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SEARCH

SPORT EDUCATION FOR ACTIVE AND RESPONSIBLE CITIZENSHIP THROUGH HEALTH CARING

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MODULE 2

ENCOURAGING SPORTS PRACTICE FOR ONE'S OWN PSYCHO-PHYSICAL WELLBEING AND TO CONTROL NATIONAL SOCIAL AND HEALTH COSTS

SEGMENT 7

Body Temperature

Your body and thermal regulation

Thermoregulation in humans is an important aspect of homeostasis. In thermoregulation, body heat is generated mostly in the deep organs, especially the liver, brain, and heart, and in contraction of skeletal muscles.

Humans have been able to adapt to a great diversity of climates, including hot humid and hot arid. High temperatures pose serious stress for the human body, placing it in great danger of injury or even death.

For humans, adaptation to varying climatic conditions includes both physiological mechanisms resulting from evolution and behavioural mechanisms resulting from conscious cultural adaptations.

Picture by Vidar Nordli-Mathisen, Unsplash

Heat loss of your body

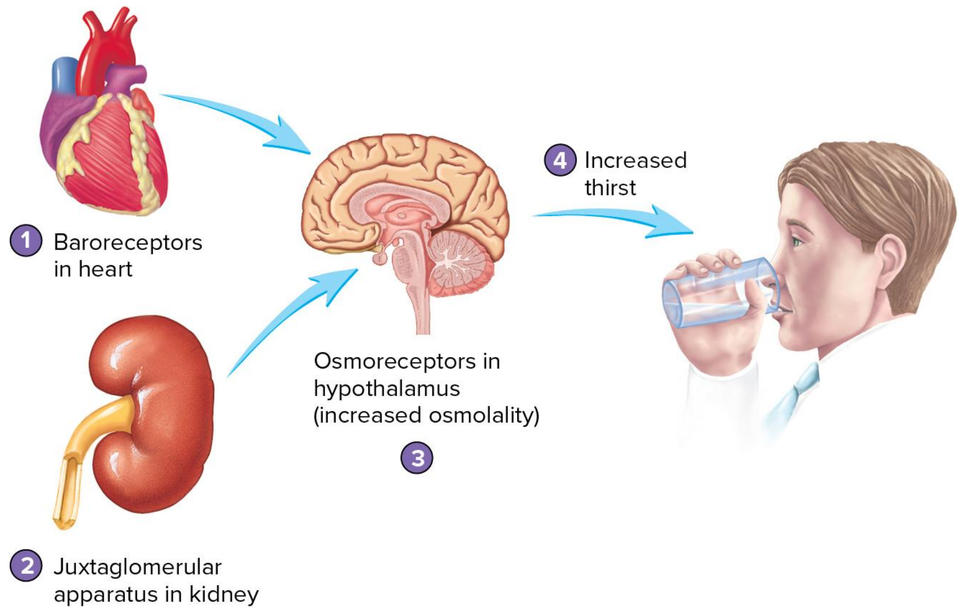
There are four ways of heat loss: **convection, conduction, radiation, and evaporation.**

If skin temperature is greater than that of the surroundings, the body can lose heat by radiation and conduction. But, if the temperature of the surroundings is greater than that of the skin, the body actually gains heat by radiation and conduction. In such conditions, the only means by which the body can rid itself of heat is by evaporation. So, when the surrounding temperature is higher than the skin temperature, anything that prevents adequate evaporation will cause the internal body temperature to rise.

During sports activities, evaporation becomes the main avenue of heat loss. Humidity affects thermoregulation by limiting sweat evaporation and thus heat loss.

Image by mohamed Hassan from Pixabay

Effect of Blood Osmolality and Blood Pressure on Thirst

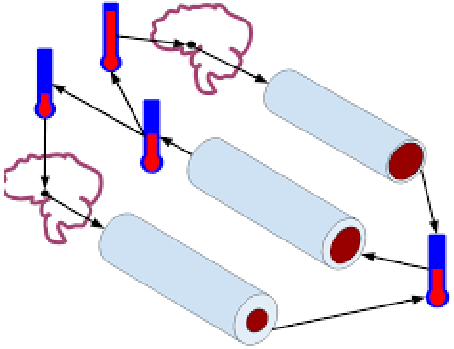


1. The baroreceptors in the carotid sinuses and aortic arch detect reduced blood pressure, which signals the hypothalamic thirst center.
2. Simultaneously, the juxtaglomerular apparatuses detect low blood pressure, which activates the renin-angiotensin system to produce angiotensin II. Angiotensin II stimulates the hypothalamic thirst center.
3. Osmo-receptors in the hypothalamus shrink when blood osmolality goes up, triggering action potentials that stimulate thirst.
4. The combination of these inputs activates thirst and promotes water consumption.

Heat Control System

The core temperature of a human is regulated and stabilized primarily by the hypothalamus, a region of the brain linking the endocrine system to the nervous system. As the core temperature varies from the set point, endocrine production initiates control mechanisms to increase or decrease energy production as needed to return the temperature toward the set point, i.e. slightly less than 37 degrees.

An important negative feedback mechanism in human beings is the ability to maintain body temperature. When the body temperature is too high or too low, the blood vessels will change size accordingly to bring the body's temperature back to normal.



Picture by Lexicunningham1

Body temperature changes depending on how it is measured:

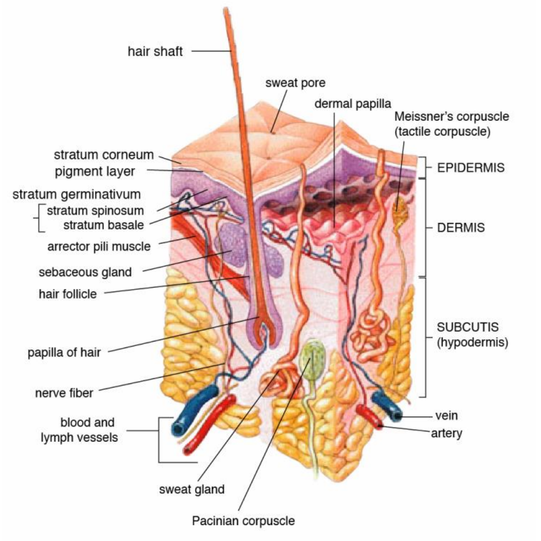
internal temperature (rectal) is higher than oral temperature (by half a degree) or axillary temperature (by one degree).

Usually it is higher in children than in the elderly, reflecting the differences in the two basal metabolisms.

Temperature is usually higher after a meal (especially if it is rich in protein), in fertile women during the ovulation period, after intense and prolonged physical exertion, while it is lower in the early morning hours.

Temperature Regulation in Hot Conditions

Sweat glands under the skin secrete sweat (a fluid containing mostly water with some dissolved ions), which travels up the sweat duct, through the sweat pore and onto the surface of the skin. This causes heat loss via evaporative cooling; however, a lot of essential water is lost.



Picture by Wikipedia

The hair on the skin lie flat, preventing heat from being trapped by the layer of still air between the hair. This is caused by tiny muscles under the surface of the skin relaxing so that their attached hair follicles are not erect. These flat hairs increase the flow of air next to the skin increasing heat loss by convection.

Arteriolar vasodilation occurs. The smooth muscle walls of the arterioles relax allowing increased blood flow through the artery. This redirects blood into the superficial capillaries in the skin increasing heat loss by convection and conduction.

Temperature Regulation in Hot and Humid Conditions

In general, humans appear physiologically well adapted to hot dry conditions. However, effective thermoregulation is reduced in hot, humid environments such as tropical environments, and deep mines where the atmosphere can be water-saturated.

In hot-humid conditions, it helps to wear light clothing such as cotton, that is pervious to sweat but impervious to radiant heat from the sun. This minimizes the gaining of radiant heat, while allowing as much evaporation to occur as the environment will allow.

Clothing such as plastic fabrics that are impermeable to sweat and thus do not facilitate heat loss through evaporation can actually contribute to heat stress.

Photo by Sahil Patel on Unsplash

Temperature Regulation in Cold Conditions

The minute muscles under the surface of the skin, each of them attached to an individual hair follicle, contract and lift the hair follicle upright. This makes the hairs stand on end, which acts as an insulating layer, trapping heat. We notice this effect as goose bumps since humans do not have very much hair and the contracted muscles can easily be seen.

Arterioles carrying blood to superficial capillaries under the surface of the skin can shrink (constrict), thereby rerouting blood away from the skin and towards the warmer core of the body. This prevents blood from losing heat to the surroundings and also prevents the core temperature dropping further. In extremely cold conditions, excessive vasoconstriction leads to numbness and pale skin. Frostbite occurs only when water within the cells begins to freeze. This destroys the cell causing damage.

Shivering

Muscles can also receive messages from the thermoregulatory centre of the brain (the hypothalamus) to cause shivering.

This increases heat production as respiration is an exothermic reaction in muscle cells. Shivering is more effective than exercise at producing heat because the body remains still. This means that less heat is lost to the environment through convection.

Shivering can also be a response to a fever, as a person may feel cold. During fever the hypothalamic set point for temperature is raised. The increased set point causes the body temperature to rise (pyrexia), but also makes the patient feel cold until the new set point is reached. Severe chills with violent shivering are called rigors. Rigors occur because the patient's body is shivering in a physiological attempt to increase body temperature to the new set point.

Photo by Spencer Backman on Unsplash

The thermoregulatory adaptations of our body therefore preserve or disperse heat according to need.

Thermogenesis (the ability to produce heat) is based on the fact that all our biochemical reactions lead to the production of heat.

It is increased by the physical activity, but also by **shivering** (*involuntary contraction of the hair muscles*) which increases heat by approximately seven times more than the muscle at rest.

Water and the body

Water is necessary for all life on Earth. **Humans can survive for four to six weeks without food but only for a few days without water.**

Fluid balance is an aspect of the equilibrium of the organism in which the amount of water needs to be controlled, via osmoregulation and behaviour, such that the concentrations of electrolytes (salts in solution) in the various body fluids are kept within healthy ranges.

The core principle of fluid balance is that the output (via respiration, perspiration, urination, defecation) must equal the input (via eating and drinking).

Profuse sweating can increase the need for electrolyte replacement. Water-electrolyte imbalance produces headache and fatigue if mild; illness if moderate, and sometimes even death if severe. **Deficits to body water result in volume contraction and dehydration.**

Photo by Laura Chouette on Unsplash

Too Much Water

Water intoxication, also known as water poisoning, hyperhydration, or overhydration, is a potentially fatal disturbance in brain functions that results when the normal balance of electrolytes in the body is pushed outside safe limits by excessive water intake.

Under normal circumstances, accidentally consuming too much water is exceptionally rare. Nearly all deaths related to water intoxication in normal individuals have resulted either from water-drinking contests, in which individuals attempt to consume large amounts of water or from long exercises during which excessive amounts of fluid were consumed.

E.g., marathon runners are susceptible to water intoxication if they drink too much while running. This is caused when sodium levels drop when athletes consume large amounts of fluid.

Photo by henri meilhac on Unsplash

Water Intoxication

Any activity or situation that promotes heavy sweating can lead to water intoxication when water is consumed to replace lost fluids. Persons working in extreme heat and/or humidity for long periods must take care to drink and eat in ways that help to maintain electrolyte balance.

Water intoxication can be prevented if a person's intake of water does not grossly exceed their losses. Healthy kidneys are able to excrete approximately 800 millilitres to 1 litre of fluid water per hour. However, stress (from prolonged physical exertion), as well as diseases, can greatly reduce this amount.

Image by mirasidia from Pixabay

Not Enough Water

Dehydration is a deficit of total body water, with an accompanying disruption of metabolic processes. It occurs when free water loss exceeds free water intake, usually due to exercise, disease, or high environmental temperature.

Most people can tolerate a 3-4% decrease in total body water without difficulty or adverse health effects. A 5-8% decrease can cause fatigue and dizziness. Loss of over ten percent of total body water can cause physical and mental deterioration, accompanied by severe thirst. Death occurs at a loss of between fifteen and twenty-five percent of the body water. Mild dehydration is characterized by thirst and general discomfort and is usually resolved with oral rehydration.

Dehydration can cause hypernatremia (high levels of sodium ions in the blood)

Picture by eMedicineHealth

Dehydration

The first symptoms of dehydration include thirst and neurological changes such as headaches, general discomfort, loss of appetite, decreased urine volume (unless polyuria is the cause of dehydration), confusion, unexplained tiredness, purple fingernails and seizures.

The symptoms of dehydration become increasingly severe with greater total body water loss. A body water loss of 1-2%, considered mild dehydration, is shown to impair cognitive performance.

Image by Engin Akyurt from Pixabay

Water Loss through Sport

In warm or humid weather or during heavy exertion, water loss can increase markedly, because humans have a large and widely variable capacity for the active secretion of sweat.

Whole-body sweat losses in men can exceed 2 litres per hour during competitive sport, with rates of 3–4 litres per hour observed during short-duration, high-intensity exercise in the heat. When such large amounts of water are being lost through perspiration, electrolytes, especially sodium, are also lost.

In most athletes, exercising and sweating for 4–5 hours, the total sodium lost is less than 10% of total body stores (approximately 58 g for a 70-kg person). These losses appear to be well tolerated by most people. The inclusion of some sodium in fluid replacement drinks has some theoretical benefits and poses little or no risk.

Photo by Markus Spiske on Unsplash

Keywords

Hypothermia

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Radiation

Homeothermy

Vasodilation

Conduction

Evaporation

Shiver

Adipose

Tissue

Heat Stroke