What happens to your body as you run?

Breathing, heart rate, temperature, muscle pain, thirsty...

**Homeostasis**

Homeostasis is the process of maintaining a relatively constant internal physiological environment despite changing external conditions. It is one of the fundamental characteristics of living things. The maintenance of a constant internal environment (homeostasis) is an example of dynamic equilibrium.

**Dynamic equilibrium** is the state of balance that is achieved within an environment as a result of internal control mechanisms that oppose outside forces that attempt to change that environment.

Examples: (text) **Homeotherms** (mammals/birds) and **Poikilotherms** (reptiles)

There are several body systems that are involved in maintaining homeostasis:
- nervous system
- endocrine system
- respiratory system
- immune system
- excretory system
- digestive system
- circulatory system

See Figure 9.2 on p. 301.

All sorts of factors can affect our bodies including temperature, salinity, acidity, and the concentrations of nutrients and wastes.

Because these properties need to be in balance to stay alive, we have built-in physiological mechanisms to maintain them at desirable levels.

Maintenance of the constant internal environment is accomplished through a monitoring system that gives feedback about the conditions such as: blood sugar; body temperature; blood pressure; oxygen levels; blood composition; heart rate; breathing rate; nervous and endocrine controls.

These are some of the key physiological states that the body works best at:
- temperature - 37°C
- blood pH - 7.35
- blood pressure - 120/80 mmHg
- blood sugar - 0.1%
Homeostasis and Temperature Regulation:

How is body temperature regulation maintained?

The body reacts to increases or decreases in temperature by means of a negative feedback loop. This mechanism is the process that detects and reverses deviations from normal body constants. It involves three parts:

1) **Sensory Receptor**: It is found throughout every body organ and tissue. It sends nerve impulses (stimuli) to the brain in response to environmental information. It monitors the body’s internal conditions.

2) **Integrator**: It is located in the brain (hypothalamus) and sends messages to the effectors.

3) **Effector**: It causes a change in internal conditions. The brain sends messages to various tissues and organs that cause the body to generate or consume heat. These messages can be transmitted by the nervous system or by chemical messengers known as hormones.

The human body generates heat as a by-product of metabolic processes and uses several different mechanisms to control the rate at which heat is lost through the skin at the effector stage.

A) Behavioral: Sit in the shade or by a fire, put a sweater on...

B) Physiological: Circulatory system including sweating and shivering. Also includes:

- **Vasoconstriction** is when blood vessels constrict in diameter thereby reducing the amount of blood that travels through.
- **Vasodilation** is when blood vessels increase in diameter thereby increasing the flow of blood through. (Flushed)

**NOTE**: Positive Feedback Mechanisms do exist but are usually associated with disease or changes such as, high blood pressure. It acts to increase the strength of the stimuli and pushes a system away from balance and stability.

HW pg 303 # 1, 3, 5, 6.
The Mammalian Circulatory System
Every day, the fist-sized heart pumps about 7,600 liters of blood, beating about 100,000 times. The blood vessels transport and circulate blood throughout the body.

**Blood vessels are organized into 3 primary cycles.**

1. **Cardiac Circulation:** the route taken by the blood within the heart.
2. **Pulmonary Circulation:** pathway of the blood from the heart to the lungs and back.
3. **Systemic Circulation:** route from the heart to the rest of the body.

The mammalian circulatory system includes 3 main types of blood vessels:

1. artery
2. vein
3. capillary

1. **Arteries**
   - Carry blood *away* from the heart.
   - Branches as it enters organs.
   - Smallest are **arterioles**.
   - Made of thick muscular walls (because blood is under high pressure in the arteries)
   - The walls are elastic in nature and expand as blood passes through snapping back to help the blood flow. This wave helps the heart push blood through the circulatory system and keeps the blood flowing. This is your pulse.
   - Located deep inside the body for protection
   - Carry blood rich in $O_2$ with the exception of the **pulmonary artery**. (It carries deoxygenated blood *away* from the heart to the lungs).

2. **Veins**
   - Carry deoxygenated blood *to* the heart. The exception is the **pulmonary vein**. The pulmonary vein returns oxygenated blood from the lungs back to the heart to be pumped into the body.
   - Walls are thinner and less elastic than arteries, but they have a larger capacity.
   - They withstand less pressure, but hold more blood. Almost two times as much blood is found in the veins compared to the arteries.
   - Found closer to the body surface than arteries. (Look at wrists)
   - Carry blood low in $O_2$
   - Smallest veins found in the organs are **vessels**.
   - **Valves** allow blood to flow in one direction - towards the heart. (*Explain pushing blood on foot vein*)
   - This flow is helped by skeletal muscle action (*say: stretch, fidgetty*)
   - When a valve fails blood builds up in a vein and the vein’s wall become stretched and lose their elasticity. This condition is called varicose veins.

3. **Capillaries**
   - Carry blood from arterioles to venules
-Walls are one cell thick and very narrow to allow for easy diffusion.
-Site of all exchanges between the blood and body cells
-Most numerous blood vessels in the body
-Damaged capillaries will seep blood causing a bruise

The Circulatory System
- Transport system (organ) which links the cells of an organism with its environment
- Unicellular organisms (e.g. bacteria) do not require a transport system

There are two major types of circulatory systems:

A) Open Circulatory System
- Found in smaller organisms such as arthropods
  - Blood is contained in blood vessels for only part of the time
  - Blood bathes the internal organs directly

B) 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)

-There are two separate transport systems within mammals. They are blood and lymph.

-The three major organs of the circulatory system are
  1) blood (transport medium)
  2) blood vessels (transport vessels)
  3) heart (pumping mechanism)

Blood
- An adult human has between 4 to 6 liters of blood
- Blood has several 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)

Blood is composed of two major divisions, the plasma (solvent) and the formed elements (solute).

1. Plasma (55% of blood)
- Solvent, the liquid component of the blood
- It is a clear, straw-colored liquid composed of:
  Water (90%)
  Dissolved substances (10%): Salts, Glucose, Amino acids, Fatty acids, Vitamins, Enzymes, Hormones, Wastes and Proteins
2. Formed Elements (45%)
- Solute, the solid components of the blood.
- Consists of red blood cells (RBCs), white blood cells, (WBC) and platelets.

A. RBCs (Erythrocytes)
- Approximately 5 million/ml of blood
- About 30 trillion/adult
- Produced in bone marrow
- Disc shaped possessing no nuclei at final stage (see fig 9.11 g 309)
- Life span of 120 days
- 2 million destroyed and 2 million produced per second.
- Dead ones are removed from circulation by the liver and spleen
- Contains the iron rich protein [hemoglobin] which combines with oxygen in the lungs to form [oxyhemoglobin].
- Transports carbon dioxide from the body cells to the lungs. CO₂ combines with the hemoglobin to form [carboxyhemoglobin]
- Pick up and drop off is based on the partial pressure of oxygen, and the acidity of the blood. The more CO₂, the more acidic, the more likely it is to drop O₂ molecules and pick up CO₂. In the less acidic, highly oxygenated blood, it will drop its CO₂, and collect O₂ molecules.
- Hemoglobin is an iron containing molecule. It turns red (like rust) is the presence of oxygen.

**RBC diseases**
- One disease associated with RBCs is [anemia]. It is caused by either a lack of hemoglobin or too few RBCs
- Symptoms of anemia include dizziness, weakness, and pale color
- [Sickle-cell anemia] is a hereditary disorder caused by an abnormal form of hemoglobin. The cells are sickle shaped (draw for them) and therefore carry little O₂ and tend to become clogged in the blood vessels.

B. WBCs (Leukocytes)
- 8000/ml (only 1% of total blood)
- 60 billion/adult
- Produced in the bone marrow and lymphatic tissue
- Larger than RBCs and contain a nucleus
- Defends body against disease by:
  - engulfing (phagocytosis) bacteria
  - producing antibodies
- They can move out of blood vessels into body tissue (RBC can’t)- Increase in numbers at times of infection (30,000 or more per ml)

C. Platelets
- 300,000/ml
- 1.5 trillion per adult
- Produced from bits of bone marrow cells. Often referred to a cell fragments.
-Only live for 7-10 days.
-Contain no nucleus
-Play a major role in blood clotting.

-Blood clotting maintains homeostasis by preventing the loss of blood from torn or ruptured blood vessels.

- The major stages are: as follows: (follow fig 9:15 pg 312)
  a. Broken blood vessels release substances that attract platelets to the injury site.
  b. Blood platelets strike a rough surface such as that created by a torn blood vessel.
  c. They break apart and combine with plasma to form **thromboplastin**
  d. Thromboplastin in the presence of calcium causes another blood protein called **prothrombin** to change into **thrombin**
  e. Thrombin acts as an enzyme causing **fibrinogen** (another blood protein) to form **fibrin**.
  f. Fibrin is an insoluble material that forms mesh strands around the injury site.
  g. These strands trap escaping RBCs and form the clot.

**Other Functions of Blood**: It acts as connective tissue because it links all the body’s cells and organs. It is necessary for the distribution of materials and gases, for the removal of the waste products of cellular respiration and as a medium for conveying chemical messengers (such as hormones). It also helps distribute heat throughout the body.

pg 313 #1, 2, 3, 5