Hierarchy of Biological Organization
Transport & Exchange
(Circulation & Respiration)
Cardiovascular System - transports materials

What materials?

Respiratory system moves O₂ into, and CO₂ out of, the body.

Cardiovascular system transports materials to and from all other systems.

Digestive system transforms food into a form that can be transported throughout the body.

Urinary system filters bodily fluids, removes waste while conserving water and other materials.
Components of Blood

Read about “The Components of the Blood” and answer the questions about each blood component.
Red Blood Cells (Erythrocytes)

What do red blood cells transport?

What protein do red blood cells contain?

Do red blood cells have a nucleus and organelles?
Anemia?

Have low amount of hemoglobin or low number of red blood cells.
White Blood Cells (Leukocytes)

What do white blood cells do for us?

Do white blood cells have a nucleus?
Leukemia?

Cancer of white blood cells or bone marrow
Platelets

Fragments of cells that are found in bone marrow.

What do platelets do for us?
Hemophilia?

When excessive bleeding occurs.

Caused by genetic mutation in genes that produce clotting factors.
Plasma

What is the major component of plasma?

Formed elements
- Red blood cells 99.9%
- White blood cells 0.1%
- Platelets

Plasma
- Water 92%
- Plasma proteins 7%
- Other solutes 1%

Red blood cells
White blood cells
Platelets
Blood Vessels

Read “Arteries, Veins, and Capillaries”

Arteries carry blood in what direction?

Veins?
Capillaries – smallest blood vessels

What vessel types do capillaries connect?
Capillaries – smallest blood vessels

Why do we need capillaries?

(a) Capillaries

(b) Interstitial fluid

epithelial cells of capillary wall

O₂ glucose

CO₂ wastes

tissue cells

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Basic Circulation

What kind of blood does the left side of heart pump?

Where does it pump it to?
Basic Circulation

What kind of blood does the right side of heart pump?

Where does it pump it to?
Which side of the heart has to pump harder? Why?

(a) Pulmonary circuit

(b) Systemic circuit

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Heart Structure

Right atrium & right ventricle pump
________________________
blood to ____________.

Left atrium & left ventricle pump
________________________ blood
to ____________.
Which chamber has to pump the hardest? Why?

Warning: Next slide is graphic!
Path of Circulation
Why doesn’t blood flow backward in heart?

Valves between chambers prevent backflow

‘lub’ = valves closing between atria & ventricles
‘dub’ = valves closing between ventricles & arteries
How do heart muscle cells create coordinated contractions?

Muscle cells produce electrical signals that cause contraction.
How do the 4 heart chambers coordinate contractions?

**Pacemaker** - cluster of specialized heart muscle cells produce spontaneous electrical signals at a regular rate.
(a) The heart’s natural pacemaker

1 Pacemaker generates electrical impulses.

2 Impulses spread through atria.

3 Impulses reach the ventricles.
How will these chemicals affect heart rate?

Caffeine?

Alcohol?

Nicotine?

Epinephrine/Adrenaline?
Blood Pressure

The force of blood pushing against artery walls

Your blood pressure is at its highest when heart beats, pumping blood = systolic pressure

When heart is at rest, between beats, blood pressure falls = diastolic pressure
1. Heart is relaxed. Blood flows in.


Diastole: 0.1 sec
Systole: 0.4 sec

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How is Blood Pressure Measured?

1. While listening with a stethoscope, the physician inflates the cuff around the patient’s arm, tightening it to a level that prevents blood from moving through the patient’s brachial artery.

2. While slowly releasing pressure on the cuff, the physician listens for the sound of a pulse. The point at which a pulse can first be heard marks the patient’s systolic or highest blood pressure. This is the point at which the patient’s blood pressure has overcome the pressure being applied by the cuff.

3. As pressure on the cuff continues to drop, the sound of a pulse begins to fade. The point at which a pulse can no longer be heard marks the patient’s diastolic or lowest blood pressure.
Why is understanding blood pressure important?

What does high blood pressure mean?

Is this healthy for your vessels?

Does this increase or decrease the chances of a stroke, heart attack & kidney problems?
What causes high blood pressure?

The constriction of arteries!

Causes resistance to blood flow & strain on heart.
The Heart’s Own Blood Supply

The heart is a large muscle that also needs its own blood supply.

Blood to heart muscle cells is supplied by the ________________.
Complete blockage of one these arteries results in a ______________.

As a result of blockage, blood supply can be cut off and heart muscle cells die. When too many heart muscle cells die, the heart is no longer able to function properly.
20% of all deaths in U.S. caused by blockage of these coronary arteries.

1. LDL molecules infiltrate the wall of the artery; immune cells follow.
2. An inflammatory reaction follows; a growing number of cells and cellular debris form a plaque.
3. Plaque cap ruptures, sending plaque material into bloodstream; a blood clot forms that blocks blood flow.
Treatments for Clogged Coronary Arteries

Coronary Bypass

- Grafted vessels carry arterial blood
- Blocked vessels

Stenting

- Clogged artery
- Stent and inflated balloon

Watch "How Many Heartbeats Do We Get?" if you want to learn more about the heart.
Respiratory System - obtains oxygen & gets rid of carbon dioxide

- Defends body against invasion
- Produces sounds for speaking
- Regulates blood volume & pressure
- Controls body pH

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Breathing

What does the diaphragm do?

- Rib cage expands as rib muscles contract
- Air inhaled
- Lung
- Diaphragm contracts (moves down)

- Rib cage gets smaller as rib muscles relax
- Air exhaled
- Diaphragm relaxes (moves up)
Oxygen breathed into lungs diffuses into capillaries while CO$_2$ diffuses from capillaries into lungs
Red blood cells (hemoglobin) transport oxygen & carbon dioxide.
CO₂ + H₂O → H₂CO₃
carbonic acid

What happens to the pH of your blood as CO₂ builds up?
Breathing control centers stimulated by CO₂ increase in blood

Nerve signals trigger contraction of muscles

Diaphragm
Rib muscles
Circulation & Respiration

CO₂ in exhaled air
O₂ in inhaled air

Alveoli

CO₂
O₂

Capillaries of lung

CO₂-rich, O₂-poor blood
O₂-rich, CO₂-poor blood

Heart

Tissue capillaries

CO₂
O₂

Tissue cells throughout body

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Circulation & Respiration

1. Breathing

2. Transport of gases by the circulatory system

3. Servicing of cells within the body tissues

Lung
Capillary
Cell

O₂
CO₂
Effects of Smoking

(a) Healthy lungs

(b) Cancerous lungs
20 minutes after quitting, your blood pressure drops to a level close to that before the last cigarette and the temperature of your hands and feet increases to normal.

8 hours after quitting, carbon monoxide levels in the blood drop to normal.

24 hours after quitting, chance of heart attack decreases.

2 weeks to 3 months after quitting, circulation improves and lung function increases up to 30%.

5 years after quitting, stroke risk is reduced to that of a nonsmoker.

15 years after quitting, risk of coronary heart disease is that of a nonsmoker.

http://www.cnprc.ucdavis.edu/outreach/smoking.aspx
How Altitude Affects Respiration

At high altitudes the air is much thinner than at sea level. As a result, a person inhales fewer oxygen molecules with each breath.
How Altitude Affects Respiration

Hypoxia - condition created by a diminished supply of oxygen to body tissues
How Altitude Affects Respiration

Three High-Altitude Peoples, Three Adaptations to Thin Air

National Geographic News, February 25, 2004

Indigenous highlanders living:

1. In the Andean Altiplano in South America
2. In the Tibetan Plateau in Asia
3. At the highest elevations of the Ethiopian Highlands in east Africa
How Altitude Affects Respiration

Three High-Altitude Peoples, Three Adaptations to Thin Air

What are some adaptations that one could have to help them live in this “low” oxygen environment?
1. Andean Altiplano in South America
   = Have higher hemoglobin concentrations in blood than people at sea level

2. Tibetan Plateau in Asia
   = Take more breaths/minute than people who live at sea level

3. Ethiopian Highlands in east Africa
   = Don't breathe more rapidly and do not have higher hemoglobin counts than sea-level people. ???