

Supporting Information for

Stereoselective Synthesis of 2,3-Unsaturated-1,6-Oligosaccharides by Means of a Glycal-derived Allyl Epoxide and *N*-Nosyl Aziridine

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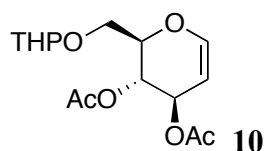
General Procedures. All reactions were performed in flame-dried modified Schlenk (Kjeldahl shape) flasks fitted with a glass stopper or rubber septa under a positive pressure of argon. Air- and moisture-sensitive liquids and solutions were transferred via a syringe. Organic solutions were dried on MgSO₄ and concentrated by a rotary evaporator below 40°C at *ca.* 25 Torr. Flash column chromatography was performed employing 230-400 mesh silica gel (Macherey-Nagel). Analytical TLC was performed on Alugram SIL G/UV₂₅₄ silica gel sheets (Macherey-Nagel) with detection by 0.5% phosphomolybdic acid solution in 95% EtOH.

Materials. Tri-*O*-acetyl-D-glucal, TBDMS-Cl, 1.0 M TBAF in THF were purchased from Aldrich and used without purification. CCL lipase (lipase from *Candida Cylindracea*), MsCl, anhydrous MeCN over molecular sieves, anhydrous pyridine over molecular sieves, anhydrous DMF over molecular sieves, and *t*-BuOK were purchased from Fluka and used without purification. Tetramethylguanidinium azide (TMGA) was prepared as described.¹ *i*-PrOH and *t*-BuOH were distilled from calcium hydride at 760 Torr. Benzene, toluene, Et₂O and THF were distilled from sodium/benzophenone. Alcohol **9**,² *trans* hydroxy mesylate **14**³ and *trans* *N*-nosyl-*O*-mesylate **26**⁴ were prepared as previously described.

Instrumentation. Infrared (IR) spectra were obtained using a FTIR spectrophotometer. Data are presented as frequency of absorption (cm⁻¹). Proton and carbon-13 nuclear magnetic resonance (¹H NMR and ¹³C NMR) spectra were recorded at 250 and 62.5 MHz, respectively; chemical shifts are expressed in parts per million (□ scale) downfield from tetramethylsilane and refer to residual protium in the NMR solvent (CHCl₃: □ 7.26; CD₃CN: □ 1.94). Data are presented as follows: chemical shift, multiplicity (s=singlet, d=doublet, t=triplet, m=multiplet and/or multiple resonances), integration, coupling constant in Hertz (Hz). Molecular weight of trisaccharides **5**, **5-triAc**, and **6** and disaccharides **34** and **36** were determined by flow injection analysis (FIA) on a 1100 MSD HP mass spectrometer (electrospray ionization): solvent: MeOH; flow: 0.3 mL/min; sample concentration: 0.1 mg/mL. Melting points are uncorrected.

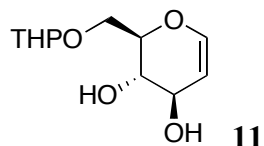
Synthesis of the glycosyl acceptor **7** (Scheme 3, text)

6-*O*-(2-Tetrahydropyranyl)-3,4-di-*O*-acetyl-D-glucal (**10**)



A solution of PPTS (0.54 g, 2.15 mmol) in anhydrous CH_2Cl_2 (150 mL) was added dropwise at room temperature to a stirred solution of alcohol **9** (4.95 g, 21.50 mmol)² in DHP (2.92 mL, 32.2 mmol) and the reaction mixture was stirred at same temperature for 16 h. Dilution with CH_2Cl_2 and evaporation of the washed (saturated aqueous NaHCO_3 and saturated aqueous NaCl) organic solution afforded a crude reaction product (6.70 g) consisting of **10** (^1H NMR), which was subjected to flash chromatography. Elution with an 8:2 hexane/AcOEt mixture yielded the THP-derivative **10** (5.18 g, 77% yield), pure as a liquid: $R_f = 0.16$ (8:2 hexane/AcOEt); FTIR (neat film) \square 1743, 1471, 1238, 1033 cm^{-1} . ^1H NMR (CDCl_3) \square 6.48 (dt, 1H, $J = 6.0, 1.3$ Hz), 5.17-5.38 (m, 2H), 4.75-4.85 (m, 1H), 4.53-4.70 (m, 1H), 4.17-4.30 (m, 1H), 3.69-4.00 (m, 2H), 3.40-3.68 (m, 2H), 2.06 and 2.07 (two singlets corresponding to two diastereoisomers, 3H), 2.03 and 2.04 (two singlets corresponding to two diastereoisomers, 3H), 1.43-1.92 (m, 6H). ^{13}C NMR (CDCl_3) \square 170.4, 169.5, 145.8, 99.3, 99.2, 98.6, 98.4, 75.3, 75.1, 74.9, 74.7, 67.7, 67.4, 65.3, 64.8, 62.1, 61.7, 30.3, 25.3, 21.0, 20.8, 19.2, 19.0. Anal. Calcd for $\text{C}_{15}\text{H}_{22}\text{O}_7$: C, 57.32; H, 7.05. Found: C, 57.38; H, 7.23.

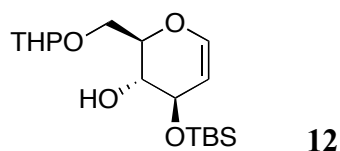
6-*O*-(2-Tetrahydropyranyl)-D-glucal (**11**)



A solution of diacetate **10** (0.377 g, 1.20 mmol) in MeOH (4.3 mL) was treated with MeONa (0.009 g, 0.167 mmol) and the reaction mixture was stirred for 2 h at room temperature. Evaporation of the organic solvent afforded a crude liquid product (0.248 g, 90% yield) consisting of diol **11**, practically pure, as a liquid: $R_f = 0.10$ (8:2 $\text{CH}_2\text{Cl}_2/\text{AcOEt}$); FTIR (neat film) \square 3398, 1647, 1350, 1232, 1126, 1080, 1026 cm^{-1} . ^1H NMR (CDCl_3) \square 6.27 (dt, 1H, $J =$

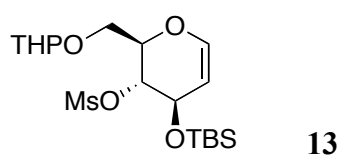
6.0, 1.9 Hz), 4.65 (dt, 1H, $J = 6.0, 1.5$ Hz), 4.45-4.62 (m, 1H), 3.37-4.31 (m, 9H), 1.38-1.84 (m, 6H). ^1H NMR (CD_3CN) \square 6.29 (d, 1H, $J = 6.0$ Hz), 4.65 (dd, 1H, $J = 6.0, 1.6$ Hz), 4.54-4.60 (m, 1H), 4.13-4.38 (m, 9H), 1.41-1.80 (m, 6H). ^{13}C NMR (CDCl_3) \square 144.3, 144.2, 103.2, 102.8, 100.8, 100.7, 99.4, 77.5, 77.1, 76.6, 69.6, 69.5, 69.4, 66.7, 66.4, 64.4, 62.6, 31.1, 30.8, 30.4, 25.3, 25.1, 21.3, 20.6, 19.5. ^{13}C NMR (CD_3CN) \square 144.4, 144.3, 104.7, 104.6, 103.7, 103.5, 102.4, 100.1, 78.7, 78.6, 78.5, 78.0, 75.2, 69.5, 68.6, 67.3, 66.8, 65.6, 65.4, 63.4, 62.8, 31.9, 31.8, 31.4, 31.2, 26.1, 26.0, 20.6, 20.3. Anal. Calcd for $\text{C}_{11}\text{H}_{18}\text{O}_5$: C, 57.38; H, 7.88. Found: C, 56.99; H, 7.95.

6-*O*-(2-Tetrahydropyranyl)-3-*O*-(*t*-butyldimethylsilyl)-*D*-glucal (**12**)



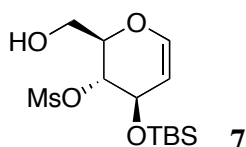
A solution of diol **11** (0.278 g, 1.21 mmol) in anhydrous DMF (3.5 mL) was treated with imidazole (0.165 g, 2.4 mmol) and TBDMS-Cl (0.20 g, 1.33 mmol) and the reaction mixture was stirred 24 h at room temperature. Dilution with CH_2Cl_2 and evaporation of the washed (saturated aqueous NaCl) organic solvent afforded a crude product (0.395 g, 95% yield) consisting of TBS-derivative **12**, practically pure, as a liquid, which was used in the next step without any further purification. An analytical sample of crude **12** was purified by flash chromatography. Elution with a 8:2 hexane/AcOEt mixture afforded pure alcohol **12** as a liquid: $R_f = 0.24$ (8:2 hexane/AcOEt); FTIR (neat film) \square 3425, 1660, 1464, 1251, 1126, 1080, 1026 cm^{-1} . ^1H NMR (CDCl_3) \square 6.30 (d, 1H, $J = 6.0$ Hz), 4.52-4.74 (m, 2H), 4.17-4.34 (m, 1H), 3.67-4.11 (m, 5H), 3.43-3.59 (m, 1H), 1.41-1.92 (m, 6H), 0.91 (s, 9H), 0.12 (s, 6H). ^{13}C NMR (CDCl_3) \square 143.8, 143.6, 104.5, 104.4, 103.6, 100.6, 100.5, 99.6, 99.5, 77.4, 71.1, 70.4, 70.2, 70.0, 66.9, 66.6, 66.1, 65.2, 64.1, 62.6, 30.9, 30.6, 26.5, 26.4, 26.1, 26.0, 20.6, 19.7, 18.4, 18.2, -4.3, -4.2. Anal. Calcd for $\text{C}_{17}\text{H}_{32}\text{O}_5\text{Si}$: C, 59.27; H, 9.36. Found: C, 59.65; H, 8.95.

6-*O*-(2-Tetrahydropyranyl)-3-*O*-(*t*-butyldimethylsilyl)-4-*O*-mesyl-*D*-glucal (**13**)



A solution of the alcohol **12** (0.344 g, 1.0 mmol) in anhydrous pyridine (2.2 mL) was treated at 0°C with MsCl (0.32 mL, 4.0 mmol) and the reaction mixture was stirred 18 h at the same temperature. Dilution with AcOEt and evaporation of the washed (saturated aqueous NaCl) organic solvent afforded a crude product (0.401 g, 95% yield) consisting of mesylate **13**, practically pure, as a liquid, which was used in the next step without any further purification. An analytical sample of crude **13** was subjected to flash chromatography. Elution with an 8:2 hexane/AcOEt mixture afforded pure mesylate **13**, as a liquid: $R_f = 0.32$ (7:3 hexane/AcOEt); FTIR (neat film) ν 1647, 1471, 1361, 1253, 1178, 1074, 956 cm^{-1} . ^1H NMR (CDCl_3) δ 6.35 (d, 1H, $J = 5.5$ Hz), 4.68-4.85 (m, 2H), 4.57-4.65 (m, 1H), 4.22-4.38 (m, 2H), 3.68-4.03 (m, 3H), 3.40-3.54 (m, 1H), 3.07 and 3.05 (two singlets corresponding to two diastereoisomers, 3H), 1.41-1.91 (m, 6H), 0.80 (s, 9H), 0.05 (s, 6H). ^{13}C NMR (CDCl_3) δ 143.5, 101.5, 99.5, 99.4, 99.1, 99.0, 98.6, 98.5, 77.7, 76.4, 75.6, 74.8, 65.4, 64.9, 64.8, 64.7, 63.3, 62.4, 62.3, 38.9, 38.8, 30.9, 30.3, 30.4, 25.7, 25.3, 19.8, 19.4, 17.9, -4.5, -4.6, -4.7. Anal. Calcd for $\text{C}_{18}\text{H}_{34}\text{O}_7\text{SSi}$: C, 51.16; H, 8.12. Found: C, 51.01; H, 7.94.

3-*O*-(*t*-Butyldimethylsilyl)-4-*O*-mesyl-D-glucal (**7**)

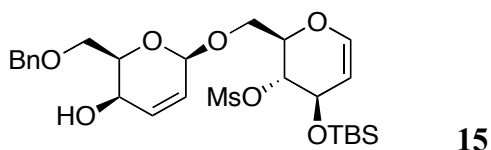


PPTS (0.030 g, 0.71 mmol) was added to a solution of mesylate **13** (0.050 g, 0.13 mmol) in absolute EtOH (6 mL) and the reaction mixture was carefully stirred 18 h at 35°C. After dilution with CH_2Cl_2 , solid NaHCO_3 was added until the solution turned out to be slightly basic. Evaporation of the organic solution afforded a crude reaction product (0.24 g) consisting of alcohol **7**, which was subjected to flash chromatography. Elution with a 6:4 hexane/AcOEt mixture yielded alcohol **7** (0.17 g, 71% yield), pure as a liquid: $[\alpha]_D^{20} -31.9$ (c 1.8, CHCl_3); $R_f = 0.29$ (6:4 hexane/AcOEt); FTIR (neat film) ν 3493, 1643, 1473, 1359, 1253, 1176 cm^{-1} . ^1H NMR (CDCl_3) (dd, 1H, $J = 6.1, 1.0$ Hz), 4.66-4.76 (m, 2H), 4.34-4.40 (m, 1H), 4.04-4.12 (m, 1H), 3.73-3.98 (m, 2H), 3.10 (s, 3H), 2.79 (dd, 1H, $J = 8.0, 6.0$ Hz), 0.86 (s, 9H), 0.09 (s, 6H). ^{13}C NMR (CDCl_3) δ 144.0, 101.4, 76.3, 75.5, 65.7, 60.5, 38.5, 25.6, 17.7, -4.6, -4.7. Anal. Calcd for $\text{C}_{13}\text{H}_{26}\text{O}_6\text{SSi}$: C, 46.13; H, 7.74. Found: C, 46.46; H, 7.65.

Synthesis of trisaccharide **5** through acetylated compounds

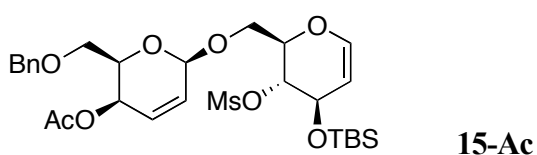
(Scheme 4, text)

6-*O*-[6'-*O*-(benzyl)-2',3'-dideoxy- β -D-*threo*-hex-2'-enopyranosyl]-4-*O*-mesyl-3-*O*-(*t*-butyldimethylsilyl)-D-glucal (**15**)



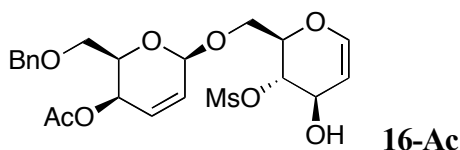
A solution of *trans* hydroxy mesylate **14** (0.125 g, 0.40 mmol)³ in anhydrous THF (3.5 mL) was treated with *t*-BuOK (0.045 g, 0.40 mmol) and the reaction mixture was stirred at room temperature for 30 min. Alcohol **7** (0.27 g, 0.80 mmol, 2 equiv) was added and the reaction mixture was stirred 18 h at room temperature. Dilution with CH₂Cl₂ and evaporation of the washed (saturated aqueous NaCl) organic solution afforded a crude product (0.34 g) consisting of a mixture of β -*O*-glycoside **15** and unreacted alcohol **7** (¹H NMR) which was subjected to flash chromatography. Elution with a 9:1 CH₂Cl₂/AcOEt mixture yielded β -*O*-glycoside **15** (0.160 g, 72% yield), pure as a liquid: [α]_D²⁰ -33.1 (*c* 2.2, CHCl₃); *R*_f = 0.24 (9:1 CH₂Cl₂/AcOEt); FTIR (neat film) $\bar{\nu}$ 3420, 1647, 1464, 1357, 1257, 1186, 1099, 1066, 968 cm⁻¹. ¹H NMR (CDCl₃) δ 7.34 (s, 5H), 6.37 (dd, 1H, *J* = 6.3, 1.0 Hz), 6.14 (ddd, 1H, *J* = 10.1, 5.0, 1.4 Hz), 5.90 (d, 1H, *J* = 10.1 Hz), 5.13 (dd, 1H, *J* = 2.8, 1.4 Hz), 4.73-4.81 (m, 2H), 4.58 (s, 2H), 4.28-4.38 (m, 2H), 4.05-4.16 (m, 1H), 3.62-4.01 (m, 6H), 3.07 (s, 3H), 0.89 (s, 9H), 0.11 (s, 6H). ¹³C NMR (CDCl₃) δ 143.6, 138.1, 130.9, 130.6, 128.5, 127.8, 101.8, 98.4, 77.3, 75.5, 74.5, 73.7, 69.7, 66.6, 65.4, 62.8, 39.1, 25.9, 18.0, -4.3, -4.4. Anal. Calcd for C₂₆H₄₀O₉SSi: C, 56.09; H, 7.24. Found: C, 56.01, H, 7.55.

6-*O*-[6'-*O*-(benzyl)-4'-*O*-acetyl-2',3'-dideoxy- β -D-*threo*-hex-2'-enopyranosyl]-4-*O*-mesyl-3-*O*-(*t*-butyldimethylsilyl)-D-glucal (**15-Ac**)



A solution of *O*-glycoside **15** (0.153 g, 0.28 mmol) in anhydrous pyridine (1.8 mL) was treated at 0°C with Ac₂O (0.6 mL) and the reaction mixture was stirred at room temperature for 16 h. Dilution with toluene and evaporation of the organic solution afforded a crude product (0.16 g, 99% yield) consisting of acetate **15-Ac**, practically pure as a liquid: $[\alpha]_D^{20}$ -87.4 (*c* 0.7, CHCl₃); R_f = 0.42 (6:4 hexane/AcOEt); FTIR (neat film) ν 1739, 1655, 1464, 1357, 1244, 1178, 1093, 1066, 960 cm⁻¹. ¹H NMR (CDCl₃) δ 7.26-7.42 (m, 5H), 6.39 (d, 1H, *J* = 6.0 Hz), 6.12 (ddd, 1H, *J* = 10.1, 4.7, 1.1 Hz), 6.01 (d, 1H, *J* = 10.1 Hz), 5.18 (s, 1H), 5.09-5.15 (m, 1H), 4.79 (dd, 2H, *J* = 6.0, 4.2 Hz), 4.60 (d, 1H, *J* = 12.0 Hz), 4.48 (d, 1H, *J* = 12.0 Hz), 4.35-4.43 (m, 1H), 4.28-4.34 (m, 1H), 4.12 (dd, 1H, *J* = 11.4, 2.8 Hz), 3.91-4.05 (m, 2H), 3.64 (d, 1H, *J* = 6.3 Hz), 3.07 (s, 3H), 2.00 (s, 3H), 0.90 (s, 9H), 0.13 (s, 6H). ¹³C NMR (CDCl₃) δ 170.6, 143.6, 138.0, 132.5, 129.1, 128.5, 128.3, 127.9, 127.8, 126.8, 125.4, 101.7, 98.1, 77.1, 75.4, 73.6, 72.6, 68.7, 66.5, 64.9, 64.0, 39.0, 25.8, 21.6, 21.0, 18.0, -4.4, -4.5. Anal. Calcd for C₂₈H₄₂O₁₀SSi: C, 56.16; H, 7.07. Found: C, 56.44; H, 6.81.

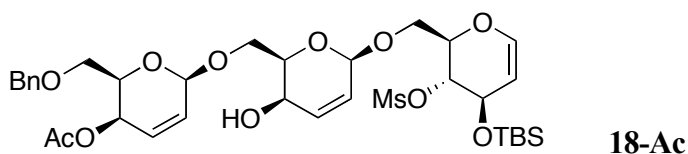
6-*O*-[6'-*O*-(benzyl)-4''-*O*-acetyl-2',3'-dideoxy- β -D-*threo*-hex-2'-enopyranosyl]-4-*O*-mesyl-D-glucal (16-Ac**)**



A solution of mesylate **15-Ac** (0.090 g, 0.15 mmol) in anhydrous THF (6.3 mL) was treated at 0°C with 1M TBAF in THF (0.15 mL). After 2h stirring at the same temperature, dilution with Et₂O and evaporation of the washed (saturated aqueous NaCl) organic solution afforded a crude product (0.071 g, 98% yield) consisting of *trans* hydroxy mesylate **16-Ac** which was used in the next step without any further purification. An analytical sample of crude **16-Ac** was purified by flash chromatography. Elution with a 6:4 hexane/AcOEt mixture afforded pure **16-Ac** as a liquid: R_f = 0.10 (6:4 hexane/AcOEt); FTIR (neat film) ν 3420, 1734, 1460, 1371, 1261, 1176, 1080, 1041, 1020, 960 cm⁻¹. ¹H NMR (CDCl₃) δ 7.27-7.40 (m, 5H), 6.37 (dd, 1H, *J* = 6.0, 1.0 Hz), 6.10 (ddd, 1H, *J* = 10.1, 4.6, 1.0 Hz), 6.00 (d, 1H, *J* = 10.1 Hz), 5.19 (s, 1H), 5.06-5.13 (m, 1H), 4.91 (dd, 1H, *J* = 9.0, 6.5 Hz), 4.78 (dd, 1H, *J* = 6.0, 2.6 Hz), 4.60 (d, 1H, *J* = 12.0 Hz), 4.48 (d, 1H, *J* = 12.0 Hz), 4.40-4.44 (m, 1H), 4.22 (dd, 1H, *J* = 11.1, 2.8 Hz), 4.05-4.15 (m, 1H), 3.95-4.04 (m, 1H), 3.86 (dd, 1H, *J* = 11.1, 4.6 Hz), 3.55-3.77 (m, 3H) 3.17 (s, 3H), 1.99 (s, 3H). ¹³C NMR (CDCl₃) δ 170.7, 144.3, 142.2, 138.0,

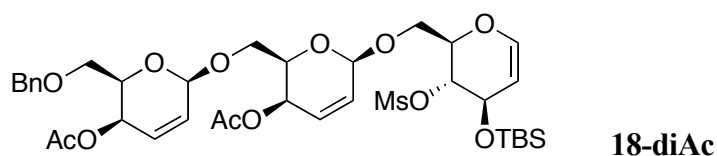
132.1, 128.5, 127.9, 127.8, 126.8, 102.8, 98.2, 78.8, 75.1, 73.6, 72.8, 68.9, 67.1, 66.4, 64.9, 64.1, 39.0, 19.8. Anal. Calcd for C₂₂H₂₈O₁₀S: C, 54.53; H, 5.83. Found: C, 54.23; H, 5.59.

6-O-[6'-O-[6''-O-(benzyl)-4-O-acetyl-2'',3''-dideoxy- α -D-threo-hex-2''-enopyranosyl]-2',3'-dideoxy- α -D-threo-hex-2'-enopyranosyl]-4-O-mesyl-3-O-(*t*-butyldimethylsilyl)-D-glucal (18-Ac)



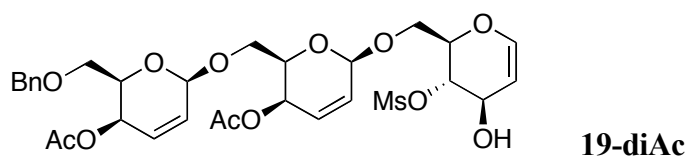
Following the same procedure used for the preparation of α -O-glycoside **15**, the treatment of a solution of *trans* hydroxy mesylate **16-Ac** (0.045 g, 0.093 mmol) in anhydrous MeCN (1 mL) with *t*-BuOK (0.011 g, 0.098 mmol, 1.05 equiv) in the presence of alcohol **7** (0.063 g, 0.186 mmol, 2 equiv) afforded, after 48 h stirring at room temperature, a crude product (0.092 g) consisting of α -O-glycoside **18-Ac** and unreacted alcohol **7** (¹H NMR) which was subjected to flash chromatography. Elution with a 1:1 hexane/AcOEt mixture yielded α -O-glycoside **18-Ac** (0.047 g, 70% yield), pure as a liquid: $[\alpha]_D^{20}$ -77.4 (*c* 0.8, CHCl₃); R_f = 0.17 (1:1 hexane/AcOEt); FTIR (neat film) ν 3431, 1739, 1655, 1464, 1363, 1251, 1178, 1112, 1066, 968 cm⁻¹. ¹H NMR (CDCl₃) δ 7.29-7.35 (m, 5H), 6.38 (d, 1H, *J* = 6.0 Hz), 6.05-6.17 (m, 2H), 5.97 (d, 1H, *J* = 10.2 Hz), 5.91 (d, 1H, *J* = 10.2 Hz), 5.18 (d, 1H, *J* = 1.0 Hz), 5.13 (d, 1H, *J* = 1.0 Hz), 5.07-5.12 (m, 1H), 4.73-4.81 (m, 2H), 4.60 (d, 1H, *J* = 12.0 Hz), 4.47 (d, 1H, *J* = 12.0 Hz), 4.29-4.38 (m, 2H), 4.05-4.14 (m, 2H), 3.76-4.04 (m, 6H), 3.58-3.69 (m, 2H), 3.07 (s, 3H), 2.00 (s, 3H), 0.90 (s, 9H), 0.12 (s, 6H). ¹³C NMR (CDCl₃) δ 170.7, 143.7, 138.2, 132.6, 130.8, 128.6, 128.0, 126.9, 102.0, 98.5, 98.2, 77.4, 75.7, 74.6, 73.7, 72.8, 68.8, 68.4, 66.5, 65.4, 64.1, 62.3, 39.2, 29.9, 29.5, 26.0, 22.9, 21.1, 18.2, 14.3, -4.3. Anal. Calcd for C₃₄H₅₀O₁₃SSi: C, 56.18; H, 6.93. Found: C, 56.39; H, 6.79.

6-O-[6'-O-[6''-O-(benzyl)-4''-O-acetyl-2'',3''-dideoxy- α -D-threo-hex-2''-enopyranosyl]-4'-O-acetyl-2',3'-dideoxy- α -D-threo-hex-2'-enopyranosyl]-4-O-mesyl-3-O-(*t*-butyldimethylsilyl)-D-glucal (18-diAc)



Following the same procedure previously used for the preparation of *O*-glycoside **15-Ac**, the treatment at 0°C of a solution of *O*-glycoside **18-Ac** (0.040 g, 0.055 mmol) in anhydrous pyridine (0.6 mL) with Ac₂O (0.12 mL) afforded a crude product (0.042 g, 99% yield) consisting of diacetate **18-diAc**, practically pure as a liquid: $[\alpha]_D^{20}$ -117.3 (*c* 0.6, CHCl₃); *R_f* = 0.22 (6:4 hexane/AcOEt); FTIR (neat film) $\bar{\nu}$ 1739, 1568, 1464, 1383, 1238, 1186, 1080, 1053, 968 cm⁻¹. ¹H NMR (CDCl₃) δ 7.27-7.38 (m, 5H), 6.37 (d, 1H, *J* = 6.0 Hz), 6.04-6.14 (m, 2H), 6.00 (d, 1H, *J* = 10.2 Hz), 5.93 (d, 1H, *J* = 10.2 Hz), 5.16 (s, 2H), 5.08-5.13 (m, 1H), 5.02-5.07 (m, 1H), 4.73-4.81 (m, 2H), 4.60 (d, 1H, *J* = 12.0 Hz), 4.48 (d, 1H, *J* = 12.0 Hz), 4.29-4.40 (m, 2H), 4.11 (dd, 1H, *J* = 11.4, 2.8 Hz), 3.88-4.05 (m, 4H), 3.76-3.86 (m, 1H), 3.59-3.69 (m, 2H), 3.08 (s, 3H), 2.04 (s, 3H), 2.00 (s, 3H), 0.90 (s, 9H), 0.12 (s, 6H). ¹³C NMR (CDCl₃) δ 170.6, 143.7, 138.2, 132.7, 132.5, 128.6, 128.0, 127.9, 126.9, 126.8, 102.0, 98.1, 98.0, 77.5, 77.4, 75.6, 73.7, 73.0, 72.8, 68.9, 67.5, 66.7, 65.4, 64.3, 64.2, 39.2, 32.1, 29.9, 26.0, 21.1, 21.0, 18.2, 1.2, -4.2, -4.3. Anal. Calcd for C₃₆H₅₂O₁₄SSi: C, 56.23; H, 6.82. Found: C, 56.12; H, 6.54.

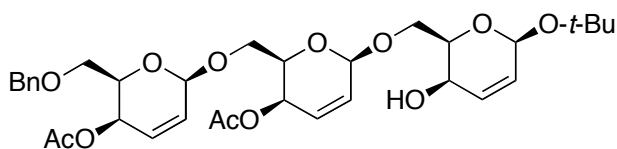
6-*O*-[6'-*O*-[6''-*O*-(benzyl)-4''-*O*-acetyl-2'',3''-dideoxy- β -D-*threo*-hex-2''-enopyranosyl]-4'-*O*-acetyl-2',3'-dideoxy- β -D-*threo*-hex-2'-enopyranosyl]-4-*O*-mesyl-D-glucal (19-diAc**)**



Following the same procedure used for the preparation of *trans* hydroxy mesylate **16-Ac**, the treatment of a solution of mesylate **18-diAc** (0.046 g, 0.060 mmol) in anhydrous THF (3 mL) with 1M TBAF in THF (0.06 mL) afforded, after 40 min at 0°C, a crude product (0.040 g) consisting of hydroxy mesylate **19-diAc** (¹H NMR) which was subjected to flash chromatography. Elution with a 3:7 hexane/AcOEt mixture yielded hydroxy mesylate **19-diAc** (0.029 g, 74% yield), pure as a liquid: $[\alpha]_D^{20}$ -132.9 (*c* 1.1, CHCl₃); *R_f* = 0.31 (3:7 hexane/AcOEt); FTIR (neat film) $\bar{\nu}$ 3398, 1739, 1655, 1469, 1377, 1238, 1178, 1069, 960 cm⁻¹. ¹H NMR (CDCl₃) δ 7.28-7.35 (m, 5H), 6.38 (dd, 1H, *J* = 6.0, 1.5 Hz), 6.04-6.13 (m, 2H),

6.01 (d, 1H, $J = 10.1$ Hz), 5.94 (d, 1H, $J = 10.1$ Hz), 5.18 (s, 2H), 5.07-5.13 (m, 1H), 5.02-5.07 (m, 1H), 4.88 (dd, 1H, $J = 9.3, 6.8$ Hz), 4.79 (dd, 1H, $J = 6.0, 2.6$ Hz), 4.58 (d, 1H, $J = 12.0$ Hz), 4.49 (d, 1H, $J = 12.0$ Hz), 4.46-4.50 (m, 1H), 4.21 (dd, 1H, $J = 11.2, 2.6$ Hz), 3.91-4.16 (m, 5H), 3.78-3.90 (m, 2H), 3.58-3.69 (m, 2H), 3.20 (s, 3H), 2.03 (s, 3H), 1.99 (s, 3H). ^{13}C NMR (CDCl_3) \square 170.7, 170.6, 144.8, 138.0, 132.6, 132.3, 128.6, 128.0, 127.9, 126.9, 126.8, 102.4, 98.0, 97.9, 78.8, 75.0, 73.7, 73.0, 72.7, 68.9, 67.8, 67.7, 66.2, 64.3, 64.2, 39.0, 21.2. Anal. Calcd for $\text{C}_{30}\text{H}_{38}\text{O}_{14}$: C, 55.04; H, 5.85. Found: C, 54.87; H, 5.71.

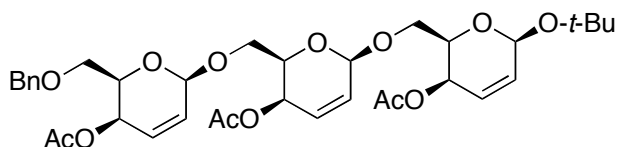
***t*-Butyl 6-*O*-[6'-*O*-[6''-*O*-(benzyl)-4''-*O*-acetyl-2'',3''-dideoxy- \square -D-*threo*-hex-2''-enopyranosyl]-4'-*O*-acetyl-2',3'-dideoxy- \square -D-*threo*-hex-2'-enopyranosyl]-2,3-dideoxy- \square -D-*threo*-hex-2-enopyranoside (5-diAc)**



5-diAc

A solution of *trans* hydroxy mesylate **19-diAc** (0.023 g, 0.035 mmol) in a 1:1 anhydrous *t*-BuOH/anhydrous MeCN mixture (0.8 mL) was treated with *t*-BuOK (0.005 g, 0.044 mmol, 1.3 equiv) and the reaction mixture was stirred 18 h at room temperature. Dilution with Et_2O and evaporation of the washed (saturated aqueous NaCl) organic solution afforded a crude product consisting of *t*-butyl \square -*O*-glycoside **5-diAc** (disaccharide **5-diAc**) (0.021 g, 94% yield), practically pure as a liquid: $[\alpha]_{\text{D}}^{20} -117.8$ (c 1.0, CHCl_3); $R_f = 0.36$ (4:6 hexane/AcOEt); FTIR (neat film) \square 3439, 1739, 1456, 1377, 1178, 1238, 1118, 1053 cm^{-1} . ^1H NMR (CDCl_3) \square 7.32 (s, 5H), 5.99-6.15 (m, 3H), 5.95 (dd, 2H, $J = 10.1, 4.4$ Hz), 5.75 (d, 1H, $J = 10.1$ Hz), 5.20 (s, 1H), 5.17 (s, 2H), 5.07-5.13 (m, 1H), 4.99-5.06 (m, 1H), 4.59 (d, 1H, $J = 12.0$ Hz), 4.49 (d, 1H, $J = 12.0$ Hz), 3.72-4.17 (m, 10H), 3.54-3.68 (m, 2H), 2.04 (s, 3H), 1.99 (s, 3H), 1.28 (s, 9H). ^{13}C NMR (CDCl_3) \square 170.7, 170.6, 144.8, 138.0, 132.6, 132.3, 128.6, 128.0, 127.9, 126.9, 126.8, 102.4, 98.0, 97.9, 78.8, 75.0, 73.7, 73.0, 72.7, 68.9, 67.8, 67.7, 66.2, 64.3, 64.2, 39.0, 21.2. Anal. Calcd. for $\text{C}_{33}\text{H}_{44}\text{O}_{12}$: C, 62.65; H, 7.01. Found: C, 62.48; H, 6.69.

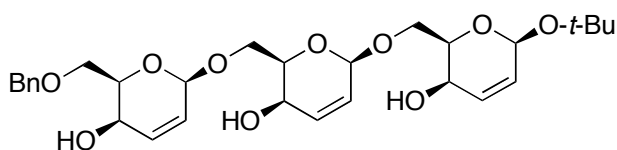
***t*-Butyl 6-*O*-[6'-*O*-[6''-*O*-(benzyloxy)-4''-*O*-acetyl-2'',3''-dideoxy- \square -D-*threo*-hex-2''-enopyranosyl]-4'-*O*-acetyl-2',3'-dideoxy- \square -D-*threo*-hex-2'-enopyranosyl]-4-*O*-acetyl-2,3-dideoxy- \square -D-*threo*-hex-2-enopyranoside (5-triAc)**



5-triAc

Following the typical procedure, a solution of *t*-butyl β -*O*-glycoside **5-diAc** (0.021 g, 0.033 mmol) in anhydrous pyridine (0.21 mL) was treated at 0°C with Ac₂O (55 μ L) and the reaction was stirred at room temperature for 16 h. Dilution with toluene and evaporation of the organic solution afforded a crude product (0.022 g, 97% yield) consisting of *t*-butyl β -*O*-glycoside **5-triAc** (trisaccharide **5-triAc**), practically pure as a liquid: $[\alpha]_D^{20}$ -206.1 (*c* 0.6, CHCl₃); *R_f* = 0.62 (4:6 hexane/AcOEt); FTIR (neat film) ν 1739, 1731, 1373, 1176, 1165, 1122, 1053 cm⁻¹. ¹H NMR (CDCl₃) δ 7.27-7.38 (m, 5H), 5.96-6.15 (m, 3H), 5.82-5.96 (m, 3H), 5.20 (s, 1H), 5.17 (broad s, 2H), 5.07-5.13 (m, 1H), 4.97-5.06 (m, 2H), 4.58 (d, 1H, *J* = 12.0 Hz), 4.49 (d, 1H, *J* = 12.0 Hz), 3.89-4.04 (m, 5H), 3.75-3.88 (m, 2H), 3.56-3.71 (m, 2H), 2.04 (s, 6H), 2.00 (s, 3H), 1.29 (s, 9H). ¹³C NMR (CDCl₃) δ 170.8, 170.7, 170.6, 138.0, 135.2, 132.7, 132.5, 129.2, 128.6, 128.4, 128.0, 127.9, 126.7, 125.9, 125.5, 98.2, 97.9, 92.7, 76.2, 73.7, 73.3, 72.9, 72.8, 68.9, 68.1, 67.5, 66.2, 64.2, 64.1, 64.0, 29.9, 28.8, 21.2, 21.1, 21.0. Anal. Calcd. for C₃₅H₄₆O₁₃: C, 62.30; H, 6.87. Found: C, 62.11; H, 6.72. MS, Calcd for [C₃₅H₄₆O₁₃ + Na⁺] = 697.3. Found 597.2.

***t*-Butyl 6-*O*-[6'-*O*-[6''-*O*-(benzyloxy)-2'',3''-dideoxy- β -D-*threo*-hex-2''-enopyranosyl]-2',3'-dideoxy- β -D-*threo*-hex-2'-enopyranosyl]-2,3-dideoxy- β -D-*threo*-hex-2-enopyranoside (5)**



5

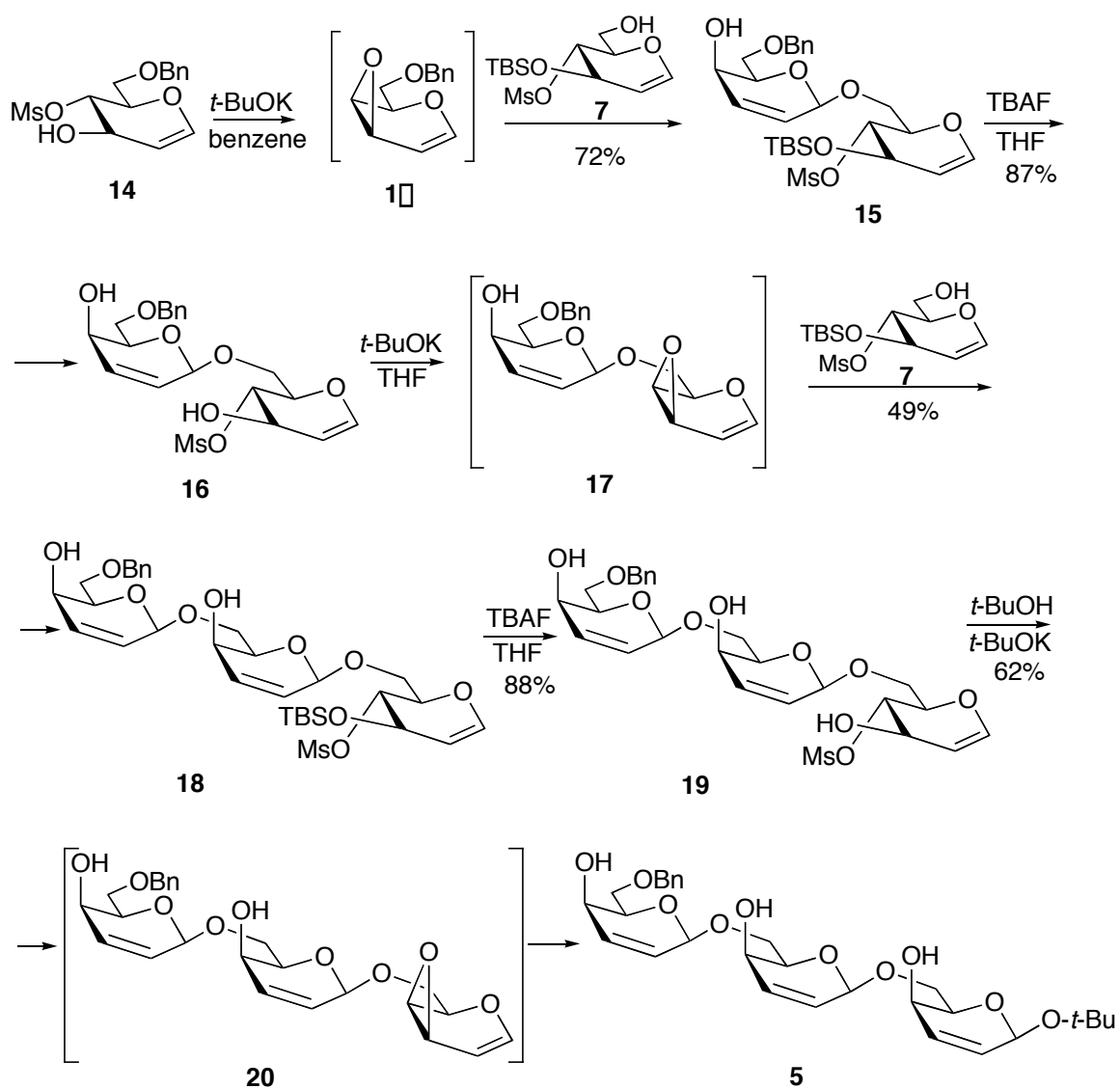
a) A solution of disaccharide **5-diAc** (0.020 g, 0.032 mmol) in MeOH (0.5 mL) was treated with MeONa (0.004 g, 0.032 mmol) and the reaction mixture was stirred 18 h at room temperature. Dilution with Et₂O and evaporation of the washed (saturated aqueous NaCl) organic solution afforded a crude liquid product (0.017 g, 97% yield) consisting of *t*-butyl β -*O*-glycoside **5** (trisaccharide **5**) (¹H NMR), practically pure as a liquid: $[\alpha]_D^{20}$ -39.2 (*c* 0.5, CHCl₃); *R_f* = 0.27 (3.6:6:0.4 hexane/AcOEt/MeOH); FTIR (neat film)

ν 3423, 1643, 1369, 1118, 1051 cm^{-1} . ^1H NMR (CDCl_3) δ 7.29-7.30 (m, 5H), 6.11-6.16 (m, 2H), 6.07 (dd, 1H, $J = 10.2, 3.6$ Hz), 5.88 (d, 1H, $J = 10.2$ Hz), 5.86 (d, 1H, $J = 10.2$ Hz), 5.76 (d, 1H, $J = 10.2$ Hz), 5.21 (s, 1H), 5.17 (s, 1H), 5.14 (s, 1H), 4.61 (d, 1H, $J = 12.0$ Hz), 4.58 (d, 1H, $J = 12.0$ Hz), 3.71-4.10 (m, 10H), 1.30 (s, 9H). ^{13}C NMR (CDCl_3) δ 138.1, 133.2, 131.1, 130.9, 130.7, 130.6, 130.1, 128.6, 128.1, 128.0, 98.8, 98.6, 93.0, 77.4, 75.0, 74.7, 74.4, 73.8, 69.9, 69.0, 68.5, 62.8, 62.5, 62.1, 29.9, 28.9. Anal. Calcd for $\text{C}_{29}\text{H}_{40}\text{O}_{10}$: C, 63.49; H, 7.35. Found: C, 63.80; H, 6.99. MS Calcd for $[\text{C}_{29}\text{H}_{40}\text{O}_{10} + \text{Cl}^-]$: 583.2. Found 583.3.

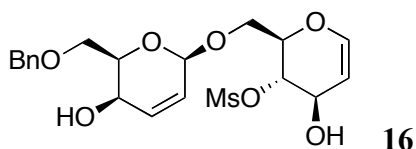
b) A solution of *t*-butyl trisaccharide **5-triAc** (0.020 g, 0.030 mmol) in MeOH (0.5 mL) was treated with MeONa (0.004 g, 0.074 mmol) and the reaction mixture was stirred 18 h at room temperature. Dilution with Et_2O and evaporation of the washed (saturated aqueous NaCl) organic solution afforded a crude liquid product (0.016 g, 97% yield) consisting of trisaccharide **5**, practically pure as a liquid.

**Synthesis of trisaccharide 5 through non-acetylated compounds
(Scheme 9)**

Scheme 9

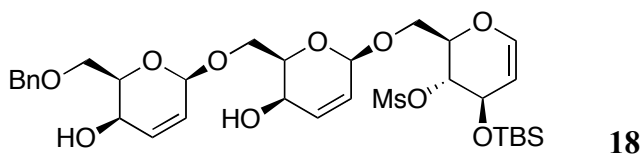


**6-O-[6'-O-(benzyl)-2',3'-dideoxy- β -D-threo-hex-2'-enopyranosyl]-4-O-mesyl-D-glucal
(16)**



A solution of α -*O*-glycoside **15**, prepared as described above, (0.117 g, 0.21 mmol) in anhydrous THF (10 mL) was treated at 0°C with 1M TBAF in THF (0.21 mL). After 30 min stirring at the same temperature, dilution with Et₂O and evaporation of the washed (saturated aqueous NaCl) organic solution afforded a crude product (0.081 g, 87% yield) consisting of *trans* hydroxy mesylate **16**, sufficiently pure to be utilized in the next step without any further purification. An analytical sample of crude **16** was subjected to flash chromatography. Elution with a 3:7 hexane/AcOEt mixture afforded pure *trans* hydroxy mesylate **16**, as a liquid: $[\alpha]_D^{20}$ -23.3 (*c* 0.5, CHCl₃); R_f = 0.20 (3:7 hexane/AcOEt); FTIR (neat film) ν 3421, 1639, 1464, 1344, 1263, 1174, 1087, 1031 cm⁻¹. ¹H NMR (CDCl₃) δ 7.35 (s, 5H), 6.29 (dd, 1H, *J* = 6.0, 1.5 Hz), 6.03 (ddd, 1H, *J* = 10.0, 5.0, 1.1 Hz), 5.83 (d, 1H, *J* = 10.0 Hz), 5.06 (d, 1H, *J* = 1.1 Hz), 4.84 (dd, 1H, *J* = 9.0, 6.7 Hz), 4.70 (dd, 1H, *J* = 6.0, 2.7 Hz), 4.53 (d, 1H, *J* = 12.0 Hz), 4.48 (d, 1H, *J* = 12.0 Hz), 4.29-4.35 (m, 1H), 4.15 (dd, 1H, *J* = 11.2, 2.8 Hz), 4.05-4.16 (m, 1H), 3.67-3.97 (m, 5H), 3.19 (s, 3H). ¹³C NMR (CDCl₃) δ 144.7, 137.9, 131.1, 130.5, 128.6, 128.0, 102.2, 98.6, 78.5, 75.0, 74.7, 73.7, 70.0, 67.6, 66.5, 63.0, 38.9. Anal. Calcd for C₂₀H₂₆O₉S: C, 54.29; H, 5.92. Found: C, 54.54; H, 5.99.

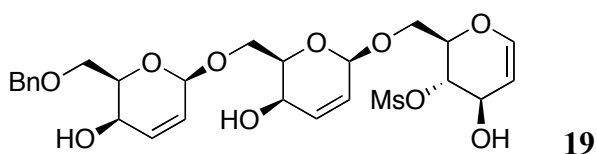
6-*O*-[6'-*O*-[6''-*O*-(benzyl)-2'',3''-dideoxy- α -D-threo-hex-2''-enopyranosyl]-2',3'-dideoxy- α -D-threo-hex-2'-enopyranosyl]-4-*O*-mesyl-3-*O*-(*t*-butyldimethylsilyl)-D-glucal (18**)**



Following the procedure previously used for the preparation of α -*O*-glycoside **15**, the treatment of a solution of *trans* hydroxy mesylate **16** (0.071 g, 0.16 mmol) in anhydrous THF (2 mL) with *t*-BuOK (0.019 g, 0.17 mmol) in the presence of alcohol **7** (0.108 g, 0.32 mmol, 2 equiv) afforded, after 18 h stirring at room temperature, a crude product (0.185 g) consisting of α -*O*-glycoside **18** and unreacted alcohol **7** (¹H NMR), which was subjected to flash chromatography. Elution with a 4:6 hexane/AcOEt mixture yielded α -*O*-glycoside **18** (0.054 g, 49% yield), pure as a liquid: R_f = 0.16 (4:6 hexane/AcOEt); FTIR (neat film) ν 3421, 1655, 1467, 1361, 1257, 1180, 1109, 1055, 960 cm⁻¹. ¹H NMR (CDCl₃) δ 7.28-7.41 (m, 5H), 6.38

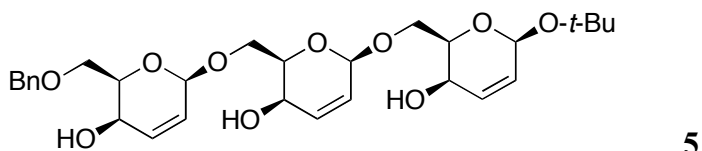
(dd, 1H, $J = 6.3, 0.9$ Hz), 6.09-6.18 (m, 2H), 5.88 (t, 2H, $J = 10.0$ Hz), 5.12-5.18 (m, 2H), 4.74-4.82 (m, 2H), 4.63 (d, 1H, $J = 12.0$ Hz), 4.55 (d, 1H, $J = 12.0$ Hz), 4.28-4.41 (m, 2H), 3.68-4.15 (m, 10H), 3.09 (s, 3H), 0.90 (s, 9H), 0.12 (s, 6H). ^{13}C NMR (CDCl_3) δ 143.7, 138.1, 131.0, 130.9, 130.8, 130.7, 128.0, 128.0, 127.9, 101.9, 98.6, 98.5, 77.4, 75.6, 74.5, 73.8, 69.7, 68.3, 66.6, 65.4, 62.9, 62.2, 39.2, 29.9, 25.9, 18.2, -4.2, -4.3. Anal. Calcd for $\text{C}_{32}\text{H}_{48}\text{O}_{12}\text{SSi}$: C, 56.12; H, 7.06. Found: C, 56.34; H, 7.41.

6-*O*-[6'-*O*-[6''-*O*-(benzyl)-2'',3''-dideoxy- β -D-threo-hex-2''-enopyranosyl]-2',3'-dideoxy- β -D-threo-hex-2'-enopyranosyl]-4-*O*-mesyl-D-glucal (19**)**



Following the same procedure previously used for the preparation of *trans* hydroxy mesylate **16**, the treatment of a solution of β -*O*-glycoside **18** (0.035 g, 0.052 mmol) in anhydrous THF (3 mL) with 1M TBAF in THF (52 μL) afforded, after 30 min at 0°C , a crude product (0.026 g, 88% yield) consisting of *trans* hydroxy mesylate **19**, sufficiently pure to be used in the next step without any further purification: $R_f = 0.32$ (3:6:1 hexane/AcOEt/MeOH); FTIR (neat film) δ 3393, 1467, 1384, 1190, 1089, 972 cm^{-1} . ^1H NMR (CDCl_3) δ 7.27-7.34 (m, 5H), 6.28 (d, 1H, $J = 6.0$ Hz), 6.00-6.16 (m, 2H), 5.72-5.92 (m, 2H), 5.03-5.16 (m, 2H), 4.80-4.90 (m, 1H), 4.54 (s, 2H), 3.63-4.27 (m, 13H), 3.26 (s, 3H).

Trisaccharide 5

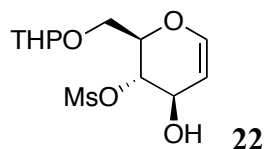


A solution of *trans* hydroxy mesylate **19** (0.020 g, 0.035 mmol) in anhydrous *t*-BuOH (0.5 mL) was treated with *t*-BuOK (0.005 g, 0.044 mmol) and the reaction mixture was stirred 18 h at room temperature. Dilution with Et_2O and evaporation of the washed (saturated aqueous NaCl) organic solution afforded a crude product (0.018 g) consisting of *t*-butyl β -*O*-glycoside **5** (trisaccharide **5**) (^1H NMR), which was subjected to flash chromatography. Elution with a

3.6:6:0.4 hexane/AcOEt/MeOH mixture afforded trisaccharide **5** (0.012 g, 62% yield), pure as a liquid.

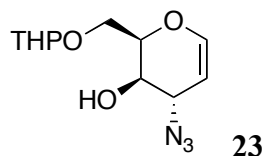
Synthesis of glycosyl acceptor **21** (Scheme 5, text)

6-*O*-(2-Tetrahydropyranyl)-4-*O*-mesyl-D-glucal (**22**)



Following the same procedure previously used for the preparation of *trans* hydroxy mesylate **16**, the treatment of a solution of mesylate **13** (1.0 g, 2.37 mmol) in anhydrous THF (83 mL) with 1M TBAF in THF (2.37 mL) afforded, after 45 min at 0°C, a crude product (0.82 g) consisting of **22**, which was subjected to flash chromatography. Elution with a 1:1 hexane/AcOEt mixture yielded *trans* hydroxy mesylate **22** (0.55 g, 75% yield), pure as a liquid: $R_f = 0.20$ (1:1 hexane/AcOEt); FTIR (neat film) \square 3421, 1639, 1464, 1344, 1263, 1174, 1087, 1031, 962 cm^{-1} . ^1H NMR (CDCl_3) \square 6.37 (d, 1H, $J = 5.9$ Hz), 4.72-4.85 (m, 2H), 4.58-4.65 (m, 1H), 4.38-4.46 (m, 1H), 3.59-4.12 (m, 4H), 3.39-4.58 (m, 2H), 3.19 and 3.17 (two singlets corresponding to two diastereoisomers, complexive 3H), 1.40-1.88 (m, 6H). ^{13}C NMR (CDCl_3) \square 144.7, 144.5, 108.2, 102.5, 102.4, 99.6, 99.5, 99.4, 98.6, 79.5, 79.2, 75.3, 75.1, 67.4, 67.3, 65.5, 65.4, 63.4, 62.7, 62.4, 38.9, 38.6, 31.0, 30.5, 30.3, 25.7, 25.5, 25.4, 19.9, 19.5, 19.4, -3.5. Anal. Calcd for $\text{C}_{12}\text{H}_{20}\text{O}_7\text{S}$: C, 46.74; H, 6.54. Found: C, 46.92; H, 6.59.

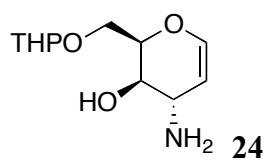
6-*O*-(2-Tetrahydropyranyl)-3-deoxy-3-azido-D-gulal (**23**)



A solution of *trans* hydroxy mesylate **22** (0.191 g, 0.62 mmol) in anhydrous MeCN (12 mL) was treated with *t*-BuOK (0.070 g, 0.62 mmol) in the presence of tetramethylguanidinium azide (TMGA) (0.293 g, 1.85 mmol, 3 equiv) and the reaction mixture was stirred 30 min at room temperature. Dilution with Et_2O and evaporation of the washed (saturated aqueous NaCl) organic solution afforded a crude product (0.153 g, 97% yield) consisting of *trans* azido alcohol **23** which was used in the next step without any further purification. An analytical sample of crude **23** was subjected to flash chromatography. Elution with a 1:1 hexane/AcOEt mixture afforded pure *trans* azido alcohol **23**, as a liquid: $R_f = 0.41$ (1:1 hexane/AcOEt); FTIR

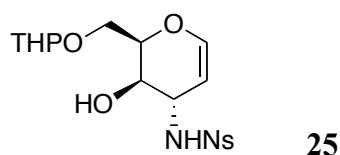
(neat film) \square 3458, 2104, 1655, 1357, 1026 cm^{-1} . ^1H NMR (CDCl_3) \square 6.70 (d, 1H, $J = 6.1$ Hz), 4.72-4.98 (m, 2H), 4.64 (d, 1H, $J = 2.1$ Hz), 4.13-4.93 (m, 3H), 3.52 (dd, 3H, $J = 10.2$, 4.7 Hz), 3.19 (d, 1H, $J = 4.7$ Hz), 1.44-1.84 (m, 6H). ^{13}C NMR (CDCl_3) \square 148.2, 110.3, 102.4, 99.4, 99.3, 98.7, 98.6, 95.2, 95.0, 72.1, 71.8, 68.6, 68.1, 67.8, 67.4, 63.5, 62.7, 62.4, 55.7, 55.6, 31.1, 30.5, 30.3, 29.8, 25.9, 25.8, 25.7, 25.6, 25.4, 25.3, 19.9, 19.5, 19.3, 9.7, 1.1.

6-*O*-(2-Tetrahydropyranyl)-3-deoxy-3-amino-D-gulal (**24**)



A solution of *trans* azido alcohol **23** (0.62 g, 2.43 mmol) in anhydrous THF (4.3 mL) was treated at 0°C with LiAlH_4 (0.138 g, 3.65 mmol), added in two portions, and the reaction mixture was stirred for 3 h at room temperature. The reaction mixture was diluted with Et_2O and carefully treated with H_2O and 10% aqueous NaOH in order to destroy the excess of hydride. Evaporation of the filtered organic solvent afforded a crude product (0.517 g, 93% yield) consisting of *trans* amino alcohol **24**, practically pure as a liquid, which was used in the next step without any further purification: $R_f = 0.11$ (9:1 $\text{CH}_2\text{Cl}_2/\text{MeOH}$); FTIR (neat film) \square 3360, 1641, 1595, 1464, 1377, 1251, 1118, 1080, 1033 cm^{-1} . ^1H NMR (CDCl_3) \square 6.59 (d, 1H, $J = 6.0$ Hz), 4.93-5.04 (m, 1H), 4.59-4.71 (m, 1H), 4.27-4.43 (m, 2H), 3.96-4.10 (m, 1H), 3.69-3.93 (m, 3H), 3.41-3.57 (m, 1H), 1.31-1.87 (m, 8H). ^{13}C NMR (CDCl_3) \square 145.4, 129.2, 127.5, 127.1, 108.1, 100.9, 100.8, 99.6, 99.5, 99.4, 99.3, 99.1, 72.1, 71.7, 71.6, 70.9, 70.2, 67.5, 62.6, 62.4, 47.8, 30.6, 30.4, 25.3, 20.9, 19.5, 19.4.

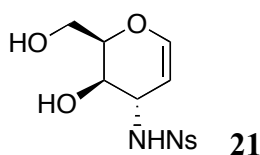
6-*O*-(2-Tetrahydropyranyl)-3-deoxy-3-(*N*-nosylamino)-D-gulal (**25**)



A solution of *trans* amino alcohol **24** (0.426 g, 1.85 mmol) in anhydrous CH_2Cl_2 (8 mL) was treated with NsCl (0.448 g, 2.04 mmol) in the presence of Et_3N (0.28 mL, 2.04 mmol) and the reaction mixture was stirred 4 h at room temperature. Dilution with CH_2Cl_2 and evaporation of the washed (saturated aqueous NaHCO_3 and saturated aqueous NaCl) organic solution

afforded a crude product (0.75 g, 98% yield) consisting of *trans* *N*-nosylamino alcohol **25**, sufficiently pure to be utilized in the next step without any further purification. An analytical sample of crude **25** was purified by flash chromatography. Elution with a 2:4:4 hexane/AcOEt/CH₂Cl₂ mixture afforded pure **25** as a semisolid: $R_f = 0.43$ (1:1 CH₂Cl₂/AcOEt); FTIR (neat film) $\bar{\nu}$ 3458, 1655, 1535, 1450, 1244, 1033 cm⁻¹. ¹H NMR (CDCl₃) δ 8.15-8.25 (m, 1H), 7.94-7.92 (m, 1H), 7.71-7.82 (m, 2H), 6.54 (d, 1H, $J = 5.9$ Hz), 5.93 (broad s, 1H, NH), 4.61-4.69 (m, 1H), 4.50 (t, 1H, $J = 5.7$ Hz), 3.33-4.24 (m, 8H), 1.43-1.82 (m, 6H). ¹³C NMR (CDCl₃) δ 148.1, 148.0, 134.1, 133.7, 133.5, 133.2, 131.5, 131.4, 125.7, 99.3, 96.4, 71.5, 71.3, 70.1, 69.3, 68.3, 67.6, 62.6, 60.5, 50.2, 50.1, 30.4, 30.2, 29.8, 25.2, 19.4, 19.3. Anal. Calcd for C₁₇H₂₂N₂O₈S: C, 49.27; H, 5.35; N, 6.76. Found: C, 49.04; H, 5.67; N, 7.00.

3-Deoxy-3-(*N*-nosylamino)-D-gulal (**21**)

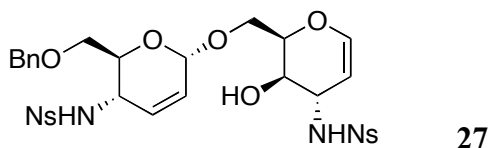


A solution of *trans* *N*-nosylamino alcohol **25** (0.360 g, 0.87 mmol) in absolute EtOH (7 mL) was treated with PPTS (0.022 g, 0.087 mmol) and the reaction mixture was carefully stirred at 35°C for 18 h. After dilution with CH₂Cl₂, solid NaHCO₃ was added under stirring in order to have a slightly alkaline solution. After 20 min stirring at room temperature, the suspension was filtered and the organic solution evaporated to dryness to give a crude solid product consisting of 1,3-diol **21** (0.282 g, 99% yield) which was subjected to flash chromatography. Elution with 1:1 CH₂Cl₂/AcOEt mixture afforded pure diol **21** (0.244 g, 85% yield), as a solid, mp 136-138°C: $[\alpha]_D^{20} +121.9$ (c 0.9, MeOH); $R_f = 0.21$ (1:1 CH₂Cl₂/AcOEt); FTIR (nujol) $\bar{\nu}$ 3346, 2723, 1645, 1455 cm⁻¹. ¹H NMR (CD₃CN) δ 8.07-8.15 (m, 1H), 7.80-7.89 (m, 3H), 6.49 (d, 1H, $J = 6.0$ Hz), 5.98 (broad s, 1H, NH), 4.49 (ddd, 1H, $J = 6.1, 5.3, 1.8$ Hz), 3.84-3.90 (m, 1H), 3.77-3.84 (m, 1H), 3.69-3.76 (m, 1H), 3.54 (dd, 1H, $J = 5.2, 2.3$ Hz), 3.46 (d, 2H, $J = 5.2$ Hz), 3.05 (t, 1H, $J = 5.6$ Hz). ¹³C NMR (CD₃CN) δ 147.9, 135.3, 134.4, 134.0, 131.5, 126.1, 97.5, 74.3, 69.4, 62.5, 51.3. Anal. Calcd for C₁₂H₁₄N₂O₇S: C, 43.64; H, 4.27; N, 8.48. Found: C, 43.82; H, 4.50; N, 8.88.

Synthesis of trisaccharide 6

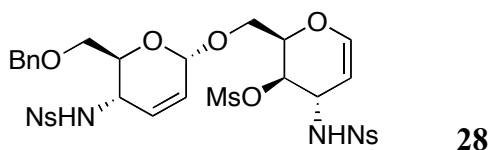
(Scheme 6, text)

6-*O*-[6'-*O*-(benzyl)-2',3',4'-trideoxy-4-*N*-(nosylamino)- β -D-erythro-hex-2'-enopyranosyl]-3-deoxy-3-*N*-(nosylamino)-D-gulal (27)



A solution of *trans* *N*-nosyl-*O*-mesylate **26** (0.201 g, 0.48 mmol)⁴ in anhydrous MeCN (28 mL) was treated with K₂CO₃ (0.20 g, 1.45 mmol, 3 equiv) in the presence of diol **21** (0.317g, 0.96 mmol, 2 equiv) and the reaction mixture was stirred at room temperature for 16 h. Dilution with AcOEt and evaporation of the washed (saturated aqueous NaCl) organic solution afforded a crude product (0.515 g) consisting of β -*O*-glycoside **27** and unreacted alcohol **21** (¹H NMR), which was subjected to flash chromatography. Elution with a 2:8 hexane/AcOEt mixture yielded β -*O*-glycoside **27** (0.260 g, 74% yield), pure as a liquid: [α]_D²⁰ +121.2 (*c* 0.1, CHCl₃); R_f = 0.36 (2:8 hexane/AcOEt); FTIR (neat film) ν 3367, 1597, 1462, 1384, 1261, 1194, 1076 cm⁻¹. ¹H NMR (CD₃CN) δ 8.02-8.13 (m, 2H), 7.68-7.87 (m, 6H), 7.21-7.39 (m, 5H), 6.44 (d, 1H, *J* = 6.2 Hz), 5.94-6.23 (m, 2H, NH), 5.73 (dt, 1H, *J* = 10.2, 2.5 Hz), 5.58 (d, 1H, *J* = 10.7 Hz), 4.97-5.06 (m, 1H), 3.32-4.64 (m, 13H). ¹³C NMR (CD₃CN) δ 144.8, 139.5, 135.4, 134.4, 134.3, 134.0, 133.3, 131.7, 131.6, 131.5, 131.4, 129.3, 128.6, 128.5, 128.2, 126.1, 126.0, 97.6, 95.2, 73.8, 70.0, 69.8, 69.0, 68.1, 61.0, 51.2, 49.6. Anal. Calcd for C₃₁H₃₂N₄O₁₃S₂: C, 52.84; H, 4.58; N, 3.98. Found: C, 53.01; H, 4.22; N, 3.69.

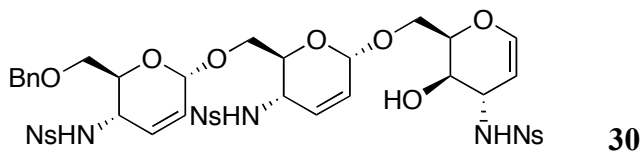
6-*O*-[6'-*O*-(benzyl)-2',3',4'-trideoxy-4-*N*-(nosylamino)- β -D-erythro-hex-2'-enopyranosyl]-4-*O*-mesyl-3-deoxy-3-*N*-(nosylamino)-D-gulal (28)



Following the same procedure previously used for the preparation of mesylate **13**, the treatment of a solution of β -*O*-glycoside **27** (0.302 g, 0.41 mmol) in anhydrous CH₂Cl₂ (3.0 mL) in the presence of anhydrous pyridine (0.1 mL, 1.24 mmol) with MsCl (0.06 mL, 0.82

mmol) afforded, after 16 h stirring at 0°C, a crude product consisting of mesylate **28** (0.312 g, 94% yield), sufficiently pure to be used in the next step without any further purification. An analytical sample of crude **28** was subjected to flash chromatography. Elution with a 4:6 hexane/AcOEt mixture afforded pure mesylate **28**, as a liquid: $[\alpha]_D^{20} +93.2$ (*c* 0.5, CHCl₃); $R_f = 0.22$ (4:6 hexane/AcOEt); FTIR (neat film) ν 3327, 1543, 1462, 1363, 1172, 1060, 960 cm⁻¹. ¹H NMR (CD₃CN) δ 8.02-8.15 (m, 2H), 7.66-7.96 (m, 6H), 7.23-7.41 (m, 5H), 6.53 (d, 1H, *J* = 5.9 Hz), 6.24-6.31 (m, 1H, NH), 6.16-6.24 (m, 1H, NH), 5.71 (dt, 1H, *J* = 10.2, 2.4 Hz), 5.54-5.63 (m, 1H), 4.98-5.03 (m, 1H), 4.83-4.89 (m, 1H), 4.60 (ddd, 1H, *J* = 6.1, 5.4, 1.8 Hz), 4.43 (d, 1H, *J* = 12.0 Hz), 4.35 (d, 1H, *J* = 12.0 Hz), 3.86-4.33 (m, 5H), 3.10 (s, 3H). ¹³C NMR (CD₃CN) δ 148.8, 138.1, 135.7, 135.4, 134.2, 134.0, 133.7, 132.0, 131.8, 131.7, 131.5, 129.3, 128.7, 128.5, 128.0, 126.4, 126.1, 97.0, 95.6, 75.8, 73.9, 75.1, 70.0, 69.9, 66.7, 49.6, 48.6, 38.6. Anal. Calcd for C₃₂H₃₄N₄O₁₅S₃: C, 47.40; H, 4.23; N, 6.91. Found: C, 47.69; H, 4.60; N, 7.17.

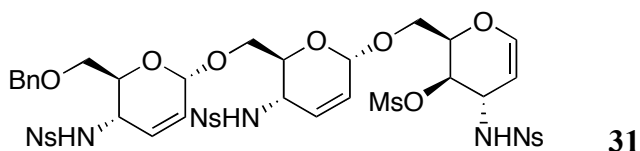
6-*O*-[6'-*O*-[6''-*O*-(benzyl)-2'',3'',4''-trideoxy-4''-*N*-(nosylamino)- β -D-erythro-hex-2''-enopyranosyl]-2',3',4'-trideoxy-4'-*N*-(nosylamino)- β -D-erythro-hex-2'-enopyranosyl]-3-deoxy-3-*N*-(nosylamino)-D-gulal (30**)**



Following the same procedure previously used for the preparation of β -*O*-glycoside **27**, the treatment of a solution of *trans N*-nosyl-*O*-mesylate **28** (0.31 g, 0.38 mmol) in anhydrous MeCN (23 mL) with K₂CO₃ (0.157 g, 1.14 mmol, 3 equiv) in the presence of diol **21** (0.376 g, 1.14 mmol, 3 equiv) afforded, after 24 h stirring at room temperature, a crude product (0.616 g) consisting of β -*O*-glycoside **30** and unreacted diol **21** (¹H NMR), which was subjected to flash chromatography. Elution with a 9:1 CH₂Cl₂/acetone mixture yielded pure β -*O*-glycoside **30** (0.257 g, 65% yield), pure as a solid, mp 103-105°C: $[\alpha]_D^{20} +153$ (*c* 0.5, CHCl₃); $R_f = 0.16$ (3:7 hexane/AcOEt); FTIR (nujol) ν 3298, 1647, 1539, 1458, 1375, 1344, 1257, 1174, 1122, 1060, 1043 cm⁻¹. ¹H NMR (CD₃CN) δ 8.01-8.15 (m, 3H), 7.75-7.91 (m, 9H), 7.22-7.41 (m, 5H), 6.46 (d, 1H, *J* = 5.6 Hz), 6.18 (d, 1H, *J* = 8.5 Hz, NH), 6.07 (d, 1H, *J* = 9.1 Hz, NH), 5.94 (d, 1H, *J* = 7.3 Hz, NH), 5.65-5.80 (m, 2H), 5.59 (d, 1H, *J* = 10.2 Hz), 5.48 (d, 1H, *J* = 10.2 Hz), 4.98 (d, 1H, *J* = 2.5 Hz), 4.94 (d, 1H, *J* = 2.5 Hz), 4.49 (ddd, 1H, *J* = 6.1, 5.4, 1.7 Hz), 4.38 (d, 1H, *J* = 12.0 Hz), 4.32 (d, 1H, *J* = 12.0 Hz), 4.09-4.22 (m, 1H), 3.84-4.08 (m,

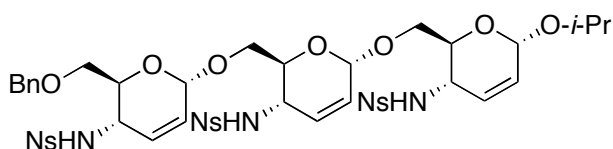
6H), 3.65-3.83 (m, 3H), 3.52-3.64 (m, 3H), 3.39 (d, 1H, $J = 6.0$ Hz). ^{13}C NMR (CD_3CN) \square 148.8, 148.7, 147.8, 139.6, 135.5, 135.4, 135.3, 134.6, 134.4, 134.2, 134.1, 134.0, 131.7, 131.6, 131.5, 131.4, 131.2, 129.3, 128.5, 128.4, 128.3, 126.2, 126.1, 126.0, 97.7, 95.1, 94.5, 73.7, 72.8, 69.8, 69.6, 69.0, 68.1, 67.5, 51.1, 50.0, 49.5, 30.9, 29.7. Anal. Calcd for $\text{C}_{43}\text{H}_{44}\text{N}_6\text{O}_{19}\text{S}_3$: C, 49.42; H, 4.24; N, 8.04. Found: C, 49.31; H, 4.39; N, 8.39.

6-*O*-[6'-*O*-[6''-*O*-(benzyl)-2'',3'',4''-trideoxy-4''-*N*-(nosylamino)- \square -D-erythro-hex-2''-enopyranosyl]-2',3',4'-trideoxy-4'-*N*-(nosylamino)- \square -D-erythro-hex-2'-enopyranosyl]-4-*O*-mesyl-3-deoxy-3-*N*-(nosylamino)-D-gulal (31**)**



Following the same procedure previously used for the preparation of mesylate **13**, the treatment of a solution of \square -*O*-glycoside **30** (0.120 g, 0.11 mmol) in anhydrous CH_2Cl_2 (2.0 mL) with MsCl (18.8 μL , 0.24 mmol) in the presence of anhydrous pyridine (30.0 μL , 0.36 mmol), afforded, after 16 h stirring at 0°C , a crude product (0.117 g, 95% yield) consisting of *trans N*-nosyl-*O*-mesylate **31**, sufficiently to be used in the next step without any further purification. An analytical sample of crude **31** was subjected to flash chromatography. Elution with a 95:5 CH_2Cl_2 /acetone mixture afforded pure *trans N*-nosyl-*O*-mesylate **31**, as a liquid: $[\alpha]_{\text{D}}^{20} +182.5$ (c 0.5, CHCl_3); $R_f = 0.22$ (4:6 hexane/AcOEt); FTIR (neat film) \square 3389, 1601, 1377, 1265, 1091, 1024 cm^{-1} . ^1H NMR (CD_3CN) \square 8.02-8.17 (m, 3H), 7.76-7.95 (m, 9H), 7.22-7.43 (m, 5H), 6.56 (d, 1H, $J = 6.2$ Hz), 6.17 (br, s, 2H, NH), 5.94-6.07 (m, 1H, NH), 5.75 (dt, 1H, $J = 10.1, 2.5$ Hz), 5.68 (dt, 1H, $J = 10.1, 2.5$ Hz), 5.60 (d, 1H, $J = 10.2$ Hz), 5.48 (d, 1H, $J = 10.2$ Hz), 4.99 (d, 1H, $J = 2.5$ Hz), 4.97 (d, 1H, $J = 2.5$ Hz), 4.88 (s, 1H), 4.63 (ddd, 1H, $J = 6.2, 5.5, 1.7$ Hz), 4.38 (d, 1H, $J = 12.0$ Hz), 4.33 (d, 1H, $J = 12.0$ Hz), 4.22-4.32 (m, 2H), 4.10-4.21 (m, 1H), 3.87-4.07 (m, 5H), 3.63-3.86 (m, 3H), 3.51-3.61 (m, 2H), 3.13 (s, 3H). ^{13}C NMR (CD_3CN) \square 148.8, 148.7, 148.2, 139.6, 135.7, 135.5, 135.4, 134.6, 134.4, 134.2, 134.1, 134.0, 133.6, 131.9, 131.6, 131.2, 129.3, 128.5, 128.4, 128.3, 128.2, 126.4, 126.1, 118.3, 97.0, 95.3, 94.6, 75.9, 73.7, 71.1, 69.8, 69.5, 67.5, 66.7, 55.3, 50.0, 49.5, 48.5, 38.7, 30.9, 29.7. Anal. Calcd for $\text{C}_{44}\text{H}_{46}\text{N}_6\text{O}_{21}\text{S}_4$: C, 48.44; H, 4.25; N, 7.70. Found: C, 48.79; H, 4.65; N, 7.38.

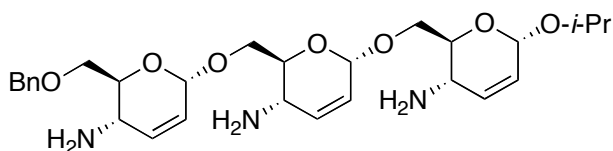
Isopropyl 6-*O*-[6'-*O*-[6''-*O*-(benzyl)-2'',3'',4''-trideoxy-4''-*N*-(nosylamino)- α -D-erythro-hex-2''-enopyranosyl]-2',3',4'-trideoxy-4'-*N*-(nosylamino)- α -D-erythro-hex-2'-enopyranosyl]-2,3,4-trideoxy-4-*N*-(nosylamino)- α -D-erythro-hex-2-enopyranoside (33)



33

A solution of *trans* *N*-nosyl-*O*-mesylate **31** (0.10 g, 0.089 mmol) in *i*-PrOH (6.0 mL) was treated with K₂CO₃ (0.037 g, 0.27 mmol, 3 equiv) and the reaction mixture was stirred 16 h at room temperature. After filtration, the organic solution was evaporated to give a crude product consisting of isopropyl α -*O*-glycoside **33** (trisaccharide **33**) (0.087 g, 90% yield), pure as a liquid: [α]_D²⁰ +196.8 (*c* 0.7, CHCl₃); R_f = 0.28 (4:6 hexane/AcOEt); FTIR (neat film) ν 3379, 1587, 1464, 1381, 1267, 1194, 1161, 1078, 1041, 968 cm⁻¹. ¹H NMR (CD₃CN) δ 8.04-8.19 (m, 3H), 7.74-7.93 (m, 9H), 7.25-7.41 (m, 5H), 6.03-6.23 (m, 3H, NH), 5.62-5.81 (m, 3H), 5.60 (d, 1H, *J* = 10.2 Hz), 5.47 (d, 1H, *J* = 10.2 Hz), 5.39 (d, 1H, *J* = 10.2 Hz), 5.04 (d, 1H, *J* = 2.6 Hz), 5.01 (d, 1H, *J* = 2.6 Hz), 4.97 (d, 1H, *J* = 2.8 Hz), 4.41 (d, 1H, *J* = 12.0 Hz), 4.36 (d, 1H, *J* = 12.0 Hz), 3.54-4.22 (m, 13H), 1.19 (d, 3H, *J* = 6.2 Hz), 1.12 (d, 3H, *J* = 6.2 Hz). ¹³C NMR (CD₃CN) δ 148.6, 139.6, 135.5, 135.4, 135.3, 134.6, 134.5, 134.3, 134.1, 134.0, 131.6, 131.5, 130.7, 130.4, 129.4, 129.2, 128.7, 128.5, 128.4, 126.2, 126.1, 126.0, 95.0, 94.7, 93.0, 73.7, 71.0, 69.8, 69.6, 69.5, 69.0, 68.7, 67.6, 50.5, 49.9, 49.5, 24.0, 22.1. Anal. Calcd for C₄₆H₅₀N₆O₁₉S₃: C, 50.82; H, 4.64; N, 7.73. Found: C, 51.03; H, 4.39; N, 7.89.

Isopropyl 6-*O*-[6'-*O*-[6''-*O*-(benzyl)-2'',3'',4''-trideoxy-4''-amino- α -D-erythro-hex-2''-enopyranosyl]-2',3',4'-trideoxy-4'-amino- α -D-erythro-hex-2'-enopyranosyl]-2,3,4-trideoxy-4-amino- α -D-erythro-hex-2-enopyranoside (6)



6

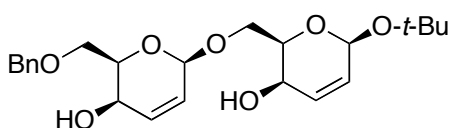
A solution of trisaccharide **33** (0.031 g, 0.029 mmol) in anhydrous MeCN (1.0 mL) was treated at room temperature with PhSH (27 μ L, 0.26 mmol, 3 equiv) in the presence of K₂CO₃ (0.048 g, 0.35 mmol, 4 equiv) and the resulting reaction mixture was stirred 5 h at room temperature. Dilution with AcOEt and evaporation of the filtered (Celite) organic solution

afforded a crude product consisting of isopropyl β -*O*-glycoside **6** and excess of PhSH (^1H NMR), which was subjected to preparative TLC with a 9:1 chloroform/methanol mixture, as the eluant. Extraction by 1:1 acetone/methanol mixture of the lower moving, most intense band afforded pure isopropyl β -*O*-glycoside **6** (trisaccharide **6**) (0.010 g, 65% yield), pure as a liquid: $[\alpha]_{\text{D}}^{20} +62.1$ (*c* 0.3, CHCl_3); $R_f = 0.14$ (1:1 $\text{CHCl}_3/\text{MeOH}$); FTIR (neat film) ν 3375, 1660, 1454, 1383, 1317, 1099, 1016 cm^{-1} . ^1H NMR (CDCl_3) δ 7.25-7.40 (m, 5H), 5.74-5.86 (m, 3H), 5.56-5.73 (m, 3H), 5.02 (broad s, 1H), 4.98 (broad s, 1H), 4.94 (t, 1H, $J = 1.0$ Hz), 4.58 (d, 1H, $J = 11.9$ Hz), 4.54 (d, 1H, $J = 11.9$ Hz), 3.85-4.08 (m, 3H), 3.40-3.82 (m, 7H), 3.07-3.35 (m, 3H), 1.16 (d, 3H, $J = 6.2$ Hz), 1.10 (d, 3H, $J = 6.2$ Hz). ^{13}C NMR (CD_3CN) δ 139.8, 136.7, 136.6, 136.0, 129.3, 128.7, 128.4, 126.8, 125.8, 94.6, 94.5, 93.5, 74.1, 73.8, 73.7, 73.5, 71.6, 70.5, 68.1, 67.9, 47.6, 47.1, 47.0, 30.9, 24.1, 22.3. Anal. Calcd for $\text{C}_{28}\text{H}_{41}\text{N}_3\text{O}_7$: C, 63.26; H, 7.77; N, 7.90. Found: C, 63.01; H, 7.54; N, 7.67. MS, Calcd for $[\text{C}_{28}\text{H}_{41}\text{N}_3\text{O}_7 + \text{H}^+] = 532.3$. Found 532.3.

Synthesis of disaccharides 34, 36 and 41

(Schemes 7 and 8, text)

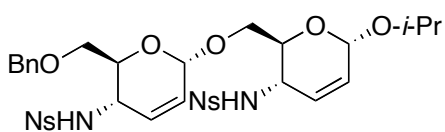
t-Butyl 6-*O*-[6'-*O*-(benzyl)-2',3'-dideoxy- α -D-threo-hex-2'-enopyranosyl]-2,3-dideoxy- α -D-threo-hex-2-enopyranoside (34)



34

Following the procedure previously used for the preparation of trisaccharide **5**, a solution of *trans* hydroxy mesylate **16** (0.050 g, 0.113 mmol) in anhydrous *t*-BuOH (1.0 mL) was treated with *t*-BuOK (0.019 g, 0.17 mmol) and the resulting mixture was stirred 24 h at room temperature. Dilution with AcOEt and evaporation of the washed (saturated aqueous NaCl) organic solution afforded a crude product (0.045 g) consisting of *t*-butyl α -*O*-glycoside **34** (^1H NMR), which was subjected to flash chromatography. Elution with a 3:7 hexane/AcOEt mixture afforded pure *t*-butyl α -*O*-glycoside **34** (disaccharide **34**) (0.031 g, 65% yield), pure as a liquid: $[\alpha]_D^{20}$ -101.2 (*c* 0.8, CHCl_3); R_f = 0.26 (3:7 hexane/AcOEt); FTIR (neat film) ν 3454, 1655, 1367, 1261, 1103, 1047 cm^{-1} . ^1H NMR (CD_3CN) δ 7.29-7.38 (m, 5H), 5.90-6.04 (m, 2H), 5.77 (dt, 1H, J = 10.1, 0.9 Hz), 5.67 (dt, 1H, J = 10.1, 0.9 Hz), 5.22 (dd, 1H, J = 2.8, 1.5 Hz), 5.11 (dd, 1H, J = 2.8, 1.5 Hz), 4.56 (d, 1H, J = 12.3 Hz), 4.55 (d, 1H, J = 12.3 Hz), 3.62-3.96 (m, 8H), 3.13 (d, 1H, J = 7.7 Hz, OH), 3.02 (d, 1H, J = 7.9 Hz, OH), 1.23 (s, 9H). ^{13}C NMR (CD_3CN) δ 139.7, 133.4, 131.7, 131.1, 130.7, 129.3, 128.6, 128.7, 128.5, 99.2, 93.5, 76.1, 75.5, 75.3, 73.8, 70.8, 69.2, 62.9, 62.4, 29.1, 28.9. Anal. Calcd for $\text{C}_{23}\text{H}_{32}\text{O}_7$: C, 65.68; H, 7.66. Found: C, 65.89; H, 7.51. MS, Calcd for $[\text{C}_{23}\text{H}_{32}\text{O}_7 + \text{Na}^+]$ = 443.2. Found 443.1. Calcd for $[\text{C}_{23}\text{H}_{32}\text{O}_7 + \text{Cl}^-]$ = 455.2. Found 455.2.

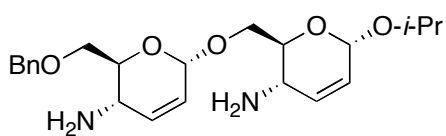
Isopropyl 6-*O*-[6'-*O*-(benzyl)-2',3',4'-trideoxy-4'-*N*-(nosylamino)- α -D-erythro-hex-2'-enopyranosyl]-2,3,4-trideoxy-4-*N*-(nosylamino)- α -D-erythro-hex-2-enopyranoside (35)



35

Following the same procedure used for the synthesis of trisaccharide **33**, a solution of *trans* *N*-nosyl *O*-mesylate **28** (0.050 g, 0.068 mmol) in anhydrous *i*-PrOH (4.0 mL) was treated with K₂CO₃ (0.028 g, 0.205 mmol, 3 equiv) and the resulting mixture was stirred 48 h at room temperature. Dilution with AcOEt and evaporation of the washed (saturated aqueous NaCl) organic solution afforded a crude product (0.042 g) consisting of isopropyl β -*O*-glycoside **35** (disaccharide **35**) (¹H NMR) which was subjected to preparative TLC with a 4:6 hexane/AcOEt mixture as the eluant. Extraction of the most intense band afforded pure disaccharide **35** (0.036 g, 73% yield), pure as a liquid: [α]_D²⁰ +150.8 (*c* 0.2, CHCl₃); R_f = 0.39 (4:6 hexane/AcOEt). FTIR (neat film) ν 3379, 1545, 1464, 1381, 1261, 1174, 1084, 1026, 968 cm⁻¹. ¹H NMR (CD₃CN) δ 8.04-8.13 (m, 2H), 7.67-7.88 (m, 6H), 7.25-7.40 (m, 5H), 6.10 (broad s, 2H, NH), 5.72 (ddd, 1H, *J* = 10.1, 2.7, 2.3 Hz), 5.65 (ddd, 1H, *J* = 10.1, 2.7, 2.3 Hz), 5.56-5.62 (m, 1H), 5.39 (dt, 1H, *J* = 10.0, 1.2 Hz), 5.01 (d, 1H, *J* = 2.7 Hz), 4.97 (d, 1H, *J* = 2.7 Hz), 4.37 (d, 1H, *J* = 12.0 Hz), 4.33 (d, 1H, *J* = 12.0 Hz), 4.09-4.18 (m, 1H), 3.83-4.08 (m, 4H), 3.78 (dd, 1H, *J* = 11.4, 4.6 Hz), 3.65 (dd, 1H, *J* = 11.4, 2.1 Hz), 3.49-3.58 (m, 2H), 1.16 (d, 3H, *J* = 6.2 Hz), 1.09 (d, 3H, *J* = 6.2 Hz). ¹³C NMR (CD₃CN) δ 148.6, 139.5, 135.4, 135.3, 134.6, 134.3, 134.1, 134.0, 131.6, 131.5, 131.4, 130.1, 129.5, 129.2, 128.5, 128.4, 128.3, 126.1, 126.0, 94.7, 93.1, 73.7, 71.0, 69.7, 69.6, 69.2, 67.6, 50.0, 49.4, 24.0, 22.2. Anal. Calcd for C₃₄H₃₈N₄O₁₃S₂: C, 52.70; H, 4.95; N, 7.23. Found: C, 52.54; H, 4.72; N, 7.01.

Isopropyl 6-*O*-[6'-*O*-(benzyl)-2',3',4'-trideoxy-4'-amino- β -D-erythro-hex-2'-enopyranosyl]-2,3,4-trideoxy-4-amino- β -D-erythro-hex-2-enopyranoside (36**)**

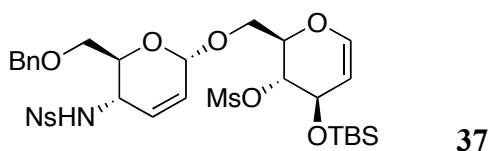


36

Following the same procedure previously used for the preparation of trisaccharide **6**, the treatment of a solution of disaccharide **35** (0.025 g, 0.032 mmol) in anhydrous MeCN (1.0 mL) with K₂CO₃ (0.034 g, 0.25 mmol, 4 equiv) in the presence of PhSH (20 μ L, 0.19 mmol, 3 equiv) afforded, after 4 h stirring at room temperature, a crude product (0.029 g) consisting of isopropyl β -*O*-glycoside **36** (disaccharide **36**) (¹H NMR) and excess of PhSH which was subjected to preparative TLC with a 95:5 CHCl₃/MeOH mixture as the eluant. Extraction of the most intense band afforded pure disaccharide **36** (0.009 g, 69% yield), pure as a liquid: [α]_D²⁰ +19.3 (*c* 0.6, CHCl₃); R_f = 0.11 (95:5 CHCl₃/MeOH); FTIR (neat film) ν 3373, 1660,

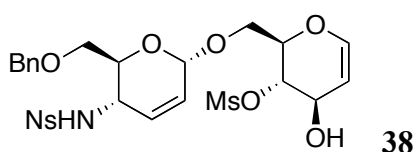
1261, 1095, 1022 cm^{-1} . ^1H NMR (acetone- d_6) \square 7.25-7.38 (m, 5H), 5.76 (dt, 1H, $J = 10.0$, 2.6 Hz), 5.69 (dt, 1H, $J = 10.0$, 2.6 Hz), 5.44-5.55 (m, 2H), 5.08 (broad s, 1H), 5.02-5.05 (m, 1H), 4.58 (d, 1H, $J = 12.1$ Hz), 4.50 (d, 1H, $J = 12.1$ Hz), 4.09-4.18 (m, 1H), 3.91-4.08 (m, 4H), 3.79 (dd, 1H, $J = 11.0$, 5.0 Hz), 3.54-3.60 (m, 1H), 3.45-3.53 (m, 2H), 1.20 (d, 3H, $J = 6.2$ Hz), 1.11 (d, 3H, $J = 6.2$ Hz). ^{13}C NMR (acetone- d_6) \square 140.4, 137.7, 129.4, 128.6, 128.4, 128.2, 127.4, 96.9, 95.3, 74.0, 71.2, 70.5, 56.2, 56.1, 24.6, 22.7. Anal. Calcd for $\text{C}_{22}\text{H}_{32}\text{N}_2\text{O}_5$: C, 65.31; H, 7.98; N, 6.93. Found: C, 65.49; H, 7.61; N, 6.74. MS, Calcd for $[\text{C}_{22}\text{H}_{32}\text{N}_2\text{O}_5 + \text{H}^+] = 405.2$. Found 405.2.

6-*O*-[6'-*O*-(benzyl)-2',3',4'-trideoxy-4'-*N*-(nosylamino)- \square -D-erythro-hex-2'-enopyranosyl]-4-*O*-mesyl-3-*O*-(*t*-butyldimethylsilyl)-D-glucal (37)



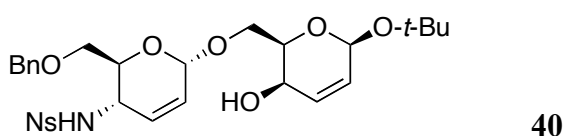
Following the same procedure used for the synthesis of \square -*O*-glycoside **27**, a solution of *trans* *N*-nosyl-*O*-mesylate **26** (0.100 g, 0.24 mmol) in anhydrous MeCN (12 mL) was treated with K_2CO_3 (0.099 g, 0.72 mmol, 3 equiv) in the presence of alcohol **7** (0.162 g, 0.48 mmol, 2 equiv) and the reaction mixture was stirred at room temperature for 16 h. Dilution with Et_2O and evaporation of the washed (saturated aqueous NaCl) organic solution afforded a crude product (0.222 g) consisting of \square -*O*-glycoside **37** and unreacted alcohol **7** (^1H NMR), which was subjected to flash chromatography. Elution with a 9:1 $\text{CH}_2\text{Cl}_2/i\text{-Pr}_2\text{O}$ mixture yielded \square -*O*-glycoside **37** (0.122 g, 68% yield), pure as a solid, mp 48-49°C: $[\alpha]^{20}_{\text{D}} +34.8$ (c 0.3, CHCl_3); $R_f = 0.54$ (1:1 hexane/AcOEt); FTIR (nujol) \square 3350, 1649, 1543, 1458, 1359, 1255, 1176, 1072, 962 cm^{-1} . ^1H NMR (CDCl_3) \square 8.06-8.12 (m, 1H), 7.79-7.86 (m, 1H), 7.58-7.74 (m, 2H), 7.33 (s, 5H), 6.30 (d, 1H, $J = 6.0$ Hz), 5.75 (dt, 1H, $J = 10.0$, 2.5 Hz), 5.55 (d, 1H, $J = 10.0$ Hz), 5.45 (d, 1H, $J = 9.2$ Hz), 5.02 (broad s, 1H), 4.70-4.79 (m, 2H), 4.48 (s, 2H), 4.26-4.38 (m, 3H), 4.01-4.08 (m, 1H), 3.94 (dt, 1H, $J = 9.8$, 2.7 Hz), 3.80 (dd, 1H, $J = 11.0$, 4.5 Hz), 3.68 (d, 2H, $J = 2.7$ Hz), 3.06 (s, 3H), 0.87 (s, 9H), 0.10 (s, 6H). ^{13}C NMR (CDCl_3) \square 147.8, 143.5, 138.2, 134.4, 133.9, 133.1, 131.0, 130.3, 128.4, 127.8, 127.7, 125.5, 101.7, 94.2, 75.5, 74.8, 73.6, 69.4, 68.6, 68.1, 64.9, 48.6, 39.0, 25.8, 18.1, -4.4. Anal. Calcd for $\text{C}_{32}\text{H}_{44}\text{N}_2\text{O}_{12}\text{S}_2\text{Si}$: C, 51.88; H, 5.99; N, 3.78. Found: C, 51.53; H, 5.69; N, 3.62.

6-*O*-[6'-*O*-(benzyl)-2',3',4'-trideoxy-4'-*N*-(nosylamino)- α -D-erythro-hex-2'-enopyranosyl]-4-*O*-mesyl-D-glucal (38**)**



Following the same procedure used for the preparation of *trans* hydroxy mesylate **16**, the treatment of a solution of α -*O*-glycoside **37** (0.074 g, 0.10 mmol) in anhydrous THF (4.4 mL) with 1M TBAF in THF (0.1 mL) afforded, after 1 h at 0°C, a crude liquid product (0.061 g, 97% yield) consisting of *trans* hydroxy mesylate **38**, which was sufficiently pure to be used in the next step without any further purification: $R_f = 0.07$ (3:7 hexane/AcOEt); FTIR (neat film) ν 3302, 1543, 1462, 1365, 1176, 1062, 972 cm^{-1} . $^1\text{H NMR}$ (CDCl_3) δ 7.98-8.05 (m, 1H), 7.48-7.75 (m, 3H), 7.35 (s, 5H), 6.17 (d, 1H, $J = 6.0$ Hz), 5.72 (d, 1H, $J = 10.1$ Hz), 5.50 (d, 1H, $J = 10.4$ Hz), 4.95 (broad s, 1H), 4.83 (dd, 1H, $J = 6.0, 1.8$ Hz), 4.68-4.77 (m, 1H), 4.44-4.52 (m, 1H), 4.21-4.43 (m, 3H), 3.90-4.06 (m, 3H), 3.50-3.75 (m, 3H), 3.19 (s, 3H).

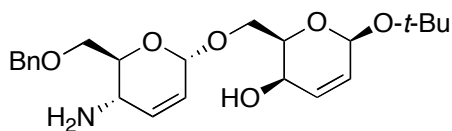
***t*-Butyl 6-*O*-[6'-*O*-(benzyl)-2',3',4'-trideoxy-4'-*N*-(nosylamino)- α -D-erythro-hex-2'-enopyranosyl]-2,3-dideoxy- α -D-threo-hex-2-enopyranoside (**40**)**



Following the same procedure used for the preparation of trisaccharide **5**, the treatment of a solution of *trans* hydroxy mesylate **38** (0.061 g, 0.097 mmol) in *t*-BuOH (1.2 mL) with *t*-BuOK (0.013 g, 0.112 mmol) afforded, after 48 h stirring at room temperature, a crude product (0.060 g) consisting of *t*-butyl α -*O*-glycoside **40** (disaccharide **40**) ($^1\text{H NMR}$) which was subjected to flash chromatography. Elution with a 3:7 hexane/AcOEt mixture yielded disaccharide **40** (0.042 g, 72% yield), pure as a liquid: $[\alpha]_D^{20} +69.8$ (c 0.4, CHCl_3); $R_f = 0.29$ (3:7 hexane/AcOEt); FTIR (neat film) ν 3377, 1462, 1381, 1263, 1085, 1020, 972 cm^{-1} . $^1\text{H NMR}$ (CDCl_3) δ 8.07-8.14 (m, 1H), 7.80-7.87 (m, 1H), 7.60-7.76 (m, 2H), 7.33 (s, 5H), 6.08 (ddd, 1H, $J = 10.0, 5.1, 1.4$ Hz), 5.67-5.79 (m, 2H), 5.51 (d, 1H, $J = 10.0$ Hz), 5.34 (d, 1H, $J = 9.1$ Hz), 5.20 (d, 1H, $J = 0.8$ Hz), 5.04 (d, 1H, $J = 2.2$ Hz), 4.50 (s, 2H), 4.24-4.36 (m, 1H), 3.65-3.95 (m, 6H), 1.27 (s, 9H). $^{13}\text{C NMR}$ (CDCl_3) δ 147.9, 138.2, 134.4, 134.0, 133.2, 133.1, 131.0, 130.2, 129.9, 128.5, 127.8, 127.7, 125.5, 94.4, 93.0, 76.2, 74.2, 73.7, 69.5, 68.8,

68.1, 62.3, 48.8, 28.8. Anal. Calcd for C₂₉H₃₆N₂O₁₀S: C, 57.60; H, 6.00; N, 4.64. Found: C, 57.42; H, 5.75; N, 4.39.

***t*-Butyl 6-*O*-[6'-*O*-(benzyl)-2',3',4'-trideoxy-4'-amino- α -D-erythro-hex-2'-enopyranosyl]-2,3-dideoxy- α -D-threo-hex-2-enopyranoside (41)**



41

Following the same procedure previously used for the preparation of trisaccharide **6**, the treatment of a solution of disaccharide **40** (0.034 g, 0.056 mmol) in anhydrous MeCN (1.5 mL) with K₂CO₃ (0.031 g, 0.225 mmol, 4 equiv) in the presence of PhSH (17 μ L, 0.169 mmol, 3 equiv) afforded, after 24 h stirring at room temperature, a crude product consisting of *i*-propyl α -*O*-glycoside **41** (disaccharide **41**) (¹H NMR) and excess of PhSH which was subjected to preparative TLC with a 96:4 CHCl₃/MeOH mixture, as the eluant. Extraction of the most intense lower moving band afforded pure disaccharide **41** (0.015 g, 64% yield), pure as a solid. mp 83-85°C: [α]_D²⁰ -12.4 (*c* 0.3, CHCl₃); R_f = 0.29 (96:4 CHCl₃/MeOH); FTIR (nujol) $\bar{\nu}$ 3234, 1581, 1464, 1371, 1257, 1118, 1099, 1047, 968 cm⁻¹. ¹H NMR (CDCl₃) δ 7.27-7.38 (m, 5H), 6.09 (dd, 1H, *J* = 10.0, 4.9 Hz), 5.86 (d, 1H, *J* = 10.0 Hz), 5.67-5.78 (m, 2H), 5.21 (broad s, 1H), 5.06 (broad s, 1H), 4.66 (d, 1H, *J* = 12.1 Hz), 4.54 (d, 1H, *J* = 12.1 Hz), 3.76-3.96 (m, 4H), 3.70-3.75 (m, 2H), 3.60-3.69 (m, 1H), 3.38-3.48 (m, 1H), 1.27 (s, 9H). C NMR (CDCl₃) δ 138.3, 135.1, 132.9, 130.3, 128.6, 127.8, 125.7, 94.8, 93.0, 76.1, 74.2, 73.6, 72.7, 70.3, 67.9, 62.3, 47.0, 28.9. Anal. Calcd for C₂₃H₃₃NO₆: C, 65.85; H, 7.93; N, 3.34. Found: C, 65.49; H, 7.61; N, 3.02.

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