Syntheses and Properties of Some Pyrimidine 2,4'-Cyclo Nucleosides

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Four pyrimidine 2,4'-cyclo nucleosides, 2,4'-didehydro-1-(5'-chloro-5'-deoxy-2',3'-*O*-isopropylidene-α-L-lyxosyl)uracil (**6a**), 2,4'-didehydro-1-(5'-chloro-5'-deoxy-2',3'-*O*-*endo*-anisylidene-α-L-lyxosyl)uracil (**6b**), its exo stereomer (**6c**), and N^4-benzoyl-2,4'-didehydro-1-(5'-chloro-5'-deoxy-2',3'-*O*-*exo*-anisylidene-α-L-lyxosyl)cytosine (**14**), were synthesized from the corresponding 4',5'-didehydro nucleosides (**2a–c** and **5b**) and *tert*-butyl hypochlorite in dry media. Their characteristic chemical and optical properties are presented.

Since Todd and coworkers reported 2',3'-*O*-isopropylidene-2,5'-anhydrocytidine tosylate in 1951 as the first base–sugar cyclized nucleoside,[1] 2,2'-,[2] 2,3'-,[3] 2,5'-,[1,4] 6,5'-,[5] 6,2'-[6] anhydro pyrimidine nucleosides and analogous purine 8-cyclo nucleosides[7] have been described and proved to be useful intermediates for chemical modifications of base and sugar moieties in natural nucleosides. The cyclo nucleosides have themselves served as prominent models for physicochemical studies on the base–sugar conformations in nucleosides and nucleotides.[8–10] Some anhydro nucleosides with nitrogen and sulfur bridges have also been obtained.[7,11] Probably, the last target in cyclo nucleoside chemistry is the one involving cyclization at the 4' position in nucleosides. In this field, 5'-bromo-5'-deoxy-2',3'-*O*-isopropylidene-N^3→4'-cycloadenosine bromide was recorded in 1968 in a synthetic study related to the total synthesis of angustmycin A.[12] Recently, we have reported the synthesis of 2,4'-didehydro-1-(5'-bromo-5'-deoxy-2',3'-*O*-isopropylidene-α-L-lyxosyl)uracil as the first pyrimidine 2,4'-cyclo nucleoside.[13] However, the fragility and low yield of this compound have hampered further study of its chemistry. This paper describes a more efficient synthesis of pyrimidine 2,4'-cyclo nucleosides and some of their chemical and optical properties.

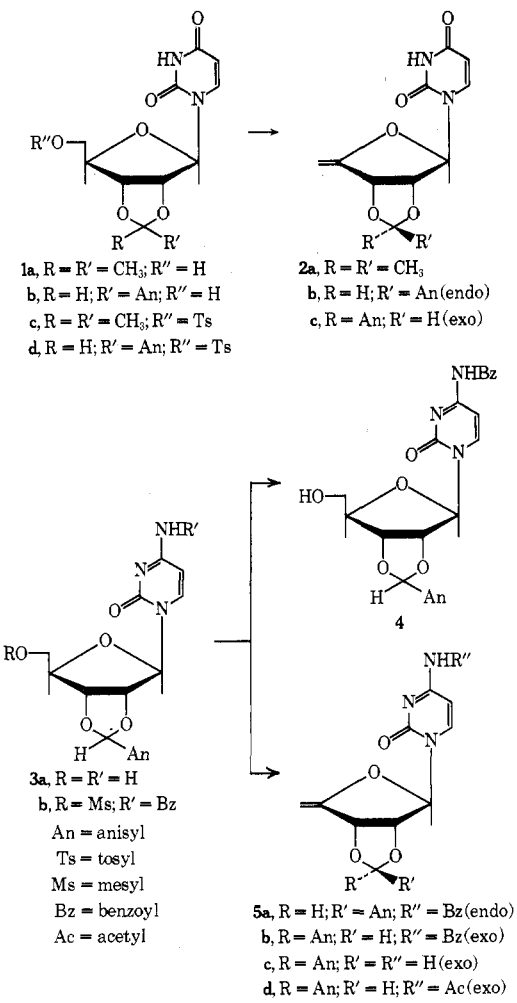
Syntheses of 4',5'-Didehydro Pyrimidine Nucleosides (Scheme I). 1-(5-Deoxy-2,3-*O*-isopropylidene-β-D-*erythro*-pent-4-enofuranosyl)uracil (**2a**) was prepared according to the described procedure.[14] Its 2,3-*O*-anisylidene analogs (**2b** and **c**) were also synthesized in the hope that the large aryl protecting group would facilitate the isolations of products in succeeding reactions and would be removed under relatively mild conditions, perhaps even by hydrogenolysis.[15]

2',3'-*O*-Anisylideneneuridine (**1b**)[16] was tosylated to 5'-*O*-tosyl-2',3'-*O*-anisylideneuridine (**1d**), which was directly treated with excess potassium *tert*-butoxide to give a diastereoisomeric mixture of 1-(5-deoxy-2,3-*O*-anisylidene-β-D-*erythro*-pent-4-enofuranosyl)uracil (**2b** and **c**). The endo and exo isomers were successfully separated by column chromatography, the major isomer being assigned the endo structure.[17] The corresponding 4',5'-didehydro nucleosides in the cytosine series were obtained similarly. 2',3'-*O*-Anisylidenecytidine (**3a**)[18] was successively treated with mesyl chloride and benzoyl chloride to give 2',3'-*O*-anisylidene-5'-*O*-mesyl-N^4-benzoylcytidine (**3b**) which was directly treated with potassium *tert*-butoxide. Partial crystallization and column chromatography separated two isomers of N^4-benzoyl-1-(5-deoxy-2,3,-*O*-anisylidene-β-D-*erythro*-pent-4-enofuranosyl)cytosine (**5a** and **5b**). The major product (42%) was assigned the exo structure **5b**, the minor product (5%) the endo structure **5a**.

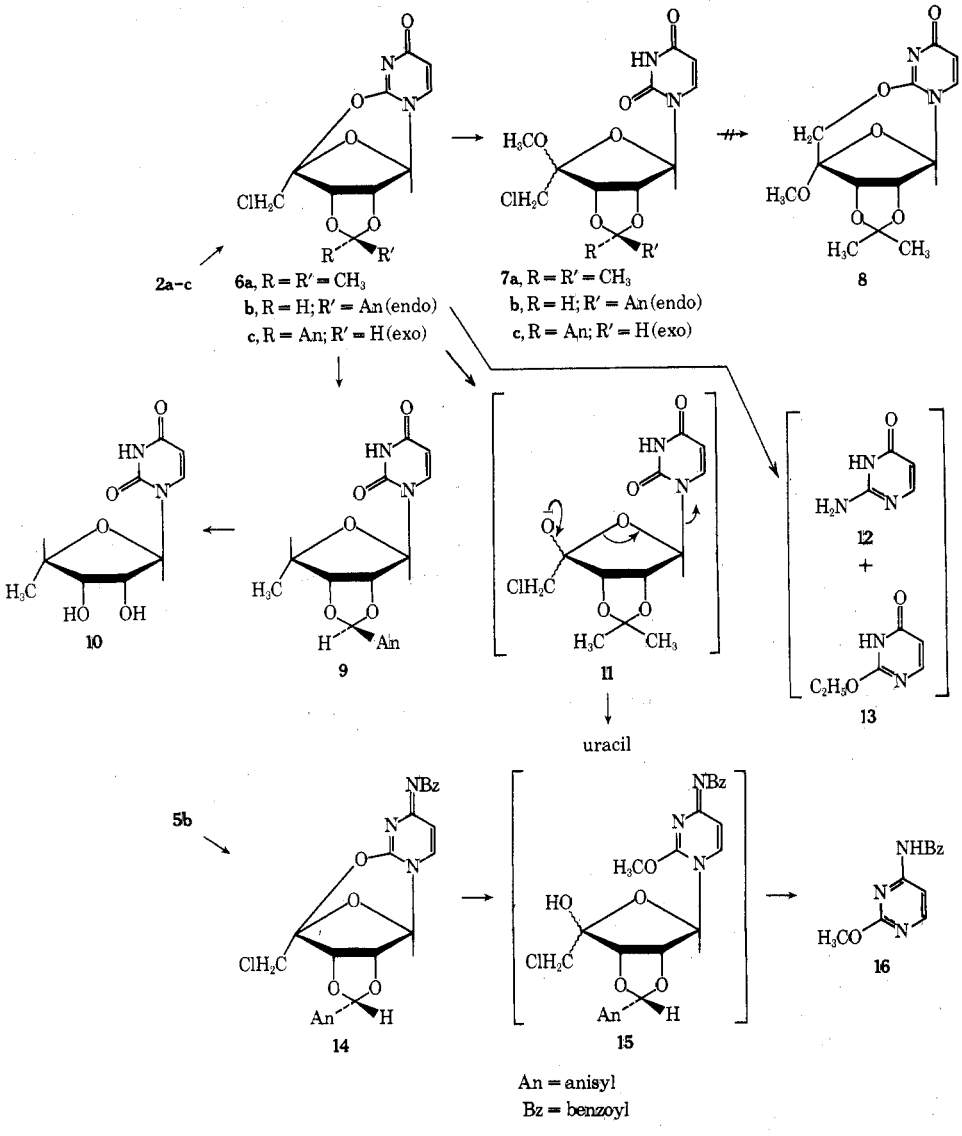
The configurations of the anisylidene groups in these 4',5'-didehydro nucleosides were deduced from the corresponding configurational assignments for compounds **6** and **7** as follows. Bagget, Lipkin, and coworkers[19,20] discussed the chemical shifts of the benzyl protons (benzyl methine protons) of 2',3'-*O*-benzylidene nucleosides and assigned the exo configuration to the stereomer with the higher benzyl proton signals. It is seen from Table I that the chemical shifts of the anisylidene methine protons of **6b** and **7b** (or of **6c** and **7c**) coincide and that there is a difference of 0.17 to 0.19 ppm between the members of each pair. These coincidences regardless of the skeletal difference between **6** and **7** series seem to justify an analogous interpretation for the differences of the chemical shifts, while the rule of Lipkin and coworkers seems to be reversed when there is an exocyclic double bond at the 4' position of the furanose ring.[21]

In the preparation of **5a** and **5b**, a third highly polar product, 2',3'-*O*-anisylidene-N^4-benzoylcytidine (**4**), was

Scheme I



Scheme II



invariably obtained as a side product. The structural assignment was essentially based on analysis and uv absorptions at 224, 259, and 302 nm, but the configuration of the anisylidene remains unknown.

The major 4′,5′-didehydro isomer (**5b**) was quantitatively debenzoylated to 1-(5-deoxy-2,3-*O*-*exo*-anisylidene-β-D-*erythro*-pent-4-enofuranosyl)cytosine (**5c**) using a mixture of acetone and aqueous ammonium hydroxide. Acetylation on **5c** gave N^4-acetyl-1-(5-deoxy-2,3-*O*-*exo*-anisylidene-β-D-*erythro*-pent-4-enofuranosyl)cytosine (**5d**) in high yield. All the above stated 4′,5′-didehydro nucleosides exhibited in the nmr spectra characteristic 5′-olefin proton signals at around 4.3 and 4.5 ppm as a set of doublets with coupling constants of 2.3–3.0 Hz.

Pyrimidine 2,4′-Cyclo Nucleosides (Scheme II). 2,4′-Cyclization can be achieved in principle by generating a carbonium ion at $C_{4'}$ using an appropriate dipolar addition reagent. It was expected that such an intermediate ion would be particularly stabilized by neighboring ether oxygen participation in our case, and the use of *tert*-butyl hypochlorite instead of hypobromous acid[13] would be more profitable since the former is used in dry media, thus precluding ionic side reactions.

Treatment of **2a** with *tert*-butyl hypochlorite in dry acetonitrile gave crystalline 2,4′-didehydro-1-(5′-chloro-5′-deoxy-2′,3′-*O*-isopropylidene-α-L-lyxosyl)uracil (**6a**) in fair yield (60%). Similar treatment of **2b** and **2c** in dry acetone gave the corresponding stereomers (**6b** and **6c**) of 2,4′-didehydro-1-(5′-chloro-5′-deoxy-2′,3′-*O*-anisylidene-α-L-lyxosyl)uracil. Compounds **6a–c** showed uv absorptions at around 230 and 245 nm, the latter being always inflections, and similar well-resolved nmr spectra (see Experimental Section). It is interesting to compare the resonance pattern of **6a** with the characteristic resonance spectra of 2′,3′-*O*-isopropylidene-2,5′-cyclouridine and 2′,3′-*O*-isopropylidene-2,5′-cyclo-6-azauridine,[22] in which the signals of $H_{2'}$ and $H_{3'}$ appeared as overlapping singlets and those of the 5′-methylene as unusually wide-spread quartets. This nmr-spectroscopic comparison suggests that compounds **6a–c** do not have a 2,5′-bridged structure. An intramolecular nuclear Overhauser effect was observed only between $H_{1'}$ and H_6, as in the case of a purine 3,5′-cyclo nucleoside (between $H_{1'}$ and H_8).[23] Thus, irradiation on the H_6 signal caused 15% enhancement of the $H_{1'}$ resonance, while $H_{1'}$ irradiation caused 13% enhancement of the H_6 resonance in dimethyl sulfoxide-d_6.[24]

A notable property of **6a–c** is their unusually high acid lability as expected on the basis of their unique polycyclic structures in which a bridged 1,3-dioxane component exists. Thus, treatment with strong acids like mineral acids,

Table I
Chemical Shifts of Anisylidene Methine Protons in 4′,5′-Didehydro Nucleosides (2b and 2c, 5a and 5b), 2,4′-Cyclo Nucleosides (6b and 6c), and 4′-Methoxy-4′-chloromethyleneuracil Nucleosides (7b and 7c)

Compd	Chemical shifts, δ	Compd	Chemical shifts, δ
2b	5.78	**6b**	6.03
2c	5.91	**6c**	5.86
5a	5.83	**7b**	6.03
5b	5.93	**7c**	5.84

dichloroacetic acid, or trifluoroacetic acid in any form resulted in complete destruction and only afforded uracil as a tangible product, while our earlier experiments with the 5′-bromo analog of compound **6a** revealed that short contact with dry, neat acetic acid gave quantitatively a stereoisomeric mixture of 1-(2′,3′-*O*-isopropylidene-4′-acetoxy-4′-bromomethylene-β-D-*erythro*-furanosyl)uracil (**7a**, acetoxyl instead of methoxyl, Br instead of Cl).[25,26] It was finally found that nitromethane, a weak acid, was an excellent catalyst for methanolysis of compounds **6a–c** to give 1-(2′,3′-*O*-isopropylidene-4′-chloromethylene-4′-methoxy-β-D-*erythro*-furanosyl)uracil (**7a**), 1-(2′,3′-*endo*-anisylidene-4′-chloromethylene-4′-methoxy-β-D-erythrofuranosyl)uracil (**7b**), and its *exo*-anisylidene analog (**7c**) as described in the Experimental Section. While in each methanolysis reaction one 4′ stereomer was isolated as crystals, isolation of the counterpart was abandoned.

Compound **7a** and the corresponding stereoisomeric mixture was treated with basic systems, 10–15% triethylamine–methanol, sodium methoxide–methanol, potassium *tert*-butoxide–tetrahydrofurane, silver acetate–methanol, to obtain a 2,5′-anhydro nucleoside (**8**). All efforts resulted in the recovery of the starting material or in intractable mixtures depending upon the reaction conditions.

Substitution of the 5′-chlorine atom with usual nucleophiles also proved to be difficult, presumably due to steric reasons. Atmospheric pressure hydrogenation (Pd–C) of **6b** gave unexpectedly 1-(5′-deoxy-2′,3′-*O*-*endo*-anisylidene-α-L-lyxofuranosyl)uracil (**9**), the anisylidene group being unaffected. The structure of compound **9** became evident from the uv absorption at 260 nm and nmr spectrum, in which the signal of 5′-methyl appeared at 1.27 ppm as a doublet with $J_{4',5'}$ = 6.0 Hz. Compound **9** was also obtained from **2b** by similar hydrogenation and could be converted to the known 1-(5′-deoxy-α-L-pentofuranosyl)uracil (**10**)[14] by acid hydrolysis. Neutral hydrolysis of **6a** in a mixture of acetone and water gave only uracil, most probably through the intermediacy of a 4′-hydroxy-4′-chloromethylene compound (**11**). Reaction of **6a** with ethanolic ammonia at ambient temperature formed isocytosine (**12**)[27] as the major product with 3,4-dihydro-4-keto-2-ethoxypyrimidine (**13**).[27] The behavior of a 2,4′-cyclo uracil nucleoside toward amines seems to be analogous to those of 2,5′-anhydro uracil nucleosides,[4,28] 4′-hydroxy anion having accelerated the deglycosidation as in **11**.

In the cytidine series, treatment of **5b** with *tert*-butyl hypochlorite gave crystalline N^4-benzoyl-2,4′-didehydro-1-(5′-chloro-5′-deoxy-2′,3′-*O*-*exo*-anisylidene-α-L-lyxosyl)-cytosine (**14**) in fair yield. Although we could not find an appropriate compound in the literature for a uv spectral comparison, the dramatic blue shifts of the longer wave length absorptions of **14** as compared with those of **5b** (see Experimental Section), as usually observed with uracil 2-cyclo nucleosides,[2–4] substantiated a 2-bridged structure. The nmr spectrum of **14** also coincides with that of uracil analog (**6a**) (see Experimental Section). The exact coincidence of the resonance pattern of the furanose protons seems to be rather fortuitous but is strong evidence for the 2,4′-cyclic structure. Formations of analogous cyclo nucleosides from **5a** and **5d** with *tert*-butyl hypochlorite were suggested by thin-layer chromatography,[29] but their isolations were unsuccessful. Compound **14** seems to be the second cytidine 2-cyclo nucleoside with a 4-imino (not immonium) structure after 2,3′-anhydro-1-(2′,5′-di-*O*-trityl-β-D-xylofuranosyl)cytosine synthesized by Mizuno and coworkers.[3c]

Methanolysis of **14** in the presence of nitromethane also proceeded smoothly to give a mixture of two products, but surprisingly, these were not 4′-methoxy compounds as indicated by the uv spectrum of the crude reaction mixture, which was quite similar to that of **14**. This is understandable if the methoxy anion attacked the 2 position of the base to give a diastereoisomeric mixture (**15**), which would be highly unstable due to the presence of a hemiacetal partial structure at $C_{4'}$ as observed in the neutral hydrolysis of **6a**. In effect, the separated major product (**15**) easily formed 2-methoxy-4-benzamidopyrimidine (**16**) on heating at 50–55° under vacuum. This methanolysis reaction was 100% specific and in sharp contrast to the behavior of uracil analogs.

The cyclo nucleosides **6a–c** and **14** showed distinct negative ORD and/or CD Cotton effects at the 260–280 nm region indicating their syn conformations (see Experimental Section),[8,30] although the CD spectrum of **14** is complicated by the presence of a benzoyl group. A typical example (**6a**) is represented in Figure 1 together with the uv absorption.

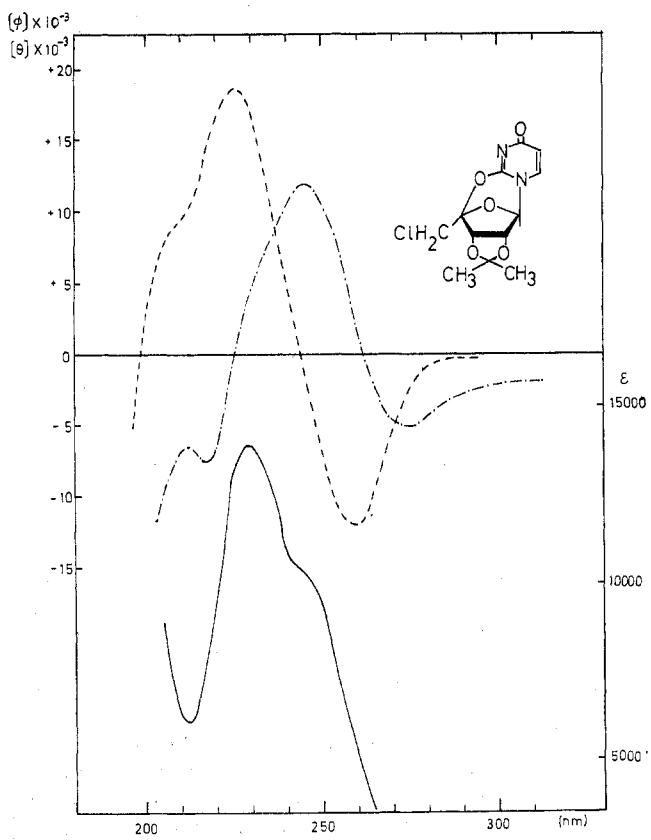


Figure 1. Uv (—), ORD (···), and CD spectra (---) of 2,4′-anhydro-1-(5′-deoxy-5′-chloro-2′,3′-*O*-isopropylidene-α-L-lyxosyl)uracil (**6a**) in methanol.

It is interesting to note that the ORD curve of **6a** is an approximate mirror image, despite the difference in the measurement conditions, to that of 6,5′-cyclo-6-hydroxyuri-

dine;[8a] hence it could better serve as an optical model of syn conformations than that of 2,5'-anhydrouridine.[8a]

Experimental Section

All the melting points are uncorrected. The electronic spectra were measured on a JASCO Model ORD/UV-5 spectrophotometer. The nuclear magnetic resonance spectra were determined using a JNM C-60 HL spectrometer and tetramethylsilane as an internal standard, while a few of the 100-MHz spectra were recorded with a Varian HA-100 spectrometer in the laboratory of the Takeda Chemical Industries Co., Ltd., for which we are grateful. The circular dichroism spectra were recorded with a JASCO Model J-20 recording spectropolarimeter in the laboratory of the Japan Spectroscopic Co., Ltd., and of Kitazato University, Tokyo, to which we owe a great deal. Wakogel B-5 silica gel was used for thin-layer chromatography, while column chromatography was carried out using Mallinkrodt silicic acid (100 mesh) after washing with ethyl acetate.

1-(5-Deoxy-2,3-*O*-*endo*- (and *exo*-) anisylidene-β-D-*erythro*-pent-4-enofuranosyl)uracil (2b and 2c). A mixture of **1b**[16] (3.36 g, 9.28 mmol) and tosyl chloride (2.30 g, 12.0 mmol) in dry pyridine (20 ml) was stirred at room temperature overnight, treated with methanol (1 ml) for 20 min, and evaporated *in vacuo* to a gum, which was dissolved in acetone (10 ml) and dropped into stirred ice–water (100 ml). The precipitate was collected by suction, dissolved in ethyl acetate, dried over sodium sulfate, and filtered with Norit. Evaporation of the solvent gave 4.35 g (91%) of 5'-*O*-tosyl-2'-3'-*O*-anisylideneuridine (**1d**) as a homogeneous foam. The total product (8.33 mmol) was dissolved in dry tetrahydrofuran (THF) (34 ml) and treated with potassium *tert*-butoxide (*t*-BuOK) (2.24 g, 20 mmol) under ice cooling for 1 hr and then at room temperature for 9 hr. The mixture was neutralized with acetic acid and evaporated to a dark residue, which was partitioned between ethyl acetate (200 ml) and water (50 ml). The separated organic layer was dried over sodium sulfate and evaporated to a gum, which was applied on a silica gel column (2 × 50 cm). Elution with chloroform–ethyl acetate (5:1, v/v) gave from the first fraction 1.31 g (45.8%) of 1-(5-deoxy-2,3-*O*-*endo*-anisylidene-β-D-*erythro*-pent-4-enofuranosyl)uracil (**2b**) as a homogeneous foam: λ_{max} (MeOH) (ε) 225 nm (13,800) and 256 (9800); nmr (DMSO-d_6) δ 3.75 (3 H, s, methoxyl), 4.33 (1 H, br d, J_{gem} = 2.25 Hz, $H_{5'a}$), 4.50 (1 H, br d, J_{gem} = 2.25 Hz, $H_{5'b}$), 5.20 (1 H, d, $J_{2',3'}$ = 6.0 Hz, $H_{2'}$ or $H_{3'}$), 5.47 (1 H, d, $J_{2',3'}$ = 6.0 Hz, $H_{3'}$ or $H_{2'}$), 5.65 (1 H, d, $J_{5,6}$ = 7.5 Hz, H_5), 5.78 (1 H, s, anisylidene methine), 6.03 (1 H, s, $H_{1'}$), 6.97 (2 H, d, J = 8.5 Hz, aryl protons), 7.42 (2 H, d, J = 8.5 Hz, aryl protons), 7.74 (1 H, d, $J_{5,6}$ = 7.5 Hz, H_6), and 11.45 (1 H, s, NH).

Anal. Calcd for $C_{17}H_{16}N_2O_6$: C, 59.30; H, 4.68; N, 8.13. Found: C, 59.55; H, 4.80; N, 8.25.

The second fraction gave 520 mg (18.2%) of an isomeric product (**2c**) as colorless crystals of mp 195–196° (from ethanol–acetone): λ_{max} (MeOH) (ε) 224 nm (14,100) and 257 (9700); nmr (DMSO-d_6) δ 3.75 (3 H, s, methoxyl), 4.23 (1 H, d, J_{gem} = 2.25 Hz, $H_{5'a}$), 4.43 (1 H, d, J_{gem} = 2.25 Hz, $H_{5'b}$), 5.22 (1 H, d, $J_{2',3'}$ = 7.5 Hz, $H_{2'}$ or $H_{3'}$), 5.34 (1 H, d, $J_{2',3'}$ = 7.5 Hz, $H_{3'}$ or $H_{2'}$), 5.63 (1 H, d, $J_{5,6}$ = 7.5 Hz, H_5), 5.91 (1 H, s, anisylidene methine), 6.03 (1 H, s, $H_{1'}$), 6.95 (2 H, d, J = 8.5 Hz, aryl protons), 7.40 (2 H, d, J = 8.5 Hz, aryl protons), 7.77 (1 H, d, $J_{5,6}$ = 7.5 Hz, H_6), and 11.46 (1 H, s, NH).

Anal. Calcd for $C_{17}H_{16}N_2O_6$: C, 59.30; H, 4.68; N, 8.13. Found: C, 59.60; H, 4.75; N, 8.19.

2',3'-*O*-Anisylidene-5'-*O*-mesyl-N^4-benzoylcytidine (3b). To a solution of **3a** (5.0 g, 13.9 mmol) in pyridine at −20° was added dropwise methanesulfonyl chloride (1.2 ml, 15.3 mmol) under stirring. After standing at −20° for 15 hr, benzoyl chloride (1.95 ml, 16.7 mmol) was added and the total was left at 0° for 24 hr. The mixture was treated with methanol (2 ml) and evaporated *in vacuo* to a paste, which was dissolved in methanol (20 ml) and poured into ice–water (300 ml). The precipitate was filtered, washed with water, and air dried. The semi-dry solid was dissolved in chloroform, thoroughly dried over sodium sulfate, and evaporated to give 7.2 g (95%) of an essentially homogeneous foam (**3b**), which was directly used for the next step: ir (KBr) $\nu_{C=O}$ 1690 cm^{-1}.

N^4-Benzoyl-1-(5-deoxy-2,3-*O*-*endo*- (and *exo*-) anisylidene-β-D-*erythro*-pent-4-enofuranosyl)cytosine (5a and 5b) and 2',3'-*O*-Anisylidene-N^4-benzoylcytidine (4). A solution of **3b** (3.26 g, 6.0 mmol) in THF (34 ml) was treated with *t*-BuOK (1.62 g, 14.4 mmol) at room temperature overnight, and the mixture was worked up as in the case of **2b** and **2c**. The ethyl acetate solution finally obtained (*ca.* 100 ml) was concentrated *in vacuo* to the one-third volume, when a crystalline solid (**5b**) precipitated. It was collected and shown to be practically homogeneous by tlc using solvent systems chloroform–ethyl acetate (1:1 and 3:1) and ethanol–benzene (1:4). The filtrate was concentrated and applied on a silica gel column (2 × 25 cm) and eluted with chloroform–ethyl acetate (5:1). The first band corresponding to the minor product gave crystals (**5b**) and the second major band gave another crop of **5b**. **5a** was recrystallized from ethyl acetate to give 135 mg (5%) of colorless needles, mp 222–223.5°: λ_{max} (MeOH) (ε) 222 nm (27,000), 258 (27,000) and 302 (8700); nmr (DMSO-d_6) δ 3.80 (3 H, s, methoxyl), 4.36 (1 H, d, J_{gem} = 3.0 Hz, $H_{5'a}$), 4.51 (1 H, d, J_{gem} = 3.0 Hz, $H_{5'b}$), 5.23 (1 H, d, $J_{2',3'}$ = 6.0 Hz, $H_{3'}$), 5.58 (1 H, dd, $J_{2',3'}$ = 6.0 Hz, $J_{1',2'}$ = 1.5 Hz, $H_{2'}$), 5.83 (1 H, s, anisylidene methine), 6.13 (1 H, d, $J_{1',2'}$ = 1.5 Hz, $H_{1'}$), 6.88–7.03 (2 H, m, J = 8.0 Hz, aryl protons), 7.38–7.56 (6 H, m, aryl protons of the anisyl and benzoyl groups and H_5), 8.00 (1 H, d, $J_{5,6}$ = 7.0 Hz, H_6), and 8.15–8.29 (2 H, m, aryl protons). The NH signal did not appear clearly.

Anal. Calcd for $C_{24}H_{21}N_3O_6$: C, 64.43; H, 4.70; N, 9.40. Found: C, 64.16; H, 4.79; N, 9.16.

The combined crop of exo isomer **5b** was also crystallized from ethyl acetate to give 1.12 g (42%) of colorless needles, mp 237–238.5°: λ_{max} (MeOH) (ε) 223 nm (18,500), 259 (20,500), and 302 (6550); nmr (DMSO-d_6) δ 3.77 (3 H, s, methoxyl), 4.29 (1 H, d, J_{gem} = 3.0 Hz, $H_{5'a}$), 4.48 (1 H, d, J_{gem} = 3.0 Hz, $H_{5'b}$), 5.25 (1 H, d, $J_{2',3'}$ = 6.0 Hz, $H_{3'}$), 5.40 (1 H, dd, $J_{2',3'}$ = 6.0 Hz, $J_{1',2'}$ = 1.50 Hz, $H_{2'}$), 5.93 (1 H, s, anisylidene methine), 6.10 (1 H, d, $J_{1',2'}$ = 1.50 Hz, $H_{1'}$), 6.87–7.02 (2 H, m, J = 8.0 Hz, aryl protons of the anisyl), 7.33–7.54 (6 H, m, aryl protons of the anisyl and benzoyl groups and H_5), 8.00 (1 H, d, $J_{5,6}$ = 7.0 Hz, H_6), 8.13–8.26 (2 H, m, J = 8.0 Hz, aryl protons).

Anal. Calcd for $C_{24}H_{21}N_3O_6$: C, 64.43; H, 4.70; N, 9.40. Found: C, 64.65; H, 4.83; N, 9.29.

The column was then thoroughly eluted with ethyl acetate to give a third crystalline product which was almost homogeneous in terms of tlc. Crystallization from aqueous ethanol gave 600 mg (22%) of 2',3'-*O*-anisylidene-N^4-benzoylcytidine (**4**) as hydrate of mp 236–238.5°: ir (KBr) $\nu_{C=O}$ 1690, 1660, and 1645 cm^{-1}. Uv absorption maxima at 224, 259, and 302 nm were revealed by qualitative measurements.

Anal. Calcd for $C_{24}H_{23}N_3O_7 \cdot H_2O$: C, 59.62; H, 5.21; N, 8.69. Found: C, 59.90; H, 5.25; N, 8.62.

Mesylation of this compound gave 3b as indicated by tlc.

1-(5-Deoxy-2,3-*O*-*exo*-anisylidene-β-D-*erythro*-pent-4-enofuranosyl)cytosine (5c). A suspension of **5b** (1.5 g, 3.36 mmol) in a mixture of acetone (75 ml) and concentrated aqueous ammonia (75 ml) was stirred at room temperature overnight. The resulting solution was evaporated *in vacuo* to a paste, which was repeatedly coevaporated with a small amount of ethanol. The obtained solid mass was triturated with a small volume of ethanol, filtered, and washed with ether. Crystallization from methanol gave 1.06 g (92%) of fine needles, mp 206–208°: ir (KBr) ν_{N-H} 3440 and 3400 cm^{-1}; λ_{max} (MeOH) (ε) 226 nm (19,800), 268 (8300), and 278 (7200).

Anal. Calcd for $C_{17}H_{17}N_3O_5$; C, 59.47; H, 4.99; N, 12.24. Found: C, 59.44; H, 5.09; N, 11.96.

N^4-Acetyl-1-(5-deoxy-2,3-*O*-*exo*-anisylidene-β-D-*erythro*-pent-4-enofuranosyl)cytosine (5d). To a stirred ice-cold suspension of **5c** (820 mg, 2.39 mmol) in pyridine (20 ml) was added acetyl chloride (0.19 ml, 2.63 mmol). The resulted solution was left at room temperature overnight, treated with a small amount of methanol, and evaporated *in vacuo* at below 40° to a thick gum, which afforded crystals on triturating with a small amount of methanol (3–4 ml). The crystals were separated and the filtrate was poured into ice–water (50 ml). The precipitate was collected, combined with the above obtained crystals, and recrystallized from acetone. A yield of 810 mg (88%) of fine needles (**5d**) was obtained, mp 233–235°: λ_{max} (MeOH) (ε) 213 nm (27,000), 226 (20,800, inflection), 246 (18,100) and 296 (6050); nmr ($CDCl_3$ + DMSO-d_6) δ 2.16 (3 H, s, acetyl), 3.78 (3 H, s, methoxyl), 4.30 (1 H, d, J_{gem} = 3.0 Hz, $H_{5'a}$), 4.52 (1 H, d, J_{gem} = 3.0 Hz, $H_{5'b}$), 5.16 (1 H, d, $J_{2',3'}$ = 6.0 Hz, $H_{3'}$), 5.40 (1 H, dd, $J_{2',3'}$ = 6.0 Hz, $J_{1',2'}$ = 1.5 Hz, $H_{2'}$), 5.89 (1 H, s, anisylidene methine), 5.95 (1 H, d, $J_{1',2'}$ = 1.5 Hz, $H_{1'}$), 6.85 (2 H, d, J = 8.0 Hz, aryl protons), 7.30 (1 H, d, $J_{5,6}$ = 7.0 Hz, H_5), 7.39 (2 H, d, J = 8.0 Hz, aryl protons), 7.87 (1 H, d, $J_{5,6}$ = 7.0 Hz, H_6), and 10.75 (1 H, br, s, NH).

Anal. Calcd for $C_{19}H_{19}N_3O_6$: C, 59.21; H, 4.97; N, 10.90. Found: C, 59.41; H, 4.96; N, 10.66.

2,4'-Didehydro-1-(5'-chloro-5'-deoxy-2',3'-*O*-isopropylidene-α-L-lyxosyl)uracil (6a). To an ice-cold stirred suspension

of **2a** (266 mg, 1 mmol) in acetonitrile (2 ml) was added *tert*-butyl hypochlorite (130 mg, 1.2 mmol). After 30 min, the precipitate was rapidly filtered by suction, washed with a small amount of ethyl acetate and ether, and dried in a desiccator under high vacuum. The filtrate was evaporated *in vacuo* at room temperature and the residue was left at −20° with a small amount of ethyl acetate to give another crop of crystals. The combined products were recrystallized from methanol at room temperature to give 180 mg (60%) of colorless needles, mp 190–192°: λ_{max} (MeOH) (ϵ) 229 nm (13,800) and 245 (10,400, inflection); CD (MeOH) (θ) (nm) −12,300 (259), +18,700 (225), and +9400 (210, shoulder); nmr (DMSO-d_6) δ 1.30 (3 H, s, methyl), 1.44 (3 H, s, methyl), 4.04 (1 H, d, J_{gem} = 12.0 Hz, $H_{5'a}$), 4.19 (1 H, d, J_{gem} = 12.0 Hz, $H_{5'b}$), 4.98 (1 H, d, $J_{2',3'}$ = 6.0 Hz, $H_{2'}$, or $H_{3'}$), 5.11 (1 H, d, $J_{2',3'}$ = 6.0 Hz, H_3, or $H_{2'}$), 5.89 (1 H, d, $J_{5,6}$ = 7.5 Hz, H_5), 6.24 (1 H, s, $H_{1'}$), and 7.68 (1 H, d, $J_{5,6}$ = 7.5 Hz, H_6).

Anal. Calcd for $C_{12}H_{13}N_2O_5Cl$: C, 47.93; H, 4.36; N, 9.32. Found: C, 47.65; H, 4.44; N, 9.18.

2,4′-Didehydro-1-(5′-chloro-5′-deoxy-2′,3′-*O*-*endo*-anisylidene-α-L-lyxosyl)uracil (6b). 2b (650 mg, 1.89 mmol) in dry acetone (5.2 ml) was treated with *tert*-butyl hypochlorite (0.34 ml, 2.83 mmol) at 0° for 2 hr, and the total was evaporated *in vacuo* to a semi-solid residue, which was triturated with a small amount of ethyl acetate. The crystals were collected by suction, dried under high vacuum, and recrystallized from a mixture of ethyl acetate and acetone to give 300 mg (42%) of **6b**, mp 166–167°: λ_{max} (MeOH) (ϵ) 227 nm (28,500) and 245 (9700, inflection); CD (MeOH) [θ] (nm) −22,000 (257) and +45,200 (226); (DMSO-d_6) δ 3.73 (3 H, s, methoxyl), 4.24 (1 H, d, J_{gem} = 13.50 Hz, $H_{5'a}$), 4.46 (1 H, d, J_{gem} = 13.50 Hz, $H_{5'b}$), 5.21 (1 H, d, $J_{2',3'}$ = 5.0 Hz, $H_{2'}$ or $H_{3'}$), 5.30 (1 H, d, $J_{2',3'}$ = 5.0 Hz, $H_{3'}$ or $H_{2'}$), 5.93 (1 H, d, $J_{5,6}$ = 7.5 Hz, H_5), 6.03 (1 H, s, anisylidene methine), 6.42 (1 H, s, $H_{1'}$), 6.94 (2 H, d, J = 9.0 Hz, aryl protons), 7.40 (2 H, d, J = 9.0 Hz, aryl protons), and 7.72 (1 H, d, $J_{5,6}$ = 7.50 Hz, H_6).

Anal. Calcd for $C_{17}H_{15}N_2O_6Cl$: C, 53.91; H, 3.99; N, 7.39. Found: C, 54.12; H, 4.00; N, 7.25.

2,4′-Didehydro-1-(5′-chloro-5′-deoxy-2′,3′-*O*-*exo*-anisylidene-α-L-lyxosyl)uracil (6c). 2c (220 mg, 0.64 mmol) in dry acetone (3.4 ml) was treated with *tert*-butyl hypochlorite (0.11 ml, 1.04 mmol) at room temperature for 3 hr, and the mixture was worked up as in the case of **6b** to give 140 mg (57.6%) of **6c** as colorless needles, mp 151–152° (ethyl acetate + acetone): λ_{max} (MeOH) (ϵ) 227 nm (25,000) and 245 (8800, inflection); CD (MeOH) [θ] (nm) −12,200 (260) and +28,800 (235); nmr (DMSO-d_6) δ 3.75 (3 H, s, methoxyl), 4.04 (1 H, d, J_{gem} = 13.5 Hz, $H_{5'}$), 4.32 (1 H, d, J_{gem} = 13.5 Hz, $H_{5'b}$), 5.07 (1 H, d, $J_{2',3'}$ = 5.0 Hz, $H_{2'}$ or $H_{3'}$), 5.22 (1 H, d, $J_{2',3'}$ = 5.0 Hz, $H_{3'}$ or $H_{2'}$), 5.86 (1 H, s, anisylidene methine), 5.93 (1 H, d, $J_{5,6}$ = 7.50 Hz, H_5), 6.42 (1 H, s, $H_{1'}$), 6.98 (2 H, d, J = 9.0 Hz, aryl protons), 7.41 (2 H, d, J = 9.0 Hz, aryl protons) and 7.71 (1 H, d, $J_{5,6}$ = 7.50 Hz, H_6).

Anal. Calcd for $C_{17}H_{15}N_2O_6Cl$: C, 53.91; H, 3.99; N, 7.39. Found: C, 53.68; H, 4.19; N, 7.14.

1-(2′,3′-*O*-isopropylidene-4′-chloromethylene-4′-methoxy-β-D-*erythro*-furanosyl)uracil (7a). To a stirred suspension of **6a** (200 mg) in methanol (20 ml) was added nitromethane (3 drops), when the mixture rapidly went into solution. Tlc after 1 hr showed only one faster moving spot and no starting material with several solvent systems such as ethanol–benzene (1:4) and chloroform–ethyl acetate (1:1, 2:1, 3:1, as well as 4:1). The mixture was concentrated *in vacuo* to give a solid which was filtered (70 mg). The filtrate was evaporated and the residue was chromatographed on a silica gel column (1.5 × 25 cm) using chloroform–ethyl acetate (5:1). No distinct separation was effected. However, some earlier collected eluants gave an additional solid (10 mg). The combined solid was recrystallized from ethyl acetate to give 70 mg of colorless needles (**7a**), mp 229–231°: λ_{max} (MeOH) 261 nm (ϵ 7000); nmr ($CDCl_3$ + DMSO-d_6) δ 1.38 (3 H, s, methyl), 1.58 (3 H, s, methyl), 3.20 (3 H, s, methoxyl), 3.0–3.60 (2 H, m, 5′-methylene), 4.68 (1 H, d, $J_{2',3'}$ = 6.0 Hz, $H_{3'}$), 5.02 (1 H, dd, $J_{2',3'}$ = 6.0 Hz, $J_{1',2'}$ = 1.7 Hz, $H_{2'}$), 5.66 (1 H, d, $J_{5,6}$ = 8.0 Hz, H_5), 6.28 (1 H, d, $J_{1',2'}$ = 1.7 Hz, $H_{1'}$), and 7.30 (1 H, d, $J_{5,6}$ = 8.0 Hz, H_6).

Anal. Calcd for $C_{13}H_{17}N_2O_6Cl$: C, 46.89; H, 5.15; N, 8.42. Found: C, 46.77; H, 5.19; N, 8.23.

The noncrystalline part seemed to be an 4′-epimer contaminated with **7a** as indicated by its nmr spectrum, in which appeared two sets of the methyl signals and multiple splittings for the sugar protons, and so was not chased further. This was also the case with the methanolysis products of compound **6b** and **6c**.

1-(2′,3′-*O*-*endo*-Anisylidene-4′-chloromethylene-4′-methoxy-β-D-*erythro*-furanosyl)uracil (7b). 2,4′-Cyclo nucleoside **6b** (200 mg, 0.53 mmol) in methanol (5 ml) was treated with nitromethane (0.05 ml) at room temperature for 1 hr, during which the mixture went into solution. On standing at room temperature overnight, the mixture gave crystals which were filtered and dried. Column chromatography on the filtrate using chloroform–ethyl acetate (4:1) gave a second crop of crystals. The combined product was recrystallized from methanol to give 55 mg (25%) of needles (**7b**), mp 205–207°: λ_{max} (MeOH) (ϵ) 225 nm (17,600) and 256 (12,000); nmr (DMSO-d_6) δ 3.07 (3 H, s, 4′-methoxyl), 3.75 (3 H, s, methoxyl of the anisyl), 3.76 (1 H, d, J_{gem} = 12.0 Hz, $H_{5'a}$), 4.10 (1 H, d, J_{gem} = 12.0 Hz, $H_{5'b}$), 4.78 (1 H, d, $J_{2',3'}$ = 6.0 Hz, $H_{2'}$ or $H_{3'}$), 5.56 (1 H, $J_{2',3'}$ = 6.0 Hz, $H_{3'}$ or $H_{2'}$), 5.69 (1 H, d, $J_{5,6}$ = 8.0 Hz, H_5), 6.03 (1 H, s, anisylidene methine), 6.30 (1 H, s, $H_{1'}$), 6.95 (2 H, d, J = 8.50 Hz, aryl protons), 7.43 (2 H, d, J = 8.50 Hz, aryl protons), 7.57 (1 H, d, $J_{5,6}$ = 8.0 Hz, H_6), and 11.38 (1 H, s, NH).

Anal. Calcd for $C_{18}H_{19}N_2O_7Cl \cdot \frac{1}{2}CH_3OH$: C, 52.06; H, 4.96; N, 6.56. Found: C, 51.92; H, 4.78; N, 6.47.

1-(2′,3′-*O*-*exo*-Anisylidene-4′-chloromethylene-4′-methoxy-β-D-*erythro*-furanosyl)uracil (7c). 6c (200 mg, 0.53 mmol) in methanol (5 ml) was treated with nitromethane (0.07 ml) at room temperature overnight. The separated crystals were collected, dried, and recrystallized from methanol to give 80 mg (37%) of needles (**7c**), mp 243–246°: λ_{max} (MeOH) (ϵ) 225 nm (16,000) and 256 (12,300); nmr (DMSO-d_6) δ 3.08 (3 H, s, 4′-methoxyl), 3.66 (1 H, d, J_{gem} = 12.0 Hz, $H_{5'a}$), 3.75 (3 H, s, methoxyl of the anisyl), 4.28 (1 H, d, J_{gem} = 12.0 Hz, $H_{5'b}$), 4.81 (1 H, d, $J_{2',3'}$ = 6.0 Hz, $H_{2'}$ or $H_{3'}$), 5.33 (1 H, d, $J_{2',3'}$ = 6.0 Hz, $H_{3'}$ or $H_{2'}$), 5.65 (1 H, d, $J_{5,6}$ = 8.0 Hz, H_5), 5.84 (1 H, s, anisylidene methine), 6.23 (1 H, s, $H_{1'}$), 6.96 (2 H, d, J = 8.5 Hz, aryl protons), 7.42 (2 H, d, J = 8.5 Hz, aryl protons), 7.53 (1 H, d, $J_{5,6}$ = 8.5 Hz, H_6), and 11.43 (1 H, br s, NH).

Anal. Calcd for $C_{18}H_{19}N_2O_7Cl$: C, 52.06; H, 4.96; N, 6.56. Found: C, 52.12; H, 5.01; N, 6.39.

1-(5′-Deoxy-2′,3′-*O*-*endo*-anisylidene-α-L-lyxopentofuranosyl)uracil (9). (A) Compound **6b** (400 mg, 1.06 mmol) in acetone (40 ml) was stirred under hydrogen (1 atm) in the presence of triethylamine (1.47 ml, 10.6 mmol) and 10% palladium on charcoal (200 mg) for 2 days. The catalyst was removed by filtration and the filtrate was evaporated to a semisolid residue, which was triturated with ethyl acetate and filtered. On washing the filter cake with a small amount of water, 150 mg of the starting material was recovered. The ethyl acetate layer was then applied on a silica gel column (1 × 20 cm) and eluted with chloroform–ethyl acetate (5:1) to give a crystalline product, which was repeatedly crystallized from ethanol to colorless needles (**9**) of mp 134–135° (50 mg, 22.5%): λ_{max} (MeOH) (ϵ) 224 nm (13,800) and 260 (8400); nmr (DMSO-d_6) δ 1.27 (3 H, d, $J_{4',5'}$ = 6.0 Hz, 5′-methyl), 3.74 (3 H, s, methoxyl), 4.24–4.60 (1 H, br m, $H_{3'}$), 4.68–4.95 (1 H, br m, $H_{2'}$), 5.30 (1 H, dd, $J_{4',5'}$ = 6.0 Hz, $J_{3',4'}$ = 12.0 Hz, $H_{4'}$), 5.55 (1 H, d, $J_{5,6}$ = 8.0 Hz, H_5), 5.69 (1 H, s, anisylidene methine), 5.81 (1 H, s, $H_{1'}$), 6.90 (2 H, d, J = 8.5 Hz, aryl protons), 7.36 (2 H, d, J = 8.50 Hz, aryl protons), and 7.65 ($J_{5,6}$ = 8.0 Hz, H_6).

Anal. Calcd for $C_{17}H_{18}N_2O_6$: C, 58.96; H, 5.24; N, 8.09. Found: C, 58.95; H, 5.33; N, 7.86.

(B) Compound **2b** (110 mg, 0.32 mmol) in acetone (15 ml) was submitted to atmospheric pressure hydrogenation using 10% palladium on charcoal (100 mg) for 18 hr. The catalyst was filtered off and the filtrate was evaporated to a paste, which crystallized on scratching in the presence of a small amount of ethyl acetate. Recrystallization from a mixture of ethanol and ethyl acetate gave 95 mg (86%) of needles of mp 132–134°, identified with the product (**9**) in procedure A by infrared spectroscopy and mixture melting point determination.

Acidic Hydrolysis of 1-(5′-Deoxy-2′,3′-*O*-*endo*-anisylidene-α-L-lyxopentofuranosyl)uracil (9). Compound **9** (150 mg, 0.43 mmol) in 80% acetic acid (3 ml) was held at 50° for 5.5 hr and evaporated *in vacuo*. The obtained gum was repeatedly coevaporated with ethanol to remove the residual acetic acid to give a solid mass, which was digested with ether and filtered. Crystallization from methanol gave 75 mg (76%) of colorless needles of mp 226–228°, which were identified with an authentic specimen of 1-(5′-deoxy-α-L-lyxopentofuranosyl)uracil (**10**) (lit.[14] mp 228–230°) in all respects.

Hydrolysis of 2,4′-Didehydro-1-(5′-chloro-5′-deoxy-2′,3′-*O*-isopropylidene-α-L-lyxosyl)uracil (6a). Compound **6a** (60 mg, 0.2 mmol) in a mixture of acetone (8 ml) and water (2 ml) was heated to reflux for 1 hr and the mixture was evaporated. The residue was dried by coevaporation with ethanol and triturated with

ether to give a solid, which was filtered (17 mg, 78%) and infrared spectroscopically identified with an authentic specimen of uracil.

Ammonolysis of 2,4′-Didehydro-1-(5′-chloro-5′-deoxy-2′,3′-*O*-isopropylidene-α-L-lyxosyl)uracil (6a). A suspension of **6a** (0.21 g, 0.7 mmol) in saturated ethanolic ammonia (25 ml) was stirred at room temperature overnight. The yellow solution was evaporated *in vacuo* and the residue was triturated with a small amount of acetone to give a tlc-pure solid, which was filtered (60 mg) and recrystallized from a mixture of methanol and ethanol. There was obtained 50 mg (64%) of colorless crystals (**12**) of mp 273–276° dec, identified with an authentic sample[27] of isocytosine by infrared spectroscopy and mixture melting point determination: λ_{max} (MeOH) (ε) 216 nm (6700, inflection) and 278 (5600).

Anal. Calcd for $C_4H_5N_3O$: C, 43.24; H, 4.54; N, 37.83. Found: C, 43.50; H, 4.66; N, 37.55.

The acetone solution separated from **12** was concentrated and applied on a silica gel column (1 × 15 cm). Elution with chloroform–ethyl acetate (3:1) gave a small amount of a less polar crystalline substance, which melted at 130–132° after recrystallization from ethyl acetate and identified as 3,4-dihydro-4-keto-2-ethoxypyrimidine (**13**) (lit.[27] mp 127.5–129° from water): yield 12 mg (12%); nmr ($CDCl_3$) δ 1.40 (3 H, t, J = 7.45 Hz, methyl), 4.47 (2 H, q, J = 7.45 Hz, methylene), 6.13 (1 H, d, $J_{5,6}$ = 7.0 Hz, H_5), and 7.77 (1 H, d, $J_{5,6}$ = 7.0 Hz, H_6).

Anal. Calcd for $C_6H_8N_2O_2$: C, 51.42; H, 5.75; N, 19.99. Found: C, 51.68; H, 5.80; N, 19.80.

N^4-Benzoyl-2,4′-didehydro-1-(5′-chloro-5′-deoxy-2′,3′-*O*-*exo*-anisylidene-α-L-lyxosyl)cytosine (14). To a stirred ice-cold suspension of **5b** (153 mg, 0.34 mmol) in acetone (4 ml) was added *tert*-butyl hypochlorite (0.04 ml, 0.35 mmol). The suspension became clear rapidly and, after 15 min, a crystalline solid began to separate. After 1 hr of being stirred at 0°, the solid was filtered, washed with a small volume of ether, dried *in vacuo*, and recrystallized from a mixture of acetone and ethyl acetate to give 80 mg (48.8%) of needles, mp 235–237° dec: λ_{max} (MeOH) (ε) 226 nm (23,600), 242 (14,100, inflection), and 279 (18,700); CD (MeOH) [θ] (nm) −490 (280), −260 (273), −640 (268), and +380 (243); nmr (DMSO-d_6) δ 3.76 (3 H, s, methoxyl), 4.08 (1 H, d, J_{gem} = 12.0 Hz, $H_{5'a}$), 4.18 (1 H, d, J_{gem} = 12.0 Hz, $H_{5'b}$), 5.05 (1 H, d, $J_{2',3'}$ = 6.0 Hz, $H_{2'}$ or $H_{3'}$), 5.21 (1 H, d, $J_{2',3'}$ = 6.0 Hz, $H_{3'}$ or $H_{2'}$), 5.84 (1 H, s, anisylidene methine), 6.41 (1 H, s, $H_{1'}$), 6.42 (1 H, d, $J_{5,6}$ = 7.0 Hz, H_5), 6.95 (2 H, d, J = 8.0 Hz, aryl protons of the anisyl), 7.39 (2 H, d, J = 8.0 Hz, aryl protons of the anisyl), 7.40–7.47 (3 H, m, benzoyl), 7.65 (1 H, d, $J_{5,6}$ = 7.0 Hz, H_6), and 7.93 (2 H, dd, benzoyl).

Anal. Calcd for $C_{24}H_{20}N_3O_6Cl$: C, 59.81; H, 4.15; N, 8.72. Found: C, 59.53; H, 4.09; N, 8.45.

Methanolysis of N^4-Benzoyl-2,4′-didehydro-1-(5′-chloro-5′-deoxy-2′,3′-*O*-*exo*-anisylidene-α-L-lyxosyl)cytosine (14). **14** (0.5 g, 1.04 mmol) in methanol (25 ml) was treated with nitromethane (0.5 ml) at room temperature for 1.5 hr. Tlc with an aliquot of the resulted solution revealed a major product with a slightly faster moving minor product in solvent systems chloroform–ethyl acetate (3:1 and 2:1). The mixture was evaporated to a paste and chromatographed on a silica gel column using chloroform–ethyl acetate (4:1) to give two pasty products, both of which showed quite similar uv absorption with that of **14** on qualitative measurements in methanol and did not become foamy on evaporating at room temperature under vacuum of 7–10 mm. The minor product was neglected and the major product was submitted to nmr measurement ($CDCl_3$) which revealed an additional methoxyl signal at 3.98 ppm and some ill-resolved signal envelope due to the sugar protons. The total major product was then dried at 50–55° under high vacuum for 20 hr, when crystallization occurred with a certain degree of decomposition. The total was then submitted to preparative tlc using silica gel and chloroform–ethyl acetate (1:1) to give *ca.* 100 mg of powder, which was recrystallized from a mixture of ethyl acetate and ether to give 90 mg (38%) of 2-methoxy-4-benzamidopyrimidine (**16**) as needles of mp 107–108°: λ_{max} (MeOH) (ε) 238 nm (12,700) and 281 (16,600); nmr ($CDCl_3$) δ 3.93 (3 H, s, methoxyl), 7.40–7.66 (3 H, m, aryl protons), 7.80–8.0 (3 H, m, aryl protons and H_5), 8.45 (1 H, d, $J_{5,6}$ = 6.0 Hz, H_6), and 8.60 (1 H, br s, NH, D_2O exchangeable).

Anal. Calcd for $C_{12}H_{11}N_3O_2$: C, 62.87; H, 4.84; N, 18.33. Found: C, 62.53; H, 5.00; N, 18.44.

Registry No.—, **1b**, 53166-52-2; **2a**, 17331-67-8; **2b**, 53166-53-3; **2c**, 53166-54-4; **3a**, 53166-55-5; **3b**, 53166-56-6; **4**, 53166-57-7; **5a**, 53166-58-8; **5b**, 53166-59-9; **5c**, 53166-60-2; **5d**, 53166-61-3; **6a**, 53198-11-1; **6b**, 53198-12-2; **6c**, 53228-48-1; **7a**, 53166-62-4; **7b**, 53166-63-5; **7c**, 53187-87-4; **9**, 53166-65-7; **12**, 108-53-2; **13**, 25957-58-8; **14**, 53166-64-6; **16**, 53166-66-8.

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(17) Here, endo and exo terms refer to the diastereomeric hydrogen, *i.e.*, anisylidene is exo when the anisylidene methine proton is projected outward from, and endo when it is underneath the sugar ring.
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(21) NOE measurements were carried out[24] on compounds **2b** and **2c** for eventual interactions between the anomeric proton and the methine and/or aryl protons of the anisylidene group. None was observed except a slight interaction between $H_{1'}$ and H_6.
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(24) The measurements were carried out by Takeda Chemical Industries Co., Ltd., for which we are grateful.
(25) Unpublished data.
(26) It is difficult to find a correct nomenclature for compounds **7** and **15** as long as the configuration at $C_{4'}$ remains unknown. These compounds might be named as derivatives of a 4′-substituted 5′-chloro-5′-deoxy-β-D-ribofuranoside when the chloromethylene group stands upward and as the corresponding 4′-substituted derivatives of a α-L-lyxofuranosyl nucleoside when it is oriented downward as once suggested for the epimeric 5′-deoxy-4′-fluoro-5′-iodoadenine nucleosides: I. D. Jenkins, J. P. H. Verheyden, and J. G. Moffatt, *J. Amer. Chem. Soc.*, **93**, 4323 (1971). For the time being, however, we simply name this class of compounds as the derivatives of a β-D-*erythro*-furanoside so as not to specify the configuration at $C_{4'}$ as formerly done by us: T. Sasaki, K. Minamoto, and K. Hattori, *J. Amer. Chem. Soc.*, **95**, 1350 (1973). On the other hand, compounds **6** are cyclo nucleosides formally produced by 2,4′-dehydrogenation of the corresponding derivatives of α-L-lyxofuranosyl nucleosides and are certainly different from the hitherto known pyrimidine 2-anhydro nucleosides which usually form by elimination of a molecule of ROH (R = H or leaving groups). The hydrogenolysis of **6b** to **9** also seems to justify this treatment. In this sense, we correct the nomenclature of cyclo nucleosides of type **6** as in the text.
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