~ SUPPORTING INFORMATION ~

A divergent approach to the synthesis of iGb3 sugar and lipid analogues via a lactosyl 2-azido-sphingosine intermediate

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~ EXPERIMENTAL ~

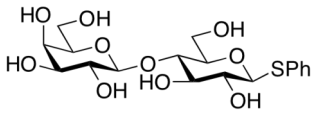
General procedure:

Unless otherwise stated all reactions were performed under argon. Prior to use, THF (Pancreac) was distilled from sodium and benzophenone, pyridine was distilled and dried over 4Å molecular sieves (4Å MS), CH_2Cl_2, (Pancreac) was distilled from P_2O_5, and H_2O and benzene (Fisher Scientific) were distilled. Anhydrous acetone (Pure Science) was distilled from sodium carbonate prior to use. $BF_3.OEt_2$ (Janssen Chimica) was distilled prior to use. $SnCl_4$ (Aldrich), PhSH (Koch-Light Laboratories), benzaldehyde dimethyl acetal (Aldrich), $Me_2C(OMe)_2$ (Aldrich), NBS (Aldrich), DBU (Merck), CSA (Acros), *n*Bu_3SnCl (Aldrich), AIBN (Aldrich), D-fucose (Aldrich), D-lactose (Aldrich), trityl chloride (Acros), anhydrous Et_2O (Pancreac), PPh_3 (Aldrich), $Pd(OH)_2/C$ (Aldrich, 20 wt%), anhydrous DMF (Acros), TFA (Aldrich), *p*TsOH (Aldrich), TMSOTf (Aldrich), H_2SO_4 (Lab-Scan), formic acid (Aldrich), AcCl (Aldrich), BnBr (Fluka), PMe_3 (Aldrich, 1M in THF), AcOH (Ajax Finechem), Ac_2O (Peking Reagent), TMSOTf (Aldrich), DiPEA (Aldrich), NaOMe (Janssen Chimica), trichloroacetonitrile (Aldrich), $C_{25}H_{51}COOH$ (Acros), lauric acid (Hopkins and Williams Ltd), 11*Z*,14*Z*-eicosadienoic acid (Allichem), BzCl (Aldrich, distilled an stored under argon), HBTU (Acros), PyBOP (Aldrich), EDCI (Aldrich), DMAP (Merck), sodium (Aldrich), trimethyl orthoacetate (Aldrich), $LiAlH_4$ (Aldrich), EtOAc (Pancreac), KF (Riedel-de-Haën), $Na_2S_2O_3$ (Panreac), NaOAc (Riedel-de-Haën), HSEt (Sigma), NaH (Avocardo Research Chemicals, 60% dispersion in mineral oil), CuBr (Chempur), Pr_4NBr (Aldrich), $ZnCl_2$ (Aldrich), I_2 (BDH), Imidazole (Aldrich), HCl (Panreac), NH_4Cl (Labserv), hexanes (Fisher Scientific), petroleum ether (Pure Science), MeOH (Pure Science), $CHCl_3$ (Pancreac), EtOH (absolute, Pure Science), $NaHCO_3$ (Pure Science), NaCl (Pancreac), NH_3 (BOC gasses), H_2 (Boc gasses) were used as received. All solvents were removed by evaporation under reduced pressure. Reactions were monitored by TLC-analysis on Macherey-Nagel silica gel coated plastic sheets (0.20 mm, with fluorescent indicator UV_{254}) with detection by UV-absorption (short wave UV – 254 nm; long wave UV – 366 nm), by dipping in 10% H_2SO_4 in EtOH followed by charring at ~150 °C, by dipping in I_2 in silica, or by dipping into a solution of ninhydrin in EtOH followed by charring at ~150 °C. Column chromatography was performed on Pure Science silica

gel (40-63 micron). AccuBOND II ODS-C18 (Agilent) was used for reverse phase chromatography. Infrared spectra were recorded as thin films using a Bruker Tensor 27 FTIR spectrometer equipped with an Attenuated Total Reflectance (ATR) sampling accessory and are reported in wave numbers (cm^{-1}). Nuclear magnetic resonance spectra were recorded at 20 °C in CD_3OD, $CDCl_3$, or pyridine-d_5 (which is a particularly good NMR solvent for the amphiphilic glycolipids final products) using either a Varian INOVA operating at 500 MHz or Varian VNMRS operating at 600 MHz. Chemical shifts are given in ppm (δ) relative to TMS. NMR peak assignments were made using COSY, HSQC and HMBC 2D experiments. Mass spectrometry was performed by submitting samples in a methanol/acetonitrile (1/1) solvent system to electrospray ionization using an Agilent LCMS QTOF (model 6530).

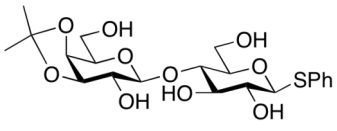
Lactosyl Ceramide Building Block

Phenyl 4-*O*-(β-D-Galactopyranosyl)-1-thio-β-D-glucopyranoside (13)



A solution of sodium acetate (20 g, 244 mmol) in acetic anhydride (100 mL, 1058 mmol) was heated to reflux and D-lactose (**10**) (40 g, 117 mmol) was added in small portions over 30 mins. The resulting mixture was refluxed for 2 h, after which time it was cooled to rt and poured over ice and stirred for 1 h. The white solid was filtered and washed with H_2O (100 mL). The filtrate was dissolved in Et_2O (800 mL) and the organic layer was washed with H_2O (2 x 800 mL), dried ($MgSO_4$), filtered and concentrated *in vacuo* to afford peracetylated D-lactose as a white solid (55 g, 81 mmol, 70%). Peracetylated D-lactose (17 g, 25 mmol) was dissolved in CH_2Cl_2 (125 mL) and thiophenol (2.09 mL, 30 mmol) was added. The reaction mixture was then cooled to 0 °C, $SnCl_4$ (289 μL, 2.5 mmol) added, and the resultant mixture stirred at rt for 4 d. The reaction mixture was diluted with CH_2Cl_2 (200 mL), quenched with sat. aq. $NaHCO_3$ (150 mL) and sat. aq. KF (150 mL) and the organic layer was isolated from the mixture and further washed with sat. aq. KF (150 mL), sat. aq. $NaHCO_3$ (150 mL), H_2O (150 mL), brine (150 mL) and dried ($MgSO_4$), filtered and concentrated *in vacuo*. Crystallisation of the crude mixture from EtOAc/petroleum ether (9/1, v/v) afforded phenyl 4-*O*-(2,3,4,6-tetra-*O*-acetyl-β-D-galactopyranosyl)-

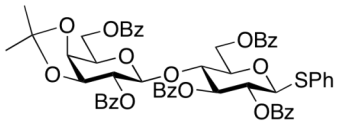
2,3,6-tri-*O*-acetyl-1-thio-β-D-glucopyranoside as a white solid (11.6 g, 16 mmol, 64%). Phenyl 4-*O*-(2,3,4,6-tetra-*O*-acetyl-β-D-galactopyranosyl)-2,3,6-tri-*O*-acetyl-1-thio-β-D-glucopyranoside (5 g, 6.86 mmol) was dissolved in MeOH (55 mL), and NaOMe was added until the pH of the reaction mixture reached 9.0. The resulting mixture was stirred at rt for 20 h, after which time the reaction mixture was neutralised with Dowex-H^+, filtered and concentrated *in vacuo*. The residue was crystallised from EtOH/MeOH (9.5/0.5, v/v) to afford thiolactoside **13** (2.8 g, 6.55 mmol, quantitative) as a white solid.[1,2,3,4] Over all, thiolactoside **13** was obtained in 45% (3 steps from D-lactose). Mp 218.2–219.9 °C;[1] R_f: 0.02 (CH_2Cl_2/MeOH, 5.7/1, v/v); $[\alpha]_D^{25}$ = -40.0 (c = 1.0, H_2O);[1] IR (film) 3360, 2884, 1644, 1583, 1479, 1439, 1373, 1278, 1117, 1069, 1020, 889, 822, 784, 743, 691 cm^{-1}; ^1H NMR (600 MHz, D_2O) δ 7.55–7.53 (m, 2H, CH-*o*), 7.39–7.33 (m, 3H, CH-*m*, CH-*p*), 4.78 (d, $J_{1,2}$ = 9.1 Hz, 1H, H-1), 4.40 (d, $J_{1',2'}$ = 7.8 Hz, 1H, H-1′), 3.91 (dd, $J_{6a,6b}$ = 12.6 Hz, $J_{5,6a}$ = 1.7 Hz, 1H, H-6a), 3.87 (d, $J_{3',4'}$ = 3.4 Hz, 1H, H-4′), 3.76 (dd, $J_{6a,6b}$ = 12.6 Hz, $J_{5,6b}$ = 5.0 Hz, 1H, H-6b), 3.76–3.70 (m, 2H, H-6′a, H-6′b), 3.69–3.66 (m, 1H, H-5′), 3.64–3.63 (m, 2H, H-3, H-4), 3.61 (dd, $J_{2',3'}$ = 9.9 Hz, $J_{3',4'}$ = 3.4 Hz, 1H, H-3′), 3.59–3.57 (m, 1H, H-5), 3.49 (dd, $J_{2',3'}$ = 9.9 Hz, $J_{1',2'}$ = 8.0 Hz, 1H, H-2′), 3.37 (t, $J_{1,2}$ = 9.1 Hz, 1H, H-2); ^{13}C NMR (150 MHz, D_2O) δ 131.9 (C-*i*), 131.6, 129.3 (C-*o*, C-*m*), 128.1 (C-*p*), 102.8 (C-1′), 87.1 (C-1), 78.7 (C-5), 77.8 (C-4), 75.8 (C-3), 75.3 (C-5′) 72.5 (C-3′), 71.4 (C-2), 70.9 (C-2′), 68.5 (C-4′), 61.0 (C-6′), 60.0 (C-6); HRMS(ESI) m/z calcd. for $[C_{18}H_{26}O_{10}S+Na]^+$: 457.1139, obsd.: 457.1148.



Phenyl 4-*O*-(3,4-*O*-Isopropylidene-β-D-galactopyranosyl)-1-thio-β-D-glucopyranoside. To a solution of thiolactoside **13** (1.98 g, 4.56 mmol) in dry DMF (17 mL) and dry acetone (34 mL), 2,2-dimethoxypropane (923 µL) and *p*TsOH (81 mg, 0.427 mmol) were added and the resulting solution stirred for 3 d at rt. The solution was quenched with NEt_3 and concentrated under reduced pressure. The residue was then crystalised from hot ethanol to give the title compound as a white crystaline product (1.14 g, 2.40 mmol, 56%). Mp 203.2–203.9 °C; R_f: 0.30 (CH_2Cl_2/MeOH, 9/1, v/v); $[\alpha]_D^{25}$ = -27.0 (c = 1.0, MeOH); IR (film) 3364, 2946, 2836, 2073, 1653, 1450, 1222, 1119, 1078, 1023, 977, 873, 737 cm^{-1}; ^1H NMR (500 MHz, $CDCl_3/CD_3OD$, 1/1, v/v) δ 7.52–7.51 (m, 2H, CH-*o*), 7.30–7.23 (m, 3H, CH-*m*,

CH-*p*), 4.58 (d, $J_{1,2}$ = 9.8 Hz, 1H, H-1), 4.31 (d, $J_{1',2'}$ = 8.3 Hz, 1H, H-1′), 4.12 (dd, $J_{3',4'}$ = 5.6 Hz, $J_{4',5'}$ = 2.2 Hz, 1H, H-4′), 4.03 (dd, $J_{2',3'}$ = 7.5 Hz, $J_{3',4'}$ = 5.6 Hz, 1H, H-3′), 3.91–3.88 (m, 1H, H-5′), 3.86–3.73 (m, 4H, H-6a, H-6b, H-6′a, H-6′b), 3.57 (t, $J_{2,3} = J_{3,4}$ = 8.7 Hz, 1H, H-3), 3.53 (t, $J_{3,4} = J_{4,5}$ = 8.7 Hz, 1H, H-4), 3.46 (t, $J_{2',3'}$ = 7.5 Hz, 1H, H-2′), 3.43–3.39 (m, 1H, H-5), 3.33–3.29 (m, 1H, H-2), 1.47 (s, 3H, CH_3 *i*Pr), 1.31 (s, 3H, CH_3 *i*Pr); ^{13}C NMR (125 MHz, $CDCl_3/CD_3OD$, 1/1, v/v) δ 132.6 (C-*i*), 131.8, 128.5 (C-*o*, C-*m*), 127.3 (C-*p*), 109.9 (C_q *i*Pr), 102.7 (C-1′), 87.6 (C-1), 79.7 (C-4), 79.1 (C-3′), 78.5 (C-5), 76.2 (C-3), 73.9 (C-5′), 73.4 (C-4′), 72.7 (C-2′), 71.7 (C-2), 61.1, 60.9 (C-6/C-6′), 27.4, 25.6 (2 x CH_3 *i*Pr); HRMS(ESI) m/z calcd. for $[C_{21}H_{30}O_{10}S+Na]^+$: 497.1452, obsd.: 497.1461. Spectral data matched that previously reported.[5]

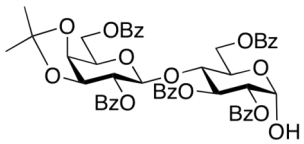
Phenyl 4-*O*-(2,6-di-*O*-benzoyl-3,4-*O*-isopropylidene-β-D-galactopyranosyl)-2,3,6-tri-*O*-benzoyl-1-thio-β-D-glucopyranoside (14)



Phenyl 4-*O*-(3,4-*O*-Isopropylidene-β-D-galactopyranosyl)-1-thio-β-D-glucopyranoside (1.10 g, 2.31 mmol) was co-evaporated with toluene (x3) and dissolved in pyridine (23 mL). Benzoyl chloride (5.9 mL, 50.86 mmol) and DMAP (0.14 g, 1.16 mmol) were added and the reaction was stirred at rt for 15 h. The reaction mixture was diluted with EtOAc (100 mL), washed with sat. aq. $NaHCO_3$ (3 x 100 mL), H_2O (100 mL) and brine (100 mL), dried ($MgSO_4$), filtered and concentrated under reduced pressure. The product was crystallised from petroleum ether/EtOAc (2/1, v/v) to give the fully protected lactoside **14** as white fluffy crystals (1.98 g, 1.99 mmol, 86%), and the remainder mother liquor was purified by silica flash chromatography (petroleum ether/EtOAc, 3/1, v/v) to afford more product (0.18 g, 0.18 mmol, 8%). R_f: 0.56 (PE/EA, 1/1, v/v); $[\alpha]_D^{25}$ = +40.0 (c = 1.0, $CHCl_3$); IR (film) 3064, 2988, 2941, 1723, 1602, 1451, 1315, 1265, 1177, 1110, 1083, 1069, 1027, 1000, 753, 708 cm^{-1}; ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.07 (d, $J_{CH\text{-}o,CH\text{-}m}$ = 7.8 Hz, 2H, CH-*o*, OBz), 8.00 (d, $J_{CH\text{-}o,CH\text{-}m}$ = 7.8 Hz, 2H, CH-*o*, OBz), 7.96 (d, $J_{CH\text{-}o,CH\text{-}m}$ = 8.0 Hz, 4H, 2 x CH-*o*, OBz), 7.92 (d, $J_{CH\text{-}o,CH\text{-}m}$ = 7.8 Hz, 2H, CH-*o*, OBz), 7.62–7.09 (m, 20H, H_{arom}), 5.73 (t, $J_{3,4}$ = 9.5 Hz, 1H, H-3), 5.40 (t, $J_{1,2}$ = 9.9 Hz, 1H, H-2), 5.13 (t, $J_{1',2'}$ = 7.6 Hz, 1H, H-2′), 4.88 (d, $J_{1,2}$ = 9.9 Hz, 1H, H-1), 4.65 (d, $J_{6a,6b}$ = 12.0 Hz, 1H, H-6a), 4.59 (d, $J_{1',2'}$ = 7.6 Hz, 1H, H-1′), 4.47 (dd, $J_{6a,6b}$ = 12.0 Hz, $J_{5,6b}$ = 5.1 Hz, 1H, H-6b), 4.26–4.21 (m,

2H, H-3′, H-6′a), 4.11 (t, $J_{3,4}$ = 9.5 Hz, 1H, H-4), 4.09 (d, $J_{4',5'}$ = 5.8 Hz, 1H, H-4′), 3.89 (dd, $J_{5,6a}$ = 9.6 Hz, $J_{4,5}$ = 5.0 Hz, 1H, H-5), 3.83–3.81 (m, 1H, H-5′), 3.66 (dd, $J_{6a,6b}$ = 11.2 Hz, (dd, $J_{6a,6b}$ = 11.2 Hz, $J_{6a,6b}$ = 7.6 Hz, 1H, H-6′b), 1.52 (s, 3H, CH_3 *i*Pr),1.25 (s, 3H, CH_3 *i*Pr); ^{13}C NMR (125 MHz, $CDCl_3$) δ 166.1 (C=O, 6′-*O*-Bn), 166.0 (C=O, 6-*O*-Bn), 165.7 (C=O, 3-*O*-Bn), 165.3 (C=O, 2-*O*-Bn), 165.0 (C=O, 2′-*O*-Bn), 133.52, 133.41, 133.30, 133.11, 133.07 (C-*p*, 5 x OBz), 132.0 (C-*i*, SPh), 130.31, 130.03, 130.00, 129.93 129.86, 129.72, 129.67, 129.47, 129.40, 128.96, 128.83, 128.63, 128.59, 128.54, 128.53, 128.27, 128.24 (30 x CH_{arom}), 111.0 (C_q *i*Pr), 100.4 (C-1′), 86.0 (C-1), 77.4 (C-3′), 77.3 (C-5), 75.5 (C-4), 74.0 (C-3), 73.8 (C-2′), 73.3 (C-4′), 71.5 (C-5′), 70.6 (C-2), 63.0 (C-6), 62.9 (C-6′), 27.6, 26.3 (2 x CH_3 *i*Pr); HRMS(ESI) m/z calcd. for $[C_{56}H_{50}O_{15}S+Na]^+$: 1017.2763, obsd.: 1017.2774. Spectral data matched that previously reported.[5]

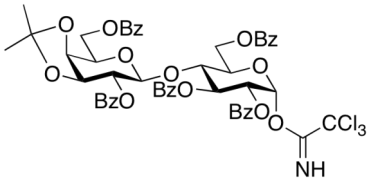
4-*O*-(2,6-Di-*O*-benzoyl-3,4-*O*-isopropylidene-β-D-galactopyranosyl-2,3,6-tri-*O*-benzoyl-α/β-D-glucopyranose.



NBS (1.86 g, 10.45 mmol) was added to lactoside **14** (2.60 g, 2.61 mmol) dissolved in acetone/H_2O (9/1, v/v, 52 mL), and the mixture was stirred at rt for 50 mins. The reaction was quenched with sat. aq. $NaHCO_3$ (10 mL), diluted with EtOAc (80 mL), washed with sat. aq. $Na_2S_2O_3$ (100 mL) and brine (100 mL), dried ($MgSO_4$), filtered and concentrated under reduced pressure. The crude mixture was purified by gradient flash chromatography (petroleum ether/EtOAc, 5/1 to 2/1, v/v) to afford the title compound as a clear oil (1.84 g, 2.04 mmol, 78%). For long term storage, the lactol can be crystallised from petroleum ether/EtOAc (2/1, v/v) to give white fluffy crystals. R_f: 0.50 (PE/EA, 1/1, v/v); $[\alpha]_D^{24}$ = +71.0 (c = 1.0, $CHCl_3$); IR (film) 3064, 1720, 1602, 1452, 1374, 1316, 1265, 1222, 1177, 1109, 1069,, 999, 755, 687 cm^{-1}; ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.08 (d, $J_{CH\text{-}o,CH\text{-}m}$ = 7.3 Hz, 2H, CH-*o*, OBz), 8.07–7.95 (m, 8H, 4 x CH-*o*, OBz), 7.62–7.26 (m, 15H, H_{arom}), 6.07 (t, $J_{2,3}$ = $J_{3,4}$ = 10.0 Hz, 1H, H-3), 5.58 (t, $J_{1,2}$ = 3.6 Hz, 1H, H-1), 5.19 (dd, $J_{2,3}$ = 10.0 Hz, $J_{1,2}$ = 3.6 Hz, 1H, H-2), 5.16 (t, $J_{1',2'}$ = $J_{2',3'}$ = 7.2 Hz, 1H, H-2′), 4.70 (d, $J_{1',2'}$ = 7.4 Hz, 1H, H-1′), 4.60 (dd, $J_{6a,6b}$ = 12.2 Hz, $J_{5,6a}$ = 1.6 Hz, 1H, H-6a), 4.52 (dd, $J_{6a,6b}$ = 12.2 Hz, $J_{5,6b}$ = 3.4 Hz, 1H, H-6b), 4.40–4.38 (m, 1H, H-5), 4.32 (dd, $J_{6'a,6'b}$ = 15.3 Hz, $J_{5,6'a}$ = 8.7 Hz, 1H, H-6′a), 4.27 (t, $J_{3',4'}$ = 6.1 Hz, 1H, H-3′), 4.20 (t, $J_{3,4}$ = 10.0 Hz, 1H, H-4), 4.13–4.11 (m, 1H, H-4′), 3.90–3.85

(m, 2H, H-5′, H-6′b), 2.90 (d, $J_{1,OH}$ = 3.6 Hz, 1H, OH), 1.51 (s, 3H, CH_3 *i*Pr), 1.26 (s, 3H, CH_3 *i*Pr); ^{13}C NMR (125 MHz, $CDCl_3$) δ 166.0, 166.0 (C=O, 6-*O*-Bn, 6′-*O*-Bn), 165.9 (C=O, 2-*O*-Bn), 165.6 (C=O, 3-*O*-Bn), 165.0 (C=O, 2′-*O*-Bn), 133.4, 133.4, 133.2, 133.1, 132.9 (C-*p*, 5 x OBz), 130.04, 129.91, 129.77, 129.70, 129.65, 129.59, 129.52, 129.33, 128.98, 128.60, 128.46, 128.43, 128.36, 128.15 (25 x CH_{arom}), 110.9 (C_q *i*Pr), 100.0 (C-1′), 90.3 (C-1), 77.1 (C-3′), 75.4 (C-4), 73.6 (C-2′), 73.6 (C-4′), 72.2 (C-2), 71.3 (C-5′), 69.5 (C-3), 68.6 (C-5), 63.0 (C-6′), 62.5 (C-6), 27.4, 26.1 (2 x CH_3 *i*Pr); HRMS(ESI) m/z calcd. for $[C_{50}H_{46}O_{16}+Na]^+$: 925.2678, obsd.: 925.2681. Spectral data matched that previously reported.[2,6]

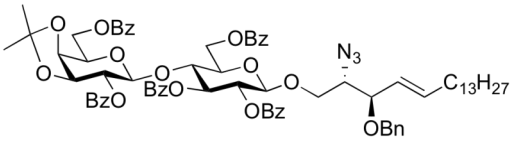
_O_-(4-_O_-(2,6-Di-_O_-benzoyl-3,4-_O_-isopropylidene-β-D-galactopyranosyl)-2,3,6-tri-_O_-benzoyl-α-D-glucopyranosyl) trichloroacetimidate (9)



4-*O*-(2,6-Di-*O*-benzoyl-3,4-*O*-isopropylidene-β-D-galactopyranosyl-2,3,6-tri-*O*-benzoyl-α/β-D-glucopyranose was co-evaporated with toluene (x3) and dissolved in dry CH_2Cl_2 (6 mL). Trichloroacetonitrile (1.13 mL, 11.30 mmol) and DBU (84 μL, 0.56 mmol) were added and the reaction mixture was stirred at rt for 1 h. Upon completion, the reaction mixture was concentrated and purified immediately by silica gel flash column chromatography (petroleum ether/EtOAc/CH_2Cl_2/NEt_3, 6/1/1/0.08, v/v) to afford imidate **9** as a colourless foam (1.08g, 1.03 mmol, 92%). R_f: 0.54 (PE/EA, 1/1, v/v); $[\alpha]_D^{24}$ = +57.0 (c = 1.0, $CHCl_3$); IR (film) 3336, 3065, 2986, 2938, 1725, 1677, 1452, 1315, 1265, 1177, 1109, 1070, 1026, 797, 755, 708 cm^{-1}; ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.55 (s, 1H, NH), 8.07 (d, $J_{CH\text{-}o,CH\text{-}m}$ = 7.1 Hz, 2H, CH-*o*, 6′-*O*-Bz), 8.02 (t, $J_{CH\text{-}o,CH\text{-}m}$ = 8.6 Hz, 4H, 2 x CH-*o*, OBz), 7.95 (t, $J_{CH\text{-}o,CH\text{-}m}$ = 8.7 Hz, 4H, 2 x CH-*o*, OBz), 7.64–7.30 (m, 15H, H_{arom}), 6.69 (d, $J_{1,2}$ = 3.4 Hz, 1H, H-1), 6.10 (t, $J_{3,4}$ = 9.2 Hz, 1H, H-3), 5.50 (dd, $J_{2,3}$ = 10.2 Hz, $J_{1,2}$ = 3.4 Hz, 1H, H-2), 5.16 (t, $J_{2',3'}$ = 6.9 Hz, 1H, H-2′), 4.70 (d, $J_{1',2'}$ = 7.6 Hz, 1H, H-1′), 4.59 (d, $J_{6a,6b}$ = 11.8 Hz, 1H, H-6a), 4.52 (d, $J_{6a,6b}$ = 11.8 Hz, 1H, H-6b), 4.31–4.24 (m, 4H, H-4, H-5, H-6′a, H-3′), 4.11 (d, $J_{3',4'} = J_{4',5'}$ =4.4 Hz, 1H, H-4′), 3.81–3.78 (m, 2H, H-5′, H-6′b), 1.50 (s, 3H, CH_3 *i*Pr), 1.25 (s, 3H, CH_3 *i*Pr); ^{13}C NMR (125 MHz, $CDCl_3$) δ 165.9 (C=O, 6′-*O*-Bn), 165.7 (C=O, 6-*O*-Bn), 165.5 (C=O, 2-*O*-Bn), 165.4 (C=O, 3-*O*-Bn), 165.0 (C=O, 2′-*O*-Bn), 160.7 (C=NH), 133.5, 133.4, 133.3, 133.2, 133.1 (C-*p*, 5 x

OBz), 130.1, 129.94, 129.86, 129.78, 129.74, 129.54, 129.50, 129.29, 128.68, 128.63, 128.47, 128.43, 128.41, 128.21 (25 x CH_{arom}), 110.8 (C_q *i*Pr), 100.7 (C-1´), 93.1 (C-1), 90.7 (CCl_3), 77.0 (C-3´), 75.1 (C-4), 73.7 (C-2´), 73.0 (C-4´), 71.4 (C-5), 71.3 (C-5´), 70.6 (C-2), 70.1 (C-3), 62.8 (C-6´), 62.1 (C-6), 27.3, 26.1 (2 x CH_3 *i*Pr); HRMS(ESI) m/z calcd. for $[C_{52}H_{46}NO_{16}Cl_3+H]^+$: 1046.1955, obsd.: 1046.1917. Spectral data matched that previously reported.[2,7]

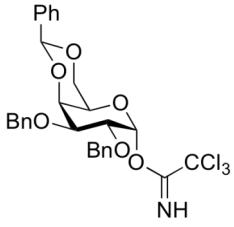
(2*S*,3*R*,4*E*)-2-Azido-1-(4-*O*-(2,6-di-*O*-benzoyl-3,4-*O*-isopropylidene-β-D-galactopyranosyl)-2,3,6-tri-*O*-benzoyl-β-D-glucopyranosyloxy)-3-benzyloxy-octadec-4-ene (6)



A solution of imidate donor **9** (973 mg, 0.93 mmol) and lipid acceptor **11**[8] (300 mg, 0.72 mmol), co-evaporated with dry toluene (x3), was dissolved in dry CH_2Cl_2 (6 mL) and 4 Å molecular sieves were added. This mixture was cooled to -20 ºC and a solution of TMSOTf in CH_2Cl_2 (1.38 mmol/mL, 157 µL, 0.22 mmol) was added slowly dropwise and the resulting solution stirred for 1.5 h at -20 ºC, and which point TLC analysis showed complete consumption of the acceptor **11**. The solution was quenched with NEt_3 (400 µL, 2.87 mmol) and concentrated under reduced pressure. The resulting oil was purified by silica gel gradient flash chromatography (petroleum ether/EtOAc, 10/1 to 5/1, v/v) to give glycolipid **6** as a colourless oil (936 mg, 0.72 mmol, Quantitative). R_f: 0.49 (PE/EA, 2/1, v/v); $[\alpha]_D^{25}$ = +10.0 (c = 1.0, CH_2Cl_2); IR (film) 3440, 3297, 3067, 2925, 2854, 2361, 2342, 2101, 1720, 1602, 1452, 1373, 1315, 1264, 1177, 1109, 1068, 1027, 825, 707 cm^{-1}; ^1H NMR (500 MHz, $CDCl_3$) δ 8.10 (d, $J_{CH\text{-}o,CH\text{-}m}$ = 7.3 Hz, 2H, CH-*o*, OBz), 8.03 (d, $J_{CH\text{-}o,CH\text{-}m}$ = 7.3 Hz, 2H, CH-*o*, OBz), 8.00 (d, $J_{CH\text{-}o,CH\text{-}m}$ = 7.3 Hz, 2H, CH-*o*, OBz), 7.96–7.94 (m, 4H, 2 x CH-*o*, OBz), 7.64–7.19 (m, 20H, H_{arom}), 5.73 (t, $J_{2',3'}$ = 9.4 Hz, 1H, H-3´), 5.46–5.39 (m, 2H, H-2´, H-5), 5.40 (t, $J_{5,6}$ = 6.7 Hz, 1H, H-5), 5.26 (dd, $J_{4,5}$ = 15.6 Hz, $J_{3,4}$ = 8.6 Hz, 1H, H-4), 5.14 (t, $J_{2'',3''}$ = 7.3 Hz, 1H, H-2´´), 4.68 (d, $J_{1',2'}$ = 7.8 Hz, 1H, H-1´), 4.60–4.58 (m, 2H, H-1´´, H-6´a), 4.47 (dd, $J_{6'a,6'b}$ = 12.3 Hz, $J_{5',6'b}$ = 4.2 Hz, 1H, H-6´b), 4.41 (d, $J_{a,b}$ = 12.0 Hz, 1H, CH-a, 3-*O*-Bn), 4.25–4.20 (m, 3H, H-4´, H-3´´, H-6´´a), 4.15 (d, $J_{a,b}$ =12.0 Hz, 1H, CH-b, 3-*O*-Bn), 4.07 (dd, $J_{4'',5''}$ = 5.6 Hz, $J_{3'',4''}$ = 1.9 Hz, 1H, H-4´´), 3.90 (dd, $J_{1a,1b}$ = 10.3 Hz, $J_{1a,2}$ = 5.7 Hz, 1H, H-1a), 3.83–3.77 (m, 2H, H-5´, H-5´´), 3.73 (dd, $J_{3,4}$ = 8.6 Hz, $J_{2,3}$

= 5.7 Hz, 1H, H-3), 3.65 (dd, $J_{6''a,6''b}$ = 11.5 Hz, $J_{5,6''b}$ = 7.4 Hz, 1H, H-6′′b), 3.60 (dd, $J_{1,2}$ = 11.2 Hz, $J_{2,3}$ = 5.7 Hz, 1H, H-2), 3.50 (dd, $J_{1a,1b}$ = 10.3 Hz, $J_{1b,2}$ = 5.7 Hz, 1H, H-1b), 1.93–1.91 (m, 2H, H-6), 1.52 (s, 3H, CH_3 *i*Pr), 1.32–1.26 (m, 25H, CH_3 *i*Pr, H-7–H-17), 0.89 (t, $J_{17,18}$ = 7.0 Hz, 3H, H-18); ^{13}C NMR (125 MHz, $CDCl_3$) δ 166.0 (C=O, 6′′-*O*-Bn), 165.9 (C=O, 6′-*O*-Bn), 165.7 (C=O, 3′-*O*-Bn), 165.1 (C=O, 2′-*O*-Bn), 165.0 (C=O, 2′′-*O*-Bn), 138.3 (C-5), 138.1 (C-*i*, 3-*O*-Bn), 133.4, 133.3, 133.24, 133.21, 133.0 (C-*p*, 5 x OBz), 129.88, 129.85, 129.82, 129.8, 129.6, 129.5, 129.35, 129.28, 128.7, 128.449, 128.44, 128.37, 128.27, 128.17, 127.53, 127.45, 127.44 (30 x CH_{arom}), 125.4 (C-4), 110.9 (C_q *i*Pr), 101.0 (C-1′), 100.2 (C-1′′), 79.6 (C-3), 77.0 (C-3′′), 75.3 (C-4′), 73.6 (C-2′′), 73.2 (C-4′′), 73.0 (C-5′), 72.7 (C-3′), 71.8 (C-2′), 71.3 (C-5′′), 70.0 (CH_2, 3-*O*-Bn), 68.5 (C-1), 63.7 (C-2), 62.8 (C-6′′), 62.5 (C-6′), 32.3 (C-6), 27.4, 26.2 (2 x CH_3 *i*Pr), 31.9, 29.70, 29.69, 29.68, 29.66, 29.63, 29.42, 29.37, 29.16, 28.9, 22.7 (C-7–C-17), 14.1 (C-18); HRMS(ESI) m/z calcd. for $[C_{75}H_{85}N_3O_{17}+Na]^+$: 1322.5771, obsd.: 1322.5764.

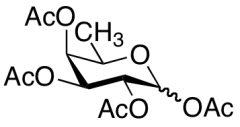
D-Glucosyl Donor (7):



2,3-di-*O*-benzyl-4,6-*O*-benzylidene-α-D-galactosyl trichloroacetimidate (7). 2,3-di-*O*-benzyl-4,6-*O*-benzylidene-α-D-galactosyl trichloroacetimidate (**7**) was prepared according to previously published procedures.[8]

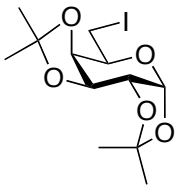
D-Fucosyl Donor (8):

1,2,3,4-Tetra-*O*-acetyl-6-deoxy-α/β-D-galactopyranose (16)

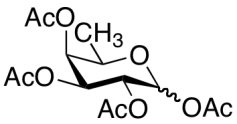


α-D-Fucose (**15**) (250 mg, 1.52 mmol) was dissolved in pyridine (7.6 mL) and Ac_2O (4.6 mL, 48.6 mmol) was added. The reaction was stirred for 14 h at rt and diluted with CH_2Cl_2, washed with H_2O (2 x 50 mL), sat. aq. $NaHCO_3$ (50 mL), brine (50 mL) and dried over $MgSO_4$. The $MgSO_4$ was filtered, the filtrate concentrated *in vacuo* and purified by silica gel gradient flash chromatography (petroleum ether/EtOAc, 10:1 to 3:1, v/v) to afford an α/β mixture (1:1.4) of peracetylated D-fucose **16** as a clear oil (506 mg,

1.52 mmol, Quantitative). R_f: 0.51 (PE/EA, 1/2, v/v); $[\alpha]_D^{25}$ = 59.0 (c = 1.0, $CHCl_3$); IR (film) 3027, 2942, 2880, 1746, 1433, 1369, 1321, 1212, 1167, 1052, 1023, 904, 668 cm^{-1}; ^1H NMR (500 MHz, $CDCl_3$) δ 5.66 (d, $J_{1,2}$ = 5.7 Hz, 1H, H-1), 5.29 (t, $J_{2,3}$ = 10.3 Hz, 1H, H-2), 5.25 (d, $J_{3,4}$ = 3.2 Hz, 1H, H-4), 5.05 (dd, $J_{2,3}$ = 10.3 Hz, $J_{3,4}$ = 3.2 Hz, 1H, H-3), 3.94 (q, $J_{5,6}$ = 6.4 Hz, 1H, H-5), 2.17 (s, 3H, 4-OAc), 2.09 (s, 3H, 1-OAc), 2.02 (s, 3H, 2-OAc), 1.97 (s, 3H, 3-OAc), 1.20 (d, $J_{5,6}$ = 6.4 Hz, 1H, H-6); ^{13}C NMR (125 MHz, $CDCl_3$) δ 170.5 (C=O, 4-OAc), 170.0 (C=O, 3-OAc), 169.5 (C=O, 2-OAc), 169.2 (C=O, 1-OAc), 92.1 (C-1), 71.2 (C-3), 70.2 (C-5), 69.9 (C-4), 67.9 (C-2), 20.8 (1-OAc), 20.7 (2-OAc), 20.63 (4-OAc), 20.56 (3-OAc), 15.9 (C-6); HRMS(ESI) m/z calcd. for $[C_{14}H_{20}O_9+NH_4]^+$: 350.1446, obsd.: 350.1450.



6-Deoxy-6-iodo-1,2:3,4-di-*O*-isopropylidene-α-D-galactopyranose (19). 6-Deoxy-6-iodo-1,2:3,4-di-*O*-isopropylidene-α-D-galactopyranose was synthesised according to previously published procedures.[9,10,11] Spectral data matched that previously reported.

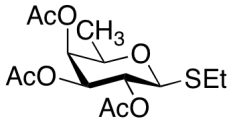


1,2,3,4-Tetra-*O*-acetyl-6-deoxy-α/β-D-galactopyranose (16): *Alternative procedure starting with 6-deoxy-6-iodo-1,2:3,4-di-O-isopropylidene-α-D-galactopyranose*.

$LiAlH_4$ (350 mg, 9.22 mmol) was carefully added to a solution of Bu_3SnCl (3 g, 9.22 mmol) in dry Et_2O (20 mL) at 0 °C. The reaction mixture was stirred at rt for 3 h, ice water (10 mL) was added, and the solution was stirred for a further 5 min. The mixture was filtered through a celite pad and the organic layer washed with H_2O (2 x 20 mL), dried ($MgSO_4$) and concentrated *in vacuo* to give Bu_3SnH as an oil, which was set aside for the next step. 6-Deoxy-6-iodo-1,2:3,4-di-*O*-isopropylidene-α-D-galactopyranose **19** (1.0 g, 2.84 mmol) was co-evaporated with toluene (x3) and dissolved in toluene (1.8 mL). Bu_3SnH (1.53 mL, 5.67 mmol) and AIBN (70 mg, 0.43 mmol) were added and stirred at 100 °C for 1.5 h, after which time the reaction mixture was diluted with EtOAc (80 mL), the organic layer was washed with water (80 mL) and brine (80 mL), dried ($MgSO_4$), filtered and concentrated *in vacuo*. The resultant oil was purified by silica gel gradient flash chromatography (petroleum ether to petroleum ether/EtOAc, 30/1 to 3/1, v/v) to afford 6-deoxy-1,2:3,4-di-*O*-

isopropylidene-α-D-galactopyranose as a clear oil (672 mg, 2.75 mmol, 97%). R_f : 0.27 (PE/EA, 10/1, v/v); $[\alpha]_D^{25}$ = -37.0 (c = 1.0, $CHCl_3$); IR (film) 3027, 2930, 1369, 1321, 1230, 1170, 1045, 1020, 904, 669 cm^{-1}; ^1H NMR (500 MHz, $CDCl_3$) δ 5.51 (d, $J_{1,2}$ = 5.1 Hz, 1H, H-1), 4.58 (dd, $J_{3,4}$ = 8.0 Hz, $J_{2,3}$ = 2.2 Hz, 1H, H-3), 4.27 (dd, $J_{1,2}$ = 5.1 Hz, $J_{2,3}$ = 2.2 Hz, 1H, H-2), 4.07 (dd, $J_{3,4}$ = 8.0 Hz, $J_{4,5}$ = 1.8 Hz, 1H, H-4), 3.90 (dq, $J_{5,6}$ = 6.6 Hz, $J_{4,5}$ = 1.8 Hz, 1H, H-5), 1.51 (s, 3H, CH_3 *i*Pr), 1.45 (s, 3H, CH_3 *i*Pr), 1.34 (s, 3H, CH_3 *i*Pr), 1.32 (s, 3H, CH_3 *i*Pr), 1.24 (d, $J_{5,6}$ = 6.5 Hz, 1H, H-6); ^{13}C NMR (125 MHz, $CDCl_3$) δ 108.9 (C_q *i*Pr-3,4), 108.2 (C_q *i*Pr-1,2), 96.5 (C-1), 73.5 (C-4), 70.9 (C-3), 70.3 (C-2), 63.4 (C-5), 26.0 (2 x CH_3 *i*Pr), 26.0 (CH_3 *i*Pr), 24.9 (CH_3 *i*Pr), 17.5 (C-6); HRMS(ESI) m/z calcd. for $[C_{12}H_{20}O_5+NH_4]^+$: 262.1649, obsd.: 262.1655. Spectral data matched that previously reported.[12] A solution of AcOH/H_2O (4/1, v/v, 5 mL) was added to 6-deoxy-1,2:3,4-di-*O*-isopropylidene-α-D-galactopyranose and stirred for 19 h, after which time the reaction mixture was warmed to 105 °C and stirred for a further 2 h. The reaction mixture was then concentrated, the residue co-evaporated with pyridine (3 x 8 mL), then dissolved in pyridine (5 mL) and Ac_2O (0.46 ml, 4.86 mmol). After stirring at rt for 16 h, the reaction mixture was taken up in EtOAc (50 mL), washed with 0.5 M HCl solution (50 mL), sat. aq. $NaHCO_3$ (50 mL), water (50 mL) and brine (50 mL), dried ($MgSO_4$), filtered and concentrated *in vacuo*. Purification by silica gel gradient flash chromatography (petroleum ether/EtOAc, 10:1 to 3:1, v/v) afforded an α/β mixture (1:5) of peracetylated D-fucose (**16**) as a clear oil (273 mg, 0.82 mmol, 85%). R_f : 0.51 (PE/EA, 1/2, v/v). Spectral data reported above.

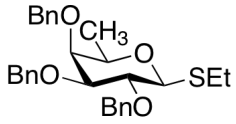
Ethyl 2,3,4-tri-*O*-acetyl-6-deoxy-1-thio-β-D-galactopyranoside (17)



Peracetylated D-fucose (**16**) (620 mg, 1.87 mmol) was co-evaporated with toluene (x3) and dissolved in dry CH_2Cl_2 (10 mL). Ethanethiol (0.41 mL, 5.60 mmol) was added at rt, followed by freshly distilled 48% $BF_3.OEt_2$ (0.71 mL, 2.80 mmol) and stirred for 2 h. The reaction mixture was diluted with CH_2Cl_2 (80 mL) and washed with H_2O (2 x 50 mL), sat. aq. $NaHCO_3$ (50 mL), brine (50 mL), and then dried over $MgSO_4$ and filtered. The concentrated filtrate was purified by silica gel flash column chromatography (petroleum ether/EtOAc, 5:1, v/v) to give β-thiofucoside (**16**) as a clear oil (452 mg, 1.35 mmol, 72%). R_f: 0.55 (PE/EA, 1/1, v/v); $[\alpha]_D^{25}$ = +49.0 (c = 1.0, $CHCl_3$); IR

(film) 3023, 2904, 1746, 1331, 1245, 1218, 1084, 1055, 1020, 863, 749, 667 cm^{-1}; ^1H NMR (500 MHz, $CDCl_3$) δ 5.23 (d, $J_{3,4}$ = 3.5 Hz, 1H, H-4), 5.17 (t, $J_{1,2} = J_{2,3}$ = 10.0 Hz, 1H, H-2), 5.00 (dd, $J_{2,3}$ = 10.0 Hz, $J_{3,4}$ = 3.5 Hz, 1H, H-3), 4.42 (d, $J_{1,2}$ = 10.0 Hz, 1H, H-1), 3.79 (q, $J_{5,6}$ = 6.4 Hz, 1H, H-5), 2.75–2.62 (m, 2H, $C\underline{H}_2CH_3$), 2.13 (s, 3H, 4-OAc), 2.02 (s, 3H, 2-OAc), 1.94 (s, 3H, 3-OAc), 1.23 (t, $J_{CH2,CH3}$ = 7.5 Hz, 3H, $CH_2C\underline{H}_3$), 1.17 (d, $J_{5,6}$ = 6.6 Hz, 3H, H-6); ^{13}C NMR (125 MHz, $CDCl_3$) δ 170.6 (C=O, 4-OAc), 170.1 (C=O, 3-OAc), 169.6 (C=O, 2-OAc), 83.5 (C-1), 73.1 (C-5), 72.3 (C-3), 70.4 (C-4), 67.3 (C-2), 24.1 ($\underline{C}H_2CH_3$), 20.8 (2-OAc), 20.7 (4-OAc), 20.6 (3-OAc), 16.4 (C-6), 14.7 ($CH_2\underline{C}H_3$); HRMS(ESI) m/z calcd. for $[C_{14}H_{22}O_7S+NH_4]^+$: 352.1424, obsd.: 352.1430.

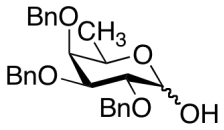
Ethyl 2,3,4-tri-*O*-benzyl-6-deoxy-1-thio-β-D-galactopyranoside (20)



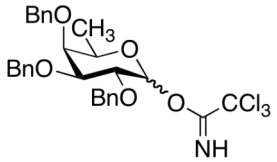
β-Thiofucoside (**17**) (389 mg, 1.16 mmol) was dissolved in methanol and NaOMe was added until the solution reached pH 9.0. The reaction mixture was stirred at rt for 1h, neutralized with Dowex H^+, filtered and concentrated *in vacuo* to give the pure triol as a colourless oil (242 mg, 1.16 mmol), which was used without further purification. The triol (243 mg, 1.16 mmol) was co-evaporated with toluene (x3), dissolved in dry DMF (12 mL) and benzyl bromide (0.55 mL, 4.66 mmol) added. The mixture was then cooled to 0 °C and NaH (60% in oil suspension, 233 mg, 5.82 mmol) added. The reaction was stirred for 17 h at rt, quenched with MeOH (5 mL) and concentrated *in vacuo* to remove the DMF. The crude oil was redissolved in EtOAc (50 mL), and washed with sat. aq. $NaHCO_3$ (50 mL) and brine (50 mL), dried ($MgSO_4$), filtered and concentrated *in vacuo*. The residue was purified by gradient flash chromatography (petroleum ether/EtOAc, 20:1 to 10:1, v/v) to afford benzylated thiofucoside **20** as a clear oil (464 mg, 0.97 mmol, 83%). R_f: 0.73 (PE/EA, 2/1, v/v); $[\alpha]_D^{27}$ = –6.0 (c = 1.0, $CHCl_3$); IR (film) 3064, 2978, 2868, 1606, 1497, 1454, 1357, 1208, 1124, 1087, 1066, 1047, 875, 745, 732, 697 cm^{-1}; ^1H NMR (500 MHz, $CDCl_3$) δ 7.44–7.29 (m, 15H, H_{arom}), 5.03 (d, $J_{a,b}$ = 11.8 Hz, 1H, CH-a, 4-*O*-Bn), 4.93 (d, $J_{a,b}$ = 10.3 Hz, 1H, CH-a, 2-*O*-Bn), 4.84 (d, $J_{a,b}$ = 10.3 Hz, 1H, CH-b, 2-*O*-Bn), 4.80 (d, $J_{a,b}$ = 12.0 Hz, 1H, CH-a, 3-*O*-Bn), 4.77 (d, $J_{a,b}$ = 12.0 Hz, 1H, CH-b, 3-*O*-Bn), 4.73 (d, $J_{a,b}$ = 11.8 Hz, 1H, CH-b, 4-*O*-Bn), 4.43 (d, $J_{1,2}$ = 9.5 Hz, 1H, H-1), 3.86 (t, $J_{1,2} = J_{2,3}$ = 9.5 Hz, 1H, H-2), 3.64 (d, $J_{3,4}$ = 2.6 Hz, 1H, H-4), 3.60 (dd, $J_{2,3}$ = 9.5 Hz, $J_{3,4}$ = 2.6 Hz, 1H, H-

3), 3.51 (q, $J_{5,6}$ = 6.4 Hz, 1H, H-5), 2.84–2.71 (m,2H, C$\underline{H_2}$CH$_3$), 1.33 (t, $J_{CH2,CH3}$ = 7.5 Hz, 2H, C$\underline{H_2}$CH$_3$), 1.24 (d, $J_{5,6}$ = 6.4 Hz, 1H, H-6); ^{13}C NMR (125 MHz, $CDCl_3$) δ 138.7 (C-*i*, 4-*O*-Bn), 138.5 (C-*i*, 3-*O*-Bn), 138.4 (C-*i*, 2-*O*-Bn), 128.6, 128.5, 128.34, 128.29, 128.22, 128.19, 128.0, 127.73, 127.69, 127.59, 127.54 (15 x CH_{arom}), 85.0 (C-1), 84.5 (C-3), 78.4 (C-2), 76.5 (C-4), 75.7 (CH_2, 2-*O*-Bn), 75.6 (C-5, CH_2, 4-*O*-Bn), 72.9 (CH_2, 3-*O*-Bn), 24.7 ($\underline{C}H_2CH_3$), 17.3 (C-6), 15.0 ($CH_2\underline{C}H_3$); HRMS(ESI) m/z calcd. for $[C_{29}H_{34}NO_4S+NH_4]^+$: 496.2516, obsd.: 496.2517. Spectral data matched that previously reported.[13]

2,3,4-Tri-*O*-benzyl-6-deoxy-α/β-D-galactopyranose (21)



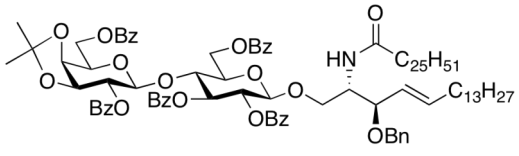
Thiofucoside **20** (183 mg, 0.38 mmol) was dissolved in acetone/H_2O (7.6 mL, 9:1, v/v) and NBS (238 mg, 1.34 mmol) was added. The reaction mixture was stirred at rt for 10 min then diluted with ethyl acetate (30 mL) and the organic layer washed with sat. aq. $NaHCO_3$ (30 mL), brine (30 mL), dried ($MgSO_4$), filtered and concentrated under reduced pressure. The residue was purified by silica gel gradient flash chromatography (petroleum ether/EtOAc, 2:1, v/v) to afford an α/β mixture (2.5:1) of lactol **21** as a colourless oil (154 mg, 0.35 mmol, 93%). R_f: 0.16 (PE/EA, 2/1, v/v); $[\alpha]_D^{27}$ = +18.0 (c = 1.0, $CHCl_3$, value obtained for 2.5:1 α/β mixture); IR (film) 3398, 3063, 3030, 2877, 1497, 1454, 1359, 1309, 1211, 1170, 1091, 1061, 1027, 950, 912, 815, 734, 696, 666 cm^{-1}; **α:** ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.41–7.28 (m, 15H, H_{arom}), 5.27 (d, $J_{1,2}$ = 3.7 Hz, 1H, H-1), 4.98 (d, $J_{a,b}$ = 11.6 Hz, 1H, CH-a, 4-*O*-Bn), 4.84 (d, $J_{a,b}$ = 11.5 Hz, 1H, CH-a, 3-*O*-Bn), 4.82 (d, $J_{a,b}$ = 10.5 Hz, 1H, CH-a, 2-*O*-Bn), 4.76 (d, $J_{a,b}$ = 11.5 Hz, 1H, CH-b, 3-*O*-Bn), 4.72 (d, $J_{a,b}$ = 10.5 Hz, 1H, CH-b, 2-*O*-Bn), 4.67 (d, $J_{a,b}$ = 11.7 Hz, 1H, CH-b, 4-*O*-Bn), 4.10 (q, $J_{5,6}$ = 6.5 Hz, 1H, H-5), 4.04 (dd, $J_{2,3}$ = 9.9 Hz, $J_{1,2}$= 3.7 Hz, 1H, H-2), 3.90 (dd, $J_{2,3}$ = 9.9 Hz, $J_{3,4}$ = 2.6 Hz, 1H, H-3), 3.67 (bs, 1H, H-4), 1.14 (d, $J_{5,6}$ = 6.5 Hz, 1H, H-6); ^{13}C NMR (125 MHz, $CDCl_3$) δ 138.7 (C-*i*, 3-*O*-Bn), 138.5 (C-*i*, 4-*O*-Bn), 138.2 (C-*i*, 2-*O*-Bn), 128.47, 128.45, 128.44, 128.35, 128.26, 128.21, 128.1, 127.8, 127.69, 127.68, 127.62, 127.60, 127.5 (15 x CH_{arom}), 91.9 (C-1), 79.1 (C-3), 77.4 (C-4), 76.5 (C-2), 74.8 (CH_2, 4-*O*-Bn), 73.5 (CH_2, 2-*O*-Bn), 73.0 (CH_2, 3-*O*-Bn), 66.7 (C-5), 16.8 (C-6); HRMS(ESI) m/z calcd. for $[C_{27}H_{30}O_5+NH_4]^+$: 452.2431, obsd.: 452.2436. Spectral data matched that previously reported.[14]



***O*-(2,3,4-Tri-*O*-benzyl-6-deoxy-α/β-D-galactopyranosyl) trichloroacetimidate (8)**.

Lactol **21** (153 mg, 0.35 mmol) was co-evaporated with toluene (x3) and dissolved in dry CH_2Cl_2 (3.5 mL). DBU (79 µL, 0.53 mmol) and trichloroacetonitrile (353 µL, 3.52 mmol) were added at rt and the mixture was stirred for 1 h. The reaction mixture was concentrated *in vacuo* and the residue purified by silica gel gradient flash chromatography (1% NEt_3 + petroleum ether to petroleum ether/EtOAc, 20:1, v/v). Both the α-isomer (126 mg, 0.22 mmol, 62%) and the β-isomer (66 mg, 0.11 mmol, 32%) were obtained as clear oils and could be separated by silica gel column chromatography. R_f: 0.61, α-anomer, R_f: 0.45, β-anomer; (PE/EA, 2/1, v/v); **α:** $[\alpha]_D^{23}$ = +58.0 (c = 1.0, $CHCl_3$); IR (film) 3343, 30064, 3030, 2935, 2904, 2874,1731, 1669, 1603, 1497, 1454, 1356, 1293, 1216, 1103, 1066, 1027, 968, 943, 838, 794, 735, 697, 644 cm^{-1}; ^1H NMR (500 MHz, $CDCl_3$) δ 8.53 (s, 1H, NH), 7.41–7.29 (m, 15H, H_{arom}), 6.55 (d, $J_{1,2}$ = 3.4 Hz, 1H, H-1), 5.04 (d, $J_{a,b}$ = 11.5 Hz, 1H, CH-a, 4-*O*-Bn), 4.89 (d, $J_{a,b}$ = 11.7 Hz, 1H, CH-a, 3-*O*-Bn), 4.80 – 4.78 (m, 3H, CH-b, 3-*O*-Bn, CH-a, CH-b, 2-*O*-Bn), 4.71 (d, $J_{a,b}$ = 11.5 Hz, 1H, CH-b, 4-*O*-Bn), 4.27 (dd, $J_{2,3}$ = 10.0 Hz, $J_{1,2}$ = 3.4 Hz, 1H, H-2), 4.12 (q, $J_{5,6}$ = 6.4 Hz, 1H, H-5), 4.06 (dd, $J_{2,3}$ = 10.0 Hz, $J_{3,4}$ = 2.6 Hz, 1H, H-3), 3.74 (bs, 1H, H-4), 1.19 (d, $J_{5,6}$ = 6.4 Hz, 1H, H-6); ^{13}C NMR (125 MHz, $CDCl_3$) δ 161.3 (C=NH), 138.6 (C-*i*, 3-*O*-Bn), 138.5 (C-*i*, 2-*O*-Bn), 138.4 (C-*i*, 4-*O*-Bn), 128.5, 128.42, 128.37, 128.29, 128.26, 127.74, 127.70, 127.6, 127.5 (15 x CH_{arom}), 95.3 (C-1), 91.6 (CCl_3), 78.3 (C-3), 77.3 (C-4), 75.8 (C-2), 75.0 (CH_2, 4-*O*-Bn), 73.2 (CH_2, 3-*O*-Bn), 72.9 (CH_2, 2-*O*-Bn), 69.6 (C-5), 16.7 (C-6); HRMS(ESI) m/z calcd. for $[C_{29}H_{30}NO_5Cl_3+Na]^+$: 600.1082, obsd.: 600.1092. ^1H and ^{13}C NMR data matched that of the previously reported enatiomer; optical rotation was of equal magnitude but opposite sign.[15,16]

iGb3 (1) and Sugar Homologues (2) and (3):

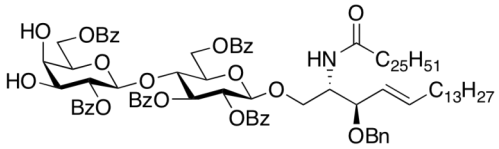


(2*S*,3*R*,4*E*)-1-(4-*O*-(2,6-Di-*O*-benzoyl-3,4-*O*-isopropylidene-β-D-galactopyranosyl)-2,3,6-tri-*O*-benzoyl-β-D-glucopyranosyloxy)-3-benzyloxy-2-hexacosanoylamido-octadecen-4-ene (22).

To a solution of glycolipid azide **6** (100 mg, 0.077 mmol) in toluene (1 mL) were added triphenylphosphine (40 mg, 0.15 mmol) and distilled water (10 drops). The solution was warmed to 80 ºC and stirred overnight. The reaction mixture was then cooled to rt, diluted with EtOAc, washed with sat. aq. NH_4Cl, dried ($MgSO_4$), filtered and concentrated under reduced pressure to give a colourless oil which was used without further purification. The oil was co-evaporated twice with dry toluene then suspended in CH_2Cl_2 (2 mL), EDCI (73 mg, 0.383 mmol), DMAP (30 mg, 0.246 mmol), and hexacosanoic acid (151 mg, 0.383 mmol) were added and the resulting solution stirred at rt over three nights. The reaction mixture was then purified directly by silica gel gradient flash chromatography (petroleum ether/EtOAc, 10/1 to 2/1, v/v) to give **22** as a colourless oil (92 mg, 0.056 mmol, 72% over two steps). R_f: 0.55 (PE/EA, 2/1, v/v); $[\alpha]_D^{22}$ = +16.0 (c = 1.0, CH_2Cl_2); IR (film) 3323, 3063, 3034, 2921, 2852, 2361, 2341, 1971, 1724, 1646, 1602, 1531, 1452, 1267, 1112, 1068, 1027, 707 cm^{-1}; ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.09 (d, $J_{CH\text{-}o,CH\text{-}m}$ = 7.3 Hz, 2H, CH-*o*, OBz), 8.02 (d, $J_{CH\text{-}o,CH\text{-}m}$ = 7.3 Hz, 2H, CH-*o*, OBz), 8.00 (d, $J_{CH\text{-}o,CH\text{-}m}$ = 7.6 Hz, 2H, CH-*o*, OBz), 7.96 (d, $J_{CH\text{-}o,CH\text{-}m}$ = 7.5 Hz, 2H, CH-*o*, OBz), 7.92 (d, $J_{CH\text{-}o,CH\text{-}m}$ = 7.3 Hz, 2H, CH-*o*, OBz), 7.62–7.11 (m, 20H, H_{arom}), 5.73 (t, $J_{2',3'}$ = 9.4 Hz, 1H, H-3′), 5.49 (dt, $J_{4,5}$ = 15.3 Hz, $J_{5,6}$ = 6.9 Hz, 1H, H-5), 5.393 (dd, $J_{2',3'}$ = 9.6 Hz, $J_{1',2'}$ = 8.0 Hz, 1H, H-2′), 5.392 (d, $J_{NH,2}$ = 9.1 Hz, 1H, NH C_{26}), 5.24 (dd, $J_{4,5}$ = 15.3 Hz, $J_{3,4}$ = 8.5 Hz, 1H, H-4), 5.14 (t, $J_{1'',2''}$ = 7.2 Hz, 1H, H-2′′), 4.60–4.55 (m, 3H, H-1′, H-1′′, H-6′a), 4.48 (dd, $J_{6'a,6'b}$ = 12.3 Hz, $J_{5',6'}$ = 4.0 Hz, 1H, H-6′b), 4.44 (d, $J_{a,b}$ = 11.5 Hz, 1H, CH-a, 3-*O*-Bn), 4.26–4.19 (m, 5H, H-1a, H-4′, H-3′′, H-6′′a, CH-b, 3-*O*-Bn), 4.09–4.05 (m, 2H, H-2, H-4′′), 3.81–3.79 (m, 1H, H-5′′), 3.75–3.69 (m, 3H, H-5′, H-6′′b, H-3), 3.47 (dd, $J_{1a,1b}$ = 9.5 Hz, $J_{1b,2}$ = 3.4 Hz, 1H, H-1b), 1.95–1.92 (m, 2H, H-6), 1.71–1.61 (m, 2H, CH_2-α), 1.52 (s, 3H, CH_3 *i*Pr), 1.55–1.03 (m, 71H, H-7–H-17, H-β–H-(ω–1), CH_3 *i*Pr), 0.88 (t, $J1_{7,18} = J_{\omega-1,\omega}$ = 6.9 Hz, 6H, H-18, H-ω); ^{13}C NMR (125 MHz, $CDCl_3$) δ 172.4 (HN<u>C</u>=O), 166.0 (C=O, 6′′-*O*-Bn), 165.8 (C=O, 6′-*O*-Bn), 165.6 (C=O, 3′-*O*-Bn), 165.3 (C=O, 2′-*O*-Bn), 165.0 (C=O, 2′′-*O*-Bn), 138.3 (C-*i*, 3-*O*-Bn), 137.0 (C-5), 133.5, 133.4, 133.3, 133.2, 133.1 (C-*p*, 5 x OBz), 129.9, 129.81, 129.78, 129.7, 129.6, 129.5, 129.3, 129.1, 128.7, 128.6, 128.5, 128.4, 128.2, 127.6, 127.4 (30 x CH_{arom}), 127.3 (C-4), 110.9 (C_q *i*Pr), 101.3 (C-1′), 100.1 (C-1′′), 79.1 (C-3), 77.0 (C-3′′), 75.2 (C-4′), 73.6 (C-2′′), 73.1 (C-4′′), 73.0 (C-5′), 72.4 (C-3′), 72.3 (C-2′), 71.3 (C-5′′), 70.3 (CH_2, 3-*O*-Bn), 68.3 (C-1), 62.8 (C-6′′), 62.6 (C-

6′), 51.2 (C-2), 36.4 (C-α), 32.2 (C-6), 31.9, 29.75, 29.73, 29.71, 29.70, 29.66, 29.56, 29.54, 29.40, 29.38, 29.37, 29.27, 29.23, 22.70 (C-7–C-17, C-γ–C-(ω–1)), 27.4, 26.1 (2 x CH_3 *i*Pr), 25.5 (C-β), 14.1 (C-18, C-ω); HRMS(ESI) m/z calcd. for $[C_{101}H_{137}NO_{18}+Na]^+$: 1674.9728, obsd.: 1674.9717.

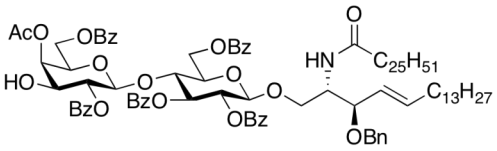
(2*S*,3*R*,4*E*)-1-(4-*O*-(2,6-Di-*O*-benzoyl-β-D-galactopyranosyl)-2,3,6-tri-*O*-benzoyl-β-D-glucopyranosyloxy)-3-benzyloxy-2-hexacosanoylamido-octadec-4-ene.



To a solution of fully protected lactosyl ceramide **22** (226 mg, 0.14 mmol) in CH_2Cl_2 (5 mL) was added TFA/H_2O solution (1/1, v/v, 0.5 mL) and the resulting solution was stirred at room temperature for 12 h. The solution was diluted with ethyl acetate and the organic layer was then washed with sat. aq. $NaHCO_3$ and brine, dried ($MgSO_4$), filtered and concentrated under reduced pressure. The colourless oil was then purified by silica gel gradient flash chromatography (petroleum ether/EtOAc, 5/1 to 1/1, v/v) to give the title compound as a colourless oil (213 mg, 0.13 mmol, 96%). R_f: 0.08 (PE/EA, 2/1, v/v); $[\alpha]_D^{25}$ = +15.0 (c = 1.0, CH_2Cl_2); IR (film) 3064, 2922, 2852, 2357, 1724, 1512, 1452, 1267, 1176, 1110, 1068, 1028, 708 cm^{-1}; ^1H NMR (500 MHz, $CDCl_3$) δ 8.07 (d, $J_{CH\text{-}o,CH\text{-}m}$ = 7.3 Hz, 2H, CH-*o*, 2′′-*O*-Bz), 8.00 (t, $J_{CH\text{-}o,CH\text{-}m}$ = 8.7 Hz, 4H, CH-*o*, OBz), 7.94 (t, $J_{CH\text{-}o,CH\text{-}m}$ = 8.7 Hz, 4H, 2 x CH-*o*, OBz), 7.59–7.14 (m, 20H, H_{arom}), 5.66 (t, $J_{2',3'}$ = $J_{3',4'}$ = 9.4 Hz, 1H, H-3′), 5.50 (dt, $J_{4,5}$ = 15.4 Hz, $J_{5,6}$ = 6.6 Hz, 1H, H-5), 5.40–5.36 (m, 2H, H-2′, NH), 5.29 (t, $J_{1'',2''}$ = 7.8 Hz, 1H, H-2′′), 5.23 (dd, $J_{4,5}$ = 15.4 Hz, $J_{3,4}$ = 8.7 Hz, 1H, H-4), 4.59 (d, $J_{1'',2''}$ = 7.8 Hz, 1H, H-1′′), 4.56 (d, $J_{1',2'}$ = 7.8 Hz, 1H, H-1′), 4.53 (bs, 2H, H-6′a, H-6′b), 4.44 (d, $J_{a,b}$ = 11.5 Hz, 1H, CH-a, 3-*O*-Bn), 4.24 (d, $J_{a,b}$ = 11.5 Hz, 1H, CH-b, 3-*O*-Bn), 4.23–4.22 (m, 1H, H-1a), (t, $J_{3',4'}$ = 9.4 Hz, 1H, H-4′), 4.08–4.05 (m, 1H, H-2), 4.00 (dd, $J_{6''a,6''b}$ = 11.3 Hz, $J_{5,6''a}$ = 6.8 Hz, 1H, H-6′′a), 3.81 (bs, 1H, H-4′′), 3.73–3.67 (m, 3H, H-3, H-5′, H-3′′), 3.63 (dd, $J_{6''a,6''b}$ = 11.3 Hz, $J_{5,6''b}$ = 6.2 Hz, 1H, H-6′′b), 3.48–3.47 (m, 2H, H-1b, H-5′′), 1.95–1.92 (m, 2H, H-6), 1.68–1.60 (m, 2H, CH_2-α), 1.37–0.90 (m, 68H, H-7–H-17, H-β–H-(ω–1)), 0.88 (t, $J_{17,18} = J_{\omega,\omega+1}$ = 6.9 Hz, 6H, H-18, H-ω); ^{13}C NMR (125 MHz, $CDCl_3$) δ 172.4 (HN<u>C</u>=O), 166.4 (C=O, 2′′-*O*-Bn), 166.1 (C=O, 6′′-*O*-Bn), 165.9 (C=O, 6′-*O*-Bn), 165.8 (C=O, 3′-*O*-Bn), 165.3 (C=O, 2′-*O*-Bn), 138.3 (C-*i*, 3-*O*-Bn), 137.0 (C-5), 133.5, 133.4, 133.3 (C-*p*, 5 x OBz), 129.9, 129.8, 129.7, 129.64, 129.56, 129.54,

129.47, 129.1, 129.0, 128.59, 128.56, 128.51, 128.4, 128.2, 127.6, 127.4 (30 x CH_{arom}), 127.3 (C-4), 101.1 (C-1′), 100.8 (C-1′′), 79.1 (C-3), 75.9 (C-4′), 73.7 (C-2′′), 73.0 (C-5′), 72.7 (C-3′), 72.6 (C-3′′), 72.5 (C-5′′), 72.1 (C-2′), 70.3 (CH_2, 3-*O*-Bn), 68.5 (C-4′′), 68.3 (C-1), 62.6 (C-6′), 61.8 (C-6′′), 51.2 (C-2), 36.4 (C-α), 32.2 (C-6), 31.9, 29.72, 29.71, 29.68, 29.66, 29.56, 29.54, 29.40, 29.37, 29.27, 29.23, 22.7 (C-7–C-17, C-γ–C-(ω–1)), 25.5 (C-β), 14.1 (C-18, C-ω); HRMS(ESI) m/z calcd. for $[C_{98}H_{134}NO_{18}+H]^+$: 1612.9595, obsd.: 1612.9612.

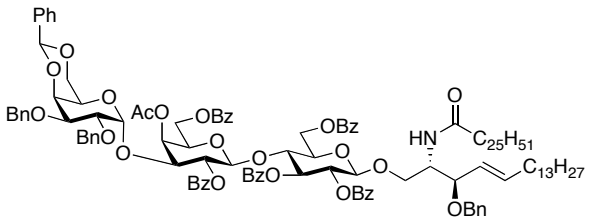
(2*S*,3*R*,4*E*)-1-(4-*O*-(4-*O*-Acetyl-2,6-di-*O*-benzoyl-β-D-galactopyranosyl)-2,3,6-tri-*O*-benzoyl-β-D-glucopyranosyloxy)-3-benzyloxy-2-hexacosanoylamido-octadec-4-ene (23).



(2*S*,3*R*,4*E*)-1-(4-*O*-(2,6-Di-*O*-benzoyl-β-D-galactopyranosyl)-2,3,6-tri-*O*-benzoyl-β-D-glucopyranosyloxy)-3-benzyloxy-2-hexacosanoylamido-octadec-4-ene (181 mg, 0.11 mmol) was co-evaporated with toluene (x3) and dissolved in dry CH_2Cl_2 (1.1 mL). Trimethyl orthoacetate (84 μL, 0.67 mmol) and CSA (52 mg, 0.22 mmol) were added and the reaction mixture was stirred at rt for 16 h. The reaction mixture was diluted with EtOAc (30 mL), washed with 1M HCl solution (3 x 30 mL), sat. aq. $NaHCO_3$ (30 mL) and brine (30 mL), dried ($MgSO_4$), filtered and concentrated *in vacuo*. The residue was purified by silica gel gradient flash chromatography (petroleum ether/EtOAc, 10/1 to 1/1, v/v) to afford acetate **23** as a clear oil (170 mg, 0.26 mmol, 92%). R_f: 0.24 (PE/EA, 2/1, v/v); $[\alpha]_D^{24}$ = +4.0 (c = 1.0, CH_2Cl_2); IR (film) 3325, 3064, 2923, 2853, 2359, 1966, 1726, 1452, 1372, 1265, 1177, 1108, 1094, 1069, 1027, 975, 736, 708 cm^{-1}; ^1H NMR (500 MHz, $CDCl_3$) δ 8.06 (d, $J_{CH\text{-}o,CH\text{-}m}$ = 7.8 Hz, 2H, CH-*o*, OBz), 8.03 (d, $J_{CH\text{-}o,CH\text{-}m}$ = 7.6 Hz, 4H, 2 x CH-*o*, OBz), 7.96 (d, $J_{CH\text{-}o,CH\text{-}m}$ = 7.3 Hz, 2H, CH-*o*, OBz), 7.96 (d, $J_{CH\text{-}o,CH\text{-}m}$ = 7.8 Hz, 2H, CH-*o*, OBz), 7.60–7.13 (m, 20H, H_{arom}), 5.72 (t, $J_{2',3'} = J_{3',4'}$ = 9.7 Hz, 1H, H-3′), 5.50 (dt, $J_{4,5}$ = 15.6 Hz, $J_{5,6}$ = 6.6 Hz, 1H, H-5), 5.41 (dd, $J_{1',2'}$ = 8.0 Hz, $J_{2',3'}$ = 9.7 Hz, 1H, H-2′), 5.37 (d, $J_{NH,2'}$ = 9.3 Hz, 1H, NH), 5.26–5.22 (m, 1H, H-4), 5.22 (d, $J_{3'',4''}$ = 3.5 Hz, 1H, H-4′′), 5.16 (dd, $J_{2'',3''}$ = 9.8 Hz, $J_{1'',2''}$ = 8.0 Hz, 1H, H-2′′), 4.65 (d, $J_{1'',2''}$ = 8.0 Hz, 1H, H-1′′), 4.61 (d, $J_{1',2'}$ = 8.0 Hz, 1H, H-1′), 4.60–4.51 (m, 2H, H-6′a, H-6′b), 4.44 (d, $J_{a,b}$ = 11.5 Hz, 1H, CH-a, 3-*O*-Bn), 4.25 (d, $J_{a,b}$ = 11.5 Hz, 1H, CH-b, 3-*O*-Bn), 4.19 (t, $J_{3',4'}$ = 9.7 Hz, 1H, H-4′), 4.07 (m, 1H, H-2),

3.82 (dd, $J_{2'',3''}$ = 9.8 Hz, $J_{3'',4''}$ = 3.5 Hz, 1H, H-3′′), 3.76 (d, $J_{4',5'}$ = 7.8 Hz, 1H, H-5′), 3.73–3.68 (m, 2H, H-3, H-6′′a), 3.64–3.59 (m, 2H, H-5′′, H-6′′b), 3.50 (dd, $J_{1a,1b}$ = 9.8 Hz, $J_{1b,2}$ = 3.5 Hz, 1H, H-1b), 1.99 (s, 3H, OAc), 1.98–1.92 (m, 2H, H-6), 1.69–1.60 (m, 2H, CH_2-α), 1.37–1.03 (m, 68H, H-7–H-17, H-β–H-(ω–1)), 0.88 (t, $J_{17,18}$ = $J_{\omega-1,\omega}$ = 6.9 Hz, 6H, H-18, H-ω); ^{13}C NMR (125 MHz, $CDCl_3$) δ 172.4 (HN<u>C</u>=O), 170.6 (C=O, OAc), 166.5 (C=O, 2′′-*O*-Bn), 165.9 (C=O, 6′-*O*-Bn), 165.6 (C=O, 6′′-*O*-Bn), 165.3 (C=O, 2′-*O*-Bn), 165.3 (C=O, 3′-*O*-Bn), 138.3 (C-*i*, 3-*O*-Bn), 137.0 (C-5), 133.6, 133.5, 133.4, 133.2 (C-*p*, 5 x OBz), 129.89, 120.82, 129.76, 129.62, 129.51, 129.41, 129.06, 128.9, 128.6, 128.58, 128.26, 128.19, 127.63, 127.40, 127.30 (30 x CH_{arom}), 101.3 (C-1′), 100.3 (C-1′′), 79.1 (C-3), 75.3 (C-4′), 73.5 (C-2′′), 73.0 (C-5′), 72.4 (C-3′), 72.1 (C-2′), 71.5 (C-3′′), 71.1 (C-5′′), 70.3 (CH_2, 3-*O*-Bn), 69.3 (C-4′′), 68.3 (C-1), 62.5 (C-6′), 61.2 (C-6′′), 21.1 (C-2), 36.4 (C-α), 32.2 (C-6), 31.92, 29.72, 29.70, 29.68, 29.66, 29.55, 29.54, 29.39, 29.37, 29.36, 29.26, 29.22, 25.45, 22.69 (C-7–C-17, C-β–C-(ω–1)), 20.6 (OAc), 14.1 (C-18, C-ω); HRMS(ESI) m/z calcd. for $[C_{100}H_{135}NO_{19}+Na]^+$: 1676.9521, obsd.: 1676.9526.

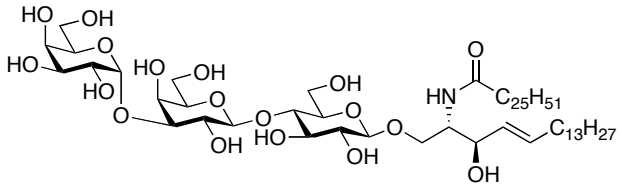
(2*S*,3*R*,4*E*)-1-(4-*O*-(4-*O*-Acetyl-2,6-di-*O*-benzoyl-3-*O*-(2,3-di-*O*-benzyl-4,6-*O*-benzylidene-α-D-galactopyranosyl)-β-D-galactopyranosyl)-2,3,6-tri-*O*-benzoyl-β-D-glucopyranosyloxy)-3-benzyloxy-2-(hexacosanoylamido)-octadec-4-ene (24). A



solution of galactose imidate **7** (26 mg, 0.0435 mmol) and glycolipid **23** (36 mg, 0.0218 mmol), co-evaporated 3 times with dry toluene, was dissolved in dry DCM (0.2 mL) and 4 Å molecular sieves were added. This mixture was cooled to -20 ºC and TMSOTf (5.5 µL of a DCM/ TMSOTf, 9/1, v/v solution) was added slowly drop wise, the resulting solution was stirred 1.5 h at 0 ºC then warmed to room temperature and stirred over night. The solution was diluted with ethyl acetate and washed sat. aq. NaHCO3 and brine, dried MgSO4, filtered and concentrated under reduced pressure. The resulting oil was purified by gradient flash column chromatography (Petroleum ether/EtOAc, 10/1 to 3/1, v/v). The product was then further purified by flash column chromatography (Petroleum ether/EtOAc, 4/1, v/v) to give fully protected iGb3 as a colourless oil (43%, 19.5 mg, 0.00936 mmol). R_f : 0.55 (Petroleum ether/EtOAc, 1/1,

v/v); ^{1}H NMR (600 MHz, pyridine-d_5) δ 8.05-7.94 (m, 10H, CH Bz), 7.63-7.12 (m, 35H, CH-arom), 5.74 (t, J = 9.7 Hz, 1H), 5.50 (dt, J = 15.2, J = 6.7 Hz, 1H), 5.43-5.34 (m, 3H), 5.24 (dd, J = 15.2, J = 8.6 Hz, 1H), 5.16 (s, 1H), 5.04 (d, J = 3.2 Hz, 1H), 4.66-4.43 (m, 9H), 4.27-4.24 (m, 2H), 4.17 (d, J = 9.5 Hz, 1H), 4.10-4.05 (m, 1H), 3.91-3.88 (m, 1H), 3.80 (dd, J = 3.5 Hz, J = 9.9 Hz, 1H), 3.76-3.60 (m, 6H), 3.53-3.39 (m, 4H), 3.31 (bs, 1H), 1.98-1.91 (m, 2H), 1.72-1.61 (m, 5H), 1.35-1.19 (m, 62H), 0.90-0.87 (m, 6H); ^{13}C NMR (125 MHz, pyridine-d_5) δ 172.3, 170.0, 166.0, 165.6, 165.3, 165.2, 164.3, 138.7, 138.6, 138.3, 137.7, 137.1, 133.6, 133.5, 133.4, 133.2, 129.84, 129.77, 129.74, 129.66, 129.57, 129.54, 129.47, 129.36, 129.07, 129.03, 128.9, 128.8, 128.64, 128.62, 128.58, 128.3, 128.22, 128.18, 128.13, 128.08, 128.06, 127.61, 127.60, 127.5, 127.39, 127.37, 127.31, 126.2, 101.4, 100.9, 100.8, 95.2, 79.1, 75.9, 75.3, 74.5, 74.3, 73.8, 73.1, 73.0, 72.4, 72.2, 71.3, 71.0, 70.3, 68.8, 68.3, 64.5, 62.8, 62.5, 61.1, 51.2, 36.4, 32.2, 31.9, 31.4, 30.2, 29.8, 29.73, 29.71, 29.69, 29.67, 29.56, 29.54, 29.40, 29.38, 29.37, 29.26, 29.23, 25.4, 22.7, 20.2, 14.1; HRMS(ESI) m/z calcd. for $[C_{127}H_{161}NO_{24}+Na]^{+}$: 2107.1301, obsd.: 2107.1323.

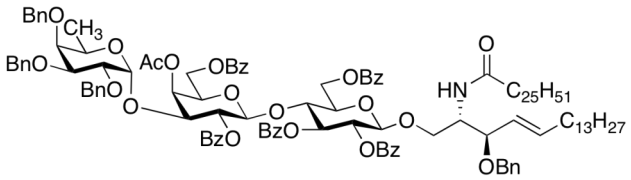
(2*S*,3*R*,4*E*)-2-(Hexacosanoylamido)-1-(4-*O*-(3-*O*-α-D-galactopyranosyl)-β-D-galactopyranosyl)-β-D-glucopyranosyloxy)-3-hydroxy-octadec-4-ene (iGb3, 1)



To a solution of fully protected iGb3 **24** (21 mg, 0.0100 mmol) in THF (1 mL), liquid NH_3 was added, followed by the careful addition of Na (s) until the blue colour remained. The solution was stirred for 1 h under refluxing NH_3, then allowed to warm to rt and the excess NH_3 to evaporate. The solution was neutralised by the addition of Dowex H^{+}, filtered and concentrated under reduced pressure. The resulting powder was purified by gradient flash column chromatography (DCM/MeOH, 50/1 to 5/1, v/v) then further purified by reverse phase column chromatography C-18 cartridge (product eluted in EtOH) to give iGb3 **1** as an amorphous white solid (95%, 11.1 mg, 0.00953 mmol). R_f: 0.38 (CH_2Cl_2/MeOH, 5/1, v/v); $[\alpha]_D^{22}$ = +44.2 (c = 0.17, pyridine); IR (film) 3407, 2953, 2918, 2849, 1635, 1541, 1455, 1377, 1275, 1116, 1081, 1015, 973, 747 cm^{-1}; ^{1}H NMR (600 MHz, pyridine-d_5) δ 8.45 (d, $J_{NH,2}$ = 8.7 Hz, 1H, NH), 6.05 (dt, $J_{4,5}$ = 15.3 Hz, $J_{5,6}$ = 6.8 Hz, 1H, H-5), 5.93 (dd, $J_{4,5}$ = 15.7 Hz, J3,4 = 6.7 Hz, 1H, H-4), 5.69 (d,

$J_{1''',2'''}$ = 3.8 Hz, 1H, H-1'''), 5.09 (d, $J_{1'',2''}$ = 8.2 Hz, 1H, H-1''), 5.07 (dd, $J_{5''',6a'''} = J_{5''',6b'''}$ = 6.2 Hz, 1H, H-5'''), 4.92 (d, $J_{1',2'}$ = 7.8 Hz, 1H, H-1'), 4.86-4.78 (m, 3H, H-2, H1a, H-3), 4.77 (dd, $J_{1''',2'''}$ = 3.8 Hz, $J_{2''',3'''}$ = 9.8 Hz, 1H, H-2'''), 4.72 (bd, $J_{3''',4'''}$ = 2.6 Hz, 1H, H-4'''), 4.60 (bd, $J_{3'',4''}$ = 2.8 Hz, 1H, H-4''), 4.59-4.54 (m, 3H, H-3''', H-2'', H-6a'''), 4.54-4.44 (m, 4H, H-6a', H-6b', H-6b''', H-6a''), 4.35 (dd, $J_{5'',6b''}$ = 5.1 Hz, $J_{6a'',6b''}$ = 11.0 Hz, 1H, H-6b''), 4.31-4.25 (m, 3H, H-4', H-3'', H-3'), 4.21-4.18 (m, 1H, H1b), 4.08 (dd, $J_{1',2'}$ = 7.8 Hz, $J_{2',3'}$ = 9.2 Hz, 1H, H-2'), 4.06 (bt, $J_{5'',6a''}$ = 7.8 Hz, = $J_{5'',6b''}$ = 5.1 Hz, 1H, H-5''), 3.91-3.87 (m, 1H, H-5'), 2.46 (t, $J_{\alpha,\beta}$ = 7.7 Hz, 2H, CH_2-α), 2.08 (app q, $J_{5,6} = J_{6,7}$ = 7.5 Hz, 2H, CH_2-6), 1.89-1.80 (m, 2H, CH_2-β), 1.42-1.35 (m, 2H, CH_2-γ), 1.34-1.22 (m, 60H, CH_2-aliphtic), 0.90-0.87 (m, 6H, CH_2-18, CH_2-ω); ^{13}C NMR (125 MHz, pyridine-d_5) δ 173.7 (C(O)N), 133.1 (C5), 132.7 (C4), 106.0 (C1'/C1''), 105.9 (C1'/C1''), 98.1 (C1'''), 82.6 (C-4'), 80.6 (C-3''), 77.1 (C-3'), 77.0 (C-5''), 76.9 (C-5'), 75.2 (C-2'), 73.3 (C-5'''), 73.1 (C-3), 72.1 (C-3'''), 71.2 (C-4'''), 71.0 (C-1), 70.9 (C-2''), 70.8 (C-2'''), 66.4 (C-4''), 62.6 (C-6'''), 62.4 (C-6'), 62.2 (C-6''), 55.3 (C-2), 37.4 (C-α), 33.2 (C-6), 32.6, 32.5, 30.49, 30.47, 30.45, 30.42, 30.41, 30.40, 30.39, 30.37, 30.34, 30.23, 30.16, 30.08, 30.05, 30.04, 26.9, 23.39, 23.37 (CH_2-alifatic), 14.73, 14.72 (C-18, C-ω); HRMS(ESI) m/z calcd. for $[C_{62}H_{117}NO_{18}+Na]^+$: 1186.8163, obsd.: 1186.8156). Spectral data matched that previously reported.[17]

(2*S*,3*R*,4*E*)-1-(4-*O*-(4-*O*-Acetyl-2,6-di-*O*-benzoyl-3-*O*-(2,3,4-tri-*O*-benzyl-6-deoxy-α-D-galactopyranosyl)-β-D-galactopyranosyl)-2,3,6-tri-*O*-benzoyl-β-D-glucopyranosyloxy)-3-benzyloxy-2-hexacosanoylamido-octadec-4-ene (25)

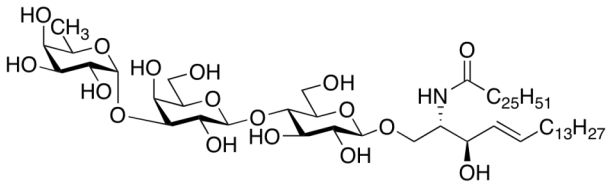


Fucosyl imidate donor **8** (32 mg, 0.055 mmol) and lactosyl ceramide acceptor **23** (44.7 mg, 0.027 mmol) were co-evaporated with toluene (x3), dissolved in dry CH_2Cl_2 (1 mL) and stirred with activated 4Å molecular sieves for 3 h. The reaction mixture was cooled to -40 °C, a solution of TMSOTf in CH_2Cl_2 (0.28 mmol/mL, 9.8 μL, 0.0027 mmol) was added and the resulting solution stirred for 1 h. The reaction was then warmed to -20 °C and further TMSOTf solution (0.28 mmol/mL, 5.9 μL, 0.0016 mmol) added. The reaction mixture was allowed to warm slowly to rt while stirring overnight (20 h), after which time it was quenched with NEt_3 (40 μL, 0.29 mmol), filtered and concentrated *in vacuo*. The resultant oil was

purified by silica gel gradient flash chromatography (3% to 8 % EtOAc in toluene) to afford the fully protected triglycosyl ceramide **25** as a clear oil (38.6 mg, 0.019 mmol, 69%). R_f: 0.49 (PE/EA, 2/1, v/v); $[\alpha]_D^{24}$ = +12.0 (c = 1.0, $CHCl_3$); IR (film) 3091, 2923, 2853, 1730, 1672, 1602, 1497, 1453, 1364, 1315, 1267, 1176, 1097, 1069, 1028, 978, 755, 710, 641 cm^{-1}; ^1H NMR (600 MHz, $CDCl_3$) δ 8.02 (d, $J_{CH\text{-}o,CH\text{-}m}$ = 7.3 Hz, 2H, CH-*o*, 6′′-*O*-Bz), 8.01 (d, $J_{CH\text{-}o,CH\text{-}m}$ = 7.0 Hz, 2H, CH-*o*, 3′-*O*-Bz), 7.98 (d, $J_{CH\text{-}o,CH\text{-}m}$ = 7.1 Hz, 2H, CH-*o*, 2′-*O*-Bz), 7.95 (d, $J_{CH\text{-}o,CH\text{-}m}$ = 7.1 Hz, 2H, CH-*o*, 2′′-*O*-Bz), 7.93 (d, $J_{CH\text{-}o,CH\text{-}m}$ = 7.1 Hz, 2H, CH-*o*, 6′-*O*-Bz), 7.61–7.13 (m, 35H, H_{arom}), 5.74 (t, $J_{3',4'}$ = 9.6 Hz, 1H, H-3′), 5.49 (dt, $J_{4,5}$ = 15.3 Hz, $J_{5,6}$ = 6.7 Hz, 1H, H-5), 5.41 (t, $J_{1',2'} = J_{2',3'}$ = 7.5 Hz, 1H, H-2′), 5.40 (t, $J_{1'',2''} = J_{2'',3''}$ = 7.5 Hz, 1H, H-2′′), 5.36 (d, $J_{NH,2'}$ = 9.1 Hz, 1H, NH), 5.34 (d, $J_{3'',4''}$ = 3.4 Hz, 1H, H-4′′), 5.23 (dt, $J_{4,5}$ = 15.3 Hz, $J_{3,4}$ = 8.8 Hz, 1H, H-4), 4.94 (d, $J_{1''',2'''}$ = 3.5 Hz, 1H, H-1′′′), 4.75 (d, $J_{a,b}$ = 11.3 Hz, 1H, CH-a, 4′′′-*O*-Bn), 4.72 (d, $J_{a,b}$ = 11.9 Hz, 1H, CH-a, 3′′′-*O*-Bn), 4.60 (d, $J_{1',2'}$ = 7.9 Hz, 1H, H-1′), 4.56 (d, $J_{1'',2''}$ = 8.2 Hz, 1H, H-1′′), 4.58–4.54 (m, 2H, CH-a, CH-b, 2′′′-*O*-Bn), 4.48 (d, $J_{a,b}$ = 11.9 Hz, 1H, CH-b, 3′′′-*O*-Bn), 4.48–4.47 (m, 2H, H-6′a, H-6′b), 4.44 (d, $J_{a,b}$ = 11.5 Hz, 1H, CH-a, 3-*O*-Bn), 4.34 (d, $J_{a,b}$ = 11.3 Hz, 1H, CH-b, 4′′′-*O*-Bn), 4.25 (dd, $J_{1a,1b}$ = 9.8 Hz, $J_{1a,2}$ = 2.7 Hz, 1H, H-1a), 4.24 (d, $J_{a,b}$ = 11.5 Hz, 1H, CH-b, 3-*O*-Bn), 4.17 (t, $J_{3',4'}$ = 9.6 Hz, 1H, H-4′), 4.09–4.05 (m, 1H, H-2), 3.83 (dd, $J_{2''',3'''}$ = 10.2 Hz, $J_{1''',2'''}$ = 3.5 Hz, 1H, H-2′′′), 3.80 (dd, $J_{2'',3''}$ = 10.3 Hz, $J_{3'',4''}$ = 3.4 Hz, 1H, H-3′′), 3.74–3.69 (m, 2H, H-5′, H-3), 3.62–3.59 (m, 2H, H-6′′a, H-6′′b), 3.57–3.55 (m, 2H, H-5′′′, H-3′′′), 3.52 (t, $J_{5'',6''}$ = 6.9 Hz, 1H, H-5′′), 3.48 (dd, $J_{1a,1b}$ = 9.8 Hz, $J_{1a,2}$ = 3.7 Hz, 1H, H-1b), 2.90 (d, $J_{3''',4'''}$ = 0.9 Hz, 1H, H-4′′′), 1.96–1.92 (m, 2H, H-6), 1.70–1.62 (m, 2H, CH_2-α), 1.63 (s, 3H, OAc), 1.31–1.04 (m, 68H, H-7–H-17, H-β–H-(ω–1)), 0.88 (t, $J_{17,18} = J_{\omega-1,\omega}$ = 7.0 Hz, 6H, H-18, H-ω), 0.79 (d, $J_{5''',6'''}$ = 6.5 Hz, 3H, H-6′′′); ^{13}C NMR (150 MHz, $CDCl_3$) δ 172.5 (HN<u>C</u>=O), 170.2 (C=O, OAc), 166.0 (C=O, 6′-*O*-Bn), 165.8 (C=O, 6′′-*O*-Bn), 165.5 (C=O, 2′′-*O*-Bn), 165.3 (C=O, 3′-*O*-Bn), 164.5 (C=O, 2′-*O*-Bn), 139.0 (C-*i*, 3′′′-*O*-Bn), 138.7 (C-*i*, 2′′′-*O*-Bn), 138.5 (C-*i*, 4′′′-*O*-Bn), 138.4 (C-*i*, 3-*O*-Bn), 137.2 (C-5), 133.7, 133.6, 133.55, 133.52, 133.3 (C-*p*, 5 x OBz), 129.97, 129.89, 129.87, 129.78, 129.67, 129.60, 129.48, 129.18, 128.75, 128.71, 128.57, 128.44, 128.34, 128.32, 128.22, 128.17, 128.09, 128.05, 127.85, 127.76, 127.61, 127.59, 127.57, 127.52, 127.41 (45 x CH_{arom}), 127.44 (C-4), 101.5 (C-1′), 100.9 (C-1′′), 94.2 (C-1′′′), 79.2 (C-3), 79.0 (C-3′′′), 77.6 (C-4′′′), 75.4 (C-4′, C-2′′′), 74.9 (CH_2, 4′′′-*O*-Bn), 73.5

(CH_2, 2′′′-*O*-Bn), 73.3 (CH_2, 3′′′-*O*-Bn), 73.1 (C-5′), 72.5 (C-3′), 72.3 (C-2′′, C-3′′), 71.4 (C-5′′), 71.1 (C-2′), 70.4 (CH_2, 3-*O*-Bn), 68.5 (C-1), 66.7 (C-5′′′), 64.4 (C-4′′), 62.5 (C-6′), 61.3 (C-6′′), 51.3 (C-2), 36.6 (C-α), 32.4 (C-6), 32.07, 30.17, 29.89, 29.87, 29.85, 29.82, 29.80, 29.70, 29.68, 29.53, 29.52, 29.51, 29.41, 29.39, 29.36, 27.22, 25.58, 22.84 (C-7–C-17, C-β–C-(ω–1)), 20.4 (OAc), 16.2 (C-6′′′), 14.3 (C-18, C-ω); HRMS(ESI) m/z calcd. for $[C_{127}H_{163}NO_{23}+Na]^+$: 2093.1508, obsd.: 2093.1463.

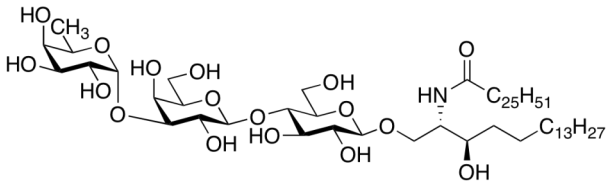
(2*S*,3*R*,4*E*)-1-(4-*O*-(3-*O*-(6-Deoxy-α-D-galactopyranosyl)-β-D-galactopyranosyl)-β-D-glucopyranosyloxy)-2-hexacosanoylamido-3-hydroxy-octadec-4-ene (2).



Fully protected triglycosyl ceramide **25** (33 mg, 0.016 mmol) was dissolved in dry THF (2 mL) and NH_3 (10 mL) was condensed into the reaction vessel at -78 °C. Small pieces of Na (s) were added carefully until the solution remained deep blue. The reaction mixture was then stirred for 30 min before being quenched with a few drops of MeOH and Na (s) was added again until the deep blue colour persisted. The reaction mixture was stirred for a further 30 min. The reaction was quenched with 10 mL MeOH then warmed slowly to rt to allow the ammonia to evaporate. Trace ammonia was removed with an Ar stream. The reaction mixture was quenched to pH 7 with Dowex-H^+, filtered and washed with pyridine and concentrated *in vacuo*. The resultant oil was purified by silica gel gradient flash chromatography (CH_2Cl_2/MeOH, 20/1 to 10/1, v/v) to afford fully deprotected 6′′′-deoxy-iGb3-sphingosine **2** as an amorphous white solid (6.2 mg, 0.0054 mmol, 34%). R_f: 0.29 (CH_2Cl_2/MeOH, 5.7/1, v/v); $[\alpha]_D^{27}$ = +37.0 (c = 0.1, pyridine); IR (film) 3402, 2922, 1653, 1558, 1541, 1458, 1134, 1099, 1072, 1038, 890, 814, 791, 694, 648, 633 cm^{-1}; ^1H NMR (500 MHz, pyridine-d_5) δ 8.45 (d, $J_{2,NH}$ = 8.2 Hz, 1H, NH), 6.04 (dd, $J_{4,5}$ = 15.2 Hz, $J_{3,4}$ = 16.4 Hz, 1H, H-4), 5.93 (dt, $J_{4,5}$ = 15.2 Hz, $J_{5,6}$ = 6.9 Hz, 1H, H-5), 5.59 (d, $J_{1''',2'''}$ = 3.7 Hz, 1H, H-1′′′), 5.11 (d, $J_{1'',2''}$ = 7.9 Hz, 1H, H-1′′), 4.95 (q, $J_{5''',6'''}$ = 6.7 Hz, 1H, H-5′′′), 4.89 (d, $J_{1',2'}$ = 7.9 Hz, 1H, H-1′), 4.81–4.79 (m, 3H, H-1a, H-2, H-3), 4.66 (dd, $J_{2''',3'''}$ = 9.9 Hz, $J_{1''',2'''}$ = 3.7 Hz, 1H, H-2′′′), 4.59 (d, $J_{3'',4''}$ = 2.1 Hz, 1H, H-4′′), 4.56–4.53 (m, 2H, H-2′′, H-3′′′), 4.50–4.44 (m, 3H, H-6′a, H-6′b, H-6′′a), 4.34 (dd, $J_{6''a,6''b}$ = 10.9 Hz, $J_{5'',6''b}$ = 3.4 Hz, 1H, H-6′′b), 4.30–4.23 (m, 3H, H-4′, H-3′′, H-3′), 4.18–4.17 (m, 1H, H-1b), 4.14 (bs, 1H,

H-4′′′), 4.10–4.05 (m, 2H, H-5′′, H-2′), 3.87–3.85 (m, 1H, H-5′), 2.46 (t, $J_{\alpha,\beta}$ = 7.4 Hz, 2H, CH_2-α), 2.08 (dd, $J_{6,7}$ = 13.9 Hz, $J_{5,6}$ = 6.9 Hz, 2H, H-6), 1.87–1.81 (m, 2H, CH_2-β), 1.59 (d, $J_{5''',6'''}$ = 6.6 Hz, 3H, H-6′′′), 1.41–1.27 (m, 66H, H-7–H-17, H-γ–H-(ω–1)), 0.90–0.86 (m, 6H, H-18, H-ω); ^{13}C NMR (125 MHz, pyridine-d_5) δ 173.7 (HN<u>C</u>=O), 133.0 (C-5), 132.6 (C-4), 105.84, 105.79 (C-1′, C-1′′), 97.9 (C-1′′′), 82.4 (C-4′), 80.4 (C-3′′), 77.00 (C-3′), 76.95 (C-5′′), 76.8 (C-5′), 75.1 (C-2′), 73.8 (C-4′′′), 73.0 (C-3), 72.0 (C-3′′′), 70.8 (C-1, C-2′′), 70.4 (C-2′′′), 68.1 (C-5′′′), 66.3 (C-4′′), 62.3 (C-6′), 62.2 (C-6′′), 55.2 (C-2), 37.3 (C-α), 33.1 (C-6), 26.8 (C-β), 32.48, 32.46, 30.38, 30.36, 30.33, 30.25, 30.14, 30.07, 29.98, 29.94, 23.29, 23.27 (C-7–C-17, C-γ–C-(ω–1)), 17.6 (C-6′′′), 14.6 (C-18, C-ω); HRMS(ESI) m/z calcd. for $[C_{62}H_{117}NO_{17}+H]^+$: 1148.8394, obsd.: 1148.8374.

(2*S*,3*R*,4*E*)-1-(4-*O*-(3-*O*-(6-Deoxy-α-D-galactopyranosyl)-β-D-galactopyranosyl)-β-D-glucopyranosyloxy)-2-hexacosanoylamido-3-hydroxy-octadecane (3).

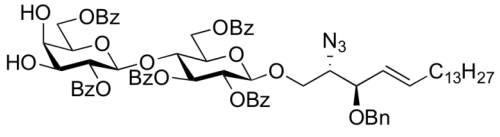


$Pd(OH)_2$/C (2 mol%) was added to a solution of fully protected triglycosyl ceramide **25** (22 mg, 0.010 mmol) dissolved in $CHCl_3$/EtOH (3/2, v/v). The reaction mixture was stirred under H_2 atmosphere for 4 h, filtered through a celite pad then concentrated under reduced pressure. The resultant oil was purified by silica gel gradient flash chromatography (2.5% to 5% MeOH in CH_2Cl_2) to afford debenzylated 6′′′-deoxy-iGb3-sphinganine (13.4 mg, 0.0078 mmol, 75%), which was subsequently dissolved in MeOH/CH_2Cl_2 (2/1, v/v, 4.5 mL). NaOMe was added until the reaction mixture reached pH 9 and stirred at rt for 17 h. The reaction mixture was then warmed to 40 °C and stirred for a further 3 h before neutralising to pH 7 using Dowex-H^+. The resin was removed by filtration and washed successively with pyridine and concentrated under reduced pressure. MeOH (5 mL) was added to the crude mixture and the solution cooled to -4 °C to give a suspension of the glycolipid. The precipitate was collected by centrifuge and washed with MeOH (2 x 5 mL) to afford the fully deprotected 6′′′-deoxy-iGb3-sphinganine **3** as an amorphous white solid (6.1 mg, 0.0053 mmol, 70%). More of the desired product was precipitated from the combined MeOH supernatant (1.7 mg, 0.0015 mmol, 19%) to givea total yield of 6′′′-deoxy-iGb3-sphinganine **3** of 89% (7.8 mg,

0.0068 mmol). R_f: 0.23 (CH_2Cl_2/MeOH, 5/1, v/v); $[\alpha]_D^{27}$ = +42.0 (c = 0.1, pyridine); IR (film) 3342, 2919, 2850, 1626, 1551, 1468, 1379, 1165, 1081, 1038, 899, 813, 778, 722, 677, 651, 632 cm^{-1}; ^1H NMR (500 MHz, pyridine-d_5) δ 8.45 (d, $J_{2,NH}$ = 9.0 Hz, 1H, NH), 7.64 (d, $J_{2',OH}$ = 3.0 Hz, 1H, H-2′-OH), 7.36 (d, $J_{2''/3''',OH}$ = 5.5 Hz, 1H, H-2′′/3′′′-OH), 7.08 (d, $J_{2''',OH}$ = 5.5 Hz, 1H, H-2′′′-OH), 6.68 (d, $J_{6'',OH}$ = 5.0 Hz, 1H, H-6′′-OH), 6.56 (d, $J_{2''/3''',OH}$ = 5.4 Hz, 1H, H-2′′/3′′′-OH), 6.48 (d, $J_{6',OH}$ = 6.2 Hz, 1H, H-6′-OH), 6.30 (d, $J_{3,OH}$ = 6.3 Hz, 1H, H-3-OH), 6.26 (d, $J_{4''',OH}$ = 3.8 Hz, 1H, H-4′′′-OH), 6.18 (s,1H, H-3′-OH), 5.83 (s,1H, H-4′′-OH), 5.60 (d, $J_{1''',2'''}$ = 3.3 Hz, 1H, H-1′′′), 5.10 (d, $J_{1'',2''}$ = 8.0 Hz, 1H, H-1′′), 4.95 (q, $J_{5''',6'''}$ = 6.5 Hz, 1H, H-5′′′), 4.89 (d, $J_{1',2'}$ = 7.6 Hz, 1H, H-1′), 4.80 (dd, $J_{1a,1b}$ = 10.4 Hz, $J_{1a,2}$ = 4.4 Hz, 1H, H-1a), 4.73–4.69 (m, 1H, H-2), 4.68–4.64 (m, 1H, H-2′′′), 4.59 (bs, 1H. H-4′′), 4.57–4.53 (m, 2H, H-2′′, H-3′′′), 4.51–4.49 (m, 2H, H-6′a, H-6′b), 4.46 (dd, $J_{6''a,6''b}$ = 12.2 Hz, $J_{5,6''a}$ = 5.6 Hz,1H, H-6′′a), 4.37–4.33 (m, 1H, H-6′′b), 4.29–4.21 (m, 4H, H-3′, H-4′, H-3′′, H-3), 4.18 (dd, $J_{1a,1b}$ = 10.4 Hz, $J_{1b,2}$ = 3.2 Hz, 1H, H-1b), 4.14 (bs, 1H, H-4′′′), 4.10–4.06 (m, 2H, H-5′′, H-2′), 4.89–4.87 (m, 1H, H-5′), 2.48 (t, $J_{\alpha,\beta}$ = 7.4 Hz, 2H, CH_2-α), 1.96–1.80 (m, 4H, H-4, CH_2-β), 1.60 (d, $J_{5''',6'''}$ = 6.5 Hz, 3H, H-6′′′), 1.41–1.27 (m, 70H, H-5–H-17, H-γ–H-(ω–1)), 0.89–0.87 (m, 6H, H-18, H-ω); ^{13}C NMR (125 MHz, pyridine-d_5) δ 173.6 (HN<u>C</u>=O), 105.9 (C-1′, C-1′′), 98.0 (C-1′′′), 82.5 (C-4′), 80.5 (C-3′′), 77.1 (C-3′), 77.0 (C-5′′), 76.9 (C-5′), 75.1 (C-2′), 73.8 (C-4′′′), 72.0 (C-3′′′), 71.7 (C-3), 71.1 (C-1), 70.9 (C-2′′), 70.4 (C-2′′′), 68.1 (C-5′′′), 66.3 (C-4′), 62.4 (C-6′), 62.2 (C-6′′), 55. 3 (C-2), 37.3 (C-α), 35.3 (C-4), 26.9 (C-β), 32.49, 32.48, 30.59, 30.48, 30.40, 30.38, 30.30, 30.27, 30.22, 30.12, 29.99, 29.96, 26.79, 23.30, 23.29 (C-7–C-17, C-γ–C-(ω–1)), 17.6 (C-6′′′), 14.6 (C-18, C-ω); HRMS(ESI) m/z calcd. for $[C_{62}H_{119}NO_{17}+H]^+$: 1150.8551, obsd.: 1150.8553.

iGb3 N-Acyl Homologues (4) and (5)

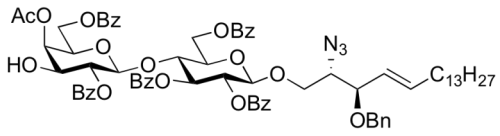
(2*S*,3*R*,4*E*)-2-Azido-1-(4-*O*-(2,6-di-*O*-benzoyl-β-D-galactopyranosyl)-2,3,6-tri-*O*-benzoyl-β-D-glucopyranosyloxy)-3-benzyloxy-octadec-4-ene.



To a solution of lactosyl 2-azido-sphingosine **6** (144 mg, 0.11 mmol) in CH_2Cl_2 (4 mL) was added TFA/H_2O (1/1, v/v, 0.4 mL) and

the resulting solution was stirred at room temperature for 20 h. The solution was diluted with EtOAc and the organic layer was then washed with sat. aq. $NaHCO_3$ (x3) and brine, dried ($MgSO_4$), filtered and concentrated under reduced pressure. The colourless oil was purified by silica gel gradient flash chromatography (petroleum ether/EtOAc, 5/1 to 1/1, v/v) to give the title compound as a colourless oil (139 mg, 0.11 mmol, 99%). R_f: 0.46 (PE/EA, 1/1, v/v); $[\alpha]_D^{21}$ = +17.0 (c = 1.0, $CHCl_3$); IR (film) 3448, 3066, 2925, 2854, 2102, 1720, 1602, 1585, 1452, 1315, 1270, 1177, 1113, 1095, 1069, 1028, 976, 756, 708 cm^{-1}; ^1H NMR (500 MHz, $CDCl_3$) δ 8.07 (d, $J_{CH\text{-}o,CH\text{-}m}$ = 7.8 Hz, 2H, CH-*o*, 2´´-*O*-Bz), 8.02–8.00 (m, 4H, 2 x CH-*o*, OBz), 7.97 (d, $J_{CH\text{-}o,CH\text{-}m}$ = 7.8 Hz, 2H, CH-*o*, OBz), 7.93 (d, $J_{CH\text{-}o,CH\text{-}m}$ = 7.8 Hz, 2H, CH-*o*, 2´-*O*-Bz), 7.61–7.19 (m, 20H, H_{arom}), 5.67 (t, $J_{2',3'} = J_{3',4'}$ = 9.4 Hz, 1H, H-3´), 5.46–5.39 (m, 2H, H-2´, H-5), 5.30–5.23 (m, 2H, H-2´´, H-4), 4.66 (d, $J_{1',2'}$ = 7.8 Hz, 1H, H-1´), 4.60 (d, $J_{1'',2''}$ = 7.8 Hz, 1H, H-1´´), 4.59–4.58 (m, 1H, H-6´a), 4.52 (dd, $J_{6'a,6'b}$ = 12.0 Hz, $J_{5',6'b}$ = 4.4 Hz, 1H, H-6´b), 4.40 (d, $J_{a,b}$ = 11.8 Hz, CH-a, 3-*O*-Bn), 4.19–4.14 (m, 2H, H-4´, CH-b, 3-*O*-Bn), 4.04 (dd, $J_{6''a,6''b}$ = 11.4 Hz, $J_{5'',6''}$ = 6.7 Hz, 1H, H-6´´a), 3.90 (dd, $J_{1a,1b}$ = 10.2 Hz, $J_{1a,2}$ = 5.8 Hz, 1H, H-1a), 3.82–3.79 (m, 1H, H-5´), 3.77 (d, $J_{3'',4''}$ = 3.3 Hz, 1H, H-4´´), 3.72 (dd, $J_{3,4}$ = 8.5 Hz, $J_{2,3}$ = 5.6 Hz, 1H, H-3), 3.66 (dd, $J_{2'',3''}$ = 9.8 Hz, $J_{3'',4''}$ = 3.3 Hz, 1H, H-3´´), 3.60–3.56 (m, 2H, H-2, H-6´´b), 3.51 (dd, $J_{1a,1b}$ = 10.2 Hz, $J_{1b,2}$ = 5.4 Hz, 1H, H-1b), 3.46 (t, $J_{5,6}$= 6.7 Hz, 1H, H-5´´), 1.93–1.90 (m, 2H, H-6), 1.31–1.25 (m, 22H, H-7–H-17), 0.88 (t, $J_{17,18}$ = 7.0 Hz, 3H, H-18); ^{13}C NMR (125 MHz, $CDCl_3$) δ 166.5 (C=O, 2´´-*O*-Bn), 166.2 (C=O, 6´´-*O*-Bn), 166.1 (C=O, 6´-*O*-Bn), 166.0 (C=O, 3´-*O*-Bn), 165.2 (C=O, 2´-*O*-Bn), 138.4 (C-5), 138.2 (C-*i*, 3-*O*-Bn), 133.6, 133.5, 133.4, 133.3 (C-*p*, 5 x OBz), 130.06, 129.95, 129.85, 129.79, 129.76, 129.70, 129.68, 129.66, 129.42, 129.22, 128.73, 128.62, 128.49, 128.39, 127.58 (30 x CH_{arom}), 125.6 (C-4), 101.0 (C-1´, C-1´´), 79.7 (C-3), 76.2 (C-4´), 73.8 (C-2´´), 73.1 (C-3´, C-5´), 72.7 (C-3´´, C-5´´), 71.7 (C-2´), 70.1 (CH_2, 3-*O*-Bn), 68.6 (C-1, C-4´´), 63.9 (C-2), 62.7 (C-6´), 61.9 (C-6´´), 32.4 (C-6), 32.0, 29.83, 29.81, 29.80, 29.79, 29.76, 29.55, 29.49, 29.29, 29.03, 22.8 (C-7–C-17), 14.3 (C-18); HRMS(ESI) m/z calcd. for $[C_{72}H_{81}N_3O_{17}+Na]^+$: 1282.5458, obsd.: 1282.5453.

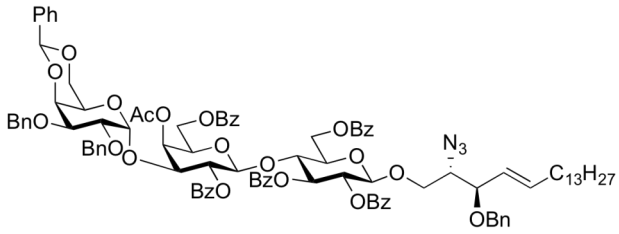
(2*S*,3*R*,4*E*)-1-(4-*O*-(4-*O*-Acetyl-2,6-di-*O*-benzoyl-β-D-galactopyranosyl)-2,3,6-tri-*O*-benzoyl-β-D-glucopyranosyloxy)-2-azido-3-benzyloxy-octadec-4-ene (26).



(2*S*,3*R*,4*E*)-2-Azido-1-(4-*O*-(2,6-di-*O*-benzoyl-β-D-galactopyranosyl)-2,3,6-tri-*O*-benzoyl-β-D-glucopyranosyloxy)-3-benzyloxy-octadec-4-ene (62 mg, 0.049 mmol) was co-evaporated with toluene (x3) and dissolved in dry CH_2Cl_2 (0.8 mL). Trimethyl orthoacetate (19 μL, 0.15 mmol) and CSA (5.7 mg, 0.025 mmol) were added and the reaction mixture was stirred at rt for 5 h. The reaction mixture was then diluted with EtOAc (30 mL), washed with 1M HCl (30 mL x 3), sat. aq. $NaHCO_3$ (30 mL) and brine (30 mL), dried ($MgSO_4$), filtered and concentrated *in vacuo*. The residue was purified by silica gel gradient flash chromatography (petroleum ether/EtOAc, 10:1 to 3:1, v/v) to afford acetate **26** as a clear oil (59 mg, 0.046 mmol, 94%). R_f: 0.63 (PE/EA, 1/1, v/v); $[\alpha]_D^{25}$ = +2.0 (c = 1.0, $CHCl_3$); IR (film) 3475, 2102, 1727, 1602, 1452, 1371, 1315, 1269, 1177, 1110, 1095, 1070, 1028, 976, 709 cm^{-1}; ^1H NMR (500 MHz, $CDCl_3$) δ 8.06 (d, $J_{CH\text{-}o,CH\text{-}m}$ = 8.3 Hz, 2H, CH-*o*, 2′′-*O*-Bz), 8.04–8.02 (m, 4H, 2 x CH-*o*, 3′-*O*-Bz, 6′′-*O*-Bz), 7.98 (d, $J_{CH\text{-}o,CH\text{-}m}$ = 7.8 Hz, 2H, CH-*o*, 6′-*O*-Bz), 7.95 (d, $J_{CH\text{-}o,CH\text{-}m}$ = 7.8 Hz, 2H, CH-*o*, 2′-*O*-Bz), 7.62–7.19 (m, 20H, H_{arom}), 5.72 (t, $J_{2',3'} = J_{3',4'}$ = 9.6 Hz, 1H, H-3′), 5.46 (dd, $J_{2',3'}$ = 9.6 Hz, $J_{1',2'}$ = 7.9 Hz, 1H, H-2′), 5.41 (dt, $J_{4,5}$ = 15.7 Hz, $J_{5,6}$ = 6.6 Hz, 1H, H-5), 5.26 (dd, $J_{4,5}$ = 15.7 Hz, $J_{3,4}$ = 8.6 Hz, 1H, H-4), 5.21 (d, $J_{3'',4''}$ = 3.4 Hz, 1H, H-4′′), 5.17 (dd, $J_{2'',3''}$ = 9.8 Hz, $J_{1'',2''}$ = 8.0 Hz, 1H, H-2′′), 4.69 (d, $J_{1',2'}$ = 7.9 Hz, 1H, H-1′), 4.65 (d, $J_{1'',2''}$ = 8.0 Hz, 1H, H-1′′), 4.62 (d, $J_{6'a,6'b}$ = 12.0 Hz, 1H, H-6′a), 4.53 (dd, $J_{6'a,6'b}$ = 12.0 Hz, $J_{5,6'b}$ = 4.3 Hz, 1H, H-6′b), 4.41 (d, $J_{a,b}$ = 11.7 Hz, 1H, CH-a, 3-*O*-Bn), 4.21 (t, $J_{3',4'}$ = 9.6 Hz, 1H, H-4′), 4.15 (d, $J_{a,b}$ = 11.7 Hz, 1H, CH-b, 3-*O*-Bn), 3.92 (dd, $J_{1a,1b}$ = 10.0 Hz, $J_{1a,2}$ = 5.9 Hz, 1H, H-1a), 3.83–3.81 (m, 2H, H-5′, H-3′′), 3.76–3.72 (m, 2H, H-3, H-6′′a), 3.61–3.56 (m, 2H, H-2, H-5′′), 3.55–3.50 (m, 2H, H-6′′b, H-1b), 2.01 (s, 3H, OAc), 1.98–1.91 (m, 2H, H-6), 1.32–1.21 (m, 22H, H-7–H-17), 0.88 (t, $J_{17,18}$ = 6.9 Hz, 3H, H-18); ^{13}C NMR (125 MHz, $CDCl_3$) δ 170.7 (C=O, OAc), 166.6 (C=O, 2′′-*O*-Bn), 166.1 (C=O, 6′-*O*-Bn), 165.8 (C=O, 6′′-*O*-Bn), 165.5 (C=O, 3′-*O*-Bn), 165.1 (C=O, 2′-*O*-Bn), 138.4 (C-5), 138.2 (C-*i*, 3-*O*-Bn), 133.7, 133.6, 133.5, 133.4, 133.3 (C-*p*, 5 x OBz), 130.02, 130.30, 129.88, 129.74, 129.67, 129.65, 129.60, 129.43, 129.02, 128.80, 128.71, 128.70, 128.50, 128.40, 128.37, 127.58 (30 x CH_{arom}), 125.6 (C-4), 101.2 (C-1′), 100.5 (C-1′′), 79.7 (C-3), 75.6 (C-4′), 73.6 (C-2′′), 73.1 (C-5′), 72.8 (C-3′), 71.8 (C-2′), 71.7 (C-3′′), 71.3 (C-5′′), 70.1 (CH_2, 3-*O*-Bn), 69.4 (C-4′′), 68.7 (C-1), 63.9 (C-2), 62.7 (C-6′),

61.3 (C-6´´), 32.4 (C-6), 32.0, 29.83, 29.81, 29.80, 29.79, 29.76, 29.55, 29.49, 29.29, 29.03, 22.8 (C-7–C-17), 20.7 (OAc), 14.3 (C-18); HRMS(ESI) m/z calcd. for $[C_{72}H_{83}N_3O_{18}+NH_4]^+$: 1319.6010, obsd.: 1319.5966.

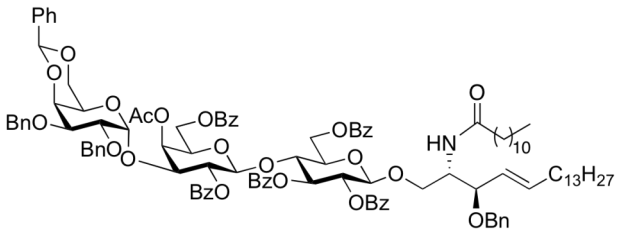
(2*S*,3*R*,4*E*)-1-(4-*O*-(4-*O*-Acetyl-2,6-di-*O*-benzoyl-3-*O*-(2,3-di-*O*-benzyl-4,6-*O*-benzylidene-α-D-galactopyranosyl)-β-D-galactopyranosyl)-2,3,6-tri-*O*-benzoyl-β-D-glucopyranosyloxy)-2-azido-3-benzyloxy-octadec-4-ene (27).



Galactosyl imidate donor **7** (165 mg, 0.278 mmol) and lactosyl 2-azido-sphingosine acceptor **26** (145 mg, 0.111 mmol) were co-evaporated with toluene (x3), dissolved in dry CH_2Cl_2 (1 mL) and stirred with activated 4Å molecular sieves for 30 min. The reaction mixture was cooled to -20 °C, and a solution of TMSOTf in CH_2Cl_2 (0.55 mmol/mL, 50 µL, 0.027 mmol) was added and the mixture stirred at 0 °C for 2 h. The reaction was warmed to rt and stirred for another 30 min upon which time the solution was diluted with EtOAc (30 mL), washed with sat. aq. $NaHCO_3$ (30 mL) and brine (30 mL), dried ($MgSO_4$), filtered and concentrated *in vacuo*. The resultant oil was purified by silca gel gradient flash chromatography (petroleum ether/EtOAc, 10:1 to 4:1, v/v) to afford the fully protected triglycosyl ceramide **26** as a clear oil (109 mg, 0.0629 mmol, 56%). R_f: 0.82 (PE/EA, 1/1, v/v); $[\alpha]_D^{26}$ = +58.0 (c = 1.0, $CHCl_3$); IR (film) 3089, 3065, 2925, 2854, 2102, 1731, 1602, 1585, 1452, 1364, 1315, 1268, 1177, 1097, 1069, 1028, 979, 755, 710 cm^{-1}; ^1H NMR (500 MHz, $CDCl_3$) δ 8.05–7.94 (m, 10H, 5 x CH-*o*, 2´-*O*-Bz, 3´-*O*-Bz, 6´-*O*-Bz, 2´´-*O*-Bz, 6´´-*O*-Bz), 7.63–7.19 (m, 35H, H_{arom}), 5.73 (t, $J_{2',3'} = J_{3',4'}$ = 9.4 Hz, 1H, H-3´), 5.45 (dd, $J_{2',3'}$ = 9.4 Hz, $J_{1',2'}$ = 8.0 Hz, 1H, H-2´), 5.43–5.38 (m, 2H, H-5, H-2´´), 5.35 (d, $J_{3'',4''}$ = 3.1 Hz, 1H, H-4´´), 5.26 (dd, $J_{4,5}$ = 15.4 Hz, $J_{3,4}$ = 8.6 Hz, 1H, H-4), 5.15 (s, 1H, PhC*H*O_2), 5.03 (d, $J_{4,5}$ = 3.2 Hz, 1H, H-1´´´), 4.68 (d, $J_{1',2'}$ = 8.0 Hz, 1H, H-1´), 4.65 (d, $J_{a,b}$ = 11.5 Hz, 1H, CH-a, 2´´´-*O*-Bn), 4.64 (d, $J_{a,b}$ = 12.2 Hz, 1H, CH-a, 3´´´-*O*-Bn), 4.59 (d, $J_{1'',2''}$ = 8.0 Hz, 1H, H-1´´), 4.55 (d, $J_{a,b}$ = 11.5 Hz, 1H, CH-b, 2´´´-*O*-Bn), 4.52– 4.50 (m, 3H, H-6´a, H-6´b, CH-b, 3´´´-*O*-Bn), 4.40 (d, $J_{a,b}$ = 11.7 Hz, 1H, CH-a, 3-*O*-Bn), 4.20–4.14 (m, 2H, H-4´, CH-b, 3-*O*-Bn), 3.92 (dd, $J_{1a,1b}$ = 10.2 Hz, $J_{1a,2}$ = 5.8 Hz, 1H, H-1a), 3.90–3.88 (m,

2H, H-2′′′, H-6′′′a), 3.81–3.78 (m, 2H, H-5′, H-3′′), 3.73 (dd, $J_{3,4}$ = 8.6 Hz, $J_{2,3}$ = 5.6 Hz, 1H, H-3), 3.67–3.64 (m, 2H, H-6′′a, H-3′′′), 3.59 (q, $J_{1,2} = J_{2,3}$ = 5.5 Hz, 1H, H-2), 3.55–3.49 (m, 3H, H-1b, H-5′′, H-6′′b), 3.46 (d, $J_{3''',4'''}$ = 2.9 Hz, 1H, H-4′′′), 3.41 (d, $J_{a,b}$ = 6.4 Hz, 1H, H-6′′′b), 3.29 (s, 1H, H-5′′′), 1.93–1.90 (2H, H-6′′), 1.63 (s, 3H, OAc), 1.26–0.92 (m, 22H, H-7–H-17), 0.89 (t, $J_{17,18}$ = 6.9 Hz, 3H, H-18); ^{13}C NMR (125 MHz, $CDCl_3$) δ 170.1 (C=O, OAc), 166.1 (C=O, 6′-*O*-Bn), 165.8 (C=O, 6′′-*O*-Bn), 165.5 (C=O, 3′-*O*-Bn), 165.2 (C=O, 2′-*O*-Bn), 164.4 (C=O, 2′′-*O*-Bn), 138.9, 138.7 (C-*i*, 2′′′-*O*-Bn, 3′′′-*O*-Bn), 138.4 (C-5), 138.2 (C-*i*, 3-*O*-Bn), 137.8 (C-*i*, benzylidene), 133.7, 133.58, 133.55, 133.4, 133.3 (C-*p*, 5 x OBz), 129.97, 129.86, 129.77, 129.70, 129.68, 129.64, 129.55, 129.44, 129.18, 129.00, 128.90, 128.80, 218.74, 128.51, 128.39, 128.33, 128.26, 128.21, 128.19, 127.72, 127.59, 127.57, 127.57, 127.50 (43 x CH_{arom}), 126.4 (C-*o*, benzylidene), 125.5 (C-4), 101.2 (C-1′), 101.0 (C-1′′, CH-benzylidene), 95.4 (C-1′′′), 79.7 (C-3), 76.0 (C-3′′′), 75.6 (C-4′), 74.7 (C-2′′′), 74.4 (C-4′′′), 73.9 (CH_2, 2′′′-*O*-Bn), 73.3 (C-3′′), 73.1 (C-5′), 72.7 (C-3′), 72.3 (CH_2, 3′′′-*O*-Bn), 71.8 (C-2′), 71.5 (C-5′′), 71.1 (C-2′′), 70.1 (CH_2, 3-*O*-Bn), 68.9 (C-6′′′), 68.7 (C-1), 64.6 (C-4′′), 63.9 (C-2), 62.9 (C-5′′′), 62.6 (C-6′), 61.3 (C-6′′), 32.4 (C-6), 32.06, 29.83, 29.82, 29.80, 29.79, 29.76, 29.55, 29.49, 29.29, 29.04, 22.83 (C-7–C-17), 20.3 (OAc), 14.3 (C-18); HRMS(ESI) m/z calcd. for $[C_{101}H_{109}N_3O_{23}+NH_4]^+$: 1749.7790, obsd. 1749.7802.

(2*S*,3*R*,4*E*)-1-(4-*O*-(4-*O*-Acetyl-2,6-di-*O*-benzoyl-3-*O*-(2,3-di-*O*-benzyl-4,6-*O*-benzylidene-α-D-galactopyranosyl)-β-D-galactopyranosyl)-2,3,6-tri-*O*-benzoyl-β-D-glucopyranosyloxy)-3-benzyloxy-2-dodecanoylamido-octadec-4-ene (28).

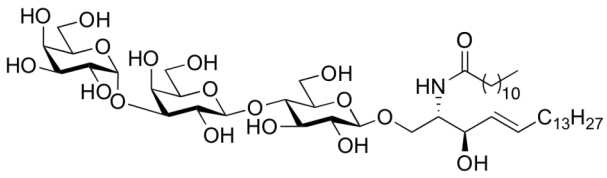


To a solution of glycolipid azide **27** 68 mg, 0.039 mmol) in dry benzene (0.8 mL) was added triphenylphosphine (21 mg, 0.078 mmol) and distilled water (30 μL) and the solution warmed to 45 ºC and stirred overnight. The reaction mixture was then cooled to room temperature, diluted with EtOAc (20 mL), washed with sat. aq. NH_4Cl, (5 mL), dried ($MgSO_4$), filtered and concentrated under reduced pressure to give a colourless oil which was used without further purification. Half of the amine intermediate obtained was coupled to the C12 fatty acid as described:

The oil was co-evaporated twice with dry toluene then suspended in CH_2Cl_2 (1 mL), EDCI (11.3 mg, 0.0589 mmol), DMAP (9.6mg, 0.0785 mmol), and lauric acid (11.8 mg, 0.0589 mmol) were added and the resulting solution stirred over 4 days at rt after which time the solution was diluted with EtOAc (30 mL), washed with sat. aq. $NaHCO_3$ (30 mL) and brine (30 mL), dried ($MgSO_4$), filtered and concentrated *in vacuo*. The reaction mixture was then purified directly by silica gel gradient flash chromatography (petroleum ether/EtOAc, 10/1 to 2/1, v/v) to give **28** as a colourless oil (28 mg, 0.015 mmol, 75% over two steps). R_f: 0.68 (PE/EA, 1/1, v/v); $[\alpha]_D^{24}$ = +62.0 (c = 0.1, $CHCl_3$); IR (film) 2924, 2854, 1733, 1718, 1576, 1558, 1541, 1473, 1177, 1098, 1070, 1028, 756, 633, 620 cm^{-1}; ^1H NMR (500 MHz, $CDCl_3$) δ 8.04–7.93 (m, 10H, 5 x CH-*o*, 2′-*O*-Bz, 3′-*O*-Bz, 6′-*O*-Bz, 2′′-*O*-Bz, 6′′-*O*-Bz), 7.56–7.18 (m, 35H, H_{arom}), 5.74 (t, $J_{2',3'} = J_{3',4'}$ = 9.6 Hz, 1H, H-3′), 5.49 (dt, $J_{4,5}$ = 15.2 Hz, $J_{5,6}$ = 7.0 Hz, 1H, H-5), 5.42–5.38 (m, 3H, H-2′, H-2′′, NH), 5.36 (m, 1H, H-4′′), 5.24 (dd, $J_{4,5}$ = 15.2 Hz, $J_{3,4}$ = 8.8 Hz, 1H, H-4), 5.15 (s, 1H, PhC*H*O_2), 5.03 (d, $J_{1''',2'''}$ = 3.0 Hz, 1H, H-1′′′), 4.64 (d, $J_{a,b}$ = 11.5 Hz, 1H, CH-a, 3′′′-*O*-Bn), 4.63 (d, $J_{a,b}$ = 12.5 Hz, 1H, CH-a, 2′′′-*O*-Bn), 4.61 (d, $J_{1',2'}$ = 8.0 Hz, 1H, H-1′), 4.59 (d, $J_{1'',2''}$ = 8.1 Hz, 1H, H-1′′), 4.51 (d, $J_{a,b}$ = 11.6 Hz, 1H, CH-b, 3′′′-*O*-Bn), 4.49–4.43 (m, 3H, H-6′a, H-6′b, CH-b, 2′′′-*O*-Bn), 4.44 (d, $J_{a,b}$ = 11.6 Hz, 1H, CH-a, 3-*O*-Bn), 4.26–4.24 (m, 2H, CH-b, 3-*O*-Bn, H-1a), 4.17 (t, $J_{2',3'} = J_{3',4'}$ = 9.6 Hz, 1H, H-4′), 4.09–4.06 (m, 1H, H-2), 3.90–3.88 (m, 2H, H-2′′′, H-6′′′a), 3.80 (dd, $J_{2'',3''}$ = 10.0 Hz, $J_{3'',4''}$ = 3.3 Hz, 1H, H-3′′), 3.75–3.70 (m, 2H, H-3, H-5′), 3.65 (dd, $J_{2''',3'''}$ = 10.0 Hz, $J_{3''',4'''}$ 3.1 Hz, 1H, H-3′′′), 3.62 (d, $J_{5'',6''}$ = 6.6 Hz, 2H, H-6′′a, H-6′′b), 3.53–3.48 (m, 2H, H-1b, H-5′′), 3.46 (d, $J_{3''',4'''}$ = 3.0 Hz, 1H, H-4′′′), 3.41 (d, $J_{3''',4'''}$ = 12.0 Hz, 1H, H-6′′′b), 3.29 (s, 1H, H-5′′′), 1.96–1.92 (m, 2H, H-6), 1.68–1.63 (m, 2H, CH_2-α), 1.61 (s, 3H, OAc), 1.29–1.03 (m, 40H, H-7–H-17, H-β–H-(ω–1)), 0.89–0.87 (m, 6H, H-18, H-ω); ^{13}C NMR (125 MHz, $CDCl_3$) δ 172.5 (HN<u>C</u>=O), 170.1 (C=O, OAc), 166.1 (C=O, 6′-*O*-Bn), 165.8 (C=O, 6′′-*O*-Bn), 165.5 (C=O, 3′-*O*-Bn), 165.4 (C=O, 2′-*O*-Bn), 164.4 (C=O, 2′′-*O*-Bn), 138.9, 138.7 (C-*i*, 2′′′-*O*-Bn, 3′′′-*O*-Bn), 138.5 (C-*i*, 3-*O*-Bn), 137.8 (C-*i*, benzylidene), 137.2 (C-5), 133.8, 133.6, 133.5, 133.3 (C-*p*, 5 x OBz), 132.99, 129.97, 129.89, 129.86, 129.78, 129.69, 129.59, 129.49, 129.20, 129.17, 128.99, 128.91, 128.76, 128.74, 128.34, 128.31, 128.24, 128.20, 128.18, 127.73, 127.71, 127.58, 127.51, 127.49, 127.44, 126.37 (45 x CH_{arom}, C-4), 101.5 (C-1′), 101.0 (C-1′′), 100.9 (CH-benzylidene), 95.4 (C-1′′′), 79.3 (C-3), 76.0 (C-3′′′), 75.5

(C-4′), 74.6 (C-2′′′), 74.4 (C-4′′′), 73.9 (CH_2, 3′′′-*O*-Bn), 73.3 (C-3′′), 73.1 (C-5′), 72.5 (C-3′), 72.3 (CH_2, 2′′′-*O*-Bn, C-2′/C-2′′), 71.5 (C-2′/C-2′′), 71.1 (C-5′′), 70.4 (CH_2, 3-*O*-Bn), 68.9 (C-6′′′), 68.5 (C-1), 64.6 (C-4′′), 62.9 (C-5′′′), 62.6 (C-6′), 61.2 (C-6′′), 51.4 (C-2), 36.6 (C-α), 32.3 (C-6), 32.05, 29.84, 29.83, 29.83, 29.80, 29.78, 29.66, 29.49, 29.39, 29.34, 25.69, 25.57, 23.99, 23.96, 22.82 (C-7–C-17, C-β–C-(ω–1)), 20.3 (OAc), 14.3 (C-18, C-ω); HRMS(ESI) m/z calcd. for $[C_{113}H_{133}NO_{24}+H]^+$: 1888.9290, obsd. 1888.9282

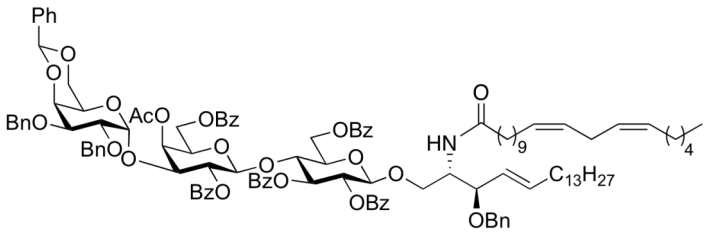
(2*S*,3*R*,4*E*)-2-Dodecanoylamido-1-(4-*O*-(3-*O*-α-D-galactopyranosyl)-β-D-galactopyranosyl)-β-D-glucopyranosyloxy)-3-hydroxy-octadec-4-ene (4).



The fully protected triglycosyl ceramide **28** (25 mg, 0.0132 mmol) was dissolved in dry THF (2 mL) and NH_3 (10 mL) was condensed into the reaction vessel at -78 °C. Small pieces of Na (s) were added carefully until the solution remained deep blue and the reaction mixture was stirred for 30 mins. The reaction was then quenched with a few drops of MeOH and Na (s) was added again until the deep blue colour persisted. The reaction mixture was stirred for a further 30 min then quenched with 10 mL MeOH and slowly warmed to rt to allow the ammonia to evaporate. Trace ammonia was removed with an Ar stream. The reaction mixture was neutralised to pH 7 using Dowex-H^+, filtered, washed with pyridine then concentrated *in vacuo*. The resultant oil was purified by silica gel gradient flash chromatography (CH_2Cl_2/MeOH, 20/1 to 5/1, v/v) to afford fully deprotected iGb3-C12 **4** as an amorphous white solid (3.1 mg, 0.0032 mmol, 24%). R_f: 0.07 (CH_2Cl_2/MeOH, 5/1, v/v); $[\alpha]_D^{24}$ = +29.0 (c = 0.1, pyridine); IR (film) 3347, 2956, 2922, 2852, 1641, 1552, 1466, 1377, 1266, 1150, 1076, 1029, 973, 803, 774, 720, 693, 662 cm^{-1}; ^1H NMR (600 MHz, pyridine-d_5) δ 8.45 (d, $J_{2,NH}$ = 8.4 Hz, 1H, NH), 7.46 (d, J = 5.3 Hz, 1H, OH), 6.78 (d, $J_{4,5}$ = 4.7 Hz, 1H, OH), 6.71, 6.64, 6.56 (3 x bs, 3H, 3 x OH), 6.51–6.49 (m, 1H, OH), 6.19 (bs, 1H, OH), 6.03 (dd, $J_{4,5}$ = 15.4 Hz, $J_{3,4}$ = 6.6 Hz, 1H, H-4), 5.95–5.90 (m, 1H, H-5), 5.70 (s, 1H, OH), 5.68 (d, $J_{1''',2'''}$ = 3.8 Hz, 1H, H-1′′′), 5.11 (d, $J_{1'',2''}$ = 7.7 Hz, 1H, H-1′′), 5.08 (t, $J_{5''',6'''}$ = 6.2 Hz, 1H, H-5′′′), 4.90 (d, $J_{1',2'}$ = 7.9 Hz, 1H, H-1′), 4.83–4.79 (m, 3H, H-1a, H-2, H-3), 4.75 (dd, $J_{2''',3'''}$ = 9.6 Hz, $J_{1''',2'''}$ = 3.8 Hz, 1H, H-2′′′), 4.69 (bs, 1H, H-4′′′),

4.59 (bs, 1H, H-4′′), 4.57–4.43 (m, 2H, H-2′′, H-3′′′), 4.47–4.45 (m, 3H, H-6′′′a, H-6′′′b, H-6′′a), 4.34–4.31 (m, 2H, H-6′a, H-6′′b), 4.28–4.23 (m, 4H, H-6′b, H-3′, H-4′, H-3′′), 4.17 (dd, $J_{1a,1b}$ = 9.7 Hz, $J_{1b,2}$ = 2.9 Hz, 1H, H-1b), 4.08–4.03 (m, 2H, H-2′, H-5′′), 3.88–3.85 (m, 1H, H-5′), 2.45 (t, $J_{\alpha,\beta}$ = 7.1 Hz, 2H, CH_2-α), 2.07 (dd, $J_{6,7}$ = 14.3 Hz, $J_{5,6}$ = 6.6 Hz, 1H, H-6), 1.88–1.88 (m, 2H, CH_2-β), 1.37–1.22 (m, 38H, H-7–H-11, H-γ–H-(ω–1)), 0.88 (t, $J_{11,12} = J_{\omega-1,\omega}$ = 6.6 Hz, 6H, H-12, H-ω); ^{13}C NMR (125 MHz, pyridine-d_5) δ 173.7 (HNC=O), 133.0 (C-4), 132.6 (C-5), 105.8 (C-1′, C-1′′), 98.0 (C-1′′′), 82.4 (C-4′), 80.4 (C-3′′), 77.0 (C-5′), 76.92 (C-3′), 76.85 (C-5′′), 75.1 (C-2′), 73.2 (C-5′′′), 73.0 (C-3), 72.0 (C-3′′′), 71.2 (C-4′′′), 70.8 (C-1, C-2′′), 70.7 (C-2′′′), 66.3 (C-4′′), 62.6 (C-6′′′), 62.29 (C-6′′), 62.17 (C-6′), 55.2 (C-2), 37.3 (C-α), 33.1 (C-6), 32.5, 30.37, 30.34, 30.31, 30.28, 30.25, 30.23, 30.21, 30.12, 30.07, 29.96, 23.28 (C7–C-11, C-γ–C-(ω–1)), 26.8 (C–β), 14.6 (C-12, C-ω); HRMS(ESI) m/z calcd. for $[C_{48}H_{89}NO_{18}+H]^+$: 968.6152, obsd.: 968.6159.

(2*S*,3*R*,4*E*)-1-(4-*O*-(4-*O*-Acetyl-2,6-di-*O*-benzoyl-3-*O*-(2,3-di-*O*-benzyl-4,6-*O*-benzylidene-α-D-galactopyranosyl)-β-D-galactopyranosyl)-2,3,6-tri-*O*-benzoyl-β-D-glucopyranosyloxy)-3-benzyloxy-2-(11*Z*,14*Z*-eicosadienoylamido)-octadec-4-ene (29).

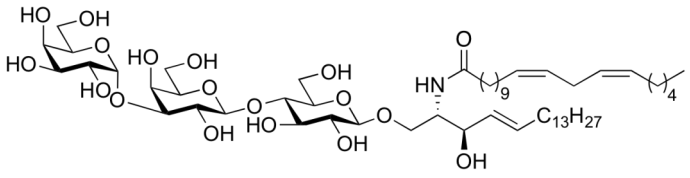


To a solution of glycolipid azide **27** (23 mg, 0.013 mmol) in dry benzene (0.8 mL) was added triphenylphosphine (7 mg, 0.026 mmol) and distilled water (5 μL). The solution was warmed to 45 ºC and stirred overnight. The reaction mixture was then cooled to room temperature, diluted with EtOAc (15 mL), washed with sat. aq. NH_4Cl (5 mL), dried ($MgSO_4$), filtered and concentrated under reduced pressure to give a colourless oil which was used without further purification. The oil was co-evaporated twice with dry toluene then suspended in CH_2Cl_2 (1 mL), EDCI (11.3 mg, 0.0589 mmol), DMAP (9.6mg, 0.0785 mmol), and 11*Z*,14*Z*-eicosadienoic acid (11.8 mg, 0.0589 mmol) were added and the resulting solution stirred over 2 days at room temperature, after which time it was diluted with EtOAc (20 mL), washed with sat. aq. $NaHCO_3$ (20 mL) and brine (20 mL), dried ($MgSO_4$), filtered and concentrated *in vacuo*. The reaction mixture was then purified directly by silica gel

gradient flash chromatography (petroleum ether/EtOAc, 10/1 to 2/1, v/v) to give **29** as a colourless oil (7.5 mg, 0.0038 mmol, 28% over two steps). The product was kept under inert argon atmosphere at all times to prevent degradation. R_f: 0.39 (PE/EA, 2/1, v/v); $[\alpha]_D^{20}$ = +40.0 (c = 1.0, $CHCl_3$); IR(film) 3062, 30111, 2956, 2926, 1730, 1453, 1438, 1270, 1177, 1119, 1070, 1028, 998, 754, 711, 634 cm^{-1}; ^1H NMR (500 MHz, $CDCl_3$) δ 8.04–7.93 (m, 10H, 5 x CH-*o*, 2′-*O*-Bz, 3′-*O*-Bz, 6′-*O*-Bz, 2′′-*O*-Bz, 6′′-*O*-Bz), 7.61–7.12 (m, 35H, H_{arom}), 5.73 (t, $J_{2',3'} = J_{3',4'}$ = 9.6 Hz, 1H, H-3′), 5.49 (dt, $J_{4,5}$ = 15.6 Hz, $J_{5,6}$ = 6.7 Hz, 1H, H-5), 5.41–5.30 (m, 4H, H-2′, H-2′′, NH, H-4′′), 5.23 (dd, $J_{4,5}$ = 15.3 Hz, $J_{3,4}$ = 8.6 Hz, 1H, H-4), 5.15 (s, 1H, PhC*H*O_2), 5.03 (d, $J_{1''',2''',}$ = 3.0 Hz, 1H, H-1′′′), 4.62 (d, $J_{a,b}$ = 11.3 Hz, 1H, CH-a, 3′′′-*O*-Bn), 4.63 (d, $J_{a,b}$ = 12.4 Hz, 1H, CH-a, 2′′′-*O*-Bn), 4.61 (d, $J_{1',2'}$ = 8.0 Hz, 1H, H-1′), 4.58 (d, $J_{1'',2''}$ = 8.0 Hz, 1H, H-1′′), 4.53 (d, $J_{a,b}$ = 11.8 Hz, 1H, CH-b, 3′′′-*O*-Bn), 4.49–4.47 (m, 3H, H-6′a, H-6′b, CH-b, 2′′′-*O*-Bn), 4.43 (d, $J_{a,b}$ = 11.7 Hz, 1H, CH-a, 3-*O*-Bn), 4.25–4.24 (m, 2H, CH-b, 3-*O*-Bn, H-1a), 4.16 (t, $J_{2',3'} = J_{3',4'}$ = 9.5 Hz, 1H, H-4′), 4.08–4.05 (m, 1H, H-2), 3.89–3.87 (m, 2H, H-2′′′, H-6′′′a), 3.79 (dd, $J_{2'',3''}$ = 9.9 Hz, $J_{3'',4''}$ = 3.1 Hz, 1H, H-3′′), 3.74–3.69 (m, 2H, H-3, H-5′), 3.65 (dd, $J_{2''',3'''}$ = 10.0 Hz, $J_{3''',4'''}$ 3.1 Hz, 1H, H-3′′′), 3.61 (d, $J_{5'',6''}$ = 6.6 Hz, 2H, H-6′′a, H-6′′b), 3.52–3.48 (m, 2H, H-1b, H-5′′), 3.45 (d, $J_{3''', 4'''}$ = 3.0 Hz, 1H, H-4′′′), 3.40 (d, $J_{3''', 4'''}$ = 12.0 Hz, 1H, H-6′′′b), 3.29 (s, 1H, H-5′′′), 2.77 (t, $J_{13,14\ (fatty\ acid)} = J_{12,13\ (fatty\ acid)}$ = 6.9 Hz, 2H, H-13 fatty acid), 2.05 (m, 4H, H-10, H-16 fatty acid), 1.95–1.92 (m, 2H, H-6), 1.68–1.63 (m, 2H, CH_2-α), 1.61 (s, 3H, OAc), 1.35–1.23 (m, 42H, H-7–H-17, H-β–H-(ω–1)), 0.89–0.86 (m, 6H, H-18, H-ω); ^{13}C NMR (125 MHz, $CDCl_3$) δ 172.5 (HN<u>C</u>=O), 170.1 (C=O, OAc), 166.1 (C=O, 6′-*O*-Bn), 165.8 (C=O, 6′′-*O*-Bn), 165.5 (C=O, 3′-*O*-Bn), 165.4 (C=O, 2′-*O*-Bn), 164.4 (C=O, 2′′-*O*-Bn), 138.9, 138.7 (C-*i*, 2′′′-*O*-Bn, 3′′′-*O*-Bn), 138.5 (C-*i*, 3-*O*-Bn), 137.8 (C-*i*, benzylidene), 137.2 (C-5), 133.8, 133.7, 133.6, 133.5, 133.3 (C-*p*, 5 x OBz), 130.35, 13.27, 129.97, 129.91, 129.88, 129.79, 129.70, 129.67, 129.61, 129.49, 129.20 ,129.16, 129.02, 128.92, 128.78, 128.76, 128.70, 128.62, 128.40, 128.36, 128.32, 128.26, 128.22, 128.19, 128.12, 128.06, 127.74, 127.73, 127.61, 127.53, 127.50, 126.39 (CH_{arom}, C-4, C-11, C-12, C-14, C-15 fatty acid), 101.5 (C-1′, C-1′′), 100.9 (CH-benzylidene), 95.4 (C-1′′′), 79.3 (C-3), 76.0 (C-3′′′), 75.5 (C-4′), 74.6 (C-2′′′), 74.4 (C-4′′′), 73.9 (CH_2, 3′′′-*O*-Bn), 73.3 (C-3′′), 73.1 (C-5′), 72.5 (C-3′), 72.3 (CH_2, 2′′′-*O*-Bn, C-2′/C-2′′), 71.5 (C-2′/C-2′′), 71.1 (C-5′′), 70.4 (CH_2, 3-*O*-Bn), 69.0 (C-6′′′), 68.5 (C-1), 64.6

(C-4′′), 62.9 (C-5′′′), 62.6 (C-6′), 61.2 (C-6′′), 51.4 (C-2), 36.6 (C-2 fatty acid), 32.4 (C-6), 32.07, 31.66, 29.86, 29.85, 29.82, 29.74, 29.68, 29.66, 29.51, 29.49, 29.39, 29.37, 27.40, 27.34, 27.23, 25.77, 25.64, 25.58, 25.19, 23.92, 22.84, 22.72, 20.21 (C-7–C-17, C-3–C-10 fatty acid, C16–C19 fatty acid) 20.3 (OAc), 14.3 (C-18-C20 fatty acid); HRMS(ESI) m/z calcd. for $[C_{121}H_{145}NO_{24}+H+NH_4]^{2+}$: 1997.0229, obsd. 1997.0240.

(2*S*,3*R*,4*E*)-2-(11*Z*,14*Z*-Eicosadienoylamido)-1-(4-*O*-(3-*O*-α-D-galactopyranosyl)-β-D-galactopyranosyl)-β-D-glucopyranosyloxy)-3-hydroxy-octadec-4-ene (5).



Fully protected triglycosyl ceramide **29** (20 mg, 0.010 mmol) was dissolved in dry THF (1 mL) and NH_3 (10 mL) was condensed into the reaction vessel at -78 °C. Small pieces of Na (s) were added carefully until the solution remained deep blue and the reaction mixture was stirred for 30 mins. The reaction was then quenched with a few drops of MeOH and Na (s) was added again until the deep blue colour persisted. The reaction mixture stirred for a further 30 mins. The reaction was quenched with 10 mL MeOH and slowly warmed to rt to allow the ammonia to evaporate. Trace ammonia was removed with an Ar stream. The reaction mixture was neutralised to pH 7 using Dowex-H^+, filtered, washed with pyridine and concentrated *in vacuo*. The resultant oil was purified by silica gel gradient flash chromatography (CH_2Cl_2/MeOH, 20/1 to 5/1, v/v) to afford fully deprotected iGb3-C12 **5** as an amorphous white solid (5.2 mg, 0.0048 mmol, 48%). R_f: 0.13 (CH_2Cl_2/MeOH, 4/1, v/v); $[\alpha]_D^{24}$ = +26.0 (c = 0.1, pyridine); IR (film) 3360, 3010, 2923, 2853, 1640, 1548, 1464, 1377, 1255, 1150, 1075, 1030, 971, 895, 804, 632 cm^{-1}; ^1H NMR (600 MHz, pyridine-d_5) δ 8.49 (d, $J_{2,NH}$ = 8.3 Hz, 1H, NH), 6.04 (dd, $J_{4,5}$ = 15.2 Hz, $J_{3,4}$ = 6.3 Hz, 1H, H-4), 5.93 (dd, $J_{4,5}$ = 15.2 Hz, $J_{5,6}$ = 6.7 Hz, H-5), 5.68 (d, $J_{1''',2'''}$ = 3.6 Hz, 1H, H-1′′′), 5.54–5.48 (m, 4H, H-11, H-12, H-14, H-15 fatty acid), 5.09 (d, $J_{1'',2''}$ = 8.0 Hz, 1H, H-1′′), 5.06 (t, $J_{5''',6'''}$ = 5.9 Hz, 1H, H-5′′′), 4.90 (d, $J_{1',2'}$ = 7.9 Hz, 1H, H-1′), 4.84–4.79 (m, 3H, H-1a, H-2, H-3), 4.76 (dd, $J_{2''',3'''}$ = 10.0 Hz, $J_{1''',2'''}$ = 3.6 Hz, 1H, H-2′′′), 4.68 (bs, 1H, H-4′′′), 4.59 (bs, 1H, H-4′′), 4.58–4.52 (m, 2H, H-2′′, H-3′′′), 4.51–4.43 (m, 3H, H-6′′′a, H-6′′′b, H-6′′a), 4.33 (dd, $J_{a,b}$= 10.9 Hz, $J_{a,b}$ = 4.9 Hz, 2H, H-6′a, H-6′′b), 4.29–4.24 (m, 4H,

H-6′b, H-3′, H-4′, H-3′′), 4.18–4.16 (m, 1H, H-1b), 4.08–4.03 (m, 2H, H-2′, H-5′′), 3.87–3.85 (m, 1H, H-5′), 2.93 (t, $J_{13,14\ (\text{fatty acid})} = J_{12,13\ (\text{fatty acid})} = 5.3$ Hz, 2H, H-13 fatty acid), 2.46 (t, $J_{\alpha,\beta} = 7.6$ Hz, 2H, H-2 fatty acid), 2.15–2.06 (m, 6H, H-10, H-16 fatty acid, H-6), 1.86–1.80 (m, 2H, CH_2-β), 1.36–1.23 (m, 42H, H-3–H-9 fatty acid, H-17–H-19 fatty acid, H7-17), 0.89–0.86 (m, 6H, H-18, H-20 fatty acid); ^{13}C NMR (150 MHz, pyridine-d_5) δ 173.7 (HN<u>C</u>=O), 133.0 (C-4), 132.6 (C-5), 130.8, 128.7 (C-11, C-12, C-14, C-15 fatty acid), 105.8 (C-1′, C-1′′), 98.0 (C-1′′′), 82.3 (C-4′), 80.4 (C-3′′), 76.97 (C-5′), 76.92 (C-3′), 76.82 (C-5′′), 75.1 (C-2′), 73.2 (C-5′′′), 73.0 (C-3), 72.0 (C-3′′′), 71.2 (C-4′′′), 70.8 (C-1, C-2′′), 70.7 (C-2′′′), 66.2 (C-4′′), 62.6, 62.2 (C-6′′′, C-6′′, C-6′), 55.2 (C-2), 37.3 (C-α), 33.1 (C-6), 30.30, 30.27, 30.24, 30.21, 30.12, 30.05, 29.96, 29.94, 293.92, 29.83, 27.90, 27.79, 27.38, 26.74, 26.37, 23.27, 23.14 (C7–C-17, C-2–C-10 fatty acid, C16–C19 fatty acid), 14.6, 14.56 (C-18, C-29 fatty acid); HRMS (ESI) m/z calcd. for $[C_{56}H_{101}NO_{18}+H]^+$: 1076.7091, obsd.: 1076.7090).

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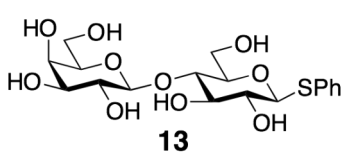
~ ^{1}H AND ^{13}C NMR SPECTRA~

Phenyl 4-*O*-(β-D-galactopyranosyl)-1-thio-β-D-glucopyranoside

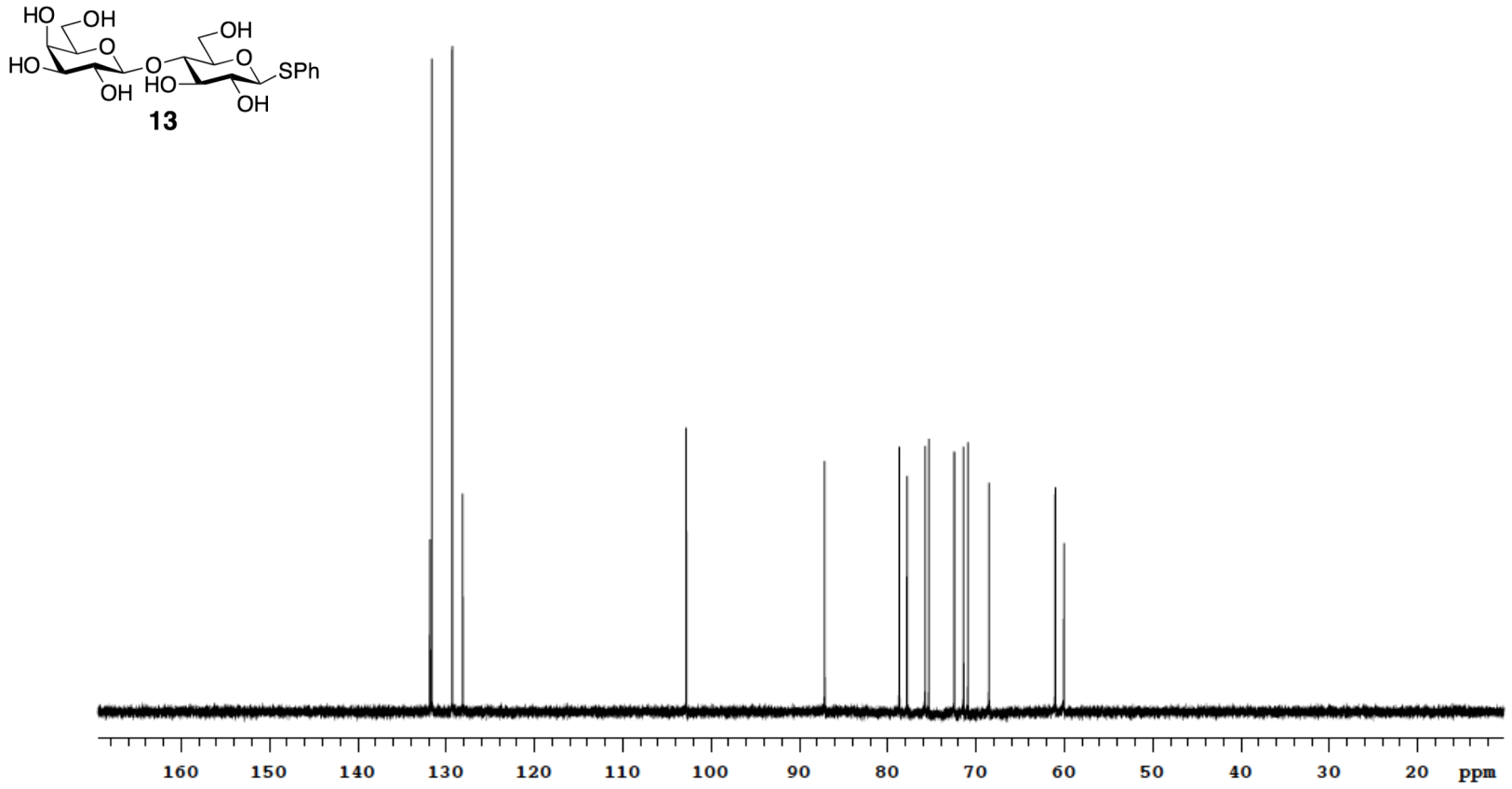
^{1}H NMR, D_2O, 600 MHz



13

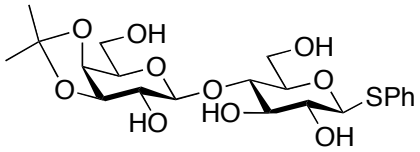
Phenyl 4-*O*-(β-D-galactopyranosyl)-1-thio-β-D-glucopyranoside (13)

^{13}C NMR, D_2O_3, 150 MHz



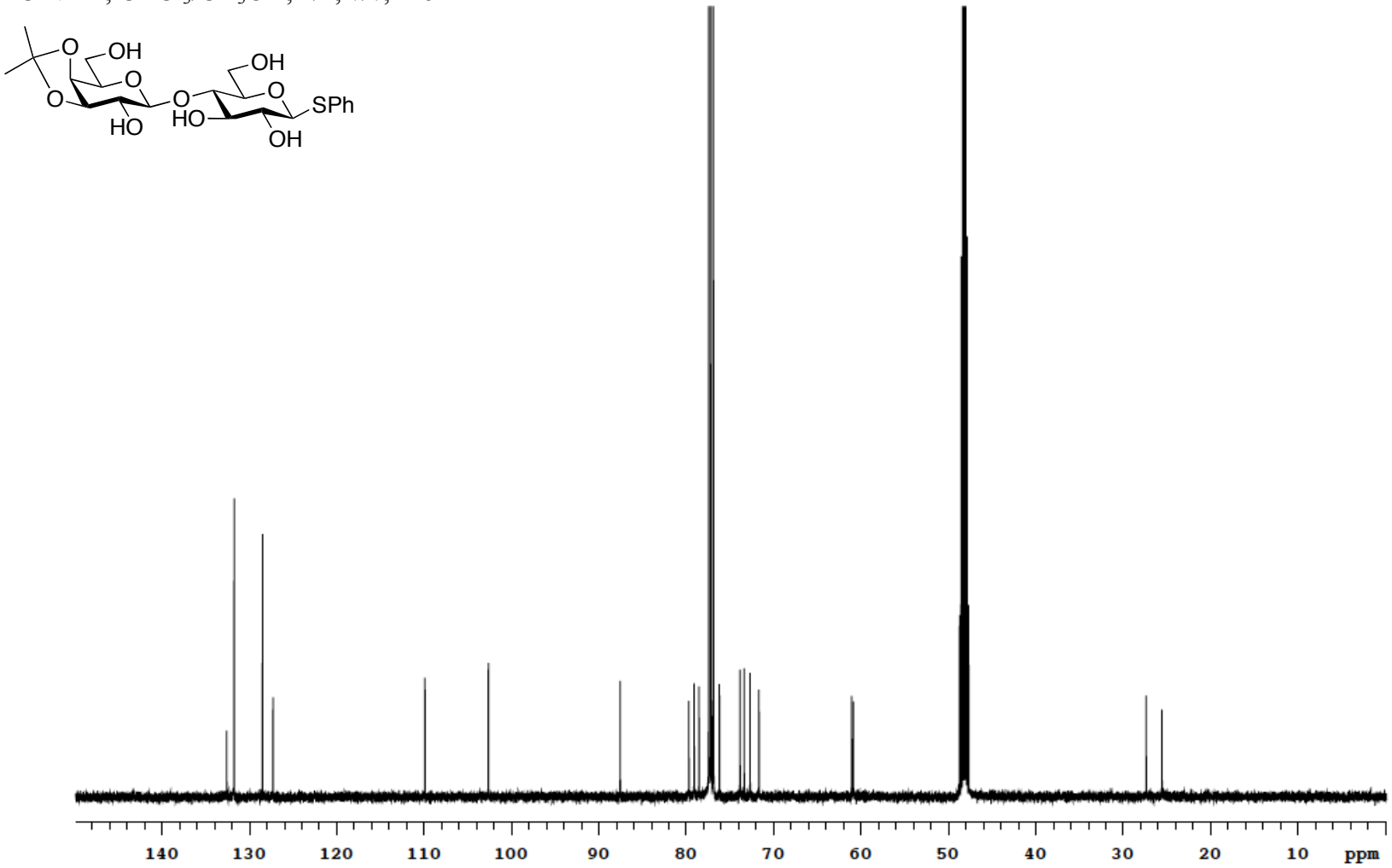
Phenyl 4-*O*-(3,4-*O*-isopropylidene-β-D-galactopyranosyl)-1-thio-β-D-glucopyranoside

^{1}H NMR, $CDCl_3/CD_3OD$, 1/1, v/v, 500 MHz



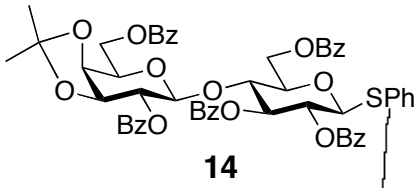
Phenyl 4-*O*-(3,4-*O*-isopropylidene-β-D-galactopyranosyl)-1-thio-β-D-glucopyranoside

^{13}C NMR, $CDCl_3/CD_3OD$, 1/1, v/v, 125 MHz



Phenyl 4-*O*-(2,6-di-*O*-benzoyl-3,4-*O*-isopropylidene-β-D-galactopyranosyl)-2,3,6-tri-*O*-benzoyl-1-thio-β-D-glucopyranoside

^{1}H NMR, $CDCl_3$, 500 MHz



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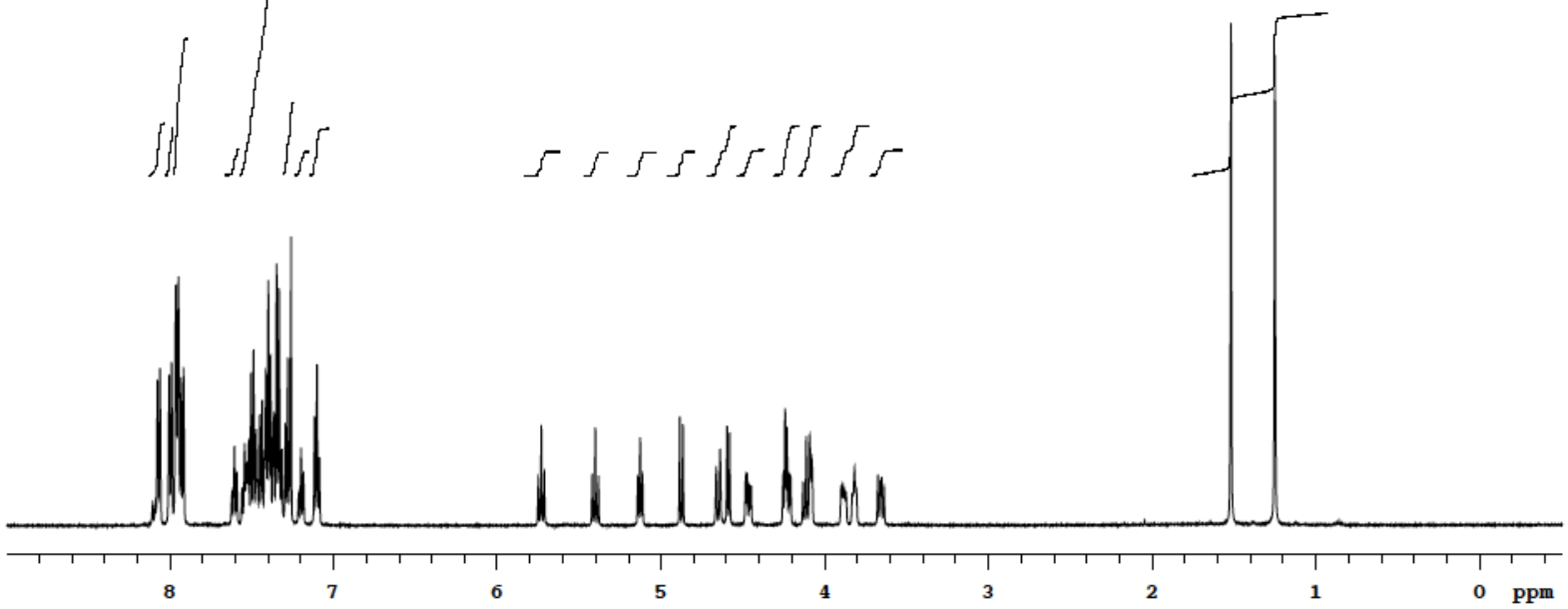
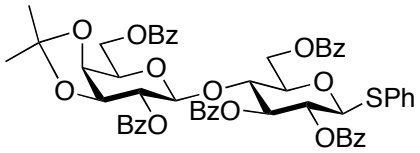


Phenyl 4-*O*-(2,6-di-*O*-benzoyl-3,4-*O*-isopropylidene-β-D-galactopyranosyl)-2,3,6-tri-*O*-benzoyl-1-thio-β-D-glucopyranoside (16)

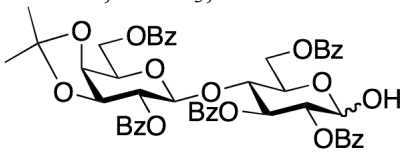
^{13}C NMR, $CDCl_3$, 125 MHz

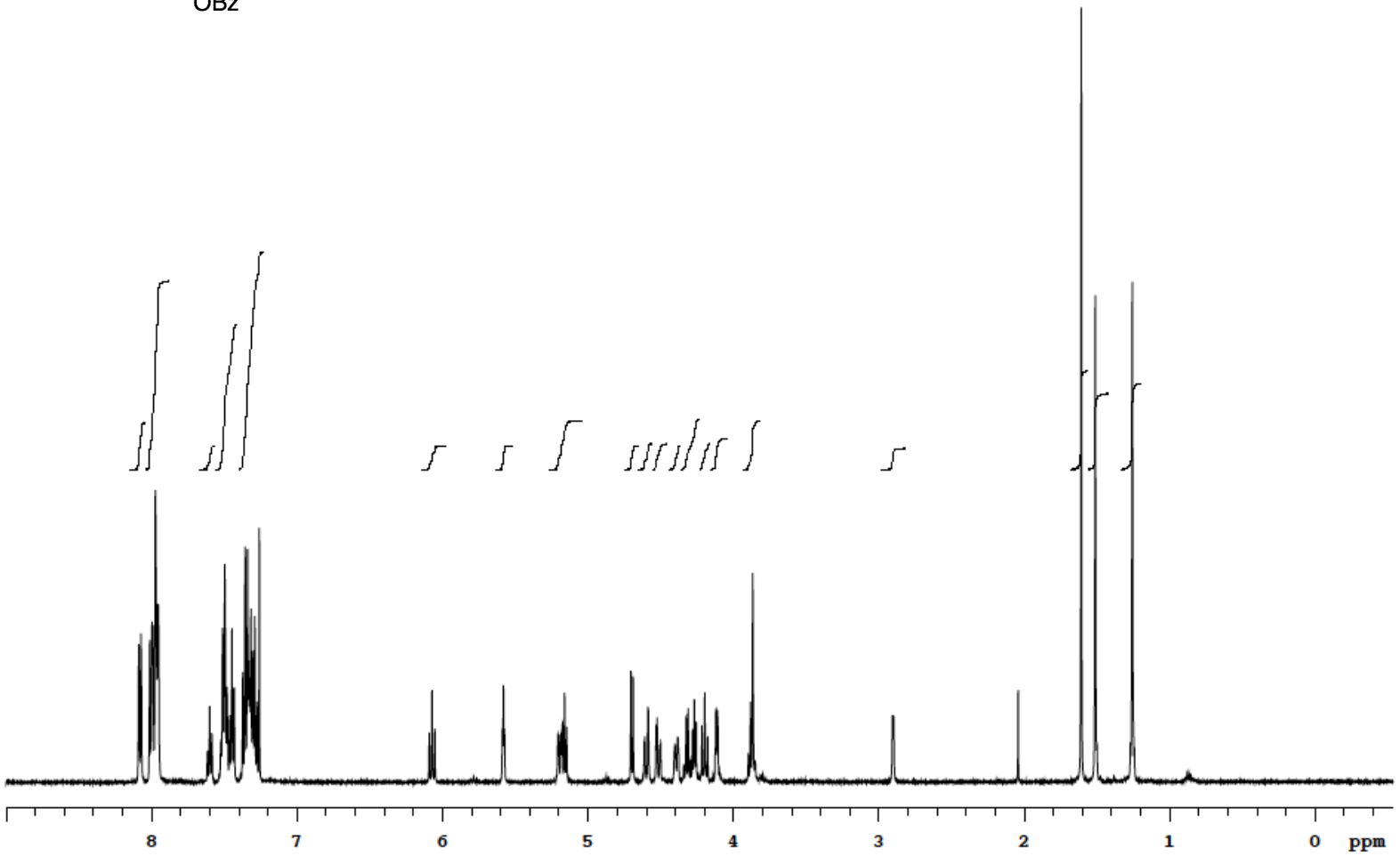


14

4-*O*-(2,6-Di-*O*-benzoyl-3,4-*O*-isopropylidene-β-D-galactopyranosyl-2,3,6-tri-*O*-benzoyl-α/β-D-glucopyranose

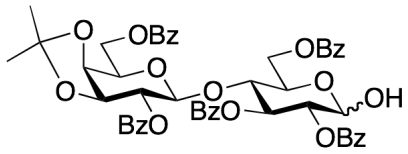
^{1}H NMR, $CDCl_3$, 500 MHz





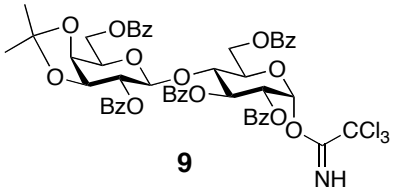
4-*O*-(2,6-Di-*O*-benzoyl-3,4-*O*-isopropylidene-β-D-galactopyranosyl-2,3,6-tri-*O*-benzoyl-α/β-D-glucopyranose (16a)

^{13}C NMR, $CDCl_3$, 125 MHz



***O*-(4-*O*-(2,6-Di-*O*-benzoyl-3,4-*O*-isopropylidene-β-D-galactopyranosyl)-2,3,6-tri-*O*-benzoyl-α-D-glucopyranosyl) trichloroacetimidate (9)**

^{1}H NMR, $CDCl_3$, 500 MHz



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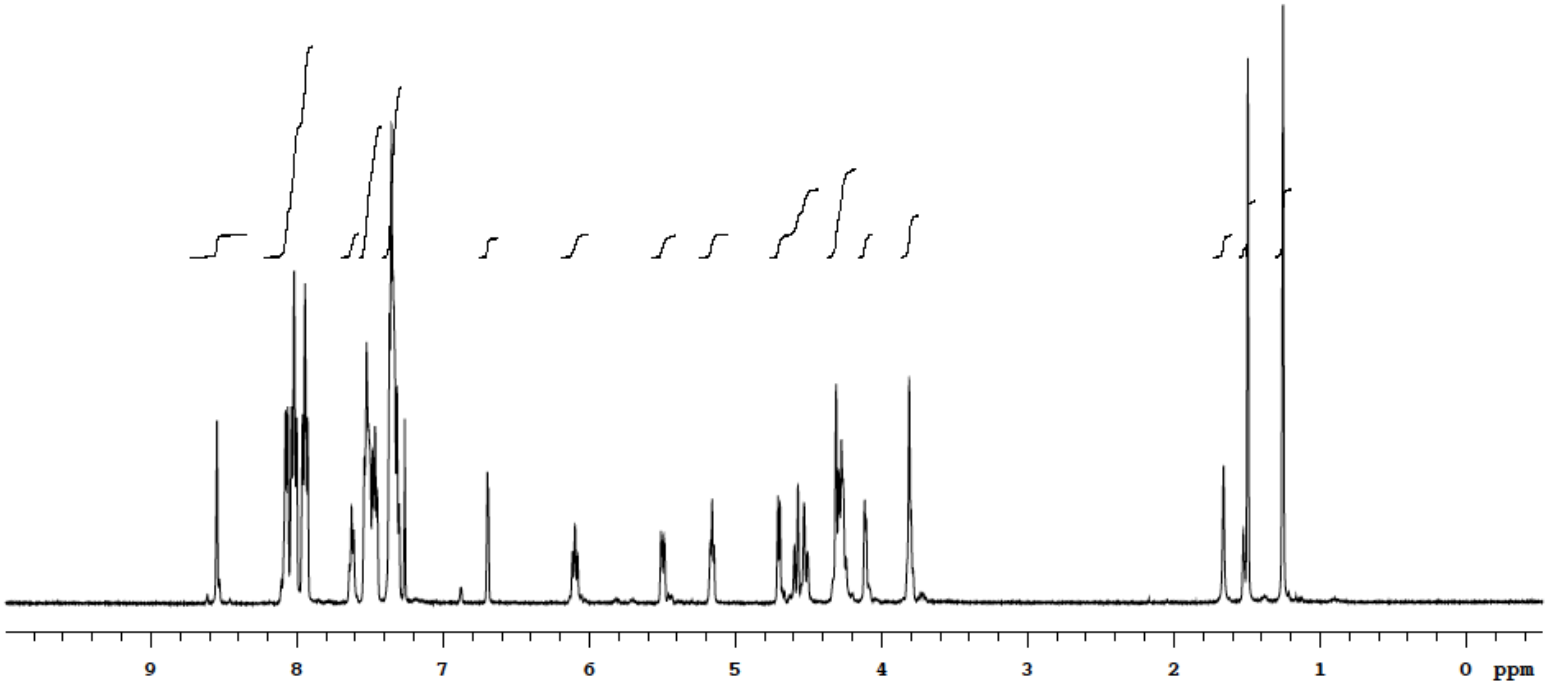
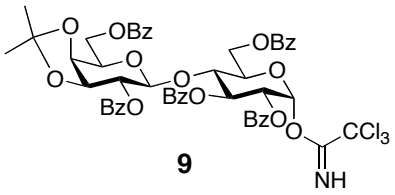


***O*-(4-*O*-(2,6-Di-*O*-benzoyl-3,4-*O*-isopropylidene-β-D-galactopyranosyl)-2,3,6-tri-*O*-benzoyl-α-D-glucopyranosyl) trichloroacetimidate**

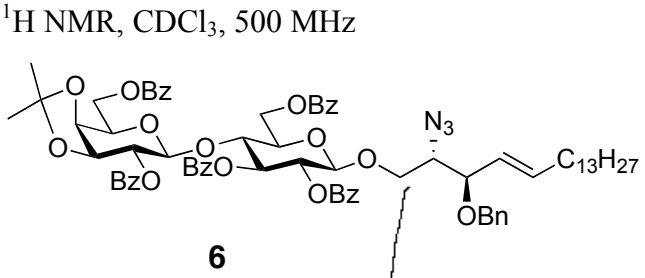
^{13}C NMR, $CDCl_3$, 125 MHz



9

(2*S*,3*R*,4*E*)-2-Azido-1-(4-*O*-(2,6-di-*O*-benzoyl-3,4-*O*-isopropylidene-β-D-galactopyranosyl)-2,3,6-tri-*O*-benzoyl-β-D-glucopyranosyloxy)-3-benzyloxy-octadec-4-ene

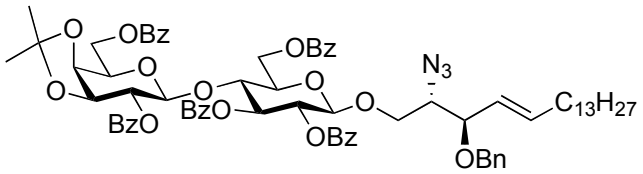
^{1}H NMR, $CDCl_3$, 500 MHz



6

(2*S*,3*R*,4*E*)-2-Azido-1-(4-*O*-(2,6-di-*O*-benzoyl-3,4-*O*-isopropylidene-β-D-galactopyranosyl)-2,3,6-tri-*O*-benzoyl-β-D-glucopyranosyloxy)-3-benzyloxy-octadec-4-ene ^{13}C NMR, $CDCl_3$, 125 MHz

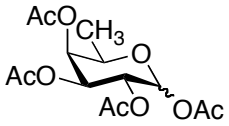
^{13}C NMR, $CDCl_3$, 125 MHz



6

1,2,3,4-Tetra-*O*-acetyl-6-deoxy-α/β-D-galactopyranose

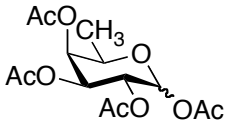
^{1}H NMR, $CDCl_3$, 500 MHz



16

1,2,3,4-Tetra-*O*-acetyl-6-deoxy-α/β-D-galactopyranose

^{13}C NMR, $CDCl_3$, 125 MHz



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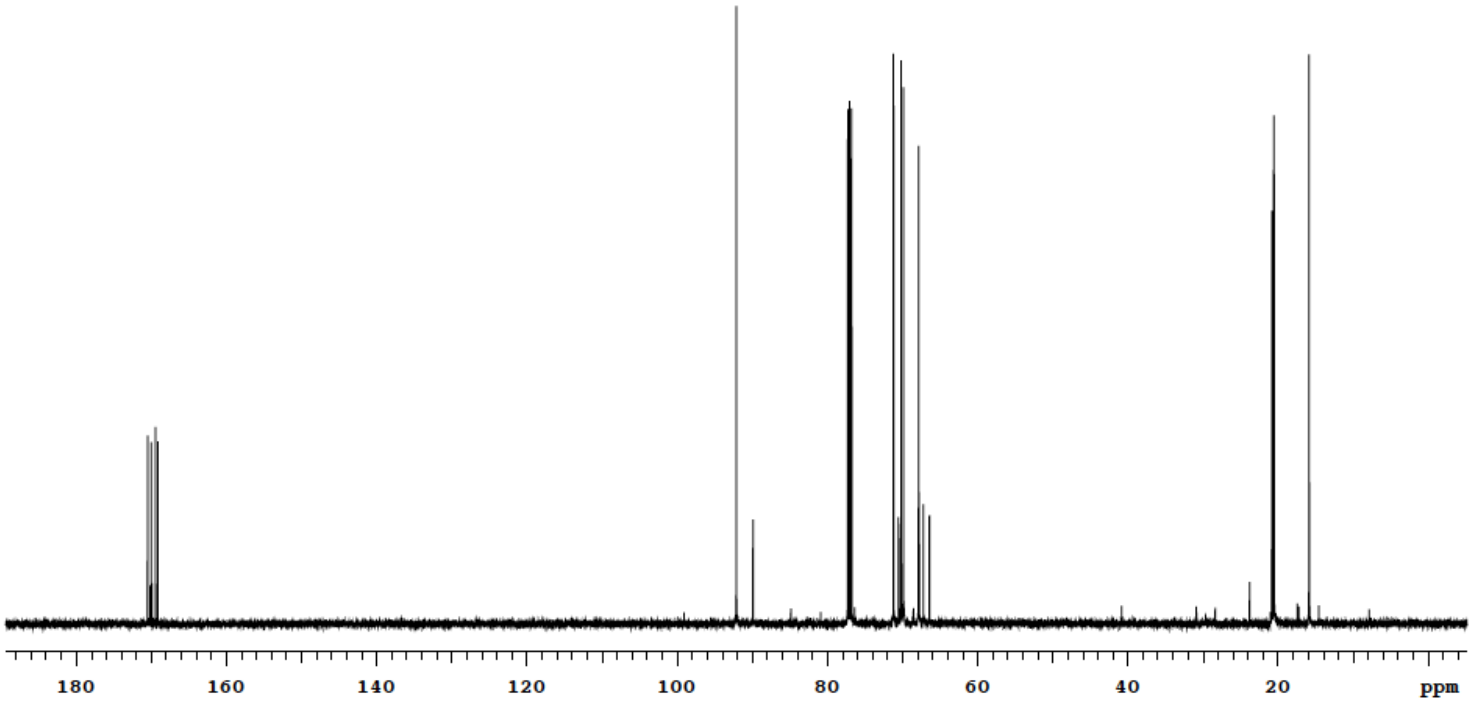
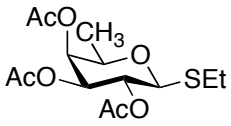


Ethyl 2,3,4-tri-*O*-acetyl-6-deoxy-1-thio-β-D-galactopyranoside

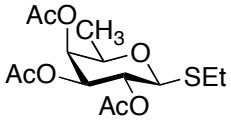
^{1}H NMR, $CDCl_3$, 500 MHz



17

Ethyl 2,3,4-tri-*O*-acetyl-6-deoxy-1-thio-β-D-galactopyranoside

^{13}C NMR, $CDCl_3$, 125 MHz



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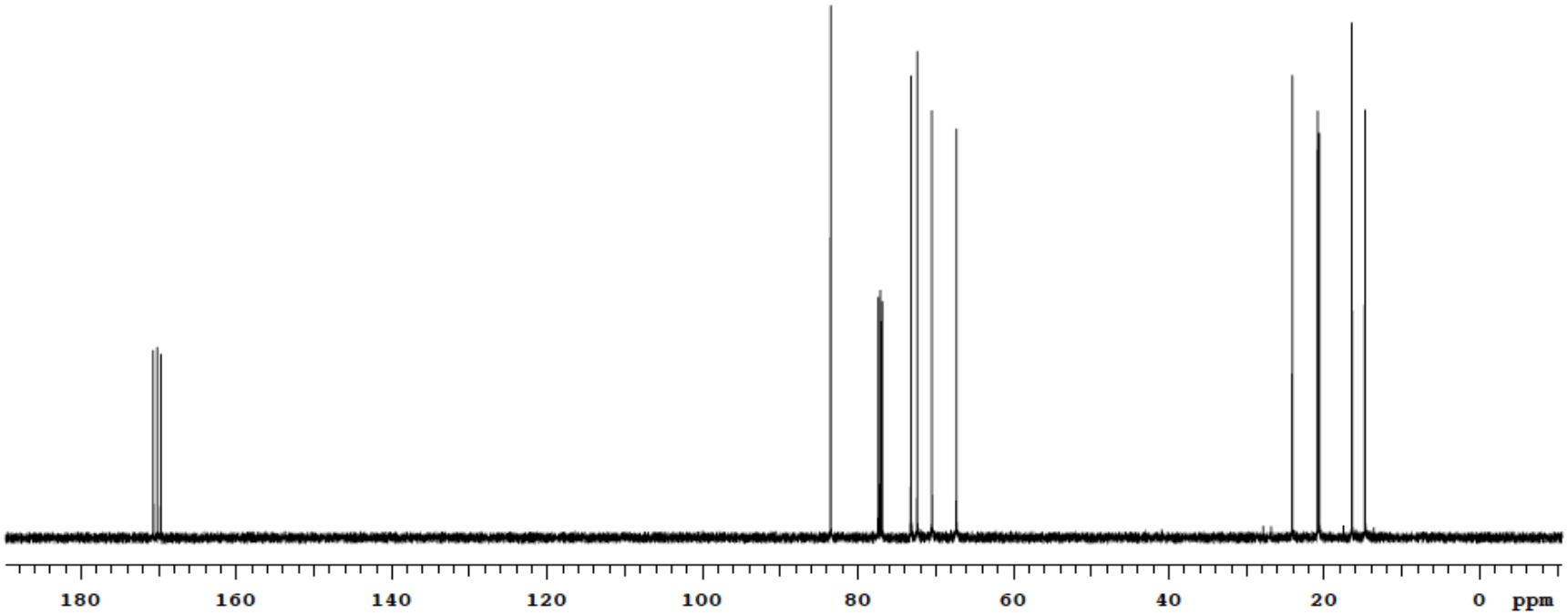
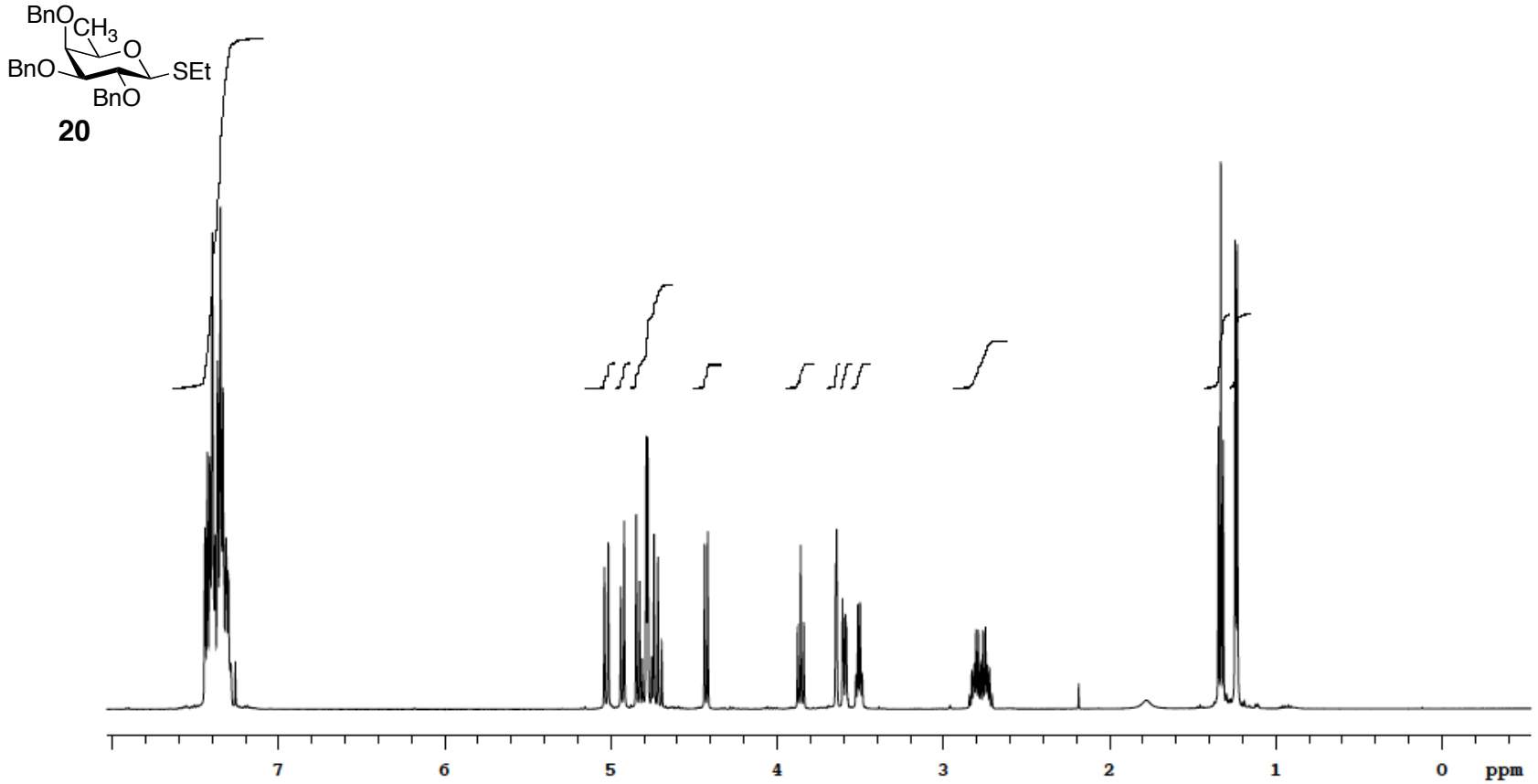


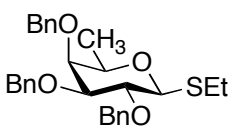
Ethyl 2,3,4-tri-*O*-benzyl-6-deoxy-1-thio-β-D-galactopyranoside

^{1}H NMR, $CDCl_3$, 500 MHz



Ethyl 2,3,4-tri-*O*-benzyl-6-deoxy-1-thio-β-D-galactopyranoside

^{13}C NMR, $CDCl_3$, 125 MHz



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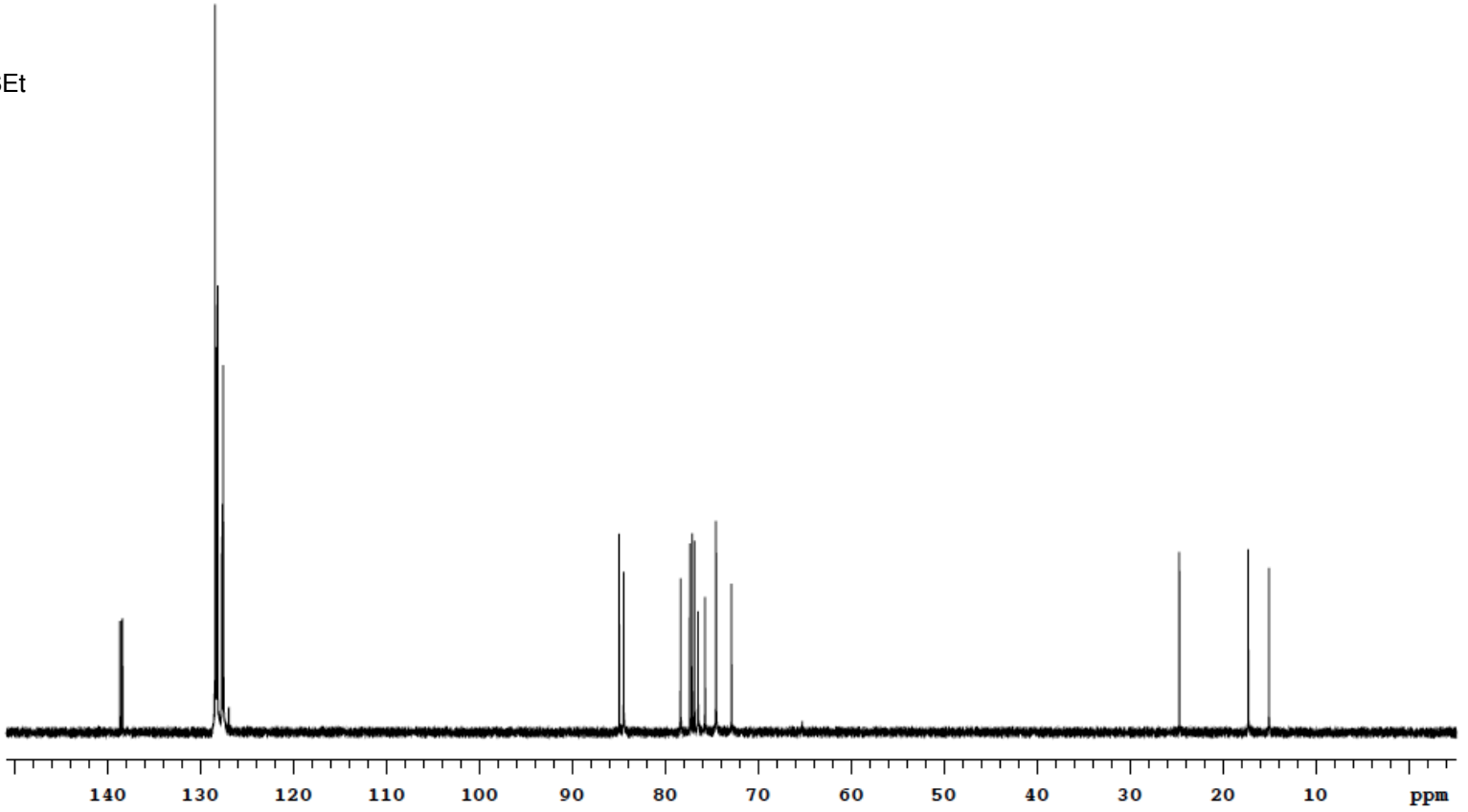
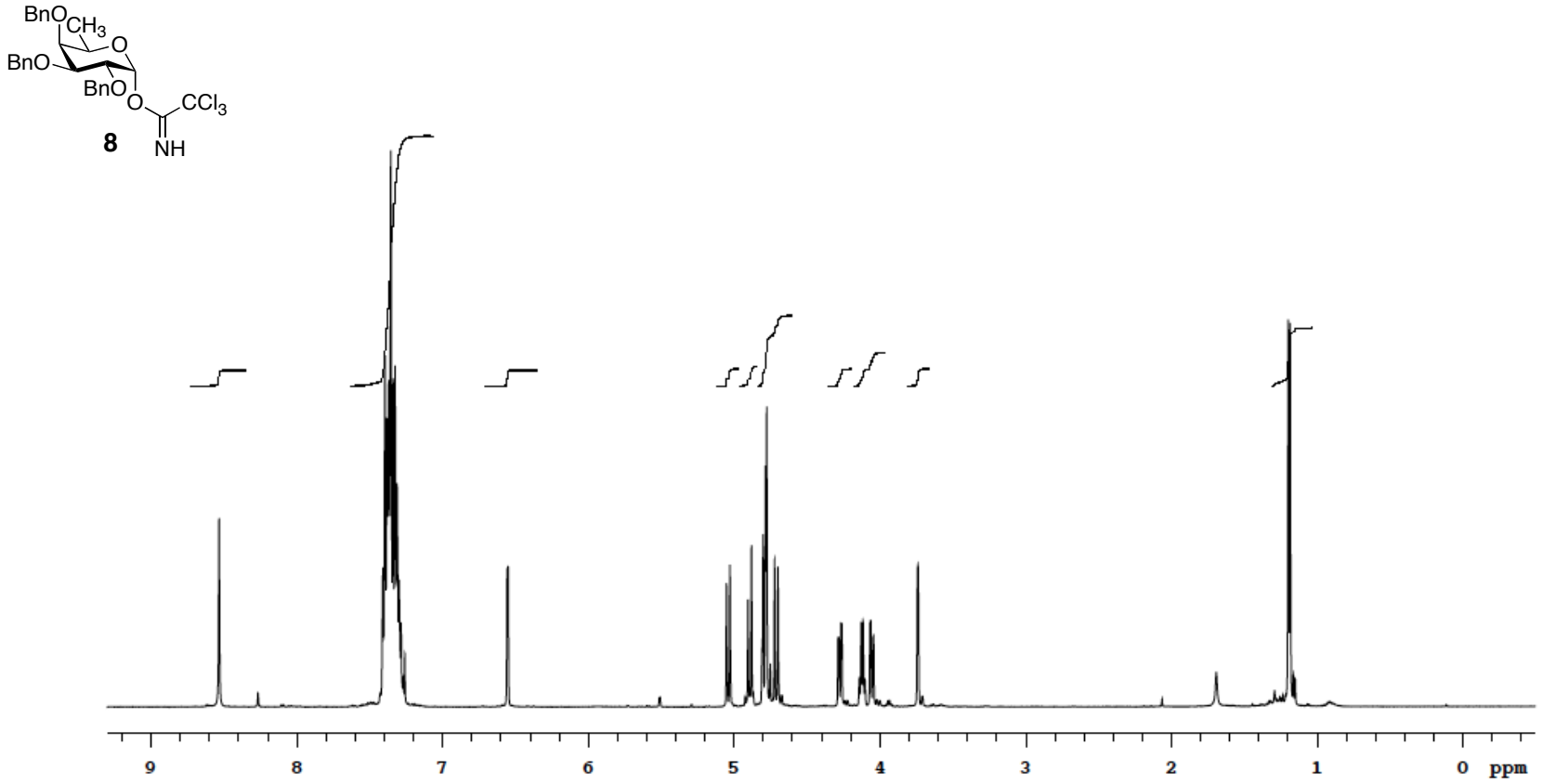


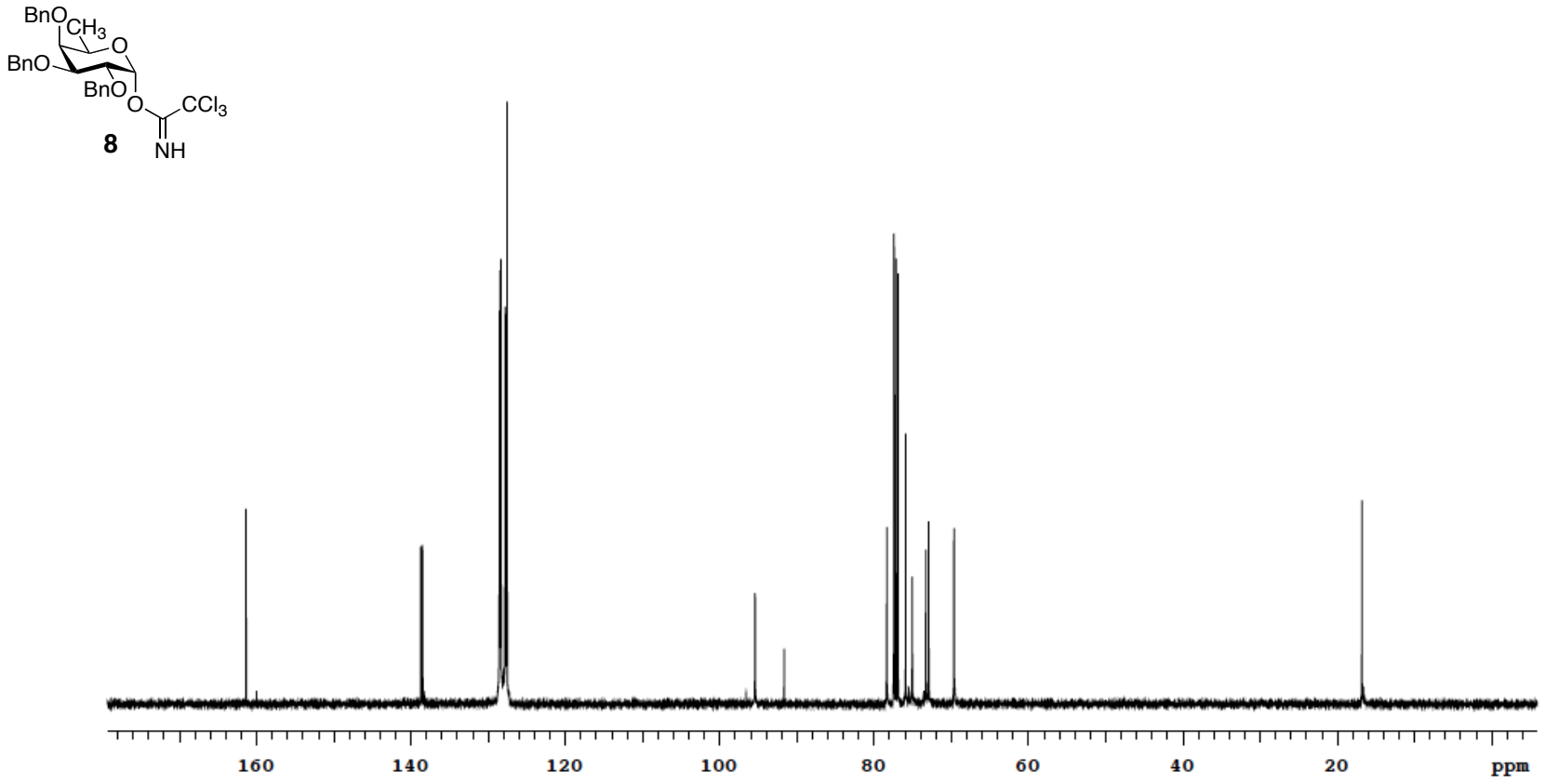
6-Deoxy-6-iodo-1,2:3,4-di-*O*-isopropylidene-α-D-galactopyranose.

^{1}H NMR, $CDCl_3$, 500 MHz



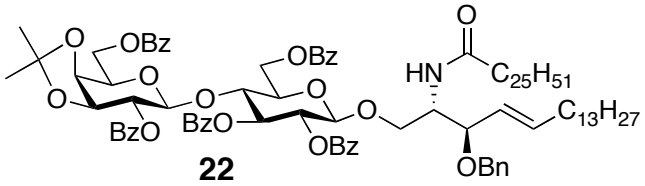
6-Deoxy-6-iodo-1,2:3,4-di-*O*-isopropylidene-α-D-galactopyranose.

^{13}C NMR, $CDCl_3$, 125 MHz



(2*S*,3*R*,4*E*)-1-(4-*O*-(2,6-Di-*O*-benzoyl-3,4-*O*-isopropylidene-β-D-galactopyranosyl)-2,3,6-tri-*O*-benzoyl-β-D-glucopyranosyloxy)-3-benzyloxy-2-hexacosanoylamido-octadecen-4-ene

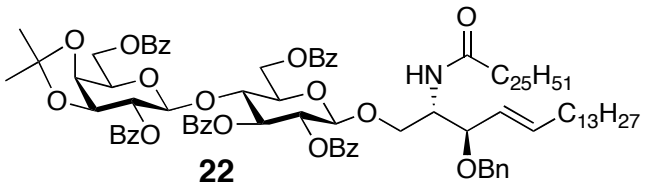
^{1}H NMR, $CDCl_3$, 500 MHz



22

(2*S*,3*R*,4*E*)-1-(4-*O*-(2,6-Di-*O*-benzoyl-3,4-*O*-isopropylidene-β-D-galactopyranosyl)-2,3,6-tri-*O*-benzoyl-β-D-glucopyranosyloxy)-3-benzyloxy-2-hexacosanoylamido-octadecen-4-ene

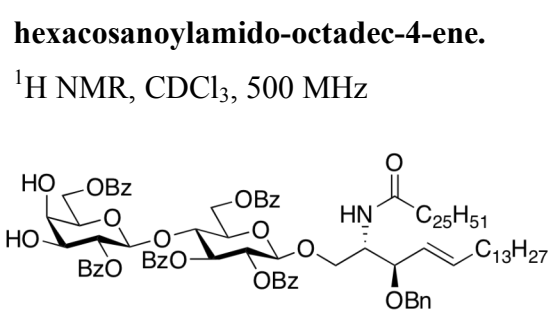
^{13}C NMR, $CDCl_3$, 125 MHz



22

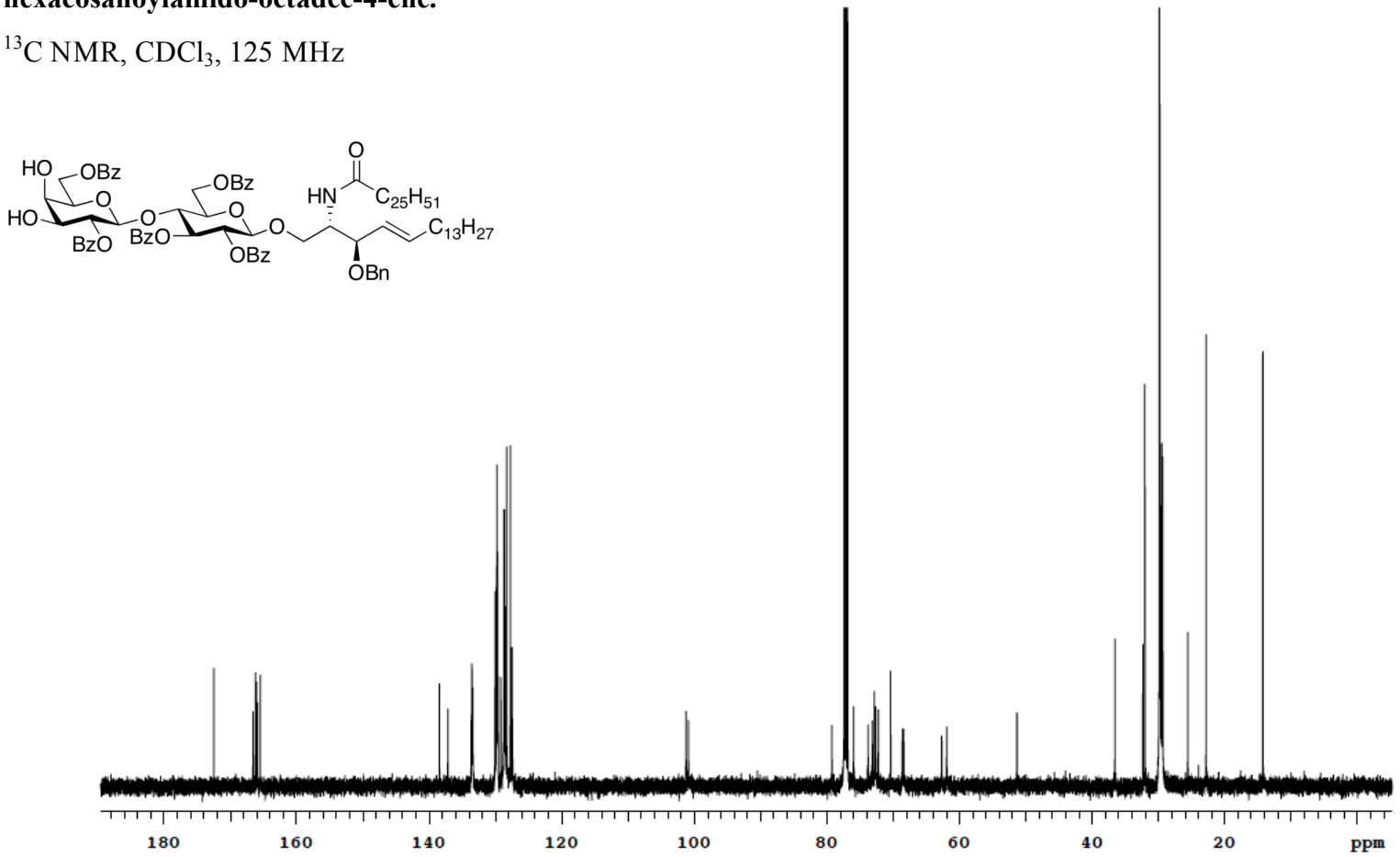
(2*S*,3*R*,4*E*)-1-(4-*O*-(2,6-Di-*O*-benzoyl-β-D-galactopyranosyl)-2,3,6-tri-*O*-benzoyl-β-D-glucopyranosyloxy)-3-benzyloxy-2-hexacosanoylamido-octadec-4-ene.

^{1}H NMR, $CDCl_3$, 500 MHz



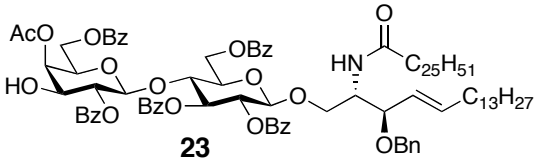
(2*S*,3*R*,4*E*)-1-(4-*O*-(2,6-Di-*O*-benzoyl-β-D-galactopyranosyl)-2,3,6-tri-*O*-benzoyl-β-D-glucopyranosyloxy)-3-benzyloxy-2-hexacosanoylamido-octadec-4-ene.

^{13}C NMR, $CDCl_3$, 125 MHz



(2*S*,3*R*,4*E*)-1-(4-*O*-(4-*O*-Acetyl-2,6-di-*O*-benzoyl-β-D-galactopyranosyl)-2,3,6-tri-*O*-benzoyl-β-D-glucopyranosyloxy)-3-benzyloxy-2-hexacosanoylamido-octadec-4-ene

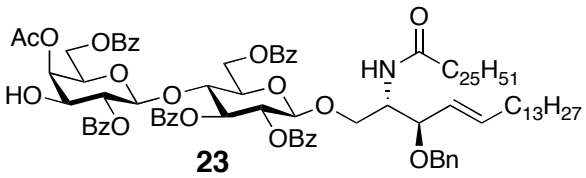
^{1}H NMR, $CDCl_3$, 500 MHz



23

(2*S*,3*R*,4*E*)-1-(4-*O*-(4-*O*-Acetyl-2,6-di-*O*-benzoyl-β-D-galactopyranosyl)-2,3,6-tri-*O*-benzoyl-β-D-glucopyranosyloxy)-3-benzyloxy-2-hexacosanoylamido-octadec-4-ene

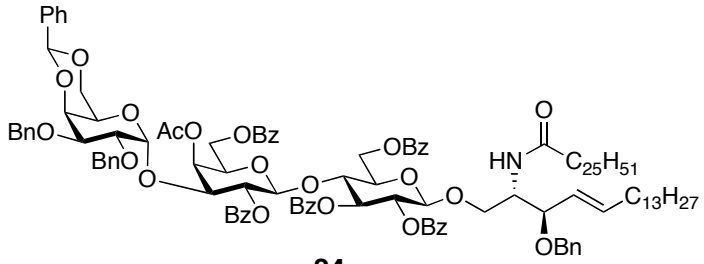
^{13}C NMR, $CDCl_3$, 125 MHz



23

(2*S*,3*R*,4*E*)-1-(4-*O*-(4-*O*-Acetyl-2,6-di-*O*-benzoyl-3-*O*-(2,3-di-*O*-benzyl-4,6-*O*-benzylidene-α-D-galactopyranosyl)-β-D-galactopyranosyl)-2,3,6-tri-*O*-benzoyl-β-D-glucopyranosyloxy)-3-benzyloxy-2-(hexacosanoylamido)-octadec-4-ene.

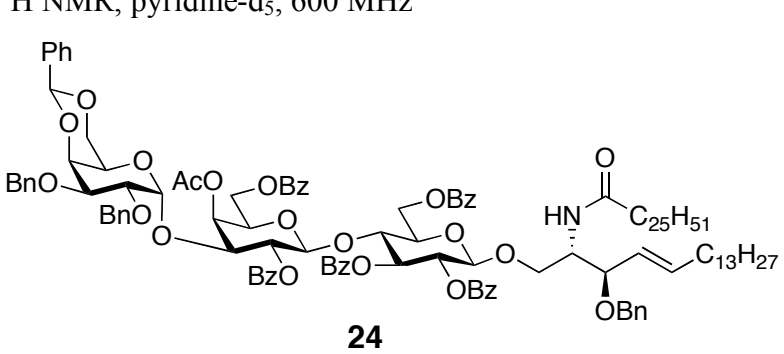
^{13}C NMR, pyridine-d_5, 125 MHz



24

(2*S*,3*R*,4*E*)-1-(4-*O*-(4-*O*-Acetyl-2,6-di-*O*-benzoyl-3-*O*-(2,3-di-*O*-benzyl-4,6-*O*-benzylidene-α-D-galactopyranosyl)-β-D-galactopyranosyl)-2,3,6-tri-*O*-benzoyl-β-D-glucopyranosyloxy)-3-benzyloxy-2-(hexacosanoylamido)-octadec-4-ene.

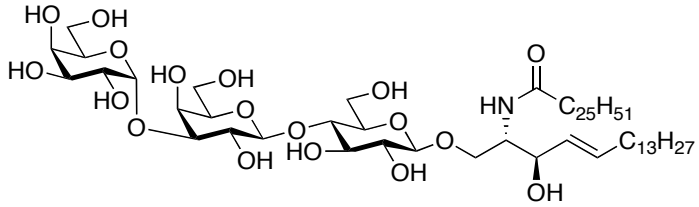
^{1}H NMR, pyridine-d$_5$, 600 MHz



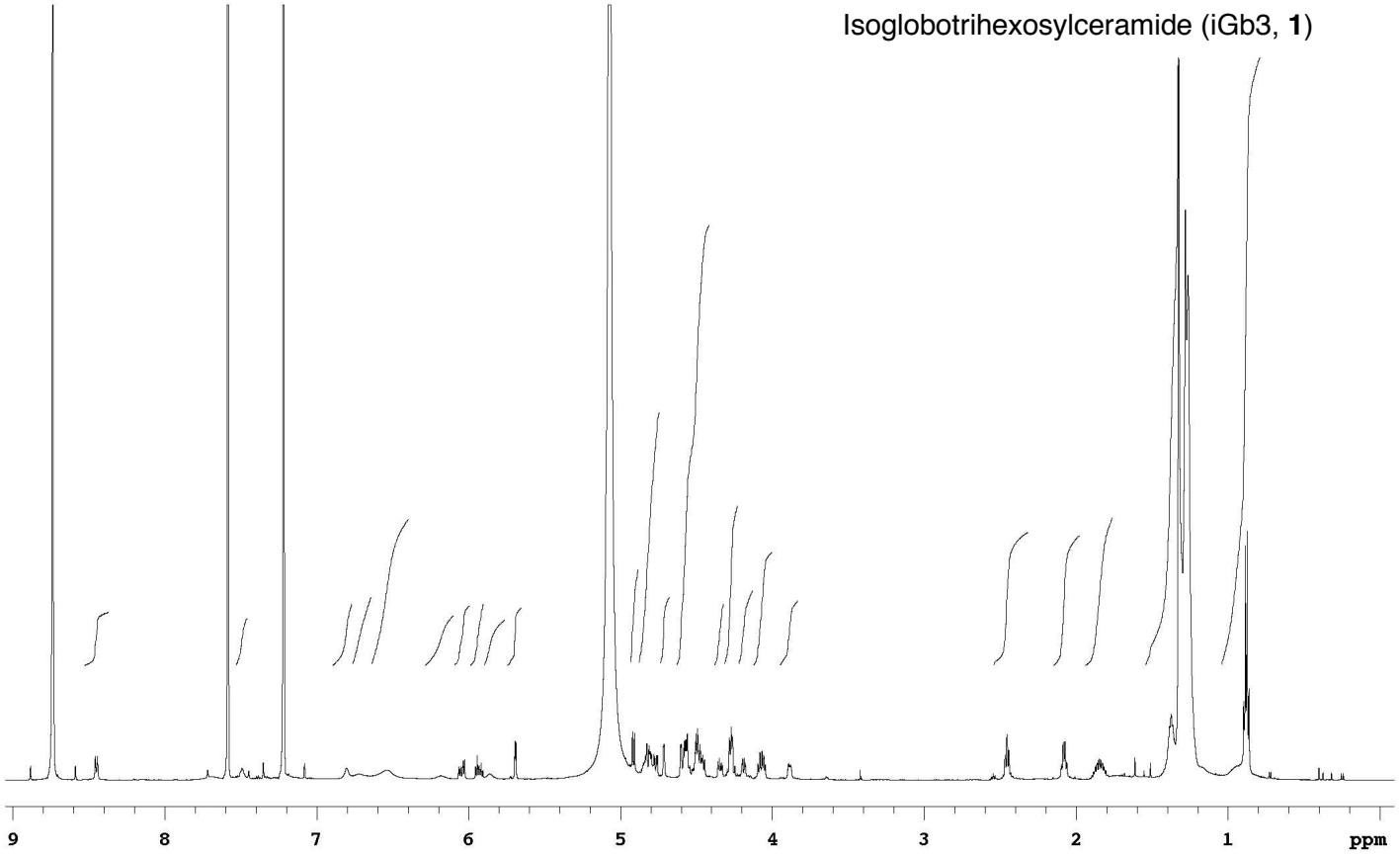
24

(2*S*,3*R*,4*E*)-2-(Hexacosanoylamido)-1-(4-*O*-(3-*O*-α-D-galactopyranosyl)-β-D-galactopyranosyl)-β-D-glucopyranosyloxy)-3-hydroxy-octadec-4-ene (iGb3, 1)

^{1}H NMR, pyridine-d_5, 600 MHz

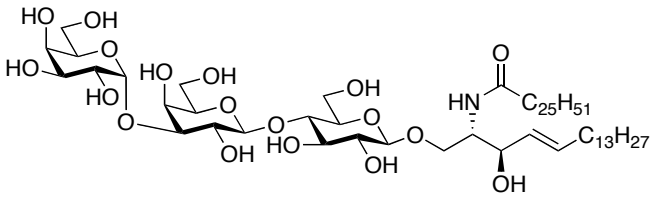


Isoglobotrihexosylceramide (iGb3, **1**)



(2*S*,3*R*,4*E*)-2-(Hexacosanoylamido)-1-(4-*O*-(3-*O*-α-D-galactopyranosyl)-β-D-galactopyranosyl)-β-D-glucopyranosyloxy)-3-hydroxy-octadec-4-ene (iGb3, 1)

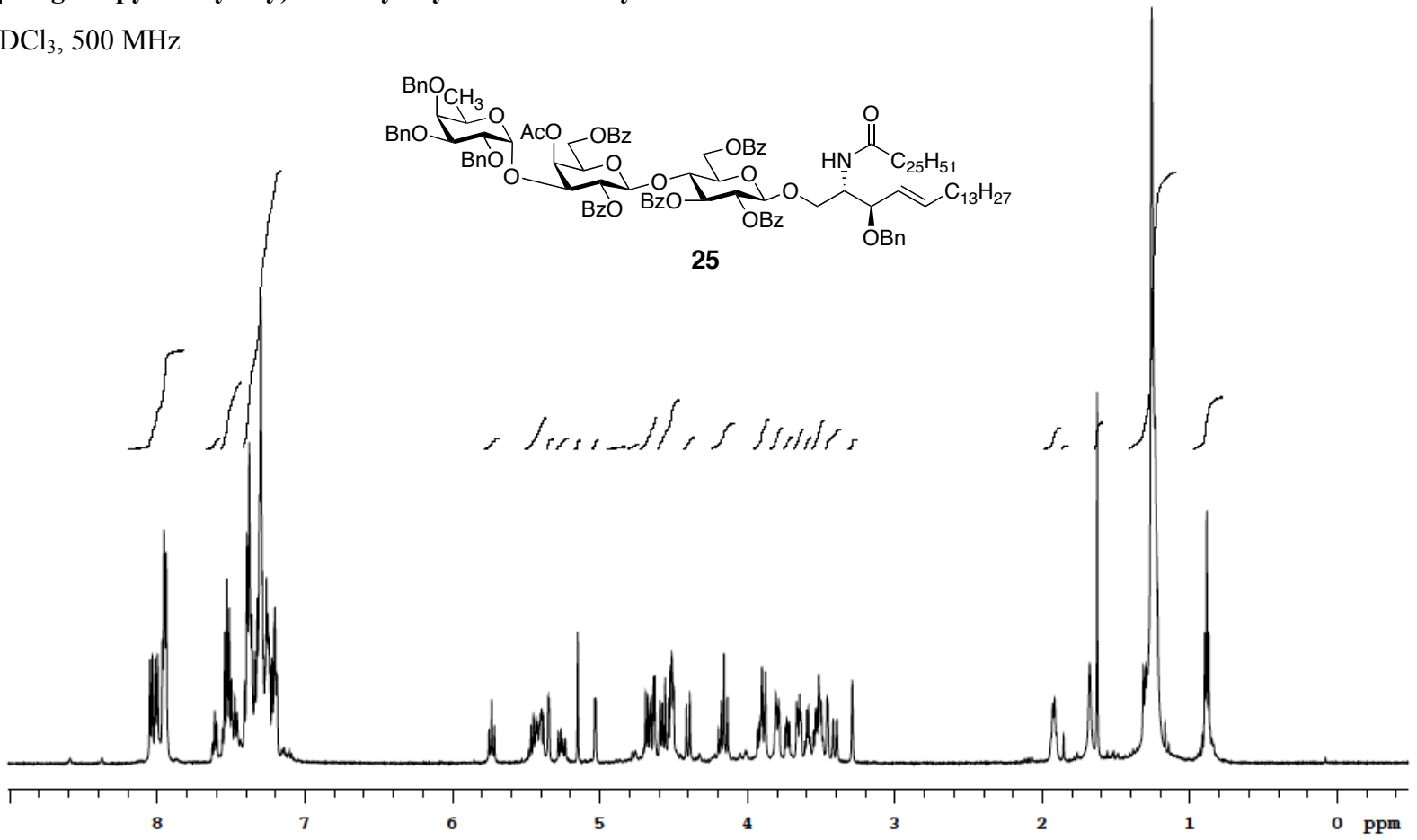
^{13}C NMR, pyridine-d_5, 125 MHz



Isoglobotrihexosylceramide (iGb3, **1**)

(2*S*,3*R*,4*E*)-1-(4-*O*-(4-*O*-Acetyl-2,6-di-*O*-benzoyl-3-*O*-(2,3,4-tri-*O*-benzyl-6-deoxy-α-D-galactopyranosyl)-β-D-galactopyranosyl)-2,3,6-tri-*O*-benzoyl-β-D-glucopyranosyloxy)-3-benzyloxy-2-hexacosanoylamido-octadec-4-ene

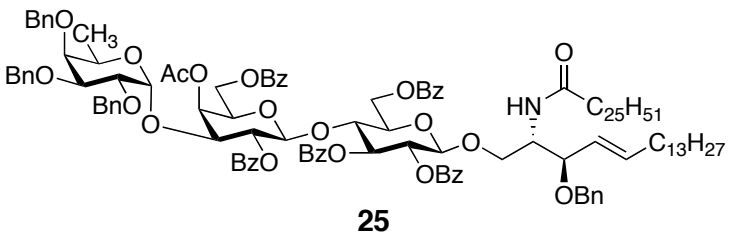
^{1}H NMR, $CDCl_3$, 500 MHz



25

(2*S*,3*R*,4*E*)-1-(4-*O*-(4-*O*-Acetyl-2,6-di-*O*-benzoyl-3-*O*-(2,3,4-tri-*O*-benzyl-6-deoxy-α-D-galactopyranosyl)-β-D-galactopyranosyl)-2,3,6-tri-*O*-benzoyl-β-D-glucopyranosyloxy)-3-benzyloxy-2-hexacosanoylamido-octadec-4-ene

^{13}C NMR, $CDCl_3$, 125 MHz



25

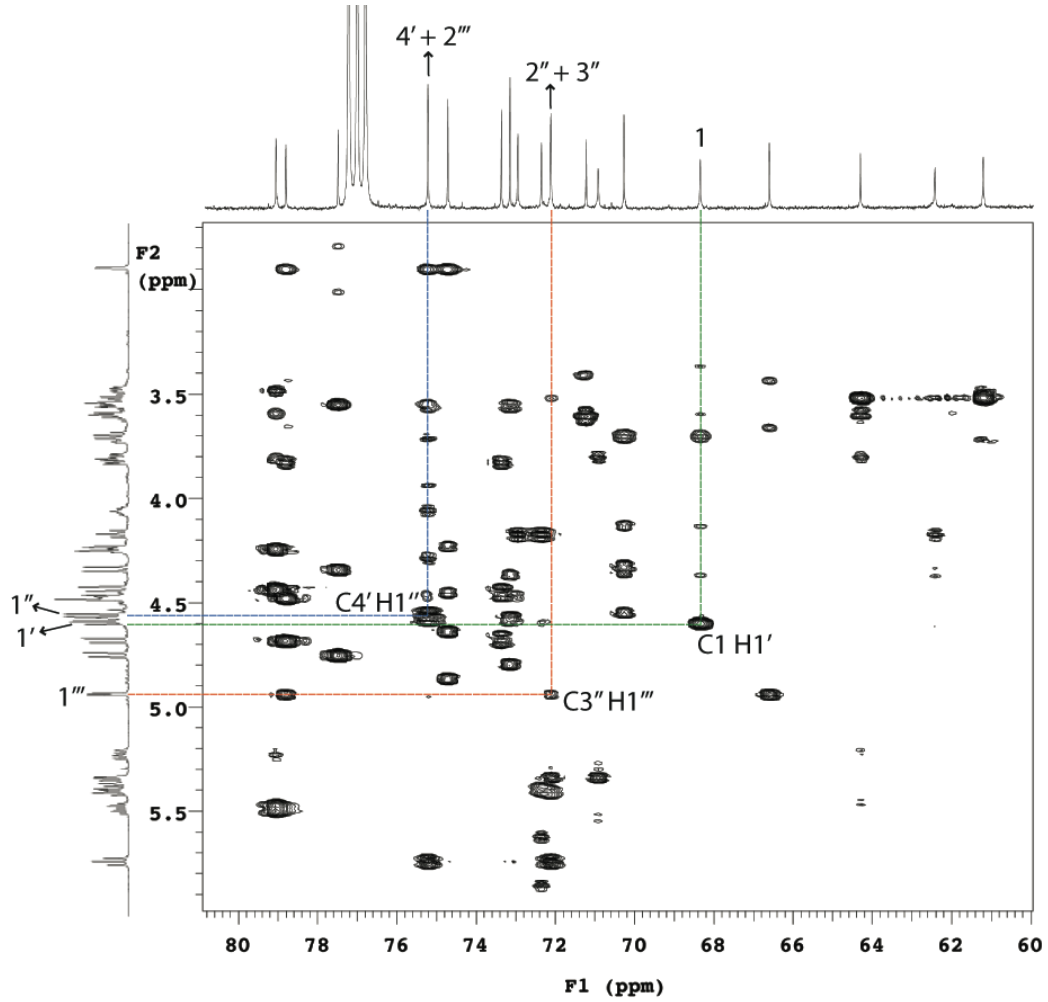


Figure 1. HMBC spectrum of 6´´´-deoxy-iGb3 **25** confirming the fucosylation of LacCer **23** at the 3´´-position.

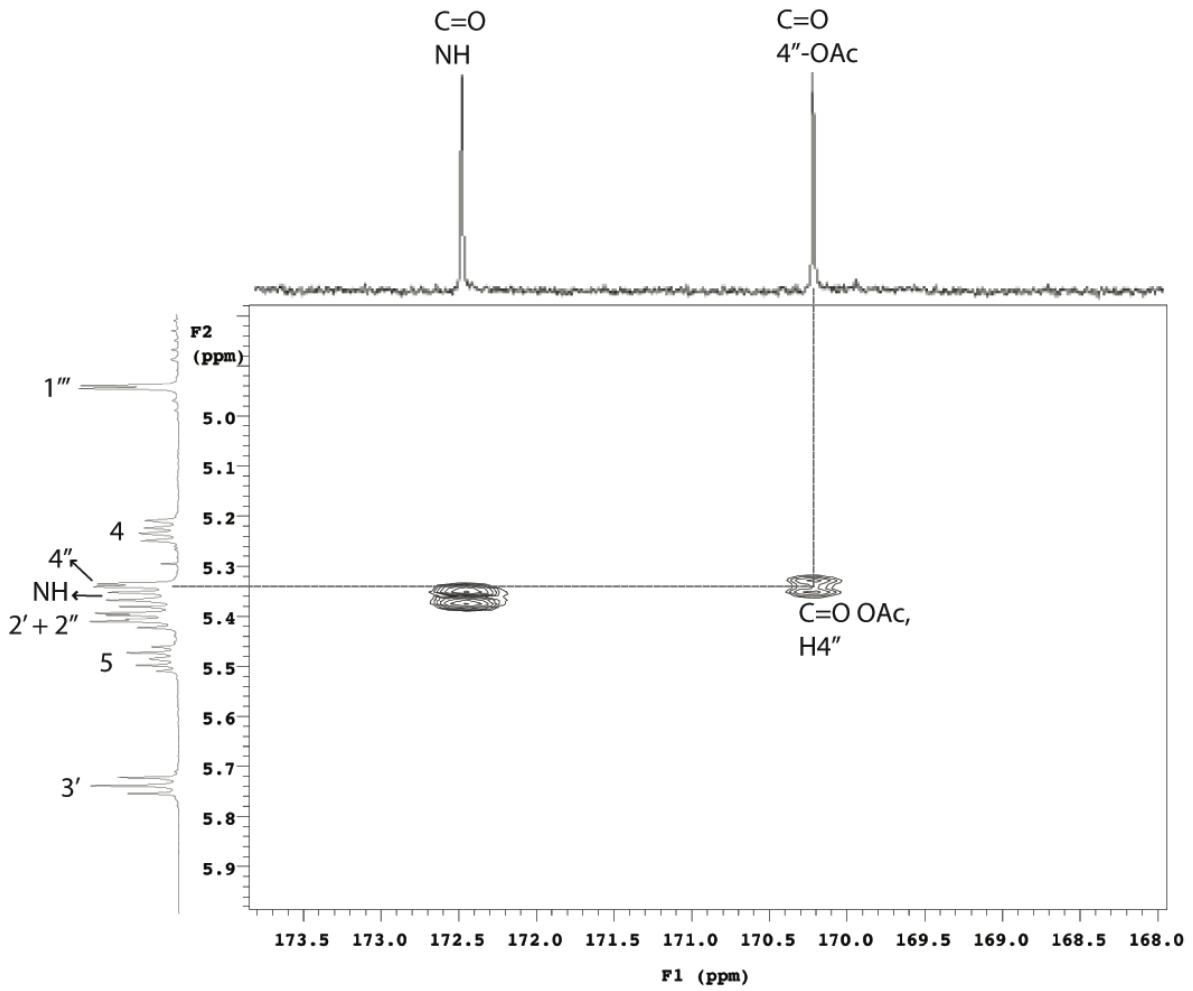
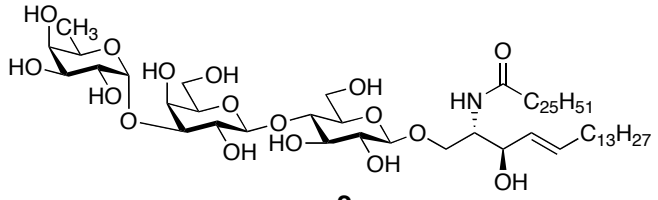


Figure 2. HMBC of 6´´´-deoxy-iGb3 **25** confirming acetylation at position 4´´

(2*S*,3*R*,4*E*)-1-(4-*O*-(3-*O*-(6-Deoxy-α-D-galactopyranosyl)-β-D-galactopyranosyl)-β-D-glucopyranosyloxy)-2-hexacosanoylamido-3-hydroxy-octadec-4-ene

^{1}H NMR, pyridine-d_5, 500 MHz



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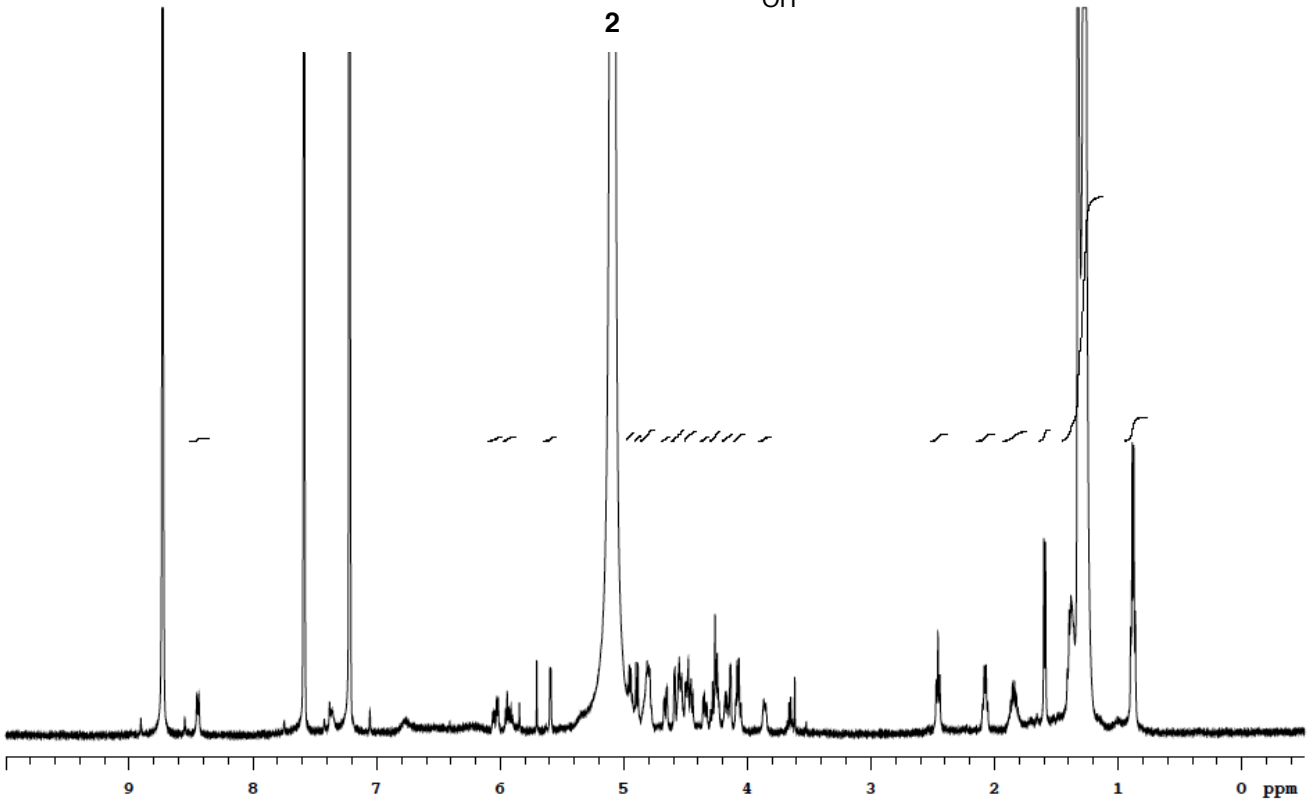
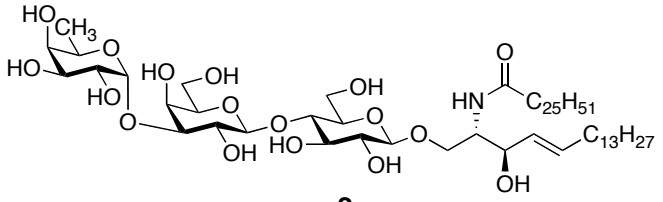


(2*S*,3*R*,4*E*)-1-(4-*O*-(3-*O*-(6-Deoxy-α-D-galactopyranosyl)-β-D-galactopyranosyl)-β-D-glucopyranosyloxy)-2-hexacosanoylamido-3-hydroxy-octadec-4-ene

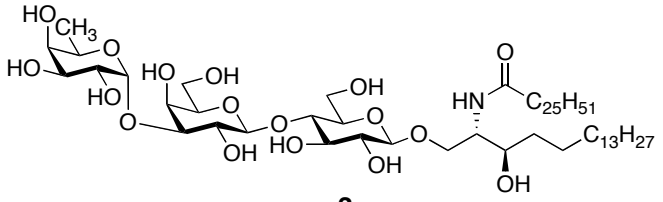
^{13}C NMR, pyridine-d_5, 125 MHz



2

(2*S*,3*R*,4*E*)-1-(4-*O*-(3-*O*-(6-Deoxy-α-D-galactopyranosyl)-β-D-galactopyranosyl)-β-D-glucopyranosyloxy)-2-hexacosanoylamido-3-hydroxy-octadecane

^{1}H NMR, pyridine-d_5, 500 MHz



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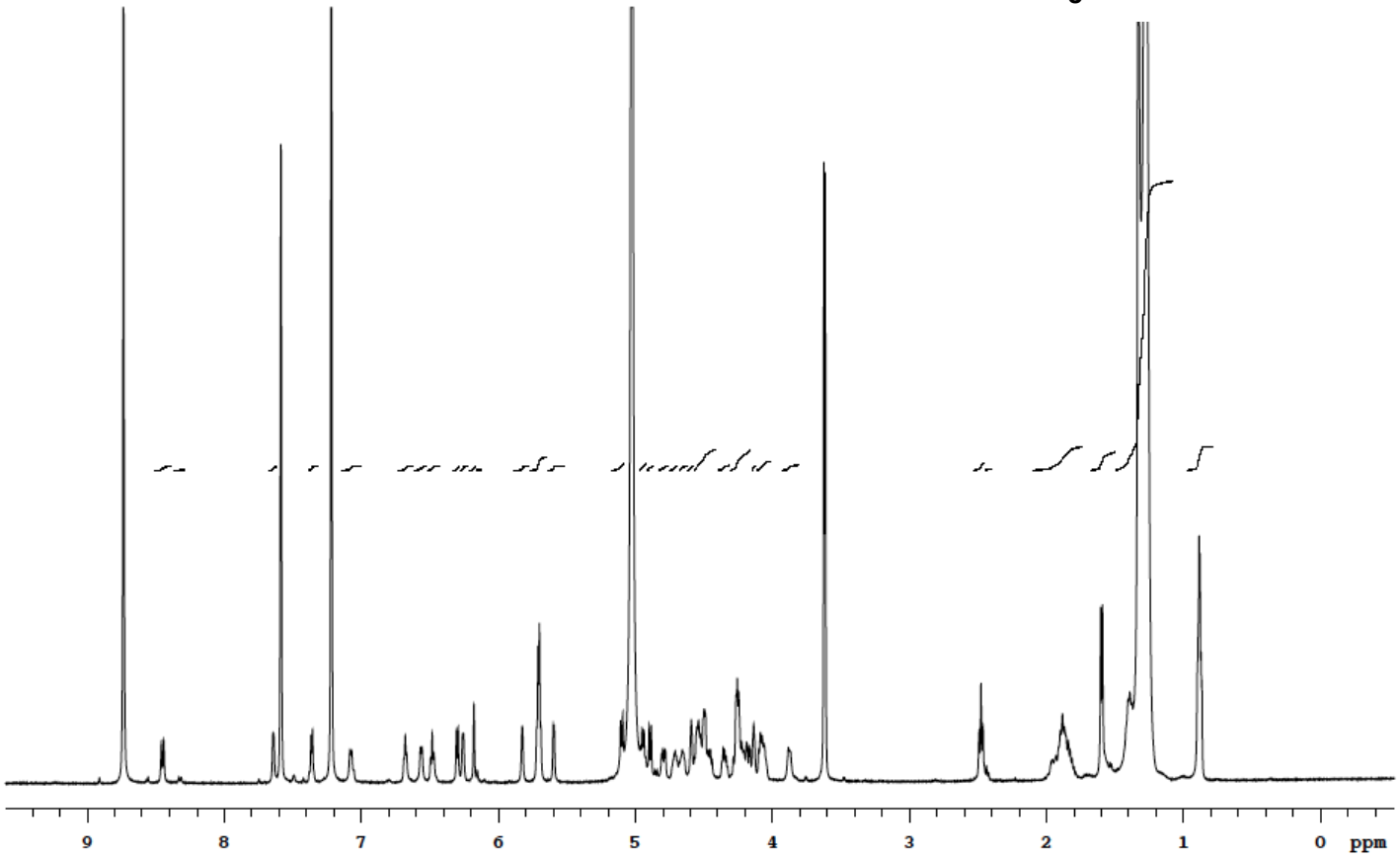
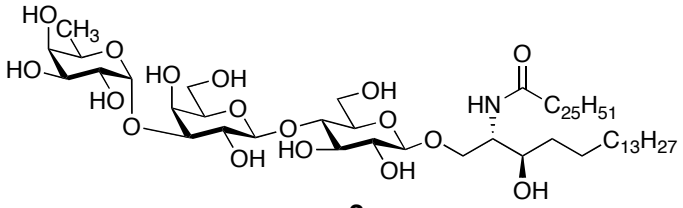


(2*S*,3*R*,4*E*)-1-(4-*O*-(3-*O*-(6-Deoxy-α-D-galactopyranosyl)-β-D-galactopyranosyl)-β-D-glucopyranosyloxy)-2-hexacosanoylamido-3-hydroxy-octadecane

^{13}C NMR, pyridine-d_5, 125 MHz



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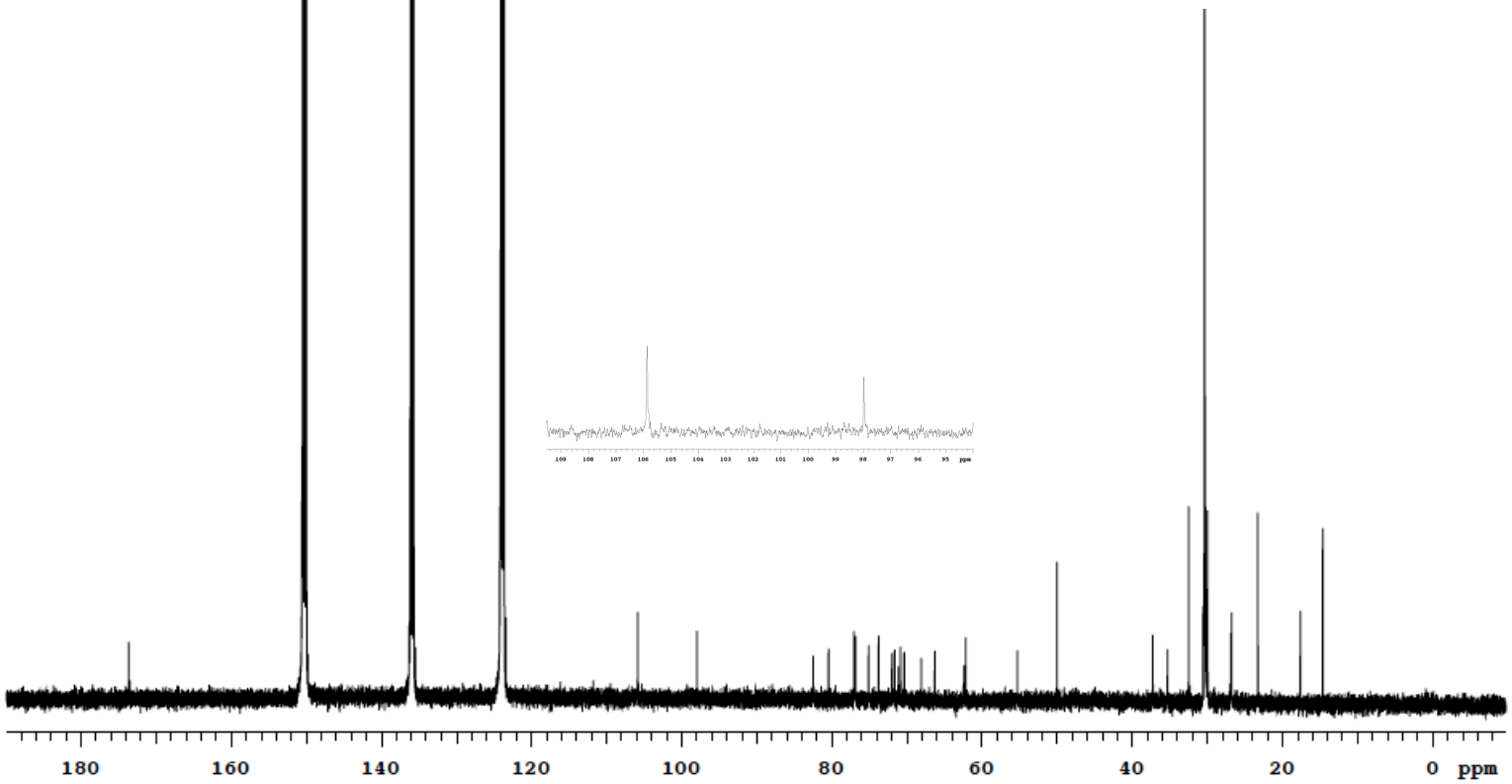
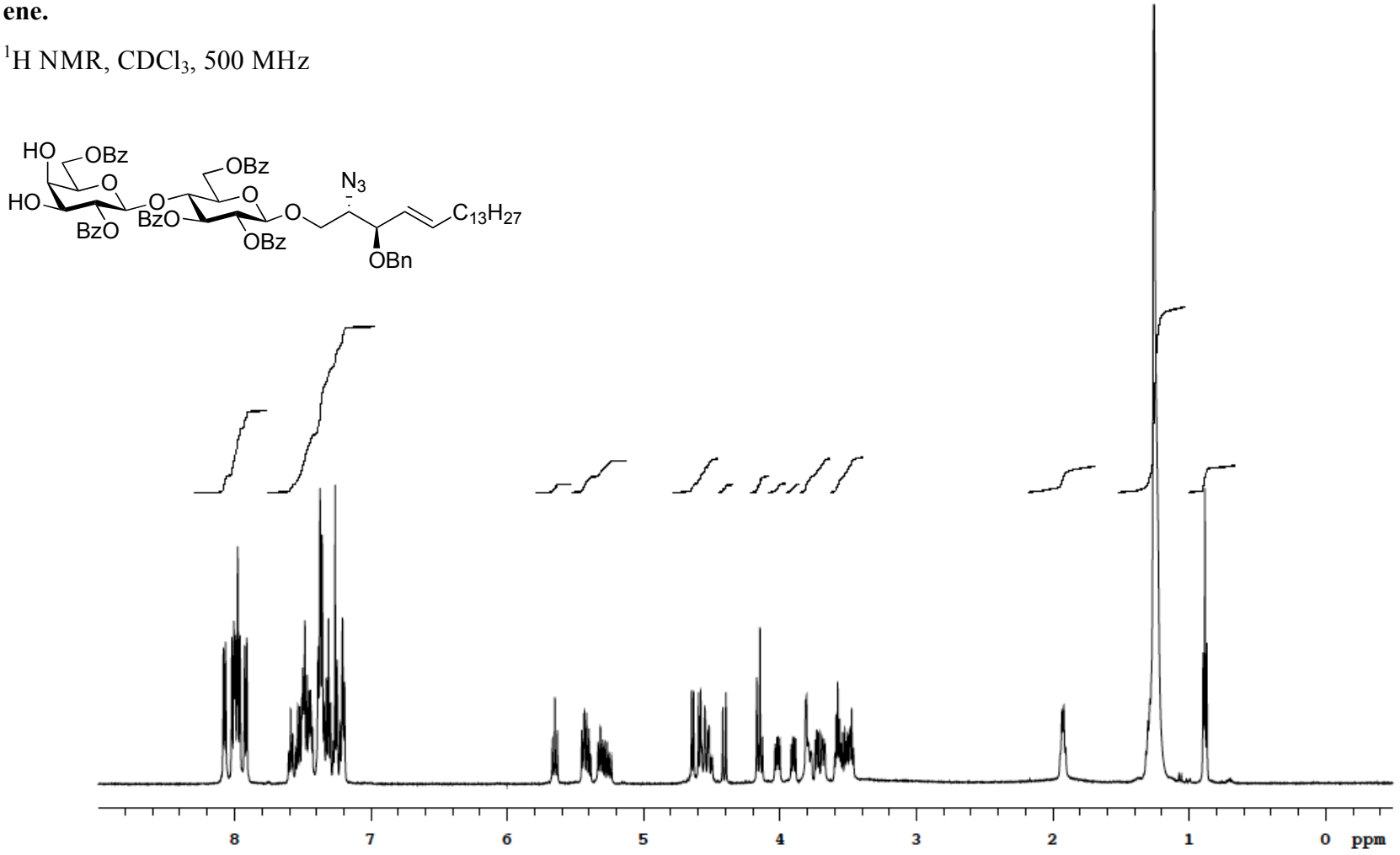


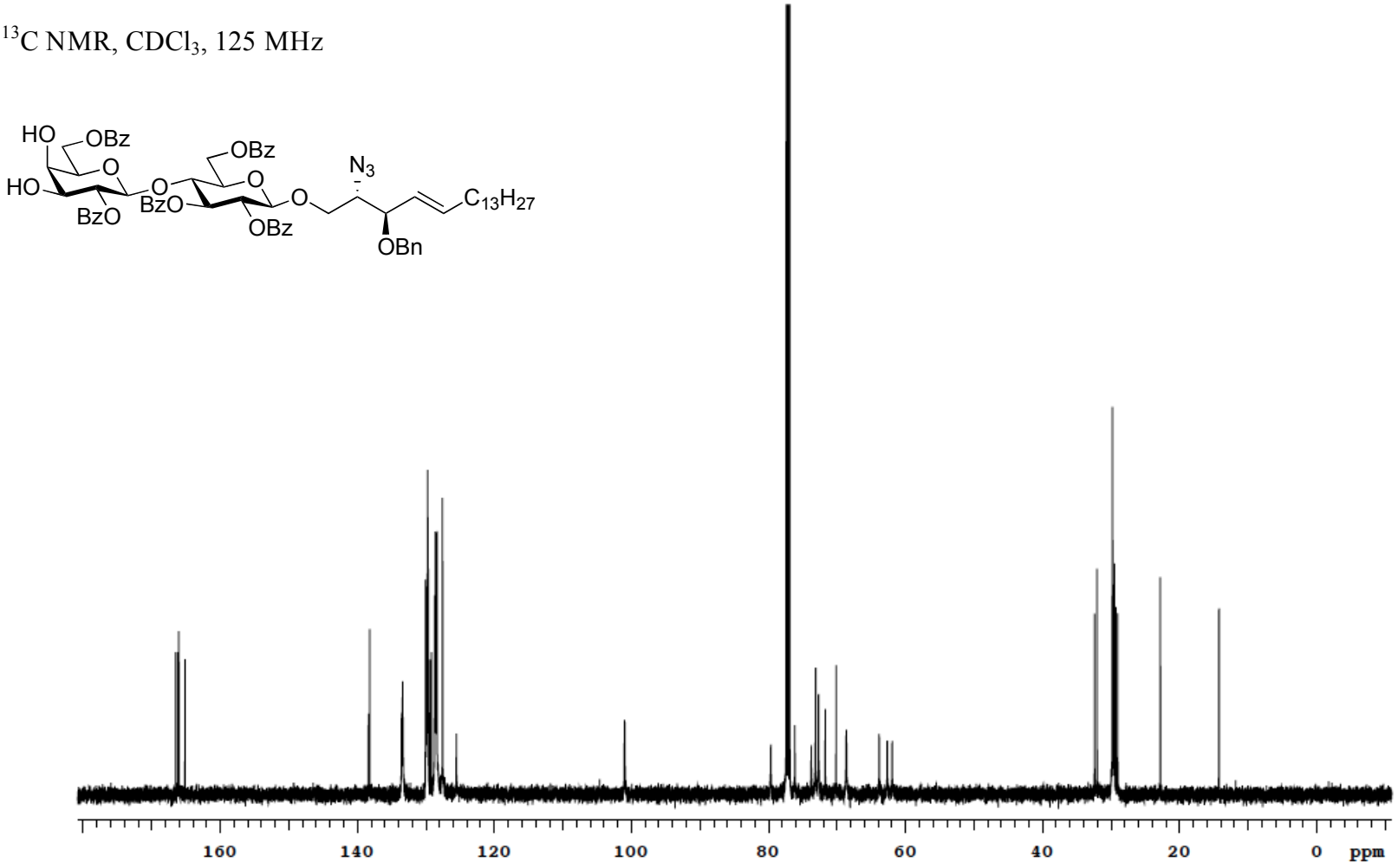
(2*S*,3*R*,4*E*)-2-Azido-1-(4-*O*-(2,6-di-*O*-benzoyl-β-D-galactopyranosyl)-2,3,6-tri-*O*-benzoyl-β-D-glucopyranosyloxy)-3-benzyloxy-octadec-4-ene.

^{1}H NMR, $CDCl_3$, 500 MHz



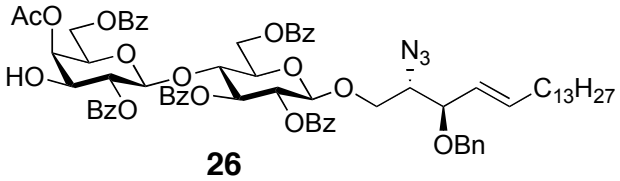
(2*S*,3*R*,4*E*)-2-Azido-1-(4-*O*-(2,6-di-*O*-benzoyl-β-D-galactopyranosyl)-2,3,6-tri-*O*-benzoyl-β-D-glucopyranosyloxy)-3-benzyloxy-octadec-4-ene.

^{13}C NMR, $CDCl_3$, 125 MHz



(2*S*,3*R*,4*E*)-1-(4-*O*-(4-*O*-Acetyl-2,6-di-*O*-benzoyl-β-D-galactopyranosyl)-2,3,6-tri-*O*-benzoyl-β-D-glucopyranosyloxy)-2-azido-3-benzyloxy-octadec-4-ene

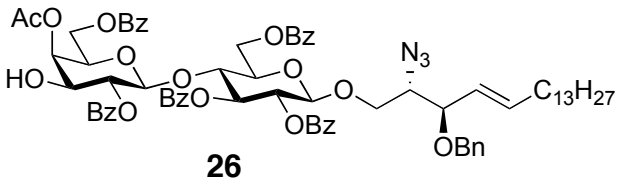
^{1}H NMR, $CDCl_3$, 500 MHz



26

(2*S*,3*R*,4*E*)-1-(4-*O*-(4-*O*-Acetyl-2,6-di-*O*-benzoyl-β-D-galactopyranosyl)-2,3,6-tri-*O*-benzoyl-β-D-glucopyranosyloxy)-2-azido-3-benzyloxy-octadec-4-ene

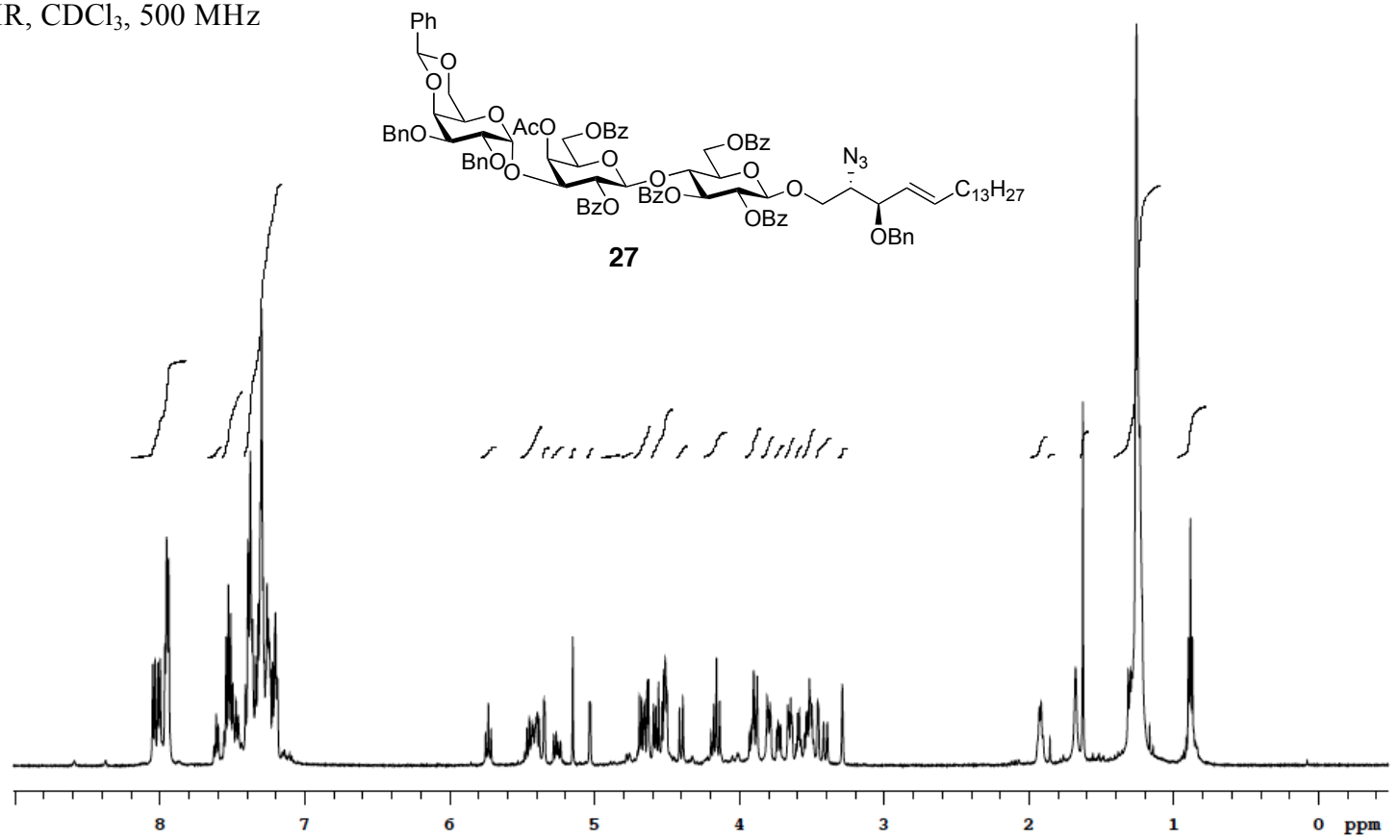
^{13}C NMR, $CDCl_3$, 125 MHz



26

(2*S*,3*R*,4*E*)-1-(4-*O*-(4-*O*-Acetyl-2,6-di-*O*-benzoyl-3-*O*-(2,3-di-*O*-benzyl-4,6-*O*-benzylidene-α-D-galactopyranosyl)-β-D-galactopyranosyl)-2,3,6-tri-*O*-benzoyl-β-D-glucopyranosyloxy)-2-azido-3-benzyloxy-octadec-4-ene

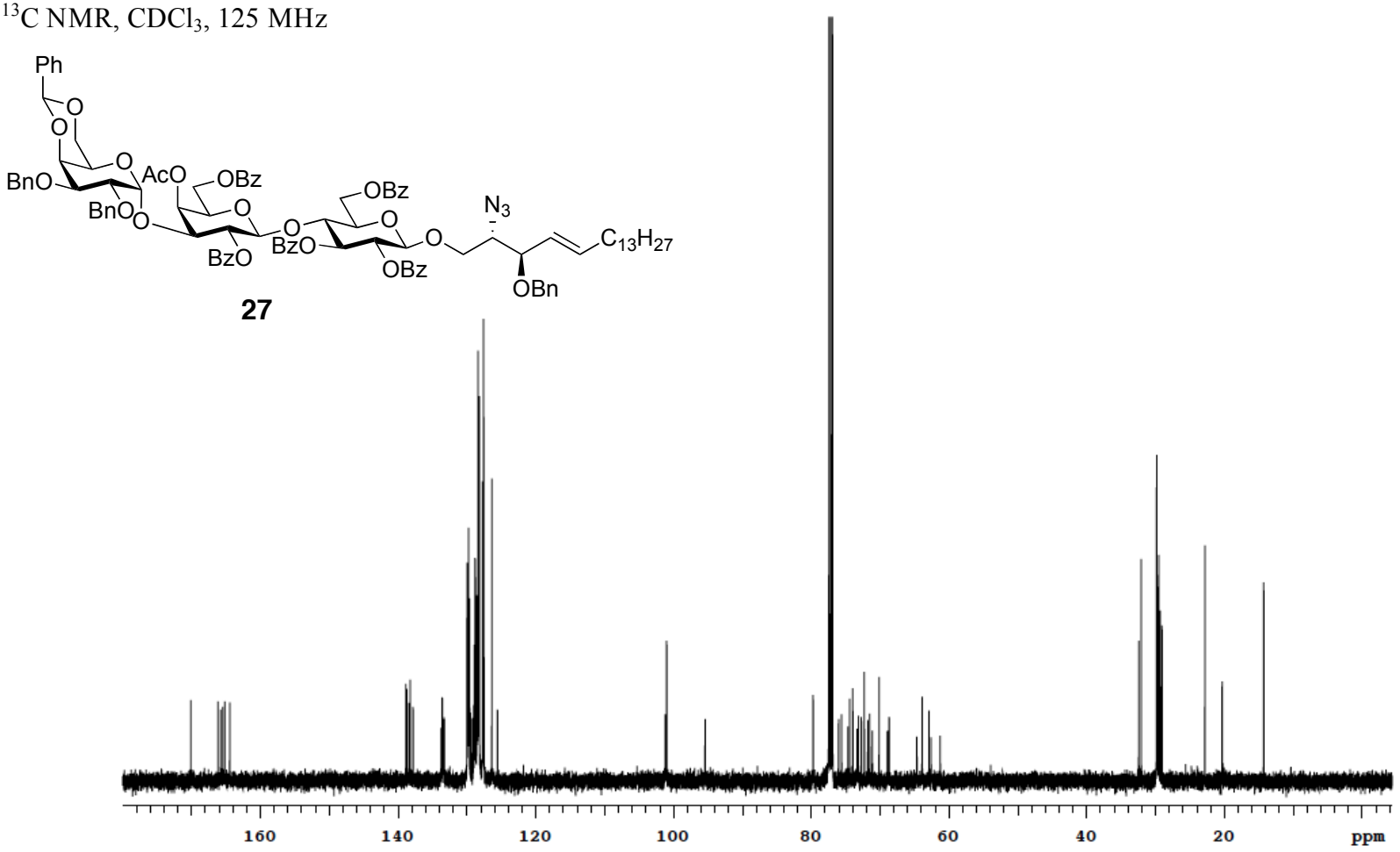
^{1}H NMR, $CDCl_3$, 500 MHz



27

(2*S*,3*R*,4*E*)-1-(4-*O*-(4-*O*-Acetyl-2,6-di-*O*-benzoyl-3-*O*-(2,3-di-*O*-benzyl-4,6-*O*-benzylidene-α-D-galactopyranosyl)-β-D-galactopyranosyl)-2,3,6-tri-*O*-benzoyl-β-D-glucopyranosyloxy)-2-azido-3-benzyloxy-octadec-4-ene

^{13}C NMR, $CDCl_3$, 125 MHz



27

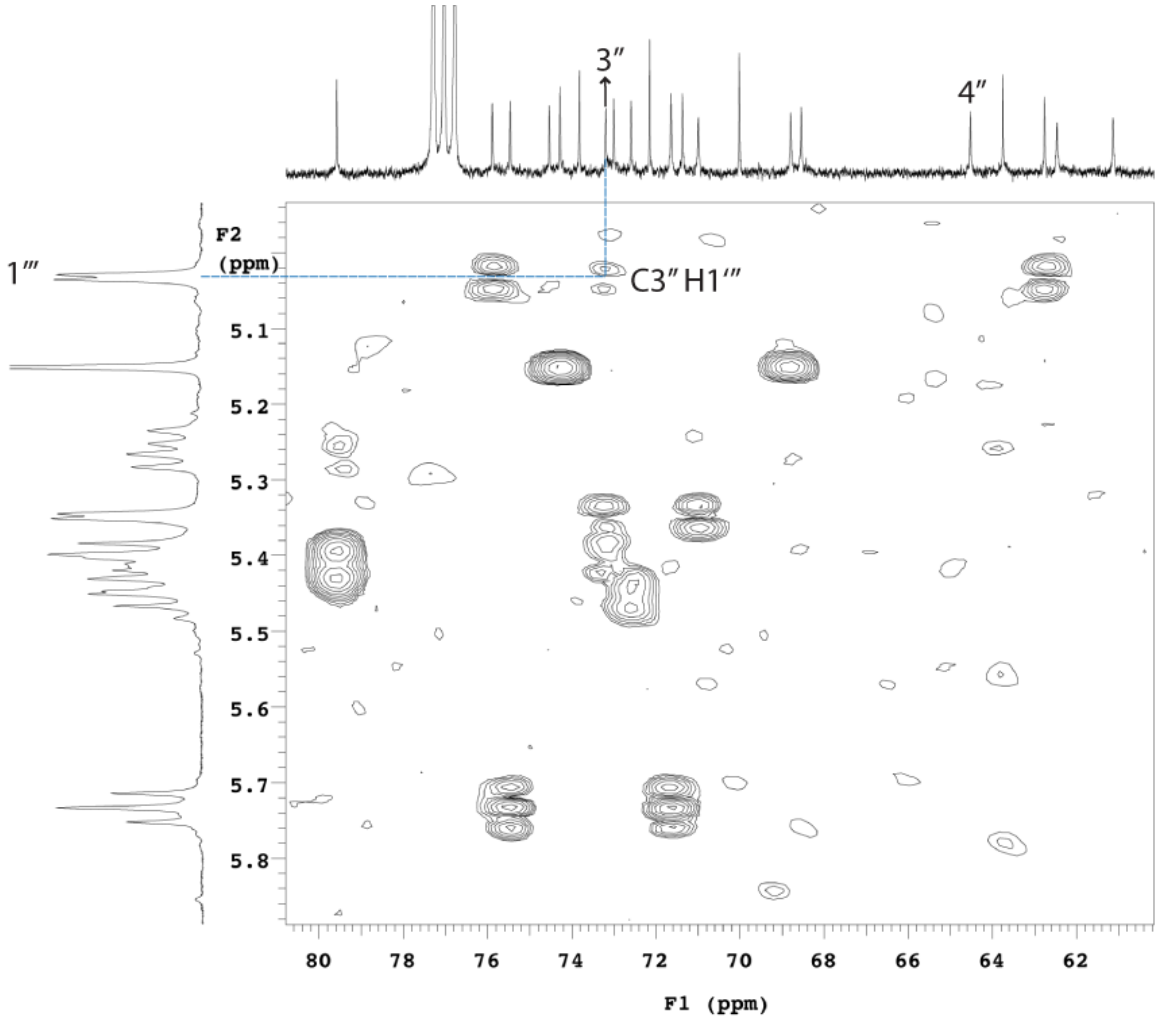
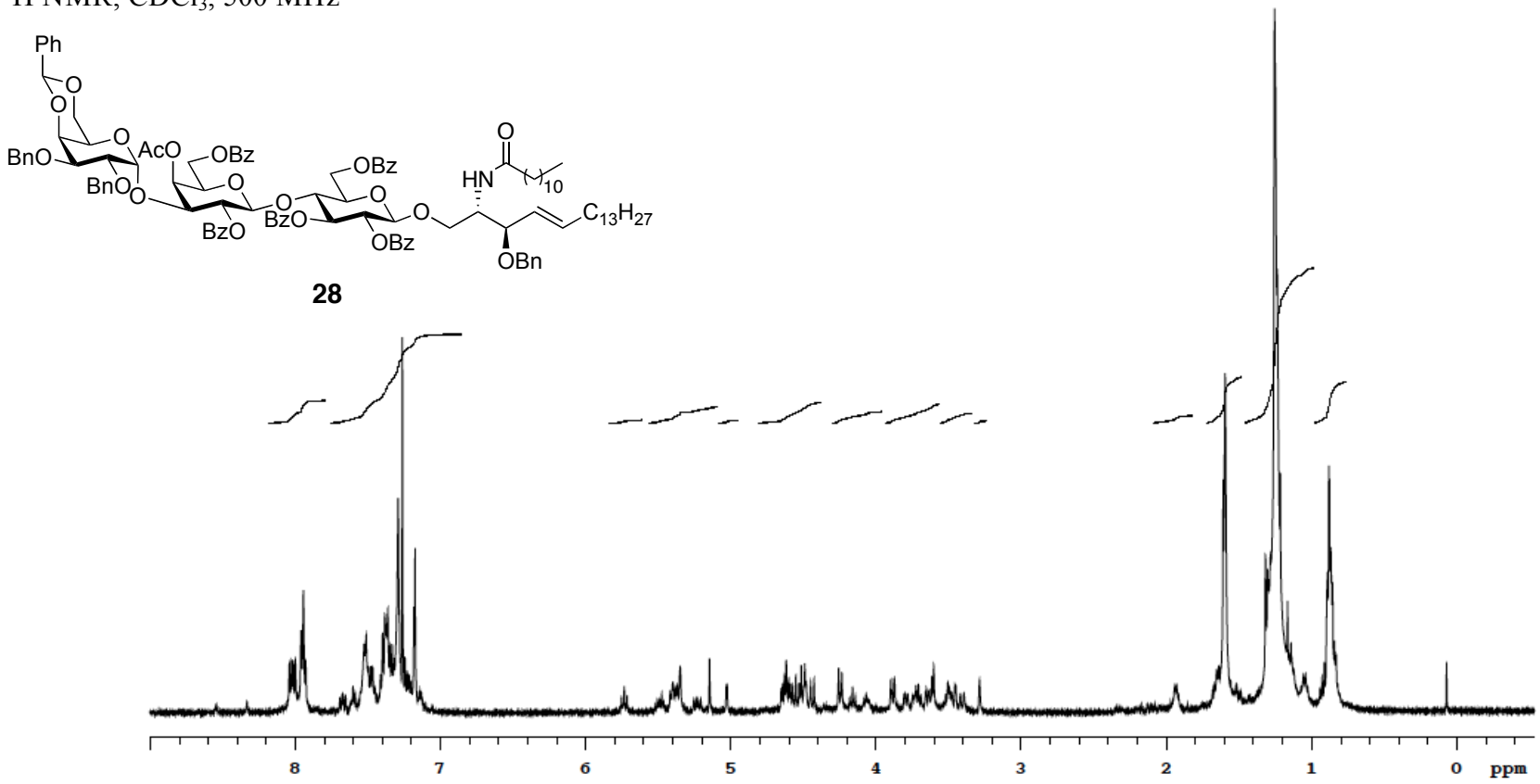


Figure 3. HMBC spectrum of triglycosyl 2-azido-sphingosine **27**

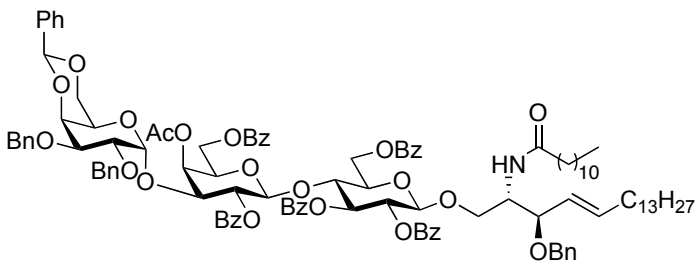
(2*S*,3*R*,4*E*)-1-(4-*O*-(4-*O*-Acetyl-2,6-di-*O*-benzoyl-3-*O*-(2,3-di-*O*-benzyl-4,6-*O*-benzylidene-α-D-galactopyranosyl)-β-D-galactopyranosyl)-2,3,6-tri-*O*-benzoyl-β-D-glucopyranosyloxy)-3-benzyloxy-2-dodecanoylamido-octadec-4-ene (28).

^{1}H NMR, $CDCl_3$, 500 MHz



(2*S*,3*R*,4*E*)-1-(4-*O*-(4-*O*-Acetyl-2,6-di-*O*-benzoyl-3-*O*-(2,3-di-*O*-benzyl-4,6-*O*-benzylidene-α-D-galactopyranosyl)-β-D-galactopyranosyl)-2,3,6-tri-*O*-benzoyl-β-D-glucopyranosyloxy)-3-benzyloxy-2-dodecanoylamido-octadec-4-ene (28).

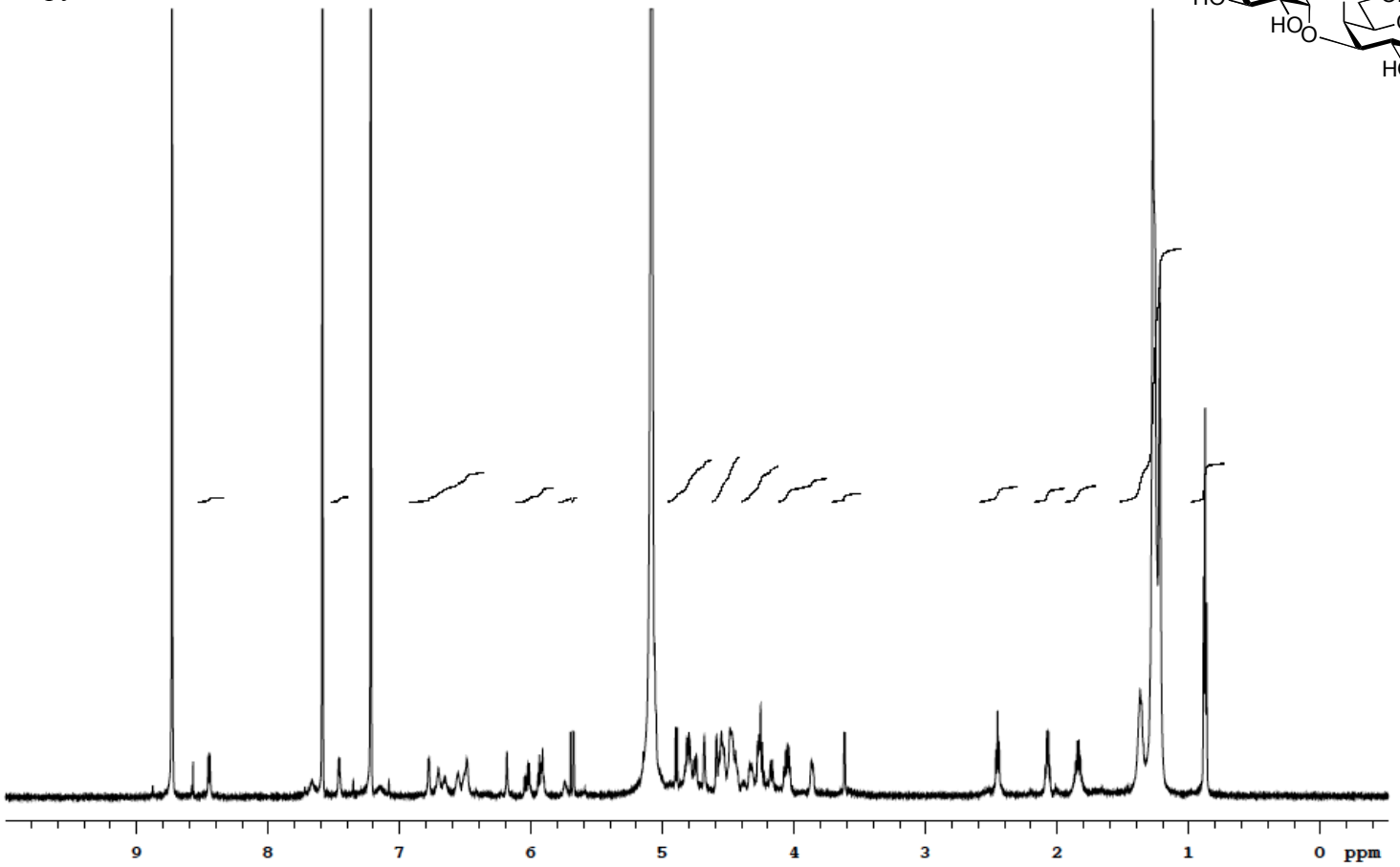
^{13}C NMR, $CDCl_3$, 125 MHz

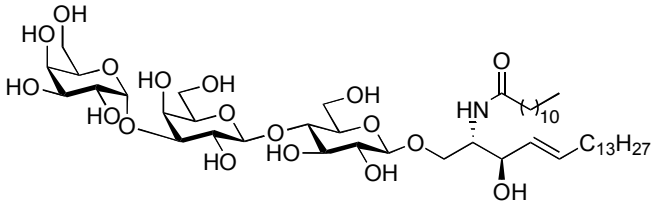


28

(2*S*,3*R*,4*E*)-2-Dodecanoylamido-1-(4-*O*-(3-*O*-α-D-galactopyranosyl)-β-D-galactopyranosyl)-β-D-glucopyranosyloxy)-3-hydroxy-octadec-4-ene

^{1}H NMR, pyridine-d_5, 600 MHz

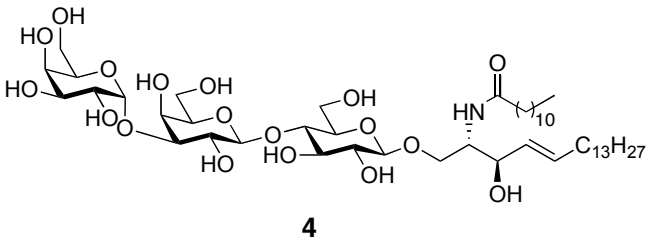




4

(2*S*,3*R*,4*E*)-2-Dodecanoylamido-1-(4-*O*-(3-*O*-α-D-galactopyranosyl)-β-D-galactopyranosyl)-β-D-glucopyranosyloxy)-3-hydroxy-octadec-4-ene

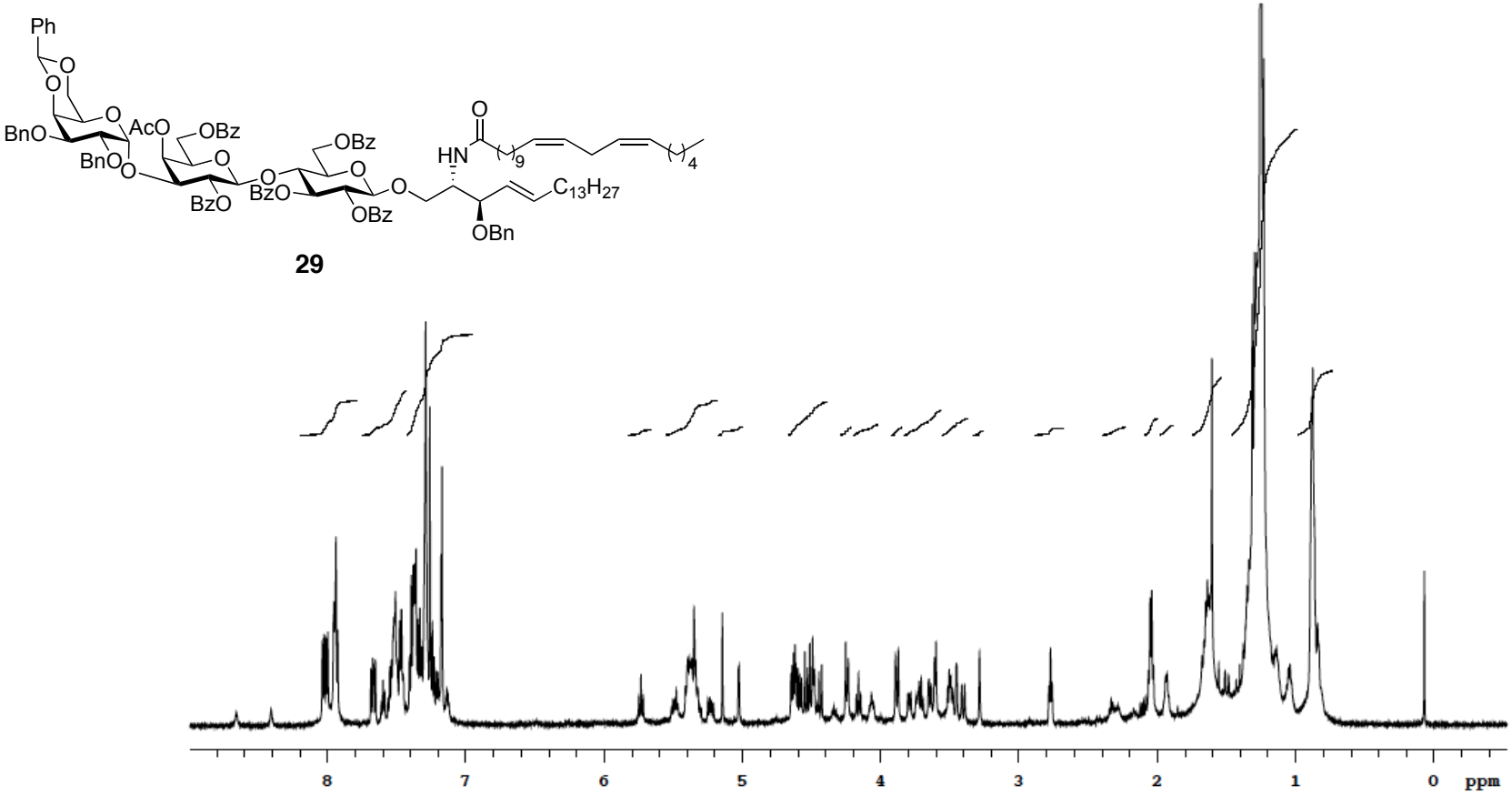
^{13}C NMR, pyridine-d_5, 125 MHz



4

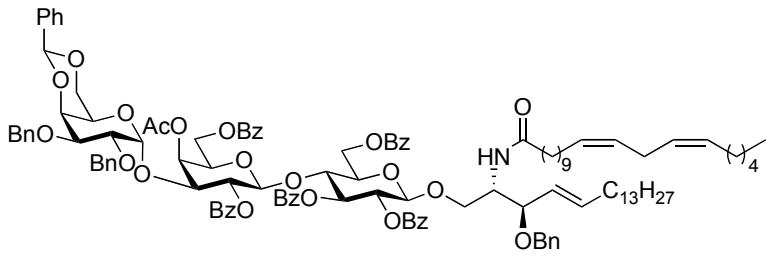
(2*S*,3*R*,4*E*)-1-(4-*O*-(4-*O*-Acetyl-2,6-di-*O*-benzoyl-3-*O*-(2,3-di-*O*-benzyl-4,6-*O*-benzylidene-α-D-galactopyranosyl)-β-D-galactopyranosyl)-2,3,6-tri-*O*-benzoyl-β-D-glucopyranosyloxy)-3-benzyloxy-2-(11*Z*,14*Z*-eicosadienoylamido)-octadec-4-ene

^{1}H NMR, $CDCl_3$, 500 MHz



(2*S*,3*R*,4*E*)-1-(4-*O*-(4-*O*-Acetyl-2,6-di-*O*-benzoyl-3-*O*-(2,3-di-*O*-benzyl-4,6-*O*-benzylidene-α-D-galactopyranosyl)-β-D-galactopyranosyl)-2,3,6-tri-*O*-benzoyl-β-D-glucopyranosyloxy)-3-benzyloxy-2-(11*Z*,14*Z*-eicosadienoylamido)-octadec-4-ene

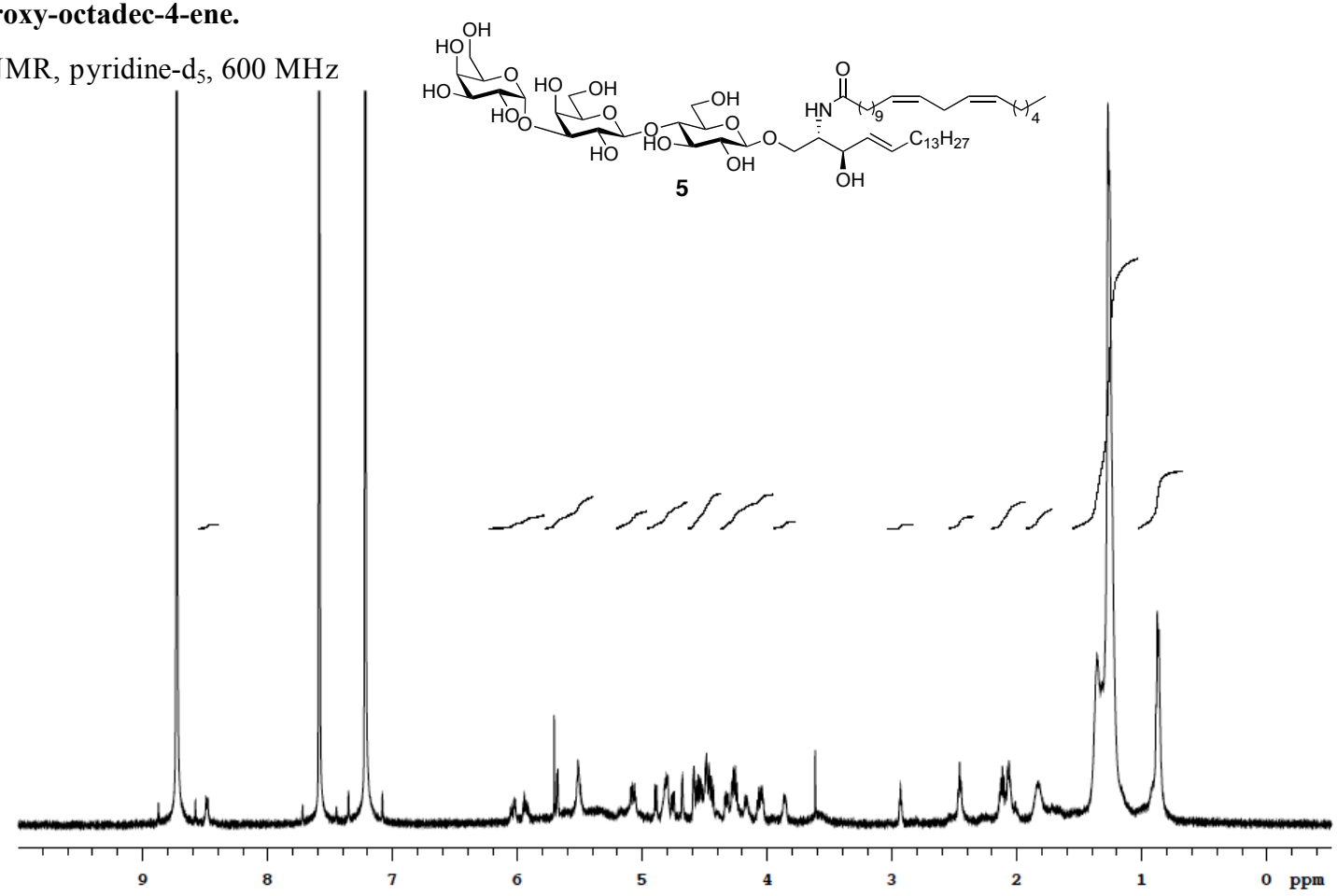
^{13}C NMR, $CDCl_3$, 125 MHz



29

(2*S*,3*R*,4*E*)-2-(11*Z*,14*Z*-Eicosadienoylamido)-1-(4-*O*-(3-*O*-α-D-galactopyranosyl)-β-D-galactopyranosyl)-β-D-glucopyranosyloxy)-3-hydroxy-octadec-4-ene.

^{1}H NMR, pyridine-d_5, 600 MHz



(2*S*,3*R*,4*E*)-2-(11*Z*,14*Z*-Eicosadienoylamido)-1-(4-*O*-(3-*O*-α-D-galactopyranosyl)-β-D-galactopyranosyl)-β-D-glucopyranosyloxy)-3-hydroxy-octadec-4-ene.

^{13}C NMR, pyridine-d_5, 150 MHz