creatic ribonuclease. In the latter case, uridine-2′,3′ cyclic phosphate was, as expected, an intermediate in the degradation. The synthetic material was, furthermore, chromatographically and electrophoretically identical with a sample of uridylyl-(5′→3′)-uridine prepared enzymically by the general method of Heppel, Whitfeld and Markham.[7]

Further work on the synthesis of C_5'–C_3' linked ribo-oligonucleotides is in progress.

(7) L. A. Heppel, P. R. Whitfeld and R. Markham, *Biochem. J.*, **60**, 8 (1955).

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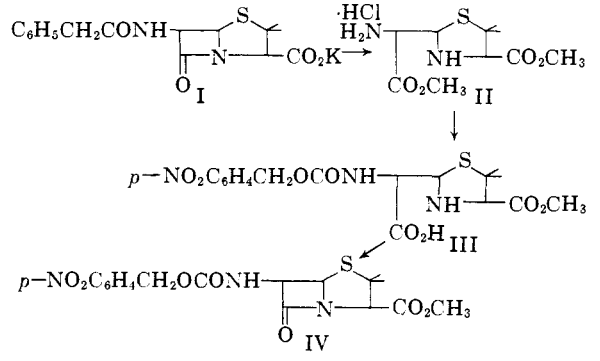
THE CHEMICAL CONVERSION OF PENICILLIN G INTO A BIOLOGICALLY ACTIVE SYNTHETIC PENICILLIN SERIES

Sir:

We wish to report the chemical removal of the phenylacetic acid side chain from penicillin G (I) to form compound II, thus opening up a promising route for the preparation of synthetic penicillins. Compound II has been converted into an intermediate (III) in a total synthetic series, thereby completing by relay a transition between a "natural" penicillin and a biologically active synthetic penicillin not directly available previously by fermentation.

Potassium benzylpenicillinate (penicillin G, potassium salt) was treated with methanol containing a catalytic amount of triethylamine to form potassium α-methyl D-α-benzylpenicilloate, which was converted directly in 22% over-all yield by reaction with methanolic hydrogen chloride to methyl D-α-4-carbomethoxy-5,5-dimethyl-α-amino-2-thiazolidineacetate hydrochloride (II), $C_{10}H_{19}ClN_2O_4S$, m.p. 174–175° dec., $\alpha^{25}D$ + 104° (C, 1.34 in methanol) [found: C, 40.28; H, 6.38; N, 9.34].

It was established that no change in configuration took place during the methanolysis by the conversion of II to the known[1] dimethyl D-α-benzylpenicilloate [m.p. 87–88°, $\alpha^{25}D$ + 82.2°] in 72% yield with phenylacetyl chloride and triethylamine. Identity with an authentic sample was established by comparison of optical rotation, melting point, mixed melting point and infrared spectra (KBr).



(1) H. T. Clarke, J. R. Johnson and R. Robinson, editors, "The Chemistry of Penicillin," Princeton University Press, Princeton, New Jersey, 1949, p. 613.

Acylation of the primary amine grouping in II was accomplished with *p*-nitrobenzyl chloroformate[2] and triethylamine to yield methyl-D-α-4-carbomethoxy-5,5-dimethyl-α-(carbo-*p*-nitrobenzyloxyamido)-thiazolidineacetate. Saponification of the α-methyl ester grouping with one equivalent of sodium hydroxide and crystallization from acetone–ether yielded D-α-4-carbomethoxy-5,5-dimethyl-α-(carbo-*p*-nitrobenzyloxyamido)-thiazolidineacetic acid (III), $C_{17}H_{21}N_3O_8S$; m.p. 138–139°, $\alpha^{27}D$ + 60.9° (C, 1.17 in methanol). [Found, C, 47.57; H, 4.98; N, 9.83.] The infrared spectrum (KBr) of this acid was identical to that of the corresponding DL-derivative prepared by total synthesis.[3] The infrared spectrum of the hydrochloride of III, m.p. 187–188°, [found, C, 44.39; H, 5.25; N, 8.84] was identical to that of the corresponding DL-hydrochloride when measured in dimethyl sulfoxide solution.

We are indebted to Bristol Laboratories of Syracuse, N. Y., for financial support and for bioassays.

(2) F. H. Carpenter and D. T. Gish, THIS JOURNAL, **74**, 3818 (1952).

(3) The DL form of this compound has been prepared in this laboratory by G. C. Stelakatos using the general procedure of J. C. Sheehan and P. A. Cruickshank (THIS JOURNAL, **78**, 3683 (1956)). DL-III has been cyclized to methyl DL-6-(carbo-*p*-nitrobenzyloxyamido)-penicillanate in 38% yield.

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THE CONFIGURATION OF MOLECULAR COMPLEXES

Sir:

Orgel and Mulliken[1] have suggested that molecular complexes may involve a variety of different relative orientations of the donor and acceptor. In order to determine the geometrical restrictions on charge-transfer interactions in molecular complexes, we synthesized and determined the spectra of a series of molecules having both the donor and acceptor groups in the same molecule and in a relatively fixed orientation with respect to each other. The donor in each case was the *p*-aminophenyl system and the acceptor, the *p*-nitrophenyl group. The compounds studied were 4-amino-4′-nitrodiphenylmethane (I), m.p. 96.9–97.5° (found for $C_{13}H_{12}O_2N_2$: C, 68.55; H, 5.21); 4-amino-4′-nitrobibenzyl (II), m.p. 136.8–137.5° (found for $C_{14}H_{14}O_2N_2$: C, 69.18; H, 5.56); 4-amino-4′-nitro-α,ω-diphenylpropane (III), m.p. 92.0–92.7°, (found for $C_{15}H_{16}O_2N_2$: C, 70.52; H, 6.40); *cis*-1-(4-aminophenyl)-2-(4-nitrophenyl)-cyclopentane (IV), m.p. 112.2–113.0° (found for $C_{17}H_{18}O_2N_2$: C, 72.25; H, 6.67); and *trans*-1-(4-aminophenyl)-2-(4-nitrophenyl)-cyclopentane (V), m.p. 76.5–77.3° (found for $C_{17}H_{18}O_2N_2$: C, 72.52; H, 6.53).

Compound I involves a 2.52 Å. separation for the 1-atoms of the ring and a 7.02 Å. separation for the 4-atoms. The aromatic rings in II and III can have an infinite variety of orientations with respect to each other because of rotation about the chain bonds. In IV the aromatic nuclei are practically

(1) L. E. Orgel and R. S. Mulliken, THIS JOURNAL, **79**, 4839 (1957).