Anal. Calcd for $C_7H_{12}O_4$: C, 52.49; H, 7.55. Found: C, 52.20; H, 7.48.

Methyl *trans*- and *cis*-1-Ethyl-2-(3-methyloxiranyl)ethyl Carbonates (19c and 19d). In a similar manner (see Table III, entries 3 and 4), the disubstituted epoxides were prepared and purified by column chromatography (1:1 hexane/ethyl acetate).

For **19c** (trans isomer): ^{1}H NMR δ 0.95 (t, 3), 1.25 (d, 3), 1.6–1.9 (m, 4), 2.6–2.8 (m, 2), 3.8 (s, 3), 4.8 (quintet, 1). A sample was further purified for analysis by preparative VPC. Anal. Calcd for $C_9H_{16}O_4$: C, 57.43; H, 8.57. Found: C, 57.79; H, 8.56.

For **19d** (cis isomer): ^{1}H NMR δ 0.95 (t, 3), 1.25 (d, 3), 1.6–2.0 (m, 4), 2.9–3.1 (m, 2), 3.8 (s, 3), 4.8 (quintet, 1). An analytical sample was purified by preparative VPC. Anal. Calcd for $C_9H_{16}O_4$: C, 57.43; H, 8.57. Found: C, 57.37; H, 8.39.

1-(3-Butenyl)-2-oxiranylethanol (20a). A mixture of 605 mg (2.0 mmol) of iodo carbonate **9** (isomer mixture) and 850 mg (6.16 mmol) of K_2CO_3 in 6 mL of methanol was stirred at 21 °C for 7 h. Ether (30 mL) was added, the mixture was washed with aqueous $Na_2S_2O_3$/$NaHCO_3$, dried ($MgSO_4$), and evaporated, and the crude product was purified by column chromatography (1:1 hexane/ethyl acetate) to give 195 mg (67% yield) of the epoxy alcohol **20a**: IR 3000–3700 (br), 2920, 1635 cm^{-1}; ^{1}H NMR δ 1.45–1.95 (m, 4), 2.1–2.3 (m, 2), 2.51 (dd, 1, J = 4.9, 2.8), 2.79 (dd, 1, J = 4.9, 4.5), 3.11 (m, 1), 3.93 (m, 1), 4.95–5.15 (m, 2), 5.75–5.95 (m,1); ^{13}C NMR δ 29.6, 36.4, 39.7, 46.3, 50.1, 69.6, 114.7, 138.2 (peaks for minor isomer at δ 35.8, 39.4, 46.8, and 68.8); no molecular ion observed in the mass spectrum.

1-Methyl-2-oxiranylethanol (20b). In a similar manner (see Table III, entry 2), iodo carbonate **6** (isomer mixture) was converted to epoxy alcohol **20b** (1-mmol scale). NMR analysis indicated that the crude product contained 10% of the methoxy diol **21b**: IR 3000–3700 (br), 2960 cm^{-1}; ^{1}H NMR δ 1.25 (d, 3, J = 6.3), 1.5–1.9 (m, 2), 2.52 (dd, 1, J = 4.9, 2.8), 2.79 (dd, 1, J = 4.9, 4.5), 3.09 (m, 1), 3.38 (s, 0.3 (CH_3O)), 4.02 (m, 1); no molecular ion observed in the mass spectrum.

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Registry No. 5b, 82770-15-8; **5c**, 82770-16-9; **6t**, 82770-17-0; **6e**, 82770-18-1; **7b**, 82770-19-2; **7c**, 82770-20-5; **7d**, 82770-21-6; **7e**, 82770-22-7; **7f**, 82770-23-8; **8E-b**, 82770-24-9; **8Z-b**, 82770-25-0; **8E-c**, 82770-26-1; **8Z-c**, 82770-27-2; **9e**, 82770-28-3; **9t**, 82770-29-4; **10**, 82770-30-7; **11**, 82796-55-2; **18a(e)**, 82770-31-8; **19a(e)**, 82770-32-9; **19a(t)**, 82770-38-5; **19b(e)**, 82770-33-0; **19c**, 82770-34-1; **19d**, 82796-56-3; **20a(e)**, 82770-35-2; 20a(t), 82770-39-6; **20b(e)**, 32815-71-7; **21b(e)**, 82770-37-4; 1,7-octadien-4-ol lithium salt, 82770-36-3; 2-[(*tert*-butoxycarbonyloxy)imino]-2-phenylacetonitrile, 58632-95-4; 4-penten-2-ol, 625-31-0; 4-methoxybenzyl alcohol, 105-13-5; 1,1′-carbonyldiimidazole, 530-62-1.

Total Synthesis of Naturally Occurring Mycolic Acids. (*E*)- and (*Z*)-*threo*-2-Docosyl-3-hydroxytetracont-21-enoate[1]

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The ethyl esters of (*E*)- and (*Z*)-2-docosyl-3-hydroxytetracont-21-enoate (**4a** and **4b**, respectively) have been prepared by a route involving alkylation of the dianion of ethyl 2-docosyl-3-oxobutyrate (**2**) with either (*E*)-1-iodo-17-hexatriacontene (**14c**) or (*Z*)-1-iodo-17-hexatriacontene (**13c**) and subsequent borohydride reduction of the intermediate β-keto esters (**3a** and **3b**, respectively). Resolution of the 3:2 mixture of erythro and threo diastereomers of **4a** and **4b** was accomplished by high-performance liquid chromatography, employing phenacyl ester derivatives. The ^{1}H NMR spectra of phenacyl (*E*)-*threo*-2-docosyl-3-hydroxytetracont-21-enoate (**6a**) and phenacyl (*Z*)-*threo*-2-docosyl-3-hydroxytetracont-21-enoate (**6b**) were identical with the spectra previously reported for the phenacyl esters of the naturally occurring monoalkene mycolic acids from *Mycobacterium smegmatis* (see ref 10). An examination of the phenacyl ester of the epoxide derivative of the naturally occurring mycolic acid by ^{1}H NMR spectroscopy established that it was a 93:7 mixture of the *Z* and *E* isomers, respectively, of phenacyl *threo*-2-docosyl-3-hydroxytetracont-21-enoate.

Mycolic acids are high molecular weight fatty acids produced by all *Mycobacteria*. All of the known mycolic acids have the basic structure $R^2CH(OH)CH(R^1)CO_2H$, wherein R^1 is a C_{22} or C_{24} linear alkane and R^2 is a more complex structure comprised of 30–60 carbon atoms and containing a variety of functional groups.[2] Our interest in these fatty acids arises because they are constituents of preparations that are being evaluated in an experimental animal model[3-6], as well as clinically,[7,8] as immunotherapeutic agents in the treatment of cancer. Advances in chromatographic methodologies have enabled us to fractionate the complex mixture of mycolic acids present in *Mycobacteria* into pure components whose structures and biological activities can be determined.[9] Our investigations in this area are most advanced for the mycolic acids of *Mycobacterium smegmatis*, which have been fractionated into three major homologous series, a monoalkene series ($C_nH_{2n-2}O_3$, n = 60, 62, 64, 66) and two different dialkene series ($C_nH_{2n-4}O_3$, one series with n = 74, 76, 78, 80, and

(1) This investigation was supported by Grant No. CA15325, awarded by the National Cancer Institute, DHEW. G.R.G. is the recipient of Faculty Research Award 143 from the American Cancer Society.

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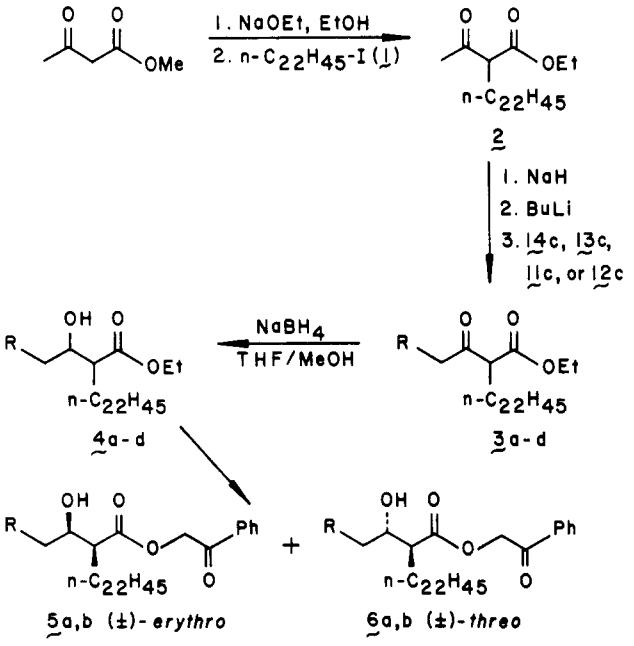
Scheme I



a, R = (*E*)-$CH_3(CH_2)_{17}CH{=}CH(CH_2)_{16}$—

b, R = (*Z*)-$CH_3(CH_2)_{17}CH{=}CH(CH_2)_{16}$—

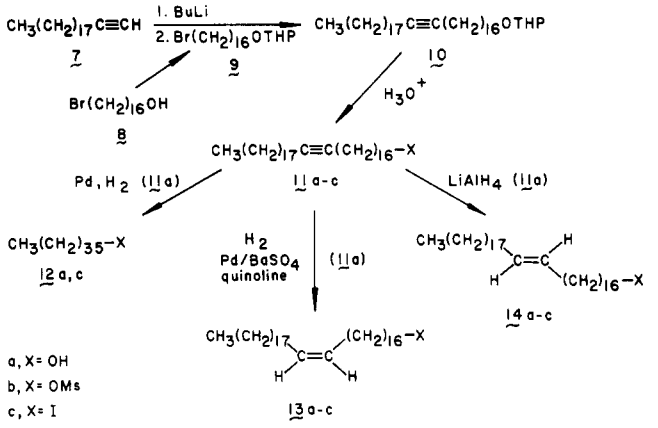
c, R = $CH_3(CH_2)_{17}C{\equiv}C(CH_2)_{16}$—

d, R = n-$C_{36}H_{73}$—

82 and the other series with n = 75, 77, 79, 81, and 83).[10] The complete structures of the individual homologues of the monoalkene series have been reported,[11] and we now report the total synthesis of one of those homologues ($C_{62}H_{122}O_3$), which has been found to be a 93:7 mixture of the *Z* and *E* isomers of *threo*-2-docosyl-3-hydroxytetracont-21-enoic acid (characterized as phenacyl esters **6b** and **6a**, respectively). We also report the synthesis of the related alkyne **4c** and alkane **4d**, for which the erythro and threo isomers were not resolved.

The synthesis of these mycolic acids was accomplished as shown in Scheme I. The key feature of this synthesis, the incorporation of the 2-docosyl side chain and functionalized main chain (R) in a regiospecific manner, is based on the alkylation of acetoacetate ester dianions as described by Weiler.[12,13] Alkylation of methyl acetoacetate at C-2 with 1-iododocosane (**1**) in ethanol as the solvent was accomplished as previously reported for the synthesis of the corresponding 2-butyl derivative.[14] From the NMR spectrum of the product, ethyl 2-docosyl-3-oxobutyrate (**2**), it was readily apparent that alkylation at C-2 had been achieved; the H-2 resonance at δ 3.30 was a triplet (J = 7 Hz), reflecting coupling to the docosyl C-1 methylene, while the H-4 resonance at δ 2.15 remained a singlet. Sequential treatment of **2** at 0 °C with slightly more than 1 equiv each of sodium hydride and *n*-butyllithium gave a yellow dianion, which was subsequently alkylated by the addition of either 1-iodo-17-hexatriacontyne (**11c**), 1-iodo-17-hexatriacontane (**12c**), (*Z*)-1-iodo-17-hexatriacontene (**13c**) or (*E*)-1-iodo-17-hexatriacontene (**14c**). That

Scheme II



alkylation occurred selectively at C-4 to give β-keto esters **3a–d** was apparent from the ^{1}H NMR spectra of the products. In each case, the H-4 resonance was observed as a multiplet at δ 2.49, whereas the H-2 resonance remained a triplet at δ 3.40.

The synthesis of the functionalized main chain (R) was accomplished as shown in Scheme II. Commercially available 16-bromohexadecanoic acid was reduced to the alcohol **8** which was converted to its tetrahydropyranyl ether (**9**) by standard procedures. Alkylation of **9** with the lithium salt of 1-eicosyne (**7**) gave the THP ether of 17-hexatriacontyn-1-ol (**10**), which was deprotected to give **11a**. Conversion of **11a** to hexatriacontan-1-ol (**12a**), (*Z*)-17-hexatriaconten-1-ol (**13a**) and (*E*)-17-hexatriaconten-1-ol (**14a**) was accomplished by standard procedures. That isomerically pure **13a** and **14a** were indeed formed as a result of catalytic hydrogenation and lithium aluminum hydride reduction,[15] respectively, was established by ^{1}H NMR spectroscopy of their epoxide derivatives. The epoxide methine protons (H-17,18) of the **13a** epoxide were observed as a multiplet at δ 2.93, whereas the epoxide methine protons of the **14a** epoxide were observed at δ 2.65.[16] The intermediate alcohols **11a**, **13a**, and **14a** were converted to their 1-iodo derivatives (**11c**, **13c**, and **14c**, respectively) by iodide displacements of their mesyl esters, but **12a** was converted to its 1-iodo derivative (**12c**) directly with hydroiodic acid.

Completion of the synthesis of the mycolates was accomplished by sodium borohydride reduction of β-keto esters **3a–d**, resulting in an erythro/threo mixture of β-hydroxy esters **4a–d**. The presence of the hydroxyl groups in **4a–d** was readily apparent from their ^{1}H NMR spectra, and its location at C-3 was confirmed by mass spectral analysis. When heated in the mass spectrometer, **4a–d** undergo a retroaldol-type reaction[17] to give aldehyde (RCH_2CHO) and ester ($C_{23}H_{47}CO_2Et$) components that are readily observed by chemical ionization mass spectrometry with ammonia as the reagent gas.[10] In all cases, the ester fragments were observed both as their protonated forms (M + 1) at m/e 397 and as their ammonium-capture ions (M + 18) at m/e 414. The aldehyde fragments were observed exclusively as their ammonium-capture ions (M + 18), and in each compound (**4a–d**), only the expected molecular weight was observed. The molecular weights of the aldehyde and ester pyrolysis products and their

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elemental compositions were also confirmed by exact mass measurement.

Separation of the erythro and threo diastereomers[18] of the synthetic mycolates was accomplished by high-performance liquid chromatography of their phenacyl ester derivatives. The separation was accomplished only for the naturally occurring (*E*)- and (*Z*)-alkenes (see below). Chromatography on μ-Porasil (Waters Associates) under the conditions previously described for the naturally occurring compounds[10] easily resolved the less polar erythro isomers (**5a,b**) from the more polar threo isomers (**6a,b**). In each case the erythro isomer was found to constitute approximately 60% of the product mixture.

The establishment of configuration for **5a,b** and **6a,b** was accomplished by 300-MHz ^{1}H NMR spectroscopy. The spectra of **5a** and **5b**, which differ only in the configuration of the carbon–carbon double bond, were indistinguishable; for both compounds, the vinylic protons were observed at the same chemical shift (δ 5.38). Similarly, the spectra of **6a** and **6b** were indistinguishable. The spectra of **5a** and **5b** were different from the spectra of **6a** and **6b**, however, in the chemical shifts observed for the hydroxyl resonances and the carbinol protons (H-3) and in the magnitude of the coupling constants between H-2 and H-3. In the erythro isomers (**5a,b**), the hydroxyl doublet (J = 6 Hz) was observed at δ 3.10, whereas in the threo isomers (**6a,b**) the hydroxyl doublet (J = 6 Hz) occurred downfield at δ 3.43. In contrast, the H-3 resonances of **5a** and **5b** (δ 3.93) occurred downfield of the H-3 resonances of **6a** and **6b** (δ 3.76). The coupling constants between H-2 and H-3 were established for all four isomers by observing the effect of irradiation at H-3 on the H-2 resonance at approximately δ 2.6. In **5a** and **5b**, the fully coupled H-2 resonance is observed at δ 2.68 as a doublet of triplets (J = 10.4 and 3.7 Hz). Irradiation at δ 3.93 (H-3) collapsed the H-2 resonance to a doublet of doublets (J = 10.4 and 3.7 Hz). Therefore, for **5a,b**, $J_{H\text{-}2,H\text{-}3}$ = 3.7 Hz. In **6a** and **6b**, the fully coupled H-2 resonance is observed at δ 2.59 as a doublet doublet of doublets with J = 4.9, 6.5, and 9.6 Hz. Irradiation at δ 3.76 (H-3) collapsed the H-2 resonance to a doublet of doublets (J = 4.9 and 9.6 Hz). Therefore, for **6a,b**, $J_{H\text{-}2,H\text{-}3}$ = 6.5 Hz. Both the magnitudes of the coupling constants between H-2 and H-3 and the relative chemical shifts for the carbinol protons of **5a,b** and **6a,b** are fully in agreement with thoose reported by Heathcock et al.[19] for the erythro and threo isomers of a wide variety of substituted β-hydroxy ester derivatives. Moreover, the downfield shift of the hydroxyl proton in the threo isomers (**6a,b**) is consistent with the presence of a stronger intramolecular hydrogen bond, which has been verified by an infrared study of the naturally occurring threo-mycolates.[20]

The determination that both (*E*)- and (*Z*)-*threo*-2-docosyl-3-hydroxytetracont-21-enoates are naturally occurring mycolic acids in *M. smegmatis* was made on the basis of a spectroscopic comparison of the phenacyl esters of the natural monoalkene mycolates and the synthetic mycolates (**6a** and **6b**), as well as the positional localization of functional grups as previously reported.[10,11] The ^{1}H NMR spectra of **6a** and **6b** are indistinguishable from the spectra previously reported[10] for the phenacyl esters of the natural mycolates. Furthermore, decoupling experiments utilizing the phenacyl ester of the natural mycolate and its epoxide derivative[21] established that $J_{H\text{-}2,H\text{-}3}$ is the same as in **6a** and **6b**. The natural mycolates, therefore, clearly possess the threo configuration. This conclusion is the same as that reached by other workers on the basis of studies of these and other naturally occurring mycolates by infrared spectroscopy,[20] optical rotation,[22] and ^{13}C NMR spectroscopy.[23] The configuration of the carbon–carbon double bond from earlier work is, however, less clear. A ^{13}C NMR study of *M. smegmatis* cord factor, a 6,6′-mycolic acid diester of trehalose, demonstrated that a cis double bond was present in the fatty acid.[23] Cord factor contains an esterified mixture of all monoalkene and dialkene homologues, however, so the configuration of the double bond in the monoalkene homologues was not clearly defined by these studies. Trans double bonds were not detected in the ^{13}C spectrum, in disagreement with an earlier infrared investigation which indicated that the dialkene homologues possessed trans double bonds.[24] In order to unequivocally establish the configuration of the double bond in the natural monoalkene homologues, the epoxide derivative was prepared and examined by ^{1}H NMR spectroscopy.[21] Epoxide methine resonances were observed at δ 2.90 (0.93 H) and δ 2.65 (0.07 H), demonstrating[16] that the natural mycolate is a 93:7 mixture of **6b** and **6a**, respectively.

In conclusion, the total synthesis of these mycolic acid isomers has made possible a rigorous chemical characterization of the natural compounds and has provided materials of defined structure and purity which will permit a careful evaluation of their biological activities.

Experimental Section

General Methods. Melting points were determined on a Fisher-Johns melting point apparatus and are uncorrected. Elemental analyses were performed by Galbraith Laboratories, Knoxville, TN, and by M-H-W Laboratories, Phoenix, AZ. Satisfactory analytical data (±0.4% for C, H, Br, and S) were reported for all compounds. Nuclear magnetic resonance spectra were recorded on Nicolet NT-300 and Varian HFT-80 instruments with $CDCl_3$ as the solvent and are referenced to internal tetramethylsilane. Mass spectra were determined on AEI MS-30 (electron impact, EI) and Finnigan 4000 (chemical ionization, CI) instruments.

1-Iododocosane (1). A mixture of docosan-1-ol (13.54 g, 41.4 mmol) and 70 mL of 55% hydroiodic acid was refluxed for 40 min and then poured into 500 mL of ice–water. The solid that formed was collected, washed with water (500 mL), and recrystallized from acetone (300 mL) to give 1: 15.14 g (84%); mp 46–47.5 °C; ^{1}H NMR ($CDCl_3$) δ 0.85 (t, J = 6 Hz, 3 H, H-22), 1.10–1.90 (complex, H-2–21), 3.15 (t, J = 7 Hz, 2 H, H-1). Anal. C, H.

Ethyl 2-Docosyl-3-oxobutyrate (2). Compound **2** was prepared by a modification of the procedure used to prepare the corresponding 2-butyl derivative.[14] Sodium metal (0.14 g, 6 mmol) was cut into small pieces and added to 10 mL of absolute ethanol contained in a 50-mL round-bottomed flask. After all the sodium had dissolved, methyl acetoacetate (0.58 g, 5 mmol) was added, and the solution was refluxed for 10 min. A solution of 1-iododocosane (1; 2.18 g, 5 mmol) in 5 mL of ethanol was then added, refluxing was continued for 5 h, and the solution was cooled and filtered. Evaporation of the filtrate gave a residue which was chromatographed on a silica gel column (2.5 × 30 cm) and eluted

(18) The stereochemical descriptions erythro and threo are employed in the sense adopted by Heathcock et al. (see ref 19): The main chain of the aldol is written in the extended (zig-zag) fashion. If the bonds to the α-alkyl substituent and the β-hydroxy group both project either toward or away from the viewer, this is the erythro diastereomer.

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(21) The ^{1}H NMR spectrum of the phenacyl ester of the epoxide derivative of the naturally occurring monoalkene mycolic acid from *M. smegmatis* contained the following relevant resonances: δ 2.59 (ddd, $J_{H\text{-}2,H\text{-}3}$ = 6.3 Hz, $J_{H\text{-}2,H\text{-}1,docosyl}$ = 5.1, 9.7 Hz, 1 H, H-2), 2.65 (m, 0.07 H, *E* isomer epoxide methine), 2.90 (m, 0.93 H, *Z* isomer epoxide methine).

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sequentially with hexane (40 mL), $CHCl_3$–hexane (100 mL, 3:7 v/v), and $CHCl_3$–hexane (200 mL, 2:3 v/v). Evaporation of the final elute gave **2** (0.88 g, 45%) as a waxy residue: ^1H NMR ($CDCl_3$) δ 0.85 (m, 3 H, H-22 docosyl), 1.05–1.95 (complex, ethyl CH_3, H-1–21 docosyl), 2.15 (s, 3 H, H-4), 3.30 (t, J = 7 Hz, 1 H, H-2), 4.13 (q, J = 8 Hz, 2 H, ethyl CH_2); MS (M^+), m/e 438.4093 ($C_{28}H_{54}O_3$ requires 438.4072). Anal. C, H.

Ethyl (*E*)-2-Docosyl-3-oxotetracont-21-enoate (3a). In a two-necked, 50-mL, round-bottomed flask, one neck fitted with a rubber septum and the other with a reflux condenser and drying tube, was placed 0.070 g of a 50% oil dispersion of NaH (1.46 mmol). After removal of the oil by extraction three times with dry petroleum ether, the flask was flushed with nitrogen, and 10 mL of THF and a solution of ethyl 2-docosyl-3-oxobutyrate (**2**; 0.479 g, 1.01 mmol) in 5 mL of THF were added. The mixture was stirred for 1 h at room temperature and then cooled to 0 °C. To the cooled solution was added 0.44 mL of 2.4 N *n*-BuLi in hexane, and the resultant yellow solution of the dianion was stirred at 0 °C for 15 min. (*E*)-1-Iodo-17-hexatriacontene (**14c**; 0.55 g, 0.87 mmol) in 5 mL of THF was added, the mixture was refluxed gently for 1 h, cooled, and diluted with 75 mL of ether. The etheral solution was extracted sequentially with 10% HCl and saturated aqueous NaCl, dried over anhydrous magnesium sulfate, and evaporated to dryness under vacuum to give an off-white solid which was chromatographed on silica gel (2.5 × 35 cm). Sequential elution with $CHCl_3$–hexane (200 mL, 1:9 v/v) and $CHCl_3$–hexane (300 mL, 1:1 v/v) gave **3a** (0.517 g, 63%) after evaporation of the latter eluate. Crystallization from ethanol gave analytically pure **3a**: mp 66–69 °C; ^1H NMR ($CDCl_3$) δ 0.88 (t, J = 7 Hz, 6 H, H-40, H-22 docosyl), 1.0–1.65 (complex, H-5–19, H-24–39, H-2–21 docosyl, ethyl CH_3), 1.82 (m, 2 H, H-1 docosyl), 1.96 (m, 4 H, H-20,23), 2.49 (m, 2 H, H-4), 3.40 (t, J = 7 Hz, 1 H, H-2), 4.17 (q, J = 7 Hz, 2 H, ethyl CH_2), 5.38 (t, J = 4 Hz, 2 H, H-21, 22); MS (CI, NH_3), m/e 958 (M + 18). Anal. C, H.

Ethyl (*Z*)-2-Docosyl-3-oxotetracont-21-enoate (3b). (*Z*)-1-Iodo-17-hexatriacontene (**13c**; 0.128 g, 0.20 mmol) was condensed with the dianion of **2** (0.20 mmol) as described above for the preparation of **3a**. Chromatography on silica gel (2.5 × 30 cm) and sequential elution with hexane (40 mL), $CHCl_3$–hexane (100 mL, 1:9 v/v), $CHCl_3$–hexane (100 mL, 3:7 v/v), and $CHCl_3$–hexane (300 mL, 2:3 v/v) gave **3b** (0.075 g, 40%) as a white residue after evaporation of the final eluate. Crystallization from acetone afforded analytically pure **3b**: mp 67–71 °C; ^1H NMR ($CDCl_3$) δ 0.88 (t, J = 6 Hz, 6 H, H-40, H-22 docosyl), 1.10–1.67 (complex, H-5–19, H-24–39, H-2–21 docosyl, ethyl CH_3), 1.82 (m, 2 H, H-1 docosyl), 1.96 (m, 4 H, H-20,23), 2.49 (m, 2 H, H-4), 3.40 (t, J = 8 Hz, 1 H, H-2), 4.18 (q, J = 7 Hz, 2 H, ethyl CH_2), 5.38 (m, 2 H, H-21,22). Anal. C, H.

Ethyl 2-Docosyl-3-oxotetracont-21-ynoate (3c). 1-Iodo-17-hexatriacontyne (**11c**; 0.126 g, 0.20 mmol) was condensed with the dianion of **2** (0.20 mmol) as described above for the preparation of **3a**, and the reaction mixture was chromatographed on silica gel as described for the isolation of **3b**. Evaporation of the final eluate ($CHCl_3$–hexane, 2:3 v/v) gave **3c** (0.062 g, 33%) as a white powder. Crystallization from acetone gave analytically pure **3c**: mp 58–62 °C; ^1H NMR ($CDCl_3$) δ 0.88 (t, J = 6 Hz, 6 H, H-40, H-22 docosyl), 1.10–1.67 (complex, H-5–19, H-24–39, H-2–21 docosyl, ethyl CH_3) 1.82 (m, 2 H, H-1 docosyl), 2.14 (t, J = 5 Hz, 4 H, H-20,23), 2.49 (m, 2 H, H-4), 3.40 (t, J = 8 Hz, 1 H, H-2), 4.18 (q, J = 7 Hz, 2 H, ethyl CH_2). Anal. C, H.

Ethyl 2-Docosyl-3-oxotetracontanoate (3d). 1-Iodohexatriacontane (**12c**; 0.130 g, 0.20 mmol) was condensed with the dianion of **2** (0.20 mmol) as described above for the preparation of **3a**, and the reaction mixture was chromatographed on silica gel as described for the isolation of **3b**. Evaporation of the final $CHCl_3$–hexane (2:3 v/v) eluate gave **3d** (0.068 g, 33%). Crystallization from acetone gave analytically pure **3d**: mp 77–82 °C; ^1H NMR ($CDCl_3$) δ 0.88 (t, J = 6 Hz, 6 H, H-40, H-22 docosyl), 1.10–1.67 (complex, H-5–39, H-2–21 docosyl, ethyl CH_3), 1.82 (m, 2 H, H-1 docosyl), 2.49 (m, 2 H, H-4), 3.40 (t, J = 8 Hz, 1 H, H-2), 4.18 (q, J = 7 Hz, 2 H, ethyl CH_2). Anal. C, H.

Ethyl (*E*)-2-Docosyl-3-hydroxytetracont-21-enoate (4a). A mixture of ethyl (*E*)-2-docosyl-3-oxotetracont-21-enoate (**3a**; 0.335 g, 0.36 mmol), sodium borohydride (0.115 g, 3.04 mmol), dry MeOH (0.5 mL), and THF (25 mL) was stirred at room temperature for 30 min under nitrogen and then diluted with ether. The etheral solution was extracted sequentially with 10% HCl and saturated aqueous NaCl, dried over anhydrous magnesium sulfate, and evaporated. Chromatography of the residue on silica gel (2.5 × 30 cm) and elution with $CHCl_3$–hexane (500 mL, 1:1 v/v) gave crystalline **4a** (0.22 g, 66%) after evaporation of the second 250 mL of eluate: mp 74–77 °C; ^1H NMR ($CDCl_3$) δ 0.88 (t, J = 6 Hz, 6 H, H-40, H-22 docosyl), 1.10–1.70 (complex, H-4–19, H-24–39, H-1–21 docosyl, ethyl CH_3), 1.96 (m, 4 H, H-20,23), 2.35–2.50 (complex, 2 H, H-2 and hydroxyls), 3.62 (m, 0.4 H, H-3), 3.78 (m, 0.6 H, H-3), 4.18 (q, J = 7 Hz, 2 H, ethyl CH_2), 5.38 (t, J = 4 Hz, 2 H, H-21,22); MS (EI; pyrolysis products), m/e 396.3983 (M^+, ester; $C_{28}H_{52}O_2$ requires 396.3967), 546.5755 (M^+, aldehyde; $C_{38}H_{74}O$ requires 546.5740); MS (CI, NH_3; pyrolysis products), m/e 397 (M + 1 ester), 414 (M + 18 ester), 564 (M + 18 aldehyde). Anal. C, H.

Ethyl (*Z*)-2-Docosyl-3-hydroxytetracont-21-enoate (4b). The reduction of **3b** (0.048 g, 0.05 mmol) was accomplished as described above for the conversion of **3a** to **4a**, and the product (**4b**) was purified by chromatography on silica gel. Elution of the column (2.5 × 30 cm) successively with $CHCl_3$–hexane (100 mL, 1:9 v/v), $CHCl_3$–hexane (100 mL, 1:1 v/v), and $CHCl_3$–hexane (100 mL, 3:2 v/v) gave unreacted **3b** (0.011 g) in the second eluate and **4b** (0.023 g, 60% based on recovered **3b**) in the final eluate. Recrystallization from acetone gave analytically pure **4b**: mp 73–76 °C; ^1H NMR ($CDCl_3$) δ 0.89 (t, J = 6 Hz, 6 H, H-40, H-22 docosyl), 1.10–1.70 (complex, H-4–19, H-24–39, H-1–21 docosyl, ethyl CH_3), 1.98 (m, 4 H, H-20,23), 2.35–2.50 (complex, 2 H, H-2 and hydroxyls), 3.66 (m, 0.33 H, H-3), 3.79 (m, 0.67 H, H-3), 4.19 (q, J = 7 Hz, 2 H, ethyl CH_2), 5.40 (m, 2 H, H-21,22); MS (EI) pyrolysis products, m/e 396.3948 (M^+, ester; $C_{26}H_{52}O_2$ requires 396.3967), m/e 546.5735 (M^+, aldehyde; $C_{38}H_{74}O$ requires 546.5740); MS (CI, NH_3; pyrolysis products), m/e 397 (M + 1 ester), 414 (M + 18 ester), 564 (M + 18 aldehyde). Anal. C, H.

Ethyl 2-Docosyl-3-hydroxytetracont-21-ynoate (4c). The reduction of **3c** (0.047 g, 0.05 mmol) was accomplished as described above for the conversion of **3a** to **4a**, and the product (**4c**) was purified by chromatography on silica gel as described for **4b**. Evaporation of the $CHCl_3$–hexane (3:2 v/v) eluate gave **4c** (0.045 g, 90%) as a white residue. Crystallization from acetone gave analytically pure **4c**: mp 65–67 °C; ^1H NMR ($CDCl_3$) δ 0.89 (t, J = 6 Hz, 6 H, H-40, H-22 docosyl), 1.10–1.70 (complex, H-4–19, H-24–39, H-1–21 docosyl, ethyl CH_3), 2.15 (t, J = 5 Hz, 4 H, H-20,23), 2.35–2.50 (complex, 2 H, H-2 and hydroxyls), 3.65 (m, 0.39 H, H-3), 3.79 (m, 0.61 H, H-3), 4.19 (q, J = 7 Hz, 2 H, ethyl CH_2); MS (EI, pyrolysis products), m/e 396.3994 (M^+ ester; $C_{26}H_{52}O_2$ requires 396.3967), m/e 544.5580 (M^+ aldehyde; $C_{38}H_{72}O$ requires 544.5565); MS (CI, NH_3; pyrolysis products), 397 (M + 1 ester), 414 (M + 18 ester), 562 (M + 18 aldehyde). Anal. C, H.

Ethyl 2-Docosyl-3-hydroxytetracontanoate (4d). The reduction of **3d** (0.068 g, 0.07 mmol) was accomplished as described above for the conversion of **3a** to **4a**, and the product (**4d**) was purified by chromatography on silica gel. Elution of the column (2.5 × 30 cm) successively with $CHCl_3$–hexane (100 mL, 1:9 v/v), $CHCl_3$–hexane (100 mL, 1:1 v/v), and $CHCl_3$–hexane (100 mL, 3:1 v/v) gave unreacted **3d** (0.007 g) in the second eluate and **4d** (0.048 g, 80%) in the final eluate. Recrystallization from acetone gave analytically pure **4d**: mp 86–88 °C; ^1H NMR ($CDCl_3$) δ 0.89 (t, J = 6 Hz, 6 H, H-40, H-22 docosyl), 1.10–1.70 (complex, H-4–39, H-1–21 docosyl, ethyl CH_3), 2.35–2.50 (complex, 2 H, H-2 and hydroxyls), 3.66 (m, 0.35 H, H-3), 3.79 (m, 0.65 H, H-3), 4.19 (q, J = 7 Hz, 2 H, ethyl CH_2); MS (EI; pyrolysis products), m/e 396.3981 (M^+, ester; $C_{26}H_{52}O_2$ requires 396.3967), m/e 548.5918 (M^+, aldehyde; $C_{38}H_{76}O$ requires 548.5896); MS (CI, NH_3; pyrolysis products), m/e 397 (M + 1 ester), 414 (M + 18 ester), 566 (M + 18 aldehyde). Anal. C, H.

***erythro*- and *threo*-Phenacyl (*E*)-2-Docosyl-3-hydroxytetracont-21-enoate (5a,6a).** Compound **4a** (0.074 g, 0.079 mmol) was dissolved in a mixture of 6% methanolic KOH (10 mL) and benzene (10 mL), and the mixture was refluxed for 2 h. After cooling, the mixture was diluted with ether (20 mL) and washed successively with 10% HCl and saturated NaCl (20 mL each). The etheral solution was dried over anhydrous $MgSO_4$ and evaporated to give a white solid (64 mg) to which were added phenacyl bromide (0.031 g, 0.16 mmol), ethyl diisopropylamine (0.07 mL, 0.40 mmol), and 25 mL of 2:1 (v/v) $CHCl_3$–CH_3CN.

The reaction mixture was heated at 50 °C for 2 h, cooled, and evaporated to dryness. Chromatography of the residue on Sephadex LH-20 in $CHCl_3$–MeOH (2:1 v/v) yielded the **5a/6a** mixture (0.060 g, 74%) in the void volume fractions.[9] Resolution of the **5a/6a** mixture was accomplished by high performance liquid chromatography on μ-Porasil (0.78 × 30 cm) as described previously for the naturally occurring isomer.[10] Two components were observed, a major, less polar isomer (**5a**, 60%) and a minor, more polar isomer (**6a**, 40%). **5a**: ^1H NMR ($CDCl_3$) δ 0.88 (t, J = 7 Hz, 6 H, H-40, H-22 docosyl), 1.0–1.85 (complex, H-4–19, H-24–39, H-1–21 docosyl), 1.96 (m, 4 H, H-20,23), 2.68 (dt, $J_{H-2,H-3}$ = 3.7 Hz, $J_{H-2,H-1,docosyl}$ = 3.7, 10.3 Hz, 1 H, H-2), 3.10 (d, J = 6 Hz, 1 H, exchanged with D_2O, hydroxyl), 3.93 (m, 1 H, H-3), 5.31 (d, J = 16.5 Hz, 1 H, phenacyl methylene), 5.38 (m, 2 H, H-21,22), 5.55 (d, J = 16.5 Hz, 1 H, phenacyl methylene), 7.49 (t, J = 7.7 Hz, 2 H, H-3,5 phenacyl), 7.63 (t, J = 7.1 Hz, H-4 phenacyl), 7.92 (d, J = 7.7 Hz, 2 H, H-2,6 phenacyl). **6a**:[25] ^1H NMR ($CDCl_3$) δ 0.88 (t, J = 7 Hz, 6 H, H-40, H-22 docosyl), 1.0–1.85 (complex, H-4–19, H-24–39, H-1–21 docosyl), 1.96 (m, 4H, H-20,23), 2.59 (ddd, $J_{H-2,H-3}$ = 6.5 Hz, $J_{H-2,H-1,docosyl}$ = 5.0, 9.6 Hz, 1 H, H-2), 3.43 (d, J = 6 Hz, 1 H, exchanged with D_2O, hydroxyl), 3.76 (m, 1 H, H-3), 5.32 (d, J = 16.5 Hz, 1 H, phenacyl methylene), 5.38 (m, 2 H, H-21,22), 5.54 (d, J = 16.5 Hz, 1 H, phenacyl methylene), 7.49 (t, J = 7.6 Hz, 2 H, H-3,5 phenacyl), 7.63 (t, J = 7.2 Hz, 1 H, H-4 phenacyl), 7.92 (d, J = 7.7 Hz, 2 H, H-2,6 phenacyl).

***erythro*- and *threo*-Phenacyl (*Z*)-2-Docosyl-3-hydroxytetracont-21-enoate (5b,6b).** Compound **4b** was saponified and converted to its phenacyl ester, and the erythro (**5b**, 64%) and threo (**6b**, 36%) isomers were resolved as described for **5a** and **6a**. **5b**: ^1H NMR ($CDCl_3$) δ 0.88 (t, J = 7 Hz, 6 H, H-40, H-22 docosyl), 1.0–1.85 (complex, H-4–19, H-24–39, H-1–21 docosyl), 1.96 (m, 4 H, H-20, 23), 2.68 (dt, $J_{H-2,H-3}$ = 3.7 Hz, $J_{H-2,H-1,docosyl}$ = 3.7, 10.5 Hz, 1 H, H-2), 3.11 (d, J = 6 Hz, 1 H, exchanged with D_2O, hydroxyl), 3.94 (m, 1 H, H-3), 5.31 (d, J = 16.5 Hz, 1 H, phenacyl methylene), 5.38 (m, 2 H, H-21,22), 5.55 (d, J = 16.5 Hz, 1 H, phenacyl methylene), 7.50 (t, J = 7.7 Hz, 2 H, H-3,5 phenacyl), 7.63 (t, J = 7.1 Hz, 1 H, H-4 phenacyl), 7.93 (d, J = 7.7 Hz, 2 H, H-2,6 phenacyl). **6b**:[25] ^1H NMR ($CDCl_3$) δ 0.88 (t, J = 7 Hz, 6 H, H-40, H-22 docosyl), 1.0–1.85 (complex, H-4–19, H-24–39, H-1–21 docosyl), 1.96 (m, 4 H, H-20,23), 2.59 (ddd, $J_{H-2,H-3}$ = 6.5 Hz, $J_{H-2,H-1,docosyl}$ = 4.8, 9.7 Hz, 1 H, H-2), 3.43 (d, J = 6 Hz, 1 H, exchanged with D_2O, hydroxyl), 3.77 (m, 1 H, H-3), 5.32 (d, J = 16.5 Hz, 1 H, phenacyl methylene), 5.38 (m, 2 H, H-21,22), 5.55 (d, J = 16.5 Hz, 1 H, phenacyl methylene), 7.50 (t, J = 7.6 Hz, 2 H, H-3,5 phenacyl), 7.63 (t, J = 7.2 Hz, 1 H, H-4 phenacyl), 7.93 (d, J = 7.7 Hz, 2 H, H-2,6 phenacyl).

1-Eicosyne (7). Compound **7** was prepared by a modification of the published procedure.[26] Lithium acetylide–ethylenediamine complex[27] (1.01 g, 11 mmol) was placed in a 50-mL round-bottomed flask, the flask was capped with a septum, degassed, and flushed with nitrogen, and 5 mL of Me_2SO was added. A solution of stearyl bromide (3.33 g, 10 mmol) in 5 mL of Me_2SO was added dropwise to the stirred slurry, and stirring was continued for 2 h at room temperature. The reaction mixture was diluted with hexane (100 mL) and extracted sequentially with dilute HCl (two times, 50 mL each) and water. The organic layer was dried over $MgSO_4$ and evaporated to dryness, and the residue was dissolved in 30 mL of ethanol and kept at room temperature overnight. A precipitate which formed was removed by filtration, and the filtrate was stored overnight at 4 °C. The white, waxy precipitate which formed was collected to give 1.15 g (45%) of **7**: ^1H NMR ($CDCl_3$) δ 0.85 (t, J = 6 Hz, 3 H, H-20), 1.20 (br s, H-4–19), 1.90 (t, J = 3 Hz, 1 H, H-1), 2.15 (m, 2 H, H-3). Anal. C, H.

16-Bromohexadecan-1-ol (8). To a solution of 3.35 g (10 mmol) of 16-bromohexadecanoic acid[28] in 20 mL of THF was added dropwise at room temperature 12 mL of 1 M borane in THF. After being stirred 2 h at room temperature, the solution was evaporated to dryness under vacuum, and the residue was dissolved and evaporated five times from 50-mL portions of methanol. Recrystallization of the residue from petroleum ether (30–60 °C) gave 2.78 g (87%) of **8**: mp 51–53 °C (lit.[29] mp 53–54 °C); ^1H NMR ($CDCl_3$, exchanged with D_2O) δ 1.25 (br s, H-2–15), 3.40 (t, J = 7 Hz, 2 H, H-16), 3.64 (t, J = 7 Hz, 2 H, H-1). Anal. C, H, Br.

***O*-(Tetrahydropyranyl)-16-bromohexadecan-1-ol (9).** One drop of concentrated HCl was added to a solution of 1.61 g (5 mmol) of **8** and 0.50 mL (5.5 mmol) of dihydropyran in 3 mL of anhydrous ether. After remaining at room temperature overnight, the reaction mixture was added dropwise to 50 mL of aqueous sodium bicarbonate (in excess). Extraction of the mixture with 50 mL of ether and evaporation of the ether gave a liquid residue which was chromatographed on silica gel. Elution of the column (2.5 × 30 cm) sequentially with hexane (40 mL), $CHCl_3$–hexane (100 mL, 1:9 v/v), and $CHCl_3$–hexane (300 mL, 3:7 v/v) gave **9** (1.54 g, 75%) after evaporation of the final eluate. Recrystallization from absolute ethanol afforded analytically pure **9**: mp 26–27 °C; ^1H NMR ($CDCl_3$) δ 1.10–1.85 (complex, H-2–15, H-2,3,4 THP), 3.32 (t, J = 7 Hz, 2 H, H-16), 3.15–3.90 (complex, 4 H, H-1, H-5 THP), 4.49 (m, 1 H, H-1, THP). Anal. C, H, Br.

***O*-(Tetrahydropyranyl)-17-hexatriacontyn-1-ol (10).** A solution of 1-eicosyne (3.76 g, 13.5 mmol) in 25 mL of HMPT was degassed with nitrogen, and 6.7 mL of 2.4 M *n*-BuLi in hexane was added. The reaction mixture was stirred for 15 min, and then liquid **9** (3.81 g, 9.41 mmol) was added dropwise via syringe. Stirring was continued for 12 h, at which time the reaction mixture was diluted with hexane (200 mL) and extracted sequentially with water (300 mL) and saturated aqueous sodium chloride (300 mL). The organic layer was dried over anhydrous $MgSO_4$ and concentrated to give a viscous yellow residue which was chromatographed on silica gel. Elution of the column (3 × 40 cm) with hexane (200 mL) and $CHCl_3$–hexane (1.5 L, 3:7 v/v) gave **10** (3.87 g, 68%) in the latter eluate. Recrystallization from absolute ethanol gave analytically pure **10**: mp 52–54 °C; ^1H NMR ($CDCl_3$) δ 0.85 (t, J = 6 Hz, 3 H, H-36), 1.10–1.70 (complex, H-2–15, H-20–35, H-2,3,4 THP), 2.10 (m, 4 H, H-16,19), 3.15–3.90 (complex, 4 H, H-1, H-5 THP), 4.50 (m, 1 H, H-1 THP). Anal. C, H.

17-Hexatriacontyn-1-ol (11a). Compound **10** (3.87 g, 6.37 mmol) was heated under reflux for 2 h in 95% ethanol (50 mL) containing 0.42 g of *p*-toluenesulfonic acid. After being cooled, the reaction mixture was diluted with ether (200 mL) and extracted two times with saturated aqueous NaCl. The etheral solution was dried over anhydrous $MgSO_4$ and concentrated to give a white solid, which was chromatographed on silica gel. Elution of the column (3 × 40 cm) with $CHCl_3$–hexane (300 mL, 1:9 v/v) and $CHCl_3$–hexane (1.5 L, 1:1 v/v) gave **11a** (3.08 g, 93%) in the latter eluate, which was recrystallized from ethanol: mp 77–78.5 °C; ^1H NMR ($CDCl_3$, exchanged with D_2O) δ 0.85 (m, 3 H, H-36), 1.10–1.70 (complex, H-2–15, H-20–35), 2.10 (m, 4 H, H-16,19), 3.60 (t, J = 6 Hz, 2 H, H-1). Anal. C, H.

17-Hexatriacontyn-1-yl Methanesulfonate (11b). To a solution of **11a** (0.26 g, 0.5 mmol) in 30 mL of methylene chloride were added diisoproylethylamine (0.46 mL, 5 mmol) and methanesulfonyl chloride (0.39 mL, 5 mmol). After being stirred for 2 h at room temperature, the solution was extracted sequentially with 20-mL portions of dilute HCl (two times) and water. After being dried over $MgSO_4$, the solution was evaporated, and the residue was chromatographed on silica gel. Elution of the column (2.5 × 30 cm) with hexane (40 mL), $CHCl_3$–hexane (100 mL, 3:7 v/v), and $CHCl_3$–hexane (300 mL, 1:1 v/v) gave **11b** in the final eluate. Recrystallization from $CHCl_3$–ethanol gave 0.26 g (88%) of **11b**: mp 65–66 °C; ^1H NMR ($CDCl_3$) δ 0.87 (m, H-36), 1.10–1.70 (complex, H-2–15, H-20–35), 2.08 (m, 4 H, H-16,19), 2.95 (s, 3 H, methanesulfonyl CH_3), 4.15 (t, J = 6 Hz, 2 H, H-1). Anal. C, H, S.

1-Iodo-17-hexatriacontyne (11c). A solution of **11b** (0.43 g, 0.72 mmol) and NaI (1.50 g, 10 mmol) in 100 mL of acetone was stored in the dark at room temperature for 10 days, and then the solvent was evaporated. The residue was extracted with $CHCl_3$ (5 mL) and hexane (5 mL), the extracts were combined and evaporated, and the residue was chromatographed on silica gel (2.5 × 30 cm). Elution with hexane gave **11c** as a white residue,

(25) The chemical shifts and coupling constants reported for **6a** and **6b** are identical with those of the naturally occurring monoalkene mycolic acid phenacyl ester (see ref 10).

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(28) Chuit, P.; Hausser, J. *Helv. Chim. Acta* **1929**, *12*, 463–492.
(29) Chuit, P.; Hausser, J. *Helv. Chim. Acta* **1929**, *12*, 850–859.

which was recrystallized from $CHCl_3$–ethanol to give pure **11c**: 0.43 g (94%); mp 44–46 °C; ^1H NMR ($CDCl_3$) δ 0.85 (m, 3 H, H-36), 1.10–1.70 (complex, H-2–15, H-20–35), 2.10 (m, 4 H, H-16,19), 3.15 (t, J = 7 Hz, 2 H, H-1). Anal. C, H.

Hexatriacontan-1-ol (12a). A mixture of **11a** (0.52 g, 1 mmol), 10% Pd on carbon (0.06 g), and 20 mL of THF was stirred under an atmosphere of hydrogen for 5 h at room temperature. The reaction mixture was diluted with an equal volume of THF, warmed in a hot water bath, and then filtered through Celite. When the filtrate was cooled, **12a** (0.44 g, 88%) precipitated: mp 93.5–94.5 °C; ^1H NMR ($CDCl_3$) δ 0.85 (m, 3 H, H-36), 1.10–1.65 (complex, H-2–35), 3.57 (t, J = 6 Hz, 2 H, H-1). Anal. C, H.

1-Iodohexatriacontane (12c). Hexatriacontan-1-ol (**12a**; 0.18 g, 0.35 mmol) was converted to **12c** as described for the preparation of **1**, and the product was recrystallized from acetone to give **12c**: 0.17 g (76%); mp 73–74 °C; ^1H NMR ($CDCl_3$) δ 0.85 (m, 3 H, H-36), 1.10–1.65 (complex, H-2–35), 3.13 (t, J = 7 Hz, 2 H, H-1). Anal. C, H.

(*Z*)-17-Hexatriaconten-1-ol (13a). A mixture of 0.130 g (0.25 mmol) of 17-hexatriacontyn-1-ol (**11a**), 0.003 g of 5% Pd on $BaSO_4$, and 10 μL of quinoline was stirred under a hydrogen atmosphere at room temperature for 2 h. After removal of the catalyst by filtration through a Celite pad, the filtrate was evaporated under vacuum. The residue was dissolved in $CHCl_3$ (20 mL) and washed twice with 20-mL portions of dilute HCl and once with 20 mL of water. The $CHCl_3$ solution was dried over $MgSO_4$ and evaporated, and the residue was recrystallized from absolute ethanol (10 mL) to give **13a**: 0.082 g (63%); mp 61.5–63 °C; ^1H NMR ($CDCl_3$, exhcanged with D_2O) δ 0.97 (m, 3 H, H-36), 1.10–1.72 (complex, H-2–15, H-20–35), 1.90 (m, 4 H, H-16, 19), 3.58 (t, J = 7 Hz, 2 H, H-1), 5.32 (m, 2 H, H-17,18). Anal. C, H. Epoxide derivative: ^1H NMR ($CDCl_3$) δ 2.93 (m, 2 H, H-17,18).

(*Z*)-17-Hexatriaconten-1-yl Methanesulfonate (13b). Compound **13a** (0.26 g, 0.5 mmol) was converted to **13b** as described above for **11b**. Recrystallization from $CHCl_3$–ethanol gave pure **13b**: 0.25 g (83%); mp 75–76 °C; ^1H NMR ($CDCl_3$) δ 0.85 (m, 3 H, H-36), 1.10–2.10 (complex, H-2–16, H-19–35), 2.95 (s, 3 H, methanesulfonyl CH_3), 4.15 (t, J = 6 Hz, 2 H, H-1), 5.30 (m, 2 H, H-17,18). Anal. C, H, S.

(*Z*)-1-Iodo-17-hexatriacontene (13c). Compound **13b** (0.26 g, 0.44 mmol) was converted to **13c** as described above for the preparation of **11c**, and the product was chromatographed on silica gel. Elution of the column (2.5 × 30 cm) with $CHCl_3$–hexane (100 mL, 1:9 v/v) afforded **13c**, which was recrystallized from $CHCl_3$–ethanol to give pure **13c**: 0.20 g (80%); mp 55–56.5 °C; ^1H NMR ($CDCl_3$) δ 0.85 (m, 3 H, H-36), 1.10–2.10 (complex, H-2–16, H-19–35), 3.15 (t, J = 7 Hz, 2 H H-1), 5.30 (m, 2 H, H-17,18). Anal. C, H.

(*E*)-17-Hexatriaconten-1-ol (14a). A mixture of 17-hexatriacontyn-1-ol (**11a**; 3.08 g, 5.95 mmol), $LiAlH_4$ (0.473 g, 12.5 mmol), and diglyme saturated with $LiAlH_4$ (60 mL) was stirred for 12 days at 125 °C under nitrogen.[15] After the mixture cooled, ice-cold 15% aqueous NaOH was slowly added, and then the aqueous slurry was diluted with 200 mL of cold water and acidified with 10% HCl. The resultant solution was extracted two times with 200-mL portions of ether, and the ether extracts were combined, dried over $MgSO_4$, and concentrated. To remove the remaining diglyme, the concentrate was diluted with warm hexane (250 mL) and extracted four times with warm water (100-mL portions). The hexane solution was dried over $MgSO_4$ and concentrated to give **14a** (2.62 g, 85%) as a white powder. Recrystallization from acetone gave analytically pure **14a**: mp 82–83 °C; ^1H NMR ($CDCl_3$) δ 0.88 (t, J = 7 Hz, 3 H, H-36), 1.1–1.6 (complex, H-2–15, H-20–35, hydroxyl), 1.96 (m, 4 H, H-16,19), 3.64 (m, 2 H, H-1), 5.38 (m, 2 H, H-17,18). Anal. C, H. Epoxide derivative: ^1H NMR ($CDCl_3$) δ 2.65 (m, 2 H, H-17,18).

(*E*)-17-Hexatriaconten-1-yl Methanesulfonate (14b). Compound **14a** (0.76 g, 1.45 mmol), dry pyridine (1.16 mL, 14.5 mmol), and methylene chloride (150 mL) were combined, and the solution was flushed with nitrogen. Methanesulfonyl chloride (1.13 mL, 14.5 mmol) was added and the reaction was refluxed for 3 days. Workup of the reaction mixture and chromatography on silica gel as described for **11b** gave a crude product which was recrystallized from $CHCl_3$–ethanol to give pure **14b**: 0.83 g (95%); mp 78–79 °C; ^1H NMR ($CDCl_3$) δ 0.88 (t, J = 7 Hz, 3 H, H-36), 1.1–1.5 (complex, H-3–15, H-20–35), 1.75 (quintet, J = 7 Hz, 2 H, H-2), 1.96 (m, 4 H, H-16,19), 3.00 (s, 3 H, methanesulfonyl CH_3), 4.22 (t, J = 7 Hz, 2 H, H-1), 5.38 (t, J = 4 Hz, 2 H, H-17,18). Anal. C, H.

(*E*)-1-Iodo-17-hexatriacontene (14c). A mixture containing **14b** (0.41 g, 0.69 mmol), sodium iodide (2.00 g, 13.3 mmol), and acetone (150 mL) was refluxed in the dark for 24 h, cooled, and evaporated to dryness. The residue was partitioned between $CHCl_3$ (100 mL) and water (100 mL), and the $CHCl_3$ layer was subsequently washed twice with water (50 mL each), dried over anhydrous $MgSO_4$, and evaporated. Chromatography on silica gel as described for **13c** gave **14c** (0.40 g, 91%). Recrystallization from ethanol gave analytically pure **14c**: mp 61–62 °C; ^1H NMR ($CDCl_3$) δ 0.88 (t, J = 7 Hz, 3 H, H-36), 1.1–1.5 (complex, H-3–15, H-20–35), 1.82 (quintet, J = 7 Hz, 2 H, H-2), 1.96 (m, 4 H, H-16,19), 3.18 (t, J = 7 Hz, 2 H, H-1), 5.38 (m, 2 H, H-17,18). Anal. C, H.

Registry No. **1**, 62127-53-1; **2**, 82741-50-2; **3a**, 82741-51-3; **3b**, 82741-52-4; **3c**, 82741-53-5; **3d**, 82741-54-6; **4a** (isomer1), 82741-55-7; **4a** (isomer 2), 82741-71-7; **4b** (isomer 1), 82741-56-8; **4b** (isomer 2), 82741-72-8; **4c** (isomer 1), 82741-57-9; **4c** (isomer 2), 82741-73-9; **4d** (isomer 1), 82741-58-0; **4d** (isomer 2), 82741-74-0; **5a**, 82752-53-2; **5b**, 82752-55-4; **a**, 82752-54-3; **6b**, 82752-56-5; **7**, 765-27-5; **8**, 59101-28-9; **9**, 82741-59-1; **10**, 82741-60-4; **11a**, 82741-61-5; **11b**, 82741-62-6; **11c**, 82741-63-7; **12a**, 82741-64-8; **12c**, 62154-87-4; **13a**, 82741-65-9; **13b**, 82741-66-0; **13c**, 82741-67-1; **14a**, 82741-68-2; **14b**, 82741-69-3; **14c**, 82741-70-6; docosan-1-01, 661-19-8; methyl acetoacetate, 105-45-3; lithium acetylide, 1111-64-4; stearyl bromide, 112-89-0; 16-bromohexadecanoic acid, 2536-35-8.