early stages of cooling (1 h), when activation of metabolism, aimed at maintaining temperature homeostasis, is accompanied by increased release of CA from the adrenal medulla, on the one hand, and preservation of a high proportion of the NA deposited in adrenergic terminals, on the other hand. This massive release of CA from the adrenals is not usually observed at the anxiety stage of immobilization stress, and it is evidently due to increased utilization of these hormones in their thermogenic role [4, 7]. In the later stages of hypothermia of the immobilized rats the rapid fall of T_b (at the rate of 3.9 ± 0.5°C/h) is associated not only with the considerable reduction of OC and HR, reflecting the degree of inhibition of heat production, but also with exhaustion of the CA reserves (especially NA). In this connection attention is drawn to the level of neurotransmitter activity of the adrenergic nerves. By contrast with control immobilization, characterized by restoration of the NA reserves at the stage of adaptation (4-24 h), the neurotransmitter concentration at these same times of hypothermia was sharply reduced. These findings, and also the manifestations of the response of the animals to immobilization stress noted above during hypothermia, lead to the conclusion that the response to stress under these conditions does not develop in the same way as in the general adaptation syndrome. It has important distinguishing features, thanks to which heat metabolism is stabilized at a new temperature level and immobilization hypothermia can be prolonged for a long time at below comfortable ambient temperatures.

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EFFECT OF EMOTIONAL STRESS ON LACTATE DEHYDROGENASE ISOZYME SPECTRUM IN THE RAT RETICULAR FORMATION

T. M. Ivanova and T. I. Belova

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KEY WORDS: lactate dehydrogenase; energy metabolism; emotional stress; mesencephalic and medullary reticular formation; blood pressure.

Lactate dehydrogenase (LDH), the key enzyme of carbohydrate metabolism, is present in the tissues in the form of several isozymes (LDH_1-LDH_5), which differ in their physicochemical properties [7]. It has been shown [6] that the LDH isozyme spectrum is linked with the character of tissue oxidative metabolism: a high proportion of LDH_1 is characteristic of tissues with a particularly high intensity of biological oxidation, coupled with phosphorylation. In tissues with predominantly anaerobic carbohydrate breakdown the rate of LDH_5 is more important.

Changes in tissue metabolism due to different causes are reflected in changes in the LDH isozyme spectrum. The LDH isozyme spectrum can thus be used as an indicate of the direction of carbohydrate metabolism in the tissues.

B. I. Lavrent'ev Laboratory of Neurohistology, P. K. Anokhin Institute of Normal Physiology, Academy of Medical Sciences of the USSR, Moscow.

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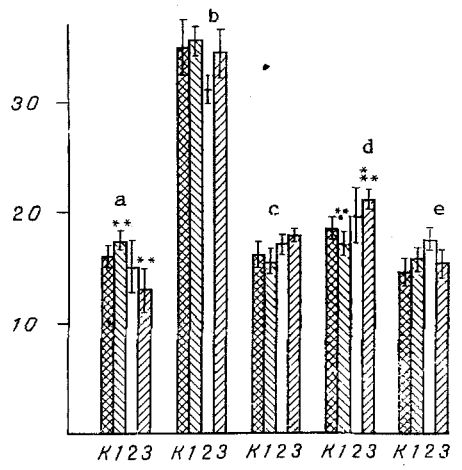

Fig. 1

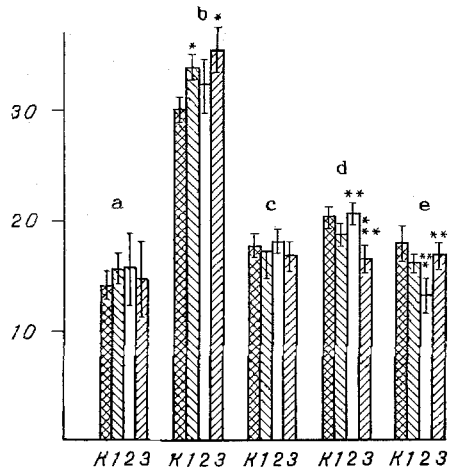

Fig. 2

Fig. 1. Relative proportions of LDH fractions in ventral mesencephalic RF. Here and in Figs. 2 and 3: abscissa, group of animals (K – control); ordinate, levels of LDH fractions (in % of total LDH); a) LDH_1; b) LDH_2; c) LDH_3; d) LDH_4; e) LDH_5; *P < 0.05 compared with control, **P < 0.05 for comparison of groups of animals.

Fig. 2. Relative proportions of LDH fractions in dorsal mesencephalic RF.

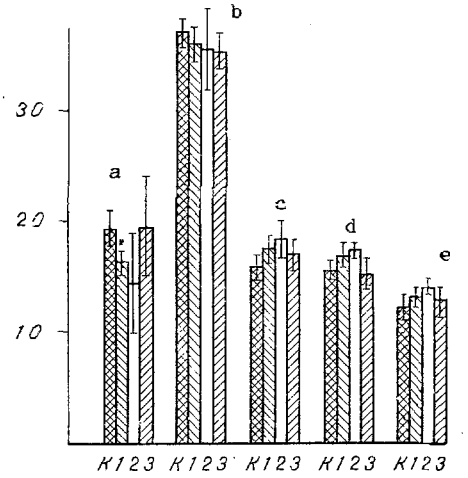

Fig. 3. Relative proportions of LDH fractions in medullary RF.

TABLE 1. Relative Propostions of LDH Isozymes (in % of total LDH Activity) in Mesencephalic and Medullary RF of Control Rats (M ± m)

Part of brain	LDH_1	LDH_2	LDH_3	LDH_4	LDH_5
Mesencephalic RF:					
Dorsal part	14,0±1,21*	30,3±1,22*	17,81±0,91	20,08±0,83*	17,8±1,52*
Ventral part	15,94±0,89	34,68±2,14	16,19±0,87	18,45±0,84	14,75±1,15
Medullary RF	19,22±1,43*	36,94*±1,10*	16,09±1,05	15,56±0,78*	12,17±0,74*

Legend: *P < 0.05 for comparison of LDH fractions in mesencephalic and medullary RF.

Numerous investigations have revealed a high level of energy metabolism in the brain, mainly due to intensive oxidative phosphorylation. However, in a study of neurochemical correlates of resistance of physiological functions to emotional stress, which was the aim of this investigation, the characteristics of metabolism not of the brain as a whole, but of individual nuclei and groups of neurons must be known.

Accordingly, in the investigation described below, the LDH isozyme spectrum was studied in three different parts of the brainstem reticular formation (RF) in control rats and changes taking place in it as a result of experimental emotional stress.

EXPERIMENTAL METHODS

Male Wistar rats weighing 250-300 g were used. Emotional stress was produced by immobilizing the animals for 6.5 h by securing the limbs and head tightly to a board [8].

Before immobilization, during unrestrained behavior (in a cage), and also every hour during immobilization, the blood pressure (BP) was measured through a polyethylene catheter introduced into the caudal artery. After immobilization the rats were decapitated and the brain quickly removed and frozen. Parts of the brain stem RF were removed from cryostat sections, 300 μ thick, by means of a hollow tube [9]: at the level of the obex (medullary RF) and at the level of the superior colliculus (dorsal and ventral parts of the mesencephalic RF). In all cases the weight of the sample did not exceed 1 mg. Intact animals served as the control.

The LDH isozyme spectrum was determined by electrophoresis in polyacrylamide gel [3] on a "Multiphor" apparatus (LKB, Sweden). The duration of electrophoresis was 2 h. After electrophoresis the gels were incubated in staining medium [4] for 2 h. The proportions of each isozyme were measured on an IFO-451 recording microphotometer. The proportion of each LDH fraction was expressed as a percentage of the total of all fractions. The significance of differences was assessed by Student's test.

EXPERIMENTAL RESULTS

The relative proportions of LDH isozymes in the control animals differed in the parts of the brain studied: the greatest difference was observed between the medullary RF and the dorsal mesencephalic RF (Table 1). In the dorsal mesencephalic RF the content of fractions LDH_4 and LDH_5 was higher, and that of LDH_1 and LDH_2 lower than in the medullary RF. Considering that the relative proportions of LDH isozymes are to some degree a criterion of the types of tissue metabolism, this suggests that in the control animals the glycolytic pathway of carbohydrate breakdown is more important in the mesencephalic RF (dorsal part) than in the medulla, and that oxidative phosphorylation is less important.

Depending on the character of changes in BP during immoblization the rats were divided into three groups: 1) animals whose BP remained virtually stable (fluctuations did not exceed 20 mm Hg), 2) animals whose BP rose by more than 20 mm Hg, and 3) rats whose BP fell during immobilization by more than 20 mm Hg.

During emotional stress the clearest changes in the relative proportions of LDH fractions, comparable with the time course of BP, were observed in the mesencephalic RF. Differences were found in the ventral part of the mesencephalic RF between rats of the normotensive (1) and hypotensive (3) groups: animals of group 1 had a higher proportion of LDH_1 and a lower proportion of LDH_4 than animals of group 3, possible evidence of intensification of anaerobic glycolysis in hypotensive rats (Fig. 1).

In the dorsal mesencephalic RF the relative proportion of LDH_4 in rats with a hypertensive BP response was significantly higher than in rats whose BP fell during stress. The relative proportion of LDH_5 also differed in the rats of groups 2 and 3, i.e., with hyper- and hypotensive responses of BP. In this case, however, changes in the content of the "anaerobic" enzyme fractions were opposite to those in LDH_4: in rats whose BP rose during emotional stress the relative proportion of LDH_5 was lower than in the animals of group 3, whose blood pressure fell (Fig. 2).

It can be concluded from these data that in the dorsal mesencephalic RF, where the relative proportion of "anaerobic" LDH fractions was high in the control animals, changes in energy metabolism induced by emotional stress involve the glycolytic pathway of carbohydrate metabolism. For instance, animals showing hypo- and hypertensive changes of BP during immobilization stress had different relative proportions of fractions LDH_4 and LDH_5.

No significant differences in the relative proportions of LDH fractions were observed in the medullary RF between groups of rats distinguished by the response of their BP to emotional stress (Fig. 3).

Some distinguishing features of energy metabolism in the mesencephalic RF in control rats and in rats with a different time course of BP during emotional stress were thus found by a microbiochemical method of determination of LDH isozyme levels. It is difficult now to identify the concrete cause of these changes. However, it is important to note that significant lesions in the walls of the blood vessels were found [1, 2, 5] in this same part of the mesencephalic RF in the same model of emotional stress. It was suggested by the authors cited that these vascular lesions are associated with changes in metabolism of the neurons, glia, and endothelium of the intracerebral vascular network, caused by emotional stress.

The results of the present investigation confirm this hypothesis and demonstrate the specific character of carbohydrate metabolism in the mesencephalic RF both in the control and in emotional stress.

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GENERAL AND LOCAL RESPONSES OF THE PROTEOLYTIC SYSTEM IN EXPERIMENTAL PNEUMONIA

A. V. Kubyshkin

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KEY WORDS: proteases; antiproteases; lungs; inflammation.

The role of the system of proteolytic enzymes and their inhibitors in the pathogenesis of inflammation in the lungs has been the subject of much research in recent years [7, 8, 11, 13]. The development of an imbalance in the proteases–inhibitors system has been demonstrated in the lungs during chronic inflammation [3, 6, 9, 10]. However, relations between the principal components of the system in the serum and the inflammatory process in the lungs during acute inflammation and during its transition into the chronic stage have not yet been studied.

The aim of this investigation was to compare the proteolytic and antiproteolytic potentials of the blood serum and bronchoalveolar secretion during the development of experimental pneumonia.

EXPERIMENTAL METHODS

Inflammation in the lungs was produced in 98 albino rats, initially weighing 150-200 g, by the introduction of a Kapron thread, 0.2 mm in diameter and 2.5-3 cm long, into the trachea. Considering that the pneumonia simulated by this method can be evaluated both as acute (until 1-2 months) and as chronic (over 2 months) stages of the process [2], the investigations were

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Department of Medical Climatology and Clinical Physiology, I. M. Sechenov Research Institute of Physical Methods of Treatment and Medical Climatology, Yalta.

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