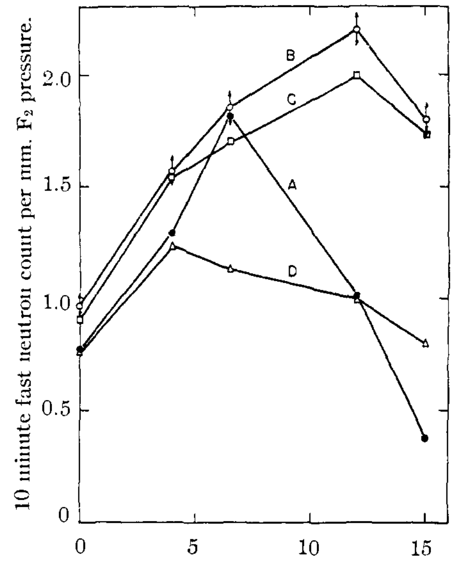

Position of reactor bottom relative to top of Hornyak button (cm.).

Fig. 1.—The change of fast neutron distributions resulting from the formation and decomposition of a volatile Po fluoride. The total fast neutron count in ten minutes divided by the F_2 pressure (330–350 mm.) is plotted against the position (cm.) of the reactor bottom below the top of the Hornyak button.

Ni tube for about 5 hours at temperatures up to 393°. The maximum neutron intensity, now observed at 12.5 cm. on the graph, indicates movement of the polonium away from the bottom of the tube. Our resolution did not permit differentiation between this observed maximum and the expected maximum at 10.1 cm. that would correspond to uniform distribution of the polonium in the tube. A further point of importance is that the total neutron yield in curve B is substantially higher than in curve A. This is a necessary result if the Po is present in the vapor rather than as a solid. In the latter case, at least half of the α-particles do not produce neutrons due to self-absorption or absorption by the walls. With the Po uniformly distributed in the vapor a much larger fraction of the α-particles produces neutrons. An estimate of the increased neutron yield was made by numerical integration of curves A and B. The value for curve B was increased by 23% to allow for the presence of Po vapor in the gauge and connectors. The ratio of this corrected area under curve B to the area under curve A was 1.9. Curve C was measured after first removing 7.7% of the polonium fluoride–fluorine vapor mixture from the reactor at room temperature and subsequently replenishing the fluorine pressure with tank F_2 for the neutron counting. The integrated neutron yield for curve C was 6.4% less than curve B, in reasonable agreement with the removal of 7.7% of the Po as vapor.

After the measurements of curve C the tip of the reactor was kept cold overnight with a solid CO_2 bath, after which curve D was measured. The peak neutron yield was now near the bottom of the reactor but the total neutron yield was much less than curve A. Investigation of the Po distribution in the gauge and connectors showed it to be most concentrated at a silver solder connection and also substantially present in the Bourdon tube. Although some of the vapor appears to have decomposed upon condensation a more substantial fraction has deposited due to its reactivity. These latter observations are perhaps an explanation of the previous unsuccessful attempts to form a volatile Po compound.

In conclusion, the results presented here indicate the formation of a volatile Po compound that subsequently decomposes due to chemical or radioactive decomposition. Further studies are in progress.

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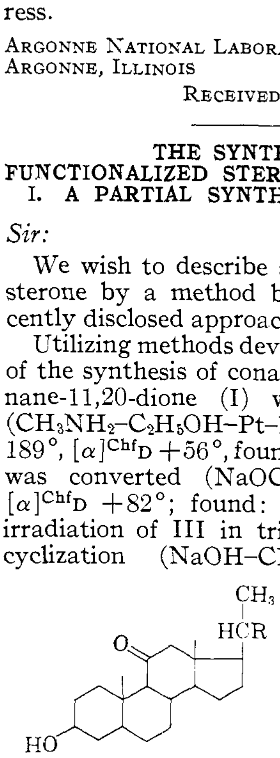
THE SYNTHESIS OF C-18 FUNCTIONALIZED STEROID HORMONE ANALOGS.
I. A PARTIAL SYNTHESIS OF ALDOSTERONE

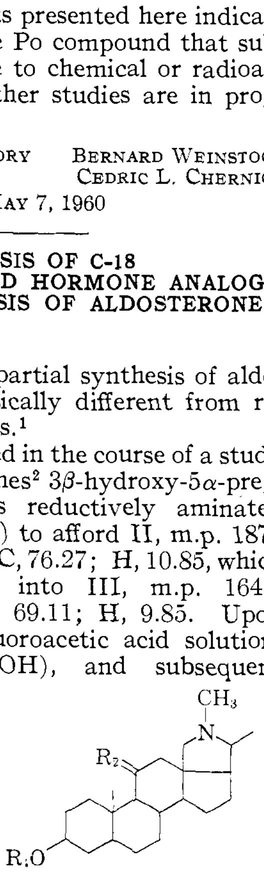
Sir:

We wish to describe a partial synthesis of aldosterone by a method basically different from recently disclosed approaches.[1]

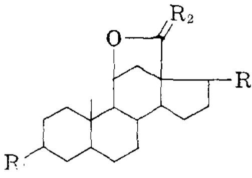
Utilizing methods devised in the course of a study of the synthesis of conanines[2] 3β-hydroxy-5α-pregnane-11,20-dione (I) was reductively aminated (CH_3NH_2–C_2H_5OH–Pt–H_2) to afford II, m.p. 187–189°, $[\alpha]^{Chf}_D$ +56°, found C, 76.27; H, 10.85, which was converted (NaOCl) into III, m.p. 164°, $[\alpha]^{Chf}_D$ +82°; found: C, 69.11; H, 9.85. Upon irradiation of III in trifluoroacetic acid solution, cyclization ($NaOH$–CH_3OH), and subsequent

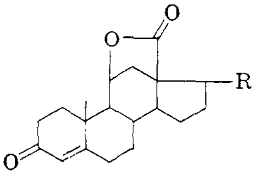


II, R = $NHCH_3$
III, R = $NClCH_3$



IV, R_1 = Ac, R_2 = O
V, R_1 = H, R_2 = OH





VII, R_1 = OH, R_2 = H_2, R_3 = $CH(N(CH_3)_2)CH_3$
VIII, R_1 = OH, R_2 = H_2, R_3 = $CH{=}CH_2$
IX, R_1 = O, R_2 = H_2, R_3 = $CH{=}CH_2$
X, R_1 = O, R_2 = H_2, R_3 = $CHOH$–CH_2OH
XI, R_1 = O, R_2 = H_2, R_3 = $CHOAcCH_2OAc$
XII, R_1 = O, R_2 = O, R_3 = $CHOAcCH_2OAc$
XIII, R = $CHOAcCH_2OAc$
XIV, R = $CHOHCH_2OH$
XV, R = $CHOH$–$CH_2OC(C_6H_5)_3$
XVI, R = $COCH_2OC(C_6H_5)_3$
XVII, R = $COCH_2OH$

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(1) K. Heusler, J. Kalvoda, Ch. Meystre, P. Wieland, G. Anner, A. Wettstein, G. Cainelli, D. Arigoni and O. Jeger, *Experientia*, **16**, 21 (1960); L. Velluz, G. Muller, R. Bardoneschi and A. Poittevin, *Compt. rend.*, **250**, 725 (1960); D. H. R. Barton and J. M. Beaton, THIS JOURNAL, **82**, 2641 (1960).

(2) J. F. Kerwin, M. E. Wolff, F. F. Owings, B. B. Lewis, B. Blank, A. Magnani and V. Georgian, in preparation.

acetylation, the conanine IV, m.p. 186–190°, $[\alpha]^{\text{Chf}}_{\text{D}}$ +83°, found C, 74.12; H, 9.76, was obtained.[3]

Reduction of IV ($LiAlH_4$–THF) gave V, m.p. 174–177°, $[\alpha]^{\text{Chf}}_{\text{D}}$ +70°, found: C, 75.79; H, 10.75; which formed the corresponding methiodide VI, m.p. 277–279°, $[\alpha]^{\text{methanol}}_{\text{D}}$ + 47°, found C, 56.14; H, 8.39. Heating the quaternary ammonium hydroxide form[4] of VI afforded VII as the hemimethanolate, m.p. 177–180°, $[\alpha]^{\text{Chf}}_{\text{D}}$ +74°, found: C, 74.80; H, 10.78; which on treatment with methyl iodide furnished the methiodide, m.p. 260°, $[\alpha]^{\text{methanol}}_{\text{D}}$ +25°, found: C, 57.04; H, 8.81. The latter was heated in DMF containing sodium methoxide to produce VIII, m.p. 145–146°, $[\alpha]^{\text{Chf}}_{\text{D}}$ +45°, found: C, 79.65; H, 10.13; which was oxidized (CrO_3-acetone) to IX, m.p. 169–170.5, $[\alpha]^{\text{Chf}}_{\text{D}}$ +77°, found: C, 79.98; H, 9.61. Hydroxylation (OsO_4) of IX afforded X as the hemihydrate, m.p. 212–215°, $[\alpha]^{\text{Chf}}_{\text{D}}$ +89.2°, found: C, 70.78; H, 9.46; which was acetylated (Ac_2O-Py) to form XI, m.p. 171–173.5, $[\alpha]^{\text{Chf}}_{\text{D}}$ +72°, found: C, 69.25; H, 8.66. The latter was oxidized (RuO_4 in CCl_4)[5] to produce XII, m.p. 242–246, $[\alpha]^{\text{Chf}}_{\text{D}}$ +51°, found: C, 67.18; H, 7.88. By use of improved methods[6] for introducing the Δ^4 moiety into 3-keto allo steroids, XII was transformed into XIII, m.p. 197–201, $[\alpha]^{\text{Chf}}_{\text{D}}$ +123°, found: C, 67.47; H, 7.48, which was hydrolyzed ($KHCO_3$) to afford XIV, m.p. 149–151°, found C, 69.71; H, 7.84.

Tritylation of XIV ($(C_6H_5)_3CCl$-Py) gave XV as the hemihydrate, m.p. 225–229°, $[\alpha]^{\text{Chf}}_{\text{D}}$ +104°, found: C, 78.24; H, 7.09, which was oxidized to XVI, obtained as the hemihydrate, m.p. 230–234°, $[\alpha]^{\text{Chf}}_{\text{D}}$ +106°, found: C, 78.90; H, 6.88. Removal of the protecting group (80% HOAc) gave XVII, m.p. 211–220°, $[\alpha]^{\text{Chf}}_{\text{D}}$ +183°, found: C, 69.96; H, 7.25, (lit[7] m.p. 212–216, 223–238 $[\alpha]^{\text{Chf}}_{\text{D}}$ +180 ± 4°). Compound XVII has been converted to aldosterone.[8,9]

(3) E. J. Corey and W. R. Hertler, THIS JOURNAL, **80**, 2903 (1958); E. J. Corey and W. R. Hertler, *ibid.*, **81**, 5209 (1959); P. Buchschacher, J. Kalvoda, D. Arigoni and O. Jeger, *ibid.*, **80**, 2905 (1958).

(4) *Cf.* J. Weinstock and V. Boekelheide, *ibid.*, **75**, 2546 (1953).

(5) L. M. Berkowitz and P. N. Rylander, *ibid.*, **80**, 6682 (1958).

(6) R. M. Evans, J. C. Hamlet, J. S. Hunt, P. G. Jones, A. G. Long, J. F. Oughton, L. Stephenson, T. Walker and B. M. Wilson, *J. Chem. Soc.*, 4356 (1956).

(7) J. Schmidlin, G. Anner, J.-R. Billeter, K. Heusler, H. Ueberwasser, P. Wieland and A. Wettstein, *Helv. Chim. Acta*, **40**, 2291 (1957).

(8) J. von Euw, R. Neher and T. Reichstein, *ibid.*, **38**, 1423 (1955).

(9) It is a pleasure to thank Dr. T. A. Geissman and Dr. Joseph Weinstock for many helpful discussions.

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STEREOCHEMISTRY OF CHLORIDE ION DISPLACEMENT FROM SILICON. HYDROLYSIS AND METHANOLYSIS OF AN OPTICALLY ACTIVE ORGANOCHLOROSILANE

Sir:

We wish to record the first stereochemical study of the hydrolysis of an optically active triorganochlorosilane, R_3Si^*Cl. The results formulated below for optically active α-naphthylphenylmethylchlorosilane,[1] taken in conjunction with the data obtained for the lithium aluminum hydride reductions, clearly indicate a high degree of stereospecificity for both hydrolysis and methanolysis reactions under the conditions specified.[2]

$$R_3Si^*Cl \xrightarrow[\text{ether}]{H_2O} R_3Si^*OH \xrightarrow{LiAlH_4} R_3Si^*H$$

I, $[\alpha]_{\text{D}}$ +6.4° II, $[\alpha]_{\text{D}}$ +20.5° III, $[\alpha]_{\text{D}}$ +30°

$$R_3Si^*Cl \xrightarrow[\text{pentane, amine}]{CH_3OH} R_3Si^*OCH_3 \xrightarrow{LiAlH_4} R_3Si^*H$$

$[\alpha]_{\text{D}}$ +6.4° IV, $[\alpha]_{\text{D}}$ +17° $[\alpha]_{\text{D}}$ +30°

$$R_3Si^*Cl \xrightarrow{LiAlH_4} R_3Si^*H \quad \text{(highly stereospecific, see ref. 1)}$$

$[\alpha]_{\text{D}}$ +6.3° $[\alpha]_{\text{D}}$ +32°

A solution of 31 g. of I in 500 ml. of ether was added rapidly to 700 ml. of cold water in a 2-liter separatory funnel which was immediately stoppered and vigorously shaken for 1–2 minutes. The ether layer then was separated, washed four times with water, and dried over potassium carbonate. Evaporation of solvent gave 28.0 g. of II (found: Si, 10.6; infrared spectrum showed typical silanol absorption at 2.80 and 3.05 microns as well as the maxima characteristic of the α-naphthylphenylmethylsilyl system). Reduction of II with lithium aluminum hydride at 140–145° using di-*n*-butyl ether as solvent gave a 72% yield of III (m.p. 62–63°; identical with III as previously reported[1] except for a somewhat smaller specific rotation).

A solution of 14 g. of I in 40 ml. of carbon tetrachloride (as prepared by chlorination of (−) III)[1] was diluted with 100 ml. of pentane and then added to a solution containing 10 ml. of methanol, 20 ml. of cyclohexylamine and 300 ml. of pentane. The reaction mixture was swirled for a moment in a separatory funnel, washed five times with cold water, dried over sodium sulfate and evacuated. Crystallization of the residue from pentane gave 89% yield of IV (m.p. 64.5–65°; found: Si, 10.2; mol. wt., 274). Reduction of IV with lithium aluminum hydride at room temperature in ethyl ether solution gave 68% yield of III.

The high degree of stereospecificity observed for both hydrolysis and methanolysis of optically active α-naphthylphenylmethylchlorosilane in ether and pentane solvents, respectively, clearly rules out a planar siliconium ion intermediate for these reactions in the specified solvents.

Rapid hydrolysis of a chlorine function linked to bridgehead silicon in 1-chloro-1-silabicyclo[2.2.1]-heptane[3] using ether as the solvent shows that hydrolysis can occur with retention of configuration.

Nevertheless, evidence partially summarized below, which will be detailed in later publications, provides strong indications that inversion of con-

(1) L. H. Sommer and C. L. Frye, THIS JOURNAL, **81**, 1013 (1959).

(2) Conditions used were imposed by two factors: rapid racemization of the silanol or methoxysilane in the presence of acid; and rapid racemization of R_3Si^*Cl by chloride ion.

(3) L. H. Sommer and O. F. Bennett, THIS JOURNAL, **79**, 1008 (1957).