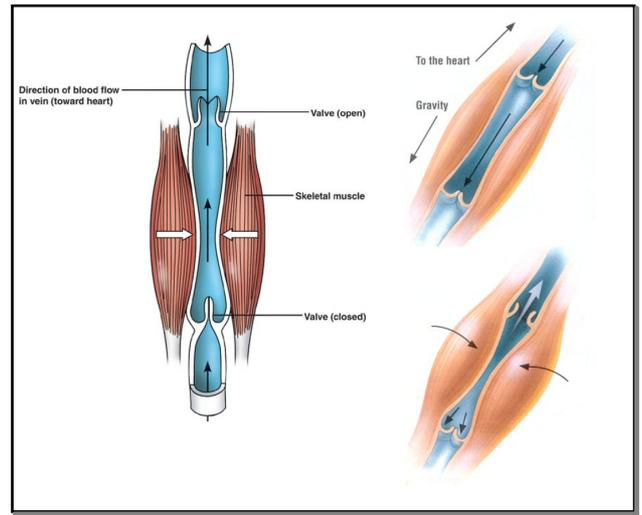
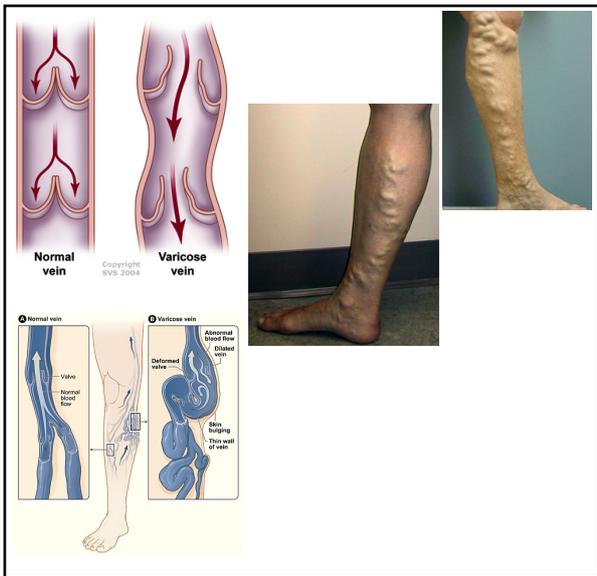


Elephantiasis



1-way valves



Varicose veins

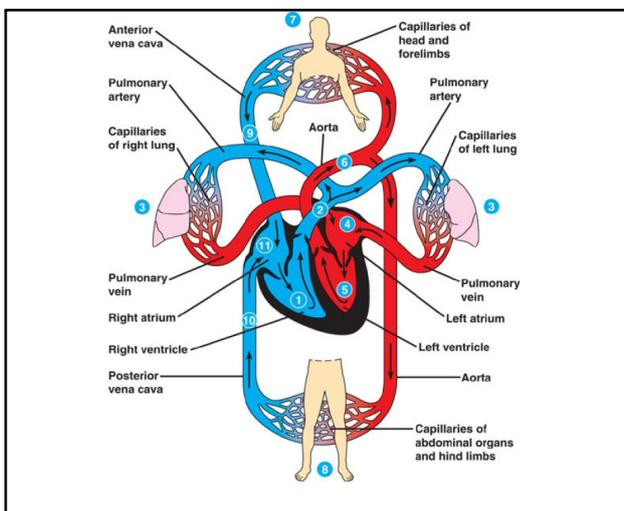
4. What function do capillaries serve?

5. Children in famine-stricken African countries are often shown with large, bloated abdomens. Explain how chronic starvation can lead to edema.

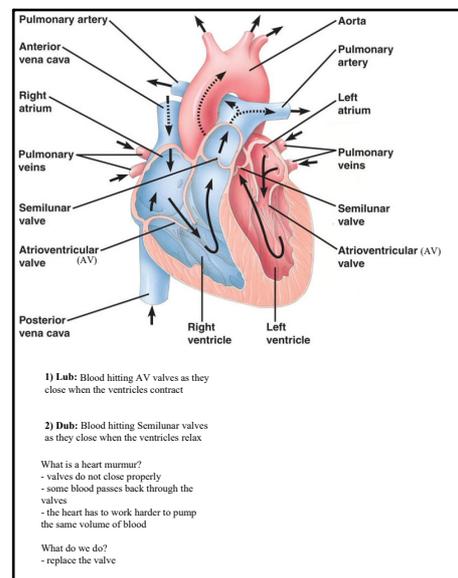
6. a) You bump into Joe on the Street at McDonalds and he says he doesn't understand what causes a head rush and complains that he hates getting one. You excitedly say that you have the explanation and the solution. What do you say?
 b) Joe then asks if arteries have those nifty valves also.

7. It is not unheard of for soldiers to faint while standing at attention for a long period of time. Explain.

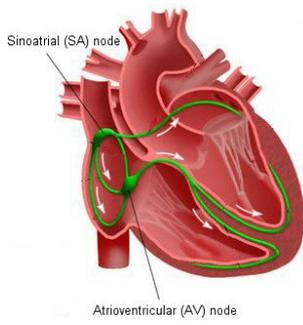
CQ



Human circulation



Human heart



Sinoatrial (SA) node

Atrioventricular (AV) node

- the heart beats on its own but can be controlled by the brain
- in order for the heart to be effective, the cells must beat at the same time
- the SA node coordinates the impulse
- AV node sends the signal to the ventricles but delays it slightly

Pacemaker

8. Occasionally, a child is born with an opening in the wall between the right and left ventricles. Explain how such a defect might affect the child?

9. Why are the atrioventricular valves and the semilunar valves so important?

10. The artificial pacemaker is a small battery-powered device that can send small electric impulses to the heart. What is its function and why would one be necessary?

CQ

Your blood pressure is measured by two numbers.

Systole

- systolic pressure is caused by the contraction of the ventricles
- blood fills the arteries
- BP rises to ~ 120 mm Hg

Diastole

- the heart relaxes between beats
- arteriole pressure drops to ~ 80mm Hg
- diastolic pressure keeps flowing between beats

Why is there pressure at all when the heart relaxes?

- the arterial walls are elastic

Blood pressure is monitored by the medulla oblongata

- sensors in the aorta and carotid arteries send BP to the medulla oblongata
- vasoconstriction can be used to increase BP
- vasodilation can be used to lower BP

What causes long-term high blood pressure?

1. Obstructed arteries
2. High salt diet

Blood pressure

Cardiac output (CO): volume of blood pumped by each ventricle per minute

Stroke volume (SV): volume of blood pumped per cycle

Cardiac output: rate of heart beat (HR) x stroke volume

- normally this is about 5 L/min in human adults

Calculate your cardiac output, assuming you have the typical stroke volume of 60-70 mL/beat.

e.g., $CO = HR \times SV$

- CO can be increased with exercise by increasing stroke volume
- the idea of training is to get the heart to be more efficient. *i.e.*, to pump more blood with each beat.
- a healthy heart beats more slowly but at a higher stroke volume
- HR can rise to ~200 beats/min during exercise. Faster rates are inefficient because the heart does not have time to fill completely

Cardiac output

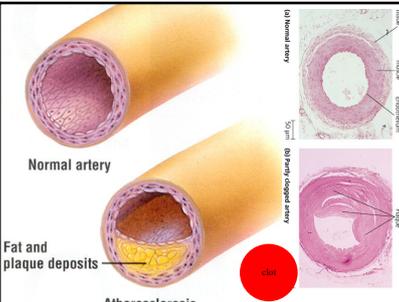
11. You visit the doctor and have your blood pressure measured. It is 150/110.

- Is this high?
- Why might the doctor be more concerned with your diastolic pressure than with your systolic pressure?

12. Imagine that you are a doctor and that you have diagnosed one of your patients as having high blood pressure. You prescribe a low salt diet. Why?

13. What is the adaptive value of the fact that arteries are usually located far below the skin?

CQ



Normal artery

Atherosclerosis

So what?

Diameter narrows → Pressure increases → Flow decreases

What happens if the artery is blocked completely?

- artery supplying the heart: heart attack
- artery supplying the brain: stroke

Blocked artery from smoking

In Canada

- someone dies of heart disease or stroke every 8 minutes.
- 2nd leading cause of death
- in 2013, accounted for 20% of all deaths and 80% of those were preventable
- 9/10 heart attacks caused by atherosclerosis

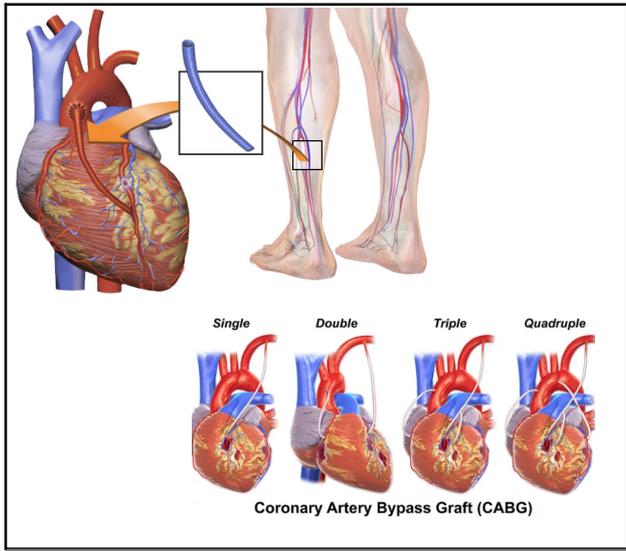
What can happen if we force the heart to work harder?

- weakens or damages the heart muscle and blood vessels
- this causes an increased risk of heart attack or stroke

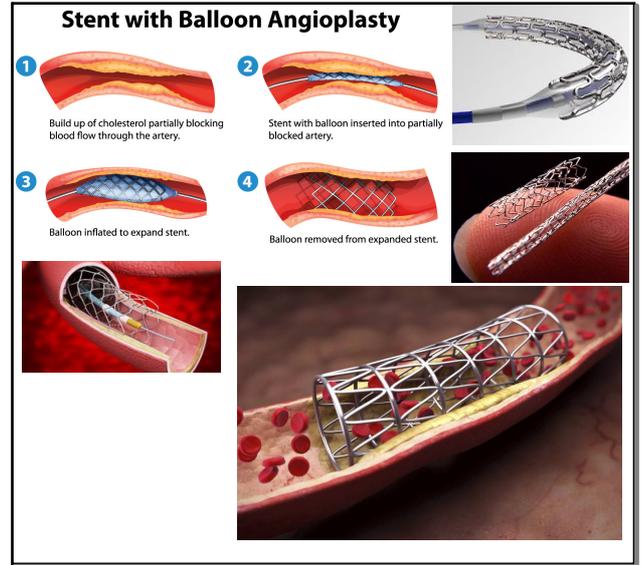
How can we improve this?

- decrease fat and cholesterol in your diet
- exercise
- don't smoke

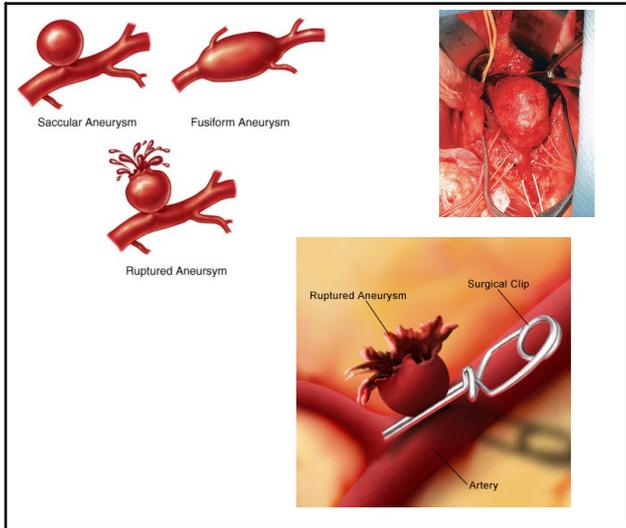
Atherosclerosis



Bypass



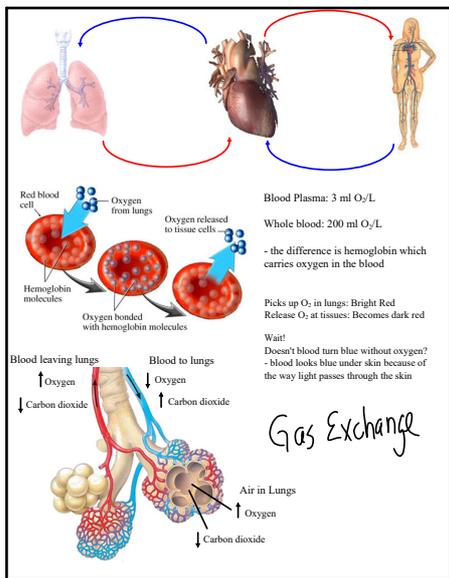
Stent



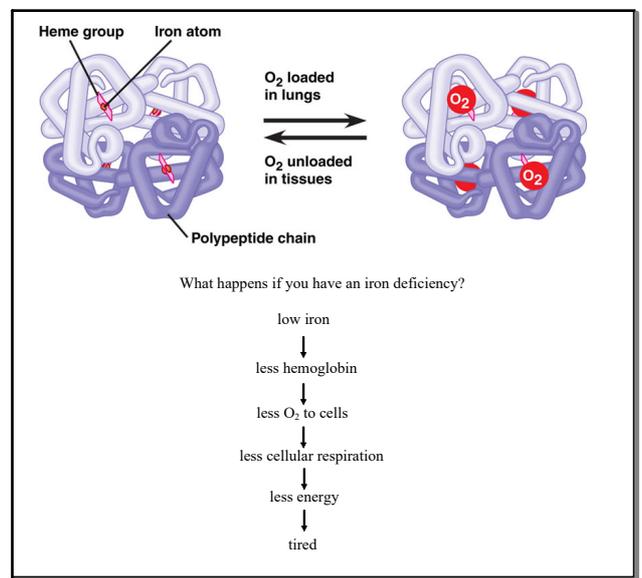
Aneurysm

14. What are the primary causes of heart attacks?
 15. How can atherosclerosis result in high blood pressure?
 16. While recent research has called this into question, for decades we thought there was a connection between a high fat diet and heart disease. What is the connection?
 17. a) What is an aneurysm?
 b) Why are they dangerous?

CQ



Oxygen transfer



Hemoglobin

Hemoglobin carries oxygen and carbon dioxide

Carbon monoxide binds very tightly to hemoglobin

Oxygen and carbon dioxide can no longer be carried

$CO_2 \quad O=C=O$

$O_2 \quad O=O$

$CO \quad C\equiv O$

1) Oxygen (O₂) and carbon monoxide (CO) are inhaled

2) O₂ and CO enter blood

Normal oxygenation

Carbon monoxide poisoning

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CO Poisoning

Plasma (55%)		Cellular elements (45%)	
Constituent	Major functions	Cell type	Number per µL (mm ³) of blood
Water	Solvent for carrying other substances	Erythrocytes (red blood cells)	5-6 million
Ions (blood electrolytes)	Osmotic balance, pH buffering, and regulation of membrane permeability	Leukocytes (white blood cells)	5,000-10,000
Sodium	Osmotic balance, pH buffering, and regulation of membrane permeability	Neutrophil	Defense and immunity
Potassium		Basophil	
Calcium		Lymphocyte	
Magnesium		Eosinophil	
Chloride			
Bicarbonate			
Plasma proteins	Osmotic balance, pH buffering, Clotting		
Albumin	Osmotic balance, pH buffering, Clotting		
Fibrinogen			
Immunoglobulins (antibodies)			
Substances transported by blood	Nutrients (such as glucose, fatty acids, vitamins) Waste products of metabolism Respiratory gases (O ₂ and CO ₂) Hormones	Platelets	250,000-400,000

Plasma (55%)

White blood cells and platelets (11%)

Red blood cells (45%)

Neutrophil

Basophil

Lymphocyte

Eosinophil

Monocyte

Platelet

White blood cell

Red blood cell

Platelets

Bone marrow

Blood components

platelets

break open

release chemicals

fibrinogen (inactive) → fibrin (active)

forms clot

RBC and clot

18. Imagine now that you became bored with the mundane life of a family physician and decided to become an Emergency Medicine Technician. At the scene of a car accident, a victim has lost a great deal of blood and is going into shock. The symptoms you observe are weak and rapid pulse, and falling body temperature. Explain.

19. a) Why might a person with anemia or a low RBC count feel tired all the time?
 b) In both Canada and the US, rates of anemia are higher in women and girls than in men and boys. Suggest a reason for this difference.

20. What would happen if a blood clot formed in a major artery?

21. Aspirin reduces the ability of blood to form clots. Why do you think doctors prescribe aspirin to patients who have had a heart attack or stroke?

22. a) Why would someone with hemophilia have to be careful not to cut himself or herself?
 b) How would injections of clotting proteins help a patient with hemophilia?

CQ

Branch from the pulmonary vein (oxygen-rich blood)

Terminal bronchiole

Alveoli

Branch from the pulmonary artery (oxygen-poor blood)

- air enters the trachea through the nostrils
- trachea branches into the two bronchi
- bronchi branch into bronchioles
- bronchioles terminate in alveoli
- you have about 700 M alveoli with a surface area of about 70 m²
- p.s. the area of this classroom is about 70 m²

Human lungs

To body

Oxygen

Carbon dioxide

3

To body

From body

Oxygen

Carbon dioxide

1

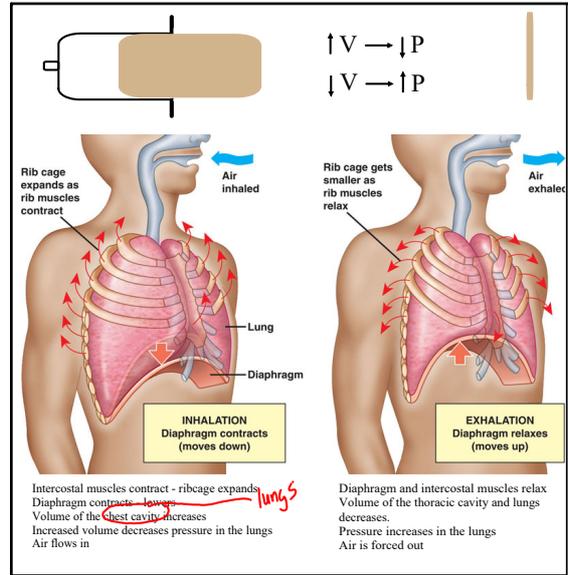
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Gas Exchange

23. a) Why is a large surface area important for a respiratory surface?
 b) How does the human respiratory system achieve a large surface area?

24. Joe on the street stops you and says "Hey, buddy. How do we breathe anyway?" What do you say?

CQ



Breathing

When breathing normally, do you use your full lung capacity?

Tidal volume (TV) = a normal breath

Respiratory rate = breaths in a certain time (min)

Lung ventilation = the amount of air you're moving in and out

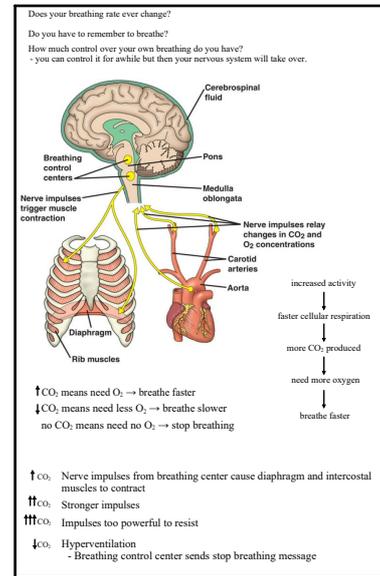
Lung ventilation = respiratory rate x tidal volume

e.g., A person's tidal volume is measured to be 500 mL

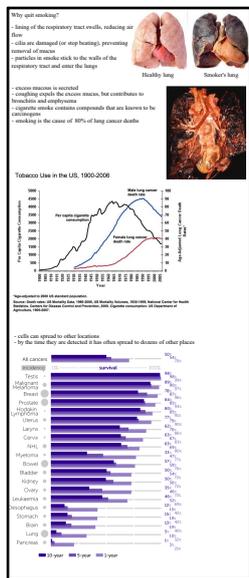
a) Calculate the pulmonary ventilation.

b) How much air is taken in to the lungs each day?

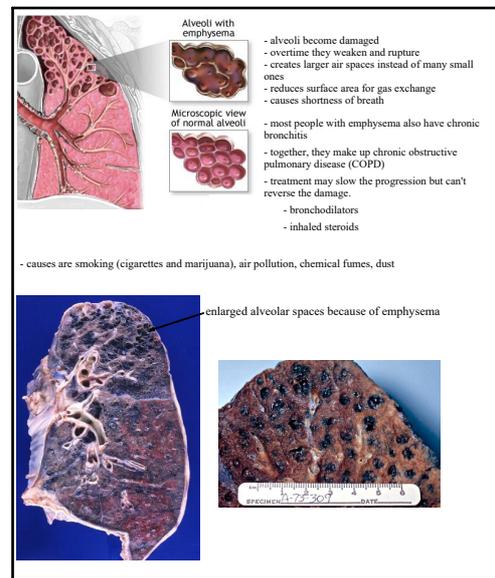
Lung ventilation calc



Control of breathing



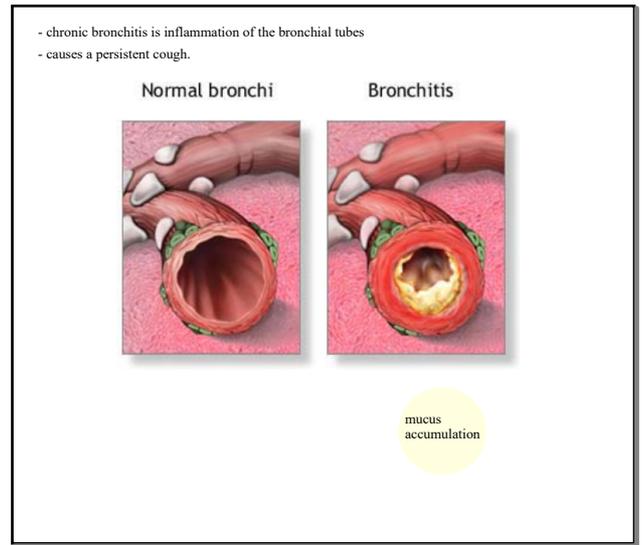
Lung cancer



Emphysema

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Apr 30-2:10 PM



Bronchitis

25. Explain what happens to result in an increase in your respiratory rate during exercise.

26. The breathing control center responds to the level of carbon dioxide in the blood - not the level of oxygen. What consequence would this have for people at high altitude where there is less oxygen?

27. A friend of yours is a smoker. Use your knowledge of the respiratory system to try to convince them to quit.

CQ