Letters to the Editor

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X-Ray Interpretation of the Molecular Structure of Gelatine

IN a recent communication[1] it was shown how X-ray studies indicate that the average dimensions associated with an amino-acid residue in an extended protein chain are of the order of $3\frac{1}{2}$, $4\frac{1}{2}$ and $9\frac{1}{2}$ A., the first being the length in the direction of the main-chain, the second the thickness of the main-chain, and the third the lateral extension of the side-chains: it was shown also how these three quantities account for the observed average density of proteins and the weight per unit area of mono-molecular protein films. More recently[2] the arguments have been applied with some precision to the case of β-keratin, for which the dimensions in question are found by X-rays to be 3·38, 4·65, and 9·8 A., respectively, while the density[3] is 1·30 and the weighted mean residue weight about 115 (so far as can be estimated from available chemical analyses[4]). We can thus set out the following relation:

$$\frac{3{\cdot}38\times 4{\cdot}65\times 9{\cdot}8\times 1{\cdot}30}{115\times 1{\cdot}65}=1{\cdot}06=1 \text{ (approx.)}$$

which is a reasonably strict demonstration of the point we wished to make, namely, that the dimensions 3·38, 4·65, and 9·8 A. in β-keratin are on the average those of *one* amino-acid residue.

In general, interactions between the side-chains, both of one and the same main-chain and of neighbouring main-chains, distort the protein molecule and therefore *diminish* the average length of an amino-acid residue.[1] For example, we have 3·5 A. in silk fibroin, 3·38 A. in β-keratin, 3·3 A. in stretched feather keratin, 3·1 A. in unstretched feather keratin, and 1·7 A. in α-keratin. The question now arises as to what are the fundamental dimensions per residue in gelatine (and in collagen, too, since the X-ray photographs are so similar). It was suggested[1] that the strong meridian arc, of spacing about 2·8 A., gives the length, while the side-dimensions are roughly those of the general postulate above. From a detailed consideration of the most recent chemical analyses we are now in a position to confirm this view. The appropriate numerical relation is as follows:

$$\frac{2{\cdot}84\times 4{\cdot}56\times 10{\cdot}0\times 1{\cdot}346}{96\times 1{\cdot}65}=1{\cdot}1=1 \text{ (approx.)}.$$

X-ray photographs of wool or hair stretched in steam show clearly how the attack of water molecules is confined almost entirely to the protein side-chains[2], and thereby give support of a purely geometrical kind to such ideas concerning swelling and organisation as have been put forward by Jordan Lloyd[5] and others. We have lately observed analogous effects in the X-ray photographs of a number of other proteins—details will be published in due course—so that it now seems fairly certain that the allocation of side-spacings given above is in general correct, or at least offers a valuable guide among the difficulties encountered. In particular, gelatine and collagen show on water absorption a very marked increase in what we have called the side-chain spacing, and it is suggested here that this is the simple interpretation of the spacing changes which have been investigated systematically by Katz[6] and others. In making the calculation given above we have used Katz's values of the spacings of nearly anhydrous gelatine, and the density (1·346) of anhydrous gelatine given by Frank (1912). The weighted mean residue weight (96) has been derived from chemical analytical data which will be discussed at length elsewhere: they are based on the results of Dakin[7] modified so as to take account of the presence of the new amino-acid reported by van Slyke[8]. It will be seen that the calculated number of residues (1·1) associated with the chosen X-ray dimensions agrees well with the number (1) predicted.

The mean residue weight of the amino-acids in gelatine still not accounted for turns out to be about 123: this number has been derived by linking up the total nitrogen content and that of the acids found with the fact that the analytical procedure adopted makes it probable that the remaining acids are mono-amino-acids. If they are not, this only serves to bring the calculated value, 1·1, still nearer the predicted value of unity, and is therefore all to the good.

Further molecular investigations along the above lines are being continued.

W. T. ASTBURY.
W. R. ATKIN.

Textile Physics Laboratory and
Leather Industries Department,
University of Leeds.
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[4] See, for example, S. G. Barker, "Wool Quality" (E.M.B., 1931).
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[7] Dakin, *Biochem. J.*, **12**, 290; 1918; *J. Biol. Chem.*, **44**, 499; 1920.
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The Influences of Electrical and Magnetic Fields upon 'Spin' in Gaseous Detonations

IN continuation of our researches upon the phenomenon of 'spin' in gaseous detonations, during the past year or more Messrs. R. P. Fraser, W. H. Wheeler and myself have been studying the effects of strong electrical and magnetic fields thereon, with results indicating that the 'head' of detonation is a locus of an intensive ionisation of the medium.

In one series of experiments, photographs were taken of $2CO+O_2$ detonations in a tube of 1·25 cm. internal diameter fitted with a glass section in which a strong electric field could be maintained between two electrodes—one of which was a ring-shaped silver mirror specially deposited on the inside of the tube—30 cm. apart.

In several 'blank' experiments with no field, the detonation flame passed through the glass section with a constant velocity of 1755 metres per second showing a quite normal 'spin' with a frequency of *circa* 45,000