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Lec.7

Homeostasis

Artificial kidney first stage

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Homeostasis

Introduction

The human body needs to maintain a stable internal environment to ensure the efficient performance of its vital functions. This is achieved through **homeostasis**, which includes temperature regulation, blood pressure control, and fluid dynamics within the body. These processes rely on complex interactions between different biological systems, such as the nervous system, circulatory system, and excretory system.

First: Thermoregulation and Homeostasis

1. Concept of Thermal Balance

Thermal balance is the process of maintaining body temperature within a normal range (**approximately 36.5 - 37.5°C**) despite external changes. Temperature regulation is controlled by physiological and neurological mechanisms that manage heat production and loss.

2. Mechanisms of Temperature Regulation

- **Heat Production:** Occurs through cellular metabolism, muscle activity, and shivering.
- **Heat Loss:** Takes place via **conduction** (contact with cold surfaces), **convection** (heat transfer through air or water), **radiation**, and **evaporation** (sweating).

3. Role of the Nervous System in Temperature Regulation

- **Hypothalamus:** The main center for temperature regulation, receiving signals from temperature receptors in the skin and internal organs.
- **Body's Response to Cold: Vasoconstriction** (narrowing of blood vessels), increased metabolic rate, and shivering.
- **Body's Response to Heat: Vasodilation** (expansion of blood vessels), increased sweating, and reduced metabolic rate.

Second: Fluid Dynamics in the Body

1. Fluid Distribution in the Body

Water makes up about **60%** of body weight and is distributed as follows:

- **Intracellular Fluid (ICF):** Represents about **two-thirds** of total body fluids.
- **Extracellular Fluid (ECF):** Includes **plasma** and **interstitial fluid** (fluid between tissues).

2. Regulation of Fluid Balance

Fluid balance depends on:

- **Fluid Intake:** Through drinking and food consumption.
- **Fluid Excretion:** Through urine, sweating, and breathing.
- **Osmotic Balance:** Regulated by **sodium and potassium**, affecting fluid movement between compartments.

3. Role of Hormones in Fluid Regulation

- **Antidiuretic Hormone (ADH):** Reduces water loss through the kidneys.
- **Aldosterone:** Increases sodium and water reabsorption to maintain blood volume.
- **Angiotensin:** Contributes to blood vessel constriction, increasing blood pressure.

Third: Blood Pressure Control

1. Definition and Mechanisms of Blood Pressure

Blood pressure is the force exerted by blood against the walls of blood vessels. It is regulated by:

- **Cardiac Output** (the amount of blood pumped by the heart).

- **Peripheral Vascular Resistance** (resistance in blood vessels).
- **Total Blood Volume.**

2. Role of the Nervous System in Blood Pressure Control

- **Baroreceptors:** Found in the aortic arch and carotid arteries, they send signals to the brain to regulate blood pressure.
- **Sympathetic Nervous System:** Increases heart rate and constricts blood vessels to raise blood pressure.
- **Parasympathetic Nervous System:** Slows the heart rate and dilates blood vessels to lower blood pressure.

3. Role of the Endocrine System in Blood Pressure Regulation

- **Renin-Angiotensin-Aldosterone System (RAAS):**
  - **Renin** stimulates the production of **angiotensin**, which causes vasoconstriction and increases blood pressure.
  - **Aldosterone** enhances sodium and water retention, increasing blood volume and raising blood pressure.
- **Other Hormones:**
  - **Adrenaline (Epinephrine):** Increases heart rate and the force of heart contractions.

4. Blood Pressure Disorders

- **Hypertension (High Blood Pressure):** Can lead to heart disease and stroke.
- **Hypotension (Low Blood Pressure):** May cause dizziness and fainting.