

Stereocontrolled General Synthesis of Pyrimidine C-Nucleosides Having Branched-chain Sugar Moieties¹⁾

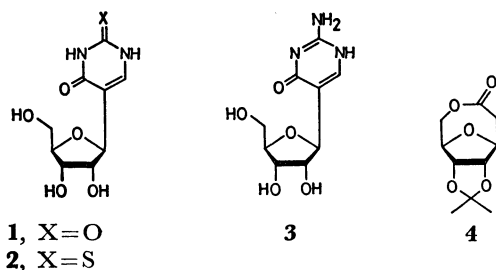
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A variety of pyrimidine C-nucleosides bearing branched-chain sugars can be synthesized starting from adequately substituted (1*R**,6*S**,7*S**,8*R**)-7,8-isopropylidenedioxy-3,9-dioxabicyclo[4.2.1]nonan-4-ones. The general procedure consists of condensation with *t*-butoxybis(dimethylamino)methane, giving the corresponding α -dimethylaminomethylene lactones, base-catalyzed heterocycle formation with urea, thiourea, or guanidine, and acid-promoted removal of the isopropylidene protective group. The overall transformation proceeds with retention of the stereochemistry to afford only C- β -glycosyl nucleoside structures.

We have recently developed a novel method²⁾ for the synthesis of pseudouridine (**1**), a component of tRNA, and its analogues such as 2-thiopseudouridine (**2**) and pseudoisocytidine (**3**)³⁾ via a common intermediate, (1*R*,6*S*,7*S*,8*R*)-7,8-isopropylidenedioxy-3,9-dioxabicyclo[4.2.1]nonan-4-one (**4**), which possesses a rigid C- β -glycoside structure. Realization of this method relies on the efficiency of the transition metal aided [3+4] annulation using polybromo ketones and furans⁴⁾ and the stereoregulation of the subsequent oxidative transformation. The great flexibility of this new procedure prompted us to prepare a variety of the synthetic analogues. So far interest in the synthesis of C-nucleoside analogues has centered around the compounds having an arabiosyl or deoxyribosyl residue.⁵⁾ Being stimulated by the discovery of the antibiotics, angustomycin A and C⁶⁾ and nucleosidin,⁷⁾ which exhibit cytostatic or virostatic activity, we were particularly interested in C-nucleosides bearing a branched-chain ribofuranosyl moiety. Although a number of routes to branched-chain sugars have been developed during the past few years,⁸⁾ there were reported no efficient total syntheses which gave directly and stereospecifically such sugar derivatives. The present paper describes a completely stereocontrolled entry to pyrimidine C-nucleosides containing branched-chain sugar moieties.



Results and Discussion

Synthesis of 5'-Modified Pyrimidine C-Nucleosides.⁹⁾

The iron carbonyl- or Zn/Ag couple-promoted cyclo-coupling of polybromo ketones and furan provides a general way to give the adducts of type **5**.⁴⁾ The bicyclic ketone **5a** thus obtained can be transformed oxidatively to **6a** under perfect stereo- and regiochemical control.¹⁾ Heating of a mixture of the lactone **6a** and a Bredereck reagent, *t*-C₄H₉OCH[N(CH₃)₂]₂¹⁰⁾

(excess), in DMF at 50 °C afforded the dimethylaminomethylene lactone **7a** (Z:E=70:30) in a good yield. Condensation of **7a** and urea with ethanolic sodium ethoxide formed the uracil derivative **8a** in 48% yield. The β stereochemistry at the anomeric 1' position was confirmed by the ¹H NMR analysis in pyridine-*d*₅. The isopropylidene methyl signals appeared at δ 1.41 and 1.67 ($\Delta\delta=0.26$ ppm), in accord with the Imbach's empirical rule.¹¹⁾ The spin-spin coupling constant, $J_{4',5'}=3.7$ Hz, also supported this assignment.¹²⁾ Subsequent treatment of **8a** with 10% HCl in methanol at 25 °C furnished ($\pm$)-5',5'-dimethylpseudouridine (**9a**). No pyranose derivatives were formed by this deprotection procedure.

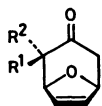
When **7a** was treated with thiourea in refluxing ethanolic sodium ethoxide, the thiouracil derivative **10a** was obtained. The glycol protective group was then removed by 10% HCl in methanol to give ($\pm$)-5',5'-dimethyl-2-thiopseudouridine (**11a**).

The base-catalyzed condensation of **7a** with guanidine furnished the pseudoisocytidine derivative **12a**, which, by treatment with 10% HCl in methanol, afforded ($\pm$)-5',5'-dimethylpseudoisocytidine (**13a**) in quantitative yield.

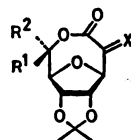
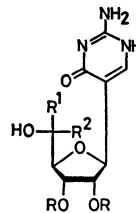
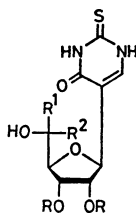
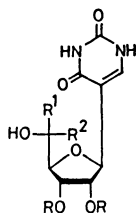
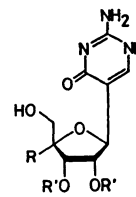
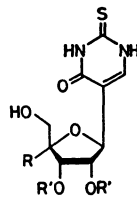
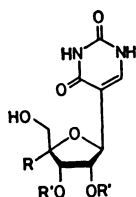
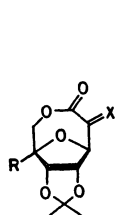
In a similar manner, the 5'-monoalkylated or -phenylated pseudouridines **9b–d**, the 5'-monosubstituted 2-thiopseudouridines **11b–d**, and 5'-monosubstituted pseudoisocytidines **13b–d** were prepared from the corresponding ketones **5b–d**. In addition to the complete stereochemical control achieved in this synthesis, the configurational relationship between the carbonyl α position in **5** and the 5' carbon of the resulting nucleosides, **9**, **11**, and **13**, is noteworthy. Since the chiral center created in the initial reductive [3+4] cyclo-coupling of polybromo ketones and furan remains intact during the subsequent transformation, the stereochemistry inherent in **5b**, for example, leads to the 6'-deoxyallofuranosyl structure, **9b**, **11b**, and **13b**. Thus this approach allows a general entry to pyrimidine C-nucleosides possessing various carbon substituents at the 5' position.¹³⁾

Synthesis of 1'- and 4'-Modified Pyrimidine C-Nucleosides.

A. 4'-Alkylated Pyrimidine C-Nucleosides:^{14,15)} The readily available lactone **14a**¹⁾ was condensed with *t*-C₄H₉OCH[N(CH₃)₂]₂ to afford the dimethylaminomethylene derivative **15a** in 70% yield. Conversion of **15a** to a uracil derivative **16a** was accomplished by heating **15a** with urea (10 equiv) in ethanolic sodium ethoxide in a fair yield. The assignment of



5

6, X = H₂
7, X = CHN(CH₃)₂8, R-R = C(CH₃)₂ 10, R-R = C(CH₃)₂ 12, R-R = C(CH₃)₂
9, R = H 11, R = H 13, R = H (HCl salt)
a, R¹ = R² = CH₃ b, R¹ = CH₃; R² = H c, R¹ = (CH₂)₄CH₃; R² = H
d, R¹ = C₆H₅; R² = H14, X = H₂ 16, R'-R' = C(CH₃)₂ 18, R'-R' = C(CH₃)₂ 20, R'-R' = C(CH₃)₂
15, X = CHN(CH₃)₂ 17, R' = H 19, R' = H 21, R' = H (HCl salt)
a, R = CH₃ b, R = (CH₂)₄CH₃ c, R = C₆H₅

β configuration of the uracil base was made on the basis of the ¹H NMR chemical shifts of the isopropylidene methyls (δ 1.40 and 1.66, $\Delta\delta=0.26$ ppm).¹¹ Exposure of **16a** to 10% HCl in methanol formed ($\pm$)-4'-methylpseudouridine (**17a**) in quantitative yield. Preparation of ($\pm$)-4'-methyl-2-thiopseudouridine (**19a**) was effected by heating **15a** with thiourea in ethanolic sodium ethoxide, followed by acidic removal of the isopropylidene group. Condensation of **15a** with guanidine followed by removal of the isopropylidene protective group produced ($\pm$)-4'-methylpseudoisocytidine (**21a**) in 64% yield.

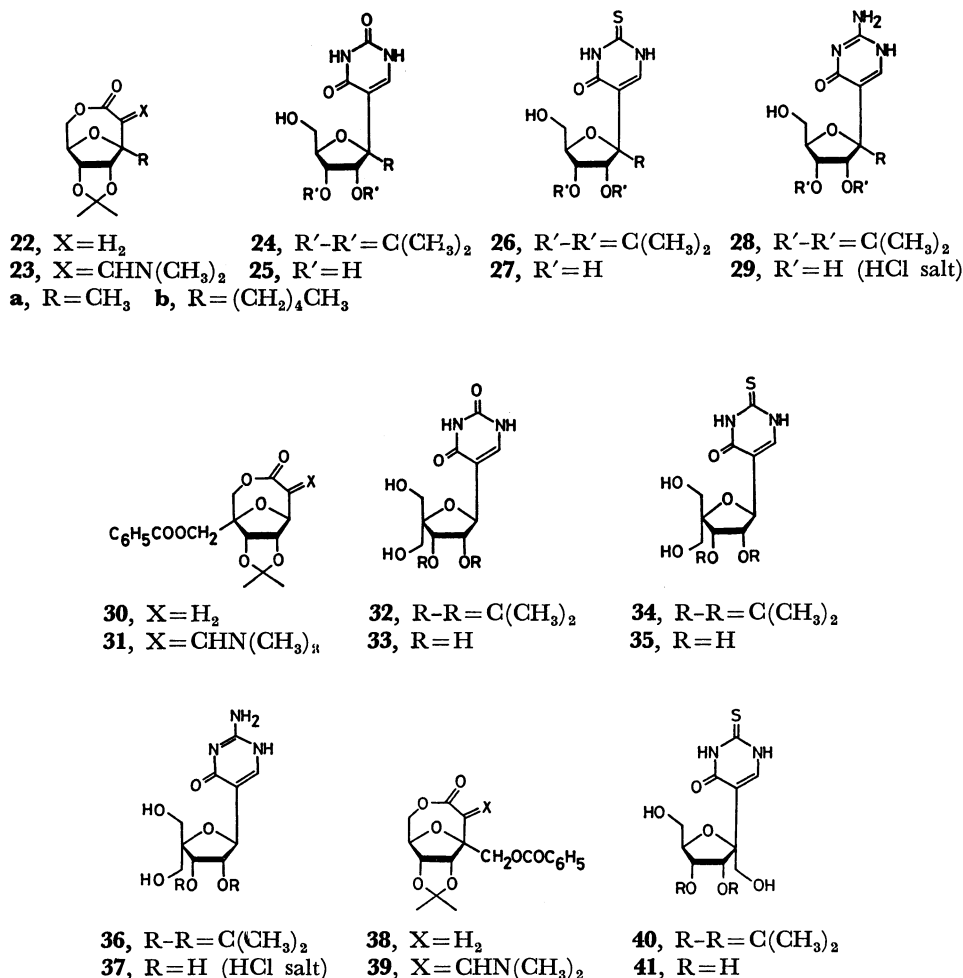
When an alkylated lactone **14b**¹⁾ was used as the starting material, the 4'-pentyl pyrimidine C-nucleosides, **17b**, **19b**, and **21b**, were obtained according to similar synthetic procedures.

The otherwise unaccessible 4'-arylated pyrimidine C-nucleoside analogues, **17c**, **19c**, and **21c**, have been prepared by this completely stereocontrolled recipe starting from the phenylated lactone **14c**, derived from 2-phenylfuran and $\alpha,\alpha,\alpha',\alpha'$ -tetrabromoacetone.¹⁸⁾

B. 1'-Alkylated Pyrimidine C-Nucleosides:¹⁴⁾ When the methylated lactone **22a**¹⁾ was treated with *t*-C₄H₉OCH[N(CH₃)₂]₂ (neat, 90 °C), there was obtained the dimethylaminomethylene lactone **23a**, displaying IR absorptions at 1670 (C=O) and 1590 cm⁻¹ (C=C). This was subjected immediately to the condensation

with urea in ethanolic sodium ethoxide to afford **24a**. The reaction proceeded only sluggishly and the yield was only 7% based on **22a**. The ¹H NMR spectrum of **24a** indicated that the product has β configuration at C-1' position; the singlets due to the isopropylidene methyls occurred at δ 1.39 and 1.65 ($\Delta\delta=0.26$ ppm).¹¹ Removal of the isopropylidene block with 10% HCl in methanol yielded ($\pm$)-1'-methylpseudouridine (**25a**). The lactone **23a** underwent the sodium ethoxide-promoted condensation with thiourea in refluxing ethanol to produce the acetone **26a**. Subsequent deprotection with 10% HCl in methanol liberated ($\pm$)-1'-methyl-2-thiopseudouridine (**27a**). Construction of the heterocyclic nucleus with guanidine gave rise to **28a**, methanolysis of which catalyzed by HCl afforded hydrochloride salt of **29a**. In a like manner, 1'-pentyl pyrimidine C-nucleosides, **25b**, **27b**, and **29b**, were obtained by employing the lactone **22b**.¹⁾ Elaboration of heterocycles onto **22** was achieved less effectively because of the severe steric hindrance caused by the C-1' alkyl substitution. Nevertheless, this method realized the first synthesis of 1'-alkylated C-nucleosides.²²⁾

C. 1'- and 4'-Hydroxymethylated Pyrimidine C-Nucleosides:²³⁾ Condensation of the lactone **30**¹⁾ with *t*-C₄H₉OCH[N(CH₃)₂]₂ in DMF at 90 °C provided the dimethylaminomethylene compound **31** in 91% yield.



Treatment of **31** with urea in the presence of sodium ethoxide constructed the uracil skeleton and simultaneous removal of the benzoyl moiety gave **32** in a moderate yield. Deprotection of the isopropylidene group by 10% HCl in methanol formed (±)-4'-hydroxymethylpseudouridine (**33**) in 89% yield. Similarly, treatment of **31** with thiourea under the basic conditions, giving **34**, followed by deprotection afforded (±)-4'-hydroxymethyl-2-thiopseudouridine (**35**). The base-catalyzed cyclization of **31** with guanidine, giving **36**, followed by removal of the isopropylidene block furnished (±)-4'-hydroxymethylpseudoisocytidine (**37**) as hydrochloride salt.

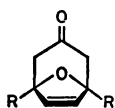
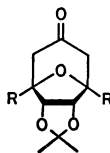
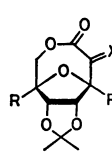
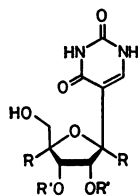
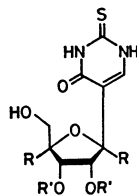
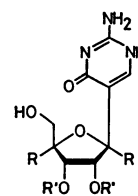
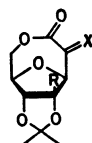
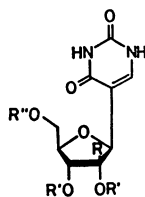
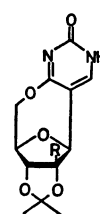
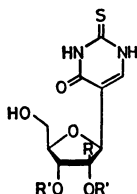
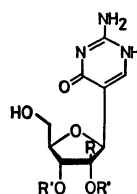
In a parallel fashion, the lactone **39**, derived from **38** by the reaction with *t*-C₄H₉OCH[N(CH₃)₂]₂, was convertible to 1'-hydroxymethylated pyrimidine C-nucleosides such as (±)-1'-hydroxymethyl-2-thiopseudouridine (**41**). Thus the base-promoted condensation of **39** and thiourea affording the acetonide **40** and subsequent removal of the protective group gave the C-nucleoside **41** which consists of psicose and a pyrimidine base.²²⁾

D. 1',4'-Dialkylated Pyrimidine C-Nucleosides:²⁴⁾ Bis-hydroxylation of **42a**²⁵⁾ using hydrogen peroxide (3 equiv) in the presence of a catalytic amount of osmium tetroxide in a 10:1:1 mixture of acetone, *t*-butyl alcohol, and ether, followed by acetonidation with CuSO₄

and *p*-toluenesulfonic acid in acetone gave **43a**. The α stereochemical assignment was made on the basis of the ¹H NMR spectrum which exhibited the H₆ and H₇ signal as a singlet at δ 4.30.²⁶⁾ Then exposure of **43a** to trifluoroacetic acid gave the lactone **44a** in 77% yield. Subsequent reaction with neat tris(dimethylamino)methane²⁷⁾ at 90 °C afforded the (*Z*)-dimethylaminomethylene lactone **45a** in 38% yield (88% based on consumed **44a**) as a single isomer. Condensation of **45a** with urea with ethanolic sodium ethoxide formed **46a** in 28% yield, which was then treated with 10% methanolic HCl to give (±)-1',4'-dimethylpseudouridine (**47a**). The ¹H NMR spectrum giving the isopropylidene methyl signals at δ 1.28 and 1.50 (Δδ=0.22 ppm) confirmed the β heterocycle stereochemistry assigned for **46a**.^{11,28)} When thiourea was employed for the analogous cyclization, there was obtained in 60% yield the 2-thiouracil derivative **48a**, leading to **49a** after deprotection. Use of guanidine in place of urea gave rise to **51a** as HCl salt via **50a** in 75% yield.

In a usual manner, the 1',4'-dipentyl analogues, **47b**, **49b**, and **51b**, have also been prepared starting with **42b**.

Thus present way appears to provide a facile, general entry to 1',4'-disubstituted pyrimidine C-nucleosides which are not available by the conventional approaches

**42****43****44**, X=H₂**45**, X=CHN(CH₃)₂**46**, R'-R'=C(CH₃)₂**47**, R'=H**a**, R=CH₃ **b**, R=(CH₂)₄CH₃**48**, R'-R'=C(CH₃)₂**49**, R'=H**50**, R'-R'=C(CH₃)₂**51**, R'=H (HCl salt)**52a**, R=CH₂OTBDMS;
X=H₂**52b**, R=CH₃; X=H₂**53a**, R=CH₂OTBDMS;
X=CHN(CH₃)₂**53b**, R=CH₃;
X=CHN(CH₃)₂**54a**, R=CH₂OTBDMS;
R'-R'=C(CH₃)₂; R''=H**54b**, R=CH₃; R'-R'=C(CH₃)₂;
R''=H**55a**, R=CH₂OH; R'=R''=H**55b**, R=CH₃; R'=R''=H**56a**, R=CH₂OTBDMS;
R'-R'=C(CH₃)₂; R''=SO₂CH₃**56b**, R=CH₃; R'-R'=C(CH₃)₂;
R''=SO₂CH₃**57a**, R=CH₂OTBDMS**57b**, R=CH₃**58a**, R=CH₂OTBDMS; R'-R'=C(CH₃)₂**58b**, R=CH₃; R'-R'=C(CH₃)₂**59a**, R=CH₂OH; R'=H**59b**, R=CH₃; R'=HTBDMS=Si(CH₃)₂-*t*-C₄H₉**60a**, R=CH₂OTBDMS; R'-R'=C(CH₃)₂**60b**, R=CH₃; R'-R'=C(CH₃)₂**61a**, R=CH₂OH; R'=H (HCl salt)**61b**, R=CH₃; R'=H (HCl salt)

reported to date.

*Synthesis of 2'-Alkylated Pyrimidine C-Nucleosides:*²⁹⁾ Treatment of **52a**¹⁾ with excess *t*-C₄H₉OCH[N(CH₃)₂]₂ at 70 °C afforded the corresponding condensation product **53a** in 52% yield. The base-aided reaction with excess urea led to the uracil derivative **54a** in 20% yield, deprotection of which by methanolic HCl gave (±)-2'-hydroxymethylpseudouridine (**55a**) in 95% yield. The β stereochemistry at the anomeric position was established chemically by converting the acetone

54a to the cyclo-C-nucleoside **57a**. Thus reaction of **54a** and methanesulfonyl chloride in pyridine and subsequent treatment with 1,8-diazabicyclo[5.4.0]-undec-7-ene (DBU) in acetonitrile gave **57a** in ca. 60% yield.³⁰⁾ Formation of the expected product was substantiated by comparison of the UV spectrum in methanol (λ_{max} 295 nm, ε 3720) showing a well-known, characteristic bathochromic shift, with that of the starting open-form **54a** (λ_{max} 266 nm, ε 7150).²¹⁾

When the lactone **53a** was annulated with thiourea,

the protected nucleoside **58a** was obtained in high yield. Brief treatment of **58a** with methanolic HCl afforded ($\pm$)-2'-hydroxymethyl-2-thiopseudouridine (**59a**). Similarly, treatment of **53a** with guanidine, giving **60a**, and acid-assisted deprotection under the standard conditions led to ($\pm$)-2'-hydroxymethylpseudoisocytidine (**61a**) as HCl salt.

In a like fashion, 2'-methylated pyrimidine C-nucleosides, **55b**, **59b**, and **61b**, were synthesized by use of **52b**.¹⁾

This method allows ready construction of the difficult-to-make hamamelose and 2'-methylribofuranose skeletons and introduction of pyrimidine rings at the 1'-position.³¹⁾

As has been outlined above, this approach is synthetically very flexible and a variety of C-nucleoside analogues can be made by parallel routes. The possibility was examined only with achiral or racemic precursors, but the optical resolution of the intermediates, leading to the "natural" configurations, could be done most conveniently at the stage of the lactones of type **4**.²⁾

Experimental

General. All melting and boiling points are uncorrected. IR spectra were recorded on a JASCO IRA-1 spectrometer in CHCl_3 solution unless otherwise stated. ^1H NMR spectra were obtained using a Varian NV-21 or HA-100 spectrometer, and ^{13}C NMR spectra were recorded at 20 MHz on a Varian CFT-20 spectrometer or at 25 MHz on a JEOL FX-100 spectrometer. The chemical shifts are recorded in parts per million relative to tetramethylsilane as an internal standard. Singlet, doublet, triplet, and multiplet are abbreviated to s, d, t, and m, respectively. Exact mass spectra were obtained at Central Research Laboratory of Ono Pharmaceutical Co. Elemental analyses were performed at the Research Laboratory of Fujisawa Pharmaceutical Co. and Faculty of Engineering of Nagoya University. Drying of organic extracts was done over anhydrous Na_2SO_4 . For concentration of organic solvents, a vacuum (50–100 mmHg)** rotary evaporator was used.

Chromatography. Thin-layer chromatography (TLC) was done using a glass plate coated with 0.25-mm layers of silica gel 60 PF₂₅₄ obtained from E. Merck and for preparative TLC, 20×20-cm glass plates coated with a 1.0-mm layer of silica gel 60 PF₂₅₄ were employed. Analytical plates were visualized by spraying with a solution of 2% $\text{Ce}(\text{SO}_4)_2$ in 5% H_2SO_4 or 2% *p*-anisaldehyde in 5% ethanolic H_2SO_4 followed by heating on a hot plate. The position of spots are shown by R_f values. For column chromatography, E. Merck Kieselgel 60 (70–230 mesh) was used. For separation of the dimethylaminomethylene lactones, silica gel treated with diluted aqueous ammonia was used.³³⁾

Solvents and Materials. DMF, acetonitrile, *t*- $\text{C}_4\text{H}_9\text{OH}$, and 1,8-diazabicyclo[5.4.0]undec-7-ene (DBU) were used after distillation from CaH_2 . Acetone and CH_2Cl_2 were distilled from P_2O_5 . Ethanol was distilled over magnesium ribbons. THF and ether were distilled from sodium benzophenone ketyl. Preparations of Zn/Ag couple,³⁴⁾ Zn/Cu couple,³⁵⁾ 2-pentylfuran,¹⁾ $\alpha,\alpha,\alpha',\alpha'$ -tetrabromoacetone,³⁶⁾ *t*-butoxybis(dimethylamino)methane,¹⁰⁾ and tris(dimethylamino)methane²⁷⁾ were performed according to the known procedures. Other commercially supplied materials and sol-

vents were used as received.

Preparation of Methyl [(2S*,3S*,4S*,5R*)-5-Hydroxymethyl-3,4-isopropylidenedioxy-5-phenyltetrahydrofuran-2-yl]acetate. A mixture of **14c** (111 mg, 0.383 mmol),¹⁾ sodium methoxide (31.0 mg, 0.574 mmol), and CH_3OH (3 ml)*** was stirred at 0 °C for 1 h under argon and to this was added oxalic acid (100 mg). Evaporation followed by extraction with chloroform afforded the title compound (115 mg, 91%) as a white solid. $R_f=0.28$ (1:1 hexane–ethyl acetate); IR 3580 (OH), 1732 cm^{-1} (C=O); ^1H NMR (CDCl_3) δ 1.04 and 1.28 (s, isopropylidene CH_3), 2.74 (dd, $J=6.0, 14.5$ Hz, $\text{H}_a\text{H}_b\text{CC}=\text{O}$), 2.96 (dd, $J=4.8, 14.5$ Hz, $\text{H}_a\text{H}_b\text{CC}=\text{O}$), 3.62 (d, $J=12.5$ Hz, $\text{H}_a\text{H}_b\text{COH}$), 3.77 (s, OCH_3), 3.86 (d, $J=12.5$ Hz, $\text{H}_a\text{H}_b\text{COH}$), 4.40 (m, H_2), 4.56 (t-like, $J=6.0$ Hz, H_3), 5.02 (br, OH), 5.16 (d, $J=6.0$ Hz, H_4), 7.35 (m, C_6H_5); ^{13}C NMR (CDCl_3) δ 25.80, 26.70, 37.21, 51.94, 69.33, 79.65, 83.86, 84.06, 90.23, 114.44, 126.50, 127.27, 127.82, 138.12, 171.69. Found: m/z , 291.1231. Calcd for $\text{C}_{18}\text{H}_{19}\text{O}_5$: (M– OCH_3), 291.1232.

Preparation of 2,5-Dipentylfuran. To a mixture of $n\text{-C}_4\text{H}_9\text{Li}$ (1.6 mol dm^{-3} hexane solution, 288 ml, 0.461 mol) and THF (350 ml) was added 2-pentylfuran (60.6 g, 0.439 mol) at –10 °C under argon. After the mixture was stirred at the same temperature for 6 h, pentyl iodide (91.3 g, 0.461 mol) was added. The reaction mixture was stirred at 20 °C for 12 h and then poured into ice-water (200 ml). The organic layer was separated and the aqueous layer was extracted with ether (150 ml×3). The combined organic extracts were dried (MgSO_4) and evaporated to leave a yellow oil, which was distilled under reduced pressure to give 2,5-dipentylfuran (68.2 g, 75%, bp 103–108 °C/9 mmHg (lit.³⁷⁾ 99–100 °C/5 mmHg) as a colorless oil. ^1H NMR (CDCl_3) δ 0.91 (t, $J=6.3$ Hz), 1.1–1.8 (m), 2.57 (t, $J=7.0$ Hz), 5.84 (s); MS m/z 208 (M^+).

1,5-Dimethyl-8-oxabicyclo[3.2.1]oct-6-en-3-one (42a). To a mixture of Zn/Ag couple (26.0 g, 0.40 g-atom) and 2,5-dimethylfuran (21.3 ml, 0.20 mol) in THF (150 ml) was added a solution of $\alpha,\alpha,\alpha',\alpha'$ -tetrabromoacetone (224 g, 0.60 mol) in THF (200 ml) over 30 min at –10 °C under argon. The mixture was allowed to warm up to 20 °C and stirred at the same temperature for 12 h. The mixture was evaporated and the residue was dissolved in CH_3OH saturated with NH_4Cl (400 ml). To this was added portionwise Zn/Cu couple (130 g, 2.0 g-atom) over 2 h at 0 °C. The mixture was stirred at 20 °C for an additional 1 h and diluted with water (400 ml) and saturated disodium dihydrogen ethylenediaminetetraacetate ($\text{Na}_2\text{H}_2\text{edta}$) solution (400 ml). The insoluble material was removed by filtration and the filtrate was extracted with CH_2Cl_2 (300 ml×3). The combined organic layers were dried (Na_2SO_4) and concentrated. Chromatography of the residue on a silica-gel column using a 3:1 hexane–ethyl acetate mixture afforded **42a** (20.0 g, 66%) as a white solid. Mp 64–66 °C (hexane–chloroform); $R_f=0.47$ (3:1 hexane–ethyl acetate); IR 1715 cm^{-1} (C=O); ^1H NMR (CDCl_3) δ 1.50 (s, CH_3), 2.32 (d, $J=16.1$ Hz, H_{2a} and H_{4a}), 2.51 (d, $J=16.1$ Hz, H_{2b} and H_{4b}), 5.97 (s, H_6 and H_7); ^{13}C NMR (CDCl_3) δ 23.30, 51.12, 83.83, 136.42, 207.07. Found: C, 71.55, H, 8.06%. Calcd for $\text{C}_9\text{H}_{12}\text{O}_2$: C, 71.02; H, 7.95%.

1,5-Dipentyl-8-oxabicyclo[3.2.1]oct-6-en-3-one (42b). A mixture of Zn/Ag couple (39.0 g, 0.60 g-atom), 2,5-dipentylfuran (62.4 g, 0.30 mol), $\alpha,\alpha,\alpha',\alpha'$ -tetrabromoacetone (337 g, 0.9 mol), and THF (400 ml) was stirred at 20 °C for 24 h. Reduction of the reaction mixture with Zn/Cu couple (292 g, 4.50 g-atom) in CH_3OH (500 ml) saturated with NH_4Cl

** 1 mmHg $\approx$ 133.322 Pa.

*** 1 ml = 0.001 dm^3 .

followed by extractive workup with CH_2Cl_2 gave a brown oil. Chromatography of the residue on a silica-gel column using a 10:1 hexane-ethyl acetate mixture afforded **42b** (32.5 g, 41%) as a colorless oil. $R_f=0.35$ (10:1 hexane-ethyl acetate); IR (neat) 1720 cm^{-1} (C=O); $^1\text{H NMR}$ (CDCl_3) δ 0.90 (t, $J=6.5\text{ Hz}$, CH_3), 1.1–1.9 (m, CH_2), 2.28 (d, $J=16.0\text{ Hz}$, H_{2a} and H_{4a}), 2.48 (d, $J=16.0\text{ Hz}$, H_{2b} and H_{4b}), 5.95 (s, H_6 and H_7); $^{13}\text{C NMR}$ (CDCl_3) δ 14.00, 22.59, 23.65, 32.18, 36.65, 50.53, 86.59, 135.42, 207.25. Found: m/z , 264.2092. Calcd for $\text{C}_{17}\text{H}_{28}\text{O}_2$: M, 264.2089. In addition, unreacted 2,5-dipentylfuran (12.9 g) was recovered.

(1S*,5R*,6S*,7R*)-1,5-Dimethyl-6,7-isopropylidenedioxy-8-oxabicyclo[3.2.1]octan-3-one (**43a**). To a mixture of **42a** (25.0 g, 0.164 mol) and OsO_4 (300 mg, 1.18 mmol) in acetone (200 ml), $t\text{-C}_4\text{H}_9\text{OH}$ (20 ml), and ether (20 ml) was added 30% H_2O_2 (36.2 ml, 0.329 mol). The mixture was stirred at 19°C for 15 h and to this was added renewedly 30% H_2O_2 (18.1 ml, 0.165 mol). The mixture was stirred for an additional 12 h and cooled to 0°C . To this was added powder of $\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$ (77 g) and stirring was continued at 20°C for 3 h. The residue obtained by evaporation was extracted with ethyl acetate (250 ml $\times$ 3). The combined organic layers were dried (Na_2SO_4) and evaporated. The residue was dissolved in acetone (250 ml) and to this was added CuSO_4 (30 g) and p -toluenesulfonic acid (250 mg). The resulting mixture was stirred at 20°C for 12 h. The insoluble material was removed by filtration and the filtrate was concentrated to afford a dark oil, which was chromatographed on a silica-gel column using a 3:1 hexane-ethyl acetate mixture to afford **43a** (22.5 g, 61%). Mp $67\text{--}68^\circ\text{C}$ (hexane-chloroform); $R_f=0.32$ (3:1 hexane-ethyl acetate); IR 1720 cm^{-1} (C=O); $^1\text{H NMR}$ (CDCl_3) δ 1.30 and 1.52 (s, isopropylidene CH_3), 1.41 (s, CH_3), 2.28 (d, $J=15.0\text{ Hz}$, H_{2a} and H_{4a}), 2.50 (d, $J=15.0\text{ Hz}$, H_{2b} and H_{4b}), 4.30 (s, H_6 and H_7); $^{13}\text{C NMR}$ (CDCl_3) δ 20.12, 25.00, 26.12, 51.71, 82.59, 85.30, 112.42, 206.90. Found: m/z , 211.0971. Calcd for $\text{C}_{11}\text{H}_{15}\text{O}_4$: (M- CH_3), 221.0970.

(1S*,5R*,6S*,7R*)-1,5-Dipentyl-6,7-isopropylidenedioxy-8-oxabicyclo[3.2.1]octan-3-one (**43b**). A mixture of **42b** (11.8 g, 44.7 mmol), acetone (70 ml), $t\text{-C}_4\text{H}_9\text{OH}$ (7 ml), ether (7 ml), OsO_4 (100 mg), and 30% H_2O_2 (14.7 ml, 134 mmol) was stirred at 20°C for 12 h and to this was added $\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$ (33.5 g) at 0°C . The resulting mixture was stirred at 20°C for 3 h. After the usual workup, the residue was dissolved in acetone (150 ml). To this was added CuSO_4 (15 g) and p -toluenesulfonic acid (100 mg). After stirring at 20°C for 24 h, the usual workup and chromatographic isolation (silica gel, 10:1 hexane-ethyl acetate) yielded **43b** (6.50 g, 43%) as a colorless oil. $R_f=0.36$ (10:1 hexane-ethyl acetate); IR 1720 cm^{-1} (C=O); $^1\text{H NMR}$ (CDCl_3) δ 0.90 (t, $J=6.0\text{ Hz}$, CH_3), 1.28 and 1.50 (s, isopropylidene CH_3), 1.1–1.9 (m, CH_2), 2.30 (d, $J=14.5\text{ Hz}$, H_{2a} and H_{4a}), 2.48 (d, $J=14.5\text{ Hz}$, H_{2b} and H_{4b}), 4.30 (s, H_6 and H_7); $^{13}\text{C NMR}$ (CDCl_3) δ 16.64, 25.19, 26.12, 27.78, 28.80, 35.03, 36.43, 52.18, 87.39, 87.59, 114.78, 210.07.

(1R*,6S*,7R*,8S*)-1,6-Dimethyl-7,8-isopropylidenedioxy-3,9-dioxabicyclo[4.2.1]nonan-4-one (**44a**). Trifluoroacetic acid prepared from trifluoroacetic anhydride (46.5 ml, 0.328 mol) and 90% H_2O_2 (11.8 ml, 0.312 mol) in CH_2Cl_2 (150 ml) was added dropwise to a stirred, ice-cooled mixture of Na_2HPO_4 (140 g, 0.984 mol), $\text{Na}_2\text{H}_2\text{edta}$ (1 g), and **43a** (35.2 g, 0.156 mol) in CH_2Cl_2 (200 ml). The mixture was stirred at 20°C for 13 h and diluted with CH_2Cl_2 (200 ml). To this was added $\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$ (78 g) at 0°C and the resulting mixture was stirred at 20°C for 3 h. The insoluble material was removed by filtration and the filtrate was evap-

orated. Chromatography of the residue on a silica-gel column using a 3:1 to 2:1 hexane-ethyl acetate mixture afforded **44a** (28.9 g, 77%). Mp $123\text{--}124^\circ\text{C}$ (hexane-chloroform); $R_f=0.15$ (3:1 hexane-ethyl acetate); IR 1735 cm^{-1} (C=O); $^1\text{H NMR}$ (CDCl_3) δ 1.27 and 1.35 (s, CH_3), 1.35 and 1.51 (s, isopropylidene CH_3), 2.83 (d, $J=16.0\text{ Hz}$, H_{5a}), 3.07 (d, $J=16.0\text{ Hz}$, H_{5b}), 4.11 (d, $J=13.5\text{ Hz}$, H_{2a}), 4.33 (d, $J=13.5\text{ Hz}$, H_{2b}), 4.56 (d, $J=6.0\text{ Hz}$, H_7), 4.88 (d, $J=6.0\text{ Hz}$, H_8); $^{13}\text{C NMR}$ (CDCl_3) δ 17.95, 22.16, 24.73, 26.01, 49.44, 75.96, 81.12, 83.63, 85.52, 112.57, 172.09. Found: C, 59.47; H, 7.60%. Calcd for $\text{C}_{12}\text{H}_{18}\text{O}_5$: C, 59.49, H, 7.49%.

(1R*,6S*,7R*,8S*)-1,6-Dipentyl-7,8-isopropylidenedioxy-3,9-dioxabicyclo[4.2.1]nonan-4-one (**44b**). To a mixture of **43b** (15.5 g, 45.9 mmol), Na_2HPO_4 (64.8 g, 0.456 mol), and CH_2Cl_2 (100 ml) was added trifluoroacetic acid in CH_2Cl_2 (1.08 mol dm^{-3} solution, 128 ml, 0.138 mol) at 0°C . After stirring at 20°C for 12 h, the reaction mixture was worked up to give a white solid, which was purified on a silica-gel column (10:1 hexane-ethyl acetate) to give **44b** (12.2 g, 77%) as a white solid. Mp $60\text{--}62^\circ\text{C}$ (chloroform-hexane); $R_f=0.37$ (5:1 hexane-ethyl acetate); IR 1736 cm^{-1} (C=O); $^1\text{H NMR}$ (CDCl_3) δ 0.89 (t, $J=6.0\text{ Hz}$, CH_3), 1.31 and 1.49 (s, isopropylidene CH_3), 1.1–1.9 (m, CH_2), 2.28 (d, $J=15.5\text{ Hz}$, H_{5a}), 2.99 (d, $J=15.5\text{ Hz}$, H_{5b}), 4.17 (d, $J=13.9\text{ Hz}$, H_{2a}), 4.32 (d, $J=13.9\text{ Hz}$, H_{2b}), 4.52 (d, $J=5.9\text{ Hz}$, H_7), 4.98 (d, $J=5.9\text{ Hz}$, H_8); $^{13}\text{C NMR}$ (CDCl_3) δ 13.96, 22.41, 23.52, 24.57, 25.92, 32.26, 32.86, 35.56, 46.74, 75.06, 83.17, 85.11, 85.30, 112.12, 173.12. Found: C, 67.79; H, 9.76%. Calcd for $\text{C}_{20}\text{H}_{34}\text{O}_5$: C, 67.76; H, 9.67%. In addition, unreacted ketone **43b** (1.90 g) was recovered.

Preparation of the α -Dimethylaminomethylene Lactones.

General Procedure: Unless otherwise stated, the dimethylaminomethylation was performed as follows. A mixture of a lactone, t -butoxybis(dimethylamino)methane or tris(dimethylamino)methane, and DMF (in some reactions, DMF was not used) was magnetically stirred at the stated temperature under argon. After stirring for the stated period, the mixture was concentrated under reduced pressure (0.01 mmHg) at $25\text{--}50^\circ\text{C}$. Chromatography was done on a silica-gel column using the described solvent system as eluent. Elution course of the column chromatography was monitored by TLC and fractions including the desired product were combined and evaporated. A sample for elemental analysis was obtained by recrystallizations of the chromatographed product.

(1S*,6R*,7R*,8S*)-2,2-Dimethyl-5-(dimethylaminomethylene)-7,8-isopropylidenedioxy-3,9-dioxabicyclo[4.2.1]nonan-4-one (**7a**). A mixture of **6a**¹⁾ (520 mg, 1.75 mmol), DMF (5 ml), and t -butoxybis(dimethylamino)methane (2.5 ml) was heated at 50°C for 3 h. The reaction mixture was subjected to the usual workup. Pure **7a** (442 mg, 85%) was obtained by silica-gel column chromatography (5:1 to 1:1 hexane-ethyl acetate). Mp $136.5\text{--}137.2^\circ\text{C}$ (ether); $R_f=0.35$ (ethyl acetate); IR 1670 (C=O) , 1590 cm^{-1} (C=C); $^1\text{H NMR}$ (CDCl_3) δ 1.33 and 1.51 (s, isopropylidene CH_3), 1.44 and 1.47 (s, CH_3), 2.93 and 3.14 (s, $\text{N}(\text{CH}_3)_2$, 3:7 ratio), 6.58 and 7.39 (s, =CHN(CH_3)₂, 3:7 ratio); MS m/z 297 (M^+); UV λ_{max} (CH_3OH) 300 nm (ϵ 15850). Found: C, 60.24; H, 7.79; N, 4.55%. Calcd for $\text{C}_{15}\text{H}_{23}\text{O}_5\text{N}$: C, 60.59; H, 7.80; N, 4.71%.

(1R*,2R*,6R*,7R*,8R*)-5-(Dimethylaminomethylene)-7,8-isopropylidenedioxy-2-methyl-3,9-dioxabicyclo[4.2.1]nonan-4-one (**7b**). A mixture of **6b**¹⁾ (35 mg, 0.15 mmol), t -butoxybis(dimethylamino)methane (0.3 ml), and DMF (1 ml) was stirred at 50°C for 1 h. After the usual workup, the crude product was purified by preparative TLC (ethyl acetate) to give

7b (20 mg, 47%). Mp 120.1–121.3 °C (ether–hexane); R_f = 0.33 (ethyl acetate); IR 1680 (C=O), 1590 cm^{-1} (C=C); ^1H NMR (CDCl_3) δ 1.34 and 1.53 (s, isopropylidene CH_3), 1.38 (d, J = 7.3 Hz, CH_3), 2.94 and 3.14 (s, $\text{N}(\text{CH}_3)_2$, 35:65 ratio), 6.66 and 7.34 (s, $=\text{CHN}(\text{CH}_3)_2$, 35:65 ratio); MS m/z 283 (M^+); UV λ_{max} (CH_3OH) 298 nm (ϵ 16590). Found: C, 59.42; H, 7.64; N, 4.85%. Calcd for $\text{C}_{14}\text{H}_{21}\text{O}_5\text{N}$: C, 59.35; H, 7.47; N, 4.94%.

(1*R**,2*R**,6*R**,7*R**,8*R**)-5-(Dimethylaminomethylene)-7,8-isopropylidenedioxy-2-pentyl-3,9-dioxabicyclo[4.2.1]nonan-4-one (**7c**). A mixture of **6c**¹⁾ (2.37 g, 8.36 mmol), *t*-butoxybis(dimethylamino)methane (12.0 ml), and DMF (15 ml) was stirred at 50 °C for 5 h. After the usual workup, the crude product was chromatographed on silica gel using ethyl acetate as the eluent to give **7c** (2.45 g, 86%). Mp 86.2–87.8 °C (ether–hexane); R_f = 0.53 (ethyl acetate); IR 1680 (C=O), 1595 cm^{-1} (C=C); ^1H NMR (CDCl_3) δ 0.89 (t-like, J = 6.0 Hz, CH_3), 1.32 and 1.50 (s, isopropylidene CH_3), 2.94 and 3.12 (s, $\text{N}(\text{CH}_3)_2$, 37:63 ratio), 6.65 and 7.32 (s, $=\text{CHN}(\text{CH}_3)_2$, 37:63 ratio); MS m/z 339 (M^+); UV λ_{max} (CH_3OH) 298 nm (ϵ 23980). Found: C, 63.62; H, 8.75; N, 4.01%. Calcd for $\text{C}_{18}\text{H}_{29}\text{O}_5\text{N}$: C, 63.69; H, 8.61; N, 4.13%.

(1*S**,2*S**,6*R**,7*R**,8*R**)-5-(Dimethylaminomethylene)-7,8-isopropylidenedioxy-2-phenyl-3,9-dioxabicyclo[4.2.1]nonan-4-one (**7d**). A mixture of **6d**¹⁾ (98 mg, 0.338 mmol), *t*-butoxybis(dimethylamino)methane (0.5 ml), and DMF (2 ml) was stirred at 50 °C for 3.5 h. The usual workup and preparative TLC (2:1 ethyl acetate–hexane) yielded **7d** (74.0 mg, 64%) as a foam. R_f = 0.51 (ethyl acetate); IR 1680 (C=O), 1590 cm^{-1} (C=C); ^1H NMR (CDCl_3) δ 1.28 and 1.47 (s, isopropylidene CH_3), 2.94 and 3.15 (s, $\text{N}(\text{CH}_3)_2$, 38:62 ratio), 6.73 (s, $=\text{CHN}(\text{CH}_3)_2$, *E*-isomer); MS m/z 345 (M^+); UV λ_{max} (CH_3OH) 299 nm (ϵ 13810).

(1*R**,6*R**,7*S**,8*S**)-5-(Dimethylaminomethylene)-7,8-isopropylidenedioxy-1-methyl-3,9-dioxabicyclo[4.2.1]nonan-4-one (**15a**).

A mixture of **14a**¹⁾ (952 mg, 4.18 mmol), tris(dimethylamino)methane (4.5 ml), and DMF (1 ml) was stirred at 70 °C for 1 h. To this was renewedly added tris(dimethylamino)methane (1.2 ml). After 2 h, tris(dimethylamino)methane (0.5 ml) was added again and stirring was continued for 3 h. The usual workup and chromatography on silica gel with a 1:1 hexane–ethyl acetate mixture to pure ethyl acetate afforded **15a** (831 mg, 70%). Mp 118–120 °C (ether); R_f = 0.37 (ethyl acetate); IR 1680 (C=O), 1590 cm^{-1} (C=C); ^1H NMR (CDCl_3) δ 1.26 and 1.51 (s, isopropylidene CH_3), 1.33 (s, CH_3), 2.94 and 3.11 (s, $\text{N}(\text{CH}_3)_2$, 33:67 ratio), 6.67 and 7.34 (s, $=\text{CHN}(\text{CH}_3)_2$, 33:67 ratio); MS m/z 297 (M^+); UV λ_{max} (CH_3OH) 297 nm (ϵ 19800). Found: C, 59.18; H, 7.79; N, 4.92%. Calcd for $\text{C}_{14}\text{H}_{21}\text{O}_5\text{N}$: C, 59.35; H, 7.47; N, 4.92%.

(1*R**,6*R**,7*S**,8*S**)-5-(Dimethylaminomethylene)-7,8-isopropylidenedioxy-1-pentyl-3,9-dioxabicyclo[4.2.1]nonan-4-one (**15b**).

A mixture of **14b**¹⁾ (754 mg, 2.23 mmol), tris(dimethylamino)methane (2.6 ml) was stirred at 70 °C for 1 h. The reaction mixture was worked up and purified by silica gel column chromatography (1:1 hexane–ethyl acetate to ethyl acetate) to give **15b** (683 mg, 91%). Mp 117–118 °C (ether); R_f = 0.46 (ethyl acetate); IR 1680 (C=O), 1595 cm^{-1} (C=C); ^1H NMR (CDCl_3) δ 0.89 (t-like, J = 6.0 Hz, CH_3), 1.30 and 1.50 (s, isopropylidene CH_3), 2.94 and 3.13 (s, $\text{N}(\text{CH}_3)_2$, 31:69 ratio), 6.67 and 7.34 (s, $=\text{CHN}(\text{CH}_3)_2$, 31:69 ratio); MS m/z 339 (M^+); UV λ_{max} (CH_3OH) 297 nm (ϵ 18500). Found: C, 63.38; H, 8.94; N, 4.09%. Calcd for $\text{C}_{18}\text{H}_{29}\text{O}_5\text{N}$: C, 63.69; H, 8.61; N, 4.09%.

(1*R**,6*R**,7*S**,8*S**)-5-(Dimethylaminomethylene)-7,8-isopropylidenedioxy-1-phenyl-3,9-dioxabicyclo[4.2.1]nonan-4-one (**15c**).

A mixture of **14c**¹⁾ (987 mg, 3.40 mmol), tris(dimethylamino)-

methane (3.5 ml), and DMF (2 ml) was stirred at 70 °C for 1 h. Purification of the reaction mixture by silica-gel column chromatography (1:1 hexane–ethyl acetate to ethyl acetate) gave **15c** (1.08 g, 92%). Mp 233–235 °C (acetone); R_f = 0.48 (ethyl acetate); IR 1680 (C=O), 1598 cm^{-1} (C=C); ^1H NMR (CDCl_3) δ 1.30 and 1.33 (s, isopropylidene CH_3), 2.98 and 3.20 (s, $\text{N}(\text{CH}_3)_2$, 37:63 ratio), 6.80 (s, $=\text{CHN}(\text{CH}_3)_2$, *E*-isomer); MS m/z 345 (M^+); UV λ_{max} (CH_3OH) 298 nm (ϵ 18300). Found: C, 66.21; H, 6.68; N, 4.02%. Calcd for $\text{C}_{19}\text{H}_{23}\text{O}_5\text{N}$: C, 66.07; H, 6.71; N, 4.06%.

(1*R**,6*R**,7*S**,8*S**)-1-Benzoyloxymethyl-5-(dimethylaminomethylene)-7,8-isopropylidenedioxy-3,9-dioxabicyclo[4.2.1]nonan-4-one (**31**).

A mixture of **30**¹⁾ (350 mg, 1.00 mmol) and *t*-butoxybis(dimethylamino)methane (1 ml) in DMF (1 ml) was stirred at 90 °C for 30 min. Workup followed by column chromatography (1:1 hexane–ethyl acetate to pure ethyl acetate) afforded **31** (368 mg, 91%) as a white foam. R_f = 0.28 (1:2 hexane–ethyl acetate); IR 1725 and 1683 (C=O), 1590 cm^{-1} (C=C); ^1H NMR (CDCl_3) δ 1.31 and 1.50 (s, isopropylidene CH_3), 2.94 and 3.11 (s, $\text{N}(\text{CH}_3)_2$, 37:63 ratio), 6.70 (s, $=\text{CHN}(\text{CH}_3)_2$, *E*-isomer).

(1*R**,6*R**,7*R**,8*R**)-6-Benzoyloxymethyl-5-(dimethylaminomethylene)-7,8-isopropylidenedioxy-3,9-dioxabicyclo[4.2.1]nonan-4-one (**39**).

A mixture of **38**¹⁾ (696 mg, 2.0 mmol), *t*-butoxybis(dimethylamino)methane (2 ml), and DMF (1.5 ml) was stirred at 60 °C for 4 h. Chromatography on a silica-gel column using a 1:1 to 3:1 ethyl acetate–hexane mixture gave **39** (223 mg, 29%, 57% based on consumed starting material) as a white foam. R_f = 0.46 (ethyl acetate); IR 1722 and 1690 (C=O), 1600 cm^{-1} (C=C); ^1H NMR (CDCl_3) δ 1.32 and 1.51 (s, isopropylidene CH_3), 2.84 and 3.16 (s, $\text{N}(\text{CH}_3)_2$, 80:20 ratio), 6.75 (s, $=\text{CHN}(\text{CH}_3)_2$, *E*-isomer). In addition, unreacted **38** was recovered (340 mg).

(1*R**,5*Z*,6*R**,7*R**,8*S**)-5-(Dimethylaminomethylene)-1,6-dimethyl-7,8-isopropylidenedioxy-3,9-dioxabicyclo[4.2.1]nonan-4-one (**45a**).

A mixture of **44a** (7.92 g, 32.7 mmol) and tris(dimethylamino)methane (30 ml) was stirred at 90 °C for 8 h. Workup gave a solid, which was purified on a silica-gel column (1:1 hexane–ethyl acetate to pure ethyl acetate) to give **45a** (3.70 g, 38%). Mp 116–118 °C (ether); R_f = 0.41 (ethyl acetate); IR 1680 (C=O), 1595 cm^{-1} (C=C); ^1H NMR (CDCl_3) δ 1.25 and 1.47 (s, CH_3), 1.33 and 1.53 (s, isopropylidene CH_3), 2.87 (s, $\text{N}(\text{CH}_3)_2$), 3.97 (d, J = 13.0 Hz, H_{2a}), 4.16 (d, J = 13.0 Hz, H_{2b}), 4.59 (d, J = 5.9 Hz, H_7), 4.72 (d, J = 5.9 Hz, H_8), 6.79 (s, $=\text{CHN}(\text{CH}_3)_2$); ^{13}C NMR (CDCl_3) δ 17.48, 20.41, 24.69, 26.04, 44.22, 75.17, 82.15, 84.26, 84.87, 88.33, 100.57, 112.10, 149.13, 170.40. Found: C, 60.25; H, 7.87; N, 4.57%. Calcd for $\text{C}_{15}\text{H}_{23}\text{O}_5\text{N}$: C, 60.59; H, 7.80; N, 4.71%. In addition, unreacted **44a** (4.51 g) was recovered.

(1*R**,5*Z*,6*R**,7*R**,8*S**)-5-(Dimethylaminomethylene)-1,6-dipentyl-7,8-isopropylidenedioxy-3,9-dioxabicyclo[4.2.1]nonan-4-one (**45b**).

A mixture of **44b** (1.76 g, 4.97 mmol) and tris(dimethylamino)methane (5 ml) was stirred at 90 °C for 4 h. The usual workup of the reaction mixture gave an oily product, which was subjected to silica-gel chromatography with a 1:1 hexane–ethyl acetate mixture to pure ethyl acetate to afford **45b** (1.23 g, 61%) as a yellow oil. R_f = 0.39 (1:1 hexane–ethyl acetate); IR 1688 (C=O), 1601 cm^{-1} (C=C); ^1H NMR (CDCl_3) δ 0.88 (t, J = 6.0 Hz, CH_3), 1.33 and 1.51 (s, isopropylidene CH_3), 1.1–1.9 (m, CH_2), 2.84 (s, $\text{N}(\text{CH}_3)_2$), 3.88 (d, J = 13.1 Hz, H_{2a}), 4.15 (d, J = 13.1 Hz, H_{2b}), 4.52 (s, H_7 and H_8), 6.39 (s, $=\text{CHN}(\text{CH}_3)_2$); ^{13}C NMR (CDCl_3) δ 14.03, 22.41, 23.37, 24.87, 26.09, 32.44, 33.00, 35.19, 43.61, 71.50, 83.22, 85.29, 86.45, 88.98, 99.58, 112.03, 146.50, 171.43.

(1R*,6S*,7R*,8R*)-5-(Dimethylaminomethylene)-7,8-isopropylidenedioxy-7-methyl-3,9-dioxabicyclo[4.2.1]nonan-4-one (**53b**).

A mixture of **52b**¹ (1.00 g, 4.41 mmol), *t*-butoxybis(dimethylamino)methane (11 ml), and DMF (1 ml) was stirred at 70 °C for 1 h. Purification of the crude product by silica-gel chromatography (1:1 hexane-ethyl acetate to pure ethyl acetate) afforded **53b** (789 mg, 63%). Mp 137–138 °C (hexane-ethyl acetate); R_f =0.45 (ethyl acetate); IR 1672 (C=O), 1592 cm⁻¹ (C=C); ¹H NMR (CDCl₃) δ 3.44 and 3.52 (s, N(CH₃)₂, 3:2 ratio), 6.64 and 7.46 (s, =CHN-(CH₃)₂, 3:2 ratio); UV λ_{max} (CH₃OH) 300 nm (ϵ 16400). Found: C, 59.18; H, 7.41; N, 4.86%. Calcd for C₁₄H₂₁O₅N: C, 59.35; H, 7.47; N, 4.94%.

(1R*,6S*,7R*,8R*)-7-*t*-Butyldimethylsiloxymethyl-5-(dimethylaminomethylene)-7,8-isopropylidenedioxy-3,9-dioxabicyclo[4.2.1]nonan-4-one (**53a**).

A mixture of **52a**¹ (1.86 g, 5.20 mmol), *t*-butoxybis(dimethylamino)methane (14.7 ml), and DMF (1.2 ml) was stirred at 70 °C for 1 h. Usual workup followed by silica-gel chromatography (2:1 to 1:2 hexane-ethyl acetate) afforded **53a** (1.12 g, 52%). Mp 139–142 °C (hexane-ethyl acetate); R_f =0.37 (1:2 hexane-ethyl acetate); IR 1675 (C=O), 1581 cm⁻¹ (C=C); ¹H NMR (CDCl₃) δ 2.95 and 3.14 (s, N(CH₃)₂, 1:2 ratio), 6.68 and 7.50 (s, =CHN(CH₃)₂, 1:2 ratio). Found: C, 57.64; H, 8.57; N, 3.21%. Calcd for C₂₆H₃₅O₆NSi: C, 58.08; H, 8.53; N, 3.39%.

Reaction of Dimethylaminomethylene Lactones with Urea, Thiourea, and Guanidine. **General Procedure:** **Method A:** A mixture of a dimethylaminomethylene lactone, urea, and a C₂H₅ONa in C₂H₅OH solution was heated at reflux under argon until the reaction completed. The mixture was cooled to room temperature and evaporated to dryness. The resulting residue was dissolved in H₂O. After careful neutralization with diluted hydrochloric acid, the aqueous solution was extracted with ethyl acetate. The organic layer was dried over anhydrous Na₂SO₄. The organic solution was concentrated under reduced pressure (50–90 mmHg), giving a crude material. The residue was subjected to preparative TLC.

In TLC separation, silica-gel layer of the product area absorbing the 254-nm light was collected and extracted with a 1:1 chloroform-CH₃OH mixture. A sample for elemental analysis was obtained by repeated preparative TLC or recrystallization of the chromatographed product.

Method B: The reaction was carried out according to Method A. After the reaction was complete, the mixture was cooled to room temperature. The reaction mixture was evaporated and the resulting residue was taken up in water. To this was carefully added diluted hydrochloric acid until the solution was neutralized by monitoring with a pH test paper. The aqueous solution was concentrated and the resulting residue was diluted with ethanol. The insoluble material was removed by the filtration through a short column of Celite 545 and concentrated with a rotary evaporator under reduced pressure (50–90 mmHg) at 25–50 °C. The residue was subjected to preparative TLC and worked up as described above.

The same procedure was applied for the reaction using thiourea and guanidine hydrochloride instead of urea.

With Urea. 5-[(2R*,3R*,4S*,5S*)-5-(1-Hydroxy-1-methylethyl)-3,4-isopropylidenedioxytetrahydrofuran-2-yl]uracil (**8a**): A mixture of **7a** (906 mg, 3.05 mmol), urea (1.90 g, 30.5 mmol), and 2.3 mol dm⁻³ C₂H₅ONa in C₂H₅OH solution (13 ml) was stirred for 5 h. The reaction mixture was subjected to the usual workup according to Method A. Pure **8a** (438 mg, 48%) was obtained by preparative TLC (5:1 chloroform-CH₃OH). Mp 153.1–156.8 °C (CH₃OH); R_f =0.42 (7:1 chloroform-CH₃OH); ¹H NMR (C₅D₅N) δ 1.41

and 1.67 (s, isopropylidene CH₃), 1.48 and 1.53 (s, CH₃), 4.12 (d, J =3.7 Hz, H₅), 5.08 (d, J =3.7 Hz, H₂), 5.30 (m, H₃ and H₄), 7.93 (s, =CH); UV λ_{max} (CH₃OH) 263 nm (ϵ 3890), λ_{max} (0.1 mol dm⁻³ NaOH) 286 nm (ϵ 5370). Found: C, 53.96; H, 6.40; N, 9.05%. Calcd for C₁₄H₂₀O₆N₂: C, 53.84; H, 6.45; N, 8.97%.

5-[(2R*,3R*,4R*,5R*)-5-[(R*)-1-Hydroxyethyl]-3,4-isopropylidenedioxytetrahydrofuran-2-yl]uracil (**8b**): A mixture of **7b** (975 mg, 3.45 mmol), urea (2.10 g, 34.5 mmol), and 2.30 mol dm⁻³ C₂H₅ONa in C₂H₅OH (15 ml) was stirred for 5 h. After the usual workup according to Method A, the crude product was purified by preparative TLC (5:1 chloroform-CH₃OH) to afford **8b** (464 mg, 47%). Mp 264.5–266 °C (CH₃OH); R_f =0.37 (7:1 chloroform-CH₃OH); ¹H NMR (C₅D₅N) δ 1.40 and 1.66 (s, isopropylidene CH₃), 1.43 (d, J =5.2 Hz, CH₃), 4.27 (dd, J =3.0, 3.5 Hz, H₅), 4.30 (m, CHOH), 4.90 (br, OH), 5.10 (d, J =3.6 Hz, H₂), 5.30 (m, H₃ and H₄), 7.90 (s, =CH); UV λ_{max} (CH₃OH) 262 nm (ϵ 8310), λ_{max} (0.1 mol dm⁻³ NaOH) 285 nm (ϵ 7410). Found: C, 52.10; H, 5.97; N, 9.40%. Calcd for C₁₃H₁₈O₆N₂: C, 52.34; H, 6.08; N, 9.39%.

5-[(2R*,3R*,4R*,5R*)-5-[(R*)-1-Hydroxyhexyl]-3,4-isopropylidenedioxytetrahydrofuran-2-yl]uracil (**8c**): A mixture of **7c** (546 mg, 1.61 mmol), urea (981 mg, 16.1 mmol), and 1.6 mol dm⁻³ C₂H₅ONa in C₂H₅OH (10 ml) was stirred for 5 h. The usual workup according to Method A and preparative TLC (5:1 chloroform-CH₃OH) gave **8c** (197 mg, 35%). Mp 209.5–212.0 °C (acetone); R_f =0.44 (7:1 chloroform-CH₃OH); ¹H NMR (C₅D₅N) δ 0.83 (t-like, J =6.0 Hz, CH₃), 1.10–1.90 (m, CH₂), 1.42 and 1.67 (s, isopropylidene CH₃), 4.19 (m, CHOH), 4.37 (t, J =3.0 Hz, H₅), 5.10 (d, J =4.5 Hz, H₂), 5.34 (m, H₃ and H₄), 7.91 (s, =CH); UV λ_{max} (CH₃OH) 263 nm (ϵ 6760), λ_{max} (0.1 mol dm⁻³ NaOH) 286 nm (ϵ 7400). Found: C, 57.47; H, 7.35; N, 7.98%. Calcd for C₁₇H₂₆O₆N₂: C, 57.61; H, 7.40; N, 7.91%.

5-[(2R*,3R*,4R*,5S*)-5-[(S*)- α -Hydroxybenzyl]-3,4-isopropylidenedioxytetrahydrofuran-2-yl]uracil (**8d**): A mixture of **7d** (205 mg, 0.594 mmol), urea (361 mg, 5.94 mmol), and 2.0 mol dm⁻³ C₂H₅ONa in C₂H₅OH (3 ml) was stirred for 4 h. The reaction mixture was worked up according to Method A and separated by preparative TLC (5:1 ethyl acetate-hexane) to afford **8d** (90 mg, 42%). Mp 250.4–251.5 °C (CH₃OH); R_f =0.48 (7:1 chloroform-CH₃OH); ¹H NMR (C₅D₅N) δ 1.27 and 1.55 (s, isopropylidene CH₃), 4.75 (dd, J =2.2, 4.2 Hz, H₅), 5.08 (dd, J =1.9, 4.0 Hz, H₂), 5.40 (m, H₃, H₄, and CHOH), 7.30–7.80 (m, C₆H₅), 7.88 (s, =CH); UV λ_{max} (CH₃OH) 263 nm (ϵ 2390), λ_{max} (0.1 mol dm⁻³ NaOH) 285 nm (ϵ 7580). Found: C, 60.09; H, 6.02; N, 7.90%. Calcd for C₁₈H₂₀O₆N₂: C, 59.99; H, 5.59; N, 7.77%.

5-[(2R*,3S*,4S*,5R*)-5-Hydroxymethyl-3,4-isopropylidenedioxy-5-methyltetrahydrofuran-2-yl]uracil (**16a**): A mixture of **15a** (537 mg, 1.90 mmol), urea (1.14 g, 19.0 mmol), and 1.58 mol dm⁻³ C₂H₅ONa in C₂H₅OH (12 ml) was stirred for 2 h. The reaction mixture was worked up according to Method A and purified by preparative TLC (10:1 chloroform-CH₃OH) to give **16a** (175 mg, 31%). Mp 200–205 °C (CH₃OH); R_f =0.60 (5:1 chloroform-CH₃OH); ¹H NMR (dimethyl-*d*₆ sulfoxide) δ 1.16 (s, CH₃), 1.24 and 1.51 (s, isopropylidene CH₃), 3.55 (br s, CH₂OH), 4.48–4.86 (m, H₂, H₃, and H₄), 7.56 (s, =CH), 10.94 (br, NH); (C₅D₅N) δ 1.40 and 1.66 (s, isopropylidene CH₃), 1.50 (s, CH₃), 3.79 (d, J =11.0 Hz, H_aH_bCOH), 3.95 (d, J =11.0 Hz, H_aH_bCOH), 5.07 (d, J =5.5 Hz, H₄), 5.15 (d, J =6.5 Hz, H₂), 5.44 (dd, J =5.5, 6.5 Hz, H₃), 7.92 (s, =CH); ¹³C NMR (dimethyl-*d*₆ sulfoxide) δ 18.18, 25.22, 26.80, 67.19, 79.12,

82.99, 84.28, 85.13, 110.38, 112.70, 140.27, 151.07, 163.61; UV $\lambda_{\max}$ (CH₃OH) 266 nm (ϵ 7230), $\lambda_{\max}$ (0.1 mol dm⁻³ NaOH) 285 nm (ϵ 7510). Found: C, 52.03; H, 6.14; N, 9.22%. Calcd for C₁₃H₁₈O₆N₂: C, 52.34; H, 6.08; N, 9.39%.

5-[(2R*,3S*,4S*,5R*)-5-Hydroxymethyl-3,4-isopropylidenedioxy-5-pentyltetrahydrofuran-2-yl]uracil (**16b**): A mixture of **15b** (571 mg, 1.68 mmol), urea (1.01 g, 16.8 mmol), and 1.4 mol dm⁻³ C₂H₅ONa in C₂H₅OH (12 ml) was stirred for 2 h. Workup according to Method A followed by preparative TLC (10:1 chloroform-CH₃OH) gave **16b** (169 mg, 28%). Mp 219–221 °C (CH₃OH); R_f =0.72 (5:1 chloroform-CH₃OH); ¹H NMR (dimethyl-*d*₆ sulfoxide) δ 0.88 (t, J =5.7 Hz, CH₃), 1.27 and 1.49 (s, isopropylidene CH₃), 1.2–1.9 (m, CH₂), 3.36 (br s, CH₂OH), 4.55 (d, J =5.0 Hz, H₄), 4.63 (d, J =6.2 Hz, H₂), 4.78 (dd, J =5.0, 6.2 Hz, H₃), 7.55 (s, =CH), 11.03 (br, NH); (C₅D₅N) δ 0.84 (t, J =6.0 Hz, CH₃), 1.1–2.2 (m, CH₂), 1.41 and 1.67 (s, isopropylidene CH₃), 3.86 (d, J =11.3 Hz, H_aH_bCOH), 4.07 (d, J =11.3 Hz, H_aH_bCOH), 5.03 (d, J =6.0 Hz, H₄), 5.20 (d, J =6.0 Hz, H₂), 5.51 (t, J =6.0 Hz, H₃), 7.96 (s, =CH); ¹³C NMR (dimethyl-*d*₆ sulfoxide) δ 13.71, 21.92, 22.66, 25.30, 26.95, 31.31, 32.15, 64.77, 79.66, 83.68, 86.74, 90.03, 110.30, 112.41, 140.37, 151.00, 163.52; UV $\lambda_{\max}$ (CH₃OH) 264 nm (ϵ 7830), $\lambda_{\max}$ (0.1 mol dm⁻³ NaOH) 285 nm (ϵ 7930). Found: C, 54.75; H, 7.32; N, 7.45%. Calcd for C₁₇H₂₆O₆N₂·H₂O: C, 54.82; H, 7.58; N, 7.52%.

5-[(2R*,3S*,4S*,5R*)-5-Hydroxymethyl-3,4-isopropylidenedioxy-5-phenyltetrahydrofuran-2-yl]uracil (**16c**): A mixture of **15c** (43.2 mg, 0.125 mmol), urea (75 mg, 1.25 mmol), and 0.83 mol dm⁻³ C₂H₅ONa in C₂H₅OH (1.5 ml, 1.25 mmol) was stirred for 2 h. Workup according to Method A gave an oil, which was purified by preparative TLC (5:1 chloroform-CH₃OH) to give **16c** (13.0 mg, 29%). Mp 282–285 °C (CH₃OH); R_f =0.62 (5:1 chloroform-CH₃OH); ¹H NMR (dimethyl-*d*₆ sulfoxide) δ 1.02 and 1.21 (s, isopropylidene CH₃), 3.50 (m, CH₂OH), 4.78 (d, J =5.1 Hz, H₂), 4.84 (m, H₃), 5.08 (d, J =5.1 Hz, H₄), 7.32 (m, C₆H₅), 7.77 (s, =CH), 11.20 (br, NH); (C₅D₅N) δ 1.24 and 1.35 (s, isopropylidene CH₃), 4.01 (d, J =6.8 Hz, H_aH_bCOH), 4.24 (d, J =6.8 Hz, H_aH_bCOH), 5.20 (m, H₃), 5.62 (m, H₂ and H₄), 7.2–7.8 (m, C₆H₅), 8.13 (s, =CH); ¹³C NMR (dimethyl-*d*₆ sulfoxide) δ 25.59, 26.72, 68.29, 80.40, 83.38, 83.81, 89.50, 109.64, 112.51, 126.43, 127.24, 139.90, 141.34, 151.01, 164.00; UV $\lambda_{\max}$ (CH₃OH) 263 nm (ϵ 7990), $\lambda_{\max}$ (0.1 mol dm⁻³ NaOH) 285 nm (ϵ 7640). Found: C, 59.62; H, 5.50; N, 7.64%. Calcd for C₁₈H₂₀O₆N₂: C, 59.99; H, 5.59; N, 7.77%.

5-[(2R*,3R*,4R*,5R*)-5-Hydroxymethyl-3,4-isopropylidenedioxy-2-methyltetrahydrofuran-2-yl]uracil (**24a**): A mixture of **22a** (619 mg, 2.72 mmol), and *t*-butoxybis(dimethylamino)-methane (2.8 ml) was stirred at 90 °C for 5 h under argon. The resulting solution was evaporated to give (1R*,6S*,7R*,8R*)-5-(dimethylaminomethylene)-7,8-isopropylidenedioxy-6-methyl-3,9-dioxabicyclo[4.2.1]nonan-4-one (**23a**) as a brown oil, which was used to the next step without purification. A mixture of crude **23a**, urea (2.45 g, 40.9 mmol), and 2 mol dm⁻³ C₂H₅ONa in C₂H₅OH (20 ml) was stirred. After 2 h, the reaction mixture was worked up according to Method A to give a brown solid, which was purified by preparative TLC (10:1 chloroform-CH₃OH) to give **24a** (54.2 mg, 7% based on **22a**) as a yellow foam. R_f =0.42 (5:1 chloroform-CH₃OH); ¹H NMR (C₅D₅N) δ 1.39 and 1.65 (s, isopropylidene CH₃), 1.94 (s, CH₃), 4.02 (m, CH₂OH), 4.56 (m, H₅), 5.00 (dd, J =4.1, 6.2 Hz, H₄), 5.31 (d, J =6.2 Hz, H₃), 8.19 (s, =CH); UV $\lambda_{\max}$ (CH₃OH)

263 nm (ϵ 8450), $\lambda_{\max}$ (0.1 mol dm⁻³ NaOH) 288 nm (ϵ 10790). Found: m/z , 298.1156. Calcd for C₁₃H₁₈O₆N₂: M, 298.1149.

5-[(2R*,3R*,4R*,5R*)-5-Hydroxymethyl-3,4-isopropylidenedioxy-2-pentyltetrahydrofuran-2-yl]uracil (**24b**): A mixture of **23b** prepared from **22b** (963 mg, 3.39 mmol) and *t*-butoxybis(dimethylamino)methane (3.4 ml), urea (2.03 g, 33.9 mmol), and 2.26 mol dm⁻³ C₂H₅ONa in C₂H₅OH (15 ml) was stirred for 2 h. Workup according to Method A and preparative TLC (7:1 chloroform-CH₃OH) afforded **24b** (45.8 mg, 4% based on **22b**) as a yellow foam. R_f =0.43 (5:1 chloroform-CH₃OH); ¹H NMR (dimethyl-*d*₆ sulfoxide) δ 0.81 (t, J =6.0 Hz, CH₃), 1.0–1.7 (m, CH₂), 1.28 and 1.46 (s, isopropylidene CH₃), 3.44 (m, CH₂OH), 3.89 (m, H₅), 4.50 (dd, J =4.3, 5.8 Hz, H₄), 4.72 (d, J =5.8 Hz, H₃), 7.44 (s, =CH); UV $\lambda_{\max}$ (CH₃OH) 264 nm (ϵ 7930), $\lambda_{\max}$ (0.1 mol dm⁻³ NaOH) 289 nm (ϵ 5670). Found: m/z , 336.1731. Calcd for C₁₇H₂₄O₆N₂: (M-H₂O), 336.1777.

5-[(2R*,3S*,4S*)-5,5-Bis(hydroxymethyl)-3,4-isopropylidenedioxytetrahydrofuran-2-yl]uracil (**32**): A mixture of **31** (594 mg, 1.47 mmol), urea (442 mg, 7.37 mmol), and 1 mol dm⁻³ C₂H₅ONa in C₂H₅OH (7 ml) was stirred for 5 h. After workup according to Method B, the residue was subjected to preparative TLC (5:1 chloroform-CH₃OH) to afford **32** (164 mg, 39%) as a white foam. R_f =0.37 (3:1 chloroform-CH₃OH); ¹H NMR (dimethyl-*d*₆ sulfoxide) δ 1.23 and 1.46 (s, isopropylidene CH₃), 3.50 (m, CH₂OH), 4.53–4.86 (m, H₂, H₃, and H₄), 7.51 (s, =CH); ¹³C NMR (dimethyl-*d*₆ sulfoxide) δ 25.11, 26.86, 60.39, 63.19, 79.81, 82.87, 84.00, 86.76, 110.19, 112.54, 140.54, 151.05, 163.55; UV $\lambda_{\max}$ (CH₃OH) 263 nm (ϵ 4910), $\lambda_{\max}$ (0.1 mol dm⁻³ NaOH) 284 nm (ϵ 4670). Found: m/z , 299.0879. Calcd for C₁₂H₁₅O₇N₂: (M-CH₃), 299.0880.

5-[(2R*,3R*,4S*,5R*)-2,5-Dimethyl-5-hydroxymethyl-3,4-isopropylidenedioxytetrahydrofuran-2-yl]uracil (**46a**): A mixture of **45a** (118 mg, 0.397 mmol), urea (119 mg, 1.99 mmol), and 1 mol dm⁻³ C₂H₅ONa in C₂H₅OH (2 ml) was stirred for 24 h. The workup of the reaction product according to Method A gave an oil, which was subjected to preparative TLC (8:1 chloroform-CH₃OH) to afford **46a** (35.1 mg, 28%) as a white foam. Mp 126–134 °C (CH₃OH); R_f =0.51 (5:1 chloroform-CH₃OH); ¹H NMR (dimethyl-*d*₆ sulfoxide) δ 1.18 and 1.28 (s, CH₃), 1.28 and 1.50 (s, isopropylidene CH₃), 3.19 (m, CH₂OH), 4.45 (d, J =6.2 Hz, H₂), 4.82 (d, J =6.2 Hz, H₄), 4.95 (br, OH), 7.47 (s, =CH), 10.80 (br, NH); (C₅D₅N) δ 1.42 and 1.70 (s, isopropylidene CH₃), 1.70 and 1.92 (s, CH₃), 3.78 (s, CH₂OH), 4.85 (d, J =6.2 Hz, H₃), 5.46 (d, J =6.2 Hz, H₄), 8.32 (br s, =CH), 12.45 (br, NH), 13.04 (br, NH); ¹³C NMR (dimethyl-*d*₆ sulfoxide) δ 19.65, 24.41, 24.94, 25.59, 66.30, 82.95, 83.12, 84.71, 85.18, 111.36, 117.30, 138.01, 151.48, 163.18; UV $\lambda_{\max}$ (CH₃OH) 264 nm (ϵ 6680), $\lambda_{\max}$ (0.1 mol dm⁻³ NaOH) 217 nm (ϵ 10070), 287 (7610). Found: C, 53.29; H, 6.61; N, 8.24%. Calcd for C₁₄H₂₀O₆N₂: C, 53.84; H, 6.45; N, 8.97%.

5-[(2R*,3R*,4S*,5R*)-2,5-Dipentyl-5-hydroxymethyl-3,4-isopropylidenedioxytetrahydrofuran-2-yl]uracil (**46b**): A mixture of **45b** (2.00 g, 4.89 mmol), urea (2.93 g, 48.9 mmol), and 1 mol dm⁻³ C₂H₅ONa in C₂H₅OH (49 ml) was stirred for 5 h. The reaction mixture was worked up according to Method A and the crude product was purified by preparative TLC (8:1 chloroform-CH₃OH) to give **46b** (472 mg, 23%) as a white foam. Mp >250 °C (CH₃OH); R_f =0.53 (10:1 chloroform-CH₃OH); ¹H NMR (dimethyl-*d*₆ sulfoxide) δ 0.84 (m, CH₃), 1.0–1.7 (m, CH₂), 1.26 and 1.46 (s, isopropylidene CH₃), 3.22 (m, CH₂OH), 4.47 (d, J =6.6 Hz, H₃), 4.63 (br, OH), 4.77 (d, J =6.6 Hz, H₄), 7.37 (s, =CH),

10.82 (br, NH); ^{13}C NMR (dimethyl- d_6 sulfoxide) δ 13.66, 21.96, 22.93, 31.73, 32.15, 24.44, 25.35, 63.89, 83.49, 84.90, 86.17, 111.16, 114.96, 138.88, 151.47, 162.89; UV λ_{max} (CH_3OH) 265 nm (ϵ 5820), λ_{max} (0.1 mol dm $^{-3}$ NaOH) 289 nm (ϵ 4240). Found: C, 62.02; H, 8.57; N, 6.33%. Calcd for $\text{C}_{22}\text{H}_{36}\text{O}_6\text{N}_2$: C, 62.24; H, 8.55; N, 6.60%.

5-[(2S*,3R*,4R*,5R*)-3-*t*-Butyldimethylsiloxymethyl-5-hydroxymethyl-3,4-isopropylidenedioxytetrahydrofuran-2-yl]uracil (**54a**): A mixture of **53a** (1.18 g, 2.86 mmol), urea (1.20 g, 8.58 mmol), and 0.41 mol dm $^{-3}$ $\text{C}_2\text{H}_5\text{ONa}$ in $\text{C}_2\text{H}_5\text{OH}$ (21 ml) was stirred for 3 h. Workup according to Method B and preparative TLC (10:1 chloroform- CH_3OH) afforded **54a** (246 mg, 20%). Mp 238–242 °C (CH_3OH -acetone-petroleum ether); R_f =0.27 (10:1 chloroform- CH_3OH); ^1H NMR (dimethyl- d_6 sulfoxide) δ 0.06 (s, $t\text{-C}_4\text{H}_9(\text{CH}_3)_2\text{Si}$), 0.84 (s, $t\text{-C}_4\text{H}_9(\text{CH}_3)_2\text{Si}$), 1.33 and 1.51 (s, isopropylidene CH_3), 3.49 (s, CH_2OSi), 3.57 (m, CH_2OH), 3.96 (m, H_5), 4.52 (d, J =2.8 Hz, H_4), 4.82 (s, H_2), 7.34 (br, =CH), 10.86 (br, NH), 11.02 (br s, NH); ^{13}C NMR (dimethyl- d_6 sulfoxide) δ 17.74, 25.49, 26.84, 28.31, 61.01, 61.60, 80.44, 82.73, 83.02, 91.54, 107.86, 113.08, 138.68, 150.78, 162.56; UV λ_{max} (CH_3OH) 266 nm (ϵ 7150), λ_{max} (0.1 mol dm $^{-3}$ NaOH) 289 nm (ϵ 6150). Found: C, 53.40; H, 7.54; N, 6.78%. Calcd for $\text{C}_{19}\text{H}_{32}\text{N}_2\text{O}_7\text{Si}$: C, 53.25; H, 7.53; N, 6.54%.

5-[(2S*,3R*,4R*,5R*)-5-Hydroxymethyl-3,4-isopropylidenedioxy-3-methyltetrahydrofuran-2-yl]uracil (**54b**): A mixture of **53b** (730 mg, 2.58 mmol), urea (1.08 g, 8.1 mmol), and 0.9 mol dm $^{-3}$ $\text{C}_2\text{H}_5\text{ONa}$ in $\text{C}_2\text{H}_5\text{OH}$ (20 ml, 18 mmol) was stirred for 3 h. Workup according to Method B followed by preparative TLC (4:1 chloroform- CH_3OH) gave **54b** (245 mg, 32%). Mp 126–128 °C; R_f =0.50 (4:1 chloroform- CH_3OH); ^1H NMR (dimethyl- d_6 sulfoxide) δ 1.12 (s, CH_3), 1.32 and 1.51 (s, isopropylidene CH_3), 3.52 (d-like, J =4.0 Hz, CH_2OH), 3.92 (m, H_5), 4.30 (d, J =3.0 Hz, H_4), 4.80 (s, H_2), 7.34 (s, =CH); ^{13}C NMR (dimethyl- d_6 sulfoxide) δ 20.37, 27.16, 28.38, 61.53, 81.39, 82.68, 87.28, 89.36, 109.17, 112.79, 139.33, 151.13, 162.89; UV λ_{max} (CH_3OH) 265 nm (ϵ 7430), λ_{max} (0.1 mol dm $^{-3}$ NaOH) 289 nm (ϵ 7750). Found: m/z , 283.0939. Calcd for $\text{C}_{12}\text{H}_{15}\text{N}_2\text{O}_6$: (M- CH_3), 283.0930.

With Thiourea. 5-[(2R*,3R*,4S*,5S*)-5-(1-Hydroxy-1-methylethyl)-3,4-isopropylidenedioxytetrahydrofuran-2-yl]-2-thiouracil (**10a**): A mixture of **7a** (423 mg, 1.42 mmol), thiourea (868 mg, 9.94 mmol), and 1.14 mol dm $^{-3}$ $\text{C}_2\text{H}_5\text{ONa}$ in $\text{C}_2\text{H}_5\text{OH}$ (10 ml) was stirred for 5 h. The reaction mixture was worked up according to Method A. Pure **10a** (332 mg, 71%) was obtained by preparative TLC (5:1 chloroform- CH_3OH). Mp 161.0–162.0 °C (ethyl acetate); ^1H NMR (acetone- d_6) δ 1.20 (s, CH_3), 1.32 and 1.51 (s, isopropylidene CH_3), 3.79 (d, J =3.1 Hz, H_5), 4.68 (dd, J =3.3, 4.5 Hz, H_3), 4.80 (d, J =3.3 Hz, H_2), 4.82 (dd, J =3.1, 4.5 Hz, H_4), 7.71 (s, =CH); UV λ_{max} (CH_3OH) 213 nm (ϵ 11100), 276 (13800), 290 (13000), λ_{max} (0.1 mol dm $^{-3}$ NaOH) 222 nm (ϵ 14700), 264 (12000), 285 (9490). Found: C, 48.07; H, 6.29; N, 8.00%. Calcd for $\text{C}_{14}\text{H}_{20}\text{O}_5\text{N}_2\text{S}\cdot 1.2\text{H}_2\text{O}$: C, 48.04; H, 6.45; N, 8.00%.

5-[(2R*,3R*,4R*,5R*)-5-[(R*)-1-Hydroxyethyl]-3,4-isopropylidenedioxytetrahydrofuran-2-yl]-2-thiouracil (**10b**): A mixture of **7b** (305 mg, 1.08 mmol), thiourea (660 mg, 8.64 mmol), and 1.23 mol dm $^{-3}$ $\text{C}_2\text{H}_5\text{ONa}$ in $\text{C}_2\text{H}_5\text{OH}$ (7 ml) was stirred for 5 h. The reaction mixture was subjected to the Method A workup and preparative TLC (7:1 chloroform- CH_3OH) afforded **10b** (277 mg, 82%). Mp 201.2–202.5 °C (ether- CH_3OH); ^1H NMR (acetone- d_6) δ 1.19 (d, J =7.0 Hz, CH_3), 1.32 and 1.52 (s, isopropylidene CH_3), 3.87 (m, H_5 and HCOH), 4.66 (d, J =4.2 Hz, H_2), 4.82

(m, H_3 and H_4), 7.66 (s, =CH); UV λ_{max} (CH_3OH) 213 nm (ϵ 12500), 274 (14400), 286 (13100), λ_{max} (0.1 mol dm $^{-3}$ NaOH) 223 nm (ϵ 16220), 264 (15140), 284 (11480). Found: C, 49.06; H, 5.85; N, 8.44%. Calcd for $\text{C}_{13}\text{H}_{18}\text{O}_5\text{N}_2\text{S}$: C, 49.67; H, 5.77; N, 8.91%.

5-[(2R*,3R*,4R*,5R*)-5-[(R*)-1-Hydroxyhexyl]-3,4-isopropylidenedioxytetrahydrofuran-2-yl]-2-thiouracil (**10c**): A mixture of **7c** (491 mg, 1.45 mmol), thiourea (776 mg, 10.2 mmol), and 1.16 mol dm $^{-3}$ $\text{C}_2\text{H}_5\text{ONa}$ in $\text{C}_2\text{H}_5\text{OH}$ (10 ml) was stirred for 5 h. After the Method A workup, the crude product was purified by preparative TLC (7:1 chloroform- CH_3OH) to give **10c** (365 mg, 68%). Mp 203.0–204.5 °C (ether); ^1H NMR (acetone- d_6) δ 0.91 (t, J =6.0 Hz, CH_3), 1.10–1.70 (m, CH_2), 1.31 and 1.51 (s, isopropylidene CH_3), 3.76 (m, HCOH), 3.95 (dd, J =3.1, 6.1 Hz, H_5), 4.65 (d, J =4.1 Hz, H_2), 4.86 (m, H_3 and H_4), 7.67 (s, =CH), 11.23 (br, NH); UV λ_{max} (CH_3OH) 214 nm (ϵ 12880), 276 (15850), 291 (14800), λ_{max} (0.1 mol dm $^{-3}$ NaOH) 222 nm (ϵ 16990), 264 (13490), 283 (10960). Found: C, 54.56; H, 7.04; N, 7.39; S, 8.68%. Calcd for $\text{C}_{17}\text{H}_{26}\text{O}_5\text{N}_2\text{S}\cdot 0.25\text{H}_2\text{O}$: C, 54.45; H, 7.12; N, 7.46; S, 8.55%.

5-[(2R*,3R*,4R*,5S*)-5-[(S*)- α -Hydroxybenzyl]-3,4-isopropylidenedioxytetrahydrofuran-2-yl]-2-thiouracil (**10d**): A mixture of **7d** (74 mg, 0.214 mmol), thiourea (115 mg, 1.50 mmol), and 0.85 mol dm $^{-3}$ $\text{C}_2\text{H}_5\text{ONa}$ in $\text{C}_2\text{H}_5\text{OH}$ (2 ml) was stirred. After stirring for 5 h, the workup according to Method A and preparative TLC (5:1 chloroform- CH_3OH) afforded **10d** (59 mg, 73%). Mp 240–241 °C; ^1H NMR ($\text{C}_5\text{D}_5\text{N}$) δ 1.29 and 1.55 (s, isopropylidene CH_3), 4.75 (dd, J =3.9, 5.0 Hz, H_5), 5.17 (d, J =4.0 Hz, H_2), 5.38 (m, H_3 , H_4 , and HCOH), 7.3–7.9 (m, C_6H_5), 7.94 (s, =CH); UV λ_{max} (CH_3OH) 276 nm (ϵ 7940), 289 (7240), λ_{max} (0.1 mol dm $^{-3}$ NaOH) 264 nm (ϵ 10970), 280 (8510). Found: C, 50.29; H, 5.57; N, 6.36%. Calcd for $\text{C}_{18}\text{H}_{20}\text{O}_5\text{N}_2\text{S}\cdot 3\text{H}_2\text{O}$: C, 50.22; H, 6.09; N, 6.51%.

5-[(2R*,3S*,4S*,5R*)-5-Hydroxymethyl-3,4-isopropylidenedioxy-5-methyltetrahydrofuran-2-yl]-2-thiouracil (**18a**): A mixture of **15a** (284 mg, 1.00 mmol), thiourea (532 mg, 7.0 mmol), and 1.4 mol dm $^{-3}$ $\text{C}_2\text{H}_5\text{ONa}$ in $\text{C}_2\text{H}_5\text{OH}$ (5 ml) was stirred for 2 h. The Method A workup and preparative TLC (5:1 chloroform- CH_3OH) gave **18a** (248 mg, 79%) as a yellow foam. R_f =0.67 (5:1 chloroform- CH_3OH); ^1H NMR (dimethyl- d_6 sulfoxide) δ 1.17 (s, CH_3), 1.28 and 1.50 (s, isopropylidene CH_3), 3.35 (br s, CH_2OH), 4.54–4.86 (m, H_2 , H_3 , and H_4), 7.56 (s, =CH); ($\text{C}_5\text{D}_5\text{N}$) δ 1.40 and 1.65 (s, isopropylidene CH_3), 1.55 (s, CH_3), 3.77 (d, J =11.5 Hz, $\text{H}_5\text{H}_b\text{COH}$), 3.93 (d, J =11.5 Hz, $\text{H}_5\text{H}_b\text{COH}$), 5.09 (d, J =6.0 Hz, H_4), 5.17 (d, J =5.0 Hz, H_2), 5.36 (dd, J =5.0, 6.0 Hz, H_3), 8.05 (s, =CH); ^{13}C NMR (dimethyl- d_6 sulfoxide) δ 18.20, 25.21, 26.70, 67.06, 78.93, 82.97, 84.56, 85.64, 112.69, 116.16, 139.44, 160.57, 175.38; UV λ_{max} (CH_3OH) 215 nm (ϵ 9490), 276 (14390), 290 (13190), λ_{max} (0.1 mol dm $^{-3}$ NaOH) 223 nm (ϵ 9640), 264 (8700), 289 (6740). Found: C, 47.89; H, 5.67; N, 8.40%. Calcd for $\text{C}_{13}\text{H}_{18}\text{O}_5\text{N}_2\text{S}\cdot 0.7\text{H}_2\text{O}$: C, 47.75; H, 5.98; N, 8.57%.

5-[(2R*,3S*,4S*,5R*)-5-Hydroxymethyl-3,4-isopropylidenedioxy-5-pentyltetrahydrofuran-2-yl]-2-thiouracil (**18b**): A mixture of **15b** (330 mg, 0.973 mmol), thiourea (517 mg, 6.81 mmol), and 0.85 mol dm $^{-3}$ $\text{C}_2\text{H}_5\text{ONa}$ in $\text{C}_2\text{H}_5\text{OH}$ (8 ml) was stirred for 2 h. The reaction mixture was worked up according to Method A. Preparative TLC (10:1 chloroform- CH_3OH) gave **18b** (247 mg, 69%). Mp 181–183 °C (ether); R_f =0.64 (5:1 chloroform- CH_3OH); ^1H NMR (dimethyl- d_6 sulfoxide) δ 0.89 (t, J =5.7 Hz, CH_3), 1.28 and 1.50 (s, isopropylidene CH_3), 1.1–1.7 (m, CH_2), 3.38 (br s, CH_2OH), 4.56–4.94 (m, H_2 , H_3 , and H_4), 7.55 (s, =CH), 12.40 (br, NH); ($\text{C}_5\text{D}_5\text{N}$) δ 0.89 (t, J =6.0 Hz, CH_3),

1.2—2.2 (m, CH₂), 1.45 and 1.70 (s, isopropylidene CH₃), 3.90 (d, $J=11.2$ Hz, H_aH_bCOH), 4.06 (d, $J=11.2$ Hz, H_aH_bCOH), 5.16 (d, $J=6.0$ Hz, H₄), 5.18 (d, $J=5.0$ Hz, H₂), 5.46 (dd, $J=5.0, 6.0$ Hz, H₃), 8.14 (s, =CH); ¹³C NMR (dimethyl-*d*₆ sulfoxide) δ 13.80, 21.93, 22.78, 25.42, 27.30, 31.67, 32.15, 65.62, 81.68, 82.99, 83.87, 86.52, 111.67, 112.39, 154.54, 156.20, 163.03; UV λ_{max} (CH₃OH) 213 nm (ϵ 13640), 276 (17330), 290 (sh, 15820), λ_{max} (0.1 mol dm⁻³ NaOH) 220 nm (ϵ 17230), 264 (13530), 282 (sh, 10910). Found: C, 55.06; H, 7.24; N, 7.56; S, 8.70%. Calcd for C₁₇H₂₆O₅N₂S: C, 55.12; H, 7.07; N, 7.56; S, 8.65%.

5-[(2R*,3S*,4S*,5R*)-5-Hydroxymethyl-3,4-isopropylidenedioxy-5-phenyltetrahydrofuran-2-yl]-2-thiouracil (**18c**): A mixture of **15c** (36.8 mg, 0.107 mmol), thiourea (57 mg, 0.749 mmol), and 0.38 mol dm⁻³ C₂H₅ONa in C₂H₅OH (2 ml) was stirred for 2 h. The reaction mixture was worked up according to Method A. Preparative TLC (5:1 chloroform-CH₃OH) afforded **18c** (23.5 mg, 58%). Mp 210—213 °C; $R_f=0.64$ (5:1 chloroform-CH₃OH); ¹H NMR (dimethyl-*d*₆ sulfoxide) δ 1.01 and 1.21 (s, isopropylidene CH₃), 3.45 (d, $J=11.1$ Hz, H_aH_bCOH), 3.72 (d, $J=11.1$ Hz, H_aH_bCOH), 4.86 (m, H₂ and H₃), 5.05 (m, H₄), 7.33 (m, C₆H₅), 7.76 (s, =CH); (C₅D₅N) δ 1.20 and 1.34 (s, isopropylidene CH₃), 4.04 (d, $J=12.0$ Hz, H_aH_bCOH), 4.25 (d, $J=12.0$ Hz, H_aH_bCOH), 5.36 (m, H₃), 5.60 (m, H₂ and H₄), 7.2—7.9 (m, C₆H₅), 8.30 (s, =CH); ¹³C NMR (dimethyl-*d*₆ sulfoxide) δ 25.42, 26.47, 67.94, 80.05, 83.23, 83.92, 89.72, 112.35, 114.97, 126.31, 126.65, 127.09, 139.62, 141.23, 160.83, 175.59; UV λ_{max} (CH₃OH) 275 nm (ϵ 12780), 291 (sh, 11250), λ_{max} (0.1 mol dm⁻³ NaOH) 264 nm (ϵ 11530), 281 (sh, 9880). Found: C, 53.98; H, 5.78; N, 6.62; S, 7.70%. Calcd for C₁₈H₂₀O₅N₂S·1.2H₂O: C, 54.31; H, 5.67; N, 7.04; S, 8.06%.

5-[(2R*,3R*,4R*,5R*)-5-Hydroxymethyl-3,4-isopropylidenedioxy-2-methyltetrahydrofuran-2-yl]-2-thiouracil (**26a**): A mixture of **23a** obtained from 1.03 g (4.50 mmol) of **22a** and *t*-butoxybis(dimethylamino)methane (4.5 ml) as described above and thiourea (2.39 g, 31.5 mmol) in 1 mol dm⁻³ C₂H₅ONa in C₂H₅OH (31.5 ml) was stirred for 2 h. Workup according to Method A followed by column chromatography (20:1 to 15:1 chloroform-CH₃OH) afforded **26a** (268 mg, 20% based on **22a**) as a yellow foam. $R_f=0.60$ (5:1 chloroform-CH₃OH); ¹H NMR (C₅D₅N) δ 1.95 (s, CH₃), 1.42 and 1.66 (s, isopropylidene CH₃), 3.90 (dd, $J=5.0, 11.0$ Hz, H_aH_bCOH), 4.07 (dd, $J=4.0, 11.0$ Hz, H_aH_bCOH), 4.59 (ddd, $J=4.0, 4.0, 5.0$ Hz, H₃), 4.99 (dd, $J=4.0, 6.0$ Hz, H₄), 5.27 (d, $J=6.0$ Hz, H₂), 8.29 (s, =CH); UV λ_{max} (CH₃OH) 214 nm (ϵ 9540), 275 (12850), 290 (11920), λ_{max} (0.1 mol dm⁻³ NaOH) 223 nm (ϵ 11880), 261 (11680), 292 (6800). Found: m/z , 314.0930. Calcd for C₁₃H₁₈N₂O₅S: M, 314.0936.

5-[(2R*,3R*,4R*,5R*)-5-Hydroxymethyl-3,4-isopropylidenedioxy-2-pentyltetrahydrofuran-2-yl]-2-thiouracil (**26b**): A mixture of **23b** obtained from **22b** (577 mg, 2.03 mmol) and *t*-butoxybis(dimethylamino)methane (3 ml), thiourea (1.08 g, 14.2 mmol), and 2.0 mol dm⁻³ C₂H₅ONa in C₂H₅OH (7 ml) was stirred for 2 h. Workup according to Method A followed by column chromatography (30:1 to 20:1 chloroform-CH₃OH) gave **26b** (88.1 mg, 12% based on **22b**) as a foam. $R_f=0.62$ (5:1 chloroform-CH₃OH); ¹H NMR (dimethyl-*d*₆ sulfoxide) δ 0.80 (t, $J=6.5$ Hz, CH₃), 1.0—1.8 (m, CH₂), 1.25 and 1.45 (s, isopropylidene CH₃), 3.91 (m, H₅), 4.50 (dd, $J=4.5, 6.0$ Hz, H₄), 4.70 (d, $J=6.0$ Hz, H₃), 7.40 (s, =CH), CH₂OH peaks obscured by H₂O peak; UV λ_{max} (CH₃OH) 214 nm (ϵ 9430), 276 (13690), 289 (12700), λ_{max} (0.1 mol dm⁻³ NaOH) 232 nm (ϵ 13400), 261 (16840), 303 (8480). Found: C, 53.19; H, 6.90; N, 7.50%.

Calcd for C₁₇H₂₆O₅N₂S·H₂O: C, 52.56; H, 7.26; N, 7.21%. 5-[(2R*,3S*,4S*)-5,5-Bis(hydroxymethyl)-3,4-isopropylidenedioxytetrahydrofuran-2-yl]-2-thiouracil (**34**).

A mixture of **31** (337 mg, 0.84 mmol), thiourea (447 mg, 5.88 mmol), and 1 mol dm⁻³ C₂H₅ONa in C₂H₅OH (6 ml) was stirred for 3 h. The Method B workup gave a solid, which was purified by preparative TLC (5:1 chloroform-CH₃OH) to give **34** (160 mg, 63%) as a white foam. $R_f=0.39$ (5:1 chloroform-CH₃OH); ¹H NMR (dimethyl-*d*₆ sulfoxide) δ 1.24 and 1.46 (s, isopropylidene CH₃), 3.50 (d-like, $J=7.5$ Hz, CH₂OH), 4.67 (m, H₂, H₃, and H₄), 5.5—8.0 (br, HN and OH), 7.56 (s, =CH); ¹³C NMR (dimethyl-*d*₆ sulfoxide) δ 25.11, 26.84, 60.42, 63.07, 79.80, 82.85, 84.25, 87.23, 127.89, 140.77, 160.68; UV λ_{max} (CH₃OH) 276 nm (ϵ 12770), 297 (11540), λ_{max} (0.1 mol dm⁻³ NaOH) 213 nm (ϵ 11320), 265 (9060), 292 (7320). Found: m/z , 330.0890. Calcd for C₁₃H₁₈O₆-N₂S: M, 330.0884.

5-[(2R*,3R*,4R*,5R*)-2,5-Bis(hydroxymethyl)-3,4-isopropylidenedioxytetrahydrofuran-2-yl]-2-thiouracil (**40**): A mixture of **39** (220 mg, 0.57 mmol), thiourea (303 mg, 3.99 mmol), and 1 mol dm⁻³ C₂H₅ONa in C₂H₅OH (5 ml) was stirred for 3 h. The reaction mixture was worked up according to Method B to give a yellow solid, which was purified by preparative TLC (5:1 chloroform-CH₃OH) to afford **40** (93.0 mg, 51%) as a white foam. $R_f=0.50$ (5:1 chloroform-CH₃OH); ¹H NMR (dimethyl-*d*₆ sulfoxide) δ 1.26 and 1.48 (s, isopropylidene CH₃), 3.3—3.8 (br, OH), 3.52 (d-like, $J=7.5$ Hz, CH₂OH), 4.56—4.88 (m, H₃, H₄, and H₅), 7.52 (s, =CH); UV λ_{max} (CH₃OH) 214 nm (ϵ 8780), 276 (11350), 293 (10040), λ_{max} (0.1 mol dm⁻³ NaOH) 223 nm (ϵ 12910), 264 (8430), 289 (7080). Found: C, 44.63; H, 5.54; N, 8.00%. Calcd for C₁₃H₁₈O₇N₂S: C, 45.08; H, 5.24; N, 8.09%.

5-[(2R*,3R*,4S*,5R*)-2,5-Dimethyl-5-hydroxymethyl-3,4-isopropylidenedioxytetrahydrofuran-2-yl]-2-thiouracil (**48a**): A mixture of **45a** (621 mg, 2.09 mmol), thiourea (1.11 g, 14.6 mmol), and 1 mol dm⁻³ C₂H₅ONa in C₂H₅OH (14 ml) was stirred for 5 h. After workup according to Method A, the residue was subjected to preparative TLC (8:1 chloroform-CH₃OH) to give **48a** (426 mg, 61%). Mp 90—95 °C (CH₃OH); $R_f=0.67$ (5:1 chloroform-CH₃OH); ¹H NMR (dimethyl-*d*₆ sulfoxide) δ 1.20 and 1.30 (s, CH₃), 1.30 and 1.50 (s, isopropylidene CH₃), 3.22 (m, CH₂OH), 4.46 (d, $J=6.2$ Hz, H₃), 4.83 (d, $J=6.2$ Hz, H₄), 4.96 (t-like, $J=4.2$ Hz, OH), 7.49 (s, =CH), 12.16 and 12.34 (br, NH); (C₅D₅N) δ 1.42 and 1.70 (s, isopropylidene CH₃), 1.70 and 1.84 (s, CH₃), 3.72 (br s, CH₂OH), 4.77 (d, $J=6.2$ Hz, H₃), 5.37 (d, $J=6.2$ Hz, H₄), 8.41 (s, =CH); ¹³C NMR (dimethyl-*d*₆ sulfoxide) δ 19.47, 24.41, 24.59, 25.59, 66.18, 83.00, 83.12, 84.89, 111.36, 122.89, 137.78, 160.25, 175.13; UV λ_{max} (CH₃OH) 215 nm (ϵ 12560), 276 (16180), 290 (14820), λ_{max} (0.1 mol dm⁻³ NaOH) 223 nm (ϵ 14860), 261 (14270), 292 (8650). Found: C, 51.02; H, 6.24; N, 8.67; S, 9.60%. Calcd for C₁₄H₂₀O₅N₂S: C, 51.21; H, 6.14; N, 8.53; S, 9.76%.

5-[(2R*,3R*,4S*,5R*)-2,5-Dipentyl-5-hydroxymethyl-3,4-isopropylidenedioxytetrahydrofuran-2-yl]-2-thiouracil (**48b**): A mixture of **45b** (1.23 g, 2.80 mmol), thiourea (1.49 g, 19.6 mmol), and 1 mol dm⁻³ C₂H₅ONa in C₂H₅OH (20 ml) was stirred. After 5 h, the reaction mixture was worked up according to Method A and the crude product was purified by preparative TLC (10:1 chloroform-CH₃OH) to give **48b** (798 mg, 64%). Mp 207—210 °C (CH₃OH); $R_f=0.47$ (10:1 chloroform-CH₃OH); ¹H NMR (C₅D₅N) δ 0.84 (m, CH₃), 1.1—1.7 (m, CH₂, 14H), 1.44 and 1.74 (s, isopropylidene CH₃), 2.1—2.3 (m, CH₂, 2H), 3.73 (d, $J=12.2$ Hz, H_aH_bCOH), 3.94 (d, $J=12.2$ Hz, H_aH_bCOH), 4.81

(d, $J=6.5$ Hz, H_3), 5.37 (d, $J=6.5$ Hz, H_4), 8.51 (s, =CH); ^{13}C NMR (dimethyl- d_6 sulfoxide) δ 13.82, 22.06, 23.12, 24.41, 25.35, 31.71, 32.18, 63.59, 83.36, 84.95, 85.71, 86.36, 111.24, 120.77, 138.77, 160.13, 175.18; UV λ_{max} (CH_3OH) 215 nm (ϵ 12820), 276 (16450), 290 (sh, 15290), λ_{max} (0.1 mol dm^{-3} NaOH) 227 nm (ϵ 9570), 261 (10640), 305 (6030). Found: C, 59.03; H, 8.06; N, 5.93%. Calcd for $\text{C}_{22}\text{H}_{36}\text{O}_5\text{N}_2\text{S}\cdot 0.5\text{H}_2\text{O}$: C, 58.76; H, 8.29; N, 6.23%.

5-[(2S*,3R*,4R*,5R*)-3-*t*-Butyldimethylsiloxymethyl-5-hydroxymethyl-3,4-isopropylidenedioxytetrahydrofuran-2-yl]-2-thiouracil (**58a**): A mixture of **53a** (500 mg, 1.21 mmol), thiourea (645 mg, 8.47 mmol), and 0.94 mol dm^{-3} $\text{C}_2\text{H}_5\text{ONa}$ in $\text{C}_2\text{H}_5\text{OH}$ (9 ml) was stirred for 3 h. The Method B workup gave a crude product which was subjected to preparative TLC (10:1 chloroform- CH_3OH) to afford **58a** (333 mg, 62%). Mp 208–210 °C (acetone-hexane); $R_f=0.27$ (10:1 chloroform- CH_3OH); ^1H NMR (dimethyl- d_6 sulfoxide) δ 0.06 (s, $t\text{-C}_4\text{H}_9(\text{CH}_3)_2\text{Si}$), 0.84 (s, $t\text{-C}_4\text{H}_9(\text{CH}_3)_2\text{Si}$), 1.34 and 1.51 (s, isopropylidene CH_3), 3.30 (br, OH), 3.4–3.7 (m, CH_2OH and CH_2OSi), 4.00 (m, H_5), 4.51 (d, $J=3.0$ Hz, H_4), 4.82 (s, H_2), 7.34 (s, =CH), 12.30 (br, NH); ^{13}C NMR (dimethyl- d_6 sulfoxide) δ 17.74, 25.49, 26.90, 28.25, 60.95, 61.65, 80.21, 82.91, 83.14, 91.65, 113.26, 113.61, 138.22, 159.52, 174.61; UV λ_{max} (CH_3OH) 216 nm (ϵ 9160), 275 (11800), 299 (11200), λ_{max} (0.1 mol dm^{-3} NaOH) 224 nm (ϵ 9990), 262 (9110), 296 (6780). Found: C, 50.74; H, 7.55; N, 6.53%. Calcd for $\text{C}_{19}\text{H}_{32}\text{O}_6\text{N}_2\text{SSi}\cdot 0.5\text{H}_2\text{O}$: C, 50.30; H, 7.33; N, 6.18%.

5-[(2S*,3R*,4R*,5R*)-5-Hydroxymethyl-3,4-isopropylidenedioxy-3-methyltetrahydrofuran-2-yl]-2-thiouracil (**58b**): A mixture of **53b** (200 mg, 0.707 mmol), thiourea (377 mg, 4.95 mmol), and 0.92 mol dm^{-3} $\text{C}_2\text{H}_5\text{ONa}$ in $\text{C}_2\text{H}_5\text{OH}$ (5.4 ml) was stirred for 3 h. The Method B workup and preparative TLC (4:1 chloroform- CH_3OH) afforded **58b** (155 mg, 70%). Mp 142–144 °C (CH_3OH); $R_f=0.62$ (5:1 chloroform- CH_3OH); ^1H NMR (dimethyl- d_6 sulfoxide) δ 1.14 (s, CH_3), 1.32 and 1.50 (s, isopropylidene CH_3), 3.56 (d-like, $J=4.0$ Hz, CH_2OH), 3.96 (m, H_5), 4.31 (d, $J=2.8$ Hz, H_4), 4.80 (s, H_2), 7.38 (s, =CH), ^{13}C NMR (dimethyl- d_6 sulfoxide) δ 20.26, 27.07, 28.32, 61.47, 81.21, 82.91, 87.30, 89.36, 112.84, 114.74, 138.92, 159.82, 175.16; UV λ_{max} (CH_3OH) 215 nm (ϵ 12600), 275 (15800), 297 (14900), λ_{max} (0.1 mol dm^{-3} NaOH) 221 nm (ϵ 13700), 262 (12100), 298 (8110). Found: m/z , 314.0949. Calcd for $\text{C}_{18}\text{H}_{18}\text{O}_5\text{N}_2\text{S}$: M, 314.0936.

With Guanidine Hydrochloride. 5-[(2R*,3R*,4S*,5S*)-5-(1-Hydroxy-1-methylethyl)-3,4-isopropylidenedioxytetrahydrofuran-2-yl]isocytosine (**12a**): Guanidine hydrochloride (1.11 g, 11.8 mmol) was dissolved in 1.69 mol dm^{-3} $\text{C}_2\text{H}_5\text{ONa}$ in $\text{C}_2\text{H}_5\text{OH}$ (7 ml). To this was added **7a** (436 mg, 1.47 mmol) and the mixture was stirred for 5 h. The Method A workup followed by trituration of the residue with ether afforded **12a** (334 mg, 73%). Mp 242.0–243.1 °C (CH_3OH); ^1H NMR (dimethyl- d_6 sulfoxide) δ 1.10 (s, CH_3), 1.28 and 1.49 (s, isopropylidene CH_3), 3.67 (d, $J=3.0$ Hz, H_5), 4.51 (m, H_3), 4.68 (m, H_2 and H_4), 6.64 (br, NH_2), 7.66 (s, =CH); UV λ_{max} (CH_3OH) 227 nm (ϵ 5330), 290 (5370), λ_{max} (0.1 mol dm^{-3} NaOH) 233 nm (ϵ 7420), 276 (5940). Found: C, 54.16; H, 6.67; N, 13.30%. Calcd for $\text{C}_{14}\text{H}_{21}\text{O}_5\text{N}_3$: C, 54.01; H, 6.80; N, 13.50%.

5-[(2R*,3R*,4R*,5R*)-5-[(R*)-1-Hydroxyethyl]-3,4-isopropylidenedioxytetrahydrofuran-2-yl]isocytosine (**12b**): A mixture of **7b** (952 mg, 3.36 mmol), guanidine hydrochloride (2.54 g, 26.9 mmol), and 2.69 mol dm^{-3} $\text{C}_2\text{H}_5\text{ONa}$ in $\text{C}_2\text{H}_5\text{OH}$ (10 ml) was stirred for 5 h. The reaction mixture was worked up according to Method A, and the product was subjected to trituration with ethyl acetate to give **12b** (665 mg, 67%). Mp 219.8–220.9 °C (CH_3OH); ^1H NMR

(dimethyl- d_6 sulfoxide) δ 1.06 (d, $J=6.0$ Hz, CH_3), 1.27 and 1.48 (s, isopropylidene CH_3), 3.71 (m, H_5 and CH_2OH), 4.71 (m, H_3), 4.74 (m, H_2 and H_4), 6.66 (br, NH_2), 7.64 (s, =CH); UV λ_{max} (CH_3OH) 226 nm (ϵ 7240), 290 (7240), λ_{max} (0.1 mol dm^{-3} NaOH) 232 nm (ϵ 9120), 276 (6920). Found: C, 52.50; H, 6.50; N, 13.97%. Calcd for $\text{C}_{13}\text{H}_{19}\text{O}_5\text{N}_3$: C, 52.51; H, 6.44; N, 14.13%.

5-[(2R*,3R*,4R*,5R*)-5-[(R*)-1-Hydroxyhexyl]-3,4-isopropylidenedioxytetrahydrofuran-2-yl]isocytosine (**12c**): A mixture of **7c** (428 mg, 1.26 mmol), guanidine hydrochloride (951 mg, 10.1 mmol), and 1 mol dm^{-3} $\text{C}_2\text{H}_5\text{ONa}$ in $\text{C}_2\text{H}_5\text{OH}$ (10 ml) was stirred for 5 h. Workup according to Method A followed by trituration (ether) of the crude product gave pure **12c** (327 mg, 74%). Mp 212.0–213.9 °C (CH_3OH); ^1H NMR ($\text{C}_5\text{D}_5\text{N}$) δ 0.81 (t, $J=6.0$ Hz, CH_3), 1.2–1.8 (m, CH_2), 1.40 and 1.68 (s, isopropylidene CH_3), 4.18 (m, CH_2OH), 4.42 (t-like, $J=4.1$ Hz, H_5), 5.06 (d, $J=4.2$ Hz, H_2), 5.38 (m, H_3 and H_4), 8.04 (s, =CH), 8.10 (br, NH_2); UV λ_{max} (CH_3OH) 227 nm (ϵ 10720), 290 (10720), λ_{max} (0.1 mol dm^{-3} NaOH) 233 nm (ϵ 11480), 277 (9330). Found: C, 57.05; H, 7.50; N, 11.91%. Calcd for $\text{C}_{17}\text{H}_{29}\text{O}_5\text{N}_3$: C, 57.77; H, 7.70; N, 11.89%.

5-[(2R*,3R*,4R*,5S*)-5-[(S*)- α -Hydroxybenzyl]-3,4-isopropylidenedioxytetrahydrofuran-2-yl]isocytosine (**12d**): A mixture of **7d** (206 mg, 0.597 mmol), guanidine hydrochloride (394 mg, 4.18 mmol), and 3.2 mol dm^{-3} $\text{C}_2\text{H}_5\text{ONa}$ in $\text{C}_2\text{H}_5\text{OH}$ (1.5 ml) was stirred for 5 h. After workup according to Method A, the crude product was purified by trituration with ether to give **12d** (44 mg, 21%). Mp 273.8–275.0 °C (CH_3OH); ^1H NMR (dimethyl- d_6 sulfoxide) δ 1.18 and 1.42 (s, isopropylidene CH_3), 4.10 (dd, $J=2.0$, 4.0 Hz, H_5), 4.50 (d, $J=4.3$ Hz, H_2), 4.90 (m, H_3 and H_4), 5.82 (dd, $J=2.0$, 4.0 Hz, CHOH), 6.60 (br, NH_2), 7.30 (m, C_6H_5), 7.64 (s, =CH), 11.0 (br, NH); UV λ_{max} (CH_3OH) 227 nm (ϵ 12310), 290 (13180), λ_{max} (0.1 mol dm^{-3} NaOH) 233 nm (ϵ 5490), 277 (4360). Found: C, 59.98; H, 6.05; N, 11.38%. Calcd for $\text{C}_{18}\text{H}_{21}\text{O}_5\text{N}_3$: C, 60.16; H, 5.89; N, 11.69%.

5-[(2R*,3S*,4S*,5R*)-5-Hydroxymethyl-3,4-isopropylidenedioxy-5-methyltetrahydrofuran-2-yl]isocytosine (**20a**): A mixture of **15a** (705 mg, 2.49 mmol), guanidine hydrochloride (1.89 g, 19.9 mmol), and 1.4 mol dm^{-3} $\text{C}_2\text{H}_5\text{ONa}$ in $\text{C}_2\text{H}_5\text{OH}$ (14 ml) was stirred for 2 h. The workup according to Method A and trituration with ethyl acetate gave **20a** (434 mg, 64%). Mp 252–254 °C (CH_3OH); $R_f=0.44$ (5:1 chloroform- CH_3OH); ^1H NMR (dimethyl- d_6 sulfoxide) δ 1.14 (s, CH_3), 1.27 and 1.50 (s, isopropylidene CH_3), 3.34 (br s, CH_2OH), 4.53 (d, $J=5.2$ Hz, H_4), 4.64 (d, $J=6.0$ Hz, H_2), 4.85 (dd, $J=5.2$, 6.0 Hz, H_3), 5.08 (br, OH), 6.82 (br, NH_2), 7.64 (s, =CH), 11.14 (br, NH); ^{13}C NMR (dimethyl- d_6 sulfoxide) δ 18.14, 25.31, 27.10, 67.70, 80.83, 83.29, 83.50, 84.72, 111.88, 112.56, 154.10, 156.09, 163.00; UV λ_{max} (CH_3OH) 225 nm (ϵ 13890), 289 (11220), λ_{max} (0.1 mol dm^{-3} NaOH) 233 nm (ϵ 10320), 276 (7930). Found: C, 52.60; H, 6.27; N, 13.85%. Calcd for $\text{C}_{18}\text{H}_{19}\text{O}_5\text{N}_3$: C, 52.51; H, 6.44; N, 14.13%.

5-[(2R*,3S*,4S*,5R*)-5-Hydroxymethyl-3,4-isopropylidenedioxy-5-pentyltetrahydrofuran-2-yl]isocytosine (**20b**): A mixture of **15b** (471 mg, 1.39 mmol), guanidine hydrochloride (1.06 g, 11.1 mmol), and 0.93 mol dm^{-3} $\text{C}_2\text{H}_5\text{ONa}$ in $\text{C}_2\text{H}_5\text{OH}$ (12 ml) was stirred for 2 h. The reaction mixture was worked up according to Method A. Trituration with ethyl acetate afforded pure **20b** (356 mg, 73%). Mp 228–230 °C (CH_3OH); $R_f=0.51$ (5:1 chloroform- CH_3OH); ^1H NMR (dimethyl- d_6 sulfoxide) δ 0.88 (t, $J=6.0$ Hz, CH_3), 1.28 and 1.51 (s, isopropylidene CH_3), 1.1–1.7 (m, CH_2), 3.39 (br s, CH_2OH), 4.46 (d, $J=6.0$ Hz, H_4), 4.68 (d, $J=6.0$ Hz, H_2), 4.87 (t, $J=6.0$ Hz, H_3), 5.14 (br, OH), 6.81

(br, NH_2), 7.64 (s, $=\text{CH}$); ($\text{C}_5\text{D}_5\text{N}$) δ 0.83 (t, $J=6.0$ Hz, CH_3), 1.2–2.1 (m, CH_2), 1.38 and 1.68 (s, isopropylidene CH_3), 3.85 (d, $J=11.5$ Hz, $\text{H}_a\text{H}_b\text{COH}$), 4.01 (d, $J=11.5$ Hz, $\text{H}_a\text{H}_b\text{COH}$), 4.99 (d, $J=5.5$ Hz, H_4), 5.20 (d, $J=5.5$ Hz, H_2), 5.59 (t, $J=5.5$ Hz, H_3), 8.06 (s, $=\text{CH}$), 8.06 (br, NH_2); UV λ_{max} (CH_3OH) 227 nm (ϵ 9510), 290 (9540), λ_{max} (0.1 mol dm^{-3} NaOH) 216 nm (ϵ 9210), 233 (9750), 276 (7740). Found: C, 57.98; H, 7.78; N, 11.36%. Calcd for $\text{C}_{17}\text{H}_{27}\text{O}_5\text{N}_3$: C, 57.77; H, 7.70; N, 11.89%.

5-[(2R*,3S*,4S*,5R*)-5-Hydroxymethyl-3,4-isopropylidenedioxy-5-phenyltetrahydrofuran-2-yl]isocytosine (**20c**): A mixture of **15c** (537 mg, 1.56 mmol), guanidine hydrochloride (1.19 g, 12.5 mmol), and 0.78 mol dm^{-3} $\text{C}_2\text{H}_5\text{ONa}$ in $\text{C}_2\text{H}_5\text{OH}$ (16 ml) was stirred for 2 h. Trituration with ethyl acetate gave **20c** (436 mg, 78%). Mp 270–272 °C (CH_3OH); $R_f=0.53$ (5:1 chloroform– CH_3OH); ^1H NMR (dimethyl- d_6 sulfoxide) δ 1.14 and 1.24 (s, isopropylidene CH_3), 4.63 (d, $J=6.0$ Hz, H_4), 5.01 (dd, $J=5.8$, 6.0 Hz, H_3), 5.13 (d, $J=5.8$ Hz, H_2), 6.75 (br, NH_2), 7.40 (m, C_6H_5), 7.67 (s, $=\text{CH}$), 11.50 (br, NH), CH_2OH peaks obscured by H_2O peaks; ^{13}C NMR (dimethyl- d_6 sulfoxide) δ 25.66, 27.21, 68.71, 82.89, 83.84, 89.40, 111.99, 112.35, 126.22, 126.54, 127.37, 140.02, 154.47, 156.77, 164.22; UV λ_{max} (CH_3OH) 226 nm (ϵ 12330), 289 (10390), λ_{max} (0.1 mol dm^{-3} NaOH) 211 nm (ϵ 15210), 234 (11940), 276 (9020). Found: C, 60.00; H, 5.88; N, 11.69%. Calcd for $\text{C}_{18}\text{H}_{21}\text{O}_5\text{N}_3$: C, 60.16; H, 5.89; N, 11.69%.

5-[(2R*,3R*,4R*,5R*)-5-Hydroxymethyl-3,4-isopropylidenedioxy-2-methyltetrahydrofuran-2-yl]isocytosine (**28a**): A mixture of crude **23a** [prepared from **22a** (248 mg, 1.09 mmol) and *t*-butoxybis(dimethylamino)methane (2 ml)], guanidine hydrochloride (1.06 g, 8.72 mmol), and 1.25 mol dm^{-3} $\text{C}_2\text{H}_5\text{ONa}$ in $\text{C}_2\text{H}_5\text{OH}$ (7 ml) was stirred for 2 h. Workup according to Method A followed by preparative TLC (5:1 chloroform– CH_3OH) afforded **28a** (53.4 mg, 17% based on **22a**) as a yellow foam. $R_f=0.40$ (5:1 chloroform– CH_3OH); ^1H NMR ($\text{C}_5\text{D}_5\text{N}$) δ 1.36 and 1.62 (s, isopropylidene CH_3), 1.91 (s, CH_3), 4.00 (d, $J=5.2$ Hz, CH_2OH), 4.54 (m, H_5), 5.01 (dd, $J=4.1$, 6.0 Hz, H_4), 5.39 (d, $J=6.0$ Hz, H_3), 8.04 (br, NH_2), 8.33 (s, $=\text{CH}$); UV λ_{max} (CH_3OH) 224 nm (ϵ 10400), 290 (8450), λ_{max} (0.1 mol dm^{-3} NaOH) 231 nm (ϵ 7710), 278 (5950). Found: m/z , 297.1312. Calcd for $\text{C}_{13}\text{H}_{19}\text{N}_3\text{O}_5$: M, 297.1325.

5-[(2R*,3R*,4R*,5R*)-5-Hydroxymethyl-3,4-isopropylidenedioxy-2-pentyltetrahydrofuran-2-yl]isocytosine (**28b**): A mixture of crude **23b** [prepared from **22b** (632 mg, 2.23 mmol) and *t*-butoxybis(dimethylamino)methane (3 ml)], guanidine hydrochloride (1.69 g, 17.8 mmol), and 1 mol dm^{-3} $\text{C}_2\text{H}_5\text{ONa}$ in $\text{C}_2\text{H}_5\text{OH}$ (18 ml) was stirred for 2 h. Workup according to Method A and column chromatography (20:1 to 10:1 chloroform– CH_3OH) afforded **28b** (31.6 mg, 4% based on **22b**) as a yellow foam. $R_f=0.42$ (5:1 chloroform– CH_3OH); ^1H NMR (dimethyl- d_6 sulfoxide) δ 0.77 (t, $J=6.0$ Hz, CH_3), 1.0–2.0 (m, CH_2), 1.22 and 1.42 (s, isopropylidene CH_3), 3.38 (d, $J=2.7$ Hz, CH_2OH), 3.82 (m, H_5), 4.43 (dd, $J=2.0$, 6.0 Hz, H_4), 4.81 (d, $J=6.0$ Hz, H_3), 6.78 (br, NH_2), 7.61 (s, $=\text{CH}$); UV λ_{max} (CH_3OH) 225 nm (ϵ 5770), 292 (3680), λ_{max} (0.1 mol dm^{-3} NaOH) 230 nm (ϵ 6720), 278 (4770). Found: m/z , 335.1842. Calcd for $\text{C}_{17}\text{H}_{25}\text{O}_4\text{N}_3$: (M– H_2O), 335.1840.

5-[(2R*,3S*,4S*)-5,5-Bis(hydroxymethyl)-3,4-isopropylidenedioxytetrahydrofuran-2-yl]isocytosine (**36**): A mixture of **31** (368 mg, 0.91 mmol), guanidine hydrochloride (608 mg, 6.37 mmol), and 1 mol dm^{-3} $\text{C}_2\text{H}_5\text{ONa}$ in $\text{C}_2\text{H}_5\text{OH}$ (7 ml) was stirred for 5 h. Workup according to Method B gave a yellow solid, which was purified by preparative TLC (3:1 chloroform– CH_3OH) to give **36** (128 mg, 45%). Mp 245–247 °C (CH_3OH); $R_f=0.39$ (3:1 chloroform– CH_3OH); ^1H

NMR (dimethyl- d_6 sulfoxide) δ 1.25 and 1.46 (s, isopropylidene CH_3), 3.53 (m, CH_2OH), 4.0–5.0 (br, OH), 4.47 (d, $J=5.5$ Hz, H_4), 4.70 (d, $J=5.5$ Hz, H_2), 4.82 (t, $J=5.5$ Hz, H_3), 6.85 (br, NH_2), 7.63 (s, $=\text{CH}$); ^{13}C NMR (dimethyl- d_6 sulfoxide) δ 25.24, 27.16, 60.71, 64.01, 81.74, 83.09, 86.44, 111.44, 112.46, 154.41, 156.45, 163.18, UV λ_{max} (CH_3OH) 227 nm (ϵ 5960), 290 (5720), λ_{max} (0.1 mol dm^{-3} NaOH) 233 nm (ϵ 10250), 277 (7770). Found: C, 49.54; H, 6.10; N, 13.40%. Calcd for $\text{C}_{13}\text{H}_{19}\text{O}_6\text{N}_3$: C, 49.83; H, 6.11; N, 13.41%.

5-[(2R*,3R*,4S*,5R*)-2,5-Dimethyl-5-hydroxymethyl-3,4-isopropylidenedioxytetrahydrofuran-2-yl]isocytosine (**50a**): A mixture of **45a** (1.07 g, 3.60 mmol), guanidine hydrochloride (2.74 g, 28.8 mmol), and 1 mol dm^{-3} $\text{C}_2\text{H}_5\text{ONa}$ in $\text{C}_2\text{H}_5\text{OH}$ (30 ml) was stirred for 5 h. Workup according to Method A followed by trituration with ethyl acetate afforded **50a** (878 mg, 77%). Mp 255–257 °C (CH_3OH), $R=0.43$ (5:1 chloroform– CH_3OH); ^1H NMR (dimethyl- d_6 sulfoxide) δ 1.19 and 1.32 (s, CH_3), 1.32 and 1.49 (s, isopropylidene CH_3), 3.18 (d-like, $J=4.8$ Hz, CH_2OH), 4.48 (d, $J=6.3$ Hz, H_3), 4.91 (d, $J=6.3$ Hz, H_4), 6.46 (br, NH_2), 7.72 (s, $=\text{CH}$), 10.90 (br, NH); ^{13}C NMR (dimethyl- d_6 sulfoxide) δ 19.82, 24.59, 24.94, 25.71, 66.71, 83.24, 83.30, 83.42, 84.59, 111.30, 119.42, 156.01; UV λ_{max} (CH_3OH) 225 nm (ϵ 9930), 292 (8160), λ_{max} (0.1 mol dm^{-3} NaOH) 231 nm (ϵ 8750), 278 (6930). Found: C, 52.90; H, 6.75; N, 12.89%. Calcd for $\text{C}_{14}\text{H}_{21}\text{O}_5\text{N}_3 \cdot 0.5\text{H}_2\text{O}$: C, 52.49; H, 6.92; N, 13.12%.

5-[(2R*,3R*,4S*,5R*)-2,5-Dipentyl-5-hydroxymethyl-3,4-isopropylidenedioxytetrahydrofuran-2-yl]isocytosine (**50b**): A mixture of **45b** (1.31 g, 3.20 mmol), guanidine hydrochloride (2.43 g, 25.6 mmol), and 1 mol dm^{-3} $\text{C}_2\text{H}_5\text{ONa}$ in $\text{C}_2\text{H}_5\text{OH}$ (25 ml) was stirred. After 5 h, the mixture was worked up according to Method A to give an oil, which was trituated with ethyl acetate to give **50b** (528 mg, 39%). Mp 168–170 °C (CH_3OH); $R_f=0.54$ (5:1 chloroform– CH_3OH); ^1H NMR (dimethyl- d_6 sulfoxide) δ 0.86 (m, CH_3), 1.0–2.0 (m, CH_2), 1.26 and 1.46 (s, isopropylidene CH_3), 3.34 (m, CH_2OH), 4.49 (d, $J=6.2$ Hz, H_3), 4.74 (br, OH), 4.87 (d, $J=6.2$ Hz, H_4), 6.60 (br, NH_2), 7.62 (s, $=\text{CH}$), 11.10 (br, NH); ^{13}C NMR (dimethyl- d_6 sulfoxide) δ 13.80, 22.02, 22.66, 23.13, 24.36, 25.42, 31.76, 32.11, 34.70, 63.58, 83.34, 85.01, 85.66, 85.95, 110.78, 116.83, 155.52; UV λ_{max} (CH_3OH) 225 nm (ϵ 7530), 292 (5810), λ_{max} (0.1 mol dm^{-3} NaOH) 231 nm (ϵ 5440), 279 (3980). Found: C, 61.28; H, 8.79; N, 9.39%. Calcd for $\text{C}_{22}\text{H}_{37}\text{O}_5\text{N}_3 \cdot 0.5\text{H}_2\text{O}$: C, 61.09; H, 8.86; N, 9.71%.

5-[(2S*,3R*,4R*,5R*)-3-*t*-Butyldimethylsiloxyethyl-5-hydroxymethyl-3,4-isopropylidenedioxytetrahydrofuran-2-yl]isocytosine (**60a**): A mixture of **53a** (500 mg, 1.21 mmol), guanidine hydrochloride (809 mg, 8.47 mmol), and 0.94 mol dm^{-3} $\text{C}_2\text{H}_5\text{ONa}$ in $\text{C}_2\text{H}_5\text{OH}$ (9 ml) was stirred for 3 h. After the Method B workup, the residue was subjected to preparative TLC (10:1 chloroform– CH_3OH) to give **60a** (339 mg, 67%). Mp 231–233 °C (CH_3OH –acetone–hexane); $R_f=0.25$ (10:1 chloroform– CH_3OH); ^1H NMR (dimethyl- d_6 sulfoxide) δ 0.06 (s, $t\text{-C}_4\text{H}_9(\text{CH}_3)_2\text{Si}$), 0.85 (s, $t\text{-C}_4\text{H}_9(\text{CH}_3)_2\text{Si}$), 1.34 and 1.51 (s, isopropylidene CH_3), 3.4–3.7 (m, CH_2OH and CH_2OSi), 3.97 (m, H_5), 4.54 (d, $J=3.0$ Hz, H_4), 4.89 (s, H_2), 6.67 (br, NH_2), 7.59 (s, $=\text{CH}$), 11.00 (br, NH); ^{13}C NMR (dimethyl- d_6 sulfoxide) δ 17.62, 25.37, 26.72, 28.31, 61.42, 81.03, 82.50, 82.73, 91.59, 108.92, 112.79, 128.29, 153.70, 155.18; UV λ_{max} (CH_3OH) 228 nm (ϵ 9500), 294 (8840), λ_{max} (0.1 mol dm^{-3} NaOH) 233 nm (ϵ 5090), 280 (3910). Found: C, 52.15; H, 7.67; N, 9.58%. Calcd for $\text{C}_{19}\text{H}_{33}\text{O}_6\text{N}_3\text{Si} \cdot 0.5\text{H}_2\text{O}$: C, 52.27; H, 7.85; N, 9.62%.

5-[(2S*,3R*,4R*,5R*)-5-Hydroxymethyl-3,4-isopropylidenedioxy-3-methyltetrahydrofuran-2-yl]isocytosine (**60b**): A mixture

of **53b** (200 mg, 0.707 mmol), guanidine hydrochloride (473 mg, 4.95 mmol), and 0.92 mol dm⁻³ C₂H₅ONa in C₂H₅OH (5.4 ml) was stirred for 3 h. The Method B workup of the reaction mixture gave a crude product which was subjected to preparative TLC (4:1 chloroform-CH₃OH) to afford **60b** (132 mg, 63%). Mp 178–180 °C (CH₃OH); *R*_f=0.45 (5:1 chloroform-CH₃OH); ¹H NMR (dimethyl-*d*₆ sulfoxide) δ 1.14 (s, CH₃), 1.34 and 1.51 (s, isopropylidene CH₃), 3.56 (d-like, *J*=5.0 Hz, CH₂OH), 3.93 (m, H₅), 4.32 (d, *J*=2.8 Hz, H₄), 4.88 (s, H₂), 6.80 (br, NH₂), 7.58 (s, =CH); ¹³C NMR (dimethyl-*d*₆ sulfoxide) δ 20.55, 27.23, 28.44, 61.72, 82.22, 82.50, 87.37, 89.47, 110.76, 112.62, 152.83, 155.77, 162.22; UV λ_{max} (CH₃OH) 226 nm (ε 6830), 293 (6290), λ_{max} (0.1 mol dm⁻³ NaOH) 233 nm (ε 11000), 280 (8690). Found: C, 50.11; H, 6.51; N, 13.30%. Calcd for C₁₃H₁₉O₅N₃·0.8H₂O: C, 50.09; H, 6.66; N, 13.48%.

Deprotection of the 5-(5-Hydroxymethyl-3,4-isopropylidenedioxy-tetrahydrofuran-2-yl)pyrimidine C-Nucleosides by Methanolic Hydrogen Chloride. General Procedure: Unless otherwise stated, removal of the isopropylidene group was performed as follows. A mixture of a 5-(5-hydroxymethyl-3,4-isopropylidenedioxytetrahydrofuran-2-yl)pyrimidine C-nucleoside and 10% methanolic hydrogen chloride solution was stirred at the room temperature until the reaction was complete (TLC analysis). The reaction mixture was concentrated under reduced pressure (50–90 mmHg), giving a crude material, which was coevaporated with C₂H₅OH. The resulting solid was triturated with ether or ethyl acetate to give the desired deprotection product. A pure sample was collected by recrystallization.

5-[(2R*,3R*,4R*,5R*)-3,4-Dihydroxy-5-[(R*)-1-hydroxy-ethyl]tetrahydrofuran-2-yl]uracil ((±)-5'-Methylpseudouridine) (**9b**): To a solution of **8b** (51.2 mg, 0.172 mmol) in CH₃OH (2 ml) was added 10% HCl in CH₃OH (2 ml) and the mixture was stirred for 10 min. The above described workup gave **9b** (42.8 mg, 96%). Mp 237.2–239.1 °C (aqueous C₂H₅OH); ¹H NMR (dimethyl-*d*₆ sulfoxide) δ 1.06 (d, *J*=6.0 Hz, CH₃), 3.50 (m, H₅ and CHOH), 4.0 (m, H₃ and H₄), 4.37 (d, *J*=6.0 Hz, H₂), 7.70 (d, *J*=6.0 Hz, =CH), 10.87 (d, *J*=6.0 Hz, NH), 11.08 (s, NH); UV λ_{max} (CH₃OH) 264 nm (ε 5620), λ_{max} (0.1 mol dm⁻³ HCl) 263 nm (ε 8130), λ_{max} (0.1 mol dm⁻³ NaOH) 287 nm (ε 8510). Found: C, 46.67; H, 5.39; N, 10.71%. Calcd for C₁₀H₁₄O₆N₂: C, 46.51; H, 5.47; N, 10.85%.

5-[(2R*,3R*,4S*,5S*)-3,4-Dihydroxy-5-(1-hydroxy-1-methyl-ethyl)tetrahydrofuran-2-yl]uracil ((±)-5',5'-Dimethylpseudouridine) (**9a**): To a solution of **8a** (218 mg, 0.699 mmol) in CH₃OH (4 ml) was added 10% HCl in CH₃OH (3 ml) and the resulting mixture was stirred for 10 min. Workup in a usual manner left pure **9a** (185 mg, 97%). Mp 221.4–224.8 °C; ¹H NMR (C₅D₅N) δ 1.53 and 1.57 (s, CH₃), 4.32 (dd, *J*=3.0, 5.0 Hz, H₄), 4.34 (d, *J*=3.0 Hz, H₅), 5.12 (dd, *J*=5.0, 6.5 Hz, H₃), 5.25 (d, *J*=6.5 Hz, H₂), 5.75 (br, OH and NH), 8.00 (s, =CH); UV λ_{max} (CH₃OH) 212 nm (ε 7940), 263 (6600), λ_{max} (0.1 mol dm⁻³ HCl) 264 nm (ε 8310), λ_{max} (0.1 mol dm⁻³ NaOH) 218 nm (ε 8310), 287 (10960). Found: C, 48.42; H, 6.02; N, 10.11%. Calcd for C₁₁H₁₆O₆N₂: C, 48.52; H, 5.92; N, 10.29%.

5-[(2R*,3R*,4R*,5R*)-3,4-Dihydroxy-5-[(R*)-1-hydroxy-hexyl]tetrahydrofuran-2-yl]uracil ((±)-5'-Pentylpseudouridine) (**9c**): A mixture of **8c** (134 mg, 0.379 mmol) in CH₃OH (3 ml) and 10% HCl in CH₃OH (3 ml) was stirred for 10 min. The usual workup gave **9c** (71 mg, 60%). Mp 193.3–197.7 °C; ¹H NMR (C₅D₅N) δ 0.81 (t, *J*=6.0 Hz, CH₃), 1.10–1.90 (m, CH₂), 4.24 (m, CHOH), 4.54 (t, *J*=2.8 Hz, H₅), 4.94 (dd, *J*=2.8, 4.3 Hz, H₄), 5.15 (m, H₂ and H₃), 5.50 (br, OH and NH), 7.95 (s, =CH); UV

λ_{max} (CH₃OH) 212 nm (ε 8510), 265 (6910), λ_{max} (0.1 mol dm⁻³ HCl) 264 nm (ε 3540), λ_{max} (0.1 mol dm⁻³ NaOH) 217 nm (ε 10960), 286 (7240). Found: C, 53.38; H, 7.21; N, 8.78%. Calcd for C₁₄H₂₂O₆N₂: C, 53.49; H, 7.05; N, 8.91%.

5-[(2R*,3R*,4R*,5S*)-3,4-Dihydroxy-5-[(S*)-α-hydroxy-benzyl]tetrahydrofuran-2-yl]uracil ((±)-5'-Phenylpseudouridine) (**9d**): To a solution of **8d** (39.0 mg, 0.108 mmol) in CH₃OH (1 ml) was added 10% HCl in CH₃OH (1.5 ml). The resulting mixture was stirred for 5 min and worked up to yield **9d** (36.3 mg, 100%) as a wax. ¹H NMR (C₅D₅N) δ 4.90 (m, H₅ and CHOH), 5.24 (m, H₃ and H₄), 5.47 (d, *J*=4.0 Hz, H₂), 7.20–7.50 (m, C₆H₅), 7.83 (s, =CH); UV λ_{max} (CH₃OH) 265 nm (ε 7410), λ_{max} (0.1 mol dm⁻³ HCl) 264 nm (ε 7250), λ_{max} (0.1 mol dm⁻³ NaOH) 285 nm (ε 9330). Found: C, 56.31; H, 5.23; N, 8.61%. Calcd for C₁₅H₁₆O₆N₂: C, 56.25; H, 5.04; N, 8.75%.

5-[(2R*,3S*,4S*,5R*)-3,4-Dihydroxy-5-hydroxymethyl-5-methyltetrahydrofuran-2-yl]uracil ((±)-4'-Methylpseudouridine) (**17a**): To a solution of **16a** (14.0 mg, 0.0392 mmol) in CH₃OH (1 ml) was added 10% HCl in CH₃OH (1 ml). After stirring for 15 min, usual workup afforded **17a** (11.6 mg, 100%). Mp 226–228 °C (CH₃OH); *R*_f=0.37 (3:1 chloroform-CH₃OH); ¹H NMR (C₅D₅N) δ 1.69 (s, CH₃), 3.90 (d, *J*=11.5 Hz, H_aH_bCOH), 4.08 (d, *J*=11.5 Hz, H_aH_bCOH), 4.87 (m, H₄), 5.26 (m, H₂ and H₃), 6.32 (br, OH), 7.98 (s, =CH), 12.50 and 13.20 (br, NH); UV λ_{max} (CH₃OH) 264 nm (ε 7760), λ_{max} (0.1 mol dm⁻³ HCl) 264 nm (ε 7510), λ_{max} (0.1 mol dm⁻³ NaOH) 286 nm (ε 7540). Found: *m/z*, 258.0855. Calcd for C₁₀H₁₄O₆N₂: M, 258.0852.

5-[(2R*,3S*,4S*,5R*)-3,4-Dihydroxy-5-hydroxymethyl-5-pentyltetrahydrofuran-2-yl]uracil ((±)-4'-Pentylpseudouridine) (**17b**): To a mixture of **16b** (16.0 mg, 0.0452 mmol) in CH₃OH (1 ml) was added 10% HCl in CH₃OH (1 ml), and the resulting mixture was stirred for 10 min. Workup afforded **17b** (15.7 mg, 100%). Mp 205–209 °C (CH₃OH); *R*_f=0.60 (3:1 chloroform-CH₃OH); ¹H NMR (C₅D₅N) δ 0.84 (t, *J*=6.0 Hz, CH₃), 1.2–2.3 (m, CH₂), 3.98 (d, *J*=11.8 Hz, H_aH_bCOH) 4.14 (d, *J*=11.8 Hz, H_aH_bCOH) 4.88 (d, *J*=4.5 Hz, H₄), 5.14 (d, *J*=8.0 Hz, H₂), 5.34 (dd, *J*=4.5, 8.0 Hz, H₃), 5.91 (br, OH), 7.89 (s, =CH), 12.50 and 13.20 (br, NH); UV λ_{max} (CH₃OH) 264 nm (ε 9530), λ_{max} (0.1 mol dm⁻³ HCl) 264 nm (ε 9210), λ_{max} (0.1 mol dm⁻³ NaOH) 287 nm (ε 8390). Found: C, 50.54; H, 6.68; N, 7.68%. Calcd for C₁₄H₂₂O₆N₂·H₂O: C, 50.59; H, 7.28; N, 8.43%.

5-[(2R*,3S*,4S*,5R*)-3,4-Dihydroxy-5-hydroxymethyl-5-phenyltetrahydrofuran-2-yl]uracil ((±)-4'-Phenylpseudouridine) (**17c**): To a solution of **16c** (34.2 mg, 0.095 mmol) in CH₃OH (2 ml) was added 10% HCl in CH₃OH (2 ml). After stirring for 15 min, the mixture was worked up to give **17c** (32.0 mg, 100%). Mp 245–249 °C (CH₃OH); *R*_f=0.55 (3:1 chloroform-CH₃OH); ¹H NMR (C₅D₅N) δ 4.07 (d, *J*=11.9 Hz, H_aH_bCOH), 4.17 (d, *J*=11.9 Hz, H_aH_bCOH), 5.28 (d, *J*=5.2 Hz, H₄), 5.35 (d, *J*=7.5 Hz, H₂), 5.62 (dd, *J*=5.2, 7.5 Hz, H₃), 5.92 (br, OH), 7.2–8.0 (m, C₆H₅), 8.08 (s, =CH), 13.30 (br, NH); UV λ_{max} (CH₃OH) 264 nm (ε 5380), λ_{max} (0.1 mol dm⁻³ HCl) 263 nm (ε 8790), λ_{max} (0.1 mol dm⁻³ NaOH) 288 nm (ε 5150).³⁸⁾

5-[(2R*,3R*,4R*,5R*)-3,4-Dihydroxy-5-hydroxymethyl-2-methyltetrahydrofuran-2-yl]uracil ((±)-1'-Methylpseudouridine) (**25a**): A mixture of a solution of **24a** (16.9 mg, 0.128 mmol) in CH₃OH (1 ml) and 10% HCl in CH₃OH (1 ml) was stirred for 30 min. Usual workup gave **25a** (15.9 mg, 100%) as a pale green foam. *R*_f=0.40 (3:1 chloroform-CH₃OH); ¹H NMR (C₅D₅N) δ 2.16 (s, CH₃), 4.22 (dd, *J*=3.1, 11.2 Hz, H_aH_bCOH), 4.38 (dd, *J*=2.5, 11.2 Hz,

H_aH_bCOH), 4.61 (ddd, $J=2.5, 3.1, 7.5$ Hz, H₅), 4.84 (dd, $J=4.7, 7.5$ Hz, H₄), 5.00 (d, $J=7.5$ Hz, H₃), 6.26 (br, OH), 8.52 (s, =CH), 12.42 and 12.96 (br, NH); UV $\lambda_{\max}$ (CH₃OH) 263 nm, $\lambda_{\max}$ (0.1 mol dm⁻³ HCl) 263 nm, $\lambda_{\max}$ (0.1 mol dm⁻³ NaOH) 265 nm (sh), 289, molar extinction coefficient has not been measured because of the extreme hygroscopicity.³⁸⁾

5-[(2R*,3R*,4R*,4R*)-3,4-Dihydroxy-5-hydroxymethyl-2-pentyltetrahydrofuran-2-yl]uracil ((±)-1'-Pentylpseudouridine) (**25b**): To a solution of **24b** (30.0 mg, 0.0847 mmol) in CH₃OH (1 ml) was added 10% HCl in CH₃OH (1 ml). After stirring for 30 min, usual workup and preparative TLC (3:1 chloroform-CH₃OH) afforded **25b** (9.6 mg, 36%) as a yellow foam. $R_f=0.44$ (3:1 chloroform-CH₃OH); ¹H NMR (C₅D₅N) δ 0.80 (t, $J=7.0$ Hz, CH₃), 1.1–2.0 (m, CH₂), 2.3–3.1 (m, CH₂, 2H), 4.36 (m, CH₂OH), 4.58 (m, H₅), 4.84 (m, H₄), 5.00 (m, H₃), 8.62 (s, =CH); UV $\lambda_{\max}$ (CH₃OH) 265 nm (ϵ 5960), $\lambda_{\max}$ (0.1 mol dm⁻³ HCl) 265 nm (ϵ 6610), $\lambda_{\max}$ (0.1 mol dm⁻³ NaOH) 266 nm (sh, ϵ 3260), 289 (4840).³⁸⁾

5-[(2R*,3S*,4S*)-3,4-Dihydroxy-5,5-bis(hydroxymethyl)-tetrahydrofuran-2-yl]uracil ((±)-4'-Hydroxymethylpseudouridine) (**33**): A mixture of **32** (50 mg, 0.175 mmol) and 10% HCl in CH₃OH (1.5 ml) was stirred for 10 min. Workup afforded **33** (38.3 mg, 89%) as a white powder. Mp 76–79 °C; ¹H NMR (dimethyl-*d*₆ sulfoxide) δ 3.46 (d-like, $J=6.0$ Hz, CH₂OH), 4.33 (m, H₂, H₃, and H₄), 4.0–5.0 (br, OH), 7.43 (d, $J=5.8$ Hz, =CH), 10.87 (d, $J=5.8$ Hz, NH), 11.05 (br s, NH); ¹³C NMR (dimethyl-*d*₆ sulfoxide) δ 61.63, 63.88, 72.40, 74.06, 78.33, 86.47, 110.59, 140.44, 150.91, 163.94; UV $\lambda_{\max}$ (CH₃OH) 264 nm (ϵ 6580), $\lambda_{\max}$ (0.1 mol dm⁻³ HCl) 264 nm (ϵ 6090), $\lambda_{\max}$ (0.1 mol dm⁻³ NaOH) 287 nm (ϵ 6780).³⁸⁾

5-[(2R*,3R*,4S*,5R*)-3,4-Dihydroxy-2,5-dimethyl-5-hydroxymethyltetrahydrofuran-2-yl]uracil ((±)-1',4'-Dimethylpseudouridine) (**47a**): To a solution of **46a** (313 mg, 0.911 mmol) in CH₃OH (2 ml) was added 10% HCl in CH₃OH (3 ml). The resulting mixture was stirred for 1 h. Usual workup afforded **47a** (274 mg, 100%). Mp 134–138 °C (CH₃OH); $R_f=0.45$ (3:1 chloroform-CH₃OH); ¹H NMR (C₅D₅N) δ 1.78 and 2.14 (s, CH₃), 3.96 (s, CH₂OH), 4.87 (d, $J=5.5$ Hz, H₃), 5.05 (d, $J=5.5$ Hz, H₄), 6.24 (br, OH), 8.48 (br s, =CH), 12.50 (br, NH), 13.04 (br, NH); ¹³C NMR (dimethyl-*d*₆ sulfoxide) δ 19.74, 23.46, 67.24, 72.11, 75.80, 82.23, 84.53, 117.80, 139.04, 151.60, 164.15; UV $\lambda_{\max}$ (CH₃OH) 265 nm (ϵ 6190), $\lambda_{\max}$ (0.1 mol dm⁻³ NaOH) 287 nm (ϵ 4760). Found: C, 46.52; H, 5.87; N, 8.98%. Calcd for C₁₁H₁₆O₆N₂·0.8H₂O: C, 46.08; H, 6.19; N, 9.77%.

5-[(2R*,3R*,4S*,5R*)-3,4-Dihydroxy-2,5-dipentyl-5-hydroxymethyltetrahydrofuran-2-yl]uracil ((±)-1',4'-Dipentylpseudouridine) (**47b**): To a solution of **46b** (100 mg, 0.236 mmol) in CH₃OH (1 ml) was added 10% HCl in CH₃OH (3 ml). After stirring for 1.5 h, the mixture was worked up to give **47b** (82.5 mg, 91%). Mp 232–236 °C (CH₃OH); ¹H NMR (dimethyl-*d*₆ sulfoxide) δ 0.86 (m, CH₃), 1.0–2.1 (m, CH₂), 3.51 (br s, CH₂OH), 4.03 (m, H₃ and H₄), 4.81 (br, OH), 7.51 (m, =CH), 10.88 (m, NH), 11.00 (br s, NH); ¹³C NMR (dimethyl-*d*₆ sulfoxide) δ 13.73, 21.98, 22.40, 22.58, 31.62, 31.77, 32.35, 32.77, 63.93, 72.11, 76.65, 83.80, 85.65, 115.67, 138.98, 151.07, 163.94; UV $\lambda_{\max}$ (CH₃OH) 265 nm (ϵ 7240), $\lambda_{\max}$ (0.1 mol dm⁻³ HCl) 265 nm (ϵ 2300), $\lambda_{\max}$ (0.1 mol dm⁻³ NaOH) 290 nm (ϵ 7200).³⁸⁾

5-[(2R*,3S*,4R*,5R*)-3,4-Dihydroxy-3,5-bis(hydroxymethyl)-tetrahydrofuran-2-yl]uracil ((±)-2'-Hydroxymethylpseudouridine) (**55a**): To a solution of **54a** (94 mg, 0.219 mmol) in CH₃OH (0.1 ml) was added 10% HCl in CH₃OH (0.2 ml). After

stirring for 30 min, the mixture was worked up to give **55a** (57 mg, 95%) as a white foam. Mp 125–130 °C; $R_f=0.29$ (10:10:1 chloroform-CH₃OH-Water); ¹H NMR (dimethyl-*d*₆ sulfoxide) δ 3.28 (s, C(OH)CH₂OH), 3.4–3.9 (m, H₄, H₅, and CH₂OH), 4.68 (s, H₂), 7.50 (d, $J=4.8$ Hz, =CH), 12.28 (d, $J=4.8$ Hz, NH), 12.40 (br, NH); ¹³C NMR (dimethyl-*d*₆ sulfoxide) δ 60.56, 63.21, 70.58, 79.62, 80.42, 82.06, 110.75, 139.17, 150.96, 164.18; UV $\lambda_{\max}$ (CH₃OH) 267 nm (ϵ 5710), $\lambda_{\max}$ (0.1 mol dm⁻³ HCl) 266 nm (ϵ 5140), $\lambda_{\max}$ (0.1 mol dm⁻³ NaOH) 285 nm (ϵ 3780).³⁸⁾

5-[(2R*,3S*,4R*,5R*)-3,4-Dihydroxy-5-hydroxymethyl-3-methyltetrahydrofuran-2-yl]uracil ((±)-2'-Methylpseudouridine) (**55b**): To a solution of **54b** (30 mg, 0.101 mmol) in CH₃OH (0.5 ml) was added 10% HCl in CH₃OH (0.5 ml) and the resulting mixture was stirred for 1 h. Workup afforded **54b** (25 mg, 96%). Mp 138–142 °C; $R_f=0.40$ (2:1 chloroform-CH₃OH); ¹H NMR (dimethyl-*d*₆ sulfoxide) δ 0.99 (s, CH₃), 3.60 (m, H₄, H₅, and CH₂OH), 4.00 (br, OH), 4.68 (s, H₂), 7.60 (d, $J=5.0$ Hz, =CH), 10.78 (d, $J=5.0$ Hz, NH), 10.99 (br, NH); ¹³C NMR (dimethyl-*d*₆ sulfoxide) δ 20.95, 60.31, 73.57, 77.99, 81.31, 81.53, 112.13, 138.92, 150.90, 163.68; UV $\lambda_{\max}$ (CH₃OH) 264 nm (ϵ 6420), $\lambda_{\max}$ (0.1 mol dm⁻³ HCl) 263 nm (ϵ 8760), $\lambda_{\max}$ (0.1 mol dm⁻³ NaOH) 285 nm (ϵ 8020).³⁸⁾

5-[(2R*,3R*,4S*,5S*)-3,4-Dihydroxy-5-(1-hydroxy-1-methyl-ethyl)tetrahydrofuran-2-yl]-2-thiouracil ((±)-5',5'-Dimethyl-2-thiopseudouridine) (**11a**): A mixture of **10a** (158 mg, 0.549 mmol) and 10% HCl in CH₃OH (5 ml) was stirred for 10 min. Usual workup afforded **11a** (135 mg, 97%) as a white powder. Mp 109–115 °C; ¹H NMR (C₅D₅N) δ 1.58 and 1.60 (s, CH₃), 4.34 (d, $J=3.8$ Hz, H₅), 4.96 (m, H₃ and H₄), 5.31 (d, $J=5.0$ Hz, H₂), 5.70 (br, OH and NH), 8.19 (s, =CH); UV $\lambda_{\max}$ (CH₃OH) 214 nm (ϵ 5780), 276 (6660), 292 (5990), $\lambda_{\max}$ (0.1 mol dm⁻³ HCl) 214 nm (ϵ 7560), 274 (8810), 289 (8890), $\lambda_{\max}$ (0.1 mol dm⁻³ NaOH) 222 nm (ϵ 7910), 263 (6670), 284 (5020).³⁸⁾

5-[(2R*,3R*,4R*,5R*)-3,4-Dihydroxy-5-[(R*)-1-hydroxyethyl]tetrahydrofuran-2-yl]-2-thiouracil ((±)-5'-Methyl-2-thiopseudouridine) (**11b**): To a solution of **10a** (52.1 mg, 0.155 mmol) in CH₃OH (2 ml) was added 10% HCl in CH₃OH (2 ml). The resulting mixture was stirred for 5 min and worked up to give **11b** (48.6 mg, 100%) as a wax. ¹H NMR (C₅D₅N) δ 1.51 (d, $J=6.0$ Hz, CH₃), 4.67 (m, H₅ and HCOH), 4.96 (m, H₃ and H₄), 5.35 (d, $J=5.2$ Hz, H₂), 6.0 (br, OH and NH), 8.16 (s, =CH); UV $\lambda_{\max}$ (CH₃OH) 215 nm (ϵ 6610), 277 (8350), 291 (7590), $\lambda_{\max}$ (0.1 mol dm⁻³ HCl) 213 nm (ϵ 6080), 280 (4630), 295 (5630), $\lambda_{\max}$ (0.1 mol dm⁻³ NaOH) 221 nm (ϵ 11400), 264 (10200), 285 (7730).³⁸⁾

5-[(2R*,3R*,4R*,5R*)-3,4-Dihydroxy-5-[(R*)-1-hydroxyhexyl]tetrahydrofuran-2-yl]-2-thiouracil ((±)-5'-Pentyl-2-thiopseudouridine) (**11c**): To a solution of **10c** (62.8 mg, 0.170 mmol) in CH₃OH (1 ml) was added 10% HCl in CH₃OH (2 ml). After stirring for 10 min, the mixture was worked up to afford **11c** (32.5 mg, 58%). Mp 164–170 °C; ¹H NMR (C₅D₅N) δ 0.81 (t, $J=7.0$ Hz, CH₃), 1.1–2.0 (m, CH₂), 4.30 (m, HCOH) 4.57 (t-like, $J=3.0$ Hz, H₅), 5.00 (m, H₃ and H₄), 5.35 (d, $J=5.2$ Hz, H₂), 5.4–6.8 (br, OH and NH), 8.14 (s, =CH); UV $\lambda_{\max}$ (CH₃OH) 214 nm (ϵ 4310), 276 (5160), 291 (4670), $\lambda_{\max}$ (0.1 mol dm⁻³ HCl) 215 nm (ϵ 7090), 276 (8230), 290 (8230), $\lambda_{\max}$ (0.1 mol dm⁻³ NaOH) 222 nm (ϵ 5300), 264 (4340), 285 (3420).³⁸⁾

5-[(2R*,3R*,4R*,5S*)-3,4-Dihydroxy-5-[(S*)- α -hydroxybenzyl]tetrahydrofuran-2-yl]-2-thiouracil ((±)-5'-Phenyl-2-thiopseudouridine) (**11d**): To a suspension of **10d** (26.6 mg, 0.071 mmol) in CH₃OH (1 ml) was added 10% HCl in CH₃OH (1 ml). The resulting mixture was stirred for 10

min and worked up to give **11d** (24.9 mg, 100%). Mp 126–130 °C; ^1H NMR (dimethyl- d_6 sulfoxide) δ 3.95 (d-like, $J=3.1$ Hz, H_6), 4.46 (d, $J=3.0$ Hz, H_4), 4.70 (m, H_3), 4.90 (m, H_2), 5.59 (d, $J=3.0$ Hz, HCOH), 7.2–7.5 (m, C_6H_5), 7.44 (s, $=\text{CH}$); UV λ_{max} (CH_3OH) 212 nm (ϵ 4380), 277 (3620), 290 (3240), λ_{max} (0.1 mol dm^{-3} HCl) 275 nm (ϵ 6900), 290 (6440), λ_{max} (0.1 mol dm^{-3} NaOH) 264 nm (ϵ 6510), 285 (5030).³⁸

5-[(2R*,3S*,4S*,5R*)-3,4-Dihydroxy-5-hydroxymethyl-5-methyltetrahydrofuran-2-yl]-2-thiouracil (($\pm$)-4'-Methyl-2-thiopseudouridine) (**19a**): To a solution of **18a** (22.1 mg, 0.0704 mmol) in CH_3OH (1.5 ml) was added 10% HCl in CH_3OH (1.5 ml) and the resulting mixture was stirred for 20 min. Usual workup afforded **19a** (18.4 mg, 95%). Mp 157–162 °C (CH_3OH); $R_f=0.55$ (3:1 chloroform- CH_3OH); ^1H NMR ($\text{C}_5\text{D}_5\text{N}$) δ 1.69 (s, CH_3), 3.93 (d, $J=11.5$ Hz, $\text{H}_a\text{H}_b\text{COH}$), 4.07 (d, $J=11.5$ Hz, $\text{H}_a\text{H}_b\text{COH}$), 4.88 (d, $J=5.5$ Hz, H_4), 5.10 (t, $J=5.5$ Hz, H_3), 5.35 (d, $J=5.5$ Hz, H_2), 8.16 (s, $=\text{CH}$); UV λ_{max} (CH_3OH) 215 nm (ϵ 10920), 276 (15550), 291 (14070), λ_{max} (0.1 mol dm^{-3} HCl) 214 nm (ϵ 13150), 276–290 (flat, 15570), λ_{max} (0.1 mol dm^{-3} NaOH) 223 nm (ϵ 12640), 264 (11240), 286 (8570). Found: m/z , 274.0613. Calcd for $\text{C}_{10}\text{H}_{14}\text{O}_5\text{N}_2\text{S}$: M, 274.0623.

5-[(2R*,3S*,4S*,5R*)-3,4-Dihydroxy-5-hydroxymethyl-5-pentyltetrahydrofuran-2-yl]-2-thiouracil (($\pm$)-4'-Pentyl-2-thiopseudouridine) (**19b**). To a suspension of **18b** (17.7 mg, 0.048 mmol) in CH_3OH (1.5 ml) was added 10% HCl in CH_3OH (1.5 ml). After stirring for 30 min, the mixture was worked up in a usual manner to give **19b** (16.9 mg, 100%). Mp 203–205 °C (CH_3OH); $R_f=0.74$ (3:1 chloroform- CH_3OH); ^1H NMR ($\text{C}_5\text{D}_5\text{N}$) δ 0.81 (t, $J=6.0$ Hz, CH_3), 1.2–2.0 (m, CH_2), 3.96 (d, $J=11.8$ Hz, $\text{H}_a\text{H}_b\text{COH}$), 4.12 (d, $J=11.8$ Hz, $\text{H}_a\text{H}_b\text{COH}$), 4.87 (br s, H_4), 5.20 (m, H_2 and H_3), 6.0 (br, OH), 8.02 (s, $=\text{CH}$); UV λ_{max} (CH_3OH) 215 nm (ϵ 13320), 276 (18690), 291 (16950), λ_{max} (0.1 mol dm^{-3} HCl) 214 nm (ϵ 14310), 275–290 (flat, 16500), λ_{max} (0.1 mol dm^{-3} NaOH) 223 nm (ϵ 13790), 264 (12100), 286 (9340).³⁸

5-[(2R*,3S*,4S*,5R*)-3,4-Dihydroxy-5-hydroxymethyl-5-phenyltetrahydrofuran-2-yl]-2-thiouracil (($\pm$)-4'-Phenyl-2-thiopseudouridine) (**19c**): A mixture of **18c** (106 mg, 0.282 mmol) and 9:1 $\text{CF}_3\text{COOH}-\text{H}_2\text{O}$ (4 ml) was stirred for 10 min. Usual workup afforded **19c** (84.1 mg, 89%). Mp 249–250 °C (CH_3OH); $R_f=0.70$ (3:1 chloroform- CH_3OH); ^1H NMR (dimethyl- d_6 sulfoxide) δ 3.34 (m, CH_2OH), 4.57 (m, H_3), 5.10 (m, H_2 and H_4), 7.30 (m, C_6H_5), 7.66 (d, $J=5.5$ Hz, $=\text{CH}$), 12.43 (d, $J=5.5$ Hz, NH), 12.57 (br s, NH); UV λ_{max} (CH_3OH) 276 nm (ϵ 16620), 290 (14970), λ_{max} (0.1 mol dm^{-3} HCl) 276 nm (ϵ 13620), 289 (13790), λ_{max} (0.1 mol dm^{-3} NaOH) 216 nm (ϵ 19540), 264 (13910), 289 (13790). Found: C, 52.75; H, 4.70; N, 8.12; S, 9.68%. Calcd for $\text{C}_{15}\text{H}_{16}\text{O}_5\text{N}_2\text{S}$: C, 53.36; H, 4.80; N, 8.33; S, 9.53%.

5-[(2R*,3R*,4R*,5R*)-3,4-Dihydroxy-5-hydroxymethyl-2-methyltetrahydrofuran-2-yl]-2-thiouracil (($\pm$)-1'-Methyl-2-thiopseudouridine) (**27a**): To a solution of **26a** (54.7 mg, 0.175 mmol) in CH_3OH (1 ml) was added 10% HCl in CH_3OH (1 ml). After stirring for 30 min, the mixture was worked up to give **27a** (50.3 mg, 100%) as a yellow foam. $R_f=0.60$ (3:1 chloroform- CH_3OH); ^1H NMR ($\text{C}_5\text{D}_5\text{N}$) δ 2.16 (s, CH_3), 4.21 (dd, $J=2.0$, 11.9 Hz, $\text{H}_a\text{H}_b\text{COH}$), 4.38 (dd, $J=3.1$, 11.9 Hz, $\text{H}_a\text{H}_b\text{COH}$), 4.60 (ddd, $J=2.0$, 3.1, 6.1 Hz, H_5), 4.82 (dd, $J=4.6$, 6.1 Hz, H_4), 4.96 (d, $J=6.1$ Hz, H_3), 6.0–6.9 (br, OH and NH), 8.71 (s, $=\text{CH}$); UV λ_{max} (CH_3OH) 215 nm (ϵ 10940), 276 (14430), 290 (13270), λ_{max} (0.1 mol dm^{-3} HCl) 215 nm (ϵ 11000), 275 (14330),

290 (sh, 13320), λ_{max} (0.1 mol dm^{-3} NaOH) 221 nm (sh, ϵ 12680), 262 (12310), 295 (sh, 6620).³⁸

5-[(2R*,3R*,4R*,5R*)-3,4-Dihydroxy-5-hydroxymethyl-2-pentyltetrahydrofuran-2-yl]-2-thiouracil (($\pm$)-1'-Pentyl-2-thiopseudouridine) (**27b**): To a solution of **26b** (52.6 mg, 0.142 mmol) in CH_3OH (1 ml) was added 10% HCl in CH_3OH (1 ml). The mixture was stirred for 30 min and worked up to give **27b** (41.6 mg, 89%) as a yellow foam. $R_f=0.72$ (3:1 chloroform- CH_3OH); ^1H NMR ($\text{C}_5\text{D}_5\text{N}$) δ 0.76 (t, $J=7.0$ Hz, CH_3), 1.0–1.9 (m, CH_2), 2.2–3.1 (m, CH_2 , 2H), 4.27 (dd, $J=2.2$, 11.9 Hz, $\text{H}_a\text{H}_b\text{COH}$), 4.44 (dd, $J=2.3$, 11.9 Hz, $\text{H}_a\text{H}_b\text{COH}$), 4.56 (ddd, $J=2.2$, 2.3, 7.0 Hz, H_5), 4.86 (dd, $J=5.0$, 7.0 Hz, H_4), 4.95 (d, $J=5.0$ Hz, H_3), 6.0–7.2 (br, OH and NH), 8.78 (s, $=\text{CH}$); UV λ_{max} (CH_3OH) 215 nm (ϵ 10910), 277 (14540), 291 (13190), λ_{max} (0.1 mol dm^{-3} HCl) 213 nm (sh, ϵ 7280), 273 (8440), 295 (sh, 6160), λ_{max} (0.1 mol dm^{-3} NaOH) 220 nm (sh, ϵ 9340), 262 (9420), 297 (sh, 4590). Found: m/z , 330.1244. Calcd for $\text{C}_{14}\text{H}_{22}\text{O}_5\text{N}_2\text{S}$: M, 330.1249.

5-[(2R*,3S*,4S*)-3,4-Dihydroxy-5,5-bis(hydroxymethyl)tetrahydrofuran-2-yl]-2-thiouracil (($\pm$)-4'-Hydroxymethyl-2-thiopseudouridine) (**35**): A mixture of **34** (35.8 mg, 0.119 mmol) and 10% HCl in CH_3OH (1 ml) was stirred for 10 min. Usual workup afforded **35** (32.3 mg, 90%) as a white powder. Mp 84–87 °C; ^1H NMR (dimethyl- d_6 sulfoxide) δ 3.48 (d-like, $J=5.9$ Hz, CH_2OH), 4.06 (m, H_3), 4.61 (m, H_2 and H_4), 4.3–5.0 (br, OH), 7.52 (d, $J=5.9$ Hz, $=\text{CH}$), 11.84 (d, $J=5.9$ Hz, NH), 11.98 (br s, NH); ^{13}C NMR (dimethyl- d_6 sulfoxide) δ 61.68, 63.94, 72.45, 74.09, 78.41, 86.51, 110.62, 140.43, 150.92, 163.95; UV λ_{max} (CH_3OH) 213 nm (ϵ 14110), 275 (15840), 296 (sh, 13120), λ_{max} (0.1 mol dm^{-3} HCl) 214 nm (ϵ 13500), 273 (13500), 292 (sh, 12080), λ_{max} (0.1 mol dm^{-3} NaOH) 265 nm (ϵ 13620), 285 (12920).³⁸

5-[(2R*,3R*,4R*,5R*)-3,4-Dihydroxy-2,5-bis(hydroxymethyl)tetrahydrofuran-2-yl]-2-thiouracil (($\pm$)-1'-Hydroxymethyl-2-thiopseudouridine) (**41**): To a solution of **40** (50 mg, 0.156 mmol) in CH_3OH (1 ml) was added 10% HCl in CH_3OH (0.5 ml). After stirring for 10 min, the mixture was worked up in a usual manner to give **41** (39 mg, 87%) as a white powder. Mp 130–135 °C; ^1H NMR (dimethyl- d_6 sulfoxide) δ 3.49 (d-like, $J=6.5$ Hz, CH_2OH), 3.9–4.3 (m, H_3 , H_4 , H_5 , and OH), 7.53 (m, $=\text{CH}$), 12.30 (br, NH), 12.44 (br s, NH); UV λ_{max} (CH_3OH) 213 nm (ϵ 12360), 275 (12540), 299 (sh, 10300), λ_{max} (0.1 mol dm^{-3} HCl) 213 nm (ϵ 13820), 274 (13340), 297 (sh, 11200), λ_{max} (0.1 mol dm^{-3} NaOH) 265 nm (ϵ 12580), 284 (10440).³⁸

5-[(2R*,3R*,4S*,5R*)-3,4-Dihydroxy-2,5-dimethyl-5-hydroxymethyltetrahydrofuran-2-yl]-2-thiouracil (($\pm$)-1',4'-Dimethyl-2-thiopseudouridine) (**49a**): To a solution of **48a** (229 mg, 0.670 mmol) in CH_3OH (2 ml) was added 10% HCl in CH_3OH (3 ml). The resulting mixture was stirred for 1 h and worked up to afford **49a** (192 mg, 98%). Mp 182–186 °C (CH_3OH); ^1H NMR ($\text{C}_5\text{D}_5\text{N}$) δ 1.75 and 2.13 (s, CH_3), 3.98 (s, CH_2OH), 4.86 (d, $J=5.2$ Hz, H_3), 4.97 (d, $J=5.2$ Hz, H_4), 6.50 (br, OH), 8.65 (s, $=\text{CH}$); ^{13}C NMR (dimethyl- d_6 sulfoxide) δ 19.59, 22.88, 66.42, 71.24, 75.06, 81.95, 84.30, 123.01, 138.83, 160.89, 175.01; UV λ_{max} (CH_3OH) 216 nm (ϵ 13430), 277 (18980), 290 (17230), λ_{max} (0.1 mol dm^{-3} HCl) 216 nm (ϵ 12870), 277 (16560), 285 (16370), λ_{max} (0.1 mol dm^{-3} NaOH) 222 nm (ϵ 15860), 262 (14800), 290 (9650). Found: C, 45.76; H, 5.74; N, 9.47; S, 10.86%. Calcd for $\text{C}_{11}\text{H}_{16}\text{O}_5\text{N}_2\text{S}$: C, 45.83; H, 5.59; N, 9.72; S, 11.12%.

5-[(2R*,3R*,4S*,5R*)-3,4-Dihydroxy-2,5-dipentyl-5-hydroxymethyltetrahydrofuran-2-yl]-2-thiouracil (($\pm$)-1',4'-Dipentyl-2-thiopseudouridine) (**49b**): To a solution of **48b** (404 mg, 0.910 mmol) in CH_3OH (3 ml) was added 10% HCl in CH_3OH

(3 ml). The mixture was stirred for 1 h and worked up in a usual manner to afford **49b** (392 mg, 100%). Mp 105–110 °C (CH₃OH); ¹H NMR (dimethyl-*d*₆ sulfoxide) δ 0.84 (m, CH₃), 1.0–2.1 (m, CH₂), 3.34 (m, CH₂OH), 3.8–5.0 (br, OH), 4.04 (m, H₃ and H₄), 7.57 (m, =CH), 12.26 (m, NH), 12.35 (br s, NH); ¹³C NMR (dimethyl-*d*₆ sulfoxide) δ 13.73, 21.99, 22.50, 31.71, 32.37, 63.71, 71.89, 76.25, 83.89, 85.78, 121.27, 138.93, 160.73, 174.68; UV λ_{max} (CH₃OH) 215 nm (ϵ 9330), 277 (13170), 290 (sh, 11690), λ_{max} (0.1 mol dm⁻³ HCl) 217 nm (ϵ 6280), 275 (9980), 289 (9460), λ_{max} (0.1 mol dm⁻³ NaOH) 225 nm (ϵ 10110), 262 (10790).³⁸⁾

5-[(2S*,3R*,4R*,5R*)-3,4-Dihydroxy-3,5-bis(hydroxymethyl)-tetrahydrofuran-2-yl]-2-thiouracil (($\pm$)-2'-Hydroxymethyl-2-thiopseudouridine) (**59a**): To a solution of **58a** (237 mg, 0.534 mmol) in CH₃OH (2.8 ml) was added 10% HCl in CH₃OH (5 ml). After stirring for 30 min, the mixture was worked up as usual to afford **59a** (148 mg, 96%). Mp 140–145 °C; *R*_f=0.48 (10:10:1 chloroform–CH₃OH–water); ¹H NMR (dimethyl-*d*₆ sulfoxide) δ 3.27 (s, C(OH)CH₂OH), 3.4–3.7 (m, H₄ and H₅), 3.64 (d, *J*=8.0 Hz, H_aH_bCOH), 3.85 (d, *J*=8.0 Hz, H_aH_bCOH), 4.25 (br, OH), 4.68 (s, H₂), 7.50 (d, *J*=5.5 Hz, =CH), 12.26 (d, *J*=5.5 Hz, NH), 12.38 (br, NH); ¹³C NMR (dimethyl-*d*₆ sulfoxide) δ 60.54, 62.70, 70.17, 79.88, 80.16, 82.05, 116.58, 138.54, 160.90, 174.63; UV λ_{max} (CH₃OH) 215 nm (ϵ 9080), 277 (11700), λ_{max} (0.1 mol dm⁻³ HCl) 215 nm (ϵ 9400), 276 (11000), λ_{max} (0.1 mol dm⁻³ NaOH) 220 nm (ϵ 11700), 264 (9060). Found: C, 37.22; H, 5.06; N, 7.42%. Calcd for C₁₀H₁₄O₆N₂S·2.3H₂O: C, 36.21; H, 5.64; N, 8.45%.

5-[(2S*,3R*,4R*,5R*)-3,4-Dihydroxy-5-hydroxymethyl-3-methyltetrahydrofuran-2-yl]-2-thiouracil (($\pm$)-2'-Methyl-2-thiopseudouridine) (**59b**): To a solution of **58b** (194 mg, 0.618 mmol) in CH₃OH (3 ml) was added 10% HCl in CH₃OH (5 ml). The mixture was stirred for 30 min and worked up to give **59b** (164 mg, 97%). Mp 132–136 °C (CH₃OH–ether); *R*_f=0.61 (2:1 chloroform–CH₃OH); ¹H NMR (dimethyl-*d*₆ sulfoxide) δ 0.98 (s, CH₃), 3.6 (m, H₄, H₅, and CH₂OH), 4.22 (br, OH), 4.70 (s, H₂), 7.68 (d, *J*=5.5 Hz, =CH), 12.26 (d, *J*=5.5 Hz, NH), 12.38 (br, NH); ¹³C NMR (dimethyl-*d*₆ sulfoxide) δ 20.87, 60.18, 73.46, 78.06, 81.05, 81.59, 117.70, 138.51, 160.53, 174.75; UV λ_{max} (CH₃OH) 215 nm (ϵ 9470), 276 (11600), λ_{max} (0.1 mol dm⁻³ HCl) 215 nm (ϵ 10200), 275 (11000), λ_{max} (0.1 mol dm⁻³ NaOH) 220 nm (ϵ 17300), 263 (14500). Found: C, 40.81; H, 5.19; N, 9.44; S, 10.58%. Calcd for C₁₀H₁₄O₅N₂S·1.1H₂O: C, 40.84; H, 5.55; N, 9.53; S, 10.90%.

5-[(2R*,3R*,4S*,5S*)-3,4-Dihydroxy-5-(1-hydroxy-1-methyl-ethyl)tetrahydrofuran-2-yl]isocytosine Hydrochloride (($\pm$)-5'-Dimethylpseudoisocytidine Hydrochloride) (**13a**): To a suspension of **12a** (35.2 mg, 0.113 mmol) in CH₃OH (2 ml) was added 10% HCl in CH₃OH (1 ml). The reaction mixture was stirred for 10 min and worked up in a usual way to afford **13a** (40.1 mg, 100%) as a wax. ¹H NMR (dimethyl-*d*₆ sulfoxide) δ 1.14 (s, CH₃), 3.52 (d, *J*=4.1 Hz, H₅), 3.97 (m, H₃ and H₄), 4.49 (d, *J*=5.0 Hz, H₂), 4.6–6.4 (br, OH), 7.91 (s, =CH), 8.53 (br, NH₂); UV λ_{max} (CH₃OH) 223 nm (ϵ 10500), 265 (7160), 290 (3910), λ_{max} (0.1 mol dm⁻³ HCl) 221 nm (ϵ 8950), 262 (6890), λ_{max} (0.1 mol dm⁻³ NaOH) 233 nm (ϵ 8670), 276 (6870).³⁸⁾

5-[(2R*,3R*,4R*,5R*)-3,4-Dihydroxy-5-[(R*)-1-hydroxy-ethyl]tetrahydrofuran-2-yl]isocytosine Hydrochloride (($\pm$)-5'-Methylpseudoisocytidine Hydrochloride) (**13b**): To a suspension of **12b** (57.4 mg, 0.193 mmol) in CH₃OH (2 ml) was added 10% HCl in CH₃OH (2 ml). After stirring for 10 min, the mixture was worked up to afford **13b** (53.1 mg, 94%). Mp 198.0–202.0 °C; ¹H NMR (C₆D₆N) δ 1.58 (d, *J*=

5.8 Hz, CH₃), 4.35 (m, H₅ and HCOH), 4.92 (m, H₄), 5.18 (m, H₂ and H₃), 6.50 (br, OH and NH), 8.12 (s, =CH); UV λ_{max} (CH₃OH) 223 nm (ϵ 10500), 265 (7160), 290 (3910), λ_{max} (0.1 mol dm⁻³ HCl) 221 nm (ϵ 8950), 262 (6890), λ_{max} (0.1 mol dm⁻³ NaOH) 233 nm (ϵ 8670), 276 (6870).³⁸⁾

5-[(2R*,3R*,4R*,5R*)-3,4-Dihydroxy-5-[(R*)-1-hydroxy-hexyl]tetrahydrofuran-2-yl]isocytosine Hydrochloride (($\pm$)-5'-Pentylpseudoisocytidine Hydrochloride) (**13c**): To a suspension of **12c** (106 mg, 0.30 mmol) in CH₃OH (3 ml) was added 10% HCl in CH₃OH (2 ml) and the resulting mixture was stirred for 15 min. Usual workup afforded **13c** (95.1 mg, 91%). Mp 168.0–172.0 °C (CH₃OH); ¹H NMR (dimethyl-*d*₆ sulfoxide) δ 0.88 (t, *J*=6.0 Hz, CH₃), 1.1–1.6 (m, CH₂), 3.60 (m, H₅ and HCOH), 4.00 (m, H₃ and H₄), 4.47 (d, *J*=4.9 Hz, H₂), 7.80 (s, =CH), 8.45 (br, NH₂); UV λ_{max} (CH₃OH) 224 nm (ϵ 9630), 266 (6220), 290 (4180), λ_{max} (0.1 mol dm⁻³ HCl) 220 nm (ϵ 11800), 262 (9070), λ_{max} (0.1 mol dm⁻³ NaOH) 233 nm (ϵ 7340), 276 (5840). Found: C, 47.83; H, 6.90; N, 12.04%. Calcd for C₁₄H₂₃O₅N₃Cl: C, 48.21; H, 6.65; N, 12.05%.

5-[(2R*,3R*,4R*,5S*)-3,4-Dihydroxy-5-[(S*)- α -hydroxy-benzyl]tetrahydrofuran-2-yl]isocytosine Hydrochloride (($\pm$)-5'-Phenylpseudoisocytidine Hydrochloride) (**13d**): To a suspension of **12d** (29.3 mg, 0.082 mmol) in CH₃OH (1 ml) was added 10% HCl in CH₃OH (1 ml). After stirring for 15 min, the mixture was worked up in a usual manner to give **13d** (33.4 mg, 100%) as a wax. ¹H NMR (dimethyl-*d*₆ sulfoxide) δ 3.98 (m, H₃, H₄, and H₅), 4.4–5.7 (br, OH), 4.48 (d, *J*=6.0 Hz, H₂), 4.70 (m, HCOH), 7.35 (m, C₆H₅), 7.61 (s, =CH), 8.57 (br, NH₂); UV λ_{max} (CH₃OH) 225 nm (ϵ 12700), 264 (8240), 290 (3960), λ_{max} (0.1 mol dm⁻³ HCl) 263 (ϵ 10300), λ_{max} (0.1 mol dm⁻³ NaOH) 233 nm (ϵ 13200), 277 (10100).³⁸⁾

5-[(2R*,3S*,4S*,5R*)-3,4-Dihydroxy-5-hydroxymethyl-5-methyltetrahydrofuran-2-yl]isocytosine Hydrochloride (($\pm$)-4'-Methylpseudoisocytidine Hydrochloride) (**21a**): To a solution of **20a** (14.9 mg, 0.05 mmol) in CH₃OH (3 ml) was added 10% HCl in CH₃OH (2 ml) and the resulting mixture was stirred for 30 min. After usual workup, pure **21a** (17.9 mg, 100%) was obtained. Mp 212–215 °C (CH₃OH); ¹H NMR (dimethyl-*d*₆ sulfoxide) δ 1.10 (s, CH₃), 3.25 (d, *J*=11.5 Hz, H_aH_bCOH), 3.41 (d, *J*=11.5 Hz, H_aH_bCOH), 3.93 (d, *J*=5.8 Hz, H₄), 4.10 (dd, *J*=5.8, 6.0 Hz, H₃), 4.52 (d, *J*=6.0 Hz, H₂), 7.80 (s, =CH), 8.38 (br, NH₂); UV λ_{max} (CH₃OH) 223 nm (ϵ 12360), 263 (8050), 290 (5530), λ_{max} (0.1 mol dm⁻³ HCl) 220 nm (ϵ 14820), 262 (10940), λ_{max} (0.1 mol dm⁻³ NaOH) 238 nm (ϵ 11760), 280 (4530). Found: C, 40.45; H, 5.30; N, 14.10%. Calcd for C₁₀H₁₅O₅N₃Cl: C, 40.89; H, 5.49; N, 14.31%.

5-[(2R*,3S*,4S*,5R*)-3,4-Dihydroxy-5-hydroxymethyl-5-pentyltetrahydrofuran-2-yl]isocytosine Hydrochloride (($\pm$)-4'-Pentylpseudoisocytidine Hydrochloride) (**21b**): To a solution of **20b** (20.3 mg, 0.0575 mmol) in CH₃OH (2 ml) was added 10% HCl in CH₃OH (2 ml). After stirring for 30 min, the mixture was worked up in a usual manner to give **21b** (12.9 mg, 58%). Mp 188–190 °C (CH₃OH); ¹H NMR (dimethyl-*d*₆ sulfoxide) δ 0.92 (t, *J*=6.0 Hz, CH₃), 1.1–1.7 (m, CH₂), 3.42 (br s, CH₂OH), 4.01 (d, *J*=5.0 Hz, H₄), 4.23 (dd, *J*=5.0, 7.0 Hz, H₃), 4.50 (d, *J*=7.0 Hz, H₂), 7.80 (s, =CH), 8.38 (br, NH₂); UV λ_{max} (CH₃OH) 225 nm (ϵ 7520), 266 (4910), 290 (3020), λ_{max} (0.1 mol dm⁻³ HCl) 220 nm (ϵ 10840), 262 (8200), λ_{max} (0.1 mol dm⁻³ NaOH) 231 nm (ϵ 12550), 276 (8620). Found: C, 46.64; H, 6.65; N, 11.60%. Calcd for C₁₄H₂₃O₅N₃Cl·0.5H₂O: C, 46.99; H, 6.76; N, 11.74%.

5-[(2R*,3S*,4S*,5R*)-3,4-Dihydroxy-5-hydroxymethyl-5-phenyl-

tetrahydrofuran-2-yl]isocytosine Hydrochloride ((±)-4'-Phenylpseudoisocytidine Hydrochloride) (21c): To a solution of **20c** (35.7 mg, 0.0994 mmol) in CH₃OH (1 ml) was added 10% HCl in CH₃OH (1 ml) and the resulting mixture was stirred for 10 min. Usual workup gave **21c** (35.0 mg, 99%). Mp 218–221 °C (CH₃OH); ¹H NMR (dimethyl-*d*₆ sulfoxide) δ 3.40 (d, *J*=11.9 Hz, H_aH_bCOH), 3.69 (d, *J*=11.9 Hz, H_aH_bCOH), 4.35 (m, H₂ and H₃), 4.69 (d, *J*=6.0 Hz, H₄), 7.30 (m, C₆H₅), 7.98 (s, =CH), 8.48 (br, NH₂); UV λ_{max} (CH₃OH) 217 nm (ε 17630), 262 (9530), λ_{max} (0.1 mol dm⁻³ HCl) 263 nm (ε 7880), λ_{max} (0.1 mol dm⁻³ NaOH) 231 nm (ε 14130), 276 (9740).³⁸⁾

5-[(2R*,3R*,4R*,5R*)-3,4-Dihydroxy-5-hydroxymethyl-2-methyltetrahydrofuran-2-yl]isocytosine Hydrochloride ((±)-1'-Methylpseudoisocytidine Hydrochloride) (**29a**): To a suspension of **28a** (52.4 mg, 0.178 mmol) in CH₃OH (1 ml) was added 10% HCl in CH₃OH (1 ml). After stirring for 30 min, the mixture was worked up as usual to afford **29a** (48.4 mg, 93%) as a yellow foam. ¹H NMR (dimethyl-*d*₆ sulfoxide) δ 1.38 (s, CH₃), 3.5–3.9 (m, H₄, H₅, and CH₂OH), 4.02 (d, *J*=3.5 Hz, H₃), 7.90 (s, =CH), 8.48 (br, NH₂); UV λ_{max} (CH₃OH) 222 nm (ε 9490), 262 (6290), 300 (sh, 1030), λ_{max} (0.1 mol dm⁻³ HCl) 221 nm (ε 8680), 262 (6450), λ_{max} (0.1 mol dm⁻³ NaOH) 230 nm (ε 11030), 278 (8250).³⁸⁾

5-[(2R*,3R*,4R*,5R*)-3,4-Dihydroxy-5-hydroxymethyl-2-pentyltetrahydrofuran-2-yl]isocytosine Hydrochloride ((±)-1'-Pentylpseudoisocytidine Hydrochloride) (**29b**): To a solution of **28b** (28.2 mg, 0.0799 mmol) in CH₃OH (1 ml) was added 10% HCl in CH₃OH (1 ml) and the resulting mixture was stirred for 30 min. Usual workup afforded **29b** (25.7 mg, 92%) as a yellow foam. ¹H NMR (dimethyl-*d*₆ sulfoxide) δ 0.81 (t, *J*=6.0 Hz, CH₃), 1.0–2.0 (m, CH₂), 3.5–3.9 (m, H₄, H₅, and CH₂OH), 4.04 (d, *J*=4.0 Hz, H₃), 7.86 (s, =CH), 8.2–8.8 (br, NH₂); UV λ_{max} (CH₃OH) 210 nm (sh, ε 12180), 225 (7940), 261 (4380), 300 (sh, 1170), λ_{max} (0.1 mol dm⁻³ HCl) 210 nm (ε 12310), 225 (sh, 8660), 262 (4780), λ_{max} (0.1 mol dm⁻³ NaOH) 230 nm (sh, ε 7120), 277 (4780).³⁸⁾

5-[(2R*,3S*,4S*)-3,4-Dihydroxy-5,5-bis(hydroxymethyl)tetrahydrofuran-2-yl]isocytosine Hydrochloride ((±)-4'-Hydroxymethylpseudoisocytidine Hydrochloride) (**37**): A mixture of **36** (56.0 mg, 0.179 mmol) and 10% HCl in CH₃OH (1.5 ml) was stirred for 15 min. Usual workup gave **37** (50.3 mg, 91%) as a white powder. Mp 177–182 °C; ¹H NMR (dimethyl-*d*₆ sulfoxide) δ 3.51 (d-like, *J*=6.1 Hz, CH₂OH), 4.08 (m, H₃ and H₄), 4.57 (m, H₂), 5.0–6.4 (br, OH), 7.82 (br s, =CH), 8.50 (br, NH₂); UV λ_{max} (CH₃OH) 224 nm (ε 9250), 263 (7870), λ_{max} (0.1 mol dm⁻³ HCl) 222 nm (ε 9580), 263 (7520), λ_{max} (0.1 mol dm⁻³ NaOH) 233 nm (ε 10870), 278 (8510).³⁸⁾

5-[(2R*,3R*,4S*,5R*)-3,4-Dihydroxy-2,5-dimethyl-5-hydroxymethyltetrahydrofuran-2-yl]isocytosine Hydrochloride ((±)-1',4'-Dimethylpseudoisocytidine Hydrochloride) (**51a**): To a suspension of **50a** (202 mg, 0.641 mmol) in CH₃OH (3 ml) was added 10% HCl in CH₃OH (3 ml). After stirring for 1 h, the mixture was worked up to afford **51a** (193 mg, 97%) as a white powder. Mp 215–220 °C; ¹H NMR (dimethyl-*d*₆ sulfoxide) δ 1.12 and 1.39 (s, CH₃), 3.29 (s, CH₂OH), 3.90 (d, *J*=5.7 Hz, H₃), 4.11 (d, *J*=5.7 Hz, H₄), 7.94 (s, =CH), 8.37 (br, NH₂); ¹³C NMR (dimethyl-*d*₆ sulfoxide) δ 19.47, 22.77, 66.07, 70.95, 74.83, 81.77, 84.24, 122.18, 137.78, 152.54, 159.42; UV λ_{max} (CH₃OH) 223 nm (ε 18460), 263 (12580), 292 (sh, 3300), λ_{max} (0.1 mol dm⁻³ HCl) 222 nm (ε 9550), 263 (6930), λ_{max} (0.1 mol dm⁻³ NaOH) 231 nm (ε 9080), 278 (6860). Found: C, 41.86; H, 5.72; N, 13.33%. Calcd for C₁₁H₁₈O₅N₃Cl·0.5H₂O: C, 41.94, H, 6.01; N, 13.34%.

5-[(2R*,3R*,4S*,5R*)-3,4-Dihydroxy-2,5-dipentyl-5-hydroxymethyltetrahydrofuran-2-yl]isocytosine Hydrochloride ((±)-1',4'-Dipentylpseudoisocytidine Hydrochloride) (**51b**): To a suspension of **50b** (269 mg, 0.63 mmol) in CH₃OH (5 ml) was added 10% HCl in CH₃OH (5 ml) and the resulting mixture was stirred for 1 h. Usual workup afforded **51b** (260 mg, 100%). Mp 245–250 °C; ¹H NMR (dimethyl-*d*₆ sulfoxide) δ 0.87 (m, CH₃), 1.0–2.0 (m, CH₂), 3.19 (d, *J*=7.1 Hz, H_aH_bCOH), 3.33 (d, *J*=7.1 Hz, H_aH_bCOH), 4.04 (m, H₃ and H₄), 4.0–5.2 (br, OH), 7.82 (s, =CH), 8.30 (br, NH₂); ¹³C NMR (dimethyl-*d*₆ sulfoxide) δ 14.02, 22.28, 22.59, 32.20, 32.64, 63.95, 72.06, 76.55, 84.14, 86.08, 120.55, 139.68, 153.32, 160.33; UV λ_{max} (CH₃OH) 263 nm (ε 5230), λ_{max} (0.1 mol dm⁻³ HCl) 265 nm (ε 3720), λ_{max} (0.1 mol dm⁻³ NaOH) 230 nm (ε 6780), 278 (3920).³⁸⁾

5-[(2S*,3R*,4R*,5R*)-3,4-Dihydroxy-3,5-bis(hydroxymethyl)-tetrahydrofuran-2-yl]isocytosine Hydrochloride ((±)-2'-Hydroxymethylpseudoisocytidine Hydrochloride) (**61a**): To a solution of **60a** (200 mg, 0.468 mmol) in CH₃OH (2.3 ml) was added 10% HCl in CH₃OH (5 ml). After stirring for 15 min, the mixture was worked up to afford **61a** (139 mg, 96%). Mp 215–217 °C; ¹H NMR (dimethyl-*d*₆ sulfoxide) δ 3.30 (s, C(OH)CH₂OH), 3.4–3.9 (m, H₄ and H₅), 3.67 (d, *J*=8.8 Hz, H_aH_bCOH), 3.92 (d, *J*=8.8 Hz, H_aH_bCOH), 4.71 (s, H₂), 7.76 (s, =CH), 8.48 (br, NH₂); ¹³C NMR (dimethyl-*d*₆ sulfoxide) δ 60.70, 62.50, 70.01, 80.20, 82.00, 116.48, 137.80, 152.49, 159.18; UV λ_{max} (CH₃OH) 224 nm (ε 12500), 265 (7770), λ_{max} (0.1 mol dm⁻³ NaOH) 232 nm (ε 8800), 280 (6420). Found: C, 37.81; H, 5.16; N, 13.08%. Calcd for C₁₀H₁₆O₆N₃Cl·0.5H₂O: C, 37.68; H, 5.38; N, 13.19%.

5-[(2S*,3R*,4R*,5R*)-3,4-Dihydroxy-5-hydroxymethyl-3-methyltetrahydrofuran-2-yl]isocytosine Hydrochloride ((±)-2'-Methylpseudoisocytidine Hydrochloride) (**61b**): To a solution of **60b** (263 mg, 0.886 mmol) in CH₃OH (3 ml) was added 10% HCl in CH₃OH (5 ml) and the resulting mixture was stirred for 30 min. Usual workup gave **61b** (253 mg, 97%). Mp 222–225 °C (CH₃OH-ether); ¹H NMR (dimethyl-*d*₆ sulfoxide) δ 1.02 (s, CH₃), 3.62 (m, H₄, H₅, and CH₂OH), 4.70 (s, H₂), 7.88 (s, =CH), 8.48 (br, NH₂); ¹³C NMR (dimethyl-*d*₆ sulfoxide) δ 20.84, 60.20, 73.35, 78.28, 80.97, 81.64, 117.18, 138.33, 152.50, 159.53; UV λ_{max} (CH₃OH) 244 nm (ε 10700), 265 (6890), λ_{max} (0.1 mol dm⁻³ HCl) 222 nm (ε 5800), 264 (4250), λ_{max} (0.1 mol dm⁻³ NaOH) 233 nm (ε 9010), 280 (6750). Found: C, 40.46; H, 5.52; N, 14.00; Cl, 12.32%. Calcd for C₁₀H₁₆O₅N₃Cl: C, 40.89; H, 5.49; N, 14.31; Cl, 12.07%.

5-[(2S*,3R*,4R*,5R*)-3-t-Butyldimethylsiloxyethyl-3,4-isopropylidenedioxy-5-mesyloxyethyltetrahydrofuran-2-yl]uracil (**56a**): To a solution of **54a** (50 mg, 0.117 mmol) in pyridine (0.8 ml) was added methanesulfonyl chloride (28 μl, 0.351 mmol) at 0 °C under argon, and then this mixture was stirred at the same temperature for 30 min and at 15 °C for 12 h. The reaction mixture was concentrated and the resulting residue was coevaporated with C₂H₅OH (2 ml × 2). Purification of the residue on preparative TLC (10:1 chloroform-CH₃OH) afforded **56a** (40 mg, 67%). Mp 195–197 °C (acetone-hexane); *R*_f=0.42 (10:1 chloroform-CH₃OH); ¹H NMR (dimethyl-*d*₆ sulfoxide) δ 0.06 (s, *t*-C₄H₉-(CH₃)₂Si), 0.84 (s, *t*-C₄H₉-(CH₃)₂Si), 1.36 and 1.52 (s, isopropylidene CH₃), 3.28 (s, CH₃SO₂), 3.52 (s, CH₂OSi), 4.2–4.6 (m, H₄, H₅, and CH₂OMs), 4.88 (s, H₂), 7.22 (d, *J*=5.0 Hz, =CH), 10.92 (d, *J*=5.0 Hz, NH), 11.12 (br, NH); ¹³C NMR (dimethyl-*d*₆ sulfoxide) δ 17.74, 25.49, 26.84, 28.31, 61.01, 61.60, 80.44, 82.73, 83.02, 91.54, 107.80, 113.08, 138.68, 150.78, 162.56; UV λ_{max} (CH₃OH) 266 nm (ε 7150), λ_{max} (0.1 mol dm⁻³ NaOH) 289 nm (ε 6150). Found: C,

45.11, H, 6.44, N, 4.91%. Calcd for $C_{20}H_{34}O_9N_2SSi \cdot 1.5H_2O$: C, 45.01, H, 6.98; N, 5.25%.

5-[(2S*,3R*,4R*,4R*)-3,4-Isopropylidenedioxy-3-methyl-5-mesyloxymethyltetrahydrofuran-2-yl]uracil (**56b**): A mixture of **54b** (20 mg, 0.067 mmol), methanesulfonyl chloride (26 μ l, 0.335 mmol), and pyridine (0.4 ml) was stirred at room temperature for 14 h and worked up as described above. Subsequent preparative TLC (5:1 chloroform- CH_3OH) afforded **56b** (21 mg, 83%). Mp 199–202 °C; R_f =0.47 (1:1 chloroform- CH_3OH); 1H NMR (dimethyl- d_6 sulfoxide) δ 1.15 (s, CH_3), 1.34 and 1.50 (s, isopropylidene CH_3), 3.22 (s, CH_3SO_2), 4.1–4.5 (m, H_3 , H_4 , and CH_2OMs), 4.86 (s, H_2), 7.22 (s, =CH), 11.00 (br, NH); UV λ_{max} (CH_3OH) 261 nm (ϵ 7000).

2'-t-Butyldimethylsilyloxymethyl-2',3'-O-isopropylidene-4,5'-cyclopseudouridine (**57a**): To a solution of **56a** (30 mg, 52.9 μ mol) in acetonitrile (1.2 ml) was added DBU (9.8 μ l, 65.1 μ mol) under argon and the mixture was stirred at 80 °C. After stirring for 2 h, DBU (4.9 μ l, 32.6 μ mol) was renewedly added. The resulting mixture was stirred for an additional 2 h and evaporated to give a yellow solid, which was purified by preparative TLC (10:1 chloroform- CH_3OH) to afford **57a** (22 mg, 90%). Mp 240–241 °C (acetone-hexane); R_f =0.34 (10:1 chloroform- CH_3OH); 1H NMR (dimethyl- d_6 sulfoxide) δ 0.06 (s, $t-C_4H_9(CH_3)_2Si$), 0.80 (s, $t-C_4H_9(CH_3)_2Si$), 1.38 and 1.45 (s, isopropylidene CH_3), 3.38 (d, J =11.5 Hz, CH_2H_bOSi), 3.62 (d, J =11.5 Hz, CH_2H_bOSi), 3.98 (d, J =13.0 Hz, H_aH_bCO), 4.32 (br s, H_2), 4.52 (d, J =13.0 Hz, H_aH_bCO), 4.70 (s, H_2), 4.90 (s, H_4), 7.96 (s, =CH); UV λ_{max} (CH_3OH) 295 nm (ϵ 3720). Found: C, 50.82; H, 7.77; N, 5.94%. Calcd for $C_{19}H_{30}O_6N_2Si \cdot 2H_2O$: C, 51.10; H, 7.67; N, 6.27%.

2',3'-O-Isopropylidene-2'-methyl-4,5'-cyclopseudouridine (**57b**): A mixture of **54b** (20 mg, 0.053 mmol), DBU (8.8 μ l, 0.059 mmol), and acetonitrile (1.1 ml) was stirred at 80 °C for 3 h and the resulting mixture was worked up as described above. Subsequent preparative TLC (5:1 chloroform- CH_3OH) gave **57b** (12 mg, 81%). Mp 225–229 °C (CH_3OH -acetone-hexane); R_f =0.47 (1:1 chloroform- CH_3OH); 1H NMR (dimethyl- d_6 sulfoxide) δ 1.10 (s, CH_3), 1.40 and 1.43 (s, isopropylidene CH_3), 3.96 (d, J =6.5 Hz, H_aH_bCO), 4.2–4.5 (m, H_3 and H_aH_bCO), 4.62 (s, H_2), 4.78 (s, H_4), 8.02 (br s, =CH); UV λ_{max} (CH_3OH) 293 nm (ϵ 3080). Found: m/z , 280.1049. Calcd for $C_{13}H_{16}O_5N_2$: M, 280.1059.

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- 18) Feature of the NMR (1H and ^{13}C) signal shift observed in going from 5-[(2R,3R,4R,5R)-3,4-isopropylidenedioxy-5-hydroxymethyltetrahydrofuran-2-yl]uracil¹⁹ to the phenyl derivative **16c** are quite similar to those induced by the struc-

tural change, methyl [(2*S*,3*S*,4*R*,5*R*)-3,4-isopropylidenedioxy-5-hydroxymethyltetrahydrofuran-2-yl]acetate²⁰) to methyl [(2*S**,3*S**,4*S**,5*R**)-3,4-isopropylidenedioxy-5-hydroxymethyl-5-phenyltetrahydrofuran-2-yl]acetate, compatible with the assigned β stereochemistry at the anomeric carbon.

19) Prepared from pseudouridine according to the reported procedure:²¹ ¹H NMR (dimethyl-*d*₆ sulfoxide) δ 1.27 and 1.49 (s, isopropylidene CH₃), 3.53 (m, CH₂OH), 3.91 (q-like, $J=4.0$ Hz, H₅), 4.6–5.0 (m, H₂, H₃, and H₄), 7.55 (s, =CH), 10.93 and 11.14 (br, NH); ¹³C NMR (dimethyl-*d*₆ sulfoxide) δ 25.45, 27.42, 61.74, 80.30, 81.55, 83.91, 84.83, 110.40, 112.81, 140.03, 151.05, 163.27.

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