A General Synthesis of N-Glycosides. IV.[1] Synthesis of Nucleosides of Hydroxy and Mercapto N-Heterocycles

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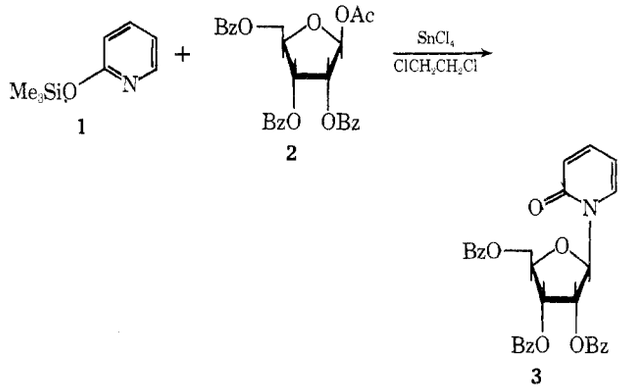
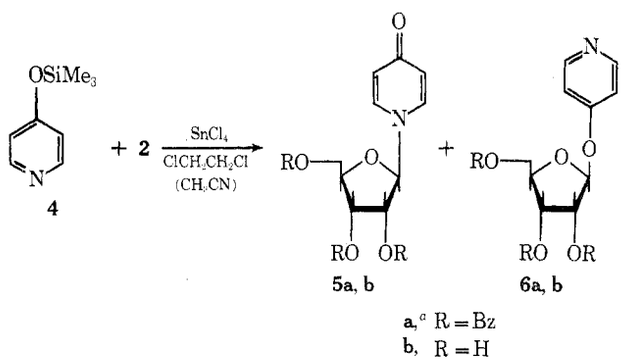
A variety of silylated hydroxy and mercapto N-heterocycles react with 1-*O*-acetyl-2,3,5-tri-*O*-benzoyl-β-D-ribofuranose in the presence of Friedel–Crafts catalysts to give N-ribosylated heterocycles in generally good yields. In the case of silylated pyrimidin-4-one both possible N-ribosides are obtained.

The smooth reaction of silylated uracils with 1-O-acylated mono-[2] and oligosaccharides[1] in the presence of $SnCl_4$ to give the corresponding nucleosides in good to excellent yields induced us to investigate analogous reactions of silylated hydroxy and mercapto N-heterocycles.

On reaction of silylated pyridin-2-one (**1**) with 1-*O*-acetyl-2,3,5-tri-*O*-benzoyl-β-D-ribofuranose (**2**) in the presence of $SnCl_4$ we obtained the crystalline benzoylated nucleoside **3** in 85% yield, which had been prepared previously by Pischel and Wagner[3] *via* the O-glycoside followed by



O,N rearrangement. Even in the presence of a large excess of $SnCl_4$ and longer reaction times at room temperature silylated pyridin-4-one (**4**) gave with **2** in either 1,2-dichloroethane or acetonitrile the expected benzoylated nucleoside **5a** and the crystalline O-glycoside **6a** (both products in ~10% yield). On refluxing the reaction mixture for 1 hr in 1,2-dichloroethane, only 2% O-riboside **6a** was still present and 63% nucleoside **5a** was obtained, which gave on methanolysis the crystalline free nucleoside **5b. 5a** had been pre-

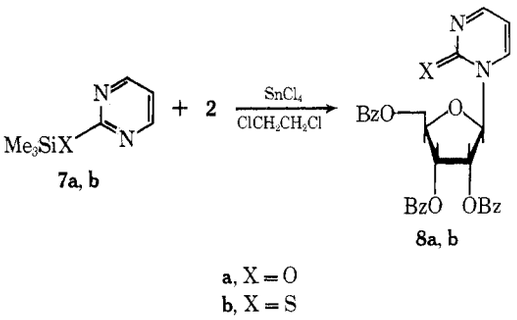


[a] After methanolysis.

pared earlier by Pischel and Wagner[3] by a Hilbert–Johnson reaction of 4-ethoxypyridine as well as by rearrangement of **6a** with $HgBr_2$ in boiling toluene. Our experiments to rearrange **6a** with $SnCl_4$ in boiling 1,2-dichloroethane as well as acetonitrile gave mostly decomposition products and only low yields of **5a.**

These results support the hypothesis that the N-glycosides are usually obtained directly *via* the N-quaternary salt from the silylated heterocycle and the sugar component in the presence of $SnCl_4$ and that a side reaction leads to the formation of O- or S-glycosides, which are then partially rearranged to the N-glycosides or decomposed by the catalyst.

Silylated pyrimidin-2-one (**7a**) afforded **8a** in 73% yield, which had been prepared earlier by the mercuric salt[4,5] method.

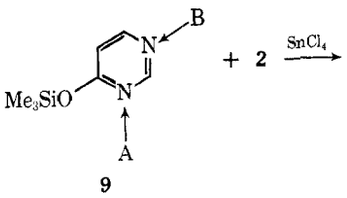


The silylated 2-mercaptopyrimidine (**7b**) gave analogously the 2-thio nucleoside **8b** in 97% yield, which was readily identified by the typical downfield shift of the H-1′ proton ($\delta_{H\text{-}1'}$ 7.02) compared to **8a** (6.35) of 1 ppm.[6] **8b** was recently prepared by Wightman and Holý[7] *via* the S-riboside and subsequent rearrangement with $SnCl_4$ in acetonitrile.

To gain further insight into the mode of electrophilic attack of sugar cations on silylated hydroxy N-heterocycles we treated silylated pyrimidin-4-one (**9**) with **2** in the presence of $SnCl_4$ and obtained beside the expected crystalline ortho quinoid nucleoside **10a** (attack A) also the crystalline para quinoid product **11a** (attack B). Depending on the polarity of the solvent[8] we isolated 26% **10a** and 60% **11a** in 1,2-dichloroethane and 27% **10a** and 38% **11a** in acetonitrile.

The formation of **11a** was surprising since methylation of 4-hydroxypyrimidine had yielded >50% 1,6-dihydro-1-methylpyrimidin-6-one (corresponding to **10**) and ~20% 4-methoxypyrimidine but apparently no 1,4-dihydro-1-methylpyrimidin-4-one.[9] Furthermore, the mercuric salt[5,10] as well as the fusion method[11] had apparently afforded only the ortho quinoid nucleoside **10a.**

The structures of **11a** as well as **11b,** which had been prepared previously by Raney nickel desulfurization of 2-thiouridine,[12] can be deduced from their typical uv **11b** [(CH_3OH), λ_{max} 243 nm (ε 15,290)]; 1,4-dihydro-1-methylpyrimidin-4-one (H_2O), λ_{max} 240 nm (ε 14,640)[9]] as well as nmr data.[13]



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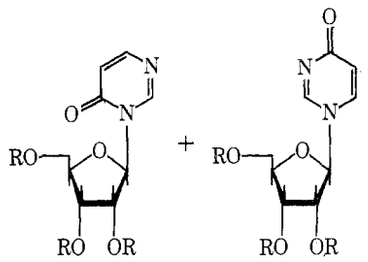


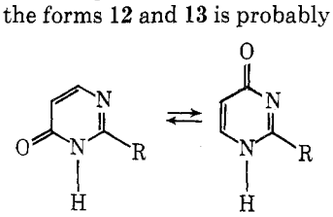
10a, b 11a, b

a, R = Bz
b,[a] R = H

[a] After methanolysis.

The preferential formation of **11a** in the silyl Hilbert–Johnson reaction in 1,2-dichloroethane might be due to the steric hindrance of the N-3 nitrogen by the bulky trimethylsilyloxy group, favoring attack B on **9**.

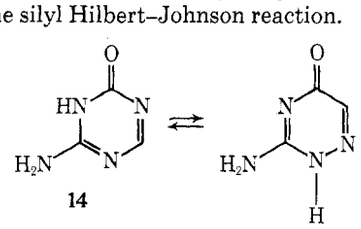
Thus the preponderance of the ortho quinoid **12a** over the para quinoid form **13a** as proved by uv, ir,[14] as well as nmr evidence[13] does not necessarily have a bearing on the reactions of the silylated form **9**. Furthermore, Pitha[15] demonstrated by uv measurements, in the case of 2-ethoxypyrimidin-4-one (**13b**), that the ortho quinoid form **12b** predominates over **13b** only in chloroform, while in water both the ortho quinoid **12b** and the para quinoid form **13b** are present in about equal amount. Thus the energy difference between the forms **12** and **13** is probably very low.



12a, b 13a, b

a, R = H
b, R = OEt

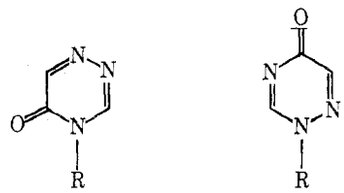
Since 6-azaisocytosine occurs mainly in the para quinoid form **15** and not in the ortho quinoid form **14**,[16] we wondered how *as*-triazin-5-one (5-hydroxy-*as*-triazine) would behave in the silyl Hilbert–Johnson reaction.



14 15

Uv data as well as alkylation studies had established for *as*-triazin-5-one (5-hydroxy-*as*-triazine)[17] that both possible tautomers, **16a** and **17a**, are present. On methylation with diazomethane in methanol as well as with methyl iodide and sodium methoxide the corresponding *N*-methyl derivatives **16b** and **17b** were obtained in roughly equal yields.[17]

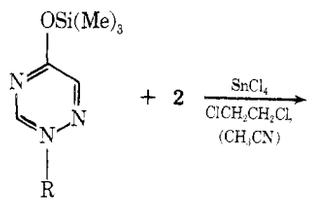
In contrast to the methylation studies, silylated *as*-triazin-5-one (**18**) afforded on reaction with **2** and $SnCl_4$ in



16a, b 17a, b

a, R = H
b, R = CH_3

1,2-dichloroethane as well as acetonitrile almost exclusively the crystalline para quinoid nucleoside **19a** in 67% yield and apparently only traces of the expected ortho quinoid **20a**, which was not isolated.



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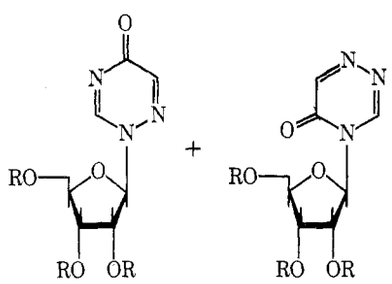


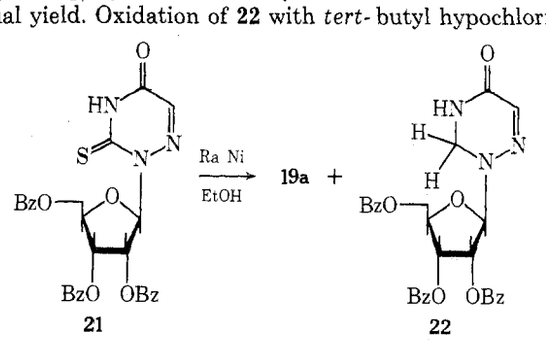
19a, b 20a

a, R = Bz
b,[a] R = H

[a] After methanolysis.

The structure of **19a** and the free nucleoside **19b** is supported by nmr data [**19a** (H-1′), δ 5.96; **19b** (H-1′), δ 5.79] and especially by the uv spectrum of **19b** in methanol [λ_{max} 242 nm (ϵ 13,600), 269 (sh, 5240)], which agrees closely with the uv spectrum of the methyl derivative **17b** (EtOH) [λ_{max} 242 nm (ϵ 11,400), 260 (sh, 4670)[17]].

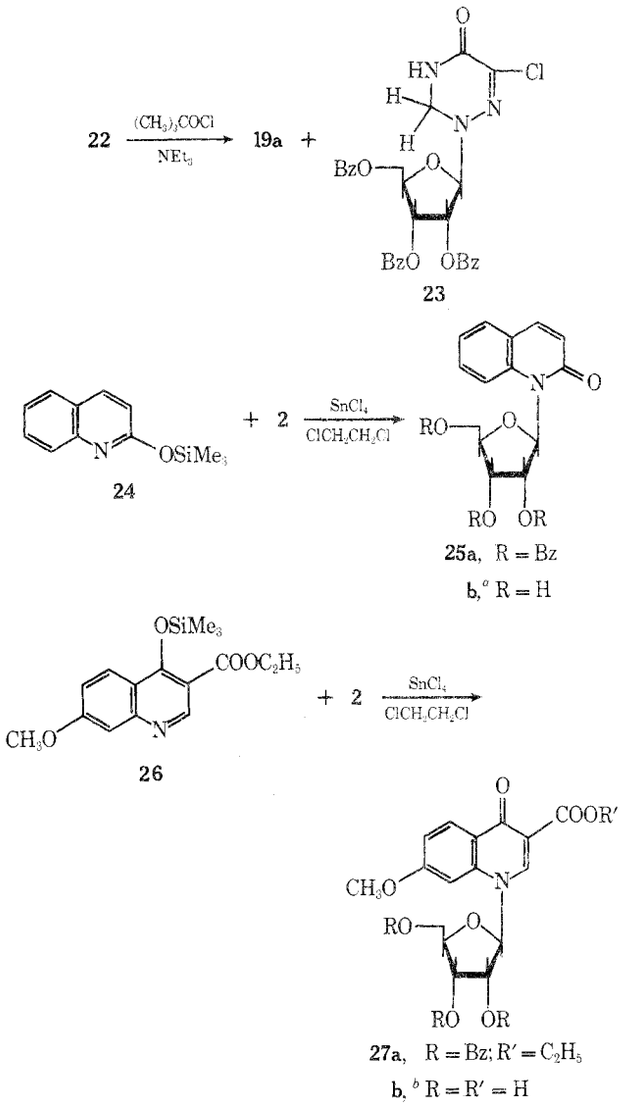
The para quinoid nucleoside **19a** was also prepared by Raney nickel desulfurization of 2′,3′,5′-tri-*O*-benzoyl-β-D-2-thio-6-azauridine (**21**), which gave, besides **19a**, the corresponding crystalline 1,2-dihydro nucleoside **22** in about equal yield. Oxidation of **22** with *tert*-butyl hypochlorite–



21 22

triethylamine[18] gave 60% **19a** as well as 2-(2,3,5-tri-*O*-benzoyl-β-D-ribofuranosyl)-6-chloro-2,3,4,5-tetrahydro-1,2,4-triazin-5-one (**23**).

Analogously, the silylated quinolin-2-one (**24**) was converted into the nucleoside **25a** in 79% yield. Silylated 7-methoxyquinolin-4-one-3-carboxylic acid ethyl ester (**26**) afforded the nucleoside **27a** in about 82% yield.



[a] After methanolysis. [b] After saponification.

These results demonstrate that a wide variety of silylated ortho or para quinoid hydroxy or mercapto N-heterocycles react with **2** and in all probability with other suitable sugar derivatives[2] in the presence of $SnCl_4$ to give the corresponding N-glycosides in good to excellent yields.

Following our preliminary publication,[2] a number of different groups have successfully used our procedure for the synthesis of nucleosides of hydroxy N-heterocycles.[19-25]

Experimental Section

For instruments, adsorbents, and the purification of solvents compare part I.[2] Tlc systems: system A [ethyl acetate–methanol (9:1)]; system B (ethyl acetate); and system C [*n*-butyl acetate–methyl glycol–H_2O (4:1:2)].[26]

The heterocyclic bases were purchased from Fluka AG. The *as*-triazin-5-one was prepared according to Lee and Paudler.[17a] The 3-carbethoxy-7-methoxy-1,4-dihydroquinolin-4-one was a gift from Dr. Albrecht, Schering A. G. The heterocyclic bases were silylated in high yields according to standard methods.[2]

1-(2,3,5-Tri-*O*-benzoyl-β-D-ribofuranosyl)-1,2-dihydropyridin-2-one (3). To **2** (9.1 g, 18 mmol) and 2-trimethylsilyloxypyridine (**1**, 22.6 mmol) in 1,2-dichloroethane (200 ml) $SnCl_4$ (2.9 ml, 24.8 mmol) in 1,2-dichloroethane (50 ml) was added. After stirring overnight and usual work-up[2] crystallization (CCl_4) gave **3** in long needles; yield, 8.3 g (85.2%); mp 139–140° (lit.[3] 139–142°); $[\alpha]^{20}D$ 61° (*c* 1, $CHCl_3$); nmr ($CDCl_3$) δ 6.59 (d, 1, $J \approx 4$ Hz, H-1′)

Anal. Calcd for $C_{31}H_{25}NO_8$ (539.55): C, 69.01; H, 4.67; N, 2.60. Found: C, 68.99; H, 4.84; N, 2.73.

1-(2,3,5-Tri-*O*-benzoyl-β-D-ribofuranosyl)-1,4-dihydropyridin-4-one (5a), 4-[(2,3,5-Tri-*O*-benzoyl-β-D-ribofuranosyl)-oxy]pyridine (6a). To **2** (4.5 g, 8.9 mmol) and **4** (1.7 g, 10 mmol) in 1,2-dichloroethane (150 ml) $SnCl_4$ (1.2 ml, 10.25 mmol) in 1,2-dichloroethane (50 ml) was added and the mixture was refluxed for 1 hr. After work-up, the residue was chromatographed on silica gel (250 g). Elution with ethyl acetate gave the crystalline O-riboside **6a** (ethanol) (tlc, system A): yield, 165 mg (2.3%); mp 139–140° (lit.[3] 139–142°); nmr ($CDCl_3$) δ 6.1–5.9 (m, 3, H-1′, H-2′, H-3′).

Anal. Calcd for $C_{31}H_{25}NO_8$ (539.55): C, 69.01; H, 4.67; N, 2.60. Found: C, 68.75; H, 4.78; N, 2.54.

Ethyl acetate–methanol (9:1) eluted the N-riboside **5a**: yield; 3.227 g (63%); amorphous; nmr ($CDCl_3$) δ 5.9–5.6 (m, 3, H-1′, H-2′, H-3′); $[\alpha]^{23}D$ −150.5° (*c* 1, $CHCl_3$)

Anal. Calcd for $C_{31}H_{25}NO_8$ (539.55): C, 69.01; H, 4.67; N, 2.60. Found: C, 68.83; H, 4.79; N, 2.52.

1-(β-D-Ribofuranosyl)-1,4-dihydropyridin-4-one (5b). **5a** (1.5 g, 2.8 mmol) was kept in dry methanolic ammonia (60 ml) overnight. After evaporation *in vacuo* and partition between water and ether, the aqueous layer was concentrated *in vacuo* to a viscous oil, which crystallized (ethanol) in colorless prisms: yield of **5b**, 514 mg (81.3%); mp 128–130°; $[\alpha]^{23}D$ −89.6° (*c* 1, ethanol + H_2O = 2:1); nmr (D_2O) δ 5.57 (d, 1, J = 3.5 Hz, H-1′); uv (CH_3OH) λ_{max} 266 nm (18,420).

Anal. Calcd for $C_{10}H_{13}NO_5$ (227.22): C, 52.86; H, 5.77; N, 6.17. Found: C, 52.81; H, 5.89; N, 6.08.

1-(2,3,5-Tri-*O*-benzoyl-β-D-ribofuranosyl)-1,2-dihydropyrimidin-2-one (8a). To **2** (5.045 g, 10 mmol) and **7a** (13.4 mmol) in CH_3CN (100 ml) $SnCl_4$ (1.73 g, 14.1 mmol) in CH_3CN (50 ml) was added. After 22° and work-up the residue (5.5 g) was chromatographed on silica gel (250 g) using ethyl acetate–methanol (9:1) as eluent to give **8a** as a white amorphous powder after precipitation from *n*-hexane: mp 139–142° [after precipitation from ethanol, mp 155–158° (lit.[6] mp 154–158°)]: yield; 3.89 g (72.9%); nmr ($CDCl_3$) δ 6.35 (d, 1, J = 3.5 Hz, H-1′).

Anal. Calcd for $C_{30}H_{24}N_2O_8$ (540.54): C, 66.66; H, 4.48; N, 5.18. Found; C, 66.59; H, 4.52; N, 5.19.

1-(2,3,5-Tri-*O*-benzoyl-β-D-ribofuranosyl)-1,2-dihydropyrimidine-2-thione (8b). To **2** (5.045 g, 10 mmol) and **7b** in CH_3CN (100 ml) $SnCl_4$ (1.73 ml, 14.1 mmol) in CH_3CN (100 ml) was added. According to tlc (system B) the reaction was complete after 5 min at 22° and was worked up after an additional 5 min. The residue was dissolved in ethyl acetate (50 ml) and added slowly to *n*-hexane (2 l.). The precipitate, a yellow powder (5.23 g), was homogenous according to tlc (system B). The hexane solution was evaporated to dryness and the residue (0.49 g) was dissolved in ethyl acetate and again precipitated by *n*-hexane to give a second crop (0.18 g): total yield of **8b**, 5.41g (96.7%); amorphous; $[\alpha]^{23}D$ 189.7° (*c* 1, $CHCl_3$); nmr ($CDCl_3$) δ 7.02 (d, 1, J = 2 Hz, H-1′).

Anal. Calcd for $C_{30}H_{24}N_2O_7S$ (559.63): C, 64.39; H, 4.86; N, 5.01; S, 5.73. Found: C, 64.31; H, 4.97; N, 5.03; S, 5.66.

1-(2,3,5-Tri-*O*-benzoyl-β-D-ribofuranosyl)-1,6-dihydropyrimidin-6-one (10a) and 1-(2,3,5-Tri-*O*-benzoyl-β-D-ribofuranosyl)-1,4-dihydropyrimidin-4-one (11a). A. Reaction in 1,2-Dichloroethane. To **2** (4.14 g, 8.20 mmol) and **9** (10 mmol) in 1,2-dichloroethane (100 ml) $SnCl_4$ (1.60 ml, 13.67 mmol) in 1,2-dichloroethane (50 ml) was added. After 0.5 hr at 15°, 3.5 hr at 22°, and work-up, tlc (system A) showed the formation of two products. The residue was dissolved in hot ethyl acetate (~150 ml) from which **11a** crystallized in long needles: yield, 2.66 g (60%); mp 224–226°; $[\alpha]^{23}D$ −138.9° (*c* 1, $CHCl_3$); nmr ($CDCl_3$) δ 5.9–5.6 (m, 3, H-1′, H-2′, H-3′).

Anal. Calcd for $C_{30}H_{24}N_2O_8$ (540.39): C, 66.66; H, 4.48; N, 5.18. Found: C, 66.61; H, 4.59; N, 5.28.

11a (1.4 g, 2.6 mmol) gave with methanolic ammonia (16 hr at 22°) **11b** (521 mg, 87.8%): mp 122–124° (ethanol–H_2O); $[\alpha]^{23}D$ −75.8° [*c* 1, ethanol–H_2O (2:1)]; nmr (D_2O) δ 5.67 (d, 1, J = 5 Hz, H-1′).

Anal. Calcd for $C_9H_{12}N_2O_5$ (228.21): C, 47.37; H, 5.30; N, 12.28. Found: C, 47.45; H, 5.67; N, 12.15.

The mother liquor of **11a** was concentrated *in vacuo* and poured into *n*-hexane to remove sugar derivatives. The precipitate crystallized (ethyl acetate–*n*-hexane) to give **10a** in needles: yield, 1.16 g (26.4%); mp (128–132°, changing point) 157–158° (lit.[5] 157–157.5°); nmr ($CDCl_3$) δ 6.24 (d, 1, J = 3 Hz, H-1′).

B. Reaction in CH_3CN. To **2** (5.045 g, 10 mmol) and **9** (10 mmol) in CH_3CN (100 ml) $SnCl_4$ (2.0 ml, 17.1 mmol) in CH_3CN (100 ml) was added. After 0.5 hr at 15° and 3.5 hr at 22° work-up gave 27% **10a** and 38% **11a.**

2-(2,3,5-Tri-*O*-benzoyl-β-D-ribofuranosyl)-2,5-dihydro-1,2,4-triazin-5-one (19a). To a solution of **2** and **18** (12 mmol) in

CH_3CN (60 ml) $SnCl_4$ (1 ml, 8.16 mmol) in CH_3CN (40 ml) was added. After 24 hr at 22° and work-up the crude product (5.3 g) was chromatographed on silica gel (250 g) using *n*-hexane–ethyl acetate (1:9) as eluent. The crude nucleoside was dissolved in ethyl acetate and poured into pentane. The precipitate crystallized (ethanol) to give **19a** as needles (3.61 g, 66.6%): mp 117–119°; $[\alpha]^{23}D$ −94° (*c* 1, $CHCl_3$); nmr ($CDCl_3$) δ 8.53 (d, 1, J = 1.5 Hz, H-3), 5.96 (d, 1, J = 3.5 Hz, H-1′).

Anal. Calcd for $C_{29}H_{23}N_3O_8$ (541.53): C, 64.32); H, 4.28; N, 7.76. Found: C, 64.25; H, 4.41; N, 7.68.

2-(β-D-Ribofuranosyl)-2,5-dihydro-1,2,4-triazin-5-one (19b). **19a** (2.5 g, 4.62 mmol) in dry methanolic ammonia (60 ml) was stored overnight to give **19b** in needles (2-propanol–H_2O): yield, 876 mg (83.5%); mp 116–119°; $[\alpha]^{23}D$ −74.2° [*c* 1, ethanol–H_2O (2:1)] nmr (D_2O) δ 8.93 (d, 1, $J \approx 1$ Hz, H-3), 8.01 (d, 1, $J \approx 1$ Hz, H-6), 5.79 (d, 1, J = 3.5 Hz, H-1′.

Anal. Calcd for $C_8H_{11}N_3O_5$ (229.20): C, 41.92; H, 4.84; N, 18.34. Found: C, 41.95; H, 5.12; N, 18.19.

Desulfurization of 2-Thio-6-azauridine 2′,3′,5′-Tri-*O*-benzoate (21) to 19a and 2-(2,3,5-Tri-*O*-benzoyl-β-D-ribofuranosyl)-2,3,4,5-tetrahydro-1,2,4-triazin-5-one (22). **21** (2.869 g, 5 mmol) and benzoic acid (0.61 g, 5 mmol) were suspended, stirred in abs ethanol (150 ml), and cooled to 0°, and freshly prepared W-2 Raney nickel[27] (12 g) was added, which had been washed with ethanol. After 4, 8, and 12 hr further portions of Raney nickel (10 g each) were added at 0° until the starting material had nearly disappeared according to tlc (system C). Thiourea (2 g) was added and stirring was continued for 1 hr at 0°. After filtering the excess Raney nickel, washing with cold ethanol (500 ml), and extracting the reagent with boiling ethanol (1 l.) the filtrates were evaporated and the residue was taken up in chloroform (200 ml). The chloroform solution was extracted with saturated $NaHCO_3$ solution (150 ml), dried ($MgSO_4$), and evaporated to give a crude product (1.828 g), which consisted according to tlc (system C) of an ~ 1:1 mixture of **19a** and the slightly slower moving **22.** On standing in ethanol (30 ml) **22** crystallized: yield, 0.82 g (30%); mp 193–197°; $[\alpha]^{23}D$ 4.4° (*c* 1, $CHCl_3$); nmr ($CDCl_3$ + D_2O) δ 6.75 (s, 1, H-6), 5.34 (d, 1, J = 3.5 Hz, H-1′); uv (CH_3OH) λ_{max} (pH 7) 281 nm (ϵ 5340), λ_{max} (pH 13) 301 (3490), λ_{max} (pH 1) 281 (5350).

Anal. Calcd for $C_{29}H_{25}N_3O_8$ (543.51): C, 64.08; H, 4.64; N, 7.73. Found: C, 63.65; H, 4.74; N, 8.13. An aliquot (0.2 g) of the evaporated mother liquor (0.98 g) was separated by preparative tlc on silica gel (system C) to give pure **19a** (83 mg, 16%), which was identified by tlc and by comparison of melting point and ir spectrum with authentic **19a.**

Conversion of 22 to 19a and 2-(2,3,5-Tri-*O*-benzoyl-β-D-ribofuranosyl)-6-chloro-2,3,4,5-tetrahydro-1,2,4-triazin-5-one (23). A solution of **22** (543 mg, 1 mmol) in chloroform (20 ml) and triethylamine (0.14 ml, 1 mmol) was stirred at −10° and *tert*-butyl hypochlorite was added with vigorous stirring until **22** had disappeared according to tlc (system C). The yellow solution was washed with sodium thiosulfate solution, dried (Na_2SO_4), and evaporated to a light brown oil, which was chromatographed on silica gel (50 g). Elution with hexane–ethyl acetate (1:1) gave first **23** (112 mg, 19.3%) followed by **19a** (316 mg, 58.4%), which was identified by tlc and ir comparison with an authentic sample of **19a.**

23 was recrystallized (2-propanol): mp 173–175°; $[\alpha]^{23}D$ −18.8° (*c* 1, $CHCl_3$); nmr ($CDCl_3$) δ 5.30 (d, 1, J = 3.5 Hz, H-1′).

Anal. Calcd for $C_{29}H_{24}N_3O_8Cl$ (577.99): C, 60.26; H, 4.19; N, 7.27; Cl, 6.13. Found: C, 60.64; H, 4.08; N, 7.66; Cl, 6.18.

1-(2,3,5-Tri-*O*-benzoyl-β-D-ribofuranosyl)-1,2-dihydroquinolin-2-one (25a). To **2** (5.045 g, 10 mmol) and **24** (12 mmol) in CH_3CN (100 ml) $SnCl_4$ (1.5 ml, 12.2 mmol) in CH_3CN (670 ml) was added. After 42 hr at 22° and work-up, the residue was treated with charcoal and chromatographed on silica gel (250 g) using *n*-hexane–ethyl acetate (2:1) as eluent. **25a** was obtained as a white foam: yield; 4.65 g (78.9%); amorphous; $[\alpha]^{23}D$ 4.7° (*c* 1, $CHCl_3$); nmr ($CDCl_3$) δ 6.77 (d, 1, J = 3 Hz, H-1′), 6.61 (d, 1, J = 9 Hz, H-3).

Anal. Calcd for $C_{35}H_{27}NO_8$ (589.61): C, 71.30; H, 4.62; N, 2.38. Found: C, 71.19; H, 4.90; N, 2.45.

25a (2.9 g, 4.92 mmol) gave with methanolic ammonia crystalline (ethanol) **25b** (1.20 g, 87.9%): mp 142–143°: $[\alpha]^{23}D$ −9.6° [*c* 1, ethanol–H_2O (2:1)]; nmr (pyridine-d_5) δ 8.09 (d, 1, J = 9 Hz, H-4), 7.12 (d, 1, J = 5 Hz, H-1′), 6.57 (d, 1, J = 9 Hz, H-3).

Anal. Calcd for $C_{14}H_{15}NO_5$ (277.28): C, 60.64; H, 5.45; N, 5.05. Found: C, 60.57; H, 5.73; N, 4.99.

1-(2,3,5-Tri-*O*-benzoyl-β-D-ribofuranosyl)-3-carbethoxy-7-methoxy-1,4-dihydroquinolin-4-one (27a). To **2** (1.73 g, 3.43 mmol) and **26**)1.2 g, 3.76 mmol) in 1,2-dichloroethane (60 ml) $SnCl_4$ (0.5 ml, 4.27 mmol) in 1,2-dichloroethane (10 ml) was added. After 2 hr at 22° and work-up the residue was crystallized (ethanol) to give **27a** as needles (1.93 g, 81.5%): mp 133–136°: $[\alpha]^{20}D$ −80.4° (*c* 1, $CHCl_3$); nmr ($CDCl_3$) δ 8.94 (s, 1, H-2), 6.45 (d, 1, J = 4.5 Hz, H-1′), 3.75 (s, 3, Ar OH_3).

Anal. Calcd for $C_{39}H_{33}NO_{11}$ (691.70): C, 67.72; H, 4.81; N, 2.03. Found: C, 67.58; H, 4.97; N, 2.11.

27a (0.448 g, 0.695 mmol) in 0.5 *N* methanolic sodium hydroxide (30 ml) was stirred for 2 hr at 22° and passed through a column of Dowex 50 H^+ (20 ml), which was washed with methanol–H_2O (3:1). The filtrate was evaporated and the residue was partitioned between water and ether. The aqueous solution was evaporated *in vacuo* and the residue crystallized (ethanol–H_2O) to give **27b:** yield, 199 mg (81.6%); mp 213°.

Anal. Calcd for $C_{16}H_{17}NO_8$ (351.32): C, 54.70; H, 4.88; N, 3.99. Found: C, 54.82; H, 4.97; N, 3.86.

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Registry No. **1,** 18292-04-1; **2,** 6974-32-9; **3,** 5116-31-4; **4,** 27248-04-0; **5a,** 18342-24-0; **5b,** 52554-33-3; **6a,** 18342-23-9; **7a,** 52523-22-5; **7b,** 52523-23-6; **8a,** 52523-24-7; **8b,** 49625-10-7; **9,** 52523-25-8; **10a,** 5116-20-1; **11a,** 52523-26-9; **11b,** 21052-20-0; **18,** 52523-27-0; **19a,** 52523-28-1; **19b,** 52554-34-4; **21,** 27089-55-0; **22,** 52523-29-2; **23,** 52523-30-5; **24,** 52523-31-6; **25a,** 52523-32-7; **25b,** 52523-33-8; **26,** 52523-34-9; **27a,** 35068-46-3; **27b,** 35068-65-6.

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