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Influence of tension on the incorporation of inorganic phosphate into ATP in glycerinated muscle fibres

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In our first attempt to detect a resynthesis of ATP in muscle stretched during contraction, we have found that ATP ^{32}P could be extracted from glycerinated fibres stretched in a medium containing $^{32}P_i$ and ATP (Gillis & Maréchal, 1969). This result has been confirmed by Mannherz (1970).

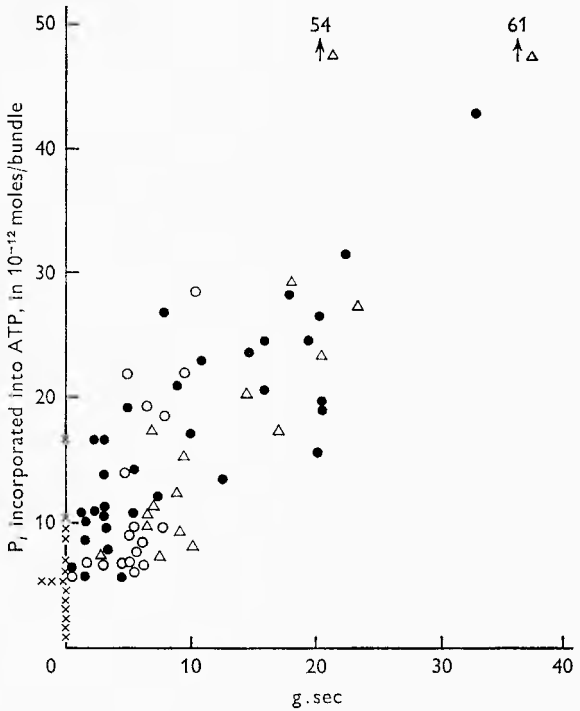

Fig. 1. Incorporation of inorganic phosphate (P_i) into ATP, in 10^{-12} moles P_i/bundle, versus the tension–time integral of the contraction (in g sec). Symbols: △, stretched; ○, released; ●, isometric; ×, isotonic contractions.

New experiments were made in presence of sodium azide and oligomycin to inhibit exchange reactions in mitochondria (Lardy, Johnson & McMurray, 1958) and a wider variety of mechanical conditions was investigated. Bundles of 10 fibres (about 60 μg of protein) from glycerinated rabbit

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psoas were incubated for 13–40 sec, in the presence of 5 mM-Mg-ATP, 1 mM-ADP and 1·7 mM-P_i containing ^{32}P. In a first group, contraction began with an isometric phase of 10 sec to get maximal isometric tension; the bundles were then either stretched ($n = 17$) or released ($n = 18$) at various speeds (0·05–0·2 mm/sec) or maintained at their initial length ($n = 34$). In another group ($n = 19$) contraction was isotonic with zero load from the beginning. Whatever the type of contraction, ATP extracted from the bundles was labelled; the incorporation of P_i into ATP varied from 5 to 60×10^{-12} moles P_i per bundle. The incorporation of P_i into ATP was determined by the magnitude of the tension maintained and by the duration of the contraction. This dependence is illustrated in Fig. 1 where the incorporation has been plotted against the tension–time integral for each contraction. As a first approximation, the same trend is observed for the results of the three types of contraction (stretched, released or isometric).

These results provide a more probable interpretation for our previous data (Gillis & Maréchal, 1969) and for those of Mannherz (1970): the higher amount of AT ^{32}P found in the stretched muscles is an effect of the high tension produced, and cannot be taken as a demonstration that ATP is resynthesized at the expenses of the mechanical energy received from the outside world.

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