to give (−)-8, which on purification by preparative VPC afforded the analytical sample, $[\alpha]^{27}D$ −6.5°.

trans-1-Phenyl-2-buten-1-ol:[19] ir (liquid) $\delta_{=CH}$ (trans) 958 cm^{-1}; ^1H NMR (CCl_4) δ 1.72 (m, 3 H, CH_3), 2.56 (s, 1 H, OH), 4.94–5.84 (m, 3 H, CH and CH=CH), 7.34 (m, 5 H, phenyl).

Acknowledgment. The authors are grateful to Professor R. K. Hill of the University of Georgia for his valuable suggestion to this work.

Registry No.—(−)-1, 57128-66-2; (−)-1 tartrate, 57128-67-3; (+)-1, 51773-65-0; (+)-1 malate, 57066-04-3; (±)-1, 57128-68-4; (−)-2, 57066-05-4; 3 picrate, 57066-07-6; 4, 51729-87-4; (−)-5, 51729-88-5; (−)-6, 22135-49-5; (+)-7, 57066-08-7; (−)-8, 57066-09-8; (−)-9, 39516-03-5; (−)-9 phenylurethane, 57066-10-1; (+)-*trans*-1-phenyl-3-benzoylamino-1-butene, 57066-11-2; (−)-benzoylalanine methyl ester, 7260-27-7; *trans*-1-phenyl-2-buten-1-ol, 52755-39-2.

References and Notes

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(2) In the preliminary communication,[1] we erroneously deduced the *R* configuration to (−)-1 based on the catalytic hydrogenation of (−)-1 to give (+)-1-phenyl-3-aminobutane, to which the *R* configuration was inferred by Červinka.[9] In contrast, the opposite *S* configuration was claimed for the same (+) enantiomer by Terent'ev [*Zh. Obshch. Khim.*, **35**, 1538 (1965); *Chem. Abstr.*, **63**, 17854*h* (1965)]. We were inextricably confused by this situation and so we worked out the absolute assignment of configuration by independent and unambiguous means in the present study.
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Adenine Nucleosides Derived from 6-Deoxyhexofuranoses[1]

Leon M. Lerner

Department of Biochemistry, State University of New York, Downstate Medical Center, Brooklyn, New York 11203

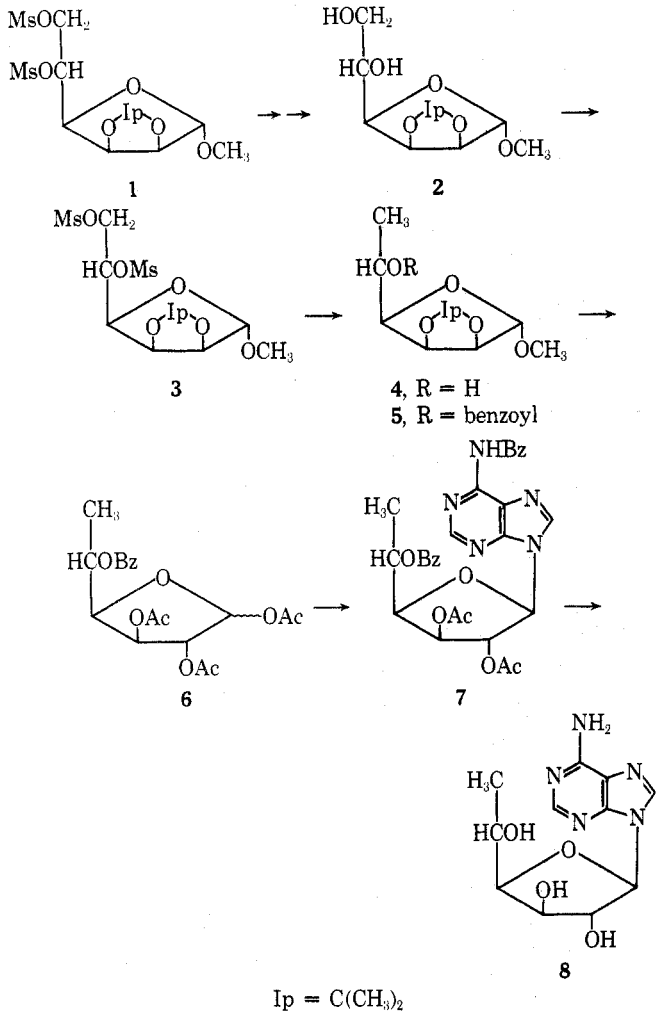
Received August 4, 1975

Methyl 2,3-*O*-isopropylidene-β-L-gulofuranoside (**2**) was converted into methyl 2,3-*O*-isopropylidene-5,6-di-*O*-methanesulfonyl-β-L-gulofuranoside (**3**) and treatment of this with lithium aluminum hydride afforded methyl 6-deoxy-2,3-*O*-isopropylidene-β-L-gulofuranoside (**4**). The 5-*O*-benzoate (**5**) was prepared and subjected to acetolysis under conditions known to result in epimerization at C-2. The acetolysis product was condensed with 6-benzamidochloromercuripurine by the titanium tetrachloride method. Removal of blocking groups afforded 9-(6-deoxy-α-L-idofuranosyl)adenine (**8**). Methyl 5-*O*-benzoyl-6-deoxy-2,3-*O*-isopropylidene-β-D-gulofuranoside (**9**) was used to prepare 9-(6-deoxy-β-D-gulofuranosyl)adenine (**14**). First, the isopropylidene group was removed and replaced with benzoates. Then the methoxyl group was exchanged for an acetoxyl group and **14** was prepared by the titanium tetrachloride coupling method. 9-(6-Deoxy-β-L-gulofuranosyl)adenine (**15**) was prepared starting from **5** by a series of reactions which were identical with the preparation of **14**. 9-(6-Deoxy-α-D-idofuranosyl)adenine (**16**) was prepared by acetolysis of **9** and coupling to the base as described for **8**. Nucleoside **8** was a substrate for adenosine deaminase from calf intestinal mucosa.

Nucleosides derived from 6-deoxyhexofuranoses are of potential use in this laboratory as precursors for the synthesis of other compounds of biological interest. However, some of these nucleosides may be of biological value in their own right. For instance, it has been demonstrated that 9-(6-deoxy-β-D-allofuranosyl)adenine is an inhibitor of adenine phosphoribosyl transferase (EC 2.4.2.7),[2] an important enzyme in nucleic acid metabolism. Furthermore, this compound is capable of acting as a substrate for adenosine deaminase (adenosine aminohydrolase, EC 3.5.4.4) and this is also the case for the 5′ epimer, 9-(6-deoxy-α-L-talofuranosyl)adenine.[3] These findings indicate that such compounds do have the ability to bind to enzymes of nucleic acid metabolism and may be useful antimetabolites.

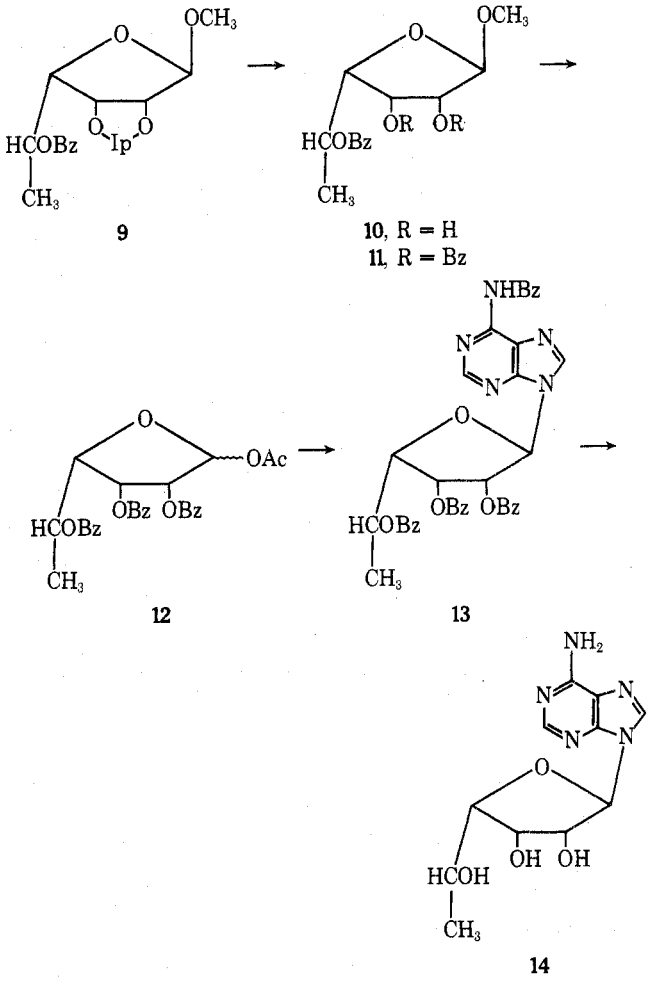
A series of 6-deoxyhexofuranosyl nucleosides was originally prepared by Baker and co-workers. They reported the synthesis of adenine nucleosides derived from 6 deoxy-L-mannose,[4a] 6-deoxy-D-allose,[4b] 6-deoxy-D-glucose,[4c] 6-deoxy-L-idose,[4d] and 6-deoxy-L-talose.[4e] It has recently been shown that the compound reported in ref 4a as 9-(6-deoxy-α-L-mannofuranosyl)adenine was incorrect and the real nucleoside bearing this name was prepared and completely structure proofed.[5] It was also shown by Ryan et al.[6] that the nucleoside reported to be 9-(6-deoxy-α-L-idofuranosyl)adenine was really 9-(5-deoxy-β-D-*xylo*-hexofuranosyl)adenine on the basis of the NMR spectrum which lacked a peak for a terminal methyl group. Later work[7] verified that treatment of 6-*O*-benzoyl-2,3-*O*-isopropylidene-5-*O*-*p*-toluenesulfonyl-α-D-glucofuranose with lithium aluminum hydride yielded 5-deoxy-1,2-*O*-isopropylidene-β-D-*xylo*-hexofuranose rather than 6-deoxy-1,2-*O*-isopropylidene-α-L-idofuranose as assumed by Baker and co-workers[4d] when they prepared it as a starting material. Since there appears to be no report in the literature dealing with the synthesis of 9-(6-deoxy-α-L-idofuranosyl)adenine, it is probable that biological data reported[8] under this name are actually for the 5′-deoxy analogue instead. The original intent of the present work was the preparation of 9-(6-deoxy-β-D-gulofuranosyl)adenine, a heretofore unknown nucleoside analogue. Owing to the recent development of some rather convenient synthetic procedures, this work has been extended to include the preparation of both enantiomers of adenine nucleosides derived from 6-deoxygulose and 6-deoxyidose.

Scheme I



Ip = $C(CH_3)_2$

Scheme II

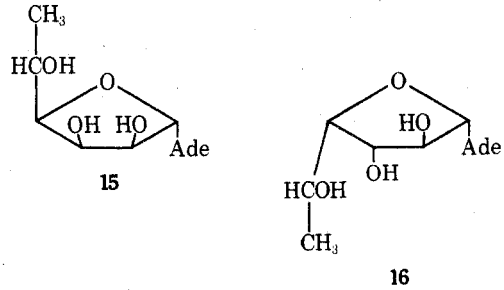


Synthetic Chemistry. The conversion of methyl 2,3-*O*-isopropylidene-5,6-di-*O*-methanesulfonyl-α-D-mannofuranoside (1) into methyl 2,3-*O*-isopropylidene-β-L-gulofuranoside (2) was recently reported by treatment of 1 with sodium acetate in hot *N,N*-dimethylformamide.[9] The preparation of 2 from 1 in large quantity in an identical yield enabled the preparation of methyl 5-*O*-benzoyl-6-deoxy-2,3-*O*-isopropylidene-β-L-gulofuranoside (5) (Scheme I), an important starting material for the synthesis of 9-(6-deoxy-α-L-idofuranosyl)adenine (8). The procedure followed for the preparation of 5 was similar to the one already reported[10] for the preparation of the D enantiomer 9. Compound 2 was treated with methanesulfonyl chloride in pyridine to give 3 as an impure syrup. Treatment of this bis(methanesulfonate) with lithium aluminum hydride in an ether–benzene mixture afforded a good yield of 6-deoxy-2,3-*O*-isopropylidene-β-L-gulofuranoside (4) which was converted into the 5-*O*-benzoate 5. The latter compound was subjected to acetolysis conditions which are known not only to result in acetyl substitution for the isopropylidene and glycoside groups, but which cause, in addition, an epimerization at C-2. This reaction is well documented in the literature[11] and has been utilized in this laboratory for synthetic purposes.[12] The carbohydrate derivative 6 was condensed with 6-benzamidochloromercuripurine by the titanium tetrachloride method in hot 1,2-dichloromethane.[13] Removal of the blocking groups with sodium methoxide in methanol afforded the desired product, 9-(6-deoxy-α-L-idofuranosyl)adenine (8).

The preparation of 9-(6-deoxy-β-D-gulofuranosyl)adenine (14) is shown in Scheme II. Methyl 5-*O*-benzoyl-6-deoxy-2,3-*O*-isopropylidene-β-D-gulofuranoside[10] (9) was treated with 9:1 trifluoroacetic acid–water to remove the isopropylidene group.[14] The free hydroxyl groups were blocked as the benzoate esters and the methoxyl group at C-1 was exchanged for an acetoxyl group by acetolysis. The configuration at C-2 is unaffected when the blocking groups are benzoates rather than acetates.[15] The nucleoside 14 was then prepared by the titanium tetrachloride procedure followed by removal of the blocking groups.

In a manner quite similar to the preparation of 14, 9-(6-deoxy-β-L-gulofuranosyl)adenine (15) was prepared from 5. 9-(6-Deoxy-α-D-idofuranosyl)adenine (16) was prepared from 9 by acetolysis and coupling as described for the L form 8.

Chart I



Ade = adenine

Proof of Structure. The elemental analyses of 8, 14, 15, and 16 agreed with theoretical values. The ir and uv spec-

Table I
Optical Rotations of Hexofuranosyl Nucleosides

Hexofuranose confign	$[\alpha]_D$, deg	
	6′-CH_2OH	6′-CH_3
β-D-gluco	−58[a]	−60[b]
α-L-talo	−32[c,d]	−35[e]
α-L-manno	−75[f]	−72[g]
β-D-allo	−57[c]	−74[h]
β-D-gulo (14)	−56[c]	−62
α-D-ido (16)	+38[i]	+24

[a] E. J. Reist, R. R. Spencer, and B. R. Baker, *J. Org. Chem.*, 23, 1958 (1958). [b] Reference 4c. [c] P. Kohn, R. H. Samaritano, and L. M. Lerner, *J. Org. Chem.*, 31, 1503 (1966). [d] The number reported is the absolute value, with a change of sign to conform to the expected value for the unknown enantiomer. [e] Reference 4e. [f] L. M. Lerner and P. Kohn, *J. Org. Chem.*, 31, 339 (1966). [g] Reference 5. [h] Reference 4b. [i] Reference 16.

tra supported the structures as being nucleosides. The peak near 260 nm, which did not change significantly with change in pH, indicated that the glycosyl bond was linked at N-9 of the adenine ring. The enantiomeric pairs had identical physical properties except for the sign of the optical rotation.

The identity of the sugar moiety was demonstrated by the rate of periodate consumption. These studies were performed on nucleosides **14** and **16**. The D-gulo nucleoside **14** consumed 0.93 molar equiv of periodate in less than 0.5 hr, whereas it took the D-ido compound nearly 1 week to consume this amount. The uptake of only 1 molar equiv of periodate demonstrated that the sugar ring structure of the nucleosides was in the furanose form, since the pyranose form would be expected to consume 2 molar equiv of periodate. The rapid uptake of periodate by **14** indicated that the vicinal hydroxyl groups were oriented in a cis relationship. Furthermore, the identity of the sugar as 6-deoxy-D-gulose was shown in a separate experiment.[10] The very slow uptake of periodate by **16** was typical for a nucleoside in the furanose form having the vicinal hydroxyls in a trans relationship. That the sugar moiety had the D-ido configuration was expected from the synthetic procedure used. The acetolysis step is known to yield a product with the configuration at C-2 inverted,[11,12] and in a previous publication[16] the preparation of 9-α-D-idofuranosyladenine was achieved from methyl 2,3-*O*-isopropylidene-β-D-gulofuranoside using the same techniques.

The assignment of the anomeric configurations was based upon the accumulation of the following evidence. It was expected that the anomeric configuration obtained in each case would be trans to the hydroxyl group at C-2′ owing to the directive effect of the acyloxy group during the condensation step.[17] A comparison of the optical rotations of the corresponding 6′-hydroxymethyl hexofuranosyl nucleosides of known anomeric configuration with the optical rotations of the 6′-methyl analogues showed a good correlation (Table I).

NMR studies with **8** revealed a one-proton singlet at δ 5.95 for the anomeric proton. Numerous studies have demonstrated that the trans relationship of the protons at C-1′ and C-2′ of furanose nucleosides can only be determined with confidence when the coupling constant is below 1 Hz.[18] Therefore, the singlet obtained was interpreted as demonstrating that the configuration of **8** was indeed α-L. Further proof was obtained by utilization of **8** as an enzyme substrate. Adenosine deaminase from calf intestinal mucosa has been shown to have very specific requirements concerning the structure of any potential substrate.[19] In addition to the adenine ring, the sugar must be in the β-D or α-L configuration and there must be a hydroxyl group for binding either at C-3′ in the "up" position, and/or an hydroxyl group at C-5′, likewise in the "up" position. For example, it was mentioned earlier that the β-D-allo and α-L-talo diastereomers of **8** were substrates for the enzyme. Since **8** is the only nucleoside of the present group to have the necessary structural features, it was treated with adenosine deaminase in a phosphate buffer and the reaction was followed spectrophotometrically. The nucleoside was found to be a substrate and the uv absorption spectrum of the product, in comparison to inosine, indicated that the product was most probably 9-(6-deoxy-α-L-idofuranosyl)hypoxanthine.

Table II
Optical Rotations of Alcohols Derived from Nucleosides

9-(6′-Deoxyhexofuranosyl)adenine	$[\alpha]_D$ of alcohol, deg[a]
β-D-gulo (14)	+37
α-D-ido (16)	−64
β-L-gluco	−69
α-L-manno	+65

[a] Based upon the calculated dry weight of the alcohol product.

Unfortunately, nature was not as kind with the NMR spectrum of **14**. The anomeric proton appeared centered at δ 5.97 as a doublet with $J_{1',2'}$ = 6 Hz. The expected coupling constant for a β-D configuration with a trans relationship for the protons at C-1′ and C-2′ is 0–8 Hz, whereas for the cis relationship the expected values are 3.5–8 Hz.[20] Therefore, no decision could be made regarding the anomeric configuration from the NMR spectrum. The preparation of the 2′,3′-*O*-isopropylidene derivative of **14** would enable two other NMR interpretations to be brought to bear on this problem,[18,21] but as yet a pure crystalline derivative has not been obtained.

There is, however, another argument that can be applied in support of the β-D configuration of **14**. For a good number of years the anomeric configurations of glycosides and nucleosides have been demonstrated by first cleaving the sugar ring with periodate and then reduction of the aldehydes to trialcohols. Since the trialcohols had only one asymmetric center, which was originally the anomeric position of the nucleoside, it was only necessary to determine the optical rotations of the unknowns and compare them to a standard of known anomeric configuration.[22] When the original configuration of the nucleoside was β-D or α-L, the optical rotation was a positive value, and when α-D or β-L, the value was negative but of equal value as expected of the enantiomer. Originally, the standards used had an aglycone that was identical with that of the unknowns, but in recent years comparisons have been made using dissimilar aglycones and arguments have been presented to support the assignment of the anomeric configuration on this basis.[23] In recent work involving the preparation of alcohols from nucleosides, some of the alcohols had two centers of asymmetry and still gave optical rotations corresponding to the same configuration designations as presented above.[24] It appeared to be a good idea to apply this procedure to 6′-deoxyhexofuranosyl nucleosides available in this laboratory even though the products would have three asymmetric centers. Each of the nucleosides was treated with sodium periodate and the products reduced with sodium borohydride. The optical rotations are shown in Table II. Two previously reported nucleosides, 9-(6-deoxy-β-L-glucofuranosyl)adenine and 9-(6-deoxy-α-L-mannofuranosyl)adenine, were of known anomeric configuration, as was **16** since the latter was the enantiomer of **8**. Although the alcohols obtained were all diastereomers, it can be seen that the

β-D and α-L nucleosides had a positive rotation and the α-D and β-L nucleosides had a negative rotation. The data argue for the assignment of **14** as the β-D configuration but should not be construed as a definitive proof, especially since the number of test samples was so small. Further work is required to determine if this correlation is a reasonably good one in those cases where it can be applied. Quite obviously this technique is not applicable to nucleosides derived from ketoses, since most of these would yield products with no asymmetric center. Another exception may be the 2′-deoxypyranosyl nucleosides. The enantiomeric dialcohols derived from the anomeric 9-(2′-deoxyribopyranosyl)adenines had optical rotations whose signs were opposite to those expected.[24]

Experimental Section[25]

Methyl 2,3-*O*-isopropylidene-β-L-gulofuranoside (2). This compound was prepared in large scale from D-mannose according to the procedure of Evans and Parrish.[9] The yield (64.5%) was identical with that reported: long, prismatic needles, mp 78.5–80°, $[\alpha]^{22}D$ +82.5° (*c* 1.10, methanol) [lit.[9] mp 76.5–77°, $[\alpha]D$ +82.3° (*c* 1.17, methanol)].

Methyl 6-Deoxy-2,3-*O*-isopropylidene-β-L-gulofuranoside (4). A mixture containing 18 g of **2** in 125 ml of dry pyridine was chilled in an ice bath. To this stirred solution was slowly added, dropwise, 35 ml of methanesulfonyl chloride. Stirring was continued at room temperature for 2 hr, then the mixture was chilled again and treated slowly with 60 ml of cold water. After 45 min, the contents were poured into 500 ml of water and extracted with chloroform (3 × 80 ml). The chloroform solution was washed with saturated sodium bicarbonate (200 ml) and water (200 ml), and dried. Evaporation and coevaporation with toluene gave 30.1 g of brown syrup (**3**).

The entire sample was dissolved in a mixture of ethyl ether (400 ml) and benzene (200 ml) and treated with 20 g of lithium aluminum hydride under reflux for 6 days. The stirring mixture was chilled in an ice bath and 20 ml of water was added very slowly, followed by 60 ml of 15% sodium hydroxide solution and an additional 20 ml of water. The white, granular precipitate was removed by suction filtration and washed well with ethyl ether. Evaporation gave a clear syrup which began to crystallize almost immediately. Recrystallization from *n*-hexane afforded 9.44 g (56%) of **4** in three crops, mp 79–79.5°, $[\alpha]^{23}D$ +88.9° (*c* 1.26, methanol). The ir spectrum was identical with that of the D form for which the following data were recorded:[10] mp 78.5–79.5°; $[\alpha]^{25}D$ −90.7° (*c* 1.26, methanol).

Anal. Calcd for $C_{10}H_{18}O_5$: C, 55.03; H, 8.31. Found: C, 55.07; H, 8.26.

Methyl 5-*O*-Benzoyl-6-deoxy-2,3-*O*-isopropylidene-β-L-gulofuranoside (5). A solution containing 6.1 g of **4** in 50 ml of dry pyridine was treated with 5.2 ml of benzoyl chloride as previously described for the D enantiomer.[10] The yield was 8.65 g (96%). A small sample was recrystallized from methanol–water for analytical purposes, mp 79.5–80°, $[\alpha]^{23}D$ +119.5° (*c* 1.23, methanol). The ir spectrum was identical with that of the D enantiomer, which had mp 78.5–79°, $[\alpha]^{22}D$ −118° (*c* 1.30, methanol).

Anal. Calcd for $C_{17}H_{22}O_6$: C, 63.33; H, 6.88. Found: C, 63.44; H, 6.92.

9-(6-Deoxy-α-L-idofuranosyl)adenine (8). A mixture containing 4.2 g of **5**, 114 ml of glacial acetic acid, 11.4 ml of acetic anhydride, and 6 ml of concentrated sulfuric acid was kept at room temperature for 65 hr. The mixture was poured into 350 ml of ice and stirred until the ice melted. The product was extracted with chloroform (3 × 50 ml) and the chloroform solution was washed with water (2 × 200 ml), saturated sodium bicarbonate (200 ml), and again with water, and dried. Evaporation and coevaporation with benzene (3 × 10 ml) afforded 3.62 g of a clear, colorless gum (**6**).

The gum was dissolved in 300 ml of 1,2-dichloroethane and 5.21 g of 6-benzamidochloromercuripurine and 5.21 g of Celite-545 were added. Distillation of 50 ml of solvent removed traces of water. Titanium tetrachloride (1.3 ml) in 50 ml of fresh, dry 1,2-dichloroethane was added and the mixture was heated under reflux for 22 hr. After cooling at room temperature, 185 ml of saturated sodium bicarbonate was added, and the mixture was stirred for 1.5 hr and then filtered through a pad of Celite. The filter cake was washed with 150 ml of hot 1,2-dichloroethane and the organic layer was separated. Evaporation gave a residue which was dissolved in 100 ml of chloroform, washed with 30% aqueous potassium iodide (2 × 100 ml) and water (100 ml), and dried. Evaporation of the solvent afforded a yellow foam weighing 5.27 g. This was dissolved in 100 ml of methanol and treated with 7 ml of 1 *N* methanolic sodium methoxide under reflux for 1.5 hr. The solution was neutralized with Amberlite CG-120 (H^+) ion-exchange resin and the resin was removed by filtration. The methanol was evaporated and the residue was coevaporated with water to remove methyl benzoate as the azeotrope. The residue was crystallized from ethanol, then recrystallized from ethanol–water to afford 0.794 g (22%) in two crops. The product (**8**) softened upon heating above 210° with small droplets forming on the cover slip until the sample melted at 239–244°, $[\alpha]^{24}D$ −22.2° (*c* 1.14, 1 *N* HCl).

Anal. Calcd for $C_{11}H_{15}N_5O_4$: C, 46.96; H, 5.41; N, 24.90. Found: C, 47.00; H, 5.31; N, 24.91.

9-(6-Deoxy-β-D-gulofuranosyl)adenine (14). Methyl 5-*O*-benzoyl-6-deoxy-2,3-*O*-isopropylidene-β-D-gulofuranoside (**9**)[10] (5.13 g) was treated at room temperature with 52 ml of 9:1 (v/v) trifluoroacetic acid–water for 0.5 hr. The solvents were removed by evaporation (35°). The residue was dissolved in 100 ml of 1:1 (v/v) ethyl acetate–benzene, washed with saturated sodium bicarbonate (2 × 50 ml) and water (50 ml), and dried. Evaporation gave a white foam containing **10**, 4.49 g. This was treated with 5 ml of benzoyl chloride in 30 ml of dry pyridine at room temperature for 21 hr. The mixture was poured into 200 ml of ice-saturated sodium bicarbonate and stirred until the ice melted. The product was extracted with chloroform three times (total volume 100 ml) and this solution was washed with saturated sodium bicarbonate (100 ml) and water (100 ml) and dried. The chloroform was evaporated and coevaporation with toluene gave an amber syrup (**11**), 8.17 g. The NMR spectrum confirmed the presence of the methoxyl group. The syrup (8.05 g) was treated with a mixture containing 60 ml of acetic acid, 6.8 ml of acetic anhydride, and 3.6 ml of sulfuric acid for 16 hr at room temperature. The reaction mixture was worked up as described for **6** above, except that the formation of emulsions during the washing steps required the use of sodium chloride solutions. After evaporation, a thick syrup (**12**) was obtained, 5.4 g.

The syrup was condensed with 6-benzamidochloromercuripurine (5.9 g) in a mixture also containing 5.9 g of Celite-545, 1.8 ml of titanium tetrachloride, and 310 ml of 1,2-dichloroethane. The reaction and work-up were carried out as described for the preparation of **8**. The blocking groups were removed in boiling methanolic sodium methoxide and immediately upon evaporation of methyl benzoate as the water azeotrope, crystallization of **14** occurred. Recrystallization from ethanol–water afforded 0.555 g (12.4%): mp 255–258° dec; $[\alpha]^{24}D$ −62.5° (*c* 1.05, 1 *N* HCl); uv λ_{max} (pH 1) 257 nm (ε 13820), λ_{max} (H_2O) 259 (14100), λ_{max} (pH 13) 259 (14460); NMR (Me_2SO-d_6) δ 8.40, 8.22 (both s, 1 proton each, H-8, H-2), 5.97 (d, 1, $J_{1',2'}$ = 6 Hz, H-1′), 1.13 (d, 3, C-6′ CH_3).

Anal. Calcd for $C_{11}H_{15}N_5O_4$: C, 46.96; H, 5.41; N, 24.90. Found: C, 46.92; H, 5.42; N, 24.88.

9-(6-Deoxy-β-L-gulofuranosyl)adenine (15). This nucleoside was prepared starting from **5** (4.14 g) by the same sequence of reactions used for the preparation of **14**. In the final step, the nucleoside did not crystallize easily, so the entire product was chromatographed on a column (28 × 2.2 cm) of Bio-Rad AG1-X2 (OH^-, 200–400 mesh) using 30% aqueous methanol as eluent.[26] Fractions of 15 ml were collected. The major uv (254 nm) absorbing peak was in tubes 6–18. The contents were combined, the solvents evaporated, and crystallization achieved from ethanol–water. Recrystallization afforded 0.339 g, mp 255–258° dec, $[\alpha]^{22}D$ +64.5° (*c* 1.05, 1 *N* HCl). The ir spectrum was identical with that of the D enantiomer.

Anal. Calcd for $C_{11}H_{15}N_5O_4$: C, 46.96; H, 5.41; N, 24.90. Found: C, 46.69; H, 5.23; N, 24.71.

9-(6-Deoxy-α-D-idofuranosyl)adenine (16). Acetolysis of **9** (3.5 g) as described for **5** yielded a gum weighing 2.95 g. This was condensed with 4.25 g of 6-benzamidochloromercuripurine in a mixture also containing 4.25 g of Celite-545, 1.0 ml of titanium tetrachloride, and 250 ml of 1,2-dichloroethane. The reaction and work-up were performed as described for the preparation of **8**. After removal of blocking groups with sodium methoxide the product **16** was crystallized from ethanol. Recrystallization from ethanol–water afforded 0.425 g (13.9%). The crystals became soft above 210°, melting at 238–244°: $[\alpha]^{23}D$ +24.4° (*c* 1.07, 1 *N* HCl); uv λ_{max} (pH 1) nm (ε 13830), λ_{max} (H_2O) 259 (14090), λ_{max} (pH 13) 260 (14230); NMR (Me_2SO-d_6) δ 8.37, 8.23 (both s, 1 proton each, H-8, H-2), 5.95 (s, 1 H-1′), and 1.19 (d, 3, C-6′ CH_3). The ir spectrum was identical with that of the L form **8**.

Anal. Calcd for $C_{11}H_{15}N_5O_4$: C, 46,96; H, 5.41; N, 24.90. Found: C, 47.11; H, 5.65; N, 24.59.

Periodate Uptake. The spectrophotometric procedure of Rammler and Rabinowitz[27] was used to determine the consumption of periodate. 9-(6-Deoxy-β-D-gulofuranosyl)adenine (**14**) consumed a total of 0.93 molar equiv of periodate in under 0.5 hr, whereas it took 9-(6-deoxy-α-D-idofuranosyl)adenine (**16**) 160 hr to consume 0.90 molar equiv.

Polarimetric Studies. Between 10 and 13 mg of each nucleoside was dissolved in 0.75 ml of hot water in a 2-ml volumetric flask and then cooled to room temperature. To the solution was added 0.5 ml of 0.25 *M* sodium periodate. The reaction mixture was kept in the dark at room temperature, the time of reaction being 1 day for **14** and 5 days for **16**. At the end of the reaction time, 60 mg of sodium borohydride was added and after 1 hr, the excess hydride was destroyed by slow addition of 0.4 ml of 20% acetic acid solution. When effervescence stopped (1–2 hr) the volume was adjusted with water to 2 ml and the optical rotation was measured. The results are shown in Table II.

Deamination of 8 with Adenosine Deaminase. The enzyme reaction was followed spectrophotometrically[28] at 265 nm at 25° in 0.5 *M* phosphate buffer (pH 7.6). The concentration of **8** was 6×10^{-6} *M* and 3 ml of this solution was added to a cuvette. A solution of buffer containing the enzyme (0.1 ml, 2.1 units) (Sigma Chemical Co.) was added to start the reaction and this was mixed thoroughly. The uv absorption leveled off at a constant value after 5 min. The uv absorption spectrum had a maximum at 249 nm. An identical reaction using adenosine gave an almost instantaneous leveling off of the optical density and a shift in the uv to λ_{max} 248 nm.

Registry No.—**1**, 50692-25-6; **2**, 50692-26-7; **4**, 57207-09-7; **5**, 57207-10-0; **8**, 57237-22-6; **9**, 57207-11-1; **14**, 57237-23-7; **15**, 57237-24-8; **16**, 57237-25-9; benzoyl chloride, 98-88-4; 6-benzamidochloromercuripurine, 17187-65-4.

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Reaction of 4,5-Diamino-1,3-dimethyluracil with Diketones

Stanley Wawzonek

Department of Chemistry, University of Iowa, Iowa City, Iowa 52242

Received August 12, 1975

4,5-Diamino-1,3-dimethyluracil when treated with acetylacetone and with dibenzoylmethane formed 4-(4-amino-1,3-dimethyluracil-5-amino)-3-buten-2-one and β-(4-amino-1,3-dimethyluracil-5-amino)chalcone, respectively. The reaction of the diamine with *trans*-1,2-di-*p*-toluylethylene in ethanol gave 3-*p*-tolyl-5,7-dimethyl-6,8-dioxo-5,6,7,8-tetrahydropteridine and 1,3-dimethyl-8-*p*-tolylxanthine. The same reaction in acetic acid gave the isomeric pteridines and a diazepine. Condensation of the diamine with 1,2-di-*p*-toluylethane in ethanol formed a pyrrole.

The reaction of 4,5-diamino-1,3-dimethyluracil (**1**) with acetylacetone, dibenzoylmethane, *trans*-di-*p*-toluylethylene, and 1,2-ditoluylethane has been studied to determine whether this diamine **1** would behave in a similar manner to that found for *o*-phenylenediamine with similar compounds.

4,5-Diamino-1,3-dimethyluracil (**1**) gave with acetylacetone and dibenzoylmethane in ethanol containing a trace of acetic acid the corresponding substituted unsaturated ketones (**2**, R = CH_3 or C_6H_5). Evidence for these structures was the elemental analysis and spectral data; the NMR spectra showed three exchangeable protons in the presence of deuterium oxide.

Attempts to convert **2** (R = CH_3) to the diazepine were