termediate in the reaction of xylulose-5-phosphate with phosphate ion to give glyceraldehyde-3-phosphate and acetyl phosphate[4] catalyzed by the enzyme phosphoketolase and the coenzyme, thiamine pyrophosphate.[5]

(4) E. C. Heath, J. Hurwitz, B. L. Horecker and A. Ginsburg, *J. Biol. Chem.*, **231**, 1009 (1958).

(5) The authors gratefully acknowledge the support of the work by the American Cancer Society.

DEPARTMENT OF BIOCHEMISTRY
UNIVERSITY OF CALIFORNIA FRED G. WHITE
DAVIS, CALIFORNIA LLOYD L. INGRAHAM

RECEIVED JUNE 21, 1960

TETRAFLUOROPYRIMIDINE[1]

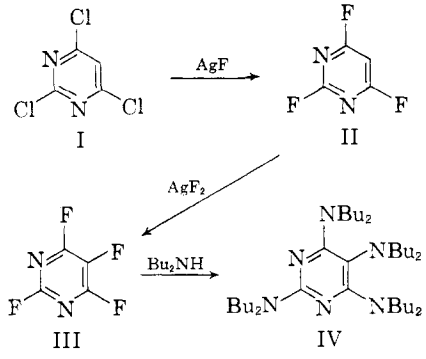
Sir:

To date there have been reported only two pseudo-aromatic perfluoro-N-heterocyclic parent compounds, namely, pentafluoropyridine and 2,4,6-trifluoro-s-triazine (cyanuric fluoride). The former compound was synthesized by defluorination of undecafluoropiperidine,[2] while cyanuric fluoride was obtained from cyanuric chloride (1) by means of potassium fluorosulfinate[3] or (2) with SbF_3Cl_2 (Swarts mixture).[4,5] Only the latter method led to exclusive formation of the desired perfluorinated triazine compound. Attempts to fluorinate other nuclear chlorinated heterocycles, such as chloropyrimidines, with SbF_3Cl_2 resulted in failure.[6]

In connection with an investigation of fluorinated heterocyclic compounds, we were interested in the synthesis of perfluorinated pyrimidine. Using 2,4,6-trichloro-pyrimidine[7] (I) as starting material, we employed silver fluoride (AgF) as the suitable inorganic fluorinating agent for the replacement of the chlorine atoms with fluorine. This selection was based upon the results of a comparative study of the effectiveness of SbF_3Cl_2, AgF, AgF_2 and HgF_2 upon certain chloro-s-triazines.[8] When compound I was refluxed and distilled from fresh AgF three times, 2,4,6-trifluoropyrimidine (II), b.p. 98°, was obtained in a 76% yield.

The conversion of II into tetrafluoropyrimidine (III) required the substitution of the hydrogen atom in 5-position by fluorine which was accomplished by means of silver difluoride (AgF_2). The reaction of II with AgF_2 either at reflux temperature or at 280° in an autoclave led to an incompletely fluorinated product; however, complete fluorination was achieved by carrying out the reaction in triperfluorobutylamine at 90°. Distillation of the reaction product gave III in 30% yield, b.p. 89°, $n^{25}D$ 1.3875 (calcd. for $C_4F_4N_2$: C, 31.60; F, 49.98; N, 18.42; found: C, 31.66; F, 49.70; N, 18.25). To our knowledge the direct replacement of hydrogen with fluorine in an aromatic system by means of silver difluoride in the liquid phase without subsequent addition of fluorine to the double bonds constitutes a novel procedure for such fluorination.

The identity of III was established by its reaction with di-*n*-butylamine to give tetra-di-*n*-butylaminopyrimidine (IV), b.p. 196° (0.3 mm.). Compound IV also was obtained from tetrachloropyrimidine. Experimental details and the description of the derivatives of II and III will be the subject of a subsequent publication.



(1) This article is based on work performed under Project 116-B of The Ohio State University Research Foundation sponsored by the Olin Mathieson Chemical Corporation, New York, N. Y.

(2) J. Burdon, D. J. Gilman, C. R. Patrick, M. Stacey and J. C. Tatlow, *Nature*, **186**, 231 (1960).

(3) D. W. Grisley, Jr., E. W. Gluesenkamp and S. A. Heininger, *J. Org. Chem.*, **23**, 1802 (1958).

(4) A. F. Maxwell, J. S. Fry and L. A. Bigelow, THIS JOURNAL, **80**, 548 (1958).

(5) E. Kober and C. Grundmann, *ibid.*, **81**, 3769 (1959); U. S. Patent 2,845,421.

(6) Unpublished results of E. Kober and H. Ulrich.

(7) M. Langermann and K. C. Banks, THIS JOURNAL, **73**, 3012 (1951).

(8) Unpublished results.

(9) Olin Mathieson Chemical Corporation, New Haven, Connecticut.

THE OHIO STATE UNIVERSITY
RESEARCH FOUNDATION HANSJUERGEN SCHROEDER[9]
COLUMBUS 10, OHIO

RECEIVED JUNE 22, 1960

THE STEREOCHEMISTRY OF THE SUCCINIC DEHYDROGENASE REACTION[1]

Sir:

The stereochemistry of the succinic dehydrogenase reaction was examined by Englard and Colowick in 1956.[2] From the data obtained on the exchange of the methylene hydrogen atoms with D_2O, it was concluded that the elimination of 2H is either random or *trans*. We now wish to report the results of some recent experiments which show that the elimination is not random, but is *trans* in nature.

Samples of fumaric acid and maleic acid were reduced catalytically with D_2 using Pd on charcoal as catalyst and ethyl acetate as solvent. The succinic acid obtained was oxidized by the Keilin–Hartree preparation of heart sarcosome.[3] An excess of ferricyanide was used to oxidize completely the succinic acid added. Although the sarcosome preparation contained fumarase, this would not affect the result since this enzymatic addition of water to fumarate has been shown to be stereo-

(1) This investigation was supported in part by a grant from the United States Public Health Service (No. H-4139 (C1)). The authors also wish to acknowledge the invaluable help from Dr. G. O. Dudek of Harvard University in the use of the analytical mass spectrometer.

(2) S. Englard and S. P. Colowick, *J. Biol. Chem.*, **221**, 1019 (1956).

(3) D. Keilin and E. F. Hartree, *Proc. Roy. Soc. (London)*, **B129**, 277 (1940). The grinding in a mortar was replaced by the use of a Waring Blendor.