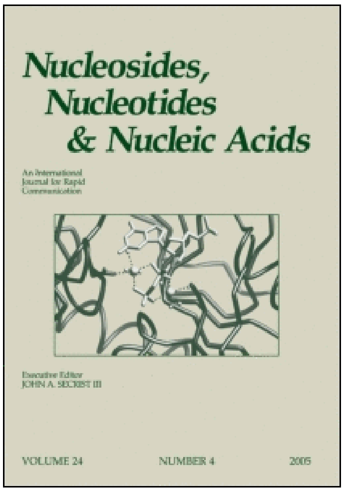

**Nucleosides, Nucleotides and Nucleic Acids**
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# Synthesis of 3'-Amino and 5'-Amino Hydantoin 2'-Deoxynucleosides

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**To cite this Article** El-Barbary, Ahmed A. , Khodair, Ahmed I. , Pedersen, Erik B. and Nielsen, Claus(1994) 'Synthesis of 3'-Amino and 5'-Amino Hydantoin 2'-Deoxynucleosides', Nucleosides, Nucleotides and Nucleic Acids, 13: 1, 707 — 717
**To link to this Article: DOI:** 10.1080/15257779408013274
**URL:** http://dx.doi.org/10.1080/15257779408013274

NUCLEOSIDES & NUCLEOTIDES, 13(1-3), 707-717 (1994)

# SYNTHESIS OF 3'-AMINO AND 5'-AMINO HYDANTOIN 2'-DEOXYNUCLEOSIDES†

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**Abstract:** 3'-Amino and 5'-amino derivatives of hydantoin 2'-deoxynucleosides have been prepared from the corresponding 3'-phthalimido and 5'-azido nucleosides, respectively, which in turn were prepared by condensation of appropriate sugars with 5-benzylidenehydantoin. The amino nucleosides were tested for their potential activity against HIV and HSV.

Recently, we have shown that hydantoin analogues of thymidine are easily synthesized by condensing a silylated hydantoin derivative with an appropriately protected 2-deoxy pentofuranoside in the presence of trimethylsilyl trifluoromethanesulfonate (TMS triflate)[1]. In continuation of this work we found it interesting to synthesize 3'-amino and 5'-amino nucleosides with a hydantoin moiety as the nucleobase because the corresponding thymidine analogues for a long time have been known for their interesting biological properties. The 5'-amino analogue of thymidine is a good competitive inhibitor of the phosphorylation of thymidine by thymidine kinase[2,3] and a modest inhibitor of thymidylate kinase.[4] The interest in amino analogues of nucleosides in general was stimulated by

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[†] This paper is dedicated to the memory of Professor Roland K. Robins.

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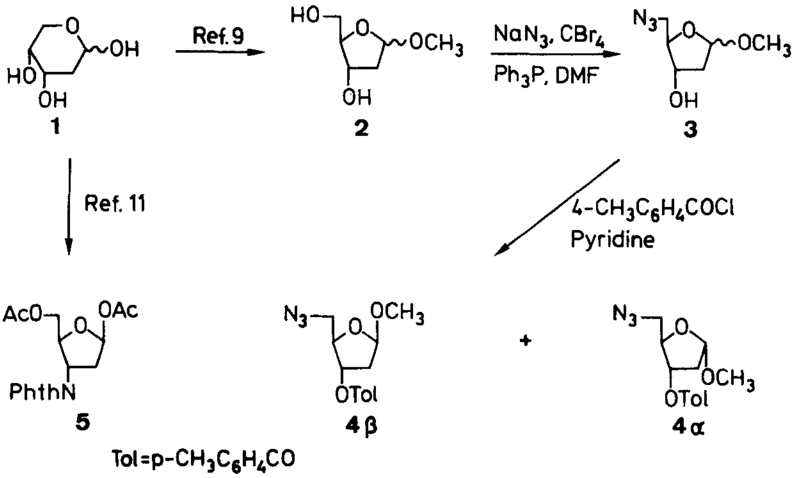
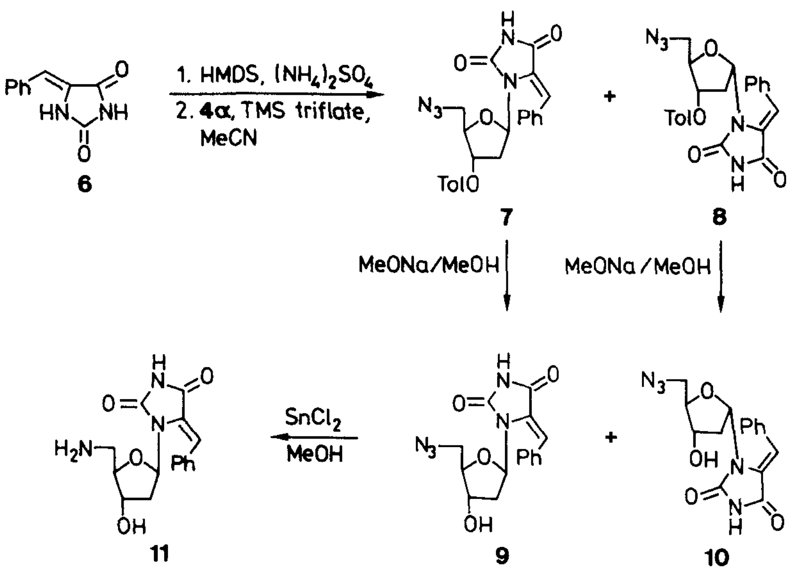
the findings that the 5'-amino analogues of thymidine and 5-iodo-2'-deoxyuridine have significant antiviral activity.[5-8] The 5'-amino analogue of thymidine was inhibiting for 98% the replication of Herpes Simplex Virus (HSV-1) in cell culture at 400 μM.[8] The 3'-amino analogue of thymidine, however, exerted a modest 62% inhibition of HSV-1 replication at 400 μM in Vero cells, while the proliferation of murine sarcoma 180 cells and of murine leukemia L1210 cells is inhibited for 50% at 5 μM and 1 μM, respectively.[8] The 5'-amino analogue is a good antiviral agent but a poor antineoplastic agent, whereas the 3'-amino analogue is an excellent antineoplastic agent but a poor antiviral agent.[8]



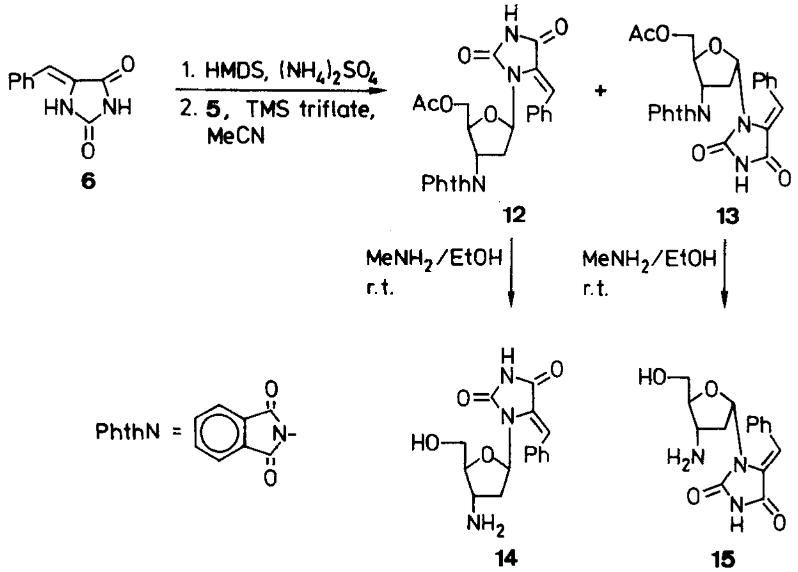
The syntheses of the synthons **4** and **5** for preparation of 3'-amino and 5'-amino hydantoin nucleosides are shown above. Treatment of 2-deoxy-D-ribose (**1**) with hydrogen chloride in methanol[9] afforded methyl 2-deoxy-D-*erythro*-pentofuranoside **2**. Replacement of 5-OH in **2** with an azido group was accomplished by treatment with sodium azide, carbon tetrabromide and triphenylphosphine in *N*,*N*-dimethyl formamide at room temperature.[10] Subsequent reaction of **3** with p-toluoyl chloride in pyridine afforded the corresponding methyl 5-azido-3-*O*-(4-methylbenzoyl)-2,5-dideoxy-β-D-*erythro*-pentofuranoside (**4β**) and its corresponding α anomer (**4α**) in the ratio 3:4. The preparation of the other synthon, 1,5-di-*O*-acetyl-2,3-dideoxy-3-phthalimido-β-D-*erythro*-pentofuranose

(**5**), has already been reported starting from **1** by use of a phthalimide / $P_4O_{10}$ / $H_2O$ / n-$Bu_4N$ reagent in chloroform followed by acetylation.[11]



Silylation of 5-(phenylmethylene)-2,4-imidazolidinedione **6** was accomplished with 1,1,1,3,3,3-hexamethyldisilazane (HMDS) in the presence of a catalytic amount of ammonium sulphate. The trimethylsilylated derivative thus obtained was condensed with methyl 5-azido-3-*O*-(4-methylbenzoyl)-2,5-dideoxy-α-D-*erythro*-pentofuranoside (**4**α) when left overnight in the presence of trimethylsilyl trifluoromethanesulfonate (TMS triflate) at -30°C. Each of the nucleosides **7** and **8** (α/β = 1:1) were isolated by silica gel chromatography in 22% yield. Removal of the protecting toluoyl group from the sugar moiety of **7** and **8** was achieved by treatment with sodium methoxide in methanol at room temperature and *(Z)*-1-(5-azido-2,5-dideoxy-β-D-*erythro*-pentofuranosyl)-5-(phenylmethylene)-2,4-imidazolidinedione (**9**) and the corresponding α anomer **10** were obtained, respectively. Treatment of **9** with tin(II)chloride in methanol afforded the corresponding 5'-amino derivative **11** in 10% yield.

1,5-Di-*O*-acetyl-2,3-dideoxy-3-phthalimido-β-D-*erythro*-pentofuranose (**5**) was



similarly condensed with the trimethylsilyl derivative of **6** in the presence of TMS triflate on standing overnight at -30°C. The nucleosides **12** and **13** ($\alpha/\beta$ = 4:5) were isolated by silica gel chromatography. Removal of the protecting phthaloyl group from the glycon moiety of **12** and **13** was performed with methyl amine in absolute ethanol at room temperature to furnish *(Z)*-1-(3-amino-2,3-dideoxy-β-D-*erythro*-pentofuranosyl)-5-(phenylmethylene)-2,4-imidazolidinedione (**14**) and its corresponding α anomer **15**.

The compounds **10** and **13** were selected for $^1$H NOE difference spectroscopy to assign the anomeric configuration, site of glycosylation on the hydantoin ring, and Z configuration of the exocyclic double bond. The protons in the $^1$H-NMR spectra were assigned by $^1$H-$^1$H-homonuclear shift correlated (COSY) 2D-NMR. A typical decisive feature for α configuration was irradiation of H2'β at the β site of the glycon which resulted in strong NOE enhancements in H1' for both compounds and in H3' for compound **13**. For both compounds strong NOE enhancements were found in H2'β when H1' or H3' were irradiated. The assignment of the H2' protons in **10** was confirmed by irradiation of H2'α which resulted in NOE enhancement in H4' (5%). Z configuration and N1 glycosylation were proven by NOE enhancements in the phenyl proton when H1' was irradiated (**10**, 4% and **13**, 4%). Besides, this NOE contact between H1' and the aromatic protons indicated a pronounced preference for syn conformation around the glycosidic bond.

No activity was found when the compounds **7, 9, 10** and **12-15** were tested against HIV-1 (HTLV-IIIB) in MT-4 cells or against HSV-1 (McIntyre) in rabbit cornea cells at non-toxic concentrations.

## EXPERIMENTAL

The $^{13}$C- and $^{1}$H-NMR spectra were recorded on a Bruker AC 250 FT and on a Varian UNITY 500 NMR spectrometer. Mass spectra (MS) were recorded using electron ionization (EI) on a Varian Mat 311A spectrometer and fast atom bombardment (FAB) on a Kratos MS 50 spectrometer.

**Methyl 5-azido-2,5-dideoxy-3-*O*-(4-methylbenzoyl)-α-D-*erythro*-pentofuranoside (4α) and its β anomer 4β.** Carbon tetrabromide (33.6 g, 101 mmol) was added to a mixture of methyl 2-deoxy-D-*erythro*-pentofuranoside **2**[10,11] (10.0 g, 67.5 mmol), triphenyl phosphine (23.0 g, 88 mmol) and $NaN_3$ (13.4 g, 200 mmol) in anhydrous *N,N*-dimethylformamide (500 ml). The mixture was stirred for 7 days at room temperature. The solvent was removed *in vacuo* and anhydrous diethyl ether (200 ml) was added and the insoluble salts were removed by filtration. The solvent was evaporated under reduced pressure and the residue chromatographed on a silica gel column with ethyl acetate and petroleum ether (1:1, v/v), to obtain 6 g (51%) of methyl 5-azido-2,5-dideoxy-D-*erythro*-pentofuranoside **3** as a yellow oil. To a stirred solution of **3** (6.0 g, 34.5 mmol) in anhydrous pyridine (75 ml) was slowly added 4-methylbenzoyl chloride (5.4 g, 35 mmol) at 0°C. The temperature was allowed to increase to room temperature and stirring was continued for 16 h. The reaction mixture was poured into crushed ice and extracted with chloroform (2 x 100 ml). The combined extracts were washed with a saturated aqueous solution of $NaHCO_3$ (3 x 100 ml) and dried over anhydrous $Na_2SO_4$. The solvent was evaporated *in vacuo* and the residue chromatographed on silica gel with petroleum ether and diethyl ether (9:1, v/v) to obtain pure anomers of **4**.

**Compound 4α:** Yield 4.0 g (40%), mp 85-87°C. Anal. calcd. for $C_{14}H_{17}N_3O_4$: C 57.72; H 5.88; N 14.42; Found: C 57.54; H 5.79; N 14.01. FAB MS *m/z* 292 (M + H$^+$). $^{1}$H NMR ($CDCl_3$, 250 MHz): δ 2.17 (1H, dd, J = 1.4, 14.6 Hz, H2'α), 2.39 (3H, s, $CH_3$), 2.48 (1H, m, H2'β), 3.40 (3H, s, $OCH_3$), 3.58 (2H, m, H5'), 4.22 (1H, q, J = 3.6 Hz, H4'), 5.19 (2H, m, H1', H3'), 7.22, 7.92 (4H, 2xd, J = 8.0 Hz, $H_{Arom}$). $^{13}C$ NMR ($CDCl_3$, 62.9 MHz): δ 21.43 ($CH_3$), 38.95 (C2'), 52.24 (C5'), 54.82 ($OCH_3$), 74.83 (C3'), 81.98 (C4'), 104.91 (C1'), 126.81, 128.92, 129.58, 143.78 ($C_{Arom}$), 166.35 (C=O). **Compound 4β:** Yield 3.0 g (30%), oil. Anal. calcd. for $C_{14}H_{17}N_3O_4$: C 57.72; H 5.88; N 14.42. Found: C 57.86; H 5.87; N 13.98. FAB MS *m/z* 292 (M + $H^+$). $^1H$ NMR ($CDCl_3$, 250 MHz): δ 2.35 (4H, m, H2', $CH_3$), 2.47 (1H, ddd, J = 2.3, 7.2, 14.1 Hz, H2'), 3.42 (3H, s, $OCH_3$), 3.49 (2H, m, H5'), 4.29 (1H, m, H4'), 5.21 (1H, dd, J = 2.4, 5.3 Hz, H1'), 5.35 (1H, m, H3'), 7.22, 7.88 (4H, 2xd, J = 8.1 Hz, $H_{Arom}$). $^{13}C$ NMR ($CDCl_3$, 62.9 Hz): δ 21.38 ($CH_3$), 38.89 (C2'), 53.97 (C5'), 55.26 ($OCH_3$), 75.56 (C3'), 83.17 (C4'), 105.74 (C1'), 126.58, 128.92, 129.46, 143.88 ($C_{Arom}$), 165.92 (C=O).

**(*Z*)-1-(5-Azido-2,5-dideoxy-3-*O*-(4-methylbenzoyl)-β-D-*erythro*-pentofuranosyl)-5-(phenylmethylene)-2,4-imidazolidinedione (7) and its α anomer (8).** A mixture of 5-(phenylmethylene)-2,4-imidazolidinedione **6** (1.5 g, 8 mmol), anhydrous $(NH_4)_2SO_4$ (0.04 mmol) and 1,1,1,3,3,3-hexamethyldisilazane (60 ml) was refluxed overnight. The clear solution obtained was cooled and the solvent was evaporated *in vacuo* to give the silylated compound as a pale yellow oil. A solution of the sugar **4α** (1.57 g, 5.4 mmol) in anhydrous MeCN (30 ml) was added to a stirred solution of the silylated compound in anhydrous MeCN (20 ml) and the mixture was cooled to -50°C. A solution of trimethylsilyl trifluoromethanesulfonate (1.08 ml, 6 mmol) in anhydrous MeCN (10 ml) was added dropwise during 5 min at -50°C and the mixture was stirred overnight at -30°C. The reaction mixture was diluted with $CH_2Cl_2$ (200 ml), washed with cold saturated aqueous $NaHCO_3$ (200 ml), water (2 x 100 ml) and dried over anhydrous $Na_2SO_4$. The mixture was concentrated *in vacuo* and the residue was chromatographed on silica gel with $CHCl_3$ to afford compounds **7** and **8**.

**Compound 7:** Yield 0.5 g (21%), white foam, FAB MS ($CHCl_3$ + 1% $CH_3COOH$ in 3-nitrobenzylalcohol) 448 (M + $H^+$). $^1H$ NMR (DMSO-$d_6$, 250 MHz): δ 2.23 (1H, ddd, J = 2.3, 6.4, 14.0 Hz, H2'), 2.34 (3H, s, $CH_3$), 3.16 (1H, m, H-2'), 3.33 (1H, dd, J = 4.2, 12.9 Hz, H5'), 3.56 (1H, dd, J = 8.1, 12.9 Hz, H5'), 3.97 (1H, m, H4'), 5.30 (1H, dd, J = 2.9, 5.8 Hz, H3'), 5.59 (1H, t, J = 7.2 Hz, H1'), 6.70 (1H, s, =CH), 7.23-7.56 (9H, m, $H_{Arom}$), 11.64 (1H, s, NH). $^{13}C$ NMR (DMSO-$d_6$, 62.9 MHz): δ 21.03 ($CH_3$), 32.64

(C2'), 51.31 (C5'), 74.99 (C3'), 82.25 (C4'), 84.27 (C1'), 111.16 (=CH), 126.23, 128.44, 128.99, 129.05, 129.09, 129.78, 132.42, 143.87 (C5, $C_{Arom}$), 154.41 (C2), 163.54 (C4), 164.71 (C=O).

**Compound 8:** Yield 0.5 g (21%), white foam, EI MS *m/z* (%) 447 (3.6, $M^+$). $^1H$ NMR ($CDCl_3$, 250 MHz): δ 2.72 (1H, m, H2'), 2.98 (1H, td, J = 7.0, 13.7 Hz, H2'), 3.33 (1H, dd, J = 4.7, 13.3 Hz, H5'), 3.52 (1H, dd, J = 3.2, 13.3 Hz, H5'), 4.55 (1H, m, H4'), 5.15 (1H, q, J = 2.7 Hz, H3'), 5.68 (1H, t, J = 7.3 Hz, H1'), 6.83 (1H, s, =CH), 7.26-7.92 (9H, m, $H_{Arom}$). $^{13}C$ NMR ($CD_3OD$, 62.9 MHz): δ 21.94 ($CH_3$), 35.82 (C2'), 53.68 (C5'), 75.55 (C3'), 83.42 (C4'), 85.65 (C1'), 113.90 (=CH), 128.41, 130.19, 130.53, 130.65, 131.13, 131.43, 131. 96, 134.54, 145.93 (C5, $C_{Arom}$), 156.81 (C2), 166.12 (C4), 168.01 (C=O).

***(Z)*-1-(5-Azido-2,5-dideoxy-β-D-*erythro*-pentofuranosyl)-5-(phenylmethylene)-2,4-imidazolidinedione (9).** To a stirred suspension of the protected nucleoside **7** (0.4 g, 0.89 mmol) in anhydrous MeOH (15 ml) was added portionwise NaOMe (0.05 g, 0.9 mmol) in anhydrous MeOH (15 ml) at room temperature and the solution was stirred overnight. After evaporation of the solvent *in vacuo*, $H_2O$ (15 ml) was added and the mixture extracted several times with $CH_2Cl_2$ to remove the formed ester during deprotection. To the resulting aqueous solution was added an ion exchange resin (Dowex 50W x 2, $H^+$-form), previously washed with MeOH. After stirring for 5 min, the solution was filtered and evaporated *in vacuo* and the residue was chromatographed on silica gel with the gradient 2-5% MeOH in $CHCl_3$ to give 0.25 g (85%) of **9** as a white foam, EI MS *m/z* (%) 329 (4, $M^+$). $^1H$ NMR ($CD_3OD$, 500 MHz): δ 1.95 (1H, ddd, J = 5.0, 8.0, 14.5 Hz, H2'α), 2.94 (1H, m, H2'β), 3.26 (1H, m, H5'), 3.44 (1H, dd, J = 7.6, 12.9 Hz, H5'), 3.65 (1H, td, J = 3.9, 8.1 Hz, H4'), 4.34 (1H, td, J = 4.8, 7.1 Hz, H3'), 5.60 (1H, dd, J = 6.1, 7.8 Hz, H1'), 6.74 (1H, s, =CH), 7.29-7.42 (5H, m, $H_{Arom}$). $^{13}C$ NMR ($CD_3OD$, 125.7 MHz): δ 37.65 (C2'), 53.07 (C5'), 72.89 (C3'), 85.61 (C1'), 86.50 (C4'), 113.63 (=CH), 129.78, 129.90, 130.37, 131.30, 134.09 (C5, $C_{Arom}$), 156.12 (C2), 165.83 (C4).

***(Z)*-1-(5-Azido-2,5-dideoxy-α-D-*erythro*-pentofuranosyl)-5-(phenylmethylene)-2,4-imidazolidinedione (10).** The protected nucleoside **8** (0.4 g, 0.89 mmol) was treated similarly as described in the preparation of **9**. Purification by column chromatography on silica gel with the gradient 2-5% MeOH in $CHCl_3$ gave 0.26 g (88%) of **10** as a white foam. FAB MS ($CHCl_3$ + 1% $CH_3COOH$ in 3-nitrobenzylalcohol) 330 (M + $H^+$). $^1H$ NMR ($CDCl_3$, 500 MHz): δ 2.44 (1H, m, H2'β), 2.65 (1H, m, H2'α), 3.25 (1H, dd, J = 4.8, 13.1 Hz, H5'), 3.41 (1H, dd, J = 3.5, 13.1 Hz, H5'), 4.17 (1H, m, H3'), 4.37 (1H, m, H4'), 4.92 (1H, d, J = 11.3 Hz, 3'-OH), 5.64 (1H, dd, J = 3.4, 9.1 Hz, H1'), 6.97 (1H, s, =CH), 7.26-7.44 (5H, m, $H_{Arom}$), 9.39 (1H, s, NH). $^{13}C$ NMR ($CDCl_3$, 125.7 MHz): δ 39.06 (C2'), 52.71 (C5'), 73.38 (C3'), 84.55 (C1'), 86.58 (C4'), 115.02 (=CH), 128.68, 128.86, 129.11, 129.14, 131.82 (C5, $C_{Arom}$), 154.98 (C2), 163.29 (C4).

***(Z)*-1-(5-Amino-2,5-dideoxy-β-D-*erythro*-pentofuranosyl)-5-(phenylmethylene)-2,4-imidazolidinedione (11).** Anhydrous tin(II)chloride (200 mg, 0.88 mmol) was added to a solution of **9** (220 mg, 0.67 mmol) in methanol (25 ml) and the mixture was stirred at room temperature for one week. The solvent was evaporated *in vacuo*. The residue was chromatographed on silica gel with the gradient 2-10% MeOH in $CHCl_3$ to give 190 mg of **9** and 20 mg (10%) of **11** as a white solid, mp 198-200°C, FAB MS (DMSO + 1% $CF_3COOH$ in glycerol) 304 (M + $H^+$). $^1H$ NMR ($CD_3OD$, 250 MHz): δ 2.20 (1H, ddd, J = 4.2, 7.7, 13.6 Hz, H2'), 3.01 (1H, td, J = 6.8, 13.5 Hz, H2'), 3.29 (2H, m, H5'), 3.95 (1H, td, J = 4.2, 7.9 Hz, H4'), 4.50 (1H, td, J = 3.6, 7.1 Hz, H3'), 5.83 (1H, t, J = 7.1 Hz, H1'), 6.91 (1H, s, =CH), 7.45-7.54 (5H, m, $H_{Arom}$). $^{13}C$ NMR ($CD_3OD$, 62.9 MHz): δ 37.86 (C2'), 42.50 (C5'), 73.20 (C3'), 83.49 (C1'), 86.27 (C4'), 113.56 (=CH), 129.86, 129.98, 130.26, 131.10, 134.00 (C5, $C_{Arom}$), 156.38 (C2), 165.60 (C4).

***(Z)*-1-(5-*O*-Acetyl-2,3-dideoxy-3-phthalimido-β-D-*erythro*-pentofuranosyl)-5-(phenylmethylene)-2,4-imidazolidinedione (12) and its α anomer (13).** A mixture of 5-(phenylmethylene)-2,4-imidazolidinedione **6** (1.5 g, 8 mmol), anhydrous $(NH_4)_2SO_4$ (0.04 mmol) and 1,1,1,3,3,3-hexamethyldisilazane (60 ml) was refluxed overnight. The clear solution obtained was cooled and the solvent was evaporated *in vacuo* to give the silylated compound as a pale yellow oil. A solution of the sugar **5**[11] (1.5 g, 4.3 mmol) in anhydrous MeCN (30 ml) was added to a stirred solution of the silylated compound in anhydrous MeCN (20 ml) and the mixture was cooled to -50°C. A solution of trimethylsilyl trifluoromethanesulfonate (0.85 ml, 4.4 mmol) in anhydrous MeCN (10 ml) was added dropwise during 5 min at -50°C and the mixture was stirred overnight at -30°C. The reaction mixture was diluted with $CH_2Cl_2$ (200 ml), washed with cold saturated aqueous $NaHCO_3$ (200 ml), water (2 x 100 ml) and dried over anhydrous $Na_2SO_4$. The mixture was concentrated *in vacuo* and the residue was chromatographed on silica gel with $CHCl_3$ to afford compounds **12** and **13**.

**Compound 12:** Yield 0.92 g (45%), white foam. $^1H$ NMR ($CDCl_3$, 250 MHz): δ 2.00 (3H, s, $CH_3$), 2.74-2.98 (2H, m, H2'), 4.15-4.33 (3H, m, H-4', H5'), 5.18 (1H, td, J = 8.0, 9.7 Hz, H3'), 5.90 (1H, dd, J = 4.8, 8.3 Hz, H1'), 6.92 (1H, s, =CH), 7.27-7.84 (9H, m, $H_{Arom}$), 8.86 (1H, s, NH). $^{13}C$ NMR ($CDCl_3$, 62.9 MHz): δ 20.54 ($CH_3$), 31.61 (C2'), 49.77 (C3'), 64.01 (C5'), 77.82 (C4'), 83.96 (C1'), 113.91 (=CH), 123.29, 128.68, 128.97, 129.03, 129.08, 131.51, 132.27, 134.12 (C5, $C_{Arom}$), 153.38 (C2), 163.39 (C4), 167.49, 170.55 (2 C=O).

**Compound 13:** Yield 0.90 g (44%), white foam. $^1H$ NMR ($CDCl_3$, 250 MHz): δ 1.96 (3H, s, $CH_3$), 2.34 (1H, m, H2'), 3.90 (1H, dd, J = 3.2, 11.9 Hz, H2'), 4.02 (1H, dd, J = 4.8, 12.4 Hz, H5'), 4.18 (1H, dd, J = 3.0, 12.3 Hz, H5'), 4.52 (1H, m, H3'), 5.23 (1H, m, H4'), 5.59 (1H, dd, J = 6.9, 8.3 Hz, H1'), 6.88 (1H, s, =CH), 7.26-7.87 (9H, m, $H_{Arom}$), 8.83 (1H, s, NH). $^{13}C$ NMR ($CDCl_3$, 62.9 MHz): δ 20.52 ($CH_3$), 30.27 (C-2'), 50.27 (C3'), 62.99 (C5'), 75.71 (C4'), 83.42 (C1'), 113.31 (=CH), 123.41, 128.66, 128.92, 129.05, 129.45, 131.50, 132.49, 134.19 (C5, $C_{Arom}$), 153.73 (C2), 163.28 (C4), 167.55, 170.43 (2 C=O).

**(*Z*)-1-(3-Amino-2,3-dideoxy-β-D-*erythro*-pentofuranosyl)-5-(phenylmethylene)-2,4-imidazolidinedione (14):** A 33% solution of $MeNH_2$ in absolute EtOH (20 ml) was added to a stirred suspension of compound **12** (0.55 g, 1.15 mmol) in abs. EtOH (10 ml) at room temperature and stirring was continued overnight. The solvent was evaporated under reduced pressure. The residue was chromatographed on silica gel using $CHCl_3$/MeOH (9:1) as eluent to give 0.3 g (86%) of **14** as a white solid, mp 150-152°C, FAB MS (DMSO + 1% $CH_3COOH$ in 3-nitrobenzylalcohol) 304 (M + $H^+$). Anal. calc. for $C_{15}H_{17}N_3O_4{\cdot}H_2O$: C, 56.07; H, 5.96; N, 13.08. Found: C, 56.28; H, 5.48; N, 13.16. $^1H$ NMR (DMSO-$d_6$, 500 MHz): δ 1.81 (1H, m, H2'), 2.70 (1H, m, H2'), 3.30 (1H, m, H3'), 3.43 (2H, m, H4', H5'), 3.56 (1H, dd, J = 4.0, 11.4 Hz, H5'), 4.86 (2H, s, $NH_2$), 5.47 (1H, dd, J = 4.8, 8.2 Hz, H1'), 6.63 (1H, s, =CH), 7.34-7.48 (5H, m, $H_{Arom}$). $^{13}C$ NMR (DMSO-$d_6$, 125.7 MHz): δ 37.58 (C2'), 51.96 (C3'), 62.25 (C5'), 83.25 (C1'), 86.34 (C4'), 110.13 (=CH), 128.37, 128.49, 129.16, 130.32, 132.81 (C5, $C_{Arom}$), 155.29 (C2), 164.85 (C4).

***(Z)*-1-(3-Amino-2,3-dideoxy-α-D-*erythro*-pentofuranosyl)-5-(phenylmethylene)-2,4-imidazolidinedione (15).** The protected nucleoside **13** (0.3 g, 1.15 mmol) was treated similarly as described for the preparation of **14**. Purification by column chromatography on silica gel with $CHCl_3$/MeOH (90:10) as eluent gave 0.32 g (92%) of **15** as a white foam.

Anal. calc. for $C_{15}H_{17}N_3O_4 \cdot 1.5H_2O$: C, 54.84; H, 6.10; N, 12.72. Found: C, 55.24; H, 5.84; N, 12.48. $^1H$ NMR (DMSO-$d_6$, 250 MHz): δ 2.46 (2H, m, H2'), 3.10 (1H, dd, J = 7.8, 15.4 Hz, H3'), 3.30 (1H, dd, J = 4.6, 11.8 Hz, H5'), 3.43 (1H, m, H5'), 3.84 (1H, m, H4'), 4.94 (1H, s, 5'-OH), 5.09 (2H, s, $NH_2$), 5.37 (1H, t, J = 7.0 Hz, H1'), 6.61 (1H, s, =CH), 7.25-7.44 (5H, m, $H_{Arom}$). $^{13}C$ NMR (DMSO-$d_6$, 62.9 Hz): δ 37.02 (C2'), 52.37 (C3'), 61.19 (C5'), 83.86 (C1'), 86.21 (C4'), 109.78 (=CH), 128.28, 128.48, 129.08, 130.78, 132.89 (C5, $C_{Arom}$), 157.10 (C2), 165.61 (C4).

**Acknowledgement:** This paper was supported by Danish Ministry of Education, Danish Medical Research Council and Egyptian Ministry of Higher Education.

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Received 6/26/93
Accepted 11/11/93