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CPK AND TOTAL CREATINE IN STRIATED MUSCLES

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Total creatine (C_T equal to creatine + phosphocreatine) remains constant in a muscle, irrespective of the rate of stimulation. This is in sharp contrast with the wide changes in concentrations of the substrates of glycolysis or oxidation which are triggered by stimulation. In contrast, C_T concentration correlates strongly with the maximal isometric force or the maintenance heat production. This fact suggests that the concentration of C_T and the activity of CPK are tightly controlled in striated muscle. We have studied the relationship between CPK and C_T in three different systems.

Regeneration. Muscles were dissected, minced into 1 mm^3 pieces, and grafted back isotopically. The day after the operation, CPK and C_T had fallen to 1 to 3 % of their control values (homolateral muscle). Then they increased during 240 days while the muscle was regenerating. The muscles became functional 30 to 60 days after the operation. The CPK increased faster than C_T, thus their ratio did not remain constant. Their relationship is described by the power equation :

$$(CPK) = 10.7\ (C_T)^{1.55} \qquad (1)$$
$$r = 0.99$$

This equation is the same for the three muscles studied: rat gastrocnemius, rat soleus and frog gastrocnemius. The controls of these three muscles are described by the same equation.

Phylogeny. CPK and C_T were analyzed in muscles of adult animals : frog gastrocnemius (n = 36), ALD (n = 6) and PLD (n = 6) of chicken, soleus (n = 18) and gastrocnemius (n = 48) of rats, soleus (n = 6) and gastrocnemius (n = 6) of mice, paravertebral muscles (n = 24) of dogs and of men (n = 35). The slower muscles have less C_T than the faster ones. Nevertheless, CPK is still not a linear function, but a power function of C_T, exactly described by Equation 1 (r = 0.94).

Ontogeny. Gastrocnemius muscles and soleus muscles were analyzed in rats from birth to day 44. The increase in CPK becomes faster than that in C_T three days (gastrocnemius) and 6 days (soleus) after birth. For the two muscles (a fast one and a slow one), CPK is a power function of C_T, but different from equation (1). It is described by

$$(CPK) = 1.43\ (C_T)^{2.06} \qquad (2)$$
$$r = 0.98$$

Conclusions. In adult muscles, the activity of CPK is tightly coupled to the concentration of C_T. Under a strong perturbation (i.e. mincing this system) it remains tightly coupled and regenerates along a trajectory which passes first through slow muscles types toward fast muscle types. Therefore CPK activity of C_T concentration might perhaps correlate strongly with the modulation status of differentiating muscle. In developing muscle, however, the trajectory of the new-born toward the adult is different, CPK increasing faster (nearly with the square of C_T). The setting of the mechanism which control the CPK-C_T relationship is thus different in adult and in the growing animals.