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THE RECOVERY PROCESS AFTER PROLONGED MUSCULAR WORK

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The process of recovery after muscular work involves not only replenishment of the energy reserves, but also their supercompensation (over-restoration) [5]. In this situation phasic changes of working capacity and of the state of various systems of the body are observed [2]. Intensification of protein synthesis [4, 10] but, at the same time, increased excretion of 3-methylhistidine (3-MH), indicating enhanced degradation of contractile proteins [15], are observed in the recovery period.

The aim of this investigation was to determine the state of protein metabolism and correlation between exchanges and replenishment of the glycogen reserves and with adrenocortical activity.

EXPERIMENTAL METHOD

Experiments were carried out on Wistar rats weighing 170-200 g. The rats were made to swim in water (33 ± 1°C) for 10 h. The animals were anesthetized superficially with ether (for 2 min) 1, 2, 6, 24, and 48 h after the end of swimming (4-5 rats in each group), and blood was taken from the heart and pieces of tissue from the quadriceps femoris muscle and the liver. The concentrations of corticosterone [12] and tyrosine were determined in the blood plasma and of 3-MH [7], free tyrosine [14], glycogen [8], and protein [9] in muscle homogenate. The glycogen concentration also was determined in liver homogenate. In animals used in the experiment 24 and 48 h after swimming, and also in the control rats, kept in special cages, 24-hourly samples of urine were collected and the 3-MH excretion was determined [11].

EXPERIMENTAL RESULTS

The total protein concentration 1 h after the end of a 10-h period of swimming showed no significant change in working muscles, calculated per gram wet weight of tissue. The protein concentration per gram dry weight of tissue was increased, which was due to a decrease in the percentage of dry residue of the muscle, and indicated increased hydration of the muscle tissue. The total protein concentration in the working muscles was increased 2 h after the end of work, when calculated per gram both wet and dry weight of tissue. (Fig. 1). It remained raised 6 and 24 h after work, and returned to its initial level after 48 h. The ob-

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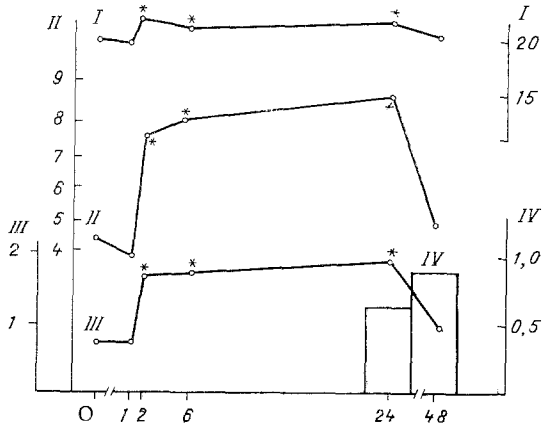

Fig. 1. Concentrations of protein and 3-MH in muscle excretion in rats after swimming for 10 h. I) Protein concentration in muscle (in g/100 g wet weight of tissue), II) 3-MH level in muscle (in μmoles/g protein), III) 3-MH level in muscle (in μmoles/g wet weight of tissue, IV) 3-MH level in urine (in μmoles/24 h/100 g). *P < 0.05 compared with initial level. Here and in Figs. 2 and 3 the abscissa is time after swimming (in h).

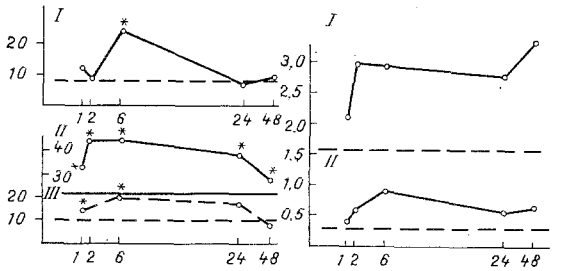

Fig. 2 Fig. 3

Fig. 2. Plasma corticosterone concentration (I, in μg/100 ml) and tyrosine concentration in muscle (II, in μg/g wet weight of tissue) and in plasma (III, in μg/ml) in rats after swimming 10 h.

Fig. 3. Glycogen concentration in liver (I) and muscle (II) of rats after swimming for 10 h (in mg/g wet weight of tissue).

served increase in concentrations of free tyrosine (with a maximum 2-6 h after work) and 3-MH in the muscle was evidence most probably of the intensification of protein degradation processes in the muscles. The tyrosine concentration was increased also in the blood plasma, with a maximum after 6 h, and it returned to normal 48 h after work.

Since the 3-MH level in proteins of the actomyosin complex is constant [15], an increase in its concentration, not only per unit weight of tissue, but also per unit weight of protein, is evidence of the release of the amino acid due to degradation of protein of the actomyosin complex. Further evidence of increased 3-MH release is given by the increase in its excretion with the urine 24 h after the end of work.

Protein metabolism is thus characterized in the recovery period after muscular work by simultaneous intensification of two opposite processes: protein synthesis and protein degradation. The simultaneous intensification of synthesis [4, 10] and degradation [10] of protein was confirmed by the results of other investigations. The reason for this combination is evidently more rapid renewal of the molecular composition of the contractile proteins in order to eliminate physiologically worn out structural elements and to increase the reliability of function of the contractile system. This is also important for the development of contractile ability of the muscles during repeated exercises.

The presence of these changes in protein metabolism was combined with a raised plasma corticosterone level in the period from 2 to 6 h after work (Fig. 2). Injection of glucocorticoids causes increased excretion of 3-MH [13]. However, the characteristic increase in 3-MH excretion after muscular work is found in adrenalectomized rats also [1]. The role of the post-work elevation of the plasma corticosterone level in intensified renewal of contractile proteins calls for further investigation.

Restoration of the glycogen reserves in the liver and muscles took place surprisingly rapidly. By 2 h after the end of work there was already a significant increase in the glycogen reserves compared with the control (supercompensation; Fig. 3). Glucocorticoids have been shown to be necessary for this change to take place [3]. This is evidently one reason at least for the post-work elevation of the corticosterone level.

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