

pool from which transformation products are formed.

The metabolism of cholesterol and its conversion to pregnenolone by adrenal homogenates have been consistently demonstrated in three additional experiments in approximately the same yield. The full details of these studies will be published subsequently. We should like to thank Dr. Harris Rosenkranz and Mr. Paul Skogstrom for the analysis and interpretations of the infrared spectra.

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### MASS SPECTRUM OF OCTABORANE

Sir:

From recent mass spectrographic studies<sup>1</sup> of various boron hydrides we have observed the mass spectrum of an octaborane, the existence of which was first postulated by Burg and Schlesinger<sup>2</sup> from vapor tension measurements.

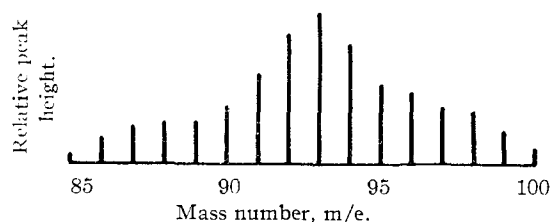


Fig. 1.—Partial mass spectrum of octaborane.

The mass spectrum of octaborane from mass numbers 85 to 100 is given in Fig. 1. The dominant peak occurs at mass number 93, and double ionization peaks are found in the region of mass numbers 44–48. The sharp cut-off in peak heights at mass number 100 suggests that the composition of the octaborane is  $B_8H_{12}$ , thus indicating that this compound belongs to the group of the (more) stable boron hydrides.<sup>3</sup>

In addition to the above findings we have been able to confirm Norton's finding of nonaborane.<sup>4</sup>

(1) A Consolidated Engineering Model 21-103 Mass Spectrometer operating at 70 volts was used in these studies.

(2) A. B. Burg and H. I. Schlesinger, *THIS JOURNAL*, **55**, 4009 (1933).

(3) E. Wiberg, *Ber.*, **69B**, 2816 (1936).

(4) F. J. Norton, *THIS JOURNAL*, **72**, 1849 (1950).

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### BIOSYNTHESIS OF OROTIC ACID FROM CITRULLINE

Sir:

Orotic acid, a pyrimidine precursor in bacteria<sup>1</sup> and in the rat,<sup>2</sup> is believed to arise from aspartate

(1) L. D. Wright, C. S. Miller, H. R. Skeggs, J. W. Huff, L. L. Weed and D. W. Wilson, *THIS JOURNAL*, **73**, 1898 (1951).

(2) H. Arvidson, N. A. Eliasson, E. Hammarsten, P. Reichard, H. von Ubich and S. Bergstrom, *J. Biol. Chem.*, **179**, 169 (1949).

via ureidosuccinate and dihydroörotate. Ureido-succinate has been pictured as arising from arginine-succinate, based on the finding that the ureide carbon of citrulline<sup>3</sup> as well as carbon dioxide<sup>4</sup> contribute to position-2 of tissue pyrimidines in the pigeon. In the rat and in rat liver homogenates, no such incorporation from citrulline could be demonstrated,<sup>3,5</sup> and this failure was attributed to active degradation of citrulline to urea in mammalian liver. In the present study, pigeon and rat liver slices have been compared in regard to incorporation into orotic acid of the ureide carbon of citrulline and the amidine carbon of arginine.

L(+)-Citrulline was prepared from urea-C<sup>14</sup> by the method of Kurtz.<sup>6</sup> L(+)-Arginine-HCl was synthesized from cyanogen bromide-C<sup>14</sup> via O-methylisouronium chloride.<sup>6</sup> Both materials had specific activities of  $2.84 \times 10^6$  c.p.m. per mmole. Incubation was carried out essentially according to Reichard<sup>7</sup> using 15–18 g. of pigeon or rat liver slices, 50 ml. of Krebs–Henseleit bicarbonate medium supplemented with 90 mg. of glucose, 50 mg. of sodium ATP and 15 mg. of carrier orotic acid. Each bath also contained either 0.1 mmole of L-citrulline-C<sup>14</sup> + 0.5 mmole of L-aspartate or 0.1 mmole of L-arginine-HCl-C<sup>14</sup> + 0.5 mmole of fumarate. After 4 hours of incubation at 37°, orotic acid was recovered from each deproteinized medium as described by Reichard.<sup>7</sup> The product was characterized by ultraviolet absorption spectrum and m.p. (341–343°) after recrystallization from water. All samples were combusted, and counted as barium carbonate under a thin-window Geiger–Mueller counter.

TABLE I

#### RADIOACTIVITY OF ISOLATED OROTIC ACID FROM LIVER SLICE STUDIES

Substrate	Rat liver, c.p.m. per milliatom C	Pigeon liver, c.p.m. per milliatom C
L(+)-Citrulline-C <sup>14</sup>	3,390	0
L(+)-Citrulline-C <sup>14</sup>	3,040	0
L(+)-Arginine-C <sup>14</sup>	0 <sup>a</sup>	0
L(+)-Arginine-C <sup>14</sup>		0

<sup>a</sup> Zero means <3 c.p.m. above background of ca. 25 c.p.m.

In contrast to expectations based upon the work of others cited above, significant incorporation of ureide carbon of citrulline into orotic acid was observed with rat but not with pigeon liver slices (Table I). An apparent paradox, as yet unresolved, arises from the demonstration that in the rat citrulline → orotic acid (present study), orotic acid → pyrimidines,<sup>8</sup> yet citrulline failed to contribute specifically to pyrimidines.<sup>3,5</sup> In the pigeon no contribution from citrulline to orotic acid was detected (present study) yet citrulline has been shown to contribute to pyrimidines.<sup>3</sup> The present findings complement the earlier ob-

(3) M. P. Shulman and S. J. Badger, *Federation Proc.*, **13**, 292 (1954).

(4) M. R. Heinrich and D. W. Wilson, *J. Biol. Chem.*, **186**, 447 (1950).

(5) C. Cooper and D. W. Wilson, *Federation Proc.*, **13**, 194 (1954).

(6) A. C. Kurtz, *J. Biol. Chem.*, **122**, 477 (1937–38), and **180**, 1253 (1949).

(7) P. Reichard, *J. Biol. Chem.*, **197**, 391 (1952).

(8) L. L. Weed and D. W. Wilson, *J. Biol. Chem.*, **189**, 435 (1951).