Letters to the Editor

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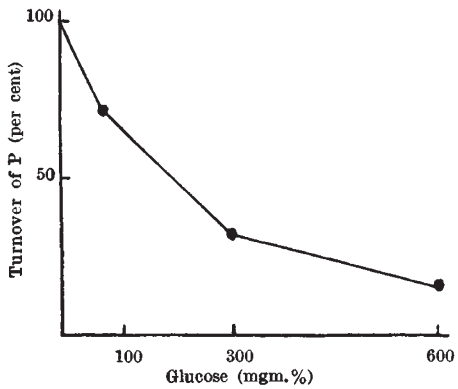
NOTES ON POINTS IN SOME OF THIS WEEK'S LETTERS APPEAR ON P. 476.

CORRESPONDENTS ARE INVITED TO ATTACH SIMILAR SUMMARIES TO THEIR COMMUNICATIONS.

Glycogen Breakdown in Muscle Extract and Yeast Juice

IT has been shown that the transport of phosphorus (P) between creatine and adenylic acid in muscle extract (Lohmann's reaction and its reversal) can be expressed as a chain of equilibria obeying the laws of thermodynamics and controlled by the *p*H[1,2]. Parnas and Ostern and their schools[3,4], have recently described another case of phosphorus transport in muscle extract in the formation of hexosemonophosphate from inorganic phosphate and glycogen. It appeared of interest to study the kinetics of this reaction.



INHIBITION OF GLYCOGEN BREAKDOWN BY GLUCOSE IN MUSCLE EXTRACT. 1 C.C. OF 10 DAYS OLD MUSCLE EXTRACT (AFTER MEYERHOF) FROM RABBIT + 2 C.C. ADDITIONAL SUBSTANCES CONTAINING 10 MGM. GLYCOGEN; 1·15 MGM. P AS PHOSPHATE BUFFER, *p*H 7·2; 200γ ADENYLIC ACID AS SODIUM SALT. 100 PER CENT TURNOVER WAS 0·51 MGM. P OF HEXOSEMONOPHOSPHATE FORMED.

It was first of all of interest to find that dialysed extract of yeast to which yeast adenylic acid was added behaved exactly like muscle extract; it phosphorylated only glycogen and not glucose. Willstätter and Rohdewald[5] showed that living bottom yeast condenses glucose to glycogen before phosphorylation occurs.

The reaction reaches in muscle extracts and yeast juice alike an equilibrium which may be expressed by the following equation, in which water cancels out and glycogen may be described sufficiently for this purpose as hexoseanhydride (n hexose$-(n-1)\,H_2O$):

$$\frac{\text{Mol. Hexosemonophosphate}}{\text{Mol. Hexoseanhydride} \times \text{Mol. Phosphate}} = K \times 10^{-2}$$

At 37° and *p*H 7·2, K was between 0·02 and 0·08 and of about half that value when starch was used instead of liver glycogen. Hexosemonophosphate, the product of the reaction, inhibits esterification of glycogen. Of more general interest is the observation that the glycogen breakdown can also be suppressed by glucose.

The braking effect of glucose on glycogen decomposition is 50 per cent at a concentration equal to that of the sugar level in normal blood, and nearly vanishes at a concentration corresponding to hypoglycæmia *in vivo*.

Two suggestions may be made which account for these observations with muscle extract.

(*a*) Lactic acid formation from glucose (which needs no inorganic phosphorus and has glutathione as coenzyme) may be different[6] in its physiological meaning from the lactic acid formation from glycogen (which needs phosphorus, magnesium, adenylic acid and cozymase). The former reaction, prevailing, for example, in brain (Ashford and Holmes[7]), and in the embryo (Needham and Nowinski[8]) would serve for continuous functioning and would be kept up steadily by the glucose level of the blood. The latter reaction, most pronounced in skeletal muscle, would act as a reserve and increase the lactic formation, acting discontinuously as a 'second wind' where sudden heavy demands on the blood sugar cause local hypoglycæmia.

(*b*) Secondly, the phenomenon observed may help to make intelligible the mechanism of hypoglycæmic convulsions. Sudden increase in breakdown of muscle glycogen, which is connected with muscular contraction, should occur when the blood sugar is low. These convulsions are already known to be independent of the brain as they can occur in the decapitated animal[9], where a dehydration of the blood takes place which, as Olmsted and Taylor[9] have described it, "could be due to increase in molecular concentration within the tissue itself". Excess of hexosemonophosphate, a very active oxygen acceptor, could account further on for the extreme deoxygenation observed by the same authors in hypoglycæmic blood which in the arteries was already of venous appearance. Hypoglycæmic convulsions in insulin shock depend in their intensity on the previous diet of the experimental animal, and they are much more marked after a diet rich in carbohydrate (Abderhalden and Wertheimer[10]). This should lead to glycogen storage in the tissues.

HERMANN LEHMANN.

Biochemical Laboratory,
Cambridge.
Jan. 25.

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[2] Lehmann, *Biochem. Z.*, **286**, 336 (1936).
[3] Parnas and Baranowski, *C.R. Soc. Biol. Paris*, **120**, 307 (1935).
[4] Ostern, Guthke and Terzakowec, *Hoppe-Seyl. Z.*, **283**, 9 (1936).
[5] Willstätter and Rohdewald, *Hoppe-Seyl. Z.*, **247**, 269 (1937).
[6] Needham and Lehmann, *Biochem. J.*, **31**, 1210 (1937).
[7] Ashford and Holmes, *Biochem. J.*, **23**, 748 (1929).
[8] Needham and Nowinski, *Biochem. J.*, **31**, 1165 (1937).
[9] Olmsted and Taylor, *Amer. J. Physiol.*, **69**, 142 (1924).
[10] Abderhalden and Wertheimer, *Arch. ges. Physiol.*, **205**, 547 (1924).