

Molecular Conformations of 5-Iodouridine

THE structure of unusual nucleic acid components is of importance in relation to conformational and model building studies on nucleic acids in general and those concerning tRNA in particular. In the case of 5-iodouridine (Fig. 1) it is particularly desirable to know the crystal structure in order to compare the effects of ionizing radiation on single crystals of 5-iodouridine with those on 5-iododeoxyuridine, using the technique of electron spin resonance¹. Such studies may elucidate the effects of radiation on the nucleic acids themselves.

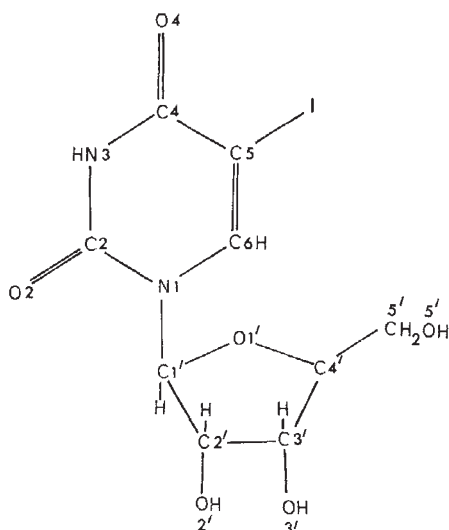


Fig. 1. The structure of 5-iodouridine.

Crystals of 5-iodouridine were obtained from aqueous solutions. The unit cell is monoclinic with dimensions $a = 4.68 \text{ \AA}$, $b = 17.14 \text{ \AA}$, $c = 14.57 \text{ \AA}$, $\beta = 90.85^\circ$. The space group is $P2_1$; there are four molecules in the unit cell and therefore two molecules in the asymmetric unit. Intensity data were collected on a Hilger and Watts linear diffractometer using molybdenum-K α radiation, and on a Wooster four-circle diffractometer using copper-K α radiation.

The coordinates of the iodine atoms were determined from a three-dimensional Patterson synthesis, and a three-dimensional Fourier synthesis—calculated with phases derived from the iodine positions—revealed all the remaining non-hydrogen atoms. Least-squares refinement, using isotropic temperature parameters, was carried out until the R factor ($R = \sum |F_o| - |F_c| / \sum |F_o|$) was 0.12, and five further cycles of refinement with anisotropic temperature parameters reduced the R factor to 0.06 for the 2,343 observed reflexions. The details of the structural determination will be given elsewhere, but there are interesting differences between the conformations of the molecules in the asymmetric unit which we wish to describe here.

One of the conformational parameters of nucleosides and nucleotides which depends on the packing arrangement in the solid state is the relative rotation of the base and the sugar about the glycosidic bond. This may be described in terms of a torsion angle, φ_{CN} , defined by Donohue and Trueblood². As is the case with all pyrimidine nucleosides and nucleotides so far studied, both molecules of 5-iodouridine are in the *anti* conformation, with $\varphi_{CN} = -13^\circ$ (molecule I) and $\varphi_{CN} = -59^\circ$ (molecule II). Similar differences are observed for other nucleosides when they pack in different environments, and the values fit into the calculated allowed ranges of φ_{CN} made by Haschemeyer and Rich³.

Another conformational parameter which depends on

the packing arrangement in the crystal is the pucker of the sugar ring⁴. The most common type of pucker is with either atom C2' or C3' displaced about 0.5 Å from the mean plane of the other four atoms of the furanose ring, and in most cases the displaced atom is *endo*, that is lying on the same side of the sugar plane as atom C5'. Exceptions to this are deoxyadenosine⁵ and thymidine⁶, where the pucker is C3' *exo*. It has recently been suggested by Arnott *et al.*⁷ that the difference in the pucker of the sugar ring in the B and A forms of DNA is related to the two biological functions of DNA, namely replication and transcription. There is evidence from proton magnetic resonance studies^{8,9} that C2' is *endo* in purine nucleosides in solution and that C3' is *endo* in pyrimidine nucleosides, but in the solid state this is not the case, and even the same nucleoside when in different environments can have a different type of pucker. This is so in the case of bromouridine¹⁰⁻¹² and inosine^{13,14}. When there is more than one molecule in the asymmetric unit, however, and the molecules as a consequence are in different environments, the pucker has been the same in these molecules. This is so in inosine dihydrate¹³ and in the 3',5'-cyclic nucleotides of adenosine and uridine^{15,16}. In 5-iodouridine, however, we find that the pucker in the two molecules is different. In molecule I the pucker is C3' *endo* and in molecule II it is C2' *endo*.

A third conformation parameter is the orientation of the C5'—O5' bond about the C4'—C5' bond¹⁷. In molecule I the C5'—O5' bond is *gauche* with respect to both the C4'—O1' bond and the C4'—C3' bond. Thus the conformation is *gauche-gauche*, the most common conformation found in nucleosides and nucleotides. The conformation of molecule II, however, is *trans-gauche*, and the only other nucleoside so far reported to have this conformation is 5-fluorodeoxyuridine¹⁸, although the 3',5'-cyclic nucleotides of adenosine and uridine have this type of conformation in order to form the necessary linkage between the C3' and C5' atoms^{15,16}.

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Orientation of Polypeptide Side Chains in Solution

THE conformational behaviour of polymers of L-aspartate esters has been of interest since it was first shown that poly(β -benzyl-L-aspartate) in chloroform takes up the anomalous left-handed helical form^{1,2}. Since then it has