

CHANGES IN TISSUE RESPIRATION OF VARIOUS ORGANS INDUCED BY A HIGH AMBIENT TEMPERATURE

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The tissue metabolism of various organs at high temperatures has received little study [1, 4, 6, 7]. However, investigations of the intensity of tissue metabolism are important, for they can shed light on the physiological mechanisms of adaptation to a high ambient temperature.

In the investigation described below an attempt was made to determine the role of various organs and skeletal muscles in the maintenance of temperature homeostasis in the body during exposure to a high ambient temperature.

EXPERIMENTAL METHOD

The test objects were albino rats weighing 160-225 g, divided into three groups with ten animals in each group. One group was exposed for 1 h to a temperature of 33-35°C, another to 38-40°C, and a third to 23-25°C. The total gas exchange was measured in pneumatic chambers. Air samples were analyzed with a Haldane's apparatus. After measurement of the gas exchange and rectal temperature the animals were decapitated and tissue samples taken. Absorption of oxygen by tissues of the liver, heart, brain, kidneys, stomach, intestine, and skeletal muscles (masticatory, pectoral, brachial, and femoral) was studied. The oxygen consumed by a mince of the organs was measured in a Warburg apparatus at 37°C, with air as the gaseous phase. The incubation medium used was that suggested by Isaakyan et al. [4].

EXPERIMENTAL RESULTS

The results are given in Table 1. The highest level of respiration was observed in the tissues of the kidneys, heart, liver, and brain. The stomach and intestine were characterized by low tissue respiration values. Tissue respiration in the different skeletal muscles varied. The highest intensity of respiration was observed in the muscle of mastication. Similar results were obtained by Isaakyan [3] and Ten [5], who studied the oxygen tension in various tissues of the body. These workers observed that different organs made different contributions to maintenance of the total metabolic level of the body as a whole, in agreement with other data in the literature [2, 8-10].

The results of these experiments showed that exposure to an ambient temperature of 33-35° was accompanied by a decrease in the intensity of the total respiratory gas exchange. The oxygen consumption fell from 2.37 ± 0.06 to 1.71 ± 0.05 ml/g/h. The body temperature, measured in the animals' rectum, in this case rose from 36.4 ± 0.20 to $37.6 \pm 0.12^\circ\text{C}$. Against the background of a decrease in the total gas exchange, the metabolic activity of tissues of the different organs and skeletal muscles fell. A considerable change was observed in the tissue respiration of the liver under these circumstances. Tissue metabolism of the kidneys also varied in a similar way, but to a lesser degree than that of the liver. Tissue metabolism of the stomach and intestine showed no significant changes at different ambient temperatures.

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TABLE 1. Oxygen Consumption by Tissues of Various Organs of Rats (n = 10) Exposed to a High Ambient Temperature

Tissue	Oxygen consumption (in $\mu\text{l}/\text{mg}$ dry weight of tissue per h)		
	23–25°	33–35°	38–40°
Liver	14,2±0,27	12,7±0,31	12,6±0,16
Kidneys	17,1±0,28	16,2±0,27	16,3±0,31
Heart	16,6±0,19	18,6±0,18	16,9±0,16
Brain	13,2±0,28	13,2±0,29	13,7±0,35
Stomach	3,4±0,17	3,6±0,23	2,7±0,12
Intestine	2,1±0,21	2,2±0,18	2,0±0,13
Masticatory muscle	14,5±0,16	11,3±0,22	12,5±0,33
Pectoral	6,9±0,15	7,0±0,19	6,6±0,11
Brachial	8,8±0,29	7,7±0,18	8,0±0,30
Femoral	9,4±0,33	8,0±0,20	9,0±0,21

Somewhat different results were obtained when respiration of the heart muscle was studied. The tissue respiratory activity of this organ increased during exposure to a high ambient temperature, unlike that of the other organs.

The tissue respiration of skeletal muscle showed significant changes during exposure to heat. The oxygen consumption of the muscles fell, especially in the case of the masticatory muscle. Respiration of the pectoral muscle in this case was unchanged. Similar results were obtained by Isaakyan et al. [4] in a study of the tissue respiration of animals during adaptation to different ambient temperatures.

Exposure to a higher ambient temperature, namely, 38–40°C, causes unequal changes in tissue respiration (Table 1). The total level of the respiratory gas exchange in the animals under these temperature conditions increased slightly: the oxygen consumption rose from $1.71 \pm 0.05 \text{ ml/g} \cdot \text{h}$ at 33–35°C to $2.06 \pm 0.06 \text{ ml/g} \cdot \text{h}$ at 38–40°C. The rectal temperature also rose (from 37.6 ± 0.12 to $39.7 \pm 0.15^\circ\text{C}$).

Changes in the tissue metabolism of the various organs observed during exposure to a high ambient temperature were accompanied by changes in respiration of the thyroid and adrenal glands. During exposure to a high ambient temperature the metabolic activity of the thyroid fell considerably: the oxygen consumption of the tissue of this gland fell from 3.1 ± 0.15 to $2.2 \pm 0.15 \mu\text{l}/\text{mg}$ moist weight of tissue per hour, i.e., by 29%. Meanwhile the tissue respiration of the adrenal glands during exposure to a high ambient temperature rose slightly, especially at 33–35°C. The oxygen consumption by the tissues of this gland rose from 3.1 ± 0.15 to $4.0 \pm 0.19 \mu\text{l}/\text{mg}$ moist tissue per hour, i.e., by 29.1%. However, exposure of the animals to a higher ambient temperature (38–40°C) slightly reduced the respiration of these glands: the oxygen consumption fell in this case from 4.0 ± 0.19 to $3.7 \pm 0.19 \mu\text{l}/\text{mg}$ moist weight of tissue per hour. These results indicate changes in the activity of the adrenal–thyroid system under the influence of a high ambient temperature. Changes in the metabolism of the various organs taking place under the influence of a high ambient temperature can be assumed to be connected to a certain extent with disturbances in this regulatory system.

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