B. Methyl β-Naphthoate.—A solution of methyl β-naphthoate (1.004 g., 0.00540 mole) in dioxane (20 ml.) was added to a slurry of lithium aluminum hydride (2.20 g., 0.057 mole) in dioxane (30 ml.). The reaction mixture was refluxed for 20 hr. and processed in the usual manner. Chromatography over 32 g. of alumina afforded β-methylnaphthalene, 0.670 g. (86%), m.p. 34–35° (lit.[15] m.p. 31–32°), eluted with petroleum ether, and β-hydroxymethylnaphthalene, 0.010 g. (1%), m.p. 81–82° (lit.[15] m.p. 80–81°), eluted with ether.

C. β-Acetylnaphthalene.—β-Acetylnaphthalene (1.096 g., 0.00645 mole) was reduced with lithium aluminum hydride (2.20 g., 0.058 mole) exactly as described above to afford β-ethylnaphthalene (0.342 g., 34%), identified from its proton magnetic resonance spectrum which exhibited a quartet (2H) at τ 7.36, a triplet (3H) at 8.79, and a multiplet (7H) at 2.2–3. The expected alcohol, 1-(β-naphthyl)ethanol, 0.702 g. (64%), showed m.p. 69–70° (lit.[16] m.p. 67–68.5°).

Reduction of Isogramine Methotosylate.—Isogramine methotosylate, m.p. 149–151° dec., was prepared in the usual manner and crystallized from acetone. The salt (2.75 g., 0.0076 mole) was added to a slurry of lithium aluminum hydride (1.18 g., 0.031 mole) in 75 ml. of tetrahydrofuran. The reaction mixture was heated under reflux for 24 hr. and worked up in the usual manner. Sublimation of the crude product afforded 2-methylindole (0.333 g., 33%), identical in all respects with an authentic sample. Isogramine could not be detected by thin layer chromatography of the crude reduction product.

Anal. Calcd. for $C_{19}H_{24}N_2O_3S$: C, 63.30; H, 6.72; N, 7.77; S, 8.89. Found: C, 63.08; H, 6.88; N, 7.51; S, 8.80.

(15) H. Adkins and E. E. Burgoyne, *J. Am. Chem. Soc.*, **71**, 3528 (1949).

(16) H. Adkins and H. R. Billica, *ibid.*, **70**, 695 (1948).

Novel Synthesis of a Tetrahydropyranylalkanol

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Condensation of 3-methyl-3-buten-1-ol at −65° with BF_3 gave the terpenoid 2-(2,4,4-trimethyltetrahydro-2-pyranyl)ethanol. The structure was proven by n.m.r. data and relationship to 3,3,5-trimethylhexanol prepared from the known 3,3,5-trimethyl-5-hexenoic acid. In similar condensations 3-ethyl-3-buten-1-ol and 2,3-dimethyl-3-buten-1-ol gave products assumed by analogy to be more highly substituted tetrahydropyranylalkanols.

Early workers[1–5] showed that the three unsaturated alcohols derived from isoprene, 3-methyl-3-buten-1-ol, 3-methyl-2-buten-1-ol, and 2-methyl-3-buten-2-ol, may be condensed in acidic systems at room temperature to give mixtures of terpenes. Much more recently it has been shown that these same compounds are involved in the biosynthesis of terpenes.[6]

A cursory chromatographic examination of the products obtained under conditions used by the earlier investigators showed that as many as twelve products were present in fractions boiling from 40 to 100° at 1 mm. Exploratory work of this sort indicated that the product mixture became markedly less complex as the reaction temperature was decreased. At a temperature of −65°, condensation of 3-methyl-3-buten-1-ol using boron trifluoride as the condensing agent and methylene chloride as solvent led to a single predominant C_{10} compound which proved to be the saturated ether–alcohol terpenoid ($C_{10}H_{20}O_2$), 2-(2,4,4-trimethyltetrahydro-2-pyranyl)ethanol (I).

The pyranylethanol I was readily oxidized to the $C_{10}H_{18}O_3$ acid II. The n.m.r. spectrum of the acid (Table I) was most helpful in assigning the structure as 2,4,4-trimethyltetrahydro-2-pyranylacetic acid. The singlet at δ 2.55 appeared clearly that of a $-CH_2$ adjacent to -COOH; the triplet at δ 3.75 was that due to $-O-CH_2-CH_2-CR_3$. The adjacent methylene ($-O-CH_2-CH_2-CR_3$) was confirmed as present in the 7-proton complex at δ 1.25–1.5 by spin decoupling[7] from the triplet at δ 3.75. This spin decoupling yielded two signals at δ ~1.5 and 1.4. The remainder of the 7-proton complex at δ 1.25–1.5 was evidently due to an isolated methylene group and a methyl group in the situation $O-CR_2CH_3$. The remaining methyl absorptions at δ 1.0 and 1.05 appeared then to be those of a *gem*-dimethyl group.

The n.m.r. data for the alcohol II was rendered interpretable only by double resonance. The 2-proton complex at δ 1.6–1.95 was collapsed to a singlet by

TABLE I

N.M.R. ABSORPTION DATA[a]

	Alcohol I			Acid II		
Assignment[b]	No. of H's[c]	Band position	Band multiplicity[d]	No. of H's	Band position	Band multiplicity[d]
COOH	..	...	..	1	11.2	s
-OH	1	~3.7	..			
>C-CH_2-CH_2O-	4	3.55–3.9	c	2	3.75	t[e]
>C-CH_2COOH	..	...	..	2	2.55	s
>C-CH_2-CH_2-O-	2	1.6–1.95	c	2	1.4	t[e]
	2	1.35	t[e]			
>C-CH_2-C<	2	1.25	s	2	~1.5	..
H_3C-C-CH_3	3	1.0	s	3	1.02	s
	3	1.05	s	3	1.04	s
H_3C-C-O-	3	1.25	s	3	1.4	s
	20			18		

[a] Determined on a Varian A-60 high-resolution n.m.r. spectrometer in $CDCl_3$ solution and reported as p.p.m. downfield from TMS included as internal standard. [b] Proton assigned is italic. [c] Determined by integration. [d] m = multiplet, c = complex, s = singlet, t = triplet. [e] J = ~5 c.p.s.

(1) T. Wagner-Jauregg, *Ann.*, **496**, 52 (1932).

(2) A. E. Favorsky and A. J. Lebedeva, *Chem. Abstr.*, **33**, 1298 (1939); *Bull. soc. chim. France*, [5] **6**, 1347 (1939); *J. Gen. Chem. USSR*, **8**, 879 (1938).

(3) T. Lennarts, *Chem. Ber.*, **76**, 831 (1943).

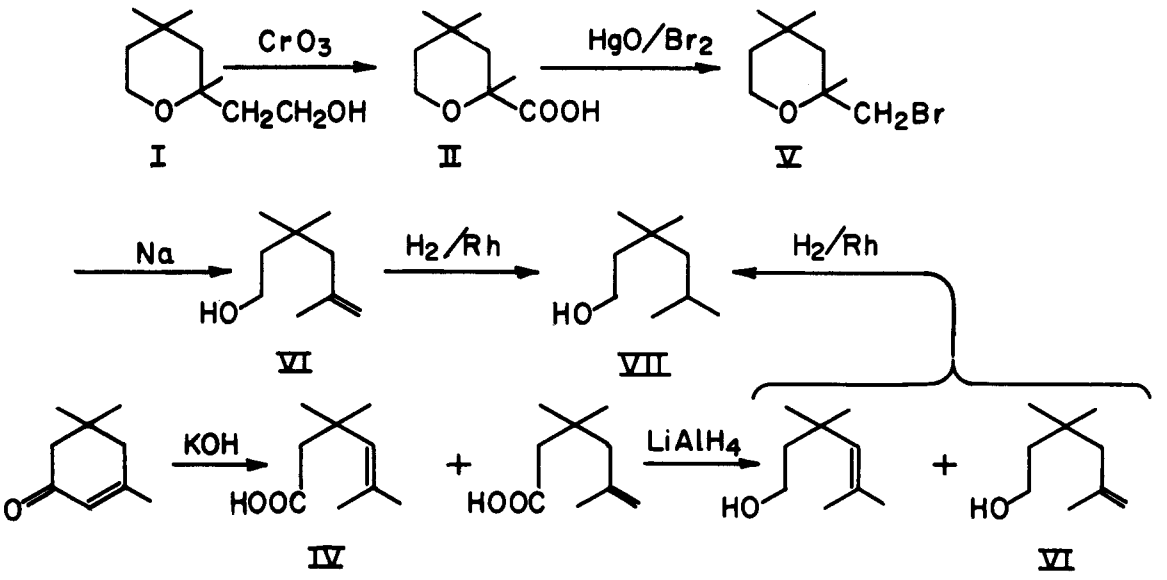
(4) T. Lennarts, *Z. Naturforsch.*, **1**, 684 (1946).

(5) A. Laforque, *Compt. rend.*, **227**, 352 (1948).

(6) F. Lynen, B. W. Agranoff, H. Eggerer, U. Henning, and E. M. Moselein, *Angew. Chem.*, **71**, 657 (1959).

(7) Method described by L. F. Johnson in "Proton–Proton Spin Decoupling Using the Varian V-3521 Integrator," Varian Associates, Palo Alto, Calif., 1962. The other equipment used in the decoupling experiments included the Varian V-4311 60 n.m.r. instrument and the Hewlett-Packard 200 ABR audio oscillator.

SCHEME I



decoupling from the δ 3.55–3.9 absorption. Confirmation of the coupling of the δ 1.6–1.95 complex to that at δ 3.55–3.9 was obtained by decoupling in the reverse sense. This operation collapsed the δ 3.55–3.9 absorptions to a singlet superimposed on a triplet (J = ~5 c.p.s.). Since the δ 1.6–1.95-complex was converted to a singlet upon oxidation to acid II, there was no doubt that it was in the situation $R_3C-CH_2-CH_2OH$ and the more complex portion of the system at δ 3.55–3.9 was due to the adjacent $-CH_2OH$. The remaining two methylene groups (on the tetrahydropyran ring) were accounted for by the triplet of J = ~5 c.p.s. at δ 1.35 which was partially overlapped by the coinciding singlets of the isolated methylene group and the methyl group on the 2-position of the ring.

Further confirmation of the structures proposed was obtained by finding that the amide III derived from acid II underwent the Hofmann reaction to give an amine which on treatment[8] with nitrous acid at pH 4.5 gave two compounds, both of which displayed hydroxyl and carbonyl absorption in the infrared. The production of two hydroxy–carbonyl compounds on deamination suggested that the amine had the structure $O-\underset{\lfloor C_x \rfloor}{\overset{CH_3}{\overset{|}{C}}}-CH_2NH_2$. Deamination of such a compound would lead to two keto alcohols through rearrangement of the intermediate carbonium ion $O-\underset{\lfloor C_x \rfloor}{\overset{CH_3}{\overset{|}{C}}}O-CH_2^+$ to the cyclic carbonium ions $O\overset{+}{-}\underset{\lfloor C_{x+1} \rfloor}{C}-CH_3$ and $O-\overset{+}{\underset{\lfloor C_x \rfloor}{C}}-CH_2CH_3$. These cyclic carbonium ions would open to give the keto alcohols, $HO-C_{x+1}-\overset{O}{\overset{\|}{C}}-CH_3$ and $HO-C_x-\overset{O}{\overset{\|}{C}}-CH_2CH_3$. Isolation of keto alcohols then was taken as evidence that I contained the grouping $O-\underset{\lfloor C_x \rfloor}{\overset{CH_3}{\overset{|}{C}}}-CH_2CH_2OH$.

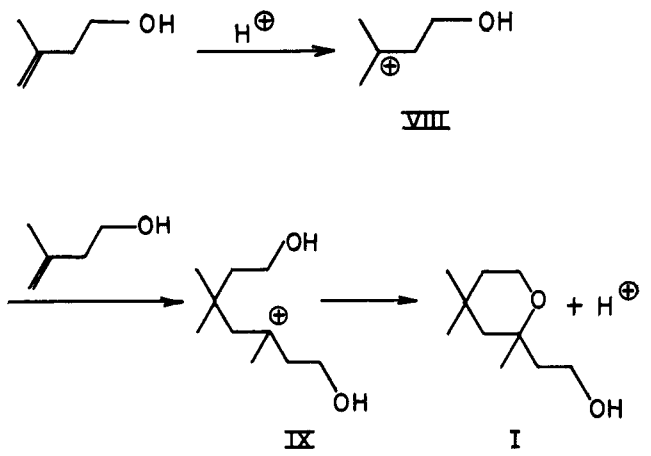
The proposed cyclic ether structure was firmly identified as a 2,4,4-trimethyltetrahydropyran by ring opening and relation to the known 3,3,5-trimethyl-5-hexenoic acid (IV).[9a] This was accomplished by first carrying out a recent and very facile modification of the Hunsdiecker reaction[9b] on the acid II and subjecting the resultant bromide V to ring opening by sodium. The unsaturated alcohol VI obtained was hydrogenated to a saturated alcohol VII which was characterized as the allophanate. The n.m.r. spectra of each of the compounds V–VII were quite characteristic of the structures proposed. The acid IV (actually in mixture with 3,3,5-trimethyl-4-hexenoic acid) was reduced first with lithium aluminum hydride, then hydrogenated to 3,3,5-trimethylhexanol. The alcohol VII was proved identical with the authentic 3,3,5-trimethylhexanol by infrared spectrum and mixture melting point of the allophanates. There was no doubt then that I was 2-(2,4,4-trimethyltetrahydro-2-pyranyl)ethanol (see Scheme I).

The mechanism by which alcohol I is formed appears to be quite straightforward, as follows. This reaction course is quite different from that followed in biosynthesis in that VIII is apparently sufficiently long lived at −65° that it reacts before conversion to the presumably more stable allylic carbonium ion. The ring closure of ion IX is apparently much favored over other possible stabilization processes which would lead to C_{10} unsaturated alcohols.

Perhaps the most interesting feature of alcohol I is that it is a "terpene" in the sense that it is formed from the natural terpene precursor without rearrangement, but unlike any of the known natural terpenes it contains a 1,2-isoprene linkage. Aside from one observation[5] of lavandulol (4,3-isoprene linkage), isoprene linkages other than 1,4 have not been pre-

(8) P. A. S. Smith and D. Baer, *J. Am. Chem. Soc.*, **74**, 6135 (1952).

(9) (a) H. Finch, K. E. Furman, and S. A. Ballard, *ibid.*, **73**, 4299 (1951); (b) S. J. Cristol and W. J. Firth, Jr., *J. Org. Chem.*, **26**, 280 (1961).



viously observed in condensations of isoprene or isoprene-related alcohols *in vitro*.

The new synthesis was extended to a number of other unsaturated alcohols. It was found that 3-ethyl-3-buten-1-ol and 2,3-dimethyl-3-buten-1-ol reacted similarly to 3-methyl-3-buten-1-ol to give saturated ether–alcohols of the formula $C_{12}H_{24}O_2$ in 65 and 57% yields, respectively. No identification work was carried out beyond direct determination of the elements, active hydrogen, and hydrogenation requirements but it appears reasonable to assume that these products are, respectively, 2-(2,4-diethyl-4-methyltetrahydro-2-pyranyl)ethanol and 2-(2,4,4,5-tetramethyltetrahydro-2-pyranyl)propanol. Under similar conditions, 2-*t*-butyl-3-methyl-3-buten-1-ol gave no dimerization and 3-neopentyl-3-buten-1-ol gave largely unsaturated products.

Experimental

Unsaturated Alcohols.—A mixture of 2270 g. of 2-methyl-2-butene, 460 g. of paraformaldehyde, 800 g. of acetic acid, and 300 g. of acetic anhydride was heated in an autoclave for 8 hr. at 190°. The excess butene was removed by distillation, then the residue was washed free of acetic acid and distilled. The 2,3-dimethyl-3-butenyl acetate (1142 g., 52.4% yield, $n^{25}D$ 1.4228) was recovered at 78–84° at 26 mm. The acetate (568 g.) was hydrolyzed by stirring for 16 hr. with excess 30% potassium hydroxide in methanol, then neutralized with acetic acid, washed twice with water, dried over sodium sulfate, and distilled. Recovery of 2,3-dimethyl-3-buten-1-ol[10] was 366 g., 91.5% yield, b.p. 66° at 37 mm., $n^{26}D$ 1.4362, purity by vapor phase chromatography[11] 98.3%.

3-Methyl-3-buten-1-ol[12] and 3-neopentyl-3-buten-1-ol[13] were prepared by similar methods and in similar yield form isobutene and 2,4,4-trimethyl-1-pentene, respectively. Similarly, 3-ethyl-3-buten-1-ol was prepared from 2-methyl-1-butene, b.p. 69–71° at 26 mm., $n^{23}D$ 1.4433.

Anal. Calcd. for $C_6H_{12}O$: C, 71.95; H, 12.08; O, 15.97. Found: C, 71.9; H, 12.1; O, 16.1.

3-Methyl-2-*t*-butyl-3-buten-1-ol, $n^{25}D$ 1.4502, b.p. 65–68° at 10 mm., m.p. 22–24°, was also prepared from 2,4,4-trimethyl-2-pentene but over-all yields obtained never exceeded 20%.

Anal. Calcd. for $C_9H_{18}O_2$: C, 76.00; H, 12.75; O, 11.25. Found: C, 75.9; H, 12.8; O, 11.6.

2-(2,4,4-Trimethyltetrahydropyranyl)ethanol (I).—3-Methyl-3-buten-1-ol (400 g.) was dissolved in 1 l. of dry methylene chloride, cooled to −65°, and saturated with gaseous boron trifluoride while being stirred. The reaction was stopped 10 min. after saturation was reached by addition of 200 ml. of methanol. The solution was washed with aqueous ammonia, dried, evaporated, and distilled. One hundred and seventy grams of I was recovered (42.5%), b.p. 55–66° at 0.05 mm., $n^{25}D$ 1.4639. There remained in the pot 192 g. of colorless residue.

Anal. Calcd. for $C_{10}H_{20}O_2$: C, 69.72; H, 11.70; O, 18.55. Found: C, 70.3; H, 11.9; O, 18.4.

The mass spectrum of I exhibited the following principal *m/e* values in order of decreasing relative intensity: 127 (parent − CH_2CH_2OH), 43 ($OCCH_3^+$), 56 (CH_2CHOC^+), 157 (parent − CH_3), 155 (parent − OH).

The *p*-nitrobenzoate of I was prepared by the use of the pyridine–*p*-nitrobenzoyl chloride method and recrystallized from alcohol, m.p. 68–68.5°.

Anal. Calcd. for $C_{17}H_{23}NO_5$: C, 63.53; H, 7.20; N, 4.36. Found: C, 63.8; H, 7.16; N, 4.6.

The allophanate of I was prepared by treatment of I in ether solution with a 30% solution of cyanic acid in ether.[14] After reaction was complete, the solid was extracted with benzene and allowed to crystallize. Recrystallization from benzene gave a product of m.p. 144–144.5°.

Anal. Calcd. for $C_{12}H_{22}N_2O_4$: C, 55.79; H, 8.59; N, 10.85; O, 24.78. Found: C, 56.1; H, 8.7; N, 10.8; O, 24.7.

The infrared spectra suggested that the by-products from the preparation of I were probably ethers of the related allylic alcohols with I. The by-product contained little free hydroxyl but treatment with aqueous phosphoric acid gave a product mixture containing I as the major component. This was separated by vapor phase chromatography from the mixture and gave an infrared absorption curve superimposable with that of pure I. The minor product components were not firmly identified, but the comparison of the vapor elution rate of one low-boiling component with a standard suggested that this component was 1,8-cineole, a product previously found among the condensation products of the isoprene-related alcohols.[4,5]

Similar condensation of 2,3-dimethyl-3-buten-1-ol gave an ether–alcohol in 65% yield, b.p. 70–75° at 0.1 mm., $n^{25}D$ 1.4672.

Anal. Calcd. for $C_{12}H_{24}O_2$: C, 71.95; H, 12.08; O, 15.97. Found: C, 71.8; H, 12.1; O, 16.1.

Similar condensation of 3-ethyl-3-buten-1-ol also gave an ether–alcohol in 57% yield, b.p. 85–90° at 0.05 mm., $n^{25}D$ 1.4775.

Anal. Calcd. for $C_{12}H_{24}O_2$: C, 71.95; H, 12.08; O, 15.97. Found: C, 72.1; H, 12.0; O, 16.1.

Similar condensation of 3-neopentyl-3-buten-1-ol gave considerable resin and 27% of an unsaturated alcohol for which infrared absorption at 5.95 and 11.9 μ indicated the grouping RCH=CRR, b.p. 90–93° at 0.05 mm.

Anal. Calcd. for $C_{18}H_{34}O$: O, 6.01. Found: O, 6.5.

Attempts to condense 2-*t*-butyl-3-methyl-3-buten-1-ol gave no product. The starting material was recovered in high yield.

2,4,4-Trimethyltetrahydro-2-pyranylacetic Acid (II).—Alcohol I, 30 g., was dissolved in 150 ml. of acetic acid and oxidized by the addition of 25.0 g. of chromic anhydride at 40–45°. The resulting mixture was evaporated to dryness *in vacuo*, dissolved in 3 *N* hydrochloric acid, and extracted with ether. The bicarbonate solution was acidified and extracted with ether, dried, and evaporated. The resulting acid was recrystallized from water to yield 14.5 g. of colorless needles, m.p. 85–86°.

Anal. Calcd. for $C_{10}H_{18}O_3$: C, 64.49; H, 9.74; O, 25.77; neut. equiv., 186.2. Found: C, 64.3; H, 9.8; O, 26.1; neut. equiv., 188.5.

2,4,4-Trimethyltetrahydropyranylacetamide (III).—The treatment of acid II with excess thionyl chloride, removal of the excess under vacuum, and addition of the resulting acid chloride to aqueous ammonia gave III, m.p. 71–73°, crystallized in fine colorless needles from water–ethanol.

Anal. Calcd. for $C_{10}H_{19}NO_2$: N, 7.56. Found: N, 7.6.

Characterization of Amide III.—The amide III (10.0 g., 0.054 mole) was dissolved in 50 ml. of methanol containing 3.4 g. of potassium hydroxide. Bromine (2.9 ml., 8.65 g., 0.054 mole) was added dropwise to the solution. The solution was finally heated 30 min. at 50°, neutralized with 5% potassium hydroxide, and evaporated to dryness. The resulting isocyanate was hydrolyzed in 5% aqueous potassium hydroxide, extracted with ether, and dried over solid potassium hydroxide. The ether was removed by vacuum evaporation. The yield was 5.0 g. The

(10) N. C. Yang, D.-D. H. Yang, and C. B. Ross [*J. Am. Chem. Soc.*, **81**, 133 (1959)] gave b.p. 66–66.5° at 31 mm., $n^{20}D$ 1.4391.

(11) Column packings used in this work were of silicone grease on alkali-washed firebrick and 0.1% Apiezon L (trade-mark for Stopcock grease of Apiezon Products Ltd.) on 0.2-mm. glass beads.

(12) A. K. Blomquist and J. A. Vertol, *J. Am. Chem. Soc.*, **77**, 78 (1955).

(13) N. O. Brace, *ibid.*, **77**, 4666 (1955).

(14) F. Zobrist and H. Schinz, *Helv. Chim. Acta*, **35**, 2380 (1952).

crude amine was dissolved in 100 ml. of water containing 17 g. of potassium dihydrogen phosphate and 2.4 g. of sodium nitrite. The resulting solution was heated 8 hr. on a steam bath. The product was taken up in ether and extracted with dilute hydrochloric acid to remove any unchanged amine. The neutral fraction was evaporated. Vapor phase chromatography showed three principal components in the approximate ratio 20:40:40. The two major components were separated by vapor phase chromatography on a 5-mg. scale. Infrared spectroscopy indicated that each of these compounds contained hydroxyl and carbonyl functions.

2-Bromomethyl-2,4,4-trimethyltetrahydropyran (V).—The acid II, 27.8 g., and 16 g. of red mercuric oxide were placed in 100 ml. of carbon tetrachloride and a solution of 24 g. of bromine in 40 ml. of carbon tetrachloride was added dropwise with stirring. The mixture was refluxed until no further carbon dioxide evolution was observed. This required about 1.5 hr. The bromide was recovered by distillation at 90–92° at 11 mm., $n^{25}D$ 1.4838, yield 13.7 g. The n.m.r. spectrum of V showed absorption at δ 3.8 (t, J = ~5 c.p.s.), 3.4 (s), 1.22–1.52 (m), and 1.02 (s) in the ratio 2:2:7:6.

Anal. Calcd. for $C_9H_{17}BrO$: C, 48.87; H, 7.75; Br, 36.13; O, 7.27. Found: C, 49.2; H, 7.6; Br, 36.0; O, 7.2.

3,3,5-Trimethyl-5-hexen-1-ol (VI).—The bromo compound V, 7.3 g., was treated with 4 g. of sodium in 100 ml. of ether for 1 hr. Excess sodium was destroyed with methanol and water, and the solution was acidified with acetic acid. The solution was extracted with ether. The ether solution was washed with water and dried over magnesium sulfate, and the ether was evaporated under vacuum. The resulting alcohol VI was distilled at 96° at 12 mm. and had $n^{23}D$ 1.4515.

Anal. Calcd. for $C_9H_{18}O$: C, 76.00; H, 12.75. Found: C, 76.1; H, 12.7.

The infrared spectrum was compatible with the structure proposed with sharp bands at 6.1 and 11.25 μ. The n.m.r. spectrum showed absorption at δ 4.81 (m), 4.67 (m), 3.62 (t, J = ~8 c.p.s.), 3.16 (s), 1.97 (s), 1.70 (s), 1.51 (t, J = ~8 c.p.s.), and 0.92 (s) in the ratio 1:1:2:1:2:3:2:6. The absorption at δ 3.16 was moved downfield by the addition of a trace of trifluoroacetic acid.

Alcohol VI was converted to the allophanate by treatment with cyanic acid in ether. The allophanate was recrystallized from benzene, m.p. 149.8–151.4°.

Anal. Calcd. for $C_{11}H_{20}H_2O_3$: C, 57.86; H, 8.83; N, 12.27. Found: C, 57.9; H, 8.5; N, 12.3.

3,3,5-Trimethyl-1-hexanol (VII).—The alcohol VI, 2 g., was saturated by hydrogenation over 1 g. of 5% rhodium on alumina in 50 ml. of acetic acid. The saturated alcohol VII was recovered by ether extraction after neutralization of the acetic acid. It was distilled at 56° at 0.5 mm., $n^{24}D$ 1.4352.

Anal. Calcd. for $C_9H_{20}O$: C, 74.93; H, 13.97. Found: C, 75.1; H, 13.7.

The infrared spectrum differed principally from that of VI by absence of the 6.1- and 11.25-μ absorptions. The n.m.r. spectrum showed absorption at δ 3.70 (t, J = ~7 c.p.s.), 2.97 (s), 1.52 (t overlying broad complex, J = ~7 c.p.s.), 1.16 (d), and 0.85–0.98 (3 peaks) in ratio 2:1:3:2:12. The absorption band at δ 2.97 was moved downfield by addition of a trace of trifluoroacetic acid.

The alcohol VII was converted to the allophanate by treatment with cyanic acid in ether. The allophanate was recrystallized from benzene and methanol, m.p. 152–153°.

Anal. Calcd. for $C_{11}H_{22}N_2O_3$: C, 57.36; H, 9.63; N, 12.16; O, 20.84. Found: C, 57.4; H, 9.4; N, 12.2; O, 21.1.

3,3,5-Trimethylhexanol.—An authentic sample of 3,3,5-trimethylhexanol was prepared *via* the published[9a] alkaline cleavage of isophorone to a mixture of 3,3,5-trimethyl-5-hexenoic acid and 3,3,5-trimethyl-4-hexenoic acid (56.6%). Recovery of this mixture rather than a single product was established by correspondence of vapor phase chromatographic determinations and isopropylidene determinations. This mixture was reduced by lithium aluminum hydride to a mixture of alcohols. The mixture of alcohols was hydrogenated in acetic acid with 5% rhodium on alumina to give a single saturated alcohol (95.5% pure by vapor phase chromatography), $n^{25}D$ 1.4332. This alcohol on reaction with cyanic acid gave an allophanate, m.p. 152–153°. The melting point of a mixture of this allophanate with the allophanate of VII was also 152–153°. Further, the infrared spectra of the two allophanates were identical.

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The Anomeric 9-(2-Amino-2-deoxy-D-glucopyranosyl)adenines[1,2]

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Condensation of 3,4,6-tri-*O*-acetyl-2-deoxy-2-(2,4-dinitroanilino)-α-D-glucopyranosyl bromide (I) with 6-acetamido-9-chloromercuripurine gives the crystalline blocked nucleoside derivative 6-acetamido-9-[3,4,6-tri-*O*-acetyl-2-deoxy-2-(2,4-dinitroanilino)-β-D-glucopyranosyl]purine (Va) and also its α-D anomer (IIa). These products were *N*-deacetylated to the corresponding crystalline 6-amino derivatives Vb and IIb by way of the picrate salts Vc and IIc. Complete deblocking was achieved under mild conditions to give 9-(2-amino-2-deoxy-β-D-glucopyranosyl)adenine (VIa) and its α-D anomer (III), both in crystalline form. An ethyl thioglycoside (IVa) prepared from 2-deoxy-2-(2,4-dinitroanilino)-D-glucose is shown to be a pyranoside by conversion of its triacetate (IVb) into the known bromide I.

Several nucleosides of amino sugars exhibit antitumor or antibacterial properties,[3] and these observations have stimulated interest in the chemical synthesis of nucleoside derivatives of 2-amino-2-deoxy-D-glucose.[4-8] The synthetic nucleoside derivatives described have all been of the β-D configuration. The amino group of the sugar moiety in the purine nucleoside derivatives[4,5,7,8] has in each case been blocked by an acetyl or other group which could not be removed to yield the nucleo-

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