Synthetic Nucleosides. LXVI. Studies on the Synthesis of *cis*-2,3-Diamino Sugars. VI. Neighboring Group Reactions with Methyl 4,6-*O*-Benzylidene-3-deoxy-2-*O*-methanesulfonyl-3-thioureido-α-D-glucopyranoside[1a,b]

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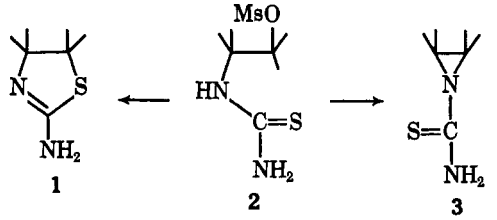
Methyl 4,6-*O*-benzylidene-3-deoxy-2-*O*-methanesulfonyl-3-thioureido-α-D-glucopyranoside (**10**) cyclized in pyridine or in methanolic sodium methoxide solution to give the thiazoline, 2-amino-4′,6′-*O*-benzylidene-1′-*O*-methyl-α-D-mannopyrano[3′,2′:4,5]-2-thiazoline (**11**). These results further confirm the view that in a strongly basic medium a sugar derivative possessing a nucleophilic trifunctional neighboring group and a suitable leaving group in a *trans*-diequatorial disposition will cyclize to form a five-membered ring rather than the thermodynamically less stable aziridine.

In previous papers in this series it was shown that the nitroguanidino,[2] thioureido,[3] ureido,[4] and guanidino[5] derivatives of methyl 4,6-*O*-benzylidene-3-deoxy-2-*O*-methanesulfonyl- and the ureido and thioureido[1a] derivatives of methyl 4,6-*O*-benzylidene-2-deoxy-3-*O*-(*p*-tolylsulfonyl)-α-D-altropyranosides undergo ring closure in pyridine to form five-membered rings (*e.g.*, **2** to **1**) and in methanolic sodium methoxide to form aziridines (**2** to **3**).[6] The facility of these reactions is believed due to the *trans*-diaxial disposition of the attacking and departing groups.[3,1a]



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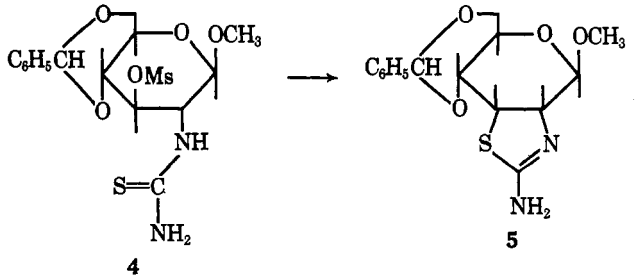
On the other hand, methyl 4,6-*O*-benzylidene-2-deoxy-3-*O*-methanesulfonyl-2-thioureido-β-D-glucopyranoside (**4**) undergoes ring closure in either pyridine or methanolic sodium methoxide to form only the thiazoline **5**.[3] The single mode of ring closure of **4** is presumably due to the *trans*-diequatorial disposition of the 2- and 3-substituents; *i.e.*, the anion of the



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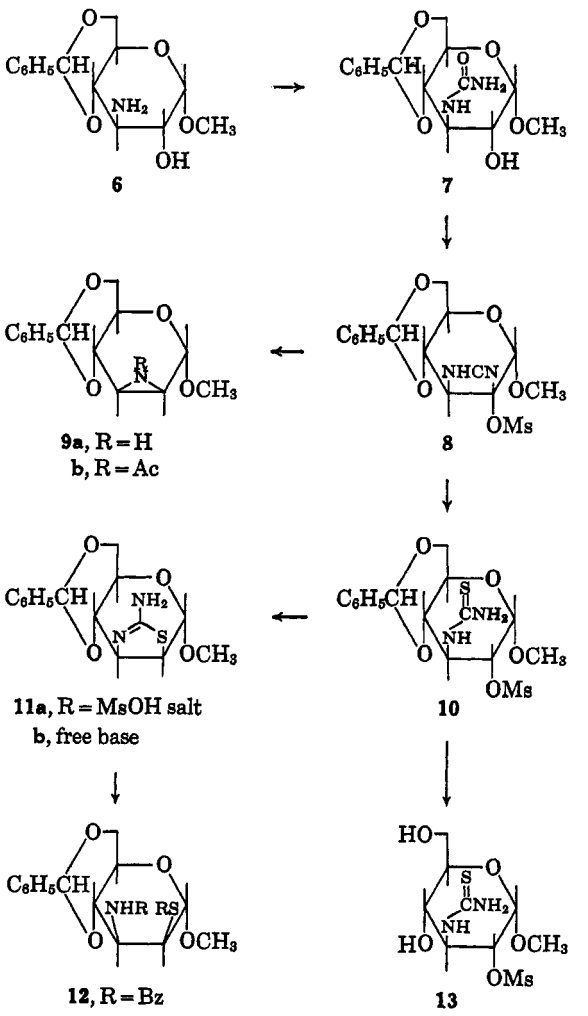
secondary nitrogen atom of the thioureido moiety is not suitably positioned to effect a ready nucleophilic displacement of the sulfonate ion. To study this phenomenon further, the ring closures of methyl 4,6-*O*-benzylidene-3-deoxy-2-*O*-methanesulfonyl-3-thioureido-α-D-glucopyranoside (**10**), which has *trans*-diequatorial substituents, and some related derivatives of **10** in pyridine and methanolic sodium methoxide were examined. The results form the subject of this paper.

SCHEME I



The route used for the synthesis of **10** has been employed earlier[3] and is outlined in Scheme I. Reaction of methyl 3-amino-4,6-*O*-benzylidene-3-deoxy-α-D-glucopyranoside (**6**)[7,8] with cyanic acid in aqueous eth-

(1) (a) For the previous paper in this series, see B. R. Baker and T. L. Hullar, *J. Org. Chem.*, **30**, 4038 (1965). (b) This work was supported in part by Grant CY-5845 of the National Cancer Institute, U. S. Public Health Service. (c) National Science Foundation Postdoctoral Fellow, 1963–1964.

(2) B. R. Baker and T. Neilson, *J. Org. Chem.*, **29**, 1047 (1964).

(3) B. R. Baker and T. Neilson, *ibid.*, **29**, 1051 (1964).

(4) B. R. Baker and T. Neilson, *ibid.*, **29**, 1057 (1964).

(5) B. R. Baker and T. Neilson, *ibid.*, **29**, 1063 (1964).

(6) Abbreviations used: Ac = acetyl; Bz = benzoyl; Ms = mesyl = methanesulfonyl; and Ts = tosyl = *p*-tolylsulfonyl.

(7) R. D. Guthrie and L. F. Johnson, *J. Chem. Soc.*, 4166 (1961).

(8) G. J. F. Chittenden and R. D. Guthrie, *ibid.*, 2358 (1963).

anol[3,1a] gave methyl 4,6-*O*-benzylidene-3-deoxy-3-ureido-α-D-glucopyranoside (**7**) in 87% yield. Treatment of **7** with 4.4 molar equiv. of mesyl chloride gave a 76% yield of crystalline methyl 4,6-*O*-benzylidene-3-cyanamido-3-deoxy-2-*O*-methanesulfonyl-α-D-glucopyranoside (**8**). It is noteworthy that this reaction afforded only the more customary[2-5] *O*-mesylation and did not give *N*-mesylation as was observed for the 2-amino-*altro* isomer.[1a]

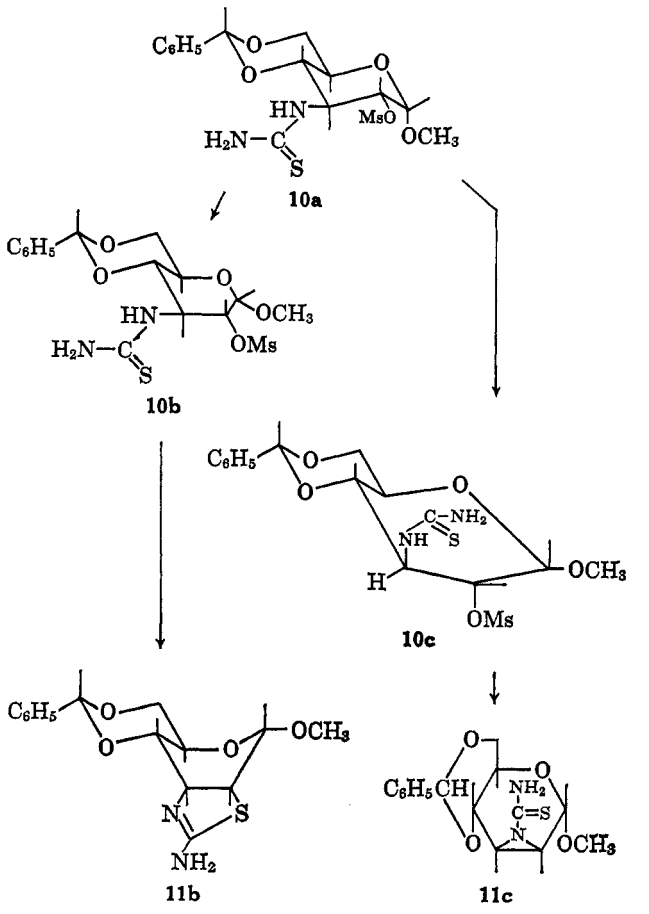
Alkaline hydrolysis[4] of **8** gave methyl 4,6-*O*-benzylidene-2,3-dideoxy-2,3-imino-α-D-mannopyranoside (**9a**)[9] in 92% yield. The identity of **9a** was established by conversion to its crystalline *N*-acetyl derivative **9b**.[9]

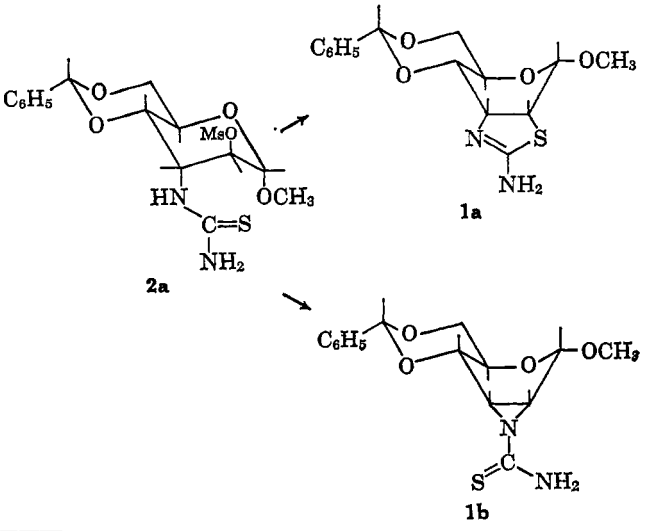
Hydrogen sulfide smoothly added to the cyanamide **8** to give methyl 4,6-*O*-benzylidene-3-deoxy-2-*O*-methanesulfonyl-3-thioureido-α-D-glucopyranoside (**10**). Reaction of **10** with hot pyridine or with hot methanolic sodium methoxide furnished 2-amino-4′,6′-*O*-benzylidene-1′-*O*-methyl-α-D-mannopyrano[3′,2′:4,5]-2-thiazoline (**11b**) which was isolated as its crystalline methanesulfonate salt **11a**. That ring closure by sulfur attack to give the thiazoline had occurred was proved by alkaline hydrolysis of **11a** followed by benzoylation to give methyl 3-benzamido-*S*-benzoyl-4,6-*O*-benzylidene-2,3-dideoxy-2-mercapto-α-D-mannopyranoside (**12**). Thus, both **10** and its 2-amino-β-D-*gluco* isomer (**4**)[3] react in weakly basic and in strongly basic media to give thiazolines; in contrast, thiazolines and aziridines, respectively, were obtained with the *altro* isomers of **10**.[1a,2-5]

The most evident explanation for this contrasting behavior is based on conformational arguments. Nucleophilic displacement of a mesylate group requires that the approaching nucleophile be disposed 180° to the leaving group. In an intramolecular displacement, this normally requires that the groups involved be *trans*-diaxial to each other. The thioureido and mesylate groups in methyl 4,6-*O*-benzylidene-3-deoxy-2-*O*-methanesulfonyl-3-thioureido-α-D-altropyranoside (**2**) are so disposed. As a consequence little or no deformation of the pyranose chair conformer **2a** is required to effect displacement of the mesylate by the secondary nitrogen, sulfur, or primary nitrogen atoms to form aziridine, thiazole, or imidazole rings. Thus, since the basicity of pyridine is insufficient to form the anion of the thioureido group, the sulfur atom, being the most nucleophilic of the three possible attacking atoms under these acid-acceptor conditions, effects displacement to furnish the thiazoline **1a**.

The basicity of methanolic sodium methoxide is sufficient to form an anion of the thioureido moiety. Nucleophilic displacement by the anion of the primary nitrogen or by the sulfur would be deterred by the repulsive effect of the axial C-1 methoxyl.[10] Ring closure by the anion of the secondary nitrogen atom would be less affected by this repulsive force since the secondary nitrogen is fixed in the most favorable position for anchimeric displacement of the mesylate moiety. Consequently, even though an aziridine ring is thermodynamically less stable than a thiazoline ring, kinetic control predominates when **2a** is treated with methanolic sodium ethoxide,[3] and the aziridine **1b** is the only isolated product. The same results and argu-

SCHEME II





(9) (a) D. H. Buss, L. Hough, and A. C. Richardson, *J. Chem. Soc.*, 5295 (1963); (b) R. D. Guthrie and D. Murphy, *ibid.*, 5288 (1963).

(10) A repulsion due to the axial C-1 methoxyl has been observed.[9a] Treatment of methyl 2-benzamido-4,6-*O*-benzylidene-2-deoxy-3-*O*-methanesulfonyl-α-D-altropyranoside with ethanolic sodium ethoxide gave the aziridine and oxazoline in a ratio of about 2:1, respectively. This may be compared to a ratio of about 4:1 of aziridine to oxazoline when *trans*-2-benzamidocyclohexyl *p*-tolylsulfonate was similarly treated.[11a] However, the action of ethanolic sodium ethoxide on methyl 3-benzamido-4,6-*O*-benzylidene-3-deoxy-2-*O*-methanesulfonyl-α-D-altropyranoside gave only the imine. This exclusive formation of the aziridine is considered to arise from repulsive interaction of the C-1 methoxyl with the benzoyl group, thus preventing oxazoline formation.[9a]

Results of a similar study[11b] suggest that in the reaction of *trans*-2-benzamidocyclohexyl methanesulfonate to form an oxazoline, the chair form accounts for 70% of the product and the boat form for 30%.

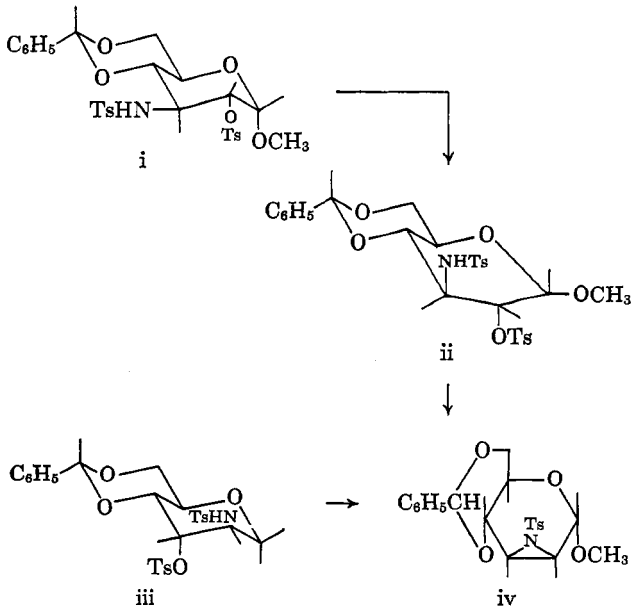
(11) (a) T. Taguchi and M. Kojima, *J. Am. Chem. Soc.*, **81**, 4316 (1959). (b) J. Sicher, M. Tichy, F. Sipos, and M. Pankova, *Proc. Chem. Soc.*, 384 (1960); *Collection Czech. Chem. Commun.*, **26**, 2418 (1961).

ments can be used for the compounds derived from 2-amino-2-deoxy-D-altrose.[1a]

In the *gluco* isomer **10a**, the mesylate and thioureido groups are *trans*-diequatorial to each other (Scheme II). Even though the thiocarbamoyl moiety can freely rotate, inspection of models shows that such rotation in the chair conformer **10a** does not permit the sulfur or primary nitrogen atoms to be directly behind the mesylate group. Conversion of the chair conformer **10a** to a half-chair **10b** allows closer proximity of the sulfur atom to the rear of the C-2 substituent. The stability of this conformer would be lessened by the eclipsing of the C-1, C-2, and C-3 substituents. The alternative conformer which could lead to the thiazoline **11** is the boat form **10c**. This conformer, however, suffers from strong interactions between the C-5 hydrogen and the bulky C-2 mesyloxy group.

The conformational requirements for the formation of **11** and the most probable intermediate are clarified by the observation that the reaction of **10** with methanolic sodium methoxide gives the thiazoline **11b** as the only isolable product. The boat form **10c** maintains a *trans*-diaxial disposition of the 2,3 substituents. If **10c** were the principal conformer in which ring closure in methanolic sodium methoxide occurs, the aziridine **11c** should be the predominant product.[12] Since the thiazoline **11b**, and not the aziridine, is obtained, it is therefore suggested that the half-chair conformer **10b** is the predominant intermediate in the formation of **11** from **10**.

(12) This may be expected because an aziridine is the only product isolated from methanolic sodium methoxide solution when the attacking and departing groups are *trans*-diaxial in the most stable chair conformation, *e.g.*, **2a** gives only **1b**. Furthermore, additional studies[13] suggest that conversion to **10a** to **10c** is not a facile reaction. Thus methyl 4,6-*O*-benzylidene-3-deoxy-3-(*p*-tolylsulfonamido)-2-*O*-(*p*-tolylsulfonyl)-α-D-glucopyranoside (i), in which the C-2, C-3 substituents are *trans*-diequatorial, is only slowly converted to the *N*-tosylimine iv when compared with an isomer where the C-2, C-3 substituents are *trans*-diaxial, namely, methyl 4,6-*O*-benzylidene-2-deoxy-2-(*p*-tolylsulfonamido)-3-*O*-(*p*-tolylsulfonyl)-α-D-altropyranoside (iii). The steric requirements for this cyclization reaction almost certainly require that i convert to the boat form ii, where attacking and departing groups are *trans*-pseudodiaxial, before ring closure occurs.



The apparent reluctance of i to convert to ii suggests, therefore, that formation of the aziridine **11c** cannot compete effectively with formation of the thiazoline **11a**, particularly since a strict *trans*-diaxial orientation of the C-2, C-3 substituents of **10** need not be obtained in the transition state leading to the thiazoline.

(13) B. R. Baker and T. L. Hullar, *J. Org. Chem.*, **30**, 4049 (1965).

The predominance of thiazoline formation and the lack of aziridine formation might be due to a conformational rigidity of the pyranose ring imposed by the 4,6-*O*-benzylidene group. To study this possibility, the ring-closure reactions of methyl 3-deoxy-2-*O*-methanesulfonyl-3-thioureido-α-D-glucopyranoside (**13**) were examined.

Treatment of **10** with aqueous methanol at room temperature in the presence of cation-exchange resin (H^+ form) effected hydrolysis of the benzylidene group to give **13**. Unfortunately, reaction of **13** with sodium methoxide and all subsequent transformations gave sirupy, heterogeneous products which could not be adequately purified. The results obtained, however, suggested that at least some ring closure of **13** occurred by sulfur attack.

Experimental Section[14]

Methyl 4,6-*O*-Benzylidene-3-deoxy-3-ureido-α-D-glucopyranoside (7).—To a solution of methyl 3-amino-4,6-*O*-benzylidene-3-deoxy-α-D-glucopyranoside[7,8] (8.63 g., 30.7 mmoles) in ethanol (130 ml.) at room temperature was added an aqueous solution (130 ml.) of potassium cyanate (3.73 g., 46.1 mmoles) and acetic acid (2.37 ml., 41.5 mmoles). The resulting solution was kept at room temperature for 1.25 hr. and was then refluxed for 1.0 hr. After standing overnight at 5°, the thick gel-like mixture was filtered. The gel was washed with cold 95% ethanol (50 ml.), refluxed with 95% ethanol (175 ml.) for 5 min., and then kept at 5° for 4 hr. The mixture was filtered and dried to give **7** as a white, amorphous powder (8.66 g., 87%) that was suitable for subsequent transformations.

To obtain the analytical sample, the gel-like mixture obtained as above was collected by filtration and washed with cold water (two 25-ml. portions 0.500 g. of **6**) to give **7** in 80% yield. Crude **7** (0.200 g.) was refluxed with ethanol (6 ml.) and the hot solution was decanted. After the third treatment, the decanted solution was cooled overnight at 5°. The resulting mixture was filtered, and the gel was dried to give pure **7** of indeterminate melting point with no softening below 295°: λ_{max} 2.90, 3.00 (NH), 6.05 (C=O), 6.25, 6.38 (NH), 13.44, and 14.45 μ (phenyl).

Anal. Calcd. for $C_{15}H_{20}N_2O_6$ (324.2): C, 55.53; H, 6.22; N, 8.64. Found: C, 55.56; H, 6.30; N, 8.62.

Methyl 4,6-*O*-Benzylidene-3-cyanamido-3-deoxy-2-*O*-methanesulfonyl-α-D-glucopyranoside (8).—To an ice-cooled, stirred solution of **7** (0.248 g., 0.76 mmole) in pyridine (15 ml.) was added mesyl chloride (0.25 ml., 3.30 mmoles) dropwise. A white precipitate appeared after 10 min. The mixture was kept at 5° for 22 hr. protected from moisture, and then poured onto crushed ice (40 g.). The aqueous mixture was extracted with chloroform (three 10-ml. portions), and the combined chloroform solutions were washed with water (three 10-ml. portions), dried, and concentrated. After decolorization in ethanol, **8** was crystallized from ethyl acetate–petroleum ether (0.216 g., 76%), m.p. 175–178°. Recrystallization from the same solvents gave the analytical sample: m.p. 188–190°; λ_{max} 3.01 (NH), 4.49 (C≡N), 7.38, 8.48 (sulfonate), 13.30, and 14.36 μ (phenyl).

Anal. Calcd. for $C_{16}H_{20}N_2O_7S$ (384.4): C, 49.99; H, 5.24; N, 7.29; S, 8.34. Found: C, 49.97; H, 5.34; N, 7.14; S, 8.31.

Methyl 4,6-*O*-Benzylidene-2,3-dideoxy-2,3-imino-α-D-mannopyranoside (9a).—A suspension of **8** (0.100 g.) in 0.2 *N* sodium hydroxide (5 ml.) was refluxed 2 hr. The resulting solution

(14) Melting points were taken with a Fisher-Johns melting block and those below 230° are corrected. Infrared spectra were determined in KBr disks, unless otherwise indicated, with a Perkin-Elmer Model 137B spectrophotometer. Petroleum ether used throughout was a fraction of b.p. 30–60°. Thin layer chromatography (t.l.c.) was done with silica gel G using chloroform–acetone (4:1 by volume) as the solvent system; the compounds were detected by exposing the plates to iodine vapor, and the relative proportions of the components were estimated visually. Chloroform extracts were dried over anhydrous magnesium sulfate. All solutions were concentrated by spin evaporation at 60–70° at reduced pressure (aspirator) unless otherwise indicated. Whenever pyridine was employed in a reaction, the residual pyridine in the chloroform extract was always removed by repeated spin evaporation of toluene until the odor of pyridine was absent.

was diluted with water (10 ml.), neutralized with carbon dioxide, and extracted with three 10-ml. portions of chloroform. The combined chloroform solutions were washed with two 10-ml. portions of water, dried, and concentrated to give sirupy **9a** (0.067 g., 92%). Trituration of the sirup with ethanol–petroleum ether gave crystalline **9a** (0.038 g.), m.p. 144–145° (lit.[9a] m.p. 145–146°).

Reactions of **9a** (0.010 g.) with acetic anhydride in pyridine gave crystalline **9b** (0.012 g.), m.p. 203–205° [lit. (for the *N*-acetyl derivative of **9a**) m.p. 205–206°,[9b] 211–212°[9a]].

Methyl 4,6-*O*-Benzylidene-3-deoxy-2-*O*-methanesulfonyl-3-thioureido-α-D-glucopyranoside (10).—Into a solution of **8** (0.100 g., 0.26 mmole) in pyridine (1.2 ml.) was bubbled hydrogen sulfide gas for 15 min. The brown solution was kept at room temperature for 17 hr. in a stoppered flask, diluted with toluene (10 ml.), and concentrated to a white powder (0.114 g.). The product was recrystallized from hot ethanol to give **10** (0.072 g., 66%), m.p. 166–170°. A second recrystallization from ethanol gave crystals which exhibited the following behavior: 166°, softened; 170°, resolidified; 193–196°, melted. Recrystallization from chloroform gave the analytical sample: m.p. 165–167° with sintering at 125°; λ_{max} 3.00, 3.03, 3.11 (NH), 6.17, 6.64 (NH), 7.40, 8.55 (sulfonate), 7.60 (C=S), 13.40, and 14.45 μ (phenyl).

Anal. Calcd. for $C_{16}H_{22}N_2O_7S_2$ (418.5): C, 45.92; H, 5.30; N, 6.69; S, 15.32. Calcd. for $C_{16}H_{22}N_2O_7S_2 \cdot H_2O$ (436.5): C, 44.08; H, 5.50; N, 6.42; S, 14.68. Found: C, 44.21; H, 5.13; N, 6.42; S, 14.69.

2-Amino-4′,6′-*O*-benzylidene-1′-*O*-methyl-α-D-mannopyrano-[3′,2′:4,5]-2-thiazoline (11b) and Methanesulfonate (11a). A.—A stirred solution of **10** (0.200 g. 0.48 mmole) in pyridine (6.7 ml.) was refluxed for 2 hr., and then poured into water (10 ml.). The aqueous solution was extracted with chloroform (three 10-ml. portions), and the combined chloroform solutions were washed with two 10-ml. portions of water, dried, and concentrated to a glass (0.146 g., 95%). Addition of a solution of methanesulfonic acid (0.43 mmole) in ethyl acetate (1 ml.) to an ice-cooled solution of the glass (0.146 g.) in ethyl acetate (2 ml.) gave a crystalline solid immediately. After standing 2 days at 5°, the crystals of **11a** were collected (0.170 g., 85%), m.p. 211–216° dec. Recrystallization from ethanol–petroleum ether gave the analytical sample of **11a**: m.p. 214–216° dec.; λ_{max} 3.1–3.6 (broad, ammonium), 6.03 (NH, C=H), 8.3 (ionic sulfonate), 13.3, and 14.4 μ (phenyl).

Anal. Calcd. for $C_{16}H_{22}N_2O_7S_2$ (418.5): C, 45.92; H, 5.30; N, 6.69; S, 15.32. Found: C, 46.05; H, 5.44; N, 6.53; S, 15.19.

A suspension of **11a** (0.073 g.) in saturated sodium bicarbonate (10 ml.) was extracted with three 6-ml. portions of chloroform. The combined chloroform solutions were processed as above to give **11b** as a colorless glass (0.050 g., 90%): λ_{max} 2.84, 2.94, 3.20 (NH), 6.00, 6.05 (C=N, NH), 13.26, and 14.28 μ (phenyl), no absorption at 8.5 μ (sulfonate).

Anal. Calcd. for $C_{15}H_{18}N_2O_4S$ (322.4): C, 55.88; H, 5.63; N, 8.69; S, 9.94. Found: C, 55.80; H, 5.83; N, 8.53; S, 9.63.

B.—A suspension of **10** (0.200 g., 0.48 mmole) in methanol (5 ml.) containing sodium methoxide (1 mmole) was stirred at reflux for 4 hr. The resulting solution was cooled, neutralized with carbon dioxide, and then poured into water (10 ml.). The aqueous solution was extracted with chloroform (three 10-ml. portions), and the combined chloroform solutions were processed as in A to give a glass (0.157 g., quantitative) whose infrared spectrum was identical with that for **11b** obtained above. Conversion of the glass to the methanesulfonate salt afforded **11a**, m.p. 216–219° dec. with sintering at 202°; infrared spectrum was identical with that for **11a** obtained in part A.

If the treatment with methanolic sodium methoxide was interrupted after 2 hr. of reflux, ring closure was incomplete as judged by infrared analysis (absorption at 7.4 and 8.5 μ of sulfonate).

Methyl 3-Benzamido-*S*-benzoyl-4,6-*O*-benzylidene-2,3-dideoxy-2-mercapto-α-D-mannopyranoside (12).—A suspension of **11a** (0.100 g.) was refluxed in 5 *N* sodium hydroxide (5 ml.) for 18 hr. The solution was diluted with water (15 ml.) and chloroform (5 ml.). Benzoyl chloride (0.53 ml.) was added, and the solution was stirred vigorously for 1.5 hr. at room temperature. The mixture was neutralized to pH 8–9 by addition of acetic acid and was then extracted with chloroform (three 10-ml. portions). The combined chloroform extracts were washed with water (three 10-ml. portions), dried, and concentrated to a glass which, by infrared analysis, was shown to contain benzoic anhydride. A solution of the glass in pyridine (5 ml.) and ethanol (2 ml.) was kept at room temperature for 1 hr. to destroy the benzoic anhydride and then processed as above to give a semicrystalline sirup. This mixture was decolorized in ethanol and crude **12** (0.052 g.), m.p. 213–217°, was obtained from ethanol–petroleum ether. Recrystallization from ethyl acetate–petroleum ether gave the analytical sample: m.p. 221–223°; λ_{max} 2.94 (NH), 6.00, 6.04 (C=O), 6.31 (C=C), 6.55 (NH), 14.00, 14.25, and 14.45 μ (phenyl).

Anal. Calcd. for $C_{28}H_{27}NO_6S$ (505.6): C, 66.52; H, 5.38; N, 2.77; S, 6.34. Found: C, 66.15; H, 5.22; N, 3.04; S, 6.44.

Methyl 3-Deoxy-2-*O*-methanesulfonyl-3-thioureido-α-D-glucopyranoside (13).—A suspension of **10** (0.300 g.) and Dowex-50 (H^+)[15] (1.20 g.) in 80% methanol (20 ml.) was stirred 13 hr. at 28° to give a turbid solution. The solution was clarified by centrifugation, and the clear solution was concentrated to a glass (0.225 g., 96%).

Anal. Calcd. for $C_9H_{18}N_2O_7S_2$ (330.4): C, 32.72; H, 5.49; N, 8.48; S, 19.41. Found: C, 32.95; H, 5.59; N, 8.39; S, 19.32.

The glass subsequently crystallized as needles from ethanol: m.p. 162–164°; λ_{max} 2.80, 2.94, 3.08 (NH), 6.18, 6.42 (NH), 7.47, 7.55 (sulfonate, C=S), 8.55, and 8.62 μ (sulfonate), no absorption at 13.3 or 14.4 μ (phenyl).

When the hydrolysis was carried out at reflux for 4 hr.,[3] a glass was obtained in 66% yield: λ_{max} 3.0–3.5 (broad), 6.02, 6.24 (C=N, NH), 7.4 (sulfonate), and 8.3–8.5 μ (ionic and covalent sulfonate), no absorption at 13.3 or 14.4 μ (phenyl). This suggests that ring closure of **13** to form the thiazoline was a facile reaction.[16]

(15) Product of the Dow Chemical Co., Midland, Mich.

(16) Ring closure prior to hydrolysis seems less likely since ring closure of **10** required refluxing for 4 hr. in the more strongly basic methanolic sodium methoxide.