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# L'économie de phosphorylcreatine durant le travail musculaire négatif, par G. MARÉCHAL *.

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*Translated from French*

# The Economy of Phosphorylcreatine during Negative Muscle Work

From 1924 FENN had noticed that the heat released by a Frog sartorius muscle during the contraction is hardly greater than that which it released during an isometric contraction: the work performed on the muscle does not seem to be entirely degraded into heat. In 1951, ABBOTT, AUBERT and HILL showed that 40 to 60 per cent. of the work made on the muscle during a stretch could disappear. These authors assumed that the absorbed work had to be transformed into chemical energy.

We have fully confirmed this hypothesis. Sartorius muscles of Rana temporaria, suspended in a moist nitrogen atmosphere and poisoned by mono-iodo-acetate, are stretched from 0.5 cm to 0.23 cm /s at 0°C during six tetanus of 3 seconds each, at intervals of 1 min. The homologous muscles of the same pair serve as controls and are stimulated isometrically. The muscles are rapidly frozen according to the method of MOMMAERTS and SCHILLING (1955). Extended muscles had an average of 1.68 ± 0.59 micromoles of phosphorylcreatine (PC) per gram of muscle more than isometric controls (n39). Stretching does not affect the ATP level of the muscle. The work imposed on the muscles is on average 65 mcal / g. The PC economy achieved by the muscles is thus equivalent to 30 per cent. of the negative work they receive, if we admit a mechano-chemical coefficient of work of 11 kcal / mole (MARÉCHAL, 1964).

In addition, HILL and HOWARTH (1959) draw up energy balances at each moment of contraction: they report experiments where the total energy balance is decreased, or even annihilated. In the latter case, the muscle would contract without using any other source of energy than the work imposed on it. However, in our experiments described above, the isometrically stimulated muscles hydrolyze 12.4 micromoles PC / g: The economy of 1.68 micromole / g realized by the stretched muscles does not therefore exceed· 14% of total consumption. An important factor that could explain these differences is the speed of stretch. HILL and HOWARTH (1959) subjected Bufo muscles to a relatively rapid rate of about 9 cm / s. We have developed a series of sartorius muscles of Rana temporaria at the equivalent rapid rate of 1.8 cm is (six tetanus of 1 s, stretches of 0.5 cm after a delay of 200 ms). Stretched muscles consume

1.48 ± 0.84 micromoles PC / g (n17) in addition to isometric controls. The intervention of this factor explains the results that we have reported previously (AUBERT and MARECHAL, 1963). The interpretations of HILL and HOWARTH are therefore not supported by our experiments.

In conclusion, during a rapid stretch, the PC-consumption of the stimulated muscle increases, but during a slow one, 30% of the work supplied to the muscle is found in the form of a PC economy (MARÉCHAL, 1964)

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