Homeostasis (Circulation)
Chapter 9

Homeostasis - the body’s maintenance of a relatively stable internal physiological environment

How does the body maintain homeostasis, for example, when running?
• Increased heart rate
• Breathing faster (increasing oxygen to muscles)
• Thirsty
• Sweating (maintaining body temperature)
• Release of sugar from stores for energy

Dynamic equilibrium - state of balance achieved within an environment as the result of internal control mechanisms that continually oppose outside forces that tend to change that environment.

Temperature Regulation is one of the body’s homeostatic mechanisms.

Homeotherms - animals that keep their body temperature constant (i.e. birds & mammals)
Poikilotherms - animals whose body temperature fluctuates (i.e. reptiles)

The circulatory system plays an important role in the body’s physiological regulation of heat:
• If need to conserve heat, blood vessels close to the skin constrict (called vasoconstriction) to limit blood flow (extremities may become cold)
• If need to release heat, blood vessels near the skin dilate (called vasodilation) to increase flow of blood under surface of skin (skin feels hot to touch)

Read Pages 300 -302 and answer pg. 303 # 1-3

The Mammalian Circulatory System (Section 9.2)

Read Pages 304- 307 and create your own notes on the 3 main transport vessels: arteries, veins, and capillaries (i.e. structure and function of each)

Blood - transport medium consisting of 2 elements:
• cells - erythrocytes, leukocytes, platelets
• plasma - made of water & dissolved gases, minerals, proteins, sugars, waste products

Erythrocytes - also known as red blood cells
• Specialized for oxygen transport as well as carbon dioxide transport
• No nucleus
• Contains millions of hemoglobin molecules (iron containing molecules which binds with oxygen)
• Live approximately 120 days

Leucocytes - also known as white blood cells
• Have nucleus, appear colourless
• Numbers increase when body is fighting an infection
• 2 main types are macrophages (able to pass through capillary walls and engulf & digest
pathogens) and lymphocytes (recognize and fend off specific pathogens the body has been exposed to before)

Platelets
- Fragments of cells that were created when larger cells in the bone marrow broke apart
- Have no nucleus and only last about 7 - 10 days
- Aid in clotting blood (protect body from excessive blood loss)

Plasma
- Fluid medium in which blood cells are suspended
- Contains many important substances needed by the body (mineral, vitamins, etc)
- Aids in the transport of carbon dioxide

Read Pages 308-313 & answer questions on pg. 313 # 1, 2

The Mammalian Heart
- acts as a “double pump” as it contracts and forces blood through the vessels
- right side of the heart send oxygen-poor blood to the lungs and the left side sends oxygen-rich blood to the rest of the body
- found slightly to the left of the middle of the chest cavity and is a little bigger than your fist
- made of cardiac muscle
- the pericardium is a tough membrane that surrounds the heart and protects it

*four chambers
- left atrium and right atrium (or auricles)-thin walled
- left ventricle and right ventricle-thick walled
- left and right sides of the heart are separated by a wall called the septum which prevents non-oxygenated and oxygenated from mixing

*four flap-like valves -control the direction of blood flow inside the heart

- atrioventricular valves (A-V valves) allow blood to flow from the atria to the ventricles
  
  Right side  tricuspid valve (three flaps)
  Left side  bicuspid or mitral valve

- semilunar valves allow blood to move from the ventricles into the arteries that carry blood away from the heart or stop the blood from flowing back into the ventricles
The Cardiac Cycle
*diastole - period of relaxation
  - A-V valves are open and blood flows from the atria into the ventricles
*ystole - period of contraction
  - atria contract and forces more blood into the ventricles
  - ventricles contract when full and the pressure closes the A-V valves and opens the semilunar valves
  - blood flows out of the right ventricle into the pulmonary artery which branches into two (one for each lung)
  - blood flows out of the left ventricle and into the aorta (largest artery in the body)
  - the aorta branches into many smaller arteries and carries oxygenated blood to all the tissues
  - when ventricles are contracting, the atria relax and blood flows into the atria from the veins
  - when the ventricles relax, a new period of diastole begins
*when the doctor uses a stethoscope, he/she is hearing the closing of your valves “lub dup”
  - if the septum or any of the valves are damaged, a heart murmur is heard

Control of the Heartbeat
-cardiac muscle has a built-in ability to contract
  - even when it is removed from the body, the heart will keep beating for a while if it is kept in a special solution
-S-A node or sinoatrial node is our “pacemaker”
  - it is a small group of specialized muscle cells in the wall of the right atrium
  - contraction of the heart begins when the heart receives electrical impulses from the S-A node
  - an electrocardiogram records each time the heart contracts
  - the rate of the heartbeat is regulated by certain nerves that enter the pacemaker
  - the rhythm of the heart is also affected by changes in body temperature and by certain chemicals in the blood (example: adrenaline)

Pathways of Human Circulation
*two major pathways*

Pulmonary Circulation (carries blood between heart and lungs)
  - adds oxygen and removes carbon dioxide from the blood
  - the pulmonary arteries are the only arteries that carry oxygen poor blood
  - the pulmonary veins are the only veins that carry oxygen rich blood

Systemic Circulation (carries blood between heart and rest of body)
  - begins in the left ventricle of the heart (thicker walls because of powerful pumping)
  - from the left ventricle, the blood is pumped into the aorta
  - the aorta branches off forming arteries to serve all parts of the body
  - exchange of materials between blood and body tissues takes place through walls of capillaries
  - capillaries merge to form veins
  - largest veins are:
    - *superior vena cava* (returns blood from the head, arms and chest)
Review of Blood Flow through the Human Circulatory System

1- **superior** and **inferior vena cava** are the main veins that receive blood from the body. The superior vena cava drains the head and arms, and the inferior vena cava drains the lower body.

2- **right atrium** receives blood from the body via the vena cavae. The atria are the receiving chambers of the heart.

3- Blood then passes through the right **Tricuspid (AV valve)**, which is forced shut when the ventricles contract, preventing blood from re-entering the atrium.

4- Blood goes into the **right ventricle** (note that it has a thinner wall; it only pumps to lungs). The ventricles are the pumping chambers of the heart.

5- The **right Semilunar Valve** closes to prevent blood from flowing back into the ventricle.

6- The **pulmonary arteries** are the main arteries taking **deoxygenated** blood to the lungs.

7- Blood goes to the right and left lungs, where capillaries are in close contact with the thin-walled alveoli so the blood can release CO$_2$ and pick up O$_2$.

8- From the lungs, the **pulmonary veins** carry oxygenated blood back into the heart.

9- The **left atrium** receives oxygenated blood from the lungs.

10- The blood passes through the left **Bicuspid (AV valve)**.

11- The blood enters the **left ventricle**. Note the thickened wall; the left ventricle must pump blood throughout the whole body.

12- The blood passes through the left **semilunar valve** at the beginning of the **aorta**.

13- The aorta divides into **arteries** to distribute blood to the body.

Blood Pressure and the Flow of Blood

* **pulse** - the expansion (high pressure) and relaxation (lower pressure) that can be felt in an artery each time the left ventricle contracts and relaxes - both the rate and the force of the heartbeat can be measured by the pulse

* **blood pressure** - measured on the upper arm with an instrument called a sphygmomanometer - measured in terms of the height of a mercury column - stated in the form of **systolic pressure/diastolic pressure** - the normal blood pressure in a resting adult is 120/80 - during exercise or times of stress, blood pressure increases - **hypertension** is a serious medical condition where people have high blood pressure throughout the heartbeat cycle - hypertension can be caused by **atherosclerosis** or “hardening of the arteries” where a build up of cholesterol and fatty materials form a plaque in the arteries.

Disorders of the Circulatory System

**Anemia** - lack of iron in the blood, low RBC count

**Hemophilia** - bleeder’s disease, due to lack of clotting factor

**Heart attack** - blood vessels around the heart become blocked with plaque
Treatments

**Clot busting drugs** - must be administered immediately after stroke symptoms to work

**Angioplasty** - insertion of a tiny balloon to the clot site where it is inflated to force the vessel open (can also insert a mesh shunt to open the vessel)

**Coronary bypass surgery** - use a healthy blood vessel from the patient’s body to create a new pathway around a blockage in a blood vessel near the heart.