Heat losses of the organism

From the point of view of thermal changes in the organism, organisms can be divided into two main groups: cold-blooded (poikilothermic) and warm-blooded (homoiothermic). Cold-blooded animals cannot maintain a constant body temperature. Their body temperature changes depending on the temperature of the outside environment. Warm-blooded animals maintain a constant body temperature through regulatory mechanisms during metabolism. Mechanisms that participate in maintaining a constant temperature even during fluctuations in ambient temperatures are collectively called **thermoregulation mechanisms**. The human organism belongs to the group of homoiotherms. Heat in the body is produced by the transformation of chemical energy. The condition for maintaining a constant temperature in the organism is **equality of the heat generated by metabolic processes and the heat removed to the surroundings*. This happens mainly by regulating the speed of heat removal - heat is mainly removed by*** *the skin and lungs*, inside the body heat exchange is mediated by the flow of blood. Blood also ensures the transfer of heat from the inside of the body to the surface. Heat in the body is produced mainly as a by-product of the transformation of other forms of energy, only exceptionally is it produced purposefully, e.g. in the case of cold shivering as a thermoregulation mechanism. So that this mostly waste heat does not accumulate in the organism and thus its temperature does not increase, the organism is able to regulate its removal to the environment to a certain extent.

The mechanisms by which heat loss from the body occurs are divided into direct and indirect.

Direct:

- radiation (*radiation*)
- management (*conduction*)
- flow (*convection*)

Indirect:

- evaporation from the lungs
- sweating (*evaporation*)

Body temperature regulation

Regulatory mechanisms for lowering body temperature:

- vasodilation
- noticeable sweating
- limitation of heat production

Regulatory mechanisms for increasing body temperature:

- vasoconstriction
- increased heat production by cold shivering
- by increasing metabolism
- "goosebumps", reaction of the vegetative nervous system - not of great importance to humans, rather a relic from ancestors

The most effective way to regulate heat dissipation is to regulate the amount of blood that goes from the core to the surface, where it cools. The rate of blood flow to the skin can fluctuate between 0-30% of the minute cardiac output. The body's temperature control itself is regulated from the hypothalamus. Sensors in the hypothalamus register the temperature of the blood that flows through it and thus determine the temperature of the internal organs. For peripheral areas, the sensors are built directly into the skin, rather in the deeper parts.

Radiation

Any body with a temperature greater than absolute zero (0 K) '*radiates electromagnetic radiation* into the environment, which has wavelengths in the ultraviolet spectrum for high temperatures, in the visible for lower and in the infrared for the temperature in which we live. The state of absolute zero is practically impossible to achieve, the movement of molecules would have to stop. We can therefore say that electromagnetic radiation is constantly emitted by every body, i.e. every organism. According to the Stefen-Boltzman law, the amount of energy radiated by a body is directly proportional to the fourth power of the body's absolute temperature. Since this law applies to all bodies, the total radiated energy is equal to the difference of the fourth power of the surface temperature of the body (organism) and the objects around it. Thermal radiation is the only "non-contact" method of heat exchange, due to its electromagnetic nature. The amount of energy emitted therefore depends on both the temperature of

Heat losses of organism

the organism and the temperature in the surrounding environment. Therefore, the overall meaning of heat loss by radiation is different in extreme climatic conditions and in the conditions in which we live. In our climate zone (temperate zone), radiation is very important, it represents up to 60% of the body's heat loss[1].

Conduction (conduction)

During conduction, heat passes from places of higher temperature to places where the temperature is lower. However, only heat, i.e. the kinetic energy of the oscillating motion of molecules, passes through, not matter. This action takes place only through direct contact. The transition is formulated by the equation:

$Q=(\lambda*\tau*S*\Delta t)/d$

where Q (J) is the amount of energy thus transferred in τ (s) time, Δt (K) is the temperature difference of the two places that transfer heat to each other, d(m) their distance and S(m^2) the area over which makes the transfer. λ is the coefficient of thermal conductivity, which tells how a given substance has the ability to transfer heat.

Comparison of some thermal conductivity coefficients:

Fabric	λ (W·m-1·K-1) at 25 °C
diamond	895-2300
iron	80.2
water	0.61
blood	0.52
brain	0.51
fat	0.21
sheep's wool	0.04
polystyrene	0.03
air	0.03

It follows from the above that metals and liquids are good conductors. On the contrary, gases, polystyrene or, in the human body, fat tissue are good insulators. Good insulators include air as a gas, but this applies under the condition that it is constant. On the contrary, a lot of heat is removed if the surrounding air flows or if the body is in a wet environment. Under normal conditions, a person loses about 15% of his thermal energy through flow. However, this is an average value that varies for example for children who have a much larger ratio

body surface : body volume [1].

Flow (convection)

Heat conduction by flow is only possible for liquids and gases, not for solids. Flow is associated with the transfer of energy (=heat) and the substance itself. Thus, it is connected with conduction, when first the heat is transferred by the body around it to the surrounding air using the conduction and then this air is carried away using the flow.

The flow process is characterized by the equation $Q= \alpha \times S \times \Delta t \times \tau$

This indicates the amount of heat that is removed during the time τ(s) by the flow from the surface of the body by S (m^2) to the environment with a lower temperature by Δt (K). α is the interface heat transfer coefficient. It depends on many factors - for example: pressure, temperature, air humidity or flow speed.

Evaporation of water (evaporation)

Thanks to the high value of the heat of evaporation of water (2.4 MJ/kg), the evaporation of water is important for the organism. Under normal conditions, it accounts for up to 25% of heat loss. Evaporation occurs in two ways - breathingm and sweatingm. We divide sweating into imperceptible and perceptible. Perceptible sweating takes place through the process of direct diffusion of water molecules from the epithelial cells in the skin to the outside of the body. Sweat glands are not involved in imperceptible sweating. The body cannot regulate this type of sweating. The amount of evaporated water (heat given off) depends on the physical properties of the external environment (air temperature, air humidity...) If the saturation with water vapor is in the vicinity of the so-called "dew point" (maximum saturation), sweating cannot take place. On average, the organism loses up to 660 ml of water per day through imperceptible sweating. Perceptible sweating is more energetically significant. It takes place with the help of sweat glands. Perceptible sweating is regulated by the organism, but its effectiveness is influenced by the physical properties of the surrounding environment. Perceptible sweating is the basic mechanism of heat removal from the body in cases where the high ambient temperature does not allow the application of other mechanisms. **Evaporation accelerates with increasing body temperature, slows down when the air is saturated with water vapor or in the absence of air flow around the body. Below 19 °C*, heat output is reduced due to minimal blood flow to the skin.*** *19–31 °C* ***blood circulation of the skin can ensure the balance between***

produced and dissipated heat. Above** 31 °C**, evaporation approaches the methods of radiation and flow and heat conduction. If the ambient temperature is higher than the body temperature, the only possible cooling mechanism is ``evaporation[2]**.**

Links

Related Articles

- Thermoregulation

References

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