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Synthesis of 2,6-disubstituted pyridin-3-yl *C*-2′-deoxyribonucleosides through chemoselective transformations of bromo-chloropyridine *C*-nucleosides†

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2-Bromo-6-chloro- and 6-bromo-2-chloropyridin-3-yl deoxyribonucleosides were prepared by the Heck coupling of bromo-chloro-iodopyridines with TBS-protected deoxyribose glycal. Some of their Pd-catalyzed cross-coupling reactions proceeded chemoselectively at the position of the bromine, whereas nucleophilic substitutions were unselective and gave mixtures of products. The mono-substituted intermediates were used for another coupling or nucleophilic substitution giving rise to a small library of title 2,6-disubstituted pyridine *C*-deoxyribonucleosides. The title nucleosides did not exert antiviral or cytostatic effects.

Introduction

C-Nucleosides are important analogues of natural nucleosides useful for many applications in medicinal chemistry and chemical biology.[1] Diverse aryl and hetaryl-*C*-2′-deoxyribonucleosides were extensively studied as candidates for novel base-pairs in the quest for extension of the genetic alphabet and some of their artificial base-pairs were efficiently replicated by DNA polymerases with high fidelity.[2] Moreover, some pyridine *C*-nucleosides have been used as probes for studying the mechanism of polymerases.[3] Most of the current approaches to the synthesis of *C*-nucleosides suffer from moderate efficiency and/or stereoselectivity.[1] Our group has developed a modular approach[4] based on the synthesis of halogenated (het)aryl *C*-nucleoside intermediates and their functionalization by Pd-catalyzed cross-couplings, aminations, carbonylations or hydroxylations. Very recently, the same approach was used even for the functionalization of *C*-nucleoside triphosphate derivatives.[5] Apart from the variation of one substituent, the synthesis of a 2D library of 2,4-disubstituted pyrimidin-5-yl *C*-2′-deoxyribonucleosides has been developed[6] through two consecutive regioselective cross-coupling reactions of the corresponding 2,4-dichloropyrimidine *C*-nucleoside intermediate. Here we report on the synthesis of a series of 2,6-disubstituted pyridine *C*-nucleosides.

Results and discussion

In our previous synthesis of 2,4-disubstituted pyrimidine *C*-nucleosides,[6] we have advantageously used the different reactivities of the two chlorines in 2,4-dichloropyrimidine for regioselective reactions. However, in the analogous 2,6-dichloropyridine *C*-nucleosides, the reactivity of the chlorines is comparable and thus no selectivity would be expected. Therefore our strategy for the target 2,6-disubstituted pyridin-3-yl *C*-2′-deoxyribonucleosides was based on chemoselective transformations[7,8] of either 2-bromo-6-chloro- or 6-bromo-2-chloropyridin-3-yl *C*-deoxyribonucleoside intermediates.

The synthesis of both bromo-chloropyridine *C*-nucleoside intermediates started from 3′-*O*-TBS-protected glycal **1** which can be easily prepared in three steps from thymidine.[9] The Heck coupling of 6-bromo-2-chloro-3-iodopyridine with glycal **1** in the presence of $Pd(OAc)_2$, tris(pentafluorophenyl)phosphine and silver carbonate was performed in freshly distilled chloroform at 70 °C (Scheme 1). After 10 hours all starting material was consumed and, because partial desilylation was observed by TLC, the crude reaction mixture was directly treated with $Et_3N{\cdot}3HF$ in THF to give fully deprotected ketone **2** in 52% yield (for two steps) as a pure β-anomer. The subsequent stereoselective reduction of **2** by $NaBH(OAc)_3$ proceeded smoothly giving rise to the desired *C*-2′-deoxyribonucleoside intermediate **3** in very good 85% yield. The crystal

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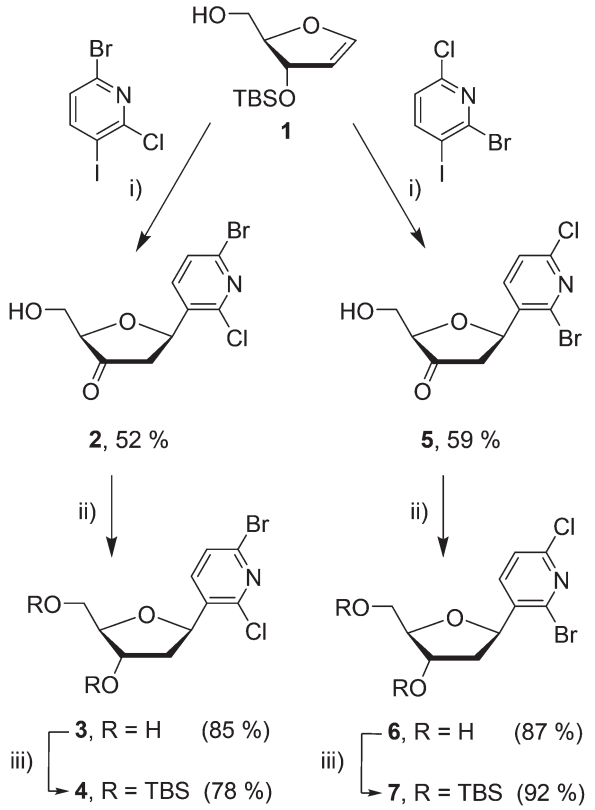


Scheme 1 *Reagents and conditions*: (i) 1. $Pd(OAc)_2$, $(PhF_5)_3P$, Ag_2CO_3, $CHCl_3$, 70 °C, 10 h; 2. $Et_3N{\cdot}3HF$, THF, rt, 15 min; (ii) $NaBH(OAc)_3$, AcOH, CH_3CN, 0 °C, 5 min; (iii) TBSCl, imidazole, DMF, rt, 14 h.

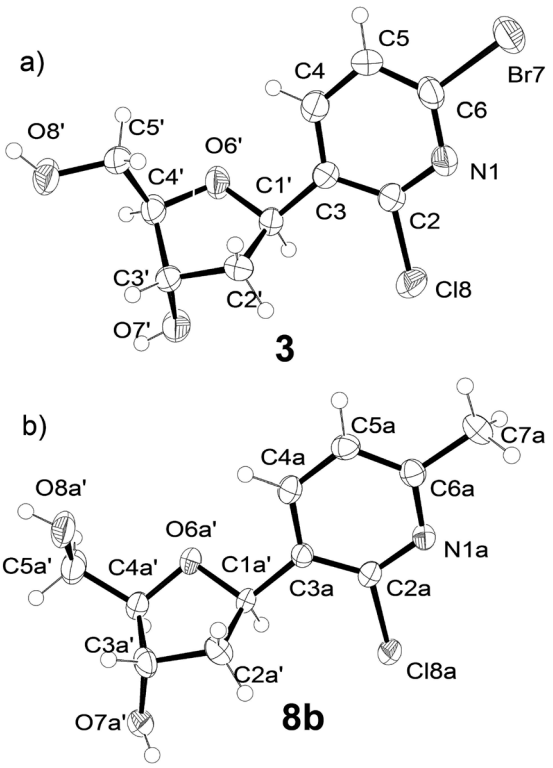


Fig. 1 Crystal structures of compounds (a) **3** (CCDC 927315) and (b) **8b** (CCDC 927314).

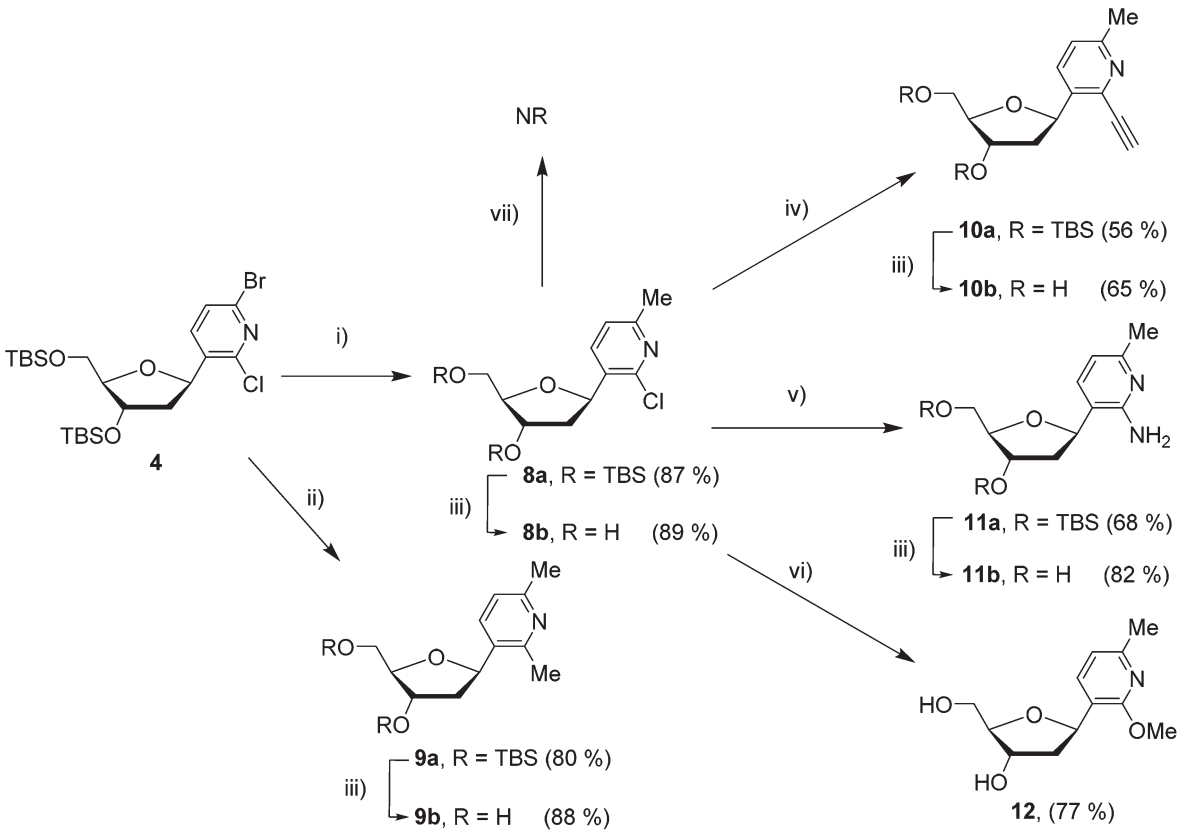
structure of 6-bromo-2-chloropyridine *C*-nucleoside **3** was determined by X-ray diffraction, which independently confirmed its β-configuration (Fig. 1). Re-protection of **3** by treatment with TBSCl gave the silylated *C*-nucleoside **4** in 78% yield. An analogous Heck coupling of **1** with 2-bromo-6-chloro-3-iodopyridine under the same conditions as above gave regioisomeric ketone **5** in 59% yield (for two steps) (Scheme 1). Subsequent reduction by $NaBH(OAc)_3$ afforded *C*-2′-deoxyribonucleoside **6** in 87% yield, which was again silylated to give the desired protected nucleoside intermediate **7** in excellent 92% yield.

Having the free (**3** and **6**) as well as the protected (**4** and **7**) key bromo-chloropyridine *C*-nucleoside intermediates, we investigated the chemoselectivity of cross-coupling reactions and nucleophilic substitutions. The bromine atom should be more reactive than chlorine but, on the other hand, steric and other factors can also play a role.

The cross-coupling of protected 6-bromo-2-chloropyridine *C*-nucleoside **4** with 1.1 equiv. of Me_3Al in the presence of $Pd(PPh_3)_4$ proceeded chemoselectively to give 2-chloro-6-methylpyridine **8a** as the only product in excellent 87% yield (Scheme 2). When the same reaction was performed with 4 equiv. of Me_3Al and prolonged reaction time, the product of disubstitution **9a** was isolated in 80% yield. Deprotection of **8a** and **9a** with $Et_3N{\cdot}3HF$ afforded free *C*-nucleosides **8b** (89%) and **9b** (88%). The structure of free 2-chloro-6-methylpyridine *C*-nucleoside **8b** was also confirmed by X-ray analysis (Fig. 1). In contrast, cross-coupling of the isomeric 2-bromo-6-chloropyridine intermediate **7** with 1.1 equivalents of Me_3Al was completely nonselective and only an unseparable mixture of the starting compound and both products of mono-substitution was obtained.

Mono-methylated 2-chloropyridine nucleoside **8a** was used for a series of follow-up transformations (Scheme 2). The Sonogashira cross-coupling with trimethylsilylacetylene catalyzed by $Pd(PPh_3)_2Cl_2$ followed by ammonolysis afforded 2-ethynyl-6-methylpyridine *C*-nucleoside **10a** (56%). Pd-catalyzed Hartwig–Buchwald amination[10] with a mixture of $LiN(SiMe_3)_2$ and Ph_3SiNH_2 gave 2-amino-6-methylpyridine *C*-nucleoside **11a** in 68% yield. Deprotection of silylated intermediates **10a** and **11a** furnished free *C*-nucleosides **10b** (65%) and **11b** (82%). The reaction of unprotected 2-chloro-6-methylpyridine *C*-nucleoside **8b** with sodium methoxide in MeOH was very sluggish (full conversion was accomplished only after 10 days of heating at 120 °C) but finally gave 2-methoxy-6-methylpyridine *C*-nucleoside **12** in good 77% yield. Attempted Pd-catalyzed hydroxylation[11] using KOH and *t*-butyl-XPhos did not proceed and only the starting compound and some degradation products were observed (probably due to instability of the pyridone product[4f]).

The Suzuki–Miyaura cross-coupling of 2-bromo-6-chloropyridine *C*-nucleoside **7** with 0.9 equivalent of phenylboronic acid in the presence of $Ph(PPh_3)_4$ at 60 °C proceeded chemoselectively at position 2 by displacement of the bromine to afford



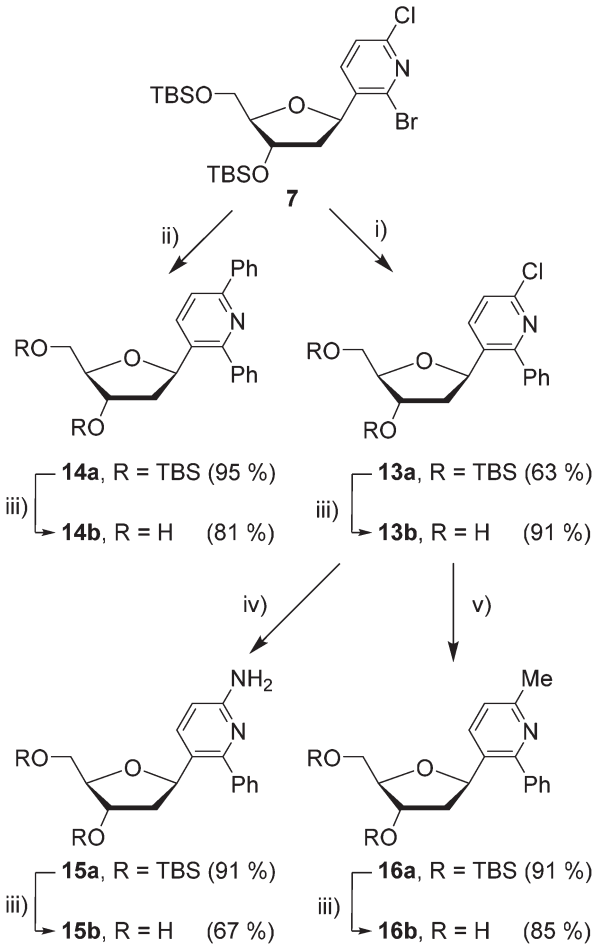
Scheme 2 *Reagents and conditions*: (i) 1.1 equiv. Me_3Al, $Pd(PPh_3)_4$, heptane, 70 °C, 3 h; (ii) 4 equiv. Me_3Al, $Pd(PPh_3)_4$, heptane, 70 °C, 12 h; (iii) $Et_3N{\cdot}3HF$, THF, rt, 14 h; (iv) 1. TMSA, $Pd(PPh_3)_2Cl_2$, CuI, Et_3N, DMF, 90 °C; 2. NH_3, MeOH, rt, 30 min; (v) $LiN(SiMe_3)_2$, Ph_3SiNH_2, CyJohnPhos, $Pd_2(dba)_3$, THF, 50 °C, 3 h; (vi) MeONa, MeOH, 120 °C, 10 d; (vii) KOH, *t*-butyl-XPhos, Pd_2dba_3, 100 °C.

6-chloro-2-phenylpyridine *C*-nucleoside **13a** in 63% yield (Scheme 3). When we used 3 equiv. of phenylboronic acid and increased the temperature to 100 °C, 2,6-diphenylpyridine *C*-nucleoside **14a** was obtained as a product of double substitution in excellent 95% yield. An analogous reaction of regioisomeric 6-bromo-2-chloropyridine *C*-nucleoside **4** with 1 equiv. of phenyl boronic acid afforded an unseparable mixture of the starting compound with the product of substitution of the bromine atom at position 6. Silylated nucleosides **13a** and **14a** were deprotected using $Et_3N{\cdot}3HF$ to obtain free *C*-nucleosides **13b** (91%) and **14b** (81%).

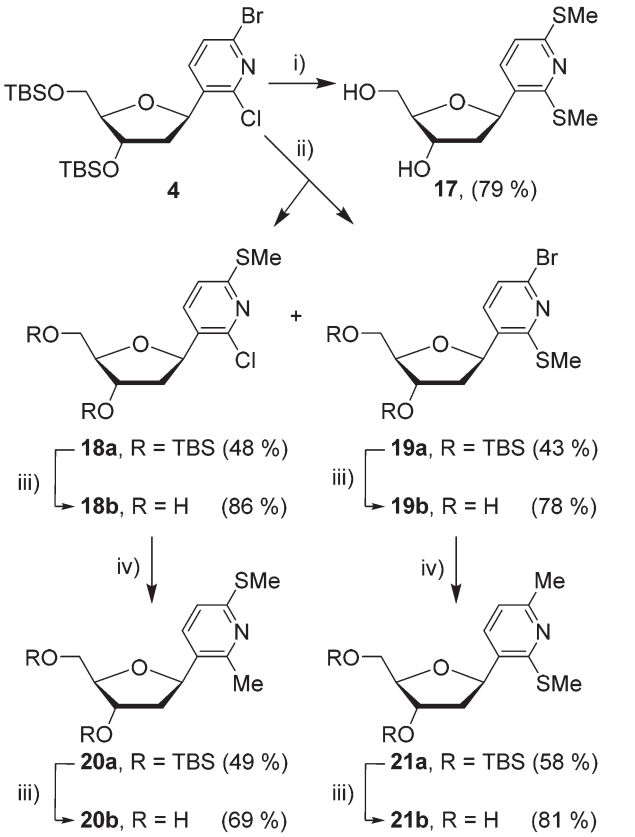
Mono-substituted 6-chloro-2-phenylpyridine *C*-nucleoside **13a** was then used for subsequent cross-coupling reactions. Hartwig–Buchwald amination with $LiN(SiMe_3)_2$ gave 6-amino-2-phenylpyridine *C*-nucleoside **15a** in excellent 91% yield. Cross-coupling with trimethylaluminum afforded 6-methyl-2-phenylpyridine *C*-nucleoside **16a** in excellent 91% yield. Deprotection of silylated intermediates gave free *C*-nucleosides **15b** (67%) and **16b** (85%).

In order to introduce amino or methoxy groups, we have studied the reactivity of intermediates **3** and **6** in nucleophilic substitutions. Our previous studies[6] showed good regioselectivity of nucleophilic aminations of 2,4-dichloropyrimidine *C*-nucleoside. Therefore, we tested reactions of **3** or **6** with methanolic ammonia or copper(I)-catalyzed reaction with liquid ammonia[12] in an autoclave using temperatures up to 120 °C but in all cases only the starting material was recovered and we did not observe any reaction. Surprisingly, attempted Buchwald–Hartwig aminations of protected intermediates **4** or **7** did not work either. Nucleophilic substitution of **6** with NaOMe proceeded only at elevated temperature (80 °C) to give an unseparable mixture of the starting compound and both mono-substituted derivatives. The same reaction at higher temperature (120 °C) led to complex mixtures. It seems that the mono-substituted intermediates (containing an electron-donating substituent) are deactivated for another nucleophilic substitution.

Next we studied nucleophilic substitutions with sodium methanethiolate (Scheme 4). The reaction of silylated intermediate **4** with 10 equivalents of NaSMe in DMF at 80 °C led to double substitution with simultaneous deprotection (due to basic conditions) affording 2,6-bis(methylsulfanyl)pyridine *C*-nucleoside **17** in good 79% yield. The reaction of **4** with 1.2 equivalents of sodium methanethiolate at rt in DMF gave a mixture of both mono-substituted derivatives **18a** and **19a** in the ratio *ca.* 1 : 1. Luckily, we were able to separate them using the flash purification system with a very slow gradient of hexanes to 1% EtOAc in hexanes to obtain 2-chloro-6-(methylsulfanyl)pyridine *C*-nucleoside **18a** (48%) and 6-bromo-2-(methylsulfanyl)pyridine *C*-nucleoside **19a** (43%). Pd-catalyzed



Scheme 3 *Reagents and conditions*: (i) 0.9 equiv. $PhB(OH)_2$, $Pd(PPh_3)_4$, K_2CO_3, PhMe, 60 °C, 12 h; (ii) 3 equiv. $PhB(OH)_2$, $Pd(PPh_3)_4$, K_2CO_3, PhMe, 100 °C, 12 h; (iii) $Et_3N{\cdot}3HF$, THF, rt, 14 h; (iv) $LiN(SiMe_3)_2$, CyJohnPhos, $Pd_2(dba)_3$, THF, 60 °C, 12 h; (v) $Pd(PPh_3)_4$, Me_3Al, THF, 70 °C, 12 h.



Scheme 4 *Reagents and conditions*: (i) MeSNa 10 equiv., DMF, 80 °C, 12 h; (ii) MeSNa 1.2 equiv., DMF, rt, 12 h; (iii) $Et_3N{\cdot}3HF$, THF, rt, 14 h; (iv) Me_3Al, $Pd(PPh_3)_4$, 90 °C, 12 h.

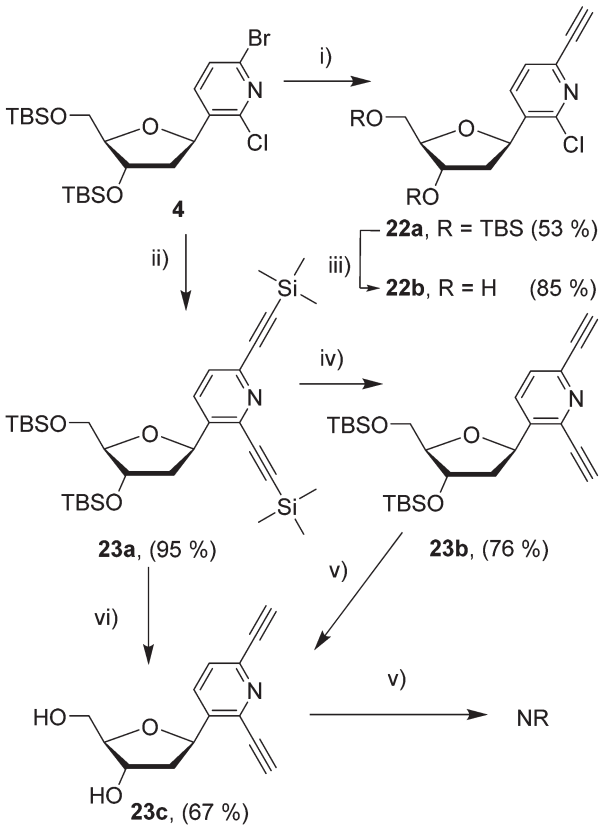
methylation of compounds **18a** or **19a** with trimethylaluminum gave two regioisomeric methyl-(methylsulfanyl)pyridine *C*-nucleosides **20a** (49%) and **21a** (58%). All silylated compounds were deprotected to afford free *C*-nucleosides **18b–21b**.

Attempted Sonogashira chemoselective cross-couplings of **4** with (trimethylsilyl)acetylene (TMSA) (Scheme 5) were very difficult to perform since the desired 2-chloro-6-(TMS-ethynyl)-pyridine *C*-nucleoside was unseparable from starting intermediate **4**. Finally, we found out that Sonogashira cross coupling with 1 equiv. of trimethylsilylacetylene catalyzed by $Pd(PPh_3)_2Cl_2$ followed by direct amonolysis gave us a separable mixture of starting compound **4** (37%) and desired product **22a** in acceptable 53% yield. When we performed the same reaction with the excess of trimethylsilylacetylene (10 equiv.) and increased the temperature to 90 °C, the product of disubstitution, protected 2,6-bis(ethynyl)pyridine *C*-nucleoside **23a**, was isolated in excellent 95% yield. In order to convert the ethynyl groups to acetyl, we have prepared partially and fully deprotected bis(ethynyl)pyridine *C*-nucleosides **23b** and **23c** and attempted a gold catalyzed hydration of the triple bond.[13] Unfortunately, only deprotection was observed despite having tried many different conditions.

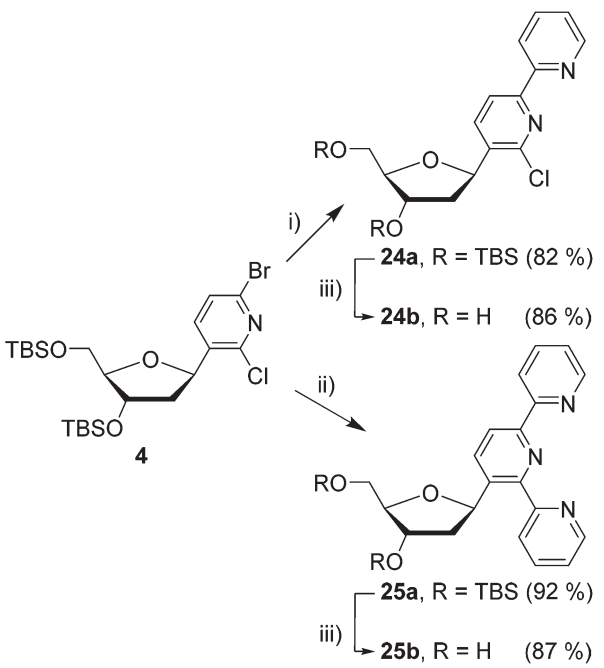
The Stille cross-coupling reaction was used for the synthesis of bipyridine and terpyridine *C*-nucleosides (Scheme 6). The reaction of **4** with tributyl(2-pyridyl)stannane catalyzed by $PdCl_2(PPh_3)_2$ gave only compound **24a**, as a product of chemoselective replacement of the bromine atom, in very good 82% yield even when we used 2 equiv. of stannane. The palladium catalyst is probably strongly coordinated to the bipyridine scaffold and any second reaction is prevented. In contrast, the Stille cross-coupling catalyzed by $Pd(PPh_3)_4$ cleanly afforded terpyridine *C*-nucleoside **25a**, as a product of double substitution, in excellent 92% yield. Deprotection gave bi- and terpyridine *C*-nucleosides **24b** and **25b** which could be used in metallabase pairs.[14]

Finally, we attempted to introduce a vinyl group by Fürstner's Fe-catalyzed cross-coupling reaction[15] with vinylmagnesium bromide (Scheme 7). Unfortunately the cross-coupling did not proceed and, instead, the magnesiation of the bromopyridine occurred which, after hydrolytic work-up, gave chloropyridine **26a**, as a product of debromination, in moderate 47% yield. Also this compound was deprotected to free nucleoside **26b**.

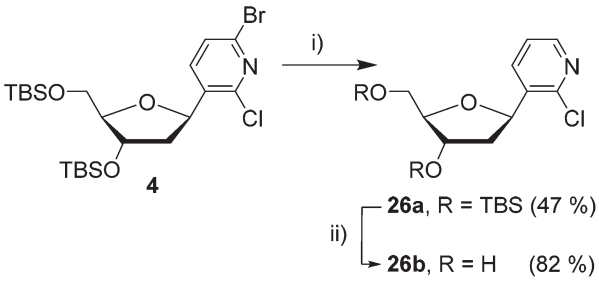
All the title free nucleosides were subjected to biological activity screening. The cytotoxic activity *in vitro* was studied on



Scheme 5 *Reagents and conditions*: (i) 1. 1 equiv. TMSA, $Pd(PPh_3)_2Cl_2$, CuI, Et_3N, DMF, 60 °C; 2. NH_3, MeOH, rt, 30 min; (ii) 10 equiv. TMSA, $Pd(PPh_3)_2Cl_2$, CuI, Et_3N, DMF, 90 °C; (iii) $Et_3N{\cdot}3HF$, THF, rt, 14 h; (iv) NH_3, MeOH, rt, 30 min; (v) $NaAuCl_4$, MeOH, H_2O, 80 °C, 6–72 h; (vi) TBAF, THF, rt, 12 h.



Scheme 6 *Reagents and conditions*: (i) 2 equiv. 2-pyridylSnBu$_3$, $PdCl_2(PPh_3)_2$, DMF, 100 °C, 12 h; (ii) 2 equiv. 2-pyridylSnBu$_3$, $Pd(PPh_3)_4$, toluene, 110 °C, 12 h; (iii) $Et_3N{\cdot}3HF$, THF, rt, 14 h.



Scheme 7 *Reagents and conditions*: (i) vinylMgBr, $Fe(acac)_3$, rt, 12 h; (ii) $Et_3N{\cdot}3HF$, THF, rt, 14 h.

the following cell cultures: (i) human promyelocytic leukemia HL60 cells (ATCC CCL 240); (ii) human cervix carcinoma HeLa S3 cells (ATCC CCL 2.2); (iii) human T lymphoblastoid CCRF-CEM cell line (ATCC CCL 119), and (iv) hepatocellular carcinoma cells HepG2 (ATCC HB 8065). Cell viability was determined following a 3-day incubation using a metabolic 2,3-bis-(2-methoxy-4-nitro-5-sulfophenyl)-2*H*-tetrazolium-5-carboxanilide (XTT) based method.[16] The antiviral activity was tested against HCV genotype 1A, 1B and 2A replicons.[17] None of the nucleosides showed any significant cytotoxicity or antiviral activity in these assays at concentrations up to 10 μM.

Conclusions

Systematic study of the chemoselectivity of cross-coupling reactions and nucleophilic substitutions of regioisomeric 2-bromo-6-chloro- and 6-bromo-2-chloropyridin-3-yl deoxyribo-nucleosides **7** and **4** was performed. The cross-couplings generally proceeded with good chemoselectivity at the position of the bromine but the choice of the starting compound depended on the separability of the mono-substituted products from the starting compound. On the other hand, nucleophilic substitution with NaSMe was unselective giving a separable mixture of both mono-substituted products, whereas the reactions with ammonia or NaOMe did not proceed or led to complex mixtures (at elevated temperature). The mono-substituted halopyridine *C*-nucleoside intermediates were used for another coupling or S_N to give a small library of 2,6-disubstituted pyridin-3-yl *C*-deoxyribonucleosides. None of the title nucleosides exerted any antiviral or cytostatic activity in concentrations up to 10 μM. Some of the disubstituted pyridine nucleosides will be converted to triphosphates and further tested for polymerase incorporation in the quest for the extension of the genetic alphabet.[2]

Experimental

All cross-coupling reactions were carried out in evacuated flame-dried glassware with magnetic stirring under an argon atmosphere. THF, toluene, and hexanes were dried and distilled from sodium–benzophenone. Other reagents were purchased from commercial suppliers and used as received. NMR

spectra were recorded on a 400 MHz spectrometer (^{1}H at 400 MHz, ^{13}C at 100.6 MHz), a 500 MHz spectrometer (^{1}H at 500 and ^{13}C MHz at 125.8), and/or a 600 MHz spectrometer (^{1}H at 600 MHz, ^{13}C at 151 MHz). The samples were measured in $CDCl_3$ using TMS as an internal standard or in DMSO-d_6 referenced to the residual solvent signal (^{1}H NMR δ 2.50 ppm, ^{13}C NMR 39.7 ppm). Chemical shifts are given in ppm (δ scale) and coupling constants (J) in hertz. Complete assignment of all NMR signals was performed using a combination of 2D-NMR (H,H-COSY, H,C-HSQC, and H,C-HMBC) experiments and configurations were established by two-dimensional ROESY spectra. High performance flash chromatography (HPFC) purifications were performed with Biotage SP1 apparatus on KP-Sil and KP-C18-HS columns. Cytostatic[16] and anti-HCV[17] activity screening was performed according to literature procedures.

General procedure for the deprotection of the TBDMS group

$Et_3N{\cdot}3HF$ (320 μL, 1.95 mmol) was added to a solution of silylated *C*-nucleoside (0.4 mmol) in THF (2 mL), and the mixture was stirred at room temperature for 14 h. After the reaction was completed (TLC in hexanes–EtOAc 10 : 1), solvents were removed under reduced pressure, and the crude product was chromatographed on silica gel (20 g) eluted with a gradient of chloroform to 15% MeOH in chloroform to give free *C*-nucleosides.

1β-(6-Bromo-2-chloropyridin-3-yl)-1,2,3-trideoxy-3-oxo-D-ribofuranose (2). Freshly distilled $CHCl_3$ (20 mL) was added to an argon-purged, flame-dried flask containing $Pd(OAc)_2$ (390 mg, 1.74 mmol) and $P(PhF_5)_3$ (1.85 g, 3.47 mmol), and the mixture was stirred at room temperature for 30 min. This solution was then added *via* a syringe to a mixture of 6-bromo-2-chloro-3-iodopyridine (3.32 g, 10.42 mmol), glycal **1** (2.00 g, 8.68 mmol) and Ag_2CO_3 (3.58 g, 13.02 mmol) in $CHCl_3$ (20 mL), and the reaction mixture was stirred at 70 °C for 10 h. The reaction mixture was then cooled and filtered on a pad of Celite and eluted with $CHCl_3$. Solvents were removed under vacuum, the crude product was dissolved in THF (100 mL), $Et_3N{\cdot}3HF$ (2 mL; 12.3 mmol) was added and the solution was stirred at rt for 15 min. The solvents were removed under vacuum, and the crude product was chromatographed on silica gel eluting with a gradient of chloroform to 1% MeOH in chloroform to give **2** (1.38 g, 52% for two steps) as a yellow oil. HRMS (ESI) for $C_{10}H_9BrClNO_3$: [M − H] calculated, 303.9382; found, 303.9382. ^{1}H NMR (500 MHz, $CDCl_3$) 2.26 (dd, 1H, J_{gem} = 18.2 Hz, $J_{2'a,1'}$ = 10.6 Hz, H-2′a); 3.18 (dd, 1H, J_{gem} = 18.2 Hz, $J_{2'b,1'}$ = 6.2 Hz, H-2′b); 3.99–4.05 (m, 2H, H-5′); 4.11 (t, 1H, $J_{4',5'a}$ = $J_{4',5'b}$ = 3.4 Hz, H-4′); 5.43 (ddt, 1H, $J_{1',2'a}$ = 10.6 Hz, $J_{1',2'b}$ = 6.2 Hz, $J_{1',4}$ = $J_{1',5}$ = 0.7 Hz, H-1′); 7.52 (bd, 1H, $J_{5,4}$ = 8.1 Hz, H-5); 7.97 (dd, 1H, $J_{4,5}$ = 8.1 Hz, $J_{4,1'}$ = 0.7 Hz, H-4). ^{13}C NMR (125.7 MHz, $CDCl_3$): 43.70 (CH_2-2′); 61.51 (CH_2-5′); 73.30 (CH-1′); 82.08 (CH-4′); 127.52 (CH-5); 134.64 (C-3); 137.72 (CH-4); 139.64 (C-6); 147.73 (C-2); 212.08 (C-3′). IR spectrum (KBr): 3436, 3095, 3068, 1760, 1574, 1546, 1426, 1221, 1033, 829, 736.

1β-(6-Bromo-2-chloropyridin-3-yl)-1,2-dideoxy-D-ribofuranose (3). $NaBH(OAc)_3$ (1.53 g, 7.25 mmol) was added to a flame-dried flask containing a solution of the nucleoside **2** (1.48 g, 4.83 mmol) in a mixture of AcOH–CH_3CN 1/10 (50 mL) at 0 °C under argon. After 5 min, all of the starting material was consumed and a solution of EtOH–H_2O 1/1 (10 mL) was added to neutralize the solution. Then the solvents were evaporated in vacuum, and the crude product was chromatographed on silica gel in a gradient of chloroform to 5% MeOH in chloroform. Nucleoside **3** (1.27 g, 85%) was isolated as a white foam. HRMS (ESI) for $C_{10}H_{11}BrClNO_3$: [M + H] calculated, 307.9684; found, 307.9684. ^{1}H NMR (500 MHz, CD_3OD) 1.78 (ddd, 1H, J_{gem} = 13.1 Hz, $J_{2'a,1'}$ = 10.0 Hz, $J_{2'a,3'}$ = 6.0 Hz, H-2′a); 2.47 (ddd, 1H, J_{gem} = 13.1 Hz, $J_{2'b,1'}$ = 5.7 Hz, $J_{2'b,3'}$ = 2.0 Hz, H-2′b); 3.68 (dd, 1H, J_{gem} = 11.8 Hz, $J_{5'a,4'}$ = 5.0 Hz, H-5′a); 3.71 (dd, 1H, J_{gem} = 11.8 Hz, $J_{5'b,4'}$ = 4.5 Hz, H-5′b); 3.97 (td, 1H, $J_{4',5'a}$ = $J_{4',5'b}$ = 4.7 Hz, $J_{4',3'}$ = 2.7 Hz, H-4′); 4.32 (bdtd, 1H, $J_{3',2'a}$ = 5.9 Hz, $J_{3',4'}$ = $J_{3',2'b}$ = 2.4 Hz, $J_{3',1'}$ = 0.5 Hz, H-3′); 5.32 (ddq, 1H, $J_{1',2'a}$ = 10.0 Hz, $J_{1',2'b}$ = 5.7 Hz, $J_{1',3'}$ = $J_{1',4}$ = $J_{1',5}$ = 0.6 Hz, H-1′); 7.57 (dd, 1H, $J_{5,4}$ = 8.1 Hz, $J_{5,1'}$ = 0.6 Hz, H-5); 8.02 (dd, 1H, $J_{4,5}$ = 8.1 Hz, $J_{4,1'}$ = 0.8 Hz, H-4). ^{13}C NMR (125.7 MHz, CD_3OD): 42.98 (CH_2-2′); 63.66 (CH_2-5′); 74.10 (CH-3′); 77.18 (CH-1′); 89.27 (CH-4′); 128.66 (CH-5); 138.16 (C-3); 139.46 (C-6); 139.96 (CH-4); 148.45 (C-2). IR spectrum (KBr): 3349, 3297, 3061, 1573, 1542, 1485, 1419, 1220, 1097, 1062, 1047, 823, 735.

1β-(6-Bromo-2-chloropyridin-3-yl)-1,2-dideoxy-3,5-di-*O*-(*t*-butyldimethylsilyl)-D-ribofuranose (4). Imidazole (1.27 g, 18.6 mmol) and then TBDMSCl (4.49 mg, 29.8 mmol) were added to a flame-dried flask containing a solution of the nucleoside **3** (2.3 g, 7.45 mmol) in dry DMF (50 mL) at 0 °C under argon and the solution was allowed to warm to room temperature and was stirred for 14 h. The reaction mixture was then poured into a saturated solution of NaCl (100 mL) and extracted with EtOAc (3 × 30 mL). Collected organic fractions were washed with a saturated NaCl solution, dried over $MgSO_4$, and the solvents were evaporated under vacuum. The crude product was chromatographed on silica gel in a gradient of hexanes to 5% EtOAc in hexanes to give the desired nucleoside **4** (3.1 g, 78%) as a colorless oil. HRMS (ESI) for $C_{22}H_{39}BrClNO_3Si_2$: [M + H] calculated, 536.1413; found, 536.1413. ^{1}H NMR (500 MHz, $CDCl_3$) 0.084, 0.086 and 0.094 (4 × s, 4 × 3H, CH_3Si); 0.89 and 0.91 (2 × s, 2 × 9H, ($(CH_3)_3C$)); 1.70 (ddd, 1H, J_{gem} = 12.6 Hz, $J_{2'a,1'}$ = 9.4 Hz, $J_{2'a,3'}$ = 5.6 Hz, H-2′a); 2.41 (ddd, 1H, J_{gem} = 12.6 Hz, $J_{2'b,1'}$ = 5.9 Hz, $J_{2'b,3'}$ = 2.5 Hz, H-2′b); 3.71 (dd, 1H, J_{gem} = 10.9 Hz, $J_{5'a,4'}$ = 4.6 Hz, H-5′a); 3.76 (dd, 1H, J_{gem} = 10.9 Hz, $J_{5'b,4'}$ = 3.3 Hz, H-5′b); 3.97 (ddd, 1H, $J_{4',5'a}$ = 4.6 Hz, $J_{4',5'b}$ = 3.3 Hz, $J_{4',3'}$ = 2.6 Hz, H-4′); 4.38 (dtd, 1H, $J_{3',2'a}$ = 5.6 Hz, $J_{3',4'}$ = $J_{3',2'b}$ = 2.6 Hz, $J_{3',1'}$ = 0.7 Hz, H-3′); 5.33 (bddq, 1H, $J_{1',2'a}$ = 9.4 Hz, $J_{1',2'b}$ = 5.9 Hz, $J_{1',3'}$ = $J_{1',4}$ = $J_{1',5}$ = 0.7 Hz, H-1′); 7.39 (dd, 1H, $J_{5,4}$ = 8.0 Hz, $J_{5,1'}$ = 0.6 Hz, H-5); 7.90 (dd, 1H, $J_{4,5}$ = 8.0 Hz, $J_{4,1'}$ = 0.7 Hz, H-4). ^{13}C NMR (125.7 MHz, $CDCl_3$): −5.49, −5.41, −4.76 and −4.62 (CH_3Si); 17.98 and 18.29 ($(CH_3)_3C$); 25.75 and 25.87 ($(CH_3)_3C$); 42.30 (CH_2-2′); 63.22 (CH_2-5′); 73.65 (CH-3′); 75.84 (CH-1′); 87.95 (CH-4′); 127.01 (CH-5); 137.08 (C-3); 138.08 (CH-4), 138.38 (C-6); 147.48 (C-2). IR spectrum (CCl_4): 3093, 3060, 2956, 2897, 1575, 1545, 1472, 1463, 1424, 1407, 1390, 1362, 1257, 1223, 1098, 1030, 1006, 939, 838, 671.

1β-(2-Bromo-6-chloropyridin-3-yl)-1,2,3-trideoxy-3-oxo-D-ribofuranose (5). Freshly distilled $CHCl_3$ (18 mL) was added to an argon-purged, flame-dried flask containing $Pd(OAc)_2$ (562 mg, 2.34 mmol) and $P(PhF_5)_3$ (2.49 g, 4.69 mmol), and the mixture was stirred at room temperature for 30 min. This solution was then added *via* a syringe to a mixture of 2-bromo-6-chloro-3-iodopyridine (4.48 g, 14.06 mmol), glycal **1** (2.70 g, 11.72 mmol) and Ag_2CO_3 (4.83 g, 17.58 mmol) in $CHCl_3$ (18 mL), and the reaction mixture was stirred at 70 °C for 10 h. The reaction mixture was then cooled and filtered on a pad of Celite and eluted with $CHCl_3$. Solvents were then removed in vacuum, the crude product was dissolved in THF (100 mL), $Et_3N{\cdot}3HF$ (3 mL; 18.5 mmol) was added and the solution was stirred at rt for 15 min. The solvents were removed under vacuum, and the crude product was chromatographed on silica gel eluting with a gradient of chloroform to 1% MeOH in chloroform to give **5** (2.12 g, 59% for two steps) as a yellow foam. HRMS (ESI) for $C_{10}H_9BrClNO_3$: [M − H] calculated, 303.9382; found, 303.9384. ^{1}H NMR (500 MHz, $CDCl_3$) 2.23 (dd, 1H, J_{gem} = 18.2 Hz, $J_{2'a,1'}$ = 10.6 Hz, H-2′a); 3.21 (dd, 1H, J_{gem} = 18.2 Hz, $J_{2'b,1'}$ = 6.2 Hz, H-2′b); 3.98–4.04 (m, 2H, H-5′); 4.11 (t, 1H, $J_{4',5'a} = J_{4',5'b}$ = 3.3 Hz, H-4′); 5.41 (ddt, 1H, $J_{1',2'a}$ = 10.6 Hz, $J_{1',2'b}$ = 6.2 Hz, $J_{1',4} = J_{1',5}$ = 0.7 Hz, H-1′); 7.37 (dd, 1H, $J_{5,4}$ = 8.1 Hz, $J_{5,1'}$ = 0.6 Hz, H-5); 8.03 (dd, 1H, $J_{4,5}$ = 8.1 Hz, $J_{4,1'}$ = 0.8 Hz, H-4). ^{13}C NMR (125.7 MHz, $CDCl_3$): 43.85 (CH_2-2′); 61.44 (CH_2-5′); 74.87 (CH-1′); 82.19 (CH-4′); 123.91 (CH-5); 136.72 (C-3); 137.85 (CH-4); 139.30 (C-2); 149.75 (C-6); 212.23 (C-3′). IR spectrum (KBr): 3428, 3095, 3071, 2924, 2854, 1760, 1630, 1575, 1546, 1460, 1429, 1224, 1057, 1032, 831, 735.

1β-(2-Bromo-6-chloropyridin-3-yl)-1,2-dideoxy-D-ribofuranose (6). $NaBH(OAc)_3$ (2.9 g, 13.7 mmol) was added to a flame-dried flask containing a solution of the nucleoside **5** (2.8 g, 9.13 mmol) in a mixture of AcOH–CH_3CN 1/10 (80 mL) at 0 °C under argon. After 5 min, all of the starting material was consumed and a solution of EtOH–H_2O 1/1 (20 mL) was added to neutralize the solution. Then the solvents were evaporated in vacuum, and the crude product was chromatographed on silica gel in a gradient of chloroform to 5% MeOH in chloroform. Nucleoside **6** (2.45 g, 87%) was isolated as a white foam. HRMS (ESI) for $C_{10}H_{11}BrClNO_3$: [M + H] calculated, 307.9684; found, 307.9683. ^{1}H NMR (500 MHz, CD_3OD) 1.76 (ddd, 1H, J_{gem} = 13.1 Hz, $J_{2'a,1'}$ = 10.0 Hz, $J_{2'a,3'}$ = 6.0 Hz, H-2′a); 2.51 (ddd, 1H, J_{gem} = 13.1 Hz, $J_{2'b,1'}$ = 5.8 Hz, $J_{2'b,3'}$ = 2.1 Hz, H-2′b); 3.69 (dd, 1H, J_{gem} = 11.8 Hz, $J_{5'a,4'}$ = 5.0 Hz, H-5′a); 3.72 (dd, 1H, J_{gem} = 11.8 Hz, $J_{5'b,4'}$ = 4.4 Hz, H-5′b); 3.97 (btd, 1H, $J_{4',5'a} = J_{4',5'b}$ = 4.7 Hz, $J_{4',3'}$ = 2.7 Hz, H-4′); 4.32 (dddd, 1H, $J_{3',2'a}$ = 6.0 Hz, $J_{3',4'}$ = 2.7 Hz, $J_{3',2'b}$ = 2.1 Hz, $J_{3',1'}$ = 0.6 Hz, H-3′); 5.31 (ddq, 1H, $J_{1',2'a}$ = 10.0 Hz, $J_{1',2'b}$ = 5.8 Hz, $J_{1',3'} = J_{1',4} = J_{1',5}$ = 0.6 Hz, H-1′); 7.44 (dd, 1H, $J_{5,4}$ = 8.1 Hz, $J_{5,1'}$ = 0.6 Hz, H-5); 8.07 (dd, 1H, $J_{4,5}$ = 8.1 Hz, $J_{4,1'}$ = 0.7 Hz, H-4). ^{13}C NMR (125.7 MHz, CD_3OD): 43.18 (CH_2-2′); 66.65 (CH_2-5′); 74.09 (CH-3′); 78.88 (CH-1′); 89.32 (CH-4′); 124.95 (CH-5); 139.94 (C-2); 139.99 (CH-4); 140.20 (C-3); 149.82 (C-6). IR spectrum (KBr): 3376, 3267, 3098, 3059, 1574, 1548, 1486, 1470, 1267, 1070, 1044, 1017, 949, 932, 898.

1β-(2-Bromo-6-chloropyridin-3-yl)-1,2-dideoxy-3,5-di-*O*-(*t*-butyldimethylsilyl)-D-ribofuranose (7). Imidazole (0.69 g, 10.18 mmol) and then TBDMSCl (2.45 mg, 16.3 mmol) were added to a flame-dried flask containing a solution of the nucleoside **6** (1.26 g, 4.07 mmol) in dry DMF (25 mL) at 0 °C under argon and the solution was allowed to warm to room temperature and was stirred for 14 h. The reaction mixture was then poured into a saturated solution of NaCl (100 mL) and extracted with EtOAc (3 × 50 mL). Collected organic fractions were washed with a saturated NaCl solution, dried over $MgSO_4$, and the solvents were evaporated under vacuum. The crude product was chromatographed on silica gel in a gradient of hexanes to 3% EtOAc in hexanes to give the desired nucleoside **7** (2.01 g, 92%) as a colorless oil. HRMS (ESI) for $C_{22}H_{39}BrClNO_3Si_2$: [M + H] calculated, 536.1413; found, 536.1412. ^{1}H NMR (500 MHz, $CDCl_3$) 0.085, 0.089 and 0.10 (4 × s, 4 × 3H, CH_3Si); 0.90 and 0.91 (2 × s, 2 × 9H, $((CH_3)_3C)$); 1.68 (ddd, 1H, J_{gem} = 12.6 Hz, $J_{2'a,1'}$ = 9.4 Hz, $J_{2'a,3'}$ = 5.6 Hz, H-2′a); 2.45 (ddd, 1H, J_{gem} = 12.6 Hz, $J_{2'b,1'}$ = 5.9 Hz, $J_{2'b,3'}$ = 2.6 Hz, H-2′b); 3.72 (dd, 1H, J_{gem} = 10.9 Hz, $J_{5'a,4'}$ = 4.5 Hz, H-5′a); 3.77 (dd, 1H, J_{gem} = 10.9 Hz, $J_{5'b,4'}$ = 3.3 Hz, H-5′b); 3.97 (ddd, 1H, $J_{4',5'a}$ = 4.5 Hz, $J_{4',5'b}$ = 3.3 Hz, $J_{4',3'}$ = 2.6 Hz, H-4′); 4.38 (bdtd, 1H, $J_{3',2'a}$ = 5.6 Hz, $J_{3',4'} = J_{3',2'b}$ = 2.7 Hz, $J_{3',1'}$ = 0.6 Hz, H-3′); 5.31 (ddq, 1H, $J_{1',2'a}$ = 9.4 Hz, $J_{1',2'b}$ = 5.9 Hz, $J_{1',3'} = J_{1',4} = J_{1',5}$ = 0.6 Hz, H-1′); 7.26 (dd, 1H, $J_{5,4}$ = 8.1 Hz, $J_{5,1'}$ = 0.6 Hz, H-5); 7.95 (dd, 1H, $J_{4,5}$ = 8.1 Hz, $J_{4,1'}$ = 0.7 Hz, H-4). ^{13}C NMR (125.7 MHz, $CDCl_3$): −5.50, −5.42, −4.76 and −4.62 (CH_3Si); 17.98 and 18.28 ($(CH_3)_3C$); 25.74 and 25.87 ($(CH_3)_3C$); 42.47 (CH_2-2′); 63.21 (CH_2-5′); 73.65 (CH-3′); 77.50 (CH-1′); 88.00 (CH-4′); 123.41 (CH-5); 138.08 (CH-4); 139.00 and 139.07 (C-2,3); 148.66 (C-6). IR spectrum (CCl_4): 3093, 3059, 2956, 2897, 1577, 1545, 1472, 1463, 1406, 1390, 1362, 1278, 1258, 1097, 939, 891, 838.

1β-(2-Chloro-6-methylpyridin-3-yl)-1,2-dideoxy-3,5-di-*O*-(*t*-butyldimethylsilyl)-D-ribofuranose (8a). Me_3Al (1.5 mL, 1.5 mmol, 1.1 equiv., 1 M in heptane) was added to a flame-dried flask containing **4** (729 mg, 1.36 mmol) and $Pd(PPh_3)_4$ (161 mg, 0.14 mmol, 10 mol%) under argon. The mixture was stirred at 70 °C for 3 h, quenched by pouring into saturated NaH_2PO_4 (50 mL), and extracted with EtOAc (3 × 50 mL). The crude product was chromatographed on silica gel eluting with a gradient of hexanes to 5% EtOAc in hexanes to give **8a** (555 mg, 87%) as a colorless oil. HRMS (ESI) for $C_{23}H_{42}ClNO_3Si_2$: [M + H] calculated, 472.2465; found, 472.2465. ^{1}H NMR (500 MHz, $CDCl_3$) 0.083, 0.085, 0.087 and 0.093 (4 × s, 4 × 3H, CH_3Si); 0.90 and 0.91 (2 × s, 2 × 9H, $((CH_3)_3C)$); 1.70 (ddd, 1H, J_{gem} = 12.7 Hz, $J_{2'a,1'}$ = 9.5 Hz, $J_{2'a,3'}$ = 5.6 Hz, H-2′a); 2.40 (ddd, 1H, J_{gem} = 12.7 Hz, $J_{2'b,1'}$ = 5.8 Hz, $J_{2'b,3'}$ = 2.5 Hz, H-2′b); 2.51 (s, 3H, CH_3); 3.69 (dd, 1H, J_{gem} = 10.8 Hz, $J_{5'a,4'}$ = 4.9 Hz, H-5′a); 3.77 (dd, 1H, J_{gem} = 10.8 Hz, $J_{5'b,4'}$ = 3.5 Hz, H-5′b); 3.96 (ddd, 1H, $J_{4',5'a}$ = 4.9 Hz, $J_{4',5'b}$ = 3.5 Hz, $J_{4',3'}$ = 2.6 Hz, H-4′); 4.38 (dtd, 1H, $J_{3',2'a}$ = 5.6 Hz, $J_{3',4'} = J_{3',2'b}$ = 2.6 Hz, $J_{3',1'}$ = 0.7 Hz, H-3′); 5.37 (bdd, 1H, $J_{1',2'a}$ = 9.5 Hz, $J_{1',2'b}$ = 5.8 Hz, H-1′); 7.06 (dm, 1H, $J_{5,4}$ = 7.8 Hz, H-5); 7.88 (dd, 1H, $J_{4,5}$ = 7.8 Hz, $J_{4,1'}$ = 0.8 Hz, H-4). ^{13}C NMR (125.7 MHz, $CDCl_3$): −5.48, −5.42, −4.76 and −4.62 (CH_3Si); 17.98 and 18.29 ($(CH_3)_3C$); 23.71 (CH_3); 25.76 and 25.88 ($(CH_3)_3C$); 42.42 (CH_2-2′); 63.33 (CH_2-5′); 73.73 (CH-3′); 76.14 (CH-1′); 87.74 (CH-4′); 122.18

(CH-5); 134.16 (C-3); 136.10 (CH-4); 147.50 (C-2); 157.50 (C-6). IR spectrum (CCl_4): 3068, 2956, 2898, 1597, 1569, 1555, 1471, 1462, 1435, 1407, 1389, 1376, 1362, 1257, 1220, 1097, 1031, 1006, 939, 838.

1β-(2-Chloro-6-methylpyridin-3-yl)-1,2-dideoxy-D-ribofuranose (8b). Compound **8b** was prepared from **8a** (225 mg, 0.93 mmol) by the general procedure to yield **8b** (103 mg, 89%) as a yellow solid. HRMS (ESI) for $C_{11}H_{14}ClNO_3$: [M + H] calculated, 244.0735; found, 244.0737. ^{1}H NMR (500 MHz, CD_3OD): 1.77 (ddd, 1H, J_{gem} = 13.1 Hz, $J_{2'a,1'}$ = 10.1 Hz, $J_{2'a,3'}$ = 6.0 Hz, H-2′a); 2.45 (ddd, 1H, J_{gem} = 13.1 Hz, $J_{2'b,1'}$ = 5.7 Hz, $J_{2'b,3'}$ = 2.0 Hz, H-2′b); 2.48 (s, 3H, CH_3); 3.68 (dd, 1H, J_{gem} = 11.8 Hz, $J_{5'a,4'}$ = 5.0 Hz, H-5′a); 3.71 (dd, 1H, J_{gem} = 11.8 Hz, $J_{5'b,4'}$ = 4.7 Hz, H-5′b); 3.97 (td, 1H, $J_{4',5'a}$ = $J_{4',5'b}$ = 4.8 Hz, $J_{4',3'}$ = 2.7 Hz, H-4′); 4.32 (dddd, 1H, $J_{3',2'a}$ = 6.0 Hz, $J_{3',4'}$ = 2.7 Hz, $J_{3',2'b}$ = 2.0 Hz, $J_{3',1'}$ = 0.7 Hz, H-3′); 5.36 (bdd, 1H, $J_{1',2'a}$ = 10.1 Hz, $J_{1',2'b}$ = 5.7 Hz, H-1′); 7.25 (dm, 1H, $J_{5,4}$ = 7.8 Hz, H-5); 8.02 (dd, 1H, $J_{4,5}$ = 7.8 Hz, $J_{4,1'}$ = 0.8 Hz, H-4). ^{13}C NMR (125.7 MHz, CD_3OD): 23.24 (CH_3); 43.20 (CH_2-2′); 63.77 (CH_2-5′); 74.16 (CH-3′); 77.44 (CH-1′); 89.12 (CH-4′); 123.97 (CH-5); 135.38 (C-3); 138.20 (CH-4); 148.33 (C-2); 159.17 (C-6). IR spectrum (KBr): 3356, 3230, 3066, 2986, 2919, 1599, 1554, 1463, 1439, 1379, 1171, 1061, 1040, 938.

1β-(2,6-Dimethylpyridin-3-yl)-1,2-dideoxy-3,5-di-*O*-(*t*-butyldimethylsilyl)-D-ribofuranose (9a). Me_3Al (1.4 mL, 1.4 mmol, 4.0 equiv., 1 M in heptane) was added to a flame-dried flask containing **4** (193 mg, 0.36 mmol) and $Pd(PPh_3)_4$ (42 mg, 0.036 mmol, 10 mol%) under argon. The mixture was stirred at 70 °C for 12 h, quenched by pouring into saturated NaH_2PO_4 (50 mL), and extracted with EtOAc (3 × 50 mL). The crude product was chromatographed on silica gel eluting with a gradient of hexanes to 9% EtOAc in hexanes to give **9a** (130 mg, 80%) as a colorless oil. HRMS (ESI) for $C_{24}H_{45}NO_3Si_2$: [M + H] calculated, 452.3011; found, 452.3010. ^{1}H NMR (500 MHz, $CDCl_3$): 0.08 and 0.09 (4 × s, 4 × 3H, CH_3Si); 0.90 and 0.91 (2 × s, 2 × 9H, ($(CH_3)_3C$)); 1.73 (ddd, 1H, J_{gem} = 12.6 Hz, $J_{2'a,1'}$ = 10.0 Hz, $J_{2'a,3'}$ = 5.5 Hz, H-2′a); 2.17 (ddd, 1H, J_{gem} = 12.6 Hz, $J_{2'b,1'}$ = 5.5 Hz, $J_{2'b,3'}$ = 2.0 Hz, H-2′b); 2.52 (s, 3H, CH_3-2); 2.53 (s, 3H, CH_3-6); 3.67 (dd, 1H, J_{gem} = 10.8 Hz, $J_{5'a,4'}$ = 5.2 Hz, H-5′a); 3.78 (dd, 1H, J_{gem} = 10.8 Hz, $J_{5'b,4'}$ = 3.6 Hz, H-5′b); 3.95 (ddd, 1H, $J_{4',5'a}$ = 5.2 Hz, $J_{4',5'b}$ = 3.6 Hz, $J_{4',3'}$ = 2.3 Hz, H-4′); 4.41 (bdtd, 1H, $J_{3',2'a}$ = 5.6 Hz, $J_{3',4'}$ = $J_{3',2'b}$ = 2.2 Hz, $J_{3',1'}$ = 0.5 Hz, H-3′); 5.28 (dd, 1H, $J_{1',2'a}$ = 10.0 Hz, $J_{1',2'b}$ = 5.4 Hz, H-1′); 6.99 (d, 1H, $J_{5,4}$ = 8.0 Hz, H-5); 7.79 (d, 1H, $J_{4,5}$ = 7.9 Hz, H-4). ^{13}C NMR (125.7 MHz, $CDCl_3$): −5.48, −5.40, −4.70 and −4.64 (CH_3Si); 17.99 and 18.31 (($(CH_3)_3\mathbf{C}$); 21.52 (CH_3-2); 23.72 (CH_3-6); 25.78 and 25.89 (($\mathbf{C}H_3)_3C$); 42.84 (CH_2-2′); 63.49 (CH_2-5′); 74.05 (CH-3′); 76.07 (CH-1′); 87.70 (CH-4′); 121.11 (CH-5); 133.37 (C-3); 134.11 (CH-4); 153.59 (C-2); 155.70 (C-6). IR spectrum (CCl_4): 3068, 2956, 2930, 2897, 2858, 1596, 1578, 1471, 1463, 1450, 1406, 1390, 1372, 1362, 1290, 1257, 1090, 940, 838.

1β-(2,6-Dimethylpyridin-3-yl)-1,2-dideoxy-D-ribofuranose (9b). Compound **9b** was prepared from **9a** (152 mg, 0.34 mmol) by the general procedure to yield **9b** (66 mg, 88%) as a yellow solid. HRMS (ESI) for $C_{12}H_{17}NO_3$: [M + H] calculated, 224.1281; found, 224.1281. ^{1}H NMR (500 MHz, CD_3OD): 1.81 (ddd, 1H, J_{gem} = 13.1 Hz, $J_{2'a,1'}$ = 10.4 Hz, $J_{2'a,3'}$ = 6.0 Hz, H-2′a); 2.28 (ddd, 1H, J_{gem} = 13.1 Hz, $J_{2'b,1'}$ = 5.4 Hz, $J_{2'b,3'}$ = 1.8 Hz, H-2′b); 2.47 (s, 3H, CH_3-6); 2.49 (s, 3H, CH_3-2); 3.67–3.71 (m, 2H, H-5′); 3.95 (td, 1H, $J_{4',5'a}$ = $J_{4',5'b}$ = 4.9 Hz, $J_{4',3'}$ = 2.7 Hz, H-4′); 4.33 (bdt, 1H, $J_{3',2'a}$ = 6.0 Hz, $J_{3',4'}$ = $J_{3',2'b}$ = 2.2 Hz, H-3′); 5.30 (dd, 1H, $J_{1',2'a}$ = 10.4 Hz, $J_{1',2'b}$ = 5.4 Hz, H-1′); 7.11 (bd, 1H, $J_{5,4}$ = 8.0 Hz, H-5); 7.88 (d, 1H, $J_{4,5}$ = 8.0 Hz, H-4). ^{13}C NMR (125.7 MHz, CD_3OD): 21.20 (CH_3-2); 23.30 (CH_3-6); 43.24 (CH_2-2′); 63.84 (CH_2-5′); 74.32 (CH-3′); 77.38 (CH-1′); 89.01 (CH-4′); 122.59 (CH-5); 134.68 (C-3); 135.88 (CH-4); 155.09 (C-2); 157.15 (C-6). IR spectrum (KBr): 3307, 1598, 1583, 1476, 1455, 1381, 1282, 1142, 1058, 1031, 976, 961.

1β-(2-Ethynyl-6-methylpyridin-3-yl)-1,2-dideoxy-3,5-di-*O*-(*t*-butyldimethylsilyl)-D-ribofuranose (10a). DMF (3 mL) and TMSA (415 μL, 2.96 mmol) were added through a septum to an argon-purged vial containing **8a** (280 mg, 0.59 mmol), $Pd(PPh_3)_2Cl_2$ (42 mg, 0.06 mmol), CuI (1 mg, 0.005 mmol) and Et_3N (827 μL, 5.93 mmol). The resulting mixture was stirred at 90 °C for 8 h. The reaction mixture was then cooled and filtered on a pad of Celite and eluted with $CHCl_3$. Solvents were then removed in vacuum, the crude product was dissolved in methanolic ammonia (26%, 10 mL) and the solution was stirred at rt for 30 min. The solvents were removed under vacuum, and the crude product was chromatographed on silica gel eluting with a gradient of hexanes to 8% EtOAc in hexanes to give **10a** (153 mg, 56% for two steps) as a colorless oil. HRMS (ESI) for $C_{25}H_{43}NO_3Si_2$: [M + H] calculated, 462.2854; found, 462.2853. ^{1}H NMR (500 MHz, DMSO-d_6): 0.07, 0.08 and 0.09 (4 × s, 4 × 3H, CH_3Si); 0.87 and 0.89 (2 × s, 2 × 9H, ($(CH_3)_3C$)); 1.73 (ddd, 1H, J_{gem} = 12.7 Hz, $J_{2'a,1'}$ = 10.2 Hz, $J_{2'a,3'}$ = 5.2 Hz, H-2′a); 2.22 (ddd, 1H, J_{gem} = 12.7 Hz, $J_{2'b,1'}$ = 5.5 Hz, $J_{2'b,3'}$ = 1.9 Hz, H-2′b); 2.43 (s, 3H, CH_3-6); 3.61 (dd, 1H, J_{gem} = 10.9 Hz, $J_{5'a,4'}$ = 5.9 Hz, H-5′a); 3.72 (dd, 1H, J_{gem} = 10.9 Hz, $J_{5'b,4'}$ = 4.0 Hz, H-5′b); 3.85 (ddd, 1H, $J_{4',5'a}$ = 5.9 Hz, $J_{4',5'b}$ = 4.0 Hz, $J_{4',3'}$ = 1.9 Hz, H-4′); 4.37 (bdt, 1H, $J_{3',2'a}$ = 5.2 Hz, $J_{3',4'}$ = $J_{3',2'b}$ = 1.9 Hz, H-3′); 4.50 (s, 1H, CH≡C-2); 5.37 (bdd, 1H, $J_{1',2'a}$ = 10.2 Hz, $J_{1',2'b}$ = 5.5 Hz, H-1′); 7.28 (d, 1H, $J_{5,4}$ = 8.1 Hz, H-5); 7.79 (bd, 1H, $J_{4,5}$ = 8.1 Hz, H-4). ^{13}C NMR (125.7 MHz, DMSO-d_6): −5.34, −5.26, −4.64 and −4.53 (CH_3Si); 17.89 and 18.10 (($(CH_3)_3\mathbf{C}$); 23.72 (CH_3-6); 25.86 and 25.92 (($\mathbf{C}H_3)_3C$); 42.44 (CH_2-2′); 63.38 (CH_2-5′); 74.28 (CH-3′); 76.11 (CH-1′); 80.86 (CH≡**C**-2); 84.26 (**C**H≡C-2); 87.55 (CH-4′); 123.66 (CH-5); 133.72 (CH-4); 137.87 (C-3); 138.36 (C-2); 157.47 (C-6). IR spectrum (CCl_4): 3310, 3062, 2956, 2929, 2897, 2858, 2523, 2803, 2113, 1585, 1566, 1472, 1463, 1445, 1406, 1389, 1361, 1370, 1275, 1258, 1177, 1098, 1087, 1006, 939, 838, 652, 632.

1β-(2-Ethynyl-6-methylpyridin-3-yl)-1,2-dideoxy-D-ribofuranose (10b). Compound **10b** was prepared from **10a** (97 mg, 0.11 mmol) by the general procedure to yield **10b** (32 mg, 65%) as a yellow foam. HRMS (ESI) for $C_{13}H_{15}NO_3$: [M + Na] calculated, 256.0944; found, 256.0944. ^{1}H NMR (500 MHz, DMSO-d_6): 1.66 (ddd, 1H, J_{gem} = 12.7 Hz, $J_{2'a,1'}$ = 10.2 Hz, $J_{2'a,3'}$ = 5.6 Hz, H-2′a); 2.20 (ddd, 1H, J_{gem} = 12.7 Hz, $J_{2'b,1'}$ = 5.6 Hz, $J_{2'b,3'}$ = 1.7 Hz, H-2′b); 2.43 (s, 3H, CH_3-6); 3.46 (dm, 1H, J_{gem} = 11.5 Hz, H-5′a); 3.51 (ddd, 1H, J_{gem} = 11.5 Hz,

$J_{5'b,OH}$ = 5.6 Hz, $J_{5'b,4'}$ = 4.8 Hz, H-5′b); 3.80 (btd, 1H, $J_{4',5'a}$ = $J_{4',5'b}$ = 5.0 Hz, $J_{4',3'}$ = 2.2 Hz, H-4′); 4.37 (m, 1H, H-3′); 4.50 (s, 1H, CH≡C-2); 4.79 (t, 1H, $J_{OH,5'a}$ = $J_{OH,5'b}$ = 5.7 Hz, OH-5′); 5.12 (d, 1H, $J_{OH,3'}$ = 3.8 Hz, OH-3′); 5.34 (bdd, 1H, $J_{1',2'a}$ = 10.2 Hz, $J_{1',2'b}$ = 5.6 Hz, H-1′); 7.28 (d, 1H, $J_{5,4}$ = 8.1 Hz, H-5); 7.86 (bd, 1H, $J_{4,5}$ = 8.1 Hz, H-4). ^{13}C NMR (125.7 MHz, DMSO-d_6): 23.72 (CH_3-6); 42.77 (CH_2-2′); 62.41 (CH_2-5′); 72.58 (CH-3′); 76.05 (CH-1′); 81.10 (CH≡C-2); 84.10 (CH≡C-2); 88.00 (CH-4′); 123.75 (CH-5); 134.14 (CH-4); 138.33 and 138.44 (C-2,3); 157.27 (C-6). IR spectrum (KBr): 3366, 3064, 2980, 2929, 2106, 2095, 1590, 1567, 1449, 1378, 1346, 1332, 1288, 1179, 1161, 1118, 1083, 1062, 1050, 969, 938, 655, 639.

1β-(2-Amino-6-methylpyridin-3-yl)-1,2-dideoxy-3,5-di-*O*-(*t*-butyldimethylsilyl)-D-ribofuranose (11a). $LiN(SiMe_3)_2$ (1.6 mL, 1.6 mmol, 3 equiv. 1.0 M solution in THF) was added to a flame-dried and argon-purged flask containing **8a** (255 mg, 0.54 mmol), Ph_3SiNH_2 (297 mg, 1.1 mmol), $Pd_2(dba)_3$ (28 mg, 0.027 mmol, 5 mol%), and (biphenyl-2-yl)dicyclohexylphosphane (38 mg, 0.11 mmol, 20 mol%), and the mixture was stirred at 50 °C for 3 h. After cooling to room temperature, the reaction mixture was diluted with Et_2O (30 mL), and washed with 2 M HCl (10 mL) and 1 M NaOH (15 mL). The crude product was chromatographed on silica gel eluting with a gradient of hexanes to 17% EtOAc in hexanes to give **11a** (167 mg, 68%) as a colorless oil. HRMS (ESI) for $C_{23}H_{44}N_2O_3Si_2$: [M + H] calculated, 453.2963; found, 453.2963. ^{1}H NMR (500 MHz, $CDCl_3$) 0.07, 0.079, 0.081 and 0.09 (4 × s, 4 × 3H, CH_3Si); 0.90 (2 × s, 2 × 9H, ($(CH_3)_3C$)); 1.86 (ddd, 1H, J_{gem} = 12.8 Hz, $J_{2'a,1'}$ = 5.6 Hz, $J_{2'a,3'}$ = 1.6 Hz, H-2′a); 2.35 (s, 3H, CH_3); 2.38 (ddd, 1H, J_{gem} = 12.8 Hz, $J_{2'b,1'}$ = 10.8 Hz, $J_{2'b,3'}$ = 6.5 Hz, H-2′b); 3.77 (dd, 1H, J_{gem} = 11.1 Hz, $J_{5'a,4'}$ = 2.4 Hz, H-5′a); 3.83 (dd, 1H, J_{gem} = 11.1 Hz, $J_{5'b,4'}$ = 3.0 Hz, H-5′b); 3.90 (bq, 1H, $J_{4',5'a}$ = $J_{4',5'b}$ = $J_{4',3'}$ = 2.7 Hz, H-4′); 4.45 (bddd, 1H, $J_{3',2'b}$ = 6.5 Hz, $J_{3',4'}$ = 2.9 Hz, $J_{3',2'a}$ = 1.6 Hz, H-3′); 5.01 (dd, 1H, $J_{1',2'b}$ = 10.8 Hz, $J_{1',2'a}$ = 5.6 Hz, H-1′); 5.31 (bs, 2H, NH_2); 6.42 (bd, 1H, $J_{5,4}$ = 7.4 Hz, H-5); 7.19 (d, 1H, $J_{4,5}$ = 7.4 Hz, H-4). ^{13}C NMR (125.7 MHz, $CDCl_3$): −5.57, −5.51, −4.72 and −4.58 (CH_3Si); 18.02 and 18.43 ($(CH_3)_3C$); 23.73 (CH_3); 25.80 and 25.88 ($(CH_3)_3C$); 39.94 (CH_2-2′); 62.93 (CH_2-5′); 73.55 (CH-3′); 80.27 (CH-1′); 88.23 (CH-4′); 112.11 (CH-5); 114.81 (C-3); 137.04 (CH-4); 155.94 (C-6); 156.38 (C-2). IR spectrum (CCl_4): 3488, 3372, 3062, 2956, 2930, 2896, 2585, 1609, 1595, 1582, 1472, 1463, 1445, 1408, 1390, 1374, 1362, 1258, 1097, 1006, 938, 837.

1β-(2-Amino-6-methylpyridin-3-yl)-1,2-dideoxy-D-ribofuranose (11b). Compound **11b** was prepared from **11a** (97 mg, 0.11 mmol) by the general procedure to yield **11b** (85 mg, 82%) as a yellow solid. HRMS (ESI) for $C_{11}H_{16}N_2O_3$: [M + H] calculated, 225.1234; found, 225.1234. ^{1}H NMR (500 MHz, DMSO-d_6): 1.88 (ddd, 1H, J_{gem} = 12.7 Hz, $J_{2'a,1'}$ = 5.6 Hz, $J_{2'a,3'}$ = 1.8 Hz, H-2′a); 2.03 (ddd, 1H, J_{gem} = 12.7 Hz, $J_{2'b,1'}$ = 10.5 Hz, $J_{2'b,3'}$ = 6.3 Hz, H-2′b); 2.21 (s, 3H, CH_3); 3.50 (ddd, 1H, J_{gem} = 11.5 Hz, $J_{5'a,OH}$ = 5.4 Hz, $J_{5'a,4'}$ = 3.9 Hz, H-5′a); 3.54 (ddd, 1H, J_{gem} = 11.5 Hz, $J_{5'b,OH}$ = 4.9 Hz, $J_{5'b,4'}$ = 3.6 Hz, H-5′b); 3.73 (td, 1H, $J_{4',5'a}$ = $J_{4',5'b}$ = 3.8 Hz, $J_{4',3'}$ = 2.8 Hz, H-4′); 4.20 (m, 1H, H-3′); 4.91 (dd, 1H, $J_{1',2'b}$ = 10.5 Hz, $J_{1',2'a}$ = 5.6 Hz, H-1′); 4.93 (t, 1H, $J_{OH,5'a}$ = $J_{OH,5'b}$ = 5.2 Hz, OH-5′); 5.02 (d, 1H, $J_{OH,3'}$ = 4.1 Hz, OH-3′); 5.76 (bs, 2H, NH_2); 6.34 (bdd, 1H, $J_{5,4}$ = 7.4 Hz, $J_{5,LR}$ = 0.6 Hz, H-5); 7.26 (bd, 1H, $J_{4,5}$ = 7.4 Hz, H-4). ^{13}C NMR (125.7 MHz, DMSO-d_6): 23.68 (CH_3); 39.76 (CH_2-2′); 61.72 (CH_2-5′); 72.13 (CH-3′); 78.13 (CH-1′); 87.82 (CH-4′); 111.08 (CH-5); 115.60 (C-3); 135.83 (CH-4); 155.00 (C-6); 156.60 (C-2). IR spectrum (KBr): 3393, 3317, 3200, 3149, 3086, 2951, 2919, 2773, 1626, 1595, 1587, 1444, 1379, 1347, 1328, 1281, 1185, 1100, 1081, 1042, 977, 938, 831.

1β-(2-Methoxy-6-methylpyridin-3-yl)-1,2-dideoxy-D-ribofuranose (12). MeONa (605 mg, 11 mmol) was added to a solution of the nucleoside **8b** (53 mg, 0.22 mmol) in methanol (10 mL) and the mixture was stirred for 10 days at 120 °C. Then the solvents were evaporated under vacuum. The crude product was chromatographed on silica gel in a gradient of chloroform to 6% MeOH in chloroform to give **12** (40 mg, 77%) as a white solid. HRMS (ESI) for $C_{12}H_{17}NO_4$: [M + Na] calculated, 262.1050; found, 262.1050. ^{1}H NMR (500 MHz, CD_3OD): 1.77 (ddd, 1H, J_{gem} = 13.1 Hz, $J_{2'a,1'}$ = 10.2 Hz, $J_{2'a,3'}$ = 6.0 Hz, H-2′a); 2.31 (ddd, 1H, J_{gem} = 13.1 Hz, $J_{2'b,1'}$ = 5.6 Hz, $J_{2'b,3'}$ = 1.9 Hz, H-2′b); 2.40 (s, 3H, CH_3-6); 3.64 (dd, 1H, J_{gem} = 11.6 Hz, $J_{5'a,4'}$ = 5.1 Hz, H-5′a); 3.66 (dd, 1H, J_{gem} = 11.6 Hz, $J_{5'b,4'}$ = 5.2 Hz, H-5′b); 3.91 (s, 3H, CH_3O); 3.92 (td, 1H, $J_{4',5'a}$ = $J_{4',5'b}$ = 5.2 Hz, $J_{4',3'}$ = 2.7 Hz, H-4′); 4.27 (dddd, 1H, $J_{3',2'a}$ = 6.0 Hz, $J_{3',4'}$ = 2.7 Hz, $J_{3',2'b}$ = 1.9 Hz, $J_{3',1'}$ = 0.7 Hz, H-3′); 5.26 (bdd, 1H, $J_{1',2'a}$ = 10.2 Hz, $J_{1',2'b}$ = 5.6 Hz, H-1′); 6.77 (dm, 1H, $J_{5,4}$ = 7.4 Hz, H-5); 7.71 (dd, 1H, $J_{4,5}$ = 7.4 Hz, $J_{4,1'}$ = 0.9 Hz, H-4). ^{13}C NMR (125.7 MHz, CD_3OD): 23.69 (CH_3-6); 42.93 (CH_2-2′); 53.54 (CH_3O-2); 64.01 (CH_2-5′); 74.32 (CH-3′); 76.08 (CH-1′); 88.69 (CH-4′); 116.83 (CH-5); 122.92 (C-3); 136.38 (CH-4); 155.78 (C-6); 161.26 (C-2). IR spectrum (KBr): 3386, 3079, 2988, 2951, 2923, 2853, 1603, 1588, 1461, 1444, 1383, 1327, 1246, 1192, 1116, 1089, 1082, 1049, 1031, 966, 942, 821.

1β-(6-Chloro-2-phenylpyridin-3-yl)-1,2-dideoxy-3,5-di-*O*-(*t*-butyldimethylsilyl)-D-ribofuranose (13a). K_2CO_3 (86 mg, 0.62 mmol), $Pd(PPh_3)_4$ (24 mg, 0.02 mmol, 5 mol%), $PhB(OH)_2$ (45 mg, 0.37 mmol, 0.9 equiv.) and starting nucleoside **7** (222 mg, 0.41 mmol) were dissolved in toluene (2 mL) under argon, and the mixture was stirred at 60 °C for 12 h. The reaction mixture was concentrated under reduced pressure, and the crude product was chromatographed on silica gel eluting with a gradient of hexanes to 1% EtOAc in hexanes to give **13a** (140 mg, 63%) as a colorless oil. HRMS (ESI) for $C_{28}H_{44}ClNO_3Si_2$: [M + H] calculated, 534.2621; found, 534.2621. ^{1}H NMR (500 MHz, $CDCl_3$): −0.01, 0.02, 0.09 and 0.10 (4 × s, 4 × 3H, CH_3Si); 0.82 and 0.92 (2 × s, 2 × 9H, ($(CH_3)_3C$)); 1.81 (ddd, 1H, J_{gem} = 12.7 Hz, $J_{2'a,1'}$ = 10.2 Hz, $J_{2'a,3'}$ = 5.4 Hz, H-2′a); 1.96 (ddd, 1H, J_{gem} = 12.7 Hz, $J_{2'b,1'}$ = 5.3 Hz, $J_{2'b,3'}$ = 1.9 Hz, H-2′b); 3.67 (dd, 1H, J_{gem} = 10.9 Hz, $J_{5'a,4'}$ = 4.8 Hz, H-5′a); 3.74 (dd, 1H, J_{gem} = 10.9 Hz, $J_{5'b,4'}$ = 3.3 Hz, H-5′b); 3.85 (ddd, 1H, $J_{4',5'a}$ = 4.8 Hz, $J_{4',5'b}$ = 3.3 Hz, $J_{4',3'}$ = 2.1 Hz, H-4′); 4.36 (dtd, 1H, $J_{3',2'a}$ = 5.5 Hz, $J_{3',4'}$ = $J_{3',2'b}$ = 2.0 Hz, $J_{3',1'}$ = 0.6 Hz, H-3′); 5.22 (bddq, 1H, $J_{1',2'a}$ = 10.2 Hz, $J_{1',2'b}$ = 5.3 Hz, $J_{1',3'}$ = $J_{1',4}$ = $J_{1',5}$ = 0.6 Hz, H-1′); 7.30 (dd, 1H, $J_{5,4}$ = 8.3 Hz, $J_{5,1'}$ = 0.7 Hz, H-5); 7.38–7.46 (m, 5H, H-*o*,*m*,*p*-Ph); 8.05 (dd, 1H, $J_{4,5}$ = 8.3 Hz, $J_{4,1'}$ = 0.6 Hz, H-4). ^{13}C NMR (125.7 MHz, $CDCl_3$): −5.51, −5.39, −4.80 and −4.76 (CH_3Si); 17.86 and 18.31 ($(CH_3)_3C$); 25.67 and 25.89

((CH_3)$_3$C); 44.62 (CH_2-2′); 63.53 (CH_2-5′); 74.20 (CH-3′); 75.74 (CH-1′); 87.91 (CH-4′); 123.01 (CH-5); 128.23 and 128.95 (CH-*o*,*m*-Ph); 128.58 (CH-*p*-Ph); 134.90 (C-3); 137.99 (CH-4); 138.33 (C-i-Ph); 149.33 (C-6); 157.84 (C-2). IR spectrum (CCl_4): 3087, 3063, 3034, 2956, 2989, 1575, 1558, 1496, 1471, 1463, 1408, 1388, 1361, 1257, 1088, 1027, 1006, 939, 838.

1β-(6-Chloro-2-phenylpyridin-3-yl)-1,2-dideoxy-D-ribofuranose (13b). Compound **13b** was prepared from **13a** (160 mg, 0.30 mmol) by the general procedure to yield **13b** (84 mg, 91%) as a white solid. HRMS (ESI) for $C_{22}H_{21}NO_3$: [M + H] calculated, 348.1594; found, 348.1593. ^{1}H NMR (500 MHz, CD_3OD): 2.01 (ddd, 1H, J_{gem} = 13.2 Hz, $J_{2'a,1'}$ = 10.1 Hz, $J_{2'a,3'}$ = 5.9 Hz, H-2′a); 2.06 (ddd, 1H, J_{gem} = 13.2 Hz, $J_{2'b,1'}$ = 5.8 Hz, $J_{2'b,3'}$ = 2.0 Hz, H-2′b); 3.70 (m, 1H, H-5′a); 3.72 (m, 1H, H-5′b); 3.85 (btd, 1H, $J_{4',5'a}$ = $J_{4',5'b}$ = 4.7 Hz, $J_{4',3'}$ = 2.7 Hz, H-4′); 4.31 (bdddd, 1H, $J_{3',2'a}$ = 5.9 Hz, $J_{3',4'}$ = 2.8 Hz, $J_{3',2'b}$ = 1.9 Hz, $J_{3',1'}$ = 0.6 Hz, H-3′); 5.24 (bddq, 1H, $J_{1',2'a}$ = 10.1 Hz, $J_{1',2'b}$ = 5.8 Hz, $J_{1',3'}$ = $J_{1',4}$ = $J_{1',5}$ = 0.6 Hz, H-1′); 7.41 (m, 1H, H-*p*-Ph-6); 7.44–7.49 (m, 3H, H-*m*-Ph-6, H-*p*-Ph-2); 7.50 (m, 2H, H-*m*-Ph-2); 7.55 (m, 2H, H-*o*-Ph-2); 7.85 (dd, 1H, $J_{5,4}$ = 8.3 Hz, $J_{5,1'}$ = 0.6 Hz, H-5); 8.01 (m, 2H, H-*o*-Ph-6); 8.22 (dd, 1H, $J_{4,5}$ = 8.3 Hz, $J_{4,1'}$ = 0.5 Hz, H-4). ^{13}C NMR (125.7 MHz, CD_3OD): 44.89 (CH_2-2′); 63.86 (CH_2-5′); 74.42 (CH-3′); 77.59 (CH-1′); 89.06 (CH-4′); 121.00 (CH-5); 128.22 (CH-*o*-Ph-6); 129.33 (CH-*m*-Ph-2); 129.43 (CH-*p*-Ph-2); 129.72 (CH-*m*-Ph-6); 130.10 (CH-*p*-Ph-6); 130.32 (CH-*o*-Ph-2); 135.29 (C-3); 137.71 (CH-4); 140.31 (C-i-Ph-6); 141.23 (C-i-Ph-2); 157.47 (C-6); 159.02 (C-2). IR spectrum (KBr): 3412, 3084, 3061, 3031, 1574, 1559, 1495, 1449, 1277, 1146, 1083, 1075, 1024, 1000, 940, 831.

1β-(2,6-Diphenylpyridin-3-yl)-1,2-dideoxy-3,5-di-*O*-(*t*-butyldimethylsilyl)-D-ribofuranose (14a). K_2CO_3 (129 mg, 0.93 mmol), $Pd(PPh_3)_4$ (21 mg, 0.0185 mmol, 5 mol%), $PhB(OH)_2$ (135 mg, 1.11 mmol, 3 equiv.) and starting nucleoside **7** (200 mg, 0.37 mmol) were dissolved in toluene (2 mL) under argon, and the mixture was stirred at 100 °C for 12 h. The reaction mixture was concentrated under reduced pressure, and the crude product was chromatographed on silica gel eluting with a gradient of hexanes to 1% EtOAc in hexanes to give **14a** (205 mg, 95%) as a colorless oil. HRMS (ESI) for $C_{34}H_{49}NO_3Si_2$: [M + H] calculated, 576.3324; found, 576.3323. ^{1}H NMR (500 MHz, $CDCl_3$): 0.04, 0.06, 0.12 and 0.14 (4 × s, 4 × 3H, CH_3Si); 0.86 and 0.96 (2 × s, 2 × 9H, ((CH_3)$_3$C)); 1.91 (ddd, 1H, J_{gem} = 12.7 Hz, $J_{2'a,1'}$ = 10.2 Hz, $J_{2'a,3'}$ = 5.4 Hz, H-2′a); 2.03 (ddd, 1H, J_{gem} = 12.7 Hz, $J_{2'b,1'}$ = 5.3 Hz, $J_{2'b,3'}$ = 1.9 Hz, H-2′b); 3.71 (dd, 1H, J_{gem} = 10.8 Hz, $J_{5'a,4'}$ = 5.1 Hz, H-5′a); 3.80 (dd, 1H, J_{gem} = 10.8 Hz, $J_{5'b,4'}$ = 3.5 Hz, H-5′b); 3.90 (ddd, 1H, $J_{4',5'a}$ = 5.1 Hz, $J_{4',5'b}$ = 3.5 Hz, $J_{4',3'}$ = 2.2 Hz, H-4′); 4.42 (bdt, 1H, $J_{3',2'a}$ = 5.4 Hz, $J_{3',4'}$ = $J_{3',2'b}$ = 2.1 Hz, H-3′); 5.33 (bdd, 1H, $J_{1',2'a}$ = 10.2 Hz, $J_{1',2'b}$ = 5.3 Hz, H-1′); 7.38–7.45 (m, 2H, H-*p*-Ph-2,6); 7.44–7.49 (m, 4H, H-*m*-Ph-2,6); 7.57 (m, 2H, H-*o*-Ph-2); 7.74 (dd, 1H, $J_{5,4}$ = 8.2 Hz, $J_{5,1'}$ = 0.6 Hz, H-5); 8.08 (m, 2H, H-*o*-Ph-6); 8.14 (bd, 1H, $J_{4,5}$ = 8.2 Hz, H-4). ^{13}C NMR (125.7 MHz, $CDCl_3$): −5.47, −5.36, −4.78 and −4.74 (CH_3Si); 17.88 and 18.33 ((CH_3)$_3$C); 25.70 and 25.92 ((CH_3)$_3$C); 44.53 (CH_2-2′); 63.61 (CH_2-5′); 74.28 (CH-3′); 76.16 (CH-1′); 87.78 (CH-4′); 119.21 (CH-5); 127.07 (CH-*o*-Ph-6); 128.06 (CH-*m*-Ph-2); 128.11 (CH-*p*-Ph-2); 128.59 (CH-*m*-Ph-6); 128.80 (CH-*p*-Ph-6); 129.22 (CH-*o*-Ph-2); 134.17 (C-3); 135.75 (CH-4); 139.16 (C-i-Ph-6); 139.94 (C-i-Ph-2); 155.58 (C-6); 157.17 (C-2). IR spectrum (CCl_4): 3110, 3086, 3064, 3034, 2956, 2897, 1602, 1588, 1576, 1563, 1495, 1472, 1463, 1442, 1406, 1389, 1361, 1280, 1258, 1096, 1030, 939, 838.

1β-(2,6-Diphenylpyridin-3-yl)-1,2-dideoxy-D-ribofuranose (14b). Compound **14b** was prepared from **14a** (205 mg, 0.36 mmol) by the general procedure to yield **14b** (100 mg, 81%) as a white solid. HRMS (ESI) for $C_{22}H_{21}NO_3$: [M + H] calculated, 348.1594; found, 348.1593. ^{1}H NMR (500 MHz, CD_3OD): 2.01 (ddd, 1H, J_{gem} = 13.2 Hz, $J_{2'a,1'}$ = 10.1 Hz, $J_{2'a,3'}$ = 5.9 Hz, H-2′a); 2.06 (ddd, 1H, J_{gem} = 13.2 Hz, $J_{2'b,1'}$ = 5.8 Hz, $J_{2'b,3'}$ = 2.0 Hz, H-2′b); 3.70 (m, 1H, H-5′a); 3.72 (m, 1H, H-5′b); 3.85 (btd, 1H, $J_{4',5'a}$ = $J_{4',5'b}$ = 4.7 Hz, $J_{4',3'}$ = 2.7 Hz, H-4′); 4.31 (bdddd, 1H, $J_{3',2'a}$ = 5.9 Hz, $J_{3',4'}$ = 2.8 Hz, $J_{3',2'b}$ = 1.9 Hz, $J_{3',1'}$ = 0.6 Hz, H-3′); 5.24 (bddq, 1H, $J_{1',2'a}$ = 10.1 Hz, $J_{1',2'b}$ = 5.8 Hz, $J_{1',3'}$ = $J_{1',4}$ = $J_{1',5}$ = 0.6 Hz, H-1′); 7.41 (m, 1H, H-*p*-Ph-6); 7.44–7.49 (m, 3H, H-*m*-Ph-6, H-*p*-Ph-2); 7.50 (m, 2H, H-*m*-Ph-2); 7.55 (m, 2H, H-*o*-Ph-2); 7.85 (dd, 1H, $J_{5,4}$ = 8.3 Hz, $J_{5,1'}$ = 0.6 Hz, H-5); 8.01 (m, 2H, H-*o*-Ph-6); 8.22 (dd, 1H, $J_{4,5}$ = 8.3 Hz, $J_{4,1'}$ = 0.5 Hz, H-4). ^{13}C NMR (125.7 MHz, CD_3OD): 44.89 (CH_2-2′); 63.86 (CH_2-5′); 74.42 (CH-3′); 77.59 (CH-1′); 89.06 (CH-4′); 121.00 (CH-5); 128.22 (CH-*o*-Ph-6); 129.33 (CH-*m*-Ph-2); 129.43 (CH-*p*-Ph-2); 129.72 (CH-*m*-Ph-6); 130.10 (CH-*p*-Ph-6); 130.32 (CH-*o*-Ph-2); 135.29 (C-3); 137.71 (CH-4); 140.31 (C-i-Ph-6); 141.23 (C-i-Ph-2); 157.47 (C-6); 159.02 (C-2). IR spectrum (KBr): 3412, 3110, 3083, 3059, 3031, 1602, 1587, 1574, 1562, 1493, 1282, 1075, 1046, 1028, 941.

1β-(6-Amino-2-phenylpyridin-3-yl)-1,2-dideoxy-3,5-di-*O*-(*t*-butyldimethylsilyl)-D-ribofuranose (15a). $LiN(SiMe_3)_2$ (1.5 mL, 1.5 mmol, 3 equiv. 1.0 M solution in THF) was added to a flame-dried and argon-purged flask containing **14a** (262 mg, 0.49 mmol), $Pd_2(dba)_3$ (45 mg, 0.049 mmol, 10 mol%), and (biphenyl-2-yl)dicyclohexylphosphane (35 mg, 0.098 mmol, 20 mol%), and the mixture was stirred at 60 °C for 12 h. After cooling to room temperature, the reaction mixture was diluted with Et_2O (30 mL), washed with 2 M HCl (10 mL) and 1 M NaOH (15 mL). The crude product was chromatographed on silica gel eluting with a gradient of hexanes to 20% EtOAc in hexanes to give **15a** (230 mg, 91%) as a colorless oil. HRMS (ESI) for $C_{28}H_{46}N_2O_3Si_2$: [M + H] calculated, 515.3120; found, 515.3118. ^{1}H NMR (500 MHz, $CDCl_3$): 0.01, 0.02, 0.085 and 0.093 (4 × s, 4 × 3H, CH_3Si); 0.82 and 0.93 (2 × s, 2 × 9H, ((CH_3)$_3$C)); 1.86 (ddd, 1H, J_{gem} = 12.7 Hz, $J_{2'a,1'}$ = 10.2 Hz, $J_{2'a,3'}$ = 5.4 Hz, H-2′a); 1.93 (ddd, 1H, J_{gem} = 12.7 Hz, $J_{2'b,1'}$ = 5.4 Hz, $J_{2'b,3'}$ = 1.9 Hz, H-2′b); 3.64 (dd, 1H, J_{gem} = 10.7 Hz, $J_{5'a,4'}$ = 5.2 Hz, H-5′a); 3.74 (dd, 1H, J_{gem} = 10.7 Hz, $J_{5'b,4'}$ = 3.5 Hz, H-5′b); 3.79 (ddd, 1H, $J_{4',5'a}$ = 5.2 Hz, $J_{4',5'b}$ = 3.5 Hz, $J_{4',3'}$ = 2.1 Hz, H-4′); 4.36 (dt, 1H, $J_{3',2'a}$ = 5.4 Hz, $J_{3',4'}$ = $J_{3',2'b}$ = 2.0 Hz, H-3′); 5.10 (dd, 1H, $J_{1',2'a}$ = 10.2 Hz, $J_{1',2'b}$ = 5.3 Hz, H-1′); 6.51 (bd, 1H, $J_{5,4}$ = 8.5 Hz, H-5); 7.36 (m, 1H, H-*p*-Ph); 7.39 (m, 2H, H-*m*-Ph); 7.41 (m, 2H, H-*o*-Ph); 7.77 (d, 1H, $J_{4,5}$ = 8.5 Hz, H-4). ^{13}C NMR (125.7 MHz, $CDCl_3$): −5.50, −5.39, −4.78 and −4.75 (CH_3Si); 17.86 and 18.31 ((CH_3)$_3$C); 25.68 and 25.91 ((CH_3)$_3$C); 44.29 (CH_2-2′); 63.68 (CH_2-5′); 74.29 (CH-3′); 76.02 (CH-1′); 87.45

(CH-4′); 108.00 (CH-5); 124.93 (C-3); 127.90 (CH-*p*-Ph); 128.03 (CH-*m*-Ph); 128.84 (CH-*o*-Ph); 137.26 (CH-4); 139.65 (C-i-Ph); 155.80 (C-2); 156.81 (C-6). IR spectrum (CCl_4): 2506, 3407, 3301, 3169, 3084, 3063, 3030, 2956, 2897, 1631, 1610, 1572, 1496, 1473, 1464, 1444, 1410, 1389, 1361, 1290, 1256, 1097, 1029, 939, 838.

1β-(6-Amino-2-phenylpyridin-3-yl)-1,2-dideoxy-D-ribofuranose (15b). Compound **15b** was prepared from **15a** (200 mg, 0.39 mmol) by the general procedure to yield **15b** (70 mg, 67%) as a yellow solid. HRMS (ESI) for $C_{16}H_{18}N_2O_3$: [M + H] calculated, 287.1390; found, 287.1390. ^{1}H NMR (500 MHz, DMSO-d_6): 1.84 (ddd, 1H, J_{gem} = 12.8 Hz, $J_{2'a,1'}$ = 5.9 Hz, $J_{2'a,3'}$ = 2.1 Hz, H-2′a); 1.88 (ddd, 1H, J_{gem} = 12.8 Hz, $J_{2'b,1'}$ = 10.1 Hz, $J_{2'b,3'}$ = 5.4 Hz, H-2′b); 3.40–3.49 (m, 2H, H-5′); 3.60 (bddd, 1H, $J_{4',5'a}$ = 5.3 Hz, $J_{4',5'b}$ = 4.8 Hz, $J_{4',3'}$ = 2.2 Hz, H-4′); 4.15 (m, 1H, H-3′); 4.71 (bt, 1H, $J_{OH,5'a}$ = $J_{OH,5'b}$ = 5.6 Hz, OH-5′); 4.85 (dd, 1H, $J_{1',2'b}$ = 10.1 Hz, $J_{1',2'a}$ = 5.8 Hz, H-1′); 4.85 (d, 1H, $J_{OH,3'}$ = 3.8 Hz, OH-3′); 6.13 (bs, 2H, NH_2); 6.54 (bd, 1H, $J_{5,4}$ = 8.6 Hz, H-5); 7.38–7.46 (m, 5H, H-*o*,*m*,*p*-Ph); 7.67 (bd, 1H, $J_{4,5}$ = 8.6 Hz, H-4). ^{13}C NMR (125.7 MHz, DMSO-d_6): 43.08 (CH_2-2′); 62.61 (CH_2-5′); 72.71 (CH-3′); 75.47 (CH-1′); 87.54 (CH-4′); 108.25 (CH-5); 122.25 (C-3); 128.02 (CH-*m*,*p*-Ph); 129.13 (CH-*o*-Ph); 137.98 (CH-4); 139.50 (C-i-Ph); 154.35 (C-2); 157.89 (C-6). IR spectrum (KBr): 3358, 3217, 3059, 1621, 1600, 1571, 1496, 1444, 1217, 1181, 1158, 1074, 1047, 830.

1β-(6-Methyl-2-phenylpyridin-3-yl)-1,2-dideoxy-3,5-di-*O*-(*t*-butyldimethylsilyl)-D-ribofuranose (16a). Me_3Al (0.92 mL, 0.92 mmol, 3.0 equiv., 1 M in heptane) was added to a flame-dried flask containing a solution of **14a** (164 mg, 0.31 mmol) and $Pd(PPh_3)_4$ (36 mg, 0.031 mmol, 10 mol%) in THF (5 mL). The mixture was stirred at 70 °C for 12 h, quenched by pouring into saturated NaH_2PO_4 (50 mL), and extracted with EtOAc (3 × 50 mL). The crude product was chromatographed on silica gel eluting with a gradient of hexanes to 6% EtOAc in hexanes to give **16a** (144 mg, 91%) as a colorless oil. HRMS (ESI) for $C_{29}H_{47}NO_3Si_2$: [M + H] calculated, 514.3167; found, 514.3166. ^{1}H NMR (500 MHz, $CDCl_3$): −0.01, 0.02, 0.08 and 0.10 (4 × s, 4 × 3H, CH_3Si); 0.82 and 0.92 (2 × s, 2 × 9H, ($(CH_3)_3C$)); 1.81 (ddd, 1H, J_{gem} = 12.7 Hz, $J_{2'a,1'}$ = 10.2 Hz, $J_{2'a,3'}$ = 5.4 Hz, H-2′a); 1.93 (ddd, 1H, J_{gem} = 12.7 Hz, $J_{2'b,1'}$ = 5.3 Hz, $J_{2'b,3'}$ = 1.9 Hz, H-2′b); 2.62 (s, 3H, CH_3-6); 3.66 (dd, 1H, J_{gem} = 10.8 Hz, $J_{5'a,4'}$ = 5.1 Hz, H-5′a); 3.75 (dd, 1H, J_{gem} = 10.8 Hz, $J_{5'b,4'}$ = 3.5 Hz, H-5′b); 3.83 (ddd, 1H, $J_{4',5'a}$ = 5.1 Hz, $J_{4',5'b}$ = 3.5 Hz, $J_{4',3'}$ = 2.2 Hz, H-4′); 4.36 (dtd, 1H, $J_{3',2'a}$ = 5.4 Hz, $J_{3',4'}$ = $J_{3',2'b}$ = 2.0 Hz, $J_{3',1'}$ = 0.5 Hz, H-3′); 5.18 (dd, 1H, $J_{1',2'a}$ = 10.2 Hz, $J_{1',2'b}$ = 5.3 Hz, H-1′); 7.16 (d, 1H, $J_{5,4}$ = 8.1 Hz, H-5); 7.38 (m, 1H, H-*p*-Ph); 7.40–7.44 (m, 4H, H-*o*,*m*-Ph); 7.97 (d, 1H, $J_{4,5}$ = 8.1 Hz, H-4). ^{13}C NMR (125.7 MHz, $CDCl_3$): −5.49, −5.39, −4.81 and −4.76 (CH_3Si); 17.85 and 18.31 (($CH_3)_3$**C**); 24.06 (CH_3-6); 25.68 and 25.90 (($CH_3)_3$C); 44.49 (CH_2-2′); 63.59 (CH_2-5′); 74.23 (CH-3′); 76.06 (CH-1′); 87.72 (CH-4′); 122.38 (CH-5); 128.14 (CH-*p*-Ph); 128.18 (CH-*m*-Ph); 128.97 (CH-*o*-Ph); 132.93 (C-3); 135.53 (CH-4); 139.32 (C-i-Ph); 156.52 (C-2,6). IR spectrum (CCl_4): 3110, 3083, 3061, 3029, 2956, 2930, 2897, 2858, 1593, 1569, 1495, 1471, 1463, 1406, 1389, 1371, 1361, 1289, 1257, 1095, 1030, 1006, 939, 838.

1β-(6-Methyl-2-phenylpyridin-3-yl)-1,2-dideoxy-D-ribofuranose (16b). Compound **16b** was prepared from **16a** (144 mg, 0.28 mmol) by the general procedure to yield **16b** (68 mg, 85%) as a white solid. HRMS (ESI) for $C_{17}H_{19}NO_3$: [M + H] calculated, 286.1438; found, 286.1438. ^{1}H NMR (500 MHz, CD_3OD): 1.93 (ddd, 1H, J_{gem} = 13.2 Hz, $J_{2'a,1'}$ = 10.2 Hz, $J_{2'a,3'}$ = 5.9 Hz, H-2′a); 1.99 (ddd, 1H, J_{gem} = 13.2 Hz, $J_{2'b,1'}$ = 5.8 Hz, $J_{2'b,3'}$ = 1.9 Hz, H-2′b); 2.54 (s, 3H, CH_3-6); 3.64–3.71 (m, 2H, H-5′); 3.80 (bddd, 1H, $J_{4',5'a}$ = 5.0 Hz, $J_{4',5'b}$ = 4.5 Hz, $J_{4',3'}$ = 2.7 Hz, H-4′); 4.27 (bdddd, 1H, $J_{3',2'a}$ = 6.0 Hz, $J_{3',4'}$ = 2.7 Hz, $J_{3',2'b}$ = 1.9 Hz, $J_{3',1'}$ = 0.6 Hz, H-3′); 5.10 (bdd, 1H, $J_{1',2'a}$ = 10.2 Hz, $J_{1',2'b}$ = 5.8 Hz, H-1′); 7.32 (bd, 1H, $J_{5,4}$ = 8.1 Hz, H-5); 7.42 (m, 2H, H-*o*-Ph); 7.43–7.51 (m, 3H, H-*m*,*p*-Ph); 8.09 (d, 1H, $J_{4,5}$ = 8.1 Hz, H-4). ^{13}C NMR (125.7 MHz, CD_3OD): 23.38 (CH_3-6); 44.85 (CH_2-2′); 63.82 (CH_2-5′); 74.36 (CH-3′); 77.47 (CH-1′); 89.02 (CH-4′); 124.14 (CH-5); 129.40 (CH-*m*-Ph); 129.52 (CH-*p*-Ph); 130.11 (CH-*o*-Ph); 134.25 (C-3); 137.65 (CH-4); 140.70 (C-i-Ph); 158.02 (C-6); 158.29 (C-2). IR spectrum (KBr): 1595, 1573, 1496, 1476, 1447, 1380, 1281, 1146, 1086, 1040, 961.

1β-[2,6-Bis(methylsulfanyl)pyridin-3-yl]-1,2-dideoxy-D-ribofuranose (17). MeSNa (59 mg, 0.84 mmol) was added to a solution of the nucleoside **4** (45 mg, 0.084 mmol) in DMF (2 mL) and the mixture was stirred for 12 h at 80 °C. Then the solvents were evaporated under vacuum. The crude product was chromatographed on silica gel in a gradient of chloroform to 7% MeOH in chloroform to give **17** (19 mg, 79%) as a pale yellow solid. HRMS (ESI) for $C_{12}H_{17}NO_3S_2$: [M + Na] calculated, 310.0542; found, 310.0542. ^{1}H NMR (500 MHz, CD_3OD): 1.75 (ddd, 1H, J_{gem} = 13.1 Hz, $J_{2'a,1'}$ = 10.1 Hz, $J_{2'a,3'}$ = 6.0 Hz, H-2′a); 2.36 (ddd, 1H, J_{gem} = 13.1 Hz, $J_{2'b,1'}$ = 5.6 Hz, $J_{2'b,3'}$ = 2.0 Hz, H-2′b); 2.57 (s, 3H, CH_3S-6); 2.59 (s, 3H, CH_3S-2); 3.67–3.70 (m, 2H, H-5′); 3.92 (td, 1H, $J_{4',5'a}$ = $J_{4',5'b}$ = 4.9 Hz, $J_{4',3'}$ = 2.8 Hz, H-4′); 4.30 (dddd, 1H, $J_{3',2'a}$ = 6.1 Hz, $J_{3',4'}$ = 2.8 Hz, $J_{3',2'b}$ = 2.0 Hz, $J_{3',1'}$ = 0.7 Hz, H-3′); 5.27 (ddq, 1H, $J_{1',2'a}$ = 10.1 Hz, $J_{1',2'b}$ = 5.6 Hz, $J_{1',4}$ = $J_{1',5}$ = $J_{1',3'}$ = 0.7 Hz, H-1′); 6.93 (dd, 1H, $J_{5,4}$ = 8.1 Hz, $J_{5,1'}$ = 0.6 Hz, H-5); 7.65 (dd, 1H, $J_{4,5}$ = 8.1 Hz, $J_{4,1'}$ = 0.8 Hz, H-4). ^{13}C NMR (125.7 MHz, CD_3OD): 11.46 and 11.56 (CH_3S-2,6); 41.24 (CH_2-2′); 62.13 (CH_2-5′); 72.62 (CH-3′); 75.06 (CH-1′); 87.16 (CH-4′); 115.88 (CH-5); 130.16 (C-3); 132.32 (CH-4); 155.15 (C-2); 157.48 (C-6). IR spectrum (KBr): 3411, 2989, 2924, 1565, 1543, 1430, 1418, 1335, 1308, 1217, 1049, 962, 840, 778.

1β-[2-Chloro-6-(methylsulfanyl)pyridin-3-yl]-1,2-dideoxy-3,5-di-*O*-(*t*-butyldimethylsilyl)-D-ribofuranose (18a). MeSNa (48 mg, 0.69 mmol, 1.2 equiv.) was added to a solution of the nucleoside **4** (310 mg, 0.58 mmol) in DMF (5 mL) and the mixture was stirred for 12 h at rt. Then the solvents were evaporated under vacuum. The crude product was purified using high performance flash chromatography with a gradient of hexanes to 1% EtOAc in hexanes to give products **18a** (141 mg, 48%) as a white solid and **19a** (136 mg, 43%) as a white solid. Compound **18a**: HRMS (ESI) for $C_{23}H_{42}ClNO_3SSi_2$: [M + H] calculated, 504.2185; found, 504.2183. ^{1}H NMR (500 MHz, $CDCl_3$) 0.082, 0.084 and 0.09 (4 × s, 4 × 3H, CH_3Si); 0.90 and 0.91 (2 × s, 2 × 9H, ($(CH_3)_3C$)); 1.70 (ddd, 1H, J_{gem} = 12.7 Hz, $J_{2'a,1'}$ = 9.5 Hz, $J_{2'a,3'}$ = 5.6 Hz, H-2′a); 2.37 (ddd, 1H, J_{gem} = 12.7 Hz, $J_{2'b,1'}$ = 5.9 Hz, $J_{2'b,3'}$ = 2.5 Hz, H-2′b); 2.56 (s, 3H, CH_3S-6); 3.69

(dd, 1H, J_{gem} = 10.8 Hz, $J_{5'a,4'}$ = 4.8 Hz, H-5′a); 3.76 (dd, 1H, J_{gem} = 10.8 Hz, $J_{5'b,4'}$ = 3.5 Hz, H-5′b); 3.95 (ddd, 1H, $J_{4',5'a}$ = 5.7 Hz, $J_{4',5'b}$ = 3.5 Hz, $J_{4',3'}$ = 2.6 Hz, H-4′); 4.38 (dtd, 1H, $J_{3',2'a}$ = 5.7 Hz, $J_{3',4'}$ = $J_{3',2'b}$ = 2.5 Hz, $J_{3',1'}$ = 0.7 Hz, H-3′); 5.35 (ddq, 1H, $J_{1',2'a}$ = 9.4 Hz, $J_{1',2'b}$ = 5.8 Hz, $J_{1',3'}$ = $J_{1',4}$ = $J_{1',5}$ = 0.7 Hz,H-1′); 7.08 (dd, 1H, $J_{5,4}$ = 8.1 Hz, $J_{5,1'}$ = 0.6 Hz, H-5); 7.80 (dd, 1H, $J_{4,5}$ = 8.1 Hz, $J_{4,1'}$ = 0.8 Hz, H-4). ^{13}C NMR (125.7 MHz, $CDCl_3$): −5.48, −5.40, −4.75 and −4.62 (CH_3Si); 13.51 (CH_3S-6); 17.99 and 18.30 ((CH_3)$_3$**C**); 25.77 and 25.88 (($\mathbf{C}H_3$)$_3$C); 42.47 (CH_2-2′); 63.32 (CH_2-5′); 73.72 (CH-3′); 76.01 (CH-1′); 87.76 (CH-4′); 120.24 (CH-5); 132.38 (C-3); 135.72 (CH-4); 147.97 (C-2); 158.71 (C-6). IR spectrum (CCl_4): 3078, 3058, 2956, 2897, 1587, 1537, 1472, 1439, 1408, 1390, 1373, 1361, 1318, 1258, 1096, 939, 838.

1β-[6-Bromo-2-(methylsulfanyl)pyridin-3-yl]-1,2-dideoxy-3,5-di-*O*-(*t*-butyldimethylsilyl)-D-ribofuranose (19a). HRMS (ESI) for $C_{23}H_{42}BrNO_3SSi_2$: [M + H] calculated, 548.1680; found, 548.1675. ^{1}H NMR (500 MHz, $CDCl_3$) 0.09, 0.098, 0.100 and 0.11 (4 × s, 4 × 3H, CH_3Si); 0.91 and 0.93 (2 × s, 2 × 9H, ((CH_3)$_3$C)); 1.68 (ddd, 1H, J_{gem} = 12.6 Hz, $J_{2'a,1'}$ = 9.4 Hz, $J_{2'a,3'}$ = 5.6 Hz, H-2′a); 2.38 (ddd, 1H, J_{gem} = 12.6 Hz, $J_{2'b,1'}$ = 5.9 Hz, $J_{2'b,3'}$ = 2.6 Hz, H-2′b); 2.59 (s, 3H, CH_3S-2); 3.70 (dd, 1H, J_{gem} = 10.9 Hz, $J_{5'a,4'}$ = 4.9 Hz, H-5′a); 3.78 (dd, 1H, J_{gem} = 10.9 Hz, $J_{5'b,4'}$ = 3.5 Hz, H-5′b); 3.95 (ddd, 1H, $J_{4',5'a}$ = 4.9 Hz, $J_{4',5'b}$ = 3.5 Hz, $J_{4',3'}$ = 2.7 Hz, H-4′); 4.39 (dtd, 1H, $J_{3',2'a}$ = 5.6 Hz, $J_{3',4'}$ = $J_{3',2'b}$ = 2.7 Hz, $J_{3',1'}$ = 0.7 Hz, H-3′); 5.27 (ddq, 1H, $J_{1',2'a}$ = 9.4 Hz, $J_{1',2'b}$ = 5.9 Hz, $J_{1',3'}$ = $J_{1',4}$ = $J_{1',5}$ = 0.7 Hz, H-1′); 7.15 (dd, 1H, $J_{5,4}$ = 8.0 Hz, $J_{5,1'}$ = 0.6 Hz, H-5); 7.67 (dd, 1H, $J_{4,5}$ = 8.0 Hz, $J_{4,1'}$ = 0.8 Hz, H-4). ^{13}C NMR (125.7 MHz, $CDCl_3$): −5.48, −5.41, −4.76 and −4.61 (CH_3Si); 13.35 (CH_3S-2); 17.99 and 18.30 ((CH_3)$_3$**C**); 25.78 and 25.89 (($\mathbf{C}H_3$)$_3$C); 41.82 (CH_2-2′); 63.24 (CH_2-5′); 73.73 (CH-3′); 75.03 (CH-1′); 87.57 (CH-4′); 122.85 (CH-5); 134.71 (CH-4); 135.45 (C-3); 139.46 (C-6); 157.09 (C-2). IR spectrum (CCl_4): 3057, 2956, 2897, 1571, 1543, 1472, 1463, 1414, 1390, 1374, 1310, 1288, 1216, 1097, 1030, 961, 939, 838.

1β-[2-Chloro-6-(methylsulfanyl)pyridin-3-yl]-1,2-dideoxy-D-ribofuranose (18b). Compound **18b** was prepared from **18a** (141 mg, 0.28 mmol) by the general procedure to yield **18b** (66 mg, 86%) as a white solid. HRMS (ESI) for $C_{11}H_{14}ClNO_3S$: [M + Na] calculated, 298.0275; found, 298.0277. ^{1}H NMR (500 MHz, CD_3OD): 1.77 (ddd, 1H, J_{gem} = 13.1 Hz, $J_{2'a,1'}$ = 10.1 Hz, $J_{2'a,3'}$ = 6.0 Hz, H-2′a); 2.42 (ddd, 1H, J_{gem} = 13.1 Hz, $J_{2'b,1'}$ = 5.6 Hz, $J_{2'b,3'}$ = 1.9 Hz, H-2′b); 2.53 (s, 3H, CH_3S-6); 3.68 (dd, 1H, J_{gem} = 11.8 Hz, $J_{5'a,4'}$ = 5.0 Hz, H-5′a); 3.70 (dd, 1H, J_{gem} = 11.8 Hz, $J_{5'b,4'}$ = 4.6 Hz, H-5′b); 3.95 (td, 1H, $J_{4',5'a}$ = $J_{4',5'b}$ = 4.8 Hz, $J_{4',3'}$ = 2.7 Hz, H-4′); 4.31 (dddd, 1H, $J_{3',2'a}$ = 6.0 Hz, $J_{3',4'}$ = 2.7 Hz, $J_{3',2'b}$ = 1.9 Hz, $J_{3',1'}$ = 0.7 Hz, H-3′); 5.34 (ddq, 1H, $J_{1',2'a}$ = 10.1 Hz, $J_{1',2'b}$ = 5.6 Hz, $J_{1',4}$ = $J_{1',5}$ = $J_{1',3'}$ = 0.7 Hz, H-1′); 7.21 (dd, 1H, $J_{5,4}$ = 8.2 Hz, $J_{5,1'}$ = 0.6 Hz, H-5); 7.90 (dd, 1H, $J_{4,5}$ = 8.2 Hz, $J_{4,1'}$ = 0.8 Hz, H-4). ^{13}C NMR (125.7 MHz, CD_3OD): 13.48 (CH_3S-6); 43.23 (CH_2-2′); 63.77 (CH_2-5′); 74.19 (CH-3′); 77.38 (CH-1′); 89.11 (CH-4′); 121.34 (CH-5); 133.08 (C-3); 137.46 (CH-4); 149.04 (C-2); 160.92 (C-6). IR spectrum (KBr): 3333, 3284, 1048, 1585, 1576, 1543, 1425, 1317, 1219, 957, 832.

1β-[6-Bromo-2-(methylsulfanyl)pyridin-3-yl]-1,2-dideoxy-D-ribofuranose (19b). Compound **19b** was prepared from **19a** (136 mg, 0.25 mmol) by the general procedure to yield **19b** (62 mg, 78%) as a white solid. HRMS (ESI) for $C_{11}H_{14}BrNO_3S$: [M + Na] calculated, 341.9770; found, 341.9771. ^{1}H NMR (500 MHz, CD_3OD): 1.73 (ddd, 1H, J_{gem} = 13.1 Hz, $J_{2'a,1'}$ = 10.0 Hz, $J_{2'a,3'}$ = 6.0 Hz, H-2′a); 2.42 (ddd, 1H, J_{gem} = 13.1 Hz, $J_{2'b,1'}$ = 5.7 Hz, $J_{2'b,3'}$ = 2.0 Hz, H-2′b); 2.55 (s, 3H, CH_3S-2); 3.67 (dd, 1H, J_{gem} = 11.8 Hz, $J_{5'a,4'}$ = 5.0 Hz, H-5′a); 3.70 (dd, 1H, J_{gem} = 11.8 Hz, $J_{5'b,4'}$ = 4.6 Hz, H-5′b); 3.93 (td, 1H, $J_{4',5'a}$ = $J_{4',5'b}$ = 4.8 Hz, $J_{4',3'}$ = 2.8 Hz, H-4′); 4.31 (dddd, 1H, $J_{3',2'a}$ = 6.0 Hz, $J_{3',4'}$ = 2.8 Hz, $J_{3',2'b}$ = 2.0 Hz, $J_{3',1'}$ = 0.7 Hz, H-3′); 5.24 (ddq, 1H, $J_{1',2'a}$ = 10.0 Hz, $J_{1',2'b}$ = 5.7 Hz, $J_{1',4}$ = $J_{1',5}$ = $J_{1',3'}$ = 0.7 Hz, H-1′); 7.24 (dd, 1H, $J_{5,4}$ = 8.0 Hz, $J_{5,1'}$ = 0.6 Hz, H-5); 7.74 (dd, 1H, $J_{4,5}$ = 8.0 Hz, $J_{4,1'}$ = 0.8 Hz, H-4). ^{13}C NMR (125.7 MHz, CD_3OD): 13.38 (CH_3S-2); 42.71 (CH_2-2′); 63.72 (CH_2-5′); 74.22 (CH-3′); 76.47 (CH-1′); 88.96 (CH-4′); 124.18 (CH-5); 136.32 (C-3); 136.36 (CH-4); 140.71 (C-6); 158.53 (C-2). IR spectrum (KBr): 3380, 3324, 3066, 1569, 1540, 1409, 1307, 1209, 1045, 948.

1β-[2-Methyl-6-(methylsulfanyl)pyridin-3-yl]-1,2-dideoxy-3,5-di-*O*-(*t*-butyldimethylsilyl)-D-ribofuranose (20a). Me_3Al (0.48 mL, 0.48 mmol, 2.0 equiv., 1 M in heptane) was added to a flame-dried flask containing a solution of **18a** (130 mg, 0.24 mmol) and $Pd(PPh_3)_4$ (28 mg, 0.024 mmol, 10 mol%) in THF (3 mL). The mixture was stirred at 90 °C for 12 h, quenched by pouring into saturated NaH_2PO_4 (50 mL), and extracted with EtOAc (3 × 50 mL). The crude product was chromatographed on silica gel eluting with a gradient of hexanes to 6% EtOAc in hexanes to give **20a** (61 mg, 49%) as a colorless oil. HRMS (ESI) for $C_{24}H_{45}NO_3SSi_2$: [M + H] calculated, 484.2731; found, 484.2731. ^{1}H NMR (500 MHz, $CDCl_3$) 0.08 and 0.09 (2 × s, 2 × 6H, CH_3Si); 0.90 and 0.91 (2 × s, 2 × 9H, ((CH_3)$_3$C)); 1.72 (ddd, 1H, J_{gem} = 12.6 Hz, $J_{2'a,1'}$ = 10.0 Hz, $J_{2'a,3'}$ = 5.6 Hz, H-2′a); 2.15 (ddd, 1H, J_{gem} = 12.6 Hz, $J_{2'b,1'}$ = 5.5 Hz, $J_{2'b,3'}$ = 2.0 Hz, H-2′b); 2.48 (s, 3H, CH_3-2); 2.54 (s, 3H, CH_3S-6); 3.67 (dd, 1H, J_{gem} = 10.8 Hz, $J_{5'a,4'}$ = 5.2 Hz, H-5′a); 3.77 (dd, 1H, J_{gem} = 10.8 Hz, $J_{5'b,4'}$ = 3.6 Hz, H-5′b); 3.94 (ddd, 1H, $J_{4',5'a}$ = 5.2 Hz, $J_{4',5'b}$ = 3.6 Hz, $J_{4',3'}$ = 2.3 Hz, H-4′); 4.41 (bdt, 1H, $J_{3',2'a}$ = 5.6 Hz, $J_{3',4'}$ = $J_{3',2'b}$ = 2.2 Hz, H-3′); 5.26 (bdd, 1H, $J_{1',2'a}$ = 10.1 Hz, $J_{1',2'b}$ = 5.5 Hz, H-1′); 6.99 (bd, 1H, $J_{5,4}$ = 8.2 Hz, H-5); 7.68 (d, 1H, $J_{4,5}$ = 8.2 Hz, H-4). ^{13}C NMR (125.7 MHz, $CDCl_3$): −5.48, −5.39, −4.69 and −4.64 (CH_3Si); 13.52 (CH_3S-6); 17.99 and 18.31 ((CH_3)$_3$**C**); 21.92 (CH_3-2); 25.78 and 25.90 (($\mathbf{C}H_3$)$_3$C); 42.86 (CH_2-2′); 63.50 (CH_2-5′); 74.06 (CH-3′); 76.03 (CH-1′); 87.67 (CH-4′); 118.61 (CH-5); 131.61 (C-3); 133.44 (CH-4); 154.56 (C-2); 157.15 (C-6). IR spectrum (CCl_4): 3062, 2956, 2897, 1583, 1560, 1472, 1450, 1408, 1389, 1373, 1361, 1315, 1258, 1098, 1088, 939, 838.

1β-[2-Methyl-6-(methylsulfanyl)pyridin-3-yl]-1,2-dideoxy-D-ribofuranose (20b). Compound **20b** was prepared from **20a** (54 mg, 0.11 mmol) by the general procedure to yield **20b** (20 mg, 69%) as a white solid. HRMS (ESI) for $C_{12}H_{17}NO_3S$: [M + H] calculated, 256.1002; found, 256.1002. ^{1}H NMR (500 MHz, CD_3OD): 1.84 (ddd, 1H, J_{gem} = 13.1 Hz, $J_{2'a,1'}$ = 10.4 Hz, $J_{2'a,3'}$ = 6.0 Hz, H-2′a); 2.28 (ddd, 1H, J_{gem} = 13.1 Hz, $J_{2'b,1'}$ = 5.5 Hz, $J_{2'b,3'}$ = 1.8 Hz, H-2′b); 2.52 (s, 3H, CH_3-2); 2.58 (s, 3H, CH_3S-6); 3.66–3.72 (m, 2H, H-5′); 3.95 (td, 1H, $J_{4',5'a}$ = $J_{4',5'b}$ = 4.8 Hz, $J_{4',3'}$ = 2.7 Hz, H-4′); 4.34 (dddd, 1H, $J_{3',2'a}$ = 6.0 Hz, $J_{3',4'}$ = 2.7 Hz, $J_{3',2'b}$ = 1.8 Hz, $J_{3',1'}$ = 0.7 Hz, H-3′); 5.29 (bddq, 1H, $J_{1',2'a}$ =

10.4 Hz, $J_{1',2'b}$ = 5.5 Hz, $J_{1',3'} = J_{1',4} = J_{1',5}$ = 0.6 Hz, H-1′); 7.22 (dt, 1H, $J_{5,4}$ = 8.4 Hz, $J_{5,LR}$ = 0.6 Hz, H-5); 7.96 (bd, 1H, $J_{4,5}$ = 8.4 Hz, H-4). ^{13}C NMR (125.7 MHz, CD_3OD): 13.92 (CH_3S-6); 20.73 (CH_3-2); 43.21 (CH_2-2′); 63.78 (CH_2-5′); 74.30 (CH-3′); 77.06 (CH-1′); 89.13 (CH-4′); 120.06 (CH-5); 133.70 (C-3); 137.11 (CH-4); 155.32 (C-2); 159.20 (C-6). IR spectrum (KBr): 3301, 2989, 2929, 2857, 1580, 1560, 1448, 1435, 1386, 1270, 1088, 1050, 1026.

1β-[6-Methyl-2-(methylsulfanyl)pyridin-3-yl]-1,2-dideoxy-3,5-di-*O*-(*t*-butyldimethylsilyl)-D-ribofuranose (21a). Me_3Al (0.40 mL, 0.40 mmol, 2.0 equiv., 1 M in heptane) was added to a flame-dried flask containing solution of **19a** (103 mg, 0.20 mmol) and $Pd(PPh_3)_4$ (23 mg, 0.020 mmol, 10 mol%) in THF (2 mL). The mixture was stirred at 90 °C for 12 h, quenched by pouring into saturated NaH_2PO_4 (50 mL), and extracted with EtOAc (3 × 50 mL). The crude product was chromatographed on silica gel eluting with a gradient of hexanes to 5% EtOAc in hexanes to give **21a** (53 mg, 58%) as a colorless oil. HRMS (ESI) for $C_{24}H_{45}NO_3SSi_2$: [M + H] calculated, 484.2731; found, 484.2732. ^{1}H NMR (500 MHz, $CDCl_3$) 0.08, 0.09 and 0.10 (4 × s, 4 × 3H, CH_3Si); 0.90 and 0.92 (2 × s, 2 × 9H, ($(CH_3)_3$C)); 1.69 (ddd, 1H, J_{gem} = 12.6 Hz, $J_{2'a,1'}$ = 9.4 Hz, $J_{2'a,3'}$ = 5.7 Hz, H-2′a); 2.35 (ddd, 1H, J_{gem} = 12.6 Hz, $J_{2'b,1'}$ = 5.8 Hz, $J_{2'b,3'}$ = 2.5 Hz, H-2′b); 2.48 (s, 3H, CH_3-6); 2.58 (s, 3H, CH_3S-2); 3.67 (dd, 1H, J_{gem} = 10.8 Hz, $J_{5'a,4'}$ = 5.2 Hz, H-5′a); 3.78 (dd, 1H, J_{gem} = 10.8 Hz, $J_{5'b,4'}$ = 3.7 Hz, H-5′b); 3.93 (ddd, 1H, $J_{4',5'a}$ = 5.2 Hz, $J_{4',5'b}$ = 3.7 Hz, $J_{4',3'}$ = 2.7 Hz, H-4′); 4.38 (dtd, 1H, $J_{3',2'a}$ = 5.7 Hz, $J_{3',4'} = J_{3',2'b}$ = 2.6 Hz, $J_{3',1'}$ = 0.6 Hz, H-3′); 5.33 (bdd, 1H, $J_{1',2'a}$ = 9.4 Hz, $J_{1',2'b}$ = 5.8 Hz, H-1′); 6.82 (bd, 1H, $J_{5,4}$ = 7.7 Hz, H-5); 7.66 (dd, 1H, $J_{4,5}$ = 7.7 Hz, $J_{4,1'}$ = 0.8 Hz, H-4). ^{13}C NMR (125.7 MHz, $CDCl_3$): −5.46, −5.39, −4.75 and −4.59 (CH_3Si); 12.94 (CH_3S-2); 18.01 and 18.32 ((CH_3)$_3$**C**); 24.09 (CH_3-6); 25.80 and 25.91 (($\mathbf{C}H_3$)$_3$C); 42.06 (CH_2-2′); 63.39 (CH_2-5′); 73.86 (CH-3′); 75.41 (CH-1′); 87.41 (CH-4′); 118.46 (CH-5); 132.52 (CH-4); 132.99 (C-3); 154.61 (C-2); 156.42 (C-6). IR spectrum (CCl_4): 3060, 2956, 2897, 1585, 1573, 1472, 1463, 1407, 1390, 1374, 1361, 1311, 1258, 1210, 1097, 1077, 1031, 971, 963, 939, 838.

1β-[6-Methyl-2-(methylsulfanyl)pyridin-3-yl]-1,2-dideoxy-D-ribofuranose (21b). Compound **21b** was prepared from **21a** (108 mg, 0.22 mmol) by the general procedure to yield **21b** (46 mg, 81%) as a white solid. HRMS (ESI) for $C_{12}H_{17}NO_3S$: [M + Na] calculated, 278.0821; found, 278.0822. ^{1}H NMR (500 MHz, CD_3OD): 1.73 (ddd, 1H, J_{gem} = 13.1 Hz, $J_{2'a,1'}$ = 10.1 Hz, $J_{2'a,3'}$ = 6.1 Hz, H-2′a); 2.39 (ddd, 1H, J_{gem} = 13.1 Hz, $J_{2'b,1'}$ = 5.7 Hz, $J_{2'b,3'}$ = 2.0 Hz, H-2′b); 2.47 (s, 3H, CH_3-6); 2.55 (s, 3H, CH_3S-2); 3.66–3.72 (m, 2H, H-5′); 3.93 (td, 1H, $J_{4',5'a} = J_{4',5'b}$ = 5.0 Hz, $J_{4',3'}$ = 2.8 Hz, H-4′); 4.30 (dddd, 1H, $J_{3',2'a}$ = 6.1 Hz, $J_{3',4'}$ = 2.8 Hz, $J_{3',2'b}$ = 2.0 Hz, $J_{3',1'}$ = 0.7 Hz, H-3′); 5.31 (bdd, 1H, $J_{1',2'a}$ = 10.1 Hz, $J_{1',2'b}$ = 5.7 Hz, H-1′); 6.94 (dt, 1H, $J_{5,4}$ = 7.8 Hz, $J_{5,LR}$ = 0.6 Hz, H-5); 7.73 (dd, 1H, $J_{4,5}$ = 7.8 Hz, $J_{4,1'}$ = 0.8 Hz, H-4). ^{13}C NMR (125.7 MHz, CD_3OD): 13.15 (CH_3S-2); 23.99 (CH_3-6); 43.01 (CH_2-2′); 63.84 (CH_2-5′); 74.31 (CH-3′); 76.92 (CH-1′); 88.80 (CH-4′); 119.77 (CH-5); 133.88 (C-3); 134.17 (CH-4); 156.15 (C-2); 158.08 (C-6). IR spectrum (KBr): 3395, 3060, 2926, 1584, 1471, 1432, 1374, 1172, 1069, 1049, 963, 946, 911, 827, 722.

1β-(2-Chloro-6-ethynylpyridin-3-yl)-1,2-dideoxy-3,5-di-*O*-(*t*-butyldimethylsilyl)-D-ribofuranose (22a). DMF (2 mL) and TMSA (35 μL, 0.25 mmol, 0.8 equiv.) were added through a septum to an argon-purged vial containing **4** (170 mg, 0.32 mmol), $Pd(PPh_3)_2Cl_2$ (22 mg, 0.032 mmol), CuI (1 mg, 0.005 mmol) and Et_3N (89 μL, 0.64 mmol). The resulting mixture was stirred at 60 °C for 12 h. The reaction mixture was then cooled and filtered on a pad of Celite and eluted with $CHCl_3$. Solvents were then removed under vacuum, the crude product was dissolved in methanolic ammonia (28%, 10 mL) and the solution was stirred at rt for 1 h. The solvents were removed under vacuum, and the crude product was chromatographed on silica gel eluting with a gradient of hexanes to 3% EtOAc in hexanes to give **22a** (81 mg, 53% for two steps) as a colorless oil. A portion of starting material **4** (65 mg, 37%) was also isolated during chromatography. HRMS (ESI) for $C_{24}H_{40}ClNO_3Si_2$: [M + H] calculated, 482.2308; found, 482.2307. ^{1}H NMR (500 MHz, $CDCl_3$): 0.08, 0.086 and 0.093 (4 × s, 4 × 3H, CH_3Si); 0.89 and 0.91 (2 × s, 2 × 9H, ($(CH_3)_3$C)); 1.71 (ddd, 1H, J_{gem} = 12.6 Hz, $J_{2'a,1'}$ = 9.4 Hz, $J_{2'a,3'}$ = 5.6 Hz, H-2′a); 2.44 (ddd, 1H, J_{gem} = 12.6 Hz, $J_{2'b,1'}$ = 6.0 Hz, $J_{2'b,3'}$ = 2.6 Hz, H-2′b); 3.16 (s, 1H, C≡CH); 3.71 (dd, 1H, J_{gem} = 10.9 Hz, $J_{5'a,4'}$ = 4.7 Hz, H-5′a); 3.77 (dd, 1H, J_{gem} = 10.9 Hz, $J_{5'b,4'}$ = 3.4 Hz, H-5′b); 3.98 (ddd, 1H, $J_{4',5'a}$ = 4.7 Hz, $J_{4',5'b}$ = 3.4 Hz, $J_{4',3'}$ = 2.6 Hz, H-4′); 4.38 (dtd, 1H, $J_{3',2'a}$ = 5.6 Hz, $J_{3',4'} = J_{3',2'b}$ = 2.6 Hz, $J_{3',1'}$ = 0.7 Hz, H-3′); 5.38 (bddq, 1H, $J_{1',2'a}$ = 9.4 Hz, $J_{1',2'b}$ = 6.0 Hz, $J_{1',3'} = J_{1',4} = J_{1',5}$ = 0.7 Hz, H-1′); 7.39 (dd, 1H, $J_{5,4}$ = 7.9 Hz, $J_{5,1'}$ = 0.6 Hz, H-5); 8.01 (dd, 1H, $J_{4,5}$ = 7.9 Hz, $J_{4,1'}$ = 0.8 Hz, H-4). ^{13}C NMR (125.7 MHz, $CDCl_3$): −5.50, −5.42, −4.77 and −4.63 (CH_3Si); 17.98 and 18.28 ((CH_3)$_3$**C**); 25.74 and 25.86 (($\mathbf{C}H_3$)$_3$C); 42.31 (CH_2-2′); 63.20 (CH_2-5′); 73.63 (CH-3′); 76.12 (CH-1′); 78.03 (C≡CH); 81.51 (**C**≡CH); 87.89 (CH-4′); 129.39 (CH-5); 135.96 (CH-4); 138.26 (C-3); 140.34 (C-6); 148.22 (C-2). IR spectrum (CCl_4): 3309, 2956, 2898, 2123, 1582, 1546, 1472, 1463, 1441, 1390, 1361, 1336, 1258, 1174, 1097, 1060, 939, 838.

1β-(2-Chloro-6-ethynylpyridin-3-yl)-1,2-dideoxy-D-ribofuranose (22b). Compound **22b** was prepared from **22a** (91 mg, 0.19 mmol) by the general procedure to yield **22b** (41 mg, 85%) as a yellow solid. HRMS (ESI) for $C_{12}H_{12}ClNO_3$: [M − H] calculated, 252.0433; found, 252.0433. ^{1}H NMR (500 MHz, CD_3OD): 1.78 (ddd, 1H, J_{gem} = 13.1 Hz, $J_{2'a,1'}$ = 10.0 Hz, $J_{2'a,3'}$ = 5.9 Hz, H-2′a); 2.50 (ddd, 1H, J_{gem} = 13.1 Hz, $J_{2'b,1'}$ = 5.8 Hz, $J_{2'b,3'}$ = 2.0 Hz, H-2′b); 3.69 (dd, 1H, J_{gem} = 11.8 Hz, $J_{5'a,4'}$ = 5.0 Hz, H-5′a); 3.72 (dd, 1H, J_{gem} = 11.8 Hz, $J_{5'b,4'}$ = 4.5 Hz, H-5′b); 3.80 (s, 1H, CH≡C); 3.99 (td, 1H, $J_{4',5'a} = J_{4',5'b}$ = 4.7 Hz, $J_{4',3'}$ = 2.9 Hz, H-4′); 4.33 (bdt, 1H, $J_{3',2'a}$ = 5.9 Hz, $J_{3',4'} = J_{3',2'b}$ = 2.4 Hz, H-3′); 5.37 (bddq, 1H, $J_{1',2'a}$ = 10.0 Hz, $J_{1',2'b}$ = 5.8 Hz, $J_{1',4} = J_{1',5} = J_{1',3'}$ = 0.5 Hz, H-1′); 7.53 (bd, 1H, $J_{5,4}$ = 7.9 Hz, H-5); 8.14 (dd, 1H, $J_{4,5}$ = 7.9 Hz, $J_{4,1'}$ = 0.9 Hz, H-4). ^{13}C NMR (125.7 MHz, CD_3OD): 43.05 (CH_2-2′); 63.67 (CH_2-5′); 74.11 (CH-3′); 77.44 (CH-1′); 80.40 (**C**H≡C); 82.12 (CH≡**C**); 89.23 (CH-4′); 128.05 (CH-5); 138.01 (CH-4); 139.22 (C-3); 141.99 (C-6); 149.13 (C-2). IR spectrum (KBr): 3302, 3275, 2121, 1630, 1581, 1545, 1363, 1332, 1208, 1130, 1072, 1064, 1045, 995, 846.

1β-[2,6-Bis(trimethylsilylethynyl)pyridin-3-yl]-1,2-dideoxy-3,5-di-*O*-(*t*-butyldimethylsilyl)-D-ribofuranose (23a). DMF (4 mL)

and TMSA (360 μL, 2.6 mmol) were added through a septum to an argon-purged vial containing **4** (138 mg, 0.26 mmol), $Pd(PPh_3)_2Cl_2$ (18 mg, 0.026 mmol), CuI (1 mg, 0.005 mmol) and Et_3N (725 μL, 5.2 mmol). The resulting mixture was stirred at 90 °C for 12 h. The reaction mixture was then cooled and filtered on a pad of Celite and eluted with $CHCl_3$. The solvents were removed under vacuum, and the crude product was chromatographed on silica gel eluting with a gradient of hexanes to 1% EtOAc in hexanes to give **23a** (150 mg, 95%) as a colorless oil. HRMS (ESI) for $C_{32}H_{57}NO_3Si_4$: [M + H] calculated, 616.3488; found, 616.3490. ^{1}H NMR (500 MHz, $CDCl_3$): 0.083, 0.085 and 0.089 (3 × s, 4 × 3H, CH_3Si); 0.24 and 0.26 (2 × s, 2 × 9H, $(CH_3)_3Si$)); 0.90 and 0.91 (2 × s, 2 × 9H, ($(CH_3)_3C$)); 1.74 (ddd, 1H, J_{gem} = 12.7 Hz, $J_{2'a,1'}$ = 9.6 Hz, $J_{2'a,3'}$ = 5.7 Hz, H-2′a); 2.41 (ddd, 1H, J_{gem} = 12.7 Hz, $J_{2'b,1'}$ = 6.0 Hz, $J_{2'b,3'}$ = 2.3 Hz, H-2′b); 3.72 (dd, 1H, J_{gem} = 10.8 Hz, $J_{5'a,4'}$ = 4.6 Hz, H-5′a); 3.77 (dd, 1H, J_{gem} = 10.8 Hz, $J_{5'b,4'}$ = 3.4 Hz, H-5′b); 3.98 (ddd, 1H, $J_{4',5'a}$ = 4.6 Hz, $J_{4',5'b}$ = 3.4 Hz, $J_{4',3'}$ = 2.5 Hz, H-4′); 4.39 (dtd, 1H, $J_{3',2'a}$ = 5.7 Hz, $J_{3',4'} = J_{3',2'b}$ = 2.4 Hz, $J_{3',1'}$ = 0.7 Hz, H-3′); 5.54 (ddq, 1H, $J_{1',2'a}$ = 9.6 Hz, $J_{1',2'b}$ = 6.0 Hz, $J_{1',3'} = J_{1',4} = J_{1',5}$ = 0.7 Hz, H-1′); 7.36 (dd, 1H, $J_{5,4}$ = 8.1 Hz, $J_{5,1'}$ = 0.7 Hz, H-5); 7.92 (dd, 1H, $J_{4,5}$ = 8.1 Hz, $J_{4,1'}$ = 0.8 Hz, H-4). ^{13}C NMR (125.7 MHz, $CDCl_3$): −5.51, −5.41, −4.74 and −4.56 (CH_3Si); −0.32 and −0.30 ($(CH_3)_3Si$); 18.37 and 18.32 ($(CH_3)_3\mathbf{C}$); 25.88 and 25.90 ($(\mathbf{C}H_3)_3C$); 43.17 (CH_2-2′); 63.49 (CH_2-5′); 74.07 (CH-3′); 76.82 (CH-1′); 88.06 (CH-4′); 94.68 and 100.17 (2 × C≡**C**Si); 100.91 (**C**≡CSi-2); 103.29 (**C**≡CSi-6); 126.94 (CH-5); 133.37 (CH-4); 140.32 (C-2); 141.47 (C-3); 141.73 (C-6). IR spectrum (CCl_4): 3067, 2958, 2899, 2161, 1576, 1553, 1472, 1463, 1444, 1408, 1390, 1362, 1258, 1252, 1232, 1097, 1031, 939, 846.

1β-(2,6-Bis(ethynyl)pyridin-3-yl)-1,2-dideoxy-3,5-di-*O*-(*t*-butyldimethylsilyl)-D-ribofuranose (23b). Methanolic ammonia (25%, 10 mL) was added to a flask containing nucleoside **23a** (287 mg, 0.47 mmol) and the mixture was stirred for 30 min at room temperature. Then the solvents were evaporated under vacuum and the crude product was chromatographed on silica gel in a gradient of hexanes to 6% EtOAc in hexanes to give **23b** (167 mg, 76%) as a colorless oil. HRMS (ESI) for $C_{26}H_{41}NO_3Si_2$: [M + Na] calculated, 494.2517; found, 494.2516. ^{1}H NMR (500 MHz, DMSO-d_6): 0.07, 0.08 and 0.09 (4 × s, 4 × 3H, CH_3Si); 0.86 and 0.89 (2 × s, 2 × 9H, $(CH_3)_3C$)); 1.76 (ddd, 1H, J_{gem} = 12.7 Hz, $J_{2'a,1'}$ = 10.2 Hz, $J_{2'a,3'}$ = 5.2 Hz, H-2′a); 2.28 (ddd, 1H, J_{gem} = 12.7 Hz, $J_{2'b,1'}$ = 5.5 Hz, $J_{2'b,3'}$ = 1.9 Hz, H-2′b); 3.61 (dd, 1H, J_{gem} = 10.9 Hz, $J_{5'a,4'}$ = 6.1 Hz, H-5′a); 3.72 (dd, 1H, J_{gem} = 10.9 Hz, $J_{5'b,4'}$ = 4.0 Hz, H-5′b); 3.88 (ddd, 1H, $J_{4',5'a}$ = 6.1 Hz, $J_{4',5'b}$ = 4.0 Hz, $J_{4',3'}$ = 1.9 Hz, H-4′); 4.37 (bdt, 1H, $J_{3',2'a}$ = 5.2 Hz, $J_{3',4'} = J_{3',2'b}$ = 1.9 Hz, H-3′); 4.38 (s, 1H, CH≡C-6); 4.67 (s, 1H, CH≡C-2); 5.37 (bdd, 1H, $J_{1',2'a}$ = 10.2 Hz, $J_{1',2'b}$ = 5.5 Hz, H-1′); 7.59 (bd, 1H, $J_{5,4}$ = 8.1 Hz, H-5); 7.92 (dd, 1H, $J_{4,5}$ = 8.1 Hz, $J_{4,1'}$ = 0.7 Hz, H-4). ^{13}C NMR (125.7 MHz, DMSO-d_6): −5.35, −5.27, −4.66 and −4.55 (CH_3Si); 17.88 and 18.09 ($(CH_3)_3\mathbf{C}$); 25.85 and 25.91 ($(\mathbf{C}H_3)_3C$); 42.14 (CH_2-2′); 63.32 (CH_2-5′); 74.29 (CH-3′); 76.11 (CH-1′); 79.93 (CH≡**C**-2); 80.78 (**C**H≡C-2); 82.39 (CH≡**C**-6); 85.52 (**C**H≡C-6); 87.72 (CH-4′); 127.56 (CH-5); 134.11 (CH-4); 139.54 (C-2); 140.93 (C-6); 141.11 (C-3). IR spectrum (CCl_4): 3309, 3066, 2956, 2897, 2115, 1579, 1554, 1472, 1463, 1445, 1406, 1390, 1361, 1275, 1258, 1180, 1098, 1083, 1006, 939, 838.

1β-[2,6-Bis(ethynyl)pyridin-3-yl]-1,2-dideoxy-D-ribofuranose (23c). Compound **23c** was prepared from **23a** (192 mg, 0.31 mmol) by the general procedure to yield **23c** (51 mg, 67%) as an orange solid. HRMS (ESI) for $C_{14}H_{13}NO_3$: [M + Na] calculated, 266.0788; found, 266.0786. ^{1}H NMR (500 MHz, DMSO-d_6): 1.68 (ddd, 1H, J_{gem} = 12.7 Hz, $J_{2'a,1'}$ = 10.2 Hz, $J_{2'a,3'}$ = 5.6 Hz, H-2′a); 2.26 (ddd, 1H, J_{gem} = 12.7 Hz, $J_{2'b,1'}$ = 5.7 Hz, $J_{2'b,3'}$ = 1.8 Hz, H-2′b); 3.59 (m, 2H, H-5′); 3.84 (td, 1H, $J_{4',5'a} = J_{4',5'b}$ = 4.9 Hz, $J_{4',3'}$ = 2.2 Hz, H-4′); 4.21 (m, 1H, H-3′); 4.36 (s, 1H, CH≡C-6); 4.65 (s, 1H, CH≡C-2); 4.83 (bt, 1H, $J_{OH,5'a} = J_{OH,5'b}$ = 5.6 Hz, OH-5′); 5.17 (d, 1H, $J_{OH,3'}$ = 3.8 Hz, OH-3′); 5.36 (bdd, 1H, $J_{1',2'a}$ = 10.2 Hz, $J_{1',2'b}$ = 5.7 Hz, H-1′); 7.59 (bd, 1H, $J_{5,4}$ = 8.1 Hz, H-5); 8.01 (dd, 1H, $J_{4,5}$ = 8.2 Hz, $J_{4,1'}$ = 0.7 Hz, H-4). ^{13}C NMR (125.7 MHz, DMSO-d_6): 42.60 (CH_2-2′); 62.31 (CH_2-5′); 72.54 (CH-3′); 76.04 (CH-1′); 80.14 (CH≡**C**-2); 80.63 (**C**H≡C-6); 82.48 (CH≡**C**-6); 85.35 (**C**H≡C-2); 88.16 (CH-4′); 127.67 (CH-5); 134.56 (CH-4); 139.50 (C-2); 140.82 (C-6); 141.78 (C-3). IR spectrum (KBr): 3428, 3299, 3070, 2107, 1579, 1558, 1447, 1235, 1078, 1050, 1026, 846.

1β-[2-Chloro-6-(2-pyridyl)pyridin-3-yl]-1,2-dideoxy-3,5-di-*O*-(*t*-butyldimethylsilyl)-D-ribofuranose (24a). DMF (2.5 mL) was added to a flame-dried and argon-purged flask, containing **4** (100 mg, 0.19 mmol), and $PdCl_2(PPh_3)_2$ (7 mg, 0.0095 mmol, 5 mol%). After 5 min of stirring at room temperature, tributyl (2-pyridyl)stannane (0.25 mL, 0.76 mmol, 4.0 equiv.) was added, and mixture was heated to 100 °C for 12 h. The crude reaction mixture was diluted with Et_2O (300 mL), washed with 2 M HCl (80 mL) and saturated $NaHCO_3$ (100 mL). After evaporation of the solvents under reduced pressure, the crude product was chromatographed on silica gel eluting with a gradient of hexanes to 3% EtOAc in hexanes to obtain **24a** (82 mg, 82%) as a colorless oil. HRMS (ESI) for $C_{27}H_{43}ClN_2O_3Si_2$: [M + H] calculated, 535.2574; found, 535.2574. ^{1}H NMR (500 MHz, $CDCl_3$): 0.098, 0.100, 0.107 and 0.109 (4 × s, 4 × 3H, CH_3Si); 0.91 and 0.92 (2 × s, 2 × 9H, ($(CH_3)_3C$)); 1.77 (ddd, 1H, J_{gem} = 12.7 Hz, $J_{2'a,1'}$ = 9.6 Hz, $J_{2'a,3'}$ = 5.6 Hz, H-2′a); 2.46 (ddd, 1H, J_{gem} = 12.7 Hz, $J_{2'b,1'}$ = 5.9 Hz, $J_{2'b,3'}$ = 2.4 Hz, H-2′b); 3.74 (dd, 1H, J_{gem} = 10.9 Hz, $J_{5'a,4'}$ = 4.8 Hz, H-5′a); 3.81 (dd, 1H, J_{gem} = 10.9 Hz, $J_{5'b,4'}$ = 3.5 Hz, H-5′b); 4.00 (ddd, 1H, $J_{4',5'a}$ = 4.8 Hz, $J_{4',5'b}$ = 3.5 Hz, $J_{4',3'}$ = 2.6 Hz, H-4′); 4.42 (dtd, 1H, $J_{3',2'a}$ = 5.7 Hz, $J_{3',4'} = J_{3',2'b}$ = 2.5 Hz, $J_{3',1'}$ = 0.7 Hz, H-3′); 5.45 (ddq, 1H, $J_{1',2'a}$ = 9.6 Hz, $J_{1',2'b}$ = 5.9 Hz, $J_{1',3'} = J_{1',4} = J_{1',5}$ = 0.7 Hz, H-1′); 7.33 (dd, 1H, $J_{5,4}$ = 7.5 Hz, $J_{5,6}$ = 4.8 Hz, $J_{5,3}$ = 1.2 Hz, H-5-py); 7.82 (td, 1H, $J_{4,5} = J_{4,3}$ = 7.8 Hz, $J_{4,6}$ = 1.8 Hz, H-4-py); 8.14 (dd, 1H, $J_{4,5}$ = 8.0 Hz, $J_{4,1'}$ = 0.8 Hz, H-4); 8.35 (bd, 1H, $J_{5,4}$ = 8.0 Hz, H-5); 8.40 (dt, 1H, $J_{3,4}$ = 8.0 Hz, $J_{3,5} = J_{3,6}$ = 1.0 Hz, H-3-py); 8.67 (ddd, 1H, $J_{6,5}$ = 4.8 Hz, $J_{6,4}$ = 1.8 Hz, $J_{6,3}$ = 0.9 Hz, H-6-py). ^{13}C NMR (125.7 MHz, $CDCl_3$): −5.47, −5.37, −4.75 and −4.62 (CH_3Si); 18.00 and 18.31 ($(CH_3)_3\mathbf{C}$); 25.77 and 25.90 ($(\mathbf{C}H_3)_3C$); 42.47 (CH_2-2′); 63.30 (CH_2-5′); 73.76 (CH-3′); 76.30 (CH-1′); 87.89 (CH-4′); 119.89 (CH-5); 121.43 (CH-3-py); 124.06 (CH-5-py); 136.73 (CH-4); 137.21 (CH-4-py); 137.65 (C-3); 147.92 (C-2); 148.96 (CH-6-py); 154.50 (C-2-py); 154.79 (C-6). IR

spectrum (CCl_4): 2956, 2897, 1588, 1568, 1472, 1463, 1445, 1390, 1361, 1340, 1258, 1218, 1174, 1071, 1054, 939, 838.

1β-[2-Chloro-6-(2-pyridyl)pyridin-3-yl]-1,2-dideoxy-D-ribofuranose (24b). Compound **24b** was prepared from **24a** (207 mg, 0.39 mmol) by the general procedure to yield **24b** (102 mg, 86%) as a white solid. HRMS (ESI) for $C_{15}H_{15}ClN_2O_3$: [M + H] calculated, 307.0844; found, 307.0844. ^{1}H NMR (500 MHz, CD_3OD): 1.84 (ddd, 1H, J_{gem} = 13.1 Hz, $J_{2'a,1'}$ = 10.1 Hz, $J_{2'a,3'}$ = 6.0 Hz, H-2′a); 2.54 (ddd, 1H, J_{gem} = 13.1 Hz, $J_{2'b,1'}$ = 5.7 Hz, $J_{2'b,3'}$ = 2.0 Hz, H-2′b); 3.72 (dd, 1H, J_{gem} = 11.8 Hz, $J_{5'a,4'}$ = 5.0 Hz, H-5′a); 3.75 (dd, 1H, J_{gem} = 11.8 Hz, $J_{5'b,4'}$ = 4.5 Hz, H-5′b); 4.01 (td, 1H, $J_{4',5'a}$ = $J_{4',5'b}$ = 4.8 Hz, $J_{4',3'}$ = 2.7 Hz, H-4′); 4.36 (dddd, 1H, $J_{3',2'a}$ = 6.0 Hz, $J_{3',4'}$ = 2.7 Hz, $J_{3',2'b}$ = 2.0 Hz, $J_{3',1'}$ = 0.7 Hz, H-3′); 5.44 (ddq, 1H, $J_{1',2'a}$ = 10.1 Hz, $J_{1',2'b}$ = 5.7 Hz, $J_{1',4}$ = $J_{1',5}$ = = $J_{1',3'}$ = 0.7 Hz, H-1′); 7.46 (ddd, 1H, $J_{5,4}$ = 7.6 Hz, $J_{5,6}$ = 4.9 Hz, $J_{5,3}$ = 1.2 Hz, H-5-py); 7.96 (ddd, 1H, $J_{4,3}$ = 8.0 Hz, $J_{4,5}$ = 7.6 Hz, $J_{4,6}$ = 1.8 Hz, H-4-py); 8.25 (dd, 1H, $J_{4,5}$ = 8.0 Hz, $J_{4,1'}$ = 0.8 Hz, H-4); 8.30 (bd, 1H, $J_{5,4}$ = 8.0 Hz, H-5); 8.35 (dt, 1H, $J_{3,4}$ = 8.0 Hz, $J_{3,5}$ = $J_{3,6}$ = 1.1 Hz, H-3-py); 8.65 (ddd, 1H, $J_{6,5}$ = 4.9 Hz, $J_{6,4}$ = 1.8 Hz, $J_{6,3}$ = 0.9 Hz, H-6-py). ^{13}C NMR (125.7 MHz, CD_3OD): 43.20 (CH_2-2′); 63.76 (CH_2-5′); 74.19 (CH-3′); 77.64 (CH-1′); 89.22 (CH-4′); 121.14 (CH-5); 122.68 (CH-3-py); 125.72 (CH-5-py); 138.33 (CH-4); 138.80 (C-3); 139.05 (CH-4-py); 149.22 (C-2); 150.14 (CH-6-py); 155.57 (C-2-py); 156.02 (C-6). IR spectrum (KBr): 3420, 3336, 3096, 3066, 1587, 1573, 1547, 1478, 1434, 1256, 1173, 1149, 993, 1063, 1047, 993.

1β-[2,6-Bis(2-pyridyl)pyridin-3-yl]-1,2-dideoxy-3,5-di-*O*-(*t*-butyldimethylsilyl)-D-ribofuranose (25a). Toluene (3.0 mL) was added to a flame-dried and argon-purged flask, containing **4** (159 mg, 0.29 mmol), and $Pd(PPh_3)_4$ (65 mg, 0.058 mmol, 20 mol%). After 5 min of stirring at room temperature, tributyl (2-pyridinyl)stannane (0.38 mL, 1.16 mmol, 4.0 equiv.) was added, and the mixture was heated to 110 °C for 12 h. The crude reaction mixture was diluted with Et_2O (300 mL), and washed with 2 M HCl (80 mL) and saturated $NaHCO_3$ (100 mL). After evaporation of the solvents under reduced pressure, the crude product was chromatographed on silica gel eluting with a gradient of hexanes to 12% EtOAc in hexanes to obtain **25a** (197 mg, 92%) as a colorless oil. HRMS (ESI) for $C_{32}H_{47}N_3O_3Si_2$: [M + H] calculated, 578.3229; found, 578.3229. ^{1}H NMR (500 MHz, $CDCl_3$): 0.08, 0.09, 0.11 and 0.13 (4 × s, 4 × 3H, CH_3Si); 0.90 and 0.93 (2 × s, 2 × 9H, ($(CH_3)_3C$)); 1.91 (ddd, 1H, J_{gem} = 12.8 Hz, $J_{2'a,1'}$ = 10.0 Hz, $J_{2'a,3'}$ = 5.6 Hz, H-2′a); 2.50 (ddd, 1H, J_{gem} = 12.8 Hz, $J_{2'b,1'}$ = 5.4 Hz, $J_{2'b,3'}$ = 2.0 Hz, H-2′b); 3.73 (dd, 1H, J_{gem} = 10.7 Hz, $J_{5'a,4'}$ = 5.2 Hz, H-5′a); 3.81 (dd, 1H, J_{gem} = 10.7 Hz, $J_{5'b,4'}$ = 3.5 Hz, H-5′b); 3.93 (ddd, 1H, $J_{4',5'a}$ = 5.2 Hz, $J_{4',5'b}$ = 3.5 Hz, $J_{4',3'}$ = 2.3 Hz, H-4′); 4.42 (bdt, 1H, $J_{3',2'a}$ = 5.5 Hz, $J_{3',4'}$ = $J_{3',2'b}$ = 2.2 Hz, H-3′); 5.74 (bdd, 1H, $J_{1',2'a}$ = 10.0 Hz, $J_{1',2'b}$ = 5.4 Hz, H-1′); 7.33 (dd, 1H, $J_{5,4}$ = 7.6 Hz, $J_{5,6}$ = 4.9 Hz, $J_{5,3}$ = 1.2 Hz, H-5-py-2); 7.39 (m, 1H, H-5-py-6); 7.87 (td, 1H, $J_{4,5}$ = $J_{4,3}$ = 7.7 Hz, $J_{4,6}$ = 1.2 Hz, H-4-py-2); 7.91 (H-4-py-6); 8.11 (dt, 1H, $J_{3,4}$ = 7.9 Hz, $J_{3,5}$ = $J_{3,6}$ = 1.1 Hz, H-3-py-2); 8.36 (bd, 1H, $J_{4,5}$ = 8.3 Hz, H-4); 8.53 (bd, 1H, $J_{5,4}$ = 8.3 Hz, H-5); 8.58 (bd, 1H, $J_{3,4}$ = 8.0 Hz, H-3-py-6); 8.67 (ddd, 1H, $J_{6,5}$ = 4.9 Hz, $J_{6,4}$ = 1.9 Hz, $J_{6,3}$ = 1.0 Hz, H-6-py-2); 8.75 (ddd, 1H, $J_{6,5}$ = 5.0 Hz, $J_{6,4}$ = 1.7 Hz, $J_{6,3}$ = 0.8 Hz, H-6-py-6). ^{13}C NMR (125.7 MHz, $CDCl_3$): −5.46, −5.33, −4.77 and −4.65 (CH_3Si); 17.98 and 18.34 ($(CH_3)_3\mathbf{C}$); 25.76 and 25.93 ($(\mathbf{C}H_3)_3C$); 44.75 (CH_2-2′); 63.65 (CH_2-5′); 74.42 (CH-3′); 76.58 (CH-1′); 87.92 (CH-4′); 121.11 (CH-5); 121.95 (CH-3-py-6); 122.89 (CH-5-py-2); 123.89 (CH-5-py-6); 124.54 (CH-3-py-2); 136.57 (CH-4); 136.74 (CH-4-py-2); 138.4 (CH-4-py-6); 138.77 (C-3); 147.89 (CH-6-py-2,6); 152.35 (C-6); 153.65 (C-2); 155.12 (C-2-py-6); 157.91 (C-2-py-2). IR spectrum (CCl_4): 3088, 3065, 2956, 2929, 2897, 285, 7, 1590, 1586, 1577, 1566, 1556, 1472, 1462, 1456, 1434, 1425, 1389, 1361, 1257, 1173, 1147, 1095, 1040, 1031, 1006, 939, 838.

1β-[2,6-Bis(2-pyridyl)pyridin-3-yl]-1,2-dideoxy-D-ribofuranose (25b). Compound **25b** was prepared from **25a** (209 mg, 0.36 mmol) by the general procedure to yield **25b** (110 mg, 87%) as a white solid. HRMS (ESI) for $C_{20}H_{19}N_3O_3$: [M + H] calculated, 350.1499; found, 350.1498. ^{1}H NMR (500 MHz, CD_3OD): 1.94 (ddd, 1H, J_{gem} = 13.3 Hz, $J_{2'a,1'}$ = 10.1 Hz, $J_{2'a,3'}$ = 6.2 Hz, H-2′a); 2.35 (ddd, 1H, J_{gem} = 13.3 Hz, $J_{2'b,1'}$ = 5.7 Hz, $J_{2'b,3'}$ = 2.0 Hz, H-2′b); 3.72 (dd, 1H, J_{gem} = 11.7 Hz, $J_{5'a,4'}$ = 5.0 Hz, H-5′a); 3.74 (dd, 1H, J_{gem} = 11.7 Hz, $J_{5'b,4'}$ = 4.5 Hz, H-5′b); 3.89 (btd, 1H, $J_{4',5'a}$ = $J_{4',5'b}$ = 4.8 Hz, $J_{4',3'}$ = 2.9 Hz, H-4′); 4.30 (dddd, 1H, $J_{3',2'a}$ = 6.2 Hz, $J_{3',4'}$ = 2.9 Hz, $J_{3',2'b}$ = 2.0 Hz, $J_{3',1'}$ = 0.6 Hz, H-3′); 5.62 (dd, 1H, $J_{1',2'a}$ = 10.1 Hz, $J_{1',2'b}$ = 5.7 Hz, H-1′); 7.44 (ddd, 1H, $J_{5,4}$ = 7.5 Hz, $J_{5,6}$ = 4.9 Hz, $J_{5,3}$ = 1.2 Hz, H-5-py-6); 7.48 (m, 1H, H-5-py-2); 7.93 (ddd, 1H, $J_{4,3}$ = 8.0 Hz, $J_{4,5}$ = 7.5 Hz, $J_{4,6}$ = 1.8 Hz, H-4-py-6); 7.98–8.01 (m, 2H, H-3,4-py-2); 8.38 (bd, 1H, $J_{5,4}$ = 8.3 Hz, H-5); 8.40 (bd, 1H, $J_{4,5}$ = 8.3 Hz, H-4); 8.46 (dt, 1H, $J_{3,4}$ = 8.0 Hz, $J_{3,5}$ = $J_{3,6}$ = 1.1 Hz, H-3-py-6); 8.65 (ddd, 1H, $J_{6,5}$ = 4.9 Hz, $J_{6,4}$ = 1.8 Hz, $J_{6,3}$ = 0.9 Hz, H-6-py-6); 8.68 (dt, 1H, $J_{6,5}$ = 4.9 Hz, $J_{6,4}$ = $J_{6,3}$ = 1.4 Hz, H-6-py-2). ^{13}C NMR (125.7 MHz, CD_3OD): 45.16 (CH_2-2′); 63.87 (CH_2-5′); 74.36 (CH-3′); 77.73 (CH-1′); 89.01 (CH-4′); 121.89 (CH-5); 122.68 (CH-3-py-6); 124.62 (CH-5-py-2); 125.31 (CH-5-py-6); 125.85 (CH-3-py-2); 137.62 (CH-4); 138.47 (CH-4-py-2); 138.73 (CH-4-py-6); 138.91 (C-3); 149.38 (CH-6-py-2); 150.11 (CH-6-py-6); 155.26 (C-6); 155.51 (C-2); 157.08 (C-2-py-6); 159.27 (C-2-py-2). IR spectrum (KBr): 3415, 3088, 3062, 2929, 1590, 1575, 1565, 1557, 1473, 1455, 1434, 1425, 1353, 1254, 1201, 1174, 1150, 1095, 1071, 1050, 1021, 942, 855.

1β-(2-Chloropyridin-3-yl)-1,2-dideoxy-3,5-di-*O*-(*t*-butyldimethylsilyl)-D-ribofuranose (26a). Vinylmagnesium chloride (1 M solution in THF, 1 mL, 1.0 mmol) was added dropwise to a flame-dried flask containing a solution of the nucleoside **4** (100 mg, 0.19 mmol) and $Fe(acac)_3$ (13 mg, 0.038 mmol) in dry THF (3.0 mL) under Ar. The reaction mixture was then stirred at rt for 12 h. Then the mixture was poured onto a mixture of ice (100 mL) and NH_4Cl (1 g), and extracted with chloroform (3 × 100 mL). Evaporation of the organic phase followed by column chromatography on silica gel eluting with a gradient of hexanes to 4% EtOAc in hexanes afforded the nucleoside **26a** (40 mg, 47%) as a colorless oil. HRMS (ESI) for $C_{22}H_{40}ClNO_3Si_2$: [M + Na] calculated, 480.2128; found, 480.2126. ^{1}H NMR (500 MHz, $CDCl_3$): 0.086, 0.088, 0.090 and 0.10 (4 × s, 4 × 3H, CH_3Si); 0.89 and 0.92 (2 × s, 2 × 9H, ($(CH_3)_3C$); 1.73 (ddd, 1H, J_{gem} = 12.6 Hz, $J_{2'a,1'}$ = 9.5 Hz, $J_{2'a,3'}$ = 5.5 Hz, H-2′a); 2.44 (ddd, 1H, J_{gem} = 12.6 Hz, $J_{2'b,1'}$ = 5.9 Hz, $J_{2'b,3'}$ = 2.5 Hz, H-2′b); 3.71 (dd, 1H, J_{gem} = 10.9 Hz, $J_{5'a,4'}$ =

4.8 Hz, H-5′a); 3.78 (dd, 1H, J_{gem} = 10.9 Hz, $J_{5'b,4'}$ = 3.5 Hz, H-5′b); 3.99 (ddd, 1H, $J_{4',5'a}$ = 4.8 Hz, $J_{4',5'b}$ = 3.5 Hz, $J_{4',3'}$ = 2.6 Hz, H-4′); 4.39 (dt, 1H, $J_{3',2'a}$ = 5.5 Hz, $J_{3',4'}$ = $J_{3',2'b}$ = 2.6 Hz, H-3′); 5.40 (dd, 1H, $J_{1',2'a}$ = 9.5 Hz, $J_{1',2'b}$ = 5.9 Hz, H-1′); 7.23 (dd, 1H, $J_{5,4}$ = 7.7 Hz, $J_{5,6}$ = 4.6 Hz, H-5); 8.03 (dd, 1H, $J_{4,5}$ = 7.6 Hz, $J_{4,6}$ = 1.3 Hz, H-4); 8.28 (bd, 1H, $J_{6,5}$ = 4.6 Hz, H-6). ^{13}C NMR (125.7 MHz, $CDCl_3$): −5.49, −5.42, −4.76 and −4.62 (CH_3Si); 17.99 and 18.28 ($(CH_3)_3\mathbf{C}$); 25.75 and 25.86 ($(\mathbf{C}H_3)_3C$); 42.32 (CH_2-2′); 63.28 (CH_2-5′); 73.71 (CH-3′); 76.14 (CH-1′); 87.82 (CH-4′); 122.68 (CH-5); 135.86 (CH-4); 137.67 (C-3); 147.93 (CH-6); 148.50 (C-2). IR spectrum (CCl_4): 2956, 2899, 1582, 1566, 1472, 1463, 1449, 1390, 1362, 1336, 1258, 1209, 1172, 1057, 1031, 1006, 968, 838.

1β-(2-Chloropyridin-3-yl)-1,2-dideoxy-D-ribofuranose (26b). Compound **26b** was prepared from **26a** (80 mg, 0.17 mmol) by the general procedure to yield **26b** (32 mg, 82%) as a white solid. HRMS (ESI) for $C_{10}H_{12}ClNO_3$: [M + Na] calculated, 252.0398; found, 252.0398. ^{1}H NMR (500 MHz, CD_3OD): 1.78 (ddd, 1H, J_{gem} = 13.1 Hz, $J_{2'a,1'}$ = 10.1 Hz, $J_{2'a,3'}$ = 6.0 Hz, H-2′a); 2.50 (ddd, 1H, J_{gem} = 13.1 Hz, $J_{2'b,1'}$ = 5.7 Hz, $J_{2'b,3'}$ = 2.0 Hz, H-2′b); 3.70 (dd, 1H, J_{gem} = 11.8 Hz, $J_{5'a,4'}$ = 5.0 Hz, H-5′a); 3.72 (dd, 1H, J_{gem} = 11.8 Hz, $J_{5'b,4'}$ = 4.6 Hz, H-5′b); 3.99 (td, 1H, $J_{4',5'a}$ = $J_{4',5'b}$ = 4.8 Hz, $J_{4',3'}$ = 2.7 Hz, H-4′); 4.33 (dddd, 1H, $J_{3',2'a}$ = 6.0 Hz, $J_{3',4'}$ = 2.7 Hz, $J_{3',2'b}$ = 2.0 Hz, $J_{3',1'}$ = 0.7 Hz, H-3′); 5.38 (ddpent, 1H, $J_{1',2'a}$ = 10.1 Hz, $J_{1',2'b}$ = 5.7 Hz, $J_{1',4}$ = $J_{1',5}$ = $J_{1',6}$ = $J_{1',3'}$ = 0.7 Hz, H-1′); 7.41 (ddd, 1H, $J_{5,4}$ = 7.7 Hz, $J_{5,6}$ = 4.8 Hz, $J_{5,1'}$ = 0.6 Hz, H-5); 8.17 (ddd, 1H, $J_{4,5}$ = 7.7 Hz, $J_{4,6}$ = 2.0 Hz, $J_{4,1'}$ = 0.8 Hz, H-4); 8.27 (ddd, 1H, $J_{6,5}$ = 4.8 Hz, $J_{6,4}$ = 2.0 Hz, $J_{6,1'}$ = 0.5 Hz, H-6). ^{13}C NMR (125.7 MHz, CD_3OD): 43.11 (CH_2-2′); 63.72 (CH_2-5′); 74.13 (CH-3′); 77.46 (CH-1′); 89.17 (CH-4′); 124.54 (CH-5); 137.86 (CH-4); 138.87 (C-3); 149.10 (CH-6); 149.33 (C-2). IR spectrum (KBr): 3359, 1630, 1580, 1571, 1450, 1442, 1389, 1181, 1073, 1063, 1043, 1023, 951.

Crystallographic data for 4

M = 308.55 g mol^{-1}, monoclinic system, space group $P2_1$, a = 8.9755 (9) Å, b = 6.9472 (5) Å, c = 9.1777 (9) Å, β = 90.968 (9)°, Z = 2, V = 572.19 (9) Å^3, D_c = 1.791 g cm^{-3}, μ(Cu-Kα) = 7.002 mm^{-1}, crystal dimensions of 0.58 × 0.56 × 0.21 mm. Data were collected at 170 (2) K on an Xcalbur Onyx CCD diffractometer with graphite monochromated Cu-Kα radiation. The structure was solved by charge flipping methods[18] using the CRYSTALS suite of programs[19] and anisotropically refined by full matrix least squares on F value to final R = 0.036 and R_w = 0.042 using 2220 independent reflections (Θ_{max} = 77.3°) and 147 parameters. The absolute configuration on stereogenic centers was confirmed by refinement of the Flack parameter (resulting value −0.02 (2)). The structure was deposited into the Cambridge Structural Database under number CCDC 927315.

Crystallographic data for 8b

M = 243.69 g mol^{-1}, monoclinic system, space group $P2_1$, a = 5.3111 (3) Å, b = 11.1077 (6) Å, c = 19.5383 (13) Å, β = 96.676 (6)°, Z = 4, V = 1144.84 (12) Å^3, D_c = 1.414 g cm^{-3}, μ(Cu-Kα) = 2.908 mm^{-1}, crystal dimensions of 0.49 × 0.37 × 0.26 mm. Data were collected at 190 (2) K on an Xcalbur Onyx CCD diffractometer with graphite monochromated Cu-Kα radiation. The structure was solved by charge flipping methods[1] using the CRYSTALS suite of programs[2] and anisotropically refined by full matrix least squares on F squared value to final R = 0.038 and R_w = 0.095 using 4688 independent reflections (Θ_{max} = 77.4°) and 291 parameters. The absolute configuration on stereogenic centers was confirmed by refinement of the Flack parameter (resulting value −0.008 (12)). The structure was deposited into the Cambridge Structural Database under number CCDC 927314.

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