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A CONVENIENT SYNTHESIS OF 5′-DEOXYRIBONUCLEOSIDES

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ABSTRACT

A facile, two-step synthesis has been devised for the chemical preparation of 5′-deoxyribonucleosides from the parent nucleosides *via* the 5′-chloro-5′-deoxynucleosides. Treatment of 5′-chloro-5′-deoxynucleosides with tributyltin hydride and α,α′-azobis(isobutyronitrile) in dry tetrahydrofuran yields the corresponding 5′-deoxynucleosides. Dechlorination of 5′-chloro-5′-deoxythymidine with tributyltin hydride gives 1-(2,5-dideoxy-β-D-*erythro*-pentofuranosyl)thymine (5′-deoxythymidine) in good yield. Similarly, dechlorination of 9-(3,5-dichloro-2,3,5-trideoxy-β-D-*threo*-pentofuranosyl)adenine and 1-(3,5-dichloro-2,3,5-trideoxy-β-D-*threo*-pentofuranosyl)thymine yields the corresponding two trideoxynucleosides.

INTRODUCTION

5′-Deoxyadenosine (**2**) has been shown to be a product in several enzyme-catalyzed reactions. In the adenosylcobalamin-dependent enzyme-reactions, 5-′deoxyadenosine is formed from the adenosyl moiety of the coenzyme[1–6]. Recently, Knappe and Schmitt[7] have shown that *S*-adenosylmethionine is reductively cleaved to L-methionine and 5′-deoxyadenosine by an enzyme system that participates in the activation of pyruvate formate-lyase (EC 2.3.1.54).

Hitherto, 5′-deoxyadenosine and other deoxynucleosides have been prepared by lengthy procedures and in only relatively low yields. For instance, Michelson and Todd[8] reported the hydrogenation of 5′-deoxy-5′-iodothymidine to 5′-deoxythymidine in the presence of palladized barium sulfate. Wagner *et al.*[1] and Robins and co-workers[9] prepared 5′-deoxyadenosine, 9-(2,3-dideoxy-β-D-*glycero*-pentofuranosyl)-adenine (2′,3′-dideoxyadenosine), 9-(2,5-dideoxy-β-D-*erythro*-pentofuranosyl)adenine (2′,5′-dideoxyadenosine), and 9-(2,3,5-trideoxy-β-D-*glycero*-pentofuranosyl)adenine (2′,3′,5′-trideoxyadenosine) by Raney nickel desulfurization of the corresponding ethylthio derivatives. Earlier syntheses of (5-deoxy-D-ribofuranosyl)purines involved

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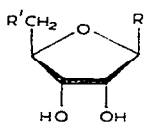
the condensation of 2,3-di-*O*-acetyl-5-deoxy-α(and β)-D-ribofuranosyl chloride with the appropriate (chloromercuri)purines[10], and the preparation of 9-(5-deoxy-β-D-arabinofuranosyl)adenine from 9-(5-deoxy-β-D-xylofuranosyl)adenine *via* the 2',3'-epoxide[11]. Duong and co-workers[12] described the dehalogenation of di-N^6-benzoyl-5'-deoxy-5'-iodo-2',3'-*O*-isopropylideneadenosine with tributyltin hydride, while, more recently, Robins *et al.*[13] used the same reagent to prepare 2'- and 3'-deoxyadenosine.

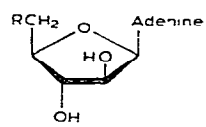
We now describe a convenient, two-step synthesis of certain deoxynucleosides; this synthesis involves the chlorination of the parent nucleoside with the hexamethylphosphoramide–thionyl chloride reagent described by Kikugawa and Ichino[14], followed by dechlorination with tributyltin hydride[15].

DISCUSSION

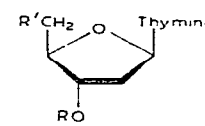
Reaction of ribo- and arabino-nucleosides with thionyl chloride in hexamethylphosphoramide gave exclusively the 5'-chloro-5'-deoxynucleosides which, on treatment with tributyltin hydride in dry tetrahydrofuran, with α,α'-azobis(isobutyronitrile) as the initiator, yielded the desired 5'-deoxynucleosides. Treatment of 2'-deoxyribonucleosides with thionyl chloride in hexamethylphosphoramide gave the 3',5'-dichloro-2',3',5'-trideoxynucleosides. Dechlorination of these dichloro-



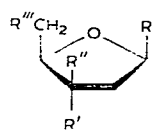
1 R = adenin-9-yl, R' = Cl
2 R = adenin-9-yl, R' = H
3 R = uracil-1-yl, R' = Cl
4 R = uracil-1-yl, R' = H
5 R = 4-amino-5-cyanopyrrolopyrimidin-7-yl, R' = OH
6 R = 4-amino-5-cyanopyrrolopyrimidin-7-yl, R' = Cl
7 R = 4-amino-5-cyanopyrrolopyrimidin-7-yl, R' = H
8 R = 4-amino-5-carboxamidopyrrolopyrimidin-7-yl, R' = H



9 R = Cl
10 R = H



11 R = Ac, R' = OH
12 R = Ac, R' = Cl
13 R = H, R' = Cl
14 R = R' = H



15 R = adenin-9-yl, R = H, R'' = R''' = Cl
16 R = adenin-9-yl, R' = R'' = R''' = H
17 R = thymin-1-yl, R' = H, R'' = R''' = Cl
18 R = thymin-1-yl, R' = R'' = R''' = H

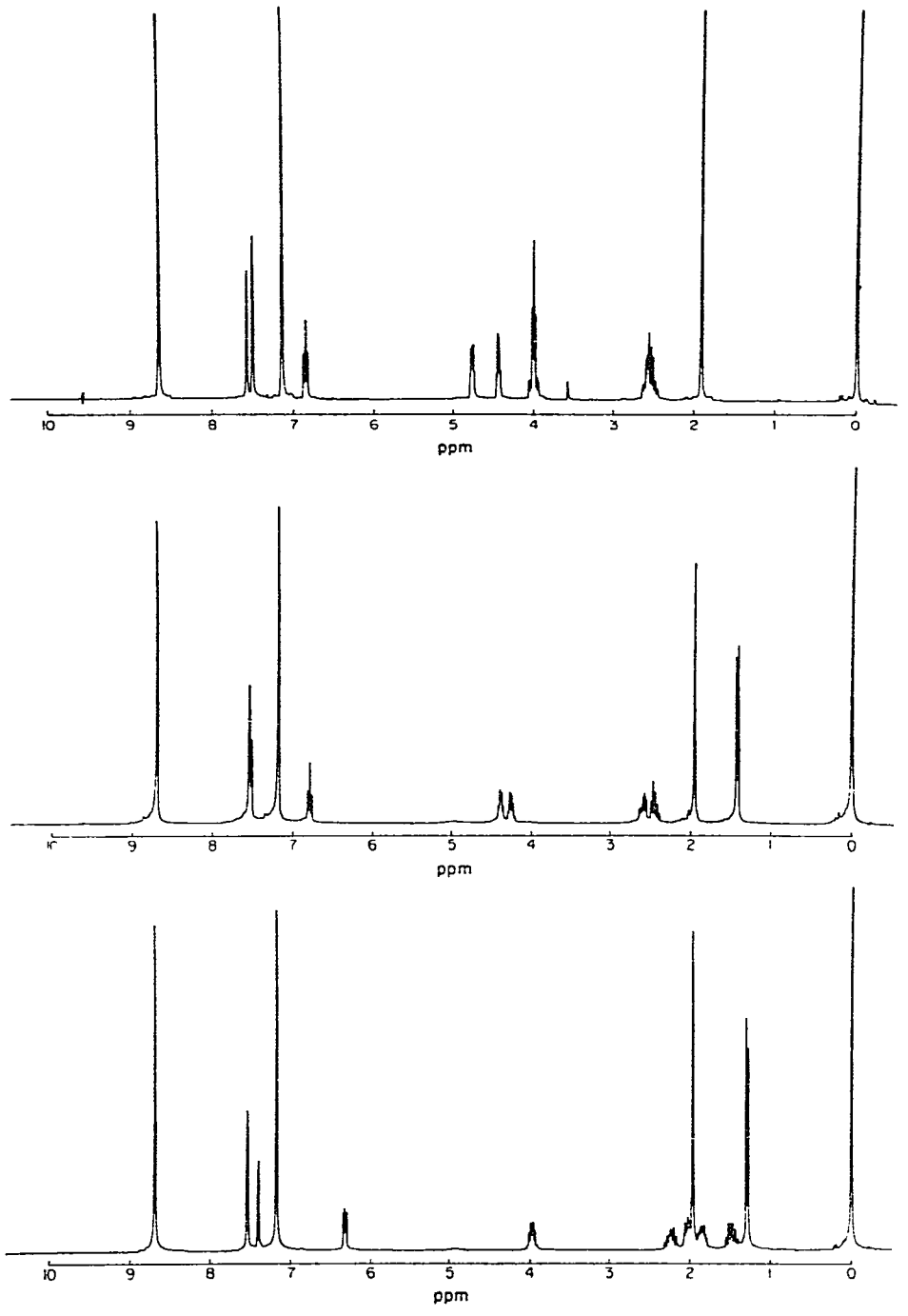


Fig. 1. The 270-MHz, p.m.r. spectra of 5′-chloro-5′-deoxythymidine (**13**) (upper), 1-(2,5-dideoxy-β-D-*erythro*-pentofuranosyl)thymine (**14**) (middle), and 1-(2,3,5-trideoxy-β-D-*glycero*-pentofuranosyl)-thymine (**18**) (lower) in pyridine-d_5.

TABLE I

P.M.R.-SPECTRAL DATA OF DEOXYRIBONUCLEOSIDES[a]

Compound	*Solvent*	*H-1'*	*H-2'*	*H-3'*	*H-4'*	*H-5'*	*Other*
5'-Deoxyadenosine (**2**)[b]	C_5D_5N	6.67(d)	4.62(m)	4.62(m)	5.35(m)	1.59(d)	7.08(d, OH), 7.77 (d, OH), 8.38(s, NH_2), 8.57(s, H-2), 8.71(s, H-8)
	Me_2SO-d_6	5.15(d)	3.98(m)	3.98(m)	4.67(q)	1.30(d)	5.45(d, OH), 5.84(d, OH), 7.30(s, NH_2), 8.15(s, H-2), 8.33(s, H-8)
9-(5-Deoxy-β-D-arabino-furanosyl)adenine (**10**)[c]	Me_2SO-d_6	5.49(d)	3.92(m)	3.82(m)	4.12(q)	1.35(d)	5.58(d, OH), 6.22(d, OH), 7.21(s, NH_2), 8.09(s, H-2), 8.14(s, H-8)
5'-Deoxyuridine (**4**)[d]	C_5D_5N	6.62(d)	4.51(t)	4.29(t)	4.75(m)	1.35(d)	5.91(d,H-5), 7.80(d, H-6)
5'-Chloro-5'-deoxy-toyocamycin (**6**)[e]	C_5D_5N	6.93(d)	5.19(t)	4.88(t)	4.80(q)	4.19(q, H-5'a) 4.21(q, H-5'b)	7.89(broad, NH_2), 8.43(s, H-2), 8.65(s, H-8)
5'-Deoxytoyocamycin (**7**)[f]	C_5D_5N	6.88(d)	5.03(m)	4.49(q)	4.61(p)	1.59(d)	7.89(broad, NH_2), 8.37(s, H-2), 8.67(s, H-8)
5'-Deoxysangivamycin (**8**)[g]	C_5D_5N	6.94(d)	4.85(m)	4.25(m)	4.49(p)	1.34(d)	7.86(broad, NH_2), 8.43(broad, $CONH_2$), 8.48(s, H-2), 8.68(s, H-8)
3'-*O*-Acetyl-5'-chloro-5'-deoxythymidine (**12**)[h]	C_5D_5N	6.74(q)	2.56(m, H-2'a and H-2'b)	5.48(m)	4.40(q)	4.09(d)	1.93(s, Me-5), 2.00(s, OAc), 7.62(s, H-6)
5'-Chloro-5'-deoxythymidine (**13**)[i]	C_5D_5N	6.92(t)	2.55(o, H-2'a) 2.64(o, H-2'b)	4.84(p)	4.50(q)	4.03(q, H-5'a) 4.06(q, H-5'b)	1.95(d, Me-5), 7.66(d, H-6)
5'-Deoxythymidine (**14**)[j]	C_5D_5N	6.83(t)	2.47(p, H-2'a) 2.62(o, H-2'b)	4.42(o)	4.28(o)	1.44(d)	1.97(s, Me-5), 7.56(s, H-6)
2',3',5'-Trideoxyadenosine (**16**)[k]	C_5D_5N	6.42(q)	2.33(m, H-2a) 2.49(m, H-2b)	1.79(m, H-3a) 1.94(m, H-3b)	4.12(o)	1.31(d)	8.40(s, NH_2), 8.42(s, H-2), 8.75(s, H-8)
3',5'-Dideoxythymidine (**18**)[l]	C_5D_5N	6.36(q)	2.04(m, H-2a) 2.26(m, H-2b)	1.49(m, H-3a) 1.87(m, H-3b)	4.00(o)	1.30(d)	1.98(d, Me-5), 7.45(d, H-6)

[a]Chemical shifts (δ) are given relative to Me_4Si at 270 MHz. Coupling constants (±0.3 Hz) were estimated from the peak positions determined by computer examination of the final, Fourier-transformed spectrum. [b]$J_{1',2'}$ 3.7, $J_{4',5'}$ 5.9 (C_5D_5N); $J_{1',2'}$ 5.2, $J_{4',5'}$ 5.7 (Me_2SO-d_6). [c]$J_{1',2'}$ 4.4, $J_{3',4'}$ 9.9, $J_{4',5'}$ 5.9. [d]$J_{1',2'}$ 3.8, $J_{2',3'}$ 6.0, $J_{3',4'}$ 6.0, $J_{4',5'}$ 6.1. [e]$J_{1',2'}$ 4.4, $J_{2',3'}$ 4.4, $J_{3',4'}$ 4.4, $J_{4',5'a} \simeq J_{4',5'b} = 10.7$, $J_{5'a,5'b}$ −22.8. [f]$J_{1',2'}$ 3.7, $J_{2',3'}$ 10.5, $J_{3',4'}$ 6.3, $J_{4',5'}$ 5.9. [g]$J_{1',2'}$ 3.7, $J_{4',5'}$ 5.9. [h]$J_{1',2'a}$ 6.16, $J_{1',2'b}$ 8.2, $J_{3',4'}$ 7.5, $J_{4',5'}$ 4.0. [i]$J_{1',2'a} = J_{1',2'b} = 7.6$, $J_{2'a,2'b}$ −14.3, $J_{2'a,3'}$ 7.5, $J_{2'b,3'}$ 2.6, $J_{3',4'}$ 4.7, $J_{4',5'b} = J_{4',5'b} = 8.3$, $J_{5'a,5'b}$ −15.8. [j]$J_{1',2'a} \simeq J_{1',2'b} = 6.6$, $J_{2'a,2'b}$ −13.2, $J_{2'a,3'}$ 6.6, $J_{2'b,3'}$ 4.4, $J_{3',4'}$ 6.0, $J_{4',5'}$ 6.6. [k]$J_{1',2'} = 2.9$ and 6.6, $J_{3'a,4'} = J_{3'b,4'} = 15.1$, $J_{4',5'}$ 6.6. [l]$J_{1',2'} = 4.0$ and 7.0, $J_{3'a,4'} = J_{3'b,4'} = 15.1$, $J_{4',5'}$ 5.9.

nucleosides yielded the corresponding 2′,3′,5′-trideoxynucleosides. In these syntheses, it is unnecessary to use protecting groups, because the hexamethylphosphoramide–thionyl chloride reagent is very specific. On the other hand, the synthesis of 2′,3′- and 2′,5′-dideoxynucleosides requires prior protection of the 5′- or 3′-hydroxyl group, respectively. Thus, chlorination of 3′-*O*-acetylthymidine (**11**) gave 3′-*O*-acetyl-5′-chloro-5′-deoxythymidine (**12**) which, after deacetylation with ammonium hydroxide, and dechlorination with tributyltin hydride, gave 1-(2,5-dideoxy-β-D-*erythro*-pentofuranosyl)thymine (5′-deoxythymidine; **14**) in good yield.

The dechlorination by tributyltin hydride is most conveniently monitored by proton-n.m.r. spectroscopy, because the reaction not only results in an upfield shift of the 5′-protons but also in a collapse of the multiplet due to the two diastereotopic 5′-protons to a doublet due to the three, equivalent, methyl protons (see Fig. 1 and Table I). Although 5′-deoxyadenosine has been prepared before by two methods, the melting points of the two preparations differed considerably. Wagner *et al.*[1] reported a melting point of 109.5–110°, whereas that prepared by Kissman and Baker[10] melted at 210–212° (liquefaction at 180°, followed by resolidification). Our preparation melts at 130–133°, resolidifies, and melts again at 188–191°.

EXPERIMENTAL

Materials. — Nucleosides were purchased from Sigma Chemical Company or P-L Biochemicals, α,α′-azobis(isobutyronitrile) from Aldrich, and tributyltin hydride from Alfa Products. The following compounds were synthesized by published procedures: 5′-chloro-5′-deoxyadenosine[14], 5′-chloro-5′-deoxyuridine[14], 9-(5-chloro-5-deoxy-β-D-arabinofuranosyl)adenine[16], 9-(3,5-dichloro-2,3,5-trideoxy-β-D-*threo*-pentofuranosyl)adenine[16], 1-(3,5-dichloro-2,3,5-trideoxy-β-D-*threo*-pentofuranosyl)-thymine[16], 3′-*O*-acetylthymidine[17], and tributyltin hydride[18].

General methods. — Elemental analyses were performed by Galbraith Laboratories, Knoxville, Tenn. Melting points were measured on a hot stage equipped with a microscope, and are not corrected. Pulse, proton nuclear magnetic (p.m.r.) spectra were recorded with a Bruker 270-MHz spectrometer; chemical shifts are recorded in p.p.m. downfield from an internal standard of tetramethylsilane (see Table I). Ultraviolet spectra were recorded with a Cary Model 15 spectrophotometer. Other absorbance measurements were made with a Zeiss PMQII spectrophotometer. Descending chromatography on Whatman No. 1 paper was conducted with the following solvent systems: solvent I, 21:4 1-butanol–water; II, 25:18:7 *sec.*-butyl alcohol–water–ammonium hydroxide; and III, 10:3:7 1-butanol–ethanol–water. Nucleosides on paper chromatograms were detected by their absorption of ultraviolet light (see Table II).

Synthesis of 5′-deoxyribonucleosides

5′-Deoxyadenosine (**2**). — To a solution of 5′-chloro-5′-deoxyadenosine (**1**; 2.0 g, 7.00 mmoles) in anhydrous tetrahydrofuran (100 ml, distilled from lithium

TABLE II

PAPER-CHROMATOGRAPHIC PROPERTIES OF NUCLEOSIDES

Nucleoside	R_F *value in solvent*		
	I	*II*	*III*
Adenosine	0.11	0.85	0.50
5′-Chloro-5′-deoxyadenosine (**1**)	0.30	0.92	0.75
5′-Deoxyadenosine (**2**)	0.22	0.88	0.66
9-(5-Deoxy-β-D-arabinofuranosyl)adenine (**10**)	0.28	0.85	0.68
3′,5′-Dichloro-2′,3′,5′-trideoxyadenosine (**15**)	0.68	0.92	0.90
2′,3′,5′-Trideoxyadenosine (**16**)	0.57	0.95	0.85
5′-Chloro-5′-deoxytoyocamycin (**6**)	0.21	0.81	0.83
5′-Deoxytoyocamycin (**7**)	0.48	0.83	0.81
5′-Deoxysangivamycin (**8**)	0.31	0.72	0.92
Uridine	0.16	0.47	0.43
5′-Chloro-5′-deoxyuridine (**3**)	0.36	0.79	0.65
5′-Deoxyuridine (**4**)	0.31	0.67	0.59
Thymidine	0.42	0.70	0.69
3′-*O*-Acetyl-5′-chloro-5′-deoxythymidine (**12**)	0.80	0.89	0.92
5′-Chloro-5′-deoxythymidine (**13**)	0.66	0.89	0.87
5′-Deoxythymidine (**14**)	0.63	0.80	0.80
3′,5′Dichloro-3′,5′-dideoxythymidine (**17**)	0.80	0.98	0.92
3′,5′-Dideoxythymidine (**18**)	0.75	0.96	0.89

aluminum hydride) were added, α,α′-azobis(isobutyronitrile) (0.5 g, 3.04 mmoles) and tributyltin hydride (8.0 g, 27.5 mmoles). The solution was boiled for 18 h under reflux, with exclusion of moisture, and then evaporated to dryness under diminished pressure. To the residual oil was added cold petroleum ether (b.p. 30–60°; 150 ml), and the crude product was isolated by filtration. The solid was thoroughly washed with cold, petroleum ether (200 ml), and recrystallized from water; yield 1.44 g (82%), m.p. 130–133°; $\lambda_{max}^{H_2O}$ at pH 1, 257 nm (ε_{mM} 14.8); at pH 7 and 11, 259 nm (ε_{mM} 14.8, 15.3).

Anal. Calc. for $C_{10}H_{13}N_5O_3$ (251.2): C, 47.81; H, 5.22; N, 27.88. Found: C, 47.77; H, 5.28; N, 27.65.

9-(5-Deoxy-β-D-arabinofuranosyl)adenine (**10**). — 9-(5-Chloro-5-deoxy-β-D-arabinofuranosyl)adenine (**9**; 2.0 g, 7.00 mmoles) was dehalogenated as just described to yield **10** in 65% yield, m.p. 174–175°, identical in all respects with the compound reported by Reist *et al.*[11]; $\lambda_{max}^{H_2O}$ at pH 1, 257 nm (ε_{mM} 14.8); at pH 7, 259 nm (ε_{mM} 15.1); and at pH 11, 260 nm (ε_{mM} 15.2).

5′-Deoxyuridine (**4**). — 5′-Chloro-5′-deoxyuridine (**3**; 2.0 g, 7.61 mmoles) was dehalogenated as described for compound **1**. The product was recrystallized from 95% ethanol; yield 1.05 g (60%); m.p. 193–194°; $\lambda_{max}^{H_2O}$ at pH 1 and 7, 262 nm (ε_{mM} 10.0); at pH 11, 262 nm (ε_{mM} 7.24).

Anal. Calc. for $C_9H_{12}N_2O_5$ (228.2): C, 47.37; H, 5.30; N, 12.27. Found: C, 47.37; H, 5.40; N, 12.22.

5′-Chloro-5′-deoxytoyocamycin (**6**). — To an ice-cooled solution of thionyl chloride (6 ml) in hexamethylphosphoramide (40 ml) was added toyocamycin (**5**;

4.365 g, 15 mmoles), and the mixture was stirred, with exclusion of moisture, for 15 h at room temperature. The mixture was then decanted from a small amount of unreacted starting-material, and poured over crushed ice (100 g), with stirring. A few drops of conc. hydrochloric acid were added, to dissolve most of the solid. The mixture was filtered, and the filtrate was applied to a column (10 × 4 cm) of Dowex 50 X-8 (H^+) ion-exchange resin (100–200 mesh). The column was washed with water, and treated with 0.5M ammonium hydroxide. The ammonium hydroxide caused **6** to crystallize on the resin. The resin was transferred to a sintered-glass funnel, and successively washed with hot, 50% ethanol (3 × 100 ml) and boiling ethanol (3 × 100 ml). The product crystallized during concentration of the washings *in vacuo*, and was recrystallized from aqueous ethanol; yield 2.20 g (47%); m.p. (dec.) >162° (foams ~195°); $\lambda_{max}^{H_2O}$ at pH 1, 272 nm (ε_{mM} 13.7); at pH 7 and 11, 277 nm (ε_{mM} 16.3) and 287 nm (sh., ε_{mM} 10.95); ν_{max} 2220 cm^{-1} (CN).

Anal. Calc. for $C_{12}H_{12}ClN_5O_3 \cdot 0.5H_2O$ (318): C, 45.28; H, 4.08; N, 22.01. Found: C, 45.13; H, 4.07; N, 21.96.

5′-Deoxytoyocamycin (**7**). — Compound **6** (2.0 g, 6.47 mmoles) was dehalogenated as described for **1**. The product was crystallized from water with the aid of charcoal; yield 1.10 g (62%); m.p. 187–188°; $\lambda_{max}^{H_2O}$ at pH 1, 272 nm (ε_{mM} 13.2); at pH 7 and 11, 277 nm (ε_{mM} 15.8) and 287 nm (sh., ε_{mM} 10.9); ν_{max} 2210 cm^{-1} (CN).

Anal. Calc. for $C_{12}H_{13}N_5O_3 \cdot 0.5H_2O$ (284): C, 50.70; H, 4.92; N, 24.64. Found: C, 50.94; H, 4.86; N, 24.88.

5′-Deoxysangivamycin (**8**). — To a suspension of **7** (300 mg, 1.1 mmoles) in 27% ammonium hydroxide (10 ml) was added 30% hydrogen peroxide (1 ml), and the mixture was stirred for 7 h at room temperature, at which time all of the solid **7** had dissolved, and a new precipitate had formed. The mixture was kept overnight at 5°, and the solid was collected by filtration, and recrystallized twice from water, to yield 170 mg (53%) of **8**, m.p. 260–262° (dec.); $\lambda_{max}^{H_2O}$ at pH 1, 274 nm (ε_{mM} 12.7); at pH 7 and 11, 278 nm (ε_{mM} 14.8).

Anal. Calc. for $C_{12}H_{15}N_5O_4 \cdot 0.25H_2O$ (297.5): C, 48.40; H, 5.21; N, 23.53. Found: C, 48.45; H, 5.20; N, 23.31.

3′-O-Acetyl-5′-chloro-5′-deoxythymidine (**12**). — To a solution of thionyl chloride (2 ml) in hexamethylphosphoramide (10 ml) was added 3′-*O*-acetylthymidine (**11**; 2.0 g, 7.0 mmoles), and the mixture was stirred, with exclusion of moisture, for 20 h at room temperature. The mixture was then added to chloroform (50 ml), and extracted with water (5 × 20 ml). The organic phase was dried (sodium sulfate), and evaporated to dryness. The residual oil was crystallized from 1:2 chloroform–hexane with the aid of charcoal, to yield 1.56 g (70%) of colorless needles, m.p. 149–150°; λ_{max}^{MeOH} 264 nm (ε_{mM} 9.74).

Anal. Calc. for $C_{12}H_{14}ClN_2O_5$ (302.7): C, 47.61; H, 4.99; Cl, 11.71; N, 9.25. Found: C, 47.68; H, 5.10; Cl, 11.92; N, 9.09.

5′-Chloro-5′-deoxythymidine (**13**). — Compound **12** (1.5 g, 4.96 mmoles) was dissolved in a mixture of methanol (12 ml) and conc. ammonium hydroxide (12 ml), and the solution was stirred for 1 h at room temperature, evaporated to dryness, and

the residue crystallized from methanol; yield 1.09 g (84%), m.p. 189–191°; λ_{max}^{MeOH} 266 nm (ε_{mM} 9.23).

Anal. Calc. for $C_{10}H_{13}ClN_2O_4$ (260.7): C, 46.08; H, 5.03; Cl, 13.60; N, 10.75. Found: C, 45.99; H, 5.12; Cl, 13.56; N, 10.64.

5'-Deoxythymidine (**14**). — Compound **13** (411 mg, 1.57 mmoles) was dehalogenated as described for compound **1**. The product was crystallized from water; yield 167 mg (47%), m.p. 213–215°; $\lambda_{max}^{H_2O}$ at pH 1 and 7, 267 nm (ε_{mM} 8.80); at pH 11, 267 nm (ε_{mM} 6.74).

Anal. Calc. for $C_{10}H_{14}N_2O_4$ (226.2): C, 53.09; H, 6.24; N, 12.38. Found: C, 52.80; H, 6.16; N, 12.33.

Syntheses of trideoxyribonucleosides

*9-(2,3,5-Trideoxy-β-*D-glycero-*pentofuranosyl)adenine* (**16**). — 9-(3,5-Dichloro-2,3,5-trideoxy-β-D-*threo*-pentofuranosyl)adenine (**15**; 600 mg, 1.97 mmoles), α,α'-azobis(isobutyronitrile) (280 mg, 1.71 mmoles), and tributyltin hydride (3.38 g, 11.61 mmoles) were dissolved in dry tetrahydrofuran (36 ml) and boiled for 48 h under reflux, with exclusion of moisture. The product was purified as described for **2**, to yield a solid that was recrystallized from benzene; yield 353 mg (76%), m.p. 179–181°; $\lambda_{max}^{H_2O}$ at pH 1, 262 nm (ε_{mM} 12.8); at pH 7 and 11, 260 nm (ε_{mM} 14.5).

Anal. Calc. for $C_{10}H_{13}N_5O$ (219.2): C, 54.78; H, 5.98; N, 31.95. Found: C, 54.56; H, 6.03; N, 31.88.

*1-(2,3,5-Trideoxy-β-*D-glycero-*pentofuranosyl)thymine* (**18**). — 1-(3,5-Dichloro-2,3,5-trideoxy-β-D-*threo*-pentofuranosyl)thymine (**17**; 1.0 g, 3.58 mmoles) was dehalogenated as described for **1**. The mixture was boiled under reflux for 5 days, to yield 393 mg (52%) of **18**, which crystallized from benzene; m.p. 150–153°; $\lambda_{max}^{H_2O}$ at pH 1 and 7, 267 nm (ε_{mM} 8.51); at pH 11, 267 nm (ε_{mM} 6.58).

Anal. Calc. for $C_{10}H_{14}N_2O_3$ (210.2): C, 57.14; H, 6.71; N, 13.33. Found: C, 57.38; H, 6.90; N, 13.11.

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