New Synthesis of 1-D-*O*-(2-Amino-2-deoxy-D-gluco- and -galactopyranosyl)-*chiro*-inositols

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New and highly effective procedures for the preparation of d-*chiro*-inositol derivatives, essentially based on selective protection of the vicinal diequatorial diol systems present in this molecule, are reported. This selective protection affords C_2-symmetric diaxial diols such as **4** and **5**, glycosylation of which under different conditions has been investigated. This study has provided a ready and convenient route to structures such as **III–V**, containing some of the structural motifs thought to be present in putative inositolphosphoglycan insulin mediators.

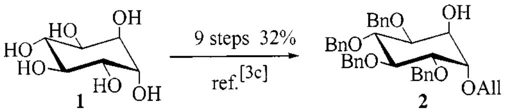
Introduction

The partially characterised inositolphosphoglycans (IPGs) have been proposed as intracellular mediators generated from inositol-containing glycolipids through the action of receptor-activated phospholipases.[1] It is generally accepted that these IPGs may belong to one of two main structural groups that differ in chemical composition, biological activity and tissue distribution:[1,2] the family of *myo*-inositol-containing IPGs − which are inhibitors of c-AMP-dependent protein kinase (PKA) and are also known as A-type IPGs − and the family of *chiro*-inositol-containing IPGs, which are activators of pyruvate dehydrogenase phosphatase (PDH) and are also known as P-type IPGs.

In an attempt to determine the minimum structural requirements for biological activity,[3] we have previously developed synthetic methodologies and strategies to prepare a variety of IPG-like molecules bearing some of the structural motifs postulated for A-type and P-type natural IPGs. An interesting observation from these biological studies was that a small pseudodisaccharide molecule such as **I**, bearing the $GlcNH_2$ α(1→6) *myo*-Ins structural motif, behaves as a natural A-type IPG in exhibiting proliferative effects in cultures of chicken embryo, whereas pseudodisaccharide **II**, with the $GlcNH_2$ α(1→1) D-*chiro*-Ins structural motif, behaves as a natural P-type IPG, inducing differentiation in the same biological system.[4] These cultures have been used as models in previous studies with insulin-like growth factor *I* (*IGF-I*),[5] as it has been shown that *IGF-I* controls growth and differentiation in the developing inner ear of chicken embryo through the generation of IPG mediators.[5,6]

While the synthesis of the $GlcNH_2$ α(1→6) *myo*-Ins structural motif may be effectively accomplished in several ways,[3a,3b,3d,3e,7] the preparation of $GlcNH_2$ α(1→1) D-*chiro*-Ins structures presents serious difficulties.[3c,8] Our first approach to **II** involved the construction of the D-*chiro*-inositol unit from methyl α-D-glucopyranoside by a multistep procedure.[8] We reported more recently on a different procedure starting from D-*chiro*-inositol (**1**), which afforded building block **2** in nine steps and in 32% yield[3c] (Scheme 1). This new synthetic route to appropriately functionalised D-*chiro*-inositol derivatives presented obvious advantages over previously reported multistep synthetic sequences starting either from *myo*-inositol or from other precursors.[8−11] However, we were aware that more efficient synthetic routes to suitably protected D-*chiro*-inositol building blocks had to be developed in order to permit effective synthesis of molecules containing the $HexNH_2$ α(1→1)-D-*chiro*-Ins structural motif for biological investigation. A recent publication on the synthesis of D-*chiro*-inositol 1,3,4,6-tetraphosphate[12] and several previous papers dealing with selective protection of vicinal diequatorial diols[13,14] prompted us to investigate some of these new synthetic routes.

Here we report on the results of this investigation, which have now enabled us to produce, in only one or two synthetic steps, D-*chiro*-inositol derivatives in which the four equatorially disposed hydroxy groups at C-2, C-3, C-4 and



Scheme 1

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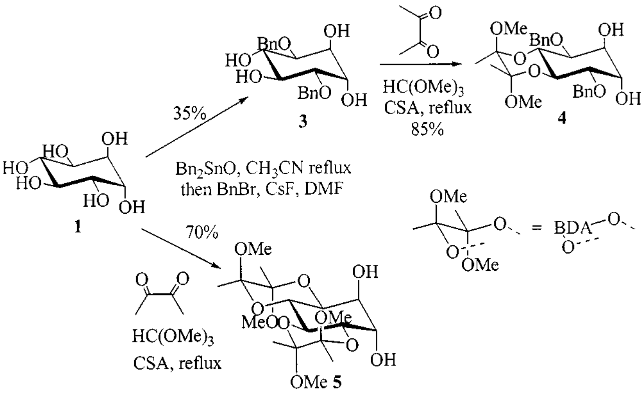
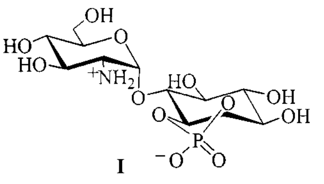
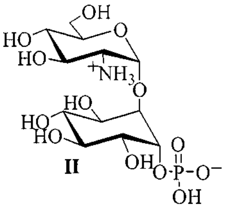
C-5 are protected while the two axially oriented hydroxy groups at C-1 and C-6 remain free (compounds **4** and **5** in Scheme 2). We have investigated the glycosylation of these C_2-symmetric diaxial diols (**4** and **5**). The selective monoglycosylation of these compounds, which can be achieved under carefully controlled conditions, provides a convenient route to the glycosyl α and $\beta(1\rightarrow1)$ D-*chiro*-inositol structural motif, affording structures such as **III**, **IV** and **V** through the use of different glycosyl donors with either D-*gluco* or D-*galacto* configurations. To the best of our knowledge, very few IPG-related structures containing an α-D-galactosaminyl residue[9b] or a β-D-glucosaminyl unit[9a,3c,15] linked to the cyclitol ring have so far been reported.



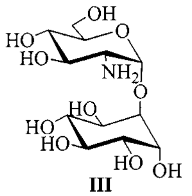
Scheme 2



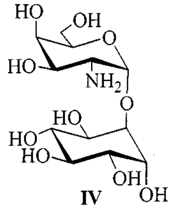
I



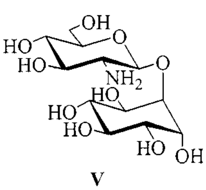
II



III



IV



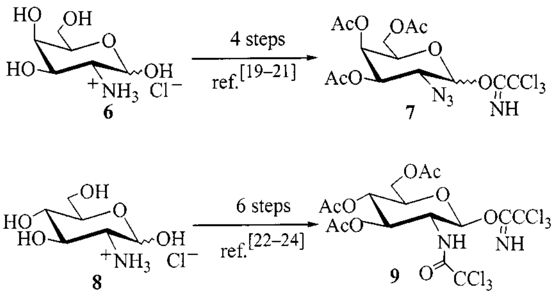
V

Results and Discussion

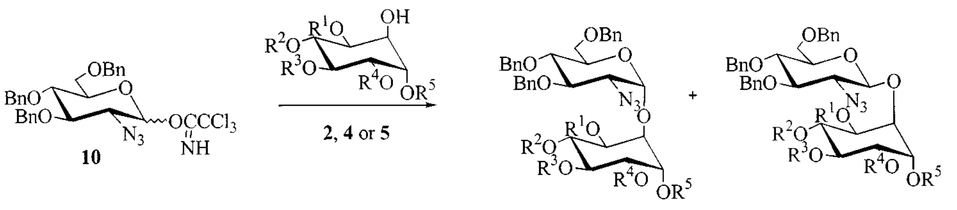
It has recently been reported[12] that treatment of D-*chiro*-inositol (**1**) with 2.5 mol-equiv. of dibutyltin oxide in acetonitrile, followed by treatment with benzyl bromide/cesium fluoride in dimethylformamide, afforded the 2,5-di-*O*-benzyl derivative **3** in 24% yield. On the other hand, protecting groups that exploit multiple anomeric effects for the selective protection of vicinal equatorial diols have been introduced in recent years[13a–13e] and it has been demonstrated that 2,2,3,3-tetramethoxybutane (TMB) can successfully be used for the protection of the C-3,C-4 diequatorial hydroxy groups of quinic acid as a butane 2,3-bis(acetal),[14] and that this approach can also be used, on a multigram scale, for protection of the C-1,C-6 and C-3,C-4 diequatorial hydroxy groups of *myo*-inositol.[16] In view of this, we envisaged the preparation of two new D-*chiro*-inositol building blocks (**4** and **5**) as shown in Scheme 2. A slight modification of the reported isolation procedure[12] for the dibutyltin acetal mediated regioselective dibenzylation of D-*chiro*-inositol (**1**) gave the 2,5-di-*O*-benzyl derivative **3** in 35% yield (details in the Exp. Sect.). Selective protection of the C-3,C-4 diequatorial hydroxy groups of **3** as a butane 2,3-bis(acetal) was then carried out by refluxing with TMB in the presence of trimethyl orthoformate and catalytic camphorsulfonic acid (CSA)[14] to afford diol **4** in 85% yield. Alternatively, the diequatorial hydroxy groups at C-2,C-3 and at C-4,C-5 of D-*chiro*-inositol (**1**) could be protected as butane 2,3-bis(acetals) by the above procedure to give diol **5** in 70% yield.[17] Through the use of these synthetic sequences, the protection of the four equatorially oriented hydroxy groups in **1** could therefore be achieved either in one single, high-yielding step (compound **5**) or in two easily performed steps with two different, orthogonal protecting groups (compound **4**). In the latter case, there is the possibility to replace the benzyl groups at C-2 and C-5 by different protecting groups, thus permitting modulation of the steric hindrance and the reactivity of the obtained D-*chiro*-inositol building blocks in subsequent glycosylation reactions.

The glycosylation of the two symmetric diols **4** and **5** was studied in an attempt to establish the experimental conditions necessary to afford monoglycosylated compounds. Since both α-D-galactosaminyl[2b] and β-D-glucosaminyl[18] building blocks seemed biologically interesting, the courses of these glycosylation reactions were investigated with 2-azido-2-deoxy-D-galactopyranosyl and 2-trichloroacetamido-2-deoxy-D-glucopyranosyl donors.

Previous experience[3a,3b] had indicated that the trichloroacetimidate procedure[19] was the method of choice for inositol glycosylation, and so the glycosyl donors **7** and **9** were prepared by well-established procedures (Scheme 3). 3,4,6-Tri-*O*-acetyl-2-azido-2-deoxy-D-galactopyranosyl trichloroacetimidate (**7**) was obtained in four steps[19–21] from commercially available D-galactosamine hydrochloride (**6**). 3,4,6-Tri-*O*-acetyl-2-deoxy-2-trichloroacetamido-D-glucopyranosyl trichloroacetimidate (**9**) was obtained in six



Scheme 3



entry 1 - R^1,R^2,R^3,R^4 = Bn ; R^5 = All	**(2)** (ref.[3c])	**11a** (35%)	**11b** (25%)
entry 2 - R^1,R^4 = Bn ; R^2,R^3 = BDA; R^5 = H	**(4)**	**12a** (42%)	**12b** (18%)
entry 3 - R^1,R^2 = BDA; R^3,R^4 = BDA; R^5 = H	**(5)**	**13a** (43%)	**13b** (20%)

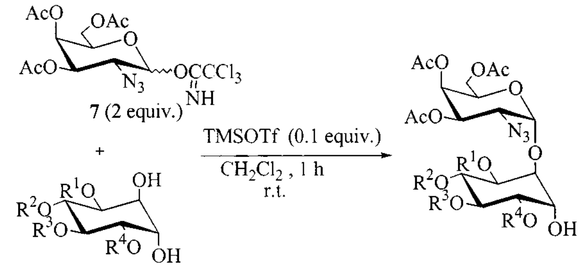
Conditions : 1.6 equiv. donor **10**, 0.1 equiv. TMSOTf, CH_2Cl_2 , 1 h, −25°C.

Scheme 4

steps from D-glucosamine hydrochloride (**8**).[22−24] The trichloroacetyl group has been used as a participating group in oligosaccharide synthesis for transformation into the *N*-acetyl derivatives. To the best of our knowledge, however, it has never been used as an *N*-protecting group in the synthesis of oligosaccharides containing free amino groups.[25]

The reactivity of diols **4** and **5** was first evaluated by examining their behaviour with 2-azido-3,4,6-tri-*O*-benzyl-2-deoxy-D-glucopyranosyl trichloroacetimidate (**10**) under the experimental conditions already optimised[3c] for glycosylation of acceptor **2** and comparing the outcome of the glycosylation reaction in the three cases. As shown in Scheme 4, a mixture containing similar amounts of α- and β-pseudodisaccharides **12** and **13** (Entries 2 and 3) was obtained and a slightly better α-selectivity than seen with acceptor **2** was observed. These results indicated that the reactivity of **4** and **5** under those experimental conditions was at least equivalent to the reactivity displayed by **2**. In addition, the observed formation of diglycosylated compounds in low yield seemed to indicate that the second hydroxy group in building blocks **4** and **5** remains a potential reacting site. Nevertheless, with the above results in hand it seemed reasonable to assume that a careful choice of experimental conditions should allow the glycosylation reaction to be controlled in such a way as to proceed to the pseudodisaccharide stage. This successful construction of the pseudodisaccharide may permit further direct functionalisation at C-6 with avoidance of protecting group manipulation.

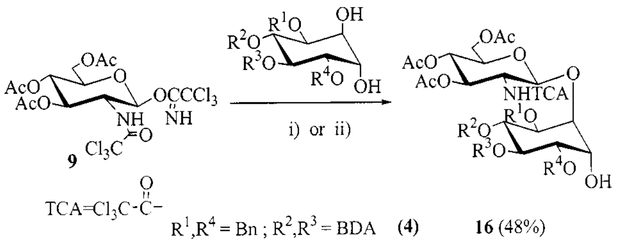
The glycosylation of **4** and **5** with donors **7** and **9** was then investigated. The optimised reaction conditions for both diols with donor **7** are shown in Scheme 5. The use of dichloromethane as solvent, TMSOTf as promoter at room temperature and a 2:1 donor/acceptor ratio afforded the α-linked pseudodisaccharides **14** and **15** in 51% and 52% yields, respectively, together with 11% and 20% yields, respectively, of the diglycosylated products. The exclusive formation of **14** and **15** was achieved through the use of a 1:1 donor acceptor ratio, but the yields were much lower in this case. An increase of the donor/acceptor ratio to 3:1 or use of a lower temperature resulted mainly in augmentation of the undesired formation of the corresponding trichloroacetamide from isomerisation of the trichloroacetimidate without significant improvement as far as pseudodisaccharide compounds were concerned. The use of an activated donor such as 2-azido-3,4,6-tri-*O*-benzyl-2-deoxy-D-galactopyranosyl trichloroacetimidate resulted in the exclusive formation of the corresponding trichloroacetamide. It is worth noting that exclusive α-selectivity was observed in this glycosidic bond formation, in contrast with the results obtained with the D-*gluco*-configured glycosyl donor shown in Scheme 4, although direct comparison of these results seems inappropriate because of the different nature of the glycosyl donor protecting groups in each case.



R^1,R^4 = Bn ; R^2,R^3 = BDA **(4)** **14** (51%)
R^1,R^2 = BDA; R^3,R^4 = BDA **(5)** **15** (52%)

Scheme 5

A similar study directed towards the obtainment of β-D-glucosaminyl derivatives (**V**) was carried out with donor **9** (Scheme 6). In both cases, TMSOTf proved to be an efficient promoter and the β-linked pseudodisaccharides **16** and **17** were isolated in 48% and 42% yields, respectively. The



R^1,R^4 = Bn ; R^2,R^3 = BDA **(4)** **16** (48%)
R^1,R^2 = BDA; R^3,R^4 = BDA **(5)** **17** (42%)

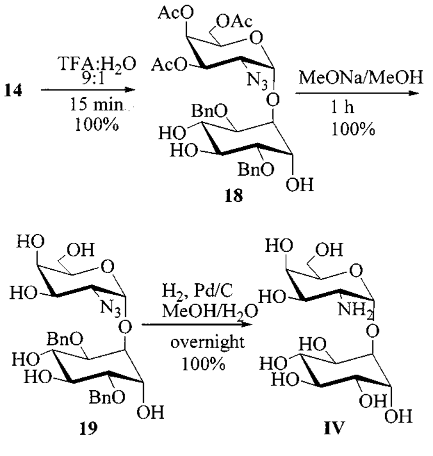
Conditions :
i) 1.0 equiv. donor **9**, 1.0 equiv. acceptor **4**, 0.2 equiv. TMSOTf, CH_2Cl_2, 4 h, 0°C.
ii) 1.2 equiv. donor **9**, 1.0 equiv. acceptor **5**, 0.2 equiv. TMSOTf, Et_2O, 2 h, 0°C.

Scheme 6

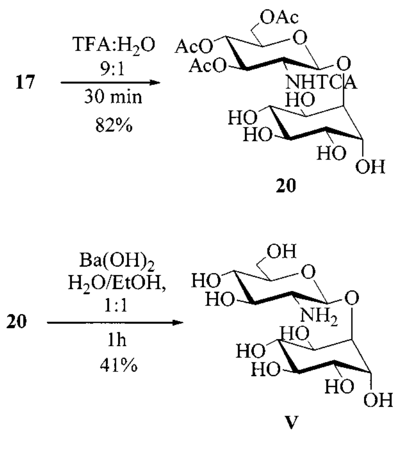
glycosylation of **5**, however, resulted in a higher proportion of diglycosylated compound, and so diethyl ether had to be used as a more convenient solvent. A small proportion of diglycosylated compound was also observed under these conditions.

Compounds **14−17** are advanced intermediates for the synthesis of IPG-like structures containing the 1-*O*-(2-amino-2-deoxy-α- and β-D-glycopyranosyl)-D-*chiro*-inositol and 1-*O*-(2-amino-2-deoxy-α and β-D-glycopyranosyl)-D-*chiro*-inositol-1-phosphate structural motifs.

In the D-*galacto* series, full deprotection was achieved (Scheme 7) without intermediate purification, by first treating **14** with a mixture of trifluoroacetic acid/water[14] to give **18**, followed by conventional deacetylation to give **19** and final hydrogenolysis to afford compound **IV**. Pseudodisaccharide **17** was similarly first treated under acidic conditions[14] to give compound **20** (Scheme 8), which was then refluxed with barium hydroxide[26] in 1:1 ethanol/water for the simultaneous cleavage of acetyl and trichloroacetyl groups and finally purified using Varian CBA (carboxylic acid) and PSA (ethylenediamine-*N*-propyl) functionalised silica gel cartridges.[27]



Scheme 7



Scheme 8

The synthetic strategy discussed in this paper provides an effective route to biologically important structures containing 1-*O*-glycosylated-D-*chiro*-inositol units, exemplified by the synthesis of the GalNH$_2$ α(1→1) D-*chiro*-Ins (**IV**) and GlcNH$_2$ β(1→1)-D-*chiro*-Ins (**V**) structural motifs. Since the synthetic steps resulting in a variety of IPG-like structures from the advanced intermediates **14−17** are well established,[3] the chemistry presented here may give rise to significant new developments in the preparation of these types of substances for biological investigation.

Experimental Section

General Methods: Abbreviation: Hex = hexane. Dichloromethane and acetonitrile were distilled from calcium hydride and diethyl ether from sodium/benzophenone. D-*chiro*-Inositol was provided by New Zealand Pharmaceuticals Limited (NZP). Molecular sieves (4 Å, powdered) were predried in an oven and activated for 5 min under vacuum at 300 °C. All aqueous (aq) solutions were saturated unless otherwise stated. All reactions were carried out under argon in predried glassware unless otherwise stated. ^{1}H and ^{13}C NMR spectra were recorded at 25 °C with Bruker Avance DPX 300 (^{1}H, 300 MHz), Bruker Avance DRX 400 (^{1}H, 400 MHz) and Bruker Avance DRX 500 (^{1}H, 500 MHz) spectrometers with CHCl$_3$ (δ = 7.26) and CDCl$_3$ (δ = 77.0) as internal reference signals. Signals were assigned by means of 2D spectra (COSY, HMQC). High-resolution mass spectra were recorded with a Micromass Autospec apparatus. Microanalyses were determined with a Leco CHNS-932 apparatus. Optical rotations were measured with a Perkin−Elmer 341 polarimeter. Purifications by column chromatography were carried out with Merck 60 silica gel (15−200 mesh) under pressure. Chromatography eluents are given as volume ratios (v/v). For purification of free pseudoligosaccharide **V**, CBA and PSA cartridges (Varian Bond elut cartridges, 100 mg/1 mL or 500 mg/3 mL) were used. Analytical thin layer chromatography (TLC) was performed on Merck 60F$_{254}$ silica gel with detection by heating with phosphomolybdic acid/EtOH and (SO$_4$)$_2$Ce in phosphomolybdic acid/H$_2$SO$_4$/H$_2$O. The organic extracts were dried with anhydrous sodium sulfate and concentrated under vacuum.

2,5-Di-*O*-benzyl-D-*chiro*-inositol (3): A mixture of D-*chiro*-inositol (1.43 g, 7.9 mmol) and Bu$_2$SnO (4.96 g, 19.9 mmol) in dry MeCN (150 mL) was heated under reflux in a Soxhlet apparatus (molecular sieves 4 Å) for 24 h. The solvent was evaporated, the resulting residue was redissolved in DMF (80 mL), and cesium fluoride (5.2 g, 34.2 mmol) and benzyl bromide (6.75 g, 39.5 mmol) were added to the solution. The mixture was stirred at room temperature for 20 h, whereupon silica was added, the solvent was evaporated to dryness under vacuum, and the solid was directly loaded into a column for flash chromatography (toluene/acetone, 9:1, then pure acetone) to give **3** as a white solid (1 g, 35%).

2,5-Di-*O*-benzyl-3,4-*O*-(2′,3′-dimethoxybutane-2′,3′-diyl)-D-*chiro*-inositol (4): A suspension of 2,5-di-*O*-benzyl-D-*chiro*-inositol (**3**) (0.5 g, 1.38 mmol), 2,3-butanedione (0.13 mL, 1.51 mmol) and trimethyl orthoformate (0.45 mL, 4.14 mmol) in dry methanol (10 mL) was treated with CSA (0.032 g, 0.138 mmol). The resulting mixture was refluxed under argon for 1 h, whereupon it was cooled, neutralised with Et$_3$N and concentrated under vacuum. Purification by flash chromatography (Hex/EtOAc, 4:1) gave **4** as a white solid (0.55 g, 85%); m.p. 69−71 °C. $[\alpha]_D^{20}$ = +81 (*c* = 1, CHCl$_3$). IR (KBr): ṽ = 3422, 3032, 2994, 2938, 1461, 1376, 1129, 1082, 1043, and 700 cm^{-1}. ^{1}H NMR (500 MHz, CDCl$_3$): δ = 7.35−7.25 (m, 10 H, 2 Ph), 4.88 (AB, 2 H, J_{A-B} = 11.5 Hz, 2 CHPh), 4.67

(AB, 2 H, $J_{\text{A-B}}$ = 11.5, 2 CHPh), 4.15−4.11 (m, 2 H, H^1, H^6), 4.08−4.02 (m, 2 H, H^2,H^5), 3.88−3.81 (m, 2 H, H^3, H^4), 3.3 (s, 6 H, 2 OCH_3), 2.46 (br. s, 2 H, 2 OH) and 1.35 (s, 6 H, 2 CH_3, BDA).^{13}C NMR (125 MHz, $CDCl_3$): δ = 138.5 (2 C), 128.4 (4 CH), 127.7 (2 CH), 127.6 (4 CH), 99.5 (2 C, BDA), 76.5 (2 CH), 73.7 (2 CH_2), 70.3 (2 CH), 69.6 (2 CH), 48.0 (2 OCH_3) and 17.9 (2 CH_3). MALDI-TOF calcd. for $C_{26}H_{34}O_8 + Na^+$: 497.5, found 497.1. FAB HRMS calcd. for $C_{18}H_{32}O_{19} + Na^+$: 497.2151, found 497.2174.

2,3:5,6-Di-*O*-(2′,3′-dimethoxybutane-2′,3′-diyl)-D-*chiro*-inositol (5): A suspension of D-*chiro*-inositol **1** (3 g, 16.65 mmol), 2,3-butanedione (2.9 mL, 33.3 mmol) and trimethyl orthoformate (14.57 mL, 133.2 mmol) in dry methanol (50 mL), was treated with CSA (0.19 g, 0.83 mmol). The resulting mixture was refluxed under Ar for 20 h, whereupon it was cooled and concentrated under vacuum. Purification by flash chromatography (Hex/EtOAc, 1:9) gave **5** as a white solid (4.8 g, 70%); m.p. 88−89 °C. $[\alpha]_D^{20}$ = −135 (*c* = 1, $CHCl_3$), IR (KBr): ṽ = 3463, 2993, 2951, 2835, 1742, 1457, 1376, 1136, 1033, 949, 882, and 847cm^{-1}.^{1}H NMR (500 MHz, $CDCl_3$): δ = 4.02−4.01 (m, 2 H, H^1, H^6), 3.97−3.95 (m, 2 H), 3.92−3.89 (m, 2 H), 3.24 (s, 6 H, 2 OCH_3), 3.21 (s, 6 H, 2 OCH_3), 2.37 (br. s, 2 H, OH), 1.29 (s, 6 H, 2 CH_3), 1.23 (s, 6 H, 2 CH_3).^{13}C NMR (125 MHz, $CDCl_3$): δ = 100.0, 98.7 (4 C, BDA), 70.3 (2 CH), 68.5 (2 CH), 66.1 (2 CH), 47.8, 47.7 (4 OCH_3), 17.6, 17.5 (4 CH_3). MALDI-TOF calcd. for $C_{18}H_{32}O_{10} + Na^+$: 431.4, found 430.9. $C_{18}H_{32}O_{10}$ (374.432) calcd. calcd. C 52.94, H 7.84; found 52.94, H 7.66.

2-Azido-3,4,6-tri-*O*-benzyl-2-deoxy-D-glucopyranosyl-α(1→1)-2,5-di-*O*-benzyl-3,4-*O*-(2′,3′-dimethoxybutane-2′,3′-diyl)-D-*chiro*-inositol (12a) and 2-Azido-3,4,6-tri-*O*-benzyl-2-deoxy-D-glucopyranosyl-β(1→1)-2,5-di-*O*-benzyl-3,4-*O*-(2′,3′-dimethoxy-butane-2′,3′-diyl)-D-*chiro*-inositol (12b): A solution of donor **10** (75 mg, 0.121 mmol) and acceptor **4** (36 mg, 0.075 mmol) was coevaporated three times with toluene and dried under vacuum overnight. This mixture was dissolved in 2 mL of CH_2Cl_2 under argon, 4 Å molecular sieves were added, and the slurry was stirred for 1 h at room temperature. A solution of TMSOTf (7 μL in 2.5 mL CH_2Cl_2, 0.5 mL, 0.1 equiv.) was then added at −25 °C and the reaction was monitored by TLC and filtered after 1 h through a short pad of Celite. The residue was concentrated and purified by flash chromatography (Hex/EtOAc, 6:1) to yield 30 mg (42%) of the α-pseudodisaccharide **12a** and 12.5 mg (18%) of the β-pseudodisaccharide **12b.**

Data for 12a: R_f (Hex/EtOAc, 4:1) = 0.26. ^{1}H NMR (500 MHz, $CDCl_3$): δ = 7.38−7.05 (m, 25 H, 5 Ph), 4.89−4.79 (m, 4 H, 4 CHPh), 4.81 (d, 1 H, $J_{\text{H1}'\text{-H2}'}$ = 3.6 Hz, H$^{1'}$), 4.69−4.16 (m, 6 H, 6 CHPh), 4.12−4.08 (m, 2 H, H^1, H$^{5'}$), 4.04−4.01 (m, 3 H, H^3, H^4, H^6), 3.92−3.84 (m, 2 H, H^2, H^5), 3.80 (dd, 1 H, $J_{\text{H3}'\text{-H2}'}$ = 10.1 Hz, $J_{\text{H3}'\text{-H4}'}$ = 9.6 Hz, H$^{3'}$), 3.68 (dd, 1 H, $J_{\text{H4}'\text{-H3}'}$ = 9.6 Hz, $J_{\text{H4}'\text{-H5}'}$ = 9.5 Hz, H$^{4'}$), 3.44 (dd, 1 H, $J_{\text{H2}'\text{-H3}'}$ = 10.1 Hz, $J_{\text{H2}'\text{-H1}'}$ = 3.6 Hz, H$^{2'}$), 3.32, 3.31 (2 s, 6 H, 2 OCH_3), 3.18 (dd, $J_{\text{H6a}'\text{-H6b}'}$ = 11.1 Hz, $J_{\text{H6a}'\text{-H5}'}$ = 2.0 Hz, 1 H, H$^{6a'}$), 2.98 (dd, $J_{\text{H6b}'\text{-H6a}'}$ = 11.1 Hz, $J_{\text{H6b}'\text{-H5}'}$ = 1.5 Hz, 1 H, H$^{6b'}$), 1.39, 1.34 (2 s, 6 H, 2 CH_3).^{13}C NMR (125 MHz, $CDCl_3$): δ = 139.1, 138.5, 138.4, 138.0, 137.9 (5 C, Bn), 128.5 (2 CH, Bn), 128.4 (2 CH, Bn), 128.3 (2 CH, Bn), 128.2 (6 CH, Bn), 127.9 (2 CH, Bn), 127.8 (2 CH, Bn), 127.7 (2 CH, Bn), 127.6 (CH, Bn), 127.5 (3 CH, Bn), 127.4 (2 CH, Bn), 127.2 (CH, Bn), 99.4, 99.3 (2 C, BDA), 97.4 (C$^{1'}$), 80.3, 78.1, 76.5, 76.3, 75.3, 75.2, 74.4, 73.8, 73.7, 73.3, 70.6, 69.9, 69.7, 68.8, 67.4 (C^1, C^2, C^3, C^4, C^5, C^6, 5 CH_2Bn, C$^{2'}$, C$^{3'}$, C$^{4'}$, C$^{5'}$), 63.7 (C$^{6'}$), 47.8 (2 OCH_3), 18.0, 17.9 (2 CH_3).

Data for 12b: R_f (Hex/EtOAc, 4:1) = 0.29. ^{1}H NMR (500 MHz, $CDCl_3$): δ = 7.38−7.12 (m, 25 H, 5 Ph), 4.98−4.48 (m, 10 H, 10 CHPh), 4.52 (d, 1 H, $J_{\text{H1}'\text{-H2}'}$ = 8.0 Hz, H$^{1'}$), 4.26 (dd, 1 H, $J_{\text{H1-H6}}$ = 3.5 Hz, $J_{\text{H1-H2}}$ = 3.2 Hz, H^1), 4.21 (dd, 1 H, $J_{\text{H4-H5}}$ = 10.3 Hz, $J_{\text{H4-H3}}$ = 10.0 Hz, H^4), 4.19 (t, *J* = 3.5 Hz, 1 H, H^6), 4.03 (dd, 1 H, $J_{\text{H3-H2}}$ = 10.1 Hz, $J_{\text{H3-H4}}$ = 10.0 Hz, H^3), 3.91 (dd, 1 H, $J_{\text{H5-H4}}$ = 10.3 Hz, $J_{\text{H5-H6}}$ = 3.5 Hz, H^5), 3.84 (dd, 1 H, $J_{\text{H2-H3}}$ = 10.1 Hz, $J_{\text{H2-H1}}$ = 3.2 Hz, H^2), 3.65 (br. d, 2 H, 2 H$^{6'}$), 3.59 (dd, 1 H, *J* = 9.4, *J* = 8.8, H$^{3'}$), 3.36−3.28 (m, 3 H, H$^{2'}$, H$^{4'}$, H$^{5'}$), 3.28.3.26 (2 s, 6 H, 2 OCH_3), 1.34, 1.31 (2 s, 6 H, 2 CH_3).

2-Azido-3,4,6-tri-*O*-benzyl-2-deoxy-D-glucopyranosyl-α(1→1)-2,3:4,5-di-*O*-(2′,3′-dimethoxybutane-2′,3′-diyl)-D-*chiro*-inositol (13a) and 2-Azido-3,4,6-tri-*O*-benzyl-2-deoxy-D-glucopyranosyl-β(1→1)2,3:4,5-di-*O*-(2′,3′-dimethoxybutane-2′,3′-diyl)-D-*chiro*-inositol (13b): A solution of donor **10** (80 mg, 0.129 mmol) and acceptor **5** (33 mg, 0.080 mmol) was coevaporated three times with toluene and dried under vacuum overnight. This mixture was dissolved in 2 mL of CH_2Cl_2 under argon, 4 Å molecular sieves were added, and the slurry was stirred for 1 h at room temperature. A solution of TMSOTf (11 μL in 2.5 mL CH_2Cl_2, 0.5 mL, 0.1 equiv.) was then added at −25 °C and the reaction was monitored by TLC and after 1 h filtered through Celite. The residue was concentrated and purified by flash chromatography (Hex/EtOAc, 6:1) to yield 30.5 mg (43%) of the α-pseudodisaccharide **13a** and 14 mg (20%) of the β-pseudodisaccharide **13b.**

Data for 13a: R_f (Hex/EtOAc, 4:1) = 0.22. $[\alpha]_D^{20}$ = +8 (*c* = 0.1, $CHCl_3$). ^{1}H NMR (500 MHz, $CDCl_3$): δ = 7.33−7.17 (m, 15 H, 3 Ph), 4.89−4.74 (m, 4 H, 3 CHPh, H$^{1'}$), 4.58−4.42 (m, 3 H, 3 CHPh), 4.36 (br. d, 1 H, $J_{\text{H5}'\text{-H4}'}$ = 9.2 Hz, H$^{5'}$), 4.00−3.86 (m, 7 H, H^1, H^2, H^3, H^4 H^5, H^6, H$^{3'}$), 3.76 (dd, 1 H, $J_{\text{H4}'\text{-H3}'}$ = 9.9 Hz, $J_{\text{H4}'\text{-H5}'}$ = 9.2 Hz, H$^{4'}$), 3.72 (dd, $J_{\text{H6a}'\text{-H6b}'}$ = 10.9 Hz, $J_{\text{H6a}'\text{-H5}'}$ = 2.5 Hz, 1 H, H$^{6a'}$), 3.62 (br. d, 1 H, $J_{\text{H6b}'\text{-H6a}'}$ = 10.9 Hz, H$^{6b'}$), 3.49 (dd, 1 H, $J_{\text{H2}'\text{-H3}'}$ = 10.0 Hz, $J_{\text{H2}'\text{-H1}'}$ = 3.5 Hz, H$^{2'}$), 3.26, 3.25, 3.23, 3.18 (4 s, 12 H, 4 OCH_3), 1.30, 1.29, 1.25, 1.18 (4 s, 12 H, 4 CH_3). ^{13}C NMR (125 MHz, $CDCl_3$): δ = 138.1 (C, Bn), 137.9 (2 C, Bn), 128.4 (2 CH, Bn), 128.3 (2 CH, Bn), 128.2 (2 CH, Bn), 128.1 (2 CH, Bn), 127.7 (3 CH, Bn), 127.6 (CH, Bn), 127.4 (CH, Bn), 127.2 (2 CH, Bn), 100.2, 99.8, 99.0, 98.6 (4 C, BDA), 97.2 (C$^{1'}$), 80.3, 78.2, 75.9, 75.3, 74.0, 73.5, 70.6, 68.9, 68.6, 68.3, 67.0, 66.3, 66.3 (C^1, C^2, C^3, C^4, C^5, C^6, 3 CH_2Ph, C$^{2'}$, C$^{3'}$, C$^{4'}$, C$^{5'}$), 63.8 (C$^{6'}$), 48.1 (2 C, 2 OCH_3), 47.8, 47.7 (2 OCH_3), 17.9, 17.8, 17.7, 17.6 (4 CH_3).

Data for 13b: R_f (Hex/EtOAc, 4:1) = 0.28. ^{1}H NMR (500 MHz, $CDCl_3$): δ = 7.35−7.13 (m, 15 H, 3 Ph), 4.95−4.62 (m, 3 H, 3 CHPh), 4.52 (d, 1 H, $J_{\text{H1}'\text{-H2}'}$ = 8.1 Hz, H$^{1'}$), 4.41 (br. d, 1 H, $J_{\text{H5}'\text{-H4}'}$ = 9.3 Hz, H$^{5'}$), 4.00−3.86 (m, 7 H, H^1, H^2, H^3, H^4 H^5, H^6, H$^{3'}$, H$^{4'}$), 3.71 (br. d, 2 H, 2 H$^{6'}$), 3.55 (dd, 1 H, $J_{\text{H2}'\text{-H3}'}$ = 10.0 Hz, $J_{\text{H2}'\text{-H1}'}$ = 8.1 Hz, H$^{2'}$), 3.27, 3.25, 3.22, 3.19 (4 s, 12 H, 4 OCH_3), 1.31, 1.29, 1.28, 1.20 (4 s, 12 H, 4 CH_3).

3,4,6-Tri-*O*-acetyl-2-azido-2-deoxy-D-galactopyranosyl-α(1→1)-2,5-di-*O*-benzyl-3,4-*O*-(2′,3′-dimethoxybutane-2′,3′-diyl)-D-*chiro*-inositol (14): A solution of donor **7** (100 mg, 0.21 mmol) and acceptor **4** (50 mg, 0.105 mmol) was coevaporated three times with toluene and dried under vacuum overnight. This mixture was dissolved under argon in 1.5 mL of CH_2Cl_2, 4 Å molecular sieves were added, and the slurry was stirred for 1 h at room temperature. A solution of TMSOTf (10 μL in 10 mL CH_2Cl_2, 0.9 mL, 0.1 equiv.) was then added and the reaction was monitored by TLC and filtered after 1 h through a short pad of Celite. The residue was evaporated and purified by flash chromatography (Hex/EtOAc, 6:1) to yield 42.5 mg (51%) of the α-pseudodisaccharide **14**: R_f (Hex/

EtOAc, 4:1) = 0.25. $[\alpha]_D^{20}$ = +83 (*c* = 0.8, $CHCl_3$). ^1H NMR (500 MHz, $CDCl_3$): δ = 7.40−7.20 (m, 10 H, 2 Ph), 5.32 (br. d, 1 H, $J_{H4'-H3'}$ = 3.2 Hz, $H^{4'}$), 5.24 (dd, 1 H, $J_{H3'-H2'}$ = 11 Hz, $J_{H3'-H4'}$ = 3.2 Hz, $H^{3'}$), 4.96, 4.94 (2 AB, 2 H, 2 CHPh), 4.98 (d, 1 H, $J_{H1'-H2'}$ = 3.5 Hz, $H^{1'}$), 4.72, 4.66 (2 AB, 2 H, 2 CHPh), 4.62 (dd, 1 H, $J_{H5'-H6'}$ = 7 Hz, $J_{H5'-H6'}$ = 6.7 Hz, $H^{5'}$), 4.17 (dd, 1 H, J_{H1-H6} = 3.5 Hz, J_{H1-H2} = 3.5 Hz, H^1), 4.08−4.04 (m, 2 H, H^3, H^4), 4.01 (dd, 1 H, J_{H6-H1} = 3.5 Hz, J_{H6-H5} = 3.4 Hz, H^6), 3.95−3.88 (m, 2 H, H^2, H^5), 3.85−3.80 (m, 2 H, $H^{2'}$, $H^{6a'}$), 3.57 (dd, $J_{H6b'-H6a'}$ = 10.9 Hz, $J_{H6b'-H5'}$ = 6.1 Hz, 1 H, $H^{6b'}$), 3.38, 3.33 (2 s, 6 H, 2 OCH_3), 2.10, 2.06, 1.86 (3 s, 9 H, 3 $\mathit{C}H_3CO$), 1.40, 1.37 (2 s, 6 H, 2 CH_3). ^{13}C NMR (75 MHz, $CDCl_3$): δ = 170.6, 170.4, 170.0 (3 $CH_3\mathit{C}O$), 139.2, 138.8 (2 C, Bn), 128.8 (2 CH, Bn), 128.7 (2 CH, Bn), 128.2 (CH, Bn), 127.9 (2 CH, Bn), 127.8 (CH, Bn), 127.6 (2 CH, Bn), 99.8, 99.6 (2 C, BDA), 96.1 ($C^{1'}$), 76.6, 75.7, 75.4 (C^1, C^2, C^5), 74.5, 74.2 (2 CH_2, Bn), 70.2, 70.0 (C^3, C^4), 69.6 ($C^{3'}$), 68.7 (C^6), 67.7 ($C^{4'}$), 66.6 ($C^{5'}$), 61.2 ($C^{6'}$), 58.2 ($C^{2'}$), 48.2 (2 OCH_3), 21.1, 21.0 (3 $\mathit{C}H_3CO$), 18.3, 18.2 (2 CH_3). MALDI-TOF calcd. for $C_{38}H_{49}N_3O_{15} + Na^+$: 810.8, found 811.0; calcd. for $C_{38}H_{49}N_3O_{15} + K^+$: 826.9, found 828.0. FAB HRMS calcd. for $C_{38}H_{49}O_{15} + Na^+$: 810.3061, found 810.3068.

3,4,6-Tri-*O*-acetyl-2-azido-2-deoxy-D-galactopyranosyl-α(1→1)-2,3:4,5-di-*O*-(2′,3′-dimethoxybutane-2′,3′-diyl)-D-*chiro*-inositol (15): A solution of donor **7** (105 mg, 0.22 mmol) and acceptor **5** (45 mg, 0.11 mmol) was coevaporated three times with toluene and dried under vacuum overnight. This mixture was dissolved in 2 mL of CH_2Cl_2 under argon, 4 Å molecular sieves were added, and the slurry was stirred for 1 h at room temperature. A solution of TMSOTf (10 μL in 10 mL CH_2Cl_2, 0.9 mL, 0.1 equiv.) was then added and the reaction was monitored by TLC and filtered after 1 h through a short pad of Celite. After evaporation, the residue was purified by flash chromatography (Hex/EtOAc, 6:1) to yield 41 mg (52%) of the α-pseudodisaccharide **15**: R_f (Hex/EtOAc, 4:1) = 0.21. $[\alpha]_D^{20}$ = +29 (*c* = 0.6, $CHCl_3$). ^1H NMR (400 MHz, $CDCl_3$): δ = 5.45 (br. d, 1 H, $J_{H4'-H3'}$ = 3.1 Hz, $H^{4'}$), 5.24 (dd, 1 H, $J_{H3'-H2'}$ = 11 Hz, $J_{H3'-H4'}$ = 3.1 Hz, $H^{3'}$), 4.91 (d, 1 H, $J_{H1'-H2'}$ = 3.4 Hz, $H^{1'}$), 4.83 (dd, 1 H, $J_{H5'-H6'}$ = 6.9 Hz, $J_{H5'-H6'}$ = 6.9 Hz, $H^{5'}$), 4.10−3.88 (m, 8 H, H^1, H^2, H^3, H^4, H^5, H^6, 2 $H^{6'}$), 3.86 (dd, 1 H, $J_{H2'-H3'}$ = 11 Hz, $J_{H2'-H1'}$ = 3.4 Hz, $H^{2'}$), 3.27, 3.25, 3.22, 3.21 (4 s, 12 H, 4 OCH_3), 2.12, 2.04, 2.00 (3 s, 9 H, 3 CH_3CO), 1.30, 1.29, 1.24 1.20 (4 s, 12 H, 4 CH_3). ^{13}C NMR (75 MHz, $CDCl_3$): δ = 170.4, 170.1, 169.6 (3 $CH_3\mathit{C}O$), 100.2, 99.9, 98.9, 98.5 (4 C, BDA), 96.3 ($C^{1'}$), 75.0, 70.3 (2 CH), 69.4 ($C^{3'}$), 68.6, 68.5 (2 CH), 67.6 ($C^{4'}$), 67.0 (CH), 66.3 ($C^{5'}$), 66.1, 66.0 (2 CH), 61.2 ($C^{6'}$), 57.9 ($C^{2'}$), 48.1, 47.9, 47.5 (4 OCH_3), 20.7, 20.6 (3 $\mathit{C}H_3CO$), 17.8, 17.7, 17.6, 17.5 (4 CH_3). MALDI-TOF calcd. for $C_{30}H_{47}N_3O_{17} + Na^+$: 744.7, found 745.6; calcd. for $C_{30}H_{47}N_3O_{17} + K^+$: 760.8, found 762.6;. FAB HRMS calcd. for $C_{30}H_{47}N_3O_{17} + Na^+$: 744.2803, found 744.2809.

3,4,6-Tri-*O*-acetyl-2-deoxy-2-trichloroacetamido-D-glucopyranosyl-β(1→1)-2,5-di-*O*-benzyl-3,4-*O*-(2′,3′-dimethoxybutane-2′,3′-diyl)-D-*chiro*-inositol (16): A 10-mL round-bottomed flask was charged with donor **9** (50 mg, 0.088 mmol. 1.0 equiv.) and acceptor **4** (44 mg, 0.093 mmol, 1.0 equiv.), coevaporated three times with dry toluene and dried under vacuum overnight. This residue was dissolved in CH_2Cl_2 (2 mL) under argon at 0 °C. TMSOTf (2.7 μL, 0.016 mmol, 0.2 equiv.) was added at room temperature and the reaction mixture was stirred for 4 h. It was then quenched with Et_3N, the solvent was removed under vacuum, and the residue was purified by flash chromatography (Hex/EtOAc, 2:1) to provide **16** (36 mg, 0.049 mmol, 48%): R_f (Hex/EtOAc, 1:1) = 0.34. $[\alpha]_D^{20}$ = +35.0 (*c* = 0.12, $CHCl_3$). ^1H NMR ($CDCl_3$, 500 MHz): δ = 7.36−7.26 (m, 10 H, 2 Ph), 6.71 (d, 1 H, $J_{NH-H2'}$ = 9.0 Hz, NH), 5.08 (br. t, 1 H, *J* = 9.2 Hz, $H^{3'}$), 5.05 (br. t, 1 H, *J* = 9.2 Hz, $H^{4'}$), 4.86 (2 AB, 2 H, 2 CHPh), 4.70 (d, *J* = 8.0 Hz, 1 H, $H^{1'}$), 4.64 (AB, 1 H, CHPh) 4.58 (AB, 1 H, CHPh), 4.25 (dd, $J_{H6a'-H6b'}$ = 12.2 Hz, $J_{H6a'-H5'}$ = 5.5 Hz, 1 H, $H^{6a'}$), 4.14 (br. t, 1 H, *J* = 3.0 Hz, H^6), 4.12 (br. t, 1 H, *J* = 3.0 Hz, H^1), 4.07 (dd, $J_{H6b'-H6a'}$ = 12.2 Hz, $J_{H6b'-H5'}$ = 2.0 Hz, 1 H, $H^{6b'}$), 4.00−3.93 (m, 3 H, $H^{2'}$, H^3, H^4), 3.89(dd, 1 H, J_{H2-H3} = 10.0 Hz, J_{H2-H1} = 3.0 Hz, H^2), 3.74 (dd, 1 H, J_{H5-H4} = 9.5 Hz, J_{H5-H6} = 3.0 Hz, H^5), 3.55 (m, 1 H, $H^{5'}$), 3.26, 3.25 (2 s, 6 H, 2 OCH_3), 2.09, 2.02, 1.97 (3 s, 9 H, 3 CH_3CO), 1.30, 1.33 (2 s, 6 H, 2 CH_3). ^{13}C NMR ($CDCl_3$, 125 MHz): δ = 170.7, 170.6, 169.3 (3 $CH_3\mathit{C}O$), 161.9 ($CCl_3\mathit{C}O$), 139.0, 138.5 (2 C, 2Bn), 128.6, 128.4 (4 CH, Bn), 127.9 (CH, Bn), 127.8 (2 CH, Bn), 127.7 (3 CH, Bn), 101.2 ($C^{1'}$), 99.4 (C, BDA), 99.3 (C, BDA), 92.1 ($Cl_3\mathit{C}CO$), 77.9 (C^6), 77.5 ($C^{2'}$), 76.5 (C^2), 76.3 (C^5), 74.5, 73.7 (2 CH_2Ph), 72.3 ($C^{4'}$), 72.1 ($C^{5'}$), 70.5 (C^1), 69.7 ($C^{4,}$ C^3), 68.3 ($C^{3'}$), 62.0 ($C^{6'}$), 48.0, 47.8 (2 OCH_3), 20.8 ($\mathit{C}H_3CO$), 20.6 (2 CH_3CO), 17.9, 17.8 (2 CH_3). HR-FABMS calcd. for $C_{40}H_{50}NO_{16}Cl_3 + Na^+$: 928.2093; found 928.2088.

3,4,6-Tri-*O*-acetyl-2-deoxy-2-trichloroacetamido-D-glucopyranosyl-β(1→1)-2,3,4,5-*O*-bis (2′,3′-dimethoxybutane-2′,3′-diyl)-D-*chiro*-inositol (17): A 10-mL round-bottomed flask was charged with donor **9** (100 mg, 0.176 mmol, 1.1 equiv.) and acceptor **5** (65 mg, 0.160 mmol, 1.0 equiv.), coevaporated 3 times with toluene and dried under vacuum overnight. This residue was dissolved in Et_2O (2.5 mL) under argon at 0 °C, TMSOTf (2.8 μL, 0.016 mmol, 0.1 equiv.) was added, and the reaction mixture was stirred for 30 min. The reaction was monitored by TLC and the solvent was removed under vacuum to provide a mixture that was fractionated by flash chromatography (Hex/EtOAc, 1:1) to obtain **17** (56 mg, 0.067 mmol, 41%): R_f (Hex/EtOAc, 1:2) = 0.24; m.p. 171−174 °C. $[\alpha]_D^{20}$ = −120 (*c* = 1, $CHCl_3$). ^1H NMR ($CDCl_3$, 500 MHz): δ = 7.18 (d, 1 H, $J_{NH-H2'}$ = 9.0 Hz, NH), 5.26 (t, *J* = 9.5 Hz, 1 H, $H_{4'}$), 5.16 (d, *J* = 8.5 Hz, 1 H, $H_{1'}$), 5.05 (t, *J* = 9.5 Hz, 1 H, $H_{3'}$), 4.22 (dd, $J_{H6a'-H6b'}$ = 12.0 Hz, $J_{H6a'-H5'}$ = 5.0 Hz, 1 H, $H^{6a'}$), 4.18 (br. t, 1 H, *J* = 3.2 Hz, H^6), 4.10 (m, 1 H, $H^{6b'}$), 4.01 (br. t, 1 H, *J* = 3.2 Hz, H^1), 3.98 (m, 2 H, $H^{2'}$, H^5), 3.89 (m, 2 H, H^4, H^3), 3.78 (dd, 1 H, J_{H2-H1} = 3.2 Hz, J_{H2-H3} = 5.5&nb6.04, N 1.55.

3,4,6-Tri-*O*-acetyl-2-azido-2-deoxy-D-galactopyranosyl-α(1→1)-2,5-di-*O*-benzyl-D-*chiro*-inositol (18): Pseudodisaccharide **14** (40 mg, 0.051 mmol) was treated with a trifluoroacetic acid/water mixture (9:1, 3 mL) at room temperature and stirred for 15 min. The reaction mixture was concentrated to dryness to give 37 mg of **18** (0.051 mmol, quantitative yield). ^1H , 74.5 (C^6), 72.2 ($C^{5'}$), 72.1 ($C^{4'}$), 70.3 (C^1), 68.8 (C^5), 68.7 ($C^{3'}$), 68.1 (C^2), 66.5, 66.4 (C^4, C^3), 62.3 ($C^{6'}$), 56.1 ($C^{2'}$), 48.2, 48.1, 47.9, 47.6 (4 OCH_3), 20.8 ($\mathit{C}H_3CO$), 20.7 (2 CH_3CO), 18.1, 17.9, 17.8, 17.7 (4 CH_3), $C_{32}H_{48}NO_{18}Cl_3$ (841.089): calcd. C 45.67, H 5.75, N 1.66; found C 45.72, H 6.04, N 1.55.

3,4,6-Tri-*O*-acetyl-2-azido-2-deoxy-D-galactopyranosyl-α(1→1)-2,5-di-*O*-benzyl-D-*chiro*-inositol (18): Pseudodisaccharide **14** (40 mg, 0.051 mmol) was treated with a trifluoroacetic acid/water mixture (9:1, 3 mL) at room temperature and stirred for 15 min. The reaction mixture was concentrated to dryness to give 37 mg of **18** (0.051 mmol, quantitative yield). ^1H NMR (500 MHz, $CDCl_3$): δ = 7.40−7.20 (m, 10 H, 2 Ph), 5.36 (br. s, 1 H, $H^{4'}$), 5.22 (dd, 1 H, $J_{H3'-H2'}$ = 11 Hz, $J_{H3'-H4'}$ = 3.1 Hz, $H^{3'}$), 4.89 (br. s, 1 H, $H^{1'}$), 4.73, 4.72, 4.66, 4.60 (4 AB, 4 H, 4 CHPh), 4.47 (br. s, 1 H, $H^{5'}$), 4.19 (br. s, 1 H, H^1), 4.06 (br. s, 1 H, H^6), 3.93−3.87 (m, 2 H, H^3, H^4), 3.84−3.79 (m, 3 H, H^2, $H^{2'}$, $H^{6a'}$), 3.74−3.71 (m, 2 H, H^5, $H^{6b'}$), 2.11, 2.04, 1.88 (3 s, 9 H, 3 CH_3CO). ^{13}C NMR (75 MHz, $CDCl_3$): δ = 171.1, 170.7, 170.4 (3 $CH_3\mathit{C}O$), 138.0, 137.9 (2 C, Bn), 129.1 (2 CH, Bn), 129.0 (2 CH, Bn), 128.8 (CH, Bn), 128.6 (2 CH, Bn), 128.4 (CH, Bn), 128.0 (2 CH, Bn), 97.4 ($C^{1'}$), 79.6, 77.7, 74.7 (C^{1}, C^{2}, C^{5}), 73.7, 73.1 (2 CH_2Ph), 73.0, 72.5 (C^{3}, C^{4}), 69.4 ($C^{3'}$), 67.7 (C^{6}), 67.3 ($C^{4'}$), 66.9 ($C^{5'}$), 61.5 ($C^{6'}$), 58.3 ($C^{2'}$), 21.1, 21.0 (3 CH_3CO).

2-Azido-2-deoxy-D-galactopyranosyl-α(1→1)-2,5-di-*O*-benzyl-D-*chiro*-inositol (19): A solution of **18** (37 mg, 0.51 mmol) in dry methanol (2 mL) was treated with a solution of MeONa/MeOH (0.03 mL, 1 N). The resulting mixture was stirred for 1 h at room temperature whereupon it was neutralized with Amberlyte IR120^{+} and concentrated under vacuum. Purification by flash chromatography (MeOH/CH_2Cl_2, 1:9) quantitatively gave **19** as a colourless oil (30 mg, 0.051 mmol). ^{1}H NMR (500 MHz, D_2O): δ = 7.45−7.20 (m, 10 H, 2 Ph), 4.84 (br. s, 1 H, $H^{1'}$), 4.77−4.63 (m, 4 H, 4 CHPh), 4.13 (m, 2 H, H^{1}, H^{6}), 4.09 (br. dd, 1 H, $J_{H5'-H6'}$ = 5.9 Hz, $J_{H5'-H6'}$ = 5.8 Hz, $H^{5'}$), 3.90 (dd, 1 H, $J_{H3'-H2'}$ = 10.6 Hz, $J_{H3'-H4'}$ = 3.2 Hz, $H^{3'}$), 3.81 (br. s, 1 H, $H^{4'}$), 3.74−3.63 (m, 4 H, H^{2}, H^{3}, H^{4}, H^{5}), 3.58−3.51 (m, 3 H, $H^{2'}$, 2 $H^{6'}$). ^{13}C NMR (75 MHz, D_2O): δ = 138.3, 138.2 (2 C, Bn), 127.5 (4 CH, Bn), 127.4 (2 CH, Bn), 127.2 (2 CH, Bn), 126.8 (CH, Bn), 126.7 (CH, Bn), 96.0 ($C^{1'}$), 78.6, 77.0, 72.5, 72.3 (C^{2}, C^{3}, C^{4}, C^{5}), 73.4 (C^{1}), 71.8, 71.5 (2 CH_2Ph), 70.0 ($C^{5'}$), 69.2 ($C^{4'}$), 67.9 ($C^{3'}$), 65.2 (C^{6}), 60.7 ($C^{6'}$), 60.1 ($C^{2'}$).

2-Amino-2-deoxy-D-galactopyranosyl-α(1→1)-D-*chiro*-inositol (IV): A suspension of **19** (30 mg, 0.051 mmol) and Pd/C 10% in MeOH/water (9:1, 3 mL) was saturated with a stream of H_2 for 15 min and stirred under H_2 overnight. The slurry was filtered through Celite, concentrated and lyophilysed to give 21 mg of **IV** (0.051 mmol). $[\alpha]_{D}^{20}$ = +137 (*c* = 0.7, H_2O), ^{1}H NMR (500 MHz, D_2O): δ = 5.07 (d, 1 H, $J_{H1'-H2'}$ = 3.7 Hz, $H^{1'}$), 4.12 (br. dd, 1 H, $J_{H5'-H6'}$ = 6.2 Hz, $J_{H5'-H6'}$ = 6.2 Hz, $H^{5'}$), 4.05 (dd, 1 H, J_{H1-H6} = 3.5 Hz, J_{H1-H2} = 3.3 Hz, H^{1}), 3.98 (dd, 1 H, J_{H6-H1} = 3.5 Hz, J_{H6-H5} = 3.1 Hz, H^{6}), 3.87−3.83 (m, 2 H, $H^{3'}$, $H^{4'}$), 3.74 (dd, 1 H, J_{H2-H3} = 9.7 Hz, J_{H2-H1} = 3.3 Hz, H^{2}), 3.62 (d, 2 H, $J_{H6'-H5'}$ = 6.2 Hz, 2 $H^{6'}$), 3.58 (dd, 1 H, J_{H5-H4} = 9.5 Hz, J_{H5-H6} = 3.1 Hz, H^{5}), 3.57−3.44 (m, 2 H, H^{3}, H^{4}), 3.17 (dd, 1 H, $J_{H2'-H3'}$ = 10.5 Hz, $J_{H2'-H1'}$ = 3.7 Hz, $H^{2'}$). ^{13}C NMR (75 MHz, D_2O): δ = 94.7 ($C^{1'}$), 75.7 (C^{1}), 72.4, 72.1 (C^{3}, C^{4}), 70.8 ($C^{5'}$), 70.2 (C^{5}), 69.0 (C^{2}), 67.8 ($C^{3'}$, $C^{4'}$), 67.5 (C^{6}), 60.5 ($C^{6'}$), 50.1 ($C^{2'}$). MALDI-TOF calcd. for $C_{12}H_{24}NO_{10}$ + Na^{+}: 365.3, found 366.2. FAB HRMS calcd. for $C_{12}H_{23}O_{10}$ + Na^{+}: 364.1220, found 364.1227.

3,4,6-Tri-*O*-acetyl-2-deoxy-2-trichloroacetamido-D-glucopyranosyl-β(1→1)-D-*chiro*-inositol (20): Pseudodisaccharide **17** was dissolved in a mixture of trifluoroacetic acid/water (9:1, 7 mL) and stirred at room temperature for 30 min. The reaction was monitored by TLC and the residue was concentrated under vacuum and purified by flash chromatography (Cl_2CH_2/MeOH, 8:1) to provide **20** (39 mg, 0.064 mmol, 82%). R_f (Cl_2CH_2/MeOH, 5:1) = 0.29. $[\alpha]_{D}^{20}$ = −1.7 (*c* = 0.72, MeOH). ^{1}H NMR ($CDCl_3$, 500 MHz): δ = 5.32 (t, *J* = 9.5 Hz, 1 H, $H_{3'}$), 5.02 (d, *J* = 8.5 Hz, 1 H, $H^{1'}$), 4.98 (t, *J* = 10.5 Hz, 1 H, $H^{4'}$), 4.28 (dd, $J_{H6a'-H6b'}$ = 12.2 Hz, $J_{H6a'-H5'}$ = 6.0 Hz, 1 H, $H^{6a'}$), 4.13 (dd, $J_{H6b'-H6a'}$ = 12.2 Hz, $J_{H6a'-H5'}$ = 2.5 Hz, 1 H, $H^{6b'}$), 4.00 (br. t, 1 H, J_{H6-H1} = 4.0 Hz, J_{H6-H5} = 2.5 Hz, H^{6}), 3.98 (br. t, 1 H, J_{H6-H1} = 4.0 Hz, J_{H1-H2} = 3.0 Hz, H^{1}), 3.86 (dd, 1 H, $J_{H2'-H1'}$ = 10.5 Hz, $J_{H2'-H3'}$ = 8.0 Hz, $H^{2'}$), 3.80 (ddd, 1 H, $J_{H5'-H4'}$ = 10.0 Hz, $J_{H5'-H6a'}$ = 6.0 Hz, $J_{H5'-H6b'}$ = 2.5 Hz, $H^{5'}$), 3.75 (m, 1 H, H^{5}), 3.58 (m, 1 H, H^{2}), 3.46 (m, 2 H, H^{4}, H^{3}), 2.06, 1.98, 1.95 (3 s, 9 H, 3 CH_3CO). ^{13}C NMR ($CDCl_3$, 125 MHz): δ = 171.1, 170.3, 169.9 (3 $CH_3\mathit{C}O$), 163.0 ($Cl_3C\mathit{C}O$), 157.8 ($Cl_3\mathit{C}CO$), 101.0 ($C^{1'}$), 79.7 (C^{6}), 73.3 (C^{3}), 73.2 (C^{4}), 72.2 ($C^{3'}$), 71.6 (C^{5}), 71.2 (C^{1}), 71.0 (C^{2}), 70.8 ($C^{5'}$), 68.9 ($C^{4'}$), 61.8 ($C^{6'}$), 56.0 ($C^{2'}$), 19.2 (3 CH_3CO). FAB HRMS for $C_{20}H_{28}NO_{14}Cl_3$ + Na^{+}: 634.0473; found 634.0474.

2-Amino-2-deoxy-D-glucopyranosyl-β(1→1)-D-*chiro*-inositol (V): Compound **20** (12 mg, 0.020 mmol, 1.0 equiv.) and $Ba(OH)_2$ (16 mg, 0.094 mmol, 4.8 equiv.) were stirred under reflux in water/EtOH (1:1, 10 mL) at 90 °C for 1 h, whereupon the solvent was removed under vacuum. The residue was dissolved in cold water and filtered through a paper filter to provide the crude material. The solvent was removed under vacuum and the residue was dissolved in a small amount of MeOH and loaded onto Varian CBA cartridges (1 mL/100 mg) preequilibrated with MeOH. After elution with a few column lengths of MeOH, the pseudodisaccharide salt was loaded directly onto a Varian PSA cartridge preequilibrated with MeOH to give **V** (2.0 mg, 0.006 mmol. 41% unoptimised yield). R_f (EtOAc/MeOH/H_2O/Et_3N, 2:2:1:1) = 0.31. $[\alpha]_{D}^{20}$ = +3.4 (*c* = 0.21, H_2O). ^{1}H NMR (D_2O, 500 MHz): δ = 4.40 (d, *J* = 8.0 Hz, 1 H, $H^{1'}$), 4.13 (t, *J* = 3.5 Hz, 1 H, H^{6}), 3.93 (t, *J* = 3.5 Hz, 1 H, H^{1}), 3.80 (dd, 1 H, $J_{H6a'-H6b'}$ = 12.5 Hz, $J_{H6a'-H5'}$ = 2.5 Hz, $H^{6a'}$), 3.71 (dd, 1 H, J_{H2-H3} = 10.0 Hz, J_{H2-H1} = 3.5 Hz, H^{2}), 3.64 (dd, 1 H, J_{H5-H4} = 9.5 Hz, J_{H5-H6} = 3.5 Hz, H^{5}), 3.60 (dd, $J_{H6b'-H6a'}$ = 12.5 Hz, $J_{H6a'-H5'}$ = 6.0 Hz, 1 H, $H^{6b'}$), 3.50 (t, *J* = 9.5 Hz, 1 H, H^{3}), 3.44 (t, *J* = 9.5 Hz, 1 H, H^{4}), 3.36 (m, 1 H, $H^{5'}$), 3.27−3.22 (m, 2 H, $H^{3'}$, $H^{4'}$), 2.54 (br. t, 1 H, *J* = 10.5 Hz, $H^{2'}$). ^{13}C NMR (D_2O, 125 MHz): δ = 105.1 ($C^{1'}$), 81.1 (C^{1}), 75.7 ($C^{5'}$), 75.3 ($C^{3'}$), 72.4 (C^{3}), 72.3 (C^{4}), 71.2 (C^{6}), 70.2 (C^{5}), 70.0 (C^{2}), 69.8 ($C^{4'}$), 61.6 ($C^{6'}$), 56.5 ($C^{2'}$). HR FABMS for $C_{12}H_{24}NO_{10}$ + Na^{+}: 342.1400; found 342.1399.

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