The Human Organism
Chapter 1

ANATOMY AND PHYSIOLOGY

1. **Anatomy** [Gr. *ana*, up; *tome*, a cutting]. The scientific discipline that investigates the structure of living things. Literally investigates by cutting up and taking apart.

2. **Physiology** [Gr. *physis*, nature; *logos*, study]. The scientific discipline that studies the vital nature (processes and functions) of living things.

STRUCTURAL AND FUNCTIONAL ORGANIZATION

FIGURE 1.1

1. **Chemical level** - atoms, ions, molecules.

2. **Cell level** - the cell is the basic living unit of all plants and animals.
   A. Molecules combine to form organelles, which are structures within cells that perform specific functions (e.g., plasma membrane and nucleus).

   B. Individual human cells are specialized and interdependent on each other.

3. **Tissue level** - a group of cells with similar structure and function plus the extracellular substances located between them. There are four primary tissue types: epithelial, connective, muscular, and nervous tissues.

4. **Organ level** - two or more tissue types that perform one or more common functions. The urinary bladder is an example.

FIGURE 1.2

5. **Organ system level** - a group of organs classified as a unit because of a common function or set of functions. Eleven organ systems are recognized.

FIGURE 1.3

   A. Controlling - nervous and endocrine systems.

   B. Support and movement - skeletal and muscular systems.

   C. Maintenance - digestive, respiratory, circulatory, urinary, lymphatic, and integumentary systems.

   D. Reproduction - the reproductive system.

6. **Organism level** - any living thing. May be a single cell (e.g., bacteria) or multicellular (e.g., human). Humans are organisms that consist of organ systems.

HOMEOSTASIS

1. **Homeostasis** [Gr. *homoio*, like; *stasis*, a standing] is the existence and maintenance of a relatively constant environment within the body, i.e., a like standing.

2. The environment referred to is the conditions necessary for the cells of the body to function properly, e.g., obtain adequate oxygen and nutrients and eliminate carbon dioxide and waste products.

3. The conditions necessary for homeostasis are called **variables** because they vary, or change. The ideal normal value for a variable is called the **set point**. The variable fluctuates around the set point, establishing a **normal range** of values. For example, body temperature is a variable that is maintained around a set point of 37° C (98.6° F).

FIGURE 1.4

4. Disruption of homeostasis can result in disease and death.

Negative Feedback

1. When homeostasis is disturbed, mechanisms act to restore homeostasis. The return to homeostasis is called **negative feedback**. The term "negative" implies that the difference between the disturbed condition and the normal condition is negated or made smaller.

2. Components of many negative feedback mechanisms.

FIGURE 1.5

   A. A **receptor** (nerve ending) monitors the value of a variable such as body temperature.

   B. A **control center**, such as the brain, determines the set point of the variable.

   C. A change in the value of the variable is a **stimulus** that can be detected by the receptor. Information about the change is sent to the control center (brain) which compares the value of the variable to the set point.

   D. The control center (brain) then causes an **effector**, such as sweat glands, to produce a **response**, such as sweating, that returns the value of the variable back to the set point (evaporation of sweat cools the body).

   ☞ What response would be produced in response to a decrease in body temperature?

3. Maintaining blood pressure through negative feedback is necessary for homeostasis.

FIGURE 1.6

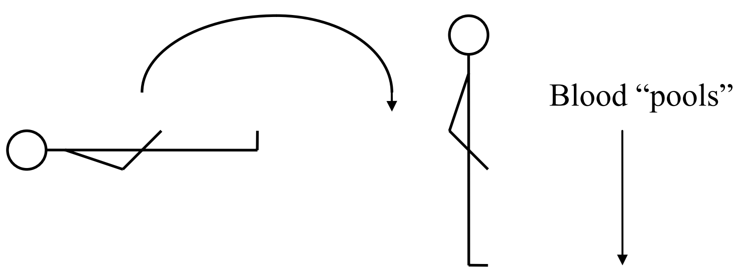
A. Blood pressure provides the force necessary to deliver blood to tissues, thereby providing cells with oxygen and nutrients and removing carbon dioxide and waste products.

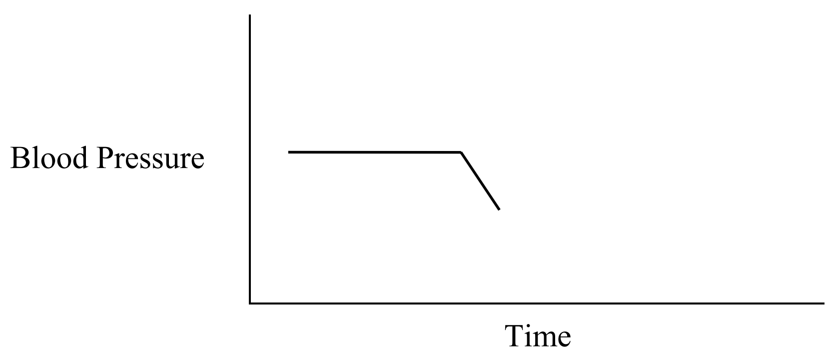
B. Blood pressure is generated by contractions of the heart. An increase in heart rate or force of contraction increases blood pressure.

C. Example of negative feedback: receptors in blood vessels detect changes in blood pressure. If blood pressure increases, the brain causes heart rate to decrease, which decreases blood pressure. Conversely, if blood pressure decreases, the brain cause heart rate to increase, which increases blood pressure.

☞ **Practice Problem**

1. You are asleep and you hear the phone ring. You jump up out of bed to answer the phone. Blood "pools" in the lower limbs, blood return to the heart decreases, which results in a decrease in blood pressure.



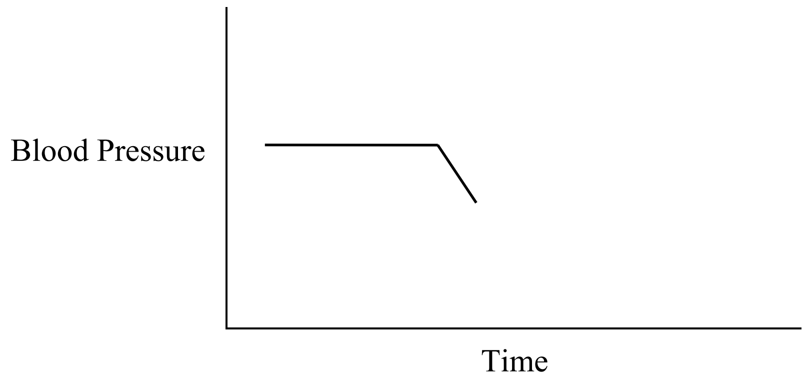


2. Decreased blood pressure results in inadequate delivery of blood to the brain. Two responses to this deviation from homeostasis are possible.
   A. You faint.

   ☞ Why does fainting restore homeostasis?

B. Receptors detect the decrease in blood pressure and the brain causes an increase in heart rate.

☞ Draw the expected response to the increase in heart rate.



3. When getting people out of bed, it is standard practice to let them "dangle" their feet for a few seconds.

☞ Why is "dangling" a good idea?

5. A change in the value of some parameter does not necessarily mean that homeostasis is not being maintained. Remember that homeostasis establishes normal values. What is normal may depend upon the conditions.

FIGURE 1.7

☞ Why is the increase in blood pressure during exercise, i.e., the movement of blood pressure away from the normal resting value, an example of homeostasis?

Positive Feedback

1. When a condition gets further away from the normal value it is called **positive feedback**. The term "positive" implies that the difference between the disturbed condition and the normal condition increases or gets larger.

FIGURE 1.8

2. Moving away from the normal condition is usually harmful.

FIGURE 1.9

   A. The heart normally pumps blood to itself through blood vessels located on the outside of the heart.

   B. A decrease in blood volume results in a decrease in blood pressure (just as letting air out of balloon reduces the air pressure within the balloon).

   C. If a person loses a large amount of blood, the result is a decrease in blood pressure.

   D. A decrease in blood pressure results in decreased blood delivery to cardiac muscle, which then does not function properly.

   E. The heart pumps less blood and blood pressure decreases even more.

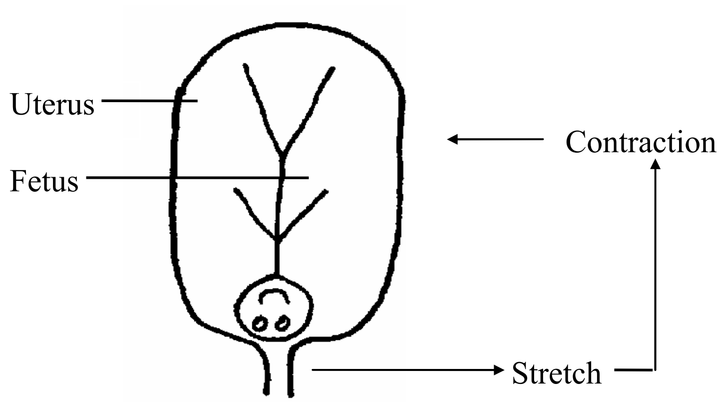
3. Positive-feedback mechanisms usually result in dysfunction, disease, and even death.

☞ While the positive-feedback mechanism just described is operating, what are the negative-feedback mechanisms that normally regulate blood pressure doing? For example, what is happening to heart rate?

4. Failure of negative-feedback-mechanisms to maintain homeostasis results in disease and death.

☞ Medical therapy often interrupts positive-feedback mechanisms or assists negative-mechanisms. In this regard, what would you recommend to help maintain blood pressure in a person who has lost a large amount of blood? Explain.

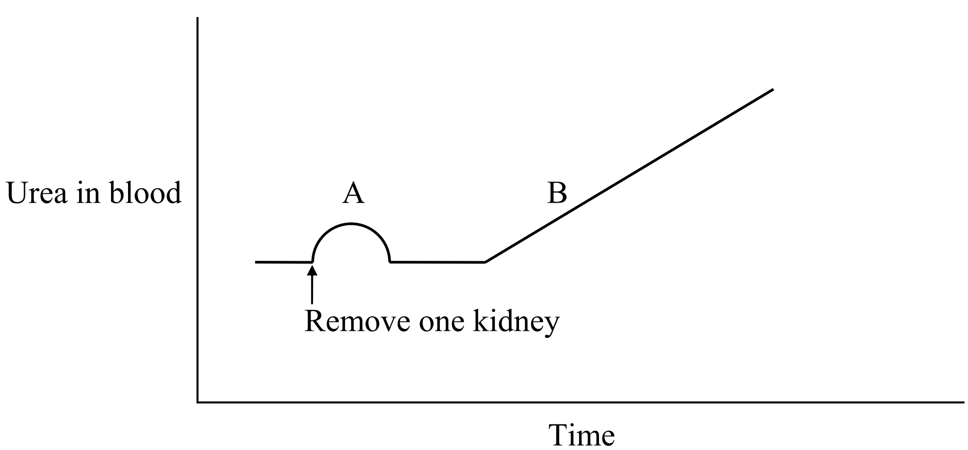
5. Not all positive-feedback-mechanisms are harmful.
   A. Delivery of the fetus.



   B. The growing fetus causes stretch of the uterus. Stretch of the uterus causes contraction of the uterus, which causes stretch of the uterus, which causes stronger contractions, etc. This is positive feedback.

   ☞ Why doesn't the positive-feedback mechanism of delivery cause the uterus to be in a continual and forcefully contracted state?

☞ **Practice Problem**
Urea is a toxic product normally produced by the metabolism of proteins. It is normally carried by the blood to the kidneys where it is eliminated.



☞ Explain the change in blood urea that occurred at A shortly following removal of one kidney.

☞ Explain the change in blood urea that occurred at B several days after removal of the kidney.

TERMINOLOGY AND THE BODY PLAN

Body Positions

FIGURE 1.10

1. The **anatomic position** refers to a person standing erect with the face directed forward, the upper limbs hanging to the sides, and the palms of the hands facing forward.

2. A person is **supine** when lying face upward and **prone** when lying face downward.

Directional Terms

1. Directional terms help you move from one part of the body to another part.

2. All directional terms are used in reference to the anatomic position.

3. Understanding directional terms is easier if you know the **etymology**, i.e., the origin and meaning of the term.

Terms	Etymology	Definition
Right		Toward the body's right side
Left		Toward the body's left side
Inferior	L. lower	A structure lower than another
Superior	L. higher	A structure higher than another
Anterior	L. before	The front of the body
Posterior	L. *posterus*, following	The back of the body
Cephalic	G. *kephale*, head	Closer to the head than another structure
Caudal	L. *cauda*, a tail	Closer to the tail than another structure
Dorsal	L. *dorsum*, back	Toward the back
Ventral	L. *venter* or *ventr*, belly	Toward the front (belly)
Proximal	L. *proximus*, nearest	Closer to the point of attachment to the body than another structure
Distal	L. *di*- + *sto*, to stand apart or to be distant	Farther from the point of attachment to the body than another structure
Lateral	L. *latus*, side	Away from the middle or midline of the body
Medial	L. *medialis*, middle	Toward the middle or midline of the body
Superficial	L. *superficialis*,	Toward or on the surface
Deep	OE. *deop*, deep	Away from the surface, internal

☞ Another word for posterior is ________________.

☞ Another word for anterior is ________________.

☞ A man is doing a "head stand." It would be correct to say that his chin is ________________ to his belly button.

Body Parts and Regions

FIGURE 1.11

1. Limbs
   A. Upper - arm, forearm, wrist, hand.
   B. Lower - thigh, leg, ankle, foot.

2. Head, neck, and trunk.
   A. The trunk is divided into the thorax, abdomen, and pelvis.

   B. The abdomen can be superficially divided into quadrants (clinicians) or into nine regions (anatomists). These areas are used as reference points to locate underlying organs.

FIGURE 1.12

Planes

1. Planes (imaginary flat surfaces) can be used to cut through the body. This allows inspection of the bodies structures from different views.

2. Planes of the body.

FIGURE 1.13

   A. **Sagittal** [L. *sagitta*, an arrow] plane divides the body into right and left parts. A **median** plane divides the body into equal right and left parts.

   B. **Coronal** (L. garland, crown) or **frontal** plane divides the body into anterior and posterior parts.

   C. **Transverse** or **horizontal** plane divides the body into superior and inferior parts.

3. Sections of organs. Organs can be cut to reveal their internal structures.

FIGURE 1.14

   A. **Longitudinal** section cuts along the long axis of the organ.

   B. **Cross** or **transverse** section cuts at right angles to the long axis.

   C. **Oblique** section cuts at any angle other than a right angle to the long axis.

Body Cavities.

1. Although there are many body cavities (e.g., nasal, cranial, joint, etc.), only the body cavities of the trunk that do not open to the outside of the body will be considered for now.

2. The trunk has three large cavities.

FIGURE 1.15

A. **Thoracic cavity**.
   1) Enclosed by the ribs and superior to the diaphragm. Divided into right and left halves by the **mediastinum** a partition of organs (e.g., trachea, thymus gland, heart, esophagus, and other structures).

   2) Each half of the thoracic cavity contains the lungs.

B. **Abdominal cavity**.
   1) Enclosed by inferior ribs, abdominal muscles, and superior part of pelvic bones. Inferior to the diaphragm and superior to a plane drawn between the sacral promontory and symphysis pubis.

   2) Contains the liver, stomach, intestines, kidneys, spleen, and pancreas.

C. **Pelvic cavity**.
   1) Enclosed by the pelvic bones inferior to a plane drawn between the sacral promontory and symphysis pubis.

   2) Contains the urinary bladder, last part of the intestine, female reproductive organs (uterus, ovaries) or male reproductive organs (prostate gland, seminal vesicles).

   3) The **abdominopelvic cavity** is the combined abdominal and pelvic cavities.

   ☞ What type of section is figure 1.15*a*? Which side of figure 1.15*a* is the right side? What type of section is figure 1.15*b*? Are you looking at figure 1.15*b* from the right or left side?

Serous Membranes.

1. The trunk cavities and their organs are lined by serous membranes. Imagine a fist (organ) stuck into a balloon (a sac formed by a serous membrane).

FIGURE 1.16

   A. The part of the balloon in contact with the fist is the **visceral** portion.

   B. The outside part of the balloon is the **parietal** portion.

   C. Between the visceral and parietal portion is a **space** or **cavity**.

2. The serous membranes function to reduce friction between an organ and its surroundings. A serous membrane is very smooth and the space between the visceral and parietal portions is filled will a slippery lubricating serous fluid.

3. Serous membranes are named according to their location.

FIGURE 1.17

   A. **Pericardial** serous membranes surround the heart.

   B. **Pleural** serous membranes surround the lungs.

   C. **Peritoneal** serous membranes are in the abdominopelvic cavity.

4. **Mesenteries** are double-layered serous membranes that connect abdominal organs to the body wall or to other organs. They hold abdominal organs in place and provide a pathway for nerves and blood vessels to reach organs.

5. Some organs (e.g., kidneys, adrenal glands, pancreas, and urinary bladder) are **retroperitoneal**. They are covered by parietal peritoneum and do not have mesenteries.

☞ State two ways an organ can be in the abdominal cavity but not in the peritoneal cavity?

☞ **Practice Problem**
A bullet strikes a man in the abdomen, passing through the body wall and the stomach and lodges in the kidney. Name in order the serous membranes the bullet passed through.