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THE SYNTHESIS OF 4′,6′-DIACETAMIDO-4′,6′-DIDEOXYCELLOBIOSE HEXA-ACETATE FROM LACTOSE*

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ABSTRACT

Reaction of methyl 4′,6′-di-*O*-mesyl-β-lactoside pentabenzoate (**8**), synthesised *via* the 4′,6′-*O*-benzylidene derivative (**6**), with sodium azide in hexamethylphosphoric triamide gave three products. In addition to the required 4′,6′-diazidocellobioside (**9**), an elimination product, methyl 4-*O*-(6-azido-2,3-di-*O*-benzoyl-4,6-dideoxy-α-L-*threo*-hex-4-enopyranosyl)-2,3,6-tri-*O*-benzoyl-β-D-gluccpyranoside (**12**), and an unexpected product of interglycosidic cleavage, methyl 2,3,6-tri-*O*-benzoyl-β-D-glucopyranoside (**13**), were formed. The origin of the latter product is discussed. The diazide **9** was converted into 4′,6′-diacetamido-4′,6′-dideoxycellobiose hexa-acetate (**16**) by sequential debenzoylation, catalytic reduction, acetylation, and acetolysis.

INTRODUCTION

Our interest in the synthesis of amino derivatives of cellobiose[1,2] led us to consider the conversion of methyl β-lactoside[3] into 4′,6′-diamino-4′,6′-dideoxycellobiose. The required inversion of configuration at C-4′ of lactoside was envisaged by bimolecular nucleophilic substitution, utilizing the action of azide anion on a suitable 4′,6′-dimethanesulphonate. This communication describes the result obtained on reaction of methyl 4′,6′-di-*O*-mesyl-β-lactoside pentabenzoate (**8**) with sodium azide in hexamethylphosphoric triamide.

RESULTS AND DISCUSSION

Conversion of methyl β-lactoside[3] (**4**) into methyl 4′,6′-di-*O*-mesyl-β-lactoside pentabenzoate was accomplished by sequential benzylidenation, benzoylation, acid-catalysed debenzylidenation, and mesylation to give **8** in an overall yield of 41%. The 220-MHz ^{1}H-n.m.r. spectral parameters for **8** and the intermediates **6** and **7** are recorded in Table I and are consistent with the structures assigned.

Nucleophilic displacement of the mesyloxy groups by reaction with sodium azide in hexamethylphosphoric triamide gave one minor and two major products,

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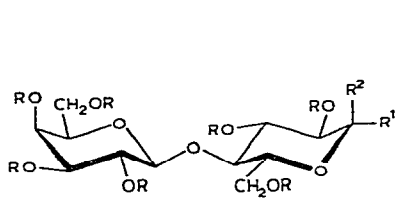
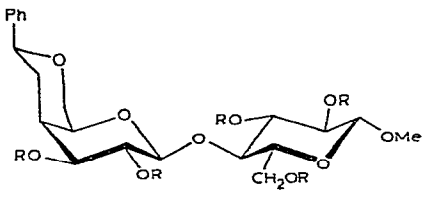
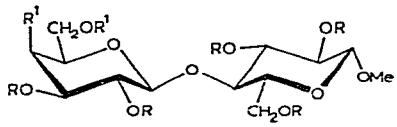


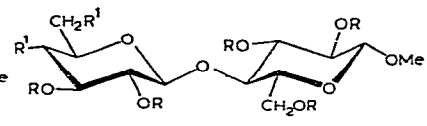
1 R = Ac; R¹, R² = H,OAc
2 R = Ac, R¹ = H, R² = Br
3 R = Ac, R¹ = OMe, R² = H
4 R = H, R¹ = OMe, R² = H



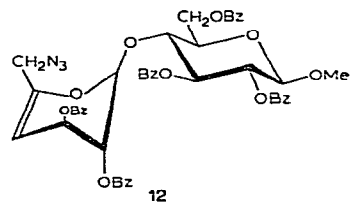
5 R = H
6 R = Bz



7 R¹ = OH, R = Bz
8 R¹ = OMs, R = Bz



9 R¹ = N_3, R = Bz
10 R¹ = N_3, R = H
11 R¹ = NHAc, R = Ac



12

which were isolated by chromatography. The product eluted first was the 6′-azido-4′-ene **12**, isolated in 35% yield. In the ^{1}H-n.m.r. spectrum of **12**, the resonances due to H-1,2,3,4,5,6a,6b were clearly recognizable (Table I), and consistent with the reducing* hexopyranoside ring being unchanged. However, the resonances due to the hydrogen substituents of the other pyranosyl ring clearly indicated that a gross conformational change had occurred in the non-reducing* moiety. The relatively high-field position (τ 6.76, s) of the signals for the 6′-hydrogens suggested the presence of a shielding azide function at C-6′, which was confirmed by the i.r. spectrum. The appearance of the H-4′ resonance as a doublet ($J_{3',4'}$ 5 Hz) at τ 4.25 and the fact that only six protons could be accounted for by integration on the non-reducing entity indicated the absence of H-5′. A doublet at τ 4.87 ($J_{1',2'}$ 4 Hz) was assigned to H-1′ on the basis that in the ^{1}H-n.m.r. spectra of an analogous 4-enopyranoside[4], H-4 resonated at lower field than H-1. The remaining resonances were assigned to H-2′ (τ 4.34, t, $J_{2',3'}$ 5 Hz) and H-3′ (τ 4.45, t, $J_{3',4'}$ 5 Hz). The n.m.r. data confirmed that the product was methyl 4-*O*-(6-azido-2,3-di-*O*-benzoyl-4,6-dideoxy-α-L-*threo*-hex-4-enopyranosyl)-2,3,6-tri-*O*-benzoyl-β-D-glucopyranoside (**12**), and the derived first-order coupling constants indicated that the non-reducing ring was held substantially in the unexpected $^1H_2$ conformation[5] (Fig. 1), in which the large substituents at C-1′, C-2′, and C-3′ are held in axial or *quasi*-axial orientations. However, the axial orientation of the C-3′ benzoyloxy group, together with the favourable anomeric

*The terms "reducing" and "non-reducing" refer to the counterparts in maltose. The ring positions in the non-reducing pyranosyl moiety are designated with primed numbers.

effect for an axial substituent at C-1′, probably stabilises this conformation, since Ferrier and Sankey[6] showed that, in pyranoid compounds containing an endocyclic double bond, allylic ester groupings favoured the *quasi*-axial orientation.

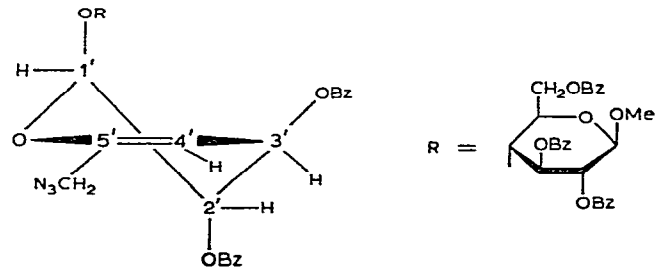
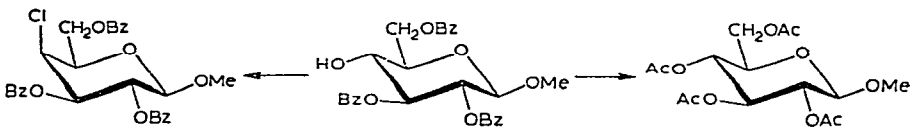
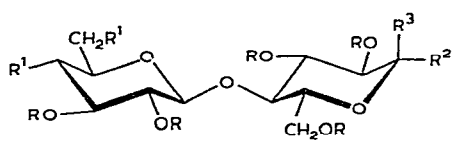


Fig. 1. $^1H_2$ conformation of the non-reducing ring of **12**.

The other major component, obtained in 36% yield, was the required 4′,6′-diazido-4′,6′-dideoxycellobioside **9**. In the 220-MHz ^{1}H-n.m.r. spectrum, the coupling constants of the hydrogens of both the reducing and non-reducing rings were consistent with the *gluco* configuration (Table I). The inversion of configuration that had occurred at C-4′ of the 4′,6′-dimethanesulphonate **8** was easily verified by noting that the H-4′ resonance appeared as a doublet at τ 4.8 ($J_{3',4'}$ 3.2, $J_{4',5'} < 1.0$ Hz) in **8**, whereas the H-4′ resonance of the diazide **9** had moved considerably upfield to τ 6.4 and was a triplet ($J_{3',4'} = J_{4',5'} = 10$ Hz). The 6′-proton resonances were also more upfield than in the spectrum of **8** (see Table I). These observations were indicative of the presence of less-deshielding azide groups at C-4′ and C-6′.

The third component (**13**), obtained in 10% yield, was unexpectedly free of nitrogen, and its i.r. spectrum contained an absorption at 3490 cm^{-1}, suggesting the





16 R = Ac; R^1 = NHAc; R^2, R^3 = H, OAc
17 R = Bz; R^1 = N_3; R^2 = H; R^3 = OAc
18 R = H; R^1 = N_3; R^2, R^3 = H, OH

TABLE I

^{1}H-N.M.R. PARAMETERS: FIRST-ORDER CHEMICAL SHIFTS (τ VALUES) AND COUPLING CONSTANTS (J Hz) AT 100 MHz

Compound	6[a]	7[a]	8[a]	8[a]	9[a]
Solvent	$CDCl_3$	CD_3COCD_3	CD_3COCD_3	$CDCl_3$	$CDCl_3$
H-1	5.4(d)	5.13(d)	5.54(d)	5.38(d)	5.38(d)
H-2	4.68(q)	4.7(q)	4.62(m)	4.58(q)	4.66(q)
H-3	4.14(t)	4.28(t)	4.23(t)	4.26(t)	4.23(t)
H-4	5.76(t)	5.53(t)	5.52(t)	5.83(t)	5.74(t)
H-5	~6.13(m)	6.0(m)	5.94(m)	~6.23(m)	6.17(m)
H-6a	5.36(q)	5.26(q)	5.26(q)	5.41(q)	5.33(q)
H-6b	5.63(q)	5.46(q)	5.48(q)	5.54(q)	5.65(q)
H-1′	5.14(d)	4.86(d)	5.07	5.17(d)	5.15(d)
H-2′	4.2(q)	4.28(t)	4.38(m)	4.38(q)	4.62(t)
H-3′	4.83(dd)	4.78(dd)	4.62(m)	4.84(m)	4.52(t)
H-4′	5.7(d)	5.75(d)	4.8(d)		6.4(t)
H-5′	~6.1(m)	6.34(t)	5.66(t)		~6.87(m)
H-6′a	~6.28(q)	6.62–	6.18(q)	~6.15–	~6.87(m)
H-6′b	6.43(q)	6.74(m)	6.4(q)	6.4	7.18(q)
OMe	6.59(s)	6.61(s)	6.58(s)	6.54(s)	6.56(s)
	CHPh 4.71(s)	OH 6.27(b)	OMs 6.93, 6.96(s)	OMs 7.04, 7.11(s)	
$J_{1,2}$	8	8	8	8	8
$J_{1,2(\alpha)}$					
$J_{1,2(\beta)}$					
$J_{2,3}$	9	10	9.2	9.2	9
$J_{3,4}$	9	10	9.2	9.2	9
$J_{4,5}$	9	10	9.2	9.2	9
$J_{5,6a}$	2.2	2	2	2.2	~2.4
$J_{5,6b}$	4.2	5.6	5.6	4.2	4.6
$J_{6a,6b}$	12.4	12.4	12	12	13
$J_{1',2'}$	8	8	8	8	8
$J_{2',3'}$	10	~10.2		10.8	10
$J_{3',4'}$	3.6	3	2.8		10
$J_{4',5'}$	<1.0	<1.0	<1.0		10
$J_{5',6'a}$		~6	6		
$J_{5',6'b}$	~2	~6	7.6		~5.4
$J_{6'a,6'b}$	13		10.2		13
$J_{NH,4'}$					
$J_{NH,6'}$					

[a]220 MHz. [b]100 MHz. [c]Unless indicated, values are for the predominant α-anomer. Key: s, singlet; doublet; dd, double doublet; t, triplet; q, quartet; m, multiplet; b, broad.

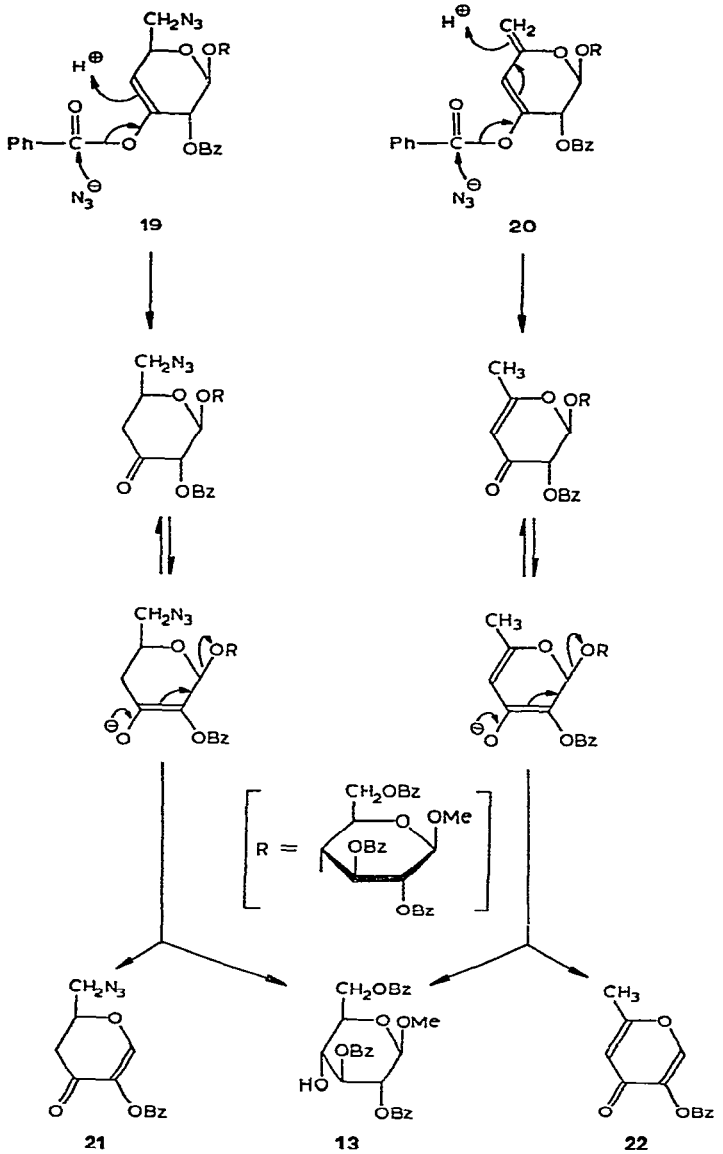
presence of a hydroxyl function. Sequential debenzoylation and acetylation gave methyl tetra-*O*-acetyl-β-D-glucopyranoside[7] (**15**). Elemental analysis and the ^{1}H-n.m.r. spectrum of the unknown product suggested that it was a methyl tri-*O*-benzoyl-β-D-glucopyranoside. Reaction of the unknown compound with the pyridine–

11[a]	12[a]	13[b]	14[b]	16[a,c]	17[a]
$CDCl_3$	CD_3COCD_3	$CD_3COCD_3+D_2O$	$CDCl_3$	$CDCl_3$	$CDCl_3$
5.57(d)	5.04(d)	5.1(d)	5.32(d)	H-1(α) 3.73(d)	H-1(α) 3.5(d)
				H-1(β) 4.29(d)	
5.67(t)	4.62(dd)	4.68(q)	4.22(q)	4.88(dd)	~5.54(m)
4.86(t)	4.14(t)	~4.33(m)	4.55(dd)	4.62(t)	3.95(t)
	5.43(t)		5.26(q)		5.7(t)
	5.83(m)		~5.71(m)		5.8(m)
5.52(q)	5.16(q)		5.32–		5.41(q)
5.89(q)	5.34(q)		5.56(m)		5.63(q)
5.43(d)	4.87(d)			5.4(d)	5.14(d)
5.15(q)	4.34(t)			5.13(q)	~5.54(m)
4.82(t)	4.45(t)			4.8(t)	4.52(t)
	4.25(d)				6.42(t)
	—			6.84(m)	6.86(m)
	6.76(s)				6.86(m)
					7.17(q)
6.52(s)	6.57(s)	6.53(s)	6.46(s)		
NHAc(4′)				NHAc(4′)	
3.65(d)				3.59(d)	
NHAc(6′)				NHAc(6′)	
3.42(m)				3.42(m)	
8	8	8	8		
				4	4
				8	
9	9.8	10	10	9	9.6
9	9.8		3.8	9	9.6
	9.8		~1.1		9.6
	2.2				~2.6
	4.8				~4
	12.8				12.2
8	4			8	8
10	5			10	10
10	5			10	10
					6
	0				14
9				9	

sulphuryl chloride reagent afforded methyl 2,3,6-tri-*O*-benzoyl-4-chloro-4-deoxy-β-D-galactopyranoside (**14**), the structure of which was indicated by its ^{1}H-n.m.r. spectral parameters (Table I). In particular, the narrow double-doublet at τ 5.26 (splittings 3.8 and 1.1) was particularly diagnostic of H-4 of a galactopyranoside. This

revealed that the free hydroxyl group was originally at C-4, thereby identifying the cleavage product as methyl 2,3,6-tri-*O*-benzoyl-β-D-glucopyranoside (**13**).

An analogous cleavage of an inter-glycosidic linkage of a β-(1→4) disaccharide was observed[1] when benzyl 4′,6′-dichloro-4′,6′-dideoxy-β-lactoside pentabenzoate was treated with sodium azide in hexamethylphosphoric triamide. A possible interpretation of the cleavage reaction depends on the formation (see Ref. 9) of either the 6′-azide-3′-ene **19** or the 3′,5′-diene **20**, which both contain an activated hydrogen atom at C-2′ which could facilitate the elimination of the glucopyranoside moiety as follows:



The products **21** and **22** are probably unstable and unable to withstand the reaction conditions.

Debenzoylation of 4′,6′diazide pentabenzoate **9** with methanolic sodium methoxide gave the syrupy 4′,6′-diazide **10**, which on hydrogenation afforded methyl 4′,6′-diamino-4′,6′-dideoxycellobioside, characterised as the crystalline diacetamido-penta-acetate **11**. The 220-MHz ^{1}H-n.m.r. spectrum (Table I) confirmed the structural assignment for **11**, in particular the resonances due to H-3 (τ 4.86, t, $J_{2,3} = J_{3,4} =$ 9 Hz) and H-3′ (τ 4.82, t, $J_{2',3'} = J_{3',4'} = 10$ Hz) consistent with the *gluco* configuration of each ring.

Acetolysis of the diacetamido derivative **11** afforded a mixture of three products. The slow-moving (t.l.c.), major component (45% yield) was characterized as the mixture of α and β anomers of the required 4′,6′-diacetamido-4′,6′-dideoxycellobiose hexa-acetate (**16**) by ^{1}H-n.m.r. spectroscopy. This revealed two low-field doublets for H-1 at τ 3.72 ($J_{1,2}$ 4 Hz) attributable to the α anomer, and at 4.29 ($J_{1,2}$ 8 Hz) due to the β anomer, in the ratio 5:1. The resonances indicative of the *gluco* configuration of both the pyranosyl rings were readily assigned (Table I). The two other fast-moving components of the acetolysis mixture could not be obtained in pure form and were, therefore, not further investigated.

Originally, we attempted the preparation of 4′,6′-diacetamido-4′,6′-dideoxy-cellobiose from the diazide pentabenzoate **9** by conducting the above reactions in a different sequence, namely by initial acetolysis, de-esterification of the product (**17**), and subsequent reduction of the deprotected 4′,6′-diazide (**18**). Acetolysis of **9** gave the 1-acetate as the α anomer (**17**), in which the *gluco* configurations of both pyranosyl rings were readily assigned from the ^{1}H-n.m.r. data. The resonances due to H-3 and H-5 of **17** were considerably downfield (0.28 and 0.37 p.p.m., respectively) relative to those of **9** (Table I) due to the axial 1-oxygen. However, de-esterification of **17** with methanolic sodium methoxide (pH 9–10) gave a multicomponent mixture, and therefore it was preferred to retain the methyl glycoside substituent intact until the penultimate stage of the synthesis.

EXPERIMENTAL

General. — Optical rotations were measured with a Perkin–Elmer 141 polarimeter, using a 1-dm cell. Melting points were determined on a Kofler microscope hot-stage, and are uncorrected. I.r. spectra were determined for Nujol mulls with a Perkin–Elmer 157 spectrophotometer. Dry-column chromatography[8] was performed on Kieselgel 7734 (Merck). Evaporations were done under reduced pressure at a bath temperature below 40°. T.l.c. was performed on Kieselgel 7731 (Merck); detection was effected by spraying with 5% of sulphuric acid in ethanol followed by heating. 100-MHz and 220-MHz p.m.r. spectra were measured by P.C.M.U. (Harwell) on Varian HA-100 and Varian HR-220 spectrometers, using tetramethylsilane as an internal reference. Light petroleum (b.p. 60–80°) was used throughout.

Methyl 4-O-β-D-galactopyranosyl-β-D-glucopyranoside (methyl β-lactoside) (**4**). — Methyl β-lactoside (**4**), prepared by the method of Smith and Cleve[3] {except that

during glycosidation [step (2) → (3)], instead of silver carbonate, dry mercuric acetate was used with a large excess of methanol}, had m.p. 213–215°, $[\alpha]_D$ +5.1° (*c* 1, water); lit.[3], m.p. 206°, $[\alpha]_D$ +5.6° (*c* 3, water).

Methyl 4-O-(4,6-O-benzylidene-β-D-galactopyranosyl)-β-D-glucopyranoside (**5**) *and methyl 2,3,6-tri-O-benzoyl-4-O-(2,3-di-O-benzoyl-4,6-O-benzylidene-β-D-galactopyranosyl)-β-D-glucopyranoside* (**6**). — Methyl β-lactoside (10 g) was dissolved in benzaldehyde (100 ml), and crushed anhydrous zinc chloride (12.5 g) was added. The mixture was stirred at room temperature for 15–20 h, and t.l.c. (ethyl acetate–methanol, 2:1) then showed one major product. The reaction mixture was poured into ether, and the resulting white precipitate was filtered off, washed with ether, and then quickly applied to a dry column of silica gel and eluted with chloroform–methanol (5:1).

The first fraction from the column containing the major product was evaporated to a syrup. A solution of the dried syrup (8.5 g, 68%) in pyridine (40 ml) was cooled in an ice-bath, and benzoyl chloride (17 ml) was slowly added with stirring. The mixture was then stirred at room temperature for 20 h, when t.l.c. (chloroform–ethyl acetate, 10:1) showed one product. The mixture was poured into ice–water and extracted with chloroform, and the extract was successively washed with 10% aqueous sulphuric acid, aqueous sodium hydrogen carbonate, and water, dried ($MgSO_4$), and evaporated. The resulting syrup was crystallized from ethyl acetate–light petroleum to give the pentabenzoate **6** (15 g, 81%), m.p. 246–249°, $[\alpha]_D$ +140.5° (*c* 1, chloroform) (Found: C, 68.65; H, 5.2. $C_{55}H_{48}O_{16}$ calc.: C, 68.45; H, 4.95%).

Methyl 2,3,6-tri-O-benzoyl-4-O-(2,3-di-O-benzoyl-β-D-galactopyranosyl)-β-D-glucopyranoside (**7**). — The pentabenzoate **6** (10 g) was dissolved in chloroform (100 ml), and a solution of conc. hydrochloric acid (5 ml) in ethanol (100 ml) was added. This mixture was refluxed for 75 min, and t.l.c. (chloroform–ethyl acetate, 10:1) then showed very little of the starting material. The mixture was then cooled, neutralized ($BaCO_3$), and evaporated to a solid mass. Crystallization from chloroform–light petroleum gave **7** (7 g, 77%), m.p. 186–189°, $[\alpha]_D$ +101.1° (*c* 1, chloroform) (Found: C, 65.5; H, 5.1. $C_{48}H_{49}O_{16}$ calc.: C, 65.4; H, 5.5%).

Methyl 2,3,6-tri-O-benzoyl-4-O-(2,3-di-O-benzoyl-4,6-di-O-mesyl-β-D-galactopyranosyl)-β-D-glucopyranoside (**8**). — A solution of the 4′,6′-diol **7** (10 g) in anhydrous pyridine (50 ml) was cooled in an ice-bath, and mesyl chloride (9 ml) was added dropwise. The solution was stored at 0° for 24 h, and t.l.c. then showed that the reaction was complete. The mixture was poured with stirring into ice–water, and the resulting brown precipitate was filtered off, washed well with water and ethanol, and then decolourized with charcoal. Crystallization from dichloromethane–ethanol afforded **8** as white needles (10 g, 85%), m.p. 219–220°, $[\alpha]_D$ +53° (*c* 1, chloroform) (Found: C, 58.2; H, 4.4. $C_{50}H_{48}O_{20}S_2$ calc.: C, 58.15; H, 4.65%).

The reaction of **8** *with sodium azide.* — The dimethanesulphonate **8** (10 g) was dissolved in anhydrous $(Me_2N)_3PO$ (25 ml), sodium azide (10 g) was added, and the mixture heated with stirring at 80° for 20 h; t.l.c. (dichloromethane–ethyl acetate, 20:1) then showed three products. The reaction mixture was poured into ice–water,

and the resulting brown precipitate was filtered off and washed with water. The precipitate was then dissolved in ethyl acetate, and the solution was washed with water to remove any remaining $(Me_2N)_3PO$. The solution was dried ($MgSO_4$) and evaporated to a syrup (9 g) that was fractionated on a dry column[8] of silica gel, using dichloromethane–ethyl acetate (80:1).

The first fraction contained a major component which was crystallised from ethyl acetate–light petroleum to afford crystalline methyl 4-*O*-(6-azido-2,3-di-*O*-benzoyl-4,6-dideoxy-α-L-*threo*-hex-4-enopyranosyl)-2,3,6-tri-*O*-benzoyl-β-D-glucopyranoside (**12**) (2.9 g, 35%), m.p. 174–176°, $[\alpha]_D$ +55.4° (*c* 1, chloroform) (Found: C, 65.25; H, 4.85; N, 4.55. $C_{48}H_{41}N_3O_{14}$ calc.: C, 65.23; H, 4.65; N, 4.75%).

The second fraction was crystallized from ethyl acetate–light petroleum to give methyl 2,3,6-tri-*O*-benzoyl-4-*O*-(4,6-diazido-2,3-di-*O*-benzoyl-4,6-dideoxy-β-D-glucopyranosyl)-β-D-glucopyranoside (**9**) (3.2 g, 36%), m.p. 201–202°, $[\alpha]_D$ +130.9° (*c* 1, chloroform) (Found: C, 62.4; H, 4.6; N, 8.95. $C_{48}H_{42}N_6O_{14}$ calc.: C, 62.2; H, 4.55; N, 9.05%).

The third fraction crystallized from chloroform–light petroleum to give methyl 2,3,6-tri-*O*-benzoyl-β-D-glucopyranoside (**13**) (490 mg, 10%), m.p. 142–145°, $[\alpha]_D$ +78.9° (*c* 1, chloroform) (Found: C, 66.35; H, 5.3. $C_{28}H_{26}O_9$ calc.: C, 66.4; H, 5.15%).

*Methyl 2,3,6-tri-*O*-acetyl-4-*O*-(2,3-di-*O*-acetyl-4,6-diacetamido-4,6-dideoxy-β-D-glucopyranosyl)-β-D-glucopyranoside* (**11**). — The 4′,6′-diazide **9** (5 g) was dissolved in methanol (40 ml), and a freshly prepared solution of sodium methoxide (1–2 ml) (0.5 g of sodium in 50 ml of methanol) was added (pH ~10). The mixture was stirred at room temperature for 2 days, and t.l.c. (chloroform–methanol, 4:1) then showed a single product. The solution was neutralised with Amberlite IR-120(H^+) resin, filtered, and evaporated to give a residue which was chromatographed on a dry column of silica gel[8], using, initially, light petroleum to elute methyl benzoate, and then chloroform–methanol (4:1) to elute the 4′,6′-diazidocellobioside **10**, which was obtained as a syrup (1.8 g, 80%). A solution of **10** (1.8 g) in methanol was hydrogenated over 5% palladium-on-charcoal at 60 p.s.i. for 20 h, and t.l.c. (acetic acid–water–ethyl acetate, 1:1:1) then showed complete conversion into a slower-moving product. The reaction mixture was filtered through Hyflo-Supercel and concentrated at room temperature under reduced pressure. A solution of the residue (1.3 g, 81%) in pyridine (8 ml) was cooled in an ice-bath, and acetic anhydride (3 ml) was slowly added. The reaction mixture was stirred at room temperature for 15–20 h, poured into ice–water (20–30 ml), and extracted five times with chloroform, and the combined extracts were washed successively with saturated, aqueous sodium hydrogen carbonate and water. The chloroform solution was then dried ($MgSO_4$) and evaporated, and the residue was crystallized from chloroform–light petroleum to give the 4′,6′-diacetamido derivative **11** (1.8 g, 78%), m.p. 226–227°, $[\alpha]_D$ −5.8° (*c* 1, chloroform) (Found: C, 49.8; H, 6.35; N, 4.15. $C_{27}H_{40}N_2O_{16}$ calc.: C, 50.0; H, 6.15; N, 4.3%).

Acetolysis of the 4′,6′-diacetamido-4′,6′-dideoxycellobioside **11**. — A solution of **11** (2 g) in acetic anhydride (5 ml) was cooled in an ice-bath, cold 1.8% sulphuric acid

in acetic anhydride (15 ml) was slowly added, and the mixture was stirred at room temperature for 36 h. T.l.c. (chloroform–methanol, 15:1) then showed three products, and the reaction was poured into ice–water and extracted five times with chloroform, and the combined extract was washed successively with saturated, aqueous sodium hydrogen carbonate and water. The chloroform solution was dried ($MgSO_4$) and evaporated, and the residue was fractionated by dry-column chromatography[8] with dichloromethane–methanol (30:1). The fractions containing the major component were evaporated, and the residue was crystallized from chloroform–light petroleum to give 1,2,3,6-tetra-*O*-acetyl-4-*O*-(4,6-diacetamido-2,3-di-*O*-acetyl-4,6-dideoxy-β-D-glucopyranosyl)-α,β-D-glucopyranose (**16**) (0.9 g, 45%) (αβ-ratio, 5:1), m.p. 115–119°, $[\alpha]_D$ +47.6° (*c* 1, chloroform) (Found: C, 49.7; H, 5.6; N, 4.0. $C_{28}H_{40}N_2O_{17}$ calc.: C, 49.7; H, 5.9; N, 4.15%).

*Methyl 2,3,4,6-tetra-*O*-acetyl-β-D-glucopyranoside* (**15**). — The tribenzoate **13** (0.4 g) was debenzoylated as described above, using sodium methoxide. The reaction mixture was neutralized with Amberlite IR-120(H^+) resin, filtered, and evaporated. The resulting residue was fractionated on a dry column, using light petroleum first to remove methyl benzoate, and then chloroform–methanol (4:1) to elute the product. The solvent was evaporated and the residue acetylated by using pyridine (4 ml) and acetic anhydride (1 ml). After the usual work-up, the product was crystallized from chloroform–light petroleum (150 mg, 50%), m.p. and mixture m.p. 104–105°; lit.[6] m.p. 104–105°.

*Methyl 2,3,6-tri-*O*-benzoyl-4-chloro-4-deoxy-β-D-galactopyranoside* (**14**). — A solution of tribenzoate **13** (0.1 g) in pyridine (3 ml) was cooled to −78° in an acetone–solid carbon dioxide bath, and sulphuryl chloride (0.02 ml) was slowly added. The reaction mixture was slowly allowed to attain room temperature and then stirred for 20 h. The mixture was then poured into ice–water and extracted with chloroform, and the extract was successively washed with 10% H_2SO_4, saturated, aqueous sodium hydrogen carbonate, and water, dried ($MgSO_4$), and evaporated. The residue was crystallized thrice from chloroform–light petroleum to give **14** (58 mg, 57%), m.p. 62–65°, $[\alpha]_D$ +65.6° (*c* 0.6, chloroform) (Found: C, 63.9; H, 4.8. $C_{28}H_{25}ClO_8$ calc.: C, 64.05; H, 4.75%).

Acetolysis of the 4',6'-diazidocellobioside pentabenzoate **9**. — A solution of **9** (1 g) in acetic anhydride (2 ml) was cooled in an ice-bath, cold 1.8% sulphuric acid in acetic anhydride (6 ml) was slowly added, and the reaction mixture was stirred at room temperature for 20 h. T.l.c. (chloroform–ethyl acetate, 10:1) then showed one major product, and the mixture was poured into ice–water and filtered. The precipitate was washed with water and ethanol, and then eluted by dry-column chromatography using ethyl acetate–light petroleum (1:2). The fractions containing the major component were evaporated and the residue was crystallized from chloroform–light petroleum to afford 1-*O*-acetyl-2,3,6-tri-*O*-benzoyl-4-*O*-(4,6-diazido-2,3-di-*O*-benzoyl-4,6-dideoxy-β-D-glucopyranosyl)-α-D-glucopyranose (**17**) (0.6 g, 59%), m.p. 205–210°, $[\alpha]_D$ +131° (*c* 1, chloroform) (Found: C, 61.65; H, 4.7; N, 8.6. $C_{49}H_{42}N_6O_{15}$ calc.: C, 61.63; H, 4.4; N, 8.8%).

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