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Acetonides of Octonolactones

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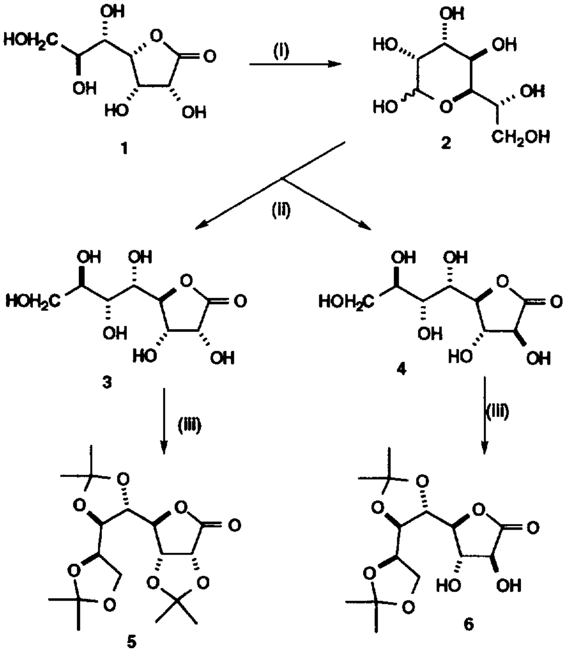
Abstract: Acetonides of the eight carbon sugar lactones, D-*erythro*-L-*talo*octono-1,4-lactone and D-*erythro*-L-*galacto*octono-1,4-lactone, readily derived from glucoheptonolactone, are easily accessible intermediates for the synthesis of sugar mimics with six adjacent stereogenic centres and eight contiguous carbon atoms bearing functional groups.

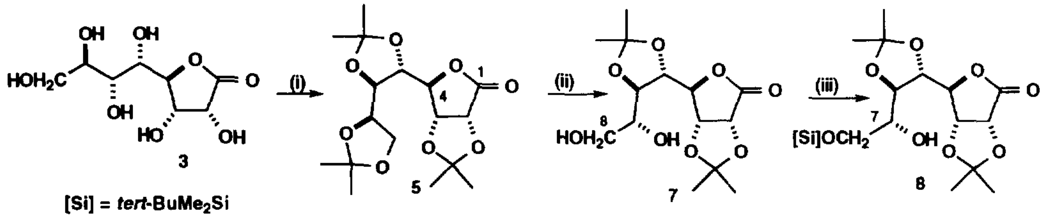
Protection of oxygen functional groups is one of the major disadvantages in the use of carbohydrates in synthesis; at first sight, the more hydroxyl groups in the sugar, the greater the apparent problem. However, there are many examples of the use of lactones in synthesis with either no protecting groups at all[1,2] or only ketal protection.[3,4] Acetonides of seven carbon sugar lactones derived from mannose[5] and from rhamnose[6] have been developed into the synthesis of a wide variety of C-glycoside mimics and other highly functionalised compounds with no further protection than the original acetonation. However, there are no reports of the use of eight carbon sugars in synthesis, presumably because of the apparently daunting problems of protecting or differentiating the reactivity of so many oxygen functions.

This paper describes easy access to acetonides of the eight carbon sugar lactones **3** and **4** from cheap and readily available[7] glucoheptonolactone **1** and indicates their potential as intermediates in the synthesis of targets with six adjacent stereogenic centres and functional groups on eight contiguous carbon atoms.



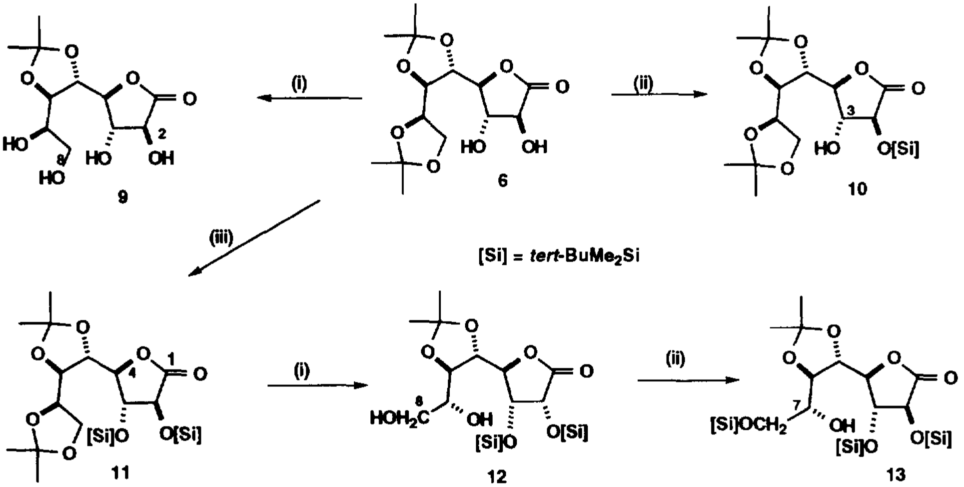
Scheme 1: (i) $NaBH_4$ in H_2O [ref. 8] (ii) NaCN [ref. 9] (iii) Me_2CO, H^+

Glucoheptonolactone **1** was reduced [Scheme 1] to the heptose **2** by sodium borohydride.[8] The crude lactol **3**, without any purification, was subjected to the Kiliani ascension with minor modifications of the Kiliani procedure[9] to give a mixture, after work-up, of the lactones **3** and **4**. The γ-lactone **3** was converted to the easily crystallised triacetonide **5** by treatment with acetone in the presence of sulphuric acid (73% yield); the chemical shifts of the three singlets due to the ketal carbons in ^{13}C NMR at δ 110.0, 110.6 and 113.1 clearly demonstrate the formation of three 5 ring ketals, rather than any alternative products which might have contained 6 ring ketals. Although the lactones 3 and 4 can be separated by fractional crystallisation, this takes some time. The separation of the epimeric lactones can be avoided at this stage since the lactone 3 can give rise to a triacetonide 5 whereas the epimeric lactone 4, in which the hydroxyl groups on the lactone ring are *trans* to each other, only forms a diacetonide 6; there is considerable difference between the polarities of the diol 6 and the fully protected lactone 5, so that separation by flash chromatography is easy. Thus, the crude mixture from the Kiliani cyanide extension was acidified, the solvent removed and the residue extracted by acetone in the presence of acid to allow the extraction of the acetonide 5 and 6 in 25% and 23% yields, respectively.



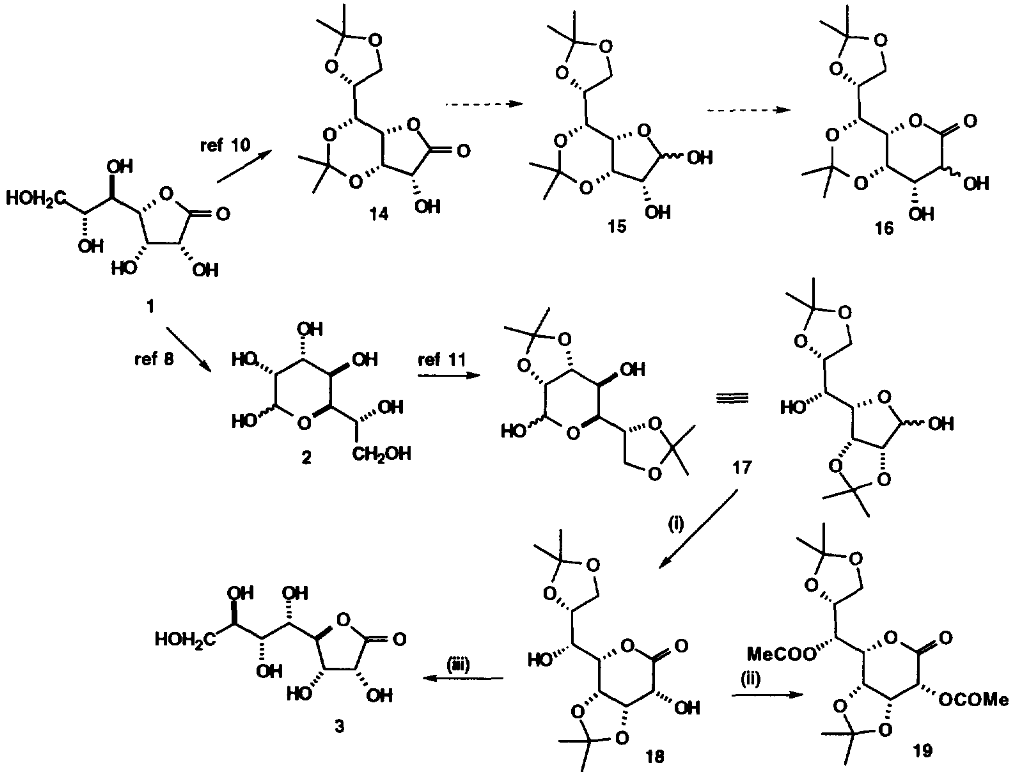
Scheme 2: (i) Me_2CO, H^+ (ii) $MeCOOH$, H_2O (iii) *tert*-$BuMe_2SiCl$, imidazole, DMF

The triacetonide 5 gives access to C1 and C4; mild hydrolysis of 5 with aqueous acetic acid afforded the diacetonide 7 [88% yield] with only the hydroxyl groups at C7 and C8 free [Scheme 2]. The primary hydroxyl group in 7 is more nucleophilic than the secondary alcohol so that reaction of 7 with *tert*-butyldimethylsilyl chloride in the presence of imidazole in dimethylformamide gives the silyl ether 8 in 89% yield, in which only the secondary alcohol function at C7 is unprotected. The greater reactivity of the free C8 hydroxyl group in 7 could also be used to introduce other functionality at C8 without any further protection. The isopropylidene protecting groups could be removed from both triacetonide 5 and the diacetonide 7 by hydrolysis with aqueous trifluoroacetic acid at room temperature to the unprotected lactone 3 in yields of 94% and 75%, respectively.



Scheme 3: (i) $MeCOOH$, H_2O (ii) *tert*-$BuMe_2SiCl$, imidazole, DMF

The diacetonide **6** undergoes partial hydrolysis by aqueous acetic acid [Scheme 3] to give the monoacetonide **9** [69% yield] in which direct functionalisation of either C2 and/or C8, without any further protection, would be possible; hydrolysis of **6** with aqueous trifluoroacetic acid removed both isopropylidene protecting groups to give **4** in 84% yield. Silylation of **6** by *tert*-butyldimethylsilyl chloride under mild conditions with *tert*-butyldimethylsilyl chloride in dimethylformamide in the presence of imidazole gave the monosilyl ether **10** (72% yield) in which only the C3 position is unprotected. More exhaustive silylation of **6** to the bis-silyl ether **11** by excess silylating agent for longer reaction times (in 62% yield) allows access to C1 and C4. Mild acid hydrolysis of 11 by aqueous acetic acid gave **12** (65% yield), giving an opportunity to modify C8. Further silylation of the primary hydroxyl group in **12** with *tert*-butyldimethylsilyl chloride in dimethylformamide gives the trisilyl ether **13** (65% yield, quantitative based on uncovered **12**) in which only C7 is left unprotected.

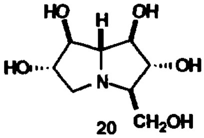


Scheme 4: (i) NaCN and then work-up (ii) $(MeCO)_2O$, pyridine (iii) aq. CF_3COOH

Thus the unprotected Kiliani ascension of the heptose **2** allows access to γ-octonolactones which form easily separated acetonides with a wide range of access to the oxygen functional groups at different carbon atoms. In principle, Kiliani chain extensions on protected derivatives of **2** would give rise to a range of δ lactones permitting access to the oxygen functionality at other carbon atoms [Scheme 4]. Thus, **1** may readily be converted to the acetonide **14**[10] in good yield. However, all attempts to reduce **14** with a wide range of reducing agents failed to give any appreciable yield of the lactol **15** so that it was not possible to study the cyanohydrin extension to give **16**, which as a δ-lactone, would give access to C1, C2, C3 and C5.

In contrast, reduction of **1** to the lactol **2**, followed by treatment with acetone and sulphuric acid, gives the 2,3:6,7-diketal **17**[11] in 55% overall yield. However, the Kiliani chain extension on **17** gave only a modest yield [14%] of the δ-lactone **18** in which only C2 and C6 are unprotected; reaction of **18** with acetic anhydride and pyridine gave the fully protected lactone **19** in 79% yield. The stereochemistry of the new stereogenic centre was established by the hydrolysis of **18** with aqueous trifluoroacetic acid to cause removal of the isopropylidene protecting groups and isomerisation to the γ-lactone **3** [quantitative yield]. The low yield of the chain extension reaction means that **18** is not at present a viable starting material for use in synthesis; further efforts directed to improving the yield of the δ-lactone **18** are in progress.

Highly oxygenated alkaloids are among the targets likely to be suitable for synthesis from octonolactones; such materials frequently occur in plants in only small quantities and are difficult to purify. Chemical synthesis of such materials would provide both authentic samples for comparison with plant extracts together with the opportunity to evaluate the biological activity of pure samples of such materials. Casuarine **20**, isolated from *Casuarina equisetifolia*,[12] and its diastereomers might be derived from **1** and **2** by joining together either C1, C4 and C7 or alternatively C2, C5 and C8. Castanospermine **21** and 6-*epi*castanospermine **22** are natural products[13] and it is also clear[14] that more hydroxylated indolizidines occur as natural products; some of these occurring in plant species in the Myrtaceae claimed to have anti-diabetic and anti-viral properties. The acetonides **3** and **4** should allow short syntheses of the four diastereomers represented by **23** and would be likely to establish which of these stereoisomers occur in plants.



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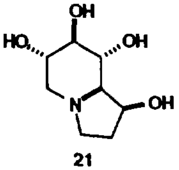

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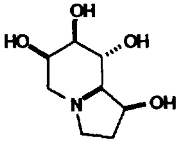

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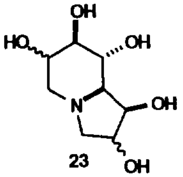

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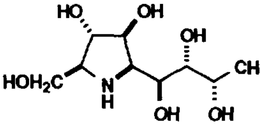
Octonolactones may also be suitable targets for the unambiguous synthesis of even more highly functionalised natural products; thus acetonide **3** provides six of the seven stereogenic centres and eight of the nine adjacent functional groups required for the synthesis of the aglycone **24** of the acaricide gualamycin.[15]



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In summary, this paper reports the synthesis of acetonides of octonolactones which are likely to be of help in the synthesis of very highly oxygenated natural products and of their analogues by short routes with simple protecting group strategies; such studies directed towards causarines **20** and hydroxylated castanospermines **23** are in progress.[16]

Experimental: Melting points were recorded on a Kofler hot block and are corrected. Proton nuclear magnetic resonance (δ_H) spectra were recorded on a Varian Gemini 200 (200 MHz), Bruker AC 200 (200 MHz) or a Bruker AM 500 (500 MHz) spectrometer. ^{13}C Nuclear magnetic resonance (δ_C) spectra were recorded on a Varian Gemini 200 (50 MHz), a Bruker AC 200 (50 MHz) or a Bruker AM 500 (125 MHz) spectrometer and multiplicities were assigned using DEPT sequence. All chemical shifts are quoted on the δ-scale. The following abbreviations were used to explain multiplicities: s, singlet; d, doublet; t, triplet; q, quartet; m, multiplet; br, broad. Infra-red spectra were recorded on a Perkin-Elmer 1750 IR FT spectrophotometer. Mass spectra were recorded on a VG Masslab 20-250, BIO-Q or using desorption chemical ionisation (NH_3, DCI), chemical ionisation (NH_3, CI), electrospray or thermospray, as stated. Optical rotations were measured on a Perkin-Elmer 241 polarimeter with a path length of 1 dm. Concentrations are given in g/100 ml. Microanalyses were performed by the microanalysis service of the Dyson Perrins laboratory. Thin layer chromatography (t.l.c.) was carried out on aluminium sheets coated with $60F_{254}$ silica, and plates were developed using a spray of 0.2% w/v cerium (IV) sulphate and 5% ammonium molybdate in 2M sulphuric acid. Flash chromatography was carried out using Sorbsil C60 40/60 silica. Solvents and commercially available reagents were dried and purified before use according to standard procedures; hexane was distilled at 68°C before use to remove less volatile fractions. Potassium dihydrogen orthophosphate (85 g) and sodium hydroxide (14.5 g) in water (950 ml) was used as buffer pH 7. D-*glycero*-D-*gulo*-Heptono-1,4-lactone **1** was purchased from Sigma. The lactone **1** (100.5 g) was reduced by sodium borohydride in water as previously described[8] to give D-*glycero*-D-*gulo*-heptose **2** (115.2 g), m.p. 189-90°C [lit.[8], 191-92°C]; $\delta_C(D_2O)$: 63.6 (t, C-7), 69.0, 69.5, 69.7, 71.8, 72.9 (5 x d, C-2, C-3, C-4, C-5, C-6), 94.7 (d, C-1) which was used without purification; yields of products arising from subsequent steps are quoted on the basis of the amount of lactone **1** used in the reduction.

D-erythro-L-talo-Octono-1,4-lactone **3** *and D-erythro-L-galacto-Octono-1,4-lactone* **4** were prepared by slight modification of the literature procedure.[9] Sodium cyanide (1.97 g) was added to a stirred solution of D-*glycero*-D-*gulo*-heptose **2** (6.95 g, crude prepared from 6.06 g of lactone **1**) in water (40 ml). The reaction mixture was stirred at room temperature for 68 hr and then heated at reflux for 23 hr. The reaction mixture was then passed through a column containing strongly acidic ion-exchange resin [Amberlite IR-120 (plus) (100 ml)]. The solvent was removed under reduced pressure to give a pale oil which was triturated with acetone (20 ml) to give D-*erythro*-L-*talo*-octono-1,4-lactone **3**, filtered and dried *in vacuo*. Trituration of the filtrate with ethanol gave further **3**, (1.29 g, 19%), m.p. 190-1°C ($EtOH/H_2O$) [lit.[9] 185.5-186°C]; $[\alpha]_D^{22}$+23.7 (*c*, 1.08, H_2O) [lit.[9] $[\alpha]_D^{20}$+24.6 (*c*, 3.24, H_2O)]; ν_{max} (KBr disc): 3353 (br, OH), 1760 (C=O); $\delta_H(D_2O)$: 3.63 (1H, dd, $J_{8,7}$5.6 Hz, $J_{8,8'}$11.7 Hz, H-8), 3.69 (1H, d, $J_{6,5}$2.8 Hz, H-6), 3.71 (1H, dd, $J_{7,8'}$2.8 Hz, $J_{7,8}$5.6 Hz, H-7)), 3.78 (1H, dd, $J_{8',7}$2.8 Hz, $J_{8',8}$11.7 Hz, H-8'), 4.02 (1H, dd, $J_{5,6}$2.8 Hz, $J_{5,4}$4.9 Hz, H-5), 4.43 (1H, d, $J_{3,2}$5.6 Hz, H-3), 4.63 (1H, d, $J_{4,5}$4.8 Hz, H-4), 4.73 (1H, d, $J_{2,3}$ 5.6 Hz, H-2); $\delta_C(D_2O)$: 63.1 (t, C-8), 69.0 (d, C-2), 69.6 (d, C-5), 70.4 (d, C-3), 71.3, 71.4 (2 x d, C-6, C-7), 88.0 (d, C-4), 178.8 (s, C=O); *m/z* (NH_3, DCI): 239 ($M+H^+$, 5%), 256 ($M+NH_4^+$, 100%). (Found: C, 40.03; H, 5.91. $C_8H_{14}O_8$ requires: C, 40.34; H, 5.92%).

Small amounts (15 mg) of D-*erythro*-L-*galacto*-octono-1,4-lactone **4**, also crystallised, m.p. 147-8°C ($EtOH/H_2O$) [lit.[9] 151-152°C]; $[\alpha]_D^{21}$+34.3 (*c*, 0.7, H_2O) [lit.[9] $[\alpha]_D^{20}$+53.7 (*c*, 1.65, H_2O)]; ν_{max} (KBr disc): 3391 (br, OH), 1780 (C=O); $\delta_H(D_2O)$: 3.54 (1H, dd, $J_{8,7}$5.1 Hz, $J_{8,8'}$11.6 Hz, H-8), 3.63 (1H, s, H-6), 3.66 (1H, m, H-7)), 3.71 (1H, dd, $J_{8',7}$2.1 Hz, $J_{8',8}$12.0 Hz, H-8'), 3.91 (1H, dd, $J_{5,6}$1.9 Hz, $J_{5,4}$5.2 Hz, H-5), 4.15 (1H, dd, $J_{3,2}$8.8 Hz, $J_{3,4}$8.8 Hz, H-3), 4.30 (1H, dd, $J_{4,5}$5.2 Hz, $J_{4,3}$8.5 Hz, H-4), 4.48 (1H, d, $J_{2,3}$ 9.0 Hz, H-2); $\delta_C(D_2O)$: 63.2 (t, C-8), 69.5 (d, C-5), 71.2 (2 x d, C-7,C-6), 74.1 (2 x d, C-2, C-3), 82.0 (d, C-4), 176.5 (s, C=O); *m/z* (Electrospray, 10 mM NH_4OAc soln.): 239 ($M+H^+$, 15%), 256 ($M+NH_4^+$, 100%), were also isolated.

***D-erythro-L-talo-Octono-1,4-lactone* 3** was also prepared by removal of acetonide groups from **5**, **7** and **18**:
(i) The triacetonide **5** (104 mg) was dissolved in trifluoroacetic acid: water, 1:1 (5 ml) and the solution left at room temperature for 3 hr after which time t.l.c. (ethyl acetate:hexane, 1:1) indicated no starting material remained. The solvent was removed under reduced pressure, the residue dissolved in water (20 ml) and washed with ethyl acetate (20 ml). The solvent was removed under reduced pressure and the residue freeze-dried to afford 3 (65 mg, 94%), identical to the material described above.
(ii) The γ-lactone diacetonide 7 (106 mg) was dissolved in trifluoroacetic acid: water, 1:1 (4 ml) and the solution stirred at room temperature for 4 hr after which time t.l.c. indicated no starting material remained. Work-up as in (i) gave **3**, (59 mg, 75%), identical to the material described above.
(iii) The δ-lactone diacetonide 18 (8 mg) was dissolved in trifluoroacetic acid: water, 1:1 (1 ml) and the solution stirred at room temperature for 54 hr. Work-up as in (i) gave **3** (5 mg) in quantitative yield.

***D-erythro-L-galacto-Octono-1,4-lactone* 4** was also prepared by removal of acetonide groups from **6**. The diacetonide **6** (305 mg) was dissolved in trifluoroacetic acid: water, 1:1 (6 ml) and the solution left at room temperature for 21 hr when t.l.c. (ethyl acetate:hexane, 3:1) indicated no starting material remained. The solvent was removed under reduced pressure, the residue dissolved in water (20 ml) and washed with ethyl acetate (20 ml). Removal of the aqueous solvent under reduced pressure and freeze-drying gave **4**, (192 mg, 84%), identical to the material described above.

*2,3:5,6:7,8-Tri-O-isopropylidene-**D**-erythro-**L**-talo-octono-1,4-lactone 5 from pure lactone 3.* Sulphuric acid (1.21 ml) was added to a stirred solution of **3** (1.00g) in acetone (150 ml) and the reaction mixture stirred under nitrogen at room temperature for 16 hr. T.l.c. (ethyl acetate:hexane, 1:2) showed a major product (R_f 0.5). Solid sodium bicarbonate (9.46g) was added and the suspension stirred for 4 hr at which time the pH of the reaction mixture was approximately 6. The reaction mixture was filtered, and the filtrate concentrated to give a residue which was taken up in ethyl acetate (150 ml) and washed with water (100 ml). The aqueous phase was extracted with ethyl acetate (2 x 100 ml), the organic phases were pooled, dried ($MgSO_4$), filtered and the solvent removed. The residue was purified by flash chromatography (ethyl acetate:hexane, 1:3, 1:2, 1:1, 3:1) to afford *the title compound* **5**, (1.10g, 73%) as a white solid; m.p. 126-7°C (ether/hexane); $[\alpha]_D^{22}$ -13.4 (*c*, 1.08, $CHCl_3$); ν_{max} (film): 1796 (C=O); δ_H(d_6-benzene): 1.13, 1.15, 1.16, 1.19, 1.23, 1.36 (6 x 3H, 6 s, $3(C(C\underline{H}_3)_2)$), 3.64 (1H, d, $J_{5,6}$8.2 Hz, H-5), 3.79 (1H, ddd, $J_{7,8'}$4.6 Hz, $J_{7,8}$5.9 Hz, $J_{7,6}$8.5 Hz, H-7), 3.83 (1H, dd, $J_{8,7}$4.5 Hz, $J_{8,8'}$8.6 Hz, H-8), 3.89 (1H, dd, $J_{8',7}$6.0 Hz, $J_{8',8}$8.6 Hz, H-8'), 4.05 (1H, dd, $J_{6,5}$8.4 Hz, $J_{6,7}$8.4 Hz, H-6), 4.34 (1H, d, $J_{3,4}$5.4 Hz, H-3), 4.71 (1H, d, $J_{4,3}$5.4 Hz, H-4), 4.79 (1H, s, H-2); δ_C(d_6-benzene): 25.3, 25.6, 26.0, 26.6, 26.9, 27.2 (6 x q, $3(C(\underline{C}H_3)_2)$), 68.0 (t, C-8), 75.4 (d, C-4), 76.8 (d, C-6), 77.5 (d, C-7), 79.0 (d, C-3), 79.2 (d, C-2), 80.6 (d, C-5), 110.0, 110.6, 113.1 (3 x s, $3(\underline{C}(CH_3)_2)$), 173.6 (s, C=O); *m/z* (NH_3, CI): 359 ($M+H^+$, 20%), 376 ($M+NH_4^+$, 100%). (Found: C, 57.12; H, 7.36. $C_{17}H_{26}O_8$ requires: C, 56.97; H, 7.31%)

*2,3:5,6:7,8-Tri-O-isopropylidene-**D**-erythro-**L**-talo-octono-1,4-lactone 5 and 5,6:7,8-Di-O-isopropylidene-**D**-erythro-**L**-galacto-octono-1,4-lactone 6.* Sodium cyanide (3.51 g) was added to a stirred solution of the unprotected heptose **2** (11.42 g, crude formed by reduction of 9.96 g of lactone **1**) in water (100 ml). The reaction mixture was stirred at room temperature for 47 hr and then heated at reflux for 23 hr, and then passed through a column containing strongly acidic ion-exchange resin (Amberlite IR-120 (plus) (300 ml)). The eluate was concentrated under reduced pressure and the residue dried thoroughly *in vacuo* to give a foam (12.01 g) which was then stirred in acetone (500 ml) with sulphuric acid (2.7 ml) and anhydrous copper sulphate (5.0 g) for 20 hr. T.l.c. (ethyl acetate:hexane, 1:1) indicated formation of two major materials (R_f 0.7, R_f 0.25). The reaction mixture was filtered, solid sodium bicarbonate (25.4 g) was added to the filtrate and the suspension was stirred vigorously for 23 hr, pH 4. The reaction mixture was filtered, the solvent removed from the filtrate and the pale oil purified by flash chromatography (ethyl acetate:hexane, 1:2, 1:1, 2:1) to give the triacetonide **5** (4.25 g, 25%), identical to the material described above and the diacetonide **6**, (3.43 g, 23%), oil (R_f 0.25). $[\alpha]_D^{23}$+33.1 (*c*, 0.51, $CHCl_3$); ν_{max} (film): 3429 (br, OH), 1785 (C=O); δ_H(d_6-acetone): 1.30, 1.33, (2 x 3H, 2 s, $(C(C\underline{H}_3)_2)$), 1.37 (6H, s, $(C(C\underline{H}_3)_2)$), 3.93 (1H, m, H-8), 4.00 (1H, m, H-7), 4.15 (2H, m, H-5, H-8'), 4.25 (1H, m, H-6), 4.26 (1H, m, H-4), 4.36 (1H, ddd, $J_{3,OH\text{-}2}$5.4 Hz, H-3), 4.44 (1H, dd, $J_{2,OH\text{-}1}$6.1 Hz, *J* 8.6 Hz, H-2), 5.15 (1H, d, $J_{OH\text{-}1,2}$6.0 Hz, OH-1), 5.24 (1H, d, $J_{OH\text{-}2,3}$5.4 Hz, OH-2); δ_C(d_6-acetone): 25.4, 26.8, 27.0, 27.5 (4 x q, $2(C(\underline{C}H_3)_2)$), 68.1 (t, C-8), 75.1 (d, C-3), 75.3 (d, C-2), 77.5 (d, C-7), 78.0 (d, C-5), 78.4 (d, C-6), 79.0 (d, C-4), 110.3, 110.4 (2 x s, $2(\underline{C}(CH_3)_2)$), 174.2 (s, C=O); *m/z* (NH_3, CI): 319 ($M+H^+$, 60%), 336 ($M+NH_4^+$, 100%). (Found: C, 52.67; H, 7.22. $C_{14}H_{22}O_8$ requires: C, 52.82; H, 6.97%).

2,3:5,6-Di-O-isopropylidene-D-erythro-L-talo-octono-1,4-lactone 7. A solution of the triacetonide **5** (600 mg) in acetic acid:water, 4:1 (20 ml) was stirred at 45-50 °C for 3 hr when t.l.c. (ethyl acetate:hexane, 3:1) indicated one major product (R_f 0.4). The solvent was removed under reduced pressure and the residue purified by flash chromatography (ethyl acetate:hexane, 2:1, 3:1) to give *the diacetonide 7*, (468 mg, 88%), oil, $[\alpha]_D^{23}$-19.8 (*c*, 0.48, $CHCl_3$); ν_{max} (film): 3457 (br, OH), 1791 (C=O); δ_H($CDCl_3$): 1.31, 1.38, 1.39, 1.48 (4 x 3H, 4 s, $2(C(C\underline{H}_3)_2)$), 3.71 (1H, dd, $J_{8,7}$4.8 Hz, $J_{8,8'}$11.3 Hz, H-8), 3.82 (1H, m, H-7), 3.89 (1H, dd, $J_{8',7}$3.4 Hz, $J_{8',8}$11.3 Hz, H-8'), 4.09 (1H, dd, $J_{6,5}$7.6 Hz, $J_{6,7}$7.6 Hz, H-6), 4.19 (1H, d, $J_{5,6}$8.2 Hz, H-5), 4.78 (2H, m, H-2, H-3), 4.86 (1H, s, H-4); δ_C(CD_3CN): 24.6, 25.3, 26.0, 26.4 (4 x q, $2(C(\underline{C}H_3)_2)$), 63.2 (t, C-8), 72.8, 74.9, 75.9, 78.7, 78.8, 80.1 (6 x d, C-2, C-3, C-4, C-5, C-6, C-7), 110.2, 111.7, (2 x s, $2(\underline{C}(CH_3)_2)$), 175.0 (s, C=O); *m/z* (NH_3, CI): 319 ($M+H^+$, 10%), 336 ($M+NH_4^+$, 100%). (Found: C, 52.62; H, 7.09. $C_{14}H_{22}O_8$ requires: C, 52.82; H, 6.97%).

8-O-tert-Butyldimethylsilyl-2,3:5,6-di-O-isopropylidene-D-erythro-L-talo-octono-1,4-lactone 8. A solution of *tert*-butyldimethylsilyl chloride (83 mg) in *N,N'*-dimethylformamide (2 ml) was added to a stirred solution of the diacetonide **7** (131 mg) and imidazole (73 mg) in *N,N'*-dimethylformamide (1 ml) under nitrogen. T.l.c. (ethyl acetate:hexane, 1:1) of the reaction mixture after 2.25 hr showed one product (R_f 0.8). The solvent was removed under reduced pressure and the residue dissolved in chloroform (30 ml) which was washed with pH 7 buffer (2 x 30 ml), dried ($MgSO_4$), filtered and the solvent removed. The residue was purified by flash chromatography (ethyl acetate:hexane, 1:4) to give *the silyl ether 8*, (159 mg, 89%) as a clear oil, which could be recrystallised from (ether/hexane). m.p. 61-2°C; $[\alpha]_D^{23}$-8.8 (*c*, 0.51, $CHCl_3$); ν_{max} (film): 1795 (C=O); δ_H($CDCl_3$): 0.10, 0.11 (2 x 3H, 2 s, $Si((C\underline{H}_3)_2C(CH_3)_3)$), 0.92 (9H, s, $Si((CH_3)_2C(C\underline{H}_3)_3)$), 1.31, 1.37, 1.39, 1.48 (4 x 3H, 4 s, $2(C(C\underline{H}_3)_2)$), 2.60 (1H, d, $J_{OH,7}$ 5.5 Hz, OH), 3.68 (1H, m, H-7), 3.71 (1H, dd, $J_{8,7}$4.8 Hz, $J_{8,8'}$9.9 Hz, H-8), 3.83 (1H, dd, $J_{8',7}$3.3 Hz, $J_{8',8}$10.0 Hz, H-8'), 4.02 (1H, dd, $J_{6,5}$8.0 Hz, $J_{6,7}$8.0 Hz, H-6), 4.13 (1H, d, $J_{5,6}$8.2 Hz, H-5), 4.77-4.78 (2H, 2 x d, *J* 5.5 Hz, H-2, H-3), 4.85 (1H, s, H-4); $\delta_C(CDCl_3)$: -5.5, -5.4 (2 x q, $Si((\underline{C}H_3)_2C(CH_3)_3)$), 18.3 (s, $Si((CH_3)_2\underline{C}(CH_3)_3)$), 25.5, 25.8, 25.9, 26.7, 27.2 (5 x q, $2(C(\underline{C}H_3)_2)$, $Si((CH_3)_2C(\underline{C}H_3)_3)$), 63.9 (t, C-8), 73.0, 74.8, 74.9, 78.7, 79.7, 79.9 (6 x d, C-2, C-3, C-4, C-5, C-6, C-7), 110.4, 113.1, (2 x s, $2(\underline{C}(CH_3)_2)$), 174.5 (s, C=O); *m/z* (NH_3, CI): 433 ($M+H^+$, 10%), 450 ($M+NH_4^+$, 100%). (Found: C, 55.49; H, 8.15. $C_{20}H_{36}O_8Si$ requires: C, 55.53; H, 8.39%).

5,6-O-Isopropylidene-D-erythro-L-galacto-octono-1,4-lactone ***9***. The diacetonide **6** (200 mg) was dissolved in acetic acid:water, 4:1 (5 ml) and the solution stirred at 50-60 °C for 2 hr. T.l.c. (chloroform:methanol:acetic acid:water, 90:30:3:5) indicated one major product (R_f 0.6). The solvent was removed under reduced pressure and the residue purified by flash chromatography (chloroform:methanol:acetic acid:water, 90:30:3:5) to give, after co-evaporation with toluene (twice) and freeze-drying, *the monoacetonide* ***9***, (121 mg, 69%), oil, ν_{max} (KBr disc): 3370 (br, OH), 1781 (C=O); $\delta_H(D_2O)$: 1.39, 1.44 (2 x 3H, 2 s, $C(C\underline{H}_3)_2$), 3.62 (1H, dd, $J_{8,7}$6.3 Hz, $J_{8,8'}$12.0 Hz, H-8), 3.77 (1H, dd, $J_{8',7}$3.2 Hz, $J_{8',8}$12.0 Hz, H-8’), 3.85 (1H, ddd, $J_{7,8'}$3.2 Hz, $J_{7,8}$6.4 Hz, $J_{7,6}$7.4 Hz, H-7), 4.17 (1H, dd, $J_{6,5}$7.3 Hz, $J_{6,7}$7.3 Hz, H-6), 4.34 (1H, dd, $J_{3,2}$8.5 Hz, $J_{3,4}$8.5 Hz, H-3), 4.39 (1H, dd, $J_{4,5}$2.5 Hz, $J_{4,3}$8.2 Hz, H-4), 4.42 (1H, dd, $J_{5,4}$2.5 Hz, $J_{5,6}$7.0 Hz, H-5), 4.61 (1H, d, $J_{2,3}$ 8.8 Hz, H-2); $\delta_C(D_2O)$: 25.5, 26.1 ($C(\underline{C}H_3)_2$), 62.6, 72.2, 73.6 75.7 (2C), 76.5, 79.2 (C-2, C-3, C-4, C-5, C-6, C-7, C-8), 111.0 ($\underline{C}(CH_3)_2$), 176.0 (s, C=O); *m/z* (Thermospray): 296 ($M+NH_4^+$, 25%).

2-O-tert-Butyldimethylsilyl-5,6:7,8-di-O-isopropylidene-D-erythro-L-galacto-octono-1,4-lactone ***10***. A solution of *tert*-butyldimethylsilyl chloride (107 mg) in *N,N'*-dimethylformamide (3 ml) was added to a stirred solution of the diacetonide **6** (184 mg) and imidazole (103 mg) in *N,N'*-dimethylformamide (2 ml) under nitrogen. T.l.c. (ethyl acetate:hexane, 1:1) of the reaction mixture after 2.25 hr showed one product (R_f 0.8). The solvent was removed under reduced pressure and the residue dissolved in chloroform (50 ml) which was washed with pH 7 buffer (2 x 50 ml), dried ($MgSO_4$), filtered and the solvent removed. The residue was purified by flash chromatography (diethyl ether:hexane, 1:1, 2:1) to afford *the monosilyl ether* ***10***, (181 mg, 72%) as a clear oil. $[\alpha]_D^{21}$+26.2 (*c*, 1.8, $CHCl_3$); ν_{max} (film): 3463 (br, OH), 1804 (C=O); $\delta_H(CDCl_3)$: 0.17, 0.20 (2 x 3H, 2 s, $Si((C\underline{H}_3)_2C(CH_3)_3)$), 0.94 (9H, s, $Si((CH_3)_2C(C\underline{H}_3)_3)$), 1.36, 1.385, 1.39, 1.42 (4 x 3H, 4 s, $2(C(C\underline{H}_3)_2)$), 3.12 (1H, d, $J_{OH,3}$4.9 Hz, OH), 3.94 (1H, dd, $J_{8,7}$5.9 Hz, $J_{8,8'}$8.7 Hz, H-8), 3.99 (1H, dd, $J_{6,5}$7.8 Hz, $J_{6,7}$7.8 Hz, H-6), 4.08 (1H, ddd, $J_{7,8}$6.0 Hz, $J_{7,8'}$6.0 Hz, $J_{7,6}$8.6 Hz, H-7), 4.11 (1H, dd, $J_{5,4}$4.5 Hz, $J_{5,6}$7.7 Hz, H-5), 4.17 (1H, dd, $J_{4,5}$4.4 Hz, $J_{4,3}$8.3 Hz, H-4), 4.20 (1H, dd, $J_{8',7}$6.0 Hz, $J_{8',8}$8.7 Hz, H-8’), 4.35 (1H, ddd, $J_{3,OH}$ 4.9 Hz, $J_{3,2}$ 8.6 Hz, $J_{3,4}$ 8.6 Hz, H-3), 4.42 (1H, d, $J_{2,3}$ 8.9 Hz, H-2); $\delta_C(CDCl_3)$: -5.1, -4.7 ($Si((\underline{C}H_3)_2C(CH_3)_3)$), 18.3 ($Si((CH_3)_2\underline{C}(CH_3)_3)$), 25.2, 25.6 (2C), 26.4, 26.9 ($2(C(\underline{C}H_3)_2)$, $Si((CH_3)_2C(\underline{C}H_3)_3)$), 68.4, 75.1, 76.7, 77.0, 77.2, 78.8, 79.4 (C-2, C-3, C-4, C-5, C-6, C-7, C-8), 110.1, 110.3 ($2(\underline{C}(CH_3)_2)$), 172.0 (C=O); *m/z* (NH_3, CI): 433 ($M+H^+$, 40%), 450 ($M+NH_4^+$, 70%). (Found: C, 55.89; H, 8.37. $C_{20}H_{36}O_8Si$ requires: C, 55.53; H, 8.39%).

2,3-Di-O-tert-butyldimethylsilyl-5,6:7,8-di-O-isopropylidene-D-erythro-L-galacto-octono-1,4-lactone ***11***. A solution of *tert*-butyldimethylsilyl chloride (704 mg) in *N,N'*-dimethylformamide (6 ml) was added to a stirred solution of the diacetonide **6** (492 mg) and imidazole (654 mg) in *N,N'*-dimethylformamide (9 ml) under nitrogen. T.l.c. (ethyl acetate:hexane, 1:4) after 2 hr showed two products (R_f 0.35, R_f 0.8). The reaction mixture was heated at 50°C for 18 hr after which time t.l.c. showed one major product (R_f 0.8). The solvent was removed under reduced pressure and the residue dissolved in chloroform (100 ml) which was washed with pH 7 buffer (100 ml), dried ($MgSO_4$), filtered and the solvent removed. The residue was purified by flash chromatography (diethyl ether: hexane, 1:10, 1:8) to give *the disilyl ether 11*, (522 mg, 62%) as a clear oil. $[\alpha]_D^{21}$+16.4 (*c*, 0.45, $CHCl_3$); ν_{max} (film): 1807 (C=O); δ_H($CDCl_3$): 0.15, 0.22 (2 x 3H, 2 s, $\mathrm{Si((C\underline{H}_3)_2C(CH_3)_3)}$), 0.16 (6H, s, $\mathrm{Si((C\underline{H}_3)_2C(CH_3)_3)}$), 0.93, 0.96 (2 x 9H, 2 s, 2 $\mathrm{Si((CH_3)_2C(C\underline{H}_3)_3)}$), 1.33, 1.38, 1.39, 1.41 (4 x 3H, 4 s, $\mathrm{2(C(C\underline{H}_3)_2)}$), 3.93 (1H, dd, $J_{8,7}$4.7 Hz, $J_{8,8'}$8.6 Hz, H-8), 4.01 (1H, dd, $J_{6,5}$8.0 Hz, $J_{6,7}$8.0 Hz, H-6), 4.05 (1H, ddd, $J_{7,8}$5.0 Hz, $J_{7,8'}$5.0 Hz, $J_{7,6}$8.3 Hz, H-7), 4.09 (1H, dd, $J_{5,4}$1.2 Hz, $J_{5,6}$7.7 Hz, H-5), 4.15 (1H, dd, $J_{8',7}$7.0 Hz, $J_{8',8}$8.7 Hz, H-8'), 4.16 (1H, dd, $J_{4,5}$1.6 Hz, $J_{4,3}$7.6 Hz, H-4), 4.39 (1H, d, $J_{2,3}$ 8.4 Hz, H-2), 4.43 (1H, dd, $J_{3,2}$ 8.3 Hz, $J_{3,4}$ 8.3 Hz, H-3); δ_C($CDCl_3$): -4.9, -4.7, -4.4, -4.0 (2 x $\mathrm{Si((\underline{C}H_3)_2C(CH_3)_3)}$), 17.8, 18.2 (2 x $\mathrm{Si((CH_3)_2\underline{C}(CH_3)_3)}$), 25.3, 25.6, 25.7, 26.4, 26.7, 27.1 ($\mathrm{2(C(\underline{C}H_3)_2)}$, 2 x $\mathrm{Si((CH_3)_2C(\underline{C}H_3)_3)}$), 68.0 (t, C-8), 75.5, 76.2, 76.3, 76.8, 77.0, 78.0 (C-2, C-3, C-4, C-5, C-6, C-7), 109.8, 110.0 ($\mathrm{2(\underline{C}(CH_3)_2)}$), 172.7 (C=O); *m/z* ($NH_3$, CI): 547 ($M+H^+$, 5%), 564 ($M+NH_4^+$, 5%), 299 (100%). (Found: C, 57.29; H, 9.29. $C_{26}H_{50}O_8Si_2$ requires: C, 57.10; H, 9.22%).

2,3-Di-O-tert-butyldimethylsilyl-5,6-O-isopropylidene-D-erythro-L-galacto-octono-1,4-lactone ***12***. A solution of the diacetonide **11** (372 mg) in acetic acid:water, 4:1 (10 ml) was left at room temperature for 71 hr when t.l.c. (ethyl acetate:hexane, 1:1) showed one major product (R_f 0.5). The solvent was removed under reduced pressure and the residue purified by flash chromatography (ethyl acetate:hexane, 1:3, 1:2, 1:1, 2:1, ethyl acetate) to afford *the monoacetonide 12* (223 mg, 65%) as a clear oil, $[\alpha]_D^{21}$+17.7 (*c*, 0.53, $CHCl_3$); ν_{max} (film): 1806 (C=O); δ_H($CDCl_3$): 0.14, 0.22 (2 x 3H, 2 s, $\mathrm{Si((C\underline{H}_3)_2C(CH_3)_3)}$), 0.15 (6H, s, $\mathrm{Si((C\underline{H}_3)_2C(CH_3)_3)}$), 0.92, 0.96 (2 x 9H, 2 s, 2 $\mathrm{Si((CH_3)_2C(C\underline{H}_3)_3)}$), 1.40 (6H, s, $\mathrm{(C(C\underline{H}_3)_2)}$), 3.69 (1H, dd, $J_{8,7}$5.1 Hz, $J_{8,8'}$11.2 Hz, H-8), 3.80 (1H, ddd, $J_{7,8'}$3.7 Hz $J_{7,8}$5.0 Hz, $J_{7,6}$6.7 Hz, H-7), 3.86 (1H, dd, $J_{8',7}$3.6 Hz, $J_{8',8}$11.2 Hz, H-8'), 4.11 (1H, dd, $J_{6,5}$1.4 Hz, $J_{6,7}$6.7 Hz, H-6), 4.20 (1H, dd, $J_{5,4}$1.4 Hz, $J_{5,6}$8.1 Hz, H-5), 4.23 (1H, dd, $J_{4,5}$1.4 Hz, $J_{4,3}$7.8 Hz, H-4), 4.38 (1H, d, $J_{2,3}$ 8.5 Hz, H-2), 4.43 (1H, dd, $J_{3,2}$ 8.1 Hz, $J_{3,4}$ 8.1 Hz, H-3); δ_C($CDCl_3$): -4.9, -4.8, -4.4, -4.0 (2 x $\mathrm{Si((\underline{C}H_3)_2C(CH_3)_3)}$), 17.8, 18.2 (2 x $\mathrm{Si((CH_3)_2\underline{C}(CH_3)_3)}$), 25.6, 25.7, 26.5, 27.1 ($\mathrm{(C(\underline{C}H_3)_2)}$, 2 x $\mathrm{Si((CH_3)_2C(\underline{C}H_3)_3)}$), 63.7, 72.6, 75.4, 75.5, 75.9, 76.3, 78.0 (C-2, C-3, C-4, C-5, C-6, C-7, C-8), 109.7 ($\mathrm{(\underline{C}(CH_3)_2)}$), 172.7 (C=O); *m/z* (Themospray): 524 ($M+NH_4^+$, 100%). (Found: C, 54.74; H, 9.29. $C_{23}H_{46}O_8Si_2$ requires: C, 54.51; H, 9.15%).

2,3,8-Tri-O-tert-butyldimethylsilyl-5,6-O-isopropylidene-D-erythro-L-galacto-octono-1,4-lactone ***13***. A solution of *tert*-butyldimethylsilyl chloride (39 mg) in *N,N'*-dimethylformamide (2 ml) was added to a stirred solution of the monoacetonide **12** (104 mg) and imidazole (35 mg) in *N,N'*-dimethylformamide (3 ml) under nitrogen. T.l.c. (ethyl acetate:hexane, 1:2) after 4 hr showed starting material (R_f 0.2) and one product (R_f 0.8). Further imidazole (39 mg) and then *tert*-butyldimethylsilyl chloride (39 mg) were added and the reaction mixture stirred for 5 hr when t.l.c. showed one product and a small amount of starting material. The solvent was removed under reduced pressure and the residue dissolved in chloroform (20 ml) which was washed with pH 7 buffer (20 ml), dried ($MgSO_4$), filtered and the solvent removed. The residue was purified by flash chromatography (ethyl acetate:hexane, 1:6, 1:2) to give *the trisilyl ether 13* (82 mg, 65%, quantitative yield based on unrecovered starting material), oil, $[\alpha]_D^{21}$+14.2 (*c*, 1.09, $CHCl_3$); ν_{max} (film): 1807 (C=O);

δ_H(CDCl$_3$): 0.095, 0.10, 0.22 (3 x 3H, 3 s, Si((C$\underline{H}_3$)$_2$C(CH$_3$)$_3$)), 0.15 (9H, s, Si((C$\underline{H}_3$)$_2$C(CH$_3$)$_3$)), 0.91, 0.92, 0.96 (3 x 9H, 3 s, 3 Si((CH$_3$)$_2$C(C$\underline{H}_3$)$_3$)), 1.38 (6H, s, (C(C$\underline{H}_3$)$_2$)), 2.55 (1H, d, $J_{OH,7}$4.9 Hz, O$\underline{H}$), 3.65 (1H, m, H-7), 3.68 (1H, dd, $J_{8,7}$5.6 Hz, $J_{8,8'}$9.5 Hz, H-8), 3.81 (1H, dd, $J_{8',7}$3.0 Hz, $J_{8',8}$9.6 Hz, H-8'), 4.02 (1H, dd, $J_{6,5}$8.0 Hz, $J_{6,7}$8.0 Hz, H-6), 4.15 (1H, dd, $J_{5,4}$1.2 Hz, $J_{5,6}$8.1 Hz, H-5), 4.23 (1H, dd, $J_{4,5}$1.3 Hz, $J_{4,3}$8.0 Hz, H-4), 4.36 (1H, d, $J_{2,3}$ 8.5 Hz, H-2), 4.43 (1H, dd, $J_{3,2}$ 8.3 Hz, $J_{3,4}$ 8.3 Hz, H-3); δ_C(CDCl$_3$): -5.5, -5.4, -4.9, -4.7, -4.4, -4.0 (3 x Si(($\underline{C}$H$_3$)$_2$C(CH$_3$)$_3$)), 17.8, 18.3 (2C), (3 x Si((CH$_3$)$_2\underline{C}$(CH$_3$)$_3$)), 25.7, 25.8, 25.9 (3 x Si((CH$_3$)$_2$C($\underline{C}$H$_3$)$_3$)), 26.4, 27.1 ((C($\underline{C}$H$_3$)$_2$)), 64.4, 73.4, 74.8, 75.4, 76.4, 76.6, 78.3 (C-2, C-3, C-4, C-5, C-6, C-7, C-8), 109.8 (($\underline{C}$(CH$_3$)$_2$)), 172.7 (C=O); *m/z* (Thermospray): 622 (M+H$^+$, 20%), 639 (M+NH$_4^+$, 100%). (Found: C, 56.33; H, 9.64. $C_{29}H_{60}O_8Si_3$ requires: C, 56.08; H, 9.74%). The starting acetonide **12** (38 mg, 35%) was also recovered.

*2,3:6,7-Di-O-isopropylidene-β-**D**-glycero-**D**-gulo-heptose **17***, m.p. 96-8°C (ether/hexane) [lit.[11], 99-100°C (CHCl$_3$/light petroleum)]; $[\alpha]_D^{22}$-31.2 (*c*, 1.1, CHCl$_3$) [lit.[11], $[\alpha]_D^{20}$-31 (*c*, 1, CHCl$_3$); ν_{max} (film): 3430 (br, OH); δ_H(CDCl$_3$): 1.33, 1.38, 1.43, 1.50 (4 x 3H, 4 s, 2 (C(C$\underline{H}_3$)$_2$)), 4.01 (1H, dd, $J_{5,4}$2.8 Hz, $J_{5,6}$7.8 Hz, H-5), 4.08 (1H, dd, $J_{7,6}$5.5 Hz, $J_{7,7'}$8.5 Hz, H-7), 4.12 (1H, dd, $J_{7',6}$6.2 Hz, $J_{7',7}$8.6 Hz, H-7'), 4.20 (1H, ddd, $J_{6,7}$5.8 Hz, $J_{6,7'}$5.8 Hz, $J_{6,5}$7.7 Hz, H-6), 4.31 (1H, dd, $J_{4,3}$3.2 Hz, $J_{4,5}$3.2 Hz, H-4), 4.66 (1H, d, $J_{2,3}$ 5.9 Hz, H-2), 4.87 (1H, dd, $J_{3,4}$3.7 Hz, $J_{3,2}$5.9 Hz, H-3), 5.48 (1H, s, H-1); δ_C(CDCl$_3$): 24.1, 25.2, 25.7, 26.4 (4 x q, 2(C($\underline{C}$H$_3$)$_2$)), 66.3 (t, C-7), 70.6, 75.4, 77.7, 81.3, 85.8 (5 x d, C-2, C-3, C-4, C-5, C-6), 100.5 (d, C-1), 109.5, 112.8, (2 x s, 2($\underline{C}$(CH$_3$)$_2$)); *m/z* (NH$_3$, CI): 291 (M+H$^+$, 60%), 308 (M+NH$_4^+$, 50%) was prepared as previously described by Brimacombe.[11]

*3,4:7,8-Di-O-isopropylidene-**D**-erythro-**L**-talo-octono-1,5-lactone **18***. Sodium cyanide (114 mg) was added to a stirred solution of the protected heptose **17** (575 mg) in water (10 ml). The reaction mixture was stirred at room temperature for 18 hr and then heated at 60-70°C for 4 hr, then washed with dichloromethane (3 x 20 ml) and sulphuric acid was added until pH 4 was reached. The solvent was removed under reduced pressure and the residue dissolved in acetic acid (25 ml) and heated at 65-75°C for 3 hr. T.l.c. (ethyl acetate: hexane, 5:1) indicated one major product (R$_f$ 0.33). The solvent was removed under reduced pressure and the residue extracted with ethyl acetate, the extraction was purified by flash chromatography (ethyl acetate:hexane, 1:1, 3:1) to give some of the diacetonide **18**; further extraction of the residue with acetone and *p*-toluenesulphonic acid afforded more of *the δ-lactone 18*, (78 mg, 14% in total), m.p. 126-8°C; $[\alpha]_D^{23}$-69.1 (*c*, 0.76, CHCl$_3$); ν_{max} (film): 3371 (br, OH), 1741 (C=O); δ_H(CDCl$_3$): 1.34, 1.37, 1.40, 1.47 (4 x 3H, 4 s, 2(C(C$\underline{H}_3$)$_2$)), 3.36 (1H, br s, OH), 3.45 (1H, br s, OH), 3.88 (1H, dd, $J_{6,5}$2.6 Hz, $J_{6,7}$8.5 Hz, H-6), 4.07 (1H, dd, $J_{8,7}$4.6 Hz, $J_{8,8'}$8.7 Hz, H-8), 4.15 (1H, dd, $J_{8',7}$6.3 Hz, $J_{8',8}$8.7 Hz, H-8'), 4.19 (1H, ddd, $J_{7,8}$4.6 Hz, $J_{7,8'}$6.2 Hz, $J_{7,6}$8.5 Hz, H-7), 4.38 (1H, dd, $J_{5,4}$2.1 Hz, $J_{5,6}$2.1 Hz, H-5), 4.42 (1H, d, $J_{2,3}$3.4 Hz, H-2), 4.76 (1H, dd, $J_{4,5}$1.7 Hz, $J_{4,3}$7.8 Hz, H-4), 4.83 (1H, dd, $J_{3,2}$3.6 Hz, $J_{3,4}$7.8 Hz, H-3); δ_C(CDCl$_3$): 24.1, 25.0, 25.7, 26.8 (4 x q, 2(C($\underline{C}$H$_3$)$_2$)), 67.1 (t, C-8), 68.6, 72.6, 73.8, 74.1, 74.9, 75.6 (6 x d, C-2, C-3, C-4, C-5, C-6, C-7), 109.7, 111.3, (2 x s, 2($\underline{C}$(CH$_3$)$_2$)), 171.4 (s, C=O); *m/z* (NH$_3$, CI): 319 (M+H$^+$, 55%), 336 (M+NH$_4^+$, 100%). (Found: C, 52.92; H, 6.64. $C_{14}H_{22}O_8$ requires: C, 52.82; H, 6.97%).

*2,6-Di-O-acetyl-3,4:7,8-di-O-isopropylidene-D-erythro-L-talo-octono-1,5-lactone **19**.* Acetic anhydride (0.5 ml) was added to a stirred solution of the δ-lactone **18** (10 mg) in pyridine (0.5 ml) under nitrogen. T.l.c. (ethyl acetate:hexane, 1:1) after 18 hr showed one major product (R_f 0.3). The solvent was removed under reduced pressure and the residue dissolved in ethyl acetate (8 ml) and washed with water (5 ml). The aqueous phase was extracted with ethyl acetate (5 ml), the organic phases were pooled, dried ($MgSO_4$) and filtered. The solvent was removed under reduced pressure and the residue purified by flash chromatography (ethyl acetate:hexane, 1:1) to give *the diacetate 19* (10 mg, 79%), oil, which could be recrystallised from (ether/hexane) m.p. 61-4°C; $[\alpha]_D^{22}$-39.3 (*c*, 0.58, $CHCl_3$); ν_{max} (film): 1780, 1755 (C=O); $\delta_H(CDCl_3)$: 1.33, 1.36, 1.44, 1.47 (4 x 3H, 4 s, $2(C(C\underline{H}_3)_2)$), 2.08, 2.28 (2 x 3H, 2 s, $2(CO.C\underline{H}_3)$), 3.86 (1H, dd, $J_{8,7}$5.3 Hz, $J_{8,8'}$8.8 Hz, H-8), 4.06 (1H, dd, $J_{8',7}$6.6 Hz, $J_{8',8}$8.8 Hz, H-8'), 4.36 (1H, ddd, $J_{7,8}$5.5 Hz, $J_{7,8'}$6.9 Hz, $J_{7,6}$6.9 Hz, H-7), 4.49 (1H, dd, $J_{5,4}$1.0 Hz, $J_{5,6}$3.9 Hz, H-5), 4.71 (1H, dd, $J_{4,5}$1.2 Hz, $J_{4,3}$7.8 Hz, H-4), 4.79 (1H, dd, $J_{3,2}$3.6 Hz, $J_{3,4}$7.7 Hz, H-3); 5.31 (1H, dd, $J_{6,5}$3.9 Hz, $J_{6,7}$7.5 Hz, H-6), 5.44 (1H, d, $J_{2,3}$3.5 Hz, H-2); $\delta_C(CDCl_3)$: 20.6, 20.9 (2 x q, $2(CO.C\underline{H}_3)$), 24.2, 24.9, 25.9, 26.6 (4 x q, $2(C(\underline{C}H_3)_2)$), 66.3 (t, C-8), 68.8, 70.7, 73.3, 73.7, 73.8, 74.2 (6 x d, C-2, C-3, C-4, C-5, C-6, C-7), 110.2, 111.5, (2 x s, $2(\underline{C}(CH_3)_2)$), 165.0, 169.9, 170.0 (3 x s, C=O, $2(\underline{C}O.CH_3)$); *m/z* (NH_3, CI): 420 ($M+NH_4^+$, 100%). (Found: C, 53.92; H, 6.49. $C_{18}H_{26}O_{10}$ requires: C, 53.72; H, 6.51%).

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