

# Circulatory and Respiratory Systems

Chapter 37

# 37-1 Functions of the Circulatory System

- Transport of oxygen, nutrients and waste
- Humans are too big for this to occur through simple diffusion
- Heart, blood vessels and blood

# 37-1 Heart

- Hollow, size of clenched fist
- Enclosed in a sac called pericardium
- In heart wall, thick muscle called myocardium
- Contracts about 72 times per minute
- Pumps 70 ml blood per contraction
- During a year pumps enough blood to fill an Olympic sized pool

# 37-1 Heart

- Septum divides the heart into 2 halves
- Upper chamber-2 atria-receives blood
- Lower chamber-2 ventricles-pumps blood out of the heart
- 4 chambers total

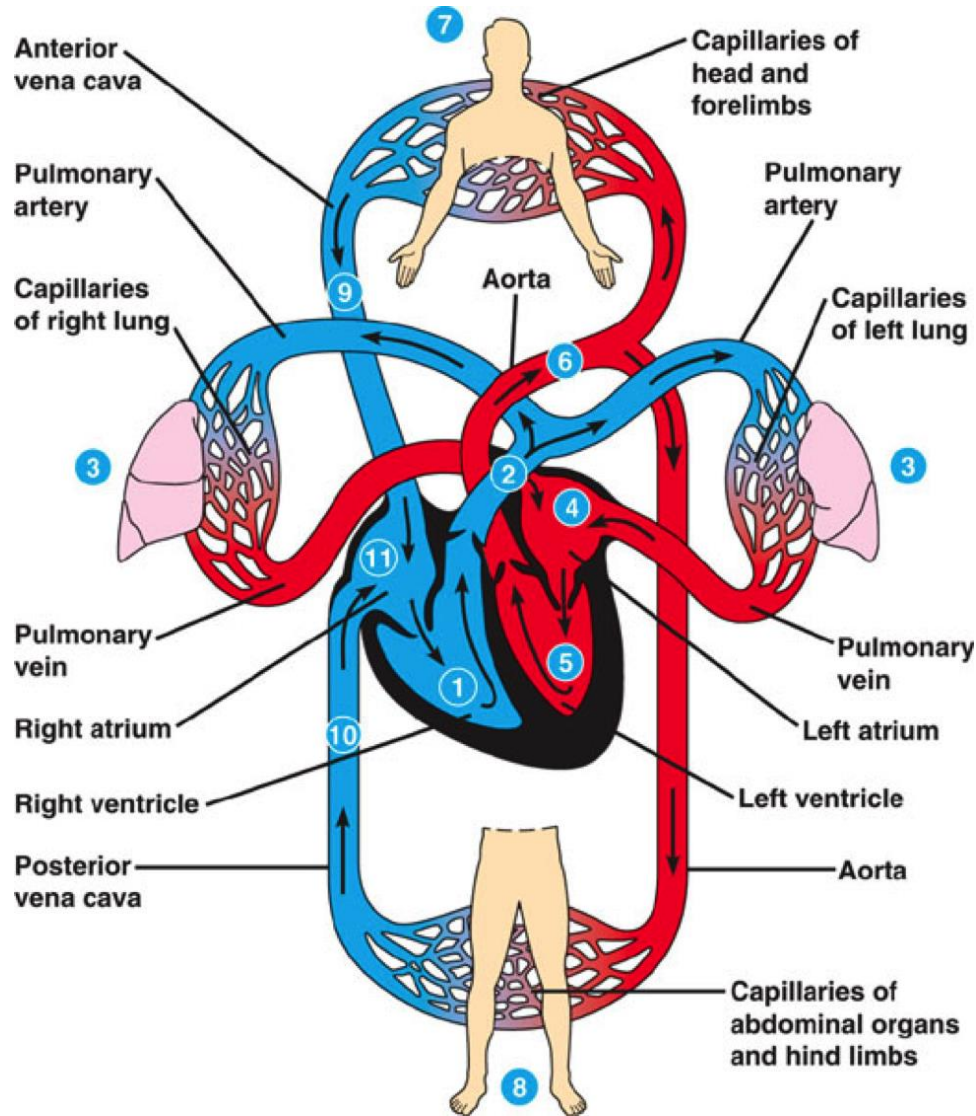
# 37-1 Heart

- Acts as two separate pumps
- Right ventricle pumps blood to lungs-Pulmonary circulation ( $\text{CO}_2$  is released to the lungs)
- Left atrium receives oxygen rich blood from lungs
- Left ventricle pumps blood to body-systemic circulation
- Right atrium receives oxygen poor blood from the body

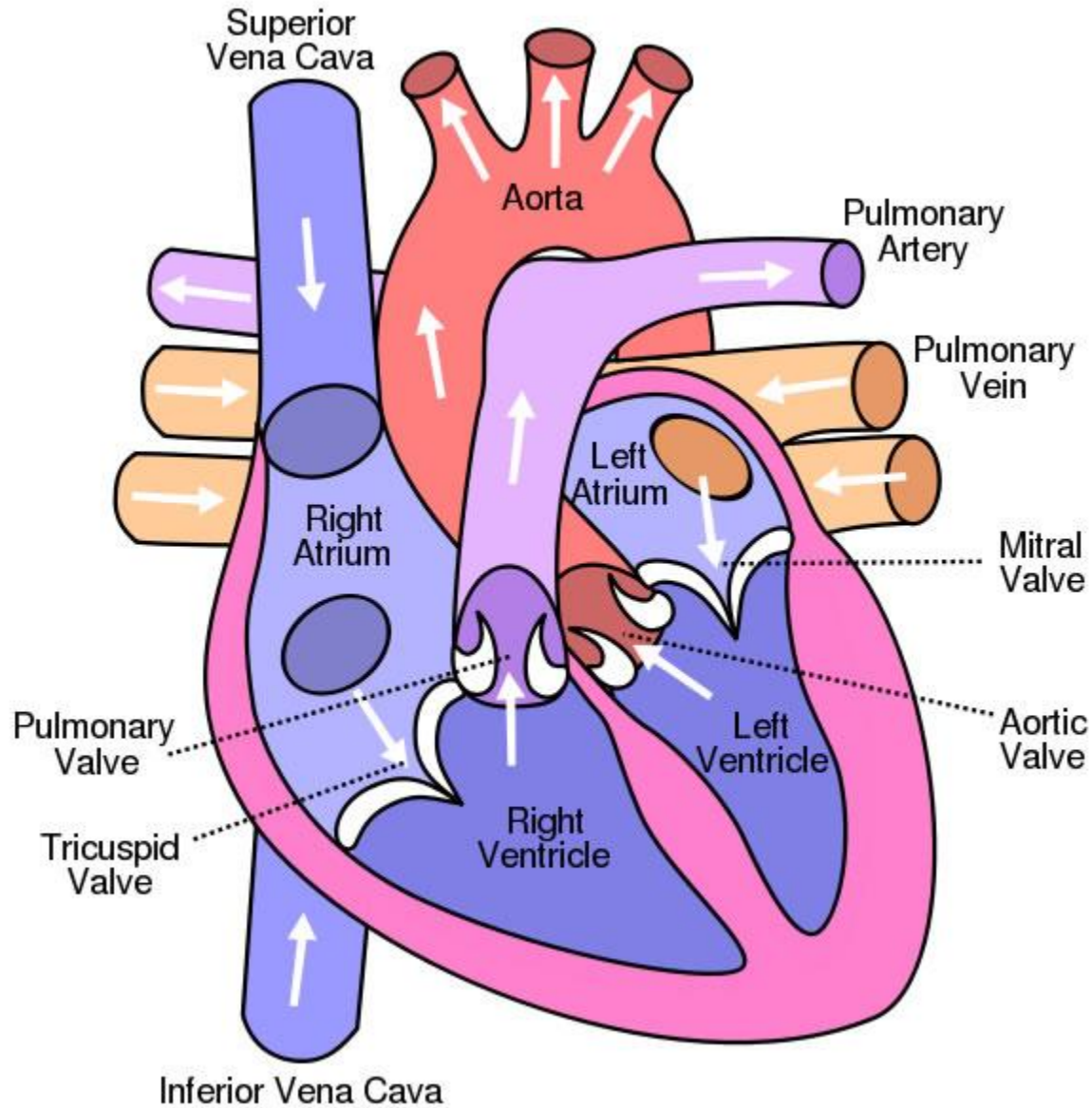
# 37-1 Heart

- Valves separate the atria and the ventricles
- Blood moving into the atria hold the valves open
- When ventricles contract, valves close so blood does not flow back into the atria
- Valves prevent blood leaving the ventricles from flowing back in
- Valves are one-way

# 37-1 Heart



# 37-1 Heart





# 37-1 Heartbeat

- Two networks of muscle fibers, one in atria, one in ventricles
- When 1 fiber is stimulated, all fibers become stimulated (remember-signal transmitted through gap junctions between muscle fibers)
- Each contraction begins in the right atrium-sinoatrial node-Pacemaker

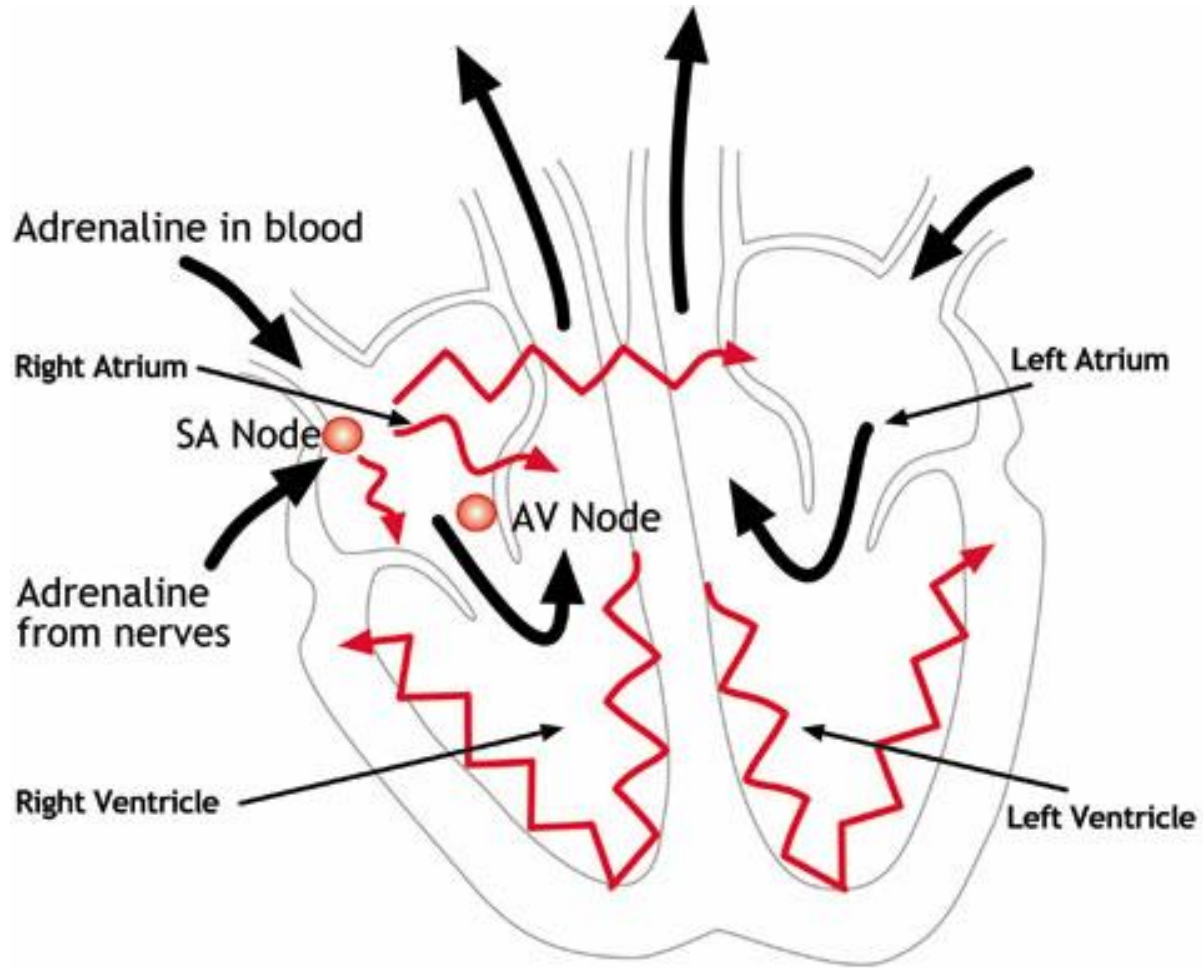
# 37-1 Heartbeat

- Impulse then spreads to all fibers in atria
- Picked up by atrioventricular node and carried to muscle fibers in ventricles
- When atria contract, blood flows into ventricles
- When ventricles contract blood flows out of heart

# 37-1 Heartbeat

- Heart can beat up to 200 bpm when exercising and you need more oxygen in the body tissue
- Autonomic nervous system controls heart rate
- Neurotransmitters released by neurons in the sympathetic NS increase heart rate
- Neurotransmitters released by neurons in the parasympathetic NS decrease heart rate

# 37-1 Heartbeat



# 37-1 Blood Vessels

- Blood leaves the left ventricle through the aorta
- Passes through arteries, capillaries, veins

# 37-1 Blood Vessels

- Arteries-largest
- Except for pulmonary artery, arteries carry oxygen rich blood
- Thick walls that can withstand pressure produced when heart contracts and pushes the blood into the arteries
- Walls contain connective tissue (elastic, allows expansion), smooth muscle (allows contraction) and epithelial cells

# 37-1 Blood Vessels

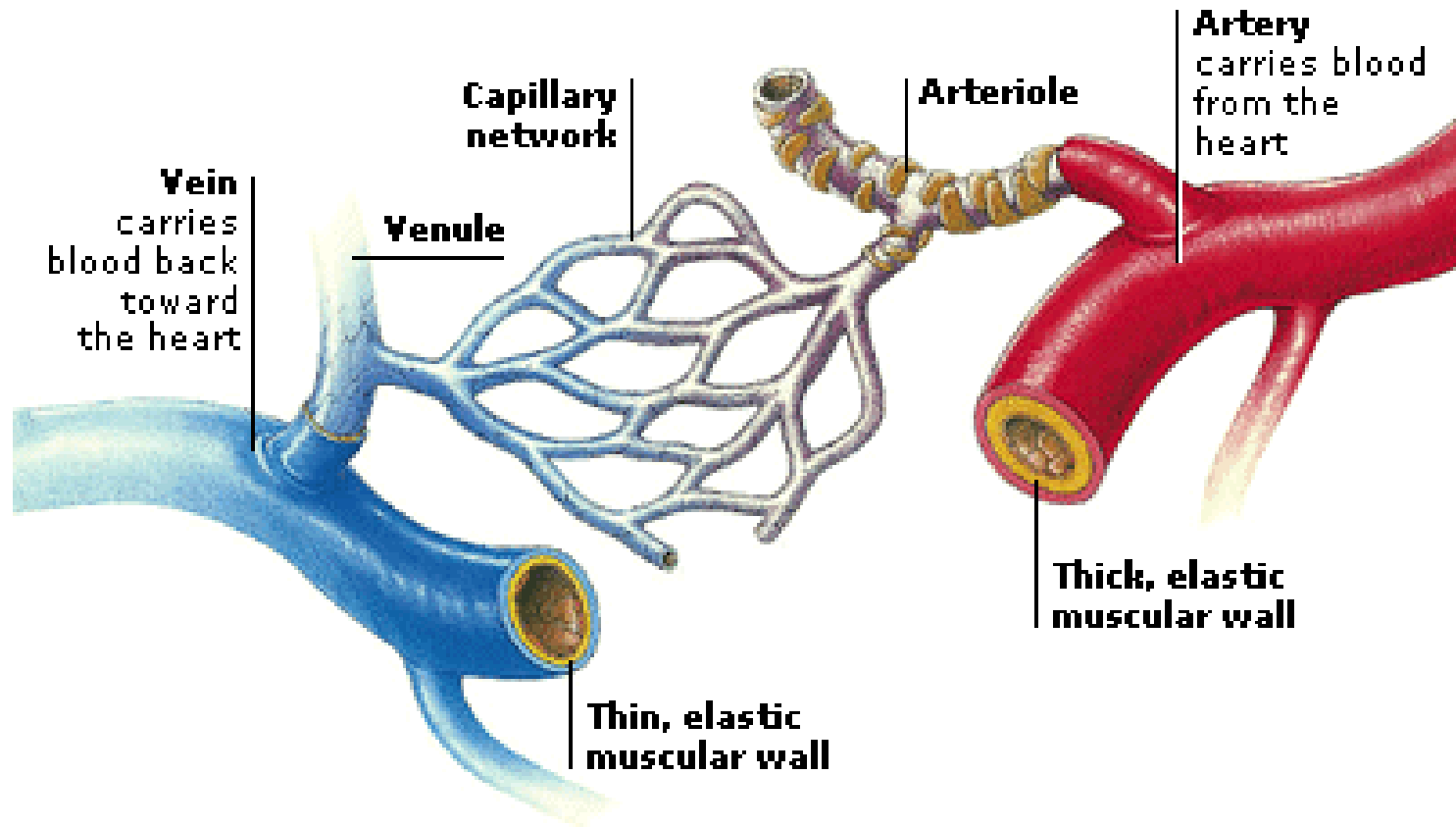
- Capillaries
- Smallest
- Walls are only one cell thick, blood cells pass through in single file
- Thin walls allow diffusion of oxygen, waste, nutrients

# 37-1 Blood Vessels

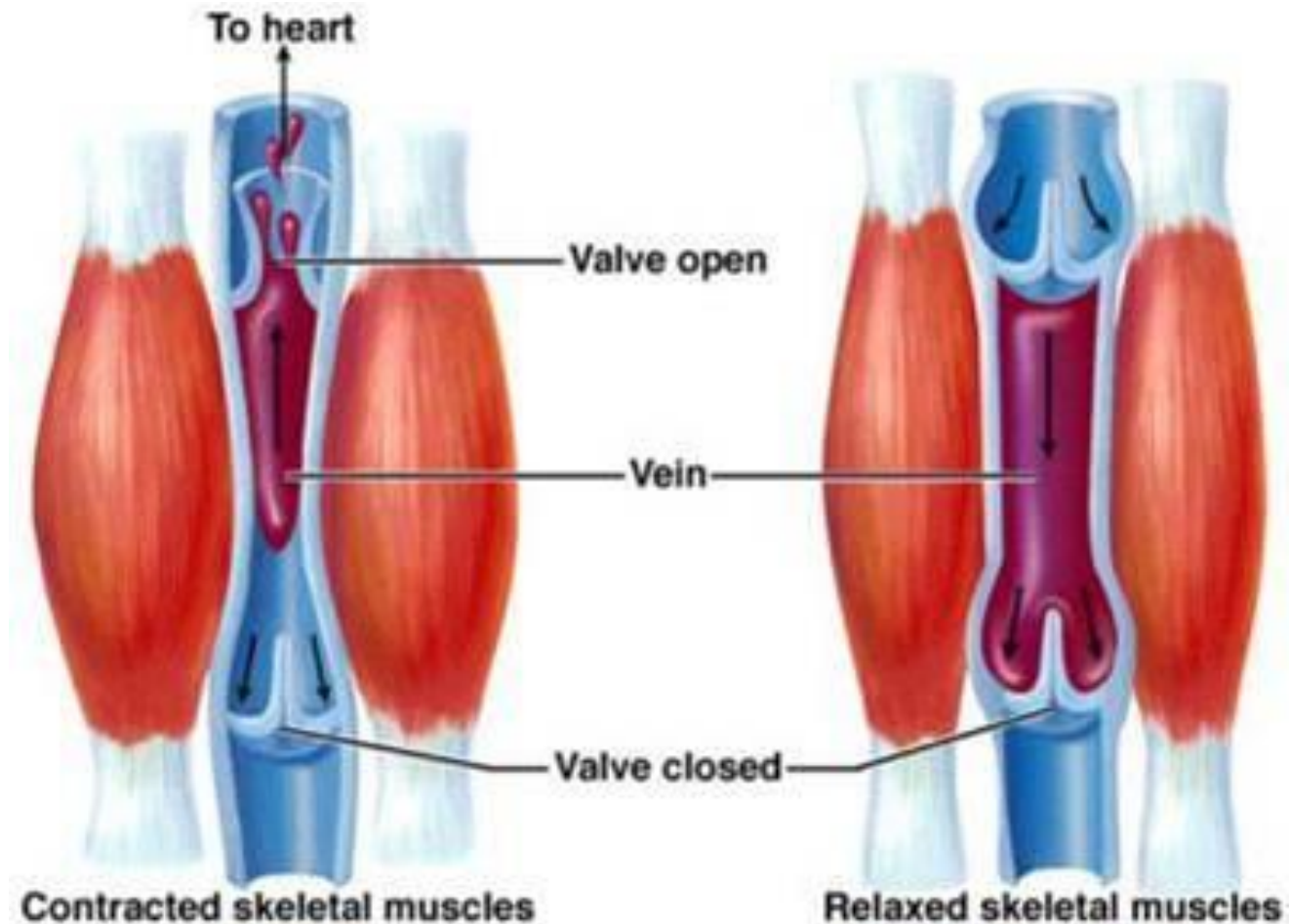
- Veins
- Returns blood from capillaries to the heart
- Walls contain connective tissue and smooth muscle
- Largest veins contain 1-way valves that keep blood flowing toward the heart
- Many are located near skeletal muscle, muscle contraction helps force blood through the veins
- Exercise helps keep blood from accumulating in the limbs and stretching the veins out of shape



# 37-1 Blood Vessels



# 37-1 Blood Vessels



# 37-1 Blood Pressure

- Pumps produce pressure
- Force of blood on artery walls when heart contracts is blood pressure
- Blood pressure decreases when the heart muscle relaxes
- Sphygmomanometer measures blood pressure
- First measurement is systolic pressure, when ventricles contract
- Second measurement is diastolic pressure, when ventricles are relaxed

# 37-1 Blood Pressure

- Blood pressure regulated by sensory neurons in several places in the body that signal back to the medulla oblongata
- When pressure too high, autonomic NS releases neurotransmitters that cause the smooth muscle in the walls of the arteries and veins to relax, lowering BP
- When pressure too low, autonomic NS releases neurotransmitters that cause the smooth muscle in the walls of the arteries and veins to contract, raising BP

# 37-1 Blood Pressure

- BP also regulated by kidneys
- Kidneys remove water from the blood to regulate BP
- Hormones produced by the heart and other organs cause the kidneys to remove water from the blood when BP is too high, reducing blood volume and pressure

# 37-1 Disorders of the circulatory system

- Atherosclerosis-fatty deposits (plaques) build up on walls of arteries
- Can get large and obstruct blood flow and cause increased BP
- Plaques can increase chances of getting blood clots
- Clots can break free and obstruct blood flow to the brain, heart or lungs

# 37-1 Disorders of the circulatory system

- High BP-hypertension
- Forces the heart to work harder which can damage or weaken the heart muscle and blood vessels
- People with high BP are more likely to have heart disease or other diseases of the circulatory system like heart attack or stroke

# 37-1 Disorders of the circulatory system

- Heart attack-Heart muscle dies due to lack of oxygen
- Caused by blockage of flow of blood to heart
- Symptoms-nausea, shortness of breath, severe crushing chest pain



# 37-1 Disorders of the circulatory system

- Stroke-blood clot in a vessel that leads to the brain, or a blood vessels that bursts
- Brain cells die due to lack of oxygen
- Can cause paralysis, loss of ability to speak or death

# 37-1 Prevention of Disorders of the circulatory system

- Easier to prevent than cure
- Exercise, weight control, sensible diet, not smoking
- Exercise increases strength of cardiac and smooth muscle, controls weight and body fat and reduces stress

# 37-2 Blood and Lymphatic system

- Blood is a connective tissue
- Contains dissolved substances and specialized cells
- Collects oxygen from lungs, nutrients from digestive tract and waste products from tissues
- Helps regulate factors in the body like temperature
- Blood components fight infections and form clots to repair damaged blood vessels

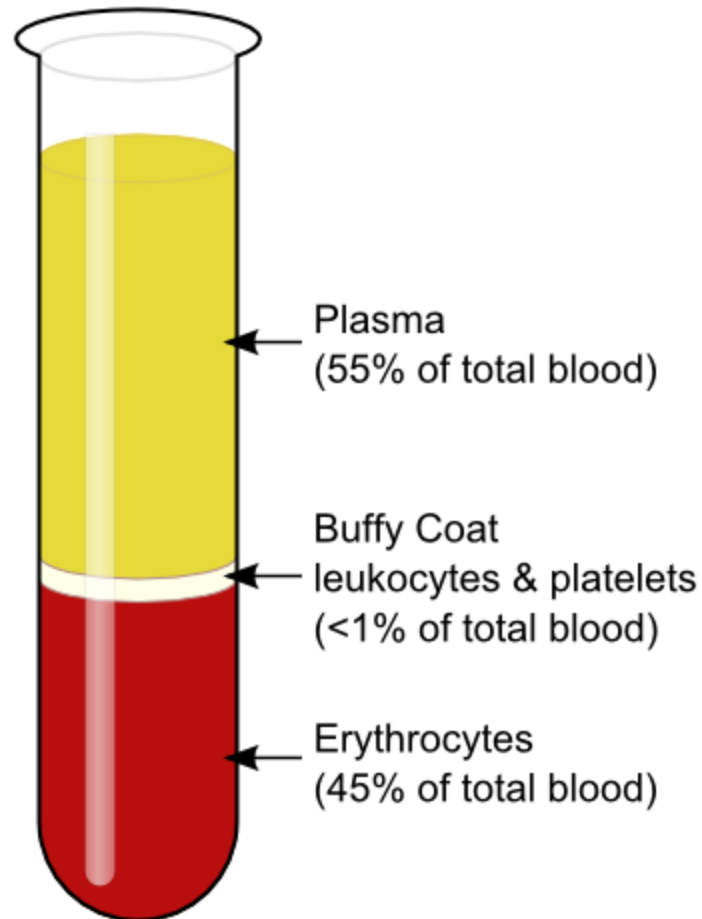
# 37-2 Blood and Lymphatic system

- Blood Plasma
- Body contains 4-6 liters of blood, 8% of body mass
- 45% of blood is cells
- 55% is plasma, a straw colored liquid
- Plasma is 90% water, 10% dissolved gases, salts, nutrients, enzymes, hormones, waste products and plasma proteins

# 37-2 Blood and Lymphatic system

- Blood Plasma (continued)
- Three plasma proteins
- Albumins, globulins transport fatty acids, hormones and vitamins
- Albumins regulate osmotic pressure and blood volume
- Some globulins fight infections
- Fibrinogen helps clot blood

# 37-2 Blood and Plasma



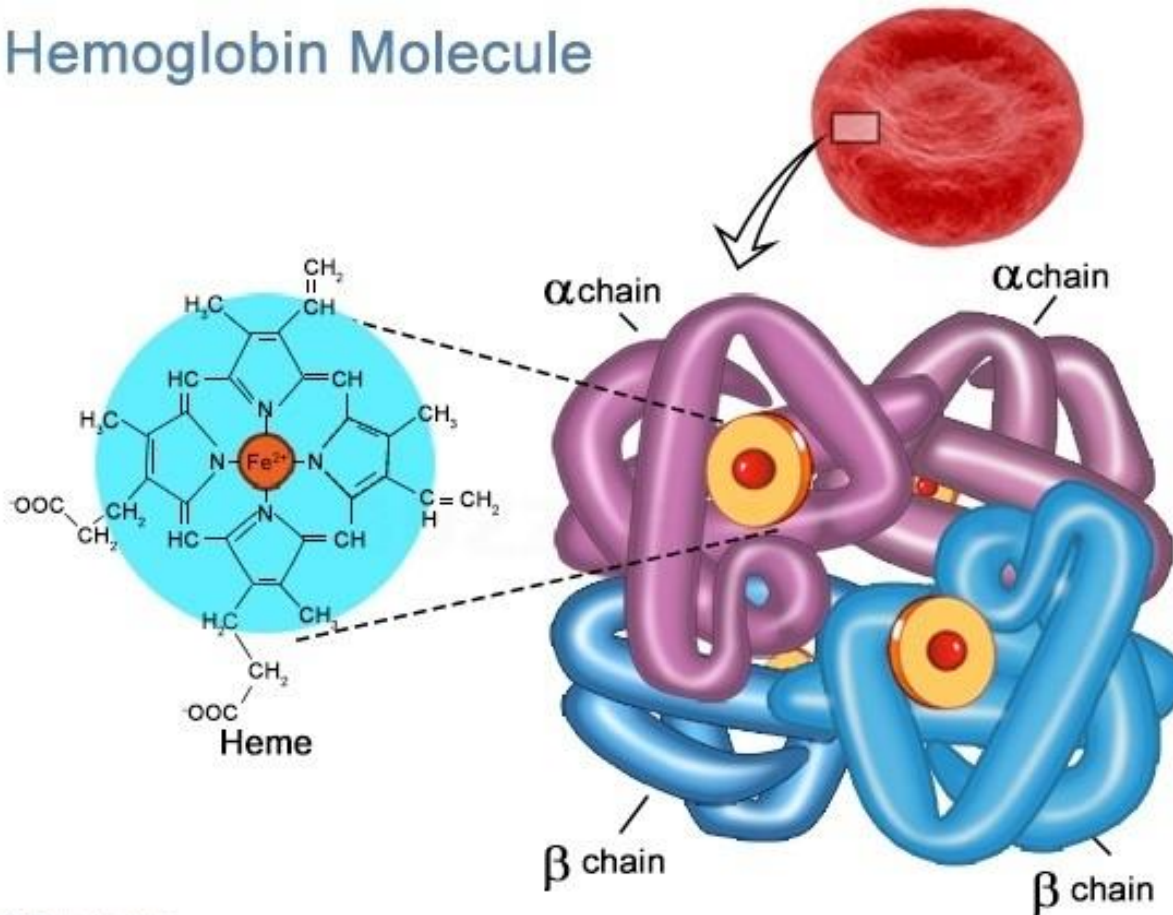
# 37-2 Blood Cells

- Red blood cells (RBC's), also called erythrocytes
- Most abundant
- 1 ml blood contains 5 million cells ( $5 \times 10^6$ )
- Transport oxygen
- Color is from protein hemoglobin
- Hemoglobin contains iron which binds to oxygen and transports it from lungs to tissues

# 37-2 Blood Cells

- Hemoglobin structure

## Hemoglobin Molecule





# 37-2 Blood Cells

- RBC's produced in bone marrow
- No nuclei or organelles (forced out as hemoglobin builds up in cells)
- Circulate for 120 days
- Get worn out by squeezing through capillaries
- Destroyed in liver and spleen

# 37-2 Blood Cells

- White blood cells (WBC's)-also called leukocytes
- Outnumbered by RBC's 700-1
- Produced in marrow
- Have nuclei
- No hemoglobin
- Some live for months, others live for days

# 37-2 Blood Cells

- WBC's (continued)
- Attack foreign substances or organisms, including cancer cells, substances that cause allergic reactions and transplanted organs
- Phagocytes engulf and digest foreign cells
- Some WBC's cross through the capillaries and attack invading organisms in body tissue
- Some WBC's release chemicals that fight disease and resist infection
- Body can increase numbers of WBC's when infection occurs

# 37-2 Types of WBC's

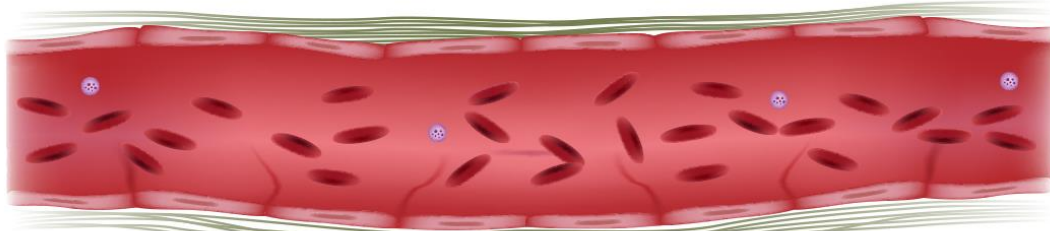
Type of Leucocyte	Approximate percent of all Leukocytes	Roles in Defense and other Actions
Monocyte, Macrophage	<6%	Phagocytosis; releasing cytokines
Neutrophil	65%	Phagocytosis; fighting fungus infections
Eosinophil	4%	Fighting protozoan infections
Basophil	<1%	Releaasing histamines
Lymphocyte	25%	Making antibodies; destroying cells infected by pathogens

# 37-2 Blood Cells

- Platelets and blood clotting
- Blood clotting occurs by plasma proteins and platelets (fragments of cells broken down in the bone marrow and released into the blood)
- When platelets contact the edge of a broken blood vessel, their surface becomes sticky, and platelets cluster up
- Platelets release clotting factors that start a series of chemical reactions that converts fibrinogen (in the plasma) into a sticky mesh of fibers that stop the bleeding

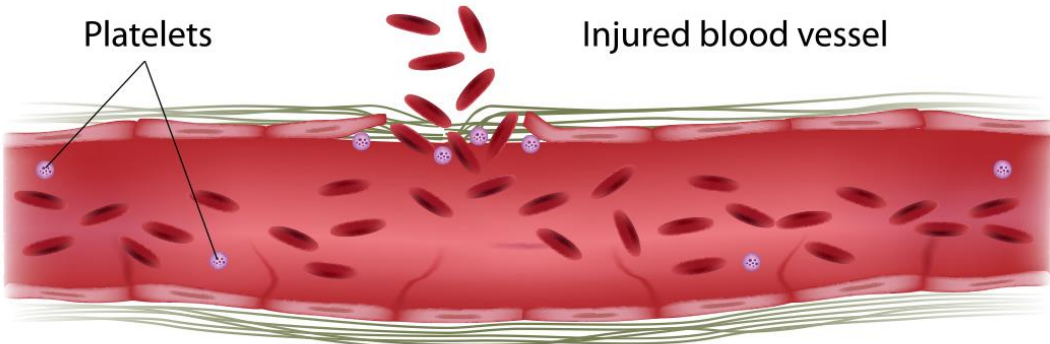
# 37-2 Blood Clotting

Normal blood vessel



Platelets

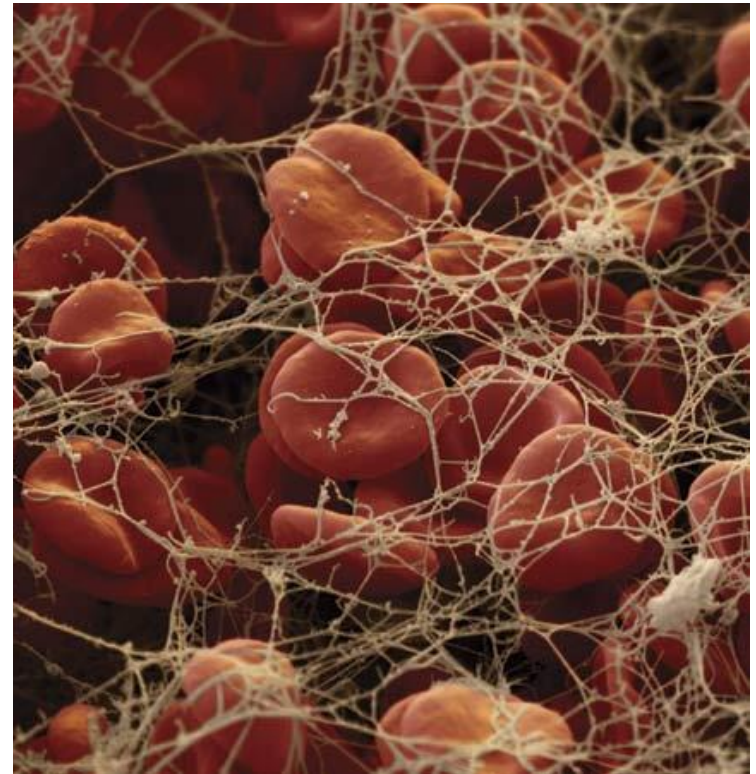
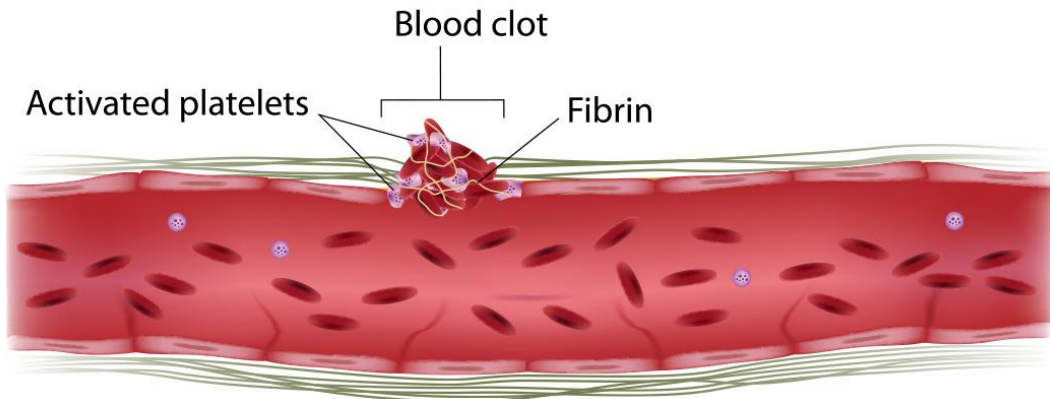
Injured blood vessel



Blood clot

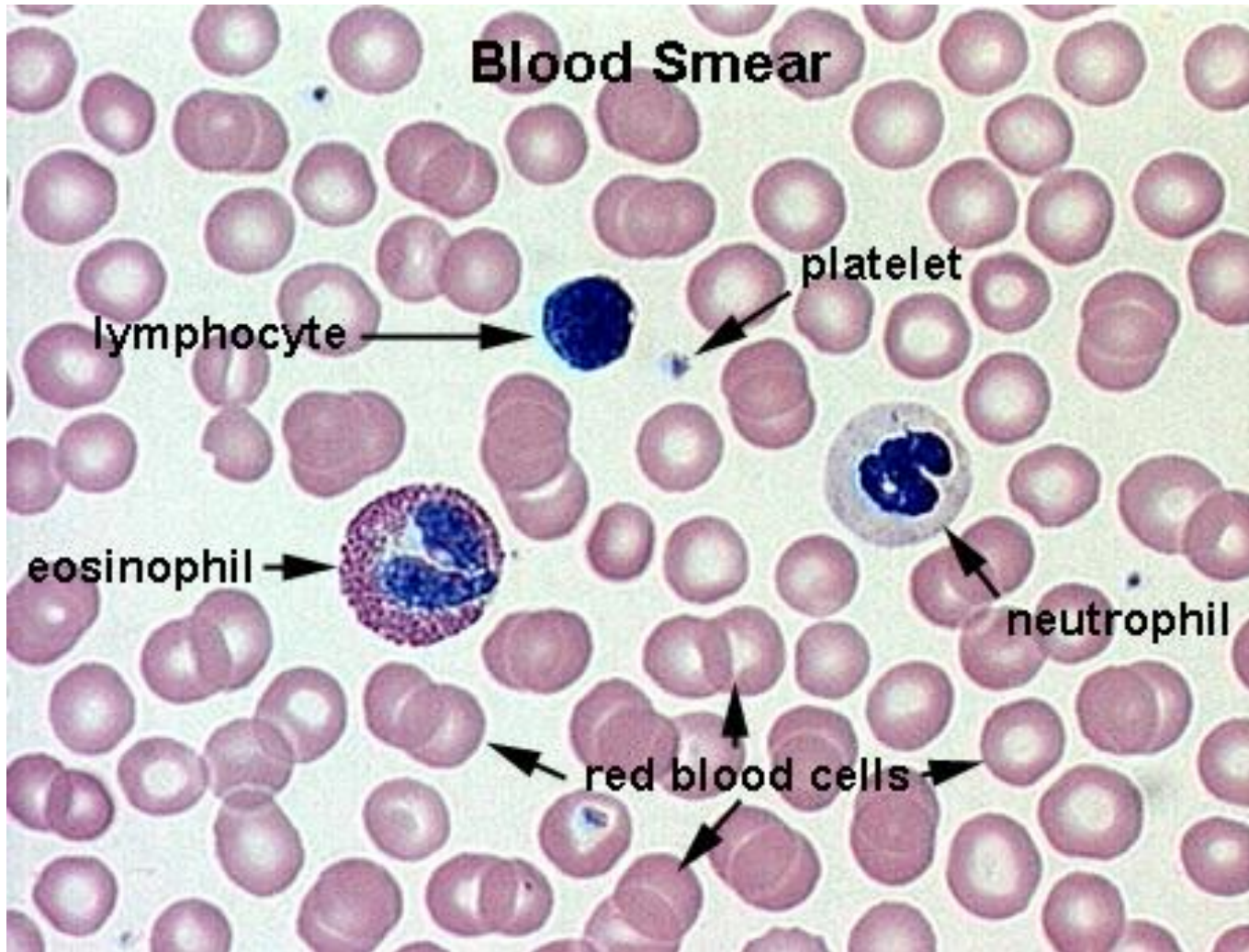
Activated platelets

Fibrin





# 37-2 Blood Cells



# 37-2 Lymphatic System

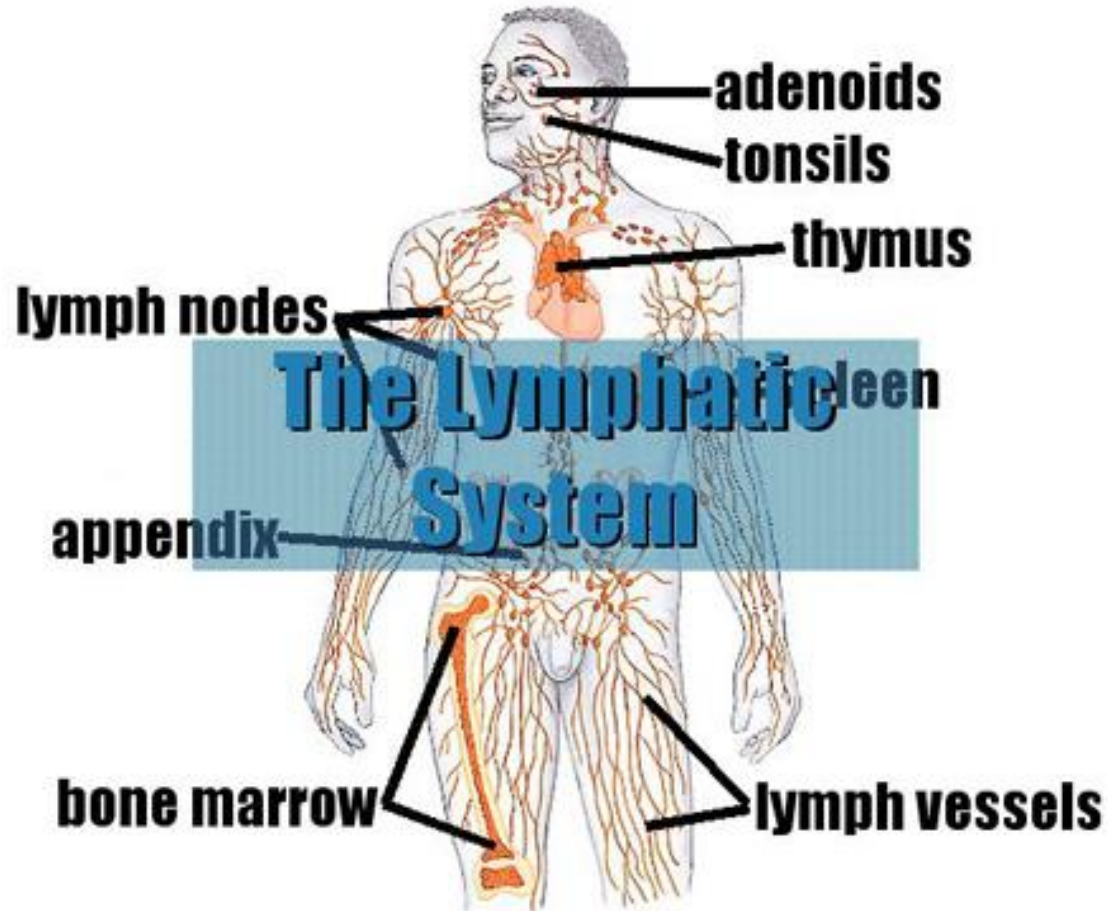
- Some fluid leaks out of the blood into surrounding tissue
- Helps to move salts and nutrients into tissues
- Fluid needs to be returned to the blood to restore the blood volume
- Network of vessels called lymphatic system returns the lymph fluid to blood
- Collects in lymphatic capillaries, slowly flows into larger vessels called lymph nodes
- Ducts from lymph nodes return lymph to blood
- Also line intestines and help absorb vitamins A,D,E,K



# 37-2 Lymphatic System

- Fluid moves by osmotic pressure
- When fluid is not returned from tissue, causes edema, or swelling

# 37-2 Lymphatic System



# 37-3 Respiratory System

- Respiration
- At cellular level, release of energy from food in the presence of oxygen, produces ATP, and cells produce  $\text{CO}_2$  which is carried away from the cells
- At the System level, function of respiration is to exchange oxygen and  $\text{CO}_2$

# 37-3 Respiratory System

- Organs in respiratory system
- Nose, pharynx, larynx, trachea, bronchi, lungs
- Epiglottis is a flap of tissue that closes over your trachea when you swallow

# 37-3 Respiratory System

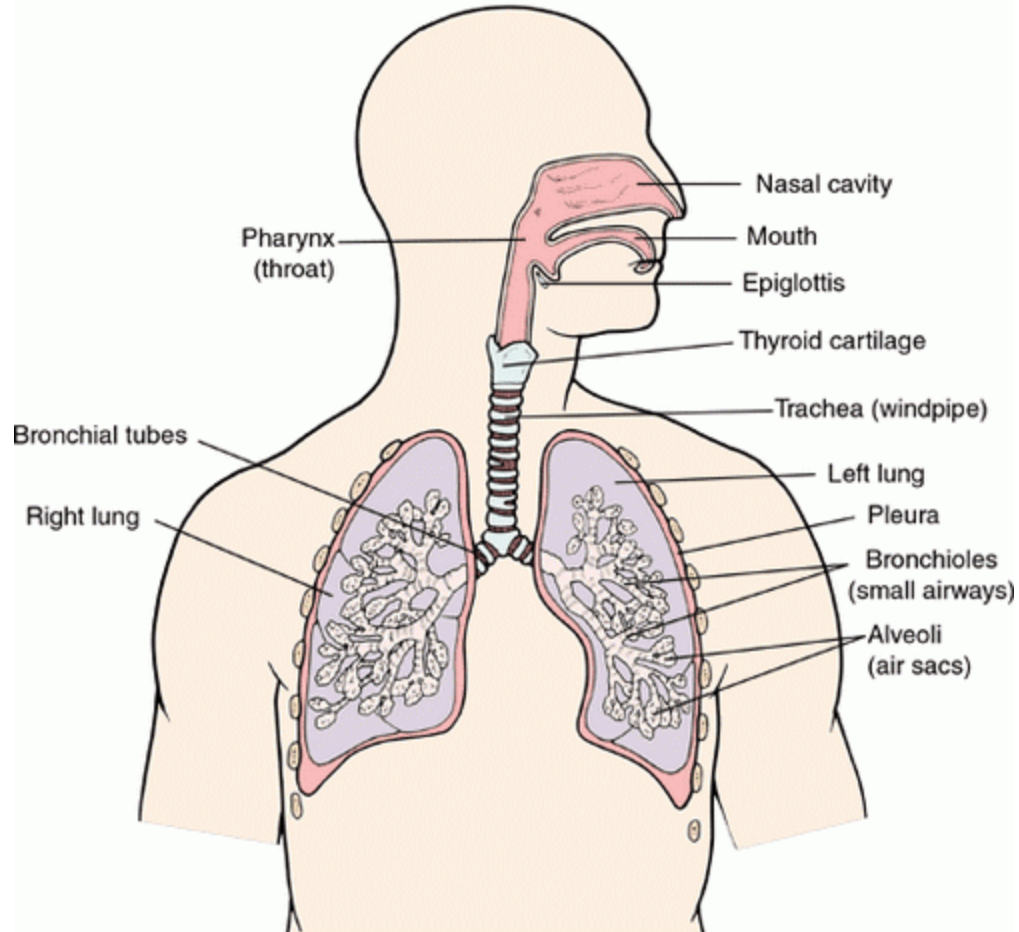
- Air entering lungs must be warm, moist and filtered
- Air warms up as it passes through the Nose, pharynx, larynx and trachea
- Air gets moistened with mucous
- Air gets filtered by small hairs called cilia

# 37-3 Respiratory System

- Larynx-vocal cords-elastic muscles that vibrate when air passes between them to make your voice
- Trachea-wind pipe
- Bronchi-2-each one leads to a lung
- Bronchioles-smaller than bronchi-surrounded by smooth muscle that can expand or contract as directed by the autonomic NS

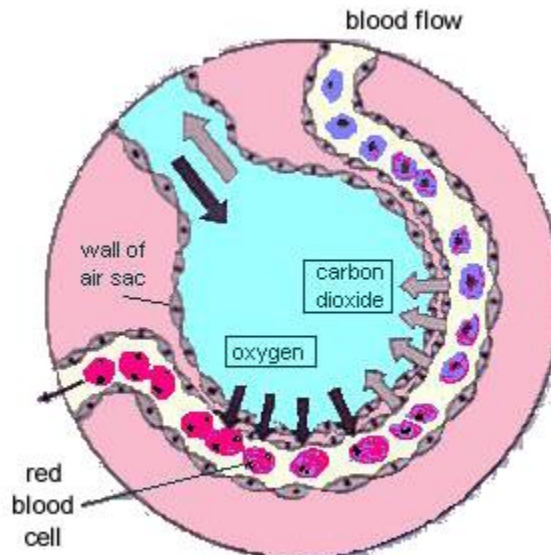
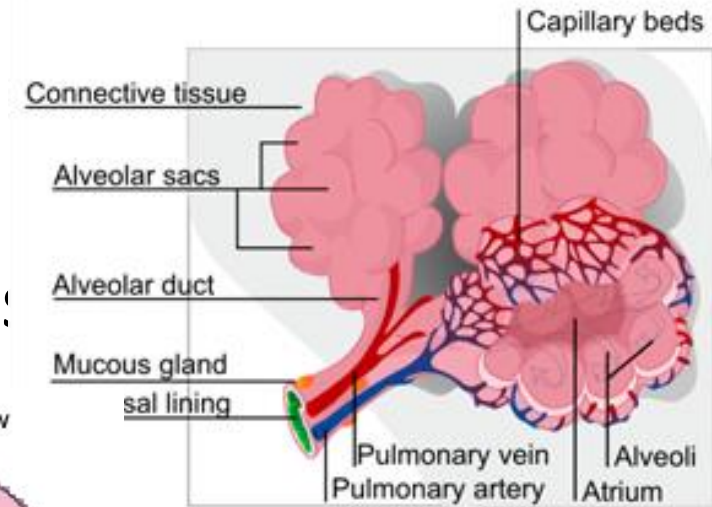
# 37-3 Respiratory System

## Respiratory System



# 37-3 Respiratory System

- Alveoli are in the bronchioles
- $350 \times 10^6$  in a healthy lung
- Gas exchange occurs here
- Lots of capillaries, therefore : gas exchange





# 37-3 Respiratory System

- Gas Exchange
- O<sub>2</sub> diffuses into capillaries, CO<sub>2</sub> diffuses out
- Air is 21% O<sub>2</sub>, .04% CO<sub>2</sub>
- Exhaled air is 15% O<sub>2</sub>, 4% CO<sub>2</sub>
- Hemoglobin increases the efficiency of the oxygen carrying capacity of the lungs by 60 fold
- Without Hb, you would need 300 L of blood to get the same results

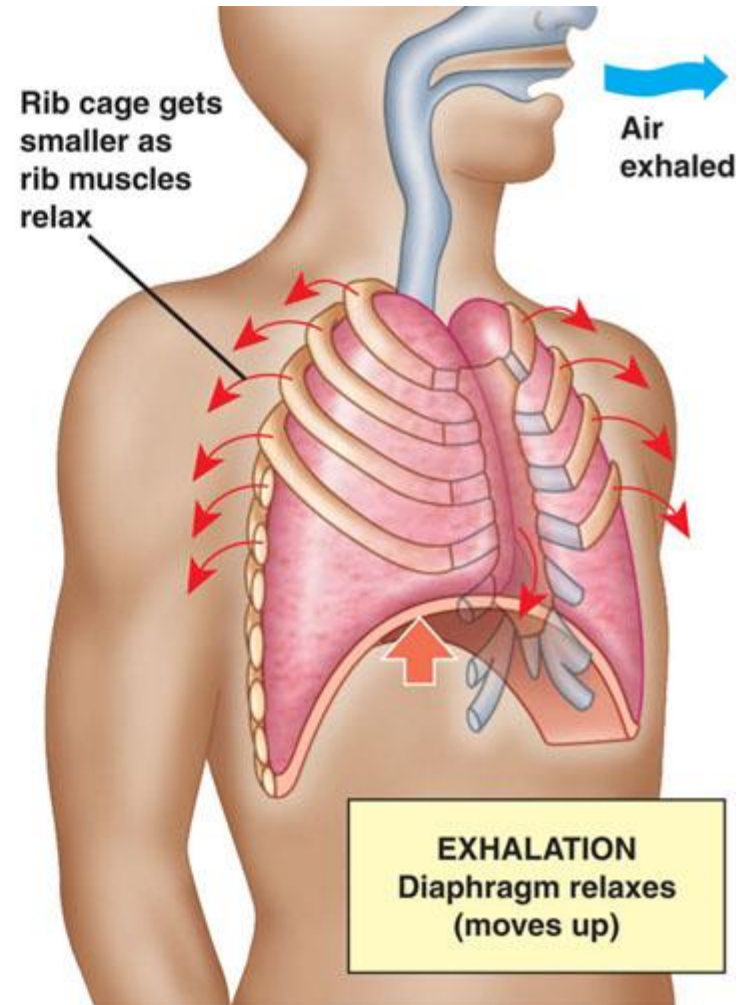
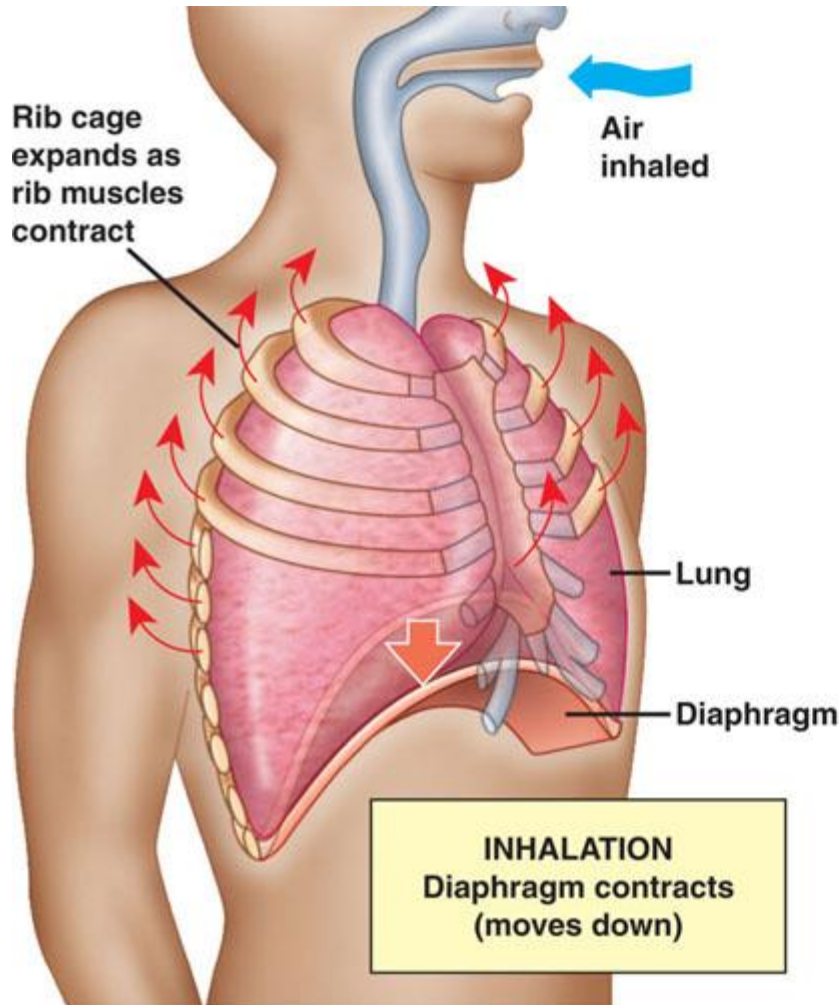
# 37-3 Respiratory System

- Breathing
- Lungs do not have muscle, air moves in and out of lungs by changes in pressure
- Diaphragm, a large flat muscle contracts and expands the volume in the chest cavity causing the pressure outside lungs to be less than inside. This makes air flow into the lungs due to atmospheric pressure

# 37-3 Respiratory System

- Diaphragm relaxes and decreases the volume in the chest cavity causing the pressure outside lungs to be greater than inside. This makes air flow out of the lungs
- Chest cavity must be sealed for this to work
- A puncture to the chest cavity will allow air to leak in and make breathing impossible

# 37-3 Respiratory System



# 37-3 Respiratory System

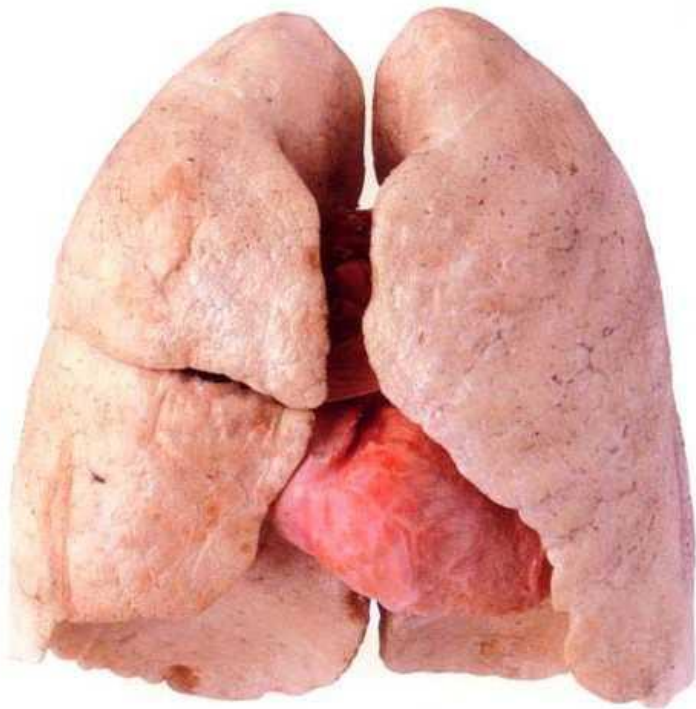
- How breathing is controlled
- Medulla oblongata is the breathing center in the brain
- Autonomic nerves come from the Medulla oblongata to the diaphragm and chest muscles
- Cells in the Medulla oblongata sense CO<sub>2</sub> levels
- CO<sub>2</sub> too high, diaphragm contracts
- Why could sensing CO<sub>2</sub> instead of O<sub>2</sub> be a problem?

# 37-3 Respiratory System

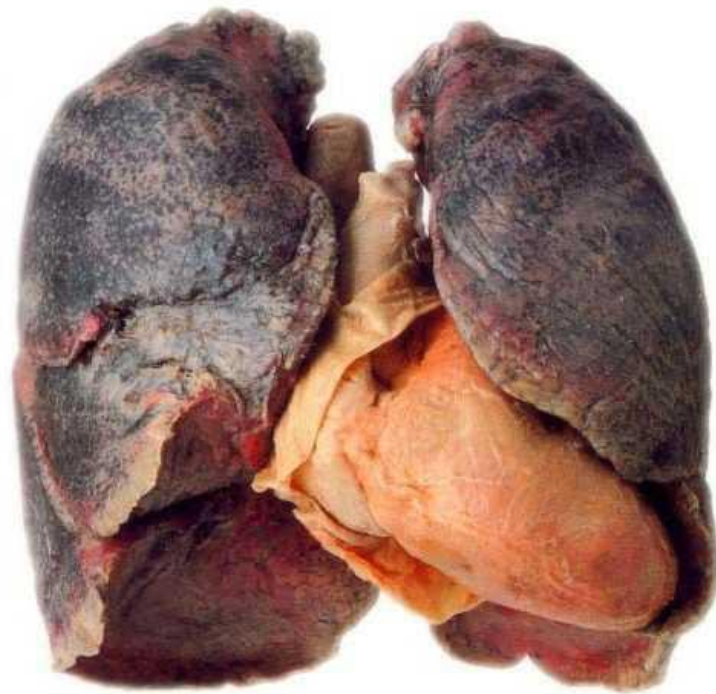
- Diseases caused by smoking
- Chronic bronchitis, emphysema, chronic obstructive pulmonary disease (COPD) and emphysema
- Children who are exposed to second-hand smoke (passive smoking) are twice as likely to have respiratory disease

# 37-3 Respiratory System

- Smoking and your lungs



Healthy Lung



Smoker's Lung

# 37-3 Respiratory System

- Smoking and your circulation

