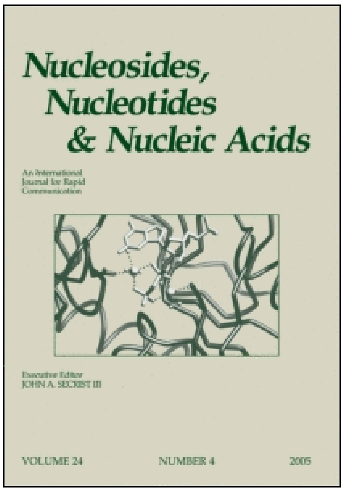

Nucleosides, Nucleotides and Nucleic Acids
Publication details, including instructions for authors and subscription information:
http://www.informaworld.com/smpp/title~content=t713597286

Stereoselective Reactions OF 1-(4,6-*O*-Benzylidene-2,3-Didehydro-2,3-dideoxy-3-nitro-β-D-hexopyranosyl)uracil with some Nucleophiles

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To cite this Article Ohta, N. , Minamoto, K. , Yamamoto, Y. , Koide, N. and Sakoda, R.(1996) 'Stereoselective Reactions OF 1-(4,6-*O*-Benzylidene-2,3-Didehydro-2,3-dideoxy-3-nitro-β-D-hexopyranosyl)uracil with some Nucleophiles', Nucleosides, Nucleotides and Nucleic Acids, 15: 4, 833 — 855
To link to this Article: DOI: 10.1080/07328319608002131
URL: http://dx.doi.org/10.1080/07328319608002131

NUCLEOSIDES & NUCLEOTIDES, 15(4), 833-855 (1996)

STEREOSELECTIVE REACTIONS OF 1-(4,6-*O*-BENZYLIDENE-2,3-DIDEHYDRO-2,3-DIDEOXY-3-NITRO-β-D-HEXOPYRANOSYL)URACIL WITH SOME NUCLEOPHILES¶

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Abstract: Michael addition of benzylamine, piperidine, morpholine, pyrrolidine, cyclohexylamine, allylamine and dimethylmalonate to the nitroolefin (**5**) generated *in situ* from 1-(4,6-*O*-benzylidene-3-deoxy-3-nitro-β-D-glucopyranosyl)uracil (**4b**) gave the corresponding 2-(substituted-amino)-3-deoxy-3-nitro-β-D-glucopyranosides (**6a-f** and **6h**). Reaction of **4b** with *N,N'*-carbonyldiimidazole directly gave **6g**. Compound **4b** was converted into the 2-deoxy analogue (**8**), which was reduced to the 3-amino (**9**) and 3-hydroxylamino analogue (**10**).

The FDA approved anti-AIDS drugs, 3'-azido-3'-deoxythymidine (AZT), 2',3'-dideoxyinosine (ddI), 2',3'-dideoxycytidine (ddC) and 2',3'-didehydro-3'-deoxythymidine (d4T)[1] have been shown to be able to chain-terminate the cDNA synthesis of HIV promoted by its reverse transcriptase owing to the lack of a 3'-hydroxyl. Clearly, the central inhibitive factors have stemmed from the modified sugar parts, and hence a wide variety of chemical modifications of the sugar moiety of the nucleosides have been achieved,[2] while reports on the synthesis and anti-HIV activity of pyranosyl nucleosides are notably missing.[2] On the other hand, from the viewpoint of functionalities on the glycones or glycone mimics, available data on the nitrosugar nucleosides are quite

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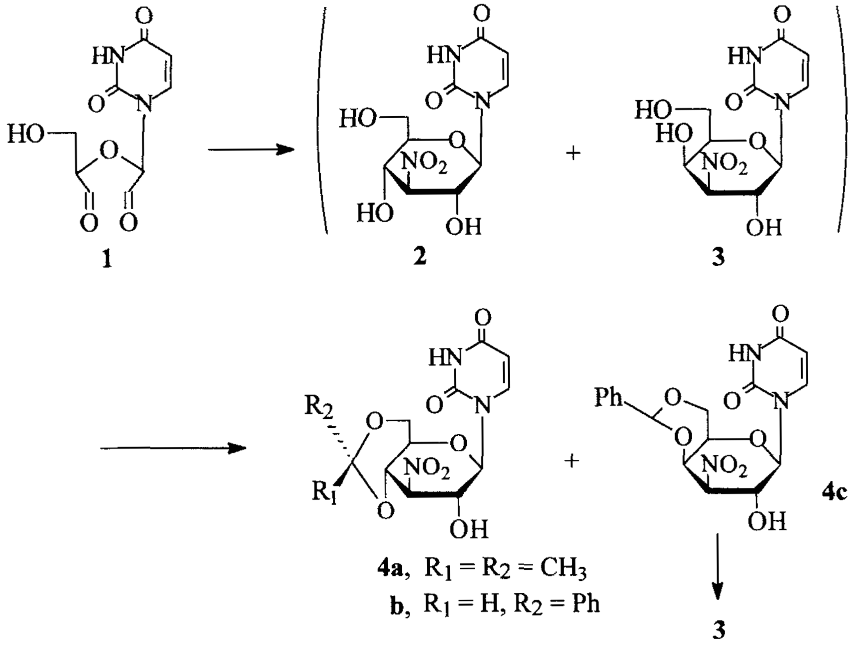
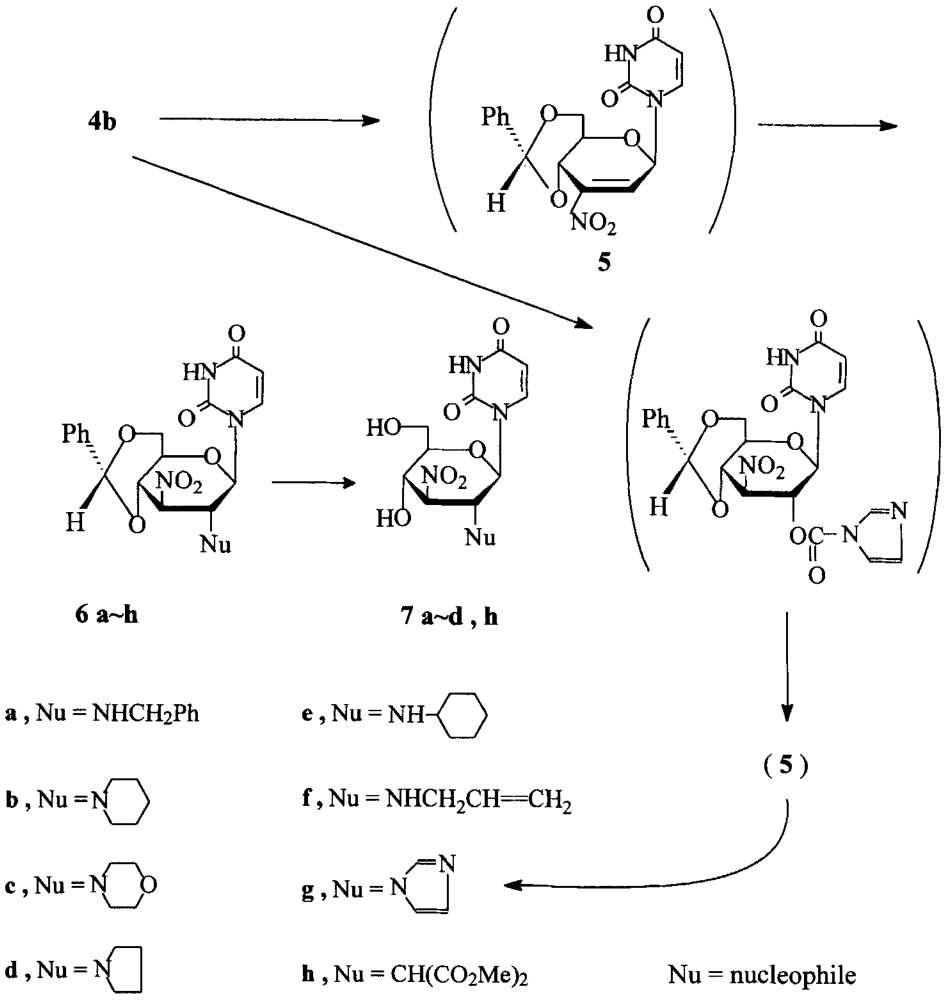
¶ This paper is dedicated to Dr. Yoshihisa Mizuno, emeritus professor of Hokkaido University, to celebrate his 75th birthday.



Scheme 1

limited. It is well known that a number of nitro or nitroso group-containing organic molecules possess hazardous biological activities involving carcinogenicity,[3] while some nitro group-containing antibiotics of natural origin such as Chloramphenicol, 2-nitroimidazole or Aureothin are known.[3] Although a consistent understanding of the biochemical role of the nitro group seems to be lacking, various biological oxidation-reduction processes involving nitrite or nitrate compounds are recorded.[3] Therefore, synthesis and biological evaluation of nitrosugar nucleosides are, at least in principle, important, especially in view of the history of the nucleoside chemistry which has recorded the synthesis of numerous aminosugar nucleosides as potential therapeutic agents. In this context, the first synthesis of 3'-deoxy-3'-nitrothymidine and its 2',3'-didehydro analogue as potential anti-AIDS substances has been recorded recently by Hossain et al.[4,5] We report herein the results of a synthetic study directed toward the synthesis of some 2-(substituted-amino)-2,3-dideoxy-3-nitro-glucopyranosyl uracils and related compounds starting from 1-(4,6-*O*-benzylidene-3-deoxy-3-nitro-β-D-glucopyranosyl)uracil (**4b**)[6] (**Scheme 1**).



Scheme 2

Michael Addition Reactions to 1-(4,6-*O*-Benzylidene-2,3-Didehydro-2,3-dideoxy-3-nitro-β-D-hexopyranosyl)uracil (5).

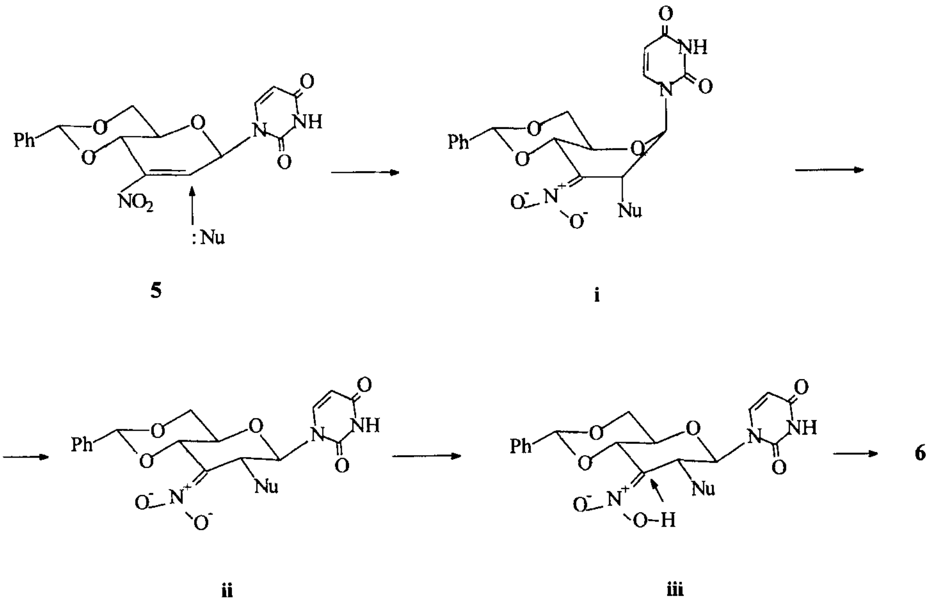
For the purpose of generation of a 2,3-didehydro-2,3-dideoxy-3-nitro intermediate (**5**) (**Scheme 2**) as a Michael acceptor, we first subjected the product[6] obtained from the dialdehyde (**1**) and nitromethane to the usual isopropylidenation reaction at room temperature. However, this product turned out to require unexpectedly drastic reaction conditions. Although a selected experiment described in the experimental section gave a 58% yield of 1-(3-deoxy-4,6-*O*-isopropylidene-3-nitro–β–D-glucopyranosyl)uracil (**4a**), this substance proved to be unstable, gradually regenerating 1-(3-deoxy-3-nitro-β-D-glucopyranosyl)uracil (**2**) in methanolic solution at room temperature. Hence, we chose to use 4,6-*O*-benzylidene derivative of **2**. Treatment of the TLC-pure nitronucleoside obtained from **1** with benzaldehyde/$ZnCl_2$ gave a mixture of two products, from which the slightly less polar major product (**4b**) was isolated in ca. 70% yield and used as the starting material. The minor product obtained in 15% yield proved to be 1-(4,6-*O*-benzylidene-3-deoxy-3-nitro-β-D-galactopyranosyl)uracil (**4c**).[7,8] Thus, the original nitronucleoside product was an inseparable mixture of the two isomers as described.[7] The ^1H NMR spectra of **4b,c** and the deprotected form of **4c** coincided with those of the known compounds.[7]

Compound **4b** in acetone was treated with methanesulfonyl chloride (MsCl) (2 equiv) and then with excess amount of triethylamine at -18 ° C[9] to give the nitroolefin intermediate **5** as a less polar product, which was too unstable to be isolated by silica gel chromatography, in contrast with the reported isolation of various nitroolefins in the areas of hexopyranose sugars[10] and pentofuranosyl nucleosides.[4,5] Treatment of this reaction mixture with benzylamine gave 1-(2-benzylamino-4,6-*O*-benzylidene-2,3-dideoxy-3-nitro-β-D-glucopyranosyl)uracil (**6a**). Similarly, its 2-piperidino (**6b**), 2-morpholino (**6c**), 2-pyrrolidino (**6d**), 2-cyclohexylamino (**6e**) and 2-allylamino analogues (**6f**) were obtained in moderate to excellent yields. In the cases of **6d-f**, formation of slight amounts of side-products was observed but these were neglected. All the spectral and elemental analysis data oi these compounds are consistent with the proposed structures (see the experimental section). The glucopyranosyl structures of these compounds are based upon the generally large $J_{1,2}$, $J_{2,3}$ and $J_{3,4}$ values in the ^1H NMR spectra.

For another purpose, **4b** in DMF was treated with *N,N'*-carbonyldiimidazole (CDI) at room temperature to give, interestingly, 1-(4,6-*O*-benzylidene-2,3-dideoxy-2-imidazol-1-yl-3-nitro-β-D-glucopyranosyl)uracil (**6g**) quantitatively under gas evolution. This observation is explicable in terms of imidazocarbonylation of the 2-hydroxyl followed by elimination of imidazo-carboxylic acid which instantaneously released carbon dioxide.

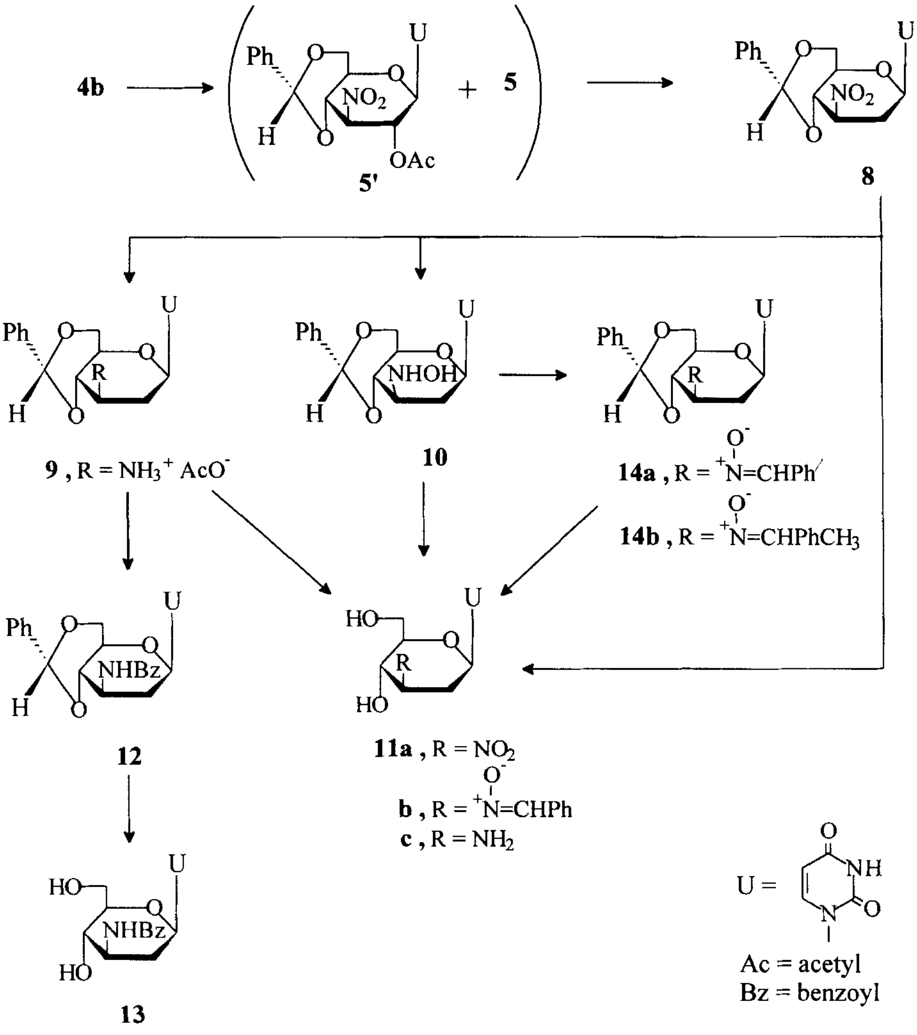
The nitroolefin **5** thus formed reacted with the released imidazole to afford **6g**. Similarly, Michael addition of dimethylmalonate to **5** gave 1-(4,6-*O*-benzylidene-2,3-dideoxy-2-*C*-dimethylmalonyl-3-nitro-β-D-gluco-pyranosyl)uracil (**6h**) in 55% yield.[11]

Debenzylidenation of **6a** with 90% trifluroacetic acid (TFA) at 0 ° C gave 1-(2,3-dideoxy-3-nitro-β-D-glucopyranosyl)uracil (**7a**). Similarly, 2-piperidino (**7b**), 2-morpholino (**7c**), 2-pyrrolodino (**7d**) and 2-*C*-dimethylmalonyl analogues (**7h**) were obtained, while the deprotected form of **6e, 6f** as well **6g** was too unstable to be isolated.



Scheme 3

Thus, the present Michael addition reactions gave the thermodynamically more stable glucopyranosyl nucleosides with all the substituents in equatorial configuration in all the cases. Probably owing to the steric hindrance by the base, the nucleophiles might have attacked the nitroolefin **5** from the α–side (axial attack) to yield transiently the boat-like *aci*-nitro intermediate **i**, which may flip to the more stable chair form **ii**. (**Scheme 3**). After protontion of **ii** to yield **iii**,[12] hydride shift must have occurred in thermodynamically favorable way to form **6**. At present, we have no evidences suggesting formation of an intermediary 2,2'-anhydro nucleoside. On the contrary, this possibility should be excluded since it has been well established that nitrogen and oxygen nucleophiles attack some 2,2'-anhydro-pentofuranosyl uracils[13] and even a 2,2'-anhydro-hexopyranosyl uracil[14] to induce the "aryl-*O*-cleavage" (cleavage between the C-2 of the base and bridge-oxygen). Furthermore, generation of **5** occurred under the basic condition which can more or less ionize the base moiety. Nevertheless, as shown in the next paragraph (**Scheme 4**), the mixture of **5** and **5'** (precursor of **5**) gave the normal product **8** on sodium borohydride reduction,[15] no indication of 2,2'-cyclization having been given.



Scheme 4

Synthesis and Reduction of 1-(4,6-*O*-Benzylidene-2,3-dideoxy-3-nitro-β-D-*arabino*-hexopyranosyl)uracil (8) (Scheme 4). Synthesis and biological evaluation of nitrososugar and hydroxylaminosugar nucleosides seems to be interesting, since these types of nucleosides as possible intermediates in the biological redox systems have never appeared in the literature as contrasted with the synthesis of various aminosugar nucleosides. Hence, we chose the title compound **8** as the simplest model substrate for stepwise reduction. According to the method of Wollenberg,[15] who directly obtained several nitroalkanes in high yields by sodium borohydride reduction of the corresponding β-acetoxynitroalkanes, compound **4b** was treated with acetic anhydride in pyridine to give a mixture of **5** and a slightly less polar product which seemed to be the desired 2-acetate of **4b** (**5'**) (see the experimental section). Attempted separation of **5** and **5'** failed. Accordingly, the mixture was directly treated with $NaBH_4$ in DMF to give 1-(4,6-*O*-benzylidene-2,3-dideoxy-3-nitro-β-D-*arabino*-hexopyranosyl)uracil (**8**) in a high yield.[10a,b] Reduction of **8** with tin powder/AcOH-MeOH gave 1-(3-amino-4,6-*O*-benzylidene-2,3-dideoxy-β-D-*arabino*-hexopyranosyl)uracil acetate (**9**), while controlled reduction of **8** with zinc powder/AcOH-EtOH permitted isolation of 1-(4,6-*O*-benzylidene-2,3-dideoxy-3-hydroxylamino-β-D-*arabino*-hexopyranosyl)uracil (**10**) in a reasonable yield. Compound **8** and **9** were deprotected to 1-(2,3-dideoxy-3-nitro-β-D-*arabino*-hexopyranosyl)uracil (**11a**) and 1-(3-amino-2,3-dideoxy-β-D-*arabino*-hexopyranosyl)uracil (**11c**), respectively, with the use of 80% acetic acid, while similar treatment of **10** yielded 1-(2,3-dideoxy-3-*N*-benzylideneaminoxido-β-D-*arabino*-hexopyranosyl)uracil (**11b**) as a single product. On the basis of the elemental analysis and ^1H NMR data, we first suspected that **11b** was 1-(3-benzamido-2,3-dideoxy-β-D-*arabino*-hexopyranosyl)uracil (**13**), which might have formed through condensation of the released benzaldehyde with the hydroxylamino nitrogen followed by dehydration. Hence, compound **13** was synthesized starting from compound **9** through 1-(3-benzamido-4,6-*O*-benzylidene-2,3-dideoxy-β-D-*arabino*-hexopyranosyl)uracil (**12**). However, compound **13** proved to be different from **11b** in terms of TLC-mobility and spectral data. At this stage, we thought of the common acid-catalyzed nitrone-formation from hydroxylamine derivatives and aldehydes or ketones.[16] In fact, compound **10** readily gave 1-(4,6-*O*-benzylidene-2,3-dideoxy-3-*N*-benzylideneaminoxido-β-D-*arabino*-hexopyranosyl)uracil (**14a**) on treatment with benzaldehyde in acetic acid. The deprotected form of **14a** was fully identified with **11b**. Since in the ^1H NMR spectra of compounds **11b** and **14a** the signal of the nitrone methine proton merged into those of aromatic protons, another analogue with an anisylidene group was synthesized for spectral comparison. Reaction of **10** with anisaldehyde was rather sluggish but gave a high yield of 1-(4,6-*O*-benzylidene-2,3-dideoxy-3-*N*-anisylideneaminoxido-β-D-*arabino*-hexopyranosyl)uracil (**14b**), whose ^1H NMR spectrum exhibited a distinct signal for the nitrone methine proton at 7.78 ppm together with the expected pair of doublets for the Ar-H on both sides (see the experimental section). Thus, although the deprotected form of **10** was not obtained in this piece of work, the facile nitrone formation suggests some new routes to chemical modification of nucleosides.

Anti-HIV bioassay and other biological tests for the new compounds are under way at separate institutes.

Experimental Section

Mps were recorded on a Yanagimoto micro melting point apparatus and are uncorrected. UV spectra were measured on a JASCO Ubest V-560DS spectrophotometer. The 200 MHz ^{1}H NMR spectra were recorded on GEMINI-200 FT NMR spectrometer. Elemental analyses were conducted using a Perkin-Elmer 240B elemental analyzer. For preparative scale thick-layer chromatography, glass plates coated with 2-mm thickness of Wakogel B-5F silica gel were used after activation at 100 °C for 10~12 h. For column chromatography, Wakogel C-300 silica gel was used. All evaporations were carried out under reduced pressure at or below 40 °C.

1-(3-Deoxy-4,6-*O*-isopropylidene-3-nitro-β-D-glucopyranosyl)uracil (4a). A mixture of the nitronucleosides (**2** and **3**)[6] (500 mg, 1.65 mmol), 2,2-dimethoxypropane (1.5 ml, 12.2 mmol) and saturated hydrogen chloride solution in dioxane (10 drops) in acetone/DMF (1:1) (10 ml) was stirred at room temperature for 40 h, at 60 °C for 4 h, at 80 °C for 20 h and then at 90 °C for 3 h. The mixture was neutralized with 2 N NH_4OH and the solvent evaporated off. The residue in acetone was directly subjected to preparative TLC (silica, 20 × 20 cm; $CHCl_3$/MeOH, 4:1) to give, from the major band, 328 mg (57.9%) of **4a** as a foam. For analysis, a part of this product was recrystallized from MeOH: mp 228-230 °C; λmax (MeOH) 259.0 nm (ε 10300); ^{1}H NMR (Me_2SO-d_6) δ 1.32 (3H, s, Me), 1.45 (3H, s, Me), 3.71-3.74 (2H, m, H-6a, H-6b), 3.89-3.92 (1H, m, H-5), 4.24-4.28 (2H, m, H-2 and H-4), 5.04 (1H, dd, $J_{3,2}$ = 10.0, $J_{3,4}$ = 10.0, H-3), 5.72 (1H, d, $J_{5,6}$ = 8.0, H^5 of the base), 5.76 (1H, d, $J_{1,2}$ = 9.2, H-1), 6.41 (1H, d, 2-OH), 7.90 (1H, d, $J_{6,5}$ = 8.0, H^6), 11.39 (1H, s, 3-NH). *Anal.* Calcd. for $C_{13}H_{17}N_3O_8 \cdot$ MeOH: C, 44.80; H, 5.64; N, 11.20. Found: C, 44.50; H, 5.78; N, 11.36.

1-(4,6-*O*-Benzylidene-3-deoxy-3-nitro-β-D-glucopyranosyl)uracil (4b) and 1-(4,6-*O*-Benzylidene-3-deoxy-3-nitro-β-D-galactopyranosyl)uracil (4c). A mixture of the nitronucleosides (**2**,**3**)[6] (4.28 g, 14.1 mmol), benzaldehyde (35 ml, 350 mmol) and zinc chloride (4.35 g, 31.9 mmol) was stirred at room temperature for 24 h. After the excess benzaldehyde was evaporated off, the residue was digested with benzene (15 ml) and the supernatant decanted off. This procedure followed further twice, and finally the solid was collected by suction with benzene (20 ml) and partitioned between EtOAc (150 ml) and 0.5 N $NaHCO_3$ (140 ml). The separated aqueous phase was again extracted with EtOAc

(2 × 50 ml). The combined organic layer was dried over Na_2SO_4 and evaporated. The residue was washed with ether (3 × 15 ml) to remove residual benzaldehyde and recrystallized from MeOH to give 3.80 g (69%) of **4b**, which became dark-colored above 230 °C and melted at 264-268 °C (lit[7], mp 258-259 °C): λmax (MeOH) 257.5 nm (ε 11400); ^{1}H NMR (Me_2SO-d_6) δ 3.77(1H, dd, $J_{4,5}$ = 9.80, H-5), 3.93 (1H, complex m, H-2), 4.30 (3H, m, H-4 and H-6a,b), 5.25 (dd, $J_{3,4}$ = 10.0, $J_{3,2}$ = 9.80, H-3), 5.67 (1H, s, benzylidene methine), 5.71 (1H, d, $J_{1,2}$ = 8.0, H-1), 5.83 (1H, d, $J_{5,6}$ = 8.20, H^5 of the base), 6.50 (1H, d, 2-OH), 7.40 (5H, Ar-H), 7.89 (1H, d, $J_{6,5}$ = 8.20, H^6 of the base), 11.44 (1H, br. s, 3-NH). *Anal.* Calcd for $C_{17}H_{17}O_8N_3$: C, 52.17; H, 4.38; N, 10.74. Found: C, 52.03; H, 4.58; N, 10.67.

The filtrate separated from the major part of **4b** was evaporated and subjected to column chromatography (silica, 2.8 x 23 cm; $CHCl_3$/EtOAc, 1:1) to give, from the major fraction, 821 mg (15%) of **4c**, mp 239-242 °C [lit[7], mp 243-244 °C (monohydrate)]: ^{1}H NMR (Me_2SO-d_6) δ 4.02 (1H, s, H-5), 4.14 (2H, s, H-6a, H-6b), 4.48 (1H, m, $J_{2,1}$ = 9.2, $J_{2,3}$ = 9.7, $J_{2,OH}$ = 5.2, H-2), 4.82 (1H, d, $J_{4,3}$ = 3.4, H-4), 5.35 (1H, dd, $J_{3,2}$ = 9.7, $J_{3,4}$ = 3.4, H-3), 5.68 (1H, s, PhC**H**=), 5.72 (1H, d, $J_{1,2}$ = 9.2, H-1), 5.76 (1H, d, $J_{5,6}$ = 7.8, H^5 of the base) 6.20 (1H, d, $J_{OH,2}$ = 5.2, 2-OH), 7.40 (5H, s, Ph), 7.60 (1H, d, $J_{6,5}$ = 7.8, H^6), 11.42 (1H, s, 3-NH). *Anal.* Calcd for $C_{17}H_{17}O_8N_3$: C, 52.17; H, 4.38; N, 10.74. Found: C, 52.20; H, 4.37; N, 10.71.

The minor mixed fraction containing **4b** was neglected.

1-(3-Deoxy-3-nitro-β-D-galactopyranosyl)uracil (3). A solution of compound **4c** (300 mg, 0.77 mmol) in 90% TFA (4 ml) was left at room temperature for 1 h. After addition of 50% EtOH (2 ml), the solvent was evaporated off and the residue repeatedly co-evaporated with 50% EtOH. After drying under high vacuum, the residue was digested with ether (6 ml) and the sparingly soluble solid collected by suction. Recrystallization of the filter-cake from water gave 209 mg (85%) of **3** as prisms, which sintered at around 180 °C and effervesced at 237 °C [lit[7], 173-174 °C (sinter), 224-225 °C (eff.) (solvent-free form)] : ^{1}H NMR (Me_2SO-d_6) δ 3.47 (2H, m, H-6a and H-6b), 3.85 (1H, t, H-5), 4.22 (1H, dd, H-4; becomes d upon addition of D_2O, $J_{4,3}$ = 3.4), 4.41 (1H, m, H-2; becomes dd upon addition of D_2O, $J_{2,1}$ = 9.6, $J_{2,3}$ = 10.0), 4.84 (1H, br. s, 6-OH), 5.10 (1H, dd, $J_{3,2}$ = 10.0, $J_{3,4}$ = 3.4, H-3), 5.51 (1H, d, 4-OH), 5.56 (1H, d, $J_{1,2}$ = 9.6, H-1), 5.75 (1H, dd, $J_{5,6}$ = 8.2, H^5), 6.04 (1H, d, 2-OH), 7.85 (1H, d, $J_{6,5}$ = 8.2, H^6), 11.35 (1H, br. s, 3-NH). *Anal.* Calcd for $C_{10}H_{13}N_3O_8 \cdot H_2O$: C, 37.39; H, 4.71; N, 13.08. Found: C, 37.33; H, 4.76; N, 13.09.

1-(2-Benzylamino-4,6-*O*-benzylidene-2,3-dideoxy-3-nitro-β-D-glucopyranosyl)uracil (6a). To a solution of **4b** (200 mg, 0.512 mmol) in acetone (6 ml) was added at -18 °C methanesulfonyl chloride (MsCl) (0.08 ml, 1.04 mmol) in one portion, then triethylamine (0.50 ml, 3,57 mmol) through a syringe during 1 min. After addition, the mixture was stirred at this temperature for 25 min. TLC-Monitoring ($CHCl_3$/MeOH, 9:1; silica) at this stage showed formation of the less polar intermediate **5** as a major product. Benzylamine (0.08 ml, 0.73 mmol) was added in one portion and the mixture stirred for 20 min. After having confirmed formation of a major less polar product (silica; $CHCl_3$/MeOH, 9:1), the mixture was neutralized with 1N AcOH/MeOH and evaporated. The residue was partitioned between EtOAc (15 ml) and H_2O (15 ml), and the separated EtOAc layer was evaporated after drying over Na_2SO_4. Recrystallization of the residue from MeOH gave TLC-homogeneous crystals (**6a**), which was collected by suction. The filtrate was fractionated on a silica plate (20 x 20 cm, $CHCl_3$/MeOH, 9:1) to give an additional crop. Recrystallization from MeOH gave 205 mg (69%) of **6a**, mp 212.5-214.5 °C: IR (KBr) 1270 and 1560 cm^{-1} (NO_2), 3380 cm^{-1} (sec NH); λmax (MeOH) 259.0 nm (ε 12400); ^1H NMR (Me_2SO-d_6) δ 2.51 (2H, overlapped the signal of Me_2SO, $PhCH_2$), 3.68 (1H, ddd, $J_{5,4}$ = 9.0, $J_{5,6a}$ = 3.60, $J_{5,6b}$ = 4.4, H-5), 3.82 (1H, dd, $J_{2,1}$ = 9.0, $J_{2,3}$ = 10.20, H-2), 3.82 (1H, dd, $J_{6a,5}$ = 3.60, J_{gem} = 10.4, H-6a), 4.32 (1H, dd, $J_{4,3}$ = 9.90, $J_{4,5}$ = 9.0, H-4), 4.34 (1H, dd, $J_{6b,5}$ = 4.40, J_{gem} = 10.40, H-6b), 5.42 (1H, dd, $J_{3,2}$ = 10.20, $J_{3,4}$ = 9.90, H-3), 5.66 (1H, d, J = 7.80, H^5 of the base), 5.68 (1H, s, benzylidene methine), 6.04 (1H, d, $J_{1,2}$ = 9.0, H-1), 7.08-7.44 (10H, m, Ar-H), 7.85 (1H, d, J = 7.80, H^6 of the base), 11.49 (1H, s, 3-NH). *Anal.* Calcd for $C_{24}H_{24}O_7N_4$: C, 59.99; H, 5.04; N, 11.66. Found; C, 60.04; H, 5.14; N, 11.51.

1-(4,6-*O*-Benzylidene-2,3-dideoxy-3-nitro-2-piperidino-β-D-glucopyranosyl)uracil (6b). Compound **4b** (1.00 g, 2.56 mmol) in acetone (20 ml) was treated wtih MsCl (0.36 ml, 4.68 mmol) and then with triethylamine (2.0 ml, 14.3 mmol) at -18 °C for 10 min as above. After the formation of the intermediate **5** was confirmed by TLC as above, piperidine (0.50 ml, 5.05 mmol) was added in one portion and the mixture stirred at this temperature for 1 h. The mixture was neutralized with 1N AcOH/MeOH, evaporated and the residue partitioned between EtOAc (50 ml) and H_2O (50 ml). Digestion of the finally obtained EtOAc-extract with MeOH gave 911 mg of TLC-homogeneous crystals, which was collected by suction. The filtrate was fractionated on a silica plate (20 x 20 cm;

$CHCl_3$/MeOH, 9:1) to give a further crop as a foam, which was combined with the above obtained product and recrystallized from MeOH to afford 1.02 g (87%) of **6b**, mp 241.0-242.0 °C: IR (KBr) 1265 and 1570 cm^{-1} (NO_2); λmax (MeOH) 259.0 nm (ε 9900); ^1H NMR ($CDCl_3$) δ 2.55-2.70 (10H, m, piperidino-methylene), 3.38 (1H, ddd, $J_{5,4}$ = 9.60, $J_{5,6a}$ = 4.50, $J_{5,6b}$ = 4.70, H-5), 3.66 (1H, dd, $J_{6a,5}$ = 4.50, J_{gem} = 9.90, H-6a), 3.80 (1H, dd, $J_{2,1}$ = 10.0, $J_{2,3}$ = 10.20, H-2), 4.17 (1H, dd, $J_{4,3}$ = 10.20, $J_{4,5}$ = 9.60, H-4), 4.40 (1H, dd, $J_{6b,5}$ = 4.70, J_{gem} = 9.9, H-6b), 5.11 (1H, dd, $J_{3,2}$ = 10.20, $J_{3,4}$ = 10.20, H-3), 5.54 (1H, s, benzylidene methine), 5.85 (1H, d, J = 7.60, H^5 of the base), 5.88 (1H, d, $J_{1,2}$ = 10.0, H-1), 7.27-7.39 (6H, m, Ar-H and H^6 of the base). *Anal.* Calcd for $C_{22}H_{26}O_7N_4$: C, 57.63; H, 5.72; N, 12.22. Found: C, 57.60; H, 5.68; N, 12.29.

1-(4,6-*O*-Benzylidene-2,3-dideoxy-2-morpholino-3-nitro-β-D-glucopyranosyl)uracil (6c). Compound **4b** (500 mg, 1.28 mmol) in acetone (10 ml) was treated with MsCl (0.18 ml, 2.34 mmol) and triethylamine (1.0 ml, 7.14 mmol) for 25 min and then with morpholine (0.30 ml, 3.45 mmol) for 1 h as above, and the mixture was similarly worked up to give 505 mg (86%) of **6c**, mp 246-247 °C: IR (KBr) 1260 and 1570 cm^{-1} (NO_2); λmax (MeOH) 258.50 nm (ε 8800); ^1H NMR (Me_2SO-d_6) δ 2.60-2.73 (8H, m, morpholino-methylene), 3.76 (1H, dd, $J_{2,1}$ = 10.0, $J_{2,3}$ = 10.50, H-2), 3.76 (1H, overlapped the signal of H-2, H-6a), 3.93 (1H, ddd, $J_{5,4}$ = 9.50, $J_{5,6a}$ = 9.50, $J_{5,6b}$ = 3.60, H-5), 4.29-4.31 (2H, overlapped signals of H-4 and H-6b), 5.58 (1H, dd, $J_{3,2}$ = 10.50, $J_{3,4}$ = 9.90, H-3), 5.67 (1H, s, benzylidene methine), 5.73 (1H, d, J = 7.90, H^5 of the base), 6.05 (1H, d, $J_{1,2}$ = 10.0, H-1), 7.39 (5H, m, Ar-H), 8.02 (1H, d, J = 7.90, H^6), 11.60 (1H, s, 3-NH). *Anal.* Calcd for $C_{21}H_{24}O_8N_4$: C, 54.78; H, 5.25; N, 12.17. Found: C, 54.87; H, 5.30; N, 12.03.

1-(4,6-*O*-Benzylidene-2,3-dideoxy-3-nitro-2-pyrrolidino-β-D-glucopyranosyl)uracil (6d). Compound **4b** (1.00 g, 2.56 mmol) in acetone (20 ml) was treated with MsCl (0.36 ml, 4.68 mmol) and triethylamine (2.0 ml, 14.3 mmol) for 15 min and then with pyrrolidine (0.50 ml, 6.02 mmol) for 40 min at -18 ° C. TLC-Monitoring (silica; $CHCl_3$/MeOH, 9:1) of the mixture showed the formation of a less polar major product together with negligible amounts of two side-products. The mixture was worked up as above and the finally obtained EtOAc-extract was treated with a small volume of MeOH to give a crystalline solid, which was collected by suction. Attempted isolation of a further crop from the filtrate by preparative TLC resulted in decomposition of the product. Recrystallization of the solid from MeOH gave 620 mg (55%) of **6d**, mp 208.5-

211 °C: IR (KBr) 1260 and 1560 cm^{-1} (NO_2); λmax (MeOH) 258.0 nm (ε 9100); ^{1}H NMR ($CDCl_3$) δ 2.77-2.80 nm (8H, m, pyrrolidino-methylene), 3.68 (1H, ddd, $J_{5,4}$ = 9.53, $J_{5,6a}$ = 9.90, $J_{5,6b}$ = 4.95, H-5), 3.77 (1H, dd, $J_{6a,5}$ = 9.90, J_{gem} = 10.44, H-6a), 3.80 (1H, dd, $J_{2,1}$ = 9.70, $J_{2,3}$ = 10.26, H-2), 4.21 (1H, dd, $J_{4,3}$ = 10.25, $J_{4,5}$ = 9.53, H-4), 4.40 (1H, dd, $J_{6b,5}$ = 4.95, J_{gem} = 10.44, H-6b), 5.13 (1H, dd, $J_{3,2}$ = 10.26, $J_{3,4}$ = 10.25, H-3), 5.55 (1H, s, benzylidene methine), 5.86 (1H, d, J = 8.06, H^5), 5.94 (1H, d, $J_{1,2}$ = 9.70, H-1), 7.34-7.43 (5H, m, Ar-H), 7.37 (1H, d, J = 8.06, H^6). *Anal.* Calcd for $C_{21}H_{24}O_7N_4$: C, 56.75; H, 5.44; N, 12.61. Found: C, 56.85; H, 5.53; N, 12.42.

1-(4,6-*O*-Benzylidene-2-cyclohexylamino-2,3-dideoxy-3-nitro-β-D-glucopyranosyl)-uracil (6e). Compound **4b** (1.00 g, 2.56 mmol) in acetone (16 ml) was treated with MsCl (0.36 ml, 4.68 mmol) and triethylamine (2.0 ml, 14.3 mmol) at -18 °C for 25 min and then with cyclohexylamine (0.35 ml, 3.07 mmol) for another 25 min. TLC-Monitoring (silica; $CHCl_3$/MeOH, 9:1) confirmed the formation of a major product together with slight amounts of by-products. The mixture was similarly worked up to give 953 mg (79%) of **6e** after recrystallization from MeOH, mp 212.5-214.5 °C: IR (KBr) 1260 and 1560 cm^{-1} (NO_2); λmax (MeOH) 258.0 nm (ε 9200); ^{1}H NMR ($CDCl_3$) δ 0.87-2.19 (11H, m, cyclohexyl-methylene), 3.42 (1H, ddd, $J_{5,4}$ = 9.5, $J_{5,6a}$ = 4.0, $J_{5,6b}$ = 4.20, H-5), 3.73 (1H, dd, $J_{6a,5}$ = 4.0, J_{gem} = 9.60, H-6a), 3.83 (1H, dd, $J_{2,1}$ = 9.70, $J_{2,3}$ = 10.0, H-2), 4.18 (1H, dd, $J_{4,3}$ = 10.20, $J_{4,5}$ = 9.50, H-4), 4.42 (1H, dd, $J_{6b,5}$ = 4.20, J_{gem} = 9.60, H-6b), 4.68 (1H, dd, $J_{3,2}$ = 10.0, $J_{3,4}$ = 10.20, H-3), 5.57 (1H, s, benzylidene methine), 5.69 (1H, d, $J_{1,2}$ = 9.70, H-1), 5.89 (1H, d, J = 8.20, H^5), 7.40 (6H, m, Ar-H and H^6), 8.64 (1H, s, cyclohexylamino-NH). *Anal.* Calcd for $C_{23}H_{28}O_7N_4$: C, 58.46; H, 5.97; N, 11.86. Found: C, 58.65; H, 5.86; N, 11.78.

1-(2-Allylamino-4,6-*O*-benzylidene-2,3-dideoxy-3-nitro-β-D-glucopyranosyl)uracil (6f). Compoud **4b** (500 mg, 1.28 mmol) in acetone (10 ml) was treated with MsCl (0.18 ml, 2.34 mmol) and triethylamine (1.0 ml, 7.14 mmol) as above for 30 min, then with allylamine (0.20 ml, 2.50 mmol) for 30 min. TLC confirmed the formation of a major product together with slight amounts of by-products. The mixture was worked up as above and the finally obtained EtOAc-extract was recrystallized from MeOH to give 365 mg (69%) of **6f**, mp 144-146 °C: IR (KBr) 1260 and 1560 cm^{-1} (NO_2); λmax (MeOH) 259.0 nm (ε 9700); ^{1}H NMR (Me_2SO-d_6) δ 2.50 (2H, overlapped the signal of Me_2SO, NH-CH_2-CH=CH_2), 3.11 (1H, ddd, $J_{5,4}$ = 10.20, $J_{5,6a}$ = 6.40, $J_{5,6b}$ = 6.40, H-5), 3.76 (1H, dd, $J_{2,1}$ = 10.0, $J_{2,3}$ = 10.40, H-2), 3.79 (2H, m, H-2 and H-6a), 4.30 (1H, dd, $J_{4,3}$ =

10.20, $J_{4,5}$ = 10.20, H-4), 4.32 (1H, dd, $J_{6b,5}$ = 6.40, J_{gem} = 9.0, H-6b), 4.92-5.64 (3H, m, $NHCH_2$-CH=CH_2), 5.29 (1H, dd, $J_{3,2}$ = 10.40, $J_{3,4}$ = 10.20, H-3), 5.67 (1H, s, benzylidene methine), 5.72 (1H, d, *J* = 8.0, H^5), 5.97 (1H, d, $J_{1,2}$ = 10.0, H-1), 7.39 (5H, m, Ar-H), 7.89 (1H, d, *J* = 8.0, H^6), 11.48 (1H, s, 3-NH). *Anal.* Calcd for $C_{20}H_{22}O_6N_4$: C, 57.96; H, 5.35; N, 13.52. Found: C, 57.88; H, 5.56; N, 13.83.

1-(4,6-*O*-Benzylidene-2,3-dideoxy-2-imidazol-1-yl-3-nitro-β-D-glucopyranosyl)-uracil (6g). *N,N'*-Carbonyldiimidazole (CDI) (464 mg, 2.86 mmol) was added to a stirred solution of compound **4b** (932 mg, 2.38 mmol), when gas evolution occurred. TLC (silica; $CHCl_3$/MeOH) confirmed that the starting material disappeared within 2 h and a single, more polar product formed. The solvent was evaporated off and the mixture partitioned between EtOAc (70 ml) and water (40 ml). The separated organic layer was repeatedly washed with H_2O (5 × 15 ml) to remove the released imidazole, when some part of the crystalline product deposited on the wall of the separatory funnel. The crystals were collected by suction and air-dried. On the other hand, the separated organic layer gave a major crop. The combined product was dissolved in acetone, treated with Norit and evaporated. Treatment of the residue with MeOH at room temperature gave 963 mg (85.5%) of **6g**, which melted at 169-175 °C (dec): IR (KBr) 1280 and 1560 cm-1 (NO_2); λmax (MeOH) 255.50 nm (ε 11100); ^1H NMR (Me_2SO-d_6) δ 3.17 (3H, d, *J* = 5.20, CH_3OH), 3.90 (1H, dd, $J_{2,1}$ = 10.20, $J_{2,3}$ = 10.20, H-2), 4.11 (1H, dd, $J_{6a,5}$ = 5.40, J_{gem} = 10.50, H-6a), 4.13 (1H, ddd, $J_{5,4}$ = 10.0, $J_{5,6a}$ = 5.40, $J_{5,6b}$ = 4.60, H-5), 4.42 (1H, dd, $J_{6b,5}$ = 4.60, J_{gem} = 10.50, H-6b), 4.48 (1H, dd, $J_{4,3}$ = 10.0, $J_{4,5}$ = 10.0, H-4), 5.51 (1H, dd, $J_{3,2}$ = 10.20, $J_{3,4}$ = 10.0, H-3), 5.75 (1H, d, *J* = 8.20, H^5), 5.82 (1H, s, benzylidene methine), 6.12 (1H, d, *J* = 9.60, imidazo-CH=CH-), 6.17 (1H, d, $J_{1,2}$ = 10.20, H-1), 6.46 (1H, d, *J* = 9.60, imidazo-CH=CH-), 7.41 (5H, m, Ar-H), 7.70 (1H, s, -N-CH=N-), 8.12 (1H, d, *J* = 8.20, H^6 of the base). *Anal.* Calcd for $C_{20}H_{19}O_7N_5 \cdot CH_3OH$: C, 53.28; H, 4.90; N, 14.79. Found: C, 53.27; H, 4.93; N, 14.74.

1-(4,6-*O*-Benzylidene-2,3-dideoxy-2-*C*-dimethylmalonyl-3-nitro-β-D-glucpyranosyl)-uracil (6h). To a solution of **4b** (1.00 g, 2.56 mmol) in DMF (15 ml) was added MsCl (0.40 ml, 5.19 mmol) and dimethyl malonate (0.8 ml, 6.78 mmol) in one portion at -18 °C. Then, triethylamine (2.2 ml, 15.71 mmol) was gradually added through a syringe in 4 min and the mixture stirred at the same temperature for 1 h and then at room temperature for another 1 h. TLC-Monitoring ($CHCl_3$/MeOH, 9:1) at this stage showed that the intermediate **5** disappeared and a less polar major product formed together with slight amounts of four sideproducts. The mixture was neutralized with 1N AcOH/MeOH, evaporated and the residue partitioned between EtOAc (50 ml) and water (50 ml). The separated organic layer was dried over Na_2SO_4, evaporated and the residue subjected to column chromatography (silica, 1.8 cm × 14 cm; $CHCl_3$/EtOAc, 3:1) to give 687 mg (55%) of **6h** as a TLC-homogeneous foam. IR (KBr) 1260 and 1560 cm^{-1} (NO_2); λmax (MeOH) 256.0 nm (ε 9200); ^1H NMR ($CDCl_3$) δ 3.22 (1H, ddd, $J_{2,1}$ = 10.0, $J_{2,3}$ = 10.50, $J_{2,CH(CO_2Me)_2}$ = 2.80, H-2), 3.37 [1H, d, $J_{CH(CO_2Me)_2,2}$ = 2.80, **CH**($(CO_2Me)_2$], 3.67 (3H, s, methyl of the malonate), 3.72 (3H, s, methyl of the malonate), 3.72-3.80 (2H, overlapped signals of H-5 and H-6a), 4.10 (1H, overlapped the signal of H-4, H-6a), 4.12 (1H, dd, $J_{4,3}$ = 10.50, $J_{4,5}$ =10.50, H-4), 5.51 (1H, dd, $J_{3,2}$ = 10.50, $J_{3,4}$ = 10.50, H-3), 5.52 (1H, s, benzylidene methine), 5.83 (1H, d, J = 8.20, H^5), 6.24 (1H, d, $J_{1,2}$ = 10.0, H-1), 7.29 (1H, d, J = 8.20, H^6), 7.34 (5H, m, Ar-H). *Anal.* Calcd for $C_{22}H_{23}O_{10}N_3$: C, 53.99; H, 4.74; N, 8.59. Found: C, 53.97; H, 4.88; N, 8.47.

1-(2-Benzylamino-2,3-dideoxy-3-nitro-β-D-glucopyranosyl)uracil (7a). A solution of **6a** (500 mg, 1.40 mmol) in 90% trifluoroacetic acid (TFA) (4 ml) was stirred at 0 °C for 1.5 h and the solvent evaporated off. The residue was repeatedly co-evaporated with 80% aqueous ethanol. Finally, the residue was neutralized with saturated methanolic solution of $NaHCO_3$ ($NaHCO_3$/MeOH), evaporated and fractionated on a silica plate (20 × 10 cm; $CHCl_3$/MeOH, 8:2) to give 302 mg (74%) of **7a**, mp 167.0-169.5 °C: IR (KBr) 1260 and 1560 cm^{-1} (NO_2); λmax (MeOH) 260.0 nm (ε 8900); ^1H NMR (Me_2SO-d_6 + D_2O) δ 2.51 (2H, overlapped the signal of Me_2SO, benzyl methylene), 3.40-3.73 (3H, overlapped signals of H-2, H-5 and H-6a), 3.93 (1H, dd, $J_{4,3}$ = 10.40, $J_{4,5}$ = 10.40, H-4), 3.93 (1H, overlapped the signal of H-4, H-6b), 5.02 (1H, dd, $J_{3,2}$ = 9.60, $J_{3,4}$ = 10.40, H-3), 5.62 (1H, d, J = 8.3, H^5 of the base), 5.79 (1H, d, $J_{1,2}$ = 9.60, H-1), 7.77 (1H, d, J = 8.30, H^6 of the base). *Anal.* Calcd for $C_{17}H_{20}O_7N_4$: C, 52.04; H, 5.14; N, 14.28. Found: C, 52.28; H, 4.93; N, 14.15.

1-(2,3-Dideoxy-3-nitro-2-piperidino-β-D-glucopyranosyl)uracil (7b). Compound **6b** (400 mg, 0.87 mmol) in 90% TFA (4 ml) was stirred at 0 °C for 35 min and the solvent evaporated off. The residue was repeatedly co-evaporated with 80% EtOH, neutralized with $NaHCO_3$/MeOH, again evaporated and the residue fractionated on a silica plate [20 × 20 cm; developed twice in $CHCl_3$/MeOH (9:1) and once in $CHCl_3$/MeOH (8:2)]. The major fraction was eluted with acetone and the obtained solid recrystallized from MeOH to give 230 mg (71%) of **7b**, mp 186.5-189.0 °C: IR (KBr) 1260 and 1570 cm^{-1} (NO_2); λmax (MeOH) 259.0 nm (ε 10100); ^1H NMR (Me_2SO-d_6 + D_2O) δ 2.52 (10H, m, piperidino methylene), 3.38-3.57 (3H, overlapped signals of H-5, H-6a and H-6b), 3.64 (1H, dd, $J_{2,1}$ = 9.80, $J_{2,3}$ = 10.40, H-2), 3.92 (1H, dd, $J_{4,3}$ = 9.90, $J_{4,5}$ = 9.20, H-4), 5.13 (1H, dd, $J_{3,2}$ = 10.40, $J_{3,4}$ = 9.90, H-3), 5.69 (1H, d, J = 8.10, H^5), 5.82 (1H, d, $J_{1,2}$ = 9.80, H-1), 7.90 (1H, d, J = 8.10, H^6). *Anal.* Calcd for $C_{15}H_{22}O_7N_4$: C, 48.64; H, 5.99; N, 15.13. Found: C, 48.67; H, 6.27; N, 14.92.

1-(2,3-Dideoxy-2-morpholino-3-nitro-β-D-glucopyranosyl)uracil (7c). Compound **6c** (400 mg, 0.87 mmol) in 90% TFA (4 ml) was stirred at 0 °C for 35 min and the solvent evaporated off. After the residual acid was repeatedly co-evaporated with 80% EtOH, the residue was digested with diethyl ether to give a solid precipitate, which was collected and taken into MeOH (5 ml). The solution was neutralized with solid $NaHCO_3$, filtered and the filtrate subjected to preparative TLC [20 × 20 cm; developed twice in $CHCl_3$/MeOH (85:15) and once in $CHCl_3$/MeOH (8:2)] after concentration. The major band was eluted with MeOH to give 230 mg (71%) of **7c** as a foam, which resisted crystallization. IR (KBr) 1260 and 1560 cm^{-1}(NO_2); λmax (MeOH) 259.0 nm (ε 8000); ^1H NMR (Me_2SO-d_6 + D_2O) δ 2.58–2.68 (8H, morpholino methylene), 3.41-3.70 (4H, overlapped signals of H-2, H-5, H-6a and H-6b), 3.95 (1H, dd, $J_{4,3}$ = 10.20, $J_{4,5}$ 10.20, H-4), 5.20 (1H, dd, $J_{3,2}$ = 10.30, $J_{3,4}$ = 10.20, H-3), 5.66 (1H, d, $J_{1,2}$ = 9.60, H-1), 5.68 (1H, d, J = 8.10, H^5), 7.93 (1H, d, J = 8.10, H^6). *Anal.* Calcd for $C_{14}H_{20}O_7N_4$: C, 45.16; H, 5.41; N, 15.05. Found: C, 45.08; H, 5.60; N, 14.94.

1-(2,3-Dideoxy-3-nitro-2-pyrrolidino-β-D-glucopyranosyl)uracil (7d). Compound **6d** (240 mg, 0.54 mmol) in 90% TFA (3 ml) was stirred at 0 °C for 25 min and the mixture worked up as in the case of **7c**. The finally obtained semi-solid residue was fractionated on a silica plate (20 × 10 cm; $CHCl_3$/MeOH, 8:2, twice developed) to give, from the major fraction, 130 mg (68%) of **7d** as crystals of mp 167.0-169.5 °C after elution with MeOH and recrystallization from the same solvent. IR (KBr) 1260 and 1570 cm^{-1} (NO_2); λmax (MeOH) 258.0 nm (ε 10100); ^1H NMR (Me_2SO-d_6 + D_2O) δ 2.65 (8H, m, pyrrolidino methylene), 3.45-3.73 (3H, overlapped signals of H-5, H-6a and H-6b), 3.79 (1H, dd, $J_{2,1}$ = 9.20, $J_{2,3}$ = 10.0, H-2), 3.97 (1H, dd, $J_{4,3}$ = 10.20, $J_{4,5}$ = 9.0, H-4), 5.15 (1H, dd, $J_{3,2}$ = 10.0, $J_{3,4}$ = 10.20, H-3), 5.68 (1H, d, J = 8.0, H^5), 5.93 (1H, d, $J_{1,2}$ = 9.20, H-1), 7.96 (1H, d, J = 8.0, H^6). *Anal.* Calcd for $C_{14}H_{20}O_7N_4$: C, 47.19; H, 5.66; N, 15.72. Found: C, 47.13; H, 5.84; N, 15.64.

1-(2,3-Dideoxy-2-*C*-dimethylmalonyl-3-nitro-β-D-glucopyranosyl)uracil (7h). Compound **6h** (300 mg, 0.61 mmol) in 90% TFA (3 ml) was stirred at 0 °C for 3 h and and the mixture worked up as in the case of **7b**. The finally obtained residue was subjected to silica gel column chromatography (1.8 × 14 cm; $CHCl_3$/MeOH, 9:1) to give 177 mg (72%) of **7h** as a foam: IR (KBr) 1260 and 1570 cm^{-1} (NO_2); λmax (MeOH) 258.0 nm (ε 8400); ^1H NMR (Me_2SO-d_6 + D_2O) δ 3.30 (1H, ddd, $J_{2,1}$ = 10.20, $J_{2,3}$ = 10.30, $J_{2,CH(CO_2Me)_2}$ = 7.20, H-2), 3.46-3.90 (3H, overlapped signals of H-5, H-6a and H-6b), 3.53 (1H, d, $J_{CH(CO_2Me)_2,2}$ = 7.20, dimethylmalonyl methine), 3.59 (3H, s, dimethylmalonyl methyl), 3.60 (3H, s, dimethylmalonyl methyl), 3.95 (1H, dd, $J_{4,3}$ = 9.80, $J_{4,5}$ = 9.80, H-4), 5.31 (1H, dd, $J_{3,2}$ = 10.30, $J_{3,4}$ = 9.80, H-3), 5.93 (1H, d, $J_{1,2}$ = 10.20, H-1), 6.03 (1H, d, *J* = 8.0, H^5), 7.86 (1H, d, *J* = 8.0, H^6). *Anal.* Calcd for $C_{15}H_{19}O_{10}N_3$: C, 44.89; H, 4.77; N, 10.47. Found: C, 45.05; H, 4.72; N, 10.36.

1-(4,6-*O*-Benzylidene-2,3-dideoxy-3-nitro-β-D-*arabino*-hexopyranosyl)uracil (8). To a stirred solution of **4b** (2.0 g, 5.11 mmol) in pyridine (16 ml) was added acetic anhydride (0.6 ml, 6.5 mmol) at room temperature. After 40 min, TLC-monitoring (silica; $CHCl_3$/MeOH, 9:1) showed the formation of **5** and less polar 2-acetate of **4b** in similar quantities. The mixture was treated with MeOH (5 ml) for 30 min and evaporated. The residue was repeatedly co-evaporated with MeOH and partitioned between EtOAc (70 ml) and water (15 ml). The separated organic layer was again washed with H_2O (2 ×15 ml), dried over sodium sulfate and evaporated to a foam, which was dissolved in DMF (20 ml) and treated with $NaBH_4$ (250 mg, 6.61 mmol) at room temperature for 2.5 h under stirrig. The mixture was neutralized with 2N AcOH/EtOH, evaporated and the residue partitioned between EtOAc (180 ml) and water (50 ml). The separated organic layer was dried over Na_2SO_4 and evaporated to a foam, which was taken into EtOH (30 ml) and vigorously stirred for 3 h to give 1.518 g of TLC-homogeneous amorphous solid. An additional crop (17 mg) was obtained from the filtrate (total yield: 1.535 g, 80%). For analysis, a part was recrystallized from EtOH to give colorless sand of mp 250-252 °C: IR (KBr) 1260 and 1560 cm^{-1} (NO_2); λmax (MeOH) 258.0 nm (ε 10400); ^1H NMR (Me_2SO-d_6) δ 2.57–2.62 (2H, overlapped signals of H-2a and H-2b), 3.76-3.91 (2H, overlapped signals of H-5 and H-6a), 4.29 (1H, dd, $J_{4,3}$ = 10.0, $J_{4,5}$ = 10.0, H-4), 4.29 (1H, dd, $J_{6b,5}$ = 5.80, J_{gem} = 10.80, H-6b), 5.46 (1H, ddd, $J_{3,2a}$ = 10.0, $J_{3,2b}$ = 6.0, $J_{3,4}$ = 10.0, H-3), 5.69 (1H, d, *J* = 8.0, H^5), 5.73 (1H, s, benzylidene methine), 6.09 (1H, dd, $J_{1,2a}$ = 9.10, $J_{1,2b}$ = 4.50, H-1), 7.39 (5H, m, Ar-H), 7.89 (1H, d, $J = 8.0$, H^6), 11.47 (1H, s, 3-NH). *Anal.* Calcd for $C_{17}H_{17}O_7N_3$: C, 54.40; H, 4.57; N, 11.20. Found: C, 54.41; H, 4.54; N, 11.15.

1-(3-Amino-4,6-*O*-benzylidene-2,3-dideoxy-β-D-*arabino*-hexopyranosyl)uracil Acetate (9). Compound **8** (400 mg, 1.08 mmol) was dissolved in a mixture of MeOH (8 ml) and AcOH (13 ml) by warming and the solution cooled to room temperature. To this solution was added tin powder (1.28 g, 10.8 mmol) and the mixture stirred vigorously for 5 h. TLC-Monitoring (silica; $CHCl_3$/MeOH, 9:1) at this stage revealed the formation of a polar major product together with slight amounts of two by-products. The mixture was evaporated, repeatedly co-evaporated with MeOH to remove acetic acid. The residue was taken into MeOH (70 ml), neutralized with 2N NH_4OH/MeOH and the insoluble solid filtered. The filter-cake was washed with MeOH (70 ml) and the washing combined with the above filtrate. Concentration of this solution gave a crystalline solid, which was collected by suction. A further crop was obtained by preparative TLC (silica, 20 × 20 cm; $CHCl_3$/MeOH, 9:1) with the filtrate. The combined product was recrystallized from MeOH to give 307 mg (70%) of **9**, mp 235-237 °C: IR (KBr) 2800-3200 cm^{-1}, 1500 cm^{-1} (NH_4^+); λmax (MeOH) 258.5 nm (ε 9000); ^1H NMR (Me_2SO-d_6 + D_2O) δ 1.80 (1H, ddd, $J_{2a,1} = 11.0$, $J_{2a,3} = 10.80$, $J_{gem} = 11.4$, H-2a), 1.91 (3H, s, CH_3CO_2H), 2.02 (1H, ddd, $J_{2b,1} = 2.70$, $J_{gem} = 11.4$, $J_{2b,3} = 4.60$, H-2b), 3.14 (1H, ddd, $J_{3,2a} = 10.80$, $J_{3,2b} = 4.60$, $J_{3,4} = 9.70$, H-3), 3.56 (1H, dd, $J_{6a,5} = 4.40$, $J_{gem} = 8.80$, H-6a), 3.60 (1H, dd, $J_{6b,5} = 0$, $J_{gem} = 8.80$, H-6b), 3.71 (1H, dd, $J_{4,3} = 9.70$, $J_{4,5} = 9.70$, H-4), 4.19 (1H, ddd, $J_{5,4} = 9.70$, $J_{5,6a} = 4.40$, $J_{5,6b} = 0$, H-5), 5.62 (1H, s, benzylidene methine), 5.66 (1H, d, $J = 8.10$, H^5), 5.84 (1H, dd, $J_{1,2a} = 11.0$, $J_{1,2b} = 2.70$, H-1), 7.40 (5H, Ar-H), 7.71 (1H, d, $J = 8.10$, H_6). *Anal.* Calcd for $C_{17}H_{19}O_5N_3 \cdot CH_3CO_2H$: C, 56.29; H, 5.72; N, 10.37. Found: C, 56.22; H, 5.82; N, 10.33.

1-(4,6-*O*-Benzylidene-2,3-dideoxy-3-hydroxylamino-β-D-*arabino*-hexopyranosyl)-uracil (10). Compound **8** (300 mg, 0.80 mmol) was dissolved in a mixture of EtOH (8 ml) and AcOH (4.8 ml) by warming. After cooling to room temperature, zinc powder (262 mg, 4.0 mmol) was added and the mixture stirred for 30 min. TLC (silica; $CHCl_3$/MeOH, 9:1) at this stage showed that the starting material disappeared and a major product less polar than **9** formed together with slight amounts of **9** and a far less polar product which seemed to be a 3-nitroso compound. The insolubles were filtered and washed with EtOH (3 ×2ml). The filtrate was evaporated and the residue repeatedly co-evaporated with a mixture of MeOH and EtOH. The final residue was digested with ice-water (5 ml) and the resulting solid precipitate collected by suction. The filtrate was extracted with $CHCl_3$ (2 × 20 ml). The $CHCl_3$-extract obtained after evaporation was combined with the above obtained solid and swirled in hot MeOH (70 ml). The insoluble material was filtered off while warm. The filtrate was evaporated and the residue fractionated on a silica plate (20 x 20 cm; $CHCl_3$/MeOH, 9:1, developed 5 times) to give, from the major fraction, 211 mg (73%) of **10** after recrystallization from MeOH, mp 251-253 °C: IR (KBr) 3305 cm^{-1} (NHOH) ; λmax (MeOH) 259.5 nm (ε 10500); ^1H NMR (Me_2SO-d_6 + D_2O) δ 1.91–2.20 (2H, overlapped signals of H-2a and H-2b), 3.64-3.76 (3H, overlapped signals of H-3, H-6a and H-6b), 3.77 (1H, dd, $J_{4,3}$ = 9.40, $J_{4,5}$ = 9.40, H-4), 4.23(1H, ddd, $J_{5,4}$ = 9.40, $J_{5,6a}$ = 3.60, $J_{5,6b}$ = 0.6, H-5), 5.64 (1H, s, benzylidene methine), 5.67 (1H, d, J = 7.90, H^5), 5.92 (1H, dd, $J_{1,2a}$ = 10.60, $J_{1,2b}$ = 2.70, H-1), 7.41 (5H, m, Ar-H), 7.75 (1H, d, J = 7.90, H^6). *Anal.* Calcd for $C_{17}H_{19}O_6N_3$: C, 56.50; H, 5.30; N, 11.63. Found: C, 56.71; H, 5.11; N, 11.61.

1-(2,3-Dideoxy-3-nitro-β-D-*arabino*-hexopyranosyl)uracil (11a). Compound **8** (150 mg, 0.40 mmol) in 80% AcOH was stirred at room temperature for 3 h and 45 min and the solvent evaporated off. The residue was repeatedly co-evaporated with MeOH and the final residue partitioned between water (7 ml) and diethyl ether (7 ml). The aqueous phase was again washed with ether (2 x 7 ml). The separated H_2O-layer was evaporated, co-evaporated with MeOH several times and the residue fractionated on a silica plate (20 x 20 cm; $CHCl_3$/MeOH, 9:1, developed 6 times) to give 100 mg (78%) of **11a** after recrystallization from MeOH, mp 194-196 °C: IR (KBr) 1270 and 1560 cm^{-1} (NO_2) ; λmax (MeOH) 259.0 nm (ε 10700); ^1H NMR (Me_2SO-d_6) δ 2.22–2.45 (2H, overlapped signals of H-2a and H-2b), 3.18 (3H, s, CH_3OH), 3.46-3.72 (3H, overlapped signals of H-5, H-6a and H-6b), 3.91 (1H, dd, $J_{4,3}$ = 9.80, $J_{4,5}$ = 9.80, H-4), 5.02 (1H, ddd, $J_{3,2a}$ = 9.80, $J_{3,2b}$ = 4.80, $J_{3,4}$ = 9.80, H-3), 5.69 (1H, d, J = 8.10, H^5), 5.82 (1H, dd, $J_{1,2a}$ = 10.30, $J_{1,2b}$ = 2.10, H-1), 7.84 (1H, d, J = 8.10, H^6), 11.40 (1H, s, 3-NH). *Anal.* Calcd for $C_{10}H_{13}O_7N_3 \cdot CH_3OH$: C, 41.38; H, 5.37; N, 13.16. Found: C, 41.19; H, 5.26; N, 13.43.

1-(2,3-Dideoxy-3-*N*-benzylideneaminoxido-β-D-*arabino*-hexopyranosyl)uracil (11b). Compound **10** (90 mg, 0.25 mmol) in 80% AcOH was stirred at 75-85 °C for 3 h. TLC-Monitoring (silica; $CHCl_3$/MeOH, 9:1) confirmed the formation of a single polar product. The mixture was evaporated, repeatedly co-evaporated with MeOH and fractionated on a silica plate (20 x 20 cm; $CHCl_3$/MeOH, 9:1, developed 5 times) to give , from the major fraction, 68 mg (75%) of **11b** as crystals of mp 272-274 °C after elution with MeOH and recrystallization from the same solvent: λmax (MeOH) nm (ε) 266.0 (18900, infl), 295.0 (25500), 307.50 (17800, infl); ^{1}H NMR (Me_2SO-d_6 + D_2O) δ 2.38 (2H, overlapped signals of H-2a and H-2b), 3.49 (1H, dd, $J_{6a,5}$ = 10.20, J_{gem} = 10.80, H-6a), 3.56 (1H, dd, $J_{6b,5}$ = 5.40, J_{gem} = 10.80, H-6b), 3.70 (1H ddd, $J_{3,2a}$ = 9.60, $J_{3,2b}$ = 2.0, $J_{3,4}$ = 9.40, H-3), 3.87 (1H, dd, $J_{4,3}$ = 9.40, $J_{4,5}$ = 9.40, H-4), 4.36 (1H, ddd, $J_{5,4}$ = 9.40, $J_{5,6a}$ = 10.20, $J_{5,6b}$ =5.40, H-5), 5.67 (1H, d, J = 8.0, H^5), 5.92 (1H, dd, $J_{1,2a}$ = 10.80, $J_{1,2b}$ = 1.60, H-1), 7.43-8.32 (7H, m, Ar-H, *N*-benzylidene methine and H^6). *Anal.* Calcd for $C_{17}H_{19}O_6N_3$: C, 56.50; H, 5.30; N, 11.63. Found: C, 56.48; H, 5.33; N, 11.62.

1-(3-Amino-2,3-dideoxy-β-D-*arabino*-hexopyranosyl)uracil (11c). A solution of **9** (70 mg, 0.17 mmol) in 80% AcOH (5 ml) was stirred at 80-85 °C for 2 h and the solvent evaporated off. The residue was repeatedly co-evaporated with MeOH and partitioned between water (3 ml) and diethyl ether (5 ml). The separated aqueous layer was evaporated. The residue was repeatedly co-evaporated with MeOH, dissolved in DMF (2 ml) and neutralized with solid $NaHCO_3$. The inorganic material was filtered and the filter-cake washed with DMF (2 ml). The filtrate was evaporated and the residue fractionated on a silica plate (20 ×20 cm; CH_2Cl_2/MeOH, 6:4). The desired fraction was eluted with MeOH and the obtained solid recrystallized from MeOH to give 36 mg (80%) of **11c**, mp 253-255 °C: λmax (MeOH) 260.50 nm (ε 6900) ; ^{1}H NMR (Me_2SO-d_6 + D_2O) δ 1.54 (1H, ddd, $J_{2a,1}$ = 10.80, J_{gem} = 11.0, $J_{2a,3}$ = 10.80, H-2a), 1.89 (1H, ddd, $J_{2b,1}$ = 1.80, J_{gem} = 11.0, $J_{2b,3}$ = 4.0, H-2b), 2.73 (1H, ddd, $J_{3,2a}$ = 10.80, $J_{3,2b}$ = 4.0, $J_{3,4}$ = 9.20, H-3), 3.01 (1H, dd, $J_{4,3}$ = 9.20, $J_{4,5}$ = 9.20, H-4), 3.25 (1H, dd, $J_{6a,5}$ = 4.40, J_{gem} = 10.0, H-6a), 3.41-3.55 (2H, overlapped signals of H-5 and H-6b), 5.61 (1H, dd, $J_{1,2a}$ = 10.80, $J_{1,2b}$ = 1.80, H-1), 5.63 (1H, d, J = 8.0, H^5), 7.74 (1H, d, J = 8.0, H^6). *Anal.* Calcd for $C_{10}H_{15}O_5N_3$: C, 46.69; H, 5.88; N, 16.34. Found: C, 46.78; H, 6.02; N, 16.10.

1-(3-Benzamido-4,6-*O*-benzylidene-2,3-dideoxy-β-D-*arabino*-hexopyranosyl)uracil (12). A solution of compound **9** (224 mg, 0.55 mmol) in a mixture of pyridine (4 ml) and triethylamine (0.5 ml) was thoroughly evaporated. The residue was again dissolved in pyridine (4 ml) and benzoic anhydride (394 mg, 1.74 mmol) was added. The mixture was stirred at room temperature for 1 h and poured into stirred ice-water (100 ml). After 1 h, the precipitate was collected by suction, washed with water, air-dried and chromatographed on a silica plate (20 × 20 cm; $CHCl_3$/EtOAc, 1:1, developed 3 times) to give 181 mg (70%) of **12**, mp 189-192 °C , after recrystallization from MeOH: λmax

(MeOH) 256.40 nm (ε 12400) ; ^{1}H NMR (Me$_2$SO-d_6) δ 1.97 (1H, ddd, $J_{2a,1}$ = 10.80, J_{gem} = 10.0, $J_{2a,3}$ =10.0, H-2a), 2.25 (1H, ddd, $J_{2b,1}$ = 2.0, J_{gem} = 10.0, $J_{2b,3}$ = 2.0, H-2b), 3.83 (3H, overlapped signals of H-3, H-6a and H-6b), 4.24 (1H, dd, $J_{4,3}$ = 9.40, $J_{4,5}$ = 9.40, H-4), 4.25 (1H, overlapped the signal of H-4, H-5), 5.61 (1H, s, benzylidene methine), 5.68 (1H, d, J = 8.10, H^5), 5.98 (1H, dd, $J_{1,2a}$ = 10.80, $J_{1,2b}$ = 2.0, H-1), 7.33-7.87 (10H, m, Ar-H), 7.65 (1H, d, J = 8.10, H^6), 11.44 (1H, br s, 3-NH). *Anal.* Calcd for $C_{24}H_{23}O_6N_3{\cdot}H_2O$: C, 61.66; H, 5.39; N, 8.99. Found: C, 61.65; H, 5.42; N, 8.96.

1-(3-Benzamido-2,3-dideoxy-β-D-*arabino*-hexopyranosyl)uracil (13). A solution of **12** (100 mg, 0.21 mmol) in 80% AcOH (8 ml) was stirred at room temperature for 15 h and then at 60 °C for 4.5 h. TLC-Monitoring (silica; CHCl$_3$/MeOH, 9:1) showed the formation of a single product which was more polar than **11b**. The mixture was evaporated, repeatedly co-evaporated with MeOH and the final residue fractionated on a silica plate (20 x 20 cm ; CHCl$_3$/MeOH, 9:1, developed 3 times). The desired fraction was eluted with acetone to give 56 mg (72%) of **13** as a foam, which resisted crystallization: λmax (MeOH) 257.0 nm (ε 13600) ; ^{1}H NMR (Me$_2$SO-d_6) δ 2.09–2.17 (2H, overlapped signals of H-2a and H-2b), 3.42-3.63 (2H, overlapped signals of H-6a and H-6b), 3.59 (1H, ddd, $J_{3,2a}$ = 9.60, $J_{3,2b}$ = 0, $J_{3,4}$ = 9.60, H-3), 3.70 (1H, dd, $J_{4,3}$ = 9.60, $J_{4,5}$ = 10.0, H-4), 4.13 (1H, ddd, $J_{5,4}$ = 10.0, $J_{5,6a}$ = 9.70, $J_{5,6b}$ = 4.80, H-5), 5.70 (1H, d, J = 8.20, H^5), 5.72 (1H, dd, $J_{1,2a}$ = 10.80, $J_{1,2b}$ = 1.60, H-1), 7.48-7.88 (5H, m, Ar-H), 7.73 (1H, d, J = 8.20, H^6), 11.44 (1H, s, 3-NH). *Anal.* Calcd for $C_{17}H_{19}O_6N_3$: C, 56.50;H, 5.30; N, 11.63. Found: C, 56.33; H, 5.39; N, 11.41.

1-(4,6-*O*-Benzylidene-2,3-dideoxy-3-*N*-benzylideneaminoxido-β-D-*arabino*-hexopyranosyl)uracil (14a). A mixture of **10** (300 mg, 0.83 mmol) and benzaldehyde (0.1 ml, 1 mmol) in AcOH (3 ml) was stirred at room temperature for 30 min. TLC (silica; CHCl$_3$/MeOH) at this stage showed that **10** disappeared and a less polar major product formed. After the solvent was evaporated off, the residue was repeatedly co-evaporated with EtOH and chromatographed on a silica plate (20 x 20 cm; CHCl$_3$/MeOH, 9:1, twice developed). The desired band was eluted with MeOH to give a glass, which crystallized from acetone. Recrystallization from acetone gave 354 mg (85%) of **14a**, m 197-198 °C: λmax (MeOH) nm (ε) 261.40 (26800), 295.60 (22600), 307.0 (16300, infl) ; ^{1}H NMR (Me$_2$SO-d_6) δ 2.10 (6H, s, acetone), 2.27 (1H, m, H-2a), 2.63 (1H, ddd, $J_{2b,1}$ = 11.20, J_{gem} = 11.20, $J_{2b,3}$ = 11.20, H-2b), 3.82-3.91 (2H, overlapped signals of H-3 and H-6a), 4.27 (1H, dd, $J_{4,3}$ = 10.0, $J_{4,5}$ = 10.0, H-4), 4.27 (1H, overlapped the signal of H-4, H-6b), 4.80 (1H, ddd, $J_{5,4}$ = 10.0, $J_{5,6a}$ = 10.80, $J_{5,6b}$ = 4.40, H-5), 5.68 (1H, d, J = 8.10, H^5), 5.69 (1H, s, benzylidene methine), 6.07 (1H, dd, $J_{1,2a}$ = 2.0, $J_{1,2b}$ = 11.20, H-1), 7.35 (5H, m, benzylidene Ar-H), 7.42-8.32 (6H, m, $O^-—N^+= CHC_6H_5$), 7.84 (1H, d, J = 8.10, H^6), 11.47 (1H, s, 3-NH). *Anal.* Calcd for $C_{24}H_{23}O_6N_3{\cdot}CH_3COCH_3$: C, 63.89; H, 5.76; N, 8.28. Found: C, 63.76; H, 5.71; N, 8.46.

Synthesis of 11b from 14a. Compound **14a** (200 mg, 0.39 mmol) in 80% AcOH (20 ml) was stirred at 75 ° C for 2.5 h. TLC (silica; $CHCl_3$/MeOH, 9:1) confirmed the formation of a single, polar product. After evaporation of the solvent, the residue was repeatedly co-evaporated with EtOH and the final residue in MeOH was neutralized with solid $NaHCO_3$. After the inorganic material was filtered off, the filtrate was evaporated and the residue subjected to preparative TLC (20 × 20 cm; $CHCl_3$/MeOH, 9:1, twice developed). The desired fraction was eluted with MeOH and the obtained solid recrystallized from MeOH to give 128 mg (90%) of **11b**, identical with an authentic sample in terms of mixture mp, IR-, UV-spectroscopy and ^{1}H NMR-spectrometry.

1-(4,6-*O*-Benzylidene-2,3-dideoxy-3-*N*-anisylideneaminoxido-β-D-*arabino*-hexopyranosyl)uracil (14b). A mixture of **10** (100 mg, 0.28 mmol), p-anisaldehyde (0.1 ml, 0.83 mmol) and AcOH (2 ml) was stirred at room temperature for 48 h and worked up exactly as in the case of **14a**, involving chromatography. The finally obtained solid was recrystallized from MeOH to give 106 mg (80%) of **14b**, mp 273.0-273.5 ° C; λmax (MeOH) nm (ε) 260.20 (12900), 295.40 (19600, infl), 310.20 (26000), 321 (19800, infl) ; ^{1}H NMR (Me_2SO-d_6) δ 2.21 (1H, m, H-2a), 2.60 (1H, ddd, $J_{2b,1}$ = 10.60, J_{gem} = 10.60, $J_{2b,3}$ = 10.60, H-2b), 3.78 (3H, s, Ar-OCH_3), 3.78-3.83 (2H, overlapped signals of H-3 and H-6a), 4.24 (1H, dd, $J_{4,3}$ = 10.0, $J_{4,5}$ = 10.0, H-4), 4.24 (1H, overlapped the signal of H-4, H-6b), 4.71 (1H, ddd, $J_{5,4}$ = 10.0, $J_{5,6a}$ = 10.80, $J_{5,6b}$ = 4.40, H-5), 5.66 (1H, s, benzylidene methine), 5.66 (1H, d, J = 8.0, H^5), 6.05 (1H, dd, $J_{1,2a}$ = 1.0, $J_{1,2b}$ = 10.60, H-1), 6.95-6.99 (2H, d, J = 9.0, Ar-H), 7.78 (1H, s, anisylidene methine), 8.25-8.29 (2H, d, J = 9.0, Ar-H), 7.33 (5H, m, benzylidene Ar-H), 7.80 (1H, d, J = 8.0, H^6). *Anal.* Calcd for $C_{25}H_{25}O_7N_3$: C, 62.62; H, 5.26; N, 8.76. Found: C, 62.62; H, 5.28; N, 8.73.

REFERENCES AND NOTES

1. *C & EN*, July 4, **1994**, 22.
2. Huryn, D. M. ; Okabe, M., *Chem. Rev.*, **1992**, *92,* 1745.
3. Venulet, J. ; VanEtten, L., "*The Chemistry of the nitro and nitroso group*", Part 2, ed. by Feuer, H., Interscience Publishers, **1970**, p. 201.

4. Hossain, N.; Papchikhin, A.; Garg, N.; Fedorov, I. ; Chattopadhyaya, J. *Nucleosides Nucleotides*, **1993**, 499.
5. Hossain, N.; Garg, N.; Chattopadhyaya, J. *Tetrahedron*, **1993**, *49*, 10061.
6. Watanabe, K.; Beranek, J.; Friedman, H. A.; Fox, J. J. *J. Org. Chem.*, **1965**, *30, 2735.*
7. Matsuda, A.; Chun, M. W.; Watanabe, K. A. *Nucleosides Nucleotides*, **1982**, 173.
8. We thank Prof. Matsuda, Hokkaido University, for the kind suggestion of the structure of the minor product **4c**.
9. (a) Melton, J.; Mc Murry, J. E. *J. Org. Chem.*, **1975**, *40*, 2138; (b) Baer, H. H.; Georges, F. F, Z., *ibid.*, **1976**, *41*, 3474; (c) *Idem.*, *Can. J. Chem.*, **1977**, *55*,1100. (d) Baer, H. H.; Neilson, T. *Ibid.*, **1965**, *43*, 840.
10. (a) Baer, H. H.; Georges, F. F. Z. *Can. J. Chem.*, **1977**, *55*, 1348; (b) Baer, H. H.; Rank, W. *Ibid.*, **1972**, *50*, 1292; (c) Baer, H. H.; Hanna, H. R. *ibid.*, **1980**, *58*, 1751. See also ref 7.
11. Similar Michael adducts with diethyl malonate, nitromethane and oxygen nucleophiles such as sodium methoxide and sodium ethoxide did form as judged by TLC but could not be isolated due to decomposition on silica gel chromatography.
12. Perekalin, V. V.; Lipina, E. S.; Berestovitskaya, V. M.; Efremov, D. A. "*Nitroalkenes*", John Wiley & Sons, **1994**, p. 81.
13. For the attack of amines, see: (a) Brwon, D. M.; Parihar, D. B.; Todd, A. R.; Varadarajan, S. *J. Chem. Soc.*, **1958**, 3028; (b) Doerr, I. L.; Fox, J. J. J. *Org. Chem.*, **1967**, *32*, 1462; (c) Sasaki, T.; Minamoto, K.; Sugiura, T. *Ibid.*, **1975**, *40*, 3498; (d) Sasaki, T.; Minamoto, K.; Nakade, H. *Nucleic Acid Res., Symposium Series*, **1983,** No. 12, 17; (e) Minamoto, K.; Tanaka, T.; Azuma, K.; Suzuki, N.; Eguchi,S.; Kadoya, S.; Hirota, T. *J. Org. Chem.*, **1986**, *51*, 4417; (f) Minamoto, K.; Azuma, K.; Fujiwara, N.; Eguchi, S. *Ibid.*, **1989**, *54*, 4543; (g) Minamoto, K.; Fujiwara, N.; Hoshino, Y.; Hamano, Y.; Eguchi, S. *J. Chem. Soc. Perkin Trans. 1*, **1990**, 3027 ; (h) Minamoto, K.; Hamano, Y.; Matsuoka, Y.; Watanabe, K.; Hirota, T.; Eguchi, S., *Nucleosides Nucleotides*, **1992**, *11*, 457; (i) Minamoto, K.; Oishi, M.; Kakehi, A.; Ohta, N.; Matsuda, I.; Watanabe, K.; Yanagihara, K.; Takeuchi, T.; Tanigawa, K. *J. Chem. Soc. Perkin Trans. 1*, **1994**, 2289. For the attack of oxygen nucleophiles, see: (j) Codington, J. F.; Fecher, R.; Fox, J. J. *J. Am. Chem. Soc.*, **1960**, *82*, 2794; (k) Fecher, R.; Codington, J. F.; Fox, J. J. *Ibid.*, **1961**, *83*, 1889; see also ref 11b and 11h.
14. Watanabe, K. A.; Fox, J. J. *J. Org. Chem.*, **1966**, 31, 211.
15. Wollenberg, R. H.; Miller, S. J. *Tetrahedron Lett.*, **1978**, No. 35, 3219.

16. "*Comprehensive Organic Chemistry*", Vol. 2, ed. by Sutherland, I. O., Pergamon Press, **1979**, p. 500.

Received April 20, 1995
Accepted October 18, 1995