

324. Anhydrides of Polyhydric Alcohols. Part XIV. Observations on the Ring Scission of 1 : 2-5 : 6-Diepoxyhexane and 3 : 4-isoPropylidene 1 : 2-5 : 6-Dianhydromannitol.

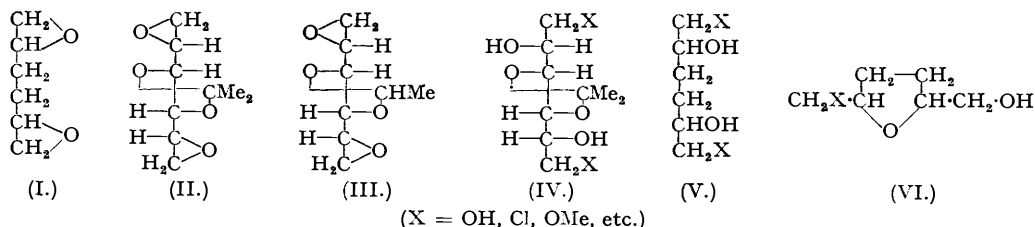
By L. F. WIGGINS and D. J. C. WOOD.

1 : 2-5 : 6-Diepoxyhexane (I) has been prepared in good yield by treatment of hexa-1 : 5-diene with perbenzoic acid. This reactive diepoxy-compound undergoes ring scission through the action of various reagents with the formation of either cyclic or straight-chain products. Water causes ring scission of (I) and gives rise to 2 : 5-bishydroxymethyltetrahydrofuran. Hydrochloric acid and (I) furnish 2-chloromethyl-5-hydroxymethyltetrahydrofuran; ammonia and (I) give what is believed to be 5-hydroxy-2-hydroxymethylpiperidine. When treated with methylmagnesium iodide (I) gives 1 : 6-di-iodo-2 : 5-dihydroxyhexane. The analogous diepoxide, 3 : 4-*isopropylidene* 1 : 2-5 : 6-dianhydromannitol (II) behaves similarly with the Grignard reagent and also suffers ring scission with reagents such as water, sodium methoxide, hydrochloric acid, and ammonia (see also Wiggins, *J.*, 1946, 384). The reactions of both of the above diepoxides with lithium aluminium hydride are also described.

IN view of the interest currently being shown in diepoxy-compounds it seems opportune to describe the results of our work on the chemical properties of two such compounds, 1 : 2-5 : 6-diepoxyhexane (I) and 3 : 4-*isopropylidene* 1 : 2-5 : 6-dianhydromannitol (II). Wiggins (*loc. cit.*) has demonstrated the extreme lability of the epoxide rings of (II) towards both acidic and alkaline reagents. 3 : 4-Ethylidene 1 : 2-5 : 6-dianhydromannitol (III) was studied and in this also the epoxide rings were shown to be very readily attacked by hydrolytic agents. Because of the interesting properties of (II) and (III) the simpler analogue, 1 : 2-5 : 6-diepoxyhexane (I), was prepared, its reactions towards various reagents examined, and its behaviour compared with that of the mannitol derivatives, (II) and (III).

Bigot (*Ann. Chim.*, 1891, 22, 441, 447) treated epichlorohydrin with sodium and obtained a liquid of formula $C_6H_{10}O_2$ which he believed to be "diallyl dioxide." Przybytek (*Ber.*, 1885, 18, 1352) treated hexa-1 : 5-diene with hypochlorous acid and obtained "dichlorohexyleneglycol" from which, on treatment with potassium hydroxide, was produced a liquid of the same composition. The reported properties and reactions of these two products suggested that they may have been essentially (I) but no evidence was advanced by either of these workers, nor has any been reported since, which proved the structure of their products.

1 : 2-5 : 6-Diepoxyhexane (I) has now been prepared by the smooth oxidation of hexa-1 : 5-diene with perbenzoic acid. The diepoxide is readily isolated and purified and may be obtained in about 70% yield.

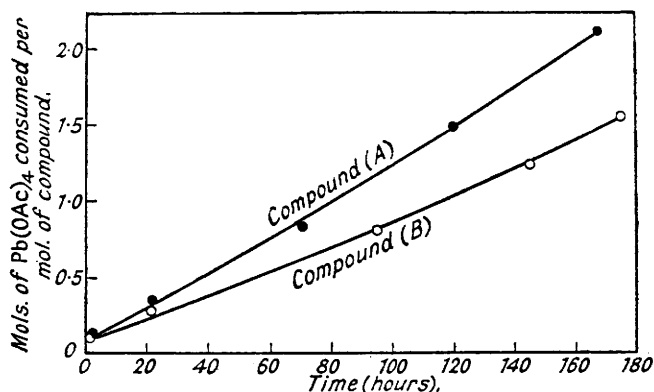


It is clear that three isomeric forms of (I) are theoretically possible and that this preparation should give a mixture of a *meso*- or *cis*-form and a *racemic* or *trans*-form composed of two enantiomorphs. That such a mixture is actually formed when hexa-1 : 5-diene is oxidised with perbenzoic acid is demonstrated by the fact that whenever crystalline materials are isolated from a reaction carried out on the product, they are invariably found to be mixtures of isomers. It has not been possible to show, when liquid reaction products are obtained, that these are also mixtures of isomers, but it is likely that the individual constituents would have closely similar boiling points and indeed be extremely difficult to separate.

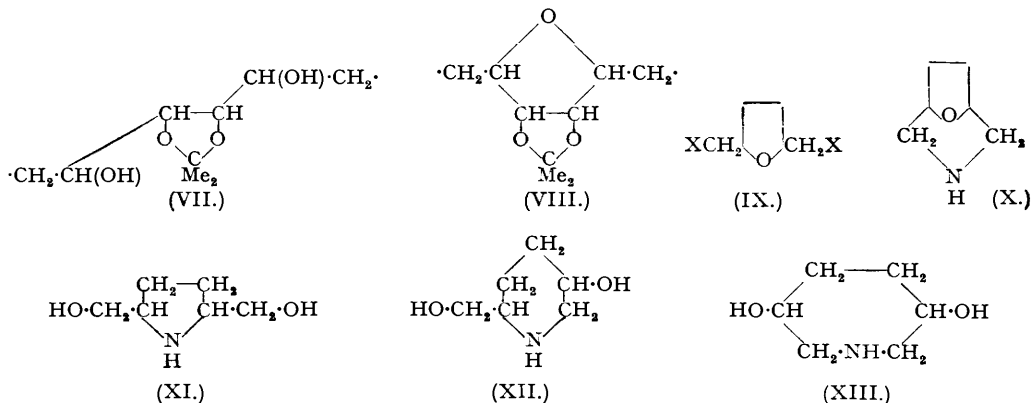
It has been found (Wiggins, *loc. cit.*) that each ethylene oxide ring in the 1 : 2-5 : 6-dianhydromannitol derivatives, (II) and (III), of mannitol reacted quite independently of the other, ring scission leading to the addition of the anionic part of the hydrolytic agent to the mannitol molecule at C₁ and C₆, giving rise to compounds of type (IV). It has been found, however, that 1 : 2-5 : 6-diepoxyhexane (I) behaves differently inasmuch as it gives rise to two distinct types of reaction product, depending on the nature of the reagent used; namely, (a) derivatives of hexane-2 : 5-diol (V), and (b) 2 : 5-disubstituted derivatives of tetrahydrofuran (VI). Type (a) must arise in

When (I) was treated with boiling water a liquid (*A*) resulted. It might be expected that when hydrolysis of the oxide rings occurred it would lead to the formation of 1 : 2 : 5 : 6-tetrahydroxyhexane but the product actually obtained showed properties which did not agree with this contention. When treated with lead tetra-acetate (according to Hockett and McClenahan's procedure, *J. Amer. Chem. Soc.*, 1939, **61**, 1667) the liquid (*A*) showed a slow consumption of reagent, a behaviour not at all indicative of the presence of two glycol groups (see Fig. 1). Treatment of (*A*) with toluene-*p*-sulphonyl chloride in pyridine solution furnished a crystalline ditoluene-*p*-sulphonyl derivative of bishydroxymethyltetrahydrofuran, which after three recrystallisations from alcohol had m. p. 113—118°, showing it to be a mixture.

FIG. 1.



2 : 5-Di(toluene-*p*-sulphonyloxymethyl)tetrahydrofuran (IX; X = TsO) (Newth and Wiggins, *J.*, 1948, 155) has m. p. 128°, and the m. p. of a mixture of the two derivatives was found to lie between the two individual values. The X-ray powder photographs of the two substances were



indistinguishable. The ditoluene-*p*-sulphonyl derivative of liquid (*A*) therefore consists at least partly of (IX; R = TsO). Treatment of the toluene-*p*-sulphonyl derivative of (*A*) with sodium iodide in dry acetone gave rise to two equivalents of sodium toluene-*p*-sulphonate indicating that both toluene-*p*-sulphonyl residues were attached to primary carbon atoms. Final proof that the toluene-*p*-sulphonyl derivative of (*A*) contained (IX; X = TsO) was given by its reaction with methyl-alcoholic ammonia, which afforded 8-oxa-3-azabicyclo[3 : 2 : 1]-octane (X) (Newth and Wiggins, *loc. cit.*). This was confirmed by the preparation of the toluene-*p*-sulphonate, picrate, and oxalate, all of which had properties in agreement with those recorded by Newth and Wiggins.

The toluene-*p*-sulphonyl derivative of (*A*) was separated by fractional crystallisation, with some difficulty, into two constituents, one having m. p. 118—122°, undepressed on admixture with (IX; X = TsO), and the other having m. p. 96—99° and the same composition, C₂₀H₂₄O₇S₂. Efforts further to separate these into products of sharper melting point were unsuccessful.

The fact that the toluene-*p*-sulphonyl derivative of (*A*) proved to be a mixture provides support for the postulated existence of 1 : 2-5 : 6-diepoxyhexane (I) as a mixture of isomers. The derivative (IX; X = TsO) can theoretically exist in *cis*- and *trans*-forms, and these are doubtless represented by the two products, m. p. 96—99° and m. p. 118—122°; from this it can be inferred that the liquid (*A*) consists of the *cis*- and the *trans*-form of 2 : 5-bishydroxymethyltetrahydrofuran. The 2 : 5-bishydroxymethyltetrahydrofuran obtained by Newth and Wiggins (*loc. cit.*) by the hydrogenation of 5-hydroxymethylfurfuraldehyde would appear, on the other hand, to be one distinct isomer (although it is not yet possible to state which) because its toluene-*p*-sulphonyl derivative, obtained in good yield, possessed a sharp melting point. This is difficult to explain because it would be expected that addition of hydrogen to the planar furan ring would lead to the production of a mixture of approximately equal amounts of the *cis*- and the *trans*-2 : 5-disubstituted tetrahydrofuran.

Since the liquid (*A*) has now been shown to be 2 : 5-bishydroxymethyltetrahydrofuran the structure of the diepoxyhexane from which it was obtained must follow as (I). The other possible structures for the diepoxide, namely 1 : 6-2 : 5 or 1 : 5-2 : 6, cannot be correct because five-, six-, or seven-membered oxide rings could not undergo ring scission under such mild conditions as obtain here.

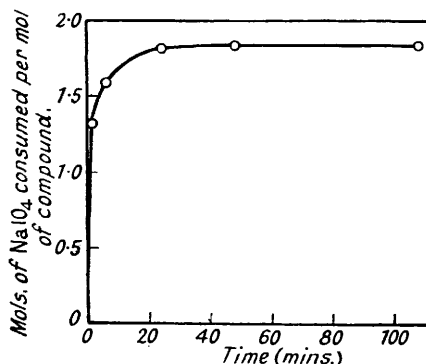
The action of water on 3 : 4-isopropylidene 1 : 2-5 : 6-dianhydromannitol (II) has now also been studied. Wiggins (*loc. cit.*) showed that the oxide rings in this compound were very labile to both acid and alkaline reagents, but did not investigate the action of boiling water alone. This reaction has now been found to yield 3 : 4-isopropylidene mannitol. Cyclisation to a tetrahydrofuran derivative is not possible for reasons already given.

When (I) was treated with fuming hydrochloric acid a violent reaction occurred and only tarry matter was obtained. The diepoxide reacted vigorously with concentrated hydrochloric acid, but a smooth reaction occurred with dilute acid although some heat was generated. The product (*B*) isolated has been shown to be 2-chloromethyl-5-hydroxymethyltetrahydrofuran (VI; X = Cl). When treated with lead tetraacetate this compound exhibited closely similar behaviour to the bishydroxymethyltetrahydrofuran (*A*) (see Fig. 1), indicating the absence of vicinal hydroxy-groups and suggesting the presence of the tetrahydrofuran nucleus. Proof of this structure was afforded by the fact that treatment with thionyl chloride in pyridine gave 2 : 5-bischloromethyltetrahydrofuran (IX; X = Cl) having constants in agreement with those recorded by Newth and Wiggins (*loc. cit.*) for the product of the direct chlorination of 2 : 5-bishydroxymethyltetrahydrofuran.

With methyl alcoholic sodium methoxide, (I) gave a compound shown to be 5-hydroxymethyl-2-methoxymethyltetrahydrofuran (VI; X = OMe) by its conversion into 2 : 5-bis-methoxymethyltetrahydrofuran (IX; X = OMe), which was synthesised for comparison by the direct methylation of 2 : 5-bishydroxymethyltetrahydrofuran.

When (I) was treated with methyl alcoholic ammonia a basic liquid (*C*) was obtained; this was shown to have the formula $C_6H_{13}O_2N$, and the structure, 5-hydroxy-2-hydroxymethylpiperidine (XII), has tentatively been assigned. This formed a liquid triacetyl derivative containing two acetyl groups hydrolysable with alkali; thus the derivative contained two *O*-acetyl groups and one *N*-acetyl group. Evidence for the inclusion of the nitrogen atom in the heterocyclic ring and the rejection of a tetrahydrofuran-type structure arises from the fact that oxidation of the base (*C*) with sodium periodate proceeds rapidly with the consumption of two equivalents of oxygen (see Fig. 2). If the hetero-atom in the ring system were oxygen, no such oxidation would take place because it has been shown that the grouping $HO\cdot CH_2\cdot \overset{|}{C}H\cdot O\cdot \overset{|}{C}H\cdot$ does not react with periodate under the conditions employed (see Jackson, "Organic Reactions," Vol. II, page 341; John Wiley, 1947). Conclusive evidence that the nitrogen atom was heterocyclic was provided by the fact that no nitrogen was evolved on treatment of (*C*) with nitrous acid; indeed a *N*-nitroso-derivative responding to the Liebermann test was obtained. Thus, on the basis of the above facts, three structures only, (XI), (XII), and (XIII), are possible for the base (*C*).

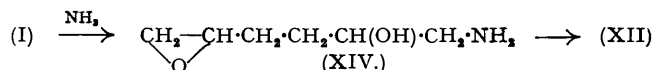
FIG. 2.



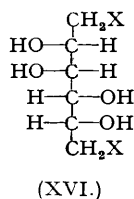
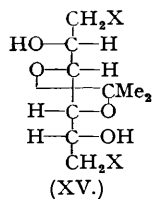
Treatment of the base (C) with toluene-*p*-sulphonyl chloride gave a hard glass which was probably a tritoluene-*p*-sulphonyl derivative; the fact that this product showed a neutral reaction in aqueous alcoholic solution indicated that the heterocyclic imino-group had undergone toluene-*p*-sulphonation in addition to the hydroxyl groups. On being treated with sodium iodide in acetone solution this compound yielded 1.2 moles of sodium toluene-*p*-sulphonate, and a product containing nitrogen, sulphur, and iodine. This indicated that only one toluene-*p*-sulphonyloxy-group was attached to a primary carbon atom. From theoretical considerations it appears impossible that the *N*-toluene-*p*-sulphonyl group could react with sodium iodide, but, in order to confirm this, *N*-toluene-*p*-sulphonylpiperidine was treated with sodium iodide under the usual conditions; no sodium toluene-*p*-sulphonate was obtained. Of the three possible structures postulated above (XI) would give a toluene-*p*-sulphonyl derivative in which two sulphonyloxy-residues could be replaced by sodium iodide whilst (XIII) would give a derivative containing no replaceable sulphonyloxy-residues. Only (XII) would yield a derivative which contained a single primary toluene-*p*-sulphonyl group.

The action of acetic anhydride in methyl alcohol on (C) gave a liquid *N*-acetyl derivative, which on treatment with toluene-*p*-sulphonyl chloride yielded a partly crystalline ditoluene-*p*-sulphonyl compound. This, with sodium iodide in acetone solution, gave rise to one equivalent of sodium toluene-*p*-sulphonate. This is in agreement with the preceding evidence, and in view of these facts we tentatively ascribe to the base (C) the structure (XII). Further work designed to prove this structure conclusively is being carried out.

The formation of (XII) from (I) can be explained if it is assumed that one of the epoxide rings suffers ring opening with ammonia giving a monoamine (XIV), the amino-group of which has a greater affinity for the second epoxide ring than has the adjacent hydroxyl group, thus giving rise to a piperidine structure instead of a tetrahydrofuran derivative :



1 : 2-5 : 6-Diepoxyhexane reacted smoothly with lithium aluminium hydride employed according to Nystrom and Brown's procedure (*J. Amer. Chem. Soc.*, 1947, **69**, 1197). The product was hexane-2 : 5-diol, and no tetrahydrofuran derivative was encountered. The hexanediol was characterised by the formation of a crystalline ditoluene-*p*-sulphonate, which was separated by fractional recrystallisation into two isomeric compounds, (i) m. p. 71—74°, and (ii), m. p. 113—114°. These are doubtless the ditoluene-*p*-sulphonates of the *meso*- and the racemic form of hexane-2 : 5-diol. The same two crystalline toluene-*p*-sulphonyl derivatives were obtained from hexane-2 : 5-diol prepared by hydrogenation of acetonylacetone in the presence of copper chromite (Hill and Adkins, *J. Amer. Chem. Soc.*, 1938, **60**, 1033). In addition, the lower-melting isomeride was found to be identical with a toluene-*p*-sulphonyl derivative obtained by Newth and Wiggins (unpublished) from the acetolysis product of 2 : 5-dimethyltetrahydrofuran. Here again it is interesting to note the isolation of two isomerides from the reaction with diepoxyhexane whilst the production of the same compound from a furan derivative yields only one of them.



3 : 4-*iso*Propylidene 1 : 2-5 : 6-dianhydromannitol reacted similarly with lithium aluminium hydride giving 3 : 4-*isopropylidene* 1 : 6-dideoxymannitol (XV; X = H). The structure of this product followed from the fact that acid hydrolysis furnished 1 : 6-dideoxymannitol (XVI; X = H), identical with that obtained by Wiggins (*Nature*, 1949, **164**, 672) by the sodium-amalgam reduction of 1 : 6-dichloro 1 : 6-dideoxymannitol, and by Micheel (*Annalen*, 1932, **496**, 96) by the action of molecular silver on 1 : 6-dichloro 2 : 4-3 : 5-dimethylene 1 : 6-dideoxymannitol and subsequent hydrolysis.

The action of Grignard reagents on oxide-ring compounds has been investigated by several authors, notably by Blaise (*Compt. rend.*, 1902, **134**, 557) and by Grignard himself (*ibid.*, 1903,

136, 1260); ethylene oxide, for example, was found to react with ethylmagnesium bromide to give chiefly ethylene bromohydrin. When 1:2-5:6-diepoxyhexane was treated with methylmagnesium iodide in ether a mixture of two isomeric crystalline di-iododihydroxyhexanes was formed. This was easily separated, by virtue of the different solubilities of the constituents in ether, into an isomer of m. p. 94—95° and one of m. p. 116—117°. These are assumed to be the *meso*- and the racemic form of 1:6-di-iodo-2:5-dihydroxyhexane (V; X = I). It was hoped that confirmation of this could be accomplished by the preparation of a ditoluene-*p*-sulphonyl derivative and its subsequent treatment with sodium iodide, but an attempt to prepare such a derivative in pyridine solution led only to the formation of a liquid product which contained free iodine. The same result followed attempts to acetylate and benzoyleate the iodo-compound. Evidence providing considerable support for the structure was, however, obtained from the reaction of 3:4-*isopropylidene* 1:2-5:6-dianhydromannitol with methylmagnesium iodide. This led to the formation of 1:6-di-iodo 3:4-*isopropylidene* 1:6-dideoxymannitol (XV; X = I), the structure of which was proved by hydrolysis with acid to give 1:6-di-iodo 1:6-dideoxymannitol (XVI; X = I) (identical with that obtained by Wiggins *J.*, 1946, 384), and subsequent conversion of this into 1:6-di-iodo 2:4-3:5-dimethylene 1:6-dideoxymannitol (Micheel, *loc. cit.*). Since 1:2-5:6-diepoxyhexane has been shown to behave in an exactly analogous manner to 3:4-*isopropylidene* 1:2-5:6-dianhydromannitol towards lithium aluminium hydride, it appears legitimate to extend the analogy to the reactions with methylmagnesium iodide (which itself resembles the hydride in many respects); hence it may be inferred that in the latter case scission of the oxide rings in diepoxyhexane occurs in the normal way giving 1:6-di-iodo-2:5-dihydroxyhexane.

The iodine atoms in 1:6-di-iodo-2:5-dihydroxyhexane were quite labile and were hydrolysed by being heated with water, addition of silver nitrate giving a copious precipitate of silver iodide. For this reason recrystallisation of the compound from water was attended by considerable losses, but no suitable alternative was found, the usual organic solvents causing separation of free iodine on being heated. When the di-iodo-compound was heated with silver acetate in aqueous alcoholic solution a quantitative yield of silver iodide resulted and a liquid product was obtained. This was found to be 2:5-bishydroxymethyltetrahydrofuran; the course of this reaction was doubtless through 1:2-5:6-diepoxyhexane, formed by removal of the elements of hydrogen iodide from the di-iodo-compound, which subsequently reacted with water in the manner already established. Repetition of the experiment in absolute alcoholic solution furnished isolable 1:2-5:6-diepoxyhexane (I). 1:6-Di-iodo 3:4-*isopropylidene* 1:6-dideoxymannitol was found to behave in quite an analogous manner to 1:6-di-iodo-2:5-dihydroxyhexane. When it was heated with silver acetate in absolute alcoholic solution, a liquid product was formed which was identified as 3:4-*isopropylidene* 1:2-5:6-dianhydromannitol.

EXPERIMENTAL.

Treatment of Hexa-1:5-diene with Perbenzoic Acid.—To a solution of perbenzoic acid (25.7 g., 2.3 mols.) (Braun, *Org. Synth.*, Coll. Vol. I, 431) in chloroform (430 c.c.) at 0° hexa-1:5-diene (9.5 c.c., 1 mol.) (Cortese, *J. Amer. Chem. Soc.*, 1929, **51**, 2266) was added; the solution was kept at 0° with occasional shaking during the first hour. Portions (2 c.c.) of the solution were withdrawn at intervals; each was added to potassium iodide (about 0.5 g.) dissolved in water (10 c.c.) acidified with acetic acid, and the liberated iodine titrated with 0.0197N-sodium thiosulphate solution. The consumption of perbenzoic acid (mols. per mol. of hexadiene) was as follows:

Time, hrs.	0.25	1.25	2.75	7.0	22.5	51	119	191
Consumption	0.30	0.85	1.07	1.39	1.70	1.76	1.79	1.82

When the reaction was complete, the chloroform solution was washed three times with 10% sodium hydroxide solution (100 c.c. portions) and water, and dried (MgSO₄). Evaporation gave a residue (8.1 g.) which, distilled under reduced pressure, afforded 1:2-5:6-diepoxyhexane as a colourless oil (6.0 g., 66%) with a faint, pleasant odour; b. p. 86—88°/15 mm., n_D^{25} 1.4445 (Found: C, 63.0; H, 8.6. C₆H₁₀O₂ requires C, 63.1; H, 8.8%).

Action of Water on 1:2-5:6-Diepoxyhexane.—Diepoxyhexane (2.6 g.) was heated under reflux with water (100 c.c.) for 18 hours and the solution was then concentrated under reduced pressure to a viscous syrup (2.9 g.) from which the last traces of water were removed by azeotropic distillation with benzene. Distillation of the product under reduced pressure gave a colourless viscous syrup (A) (1.9 g., 64%), b. p. (bath temp.) 145—149°/0.05 mm., n_D^{25} 1.4810 (Found: C, 54.2; H, 9.6. C₆H₁₂O₃ requires C, 54.6; H, 9.1%).

Oxidation of Syrup (A) by Lead Tetra-acetate.—The syrup (A) (0.0307 g.) was treated with an excess (50 c.c.) of a solution of lead tetra-acetate in glacial acetic acid; the consumption (Fig. 1) of oxidising agent was measured by titration of aliquot portions with sodium thiosulphate solution according to Hockett and McClenahan's general procedure (*loc. cit.*).

*Treatment of Syrup (A) with Toluene-*p*-sulphonyl Chloride.*—The syrup (A) (0.45 g.) was dissolved

in dry pyridine (10 c.c.) and toluene-*p*-sulphonyl chloride (2.0 g.) was added at 0°. After being kept overnight at 30° the solution was poured into water; the solid product (1.5 g.) was collected, washed with water, and recrystallised from alcohol, from which it separated in fine needles (0.63 g.), m. p. 98—110° (Found: C, 54.6; H, 5.5; S, 13.6. $C_{20}H_{24}O_7S_2$ requires C, 54.6; H, 5.5; S, 14.6%). Further recrystallisations from the same solvent gave a product, m. p. 113—118°. An admixture of this with 2 : 5-bishydroxymethyltetrahydrofuran ditoluene-*p*-sulphonate, m. p. 128°, prepared by Newth and Wiggins's method (*loc. cit.*) had m. p. 118—124° with shrinkage at 108—118°.

By fractional recrystallisation from a large volume of alcohol, the toluene-*p*-sulphonyl derivative was with difficulty separated into two fractions: (i) m. p. 118—122° unchanged after further recrystallisation and undepressed on admixture with Newth and Wiggins's compound (*loc. cit.*); (ii) m. p. 96—99° also unchanged by further recrystallisation (Found: C, 54.3; H, 5.2. $C_{20}H_{24}O_7S_2$ requires C, 54.6; H, 5.5%).

*Action of Sodium Iodide on the Toluene-*p*-sulphonyl Derivative of (A).*—The toluene-*p*-sulphonyl derivative (0.264 g.), m. p. 98—110°, was heated with anhydrous sodium iodide (0.75 g.) and dry acetone (10 c.c.) in a sealed tube at 105—110° for 5 hours. The precipitated sodium toluene-*p*-sulphonate was collected, washed with a little dry acetone, and dried at 110°. Yield, 0.234 g., 2.01 equivalents.

*Treatment of the Toluene-*p*-sulphonyl Derivative of (A) with Methyl Alcoholic Ammonia.*—The toluene-*p*-sulphonyl derivative (5.0 g.), m. p. 98—110°, was heated with dry methyl alcoholic ammonia (600 c.c.; saturated at 0°) in an autoclave at 160—170° for 24 hours. The methyl alcohol was evaporated in an atmosphere of nitrogen, and the residue was heated with a solution of barium hydroxide (5.4 g.) in water (70 c.c.) on the water-bath at 80—90° for 1 hour; the water was then removed under reduced pressure and the residue dried by evaporation with benzene. The solid was extracted under reflux four times with chloroform; the extract was dried ($MgSO_4$) and evaporated to a brown syrup (1.2 g.). Distillation of this material at atmospheric pressure yielded 8-oxa-3-azabicyclo[3 : 2 : 1]octane (0.32 g.), b. p. (bath temp.) 195—200°, n_D^{20} 1.4865 (Newth and Wiggins, *loc. cit.*, record b. p. 176—178°, n_D^{15} 1.4883). The toluene-*p*-sulphonate crystallised from alcohol-ether in needles, m. p. 200—202°, undepressed on admixture with an authentic specimen; the picrate gave yellow plates, m. p. 188—190°, from alcohol (the original authors record m. p. 188—189°); and the oxalate formed prisms (from alcohol), m. p. 261—262° alone or in admixture with an authentic specimen.

Action of Water on 3 : 4-iso-Propylidene 1 : 2-5 : 6-Dianhydromannitol.—*iso*Propylidene dianhydromannitol (0.5 g.) (Wiggins, *J.*, 1946, 384) was heated under gentle reflux with water (30 c.c.) for 7 hours; the solution was then evaporated under reduced pressure to a syrup (0.7 g.) which, after being dried by evaporation with benzene, crystallised completely. Recrystallisation from acetone-benzene gave 3 : 4-*isopropylidene* mannitol (0.41 g., 67%) in colourless needles, m. p. 80—81° alone or in admixture with an authentic specimen.

Action of Hydrochloric Acid on 1 : 2-5 : 6-Diepoxyhexane.—Diepoxyhexane (1.5 g.) was diluted with water (15 c.c.) and added to concentrated hydrochloric acid (15 c.c.). The solution was heated on the water-bath for 4 hours, then neutralised with sodium hydrogen carbonate and extracted with chloroform. The extract was dried ($MgSO_4$) and evaporated to an oil (1.6 g.) which was distilled under reduced pressure, giving 2-chloromethyl-5-hydroxymethyltetrahydrofuran (B) as a colourless oil (0.9 g., 46%), b. p. (bath temp.) 152—158°/15 mm., n_D^{19} 1.4840 (Found: C, 47.3; H, 7.7; Cl, 25.1; OH, 11.0. $C_6H_{11}O_2Cl$ requires C, 47.8; H, 7.3; Cl, 23.6; OH, 11.3%).

Action of Lead Tetra-acetate on 2-Chloromethyl-5-hydroxymethyltetrahydrofuran.—The chloro-compound (0.0304 g.) was treated with lead tetra-acetate in glacial acetic acid. The uptake of the reagent is recorded in Fig. 1.

Treatment of 2-Chloromethyl-5-hydroxymethyltetrahydrofuran with Thionyl Chloride.—The chloro-compound (1.3 g.) was dissolved in dry pyridine (4 c.c.) and thionyl chloride (1.5 c.c.) added dropwise with shaking and cooling in an ice-bath. A few grains of anhydrous magnesium sulphate were added and the mixture was heated on an oil-bath at 100° for 2½ hours. The product was poured into ice-water and extracted with ether; the extract was washed with dilute sodium hydrogen carbonate solution and with water, dried ($MgSO_4$), and evaporated to an oil (0.8 g.). Distillation under reduced pressure gave 2 : 5-bischloromethyltetrahydrofuran (0.5 g., 34%), b. p. (bath temp.) 120—126°/15 mm., n_D^{18} 1.4855 (Found: C, 42.7; H, 6.1; Cl, 43.8. Calc. for $C_6H_{10}OCl_2$: C, 42.6; H, 5.9; Cl, 42.0). Newth and Wiggins (*loc. cit.*) give b. p. (bath temp.) 130°/15 mm., n_D^{18} 1.4840.

Action of Sodium Methoxide on 1 : 2-5 : 6-Diepoxyhexane.—Sodium (2 g.) was dissolved in absolute methyl alcohol (40 c.c.) and diepoxyhexane (1.5 g.) was added. The solution was heated under reflux on the water-bath for 6 hours, diluted with water (100 c.c.), and extracted with chloroform. The extract was washed with water, dried ($MgSO_4$) and evaporated to a liquid residue (1.1 g.), distillation of which under reduced pressure gave 5-hydroxymethyl-2-methoxymethyltetrahydrofuran as a colourless oil (0.7 g., 36%), b. p. (bath temp.) 159—164°/15 mm., n_D^{19} 1.4511 (Found: C, 56.9; H, 9.6; OMe, 22.2; OH, 11.4. $C_8H_{14}O_3$ requires C, 57.5; H, 9.6; OMe, 21.2; OH, 11.6%).

Methylation of 5-Hydroxymethyl-2-methoxymethyltetrahydrofuran.—The monomethoxy-compound (0.39 g.) was heated overnight under gentle reflux with methyl iodide (10 c.c.) and dry silver oxide (1 g.). The methyl iodide was then evaporated and the residue extracted four times with boiling chloroform. The extract was dried ($MgSO_4$) and evaporated to an oil, which was re-subjected to the methyl iodide-silver oxide treatment. This process was repeated three times. The final oily product (0.31 g.) was distilled under reduced pressure giving 2 : 5-bismethoxymethyltetrahydrofuran as a colourless, mobile liquid (0.11 g.), b. p. (bath temp.) 90—95°/12 mm., 160—165°/250 mm., n_D^{21} 1.4370 (Found: OMe, 38.0. $C_8H_{16}O_3$ requires OMe, 38.7%).

Methylation of 2 : 5-Bishydroxymethyltetrahydrofuran.—The bishydroxy-compound (0.52 g.) (Haworth, Jones, and Wiggins, *J.*, 1945, 1) was heated under gentle reflux with methyl iodide (10 c.c.) and dry silver oxide (1 g.) for 16 hours. The product was isolated as in the preceding experiment; distillation of the crude material (0.63 g.) gave 2 : 5-bismethoxymethyltetrahydrofuran as a colourless, mobile liquid, b. p. (bath temp.) 90—95°/12 mm., $n_D^{19.5}$ 1.4369 (Found: C, 59.2; H, 9.8; OMe, 38.9. Calc. for $C_8H_{16}O_3$: C, 60.0; H, 10.0; OMe, 38.7%).

Action of Ammonia on 1 : 2 : 5 : 6-Diepoxyhexane.—Diepoxyhexane (2.0 g.) was heated with dry methyl alcoholic ammonia (400 c.c.; saturated at 0°) in an autoclave at 120° for 40 hours. The solution was evaporated to a syrup (2.5 g.) which on distillation gave the ring scission product (C) as a colourless, highly viscous syrup (1.5 g., 63%), b. p. (bath temp.) 132—138°/0.04 mm., n_D^{20} 1.5161, believed to be 5-hydroxy-2-hydroxymethylpiperidine (Found : C, 55.5; H, 10.0; N, 10.6. $C_8H_{15}O_3N$ requires C, 55.0; H, 9.9; N, 10.7%). The compound was freely soluble in water giving a strongly alkaline solution.

Acetylation of Compound (C) in Pyridine Solution.—The material (0.60 g.) was dissolved in dry pyridine (10 c.c.) and acetic anhydride (3 c.c.) added. The solution was kept at room temperature for 12 hours, then at 30° for a further 36 hours; thereafter it was poured into water and extracted with chloroform. The extract was washed successively with dilute sulphuric acid, sodium hydrogen carbonate solution, and water, dried ($MgSO_4$), and evaporated to a syrupy residue (0.89 g.). This was distilled under reduced pressure, giving the triacetyl derivative as a colourless, viscous syrup (0.82 g., 70%), b. p. (bath temp.) 159—162°/0.05 mm., n_D^{20} 1.4815 (Found : C, 56.1; H, 7.3; N, 5.5; O-Ac, 32.8. $C_{12}H_{19}O_5N$ requires C, 56.0; H, 7.4; N, 5.5; O-Ac, 33.4%).

Oxidation of Compound (C) with Sodium Periodate.—The syrup (C) (0.0520 g.) was treated with an excess (about 6 equivs.) of a standard solution of sodium metaperiodate in water. The reaction was followed by the periodical withdrawal of 1 c.c. portions of the reaction mixture, each being added to a solution of potassium iodide (about 1 g.) and sodium hydrogen carbonate (about 0.5 g.) in water (10 c.c.) and the liberated iodine titrated with 0.01N-sodium arsenite solution (see Fig. 2).

Action of Nitrous Acid on the Compound (C).—The syrup (C) (0.063 g.) was dissolved in water (3 c.c.), acidified (Congo-red) with hydrochloric acid and cooled to 0°. A solution of sodium nitrite (0.05 g.) in water (2 c.c.), also at 0°, was added; no evolution of gas took place. The mixture was allowed to attain room temperature and was kept thereat for 20 hours; it was then evaporated to dryness repeatedly with water until the residue had no action on moist starch-iodide paper. The residue was extracted several times with boiling ethyl acetate and the combined extracts evaporated. A residual brown syrup was obtained which gave a positive reaction to the Liebermann test for a nitroso-compound; the product was therefore the N-nitroso-derivative of (C).

Treatment of (C) with Toluene-p-sulphonyl Chloride.—The syrup (C) (0.10 g.) was dissolved in dry pyridine (5 c.c.) and toluene-p-sulphonyl chloride (0.7 g.) added at 0°. After being kept at 30° for 48 hours, the solution was poured into water and extracted with chloroform. The extract was washed successively with dilute sulphuric acid, sodium hydrogen carbonate solution, and water, dried ($MgSO_4$), and evaporated to a very viscous syrup (0.10 g.), which formed a brittle glass when cold but showed no tendency to crystallise on prolonged keeping. The product contained sulphur, was neutral to phenolphthalein in aqueous alcoholic solution, and was probably the tritoluene-p-sulphonyl derivative of (C) (Found : C, 55.9; H, 4.9. Calc. for $C_{27}H_{31}O_8NS_3$: C, 54.7; H, 5.2%).

Action of Sodium Iodide on the Toluene-p-sulphonyl Derivative of (C).—The compound (0.149 g.) was heated with dry sodium iodide (0.5 g.) and dry acetone (10 c.c.) in a sealed tube at 100—110° for 8 hours. Sodium toluene-p-sulphonate (1.2 equivs.) was obtained; evaporation of the acetone filtrate and extraction of the residue with water gave an insoluble material containing nitrogen, sulphur, and iodine.

Acetylation of Compound (C) in Methyl Alcohol Solution.—The syrup (C) (0.70 g.) was dissolved in absolute methyl alcohol (10 c.c.) and acetic anhydride (1 c.c.) added. The solution was kept at room temperature for 3 days, then evaporated in a vacuum over moist potassium hydroxide to a viscous syrup (0.63 g.); this product was distilled under reduced pressure and gave the N-acetyl derivative as a colourless viscous syrup, b. p. (bath temp.) 178—184°/0.05 mm., n_D^{20} 1.5128 (Found : C, 56.3; H, 8.95; N, 7.8. $C_8H_{15}O_3N$ requires C, 55.5; H, 8.7; N, 8.1%). The derivative was freely soluble in water but the solution exhibited only a very faintly alkaline reaction, indicating that acetylation of the nitrogen atom had occurred.

Treatment of the N-Acetyl Derivative with Toluene-p-sulphonyl Chloride.—The acetyl compound (0.14 g.) was treated with pyridine and toluene-p-sulphonyl chloride, as described for the syrup (C) (above). The syrupy product (0.21 g.) which contained sulphur, partly crystallised after prolonged storage. The resultant ditoluene-p-sulphonyl N-acetyl derivative of (C) (0.013 g.) was separated by filtration; it recrystallised from alcohol in clusters of needles, m. p. 135—136.5° (Found : C, 54.8; H, 5.7; N, 3.0. $C_{22}H_{27}O_7NS_2$ requires C, 54.9; H, 5.6; N, 2.9%).

Action of Sodium Iodide on the Ditoluene-p-sulphonyl N-Acetyl Derivative of (C).—This experiment was carried out on the original syrup before separation of the crystalline matter. The syrup (0.066 g.) when treated with dry sodium iodide (0.1 g.) and dry acetone (10 c.c.) gave sodium toluene-p-sulphonate (0.029 g., 1.07 equivs.). The acetone mother liquors were evaporated to dryness, extracted with water, and the insoluble matter taken up in chloroform. After being washed with water and dried ($MgSO_4$) the chloroform solution was evaporated to a syrupy residue (0.05 g.) which was found to contain both iodine and sulphur, confirming the replacement of only one toluene-p-sulphonyloxy-group.

Toluene-p-sulphonpiperidide.—Piperidine (0.85 g.) was dissolved in 10% sodium hydroxide solution (20 c.c.), powdered toluene-p-sulphonyl chloride (2.1 g.) was added, and the mixture was shaken vigorously for 20 minutes, the reaction being started by warming on the water-bath. The solid derivative was collected, washed with water and recrystallised from alcohol; it formed stout needles (1.6 g.), m. p. 95—96° (Staudinger and Schneider, *Ber.*, 1923, 56, 711, record m. p. 98—99° for toluene-p-sulphonpiperidide).

Treatment of Toluene-p-sulphonpiperidide with Sodium Iodide.—The toluene-p-sulphonyl derivative was heated with dry sodium iodide and dry acetone; no sodium toluene-p-sulphonate was formed.

Action of Lithium Aluminium Hydride on 1 : 2 : 5 : 6-Diepoxyhexane.—Lithium aluminium hydride was prepared essentially according to the method of Finholt, Bond, and Schlesinger (*J. Amer. Chem. Soc.*, 1947, 69, 1200); the following experiment was based on Nystrom and Brown's general procedure (*loc. cit.*).

To a solution of lithium aluminium hydride (0.5 g.) in ether (20 c.c.) a solution of diepoxyhexane

(0.5 g.) in dry ether (20 c.c.) was added slowly, with stirring. The warm mixture was gently refluxed on the water-bath with continuous stirring for $\frac{1}{2}$ hour. A further addition of lithium aluminium hydride (0.25 g.) in ether (10 c.c.) was then made and the mixture heated under reflux for 1 hour. The product was poured into ice-water acidified with sulphuric acid, the ether layer separated, and the aqueous layer extracted with more ether. The combined ethereal solutions were washed with sodium hydrogen carbonate solution and with water, dried (MgSO_4), and evaporated; the residual syrup weighed only 11 mg. The aqueous residues was therefore neutralised with sodium carbonate and evaporated to dryness under reduced pressure; the solid residue was extracted several times with ether under reflux, and the combined extracts dried (MgSO_4) and evaporated to a colourless viscous syrup (*D*) (0.33 g.), n_D^{20} 1.4480.

Duden and Lemme (*Ber.*, 1902, **35**, 1335) record hexane-2 : 5-diol as having n_D^{20} 1.4475.

Treatment of (D) with Toluene-p-sulphonyl Chloride.—The syrup (*D*) (0.08 g.) was dissolved in dry pyridine (2 c.c.) and toluene-p-sulphonyl chloride (0.4 g.) added at 0°. After being kept overnight at 30° the product was poured into water, and the solid derivative (0.09 g.) was collected and fractionally crystallised from alcohol, giving an initial fraction (*E*), prisms, m. p. 112.5–114°, and a final fraction (*F*), prisms, m. p. 71–74°.

Preparation of Hexane-2 : 5-diol from Acetylacetone.—The following experiment is a modification of the method of Hill and Adkins (*J. Amer. Chem. Soc.*, 1938, **60**, 1033).

Acetylacetone (10 g.) was diluted with alcohol (20 c.c.) and hydrogenated at 200–210° under 200 atmospheres pressure, in the presence of copper chromite catalyst (2 g.) (Lazier and Arnold, *Org. Synth.*, Coll. Vol. II, p. 142), for 2 hours. After filtration the solution was evaporated under reduced pressure giving hexane-2 : 5-diol as a viscous syrup (9 g.), n_D^{16} 1.4494.

Treatment of Hexane-2 : 5-diol with Toluene-p-sulphonyl Chloride.—Hexanediol (0.20 g.) was treated in dry pyridine (5 c.c.) with toluene-p-sulphonyl chloride (1.0 g.). The solid derivative (0.25 g.) was fractionally crystallised from dilute alcoholic solution, giving two forms of hexane-2 : 5-diol ditoluene-p-sulphonate: the first fraction formed prisms, m. p. 113–114°, undepressed on admixture with fraction (*E*) (Found: C, 56.7; H, 6.4. $\text{C}_{26}\text{H}_{28}\text{O}_8\text{S}_2$ requires C, 56.4; H, 6.1%); the final fraction also separated as prisms, m. p. 74–76°, not appreciably depressed on admixture with fraction (*F*) (Found: C, 56.2; H, 6.0%). The m. p. of the final fraction was also undepressed on admixture with the hexane-2 : 5-diol ditoluene-p-sulphonate, m. p. 74–77°, prepared by Newth and Wiggins (unpublished work) by acetolysis of 2 : 5-dimethyltetrahydrofuran.

Action of Lithium Aluminium Hydride on 3 : 4-isoPropylidene 1 : 2-5 : 6-Dianhydromannitol.—To a stirred solution of lithium aluminium hydride (1.2 g.) in dry ether (30 c.c.) isopropylidene dianhydromannitol (0.5 g.) dissolved in dry ether (20 c.c.) was added, and the mixture was gently refluxed for 2½ hours. An hour later it was poured into ice-water acidified with sulphuric acid, the ether layer was separated, the aqueous layer extracted with more ether, and the combined ethereal extracts were washed with sodium hydrogen carbonate solution and water, dried (MgSO_4), and evaporated under reduced pressure. The solid residue (0.21 g.) was recrystallised from light petroleum (40–60°) giving 3 : 4-isoPropylidene 1 : 6-dideoxymannitol as long, prismatic needles, m. p. 90.5–91.5°, $[\alpha]_D^{18}$ –3.9° (c, 0.51; in chloroform) (Found: C, 56.4; H, 9.4. $\text{C}_9\text{H}_{18}\text{O}_4$ requires C, 56.8; H, 9.5%).

Hydrolysis of 3 : 4-isoPropylidene 1 : 6-Dideoxymannitol.—3 : 4-isoPropylidene dideoxymannitol (0.1 g.) was heated with 0.1N-sulphuric acid (25 c.c.) at 70° for 1 hour. The solution was neutralised with barium carbonate, the whole was evaporated to dryness, and the residue was extracted with boiling ethyl acetate. Evaporation of the extract gave a crystalline residue (0.05 g.) which on recrystallisation from ethyl acetate yielded 1 : 6-dideoxymannitol in prisms, m. p. 142–144°, $[\alpha]_D^{20}$ –20.9° (c, 0.76; in water) (Found: C, 48.2; H, 9.4. Calc. for $\text{C}_6\text{H}_{14}\text{O}_4$: C, 48.0; H, 9.3%). The product gave a positive iodoform reaction, indicating the presence of the $\text{CH}_2\text{-CH}(\text{OH})\cdot$ group. The m. p. was not depressed on admixture with an authentic specimen prepared by Wiggins's method (*Nature*, 1949, **164**, 672). Micheel (*loc. cit.*) records m. p. 148°, $[\alpha]_D^{18}$ –17.6° (in chloroform) for 1 : 6-dideoxymannitol.

Action of Methylmagnesium Iodide on 1 : 2-5 : 6-Diepoxyhexane.—A solution of methylmagnesium iodide was prepared from magnesium (2.4 g., 2.4 mols.), methyl iodide (6.0 c.c., 2.4 mols.), and ether (30 c.c.). A solution of diepoxyhexane (4.4 g., 1 mol.) in dry ether (30 c.c.) was added dropwise with agitation at room temperature. Ether (10 c.c.) was then added and the reaction completed by gentle refluxing on the water-bath for 2½ hours. The mixture was poured into ice-water (300 c.c.) acidified with sulphuric acid, and the ether allowed to evaporate. The solid product (7.3 g.) was exhaustively extracted with ether under reflux, and the insoluble residue recrystallised from hot water, giving 1 : 6-di-iodo-2 : 5-dihydroxyhexane as colourless plates (0.4 g.), m. p. 116–117° (Found: C, 19.6; H, 3.5; I, 70.1. $\text{C}_6\text{H}_{12}\text{O}_2\text{I}_2$ requires C, 19.5; H, 3.2; I, 68.7%). The ether extract on evaporation gave a solid residue which was recrystallised from hot water containing a little alcohol; the isomeric 1 : 6-di-iodo-2 : 5-dihydroxyhexane was obtained as colourless prismatic needles (4.5 g.), m. p. 94–95° (Found: C, 19.8; H, 3.1; I, 68.8%). The aqueous filtrate from the reaction mixture was extracted with ether; evaporation of the extract gave a solid which on recrystallisation yielded a further quantity (0.3 g.) of the lower-melting iodo-compound. The m. p. of a mixture of the two isomers was 95–110°.

Action of Methylmagnesium Iodide on 3 : 4-isoPropylidene 1 : 2-5 : 6-Dianhydromannitol.—To an agitated solution of methylmagnesium iodide [prepared from magnesium (1.2 g., 2.4 mols.), methyl iodide (3 c.c., 2.4 mols.), and dry ether (20 c.c.)] a solution of isopropylidene dianhydromannitol (3.7 g., 1 mol.) in dry ether (20 c.c.) was added slowly at room temperature. The mixture was heated under reflux on the water-bath for 3 hours, and then poured into ice-water (300 c.c.) acidified with sulphuric acid. The ether layer was separated and the aqueous layer extracted with ether; the combined ether solutions were washed with sodium hydrogen carbonate solution and water, dried (MgSO_4), and evaporated. The resultant syrupy residue (7.5 g.) subsequently almost completely crystallised; recrystallisation from light petroleum (100–120°) gave 1 : 6-di-iodo 3 : 4-isoPropylidene 1 : 6-dideoxymannitol as long colourless needles (4.9 g., 54%), m. p. 84° (Found: C, 24.9; H, 3.7; I, 57.1. $\text{C}_9\text{H}_{16}\text{O}_4\text{I}_2$ requires C, 24.4; H, 3.6; I, 57.5%).

Hydrolysis of 1:6-Di-iodo 3:4-isoPropylidene 1:6-Dideoxymannitol.—The isopropylidene compound (0.15 g.) was boiled with hydrochloric acid (10 c.c.; 2%) until all the oily material had dissolved. On cooling, 1:6-di-iodo 1:6-dideoxymannitol was deposited as pale yellow plates (0.09 g.), m. p. 165–166° (decomp.). Wiggins (*J.*, 1946, 384) records m. p. 165–167° (decomp.).

Methylenation of 1:6-Di-iodo 1:6-Dideoxymannitol.—Di-iodo dideoxymannitol was suspended in approximately twenty times its weight of 40% formalin, and hydrogen chloride passed in at 0° until the solution was saturated. After 2 days at 0° the mixture was diluted with water and the solid collected; recrystallisation from alcohol gave 1:6-di-iodo 2:4-3:5-dimethylene 1:6-dideoxymannitol in prisms, m. p. 192–193.5° alone or in admixture with an authentic specimen (Wiggins, *J.*, 1946, 384).

Treatment of 1:6-Di-iodo-2:5-dihydroxyhexane, m. p. 94–95°, with Silver Acetate.—(i) *In aqueous alcoholic solution.* A solution of silver acetate (1.5 g., 2.2 mols.) in hot water (30 c.c.) was added to the iodo-compound (1.53 g.) in water (25 c.c.) and alcohol (25 c.c.). Silver iodide was immediately precipitated; the reaction was completed by heating under reflux for 3 hours, and the yield of silver iodide was then quantitative. The combined filtrate and washings from the removal of the iodide were evaporated under reduced pressure giving a colourless syrup (0.73 g.), which was acetylated by use of acetic anhydride (4 c.c.) and dry pyridine (20 c.c.). The syrupy product (0.62 g.) was distilled giving 2:5-bisacetoxymethyltetrahydrofuran as a colourless, somewhat viscous liquid (0.36 g.), b. p. 158–164°/15 mm., n_D^{25} 1.4511 (Found: C, 55.6; H, 7.45; O-Ac, 39.3. Calc. for $C_{10}H_{16}O_5$: C, 55.6; H, 7.4; O-Ac, 39.8%). Haworth, Jones, and Wiggins (*loc. cit.*) record b. p. (bath temp.) 115°/0.015 mm., n_D 1.4515.

The acetyl compound (0.09 g.) was hydrolysed by heating it with 0.1N-sodium hydroxide solution (25 c.c.) at 90° for 3 hours. The solution was neutralised with hydrochloric acid and evaporated to dryness. Boiling-chloroform extraction of the residue gave a syrup (0.04 g.), which was then treated with toluene-*p*-sulphonyl chloride (0.12 g.) in dry pyridine (5 c.c.) at 0°. 2:5-Bishydroxymethyltetrahydrofuran ditoluene-*p*-sulphonate (0.03 g.) was obtained as needles (from alcohol), m. p. 111–115° undepressed on admixture with a specimen obtained by direct hydrolysis of diepoxyhexane.

(ii) *In absolute alcoholic solution.* Finely powdered, dry silver acetate (2.0 g., 3 mols.) was added to a solution of the iodo-compound (1.5 g.) in absolute alcohol (100 c.c.) and the mixture was heated under reflux on the water bath for 4 hours, silver iodide was filtered off and the filtrate was evaporated to about 15 c.c.; a strong odour of acetic acid was noticed. The residue was diluted with chloroform, washed with sodium carbonate solution and with water, dried ($MgSO_4$), and evaporated to an oil which on distillation gave 1:2-5:6-diepoxyhexane (0.16 g., 35%), b. p. (bath temp.) 125–129°/50 mm., n_D^{18} 1.4410.

The product (0.11 g.) was boiled with water (10 c.c.) for 7 hours, and the solution evaporated to a syrup (0.13 g.) which was dried by evaporation with benzene. The syrup was treated with toluene-*p*-sulphonyl chloride (0.32 g.) in dry pyridine (5 c.c.) giving 2:5-bishydroxymethyltetrahydrofuran ditoluene-*p*-sulphonate in needles (from alcohol), m. p. 109–113° not depressed on admixture with a specimen obtained from authentic diepoxyhexane.

Action of Silver Acetate on 1:6-Di-iodo 3:4-isoPropylidene 1:6-Dideoxymannitol.—The iodo-compound (1.2 g.) was heated with absolute alcohol (100 c.c.) and dry, finely powdered silver acetate (1.1 g.) under vigorous reflux for 3 hours. A further quantity (0.5 g.) of silver acetate was added and the mixture heated for 1½ hours. The silver iodide was filtered off and the filtrate, which possessed a strong odour of acetic acid, concentrated to a small bulk; chloroform was added, the solution was washed with sodium hydrogen carbonate solution and water, dried ($MgSO_4$), and evaporated. Distillation of the syrupy residue (0.48 g.) afforded 3:4-isopropylidene 1:2-5:6-dianhydromannitol (0.34 g., 67%), b. p. (bath temp.) 138–143°/12 mm., n_D^{19} 1.4530, $[\alpha]_D$ zero (in chloroform) (Found: C, 58.3; H, 7.8. Calc. for $C_9H_{14}O_4$: C, 58.1; H, 7.5%). Hydrolysis of the product with dilute acid gave acetone (detected by the iodoform reaction) and mannitol, m. p. 162–163°.

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