Organism thermoregulation

This article was checked by pedagogue

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All living organisms depend on maintaining a complex set of interacting metabolic chemical reactions. From the simplest unicellular organisms to the most complex plants and animals, internal processes operate to keep the conditions within tight limits to allow these reactions to proceed. Homeostasis is a process that maintains the stability of the body's internal environment in response to changes in external conditions. It processes act at the level of the cell, the tissue, and the organ, as well as for the organism as a whole. Examples of homeostasis include the regulation of temperature and the balance between acidity and alkalinity (pH). Regarding the temperature toleration, human beings may be referred as homeotherms, which means that (on opposite to poikilotherms) we maintain the body temperature within a narrow range. In addition, human species belong to endotherms, which means that we regulate our body temperature through various internal metabolic processes.

As for the importance of thermoregulation, it is important to mention that there is usually a limit beyond which an organism’s biochemical processes and tissues are deeply affected and even damaged. Physiologically, organisms can be affected both by low (hypothermia) and high temperature (hyperthermia). Therefore, thermoregulation is maintained by, sometimes, logically contrary processes to assure the right temperature. It means both constant producing of a heat and getting rid of it when it’s excess can affect metabolic pathways, membrane structures and tissues.

Heat Generation

The heat of our bodies is usually generated by means of the normal metabolism, in catabolic processes and as energy lost in cellular respiration. It is linked with food intake, as, in a big simplification, the food state the substrate for those complicated processes. Heat it’s thus mostly produced in liver (warmest organ in a body), but also heart and brain. Those deep organs spread it by blood that pass through and therefore efficiently warm up nearly the whole body. Under conditions of excessive cold or low activity, we can generate additional heat by shivering - contraction of skeletal muscles. To cause shivering, muscles receive messages from the thermoregulatory center of the brain (the hypothalamus). This increases heat production as respiration is an exothermic reaction in muscle cells. There are two types of shivering: low intensity and high intensity. The one that occur in human bodies are high intensity, which means that it proceed violently and for a relatively short time. It consume glucose as a energy source. In comparison, some animals that hibernate in winter use low intensity shivering which occur constantly at a low level for months. They use brown fat as a fuel for mitochondrias. In addition, newborns also make use of brown adipose tissue in the first months after birth as far as they don't have yet developed effective mechanisms of heat generation.

Heat Loss

As it was mentioned before, too high temperature affect an organism as much as too low temperature. To avoid that we consist in the physical processes of a heat loss.

There are four avenues of heat loss:

- Convection
- Conduction
- Radiation
- Evaporation

When the temperature of the skin overcome the temperature of the surroundings then the organism is susceptible for heat gain. Analogically, if the environmental temperature is above core body temperature, perspiration i.e. sweating is the only physiological way for humans to lose heat. So when the surrounding temperature is higher than the skin temperature, anything that prevents adequate evaporation will cause the internal body temperature to rise. When you sweat you release liquid from the body's sweat glands Secreted liquid, localised on the surface of the skin, will subsequently undergo evaporation; during intense exercise, human body loses approximately 85% of its heat through sweating. The degree of sweat secretion is directly related to temperature of the ambient, physical activity and psychological circumstances such as stress or anxiety. Likewise, the heat contained by human body is disposed by means radiation. This process concerns the transmission of heat from an hyperthermic environment, the body, to a hypothermic environment such as, in natural circumstances, air is. Similarly, an influential part of heat is lost through conduction (such as heat loss from sleeping on the cold ground). Furthermore, when the body is wet or surrounded by water the magnitude of these processes is increased in comparison to air; thus proportionally the humidity of the air considerably affects these variables by limiting sweat evaporation.

Vasodilatation

Another process relevant for heat disposal, strongly associated with radiation, concerns the expansion in volume of vessels of the body. So called vasodilatation, essentially consists in relaxation of smooth muscle cells located in broad arteries and veins which causes a decrease of vascular resistance and directly results in increased blood flow. Consequently, enlargement of arterial blood vessels (mainly the arterioles) reduces blood pressure.

Hormones proceeding from the nervous system are commonly responsible of the induction of this process, although such response can be also generated within surrounding tissue. In case of brain for instance, the heat produced by this very active organ has to be excreted to protect it from so called: heat stroke. The head has a complex system of blood vessels which keeps the brain from overheating by bringing blood to the thin skin on the head, allowing heat to escape. Moreover, vasodilatation can concern the whole circulatory system as well as it may be narrowed to a specific organ.

Vasoconstriction represents the analogical process during which the blood vessels narrow instead of enlarging themselves in order to limit heat loss by radiation.

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