COMMUNICATIONS TO THE EDITOR

KANAMYCIN. IV. THE STRUCTURE OF KANAMYCIN

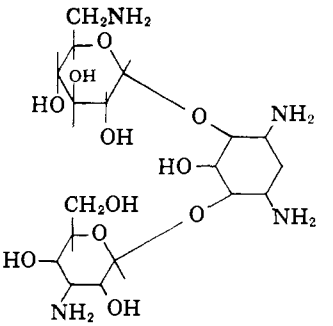
Sir:

The N-acetyl derivative of kanosamine,[1] the remaining unknown moiety of kanamycin,[2] rapidly consumes one mole of periodate in unbuffered 0.01*N* $NaIO_4$ solution with the formation of one mole of formic acid. Treatment with a large excess of periodate at *p*H 7 yielded 2.8 moles of formic acid and 0.7 mole of formaldehyde after the consumption of 6.2 moles of periodate, values very similar to those obtained in a parallel experiment with N-acetyl-2-glucosamine. Kanosamine thus must be a straight-chain aldohexosamine. Tetra-N-acetylkanamycin in 0.5*N* $NaIO_4$ solution at *p*H 2.5 rapidly consumed 2 moles of periodate with the formation of 1 mole of formic acid and no formaldehyde. Chromatography of the hydrolyzed reaction mixture on Whatman 52 paper in a 1-butanol, pyridine, water, acetic acid, 6:4:3:1, system showed 2-deoxystreptamine (R_f 0.09), kanosamine (R_f 0.23), and a new material of R_f 0.16 but no 6-glucosamine[1] (R_f 0.14). Together with the data cited above, this lack of oxidation of the N-acetylkanosamine moiety requires that kanosamine be a 3-deoxy-3-aminoaldohexose. These data also indicate the presence of pyranose rings in both the 6-glucosamine and kanosamine moieties of kanamycin. Nitrous acid deamination of crude O-acetylated kanosamine and reacetylation gave α-D-glucopyranose pentaacetate, confirming the straight-chain aldohexose formulation for kanosamine and establishing C 5 as being of the *D* configuration.

Kanamycin base was hydrolyzed under mild conditions (2 hr. boiling, 2 *N* HCl) and the products separated by paper chromatography. Two separate spots running between unchanged kanamycin and deoxystreptamine were eluted separately, hydrolyzed and rechromatographed yielding deoxystreptamine and kanosamine from the faster-moving and deoxystreptamine and 6-glucosamine from the slower-moving material, thus proving that both hexosamines are glycosidically linked to deoxystreptamine.

Kanamycin base in *p*H 4–5 $NaIO_4$ solution rapidly consumed 6 moles of periodate. Paper chromatography of the reaction mixture hydrolyzate showed the presence of deoxystreptamine and complete absence of 6-glucosamine and kanosamine. The survival of deoxystreptamine under these reactions conditions is indicative of substitution at the 4 and 6 positions of deoxystreptamine[3] and allows one to write a structure for kanamycin.

It should be pointed out that even though deoxystreptamine is a *meso* form with all-*trans* configuration[4] positions 4 and 6 on the deoxystreptamine moiety are not sterochemically equivalent. Studies on this and other remaining configurational problems are under way.



(1) M. J. Cron, O. B. Fardig, D. L. Johnson, H. Schmitz, D. F. Whitehead, I. R. Hooper and R. U. Lemieux, THIS JOURNAL, **80**, 2342 (1958).

(2) T. Takeuchi, T. Hikiji, K. Nitta, S. Yamazuki, S. Abe, H. Takayama and H. Umezawa, *J. Antibiotics*, Ser A, **10**, 107 (1957); M. J. Cron, D. L. Johnson, F. M. Palermiti, Y. Perron, H. D. Taylor, D. F. Whitehead and I. R. Hooper, THIS JOURNAL, **80**, 752 (1958).

(3) Lack of oxidation of deoxystreptamine under these conditions does not completely exclude substitution at the 4 (6) and 6 positions of deoxystreptamine. Resistance of the α-amino alcohol grouping to periodate oxidation must be considered a definite possibility, although unlikely to occur (*cf.* G. Dangschat and H. Fischer, *Naturwissenschaften* **30**, 146 (1942)).

(4) F. A. Kuehl, Jr., M. N. Bishop and K. Folkers, THIS JOURNAL, **73**, 881 (1951); J. R. Dyer, Thesis, University of Illinois, 1954.

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CRYSTALLINE POLY-(*t*-BUTYL ACRYLATE)

Sir:

We have prepared crystalline poly-(*t*-butyl acrylate) using lithium dispersions (0.1 to 1% lithium based on monomer) as polymerization catalysts. This has been done with the monomer alone and with mixtures of monomer and hexane. The purity of the monomer is very important for the preparation. In early experiments, there was an induction period of 2 to 3 weeks at 50°, followed by rapid polymerization that went to about 90% of completion. With purer monomer, the induction period has been cut to 1 to 2 days at room temperature. The crystalline polymer, 35 to 60% of the total polymer, was separated from the amorphous polymer by its insolubility in boiling acetone, a solvent which readily dissolves the amorphous polymer. Crystalline poly-(*t*-butyl acrylate) has been made with weight average molecular weights from 160,000 to 2,000,000. The crystalline polymer is insoluble in most solvents, *i.e.*, monomer, hexane, benzene, acetone, *etc.*, but does dissolve in hot chloroform.

That the polymer is crystalline is shown by (1) sharp lines in its X-ray diffraction pattern with "d" spacings at 10.9 (2), 9.3 (8), 5.3 (10), 4.6 (3), 4.2 (1) and 3.7 (1) Å. (figures in parentheses indicate

relative intensities), (2) a 5% density difference between the amorphous and crystalline polymers (0.99 as against 1.04), (3) a 35° difference in softening points between the amorphous and crystalline polymers (37 as against 72°), (4) the observation of definite birefringent spherulites, and (5) a splitting of infrared bands which disappears above 72° and reappears on cooling. The change in the appearance of the infrared absorption spectrum on melting is shown in Fig. 1 for the frequency range between 1500 and 1050 cm.$^{-1}$.

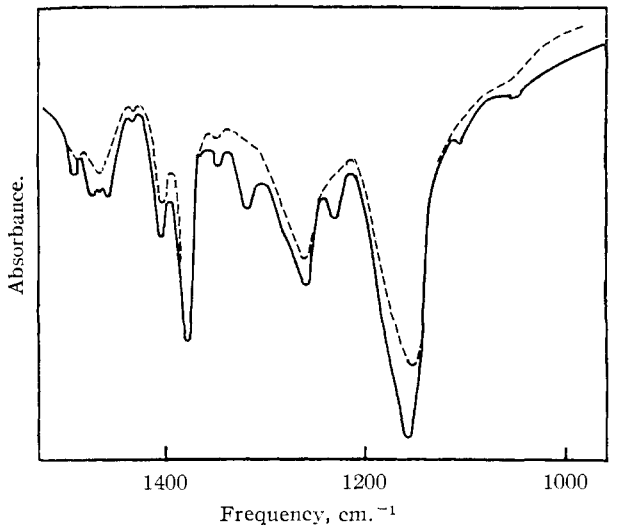

Fig. 1.—Infrared absorbance of poly-(*t*-butyl acrylate): ---------, melted; ———, crystalline.

The same polymerization technique gave crystalline polymer from *t*-butyl methacrylate but not from methyl acrylate, *n*-butyl, *sec*-butyl or *iso*-butyl acrylates (or the corresponding methacrylates[1]). This suggests that steric factors are helpful in obtaining stereospecific polymerization. We were not able to prepare crystalline polymers from cyclohexyl acrylate.

(1) Fox and associates, THIS JOURNAL, **80**, 1768 (1958), have prepared crystalline poly-(methyl methacrylate) using different techniques from ours and lower temperatures.

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STRUCTURE OF SUPRASTEROL-II[1]

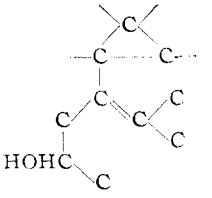
Sir:

Suprasterol-II, an ultraviolet irradiation transformation product of Vitamin D_2, has been shown to possess the normal ergosterol side-chain[2] and an acylatable hydroxyl group.[3,4] The nature of the ring system[5] and the degree of unsaturation remained in doubt.[5,6] Present findings permit the assignment of a novel structure to this material.

Suprasterol-II possesses 4 C-methyl groups (Kuhn–Roth) and upon quantitative microhydrogenation in acetic acid is found to have three reactive groupings, one of which is the *trans*-symmetrically disubstituted double bond (970 cm.$^{-1}$) in the side-chain. The nuclear magnetic resonance spectrum indicates only *two* vinyl protons. Hydrogenation over Pd–$CaCO_3$ yields the 22-dihydro derivative (no 970 cm.$^{-1}$ band; m.p. 120–121°; C, 84.12; H, 11.64) which shows no vinyl proton absorption in the n.m.r. Suprasterol-II with osmium tetroxide gives a triol (m.p. 248–256°; C, 77.95; H, 10.06; 970 cm.$^{-1}$) which upon hydrogenation yields a 22-dihydro derivative (m.p. 232–233°; C, 77.71; H, 11.45) possessing no absorption in the ultraviolet (ϵ_{205} 140). Thus, suprasterol-II possesses a *trans*-disubstituted and a tetrasubstituted double bond and five rings, one of which is reactive toward hydrogenolysis.

Tetrahydrosuprasterol-II (m.p. 99–100°, lit.[6] 99–102°) shows high end absorption in the ultraviolet (ϵ_{205} 5200) and no vinyl proton absorption in the n.m.r. and possesses 4 C-methyl groups. The triol (m.p. 180–182°; C, 77.19; H, 11.36) obtained by OsO_4 reaction shows no ultraviolet absorption and upon cleavage with lead tetraacetate yields an oily product possessing no aldehyde groupings. Thus, tetrahydrogenation saturates the side-chain double bond and cleaves a ring (indicating a cyclopropane structure) and leaves the tetrasubstituted olefinic linkage. The generation of no additional C-methyl groups suggests the absence of a methylenic grouping in the cyclopropane ring.

22-Dihydrosuprasterol-II (λ_{max} 210 mμ, ϵ 7100) upon oxidation with CrO_3–H_2SO_4 in acetone yields an oily ketone (no maximum above 220 mμ) which upon chromatography over alumina gives 22-dihydroisosuprasterone-II (λ_{max} 268 mμ, ϵ 19,200; m.p. 125–126°; C, 84.39; H, 11.06; semicarbazone m.p. 234–235° (dec.); C, 77.39; H, 10.26). These data show that the tetrasubstituted double bond in suprasterol-II is β,γ to the hydroxyl and that the cyclopropane ring is attached to the β-carbon of the olefinic linkage, *i.e.*, conjugated before and after bond migration.



Tetrahydrosuprasterol-II upon similar oxidation also gives rise to an oily non-conjugated ketone which upon chromatography yields a crystalline, conjugated, unsaturated ketone, tetrahydroisosuprasterone-II (λ_{max} 242 mμ, ϵ 14,600; m.p. 66–68°; semicarbazone, m.p. 233–234° (dec.); C, 76.24; H, 10.75). Ozonization of the ketone, and then methylation of the resulting keto-ester, yields a liquid ester (C, 77.21; H, 11.09) with infrared absorption at 1736 cm.$^{-1}$ (ester) and 1704 cm.$^{-1}$ (six or larger ring ketone). Thus, the ketone possesses a trisubstituted double bond which

(1) This work was supported, in part, by grant No. G-3589(C)-Bio(5), U. S. Public Health Service.

(2) A. Guiteras, Z. Nakamiya and H. H. Inhoffen, *Ann.*, **494**, 116 (1932).

(3) A. Windaus, J. Gaede, J. Köser and G. Stein, *ibid.*, **483**, 17 (1930).

(4) P. Setz, *Z. physiol. Chem.*, **215**, 183 (1933).

(5) M. Müller, *ibid.*, **233**, 223 (1935).

(6) G. Ahrens, E. Fernholz and W. Stoll, *Ann.*, **500**, 109 (1933).