Lecture 1 / Introduction to Physiology

Human physiology is the study of the functioning of the normal body, and is responsible for describing how various systems of the human body work. Explanations often begin at a macroscopic level and proceed to a molecular level. Physiology (from the Greek; physis=nature; logos = study). A related science –**Pathophysiology**- is connected with how physiological processes are related in disease or injury. Pathophysiology and the study of normal physiology complement one another.

Scientific method:

The scientific method involves specific steps:

- Making certain observations regarding the natural world,
- A hypothesis is formulated. In order for this hypothesis to be scientific, it must be capable of being refuted by experiments or other observations of the natural world
- Experiments are conducted, or other observations are made,
- Results are analyzed.
- Conclusions are then drawn as to whether the new data either refute or support the hypothesis .

Extracellular Fluid—the "Internal Environment"

About 60% of the adult human body is fluid, mainly a water solution of ions and other substances. Although most of this fluid is inside the cells and is called intracellular fluid, about one third is in the spaces outside the cells and is called **extracellular fluid.** It is transported rapidly in the circulating blood and then mixed between the blood and the tissue fluids by diffusion through the capillary walls.

In the extracellular fluid are the ions and nutrients needed by the cells to maintain cell life. Thus, all cells live, essentially in the same environment—the extracellular fluid. For this reason, the extracellular fluid is also called the Internal environment of the body, or the milieu intérieur, a term introduced more than 100 years ago by the great 19th-century French physiologist Claude Bernard.

The **extracellular fluid** contains large amounts of sodium, chloride, and bicarbonate ions plus nutrients for the cells, such as oxygen, glucose, fatty acids, and amino acids. It also contains carbon dioxide that is being transported from the cells to the lungs to be excreted, plus other cellular waste products that are being transported to the kidneys for excretion.

The **intracellular fluid** differs significantly from the extracellular fluid; specifically, it contains large amounts of

potassium, magnesium, and phosphate ions **instead** of the sodium and chloride ions found in the extracellular fluid.

Organization of the Human Body

The human organism is a complex structure composed of many parts. The major features of the human body include cavities, various types of membranes, and organ systems.

Body Cavities

The human organism can be divided into :

A. An axial portion, which includes the head, neck, and trunk

B. An appendicular portion, which includes the upper and lower limbs. Within the axial portion are:

1. **Cranial cavity**, which houses the brain

2. **Spinal cavity**, which contains the spinal cord

3.**Thoracic cavity**, is separated from the lower abdominopelvic cavity by a broad, thin muscle called the **Diaphragm**. It contain the lungs, heart, esophagus, trachea, and thymus gland.

4. **Abdominopelvic cavity**. The organs within these last two cavities are called **Viscera** , which includes the stomach, liver, spleen, gallbladder, and the small and large intestines, the urinary bladder, and the internal reproductive organs.

Smaller cavities within the head include the following:

1. Oral cavity, containing the teeth and tongue.
2. Nasal cavity located within the nose
3. Orbital cavities, containing the eyes.
4. Middle ear cavities, containing the middle ear bones.

Body organ systems :

System	Major structure	General functions
Nervous system	Divided into two subdivisions: 1-Central Nervous System (CNS) ,which include the brain and spinal cord. 2-Peripheral Nervous System (PNS) ,which include the cranial nerves arising from the brain and spinal nerves arising from the spinal cord.	1. Integration of body processes. 2. Control of voluntary effectors (skeletal muscles). 3. Control of involuntary effectors (smooth muscle, cardiac muscle, glands. 4. Response to stimuli. 5. Responsible for conscious, thought and perception, emotions, personality, the mind.
Muscular system	There are three kinds of muscle: 1. Skeletal muscle 2. Cardiac muscle 3. Smooth muscle	1. Muscles produce movement by acting on the bones of the skeleton, pumping blood, or propelling substances throughout hollow organ systems. 2. Muscles aid in maintaining posture by adjusting the position of the body with respect to gravity. 3. Muscles stabilize joints by

		exerting tension around the joint. 4. Muscles generate heat as a function of their cellular metabolic processes.
Skeletal system	**Bones and Joints**	1- Protects and supports the body and organs 2- Interacts with skeletal muscles 3- Produces red blood cells, white blood cells , and platlets
Reproductive system	Testes, penis in **male** Ovary , uterus , breasts in **female**	Produce gametes and offspring
Integumentary system	Skin, nails, hair	1-Protect against injury, infection , and fluid loss 2-Help regulate body temperature
Endocrine system	Hypothalamus , pituitary gland, thyroid gland , adrenal gland , pancreas ,testis and ovary	1-Regulate body temperature 2-Metabolism, 3-Development 4- Reproduction 5-Maintain hemostasis 6-Regulate other organ system

Immune system	White blood cells, lymph nodes, skin	Defend against pathogens and disease
Digestive system	1. Mouth 2. Throut 3. Esophagus 4. Stomach 5. Liver 6. Pancreas 7. Small intestine 8. Large intestine	1-Extracts and absorbe nutrients from food 2-Removes wastes 3-Maintains water 4-Chemical balance
Respiratory system	**The Upper Respiratory Tract** • Nose (nostrils) • Pharynx • Larynx (voice box) • Trachea (windpipe) **The Lower Respiratory Tract** • Bronchi (bronchioles) • Alveoli (air sacs) - The sacs in the lungs where gas exchange occurs. • Lungs - The two inverted- cone shaped organs present in the chest of human beings	1-Ventilate the lungs 2-Extract oxygen from the air and transfer it to the blood stream 3-Excrete carbon dioxide and water vapor 4-Maintain the acid base of the blood

Urinary system	**1. Kidneys** **2. Ureters** **3. Urinary bladder** **4. Urethra**	**A. Filters Waste Products from Blood** / as ammonia and urea (amino acids break down), and uric acid (nucleic acids break down). **B. Regulates Ion Levels in the Plasma** /as (sodium, potassium, chloride and other ions) lost in the urine. **C. Regulates Blood pH** /by regulating the number of H+ and bicarbonate ions (HCO3-) lost in the urine. **D. Conserves Valuable Nutrients** /as (glucose, amino acids and other valuable nutrients). **E. Regulates Blood Volume** / by: 1. Releasing renin, a hormone that after a series of reactions eventually restricts salt and water loss at the kidneys. 2. Adjusting the volume of water lost in the urine **F. Regulates RBC Production** /the kidneys release erythropoietin, (EPO) a hormone that stimulates the hemocytoblasts (stem cells in the bone marrow) to increase red blood cell formation.

Circulatory system	The circulatory system consists of two subdivisions: **A/** Cardiovascular system: Consist of heart, blood vessels. **B/** Lymphatic system: Include lymphatic vessels and lymphatic tissue (Spleen, Thymus, Tonsils and Lymph nodes).	**1- Functions in respiration**/ by delivering oxygen (O2) to the cells and removing carbon dioxide (CO2) from them. **2- Functions in nutrition** /by carrying digested food substances to the cells of the body. **3- Functions in Excretion** through helping to dispose waste products and poisons that would harm the body if they accumulated. These substances include carbon dioxide, salts, and ammonia. **4- Functions in transportation**/All the substances essential for cellular metabolism are transported by circulatory system, which include respiratory, nutritive & excretory substances. **5- Functions in regulation**/ include : Hormonal regulation where the blood carry hormones from their site of origin to their target organs. , and temperature regulation which is aided by the diversion of blood from deeper to more superficial cutaneous vessels or vice versa. **6- Functions in defense (Immunity)** through protect against blood loss from injury and (by clotting mechanism) and against foreign microbes or toxins introduced in to the body (by the

		Leukocytes).

Homeostasis

Homeostasis in a general sense refers to stability, balance or equilibrium. Maintaining a stable internal environment requires constant monitoring and adjustments as conditions change. This adjusting of physiological systems within the body is called homeostatic regulation.

The body maintains homeostasis through a number of self regulting control systems, or homeostatic mechanisms. These mechanisms share the following three components:

1. Receptors, which provide information about specific conditions (stimuli) in the internal environment.

2. A control center, which includes a set point, tells what a particular value should be (such as body temperature at 98.6°F).

3. Effectors, such as muscles or glands, which elicit responses that alter conditions in the internal environment

Our bodies control body temperature in a similar way. The brain is the control center, the receptor is our body's temperature sensors, and the effector is our blood vessels and sweat glands in our skin. When we feel heat, the temperature sensors in our skin send the message to our brain. Our brain then sends the message to the sweat glands to increase sweating

and increase blood flow to our skin. When we feel cold, the opposite happens. Our brain sends a message to our sweat glands to decrease sweating, decrease blood flow, and begin shivering. This is an ongoing process that continually works to restore and maintain homeostasis.

Because the internal and external environment of the body is constantly changing and adjustments must be made continuously to stay at or near the set point, homeostasis can be thought of as a dynamic equilibrium.

Homeostasis Mechanisms:

When a change of variable occurs, there are two main types of feedback to which the system reacts:

•**Negative feedback**: a reaction in which the system responds in such a way as to reverse the direction of change. Since this tends to keep things constant, it allows the maintenance of homeostasis. For instance, when the concentration of carbon dioxide in the human body increases, the lungs are signaled to increase their activity and expel more carbon dioxide. Thermoregulation is another example of negative feedback. When body temperature rises, receptors in the skin and the hypothalamus sense a change, triggering a command from the brain. This command, in

turn, affects the correct response, in this case a decrease in body temperature.

•**Positive feedback**: a response is to amplify the change in the variable. This has a destabilizing effect, so does not result in homeostasis. Positive feedback is less common in naturally occurring systems than negative feedback, but it has its applications. For example, in nerves, a threshold electric potential triggers the generation of a much larger action potential. Blood clotting and events in childbirth are other types of positive feedback.

***Harmful Positive Feedback'** although Positive Feedback is needed within Homeostasis it also can be harmful at times. When you have a high fever it causes a metabolic change that can push the fever higher and higher. In rare occurrences the body temperature reaches 113 degrees the cellular proteins stop working and the metabolism stops, resulting in death.

Human homeostasis refers to the body's ability to physiologically regulate its inner environment to ensure its stability in response to fluctuations in the outside environment and the weather. Examples:

Sugar

Blood glucose is regulated with two hormones, Insulin and Glucagon, both released from the pancreas. When blood sugar levels become too high, insulin is released from the pancreas. Glucose is stored in body cells as glycogen, lowering the blood sugar levels. On the other hand, when blood sugar levels become too low, glucagon is released. It promotes the release of glycogen, converted back into glucose. This increases blood sugar levels. If the pancreas is for any reason unable to produce enough of these two hormones, Diabetes results.

Calcium

When blood calcium becomes too low, calcium-sensing receptors in the parathyroid gland become activated. This results in the release of Prathyroid hormone (PTH), which acts to increase blood calcium, e.g. by release from bones (increasing the activity of bone-degrading cells called osteoclasts). This hormone also causes calcium to be reabsorbed from urine and the GI tract.

Calcitonin, released from the C cells in the thyroid gland, works the opposite way, decreasing calcium levels in the blood by causing more calcium to be fixed in bone.