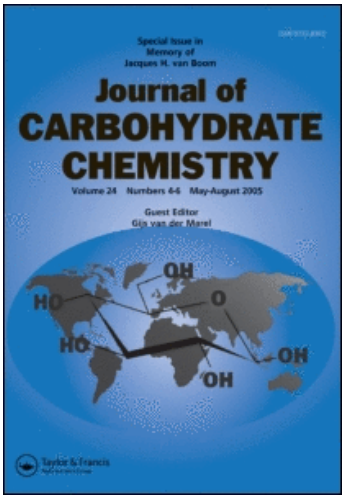

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SYNTHESIS OF METHYLENE BRIDGED C-DISACCHARIDES

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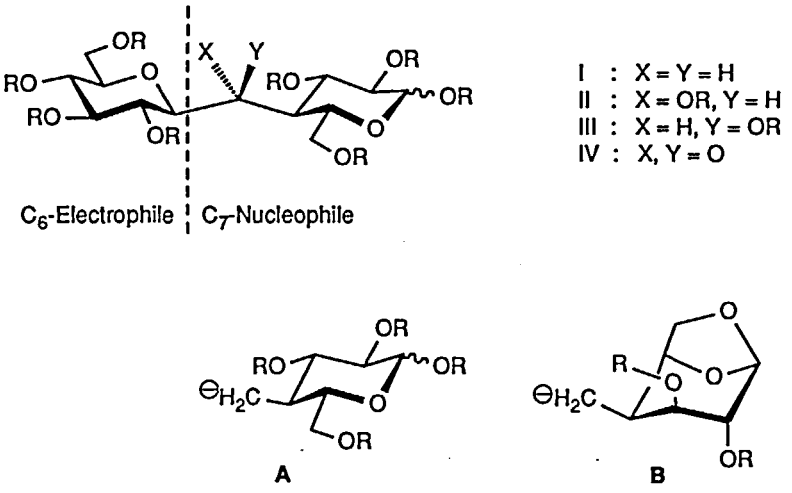
ABSTRACT

The methylene bridged C-disaccharides **14** [Glcβ(1-4 CH_2)-Gal structure] and **15** [Galβ(1-4 CH_2)Gal structure] were obtained via a C_6-electrophile and C_7-nucleophile route. Lithio compound **6B**, readily obtained from 1,6-anhydro-2,3-di-O-benzyl-D-glucopyranose (**1**), served as the C_7-nucleophile. As C_6-electrophiles gluconolactone **7** and galactonolactone **8**, respectively, were employed. Their reaction with **6B** led to the required C-C bond formation between the reactants. Products **9** and **10**, respectively, were transformed into the target molecules via reductive removal of the anomeric hydroxylic group of the ketose moiety, opening of the 1,6-anhydro bridge, hydrogenolytic debenzylation, and then O-acetylation.

INTRODUCTION

The great interest in natural and unnatural glycosidase inhibitors[1-3] has recently even increased because HIV activity might be affected by such compounds.[4] Though many different structural variants have been generated by Nature itself for this purpose, carbon bridged C-disaccharide moieties constituting structural entities of common natural oligosaccharides and glycoconjugates, respectively, have



Scheme 1

not been reported.[5] However, the inaccessibility to hydrolytic cleavage of such compounds is a particular stimulus to their synthesis.

The first synthesis reported for a β(1-6)-methylene bridged gentiobiose derivative follows a C_6-electrophile, C_7-nucleophile course; it requires diastereocontrol only at the C_6-species.[6] The addition of glycosyl radicals to sugar 2-methylene lactones leads preferentially to α(1-2)-connection with 2,3-*trans* stereochemistry in the former lactone species.[7] The synthesis of type I compounds (Scheme 1) by Kishi and coworkers[8] uses a combination of C_5-electrophile + C_8-nucleophile species; commonly it leads to all four possible isomers. Thus, versatile and efficient syntheses especially of (1-4)- and (1-3)-connected C-disaccharides are required.[9] Therefore, based on the ready access to heteroatom-stabilized 1-C-lithiated glycals[10] as C_6-nucleophiles, we have introduced a diastereocontrolled synthesis of carbon bridged C-disaccharides of type II-IV having additionally functional groups in the bridging position.[3,11] In this paper we report on a simple synthesis of methylene

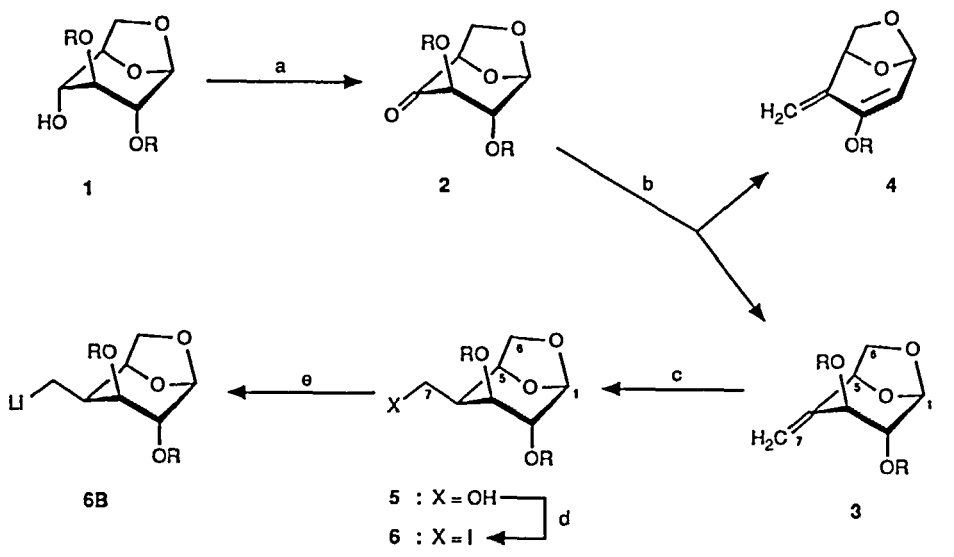
bridged C-disaccharides of type I via a C_6-electrophile + C_7-nucleophile route (Scheme 1) which takes advantage of the ready accessibility of hexosonate δ-lactones as C_6-electrophiles.

RESULTS AND DISCUSSION

For the synthesis of the required C_7-nucleophile of type **A** (Scheme 1) first a $^4C_1$-derived conformer was investigated.[11] However, due to unfavorable intramolecular interaction in the product between the 6-O-oxygen of the **A** moiety and the newly generated ketose anomeric center of the former lactone moiety, a rigid $^1C_4$-conformer, as shown in type **B**, was selected instead as the C_7-nucleophile.

Thus, the ready accessible 1,6-anhydro-2,3-di-O-benzyl-glucopyranose **1**[2b] was selected as the starting material. Its oxidation with dicyclohexyl carbodiimide (DCC) in DMSO[12] furnished the ketone **2** which could be transformed by Wittig reaction with methylenephosphorane into the olefin derivative **3**. Due to the basicity of the reagent, the elimination product **4** was obtained as a by-product which was readily separated by chromatography. Borane addition ($BH_3 \cdot SMe_2$ complex in THF[13]) to the ethylene moiety of compound **3** took place exclusively from the α-face as proven in a later stage. Oxidative cleavage of the C-B bond provided the hydroxy methyl derivative **5** which possesses then *galacto*-configuration. Treatment of compound **5** with PPh_3/I_2 in presence of imidazole[14] furnished the iodo derivative **6** required for generating the C_7-nucleophilic species **6B**; this was performed by iodine/lithium exchange with n-butyllithium in THF at -90 °C.

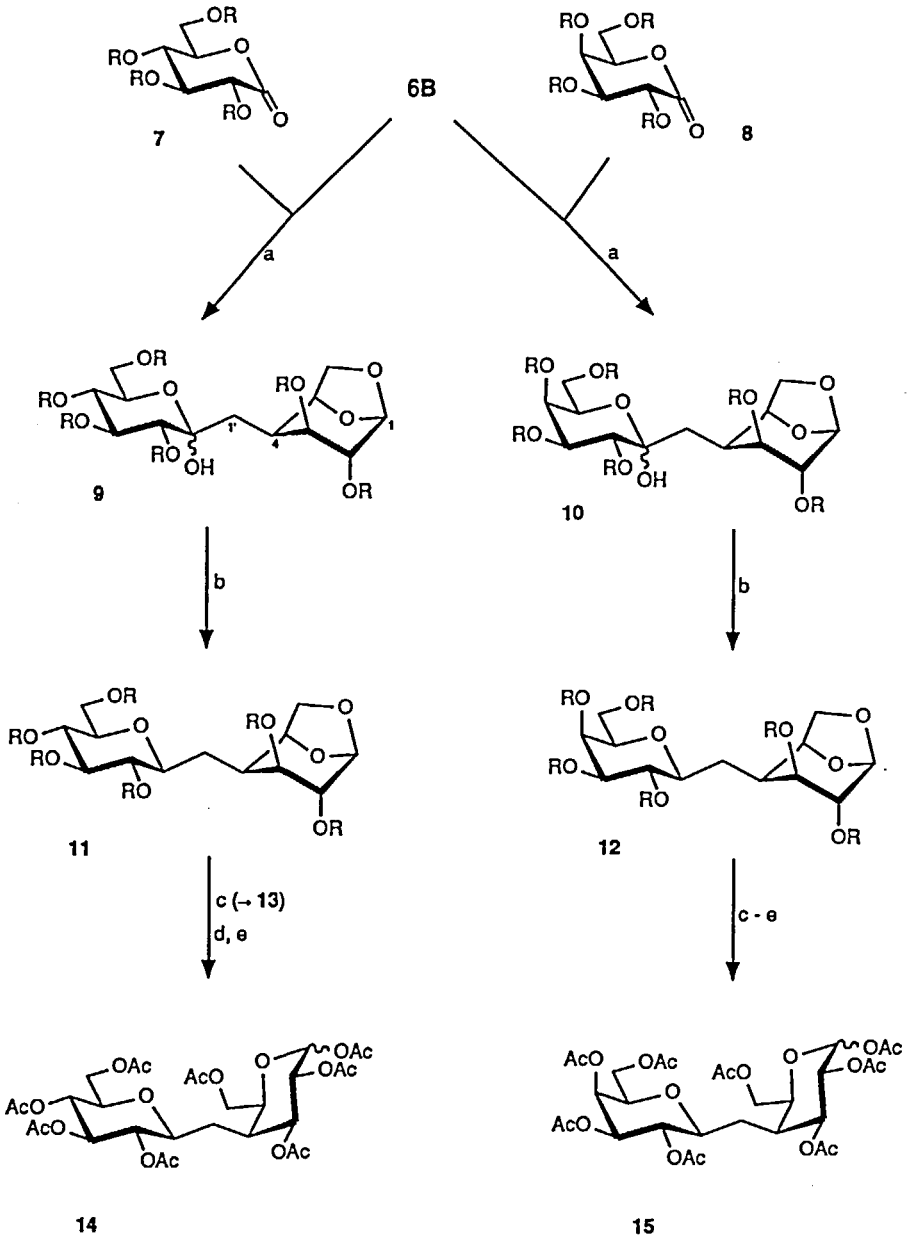
Reaction of C_7-nucleophile **6B** with O-benzyl protected gluconolactone **7**[15] and galactonolactone **8**[16] provided the long chain osulose derivatives **9** and **10**, respectively, in reasonable yields. Reductive removal of the ketose anomeric hydroxy group in **9** and **10** was reached by treatment with



Scheme 2 (a) DCC, DMSO, (b) CH_3-$PPh_3^+Br^-$, n-BuLi, THF, -10°C; (c) BH_3·SMe_2; NaOH, H_2O_2, THF, 0°C; (d) PPh_3, I_2, Imidazole, toluene; (e) n-BuLi, THF, -90°C.

triethylsilane in presence of $BF_3 \cdot OEt_2$, a method reported by Kishi et al.[16]

The C-2' configuration of the products **11** and **12**, respectively, could be assigned by transformation into the O-acetylated target molecules **14** and **15**, respectively. This was reached by cleaving the anhydro bridge with trifluoroacetic acid/acetic anhydride, hydrogenolytic O-debenzylation, and subsequent O-acetylation with acetic anhydride in pyridine. For both anomers thus obtained the H-1 and H-2' ^1H NMR shifts and coupling constants could be assigned thus confirming these configurations. The C-4 configuration could be unequivocally assigned in the 1,6-anhydro ring cleavage product **13**, obtained from **11** as an intermediate. Both anomers exhibit $J_{2,3}$ = 9.5 and 9.8 Hz and $J_{3,4}$ = 4 and 4.4 Hz, respectively, coupling constants which prove the $^1C_4$ *galacto* structure of this moiety.



Scheme 3 : (a) THF, -90°C; (b) $Et_3 \cdot OEt_2$, CH_3CN, -20°C;
(c) CF_3COOH, Ac_2O; (d) Pd/C, H_2; (e) Ac_2O, Pyridine

R = Bn

EXPERIMENTAL

General procedures. Melting points were determined in a metal block and are uncorrected. Specific rotations were determined with a Perkin Elmer 241 MC polarimeter and ^1H NMR spectra were recorded with a Bruker WM 250 spectrometer. Preparative chromatography was performed on silica gel (Merck 60 mesh) and TLC on silica gel (Merck 60 F_{254}) with the solvent systems specified. Evaporations were conducted *in vacuo*.

1,6-Anhydro-2,3-di-O-benzyl-β-D-xylo-4-hexulopyranose (2). To a solution of 1,6-anhydro-2,3-di-O-benzyl-β-D-glucose[2b] (**1**, 10.0 g, 29.1 mmol) in dry diethyl ether (100 mL) were added DCC (15.0 g, 116 mmol), pyridine (3.0 mL, 38 mmol) and DMSO (13 mL, 182 mmol). The solution was cooled to 0 °C and then trifluoroacetic acid (3.0 ml, 38 mmol) was added. The mixture was stirred for about 2 h at 0 °C while the reaction course was monitored by TLC. Then oxalic acid-dihydrate (9.0 g, 70.5 mmol) was added and the mixture was warmed up to room temperature. The crude by-product was filtered off and the filtrate was extracted with water and dried over $MgSO_4$. The solvent was removed and the residue was purified by flash-chromatography on a column of silica gel (200 g) with 4:1 petroleum ether-ethyl acetate to give 8.0 g (81%) of compound **2** as a colourless wax: TLC (petroleum ether-ethyl acetate, 4:1) R_F 0.35; $[\alpha]_D^{20}$ +21.0 (*c* 2.0, ethyl acetate); ^1H NMR ($CDCl_3$) δ 3.54 (d, 1H, $J_{2,3}$ = 5.9 Hz, H-2), 3.69 (dd, 1H, $J_{5,6a}$ = 5.1 Hz, $J_{6a,6b}$ = 7.5 Hz, H-6a), 3.95 (d, 1H, $J_{6a,6b}$ = 7.5 Hz, H-6_b), 4.42 (d, 1H, $J_{2,3}$ = 5.9 Hz, H-3), 4.57 (d, 1H, J = 11.4 Hz, CH_2Ph), 4.60-4.66 (m, 3H, H-5, CH_2Ph), 5.59 (s, 1H, H-1), 7.28-7.40 (m, 10H, C_6H_5).

Anal. Calcd for $C_{20}H_{20}O_5$: C, 70.58; H, 5.92. Found: C, 70.19; H, 6.01.

1,6-Anhydro-2,3-di-O-benzyl-4-deoxy-4C-(methylene)-β-D-xylo-hexopyranose (3) and **1,6-Anhydro-3-O-benzyl-2,4-dideoxy-4C-(methylene)-β-D-glycero-hex-2-enopyranose (4).** To a

mixture of methyltriphenylphosphonium bromide (2.0 g, 5.6 mmol) in dry THF (30 mL) was added a solution of 1.6N n-butyllithium (2.4 mL, 3.8 mmol). After 30 min a solution of **2** (1.0 g, 2.9 mmol) in dry THF (7 mL) was added slowly over a period of 10 min. The temperature was slowly raised to room temperature and the solution was stirred overnight. The solution was extracted with saturated NH_4Cl-solution and dried (magnesium sulfate). The solvents were evaporated. The yellow syrup obtained was flash-chromatographed on a column of silica gel (50 g) with 4:1 petroleum ether-ethyl acetate. The two products could not be separated and were obtained as a yellow unstable oil 740 mg (74%) of a mixture **3:4** as 2:1 which was immediately used in the next step.

(3): TLC (petroleum ether-ethyl acetate, 4:1): R_F 0.42; ^1H NMR ($CDCl_3$) δ 3.54 (dd, 1H, J = 1.7 Hz, J = 1.8 Hz), 3.75 (dd, 1H, J = J = 6.7 Hz), 3.90-3.91 (m, 1H), 4.01 (d, 1H, J = 6.9 Hz), 4.36-4.61 (m, 4H, CH_2Ph), 4.76 (s, 1H), 5.13 (s, 1H, H-7a), 5.27 (s, 1H, H-7_b), 5.45 (s, 1H, H-1), 7.28-7.34 (m, 10H, C_6H_5).

(4): TLC (petroleum ether-ethyl acetate, 4:1): R_F 0.48; ^1H NMR ($CDCl_3$) δ 3.68 (dd, 1H, $J_{5,6a}$ = 1.5 Hz, $J_{6a,6b}$ = 7.2 Hz, H-6a), 4.02 (dd, 1H, $J_{5,6b}$ = 6.0 Hz, $J_{6a,6b}$ = 7.2 Hz, H-6_b), 4.74-4.85 (m, 2H, CH_2Ph), 4.97 (dd, 1H, $J_{5,6a}$ = 1.5 Hz, $J_{5,6b}$ = 6.0 Hz, H-5), 5.05 (sb, 1H, H-7a), 5.20 (dd, 1H, J = 1.4 Hz, J = 4.1 Hz, H-2), 5.47 (s, 1H, H-7_b), 5.81 (d, 1H, $J_{1,2}$ = 4.2 Hz, H-1), 7.30-7.39 (m, 5H, C_6H_5).

1,6-Anhydro-2,3-di-O-benzyl-4-deoxy-4-C-(hydroxymethyl)-β-D-galactopyranose (5). To a solution of a 2:1 mixture of **3** and **4** (2.6 g, 5.1 mmol **3**) in dry THF (50 mL) was added a 2M solution of $BH_3 \cdot SMe_2$ in dry THF (8 mL, 16 mmol) at -10 °C and the mixture was stirred at 5 °C until the reaction was complete (12 h). Then the solution was cooled to 0 °C and first a 10% solution of sodium hydroxide (2.3 mL) and then a solution of 30% hydrogen peroxide (0.8 mL) were slowly added. The solution was stirred for 1 h at room temperature, extracted with brine and dried (magnesium sulfate). The solvent was evaporated to leave a syrup. The

product was flash-chromatographed on a column of silica gel with 1:2 petroleum ether-ethyl acetate to give 1.3 g (70%) of compound **5** as a syrup: TLC (petroleum ether-ethyl acetate, 1:2): R_F 0.50; $[\alpha]_D^{20}$ -40.0 (*c* 2.2, ethyl acetate); ^1H NMR δ 2.17 (s, 1H, OH), 2.35-2.43 (m, 1H, H-4), 3.44 (s, 1H), 3.60-3.67 (m, 4H), 4.17-4.26 (m, 2H), 4.49-4.56 (m, 4H), 5.46 (s, 1H, H-1), 7.22-7.38 (m, 10H, C_6H_5).

Anal. Calcd for $C_{21}H_{24}O_5$: C, 70.77; H, 6.79. Found: C, 70.34; H, 6.99.

1,6-Anhydro-2,3-di-O-benzyl-4-deoxy-4-C-(iodomethyl)-β-D-galactopyranose (6). To a solution of **5** (400 mg, 1.12 mmol) triphenylphosphine (410 mg, 1.56 mmol) in dry toluene (30 mL) were added imidazole (160 mg, 2.35 mmol) and iodine (320 mg, 1.23 mmol). The solution was heated to 60 °C and stirred (1 h) while the course of the reaction was monitored by TLC. Then a saturated solution of sodium bicarbonate (20 mL) was added and stirring was intensified. Iodine was added until the organic layer had a brown colour. After this procedure a solution of sodium thiosulfate was added until the organic layer was colourless. The mixture was extracted with toluene and the extract was dried (magnesium sulfate). The toluene was evaporated and the residue purificated by flash-chromatography on a column of silica gel with 4:1 petroleum ether-ethyl acetate to give 500 mg (96%) of compound **6** as colourless crystals: mp 108 °C; TLC (petroleum ether-ethyl acetate, 4:1) R_F 0.42; $[\alpha]_D^{20}$ -92.5 (*c* 0.7 ethyl acetate); ^1H NMR ($CDCl_3$) δ 2.49-2.58 (m, 1H, H-4), 3.09 (dd, 1H, $J_{4,7a}$ = 6.9 Hz, $J_{7a,7b}$ = 9.6 Hz, H-7a), 3.21 (dd, 1H, $J_{4,7b}$ = 9.3 Hz, $J_{7a,7b}$ = 9.6 Hz, H-7_b), 3.46 (d, 1H, J = 1.3 Hz), 3.58 (dd, 1H, J = 5.9 Hz, J = 6.4 Hz), 3.67-3.70 (m, 1H), 4.10 (d, 1H, J = 7.0 Hz), 4.32 (d, 1H, J = 11.3 Hz, CH_2Ph), 4.47-4.65 (m, 4H), 5.39 (dd, 1H, J = 1.5 Hz, J = 1.6 Hz, H-1), 7.28-7.38 (m, 10H, C_6H_5).

Anal. Calcd for $C_{21}H_{23}O_4$: C, 54.09; H, 4.97. Found: C, 54.09; H, 5.07.

1,6-Anhydro-2,3-di-O-benzyl-4-deoxy-4-C-(3,4,5,7-tetra-O-benzyl-1-deoxy-α-D-gluco-2-heptulopyranos-1-yl)-β-D-ga-

lactopyranose (9). To a solution of **6** (300 mg, 0.64 mmol) in dry THF (20 mL) was added a 1.6M solution of n-butyllithium (0.52 mL, 0.83 mmol in hexane) at -90 °C under N_2-atmosphere. The solution was stirred for 30 min and then a solution of 2,3,4,6-tetra-O-benzyl-D-gluconolactone[15] (410 mg, 0.76 mmol) in dry THF (5 mL) was slowly added at the same temperature. After 45 min the temperature was raised to -50 °C and the solution was added to a saturated solution of ammonium chloride. The mixture was extracted with diethyl ether and the extract dried (magnesium sulfate). The solvents were evaporated and the residue was purified by flash-chromatography on a column of silica gel with 3:1 petroleum ether-ethyl acetate to give 300 mg (53%) of compound **9** as a colourless syrup: TLC (petroleum ether-ethyl acetate) R_F 0.37; $[\alpha]_D^{20}$ -16.5 (*c* 1.0, ethyl acetate); ^1H NMR ($CDCl_3$) δ 1.40 (dd, 1H, $J_{4,1'a}$ = 7.1 Hz, $J_{1'a,1'b}$ = 14.6 Hz, H-1'a), 1.89 (dd, 1H, $J_{4,1'b}$ = 6.7 Hz, $J_{1'a,1'b}$ = 14.6 Hz, H-1'b), 2.64-2.67 (m, 1H, H-4), 3.03 (s, 1H, OH), 3.33-3.76 (m, 6H), 3.90-3.99 (m, 2H), 4.11 (d, 1H, J = 6.9 Hz), 4.22 (d, 1H, J = 11.8 Hz), 4.37-4.62 (m, 8H), 4.80-4.94 (m, 4H), 5.41 (s, 1H, H-1), 7.16-7.35 (m, 30H, C_6H_5).

Anal. Calcd for $C_{55}H_{58}O_{10}$: C, 75.15; H, 6.65. Found: C, 75.26; H, 6.87.

1,6-Anhydro-2,3-di-O-benzyl-4-deoxy-4-C-(3,4,6,7-tetra-O-benzyl-1-deoxy-D-galacto-2-heptulopyranos-1-yl)-β-D-galactopyranose (10). Compound **10** was prepared from **6** (300 mg, 0.64 mmol), 1.6M solution of n-butyllithium (0.52 mL, 0.83 mmol) and 2,3,4,6-tetra-O-benzyl-D-galactonolactone[16] (410 mg, 0.76 mmol) as described for compound **9** and purified by flash-chromatography with 3:1 petroleum ether-ethyl acetate to give 270 mg (48%) of compound **10** as a colourless syrup: TLC (petroleum ether-ethyl acetate, 3:1) R_F 0.37; $[\alpha]_D^{20}$ -3.5 (*c* 2.0, ethyl acetate); ^1H NMR ($CDCl_3$) δ 1.45 (dd, 1H, $J_{4,1'a}$ = 6.9 Hz, $J_{1'a,1'b}$ = 14.6 Hz, H-1'a), 1.93 (dd, 1H, $J_{4,1'b}$ = 6.7 Hz, $J_{1'a,1'b}$ = 14.6 Hz, H-1'b), 2.60-2.70 (m, 1H, H-4), 2.93 (s, 1H, OH), 3.39-3.58 (m, 5H),

3.73-4.22 (m, 5H), 4.35-4.97 (m, 13H), 5.39 (s, 1H, H-1), 7.18-7.36 (m, 30H, C_6H_5).

Anal. Calcd for $C_{55}H_{58}O_{10}$: C, 75,15; H, 6.65. Found: C,75.10; H, 6.82.

1,6-Anhydro-4-C-(2,6-anhydro-3,4,5,7-tetra-O-benzyl-1-deoxy-D-glycero-D-gulo-heptitol-1-yl)-2,3-di-O-benzyl-4-deoxy-β-D-galactopyranose (11). To a solution of **9** (140 mg, 0.16 mmol) in dry acetonitrile (5 mL) was added at -20 °C a 1M solution of $BF_3 \cdot OEt_2$ (0.2 mL, 0.2 mmol) and then triethylsilane (0.2 mL, 0.24 mmol) was added. The mixture was stirred for 20 min and then a saturated solution of sodium bicarbonate (10 mL) was added and the mixture was extracted with diethyl ether. The extract was concentrated and the residue was purified by flash-chromatography on a column of silica gel with 3:1 petroleum ether-ethyl acetate to give 90 mg (65%) of **11** as a colourless syrup: TLC (petroleum ether-ethyl acetate, 3:1) R_F 0.41; $[\alpha]_D^{20}$ -20.5 (*c* 2.1, ethyl acetate); ^1H NMR ($CDCl_3$) δ 1.21-1.39 (m, 1H, H-1'a), 1.95 (dd, 1H, $J_{4,1'b}$ = 7.3 Hz, $J_{1'a,1'b}$ = 14.2 Hz, H-1'$_b$), 2.49-2.54 (m, 1H, H-4), 3.14-3.30 (m, 3H, contains H-2'), 3.42-3.45 (m, 2H), 3.51-3.70 (m, 5H), 4.15-4.19 (m, 2H), 4.39-4.61 (m, 8H), 4.79-4.91 (m, 4H), 5.43 (s, 1H, H-1), 7.15-7.37 (m, 30H, C_6H_5).

1,6-Anhydro-4-C-(2,6-anhydro-3,4,5,7-tetra-O-benzyl-1-deoxy-D-glycero-L-manno-heptitol-1-yl)-2,3-di-O-benzyl-4-deoxy-β-D-galactopyranose (12). Compound **12** was prepared from **10** (410 mg, 0.47 mmol), triethylsilane (0.6 mL, 0.72 mmol), and 1M $BF_3 \cdot OEt_2$ solution (0.5 mL, 0.5 mmol) as described for compound **11** and was purified by flash-chromatography on a column of silica gel with 2:1 petroleum ether-ethyl acetate to give 330 mg (82%) of compound **12** as a colourless syrup: TLC (petroleum ether-ethyl acetate, 2:1) R_F 0.46; $[\alpha]_D^{20}$ -16.0 (*c* 2.0, ethyl acetate); ^1H NMR ($CDCl_3$) δ 1.31-1.43 (m, 1H, H-1'a), 1.98 (ddd, $J_{2',1'b}$ = 0.5 Hz, $J_{4,1'b}$ = 7.7 Hz, $J_{1'a,1'b}$ = 12.8 Hz, H-1'b), 2.42-2.52 (m, 1H, H-4), 3.11 (dd, 1H, J = J = 8.8 Hz, H-2'), 3.37-3.63 (m, 8H), 3.96 (d, 1H, J = 2.1 Hz), 4.14-4.18 (m, 2H), 4.35-4.76 (m, 10H), 4.90

(d, 1H, J = 11.7 Hz, CH_2Ph), 4.92 (d, 1H, J = 11.1 Hz, CH_2Ph), 5.40 (s, 1H, H-1), 7.18-7.38 (m, 30H, C_6H_5).

1,2,3,6-Tetra-O-acetyl-4-deoxy-4-C-(3,4,5,7-tetra-O-acetyl-2,6-anhydro-1-deoxy-D-glycero-D-gulo-heptitol-1-yl)-α,β-D-galactopyranose (14α,β). A solution of **11** (130 mg, 0.15 mmol) in acetic anhydride (5 mL) and trifluoroacetic acid (0.25 mL) was stirred at 40 °C while the course of the reaction was monitored by TLC. The solution was concentrated to provide compound **13**. ^1H NMR data of **13**: ($CDCl_3$) δ 1.16-1.38 (m, 2H, H-1'aα, H-1'aβ), 1.94-2.27 (m, 2H, H-1'bα, H-1'bβ), 2.01-2.11 (m, 12H, AcO), 2.30-2.40 (m, 2H, H-4α, H-4β), 3.10-3.20 (m, 2H), 3.27-3.68 (m, 12H), 3.65 (dd, 1H, $J_{2,3}$ = 9 Hz, $J_{3,4}$ = 4 Hz, H-3), 3.76-3.81 (m, 1H), 3.89 (dd, 1H, $J_{2,3}$ = 9.8 Hz, $J_{3,4}$ = 4.4 Hz, H-3), 4.04-4.24 (m, 7H), 4.29-4.34 (m, 2H, CH_2Ph), 4.55-4.92 (m, 22H, CH_2Ph), 5.59 (d, 1H, $J_{1,2}$ = 7.1 Hz, H-1β), 6.19 (d, 1H, $J_{1,2}$ = 3.9 Hz, H-1α), 7.22-7.32 (m, 60H, C_6H_5).

13 was dissolved in methanol (3 mL) and ethyl acetate (1 mL). Then palladium on charcoal (1 mg) was added and the solution was stirred under an atmosphere of hydrogen under normal pressure while the hydration was monitored by TLC. The catalyst was filtered off and the solvent was evaporated. The syrupy residue was dissolved in acetic anhydride (2,5 mL) and pyridine (2.5 mL) and the solution was stirred for 8 h. The solvent was evaporated and the crude residue purified by flash-chormatography on a column of silica gel with 1:2 petroleum ether-ethyl acetate to give 40 mg (40%) of an inseparable 1:1 anomeric mixture of **14α** and **14β**: TLC (petroleum ether-ethyl acetate, 1:2) R_F 0.43; $[\alpha]_D^{20}$ +49.5 (*c* 1.0, ethylacetate); ^1H NMR ($CDCl_3$) δ 1.36-1.82 (m, 4H, H-1'aα, H-1'aβ, H-1'bα, H-1'bβ), 2.01-2.14 (m, 48H, AcO), 2.46-2.53 (m, 2H, H-4α, H-4β), 3.36 (dd, 1H, J = 9.8 Hz, J = 9.9 Hz, H-2'), 3.37 (dd, 1H, J = 9.5 Hz, J = 10.0 Hz, H-2'), 3.53-3.60 (m, 2H), 3.93-4.32 (m, 10H), 4.78-5.36 (m, 10H), 5.64 (d, 1H, $J_{1,2}$ = 7.3 Hz, H-1β), 6.27 (d, 1H, $J_{1,2}$ = 3.9 Hz, H-1α).

Anal. Calcd for $C_{29}H_{40}O_{18}$: C, 51.48; H, 5.96. Found: C, 51.77; H, 6.10.

1,2,3,6-Tetra-O-acetyl-4-deoxy-4-C-(3,4,5,7-tetra-O-acetyl-2,6-anhydro-1-deoxy-D-glycero-L-manno-heptitol-1-yl)-α,β-D-galactopyranose (15α,β). The compounds **15α,β** were prepared from **12** (330 mg, 0.38 mmol), acetic anhydride (10 mL), trifluoroacetic acid (0.5 mL), palladium on charcoal (1 mg), ethyl acetate (2.5 mL) and pyridine (2.5 mL). The residue was purified by flash-chromatography on a column of silica gel with 1:2 petroleum ether-ethyl acetate to give 145 mg (56%) of an inseparable 1:1 anomeric mixture of **15α** and **15β**: TLC (petroleum ether-ethyl acetate, 1:2) R_F 0.42; $[\alpha]_D$ +53.5 (*c* 2.2, ethyl acetate); ^1H NMR ($CDCl_3$) δ 1.64-1.88 (m, 4H, H-1'aα, H-1'aβ, H-1'bα, H-1'bβ), 1.98-2.17 (m, 48H, AcO), 2.46-2.55 (m, 2H, H-4α, H-4β) 3.34 (dd, 2H, J = 8.2 Hz, J = 9.4 Hz, H-2'α, H-2'β), 3.76-3.81 (m, 2H), 3.94-4.33 (m, 10H), 4.91-5.15 (m, 7H), 5.31-5.40 (m, 3H), 5.65 (d, 1H, $J_{1,2}$ = 7.3 Hz, H-1β), 6.28 (d, 1H, $J_{1,2}$ = 3.9 Hz, H-1α).

Anal. Calcd for $C_{29}H_{40}O_{18}$: C, 51.48; H, 5.96. Found: C, 51.14; H, 5.98.

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