

our ester with the one prepared by him from digoxigenin. He reported [private communication] that the melting points were identical and that the melting point of a mixture was not depressed. He has also supplied the specific rotation of his ester, $[\alpha]^{24}_{D} + 45.6 \pm 3^\circ$; $[\alpha]^{24}_D + 38.9 \pm 3^\circ$ (1.183% in methanol).

The esters of three acids derived from digoxigenin have now been compared with the corresponding esters of known structure. The results show that digoxigenin has a hydroxyl group at C-12, the steric arrangement of which is opposite to that of the corresponding hydroxyl group of desoxycholic acid. A similar steric arrangement of the hydroxyl group at C-12 is present in the α -lagodesoxycholic acid described by Kishi [*Z. physiol. Chem.*, **238**, 210 (1936)].

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THE ACTION OF PERIODIC ACID ON α -AMINO ALCOHOLS

Sir:

Periodic acid readily splits [Malaprade, *Bull. soc. chim.*, (5) 1, 833 (1934)] substances carrying the grouping $\begin{array}{c} \text{R} \quad \text{R}' \\ | \quad | \\ \text{---C---C---} \\ | \quad | \\ \text{OH} \quad \text{OH} \end{array}$ (in which R or R' may be H) to the ketones or aldehydes ---C(=O)R and $\text{---C(=O)R}'$. This reaction recently has been applied very effectively to glucoside derivatives [Jackson and Hudson, *THIS JOURNAL*, **59**, 994, 2049 (1937); **60**, 989 (1938)]. We now find that this reaction may be extended to cases in which hydroxyl is replaced by ---NH_2 or by ---NHR , and are actively engaged in trying to determine the range of its applicability.

Specifically, serine ($\text{HOCH}_2\text{CH}(\text{NH}_2)\text{CO}_2\text{H}$) is rapidly and quantitatively split, and the dimedon derivative of H_2CO can be isolated in 95% yield. The progress of HIO_4 consumption with time is entirely consistent with the assumption that the other direct products from serine are (as would be expected) ammonia and glyoxylic acid. The latter is further oxidized, over a period of a day or two, to formic acid and carbon dioxide, according to the established reaction [Fleury and Bon-Bernatets, *J. pharm. chim.*, **23**, 85 (1936)]. Threonine reacts like serine, producing acetaldehyde, which has not as yet been quantitatively determined.

Of the naturally occurring amino acids which

do not have a β -hydroxy group, tryptophan reacts rapidly with much more than one mole of periodic acid to form an insoluble product. Methionine and cystine are also somewhat rapidly attacked, but, we believe, chiefly through oxidation of their sulfur. Glycine, alanine, tyrosine, histidine, aspartic acid, asparagine, and glutamic acid reduce periodic acid at somewhat varying rates, which are estimated to be at most $1/1000$ as fast as the reaction with serine. The nature of these reactions has not yet been established, but they do not seem likely to offer any insurmountable obstacle to the use of periodic acid for the quantitative study of serine, threonine, and the somewhat hypothetical hydroxy-glutamic acid in protein hydrolyzates, which we are undertaking.

As a secondary amine, diethanolamine ($\text{NH}(\text{CH}_2\text{CH}_2\text{OH})_2$) reacts very rapidly to liberate 4 moles of formic acid. In contrast with this, diethylaminoethanol ($(\text{C}_2\text{H}_5)_2\text{NCH}_2\text{CH}_2\text{OH}$) shows practically no reaction. This behavior is probably typical of tertiary amines, and suggests that the fourth hydrogen of an ammonium ion (R_3NH^+) is not sufficient to permit the desired reaction.

Preliminary results with an acylated derivative of serine indicate an extremely slow attack, the course of which is not yet definitely determined. Since, however, this last reaction could, if successful, be of even more interest in the study of protein chemistry than those already noted, our interest in it is being continued.

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PANTOTHENIC ACID AS A FACTOR IN RAT NUTRITION

Sir:

In the course of experiments designed to isolate from liver extracts a substance necessary for rat growth, it became apparent that the substance was unstable in the presence of acid and alkali, and that it could be concentrated by procedures many of which previously had been used for the isolation of pantothenic acid. Starting with 95% alcoholic liver extract, the following methods were employed: (1) extraction from acid aqueous solution by amyl alcohol and return into dilute aqueous alkali; (2) adsorption on norite and