DEPTH OF BIOLOGY

Unit - I

Introduction to human body

Definition and scope of anatomy and physiology, levels of structural organization and body systems, basic life processes, homeostasis, basic anatomical terminology.

Cellular level of organization

Structure and functions of cell, transport across cell membrane, cell division, cell junctions. General principles of cell communication, intracellular signaling pathway activation by extracellular signal molecule, Forms of intracellular signaling: a) Contact-dependent b) Paracrine c) Synaptic d) Endocrine

Tissue level of organization

Classification of tissues, structure, location and functions of epithelial, muscular and nervous and connective tissues.

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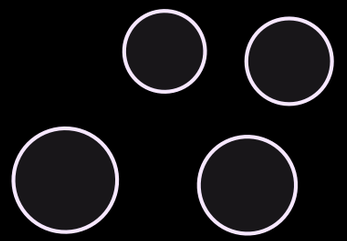
→ Complex Organism → Made up of Trillions of Cell.

↓

Each Cell has Specific function.

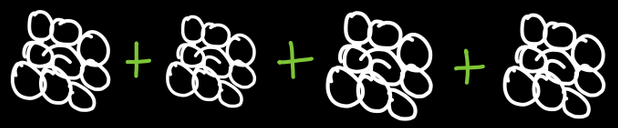


Cells.

↓

Tissue

↓



[Organ]

↓ InterConnected.

Organ System.

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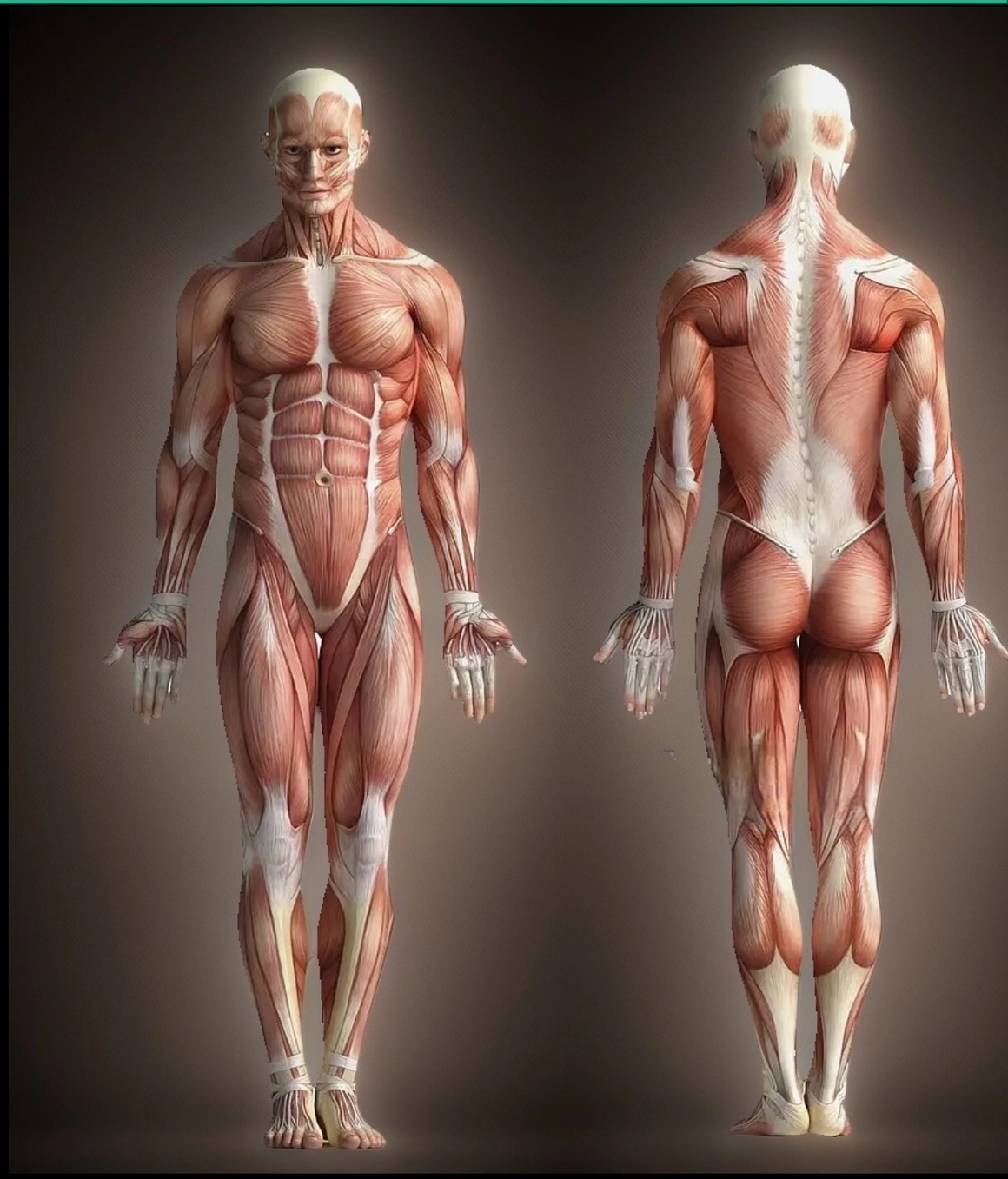
Introduction to Human Body

1. The human body is a complex and complex organism 2. composed of various systems that work together to maintain life.

It is made up of trillions of cells, each performing specific functions essential for survival.

These cells form tissues, organs, and systems, each contributing to the overall functioning of the body.



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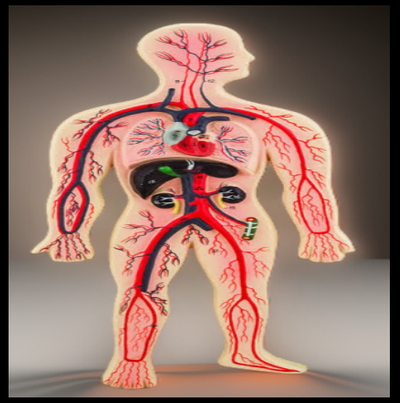
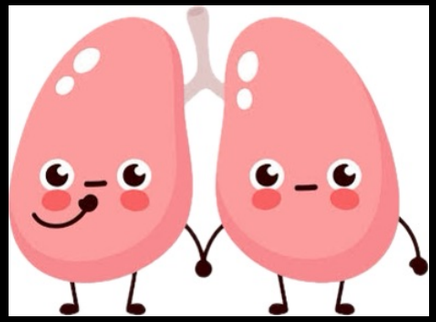
Key Systems of the Human Body

Total 11 Organ System.

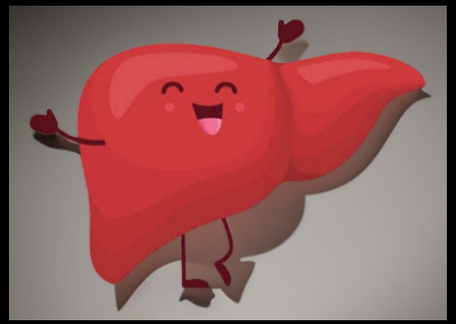


1.Circulatory System: The heart, blood, and blood vessels transport oxygen, nutrients, and waste products throughout the body. This system is essential for maintaining homeostasis and supporting cellular functions.



2. Respiratory System: The lungs and airways allow the exchange of gases, such as oxygen and carbon dioxide, essential for cellular respiration.

Food ⟶ Nutrient



3. Digestive System: This system breaks down food into nutrients that the body can use for energy, growth, and repair. It includes the mouth, stomach, intestines, and accessory organs like the liver and pancreas.

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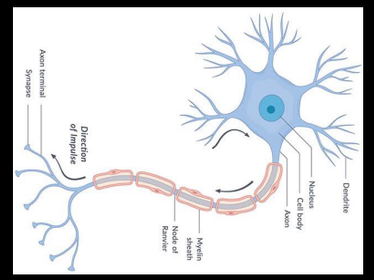
4. Nervous System: The brain, spinal cord, and nerves control and coordinate body activities. It processes sensory information, controls motor functions, and enables cognition and emotional responses.

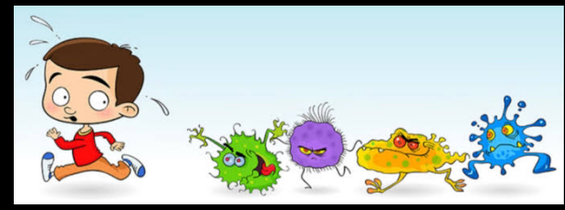


Muscular Skeletal

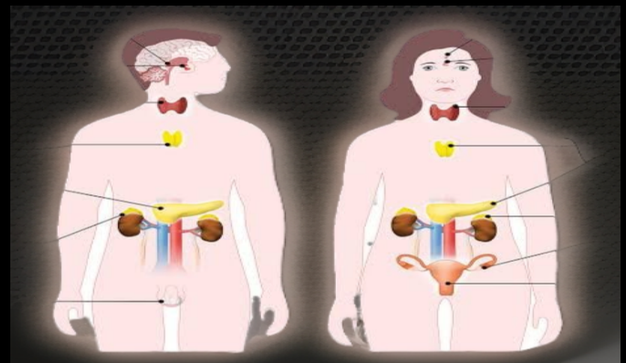
5.Musculoskeletal System: Bones, muscles, and joints provide structure, support, movement, and protection to vital organs. Muscles enable movement by contracting and relaxing, while bones provide strength and leverage.

or Lymphatic System.

6.Immune System: This system defends the body against pathogens, such as bacteria, viruses, and other harmful invaders. It includes white blood cells, antibodies, and various organs like the spleen and lymph nodes.



7.Endocrine System: Glands such as the thyroid, adrenal glands, and pancreas release hormones that regulate metabolism, growth, mood, and various other bodily functions.



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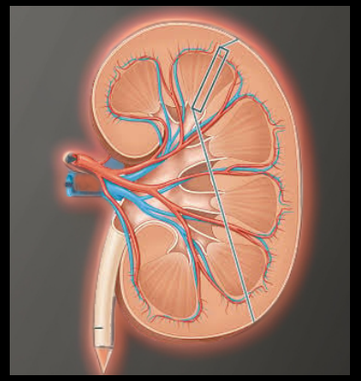
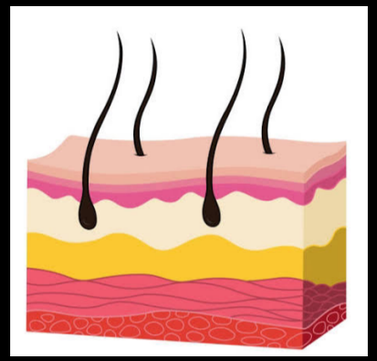
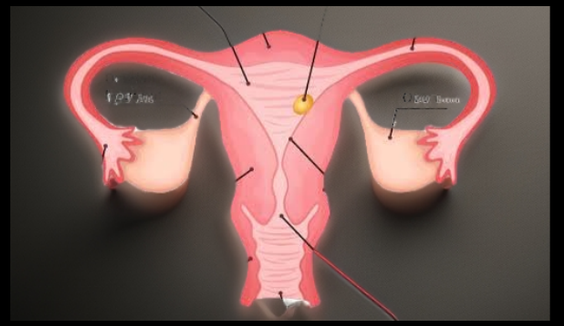
8. Excretory System: This system removes waste products from the body, including excess water, salts, and metabolic waste. It includes the kidneys, bladder, and other parts of the urinary system.



9.Integumentary System: The skin, hair, and nails protect the body, regulate temperature, and act as a barrier to harmful microorganisms and environmental factors.



10.Reproductive System: The reproductive organs allow for reproduction, ensuring the continuation of the human species. It includes the testes and ovaries, as well as the associated structures for producing and transporting gametes.



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Definition and scope of anatomy and physiology

Anatomy- Anatomy is the study of the structure and parts of living organisms, including their organs, tissues, and cells.
It focuses on how these parts are organized and how they work together in the body.

The scope of anatomy includes the following areas:

1.Gross Anatomy (Macroscopic Anatomy): The study of body structures that are visible to the naked eye, such as organs, muscles, and bones.

2. Microscopic Anatomy: The study of structures that are too small to be seen without a microscope, such as cells and tissues (includes histology and cytology).

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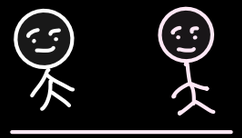
3. Developmental Anatomy: The study of the changes in body structures from conception through growth and development to maturity.

4.Comparative Anatomy: The study of similarities and differences in the anatomy of different species to understand evolutionary relationships.



(2 diff. species).

5. Functional Anatomy: Understanding how the structure of body parts relates to their function in maintaining life. (How they work together).

6.Regional Anatomy: The study of specific regions of the body, such as the head, neck, or limbs, and how their structures are organized.

7. Systemic Anatomy: The study of the body's organ systems (e.g., circulatory, respiratory, nervous systems) and how their structures work together.

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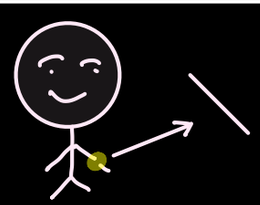
Importance of Anatomy in Medicine and Other Fields

1.Medical Application: Anatomy is essential for understanding the human body in health and disease. It provides the foundational knowledge required for medical professionals to perform surgeries, diagnose conditions, and understand treatment methods.

2. Education and Research: Anatomical knowledge is vital in medical education, training, and research. It helps in the development of new treatments and medical technologies.

3.Forensic Science: Anatomical knowledge is used in forensic science to determine cause of death, identify victims, and analyze injury patterns.

4. Physical Therapy and Rehabilitation: Understanding anatomy helps physical therapists design appropriate rehabilitation strategies after injury, ensuring that body parts heal and function correctly.



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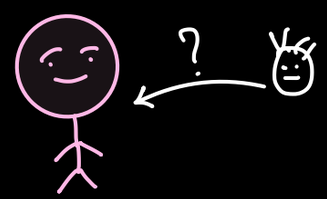
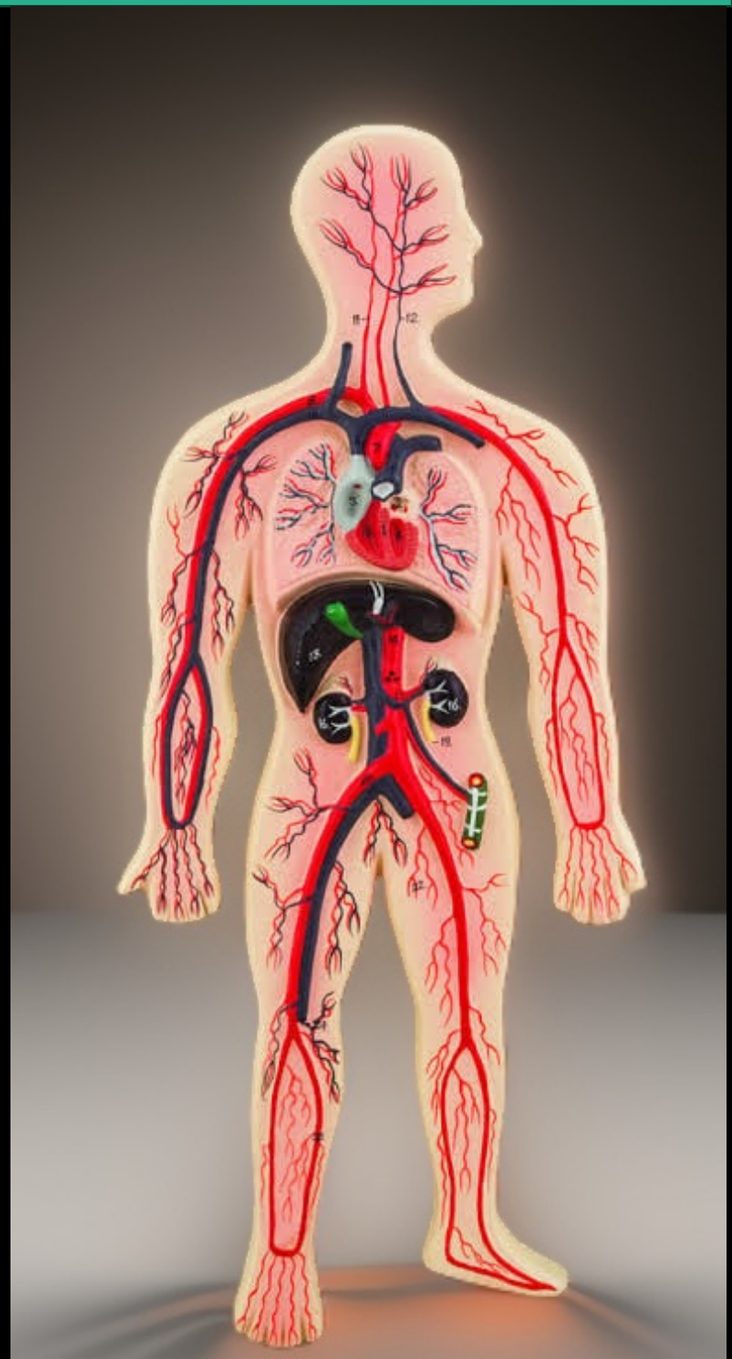
Physiology

Physiology is the branch of biology that studies how the organs and systems of living organisms function and work together to maintain life.

This includes functions like breathing, digestion, circulation, movement, and nerve signaling, among others.

Physiology helps us understand how the body responds to different conditions, adapts to changes, and how it works in both health and disease.





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The scope of physiology is vast, covering a wide range of topics related to the functions of living organisms–

1.Cell Physiology: The study of the functions and processes occurring within individual cells, including energy production, signaling, and cell division.

2. Systemic Physiology: This focuses on how different organ systems work together. Examples include:

Cardiovascular Physiology: How the heart and blood vessels function to circulate blood.

Respiratory Physiology: The process of breathing and how oxygen and carbon dioxide are exchanged in the lungs.

Muscular Physiology: How muscles contract and produce movement.

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3. Nervous System Physiology: The workings of the brain, spinal cord, and peripheral nerves in processing information and controlling bodily functions.

4.Endocrine Physiology: How hormones are produced and regulate processes like metabolism, growth, and stress response.

5.Renal Physiology: The functions of the kidneys in filtering blood and regulating water balance and electrolytes.

6.Digestive Physiology: The processes involved in the breakdown and absorption of food.

7.Pathophysiology: The study of how physiological processes are altered in disease or injury, helping to understand the mechanisms behind various health conditions.

8.Developmental Physiology: Understanding how physiological processes change and develop over the lifespan of an organism, from conception through aging.

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Human Physiology: The study of the physiological processes specifically in humans, often in health and disease.

Comparative Physiology: Examining how different species adapt to their environments and how their physiological processes differ or are similar to those of humans.

Exercise Physiology: The study of how the body responds to physical activity, including changes in metabolism, muscle function, and cardiovascular function.

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Scopes of physiology

eg → Glucon – D

1. Understanding Body Functions: Physiology helps in understanding how the human body and its systems (like circulatory, respiratory, nervous systems, etc.) function under normal conditions.

2. Medical Applications: It forms the foundation of medical sciences, helping doctors and healthcare professionals diagnose and treat diseases.

3. Pharmacology and Drug Development: Knowledge of physiology is crucial for developing new drugs and understanding how drugs affect different organs and systems.

4. Sports and Exercise Science: It helps in improving athletic performance and designing exercise programs by understanding muscle function, energy metabolism, and endurance.

5. Nutrition and Dietetics: Physiology helps in understanding digestion, absorption, and metabolism of nutrients for maintaining health.

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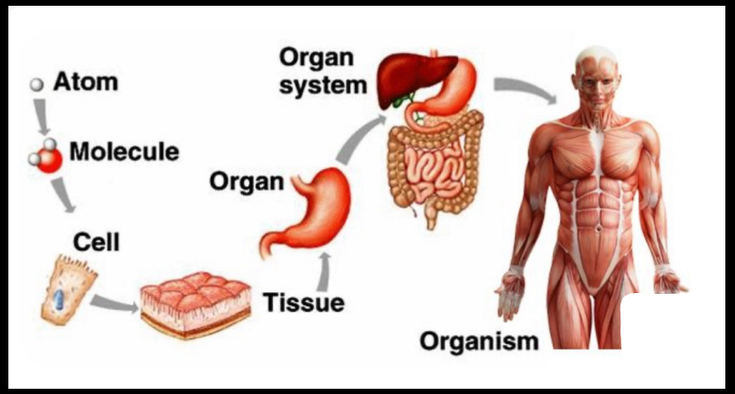
Levels of structural organization and body systems

Levels of Structural Organization:

These are the different stages that make up the structure of the body, starting from the smallest parts (atoms) to the entire organism. They include:



Chemical Level: Atoms and molecules.
Cellular Level: Cells, the basic unit of life.
Tissue Level: Groups of similar cells working together.
Organ Level: Different tissues working together to form an organ.
Organ System Level: Groups of organs that work together for a specific function.
Organismal Level: The complete human body, made up of all the systems working together.

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Chemical Level: This is the most basic level, made up of atoms and molecules that form the building blocks of life.

Cellular Level: Cells are the basic units of life. Different types of cells work together to perform specific tasks.

Tissue Level: Tissues are groups of similar cells working together to do a specific job. There are four main types: epithelial, connective, muscle, and nervous tissue.

Organ Level: Organs are made up of different tissues working together to perform a particular function. Examples include the heart, lungs, and liver.

Organ System Level: Organ systems are groups of organs that work together to carry out a major function, such as digestion or circulation.

Organismal Level: This is the highest level, where all the organ systems work together to form a complete, functioning organism, like a human.

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Body Systems 

Integumentary System: Includes skin, hair, and nails. It protects the body and helps regulate temperature.

Skeletal System: Composed of bones. It provides structure, protects organs, and helps with movement.

Muscular System: Made up of muscles. It helps the body move and maintain posture.

Nervous System: Includes the brain, spinal cord, and nerves. It controls body functions and allows us to sense and respond to the environment.

Endocrine System: Includes glands like the thyroid and pancreas. It releases hormones to regulate processes like growth, metabolism, and mood.

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Cardiovascular System: Composed of the heart and blood vessels. It circulates blood to deliver oxygen and nutrients to the body.

Lymphatic/Immune System: Includes lymph nodes and white blood cells. It helps defend the body against infections.

Respiratory System: Includes the lungs and airways. It brings oxygen into the body and removes carbon dioxide.

Digestive System: Includes organs like the stomach and intestines. It breaks down food and absorbs nutrients.

Urinary System: Includes the kidneys and bladder. It removes waste from the body and helps maintain water balance.

Reproductive System: Includes organs like the ovaries and testes. It allows for reproduction and produces sex cells.

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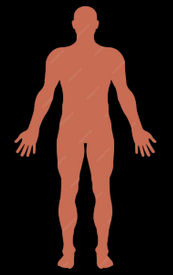
Basic life processes



The basic life processes are the essential functions that organisms carry out to maintain life. They include:

1.Metabolism: The chemical reactions that occur within cells to provide energy, build molecules, and maintain body functions. It includes catabolism (breaking down molecules for energy) and anabolism (building molecules from smaller ones).

2. Responsiveness: The ability to detect and respond to changes in the environment, such as reacting to light, temperature, or touch.

3. Movement: The ability to move parts of the body, such as walking, or internal movements like blood circulation or the movement of food through the digestive system.

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4.Growth: The process of increasing in size and developing new cells, tissues, and organs. This includes both the growth of individual cells and overall growth of the organism.

Unspecialized
↓
5. Differentiation: The process by which cells become specialized to perform specific functions (e.g., muscle cells, nerve cells).

6.Reproduction: The ability to produce offspring and ensure the continuation of the species, either through sexual or asexual reproduction.

7. Excretion: The removal of waste products from the body, such as urine, carbon dioxide, and other metabolic waste.

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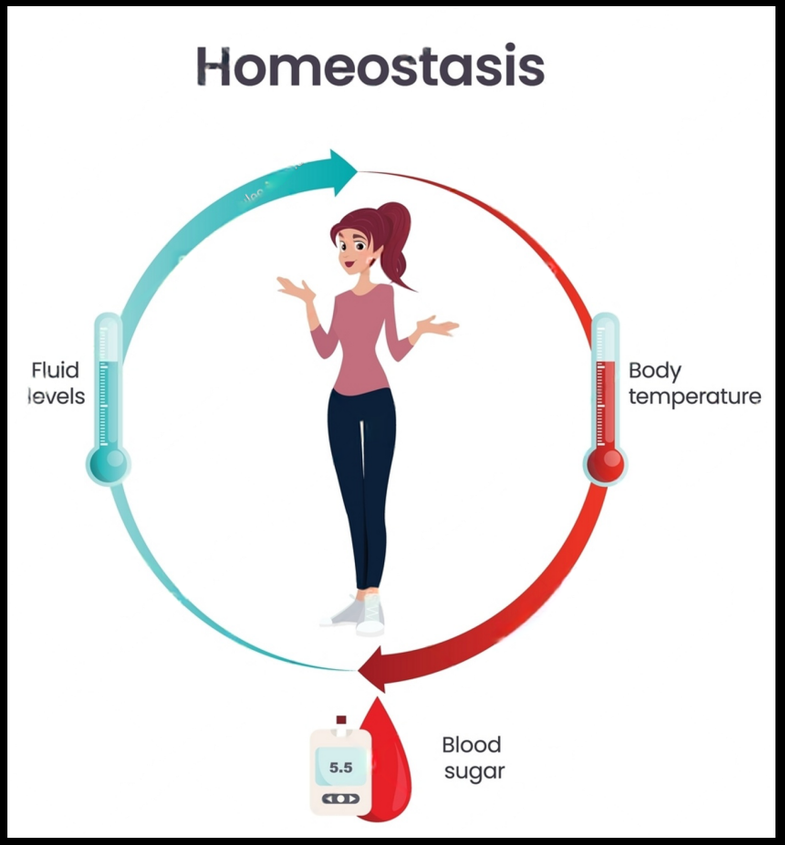
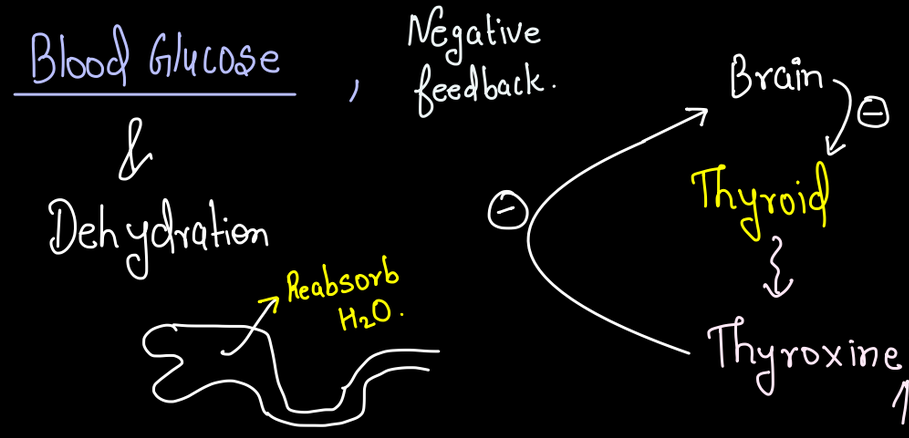
Homeostasis

Homeostasis is the process by which the body maintains a stable internal environment despite changes in the external environment. This balance is essential for the proper functioning of cells, tissues, and organs.

Homeostasis involves regulating factors such as body temperature, blood pressure, pH levels, and the concentration of nutrients and waste products.





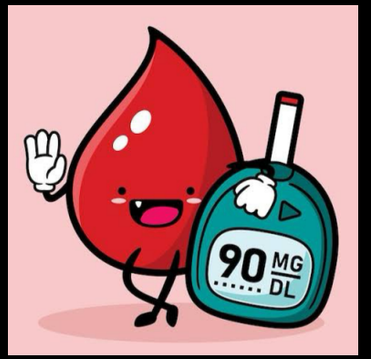
Examples of Homeostatic Processes:

Temperature Regulation:

The body maintains a relatively constant internal temperature. When the body gets too hot, mechanisms like sweating and vasodilation help release heat. Conversely, when the body becomes too cold, shivering and vasoconstriction help conserve heat.

Blood Glucose Levels:

Blood sugar is tightly regulated by hormones like insulin and glucagon. After eating, blood glucose levels rise, triggering insulin release to facilitate glucose uptake by cells, lowering blood sugar. When levels drop too low, glucagon is released to promote the release of glucose from the liver into the bloodstream.



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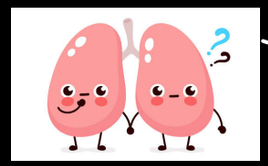
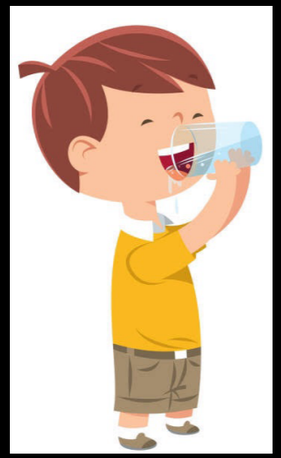
Fluid and Electrolyte Balance:

The body maintains the balance of water and salts. For instance, the kidneys regulate the amount of water reabsorbed into the bloodstream, adjusting urine output depending on the body's hydration status.

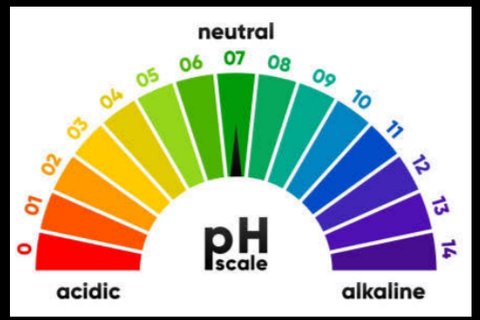


→ Reabsorb H_2O.



pH Balance:

The body also regulates the pH of blood and other fluids to stay within a narrow range (around 7.35–7.45 for blood). The *respiratory and *renal systems work together to remove excess hydrogen ions (H+) or bicarbonate (HCO_3^-) from the body, thus controlling pH.



$CO_2 + H_2O \rightarrow H_2CO_3$ (Carbonic Acid).

↓

$H^+ + HCO_3^-$ (Bicarbonate).

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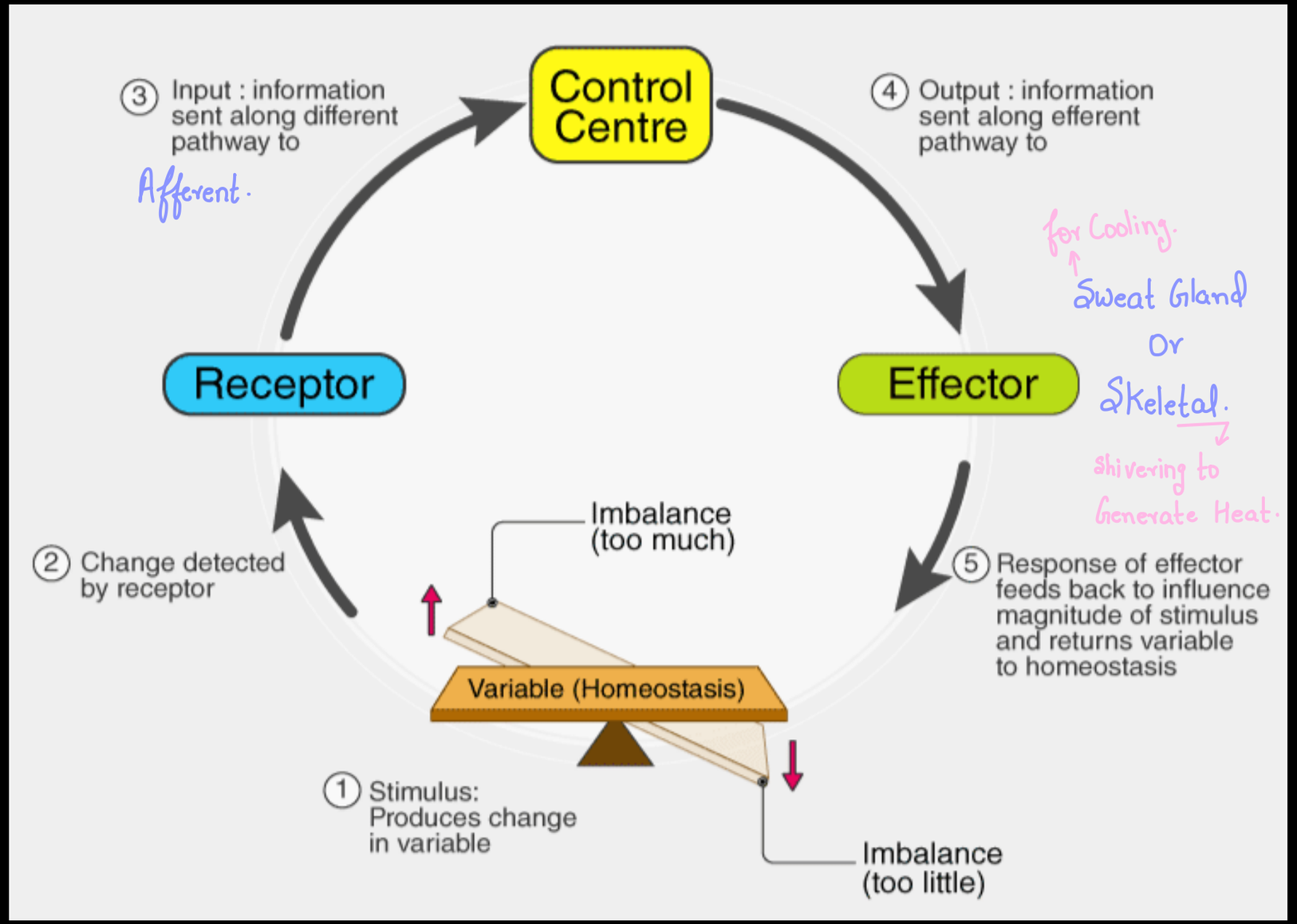
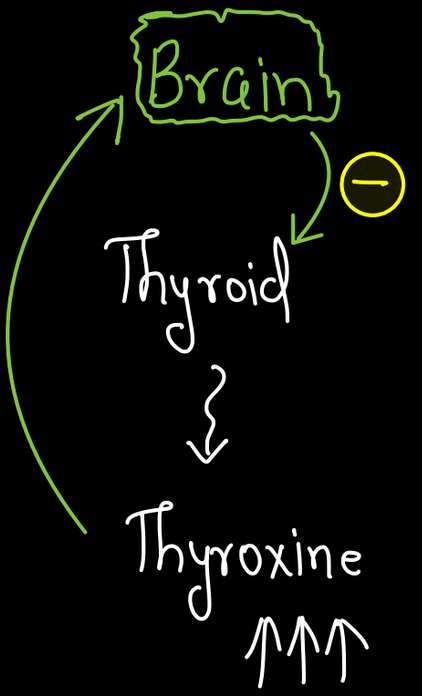
Mechanism of Homeostasis





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Mechanism of Homeostasis

The mechanism of homeostasis involves a series of processes and feedback loops that help organisms maintain a stable internal environment despite external changes.

The key components of this mechanism include sensors, effectors, a control center, and feedback mechanisms, which work together to monitor and adjust variables in the body.

1. Sensors (Receptors)

Sensors are specialized structures that detect changes in the internal environment. These receptors are sensitive to specific changes, such as temperature, pH, pressure, or concentration of specific molecules (e.g., oxygen, glucose, or sodium ions).

Example: Thermoreceptors in the skin and hypothalamus detect changes in body temperature.

Example: Osmoreceptors in the hypothalamus monitor the concentration of solutes (e.g., sodium) in the blood.

2. Control Center (Integrator)

The control center is usually located in the brain, specifically in the hypothalamus (in many cases). Once the sensors detect a change, they send signals to the control center, which processes this information and compares it to the set point (ideal value).

Example: If thermoreceptors detect that body temperature is too high or too low, the hypothalamus receives this information and decides the appropriate response.

The control center's role is to evaluate the discrepancy between the current state and the desired state, then activate the necessary effectors to bring the body back to its set point.

3. Effectors

Effectors are organs, tissues, or cells that carry out the response to the stimuli. They are activated by signals from the control center to restore the internal environment to its set point. Effectors can include muscles, glands, or organs that directly influence physiological processes.

Example: In temperature regulation, effectors might include sweat glands (for cooling) or skeletal muscles (for shivering to generate heat).

Example: In glucose regulation, the pancreas acts as an effector by secreting insulin or glucagon to adjust blood glucose levels.

4. Feedback Mechanisms

There are two primary types of feedback mechanisms that maintain homeostasis: negative feedback and positive feedback.

Negative Feedback

Negative feedback is the most common mechanism in homeostasis. It works by counteracting or reversing a change in the internal environment, bringing the variable back toward the set point. When the variable returns to the set point, the response from the effector is reduced or stopped.

Example: Blood glucose regulation

After eating, blood glucose rises above the normal range. The pancreas detects this increase and secretes insulin, which promotes the uptake of glucose into cells, reducing blood glucose levels.

When blood glucose levels drop too low, the pancreas secretes glucagon, which signals the liver to release stored glucose, raising blood sugar levels.

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Basic Anatomical Terminology

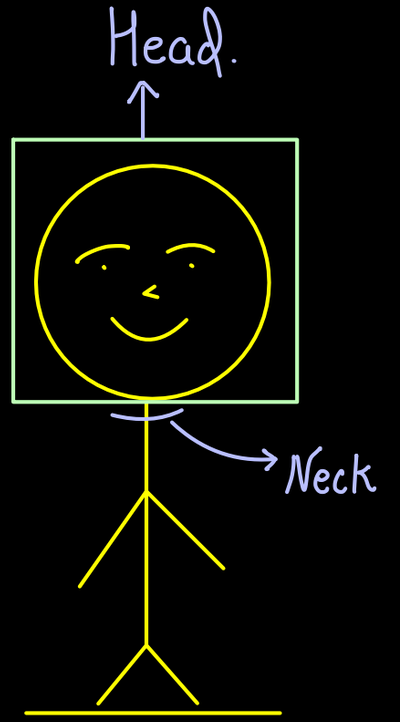
Basic anatomical terminology is essential for understanding the human body and its functions. Here are some key terms:

Directional Terms

Superior (Cranial): Toward the head or upper part of the body.

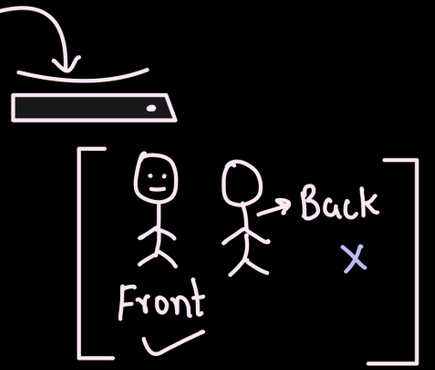
Inferior (Caudal): Away from the head or toward the lower part of the body.

Mouth is Inferior to Nose.



Anterior (Ventral): Toward the front of the body.

Chest Bone (Sternum) is Anterior to Heart.



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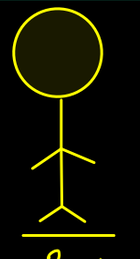
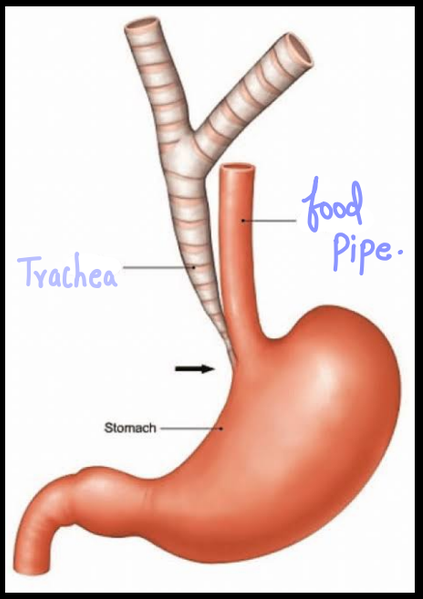
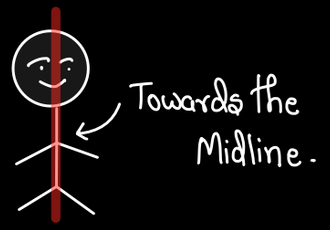
Posterior (Dorsal): Toward the back of the body.

Eg→ Food pipe is posterior to Trachea.



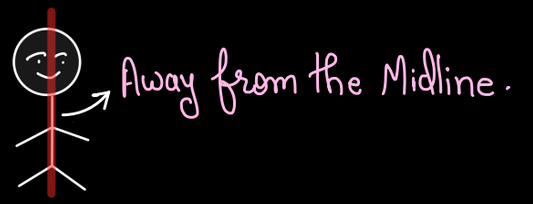


Medial: Toward the midline of the body.



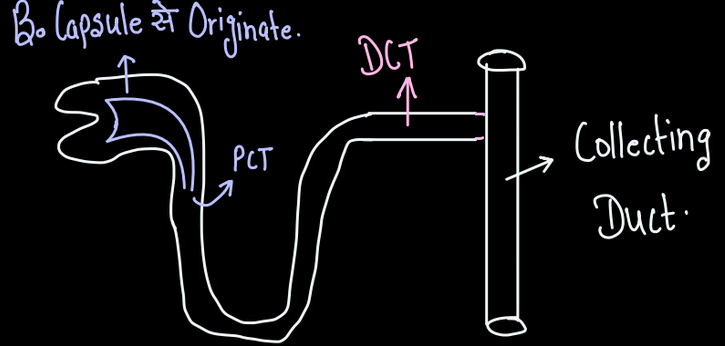
The chest (or torso) is considered medial to the arms. Medial means closer to the midline of the body

Lateral: Away from the midline of the body.



Proximal: Closer to the point of attachment or near to origin.

Wrist is Proximal to Hand.



Distal: Farther from the point of attachment or away to origin.

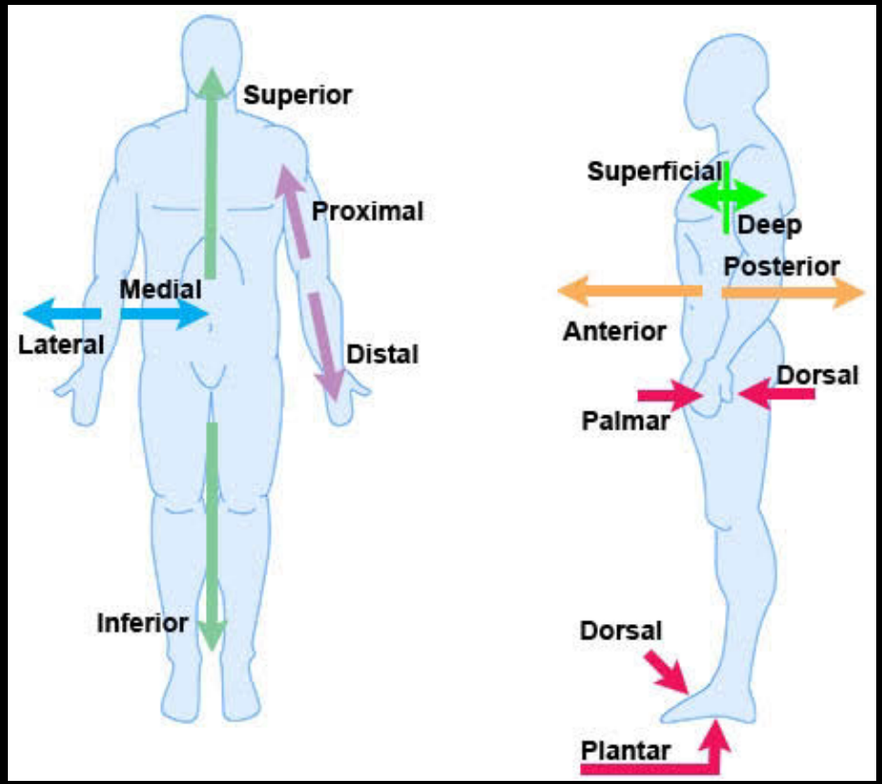
DEPTH OF BIOLOGY

Body Planes and Sections

Sagittal Plane: Divides the body into right and left parts.

Frontal (Coronal) Plane: Divides the body into front and back parts.

Transverse (Horizontal) Plane: Divides the body into upper and lower parts.



Other Key Terms

Superficial: Near the surface of the body.

Deep: Away from the surface, deeper into the body.

Visceral: Relating to the internal organs.

Parietal: Relating to the walls of a body cavity.

Bones are deeper to Skin.

Ribs are Superficial to Lungs.

DEPTH OF BIOLOGY

Regional Terms

Cephalic: Head region.

Cervical: Neck region.

Thoracic: Chest region.

Abdominal: Abdomen region.

Pelvic: Pelvis region.

Brachial: Upper arm.

Crural: Lower leg.

Plantar: Sole of the foot.