The angles between the lithium and boron vary from 97 to 116°. A tetrahedral arrangement of the hydrogens about the boron leads to an arrangement in which each lithium is surrounded by four hydrogen atoms which are arranged about it in the form of a distorted tetrahedron, each of the hydrogens being from a different borohydride group. The over-all structure of lithium borohydride may be described as that of strings of borohydride tetrahedra stacked edge on edge in the b direction of the crystal.

Lithium borohydride does not appear to be isomorphous with lithium aluminum hydride, lithium perchlorate, lithium fluoborate, or with the sulfates of magnesium and beryllium.

More complete details will be presented shortly.

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RECEIVED APRIL 18, 1947

THE COMPETITIVE INHIBITION OF THE METABOLISM OF α-AMINO ACIDS BY THEIR HALOGENATED ANALOGS

Sir:

A wild type strain of *Neurospora crassa* 8815-3a, has been used for testing a number of halogenated phenylalanines and tyrosines in respect to their capacities as growth inhibitors. Relative activities of the individual compounds were determined from the quantities of substance required to reduce the growth rate of the mold in growth tubes[1] to one-half of the normal value. The tubes contained 10 ml. of minimal medium[2] solidified with one per cent. agar and a small amount of the natural amino acid corresponding to the derivative being tested. Some of the results obtained are given in Table I.

INHIBITION OF GROWTH OF *Neurospora crassa* BY SOME HALOGENATED α-AMINO ACIDS

Compound	Mg./ml. for 50% inhibition[a]	moles inhibitor / moles amino acid
3-Fluoro-DL-phenylalanine	0.04	1.2
3-Fluoro-DL-tyrosine	.23	10.5
3-Fluoro-L-tyrosine	.15	6.8
3-Fluoro-D-tyrosine	.41	18.5

[a] Tubes for testing phenylalanine derivatives contained 0.03 mg./ml. of DL-phenylalanine; for tyrosine derivatives 0.02 mg./ml. of L-tyrosine.

It also has been shown that the inhibitory quotients for 2-chloro-, 3-chloro-, 4-chloro-, 3-bromo-, 3-iodo-DL-phenylalanine and for 3,5-difluoro-DL-tyrosine are greater than 150 and that the inhibitory action observed for all compounds is competitive in nature. Further it has been noted that effective inhibitors exhibit a high degree of specificity.

In respect to the inhibitory action of 3-fluoro-D-tyrosine and 3-fluoro-L-tyrosine the L-isomer is the more active of the two but in the presence of the D-isomer the mold produces considerable quantities of a dark brown pigment, an effect which is not observed with either the L-isomer or the racemic mixture. It is evident that the above actions must be interpreted in terms of at least two different systems concerned with the metabolism of tyrosine.

The most effective of the inhibitors described have not been tested on pure cultures of organisms other than *Neurospora*. However, it has been demonstrated that 3-fluoro-DL-phenylalanine is far more effective than sulfathiazole for inhibition of growth of those micellaneous airborne yeasts, molds and bacteria that can be obtained on exposed plates containing a yeast extract–agar medium.

The outstanding effectiveness of the monofluoro-phenylalanines and tyrosines as competitive inhibitors for their parent amino acids, and as antimetabolites, may be interpretable on simple steric grounds associated with the small size of the fluorine atom. In this connection it may be significant to consider the *p*-aminobenzoic acid reversal of the inhibition of growth of *E. coli* by 3-fluoro-*p*-aminobenzoic acid,[3] the apparent replacement of *p*-aminobenzoic acid by 2-fluoro-*p*-aminobenzoic acid[3] and the inhibition of acetate metabolism by fluoroacetate.[4]

Studies are now in progress on the effectiveness of the various isomeric monofluoro-tyrosines and phenylalanines as growth inhibitors in *Neurospora* and other biological systems and in extending the principles disclosed in the case of the above two α-amino acids to other α-amino acids.

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(2) G. W. Beadle and E. L. Tatum, *ibid.*, **32**, 678 (1945).

(3) (a) F. C. Schmelkes and M. Rubin, THIS JOURNAL, **66**, 1631 (1944); (b) O. Wyss, M. Rubin and F. B. Strandskov, *Proc. Soc. Exptl. Biol. Med.*, **52**, 155 (1943).

(4) (a) E. S. Guzman-Barron, G. R. Bartlett and G. Kalnitsky, *Proc. Fed. Am. Soc. Expll. Biol.*, **5**, 121 (1946); (b) E. S. Guzman-Barron and G. Kalnitsky, *Biol. Bull.*, **91**, 238 (1946).

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THE DECARBONYLATION OF ETHYL PYRUVATE[1]

Sir:

The decarbonylation of α-keto-esters has importance in synthetic chemistry,[2] and related reactions are widely postulated in biochemical mechanisms. We have investigated one aspect of the mechanism of the thermal decarbonylation of ethyl pyruvate with the aid of C^{14}. Pyruvic ester labelled in the α carbon atom was synthesized by the following sequence of reactions:

(1) This paper is based on work performed under Contract #W-7405-Eng-48 with the Atomic Energy Commission in connection with the Radiation Laboratory, and the Department of Chemistry, University of California, Berkeley, California.

(2) "Org. Synth.," Coll. Vol. II, p. 531.