H. Iizuka A. Naito

Microbial Conversion of Steroids and Alkaloids

PREFACE

The authors of this volume have been conducting studies on microbial transformation of steroids and alkaloids since 1956. Their findings together with the data from other researchers up to 1966 were compiled into a volume entitled *Microbial Transformation of Steroids and Alkaloids* (University of Tokyo Press, Tokyo, and University Park Press, State College, Pennsylvania) published in 1967.

In the preface to that volume, the authors stated that "Biological systems display a far greater specificity than the more conventional forms of organic chemical reactions, and of all the systems available, that which has the greatest immediate potential in organic synthesis is microbial transformation." They went on to say, "Thus it would seem that the new field of microbial transformation will develop more and more in the near future."

In the last decade microbial transformation has come to be applied to a wide range of organic compounds just as the authors had anticipated, or perhaps even to a greater extent than they had expected.

One of the outstanding features of microbial transformation is that it allows various specific reactions which had been presumedly infeasible by the means of conventional organic synthesis, such as some oxidation and reduction, and the splitting of the carbon-carbon bond, under normal temperature and pressure with a good yield of high purity products.

Microbial transformation has also been utilized more extensively in the introduction of functional groups for obtaining biologically useful substances, in reactions showing stereochemical specificity, and even in identification of unknown organic compounds in recent years. It will probably be used for microbial decomposition treatment of natural and non-natural wastes for protecting the environment as well. In the not-too-distant future, moreover, this technique is likely to see practical application in the form of so-called bioreactors, or biochemical reactors.

In the light of such developments, the authors decided to publish the present volume as a sequel to their 1967 work, compiling herein data and other findings from their studies thereafter up to 1978 that cover such chemical reactions as synthesis, decomposition, and conversion using microorganisms and plant culture cells.

In the previous volume, the contents were divided into ten chapters according to the structural type of substrate used in the microbial reactions, and these reactions in each chapter were grouped by the type of transformation reaction. In the present volume, however, the contents are divided into eight chapters according to the structural type of substrate used, with entries in each chapter placed under the names of microorganisms arranged in alphabetical order. This was done in conformity with the trend that researchers in recent years classify different types of conversion reaction by microorganisms. In other words, a more efficient procedure for pursuing research in this

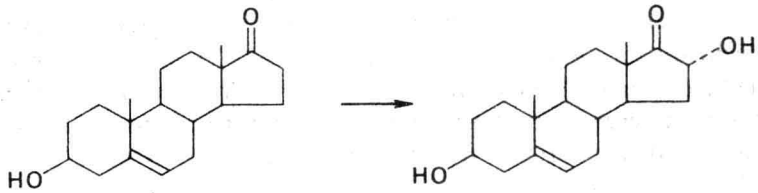
field henceforth will be to determine the various kinds of properties of each strain possessing conversion reactions.

In this manner, the present volume covers 853 substrates, 1,735 conversion products, a total of 83 genera comprising 163 species of microorganisms and a total of 16 genera comprising 17 species of plants.

For clarification, the reader is referred to the following entry examples.

Example 1
Streptomyces roseochromogenes NRRL B-1233

Iida, M., T. Shinozuka and H. Iizuka
Z. Allg. Mikrobiol., **19**, 557–561 (1979)

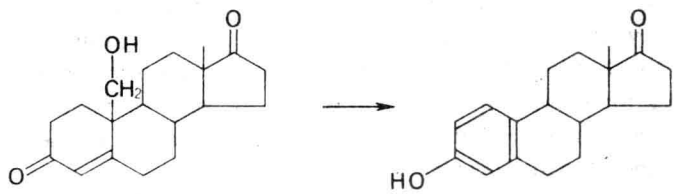


3β-Hydroxyandrost-5-en-17-one (Dehydroepiandrosterone)

3β, 16α-Dihydroxyandrost-5-en-17-one (16α-Hydroxydehydroepiandrosterone, 85%)

Example 2
Corynebacterium equi SANK 73460

Naito, A. and M. Shirasaka
Japan Pat. 674,232
674,233 (1967)



19-Hydroxyandrost-4-ene-3, 17-dione

3-Hydroxyestra-1, 3, 5 (10)-trien-17-one (Estrone, 78%)

First, the scientific name of the microorganism or plant is given in the top line with the nomenclator(s) of that name omitted. This is followed by the strain name and number in the case of those that have them. Next comes the name or names of the original author(s) together with the bibliographical reference complete with volume number, page number, and the year of publication. Conversion reaction is illustrated by the chemical structures with the structure names of the substrate on the left and the product on the right. Their conventional names and the percentage yield are given in parentheses below.

This volume may well be the first work to compile actual reactions using plant cul-

ture cells which have come to attract considerable interest in recent years. Original reports not cited in the authors' previous work (1967) were also included in the present volume. Separate indexes to authors, microorganisms, and substances are provided at the end of this volume. Used in combination with the previous work, therefore, this book should serve as a key guide enabling the reader to find what he or she is looking for quickly and without fail from a large number of research data spanning a relatively long period of time.

Tokyo
January, 1981

Hiroshi IIZUKA
and
Atsushi NAITO

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VIII. CONVERSION OF CARDENOLIDES BY PLANT CELL SUSPENSION CULTURE

H. Iizuka A. Naito

Microbial Conversion of Steroids and Alkaloids

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Dr. Hiroshi Iizuka
Director of Institute of Applied Biology
Science University of Tokyo, Noda

Yamazaki, Noda-city, Chiba 278, Japan

Dr. Atsushi Naito
Fermentation Res. Laboratories
Sankyo Co. Ltd., Tokyo

Hiroo-machi 1-2-58, Shinagawa-ku, Tokyo 140, Japan

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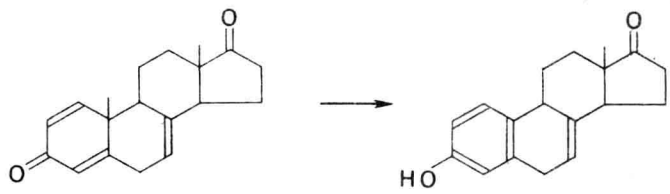
2131/3140-543210

I. MICROBIAL CONVERSION OF STEROID HORMONES

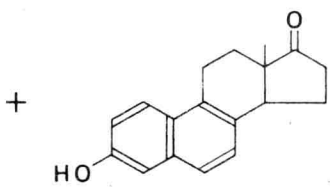
1–1. *Absidia coerulea*

Kluepfel, D. and C. Vézina
Appl. Microbiol., **20**, 515—516 (1970)



Androsta-1, 4, 7-triene-3, 17-dione

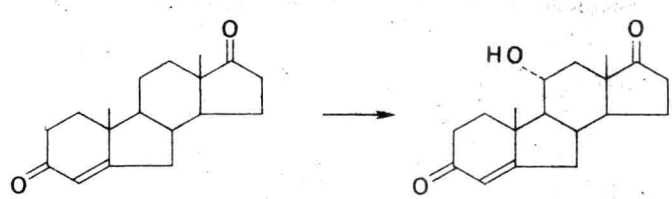
3-Hydroxyestra-1, 3, 5(10), 7-tetraen-17-one (Equilin)



3-Hydroxyestra-1, 3, 5(10), 6, 8(9)-pentaen 17-one (Equilenin)

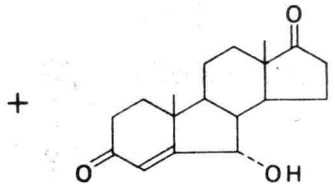
1–2. *Absidia orchidis*

Joska, J., Ž. Procházka, J. Fajkoš and F. Šorm
Collect. Czech. Chem. Commun., **38**, 1398—1405 (1973)



B-Norandrost-4-ene-3, 17-dione

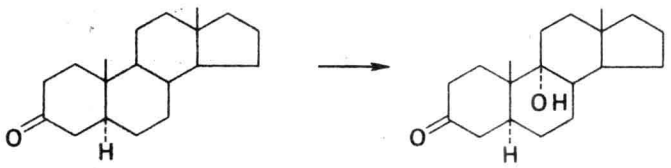
11α-Hydroxy-B-norandrost-4-ene-3, 17-dione (4.2%)



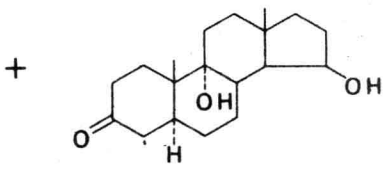
6α-Hydroxy-B-norandrost-4-ene-3, 17-dione
(35.6%)

1–3. *Absidia regnieri*

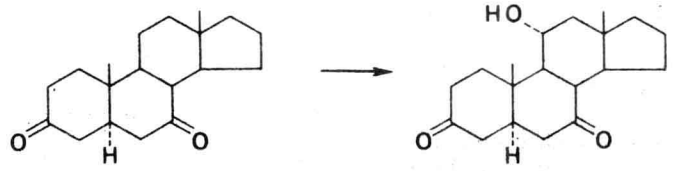
Bell, A. M., Sir E.R.H. Jones, G. D. Meakins, J. O. Miners and A. L. Wilkins
J. Chem. Soc., Perkin 1, 1975, 2040—2043.



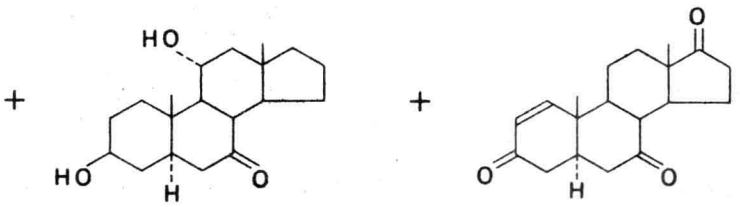
5α-Androstan-3-one 9α-Hydroxy-5α-androstan-3-one (4%)



9α, 15β-Dihydroxy-5α-androstan-3-one (8%)



5α-Androstane-3, 7-dione 11α-Hydroxy-5α-androstane-3, 7-dione (1%)



3β, 11α-Dihydroxy-5α-androstan-7-one (6%) 5α-Androst-1-ene-3, 7, 17-trione

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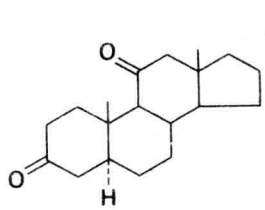
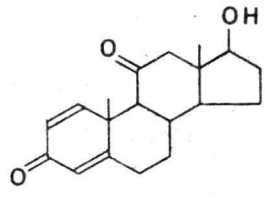
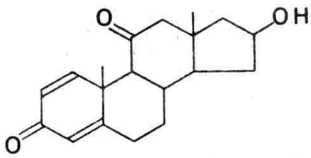


5α-Androstane-3, 11-dione



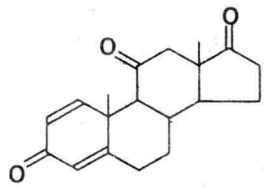
17β-Hydroxyandrosta-1, 4-diene-3, 11-dione (6%)

+



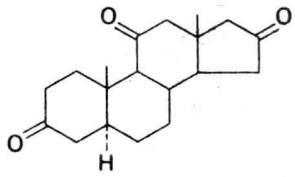
16β-Hydroxyandrosta-1, 4-diene-3, 11-dione (4%)

+

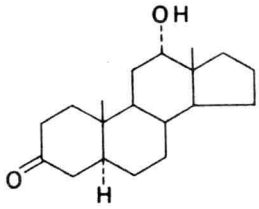


Androsta-1, 4-diene-3, 11, 17-trione (2%)

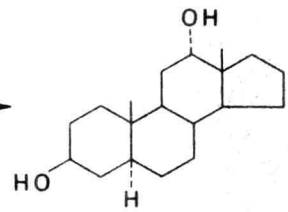
+



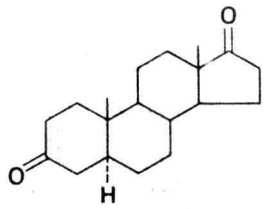
5α-Androstane-3, 11, 16-trione (2%)



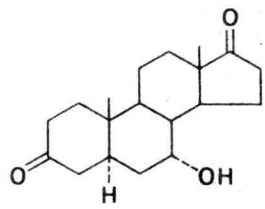
12α-Hydroxy-5α-androstan-3-one



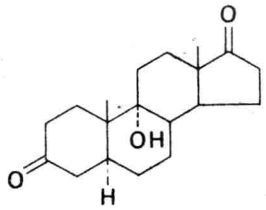
3β, 12α-Dihydroxy-5α-androstane (10%)



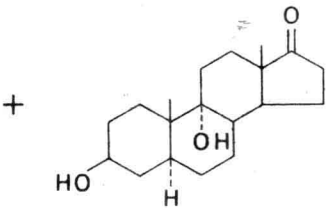
5α-Androstane-3, 17-dione



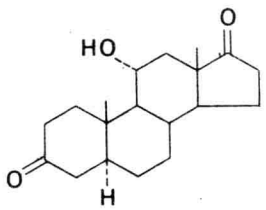
7α-Hydroxy-5α-androstane-3, 17-dione (10%)

+ 

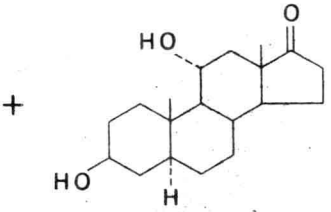
9α-Hydroxy-5α-androstane-3, 17-dione (8—14%)

+ 

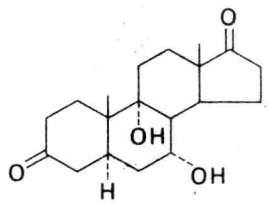
3β, 9α-Dihydroxy-5α-androstan-17-one (5—7%)

+ 

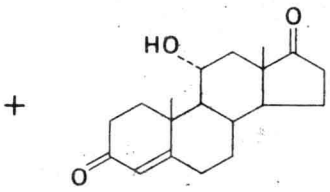
11α-Hydroxy-5α-androstane-3, 17-dione (14%)

+ 

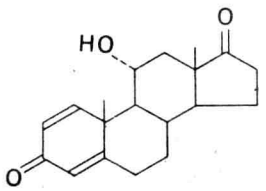
3β, 11α-Dihydroxy-5α-androstan-17-one (11%)

+ 

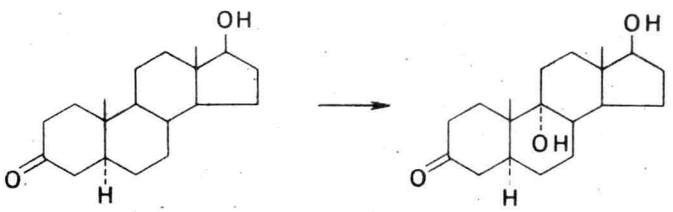
7α, 9α-Dihydroxy-5α-androstane-3, 17-dione (13%)

+ 

11α-Hydroxyandrost-4-ene-3, 17-dione (9%)

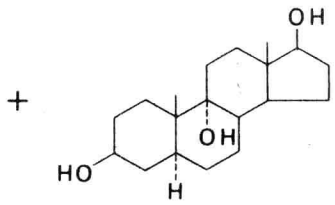
+ 

11α-Hydroxyandrosta-1, 4-diene-3, 17-dione (16%)

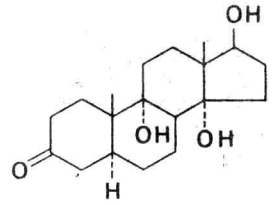


17β-Hydroxy-5α-androstan-3-one

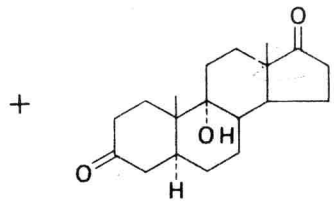
9α, 17β-Dihydroxy-5α-androstan-3-one (14—30%)



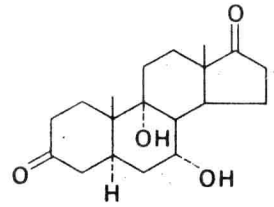
3β, 9α, 17β-Trihydroxy-5α-androstane (8%)



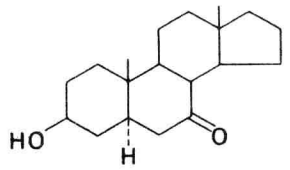
9α, 14α, 17β-Trihydroxy-5α-androstan-3-one (2%)



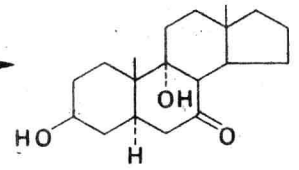
9α-Hydroxy-5α-androstane-3, 17-dione (2%)



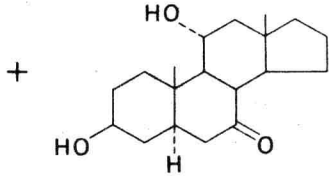
7α, 9α-Dihydroxy-5α-androstane-3, 17-dione (7%)



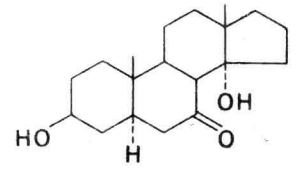
3β-Hydroxy-5α-androstan-7-one



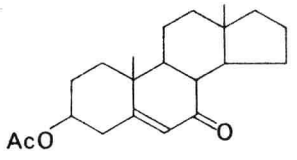
3β, 9α-Dihydroxy-5α-androstan-7-one (23%)



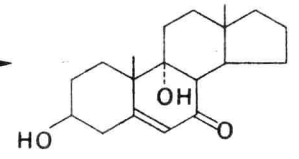
3β, 11α-Dihydroxy-5α-androstan-7-one (5%)



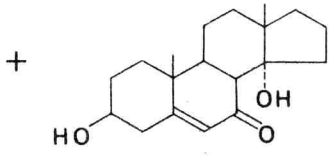
3β, 14α-Dihydroxy-5α-androstan-7-one (9%)



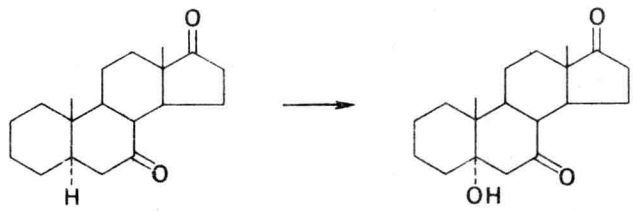
3β-Acetoxyandrost-5-en-7-one



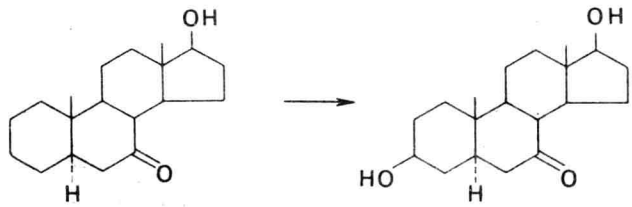
3β, 9α-Dihydroxyandrost-5-en-7-one (21%)



3β, 14α-Dihydroxyandrost-5-en-7-one (19%)

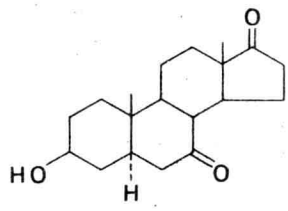


5α-Androstane-7, 17-dione → 5α-Hydroxy-5α-androstane-7, 17-dione (6%)

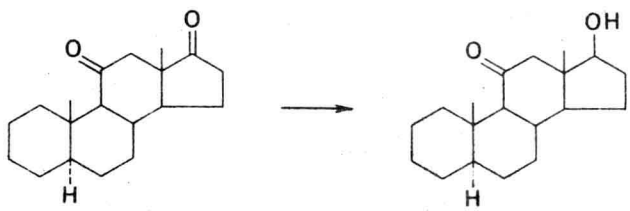


17β-Hydroxy-5α-androstan-7-one → 3β, 17β-Dihydroxy-5α-androstan-7-one (24%)

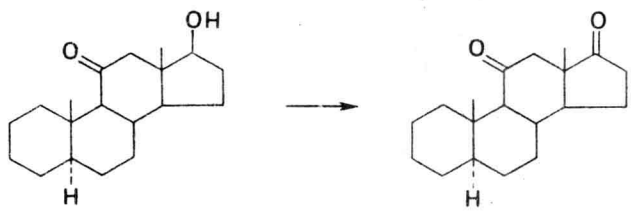
\+



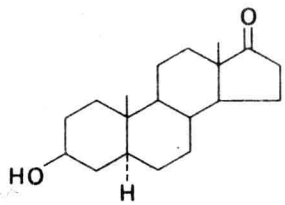
3β-Hydroxy-5α-androstane-7, 17-dione (6%)



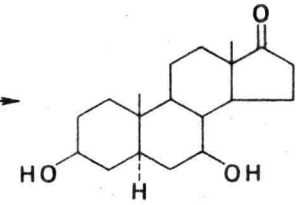
5α-Androstane-11, 17-dione → 17β-Hydroxy-5α-androstan-11-one (28%)



17β-Hydroxy-5α-androstan-11-one → 5α-Androstane-11, 17-dione (25%)

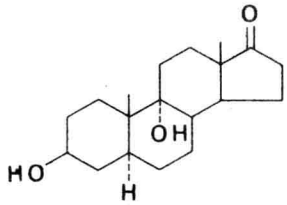


3β-Hydroxy-5α-androstan-17-one



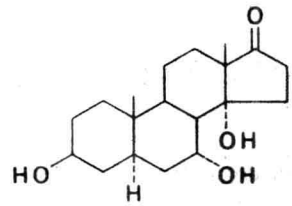
3β, 7β-Dihydroxy-5α-androstan-17-one (9—12%)

+



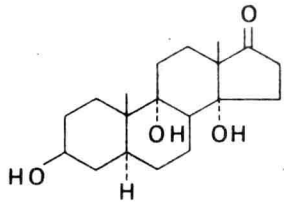
3β, 9α-Dihydroxy-5α-androstan-17-one (19—49%)

+

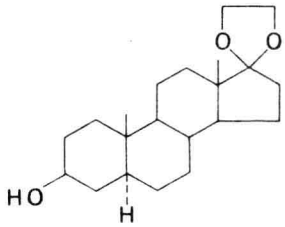


3β, 7α, 14α-Trihydroxy-5α-androstan-17-one (4%)

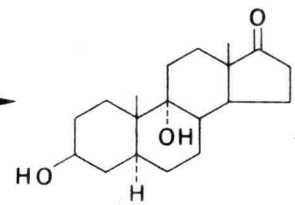
+



3β, 9α, 14α-Trihydroxy-5α-androstan-17-one (2%)

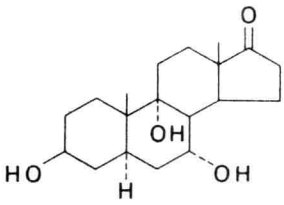


17, 17-Ethylenedioxy-5α-androstan-3β-ol



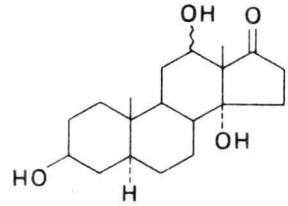
3β, 9α-Dihydroxy-5α-androstan-17-one (14%)

+

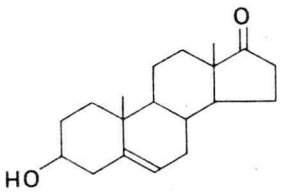


3β, 7α, 9α-Trihydroxy-5α-androstan-17-one (4%)

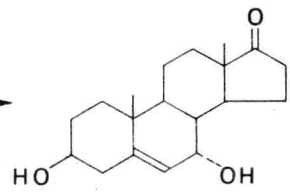
+



3β, 12ξ, 14α-Trihydroxy-5α-androstan-17-one (4%)

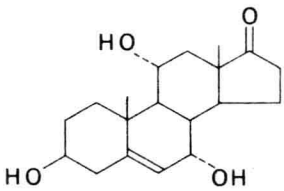


3β-Hydroxyandrost-5-en-17-one

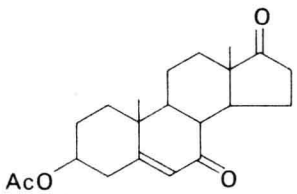


3β, 7α-Dihydroxyandrost-5-en-17-one (21%)

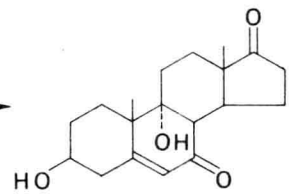
+



3β, 7α, 11α-Trihydroxyandrost-5-en-17-one (39%)

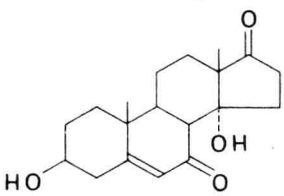


3β-Acetoxyandrost-5-ene-7, 17-dione



3β, 9α-Dihydroxyandrost-5-ene-7, 17-dione (37%)

+



3β, 14α-Dihydroxyandrost-5-ene-7, 17-dione (10%)

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