obtained from syntheses on the one millimole scale by this procedure melted at 110–129°, and melted at 125–130° after purification. On a five millimole scale the products melted at 123–131°, and melted at 131–133° after purification. These products were considered sufficiently pure for syntheses and were not purified further.

A typical isotopic synthesis, using 2.53 millimoles (0.500 g. containing 5 mc. of C^{14}) of barium carbonate gave a yield of 144.8 mg. of urea (95.2%) melting at 125–130°. Recrystallized from acetone, the yield was 123 mg. melting at 132–133°. This product contained 1.98 millicuries/millimole.

Summary

Urea has been synthesized using barium carbonate containing C^{14} to give a 95.2% yield of product containing 1.98 millicuries of radioactivity per millimole. The method employed involved a new synthesis of cyanamide.

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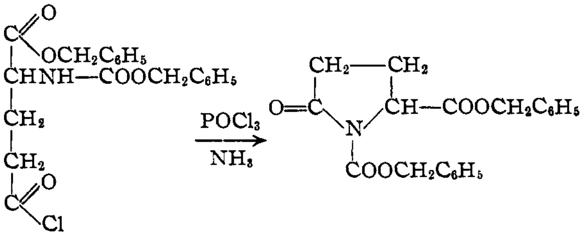
NOTES

The Preparation of Benzyl N-Carbobenzoxypyrrolidone-2-carboxylate-5

By Max Berenbom[1] and Julius White

In the synthesis of glutamine by the method of Bergmann, Zervas and Salzmann,[2] one of the steps is the formation of α-benzyl N-carbobenzoxyglutamoyl chloride (I) by treating the corresponding carboxylic acid with phosphorus pentachloride. The phosphorus oxychloride formed in this reaction is washed out with petroleum ether. (I) is then treated with an ice cold solution of ammonia in ether to form the amide which is subsequently hydrogenated to yield glutamine. We wish to point out that if the phosphorus oxychloride is not removed in the preparation of (I), subsequent treatment with ammonia yields benzyl N-carbobenzoxypyrrolidone-2-carboxylate-5 (II), instead of the desired amide.



(I) (II)

This compound (II), m. p. 110° (uncorrected), $[\alpha]^{25}\text{D}$ − 39.5 (in ethanol), which has not been described previously can be obtained in 70% yield. It is insoluble in water, ether, petroleum ether, and benzene, soluble in ethanol and methanol.

Anal. Calcd. for $C_{20}H_{19}NO_5$: C, 68.0; H, 5.7; N, 4.0. Found: C, 68.1; H, 5.7; N, 3.9.

(II) was identified by hydrogenation in methanol in the presence of palladium to yield 90% of 2-pyrrolidone-5-carboxylic acid, m. p. 162–164° (uncorrected), $[\alpha]^{25}\text{D}$ − 11.4 (in water).[3] A mixed melting point of the hydrogenated product with synthetic 2-pyrrolidone-5-carboxylic acid showed no depression.

Anal. Calcd. for $C_5H_7NO_3$: C, 46.5; H, 5.7; N, 10.9. Found: C, 46.8; H, 5.7; N, 10.9.

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[2] M. Bergmann, L. Zervas and L. Salzmann, *Ber.*, **66**, 1288 (1933).

[3] M. Bergmann and L. Zervas, *Z. physiol. Chem.*, **221**, 51 (1933).

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The Exchange between a Formamido Group and Formamide, Studied with C^{13},[1]

By Liebe F. Cavalieri and George Bosworth Brown

Adenine (I) may be prepared by heating 4,6-diamino-5-formamidopyrimidine (II) in formamide.[2] In order to prepare adenine labeled with C^{13} in the 8-position, 4,5,6-triaminopyrimidine (III) as the sulfate was converted to II by formylation with C^{13} labeled formic acid. When the sulfate of II was heated in formamide, extensive exchange with the formamide occurred and only 25% of the carbon isotope contained in II was found in the adenine (I) which resulted. Formamide decomposes to ammonia and carbon monoxide when heated[3] and it is probable that the mechanism for the exchange involves ammonolysis of the formyl group.[4]

Evidence in support of this mechanism is found in the fact that the triamine (III) when heated with formamide is converted to adenine in 62% yield. Further, it appears that once the adenine is formed it remains intact, since a sample of adenine subjected to the reaction conditions was recovered in quantitative yield (95%).

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[1] The authors wish to acknowledge the assistance of the Office of Naval Research and the National Cancer Institute of the United States Public Health Service.

[2] Cavalieri, Tinker and Bendich, This Journal, **71**, 533 (1949).

[3] Freer and Sherman, *Am. Chem. J.*, **20**, 223 (1898).

[4] In general when pyrimidine sulfates are cyclized to purines in formamide one mole of ammonium sulfate is recovered; Bendich, Tinker and Brown, This Journal, **70**, 3109 (1948).