The [3 + 2] Annulation of Allylic Silanes in Acyclic Stereocontrol: Total Synthesis of (9*S*)-Dihydroerythronolide A

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Supporting Information

Contents:

I. Ring-opening of the annulation product	S-1
II. Synthesis of the model aldol substrates and the model aldol reaction	S-4
III. Stereochemical proofs of the model aldol product	S-12
IV. Total synthesis of (9 <i>S</i>)-dihydroerythronolide A	S-15
V. Analytical Data	S-30

General. ^1H NMR and ^{13}C NMR spectra were recorded at ambient temperature at 500 MHz and 125 MHz, respectively, using a Bruker DRX 500 spectrometer. The data are reported as follows: chemical shift in ppm from internal tetramethylsilane on the δ scale, multiplicity (br = broad, s = singlet, d = doublet, t = triplet, q = quartet, m = multiplet), coupling constants (Hz) and integration. High resolution mass spectra were acquired on a VG Analytical 7070E or Fisons Autospec spectrometer, and were obtained by peak matching. Microanalyses were performed by Atlantic Microlab, Atlanta, GA. Melting points are reported uncorrected. Analytical thin layer chromatography was performed using EM Reagents 0.25 mm silica gel 60-F plates. Liquid chromatography was performed using forced flow (flash chromatography) of the indicated solvent system on EM Reagents silica gel (SiO_2) 60 (230–400 mesh). Enantiomeric excesses were determined by HPLC analysis on a Hewlett Packard series 1100 using a Chiralcel OJ column, and the enantiomerically enriched material was compared with racemic material. All reactions were carried out under an atmosphere of nitrogen in glassware which had been flame-dried under a stream of nitrogen. Unless otherwise noted, all reagents were commercially obtained and, where appropriate, purified prior to use. THF, Et_2O , and CH_2Cl_2 were dried by filtration through alumina according to the procedure of Grubbs.¹

I. Ring-opening of the annulation product

Acetic acid 2-methyl-3-(dimethylphenylsilyl)-(E)-pent-1-enyl ester (2). To a solution of PhMe_2SiCl (16.8 mL, 100 mmol) in 100 mL of THF was added lithium wire (4.14 g, 600 mmol). After 16 h at 23 °C, the resultant dark red solution was added to a cooled (–30 °C) suspension of CuI (9.50 g, 50.0 mmol) in 10 mL of THF by cannula. After 4 h at –30 °C, the slurry was cooled to –78 °C, followed by the addition of aldehyde **19** (5.70 mL, 50.0 mmol) dropwise by syringe. The reaction mixture was stirred at –78 °C for 1 h and was warmed to –30 °C for an additional 2 h. Ac_2O (18.9 mL, 200 mmol) was then added and the reaction mixture was

¹ Pangborn, A. B.; Giardello, M. A.; Grubbs, R. H.; Rosen, R. K.; Timmers, F. J. *Organometallics* **1996**, 15, 1518-1520.

allowed to warm to 23 °C, and after 12 h, 200 mL of Et₂O was added. The mixture was washed sequentially with 100 mL of 1 N HCl, 50 mL of saturated aqueous NaHCO₃ solution, and 30 mL of brine. The organic layer was dried (MgSO₄), filtered, and concentrated *in vacuo*. Purification by flash chromatography (benzene) afforded **2** as a colorless oil (13.5 g, 98%): ¹H NMR (CDCl₃, 500 MHz) δ 7.54 (m, 2H), 7.38 (m, 3H), 6.86 (d, *J* = 1.4 Hz, 1H), 2.14 (s, 3H), 1.60–1.49 (m, 3H), 1.54 (d, *J* = 1.4 Hz, 3H), 0.86 (d, *J* = 7.2 Hz, 3H), 0.36 (s, 3H), 0.31 (s, 3H); ¹³C NMR (CDCl₃, 125 MHz) δ 168.0, 138.1, 133.8, 130.0, 128.9, 127.6, 122.1, 35.3, 20.7, 20.5, 13.9, 13.3, –3.6, –4.4; IR (thin film) 1749, 1227 cm^{–1}; HRMS (CI/NH₃) *m/z* calcd for C₁₆H₂₄O₂Si (M⁺) 276.1545, found 276.1541. Anal. Calcd for C₁₆H₂₄O₂Si: C, 69.53; H, 8.76. Found: C, 69.26; H, 8.85.

(2*S**,3*R**,4*R**,5*R**)-3-Acetoxy-4-dimethylphenylsilyl-2,4-dimethyl-5-ethyltetrahydrofuran-2-carboxylic acid ethyl ester (3**).** To a cooled (–78 °C) solution of ethyl pyruvate (1.83 mL, 5.00 mmol) and allylsilane **2** (4.14 g, 15.0 mmol) in 75 mL of dry CH₂Cl₂ was added dropwise SnCl₄ (0.200 M solution in CH₂Cl₂, 82.5 mL, 16.5 mmol) by syringe. After 1 h, 3.0 mL of Et₃N was added followed by 40 mL of water. The mixture was warmed to 23 °C and the layers were separated. The aqueous layer was extracted with 3 × 60 mL of EtOAc. The combined organic layers were washed with 10 mL of brine, dried (MgSO₄), filtered, and concentrated *in vacuo*. Purification by flash chromatography (5:95 to 10:90 EtOAc/hexanes) afforded a colorless oil **3** (4.50 g, 77%) as a single stereoisomer as determined by ¹H NMR spectroscopy of the crude product: ¹H NMR (CDCl₃, 500 MHz) δ 7.50 (m, 2H), 7.39 (m, 3H), 5.62 (s, 1H), 4.15 (m, 2H), 3.92 (dd, *J* = 10.2, 1.7 Hz, 1H), 1.85 (s, 3H), 1.48 (m, 1H), 1.33 (m, 1H), 1.26 (s, 3H), 1.23 (t, *J* = 7.1 Hz, 3H), 1.06 (s, 3H), 1.01 (t, *J* = 7.4 Hz, 3H), 0.38 (s, 3H), 0.37 (s, 3H); ¹³C NMR (CDCl₃, 125 MHz) δ 173.7, 169.8, 135.8, 134.2, 129.3, 127.7, 84.1, 82.0, 79.7, 60.9, 35.4, 23.7, 20.3, 19.8, 14.0, 11.8, 10.1, –5.5, –5.7; IR (thin film) 1747, 1731 cm^{–1}; HRMS (CI/NH₃) *m/z* calcd for C₂₀H₂₉O₅Si, (M – CH₃)⁺ 377.1784, found 377.1786. Anal. Calcd for C₂₁H₃₂O₅Si: C, 64.25; H, 8.22. Found: C, 64.47; H, 8.24.

(2*R**,3*R**,4*R**,5*R**)-4-Dimethylphenylsilyl-3-hydroxy-2-hydroxymethyl-2,4-dimethyl-5-ethyltetrahydrofuran (13**).** To a cooled (0 °C) suspension of LiAlH₄ (0.736 g, 19.4 mmol) in 40 mL of Et₂O was added a solution of **3** (3.80 g, 9.70 mmol) in 40 mL of Et₂O. After 10 h at 23 °C, the excess hydride was carefully quenched by 3 g of Na₂SO₄·10H₂O. The mixture was filtered and the solid was washed with 3 × 50 mL of EtOAc. The combined filtrate was concentrated *in vacuo*. Purification by flash chromatography (30:70 to 50:50 EtOAc/hexanes) afforded **13** as a white solid (2.92 g, 98%): mp 91–93 °C; ¹H NMR (CDCl₃, 500 MHz) δ 7.53 (m, 2H), 7.40 (m, 3H), 4.10 (d, *J* = 6.2 Hz, 1H), 3.56 (dd, *J* = 10.1, 1.8 Hz, 1H), 3.33 (dd, *J* = 11.0, 5.5 Hz, 1H), 3.29 (dd, *J* = 11.0, 7.4 Hz, 1H), 1.73 (dd, *J* = 7.3, 5.5 Hz, 1H), 1.57 (d, *J* = 6.2 Hz, 1H), 1.47 (m, 1H), 1.33 (m, 1H), 1.13 (s, 3H), 1.00 (s, 3H), 0.98 (t, *J* = 7.4 Hz, 3H), 0.38 (s, 3H), 0.37 (s, 3H); ¹³C NMR

(CDCl₃, 125 MHz) δ 136.3, 134.0, 129.5, 128.1, 82.3, 81.7, 78.0, 68.1, 37.0, 24.3, 19.6, 12.1, 9.1, -5.3, -5.5; IR (KBr) 3426 cm⁻¹; HRMS (CI/NH₃) m/z calcd for C₁₆H₂₅O₂Si (M - CH₂OH)⁺ 277.1624, found 277.1629. Anal. Calcd for C₁₇H₂₈O₃Si: C, 66.19; H, 9.16. Found: C, 66.16; H, 9.19.

(2*S**,3*R**,4*R**,5*R**)-2,4-Dimethyl-4-dimethylphenylsilyl-5-ethyl-3-hydroxy-2-iodomethyltetrahydrofuran

(4). To a solution of **13** (0.466 g, 1.51 mmol) in 20 mL of benzene was added Ph₃P (0.476 g, 1.82 mmol), imidazole (0.248 g, 3.64 mmol), and I₂ (0.462 g, 1.82 mmol). The mixture was heated at reflux for 1 h. After being cooled to 23 °C, the mixture was filtered through Celite, and the cake was washed with 3 × 20 mL of ether. The filtrate was concentrated *in vacuo*. Purification by flash chromatography (2:98 to 5:95 EtOAc/hexanes) afforded **4** as a colorless oil (0.500 g, 79%): ¹H NMR (CDCl₃, 500 MHz) δ 7.53 (m, 2H), 7.41 (m, 3H), 4.18 (d, J = 5.7 Hz, 1H), 3.56 (dd, J = 9.9, 1.2 Hz, 1H), 3.09 (d, J = 9.7 Hz, 1H), 3.01 (d, J = 9.7 Hz, 1H), 1.44 (m, 1H), 1.32 (s, 3H and m, 1H), 1.25 (d, J = 5.7 Hz, 1H), 1.00 (s, 3H), 0.96 (t, J = 7.4 Hz, 3H), 0.41 (s, 3H), 0.40 (s, 3H); ¹³C NMR (CDCl₃, 125 MHz) δ 136.2, 134.1, 129.6, 128.1, 81.8, 81.0, 79.8, 38.1, 23.9, 22.5, 17.8, 12.0, 8.5, -5.3; IR (thin film) 3578, 1252, 1110 cm⁻¹; HRMS (CI/NH₃) m/z calcd for C₁₇H₂₇IO₂Si (M⁺) 418.0825, found 418.0826. Anal. Calcd for C₁₇H₂₇IO₂Si: C, 48.80; H, 6.50. Found: C, 49.11; H, 6.65.

(3*R**,4*R**,5*R**)-2,4-Dimethyl-4-dimethylphenylsilylhept-1-en-3,5-diol

(5). To a solution of the iodide **4** (0.320 g, 0.770 mmol) in 3 mL of Et₂O and 3 mL of MeOH was added zinc powder (0.504 g, 7.70 mmol) followed by AcOH (0.095 mL, 1.54 mmol). The reaction mixture was stirred for 12 h at 23 °C, at which point the reaction mixture was diluted with 50 mL of Et₂O and filtered. The filtrate was washed with 20 mL of saturated aqueous NaHCO₃, brine (10 mL), dried (MgSO₄), and concentrated *in vacuo*. Purification by flash chromatography (5:95 to 10:90 EtOAc/hexanes) afforded **5** as a white solid (0.183 g, 82%): mp 120–122 °C; ¹H NMR (CDCl₃, 500 MHz) δ 7.73 (m, 2H), 7.39 (m, 3H), 5.28 (s, 1H), 5.08 (s, 1H), 4.35 (s, 1H), 3.32 (d, J = 8.2 Hz, 1H), 3.21 (t, J = 8.5 Hz, 1H), 2.96 (br, 1H), 1.81 (s, 3H), 1.67 (m, 1H), 1.57 (m, 1H), 1.05 (s, 3H), 1.01 (t, J = 7.3 Hz, 3H), 0.63 (s, 3H), 0.47 (s, 3H); ¹³C NMR (CDCl₃, 125 MHz) δ 147.7, 139.0, 135.2, 128.5, 127.3, 114.0, 81.8, 81.3, 37.6, 23.6, 21.9, 18.3, 11.4, -0.6, -1.5; IR (thin film) 3346, 1428, 1099 cm⁻¹; HRMS (CI/NH₃) m/z calcd for C₁₇H₂₆O₂Si (M - H₂O)⁺ 274.1753, found 274.1755. Anal. Calcd for C₁₇H₂₈O₂Si: C, 69.81; H, 9.65. Found: C, 69.73; H, 9.39.

II. Synthesis of the model aldol substrates and the model aldol reaction

Synthetic scheme:

(2R,3S,4S,5S)-3-Acetoxy-4-dimethylphenylsilyl-2,4-dimethyl-5-ethyl-tetrahydrofuran-2-carboxylic acid (S)-4,4-dimethyl-2-oxotetrahydrofuran-3-yl ester [(–)-21]. To a solution of (+)-**20** (5.26 g, 26.3 mmol)² and (±)-allylsilane **2** (13.8 g, 50.0 mmol) in 120 mL of dry CH₂Cl₂ was added dropwise SnCl₄ (0.200 M solution in CH₂Cl₂, 137 mL, 27.4 mmol) by syringe at –78 °C. After 24 h at –78 °C, 10 mL of Et₃N was added followed by 200 mL of water. The layers were separated and the aqueous layer was extracted with 3 × 200 mL of EtOAc. The combined organic layers were washed with 50 mL of brine, dried (MgSO₄), filtered, and concentrated *in vacuo*. Purification by flash chromatography (5:95 to 30:70 EtOAc/hexanes) afforded (–)-**2** (6.81 g, 49%) as a colorless oil and (–)-**21** (9.53 g, 80%) as a white solid. The spectra data of the resolved (–)-**2** were identical to the racemic one (*vide supra*): [α]_D²³ –18.6 (c 1.02, CHCl₃). Compound (–)-**21** was determined to be a single stereoisomer by ¹H NMR spectroscopy analysis of the crude mixture: mp 153–155 °C; ¹H NMR (CDCl₃, 500 MHz) δ 7.44 (m, 2H), 7.33 (m, 3H), 5.66 (s, 1H), 5.32 (s, 1H), 4.02 (m, 3H), 1.77 (s, 3H), 1.48 (m, 1H), 1.33

² Peng, Z.-H.; Woerpel, K. A. *Org. Lett.* **2002**, *4*, 2945–2948.

(m, 1H), 1.28 (s, 3H), 1.23 (s, 3H), 1.11 (s, 3H), 1.07 (s, 3H), 1.02 (t, $J = 7.3$ Hz, 3H), 0.36 (s, 3H), 0.35 (s, 3H); ^{13}C NMR (CDCl_3 , 125 MHz) δ 172.2, 171.7, 170.1, 135.8, 134.1, 129.3, 127.7, 84.1, 81.9, 79.4, 76.0, 75.7, 40.6, 35.5, 23.5, 23.0, 20.1, 19.8, 19.7, 11.7, 10.0, -5.4, -5.6; IR (KBr) 1794, 1752; $[\alpha]_{\text{D}}^{23} -72.1$ (c 1.20, CHCl_3); HRMS (CI/NH_3) m/z calcd for $\text{C}_{25}\text{H}_{36}\text{O}_7\text{Si}$ (M^+) 476.2230, found 476.2229. Anal. Calcd for $\text{C}_{25}\text{H}_{36}\text{O}_7\text{Si}$: C, 63.00; H, 7.61. Found: C, 62.88; H, 7.65.

(2S,3S,4S,5S)-4-Dimethylphenylsilyl-3-hydroxy-2-hydroxymethyl-2,4-dimethyl-5-ethyltetrahydrofuran [(-)-13]. To a cooled (0 °C) suspension of LiAlH_4 (2.90 g, 76.4 mmol) in 100 mL of THF was added a solution of (-)-21 (9.10 g, 19.1 mmol) in 100 mL of THF. After 12 h, the excess hydride was carefully quenched by addition of 10 g of $\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$. The mixture was filtered and the solid was washed with 3×100 mL of EtOAc. The combined filtrate was concentrated *in vacuo*. Purification by flash chromatography (30:70 to 50:50 EtOAc/hexanes) afforded (-)-13 as a white solid (5.45 g, 93%) with an ee of > 98% as determined by chiral HPLC analysis: $[\alpha]_{\text{D}}^{23} -46.9$ (c 1.40, CHCl_3); mp 93–94 °C; The spectral data of (-)-13 were identical to the racemic compound (*vide supra*).

(2S,3R,4R,5R)-3-Acetoxy-4-dimethylphenylsilyl-2,4-dimethyl-5-ethyl-tetrahydrofuran-2-carboxylic acid ethyl ester [(+)-3] and (2R,3R,4R,5R)-4-Dimethylphenylsilyl-3-hydroxy-2-hydroxymethyl-2,4-dimethyl-5-ethyltetrahydrofuran [(+)-13]. The same procedures developed for the racemic compounds were employed. Diol (+)-13 was obtained as a white solid with an ee of > 99% as determined by chiral HPLC analysis. The spectral data of (+)-3 and (+)-13 were identical to the racemic ones (*vide supra*): (+)-3: $[\alpha]_{\text{D}}^{23} +38.5$ (c 1.38, CHCl_3); (+)-13: $[\alpha]_{\text{D}}^{23} +47.7$ (c 1.20, CHCl_3).

(2S,3S,4S,5S)-3-Benzoyloxy-2-benzoyloxymethyl-2,4-dimethyl-4-dimethylphenylsilyl-5-ethyltetrahydrofuran (26). To a suspension of NaH (4.10 g, 60% oil dispersion, 102.6 mmol, washed with 3×40 mL of hexanes) in 70 mL of DMF was added a solution of diol (-)-13 (7.90 g, 25.6 mmol) in 70 mL of DMF at 0 °C. After 0.5 h, BnBr (12.2 mL, 102.6 mmol) and $n\text{-Bu}_4\text{NI}$ (0.472 g, 1.28 mmol) were added at 0 °C, and the reaction mixture was allowed to warm to 23 °C. After 12 h, a solution of saturated aqueous NH_4Cl (100 mL) was added. The mixture was extracted with 3×200 mL of Et_2O , and the combined organic layers were

washed with brine (40 mL), dried (MgSO₄), and concentrated *in vacuo*. Purification by flash chromatography (1:99 to 5:95 Et₂O/hexanes) afforded **26** as a colorless oil (12.0 g, 96%): ¹H NMR (CDCl₃, 500 MHz) δ 7.48–7.19 (m, 15H), 4.58 (d, *J* = 11.6 Hz, 1H), 4.50 (d, *J* = 12.1 Hz, 1H), 4.44 (d, *J* = 12.1 Hz, 1H), 4.18 (d, *J* = 11.6 Hz, 1H), 3.97 (s, 1H), 3.52 (dd, *J* = 10.0, 1.4 Hz, 1H), 3.22 (d, *J* = 9.2 Hz, 1H), 3.11 (d, *J* = 9.2 Hz, 1H), 1.37 (m, 1H), 1.23 (m, 1H and s, 3H), 1.07 (s, 3H), 0.92 (t, *J* = 7.3 Hz, 3H), 0.30 (s, 3H), 0.29 (s, 3H); ¹³C NMR (CDCl₃, 125 MHz) δ 138.9, 138.5, 137.0, 134.4, 129.1, 128.3, 128.1, 127.64, 127.56, 127.5, 127.14, 127.11, 86.3, 82.0, 81.4, 76.1, 73.4, 72.0, 37.5, 24.0, 20.7, 12.2, 9.8, –4.8, –5.1; IR (thin film) 2960, 1453, 1110 cm^{–1}; [α]_D²³ +15.4 (*c* 1.04, CHCl₃); HRMS (ESI) *m/z* calcd for C₃₁H₄₀O₃SiNa (M + Na)⁺ 511.2644, found 511.2630. Anal. Calcd for C₃₁H₄₀O₃Si: C, 76.19; H, 8.26. Found: C, 76.31; H, 8.31.

(2S,3S,4S,5S)-3-Benzyloxy-2-benzyloxymethyl-2,4-dimethyl-5-ethyl-4-hydroxytetrahydrofuran (22). To a suspension of KH (7.20 g, 180 mmol) in 100 mL of NMP was added cumene hydroperoxide (25.1 mL, 88.0%, 150 mmol). After 20 min, silane **26** (14.6 g, 30.0 mmol) in 100 mL of NMP was added dropwise followed by *n*-Bu₄NF (60.0 mL, 1 M solution in THF, 60.0 mmol). After 40 h at 23 °C, 100 mL of aqueous saturated Na₂S₂O₃ solution was added, and the mixture was stirred for 30 min at 23 °C. The mixture was then extracted with 5 × 200 mL of *t*-BuOMe. The combined organic layers were washed with brine (50 mL), dried (MgSO₄), and concentrated *in vacuo*. Purification by flash chromatography (5:95 to 30:70 EtOAc/hexanes) afforded **22** (9.40 g, 85%) as a colorless oil: ¹H NMR (CDCl₃, 500 MHz) δ 7.30 (m, 10H), 4.69 (d, *J* = 12.0 Hz, 1H), 4.67 (d, *J* = 12.0 Hz, 1H), 4.64 (d, *J* = 12.0 Hz, 1H), 4.59 (d, *J* = 12.0 Hz, 1H), 3.91 (s, 1H), 3.66 (dd, *J* = 9.2, 4.7 Hz, 1H), 3.49 (d, *J* = 9.6 Hz, 1H), 3.41 (d, *J* = 9.6 Hz, 1H), 2.95 (s, 1H), 1.54 (m, 2H), 1.32 (s, 3H), 1.25 (s, 3H), 1.04 (t, *J* = 7.4 Hz, 3H); ¹³C NMR (CDCl₃, 125 MHz) δ 138.5, 137.8, 128.4, 128.3, 127.7, 127.6, 127.5, 127.4, 88.8, 85.4, 82.0, 81.0, 76.6, 73.6, 73.3, 23.0, 20.3, 16.8, 10.7; IR (thin film) 3445, 1453 cm^{–1}; [α]_D²³ –39.1 (*c* 0.92, CHCl₃); HRMS (CI/NH₃) *m/z* calcd for C₁₅H₂₁O₃ (M – BnOCH₂)⁺ 249.1491, found 249.1490. Anal. Calcd for C₂₃H₃₀O₄: C, 74.55; H, 8.17. Found: C, 74.31; H, 8.20.

(2S,3S,4S,5S)-2,4-Dimethyl-3,4-dihydroxy-5-ethyl-2-hydroxymethyltetrahydrofuran (27). Dibenzyl ether **22** (1.39 g, 3.76 mmol) was dissolved in 30 mL of EtOH, then 10% Pd–C (0.300 g) was added, and the mixture was hydrogenated with H₂ supplied by a balloon (1 atm). After 24 h, the reaction mixture was filtered, and the filtrate was concentrated *in vacuo*. Purification by flash chromatography (5:95 to 10:90 MeOH/CH₂Cl₂) afforded **27** as a colorless oil (0.700 g, 98%): ¹H NMR (CDCl₃, 500 MHz) δ 4.07 (d, *J* = 5.3 Hz, 1H), 3.61 (t, *J* = 6.9 Hz, 1H), 3.56 (m, 2H), 3.08 (br, 1H), 2.61 (br, 1H), 2.35 (br, 1H), 1.53 (quintet, *J* = 7.3 Hz, 2H), 1.25 (s, 3H), 1.16 (s, 3H), 1.00 (t, *J* = 7.4 Hz, 3H); ¹³C NMR (CDCl₃, 125 MHz) δ 84.8, 82.1, 80.7, 80.6, 68.5, 23.1, 19.3, 16.1, 10.7; IR (thin film) 3424, 1047 cm^{–1}; [α]_D²³ –50.7 (*c* 1.14, CHCl₃); HRMS (CI/NH₃) *m/z* calcd for C₉H₁₉O₃ (M + H)⁺ 191.1283, found 191.1285.

(2S,3S,4S,5S)-2,4-Dimethyl-3,4-dihydroxy-5-ethyl-2-triisopropylsiloxymethyltetrahydrofuran (28). To triol **27** (0.333 g, 1.75 mmol) in 8 mL of dry DMF was added imidazole (0.143 g, 2.10 mmol) and TIPSCl (0.450 mL, 2.10 mmol). After 12 h at 23 °C, 10 mL of saturated aqueous NH_4Cl was added and the solution was extracted with 3×30 mL of Et_2O . The combined organic layers were washed with brine (10 mL), dried (MgSO_4), and concentrated *in vacuo*. Purification by flash chromatography (15:85 to 20:80 EtOAc/hexanes) afforded **28** as a white solid (0.583 g, 96%): mp 102–103 °C; ^1H NMR (CDCl_3 , 500 MHz) δ 4.17 (d, $J = 4.8$ Hz, 1H), 3.68 (d, $J = 9.7$ Hz, 1H), 3.66 (dd, $J = 7.9, 2.0$ Hz, 1H), 3.63 ($J = 9.7$ Hz, 1H), 2.87 (s, 1H), 1.72 (d, $J = 4.8$ Hz, 1H), 1.50 (m, 2H), 1.24 (s, 3H), 1.16 (s, 3H), 1.09 (m, 21H), 0.99 (t, $J = 7.4$ Hz, 3H); ^{13}C NMR (CDCl_3 , 125 MHz) 85.1, 82.2, 81.9, 80.3, 70.3, 23.2, 19.5, 18.0, 16.2, 11.9, 10.9; IR (thin film) 3326, 1460, 1094 cm^{-1} ; $[\alpha]_D^{23}$ -35.8 (c 1.65, CHCl_3); HRMS (CI/NH_3) m/z calcd for $\text{C}_{18}\text{H}_{39}\text{O}_4\text{Si}$ ($\text{M} + \text{H}$) $^+$ 347.2617, found 347.2621. Anal. Calcd for $\text{C}_{18}\text{H}_{38}\text{O}_4\text{Si}$: C, 62.38; H, 11.05. Found: C, 62.52; H, 11.19.

(2S,3S,4S,5S)-3,4-Dibenzyloxy-2,4-dimethyl-5-ethyl-2-triisopropylsiloxymethyltetrahydrofuran (23). To a suspension of NaH (0.800 g, 60% oil dispersion, 20.2 mmol, washed with 3×20 mL of hexanes) in 20 mL of DMF was added a solution of diol **28** (1.40 g, 4.05 mmol) in 20 mL of DMF at 0 °C. After 0.5 h, BnBr (2.41 mL, 20.2 mmol) and $n\text{-Bu}_4\text{NI}$ (0.074 g, 0.200 mmol) were added at 0 °C, and the reaction mixture was allowed to warm to 23 °C. After 12 h, a solution of saturated aqueous NH_4Cl (40 mL) was added. The mixture was extracted with 3×100 mL of Et_2O , and the combined organic layers were washed with brine (40 mL), dried (MgSO_4), and concentrated *in vacuo*. Purification by flash chromatography (1:99 Et_2O /hexanes) afforded **23** as a colorless oil (2.05 g, 96%): ^1H NMR (CDCl_3 , 500 MHz) δ 7.44–7.31 (m, 10H), 4.79 (d, $J = 11.8$ Hz, 1H), 4.70 (d, $J = 11.7$ Hz, 1H), 4.57 (d, $J = 11.8$ Hz, 1H), 4.55 (d, $J = 11.7$ Hz, 1H), 4.35 (s, 1H), 3.87 (dd, $J = 9.0, 3.9$ Hz, 1H), 3.82 (d, $J = 9.6$ Hz, 1H), 3.70 ($J = 9.6$ Hz, 1H), 1.67 (m, 1H), 1.57 (m, 1H), 1.43 (s, 3H), 1.30 (s, 3H), 1.19 (m, 21H), 1.08 (t, $J = 7.5$ Hz, 3H); ^{13}C NMR (CDCl_3 , 125 MHz) 139.5, 138.7, 128.3, 128.2, 127.4, 127.3, 127.12, 127.10, 87.3, 84.9, 82.04, 82.01, 72.2, 70.1, 65.5, 22.8, 19.7, 18.1, 13.2, 12.0, 11.0; IR (thin film) 1462, 1098 cm^{-1} ; $[\alpha]_D^{23}$ $+19.0$ (c 1.01, CHCl_3); HRMS (CI/NH_3) m/z calcd for $\text{C}_{32}\text{H}_{51}\text{O}_4\text{Si}$ ($\text{M} + \text{H}$) $^+$ 527.3556, found 527.3554. Anal. Calcd for $\text{C}_{32}\text{H}_{50}\text{O}_4\text{Si}$: C, 72.95; H, 9.57. Found: C, 73.12; H, 9.59.

(2*S*,3*S*,4*S*,5*S*)-3,4-Dibenzyloxy-2,4-dimethyl-5-ethyl-2-hydroxymethyltetrahydrofuran (29). To a solution of **23** (0.130 g, 0.250 mmol) in 3 mL of dry THF was added *n*-Bu₄NF (1.00 M solution in THF, 0.375 mL, 0.375 mmol). After stirring for 12 h at 23 °C, saturated aqueous NH₄Cl solution (5 mL) was added. The mixture was extracted with 3 × 20 mL of Et₂O. The combined organic layers were washed with 10 mL of brine, dried (MgSO₄), filtered, and concentrated *in vacuo*. Purification by flash chromatography (15:85 to 20:80 EtOAc/hexanes) afforded **29** as a colorless oil (0.090 g, 97%): ¹H NMR (CDCl₃, 500 MHz) δ 7.47–7.32 (m, 10H), 4.72 (d, *J* = 11.6 Hz, 1H), 4.70 (d, *J* = 11.5 Hz, 1H), 4.63 (d, *J* = 11.6 Hz, 1H), 4.56 (d, *J* = 11.5 Hz, 1H), 4.13 (s, 1H), 3.83 (dd, *J* = 8.9, 4.2 Hz, 1H), 3.71 (d, *J* = 11.1 Hz, 1H), 3.59 (*J* = 11.1 Hz, 1H), 2.50 (br, 1H), 1.70 (m, 2H), 1.47 (s, 3H), 1.35 (s, 3H), 1.12 (t, *J* = 7.5 Hz, 3H); ¹³C NMR (CDCl₃, 125 MHz) 139.0, 138.0, 128.3, 128.2, 127.7, 127.5, 127.2, 127.1, 87.2, 84.8, 82.1, 82.0, 72.6, 69.0, 65.5, 22.9, 19.2, 13.2, 10.8; IR (thin film) 3451, 1454, 1057 cm⁻¹; [α]_D²³ +28.3 (*c* 1.22, CHCl₃); HRMS (CI/NH₃) *m/z* calcd for C₂₂H₂₇O₃ (M - CH₂OH)⁺ 339.1960, found 339.1963. Anal. Calcd for C₂₃H₃₀O₄: C, 74.56; H, 8.16. Found: C, 74.30; H, 8.35.

(2*S*,3*S*,4*S*,5*S*)-3,4-Dibenzyloxy-2,4-dimethyl-5-ethyl-2-iodomethyltetrahydrofuran (30). To a solution of **29** (1.47 g, 3.97 mmol) in 40 mL of benzene was added Ph₃P (1.25 g, 4.77 mmol), imidazole (0.650 g, 9.54 mmol), and I₂ (1.21 g, 4.77 mmol). The mixture was heated at reflux for 0.5 h. After being cooled to 23 °C, the mixture was filtered through Celite and washed with ether. The filtrate was concentrated *in vacuo*. Purification by flash chromatography (5:95 EtOAc/hexanes) afforded **30** as a colorless oil (1.23 g, 65%): ¹H NMR (CDCl₃, 500 MHz) δ 7.49–7.32 (m, 10H), 4.83 (d, *J* = 11.5 Hz, 1H), 4.69 (d, *J* = 11.5 Hz, 1H), 4.65 (d, *J* = 11.4 Hz, 1H), 4.52 (d, *J* = 11.4 Hz, 1H), 4.18 (s, 1H), 3.90 (dd, *J* = 8.2, 4.9 Hz, 1H), 3.52 (d, *J* = 10.1 Hz, 1H), 3.49 (*J* = 10.1 Hz, 1H), 1.64 (m, 2H), 1.49 (s, 3H), 1.42 (s, 3H), 1.11 (t, *J* = 7.4 Hz, 3H); ¹³C NMR (CDCl₃, 125 MHz) 138.9, 138.0, 128.4, 128.3, 127.7, 127.6, 127.3, 127.1, 89.1, 86.4, 82.5, 81.0, 73.0, 65.5, 23.1, 22.6, 17.7, 13.2, 10.9; IR (thin film) 1455, 1105 cm⁻¹; [α]_D²³ +33.1 (*c* 1.11, CHCl₃); HRMS (CI/NH₃) *m/z* calcd for C₂₃H₃₃IO₃N (M + NH₄)⁺ 498.1981, found 498.1973. Anal. Calcd for C₂₃H₂₉IO₃: C, 57.51; H, 6.08. Found: C, 57.78; H, 6.25.

(3*R*,4*S*,5*R*)-3,4-Dibenzyloxy-2,4-dimethylhept-1-en-5-ol (31). To a solution of the iodide **30** (1.20 g, 2.50 mmol) in 10 mL of Et₂O and 10 mL of MeOH was added zinc powder (1.63 g, 25.0 mmol) followed by AcOH

(0.310 mL, 5.00 mmol). The reaction mixture was stirred for 12 h at 23 °C, at which point the reaction mixture was diluted with 100 mL of Et₂O and filtered. The filtrate was washed with 30 mL of saturated aqueous NaHCO₃ and brine (20 mL), then dried (MgSO₄) and concentrated *in vacuo*. Purification by flash chromatography (10:90 EtOAc/hexanes) afforded **31** as a colorless oil (0.840 g, 95%): ¹H NMR (CDCl₃, 500 MHz) δ 7.47–7.32 (m, 10H), 5.30 (t, *J* = 1.6 Hz, 1H), 5.12 (s, 1H), 4.82 (d, *J* = 11.3 Hz, 1H), 4.69 (d, *J* = 11.6 Hz, 1H), 4.63 (d, *J* = 11.3 Hz, 1H), 4.34 (d, *J* = 11.6 Hz, 1H), 4.10 (s, 1H), 3.84 (ddd, *J* = 10.5, 6.5, 1.8 Hz, 1H), 3.44 (d, *J* = 6.5 Hz, 1H), 2.00 (s, 3H), 1.66 (m, 1H), 1.33 (s, 3H and m, 1H), 1.14 (t, *J* = 7.3 Hz, 3H); ¹³C NMR (CDCl₃, 125 MHz) 142.2, 139.4, 137.4, 128.4, 128.2, 128.1, 127.8, 127.2, 126.9, 117.0, 87.2, 80.1, 76.2, 70.5, 64.2, 24.9, 19.6, 18.2, 11.4; IR (thin film) 3500, 1450, 1061 cm⁻¹; [α]_D²³ +33.2 (*c* 1.04, CHCl₃); HRMS (CI/NH₃) *m/z* calcd for C₂₃H₃₁O₃ (M + H)⁺ 355.2273, found 355.2285. Anal. Calcd for C₂₃H₃₀O₃: C, 77.93; H, 8.53. Found: C, 77.81; H, 8.45.

(3R,4S,5R)-4,5-Dibenzzyloxy-4,6-dimethylhept-6-en-3-one (10). To a solution of oxalyl chloride (0.350 mL, 2.0 M solution in CH₂Cl₂, 0.700 mmol) in 4 mL of CH₂Cl₂ at –78 °C was added a solution of DMSO (0.099 mL, 1.39 mmol) in 0.5 mL of CH₂Cl₂. The mixture was stirred at –78 °C for 10 min, and then a solution of alcohol **31** (0.205 g, 0.580 mmol) in 2 mL of CH₂Cl₂ was added dropwise by syringe. After 1 h at –78 °C, 0.400 mL (2.90 mmol) of Et₃N was added. The mixture was allowed to warm to 23 °C and was then poured into 10 mL of water. The layers were separated, and the aqueous layer was extracted with 3 × 30 mL of CH₂Cl₂. The combined organic layers were washed with 1N HCl (10 mL), aqueous NaHCO₃ (10 mL), brine (10 mL), dried (MgSO₄), and concentrated *in vacuo*. Purification by flash chromatography (3:97 to 5:95 EtOAc/hexanes) afforded **10** as a colorless oil (0.196 g, 96%): ¹H NMR (CDCl₃, 500 MHz) δ 7.51–7.37 (m, 10H), 5.27 (t, *J* = 1.6 Hz, 1H), 5.09 (s, 1H), 4.69 (d, *J* = 11.9 Hz, 1H), 4.64 (d, *J* = 11.8 Hz, 1H), 4.63 (d, *J* = 11.9 Hz, 1H), 4.32 (d, *J* = 11.8 Hz, 1H), 4.07 (s, 1H), 3.00 (dq, *J* = 18.7, 7.2 Hz, 1H), 2.60 (dq, *J* = 18.7, 7.2 Hz, 1H), 1.99 (s, 3H), 1.49 (s, 3H), 1.12 (t, *J* = 7.2 Hz, 3H); ¹³C NMR (CDCl₃, 125 MHz) 215.0, 141.7, 138.7, 137.9, 128.2, 128.1, 127.7, 127.4, 127.1, 126.8, 117.6, 88.2, 87.4, 70.5, 67.0, 32.3, 18.8, 18.2, 7.5; IR (thin film) 1711, 1455, 1088 cm⁻¹; [α]_D²³ +65.0 (*c* 1.29, CHCl₃); HRMS (CI/NH₃) *m/z* calcd for C₂₃H₃₀O₄ (M + NH₄)⁺ 370.2382, found 370.2385. Anal. Calcd for C₂₃H₂₈O₃: C, 78.38; H, 8.01. Found: C, 78.31; H, 8.09.

(2S,4R,5R)-4-Isopropyl-2-(*p*-methoxyphenyl)-5-methyl-1,3-dioxane (32). To a solution of **25**³ (0.500 g, 3.82 mmol) in 20 mL of CH₂Cl₂ was added *p*-anisaldehyde dimethylacetal (0.720 mL, 4.20 mmol) and CSA (0.044 g, 0.190 mmol). After 6 h at 23 °C, 0.2 mL of Et₃N was added to the reaction mixture. The mixture was then concentrated *in vacuo*. Purification by flash chromatography (5:95 EtOAc/hexanes) afforded **32** as a colorless

³ Crimmins, M. T.; King, B. W.; Tabet, E. A.; Chaudhary, K. *J. Org. Chem.* **2001**, 66, 894-902.

Chemical reaction scheme showing the conversion of compound **32** to compound **33**. Compound **32** is a bicyclic acetal with a PMP group and three methyl groups. Compound **33** is an acyclic alcohol with a PMBO group and three methyl groups. The reaction is indicated by a right-pointing arrow.

(2S,3R)-2,4-Dimethyl-3-(*p*-methoxybenzyloxy)pentanal (11). To a solution of oxalyl chloride (0.330 mL, 2.0 M solution in CH₂Cl₂, 0.660 mmol) in 4 mL of CH₂Cl₂ at -78 °C was added a solution of DMSO (0.094 mL, 1.32 mmol) in 0.5 mL of CH₂Cl₂. The mixture was stirred at -78 °C for 10 min, and then a solution of alcohol **33** (0.151 g, 0.600 mmol) in 2 mL of CH₂Cl₂ was added dropwise by syringe. After 30 min at -78 °C, 0.250 mL (1.80 mmol) of Et₃N was added. The mixture was allowed to warm to 23 °C and was then poured into 10 mL of water. The layers were separated, and the aqueous layer was extracted with 3 × 30 mL of CH₂Cl₂. The combined organic layers were washed with 1N HCl (10 mL), aqueous NaHCO₃ (10 mL), brine (10 mL), dried (MgSO₄), and concentrated *in vacuo*. Purification by flash chromatography (5:95 EtOAc/hexanes) afforded **11** as a colorless oil (0.140 g, 93%): ¹H NMR (CDCl₃, 500 MHz) δ 9.84 (d, *J* = 1.0 Hz, 1H), 7.28 (d, *J* = 8.7 Hz, 2H), 6.92 (d, *J* = 8.7 Hz, 2H), 4.46 (s, 2H), 3.85 (s, 3H), 3.64 (dd, *J* = 7.4, 3.5 Hz, 1H), 2.65 (m, 1H), 1.96 (m,

^1H , 1.22 (d, $J = 7.0$ Hz, 3H), 1.09 (d, $J = 6.7$ Hz, 3H), 1.00 (d, $J = 6.8$ Hz, 3H); ^{13}C NMR (CDCl_3 , 125 MHz) 204.8, 159.1, 130.3, 129.2, 113.7, 83.2, 73.5, 55.2, 49.2, 31.2, 19.6, 18.9, 8.0; IR (thin film) 2961, 1721, 1613, 1514 cm^{-1} ; $[\alpha]_{\text{D}}^{23} -41.4$ (c 1.45, CHCl_3); HRMS (CI/NH_3) m/z calcd for $\text{C}_{15}\text{H}_{22}\text{O}_3$ (M) $^+$ 250.1569, found 250.1564.

(3S,4R,6R,7S,8R,9R)-3,4-Dibenzoyloxy-7-hydroxy-9-(p-methoxybenzyloxy)-2,4,6,8,10-pentamethylundec-1-en-5-one (12). To a stirred suspension of $\text{Sn}(\text{OTf})_2$ (0.217 g, 0.520 mmol) in 2 mL of CH_2Cl_2 was added Et_3N (0.089 mL, 0.640 mmol) at 23 °C. The mixture was then cooled to -78 °C, and a solution of ketone **10** (0.141 g, 0.400 mmol) in 2 mL of CH_2Cl_2 was added. After 2 h at -78 °C, a solution of aldehyde **11** (0.138 g, 0.550 mmol) in 2 mL of CH_2Cl_2 was added, and the mixture was warmed to -50 °C. After 15 h, pH 7 buffer (10 mL) was added. The mixture was extracted with 3×30 mL of Et_2O . The combined organic layers were washed with brine (10 mL), dried (MgSO_4), and concentrated *in vacuo*. Purification by flash chromatography (3:97 to 8:92 EtOAc /hexanes) afforded a colorless oil **12** as a single stereoisomer as determined by ^1H NMR spectroscopy of the crude mixture (0.202 g, 84%): ^1H NMR (CDCl_3 , 500 MHz) δ 7.40 (m, 2H), 7.30 (m, 10H), 6.82 (m, 2H), 5.24 (t, $J = 1.6$ Hz, 1H), 5.10 (s, 1H), 4.75 (d, $J = 11.6$ Hz, 1H), 4.70 (d, $J = 11.6$ Hz, 1H), 4.48 (d, $J = 11.5$ Hz, 1H), 4.45 (d, $J = 10.7$ Hz, 1H), 4.39 (d, $J = 10.7$ Hz, 1H), 4.24 (d, $J = 11.5$ Hz, 1H), 4.20 (dt, $J = 10.1, 2.1$ Hz, 1H), 4.18 (s, 1H), 3.82 (s, 3H), 3.50 (m, 2H), 3.25 (d, $J = 2.2$ Hz, 1H), 1.92 (s, 3H), 1.80 (m, 2H), 1.50 (s, 3H), 1.09 (d, $J = 7.1$ Hz, 3H), 1.07 (d, $J = 7.2$ Hz, 3H), 0.87 (d, $J = 6.8$ Hz, 3H), 0.71 (d, $J = 7.0$ Hz, 3H); ^{13}C NMR (CDCl_3 , 125 MHz) 220.2, 158.8, 141.3, 138.3, 137.1, 131.8, 129.3, 128.33, 128.29, 127.8, 127.3, 126.9, 118.1, 113.5, 88.0, 87.8, 83.5, 74.6, 70.9, 70.2, 67.1, 55.2, 42.3, 37.2, 31.5, 20.5, 19.6, 19.4, 19.2, 8.9, 8.6; IR (thin film) 3519, 1704, 1613, 1514 cm^{-1} ; $[\alpha]_{\text{D}}^{23} +27.0$ (c 1.02, CHCl_3); HRMS (ESI) m/z calcd for $\text{C}_{38}\text{H}_{50}\text{O}_6\text{Na}$ ($\text{M} + \text{Na}$) $^+$ 625.3505, found 625.3517. Anal. Calcd for $\text{C}_{38}\text{H}_{50}\text{O}_6$: C, 75.71; H, 8.36. Found: C, 75.64; H, 8.45.

III. Stereochemical proofs of the model aldol product

A. The stereochemistry of C7-OH was determined by analysis of ^1H NMR coupling constant data and nOe data of acetal **34:**

(2*S*,4*S*,5*S*,6*R*)-4-[(1*R*,3*R*,4*S*)-3,4-Dibenzyloxy-2-oxo-1,3,5-trimethylhex-5-en-1-yl]-6-isopropyl-2-(*p*-methoxyphenyl)-5-methyl-1,3-dioxane (34**).** To a mixture of **12** (0.060 g, 0.100 mmol) and 0.080 g of activated 4 Å molecular sieves powder in 1 mL of CH_2Cl_2 was added a solution of DDQ (0.027 g, 0.120 mmol) in 2 mL of CH_2Cl_2 at 0 °C *via* cannula. After 1 h, the mixture was filtered through Celite, and the filtrate was washed with 10 mL of aqueous saturated NaHCO_3 solution. The aqueous layer was back-extracted with 2×10 mL of CH_2Cl_2 . The combined organic layers were washed with brine (10 mL), dried (MgSO_4), and concentrated *in vacuo*. Purification by flash chromatography (1:99 EtOAc/benzene) afforded a white solid **34** as a single stereoisomer as determined by ^1H NMR spectroscopy of the crude mixture (0.045 g, 75%): mp 83–84 °C; ^1H NMR (CDCl_3 , 500 MHz) δ 7.52–7.29 (m, 12H), 6.94 (d, $J = 8.6$ Hz, 2H), 5.37 (s, 1H), 5.31 (s, 1H), 5.12 (s, 1H), 4.85 (d, $J = 11.5$ Hz, 1H), 4.80 (d, $J = 11.5$ Hz, 1H), 4.51 (d, $J = 11.5$ Hz, 1H), 4.36 (m, 1H), 4.32 (s, 1H), 4.26 (d, $J = 11.5$ Hz, 1H), 4.10 (d, $J = 11.1$ Hz, 1H), 3.86 (s, 3H), 3.30 (dd, $J = 9.8, 1.8$ Hz, 1H), 1.99 (s, 3H), 1.67 (m, 1H), 1.61 (m, 1H), 1.51 (s, 3H), 1.28 (d, $J = 6.8$ Hz, 3H), 1.03 (d, $J = 6.9$ Hz, 3H), 0.82 (d, $J = 6.4$ Hz, 3H), 0.48 (d, $J = 6.8$ Hz, 3H); ^{13}C NMR (CDCl_3 , 125 MHz) 217.3, 159.7, 141.6, 138.4, 137.6, 132.0, 128.5, 128.2, 127.6, 127.4, 127.1, 118.3, 113.5, 95.2, 87.2, 87.0, 81.5, 81.1, 71.0, 67.4, 55.3, 38.2, 31.1, 29.1, 21.0, 19.4, 19.2, 16.8, 16.2, 13.2; IR (KBr) 1708, 1617, 1518 cm^{-1} ; $[\alpha]_D^{23} -4.4$ (c 1.25, CHCl_3); HRMS (ESI) m/z calcd for $\text{C}_{38}\text{H}_{48}\text{O}_6\text{Na}$ ($M + \text{Na}$) $^+$ 623.3348, found 623.3358. Anal. Calcd for $\text{C}_{38}\text{H}_{48}\text{O}_6$: C, 75.97; H, 8.05. Found: C, 76.17; H, 8.05.

Relevant ^1H NMR coupling constants and DPGSE-nOe data (mixing time 0.5s): (the peaks in the ^1H NMR spectra were assigned using $^1\text{H}/^1\text{H}$ COSY, $^1\text{H}/^{13}\text{C}$ HMQC, ^1H NMR chemical shifts, and ^1H NMR coupling constants)

^1H NMR coupling constants:

$J_{89} = 1.8$ Hz

$J_{78} = 0$ Hz

nOe data:

H_a irradiated: H₆ (5.1%), H₉ (5.4%), Me₆ (2.1%)

H₉ irradiated: H_a (6.8%), H₆ (6.6%), H₈ (4.2%), Me₁₀ (2.2%), Me_{10'} (2.9%)

H₇ irradiated: H₈ (2.3%), Me₆ (1.9%), Me₈ (3.0%)

H₈ irradiated: H₆ (1.3%), H₇ (2.0%), H₉ (2.3%), Me₈ (2.4%), Me₁₀ (2.4%)

Note: The absence of nOe between H₇ and H₉ indicates that C7 and C9 are *anti*, and the absence of nOe between H_a and H₇ and the observed nOe between H_a and H₉ indicate that the acetal proton H_a and H₉ take axial positions and H₇ is equatorial.

B. The stereochemistry of C8-Me was determined by analysis of ¹H NMR coupling constant data and nOe data of acetone 35:

(3*S*,4*R*,5*S*,6*R*,7*S*,8*R*,9*R*)-3,4-Dibenzyloxy-9-(*p*-methoxybenzyloxy)-2,4,6,8,10-pentamethylundec-1-en-5,7-diol (36). To a cooled solution (−40 °C) of ketone **12** (0.060 g, 0.10 mmol) in 1 mL of Et₂O was added 1.5 mL (0.30 mmol, 0.20 M in Et₂O) of Zn(BH₄)₂. After 12 h, the excess hydride was quenched by 2 mL each of aqueous saturated NH₄Cl solution and 1 M HCl. The mixture was extracted with 3 × 10 mL Et₂O, and the combined organic extracts were dried over MgSO₄, filtered, and concentrated *in vacuo*. Purification by flash chromatography (10:90 to 20:80 Et₂O/hexanes) afforded a colorless oil **36** as a single stereoisomer (0.032 g, 53%): ¹H NMR (CDCl₃, 500 MHz) δ 7.43–7.28 (m, 12H), 6.90 (m, 2H), 5.26 (s, 1H), 5.12 (s, 1H), 4.74 (d, *J* = 11.5 Hz, 1H), 4.68 (d, *J* = 11.0 Hz, 1H), 4.66 (d, *J* = 11.5 Hz, 1H), 4.62 (d, *J* = 11.4 Hz, 1H), 4.60 (d, *J* = 11.0 Hz, 1H), 4.33 (d, *J* = 11.4 Hz, 1H), 4.14 (s, 1H), 4.07 (dd, *J* = 4.9, 1.4 Hz, 1H), 3.84 (s, 3H), 3.76 (d, *J* = 9.8 Hz, 1H), 3.59 (br, 1H), 3.57 (d, *J* = 4.9 Hz, 1H), 3.51 (dd, *J* = 9.0, 1.6 Hz, 1H), 2.17 (m, 1H), 1.92 (s, 3H), 1.86 (m, 2H), 1.45 (s, 3H), 1.10 (d, *J* = 6.6 Hz, 3H), 1.03 (d, *J* = 6.9 Hz, 3H), 0.92 (d, *J* = 6.8 Hz, 3H), 0.82 (d, *J* = 6.9 Hz, 3H); ¹³C NMR (CDCl₃, 125 MHz) 158.9, 141.7, 139.2, 137.7, 131.8, 129.2, 128.5, 128.2, 127.9, 127.8, 127.1, 127.0, 117.5, 113.6, 88.5, 84.5, 80.9, 79.0, 78.5, 74.4, 70.9, 65.1, 55.2, 37.5, 34.1, 31.2, 20.4, 19.8, 18.2, 9.8, 6.2; IR (thin film) 3488, 1613, 1514 cm^{−1}; [α]_D²³ +14.2 (*c* 0.60, CHCl₃); HRMS (ESI) *m/z* calcd for C₃₈H₅₂O₆Na (M + Na)⁺ 627.3661, found 627.3670.

(4*S*,5*R*,6*S*)-4-[(1*R*,2*S*)-1,2-Dibenzyloxy-1,3-dimethyl-but-3-enyl]-6-[(1*S*,2*R*)-1,3-dimethyl-2-(*p*-methoxybenzyloxy)butyl]-2,2,5-trimethyl-1,3-dioxane (35). To a solution of diol **36** (0.025 g, 0.041 mmol)

in 1 mL of 2,2-dimethoxypropane at 23 °C was added CSA (0.0010 g, 0.0040 mmol). The mixture was stirred for 12 h before 0.05 mL of Et₃N was added. The mixture was then concentrated *in vacuo*. Purification by flash chromatography (5:95 Et₂O/hexanes) afforded **35** as a colorless oil (0.020 g, 76%): ¹H NMR (CDCl₃, 500 MHz) δ 7.42–7.28 (m, 12H), 6.93 (m, 2H), 5.15 (t, *J* = 1.6 Hz, 1H), 5.07 (s, 1H), 4.90 (d, *J* = 11.9 Hz, 1H), 4.82 (d, *J* = 11.9 Hz, 1H), 4.60 (d, *J* = 11.0 Hz, 1H), 4.58 (d, *J* = 11.7 Hz, 1H), 4.56 (d, *J* = 11.0 Hz, 1H), 4.30 (d, *J* = 11.7 Hz, 1H), 4.09 (d, *J* = 1.9 Hz, 1H), 3.94 (s, 1H), 3.87 (s, 3H), 3.81 (dd, *J* = 9.9, 1.7 Hz, 1H), 3.43 (dd, *J* = 8.9, 1.2 Hz, 1H), 2.01 (m, 1H), 1.93 (m, 1H), 1.89 (s, 3H), 1.84 (m, 1H), 1.48 (s, 3H), 1.47 (s, 3H), 1.34 (s, 3H), 1.10 (d, *J* = 6.5 Hz, 3H), 1.08 (d, *J* = 6.6 Hz, 3H), 0.93 (d, *J* = 6.8 Hz, 3H), 0.79 (d, *J* = 7.0 Hz, 3H); ¹³C NMR (CDCl₃, 125 MHz) 158.9, 142.4, 140.3, 138.8, 131.8, 128.5, 128.2, 128.1, 127.6, 127.2, 127.1, 126.8, 118.1, 113.7, 99.2, 90.5, 83.3, 80.7, 75.9, 75.3, 74.2, 70.1, 66.6, 55.3, 36.5, 31.6, 31.2, 30.1, 20.4, 19.8, 19.6, 18.5, 16.2, 7.9, 6.9; IR (thin film) 2916, 1613, 1514 cm⁻¹; [α]_D²³ +19.5 (*c* 0.95, CHCl₃); HRMS (ESI) *m/z* calcd for C₄₁H₅₆O₆Na (M + Na)⁺ 667.3975, found 667.3980.

Relevant ¹H NMR coupling constants, ¹³C chemical shifts, and DPGSE-nOe data (mixing time 0.5s): (the peaks in the ¹H NMR and ¹³C NMR spectra were assigned using ¹H/¹H COSY, ¹H/¹³C HMQC, ¹H NMR chemical shifts, ¹³C NMR chemical shifts, and ¹H NMR coupling constants)

¹³ C NMR chemical shifts:	¹ H NMR coupling constants:	nOe data:
Me_a : 19.8 ppm	<i>J</i> ₅₆ = 1.7 Hz	H₅ irradiated: H ₇ (6.4%), H ₆ (4.4%), Me _a (5.6%)
Me_e : 30.1 ppm	<i>J</i> ₆₇ = 1.7 Hz	H₆ irradiated: H ₅ (4.2%), H ₇ (3.9%), Me ₆ (4.0%)
		H₇ irradiated: H ₅ (6.1%), H ₆ (4.7%), Me _a (5.1%)

Note: The ¹³C NMR chemical shifts of the ketal carbons indicate the *syn* C5/C7 relationship and the chair conformation of the acetonide.⁴

⁴ Rychnovsky, S. D.; Rogers, B.; Yang, G. *J. Org. Chem.* **1993**, 58, 3511-3515.

IV. Total synthesis of (9S)-dihydroerythronolide A

(2R,3R,4R,5R)-2,4-Dimethyl-4-dimethylphenylsilyl-5-ethyl-3-(p-methoxybenzyloxy)-2-(p-methoxybenzyloxymethyl)tetrahydrofuran (37). To a suspension of NaH (1.74 g, 60% oil dispersion, 43.6 mmol, washed with 3×20 mL of hexanes) in 30 mL of dry DMF was added a solution of diol (+)-**13** (3.35 g, 10.9 mmol) in 30 mL of DMF. After 0.5 h at 23 °C, *p*-methoxybenzyl chloride (5.91 mL, 43.6 mmol) and *n*-Bu₄NI (0.200 g, 0.545 mmol) were added, and the reaction mixture was stirred for 12 h at 23 °C. To the mixture was added 60 mL of saturated aqueous NH₄Cl. The mixture was extracted with 3×100 mL of Et₂O, and the combined organic layers were washed with brine (40 mL), dried (MgSO₄), and concentrated *in vacuo*. Purification by flash chromatography (5:95 EtOAc/hexanes) afforded **37** as a colorless oil (5.75 g, 96%): ¹H NMR (CDCl₃, 500 MHz) δ 7.58 (m, 2H), 7.45 (m, 3H), 7.34 (d, *J* = 8.6 Hz, 2H), 7.23 (d, *J* = 8.6 Hz, 2H), 6.99 (d, *J* = 8.6 Hz, 2H), 6.94 (d, *J* = 8.7 Hz, 2H), 4.59 (d, *J* = 11.0 Hz, 1H), 4.54 (d, *J* = 11.7 Hz, 1H), 4.48 (d, *J* = 11.7 Hz, 1H), 4.22 (d, *J* = 11.0 Hz, 1H), 4.05 (s, 1H), 3.91 (s, 3H), 3.89 (s, 3H), 3.62 (d, *J* = 9.9 Hz, 1H), 3.30 (d, *J* = 9.2 Hz, 1H), 3.20 (d, *J* = 9.2 Hz, 1H), 1.48 (m, 1H), 1.34 (m, 1H and s, 3H), 1.15 (s, 3H), 1.03 (t, *J* = 7.3 Hz, 3H), 0.41 (s, 3H), 0.40 (s, 3H); ¹³C NMR (CDCl₃, 125 MHz) δ 159.0, 158.8, 137.1, 134.3, 131.0, 130.6, 129.1, 129.0, 128.8, 127.6, 113.6, 113.5, 86.0, 81.9, 81.4, 75.8, 73.0, 71.7, 55.20, 55.16, 37.4, 23.9, 20.8, 12.2, 9.7, -4.8, -5.1; IR (thin film) 2959, 1613, 1513, 1247, 1082 cm⁻¹; [α]_D²³ -13.7 (*c* 1.17, CHCl₃); HRMS (ESI) *m/z* calcd for C₃₃H₄₃O₅Si (M - H)⁺ 547.2880, found 547.2869. Anal. Calcd for C₃₃H₄₄O₅Si: C, 72.22; H, 8.08. Found: C, 72.33; H, 8.23.

(2R,3R,4R,5R)-2,4-Dimethyl-5-ethyl-4-hydroxyl-3-(p-methoxybenzyloxy)-2-(p-methoxybenzyloxymethyl)tetrahydrofuran (38). To a suspension of KH (6.28 g, 157 mmol) in 50 mL of NMP was added cumene hydroperoxide (21.2 mL, 88.0%, 126 mmol) dropwise at 0 °C. After 20 min at 0 °C, silane **37** (8.60 g, 15.7 mmol) in 50 mL of NMP was added dropwise followed by *n*-Bu₄NF (31.4 mL, 1 M solution in THF, 31.4 mmol). The mixture was allowed to stir at 60 °C for 15 h, at which point 100 mL of saturated aqueous Na₂S₂O₃ solution was added. The mixture was stirred for 30 min at 23 °C, and was then extracted with 5×100 mL of *t*-BuOMe. The combined organic layers were washed with brine (50 mL), dried (MgSO₄), and concentrated *in vacuo*. The residue was then subjected to bulb-to-bulb distillation (70 °C/0.1 mmHg) to remove most of the NMP and cumene alcohol. Further purification by flash chromatography (5:95 to 25:75 EtOAc/hexanes) afforded **38** (5.74 g, 85%) as colorless oil: ¹H NMR (CDCl₃, 500 MHz) δ 7.33 (d, *J* = 8.6 Hz, 2H), 7.28 (d, *J* = 8.6 Hz, 2H), 6.93 (m, 4H), 4.63 (d, *J* = 11.6 Hz, 1H), 4.60 (d, *J* = 11.6 Hz, 1H), 4.56 (d, *J* = 9.6 Hz, 1H), 4.52 (d, *J* = 9.6 Hz, 1H), 3.87 (s, 1H), 3.86 (s, 3H), 3.85 (s, 3H), 3.66 (dd, *J* = 9.5, 4.5 Hz, 1H), 3.47 (d, *J* = 9.7 Hz, 1H), 3.37 (d, *J* = 9.7 Hz, 1H), 3.19 (s, 1H), 1.54 (m, 2H), 1.31 (s, 3H), 1.22 (s, 3H),

1.04 (t, $J = 7.4$ Hz, 3H); ^{13}C NMR (CDCl_3 , 125 MHz) δ 159.2, 159.1, 130.6, 129.8, 129.3, 129.1, 113.7, 113.6, 88.6, 85.8, 82.2, 81.0, 76.2, 73.2, 73.1, 55.1, 23.1, 20.3, 16.8, 10.7; IR (thin film) 3455, 1613, 1513, 1247, 1084 cm^{-1} ; $[\alpha]_{\text{D}}^{23} +44.4$ (c 1.08, CHCl_3); HRMS (CI/NH_3) m/z calcd for $\text{C}_{25}\text{H}_{33}\text{O}_6$ ($\text{M} - \text{H}$) $^+$ 429.2277, found 429.2278. Anal. Calcd for $\text{C}_{25}\text{H}_{34}\text{O}_6$: C, 69.74; H, 7.96. Found: C, 69.47; H, 8.12.

(2R,3R,4R,5R)-4-Benzyloxy-2,4-dimethyl-5-ethyl-3-(p-methoxybenzyloxy)-2-(p-methoxybenzyloxymethyl)tetrahydrofuran (39). To a suspension of NaH (3.12 g, 60% oil dispersion, 78.0 mmol, washed with 3×30 mL of hexanes) in 100 mL of dry DMF was added a solution of diol **38** (11.2 g, 26.0 mmol) in 100 mL of DMF at 0 °C. After 0.5 h at 0 °C, BnBr (9.30 mL, 78.0 mmol) and $n\text{-Bu}_4\text{NI}$ (0.480 g, 1.30 mmol) were added, and the reaction mixture was stirred for 12 h at 23 °C. A saturated aqueous solution of NH_4Cl (100 mL) was then added. The mixture was extracted with 3×200 mL of Et_2O , and the combined organic layers were washed with brine (50 mL), dried (MgSO_4), and concentrated *in vacuo*. Purification by flash chromatography (5:95 to 10:90 EtOAc /hexanes) afforded **39** as a colorless oil (12.8 g, 95%): ^1H NMR (CDCl_3 , 500 MHz) δ 7.36 (m, 9H), 6.96 (m, 4H), 4.65 (m, 4H), 4.48 (d, $J = 11.5$ Hz, 1H), 4.43 (d, $J = 11.7$ Hz, 1H), 4.23 (s, 1H), 3.89 (s, 3H), 3.88 (s, 3H), 3.81 (dd, $J = 8.7, 4.1$ Hz, 1H), 3.57 (d, $J = 9.3$ Hz, 1H), 3.50 (d, $J = 9.3$ Hz, 1H), 1.67 (m, 1H), 1.60 (m, 1H), 1.41 (s, 3H), 1.34 (s, 3H), 1.10 (t, $J = 7.4$ Hz, 3H); ^{13}C NMR (CDCl_3 , 125 MHz) δ 159.08, 159.05, 139.4, 130.6, 130.4, 129.3, 129.2, 128.1, 127.1, 127.0, 113.68, 113.63, 87.1, 84.5, 81.7, 81.1, 76.1, 73.1, 71.6, 65.4, 55.2, 22.6, 20.1, 13.10, 10.9; IR (thin film) 2934, 1613, 1513, 1247, 1086 cm^{-1} ; $[\alpha]_{\text{D}}^{23} -35.1$ (c 1.14, CHCl_3); HRMS (CI/NH_3) m/z calcd for $\text{C}_{32}\text{H}_{39}\text{O}_6$ ($\text{M} - \text{H}$) $^+$ 519.2747, found 519.2742. Anal. Calcd for $\text{C}_{32}\text{H}_{40}\text{O}_6$: C, 73.82; H, 7.74. Found: C, 73.79; H, 7.90.

(2R,3R,4R,5R)-4-Benzyloxy-2,4-dimethyl-5-ethyl-3-hydroxy-2-hydroxymethyltetrahydrofuran (40). To a solution of **39** (12.5 g, 24.0 mmol) in 200 mL of CH_3CN and 20 mL of H_2O was added ceric ammonium nitrate (65.8 g, 120 mmol). After 1 h at 23 °C, 300 mL of saturated aqueous NaHCO_3 solution and 20.0 g of NaHSO_3 were added to the reaction mixture. After 15 min, the mixture was extracted with 4×500 mL of EtOAc . The combined organic layers were washed with brine (100 mL), dried (MgSO_4), and concentrated *in vacuo*. Purification by flash chromatography (30:70 to 50:50 EtOAc /hexanes) afforded **40** as a white solid (6.45 g, 96%): mp 82–82 °C; ^1H NMR (CDCl_3 , 500 MHz) δ 7.35 (m, 5H), 4.70 (d, $J = 11.6$ Hz, 1H), 4.67 (d, $J = 11.6$ Hz, 1H), 4.27 (d, $J = 6.1$ Hz, 1H), 3.74 (dd, $J = 9.0, 4.2$ Hz, 1H), 3.61 (dd, $J = 10.9, 2.4$ Hz, 1H), 3.51 (dd, $J = 10.9, 5.1$ Hz, 1H), 2.53 (br, 1H), 2.34 (br, 1H), 1.65 (m, 1H), 1.55 (m, 1H), 1.36 (s, 3H), 1.20 (s, 3H), 1.06 (t, $J = 7.4$ Hz, 3H); ^{13}C NMR (CDCl_3 , 125 MHz) δ 139.1, 128.4, 127.4, 127.2, 84.5, 82.6, 81.9, 80.5, 68.4, 65.6, 23.1, 19.0, 12.5, 10.9; IR (KBr) 3416, 3342, 1060 cm^{-1} ; $[\alpha]_{\text{D}}^{23} +28.9$ (c 1.09, CHCl_3); HRMS (CI/NH_3) m/z

calcd for $C_{16}H_{25}O_4$ ($M + H$)⁺ 281.1753, found 281.1747. Anal. Calcd for $C_{16}H_{24}O_4$: C, 68.54; H, 8.63. Found: C, 68.78; H, 8.66.

(2R,3R,4R,5R)-4-Benzyloxy-2,4-dimethyl-5-ethyl-3-hydroxy-2-iodomethyltetrahydrofuran (41). To a solution of **40** (4.35 g, 15.5 mmol) in 100 mL of benzene was added Ph_3P (4.88 g, 18.6 mmol), imidazole (1.58 g, 23.2 mmol), and I_2 (4.72 g, 18.6 mmol). The mixture was heated at reflux for 1 h. After being cooled to 23 °C, the mixture was filtered through Celite, and the cake was washed with 100 mL of ether. The filtrate was concentrated *in vacuo*. Purification by flash chromatography (5:95 to 10:90 EtOAc/hexanes) afforded **41** as a white solid (4.70 g, 78%): mp 93–94 °C; ^1H NMR ($CDCl_3$, 500 MHz) δ 7.35 (m, 5H), 4.74 (d, $J = 11.7$ Hz, 1H), 4.71 (d, $J = 11.7$ Hz, 1H), 4.37 (d, $J = 5.4$ Hz, 1H), 3.74 (dd, $J = 8.9, 4.9$ Hz, 1H), 3.43 (d, $J = 9.6$ Hz, 1H), 3.33 (d, $J = 9.6$ Hz, 1H), 1.80 (d, $J = 5.4$ Hz, 1H), 1.65 (m, 1H), 1.57 (m, 1H), 1.41 (s, 3H), 1.35 (s, 3H), 1.06 (t, $J = 7.4$ Hz, 3H); ^{13}C NMR ($CDCl_3$, 125 MHz) δ 139.2, 128.4, 127.4, 127.2, 84.7, 83.6, 82.2, 80.4, 65.8, 22.5, 21.5, 17.3, 12.0, 10.9; IR (KBr) 3437, 1092 cm^{-1} ; $[\alpha]_D^{23}$ -42.9 (c 1.06, $CHCl_3$); HRMS (CI/NH_3) m/z calcd for $C_{16}H_{27}NO_3$ ($M + NH_4$)⁺ 408.1036, found 408.1037. Anal. Calcd for $C_{16}H_{23}IO_3$: C, 49.24; H, 5.94. Found: C, 49.41; H, 5.82.

2,2-Dimethyl propionic acid (2R,3R,4R,5R)-4-Benzyloxy-2,4-dimethyl-5-ethyl-2-iodomethyltetrahydrofuran-3-yl ester (14). To a mixture of alcohol **41** (4.70 g, 12.1 mmol) and trimethylacetic anhydride (12.2 mL, 60.3 mmol) in acetonitrile (60 mL) was added dropwise a solution of $Sc(OTf)_3$ (0.296 g, 0.600 mmol) in 10 mL of acetonitrile at 23 °C. After 1 h, 50 mL of saturated aqueous $NaHCO_3$ solution was added. The mixture was extracted with 3×100 mL of ether. The combined organic layers were washed with brine (50 mL), dried ($MgSO_4$), and concentrated *in vacuo*. Purification by flash chromatography (1:99 Et₂O/hexanes) afforded **14** as a colorless oil (5.72 g, 100%): ^1H NMR ($CDCl_3$, 500 MHz) δ 7.37 (m, 5H), 5.45 (s, 1H), 4.60 (d, $J = 11.0$ Hz, 1H), 4.46 (d, $J = 11.0$ Hz, 1H), 3.89 (dd, $J = 9.1, 4.0$ Hz, 1H), 3.66 (d, $J = 10.5$ Hz, 1H), 3.63 (d, $J = 10.5$ Hz, 1H), 1.60 (m, 2H), 1.37 (s, 3H), 1.34 (s, 9H), 1.30 (s, 3H), 1.10 (t, $J = 7.4$ Hz, 3H); ^{13}C NMR ($CDCl_3$, 125 MHz) δ 177.1, 138.3, 128.4, 127.5, 127.4, 85.8, 83.7, 81.3, 80.4, 65.9, 39.0, 27.1, 22.9, 22.7, 16.1, 13.6, 10.9; IR (thin film) 1732, 1148 cm^{-1} ; $[\alpha]_D^{23}$ -2.0 (c 0.99, $CHCl_3$); HRMS (CI/NH_3) m/z calcd for $C_{21}H_{31}IO_4$ ($M + H$)⁺ 475.1345, found 475.1341. Anal. Calcd for $C_{21}H_{31}IO_4$: C, 53.17; H, 6.59. Found: C, 53.61; H, 6.78.

2,2-Dimethyl propionic acid (*R*)-[(1*R*,2*R*)-1-benzyloxy-1-methyl-2-hydroxybutyl]-2-methylallyl ester (42**).**

To a solution of the iodide **14** (5.72 g, 12.0 mmol) in 30 mL of dry Et₂O and 30 mL of dry MeOH was added zinc powder (15.7 g, 24.0 mmol) followed by AcOH (2.23 mL, 36.0 mmol). The reaction mixture was stirred for 12 h at 23 °C, at which point the reaction mixture was diluted with 400 mL of Et₂O and filtered. The filtrate was washed with 50 mL of saturated aqueous NaHCO₃ and brine (50 mL), dried (MgSO₄), and concentrated *in vacuo*. Purification by flash chromatography (5:95 to 10:90 EtOAc/hexanes) afforded **42** as a white solid (3.45 g, 83%): mp 54–55 °C; ¹H NMR (CDCl₃, 500 MHz) δ 7.35 (m, 5H), 5.51 (s, 1H), 5.11 (t, *J* = 1.5 Hz, 1H), 5.09 (s, 1H), 4.63 (d, *J* = 11.2 Hz, 1H), 4.60 (d, *J* = 11.2 Hz, 1H), 3.68 (ddd, *J* = 10.4, 4.5, 1.7 Hz, 1H), 2.57 (dd, *J* = 4.5, 1.2 Hz, 1H), 1.94 (s, 3H), 1.74 (m, 1H), 1.48 (m, 1H), 1.35 (s, 3H), 1.32 (s, 9H), 1.09 (t, *J* = 7.4 Hz, 3H); ¹³C NMR (CDCl₃, 125 MHz) δ 177.6, 141.9, 138.8, 128.3, 127.3, 127.0, 115.4, 80.6, 79.4, 75.1, 64.8, 39.0, 27.1, 23.7, 20.6, 16.5, 11.4; IR (thin film) 3520, 1732, 1150 cm⁻¹; [α]_D²³ +15.3 (*c* 1.15, CHCl₃); HRMS (CI/NH₃) *m/z* calcd for C₂₁H₃₂O₄ (*M* + H)⁺ 349.2379, found 349.2383. Anal. Calcd for C₂₁H₃₂O₄: C, 72.38; H, 9.26. Found: C, 72.66; H, 9.43.

2,2-Dimethyl propionic acid (*R*)-[(1*R*,2*R*)-benzyloxy-1-methyl-*tert*-butyldimethylsiloxy-butyl]-2-methylallyl ester (43**).**

To a solution of alcohol **42** (3.45 g, 10.0 mmol) was added 2,6-lutidine (2.31 mL, 20.0 mmol) and TBSOTf (4.59 mL, 20.0 mmol) at 0 °C. The reaction mixture was allowed to stir for 3 h at 23 °C. The reaction mixture was diluted with 300 mL of Et₂O and washed with saturated aqueous NaHCO₃ (30 mL) and brine (30 mL), dried (MgSO₄), and concentrated *in vacuo*. Purification by flash chromatography (2:98 Et₂O/hexanes) afforded **43** as a colorless oil (4.42 g, 97%): ¹H NMR (CDCl₃, 500 MHz) δ 7.38 (m, 4H), 7.31 (m, 1H), 5.32 (s, 1H), 5.11 (s, 1H), 5.10 (t, *J* = 1.5 Hz, 1H), 4.89 (d, *J* = 11.9 Hz, 1H), 4.71 (d, *J* = 11.9 Hz, 1H), 3.85 (dd, *J* = 7.4, 2.7 Hz, 1H), 1.92 (m, 1H, and s, 3H), 1.60 (m, 1H), 1.39 (s, 3H), 1.30 (s, 9H), 1.07 (t, *J* = 7.5 Hz, 3H), 1.01 (s, 9H), 0.16 (s, 3H), 0.13 (s, 3H); ¹³C NMR (CDCl₃, 125 MHz) δ 177.0, 142.1, 139.8, 128.1, 126.8, 126.6, 116.1, 81.9, 80.0, 76.9, 65.9, 38.9, 27.2, 26.1, 25.4, 21.0, 18.3, 16.1, 12.0, -3.6, -4.2; IR (thin film) 1733, 1149 cm⁻¹; [α]_D²³ +6.1 (*c* 1.01, CHCl₃); HRMS (CI/NH₃) *m/z* calcd for C₂₇H₄₆O₄Si (*M* + H)⁺ 463.3243, found 463.3244. Anal. Calcd for C₂₇H₄₆O₄Si: C, 70.08; H, 10.02. Found: C, 70.32; H, 10.13.

(3R,4S,5R)-4-Benzyloxy-2,4-dimethyl-5-(tert-butyldimethylsiloxy)hept-1-en-3-ol (15). To a solution of **43** (4.47 g, 9.68 mmol) in 60 mL of CH₂Cl₂ was added *i*-Bu₂AlH (25.8 mL, 1.5 M solution in toluene, 38.7 mmol) dropwise at –78 °C. The reaction mixture was allowed to warm to 0 °C. After being stirred at 0 °C for 3 h, the mixture was cooled to –78 °C, followed by the addition of 5 mL of MeOH and 50 mL of a saturated aqueous solution of potassium sodium tartrate. The mixture was then stirred at 23 °C for 1 h. The layers were separated, and the aqueous layer was extracted with 3 × 50 mL of CH₂Cl₂. The combined organic layers were washed with brine (30 mL), dried (MgSO₄), and concentrated *in vacuo*. Purification by flash chromatography (5:95 Et₂O/hexanes) afforded **15** as a colorless oil (3.45 g, 94%): ¹H NMR (CDCl₃, 500 MHz) δ 7.40 (m, 4H), 7.35 (m, 1H), 5.08 (t, *J* = 1.6 Hz, 1H), 5.03 (s, 1H), 4.78 (d, *J* = 11.2 Hz, 1H), 4.67 (d, *J* = 11.2 Hz, 1H), 4.27 (d, *J* = 5.4 Hz, 1H), 3.93 (dd, *J* = 7.2, 3.3 Hz, 1H), 3.42 (d, *J* = 5.4 Hz, 1H), 1.92 (s, 3H), 1.91 (m, 1H), 1.68 (m, 1H), 1.32 (s, 3H), 1.12 (t, *J* = 7.5 Hz, 3H), 1.01 (s, 9H), 0.20 (s, 3H), 0.18 (s, 3H); ¹³C NMR (CDCl₃, 125 MHz) δ 145.0, 139.0, 128.3, 127.2, 114.8, 81.6, 77.9, 77.6, 65.7, 26.1, 25.6, 19.6, 18.3, 15.7, 11.8, –3.8, –4.4; IR (thin film) 3555, 1108 cm^{–1}; [α]_D²³ –3.4 (*c* 1.02, CHCl₃); HRMS (CI/NH₃) *m/z* calcd for C₂₂H₃₉O₃Si (M + H)⁺ 379.2668, found 379.2671. Anal. Calcd for C₂₂H₃₈O₃Si: C, 69.79; H, 10.12. Found: C, 69.95; H, 10.22.

(2S,3R,4S,5R)-4-Benzyloxy-2,4-dimethyl-5-(tert-butyldimethylsiloxy)heptane-1,3-diol (16).⁵ A mixture of alcohol **15** (3.40 g, 9.00 mmol) and HN(SiHMe₂) (16.0 mL, 90.0 mmol) was placed in a 90 °C bath and allowed to stir for 24 h. The reaction mixture was then cooled to 23 °C and was placed under high vacuum (0.1 mmHg) for 4 h to remove the volatile materials. The residue was dissolved in 30 mL of toluene and platinum(0)-1,3-divinyl-1,1,3,3-tetramethyldisiloxane complex (0.5 mL, in xylenes) was added. The reaction mixture was stirred at 70 °C for 12 h. After being cooled to 23 °C, the mixture was diluted with 80 mL of hexanes and 10 g of EDTA disodium salt was added. The mixture was stirred for 12 h, filtered, and concentrated *in vacuo*. The residue was dissolved in 40 mL of MeOH and 40 mL of THF. To this solution was added KHCO₃ (1.80 g, 18.0 mmol), KF (1.04 g, 18.0 mmol) and H₂O₂ (20.4 mL, 30% solution in water, 180 mmol). The resulting mixture was stirred at 23 °C for 12 h and was quenched by the addition of 30 mL of saturated aqueous Na₂S₂O₃ solution. The mixture was extracted with 4 × 50 mL of EtOAc. The combined organic layers were washed with brine (30 mL), dried (MgSO₄), and concentrated *in vacuo*. Purification by flash chromatography (5:95 to 20:80 EtOAc/hexanes) afforded a white solid **16** (3.10 g, 87%) as a single diastereomer as determined by ¹H NMR spectroscopy analysis of the crude mixture: mp 84–85 °C; ¹H NMR (CDCl₃, 500 MHz) δ 7.39 (m, 4H), 7.32 (m, 1H), 4.74 (d, *J* = 11.2 Hz, 1H), 4.64 (d, *J* = 11.2 Hz, 1H), 3.97 (dd, *J* = 5.8, 2.4 Hz, 1H), 3.93 (dd, *J* = 6.7, 3.8 Hz, 1H), 3.73 (dd, *J* = 10.4, 3.8 Hz, 1H), 3.68 (m, 1H), 3.40 (d, *J* = 5.7 Hz, 1H), 2.83 (br, 1H), 1.96 (m, 1H), 1.84 (m, 1H), 1.64 (m, 1H), 1.36 (s, 3H), 1.12 (d, *J* = 7.0 Hz, 3H), 1.09 (t, *J* = 7.5 Hz, 3H), 0.98 (s, 9H), 0.19 (s,

⁵ Tamao, K. Nakajima, T.; Sumiya, R.; Arai, H.; Higuchi, N.; Ito, Y. *J. Am. Chem. Soc.* **1986**, *108*, 6090–6093.

3H), 0.16 (s, 3H); ^{13}C NMR (CDCl_3 , 125 MHz) δ 138.8, 128.3, 127.3, 81.5, 78.2, 75.6, 68.4, 65.1, 36.1, 26.0, 25.7, 18.3, 16.1, 11.8, 11.1, -3.8 , -4.4 ; IR (KBr) 3503, 1106 cm^{-1} ; $[\alpha]_{\text{D}}^{23} +15.9$ (c 1.16, CHCl_3); HRMS (CI/NH_3) m/z calcd for $\text{C}_{22}\text{H}_{41}\text{O}_4\text{Si}$ ($\text{M} + \text{H}^+$) 397.2774, found 397.2779. Anal. Calcd for $\text{C}_{22}\text{H}_{40}\text{O}_4\text{Si}$: C, 66.62; H, 10.16. Found: C, 66.36; H, 10.31.

(2R,4R,5S)-4-[(1S,2R)-1-Benzyloxy-2-*tert*-butyldimethylsiloxy-1-methylbutyl]-2-(*p*-methoxyphenyl)-5-methyl-1,3-dioxane (44**).** To a solution of **16** (3.06 g, 7.73 mmol) in 50 mL of CH_2Cl_2 was added *p*-anisaldehyde dimethylacetal (1.84 mL, 10.8 mmol) and PPTS (0.388 g, 1.55 mmol). After 5 h at 23 °C, 30 mL of saturated aqueous NaHCO_3 was added to the mixture. The layers were separated and the organic layer was extracted with 3×50 mL of CH_2Cl_2 . The combined organic layers were washed with brine (30 mL), dried (MgSO_4), and concentrated *in vacuo*. Purification by flash chromatography (2:98 EtOAc/hexanes) afforded **44** as needles (3.80 g, 96%): mp 100–101 °C; ^1H NMR (CDCl_3 , 500 MHz) δ 7.56 (m, 2H), 7.41 (m, 4H), 7.34 (m, 1H), 7.02 (m, 2H), 5.60 (s, 1H), 5.15 (d, $J = 11.8$ Hz, 1H), 4.57 (d, $J = 11.8$ Hz, 1H), 4.37 (d, $J = 1.2$ Hz, 1H), 4.34 (dd, $J = 6.9, 2.3$ Hz, 1H), 4.15 (dd, $J = 11.2, 2.2$ Hz, 1H), 4.08 (dd, $J = 11.3, 1.3$ Hz, 1H), 3.91 (s, 3H), 2.00 (m, 1H), 1.97 (m, 1H), 1.57 (m, 1H and d, $J = 6.9$ Hz, 3H), 1.26 (s, 3H), 1.14 (t, $J = 7.5$ Hz, 3H), 1.06 (s, 9H), 0.22 (s, 3H), 0.20 (s, 3H); ^{13}C NMR (CDCl_3 , 125 MHz) δ 159.8, 140.1, 131.7, 128.1, 127.4, 127.2, 126.9, 113.6, 102.4, 81.6, 81.3, 75.5, 73.5, 66.2, 55.2, 30.2, 26.2, 24.2, 18.4, 17.0, 12.7, 12.1, -3.2 , -4.3 ; IR (thin film) 2956, 1614, 1518, 1249, 1112 cm^{-1} ; $[\alpha]_{\text{D}}^{23} +8.0$ (c 1.09, CHCl_3); HRMS (CI/NH_3) m/z calcd for $\text{C}_{30}\text{H}_{47}\text{O}_5\text{Si}$ ($\text{M} + \text{H}^+$) 515.3193, found 515.3192. Anal. Calcd for $\text{C}_{30}\text{H}_{46}\text{O}_5\text{Si}$: C, 70.00; H, 9.01. Found: C, 70.38; H, 9.02.

(2S,3R,4S,5R)-4-Benzyloxy-5-(*tert*-butyldimethylsiloxy)-2,4-dimethyl-3-(*p*-methoxybenzyloxy)-1-heptanol (45**).** To a solution of **44** (3.90 g, 7.59 mmol) in 70 mL of CH_2Cl_2 was added *i*- Bu_2AlH (15.2 mL, 1.5 M solution in toluene, 22.8 mmol) dropwise at -78 °C. The reaction mixture was allowed to warm to 0 °C. After being stirred at 0 °C for 0.5 h, the mixture was cooled to -78 °C, followed by the addition of 5 mL of MeOH followed by 50 mL of a saturated aqueous solution of potassium sodium tartrate. The mixture was then stirred at 23 °C for 1 h. The layers were separated, the aqueous layer was extracted with 3×50 mL of CH_2Cl_2 . The combined organic layers were washed with brine (30 mL), dried (MgSO_4), and concentrated *in vacuo*. Purification by flash chromatography (10:90 to 15:85 EtOAc/hexanes) afforded **45** as a colorless oil (3.85 g, 98%): ^1H NMR (CDCl_3 , 500 MHz) δ 7.46–7.29 (m, 7H), 6.94 (m, 2H), 4.97 (d, $J = 11.4$ Hz, 1H), 4.90 (d, $J = 11.2$ Hz, 1H), 4.75 (d, $J = 11.4$ Hz, 1H), 4.62 (d, $J = 11.2$ Hz, 1H), 3.87 (s, 3H), 3.86 (d, $J = 2.1$ Hz, 1H), 3.77 (dd, $J = 6.6, 3.8$ Hz, 1H), 3.55 (m, 2H), 1.91 (m, 2H), 1.79 (m, 2H), 1.53 (s, 3H), 1.12 (t, $J = 7.5$ Hz, 3H), 1.07

(d, $J = 7.0$ Hz, 3H), 1.06 (s, 9H), 0.22 (s, 3H), 0.20 (s, 3H); ^{13}C NMR (CDCl_3 , 125 MHz) δ 158.9, 140.2, 131.4, 129.3, 128.2, 127.6, 126.9, 113.6, 84.7, 83.1, 78.8, 74.5, 67.5, 65.8, 55.2, 36.8, 26.2, 25.5, 18.4, 16.8, 11.6, 11.4, -3.7, -3.8; IR (thin film) 3442, 1613, 1514, 1249, 1081 cm^{-1} ; $[\alpha]_{\text{D}}^{23} +24.6$ (c 1.12, CHCl_3); HRMS (CI/NH_3) m/z calcd for $\text{C}_{30}\text{H}_{49}\text{O}_5\text{Si}$ ($\text{M} + \text{H}$) $^+$ 517.3349, found 517.3349. Anal. Calcd for $\text{C}_{30}\text{H}_{48}\text{O}_5\text{Si}$: C, 69.72; H, 9.36. Found: C, 69.45; H, 9.59.

(2*S*,3*R*,4*S*,5*R*)-4-Benzyloxy-5-(*tert*-butyldimethylsiloxy)-2,4-dimethyl-3-(*p*-methoxybenzyloxy)heptanal (7). To a solution of oxalyl chloride (2.40 mL, 2.0 M solution in CH_2Cl_2 , 4.80 mmol) in 20 mL of CH_2Cl_2 at -78 $^\circ\text{C}$ was added a solution of DMSO (0.680 mL, 9.60 mmol) in 5 mL of CH_2Cl_2 . The mixture was stirred at -78 $^\circ\text{C}$ for 10 min, and then a solution of alcohol **45** (2.06 g, 4.00 mmol) in 15 mL of CH_2Cl_2 was added dropwise by syringe. After 30 min at -78 $^\circ\text{C}$, 1.67 mL (12.0 mmol) of Et_3N was added. The mixture was allowed to warm to -10 $^\circ\text{C}$ over 1 h and was then poured into 40 mL of water. The layers were separated, and the aqueous layer was extracted with 3×40 mL of CH_2Cl_2 . The combined organic layers were washed with brine (30 mL), dried (MgSO_4), and concentrated *in vacuo*. Purification by flash chromatography (5:95 EtOAc/hexanes) afforded **7** as a colorless oil (2.04 g, 99%): ^1H NMR (CDCl_3 , 500 MHz) δ 9.68 (d, $J = 1.0$ Hz, 1H), 7.38 (m, 4H), 7.32 (m, 1H), 7.25 (d, $J = 8.7$ Hz, 2H), 6.92 (m, 2H), 4.84 (d, $J = 11.4$ Hz, 1H), 4.63 (d, $J = 11.4$ Hz, 1H), 4.61 (d, $J = 11.0$ Hz, 1H), 4.49 (d, $J = 11.0$ Hz, 1H), 4.23 (d, $J = 3.5$ Hz, 1H), 3.87 (s, 3H), 3.88 (dd, $J = 7.7, 2.7$ Hz, 1H), 2.82 (m, 1H), 1.87 (m, 1H), 1.65 (m, 1H), 1.41 (s, 3H), 1.31 (d, $J = 7.2$ Hz, 3H), 1.08 (t, $J = 7.5$ Hz, 3H), 0.99 (s, 9H), 0.15 (s, 3H), 0.12 (s, 3H); ^{13}C NMR (CDCl_3 , 125 MHz) δ 203.9, 159.0, 139.6, 130.6, 129.1, 128.2, 127.5, 127.1, 113.6, 83.3, 81.4, 78.2, 74.0, 65.7, 55.2, 47.7, 26.2, 25.9, 18.45, 18.41, 12.0, 9.6, -3.86, -3.93; IR (thin film) 1720, 1612, 1513, 1249 cm^{-1} ; $[\alpha]_{\text{D}}^{23} -1.8$ (c 1.15, CHCl_3); HRMS (CI/NH_3) m/z calcd for $\text{C}_{30}\text{H}_{45}\text{O}_5\text{Si}$ ($\text{M} - \text{H}$) $^+$ 513.3037, found 513.3036.

(4*R*)-4-Benzyl-3-[(2*R*,3*S*,4*S*,5*R*,6*S*,7*R*)-3-(6-benzyloxy-7-*tert*-butyldimethylsiloxy-3-hydroxy-5-(*p*-methoxyphenylmethoxy)-1-oxo-2,4,6-trimethylnonyl]-2-oxazolidinone (46).³ To a solution (*R*)-4-benzyl-3-propionyloxazolidin-2-one (0.867 g, 3.72 mmol) in 20 mL of CH_2Cl_2 was added TiCl_4 (0.428 mL, 3.91 mmol) at 0 $^\circ\text{C}$. After 5 min, a solution of (-)-sparteine (2.14 mL, 9.3 mmol) in 10 mL of CH_2Cl_2 was added slowly dropwise. After complete addition, the mixture was stirred for 20 min at 0 $^\circ\text{C}$. The mixture was cooled to -78 $^\circ\text{C}$, and aldehyde **7** (1.91 g, 3.72 mmol) in 10 mL of CH_2Cl_2 was added dropwise. The mixture was stirred for 1 h at -78 $^\circ\text{C}$, gradually warmed to 0 $^\circ\text{C}$, and stirred for 1 h at 0 $^\circ\text{C}$. To the mixture was added 40 mL of a half-saturated aqueous solution of NH_4Cl . The layers were separated, and the aqueous layer was extracted with 3×50 mL of CH_2Cl_2 . The combined organic layers were washed with brine (30 mL), dried (MgSO_4), and concentrated *in vacuo*. Purification by flash chromatography (10:90 to 15:85 EtOAc/hexanes) afforded **46** as a

foam (2.61 g, 94%): ^1H NMR (CDCl_3 , 500 MHz) δ 7.42–7.24 (m, 12H), 6.88 (m, 2H), 4.99 (d, J = 11.5 Hz, 1H), 4.96 (d, J = 11.3 Hz, 1H), 4.70 (d, J = 11.5 Hz, 1H), 4.64 (m, 1H), 4.58 (d, J = 11.3 Hz, 1H), 4.23 (d, J = 5.3 Hz, 2H), 4.04 (dt, J = 7.6, 2.4 Hz, 1H), 3.86 (m, 1H), 3.85 (s, 3H), 3.82 (d, J = 2.2 Hz, 1H), 3.61 (dd, J = 7.4, 2.7 Hz, 1H), 3.29 (dd, J = 13.4, 3.2 Hz, 1H), 3.19 (d, J = 1.8 Hz, 1H), 2.81 (dd, J = 13.4, 9.5 Hz, 1H), 1.70 (m, 3H), 1.50 (s, 3H), 1.36 (d, J = 6.9 Hz, 3H), 1.06 (d, J = 7.0 Hz, 3H), 1.05 (t, J = 7.5 Hz, 3H), 1.02 (s, 9H), 0.19 (s, 3H), 0.16 (s, 3H); ^{13}C NMR (CDCl_3 , 125 MHz) δ 176.3, 158.9, 152.6, 140.1, 135.0, 131.1, 129.34, 129.29, 128.9, 128.1, 127.5, 127.4, 126.9, 113.7, 87.5, 84.5, 79.3, 76.0, 74.2, 66.0, 65.7, 55.2, 55.0, 40.8, 37.7, 37.0, 26.2, 25.7, 18.4, 16.2, 14.0, 11.8, 8.7, -3.57 , -3.62 ; IR (thin film) 3521, 1789, 1684, 1613, 1514, 1249, 1048 cm^{-1} ; $[\alpha]_{\text{D}}^{23}$ -14.3 (c 1.40, CHCl_3); HRMS (ESI) m/z calcd for $\text{C}_{43}\text{H}_{61}\text{NO}_8\text{SiNa}$ ($\text{M} + \text{Na}$) $^+$ 770.4064, found 770.4077. Anal. Calcd for $\text{C}_{43}\text{H}_{61}\text{NO}_8\text{Si}$: C, 69.04; H, 8.22; N, 1.87. Found: C, 68.93; H, 8.23; N, 1.91.

(4R)-4-Benzyl-3-[(2R)-2-[(2R,4S,5S,6R)-6-[(1S,2R)-1-benzyloxy-2-(tert-butyldimethylsiloxy)-1-methylbutyl]-2-(p-methoxyphenyl)-5-methyl-1,3-dioxan-4-yl]propionyl]-2-oxazolidinone (47). To a mixture of **46** (2.53 g, 3.39 mmol) and 4 g of activated 4 Å molecular sieves powder in 20 mL of CH_2Cl_2 was added a solution of DDQ (0.920 g, 4.07 mmol) in 60 mL of CH_2Cl_2 at 0 °C by cannula. After 1 h, the mixture was filtered through Celite, and the filtrate was washed with 40 mL of saturated aqueous NaHCO_3 solution. The aqueous layer was back-extracted with 2×30 mL of CH_2Cl_2 . The combined organic layers were washed with brine (30 mL), dried (MgSO_4), and concentrated *in vacuo*. Purification by flash chromatography (10:90 to 15:85 EtOAc/hexanes) afforded **47** as a foam (2.30 g, 91%): ^1H NMR (CDCl_3 , 500 MHz) δ 7.54 (d, J = 8.7 Hz, 2H), 7.35 (m, 10H), 7.00 (d, J = 8.7 Hz, 2H), 5.62 (s, 1H), 5.08 (d, J = 11.7 Hz, 1H), 4.80 (m, 1H), 4.53 (d, J = 11.7 Hz, 1H), 4.38 (dd, J = 6.5, 2.1 Hz, 1H), 4.30–4.13 (m, 5H), 3.90 (s, 3H), 3.32 (dd, J = 13.4, 3.2 Hz, 1H), 2.85 (dd, J = 13.4, 9.6 Hz, 1H), 2.08 (m, 1H), 2.02 (m, 1H), 1.54 (m, 1H), 1.48 (d, J = 6.3 Hz, 3H), 1.30 (d, J = 7.0 Hz, 3H), 1.22 (s, 3H), 1.13 (t, J = 7.5 Hz, 3H), 1.04 (s, 9H), 0.20 (s, 3H), 0.19 (s, 3H); ^{13}C NMR (CDCl_3 , 125 MHz) δ 174.7, 159.8, 152.6, 140.0, 135.0, 131.6, 129.4, 129.0, 128.1, 127.41, 127.36, 127.3, 126.9, 113.6, 102.1, 83.0, 82.2, 81.4, 73.5, 66.2, 66.0, 55.3, 55.0, 39.7, 37.7, 30.9, 26.3, 24.3, 18.4, 17.3, 15.9, 12.2, 7.7, -3.3 , -4.1 ; IR (thin film) 1782, 1695, 1615, 1518, 1248, 1051 cm^{-1} ; $[\alpha]_{\text{D}}^{23}$ -42.1 (c 1.01, CHCl_3); HRMS (ESI) m/z calcd for $\text{C}_{43}\text{H}_{59}\text{NO}_8\text{SiNa}$ ($\text{M} + \text{Na}$) $^+$ 768.3907, found 768.3918. Anal. Calcd for $\text{C}_{43}\text{H}_{59}\text{NO}_8\text{Si}$: C, 69.23; H, 7.97; N, 1.88. Found: C, 69.40; H, 8.07; N, 1.85.

(4R)-4-Benzyl-3-[(2R)-2-[(2R,4S,5S,6R)-6-[(1S,2R)-1-benzyloxy-2-hydroxy-1-methylbutyl]-2-(p-methoxyphenyl)-5-methyl-1,3-dioxan-4-yl]propionyl]-2-oxazolidinone (48). To a solution of **47** (0.990 g, 1.33 mmol) in 10 mL of THF was added 3 mL of pyridine and 4 mL of HF·Py complex. After being stirred at

23 °C for 3 days, the reaction mixture was quenched by the slow addition of 40 mL of saturated aqueous NaHCO₃ solution. The mixture was then extracted with 3 × 100 mL of EtOAc. The combined organic layers were washed with brine (30 mL), dried (MgSO₄), and concentrated *in vacuo*. Purification by flash chromatography (20:80 to 30:70 EtOAc/hexanes) afforded **48** as a foam (0.790 g, 94%): ¹H NMR (CDCl₃, 500 MHz) δ 7.49 (d, *J* = 8.7 Hz, 2H), 7.37 (m, 10H), 6.97 (d, *J* = 8.7 Hz, 2H), 5.61 (s, 1H), 4.84 (d, *J* = 11.4 Hz, 1H), 4.74 (m, 1H), 4.62 (d, *J* = 11.4 Hz, 1H), 4.30–4.12 (m, 5H), 3.87 (m, 1H and s, 3H), 3.30 (dd, *J* = 13.4, 3.3 Hz, 1H), 2.83 (dd, *J* = 13.4, 9.5 Hz, 1H), 2.70 (br, 1H), 2.01 (m, 1H), 1.73 (m, 1H), 1.53 (m, 1H), 1.45 (d, *J* = 6.3 Hz, 3H), 1.36 (s, 3H), 1.22 (d, *J* = 7.0 Hz, 3H), 1.15 (t, *J* = 7.3 Hz, 3H); ¹³C NMR (CDCl₃, 125 MHz) δ 174.7, 160.0, 152.5, 139.6, 135.0, 130.9, 129.4, 129.0, 128.1, 127.4, 127.33, 127.26, 127.0, 113.6, 102.2, 84.7, 83.2, 80.0, 75.9, 66.0, 64.9, 55.3, 55.0, 39.6, 37.7, 31.0, 25.3, 17.7, 15.8, 11.5, 8.5; IR (thin film) 3532, 1774, 1686, 1617, 1518, 1212, 1112 cm⁻¹; [α]_D²³ –38.2 (*c* 1.35, CHCl₃); HRMS (ESI) *m/z* calcd for C₃₇H₄₅NO₈SiNa (M + Na)⁺ 654.3043, found 654.3037. Anal. Calcd for C₃₇H₄₅NO₈: C, 70.34; H, 7.18; N, 2.22. Found: C, 70.19; H, 7.21; N, 2.23.

(4R)-4-Benzyl-3-[(2R)-2-[(2R,4S,5S,6R)-6-[(1S)-1-benzyloxy-1-methyl-2-oxobutyl]-2-(*p*-methoxyphenyl)-5-methyl-1,3-dioxan-4-yl]propionyl]-2-oxazolidinone (8). To a solution of oxalyl chloride (0.810 mL, 2.0 M solution in CH₂Cl₂, 1.62 mmol) in 12 mL of CH₂Cl₂ at –78 °C was added a solution of DMSO (0.230 mL, 3.24 mmol) in 2 mL of CH₂Cl₂. The mixture was stirred at –78 °C for 10 min, and then a solution of alcohol **48** (0.850 g, 1.35 mmol) in 6 mL of CH₂Cl₂ was added dropwise by syringe. After 30 min at –78 °C, the mixture was allowed to warm to –20 °C and stirred for 1 h. The reaction mixture was then cooled to –78 °C, and 0.940 mL (6.75 mmol) of Et₃N was added. The mixture was allowed to warm to –10 °C over 1 h and was then poured into 30 mL of water. The layers were separated, and the aqueous layer was extracted with 3 × 40 mL of CH₂Cl₂. The combined organic layers were washed with brine (30 mL), dried (MgSO₄), and concentrated *in vacuo*. Purification by flash chromatography (15:85 to 20:80 EtOAc/hexanes) afforded **8** as a foam (0.740 g, 87%): ¹H NMR (CDCl₃, 500 MHz) δ 7.47–7.27 (m, 12H), 6.96 (m, 2H), 5.58 (s, 1H), 4.75 (m, 1H), 4.64 (s, 2H), 4.30–4.11 (m, 5H), 3.87 (s, 3H), 3.29 (dd, *J* = 13.4, 3.2 Hz, 1H), 2.85–2.68 (m, 3H), 1.99 (m, 1H), 1.49 (s, 3H), 1.44 (d, *J* = 6.4 Hz, 3H), 1.15 (d, *J* = 7.0 Hz, 3H), 1.08 (t, *J* = 7.2 Hz, 3H); ¹³C NMR (CDCl₃, 125 MHz) δ 215.1, 174.5, 159.8, 152.5, 138.8, 135.0, 131.0, 129.4, 128.9, 128.3, 127.4, 127.3, 126.9, 113.5, 102.1, 86.5, 84.9, 82.7, 67.3, 66.0, 55.3, 54.9, 39.6, 37.7, 31.7, 30.7, 18.2, 15.8, 7.9, 7.7; IR (thin film) 1782, 1714, 1694, 1615, 1518, 1212, 1103 cm⁻¹; [α]_D²³ –65.5 (*c* 1.46, CHCl₃); HRMS (ESI) *m/z* calcd for C₃₇H₄₃NO₈SiNa (M + Na)⁺ 652.2886, found 652.2902. Anal. Calcd for C₃₇H₄₃NO₈: C, 70.57; H, 6.88; N, 2.22. Found: C, 70.38; H, 6.86; N, 2.25.

(4R)-4-Benzyl-3-[(2R)-2-[(2R,4S,5S,6R)-6-[(1S,3S,4R,5S,6R,7S,8R)-8-(*tert*-butyldimethylsiloxy)-1,7-dibenzyloxy-4-hydroxy-6-(*p*-methoxybenzyloxy)-2-oxo-1,3,5,7-tetramethyldecyl]-2-(*p*-methoxyphenyl)-5-methyl-1,3-dioxan-4-yl]propionyl]-2-oxazolidinone (17). To a stirred suspension of $\text{Sn}(\text{OTf})_2$ (0.459 g, 1.10 mmol) in 5 mL of CH_2Cl_2 was added Et_3N (0.145 mL, 1.90 mmol) at 23 °C. The mixture was then cooled to 0 °C, and a solution of ketone **8** (0.346 g, 0.550 mmol) in 5 mL of CH_2Cl_2 was added. After 4 h, the reaction mixture was cooled to -35 °C followed by the addition of a solution of aldehyde **7** (1.13 g, 2.20 mmol) in 10 mL of CH_2Cl_2 . The mixture was maintained at -35 °C for 40 h, at which point 30 mL of saturated aqueous NaHSO_4 solution was added. The mixture was extracted with 3×50 mL of CH_2Cl_2 . The combined organic layers were washed with brine (30 mL), dried (MgSO_4), and concentrated *in vacuo*. Purification by flash chromatography (5:95 to 15:85 EtOAc /hexanes) afforded the unreacted aldehyde **7** (0.814 g) and a foam **17** (0.563 g, 90%) as a single stereoisomer as determined by ^1H NMR spectroscopy of the crude mixture: ^1H NMR (CDCl_3 , 500 MHz) δ 7.42–7.23 (m, 19H), 6.86 (m, 4H), 5.47 (s, 1H), 4.88 (d, J = 11.8 Hz, 1H), 4.72 (m, 5H), 4.39 (d, J = 11.3 Hz, 1H), 4.30 (d, 1H), 4.24 (m, 2H), 4.12 (m, 2H), 4.01 (s, 1H), 3.86 (d, J = 10.1 Hz, 1H), 3.81 (s, 3H), 3.73 (s, 3H), 3.66 (dd, J = 7.4 Hz, 1H), 3.43 (q, J = 6.9 Hz, 1H), 3.27 (dd, J = 13.4, 3.2 Hz, 1H), 3.00 (d, 1H), 2.82 (dd, J = 13.4, 10.4 Hz, 1H), 2.06 (m, 1H), 1.82 (m, 1H), 1.67 (m, 2H), 1.54 (s, 3H), 1.41 (d, J = 5.8 Hz, 3H), 1.37 (s, 3H), 1.15 (d, J = 6.9 Hz, 3H), 1.03 (m, 6H), 1.00 (s, 9H), 0.70 (d, J = 6.8 Hz, 3H), 0.14 (s, 3H), 0.13 (s, 3H); ^{13}C NMR (CDCl_3 , 125 MHz) δ 219.3, 174.6, 160.0, 158.6, 152.5, 140.7, 138.4, 134.9, 132.4, 130.5, 129.4, 128.93, 128.85, 128.3, 128.0, 127.5, 127.4, 127.3, 126.9, 126.6, 113.6, 113.4, 102.5, 87.0, 85.5, 84.5, 82.7, 81.5, 79.1, 75.0, 71.4, 67.1, 66.0, 65.7, 55.2, 55.1, 54.9, 42.0, 39.5, 37.7, 36.9, 30.6, 26.2, 25.2, 19.2, 18.4, 16.9, 15.8, 11.7, 10.4, 8.5, 7.8, -3.7, -3.8; IR (thin film) 3547, 1784, 1736, 1694, 1614, 1515, 1248, 1054 cm^{-1} ; $[\alpha]_D^{23}$ -22.3 (c 1.55, CHCl_3); Anal. Calcd for $\text{C}_{67}\text{H}_{89}\text{NO}_{13}\text{Si}$: C, 70.31; H, 7.84; N, 1.22. Found: C, 70.03; H, 7.94; N, 1.24.

(4R)-4-Benzyl-3-[(2R)-2-[(2R,4S,5S,6R)-6-[(1S,2R,3S,4R,5S,6R,7S,8R)-8-(*tert*-butyldimethylsiloxy)-1,7-dibenzyloxy-2,4-dihydroxy-6-(*p*-methoxybenzyloxy)-1,3,5,7-tetramethyldecyl]-2-(*p*-methoxyphenyl)-5-methyl-1,3-dioxan-4-yl]propionyl]-2-oxazolidinone (49). To a solution of aldol adduct **17** (0.115 g, 0.100 mmol) in 2 mL of CH_2Cl_2 at 0 °C was added 1.50 mL (0.300 mmol, 0.20 M in Et_2O) of $\text{Zn}(\text{BH}_4)_2$. After 4 h, 1 mL each of pH 7 buffer and MeOH was added slowly, and the resultant mixture was warmed to 23 °C and stirred for 12 h. The mixture was extracted with 3×20 mL CH_2Cl_2 , and the combined organic extracts were dried over Mg_2SO_4 , filtered, and concentrated *in vacuo*. The residue was dissolved in 20 mL of MeOH and stirred at 23 °C for 24 h. Following concentration, the residue was partitioned between 10 mL of saturated

aqueous NH_4Cl and 10 mL of CH_2Cl_2 . The aqueous layer was extracted with 3×20 mL CH_2Cl_2 . The combined organic layers were washed with brine (10 mL), dried (MgSO_4), and concentrated *in vacuo*. Purification by flash chromatography (2:98 EtOAc/benzene) afforded **49** as a foam (0.094 g, 82%): ^1H NMR (CDCl_3 , 500 MHz) δ 7.50 (d, $J = 8.7$ Hz, 2H), 7.36 (m, 13H), 7.24 (m, 4H), 6.98 (d, $J = 8.6$ Hz, 2H), 6.79 (d, $J = 8.5$ Hz, 2H), 5.65 (s, 1H), 4.94 (d, $J = 11.5$ Hz, 1H), 4.75 (m, 4H), 4.63 (d, $J = 11.5$ Hz, 1H), 4.59 (m, 1H), 4.28 (s, 1H), 4.22–4.07 (m, 4H), 4.02 (m, 1H), 3.94 (t, $J = 8.4$ Hz, 1H), 3.89 (s, 3H), 3.80 (m, 1H and s, 3H), 3.53 (d, $J = 9.7$ Hz, 1H), 3.36 (br, 1H), 3.24 (dd, $J = 13.3$, 3.1 Hz, 1H), 3.12 (br, 1H), 2.76 (dd, $J = 13.3$, 9.6 Hz, 1H), 2.12 (m, 1H), 1.96 (m, 1H), 1.91 (m, 1H), 1.84 (m, 1H), 1.72 (m, 1H), 1.50 (s, 3H), 1.46 (s, 3H), 1.44 (d, $J = 6.5$ Hz, 3H), 1.21 (d, $J = 6.9$ Hz, 3H), 1.08 (t, $J = 7.5$ Hz, 3H), 1.03 (s, 9H), 1.01 (d, $J = 6.9$ Hz, 3H), 0.99 (d, $J = 6.9$ Hz, 3H), 0.18 (s, 3H), 0.17 (s, 3H); ^{13}C NMR (CDCl_3 , 125 MHz) δ 174.4, 159.9, 158.8, 152.6, 140.1, 139.6, 135.0, 131.9, 131.1, 129.4, 129.0, 128.9, 128.22, 128.16, 127.6, 127.4, 127.3, 127.2, 127.1, 127.0, 113.6, 113.4, 102.1, 85.4, 84.4, 82.9, 82.2, 81.3, 80.7, 78.8, 78.3, 74.9, 66.3, 66.0, 65.9, 55.3, 55.2, 55.0, 39.5, 37.6, 36.7, 33.7, 30.9, 26.2, 25.6, 18.4, 18.2, 17.8, 15.8, 11.5, 11.0, 8.5, 6.1, -3.7 , -3.8 ; IR (thin film) 3502, 1784, 1695, 1614, 1515, 1249, 1077 cm^{-1} ; $[\alpha]_D^{23} -33.7$ (c 0.70, CHCl_3); Anal. Calcd for $\text{C}_{67}\text{H}_{91}\text{NO}_{13}\text{Si}$: C, 70.19; H, 8.00; N, 1.22. Found: C, 70.27; H, 7.96; N, 1.33.

(4R)-4-Benzyl-3-[(2R)-2-[(2R,4S,5S,6R)-6-[(1S,2R,3R)-3-[(2R,4S,5S,6R)-6-[(1S,2R)-1-benzyloxy-2-(tert-butyl)dimethylsiloxy]-1-methyl-butyl]-2-(p-methoxyphenyl)-5-methyl-1,3-dioxan-4-yl]-1-benzyloxy-2-hydroxy-1-methylbutyl]-2-(p-methoxyphenyl)-5-methyl-1,3-dioxan-4-yl]propionyl]-2-oxazolidinone (18). To a mixture of **49** (0.126 g, 0.110 mmol) and 0.100 g of activated 4 Å molecular sieves powder in 3 mL of CH_2Cl_2 was added a solution of DDQ (0.030 g, 0.132 mmol) in 3 mL of CH_2Cl_2 at 0 °C by syringe. After 1 h, the mixture was filtered through Celite, and the filtrate was washed with 10 mL of saturated aqueous NaHCO_3 solution. The aqueous layer was back-extracted with 2×20 mL of CH_2Cl_2 . The combined organic layers were washed with brine (10 mL), dried (MgSO_4), and concentrated *in vacuo*. Purification by flash chromatography (15:85 EtOAc/hexanes) afforded **18** as a foam (0.112 g, 89%): ^1H NMR (CDCl_3 , 500 MHz) δ 7.59 (d, $J = 8.7$ Hz, 2H), 7.52 (d, $J = 8.7$ Hz, 2H), 7.46–7.28 (m, 15H), 7.00 (m, 4H), 5.78 (s, 1H), 5.71 (s, 1H), 5.19 (d, $J = 11.9$ Hz, 1H), 4.85 (d, $J = 11.2$ Hz, 1H), 4.73 (m, 1H), 4.66 (d, $J = 11.2$ Hz, 1H), 4.61 (d, $J = 11.9$ Hz, 1H), 4.48 (d, $J = 1.6$ Hz, 1H), 4.44 (d, $J = 4.6$ Hz, 1H), 4.22 (m, 5H), 3.94 (d, $J = 7.2$ Hz, 1H), 3.90 (s, 6H), 3.76 (d, $J = 10.0$ Hz, 1H), 3.41 (d, $J = 7.2$ Hz, 1H), 3.31 (dd, $J = 13.3$, 2.8 Hz, 1H), 2.84 (dd, $J = 13.3$, 9.6 Hz, 1H), 2.54 (m, 1H), 2.06 (m, 3H), 1.63 (d, $J = 6.8$ Hz, 3H), 1.55 (m, 1H), 1.49 (d, $J = 6.3$ Hz, 3H), 1.40 (s, 3H), 1.28 (d, $J = 7.0$ Hz, 3H), 1.27 (d, $J = 7.3$ Hz, 3H), 1.24 (s, 3H), 1.16 (t, $J = 7.5$ Hz, 3H), 1.12 (s, 9H), 0.25 (s, 3H), 0.23 (s, 3H); ^{13}C NMR (CDCl_3 , 125 MHz) δ 174.1, 160.0, 159.8, 152.6, 139.9, 139.1, 135.0, 131.8, 130.5, 129.4, 128.9, 128.2, 128.1, 127.4, 127.3, 127.2, 127.01, 126.98, 113.7, 102.0, 96.5, 84.3, 83.8, 83.4, 81.5, 79.7, 76.3, 75.0, 73.2, 66.2, 66.0, 64.0, 55.2, 55.0, 39.4, 37.6, 33.5, 31.3, 30.0, 26.0, 24.2, 18.5, 18.4, 17.1, 15.8, 15.0, 12.2, 10.3, 9.0, -3.4 , -4.3 ; IR (thin film) 3538, 1789, 1738, 1693, 1588, 1510, 1061 cm^{-1} ; $[\alpha]_D^{23} -25.5$ (c 1.06, CHCl_3); Anal. Calcd for $\text{C}_{67}\text{H}_{89}\text{NO}_{13}\text{Si}$: C, 70.31; H, 7.84; N, 1.22. Found: C, 70.09; H, 8.11; N, 1.20.

(4R)-4-Benzyl-3-[(2R)-2-[(2R,4S,5S,6R)-6-[(1S,2R,3R)-3-[(2R,4S,5S,6R)-6-[(1S,2R)-1-benzyloxy-2-(*tert*-butyldimethylsiloxy)-1-methylbutyl]-2-(4-methoxyphenyl)-5-methyl-1,3-dioxan-4-yl]-1-benzyloxy-2-hydroxy-1-methylbutyl]-2-(4-methoxyphenyl)-5-methyl-1,3-dioxan-4-yl]propionyl]-2-oxazolidinone, methyl dithiocarbonate (50).⁶ To a suspension of NaH (0.023 g, 60% oil dispersion, 0.578 mmol, washed with 3 × 5 mL of hexanes) in 4 mL of THF was added a solution of alcohol **18** (0.330 g, 0.289 mmol) in 4 mL of THF at 0 °C, followed by freshly distilled CS₂ (0.174 mL, 2.89 mmol). The resultant mixture was stirred for 1 h at 0 °C and 1 h at 23 °C. The reaction mixture was then cooled to 0 °C before 0.720 mL (11.6 mmol) of methyl iodide was added by syringe. After 4 h at 0 °C, the reaction mixture was warmed to 23 °C and allowed to stir for 12 h. The mixture was partitioned between 10 mL of CH₂Cl₂ and 5 mL of H₂O, and the aqueous layer was extracted with 3 × 20 mL of CH₂Cl₂. The combined organic layers were washed with brine (10 mL), dried (MgSO₄), and concentrated *in vacuo*. Purification by flash chromatography (10:90 to 15:85 EtOAc/hexanes) afforded **50** as a foam (0.310 g, 87%): ¹H NMR (CDCl₃, 500 MHz) δ 7.49 (d, *J* = 8.7 Hz, 2H), 7.44 (d, *J* = 8.7 Hz, 2H), 7.42–7.26 (m, 15H), 6.95 (d, *J* = 8.7 Hz, 2H), 6.92 (d, *J* = 8.7 Hz, 2H), 6.30 (s, 1H), 5.55 (s, 1H), 5.48 (s, 1H), 5.02 (d, *J* = 12.1 Hz, 1H), 4.93 (d, *J* = 11.8 Hz, 1H), 4.74 (m, 1H), 4.70 (d, *J* = 11.8 Hz, 1H), 4.57 (d, *J* = 12.1 Hz, 1H), 4.25 (m, 3H), 4.14 (m, 2H), 4.03 (d, *J* = 4.5 Hz, 1H), 3.92 (d, *J* = 1.4 Hz, 1H), 3.88 (s, 3H), 3.86 (s, 3H), 3.74 (d, *J* = 11.1 Hz, 1H), 3.30 (dd, *J* = 13.4, 3.0 Hz, 1H), 3.13 (m, 1H), 2.83 (dd, *J* = 13.4, 9.6 Hz, 1H), 2.47 (s, 3H), 2.13 (m, 1H), 2.06 (m, 1H), 1.90 (m, 1H), 1.55 (m, 1H), 1.51 (s, 3H), 1.48 (d, *J* = 6.7 Hz, 3H), 1.43 (d, *J* = 5.9 Hz, 3H), 1.31 (d, *J* = 6.7 Hz, 3H), 1.21 (s, 3H), 1.16 (d, *J* = 6.9 Hz, 3H), 1.06 (t, *J* = 7.5 Hz, 3H), 1.01 (s, 9H), 0.16 (s, 3H), 0.12 (s, 3H); ¹³C NMR (CDCl₃, 125 MHz) δ 216.4, 174.4, 160.0, 159.8, 152.6, 140.0, 138.9, 135.0, 131.8, 131.1, 129.4, 129.0, 128.11, 128.05, 127.7, 127.4, 127.3, 127.03, 127.00, 126.9, 126.7, 113.6, 113.4, 102.5, 96.2, 83.8, 83.0, 82.0, 81.7, 80.7, 78.1, 75.4, 66.12, 66.06, 65.9, 55.3, 55.2, 55.1, 39.5, 37.7, 34.1, 31.2, 30.2, 26.1, 25.1, 18.8, 18.6, 18.4, 16.8, 15.8, 15.0, 11.8, 11.1, 8.3, –3.6, –4.0; IR (thin film) 1789, 1694, 1614, 1588, 1516, 1116 cm^{–1}; [α]_D²³ –41.0 (*c* 1.45, CHCl₃); Anal. Calcd for C₆₉H₉₁NO₁₃S₂Si: C, 67.12; H, 7.43; N, 1.13. Found: C, 67.12; H, 7.50; N, 1.12.

(4R)-4-Benzyl-3-[(2R)-2-[(2R,4S,5S,6R)-6-[(1S,3R)-3-[(2R,4S,5S,6R)-6-[(1S,2R)-1-benzyloxy-2-(*tert*-butyldimethylsiloxy)-1-methylbutyl]-2-(*p*-methoxyphenyl)-5-methyl-1,3-dioxan-4-yl]-1-benzyloxy-1-

⁶ (a) Barton, D. H. R.; McCombie S. W. *J. Chem. Soc., Perkin Trans. 1* **1975**, 1574-1585. (b) Evans, D. A.; Kim, A. S.; Metternich, R.; Novack, V. J. *J. Am. Chem. Soc.* **1998**, 120, 5921-5942.

methylbutyl]-2-(*p*-methoxyphenyl)-5-methyl-1,3-dioxan-4-yl]propionyl]-2-oxazolidinone (51**).⁶ Xanthate **50** (0.300 g, 0.243 mmol) and a catalytic amount of AIBN (0.002 g, 0.0141 mmol) were taken up in 3.00 mL of tributyltin hydride and heated to 110 °C. After 30 min, the reaction mixture was cooled to 23 °C and filtered through a plug of silica gel to remove tributyltin hydride (washed with 10:90 to 50:50 EtOAc/hexanes). Further purification by flash chromatography (1:99 EtOAc/benzene) afforded **51** as a foam (0.202 g, 74%): ¹H NMR (CDCl₃, 500 MHz) δ 7.52 (d, *J* = 8.7 Hz, 2H), 7.51–7.36 (m, 17H), 6.99 (d, *J* = 8.8 Hz, 2H), 6.95 (d, *J* = 8.8 Hz, 2H), 5.65 (s, 1H), 5.29 (s, 1H), 5.16 (d, *J* = 11.7 Hz, 1H), 4.78 (m, 3H), 4.53 (d, *J* = 11.8 Hz, 1H), 4.48 (d, *J* = 2.1 Hz, 1H), 4.40 (m, 1H), 4.30 (t, *J* = 8.4 Hz, 1H), 4.25 (dd, *J* = 9.1, 2.7 Hz, 1H), 4.14 (m, 2H), 3.88 (s, 6H and m, 1H), 3.37 (d, *J* = 10.5 Hz, 1H), 3.31 (dd, *J* = 13.3, 3.2 Hz, 1H), 2.82 (dd, *J* = 13.3, 9.5 Hz, 1H), 2.49 (m, 1H), 2.20 (m, 1H), 1.98 (m, 2H), 1.90 (m, 1H), 1.59 (d, *J* = 7.0 Hz, 3H), 1.48 (m, 2H), 1.44 (s, 3H), 1.42 (d, *J* = 6.6 Hz, 3H), 1.21 (d, *J* = 6.5 Hz, 3H), 1.16 (d, *J* = 6.9 Hz, 3H), 1.08 (t, *J* = 7.6 Hz, 3H), 1.06 (s, 3H), 1.05 (s, 9H), 0.17 (s, 3H), 0.16 (s, 3H); ¹³C NMR (CDCl₃, 125 MHz) δ 174.5, 159.84, 159.82, 152.6, 140.5, 140.1, 135.1, 132.0, 131.3, 129.4, 129.0, 128.2, 128.0, 127.43, 127.37, 127.3, 127.25, 126.94, 126.9, 126.7, 113.7, 113.5, 101.8, 96.4, 86.1, 85.6, 82.9, 81.6, 79.0, 76.6, 73.0, 66.2, 66.1, 65.6, 55.3, 55.1, 41.1, 39.5, 37.8, 31.0, 29.2, 28.3, 26.2, 24.1, 21.0, 18.5, 18.4, 17.1, 15.9, 15.2, 12.2, 8.1, –3.4, –4.3; IR (thin film) 1784, 1738, 1694, 1615, 1517, 1115 cm^{–1}; [α]_D²³ –27.3 (*c* 0.70, CHCl₃); Anal. Calcd for C₆₇H₈₉NO₁₂Si: C, 71.31; H, 7.95; N, 1.24. Found: C, 71.11; H, 7.99; N, 1.37.**

(2*R*,4*S*,5*S*,6*R*)-6-[(1*S*,3*R*)-3-[(2*R*,4*S*,5*S*,6*R*)-6-[(1*S*,2*R*)-1-Benzyl-2-(*tert*-butyldimethylsiloxy)-1-methylbutyl]-2-(*p*-methoxyphenyl)-5-methyl-1,3-dioxan-4-yl]-1-benzyl-2-(*tert*-butyldimethylsiloxy)-1-methylbutyl]-4-[(1*R*)-1-carboxyethyl-1-yl]-2-(*p*-methoxyphenyl)-5-methyl-1,3-dioxane (52**). To a solution of imide **51** (0.176 g, 0.156 mmol) in 7.5 mL of THF and 1.5 mL of H₂O at 0 °C was added 0.177 mL (1.56 mmol) of a 30% aqueous solution of H₂O₂ followed by 2.34 mL (0.468 mmol) of a 0.2 M aqueous solution of LiOH. After 1 h, the solution was warmed to 23 °C and stirred for 6 h. The reaction mixture was then cooled to 0 °C before treatment with 5 mL of a solution of 1.5 M Na₂SO₃. After 15 min, the mixture was diluted with 10 mL of Et₂O and then acidified to pH 1 with 1 M HCl. The aqueous layer was isolated and extracted with 3 × 40 mL of Et₂O. The combined organic layers were washed with brine (10 mL), dried (MgSO₄), and concentrated *in vacuo*. Purification by flash chromatography (20:80 to 30:70 EtOAc/hexanes) afforded **52** as a foam (0.140 g, 93%): ¹H NMR (CDCl₃, 500 MHz) δ 7.51 (d, *J* = 8.7 Hz, 2H), 7.43 (d, *J* = 8.7 Hz, 2H), 7.39–7.24 (m, 10H), 6.97 (m, 4H), 5.65 (s, 1H), 5.33 (s, 1H), 5.13 (d, *J* = 11.8 Hz, 1H), 4.79 (d, *J* = 13.5 Hz, 1H), 4.77 (d, *J* = 13.5 Hz, 1H), 4.56 (d, *J* = 11.8 Hz, 1H), 4.45 (d, *J* = 1.8 Hz, 1H), 4.36 (d, *J* = 4.2 Hz, 1H), 3.89 (s, 3H), 3.88 (s, 3H), 3.87 (m, 2H), 3.35 (d, *J* = 10.3 Hz, 1H), 2.88 (m, 1H), 2.46 (m, 1H), 2.14 (m, 1H), 1.96 (m, 3H), 1.56 (d, *J* = 6.9 Hz, 3H), 1.44 (s, 3H and m, 2H), 1.41 (d, *J* = 6.8 Hz, 3H), 1.28 (d, *J* = 6.8 Hz, 3H), 1.20 (d, *J* = 6.5 Hz, 3H), 1.09 (s, 3H), 1.08 (t, *J* = 7.5 Hz, 3H), 1.01 (s, 9H), 0.17 (s, 3H), 0.13 (s, 3H); ¹³C NMR (CDCl₃, 125 MHz) δ 178.5, 159.9, 159.8, 140.3, 140.0, 132.0, 131.1, 128.2, 128.1, 127.32, 127.29, 127.2, 127.0, 126.9, 126.8, 113.7, 113.6, 101.9, 96.3, 86.1, 85.6, 82.9, 81.8, 79.0, 76.7, 73.2, 66.2, 65.5, 55.3, 41.5, 40.9, 31.8, 29.2, 28.3, 26.2, 24.2, 21.3, 18.4, 18.3, 17.1, 15.3, 15.1, 12.2, 7.8, –3.3, –4.4; IR (thin film) 1738, 1616, 1518, 1115 cm^{–1}; [α]_D²³ –19.1 (*c* 0.89, CHCl₃); HRMS (ESI) *m/z* calcd for C₅₇H₈₀O₁₁SiNa (M + Na)⁺ 969.5548, found 969.5562.**

with 3×40 mL of CH_2Cl_2 . The combined organic layers were washed with brine (10 mL), dried (MgSO_4), and concentrated *in vacuo*. Purification by flash chromatography (10:90 to 15:85 EtOAc/hexanes) afforded **53** as a foam (0.086 g, 84%): ^1H NMR (CDCl_3 , 500 MHz) δ 7.61 (d, $J = 8.7$ Hz, 2H), 7.55 (d, $J = 8.7$ Hz, 2H), 7.41–7.28 (m, 10H), 7.02 (m, 4H), 5.85 (dd, $J = 11.0, 1.5$ Hz, 1H), 5.79 (s, 1H), 5.75 (s, 1H), 5.26 (d, $J = 12.3$ Hz, 1H), 4.80 (d, $J = 12.3$ Hz, 1H), 4.67 (d, $J = 12.3$ Hz, 1H), 4.56 (d, $J = 12.3$ Hz, 1H), 4.35 (s, 1H), 4.06 (d, $J = 10.8$ Hz, 1H), 3.95 (s, 1H), 3.90 (s, 3H), 3.89 (s, 3H), 3.43 (d, $J = 10.7$ Hz, 1H), 3.02 (m, 1H), 2.64 (m, 1H), 2.13 (m, 1H), 1.94 (m, 1H), 1.81 (m, 1H), 1.71 (m, 1H), 1.61 (d, $J = 6.6$ Hz, 3H and m, 2H), 1.50 (s, 3H), 1.42 (d, $J = 6.5$ Hz, 3H), 1.40 (d, $J = 6.8$ Hz, 3H), 1.29 (d, $J = 6.3$ Hz, 3H and s, 3H), 0.97 (t, $J = 7.4$ Hz, 3H); ^{13}C NMR (CDCl_3 , 125 MHz) δ 174.7, 159.9, 159.8, 140.3, 139.7, 131.8, 131.1, 128.2, 128.1, 127.4, 127.3, 127.1, 127.0, 126.8, 113.6, 113.5, 102.4, 95.8, 87.2, 86.7, 84.5, 79.4, 78.8, 77.1, 75.4, 67.3, 65.1, 55.3, 42.0, 38.8, 32.7, 28.4, 27.5, 21.1, 20.9, 17.8, 17.7, 14.1, 10.4, 8.9; IR (thin film) 1731, 1616, 1519, 1116 cm^{-1} ; $[\alpha]_{\text{D}}^{23} -38.8$ (c 0.58, CHCl_3); HRMS (ESI) m/z calcd for $\text{C}_{51}\text{H}_{64}\text{O}_{10}\text{Na}$ ($\text{M} + \text{Na}$) $^+$ 859.4397, found 859.4396.

(2R,3S,4R,5S,6R,8R,9S,10S,11R,12S,13R)-13-Ethyl-3,5,6,9,11,12-hexahydroxy-2,4,6,8,10,12-

hexamethyltetradecanolide [(9S)-Dihydroerythronolide A] (1). To a solution of lactone **53** (0.086 g, 0.103 mmol) in 5 mL of EtOH at 23 °C was added 150 mg of $\text{Pd}(\text{OH})_2$ on carbon. The flask was purged for 5 min with H_2 under balloon pressure and then maintained under positive pressure (balloon). After 20 h, the mixture was filtered and the filtrate was concentrated *in vacuo*. Purification by flash chromatography (50:50 to 70:30 EtOAc/hexanes) afforded (9S)-dihydroerythronolide A **1** (0.041 g, 95%) as a white solid. Recrystallization from EtOAc-hexanes afforded fine needles: mp 205–206 °C {lit.⁷ mp 203–206 °C (acetone-hexane)}; ^1H NMR (CDCl_3 , 500 MHz) δ 4.63 (dd, $J = 10.7, 1.6$ Hz, 1H), 4.28 (d, $J = 4.2$ Hz, 1H), 3.96 (s, 1H), 3.85 (d, $J = 10.3$ Hz, 1H), 3.52 (br, 1H), 3.49 (d, $J = 9.0$ Hz, 1H), 3.48 (s, 1H), 3.03 (br, 1H), 2.96 (td, $J = 9.1, 2.5$ Hz, 1H), 2.79 (dq, $J = 10.4, 6.7$ Hz, 1H), 2.58 (s, 1H), 2.05 (m, 1H), 1.93 (m, 1H and s, 1H), 1.56 (m, 3H), 1.43 (dd, $J = 14.9, 2.5$ Hz, 1H), 1.30 (d, $J = 6.2$ Hz, 3H), 1.29 (d, $J = 6.7$ Hz, 3H), 1.24 (s, 3H), 1.23 (d, $J = 5.9$ Hz, 3H), 1.20 (dd, $J = 14.9, 2.4$ Hz, 1H), 1.06 (s, 3H), 1.04 (d, $J = 6.9$ Hz, 3H), 0.91 (t, $J = 7.3$ Hz, 3H); ^{13}C NMR (CDCl_3 , 125 MHz) δ 178.1, 83.1, 80.4, 79.9, 78.8, 75.9, 75.0, 70.1, 43.6, 41.5, 36.2, 33.8, 32.3, 26.7, 20.8, 17.1, 15.8, 14.5, 12.9, 11.0, 5.5; IR (thin film) 3448, 1718, 1183 cm^{-1} ; $[\alpha]_{\text{D}}^{23} +9.3$ (c 0.85, MeOH) {lit.⁷ $[\alpha]_{\text{D}}^{23} +9.5$ (c 2.0, MeOH)}; HRMS (ESI) m/z calcd for $\text{C}_{21}\text{H}_{40}\text{O}_8\text{Na}$ ($\text{M} + \text{Na}$) $^+$ 443.2621, found 443.2625. Anal. Calcd for $\text{C}_{21}\text{H}_{40}\text{O}_8$: C, 59.98; H, 9.59. Found: C, 60.02; H, 9.76.

⁷ Nakata, M.; Arai, M.; Tomooka, K.; Ohsawa, N.; Kinoshita, M. *Bull. Chem. Soc. Jpn.* **1989**, 62, 2618–2635.

V. Analytical Data

A. HPLC traces of (±)-13, (+)-13, and (-)-13:

Data File D:\DATA\PENG\PENG-5.D

Sample Name: ZPIV-114+115

5%IPA/hex; 1mL/min

Injection Date : 11/19/01 5:52:25 PM Location : Vial 45
 Sample Name : ZPIV-114+115
 Acq. Operator : peng Inj Volume : 10 µl
 Method : D:\METHODS\PENG.M
 Last changed : 11/19/01 4:49:30 PM by peng
 (modified after loading)

5% IPA/Hexanes

1mL/min:

Area Percent Report

Sorted By : Signal
 Multiplier : 1.0000
 Dilution : 1.0000

Signal 1: DAD1 A, Sig=250,100 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	3.789	BB	0.1877	72.54440	5.57832	0.4764
2	5.945	BV	0.4250	7074.70166	260.38809	46.4638
3	7.136	VB	0.5869	8079.00391	213.77336	53.0597

Totals : 1.52262e4 479.73978

Results obtained with enhanced integrator!

Data File D:\DATA\PENG\PENG-5.D

Sample Name: ZPIV-112-C

5%IPA/hex; 1mL/min

Injection Date : 11/19/01 5:27:47 PM Location : Vial 43
 Sample Name : ZPIV-112-C
 Acq. Operator : peng Inj Volume : 10 µl
 Method : D:\METHODS\PENG.M
 Last changed : 11/19/01 4:49:30 PM by peng
 (modified after loading)

5% IPA/Hexanes

1mL/min:

Area Percent Report

Sorted By : Signal
 Multiplier : 1.0000
 Dilution : 1.0000

Signal 1: DAD1 A, Sig=250,100 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	3.798	BB	0.1856	79.47813	5.95787	0.8098
2	5.953	PV	0.3875	98.75394	3.74684	1.0062
3	7.114	VB	0.5903	9636.78418	254.20386	98.1841

Totals : 9815.01625 263.90856

Results obtained with enhanced integrator!

File D:\DATA\PENG\PENG-5.D

Sample Name: ZPIV-114-B

5%IPA/hex; 1mL/min

Injection Date : 11/19/01 5:03:00 PM Location : Vial 41
 Sample Name : ZPIV-114-B
 Acq. Operator : peng Inj Volume : 10 µl
 Method : D:\METHODS\PENG.M
 Last changed : 11/19/01 4:49:30 PM by peng
 (modified after loading)

5% IPA/Hexanes

1mL/min:

Area Percent Report

Sorted By : Signal
 Multiplier : 1.0000
 Dilution : 1.0000

Signal 1: DAD1 A, Sig=250,100 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	3.803	BP	0.1702	100.68839	8.75323	0.7977
2	5.919	BP	0.4464	1.25211e4	439.50714	99.2023

Totals : 1.26218e4 448.26037

Results obtained with enhanced integrator!

[illegible]

¹H NMR spectrum of (9S)-dihydroerythronolide A provided by Professor Kazunobu Toshima: