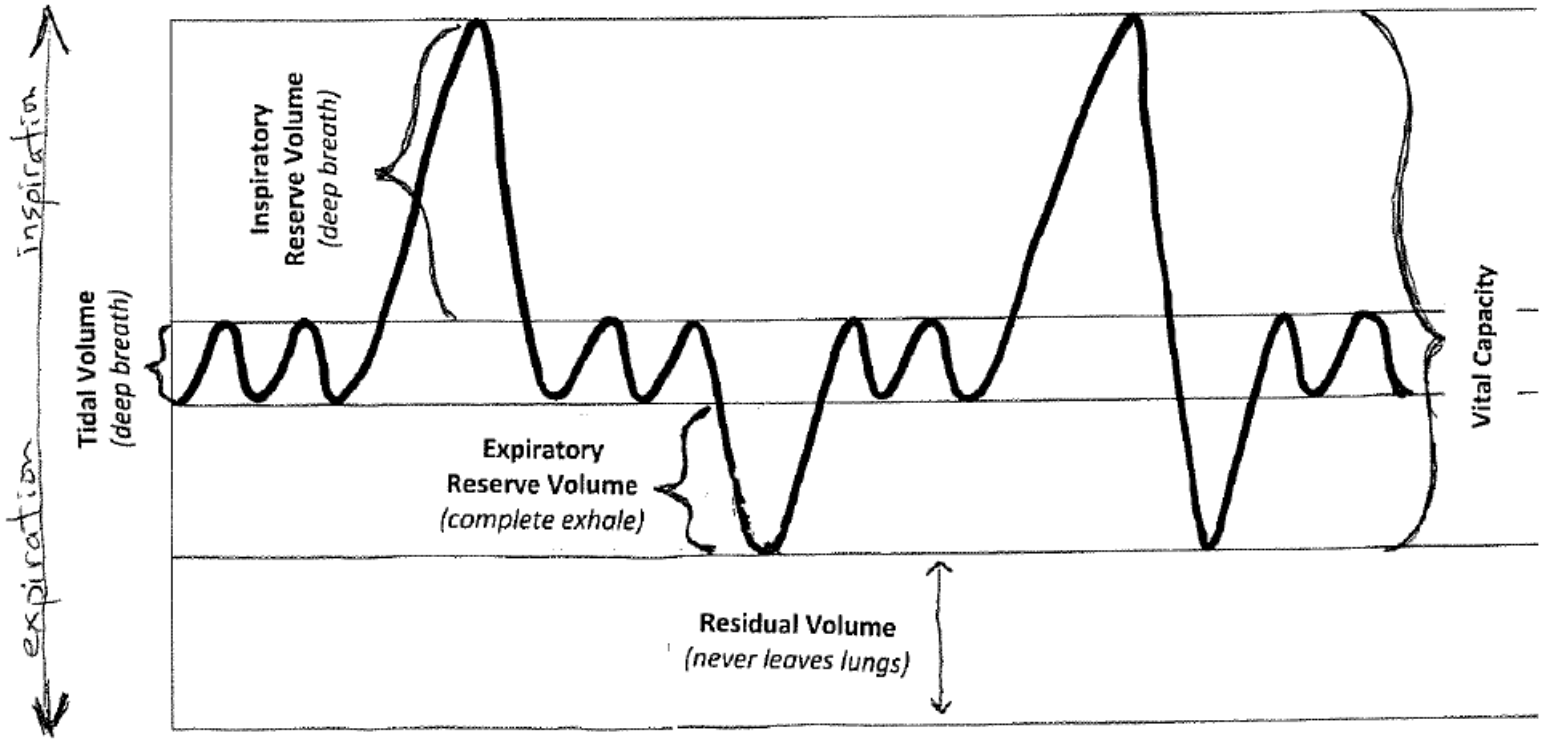
1. Diaphragm muscle contracts and moves down, enlarging the thoracic cavity and creating NEGATIVE PRESSURE within the alveoli.
2. Air rushes into lungs to equalize pressure.
3. This is an ACTIVE PROCESS.

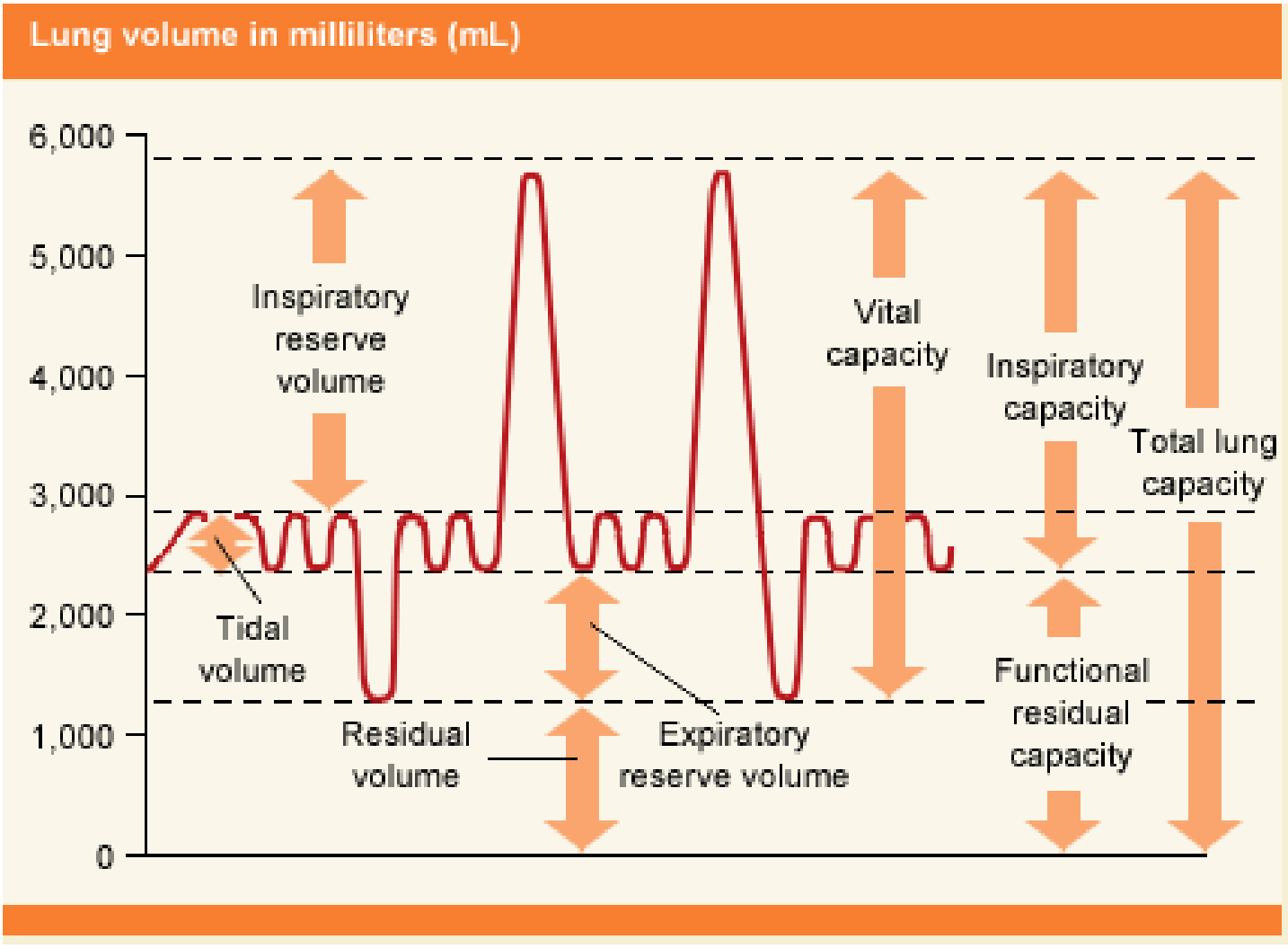
B. Expiration *(aka: "Exhaling")*

1. Diaphragm muscle relaxes and moves up, compressing the thoracic cavity and causing POSITIVE PRESSURE within the alveoli.
2. Air rushes out to equalize the pressure.
3. This is a PASSIVE PROCESS.

C. Lung Volumes

C. Lung Volumes

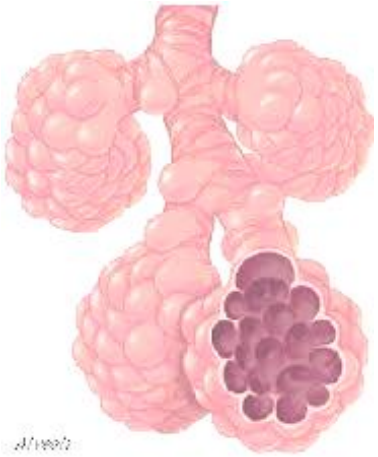


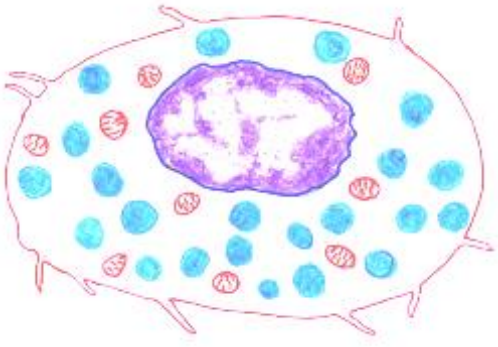


III. Gas Exchange and Transport

A. Gases move according to RELATIVE CONCENTRATIONS!

B. Here's how it works:





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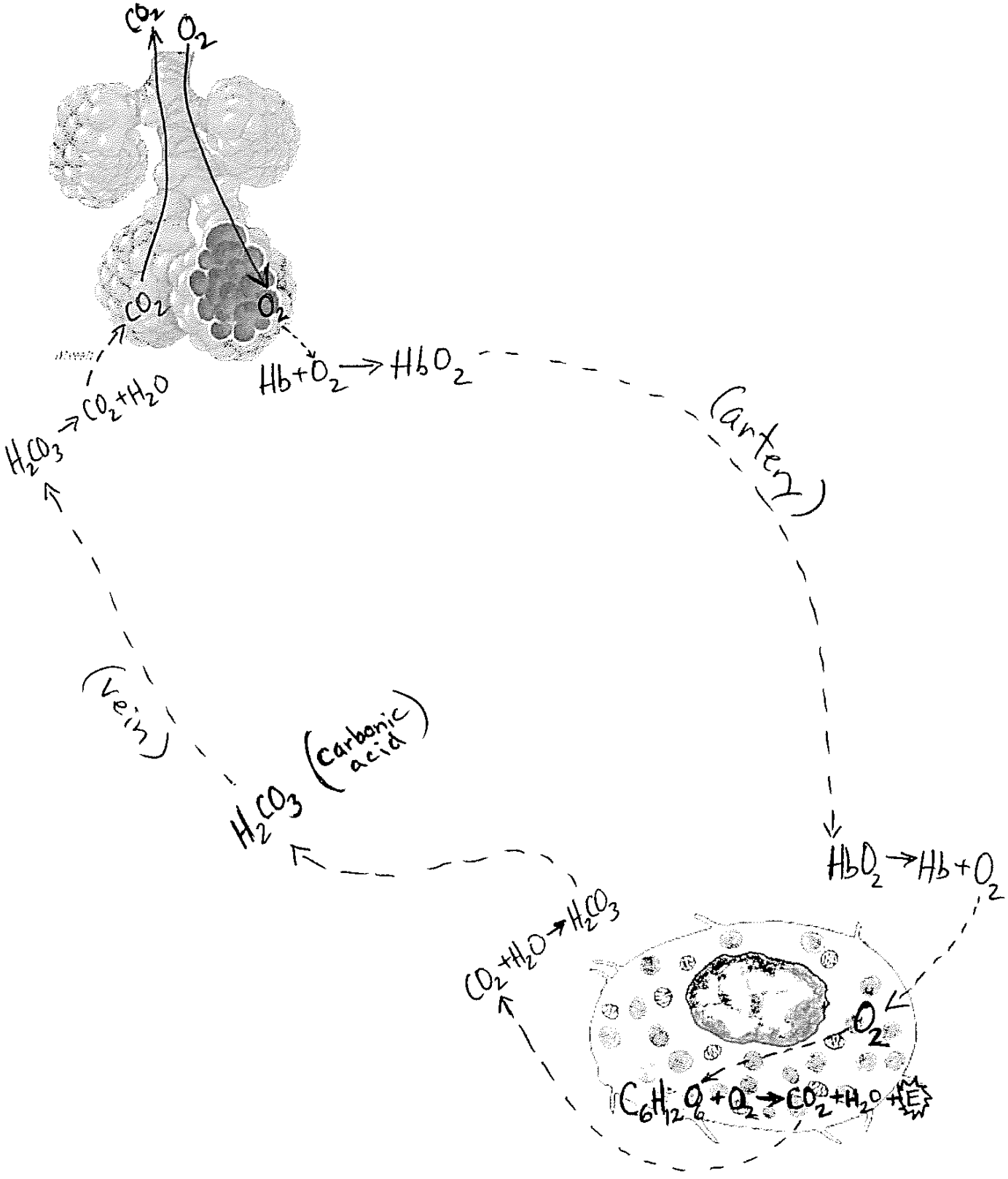

IV. Volition – the urge to breathe

A. Controlled by blood pH (low pH = breathe!)

B. Build-up of carbonic acid lowers pH, so urge to breathe actually results from excess CO_2 (not a lack of O_2).

C. Factors affecting volition:

1. Aspirin Overdose

- Aspirin = Salicylic Acid
- Lowers blood pH which increases volition (hyperventilation)
- Body may overcorrect, causing blood pH to ride too high which reduces volition and breathing rate.

2. Carbon Monoxide

- CO binds to Hb more tightly than O_2 does.
- RBC's cannot carry oxygen to cells.