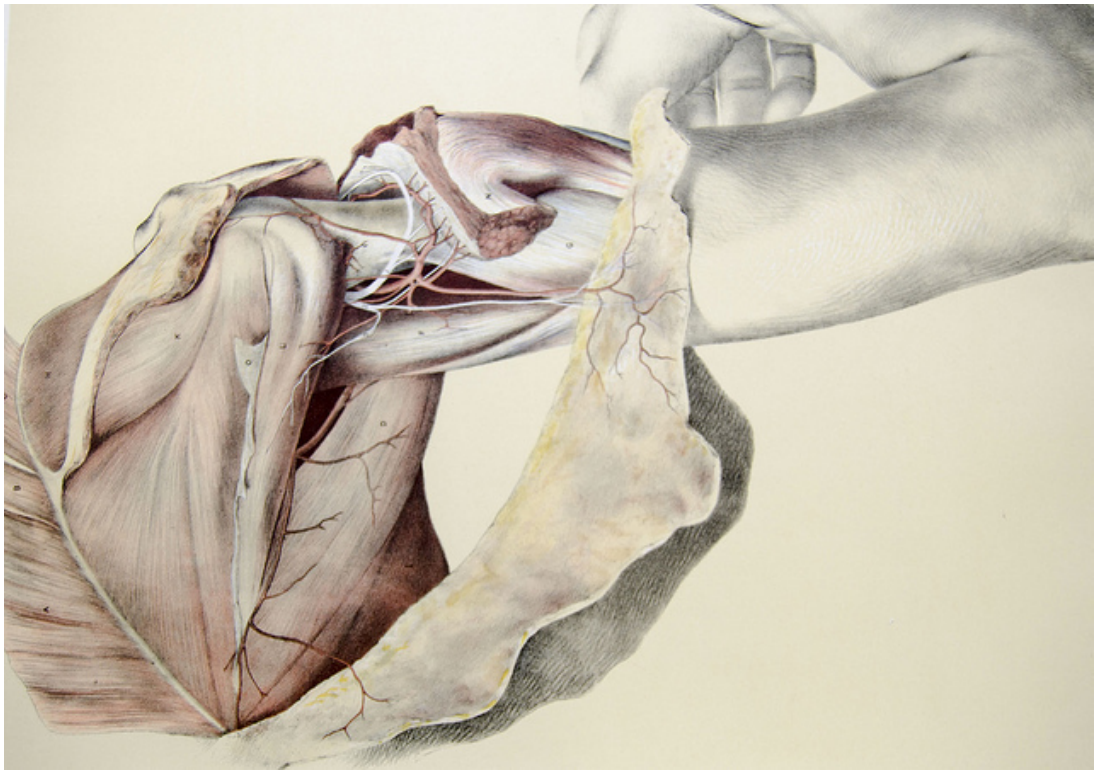
General Physiology – An Introduction

See online here

Physiology is defined as the study of how biological systems work to bring about the development and progression of life. This vast field of science covers all living organisms including viruses, bacteria, plants, humans, and much more. Human physiology deals with the ways in which the human body carries out its fundamental characteristics, making it a living system. Although complex, an understanding of the basic concepts involved in the study of human functioning is extremely important.



Cells: The Basic Unit of the Human Body

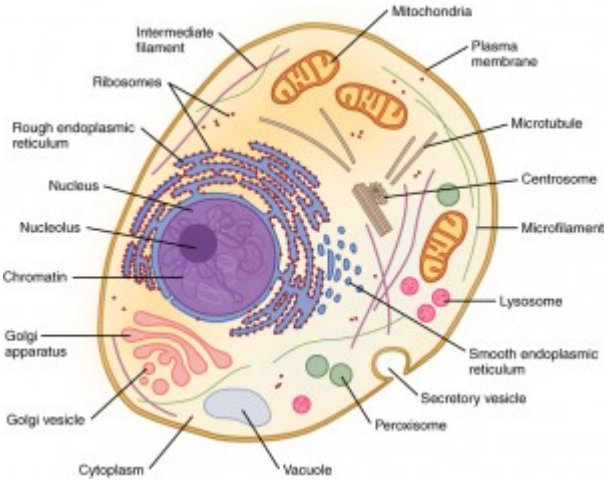


Image: "Prototypical Human Cell" by philschatz. License: CC BY 4.0

All living organisms, including human beings, begin life with only a **few cells**. Cells are the fundamental unit of the human body. When clumped together using supporting structures, cells make up a **tissue**. Different tissues, grouped together, become an **organ**.

There are many types of cells. They are characterized according to their morphology, how they work, and their placement in the body, among other things.

For example, **neurons,** which make up the majority of the nervous system, are different in terms of their ability to transmit neural signals than white blood cells, which are an important part of the immune system. Each cell in the body develops certain characteristics that allow it to perform **specific functions** required of the organ system from whence it comes.

Although the body's cells are very diverse, they all share certain characteristics. **All cells require nutrients and other raw materials** for them to function well, and all cells are able to **create copies of themselves**, something which is exemplified during both normal growth and in damage repair.

Fluid Compartments

You will learn that water makes up a significant portion of a cell's structure. With this in mind, one would think that the human body is composed of a significant percentage of fluids. Although fluids do make up a larger percentage of the body than other components, such as minerals, fat, and protein, this percentage changes as we age. Neonates and infants have the largest percentage of fluid in the body, while older adults have the lowest. Generally, an adult **human body is made up of 60% fluid**. Despite their significant presence in the body, however, fluids are organized into compartments.

Intracellular fluid (ICF)

Water found inside the cell makes up this compartment and the majority of fluids in the human body. ICF contains large amounts of so-called intracellular **ions such as magnesium, phosphates, and potassium.**

Extracellular fluid (ECF)

This compartment is defined simply as the fluid that surrounds the cell. Claude Bernard, a French physiologist, coined the term ***milieu interieur*** to describe the ECF's ability to **dissolve and carry the requirements needed for all types of cells to thrive**. Unlike the ICF, the ECF contains sodium, chloride, and bicarbonate ions. It is further divided into two spaces:

- **Intravascular space**—the fluid that comprises blood; confined within the lumen of the heart and blood vessels.
- **Extravascular space**—surrounds the tissues; it can either be interstitial (space directly surrounding cells; the microenvironment of the cells) or transcellular (areas in the body where only small amounts of fluid can be accommodated—e.g., peritoneal cavity, joints, and the inside of the eyeball).

Overview on the Major Body Systems

In order to bring about harmony within the human body, or **homeostasis**, different physiologic systems maintain a fairly constant *milieu interieur.* This is achieved through the systems' ability to maintain interdependent functions with each other.

Circulatory system

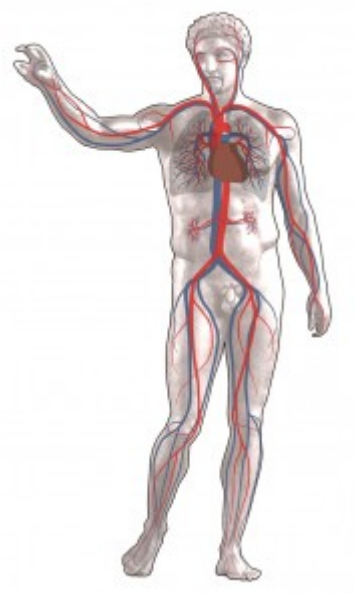


Image: "The human circulatory system. Red indicates oxygenated blood, blue indicates deoxygenated." by Sansculotte. License: CC BY-SA 2.5

As outlined above, ECF, particularly inside blood vessels, is responsible for the transport of oxygen, nutrients, and metabolic wastes to and from the different areas of the body. (See also blood circulation.)

Respiratory system

The respiratory system answers the cell's need for oxygen by supplying it through alveolar respiration. As gas transport occurs at the level of the alveoli, the blood receives

oxygen for cells and unloads carbon dioxide. The respiratory system also plays a significant role in pH balance.

Gastrointestinal system (GIS)

As noted, blood passes through most organs in the body, including the gastrointestinal system. Like the respiratory system, the gastrointestinal system supplies other nutrients needed for cell metabolism such as ingested protein, fats, and carbohydrates.

Accessory glands along the GIS

Organs such as the liver and the pancreas provide enzymes that participate in making nutrients easily available for absorption. The liver also metabolizes nutrients from the gastrointestinal system, making them available to the rest of the body.

Musculoskeletal system

The musculoskeletal system has a relatively straightforward function in the maintenance of homeostasis: it allows a person to move around for the purpose of food ingestion, avoidance of danger, and performance of vital activities and reflexes (e.g., breathing, sneezing, defecation).

Urinary system

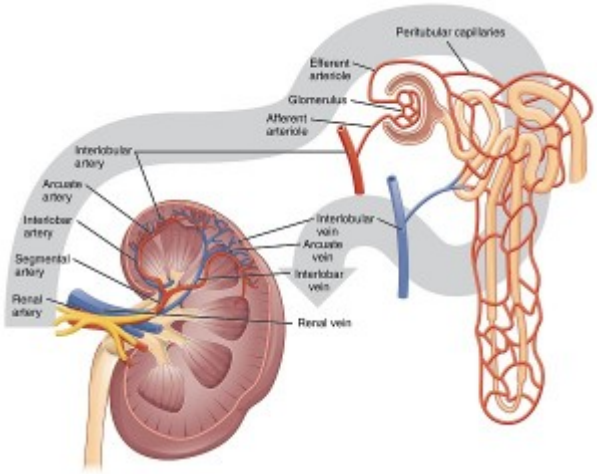


Image: Detail: “Nephrons and Vessels” by Phil Schatz. License: CC BY 4.0

The kidneys perform a somewhat similar job as the lungs, as they contribute to the disposal of some metabolic wastes and participate in the buffering of the blood’s pH. All blood passes through the kidneys in order to be filtered, resulting in the formation of urine.

Nervous system

Although organ systems must coordinate with each other in order to maintain homeostasis, the human body also has to interact harmoniously with the environment in order for it to function well. Both of these functions can be accomplished with the help of the nervous system through its affective, integrative, and effective systems. The autonomic system also helps regulate vital body activities such as the respiratory rate,

heart rate, and gastrointestinal motility.

Endocrine system

Like the nervous system, the endocrine system also contributes to intersystem communications. However, instead of using neural impulses, it makes use of chemical transmitters in the form of hormones to regulate organ functions.

Immune system

The cells of the immune system monitor which cells do not belong to the system. For example, when invader cells make their way inside the body, the components of the immune system either directly attack the invaders or set off efficient cascades that effectively deactivate and/or eradicate them.

Integumentary system

Without our skin, we would have no protection from our environment. The skin and its appendages serve as a protective structure, shielding our internal environment from the constantly changing environment outside our bodies. It also functions as a thermoregulatory and an excretory organ.

Reproductive system

Although reproduction does not offer to contribute to homeostasis, it allows the lineage of a human being to continue.

Regulatory Systems of the Body

As noted above, the human body contains a **vast diversity of cells**. This also means that the body's numerous tissues and organs have many different functions. For homeostasis to occur, these diverse systems have to work in harmony. This is where the regulation of the key functions of each system comes into play.

Regulatory systems control the intracellular and extracellular environment. They may also drive the inherent functions of each organ or maintain good relationships between organs within, or among, different systems.

These control mechanisms explain how the body maintains a **physiologic level of oxygen, carbon dioxide, trace metals, and other substances in the body**. For example, nerve receptors found in various areas in the body help regulate key processes such as breathing, digestion, and thermoregulation.

Negative feedback systems

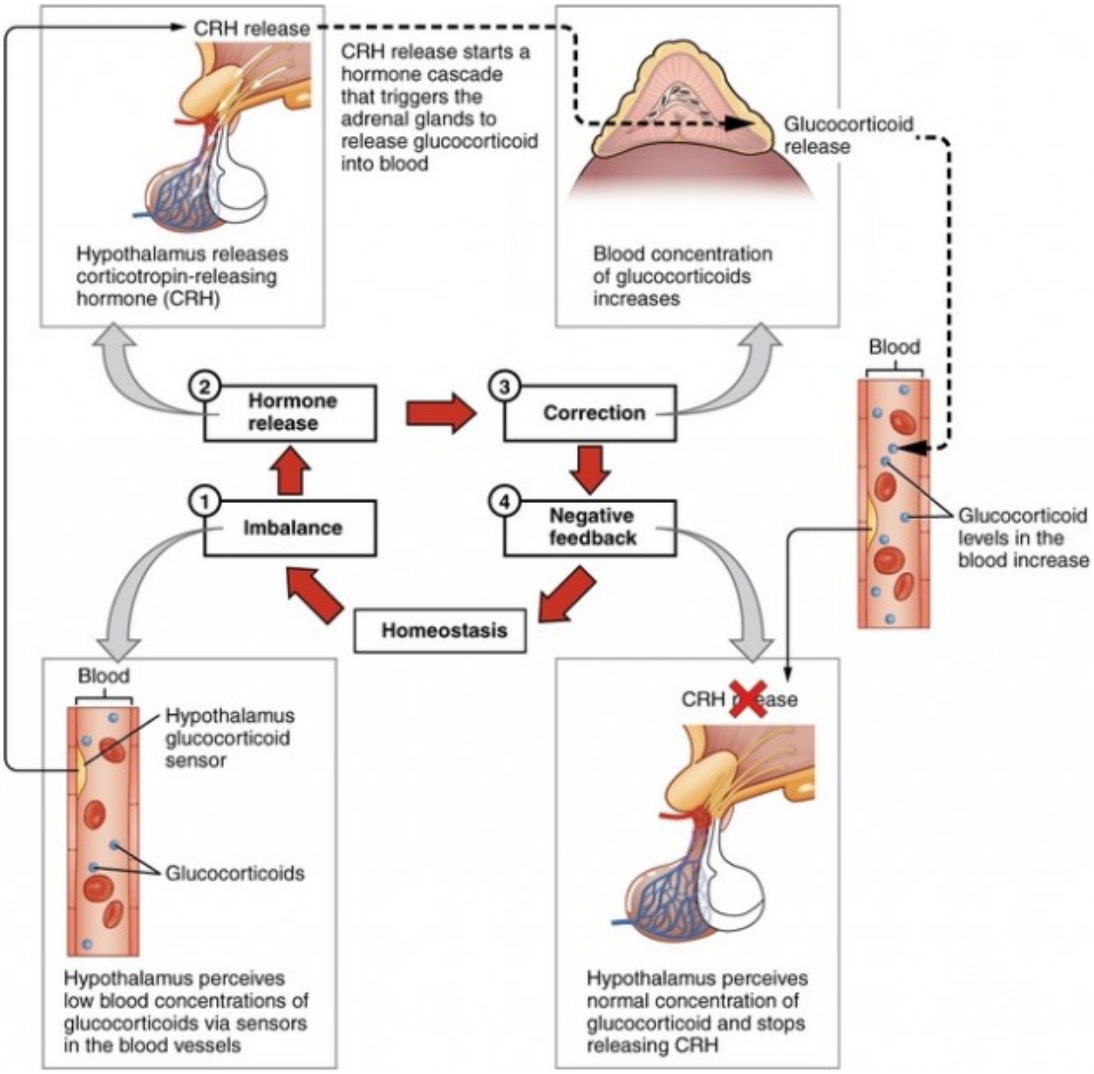


Image: “Negative Feedback Loop” by Phil Schatz. License: CC BY 4.0

The most commonly shared attribute among the body’s many regulatory systems is that they work in a **negative feedback fashion**, which is the body’s inherent ability to suppress a cellular activity once the amount of substrate for a particular cell (either the cell’s own products or their analogues) overwhelms its receptors. This also applies to other body processes.

For example, if the receptors within blood vessels register that blood pressure is low and that not enough blood is getting through to the tissues, the autonomic system drives the cardiovascular system to increase the heart rate and constrict the blood vessels in order to achieve a normal blood pressure.

Positive feedback systems

In contrast, a few processes in the human body make use of the **positive feedback system**. Instead of inhibition, certain stimuli promote the activity of a certain cell or organ.

For example, during childbirth, the stimulus (cervical stretch when the baby’s head begins to crown) stimulates the release of more oxytocin from the posterior pituitary gland, thereby causing more uterine contractions and assisting in the birth process. Other examples of body processes that make use of positive feedback systems are blood clotting and nerve impulse transmission.

Review Questions

The correct answers can be found below the references.

1. Which, among the following compartments in the human body, contains the most amount of fluid?

A. Extracellular
B. Plasma
C. Intracellular
D. Interstitial fluid

2. Most of the body processes are controlled by:

A. A mechanism by which a feedback system ultimately increases the activity of a certain organ.
B. A dampening control system in which the output, when applied to certain tissues and organs, inhibits their activity.
C. A regulatory system that neatly compartmentalizes each organ system so that it can perform a specific function.
D. Nothing; there is no inherent control system.

References

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Correct answers: 1C, 2B

Notes