# "[Correlation between heat production of a muscle tetanized at 20 degrees and phosphorylcreatine and nucleotide consumption]."

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## ABSTRACT

Sartorius muscles of frogs were tetanized 0.5 to 12 s at 20°C, rapidly frozen and analyzed for their content in phosphocreatine (PC), ATP, ADP, IMP. Heat production were measured in other muscles placed in the same conditions. Hydrolysis of PC and heat production decreases exponentially during the tetani, but at different rates. The calculated enthalpy change of PC breakdown (- ΔH) increases from 12.2 kcal/mole at beginning to 42 kcal/mole at the end of the tetanus. The excess of heat production may go up by +45% and is not suppressed by oxygen lack or iodoacetate. The source of this large excess heat is unknown

## CITE THIS VERSION

Imprimé avec le périodique *Journal de Physiologie,* extrait du Tome 63, 1971, no 6, 181 A.
Association des Physiologistes, Trente-neuvième réunion, Liège, 3-5 juin 1971.

# Corrélation entre la production de chaleur d'un muscle tétanisé à 20°C et la consommation de phosphorylcréatine et de nucléotides,

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*Translated from French.*

## Correlation between heat production of a muscle tetanized at 20 degrees and phosphorylcreatine and nucleotide consumption

Frog Sartorius muscles are tetanized at 20°C for 0.5 to 12 seconds, and frozen at the end of tetanus before release. The content of their perchloric extracts in free creatine, phosphorylcreatine (PC), ATP, ADP, AMP and inosine monophosphate (IMP) is analyzed. At the same time, we measure the heat production of muscles treated exactly as the muscles subjected to chemical analysis.

It is observed that the levels of the nucleotides do not change, except for a slight production of IMP after 8 seconds of tetanus. The rates of heat production and PC hydrolysis decrease exponentially but at different rates. It follows that the apparent hydrolysis enthalpy ($-\Delta H$) evaluated by the ratio of these two rates increases from 12.2 kcal/mole at the beginning of tetanus to 42 kcal/mole to the twelfth second. This fact suggests that chemical reactions other than PC hydrolysis must occur during tetanus.

Thus, there was a second series of experiments in which glycolysis and oxidation were suppressed by monoiodoacetate poisoning in an anaerobic medium. Heat production is not altered, but the chemical reactions occurring in the muscle are severely disrupted: after 2 seconds of tetanus there are appreciable amounts of AMP and IMP; ADP increases slightly and ATP decreases.

PC hydrolysis is the only reaction observed in the first two seconds, but it is faster than that seen in non-intoxicated muscle. The apparent enthalpy of the hydrolysis of the PC at this time was 8.3 kcal/mole (888 microcal/mole total creatine/sec / 107 micromole PC/micromolar total creatine/sec = 34 micromoles/g). It is much lower than that of 12.2 kcal/mole found at the beginning of the tetanus of a muscle in $O_2$. This difference, caused by iodoacetic intoxication, can be explained by the fact that, in the muscle at 0°C, glycolysis starts at a high rate from the onset of tetanus.

Beyond 4 seconds of tetanus in iodoacetate, the heat produced is higher than the heat calculated from the hydrolysis of PC increased from that produced during dephosphorylation and deamination of ATP. It is concluded that the enthalpy of PC (or ATP) hydrolysis increases after 4 seconds of tetanus, or that unidentified processes are responsible for the excess heat production observed.