Physiology of the Human Body

What is Physiology?

- Physiology is the scientific study of how living things function.
- It explores the mechanisms that keep us alive and healthy.
- Think of it as understanding the "how" and "why" behind the body's actions.
- Anatomy (the study of structure) and Physiology (the study of function) are closely linked. You can't truly understand one without the other!

Levels of Organization

- The human body is organized in a hierarchical manner, from simple to complex:
- Chemical Level: Atoms (like carbon, hydrogen, oxygen) form molecules (like water, proteins, DNA).
- Cellular Level: Molecules combine to form cells, the basic unit of life.
- Tissue Level: Groups of similar cells working together form tissues (e.g., muscle tissue, nervous tissue).
- Organ Level: Different tissues working together form organs (e.g., heart, lungs, stomach).
- Organ System Level: Several organs working together for a common purpose form an organ system (e.g., digestive system, circulatory system).
- Organismal Level: All organ systems working together make up the complete organism (you!).

Homeostasis: The Body's Balance

- Homeostasis is the body's ability to maintain a stable internal environment despite changes in the external environment.
- It's like your body's built-in thermostat, constantly adjusting to keep things just right.
- Examples: Maintaining body temperature, blood sugar levels, blood pressure, and pH.
- Disruption of homeostasis can lead to illness or disease.

Feedback Mechanisms

- Homeostasis is primarily maintained through feedback mechanisms.
  - **Negative Feedback:** The most common type. It **reverses** the original stimulus.
    - **Example:** If body temperature rises, sweating and vasodilation occur to cool the body down, bringing the temperature back to normal.
  - **Positive Feedback:** Less common. It **amplifies** the original stimulus.
    - **Example:** Childbirth contractions or blood clotting.

The Nervous System

- Function: The body's control and communication system. It detects changes, processes information, and initiates responses.
- Major Organs: Brain, spinal cord, nerves.
- Divisions:
  - **Central Nervous System (CNS):** Brain and spinal cord. The "command center."
  - **Peripheral Nervous System (PNS):** Nerves extending from the CNS to the rest of the body. The "messengers."

Nervous System: Brain Functions

- The brain is an incredibly complex organ responsible for:
  - Thought, memory, and emotion.
  - Controlling voluntary movements.
  - Processing sensory information (sight, sound, touch, taste, smell).
  - Regulating involuntary functions (breathing, heart rate, digestion).
- Different parts of the brain specialize in different functions (e.g., cerebrum for higher thought, cerebellum for coordination).

Nervous System: Nerve Impulses

•Neurons (nerve cells) transmit information via **electrical signals** called **nerve impulses** or **action potentials**.
•These impulses travel rapidly along the neuron's axon.
•At the end of the neuron, **neurotransmitters** (chemical messengers) are released into the **synapse** (gap between neurons) to communicate with the next cell.

The Endocrine System

- Function: Regulates body processes through the production and release of hormones.
- Hormones are chemical messengers transported by the blood to target cells/organs.
- Major Glands: Pituitary, thyroid, adrenal, pancreas, ovaries (females), testes (males).

Endocrine System: Hormone Action

- Hormones work like keys that fit into specific locks (receptors) on target cells.
- Once a hormone binds to its receptor, it triggers a specific response within the cell.
- Examples of hormone functions: Regulating metabolism, growth, development, mood, reproduction.

The Circulatory System

- Function: Transports blood throughout the body, delivering oxygen and nutrients, and removing waste products.
- Major Organs: Heart, blood vessels (arteries, veins, capillaries), blood.
- Key Components:
  - **Heart:** A muscular pump that drives blood circulation.
  - **Arteries:** Carry oxygenated blood away from the heart.
  - **Veins:** Carry deoxygenated blood back to the heart.
  - **Capillaries:** Tiny vessels where exchange of gases, nutrients, and waste occurs between blood and tissues.

Circulatory System: The Heart

- The heart is a four-chambered organ.
  - **Atria (upper chambers):** Receive blood.
  - **Ventricles (lower chambers):** Pump blood out.
- Pulmonary Circulation: Blood flows between the heart and lungs (for oxygenation).
- Systemic Circulation: Blood flows between the heart and the rest of the body.

Circulatory System: Blood

- Blood is a vital fluid with several components:
  - **Red Blood Cells (Erythrocytes):** Carry oxygen using hemoglobin.
  - **White Blood Cells (Leukocytes):** Part of the immune system, fight infections.
  - **Platelets (Thrombocytes):** Involved in blood clotting.
  - **Plasma:** The liquid component, transports nutrients, hormones, and waste.

The Respiratory System

- **Function:** Facilitates the exchange of **gases** (oxygen and carbon dioxide) between the body and the external environment.
- **Major Organs:** Lungs, trachea (windpipe), bronchi, diaphragm.
- **Process:**
- **Inhalation:** Taking oxygen-rich air into the lungs.
- **Exhalation:** Releasing carbon dioxide-rich air from the lungs.

Respiratory System: Gas Exchange

- Gas exchange occurs in tiny air sacs called alveoli within the lungs.
- Oxygen from the inhaled air diffuses across the thin walls of the alveoli into the capillaries, where it binds to red blood cells.
- Carbon dioxide from the blood diffuses from the capillaries into the alveoli to be exhaled.

The Digestive System

- Function: Breaks down food into nutrients that the body can absorb and use for energy, growth, and repair.
- Major Organs: Mouth, esophagus, stomach, small intestine, large intestine, liver, pancreas, gallbladder.
- Processes:
  - **Ingestion:** Taking food in.
  - **Digestion:** Breaking down food (mechanical and chemical).
  - **Absorption:** Nutrients move into the bloodstream.
  - **Elimination:** Removing undigested waste.

Digestive System: Key Stages

- Mouth: Chewing (mechanical) and saliva (chemical) begin digestion.
- Stomach: Muscular contractions and gastric acid further break down food.
- Small Intestine: Most nutrient absorption occurs here. Enzymes from the pancreas and bile from the liver aid digestion.
- Large Intestine: Absorbs water and forms feces.

The Excretory System

- Function: Removes waste products and excess substances from the body to maintain fluid and electrolyte balance.
- Major Organs: Kidneys, ureters, bladder, urethra.
- Other organs involved in excretion: Lungs (CO_2), skin (sweat), liver (various wastes).

Excretory System: The Kidneys

- The kidneys are a pair of bean-shaped organs responsible for:
  - **Filtering blood** to remove waste products (like urea, creatinine).
  - **Regulating blood volume and blood pressure.**
  - **Maintaining electrolyte balance** (e.g., sodium, potassium).
  - **Producing hormones** (e.g., erythropoietin).
- Nephrons are the functional units of the kidney, where filtration and reabsorption occur.

The Muscular System

- **Function:** Enables **movement**, maintains posture, and produces heat.
- **Types of Muscle Tissue:**
- **Skeletal Muscle:** Attached to bones, responsible for voluntary movement (e.g., walking, lifting).
- **Smooth Muscle:** Found in internal organs (e.g., digestive tract, blood vessels), responsible for involuntary movements.
- **Cardiac Muscle:** Found only in the heart, responsible for pumping blood (involuntary).

Muscular System: How Muscles Contract

- Skeletal muscle contraction occurs through the interaction of two protein filaments: actin and myosin.
- This is explained by the sliding filament theory, where myosin heads pull on actin filaments, shortening the muscle fiber.
- Requires energy from ATP (adenosine triphosphate).

The Skeletal System

- Function: Provides support, protection for internal organs, allows movement (with muscles), produces blood cells (in bone marrow), and stores minerals (calcium, phosphorus).
- Major Organs: Bones, cartilage, ligaments, tendons.
- Bones are living tissues that are constantly being remodeled.

Skeletal System: Joints

- Joints are where two or more bones meet.
- They allow for various degrees of movement.
- Types of Joints:
  - **Fibrous:** Immovable (e.g., skull sutures).
  - **Cartilaginous:** Slightly movable (e.g., vertebrae).
  - **Synovial:** Freely movable (e.g., knee, shoulder, hip). Most common type.

The Integumentary System

- Function: The body's outer covering, providing protection, regulating body temperature, sensing external stimuli, and synthesizing Vitamin D.
- Major Organs: Skin, hair, nails, glands (sweat and oil).
- The skin is the largest organ of the body.

Integumentary System: Skin Layers

- Epidermis: The outermost layer, provides protection, contains keratinocytes and melanocytes.
- Dermis: The middle layer, contains connective tissue, blood vessels, nerves, hair follicles, and glands.
- Hypodermis (Subcutaneous Layer): Innermost layer, primarily fat, provides insulation and cushioning.

The Immune System

- Function: Defends the body against pathogens (bacteria, viruses, fungi, parasites) and abnormal cells (like cancer cells).
- Major Components: White blood cells, lymph nodes, spleen, thymus, bone marrow.
- Two main types of immunity:
  - **Innate Immunity:** Non-specific, first line of defense (e.g., skin, fever, phagocytes).
  - **Adaptive (Acquired) Immunity:** Specific, targets particular pathogens, involves lymphocytes (B cells and T cells) and memory.

The Reproductive System

- **Function:** Essential for the **continuation of the species** by producing offspring.
- **Major Organs (Males):** Testes, epididymis, vas deferens, seminal vesicles, prostate gland, penis.
- **Major Organs (Females):** Ovaries, fallopian tubes, uterus, vagina.
- Involves the production of **gametes** (sperm and egg) and hormones.

Reproductive System: Key Processes

- Males: Spermatogenesis (sperm production), testosterone production.
- Females: Oogenesis (egg production), menstrual cycle, estrogen and progesterone production, pregnancy, childbirth.
- Fertilization: The fusion of sperm and egg to form a zygote, initiating development.

Interconnectedness of Systems

- It's crucial to remember that **all organ systems work together** in a coordinated manner.
- **Example:** The circulatory system delivers oxygen from the respiratory system to all cells, which then use the oxygen for energy production (aided by the digestive system for nutrients). Waste products are then removed by the excretory system.
- The **nervous** and **endocrine** systems act as the primary coordinating centers.

Thank you

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