ature independent at 3130 Å. If this compound should prove to be isopropyl iodide, a new primary process is indicated in which isopropyl radicals are formed. Further experiments are in progress to establish unequivocally the structure of this iodide and the nature of the reaction by which it is formed.

DEPARTMENT OF CHEMISTRY
NORTHWESTERN UNIVERSITY
EVANSTON, ILLINOIS JAMES N. PITTS, JR.[6]
DEPARTMENT OF CHEMISTRY
UNIVERSITY OF CALIFORNIA
LOS ANGELES, CALIFORNIA F. E. BLACET

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[6] du Pont Fellow in Chemistry, University of California, Los Angeles, 1947–1949.

THE ISOLATION OF AN ISOMERIC CYTIDYLIC ACID FROM HYDROLYSATES OF YEAST RIBONUCLEIC ACID[1]

Sir:

In search of an explanation for the variations in optical activity reported for different samples of cytidylic acid, from $[\alpha]_D + 36.7°$ to $[\alpha]_D + 49.1°$,[2] we have examined various cytidylic acid fractions isolated from yeast ribonucleic acid hydrolysates. After *N* acid hydrolysis for one hour and removal of purines with silver sulfate in acid solution, the cytidylic acid fraction was separated from uridylic acid as the insoluble phospho-12-tungstate.[3] Upon recrystallization, the most insoluble fraction was converted to free cytidylic acid which, recrystallized from water, gave a product melting with decomposition at 238–239° (in bath at 230°) and giving $[\alpha]^{23}_D + 20.7°$, *c*, 1.0 in water. *Anal.* Found: N, 12.9; P, 9.75. Calcd. for $C_9H_{14}O_8N_3P$: N, 13.0; P, 9.6. The cytidylic acid obtained from the remaining phosphotungstates gave crystalline fractions ranging in rotation from $[\alpha]_D + 30°$ to $[\alpha]_D + 40°$, consisting evidently of nearly equimolar mixtures of the two isomers, $[\alpha]_D + 20.7°$ and $[\alpha]_D + 49°$. The latter has been obtained from a mixture of dibrucine cytidylate and uridylate by extraction with pyridine and recrystallization of the pyridine insoluble residue from 35% alcohol. A sample with $[\alpha]^{20}_D + 49.4°$ decomposed at 233–234° (in bath at 230°). *Anal.* Found: N, 13.06; P, 9.36.

Another sample of yeast ribonucleic acid was hydrolyzed in *N* sodium hydroxide at room temperature for nineteen hours. The solution was neutralized with formic acid and the nucleotides partly removed on a Dowex-1 formate ion exchange column.[4] The cytidylic acid fraction was eluted with 0.1 *N* formic acid and again placed on a Dowex-1 formate column. Elution with 0.05 *N* formic acid gave effluents with optical density ratios, 278 mμ/260 mμ, in 0.1 *N* hydrochloric acid ranging from 1.83 to 2.0. Concentration of the fractions giving ratios from 1.83 to 1.89 to dryness and recrystallization of the residue gave a product with $[\alpha]_D + 20.6°$, *c*, 0.5%. *Anal.* Found: C, 33.26, 33.4; H, 4.34, 4.43; N, 12.97, 13.18. Calcd. for $C_9H_{14}O_8N_3P$: C, 33.4; H, 4.03; N, 13.0. Fractions with ratios from 1.96 to 2.0 treated similarly gave a product with $[\alpha]_D + 49°$, *c*, 0.5%. The two isomers obtained by these procedures gave similar decomposition points as found above.

The natural cytidylic acid isomer, $[\alpha]_D + 20.6°$, agrees in properties with synthetic cytidine-2-phosphate as given by Gulland, *et al.*[5] Data on the properties of the latter compound, however, are conflicting.[6] The low-rotating compound in our experiments was not oxidized by periodate and, therefore, contained no cytidine-5-phosphate.

The cytidylic acid, $[\alpha]_D + 49°$, on deamination[7] gave a product which could be isolated readily in 87% yield as a dibrucine salt with $[\alpha]_D - 58.7°$, *c*, 1.0 in pyridine. The solubility of this compound and its rotation are similar to those of the dibrucine salts of both the uridylic acid usually isolated and synthetic uridine-3-phosphate.[6] The low-rotating cytidylic acid on deamination under similar conditions gave a much more soluble brucine salt which has not yet been fully characterized.

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DEPARTMENT OF CHEMISTRY AND
THE SCHOOL OF MEDICINE
STANFORD UNIVERSITY
STANFORD, CALIFORNIA
HUBERT S. LORING
NYDIA G. LUTHY
HENRY W. BORTNER
LUIS W. LEVY

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[1] Aided by a grant from the Rockefeller Foundation.

[2] G. R. Barker, J. M. Gulland, H. Smith and J. F. Thomas, *J. Chem. Soc.*, 904 (1949); H. Bredereck and G. Richter, *Ber.*, **71**, 718 (1938).

[3] H. S. Loring, P. M. Roll and J. G. Pierce, *J. Biol. Chem.*, **174**, 729 (1948).

[4] W. E. Cohn, THIS JOURNAL, **71**, 2275 (1949).

[5] J. M. Gulland and H. Smith, *J. Chem. Soc.*, 1527 (1948).

[6] A. M. Michelson and A. R. Todd, *ibid.*, 2476 (1949); D. M. Brown, L. J. Haynes and A. R. Todd, *ibid.*, 408 (1950).

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[8] The report of the isolation of an isomeric cytidylic acid presented in this paper was first received on February 21, 1950.

HETEROGENEITY IN PYRIMIDINE NUCLEOTIDES

Sir:

Previous communications from this laboratory[1,2,3,4] have presented evidence for isomerism in the naturally occurring purine ribonucleotides, adenylic and guanylic acids, the nature of which remains to be established. The first step in the establishment of this heterogeneity—namely, two peaks in the ion-exchange elution diagram—has now been duplicated in the pyrimidine nucleotides, cytidylic and uridylic acids (see Fig. 1), iso-

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[1] C. E. Carter and W. E. Cohn, *Federation Proc.*, **8**, 190 (1949).

[2] W. E. Cohn, THIS JOURNAL, **71**, 2275 (1949).

[3] W. E. Cohn, *ibid.*, **72**, 1471 (1950).

[4] C. E. Carter, *ibid.*, **72**, 1466 (1950).