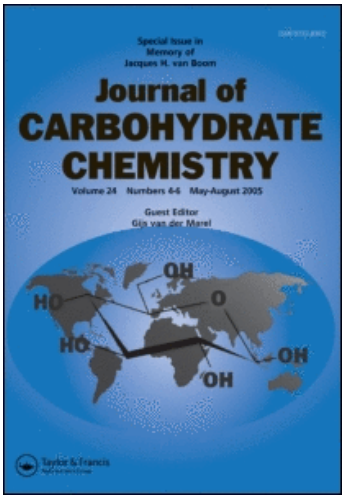

Journal of Carbohydrate Chemistry
Publication details, including instructions for authors and subscription information:
http://www.informaworld.com/smpp/title~content=t713617200

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To cite this Article Hasegawa, Akira , Ogawa, Masayuki , Kojima, Yukiya and Kiso, Makoto(1992) 'Synthetic Studies on Sialoglycoconjugates 36: α-Selective Glycoside Synthesis of *N*-Acetylneuraminic Acid with the Secondary Hydroxyl Group in D-Glucofyranose, 2-Acetamido-2-deoxy-D-glucopyranose and D-Galactopyranose Derivatives', Journal of Carbohydrate Chemistry, 11: 3, 333 — 341
To link to this Article: DOI: 10.1080/07328309208017997
URL: http://dx.doi.org/10.1080/07328309208017997

J. CARBOHYDRATE CHEMISTRY, 11(3), 333-341 (1992)

SYNTHETIC STUDIES ON SIALOGLYCOCONJUGATES 36: α-SELECTIVE GLYCOSIDE SYNTHESIS OF *N*-ACETYLNEURAMINIC ACID WITH THE SECONDARY HYDROXYL GROUP IN D-GLUCOPYRANOSE, 2-ACETAMIDO-2-DEOXY-D-GLUCOPYRANOSE AND D-GALACTOPYRANOSE DERIVATIVES

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Received November 4, 1991 - Final form December 30, 1991

ABSTRACT

Coupling of the secondary hydroxyl group in the 6-*O*-benzoyl derivatives **3**, **5** and **8**, prepared from 2-(trimethylsilyl)ethyl β-D-glucopyranoside (**2**), 2-acetamido-2-deoxy-β-D-glucopyranoside (**4**), and 2-acetamido-2-deoxy-β-D-galactopyranoside (**6**), with methyl (methyl 5-acetamido-4,7,8,9-tetra-*O*-acetyl-3,5-dideoxy-2-thio-D-*glycero*-α-D-*galacto*-2-nonulopyranosid)onate (**1**) as the glycosyl donor in acetonitrile in the presence of dimethyl(methylthio)sulfonium triflate (DMTST) as a glycosyl promoter, exclusively gave the α-glycosides at C-2 in **3**, at C-3 in **5** and **8**, respectively.

INTRODUCTION

Sialic acids are well known as constituents of glycoproteins and glycolipids of cell membranes, and they play important roles in various biological processes. As far as we know, sialic acids are linked in α-configuration at C-3, -4 and -6 of the Gal, at C-6 of the Glc, at C-6 of the GlcNAc and GalNAc, and at C-8 of the sialic acid residue in sialoglycoconjugates. Therefore, a facile α-selective glycoside synthesis of sialic acids, especially with the secondary hydroxyl groups of sugar derivative, is critically important in order to investigate the functions of sialoglycoconjugates at the molecular level.

Recently, new efforts[1,2] have been made at obtaining mainly α-glycosides of sialic acid using 3-substituted Neu5Ac derivatives as glycosyl donors. We have developed[3] a facile α-stereoselective glycosylation of sialic acids by using 2-thioglycosides of sialic acids as the glycosyl donor and suitably protected acceptors, with dimethyl(methylthio)-sulfonium triflate[4] (DMTST) or *N*-iodosuccinimide (NIS)-trifluoromethanesulfonic acid[5] (Tf-OH) as the glycosyl promoter in acetonitrile under kinetically controlled conditions. The α-glycosides of sialic acids thus obtained were effectively employed[6] as the building blocks for the following ganglioside synthesis. As a part of our continuing efforts on the synthesis of α-glycosides of sialic acid and sialoglycolipids, we describe here the synthesis of sialosyl α-(2→2)-D-glucopyranose and sialosyl α-(2→3)-2-acetamido-2-deoxy -D-gluco- and D-galactopyranoses derivatives.

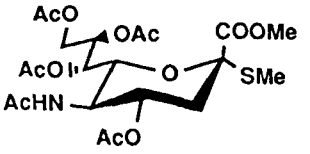
RESULTS AND DISCUSSION

For the synthesis of the desired α-glycosides of Neu5Ac, we have chosen the 6-*O*-benzoylated derivatives **3**, **5**, and **9** of 2-(trimethylsilyl)ethyl β-D-glucopyranoside[7] (**2**), 2-acetamido-2-deoxy-β-D-glucopyranoside[8] (**4**), and 2-acetamido-2-deoxy-β-D-galacto-pyranoside[9] (**6**) as the glycosyl acceptor. We have employed methyl (methyl 5-acetamido-4,7,8,9-tetra-*O*-acetyl-3,5-dideoxy-2-thio-D-*glycero*-α-D-*galacto*-2-nonulo-pyranosid)onate[10] (**1**) as the glycosyl donor.

Treatment of **2** or **4** with benzoyl chloride in pyridine-dichloromethane at -50 °C gave the corresponding 6-*O*-benzoyl derivatives **3** and **5** in 60% yields, respectively.

Treatment of **6** with 2,2-dimethoxypropane in *N*,*N*-dimethylformamide in the presence of *p*-toluenesulfonic acid monohydrate for 2 h at 80 °C, gave the 3,4-*O*-isopropylidene derivative **7** in 80% yield, which, on *O*-benzoylation and subsequent hydrolysis of the isopropylidene group with 80% aqueous acetic acid for 2 h at 45 °C, afforded 2-(trimethylsilyl)ethyl 2-acetamido-6-*O*-benzoyl-2-deoxy-β-D-galactopyranoside (**9**) in high yield.

The glycosylation of **3** with the methyl α-2-thioglycoside **1** (2.0 equiv. relative to the acceptor) of Neu5Ac in acetonitrile for 15 h at -15-20 °C in the presence of DMTST, gave the expected α-glycoside **10** of Neu5Ac, 2-(trimethylsilyl)ethyl *O*-(methyl 5-acetamido-4,7,8,9-tetra-*O*-acetyl-3,5-dideoxy-D-*glycero*-α-*galacto*-2-nonulo-pyranosyl-onate)-(2→2)-6-*O*-benzoyl-β-D-glucopyranoside (**10**) in 48% yield. The observed chemical shifts and coupling constants (δ 2.91, $J_{3a,3e}$ = 12.5 Hz, $J_{3e,4}$ = 4.4 Hz, δ 4.98, and δ 5.40, $J_{7,8}$ = 7.8 Hz) for H-3e, H-4, and H-7 in Neu5Ac moiety are characteristic for α-glycosidic linkages.[2,4b,11,12] The linkage position of the Neu5Ac



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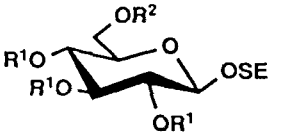
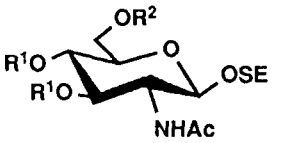
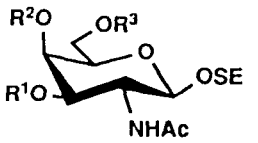


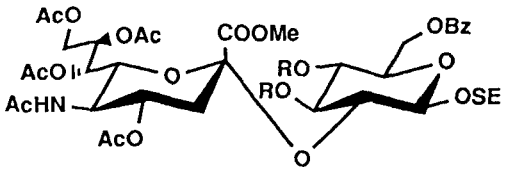
2 $R^1 = R^2 = H$
3 $R^1 = H$, $R^2 = Bz$



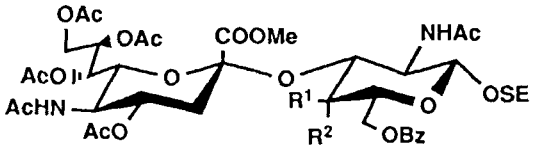
4 $R^1 = R^2 = H$
5 $R^1 = H$, $R^2 = Bz$



6 $R^1 = R^2 = R^3 = H$
7 $R^1, R^2 = Ip$, $R^3 = H$
8 $R^1, R^2 = Ip$, $R^3 = Bz$
9 $R^1 = R^2 = H$, $R^3 = Bz$



10 R = H
11 R = Ac



12 $R^1 = OH$, $R^2 = H$
13 $R^1 = OAc$, $R^2 = H$
14 $R^1 = H$, $R^2 = OH$
15 $R^1 = H$, $R^2 = OAc$

SE = 2-(trimethylsilyl)ethyl
Bz = benzoyl
Ip = isopropylidene

unit to the Glc residue was unambiguously proved from the ^{1}H NMR data of the acetylated derivative **11**. Significant signals of **11** were a one-proton doublet of doublets at δ 4.28 ($J_{1,2}$ = 8.1 Hz, $J_{2,3}$ = 8.4 Hz, H-2) and a one-proton doublet at δ 4.41 (H-1) in the Glc residue, indicating the linkage position assigned. Other ^{1}H NMR data are given in the Experimental Section and are consistent with the structure. In the same way, when treated with the glycosyl acceptors **5** and **9**, compound **1** yielded the corresponding α-glycosides **12** and **14** at *O*-3 in the acceptor moiety in 49 and 46% yields, respectively; no β-glycoside and no position isomer of Neu5Ac was isolated. Acetylation of the glycosides **12** and **14** thus obtained gave the acetates **13** and **15**. The structures of the glycosides **13** and **15** were determined from the ^{1}H NMR data; the observed chemical shifts and coupling constants of the sialic acid units for H-3e (δ 2.58, $J_{3a,3e}$ = 12.8 Hz, $J_{3e,4}$ = 4.4 Hz for **13**; δ 2.66, $J_{3a,3e}$ = 12.5 Hz, $J_{3e,4}$ = 4.4 Hz, for **15**) and for H-4 (δ 4.91, $J_{3a,4}$ = 12.5 Hz for **13**; δ 4.80, $J_{3a,4}$ = 12.4 Hz for **15**), are of α-anomeric configuration; H-4 for **13** appeared at δ 5.09 (t, $J_{3,4}$ = $J_{4,5}$ = 8.1 Hz) and for **15** at δ 4.95 (broad d), indicating the linkage position of the Neu5Ac residue in **13** and **15** to be *O*-3. Other ^{1}H NMR data are consistent with structures **13** and **15**, respectively.

In conclusion, α-stereoselective glycosylation of Neu5Ac has been also observed by using the methyl 2-thioglycoside **1** of Neu5Ac as the glycosyl donor and the 6-*O*-benzoyl derivatives **3**, **5**, and **9** of 2-(trimethylsilyl)ethyl β-D-glucopyranoside and 2-acetamido-2-deoxy-β-D-hexopyranosides) with DMTST in acetonitrile under kinetically controlled conditions. The α-glycosides described herein could be used as intermediates suitable for the neoganglioside synthesis, and they are also inportant as building units for sialoglycoconjugate synthesis.

EXPERIMENTAL

General Procedures. Specific rotations were determined with a Union PM-201 polarimeter at 25 °C, and IR spectra were recorded with a Jasco A-100 spectrophotometer. ^{1}H NMR spectra were recorded with a JEOL JNM-GX 270 spectrometer. Preparative chromatography was performed on silica gel (Wako Chemical Co., 200 mesh) with the solvent systems specified. Concentrations were conducted *in vacuo*.

2-(Trimethylsilyl)ethyl 6-*O*-Benzoyl-β-D-glucopyranoside (3). To a solution of 2-(trimethylsilyl)ethyl β-D-glucopyranoside[7] (**2**; 1.01 g, 3.6 mmol) in pyridine (10 mL) and dichloromethane (10 mL), cooled to -50 °C, was added benzoyl chloride (0.63 mL, 5.4 mmol), and the mixture was stirred for 15 min at -30 °C.

The reaction was monitored by TLC and, when complete, methanol (1 mL) was added, and the mixture was concentrated. Column chromatography (*10:1* ethyl acetate-

hexane) of the residue on silica gel (60 g) gave **3** (830 mg, 60%) as an amorphous mass: $[\alpha]_D$ -50.5° (*c* 0.95, $CHCl_3$); ^1H NMR ($CDCl_3$) δ 1.01 (m, 2H, $Me_3SiCH_2CH_2$), 4.36 (d, 1H, $J_{1,2}$ = 7.7 Hz, H-1), 4.49 (dd, 1H, $J_{5,6'}$ = 6.2 Hz, $J_{6,6'}$ = 12.1 Hz, H-6'), 4.72 (dd, 1H, $J_{5,6}$ = 1.7 Hz, H-6), and 7.42-8.08 (m, 5H, Ph).

Anal. Calcd for $C_{18}H_{28}O_7Si$ (384.5): C, 56.22; H, 7.34. Found: C, 56.31; H, 7.50.

2-(Trimethylsilyl)ethyl 2-Acetamido-6-*O*-benzoyl-2-deoxy-β-D-glucopyranoside (5). To a solution of **4**[8] (2.0 g, 6.2 mmol) in pyridine (10 mL) and dichloromethane (10 mL), cooled to -50 °C, was added benzoyl chloride (1.1 mL, 9.35 mmol), and the mixture was stirred for 20 min at -50 °C. MeOH (1 mL) was added, and the mixture was concentrated. Column chromatography (2:1 ethyl acetate-hexane) of the residue on silica gel (70 g) gave **5** (1.56 g, 59%) as an amorphous mass: $[\alpha]_D$ -49.0° (*c* 0.8, $CHCl_3$); IR (KBr) 3600-3300 (OH, NH), 1730 and 1280 (ester), 1660 and 1560 (amide), 860 and 840 (TMS), and 710 cm^{-1} (Ph); ^1H NMR (1:1 CD_3OD-$CDCl_3$) δ 0.98 (m, 2H, $Me_3SiCH_2CH_2$), 2.08 (s, 3H, AcN), 3.96 (m, 1H, $Me_3SiCH_2CH_2$), 4.48-4.61 (m, 2H, H-6,6'), 4.79 (d, 1H, $J_{1,2}$ = 11.0 Hz, H-1), and 7.40-8.07 (m, 5H, Ph).

Anal. Calcd for $C_{20}H_{31}NO_7Si$ (425.6): C, 56.42; H, 7.34; N, 3.29. Found: C, 56.43; H, 7.41; N, 3.18.

2-(Trimethylsilyl)ethyl 2-Acetamido-2-deoxy-3,4-*O*-isopropylidene-β-D-galactopyranoside (7). To a solution of **6**[9] (1.0 g, 3.1 mmol) in *N,N*-dimethylformamide (DMF; 10 mL) were added 2,2-dimethoxypropare (0.77 mL, 6 mmol) and *p*-toluenesulfonic acid monohydrate (10 mg), and the mixture was stirred for 2 h at 80 °C and neutralized with Amberlite IR-410 (OH^-) resin. The resin was filtered off and washed with methanol, and the combined filtrate and washings were concentrated. Column chromatography (2:1 ethyl acetate-hexane) of the residue on silica gel (100 g) gave 7 (980 mg, 81%) as an amorphous mass: $[\alpha]_D$ +1.6° (*c* 2.0, $CHCl_3$); IR (KBr) 3600-3300 (OH, NH), 1660 and 1550 (amide), and 840 cm^{-1} (TMS, Me_2C); ^1H NMR ($CDCl_3$) δ 0.92 (m, 2H, $Me_3SiCH_2CH_2$), 1.32, 1.51 (2s, 6H, Me_2C), 1.98 (s, 3H, AcN), 3.54 (m, 1H, $Me_3SiCH_2CH_2$), 4.75 (dd, 1H, $J_{3,4}$ = 5.5 Hz, $J_{4,5}$ = 2.6 Hz, H-4), 5.00 (d, 1H, $J_{1,2}$ = 8.4 Hz, H-1), and 5.94 (d, 1H, NH).

Anal. Calcd for $C_{16}H_{32}NO_6Si$ (347.5): C, 55.30; H, 9.28; N, 4.03. Found: C, 55.28; H, 9.40; N, 4.01.

2-(Trimethylsilyl)ethyl 2-Acetamido-6-*O*-benzoyl-2-deoxy-3,4-*O*-isopropylidene-β-D-galactopyranoside (8). To a solution of **7** (710 mg, 2.04 mmol) in pyridine (10 mL), cooled to -20 °C, was added benzoyl chloride (0.4 mL, 3.4 mmol), and the mixture was stirred for 15 min at -5 °C and then worked-up, as described for **3**, to give **8** (770 mg, 84%) as an amorphous mass: $[\alpha]_D$ +22.5° (*c* 1.1, $CHCl_3$); ^1H NMR

(CDCl3) δ 0.96 (m, 2H, Me3SiC*H*2CH2), 1.37, 1.57 (2s, 6H, Me2C), 2.01 (s, 3H, AcN), 3.59, 3.98 (2m, 2H, Me3SiCH2C*H*2), 5.03 (d, 1H, $J_{1,2}$ = 8.4 Hz, H-1), 6.64 (d, 1H, $J_{2,NH}$ = 7.3 Hz, NH), and 7.43-8.09 (m, 5H, Ph).

Anal. Calcd for $C_{23}H_{35}NO_7Si$ (451.6): C, 61.17; H, 7.81; N, 3.10. Found: C, 61.22; H, 7.98; N, 3.15.

2-(Trimethylsilyl)ethyl 2-Acetamido-6-*O*-benzoyl-2-deoxy-β-D-galactopyranoside (9). A solution of **8** (770 mg, 1.7 mmol) in aqueous 80% acetic acid (15 mL) was heated for 2 h at 45 °C, and concentrated. Column chromatography (50:1 dichloromethane-methanol) of the residue on silica gel (80 g) gave **9** (730 mg, quantitative) as an amorphous mass: $[\alpha]_D$ -35.0° (*c* 0.5, CHCl3); IR (KBr) 3700-3200 (OH, NH), 1710 and 1250 (ester), 1630 and 1550 (amide), 850 and 830 (TMS), and 710 cm-1 (Ph); ^{1}H NMR (CDCl3) δ 0.93 (m, 2H, Me3SiC*H*2CH2), 2.02 (s, 3H, AcN), 3.61 (m, 1H, Me3SiCH2C*H*2), 4.50 (d, 1H, $J_{1,2}$ = 8.4 Hz, H-1), and 7.45-8.08 (m, 5H, Ph).

Anal. Calcd for $C_{20}H_{31}NO_7Si$ (425.6): C, 56.42; H, 7.34; N, 3.29. Found: C, 56.35; H, 7.36; N, 3.19.

2-(Trimethylsilyl)ethyl *O*-(Methyl 5-Acetamido-4,7,8,9-tetra-*O*-acetyl-3,5-dideoxy-D-glycero-α-D-galacto-2-nonulopyranosylonate)-(2→2)-6-*O*-benzoyl-β-D-glucopyranoside (10). To a solution of **3** (1.5 g, 3.9 mmol) and **1**[10] (4.1 g, 7.9 mmol) in acetonitrile (15 mL) were added powdered molecular sieves 3Å (5.0 g), and the mixture was stirred for 6 h at room temperature, then cooled to -20 °C. A mixture of dimethyl(methylthio)sulfonium triflate (DMTST; 4 g) and molecular sieves 3Å (4 g) was added, the mixture was stirred for 24 h at -20 °C, and the reaction was monitored by TLC. The precipitate was collected and washed with dichloromethane, and the combined filtrate and washings were washed with M sodium carbonate and water, dried (Na2SO4), and concentrated. Column chromatography (2:1 ethyl acetate-hexane) of the residue on silica gel (250 g) gave **10** (1.6 g; 48%) as an amorphous mass: $[\alpha]_D$ -17.8° (*c* 1.0, CHCl3); IR (KBr) 3600-3300 (OH, NH), 1750 and 1230 (ester), 1660 and 1550 (amide), 860 and 840 (TMS), and 710 cm^{-1} (Ph); ^{1}H NMR (CDCl3) Neu5Ac unit δ 1.94 (s, 3H, AcN), 2.03, 2.07, 2.17, 2.18 (4s, 12H, 4AcO), 2.91 (dd, 1H, $J_{3a,3e}$ = 12.5 Hz, $J_{3e,4}$ = 4.4 Hz, H-3e), 3.82 (s, 3H, MeO), 4.02 (q, 1H, $J_{4,5} = J_{5,6} = J_{5,NH}$ = 10.1 Hz, H-5), 4.13 (dd, 1H, $J_{8,9'}$ = 5.5 Hz, $J_{9,9'}$ = 12.5 Hz, H-9'), 4.43 (dd, 1H, $J_{8,9}$ = 2.6 Hz, H-9), 4.98 (m, 1H, H-4), 5.40 (dd, 1H, $J_{6,7}$ = 2.0 Hz, $J_{7,8}$ = 7.8 Hz, H-7), 5.44 (m, 1H, H-8), and 5.54 (d, 1H, NH); Glc unit δ 0.87-1.05 (m, 2H, Me3SiC*H*2CH2), 4.35 (d, 1H, $J_{1,2}$ = 7.7 Hz, H-1), and 7.42-8.13 (m, 5H, Ph).

Anal. Calcd for $C_{38}H_{55}NO_{19}Si$ (857.9): C, 53.20; H, 6.46; N, 1.63. Found: C, 53.31; H, 6.70; N, 1.62.

A sample of **10** (92 mg, 0.11 mmol) was acetylated with acetic anhydride (1 mL)-pyridine (2 mL) overnight at room temperature. Column chromatography (80:1 dichloromethane-methanol) of the product on silica gel (30 g) gave **11** (100 mg, quantitative) as an amorphous mass: $[\alpha]_D$ -6.5° (*c* 1.1, $CHCl_3$); ^1H NMR ($CDCl_3$) Neu5Ac unit δ 1.87 (s, 3H, AcN), 2.30 (dd, 1H, $J_{3a,3e}$ = 12.5 Hz, $J_{3e,4}$ = 4.8 Hz, H-3e), 3.83 (s, 3H, MeO), 4.50 (dd, 1H, $J_{8,9'}$ = 2.6 Hz, $J_{9,9'}$ = 12.1 Hz, H-9'), 4.87 (m, 1H, H-4), 5.40 (dd, 1H, $J_{6,7}$ = 2.5 Hz, $J_{7,8}$ = 9.3 Hz, H-7), and 5.52 (m, 1H, H-8); Glc unit δ 0.96 (m, 2H, $Me_3SiCH_2CH_2$), 3.60 (m, 1H, $Me_3SiCH_2CH_2$), 4.25 (dd, 1H, $J_{1,2}$ = 8.1 Hz, $J_{2,3}$ = 8.4 Hz, H-2), 4.41 (d, 1H, H-1), 5.20 (m, 2H, H-3,4), and 7.31-8.13 (m, 5H, Ph); *O*-acetyl groups 2.03, 2.05, 2.06, 2.10, 2.18, 2.27 (6s, 18H, 6AcO).

Anal. Calcd for $C_{42}H_{59}NO_{21}Si$ (942.0): C, 53.55; H, 6.31; N, 1.49. Found: C, 53.64; H, 6.39; N, 1.43.

2-(Trimethylsilyl)ethyl *O*-(Methyl 5-Acetamido-4,7,8,9-tetra-*O*-acetyl-3,5-dideoxy-D-glycero-α-D-galacto-2-nonulopyranosylonate)-(2→3)-2-acetamido-6-*O*-benzoyl-2-deoxy-β-D-glucopyranoside (12). Glycosylation of **5** (460 mg, 1.08 mmol) with **1** (1.2 g, 2.3 mmol) in acetonitrile (6 mL) in the presence of DMTST (1.02 g) and molecular sieves 3Å (2.0 g), as described for the synthesis of **10**, gave **12** (465 mg, 49%) as an amorphous mass: $[\alpha]_D$ -26.7° (*c* 0.9, $CHCl_3$); ^1H NMR ($CDCl_3$) Neu5Ac unit δ 2.68 (dd, 1H, $J_{3a,3e}$ = 12.5 Hz, $J_{3e,4}$ = 4.6 Hz, H-3e), 3.76 (s, 3H, MeO), 4.37 (m, 1H, H-9), 4.81 (m, 1H, H-4), 5.29 (dd, 1H, $J_{6,7}$ = 2.0 Hz, $J_{7,8}$ = 8.5 Hz, H-7), and 5.67 (m, 1H, H-8); GlcNAc unit δ 0.98 (m, 2H, $Me_3SiCH_2CH_2$), 4.52 (d, 1H, $J_{1,2}$ = 8.4 Hz, H-1), and 7.41-8.06 (m, 5H, Ph); other groups δ 1.86, 2.02 (2s, 6H, 2AcN), 2.05, 2.13, 2.16, 2.21 (4s, 12H, 4AcO), and 5.40, 6.59 (2d, 2H, 2NH).

Anal. Calcd for $C_{40}H_{58}N_2O_{19}Si$ (899.0): C, 53.44; H, 6.50; N, 3.12. Found: C, 53.39; H, 6.34; N, 3.24.

A sample of **12** (150 mg, 0.17 mmol) was acetylated with acetic anhydride (2 mL)-pyridine (4 mL), as described for **11**, to give **13** (143 mg, 87%) as an amorphous mass: $[\alpha]_D$ -11.1° (*c* 1.0, $CHCl_3$); ^1H NMR ($CDCl_3$) Neu5Ac unit δ 2.58 (dd, 1H, $J_{3a,3e}$ = 12.8 Hz, $J_{3e,4}$ = 4.4 Hz, H-3e), 3.80 (s, 3H, MeO), 4.91 (m, 1H, $J_{3a,4}$ = 12.5 Hz, H-4), 5.31 (dd, 1H, $J_{6,7}$ = 1.2 Hz, $J_{7,8}$ = 7.9 Hz, H-7), and 5.54 (m, 1H, H-8); GlcNAc unit δ 0.97 (m, 2H, $Me_3SiCH_2CH_2$), 3.61 (m, 1H, $Me_3SiCH_2CH_2$), 4.48 (d, 1H, $J_{1,2}$ = 7.7 Hz, H-1), 5.09 (t, 1H, $J_{3,4}$ = $J_{4,5}$ = 8.1 Hz, H-4), and 7.34-8.04 (m, 5H, Ph); other groups δ 1.87, 2.02 (2s, 6H, 2AcN), 2.06 (2), 2.15, 2.19 (2) (5s, 15H, 5AcO), and 6.24, 6.48 (2d, 2H, 2NH).

Anal. Calcd for $C_{42}H_{60}N_2O_{20}Si$ (941.0): C, 53.60; H, 6.43; N, 2.98. Found: C, 53.58; H, 6.45; N, 2.71.

2-(Trimethylsilyl)ethyl *O*-(Methyl 5-Acetamido-4,7,8,9-tetra-*O*-acetyl-3,5-dideoxy-D-glycero-α-D-galacto-2-nonulopyranosylonate)-(2→3)-2-acetamido-6-*O*-benzoyl-2-deoxy-β-D-galactopyranoside (14). Glycosylation of **9** (100 mg, 0.23 mmol) with **1** (250 mg, 0.48 mmol) in acetonitrile (3 mL) and tetrahydrofuran (3 mL) in the presence of DMTST (170 mg) and molecular sieves 3Å (670 mg), as described for **10**, afforded **14** (98 mg, 46%) as an amorphous mass: $[\alpha]_D$ -30.5° (*c* 0.5, $CHCl_3$); ^1H NMR ($CDCl_3$) Neu5Ac unit δ 2.66 (dd, 1H, $J_{3a,3e}$ = 12.5 Hz, $J_{3e,4}$ = 4.4 Hz, H-3e), 3.71 (s, 3H, MeO), 4.80 (m, 1H, H-4), 5.26 (dd, 1H, $J_{6,7}$ = 2.6 Hz, $J_{7,8}$ = 9.5 Hz, H-7), and 5.71 (m, 1H, H-8); GalNAc unit δ 0.92 (m, 2H, $Me_3SiCH_2CH_2$), 3.60 (m, 1H, $Me_3SiCH_2CH_2$), and 7.40-8.05 (m, 5H, Ph); other groups δ 1.87, 2.03 (2s, 6H, 2AcN), 2.03, 2.14 (3) (4s, 12H, 4AcO), and 5.69, 5.94 (2d, 2H, NH).

Anal. Calcd for $C_{40}H_{58}N_2O_{19}Si$ (899.0): C, 53.44; H, 6.50; N, 3.12. Found: C, 53.51; H, 6.73; N, 3.05.

A sample of **14** (70 mg, 0.078 mmol) was acetylated with acetic anhydride (1 mL)-pyridine (2 mL), as described for **11**, to give **15** (73 mg, quantitative) as an amorphous mass: ^1H NMR ($CDCl_3$) Neu5Ac unit δ 2.58 (dd, 1H, $J_{3a,3e}$ = 12.8 Hz, $J_{3e,4}$ = 4.4 Hz, H-3e), 3.74 (s, 3H, MeO), 4.34 (dd, 1H, $J_{8,9'}$ = 2.2 Hz, $J_{9,9'}$ = 11.7 Hz, H-9), 4.85 (m, 1H, $J_{3a,4}$ = 12.5 Hz, H-4), 5.25 (dd, 1H, $J_{6,7}$ = 2.4 Hz, $J_{7,8}$ = 9.2 Hz, H-7), and 5.67 (m, 1H, H-8); GalNAc unit δ 1.00 (m, 2H, $Me_3SiCH_2CH_2$), 3.62 (m, 1H, $Me_3SiCH_2CH_2$), 4.48 (d, 1H, $J_{1,2}$ = 7.7 Hz, H-1), 4.95 (broad s, 1H, H-4), and 7.34-8.04 (m, 5H, Ph); other groups δ 1.84, 2.00, (2s, 6H, 2AcN), 2.03, 2.12 (2), 2.14 (2) (5s, 15H, 5AcO).

Anal. Calcd for $C_{42}H_{60}N_2O_{20}Si$ (941.0): C, 53.60; H, 6.43; N, 2.98. Found: C, 53.74; H, 6.33; N, 2.96.

ACKNOWLEDGMENT

This work was supported in part by a Grant-in-Aid (No. 03255207) for the Scientific Research on Priority Areas from the Ministry of Education, Science and Culture of Japan.

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