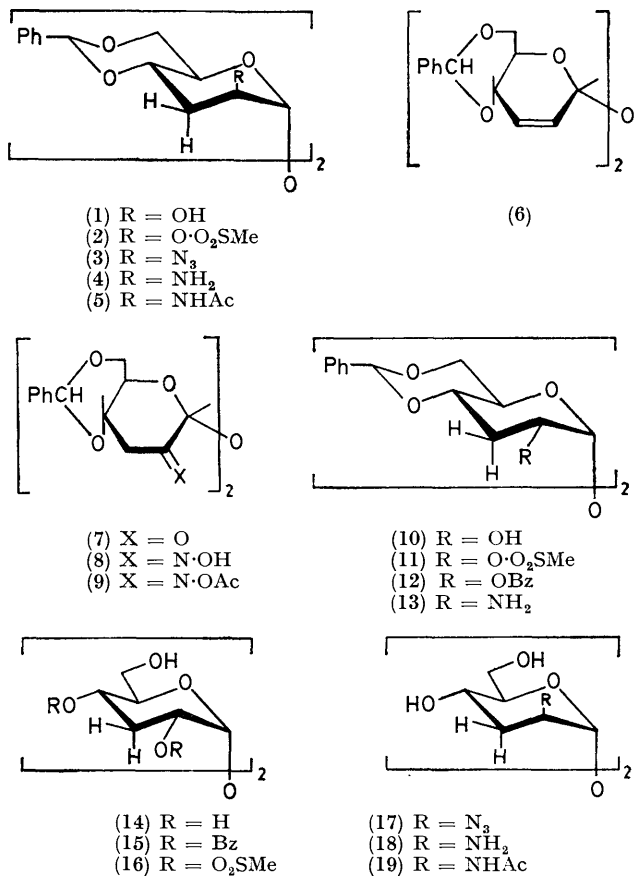
Chemical Modification of Trehalose. Part X.[1] Some Further 3,3'-Dideoxy-analogues

By A. C. Richardson and E. Tarelli, Department of Chemistry, Queen Elizabeth College, London W8 7AH

3,3'-Dideoxy-αα-trehalose has been synthesised from the readily available 4,6-*O*-benzylidene-3-deoxy-α-D-*arabino*-hexopyranosyl 4,6-O-benzylidene-3-deoxy-α-D-*arabino*-hexopyranoside by sequential oxidation to the 2,2'-diulose, reduction to the 2,2'-diepimer, and hydrolytic removal of the benzylidene substituents. The dibenzylidene derivative formed by reduction of the diulose was converted into its 2,2'-di-*O*-methanesulphonate, which underwent a slow S_N2 displacement reaction with azide anion to give, with inversion of configuration at C-2 and C-2', the 2,2'-diazide. Subsequent removal of the benzylidene groups, reduction, and *N*-acetylation afforded 2-acetamido-2,3-dideoxy-α-D-*arabino*-hexopyranosyl 2-acetamido-2,3-dideoxy-α-D-*arabino*-hexopyranoside.

We have previously described the synthesis of a 3,3'-dideoxy-analogue of the symmetrical disaccharide trehalose (α-D-glucopyranosyl α-D-glucopyranoside) which differed configurationally from trehalose only at the 2- and 2'-positions.[2] This analogue was readily prepared from 2,3-anhydro-4,6-*O*-benzylidene-α-D-mannopyranosyl 2,3-anhydro-4,6-*O*-benzylidene-α-D-mannopyranoside by reduction with lithium aluminium hydride. Initial attempts to invert the configuration at the 2- and 2'-positions *via* the 2,2'-dimesylate (2) failed. Treatment of compound (2) with either sodium azide or sodium benzoate resulted in elimination rather than nucleophilic replacement to give 4,6-*O*-benzylidene-2,3-dideoxy-α-D-*erythro*-hex-2-enopyranosyl 4,6-*O*-benzylidene-2,3-dideoxy-α-D-*erythro*-hex-2-enopyranoside (6). Such a result was not surprising, since nucleophilic displacement at the 2-positions of a hexopyranoside is notoriously difficult, owing to unfavourable dipolar factors which affect the formation of the transition state.[3] The ease of the elimination reaction of the dimesylate (2) to give the 2,2'-diene (6) was further facilitated by the *trans*-diaxial orientation of the 2- and 2'-sulphonyloxy-groups and the 3- and 3'-hydrogen atoms in the ground state conformation of (2). Furthermore, the methyl glycoside analogue, methyl 4,6-*O*-benzylidene-3-deoxy-2-*O*-mesyl-α-D-*arabino*-hexopyranoside, is readily converted into the 2-ene by the action of base,[4] although elimination reactions with more powerfully nucleophilic and less basic anions have not been reported. The structure of the 2,2'-diene (6) was indicated by its ^1H n.m.r. spectrum (see Experimental section). The observed coupling constants were similar to those described for methyl 4,6-*O*-benzylidene-2,3-dideoxy-α-D-*erythro*-hex-2-enopyranoside,[5] with the exception that the long-range coupling $J_{1,3}$ (1·5 Hz) was considerably larger than that observed for the methyl glycoside analogue (<0·3 Hz). Further transformations of the diene (6) will be described in a forthcoming paper.

The recent improvements effected in the methods of oxidation of secondary hydroxy-groups has made, in certain circumstances, sequential oxidation and reduction of an hydroxy-group an attractive means of inverting configuration.[6] However, reduction of six-membered cyclic ketones with borohydride usually affords the product with an axial hydroxy-group through approach



(1) R = OH
(2) R = O·O$_2$SMe
(3) R = N$_3$
(4) R = NH$_2$
(5) R = NHAc

(6)

(7) X = O
(8) X = N·OH
(9) X = N·OAc

(10) R = OH
(11) R = O·O$_2$SMe
(12) R = OBz
(13) R = NH$_2$

(14) R = H
(15) R = Bz
(16) R = O$_2$SMe

(17) R = N$_3$
(18) R = NH$_2$
(19) R = NHAc

of the borohydride anion from the equatorial direction,[7] but an exception is the reduction of α-*arabino*-hex-2-ulopyranosides, which undergo preferential attack by borohydride from the axial position, presumably because the equatorial approach is hindered by the

[1] Part IX, A. C. Richardson and E. Tarelli, *J. Chem. Soc.* (*C*), 1971, 3733.
[2] L. Hough, A. C. Richardson, and E. Tarelli, *J. Chem. Soc.* (*C*), 1971, 2122.
[3] A. C. Richardson, *Carbohydrate Res.*, 1969, **10**, 395.
[4] S. McNally and W. G. Overend, *J. Chem. Soc.* (*C*), 1966, 1978.
[5] R. U. Lemieux, E. Fraga, and K. A. Watanabe, *Canad. J. Chem.*, 1968, **46**, 61.
[6] L. Hough and A. C. Richardson, in Rodd's 'Chemistry of Carbon Compounds,' vol. 1F, Elsevier, Amsterdam, 1967, p. 226.
[7] M. Hanack, 'Conformation Theory,' Academic Press, New York, 1965, p. 269.

adjacent axial glycosidic group.[8] This procedure was applied to the 2,2′-diol (1). Oxidation with ruthenium tetroxide[9] afforded the 2,2′-diulose (7) in 45% yield. The oxidation could also be conducted with dimethyl sulphoxide–acetic anhydride, but in this case the diulose (7) was formed together with a number of side-products and was only isolated crystalline in 30% yield. The crystalline diulose (7) underwent stereospecific reduction with sodium borohydride to give 4,6-*O*-benzylidene-3-deoxy-α-D-*ribo*-hexopyranosyl 4,6-*O*-benzylidene-3-deoxy-α-D-*ribo*-hexopyranoside (10) in 67% yield. No other isomers were apparent (t.l.c.). Subsequently, it was found that isolation of the intermediate 2,2′-diulose (7) was not necessary; direct reduction of the crude oxidation product afforded the 2,2′-diol (10) in 48% overall yield from (1).

The configuration of the 2,2′-diol (10) was indicated by its ^{1}H n.m.r. spectrum (see Table). The H-1, H-1′ resonance was readily recognised as a low-field doublet at τ 4·92 with a splitting of 3·7 Hz in accord with an equatorial–axial relationship between H-1 and H-2 (and H-1′ and H-2′). In the case of compound (1), which has a diequatorial relationship between these pairs of protons, $J_{1,2}$ is <1 Hz.[2] Furthermore, the large value (11·5 Hz) for $J_{2,3ax}$ confirmed the presence of axial hydrogen atoms at the 2- and 2′-positions. Additional ^{1}H n.m.r. evidence was provided by the spectra of the derived dimesylate (11) and dibenzoate (12) (Table).

Selective acid-catalysed methanolysis of the dibenzylidene-2,2′-diol (10) gave syrupy 3,3′-dideoxy-αα-trehalose (14), which was best characterised either as its hexabenzoate (15) or its hexamesylate (16), both of which had ^{1}H n.m.r. spectra in keeping with their structures (Table).

The report that methyl 4,6-*O*-benzylidene-3-deoxy-2-*O*-tosyl-α-D-*ribo*-hexopyranoside undergoes displacement of the sulphonate group by azide[10] represents the only case of a successful displacement at the 2-position of a hexopyranoside by a charged nucleophile, and is in contrast to the well known reluctance of pyranoside 2-sulphonates to undergo replacement.[3] The displacement in this particular example was facilitated by two factors. Firstly, the absence of a polar substituent at C-3 reduced polar interactions in the transition state and, secondly, the diequatorial relationship between the sulphonyloxy-group and the *trans*-3-hydrogen atom was unfavourable for the alternative pathway of elimination. Consequently the dibenzylidene-2,2′-dimesylate (11) should undergo a double displacement with azide providing a route through to 2-amino-2,3-dideoxy-α-D-*arabino*-hexopyranosyl 2-amino-2,3-dideoxy-α-D-*arabino*-hexopyranoside (18).

As anticipated, the 2,2′-dimesylate (11) underwent a slow, but clean displacement with sodium azide in hexamethylphosphoric triamide (10 days at 110°) to give the diazide (3) in 67% yield. No other products were apparent (t.l.c.), suggesting that elimination, which was the predominant pathway in the case of the 2,2′-di-epimer (2), did not occur to any marked extent. The ^{1}H n.m.r. spectrum of (3), although complex and poorly resolved, showed the H-1,H-1′ resonance as a low-field singlet at τ 4·96. The small value (*ca.* 1 Hz) of $J_{1,2}$ was indicative[2] of a change in configuration at C-2 and C-2′.

The 2,2′-diazide (3) was reduced with hydrazine–Raney nickel to the 2,2′-diamine (4), which was characterised as the di-*N*-acetate (5). Selective methanolysis of (5) afforded 2-acetamido-2,3-dideoxy-α-D-*arabino*-hexopyranosyl 2-acetamido-2,3-dideoxy-α-D-*arabino*-hexopyranoside (19), which was also prepared by the sequence (3) ⟶ (17) ⟶ (18) ⟶ (19).

It was anticipated that the 2,2′-diepimer (13) of the

^{1}H N.m.r. parameters. First-order chemical shifts (τ values)[a] and coupling constants (Hz) at 100 MHz

Compound:	(7)[b]	(7)[c]	(10)[b]	(11)[b]	(12)[c]	(15)[c]	(16)[d]	(3)[b]	(5)[c]
H-1, H-1′	4·96(s)	4·88(s)	4·92(d)	4·68(d)	4·44(d)	4·21(d)	4·56(d)	4·96(s)	4·68(s)
H-2, H-2′				5·15(oct)	4·72(cm)	4·6(cm)	5·02(sx)		5·55(t)
H-3*ax*, H-3′*ax*	7·1(cm)	7·14(d)	8·12(q)	7·7(cm)	7·6(cm)	7·5(cm)	7·62(q)	7·8(cm)	7·8(cm)
H-3*eq*, H-3′*eq*			7·68(sx)				7·20(sx)		
H-4, H-4′	5·88(sx)	5·93(sx)		5·98(sx)	5·96(sx)	4·6(cm)	5·14(sx)		
H-5, H-5′	5·58(q)	5·72(q)	5·75(q)	5·70(q)	6·17(q)		5·72(sx)		
H-6a, H-6′a	6·31(d)	6·24(cm)		6·35(cm)	6·45(cm)		5·56(cm)		
H-6b, H-6′b	6·14(q)								
C*H*Ph	4·48(s)	4·50(s)	4·54(s)	4·49(s)	4·54(s)			4·41(s)	4·60(s)
$J_{1,2}$			3·7	3·5	3·5	3·5	3·5	*ca.* 1	*ca.* 1
$J_{2,3ax}$			*ca.* 11	*ca.* 11			*ca.* 11		*ca.* 3
$J_{2,3eq}$			*ca.* 4	*ca.* 6			*ca.* 4		*ca.* 3
$J_{3ax,3eq}$			*ca.* 11				*ca.* 11		
$J_{3ax,4}$	9·3	9·2	*ca.* 11	*ca.* 10	*ca.* 10		*ca.* 11		
$J_{3eq,4}$	4·3	4·6	*ca.* 4	*ca.* 4	*ca.* 4		*ca.* 4·5		
$J_{4,5}$	9·6	9·4	*ca.* 11	9·5	*ca.* 10		10·2		
$J_{5,6a}$	0	0	0	0	0		2·5		
$J_{5,6b}$	4·4	4·5	*ca.* 3	4·5	3·3		2·5		
$J_{6a,6b}$	9·5								

[a] sx = Sextet, cm = complex multiplet, oct = octet. [b] In deuteriochloroform. [c] In deuteriopyridine. [d] In deuterioacetone.

[8] B. R. Baker and D. H. Buss, *J. Org. Chem.*, 1965, **30**, 2308.
[9] P. J. Beynon, P. M. Collins, D. Gardiner, and W. G. Overend, *Carbohydrate Res.*, 1968, **6**, 431.
[10] M. Nakajima, H. Shibita, K. Kitahara, S. Takahushi, and A. Hasegawa. *Tetrahedron Letters*, 1968, 2271.

diamine (4) could be synthesised by lithium aluminium hydride reduction [11] of the dioxime (8) derived from the 2,2′-diulose (7). A related stereoselective synthesis of the 2-amino-2,3-dideoxy-α-D-*ribo*-hexopyranoside has been carried out using the methyl glycoside analogues of (8), and many related syntheses have been achieved using pyranulose oximes.[12] Accordingly, the crystalline dioxime (8) was prepared in the usual way. The ^{1}H n.m.r. spectrum, however, revealed it to be a mixture of the three possible geometrical isomers. The spectrum showed four singlets attributable to anomeric protons, at τ 3·17, 3·20, 4·20, and 4·25 in an approximate ratio of 3 : 5 : 5 : 7 (based on peak heights). The two low-field singlets were assigned to those protons deshielded by a *syn*-hydroxy-system in the hydroxyimino-group, whereas those at higher field were assigned to those in which this hydroxy-group is *anti*. The *syn,anti*-isomer would therefore have two singlets of equal intensity, one at high field and the other at lower field, whereas the symmetrical *anti,anti* and *syn,syn*-isomers would show one singlet each at high and low field, respectively. It is apparent from the ratios given that the *anti,syn*-isomer (singlets at τ 3·20 and 4·20) predominates (50%) over the *anti,anti*- (τ 4·25) (35%) and *syn,syn*-isomers (τ 3·17) (15%). These results suggest that there is a preference for the oxime hydroxy-group to adopt a position adjacent to the deoxy-group rather than *syn* to the anomeric oxygen atom, although this preference is not so marked as in the case of the corresponding 3,3′-dioxime.[12] The dioxime mixture (8) afforded a crystalline product on acetylation with acetic anhydride–pyridine which, from the ^{1}H n.m.r. spectrum in deuterioacetone appeared to be a mixture of the *anti,anti*- (singlet at τ 4·36) (45%) and the *anti,syn*-isomers (singlets at τ 3·69 and 4·34) (55%).

The reduction of either the dioxime (8) or the dioxime diacetate (9) with lithium aluminium hydride in either diethyl ether or tetrahydrofuran afforded complex mixtures from which no homogeneous products were isolated. The route was therefore abandoned. However, it is noteworthy that whereas the reduction of oximes in the monosaccharide series is usually specific,[11,12] reduction of 2,2′- and 3,3′-dioximes [13] in the trehalose series has led to the formation of complex mixtures and therefore such reductions do not seem to be generally applicable.

EXPERIMENTAL

For general notes see ref. 13.

4,6-O-*Benzylidene*-2,3-*dideoxy*-α-D-erythro-*hex*-2-*enopyranosyl* 4,6-O-*Benzylidene*-2,3-*dideoxy*-α-D-erythro-*hex*-2-*enopyranoside* (6).—Sodium benzoate (5 g) was added to a solution of the 2,2′-dimesylate [2] (2) (2·2 g) in *NN*-dimethylformamide (15 ml) and the mixture was heated under reflux for 3 days. T.l.c. then indicated that reaction was complete. The mixture was mixed with water and the resulting precipitate filtered off, washed well with water, and recrystallised from dichloromethane–propan-2-ol to give the *diene* (1·1 g, 74%), m.p. 237—239°, $[\alpha]_D$ +61° (*c* 1) (Found: C, 68·9; H, 6·0. $C_{26}H_{26}O_7$ requires C, 69·3; H, 5·8%) τ (C_5D_5N) τ 4·42 (quint, $J_{1,2}$ 2·5, $J_{1,3}$ 1·5, $J_{1,4}$ 1·5 Hz, H-1, H-1′), 4·22 (dt, $J_{2,3}$ 10, $J_{2,4}$ 2·5 Hz, H-2, H-2′, (broad-limbed d, H-3, H-3′), 5·6—6·3 (complex m), and 4·30 (s, PhC*H*).

The *diene* was obtained in lower yield (60%) {m.p. 239—240°, $[\alpha]_D$ +60° (*c* 0·9)} when sodium azide in hexamethylphosphoric triamide at 90° was used. In this case, the reaction time was extended to 6 days.

4,6-O-*Benzylidene*-3-*deoxy*-α-D-erythro-*hexopyranosyl*-2-*ulose* 4,6-O-*Benzylidene*-3-*deoxy*-α-D-erythro-*hexopyranosid*-2-*ulose* (7).—(*a*) To a solution of the diol (1) (2 g) in redistilled dichloromethane (75 ml) was added a solution of ruthenium tetroxide (2·8 g) in carbon tetrachloride (120 ml). The mixture was stirred at room temperature for 12 h, after which propan-2-ol (2 ml) was added to decompose the excess of oxidising agent. The mixture was filtered through Hyflo Supercel and the filtrate concentrated to a white crystalline solid, which was immediately (decomposition rapidly ensued otherwise) purified by dissolution in the minimum of dichloromethane and passage through a short column of silica gel (20 g) with ether (500 ml) as eluant. Evaporation of the eluate and recrystallisation of the residue from di-isopropyl ether gave the *diulose* (0·9 g, 45%), m.p. 194—195°, $[\alpha]_D$ +101° (*c* 0·5) (Found: C, 64·5; H, 5·3. $C_{26}H_{26}O_9$ requires C, 64·7; H, 5·4%).

(*b*) A mixture of the diol (1 g), anhydrous dimethyl sulphoxide (10 ml) and acetic anhydride (6 ml) was kept at room temperature for 28 h; t.l.c. then indicated the absence of starting material and the formation of several products. The solution was poured into water and the mixture set aside to enable the resulting precipitated syrup to solidify. Filtration and four recrystallisations from di-isopropyl ether gave the diulose (0·3 g, 30%) identical with that obtained in (*a*).

The *dioxime* (8) was prepared as a mixture of geometrical isomers (see Discussion section) from the diulose (0·7 g) by heating under reflux with ethanol (30 ml), water (10 ml), sodium acetate (1 g) and hydroxylamine hydrochloride (0·28 g) for 1 h. On cooling, followed by addition of water, crystals separated which were filtered off and recrystallised from ethanol–water to give the *dioxime* as a hemihydrate (0·65 g, 86%), m.p. 212—214°, $[\alpha]_D$ +177° (*c* 0·55 in Me_2CO) (Found: C, 59·8; H, 5·7; N, 5·2. $C_{26}H_{28}N_2O_9,0{\cdot}5H_2O$ requires C, 59·9; H, 5·6; N, 5·4%).

The dioxime diacetate (9) was prepared in the usual way (80%) (acetic anhydride–pyridine). It crystallised as a mixture of geometrical isomers (see Discussion section). The m.p. varied from sample to sample between *ca.* 120° and 130°, $[\alpha]_D$ +150° (*c* 0·5 in Me_2CO). A reliable analysis was not obtained, probably owing to variable hydration (1—2·5 mol. equiv. of H_2O), which was also indicated by integration of the ^{1}H n.m.r. spectrum.

4,6-O-*Benzylidene*-3-*deoxy*-α-D-ribo-*hexopyranosyl* 4,6-O-*Benzylidene*-3-*deoxy*-α-D-ribo-*hexopyranoside* (10).—A solution of the diulose (7) (0·5 g) in dichloromethane (10 ml) and methanol (10 ml) was treated with sodium borohydride (0·3 g) in small portions, and the mixture was kept at room temperature for 1 h. The resulting solution was then

[11] A. Rosenthal and P. Catsoulacos, *Canad. J. Chem.*, 1969, **47**, 2747.

[12] D. Horton in 'The Amino Sugars,' ed. R. W. Jeanloz, Academic Press, New York, 1969, p. 39.

[13] L. Hough, A. C. Richardson, and E. Tarelli, *J. Chem. Soc.* (*C*), 1971, 1732.

concentrated to dryness and the residue extracted with boiling dichloromethane (3 × 100 ml). Evaporation of the extract afforded a white solid, which was recrystallised from propan-2-ol giving the 2,2′-*diol solvate* (0·24 g, 67%), m.p. 202—204°, $[\alpha]_D$ +99° (*c* 0·5) (Found: C, 64·0; H, 6·9. $C_{26}H_{30}O_9,C_3H_8O$ requires C, 63·7; H, 7·0%), τ 8·89 (6H, d, $Me_2CH{\cdot}OH$).

It was later found to be more convenient to conduct the borohydride reduction on the crude diulose (7) prior to chromatography; in this case overall yields of about 48% were obtained from (1).

The *dibenzoate* (12) (70%) had m.p. 155—157° (from dichloromethane–ethanol), $[\alpha]_D$ +116° (*c* 0·85) (Found: C, 69·4; H, 5·6. $C_{40}H_{38}O_{11}$ requires C, 69·2: H, 5·7%). The *dimesylate* (11) (76%) had m.p. 224—226°, $[\alpha]_D$ +71° (*c* 1·15) (from EtOH) (Found: C, 52·3; H, 5·9; S, 9·9. $C_{28}H_{34}O_{13}S_2$ requires C, 52·3; H, 5·3; S, 10·0%).

3-*Deoxy*-α-D-ribo-*hexopyranosyl* 3-*Deoxy*-α-D-ribo-*hexopyranoside* (14).—To a solution of the diacetal (10) (0·75 g) in dichloromethane (20 ml) was added methanolic 1% hydrogen chloride (10 ml) and the solution was stored at room temperature for 18 h. It was then neutralised ($PbCO_3$), filtered, and evaporated to dryness. The syrupy residue was chromatographed on silica gel (50 g); dichloromethane (300 ml) was used initially as eluant, followed by dichloromethane–methanol (2 : 1 v/v; 500 ml). Evaporation of the latter eluate gave 3,3′-*dideoxy*-αα-*trehalose* (0·4 g, 83%) as a hygroscopic syrup which failed to crystallise, $[\alpha]_D$ +188° (*c* 0·65 in EtOH).

The hexabenzoate (12) (87%) crystallised as a *hemiethanolate*, m.p. 153—155° (from ethanol), $[\alpha]_D$ +131° (*c* 1·1) (Found: C, 68·7; H, 5·2. $C_{54}H_{46}O_{15},0{\cdot}5C_2H_6O$ requires C, 69·2; H, 5·1%), τ 8·85 (1·5H, t, $MeCH_2{\cdot}OH$). The *hexamesylate* (13) (96%) had m.p. 192—194°, $[\alpha]_D$ +118·5° (*c* 1·25 in Me_2CO) (Found: C, 28·1; H, 4·4; S, 23·8. $C_{18}H_{34}O_{21}S_6$ requires C, 27·8; H, 4·4; S, 24·7%).

2-*Azido*-4,6-O-*benzylidene*-2,3-*dideoxy*-α-D-arabino-*hexopyranosyl* 2-*Azido*-4,6-O-*benzylidene*-2,3-*dideoxy*-α-D-arabino-*hexopyranoside* (3).—A mixture of the 2,2′-dimesylate (11) (0·8 g) and sodium azide (1·5 g) in hexamethylphosphoric triamide (4 ml) was heated at 110° (bath temp.) and the reaction was continuously monitored by t.l.c. After 10 days reaction was complete; the dark coloured solution was poured into water and the precipitated solid filtered off and chromatographed on silica gel (100 g) with dichloromethane–light petroleum (3 : 1 v/v) as eluant. Concentration of the eluate afforded a white crystalline solid which was recrystallised from propan-2-ol to give the 2,2′-*diazide* (0·45 g, 67%), m.p. 203—205°, $[\alpha]_D$ +140° (*c* 0·8) (Found: C, 58·2; H, 5·6; N, 15·9. $C_{26}H_{28}N_6O_7$ requires C, 58·2; H, 5·3; N, 15·7%).

2-*Acetamido*-4,6-O-*benzylidene*-2,3-*dideoxy*-α-D-arabino-*hexopyranosyl* 2-*Acetamido*-4,6-O-*benzylidene*-2,3-*dideoxy*-α-D-arabino-*hexopyranoside* (5).—A solution of the diazide (3) (0·3 g) in ethanol (25 ml) was mixed with Raney nickel [14] (*ca.* 1 spatula load), brought to the boil, and treated dropwise with hydrazine hydrate (2 ml) so as to maintain a steady effervescence. The mixture was maintained at reflux for a further 5 min and then, after filtration, evaporated to dryness to give the 2,2′-diamine (4), which failed to crystallise. The syrupy amine was dissolved in ethanol (5 ml), treated with acetic anhydride (10 drops), and stored at room temperature for 12 h. Light petroleum was then added and the resulting precipitate was filtered off and recrystallised from ethanol–light petroleum to give the *di*-N-*acetyl derivative* (0·29 g, 91%), m.p. 235—237°, $[\alpha]_D$ +110° (*c* 0·5 in MeOH) (Found: C, 63·9; H, 6·7; N, 4·9. $C_{30}H_{36}N_2O_9$ requires C, 63·4; H, 6·4; N, 4·9%).

2-*Azido*-2,3-*dideoxy*-α-D-arabino-*hexopyranosyl* 2-*Azido*-2,3-*dideoxy*-α-D-arabino-*hexopyranoside* (17).—To a solution of the diazido-diacetal (3) (0·35 g) in dichloromethane (10 ml) was added methanolic 1% hydrogen chloride (5 ml), and the solution was kept at room temperature for 4 h. The mixture was then processed as before and the solid product recrystallised from ethyl acetate–light petroleum to give the *diazido-disaccharide* (0·2 g, 85%), m.p. 73—75°, $[\alpha]_D$ +180° (*c* 1 in EtOH) (Found: C, 40·5; H, 5·8; N, 23·4. $C_{12}H_{20}N_6O_7$ requires C, 40·0; H, 5·6; N, 23·3%).

2-*Acetamido*-2,3-*dideoxy*-α-D-arabino-*hexopyranosyl* 2-*Acetamido*-2,3-*dideoxy*-α-D-arabino-*hexopyranoside* (19).—(*a*) The di-*N*-acetyl-diacetal (5) (0·12 g) was methanolysed as already described to give the *di*-N-*acetyl derivative* as a hemihydrate (0·06 g, 72%) (from ethanol–light petroleum), m.p. 290—295° with a transition and partial melting at *ca.* 225—235°, $[\alpha]_D$ +67° (0·7 in EtOH) (Found: C, 48·0; H, 7·1; N, 6·9. $C_{16}H_{28}N_2O_9,0{\cdot}5H_2O$ requires C, 47·9; H, 7·2; N, 7·0%).

(*b*) A solution of the diazido-disaccharide (17) (0·2 g) in ethanol (20 ml) was hydrogenated at 50 lb in^{-2} over palladium–charcoal for 12 h. The catalyst was filtered off; evaporation of the filtrate afforded the syrupy diamine (18), which failed to crystallise during several months. The syrup was dissolved in ethanol (5 ml) and treated with acetic anhydride (0·5 ml) and the mixture was stored at room temperature for 12 h. Addition of light petroleum resulted in crystallisation of the *diacetamido-disaccharide*, which was recrystallised from ethanol–light petroleum (yield 0·17 g, 78%), m.p. 292—297° (with premelting), $[\alpha]_D$ +68° (*c* 1 in EtOH), and was identical with that from (*a*).

We thank Eli Lilly (Indianapolis) for financial support and the Physico-Chemical Measurements Unit (Harwell) for the determination of the 100 MHz ^1H n.m.r. spectra.

[1/2315 *Received*, 6*th December*, 1971]

[14] S. Nishimura, *Bull. Chem. Soc. Japan*, 1959, **32**, 61.