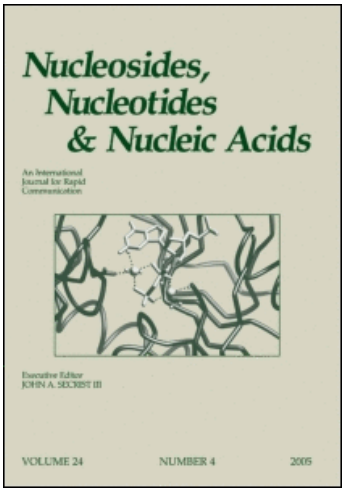

Nucleosides, Nucleotides and Nucleic Acids
Publication details, including instructions for authors and subscription information:
http://www.informaworld.com/smpp/title~content=t713597286

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Online publication date: 17 September 2003

To cite this Article Wirsching, Jörn , Voss, Jürgen , Giesler, Anja , Kopf, Jürgen , Adiwidjaja, Gunadi , Balzarini, Jan and De Clercq, Erik(2003) 'Thiosugars. X. Novel Nucleoside Analogues Derived from 4-Thio-L-lyxofuranose', Nucleosides, Nucleotides and Nucleic Acids, 22: 10, 1867 — 1897
To link to this Article: DOI: 10.1081/NCN-120025236
URL: http://dx.doi.org/10.1081/NCN-120025236

NUCLEOSIDES, NUCLEOTIDES & NUCLEIC ACIDS
Vol. 22, No. 10, pp. 1867–1897, 2003

Thiosugars. X. Novel Nucleoside Analogues Derived from 4-Thio-L-lyxofuranose[#]

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ABSTRACT

1-*O*-Acetyl-2,3,5-tri-*O*-benzyl-4-thio-L-lyxofuranose **1** was transformed into *O*-benzyl- and *O*-acetyl-protected 1-(4-thio-L-lyxofuranosyl) nucleoside derivatives by use of the TMSOTf method. Debenzylation with boron tribromide or deacetylation with sodium methoxide yielded the corresponding pyrimidine (**7**–**11**, **17**, **18**, **26** and **27**) and purine (**29** and **34**) nucleoside analogues. The anomeric configurations were determined by NMR spectroscopy and, in the case of the 5-halo- (**7**–**9**) and nitrouridine derivative **11** and the 6-methylcytidine derivative **27**, by X-ray structural analyses. – The unprotected nucleosides were not antivirically inhibitory at 250 μM.

[#]Part IX: Wirsching, J.; Voss, J.; Adiwidjaja, G.; Balzarini, J.; De Clercq, E. Bioorg. Med. Chem. Lett. **2001**, *11*, 1049–1051.

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DOI: 10.1081/NCN-120025236
1525-7770 (Print); 1532-2335 (Online)

Key Words: Thiosugars; Nucleosides; 4-Thio-L-lyxofuranose; Configurations; Biological tests; X-ray structure.

INTRODUCTION

In 1992, the synthesis of 2′,3′-dideoxy-3′-thia-L-cytidine (**3TC**) was described and its *anti*-HIV activity was discovered.[1] Unfortunately, monotherapy with **3TC** resulted in the rapid appearance of a highly resistant virus strain. The activity and, in particular, the long-time efficacy of the well-known *anti*-HIV drug 3′-azido-2′,3′-dideoxythymidine (**AZT**) was, however, significantly improved when a combination of **3TC** and **AZT** was applied.[2] Further combinations of drugs that reduce retrovirus replication more effectively and delay the onset of drug resistance are nevertheless urgently required.[2] Because **3TC** exhibits the L-configuration in the pentofuranose moiety, a variety of L-nucleoside analogues have been synthesized and tested for antiviral and other biological activities.[3] It has also been reported that, in certain cases, replacement of oxygen by sulfur led to marked changes in the biochemical properties of the corresponding nucleosides.[3–6] This effect may be due to a higher lipophilicity of the thionucleoside and hence an increase of its ability to penetrate a cell. Accordingly, the 4′-thio-L-pentofuranosyl nucleosides became interesting targets of synthetic efforts.[6–10] In continuation of our comprehensive investigations of 4-thiofuranosyl nucleosides,[11–14] we were particularly interested in the synthesis and biological activities of derivatives with L-lyxo-,[12] and 2′-deoxy-L-*threo*-("2′-deoxy-L-lyxo")[13] configurations, because these compounds apparently exhibit the same configuration at C-2′ and C-3′ as the natural D-ribo- and 2′-deoxy-D-ribo-nucleosides. The first examples of the 4-thio-L-lyxo series which we prepared proved to be biologically inactive.[12] We therefore present here the synthesis and structural assignment of novel 4′-thio-L-lyxo-nucleoside analogues which, in addition to the unnatural sugar moiety, contain modified nucleobases. Results on biological tests are also reported.

RESULTS AND DISCUSSION

1-*O*-Acetyl-2,3,5-tri-*O*-benzyl-4-thio-L-lyxofuranose (**1**),[12] which is prepared in six steps from D-ribose[15,16] with an overall yield of 39%, has proved to be a useful starting material for the synthesis of 4′-thionucleosides with L-lyxo configuration.[12] Coupling of **1** with silylated 5-halo- and 5-nitrouracil derivatives in the presence of trimethylsilyl trifluoromethanesulfonate (TMSOTf)[17–20] yielded the benzyl-protected nucleosides **2**–**6** (Sch. 1). According to our experiences with the 4′-thio-L-lyxo-uridine analogue and its methyl derivatives[12] and to the results which we have recently obtained in the corresponding L-arabino[11] and in the 2′-deoxy-4′-thio-L-*threo*-("2′-deoxy-4′-thio-L-lyxo")[13] series we achieved the best results for these syntheses by using four equivalents of the silylated bases. The total yields varied between 69% and 84%. The benzyl-protected nucleosides **2**–**6** were obtained as anomeric mixtures (Sch. 1). The anomers of **5** and **6** could be separated by column chromatography (see Experimental Part).

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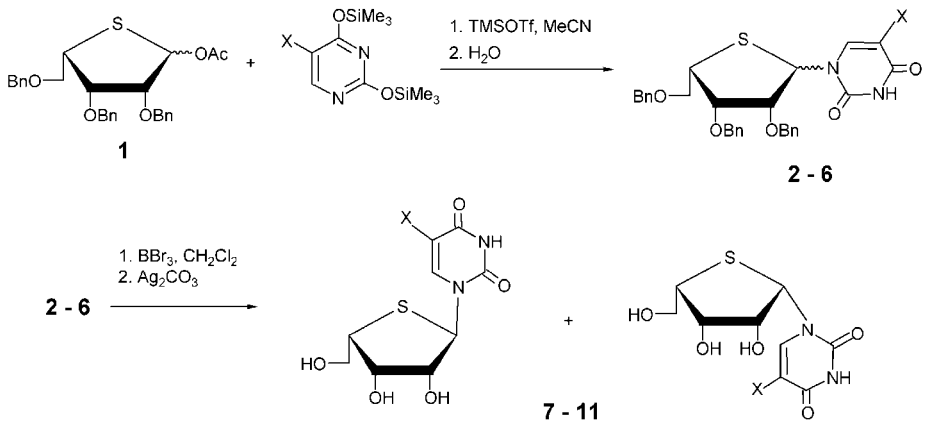

Compound	1	2	3	4	5	6	7	8	9	10	11
X	-	F	Cl	Br	I	NO_2	F	Cl	Br	I	NO_2
Total yield [%]	-	84	78	77	72	69	34	30	36	16	8
α/β ratio	1:10	3:5	2:3	1:2	2:3	1:2	4:3	5:3	10:9	3:4	9:11

Scheme 1.

Cleavage of the benzyl groups was carried out with boron tribromide.[18,21–23] It was absolutely necessary to neutralize the reaction mixture carefully with silver carbonate[24] after the quenching with methanol. Otherwise, the large amounts of hydrobromic acid which are formed would produce hydrobromides of the nucleobases. These cannot be chromatographed or even isolated in a definitely pure form. After column chromatography, the complete series of the four homologous 5-halouracil nucleoside analogues **7**–**10** were obtained as anomeric mixtures in the unprotected form with total yields between 16% and 36% (Sch. 1). Separation by reversed phase HPLC led to the pure anomers of **7**–**10**. The two anomers of **11** (total yield 8%) were separated by fractionated crystallization from water. First **β-11** crystallized as colorless sheets. After complete crystallization of the β-anomer **α-11** crystallized from the mother liquid as small needles.

Coupling of **1** with silylated 2-thiouracil in the presence of TMSOTf yielded 41% of the benzyl-protected 2-thio-4′-uridine nucleoside **12**. Analogously, the 6-methyl-2-thio-4′-thiouridine nucleoside **13** was obtained from **1** and silylated 6-methyl-2-thiouracil with a yield of 78%. Both uridine derivatives were formed as 2:1 mixtures of anomers, the assignment of which was not possible. Subsequent cleavage of the benzyl protecting groups with boron tribromide did, however, not lead to the desired nucleosides **17** and **18**. Only a large quantity of inseparable decomposition products was obtained. Therefore, we prepared **17** and **18** by an alternative route via the acetyl-protected methyl 4-thiofuranoside **14**.[12] Coupling of **14** with silylated 2-thiouracil and silylated 6-methyl-2-thiouracil yielded anomeric mixtures of the acetyl-protected uridine derivatives **15** (44%) and **16** (23%) with anomeric ratios of

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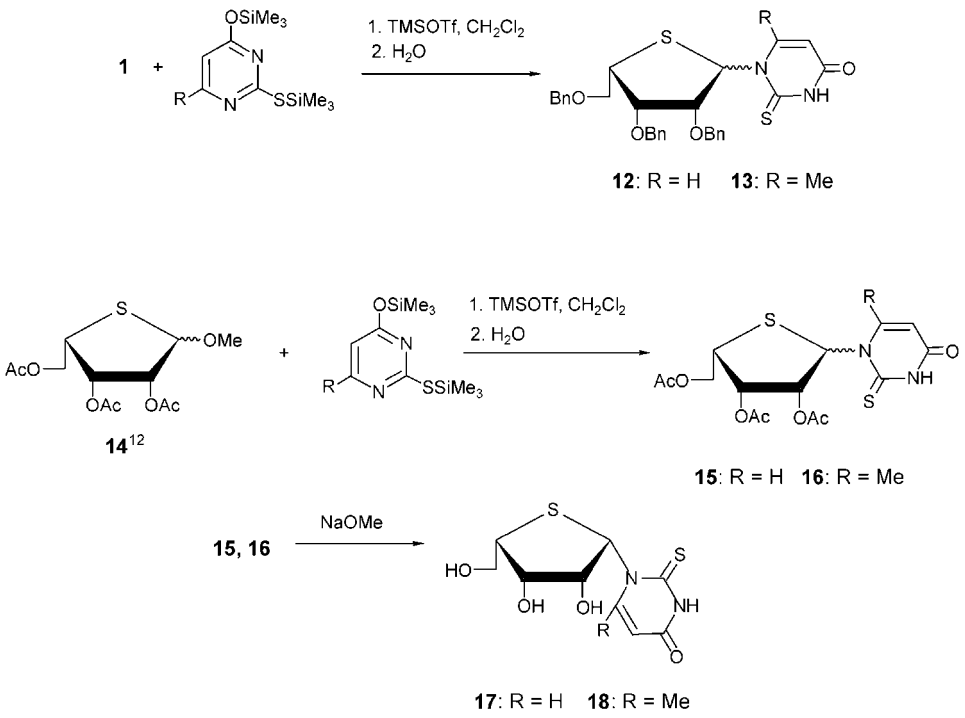

Scheme 2.

5:2 (**15**) and 2:1 (**16**). The anomers could not be separated and assigned. The cleavage of the *O*-acetyl groups was achieved by reaction of **15** and **16** with sodium methoxide (Sch. 2). Due to significant losses during the purification of the crude products by column chromatography and reversed-phase HPLC, only the β-anomer of the 2-thio-4′-thiouridine derivative **17** could be isolated with 10% yield. Also, only the β-anomer of the 6-methyl-2-thio-4′-thiouridine **18** was obtained with 24% yield after HPLC (Sch. 2).

Since **17** and **18** did not form suitable single crystals for X-ray structural analyses and, in addition, no NOE contacts in their NMR spectra could be detected, the assignment of the configurations was not straightforward. However, the comparison of all NMR data enabled a reasonable assignment to be reached (see: Configurations and Conformations).

When we tried to prepare the 4′-thiocytidine nucleoside **24** from **1** and 2,4-bis-*N,O*-(trimethylsilyl)cytosine,[25] we did not obtain the expected coupling product. Instead, the bicyclic oxazoline **19** was formed with 75% yield. This can be explained by nucleophilic attack of the solvent acetonitrile at the glycosyl donor (Sch. 3). Replacement of acetonitrile by dichloromethane was not helpful, with 90% of the starting material **1** being recovered in this solvent. Following a second strategy,[26] we transformed **20** into the 4-(1,2,4-triazole-1-yl)uridine derivative **22** as described by Uenishi et al.[27] We improved Uenishi's moderate yield of 22% to 82% by applying a 60-fold molar excess of 1,2,4-triazole instead of only 10 equivalents as reported

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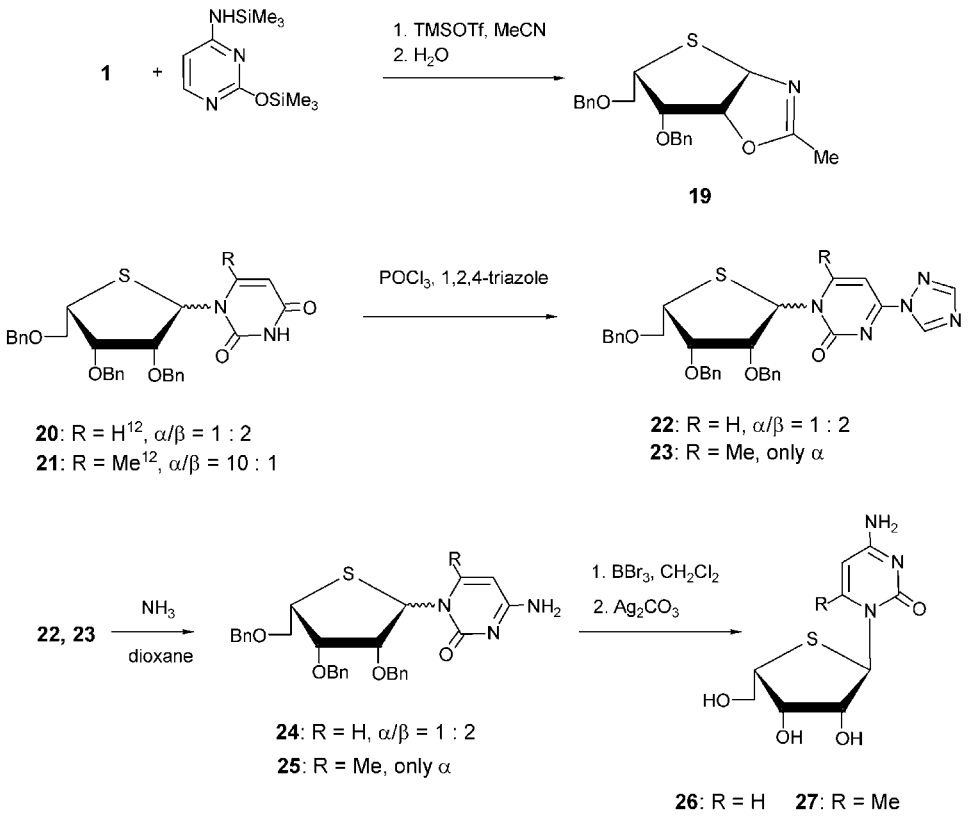

Scheme 3.

by Uenishi et al. The anomers of **22** ($\alpha/\beta = 1{:}2$) were separable by column chromatography. Replacement of the triazolyl substituent with 25% aqueous ammonia solution led to a 82% yield of **24** as a separable mixture of anomers ($\alpha/\beta = 1{:}2$). Cleavage of the benzyl protecting groups was achieved, again with great losses, by reaction of **24** with boron tribromide at $-90°C$.[24] After reversed-phase HPLC, only the α-anomer of 4′-thiocytidine **26** could be isolated with 3% yield (Sch. 3). The β-anomer of **26** was not obtained. Analogously, the reaction of **21** with triazole[26,27] gave 68% of **23**, which was then treated with ammonia to yield **25** (85%). Cleavage of the benzyl groups of **25** and subsequent reversed-phase HPLC finally led to a very low quantity (3%) of the unprotected 6-methyl-4′-thiocytidine nucleoside **27** with α-configration (Sch. 3). We could not increase this poor yield, despite making every effort.[28] Nevertheless, other *O*-benzyl-4′-thio-L-lyxo-pyrimidine nucleoside analogues could be deprotected significantly more successfully[11,12] and the result was also better for **7**–**10**. The nucleoside **27** was crystallized from water-ethanol as colorless needles, which were suitable for an X- ray structural analysis (cf. Fig. 1).

Coupling of the thiosugar **1** with adenine in the presence of TMSOTf gave the adenosine **28** with a yield of 65% as a 2:1 (α/β) mixture of anomers. The reaction

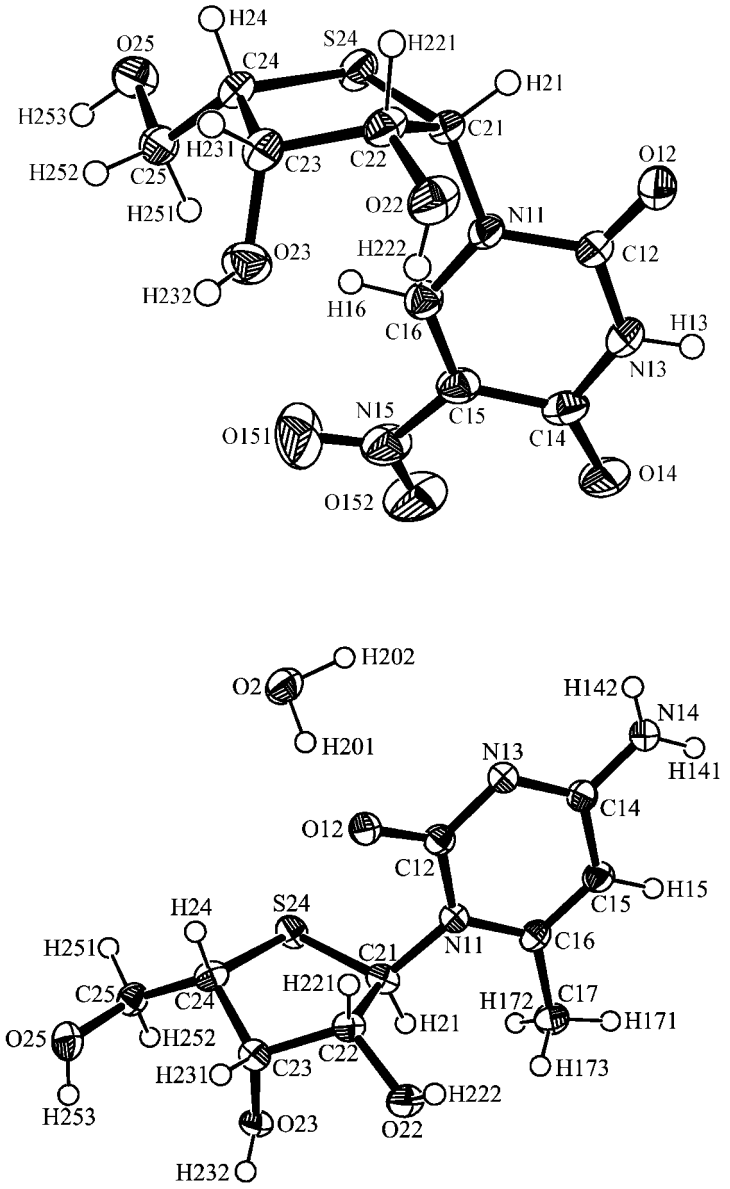

Figure 1. ORTEP views of the X-ray diffraction structures of the 5-nitrouridine derivative **β-11** (top) and the 6-methylcytidine derivative **27** (bottom; with one molecule of crystal water) with atom numbering; thermal ellipsoids are drawn at the 50% probability level.

of **28** with boron tribromide led to a mixture of the completely unprotected adenosine analogue **29** (6%, $\alpha/\beta = 2{:}1$) and its 2′-*O*-benzyl derivative **30** (19%). HPLC separation gave the pure anomers **α-29** and **β-29** and, in addition, **30** which also exhibits α-configuration (Sch. 4).

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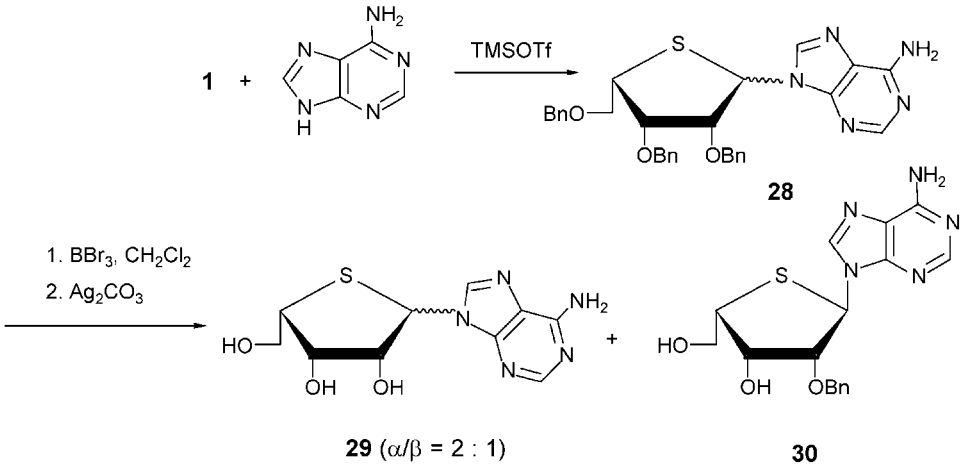

Scheme 4.

The inosine derivative **31** was obtained from **1**, hypoxanthine and TMSOTf as a 5:4 mixture of anomers with 67% yield. Reaction of **31** with boron tribromide failed to yield the unprotected inosine **34**. Instead, the 2′-*O*-benzyl derivative **32** was formed and after chromatographic work-up 7% of pure **α-32** were isolated. Therefore, we synthesized **34** via the alternative route from the thiosugar **14**. The first step led to 33% acetyl-protected inosine **33**. The predominant formation of the α-anomer is due to neighboring group participation. Treatment of **33** with sodium methoxide and reversed phase HPLC gave the inosine derivative **34** with 16% yield (Sch. 5).

Configurations and Conformations

The starting glycosyl donors **1**, **14**, **20** and **21** were used as anomeric mixtures with α/β ratios of 1:10 for **1**, 1:2 for **20** and 10:1 for **21**. The anomers of **14** (1:2) could not be assigned. These ratios are not preserved during the formation of the N-glycosides under S_N1-conditions. They are different for the products **2**–**6**, **12**, **13**, **19**, **28** and **31**. Moreover, the reaction of the acetate **14** to form **15**, **16** and **33** is controlled by the formation of an intermediate acetoxonium ion. In fact, in the case of **33** only the expected α-anomer was isolated. The deprotection of the *O*-benzyl derivatives with a large excess of the Lewis-acid boron tribromide also changed the ratios considerably because anomerisation can take place under these conditions. A consistent discussion of the stereochemistry is not well possible since the isolated yields are low in many cases. The anomeric ratios found in the products are thus not indicative of the stereochemical course of the reaction.

Irrespective of this, the configuration of the final products, the unprotected nucleoside analogues, could be determined. The assignment of the anomers of **7**, **8**, **9**, **11** and **27** was unequivocal, as X-ray structural analyses of one or both anomers could be performed. For illustration, the ORTEP plots of **α-7**, **β-7**, **β-11** and **27** are

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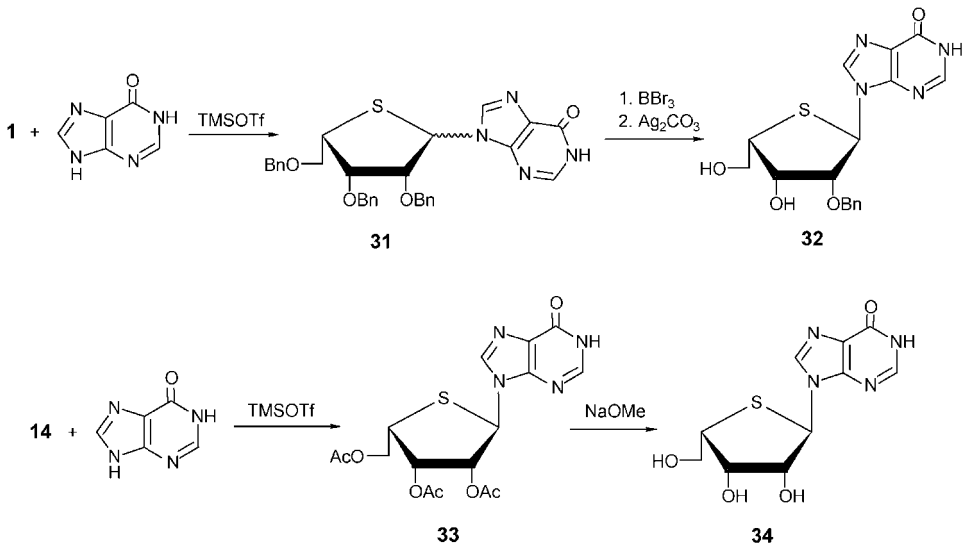

Scheme 5.

shown in Fig. 1 and 2. The molecular structures of **8** and **9** resemble very closely those of the corresponding anomers of **7**. The sugar moieties of **α-7** and **β-7** have twisted conformations ($^2T_3$), whereas both anomers of the chloro and bromo derivatives exhibit envelope conformations (**α-8** and **α-9**: E_3; **β-8** and **β-9**: ^2E).[29] Intramolecular hydrogen bridges between the hydroxyl groups at C-2′ and the oxygen at C-3′ are observed for **β-7** (254 pm), **β-8** (248 pm), **α-9** (254 pm) and **β-9** (253 pm), which might contribute to the stabilization of the respective twisted or envelope conformations in the crystal. An envelope conformation (^2E) of the thiofuranose moiety with an intramolecular OH···O hydrogen bond of 237 pm length between 2′-OH (H 222) and O-3′ (O 23) results from the X-ray structure of **β-11** (cf. Fig. 2).[29]

The sugar moiety of **27** exhibits the envelope conformation E_3, which was also observed for the 6-methyluridine derivative **α-21**.[12] In contrast to **α-21**, no intramolecular hydrogen bond was found in compound **27** (cf. Fig. 1).[29]

The configurations of the remaining 4-thio-L-lyxofuranosyl nucleosides were assigned on the basis of their ^{1}H NMR spectra. Although no NOE contacts could be detected in spite of intensive efforts, the sequences of the chemical shifts and, in particular, the coupling constants $J_{1',2'}$ allowed reliable and convincing assignments in most cases. The relevant NMR data of the new compounds are compiled in Table 1. For comparison, four related 4-thio-L-lyxofuranosyl nucleosides with established configuration[12] are included in Table 1.

Two structural types of nucleosides must be distinguished. The majority of compounds do not exhibit a substituent in the 6-position of the nucleobase. The purine nucleosides **29**, **30**, **32**, and **34** can be classed with this group. The compounds **18** and **27**, on the other hand, are 6-methyl derivatives, in which steric hindrance might influence the NMR parameters. In the first class of nucleosides, the chemical shifts δ of H-1′ are larger for the α-anomers (>6 ppm) than for the β-anomers (<6 ppm).

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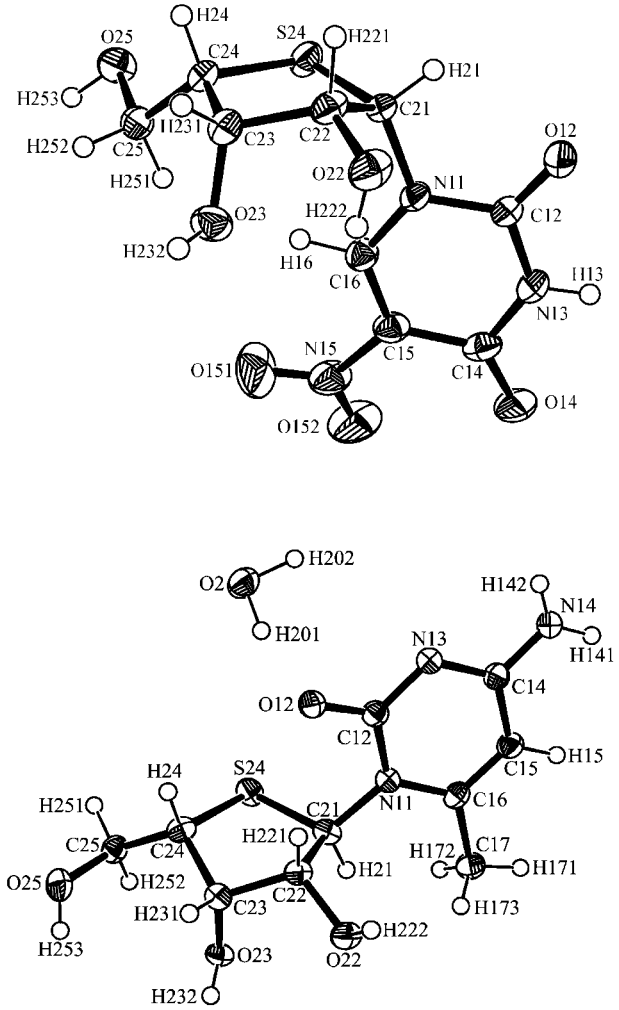

Figure 2. ORTEP views of the X-ray diffraction structures of the 5-fluorouridine derivatives **α-7** (top) and **β-7** (bottom) with atom numbering; thermal ellipsoids are drawn at the 50% probability level.

The same order is observed for H-3′. For all α-anomers, δ(H-4′) is smaller than δ(H-5′), whereas for the β-anomers δ(H-4′) is larger than δ(H-5′). Without exception, the coupling constants of the anomeric protons are found significantly smaller in the α-series ($J_{1',2'} = 6.6$–7.2 Hz) than in the β-series ($J_{1',2'} = 8.4$–9.1 Hz). In addition, the carbon-13 data allow some conclusions on the configurations. In all cases studied the signals of the anomeric carbon atom C-1′ and of the neighboring center C-2′ are shifted downfield by ca. 2 ppm and by ca. 3 ppm, respectively, in the β-anomers as compared with the α-anomers. – As mentioned above, there is some doubt about the configuration of the 2-thio-nucleoside **17**. However, the chemical shift data and, in particular, the coupling constant ($J_{1',2'} = 8.6$ Hz) suggest its β-configuration.

Table 1. Proton chemical shifts δ and coupling constants $J_{1',2'}$ (Hz) of (4-thio-L-lyxofuranosyl)-pyrimidine and -purine nucleosides.

R-5[a]	R-6[a]	Nr.	[b]	H-1′	H-2′	H-3′	H-4′	H-5a′	H-5b′	$J_{1',2'}$
H	H	[c]	α	6.11	4.21	4.16	3.47	3.60	3.87	7.0
		[c]	β	5.98	4.23	4.10	3.84	3.42	3.76	9.1
Me	H	[d]	α[e]	6.12	4.19	4.16	3.47	3.63	3.88	7.0
		[d]	β	5.92	4.19	4.03	3.78	3.35	3.70	9.1
F	H	**7**	α[e]	6.08	4.24	4.14	3.47	3.59	3.87	7.2
		7	β[e]	5.97	4.29	4.09	3.86	3.42	3.76	8.9
Cl	H	**8**	α[e]	6.08	4.23	4.15	3.49	3.60	3.88	7.2
		8	β[e]	5.97	4.31	4.09	3.91	3.42	3.76	8.9
Br	H	**9**	α[e]	6.08	4.23	4.15	3.49	3.59	3.88	7.1
		9	β[e]	5.95	4.30	4.07	3.90	3.40	3.74	9.0
I	H	**10**	α	6.05	4.19	4.14	3.48	3.59	3.87	6.9
		10	β	5.96	4.32	4.08	3.92	3.42	3.76	9.0
NO_2	H	**11**	α	6.07	4.25	4.13	3.52	3.62	3.91	6.9
		11	β[e]	6.00	4.38	4.12	3.96	3.46	3.78	8.6
H	H	**17**	β	5.05	4.00	4.13	3.55	3.40	3.73	8.6
H	H	**26**	α	6.26	4.13	4.18	3.45	3.63	3.84	6.6
H	Me	[f]	α[e]	5.34	4.99	4.09	3.80	3.43	3.76	7.6
		[f]	β	5.95	4.34	4.04	3.45	3.58	3.91	8.5
Me	Me	[g]	α[e]	5.29	5.04	4.1	3.8	3,43	3.8	7.5
H	Me	**18**	β	5.01	4.12	4.00	3.55	3.41	3.73	8.4
H	Me	**27**	α[e]	5.56	5.1	4.07	3.84	3.41	3.75	[h]
		29	α	6.06	4.35	4.27	3.57	3.61	3.91	7.0
		29	β	5.91	4.83	4.21	3.91	3.43	3.80	8.8
		30	α	6.36	4.32	4.5	3.65	3.65	3.99	7.2
		32	α	6.25	4.32	4.5	3.6	3.6	3.95	7.2
		34	α	6.02	4.36	4.28	3.59	3.64	3.93	7.2

[a]Substituent at C-5 or C-6 of the pyrimidine base.
[b]Anomer configuration.
[c]1-(4-Thio-L-lyxofuranosyl)uracil.[12]
[d]1-(4-Thio-L-lyxofuranosyl)thymine.[12]
[e]X-Ray structural analysis.
[f]6-Methyl-1-(4-thio-L-lyxofuranosy)uracil; $\delta(\text{H-1}') = 5.51$ and $J_{1'2'} = 0.0\,\text{Hz}$ given for the α-anomer in Ref.[12] are erroneous.
[g]5,6-Dimethyl-1-(4-thio-α-L-lyxofuranosyl)uracil; $\delta(\text{H-1}') = 5.50$ and $J_{1'2'} = 0.0\,\text{Hz}$ given in Ref.[12] are erroneous.
[h]Not detectable.

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– Due to its X-ray structural analysis, the α-configuration of the 6-methylcytosine derivative **27** is unmistakable. Interestingly, **27** exhibits chemical shifts δ for H-4′, H-5_a′ and H-5_b′ which are typical of a β-configuration in the unsubstituted series. They are, however, in good agreement with the data for the α-anomer of the corresponding 6-methyluracil derivative. Again, the nature of the configuration of the 2-thio-nucleoside **18** remains in doubt, but in our view, the coupling constant $J_{1',2'} = 8.4$ Hz and the nearly identical proton chemical shifts in **18** and **17** argue strongly in favor of the β-configuration.

Biological Activities

The unprotected nucleosides **α-** and **β-7–11**, **17**, **18**, **26**, **27**, **α-29**, **β-29** and **34** were biologically tested. The compounds **7**–**11**, **26**, **27** and **34** did not exhibit antiviral activity against HIV-1 (III_B), HIV-2 (ROD), HCMV (Human Cytomegalovirus, strain Davis) or VZV (Varicella Zoster virus, strain OKA) at the highest concentration tested (250 μM). The compounds **11**, **17**, **18**, **26**, **27**, **29** and **34** were also found to be inactive against HSV-1 (KOS), HSV-2 (G), Vaccinia virus, Vesicular stomatitis virus, Coxsackie virus B4, Respiratory syncytial virus, Parainfluenza 3 virus, Reovirus-1, Sindbis virus or Punta Toro virus. – None of the nucleoside analogues was cytotoxic at 250 μM. – The obvious lack of physiological activity might be due to the choice of the nucleobases since their similarity with the natural nucleobases is low in most cases, despite compounds **27**, **29** and **34** being derived from the natural nucleobases cytosine, adenine and hypoxanthine, respectively, which justified the testing of these compounds.

EXPERIMENTAL SECTION

Melting points (corrected) were taken on an Electrothermal apparatus. IR spectra (KBr pellets or films) were recorded on an ATI Mattson Genesis spectrometer. NMR measurements were carried out with Bruker AMX 400 and DRX 500 spectrometers. Chemical shifts (ppm) are related to Me_4Si (^1H) and $CDCl_3$ (^{13}C, $\delta = 77.05$). Standard correlation techniques were used for assignments. Mass spectra were measured on Varian CH 7 (EI) and VG Analytical 70–250 S (FAB MS and FAB HRMS with *meta*-nitrobenzyl alcohol as matrix). HPLC (Merck–Hitachi equipment): Semi-preparative HPLC was carried out with a LiChroCART 250–10 column containing LiChrosher 100 RP-18 (10 μm) and analytical HPLC was performed with an Eco-CART 125-3 column containing LiChrosher 100 RP-18 end capped (5 μm). Solvents for HPLC were obtained from Merck (MeCN, HPLC grade) and Riedel-de Haën (water, HPLC grade). A_1 and A_2 correspond to fast and slowly eluted fractions without assignment of anomers. Optical rotations were measured with a Perkin Elmer Polarimeter 341. Thin layer chromatography (TLC) was carried out on Merck PF_{254} foils (detection: UV light, iodine vapour, or $EtOH/H_2SO_4$ spray/200°C), and column chromatography (CC) on Merck Kieselgel 60 (70–230 mesh). Solvents (PE = petroleum ether 60–70°C) were purified and dried according to standard laboratory procedures.[30]

X-Ray Structure Analyses

The crystal data and a summary of experimental details are given in Table 2,3,4. The data collection for **α-7**, **β-7**, **α-8**, **β-8**, **α-9**, **β-9** and **β-11** was performed on a Kappa-CCD Nonius diffractometer, with graphite-monochromated Mo-K_α radiation ($\lambda = 0.71073$ Å) in the rotation Φ scan mode at 293 K. The X-ray data of **27** were measured on an Enraf-Nonius CAD4 diffractometer, with graphite-monochromated Cu-K_α radiation ($\lambda = 1.54178$ Å) in the $2\theta/\omega$ scan mode at 173 K. The structures were solved by direct methods using the SIR-97[31] program, and refined by full-matrix-block least-squares on F^2 using all data and the SHELXL-97[32] program. Crystallographic data have been deposited with the Cambridge Crystallographic Data Centre as supplementary publications no. CCDC-144010 (**α-7**), CCDC-144011 (**β-7**), CCDC-144012 (**α-8**), CCDC-144013 (**β-8**), CCDC-144014 (**α-9**), CCDC-144015 (**β-9**), CCDC-144159 (**β-11**) and CCDC-148667 (**27**). Copies of the

Table 2. Crystal data and structure refinement for **α-7**, **α-8**, and **α-9**.

	α-7	**α-8**	**α-9**
Crystal system	monoclinic	orthorhombic	orthorhombic
Space group	$P2_1$	$P2_12_12_1$	$P2_12_12_1$
a [Å]	4.8100 (10)	4.9120 (10)	4.9710 (10)
b [Å]	10.7500 (10)	11.3290 (10)	11.5180 (10)
c [Å]	10.7010 (10)	20.7010 (10)	20.5780 (10)
β [°]	100.860 (10)		
Formula units per cell, Z	2	4	4
Crystal size [mm]	$0.38 \times 0.23 \times 0.11$	$0.46 \times 0.10 \times 0.08$	$0.45 \times 0.08 \times 0.06$
$\rho_{calcd.}$ [g cm^{-3}]	1.701	1.699	1.912
F_{000}	288	608	680
μ [mm^{-1}]	0.330	0.529	3.682
$h/k/l$ limits	0,6/–13,12/−13,13	0,6/0,14/−26,26	0,6/0,14/−26,26
θ limits [°]	1.94/27.48	1.97/27.46	2.65/27.44
Number of reflections	4996	7232	10494
Independent reflections	2357	2537	2540
Reflections with $I \leq 2\sigma(I)$	2196	2351	2328
Weighting scheme $[\Sigma w(F_0^2 - F_c^2)^2]$	$w = 1/[\sigma^2(F_0^2) + (0.0350P)^2 + 0.0922P]$; $P = (F_0^2 + 2F_c^2)/3$	$w = 1/[\sigma^2(F_0^2) + (0.0647P)^2 + 0.0352P]$; $P = (F_0^2 + 2F_c^2)/3$	$w = 1/[\sigma^2(F_0^2) + (0.0276P)^2 + 0.4185P]$; $P = (F_0^2 + 2F_c^2)/3$
Number of parameters	208	208	208
Final R indices $[I \leq 2\sigma(I)]$	$R_1 = 0.0276$, $R_w = 0.0649$	$R_1 = 0.0298$, $R_w = 0.0779$	$R_1 = 0.0265$, $R_w = 0.0548$
R indices (all data)	$R_1 = 0.0311$, $R_w = 0.0678$	$R_1 = 0.0358$, $R_w = 0.0997$	$R_1 = 0.0323$, $R_w = 0.0613$
Goodness-of-fit on F^2	972	1.147	0.999
Largest difference peak and hole [e Å^{-3}]	0.168 and –0.165	0.408 and –0.341	0.269 and –0.340
Refinement of H atoms	difmap/geom.	difmap/geom	difmap/geom

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Table 3. Crystal data and structure refinement for **β-7**, **β-8**, and **β-9**.

	β-7	**β-8**	**β-9**
Crystal system	monoclinic	monoclinic	monoclinic
Space group	$P2_1$	$P2_1$	$P2_1$
a [Å]	7.1750 (10)	7.1680 (10)	7.2020 (10)
b [Å]	6.6200 (10)	6.7180 (10)	6.7260 (10)
c [Å]	11.7830 (10)	12.3630 (10)	12.6030 (10)
β [°]	100.040 (10)	103.600 (10)	104.800 (10)
Formula units per cell, Z	2	2	2
Crystal size [mm]	$0.45 \times 0.32 \times 0.12$	$0.40 \times 0.34 \times 0.06$	$0.18 \times 0.17 \times 0.06$
$\rho_{\text{calcd.}}$ [g cm^{-3}]	1.677	1.691	1.908
F_{000}	288	304	340
μ[mm^{-1}]	0.325	0.526	3.674
$h/k/l$ limits	0,8/−7,7/−14,13	0,9/−8,8/−16,15	0,9/−8,8/−16,15
θ limits [°]	1.76/25.03	1.69/27.48	1.67/27.52
Number of reflections	7924	5068	4872
Independent reflections	1934	2503	2613
Reflections with $I \leq 2\sigma(I)$	1847	2295	2436
Weighting scheme $[\Sigma w(F_0^2 - F_c^2)^2]$	$w = 1/[\sigma^2(F_0^2) + (0.0781P)^2 + 0.0514P]$; $P = (F_0^2 + 2F_c^2)/3$	$w = 1/[\sigma^2(F_0^2) + (0.0397P)^2 + 0.1617P]$; $P = (F_0^2 + 2F_c^2)/3$	$w = 1/[\sigma^2(F_0^2) + (0.0549P)^2 + 0.1712P]$; $P = (F_0^2 + 2F_c^2)/3$
Number of parameters	208	208	208
Final R indices $[I \leq 2\sigma(I)]$	$R_1 = 0.0306$, $R_w = 0.0926$	$R_1 = 0.0281$, $R_w = 0.0678$	$R_1 = 0.0331$, $R_w = 0.0804$
R indices (all data)	$R_1 = 0.0342$, $R_w = 0.1067$	$R_1 = 0.0338$, $R_w = 0.0723$	$R_1 = 0.0379$, $R_w = 0.0948$
Goodness-of-fit on F^2	1.137	0.964	1.085
Largest difference peak and hole [e Å^{-3}]	0.306 and –0.308	0.209 and –0.209	0.416 and –0.424
Refinement of H atoms	difmap/geom	difmap/geom	difmap/geom

data can be obtained free of charge on application to CCDC, 12 Union Road, Cambridge CB2 1EZ, UK. [Tel. +44-1223-336408, Fax +44-1223-336033, E-mail deposit@ccdc.cam.ac.uk.].

5-Nitro-2,4-bis-*O*-trimethylsilyluracil (viscous, yellowish liquid, 91% yield. B.p. 156°C/0.5 Torr); **4-trimethylsilyloxy-2-trimethylsilylthiopyrimidine** (yellow liquid, 86% yield. B.p. 129°C/0.5 Torr) and **6-methyl-4-trimethylsilyloxy-2-trimethylsilylthiopyrimidine** (colorless liquid, 93% yield. B.p. 134–136°C/0.5 Torr) were obtained from the corresponding pyrimidine bases (30 mmol) according to literature procedures.[25,33]

Glycosylation of Nucleobases. General Procedure (GP1) .[17] Millimolar amounts of the glycosyl donor 1 ($\alpha/\beta = 1{:}10$)[12] or 14,[12] the respective silylated nucleobase (4.5 equivalents) and 4 Å molecular sieves (40 mg) were dissolved in dry acetonitrile (15 mL) at −18°C. TMSOTf (3.3 equivalents) was added under rapid stirring. Stirring was continued without further cooling until the reaction was complete

Table 4. Crystal data and structure refinement for **β-11** and **27**.

	β-11	**27**
Crystal system	monoclinic	tetragonal
Space group	$P2_1$	$P4_3$
a [Å]	7.0470 (10)	8.8543 (6)
b [Å]	6.7460 (10)	8.8543 (6)
c [Å]	12.7560 (2)	16.282 (2)
β [°]	104.00° (1)	
Crystal size [mm]	$0.42 \times 0.35 \times 0.08$	$0.60 \times 0.30 \times 0.30$
Formula units per cell, Z	2	4
$\rho_{calcd.}$ [g cm^{-3}]	1.723	1.516
F_{000}	316	616
μ [mm^{-1}]	0.316	2.482
$h/k/l$ limits	0,9/−8,8/−16,16	−3,11/−11,3/−20,3
θ limits [°]	1.65–27.49	4.99–76.43
Number of reflections	4073	1576
Independent reflections	2469	1386
Reflections with $I \leq 2\sigma(I)$	2405	1382
Weighting scheme $[\Sigma w(F_0^2 - F_c^2)^2]$	$w = 1/[\sigma^2(F_0^2) + (0.0611P)^2 + 0.1542P]$; $P = (F_0^2 + 2F_c^2)/3$	$w = 1/[\sigma^2(F_0^2) + (0.0752P)^2 + 0.3532P]$; $P = (F_0^2 + 2F_c^2)/3$
Number of parameters	226	197
Final R indices $[I \leq 2\sigma(I)]$	$R_1 = 0.0323$, $wR_2 = 0.0882$	$R_1 = 0.0352$, $wR_2 = 0.0932$
Goodness-of-fit on F^2	0.996	1.037
R indices (all data)	$R_1 = 0.0335$, $wR_2 = 0.0904$	$R_1 = 0.0353$, $wR_2 = 0.0932$
Largest difference peak and hole [e Å^{-3}]	0.266 and −0.240	0.266 and −0.548
Refinement of H atoms	difmap/geom	geom

(ca. 1.5 h, TLC monitoring). The reaction mixture was quenched with satd. aq. $NaHCO_3$ solution (20 mL) and stirred for another 30 min. After filtration, the aq. solution was extracted with $CHCl_3$. The extract was dried with $MgSO_4$ and evaporated. The product was purified by CC.

Deprotection of *O*-Benzyl Derivatives. General Procedure (GP2).[24] Millimolar amounts of the benzyl-protected nucleoside analogue were dissolved in dry CH_2Cl_2 (10 mL) and added dropwise under vigorous stirring at −80°C to a cooled solution (−80°C) of BBr_3 (5 equivalents) in dry CH_2Cl_2 under N_2. Stirring was continued at −90°C for 1 h. The excess of BBr_3 was quenched at −90°C by dropwise addition of a 1:1 mixture of CH_2Cl_2/MeOH (10 mL). After warming to room temperature, Ag_2CO_3 (30 mmol) was added to neutralize the HBr. After 30 min the inorganic salts were filtered off, the solution was evaporated to dryness and the remaining product was purified by CC. Further purification and separation steps followed when required.

5-Fluoro-1-(2,3,5-tri-*O*-benzyl-4-thio-L-lyxofuranosyl)uracil (2). **GP1**; from **1**[12] (502 mg, 1.05 mmol) and 5-fluoro-2,4-bis-*O*-trimethylsilyluracil.[33] CC [PE/EtOAc 1:1, $R_f(A_l)$ 0.45, $R_f(A_2)$ 0.41] yielded the inseparable anomers ($\alpha/\beta = 3{:}5$) of **2** (484 mg, 84%) as a white solid. IR: ν 3184 (NH), 1692 (C=O), cm^{-1}. FAB MS; m/z: 549 $[M+H]^+$. FAB HRMS: calcd. 549.1859 $[M+H]^+$; found 549.1903. **α-2**: ^{1}H NMR (400 MHz, $CDCl_3$): δ 3.56–3.59 (m, 1H, H-4′), 3.63 (dd, 1H, H-5′$_a$), 3.92 (dd, 1H, H-5′$_b$), 4.08 (dd, 1H, H-2′), 4.20 (dd, 1H, H-3′), 4.52–4.56 (m, 2H, CH_2Ph), 4.66–4.69 (m, 2H, CH_2Ph), 4.58, 4.79 (AB-system, 2H, CH_2Ph, $J_{AB} = 10.9$ Hz), 6.39 (dd, 1H, H-1′), 7.20–7.37 (m, 15H, ArH), 8.29 (d, 1H, H-6), 8.97 (d, 1H, NH). $J_{1',2'} = 7.0$, $J_{1'F} = 1.6$, $J_{2',3'} = 3.3$, $J_{3',4'} = 4.1$, $J_{4',5'a} = 6.7$, $J_{4',5'b} = 7.3$, $J_{5'a,5'b} = 9.0$, $J_{6,F} = 7.2$. $J_{NH,F} = 4.7$ Hz. ^{13}C NMR (101 MHz, $CDCl_3$): δ 46.7 (C-4′), 59.6 (C-1′), 68.8 (C-5′), 73.5 (CH_2Ph), 73.6 (CH_2Ph), 74.7 (CH_2Ph), 79.2 (C-3′), 82.9 (C-2′), 127.85, 127.91, 127.95, 127.98, 128.17, 128.22, 128.27, 128.5, 128.6, 128.6 (C-6, C_{Ar}H), 137.6, 137.7, 138.0 (C_{Ar}), 139.1 (C-5), 150.2 (C-2), 156.9 (C-4). **β-2**: ^{1}H NMR (400 MHz, $CDCl_3$): δ 3.52–3.55 (m, 1H, H-5′$_a$), 3.80 (dd, 1H, H-2′), 3.83–3.88 (m, 2H, H-4′, H-5′$_b$), 4.22–4.25, 4.66–4.69 (m, 2H, CH_2Ph), 4.23–4.24 (m, 1H, H-3′), 4.50 (s. 2H, CH_2Ph), 4.59, 4.78 (AB-system, 2H, CH_2Ph, $J_{AB} =$ 11.9 Hz), 6.26 (dd, 1H, H-1′), 7.20–7.37 (m, 16H, H-6, ArH), 8.84 (d 1H, NH). $J_{1',2'} = 8.1$. $J_{1',F} = 1.5$, $J_{2',3'} = 3.0$, $J_{NH,F} = 4.7$ Hz. ^{13}C NMR (101 MHz, $CDCl_3$) δ 46.8 (C-4′), 62.7 (C-1′), 69.4 (C-5′), 72.4 (CH_2Ph), 73.5 (CH_2Ph), 74.0 (CH_2Ph), 75.7 (C-3′), 84.8 (C-2′), 123.6 (C-6), 127.5, 127.9, 128.1, 128.3, 128.4, 128.49, 128.53, 128.8 (C_{Ar}H), 136.7, 137.0, 137.8 (C_{Ar}), 141.0 (C-5), 149.1 (C-2), 156.4 (C-4).

5-Chloro-1-(2,3,5-tri-*O*-benzyl-4-thio-L-lyxofuranosyl)uracil (3). **GP1**; from **1**[12] (500 mg, 1.04 mmol) and 5-chloro-2,4-bis-*O*-trimethylsilyluracil.[33] CC [PE/EtOAc 1:1, $R_f(A_1)$ 0.39, $R_f(A_2)$ 0.35] yielded the inseparable anomers ($\alpha/\beta = 2{:}3$) of **3** as a white solid (460 mg, 78%). IR: ν 3185 (NH), 1691 (C=O) cm^{-1}. FAB MS; m/z: 565 $[M+H]^+$. FAB HRMS: calcd. 565.1564 $[M+H]^+$; found 565.1614. **α-3**: ^{1}H NMR (500 MHz, $CDCl_3$): δ 3.59 (ddd, 1H, H-4′), 3.65 (dd, 1H, H-5′$_a$), 3.95 (dd, 1H, H-5′$_b$). 4.08 (dd, 1H, H-2′), 4.20 (dd, 1H, H-3′), 4.53 (d, 2H, CH_2Ph, $J = 2.5$ Hz), 4.58, 4.78 (AB-system, 2H, CH_2Ph, $J_{AB} = 11.0$ Hz), 4.59, 4.67 (AB-system, 2H, CH_2Ph, $J_{AB} = 12.1$ Hz), 6.39 (d, 1H, H-1′), 7.20–7.37 (m, 15H, ArH), 8.37 (s, 1H, H-6), 9.09 (bs, 1H, NH). $J_{1',2'} = 6.9$, $J_{2',3'} = 3.6$, $J_{3',4'} = 4.1$, $J_{4',5'a} = 6.8$, $J_{4',5'b} = 7.2$, $J_{5'a,5'b} = 9.0$ Hz. ^{13}C NMR (126 MHz, $CDCl_3$): δ 46.7 (C-4′), 59.6 (C-1′), 68.8 (C-5′), 73.49 (CH_2Ph), 73.53 (CH_2Ph), 74.8 (CH_2Ph), 79.4 (C-3′), 82.9 (C-2′), 107.4 (C-5), 127.90, 127.94, 127.96, 128.10, 128.14, 128.2, 128.56, 128.62, 128.7 (C_{Ar}H), 137.0, 137.1, 137.6 (C_{Ar}), 141.4 (C-6), 150.7 (C-2), 158.9 (C-4). **β-3**: ^{1}H NMR (500 MHz, $CDCl_3$): δ 3.54 (dd, 1H, H-5′$_a$), 3.82–3.86 (m, 2H, H-2′, H-5′$_b$), 3.89 (ddd, 1H, H-4′), 4.21–4.25 (m, 1H, H-3′), 4.21–4.25, 4.66–4.70 (m, 2H, CH_2Ph), 4.50 (s, 2H, CH_2Ph), 4.68, 4.87 (AB-system, 2H, CH_2Ph, $J_{AB} = 11.7$ Hz), 6.26 (d, 1H, H-1′), 7.23–7.37 (m, 15H, ArH), 7.39 (s, 1H, H-6), 8.97 (bs, 1H, NH). $J_{1',2'} = 8.1$, $J_{3',4'} = 3.7$, $J_{4',5'a} = 6.7$, $J_{4',5'b} = 6.8$, $J_{5'a,5'b} = 9.1$ Hz. ^{13}C NMR (126 MHz, $CDCl_3$): δ 46.9 (C-4′), 62.8 (C-1′), 69.3 (C-5′), 72.4 (CH_2Ph), 73.5 (CH_2Ph), 74.0 (CH_2Ph), 75.7 (C-3′), 84.9 (C-2′), 109.3 (C-5), 127.5, 127.8, 128.1, 128.2. 128.4, 128.49, 128.52, 128.8 (C_{Ar}H), 136.6, 137.0, 137.7 (C_{Ar}), 137.8 (C-6), 149.6 (C-2), 158.4 (C-4).

5-Bromo-1-(2,3,5-tri-*O*-benzyl-4-thio-L-lyxofuranosyl)uracil (4). **GP1**; from **1**[12] (505 mg, 1.06 mmol) and 5-bromo-2,4-bis-*O*-trimethylsilyluracil.[33] CC [PE/EtOAc 1:1, $R_f(A_1)$ 0.40, $R_f(A_2)$ 0.36] yielded the inseparable anomers ($\alpha/\beta = 1{:}2$) of **4** as a white solid (498 mg, 77%). IR: ν 3178 (NH), 1690 (C=O) cm^{-1}. FAB MS; m/z: 611 $[M+H]^+$ for ^{81}Br, 609 $[M+H]^+$ for ^{79}Br. FAB HRMS: calcd. 611.1038 $[M+H]^+$ for ^{81}Br, 609.1059 $[M+H]^+$ for ^{79}Br; found 611.1080, 609.1088. **α-4**: ^1H NMR (400 MHz, $CDCl_3$): δ 3.59 (ddd, 1H, H-4′), 3.66 (dd, 1H, H-5′$_a$), 3.95 (dd, 1H, H-5′$_b$), 4.07 (dd, 1H, H-2′), 4.19–4.21 (m, 1H, H-3′), 4.53 (s, 2H, C*H*$_2$Ph), 4.58, 4.67 (AB-system, 2H, C*H*$_2$Ph, $J_{AB} = 12.0$ Hz), 4.59, 4.78 (AB-system, 2H, C*H*$_2$Ph, $J_{AB} = 11.1$ Hz), 6.38 (d, 1H, H-1′), 7.23–7.37 (m, 15H, ArH), 8.47 (s, 1H, H-6), 8.87 (bs, 1H, NH). $J_{1',2'} = 6.9$, $J_{2',3'} = 3.3$, $J_{3',4'} = 4.3$, $J_{4',5'a} = 6.8$, $J_{4',5b} = 7.1$, $J_{5'a,5'b} = 9.1$ Hz. ^{13}C NMR (101 MHz, $CDCl_3$): δ 46.7 (C-4′), 59.6 (C-1′), 68.8 (C-5′), 73.48 (*C*H$_2$Ph), 73.53 (*C*H$_2$Ph), 74.70 (*C*H$_2$Ph), 79.4 (C-3′), 82.9 (C-2′), 90.0 (C-5), 127.91, 127.95, 127.96, 128.1, 128.2, 128.3, 128.5, 128.6, 128.7 ($C_{Ar}H$), 137.0, 137.2, 137.6 (C_{Ar}), 144.0 (C-6), 150.8 (C-2), 158.9 (C-4). **β-4**: ^1H NMR (400 MHz, $CDCl_3$): δ 3.54 (dd, 1H, H-5′$_a$), 3.82 (dd, 1H, H-2′), 3.83–3.87 (m, 1H, H-5′$_b$), 3.89 (ddd, 1H, H-4′), 4.22, 4.69 (AB-system, 2H, C*H*$_2$Ph, $J_{AB} = 11.9$ Hz), 4.23–4.25 (m, 1H, H-3′), 4.50 (s, 2H, C*H*$_2$Ph), 4.69, 4.88 (AB-system, 2H, C*H*$_2$Ph, $J_{AB} = 11.7$ Hz), 6.26 (d, 1H, H-1′), 7.23–7.37 (m, 15H, ArH), 7.50 (s, 1H, H-6), 8.77 (bs, 1H, NH). $J_{1',2'} = 8.2$, $J_{2',3'} = 3.0$, $J_{3',4'} = 3.5$, $J_{4',5'a} = 6.5$, $J_{4',5'b} = 6.8$, $J_{5'a,5'b} = 8.7$ Hz. ^{13}C NMR (101 MHz, $CDCl_3$): δ 46.7 (C-4′), 62.7 (C-l′), 69.3 (C-5′), 72.4 (*C*H$_2$Ph), 73.5 (*C*H$_2$Ph), 74.0 (*C*H$_2$Ph), 75.6 (C-3′), 85.0 (C-2′), 97.1 (C-5), 127.5, 127.83, 127.84, 128.1, 128.2, 128.4, 128.5, 128.6, 128.8 ($C_{Ar}H$), 136.5, 137.6, 137.7 (C_{Ar}), 139.6 (C-6), 149.8 (C-2), 158.4 (C-4).

5-Iodo-1-(2,3,5-tri-*O*-benzyl-4-thio-L-lyxofuranosyl)uracil (5). **GP1**; from **1**[12] (598 mg, 1.25 mmol) and 5-iodo-2,4-bis-*O*-trimethylsilyluracil.[33] CC [PE/EtOAc 1:1, $R_f(\alpha)$ 0.26, $R_f(\beta)$ 0.33] yielded the separated anomers **α-5** (231 mg, 28%) and **β-5** (364 mg, 44%) as white solids. **α-5**: $[\alpha]_D^{20} + 38.8$ (*c* 1.0, $CHCl_3$). M.p. 68–70°C. IR: ν 3186 (NH), 1688 (C=O) cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$): δ 3.59 (ddd, 1H, H-4′), 3.67 (dd, 1H, H-5′$_a$), 3.95 (dd, 1H, H-5′$_b$), 4.16 (dd, 1H, H-2′), 4.19 (dd, 1H, H-3′), 4.53 (d, 2H, C*H*$_2$Ph, $J = 1.1$ Hz), 4.58, 4.65 (AB-system, 2H, C*H*$_2$Ph, $J_{AB} = 12.0$ Hz), 4.61, 4.77 (AB-system, 2H, C*H*$_2$Ph, $J_{AB} = 11.4$ Hz), 6.36 (d, 1H, H-1′), 7.26–7.38 (m, 15H, ArH), 8.55 (s, 1H, H-6), 8.74 (bs, 1H, NH). $J_{1',2'} = 6.9$, $J_{2',3'} = 3.4$, $J_{3',4'} = 4.3$, $J_{4',5'a} = 6.8$, $J_{4',5'b} = 7.1$, $J_{5'a,5'b} = 9.2$ Hz. ^{13}C NMR (101 MHz, $CDCl_3$): δ 46.8 (C-4′), 59.4 (C-l′), 66.2 (C-5), 69.0 (C-5′), 73.5 (*C*H$_2$Ph), 73.5 (*C*H$_2$Ph), 74.6 (*C*H$_2$Ph), 79.4 (C-3′), 82.9 (C-2′), 127.6, 127.8, 128.0, 128.13, 128.14, 128.3, 128.5, 128.6 ($C_{Ar}H$), 137.0, 137.3, 137.6 (C_{Ar}), 149.2 (C-6), 151.1 (C-2), 159.8 (C-4). FAB MS; m/z: 657 $[M+H]^+$. FAB HRMS: calcd. 657.0920 $[M+H]^+$; found 657.0930. **β-5**: $[\alpha]_D^{20}$ −96.8 (*c* 1.0, $CHCl_3$). M.p. 62–64°C. IR: ν 3187 (NH), 1689 (C=O), 1610 (C=O) cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$): δ 3.54 (dd, 1H, H-5′$_a$), 3.82–3.86 (m, 2H, H-2′, H-5′$_b$), 3.91 (ddd, 1H, H-4′), 4.23–4.25 (m, 1H, H-3′), 4.22, 4.68 (AB-system, 2H, C*H*$_2$Ph, $J_{AB} = 12.7$ Hz), 4.50 (s, 2H, C*H*$_2$Ph), 4.68, 4.88 (AB-system, 2H, C*H*$_2$Ph, $J_{AB} = 11.7$ Hz), 6.24 (d, 1H, H-1′), 7.26–7.37 (m, 15H, ArH), 7.61 (s, 1H, H-6), 8.92 (bs, 1H, NH). $J_{1',2'} = 8.1$, $J_{3',4'} = 3.7$, $J_{4',5'a} = 6.8$, $J_{4',5'b} = 6.9$, $J_{5'a,5'b} = 8.9$ Hz. ^{13}C NMR (101 MHz, $CDCl_3$): δ 47.0 (C-4′), 62.8 (C-1′), 69.0 (C-5), 69.3 (C-5′), 72.4 (*C*H$_2$Ph), 73.5 (*C*H$_2$Ph), 73.9

(CH_2Ph), 75.7 (C-3′), 85.0 (C-2′), 127.8, 127.88, 127.92, 128.05, 128.14, 128.4, 128.5, 128.7, 128.8 ($C_{Ar}H$), 136.6, 137.65, 137.67 (C_{Ar}), 144.9 (C-6), 150.1 (C-2), 159.5 (C-4). FAB MS; m/z: 657 $[M+H]^+$. FAB HRMS: calcd. 657.0920 $[M+H]^+$; found 657.0887.

5-Nitro-1-(2,3,5-tri-*O*-benzyl-4-thio-L-lyxofuranosyl)uracil (6). GP1; from **1**[12] (603 mg, 1.26 mmol) and 5-nitro-2,4-bis-*O*-trimethylsilyluracil. CC [PE/EtOAc 1:2, R_f(β) 0.37, R_f(α) 0.28] yielded **α-6** (173 mg, 24%) and **β-6** (326 mg, 45%) as white solids. **α-6**: M.p. 66–68°C. $[\alpha]_D^{20}$ + 56.4 (*c* 0.9, $CHCl_3$). IR: ν 3201 (NH), 1712 (C=O), 1617 (C=O), 1517 (NO_2), 1346 (NO_2) cm^{-1}. ^{1}H NMR (500 MHz, $CDCl_3$): δ 3.62 (ddd, 1H, H-4′), 3.69 (dd, 1H, H-5′$_a$), 3.96 (dd, 1H, H-5′$_b$), 4.08 (dd, 1H, H-2′), 4.22 (dd, 1H, H-3′), 4.55, 4.67 (AB system, 2H, CH_2Ph, J_{AB} = 10.6 Hz), 4.56 (s, 2H, CH_2Ph), 4.59, 4.70 (AB system, 2H, CH_2Ph, J_{AB} = 11.9 Hz), 6.33 (d, 1H, H-1′), 7.13–7.38 (m, 15H, ArH), 8.62 (s, 1H, H-6), 9.57 (bs, 1H, NH). $J_{1',2'}$ = 6.5, $J_{2',3}$ = 3.4, $J_{3',4'}$ = 4.1, $J_{4',5'a}$ = 6.7, $J_{4',5'b}$ = 7.5, $J_{5'a,5'b}$ = 9.2 Hz. ^{13}C NMR (126 MHz, $CDCl_3$): δ 47.0 (C-4′), 61.6 (C-1′), 68.7 (C-5′), 73.7 (CH_2Ph), 73.8 (CH_2Ph), 75.0 (CH_2Ph), 78.9 (C-3′), 83.2 (C-2′), 123.9 (C-5), 127.7, 127.9, 128.1, 128.4, 128.52, 128.54, 128.6, 128.7 ($C_{Ar}H$), 136.4, 136.8, 137.4 (C_{Ar}), 149.46 (C-6), 149.48 (C-2), 153.8 (C-4). FAB MS; m/z: 576 $[M+H]^+$. $C_{30}H_{29}N_3O_7S$ (575.65): calcd. C 62.60, H 5.08, N 7.30, S 5.57; found C 62.51, H 5.09, N 7.09, S 5.38. **β-6**: M.p. 79–80°C. $[\alpha]_D^{20}$ −171.6 (*c* = 1.0, $CHCl_3$). IR: ν 3207 (NH), 1712 (C=O), 1621 (C=O), 1517 (NO_2), 1346 (NO_2) cm^{-1}. ^{1}H NMR (500 MHz, $CDCl_3$): δ 3.56 (dd, 1H, H-5′$_a$), 3.87 (dd, 1H, H-5′$_b$), 3.89 (dd, 1H, H-2′), 4.01 (ddd, 1H, H-4′), 4.15, 4.71 (AB system, 2H, CH_2Ph, J_{AB} = 12.5 Hz), 4.30 (dd, 1H, H-3′), 4.52 (s, 2H, CH_2Ph), 4.72, 4.89 (AB system, 2H, CH_2Ph, J_{AB} = 11.6 Hz), 6.27 (d, 1H, H-1′), 7.17–7.36 (m, 15H, ArH), 8.60 (s, 1H, H-6), 8.61 (bs, 1H, NH). $J_{1',2'}$ = 8.4, $J_{2',3'}$ = 3.1, $J_{3',4'}$ = 3.4, $J_{4',5'a}$ = 7.0, $J_{4',5'b}$ = 7.3, $J_{5'a,5'b}$ = 9.3 Hz. ^{13}C NMR (126 MHz, $CDCl_3$): δ 47.2 (C4′), 63.5 (C-1′), 69.1 (C-5′), 72.6 (CH_2Ph), 73.5 (CH_2Ph), 74.1 (CH_2Ph), 75.5 (C-3′), 85.5 (C-2′), 125.5 (C-5), 127.8, 128.0, 128.05, 128.09, 128.46, 128.51, 128.6, 128.8, 129.0 ($C_{Ar}H$), 136.4, 137.6, 137.6 (C_{Ar}), 144.6 (C-6), 148.3 (C-2), 153.2 (C-4). FAB MS; m/z: 576 $[M+H]^+$. FAB HRMS: calcd. 576.1804 $[M+H]^+$; found 576.1827. $C_{30}H_{29}N_3O_7S$ (575.65): calcd. C 62.60, H 5.08, N 7.30, S 5.57; found C 62.50, H 5.08, N 7.04, S 5.62.

5-Fluoro-1-(4-thio-L-lyxofuranosyl)uracil (7). GP2; from **2** (770 mg, 1.40 mmol, α/β = 3:5). CC [$CHCl_3$/MeOH 4:1, R_f(α) 0.23, R_f(β) 0.14] yielded **α-7** (68 mg, 19%) and **β-7** (53 mg, 15%). Further purification by reversed phase HPLC (MeCN/H_2O 8:92) gave **α-7** (59 mg, 16%) and **β-7** (44 mg, 12%) as white solids. **α-7** was crystallized from water (thin, colorless needles) and **β-7** from MeOH (colorless needles). In both cases the crystals were suitable for an X-ray structural analysis. **α-7**: M.p. 236°C (decomp.). $[\alpha]_D^{20}$ −16.2 (*c* 1.0, MeOH). IR: ν 3402 (OH), 3153 (NH), 1697 (C=O), 1659 (C=O) cm^{-1}. ^{1}H NMR (500 MHz, [D_6]DMSO): δ 3.47 (ddd, 1H, H-4′), 3.59 (ddd, 1H, H-5′$_a$), 3.87 (ddd, 1H, H-5′$_b$), 4.14 (ddd, 1H, H-3′), 4.24 (ddd, 1H, H-2′), 4.94 (dd, 1H, 5′-OH), 5.62 (d, 1H, 2′-OH), 5.65 (d, 1H, 3′-OH), 6.08 (dd, IH, H-1′), 8.54 (d, 1H, H-6), 11.74 (bs, 1H, NH). $J_{1',2'}$ = 7.2, $J_{1',F}$ = 1.8, $J_{2',3'}$ = 3.8, $J_{2',OH}$ = 5.4, $J_{3',4'}$ = 7.0, $J_{3',OH}$ = 4.2, $J_{4',5'a}$ = 7.8, $J_{4',5'b}$ = 5.6, $J_{5'a,5'b}$ = 10.7, $J_{5'a,OH}$ = 5.8, $J_{5'b,OH}$ = 5.1, $J_{6,F}$ = 8.2 Hz. ^{13}C NMR (126 MHz, [D_6]DMSO): δ 51.3

(C-4′), 61.0 (C-1′), 61.2 (C-5′), 72.7 (C-3′), 75.4 (C-2′), 129.7 (d, C-6), 138.6 (d, C-5), 150.4 (C-2), 157.3 (d, C-4). $J_{4,F} = 26.4$, $J_{5,F} = 226.5$, $J_{6,F} = 35.1$ Hz. ^{19}F NMR (471 MHz, [D$_6$]DMSO): δ −169.4 (ddd, 1F, F-5). $J_{1',F} = 1.9$, $J_{NH,F} = 5.5$, $J_{6,F} = 7.4$ Hz. MS (70 eV); *m/z*: 278 (1.1) [$M^{+\bullet}$], 260 (20) $[M - H_2O]^{+\bullet}$, 230 (6), 212 (11), 131 (99) [$C_5H_7O_2S^+$], 130 (64), 101 (38), 87 (51), 86 (10), 85 (28), 57 (100), 44 (71). FAB HRMS: calcd. 260.0267 $[M - H_2O]^{+\bullet}$; found 260.0295. **β-7**: M.p. 229–230°C (decomp.). $[\alpha]_D^{20}$ –103.0 (*c* 1.0, MeOH). IR: ν 3417 (OH), 1680 (C=O), 1658 (C=O) cm^{-1}. ^{1}H NMR (500 MHz, [D$_6$]DMSO) δ 3.42 (ddd, 1H, H-5′$_a$), 3.76 (ddd, 1H, H-5′$_b$), 3.86 (ddd, 1H, H-4′), 4.09 (ddd, 1H, H-3′), 4.25 (ddd, 1H, H-2′), 4.79 (dd, 1H, 5′-OH), 5.20 (d, 1H, 3′-OH), 5.51 (d, 1H, 2′-OH), 5.97 (dd, 1H, H-1′), 8.40 (d, 1H, H-6), 11.82 (bs, 1H, NH). $J_{1',2'} = 8.9$, $J_{1',F} = 2.0$, $J_{2',3'} = 3.4$, $J_{2',OH} = 6.0$, $J_{3',4'} = 3.3$, $J_{3',OH} = 4.1$, $J_{4',5'a} = 7.6$, $J_{4',5'b} = 6.4$, $J_{5'a,5'b} = 10.7$, $J_{5'a,OH} = 5.4$, $J_{5'b,OH} = 4.9$, $J_{6,F} = 7.4$ Hz. ^{13}C NMR (126 MHz, [D$_6$]DMSO): δ 50.4 (C-4′), 61.7 (C-5′), 63.2 (C-1′), 72.4 (C-3′), 78.6 (C-2′), 126.7 (d, C-6), 140.7 (d, C-5), 150.6 (C-4), 157.5 (d, C-4). $J_{4,F} = 25.4$, $J_{5,F} = 230.8$, $J_{6,F} = 34.2$ Hz. ^{19}F NMR (471 MHz, [D$_6$]DMSO): δ = –166.4 (bd, 1F, F-5). $J = 6.5$ Hz. MS (70 eV); *m/z*: 278 (0.1) [$M]^{+\bullet}$, 260 (16) $[M - H_2O]^{+\bullet}$, 212 (13), 131 (88) [$C_5H_7O_2S^+$], 101 (35), 87 (31), 57 (100), 45 (34). FAB HRMS: calcd. 260.0267 $[M - H_2O]^{+\bullet}$ found 260.0270.

5-Chloro-1-(4-thio-L-lyxofuranosyl)uracil (8). **GP2**; from **3** (920 mg, 1.63 mmol, α/β = 2:3). CC [$CHCl_3$/MeOH 4:1, R_f(α) 0.29, R_f(β) 0.17] yielded **α-8** (92 mg, 19%) and **β-8** (55 mg, 11%). Further purification by reversed phase HPLC (MeCN/H_2O 11:89) gave **α-8** (79 mg, 16%) and **β-8** (49 mg, 10%) as white solids. **α-8** was crystallized from water (colorless sheets) and **β-8** was crystallized from water/MeOH (thin, colorless, needles). The crystals were suitable for X-ray structural analyses. **α-8**: M.p. 243°C (decomp.). $[\alpha]_D^{20}$ –8.9 (*c* 1.0, MeOH). IR: ν 3436 (OH), 3177 (NH), 1692 (C=O), 1632 (C=O) cm^{-1}. ^{1}H NMR (500 MHz, [D$_6$]DMSO): δ 3.49 (ddd, 1H, H-4′), 3.60 (ddd, 1H, H-5′$_a$), 3.88 (ddd, 1H, H-5′$_b$), 4.15 (ddd, 1H, H-3′), 4.23 (ddd, 1H, H-2′), 4.95 (dd, 1H, 5′-OH), 5.647 (d, 1H, 3′-OH), 5.650 (d, 1H, 2′-OH), 6.08 (d, 1H, H-1′), 8.61 (s, 1H, H-6), 11.73 (bs, 1H, NH). $J_{1',2'} = 7.2$, $J_{2',3'} = 3.8$, $J_{2',OH} = 6.9$, $J_{3',4'} = 4.2$, $J_{3',OH} = 4.2$, $J_{4',5'a} = 5.8$, $J_{4',5'b} = 7.9$, $J_{5'a,5'b} = 10.7$, $J_{5'a,OH} = 5.8$, $J_{5'b,OH} = 5.1$ Hz. ^{13}C NMR (126 MHz, [D$_6$]DMSO): δ 51.4 (C-4′), 61.1 (C-1′), 61.2 (C-5′), 72.8 (C-3′), 75.4 (C-2′), 105.3 (C-5), 142.7 (C-6), 150.9 (C-2), 159.3 (C-4). MS (70 eV); *m/z*: 276 (4) $[M - H_2O]^{+\bullet}$, 131 (100) [$C_5H_7O_2S^+$], 103 (18), 85 (15), 57 (49), 40 (17). FAB HRMS: calcd. 275.9972 $[M - H_2O]^{+\bullet}$, found 275.9967. **β-8**: M.p. 223–227°C (decomp.). $[\alpha]_D^{20}$ –126.6 (*c* 1.0, MeOH). IR: ν 3465 (OH), 3188 (NH), 1694 (C=O), 1628 (C=O) cm^{-1}. ^{1}H NMR (500 MHz, [D$_6$]DMSO): δ 3.42 (ddd, 1H, H-5′$_a$), 3.76 (ddd, 1H, H-5′$_b$), 3.91 (ddd, 1H, H-4′), 4.09 (ddd, 1H, H-3′), 4.31 (ddd, 1H, H-2′), 4.79 (dd, 1H, 5′-OH), 5.20 (d, 1H, 3′-OH), 5.52 (d, 1H, 2′-OH), 5.97 (d, 1H, H-1′), 8.43 (s, 1H, H-6), 11.84 (bs, 1H, NH). $J_{1',2'} = 8.9$, $J_{2',3'} = 3.2$, $J_{2',OH} = 5.9$, $J_{3',4'} = 3.1$, $J_{3',OH} = 4.0$, $J_{4',5'a} = 7.8$, $J_{4',5'b} = 6.3$, $J_{5'a,5'b} = 10.7$, $J_{5'a,OH} = 5.7$, $J_{5'b,OH} = 4.8$ Hz. ^{13}C NMR (126 MHz, [D$_6$]DMSO): δ 50.4 (C-4′), 61.5 (C-5′), 62.9 (C-1′), 72.2 (C-3′), 78.5 (C-2′), 108.1 (C-5), 139.5 (C-6), 150.8 (C-2), 159.2 (C-4). MS (70 eV); *m/z*: 276 (6) $[M - H_2O]^{+\bullet}$, 131 (53) [$C_5H_7O_2S^+$], 103 (46), 76 (22), 57 (100), 40 (45). FAB HRMS: calcd. 275.9972 $[M - H_2O]^{+\bullet}$, found 275.9979.

5-Bromo-1-(4-thio-L-lyxofuranosyl)uracil (9). **GP2**; from **4** (960 mg, 1.57 mmol, $\alpha/\beta = 1{:}2$). CC [$CHCl_3$/MeOH 4:1, $R_f(\alpha)$ 0.26, $R_f(\beta)$ 0.17] yielded **α-9** (102 mg, 19%) and **β-9** (89 mg, 17%). Further purification by reversed phase HPLC (MeCN/H_2O 10:90) gave **α-9** (87 mg, 16%) and **β-9** (79 mg, 15%) as white solids. **α-9** and **β-9** were crystallized from water to give colorless sheets and thin, colorless needles, respectively. The crystals were suitable for X-ray structural analyses. **α-9**: M.p. 227°C (decomp.). $[\alpha]_D^{20}$ +5.0 (*c* 1.0, MeOH). IR: ν 3438 (OH), 3187 (NH), 1693 (C=O), 1626 (C=O) cm^{-1}. ^1H NMR (500 MHz, [D_6]DMSO): δ 3.49 (ddd, 1H, H-4′), 3.59 (ddd, 1H, H-5′$_a$), 3.88 (ddd, 1H, H-5′$_b$), 4.15 (ddd, 1H, H-3′), 4.23 (ddd, 1H, H-2′), 4.95 (dd, 1H, 5′-OH), 5.64 (d, 1H, 3′-OH), 5.65 (d, 1H, 2′-OH), 6.08 (d, 1H, H-1′), 8.69 (s, 1H, H-6), 11.70 (bs, 1H, NH). $J_{1',2'} = 7.1$, $J_{2',3'} = 3.8$, $J_{2',OH} = 6.9$, $J_{3',4'} = 4.3$, $J_{3',OH} = 4.6$, $J_{4',5'a} = 7.9$, $J_{4',5'b} = 5.5$, $J_{5'a,5'b} = 10.7$, $J_{5'a,OH} = 5.8$, $J_{5'b,OH} = 5.1$ Hz. ^{13}C NMR (126 MHz, [D_6]DMSO): δ 51.4 (C-4′), 61.0 (C-1′), 61.3 (C-5′), 72.8 (C-3′), 75.4 (C-2′), 93.8 (C-5), 145.2 (C-6), 151.2 (C-2), 159.5 (C-4). MS (70 eV); *m/z*: 340 (1) [$M^{+\bullet}$] (for ^{81}Br), 338 (1) [$M^{+\bullet}$] (for ^{79}Br), 322 (4) $[M - H_2O]^{+\bullet}$ (for ^{81}Br), 320 (4) $[M - H_2O]^{+\bullet}$ (for ^{79}Br), 258 (10), 192 (20) [$C_4H_3BrN_2O_2^{+\bullet}$] (for ^{81}Br), 190 (19) [$C_4H_3BrN_2O_2^{+\bullet}$] (for ^{79}Br), 153 (14), 131 (74) $[C_5H_7O_2S]^+$, 101 (31), 85 (29), 57 (100), 44 (100). FAB HRMS: calcd. 339.9552 [$M^{+\bullet}$] (for ^{81}Br), 337.9572 [$M^{+\bullet}$] (for ^{79}Br), 321.9446 $[M - H_2O]^{+\bullet}$ (for ^{81}Br), 319.9466 $[M - H_2O]^{+\bullet}$ (for ^{79}Br); found 339.9548, 337.9579, 321.9445, 319.9474. **β-9**: M.p. 243°C (decomp.). $[\alpha]_D^{20}$ –35.4 (*c* 0.7, MeOH). IR: ν 3352 (OH), 1682 (C=O), 1623 (C=O) cm^{-1}. ^1H NMR (500 MHz, [D_6]DMSO): δ = 3.40 (ddd, 1H, H-5′$_a$), 3.74 (ddd, 1H, H-5′$_b$), 3.90 (ddd, 1H, H-4′), 4.07 (ddd, 1H, H-3′), 4.30 (ddd, 1H, H-2′), 4.77 (dd, 1H, 5′-OH), 5.17 (d, 1H, 3′-OH), 5.50 (d, 1H, 2′-OH), 5.95 (d, 1H, H-1′), 8.45 (s, 1H, H-6), 11.82 (bs, 1H, NH) ppm. $J_{1',2'} = 9.0$, $J_{2',3'} = 3.1$, $J_{2',OH} = 6.0$, $J_{3',4'} = 3.0$, $J_{3',OH} = 3.9$, $J_{4',5'a} = 7.8$, $J_{4',5'b} = 6.3$, $J_{5'a,5'b} = 10.8$, $J_{5'a,OH} = 5.8$, $J_{5'b,OH} = 4.8$ Hz. ^{13}C NMR (126 MHz, [D_6]DMSO): δ 49.9 (C-4′), 61.0 (C-5′), 62.4 (C-1′), 71.8 (C-3′), 78.1 (C-2′), 96.2 (C-5), 141.4 (C-6), 150.5 (C-2), 158.8 (C-4). MS (70 eV); *m/z*: 322 (5) $[M - H_2O]^{+\bullet}$ (for ^{81}Br), 320 (5) $[M - H_2O]^{+\bullet}$ (for ^{79}Br), 192 (16) [$C_4H_3BrN_2O_2^{+\bullet}$] (for ^{81}Br), 190 (17) [$C_4H_3BrN_2O_2^{+\bullet}$] (for ^{79}Br), 131 (71) [$C_5H_7O_2S^+$], 101 (19), 85 (36), 57 (100), 45 (32). FAB HRMS: calcd. 321.9446 $[M - H_2O]^{+\bullet}$ (for ^{81}Br), 319.9466 $[M - H_2O]^{+\bullet}$ (for ^{79}Br); found 321.9453, 319.9459.

5-Iodo-1-(4-thio-L-lyxofuranosyl)uracil (10). **GP2**; from **5** (538 mg, 0.82 mmol, $\alpha/\beta = 5{:}8$). CC [$CHCl_3$/MeOH 4:1, $R_f(\alpha)$ 0.26, $R_f(\beta)$ 0.19] yielded **α-10** (22 mg, 7%) and **β-10** (29 mg, 9%). Further purification by reversed phase HPLC (MeCN/H_2O 12:88) gave **α-10** (16 mg, 5%) and **β-10** (26 mg, 8%) as white solids. **α-10**: M.p. 186–189°C, (decomp.). $[\alpha]_D^{20}$ +6.9 (*c* 0.6, MeOH). IR: ν 3424 (OH), 1689 (C=O), 1607 (C=O) cm^{-1}. ^1H NMR (500 MHz, [D_6]DMSO): δ 3.48 (ddd, 1H, H-4′), 3.59 (ddd, 1H, H-5′$_a$), 3.87 (ddd, 1H, H-5′$_b$), 4.14 (ddd, 1H, H-3′), 4.19 (ddd, 1H, H-2′), 4.95 (dd, 1H, 5′-OH), 5.59 (d, 1H, 3′-OH), 5.63 (d, 1H, 2′-OH), 6.05 (d, 1H, H-1′), 8.70 (s, 1H, H-6), 11.56 (bs, 1H, NH). $J_{1',2'} = 6.9$, $J_{2',3'} = 3.8$, $J_{2',OH} = 6.6$, $J_{3',4'} = 4.4$, $J_{3',OH} = 4.4$, $J_{4',5'a} = 7.9$, $J_{4',5'b} = 5.4$, $J_{5'a,5'b} = 10.7$, $J_{5'a,OH} = 5.5$, $J_{5'b,OH} = 5.2$ Hz. ^{13}C NMR (126 MHz, [D_6]DMSO): δ 49.1 (C-4′), 58.6 (C-1′), 59.1 (C-5′), 64.9 (C-5), 70.6 (C-3′), 73.1 (C-2′), 147.8 (C-6), 149.3 (C-2), 158.6 (C-4). MS (70 eV); *m/z*: 386 (17) [$M^{+\bullet}$], 368 (22) $[M - H_2O]^{+\bullet}$, 320 (8), 253

(66), 238 (100) [$C_4H_3IN_2O_2^{+\bullet}$], 195 (34), 168 (15), 131 (41) [$C_5H_7O_2S^+$], 101 (11), 85 (7), 57 (24), 40 (30). FAB HRMS: calcd. 385.9433 [$M^{+\bullet}$], 367.9328 [$M-H_2O]^{+\bullet}$, 237.9239 [$C_4H_3IN_2O_2^{+\bullet}$]; found 385.9446, 367.9341, 237.9239. **β-10**: Decomp. at 209–212°C without melting. $[\alpha]_D^{20}$ –88.3 (*c* 1.0, MeOH). IR: ν 3421 (OH), 1691 (C=O), 1608 (C=O) cm^{-1}. ^1H NMR (500 MHz, [D_6]DMSO): δ 3.42 (ddd, 1H, H-5′$_a$), 3.76 (ddd, 1H, H-5′$_b$), 3.92 (ddd, 1H, H-4′), 4.08 (ddd, 1H, H-3′), 4.32 (ddd, 1H, H-2′), 4.79 (dd, 1H, 5′-OH), 5.18 (d, 1H, 3′-OH), 5.51 (d, 1H, 2′-OH), 5.96 (d, 1H, H-1′), 8.43 (s, 1H, H-6), 11.67 (bs, 1H, NH). $J_{1',2'}=9.0$, $J_{2',3'}=3.1$, $J_{2',OH}=6.1$, $J_{3',4'}=3.0$, $J_{3',OH}=4.0$, $J_{4',5'a}=7.9$, $J_{4',5'b}=6.2$, $J_{5'a,5'b}=10.8$, $J_{5'a,OH}=5.8$, $J_{5'b,OH}=4.8$ Hz. ^{13}C NMR (126 MHz, [D_6]DMSO): δ 49.8 (C-4′), 61.0 (C-5′), 62.1 (C-1′), 70.0 (C-5), 71.7 (C-3′), 77.9 (C-2′), 145.8 (C-6), 150.8 (C-2), 160.1 (C-4). MS (70 eV); *m/z*: 386 (7) [$M^{+\bullet}$], 368 (21) [$M-H_2O]^{+\bullet}$, 320 (5), 253 (55), 238 (16) [$C_4H_3IN_2O_2^{+\bullet}$], 205 (6), 179 (6), 151 (10), 131 (38) [$C_5H_7O_2S^+$], 109 (15), 97 (24), 57 (34), 40 (100). FAB HRMS: calcd. 385.9433 [$M^{+\bullet}$], 367.9328 [$M-H_2O]^{+\bullet}$, 237.9239 [$C_4H_3IN_2O_2^{+\bullet}$]; found 385.9465, 367.9343, 237.9232.

5-Nitro-1-(4-thio-L-lyxofuranosyl)uracil (11). **GP2**; from **6** (467 mg, 0.81 mmol). CC [$CHCl_3$/MeOH 4:1, $R_f(A_1)$ 0.16, $R_f(A_2)$ 0.11] followed by fractionated crystallization from water gave first **β-11** (11 mg, 5%) as colorless sheets and then **α-11** as white needles (9 mg, 4%). **α-11**: M.p. 154°C (decomp.). $[\alpha]_D^{20}$ −11.2 (*c* 1.0, MeOH). IR: ν 3382 (OH), 1709 (C=O), 1610 (C=O), 1518 (NO_2), 1344 (NO_2) cm^{-1}. ^1H NMR (500 MHz, [D_6]DMSO): δ 3.52 (ddd, 1H, H-4′), 3.62 (ddd, 1H, H-5′$_a$), 3.91 (ddd, 1H, H-5′$_b$), 4.13 (ddd, 1H, H-3′), 4.25 (ddd, 1H, H-2′), 4.97 (dd, 1H, 5′-OH), 5.65 (d, 1H, 3′-OH), 5.68 (d, 1H, 2′-OH), 6.07 (d, 1H, H-1′), 9.77 (s, 1H, H-6), 11.93 (bs, 1H, NH). $J_{1',2'}=6.9$, $J_{2',3'}=3.7$, $J_{2',OH}=7.4$, $J_{3',4'}=4.2$, $J_{3',OH}=4.3$, $J_{4',5'a}=8.1$, $J_{4',5'b}=5.5$, $J_{5'a,5'b}=10.5$, $J_{5'a,OH}=5.3$, $J_{5'b,OH}=5.2$ Hz. ^{13}C NMR (126 MHz, [D_6]DMSO): δ = 51.5 (C-4′), 61.4 (C-5′), 62.7 (C-1′), 73.0 (C-3′), 75.8 (C-2′), 124.3 (C-5), 150.0 (C-6), 150.8 (C-2), 155.0 (C-4). **β-11**: M.p. = 188°C (decomp.). $[\alpha]_D^{20}$ −49.4 (*c* 0.9, MeOH). IR: ν 3447 (OH), 1709 (C=O), 1613 (C=O), 1509 (NO_2), 1343 (NO_2) cm^{-1}. ^1H NMR (500 MHz, [D_6]DMSO): δ 3.46 (ddd, 1H, H-5′$_a$), 3.78 (ddd, 1H, H-5′$_b$), 3.96 (ddd, 1H, H-4′), 4.12 (ddd, 1H, H-3′), 4.38 (ddd, 1H, H-2′), 4.83 (dd, 1H, 5′-OH), 5.27 (d, 1H, 3′-OH), 5.60 (d, 1H, 2′-OH), 6.00, (d, 1H, H-1′), 9.31 (s, 1H, H-6), 12.10 (bs, 1H, NH). $J_{1',2'}=8.6$, $J_{2',3'}=3.1$, $J_{2',OH}=5.7$, $J_{3',4'}=3.2$, $J_{3',OH}=4.2$, $J_{4',5'a}=8.1$, $J_{4',5'b}=5.9$, $J_{5'a,5'b}=10.7$, $J_{5'a,OH}=5.8$, $J_{5'b,OH}=4.8$ Hz. ^{13}C NMR (126 MHz, [D_6]DMSO): δ 50.6 (C-4′), 61.3 (C-5′), 63.9 (C-1′), 72.7 (C-3′), 79.4 (C-2′), 126.6 (C-5), 146.6 (C-6), 149.7 (C-2), 154.6 (C-4).

1-(2,3,5-Tri-*O*-benzyl-4-thio-L-lyxofuranosyl)-2-thiouracil (12). **GP1**; from **1**[12] (600 mg, 1.25 mmol) and 4-trimethylsilyloxy-2-trimethylsilylthiopyrimidine. CC [PE/EtOAc 1:2, R_f(α,β) 0.21] yielded the inseparable anomers of **12** (283 mg, 41%, $A_1/A_2=2:1$) as a white solid. IR: ν 3195 (NH), 1664 (C=O), 1565 (thioamide-B) cm^{-1}. $C_{30}H_{30}N_2O_4S_2$ (546.71): calcd. C 65.91, H 5.53, N 5.12, S 11.73; found C 65.25, H 5.81, N 4.90, S 11.14. Major anomer: ^1H NMR (500 MHz, $CDCl_3$): δ 3.74–3.79 (m, 2H, H-4′, H-5′$_a$), 4.01 (dd, 1H, H-5′$_b$), 4.18 (dd, 1H, H-2′), 4.35 (dd, 1H, H-3′), 4.41–5.00 (m, 6H, 3 CH_2Ph), 5.31 (d, 1H, H-1′), 6.22 (d, 1H, H-5),

7.23–7.40 (m, 15H, ArH), 7.82 (d, 1H, H-6). $J_{1',2'} = 4.1$, $J_{2',3'} = 3.3$, $J_{3',4'} = 5.4$, $J_{4',5'b} = 4.2$, $J_{5'a,5'b} = 9.0$, $J_{5,6} = 6.6$ Hz. ^{13}C NMR (126 MHz, $CDCl_3$): δ 47.0 (C-4′), 50.6 (C-1′), 71.4 (C-5′), 72.5 (CH_2Ph), 73.27 (CH_2Ph), 73.33 (CH_2Ph), 79.4 (C-3′), 85.9 (C-2′), 111.6 (C-5), 127.6, 127.68, 127.71, 127.8, 128.1, 128.4, 128.4, 128.5 (C_{Ar}H), 137.8, 137.8, 138.2 (C_{Ar}), 154.6 (C-6), 161.0, 164.1 (C-2, C-4). Minor anomer: ^{1}H NMR (500 MHz, $CDCl_3$): δ 3.52 (dd, 1H, H-5′$_a$), 3.58–3.62 (m, 1H, H-4′), 3.86–3.90 (m, 1H, H-5′$_b$), 4.27–4.29 (m, 2H, H-2′, H-3′), 4.41–5.00 (m, 6H, 3 CH_2Ph), 5.94 (d, 1H, H-1′), 6.15 (d, 1H, H-5), 7.23–7.40 (m, 15H, ArH), 7.82 (d, 1H, H-6). $J_{1',2'} = 6.2$, $J_{4',5'a} = 6.4$, $J_{5'a,5'b} = 9.1$, $J_{5,6} = 6.6$ Hz. ^{13}C NMR (126 MHz, $CDCl_3$): δ 46.0 (C-4′), 52.1 (C-1′), 69.7 (C-5′), 72.4 (CH_2Ph), 73.4 (CH_2Ph), 73.5 (CH_2Ph), 79.6 (C-3′), 83.7 (C-2′), 110.9 (C-5), 127.59, 127.63, 127.82, 127.83, 127.96, 127.98, 128.4, 128.5, 128.7 (C_{Ar}H), 136.9, 137.2, 137.9 (C_{Ar}), 154.3 (C-6), 162.7, 163.7 (C-2, C-4).

6-Methyl-1-(2,3,5-tri-*O*-benzyl-4-thio-L-lyxofuranosyl)-2-thiouracil (13). GP1; from **1**[12] (600 mg, 1.25 mmol) and 6-methyl-4-trimethylsilyloxy-2-trimethylsilylthiopyrimidine. CC [PE/EtOAc 1:2, R_f(α,β) 0.34] yielded the inseparable anomers of **13** as a white solid (548 mg, 78%, $A_1/A_2 = 2{:}1$). IR: ν 3199 (NH), 1659 (C=O), 1580 (thioamide-B) cm^{-1}. FAB MS: m/z: 561 $[M+H]^+$. $C_{31}H_{32}N_2O_4S_2$ (560.74): calcd. C 66.40, H 5.75, N 5.00, S 11.44; found C 65.70, H 5.74, N 5.05, S 11.11. Major anomer: ^{1}H NMR (500 MHz, $CDCl_3$): δ 2.24 (d, 3H, CH_3), 3.51 (dd, 1H, H-5′$_a$), 3.57 (ddd, 1H, H-4′), 3.88 (dd, 1H, H-5′$_b$), 4.26–4.28 (m, 2H, H-2′, H-3′), 4.42, 4.45 (AB system, 2H, CH_2Ph, $J_{AB} = 11.8$ Hz), 4.53, 4.73 (AB system, 2H, CH_2Ph, $J_{AB} = 11.9$ Hz), 4.67, 5.01 (AB system, 2H, CH_2Ph, $J_{AB} = 11.7$ Hz), 5.96 (d, 1H, H-1′), 5.99 (q, 1H, H-5), 7.24–7.40 (m, 15H, ArH). $J_{1',2'} = 5.7$, $J_{3',4'} = 4.1$, $J_{4',5'a} = 6.7$, $J_{4',5'b} = 7.7$, $J_{5'a,5'b} = 8.9$, $J_{5,Me} = 0.9$ Hz. ^{13}C NMR (126 MHz, $CDCl_3$): δ 24.1 (CH_3), 45.9 (C-4′), 51.9 (C-1′), 69.7 (C-5′), 72.4 (CH_2Ph), 73.4 (CH_2Ph), 74.0 (CH_2Ph), 79.5 (C-3′), 83.7 (C-2′), 108.2 (C-5), 127.68, 127.69, 127.74, 127.8, 128.1, 128.3, 128.38, 128.39, 128.5 (C_{Ar}H), 137.6, 138.0, 138.2 (C_{Ar}), 161.0 (C-6), 164.1, 165.1 (C-2, C-4). Minor anomer: ^{1}H NMR (500 MHz, $CDCl_3$): δ 2.25 (d, 3H, CH_3), 3.75–3.81 (m, 2H, H-4′, H-5′$_a$), 4.02 (dd, 1H, H-5′$_b$), 4.21 (dd, 1H, H-2′), 4.37 (dd, 1H, H-3′), 4.48, 4.53 (AB system, 2H, CH_2Ph, $J_{AB} = 12.0$ Hz), 4.58, 4.61 (AB system, 2H, CH_2Ph, $J_{AB} = 11.7$ Hz), 4.70, 4.88 (AB system, 2H, CH_2Ph, $J_{AB} = 12.2$ Hz), 5.33 (d, 1H, H-1′), 6.05 (q, 1H, H-5), 7.24–7.40 (m, 15H, ArH). $J_{1',2'} = 3.3$, $J_{2',3'} = 3.3$, $J_{3',4'} = 6.2$, $J_{4',5'b} = 4.0$, $J_{5'a,5'b} = 8.8$, $J_{5,Me} = 0.9$ Hz. ^{13}C NMR (126 MHz, $CDCl_3$): δ 24.0 (CH_3), 47.0 (C-4′), 50.3 (C-1′), 71.46 (C-5′), 72.48 (CH_2Ph), 73.2 (CH_2Ph), 73.3 (CH_2Ph), 79.8 (C-3′), 86.4 (C-2′), 108.9 (C-5), 127.3, 127.6, 127.7, 127.8, 127.9, 127.95, 128.00, 128.4, 128.5 (C_{Ar}H), 137.8, 138.0, 138.3 (C_{Ar}), 159.5 (C-6), 164.6, 165.5 (C-2, C-4).

1-(2,3,5-Tri-*O*-acetyl-4-thio-L-lyxofuranosyl)-2-thiouracil (15). GP1; from **14**[12] (100 mg, 0.33 mmol) and 4-trimethylsilyloxy-2-trimethylsilylthiopyrimidine. CC [PE/EtOAc 1:2, R_f(α,β) 0.11] yielded the inseparable anomers of **15** as a white solid (58 mg, 44%, $A_1/A_2 = 5{:}2$). IR: ν 3436 (NH), 1753 (C=O), 1667 (C=O), 1528 (thioamide-B) cm^{-1}. FAB MS; m/z: 403 $[M+H]^+$. Major anomer: ^{1}H NMR (500 MHz, $CDCl_3$): δ 2.04 (s, 3H, $COCH_3$), 2.09 (s, 3H, $COCH_3$), 2.11 (s, 3H, $COCH_3$), 4.00 (ddd, 1H, H-4′), 4.14 (dd, 1H, H-5′$_a$), 4.40 (dd, 1H, H-5′$_b$), 5.38

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(d, 1H, H-1′), 5.51 (dd, 1H, H-2′), 5.73 (dd, 1H, H-3′), 6.25 (d, 1H, H-5), 7.89 (d, 1H, H-6). $J_{1',2'} = 6.9$, $J_{2',3'} = 3.5$, $J_{3',4'} = 5.3$, $J_{4',5'a} = 7.4$, $J_{4',5'b} = 7.3$, $J_{5'a,5'b} = 11.1$, $J_{5,6} = 6.6$ Hz. ^{13}C NMR (126 MHz, $CDCl_3$): δ 21.0 (CO*C*H$_3$), 21.05 (CO*C*H$_3$), 21.08 (CO*C*H$_3$), 44.6 (C-4′), 50.9 (C-1′), 64.6 (C-5′), 72.3 (C-3′), 77.5 (C-2′), 112.0 (C-5), 155.2 (C-6), 160.6 (C-2, C-4), 169.8 (*C*OCH$_3$), 170.1 (*C*OCH$_3$), 170.8 (*C*OCH$_3$). Minor anomer: ^{1}H NMR (500 MHz, $CDCl_3$): δ 2.03 (s, 3H, COCH$_3$), 2.06 (s, 3H, COCH$_3$), 2.20 (s, 3H, COCH$_3$), 3.86 (ddd, 1H, H-4′), 4.15 (dd, 1H, H-5′$_a$), 4.42 (dd, 1H, H-5′$_b$), 5.60 (dd, 1H, H-2′), 5.72 (dd, 1H, H-3′), 5.88 (d, 1H, H-1′), 6.22 (d, 1H, H-5), 7.85 (d, 1H, H-6). $J_{1',2'} = 6.3$, $J_{2',3'} = 3.4$, $J_{3',4'} = 5.2$, $J_{4',5'a} = 7.3$, $J_{4',5'b} = 7.7$, $J_{5'a,5'b} = 11.1$, $J_{5,6} = 6.6$ Hz. ^{13}C NMR (126 MHz, $CDCl_3$): δ 21.0 (CO*C*H$_3$), 21.07 (CO*C*H$_3$), 21.08 (CO*C*H$_3$), 44.6 (C-4′), 51.6 (C-1′), 63.5 (C-5′), 72.3 (C-3′), 74.6 (C-2′), 111.6 (C-5), 155.2 (C-6), 161.5, 164.8 (C-2, C-4), 169.8 (*C*OCH$_3$), 169.9 (*C*OCH$_3$), 170.8 (*C*OCH$_3$).

6-Methyl-1-(2,3,5-tri-*O*-acetyl-4-thio-L-lyxofuranosyl)-2-thiouracil (16). GP1; from **14**[12] (100 mg, 0.33 mmol) and 6-methyl-4-trimethylsilyloxy-2-trimethylsilylthiopyrimidine. CC [PE/EtOAc 1:2, R_f(α,β) 0.13] gave the inseparable anomers of **16** as a white solid (31 mg, 23%, $A_1/A_2 = 2{:}1$). IR: ν 3451 (NH), 1753 (C=O), 1659 (C=O), 1581 (thioamide-B) cm^{-1}. FAB MS; *m/z*: 417 $[M + H]^+$. Major anomer: ^{1}H NMR (500 MHz, $CDCl_3$): δ 2.05 (s, 3H, COCH$_3$), 2.11 (s, 3H, COCH$_3$), 2.12 (s, 3H, COCH$_3$), 2.26 (s, 3H, CH$_3$), 3.98 (ddd, 1H, H-4′), 4.17 (dd, 1H, H-5′$_a$), 4.41 (dd, 1H, H-5′$_b$), 5.31 (d, 1H, H-1′), 5.61 (dd, 1H, H-2′), 5.70 (dd, 1H, H-3′), 6.08 (q, 1H, H-5). $J_{1',2'} = 5.3$, $J_{2',3'} = 3.7$, $J_{3',4'} = 6.0$, $J_{4',5'a} = 7.5$, $J_{4',5'b} = 7.2$, $J_{5'a,5'b} = 11.2$, $J_{5,Me} = 0.8$ Hz. ^{13}C NMR (126 MHz, $CDCl_3$): δ 21.0 (CO*C*H$_3$), 21.08 (CO*C*H$_3$), 21.10 (CO*C*H$_3$), 24.4 (CH$_3$), 44.7 (C-4′), 50.9 (C-1′), 64.2 (C-5′), 72.6 (C-3′), 78.0 (C-2′), 109.2 (C-5), 159.0 (C-6), 165.5, 166.4 (C-2, C-4), 169.6 (*C*OCH$_3$), 170.0 (*C*OCH$_3$), 170.8 (*C*OCH$_3$). Minor anomer: ^{1}H NMR (500 MHz, $CDCl_3$): δ 2.03 (s, 3H, COCH$_3$), 2.04 (s, 3H, COCH$_3$), 2.20 (s, 3H, COCH$_3$), 2.25–2.26 (m, 3H, CH$_3$), 3.85 (ddd, 1H, H-4′), 4.12 (dd, 1H, H-5′$_a$), 4.14 (dd, 1H, H-5′$_b$), 5.60–5.63 (m, 1H, H-2′), 5.72 (dd, 1H, H-3′), 5.89 (d, 1H, H-1′), 6.05 (q, 1H, H-5). $J_{1',2'} = 6.3$, $J_{2',3'} = 3.4$, $J_{3',4'} = 5.1$, $J_{4',5'a} = 7.3$, $J_{4',5'b} = 7.3$, $J_{5'a,5'b} = 11.1$, $J_{5,Me} = 0.9$ Hz. ^{13}C NMR (126 MHz, $CDCl_3$): δ 20.95 (CO*C*H$_3$), 21.05 (CO*C*H$_3$), 21.13 (CO*C*H$_3$), 24.4 (CH$_3$), 44.4 (C-4′), 51.7 (C-1′), 63.5 (C-5′), 73.1 (C-3′), 74.5 (C-2′), 108.8 (C-5), 160.0 (C-6), 165.4, 166.2 (C-2, C-4), 169.7 (*C*OCH$_3$), 170.0 (*C*OCH$_3$), 170.8 (*C*OCH$_3$).

1-(4-Thio-β-L-lyxofuranosyl)-2-thiouracil (17). A solution of **15** (56 mg, 0.14 mmol) in dry MeOH (1.0 mL) was added to a solution of sodium (1 mg, 0.04 mmol) in dry MeOH (6.0 mL). The reaction mixture was stirred at room temperature for 24 h. Water was added. The solvent was evaporated and the residue was purified by CC ($CHCl_3$/MeOH 4:1, R_f 0.21) and reversed phase HPLC (MeCN/H_2O 7:93) to yield **17** (4 mg, 10%) as a white solid. M.p. 169–172°C (decomp.). $[\alpha]_{D^{20}}$ −89.7 (*c* 0.4, MeOH). IR: ν 3433 (OH), 1662 (C=O), 1531 thioamide-B) cm^{-1}. ^{1}H NMR (500 MHz, [D$_6$]DMSO): δ 3.40 (dd, 1H, H-5′$_a$), 3.55 (ddd, 1H, H-4′), 3.73 (dd, 1H, H-5′$_b$), 4.00 (dd, 1H, H-2′), 4.13 (dd, 1H, H-3′), 4.75 (bs, 1H, 5′-OH), 5.05 (d, 1H, H-1′), 5.11 (bs, 2H, 2′-OH, 3′-OH), 6.08 (d, 1H, H-5), 7.84 (d, 1H, H-6). $J_{1',2'} = 8.6$, $J_{2',3'} = 3.4$, $J_{3',4'} = 3.8$, $J_{4',5'a} = 7.3$, $J_{4',5'b} = 6.2$, $J_{5',a,5'b} = 10.7$,

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$J_{5,6} = 6.4$ Hz. ^{13}C NMR (126 MHz, [D$_6$]DMSO): δ 50.2 (C-4′), 52.6 (C-l′), 61.1 (C-5′), 72.6 (C-3′), 79.7 (C-2′), 109.6 (C-5), 154.1 (C-6), 164.0 (C-4), 172.3 (C-2). FAB MS; m/z: 277 $[M + H]^+$. FAB HRMS: calcd. 277.0317 $[M + H]^+$; found 277.0319.

6-Methyl-1-(4-thio-β-L-lyxofuranosyl)-2-thiouracil (18). Compound **18** was prepared as described for **17** from **16** (30 mg, 0.07 mmol). CC ($CHCl_3$/MeOH 4:1, $R_f = 0.25$) and reversed phase HPLC (MeCN/H_2O 9:91) gave **18** as a white solid (5 mg, 24%). M.p. 162–164°C (decomp.). $[\alpha]_D^{20}$ −46.0 (c 0.5, MeOH). IR: ν 3434 (OH), 1655 (C=O), 1565 (thioamide-B) cm^{-1}. ^{1}H NMR (500 MHz, [D$_6$]DMSO): δ 2.12 (d, 3H, CH_3), 3.41 (dd, 1H, H-5′$_a$), 3.55 (ddd, 1H, H-4′), 3.73 (dd, 1H, H-5′$_b$), 4.00 (dd, 1H, H-3′), 4.12 (dd, 1H, H-2′), 4.75 (bs, 1H, 5′-OH), 5.01 (d, 1H, H-1′), 5.10 (bs, 2H, 2′-OH, 3′-OH), 5.90 (bs, 1H, H-5). $J_{1',2'} = 8.4$, $J_{2',3'} = 3.4$, $J_{3',4'} = 3.7$, $J_{4',5'a} = 7.4$, $J_{4',5'b} = 6.2$, $J_{5'a,5'b} = 10.7$, $J_{5,Me} = 0.6$ Hz. ^{13}C NMR (126 MHz, [D$_6$]DMSO): δ 23.3 (CH_3), 50.4 (C-4′), 52.5 (C-1′), 61.0 (C-5′), 72.9 (C-3′), 80.4 (C-2′), 106.6 (C-5), 151.7 (C-6), 163.8 (C-4), 171.9 (C-2). FAB MS; m/z: 291 $[M + H]^+$. – FAB HRMS: calcd. 291.0473 $[M + H]^+$; found 291.0492.

2-Methyl-4,5-dihydro-(3,5-di-*O*-benzyl-1,2-dideoxy-4-thio-β-L-lyxofuranoso)-[1,2-d]-1,3-oxazole (19). GP1; from **1** (100 mg, 0.21 mmol) and 2,4-bis-*N*,*O*-trimethylsilylcytosine.[25] CC ($CHCl_3$/MeOH 10:1, R_f 0.70) gave **19** as a pale yellow oil (58 mg, 75%). $[\alpha]_D^{20}$+20.5 (c 1.0, $CHCl_3$). IR (film): ν 1741 (C=N) cm^{-1}. ^{1}H NMR (400 MHz, $CDCl_3$): δ 1.82 (d, 3H, CH_3), 3.36 (dd, 1H, H-5$_a$), 3.61 (ddd, 1H, H-4), 3.87 (dd, 1H, H-5$_b$), 4.23 (dd, 1H, H-3), 4.53, 4.58 (AB system, 2H, CH_2Ph, $J_{AB} = 12.3$ Hz), 4.64, 4.75 (AB system, 2H, CH_2Ph, $J_{AB} = 12.1$ Hz), 4.96 (dd, 1H, H-2), 5.35 (dq, 1H, H-1), 7.27–7.38 (m, 10H, ArH). $J_{1,2} = 7.6$, $J_{1,Me} = 0.8$, $J_{2,3} = 5.0$, $J_{3,4} = 6.5$, $J_{4,5a} = 8.9$, $J_{4,5b} = 4.4$, $J_{5a,5b} = 9.9$ Hz. ^{13}C NMR (101 MHz, $CDCl_3$): δ 12.5 (CH_3), 46.4 (C-4), 68.3 (C-5), 70.8 (CH_2Ph), 71.5 (CH_2Ph), 71.6 (C-1), 81.2 (C-3), 82.3 (C-2), 125.8, 126.0, 126.2, 126.4, 126.6, 126.8 ($C_{Ar}H$), 135.3, 136.2 (C_{Ar}), 165.9 (CCH_3).

4-(1,2,4-Triazol-1-yl)-1-(2,3,5-tri-*O*-benzyl-4-thio-L-lyxofuranosyl)-2(1*H*)-pyrimidinone (22). $POCl_3$ (0.93 mL, 1.56 g, 10.19 mmol) was added at 0°C to a suspension of 1,2,4-triazole (3.23 g, 46.75 mmol) in dry MeCN (10 mL). After stirring for 0.5 h, Et_3N (6.20 mL, 4.53 g, 44.73 mmol) was added and the suspension was warmed to room temperature. A solution of **20**[12] (416 mg, 0.78 mmol; α/β = 1:2) in dry MeCN (5 mL) was added and stirring was continued for 2.5 h. When the reaction was completed Et_3N (4.28 mL, 3.12 g, 30.88 mmol) and water (1.13 mL, 62.71 mmol) were added. The suspension was stirred for another 0.5 h. The resulting suspension was diluted with water (100 mL) and extracted with $CHCl_3$. The extract was dried with $MgSO_4$ and evaporated. The residue was purified by CC [PE/EtOAc 1:2, R_f(α) 0.19, R_f(β) 0.27] to yield **α-22** (130 mg, 29%) and **β-22** (239 mg, 53%) as white resinous solids. **α-22**: $[\alpha]_D^{20}$ −71.2 (c 1.0, $CHCl_3$). IR: ν 3112 (NH), 1674 (C=O), 1630 (C=N) cm^{-1}. ^{1}H NMR (400 MHz, $CDCl_3$): δ 3.72 (dd, 1H, H-5′$_a$), 3.96–3.98 (m, 1H, H-4′), 3.97 (dd, 1H, H-5′$_b$), 4.11–4.13 (m, 2H, H-2′, H-3′), 4.52, 4.55 (AB system, 2H, CH_2Ph, $J_{AB} = 11.7$ Hz), 4.54, 4.74 (AB system, 2H, CH_2Ph, $J_{AB} = 12.4$ Hz), 4.57, 4.69 (AB system, 2H, CH_2Ph, $J_{AB} = 11.6$ Hz), 6.31 (d, 1H, H-1′),

6.89 (d, 1H, H-5), 7.21–7.38 (m, 15H, ArH), 8.14 (s, 1H, $CH_{triazole}$), 8.15 (d, 1H, H-6), 9.28 (s, 1H, $CH_{triazole}$). $J_{1',2'} = 5.1$, $J_{4',5'a} = 10.0$, $J_{4',5'b} = 6.1$, $J_{5'a,5'b} = 11.5$, $J_{5,6} =$ 7.4 Hz. ^{13}C NMR (101 MHz, $CDCl_3$): δ 47.6 (C-4′), 65.9 (C-1′), 70.3 (C-5′), 72.3 (CH_2Ph), 73.5 (2C, CH_2Ph), 77.2 (C-3′), 86.7 (C-2′), 95.1 (C-5), 127.81, 127.83, 127.9, 128.06, 128.14, 128.4, 128.46, 128.51 ($C_{Ar}H$), 137.1, 137.5, 137.9 (C_{Ar}), 143.2 ($CH_{triazole}$), 147.7 (C-6), 154.1 ($CH_{triazole}$), 154.8, 158.9 (C-2, C-4). FAB MS; m/z: 582 $[M + H]^+$. **β-22**: $[\alpha]_D^{20}$+54.2 (c 0.9, $CHCl_3$). IR: ν 3134 (NH), 1682 (C=O), 1631 (C=N) cm^{-1}. ^{1}H NMR (400 MHz, $CDCl_3$): δ 3.69–3.75 (m, 1H, H-4′), 3.95–3.99 (m, 1H, H-5′$_a$), 4.09–4.15 (m, 1H, H-5′$_b$), 4.22–4.25 (m, 2H, H-2′, H-3′), 4.52–4.76 (m, 6H, 3CH_2Ph), 6.64–6.66 (m, 2H, H-1′, H-5), 7.20–7.37 (m, 15H, ArH), 8.12 (s, 1H, $CH_{triazole}$), 8.65 (d, 1H, H-6), 9.27 (s, 1H, $CH_{triazole}$). $J_{5,6} = 7.4$ Hz. ^{13}C NMR (101 MHz, $CDCl_3$): δ 47.0 (C-4′), 61.0 (C-1′), 69.0 (C-5′), 73.4 (CH_2Ph), 74.0 (CH_2Ph), 74.1 (CH_2Ph), 80.3 (C-3′), 82.4 (C-2′), 93.5 (C-5), 127.78, 127.84, 127.92, 127.94, 128.17, 128.22, 128.40, 128.41, 128.5 ($C_{Ar}H$), 137.1, 137.3, 137.7 (C_{Ar}), 152.0 (C-6), 153.8, 154.8 ($CH_{triazole}$), 155.9, 158.6 (C-2, C-4). FAB MS; m/z: 582 $[M + H]^+$.

1-(2,3,5-Tri-*O*-benzyl-4-thio-L-lyxofuranosyl)cytosine (24). A 25% aq. NH_3 solution (17.2 mL) was added to a solution of **22** (330 mg, 0.57 mmol, α/β = 1:2) in 1,4-dioxane (7.0 mL). The mixture was stirred at room temperature for 24 h. The solvents were evaporated, the residue was dissolved in $CHCl_3$ and washed with water. The organic phase was dried with $MgSO_4$ and evaporated. The crude **24** was purified by CC [$CHCl_3$/MeOH 9:1, R_f(α) 0.35, R_f(β) 0.19] to yield **α-24** (80 mg, 27%) and **β-24** (167 mg, 56%) as white solids. **α-24**: M.p. 80–83°C. $[\alpha]_D^{20}$ −33.6 (c 1.0, $CHCl_3$). IR: ν 3192 (NH), 1690 (C=O) cm^{-1}. ^{1}H NMR (400 MHz, $CDCl_3$): δ 3.63 (dd, 1H, H-5′$_a$), 3.85–3.93 (m, 2H, H-4′, H-5′$_b$), 4.06–4.10 (m, 2H, H-2′, H-3′), 4.47, 4.50 (AB system, 2H, CH_2Ph, $J_{AB} = 11.8$ Hz), 4.55, 4.61 (AB system, 2H, CH_2Ph, $J_{AB} = 12.4$ Hz), 4.55, 4.69 (AB system, 2H, CH_2Ph, $J_{AB} = 11.7$ Hz), 5.78 (d, 1H, H-5), 6.27 (d, 1H, H-1′), 7.20–7.34 (m, 15H, ArH), 7.45 (d, 1H, H-6), 8.18 (bs, 2H, NH_2). $J_{1',2'} = 5.8$, $J_{4',5'a} = 6.5$, $J_{5'a,5'b} = 8.2$, $J_{5,6} = 7.5$ Hz. ^{13}C NMR (101 MHz, $CDCl_3$): δ 47.0 (C-4′), 64.2 (C-1′), 70.4 (C-5′), 72.3 (CH_2Ph), 73.4 (CH_2Ph), 73.5 (CH_2Ph), 77.7 (C-3′), 85.0 (C-2′), 95.7 (C-5), 127.7, 127.75, 127.76, 127.78, 127.79, 127.80, 128.35, 128.41, 128.5 ($C_{Ar}H$), 137.5, 137.9, 138.0 (C_{Ar}), 141.8 (C-6), 156.2, 165.5 (C-2, C-4). FAB MS; m/z: 530 $[M + H]^+$. **β-24**: M.p. 51–53°C. $[\alpha]_D^{20}$+26.0 (c 1.0, $CHCl_3$). IR: ν 3180 (NH), 1678 (C=O) cm^{-1}. ^{1}H NMR (400 MHz, $CDCl_3$): δ 3.59–3.63 (m, 1H, H-4′), 3.71 (dd, 1H, H-5′$_a$), 3.97 (dd, 1H, H-5′$_b$), 4.14–4.17 (m, 2H, H-2′, H-3′), 4.48, 4.53 (AB system, 2H, CH_2Ph, $J_{AB} = 11.9$ Hz), 4.51, 4.57 (AB system, 2H, CH_2Ph, $J_{AB} = 11.8$ Hz), 4.55, 4.68 (AB system, 2H, CH_2Ph, $J_{AB} = 11.3$ Hz), 5.54 (d, 1H, H-5), 6.60 (d, 1H, H-1′), 7.17–7.34 (m, 15H, ArH), 8.07 (d, 1H, H-6), 8.36 (bs, 2H, NH_2). $J_{1',2'} = 6.3$, $J_{4',5'a} = 7.6$, $J_{4',5'b} = 6.2$, $J_{5'a,5'b} = 9.5$, $J_{5,6} = 7.6$ Hz. ^{13}C NMR (101 MHz, $CDCl_3$): δ = 47.0 (C-4′), 59.2 (C-1′), 69.8 (C-5′), 73.3 (CH_2Ph), 73.5 (CH_2Ph), 73.6 (CH_2Ph), 80.6 (C-3′), 81.6 (C-2′), 93.7 (C-5), 127.74, 127.75, 127.9, 128.0, 128.35, 128.36, 128.4 ($C_{Ar}H$), 137.55, 137.63, 137.9 (C_{Ar}), 145.9 (C-6), 156.8, 165.3 (C-2, C-4). FAB MS; m/z: 530 $[M + H]^+$.

1-(4-Thio-α-L-lyxofuranosyl)cytosine (26). GP2; from **26** (780 mg, 1.47 mmol, α/β = 1:2). CC ($CHCl_3$/MeOH 2:1, R_f 0.10) and reversed phase HPLC (MeCN/H_2O

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O 9:91) gave **26** as a white solid (13 mg, 3%). M.p. 188–191°C. $[\alpha]_D^{20}$ −48.5 (*c* 1.0, MeOH). IR: ν 3352 (OH), 3210 (NH), 1645 (C=O), 1603 (C=N) cm^{-1}. ^1H NMR (500 MHz, [D$_6$]DMSO): δ 3.45 (ddd, 1H, H-4′), 3.63 (ddd, 1H, H-5′$_a$), 3.84 (ddd, 1H, H-5′$_b$), 4.13 (ddd, 1H, H-2′), 4.18 (ddd, 1H, H-3′), 4.94 (dd, 1H, 5′-OH), 5.35 (d, 1H, 3′-OH), 5.49 (d, 1H, 2′-OH), 5.68 (d, 1H, H-5), 6.26 (d, 1H, H-1′), 6.97 (bs, 1H, N*H*H), 7.07 (bs, 1H, NH*H*), 8.20 (d, 1H, H-6). $J_{1',2'} = 6.6$, $J_{2',3'} = 3.7$, $J_{2',OH} = 6.0$, $J_{3',4'} = 5.1$, $J_{3',OH} = 4.6$, $J_{4',5'a} = 7.3$, $J_{4',5'b} = 5.2$, $J_{5'a,5'b} = 10.9$, $J_{5'a,OH} = 5.5$, $J_{5'b,OH} = 5.2$, $J_{5,6} = 7.5$ Hz. ^{13}C NMR (126 MHz, [D$_6$]DMSO): δ 50.4 (C-4′), 59.2 (C-1′), 60.3 (C-5′), 72.6 (C-3′), 73.5 (C-2′), 91.8 (C-5), 144.9 (C-6), 155.4, 164.5 (C-2, C-4). FAB MS; *m/z*: 260 $[M+H]^+$. FAB HRMS: calcd. 260.0705 $[M+H]^+$; found 260.0707.

6-Methyl-4-(1,2,4-triazol-1-yl)-1-(2,3,5-tri-*O*-benzyl-4-thio-α-L-lyxofuranosyl)-2(1*H*)-pyrimidinone (23). Compound **23** was prepared as described for **22** from 1,2,4-triazole (12.86 g, 186 mmol) and **21**[12] (1.69 g, 3.10 mmol, α/β = 10:1). CC (PE/EtOAc EtOAc 1:2, R_f 0.21) gave **23** as a white solid (1.25 g, 68%). M.p. 54–56°C. $[\alpha]_D^{20}$ −128.5 (*c* 1.0, $CHCl_3$). IR: ν 1680 (C=O), 1644 (C=N) cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$): δ 2.47 (s, 3H, CH_3), 3.55 (dd, 1H, H-5′$_a$), 3.83 (dd, 1H, H-5′$_b$), 4.25, 4.52 (AB system, 2H, C*H*$_2$Ph, $J_{AB} = 12.1$ Hz), 4.34 (ddd, 1H, H-4′), 4.38 (dd, 1H, H-3′), 4.50 (s, 2H, C*H*$_2$Ph), 4.72, 4.88 (AB system, 2H, C*H*$_2$Ph, $J_{AB} = 11.7$ Hz), 5.30 (dd, 1H, H-2′), 5.96 (d, 1H, H-1′), 6.76 (s, 1H, H-5), 7.17–7.38 (m, 15H, ArH), 8.11 (s, 1H, $CH_{triazole}$), 9.21 (s, 1H, $CH_{triazole}$). $J_{1',2'} = 7.5$, $J_{2',3} = 3.4$, $J_{3',4'} = 3.0$, $J_{4',5'a} = 6.1$, $J_{4',5'b} = 8.5$, $J_{5'a,5'b} = 9.3$ Hz. ^{13}C NMR (101 MHz, $CDCl_3$): δ 21.9 (CH_3), 49.0 (C-4′), 65.8 (C-1′), 68.1 (C-5′), 73.2 (*C*H$_2$Ph), 73.4 (*C*H$_2$Ph), 74.3 (*C*H$_2$Ph), 77.8 (C-3′), 83.2 (C-2′), 96.3 (C-5), 127.7, 127.78, 127.80, 127.82, 128.0, 128.1, 128.36, 128.44, 128.5 ($C_{Ar}H$), 137.5, 137.8, 138.3 (C_{Ar}), 143.9 ($CH_{triazole}$), 153.9 ($CH_{triazole}$), 154.3 (C-6), 157.8, 161.7 (C-2, C-4). FAB MS; *m/z*: 596 $[M+H]^+$.

6-Methyl-1-(2,3,5-tri-*O*-benzyl-4-thio-α-L-lyxofuranosyl)cytosine (25). Compound **25** was prepared as described for **24** from **23** (1.24 g, 2.08) and 25% aq. NH_3 solution (16.8 mL). CC (PE/EtOAc 1:2, R_f 0.29) gave **25** as a white solid (959 mg, 68%). M.p. 82–83°C. $[\alpha]_D^{20}$ −107.7 (*c* 1.1, $CHCl_3$). IR: ν 3191 (NH), 1665 (C=O) cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$): δ = 2.12 (s, 3H, CH_3), 3.53 (dd, 1H, H-5′$_a$), 3.80 (dd, 1H, H-5′$_b$), 4.24 (ddd, 1H, H-4′), 4.29 (dd, 1H, H-3′), 4.39, 4.50 (AB system, 2H, C*H*$_2$Ph, $J_{AB} = 11.9$ Hz), 4.43, 4.47 (AB system, 2H, C*H*$_2$Ph, $J_{AB} = 11.7$ Hz), 4.65, 4.87 (AB system, 2H, C*H*$_2$Ph, $J_{AB} = 11.8$ Hz), 5.36 (dd, 1H, H-2′), 5.40 (s, 1H, H-5), 5.81 (d, 1H, H-1′), 7.17–7.34 (m, 15H, ArH). $J_{1',2'} = 7.3$, $J_{2',3'} = 3.4$, $J_{3',4'} = 3.0$, $J_{4',5'a} = 7.0$, $J_{4',5'a} = 7.3$, $J_{5'a,5'b} = 9.3$ Hz. ^{13}C NMR (101 MHz, $CDCl_3$): δ 28.8 (CH_3), 49.7 (C-4′), 64.6 (C-1′), 69.1 (C-5′), 73.3 (*C*H$_2$Ph), 73.4 (*C*H$_2$Ph), 74.0 (*C*H$_2$Ph), 78.4 (C-3′), 84.4 (C-2′), 94.4 (C-5), 127.4, 127.7, 127.76, 127.80, 128.04, 128.3, 128.4, 128.5 ($C_{Ar}H$), 137.9, 138.0, 138.5 (C_{Ar}), 154.3, 156.3, 165.0 (C-4, C-2, C-6). FAB MS; *m/z*: 544 $[M+H]^+$. FAB HRMS: calcd. 544.2270 $[M+H]^+$; found 544.2209.

6-Methyl-1-(4-thio-α-L-lyxofuranosyl)cytosine (27). GP2; from **25** (940 mg, 1.73 mmol). CC ($CHCl_3$/MeOH 2:1, R_f 0.10) and reversed phase HPLC

(MeCN/H_2O 6:94) gave **27** as a white solid (15 mg, 3%), which was crystallized from H_2O/EtOH 1:2 (colorless needles). M.p. 157°C (decomp.). $[\alpha]_D^{20}$ −50.8 (*c* 0.5, MeOH). IR: ν 3408 (OH), 3217 (NH), 1649 (C=O) cm^{-1}. ^1H NMR (500 MHz, [D_6]DMSO): δ 2.22 (s, 3H, CH_3), 3.41 (ddd, 1H, H-5′$_a$), 3.75 (ddd, 1H, H-5′$_b$), 3.84 (ddd, 1H, H-4′), 4.07 (ddd, 1H, H-3′), 4.71 (dd, 1H, 5′-OH), 4.98 (d, 1H, 3′-OH), 5.10–5.14 (m, 2H, H-2′, 2′-OH), 5.53 (s, 1H, H-5), 5.56 (bs, 1H, H-1′), 6.92 (bs, 2H, NH_2). $J_{2',3'} = 3.3$, $J_{3',4'} = 3.0$, $J_{3',OH} = 4.4$, $J_{4',5'a} = 7.2$, $J_{4',5'b} = 6.8$, $J_{5'a,5'b} = 10.6$, $J_{5'a,OH} = 5.7$, $J_{5'b,OH} = 5.3$ Hz. ^{13}C NMR (126 MHz, [D_6]DMSO): δ 22.7 (CH_3), 54.5 (C-4′), 60.6 (C-1′), 62.8 (C-5′), 75.1 (C-3′), 78.1 (C-2′), 97.1 (C-5), 156.8, 157.7, 166.8 (C-6, C-2, C-4). FAB MS; *m/z*: 274 $[M+H]^+$. FAB HRMS: calcd. 274.0862 $[M+H]^+$; found 274.0869.

9-(2,3,5-Tri-*O*-benzyl-4-thio-L-lyxofuranosyl)adenine (28). **GP1**; from **1**[12] (500 mg, 1.04 mmol) and adenine. CC ($CHCl_3$/MeOH 19:1, R_f 0.41) gave **28** as a white amorphous solid (377 mg, 65%, α/β = 2:1). IR: ν 3184 (NH), (C=N) cm^{-1}. FAB MS; *m/z*: 544 $[M+H]^+$. FAB HRMS: calcd. 554.2226 $[M+H]^+$; found 554.2218. **α-28**: ^1H NMR (400 MHz, $CDCl_3$): δ 3.70–3.76 (m, 2H, H-4′, H-5′$_a$), 4.03 (dd, 1H, H-5′$_b$), 4.21 (dd, 1H, H-2′), 4.32 (dd, 1H, H-3′), 4.47–4.56 (m, 4H, 2 CH_2Ph), 4.61, 4.76 (AB system, 2H, CH_2Ph, $J_{AB} = 11.5$ Hz), 6.16 (bs, 2H, NH_2), 6.39 (d, 1H, H-1′), 7.24–7.37 (m, 15H, ArH), 8.31 (s, 1H, $H_{adenine}$), 8.47 (s, 1H, $H_{adenine}$). $J_{1',2'} = 6.5$, $J_{2',3'} = 3.3$, $J_{3',4'} = 4.0$, $J_{4',5'b} = 9.7$, $J_{5'a,5'b} = 12.0$ Hz. – ^{13}C NMR (101 MHz, $CDCl_3$): δ 46.8 (C-4′), 56.2 (C-1′), 69.4 (C-5′), 73.0 (*C*H_2Ph), 73.5 (*C*H_2Ph), 74.1 (*C*H_2Ph), 79.9 (C-3′), 82.8 (C-2′), 118.9 ($C_{adenine}$), 127.5, 127.6, 127.8, 127.99, 128.03, 128.2, 128.4, 128.47, 128.48 ($C_{Ar}H$), 137.0, 137.5, 137.8 (C_{Ar}), 143.1 ($CH_{adenine}$), 150.7 ($C_{adenine}$), 152.4 ($CH_{adenine}$), 155.3 ($C_{adenine}$). **β-28**: ^1H NMR (400 MHz, $CDCl_3$): δ 3.58 (dd, 1H, H-5′$_a$), 3.91 (dd, 1H, H-5′$_b$), 4.14 (ddd, 1H, H-4′), 4.36 (dd, 1H, H-3′), 4.47–4.56 (m, 4H, 2 CH_2Ph), 4.70, 4.87 (AB system, 2H, CH_2Ph, $J_{AB} = 11.7$ Hz), 4.74–4.77 (m, 1H, H-2′), 6.09 (bs, 2H, NH_2), 6.12 (d, 1H, H-1′), 7.24–7.37 (m, 15H, ArH), 7.82 (s, 1H, $H_{adenine}$), 8.27 (s, 1H, $H_{adenine}$). $J_{1',2'} = 7.8$, $J_{2',3'} = 3.5$, $J_{3',4'} = 3.8$, $J_{4',5'a} = 6.6$, $J_{4',5'b} = 7.7$, $J_{5'a,5'b} = 9.3$ Hz. ^{13}C NMR (101 MHz, $CDCl_3$): δ 47.0 (C-4′), 61.7 (C-1′), 69.2 (C-5′), 72.6 (*C*H_2Ph), 73.4 (*C*H_2Ph), 74.0 (*C*H_2Ph), 76.9 (C-3′), 84.6 (C-2′), 120.4 ($C_{adenine}$), 127.80, 127.81, 127.86, 127.89, 128.2, 128.38, 128.42, 128.45, 128.46 ($C_{Ar}H$), 136.77, 137.81, 138.0 (C_{Ar}), 140.2 ($CH_{adenine}$), 149.9 ($C_{adenine}$), 152.7 ($CH_{adenine}$), 155.5 ($C_{adenine}$).

9-(4-Thio-L-lyxofuranosyl)adenine (29) and 9-(2-*O*-Benzyl-4-thio-α-L-lyxofuranosyl)adenine (30). **GP2**; from **28** (370 mg, 0.67 mmol, α/β = 2:1). CC ($CHCl_3$/MeOH 2:1, R_f 0.15) and reversed phase HPLC (MeCN/H_2O 8:92) gave **α-29** (7 mg, 4 %), **β-29** (4 mg, 2%) and **30** (47 mg, 19%) as white solids. **α-29**: M.p. 148°C (decomp.). $[\alpha]_D^{20}$+16.3 (c 0.7, MeOH). IR: ν 3429 (OH), 1645 (C=N) cm^{-1}. ^1H NMR (500 MHz, [D_6]DMSO): δ 3.57 (ddd, 1H, H-4′), 3.61 (dd, 1H, H-5′$_a$), 3.91 (dd, 1H, H-5′$_b$), 4.27 (dd, 1H, H-3′), 4.35 (dd, 1H, H-2′), 5.01 (bs, 1H, 5′-OH), 5.68 (bs, 1H, 3′-OH), 5.86 (bs, 1H, 2′-OH), 6.06 (d, 1H, H-1′), 7.14 (bs, 2H, NH_2), 8.10 (s, 1H, $H_{adenine}$), 8.51 (s, 1H, $H_{adenine}$). – $J_{1',2'} = 7.0$, $J_{2',3'} = 3.7$, $J_{3',4'} = 4.1$, $J_{4',5'a} = 7.5$, $J_{4',5'b} = 5.4$, $J_{5'a,5'b} = 10.3$ Hz. – ^{13}C NMR (126 MHz, [D_6]DMSO): δ = 51.2 (C-4′), 58.0 (C-1′), 61.2 (C-5′), 72.9 (C-3′), 75.6 (C-2′), 118.2 ($C_{adenine}$), 142.7 ($CH_{adenine}$), 150.3 ($C_{adenine}$), 152.3 ($CH_{adenine}$), 156.0 ($C_{adenine}$). FAB MS; *m/z*: 284 $[M+H]^+$.

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FAB HRMS: calcd. 284.0817 $[M+H]^+$; found 284.0813. **β-29**: M.p. 196–198°C (decomp.). $[\alpha]_D^{20}$ −5.0 (*c* 0.4, MeOH). IR: ν 3411 (OH), 1650 (C=N) cm^{-1}. ^1H NMR (500 MHz, [D_6]DMSO): δ 3.43 (dd, 1H, H-5′$_a$), 3.80 (dd, 1H, H-5′$_b$), 3.91 (ddd, 1H, H-4′), 4.21 (dd, 1H, H-3′), 4.83 (dd, 1H, H-2′), 4.88 (bs, 1H, 5′-OH), 5.60 (bs, 2H, 2′-OH, 3′-OH), 5.91 (d, 1H, H-1′), 7.21 (bs, 2H, NH_2), 8.12 (s, 1H, $H_{adenine}$), 8.42 (s, 1H, $H_{adenine}$). $J_{1',2'}=8.8$, $J_{2',3'}=3.1$, $J_{3',4'}=3.2$, $J_{4',5'a}=7.5$, $J_{4',5'b}=6.5$, $J_{5'a,5'b}=10.7$ Hz. ^{13}C NMR (500 MHz, [D_6]DMSO): δ 50.6 (C-4′), 61.2 (C-5′), 61.3 (C-1′), 72.2 (C-3′), 78.9 (C-2′), 119.2 ($C_{adenine}$), 140.1 ($CH_{adenine}$), 150.1 ($C_{adenine}$), 152.6 ($CH_{adenine}$), 156.1 ($C_{adenine}$). FAB MS; *m*/*z*: 284 $[M+H]^+$. FAB HRMS: calcd. 284.0817 $[M+H]^+$; found 284.0809. **30**: M.p. 128–131°C (decomp.). – $[\alpha]_D^{20}$+34.1 (c 1.0 in MeOH). IR: ν 3426 (OH), 1655 (C=N) cm^{-1}. ^1H NMR (500 MHz, [D_6]DMSO): δ 3.64–3.67 (m, 2H, H-4′, H-5′$_a$), 3.99 (dd, 1H, H-5′$_b$), 4.32 (dd, 1H, H-2′), 4.46, 4.54 (AB system, 2H, CH_2Ph, $J_{AB}=11.7$ Hz), 4.49–4.51 (m, 1H, H-3′), 4.95 (bs, 1H, 5′-OH), 5.84 (d, 1H, 3′-OH), 6.36 (d, 1H, H-1′), 7.02 (bs, 2H, NH_2), 7.18–7.25 (m, 5H, ArH), 8.17 (s, 1H, $H_{adenine}$), 8.62 (s, 1H, $H_{adenine}$). $J_{1',2'}=7.2$, $J_{2',3'}=3.4$, $J_{4'5'b}=5.4$, $J_{5'a,5'b}=9.9$ Hz. ^{13}C NMR (126 MHz, [D_6]DMSO): δ 51.0 (C-4′), 56.3 (C-1′), 61.2 (C-5′), 71.2 (C-31), 83.1 (C-2′), 118.3 ($C_{adenine}$), 127.6, 127.8, 128.4 ($C_{Ar}H$), 138.0 (C_{Ar}), 142.9 ($CH_{adenine}$), 150.4 ($C_{adenine}$), 152.6 ($CH_{adenine}$), 156.2 ($C_{adenine}$).

9-(2,3,5-Tri-*O*-benzyl-4-thio-L-lyxofuranosyl)inosine (31). GP1; from **1**[12] (600 mg, 1.25 mmol) and hypoxanthine. CC ($CHCl_3$/MeOH 9:1, R_f 0.51) yielded **31** as a white amorphous solid (464 mg, 67%, $A_1/A_2=5{:}4$). IR: ν 3437 (NH), 1627 (C=O) cm^{-1}. FAB MS; *m*/*z*: 555 $[M+H]^+$. FAB HRMS: calcd. 555.2066 $[M+H]^+$; found 555.2075. Major anomer: ^1H NMR (400 MHz, $CDCl_3$): δ 3.70–3.79 (m, 2H, H-4′, H-5′$_a$), 3.98–4.02 (m, 1H, H-5′$_b$), 4.26–4.29 (m, 2H, H-2′, H-3′), 4.43–4.76 (m, 6H, 3 CH_2Ph), 6.32 (d, 1H, H-1′), 7.18–7.38 (m, 15H, ArH), 8.20 (s, 1H, $H_{inosine}$), 8.51 (s, 1H, $H_{inosine}$). $J_{1',2'}=6.5$ Hz. ^{13}C NMR (101 MHz, $CDCl_3$): δ 47.5 (C-4′), 56.7 (C-1′), 69.4 (C-5′), 73.5 (*C*H_2Ph), 73.6 (*C*H_2Ph), 74.0 (*C*H_2Ph), 79.8 (C-3′), 82.2 (C-2′), 123.7 ($C_{inosine}$), 127.4, 127.5, 127.85, 127.91, 128.2, 128.4, 128.5 ($C_{Ar}H$), 136.6, 137.2, 137.7 (C_{Ar}), 141.2 ($CH_{inosine}$), 144.9 ($C_{inosine}$), 149.0 ($CH_{inosine}$), 159.0 ($C_{inosine}$). Minor anomer: ^1H NMR (400 MHz, $CDCl_3$): δ 3.70–3.79 (m, 2H, H-4′, H-5′$_a$), 3.98–4.02 (m, 1H, H-5′$_b$), 4.20 (dd, 1H, H-2′), 4.32 (dd, 1H, H-3′), 4.43–4.76 (m, 6H, 3 CH_2Ph), 6.64–6.65 (m, 1H, H-1′), 7.18–7.38 (m, 15H, ArH), 8.06 (s, 1H, $H_{inosine}$), 9.16 (s, 1H, $H_{inosine}$). $J_{1',2'}=6.5$, $J_{2',3'}=3.4$ Hz. – ^{13}C NMR (101 MHz, $CDCl_3$): δ 47.0 (C-4′), 61.3 (C-1′), 73.0 (C-5′), 73.5 (*C*H_2Ph), 73.6 (*C*H_2Ph), 74.2 (*C*H_2Ph), 79.6 (C-3′), 82.9 (C-2′), 114.4 ($C_{inosine}$), 127.5, 127.89, 127.94, 128.01, 128.02, 128.1, 128.3, 128.4, 128.6 ($C_{Ar}H$), 136.9, 137.4, 137.7 (C_{Ar}), 138.3 ($CH_{inosine}$), 142.9 ($C_{inosine}$), 149.9 ($CH_{inosine}$), 159.0 ($C_{inosine}$).

9-(2-*O*-Benzyl-4-thio-α-L-lyxofuranosyl)inosine (32). GP2; from **31** (676 mg, 1.22 mmol, $A_1/A_2=5{:}4$). CC ($CHCl_3$/MeOH 2:1, R_f 0.17) yielded **32** (34 mg, 7%) as a pale pink colored solid. M.p. 152°C. $[\alpha]_D^{20}$ −16.3 (*c* 1.0, $CHCl_3$). IR: ν 3420 (OH), 1687 (C=O) cm^{-1}. ^1H NMR (400 MHz, [D_6]DMSO): δ 3.56–3.65 (m, 2H, H-4′, H-5′$_a$), 3.95 (ddd, 1H, H-5′$_b$), 4.32 (dd, 1H, H-2′), 4.46, 4.55 (AB system, 2H, CH_2Ph, $J_{AB}=11.8$ Hz), 4.47–4.50 (m, 1H, H-3′), 4.93 (dd, 1H, 5′-OH), 5.73 (d, 1H, 3′-OH), 6.25 (d, 1H, H-1′), 7.18–7.29 (m, 5H, ArH), 8.04 (d, 1H, H-8),

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8.53 (s, 1H, H-2). $J_{1',2'} = 7.1$, $J_{2',3'} = 3.3$, $J_{3',OH} = 4.4$, $J_{4',5'b} = 9.3$, $J_{5'a,5'b} = 9.3$, $J_{5'a,OH} = 5.6$, $J_{5'b,OH} = 4.9$, $J_{8,NH} = 2.6$ Hz. ^{13}C NMR (101 MHz, [D$_6$]DMSO): δ 51.1 (C-4′), 56.8 (C-1′), 61.2 (C-5′), 71.1 (C-3′), 71.8, (*C*H$_2$Ph), 83.2 (C-2′), 123.4 (C$_{inosine}$), 127.5, 127.8, 128.4 (C$_{Ar}$H), 138.1 (C$_{Ar}$), 142.4 (C-2), 145.8 (C-8), 149.2 (C$_{inosine}$), 156.9 (C$_{inosine}$). FAB MS; *m/z*: 375 [M + H]$^+$. FAB HRMS: calcd. 375.1127 [M + H]$^+$; found 375.1130.

9-(2,3,5-Tri-*O*-acetyl-4-thio-α-L-lyxofuranosyl)inosine (33). GP1; from **14** (118 mg, 0.39 mmol) and hypoxanthine. CC (CHCl$_3$/MeOH 9:1, R_f 0.28) yielded **33** as a white solid (52 mg, 33%). M.p. 210–212°C. [α]$_D^{20}$ −19.2 (*c* 1.0 CHCl$_3$). IR: ν 3113 (NH), 1744 (C=O), 1690 (C=O) cm^{-1}. ^{1}H NMR (500 MHz, CDCl$_3$): δ 1.80 (s, 3H, COCH$_3$), 2.05 (s, 3H, COCH$_3$), 2.09 (s, 3H, COCH$_3$), 4.06 (ddd, 1H, H-4′), 4.37 (dd, 1H, H-5′$_a$), 4.59 (dd, 1H, H-5′$_b$), 5.66 (dd, 1H, H-2′), 5.80 (dd, 1H, H-3′), 6.34 (d, 1H, H-1′), 8.22 (s, 1H, H$_{inosine}$), 8.47 (s, 1H, H$_{inosine}$), 13.16 (bs, 1H, NH). $J_{1',2'} = 6.4$, $J_{2',3'} = 3.8$, $J_{3',4'} = 4.8$, $J_{4',5'a} = 7.2$, $J_{4',5'b} = 7.5$, $J_{5'a,5'b} = 11.2$ Hz. ^{13}C NMR (126 MHz, CDCl$_3$): δ 20.3 (CO*C*H$_3$), 20.6 (CO*C*H$_3$), 20.7 (CO*C*H$_3$), 45.1 (C-4′), 57.9 (C-1′), 62.3 (C-5′), 72.1 (C-3′), 73.9 (C-2′), 124.2 (C$_{inosine}$), 140.3 (C$_{inosine}$), 141.1 (CH$_{inosine}$), 145.3, (CH$_{inosine}$), 158.9 (C$_{inosine}$), 168.8 (*C*OCH$_3$), 169.1 (*C*OCH$_3$), 170.4 (*C*OCH$_3$).

9-(4-Thio-α-L-lyxofuranosyl)inosine (34). Compound **34** was prepared as described for **17** from **33** (45 mg, 0.11 mmol). CC (Sephadex LH20, MeOH, R_f 0.13 in CHCl$_3$/MeOH 2:1) and reversed phase HPLC (MeCN/H$_2$O 8:92) gave **34** as a white solid (5 mg, 16%). M.p. 145°C (decomp.). [α]$_D^{20}$+11.0 (*c* 0.5 MeOH). IR: ν 3393 (OH), 3170 (NH), 1699 (C=O) cm^{-1}. ^{1}H NMR (500 MHz, [D$_6$]DMSO): δ 3.59 (ddd, 1H, H-4′), 3.64 (dd, 1H, H-5′$_a$), 3.93 (dd, 1H, H-5′$_b$), 4.28 (dd, 1H, H-3′), 4.36 (dd, 1H, H-2′), 4.96 (bs, 1H, 5′-OH), 5.65 (bs, 2H, 2′-OH, 3′-OH), 6.02 (d, 1H, H-1′), 8.00 (s, 1H, H$_{inosine}$), 8.42 (s, 1H, H$_{inosine}$). $J_{1',2'} = 7.0$, $J_{2',3'} = 3.8$, $J_{3',4'} = 4.1$, $J_{4',5'a} = 7.7$, $J_{4',5'b} = 5.4$, $J_{5'a,5'b} = 10.5$ Hz. – ^{13}C NMR (126 MHz, [D$_6$]DMSO): δ = 51.5 (C-4′), 58.6 (C-1′), 61.4 (C-5′), 73.1 (C-3′), 75.9 (C-2′), 123.4 (C$_{inosine}$), 142.0 (CH$_{inosine}$), 146.3 (CH$_{inosine}$), 149.4 (C$_{inosine}$), 157.9 (C$_{inosine}$). FAB MS; *m/z*: 285 [M + H]$^+$. FAB HRMS: calcd. 285.0658 [M + H]$^+$; found 285.0639.

ACKNOWLEDGMENTS

The *Deutsche Forschungsgemeinschaft*, the *European Commission*, and the *Fonds der Chemischen Industrie* are gratefully acknowledged for their financial support. We thank the Degussa-Hüls AG for supplying silver carbonate. We also thank Prof. Dr. Chris Meier and Dipl.-Chem. Andreas Lomb for making their HPLC equipment available to us as well as Mrs. Ann Absillis, Mrs. Anita Camps, Mrs. Anita Van Lierde, Mrs. Frieda De Meyer and Miss Lies Vandenheurck for technical assistance.

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Received January 22, 2003
Accepted June 9, 2003

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