and the solvent was removed by evaporation. The activity was measured in a Tracerlab internal flow Geiger counter. As the concentration of nitrogenous base in each aliquot was known from optical density measurements, specific activity could be calculated.

Purity Criteria.—The fractions of each base were found to be satisfactorily pure as judged from the ratio of the optical densities at two selected wave lengths and by the ratio of radioactivity to optical density.

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Chemical Studies with 11-Oxygenated Steroids. V. 3α,20β-Dihydroxypregnan-11-one 11-Ethylene Ketal[1]

BY BARNEY J. MAGERLEIN AND ROBERT H. LEVIN

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It is well established that the 11-keto function frequently found in steroids fails to react with the usual carbonyl reagents.[2] Catalytic or chemical reduction to the 11-hydroxyl function[2,3] and participation in the Wolff–Kishner reduction[4] are the only recorded reactions of the 11-keto moiety.

Various investigators have reported the selective preparation of cyclic ketals at other positions in the molecule leaving the 11-keto function intact.[5] It was found in these laboratories that prolonged boiling of 3α,20β-dihydroxypregnan-11-one with ethylene glycol in benzene solution in the presence of *p*-toluenesulfonic acid gave the 11-ketal in 50% yield. This compound shows strong hydroxyl absorption and complete lack of carbonyl absorption in its infrared absorption spectrum. Acidic hydrolysis gave 85% yield of the starting 3α,20β-dihydroxypregnan-11-one which was identified by mixed melting point and infrared data.

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Experimental[6]

3α,20β-Dihydroxypregnan-11-one 11-Ethylene Ketal.—A mixture of 4.0 g. of 3α,20β-dihydroxypregnan-11-one,[7] 12 ml. of ethylene glycol, 100 mg. of *p*-toluenesulfonic acid monohydrate and 150 ml. of benzene was stirred and heated under reflux for 72 hours. The water formed in the reaction was codistilled with the benzene and removed in a water trap. The cooled solution was filtered to give, after washing with methylene dichloride, 2.27 g. (50.2% yield) of crystals, m.p. 250–255°. The benzene–ethylene glycol solution, after washing with water and concentrating, gave an additional 1.51 g. of crystals, m.p. 208–216°. The 2.27 g. of ketal was recrystallized from methanol to give 1.58 g., m.p. 257–259°. The infrared absorption spectrum of this material showed no carbonyl absorption in the 6 μ region.

Anal. Calcd. for $C_{23}H_{38}O_4$: C, 72.97; H, 10.12. Found: C, 72.92, 73.00; H, 10.24, 10.22.

Hydrolysis of 3α,20β-Dihydroxypregnan-11-one 11-Ethylene Ketal.—A solution of 200 mg. of the 11-ketal in 20 ml. of acetone and 2 ml. of water containing 2 drops of concentrated sulfuric acid was heated under reflux for 2 hours. The acetone was distilled under vacuum, water added and the product filtered. It weighed 150 mg. (84.6% yield), m.p. 231–235°. After recrystallization from benzene–methanol there was obtained 130 mg., m.p. 235–237°. This material gave no melting point depression with 3α,-20β-dihydroxypregnan-11-one. Its infrared absorption spectrum was identical with the starting ketone.

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[6] Melting points are uncorrected.

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Deuterium-Hydrogen Exchange in the *para* Position of Phenyl Alkyl Ethers[1]

BY W. M. LAUER AND J. T. DAY[2]

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The influence of groups in the aromatic nucleus on chemical reactivity at a particular position has been the subject of many experimental and theoretical studies. The present study constitutes an investigation of the rates of deuterium–hydrogen exchange occurring in the *ortho* and the *para* positions of anisole and in the *para* positions of phenetole, phenyl *n*-propyl ether and phenyl isopropyl ether. These exchange reactions were conducted in acid solution at a temperature of 100°.

The deuterium labeled aromatic ethers were prepared from the corresponding bromo ethers by first converting these compounds to their lithium derivatives and then replacing the metal by deuterium with heavy water. These labeled aromatic ethers after dilution with unlabeled material were dissolved in glacial acetic acid containing sulfuric acid and the time required for one-half of the deuterium to be replaced by hydrogen was determined. The labeled aromatic ethers, held at constant temperature for definite time intervals, were isolated from solution by treatment with aqueous sodium hydroxide. These samples were then burned in a stream of oxygen and the water of combustion, after purification, was analyzed for deuterium. This analysis was accomplished by the falling drop procedure.[3]

The half-life of deuterium in the case of *para*-labeled anisole at 100° in a solution containing the aromatic ether (0.01 mole), glacial acetic acid (0.05 mole) and sulfuric acid (0.001 mole) was found to be 39 minutes ($k = 3.0 \times 10^{-4}$ sec.$^{-1}$), and the half-life of deuterium in the case of *ortho*-labeled anisole under similar conditions was found to be 75 minutes ($k = 1.5 \times 10^{-4}$ sec.$^{-1}$). A comparison of the exchange rates of *o*-deuteroanisole with the

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[1] From the Ph.D. Thesis of John T. Day, September, 1951.

[2] Abbott Laboratories Fellow, 1950–1951.

[3] I. Kirshenbaum, "Physical Properties and Analysis of Heavy Water," McGraw-Hill Book Co., Inc., New York, N. Y., 1951.