DOI: 10.1002/ejoc.201501219

Synthesis of Benzene and Pyridine 2′-*C*-Methyl-*C*-ribonucleosides and -nucleotides

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Keywords: Nucleosides / Nucleotides / Glycosides / Antiviral agents / Cross-coupling

A general and modular synthesis of substituted benzene and pyridine 2′-*C*-methyl-*C*-ribonucleosides was developed. Benzyl-protected haloaryl-*C*-nucleoside intermediates were prepared by the addition of bromo(het)aryllithium reagents to a protected lactone, followed by acetylation and reduction. These halogenated intermediates were further transformed by Pd-catalysed cross-couplings, aminations, or hydroxylations. The final deprotection was rather troublesome, and different procedures involving catalytic hydrogenation on Pd/C, or treatment with BCl_3, were optimized for each derivative. The final *C*-nucleosides were also all converted into the corresponding NTPs. None of the *C*-nucleosides showed any activity in the HCV replicon assay, and none of the NTPs showed any significant inhibition of the HCV polymerase.

Introduction

Hepatitis C virus (HCV) is an RNA virus. It is a cause of chronic hepatitis, which often leads to cirrhosis and carcinoma. Nucleoside inhibitors of the RNA-dependent RNA polymerase of HCV show a broad spectrum of activity across different serotypes.[1] The attachment of a methyl group at the 2′-position of ribose to generate modified ribonucleoside triphosphates is now an established approach to achieving specific inhibition of the viral RNA polymerase (without affecting the eukaryotic RNA polymerases).[2] On the other hand, it is known that most sugar-modified nucleosides are not efficiently phosphorylated by nucleoside kinases, and therefore they are often delivered as phosphate prodrugs.[3] Figure 1 shows the structures of Sofosbuvir (**1**),[4] a phosphate prodrug of a 2′-Me-2′-fluoro-ribonucleoside which is now used clinically to treat HCV, and Valopicitabine (**2**),[5] a related unsuccessful clinical candidate. Although Sofosbuvir seems to be a very efficient drug, there is always the threat of the development of resistance, and other related RNA viruses (e.g., Dengue) are emerging. Therefore, the search for new nucleoside antivirals is still worthwhile.

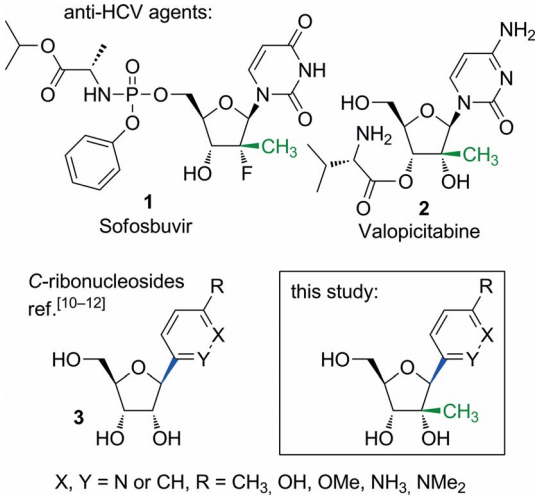

Figure 1. Structures of anti-HCV nucleosides, and the design of *C*-nucleoside analogues.

C-Nucleosides are characterized by replacement of the enzymatically cleavable C–N nucleosidic bond by a more stable C–C bond.[6] There have been several reported examples of the synthesis of *C*-nucleoside analogues of 2′-Me-ribonucleosides, mostly of purine analogues. Some of the triphosphate derivatives of these compounds showed good inhibition of the HCV RNA polymerase.[7,8] In most cases, the corresponding nucleosides were inactive or less active due to inefficient activation, and were tested as diverse phosphate prodrugs.[7,8] The syntheses of those *C*-nucleosides were laborious linear multistep sequences.[7,8] Each was aimed at a particular derivative of interest, so this did not allow the synthesis of larger series of derivatives. In our laboratory, we have recently developed a general modular

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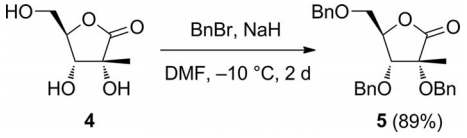
approach to *C*-nucleosides based on the synthesis of halogenated (het)aryl-*C*-nucleoside intermediates, and their divergent functionalization by cross-coupling or nucleophilic substitution.[9–13] This approach is advantageous for the synthesis of larger series of *C*-nucleosides, including benzene and pyridine *C*-ribonucleosides **3**[10–12] (Figure 1) bearing different substituents. Therefore, we planned to apply this approach to the synthesis of three types of new benzene and pyridine C-2′-Me-ribonucleosides that are carba- and dicarba-analogues of parent pyrimidine nucleosides related to Sofosbuvir. The choice of nucleobase surrogates included phenyl and two isomeric pyridyl moieties substituted either by hydrophobic (CH_3, OCH_3, NMe_2) or hydrophilic (NH_2, OH) substituents. It has repeatedly been shown that even hydrophobic analogues of nucleotides (lacking hydrogen-bond donors or acceptors) can be substrates of polymerases.[14] Moreover, the lack of a minor groove hydrogen-bond acceptor (i.e., the oxo group of cytosine or uracil) might prevent extension[15] of the growing DNA or RNA strand, which would be an advantage for chain terminators.

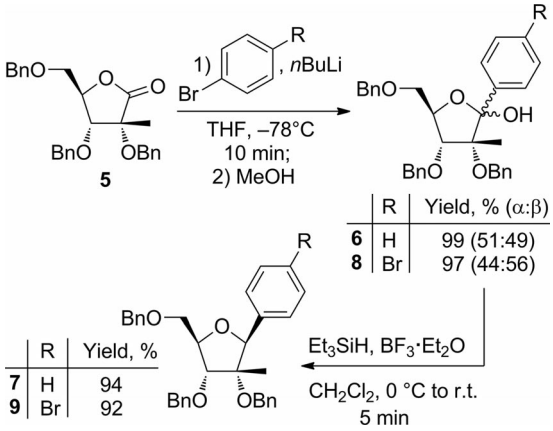
Results and Discussion

The key intermediates for the synthesis of the target *C*-nucleosides were the corresponding suitably protected 4-bromophenyl, 2-bromopyridin-5-yl, and 5-bromopyridin-2-yl 2′-*C*-methyl *C*-ribonucleosides. Initially, we attempted to work with silyl-protected sugar building blocks (similarly to our previous work[10–12]), but this gave mixtures of products that were difficult to separate. Therefore, we chose benzyl ether protection for the sugars. The starting material, 2-*C*-methyl-D-ribonolactone (**4**), is available in two steps from D-glucose.[16] Reaction of the lactone **4** with BnBr and NaH in DMF at –10 °C gave key perbenzylated building block **5** in very good yield (89%) on a multigram scale (Scheme 1).



Scheme 1.

To attach the aromatic nucleobase surrogate to lactone **5**, we ran a series of addition reactions using aryllithium compounds. Treatment of bromobenzene with *n*BuLi in THF at –78 °C gave phenyllithium, which subsequently reacted with the lactone to give hemiketal **6** in excellent yield (99%) as an inseparable mixture of anomers (α/β = 51:49; Scheme 2). Interestingly, when a solution of **6** in [D$_6$]DMSO was kept at 4 °C, epimerization occurred, and after 2 weeks, the ratio of anomers had changed to α/β = 31:69 (in favour of the thermodynamically more stable β-hemiketal). Reduction of **6** (the originally obtained mixture of anomers α/β = 51:49) was carried out using Et_3SiH and $BF_3{\cdot}Et_2O$ in CH_2Cl_2 in analogy to a previously developed procedure[10] to obtain the desired protected *C*-nucleoside (i.e., **7**) in excellent yield (94%) as a pure β isomer. For assignment of the configuration at C-1, the α and β anomers in hemiketals (and their acetates) refer to the relative configuration of the OH (OAc) at C-1 and O at C-4, whereas in *C*-nucleosides, the α and β isomers refer to the relative configuration of the aryl group at C-1 and O at C-4 in analogy to the assignment of α and β anomers in natural *N*-linked nucleosides (Figure 2).



Scheme 2.

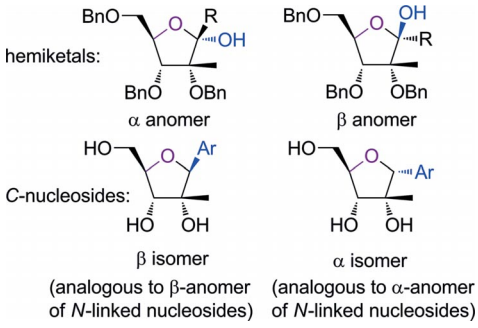
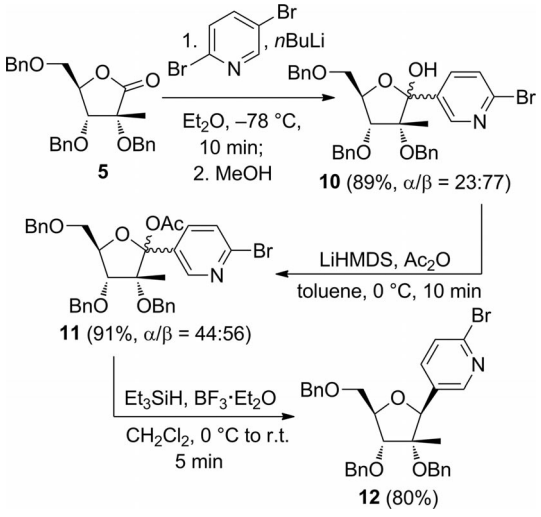


Figure 2. Assignment of the relative configuration at C-1 in hemiketals and *C*-nucleosides.

4-Bromophenyl *C*-nucleoside intermediate **9** was prepared in a similar way. 4-Bromophenyllithium, generated by treatment of 1,4-dibromobenzene with *n*BuLi in THF at –78 °C, was added to lactone **5** to give hemiketal **8** in excellent yield (97%; Scheme 2). As in the previous case, an inseparable mixture of anomers (α/β = 44:56) was formed, and similar epimerization occurred when a solution of **8** in [D$_6$]DMSO was stored at 4 °C (after 2 weeks, the ratio of anomers became α/β = 8:92). Reduction of **8** (α/β = 44:56) under the standard conditions[10] using a mixture of Et_3SiH and $BF_3{\cdot}Et_2O$ in CH_2Cl_2 gave the desired Bn-protected *C*-nucleoside (i.e., **9**) in 92% yield as a single β isomer. This stereoselectivity (which is similar to that seen in our previous work[12] on ribonucleosides) probably results from the formation of a planar oxocarbenium cation intermediate (after treatment with Lewis acid), which is then reduced by Et_3SiH.

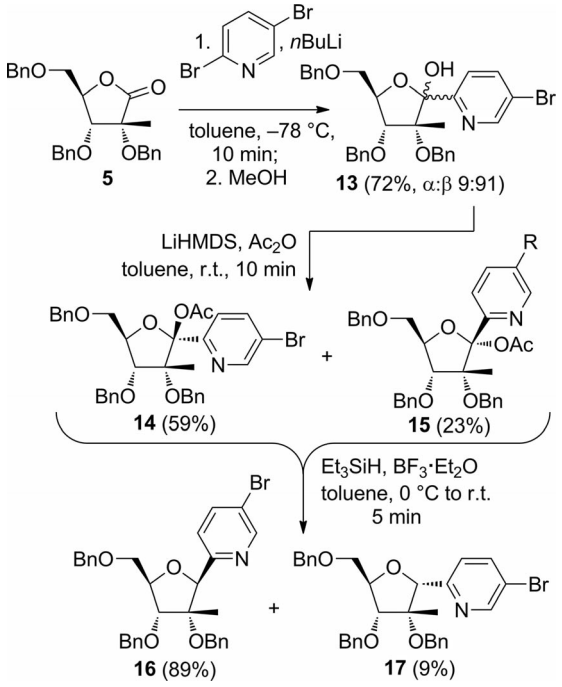
The preparation of isomeric benzyl-protected 2-bromopyridin-5-yl and 5-bromopyridin-2-yl 2′-*C*-methyl-*C*-ribonucleosides was based on the known dichotomy[17] in the

regioselective lithiation of 2,5-dibromopyridine using *n*BuLi in different solvents at –78 °C, in analogy to our previous paper on ribonucleosides.[12] In Et_2O, a coordinating solvent, 2-bromo-5-lithiopyridine is the dominant species, and this reacts with lactone **5** to give the desired hemiketal (i.e., **10**) in very good yield (89%; Scheme 3). Again, an inseparable mixture of two anomers was obtained (α/β = 23:77). All our attempts to reduce **10** under the conditions used for the two previous hemiketals (i.e., **6** and **8**; treatment with Et_3SiH and $BF_3{\cdot}Et_2O$ in CH_2Cl_2) were unsuccessful: no reaction was observed, and only starting material was isolated. In analogy to our previous work,[12] we converted hemiketal **10** into its acetate **11**, which should be more reactive towards reduction. Treatment of **10** with LiHMDS (lithium hexamethyldisilazide) in toluene at 0 °C and subsequent quenching with Ac_2O gave hemiketal acetate **11** in 91% yield as an inseparable mixture of anomers (α/β = 44:56). Reduction of **11** by treatment with Et_3SiH and $BF_3{\cdot}Et_2O$ in CH_2Cl_2 yielded the desired *C*-nucleoside (i.e., **12**) in good yield (80%) as a single β isomer.



Scheme 3.

In a noncoordinating solvent, such as toluene, the lithiation gives[17] another regioisomer, 5-bromo-2-lithiopyridine. The addition of this organolithium reagent to lactone **5** gave hemiketal **13** in 72% yield as an inseparable mixture of anomers (α/β = 9:91; Scheme 4). An attempted direct reduction of **13** using Et_3SiH and $BF_3{\cdot}Et_2O$ failed, as had been seen for **10**. To facilitate the reduction, we again tried to convert **13** into its acetate by treatment with LiHMDS and Ac_2O in toluene. In this case, the yield was higher when the deprotonation was carried out at room temperature. As a result, we got a mixture of two anomers **14** (59%) and **15** (23%), which were separated by flash chromatography. The structure of compound **14** was also confirmed by X-ray structural analysis (Figure 3). Then, we turned our attention to the reduction of hemiketal acetates **14** and **15**. Reduction of a mixture of **14** and **15** using the standard procedure (Et_3SiH and $BF_3{\cdot}Et_2O$ in CH_2Cl_2) resulted in the formation of the desired β isomer (i.e., **16**) accompanied by an unwanted α-isomeric side-product **17**. The two isomers were easily separable by flash chromatography. Interestingly, the stereoselectivity (the ratio of β isomer **16** to α isomer **17**) of the reduction using Et_3SiH and $BF_3{\cdot}Et_2O$ was always the same, irrespective of whether we started from pure **14**, pure **15**, or from a mixture of the two anomers. However, the ratio could be slightly influenced by the choice of solvent. The best results [89% of the desired β isomer (i.e., **16**)] were achieved when reduction was carried out in toluene. Therefore, in preparative experiments, mixtures of anomers of intermediate **13** and mixtures of **14** and **15** were used directly, and the desired protected bromopyridyl *C*-nucleoside (i.e., **16**) was obtained in 53% overall yield (starting from **5**) on a multigram scale.



Scheme 4.

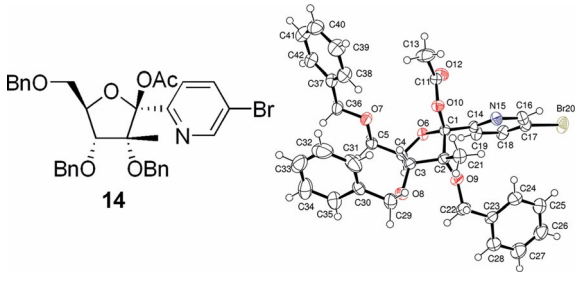
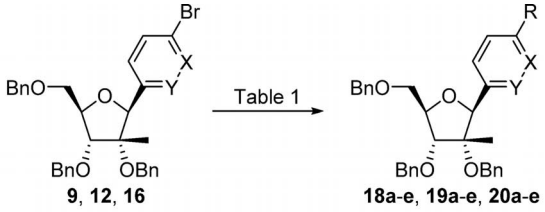


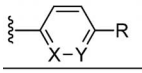
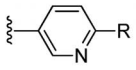
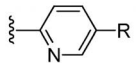
Figure 3. Chemical and X-ray structures (ORTEP[18] drawing) of **14** with the atom numbering scheme. Thermal ellipsoids are drawn at the 50% probability level.

With all three key intermediates **9**, **12**, and **16** in hand in sufficient quantities, we carried out a series of Pd-catalysed cross-coupling, amination and hydroxylation reactions (Table 1) in analogy to our previous papers on ribonucleosides.[10–12] Cross-coupling of **9**, **12**, and **16** with trimethylaluminium in the presence of $Pd(PPh_3)_4$ was used to intro-

Table 1. Cross-coupling, amination, and hydroxylation reactions of intermediates **9**, **12**, and **16**.



9, **12**, **16** — **18a-e**, **19a-e**, **20a-e**

	R	Reagent	Catalyst	Ligand, base	Solvent	Conditions	Compd.	Yield, %
	Me	Me_3Al	$Pd(PPh_3)_4$		THF	66 °C, 1 h	**18a**	91
	NH_2	LiHMDS	Pd_2dba_3	Cy-JohnPhos	THF	66 °C, 30 min[a]	**18b**	85
	NMe_2	Me_2NH	Pd_2dba_3	JohnPhos, *t*BuONa	toluene	70 °C, 24 h	**18c**	83
	OH	KOH	Pd_2dba_3	$Me_4(tBu)_2$XPhos	dioxane/H_2O	80 °C, 2 h	**18d**	95
	OMe[b]	CH_3I		KOH, TBAB	dioxane/H_2O	80 °C, 30 min	**18e**	81
	Me	Me_3Al	$Pd(PPh_3)_4$		THF	66 °C, 1 h	**19a**	95
	NH_2	LiHMDS	Pd_2dba_3	Cy-JohnPhos	THF	70 °C, 30 min[a]	**19b**	94
	NMe_2	Me_2NH	Pd_2dba_3	JohnPhos, *t*BuONa	toluene	70 °C, 4 h	**19c**	87
	OH	KOH	Pd_2dba_3	$Me_4(tBu)_2$XPhos	dioxane/H_2O	80 °C, 2 h	**19d**	93
	OMe[c]	CH_3I		Ag_2CO_3	CH_2Cl_2	60 °C, 2 h	**19e**	68
	Me	Me_3Al	$Pd(PPh_3)_4$		THF	66 °C, 1 h	**20a**	77
	NH_2	LiHMDS	Pd_2dba_3	$P(tBu)_3{\cdot}HBF_4$	THF	66 °C, 3 h[a]	**20b**	73
	NMe_2	Me_2NH	Pd_2dba_3	JohnPhos, *t*BuONa	toluene	70 °C, 2 h	**20c**	84
	OH	KOH	Pd_2dba_3	$Me_4(tBu)_2$XPhos	dioxane/H_2O	80 °C, 4 h	**20d**	98
	OMe[d]	CH_3I		KOH, TBAB	dioxane/H_2O	80 °C, 30 min	**20e**	66

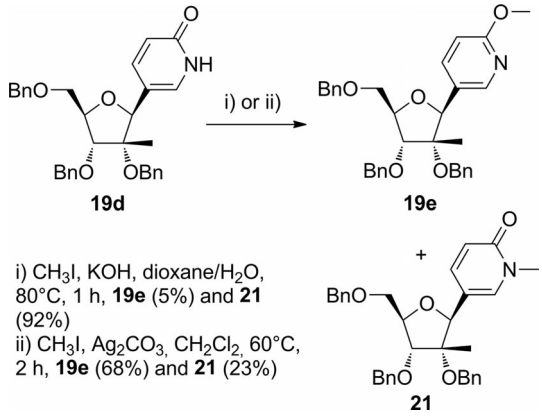
[a] Then HCl (2 M). [b] Starting from **18d**. [c] Starting from **19d**. [d] Starting from **20d**.

duce a methyl group. Reactions were carried out in THF at 66 °C, and gave compounds **18a**, **19a**, and **20a** in very good to excellent yields (91, 95, and 77% respectively).

Pd-catalysed Hartwig–Buchwald amination reactions[19] were used to introduce primary and tertiary amino groups. Reaction with LiHMDS in the presence of $Pd_2(dba)_3$ and Cy-JohnPhos[20,21] as a ligand yielded aniline and aminopyridine *C*-nucleosides **18b** and **19b** in 85 and 94% yields, respectively. For the synthesis of **20b**, $P(tBu)_3{\cdot}HBF_4$ was used as a ligand to get an acceptable yield of 73%. The dimethylamino group was introduced by reaction with dimethylamine in toluene in the presence of $Pd_2(dba)_3$, with JohnPhos as a ligand and *t*BuONa as a base. Under these conditions, compounds **18c**, **19c**, and **20c** were obtained in good yields of 83–87%.

Palladium-catalysed hydroxylation reactions using KOH, $Pd_2(dba)_3$, and tetramethyl-di-*t*BuXPhos were used for the preparation of hydroxy derivatives.[22] Reactions were carried out in a mixture of 1,4-dioxane and water (3:1) at 80 °C, and after heating for 2–4 h gave compounds **18d**, **19d**, and **20d** in excellent yields (93–98%).

Since direct nucleophilic methoxylation of halogenated intermediates **9**, **12**, and **16** gave low yields and complex mixtures, the desired methoxy derivatives were prepared by methylation of the corresponding hydroxy compounds.[23] The crude reaction mixtures after the synthesis of compounds **18d** and **20d** were directly heated for 30 min with CH_3I in the presence of KOH and TBAB (tetrabutylammonium bromide) at 80 °C to give methoxy compounds **18e** and **20e** in 81 and 66% yields (over two steps), respectively. Since compound **19d** exists mainly in a pyridone form, its alkylation could yield products of *N*- as well as *O*-methylation. Under the conditions described above for the preparation of compounds **18e** and **20e** (treatment with CH_3I and KOH in 1,4-dioxane/water), compound **19d** was methylated mainly at the *N*-site to give 92% of **21**, and only 5% of the desired *O*-methylated product (i.e., **19e**; Scheme 5). By changing the base to Ag_2CO_3 and the solvent to CH_2Cl_2,

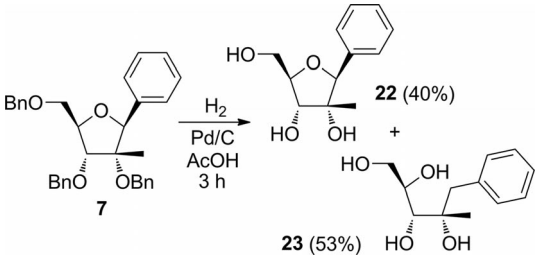


Scheme 5.

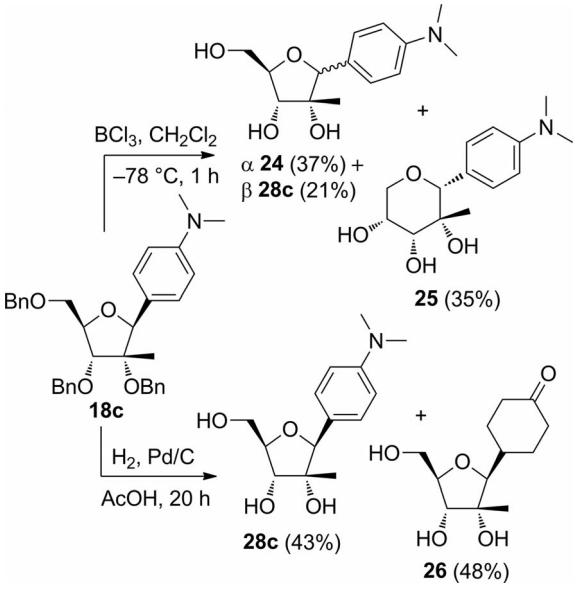
we were able to obtain the desired methoxypyridine *C*-nucleoside (i.e., **19e**) in 68% yield.

With all three series of benzyl-protected 2′-*C*-methyl-*C*-ribonucleosides complete, we proceeded to the final deprotection step. The challenge here was the fact that the aryl-*C*-nucleosides inherently contain a cyclic benzylic ether group, which might be cleaved by common methods of debenzylation. We tested two different methods for the debenzylation: catalytic hydrogenation, and treatment with a Lewis acid. For some compounds, the use of either one or both of these methods resulted in the formation of the desired β-isomeric *C*-nucleosides. However, in many cases we observed the formation of different undesired side-products, and therefore the deprotection procedure had to be selected and optimized for each particular derivative. For example, catalytic hydrogenation of compound **7** with H_2 and Pd on charcoal (10%) in acetic acid gave the desired β-*C*-nucleoside (i.e., **22**) in 40% yield, accompanied by an acyclic side-product **23** (53%) containing an overreduced sugar ring (Scheme 6). Better results were obtained when **7** was treated with BCl_3 at –78 °C for 2 h. Under these conditions, the desired deprotected β isomer (i.e., **22**) was obtained in an excellent 94% yield (Table 2).

The deprotection of dimethylaniline derivative **18c** was the most difficult. Both methods of debenzylation led to the formation of mixtures of the desired β-*C*-nucleoside and other side-products (Scheme 7). Treatment with BCl_3 at –78 °C gave three compounds: β isomer **28c** (21%), α isomer **24** (37%), and a pyranose derivative **25** (35%). On the other hand, catalytic hydrogenation of **18c** gave a mixture of the desired β sugar (i.e., **28c**; 43%) and an unexpected

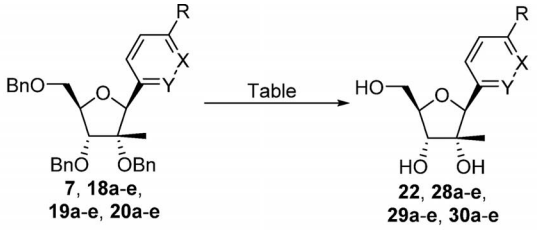


Scheme 6.



Scheme 7.

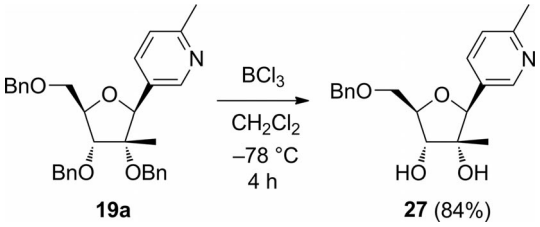
Table 2. Deprotection of benzylated *C*-nucleosides.



	R	Reagent	Catalyst	Solvent	Conditions	Compd.	Yield, %
	H	BCl_3		CH_2Cl_2	–78 °C, 2 h	**22**	94
	Me	H_2	Pd/C (5%, "eggshell", unreduced)	AcOH	r.t., 6 h	**28a**	93
	NH_2	H_2	Pd/C (5%, "eggshell", unreduced)	AcOH	r.t., 3 d	**28b**	75
	NMe_2	H_2	Pd/C (10%)	AcOH	r.t., 20 h	**28c**	43
	OH	H_2	Pd/C (5%, "eggshell", unreduced)	AcOH	r.t., 2 h	**28d**	91
	OMe	H_2	Pd/C (5%, "eggshell", unreduced)	AcOH	r.t., 6 h	**28e**	91
	Me	H_2	Pd/C (5%, "eggshell", unreduced)	AcOH	r.t., 2 d	**29a**	80
	NH_2	BCl_3		CH_2Cl_2	0 °C to r.t., 2 h	**29b**	95
	NMe_2	H_2	Pd/C (5%, "eggshell", unreduced)	AcOH	r.t., 3 d	**29c**	55
	OH	BCl_3		CH_2Cl_2	–78 °C, 1 h	**29d**	92
	OMe	H_2	Pd/C (5%, "eggshell", unreduced)	AcOH	r.t., 1 d	**29e**	89
	Me	H_2	Pd/C (5%, "eggshell", unreduced)	AcOH	r.t., 1 d	**30a**	87
	NH_2	BCl_3		CH_2Cl_2	–78 °C, 1 h	**30b**	98
	NMe_2	BCl_3		CH_2Cl_2	–78 °C, 1 h	**30c**	91
	OH	H_2	Pd/C (5%, "eggshell", unreduced)	AcOH	r.t., 1 d	**30d**	97
	OMe	H_2	Pd/C (5%, "eggshell", unreduced)	AcOH	r.t., 1 d	**30e**	76

cyclohexanone side-product **26** (48%), which was apparently formed by partial reduction of the aromatic ring and hydrolysis of an enamine intermediate. In both cases, HPLC was required to separate the mixtures of products. The latter method was used for preparative purposes.

Treatment of compound **19a** with BCl_3 at –78 °C resulted in partial deprotection, and gave *C*-nucleoside **27** with one benzyl group remaining at the 5′-position in 84% yield (Scheme 8). Full deprotection of this *C*-nucleoside was achieved by gradual warming of the reaction mixture to room temperature, or by catalytic hydrogenation of **19a**. (Table 2).



Scheme 8.

The optimized preparative procedures and conditions for the deprotection of each of the *C*-nucleosides are summarized in the Table 2. In general, catalytic hydrogenation proceeded better when a special type of palladium catalyst was used.[24] Unlike the usual Pd on charcoal (10%), this catalyst contained an unreduced form of Pd distributed as an "eggshell" on the charcoal particles. Reduction using this catalyst usually proceeded more quickly, and gave better yields of the desired β-*C*-nucleosides.

The structures of all the intermediates and all the final *C*-nucleosides were confirmed by NMR spectroscopy. The assignment of the C-1 configuration was based on two-dimensional ROESY experiments. The structure of free phenol *C*-nucleoside **28d** was confirmed by X-ray structural analysis; this showed that the sugar ring had a 3′-*endo* conformation, which is typical for *N*-linked 2′-methylribonucleosides (Figure 4). In contrast to the hemiketal intermediates, which spontaneously epimerized, the final *C*-nucleosides were sufficiently stable for testing and further transformations.

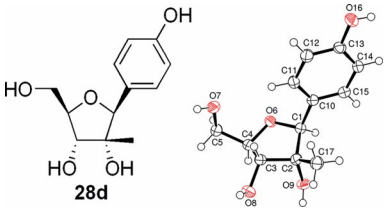
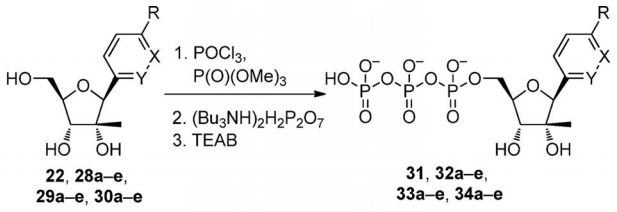


Figure 4. Chemical and X-ray structures (ORTEP) of **28d** with the atom numbering scheme. Thermal ellipsoids are drawn at the 50% probability level.

Since it was previously reported that sugar-modified nucleosides might be poor substrates for nucleoside kinases, and may not be activated by phosphorylation,[3] we finally needed to convert all of the *C*-nucleosides to the corresponding nucleoside triphosphates (NTPs), which would then be suitable for direct testing for HCV RNA polymerase inhibition. The NTPs were prepared similarly to a published procedure.[25] First, the corresponding *C*-nucleoside was dissolved in $P(O)(OMe)_3$, and treated with $POCl_3$ for 2 h at 0 °C. Then, a precooled solution of tributylammonium pyrophosphate in DMF and Bu_3N was added, and the reaction mixture was stirred for an additional 2 h. Quenching with TEAB (triethylammonium bicarbonate), and separation using Sephadex and HPLC gave sodium or triethylammonium salts of the triphosphates in good to excellent yields (51–96%) as hygroscopic white solids after lyophilization (Table 3).

Table 3. Synthesis of NTPs.



	R	Compound	Yield, %
	H	**31**	93
	Me	**32a**	60
	NH_2	**32b**	64
	NMe_2	**32c**	82
	OH	**32d**	70
	OMe	**32e**	77
	Me	**33a**	89
	NH_2	**33b**	88
	NMe_2	**33c**	87
	OH	**33d**	75
	OMe	**33e**	96
	Me	**34a**	93
	NH_2	**34b**	51
	NMe_2	**34c**	91
	OH	**34d**	63
	OMe	**34e**	96

All 16 final free *C*-nucleosides **22**, **28a**–**28e**, **29a**–**29e**, and **30a**–**30e** were tested for antiviral activity in Huh-7 cells harbouring sub-genomic reporter replicons derived from HCV subtypes 1B and 2A.[26] No inhibitory activity was observed at a 10 μM concentration. All the NTPs (i.e., **31**, **32a**–**32e**, **33a**–**33e**, and **34a**–**34e**) were tested for inhibition of HCV polymerase (NS5B),[8] and no significant activity was observed at a 10 μM concentration. Neither was any of the NTPs found to be a substrate for T7 RNA polymerase.

Conclusions

We have developed a general and modular synthesis of various substituted benzene and pyridine 2′-*C*-methyl-*C*-ribonucleosides. Although the overall approach is similar to

our previous papers on the related *C*-ribonucleosides,[10–12] the presence of the additional methyl group at the 2′-position of the sugar brought several synthetic challenges. There was increased steric hindrance at C-1, it was necessary to use more stable benzyl ether protection, and each step had to be optimized. The synthesis of the key protected haloaryl-*C*-nucleoside intermediates was based on additions of bromo(het)aryllithium species to protected lactone **5**, followed by acetylation and reduction, which, in most cases, gave the desired β-configured *C*-nucleosides stereoselectively. These halogenated intermediates **9**, **12**, and **16** underwent a series of Pd-catalysed cross-couplings, aminations, and hydroxylations to introduce methyl, amino, dimethylamino, and hydroxy groups. The hydroxy groups were also further methylated to give methoxy derivatives. The final deprotection was the most difficult. Unwanted side-products were often seen, and either catalytic hydrogenation on Pd/C or treatment with BCl_3 had to be chosen and optimized for each particular derivative. The final *C*-nucleosides were also all converted into the corresponding NTPs. Unfortunately, none of the *C*-nucleosides showed any activity in the HCV replicon assay, and none of the NTPs showed any significant inhibition of the HCV polymerase, which demonstrates the relatively narrow specificity of this enzyme. On the other hand, we have shown that our previously developed modular approach[9–13] can be extended to sugar-modified *C*-nucleosides, which are very rare in the literature and have much potential in medicinal chemistry.

Experimental Section

General Information: All reactions were carried out in dried glassware with magnetic stirring under an argon atmosphere, unless otherwise specified. THF, toluene, and Et_2O were dried and distilled from sodium and benzophenone. Other reagents were purchased from commercial suppliers, and were used directly without further purification. NMR spectra were recorded with Bruker Avance II 400 (^{1}H at 400 MHz, and ^{13}C at 100.6 MHz), Bruker Avance II 500 (^{1}H at 500 MHz, and ^{13}C at 125.7 MHz) and Bruker Avance II 600 (^{1}H at 600 MHz, and ^{13}C at 150.9 MHz) spectrometers. Samples were measured in $CDCl_3$ (referenced to the solvent signal ^{1}H NMR δ = 7.26 ppm, ^{13}C NMR δ = 77.0 ppm), [D$_6$]-DMSO (referenced to the solvent signal ^{1}H NMR δ = 2.50 ppm, ^{13}C NMR δ = 39.7 ppm), or D_2O (referenced to dioxane as an internal standard ^{1}H NMR δ = 3.75 ppm, ^{13}C NMR δ = 67.19 ppm). Chemical shifts are given in ppm (δ scale), and coupling constants (*J*) in Hertz. Complete assignment of all NMR signals was carried out using a combination of 2D NMR (H,H-COSY, H,C-HSQC, and H,C-HMBC) experiments, and configurations were established using two-dimensional ROESY spectra. High-resolution mass spectrometry (HRMS) was carried out with an LTQ Orbitrap XL mass spectrometer (Thermo Fisher Scientific) using the electrospray ionization (ESI) technique. Melting points were measured with a Stuart SMP3 apparatus. IR spectra were measured with Nicolet 6700 (in CCl_4) and Bruker Alpha (ATR) FTIR spectrometers. X-ray diffraction experiments of single crystals were carried out with an X-ray diffractometer using $Cu_{K\alpha}$ radiation (λ = 1.54180 Å). The purity of all final free *C*-nucleosides was determined by analytical HPLC.

2,3,5-Tri-*O*-benzyl-2-*C*-methyl-D-ribono-1,4-lactone (5): A suspension of NaH (60% in mineral oil; 6.42 g, 160 mmol) in dry DMF (30 mL) was added to a stirred solution of 2-*C*-methyl-D-ribono-1,4-lactone (**4**; 20 g, 123 mmol) in dry DMF (400 mL) at –10 °C. After 1 h, BnBr (22 mL, 185 mmol) was added, and the reaction mixture was stirred at –10 °C for 30 min. The addition of a suspension of NaH [NaH (6.42 g) in dry DMF (30 mL)] followed by BnBr (22 mL) was repeated two more times. The mixture was stirred at –10 °C for 2 d, then it was poured onto ice, and extracted with ethyl acetate. The organic phase was dried with anhydrous $MgSO_4$, and concentrated under reduced pressure. The crude product was purified by flash chromatography on silica gel (14 to 50% of ethyl acetate in hexane) to give protected lactone **5** (47.5 g, 110 mmol, 89%) as a yellowish oil. HRMS (ESI): calcd. for $C_{27}H_{28}O_5Na$ [M + Na]$^+$ 455.18290; found 455.18281. ^{1}H NMR (500 MHz, [D$_6$]-DMSO): δ = 1.51 (s, 3 H, CH_3-2), 3.63 (dd, 1 H, J_{gem} = 11.6, $J_{5a,4}$ = 5.0 Hz, 5a-H), 3.75 (dd, 1 H, J_{gem} = 11.6, $J_{5b,4}$ = 2.5 Hz, 5b-H), 4.09 (d, 1 H, $J_{3,4}$ = 7.5 Hz, 3-H), 4.50 (br. d, 1 H, J_{gem} = 12.1 Hz, CH_2Bn-5), 4.55 (br. d, 1 H, J_{gem} = 12.1 Hz, CH_2Bn-5), 4.57 (ddd, 1 H, $J_{4,3}$ = 7.5, $J_{4,5a}$ = 5.0, $J_{4,5b}$ = 2.5 Hz, 4-H), 4.55–4.59 (m, 2 H, CH_2Bn-2), 4.61 (br. d, 1 H, J_{gem} = 11.7 Hz, CH_2Bn-3), 4.75 (br. d, 1 H, J_{gem} = 11.7 Hz, CH_2Bn-3), 7.25–7.39 (m, 15 H, H-*o*,*m*,*p*-Bn) ppm. ^{13}C NMR (125.7 MHz, [D$_6$]DMSO): δ = 19.8 (CH_3-2), 67.0 (CH_2Bn-2), 68.6 (CH_2-5), 72.7 (CH_2Bn-3), 72.9 (CH_2Bn-5), 77.3 (C-2), 80.3 and 80.5 (CH-3,4), 127.9 (CH-*o*-Bn), 128.0 and 128.1 (CH-*p*-Bn), 128.1 (CH-*o*-Bn), 128.3 (CH-*p*-Bn), 128.4 (CH-*o*-Bn), 128.7, 128.7, and 128.8 (CH-*m*-Bn), 138.1, 138.3, and 138.4 (C-*i*-Bn), 173.8 (C-1) ppm. IR (CCl_4): 3034, 2943, 2868, 1787, 1732, 1603, 1497, 1454, 1277, 1111, 1028 cm^{-1}.

2,3,5-Tri-*O*-benzyl-2-*C*-methyl-1-*C*-phenyl-α,β-D-ribofuranose (6): *n*BuLi (1.6 M in hexanes; 8 mL, 12.71 mmol) was added to a cooled (–78 °C) stirred solution of PhBr (1.21 mL, 11.55 mmol) in dry THF (27 mL). After 20 min, a solution of lactone **5** (1 g, 2.31 mmol) in dry THF (10 mL) was added, and reaction mixture was stirred for a further 10 min. Subsequently, MeOH (2.8 mL, 69.3 mmol) was added, and the resulting solution was warmed to room temp., and neutralized with HCl (2 M). The mixture was washed with satd. aq. $NaHCO_3$ (50 mL), and the aqueous phase was extracted with ethyl acetate. The combined organic layers were dried with anhydrous $MgSO_4$, and concentrated under reduced pressure. The residue was purified by flash chromatography on silica gel (0 to 6% of ethyl acetate in hexane) to give hemiketal **6** (1.17 g, 2.29 mmol, 99%; α/β = 51:49) as a colourless oil. HRMS (ESI): calcd. for $C_{33}H_{34}O_5Na$ [M + Na]$^+$ 533.22985; found 533.22972. ^{1}H NMR (500 MHz, [D$_6$]DMSO) α anomer: δ = 0.89 (s, 3 H, CH_3-2), 3.70–3.75 (m, 2 H, 5-H), 3.88 (d, 1 H, $J_{3,4}$ = 4.2 Hz, 3-H), 4.39 (td, 1 H, $J_{4,5a}$ = $J_{4,5b}$ = 4.7, $J_{4,3}$ = 4.2 Hz, 4-H), 4.52–4.66 (m, 6 H, CH_2Bn-2,3,5), 5.58 (s, 1 H, OH-1), 7.23–7.41 (m, 18 H, H-*o*,*m*,*p*-Bn, H-*m*,*p*-Ph), 7.53 (m, 2 H, H-*o*-Ph); β anomer: δ = 1.36 (s, 3 H, CH_3-2), 3.65 (dd, 1 H, J_{gem} = 10.4, $J_{5a,4}$ = 6.4 Hz, 5a-H), 3.68 (dd, 1 H, J_{gem} = 10.4, $J_{5b,4}$ = 4.0 Hz, 5b-H), 4.07 (d, 1 H, J_{gem} = 12.5 Hz, CH_2Bn-2), 4.19 (d, 1 H, $J_{3,4}$ = 8.0 Hz, 3-H), 4.30 (ddd, 1 H, $J_{4,3}$ = 8.0, $J_{4,5a}$ = 6.4, $J_{4,5b}$ = 4.0 Hz, 4-H), 4.54–4.57 (m, 2 H, CH_2Bn-5), 4.59 (d, 1 H, J_{gem} = 12.5 Hz, CH_2Bn-2), 4.67 and 4.71 (2 d, 2× 1 H, J_{gem} = 11.8 Hz, CH_2Bn-3), 6.65 (s, 1 H, OH-1), 6.89 (m, 2 H, H-*o*-Bn), 7.09–7.16 and 7.23–7.42 (m, 16 H, H-*o*,*m*,*p*-Bn, H-*m*,*p*-Ph), 7.52 (m, 2 H, H-*o*-Ph) ppm. ^{13}C NMR (125.7 MHz, [D$_6$]DMSO) α anomer: δ = 20.7 (CH_3-2), 66.2 (CH_2Bn-2), 70.2 (CH_2-5), 71.9 and 72.7 (CH_2Bn-3,5), 80.1 (CH-4), 82.5 (CH-3), 82.0 (C-2), 105.2 (C-1), 127.0 (CH-*o*-Ph), 127.3 (CH-*p*-Bn), 127.7 (CH-*o*-Bn), 127.8 (CH-*p*-Bn), 127.9 (CH-*o*-Bn), 128.2 and 128.3 (CH-*o*-Bn), 128.2, 128.4, and 128.5 (CH-*m*-Bn), 136.2, 138.5, and 139.5 (C-*i*-Bn), 141.1 (C-*i*-Ph); β anomer: δ = 15.0 (CH_3-

2), 65.6 (CH_2Bn-2), 72.6 (CH_2Bn-5), 73.2 (CH_2-5 and CH_2Bn-3), 79.4 (CH-4), 83.8 (C-2), 86.9 (CH-3), 106.7 (C-1), 126.3 (CH-*o*-Bn), 126.7 (CH-3), 126.9 and 127.7 (CH-*p*-Bn), 127.9 (CH-*o*-Bn), 127.9 (CH-*p*-Bn), 127.8, 127.9, and 128.0 (CH-*o*,*m*-Bn, CH-*m*-Ph), 128.2 (CH-*o*-Ph), 128.4 and 128.5 (CH-*m*-Bn), 138.6, 138.7, and 140.4 (C-*i*-Bn), 140.9 (C-*i*-Ph) ppm. IR (CCl_4): 3592, 3534, 3032, 2866, 1497, 1454, 1362, 1208, 1097, 1068, 1029 cm^{-1}.

(2,3,5-Tri-*O*-benzyl-2-*C*-methyl-β-D-ribofuranosyl)benzene (7): Et_3SiH (1.5 mL, 9.2 mmol) was added to a stirred solution of hemiketal **6** (1.17 g, 2.29 mmol) in dry CH_2Cl_2 (12 mL) at 0 °C. After 5 min, $BF_3{\cdot}Et_2O$ (0.6 mL, 4.6 mmol) was slowly added, and the resulting mixture was warmed to room temp. over 5 min. Subsequently, Et_3N (3.2 mL, 23 mmol) was added, and the reaction mixture was concentrated under reduced pressure. The crude product was purified by flash chromatography on silica gel (0 to 5% of ethyl acetate in hexane) to give **7** (1.07 g, 2.16 mmol, 94%) as a colourless oil. HRMS (ESI): calcd. for $C_{33}H_{34}O_4Na$ $[M + Na]^+$ 517.23493; found 517.23486. ^1H NMR (500 MHz, $CDCl_3$): δ = 0.92 (s, 3 H, CH_3), 3.73 (dd, 1 H, J_{gem} = 10.3, $J_{5'a,4'}$ = 5.2 Hz, 5′a-H), 3.76 (dd, 1 H, J_{gem} = 10.3, $J_{5'b,4'}$ = 4.6 Hz, 5′b-H), 3.81 (d, 1 H, $J_{3',4'}$ = 4.6 Hz, 3′-H), 4.36 (br. q, 1 H, $J_{4',5'a} = J_{4',5'b} = J_{4',3'}$ = 4.8 Hz, 4′-H), 4.55, 4.58, 4.62, 4.65, 4.68, and 4.69 (6 d, 6× 1 H, J_{gem} = 11.5, 11.8, 11.6, 11.9, 12.0, and 11.8 Hz, CH_2-Bn), 5.09 (s, 1 H, 1′-H), 7.21–7.39 (m, 20 H, H-*o*,*m*,*p*-Ph,Bn) ppm. ^{13}C NMR (125.7 MHz, $CDCl_3$): δ = 19.2 (CH_3), 66.0 (CH_2Bn), 70.3 (CH_2-5′), 71.9 and 73.5 (CH_2Bn), 81.7 (CH-4′), 83.1 (CH-3′), 83.2 (C-2′), 84.5 (CH-1′), 126.5 (CH-*o*-Ph), 127.1 (CH-*p*-Bn), 127.2 (CH-*o*-Bn), 127.3 and 127.7 (CH-*p*-Bn), 127.7, 127.8, and 128.2 (CH-*o*-Bn, CH-*m*-Ph, CH-*p*-Ph), 128.3, 128.4, and 128.4 (CH-*m*-Bn), 137.8 and 138.1 (C-*i*-Bn), 138.3 (C-*i*-Ph), 139.3 (C-*i*-Bn) ppm. IR (CCl_4): 3033, 2866, 1607, 1497, 1454, 1382, 1362, 1187, 1097, 1029 cm^{-1}.

2,3,5-Tri-*O*-benzyl-1-*C*-(4-bromophenyl)-2-*C*-methyl-α,β-D-ribofuranose (8): *n*BuLi (1.6 M in hexanes; 11.9 mL, 19.07 mmol) was added dropwise to a cooled (–78 °C) solution of 1,4-dibromobenzene (4.09 g, 17.34 mmol) in dry THF (105 mL). After 30 min, a solution of lactone **5** (2.5 g, 5.78 mmol) in dry THF (25 mL) was added, and the reaction mixture was stirred for a further 10 min. Subsequently, MeOH (7 mL, 173.4 mmol) was added, and the resulting solution was warmed to room temp., and neutralized with HCl (2 M). The mixture was washed with satd. aq. $NaHCO_3$ (130 mL), and the aqueous phase was extracted with ethyl acetate. The combined organic layers were dried with anhydrous $MgSO_4$, and concentrated under reduced pressure. The residue was purified by flash chromatography on silica gel (0 to 10% of ethyl acetate in hexane) to give hemiketal **8** (3.3 g, 5.6 mmol, 97%; α/β = 44:56) as a colourless oil. HRMS (ESI): calcd. for $C_{33}H_{33}O_5{}^{79}BrNa$ $[M + Na]^+$ 611.14036; found 611.14042. ^1H NMR (500 MHz, [D_6]-DMSO) α anomer: δ = 0.89 (s, 3 H, CH_3-2), 3.67–3.74 (m, 2 H, 5-H), 3.87 (d, 1 H, $J_{3,4}$ = 4.1 Hz, 3-H), 4.39 (td, 1 H, $J_{4,5a} = J_{4,5b}$ = 4.8, $J_{4,3}$ = 3.1 Hz, 4-H), 4.51–4.69 (m, 6 H, CH_2Bn-2,3,5), 5.68 (s, 1 H, OH), 7.22–7.56 (m, 19 H, H-*o*,*m*,*p*-Bn, H-*o*,*m*-Ph); β anomer: δ = 1.35 (s, 3 H, CH_3-2), 3.64 (dd, 1 H, J_{gem} = 10.5, $J_{5a,4}$ = 6.5 Hz, 5a-H), 3.68 (dd, 1 H, J_{gem} = 10.5, $J_{5b,4}$ = 3.8 Hz, 5b-H), 4.18 (d, 1 H, J_{gem} = 12.6 Hz, CH_2Bn-2), 4.18 (d, 1 H, $J_{3,4}$ = 8.1 Hz, 3-H), 4.30 (ddd, 1 H, $J_{4,3}$ = 8.1, $J_{4,5a}$ = 6.5, $J_{4,5b}$ = 3.8 Hz, 4-H), 4.50–4.67 (m, 3 H, CH_2Bn-2,5), 4.67 (d, 1 H, J_{gem} = 11.8 Hz, CH_2Bn-3), 4.70 (d, 1 H, J_{gem} = 11.8 Hz, CH_2Bn-3), 6.79 (m, 2 H, OH), 6.87–6.92 (m, 2 H, H-*o*-Bn), 7.11–7.19 and 7.22–7.55 (2 m, 17 H, H-*o*,*m*,*p*-Bn, H-*o*,*m*-Ph) ppm. ^{13}C NMR (125.7 MHz, [D_6]DMSO) α anomer: δ = 20.7 (CH_3-2), 66.3 (CH_2Bn-2), 70.1 (CH_2-5), 71.9 (CH_2Bn-3), 72.7 (CH_2Bn-5), 80.3 (CH-4), 82.4 (CH-3), 83.0 (C-2), 104.9 (C-1), 121.4 (C-*p*-Ph), 127.3 and 127.3 (CH-*p*-Bn), 127.4 and 127.7 (CH-*o*-Bn), 127.7 (CH-*p*-Bn), 128.2 and 127.3 (CH-*o*,*m*-Bn), 128.4 and 128.5 (CH-*m*-Bn), 129.3 and 130.6 (CH-*o*,*m*-Ph), 138.1, 138.5, and 139.4 (C-*i*-Bn), 140.5 (C-*i*-Ph); β anomer: δ = 14.8 (CH_3-2), 65.8 (CH_2Bn-2), 72.6 (CH_2Bn-5), 73.0 (CH_2-5), 73.3 (CH_2Bn-3), 79.5 (CH-4), 83.7 (C-2), 86.7 (CH-3), 106.4 (C-1), 121.4 (C-*p*-Ph), 126.3 (CH-*o*-Bn), 126.8 and 127.6 (CH-*p*-Bn), 127.8 (CH-*o*,*p*-Bn), 128.0 (CH-*o*,*m*-Bn), 128.4 and 128.5 (CH-*m*-Bn), 130.0 (CH-*m*-Ph), 130.5 (CH-*o*-Ph), 138.6, 138.6, and 140.3 (C-*i*-Bn), 140.4 (C-*i*-Ph) ppm. IR (ATR): 3427, 3040, 2874, 1598, 1501, 1458, 1366, 1211, 1072, 1030, 1012 cm^{-1}.

1-(2,3,5-Tri-*O*-benzyl-2-*C*-methyl-β-D-ribofuranosyl)-4-bromobenzene (9): Et_3SiH (4.2 mL, 26.48 mmol) was added to a stirred solution of hemiketal **8** (3.9 g, 6.62 mmol) in dry CH_2Cl_2 (39 mL) at 0 °C. After 5 min, $BF_3{\cdot}Et_2O$ (1.63 mL, 13.24 mmol) was slowly added, and the resulting mixture was warmed to room temp. over 5 min. Subsequently, Et_3N (9.2 mL, 66.2 mmol) was added, and the reaction mixture was concentrated under reduced pressure. The crude product was purified by flash chromatography on silica gel (0 to 5% of ethyl acetate in hexane) to give **9** (3.49 g, 6.09 mmol, 92%) as a colourless oil. HRMS (ESI): calcd. for $C_{33}H_{33}O_4{}^{79}BrNa$ $[M + Na]^+$ 595.14544; found 595.14553. ^1H NMR (500 MHz, [D_6]-DMSO): δ = 0.87 (s, 3 H, CH_3-2′), 3.69 (dd, 1 H, J_{gem} = 10.6, $J_{5'a,4'}$ = 4.9 Hz, 5′a-H), 3.72 (dd, 1 H, J_{gem} = 10.6, $J_{5'b,4'}$ = 4.6 Hz, 5′b-H), 3.84 (d, 1 H, $J_{3',4'}$ = 4.5 Hz, 3′-H), 4.23 (q, 1 H, $J_{4',3'} = J_{4',5'a} = J_{4',5'b}$ = 4.6 Hz, 4′-H), 4.52 (d, 1 H, J_{gem} = 11.5 Hz, CH_2Bn-3′), 4.54 and 4.58 (2 d, 2× 1 H, J_{gem} = 11.6 Hz, CH_2Bn-2′), 4.60 (d, 1 H, J_{gem} = 12.1 Hz, CH_2Bn-5′), 4.62 (d, 1 H, J_{gem} = 11.5 Hz, CH_2Bn-3′), 4.62 (d, 1 H, J_{gem} = 12.1 Hz, CH_2Bn-5′), 4.88 (s, 1 H, 1′-H), 7.22–7.35 and 7.36–7.41 (2 m, 17 H, H-*o*,*m*,*p*-Bn, 2-H, 6-H), 7.48–7.52 (m, 2 H, 3-H, 5-H) ppm. ^{13}C NMR (125.7 MHz, [D_6]DMSO): δ = 18.8 (CH_3-2′), 65.6 (CH_2Bn-2′), 70.2 (CH_2-5′), 71.5 (CH_2Bn-3′), 72.7 (CH_2Bn-5′), 81.8 (CH-4′), 82.8 (C-2′, CH-3′), 83.3 (CH-1′), 120.7 (C-4), 127.3 (CH-*p*-Bn), 127.4 (CH-*o*-Bn), 127.7 (CH-*p*-Bn), 127.8 (CH-*o*-Bn), 127.8 (CH-*p*-Bn), 128.2 (CH-*o*-Bn), 128.3, 128.4, and 128.5 (CH-*m*-Bn), 128.6 (CH-2, CH-6), 130.9 (CH-3, CH-5), 138.0 (C-1), 138.2, 138.5, and 139.5 (C-*i*-Bn) ppm. IR (CCl_4): 3032, 2866, 1608, 1595, 1489, 1454, 1362, 1187, 1093, 1073, 1029, 1013 cm^{-1}.

2,3,5-Tri-*O*-benzyl-1-*C*-(2-bromopyridin-5-yl)-2-*C*-methyl-α,β-D-ribofuranose (10): *n*BuLi (1.6 M in hexanes; 8 mL, 12.72 mmol) was added dropwise to a cooled (–78 °C) solution of 2,5-dibromopyridine (2.74 g, 11.56 mmol) in dry Et_2O (140 mL). After 30 min, a solution of lactone **5** (1 g, 2.31 mmol) in dry Et_2O (10 mL) was added, and the reaction mixture was stirred for a further 10 min. Subsequently, MeOH (2.8 mL, 69.3 mmol) was added, and the resulting yellow solution was warmed to room temp., and neutralized with HCl (2 M). The mixture was washed with satd. aq. $NaHCO_3$ (150 mL), and extracted with Et_2O. The combined organic layers were dried with anhydrous $MgSO_4$, and concentrated under reduced pressure. The residue was purified by flash chromatography on silica gel (9 to 16% of ethyl acetate in hexane) to give hemiketal **10** (1.21 g, 2.06 mmol, 89%; α/β = 23:77) as a white foam. HRMS (ESI): calcd. for $C_{32}H_{32}O_5N^{79}BrNa$ $[M + Na]^+$ 612.13561; found 612.13574. ^1H NMR (500 MHz, [D_6]DMSO) α anomer: δ = 0.93 (s, 3 H, CH_3-2), 3.70 (dd, 1 H, J_{gem} = 10.7, $J_{5a,4}$ = 4.8 Hz, 5a-H), 3.72 (dd, 1 H, J_{gem} = 10.7, $J_{5b,4}$ = 4.7 Hz, 5b-H), 3.89 (d, 1 H, $J_{3,4}$ = 4.2 Hz, 3-H), 4.40 (td, 1 H, $J_{4,5a} = J_{4,5b}$ = 4.7, $J_{4,3}$ = 4.2 Hz, 4-H), 4.54–4.65 (m, 6 H, CH_2Bn-2,3,5), 5.97 (br. s, 1 H, OH-1), 7.23–7.41 (m, 15 H, H-*o*,*m*,*p*-Bn), 7.62 (dd, 1 H, $J_{3',4'}$ = 8.3, $J_{3',6'}$ = 0.8 Hz, 3′-H), 7.79 (dd, 1 H, $J_{4',3'}$ = 8.3, $J_{4',6'}$ = 2.5 Hz, 4′-H), 8.46 (dd, 1 H, $J_{6',4'}$ = 2.5, $J_{6',3'}$ = 0.8 Hz, 6′-H); β anomer: δ = 1.34 (s, 3 H, CH_3-2), 3.63 (dd, 1 H, J_{gem} = 10.5, $J_{5a,4}$ = 6.5 Hz, 5a-H), 3.68 (dd, 1 H, J_{gem} = 10.5, $J_{5b,4}$ = 3.6 Hz, 5b-H), 4.20 (d, 1 H, $J_{3,4}$ =

8.1 Hz, 3-H), 4.27 (d, 1 H, J_{gem} = 12.4 Hz, CH_2Bn-2), 4.31 (ddd, 1 H, $J_{4,3}$ = 8.1, $J_{4,5a}$ = 6.5, $J_{4,5b}$ = 3.6 Hz, 4-H), 4.52 and 4.55 (2 d, 2× 1 H, J_{gem} = 12.0 Hz, CH_2Bn-5), 4.67 and 4.72 (2 d, 2× 1 H, J_{gem} = 11.8 Hz, CH_2Bn-3), 4.76 (d, 1 H, J_{gem} = 12.4 Hz, CH_2Bn-2), 6.89–6.93 (m, 2 H, H-*o*-Bn), 7.06 (br. s, 1 H, OH-1), 7.13–7.22 and 7.27–7.38 (2 m, 13 H, H-*o*,*m*,*p*-Bn), 7.57 (dd, 1 H, $J_{3',4'}$ = 8.3, $J_{3',6'}$ = 0.8 Hz, 3′-H), 7.72 (dd, 1 H, $J_{4',3'}$ = 8.3, $J_{4',6'}$ = 2.5 Hz, 4′-H), 8.38 (dd, 1 H, $J_{6',4'}$ = 2.5, $J_{6',3'}$ = 0.8 Hz, 6′-H) ppm. ^{13}C NMR (125.7 MHz, [D$_6$]DMSO) α anomer: δ = 20.8 (CH_3-2), 66.3 (CH_2Bn-2), 69.9 (CH_2-5), 72.0 and 72.7 (CH_2Bn-3,5), 80.7 (CH-4), 82.2 (CH-3), 83.0 (C-2), 104.0 (C-1), 127.3 (CH-*p*-Bn), 127.4 (CH-3′), 127.7 (CH-*o*-Bn), 127.8 (CH-*p*-Bn), 127.9 (CH-*o*-Bn), 128.2 and 128.3 (CH-*o*,*m*-Bn), 128.4 and 128.5 (CH-*m*-Bn), 136.6 (C-*i*-Bn), 138.2 (C-5′), 138.2 (CH-4′), 138.4 and 139.3 (C-*i*-Bn), 141.2 (C-2′), 149.0 (CH-6′); β anomer: δ = 14.7 (CH_3-2), 66.1 (CH_2Bn-2), 72.6 (CH_2Bn-5), 72.7 (CH_2-5), 73.4 (CH_2Bn-3), 79.8 (CH-4), 83.6 (C-2), 86.4 (CH-3), 105.6 (C-1), 126.4 (CH-*o*-Bn), 126.7 (CH-3′), 126.9 and 127.7 (CH-*p*-Bn), 127.9 (CH-*o*-Bn), 127.9 (CH-*p*-Bn), 128.1 (CH-*o*,*m*-Bn), 128.5 (CH-*m*-Bn), 136.3 (C-5′), 138.5 (C-*i*-Bn), 139.4 (CH-4′), 140.0 (C-*i*-Bn), 141.0 (C-2′), 150.0 (CH-6′) ppm. IR (CCl_4): 3033, 2927, 2867, 1583, 1497, 1454, 1361, 1208, 1087, 1029 cm^{-1}.

1-*O*-Acetyl-2,3,5-tri-*O*-benzyl-1-*C*-(2-bromopyridin-5-yl)-2-*C*-methyl-α,β-D-ribofuranose (11): LiHMDS (1 M in THF; 5.5 mL, 5.49 mmol) was added dropwise to a cooled (0 °C) solution of **10** (2.16 g, 3.66 mmol) in dry toluene (25 mL). After 10 min, Ac_2O (0.53 mL, 5.49 mmol) was added, and the mixture was stirred for a further 10 min. Then, the mixture was warmed to room temp., poured into satd. aq. $NaHCO_3$ (50 mL), and extracted with toluene. The combined organic layers were dried with anhydrous $MgSO_4$, and concentrated under reduced pressure. The residue was purified by flash chromatography on silica gel (9 to 16% of ethyl acetate in hexane) to give hemiketal acetate **11** (2.11 g, 3.33 mmol, 91%; α/β = 44:56) as a yellowish oil. HRMS (ESI): calcd. for $C_{34}H_{34}O_6N^{79}BrNa$ [M + Na]$^+$ 654.14617; found 654.14623. ^{1}H NMR (500 MHz, [D$_6$]DMSO) α anomer: δ = 0.90 (s, 3 H, CH_3-2), 1.99 (s, 3 H, CH_3CO), 3.68 (dd, 1 H, J_{gem} = 10.9, $J_{5a,4}$ = 4.7 Hz, 5a-H), 3.71 (dd, 1 H, J_{gem} = 10.9, $J_{5b,4}$ = 4.7 Hz, 5b-H), 3.94 (d, 1 H, $J_{3,4}$ = 3.4 Hz, 3-H), 4.42 (td, 1 H, $J_{4,5a}$ = $J_{4,5b}$ = 4.7, $J_{4,3}$ = 3.4 Hz, 4-H), 4.53 (d, 1 H, J_{gem} = 11.7 Hz, CH_2Bn-3), 4.56 (d, 1 H, J_{gem} = 12.0 Hz, CH_2Bn-2), 4.57–4.64 (m, 2 H, CH_2Bn-5), 4.61 (d, 1 H, J_{gem} = 11.9 Hz, CH_2Bn-2), 4.63 (d, 1 H, J_{gem} = 11.7 Hz, CH_2Bn-3), 7.20–7.42 (m, 15 H, H-*o*,*m*,*p*-Bn), 7.65 (dd, 1 H, $J_{3',4'}$ = 8.3, $J_{3',6'}$ = 0.8 Hz, 3′-H), 7.70 (dd, 1 H, $J_{4',3'}$ = 8.3, $J_{4',6'}$ = 2.5 Hz, 4′-H), 8.38 (dd, 1 H, $J_{6',4'}$ = 2.5, $J_{6',3'}$ = 0.8 Hz, 6′-H); β anomer: δ = 1.45 (s, 3 H, CH_3-2), 1.77 (s, 3 H, CH_3CO), 3.52 (dd, 1 H, J_{gem} = 11.3, $J_{5a,4}$ = 3.3 Hz, 5a-H), 3.71 (dd, 1 H, J_{gem} = 11.3, $J_{5b,4}$ = 2.5 Hz, 5b-H), 4.23 (d, 1 H, J_{gem} = 12.3 Hz, CH_2Bn-2), 4.38 (br. ddd, 1 H, $J_{4,3}$ = 8.4, $J_{4,5a}$ = 3.3, $J_{4,5b}$ = 2.4 Hz, 4-H), 4.41 (d, 1 H, $J_{3,4}$ = 8.4 Hz, 3-H), 4.45 and 4.48 (2 d, 2× 1 H, J_{gem} = 12.0 Hz, CH_2Bn-5), 4.67 (d, 1 H, J_{gem} = 11.8 Hz, CH_2Bn-3), 4.70 (d, 1 H, J_{gem} = 12.3 Hz, CH_2Bn-2), 4.75 (d, 1 H, J_{gem} = 11.8 Hz, CH_2Bn-3), 6.86 (m, 2 H, H-*o*-Bn), 7.18–7.42 (m, 13 H, H-*o*,*m*,*p*-Bn), 7.58 (dd, 1 H, $J_{3',4'}$ = 8.3, $J_{3',6'}$ = 0.8 Hz, 3′-H), 7.65 (dd, 1 H, $J_{4',3'}$ = 8.3, $J_{4',6'}$ = 2.5 Hz, 4′-H), 8.31 (dd, 1 H, $J_{6',4'}$ = 2.5, $J_{6',3'}$ = 0.8 Hz, 6′-H) ppm. ^{13}C NMR (125.7 MHz, [D$_6$]DMSO) α anomer: δ = 20.9 (CH_3-2), 22.0 (CH_3CO), 66.2 (CH_2Bn-2), 69.6 (CH_2-5), 71.5 (CH_2Bn-3), 72.8 (CH_2Bn-5), 80.9 (CH-3), 83.7 (CH-4), 84.5 (C-2), 106.5 (C-1), 127.2 (CH-*o*-Bn), 127.2 (CH-*p*-Bn), 127.6 (CH-3′), 127.7 (CH-*p*-Bn), 127.8 and 127.8 (CH-*o*-Bn), 128.2, 128.3, and 128.5 (CH-*m*-Bn), 133.8 (C-5′), 137.0 (CH-4′), 138.3, 138.5, and 139.5 (C-*i*-Bn), 141.1 (C-2′), 147.7 (CH-6′), 168.4 (CH_3CO); β anomer: δ = 14.2 (CH_3-2), 21.7 (CH_3CO), 66.1 (CH_2Bn-2), 68.9 (CH_2-5), 72.6 (CH_2Bn-5), 73.5 (CH_2Bn-3), 81.2 (CH-4), 83.3 (CH-3), 84.2 (C-2), 108.0 (C-1), 126.4 (CH-*o*-Bn), 127.0 and 127.1 (CH-*p*-Bn, CH-3′), 127.8 (CH-*p*-Bn), 128.0 (CH-*o*-Bn), 128.0 (CH-*p*-Bn), 128.1 and 128.1 (CH-*o*,*m*-Bn), 128.5 and 128.5 (CH-*m*-Bn), 133.1 (C-5′), 137.9 (CH-4′), 138.3, 138.4, and 139.5 (C-*i*-Bn), 140.9 (C-2′), 148.6 (CH-6′), 167.6 (CH_3CO) ppm. IR (ATR): 3040, 2934, 2868, 1755, 1589, 1457, 1368, 1221, 1087 cm^{-1}.

5-(2,3,5-Tri-*O*-benzyl-2-*C*-methyl-β-D-ribofuranosyl)-2-bromopyridine (12): Et_3SiH (2 mL, 12.6 mmol) was added to a stirred solution of hemiketal acetate **11** (2.64 g, 4.2 mmol) in dry CH_2Cl_2 (27 mL) at 0 °C. After 5 min, $BF_3{\cdot}Et_2O$ (0.8 mL, 6.3 mmol) was slowly added, and the resulting mixture was warmed to room temp. over 5 min. Subsequently, Et_3N (5.85 mL, 42 mmol) was added, and the reaction mixture was concentrated under reduced pressure. The residue was purified by flash chromatography on silica gel (6 to 13% of ethyl acetate in hexane) to give **12** (1.93 g, 3.36 mmol, 80%) as a yellowish oil. HRMS (ESI): calcd. for $C_{32}H_{32}O_4N^{79}BrNa$ [M + Na]$^+$ 596.14069; found 596.14079. ^{1}H NMR (500 MHz, [D$_6$]DMSO): δ = 0.91 (s, 3 H, CH_3-2′), 3.70 (dd, 1 H, J_{gem} = 10.7, $J_{5'a,4'}$ = 4.9 Hz, 5′a-H), 3.73 (dd, 1 H, J_{gem} = 10.7, $J_{5'b,4'}$ = 4.7 Hz, 5′b-H), 3.88 (d, 1 H, $J_{3',4'}$ = 4.4 Hz, 3′-H), 4.25 (br. q, 1 H, $J_{4',3'}$ = $J_{4',5'a}$ = $J_{4',5'b}$ = 4.6 Hz, 4′-H), 4.53 (d, 1 H, J_{gem} = 11.4 Hz, CH_2Bn-3′), 4.54–4.65 (m, 5 H, CH_2Bn-2′,3′,5′), 4.95 (br. s, 1 H, 1′-H), 7.23–7.35 and 7.36–7.41 (2 m, 15 H, H-*o*,*m*,*p*-Bn), 7.60 (dd, 1 H, $J_{3,4}$ = 8.3, $J_{3,6}$ = 0.8 Hz, 3-H), 7.70 (dd, 1 H, $J_{4,3}$ = 8.3, $J_{4,6}$ = 2.5 Hz, 4-H), 8.34 (dd, 1 H, $J_{6,4}$ = 2.5, $J_{6,3}$ = 0.8 Hz, 6-H) ppm. ^{13}C NMR (125.7 MHz, [D$_6$]DMSO): δ = 18.7 (CH_3-2′), 65.7 (CH_2Bn-2′), 70.0 (CH_2-5′), 71.5 (CH_2Bn-3′), 72.7 (CH_2Bn-5′), 81.4 (CH-1′), 82.2 (CH-4′), 82.7 (CH-3′), 82.8 (C-2′), 127.3 (CH-*p*-Bn), 127.5 (CH-*o*-Bn), 127.6 (CH-3), 127.8 (CH-*o*,*p*-Bn), 127.9 (CH-*p*-Bn), 128.3 (CH-*o*-Bn), 128.3, 128.4, and 128.5 (CH-*m*-Bn), 134.0 (C-5), 137.6 (CH-4), 138.2, 138.4, and 139.2 (C-*i*-Bn), 140.6 (C-2), 148.5 (CH-6) ppm. IR (CCl_4): 3033, 2867, 1584, 1562, 1497, 1455, 1384, 1188, 1089, 1024 cm^{-1}.

2,3,5-Tri-*O*-benzyl-1-*C*-(5-bromopyridin-2-yl)-2-*C*-methyl-α,β-D-ribofuranose (13): *n*BuLi (1.6 M in hexanes; 3.4 mL, 5.5 mmol) was added dropwise to a cooled (–78 °C) solution of 2,5-dibromopyridine (1.184 g, 5 mmol) in dry toluene (59 mL). The reaction mixture was stirred at –78 °C for 7 h. Then, a solution of lactone **5** (0.433 g, 1 mmol) in dry toluene (5 mL) was added, and the mixture was stirred for a further 10 min. Subsequently, MeOH (1.2 mL, 30 mmol) was added, and the resulting brown-yellow solution was warmed to room temp., and neutralized with HCl (2 M). The mixture was washed with satd. aq. $NaHCO_3$ (70 mL), and extracted with toluene. The combined organic layers were dried with anhydrous $MgSO_4$, and concentrated under reduced pressure. The crude product was purified by flash chromatography on silica gel (9 to 16% of ethyl acetate in hexane) to give hemiketal **13** as a yellowish oil (0.425 g, 0.72 mmol, 72%; α/β = 9:91). HRMS (ESI): calcd. for $C_{32}H_{32}O_5N^{79}BrNa$ [M + Na]$^+$ 612.13561; found 612.13570. ^{1}H NMR (500 MHz, [D$_6$]DMSO) α anomer: δ = 0.96 (s, 3 H, CH_3-2), 3.72 (dd, 1 H, J_{gem} = 10.7, $J_{5a,4}$ = 4.2 Hz, 5a-H), 3.74 (dd, 1 H, J_{gem} = 10.7, $J_{5b,4}$ = 5.2 Hz, 5b-H), 4.00 (d, 1 H, $J_{3,4}$ = 6.5 Hz, 3-H), 4.35 (br. ddd, 1 H, $J_{4,3}$ = 6.5, $J_{4,5b}$ = 5.1, $J_{4,5a}$ = 4.2 Hz, 4-H), 4.55 and 4.58 (2 br. d, 2× 1 H, J_{gem} = 12.0 Hz, CH_2Bn-5), 4.58 and 4.65 (2 d, 2× 1 H, J_{gem} = 11.5 Hz, CH_2Bn-3), 4.71 and 4.78 (2 d, 2× 1 H, J_{gem} = 11.7 Hz, CH_2Bn-2), 6.01 (br. s, 1 H, OH-1), 7.23–7.45 (m, 15 H, H-*o*,*m*,*p*-Bn), 7.62 (dd, 1 H, $J_{3',4'}$ = 8.5, $J_{3',6'}$ = 0.8 Hz, 3′-H), 8.03 (dd, 1 H, $J_{4',3'}$ = 8.5, $J_{4',6'}$ = 2.4 Hz, 4′-H), 8.69 (dd, 1 H, $J_{6',4'}$ = 2.4, $J_{6',3'}$ = 0.8 Hz, 6′-H); β anomer: δ = 1.53 (s, 3 H, CH_3-2), 3.65 (dd, 1 H, J_{gem} = 10.5, $J_{5a,4}$ = 6.4 Hz, 5a-H), 3.69 (dd, 1 H, J_{gem} = 10.5, $J_{5b,4}$ = 3.7 Hz, 5b-H), 4.14 (d, 1 H, $J_{3,4}$

= 8.1 Hz, 3-H), 4.27 (d, 1 H, J_{gem} = 12.5 Hz, CH_2Bn-2), 4.29 (ddd, 1 H, $J_{4,3}$ = 8.1, $J_{4,5a}$ = 6.4, $J_{4,5b}$ = 3.7 Hz, 4-H), 4.55 and 4.58 (2 d, 2× 1 H, J_{gem} = 12.0 Hz, CH_2Bn-5), 4.68 (d, 1 H, J_{gem} = 11.8 Hz, CH_2Bn-3), 4.69 (d, 1 H, J_{gem} = 12.5 Hz, CH_2Bn-2), 4.72 (d, 1 H, J_{gem} = 11.8 Hz, CH_2Bn-3), 6.74 (s, 1 H, OH-1), 6.78–6.84 (m, 2 H, H-*o*-Bn), 7.11–7.16 and 7.26–7.39 (2 m, 13 H, H-*o*,*m*,*p*-Bn), 7.58 (dd, 1 H, $J_{3',4'}$ = 8.5, $J_{3',6'}$ = 0.8 Hz, 3′-H), 7.95(dd, 1 H, $J_{4',3'}$ = 8.5, $J_{4',6'}$ = 2.4 Hz, 4′-H), 8.68 (dd, 1 H, $J_{6',4'}$ = 2.4, $J_{6',3'}$ = 0.8 Hz, 6′-H) ppm. ^{13}C NMR (125.7 MHz, [D$_6$]DMSO) α anomer: δ = 19.4 (CH_3-2), 66.4 (CH_2Bn-2), 70.6 (CH_2-5), 72.6 and 72.6 (CH_2Bn-3,5), 79.6 (CH-4), 82.7 (C-2), 83.9 (CH-3), 105.5 (C-1), 119.8 (C-5′), 123.7 (CH-3′), 127.2 (CH-*p*-Bn), 127.5 and 127.7 (CH-*o*-Bn), 127.8 and 127.9 (CH-*p*-Bn), 127.9 (CH-*o*-Bn), 128.2, 128.2, and 128.4 (CH-*m*-Bn), 138.4 and 138.5 (C-*i*-Bn), 139.1 (CH-4′), 139.8 (C-*i*-Bn), 149.2 (CH-6′), 159.0 (C-2′); β anomer: δ = 15.6 (CH_3-2), 65.9 (CH_2Bn-2), 72.6 (CH_2Bn-5), 72.7 (CH_2-5), 73.3 (CH_2Bn-3), 79.5 (CH-4), 84.6 (C-2), 86.5 (CH-3), 105.7 (C-1), 119.6 (C-5′), 125.0 (CH-3′), 126.3 (CH-*o*-Bn), 126.8 and 127.6 (CH-*p*-Bn), 127.9 (CH-*o*,*p*-Bn), 128.9 (CH-*o*-Bn), 128.0, 128.4, and 128.5 (CH-*m*-Bn), 138.3 (CH-4′), 138.6 and 140.2 (C-*i*-Bn), 148.7 (CH-6′), 158.7 (C-2′) ppm. IR (ATR): 3039, 2945, 2867, 1581, 1562, 1500, 1457, 1366, 1261, 1211, 1181, 1094, 1030 cm^{-1}.

1-*O*-Acetyl-2,3,5-tri-*O*-benzyl-1-*C*-(5-bromopyridin-2-yl)-2-*C*-methyl-β-D-ribofuranose (14) and 1-*O*-Acetyl-2,3,5-tri-*O*-benzyl-1-*C*-(5-bromopyridin-2-yl)-2-*C*-methyl-α-D-ribofuranose (15): LiHMDS (1 M in THF; 13 mL, 12.98 mmol) was added dropwise to solution of **13** (5.11 g, 8.65 mmol) in dry toluene (70 mL) at room temp. After 10 min, Ac_2O (1.23 mL, 12.98 mmol) was added, and the mixture was stirred for a further 10 min. Then, the mixture was poured into satd. aq. $NaHCO_3$ (100 mL), and extracted with toluene. The combined organic layers were dried with anhydrous $MgSO_4$, and concentrated under reduced pressure. The residue was purified by flash chromatography on silica gel (9 to 16% of ethyl acetate in hexane) to give hemiketal acetates **14** (3.23 g, 5.1 mmol, 59%) as a white solid, and **15** (1.26 g, 1.99 mmol, 23%) as a yellowish oil, which were used as a mixture for the next step.

Data for **14**: m.p. 112–113 °C. HRMS (ESI): calcd. for $C_{34}H_{34}O_6N^{79}BrNa$ [M + Na]$^+$ 654.14617; found 654.14626. ^{1}H NMR (500 MHz, [D$_6$]DMSO): δ = 1.58 (s, 3 H, CH_3-2), 1.72 (s, 3 H, CH_3CO), 3.55 (dd, 1 H, J_{gem} = 11.1, $J_{5a,4}$ = 3.4 Hz, 5a-H), 3.73 (dd, 1 H, J_{gem} = 11.1, $J_{5b,4}$ = 2.3 Hz, 5b-H), 4.16 (br. d, 1 H, J_{gem} = 12.5 Hz, CH_2Bn-2), 4.36 (d, 1 H, $J_{3,4}$ = 8.4 Hz, 3-H), 4.38 (ddd, 1 H, $J_{4,3}$ = 8.4, $J_{4,5a}$ = 3.4, $J_{4,5b}$ = 2.4 Hz, 4-H), 4.47 and 4.50 (2 d, 2× 1 H, J_{gem} = 12.0 Hz, CH_2Bn-5), 4.63 (br. d, 1 H, J_{gem} = 12.5 Hz, CH_2Bn-2), 4.68 and 4.76 (2 d, 2× 1 H, J_{gem} = 11.8 Hz, CH_2Bn-3), 6.78 (m, 2 H, H-*o*-Bn-2), 7.12–7.17 (m, 3 H, H-*m*,*p*-Bn-2), 7.26–7.40 (m, 10 H, H-*o*,*m*,*p*-Bn-3,5), 7.55 (dd, 1 H, $J_{3',4'}$ = 8.5, $J_{3',6'}$ = 0.8 Hz, 3′-H), 7.97 (dd, 1 H, $J_{4',3'}$ = 8.5, $J_{4',6'}$ = 2.4 Hz, 4′-H), 8.62 (dd, 1 H, $J_{6',4'}$ = 2.4, $J_{6',3'}$ = 0.8 Hz, 6′-H) ppm. 13C NMR (125.7 MHz, [D$_6$]DMSO): δ = 14.9 (CH_3-2), 21.5 (CH_3CO), 65.9 (CH_2Bn-2), 69.3 (CH_2-5), 72.6 (CH_2Bn-5), 73.5 (CH_2Bn-3), 81.1 (CH-4), 83.8 (CH-3), 84.8 (C-2), 107.4 (C-1), 119.5 (C-5′), 125.3 (CH-3′), 126.3 (CH-*o*-Bn), 127.0 and 127.7 (CH-*p*-Bn), 127.9 (CH-*o*-Bn), 128.0 (CH-*p*-Bn), 128.0 (CH-*o*,*m*-Bn), 128.5 and 128.5 (CH-*m*-Bn), 138.4 and 138.4 (C-*i*-Bn), 138.4 (CH-4′), 139.6 (C-*i*-Bn), 148.5 (CH-6′), 155.8 (C-2′), 167.5 (CH_3CO) ppm. IR (ATR): 3042, 2946, 2880, 1747, 1501, 1460, 1369, 1239, 1080, 1031 cm^{-1}.

Data for **15**: HRMS (ESI): calcd. for $C_{34}H_{34}O_6N^{79}BrNa$ [M + Na]$^+$ 654.14617; found 654.14652. ^{1}H NMR (500 MHz, [D$_6$]-DMSO): δ = 0.92 (s, 3 H, CH_3-2), 1.96 (s, 3 H, CH_3CO), 3.70 (dd, 1 H, J_{gem} = 11.1, $J_{5a,4}$ = 4.2 Hz, 5a-H), 3.79 (dd, 1 H, J_{gem} = 11.1, $J_{5b,4}$ = 3.3 Hz, 5b-H), 3.83 (d, 1 H, $J_{3,4}$ = 6.1 Hz, 3-H), 4.37 (ddd, 1 H, $J_{4,3}$ = 6.1, $J_{4,5a}$ = 4.2, $J_{4,5b}$ = 3.3 Hz, 4-H), 4.54 (d, 1 H, J_{gem} = 11.7 Hz, CH_2Bn-3), 4.57 (d, 1 H, J_{gem} = 12.0 Hz, CH_2Bn-5), 4.59 (br. d, 1 H, J_{gem} = 11.9 Hz, CH_2Bn-2), 4.61 (d, 1 H, J_{gem} = 12.1 Hz, CH_2Bn-5), 4.64 (d, 1 H, J_{gem} = 11.8 Hz, CH_2Bn-3), 4.90 (d, 1 H, J_{gem} = 11.9 Hz, CH_2Bn-2), 7.21–7.46 (m, 15 H, H-*o*,*m*,*p*-Bn), 7.58 (dd, 1 H, $J_{3',4'}$ = 8.5, $J_{3',6'}$ = 0.8 Hz, 3′-H), 7.99 (dd, 1 H, $J_{4',3'}$ = 8.5, $J_{4',6'}$ = 2.4 Hz, 4′-H), 8.67 (dd, 1 H, $J_{6',4'}$ = 2.4, $J_{6',3'}$ = 0.8 Hz, 6′-H) ppm. ^{13}C NMR (125.7 MHz, [D$_6$]DMSO): δ = 20.7 (CH_3-2), 21.8 (CH_3CO), 66.0 (CH_2Bn-2), 69.0 (CH_2-5), 72.2 (CH_2Bn-3), 72.7 (CH_2Bn-5), 81.4 (CH-4), 82.1 (CH-3), 84.0 (C-2), 107.7 (C-1), 119.5 (C-5′), 123.9 (CH-3′), 127.1 (CH-*p*-Bn), 127.3 (CH-*o*-Bn), 127.8 and 127.8 (CH-*p*-Bn), 127.9 and 128.0 (CH-*o*-Bn), 128.2, 128.3, and 128.6 (CH-*m*-Bn), 138.3 and 138.5 (C-*i*-Bn), 139.1 (CH-4′), 140.0 (C-*i*-Bn), 149.2 (CH-6′), 156.5 (C-2′), 168.2 (CH_3CO) ppm. IR (CCl_4): 3032, 2917, 2865, 1756, 1574, 1497, 1454, 1365, 1232, 1094, 1029 cm^{-1}.

2-(2,3,5-Tri-*O*-benzyl-2-*C*-methyl-β-D-ribofuranosyl)-5-bromopyridine (16) and 2-(2,3,5-Tri-*O*-benzyl-2-*C*-methyl-α-D-ribofuranosyl)-5-bromopyridine (17): Et_3SiH (3.77 mL, 23.61 mmol) was added to a stirred solution of a mixture of hemiketal acetates **14** and **15** (4.98 g, 7.87 mmol) in dry toluene (50 mL) at 0 °C. After 5 min, $BF_3{\cdot}Et_2O$ (1.46 mL, 11.81 mmol) was slowly added, and the resulting mixture was warmed to room temp. over 5 min. Subsequently, Et_3N (11 mL, 78.7 mmol) was added, and the reaction mixture was concentrated under reduced pressure. The crude product was purified by flash chromatography on silica gel (6 to 13% of ethyl acetate in hexane) to give **16** (4.02 g, 7 mmol, 89%) as a yellowish oil, and as a side-product, α isomer **17** (0.41 g, 0.71 mmol, 9%) as a yellowish oil.

Data for **16**: HRMS (ESI): calcd. for $C_{32}H_{32}O_4N^{79}BrNa$ [M + Na]$^+$ 596.14069; found 596.14080. ^{1}H NMR (500 MHz, [D$_6$]-DMSO): δ = 0.94 (s, 3 H, CH_3-2′), 3.72 (dd, 1 H, J_{gem} = 11.0, $J_{5'a,4'}$ = 4.5 Hz, 5′a-H), 3.81 (dd, 1 H, J_{gem} = 11.0, $J_{5'b,4'}$ = 3.1 Hz, 5′b-H), 3.88 (d, 1 H, $J_{3',4'}$ = 7.6 Hz, 3′-H), 4.21 (ddd, 1 H, $J_{4',3'}$ = 7.6, $J_{4',5'a}$ = 4.5, $J_{4',5'b}$ = 3.1 Hz, 4′-H), 4.57 (d, 1 H, J_{gem} = 11.9 Hz, CH_2Bn-5′), 4.59 (d, 1 H, J_{gem} = 11.7 Hz, CH_2Bn-3′), 4.61 (d, 1 H, J_{gem} = 11.9 Hz, CH_2Bn-5′), 4.63 (d, 1 H, J_{gem} = 11.7 Hz, CH_2Bn-3′), 4.69 (m, 2 H, CH_2Bn-2′), 5.02 (s, 1 H, 1′-H), 7.23–7.41 (m, 15 H, H-*o*,*m*,*p*-Bn), 7.59 (dt, 1 H, $J_{3,4}$ = 8.4, $J_{3,6}$ = $J_{3,1'}$ = 0.8 Hz, 3-H), 7.94 (dd, 1 H, $J_{4,3}$ = 8.4, $J_{4,6}$ = 2.4 Hz, 4-H), 8.67 (dd, 1 H, $J_{6,4}$ = 2.4, $J_{6,3}$ = 0.8 Hz, 6-H) ppm. ^{13}C NMR (125.7 MHz, [D$_6$]DMSO): δ = 19.1 (CH_3-2′), 65.2 (CH_2Bn-2′), 69.7 (CH_2-5′), 72.5 (CH_2Bn-3′), 72.6 (CH_2Bn-5′), 80.1 (CH-4′), 83.1 (CH-3′), 83.3 (C-2′), 85.7 (CH-1′), 119.2 (C-5), 123.4 (CH-3), 127.3 (CH-*p*-Bn), 127.4 (CH-*o*-Bn), 127.7 and 127.8 (CH-*p*-Bn), 127.9 and 128.1 (CH-*o*-Bn), 128.3, 128.4, and 128.5 (CH-*m*-Bn), 138.4 and 138.5 (C-*i*-Bn), 139.3 (CH-4), 139.5 (C-*i*-Bn), 149.5 (CH-6), 158.3 (C-2) ppm. IR (CCl_4): 3033, 2894, 2864, 1575, 1497, 1465, 1454, 1367, 1206, 1091, 1029 cm^{-1}.

Data for **17**: HRMS (ESI): calcd. for $C_{32}H_{33}O_4N^{79}Br$ [M + H]$^+$ 574.15875; found 574.15905. ^{1}H NMR (500 MHz, [D$_6$]DMSO): δ = 1.52 (s, 3 H, CH_3-2′), 3.61 (dd, 1 H, J_{gem} = 10.9, $J_{5'a,4'}$ = 5.0 Hz, 5′a-H), 3.71 (dd, 1 H, J_{gem} = 10.9, $J_{5'b,4'}$ = 2.7 Hz, 5′b-H), 4.13 (d, 1 H, $J_{3',4'}$ = 8.6 Hz, 3′-H), 4.27 (d, 1 H, J_{gem} = 12.4 Hz, CH_2Bn-2′), 4.30 (ddd, 1 H, $J_{4',3'}$ = 8.6, $J_{4',5'a}$ = 5.0, $J_{4',5'b}$ = 2.7 Hz, 4′-H), 4.51 and 4.56 (2 d, 2× 1 H, J_{gem} = 12.2 Hz, CH_2Bn-5′), 4.65 (d, 1 H, J_{gem} = 11.7 Hz, CH_2Bn-3′), 4.70 (d, 1 H, J_{gem} = 12.4 Hz, CH_2Bn-2′), 4.74 (d, 1 H, J_{gem} = 11.7 Hz, CH_2Bn-3′), 4.84 (s, 1 H, 1′-H), 6.85 (m, 2 H, H-*o*-Bn-2′), 7.12–7.18 (m, 3 H, H-*m*,*p*-Bn-2′), 7.27–7.40 (m, 10 H, H-*o*,*m*,*p*-Bn-3′,5′), 7.46 (dt, 1 H, $J_{3,4}$ = 8.4, $J_{3,6}$ = $J_{3,1'}$ = 0.7 Hz, 3-H), 7.98 (dd, 1 H, $J_{4,3}$ = 8.4, $J_{4,6}$ = 2.4 Hz, 4-H), 8.63 (dd, 1 H, $J_{6,4}$ = 2.4, $J_{6,3}$ = 0.7 Hz, 6-H) ppm. ^{13}C NMR

(125.7 MHz, [D$_6$]DMSO): δ = 17.9 (CH$_3$-2′), 65.8 (CH$_2$Bn-2′), 70.5 (CH$_2$-5′), 72.6 (CH$_2$Bn-5′), 73.3 (CH$_2$Bn-3′), 79.7 (CH-4′), 81.8 (C-2′), 86.0 (CH-3′), 86.5 (CH-1′), 118.9 (C-5), 124.4 (CH-3), 126.3 (CH-*o*-Bn-2′), 126.9 (CH-*p*-Bn-2′), 127.7, 127.8, 129.9, and 128.0 (CH-*o*,*p*-Bn-3′,5′ and CH-*m*-Bn-2′), 128.5 and 128.5 (CH-*m*-Bn-3′,5′), 138.5 (C-*i*-Bn-3′,5′), 138.6 (CH-4), 140.1 (C-*i*-Bn-2′), 148.7 (CH-6), 157.7 (C-2) ppm. IR (CCl$_4$): 3032, 2876, 1578, 1497, 1467, 1454, 1367, 1209, 1090, 1029 cm^{-1}.

1-(2,3,5-Tri-*O*-benzyl-2-*C*-methyl-β-D-ribofuranosyl)-4-methylbenzene (18a): Me$_3$Al (2 M in toluene; 3.15 mL, 6.3 mmol) was added to a stirred solution of **9** (1.2 g, 2.1 mmol) and Pd(PPh$_3$)$_4$ (127 mg, 0.11 mmol) in dry THF (12 mL) in a flame-dried septum-sealed flask. The resulting mixture was stirred at 66 °C for 1 h, then it was quenched by pouring into saturated NaH$_2$PO$_4$ (50 mL). The mixture was extracted with ethyl acetate. The combined organic layers were dried with anhydrous MgSO$_4$, and concentrated under reduced pressure. The residue was purified by flash chromatography on silica gel (0 to 5% of ethyl acetate in hexane) to give **18a** (971 mg, 1.91 mmol, 91%) as a white solid, m.p. 57–58 °C. HRMS (ESI): calcd. for C$_{34}$H$_{36}$O$_4$Na [M + Na]$^+$ 531.25058; found 531.25072. ^{1}H NMR (500 MHz, [D$_6$]DMSO): δ = 0.88 (s, 3 H, CH$_3$-2′), 2.28 (s, 3 H, CH$_3$-4), 3.70 (dd, 1 H, J_{gem} = 10.7, $J_{5'a,4'}$ = 4.9 Hz, 5′a-H), 3.73 (dd, 1 H, J_{gem} = 10.7, $J_{5'b,4'}$ = 4.6 Hz, 5′b-H), 3.82 (d, 1 H, $J_{3',4'}$ = 4.8 Hz, 3′-H), 4.20 (q, 1 H, $J_{4',3'}$ = $J_{4',5'a}$ = $J_{4',5'b}$ = 4.7 Hz, 4′-H), 4.51–4.65 (m, 6 H, CH$_2$Bn), 4.86 (s, 1 H, 1′-H), 7.11 (m, 2 H, 3-H, 5-H), 7.24 (m, 2 H, 2-H, 6-H), 7.25–7.42 (m, 15 H, H-*o*,*m*,*p*-Bn) ppm. ^{13}C NMR (125.7 MHz, [D$_6$]DMSO): δ = 18.9 (CH$_3$-2′), 20.9 (CH$_3$-4), 65.5 (CH$_2$Bn-2′), 70.3 (CH$_2$-5′), 71.5 (CH$_2$Bn-3′), 72.6 (CH$_2$Bn-5′), 81.5 (CH-4′), 82.8 (C-2′), 83.1 (CH-3′), 84.0 (CH-1′), 126.4 (CH-2, CH-6), 127.2 (CH-*p*-Bn), 127.3 (CH-*o*-Bn), 127.7 (CH-*o*,*p*-Bn), 127.8 (CH-*p*-Bn), 128.2 and 128.2 (CH-*o*,*m*-Bn), 128.3 and 128.5 (CH-*m*-Bn), 128.6 (CH-3, CH-5), 135.6 (C-1), 136.5 (C-4), 138.3, 138.5, and 138.6 (C-*i*-Bn) ppm. IR (CCl$_4$): 3032, 2866, 1608, 1497, 1454, 1382, 1362, 1180, 1095, 1029 cm^{-1}.

4-(2,3,5-Tri-*O*-benzyl-2-*C*-methyl-β-D-ribofuranosyl)aniline (18b): LiHMDS (1 M in THF; 4.2 mL, 4.18 mmol) was added to a flame-dried septum-sealed flask containing **9** (1.2 g, 2.09 mmol), Pd$_2$(dba)$_3$ (48 mg, 0.05 mmol), and Cy-JohnPhos [(2-biphenyl)dicyclohexylphosphine; 73 mg, 0.21 mmol] in dry THF (15 mL). The resulting solution was stirred at 66 °C for 30 min. The mixture was then cooled to room temp., and stirred with HCl (2 M aq.; 10 mL) for 10 min. The mixture was then washed with satd. aq. NaHCO$_3$ (20 mL), and the aqueous phase was extracted with ethyl acetate. The combined organic layers were dried with anhydrous MgSO$_4$, and concentrated under reduced pressure. The crude product was purified by flash chromatography on silica gel (10 to 60% of ethyl acetate in hexane) to (0.91 g, 1.78 mmol, 85%) give **18b** as a yellowish solid, m.p. 89–91 °C. HRMS (ESI): calcd. for C$_{33}$H$_{35}$O$_4$NNa [M + Na]$^+$ 532.24583; found 532.24566. ^{1}H NMR (500 MHz, [D$_6$]-DMSO): δ = 0.89 (s, 3 H, CH$_3$-2′), 3.68 (dd, 1 H, J_{gem} = 10.6, $J_{5'a,4'}$ = 4.9 Hz, 5′a-H), 3.71 (dd, 1 H, J_{gem} = 10.6, $J_{5'b,4'}$ = 4.5 Hz, 5′b-H), 3.78 (d, 1 H, $J_{3',4'}$ = 5.2 Hz, 3′-H), 4.13 (br. q, 1 H, $J_{4',3'}$ = $J_{4',5'a}$ = $J_{4',5'b}$ = 4.9 Hz, 4′-H), 4.53 (br. d, 1 H, J_{gem} = 11.6 Hz, CH$_2$Bn-2′), 4.54 (d, 1 H, J_{gem} = 11.5 Hz, CH$_2$Bn-3′), 4.58 (br. d, 1 H, J_{gem} = 11.5 Hz, CH$_2$Bn-2′), 4.59 (d, 1 H, J_{gem} = 12.1 Hz, CH$_2$Bn-5′), 4.61 (d, 1 H, J_{gem} = 11.5 Hz, CH$_2$Bn-3′), 4.62 (d, 1 H, J_{gem} = 12.1 Hz, CH$_2$Bn-5′), 4.73 (s, 1 H, 1′-H), 4.98 (br. s, 2 H, NH$_2$), 6.48 (m, 2 H, 2-H, 6-H), 6.99 (m, 2 H, 3-H, 5-H), 7.21–7.35 (m, 11 H, H-*o*,*m*,*p*-Bn), 7.36–7.42 (m, 4 H, H-*o*,*m*-Bn) ppm. ^{13}C NMR (125.7 MHz, [D$_6$]DMSO): δ = 19.0 (CH$_3$-2′), 65.4 (CH$_2$Bn-2′), 70.4 (CH$_2$-5′), 71.6 (CH$_2$Bn-3′), 72.6 (CH$_2$Bn-5′), 80.9 (CH-4′), 82.8 (C-2′), 83.2 (CH-3′), 84.8 (CH-1′), 113.4 (CH-2, CH-6), 125.6 (C-4), 127.2 (CH-*p*-Bn), 127.3 (CH-3, CH-5, CH-*o*-Bn), 127.4 (CH-*p*-Bn), 127.7 (CH-*o*-Bn), 127.8 (CH-*p*-Bn), 128.2 and 128.3 (CH-*o*,*m*-Bn), 128.3 and 128.5 (CH-*m*-Bn), 138.4, 138.6, and 138.7 (C-*i*-Bn), 148.1 (C-1) ppm. IR (CCl$_4$): 3479, 3394, 3032, 2866, 1623, 1519, 1497, 1454, 1382, 1362, 1275, 1177, 1096, 1029 cm^{-1}.

4-(2,3,5-Tri-*O*-benzyl-2-*C*-methyl-β-D-ribofuranosyl)-*N*,*N*-dimethylaniline (18c): Me$_2$NH (2 M in THF; 9 mL, 17.95 mmol) was added to a stirred suspension of **9** (2 g, 3.49 mmol), Pd$_2$(dba)$_3$ (80 mg, 0.087 mmol), JohnPhos [(2-biphenyl)-di-*tert*-butylphosphine; 107 mg, 0.349 mmol], and *t*BuONa (2.012 g, 20.94 mmol) in dry toluene (10 mL) in a flame-dried septum-sealed flask. The resulting mixture was stirred at 70 °C for 24 h, then it was quenched by pouring into satd. aq. NaHCO$_3$ (30 mL). The mixture was extracted with toluene. The combined organic layers were dried with anhydrous MgSO$_4$, and concentrated under reduced pressure. The residue was purified by flash chromatography on silica gel (5 to 15% of ethyl acetate in hexane) to give **18c** (1.56 g, 2.9 mmol, 83%) as a yellowish solid, m.p. 65–66 °C. HRMS (ESI): calcd. for C$_{35}$H$_{40}$O$_4$N [M + H]$^+$ 538.29519; found 538.29510. ^{1}H NMR (500 MHz, [D$_6$]DMSO): δ = 0.90 (s, 3 H, CH$_3$-2′), 2.86 [s, 6 H, (CH$_3$)$_2$N], 3.69 (dd, 1 H, J_{gem} = 10.6, $J_{5'a,4'}$ = 4.9 Hz, 5′a-H), 3.72 (dd, 1 H, J_{gem} = 10.6, $J_{5'b,4'}$ = 4.5 Hz, 5′b-H), 3.81 (d, 1 H, $J_{3',4'}$ = 4.9 Hz, 3′-H), 4.16 (q, 1 H, $J_{4',3'}$ = $J_{4',5'a}$ = $J_{4',5'b}$ = 4.8 Hz, 4′-H), 4.53 (br. d, 1 H, J_{gem} = 11.5 Hz, CH$_2$Bn-2′), 4.54 (d, 1 H, J_{gem} = 11.5 Hz, CH$_2$Bn-3′), 4.58 (br. d, 1 H, J_{gem} = 11.5 Hz, CH$_2$Bn-2′), 4.60 (d, 1 H, J_{gem} = 12.1 Hz, CH$_2$Bn-5′), 4.61 (d, 1 H, J_{gem} = 11.5 Hz, CH$_2$Bn-3′), 4.62 (d, 1 H, J_{gem} = 12.1 Hz, CH$_2$Bn-5′), 4.80 (s, 1 H, 1′-H), 6.65 (m, 2 H, 2-H, 6-H), 7.16 (m, 2 H, 3-H, 5-H), 7.22–7.36 (m, 11 H, H-*o*,*m*,*p*-Bn), 7.36–7.42 (m, 4 H, H-*o*,*m*-Bn) ppm. ^{13}C NMR (125.7 MHz, [D$_6$]DMSO): δ = 18.9 (CH$_3$-2′), 40.3 [(CH$_3$)$_2$N], 65.4 (CH$_2$Bn-2′), 70.4 (CH$_2$-5′), 71.6 (CH$_2$Bn-3′), 72.6 (CH$_2$Bn-5′), 81.2 (CH-4′), 82.9 (C-2′), 83.2 (CH-3′), 84.4 (CH-1′), 111.9 (CH-2, CH-6), 125.9 (C-4), 128.2 (CH-*p*-Bn), 127.3 (CH-3, CH-5, CH-*o*-Bn), 127.7 (CH-*p*-Bn), 127.7 (CH-*o*-Bn), 127.8 (CH-*p*-Bn), 128.2 and 128.2 (CH-*o*,*m*-Bn), 128.3 and 128.5 (CH-*m*-Bn), 138.4, 138.6, and 138.7 (C-*i*-Bn), 149.9 (C-1) ppm. IR (ATR): 3072, 3040, 2876, 1621, 1528, 1457, 1359, 1190, 1092, 1065, 1030 cm^{-1}.

4-(2,3,5-Tri-*O*-benzyl-2-*C*-methyl-β-D-ribofuranosyl)phenol (18d): A suspension of **9** (1.15 g, 2 mmol), Pd$_2$(dba)$_3$ (46 mg, 0.05 mmol), Me$_4$(*t*Bu)$_2$XPhos (2-di-*tert*-butylphosphino-3,4,5,6-tetramethyl-2′,4′,6′-triisopropylbiphenyl; 96 mg, 0.2 mmol), and KOH (337 mg, 6 mmol) in a mixture of 1,4-dioxane (9 mL) and water (3 mL) was stirred at 80 °C for 2 h. The mixture was cooled to room temp., diluted with ethyl acetate, filtered through Celite, and concentrated under reduced pressure. The crude product was purified by flash chromatography on silica gel (9 to 14% of ethyl acetate in hexane) to give **18d** (0.972 g, 1.9 mmol, 95%) as a colourless oil. HRMS (ESI): calcd. for C$_{33}$H$_{34}$O$_5$Na [M + Na]$^+$ 533.22985; found 533.22966. ^{1}H NMR (500 MHz, [D$_6$]DMSO): δ = 0.88 (s, 3 H, CH$_3$-2′), 3.69 (dd, 1 H, J_{gem} = 10.6, $J_{5'a,4'}$ = 4.8 Hz, 5′a-H), 3.72 (dd, 1 H, J_{gem} = 10.6, $J_{5'b,4'}$ = 4.5 Hz, 5′b-H), 3.81 (d, 1 H, $J_{3',4'}$ = 4.9 Hz, 3′-H), 4.17 (q, 1 H, $J_{4',3'}$ = $J_{4',5'a}$ = $J_{4',5'b}$ = 4.8 Hz, 4′-H), 4.53 (d, 1 H, J_{gem} = 11.5 Hz, CH$_2$Bn-3′), 4.53 (d, 1 H, J_{gem} = 11.6 Hz, CH$_2$Bn-2′), 4.58 (d, 1 H, J_{gem} = 11.7 Hz, CH$_2$Bn-2′), 4.60 (d, 1 H, J_{gem} = 12.0 Hz, CH$_2$Bn-5′), 4.61 (d, 1 H, J_{gem} = 11.5 Hz, CH$_2$Bn-3′), 4.62 (d, 1 H, J_{gem} = 12.0 Hz, CH$_2$Bn-5′), 4.80 (s, 1 H, 1′-H), 6.68 (m, 2 H, 2-H, 6-H), 7.14 (m, 2 H, 3-H, 5-H), 7.22–7.34 and 7.36–7.42 (2 m, 15 H, H-*o*,*m*,*p*-Bn), 9.32 (s, 1 H, OH-Ph) ppm. ^{13}C NMR (125.7 MHz, [D$_6$]DMSO): δ = 18.9 (CH$_3$-2′), 65.4 (CH$_2$Bn-2′), 70.3 (CH$_2$-5′), 71.6 (CH$_2$Bn-3′), 72.7 (CH$_2$Bn-5′), 81.2 (CH-4′), 82.8 (C-2′), 83.1 (CH-3′), 84.3 (CH-1′), 114.8 (CH-2, CH-6), 127.2 (CH-*p*-Bn), 127.3 (CH-*o*-Bn), 127.7 (CH-*o*-Bn, CH-3, CH-5), 127.7 (CH-*p*-Bn), 127.8 (CH-*p*-Bn), 128.2 (CH-*o*-Bn),

128.3, 128.3, and 128.5 (CH-*m*-Bn), 128.8 (C-4), 138.3, 138.6, and 139.7 (C-*i*-Bn), 156.8 (C-1) ppm. IR (ATR): 3368, 3039, 2875, 1620, 1521, 1457, 1366, 1268, 1172, 1078, 1029 cm^{-1}.

4-(2,3,5-Tri-*O*-benzyl-2-*C*-methyl-β-D-ribofuranosyl)anisole (18e): A suspension of **9** (140 mg, 0.244 mmol), $Pd_2(dba)_3$ (6 mg, 0.006 mmol), $Me_4(tBu)_2$XPhos (2-di-*tert*-butylphosphino-3,4,5,6-tetramethyl-2′,4′,6′-triisopropylbiphenyl; 12 mg, 0.024 mmol), and KOH (41 mg, 0.732 mmol) in a mixture of 1,4-dioxane (0.9 mL) and water (0.3 mL) was stirred at 80 °C for 2 h. Then, the reaction mixture was cooled to room temp., and TBAB (8 mg, 0.024 mmol), additional KOH (27 mg, 0.488 mmol), and CH_3I (0.03 mL, 0.488 mmol) were added. The resulting suspension was stirred for a further 30 min at 80 °C. The mixture was cooled to room temp., diluted with ethyl acetate, filtered through Celite, and concentrated under reduced pressure. The residue was purified by flash chromatography on silica gel (5 to 11% of ethyl acetate in hexane) to give **18e** (0.972 g, 1.9 mmol, 95%) as a white solid, m.p. 67–68 °C. HRMS (ESI): calcd. for $C_{34}H_{36}O_5Na$ $[M + Na]^+$ 547.24550; found 547.24537. ^1H NMR (500 MHz, [D$_6$]DMSO): δ = 0.88 (s, 3 H, CH_3-2′), 3.70 (dd, 1 H, J_{gem} = 10.6, $J_{5'a,4'}$ = 4.9 Hz, 5′a-H), 3.73 (dd, 1 H, J_{gem} = 10.6, $J_{5'b,4'}$ = 4.6 Hz, 5′b-H), 3.73 (s, 3 H, CH_3O), 3.82 (d, 1 H, $J_{3',4'}$ = 4.8 Hz, 3′-H), 4.19 (q, 1 H, $J_{4',3'}$ = $J_{4',5'a}$ = $J_{4',5'b}$ = 4.8 Hz, 4′-H), 4.54 (d, 1 H, J_{gem} = 11.5 Hz, CH_2Bn-3′), 4.54 and 4.59 (2 br. d, 2 × 1 H, J_{gem} = 11.6 Hz, CH_2Bn-2′), 4.61 (d, 1 H, J_{gem} = 12.1 Hz, CH_2Bn-5′), 4.62 (d, 1 H, J_{gem} = 11.5 Hz, CH_2Bn-3′), 4.63 (d, 1 H, J_{gem} = 12.1 Hz, CH_2Bn-5′), 4.85 (s, 1 H, 1′-H), 6.86 (m, 2 H, 2-H, 6-H), 7.22–7.42 (m, 17 H, H-*o*,*m*,*p*-Bn, CH-3, CH-5) ppm. ^{13}C NMR (125.7 MHz, [D$_6$]DMSO): δ = 18.8 (CH_3-2′), 55.1 (CH_3O), 65.5 (CH_2Bn-2′), 70.3 (CH_2-5′), 71.5 (CH_2Bn-3′), 72.6 (CH_2Bn-5′), 81.4 (CH-4′), 82.8 (C-2′), 83.1 (CH-3′), 83.9 (CH-1′), 113.3 (CH-2, CH-6), 127.2 (CH-*p*-Bn), 127.3 (CH-*o*-Bn), 127.7 (CH-*o*,*p*-Bn, CH-3, CH-5, CH-*p*-Bn), 128.2, 128.3, and 128.5 (CH-*o*-Bn, CH-*m*-Bn), 130.5 (C-4), 138.3, 138.5, and 139.6 (C-*i*-Bn), 158.7 (C-1) ppm. IR (CCl_4): 2900, 2865, 1615, 1514, 1454, 1382, 1362, 1248, 1172, 1094, 1041, 1029 cm^{-1}.

5-(2,3,5-Tri-*O*-benzyl-2-*C*-methyl-β-D-ribofuranosyl)-2-methylpyridine (19a): Me_3Al (2 M in toluene; 1 mL, 2.1 mmol) was added to a stirred solution of **12** (400 mg, 0.7 mmol) and $Pd(PPh_3)_4$ (41 mg, 0.035 mmol) in dry THF (8 mL) in a flame-dried septum-sealed flask. The resulting mixture was stirred at 66 °C for 1 h, then it was quenched by pouring into saturated NaH_2PO_4 (50 mL). The mixture was extracted with ethyl acetate. The combined organic layers were dried with anhydrous $MgSO_4$, and concentrated under reduced pressure. The crude product was purified by flash chromatography on silica gel (17 to 25% of ethyl acetate in hexane) to give **19a** (340 mg, 0.67 mmol, 95%) as a yellowish oil. HRMS (ESI): calcd. for $C_{33}H_{36}O_4N$ $[M + H]^+$ 510.26389; found 510.26395. ^1H NMR (500 MHz, $CDCl_3$): δ = 0.91 (s, 3 H, CH_3-2′), 2.62 (s, 3 H, CH_3-2), 3.66 (dd, 1 H, J_{gem} = 10.2, $J_{5'a,4'}$ = 5.6 Hz, 5′a-H), 3.71 (dd, 1 H, J_{gem} = 10.2, $J_{5'b,4'}$ = 4.7 Hz, 5′b-H), 3.78 (d, 1 H, $J_{3',4'}$ = 3.8 Hz, 3′-H), 4.36 (ddd, 1 H, $J_{4',5'a}$ = 5.6, $J_{4',5'b}$ = 4.7, $J_{4',3'}$ = 3.8 Hz, 4′-H), 4.49 (d, 1 H, J_{gem} = 11.1 Hz, CH_2Bn-2′), 4.53 (d, 1 H, J_{gem} = 11.7 Hz, CH_2Bn-3′), 4.56 (d, 1 H, J_{gem} = 11.1 Hz, CH_2Bn-2′), 4.63 and 4.65 (2 d, 2× 1 H, J_{gem} = 11.9 Hz, CH_2Bn-5′), 4.68 (d, 1 H, J_{gem} = 11.7 Hz, CH_2Bn-3′), 5.05 (s, 1 H, 1′-H), 7.15 (br. d, 1 H, $J_{3,4}$ = 8.1 Hz, 3-H), 7.23–7.41 (m, 15 H, H-*o*,*m*,*p*-Bn), 7.75 (br. d, 1 H, $J_{4,3}$ = 8.1 Hz, 4-H), 8.56 (br. dt, 1 H, $J_{6,4}$ = 2.2, $J_{6,3}$ = $J_{6,1'}$ = 0.8 Hz, 6-H) ppm. ^{13}C NMR (125.7 MHz, $CDCl_3$): δ = 19.04 (CH_3-2′), 23.2 (CH_3-2), 66.3 (CH_2Bn-2′), 70.1 (CH_2-5′), 71.7 (CH_2Bn-3′), 73.6 (CH_2Bn-5′), 82.0 (CH-1′), 82.6 (CH-4′), 82.7 (CH-3′), 83.0 (C-2′), 123.2 (CH-3), 127.3 (CH-*o*-Bn), 127.3 (CH-*p*-Bn), 127.8 (CH-*o*-Bn), 127.8 and 127.9 (CH-*p*-Bn), 128.2 (CH-*o*-Bn), 128.3, 128.4, and 128.5 (CH-*m*-Bn), 131.7 (C-5), 136.3 (CH-4), 137.5, 137.9, and 138.8 (C-*i*-Bn), 145.7 (CH-6), 156.5 (C-2) ppm. IR (CCl_4): 3067, 3032, 2866, 1604, 1571, 1496, 1454, 1382, 1188, 1095, 1029 cm^{-1}.

2-Amino-5-(2,3,5-Tri-*O*-benzyl-2-*C*-methyl-β-D-ribofuranosyl)-pyridine (19b): LiHMDS (1 M in THF; 1.4 mL, 1.4 mmol) was added to a flame-dried septum-sealed flask containing **12** (400 mg, 0.7 mmol), $Pd_2(dba)_3$ (16 mg, 0.018 mmol), and Cy-JohnPhos [(2-biphenyl)dicyclohexylphosphine; 25 mg, 0.07 mmol] in dry THF (7.5 mL). The resulting solution was stirred at 70 °C for 30 min. The mixture was cooled to room temp., and stirred with HCl (2 M aq.; 4 mL) for 10 min. The mixture was then washed with satd. aq. $NaHCO_3$ (10 mL), and the aqueous phase was extracted with ethyl acetate. The combined organic layers were dried with anhydrous $MgSO_4$, and concentrated under reduced pressure. The residue was purified by flash chromatography on silica gel (33 to 67% of ethyl acetate in hexane) to give **19b** (335 mg, 0.66 mmol, 94%) as a yellowish oil. HRMS (ESI): calcd. for $C_{32}H_{35}O_4N_2$ $[M + H]^+$ 511.25913; found 511.25905. ^1H NMR (500 MHz, [D$_6$]DMSO): δ = 0.94 (s, 3 H, CH_3-2′), 3.67 (dd, 1 H, J_{gem} = 10.6, $J_{5'a,4'}$ = 4.8 Hz, 5′a-H), 3.70 (dd, 1 H, J_{gem} = 10.6, $J_{5'b,4'}$ = 4.6 Hz, 5′b-H), 3.81 (d, 1 H, $J_{3',4'}$ = 4.8 Hz, 3′-H), 4.16 (td, 1 H, $J_{4',5'a}$ = $J_{4',3'}$ = 4.8, $J_{4',5'b}$ = 4.6 Hz, 4′-H), 4.51–4.63 (m, 6 H, CH_2Bn-2′,3′,5′), 4.75 (s, 1 H, 1′-H), 5.86 (br. s, 2 H, NH_2), 6.37 (dd, 1 H, $J_{3,4}$ = 8.5, $J_{3,6}$ = 0.8 Hz, 3-H), 7.22–7.34 and 7.35–7.40 (2 m, 16 H, H-*o*,*m*,*p*-Bn, 4-H), 8.01 (dt, 1 H, $J_{6,4}$ = 2.4, $J_{6,3}$ = $J_{6,1'}$ = 0.8 Hz, 6-H) ppm. ^{13}C NMR (125.7 MHz, [D$_6$]DMSO): δ = 18.9 (CH_3-2′), 65.4 (CH_2Bn-2′), 70.9 (CH_2-5′), 71.5 (CH_2Bn-3′), 72.6 (CH_2Bn-5′), 81.3 (CH-4′), 82.7 (C-2′), 82.9 (CH-1′), 83.0 (CH-3′), 107.3 (CH-3), 121.4 (C-5), 127.2 (CH-*p*-Bn), 127.3 (CH-*o*-Bn), 127.7 (CH-*o*,*p*-Bn), 127.8 (CH-*p*-Bn), 128.2 (CH-*o*-Bn), 128.3, 128.3, and 128.5 (CH-*m*-Bn), 135.7 (CH-4), 138.3 (C-*i*-Bn-3′), 138.5 (C-*i*-Bn-5′), 139.6 (C-*i*-Bn-2′), 146.2 (CH-6), 159.5 (C-2) ppm. IR (ATR): 3477, 3374, 3186, 3039, 2875, 1623, 1504, 1412, 1364, 1088 cm^{-1}.

5-(2,3,5-Tri-*O*-benzyl-2-*C*-methyl-β-D-ribofuranosyl)-2-(dimethylamino)pyridine (19c): Me_2NH (2 M in THF; 4.9 mL, 9.85 mmol) was added to a stirred suspension of **12** (1.13 g, 1.97 mmol), $Pd_2(dba)_3$ (45 mg, 0.049 mmol), JohnPhos [(2-biphenyl)-di-*tert*-butylphosphine; 59 mg, 0.197 mmol], and *t*BuONa (1.136 g, 11.82 mmol) in dry toluene (4 mL) in a flame-dried septum-sealed flask. The resulting mixture was stirred at 70 °C for 4 h, then it was quenched by pouring into satd. aq. $NaHCO_3$ (15 mL), and the mixture was extracted with toluene. The combined organic layers were dried with anhydrous $MgSO_4$, and concentrated under reduced pressure. The crude product was purified by flash chromatography on silica gel (5 to 30% of ethyl acetate in hexane) to give **19c** (923 mg, 1.72 mmol, 87%) as a yellowish solid, m.p. 76–78 °C. HRMS (ESI): calcd. for $C_{34}H_{39}O_4N_2$ $[M + H]^+$ 539.29043; found 539.29035. ^1H NMR (500 MHz, [D$_6$]DMSO): δ = 0.94 (s, 3 H, CH_3-2′), 2.99 [s, 6 H, $(CH_3)_2$N], 3.68 (dd, 1 H, J_{gem} = 10.6, $J_{5'a,4'}$ = 4.9 Hz, 5′a-H), 3.71 (dd, 1 H, J_{gem} = 10.6, $J_{5'b,4'}$ = 4.6 Hz, 5′b-H), 3.83 (d, 1 H, $J_{3',4'}$ = 4.7 Hz, 3′-H), 4.17 (ddd, 1 H, $J_{4',5'a}$ = 4.9, $J_{4',3'}$ = 4.7, $J_{4',5'b}$ = 4.6 Hz, 4′-H), 4.53 (d, 1 H, J_{gem} = 11.4 Hz, CH_2Bn-3′), 4.53 and 4.57 (2 br. d, 2× 1 H, J_{gem} = 11.6 Hz, CH_2Bn-2′), 4.60 and 4.62 (2 br. d, 2× 1 H, J_{gem} = 12.1 Hz, CH_2Bn-5′), 4.61 (d, 1 H, J_{gem} = 11.5 Hz, CH_2Bn-3′), 4.79 (s, 1 H, 1′-H), 6.56 (dd, 1 H, $J_{3,4}$ = 8.8, $J_{3,6}$ = 0.8 Hz, 3-H), 7.21–7.33 and 7.36–7.41 (2 m, 15 H, H-*o*,*m*,*p*-Bn), 7.46 (ddd, 1 H, $J_{4,3}$ = 8.8, $J_{4,6}$ = 2.5, $J_{4,1'}$ = 0.6 Hz, 4-H), 8.01 (dt, 1 H, $J_{6,4}$ = 2.5, $J_{6,3}$ = $J_{6,1'}$ = 0.8 Hz, 6-H) ppm. ^{13}C NMR (125.7 MHz, [D$_6$]DMSO): δ = 18.9 (CH_3-2′), 37.9 [$(CH_3)_2$N], 65.5 (CH_2Bn-2′), 70.3 (CH_2-5′), 71.5 (CH_2Bn-3′), 72.7 (CH_2Bn-5′), 81.5 (CH-4′), 82.7 (C-2′), 82.8 (CH-1′), 83.1 (CH-3′), 105.1 (CH-3), 120.9 (C-5), 127.2 (CH-*p*-Bn), 127.4 (CH-*o*-Bn), 127.7 (CH-*o*,*p*-Bn), 127.8 (CH-*p*-Bn), 128.2 (CH-

o-Bn), 128.3, 128.4, and 128.5 (CH-*m*-Bn), 135.9 (CH-4), 138.3 (C-*i*-Bn-3′), 138.5 (C-*i*-Bn-5′), 139.5 (C-*i*-Bn-2′), 146.1 (CH-6), 158.9 (C-2) ppm. IR (ATR): 3071, 3039, 2884, 1702, 1613, 1522, 1458, 1381, 1200, 1108, 1030 cm^{-1}.

5-(2,3,5-Tri-*O*-benzyl-2-*C*-methyl-β-D-ribofuranosyl)-2-pyridone (19d): A suspension of **12** (1.344 g, 2.34 mmol), $Pd_2(dba)_3$ (54 mg, 0.059 mmol), $Me_4(tBu)_2$XPhos (2-di-*tert*-butylphosphino-3,4,5,6-tetramethyl-2′,4′,6′-triisopropylbiphenyl; 112 mg, 0.234 mmol), and KOH (394 mg, 7.02 mmol) in a mixture of 1,4-dioxane (9.6 mL) and water (3.2 mL) was stirred at 80 °C for 2 h. The mixture was cooled to room temp., then it was diluted with ethyl acetate, filtered through Celite, and concentrated under reduced pressure. The residue was purified by flash chromatography on silica gel (0 to 5% of MeOH in ethyl acetate) to give **19d** (1.115 g, 2.18 mmol, 93%) as a yellowish oil. HRMS (ESI): calcd. for $C_{32}H_{33}O_5NNa$ $[M + Na]^+$ 534.22509; found 534.22498. ^1H NMR (500 MHz, [D$_6$]DMSO): δ = 1.00 (s, 3 H, CH_3-2′), 3.65 (dd, 1 H, J_{gem} = 10.7, $J_{5'a,4'}$ = 4.9 Hz, 5′a-H), 3.69 (dd, 1 H, J_{gem} = 10.7, $J_{5'b,4'}$ = 4.4 Hz, 5′b-H), 3.82 (d, 1 H, $J_{3',4'}$ = 4.9 Hz, 3′-H), 4.15 (br. q, 1 H, $J_{4',3'}$ = $J_{4',5'a}$ = $J_{4',5'b}$ = 4.6 Hz, 4′-H), 4.53 (d, 1 H, J_{gem} = 11.5 Hz, CH_2Bn-3′), 4.57 (m, 2 H, CH_2Bn-2′), 4.57 and 4.60 (2 d, 2× 1 H, J_{gem} = 12.1 Hz, CH_2Bn-5′), 4.60 (d, 1 H, J_{gem} = 11.5 Hz, CH_2Bn-3′), 4.69 (br. d, 1 H, $J_{1',LR}$ = 0.9 Hz, 1′-H), 6.26 (dd, 1 H, $J_{3,4}$ = 9.5, $J_{3,6}$ = 0.8 Hz, 3-H), 7.21–7.41 (m, 16 H, H-*o*,*m*,*p*-Bn, 6-H), 7.40 (br. dd, 1 H, $J_{4,3}$ = 9.5, $J_{4,6}$ = 2.6 Hz, 4-H), 11.53 (br. s, 1 H, NH) ppm. ^{13}C NMR (125.7 MHz, [D$_6$]DMSO): δ = 18.7 (CH_3-2′), 65.5 (CH_2Bn-2′), 70.0 (CH_2-5′), 71.6 (CH_2Bn-3′), 72.6 (CH_2Bn-5′), 81.4 (CH-4′), 81.7 (CH-1′), 82.7 (C-2′), 82.8 (CH-3′), 115.3 (C-5), 119.5 (CH-3), 127.2 (CH-*p*-Bn), 127.4 (CH-*o*-Bn), 127.7 (CH-*p*-Bn, CH-*o*-Bn), 127.8 (CH-*p*-Bn), 128.2 (CH-*o*-Bn), 128.2, 128.3, and 128.5 (CH-*m*-Bn), 132.9 (CH-4 or CH-6), 138.2, 138.4, and 139.4 (C-*i*-Bn), 139.9 (CH-4 or CH-6), 162.3 (C-2) ppm. IR (CCl_4): 3067, 2976, 2901, 1665, 1627, 1552, 1454, 1364, 1207, 1187, 1095, 1029 cm^{-1}.

5-(2,3,5-Tri-*O*-benzyl-2-*C*-methyl-β-D-ribofuranosyl)-2-methoxypyridine (19e) and 5-(2,3,5-Tri-*O*-benzyl-2-*C*-methyl-β-D-ribofuranosyl)-1-methyl-2-pyridone (21): A suspension of **19d** (240 mg, 0.47 mmol), CH_3I (0.09 mL, 1.41 mmol), and $Ag_2(CO)_3$ (196 mg, 0.71 mmol) in CH_2Cl_2 (4 mL) was heated at 80 °C for 2 h. The mixture was cooled to room temp., then it was filtered through Celite, and concentrated under reduced pressure. The residue was purified by flash chromatography on silica gel (0 to 50% of ethyl acetate in hexane) to give **19e** (165 mg, 0.32 mmol, 68%) as a colourless oil, and as a side-product, **21** (58 mg, 0.11 mmol, 23%) as a yellowish oil.

Data for **19e**: HRMS (ESI): calcd. for $C_{33}H_{36}O_5N$ $[M + H]^+$ 526.25880; found 526.25881. ^1H NMR (500 MHz, [D$_6$]DMSO): δ = 0.92 (s, 3 H, CH_3-2′), 3.70 (dd, 1 H, J_{gem} = 10.7, $J_{5'a,4'}$ = 4.6 Hz, 5′a-H), 3.73 (dd, 1 H, J_{gem} = 10.7, $J_{5'b,4'}$ = 4.6 Hz, 5′b-H), 3.83 (s, 3 H, CH_3O), 3.86 (d, 1 H, $J_{3',4'}$ = 4.6 Hz, 3′-H), 4.22 (q, 1 H, $J_{4',3'}$ = $J_{4',5'a}$ = $J_{4',5'b}$ = 4.7 Hz, 4′-H), 4.54 (d, 1 H, J_{gem} = 11.5 Hz, CH_2Bn-3′), 4.55 and 4.59 (2 d, 2× 1 H, J_{gem} = 11.5 Hz, CH_2Bn-2′), 4.60 (br. d, 1 H, J_{gem} = 12.1 Hz, CH_2Bn-5′), 4.62 (d, 1 H, J_{gem} = 11.5 Hz, CH_2Bn-3′), 4.63 (br. d, 1 H, J_{gem} = 12.1 Hz, CH_2Bn-5′), 4.90 (s, 1 H, 1′-H), 6.76 (dd, 1 H, $J_{3,4}$ = 8.6, $J_{3,6}$ = 0.8 Hz, 3-H), 7.22–7.41 (m, 15 H, H-*o*,*m*,*p*-Bn), 7.66 (ddd, 1 H, $J_{4,3}$ = 8.6, $J_{4,6}$ = 2.4, $J_{4,1}$ = 0.7 Hz, 4-H), 8.11 (dpent, 1 H, $J_{6,4}$ = 2.4, $J_{6,3}$ = $J_{6,1'}$ = 0.8 Hz, 6-H) ppm. ^{13}C NMR (125.7 MHz, [D$_6$]DMSO): δ = 18.7 (CH_3-2′), 53.2 (CH_3O), 65.5 (CH_2Bn-2′), 70.2 (CH_2-5′), 71.5 (CH_2Bn-3′), 72.7 (CH_2Bn-5′), 81.7 (CH-4′), 82.1 (CH-1′), 82.7 (C-2′), 82.9 (CH-3′), 109.9 (CH-3), 127.0 (C-5), 127.2 (CH-*p*-Bn), 127.3 (CH-*o*-Bn), 127.6 (CH-*p*-Bn), 127.7 (CH-*o*-Bn), 127.7 (CH-*p*-Bn), 128.2 (CH-*o*-Bn), 128.2, 128.3, and 128.4 (CH-*m*-Bn), 137.5 (CH-4), 138.2, 138.4, and 139.4 (C-*i*-Bn), 144.9 (CH-6), 163.3 (C-2) ppm. IR (ATR): 3039, 2874, 1613, 1579, 1498, 1458, 1287, 1093, 1028 cm^{-1}.

Data for **21**: HRMS (ESI): calcd. for $C_{33}H_{36}O_5N$ $[M + H]^+$ 526.25880; found 526.25874. ^1H NMR (500 MHz, [D$_6$]DMSO): δ = 1.03 (s, 3 H, CH_3-2′), 3.32 (s, 3 H, CH_3N), 3.68 (dd, 1 H, J_{gem} = 10.7, $J_{5'a,4'}$ = 4.6 Hz, 5′a-H), 3.72 (dd, 1 H, J_{gem} = 10.7, $J_{5'b,4'}$ = 4.3 Hz, 5′b-H), 3.85 (d, 1 H, $J_{3',4'}$ = 5.4 Hz, 3′-H), 4.16 (dt, 1 H, $J_{4',3'}$ = 5.4, $J_{4',5'a}$ = $J_{4',5'b}$ = 4.4 Hz, 4′-H), 4.56 (d, 1 H, J_{gem} = 11.5 Hz, CH_2Bn-3′), 4.62–4.56 (m, 4 H, CH_2Bn-2′,5′), 4.62 (d, 1 H, J_{gem} = 11.5 Hz, CH_2Bn-3′), 4.69 (s, 1 H, 1′-H), 6.31 (br. dd, 1 H, $J_{3,4}$ = 9.4, $J_{3,6}$ = 0.5 Hz, 3-H), 7.22–7.39 (m, 15 H, H-*o*,*m*,*p*-Bn), 7.39 (dd, 1 H, $J_{4,3}$ = 9.5, $J_{4,6}$ = 2.5 Hz, 4-H), 7.60 (dt, 1 H, $J_{6,4}$ = 2.5, $J_{6,3}$ = $J_{6,1'}$ = 0.7 Hz, 6-H) ppm. ^{13}C NMR (125.7 MHz, [D$_6$]DMSO): δ = 18.7 (CH_3-2′), 37.0 (CH_3N), 65.5 (CH_2Bn-2′), 69.9 (CH_2-5′), 71.7 (CH_2Bn-3′), 72.6 (CH_2Bn-5′), 81.0 (CH-4′), 82.0 (CH-1′), 82.7 (CH-3′), 82.8 (C-2′), 115.6 (C-5), 118.6 (CH-3), 127.2 (CH-*p*-Bn), 127.4 (CH-*o*-Bn), 127.7 (CH-*p*-Bn), 127.8 (CH-*o*,*p*-Bn), 127.2 (CH-*o*,*m*-Bn), 128.3 and 128.5 (CH-*m*-Bn), 137.4 (CH-6), 138.3 and 138.4 (C-*i*-Bn), 138.9 (CH-4), 139.5 (C-*i*-Bn), 161.7 (C-2) ppm. IR (CCl_4), 3032, 2866, 1673, 1614, 1541, 1497, 1454, 1362, 1188, 1096, 1029.

2-(2,3,5-Tri-*O*-benzyl-2-*C*-methyl-β-D-ribofuranosyl)-5-methylpyridine (20a): Me_3Al (2 M in toluene; 2.61 mL, 5.22 mmol) was added to a stirred solution of **16** (1 g, 1.74 mmol) and $Pd(PPh_3)_4$ (101 mg, 0.087 mmol) in dry THF (11 mL) in a flame-dried septum-sealed flask. The resulting mixture was stirred at 66 °C for 1 h, then it was quenched by pouring into saturated NaH_2PO_4 (70 mL). The mixture was extracted with ethyl acetate. The combined organic layers were dried with anhydrous $MgSO_4$, and concentrated under reduced pressure. The crude product was purified by flash chromatography on silica gel (5 to 30% of ethyl acetate in hexane) to give **20a** (685 mg, 1.344 mmol, 77%) as a yellowish oil. HRMS (ESI): calcd. for $C_{33}H_{36}O_4N$ $[M + H]^+$ 510.26389; found 510.26378. ^1H NMR (500 MHz, [D$_6$]DMSO): δ = 0.92 (s, 3 H, CH_3-2′), 2.28 (s, 3 H, CH_3-5), 3.74 (dd, 1 H, J_{gem} = 10.9, $J_{5'a,4'}$ = 4.6 Hz, 5′a-H), 3.82 (dd, 1 H, J_{gem} = 10.9, $J_{5'b,4'}$ = 3.0 Hz, 5′b-H), 3.89 (d, 1 H, $J_{3',4'}$ = 7.8 Hz, 3′-H), 4.20 (ddd, 1 H, $J_{4',3'}$ = 7.8, $J_{4',5'a}$ = 4.5, $J_{4',5'b}$ = 3.0 Hz, 4′-H), 4.57 (d, 1 H, J_{gem} = 11.9 Hz, CH_2Bn-5′), 4.59 (d, 1 H, J_{gem} = 11.7 Hz, CH_2Bn-3′), 4.62 (d, 1 H, J_{gem} = 11.9 Hz, CH_2Bn-5′), 4.64 (d, 1 H, J_{gem} = 11.7 Hz, CH_2Bn-3′), 4.69 and 4.72 (2 d, 2× 1 H, J_{gem} = 11.9 Hz, CH_2Bn-2′), 5.01 (s, 1 H, 1′-H), 7.23–7.41 (m, 15 H, H-*o*,*m*,*p*-Bn), 7.49 (dd, 1 H, $J_{3,4}$ = 8.4, $J_{3,6}$ = 1.1 Hz, 3-H), 7.51 (ddq, 1 H, $J_{4,3}$ = 8.0, $J_{4,6}$ = 2.1, $J_{4,CH3}$ = 0.7 Hz, 4-H), 8.37 (dpent, 1 H, $J_{6,4}$ = 2.1, $J_{6,3}$ = $J_{6,CH3}$ = 0.9 Hz, 6-H) ppm. ^{13}C NMR (125.7 MHz, [D$_6$]DMSO): δ = 17.8 (CH_3-5), 19.1 (CH_3-2′), 65.1 (CH_2Bn-2′), 69.8 (CH_2-5′), 72.5 (CH_2Bn-3′), 72.6 (CH_2Bn-5′), 79.8 (CH-4′), 83.3 (CH-3′), 83.3 (C-2′), 86.3 (CH-1′), 121.0 (CH-3), 127.3 (CH-*p*-Bn), 127.4 (CH-*o*-Bn), 127.7 (CH-*p*-Bn), 127.8 (CH-*o*-Bn), 127.8 (CH-*p*-Bn), 128.1 (CH-*o*-Bn), 128.3, 128.4, and 128.5 (CH-*m*-Bn), 131.9 (C-5), 136.9 (CH-4), 138.5, 138.5, and 139.7 (C-*i*-Bn), 149.0 (CH-6), 156.6 (C-2) ppm. IR (ATR): 3072, 3039, 2875, 1607, 1578, 1500, 1458, 1385, 1079, 1030 cm^{-1}.

5-Amino-2-(2,3,5-tri-*O*-benzyl-2-*C*-methyl-β-D-ribofuranosyl)-pyridine (20b): LiHMDS (1 M in THF; 0.52 mL, 0.52 mmol) was added to a flame-dried septum-sealed flask containing **16** (150 mg, 0.26 mmol), $Pd_2(dba)_3$ (6 mg, 0.0065 mmol), and $P(tBu)_3{\cdot}HBF_4$ (15 mg, 0.052 mmol) in dry THF (3 mL). The resulting solution was stirred at 66 °C for 3 h. The mixture was cooled to room temp., and stirred with HCl (2 M aq.; 3 mL) for 10 min. The mixture was

then washed with satd. aq. $NaHCO_3$ (8 mL), and the aqueous phase was extracted with ethyl acetate. The combined organic layers were dried with anhydrous $MgSO_4$, and concentrated under reduced pressure. The residue was purified by flash chromatography on silica gel (25 to 75% of ethyl acetate in hexane) to give **20b** (97 mg, 0.19 mmol, 73%) as a yellowish oil. HRMS (ESI): calcd. for $C_{32}H_{34}O_4N_2Na$ $[M + Na]^+$ 533.24108; found 533.24098. ^1H NMR (500 MHz, [D$_6$]DMSO): δ = 0.93 (s, 3 H, CH_3-2′), 3.71 (dd, 1 H, J_{gem} = 10.9, $J_{5'a,4'}$ = 4.7 Hz, 5′a-H), 3.79 (dd, 1 H, J_{gem} = 10.9, $J_{5'b,4'}$ = 3.0 Hz, 5′b-H), 3.87 (d, 1 H, $J_{3',4'}$ = 7.9 Hz, 3′-H), 4.14 (ddd, 1 H, $J_{4',3'}$ = 7.9, $J_{4',5'a}$ = 4.7, $J_{4',5'b}$ = 3.0 Hz, 4′-H), 4.56, 4.59, 4.60, and 4.64 (4 d, 4× 1 H, J_{gem} = 11.9, 11.7, 12.0, and 11.7 Hz, CH_2Bn-3′,5′), 4.67 (br. s, 2 H, CH_2Bn-2′), 4.87 (s, 1 H, 1′-H), 6.28 (br. s, 2 H, NH_2), 6.83 (dd, 1 H, $J_{4,3}$ = 8.4, $J_{4,6}$ = 2.7 Hz, 4-H), 7.21 (d, 1 H, $J_{3,4}$ = 8.4 Hz, 3-H), 7.22–7.40 (m, 15 H, H-*o*,*m*,*p*-Bn), 7.87 (br. d, 1 H, $J_{6,4}$ = 2.7 Hz, 6-H) ppm. ^{13}C NMR (125.7 MHz, [D$_6$]DMSO): δ = 19.0 (CH_3-2′), 65.0 (CH_2Bn-2′), 70.1 (CH_2-5′), 72.5 and 72.6 (CH_2Bn-3′,5′), 79.4 (CH-4′), 83.3 (C-2′), 83.5 (CH-3′), 86.6 (CH-1′), 120.2 (CH-4), 121.6 (CH-3), 127.2 (CH-*p*-Bn), 127.4 (CH-*o*-Bn), 127.6 (CH-*p*-Bn), 127.7 (CH-*o*-Bn), 127.8 (CH-*p*-Bn), 128.1 (CH-*o*-Bn), 128.3 and 128.4 (CH-*m*-Bn), 135.2 (CH-6), 138.5, 138.6, and 139.8 (C-*i*-Bn), 144.0 (C-5), 146.3 (C-2) ppm. IR (ATR): 3470, 3365, 3222, 3040, 2869, 1631, 1577, 1498, 1456, 1306, 1078, 1026 cm^{-1}.

2-(2,3,5-Tri-*O*-benzyl-2-*C*-methyl-β-D-ribofuranosyl)-5-(dimethylamino)pyridine (20c): Me_2NH (2 M in THF; 3.7 mL, 7.4 mmol) was added to a stirred suspension of **16** (850 mg, 1.48 mmol), $Pd_2(dba)_3$ (34 mg, 0.037 mmol), JohnPhos [(2-biphenyl)-di-*tert*-butylphosphine; 44 mg, 0.148 mmol], and *t*BuONa (855 mg, 8.88 mmol) in dry toluene (5 mL) in a flame-dried septum-sealed flask. The resulting mixture was stirred at 70 °C for 2 h, then it was quenched by pouring into satd. aq. $NaHCO_3$ (12 mL). The mixture was extracted with toluene. The combined organic layers were dried with anhydrous $MgSO_4$, and concentrated under reduced pressure. The crude product was purified by flash chromatography on silica gel (5 to 40% of ethyl acetate in hexane) to give **20c** (672 mg, 1.25 mmol, 84%) as a yellowish oil. HRMS (ESI): calcd. for $C_{34}H_{39}O_4N_2$ $[M + H]^+$ 539.29043; found 539.29030. ^1H NMR (500 MHz, [D$_6$]DMSO): δ = 0.95 (s, 3 H, CH_3-2′), 2.91 [s, 6 H, $(CH_3)_2$N], 3.72 (dd, 1 H, J_{gem} = 10.9, $J_{5'a,4'}$ = 4.8 Hz, 5′a-H), 3.80 (dd, 1 H, J_{gem} = 10.9, $J_{5'b,4'}$ = 3.1 Hz, 5′b-H), 3.90 (d, 1 H, $J_{3',4'}$ = 7.8 Hz, 3′-H), 4.16 (ddd, 1 H, $J_{4',3'}$ = 7.8, $J_{4',5'a}$ = 4.8, $J_{4',5'b}$ = 3.1 Hz, 4′-H), 4.57 (d, 1 H, J_{gem} = 12.0 Hz, CH_2Bn-5′), 4.59 (d, 1 H, J_{gem} = 11.7 Hz, CH_2Bn-3′), 4.61 (d, 1 H, J_{gem} = 12.0 Hz, CH_2Bn-5′), 4.64 (d, 1 H, J_{gem} = 11.7 Hz, CH_2Bn-3′), 4.68 and 4.70 (2 d, 2× 1 H, J_{gem} = 11.7 Hz, CH_2Bn-2′), 4.94 (s, 1 H, 1′-H), 6.99 (dd, 1 H, $J_{4,3}$ = 8.8, $J_{4,6}$ = 3.1 Hz, 4-H), 7.23–7.39 (m, 16 H, H-*o*,*m*,*p*-Bn, 3-H), 8.05 (dd, 1 H, $J_{6,4}$ = 3.1, $J_{6,3}$ = 0.7 Hz, 6-H) ppm. ^{13}C NMR (125.7 MHz, [D$_6$]DMSO): δ = 19.1 (CH_3-2′), 39.8 [$(CH_3)_2$N], 65.1 (CH_2Bn-2′), 70.1 (CH_2-5′), 72.4 (CH_2Bn-3′), 72.6 (CH_2Bn-5′), 79.6 (CH-4′), 83.3 (C-2′), 83.7 (CH-3′), 86.5 (CH-1′), 118.8 (CH-4), 121.4 (CH-3), 127.2 (CH-*p*-Bn), 127.3 (CH-*o*-Bn), 127.6 (CH-*p*-Bn), 127.7 (CH-*o*,*p*-Bn), 128.0 (CH-*o*-Bn), 128.2, 128.3, and 128.4 (CH-*m*-Bn), 133.6 (CH-6), 138.5, 138.5, and 139.8 (C-*i*-Bn), 145.3 (C-5), 146.4 (C-2) ppm. IR (CCl_4): 3032, 2876, 2807, 1596, 1561, 1498, 1454, 1356, 1207, 1098, 1029 cm^{-1}.

2-(2,3,5-Tri-*O*-benzyl-2-*C*-methyl-β-D-ribofuranosyl)-5-hydroxypyridine (20d): A suspension of **16** (800 mg, 1.39 mmol), $Pd_2(dba)_3$ (32 mg, 0.035 mmol), $Me_4(tBu)_2$XPhos (2-di-*tert*-butylphosphino-3,4,5,6-tetramethyl-2′,4′,6′-triisopropylbiphenyl; 67 mg, 0.139 mmol), and KOH (234 mg, 4.17 mmol) in a mixture of 1,4-dioxane (3.6 mL) and water (1.2 mL) was stirred at 80 °C for 4 h. The mixture was cooled to room temp., diluted with ethyl acetate, filtered through Celite, and concentrated under reduced pressure. The residue was purified by flash chromatography on silica gel (10 to 50% of ethyl acetate in hexane) to give **20d** (700 mg, 1.37 mmol, 98%) as a yellowish oil. HRMS (ESI): calcd. for $C_{32}H_{34}O_5N$ $[M + H]^+$ 512.24315; found 512.24315. ^1H NMR (500 MHz, [D$_6$]-DMSO): δ = 0.93 (s, 3 H, CH_3-2′), 3.73 (dd, 1 H, J_{gem} = 10.9, $J_{5'a,4'}$ = 4.6 Hz, 5′a-H), 3.81 (dd, 1 H, J_{gem} = 10.9, $J_{5'b,4'}$ = 3.0 Hz, 5′b-H), 3.88 (d, 1 H, $J_{3',4'}$ = 7.8 Hz, 3′-H), 4.14 (ddd, 1 H, $J_{4',3'}$ = 7.8, $J_{4',5'a}$ = 4.6, $J_{4',5'b}$ = 3.0 Hz, 4′-H), 4.57 (d, 1 H, J_{gem} = 11.9 Hz, CH_2Bn-5′), 4.59 (d, 1 H, J_{gem} = 11.7 Hz, CH_2Bn-3′), 4.60 (d, 1 H, J_{gem} = 11.9 Hz, CH_2Bn-5′), 4.69 (d, 1 H, J_{gem} = 11.7 Hz, CH_2Bn-3′), 4.68 (s, 2 H, CH_2Bn-2′), 4.95 (s, 1 H, 1′-H), 7.05 (dd, 1 H, $J_{4,3}$ = 8.5, $J_{4,6}$ = 2.9 Hz, 4-H), 7.23–7.39 (m, 15 H, H-*o*,*m*,*p*-Bn), 7.41 (br. d, 1 H, $J_{3,4}$ = 8.5 Hz, 3-H), 8.08 (dd, 1 H, $J_{6,4}$ = 2.9, $J_{6,3}$ = 0.6 Hz, 6-H) ppm. ^{13}C NMR (125.7 MHz, [D$_6$]DMSO): δ = 19.0 (CH_3-2′), 65.1 (CH_2Bn-2′), 69.9 (CH_2-5′), 72.5 and 72.6 (CH_2Bn-3′,5′), 79.6 (CH-4′), 83.3 (C-2′, CH-3′), 86.3 (CH-1′), 122.0 (CH-3), 122.4 (CH-4), 127.2 (CH-*p*-Bn), 127.3 (CH-*o*-Bn), 127.7 (CH-*p*-Bn), 127.8 (CH-*o*,*p*-Bn), 128.1 (CH-*o*-Bn), 128.3, 128.3, and 128.4 (CH-*m*-Bn), 136.9 (CH-6), 138.5, 138.5, and 139.7 (C-*i*-Bn), 149.8 (C-2), 152.9 (C-5) ppm. IR (CCl_4): 3600, 3032, 2864, 1600, 1577, 1497, 1454, 1361, 1283, 1097, 1029 cm^{-1}.

2-(2,3,5-Tri-*O*-benzyl-2-*C*-methyl-β-D-ribofuranosyl)-5-methoxypyridine (20e): A suspension of **16** (140 mg, 0.244 mmol), $Pd_2(dba)_3$ (6 mg, 0.006 mmol), $Me_4(tBu)_2$XPhos (2-di-*tert*-butylphosphino-3,4,5,6-tetramethyl-2′,4′,6′-triisopropylbiphenyl; 12 mg, 0.024 mmol), and KOH (41 mg, 0.732 mmol) in a mixture of 1,4-dioxane (0.9 mL) and water (0.3 mL) was stirred at 80 °C for 4 h. Then, the reaction mixture was cooled to room temp., and TBAB (8 mg, 0.024 mmol), additional KOH (27 mg, 0.488 mmol), and CH_3I (0.03 mL, 0.488 mmol) were added. The resulting suspension was stirred for a further 30 min at 80 °C. The mixture was cooled to room temp., diluted with ethyl acetate, filtered through Celite, and concentrated under reduced pressure. The residue was purified by flash chromatography on silica gel (6 to 13% of ethyl acetate in hexane) to give **20e** (84 mg, 0.16 mmol, 66%) as a yellowish oil. HRMS (ESI): calcd. for $C_{33}H_{35}O_5NNa$ $[M + Na]^+$ 548.24074; found 548.24013. ^1H NMR (500 MHz, [D$_6$]DMSO): δ = 0.94 (s, 3 H, CH_3-2′), 3.73 (dd, 1 H, J_{gem} = 10.9, $J_{5'a,4'}$ = 4.7 Hz, 5′a-H), 3.81 (dd, 1 H, J_{gem} = 10.9, $J_{5'b,4'}$ = 3.0 Hz, 5′b-H), 3.81 (s, 3 H, CH_3O), 3.90 (d, 1 H, $J_{3',4'}$ = 7.7 Hz, 3′-H), 4.19 (ddd, 1 H, $J_{4',3'}$ = 7.7, $J_{4',5'a}$ = 4.7, $J_{4',5'b}$ = 3.0 Hz, 4′-H), 4.58 (d, 1 H, J_{gem} = 11.9 Hz, CH_2Bn-5′), 4.59 (br. d, 1 H, J_{gem} = 11.6 Hz, CH_2Bn-3′), 4.62 (br. d, 1 H, J_{gem} = 11.8 Hz, CH_2Bn-5′), 4.64 (d, 1 H, J_{gem} = 11.7 Hz, CH_2Bn-3′), 4.70 (s, 2 H, CH_2Bn-2′), 5.01 (s, 1 H, 1′-H), 7.23–7.40 (m, 16 H, H-*o*,*m*,*p*-Bn, 4-H), 7.52 (dm, 1 H, $J_{3,4}$ = 8.6 Hz, 3-H), 8.25 (dd, 1 H, $J_{6,4}$ = 3.0, $J_{6,3}$ = 0.7 Hz, 6-H) ppm. ^{13}C NMR (125.7 MHz, [D$_6$]DMSO): δ = 19.1 (CH_3-2′), 55.7 (CH_3O), 65.1 (CH_2Bn-2′), 69.9 (CH_2-5′), 72.4 (CH_2Bn-3′), 72.6 (CH_2Bn-5′), 79.8 (CH-4′), 83.3 (C-2′), 83.4 (CH-3′), 86.1 (CH-1′), 120.8 (CH-4), 122.0 (CH-3), 127.2 (CH-*p*-Bn), 127.3 (CH-*o*-Bn), 127.6 (CH-*p*-Bn), 127.7 (CH-*o*,*p*-Bn), 128.0 (CH-*o*-Bn), 128.2, 128.3, and 128.4 (CH-*m*-Bn), 136.3 (CH-6), 138.5 and 139.7 (C-*i*-Bn), 151.2 (C-2), 154.7 (C-5) ppm. IR (CCl_4): 3032, 2897, 2864, 1575, 1496, 1454, 1384, 1294, 1269, 1245, 1098, 1029 cm^{-1}.

(2-*C*-Methyl-β-D-ribofuranosyl)benzene (22) and 1-Deoxy-2-*C*-methyl-1-*C*-phenylribitol (23)

Method 1: Catalytic Hydrogenation: A suspension of **7** (100 mg, 0.2 mmol) and Pd/C (10%; 21 mg, 0.02 mmol) in acetic acid (1 mL) was vigorously stirred under a hydrogen atmosphere at room temp. for 3 h. Then, the reaction mixture was filtered through a paper filter, and the filtrate was concentrated under reduced pressure. The

residue was purified by flash chromatography on silica gel (0 to 5% of MeOH in CH_2Cl_2) to give **22** (18 mg, 0.08 mmol, 40%) as a white foam, and as a side-product, **23** (24 mg, 0.11 mmol, 53%) as a white foam.

Method 2: Treatment with BCl_3: BCl_3 (1 M in CH_2Cl_2; 1.3 mL, 1.28 mmol) was added dropwise to a cooled (–78 °C) solution of **7** (210 mg, 0.425 mmol) in dry CH_2Cl_2 (2 mL). The resulting solution was stirred at –78 °C for 2 h. Subsequently, MeOH (1 mL) was added, the reaction mixture was warmed to room temp., and concentrated under reduced pressure. The crude product was purified by flash chromatography on silica gel (0 to 5% of MeOH in CH_2Cl_2) to give **22** (90 mg, 0.4 mmol, 94%) as a white foam.

Data for **22**: HRMS (ESI): calcd. for $C_{12}H_{16}O_4Na$ $[M + Na]^+$ 247.09408; found 247.09402. ^1H NMR (500 MHz, [D$_6$]DMSO): δ = 0.64 (s, 3 H, CH_3), 3.49 (t, 1 H, $J_{3',4'} = J_{3',OH}$ = 5.8 Hz, 3′-H), 3.59 (dt, 1 H, J_{gem} = 11.8, $J_{5'a,4'} = J_{5',OH}$ = 5.4 Hz, 5′a-H), 3.68 (ddd, 1 H, J_{gem} = 11.8, $J_{5'b,OH}$ = 5.6, $J_{5'b,4'}$ = 3.7 Hz, 5′b-H), 3.73 (ddd, 1 H, $J_{4',3'}$ = 5.9, $J_{4',5'a}$ = 5.2, $J_{4',5'b}$ = 3.7 Hz, 4′-H), 4.63 (s, 1 H, 1′-H), 4.66 (s, 1 H, OH-2′), 4.81 (t, 1 H, $J_{OH,5'a} = J_{OH,5'b}$ = 5.6 Hz, OH-5′), 5.11 (d, 1 H, $J_{OH,3'}$ = 5.8 Hz, OH-3′), 7.24 (m, 1 H, H-*p*-Ph), 7.30 (m, 2 H, H-*m*-Ph), 7.35 (m, 2 H, H-*o*-Ph) ppm. ^{13}C NMR (125.7 MHz, [D$_6$]DMSO): δ = 22.3 (CH_3), 61.8 (CH_2-5′), 75.7 (CH-3′), 77.6 (C-2′), 84.0 (CH-4′), 86.3 (CH-1′), 126.4 (CH-*o*-Ph), 127.2 (CH-*p*-Ph), 127.8 (CH-*m*-Ph), 139.9 (C-*i*-Ph) ppm. IR (ATR): 3363, 2937, 1500, 1458, 1380, 1295, 1220, 1177, 1071, 1044, 1030 cm^{-1}. $[\alpha]_D^{20}$ = –9.2 (*c* 0.250, MeOH). $C_{12}H_{16}O_4 \cdot 0.1H_2O$: calcd. C 63.76, H 7.22; found C 63.75, H 7.43.

Data for **23**: HRMS (ESI): calcd. for $C_{12}H_{18}O_4Na$ $[M + Na]^+$ 249.10973; found 249.10972. ^1H NMR (500 MHz, [D$_6$]DMSO): δ = 1.06 (s, 3 H, CH_3-2), 2.67 (d, 1 H, J_{gem} = 13.3 Hz, 1a-H), 2.78 (d, 1 H, J_{gem} = 13.3 Hz, 1b-H), 3.11 (dd, 1 H, $J_{3,4}$ = 8.3, $J_{3,OH}$ = 6.5 Hz, 3-H), 3.39 (br. dt, 1 H, J_{gem} = 11.7, $J_{5a,4} = J_{5a,OH}$ = 6.2 Hz, 5a-H), 3.56–3.62 (m, 2 H, 4-H, 5b-H), 4.43 (br. dd, 1 H, $J_{OH,5a}$ = 6.0, $J_{OH,5b}$ = 5.4 Hz, OH-5), 4.82 (d, 1 H, $J_{OH,3}$ = 6.5 Hz, OH-3), 4.89 (s, 1 H, OH-2), 5.22 (d, 1 H, $J_{OH,4}$ = 3.6 Hz, OH-4), 7.16 (m, 1 H, H-*p*-Ph), 7.20–7.27 (m, 4 H, H-*o*,*m*-Ph) ppm. ^{13}C NMR (125.7 MHz, [D$_6$]DMSO): δ = 22.0 (CH_3-2), 45.1 (CH_2-1), 64.2 (CH_2-5), 72.7 (CH-3), 73.5 (CH-4), 75.0 (C-2), 125.7 (CH-*p*-Ph), 127.5 (CH-*m*-Ph), 131.2 (CH-*o*-Ph), 138.4 (C-*i*-Ph) ppm.

5-(5-*O*-Benzyl-2-*C*-methyl-β-D-ribofuranosyl)-2-methylpyridine (27): BCl_3 (1 M in CH_2Cl_2; 1.8 mL, 1.77 mmol) was added dropwise to a cooled (–78 °C) solution of **19a** (300 mg, 0.589 mmol) in dry CH_2Cl_2 (3 mL). The resulting solution was stirred at –78 °C for 4 h. Subsequently, MeOH (1.5 mL) was added, and the reaction mixture was warmed to room temp., and concentrated under reduced pressure. The crude product was purified by flash chromatography on silica gel (0 to 10% of MeOH in CH_2Cl_2) to give **27** (162 mg, 0.492 mmol, 84%) as a white solid, m.p. 101–102 °C. HRMS (ESI): calcd. for $C_{19}H_{24}O_4N$ $[M + H]^+$ 330.16998; found 330.16986. ^1H NMR (500 MHz, [D$_6$]DMSO): δ = 0.66 (s, 3 H, CH_3-2′), 2.44 (s, 3 H, CH_3-2), 3.53 (t, 1 H, $J_{3',4'} = J_{3',OH}$ = 6.1 Hz, 3′-H), 3.67 (dd, 1 H, J_{gem} = 10.9, $J_{5'a,4'}$ = 3.2 Hz, 5′a-H), 3.74 (dd, 1 H, J_{gem} = 10.9, $J_{5'b,4'}$ = 3.2 Hz, 5′b-H), 3.91 (ddd, 1 H, $J_{4',3'}$ = 6.4, $J_{4',5'a}$ = 5.5, $J_{4',5'b}$ = 3.2 Hz, 4′-H), 4.59 (s, 2 H, CH_2Bn), 4.68 (s, 1 H, 1′-H), 4.81 (m, 1 H, OH-2′), 5.25 (dm, 1 H, $J_{OH,3'}$ = 5.9 Hz, OH-3′), 7.17 (dm, 1 H, $J_{3,4}$ = 7.9 Hz, 3-H), 7.30 (m, 1 H, H-*p*-Bn), 7.34–7.40 (m, 4 H, H-*o*,*m*-Bn), 7.60 (ddd, 1 H, $J_{4,3}$ = 7.9, $J_{4,6}$ = 2.3, $J_{4,1'}$ = 0.8 Hz, 4-H), 8.36 (dt, 1 H, $J_{6,4}$ = 2.3, $J_{6,3} = J_{6,1'}$ = 0.8 Hz, 6-H) ppm. 13C NMR (125.7 MHz, [D$_6$]-DMSO): δ = 22.3 (CH_3-2′), 23.9 (CH_3-2), 70.3 (CH_2-5′), 72.5 (CH_2-Bn), 75.7 (CH-3′), 77.6 (C-2′), 82.2 (CH-4′), 84.8 (CH-1′), 122.5 (CH-3), 127.6 (CH-*o*-Bn, CH-*p*-Bn), 128.5 (CH-*m*-Bn), 132.2 (C-5), 134.3 (CH-4), 138.6 (C-*i*-Bn), 147.0 (CH-6), 156.9 (C-2) ppm. IR (ATR): 3420, 3071, 2805, 1505, 1454, 1305, 1151, 1090, 1018 cm^{-1}.

4-Methyl-1-(2-*C*-methyl-β-D-ribofuranosyl)benzene (28a): A suspension of **18a** (300 mg, 0.59 mmol) and Pd/C (5%; "eggshell", unreduced form, 50% wet; 251 mg, 0.059 mmol) in acetic acid (3 mL) was vigorously stirred under a hydrogen atmosphere at room temp. After stirring for 6 h, the reaction mixture was filtered through a paper filter, and the filtrate was concentrated under reduced pressure. The residue was purified by flash chromatography on silica gel (0 to 5% of MeOH in CH_2Cl_2) to give **28a** (131 mg, 0.55 mmol, 93%) as a white foam. HRMS (ESI): calcd. for $C_{13}H_{18}O_4Na$ $[M + Na]^+$ 261.10973; found 261.10975. ^1H NMR (500 MHz, [D$_6$]-DMSO): δ = 0.63 (s, 3 H, CH_3-2′), 2.28 (s, 3 H, CH_3-Ph), 3.47 (t, 1 H, $J_{3',4'} = J_{3',OH}$ = 5.8 Hz, 3′-H), 3.57 (dt, 1 H, J_{gem} = 11.7, $J_{5'a,4'} = J_{5'a,OH}$ = 5.4 Hz, 5′a-H), 3.66 (ddd, 1 H, J_{gem} = 11.7, $J_{5'b,OH}$ = 5.6, $J_{5'b,4'}$ = 3.7 Hz, 5′b-H), 3.70 (br. td, 1 H, $J_{4',5'a} = J_{4',3'}$ = 5.5, $J_{4',5'b}$ = 3.7 Hz, 4′-H), 4.58 (s, 1 H, 1′-H), 4.62 (s, 1 H, OH-2′), 4.80 (t, 1 H, $J_{OH,5'a} = J_{OH,5'b}$ = 5.7 Hz, OH-5′), 5.09 (d, 1 H, $J_{3',OH}$ = 5.8 Hz, OH-3′), 7.11 (m, 2 H, 3-H, 5-H), 7.22 (m, 2 H, 2-H, 6-H) ppm. ^{13}C NMR (125.7 MHz, [D$_6$]DMSO): δ = 21.2 (CH_3-Ph), 22.6 (CH_3-2′), 62.1 (CH_2-5′), 76.0 (CH-3′), 77.9 (C-2′), 84.2 (CH-4′), 86.6 (CH-1′), 126.6 (CH-2, CH-6), 128.7 (CH-3, CH-5), 136.4 (C-4), 137.2 (C-1) ppm. IR (ATR): 3369, 2932, 1521, 1455, 1381, 1180, 1039, 1024 cm^{-1}. $[\alpha]_D^{20}$ = –7.7 (*c* 0.222, MeOH). $C_{13}H_{18}O_4 \cdot 0.3H_2O$: calcd. C 64.07,; H 7.69; found C 64.12, H 7.68.

4-(2-*C*-Methyl-β-D-ribofuranosyl)aniline (28b): A suspension of **18b** (400 mg, 0.785 mmol) and Pd/C (5%; "eggshell", unreduced form, 50% wet; 176 mg, 0.039 mmol) in acetic acid (4 mL) was vigorously stirred under a hydrogen atmosphere at room temp. After stirring for 3 d, the reaction mixture was filtered through a paper filter, and the filtrate was concentrated under reduced pressure. The residue was purified by flash chromatography on silica gel (0 to 3% of MeOH in ethyl acetate) to give **28b** (140 mg, 0.585 mmol, 75%) as a yellowish foam. HRMS (ESI): calcd. for $C_{12}H_{17}O_4NNa$ $[M + Na]^+$ 262.10498; found 262.10504. ^1H NMR (500 MHz, [D$_6$]-DMSO): δ = 0.65 (s, 3 H, CH_3-2′), 3.43 (t, 1 H, $J_{3',4'} = J_{3',OH}$ = 6.0 Hz, 3′-H), 3.55 (br. dt, 1 H, J_{gem} = 12.3, $J_{5'a,4'} = J_{5'a,OH}$ = 6.0 Hz, 5′a-H), 3.63–3.70 (m, 2 H, 4′-H, 5′b-H), 4.46 (s, 1 H, 1′-H), 4.46 (s, 1 H, OH-2′), 4.74 (t, 1 H, $J_{OH,5'a} = J_{OH,5'b}$ = 5.5 Hz, OH-5′), 4.92 (br. s, 2 H, NH_2), 4.98 (d, 1 H, $J_{OH,3'}$ = 6.0 Hz, OH-3′), 6.49 (m, 2 H, 2-H, 6-H), 6.96 (m, 2 H, 3-H, 5-H) ppm. ^{13}C NMR (125.7 MHz, [D$_6$]DMSO): δ = 22.5 (CH_3-2′), 62.0 (CH_2-5′), 75.6 (CH-3′), 77.6 (C-2′), 83.4 (CH-4′), 87.2 (CH-1′), 113.4 (CH-2, CH-6), 127.1 (C-4), 127.2 (CH-3, CH-5), 148.0 (C-1) ppm. IR (ATR): 3404, 3331, 3255, 2896, 1619, 1521, 1451, 1384, 1275, 1162, 1076, 1024 cm^{-1}. $[\alpha]_D^{20}$ = –4.2 (*c* 0.283, MeOH). $C_{12}H_{17}O_4N \cdot 0.15H_2O$: calcd. C 59.57, H 7.21, N 5.79; found C 59.75, H 7.2, N 5.47.

***N*,*N*-Dimethyl-4-(2-*C*-methyl-β-D-ribofuranosyl)aniline (28c), *N*,*N*-Dimethyl-4-(2-*C*-methyl-α-D-ribofuranosyl)aniline (24), *N*,*N*-Dimethyl-4-(2-*C*-methyl-α-D-ribopyranosyl)aniline (25), and 4-(2-*C*-Methyl-β-D-ribofuranosyl)cyclohexanone (26)**

Method 1: Catalytic Hydrogenation: A suspension of **18c** (1.56 g, 2.9 mmol) and Pd/C (10%; 309 mg, 0.29 mmol) in acetic acid (16 mL) was vigorously stirred under a hydrogen atmosphere at room temp. for 20 h. Then, the reaction mixture was filtered through a paper filter, and the filtrate was concentrated under reduced pressure. The residue was purified by HPLC (0 to 100% of MeOH in water) to give **28c** (333 mg, 1.25 mmol, 43%) as a white solid, and as an undesired side-product, **26** (340 mg, 1.39 mmol, 48%) as a colourless oil.

Method 2: Treatment with BCl_3: BCl_3 (1 M in CH_2Cl_2; 1.92 mL, 1.92 mmol) was added dropwise to a cooled (–78 °C) solution of **18c** (341 mg, 0.64 mmol) in dry CH_2Cl_2 (4 mL). The resulting solution was stirred at –78 °C for 1 h. Subsequently, MeOH (2 mL) was added, and reaction mixture was warmed to room temp., and concentrated under reduced pressure. The crude product was purified by HPLC (0 to 100% of MeOH in water) to give **28c** (36 mg, 0.134 mmol, 21%) as a white solid, and as undesired side-products, **24** (63 mg, 0.237 mmol, 37%) as a white foam, and **25** (60 mg, 0.224 mmol, 35%) as a white foam.

Data for **28c**: m.p. 126–127 °C. HRMS (ESI): calcd. for $C_{14}H_{21}O_4NNa$ $[M + Na]^+$ 290.13628; found 290.13635. ^1H NMR (500 MHz, [D$_6$]DMSO): δ = 0.65 (s, 3 H, CH_3-2′), 2.86 [s, 6 H, $(CH_3)_2N$], 3.46 (m, 1 H, 3′-H), 3.57 (m, 1 H, 5′a-H), 3.63–3.70 (m, 2 H, 4′-H, 5′b-H), 4.50 (br. s, 1 H, OH-2′), 4.52 (s, 1 H, 1′-H), 4.75 (t, 1 H, $J_{OH,5'a} = J_{OH,5'b}$ = 5.6 Hz, OH-5′), 5.00 (br. s, 1 H, OH-3′), 6.66 (m, 2 H, 2-H, 6-H), 7.13 (m, 2 H, 3-H, 5-H) ppm. ^{13}C NMR (125.7 MHz, [D$_6$]DMSO): δ = 22.5 (CH_3-2′), 40.4 [$(CH_3)_2N$], 61.9 (CH_2-5′), 75.7 (CH-3′), 77.6 (C-2′), 83.5 (CH-4′), 86.8 (CH-1′), 111.9 (CH-2, CH-6), 127.2 (C-4), 127.5 (CH-3, CH-5), 149.7 (C-1) ppm. IR (ATR): 3503, 3340, 2894, 2810, 1621, 1530, 1452, 1357, 1233, 1118, 1074, 1049 cm^{-1}. $[\alpha]_D^{20}$ = –9.6 (*c* 0.198, MeOH). $C_{14}H_{21}O_4N{\cdot}0.25H_2O$: calcd. C 61.86, H 7.97, N 5.15; found C 61.99, H 7.87, N 5.03.

Data for **24**: HRMS (ESI): calcd. for $C_{13}H_{16}O_5N$ $[M - H]^-$ 266.10340; found 266.10351. ^1H NMR (500 MHz, [D$_6$]DMSO): δ = 1.00 (s, 3 H, CH_3-2′), 2.87 [s, 6 H, $(CH_3)_2N$], 3.44 (ddd, 1 H, J_{gem} = 11.8, $J_{5'a,OH}$ = 6.3, $J_{5'a,4'}$ = 4.6 Hz, 5′a-H), 3.61 (ddd, 1 H, J_{gem} = 11.8, $J_{5'b,OH}$ = 5.2, $J_{5'b,4'}$ = 2.4 Hz, 5′b-H), 3.76 (dd, 1 H, $J_{3',4'}$ = 8.4, $J_{3',OH}$ = 7.0 Hz, 3′-H), 3.80 (ddd, 1 H, $J_{4',3'}$ = 8.4, $J_{4',5'a}$ = 4.6, $J_{4',5'b}$ = 2.4 Hz, 4′-H), 3.91 (d, 1 H, $J_{OH,LR}$ = 0.7 Hz, OH-2′), 4.48 (s, 1 H, 1′-H), 4.65 (dd, 1 H, $J_{OH,5'a}$ = 6.3, $J_{OH,5'b}$ = 5.2 Hz, OH-5′), 4.82 (d, 1 H, $J_{OH,3'}$ = 7.1 Hz, OH-3′), 6.66 (m, 2 H, 2-H, 6-H), 7.13 (m, 2 H, 3-H, 5-H) ppm. ^{13}C NMR (125.7 MHz, [D$_6$]DMSO): δ = 21.1 (CH_3-2′), 40.5 [$(CH_3)_2N$], 62.5 (CH_2-5′), 76.5 (C-2′), 76.6 (CH-3′), 81.9 (CH-4′), 85.8 (CH-1′), 111.6 (CH-2, CH-6), 126.0 (C-4), 128.9 (CH-3, CH-5), 150.1 (C-1) ppm.

Data for **25**: HRMS (ESI): calcd. for $C_{13}H_{16}O_5N$ $[M - H]^-$ 266.10340; found 266.10349. ^1H NMR (500 MHz, [D$_6$]DMSO): δ = 0.77 (s, 3 H, CH_3-2′), 2.86 [s, 6 H, $(CH_3)_2N$], 3.34 (dd, 1 H, $J_{3',OH}$ = 8.1, $J_{3',4'}$ = 3.2 Hz, 3′-H), 3.58 (dd, 1 H, J_{gem} = 12.1, $J_{5'a,4'}$ = 1.3 Hz, 5′a-H), 3.73 (dddd, 1 H, $J_{4',OH}$ = 5.2, $J_{4',3'}$ = 3.2, $J_{4',5'b}$ = 1.9, $J_{4',5'a}$ = 1.3 Hz, 4′-H), 3.88 (dd, 1 H, J_{gem} = 12.1, $J_{5'b,4'}$ = 2.0 Hz, 5′a-H), 3.96 (s, 1 H, 1′-H), 4.39 (br. s, 1 H, OH-2′), 4.52 (d, 1 H, $J_{OH,3'}$ = 8.1 Hz, OH-3′), 5.39 (d, 1 H, $J_{OH,4'}$ = 5.2 Hz, OH-4′), 6.63 (m, 2 H, 2-H, 6-H), 7.17 (m, 2 H, 3-H, 5-H) ppm. ^{13}C NMR (125.7 MHz, [D$_6$]DMSO): δ = 20.9 (CH_3-2′), 40.4 [$(CH_3)_2N$], 70.0 (CH-4′), 71.3 (CH_2-5′), 71.9 (CH-3′), 74.5 (C-2′), 85.1 (CH-1′), 111.4 (CH-2, CH-6), 126.3 (C-4), 129.6 (CH-3, CH-5), 149.9 (C-1) ppm.

Data for **26**: HRMS (ESI): calcd. for $C_{12}H_{19}O_5$ $[M - H]^-$ 243.12380; found 243.12350. ^1H NMR (500 MHz, [D$_6$]DMSO): δ = 1.10 (s, 3 H, CH_3-2′), 1.32–1.48 (m, 2 H, 3b-H, 5b-H), 1.83 (tdt, 1 H, $J_{4,3} = J_{4,3}$ = 10.7, $J_{4,1'}$ = 9.2, $J_{4,3} = J_{4,3}$ = 3.4 Hz, 4-H), 2.08–2.23 (m, 4 H, 3a-H, 5a-H, 2b-H, 6b-H), 2.30–2.41 (m, 2 H, 2a-H, 6a-H), 3.19 (d, 1 H, $J_{1',4}$ = 9.2 Hz, 1′-H), 3.31 (m, 1 H, 3′-H), 3.40–3.53 (m, 3 H, 4′-H, 5′-H), 4.29 (br. s, 1 H, OH-2′), 4.71 (br. t, 1 H, $J_{OH,5'a} = J_{OH,5'b}$ = 5.4 Hz, OH-5′), 5.17 (br. d, 1 H, $J_{3',OH}$ = 4.3 Hz, OH-3′) ppm. ^{13}C NMR (125.7 MHz, [D$_6$]DMSO): δ = 21.1 (CH_3-2′), 28.0 and 30.2 (CH_2-3,5), 35.9 (CH-4), 40.0 and 40.1 (CH_2-2,6), 62.2 (CH_2-5′), 76.1 (C-2′), 77.4 (CH-3′), 85.0 (CH-4′), 85.5 (CH-1′), 211.2 (C-1) ppm. IR (ATR): 3390, 2941, 2874, 1708, 1455, 1339, 1176, 1133, 1035 cm^{-1}.

4-(2-*C*-Methyl-β-D-ribofuranosyl)phenol (28d): A suspension of **18d** (570 mg, 1.12 mmol) and Pd/C (5%; "eggshell", unreduced form, 50% wet; 477 mg, 0.112 mmol) in acetic acid (6 mL) was vigorously stirred under a hydrogen atmosphere at room temp. After stirring for 2 h, the reaction mixture was filtered through a paper filter, and the filtrate was concentrated under reduced pressure. The residue was purified by flash chromatography on silica gel (0 to 10% of MeOH in CH_2Cl_2) to give **28d** (244 mg, 1.02 mmol, 91%) as a white solid, m.p. 179–181 °C. HRMS (ESI): calcd. for $C_{12}H_{15}O_5$ $[M - H]^-$ 239.09250; found 239.09258. ^1H NMR (500 MHz, [D$_6$]-DMSO): δ = 0.64 (s, 3 H, CH_3-2′), 3.45 (t, 1 H, $J_{3',4'} = J_{3',OH}$ = 5.9 Hz, 3′-H), 3.56 (m, 1 H, 5′a-H), 3.63–3.70 (m, 2 H, 4′-H, 5′b-H), 4.52 (s, 1 H, 1′-H), 5.55 (s, 1 H, OH-2′), 4.78 (t, 1 H, $J_{OH,5'a} = J_{OH,5'b}$ = 5.6 Hz, OH-5′), 5.03 (d, 1 H, $J_{3',OH}$ = 5.9 Hz, OH-3′), 6.68 (m, 2 H, 2-H, 6-H), 7.11 (m, 2 H, 3-H, 5-H), 9.24 (s, 1 H, OH-1) ppm. ^{13}C NMR (125.7 MHz, [D$_6$]DMSO): δ = 22.4 (CH_3-2′), 61.9 (CH_2-5′), 75.6 (CH-3′), 77.6 (C-2′), 83.6 (CH-4′), 86.6 (CH-1′), 114.6 (CH-2, CH-6), 127.6 (CH-3, CH-5), 130.2 (C-4), 156.5 (C-1) ppm. IR (ATR): 3279, 3166, 2940, 2886, 1620, 1523, 1474, 1387, 1272, 1229, 1117, 1075, 1043 cm^{-1}. $[\alpha]_D^{20}$ = –6.6 (*c* 0.288, MeOH). $C_{12}H_{16}O_5$: calcd. C 59.99, H 6.71; found C 59.69, H 6.89.

4-(2-*C*-Methyl-β-D-ribofuranosyl)anisole (28e): A suspension of **18e** (220 mg, 0.42 mmol) and Pd/C (5%; "eggshell", unreduced form, 50% wet; 89 mg, 0.021 mmol) in acetic acid (2 mL) was vigorously stirred under a hydrogen atmosphere at room temp. After stirring for 6 h, the reaction mixture was filtered through a paper filter, and the filtrate was concentrated under reduced pressure. The residue was purified by flash chromatography on silica gel (0 to 10% of MeOH in ethyl acetate) to give **28e** (97 mg, 0.38 mmol, 91%) as a white solid, m.p. 79–80 °C. HRMS (ESI): calcd. for $C_{13}H_{18}O_5Na$ $[M + Na]^+$ 277.10464; found 277.10462. ^1H NMR (500 MHz, [D$_6$]-DMSO): δ = 0.64 (s, 3 H, CH_3-2′), 3.47 (d, 1 H, $J_{3',4'}$ = 5.9 Hz, 3′-H), 3.47 (dd, 1 H, J_{gem} = 11.5, $J_{5'a,4'}$ = 5.0 Hz, 5′a-H), 3.67 (dd, 1 H, J_{gem} = 11.5, $J_{5'b,4'}$ = 3.6 Hz, 5′b-H), 3.70 (ddd, 1 H, $J_{4',3'}$ = 5.9, $J_{4',5'a}$ = 5.0, $J_{4',5'b}$ = 3.6 Hz, 4′-H), 3.73 (s, 3 H, CH_3O), 4.57 (s, 1 H, 1′-H), 6.87 (m, 2 H, 2-H, 6-H), 7.25 (m, 2 H, 3-H, 5-H) ppm. ^{13}C NMR (125.7 MHz, [D$_6$]DMSO): δ = 22.4 (CH_3-2′), 55.1 (CH_3-O), 61.8 (CH_2-5′), 75.6 (CH-3′), 77.6 (C-2′), 83.8 (CH-4′), 86.3 (CH-1′), 113.2 (CH-2, CH-6), 127.5 (CH-3, CH-5), 131.9 (C-4), 158.5 (C-1) ppm. IR (ATR): 3379, 2975, 1619, 1519, 1464, 1295, 1260, 1164, 1120, 1057 cm^{-1}. $[\alpha]_D^{20}$ = –5.2 (*c* 0.317, MeOH). $C_{13}H_{18}O_5{\cdot}0.3H_2O$: calcd. C 60.13, H 7.22; found C 60.14, H 7.15.

2-Methyl-5-(2-*C*-methyl-β-D-ribofuranosyl)pyridine (29a): A suspension of **19a** (420 mg, 0.85 mmol) and Pd/C (5%; "eggshell", unreduced form, 50% wet; 362 mg, 0.085 mmol) in acetic acid (5 mL) was vigorously stirred under a hydrogen atmosphere at room temp. After stirring for 2 d, the reaction mixture was filtered through a paper filter, and the filtrate was concentrated under reduced pressure. The residue was purified by flash chromatography on silica gel (0 to 15% of MeOH in ethyl acetate) to give **29a** (162 mg, 0.68 mmol, 80%) as a yellowish solid, m.p. 155–158 °C. HRMS (ESI): calcd. for $C_{12}H_{18}O_4N$ $[M + H]^+$ 240.12303; found 240.12297. ^1H NMR (500 MHz, [D$_6$]DMSO): δ = 0.66 (s, 3 H, CH_3-2′), 2.44 (s, 3 H, CH_3-2), 3.52 (t, 1 H, $J_{3',4'} = J_{3',OH}$ = 5.7 Hz, 3′-H), 3.58 (ddd, 1 H, J_{gem} = 11.8, $J_{5'a,4'}$ = 5.8, $J_{5'a,OH}$ = 5.0 Hz, 5′a-H), 3.67 (ddd, 1 H, J_{gem} = 11.8, $J_{5'b,OH}$ = 5.5, $J_{5'b,4'}$ = 3.7 Hz, 5′b-H), 3.73 (ddd, 1 H, $J_{4',3'}$ = 5.8, $J_{4',5'a}$ = 5.0, $J_{4',5'b}$ = 3.7 Hz, 4′-H), 4.63 (s, 1 H, 1′-H), 4.74 (s, 1 H, OH-2′), 4.85 (t, 1 H, $J_{OH,5'a} = J_{OH,5'b}$ = 5.7 Hz, OH-5′), 5.17 (d, 1 H, $J_{OH,3'}$ = 5.7 Hz, OH-3′), 7.20 (dm, 1 H, $J_{3,4}$ = 7.9 Hz, 3-H), 7.62 (ddd, 1 H, $J_{4,3}$ = 7.9, $J_{4,6}$ = 2.3, $J_{4,1'}$

= 0.8 Hz, 4-H), 8.39 (dt, 1 H, $J_{6,4}$ = 2.3, $J_{6,3}$ = $J_{6,1'}$ = 0.8 Hz, 6-H) ppm. ^{13}C NMR (125.7 MHz, [D$_6$]DMSO): δ = 22.2 (CH_3-2′), 23.9 (CH_3-2), 61.6 (CH_2-5′), 75.5 (CH-3′), 77.7 (C-2′), 84.3 and 84.3 (CH-1′, CH-4′), 122.4 (CH-3), 132.2 (C-5), 134.4 (CH-4), 147.1 (CH-6), 156.8 (C-2) ppm. IR (ATR): 3464, 3350, 2943, 2886, 1610, 1501, 1451, 1308, 1246, 1132, 1028 cm^{-1}. $[\alpha]_D^{20}$ = –11.5 (*c* 0.253, MeOH). $C_{12}H_{17}O_4N$: calcd. C 60.24, H 7.16, N 5.85; found C 59.93, H 7.2, N 5.56.

2-Amino-5-(2-*C*-methyl-β-D-ribofuranosyl)pyridine (29b): BCl_3 (1 M in CH_2Cl_2; 3.9 mL, 3.9 mmol) was added dropwise to a cooled (0 °C) solution of **19b** (200 mg, 0.39 mmol) in dry CH_2Cl_2 (2 mL). The mixture was stirred for 1 h at 0 °C, then it was warmed to room temp., and stirred for a further 1 h. Subsequently, MeOH (1 mL) was added, and the resulting solution was concentrated under reduced pressure. The crude product was purified by flash chromatography on silica gel (0 to 30% of MeOH in ethyl acetate) to give **29b** (89 mg, 0.37 mmol, 95%) as a yellowish foam. HRMS (ESI): calcd. for $C_{11}H_{17}O_4N_2$ [M + H]$^+$ 241.11828; found 241.11829. ^{1}H NMR (500 MHz, [D$_6$]DMSO): δ = 0.70 (s, 3 H, CH_3-2′), 3.47 (t, 1 H, $J_{3',4'}$ = $J_{3',OH}$ = 5.7 Hz, 3′-H), 3.54 (m, 1 H, 5′a-H), 3.62–3.68 (m, 2 H, 5′b-H, 4′-H), 4.46 (s, 1 H, 1′-H), 4.57 (s, 1 H, OH-2′), 4.78 (br. t, 1 H, $J_{OH,5'a}$ = $J_{OH,5'b}$ = 5.5 Hz, OH-5′), 5.06 (d, 1 H, $J_{OH,3'}$ = 5.7 Hz, OH-3′), 5.79 (br. s, 2 H, NH_2), 6.38 (d, 1 H, $J_{3,4}$ = 8.5 Hz, 3-H), 7.32 (dd, 1 H, $J_{4,3}$ = 8.5, $J_{4,6}$ = 2.4 Hz, 4-H), 7.81 (d, 1 H, $J_{6,4}$ = 2.4 Hz, 6-H) ppm. ^{13}C NMR (125.7 MHz, [D$_6$]DMSO): δ = 22.4 (CH_3-2′), 61.7 (CH_2-5′), 75.5 (CH-3′), 77.6 (C-2′), 83.7 (CH-4′), 85.2 (CH-1′), 107.3 (CH-3), 122.9 (C-5), 135.7 (CH-4), 146.0 (CH-6), 159.3 (C-2) ppm. IR (ATR): 3353, 3232, 2936, 1628, 1574, 1510, 1457, 1416, 1026 cm^{-1}. $[\alpha]_D^{20}$ = –6.2 (*c* 0.273, MeOH). $C_{11}H_{16}O_4N_2 \cdot 0.65H_2O$: calcd. C 52.44, H 6.92, N 11.12; found C 52.66, H 6.54, N 10.73.

2-(Dimethylamino)-5-(2-*C*-methyl-β-D-ribofuranosyl)pyridine (29c): A suspension of **19c** (850 mg, 1.58 mmol) and Pd/C (5%; "eggshell", unreduced form, 50% wet; 337 mg, 0.08 mmol) in acetic acid (9 mL) was vigorously stirred under a hydrogen atmosphere at room temp. After stirring for 3 d, the reaction mixture was filtered through a paper filter, and the filtrate was concentrated under reduced pressure. The residue was purified by flash chromatography on silica gel (0 to 10% of MeOH in CH_2Cl_2) to give **29c** (233 mg, 0.87 mmol, 55%) as a white solid, m.p. 163–165 °C. HRMS (ESI): calcd. for $C_{13}H_{21}O_4N_2$ [M + H]$^+$ 269.14958; found 269.14957. ^{1}H NMR (500 MHz, [D$_6$]DMSO): δ = 0.69 (s, 3 H, CH_3-2′), 2.99 [s, 6 H, $(CH_3)_2$N], 3.46 (d, 1 H, $J_{3',4'}$ = 6.1 Hz, 3′-H), 3.55 (m, 1 H, 5′a-H), 3.66 (m, 1 H, 5′b-H), 3.68 (br. ddd, 1 H, $J_{4',3'}$ = 6.1, $J_{4',5'}$ = 4.8 and 3.5 Hz, 4′-H), 4.52 (s, 1 H, 1′-H), 4.60 (s, 1 H, OH-2′), 4.80 (m, 1 H, OH-5′), 5.07 (br. s, 1 H, OH-3′), 6.58 (br. d, 1 H, $J_{3,4}$ = 8.8 Hz, 3-H), 7.46 (dd, 1 H, $J_{4,3}$ = 8.8, $J_{4,6}$ = 2.4 Hz, 4-H), 8.00 (d, 1 H, $J_{6,4}$ = 2.4 Hz, 6-H) ppm. ^{13}C NMR (125.7 MHz, [D$_6$]-DMSO): δ = 22.5 (CH_3-2′), 37.9 [$(CH_3)_2$N], 61.7 (CH_2-5′), 75.4 (CH-3′), 77.7 (C-2′), 83.7 (CH-4′), 85.1 (CH-1′), 105.1 (CH-3), 122.6 (C-5), 135.9 (CH-4), 145.9 (CH-6), 158.8 (C-2) ppm. IR (ATR): 3339, 3192, 2929, 1623, 1534, 1444, 1414, 1331, 1266, 1081 cm^{-1}. $[\alpha]_D^{20}$ = –4.5 (*c* 0.246, MeOH). $C_{13}H_{20}O_4N_2 \cdot 0.35H_2O$: calcd. C 56.86, H 7.6, N 10.2; found C 57.13, H 7.45, N 9.78.

5-(2-*C*-Methyl-β-D-ribofuranosyl)-2-pyridone (29d): BCl_3 (1 M in CH_2Cl_2; 7.82 mL, 7.82 mmol) was added dropwise to a cooled (–78 °C) solution of **19d** (400 mg, 0.782 mmol) in dry CH_2Cl_2 (2 mL). The resulting solution was stirred at –78 °C for 1 h. Subsequently, MeOH (2 mL) was added, and the reaction mixture was warmed to room temp., and concentrated under reduced pressure. The crude product was purified by flash chromatography on silica gel (0 to 20% of MeOH in ethyl acetate) to give **29d** (174 mg, 0.721 mmol, 92%) as a white solid, m.p. 79–81 °C. HRMS (ESI): calcd. for $C_{11}H_{15}O_5NNa$ [M + Na]$^+$ 264.08424; found 264.08432. ^{1}H NMR (500 MHz, [D$_6$]DMSO): δ = 0.77 (s, 3 H, CH_3-2′), 3.48 (br. d, 1 H, $J_{3',4'}$ = 5.9 Hz, 3′-H), 3.52 (m, 1 H, 5′a-H), 3.61–3.68 (m, 2 H, 5′b-H, 4′-H), 4.40 (s, 1 H, 1′-H), 4.61 (s, 1 H, OH-2′), 4.81 (m, 1 H, OH-5′), 5.08 (br. s, 1 H, OH-3′), 6.29 (dd, 1 H, $J_{3,4}$ = 9.4, $J_{3,6}$ = 0.6 Hz, 3-H), 7.27 (dt, 1 H, $J_{6,4}$ = 2.6, $J_{6,3}$ = $J_{6,1'}$ = 0.8 Hz, 6-H), 7.40 (dd, 1 H, $J_{4,3}$ = 9.4, $J_{4,6}$ = 2.6 Hz, 4-H), 11.49 (br. s, 1 H, NH) ppm. ^{13}C NMR (125.7 MHz, [D$_6$]DMSO): δ = 22.1 (CH_3-2′), 61.3 (CH_2-5′), 75.1 (CH-3′), 77.6 (C-2′), 83.8 (CH-1′, 4′-H), 116.6 (C-5), 119.3 (CH-3), 132.4 (CH-6), 140.2 (CH-4), 162.4 (C-2) ppm. IR (ATR): 3266, 3154, 2885, 1662, 1614, 1551, 1460, 1425, 1073 cm^{-1}. $[\alpha]_D^{20}$ = –29.1 (*c* 0.234, MeOH). $C_{11}H_{15}O_5N \cdot 0.2H_2O$: calcd. C 53.96, H 6.34, N 5.72; found C 54.01, H 6.27, N 5.53.

2-Methoxy-5-(2-*C*-methyl-β-D-ribofuranosyl)pyridine (29e): A suspension of **19e** (500 mg, 0.95 mmol) and Pd/C (5%; "eggshell", unreduced form, 50% wet; 404 mg, 0.095 mmol) in acetic acid (5 mL) was vigorously stirred under a hydrogen atmosphere at room temp. After stirring for 1 d, the reaction mixture was filtered through a paper filter, and the filtrate was concentrated under reduced pressure. The residue was purified by flash chromatography on silica gel (0 to 3% of MeOH in ethyl acetate) to give **29e** (215 mg, 0.84 mmol, 89%) as a white foam. HRMS (ESI): calcd. for $C_{12}H_{18}O_5N$ [M + H]$^+$ 256.11795; found 256.11797. ^{1}H NMR (500 MHz, [D$_6$]DMSO): δ = 0.68 (s, 3 H, CH_3-2′), 3.53 (t, 1 H, $J_{3',4'}$ = $J_{3'OH'}$ = 5.8 Hz, 3′-H), 3.57 (ddd, 1 H, J_{gem} = 11.8, $J_{5'a,OH}$ = 5.8, $J_{5'a,4'}$ = 4.8 Hz, 5′a-H), 3.67 (ddd, 1 H, J_{gem} = 11.8, $J_{5'b,OH}$ = 5.5, $J_{5'b,4'}$ = 3.6 Hz, 5′b-H), 3.72 (ddd, 1 H, $J_{4',3'}$ = 5.9, $J_{4',5'a}$ = 4.8, $J_{4',5'b}$ = 3.6 Hz, 4′-H), 3.83 (s, 3 H, CH_3O), 4.62 (s, 1 H, 1′-H), 4.69 (s, 1 H, OH-2′), 4.82 (t, 1 H, $J_{OH,5'a}$ = $J_{OH,5'b}$ = 5.6 Hz, OH-5′), 5.11 (d, 1 H, $J_{OH,3'}$ = 5.8 Hz, OH-3′), 6.77 (dd, 1 H, $J_{3,4}$ = 8.5, $J_{3,6}$ = 0.9 Hz, 3-H), 7.67 (ddd, 1 H, $J_{4,3}$ = 8.5, $J_{4,6}$ = 2.4, $J_{4,1'}$ = 0.6 Hz, 4-H), 8.10 (dt, 1 H, $J_{6,4}$ = 2.4, $J_{6,3}$ = $J_{6,1'}$ = 0.8 Hz, 6-H) ppm. ^{13}C NMR (125.7 MHz, [D$_6$]DMSO): δ = 22.2 (CH_3-2′), 53.2 (CH_3O), 61.5 (CH_2-5′), 75.3 (CH-3′), 77.7 (C-2′), 84.1 (CH-4′), 84.3 (CH-1′), 109.8 (CH-3), 128.4 (C-5), 137.6 (CH-4), 144.8 (CH-6), 163.1 (C-2) ppm. IR (ATR): 3359, 2935, 1614, 1579, 1499, 1457, 1399, 1288, 1259, 1068, 1024 cm^{-1}. $[\alpha]_D^{20}$ = –6.7 (*c* 0.255, MeOH). $C_{12}H_{17}O_5N$: calcd. C 56.46, H 6.71, N 5.49; found C 56.24, H 6.8, N 5.21.

5-Methyl-2-(2-*C*-methyl-β-D-ribofuranosyl)pyridine (30a): A suspension of **20a** (430 mg, 0.844 mmol) and Pd/C (5%; "eggshell", unreduced form, 50% wet; 360 mg, 0.0844 mmol) in acetic acid (5 mL) was vigorously stirred under a hydrogen atmosphere at room temp. After stirring for 1 d, the reaction mixture was filtered through a paper filter, and the filtrate was concentrated under reduced pressure. The residue was purified by flash chromatography on silica gel (0 to 5% of MeOH in CH_2Cl_2) to give **30a** (175 mg, 0.731 mmol, 87%) as a yellowish foam. HRMS (ESI): calcd. for $C_{12}H_{18}O_4N$ [M + H]$^+$ 240.12303; found 240.12296. ^{1}H NMR (500 MHz, [D$_6$]DMSO): δ = 0.68 (s, 3 H, CH_3-2′), 2.27 (s, 3 H, CH_3-5), 3.60 (m, 1 H, 5′a-H), 3.69 (dd, 1 H, $J_{3',4'}$ = 8.2, $J_{3',OH}$ = 6.9 Hz, 3-H), 3.77 (ddd, 1 H, J_{gem} = 11.7, $J_{5'b,OH}$ = 4.1, $J_{5'b,4'}$ = 2.6 Hz, 5′b-H), 3.80 (ddd, 1 H, $J_{4',3'}$ = 8.2, $J_{4',5'a}$ = 3.8, $J_{4',5'b}$ = 2.6 Hz, 4′-H), 4.70 (s, 1 H, OH-2′), 4.75 (s, 1 H, 1′-H), 4.93 (d, 1 H, $J_{OH,3'}$ = 6.9 Hz, OH-3′), 5.20 (dd, 1 H, $J_{OH,5'a}$ = 6.5, $J_{OH,5'b}$ = 4.1 Hz, OH-5′), 7.41 (dd, 1 H, $J_{3,4}$ = 8.0, $J_{3,6}$ = 0.8 Hz, 3-H), 7.58 (ddq, 1 H, $J_{4,3}$ = 8.0, $J_{4,6}$ = 2.3, $J_{4,CH3}$ = 0.8 Hz, 4-H), 8.37 (dpent, 1 H, $J_{6,4}$ = 2.3, $J_{6,3}$ = $J_{6,CH3}$ = 0.8 Hz, 6-H) ppm. ^{13}C NMR (125.7 MHz, [D$_6$]DMSO): δ = 17.8 (CH_3-5), 22.2 (CH_3-2′), 61.1 (CH_2-5′), 73.9 (CH-3′), 78.6 (C-2′), 82.4 (CH-4′), 88.7 (CH-1′), 121.3 (CH-3), 131.8 (C-5), 137.1 (CH-4), 148.7 (CH-6), 157.8 (C-

2) ppm. IR (ATR): 3330, 2933, 1610, 1579, 1497, 1456, 1382, 1294, 1073, 1048, 1021 cm^{-1}. $[\alpha]_D^{20}$ = –22 (*c* 0.286, MeOH). $C_{12}H_{17}O_4N·0.35H_2O$: calcd. C 58.69, H 7.26, N 5.7; found C 58.95, H 7.42, N 5.4.

5-Amino-2-(2-*C*-methyl-β-D-ribofuranosyl)pyridine (30b): BCl_3 (1 M in CH_2Cl_2; 1.96 mL, 1.96 mmol) was added dropwise to a cooled (–78 °C) solution of **20b** (100 mg, 0.196 mmol) in dry CH_2Cl_2 (1 mL). The resulting solution was stirred at –78 °C for 1 h. Subsequently, MeOH (1 mL) was added, and the reaction mixture was warmed to room temp., and concentrated under reduced pressure. The crude product was purified by flash chromatography on silica gel (0 to 25% of MeOH in ethyl acetate) to give **30b** (46 mg, 0.191 mmol, 98%) as a white foam. HRMS (ESI): calcd. for $C_{11}H_{17}O_4N_2$ $[M + H]^+$ 241.11828; found 241.11811. ^1H NMR (500 MHz, [D$_6$]DMSO): δ = 0.69 (s, 3 H, CH_3-2′), 3.56 (m, 1 H, 5′a-H), 3.72–3.79 (m, 3 H, 5′b-H, 4′-H, 3′-H), 4.56 (s, 1 H, OH-2′), 4.61 (s, 1 H, 1′-H), 4.86 (d, 1 H, $J_{OH,3'}$ = 6.3 Hz, OH-3′), 5.27 (br. s, 2 H, NH_2), 5.43 (br. s, 1 H, OH-5′), 6.89 (dd, 1 H, $J_{4,3}$ = 8.3, $J_{4,6}$ = 2.7 Hz, 4-H), 7.08 (br. d, 1 H, $J_{3,4}$ = 8.3 Hz, 3-H), 7.82 (dd, 1 H, $J_{6,4}$ = 2.7, $J_{6,3}$ = 0.7 Hz, 6-H) ppm. ^{13}C NMR (125.7 MHz, [D$_6$]DMSO): δ = 22.1 (CH_3-2′), 61.2 (CH_2-5′), 73.7 (CH-3′), 78.7 (C-2′), 82.1 (CH-4′), 88.6 (CH-1′), 120.5 (CH-4), 122.1 (CH-3), 134.9 (CH-6), 144.1 (C-5), 147.6 (C-2) ppm. IR (ATR): 3352, 3238, 2918, 1634, 1606, 1501, 1305, 1073, 1048, 1013 cm^{-1}. $[\alpha]_D^{20}$ = –18 (*c* 0.316, MeOH). $C_{11}H_{16}O_4N_2·0.3H_2O$: calcd. C 53.78, H 6.81, N 11.4; found C 54.02, H 6.76, N 11.08.

5-(Dimethylamino)-2-(2-*C*-methyl-β-D-ribofuranosyl)pyridine (30c): BCl_3 (1 M in CH_2Cl_2; 9.28 mL, 9.28 mmol) was added dropwise to a cooled (–78 °C) solution of **20c** (500 mg, 0.928 mmol) in dry CH_2Cl_2 (5 mL). The resulting solution was stirred at –78 °C for 1 h. Subsequently, MeOH (1 mL) was added, and the reaction mixture was warmed to room temp., and concentrated under reduced pressure. The crude product was purified by flash chromatography on silica gel (0 to 40% of MeOH in ethyl acetate) to give **30c** (226 mg, 0.842 mmol, 91%) as a white solid, m.p. 143–144 °C. HRMS (ESI): calcd. for $C_{13}H_{21}O_4N_2$ $[M + H]^+$ 269.14958; found 269.14969. ^1H NMR (500 MHz, [D$_6$]DMSO): δ = 0.69 (s, 3 H, CH_3-2′), 2.91 [s, 6 H, $(CH_3)_2N$], 3.58 (ddd, 1 H, J_{gem} = 11.7, $J_{5'a,OH}$ = 6.7, $J_{5',4'}$ = 3.4 Hz, 5′a-H), 3.73–3.81 (m, 3 H, 5′b-H, 4′-H, 3′-H), 4.60 (s, 1 H, OH-2′), 4.69 (s, 1 H, 1′-H), 4.88 (d, 1 H, $J_{OH,3'}$ = 6.3 Hz, OH-3′), 5.35 (br. dd, 1 H, $J_{OH,5'a}$ = 6.7, $J_{OH,5'b}$ = 3.4 Hz, OH-5′), 7.08 (dd, 1 H, $J_{4,3}$ = 8.7, $J_{4,6}$ = 3.1 Hz, 4-H), 7.26 (br. dt, 1 H, $J_{3,4}$ = 8.7, $J_{3,6}$ = $J_{3,1'}$ = 0.6 Hz, 3-H), 7.99 (dd, 1 H, $J_{6,4}$ = 3.1, $J_{6,3}$ = 0.7 Hz, 6-H) ppm. ^{13}C NMR (125.7 MHz, [D$_6$]DMSO): δ = 22.1 (CH_3-2′), 39.9 [$(CH_3)_2N$], 61.3 (CH_2-5′), 73.8 (CH-3′), 78.7 (C-2′), 82.2 (CH-4′), 88.6 (CH-1′), 119.2 (CH-4), 121.9 (CH-3), 133.2 (CH-6), 145.4 (C-5), 147.8 (C-2) ppm. IR (ATR): 3410, 2887, 1603, 1562, 1508, 1452, 1365, 1311, 1218, 1104, 1060 cm^{-1}. $[\alpha]_D^{20}$ = –21.5 (*c* 0.256, MeOH). $C_{13}H_{20}O_4N_2$: calcd. C 58.19, H 7.51, N 10.44; found C 57.93, H 7.17, N 10.23.

5-Hydroxy-2-(2-*C*-methyl-β-D-ribofuranosyl)pyridine (30d): A suspension of **20d** (170 mg, 0.33 mmol) and Pd/C (5%; "eggshell", unreduced form, 50% wet; 72 mg, 0.017 mmol) in acetic acid (2 mL) was vigorously stirred under a hydrogen atmosphere at room temp. After stirring for 1 d, the reaction mixture was filtered through a paper filter, and the filtrate was concentrated under reduced pressure. The residue was purified by flash chromatography on silica gel (0 to 10% of MeOH in ethyl acetate) to give **30d** (77 mg, 0.32 mmol, 97%) as a white foam. HRMS (ESI): calcd. for $C_{11}H_{15}O_5NNa$ $[M + Na]^+$ 264.08424; found 264.08431. ^1H NMR (500 MHz, [D$_6$]DMSO): δ = 0.68 (s, 3 H, CH_3-2′), 3.58 (m, 1 H, 5′a-H), 3.69 (dd, 1 H, $J_{3',4'}$ = 8.3, $J_{3',OH}$ = 6.7 Hz, 3′-H), 3.75 (m, 1 H, 5′b-H), 3.78 (ddd, 1 H, $J_{4',3'}$ = 8.3, $J_{4',5'a}$ = 3.8, $J_{4',5'b}$ = 2.5 Hz, 3′-H), 4.61 (s, 1 H, OH-2′), 4.69 (s, 1 H, 1′-H), 4.88 (d, 1 H, $J_{OH,3'}$ = 6.8 Hz, OH-3′), 5.14 (br. dd, 1 H, $J_{OH,5'a}$ = 6.6, $J_{OH,5'b}$ = 4.1 Hz, OH-5′), 7.13 (dd, 1 H, $J_{4,3}$ = 8.5, $J_{4,6}$ = 2.8 Hz, 4-H), 7.31 (d, 1 H, $J_{3,4}$ = 8.5 Hz, 3-H), 8.03 (dd, 1 H, $J_{6,4}$ = 2.8, $J_{6,3}$ = 0.7 Hz, 6-H), 9.84 (br. s, 1 H, OH) ppm. ^{13}C NMR (125.7 MHz, [D$_6$]DMSO): δ = 22.1 (CH_3-2′), 61.2 (CH_2-5′), 73.9 (CH-3′), 78.5 (C-2′), 82.3 (CH-4′), 88.6 (CH-1′), 122.4 (CH-3), 122.7 (CH-4), 136.5 (CH-6), 151.1 (C-2), 152.8 (C-5) ppm. IR (ATR): 3354, 2882, 1583, 1501, 1454, 1277, 1123, 1073 cm^{-1}. $[\alpha]_D^{20}$ = –22.3 (*c* 0.292, MeOH). $C_{11}H_{15}O_5N·0.4H_2O$: calcd. C 53.18, H 6.41, N 5.64; found C 53.4, H 6.41, N 5.4.

5-Methoxy-2-(2-*C*-methyl-β-D-ribofuranosyl)pyridine (30e): A suspension of **20e** (194 mg, 0.37 mmol) and Pd/C (5%; "eggshell", unreduced form, 50% wet; 78 mg, 0.019 mmol) in acetic acid (2 mL) was vigorously stirred under a hydrogen atmosphere at room temp. After stirring for 1 d, the reaction mixture was filtered through a paper filter, and the filtrate was concentrated under reduced pressure. The residue was purified by flash chromatography on silica gel (0 to 10% of MeOH in ethyl acetate) to give **30e** (72 mg, 0.28 mmol, 76%) as a white foam. HRMS (ESI): calcd. for $C_{12}H_{17}O_5NNa$ $[M + H]^+$ 278.09989; found 278.09993. ^1H NMR (500 MHz, [D$_6$]DMSO): δ = 0.68 (s, 3 H, CH_3-2′), 3.60 (m, 1 H, 5′a-H), 3.68 (dd, 1 H, $J_{3',4'}$ = 8.3, $J_{3',OH}$ = 6.9 Hz, 3′-H), 3.76 (m, 1 H, 5′b-H), 3.79 (ddd, 1 H, $J_{4',3'}$ = 8.3, $J_{4',5'a}$ = 3.9, $J_{4',5'b}$ = 2.5 Hz, 4′-H), 3.81 (s, 3 H, CH_3O), 4.67 (s, 1 H, OH-2′), 4.74 (s, 1 H, 1′-H), 4.92 (d, 1 H, $J_{OH,3'}$ = 6.9 Hz, OH-3′), 5.09 (dd, 1 H, $J_{OH,5'a}$ = 6.3, $J_{OH,5'b}$ = 4.3 Hz, OH-5′), 7.36 (dd, 1 H, $J_{4,3}$ = 8.6, $J_{4,6}$ = 3.0 Hz, 4-H), 7.47 (br. d, 1 H, $J_{3,4}$ = 8.6 Hz, 3-H), 8.20 (dd, 1 H, $J_{6,4}$ = 3.0, $J_{6,3}$ = 0.7 Hz, 6-H) ppm. ^{13}C NMR (125.7 MHz, [D$_6$]DMSO): δ = 22.2 (CH_3-2′), 55.7 (CH_3O), 61.1 (CH_2-5′), 73.9 (CH-3′), 78.5 (C-2′), 82.3 (CH-4′), 88.6 (CH-1′), 121.1 (CH-4), 122.2 (CH-3), 135.9 (CH-6), 152.7 (C-2), 154.6 (C-5) ppm. IR (ATR): 3334, 2939, 1580, 1495, 1461, 1403, 1275, 1122, 1073, 1018 cm^{-1}. $[\alpha]_D^{20}$ = –18.9 (*c* 0.312, MeOH). $C_{12}H_{17}O_5N·1.05H_2O$: calcd. C 52.57, H 7.02, N 5.11; found C 52.89, H 6.93, N 4.79.

General Procedure for the Synthesis of Triphosphates 31, 32a–32e, 33a–33e, and 34a–34e: A solution of *C*-nucleoside (0.2 mmol) in $P(O)(OMe)_3$ (0.47 mL, 4 mmol) was treated with $POCl_3$ (22 μL, 0.24 mmol) at 0 °C for 2 h. Then, an ice-cold solution of $(Bu_3NH)_2H_2P_2O_7$ (548 mg, 1 mmol) and Bu_3N (0.19 mL, 0.8 mmol) in dry DMF (1.5 mL) was added, and the resulting solution was stirred at 0 °C for an additional 2 h. The reaction mixture was quenched with TEAB (2 M aq.; 1.5 mL), then it was warmed to room temp., and concentrated under reduced pressure. The residue was coevaporated several times with water. The crude product was purified on Sephadex [0 to 60% of TEAB (2 M aq.) in water] and then by HPLC {C18 column; TEAB (0.1 M aq.) to TEAB [0.1 M in water/MeOH (1:1)]} to give the desired triphosphates.

(2-*C*-Methyl-β-D-ribofuranosyl)benzene 5′-*O*-Triphosphate (31): Compound **31** was prepared from compound **22** (45 mg, 0.2 mmol) following the general procedure for the synthesis of triphosphates. Before lyophilization, **31** was converted to its sodium salt form (Dowex 50WX8 in Na^+ cycle). Lyophilization from water gave triphosphate **31** (99 mg, 0.186 mmol, 93%; trisodium salt) as a white powder. HRMS (ESI): calcd. for $C_{12}H_{16}O_{13}Na_2P_3$ $[M·3Na – Na]^-$ 506.95937; found 506.95962. ^1H NMR (500 MHz, D_2O): δ = 0.87 (s, 3 H, CH_3-2′), 3.99 (d, 1 H, $J_{3',4'}$ = 7.3 Hz, 3′-H), 4.14 (dddd, 1 H, $J_{4',3'}$ = 7.3, $J_{4',5'a}$ = 4.9, $J_{4',5'b}$ = 3.1, $J_{4',P}$ = 1.2 Hz, 4′-H), 4.28 (ddd, 1 H, J_{gem} = 11.7, $J_{5'a,P}$ = 6.5, $J_{5'a,4'}$ = 4.9 Hz, 5′a-H), 4.36 (ddd, 1 H, J_{gem} = 11.7, $J_{5'b,P}$ = 5.6, $J_{5'b,4'}$ = 3.1 Hz, 5′b-H), 4.91 (s, 1 H, 1′-H), 7.36–7.50 (m, 5 H, H-*o*,*m*,*p*-Ph) ppm. ^{13}C NMR

(125.7 MHz, D_2O): δ = 21.72 (CH_3-2′), 65.9 [d, $J_{C,P}$ = 5.6 Hz, CH_2-5′], 75.1 (CH-3′), 79.4 (C-2′), 81.4 (d, $J_{C,P}$ = 8.8 Hz, CH-4′), 88.7 (CH-1′), 127.4 (CH-*o*-Ph), 128.8 (CH-*p*-Ph), 129.0 (CH-*m*-Ph), 138.7 (C-*i*-Ph) ppm. ^{31}P NMR (202.4 MHz, D_2O): δ = –22.59 (t, 1 P, $J_{\beta,\alpha}$ = $J_{\beta,\gamma}$ = 19.6 Hz, P_β), –10.94 (d, 1 P, $J_{\alpha,\beta}$ = 19.5 Hz, P_α), –9.45 (d, 1 P, $J_{\gamma,\beta}$ = 19.7 Hz, P_γ) ppm.

4-Methyl-1-(2-*C*-methyl-β-D-ribofuranosyl)benzene 5′-*O*-Triphosphate (32a): Compound **32a** was prepared from compound **28a** (48 mg, 0.2 mmol) following the general procedure for the synthesis of triphosphates. Lyophilization from water gave triphosphate **32a** (94 mg, 0.12 mmol, 60%; triethylammonium salt) as a white foam. HRMS (ESI): calcd. for $C_{13}H_{20}O_{13}P_3$ [M – H]$^-$ 477.01222; found 477.01166. ^{1}H NMR (500 MHz, D_2O): δ = 0.86 (s, 3 H, CH_3-2′), 1.27 [t, 27 H, $J_{CH3,CH2}$ = 7.3 Hz, (CH_3CH_2)$_3$NH$^+$], 2.34 (s, 3 H, CH_3-Ph), 3.19 [q, 18 H, $J_{CH2,CH3}$ = 7.3 Hz, (CH_3CH_2)$_3$NH$^+$], 3.98 (d, 1 H, $J_{3',4'}$ = 7.3 Hz, 3′-H), 4.12 (dddd, 1 H, $J_{4',3'}$ = 7.3, $J_{4',5'a}$ = 4.9, $J_{4',5'b}$ = 3.1, $J_{4',P}$ = 1.3 Hz, 4′-H), 4.27 (ddd, 1 H, J_{gem} = 11.6, $J_{5'a,P}$ = 6.4, $J_{5'a,4'}$ = 4.9 Hz, 5′a-H), 4.34 (ddd, 1 H, J_{gem} = 11.6, $J_{5'b,P}$ = 5.5, $J_{5'b,4'}$ = 3.1 Hz, 5′b-H), 4.87 (s, 1 H, 1′-H), 7.29 (m, 2 H, 3-H, 5-H), 7.33 (m, 2 H, 2-H, 6-H) ppm. ^{13}C NMR (125.7 MHz, D_2O): δ = 8.8 [(CH_3CH_2)$_3$NH$^+$], 20.8 (CH_3-Ph), 21.7 (CH_3-2′), 47.3 [(CH_3CH_2)$_3$NH$^+$], 65.9 (d, $J_{C,P}$ = 6.0 Hz, CH_2-5′), 75.0 (CH-3′), 79.4 (C-2′), 81.2 (d, $J_{C,P}$ = 9.0 Hz, CH-4′), 88.7 (CH-1′), 127.5 (CH-2, CH-6), 129.6 (CH-3, CH-5), 135.8 (C-1), 139.0 (C-4) ppm. ^{31}P NMR (202.4 MHz, D_2O): δ = –22.56 (t, 1 P, $J_{\beta,\alpha}$ = $J_{\beta,\gamma}$ = 19.7 Hz, P_β), –10.49 (d, 1 P, $J_{\alpha,\beta}$ = 19.9 Hz, P_α), –10.23 (d, 1 P, $J_{\gamma,\beta}$ = 19.6 Hz, P_γ) ppm.

4-(2-*C*-Methyl-β-D-ribofuranosyl)aniline 5′-*O*-Triphosphate (32b): Compound **32b** was prepared from compound **28b** (48 mg, 0.2 mmol) following the general procedure for the synthesis of triphosphates. Lyophilization from water gave triphosphate **32b** (87 mg, 0.128 mmol, 64%; diethylammonium salt) as a white foam. HRMS (ESI): calcd. for $C_{12}H_{19}O_{13}NP_3$ [M – H]$^-$ 478.00747; found 478.00726. ^{1}H NMR (500 MHz, D_2O): δ = 0.88 (s, 3 H, CH_3-2′), 1.27 [t, 18 H, $J_{CH3,CH2}$ = 7.4 Hz, (CH_3CH_2)$_3$NH$^+$], 3.19 [q, 12 H, $J_{CH2,CH3}$ = 7.4 Hz, (CH_3CH_2)$_3$NH$^+$], 3.99 (d, 1 H, $J_{3',4'}$ = 7.4 Hz, 3′-H), 4.10 (dddd, 1 H, $J_{4',3'}$ = 7.4, $J_{4',5'a}$ = 4.7, $J_{4',5'b}$ = 3.0, $J_{4',P}$ = 1.4 Hz, 4′-H), 4.26 (ddd, 1 H, J_{gem} = 11.7, $J_{5'a,P}$ = 6.4, $J_{5'a,4'}$ = 4.7 Hz, 5′a-H), 4.34 (ddd, 1 H, J_{gem} = 11.7, $J_{5'b,P}$ = 5.4, $J_{5'b,4'}$ = 3.0 Hz, 5′b-H), 4.83 (s, 1 H, 1′-H), 6.99 (m, 2 H, 2-H, 6-H), 7.31 (m, 2 H, 3-H, 5-H) ppm. ^{13}C NMR (125.7 MHz, D_2O): δ = 8.9 [(CH_3CH_2)$_3$NH$^+$], 21.7 (CH_3-2′), 47.3 [(CH_3CH_2)$_3$NH$^+$], 65.8 (d, $J_{C,P}$ = 5.6 Hz, CH_2-5′), 74.9 (CH-3′), 79.4 (C-2′), 81.1 (d, $J_{C,P}$ = 8.9 Hz, CH-4′), 88.7 (CH-1′), 118.3 (CH-2, CH-6), 128.8 (CH-3, CH-5), 132.0 (C-4), 142.9(C-1) ppm. ^{31}P NMR (202.4 MHz, D_2O): δ = –22.51 (t, 1 P, $J_{\beta,\alpha}$ = $J_{\beta,\gamma}$ = 19.8 Hz, P_β), –10.44 (d, 1 P, $J_{\alpha,\beta}$ = 19.9 Hz, P_α), –10.08 (d, 1 P, $J_{\gamma,\beta}$ = 19.8 Hz, P_γ) ppm.

***N*,*N*-Dimethyl-4-(2-*C*-methyl-β-D-ribofuranosyl)aniline 5′-*O*-Triphosphate (32c):** Compound **32c** was prepared from compound **28c** (53 mg, 0.2 mmol) following the general procedure for the synthesis of triphosphates. Lyophilization from water gave triphosphate **32c** (133 mg, 0.164 mmol, 82%; triethylammonium salt) as a white foam. HRMS (ESI): calcd. for $C_{14}H_{23}O_{13}NP_3$ [M – H]$^-$ 506.03877; found 506.03847. ^{1}H NMR (500 MHz, D_2O): δ = 0.87 (s, 3 H, CH_3-2′), 1.27 [t, 27 H, $J_{CH3,CH2}$ = 7.3 Hz, (CH_3CH_2)$_3$NH$^+$], 2.97 [s, 6 H, (CH_3)$_2$N], 3.19 [q, 18 H, $J_{CH2,CH3}$ = 7.3 Hz, (CH_3CH_2)$_3$NH$^+$], 4.00 (d, 1 H, $J_{3',4'}$ = 7.5 Hz, 3′-H), 4.11 (dddd, 1 H, $J_{4',3'}$ = 7.5, $J_{4',5'a}$ = 4.5, $J_{4',5'b}$ = 2.9, $J_{4',P}$ = 1.4 Hz, 4′-H), 4.27 (ddd, 1 H, J_{gem} = 11.7, $J_{5'a,P}$ = 6.4, $J_{5'a,4'}$ = 4.6 Hz, 5′a-H), 4.35 (ddd, 1 H, J_{gem} = 11.7, $J_{5'b,P}$ = 5.3, $J_{5'b,4'}$ = 2.9 Hz, 5′b-H), 4.87 (s, 1 H, 1′-H), 7.20 (m, 2 H, 2-H, 6-H), 7.43 (m, 2 H, 3-H, 5-H) ppm. ^{13}C NMR (125.7 MHz, D_2O): δ = 8.9 [(CH_3CH_2)$_3$NH$^+$], 21.7 (CH_3-2′), 43.2 [(CH_3)$_2$N], 47.3 [(CH_3CH_2)$_3$NH$^+$], 65.7 (d, $J_{C,P}$ = 5.6 Hz, CH_2-5′), 74.8 (CH-3′), 79.6 (C-2′), 81.1 (d, $J_{C,P}$ = 8.8 Hz, CH-4′), 88.5 (CH-1′), 117.3 (CH-2, CH-6), 128.7 (CH-3, CH-5), 132.9 (C-4), 149.2 (C-1) ppm. ^{31}P NMR (202.4 MHz, D_2O): δ = –22.54 (t, 1 P, $J_{\beta,\alpha}$ = $J_{\beta,\gamma}$ = 19.8 Hz, P_β), –10.48 (d, 1 P, $J_{\alpha,\beta}$ = 19.9 Hz, P_α), –9.95 (d, 1 P, $J_{\gamma,\beta}$ = 19.8 Hz, P_γ) ppm.

4-(2-*C*-Methyl-β-D-ribofuranosyl)phenol 5′-*O*-Triphosphate (32d): Compound **32d** was prepared from compound **28d** (48 mg, 0.2 mmol) following the general procedure for the synthesis of triphosphates. Lyophilization from water gave triphosphate **32d** (110 mg, 0.14 mmol, 70%; triethylammonium salt) as a white foam. HRMS (ESI): calcd. for $C_{12}H_{18}O_{14}P_3$ [M – H]$^-$ 478.99149; found 478.99063. ^{1}H NMR (500 MHz, D_2O): δ = 0.88 (s, 3 H, CH_3-2′), 1.27 [t, 27 H, $J_{CH3,CH2}$ = 7.4 Hz, (CH_3CH_2)$_3$NH$^+$], 3.19 [q, 18 H, $J_{CH2,CH3}$ = 7.4 Hz, (CH_3CH_2)$_3$NH$^+$], 3.99 (d, 1 H, $J_{3',4'}$ = 7.4 Hz, 3′-H), 4.10 (dddd, 1 H, $J_{4',3'}$ = 7.4, $J_{4',5'a}$ = 4.6, $J_{4',5'b}$ = 3.0, $J_{4',P}$ = 1.3 Hz, 4′-H), 4.26 (ddd, 1 H, J_{gem} = 11.6, $J_{5'a,P}$ = 6.4, $J_{5'a,4'}$ = 4.7 Hz, 5′a-H), 4.34 (ddd, 1 H, J_{gem} = 11.6, $J_{5'b,P}$ = 5.4, $J_{5'b,4'}$ = 3.0 Hz, 5′b-H), 4.83 (s, 1 H, 1′-H), 6.92 (m, 2 H, 2-H, 6-H), 7.31 (m, 2 H, 3-H, 5-H) ppm. ^{13}C NMR (125.7 MHz, D_2O): δ = 8.8 [(CH_3CH_2)$_3$NH$^+$], 21.7 (CH_3-2′), 47.3 [(CH_3CH_2)$_3$NH$^+$], 65.8 (d, $J_{C,P}$ = 5.6 Hz, CH_2-5′), 74.9 (CH-3′), 79.4 (C-2′), 81.1 (d, $J_{C,P}$ = 8.9 Hz, CH-4′), 88.7 (CH-1′), 115.7 (CH-2, CH-6), 129.1 (CH-3, CH-5), 130.9 (C-4), 155.9 (C-1) ppm. ^{31}P NMR (202.4 MHz, D_2O): δ = –22.36 (t, 1 P, $J_{\beta,\alpha}$ = $J_{\beta,\gamma}$ = 19.5 Hz, P_β), –10.44 (d, 1 P, $J_{\alpha,\beta}$ = 19.7 Hz, P_α), –9.47 (br. s, 1 P, P_γ) ppm.

4-(2-*C*-Methyl-β-D-ribofuranosyl)anisole 5′-*O*-Triphosphate (32e): Compound **32e** was prepared from compound **28e** (51 mg, 0.2 mmol) following the general procedure for the synthesis of triphosphates. Before lyophilization, **32e** was converted to its sodium salt form (Dowex 50WX8 in Na^+ cycle). Lyophilization from water gave triphosphate **32e** (86 mg, 0.154 mmol, 77%; trisodium salt) as a white powder. HRMS (ESI): calcd. for $C_{13}H_{18}O_{14}Na_2P_3$ [M·3Na – Na]$^-$ 536.96993; found 536.96975. ^{1}H NMR (500 MHz, D_2O): δ = 0.87 (s, 3 H, CH_3-2′), 3.84 (s, 3 H, CH_3O), 4.00 (d, 1 H, $J_{3',4'}$ = 7.5 Hz, 3′-H), 4.12 (dddd, 1 H, $J_{4',3'}$ = 7.5, $J_{4',5'a}$ = 4.7, $J_{4',5'b}$ = 3.0, $J_{4',P}$ = 1.2 Hz, 4′-H), 4.28 (ddd, 1 H, J_{gem} = 11.7, $J_{5'a,P}$ = 6.5, $J_{5'a,4'}$ = 4.8 Hz, 5′a-H), 4.35 (ddd, 1 H, J_{gem} = 11.7, $J_{5'b,P}$ = 5.5, $J_{5'b,4'}$ = 3.1 Hz, 5′b-H), 4.87 (s, 1 H, 1′-H), 6.92 (m, 2 H, 2-H, 6-H), 7.27 (m, 2 H, 3-H, 5-H) ppm. ^{13}C NMR (125.7 MHz, D_2O): δ = 21.7 (CH_3-2′), 56.0 (CH_3O), 65.8 (d, $J_{C,P}$ = 5.8 Hz, CH_2-5′), 74.9 (CH-3′), 79.5 (C-2′), 81.2 (d, $J_{C,P}$ = 8.7 Hz, CH-4′), 88.6 (CH-1′), 114.5 (CH-2, CH-6), 128.9 (CH-3, CH-5), 131.5 (C-4), 159.3 (C-1) ppm. ^{31}P NMR (202.4 MHz, D_2O): δ = –20.08 (m, 1 P, P_β), –10.80 (br. d, 1 P, $J_{\alpha,\beta}$ = 19.5 Hz, P_α), –7.54 (m, 1 P, P_γ) ppm.

2-Methyl-5-(2-*C*-methyl-β-D-ribofuranosyl)pyridine 5′-*O*-Triphosphate (33a): Compound **33a** was prepared from compound **29a** (48 mg, 0.2 mmol) following the general procedure for the synthesis of triphosphates. Lyophilization from water gave triphosphate **33a** (139 mg, 0.178 mmol, 89%; triethylammonium salt) as a white foam. HRMS (ESI): calcd. for $C_{12}H_{19}O_{13}NP_3$ [M – H]$^-$ 478.00747; found 478.00725. ^{1}H NMR (500 MHz, D_2O): δ = 0.93 (s, 3 H, CH_3-2′), 2.65 (s, 3 H, CH_3-2), 1.27 [t, 27 H, $J_{CH3,CH2}$ = 7.3 Hz, (CH_3CH_2)$_3$NH$^+$], 3.19 [q, 18 H, $J_{CH2,CH3}$ = 7.3 Hz, (CH_3CH_2)$_3$NH$^+$], 4.07 (d, 1 H, $J_{3',4'}$ = 7.6 Hz, 3′-H), 4.16 (dddd, 1 H, $J_{4',3'}$ = 7.6, $J_{4',5'a}$ = 3.6, $J_{4',5'b}$ = 2.6, $J_{4',P}$ = 2.0 Hz, 4′-H), 4.28 (ddd, 1 H, J_{gem} = 11.8, $J_{5'a,P}$ = 6.0, $J_{5'a,4'}$ = 3.7 Hz, 5′a-H), 4.38 (ddd, 1 H, J_{gem} = 11.8, $J_{5'b,P}$ = 4.7, $J_{5'b,4'}$ = 2.6 Hz, 5′b-H), 5.02 (s, 1 H, 1′-H), 7.60 (d, 1 H, $J_{3,4}$ = 8.3 Hz, 3-H), 8.08 (br. d, 1 H, $J_{4,3}$ = 8.3 Hz, 4-H), 8.66 (br. s, 1 H, 6-H) ppm. ^{13}C NMR (125.7 MHz, D_2O): δ = 8.8 [(CH_3CH_2)$_3$NH$^+$], 21.2 (CH_3-2), 21.5 (CH_3-2′), 47.3

[$(CH_3CH_2)_3NH^+$], 64.9 (d, $J_{C,P}$ = 5.1 Hz, CH_2-5′), 73.9 (CH-3′), 79.6 (C-2′), 81.5 (d, $J_{C,P}$ = 9.0 Hz, CH-4′), 85.8 (CH-1′), 126.2 (CH-3), 134.6 (C-5), 140.8 (CH-4), 142.9 (CH-6), 156.9 (C-2) ppm. ^{31}P NMR (202.4 MHz, D_2O): δ = –22.17 (t, 1 P, $J_{\beta,\alpha} = J_{\beta,\gamma}$ = 19.5 Hz, P_β), –10.18 (d, 1 P, $J_{\alpha,\beta}$ = 18.8 Hz, P_α), –8.58 (d, 1 P, $J_{\gamma,\beta}$ = 20.2 Hz, P_γ) ppm.

2-Amino-5-(2-*C*-methyl-β-D-ribofuranosyl)pyridine 5′-*O*-Triphosphate (33b): Compound **33b** was prepared from compound **29b** (48 mg, 0.2 mmol) following the general procedure for the synthesis of triphosphates. Lyophilization from water gave triphosphate **33b** (120 mg, 0.176 mmol, 88%; diethylammonium salt) as a white foam. HRMS (ESI): calcd. for $C_{11}H_{20}O_{13}N_2P_3$ [M + H]$^+$ 481.01727; found 481.01746. ^{1}H NMR (500 MHz, D_2O): δ = 1.01 (s, 3 H, CH_3-2′), 1.27 [t, 18 H, $J_{CH3,CH2}$ = 7.3 Hz, $(CH_3CH_2)_3$-NH^+], 3.19 [q, 12 H, $J_{CH2,CH3}$ = 7.3 Hz, $(CH_3CH_2)_3NH^+$], 4.07 (d, 1 H, $J_{3',4'}$ = 8.2 Hz, 3′-H), 4.11 (dq, 1 H, $J_{4',3'} = 8.2$, $J_{4',5'a} = J_{4',5'b} = J_{4',P}$ = 2.5 Hz, 4′-H), 4.24 (ddd, 1 H, J_{gem} = 11.9, $J_{5'a,P}$ = 5.8, $J_{5'a,4'}$ = 2.8 Hz, 5′a-H), 4.36 (ddd, 1 H, J_{gem} = 11.9, $J_{5'b,P}$ = 4.3, $J_{5'b,4'}$ = 2.2 Hz, 5′b-H), 4.88 (s, 1 H, 1′-H), 6.79 (d, 1 H, $J_{3,4}$ = 9.2 Hz, 3-H), 7.83 (dd, 1 H, $J_{4,3}$ = 9.2, $J_{4,6}$ = 2.0 Hz, 4-H), 8.10 (br. s, 1 H, 6-H) ppm. ^{13}C NMR (125.7 MHz, D_2O): δ = 8.8 [(CH_3-$CH_2)_3NH^+$], 21.2 (CH_3-2′), 47.3 [$(CH_3CH_2)_3NH^+$], 64.4 (d, $J_{C,P}$ = 5.0 Hz, CH_2-5′), 73.2 (CH-3′), 79.8 (C-2′), 80.8 (d, $J_{C,P}$ = 9.1 Hz, CH-4′), 85.7 (CH-1′), 113.6 (CH-3), 125.1 (C-5), 134.7 (CH-6), 143.1 (CH-4), 154.5 (C-2) ppm. ^{31}P NMR (202.4 MHz, D_2O): δ = –22.23 (br. t, 1 P, $J_{\beta,\alpha} = J_{\beta,\gamma}$ = 17.7 Hz, P_β), –10.09 (d, 1 P, $J_{\alpha,\beta}$ = 18.6 Hz, P_α), –8.87 (br. d, 1 P, $J_{\gamma,\beta}$ = 16.7 Hz, P_γ) ppm.

2-(Dimethylamino)-5-(2-*C*-methyl-β-D-ribofuranosyl)pyridine 5′-*O*-Triphosphate (33c): Compound **33c** was prepared from compound **29c** (54 mg, 0.2 mmol) following the general procedure for the synthesis of triphosphates. Lyophilization from water gave triphosphate **33c** (124 mg, 0.174 mmol, 87%; diethylammonium salt) as a white foam. HRMS (ESI): calcd. for $C_{13}H_{22}O_{13}N_2P_3$ [M – H]$^-$ 507.03402; found 507.03370. ^{1}H NMR (500 MHz, D_2O): δ = 1.00 (s, 3 H, CH_3-2′), 1.27 [t, 18 H, $J_{CH3,CH2}$ = 7.4 Hz, $(CH_3$-$CH_2)_3NH^+$], 3.19 [q, 12 H, $J_{CH2,CH3}$ = 7.4 Hz, $(CH_3CH_2)_3NH^+$], 3.22 [s, 6 H, $(CH_3)_2N$], 4.08 (d, 1 H, $J_{3',4'}$ = 8.2 Hz, 3′-H), 4.11 (dq, 1 H, $J_{4',3'}$ = 8.2, $J_{4',5'a} = J_{4',5'b} = J_{4',P}$ = 2.4 Hz, 4′-H), 4.27 (ddd, 1 H, J_{gem} = 11.9, $J_{5'a,P}$ = 6.0, $J_{5'a,4'}$ = 2.7 Hz, 5′a-H), 4.37 (ddd, 1 H, J_{gem} = 11.9, $J_{5'b,P}$ = 4.2, $J_{5'b,4'}$ = 2.2 Hz, 5′b-H), 4.87 (s, 1 H, 1′-H), 7.08 (dd, 1 H, $J_{3,4}$ = 9.5, $J_{3,6}$ = 0.7 Hz, 3-H), 7.84 (br. dd, 1 H, $J_{4,3}$ = 9.5, $J_{4,6}$ = 2.2 Hz, 4-H), 8.10 (dt, 1 H, $J_{6,4}$ = 2.2, $J_{6,3} = J_{6,1'}$ = 0.8 Hz, 6-H) ppm. ^{13}C NMR (125.7 MHz, D_2O): δ = 8.8 [$(CH_3CH_2)_3NH^+$], 21.3 (CH_3-2′), 39.4 [$(CH_3)_2N$], 47.3 [$(CH_3CH_2)_3NH^+$], 64.6 (d, $J_{C,P}$ = 5.2 Hz, CH_2-5′), 73.2 (CH-3′), 79.8 (C-2′), 80.8 (d, $J_{C,P}$ = 9.1 Hz, CH-4′), 85.7 (CH-1′), 111.9 (CH-3), 123.6 (C-5), 135.4 (CH-6), 141.8 (CH-4), 153.6 (C-2) ppm. ^{31}P NMR (202.4 MHz, D_2O): δ = –22.16 (br. m, 1 P, P_β), –10.27 (d, 1 P, $J_{\alpha,\beta}$ = 19.3 Hz, P_α), –8.72 (br. s, 1 P, P_γ) ppm.

5-(2-*C*-Methyl-β-D-ribofuranosyl)-2-pyridone 5′-*O*-Triphosphate (33d): Compound **33d** was prepared from compound **29d** (48 mg, 0.2 mmol) following the general procedure for the synthesis of triphosphates. Lyophilization from water gave triphosphate **33d** (118 mg, 0.15 mmol, 75%; triethylammonium salt) as a white foam. HRMS (ESI): calcd. for $C_{11}H_{17}O_{14}NP_3$ [M – H]$^-$ 479.98674; found 479.98593. ^{1}H NMR (500 MHz, D_2O): δ = 1.01 (s, 3 H, CH_3-2′), 1.27 [t, 27 H, $J_{CH3,CH2}$ = 7.4 Hz, $(CH_3CH_2)_3NH^+$], 3.19 [q, 18 H, $J_{CH2,CH3}$ = 7.4 Hz, $(CH_3CH_2)_3NH^+$], 4.01 (d, 1 H, $J_{3',4'}$ = 7.7 Hz, 3′-H), 4.09 (br. dddd, 1 H, $J_{4',3'}$ = 7.7, $J_{4',5'a}$ = 3.8, $J_{4',5'b}$ = 2.7, $J_{4',P}$ = 2.0 Hz, 4′-H), 4.24 (ddd, 1 H, J_{gem} = 11.8, $J_{5'a,P}$ = 6.1, $J_{5'a,4'}$ = 3.8 Hz, 5′a-H), 4.33 (ddd, 1 H, J_{gem} = 11.8, $J_{5'b,P}$ = 4.8, $J_{5'b,4'}$ = 2.7 Hz, 5′b-H), 4.79 (s, 1 H, 1′-H), 6.66 (m, 1 H, 3-H), 7.70 –7.74 (m, 2 H, 4-H, 6-H) ppm. ^{13}C NMR (125.7 MHz, D_2O): δ = 8.9 [$(CH_3CH_2)_3NH^+$], 21.4 (CH_3-2′), 47.3 [$(CH_3CH_2)_3NH^+$], 65.1 (d, $J_{C,P}$ = 5.6 Hz, CH_2-5′), 74.0 (CH-3′), 79.4 (C-2′), 81.1 (d, $J_{C,P}$ = 9.0 Hz, CH-4′), 85.7 (CH-1′), 119.2 (CH-3), 120.7 (C-5), 133.7 and 143.3 (CH-4,6), 165.1 (C-2) ppm. ^{31}P NMR (202.4 MHz, D_2O): δ = –22.47 (br. s, 1 P, P_β), –10.48 (br. d, 1 P, $J_{\alpha,\beta}$ = 19.2 Hz, P_α), –10.16 (br. s, 1 P, P_γ) ppm.

2-Methoxy-5-(2-*C*-methyl-β-D-ribofuranosyl)pyridine 5′-*O*-Triphosphate (33e): Compound **33e** was prepared from compound **29e** (51 mg, 0.2 mmol) following the general procedure for the synthesis of triphosphates. Lyophilization from water gave triphosphate **33e** (153 mg, 0.192 mmol, 96%; triethylammonium salt) as a white foam. HRMS (ESI): calcd. for $C_{12}H_{19}O_{14}NP_3$ [M – H]$^-$ 494.00239; found 494.00244. ^{1}H NMR (500 MHz, D_2O): δ = 0.91 (s, 3 H, CH_3-2′), 1.27 [t, 27 H, $J_{CH3,CH2}$ = 7.3 Hz, $(CH_3CH_2)_3NH^+$], 3.19 [q, 18 H, $J_{CH2,CH3}$ = 7.3 Hz, $(CH_3CH_2)_3NH^+$], 3.92 (s, 3 H, CH_3O), 4.02 (d, 1 H, $J_{3',4'}$ = 7.3 Hz, 3′-H), 4.13 (dddd, 1 H, $J_{4',3'}$ = 7.3, $J_{4',5'a}$ = 4.4, $J_{4',5'b}$ = 3.0, $J_{4',P}$ = 1.5 Hz, 4′-H), 4.27 (ddd, 1 H, J_{gem} = 11.7, $J_{5'a,P}$ = 6.4, $J_{5'a,4'}$ = 4.4 Hz, 5′a-H), 4.34 (ddd, 1 H, J_{gem} = 11.7, $J_{5'b,P}$ = 5.3, $J_{5'b,4'}$ = 3.0 Hz, 5′b-H), 4.90 (s, 1 H, 1′-H), 6.96 (d, 1 H, $J_{3,4}$ = 8.8 Hz, 3-H), 7.86 (dd, 1 H, $J_{4,3}$ = 8.8, $J_{4,6}$ = 2.4 Hz, 4-H), 8.10 (br. d, 1 H, $J_{6,4}$ = 2.3 Hz, 6-H) ppm. ^{13}C NMR (125.7 MHz, D_2O): δ = 8.8 [$(CH_3CH_2)_3NH^+$], 21.6 (CH_3-2′), 47.3 [$(CH_3CH_2)_3NH^+$], 54.8 (CH_3O), 65.5 (d, $J_{C,P}$ = 5.5 Hz, CH_2-5′), 74.7 (CH-3′), 79.4 (C-2′), 81.5 (d, $J_{C,P}$ = 8.9 Hz, CH-4′), 86.3 (CH-1′), 110.9 (CH-3), 128.1 (C-5), 139.7 (CH-4), 145.1 (CH-6), 164.5 (C-2) ppm. ^{31}P NMR (202.4 MHz, D_2O): δ = –22.35 (t, 1 P, $J_{\beta,\alpha} = J_{\beta,\gamma}$ = 19.7 Hz, P_β), –10.48 (d, 1 P, $J_{\alpha,\beta}$ = 19.8 Hz, P_α), –9.76 (d, 1 P, $J_{\gamma,\beta}$ = 19.7 Hz, P_γ) ppm.

5-Methyl-2-(2-*C*-methyl-β-D-ribofuranosyl)pyridine 5′-*O*-Triphosphate (34a): Compound **34a** was prepared from compound **30a** (48 mg, 0.2 mmol) following the general procedure for the synthesis of triphosphates. Lyophilization from water gave triphosphate **34a** (146 mg, 0.186 mmol, 93%; triethylammonium salt) as a white foam. HRMS (ESI): calcd. for $C_{12}H_{19}O_{13}NP_3$ [M – H]$^-$ 478.00747; found 478.00737. ^{1}H NMR (500 MHz, D_2O): δ = 0.89 (s, 3 H, CH_3-2′), 2.39 (s, 3 H, CH_3-5), 1.27 [t, 27 H, $J_{CH3,CH2}$ = 7.3 Hz, $(CH_3CH_2)_3NH^+$], 3.19 [q, 18 H, $J_{CH2,CH3}$ = 7.3 Hz, $(CH_3CH_2)_3$-NH^+], 4.00 (d, 1 H, $J_{3',4'}$ = 7.6 Hz, 3′-H), 4.18 (dddd, 1 H, $J_{4',3'}$ = 7.6, $J_{4',5'a}$ = 4.3, $J_{4',5'b}$ = 2.7, $J_{4',P}$ = 1.6 Hz, 4′-H), 4.30 (ddd, 1 H, J_{gem} = 11.8, $J_{5'a,P}$ = 6.4, $J_{5'a,4'}$ = 4.3 Hz, 5′a-H), 4.40 (ddd, 1 H, J_{gem} = 11.8, $J_{5'b,P}$ = 5.3, $J_{5'b,4'}$ = 2.7 Hz, 5′b-H), 5.01 (s, 1 H, 1′-H), 7.67 (d, 1 H, $J_{3,4}$ = 8.2 Hz, 3-H), 7.92 (br. d, 1 H, $J_{4,3}$ = 8.2 Hz, 4-H), 8.41 (br. s, 1 H, 6-H) ppm. ^{13}C NMR (125.7 MHz, D_2O): δ = 8.8 [$(CH_3CH_2)_3NH^+$], 17.9 (CH_3-5), 21.2 (CH_3-2′), 47.3 [$(CH_3CH_2)_3NH^+$], 65.4 (d, $J_{C,P}$ = 5.6 Hz, CH_2-5′), 74.4 (CH-3′), 79.9 (C-2′), 81.6 (d, $J_{C,P}$ = 8.6 Hz, CH-4′), 87.8 (CH-1′), 122.8 (CH-3), 135.6 (C-5), 141.5 (CH-4), 147.0 (CH-6), 153.6 (C-2) ppm. ^{31}P NMR (202.4 MHz, D_2O): δ = –22.25 (t, 1 P, $J_{\beta,\alpha} = J_{\beta,\gamma}$ = 19.0 Hz, P_β), –10.40 (d, 1 P, $J_{\alpha,\beta}$ = 19.5 Hz, P_α), –9.49 (d, 1 P, $J_{\gamma,\beta}$ = 18.5 Hz, P_γ) ppm.

5-Amino-2-(2-*C*-methyl-β-D-ribofuranosyl)pyridine 5′-*O*-Triphosphate (34b): Compound **34b** was prepared from compound **30b** (48 mg, 0.2 mmol) following the general procedure for the synthesis of triphosphates. Lyophilization from water gave triphosphate **34b** (70 mg, 0.102 mmol, 51%; diethylammonium salt) as a white foam. HRMS (ESI): calcd. for $C_{11}H_{18}O_{13}N_2P_3$ [M – H]$^-$ 479.00272; found 479.00163. ^{1}H NMR (500 MHz, D_2O): δ = 0.95 (s, 3 H, CH_3-2′), 1.27 [t, 18 H, $J_{CH3,CH2}$ = 7.3 Hz, $(CH_3CH_2)_3NH^+$], 3.19 [q, 12 H, $J_{CH2,CH3}$ = 7.3 Hz, $(CH_3CH_2)_3NH^+$], 3.99 (d, 1 H, $J_{3',4'}$ = 7.3 Hz, 3′-H), 4.18 (dddd, 1 H, $J_{4',3'}$ = 7.3, $J_{4',5'a}$ = 4.1, $J_{4',5'b}$ = 2.6, $J_{4',P}$ = 1.8 Hz, 4′-H), 4.28 (ddd, 1 H, J_{gem} = 11.9, $J_{5'a,P}$ = 6.4, $J_{5'a,4'}$ =

4.1 Hz, 5′a-H), 4.40 (ddd, 1 H, J_{gem} = 11.9, $J_{5'b,P}$ = 5.2, $J_{5'b,4'}$ = 2.6 Hz, 5′b-H), 4.99 (s, 1 H, 1′-H), 7.57 (dd, 1 H, $J_{4,3}$ = 8.7, $J_{4,6}$ = 2.4 Hz, 4-H), 7.59 (dd, 1 H, $J_{3,4}$ = 8.7, $J_{3,6}$ = 0.9 Hz, 3-H), 8.07 (br. dd, 1 H, $J_{6,4}$ = 2.3, $J_{6,3}$ = 0.9 Hz, 6-H) ppm. ^{13}C NMR (125.7 MHz, D_2O): δ = 8.9 [(CH_3CH_2)$_3NH^+$], 21.1 (CH_3-2′), 47.3 [(CH_3CH_2)$_3NH^+$], 65.3 (d, $J_{C,P}$ = 5.4 Hz, CH_2-5′), 74.4 (CH-3′), 79.9 (C-2′), 81.9 (d, $J_{C,P}$ = 8.5 Hz, CH-4′), 86.1 (CH-1′), 124.6 (CH-3), 128.7 (CH-4), 131.3 (CH-6), 143.4 (C-2), 145.7 (C-5) ppm. ^{31}P NMR (202.4 MHz, D_2O): δ = –22.49 (t, 1 P, $J_{\beta,\alpha}$ = $J_{\beta,\gamma}$ = 19.8 Hz, P_β), –10.42 (d, 1 P, $J_{\alpha,\beta}$ = 19.9 Hz, P_α), –9.94 (d, 1 P, $J_{\gamma,\beta}$ = 19.8 Hz, P_γ) ppm.

5-(Dimethylamino)-2-(2-*C*-methyl-β-D-ribofuranosyl)pyridine 5′-*O*-Triphosphate (34c): Compound **34c** was prepared from compound **30c** (54 mg, 0.2 mmol) following the general procedure for the synthesis of triphosphates. Lyophilization from water gave triphosphate **34c** (129 mg, 0.182 mmol, 91%; diethylammonium salt) as a white foam. HRMS (ESI): calcd. for $C_{13}H_{22}O_{13}N_2P_3$ [M – H]$^-$ 507.03402; found 507.03323. ^{1}H NMR (500 MHz, D_2O): δ = 0.95 (s, 3 H, CH_3-2′), 1.27 [t, 18 H, $J_{CH3,CH2}$ = 7.3 Hz, (CH_3CH_2)$_3$-NH^+], 3.02 [s, 6 H, (CH_3)$_2$N], 3.19 [q, 12 H, $J_{CH2,CH3}$ = 7.3 Hz, (CH_3CH_2)$_3NH^+$], 4.00 (d, 1 H, $J_{3',4'}$ = 7.3 Hz, 3′-H), 4.18 (dddd, 1 H, $J_{4',3'}$ = 7.3, $J_{4',5'a}$ = 4.0, $J_{4',5'b}$ = 2.6, $J_{4',P}$ = 1.8 Hz, 4′-H), 4.30 (ddd, 1 H, J_{gem} = 11.9, $J_{5'a,P}$ = 6.5, $J_{5'a,4'}$ = 4.0 Hz, 5′a-H), 4.42 (ddd, 1 H, J_{gem} = 11.9, $J_{5'b,P}$ = 5.2, $J_{5'b,4'}$ = 2.6 Hz, 5′b-H), 5.02 (s, 1 H, 1′-H), 7.62 (dd, 1 H, $J_{4,3}$ = 9.2, $J_{4,6}$ = 2.7 Hz, 4-H), 7.65 (dd, 1 H, $J_{3,4}$ = 9.2, $J_{3,6}$ = 0.9 Hz, 3-H), 8.06 (dd, 1 H, $J_{6,4}$ = 2.7, $J_{6,3}$ = 0.9 Hz, 6-H) ppm. ^{13}C NMR (125.7 MHz, D_2O): δ = 8.8 [(CH_3CH_2)$_3NH^+$], 21.1 (CH_3-2′), 40.2 [(CH_3)$_2$N], 47.3 [(CH_3-CH_2)$_3NH^+$], 65.3 (d, $J_{C,P}$ = 5.6 Hz, CH_2-5′), 74.3 (CH-3′), 80.0 (C-2′), 82.0 (d, $J_{C,P}$ = 8.4 Hz, CH-4′), 85.8 (CH-1′), 124.3 (CH-3), 126.1 (CH-4), 128.4 (CH-6), 140.7 (C-2), 148.1 (C-5) ppm. ^{31}P NMR (202.4 MHz, D_2O): δ = –22.44 (t, 1 P, $J_{\beta,\alpha}$ = $J_{\beta,\gamma}$ = 20.0 Hz, P_β), –10.44 (d, 1 P, $J_{\alpha,\beta}$ = 19.9 Hz, P_α), –9.70 (d, 1 P, $J_{\gamma,\beta}$ = 20.0 Hz, P_γ) ppm.

5-Hydroxy-2-(2-*C*-methyl-β-D-ribofuranosyl)pyridine 5′-*O*-Triphosphate (34d): Compound **34d** was prepared from compound **30d** (48 mg, 0.2 mmol) following the general procedure for the synthesis of triphosphates. Lyophilization from water gave triphosphate **34d** (99 mg, 0.126 mmol, 63%; triethylammonium salt) as a white foam. HRMS (ESI): calcd. for $C_{11}H_{17}O_{14}NP_3$ [M – H]$^-$ 479.98674; found 479.98593. ^{1}H NMR (500 MHz, D_2O): δ = 0.92 (s, 3 H, CH_3-2′), 1.27 [t, 27 H, $J_{CH3,CH2}$ = 7.3 Hz, (CH_3CH_2)$_3NH^+$], 3.19 [q, 18 H, $J_{CH2,CH3}$ = 7.3 Hz, (CH_3CH_2)$_3NH^+$], 4.00 (d, 1 H, $J_{3',4'}$ = 7.5 Hz, 3′-H), 4.17 (dddd, 1 H, $J_{4',3'}$ = 7.5, $J_{4',5'a}$ = 4.1, $J_{4',5'b}$ = 2.7, $J_{4',P}$ = 1.7 Hz, 4′-H), 4.29 (ddd, 1 H, J_{gem} = 11.8, $J_{5'a,P}$ = 6.4, $J_{5'a,4'}$ = 4.1 Hz, 5′a-H), 4.39 (ddd, 1 H, J_{gem} = 11.8, $J_{5'b,P}$ = 5.2, $J_{5'b,4'}$ = 2.7 Hz, 5′b-H), 4.99 (s, 1 H, 1′-H), 7.58 (dd, 1 H, $J_{4,3}$ = 8.8, $J_{4,6}$ = 2.8 Hz, 4-H), 7.65 (br. d, 1 H, $J_{3,4}$ = 8.8 Hz, 3-H), 8.12 (dm, 1 H, $J_{6,4}$ = 2.8 Hz, 6-H) ppm. ^{13}C NMR (125.7 MHz, D_2O): δ = 8.8 [(CH_3CH_2)$_3NH^+$], 21.2 (CH_3-2′), 47.3 [(CH_3CH_2)$_3NH^+$], 65.3 (d, $J_{C,P}$ = 5.5 Hz, CH_2-5′), 74.4 (CH-3′), 79.8 (C-2′), 81.7 (d, $J_{C,P}$ = 8.6 Hz, CH-4′), 87.0 (CH-1′), 124.5 (CH-3), 129.0 (CH-4), 134.3 (CH-6), 146.1 (C-2), 155.6 (C-5) ppm. ^{31}P NMR (202.4 MHz, D_2O): δ = –22.57 (t, 1 P, $J_{\beta,\alpha}$ = $J_{\beta,\gamma}$ = 19.8 Hz, P_β), –10.46 (d, 1 P, $J_{\alpha,\beta}$ = 19.8 Hz, P_α), –10.14 (d, 1 P, $J_{\gamma,\beta}$ = 19.8 Hz, P_γ) ppm.

5-Methoxy-2-(2-*C*-methyl-β-D-ribofuranosyl)pyridine 5′-*O*-Triphosphate (34e): Compound **34e** was prepared from compound **30e** (51 mg, 0.2 mmol) following the general procedure for the synthesis of triphosphates. Lyophilization from water gave triphosphate **34e** (153 mg, 0.192 mmol, 96%; triethylammonium salt) as a white foam. HRMS (ESI): calcd. for $C_{12}H_{19}O_{14}NP_3$ [M – H]$^-$ 494.00239; found 494.00168. ^{1}H NMR (500 MHz, D_2O): δ = 0.88 (s, 3 H, CH_3-2′), 3.91 (s, 3 H, CH_3O), 1.27 [t, 27 H, $J_{CH3,CH2}$ = 7.3 Hz, (CH_3CH_2)$_3NH^+$], 3.19 [q, 18 H, $J_{CH2,CH3}$ = 7.3 Hz, (CH_3CH_2)$_3$-NH^+], 4.01 (d, 1 H, $J_{3',4'}$ = 8.0 Hz, 3′-H), 4.16 (dddd, 1 H, $J_{4',3'}$ = 8.0, $J_{4',5'a}$ = 4.3, $J_{4',5'b}$ = 2.7, $J_{4',P}$ = 1.6 Hz, 4′-H), 4.30 (ddd, 1 H, J_{gem} = 11.8, $J_{5'a,P}$ = 6.3, $J_{5'a,4'}$ = 4.3 Hz, 5′a-H), 4.39 (ddd, 1 H, J_{gem} = 11.8, $J_{5'b,P}$ = 5.2, $J_{5'b,4'}$ = 2.7 Hz, 5′b-H), 4.97 (s, 1 H, 1′-H), 7.61 (dd, 1 H, $J_{4,3}$ = 8.8, $J_{4,6}$ = 2.9 Hz, 4-H), 7.70 (br. d, 1 H, $J_{3,4}$ = 8.8 Hz, 3-H), 8.23 (dd, 1 H, $J_{6,4}$ = 2.9, $J_{6,3}$ = 0.6 Hz, 6-H) ppm. ^{13}C NMR (125.7 MHz, D_2O): δ = 8.8 [(CH_3CH_2)$_3NH^+$], 21.2 (CH_3-2′), 47.3 [(CH_3CH_2)$_3NH^+$], 56.6 (CH_3O), 65.4 (d, $J_{C,P}$ = 5.6 Hz, CH_2-5′), 74.3 (CH-3′), 79.9 (C-2′), 81.2 (d, $J_{C,P}$ = 8.8 Hz, CH-4′), 88.4 (CH-1′), 123.6 (CH-3), 124.4 (CH-4), 135.5 (CH-6), 149.6 (C-2), 156.2 (C-5) ppm. ^{31}P NMR (202.4 MHz, D_2O): δ = –22.39 (t, 1 P, $J_{\beta,\alpha}$ = $J_{\beta,\gamma}$ = 19.6 Hz, P_β), –10.43 (d, 1 P, $J_{\alpha,\beta}$ = 19.9 Hz, P_α), –9.93 (d, 1 P, $J_{\gamma,\beta}$ = 19.3 Hz, P_γ) ppm.

Single-Crystal X-Ray Structural Analysis: Single-crystal diffraction data for **14** and **28d** were collected with an Xcalibur X-ray diffractometer with Cu-K_α radiation (λ = 1.54180 Å) at 180 K. CrysAlisProCCD[27] was used for data collection, cell refinement, and data reduction. The structures were solved by direct methods with SIR92,[28] and refined by the full-matrix least-squares method on *F* with CRYSTALS.[29] The hydrogen atoms were all located in a difference Fourier map, but those attached to carbon atoms were recalculated into idealized positions and refined with riding constraints. All non-hydrogen atoms were refined with anisotropic displacement parameters.

Crystal Data for 14: (colourless block, 0.19 × 0.36 × 0.74 mm): $C_{34}H_{34}Br_1N_1O_6$, monoclinic, space group $P2_1$, a = 7.91533(7) Å, b = 18.37168(13) Å, c = 10.53591(8) Å, β = 95.3841(7)°, V = 1525.35(2) Å^3, Z = 2, M = 632.55, 19330 reflections measured, 6149 independent reflections. Final R = 0.032, wR = 0.039, GoF = 1.010 for 6078 reflections with $I > 2\sigma(I)$ and 381 parameters, Flack parameter x = –0.026(10).

Crystal Data for 28d: (colourless block, 0.18 × 0.37 × 0.53 mm): $C_{12}H_{16}O_5$, orthorhombic, space group $P2_12_12_1$, a = 6.90623(14) Å, b = 9.06533(16) Å, c = 19.1665(3) Å, V = 1199.96(4) Å^3, Z = 4, M = 240.26, 6593 reflections measured, 2423 independent reflections. Final R = 0.044, wR = 0.052, GoF = 1.063 for 2291 reflections with $I > 2\sigma(I)$ and 155 parameters, Flack parameter x = 0.10(19).

CCDC-1415995 (for **14**) and -1415996 (for **28d**) contain the supplementary crystallographic data for this paper. These data can be obtained free of charge from The Cambridge Crystallographic Data Centre via www.ccdc.cam.ac.uk/data_request/cif

Supporting Information Available. Copies of ^{1}H, ^{13}C, and ^{31}P NMR spectra of the products; HPLC purity of final unprotected *C*-nucleosides; cif files for the crystal structures.

Acknowledgments

This work was supported by the Czech Science Foundation (P207/11/0344 to A. T. and M. H.), and by Gilead Sciences, Inc. The authors thank Drs. Joy Feng and Gina Bahador (Gilead Sciences, Inc.) for anti-HCV testing, and Dr. Jaroslav Kozák (IOCB) for testing the inhibition of RNA polymerase.

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Received: September 22, 2015
Published Online: November 17, 2015

