Department of Anesthesia Techniques
Title of the lec1: - Homostasis
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Homeostasis

is the regulation of the internal environment of the body, to maintain a stable and relatively constant environment for the cells. Essentially all organs and tissues of the body perform functions that help maintain these constant conditions. For instance, the lungs provide oxygen to the extracellular fluid to replenish the oxygen used by the cells, the kidneys maintain constant ion concentrations, and the gastrointestinal system provides nutrients.

About 60 per cent of the adult human body is fluid, mainly a water solution of ions and other substances. **Although most of this fluid (about 2/3) is inside the cells and is called intracellular fluid**, about one third (1/3) is in the spaces outside the cells and is called **extracellular fluid.**

Most of the extracellular fluid presented in two compartments: **interstitial fluid** and **plasma,** in addition to lymph and transcellular fluid.

Differences Between Extracellular and Intracellular Fluids

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 :it contains large amounts of potassium, magnesium, and phosphate ions instead of the sodium and chloride ions found in the extracellular fluid.

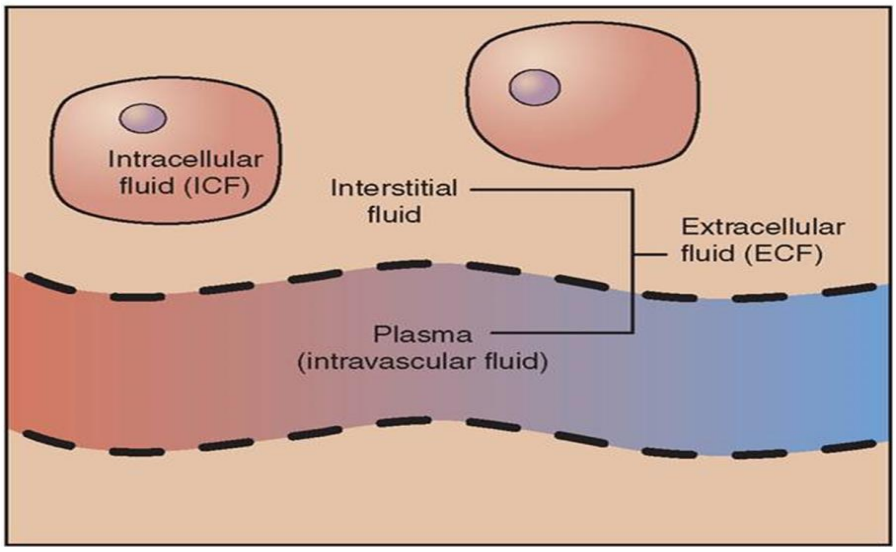

Figure 1-extracellular fluid

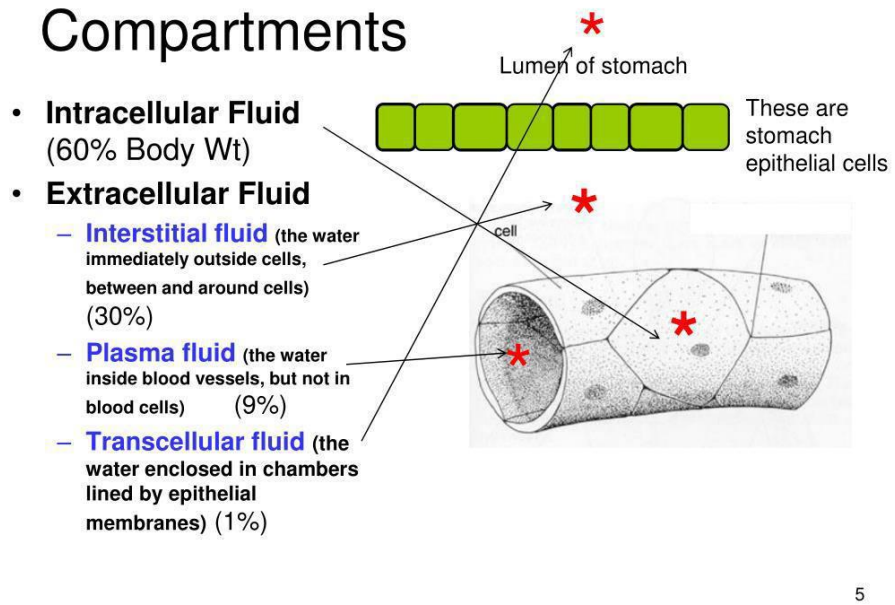

Figure 1-extracellular fluid and intracellular fluid

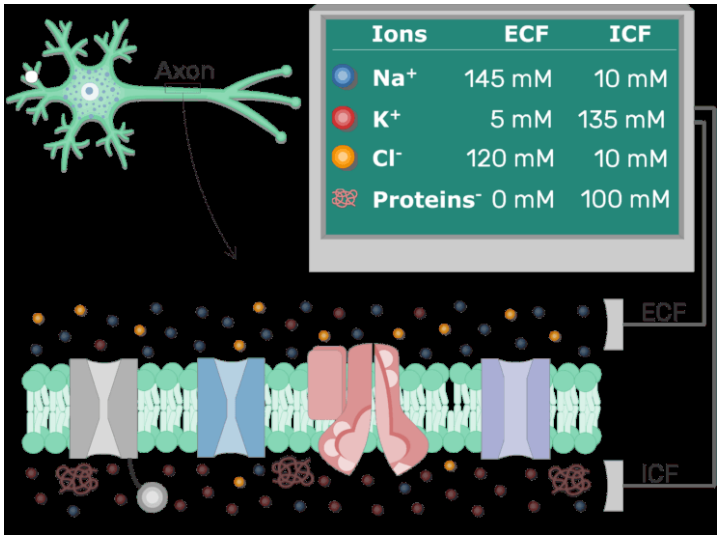

Figure –ions composition in nerve cell

Classification of Homeostasis:

1-**Intirnsic Controls** are inherentent compensatory response of an organ to a change. As in the heart function

2-**Extirnsic Controls** are responses of an organ that are triggered by factors externals to organs mainly ,by nervous or endocrine system.

Both **Intirnsic and Extirnsic controls system are operated by negative and positive feedback mechanisms.**

These system consist from:

1-Stimulus 2-Detector 3-Control System 4-Effector

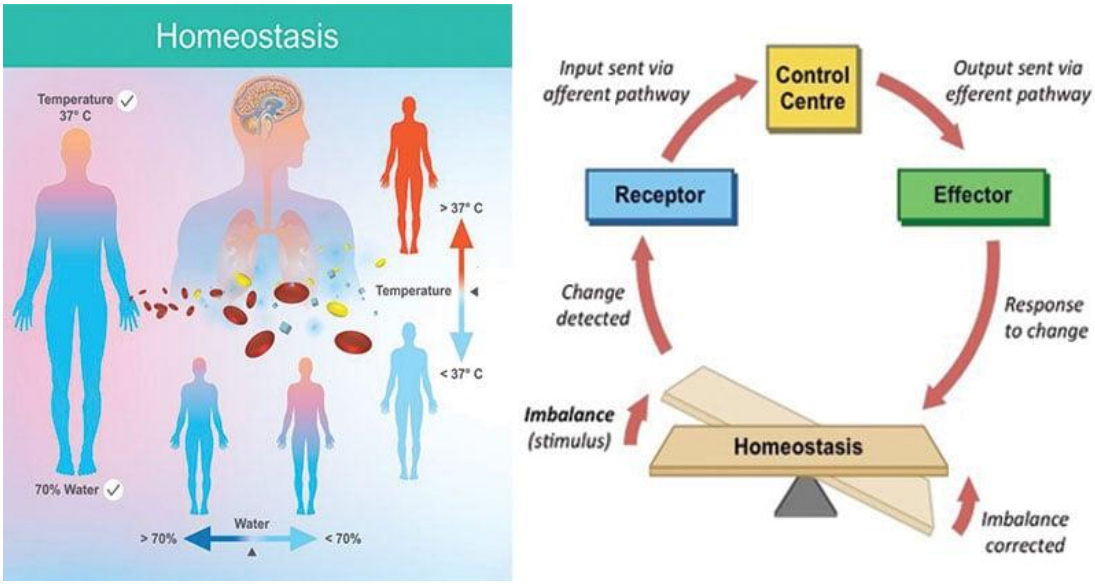

Figure-components for homeostasis

Example Negative Feedback:

1. If the blood pressure increases, receptors in the carotid arteries detect the change in blood pressure and send a message to the brain. The brain will cause the heart to beat slower and thus decrease blood pressure. Decreasing heart rate has a negative effect on blood pressure.

2. The regulation of our body temperature at a constant 37°C. If we get too hot, blood vessels in our skin vasodilate, and we lose heat and cool down. If we get too cold, blood vessels in our skin vasoconstriction lose less heat, and our body warms up.

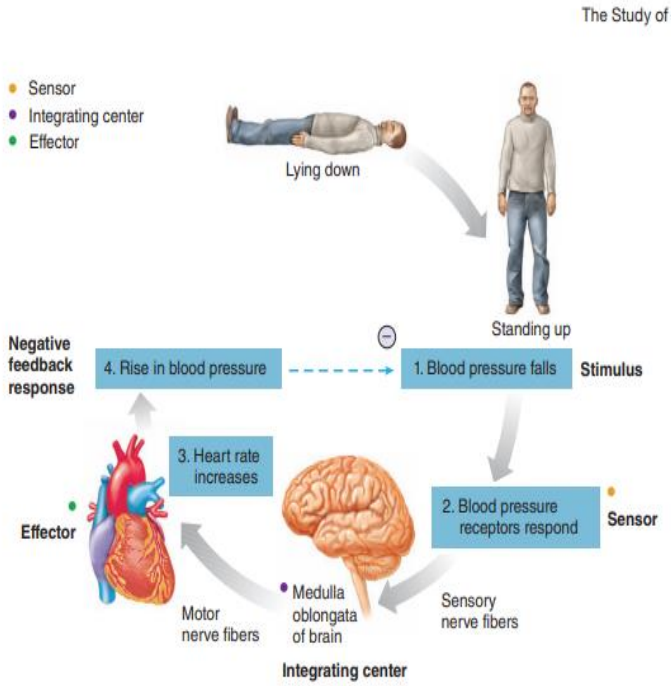

Figure 1.6 **Negative feedback control of blood pressure.** Blood pressure influences the activity of sensory neurons from the blood pressure receptors (sensors); a rise in pressure increases the firing rate, and a fall in pressure decreases the firing rate of nerve impulses. When a person stands up from a lying-down position, the blood pressure momentarily falls. The resulting decreased firing rate of nerve impulses in sensory neurons affects the medulla oblongata of the brain (the integrating center). This causes the motor nerves to the heart (effector) to increase the heart rate, helping to raise the blood pressure.

Figure: negative feedback mechanism.

Example for Positive feedback:

Is the release of oxytocin to improve and keep the contractions of childbirth happening.

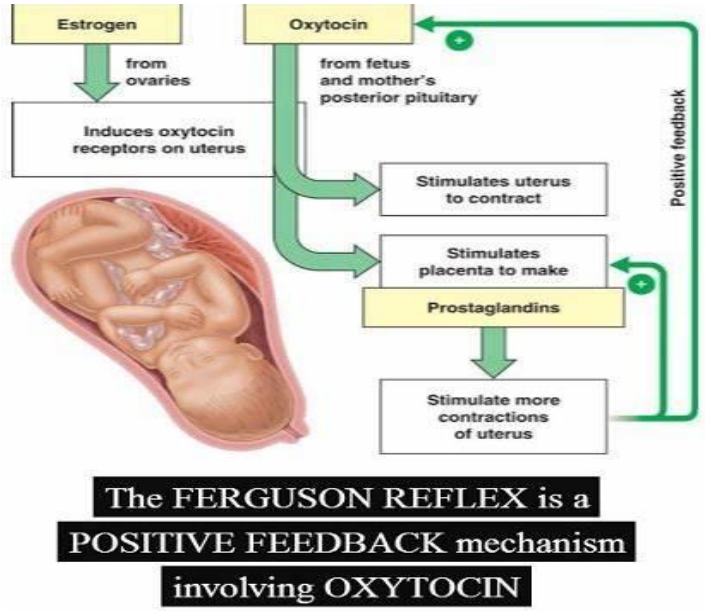

Figure: positive feedback mechanism.

Factors affecting homeostasis:

1- Disease and injury
2- Stress
3- dehydration
4- starvation
5- life style (smoking, diet,..)
6- Environmental temperature.

Acid-base imbalances underlie acid-base disorders and electrolyte abnormalities that exist from a plethora of medical conditions or medication side effects.

Water balance

Drinking water is considered voluntary. So how is water intake regulated by the body. **dehydration**, a net loss of water that results in insufficient water in blood and other tissues. The water that leaves the body, **as exhaled air, sweat, or urine, is ultimately extracted from blood plas**ma.

Regulation of water balance:

As the blood becomes more concentrated the body responed by ,

1- **the thirst response**—a sequence of physiological processes—is triggered (Osmoreceptors are sensory receptors in the thirst center in the hypothalamus that monitor the concentration of solutes (osmolality) of the blood.
2- **ADH (antidiuretic hormone):** released from pituitary gland to stimulate water reabsorption by the kidney.

The principal sources of body water are:

(1) ingested water
(2) water produced as an end-product of metabolism.

Water losses are classified as:

1) sensible: from the kidneys and gastrointestinal tract.
2) insensible losses: from the skin and lung

• Normal balance is maintained with intake and losses of 2.5—3 litres per day .
• Intake from ingested fluid (1300 ml), solid food800) ml) and metabolic waste (400 ml (.

This is balanced by insensible fluid losses of 0.5 ml kg-l h-l (850 ml) from skin and lungs; plus losses from urine (1500 ml) and faeces (100 ml)

These values are in health, normo-thermia & rest.

Sodium Balance

- Sodium balance is related to ECF volume and water balance .

Daily ingestion has a range (50—300 mmol . Regulation of volume • It is important to realize that water will only remain in the extracellular compartment if it is held there by the osmotic effect of ions. As sodium (and accompanying anions, mainly chloride) are largely restricted to the extracellular compartment, the amount of sodium in the ECF determines what the volume of the compartment will be.

Regulation of sodium balance

1- **Aldosterone** • decreases urinary sodium excretion by increasing sodium reabsorption in the renal tubules in exchange with potassium and hydrogen ions.

Aldosterone also stimulates sodium conservation by the sweat glands and the mucosal cells of the colon, but in normal circumstances these effects are trivial. A major stimulus to aldosterone secretion is the volume of the ECF. Aldosterone and anti-diuretic hormone(**ADH**) interact to maintain normal volume and concentration of the ECF.

2- **Natriuretic hormone**: • It is a polypeptide hormone that increases urinary sodium excretion and play important role in the regulation of ECF volume and sodium balance.

Q/ Who aldosterone and ADH work together to correct water and sodium depletion ?

Consider a patient who has been vomiting and has diarrhoea from a gastrointestinal infection. With no intake the patient becomes fluid depleted. Water and sodium have been lost. Because the ECF volume is low, aldosterone secretion is high. Thus, as the patient begins to take fluids orally, any salt ingested is maximally retained. As this raises the ECF osmolality, ADH action then ensures that water is retained too. Thus, aldosterone and ADH interaction continues until ECF fluid volume and composition return to normal.

Sodium balance disturbance

Hypernatraemia:means an increased of sodium concentration in blood which may Leads to pyrexia (fever), nausea, vomiting, convulsions, coma and focal neurological signs**.** Usually due to excess sodium or water depletion

Hyponatraemia: refer to a decreased level for sodium in blood**.** Lead to Headache, Faitague, And Low blood pressure
hyponatremia usually happened due to

1- **Water retention**: usually results from impaired water excretion and rarely from increased intake. Causing dilution of plasma sodium
2- **Sodium loss** : Sodium depletion is extremely rare and effectively occurs only when there is pathological sodium loss, either from the gastrointestinal tract or in urine. Gastrointestinal losses commonly include those from vomiting and diarrhoea.

Impact of Anesthesia :

Understanding basic fluid and electrolyte physiology is essential to good perioperative fluid management .
Anesthesia and critical care patients are often fasted and under physiological stress. Therefore, homoeostatic regulation of fluid balance is impaired .
A disturbance in normal fluid balance induces a physiological 'stress' response via :
1. Metabolic
2. Neuroendocrine
3. Immune-mediated systems

- The characteristic response to anesthesia and surgery is **water retention** and Na and electrolytes disturbance due to increase release of antidiuretic hormone **(ADH)** in response to stress.