noted that the strong reflections corresponding to 9.05 Å and 10.8 Å occur as more extended arcs merging into the equatorial spots. The observation of this series of meridional reflections in such detail warrants further investigation and it is proposed to continue with this work.

I am indebted to Mr. S. J. EDMONDS for the supply of the muscles and for his assistance in their preparation. It is a pleasure to thank Dr. S. G. TOMLIN for his encouragement and interest and Professor W. T. ASTBURY for a valuable discussion during his visit to this University.

Physics Department, University of Adelaide (South Australia) C. R. WORTHINGTON

[1] S. J. EDMONDS, *Australian J. Marine and Freshwater Research* (to be published).
[2] R. S. BEAR, *J. Am. Chem. Soc.*, 67 (1945) 1625.
[3] W. T. ASTBURY, *Exptl. Cell Research*, 1 (1947) 234.
[4] R. O. HERZOG AND W. JANCKE, *Naturwissenschaften*, 14 (1926) 1223.
[5] W. LOTMAR AND L. E. R. PICKEN, *Helv. Chim. Acta*, 25 (1942) 538.
[6] R. S. BEAR AND C. M. M. CANNAN, *Nature*, 168 (1951) 684.
[7] H. E. HUXLEY AND J. C. KENDREW, *Nature*, 170 (1952) 882.
[8] C. R. WORTHINGTON, *J. Sci. Instr.* (in the press).
[9] H. E. HUXLEY, *Proc. Roy. Soc. B*, 141 (1953) 59.

Received October 15th, 1955

Heat stable protein from skeletal muscle

A substance having the general properties of a protein has been isolated from muscle by the following method:

Four-hundred grams of ground beef are stirred with 320 ml of 2 *M* $MgCl_2$ and 880 ml of water containing 12 ml of *N* HCl. The suspension, the pH of which should be 4.5, is heated to 90° and filtered hot. The filtrate is neutralized with NaOH and treated with 1 volume of methanol. The precipitate is sedimented and dissolved in 350 ml of 0.4 *M* $MgCl_2$ adjusted to pH 5.0. The solution is heated to 90°, the precipitate discarded. The supernatant is neutralized, the precipitate again discarded. The supernatant is dialyzed at 4° against 20 volumes of distilled water. The protein crystallizes in the form of thin needles or coarse sphenoids (Fig. 1). Crystallization is repeated by the same procedure. The yield is 0.4 g. The same method has yielded material of the same crystalline appearance when applied to human muscle.

The extraction of the protein was unsuccessful when NaCl or $BaCl_2$ was used instead of $MgCl_2$. Crystallization did not take place in the absence of Ca, Ba or Mg. $MnCl_2$ and $CoCl_2$ dissolved the protein but did not promote crystallization. Zn and heavy metals did not dissolve it.

Its solubility was approximately as follows: In the absence of salt, above pH 7 and below pH 4; in 0.02 *M* $MgCl_2$, only below pH 4; in 0.4 *M* $MgCl_2$, only above pH 5.

The crystalline preparations yielded a high ash (6.1 % when $BaCl_2$ was used for crystallization). This decreased to 0.25 % after dialysis against 0.01 *N* HCl. Nitrogen content was 14.0 %, carbon 42.6 %; phosphorus and sugar were not detected.

The viscosity of solutions in 0.4 *M* $MgCl_2$, pH 7.0, was measured at 30° in Ostwald type pipettes and yielded an intrinsic viscosity $[\eta] = 0.38$. Hence[1], Simha's factor $\nu = [\eta]\ 100/\bar{v} = 51$ (assuming 0.74 for the partial specific volume $\bar{v}$); hence[2], an axial ratio of 24:1.

The protein was homogeneous in the ultracentrifuge in 0.4 *M* $MgCl_2$, pH 7.0, and yielded $s = 2.7 \cdot 10^{-13}$ at infinite dilution. From this and the axial ratio, with the help of the simplified form of Perrin's equation[3], the following values were obtained: radius of an ellipsoid of revolution, $b = 1.03$ mμ; semi long axis, $a = 25$ mμ; molecular weight = 91,000. In 0.01 *N* HCl, pH 2.5, ultracentrifugation revealed two components, whose sedimentation rates at zero concentration appeared to be of the order of magnitude of 2 and $3 \cdot 10^{-13}$ very approximately. The curve relating s to concentration was, however, so convex toward the origin that no satisfactory extrapolation could be made.

The substance shares with the other muscle proteins, myosin[4], actin[4], and the peptomyosins[*,5,6], the property of being insoluble in high salt concentration at pH below 4. It resembles peptomyosin B[6] in molecular shape, being slightly less elongated. However, since the sedimen-

[*] Peptomyosin A also is insoluble below pH 4 in *M* NaCl. This fact was not stated in the original description.

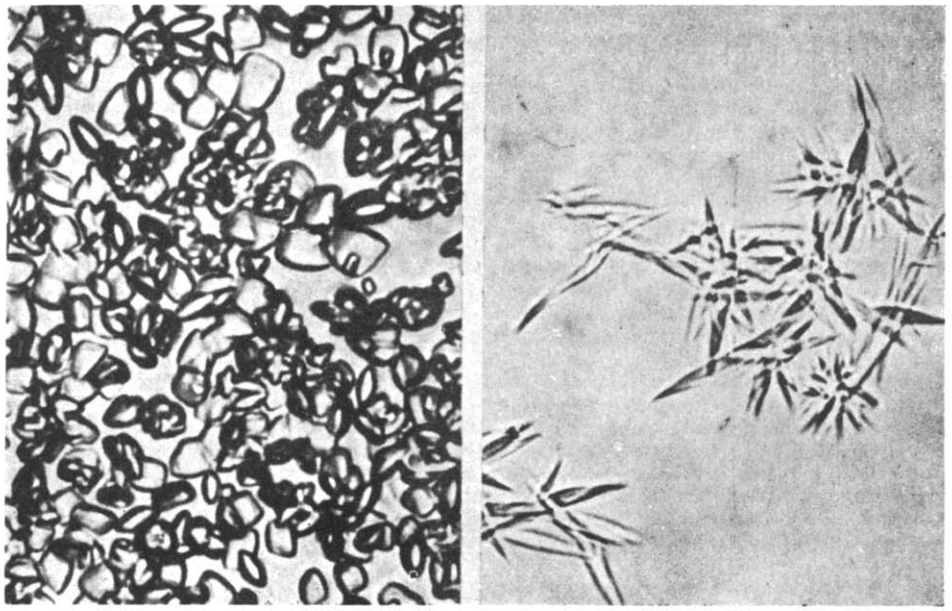

Fig. 1. Heat stable muscle protein. (Magnification 850 ×)

tation rate of very elongated particles depends primarily on width and very little on length, the homogeneity suggested by a sharp sedimenting boundary may be illusory, and the results compatible with the assumption that the material consists of thread-like particles of uniform width, in various degrees of linear aggregation. Osmotic pressure measurements by the senior author's method[7] yielded only erratic results, a fact usually observed with material that can be suspected of physical instability.

JAQUES BOURDILLON
Division of Laboratories and Research, New York State Department of Health, WINFIELD H. BAKER
Albany, N.Y. (U.S.A.)

[1] J. T. EDSALL, in *The Proteins*, edited by H. NEURATH AND K. BAILEY, Academic Press, Inc., New York, 1953, Vol. I, Part B, p. 689 (Table).
[2] T. SVEDBERG AND K. O. PEDERSEN, *The Ultracentrifuge*, Clarendon Press, Oxford, 1940, p. 41 (Table).
[3] A. R. PEACOCKE AND H. K. SCHACHMAN, *Biochim. Biophys. Acta*, 15 (1954) 198.
[4] A. SZENT-GYÖRGYI, *Chemistry of Muscular Contraction*, Academic Press, Inc., New York, 1951, 2nd ed.
[5] J. BOURDILLON, *Arch. Biochem.*, 16 (1948) 61.
[6] J. BOURDILLON, *J. Am. Chem. Soc.* (in press).
[7] J. BOURDILLON, *J. Biol. Chem.*, 127 (1939) 617.

Received November 5th, 1955

Synthesis of ribose by the rat*

The biosynthesis of ribose[1] has been postulated to occur (a) directly from hexose by loss of an end carbon and (b) from smaller units by condensation, *e.g.* $C_2 + C_3$. Data obtained in previous experiments[2] have been interpreted to indicate that in the chick, the synthesis of this pentose probably occurs by the latter mechanism, *possibly* by a condensation of glyceraldehyde-3-phosphate and an active C_2 unit (*e.g.* from fructose-6-phosphate[3]) catalyzed by transketolase. The technique employed was to isolate glycogen and ribose from the combined internal organs

* Presented at the meeting of the American Chemical Society, Cincinnati, Ohio, April, 1955.