25.1A: Regulation of Water Intake

Fluid can enter the body as preformed water, ingested food and drink, and, to a lesser extent, as metabolic water.

Learning Objectives

• Describe the regulation of water intake in the body

Key Points

• A constant supply of water is needed to replenish the fluids lost through normal physiological activities, such as respiration, sweating, and urination.
• Thirst is a sensation created by the hypothalamus that drives organisms to ingest water.
• Increased osmolarity in the blood acts on osmoreceptors that either stimulate the hypothalamus directly or cause the release of angiotensin II to stimulate the hypothalamus to cause thirst.
• The renin–angiotensin system increases thirst as a way to increase blood volume. It is activated by high plasma osmolarity, low blood volume, low blood pressure, and stimulation of the sympathetic nervous system.

Key Terms

• thirst: The sensation that drives organisms to ingest water. It is considered a basic survival instinct.
• osmoreceptors: Sensory receptors that are primarily found in the hypothalamus or macula densa that detect changes in the solute concentration of blood.
Water Intake

Fluid can enter the body as preformed water, ingested food and drink, and, to a lesser extent, as metabolic water that is produced as a by-product of aerobic respiration and dehydration synthesis. A constant supply is needed to replenish the fluids lost through normal physiological activities, such as respiration, sweating, and urination.

Water generated from the biochemical metabolism of nutrients provides a significant proportion of the daily water requirements for some arthropods and desert animals, but it provides only a small fraction of a human’s necessary intake. In the normal resting state, the input of water through ingested fluids is approximately 2500 ml/day.

Body water homeostasis is regulated mainly through ingested fluids, which, in turn, depends on thirst. Thirst is the basic instinct or urge that drives an organism to ingest water.

Thirst is a sensation created by the hypothalamus, the thirst center of the human body. Thirst is an important component of blood volume regulation, which is slowly regulated by homeostasis.

Hypothalamus-Mediated Thirst

An osmoreceptor is a sensory receptor that detects changes in osmotic pressure and is primarily found in the hypothalamus of most homeothermic organisms. Osmoreceptors detect changes in plasma osmolarity (that is, the concentration of solutes dissolved in the blood).

When the osmolarity of blood changes (it is more or less dilute), water diffusion into and out of the osmoreceptor cells changes. That is, the cells expand when the blood plasma is more dilute and contract with a higher concentration.

When the osmoreceptors detect high plasma osmolarity (often a sign of a low blood volume), they send signals to the hypothalamus, which creates the biological sensation of thirst. Osmoreceptors also stimulate vasopressin (ADH) secretion, which starts the events that will reduce plasma osmolarity to normal levels.

The hypothalamus: The hypothalamus is the thirst center of the human body.
Renin–Angiotensin System-Mediated Thirst

Another way through which thirst is induced is through angiotensin II, one of the hormones involved in the renin–angiotensin system. The renin–angiotensin system is a complex homeostatic pathway that deals with blood volume as a whole, as well as plasma osmolarity and blood pressure.

The macula densa cells in the walls of the ascending loop of Henle of the nephron is another type of osmoreceptor; however it stimulates the juxtaglomerular apparatus (JGA) instead of the hypothalamus. When the macula densa is stimulated by high osmolarity, the JGA releases renin into the bloodstream, which cleaves angiotensinogen into angiotensin I. Angiotensin I is converted into angiotensin II by ACE in the lungs. ACE is a hormone that has many functions.

Angiotensin II acts on the hypothalamus to cause the sensation of thirst. It also causes vasoconstriction, and the release of aldosterone to cause increased water reabsorption in a mechanism that is very similar to that of ADH.

Note that the renin–angiotensin system, and thus thirst, can be caused by other stimuli besides increased plasma osmolarity or a decrease in blood volume. For example, stimulation of the sympathetic nervous system and low blood pressure in the kidneys (decreased GFR) will stimulate the renin–angiotensin system and cause an increase in thirst.