subunit, causes a 40 per cent reduction of the 70*S* fraction in the presence of potassium. Other antibiotics, on the other hand, which are not involved in the initiation process, do not disturb the pattern.

It seems therefore that the 70*S* ribosomes are produced in the presence of potassium by association of 50*S* and 30*S* subunits. This apparently involves an aminoacyl-*t*RNA or an N-acylated form, for trimethoprim, which brings about a depletion of formylmethionyl-*t*RNA, causes a diminution in the proportion both of polysomes and of subunits, and a corresponding increase in monosomes. Finally, a pulse-label introduced into the messenger is incorporated into the 70*S* fraction in the potassium-containing lysate as a polydisperse material sedimenting at up to 14*S*. It is well known that nuclease degradation of polysomes leaves only a messenger fraction of about 4*S* on the resulting 70*S* particles, and so it seems that one is indeed dealing here with a new complex, formed with intact messenger. The moral of this work is that the distribution produced on lysis of bacterial cells may by no means necessarily reflect the *in vivo* state, depending on the nature of the medium. In the presence of sodium in place of potassium, Phillips *et al.* imply that the *in vivo* pattern is frozen and that in these circumstances the truth is vouchsafed.

POLYSACCHARIDES

Seaweed Double Helix

from our Biochemistry Correspondent

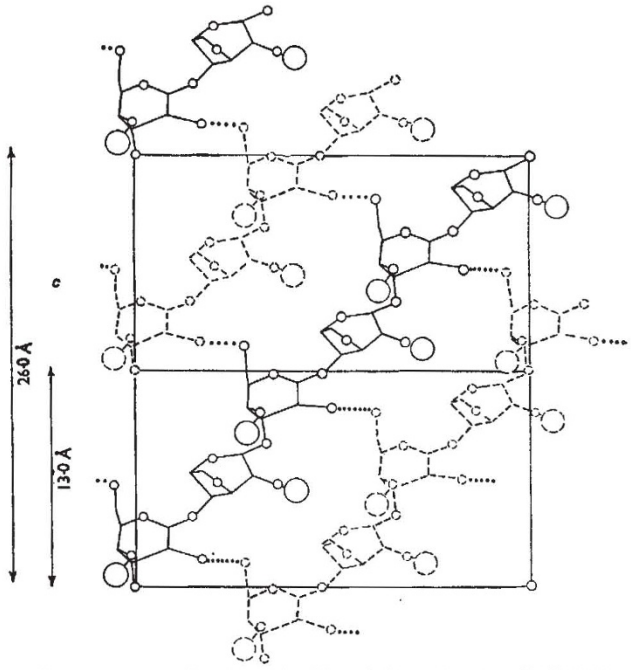
ANY carbohydrate chemist who feels that his chosen sphere is being ignored in the march of biophysics will be gladdened to find—among the numberless studies on nucleic acids and proteins—an article describing the tertiary structure of a polysaccharide. In a recent issue of the *Journal of Molecular Biology* (**45**, 85; 1969), N. S. Anderson, J. W. Campbell, M. M. Harding, D. A. Rees and J. W. B. Samuel describe X-ray diffraction work and model building which leads them to propose a double helical structure for the sulphated polysaccharide carrageenan. Helical forms are not unknown in polysaccharides—indeed a triple helix has been put forward for an algal xylan (E. D. T. Atkins, K. D. Parker, and R. D. Preston, *Proc. Roy. Soc.*, B, **173**, 209; 1969)—but a double helix has not previously been confirmed.

Why have we heard so little about the spatial form of polysaccharides, which are so much less complex than proteins or nucleic acids? It is true, of course, that a simple repeating sequence is no indication that tertiary structural elucidation will be easy: after all, the "simplicity" of insulin concealed difficulties for the biophysicist which have only recently been resolved (see page 491 this week). The problem with polysaccharides is that of obtaining a sufficiently "structured" preparation for X-ray diffraction analysis. Carbohydrates are characteristically gummy, even though a more defined and rigid form may exist in the natural environment, such as the cell wall. Away from this environment, the structure must be maintained artificially. The molecules studied by Anderson *et al.*, κ and ι-carrageenans, are regularly alternating polymers of the type $(—AB—)_n$ in which *B* is a residue of β-D-galactose-4 sulphate and *A* is 3,6-anhydro-α-D-galactose (κ form) or its 2-sulphate (ι form); the glycosidic linkages are *A*1–3*B* and *B*1–4*A*. Before any interpretable diffraction pattern could be obtained for these molecules, some chemical modification was required, and the cation was sought which promoted the most rigid orientation.

Fibres were drawn from concentrated solutions of the freeze-dried derivatives and mounted for diffraction analysis with a tilt of 10°. Intensity distributions were correlated with possible molecular conformations, in the usual way, and found to correspond with a helical arrangement of three disaccharides in one turn of helix, with a repeating distance of 26·0 Å (iota) or 24·6 Å (kappa). Systematic exploration of models which would be at once stereochemically acceptable and in accordance with the diffraction lines, resulted in the postulation of a double helix, a diagram of which is reproduced here. An important feature of this structure is a hydrogen bond between O6 of one galactose ring and O2 of its partner; support for this is adduced from the infrared spectrum and the resistance to deuteration of a bond buried in the interior of the helix.

It is likely that many polysaccharides containing 1–3 links will be found to have a double helical structure. The 1–3 link confers spirality on the chain of monosaccharides for the simple reason that the units are tilted with respect to each other. In 1–4 linked molecules like starch and cellulose the planes of the monosaccharide units are parallel, and there is only a low potential barrier to twisting around the glycosidic bond. In 1–3 linked molecules (or, for that matter, molecules like carrageenan which contain alternating 1–3 and 1–4 linkages) steric restraint and hydrogen bonding stabilize the helical form, and promote a degree of crystallinity sufficient for the purposes of X-ray diffraction.

With a knowledge of tertiary structure one can see how the texture of polysaccharide gels is determined in the natural state. The degree of sulphation and the ability to form regions of double helical structure are clearly factors of relevance to the way in which these gels melt and set and perform their biological function.



Arrangement of polysaccharide chains, showing hydrogen bonds, in the double helix model for ι-carrageenan.