12 to 2). Further conversion to 9 was achieved straightforwardly by a standard silylation/dehydrogenation procedure.[10]

Now the stage is set for the crucial (Me_3SiCl/Cu(I)-μmediated) conjugate addition of the zinc homoenolate of propionate onto the enone 9. We fully anticipated very selective formation of the desired adduct 10 via the sterically favorable approach of the organocopper reagent.[3d] Surprisingly, a nearly quantitative reaction yielded an inseparable 1:1 mixture of stereoisomers (δ 0.92 and 1.12 for the 18-methyl group). This unexpected result necessitated extensive search of the conditions that produce the desired 8α-compound. The work along this line, however, was greatly hampered by the very low reactivity of the (copper) homoenolate.[5] To our great satisfaction, $BF_3 \cdot Et_2O$[11] was found not only to promote the addition but to direct it to the desired α-side attack (>80% yield, >95% α).[12] To our knowledge, this is a rare example of the additive dependence of the stereochemistry of the conjugate addition.[13]

Conversion of 10[6] to the steroid nucleus (2) was then achieved via an internal Diels–Alder route.[3b] The 16-hydroxyl group was protected, the ester hydrolyzed, and the keto acid 11 (35% from 8) subjected to Stork's three-step protocol to obtain the tetracyclic ketone 12 in 68% overall yield, together with two structural isomers (20%).[14] Ozonolysis (13,[6] 80%) followed by treatment with DBU (2,[6] 75%) not only completed the AB ring synthesis but also set the D ring ready for the final hydroxylation of the side chain.

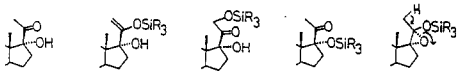
The last stage of the synthesis was initiated by functionalizing the C-17 position. Thus, the less hindered Δ^{16}-double bond in 2 was selectively reduced by Rh-catalyzed hydrosilylation[15] to obtain the enol silyl ether 14[6] (89% on 74% conversion), which was then to be subjected to *m*-CPBA oxidation.[16] The whole synthetic scheme afterward, which would amount to a very complicated one by conventional routes, was greatly simplified by development of a novel double hydroxylation reaction. Thus, treatment of a mixture of enol silyl ether 14 and finely powdered $KHCO_3$ in methylene chloride with *m*-CPBA (3 equiv added slowly as a methylene chloride solution at 0 °C) resulted in highly chemoselective hydroxylation of *both C-17 and C-21 positions*[17] to give, after aqueous acidic workup, (±)-cortisone in 83% isolated yield. The synthetic material was identical with an authentic sample by 200-MHz ^1H NMR, 50-MHz ^{13}C NMR, and TLC mobility under several different conditions.

A very slight modification of the final oxidation step converts the enol silyl ether 14 directly into (±)-adrenosterone. Thus, treatment of 14 with a mixture of excess *m*-CPBA and $KHCO_3$ at room temperature produced 15 in about 50% yield.

The above-mentioned double hydroxylation precedure with its considerable generality,[16b] has obvious importance for the synthesis of various other pharmaceutically important compounds, and further studies are under way.[18]

Supplementary Material Available: Physical properties of several key synthetic intermediates [compounds 2, 6–8, 10–14] (4 pages). Ordering information is given on any current masthead page.

(10) Ito, Y.; Hirao, T.; Saegusa, T. *J. Org. Chem.* **1978**, *43*, 1011.
(11) Yamamoto, Y.; Yamamoto, S.; Yatagai, H.; Ishihara, Y.; Maruyama, K. *J. Org. Chem.* *1982*, *47*, 119.
(12) The stereochemistry at *pro*-C-8, -13, and -14 was confirmed by correlating to a Stork's intermediate.[3b] We thank Prof. Stork for generous provision of an authentic ^1H NMR spectrum.
(13) After completion of this work, a similar observation has been reported: Corey, E. J.; Boaz, N. W. *Tetrahedon Lett.* **1985**, *26*, 6015.
(14) These involve both an olefinic regioisomer (12% yield) due to the dehydration reaction (inert to the Diels–Alder conditions) and a stereoisomer (8%) due to the cycloaddition reaction. Attempted isomerization ($RhCl_3$) of the regioisomer resulted in destruction of the homoallylic alcohol moietry.
(15) Ojima, I.; Kogure, T.; Nagai, Y. *Tetrahedron Lett.* **1972**, 5035.
(16) (a) Brook, A. G.; Macrae, D. M. *J. Organomet. Chem.* **1974**, *77*, C19. (b) Rubottom, G. M.; Vazquez, M. A.; Pelegrina, D. R. *Tetrahedron Lett.* **1974**, 4319. (c) Hassner, A.; Reuss, R. H.; Pinnick, H. W. *J. Org. Chem.* **1975**, *40*, 3427.
(17) (a) Some comments on the mechanism may be due. Unoptimized reactions produced varying amounts of compounds i–iii and none of the "normal" product iv. Since the siloxy ketone iv produces neither of these



i ii iii iv v

three products upon exposure to the reaction conditions, we consider that a presumed[16] epoxide v directly rearranges to ii, which is then further oxidized to iii. (b) For example, this reaction applies to preparations of 16α-methylcorticoids and to derivatization of 1-acetylcyclohexene.
(18) Financial support from the Ministry of Education, Science, and Culture (Grant-in-Aid for Special Research) is gratefully acknowledged.

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Additions and Corrections

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Emmanuel Y. Osei-Twum, Doug McCallion, Avtar S. Nazran, Rick Panicucci, Prabhakar A. Risbood, and John Warkentin*. Hydroxyalkylation with α-Hydroperoxydiazenes. Alcohols from Olefins and Carbonyl Compounds from Enol Ethers.

Page 341. The symbol I should appear in the blank space under $CH_2{=}C(CH_3)OCH_3$ in the second column. The last part of footnote r (2,4-DNP mp 95–95.5 °C[15]) should appear instead as the last part of footnote s.

David A. Jaeger,* Craig A. Martin, and Timothy G. Golich. "Destructible" Surfactants Based on a Ketal Group.

Page 4546. Line 12 of column 2 should read: 5-cm column of neutral Al_2O_3 (pH 7.4) using 1:9....