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THE SPECIFICS OF THE SOCIO-ECONOMIC DEVELOPMENT OF THE REGIONS OF THE ARCTIC ZONE OF THE RUSSIAN FEDERATION

***Abstract**: In the article, the authors analyze the specifics of the socio-economic development of the Arctic zone of the Russian Federation for the possible predictable allowable time for a person to stay in the cold for nine regions of the Russian Arctic. At the same time, taking into account the possible risks of cooling and a lack of heat in the body, it is recommended to recommend comfortable operating modes for the performer, which is especially relevant now, during the period of intensive development of all nine regions of the Russian Federation.*

***Key words**: Karelia, Nenets Autonomous Okrug, Chukotka Autonomous Okrug, Krasnoyarsk Territory, Republic of Sakha, Yakutia, Arkhangelsk Region, Murmansk Region, Komi Republic, Vorkuta, priorities, hypothermia, comfort, product range, migration.*

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Introduction

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The Arctic is the subject of international agreements implemented by the following organizations:

Arctic Council(Arctic council) - a key high-level body, established at the initiative of Canada in 1996, on the day of the signing of the Ottawa Declaration. The Arctic Council coordinates international cooperation, regularly holds meetings at the level of foreign ministers of the council member countries:

- **core business**international advisory body are research and analytics (much attention is paid to data on the state of the environment of the Arctic), on the basis of which it initiates international treaties;
- **goals of the Arctic Council**: providing the necessary conditions for cooperation, coordination and interaction between the Arctic states with the participation of indigenous communities and other inhabitants of the Arctic on common issues, in particular, issues of sustainable development and environmental protection.

Working groups of the Arctic Council:

- **Arctic Pollution Working Group**(ACAP) acts as a support mechanism to promote action by countries to reduce emissions and other releases of pollutants into the environment;
- **working group for the implementation of the Arctic Monitoring and Assessment Program**(AMAP) monitors the Arctic environment, ecosystems and populations, and provides scientific advice to support governments in combating pollution and the adverse effects of climate change;
- **Working Group on the Conservation of Arctic Flora and Fauna**(CAFF) is engaged in the conservation of Arctic biodiversity, striving to ensure the sustainability of the biological resources of the Arctic;
- **working group on prevention, readiness for liquidation of emergency situations**(EPPR) is dedicated to protecting the Arctic environment from the threat and impact of accidental releases of pollutants and radionuclides;
- **Working Group on the Protection of the Arctic Marine Environment**(PAME) is the focal point for all Arctic Council activities related to the protection and sustainable use of the Arctic marine environment;
- **working group on sustainable development**(SDWG) is dedicated to promoting sustainable development in the Arctic and improving the living conditions of Arctic communities in general.

Figure 1. Arctic territories of the Russian Federation.

The Council may establish task and expert groups for the implementation of specific areas. In the period 2018 - 2022 activities carried out:

- the Arctic Maritime Cooperation Group (TFAMC);
- Arctic Telecommunications Infrastructure Group (TFTIA);
- Arctic Science Cooperation Task Force (SCTF);
- an expert group promoting the implementation of the Framework for Action on Accelerated Reductions in Black Carbon and Methane Emissions.

Arctic countries, namely:

➢ **Permanent members of the Arctic Council:**Canada, Denmark, Finland, Iceland, Norway, Russia, Sweden, USA.

➢ **Permanent Participants of the Arctic Council**- organizations representing the indigenous peoples of the Arctic: Aleut International Association, Arctic Athabaskan Council, International Gwich'in Council, Inuit Circumpolar Council, Association of

Indigenous Peoples of the North, Siberia and the Far East of the Russian Federation and the Saami Council. A feature of Canada is the right of indigenous peoples to self-government, which includes the right to create governments of "First Nations". This rule has been transferred to the international level.

➢ **Arctic Council Observers**: France, Germany, the Netherlands, Poland, Spain, Great Britain, China, Italy, Japan, Korea, Singapore, India, as well as a number of international organizations.

Observer countries are interested in various types of economic activities carried out in the Arctic. Singapore, which has research organizations specializing in the Arctic, is hosting a forum on the development of the region, where issues of navigation along the Northern Sea Route are discussed. The Chinese concept of the transport system "New Silk Road" considers the Arctic route, that is, the possible use of the Northern Sea Route. In this connection, China is showing interest in the development of infrastructure in Russia (ports, railways). The China Polar Research Institute operates five polar research stations and two icebreaking research vessels. Since the beginning of the 21st century, the extraction of useful resources has been a subject of strong interest for many countries. The Arctic Council adopts agreements

- **Denmark**(including Greenland and the Faroe Islands) - maritime areas north of the southern boundary of the Greenland exclusive economic zone and the Faroe Islands fishing zone;
- **Finland**- sea areas north of 63°30' north latitude;
- **Iceland**- maritime areas north of the southern border of the Icelandic exclusive economic zone;
- **Norway**- sea areas north of the Arctic Circle;
- **Sweden**- sea areas north of 63°30' north latitude;
- **Russia**- sea areas north of the coastline of the White Sea, the Barents Sea, the Kara Sea, the Laptev Sea, the East Siberian Sea, the Chukchi Sea and in the mouths of rivers flowing into these seas - from the baselines for measuring the width of the territorial sea;
- **USA**- sea areas on the high seas from the original coastline from the border between the United States and Canada in the Beaufort Sea and along the north side of the Alaska mainland to the Aleutian Islands beyond 24 nautical miles south of the Aleutian Islands and in the Bering Sea east of the boundaries of the exclusive economic US zones.
- **Canada**- sea areas north of 60° north latitude;

European Arctic

Arctic issues are considered at the sites of the United Nations (UN) and the European Council, as well as the Northern Forum, which is an international organization uniting the Arctic regions and municipalities. In 2019, the Governor of the Nenets Autonomous Okrug was the Chairman of the Northern Forum, which involves the development of cultural interaction and the improvement of the quality of life in the North.

Legislated borders of the Arctic

Russia is the only country where the border of the Arctic is fixed by law - by decree of the President of the Russian Federation, the Arctic zone of the Russian Federation (AZRF) is allocated. The latest version of the Arctic borders is enshrined in Decree No. 220 dated May 13, 2019. Climatically, the Arctic may be located south of the modern Arctic zone, the Republic of Sakha (Yakutia) has long defended the need to include the second line of Arctic uluses in the Russian Arctic. The development strategy of the Russian Arctic suggests that it will become a special zone of economic activity that provides benefits for companies (Figure 2).

Figure 2. The Arctic zone (purple sector), the zone of the Far North (turquoise) and equivalent regions of the Russian Federation (blue)

The concept of "Far North" has existed since the 30s of the last century, since the 40s the concept of "Regions of the Far North and equivalent areas" has appeared. In Russia, there is also a category of territories called "Regions of the Far North and equivalent areas with a limited period for the delivery of goods." It is more economically advantageous to deliver goods to hard-to-reach areas by water, but in the case of only small and shallow rivers, the delivery time can be as little as two weeks. In these territories, prices are regulated, fines are provided for exceeding their threshold value by an entrepreneur, and priority importation of medicines is carried out.

Main part

The climate of the Arctic is considered harsh and cold, but as a result of the appearance of cyclones, the temperature can rise sharply to positive values.The average temperatures of the coldest winter month - January - range from -2 ... -4 °C in the southern part of the Arctic region to -25 ° C in the northBarents Sea, westGreenland Sea, in the seas Baffin And Chukotka and from −32…−36 °C; in the Siberian region, in the north of the Canadian and in the adjacent part of the Arctic basin up to -45 ... -50 °C in the central partGreenland. The minimum temperatures in these areas sometimes drop to -55...-60 °C, only in the Arctic basin they do not fall below -45...-50 °C. When breaking deepcyclonesthe temperature sometimes rises to -2 ... -10 °C. Average July temperatures in the Arctic Basin are 0…−1 °C

The ice cover of sea areas is about 11 million km² in winter and about 8 million km² in summer. The air here is colder than the water. The air temperature in the Siberian basin is minus 50°C, in the Chukchi Sea the air temperature is minus 36°C. During the polar night, the air temperature constantly drops, because neither light nor heat enters. When the polar day comes, large amounts of heat and light are absorbed by snow and ice. The areas adjacent to the waters of the Atlantic and Pacific Oceans are warmer and have more precipitation, while the climate of the interior is colder and drier.

In winter, the actions of cyclones from the Atlantic Ocean intensify in the Arctic. At this time, high air temperatures, strong winds, maximum rainfall and cloudiness. There are anticyclones in the Siberian part of the Arctic. The winds here are negligible, very low temperatures, little precipitation. The temperature in the Arctic basin in summer is 0-5°C, very humid (up to 98%), frequent fogs, precipitation in the form of sleet and rain, moderate winds.

The climate of the Arctic has changed significantly over the past 600 years. During this period of time, at least three or four warmings occurred, quite commensurate both in scale and duration with the famous “warming of the Arctic” in the first half of the 20th century.

According to research, the temperature in the Arctic is rising twice as fast as in the rest of the world. This can lead to the extinction of many plant and animal species in the region. Also, warming threatens the existenceindigenous peoples of the arctic.

Arctic ice is of great importance for the Earth's climate system.ice capreflects the sun's rays and thus prevents the planet from overheating. In addition, Arctic ice plays an important role inwater circulation systems in the oceans.

The total mass of Arctic ice, compared with the level of the 1980s, has decreased by 70%. In September 202, according tohydrometeorological center, the area of the ice cap reached its minimum for the entire observation period, amounting to 3346.2 thousand km.

It should be taken into account that even before the start of satellite observations (1979), very short ice periods were also observed. According to American scientists who have studied climate change in all areas of the Arctic, in recent years the area of ice cover has been rapidly decreasing. As of February 20, 2022, this figure was 14.54 million km². Many experts suggest that in the 21st century, most of the Arctic waters will be completely ice-free in the summer, and this will open up new prospects for maritime transport.

Table 1. Indicators of meteorological conditions in the regions of the Arctic zone

	cold season	The lowest recorded t	warm season	Average annual t
Republic of Karelia	-9.0 °C to -13.0 °C	-54.0 °C	from + 14.0 °C to + 17.0 °C	from 0 °C in the north to 3 °C in the south
Murmansk region	- 9 -10 °C	-45 °C on the White Sea coast and -51 °C in the central regions	+9°C to +11°C	-8 °C
Arkhangelsk region	-11-14 °C	-45.2°C	+10-+12 °C	+0.8 °C
Nenets Autonomous Okrug	-17-20 °C	-47.6 °C	+5-+7 °C	from -1 °C in the southwest to -9 °C in the northeast

Yamalo-Nenets Autonomous Okrug	−9 °C to −20 °C	-59 °C	from +6 °C in the north to +13 °C	−10 °C
Krasnoyarsk Territory	-16.0 °C	-52.8 °C	+18.7 °C	+2 °C
Republic of Sakha (Yakutia)	-36.3°C	-50 °C	20.0 °C	-7.5°C
Chukotka Autonomous Okrug	-16 to -40 °C	−61 °C	+5 to +13 °C	-4.1°C
Republic of Komi	-15 to -22° C	-55 °C	11 to 17 °C	-1 °C
The average air temperature in the winter months in various regions of the Arctic Ocean ranges from + 3 to - 40 ° C, in summer - from 0 to + 10 °C.				

Table 2. Indicators of meteorological conditions in various climatic regions (belts) of Russia (for the XI-III months of the year)

Climatic region (belt)	Air temperature, ^{0}C			Wind speed, m/s			Relative humidity, %	Representative cities
	Average for XI-III months	min	max	Average for XI-III months	Most Likely	Probability, %		
IA ("special")	-27.1	-57	-3	6.8	2	69.4	75	Norilsk, Tiksi, Dikson
I B (IV)	-41	-68	0	1.3	0-1	62.8	79	Yakutsk, Oymyakon, Vernoyarsk, Turukhansk, Urengoy, Nadym, Salekhard, Magadan, Olekminsk
II(III)	-17.9	-48	4	3.6	0-5	80	78	Novosibirsk, Omsk, Tomsk, Syktyvkar, Chelyabinsk, Chita, Tyumen, Surgut, Tobolsk, Irkutsk, Khabarovsk, Perm, Orenburg
III(II)	-eleven	-35	8	5.6	4-8	70	84	Arkhangelsk, St. Petersburg, Moscow, Saratov, Murmansk, Nizhny Novgorod, Tver, Smolensk, Tambov, Kazan, Volgograd, Samara
IV(I)	-0.9	-25	20	5.6	4-8	70	80	Stavropol, Krasnodar, Novorossiysk, Rostov-on-Don, Sochi, Astrakhan

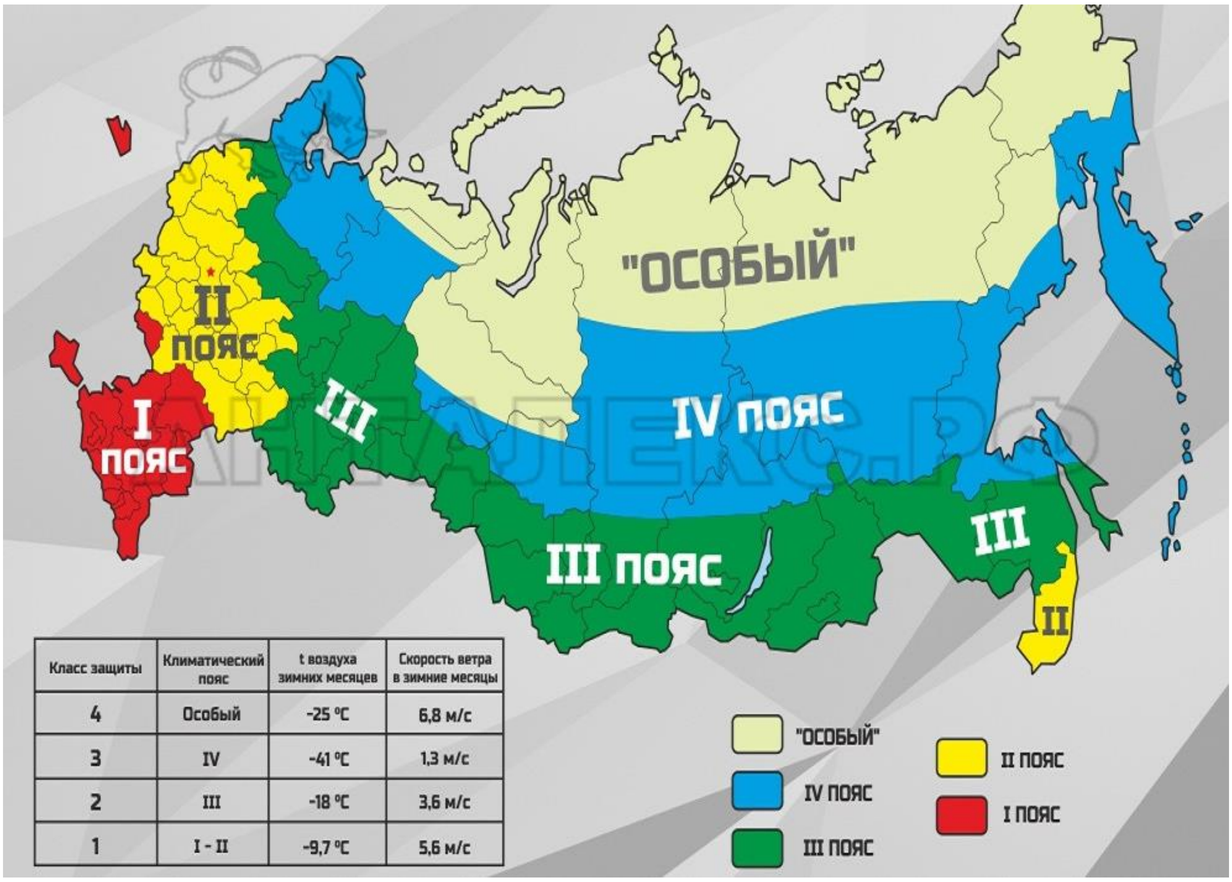

Figure 3. Scheme of location of climatic zones.

Figure 4. Scheme of location of climatic zones.

Figure 5. Layout of the Arctic regions of all interested countries.

The best part is that a temperature of 36.6 °C is considered normal. Of course, the facts formulated below will not become a discovery for knowledgeable people, while others will be interested in learning something new for themselves about the temperature of the human body, namely:

* the temperature of a person during the day changes by 0.5-1 degrees, unless of course the person is healthy and does not artificially increase the temperature of his body;

*human temperature is different in different places of its measurement. For example, the normal body temperature under the arm is 36.5 °C, when measured orally (in the mouth), a temperature of 37 °C is considered normal. With rectal (anus) measurement of human body temperature, 37.5 ° C is the norm;

* The maximum allowable human body temperature is considered to be 42 °C. Upon reaching it, the metabolism in the brain tissues is disrupted and its cells begin to die;

* doctors consider the minimum temperature of a human body to be 25 °C. At this time, irreversible consequences occur in the human body. Although even at a temperature of 27 °C, a person almost always falls into a coma, a person's cardiac activity and breathing are disturbed. But the temperature of 32 °C causes only chills, and practically no danger.

With his consciousness and inner conviction, a person is able to raise the temperature of his body. There are cases when the opposite effect was achieved. Consider evaporation as a factor of heat transfer from the surface of the human body. Clothing and evaporation from the surface of the body. When water evaporates from the surface of the body, 0.58 Kcal of heat is consumed for every 1 g of evaporating water. Even if a person does not sweat, water continues to evaporate imperceptibly from the surface of the skin and lungs at a rate of about 600-700 ml / day, causing a constant heat transfer at a rate of 16-19 Kcal / h. This imperceptible evaporation from the surface of the skin and lungs cannot perform the function of thermoregulation, because. is the result of constant diffusion of water molecules through the skin and the surface of the lungs. The intensity of perspiration is regulated, and heat loss through evaporation during sweating can serve as a means of this thermoregulation (Figure 6).

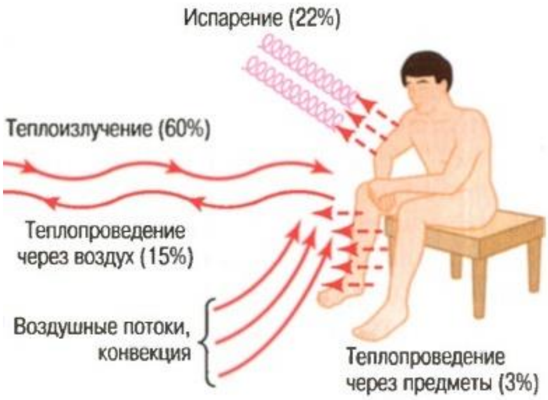

Figure 6. Mechanisms of heat transfer from the surface of the human body.

Evaporation is a necessary heat transfer mechanism. As soon as the skin temperature becomes higher than the ambient temperature, heat transfer can be carried out by the processes of heat radiation and heat conduction. However, as soon as the ambient temperature becomes higher than the temperature of the skin, instead of heat transfer, the body begins to receive heat through the same mechanisms. Under such conditions, the only way to release the body from excess heat is evaporation. Anything that prevents adequate evaporation when the ambient temperature rises above body temperature can cause the temperature of the deep parts of the body to rise. This possibility exists in cases of congenital absence of sweat glands.

Sweating. Mechanism of sweat secretion

Sweating and its regulation by the autonomic nervous system. Irritation of the preoptic zone of the anterior hypothalamus by electrical stimulation or heating leads to sweating. Nerve impulses from this area, causing sweating, are transmitted along the pathways of the autonomic nervous system to the spinal cord, and then along the sympathetic outputs to the skin in all areas of the body.

It is appropriate to recall that the sweat glands are innervated by cholinergic nerve fibers (fibers at the ends of which acetylcholine is released), which are part of the sympathetic nerves along with adrenergic fibers. The sweat glands can be stimulated in some cases by circulating adrenaline and norepinephrine, despite the fact that the glands themselves lack adrenergic innervation. This plays an important role during physical work, when both hormones are secreted by the adrenal medulla, and the body needs to get rid of excess heat produced by actively working muscles.

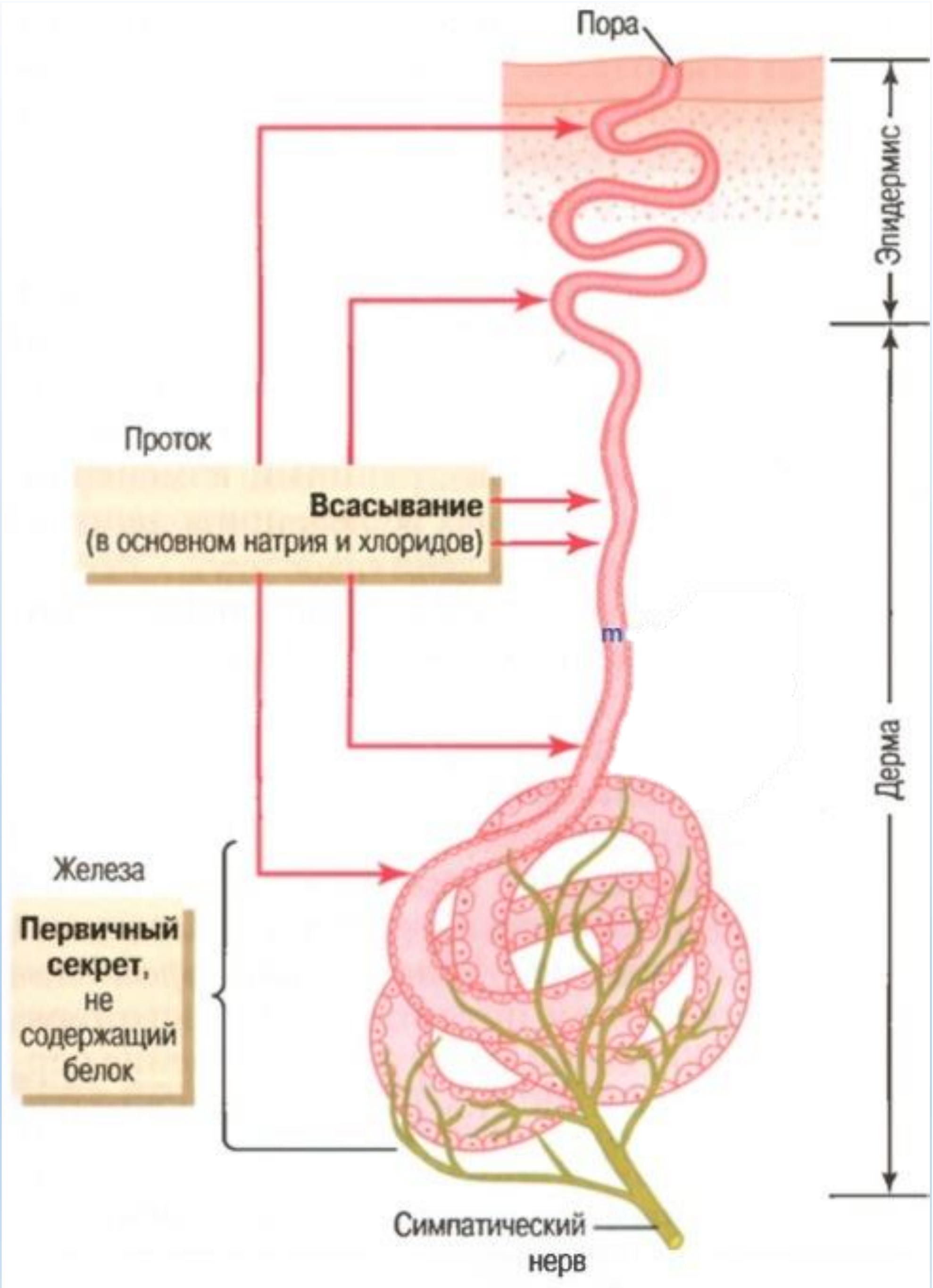

Figure 7. Mechanism of sweat secretion

Sweat gland innervated by sympathetic cholinergic nerves. Primary protein-free secretion is formed in the glandular part, most of the electrolytes are reabsorbed into the ducts, the secretion is diluted, becoming a dilute aqueous liquid.

As shown in Figure 7, the sweat gland is a tube that consists of two parts:

(1) deep subdermal volute;

(2) a duct that runs outward through the dermis and epidermis of the skin.

Exactly as it happens in many other glands, the secreting part of the sweat gland produces a liquid, which is called the primary secretion, or precursor secretion; the concentration of the components of this secret may change during its passage through the duct.

The precursor secretion is a product of the active secretion of epithelial cells located in the spiral part of the sweat gland. Cholinergic sympathetic nerve fibers terminate at or near glandular cells, causing the onset of secretion.

The composition of the primary secret is similar to the composition of plasma, only it does not include proteins (the concentration of sodium ions is about 142 Meq / l, chloride ions - about 104 Meq / l). During the passage of the precursor secretion through the duct, its composition changes due to the reabsorption of a large amount of sodium and chlorine ions. Quantitatively, the reabsorption of these ions depends on the intensity of sweating.

With mild stimulation of the sweat glands, the precursor secretion passes slowly through the duct. Because of this, almost all sodium and chloride ions have time to be reabsorbed, and the concentration of each of them decreases to 5 meq/l. A decrease in the osmotic pressure in the primary secretion leads to water reabsorption, accompanied by a concentration of other components of the solution, therefore, at low sweating rates, components such as urea, lactic acid and potassium ions are in solution at a very high concentration. On the contrary, with strong stimulation of the sweat glands by the sympathetic nervous system, a large amount of secretion precursor is formed, and the duct can reabsorb only a little more than half of the sodium chloride; the concentration of sodium and chlorine ions in this case (in non-acclimatized people) becomes maximum - 50-60 Meq / l, which is almost half of their concentration in plasma.

Consider the mechanism of sweating during acclimatization. Heat dissipation during shortness of breath.

Mechanism of sweat formation during heat acclimatization. The role of aldosterone. A healthy, unacclimatized person rarely produces more than 1 liter/hour of sweat, but when a person is exposed to heat for 1-6 weeks, he begins to sweat profusely, often increasing sweating to 2-3 liters/hour. The evaporation of this amount of sweat can increase heat output by more than 10 times compared to the basal level of heat output. The increase in the efficiency of the sweating mechanism is explained by internal changes in the activity of the sweat glands, leading to an increase in sweating. With acclimatization, a further decrease in the concentration of sodium chloride in sweat is associated, which makes it possible to consistently improve the safety of salts in the body. Most of the effects of acclimatization are associated with an increase in the production of aldosterone by the adrenal cortex, which is the result of a slight decrease in the concentration of sodium chloride in the extracellular fluid and plasma. Unacclimatized people with profuse sweating often lose from 15 to 30 g of salts daily during the first few days. After 4-6 weeks of acclimatization, salt loss is reduced to 3-5 g / day.

Features of heat transfer through shortness of breath. Many animals do not have the ability to transfer heat from the surface of the body for two reasons:

(1) the surface of the skin is covered with hair;

(2) animals do not have sweat glands, which does not allow heat transfer by evaporation from the surface of the skin.

A substitute for this mechanism may be the dyspnea-mediated mechanism used by most animals for the purpose of heat loss.

The mechanism of forced breathing (shortness of breath) is triggered by the hypothalamic thermoregulatory center. This means that when the blood is too hot, the hypothalamus initiates a nerve signal to lower the temperature. One of these signals is associated with the appearance of shortness of breath. Shortness of breath is regulated by a special center - the center of shortness of breath, associated with the pneumotoxic respiratory center, localized in the brain. The appearance of shortness of breath in the animal against the background of a rapid alternation of inhalation and exhalation, when large amounts of new portions of air come from outside and come into contact with the surface of the airways, cools the blood. In the mucous membranes of the airways, the blood is also cooled as a result of the evaporation of water from the surface of the mucous membrane and, most importantly, the evaporation of saliva from the surface of the tongue. Dyspnea does not increase alveolar ventilation more than is necessary for adequate regulation of blood gases due to the fact that breathing in this case becomes superficial, so most of the air entering the alveoli is dead space air rather than atmospheric air. Body temperature regulation. The role of the hypothalamus.

Figure 8 shows what happens to the temperature of the "core" of the body of a naked person after several hours of exposure to dry air when the air temperature changes from -1 to 72°C.

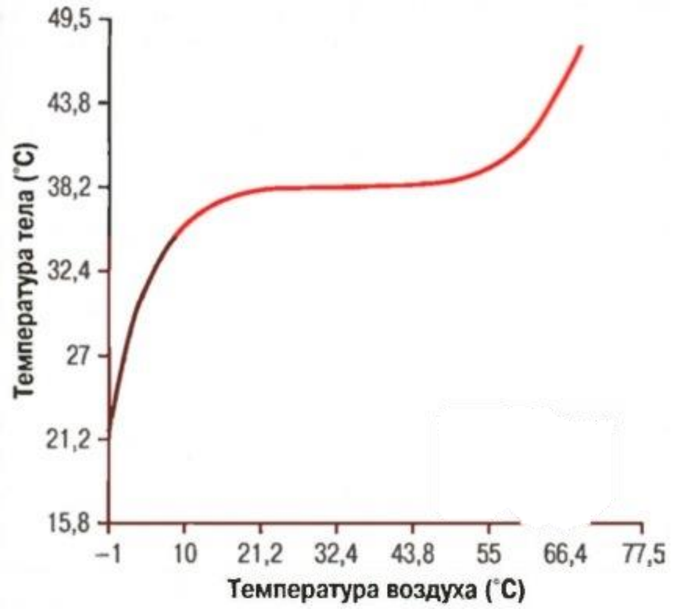

Figure 8. Influence of high and low air temperature on the temperature of the "core" of the body recorded for several hours.

The internal temperature remains stable despite significant changes in air temperature. The exact temperature values presented in the form of a curve depend on the movement, air humidity and even the surrounding nature. In general, a naked person in dry air, whose temperature varies from 13 to 55°C, is able to maintain a normal body temperature between 32.5 and 38.2°C. Body temperature is regulated by a feedback mechanism mediated by the nervous system and controlled by a thermoregulatory center located in the hypothalamus. In order for the feedback mechanism to function, there must be ways to detect temperature deviations from normal values when it becomes too high or too low.

Thermoregulation by the hypothalamus. thermoreceptors

The role of the preoptic region of the anterior hypothalamus in recording body temperature deviations from stable values. Experiments have been performed in which a tiny region of the brain of animals was heated or cooled using a thermode. This small, sewing-needle-like device is heated using electric current or hot water. You can cool the device with cold water. The main area of the brain, heating or cooling of which leads to the activation of thermoregulation mechanisms, is the preoptic area and nuclei of the anterior hypothalamus. Thus, using a thermode, it was found that the preoptic area of the anterior hypothalamus contains a large number of heat and cold sensitive neurons. Presumably, these neurons act as thermosensors that control body temperature. They increase the frequency of discharges by 2-10 times in response to an increase in body temperature by 10°C. Cooling-sensitive neurons, on the other hand, increase their firing rate as the temperature decreases. When the pre-optical area is heated, the entire surface of the skin of the body begins to become covered with sweat against the background of a pronounced dilatation of skin vessels. This immediate reaction provides heat transfer, allowing the body temperature to return to normal values. In addition, excess heat production is blocked.

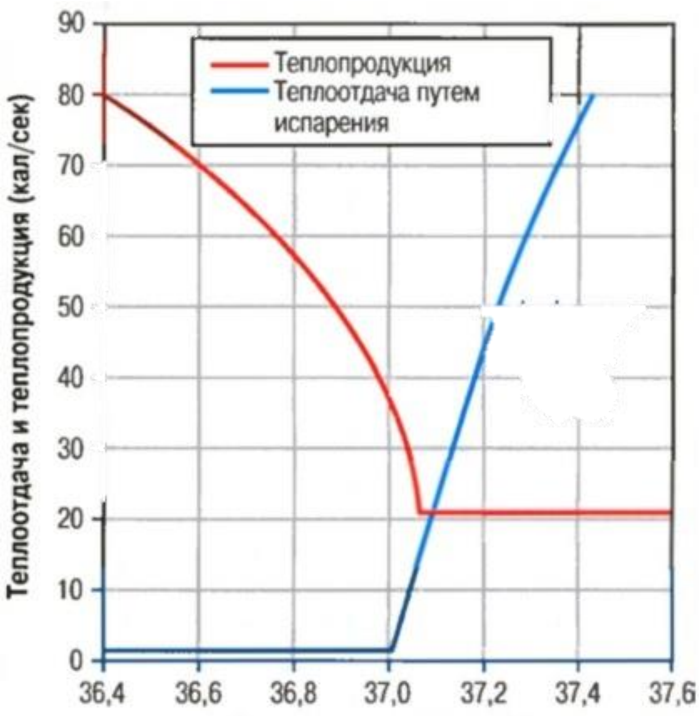

Figure 9. Effect of hypothalamus temperature on body heat loss by evaporation and on heat production, mainly due to muscle tremors.

An extremely high level of critical temperature, at which heat transfer begins to increase, and heat production reaches a minimum stable level. Tracking temperature values through skin and deep tissue receptors. The signals generated by thermoreceptors in the hypothalamus have a powerful influence on the regulation of body temperature, but receptors in other areas complement their influence on the process of thermoregulation. This is especially true for temperature receptors in the skin and some specific deep tissues of the body. Recall that the skin is equipped with both types of receptors: both cold and heat. In some areas of the body, there are significantly more cold receptors than heat receptors - in fact, 10 times, so the tracking of temperature changes by peripheral receptors is associated mainly with the detection of cold and cool, than with the detection of warm. If the skin on the entire surface of the body begins to cool, this immediately involves the reflex mechanisms aimed at warming in response, by:

* provide powerful stimulation of muscle tremors with a resulting increase in heat production;

* inhibition of sweating, if it is still carried out;

* ensuring vasoconstriction, which reduces heat transfer from the skin surface.

Deep thermoreceptors are found mainly in the spinal cord, abdominal organs, and around large veins in the upper abdomen and chest. The functions of deep receptors differ from the functions of skin receptors, since they are affected by the temperature of the "core" of the body, and not by the temperature of the skin, although, like skin thermoreceptors, they respond more to a decrease than to an increase in temperature. It is possible that the activity of both skin receptors and deep tissue receptors is aimed at preventing the development of hypothermia, i.e. decrease in body temperature. The posterior hypothalamus integrates central and peripheral temperature sensory signals. Signals from peripheral thermoreceptors are involved in the control of body temperature through the hypothalamus. area of the hypothalamus, to which signals from peripheral thermoreceptors are addressed, is localized bilaterally in the posterior sections, approximately at the level of the mammillary bodies. Temperature signals entering the preoptic zone of the anterior hypothalamus are then transmitted to the posterior regions. Here, in the region of the posterior hypothalamus, signals from the preoptic region and signals from thermoreceptors from all areas of the body converge, then they are summed up and integrated to control heat production and heat loss of the body together.

Neuronal mechanisms of temperature regulation. muscle tremor

Neuronal effector mechanisms of increase and decrease in body temperature. If the hypothalamic thermoregulatory centers detect that the body temperature is too high or too low, they organize reactions aimed at raising or lowering the body temperature. The reader is familiar with these reactions from his own experience. The most characteristic of these are the three main mechanisms aimed at lowering body temperature when it becomes too high, namely:

* vasodilation of the skin. In almost all areas of the body, the vessels of the skin are intensively dilated. This reaction is due to inhibition of the sympathetic centers of the posterior hypothalamus, which cause vasoconstriction. Complete vasodilation can increase the rate of heat loss from the skin surface by more than 8 times;

*sweating, An increase in body temperature causes sweating, as illustrated by the blue curve in the figure below, which shows a sharp increase in the rate of heat loss due to sweating when the temperature of the "core" of the body rises above the critical level of 37 ° C. An additional increase in body temperature by 1 ° C causes sweating sufficient to reduce the effectiveness of the level of basal heat production by 10 times,

*Decrease in heat production. There is a sharp inhibition of heat production mechanisms, such as muscle tremors or chemical heat production.

Mechanisms for increasing heat production when it gets too cold

If it gets too cold, the system that controls body temperature organizes exactly the opposite reactions, namely:

* Widespread vasospasm of the skin. This reaction is caused by stimulation of the sympathetic centers of the posterior hypothalamus;

*saw erection. Pilo erection is a reaction of the muscles on the head (the hair "gets up"). It occurs due to sympathetic stimulation of the muscles attached to the hair follicles and causing them to contract. As a result, the hair really rises. This is not significant for humans, but in animals such an elevated position of the hair allows you to increase the thickness of the insulating layer of air next to the skin, which significantly reduces heat transfer from the skin surface to the environment;

* increase in heat production (thermogenesis). Heat production by metabolic systems increases with muscle tremors, excitation of the sympathetic nervous system, which affects heat production, and an increase in thyroxine secretion.

These methods of stimulating heat production require additional explanation. Stimulation of muscle trembling by the hypothalamus. The region of the hypothalamus, localized in the dorsomedial regions of the posterior hypothalamus, close to the wall of the third ventricle, is called the primary motor center of muscular trembling. This area is normally inhibited by signals from the thermoregulatory center located in the preoptic region of the anterior hypothalamus, but is excited by signals from cold receptors in the skin and spinal cord. Therefore, as shown in connection with the sharply increased heat production (see the red curve in Figure 9), this center is activated when the body temperature drops a fraction of a degree below the critical level. This is the reason for the transmission of signals that cause muscle tremors. Signals are conducted along bilateral descending pathways of the spinal cord,

These non-rhythmic signals cannot cause actual muscle contractions, but they increase the tone of skeletal muscles throughout the body and increase the activity of neurons in the anterior horn of the spinal cord. When the tone rises, reaching a certain critical level, muscle tremors begin. Perhaps this is the result of increased oscillation of the intrafusal fibers of the muscle spindles responsible for the stretch reflex, as discussed in a separate article on the site (please use the search form above). During maximum muscle tremors, the production of heat by the body increases 4-5 times relative to the norm.

Heat production. Mechanisms for increasing heat production

An increase in heat production by the mechanism of chemical heat production, caused by the excitation of the sympathetic nervous system. As stated in a separate article on the site (please use the search form above), increased sympathetic stimulation or circulation of norepinephrine and epinephrine in the blood can cause an immediate increase in the rate of metabolism in cells. This effect is called chemical thermogenesis. It is a consequence of the ability of norepinephrine and adrenaline to cause uncoupling of oxidative phosphorylation reactions. This means that when a large amount of nutrients are oxidized, the released energy is released as heat rather than being stored in the form of ATP.

As shown in animal experiments, the intensity of chemical heat production is directly proportional to the amount of brown fat in animal tissues. This type of adipose tissue contains a large number of special mitochondria, in which oxidative phosphorylation reactions are uncoupled (please use the search form above). These cells have powerful sympathetic innervation.

Acclimatization significantly affects the intensity of chemical heat generation. In some animals, such as rats, exposed to cold exposure for several weeks, an increase in heat production by 100-500% was found in response to the action of cold. At the same time, in non-acclimatized animals, heat production against the background of cold exposure increased by only 1/3. An increase in heat production leads to a corresponding increase in food intake.

In adults who have practically no brown fat, the intensity of heat production due to chemical heat production rarely increases by more than 10-15%, however, in infants with a small amount of brown fat in the interscapular region, due to chemical thermogenesis, heat production can increase by 100%, which may be an important mechanism for maintaining body temperature in newborns. An increase in thyroxine release as a cause of a long-term increase in heat production.

Cooling of the preoptic zone leads to an increase in the production of the hypothalamic neurosecretory hormone thyrotropin-releasing hormone (TRH). The portal veins of the hypothalamus carry this hormone to the anterior pituitary gland, where it stimulates the production of thyroid-stimulating hormone. Thyroid-stimulating hormone, in turn, stimulates an increase in the release of thyroxine by the thyroid gland (please use the search form above). An increase in the concentration of thyroxin leads to an increase in the intensity of cell metabolism, which is another mechanism of chemical heat production. An increase in the intensity of metabolism does not occur immediately and requires several weeks of cold exposure, which is necessary for hypertrophy of the thyroid gland and the achievement of a new level of thyroxine secretion. Placing animals in very cold conditions for up to several weeks can cause an increase in the size of the thyroid gland by 20-40%. However, people rarely allow themselves to be exposed to such low temperatures as animals are exposed to, so so far we do not have a quantitative assessment of the contribution of the thyroid mechanism to human adaptation to low temperatures. Separate studies have shown that the military, stationed for several months in the Arctic regions, the intensity of metabolism increases. Some Eskimos have an abnormally high basal metabolic rate. Perhaps the stimulating effect of cold may explain the higher incidence of thyroid goiter in people living in cold climates compared to people living in warm climates.

The concept of "set value" in the regulation of body temperature. On the example of the figure below, it is clear that in the case of a critical temperature of the "core" of the body close to 37.1°C, there are fundamental changes in both the intensity of heat production and the intensity of heat transfer. At temperatures above this level, the rate of heat transfer becomes higher than the rate of heat production, as a result, the body temperature decreases and approaches the level of 37.1 ° C. At temperatures below this level, the rate of heat production becomes higher than the rate of heat transfer, so the body temperature rises and again approaches the level of 37.1 ° C. This critical temperature level is called the "setpoint" of the thermoregulatory mechanism. Thus, all mechanisms of thermoregulation are constantly striving to return the body temperature to this value.

The efficiency of the thermoregulation system. Once again, we will discuss the issue related to the concept of "efficiency" in relation to the regulatory system. The efficiency factor is a way to assess the effectiveness of the functioning of the control system. In the case of thermoregulation, this is extremely important to limit changes in the temperature of the "core" of the body with significant fluctuations in ambient temperature during the day and even hour. The efficiency of the thermoregulation system is equal to the ratio of the change in ambient temperature to the change in the temperature of the "core" of the body minus 1. Experiments have shown that the temperature of the human body changes by approximately 1 ° for every 25-30 ° change in the temperature of the external environment, therefore, the efficiency of the system thermoregulation is on average 27 (28/1, 0 - 1.0 = 27), being extremely high for a biological regulatory system.

Figure 10 shows the effect of different skin temperatures on the "set point" value in relation to perspiration.

Figure 10. Influence of changes in the internal temperature of the head on the intensity of heat transfer by evaporation.

The temperature of the skin determines the "set point" at which perspiration begins. It can be seen that the "set point" values increase as the skin temperature decreases. In Figure 6, the human hypothalamic “setpoint” rises from 36.7°C when skin temperature is above 33°C to 37.4°C when skin temperature drops to 29°C. Therefore, if the skin temperature was high, sweating began at a lower hypothalamic temperature than at a lower skin temperature. This mutual influence is understandable, because perspiration is inhibited at low skin temperature, otherwise the combined effects of low skin temperature and perspiration could cause the body to lose too much heat.

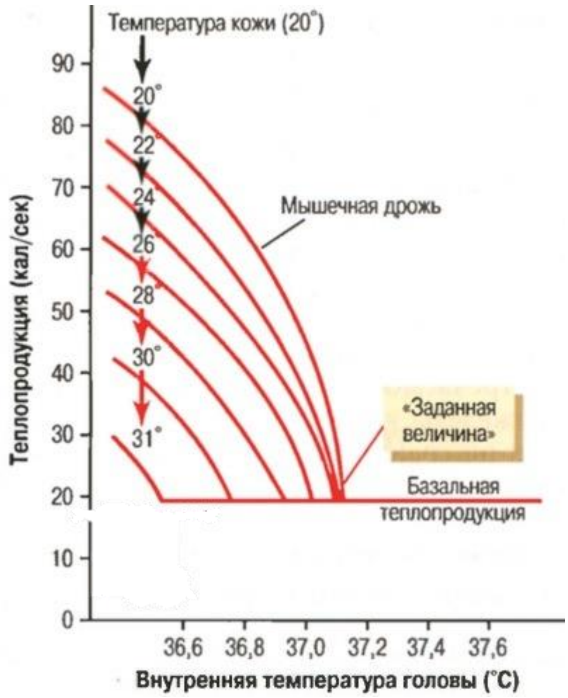

Figure 11. Influence of changes in the internal temperature of the head on the intensity of heat production.

The temperature of the skin determines the value of the "set point" at which the muscle tremors begin. When the skin becomes cold, it causes the hypothalamic center of thermoregulation to shift its "set point" toward the shiver threshold, even though the temperature of the hypothalamus itself remains normal. At the same time, low skin temperature can cause a decrease in the temperature of the “core” of the body, unless heat production increases. Thus, the low skin temperature “anticipates” a drop in the core body temperature and prevents it.

Local skin temperature reflexes. Fever and pyrogens

Behavioral mechanisms of body temperature regulation. In addition to the subconscious mechanisms of thermoregulation, the body has another, more powerful mechanism. This is the behavioral control of thermoregulation, which can be explained as follows: if the core temperature of the body becomes too high, signals from the thermoregulatory systems of the brain make a person feel that he is overheating; on the contrary, if it becomes cold, signals from some deep-seated receptors form a feeling of cold.

In this regard, a person will take any actions that correct external conditions, aimed at restoring comfort, for example, go to a heated room or put on warm clothes. This mechanism is certainly more powerful in thermoregulation than most physiologists have realized in the past. Indeed, this mechanism is an effective way to prevent the failure of the thermoregulation system in conditions of severe cold. Local skin temperature reflexes. If you place a limb under a switched on lamp and hold it there for a while, you can observe local vasodilation and slight sweating. Conversely, immersion of the limb in cold water causes local vasoconstriction and local cessation of sweating. These local reactions are caused by local effects of temperature directly on the blood vessels, as well as local reflexes from skin receptors mediated by the spinal cord and the irritated area of the skin. Excitation, having passed from the place of origin in the region of skin receptors, is conducted through the spinal cord and returns to the same region of the skin and sweat glands.

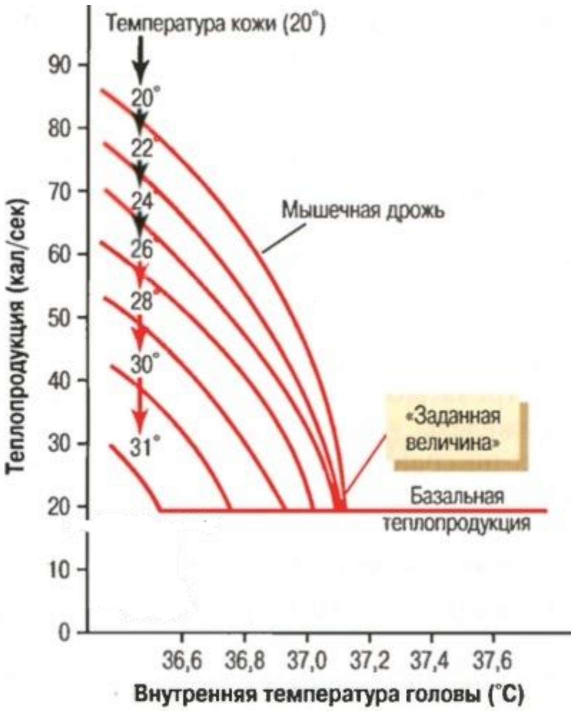

Figure 12. The influence of changes in the internal temperature of the head on the intensity of heat production.

Skin temperature determines the “setpoint” at which muscle tremors begin. The regulation of core body temperature deteriorates when the spinal cord is transected. After transection of the spinal cord in the neck, above the exits of the sympathetic nervous system from the spinal cord, the regulation of body temperature is extremely weakened, because. The hypothalamus can no longer control skin temperature, blood flow, or sweating anywhere in the body, despite the preservation of local temperature reflexes mediated by the skin, spinal cord, and abdominal receptors. These reflexes are too weak compared to the hypothalamic regulation of body temperature. In people under such conditions, body temperature can be regulated by sensations of cold or heat in the head area and supplemented by behavioral control.

Thermoregulation disorders. Fever. Fever refers to an increase in body temperature above the usual normal level. This condition can be caused by disorders in the brain itself or by the effect of toxic substances on the thermoregulatory center. Some causes of fever (as well as subnormal body temperature) are shown in Figure 13.

Figure 13. Body temperature under different conditions.

These include infectious diseases, brain tumors, and environmental conditions that can result in heat stroke. Restoration of hypothalamic control of thermoregulation in case of febrile illnesses. Influence of pyrogens. Many proteins, their degradation products, and various other substances, especially lipopolysaccharide toxins released by epithelial cell membranes, can cause an increase in the hypothalamus "set point". Substances that cause this effect are called pyrogens. Pyrogens secreted by toxic bacteria or released by degenerating body tissues cause fever during illness. If the "set value" of the hypothalamic center of thermoregulation is higher than normal, all mechanisms of temperature increase are involved, including heat conservation and an increase in heat production.

Figure 14. Influence of changes in the "setpoint" of the hypothalamic thermostat.

An attack of fever. Heatstroke

Crisis, or "attack" of fever. If the factor that caused the high temperature is removed, the hypothalamic thermostat "setpoint" returns to a lower level, possibly even to normal, as shown in Figure 15.

Figure 15. Influence of changes in the "setpoint" of the hypothalamic thermostat.

In this case, the body temperature still remains at 40°C, but the hypothalamus attempts to bring it back to 37.5°C. This situation is analogous to excessive heating of the preoptic region of the anterior hypothalamus, which was accompanied by intense sweating and sudden warming of the skin. These sudden changes in the febrile state are called a crisis, or a more appropriate term for the situation - an attack of fever. In times before antibiotics, the advent of a crisis was always anticipated with excitement, because his arrival gave reason to the doctor to say that the temperature would soon begin to decrease. Heatstroke. The upper limit of air temperature that a person can withstand depends mainly on the saturation of the air with water vapor, i.e. whether it is wet or dry.

High temperatures are extremely dangerous for tissues, especially the brain, which explains many of these symptoms. A very high temperature, even for a few minutes, can lead to death. Because of this, many physicians recommend immediately starting treatment in case of heat stroke by placing the patient in a pool of cold water. Due to the fact that such a measure can cause muscle tremors, accompanied by significant heat production, there are other recommendations that boil down to rubbing or splashing the skin with cold water, which seems to be a more promising means for quickly lowering core body temperature.

The damaging effects of high temperature. Pathological changes found in people who died from hyperpyrexia are manifested by local hemorrhages and degenerative changes in the cells of parenchymal organs, found everywhere, but especially pronounced in the brain. Once destroyed, neurons never regenerate. Damage to the liver, kidneys, and other organs can be severe enough to cause functional failure of one or more organs, sometimes leading to death a few days after heatstroke.

Acclimatization to the heat. Acclimatizing people to the heat can be extremely important. Examples would be soldiers serving in tropical regions, or miners working in the gold mines of South Africa at a depth of 3.2 km, where the temperature is equal to body temperature and the saturation of the air with water vapor approaches 100%. A person who is exposed to heat daily for several hours on the background of heavy physical work should acquire resistance to heat and humidity within 1-3 weeks. The most important physiological changes observed in connection with the process of acclimatization include an almost doubling of the rate of maximum sweating, an increase in plasma volume, a decrease in salt loss in sweat and urine to almost no salt in the secretions.

In order for the enterprise to function successfully, employees must feel comfortable in the performance of their professional duties. To protect the worker from external negative factors, overalls are traditionally used, which must meet a number of requirements. Particular attention should be paid to protecting people from low temperatures in winter.

Therefore, when choosing clothes, you should take into account the climatic zone in which it will be used. There are five of them in our country: I, II, III, IV and special.

Let's look at each belt in more detail:

Special (regions of the Far North). This area is characterized by the coldest and most severe climate. It included all regions of the Far North.

People here have to work at temperatures up to -25 °C and wind speeds of 6.8 m/s.

IV climatic zone (arctic zone). The temperature here can even reach -60 ° C, but

the wind is weaker than in the previous belt - 1.3 m/s. Previously, these regions were considered unsuitable for life and work. Working in them is now very difficult and dangerous to health.

III climatic zone. It includes settlements with a sharp and temperate continental climate. In winter, the temperature reaches -18 °C, and the wind speed is 3.6 m/s on average. This season is marked by an abundance of snow.

II climatic zone. The average winter air temperature is -9°C, and the wind speed is slightly higher - 5.6 m/s. The regions belonging to this belt are considered favorable for outdoor work, although the weather in them can be unstable.

I climatic zone. Occupies a relatively small area. It includes an area with a subtropical climate, in which snow almost never falls. In winter, the air temperature is rarely below -10 °C, and the wind speed is 5.6 m/s. Living and working here is very comfortable.

The colder the region, the faster the overall wear, footwear and other personal protective equipment for workers in various industries will wear out.

What to look for when choosing clothes

Overalls must comply with the parameters of a particular climatic zone. The time allowed for a person to stay in the cold depends on the characteristics of the work performed by him and the energy costs associated with them. For insulated overalls, GOST R 12.4.236-2011 standards have been developed, according to which it is divided into four protection classes. The set that is issued to employees is also determined by the industry of the enterprise and job responsibilities. The following elements remain unchanged:

insulated jacket, trousers or overalls; winter shoes;

hat with fur or warm lining; insulated gloves or mittens.

Other personal protective equipment depends on the nature of the work. For example, for welders, insulated balaclavas may be additionally required. How to issue overalls depending on climatic zones.

As already mentioned, the choice of kit is largely determined by the climatic zone. The higher the class of protection against cold, the more severe the working conditions for which it is intended.

The heat-shielding properties of class IV clothing are the highest.

climaticzone	Protection class	Total thermal resistance*, sq. mx °C/W	
		Shoulderproduct (jacket)	Belt product (trousers, semi-overalls)
I and II	1	0.51	0.50
III	2	0.64	0.57
IV	3	0.83	0.80
special zone	4	0.77	0.69

chinhood area;

wristlets;

insulated belt.

Overalls of classes I and II are usually made without a vest, hood lining, thermal underwear, inner strap. The recommended replacement intervals for the kits are shown in the table:

climate zone	Service life (years)
I	3
II	2.5
III	2
IV and special	1.5

Vanguard Company. Professional equipment" offers to purchase overalls for all types of activities in any climatic zones. For work in conditions of low air temperatures, there are specially designed clothing. Special tailoring rules apply to these winter clothes, as well as standards for fabrics and insulation. All of them are regulated in GOST.

As required, all special clothingdivided into 4 protection classes, which take into account air temperature, humidity and wind speed, depending on the main climatic zones in Russia. When developing the regulations, the starting point was a two-hour stay of a person in the cold while maintaining health and working capacity. The table shows the main parameters.

Protection class	Climatic zone (region)	Air temperature in winter, ° C	Wind speed in winter, m/s
4	"Special" (IA)	-25	6.8
3	IV (1B)	-41	1.3
2	III(II)	-18	3.6
1	II-I (III-IV)	-9.7	5.6

Note that the 4th or "special" class is clothing for the regions of the Far North. It also has very stringent requirements.

In addition to taking into account temperature and other conditions, much attention is paid to tailoring and materials. First of all, winter clothing for working in cold conditions should be as convenient and comfortable as possible, with a large number of internal and patch pockets.

Also, clothing of all classes must havebe:

knitted cuffs on the sleeves;

collars and hoods;

insulatedwind protection strips.

There are, of course, nuances. So, for clothes of the first and second classes, the presence of a hood and collar without insulation is allowed. While in grades 3 and 4, insulation on hoods is required.

In terms of materials, the winter specialclothing for work in conditions with sub-zero temperatures should be made of "breathable" fabrics. Therefore, mixed compositions, for example, such as cotton + polyester, are most widely used. The fibers of the first material impart vapor permeability to the garment. In addition, the cotton in the composition prevents the rustling and hardening of the fabric at critically low temperatures. And polyester, in turn, adds strength and durability to the material. As a result, such a mixed composition of the fabric gives durability to overalls, providing excellent thermal insulation and, at the same time, removing excess moisture from the body.

As a heater, modern artificial materials are also used, for example, holofiber, polyester. They have proven themselves well, because they do not attach to clothes

additional volume, do not make it heavier, while,excellent protection against low temperatures.

These are general requirements. However, there are also special recommendations for the overalls of workers whose activities involve special conditions.

So, for example, if you are supposed to work at nighttime, the clothing must be equipped with reflective elements. And for the clothes of rescuers, a special fabric is selected, which, in addition to protection from moisture, wind and cold, must also have fire-resistant properties.

In any case, when buying workwear for private use, for example, fishing, hunting, or traveling, it is necessary to take into account all the conditions in which you plan to be. And already in accordance with them to select clothes of one class or another.

When there is a need for the speed of implementation of large-scale projects? The frontier arises when for a long time a large amount of resources could not be put into economic circulation due to certain barriers: too far, expensive transportation, no development infrastructure. The Prudhoe Bay field came into full operation when an oil pipeline was built in Alaska, a similar situation with the oil fields of Western Siberia and the Kolyma gold. Almost all major Arctic projects have been associated with overcoming barriers, primarily infrastructural ones. Small projects do not justify the construction of infrastructure when the project is developed gradually - it has a very long payback period. The Karachayevo - Salekhard road has been under construction since 2003, during which time the Trans-Siberian Railway from Chelyabinsk to Irkutsk was built. The project is stalling because the "cream" from the development of gas fields in the Nadym region has already been removed. The road had good chances in the 60s, when a decision was made to restore the Salekhard - Igarka road, which was not implemented, which led to significant losses of funds.

Explosive involvement in economic turnover creates a rare case when the raw materials industry brings increasing returns - the more invested, the greater the return per invested unit of funds. Note that this effect is short-lived, since further resource extraction is carried out in increasingly depleted or difficult areas, therefore, extraction costs increase, returns decrease. Huge investments in new resource projects (railroads, sea route development) are justified in the presence of a large infrastructure project.

The development of new resource regions goes through several phases, which fit the emergence of frontier people, superorganizations and other phenomena associated with the development of the Arctic, namely:

- **zero phase**- rumors, tests and barriers: assumptions and information about potentially rich resources that are inaccessible for one reason or another (remoteness, imperfection of technologies, etc.). M.K. At the end of the 19th century, Sidorov was the first to try to deliver graphite along the Northern Sea Route, J. Lid organized the first trading operations at a time when freight rates were still very expensive. Alaska was supposed to have gold back in the days when it was the territory of Russia, but the gold rush began only after a considerable time;
- **first phase**- information (demonstration) breakthrough: there is a pioneer (F. Salmanov), who proves the possibility of obtaining energy in a new space. This phenomenon is also explained from the

point of view of the bifurcation theory: when the trajectory breaks down, a random factor plays a significant role, which justifies the enormous role of the individual in history. The economic effect, as a rule, is still small, the information effect is powerful, but the barrier has not yet been broken (project stage);

- **second phase**- demolition of the barrier: a revolution in infrastructure, ideology, technology; large (venture) investments, most often state ones; institutional and organizational building; powerful ideological support (advertisement of the project - a demonstration of Igarka to foreign journalists as a demonstration of the achievements of the Soviet government in the development of the Far North, the legitimation of large investments). Sprinters stage, city foundations;
- **third phase**- peak production: ossification of institutions and organizations; the greatest economic return, while reducing enthusiasm. The stage of stayers and the emergence of superorganizations;

3.1. peak production: development of a proven resource;

3.2. blast effect.

- **fourth phase**- flooding of the frontier:

4.1. ghost towns or shift towns;

4.2. transition from the frontier to the "normal" economy: economist L. Husky notes that after the stage of peak production it is possible to reach such a level of the local economy, when a city appears on the site of the frontier city, which can independently maintain its existence by providing services to the surrounding territories, (for example, the city of Surgut).

At the peak of production, when the infrastructure has been built and a large organization has been created in which a rigid hierarchy has been established, there are no more pioneers, managers and specialists - engineers - work. People who are frontier in spirit manifest themselves in the zero and first phases of the cycle, where they can fulfill themselves in the best possible way. Geologist I.L. Zhulanova described the Dalstroi paradox, noting that as a result of the work of the most freedom-loving people in the country - geologists - a powerful administrative-repressive structure was created.

Conclusion

Cooling microclimate (low air temperature) is a combination of physical factors (air temperature, air humidity, radiation temperature, wind speed) that cause a person to cool and require appropriate measures to reduce his heat loss. Those who work outdoors during the winter and transition periods of the year (builders, drivers, railway workers, trade workers, lumberjacks, workers in the oil and gas industry, etc.) are at the greatest risk of cooling.

The cause of a person's cooling may be a discrepancy between the heat-shielding ability of clothing for working conditions (microclimate parameters, the severity of work, the length of stay in the cold), as well as individual adverse human reactions to cold caused by various reasons.

In the course of evolutionary development, a person did not choose a stable adaptation to cold due to biological capabilities and the main way of protection is “behavioral” thermoregulation, aimed at reducing heat transfer to the environment (clothing, housing), generating additional heat in the body (physical activity), reducing time stay in the cold (regulation of periods of work in the cold and rest in a room with a comfortable microclimate).

Depending on the situation, a person can be subjected to both general and predominantly local cooling. The hands, feet, face, upper respiratory tract are exposed to the most frequent cooling. Cooling of the face and respiratory organs causes contraction of arterial vessels in the extremities, coronary arteries of the heart, resulting in an increase in blood pressure.

Feet and hands can be subjected to significant cooling due to the low efficiency of their insulation and the use of shoes and gloves (mittens) with insufficient thermal insulation performance. As a result of cooling, the sensitivity of muscle receptors decreases, as a result of this, coordination of movements worsens, which can lead to an increase in accidents, especially when working in the cold with hand tools. Changes in motor reactions and coordination of movements, the inability to focus on the performance of work operations arise as a result of the development of inhibitory processes in the cerebral cortex. It is known that injuries significantly increase among those working in open areas during the cold season.

When working in a cooling microclimate, respiratory diseases can occur, cardiovascular pathology can develop, peptic ulcer disease can worsen. Even with short-term exposure to cold, the body undergoes a restructuring of regulatory and homeostatic systems, and the immune status worsens.

Chronic cooling, both general and local, in the course of work causes "cold cold" neurovasculitis, angiotrophoneses. With local cooling, changes in kidney function are observed.

The influence of cooling can be aggravated by the simultaneous influence of other factors, in particular, local muscle load, vibration. With their combined action, vasospasm increases, the number of cases of vibration disease increases and the time of its development is reduced.

Of great importance are the thermophysical parameters of the materials of clothing, footwear, and mittens. If, for example, in accordance with working conditions, an employee must wear rubber shoes that are air and moisture resistant, then there will be an accumulation of moisture in the “inner shoes” (insoles, socks, insulation), which will lead to a significant decrease in its thermal insulation and subsequent cooling, which is the risk of developing pathology.

In order to protect against excessive heat losses, workers should first of all be provided with a set of heat-protective clothing. It is imperative to protect all areas of the human body, including the head, feet, insufficient insulation of which can significantly increase the heat loss of a person, shorten the period of his stay in a cooling environment, including due to pain, and be the cause of the development of pathologies.

A set of heat-protective clothing as a whole and its individual components (in particular, headgear, mittens, shoes) must meet the requirements for adequate protection against increased heat loss. Requirements for thermal insulation of a set of clothing in relation to different climatic zones are presented in GOST R SSBT 12.4.235-2007 “Special clothing for protection against low temperatures. Technical requirements” and in MR 2.2.8.2127-06 “Hygienic requirements for thermal insulation of a set of personal protective equipment against cold in various climatic regions and methods for its assessment” [. However, it should be understood that clothing that meets these requirements will protect a person from cooling only in the following cases, namely:

- the air temperature corresponds to the average value of the winter months;
- wind speed does not exceed its most probable value for a given climatic zone;
- a person performs work of moderate severity (energy consumption is about 234 W);
- the employee is continuously in the cooling environment for no more than two hours.

With regard to other conditions, proper thermal insulation of the clothing set as a whole and its individual components (shoes, mittens, headgear) can be calculated taking into account the time spent in the cooling medium in accordance with the Methodological recommendations of the Ministry of Health of the Russian Federation No. 11-0 / 279-09 dated October 25 2021 "Methodological recommendations for calculating the thermal insulation of a set of personal protective equipment for workers from cooling and the time of permissible stay in the cold." Compliance with the thermal insulation of shoes, mittens and hats by the conditions of their use is determined in accordance with the developed methods presented in chapters 13 and 14, as well as in the Guidelines MUK 4.3.1901-22, approved. 03.03.22 "Methodology for determining the thermal insulation of personal protective equipment for the head, feet, hands for compliance with hygienic requirements."

In order to avoid hypothermia of the body in the cold, a work and rest regime must be observed (MR 2.2.7.2129-22), which regulates the time of continuous stay in the cold at different air temperatures, wind speeds and the duration of rest in conditions of thermal comfort in order to normalize the thermal state of workers. Compliance with the regime prevents excessive cooling of the body, a decrease in efficiency and reduces unproductive time spent on heating, since with less cooling, a faster normalization of the thermal state of the body occurs. These recommendations can be used, for example, when planning the scope of work carried out in a cold environment. It should be noted that at an air temperature of -40 ° C and below, respiratory protection is necessary. The worker should also warm up, who has had an overheating of the body, due, for example, to performing hard work, in which there is increased sweating. In this case, resting in cold conditions (more than 5 minutes) can lead to colds.

Outerwear, and when cooling the feet, and shoes should be removed. This will speed up both the process of normalization of the thermal state of a person, and will reduce the rate of his cooling in the subsequent period of stay in the cold. For faster normalization of the temperature of the surface of the feet and hands, it is advisable to use special heated means, while the temperature of their surface in contact with the surface of the feet and hands should be within 36 - 40 ° C. It is advisable to dry or replace “inner shoes”, socks, mittens during the rest period, because, even in cold conditions, the feet emit sweat, the amount of which is sufficient to significantly reduce the thermal insulation of shoes and subsequently cool the feet.

Drying a set of clothes after the end of the work shift is one of the important measures in maintaining its thermal insulation, preventing cooling and its adverse effects.

Contamination of clothing also leads to a significant loss of its heat-shielding ability. Of course, a more “gentle” way of cleaning it is chemical, but if synthetic materials such as Artika, Thinsulate ™, Sintepon, Hollofibe are used as a heater, then washing is also possible. Such clothes do not lose their heat-shielding ability even after five washes.

However, due to the fact that cold is a risk of developing pathology, even with appropriate warming of a person (cooling the face, respiratory organs), medical supervision should be provided for workers.

Cold exposure is especially dangerous for people suffering from:

- cardiovascular diseases (hypertension, ischemic disease);
- peripheral vascular disease;
- bronchial asthma (cold can provoke an asthmatic attack);
- respiratory diseases;

Cold exposure is dangerous for people with:

- physical fatigue;
- history of local cold lesions;
- thyroid disease and other endocrine diseases;
- as well as for people who consume alcohol, antidepressants, tranquilizers, sedatives, anti-obesity

drugs, hypoglycemic, antithyroid drugs and ganglionic blockers.

Medical control from the standpoint of preventing pathology caused by exposure to cold is necessary in all cases where there is a risk of cold injuries:

- the air temperature and the level of energy consumption are lower than the average values at which the permissible thermal state of workers wearing clothes with thermal insulation provided for by GOST R SSBT 12.4.236-2007 is ensured;
- wetting clothes (shoes, gloves) with sweat or external moisture, leading to a decrease in its thermal insulation, general and / or local cooling;
- performance of work not related to physical activity, which serves general and local cooling;
- the estimated time spent in the cold is less than the planned one, for example, due to the impossibility of changing the tasks and working conditions, i.e. when you can expect the formation of a deficiency of heat in the body above the permissible level.

If the thermal insulation of the clothing used is higher than required to maintain the thermal state of a person at an acceptable level and there is no risk of local cold injuries, then medical control is not necessary.

When purchasing workwear, footwear, you should make sure that its thermal insulation and breathability meet the hygienic requirements for the climatic region (zone) in which it is intended to be used. In addition, it is important that the design of clothing provides the necessary protection for all areas of the body. Attention should be focused on protecting the lumbar region, especially when performing work related to inclinations. As mentioned above, with local cooling of the lumbar region, in addition to exacerbation of sciatica, there may be a change in kidney function as a result of vasospasm, leading to ischemia, contributing to a persistent change in their tissues.

At air temperatures below -10 °C, especially combined with wind, cold damage to the face may occur (numbness, whitening of the skin area, pain, itching, tingling). To avoid this, workers should be warned about this possibility and the need for mutual supervision. The worker should also be informed of the measures to be taken in this case, for example, stop working in the cold and go into a heated room; put your hand on the affected area. In no case, do not rub this area with snow.

Thus, the employer must know:

- what is cold and how does it affect the decrease in working capacity, labor productivity, attentiveness, etc., as well as the state of health (exacerbation of chronic diseases, the development of various types of pathology);
- what are the contraindications to work in the cold;
- how to protect a person from general and/or local cooling;
- how to organize work in the cold;
- in what cases should medical supervision be provided for those working outdoors in the cold;
- what are the rules for working in the cold (inform the worker).

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