Dynamic Equilibrium

- A state of balance.
- Achieved by internal control mechanisms that counteract outside forces that could change the inside environment (body)
Homeostasis

The steady state of conditions inside a living organism that allows it to function properly. (Our Body’s Happy Place!)

Homeostasis is the dynamic equilibrium of the internal environment of the human body.
Not too fast... Not too slow
Examples of Homeostasis

- Temperature Regulation
- Food and Water Balance
- Regulation of blood sugar levels
- Regulation of blood calcium levels
Optimal physiological states of the body:

- Temperature 37°C
- Blood pH 7.35
- Blood pressure 120/80
- Blood sugar 0.1%

Body Systems involved in Homeostasis:

- Nervous System
- Endocrine System
- Circulatory System
- Digestive System
- Excretory System
- Respiratory System
- Immune System
Temperature Regulation

- **Homeotherms**
  - Warm blooded - body temperature stays relatively constant (Endotherm)
  - birds and mammals

- **Poikilotherms**
  - Cold blooded animals - body temperature fluctuates depending on their environment (Ectotherm)
  - Lizards
How is temperature controlled?

- **Behaviourally**
  - wearing more or less clothing
  - Excercising

- **Physiological**
  - Shivering
  - Vasoconstriction
  - Vasodilation
  - Sweat
Physiologically - how does it work?

Our body has a mechanism in place to recognize when it is not functioning at its optimal level (ie: is knocked out of homeostasis).

- Involves:
  - Receptor (Skin)
  - Integrator (Brain)
  - Effector (Sweat or shiver)
Negative Feedback Loop

- A process by which a receptor, an integrator and an effector detects, processes and reverses any deviation from normal body constants.
Negative Feedback Loop

- **Receptor (skin)**
  - the structure that monitors external/internal conditions
  - connected to a control center that integrates the information (brain)
  - Sends nerve impulses to brain as a result of environmental stimulus

- **Integrator (Brain)**
  - receives information about a change in the body's internal conditions and decides what to do.
  - Sends a message via nerves to communicate how to handle the situation.

- **Effector (Muscle/Gland)**
  - structures that carry out instructions from the brain, causing changes in the body.
  - Example is sweat glands
Integrator (hypothalamus of brain)

Effectors (sweat; vasodilation)

Receptor (skin)

Heat Gained

Heat lost

Effectors (shivering...)

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Physiological Responses to Changes in Body Temperature:

Vasoconstriction

- Blood vessels constrict in diameter thereby reducing the amount of blood that travels through. This helps to conserve heat and raise temperature.

Vasodilation

- Blood vessels increase in diameter thereby increasing the flow of blood through. This helps to release heat and lower temperature.
Vasoconstriction

Vasodilation
Topic 2: The Circulatory System

- Functions:
  - Transport materials to and from the body cells
  - Distribute heat in the body
  - Provides defense against invading organisms
  - Serves as a regulator in the body (homeostasis)
Two Major Types of Circulatory Systems:

- **Open Circulatory System**
  - Found in smaller organisms such as arthropods
  - Blood bathes the internal organs directly

- **Closed Circulatory System**
  - Blood is always contained in blood vessels
  - Materials are exchanged between the blood and cells
  - Found in large complex organisms (e.g. humans)
The Human Circulatory system is composed of:

- Blood Vessels
  1. Arteries
  2. Veins
  3. Capillaries
- Blood
- Heart
Arteries

- Blood vessel that carries blood away from the heart
- Made up of elastic fibres and smooth muscle
- Thin layer of epithelial cells reduces friction
- In measuring your pulse you can feel the artery contracting and expanding
Veins

- Blood vessel that carries blood to the heart
- Has a thinner wall than arteries, but a larger circumference
- Is not elastic
- Gravity aide flow above the heart, one-way valves prevent back flow against gravity below the heart
Capillary

- The smallest blood vessel, only a single cell thick
- Allows for the exchange of oxygen and nutrients in the blood for carbon dioxide and wastes in the body cells.
Figure 9.12. Sections through an artery, capillary, and vein. At any given moment, about 30% of the blood in your systemic circulation will be found in the arteries, 5% in the capillaries, and 65% in the veins.
Three Cycles of Blood Circulation

- **Cardiac**
  - Pathway blood takes in the heart

- **Pulmonary**
  - Pathway of blood from the heart to the lungs and back

- **Systemic**
  - Path through the rest of the body
Coronary/Cardiac Circulation

Includes Blood that travels through the chambers of the heart, but also the blood vessels covering the outside of the heart that supplies the oxygen and nutrients the heart needs as a working muscle.
Pulmonary and Systemic Circulation
• Heart
  • Muscular organ found in all vertebrates
  • Responsible for pumping blood throughout the blood vessels by repeated, rhythmic contractions
• Located in the center of the chest
• 4 Chambers
• *Pericardium* is the membrane that surrounds the heart.
Blood Flow Through the Heart

1. Superior/Inferior Vena Cava
2. Right Atrium
3. Tricuspid Valve
4. Right Ventricle
5. Pulmonary Valve
6. Pulmonary Artery
7. Lungs
8. Pulmonary Vein
9. Left Atrium
10. Mitral (Bicuspid) Valve
11. Left Ventricle
12. Aortic Valve
13. Aorta
14. Body
Major Parts of the Heart

Atria (Atrium)

- The upper chambers of the heart that receives blood from the veins.

Ventricle

- The lower chambers of the heart that receive blood from the atria and pump blood to the arteries.

Septum

- wall of muscle that separates the left side of the heart from the right side. This prevents the mixing of oxygenated and deoxygenated blood.
Parts- continued

Atrioventricular Valves
• Separate the atria and ventricles from one another
• Keeps blood in the ventricle from flowing back into the atrium
• Bicuspid and Tricuspid valves

Semilunar Valves
• Valves that control the flow of blood out of the heart
• Pulmonary and Aortic Valves
Aorta

- The largest artery
- Carries blood from the left side of the heart into systemic circulation.
Vena Cava

- Either of two large veins that drain blood from the upper body (superior vena cava) and from the lower body (inferior vena cava) and empty into the right atrium of the heart.
Sinoatrial/ SA/ Sinus Node

- A small bundle of specialized cardiac muscle tissue located in the wall of the right atrium of the heart that acts as a pacemaker by generating electrical impulses that keep the heart beating.
Electrocardiogram

- A device that measures the voltage of the electrical signals produced by the SA and AV nodes.
Electrocardiograph

- The tracing produced by an electrocardiogram.

ECG tracing of a normal heart rhythm.

In atrial fibrillation, the tracing shows tiny, irregular "fibrillation" waves between heartbeats. The rhythm is irregular and erratic.
Blood Flow Through the Heart (Recap):

**Inferior/Superior Vena Cava**: Returns *deoxygenated* blood to the right atrium from the body.

**Right Atrium**: Thin walled chamber of the heart that receives deoxygenated blood from the body.

**Tricuspid valve**: A valve that controls the flow of blood from the right atrium to the right ventricle.

**Right Ventricle**: Muscular chamber that pumps blood to the lungs.
**Pulmonary valve:** Valve that controls the flow of blood from the right ventricle to the pulmonary arteries.

**Pulmonary Arteries:** Arteries that carry blood to the lungs.

**Lungs:** Site of gas exchange (release CO2, pick up O2).

**Pulmonary Veins:** Veins that bring blood to the heart from the lungs.
**Left Atrium**: Thin walled chamber that receives oxygenated blood from the lungs.

**Bicuspid Valve**: A valve that controls the flow of blood from the left atrium to the left ventricle.

**Left Ventricle**: Thick walled chamber that pumps blood out of the heart and to the body.

**Aortic Valve**: Valve that control the flow of blood from the left ventricle to the aorta.

**Aorta**: Large artery that carries blood away from the heart and to all parts of the body.
Pathway of a Blood Cell

Colour the parts of the circulatory system that would have deoxygenated blood flow BLUE. Colour the parts that would have oxygenated blood flow RED.
Components of Blood

- **Plasma** - 55% of the blood
  - the liquid component of the blood
  - Water, proteins, dissolved gasses, sugars, vitamins, minerals and waste products

- **Red Blood Cells** - 44% of the blood

- **White Blood Cells** - 1% of the blood

- **Platelets**
Erythrocytes (Red Blood Cells)

- Transport oxygen and carbon dioxide to and from the tissues.
- In mammals, these cells are disk-shaped and biconcave, contain hemoglobin, and lack a nucleus.
Hemoglobin

- Red Blood Cells are packed with this iron containing molecule that binds with oxygen. It allows oxygen to be transported in the blood.
Anemia

- This deficiency occurs when the number of healthy red blood cells decrease in the body which causes a shortage of hemoglobin (and thus low iron).
Leukocytes (White Blood Cells)

- Larger than RBCs
- Contain a nucleus
- Fight foreign invaders and Infections

Types of White Blood Cells

a) Macrophages
   - Cells that protect the body by engulfing and digesting foreign invaders (pathogens). [Video]

b) Lymphocytes
   - Blood cells that produce antibodies.
Macrophages

Four macrophages or "engulfing" cells. Macrophages are highly deformable cells. They are able to creep actively into the smallest gaps (and so also to penetrate the vascular walls, for example) and work their way into the most diverse tissue types. They form semi-liquid projections which are used for motility and also for trapping pathogens and other foreign bodies.
Lymphocytes

- Non-phagocytic cells that play a role in immunity by recognizing and fighting off specific pathogens.
Platelets

- called cell fragments
- contain no nucleus
- play a major role in blood clotting
  - Blood Cells (clotting)
The Clotting Process

Step 1:
- Platelets rush to the area. They release an enzyme called Thromboplastin.

Step 2:
- Thromboplastin causes prothrombin (a protein) to be converted to thrombin (enzyme).

Step 3:
- Thrombin causes fibrinogen (found in blood plasma) to be changed into fibrin.

Step 4:
- Fibrin forms a net of fibers over the cut and traps red blood cells and platelets and forms a blood clot.
**Blood Pressure**

**Blood Pressure**: The force that blood exerts on the vessels during and in between heart beats.

- Blood Pressure = Systolic Pressure/ Diastolic Pressure
- **Systolic pressure** in an artery while the heart is contracting
- **Diastolic pressure** the pressure while the heart is resting
- Normal blood pressure is usually around 120/80.
Systolic and Diastolic Pressure

**Arteries**

- Low resistance, rapid transit passageways
- Muscle & elastic connective tissue in walls

*elastic recoil*

SYSTOLE

From Veins to Arterioles to Capillaries

DIASTOLE

From Veins to Arterioles to Capillaries
Sphygmomanometer

- An instrument for measuring blood pressure in the arteries.
Disorders of the Circulatory System

1. Hypertension

- Condition where blood pressure is chronically (always) high
Atherosclerosis & Arteriosclerosis

2. Atherosclerosis
   - A narrowing of the arteries caused by cholesterol or fatty tissue buildup called plaques, ON the inner lining of the artery wall.

3. Arteriosclerosis
   - A condition where plaque material becomes deposited UNDER the inner lining of the arteries
Atherosclerosis & Arteriosclerosis
Stroke

- A condition that occurs when a blood clot blocks an artery going to the brain and causes the brain to be starved of oxygen, killing the brain tissue.
Heart Attack

A condition that occurs when a blood clot blocks an artery going to the heart muscle and causes the heart to beat irregularly or stop altogether. A part of the heart actually dies when this happens.
Heart Murmur

- A condition that occurs when one or more of the heart valves does not open or close properly.
## Circulatory System Disorders

<table>
<thead>
<tr>
<th>Disorder</th>
<th>Cause</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hypertension</strong> (High Blood Pressure)</td>
<td>Diet, stress, inactivity.</td>
<td>Leads to heart disease and possible heart failure</td>
</tr>
<tr>
<td><strong>Arteriosclerosis</strong> (Hardening of the Arteries)</td>
<td>Diet – High in Cholesterol and Fats.</td>
<td>Causes arteries to become inelastic which can reduce the amount of blood flow in them. This can lead to a heart attack and/or stroke.</td>
</tr>
<tr>
<td><strong>Atherosclerosis</strong> (Narrowing of Arteries)</td>
<td>Fatty deposits within the artery walls from poor diet, fat intake etc.</td>
<td>Narrowing of arteries reduces blood flow to heart and brain which may lead to heart attack and/or stroke.</td>
</tr>
<tr>
<td><strong>Stroke</strong></td>
<td>Loss of blood flow to brain tissue causing cell death.</td>
<td>Loss of brain function and/or motor control (paralysis), Death.</td>
</tr>
<tr>
<td><strong>Coronary Blockage</strong></td>
<td>A blockage in the coronary arteries of the heart, diet, lack of exercise.</td>
<td>Heart attack, Death.</td>
</tr>
</tbody>
</table>
Treatments for Circulatory System Disorders

1. Thrombolytics
   - A class of drugs known as “Clot busting” drugs.
   - Help to clear blocked passageways etc
2. Coronary Bypass Surgery

- Healthy blood vessel from another area in the body (leg or arm) is used to create a new pathway around a blockage in a blood vessel near the heart.

- [http://www.youtube.com/watch?v=dee8CMamoQ0&feature=related](http://www.youtube.com/watch?v=dee8CMamoQ0&feature=related)
3. **Angioplasty**

- Small catheter (tube) with a balloon attached is inserted into an artery and then inflated.
- Artery is stretched in an attempt to increase blood flow to the heart.
- Sometimes a *Stent* (small mesh netting) is put in place to keep the artery open after the balloon is removed.

http://www.youtube.com/watch?v=S9AqBd4REvk&feature=related