Synthetic Studies on Halichondrin B, an Antitumor Polyether Macrolide Isolated from a Marine Sponge. 9. Synthesis of the C16—C36 Unit *via* Stereoselective Construction of the D and E Rings

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The C16—C36 unit of halichondrin B was stereoselectively synthesized *via* the aldol condensation of two C16—C26 esters with the previously synthesized C27—C36 aldehyde followed by E ring construction. The C16—C26 esters were prepared starting from (2*S*)-3-hydroxy-2-methylpropionic acid and L-tartaric acid *via* construction of the D ring by iodoetherification.

Key words iodoetherification; 2,5-*trans*-tetrahydrofuran; aldol condensation; 2,6-*cis*-tetrahydropyran; stereoselective synthesis; polyether macrolide

Halichondrin B (**1**), a representative member of highly active antitumor polyether macrolides with complex structures, was isolated from the marine sponge *Halichondria okadai* by Uemura *et al.* in 1985,[1] and the first total synthesis was achieved by Kishi and co-workers in 1992.[2] As part of our synthetic studies directed to **1**, we recently reported in preliminary form the synthesis of the lactone portion (C1—C36) (**2**) *via* coupling of C1—C15 unit (**3**)[3] with C16—C36 unit (**4**), after oxidation to the corresponding aldehyde.[4] In this full paper we describe the synthetic study leading to **4**, starting from D-malic acid, (2*S*)-3-hydroxy-2-methylpropionic acid, and L-tartaric acid, *via* construction of the D ring by iodoetherification to give two C16—C26 units (**5a, b**), coupling of **5a, b** with the C27—C36 unit (**6**),[5] and construction of the E ring by a reductive tetrahydropyran formation process.[6–8]

For the synthesis of **4** the most crucial step was predicted to be the stereoselective construction of the E ring, which we originally planned to construct *via* aldol condensation of a C16—C26 ester (**5a** or **5b**) with the C27—C36 aldehyde (**6**), followed by an *S*N2 type cyclization. The stereochemistry of the aldol reaction is now well understood, however it is still quite difficult to predict the stereoselectivity in the case of highly functionalized esters and aldehydes. Therefore, we prepared two C23 epimeric esters, **5a** and **5b**, and after aldol condensation with **6**, the C23 hydroxy groups in **7a** and **8** were used as an attacking group and a leaving group, respectively, for the construction of the E ring by *S*N2 type cyclization (Chart 1).

Synthesis of the C16—C26 Fragments (5a, 5b) A retrosynthesis of **5a** and **5b** is shown in Chart 2. The most important step is the stereoselective construction of the D ring by iodoetherification reaction of **9a, b**. After the reactivity and selectivity of this reaction[9] were carefully examined using some derivatives of **9a**, we chose **9a** and **9b** as the most promising substrates.

D-(+)-Malic acid (**12**) was first converted to the diol (**14**),[10] which was then protected as an acetonide, and then readily transformed to the β-ketophosphonate (**10**)[11] in the usual way (Chart 3).

Methyl (2*S*)-3-hydroxy-2-methylpropionate (**13**) was first converted to the tosylate (**15**)[12] *via* three conventional reactions; protection of the hydroxy group with a

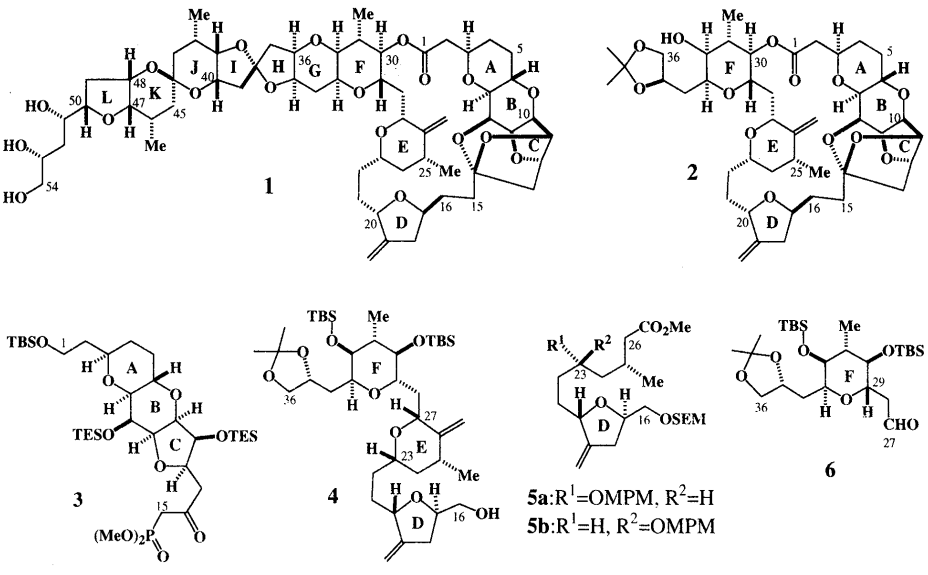

Fig. 1

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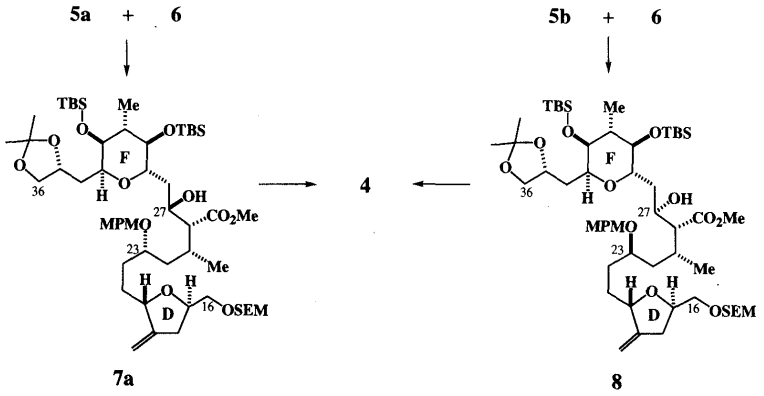


Chart 1

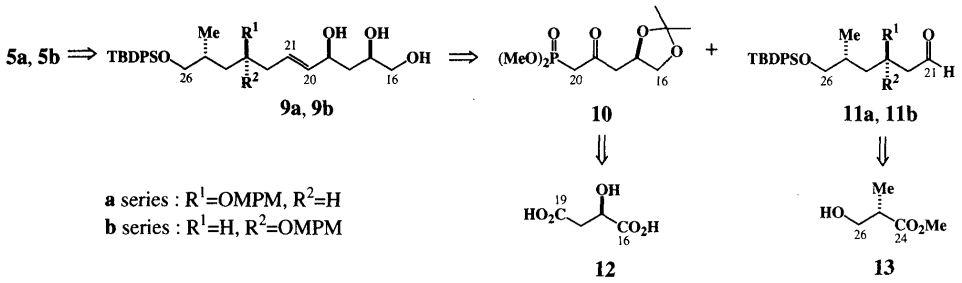
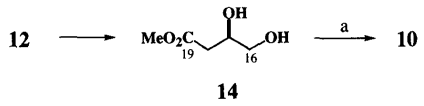


Chart 2



(a) 1) $Me_2C(OMe)_2$, PPTS, CH_2Cl_2 (75%); 2) $(MeO)_2P(O)Me$, *n*-BuLi, THF (63%).

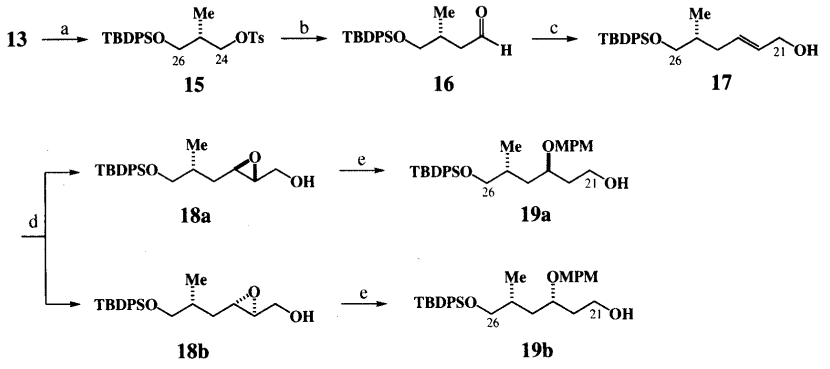
Chart 3

tert-butyldiphenylsilyl (TBDPS) group, reduction of the ester group with calcium borohydride, and tosylation of the resulting hydroxy group. After conversion of **15** to the cyanide, reduction with diisobutylaluminum hydride (DIBAH) easily gave the aldehyde (**16**),[13] which was transformed to the allyl alcohol (**17**) *via* Wittig reaction and subsequent DIBAH reduction. Sharpless asymmetric epoxidation[14] of **17** in the presence of diethyl D-(−)-tartrate ((−)-DET) gave the epoxyalcohol (**18a**),[15] which was selectively reduced with sodium bis(2-methoxyethoxy)aluminum hydride (Red-Al)[16] to give a diol. Stereoselective protection of the C23 secondary alcohol with the *p*-methoxybenzyl (MPM) group was carried out in the usual way: protection of the diol as a methoxybenzylidene acetal followed by DIBAH reduction to give the C21—C26 alcohol (**19a**). Similarly, **17** was converted to the alternate C21—C26 alcohol (**19b**) *via* **18b**[17] using L-(+)-tartrate ((+)-DET) (Chart 4).

Swern oxidation of **19a** readily gave the aldehyde (**11a**), which was immediately coupled with the lithium salt of **10** under Horner–Emmons conditions to give the enone (**20a**). Reduction of **20a** with lithium aluminum hydride ($LiAlH_4$) in the presence of lithium iodide (LiI) at −100 °C under chelation-controlled conditions[18] proceeded stereoselectively to give the allyl alcohol in almost quantitative yield. Removal of the isopropylidene protection smoothly gave the triol (**9a**).

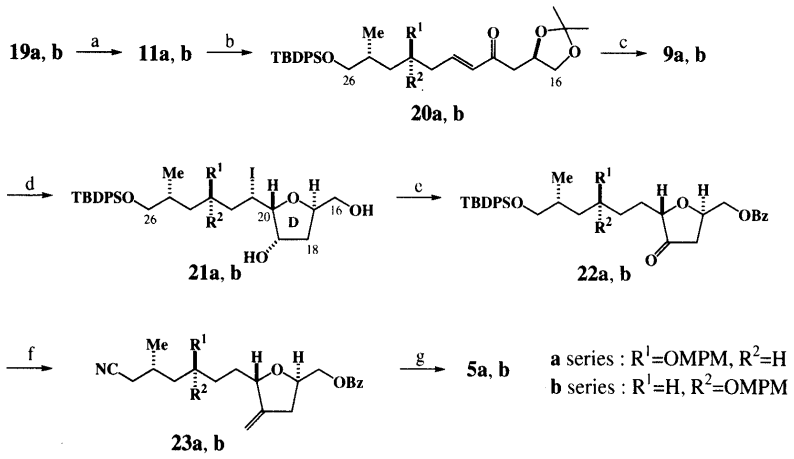
Iodoetherification is a general method for the construction of tetrahydrofuran rings,[9] thus **9a** was treated with iodine (I_2) and sodium hydrogen carbonate ($NaHCO_3$) in tetrahydrofuran (THF) under the usual conditions. A completely stereoselective reaction proceeded rather rapidly to give the expected 2,5-*trans*-tetrahydrofuran (**21a**) in good yield, whereas the C19-epimer of **9a** gave a 6.5:1 mixture of 2,5-*cis* and 2,5-*trans*-tetrahydrofurans. After acetylation of the two hydroxy groups, the structure of **21a** was confirmed by nuclear Overhauser and exchange spectroscopy (NOESY), in which clear correlations between C17α- and C18α-, C18β- and C19β-, and C19β- and C20β-protons were observed. Treatment of **21a** with sodium hydride (NaH), subsequent hydrogenation over Raney nickel, and selective protection of the C16 primary alcohol with a benzoyl group (Bz) gave a secondary hydroxy compound, which was readily oxidized to the ketone (**22a**) under Swern conditions. After conversion of the carbonyl group of **22a** to the olefin by Wittig reaction, the C26-OTBDPS group was transformed to the nitrile (**23a**) *via* three conventional reactions. Final conversion of **23a** to the C16—C26 fragment (**5a**) was accomplished without any difficulty by a series of five reactions; hydrolysis of the Bz group, protection with a trimethylsilylethoxymethyl (SEM) group, DIBAH reduction, Jones oxidation, and methylation with diazomethane. The overall yield from **19a** to **5a** was 21.3%. Similarly, **19b** was smoothly transformed to the other C16—C26 fragment (**5b**) in 16.3% overall yield. Thus, the synthesis of the two C23 epimeric C16—C26 fragments was completed (Chart 5).

Synthesis of the C16—C36 Unit (4) As mentioned above, stereoselective construction of the E ring is crucial for the synthesis of **4**, and hence exact stereocontrol of the aldol condensation between **5** and the C27—C36 aldehyde (**6**)[5] is very important. Aldol reaction of a simple



(a) 1) TBDPSCl, imidazole, CH_2Cl_2; 2) $Ca(BH_4)_2$, EtOH; 3) TsCl, DMAP, CH_2Cl_2 (3 steps 93%). (b) 1) NaCN, DMSO (92%); 2) DIBAH, CH_2Cl_2 (98%). (c) 1) $Ph_3P{=}CHCO_2Me$, C_6H_6 (92%); 2) DIBAH, CH_2Cl_2 (100%). (d) (-)-DET (for **18a**), (+)-DET (for **18b**), (iso-PrO)$_4$Ti, TBHP, CH_2Cl_2 (**18a**, **b** 90%). (e) 1) Red-Al, THF; 2) $MPCH(OMe)_2$, TsOH, C_6H_6; 3) DIBAH, CH_2Cl_2 (3 steps **19a** 84%, **19b** 92%).

Chart 4



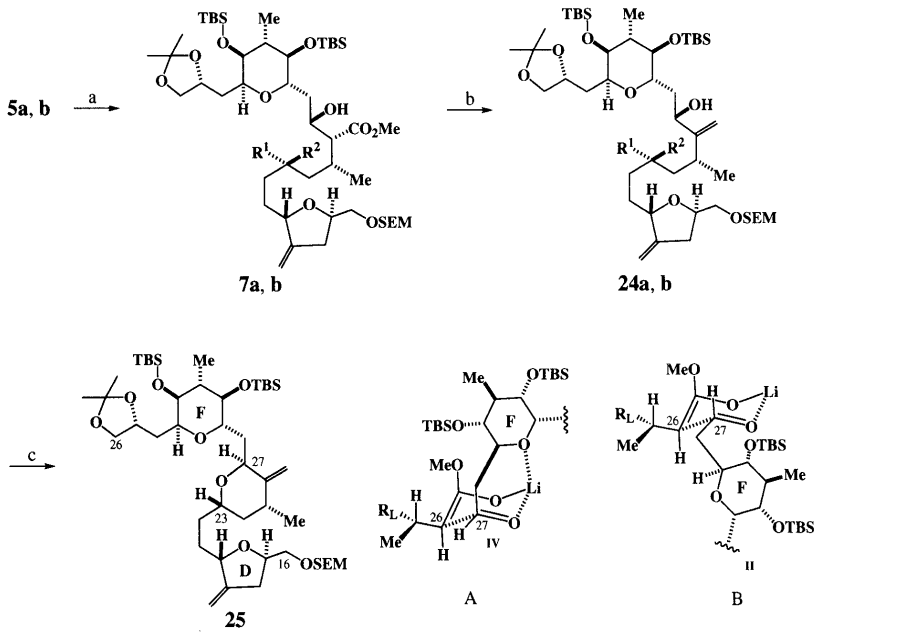
(a) DMSO, $(COCl)_2$, CH_2Cl_2. (b) **10**, *n*-BuLi, THF (2 steps **20a** 80%, **20b** 88%). (c) 1) LiI, $LiAlH_4$, Et_2O; 2) AcOH, MeOH (2 steps **9a** 88%, **9b** 93%). (d) I_2, $NaHCO_3$, THF (**21a** 88%, **21b** 86%). (e) 1) NaH, THF; 2) Raney Ni, H_2; 3) BzCl, pyridine, CH_2Cl_2; 4) DMSO, $(COCl)_2$, CH_2Cl_2 (4 steps **22a** 76%, **22b** 45%). (f) 1) Ph_3PMeBr, *t*-BuOK, THF; 2) BzCl, Et_3N, CH_2Cl_2; 3) TBAF, THF; 4) TsCl, TEA, DMAP, CH_2Cl_2; 5) NaCN, DMSO (5 steps **23a** 49%, **23b** 60%). (g) 1) K_2CO_3, MeOH; 2) SEMCl, $(iso\text{-}Pr)_2EtN$, CH_2Cl_2; 3) DIBAH, CH_2Cl_2; 4) Jones oxid; 5) CH_2N_2 (5 steps **5a** 92%, **5b** 91%).

Chart 5

ester *E*-enolate with an aldehyde under kinetic conditions usually proceeds *via* a six-membered transition state and a 2,3-*anti* substituted ester is predominantly obtained, although high selectivity is not necessarily produced, in contrast with a ketone enolate.[19] If this is also the case for the reaction between **5b** and **6**, the expected main product should be **8**.

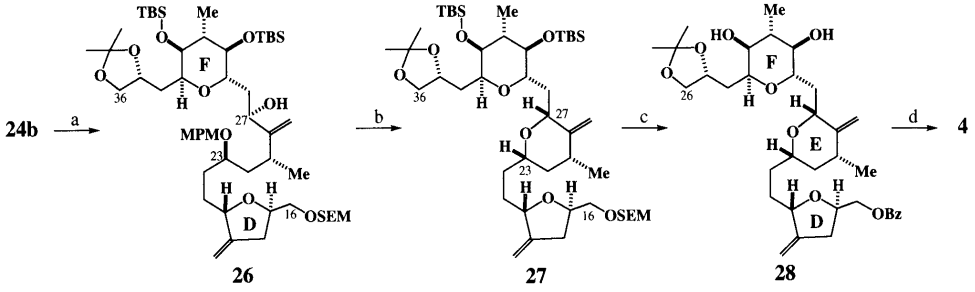
When **5b** was treated with lithium diisopropylamide (LDA) at $-78\,^{\circ}C$ to form its ester enolate and subjected to reaction with **6**, a completely stereoselective reaction took place and was completed within only 10 min to give a single coupling product, which was disappointingly not the expected 2,3-*anti* substituted hydroxy ester **8**, but the 2,3-*syn* substituted hydroxy ester (**7b**). The configuration at C27 of **7b** was proven after conversion of **7b** into **25** *via* **24b**. The C26 ester group of **7b** was first converted to an *exo*-methylene group to give **24b** in the usual way. In order to construct a tetrahydropyran ring, the C27 secondary alcohol of **24b** was first temporarily protected with a trimethylsilyl (TMS) group, then the MPM protecting group at C23 was replaced with a mesyl group, and the C27 hydroxy group was regenerated by treatment with pyridinium *p*-toluenesulfonate (PPTS). Treatment of the mesylate with potassium hydride (KH) at $80\,^{\circ}C$ gave **25**, which has unfortunately the wrong configuration at C27 (C23, 27-*trans*), namely, in the NMR spectrum, a NOESY correlation between C23-H and C28-H, not between C23-H and C27-H, was clearly observed. Therefore, the most probable transition state structure in this aldol reaction between **5b** and **6** is depicted as A, in which lithium is chelating not only to the aldehyde oxygen but also to the F ring oxygen, although usual aldol reactions proceed *via* the B transition structure (Chart 6).

In order to construct correctly the C23, 27-*cis*-E ring starting from **7b**, it is necessary to invert the configuration of the C27 hydroxy group. After **7b** was again transformed to **24b**, the hydroxy group was oxidized under Dess–Martin conditions[20] to give the C27 ketone, which was reduced with $LiAlH_4$ in the presence of LiI[18] to give the expected alcohol (**26**) as the main product, although as a 4 : 1 mixture with **7b**. Transformation of **26** into the expected **27** proceeded smoothly in the same way as described for **25**.



(a) LDA, **6**, THF (**7a** 78%, **7b** 79%). (b) 1) $LiAlH_4$, THF; 2) TsCl, pyridine, CH_2Cl_2; 3) NaI, $NaHCO_3$, DBU, THF (3 steps **24a** 53%, **24b** 55%). (c) TMS-imidazole, CH_2Cl_2 (96%); 2) DDQ, CH_2Cl_2·H_2O (75%); 3) Ms_2O, TEA, CH_2Cl_2 (74%); 4) PPTS, THF-MeOH (75%); 5) KH, DME (39%).

Chart 6



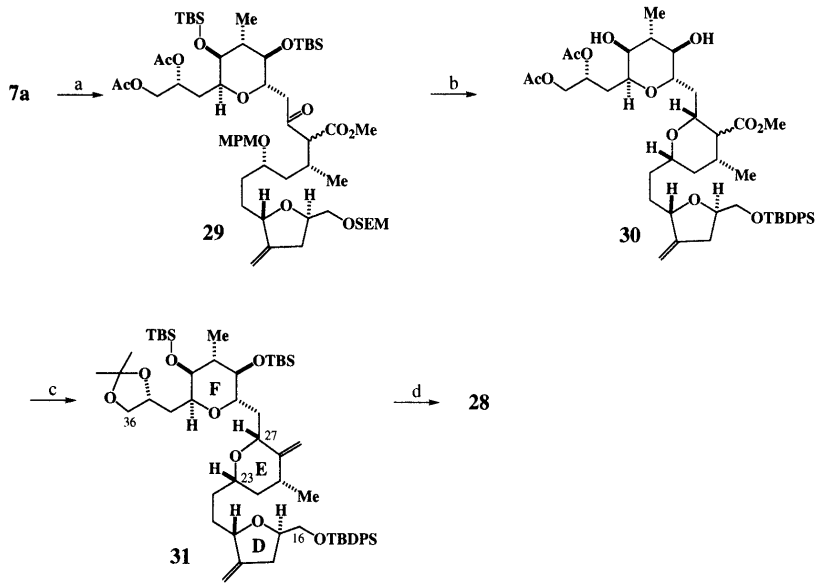
(a) 1) Dess-Martin oxid. (78%); 2) LiI-$LiAlH_4$, Et_2O (64%). (b) TMS-imidazole, CH_2Cl_2; 2) DDQ, C_6H_6-H_2O (2 steps 72%); 3) Ms_2O, TEA, CH_2Cl_2; 4) PPTS, THF-H_2O (2 steps 81%); 5) KH, DME (69%). (c) 1) TBAF, HMPA-THF; 2) BzCl, pyridine, CH_2Cl_2 (2 steps 93%). (d) 1) TBSOTf, 2,6-lutidine CH_2Cl_2 (91%); 2) K_2CO_3, MeOH (93%).

Chart 7

The structure of the E ring was confirmed by NOESY correlations among the C23-, C25- and C27-protons. Finally, **27** was easily converted to the title compound (**4**) *via* **28**. Thus, the synthesis of **4** was completed, but the overall yield from **6** to **4** requiring fifteen steps was only 7.4%.

The synthesis of **4** starting from the other C16—C26 unit (**5a**) was next examined. When the lithium enolate of **5a** was coupled with **6**, as described above for **5b**, aldol reaction *via* the A-type transition state again proceeded to give 2,3-*syn* substituted hydroxy ester (**7a**). If the C27 hydroxy group can be directly used as a leaving group for the construction of the E ring, we are able to complete a concise synthesis of **4** as originally planned. The C26 ester group was transformed to the *exo*-methylene group to give **24a**, whose C27 hydroxy group could not be converted to a mesylate. Other compounds, such as **7a** itself and a C26 benzoyloxymethyl derivative gave the corresponding C27-*O*-mesylates, but unfortunately all attempts at construction of the E ring were unsuccessful.

Six-membered lactols can be reduced to the corresponding tetrahydropyrans by reductive deoxygenation with triethylsilane (Et_3SiH) in the presence of boron trifluoride etherate ($BF_3 \cdot Et_2O$),[21] and this reaction was extended to the selective synthesis of 2,6-*cis* disubstituted tetrahydropyrans (C-glycosides).[22] If a lactol is formed from **7a**, this reduction method should be applicable to the selective construction of the E ring. The C27 hydroxy group was oxidized under Dess–Martin conditions and the isopropylidene protection of the C35, 36 diols was replaced to acetyl groups[23] to give **29** as a 1 : 1 mixture with respect to C26. When **29** was treated with Et_3SiH and $BF_3 \cdot Et_2O$ at 0 °C, removal of the MPM protecting group and subsequent deoxygenation of the lactol occurred very rapidly with concomitant loss of the SEM and *tert*-butyldimethylsilyl (TBS) groups to give stereoselectively the expected E-ring compound, whose C16 primary hydroxy group was selectively protected with a TBDPS group and **30** was thus easily isolated in good yield. After the diacetyl group was reconverted to the



(a) 1) Dess-Martin oxid. 96%; 2) PPTS, MeOH; 3) Ac_2O, TEA, DMAP, CH_2Cl_2 (3 steps 77%). (b) Et_3SiH, BF_3-OEt_2, MeCN; 2) TBDPSCl, imidazole, CH_2Cl_2 (2 steps 88%). (c) 1) K_2CO_3, MeOH; 2) $(MeO)_2CMe_2$, CSA, benzene; 3) TBSOTf, 2,6-lutidine, CH_2Cl_2 (3 steps 82%); 4) DIBAH, toluene; 5) TsCl, TEA, DMAP; 6) NaI, $NaHCO_3$, DBU, THF (3 steps 70%). (d) 1) TBAF, THF; 2) BzCl, pyridine, CH_2Cl_2 (2 steps 93%).

Chart 8

isopropylidene group, transformation of the C26 ester to a methylene group, as described above, gave **31** corresponding to **27**. Finally, **31** was readily converted to **4**. The overall yield for sixteen steps from **6** to **4** was 27.3%.

Experimental

(4*R*)-4,5-Isopropylidenedioxy-1-(dimethoxyphosphoryl)-2-pentanone (10) 2,2-Dimethoxypropane (31.9 g, 306 mmol) and pyridinium *p*-toluenesulfonate (PPTS) (0.2 g) were added to a stirred solution of methyl (3*R*)-3,4-dihydroxybutanoate (**14**) (13.7 g, 102 mmol) in CH_2Cl_2 (100 ml) at 0 °C. After 8 h at room temperature, the reaction mixture was quenched with saturated aqueous $NaHCO_3$, and extracted with CH_2Cl_2. The extract was dried over Na_2SO_4, and evaporated *in vacuo*. The residue was chromatographed on a silica gel column (*n*-hexane–EtOAc 3 : 1) to give methyl (3*R*)-3,4-isopropylidenedioxybutanoate as a colorless oil (13.4 g, 75%). $[\alpha]_D^{18}$ −145.1° (*c* = 0.43, $CHCl_3$). IR (neat) cm^{-1}: 3000, 2970, 2900, 1750. ^{1}H-NMR ($CDCl_3$) δ: 1.35 (s, 3H), 1.41 (s, 3H), 2.50 (dd, 1H, *J* = 7.0, 16.0 Hz), 2.71 (dd, 1H, *J* = 6.5, 16.0 Hz), 3.64 (dd, 1H, *J* = 6.5, 8.5 Hz), 3.69 (s, 3H), 4.15 (dd, 1H, *J* = 6.0, 8.5 Hz), 4.46 (dt, 1H, *J* = 6.5, 13.0 Hz). ^{13}C-NMR ($CDCl_3$) δ: 25.51, 26.88, 38.77, 51.77, 69.13, 72.02, 109.24, 171.05. EI-MS *m/z* (%): 159 ($M^+ - CH_3$ (15), 39), 143 (6.3), 115 (6.7), 101 (13), 99 (61), 85 (23), 72 (22), 59 (19), 57 (12), 55 (6.7), 43 (100). HR-MS (EI) Calcd for $C_7H_{11}O_4$ ($M^+ - CH_3$): 159.0658. Found: 159.0674.

A 1.56 M solution of *n*-BuLi in *n*-hexane (11.7 ml, 18.2 mmol) was added to a stirred solution of dimethyl methylphosphonate (2.6 g, 21 mmol) in THF (20 ml) at −78 °C under argon. After 15 min, a solution of the above ester (1.04 g, 5.97 mmol) in THF was added. The reaction mixture was stirred for 30 min, then quenched with saturated aqueous NH_4Cl, and extracted with CH_2Cl_2. The extract was dried over Na_2SO_4, and evaporated *in vacuo*. The residue was chromatographed on a silica gel column (EtOAc–MeOH 20 : 1) to give **10** as a colorless oil (1.0 g, 63%). $[\alpha]_D^{20}$ +1.8° (*c* = 0.81, $CHCl_3$). IR (neat) cm^{-1}: 3450, 3000, 2980, 2870, 1720. ^{1}H-NMR ($CDCl_3$) δ: 1.32 (s, 3H), 1.38 (s, 3H), 2.78 (ddd, 1H, *J* = 2.0, 7.0, 18.0 Hz), 3.03 (ddd, 1H, *J* = 1.5, 6.5, 17.0 Hz), 3.10 (dd, 1H, 1.5, 3.5 Hz), 3.15 (dd, 1H, 1.5, 3.5 Hz), 3.54 (ddd, 1H, *J* = 2.0, 7.0, 8.0 Hz), 3.75 (d, 3H, *J* = 1.5 Hz), 3.78 (d, 3H, *J* = 1.5 Hz), 4.15 (ddd, 1H, *J* = 2.5, 5.5, 8.0 Hz), 4.45 (ddt, 1H, *J* = 2.0, 6.5, 7.0 Hz). ^{13}C-NMR ($CDCl_3$) δ: 25.42, 26.81, 41.26, 42.52, 48.17, 53.09, 69.20, 71.40, 109.05, 199.71. FAB-MS *m/z* (%): 267 ($M^+ + H$), 219 (25), 209 (19), 191 (100), 154 (77), 136 (51), 121 (14), 107 (22), 89 (14). HR-MS (FAB) Calcd for $C_{10}H_{20}O_6P$ ($M^+ + H$): 267.0998. Found: 267.0995.

(2*S*)-1-(*tert*-Butyldiphenylsilyloxy)-2-methyl-3-(toluenesulfonyloxy)-propane (15) TBDPS chloride (TBDPSCl) (69.6 g, 0.25 mol) was added dropwise during 1 h to a stirred solution of methyl (2*S*)-3-hydroxy-2-methylpropionate (**13**) (25 g, 0.211 mol) and imidazole (20.3 g, 0.298 mol) in CH_2Cl_2 (250 ml) at 0 °C. After an additional 1 h at room temperature, the reaction mixture was diluted with H_2O, and extracted with CH_2Cl_2. The extract was washed with brine, dried over Na_2SO_4, and evaporated *in vacuo* to give an oil, which was subjected to the next reaction without purification.

An EtOH solution (500 ml) of the above oil was added dropwise to a stirred $Ca(BH_4)_2$ solution, prepared from $CaCl_2$ (93.9 g, 0.846 mol) and $NaBH_4$ (32.0 g, 0.846 mol) in EtOH (1000 ml), at −25 °C under argon. After 15 h at room temperature, the reaction mixture was quenched with 1 N HCl, then neutralized with $NaHCO_3$, and filtered through Celite to remove precipitates. The filtrate was extracted with CH_2Cl_2. The extract was washed with brine, dried over Na_2SO_4, and evaporated *in vacuo*. The residue was purified on a silica gel column (*n*-hexane EtOAc 5 : 1) to give an alcohol (64.2 g, 93%), which was dissolved in CH_2Cl_2 (1000 ml), then mixed with *p*-dimethylaminopyridine (DMAP) (1.0 g), Et_3N (29.7 g, 293 mmol) and *p*-toluenesulfonyl chloride (TsCl) (48.3 g, 0.253 mol) under stirring at 0 °C. After 5 h at room temperature, the reaction mixture was diluted with H_2O, and extracted with Et_2O. The extract was washed with brine, dried over Na_2SO_4, and evaporated *in vacuo*. The residue was chromatographed on a silica gel column (*n*-hexane–EtOAc 5 : 1) to give **15** as a colorless oil (93.8 g, 100%). $[\alpha]_D^{21}$ +6.1° (*c* = 1.06, $CHCl_3$). IR (neat) cm^{-1}: 3060, 3040, 2950, 2930, 2850. ^{1}H-NMR ($CDCl_3$) δ: 0.89 (d, 3H, *J* = 7.0 Hz), 0.98 (s, 9H), 1.97—2.03 (m, 1H), 2.42 (s, 3H), 3.45 (dd, 1H, *J* = 6.5, 10.5 Hz), 3.55 (dd, 1H, *J* = 5.0, 10.5 Hz), 4.01 (dd, 1H, *J* = 6.0, 9.5 Hz), 4.12 (dd, 1H, *J* = 5.5, 9.5 Hz), 7.26—7.45 (m, 8H), 7.57—7.60 (m, 4H), 7.78—7.80 (m, 2H). ^{13}C-NMR ($CDCl_3$) δ: 13.31, 19.22, 21.64, 35.66, 64.52, 72.13, 127.71, 127.94, 129.72, 129.81, 133.36, 135.53, 144.60. FAB-MS *m/z* (%): 483 ($M^+ + H$, 3.7), 425 (16), 353 (100), 333 (44), 293 (15), 273 (12), 255 (10), 197 (21), 135 (31), 105 (6.7), 91 (12). HR-MS (FAB) Calcd for $C_{27}H_{35}O_4SSi$ ($M^+ + H$): 483.2025. Found: 483.2001.

(3*R*)-4-(*tert*-Butyldiphenylsilyloxy)-3-methylbutanal (16) NaCN (19.0 g, 0.387 mol) was added to a stirred solution of **15** (93.5 g, 0.193 mol) in dimethyl sulfoxide (DMSO) (200 ml) at room temperature. The reaction mixture was stirred at 50 °C for 2 h, then diluted with H_2O, and extracted with Et_2O. The extract was washed with brine, dried over Na_2SO_4, and evaporated *in vacuo*. The residue was chromatographed on a silica gel column (*n*-hexane–EtOAc 3 : 1) to give (2*R*)-1-(*tert*-butyldiphenylsilyloxy)-3-cyano-2-methylpropane as a colorless oil (60.9 g, 92%). $[\alpha]_D^{22}$ +15.5°

($c=1.50$, $CHCl_3$). IR (neat) cm^{-1}: 3070, 3050, 2960, 2930, 2855, 2250, 1585. ^{1}H-NMR ($CDCl_3$) δ: 1.04 (d, 3H, $J=7.0$ Hz), 1.07 (s, 9H), 2.06—2.12 (m, 1H), 2.39 (dd, 1H, $J=7.5$, 16.5 Hz), 2.57 (dd, 1H, $J=5.5$, 16.5 Hz), 3.47 (dd, 1H, $J=7.5$, 10.0 Hz), 3.64 (dd, 1H, $J=5.0$, 10.0 Hz), 7.38—7.47 (m, 6H), 7.63—7.66 (m, 4H). ^{13}C-NMR ($CDCl_3$) δ: 15.91, 19.28, 21.09, 26.85, 33.30, 66.84, 118.86, 127.80, 129.85, 133.16, 133.23, 135.51, 133.55. FAB-MS m/z (%): 338 ($M^+ + H$, 7), 280 (100), 260 (19), 218(8), 199 (17), 183 (10), 154 (5.8), 135 (15), 121 (10), 105 (6). HR-MS (FAB) Calcd for $C_{21}H_{28}NOSi$ ($M^+ + H$): 338.1940. Found: 338.1958.

A 0.93 M solution of DIBAH in THF (94 ml, 0.18 mol) was added dropwise to a stirred solution of the above nitrile (60.9 g, 0.18 mol) in CH_2Cl_2 (1500 ml) at -78 °C under argon. After 40 min, 1 N HCl was added to make the solution pH 3.0, and then Et_2O and saturated aqueous Rochelle salt were added. The whole mixture was stirred for 12 h at room temperature, and extracted with Et_2O. The extract was washed with brine, dried over Na_2SO_4, and evaporated *in vacuo*. The residue was chromatographed on a silica gel column (*n*-hexane–EtOAc 10 : 1) to give **16** as a colorless oil (60.4 g, 98%). $[\alpha]_D^{22}$ +3.8° ($c=0.14$, $CHCl_3$). IR (neat) cm^{-1}: 3060, 3040, 2960, 2925, 2860, 2710, 1720, 1585. ^{1}H-NMR ($CDCl_3$) δ: 0.94 (d, 3H, $J=7.0$ Hz), 1.05 (s, 9H), 2.17—2.27 (m, 1H), 2.28—2.37 (m, 1H), 2.58—2.66 (m, 1H), 3.44 (dd, 1H, $J=7.0$, 10.0 Hz), 3.58 (dd, 1H, $J=5.0$, 10.0 Hz), 7.35—7.46 (m, 4H), 7.63—7.68 (m, 6H), 9.79 (m, 1H). ^{13}C-NMR ($CDCl_3$) δ: 16.62, 16.79, 19.26, 26.83, 31.29, 32.86, 38.00, 48.15, 68.21, 68.38, 127.70, 129.71, 133.50, 135.61, 202.71. FAB-MS m/z (%): 339 ($M^+ - H$, 11), 319 (5.9), 283 (9.9), 259 (5.7), 239 (13), 221 (8.2), 207 (6.4), 199 (65), 183 (20), 135 (100). HR-MS (FAB) Calcd for $C_{21}H_{27}O_2Si$ (M^+-H): 339.1781. Found: 339.1799.

(2*E*,5*R*)-6-(*tert*-Butyldiphenylsilyloxy)-5-methyl-2-hexen-1-ol (17) Methoxycarbonylmethylenetriphenylphosphorane (177.8 g, 0.53 mol) was added to a stirred solution of **16** (60.4 g, 0.177 mol) in CH_2Cl_2 (1800 ml) at room temperature. After 10 h, the reaction mixture was concentrated *in vacuo*, diluted with *n*-hexane, and filtered to remove insoluble precipitates. The filtrate was concentrated and chromatographed on a silica gel column (*n*-hexane–EtOAc 5 : 1) to give methyl (2*E*,5*R*)-6-(*tert*-butyldiphenylsilyloxy)-5-methyl-2-hexenoate as a colorless oil (64.9 g, 92%). $[\alpha]_D^{23}$ +4.8° ($c=0.94$, $CHCl_3$). IR (neat) cm^{-1}: 3060, 3045, 2960, 2930, 2850, 1720, 1645, 1585. ^{1}H-NMR ($CDCl_3$) δ: 0.91 (d, 3H, $J=7.0$ Hz), 1.06 (s, 9H), 1.83—1.88 (m, 1H), 2.06 (dddd, 1H, $J=1.5$, 8.0, 8.0, 14.0 Hz), 2.45 (dddd, 1H, $J=1.5$, 5.5, 7.0, 14.0 Hz), 3.46 (dd, 1H, $J=6.5$, 10.0 Hz), 3.52 (dd, 1H, $J=5.5$, 10.0 Hz), 3.73 (s, 3H), 5.83 (dt, 1H, $J=1.5$, 15.5 Hz), 6.95 (ddd, 1H, $J=8.0$, 8.0, 15.5 Hz), 7.36—7.45 (m, 6H), 7.65—7.66 (m, 4H). ^{13}C-NMR ($CDCl_3$) δ: 16.42, 19.30, 26.87, 35.41, 36.08, 51.37, 68.14, 122.13, 127.65, 129.61, 133.74, 135.59, 148.28, 166.90. FAB-MS m/z (%): 397 ($M^+ + H$, 4.6), 395 (7.3), 365 (11), 339 (158), 319 (100), 279 (7.5), 261 (6.3), 239 (8.4), 213 (67), 199 (53), 183 (27), 135 (58), 81 (35). HR-MS (FAB) Calcd for $C_{24}H_{33}O_3Si$ ($M^+ + H$): 397.2199. Found: 397.2200.

A 0.93 M solution of DIBAH in THF (390 ml, 0.363 mol) was added dropwise to a stirred solution of the above ester (36.36 g, 0.091 mol) in CH_2Cl_2 (1500 ml) at -78 °C under argon. After 1.5 h, MeOH (10 ml) was added. The reaction mixture was diluted with Et_2O and stirred with saturated aqueous Rochelle salt for 12 h at room temperature, and extracted with Et_2O. The extract was washed with brine, dried over Na_2SO_4, and evaporated *in vacuo*. The residue was chromatographed on a silica gel column (*n*-hexane–EtOAc 5 : 1) to give **17** as a colorless oil (33.8 g, 100%). $[\alpha]_D^{22}$ +5.3° ($c=1.68$, $CHCl_3$). IR (neat) cm^{-1}: 3300, 3070, 3045, 3020, 3000, 2960, 2940, 2900, 2860, 1570. ^{1}H-NMR ($CDCl_3$) δ: 0.92 (d, 3H, $J=7.0$ Hz), 1.07 (s, 9H), 1.26 (t, 1H, $J=5.5$ Hz), 1.64—1.67 (m, 1H), 1.88—1.95 (m, 1H), 2.22—2.27 (m, 1H), 3.50 (d, 2H, $J=6.0$ Hz), 4.06 (br s, 2H), 5.62—5.64 (m, 2H), 7.36—7.46 (m, 6H), 7.66—7.69 (m, 4H). ^{13}C-NMR ($CDCl_3$) δ: 16.55, 19.33, 26.90, 35.86, 35.92, 63.77, 68.20, 127.60, 127.69, 129.55, 130.41, 131.51, 133.98, 135.64. FAB-MS m/z (%): 369 ($M^+ + H$, 4.6), 339 (100), 319 (62), 213 (27), 199 (20), 154 (21), 137 (27), 81 (18). HR-MS (FAB) Calcd for $C_{23}H_{33}O_2Si$ ($M^+ + H$): 369.2251. Found: 369.2151.

(2*R*,3*R*,5*R*)-6-(*tert*-Butyldiphenylsilyloxy)-2,3-epoxy-5-methyl-1-hexanol (18a) Titanium tetraisopropoxide (8.0 ml, 27.1 mmol) was added dropwise to a stirred solution of D-(−)-DET (9.34 g, 45.3 mmol) in CH_2Cl_2 (300 ml) containing powdered molecular sieves 3 Å (50 g) during 20 min at room temperature. After 15 min, a solution of **17** (32.8 g, 89.0 mmol) in CH_2Cl_2 (55 ml), and a 3 M solution of *tert*-butylhydroperoxide (TBHP) in toluene (179 ml, 53.7 mmol) were added, and stirring was continued for 8 h. The reaction mixture was poured into an ice-cold solution of $FeSO_4 \cdot 7H_2O$ (30 g) and tartaric acid (8.1 g) in H_2O (100 ml), stirred for 30 min at room temperature, and filtered through Celite. After addition of 30% NaOH in brine (10 ml), the mixture was stirred for 1 h at room temperature, and then extracted with CH_2Cl_2. The extract was washed with brine, dried over Na_2SO_4, and evaporated *in vacuo*. The residue was chromatographed on a silica gel column (*n*-hexane–EtOAc 3 : 1) to give **18a** as a colorless oil (30.7 g, 90%). $[\alpha]_D^{23}$ +19.5° ($c=0.24$, $CHCl_3$). IR (neat) cm^{-1}: 3440, 3080, 3055, 2970, 2945, 2870. ^{1}H-NMR ($CDCl_3$) δ: 0.99 (d, 3H, $J=7.0$ Hz), 1.06 (s, 9H), 1.39 (ddd, 1H, $J=5.5$, 8.0, 14.0 Hz) 1.76 (dd, 1H, $J=5.5$, 7.0 Hz), 1.76—1.83 (m, 1H), 1.85—1.96 (m, 1H), 2.89 (dt, 1H, $J=2.5$, 4.0 Hz), 2.97 (ddd, 1H, $J=2.5$, 6.0, 6.0 Hz), 3.53 (d, 2H, $J=5.5$ Hz), 3.60 (ddd, 1H, $J=4.5$, 7.5, 12.5 Hz), 3.89 (ddd, 1H, $J=2.5$, 6.0, 12.5 Hz), 7.36—7.46 (m, 6H), 7.64—7.68 (m, 4H). ^{13}C-NMR ($CDCl_3$) δ: 16.63, 19.31, 26.88, 33.69, 35.32, 54.52, 58.89, 61.61, 68.71, 127.65, 129.61, 133.80, 135.61. FAB-MS m/z (%): 385 ($M^+ + H$, 12), 341 (6.0), 327 (35), 307 (19), 289 (14), 269 (5.0), 249 (15), 241 (8.6), 229 (15), 219 (15), 211 (3.5), 199 (100), 183 (2.5). HR-MS (FAB) Calcd for $C_{23}H_{33}O_3Si$ ($M^+ + H$): 385.2199. Found: 385.2183.

(2*S*,3*S*,5*R*)-6-(*tert*-Butyldiphenylsilyloxy)-2,3-epoxy-5-methyl-1-hexanol (18b) **17** (30 g, 81.4 mmol) was oxidized to a colorless oil of **18b** (28.1 g, 90%) as in the foregoing experiment using L-(+)-DET instead of D-(−)-DET. $[\alpha]_D^{23}$ −12.2° ($c=0.73$, $CHCl_3$). IR (neat) cm^{-1}: 3450, 3080, 3055, 2960, 2870, 1600. ^{1}H-NMR ($CDCl_3$) δ: 1.01 (d, 3H, $J=7.0$ Hz), 1.07 (s, 9H), 1.42 (q, 1H, $J=7.0$ Hz), 1.68—1.83 (m, 2H), 1.84—1.92 (m, 1H), 2.83—2.85 (m, 1H), 2.92—2.96 (m, 1H), 3.49—3.57 (m, 3H), 3.82 (ddd, 1H, $J=2.5$, 3.0, 5.5 Hz), 7.36—7.46 (m, 6H), 7.64—7.69 (9m, 4H). ^{13}C-NMR ($CDCl_3$) δ: 17.25, 19.31, 26.90, 34.24, 35.37, 54.92, 58.34, 61.61, 68.20, 127.65, 129.65, 133.74, 133.78, 135.63. FAB-MS m/z (%): 385 ($M^+ + H$, 13), 341 (5.0), 327 (34), 307 (13), 289 (9.4), 283 (3.5), 269 (2.5), 249 (13), 239 (14), 229 (16), 219 (18), 213 (5.9), 199 (100). HR-MS (FAB) Calcd for $C_{23}H_{33}O_3Si$ ($M^+ + H$): 385.2199. Found: 385.2227.

(3*R*,5*R*)-6-(*tert*-Butyldiphenylsilyloxy)-3-(4-methoxybenzyloxy)-5-methyl-1-hexenol (19a) A solution of **18a** (42.3 g, 110 mmol) in THF (100 ml) was added dropwise to a stirred solution of 70% Red-Al (95.3 g, 330 mmol) in THF (200 ml) at -78 °C under argon. The reaction mixture was allowed to warm to -20 °C, stirred for 30 h, and quenched with MeOH (10 ml). After 1 N HCl and CH_2Cl_2 were added at 0 °C, the mixture was stirred for 1 h, and then extracted with CH_2Cl_2. The extract was washed with brine, dried over Na_2SO_4, and evaporated *in vacuo*. The residue was chromatographed on a silica gel column (*n*-hexane–EtOAc 2 : 1) to give (3*R*,5*R*)-6-(*tert*-butyldiphenylsilyloxy)-5-methylhexane-1,3-diol as a colorless oil (39.6 g, 93%). $[\alpha]_D^{23}$ +5.2° ($c=0.76$, $CHCl_3$). IR (neat) cm^{-1}: 3400, 3080, 3060, 2970, 2950, 2870. ^{1}H-NMR ($CDCl_3$) δ: 0.86 (d, 3H, $J=7.0$ Hz), 1.06 (s. 9H), 1.41 (ddd, 1H, $J=3.0$, 6.5, 18.5 Hz), 1.59 (ddd, 1H, $J=7.0$, 10.0, 14.5 Hz), 1.66—1.72 (m, 2H), 1.80—1.90 (m, 1H), 3.04 (br s, 1H), 3.48 (dd, 1H, $J=7.5$, 10.0 Hz), 3.54 (dd, 1H, $J=5.0$, 10.0 Hz), 3.78—3.90 (m, 3H), 3.94—4.01 (m, 1H), 7.37—7.47 (m, 6H), 7.65—7.69 (m, 4H). ^{13}C-NMR ($CDCl_3$) δ: 17.72, 19.18, 26.81, 33.85, 39.05, 43.56, 61.91, 70.04, 71.10, 127.72, 129.77, 133.21, 135.59. FAB-MS m/z (%): 387 ($M^+ + H$, 52), 329 (10), 307 (15), 289 (13), 251 (14), 229 (10), 219 (10), 200 (18), 199 (100), 197 (33), 195 (22), 154 (76), 139 (30), 138 (27), 137 (70), 136 (63), 135 (42), 107 (23), 95 (62). HR-MS (FAB) Calcd for $C_{23}H_{35}O_3Si$ ($M^+ + H$): 387.2355. Found: 387.2374.

p-Anisaldehyde dimethyl acetal [MPCH (OMe)2] (7.54 g, 41.4 mmol) and *p*-toluenesulfonic acid ($TsOH \cdot H_2O$) (0.5 g) were added to a stirred solution of the above diol (8.0 g, 20.7 mmol) in benzene (100 ml) at room temperature. After 3 h, the reaction mixture was neutralized with Et_3N, and extracted with EtOAc. The extract was washed with brine, dried over Na_2SO_4, and evaporated *in vacuo*. The residue was chromatographed on a silica gel column (*n*-hexane–EtOAc 5 : 1) to give an acetal as a colorless oil (10.3 g, 100%).

A solution of the acetal (10.3 g, 20.4 mmol) in CH_2Cl_2 (30 ml) was added dropwise to a stirred solution of 0.93 M DIBAH (100 ml, 93 mmol) in CH_2Cl_2 (100 ml) at -78 °C under argon. After 1.5 h, the reaction mixture was allowed to warm to 0 °C, then treated with MeOH (3 ml), diluted with Et_2O, stirred with Rochelle salt for 12 h at room temperature, and extracted with Et_2O. The extract was washed with brine, dried over Na_2SO_4, and evaporated *in vacuo*. The residue was chromatographed on a silica gel column (*n*-hexane–EtOAc 1 : 1) to give **19a** as a colorless oil (9.39 g, 90%). $[\alpha]_D^{18}$ −8.4° ($c=1.08$, $CHCl_3$). IR (neat) cm^{-1}: 3400, 3050, 2900, 2840, 1600, 1580, 1500. ^{1}H-NMR ($CDCl_3$) δ: 0.96 (d, 3H, $J=6.5$ Hz), 1.07 (s, 9H), 1.22—1.32 (m, 1H), 1.62—1.76 (m, 1H),

1.78—1.91 (m, 3H), 2.39—2.46 (m, 1H), 3.49 (dd, 1H, J=6.0, 10.0 Hz), 3.52 (dd, 1H, J=5.5, 10.0 Hz), 3.65—3.75 (m, 2H), 3.75—3.83 (m, 1H), 3.79 (s, 3H), 4.42 (d, 1H, J=11.0 Hz), 4.48 (d, 1H, J=11.0 Hz), 6.85 (d, 2H, J=9.0 Hz), 7.22 (d, 2H, J=9.0 Hz), 7.36—7.47 (m, 6H), 7.65—7.69 (m, 4H). ^{13}C-NMR ($CDCl_3$) δ: 17.5, 19.3, 26.9, 32.5, 36.2, 37.7, 55.3, 60.7, 69.0, 76.4, 113.9, 127.6, 129.4, 129.6, 130.5, 135.6, 159.2. FAB-MS m/z (%): 507 (M^++H, 9.0), 369 (4.6), 291 (3.6), 251 (3.6), 241 (3.5), 239 (7.9), 227 (4.1), 213 (5.4), 211 (4.2), 199 (54), 183 (16), 139 (14), 137 (32), 136 (15), 135 (62), 122 (58), 121 (100). HR-MS (FAB) Calcd for $C_{31}H_{43}O_4Si$ (M^++H): 507.2930. Found: 507.2922.

(3*S*,5*R*)-6-(*tert*-Butyldiphenylsilyloxy)-3-(4-methoxybenzyloxy)-5-methyl-1-hexenol (19b) **18b** (27.6 g, 71.8 mmol) was reduced to a colorless oil of (3*S*,5*R*)-(*tert*-butyldiphenylsilyloxy)-5-methylhexane-1,3-diol (27.1 g, 98%) as in the foregoing experiment. $[\alpha]_D^{23}$ −1.3° (c=0.73, $CHCl_3$). IR (neat) cm^{-1}: 3380, 3080, 3060, 2970, 2950, 2900, 2870. ^{1}H-NMR ($CDCl_3$) δ: 0.98 (d, 3H, J=7.0 Hz), 1.06 (s, 9H), 1.53 (t, 2H, J=6.5 Hz), 1.64—1.71 (m, 2H), 1.88—1.96 (m, 1H), 2.84—2.88 (m, 1H), 3.34 (d, 1H, J=3.5 Hz), 3.50 (dd, 1H, J=7.0, 10.0 Hz), 3.57 (dd, 1H, J=4.5, 10.0 Hz), 3.78—3.90 (m, 2H), 3.99—4.06 (m, 1H), 7.37—7.47 (m, 6H), 7.64—7.68 (m, 4H). ^{13}C-NMR ($CDCl_3$) δ: 17.59, 19.20, 26.85, 32.19, 38.46, 42.70, 62.05, 69.15, 70.03, 127.74, 129.79, 133.25, 135.57, 135.66. FAB-MS m/z (%): 387 (M^++H, 21), 311 (8.0), 251 (10), 239 (10), 229 (8.9), 211 (5.5), 199 (100), 181 (16), 135 (56). HR-MS (FAB) Calcd for $C_{23}H_{35}O_3Si$ (M^++H): 387.2355. Found: 387.2374.

The above diol (26.7 g, 69 mmol) was converted to a colorless oil of **19b** (32.7 g, 94%) as in the foregoing experiment. $[\alpha]_D^{23}$ +23.9° (c=0.88, $CHCl_3$). IR (neat) cm^{-1}: 3450, 3090, 3060, 3020, 2970, 2950, 2880, 1620, 1590. ^{1}H-NMR ($CDCl_3$) δ: 0.94 (d, 3H, J=7.0 Hz), 1.05 (s, 9H), 1.53 (dddd, 1H, J=5.5, 5.5, 8.5, 8.5 Hz), 1.60—1.68 (m, 1H), 1.62 (s, 1H), 1.68—1.78 (m, 1H), 1.83 (dddd, 1H, J=3.5, 3.5, 7.0, 7.5 Hz), 2.43 (t, 1H, J=5.5 Hz), 3.47 (dd, 1H, J=6.0, 10.0 Hz), 3.51 (dd, 1H, J=6.0, 10.0 Hz), 3.61—3.73 (m, 2H), 3.75—3.83 (m, 1H), 3.79 (s, 3H), 4.37 (d, 1H, J=11.0 Hz), 4.45 (d, 1H, J=11.0 Hz), 6.83—6.88 (m, 2H), 7.20—7.24 (m, 2H), 7.35—7.46 (m, 6H), 7.64—7.68 (m, 4H). ^{13}C-NMR ($CDCl_3$) δ: 17.25, 19.31, 26.90, 32.55, 35.84, 37.09, 55.27, 60.72, 68.78, 70.41, 113.88, 127.63, 129.48, 129.59, 130.39, 133.89, 135.64, 159.25. FAB-MS m/z (%): 507 (M^++H, 24), 369 (7.9), 239 (16), 219 (15), 200 (20), 196 (96), 154 (85), 137 (100). HR-MS (FAB) Calcd for $C_{31}H_{43}O_4Si$ (M^++H): 507.2930. Found: 507.2922.

(3*R*,5*R*)-6-(*tert*-Butyldiphenylsilyloxy)-3-(4-methoxybenzyloxy)-5-methylhexanal (11a) DMSO (5.5 g, 70 mmol) was added to a stirred solution of $(COCl)_2$ (4.5 g, 35.5 mmol) in CH_2Cl_2 (40 ml) at −78 °C under argon. After 10 min, a solution of **19a** (6.0 g, 11.8 mmol) in CH_2Cl_2 (12 ml) was added dropwise, and stirring was continued for 15 min. Et_3N (10.8 g, 107 mmol) was added slowly dropwise. The reaction mixture was stirred for 1 h at −30 °C, then quenched with saturated aqueous NH_4Cl, and extracted with Et_2O. The extract was washed with brine, dried over Na_2SO_4, and evaporated *in vacuo* to give a crude aldehyde, which was subjected to the next reaction. A part of the crude aldehyde was chromatographed on a silica gel column (*n*-hexane–EtOAc 5 : 1) to give **11a** as a colorless oil. $[\alpha]_D^{24}$ +2.1° (c=1.24, $CHCl_3$). IR (neat) cm^{-1}: 3100, 2970, 2950, 2890, 2750, 1730, 1620, 1600, 1520. ^{1}H-NMR ($CDCl_3$) δ: 0.93 (d, 3H, J=7.0 Hz), 1.05 (s, 9H), 1.25—1.31 (m, 1H), 1.81—1.87 (m, 2H), 2.55 (ddd, 1H, J=2.0, 5.5, 16.5 Hz), 2.65 (ddd, 1H, J=2.5, 7.0, 16.0 Hz), 3.50 (ddd, 2H, J=6.0, 10.0, 16.5 Hz), 3.79 (s, 3H), 3.96—4.02 (m, 1H), 4.43 (d, 2H, J=3.0 Hz), 6.85 (d, 2H, J=8.5 Hz), 7.20 (d, 2H, J=9.0 Hz), 7.34—7.44 (m, 6H), 7.63—7.67 (m, 4H), 9.75 (dd, 1H, J=2.0, 2.5 Hz). ^{13}C-NMR ($CDCl_3$) δ: 17.0, 19.3, 26.9, 32.4, 38.7, 48.7, 55.3, 69.0, 70.8, 72.2, 113.8, 127.6, 129.4, 129.6, 130.3, 133.8, 135.6, 159.3, 201.7. FAB-MS m/z (%): 505 (M^++H, 35), 486 (5.0), 434 (7.5), 391 (10), 371 (15), 320 (16), 307 (20), 251 (22), 199 (60), 121 (100). HR-MS (FAB) Calcd for $C_{31}H_{41}O_4Si$ (M^++H): 505.2776. Found: 505.2770.

(5*E*,2*R*,8*S*,10*R*)-11-(*tert*-Butyldiphenylsilyloxy)-1,2-isopropylidenedioxy-8-(4-methoxybenzyloxy)-10-methyl-5-undecen-4-one (20a) A 1.66 M solution of *n*-BuLi in *n*-hexane (322 μl, 0.53 mmol) was added to a stirred solution of **10** (200 mg, 0.75 mmol) in THF (2 ml) at −78 °C under argon. After 20 min, a solution of **11a** (200 mg, 0.39 mmol) in THF (1 ml) was added dropwise. The reaction mixture was allowed to warm to room temperature, stirred for 1 h, then quenched with saturated aqueous NH_4Cl, and extracted with Et_2O. The extract was washed with brine, dried over Na_2SO_4, and evaporated *in vacuo*. The residue was chromatographed on a silica gel column (*n*-hexane–EtOAc 3 : 1) to give **20a** as a colorless oil (204 mg, 80%). $[\alpha]_D^{18}$ +2.0° (c=1.0, $CHCl_3$). IR (neat) cm^{-1}: 3050, 2900, 2830, 1680, 1660, 1600, 1500. ^{1}H-NMR ($CDCl_3$) δ: 0.90 (d, 3H, J=7.0 Hz), 1.05 (s, 9H), 1.20 (ddd, 1H, J=5.0, 8.5, 13.5 Hz), 1.35 (s, 3H), 1.41 (s, 3H), 1.72 (ddd, 1H, J=5.0, 8.0, 14.0 Hz), 1.81—1.91 (m, 1H), 2.35—2.50 (m, 2H), 2.66 (dd, 1H, J=7.5, 17.0 Hz), 3.05 (dd, 1H, J=6.0, 17.0 Hz), 3.45 (dd, 1H, J=6.0, 10.0 Hz), 3.51 (dd, 1H, J=5.5, 10.0 Hz), 3.55 (dd, 1H, J=7.0, 8.5 Hz), 3.57—3.64 (m, 1H), 3.80 (s, 3H), 4.20 (dd, 1H, J=6.5, 8.5 Hz), 4.38 (d, 1H, J=16.0 Hz), 4.45 (d, 1H, J=16.0 Hz), 4.45—4.52 (m, 1H), 6.10 (dt, 1H, J=1.0, 16.0 Hz), 6.78—6.88 (m, 3H), 7.17—7.22 (m, 2H), 7.34—7.44 (m, 6H), 7.62—7.66 (m, 4H). ^{13}C-NMR ($CDCl_3$) δ: 17.6, 19.3, 25.5, 26.9, 32.4, 37.3, 37.9, 44.0, 55.3, 68.2, 69.6, 70.7, 72.0, 75.6, 109.0, 113.8, 127.6, 129.4, 135.6, 144.8, 197.6. FAB-MS m/z (%): 645 (M^++H, 4.7), 627 (6.8), 587 (3.9), 571 (5.3), 539 (3.6), 525 (4.7), 507 (13), 486 (4.8), 449 (14), 433 (7.3), 393 (18), 283 (100), 199 (100), 137 (100), 122 (100), 101 (90), 91 (58). HR-MS (FAB) Calcd for $C_{39}H_{53}O_6Si$ (M^++H): 645.3611. Found: 645.3597.

(5*E*,2*R*,4*S*,8*S*,10*R*)-11-(*tert*-Butyldiphenylsilyloxy)-8-(4-methoxybenzyloxy)-10-methyl-5-undecene-1,2,4-triol (9a) LiI (19.5 g, 0.145 mol) and then **20a** (9.4 g, 14.5 mmol) were dissolved in Et_2O (250 ml) at −40 °C. The solution was cooled to −100 °C, and $LiAlH_4$ (5.53 g, 0.145 mol) was slowly added portionwise. The reaction mixture was stirred for 1 h at −100 °C, then quenched with MeOH (5.0 ml), and mixed with 1 N HCl below 0 °C. The Et_2O layer was washed with brine, dried over Na_2SO_4, and evaporated *in vacuo*. The residue was chromatographed on a silica gel column (*n*-hexane–EtOAc 2 : 1) to give (5*E*,2*R*,4*S*,8*S*,10*R*)-11-(*tert*-butyldiphenylsilyloxy)-1,2-isopropylidenedioxy-8-(4-methoxybenzyloxy)-10-methyl-5-undecen-4-ol (9.4 g, 99%). $[\alpha]_D^{20}$ +5.6° (c=1.60, $CHCl_3$). IR (neat) cm^{-1}: 3400, 3050, 2900, 2840, 1600, 1500. ^{1}H-NMR ($CDCl_3$) δ: 0.90 (d, 3H, J=7.0 Hz), 1.05 (s, 9H), 1.23 (ddd, 1H, J=4.0, 9.0, 14.0 Hz), 1.35 (s, 3H), 1.42 (s, 3H), 1.56—1.84 (m, 3H), 1.86—1.96 (m, 1H), 2.20—2.36 (m, 2H), 2.70 (s, 1H), 3.44 (dd, 1H, J=7.0, 10.0 Hz), 3.47—3.57 (m, 3H), 3.79 (s, 3H), 4.05 (dd, 1H, J=6.0, 8.5 Hz), 4.19—4.25 (m, 1H), 4.25—4.32 (m, 1H), 4.35 (d, 1H, J=11.0 Hz), 4.48 (d, 1H, J=11.0 Hz), 5.49—5.59 (m, 1H), 5.65—5.75 (m, 1H), 6.80—6.86 (m, 2H), 7.18—7.24 (m, 2H), 7.33—7.43 (m, 6H), 7.63—7.68 (m, 4H). ^{13}C-NMR ($CDCl_3$) δ: 16.7, 19.4, 25.8, 26.9, 32.4, 37.1, 38.1, 40.9, 55.3, 69.4, 69.7 70.3, 71.5, 75.1, 76.0, 109.3, 113.8, 127.6, 127.8, 129.3, 129.5, 135.6, 159.1. FAB-MS m/z (%): 647 (M^++H, 2.8), 630 (3.0), 589 (2.6), 491 (8.5), 433 (5.9), 341 (22), 283 (37), 199 (100), 137 (100), 122 (100). HR-MS (FAB) Calcd for $C_{39}H_{55}O_6Si$ (M^++H): 647.3768. Found: 647.3792.

A solution of the above alcohol (8.9 g) in AcOH (60 ml) and MeOH (30 ml) was stirred for 24 h at room temperature. After evaporation *in vacuo*, the residue was chromatographed on a silica gel column (*n*-hexane–EtOAc 1 : 2) to give **9a** as a colorless oil (7.43 g, 89%). $[\alpha]_D^{19}$ +5.8° (c=3.0, $CHCl_3$). IR (neat) cm^{-1}: 3350, 2900, 2850, 1600, 1500. ^{1}H-NMR ($CDCl_3$) δ: 0.90 (d, 3H, J=7.0 Hz), 1.05 (s, 9H), 1.21 (ddd, 1H, J=4.5, 9.0, 13.0 Hz), 1.58 (dt, 1H, J=3.5, 15.0 Hz), 1.54—1.73 (m, 3H), 1.82—1.94 (m, 1H), 2.14—2.26 (m, 1H), 2.27 (t, 2H, J=6.5 Hz), 3.45 (dd, 2H, J=6.0, 12.0 Hz), 3.52 (dd, 2H, J=5.5, 10.0 Hz), 3.60 (m, 1H), 3.79 (s, 3H), 3.89—3.96 (m, 1H), 4.30—4.39 (m, 1H), 4.35 (d, 1H, J=11.0 Hz), 4.45 (d, 1H, J=11.0 Hz), 5.55 (dd, 1H, J=6.5, 16.0 Hz), 5.66 (dt, 1H, J=7.5 Hz), 6.81—6.87 (m, 2H), 7.18—7.23 (m, 2H), 7.34—7.44 (m, 6H), 7.60—7.68 (m, 4H). ^{13}C-NMR ($CDCl_3$) δ: 16.9, 19.4, 27.0, 32.4, 36.9, 38.1, 39.5, 55.3, 66.8, 69.4, 70.3, 71.8, 72.8, 76.0, 113.8, 127.6, 128.0, 129.3, 129.5, 159.2, 195.7. FAB-MS m/z (%): 607 (M^++H, 4.9), 589 (5.9), 543 (4.8), 499 (4.3), 469 (8.1), 446 (6.3), 391 (53), 307 (28), 289 (25), 199 (47), 154 (100), 137 (100), 121 (100). HR-MS (FAB) Calcd for $C_{36}H_{51}O_6Si$ (M^++H): 607.3457. Found: 607.3483.

(2*R*,3*S*,5*R*)-2-[(1*S*,3*R*,5*R*)-6-(*tert*-Butyldiphenylsilyloxy)-1-iodo-3-(4-methoxybenzyloxy)-5-methylhexyl]-5-(hydroxymethyl)tetrahydrofuran-3-ol (21a) $NaHCO_3$ (10.46 g, 124 mmol) and then I_2 (15.8 g, 62 mmol) were added to a stirred solution of **9a** (7.56 g, 12.4 mmol) in THF (124 ml) at 0 °C under argon. After 30 min, the reaction mixture was quenched by stirring with aqueous $Na_2S_2O_3$ for 30 min, and extracted with EtOAc. The extract was washed with brine, dried over Na_2SO_4, and evaporated *in vacuo*. The residue was chromatographed on a silica gel column (*n*-hexane–EtOAc 3 : 1) to give **21a** as a colorless oil (8.05 g, 88%). $[\alpha]_D^{20}$ −6.2° (c=1.20, $CHCl_3$). IR (neat) cm^{-1}: 3400, 2920, 2850, 1610, 1580, 1510. ^{1}H-NMR ($CDCl_3$) δ: 1.01 (d, 3H, J=7.0 Hz), 1.08 (s, 9H), 1.31 (dt, 1H, J=7.0, 9.0 Hz), 1.80—1.90 (m, 4H), 1.94—2.02 (m, 2H), 2.10—2.16 (m, 1H), 2.30 (ddd, 1H, J=2.0, 10.5, 15.0 Hz), 3.41—3.48 (m, 1H), 3.50—3.57 (m, 2H), 3.66—3.74 (m, 1H), 3.74—3.82 (m, 1H), 3.79 (s, 3H), 4.08 (dd, 1H, J=3.0, 10.5 Hz), 4.33—4.46 (m, 2H), 4.43 (d, 1H, J=11.0 Hz), 4.55 (d, 1H, J=11.0 Hz), 4.59—4.63 (m, 1H), 6.83—6.87 (m, 2H), 7.23—7.28 (m, 2H), 7.35—7.46 (m, 6H), 7.65—7.71 (m, 4H).

^{13}C-NMR ($CDCl_3$) δ: 17.6, 19.1, 26.9, 32.7, 35.9, 37.2, 42.5, 55.2, 64.5, 68.1, 70.5, 74.5, 76.4, 80.0, 86.7, 113.5, 127.4, 129.4, 130.9, 133.7, 135.5, 159.2. FAB-MS *m/z* (%): 733 (M^++H, 20), 613 (6.9), 339 (8.9), 283 (5.9), 241 (13), 199 (73), 181 (19), 135 (92), 122 (100). HR-MS (FAB) Calcd for $C_{36}H_{50}IO_6Si$ (M^++H): 733.2423. Found: 733.2400.

Diacetate of **21a**: ^{1}H-NMR ($CDCl_3$) δ: 1.01 (d, 1H, J=6.5 Hz), 1.08 (s, 9H), 1.31 (dt, 1H, J=9.0, 14.0 Hz), 1.71—1.89 (m, 2H), 1.93—2.10 (m, 3H), 2.06 (s, 3H), 2.07 (s, 3H), 2.26 (ddd, 1H, J=2.5, 9.0, 15.0 Hz), 3.52 (d, 2H, J=5.0 Hz), 3.45—3.57 (m, 1H), 3.78 (s, 3H), 3.75—3.85 (m, 1H), 4.01 (dd, 1H, J=5.5, 7.0 Hz), 4.14 (dd, 1H, J=4.5, 11.5 Hz), 4.25 (dd, 1H, J=3.0, 10.5 Hz), 4.38—4.48 (m, 1H), 4.42 (d, 1H, J=11.0 Hz), 4.57 (d, 1H, J=11.0 Hz), 5.56 (t, 1H, J=4.5 Hz), 6.82—6.86 (m, 2H), 7.22—7.25 (m, 2H), 7.31—7.45 (m, 6H), 7.64—7.71 (m, 4H). ^{13}C-NMR ($CDCl_3$) δ: 17.83, 19.39, 20.89, 20.94, 26.96, 29.90, 30.93, 32.65, 35.54, 37.46, 42.59, 55.30, 66.00, 68.30, 70.83, 70.84, 76.15, 85.24, 113.79, 127.67, 129.59, 131.03, 133.85, 133.92, 135.68, 159.20, 169.97, 170.85.

(2*S*,5*R*)-5-(Benzoyloxymethyl)-2-[(3*S*,5*R*)-6-(*tert*-butyldiphenylsilyloxy)-3-(4-methoxybenzyloxy)-5-methylhexyl]tetrahydrofuran-3-one (22a) A solution of **21a** (7.6 g, 10.3 mmol) in THF (20 ml) was added to a stirred suspension of 60% NaH (1.03 g, 25.8 mmol) in THF (80 ml) at −10 °C. After 1 h at room temperature, the reaction mixture was quenched with MeOH and then saturated aqueous NH_4Cl, and extracted with EtOAc. The extract was washed with brine, dried over Na_2SO_4, and evaporated *in vacuo*. The residue was chromatographed on a silica gel column (*n*-hexane–EtOAc 1 : 1) to give (2*S*,3*S*,5*R*)-2-[(1*E*,3*R*,5*R*)-6-(*tert*-butyldiphenylsilyloxy)-3-(4-methoxybenzyloxy)-5-methyl-1-hexenyl]-5-(hydroxymethyl)tetrahydrofuran-3-ol as a colorless oil (5.6 g, 90%). $[\alpha]_D^{21}$ +16.8° (c=0.60, $CHCl_3$). IR (neat) cm^{-1}: 3400, 3030, 2970, 1730, 1650, 1520. ^{1}H-NMR ($CDCl_3$) δ: 0.89 (d, 3H, J=6.5 Hz), 1.05 (s, 9H), 1.25—1.32 (m, 1H), 1.61 (d, 1H, J=4.0 Hz), 1.64 (s, 1H), 1.79 (ddd, 1H, J=5.0, 8.5, 14.0 Hz), 1.86—2.09 (m, 3H), 3.44 (dd, 1H, J=6.5, 10.0 Hz), 3.49—3.57 (m, 2H), 3.47—3.83 (m, 1H), 3.79 (s, 3H), 3.84—3.92 (m, 1H), 4.26 (d, 1H, J=11.5 Hz), 4.27—4.31 (m, 1H), 4.38—4.45 (m, 2H), 4.51 (d, 1H, J=11.5 Hz), 5.69 (dd, 1H, J=5.5, 17.0 Hz), 5.80 (ddd, 1H, J=7.0, 17.0 Hz), 6.81—6.86 (m, 2H), 7.20—7.24 (m, 2H), 7.34—7.44 (m, 6H), 7.62—7.67 (m, 4H). ^{13}C-NMR ($CDCl_3$) δ: 16.8, 19.3, 26.9, 32.2, 36.5, 39.0, 53.4, 55.3, 64.9, 69.1, 70.0, 74.1, 77.0, 78.3, 82.9, 113.7, 127.2, 127.6, 129.3, 129.5, 130.7, 134.0, 135.6, 135.8, 159.0. FAB-MS *m/z* (%): 605 (M^++H, 5.7), 587 (6.7), 467 (24), 391 (19), 307 (85), 289 (71), 199 (100), 183 (28), 165 (30). HR-MS (FAB) Calcd for $C_{36}H_{49}O_6Si$ (M^++H): 605.3298. Found: 605.3286.

A solution of the above olefin (5.2 g, 8.6 mmol) in EtOH (40 ml) was hydrogenated with Raney-Ni (1.0 g) at room temperature under ordinary pressure. After removal of the catalyst by filtration, the filtrate was evaporated *in vacuo*. The residue was chromatographed on a silica gel column (*n*-hexane–EtOAc 1 : 2) to give (2*S*,3*S*,5*R*)-2-[(3*S*,5*R*)-6-(*tert*-butyldiphenylsilyloxy)-3-(4-methoxybenzyloxy)-5-methylhexyl]-5-(hydroxymethyl)tetrahydrofuran-3-ol as a colorless oil (5.21 g, 100%). $[\alpha]_D^{21}$ +4.4° (c=0.29, $CHCl_3$). IR (neat) cm^{-1}: 3400, 2920, 2840, 1610, 1510. ^{1}H-NMR ($CDCl_3$) δ: 0.92 (d, 3H, J=6.5 Hz), 1.06 (s, 9H), 1.19—1.28 (m, 1H), 1.49—1.59 (m, 1H), 1.61—1.82 (m, 4H), 1.82—2.05 (m, 4H), 2.08—2.13 (m, 1H), 3.42—3.58 (m, 4H), 3.64—3.71 (m, 1H), 3.72—3.81 (m, 1H), 3.79 (s, 3H), 4.20—4.25 (m, 1H), 4.28—4.35 (m, 1H), 4.38 (d, 1H, J=11.0 Hz), 4.43 (d, 1H, J=11.0 Hz), 6.82—6.86 (m, 2H), 7.20—7.25 (m, 2H), 7.34—7.44 (m, 6H), 7.64—7.68 (m, 4H). ^{13}C-NMR ($CDCl_3$) δ: 17.2, 19.3, 24.0, 26.9, 30.1, 32.5, 36.7, 37.5, 55.3, 64.8, 69.2, 69.8, 72.9, 76.1, 77.2, 82.9, 113.8, 127.6, 129.3, 129.5, 130.7, 133.9, 135.6, 159.0. FAB-MS *m/z* (%): 607 (M^++H, 8.6), 456 (8.8), 368 (5.0), 268 (10), 239 (16), 199 (100), 135 (94), 121 (100). HR-MS (FAB) Calcd for $C_{36}H_{51}O_6Si$ (M^++H): 607.3457. Found: 607.3428.

Pyridine (1.35 g, 17.1 mmol) and then benzoyl chloride (1.44 g, 10.3 mmol) were added dropwise to a stirred solution of the above diol (5.2 g, 8.5 mmol) in CH_2Cl_2 (100 ml) during 1 h at 0 °C under argon. After 3 h, the reaction mixture was quenched with saturated aqueous $NaHCO_3$, and extracted with Et_2O. The extract was washed with 0.5 N HCl and brine, dried over Na_2SO_4, and evaporated *in vacuo*. The residue was chromatographed on a silica gel column (*n*-hexane–EtOAc 1 : 2) to give (2*S*,3*S*,5*R*)-2-[(3*S*,5*R*)-6-(*tert*-butyldiphenylsilyloxy)-3-(4-methoxybenzyloxy)-5-methylhexyl]-5-(benzoyloxymethyl)tetrahydrofuran-3-ol as a colorless oil (5.12 g, 84%). $[\alpha]_D^{21}$ +0.27° (c=3.80, $CHCl_3$). IR (neat) cm^{-1}: 3430, 3050, 2940, 2850, 1715, 1605,1580, 1505. ^{1}H-NMR ($CDCl_3$) δ: 0.91 (d, 3H, J=7.0 Hz), 1.06 (s, 9H), 1.20—1.28 (m, 1H), 1.50—1.60 (m, 1H), 1.62—1.81 (m, 4H), 1.82—1.91 (m, 1H), 1.98 (ddd, 1H, J=5.0, 9.5, 14.0 Hz), 2.06—2.17 (m, 1H), 2.15 (dd, 1H, J=7.0, 13.0 Hz), 3.44 (dd, 1H, J=6.5, 10.0 Hz), 3.52 (dd, 1H, J=5.5, 10.0 Hz), 3.51—3.59 (m, 1H), 3.79 (s, 3H), 3.81—3.87 (m, 1H), 4.25—4.29 (m, 1H), 4.27—4.36 (m, 2H), 4.37 (d, 1H, J=11.0 Hz), 4.42 (d, 1H, J=11.0 Hz), 4.54—4.62 (m, 1H), 6.81—6.85 (m, 2H), 7.19—7.23 (m, 2H), 7.34—7.46 (m, 8H), 7.53—7.58 (m, 1H), 7.63—7.68 (m, 4H), 8.03—8.07 (m, 2H). ^{13}C-NMR ($CDCl_3$) δ: 17.2, 19.3, 23.9, 26.9, 30.0, 32.5, 37.7, 55.3, 66.8, 69.2, 69.8, 72.7, 74.8, 76.1, 83.1, 113.8, 127.6, 128.4, 129.4, 130.8, 133.0, 134.0, 135.6, 159.1, 166.5. FAB-MS *m/z* (%): 711 (M^++H, 11), 654 (5.5), 307 (37), 154 (100), 137 (93), 121 (100), 105 (48). HR-MS (FAB) Calcd for $C_{43}H_{55}O_7Si$ (M^++H): 711.3716. Found: 711.3741.

DMSO (3.08 g, 39.4 mmol) was added dropwise to a stirred solution of $(COCl)_2$ (2.67 g, 21.0 mmol) in CH_2Cl_2 (100 ml) at −78 °C under argon. After 10 min, a solution of the above alcohol (5.0 g, 7.0 mmol) in CH_2Cl_2 (15 ml) was added dropwise, and stirring was continued for 15 min, and then Et_3N (6.4 g, 63.2 mmol) was added very slowly. The reaction mixture was stirred for 1 h at −78 °C, then quenched with saturated aqueous NH_4Cl, and extracted with Et_2O. The extract was washed with brine, dried over Na_2SO_4, and evaporated *in vacuo*. The residue was chromatographed on a silica gel column (*n*-hexane EtOAc 1 : 1) to give **22a** as a colorless oil (4.98 g, 100%). $[\alpha]_D^{22}$ −12.6° (c=1.67, $CHCl_3$). IR (neat) cm^{-1}: 3000, 2950, 2920, 2850, 1750, 1720, 1610, 1580, 1510. ^{1}H-NMR ($CDCl_3$) δ: 0.91 (d, 3H, J=6.5 Hz), 1.06 (s, 9H), 1.20 (ddd, 1H, J=4.5, 8.0, 13.5 Hz), 1.60—1.80 (m, 5H), 1.82—1.92 (m, 1H), 2.52 (dd, 1H, J=5.0, 18.0 Hz), 2.70 (dd, 1H, J=8.5, 18.0 Hz), 3.44 (dd, 1H, J=6.5, 10.0 Hz), 3.46—3.53 (m, 1H), 3.52 (dd, 1H, J=5.5, 10.0 Hz), 3.79 (s, 3H), 4.05—4.09 (m, 1H), 4.33 (d, 1H, J=11.0 Hz), 4.42 (d, 1H, J=11.0 Hz), 4.45 (dd, 1H, J=4.5, 12.0 Hz), 4.53 (dd, 1H, J=3.5, 12.0 Hz), 4.70—4.77 (m, 1H), 6.81—6.86 (m, 2H), 7.19—7.24 (m, 2H), 7.34—7.47 (m, 8H), 7.55—7.60 (m, 1H), 7.64—7.68 (m, 4H), 7.97—8.01 (m, 2H). ^{13}C-NMR ($CDCl_3$) δ: 17.1, 19.3, 26.9, 27.1, 32.4, 37.8, 38.5, 55.3, 67.1, 69.2, 70.0, 72.8, 75.9, 79.7, 113.7, 127.6, 129.5, 130.9, 133.3, 134.0, 135.6, 159.0, 166.2, 215.0. FAB-MS *m/z* (%): 709 (M^++H, 10), 651 (12), 571 (17), 307 (51), 199 (73), 154 (100), 138 (84), 122 (100), 105 (100), 77 (84). HR-MS (FAB) Calcd for $C_{43}H_{53}O_7Si$ (M^++H): 709.3560. Found: 709.3563.

(3*R*,5*S*)-7-[(2*S*,5*R*)-5-Benzoyloxymethyl-3-(methylidene)tetrahydrofuryl]-5-(4-methoxybenzyloxy)-3-methylheptanenitrile (23a) A 1.0 M solution of *tert*-BuOK in THF (55.5 ml, 55.5 mmol) was added dropwise to a stirred solution of methyltriphenylphosphonium bromide (24.8 g, 69.4 mmol) in THF (250 ml) at 0 °C under argon. After 1 h at room temperature, a solution of **22a** (4.92 g, 6.9 mmol) in THF (10 ml) was added dropwise at 0 °C. The reaction mixture was stirred for 2 h, then quenched with saturated aqueous NH_4Cl, and extracted with EtOAc. The extract was washed with brine, dried over Na_2SO_4, and evaporated *in vacuo*. The residue was dissolved in CH_2Cl_2 (30 ml), and to this solution were added Et_3N (1.31 g, 12.9 mmol), then benzoyl chloride (1.36 g, 9.7 mmol) and DMAP (0.2 g) at 0 °C under argon. The reaction mixture was stirred for 1 h, then quenched with saturated aqueous Na_2SO_3, and extracted with Et_2O. The extract was washed with 0.5 N HCl and brine, dried over Na_2SO_4, and evaporated *in vacuo*. The residue was chromatographed on a silica gel column (*n*-hexane–EtOAc 2 : 1) to give (2*S*,5*R*)-2-[(3*S*,5*R*)-6-(*tert*-butyldiphenylsilyloxy)-3-(4-methoxybenzyloxy)-5-methylhexyl]-5-benzoyloxymethyl-3-(methylidene)tetrahydrofuran as a colorless oil (3.57 g, 73%). $[\alpha]_D^{20}$ −21.5° (c=1.09, $CHCl_3$). IR (neat) cm^{-1}: 3050, 2910, 2840, 1710, 1600, 1580, 1505. ^{1}H-NMR ($CDCl_3$) δ: 0.92 (d, 3H, J=7.0 Hz), 1.06 (s, 9H), 1.21 (ddd, 1H, J=5.0, 8.5, 13.0 Hz), 1.57—1.78 (m, 5H), 1.85—1.95 (m, 1H), 2.49—2.58 (m, 1H), 2.74—2.88 (m, 1H), 3.44 (dd, 1H, J=6.5, 10.0 Hz), 3.48—3.56 (m, 1H), 3.53 (dd, 1H, J=5.5, 10.0 Hz), 3.79 (s, 3H), 4.32 (dd, 1H, J=4.5, 11.5 Hz), 4.36 (dd, 1H, J=5.5, 11.0 Hz), 4.37 (d, 1H, J=11.0 Hz), 4.40—4.47 (m, 1H), 4.44 (d, 1H, J=11.0 Hz), 4.48—4.52 (m, 1H), 4.89 (dd, 1H, J=1.0, 2.0 Hz), 5.03 (q, 1H, J=2.0 Hz), 6.81—6.86 (m, 2H), 7.19—7.24 (m, 2H), 7.34—7.45 (m, 8H), 7.52—7.58 (m, 1H), 7.64—7.68 (m, 4H), 8.03—8.49 (m, 2H). ^{13}C-NMR ($CDCl_3$) δ: 17.0, 19.4, 26.9, 29.6, 30.9, 32.5, 35.3, 37.9, 55.3, 66.6, 69.9, 75.0, 76.2, 80.7, 105.3, 113.7, 127.6, 128.3, 129.3, 129.5, 129.7, 131.1, 133.0, 135.6, 150.3, 159.0, 166.5. FAB-MS *m/z* (%): 707 (M^++H, 8.0), 649 (8.5), 585 (6.6), 569 (7.2), 513 (5.2), 430 (4.1), 391 (4.2), 370 (40), 329 (8.7), 313 (20), 307 (18), 303 (22), 289 (15), 243 (16), 199 (50), 154 (83), 137 (79), 121 (100), 105 (100), 77 (45). HR-MS (FAB) Calcd for $C_{44}H_{55}O_6Si$ (M^++H): 707.3767. Found: 707.3777.

A 1.0 M solution of tetra-*n*-butylammonium fluoride (TBAF) in THF (18 ml, 18 mmol) was added to a stirred solution of the above olefin (4.24 g, 6.0 mmol) in THF (40 ml) at 0 °C. After 3 h at room temperature,

the reaction mixture was quenched with H_2O, and extracted with EtOAc. The extract was washed with brine, dried over Na_2SO_4, and evaporated *in vacuo*. The residue was chromatographed on a silica gel column (*n*-hexane–EtOAc 1 : 1) to give (2*S*,5*R*)-2-[(3*S*,5*R*)-6-hydroxy-3-(4-methoxybenzyloxy)-5-methylhexyl]-5-benzoyloxymethyl-3-(methylidene)tetrahydrofuran as a colorless oil (2.45 g, 88%). $[\alpha]_D^{20}$ +0.76° (*c* = 1.06, $CHCl_3$). IR (neat) cm^{-1}: 3400, 2930, 2850, 1710, 1660, 1600, 1580, 1510. ^{1}H-NMR ($CDCl_3$) δ: 0.88 (d, 3H, *J* = 7.0 Hz), 1.30 (ddd, 1H, *J* = 3.5, 7.0, 14.5 Hz), 1.52—1.84 (m, 6H), 2.31 (m, 1H), 2.50—2.57 (m, 1H), 2.74—2.83 (m, 1H), 3.38 (dd, 1H, *J* = 6.0, 10.5 Hz), 3.42—3.49 (m, 1H), 3.52—3.59 (m, 1H), 3.78 (s, 3H), 4.31 (dd, 1H, *J* = 4.5, 11.0 Hz), 4.35 (d, 1H, *J* = 11.0 Hz), 4.37 (dd, 1H, *J* = 6.0, 11.0 Hz), 4.41—4.47 (m, 1H), 4.47—4.52 (m, 1H), 4.52 (d, 1H, *J* = 11.0 Hz), 4.90 (q, 1H, *J* = 2.0 Hz), 5.04 (q, 1H, *J* = 2.0 Hz), 6.82—6.88 (m, 2H), 7.21—7.27 (m, 2H), 7.40—7.45 (m, 2H), 7.53—7.58 (m, 1H), 8.02—8.07 (m, 2H). ^{13}C-NMR ($CDCl_3$) δ: 17.6, 29.2, 30.5, 33.6, 35.3, 38.8, 55.3, 66.6, 68.5, 70.1, 75.1, 80.6, 105.4, 113.8, 128.4, 129.4, 129.7, 130.0, 133.0, 150.2, 159.2, 166.5. FAB-MS *m*/*z* (%): 469 (M^+ + H, 15), 331 (4.8), 219 (5.8), 154 (33), 136 (29), 121 (100), 105 (28). HR-MS (FAB) Calcd for $C_{28}H_{37}O_6$ (M^+ + H): 469.2592. Found: 469.2614.

Et_3N (1.1 g, 10.9 mmol), DMAP (0.2 g) and a solution of TsCl (1.35 g, 7.1 mmol) in CH_2Cl_2 were added successively to a stirred solution of the above alcohol (2.56 g, 5.5 mmol) in CH_2Cl_2 (30 ml) at 0 °C under argon. After 2 h at room temperature, MeOH (2 ml) was added dropwise at −30 °C, and stirring was continued for 1 h. The reaction mixture was quenched with saturated aqueous NH_4Cl, and extracted with Et_2O. The extract was washed with brine, dried over Na_2SO_4, and evaporated *in vacuo*. The residue was chromatographed (*n*-hexane–EtOAc 2 : 1) to give (2*S*,5*R*)-2-[(3*S*,5*R*)-3-(4-methoxybenzyloxy)-6-toluenesulfonyloxy-5-methylhexyl]-5-benzoyloxymethyl-3-(methylidene)tetrahydrofuran as a colorless oil. $[\alpha]_D^{20}$ −25.3° (*c* = 0.80, $CHCl_3$). IR (neat) cm^{-1}: 3400, 2940, 2850, 1710, 1660, 1605, 1580, 1505. ^{1}H-NMR ($CDCl_3$) δ: 0.83 (d, 3H, *J* = 7.0 Hz), 1.20 (ddd, 1H, *J* = 4.0, 9.5, 14.0 Hz), 1.48—1.76 (m, 5H), 1.94—2.04 (m, 1H), 2.42 (s, 3H), 2.49—2.57 (m, 1H), 2.74—2.82 (m, 1H), 3.43—3.50 (m, 1H), 3.79 (s, 3H), 3.75—3.82 (m, 1H), 3.91 (dd, 1H, *J* = 5.0, 9.5 Hz), 4.27—4.50 (m, 4H), 4.28 (d, 1H, *J* = 11.0 Hz), 4.44 (d, 1H, *J* = 11.0 Hz), 4.89 (dt, 1H, *J* = 2.0, 2.5 Hz), 5.04 (dt, 1H, *J* = 2.0, 2.5 Hz), 6.82—6.87 (m, 2H), 7.17—7.22 (m, 2H), 7.30 (d, 2H, *J* = 8.5 Hz), 7.40—7.46 (m, 2H), 7.53—7.58 (m, 1H), 7.74—7.77 (m, 2H), 8.02—8.07 (m, 2H). ^{13}C-NMR ($CDCl_3$) δ: 16.4, 21.6, 29.3, 29.7, 30.6, 35.3, 37.5, 55.3, 66.6, 70.1, 75.1, 75.5, 75.7, 80.5, 105.4, 113.8, 127.9, 128.4, 129.4, 129.7, 129.8, 133.0, 144.6, 150.2, 159.2, 166.5. FAB-MS *m*/*z* (%): 623 (M^+ + H, 6.0), 460 (4.9), 307 (41), 219 (13), 154 (100), 137 (95), 121 (58), 107 (37). HR-MS (FAB) $C_{35}H_{43}O_8S$ (M^+ + H): Calcd for 623.2678. Found: 623.2687.

The above tosylate was dissolved in DMSO (5 ml) and stirred with NaCN (1.33 g, 27.1 mmol) for 30 min at 50 °C. The reaction mixture was diluted with H_2O, and extracted with EtOAc. The extract was washed with brine, dried over Na_2SO_4, and evaporated *in vacuo*. The residue was chromatographed on a silica gel column (*n*-hexane–EtOAc 2 : 1) to give **23a** as a colorless oil (2.0 g, 77%). $[\alpha]_D^{19}$ −32.1° (*c* = 0.79, $CHCl_3$). IR (neat) cm^{-1}: 2930, 2850, 1715, 1610, 1510. ^{1}H-NMR ($CDCl_3$) δ: 1.01 (d, 3H, *J* = 6.5 Hz), 1.36 (ddd, 1H, *J* = 4.0, 9.0, 14.5 Hz), 1.52—1.80 (m, 5H), 2.00—2.10 (m, 1H), 2.22 (dd, 1H, *J* = 7.0, 17.0 Hz), 2.34 (dd, 1H, *J* = 5.5, 17.0 Hz), 2.50—2.58 (m, 1H), 2.74—2.84 (m, 1H), 3.47—3.54 (m, 1H), 3.80 (s, 3H), 4.30 (dd, 1H, *J* = 4.5, 11.0 Hz), 4.34 (d, 1H, *J* = 11.0 Hz), 4.34—4.41 (m, 1H), 4.40—4.52 (m, 2H), 4.50 (d, 1H, *J* = 11.0 Hz), 4.89 (dt, 1H, *J* = 2.0, 2.5 Hz), 5.05 (dt, 1H, *J* = 2.0, 2.5 Hz), 6.84—6.88 (m, 2H), 7.21—7.26 (m, 2H), 7.40—7.46 (m, 2H), 7.53—7.58 (m, 1H), 8.03—8.07 (m, 2H). ^{13}C-NMR ($CDCl_3$) δ: 19.3, 25.2, 27.4, 29.2, 30.5, 35.3, 40.5, 55.3, 66.6, 70.2, 75.1, 75.7, 80.5, 105.5, 113.9, 118.8, 128.4, 129.4, 129.7, 130.0, 130.6, 133.0, 150.2, 159.3, 166.5. FAB-MS *m*/*z* (%): 478 (M^+ + H, 7.0), 341 (5.2), 307 (29), 289 (18), 165 (7.2), 154 (100), 136 (75). HR-MS (FAB) Calcd for $C_{29}H_{36}NO_5$ (M^+ + H): 478.2595. Found: 478.2577.

Methyl (3*R*,5*S*)-7-[(2*S*,5*R*)-3-Methyldidene-5-(2-(trimethylsilyl)ethoxymethoxymethyl)tetrahydrofuryl]-5-(4-methoxybenzyloxy)-5-methylheptanoate (5a) K_2CO_3 (0.4 g, 2.9 mmol) was added to a stirred solution of **23a** (1.4 g, 2.9 mmol) in MeOH (30 ml) at room temperature. After 4 h, the reaction mixture was diluted with H_2O, and extracted with CH_2Cl_2. The extract was washed with brine, dried over Na_2SO_4, and evaporated *in vacuo*. The residue was chromatographed on a silica gel column (*n*-hexane–EtOAc 1 : 1) to give an alcohol as a colorless oil (1.08 g, 99 %). $[\alpha]_D^{20}$ −22.1° (*c* = 3.39, $CHCl_3$). IR (neat) cm^{-1}: 3450, 2900, 2850, 1600, 1580, 1500. ^{1}H-NMR ($CDCl_3$) δ: 1.00 (d, 3H, *J* = 8.0 Hz), 1.36 (ddd, 1H, *J* = 3.5, 6.5, 13.5 Hz), 1.48—1.58 (m, 1H), 1.60—1.70 (m, 3H), 1.70—1.80 (m, 1H), 2.05—2.11 (m, 2H), 2.24 (dd, 1H, *J* = 7.0, 17.0 Hz), 2.35 (dd, 1H, *J* = 5.5, 17.0 Hz), 2.40—2.48 (m, 1H), 2.59—2.67 (m, 1H), 3.47—3.56 (m, 2H), 3.58—3.65 (m, 1H), 3.80 (s, 3H), 4.17 (ddd, 1H, *J* = 3.5, 6.5, 13.0 Hz), 4.34 (d, 1H, *J* = 11.0 Hz), 4.36—4.42 (m, 1H), 4.52 (d, 1H, *J* = 11.0 Hz), 4.86 (dd, 1H, *J* = 2.5, 4.5 Hz), 5.01 (dd, 1H, *J* = 2.0, 4.5 Hz), 6.85—6.95 (m, 2H), 7.22—7.26 (m, 2H). ^{13}C-NMR ($CDCl_3$) δ: 19.2, 25.2, 27.3, 29.2, 30.4, 34.2, 40.4, 55.3, 64.3, 70.1, 75.6, 77.5, 80.2, 105.4, 113.8, 118.8, 129.4, 130.5, 150.6, 159.2. FAB-MS *m*/*z* (%): 374 (M^+ + H, 22), 307 (17), 289 (14), 154 (70), 121 (100). HR-MS (FAB) Calcd for $C_{22}H_{32}NO_4$ (M^+ + H): 374.2333. Found: 374.2328.

(iso-Pr)$_2$EtN (1.52 ml, 8.7 mmol) and SEMCl (1.16 g, 7.0 mmol) were added to a stirred solution of the above alcohol (1.08 g, 2.9 mmol) in CH_2Cl_2 (30 ml) at room temperature. After 2 h, the reaction mixture was quenched with H_2O, and extracted with Et_2O. The extract was washed with brine, dried over Na_2SO_4, and evaporated *in vacuo*. The residue was chromatographed on a silica gel column (*n*-hexane–EtOAc 2 : 1) to give a nitrile as a colorless oil (1.42 g, 97%). $[\alpha]_D^{29}$ −11.1° (*c* = 1.80, $CHCl_3$). IR (neat) cm^{-1}: 2951, 2874, 2300, 1612, 1514. ^{1}H-NMR ($CDCl_3$) δ: 0.02 (s, 9H), 0.90—0.97 (m, 2H), 1.01 (d, 3H, *J* = 6.0 Hz), 1.35 (ddd, 1H, *J* = 4.0, 8.5, 14.0 Hz), 1.48—1.84 (m, 5H), 1.95—2.14 (m, 1H), 2.22 (dd, 1H, *J* = 7.5, 16.0 Hz), 2.36 (dd, 1H, *J* = 5.0, 17.0 Hz), 2.37—2.50 (m, 1H), 2.62—2.75 (m, 1H), 3.45—3.57 (m, 1H), 3.53 (s, 1H), 3.54 (d, 1H, *J* = 1.5 Hz), 3.61 (d, 1H, *J* = 7.5 Hz), 3.64 (d, 1H, *J* = 7.5 Hz), 3.80 (s, 3H), 4.26 (dd, 1H, *J* = 5.0, 7.5 Hz), 4.33 (d, 1H, *J* = 16.5 Hz), 4.38—4.46 (m, 1H), 4.52 (d, 1H, *J* = 16.5 Hz), 4.70 (s, 2H), 4.86 (q, 1H, *J* = 1.5 Hz), 5.01 (q, 1H, *J* = 1.5 Hz), 6.83—6.91 (m, 2H), 7.21—7.27 (m, 2H). ^{13}C-NMR ($CDCl_3$) δ: −0.95, 18.54, 19.66, 25.62, 27.87, 29.60, 30.83, 35.74, 40.88, 55.17, 65.57, 69.91, 70.57, 76.10, 77.92, 80.62, 95.45, 105.65, 114.26, 119.27, 129.84, 151.03, 159.64. FAB-MS *m*/*z* (%): 504 (M^+ + H, 0.04), 503 (0.05), 372 (7.1), 236 (15), 121 (100), 73 (37). HR-MS (FAB) Calcd for $C_{28}H_{46}NO_5Si$ (M^+ + H): 504.3147. Found: 504.3132.

A 1.0 M solution of DIBAH in *n*-hexane (188 μl, 188 μmol) was added to a stirred solution of the above nitrile (47.4 mg, 94 μmol) in CH_2Cl_2 (5.0 ml) at −78 °C under argon. After 30 min, aqueous Rochelle salt was added, and the reaction mixture was stirred for 3 h at room temperature and then extracted with Et_2O. The extract was washed with brine, dried over Na_2SO_4, and evaporated *in vacuo* to leave an oil. $[\alpha]_D^{19}$ −3.8° (*c* = 2.36, $CHCl_3$). IR (neat) cm^{-1}, 2700, 1720, 1610, 1510. ^{1}H-NMR ($CDCl_3$) δ: 0.02 (s, 9H), 0.91 (d, 3H, *J* = 6.5 Hz), 0.90—0.96 (m, 2H), 1.28 (ddd, 1H, *J* = 3.5, 8.5, 14.0 Hz), 1.50—1.69 (m, 4H), 1.69—1.80 (m, 1H), 2.22 (ddd, 1H, *J* = 2.5, 7.5, 15.0 Hz), 2.22—2.34 (m, 1H), 2.40 (ddd, 1H, *J* = 2.0, 5.0, 15.0 Hz), 2.39—2.47 (m, 1H), 2.64—2.73 (m, 1H), 3.47—3.57 (m, 3H), 3.62 (dd, 2H, *J* = 7.5, 9.0 Hz), 3.79 (s, 3H), 4.22—4.29 (m, 1H), 4.34 (d, 1H, *J* = 11.0 Hz), 4.39—4.45 (m, 1H), 4.51 (d, 1H, *J* = 11.0 Hz), 4.70 (s, 2H), 4.86 (dt, 1H, *J* = 2.0, 2.5 Hz), 5.00 (dt, 1H, *J* = 2.0, 2.5 Hz), 6.84—6.89 (m, 2H), 7.22—7.27 (m, 2H), 9.70 (t, 1H, *J* = 2.5 Hz). ^{13}C-NMR ($CDCl_3$) δ: −1.4, 18.1, 19.9, 25.0, 29.3, 30.5, 35.3, 41.5, 51.6, 55.3, 65.1, 69.5, 70.1, 75.9, 76.1, 80.3, 95.0, 105.2, 113.8, 129.4, 130.9, 150.7, 159.1, 202.5. FAB-MS *m*/*z* (%): 505 (M^+ − H, 5.9), 474 (10), 447 (10), 359 (14), 239 (76), 154 (52), 136 (100), 122 (100), 73 (100). HR-MS (FAB) Calcd for $C_{28}H_{45}O_6Si$ (M^+ − H): 505.2988. Found: 505.2958.

The residue was dissolved in acetone (1 ml) and stirred with 2.67 M Jones reagent (0.1 ml, 267 μmol) for 30 min at −20 °C. The reaction mixture was quenched slowly with iso-PrOH, diluted with H_2O, and extracted with Et_2O. The extract was washed with brine, dried over Na_2SO_4, and evaporated *in vacuo*. The residue was then treated with diazomethane in Et_2O, evaporated *in vacuo*, and chromatographed on a silica gel column (*n*-hexane–EtOAc 2 : 1) to give **5a** as a colorless oil (48.5 mg, 96%). $[\alpha]_D^{29}$ −28.2° (*c* = 0.16, $CHCl_3$). IR (neat) cm^{-1}: 3085, 2960, 2950, 2875, 1740, 1670, 1620, 1520. ^{1}H-NMR ($CDCl_3$) δ: 0.02 (s, 9H), 0.91 (d, 3H, *J* = 6.5 Hz), 0.92—0.96 (m, 2H), 1.26 (ddd, 1H, *J* = 4.0, 8.5, 10.0 Hz), 1.50—1.67 (m, 4H), 1.67—1.77 (m, 1H), 2.13 (dd, 1H, *J* = 7.5, 13.5 Hz), 2.09—2.23 (m, 1H), 2.32 (dd, 1H, *J* = 4.5, 13.5 Hz), 2.39—2.47 (m, 1H), 2.63—2.72 (m, 1H), 3.44—3.54 (m, 1H), 3.53 (dd, 1H, *J* = 5.5, 10.5 Hz), 3.54 (dd, 1H, *J* = 6.0, 10.5 Hz), 3.59—3.65 (m, 2H), 3.65 (s, 3H), 3.79 (s, 3H), 4.24—4.29 (m, 1H), 4.37 (d, 1H, *J* = 10.5 Hz), 4.38—4.45 (m, 1H), 4.48 (d, 1H, *J* = 10.5 Hz), 4.69 (s, 2H), 4.85 (dt, 1H, *J* = 2.0, 2.5 Hz), 5.0 (dt, 1H, *J* = 2.0, 2.5 Hz), 6.84—6.89 (m, 2H), 7.21—7.28 (m, 2H). ^{13}C-NMR ($CDCl_3$) δ: −1.39, 18.2, 19.8, 27.3, 29.5, 30.7, 35.4, 41.3, 42.1, 51.3, 55.3, 65.1, 69.6, 70.0, 76.1, 80.4, 95.1, 105.1,

113.8, 129.4, 131.0, 150.7, 159.1, 173.4. FAB-MS *m/z* (%): 537 ($M^+ + H$, 4.7), 535 (5.6), 509 (3.0), 490 (3.3), 419 (33), 299 (26), 269 (56), 226 (55), 209 (38), 154 (39), 136 (81), 121 (100), 73 (100). HR-MS (FAB) Calcd for $C_{29}H_{49}O_7Si$ ($M^+ + H$): 537.3247. Found: 537.3249.

(3*S*,5*R*)-6-(*tert*-Butyldiphenylsilyoxy)-3-(4-methoxybenzyloxy)-5-methylhexanal (11b) **19b** (3.0 g, 5.9 mmol) was oxidized with DMSO (2.59 g, 33.1 mmol) and $(COCl)_2$ (2.25 g, 17.7 mmol) as described for **11a** to give **11b** as a colorless oil (2.96 g). $[\alpha]_D^{22}$ −10.3° (*c* = 0.50, $CHCl_3$). IR (neat) cm^{-1}: 3080, 3060, 3020, 2970, 2950, 2870, 2740, 1730, 1620, 1590. ^{1}H-NMR ($CDCl_3$) δ: 0.96 (d, 3H, *J* = 6.5 Hz), 1.07 (s, 9H), 1.55 (dt, 1H, *J* = 7.0, 13.5 Hz), 1.68 (dt, 1H, *J* = 6.5, 13.5 Hz), 1.72—1.82 (m, 1H), 2.48—2.64 (m, 2H), 3.48 (dd, 1H, *J* = 6.5, 10.0 Hz), 3.53 (dd, 1H, *J* = 6.5, 10.0 Hz), 3.79 (s, 3H), 3.93 (dt, 1H, *J* = 5.0, 16.5 Hz), 4.40 (s, 2H), 6.83—6.85 (m, 2H), 7.17—7.21 (m, 2H), 7.36—7.46 (m, 6H), 7.64—7.68 (m, 4H), 9.77 (s, 1H). ^{13}C-NMR ($CDCl_3$) δ: 17.43, 19.29, 26.90, 32.44, 38.09, 48.50, 55.25, 68.32, 70.74, 72.55, 113.82, 127.65, 129.40, 129.63, 130.19, 133.81, 135.62, 159.25, 201.68. FAB-MS *m/z* (%): 505 ($M^+ + H$, 9.2), 369 (3.0), 307 (5.0), 289 (5.7), 239 (6.2), 199 (36), 137 (37), 121 (100). HR-MS (FAB) Calcd for $C_{31}H_{41}O_4Si$ ($M^+ + H$): 505.2776. Found: 505.2770.

(5*E*,2*R*,8*R*,10*R*)-11-(*tert*-Butyldiphenylsilyloxy)-1,2-isopropylidenedioxy-8-(4-methoxybenzyloxy)-10-methyl-5-undecen-4-one (20b) **11b** (2.96 g, 5.9 mmol) was coupled with **10** (3.62 g, 13.6 mmol) in the presence of *n*-BuLi (7.4 mmol) as described for **20a** to give **20b** as a colorless oil (3.5 g, 92%). $[\alpha]_D^{24}$ −13.2° (*c* = 0.19, $CHCl_3$). IR (neat) cm^{-1}: 3350, 3330, 2940, 2920, 2870, 2840, 1685, 1660, 1620, 1600, 1580, 1500. ^{1}H-NMR ($CDCl_3$) δ: 0.95 (d, 3H, *J* = 6.5 Hz), 1.05 (s, 9H), 1.35 (s, 3H), 1.41 (s, 3H), 1.39—1.47 (m, 1H), 1.59 (dt, 1H, *J* = 5.5, 14.5 Hz), 1.73—1.82 (m, 1H), 2.30—2.40 (m, 1H), 2.40—2.49 (m, 1H), 2.65 (dd, 1H, *J* = 8.0, 16.5 Hz), 3.07 (dd, 1H, *J* = 5.0, 16.5 Hz), 3.44 (dd, 1H, *J* = 6.0, 10.0 Hz), 3.49 (dd, 1H, *J* = 5.0, 10.0 Hz), 3.47—3.57 (m, 1H), 3.54 (dd, 1H, *J* = 6.5, 8.5 Hz), 3.77 (s, 3H), 4.22 (dd, 1H, *J* = 6.5, 8.0 Hz), 4.33 (d, 1H, *J* = 11.0 Hz), 4.39 (d, 1H, *J* = 11.0 Hz), 4.44—4.57 (m, 1H), 6.10 (dt, 1H, *J* = 2.0, 16.5 Hz), 6.79—6.87 (m, 3H), 7.16—7.19 (m, 2H), 7.34—7.45 (m, 6H), 7.62—7.65 (m, 4H). ^{13}C-NMR ($CDCl_3$) δ: 17.65, 19.31, 25.45, 26.90, 32.42, 37.36, 37.94, 44.02, 55.26, 68.25, 69.62, 70.66, 71.98, 75.65, 108.66, 113.73, 113.82, 127.63, 129.37, 129.62, 130.37, 132.49, 133.81, 133.85, 135.62, 144.80, 159.21, 197.56. FAB-MS *m/z* (%): 645 ($M^+ + H$, 0.01), 627 (0.02), 511 (0.58), 391 (1.1), 309 (1.1), 121 (100). HR-MS (FAB) Calcd for $C_{39}H_{53}O_6Si$ ($M^+ + H$): 645.3611. Found: 645.3597.

(5*E*,2*R*,4*S*,8*R*,10*R*)-11-(*tert*-Butyldiphenylsilyloxy)-8-(4-methoxybenzyloxy)-10-methyl-5-undecene-1,2,4-triol (9b) **20b** (3.2 g, 49.6 mmol) was treated with LiI (6.8 g, 50.8 mmol) and $LiAlH_4$ (1.93 g, 50.8 mmol) as described for **9a** to give (5*E*,2*R*,4*S*,8*S*,10*R*)-11-(*tert*-butyldiphenylsilyloxy)-1,2-isopropylidenedioxy-8-(4-methoxybenzyloxy)-10-methyl-5-undecen-4-ol as a colorless oil (3.1 g, 97%). $[\alpha]_D^{24}$ −11.0° (*c* = 0.52, $CHCl_3$). IR (neat) cm^{-1}: 3460, 3080, 3020, 2970, 2950, 2870, 1620, 1595, 1520. ^{1}H-NMR ($CDCl_3$) δ: 0.95 (d, 3H, *J* = 7.0 Hz), 1.05 (s, 9H), 1.35 (s, 3H), 1.42 (s, 3H), 1.34—1.44 (m, 1H), 1.60 (dt, 1H, *J* = 6.0, 16.0 Hz), 1.67 (dt, 1H, *J* = 3.5, 16.0 Hz), 1.71—1.86 (m, 2H), 2.21 (dt, 1H, *J* = 6.5, 15.0 Hz), 2.30 (dt, 1H, *J* = 6.5, 15.0 Hz), 2.75 (d, 1H, *J* = 2.5 Hz), 3.43 (dd, 1H, *J* = 5.5, 10.5 Hz), 3.45 (dd, 1H, *J* = 5.5, 10.5 Hz), 3.50 (t, 1H, *J* = 5.0 Hz), 3.52 (t, 1H, *J* = 7.5 Hz), 3.77 (s, 3H), 4.04 (dd, 1H, *J* = 5.5, 7.5 Hz), 4.17—4.24 (m, 1H), 4.24-4.30 (m, 1H), 4.30 (d, 1H, *J* = 11.5 Hz), 4.43 (d, 1H, *J* = 11.5 Hz), 5.53 (dd, 1H, *J* = 7.0, 16.0 Hz), 5.71 (dt, 1H, *J* = 6.5, 16.0 Hz), 6.79—6.85 (m, 2H), 7.17—7.21 (m, 2H), 7.34—7.45 (m, 6H), 7.62—7.66 (m, 4H). ^{13}C-NMR ($CDCl_3$) δ: 17.77, 19.35, 25.81, 26.92, 32.39, 36.82, 37.73, 40.76, 55.25, 68.34, 69.66, 70.45, 71.65, 75.07, 76.46, 109.27, 113.72, 127.61, 12.791, 129.31,129.53, 130.85, 133.92, 133.98, 134.51, 135.63, 159.07. FAB-MS *m/z* (%): 631 ($M^+ - CH_3$, 0.12), 589 (0.2), 445 (0.3), 306 (0.64), 283 (4.1), 121 (100). HR-MS (FAB) Calcd for $C_{38}H_{51}O_6Si$ ($M^+ - CH_3$): 631.3457. Found: 631.3458.

The above alcohol (3.0 g) in AcOH (30 ml) and MeOH (30 ml) was stirred to give **9b** as a colorless oil (2.69 g, 96%). $[\alpha]_D^{22}$ −10.3° (*c* = 0.5, $CHCl_3$). IR (neat) cm^{-1}: 3350, 3050, 3020, 2930, 2910, 2830, 1600, 1580, 1500. ^{1}H-NMR ($CDCl_3$) δ: 0.95 (d, 3H, *J* = 7.0 Hz), 1.05 (s, 9H), 1.39 (dt, 1H, *J* = 7.0, 14.5 Hz), 1.52—1.70 (m, 4H), 1.75—1.85 (m, 1H), 2.14—2.33 (m, 1H), 2.24—2.33 (m, 2H), 3.41—3.50 (m, 3H), 3.50 (dd, 1H, *J* = 5.5, 10.0 Hz), 3.58 (dd, 1H, *J* = 3.5, 11.0 Hz), 3.77 (s, 3H), 3.88—3.96 (m, 1H), 4.28—4.36 (m, 1H), 4.31 (d, 1H, *J* = 11.0 Hz), 4.40 (d, 1H, *J* = 11.0 Hz), 5.53 (dd, 1H, *J* = 5.5, 15.5 Hz), 5.67 (dt, 1H, *J* = 8.5, 15.5 Hz), 6.81—6.86 (m, 2H), 7.17—7.21 (m, 2H), 7.34—7.45 (m, 6H), 7.62—7.66 (m, 4H). ^{13}C-NMR ($CDCl_3$) δ: 17.76, 19.36, 26.95, 32.48, 36.61, 37.67, 39.47, 55.30, 66.73, 68.41, 70.43, 71.78, 72.87, 76.42, 113.78, 127.63, 127.98, 129.37, 129.61, 130.81, 133.96, 134.01, 134.87, 135.64, 159.18. FAB-MS *m/z* (%): 607 ($M^+ + H$, 5.6), 589 (5.9), 543 (4.9), 469 (8.2), 391 (54), 341 (14), 307 (28), 199 (48), 154 (100). HR-MS (FAB) Calcd for $C_{36}H_{51}O_6Si$ ($M^+ + H$): 607.3457. Found: 607.3469.

(2*R*,3*S*,5*R*)-2-[(1*S*,3*S*,5*R*)-6-(*tert*-Butyldiphenylsilyloxy)-1-iodo-3-(4-methoxybenzyloxy)-5-methylhexyl]-5-(hydroxymethyl)tetrahydrofuran-3-ol (21b) $NaHCO_3$ (3.54 g, 42 mmol) and then I_2 (5.35 g, 21 mmol) were added portionwise to a stirred solution of **9b** (2.56 g, 4.2 mmol) in THF (42 ml) at 0 °C under argon. After 30 min, the reaction mixture was quenched with aqueous $Na_2S_2O_3$, and extracted with EtOAc. The extract was washed with brine, dried over Na_2SO_4, and evaporated *in vacuo*. The residue was chromatographed on a silica gel column (*n*-hexane–EtOAc 3 : 1) to give **21b** (2.65 g, 86%) as a colorless oil, which was immediately subjected to the next reaction.

(2*S*,5*R*)-5-(Benzoyloxymethyl)-2-[(3*R*,5*R*)-6-(*tert*-butyldiphenylsilyloxy)-3-(4-methoxybenzyloxy)-5-methylhexyl] tetrahydrofuran-3-one (22b) **21b** (32.6 mg, 44 μmol) was treated with 60% NaH (5.3 mg, 132 μmol) as described for **22a** to give (2*S*,3*S*,5*R*)-2-[(1*E*,3*S*,5*R*)-6-(*tert*-butyldiphenylsilyloxy)-3-(4-methoxybenzyloxy)-5-methyl-1-hexenyl]-5-(hydroxymethyl)tetrahydrofuran-3-ol as a colorless oil (16.2 mg, 60%). $[\alpha]_D^{23}$ +2.9° (*c* = 0.38, $CHCl_3$). IR (neat) cm^{-1}: 3400, 3360, 3340, 2990, 2940, 2920, 2850, 1610, 1580, 1510. ^{1}H-NMR ($CDCl_3$) δ: 0.95 (d, 3H, *J* = 7.0 Hz), 1.05 (s, 9H), 1.51 (dt, 1H, *J* = 7.5, 13.5 Hz), 1.61—1.74 (m, 3H), 1.80—1.90 (m, 1H), 1.94—2.08 (m, 3H), 3.40—3.56 (m, 4H), 3.74—3.81 (m, 1H), 3.77 (s, 3H), 3.82—3.89 (m, 1H), 4.24 (d, 1H, *J* = 11.5 Hz), 4.29 (t, 1H, *J* = 3.5 Hz), 4.37—4.45 (m, 1H), 4.46 (d, 1H, *J* = 11.5 Hz), 5.69 (dd, 1H, *J* = 5.5, 15.5 Hz), 5.76 (dd, 1H, *J* = 6.0, 15.5 Hz), 6.81—6.86 (m, 2H), 7.17—7.23 (m, 2H), 7.34—7.44 (m, 6H), 7.61—7.68 (m, 4H). ^{13}C-NMR ($CDCl_3$) δ: 17.57, 19.35, 26.90, 32.15, 36.45, 39.28, 55.27, 64.68, 68.27, 70.13, 74.14, 77.47, 78.31, 82.90, 113.75, 127.30, 127.59, 129.31, 129.51, 130.67, 133.92, 135.49, 135.62, 159.07. FAB-MS *m/z* (%): 605 ($M^+ + H$, 11), 585 (4.0), 468 (9.0), 467 (25), 307 (78), 289 (60), 199 (98), 154 (100), 138 (100), 122 (100), 107 (100). HR-MS (FAB) Calcd for $C_{36}H_{49}O_6Si$ ($M^+ + H$): 605.3298. Found: 605.3320.

The above olefin (0.8 g, 1.32 mmol) was hydrogenated over Raney-Ni catalyst to give (2*S*,3*S*,5*R*)-2-[(3*R*,5*R*)-6-(*tert*-butyldiphenylsilyloxy)-3-(4-methoxybenzyloxy)-5-methylhexyl]-5-(hydroxymethyl)tetrahydrofuran-3-ol as a colorless oil (720 mg, 90%). $[\alpha]_D^{20}$ +13.1° (*c* = 0.44, $CHCl_3$). IR (neat) cm^{-1}: 3400, 3060, 3040, 2950, 2935, 2850, 1610, 1580, 1510. ^{1}H-NMR ($CDCl_3$) δ: 0.94 (d, 3H, *J* = 7.0 Hz), 1.05 (s, 9H), 1.32—1.42 (m, 1H), 1.46 (ddd, 1H, *J* = 5.5, 7.5, 13.5 Hz), 1.59 (ddd, 1H, *J* = 5.5, 7.5, 13.5 Hz), 1.63—1.81 (m, 4H), 1.84—2.05 (m, 3H), 2.16 (d, 1H, *J* = 9.0 Hz), 3.37—3.54 (m, 4H), 3.78 (s, 3H), 3.65—3.80 (m, 2H), 4.23 (br s, 1H), 4.03—4.36 (m, 1H), 4.37 (d, 1H, *J* = 11.5 Hz), 4.42 (d, 1H, *J* = 11.5 Hz), 6.82—7.24 (m, 2H), 7.19—7.24 (m, 2H), 7.34—7.45 (m, 6H), 7.63—7.67 (m, 4H). ^{13}C-NMR ($CDCl_3$) δ: 17.46, 19.33, 24.67, 26.90, 30.45, 32.55, 36.48, 37.53, 55.27, 64.86, 68.80, 70.45, 72.71, 76.96, 77.58, 82.93, 113.77, 127.62, 129.53, 129.57, 130.56, 133.92, 135.63, 159.14. FAB-MS *m/z* (%): 607 ($M^+ + H$, 23), 467 (6.0), 341 (6.8), 307 (12), 289 (15), 239 (14), 213 (16), 199 (83), 154 (93), 135 (87), 122 (100). HR-MS (FAB) Calcd for $C_{36}H_{51}O_6Si$ ($M^+ + H$): 607.3457. Found: 607.3434.

The above diol (0.7 g, 1.15 mmol) was treated with benzoyl chloride (195 mg, 1.39 mmol) and pyridine (182 mg, 2.3 mmol) to give (2*S*,3*S*,5*R*)-2-[(3*R*,5*R*)-6-(*tert*-butyldi-phenylsilyloxy)-3-(4-methoxybenzyloxy)-5-methylhexyl]-5-(benzoyloxymethyl)tetrahydrofuran-3-ol as a colorless oil (687 mg, 84%). $[\alpha]_D^{24}$ +9.4° (*c* = 0.17, $CHCl_3$). IR (neat) cm^{-1}: 3430, 3080, 3050, 2970, 2950, 2870, 1730, 1620, 1580, 1520. ^{1}H-NMR ($CDCl_3$) δ: 0.93 (d, 3H, *J* = 7.0 Hz), 1.05 (s, 9H), 1.32—1.41 (m, 1H), 1.46 (ddd, 1H, *J* = 6.0, 8.0, 13.5 Hz), 1.58 (ddd, 1H, *J* = 7.0, 11.5, 14.0 Hz), 1.64—1.80 (m, 4H), 1.96 (ddd, 1H, *J* = 4.5, 10.0, 13.5 Hz), 2.16 (dd, 1H, *J* = 7.0, 8.5 Hz), 2.00 (br s, 1H), 3.38—3.48 (m, 1H), 3.45 (dd, 1H, *J* = 5.5, 10.0 Hz), 3.51 (dd, 1H, *J* = 5.5, 10.0 Hz), 3.78 (s, 3H), 3.81—3.87 (m, 1H), 4.25—4.32 (m, 1H), 4.32 (dd, 1H, *J* = 6.0, 11.5 Hz), 4.36 (d, 1H, *J* = 3.5 Hz), 4.37 (d, 1H, *J* = 11.5 Hz), 4.41 (d, 1H, *J* = 11.5 Hz), 4.56—4.63 (m, 1H), 6.80—6.86 (m, 2H), 7.19—7.23 (m, 2H), 7.34—7.45 (m, 8H), 7.53—7.58 (m, 1H), 7.62—7.67 (m, 4H), 8.03—8.07 (m, 2H). ^{13}C-NMR ($CDCl_3$) δ: 17.44, 19.31, 24.58, 26.90, 30.41, 32.55, 37.43, 37.54, 55.24, 66.86, 68.81, 70.48, 72.46, 72.67, 74.94, 77.23, 83.13, 113.78, 127.61, 128.36, 129.55, 129.68, 130.06, 130.55, 133.02, 133.92, 135.62, 159.14, 166.53. FAB-MS *m/z* (%): 711 ($M^+ + H$, 16), 653 (6.9), 517 (12), 317 (35), 239 (16), 199 (100). HR-MS (FAB) Calcd for $C_{43}H_{55}O_7Si$ ($M^+ + H$): 711.3717. Found: 711.3731.

The above alcohol (645 mg, 0.9 mmol) was oxidized with DMSO

(398 mg, 5.1 mmol) and $(COCl)_2$ (345 mg, 2.7 mmol) to give **22b** as a colorless oil (642 mg, 100%). $[\alpha]_D^{25}$ −16.9° (c=0.18, $CHCl_3$). IR (neat) cm^{-1}: 3080, 3060, 2970, 2950, 2870, 1760, 1730, 1620, 1610, 1590, 1520. ^{1}H-NMR ($CDCl_3$) δ: 0.93 (d, 3H, J=7.0 Hz), 1.05 (s, 9H), 1.41 (dt, 1H, J=3.0, 13.5 Hz), 1.45—1.60 (m, 4H), 1.65—1.87 (m, 2H), 2.51 (dd, 1H, J=5.0, 18.0 Hz), 2.62 (dd, 1H, J=8.0, 18.0 Hz), 3.38—3.46 (m, 1H), 3.44 (dd, 1H, J=6.0, 10.0 Hz), 3.49 (dd, 1H, J=5.5, 10.0 Hz), 3.77 (s, 3H), 4.06 (dd, 1H, J=2.0, 5.0 Hz), 4.31 (d, 1H, J=11.5 Hz), 4.34 (d, 1H, J=11.5 Hz), 4.49 (dd, 1H, J=4.0, 11.5 Hz), 4.50 (dd, 1H, J=3.5, 11.5 Hz), 4.72 (dt, 1H, J=4.5, 8.0 Hz), 6.81—6.85 (m, 2H), 7.17—7.23 (m, 2H), 7.34—7.47 (m, 8H), 7.55—7.59 (m, 1H), 7.63—7.67 (m, 4H), 7.96—8.00 (m, 2H). FAB-MS m/z (%): 709 (M^++H, 7.6), 680 (5.0), 651 (22), 571 (17), 450 (8.6), 371 (12), 303 (40), 239 (61), 199 (100), 183 (100). HR-MS (FAB) Calcd for $C_{43}H_{53}O_7Si$ (M^++H): 709.3563. Found: 709.3581.

(3*R*,5*R*)-7-[(2*S*,5*R*)-5-(Benzoyloxymethyl)-3-(methylidene)tetrahydrofuryl]-5-(4-methoxybenzyloxy)-3-methylheptanenitrile (23b) 22b (620 mg, 0.87 mmol) was treated with methyltriphenylphosphonium bromide (3.12 g, 8.7 mmol) and *tert*-BuOK (7.0 mmol) as described for **23a** to give (2*S*,5*R*)-2-[(3*R*,5*R*)-6-(*tert*-butyldiphenylsilyloxy)-3-(4-methoxybenzyloxy)-5-methylhexyl]-5-benzoyloxymethyl-3-(methylidene)tetrahydrofuran as a colorless oil (597 mg, 97%). $[\alpha]_D^{25}$ −41.8° (c=0.12, $CHCl_3$). IR (neat) cm^{-1}: 3080, 3050, 2970, 2950, 2870, 1730, 1670, 1620, 1590, 1520. ^{1}H-NMR ($CDCl_3$) δ: 0.95 (d, 3H, J=7.0 Hz), 1.05 (s, 9H), 1.42 (dt, 1H, J=7.0, 7.0 Hz), 1.50—1.66 (m, 3H), 1.69—1.76 (m, 2H), 1.75—1.86 (m, 1H), 2.49—2.57 (m, 1H), 2.74—2.82 (m, 1H), 3.44 (dd, 1H, J=5.5, 10.0 Hz), 3.40—3.45 (m, 1H), 3.51 (dd, 1H, J=5.5, 10.0 Hz), 3.77 (s, 3H), 4.32 (d, 1H, J=11.5 Hz), 4.30—4.40 (m, 2H), 4.40 (d, 1H, J=11.5 Hz), 4.40—4.70 (m, 1H), 4.45 (br s, 1H), 4.89 (dt, 1H, J=2.0, 2.5 Hz), 5.03 (dt, 1H, J=2.0, 2.5 Hz), 6.79—6.85 (m, 2H), 7.18—7.23 (m, 2H), 7.34—7.47 (m, 8H), 7.52—7.58 (m, 1H), 7.63—7.67 (m, 4H), 8.03—8.07 (m, 2H). ^{13}C-NMR ($CDCl_3$) δ: 17.68, 19.33, 26.90, 29.49, 30.92, 32.49, 35.29, 37.62, 52.10, 55.27, 66.69, 68.52, 70.19, 74.98, 80.90, 105.285, 113.716, 127.59, 128.34, 129.33, 129.53, 129.57, 129.71, 130.04, 131.07, 132.91, 133.01, 133.97, 135.64, 150.38, 159.01, 166.51. FAB-MS m/z (%): 707 (M^++H, 8.4), 649 (11), 588 (5.8), 569 (14), 513 (11), 451 (6.1), 329 (19), 313 (46), 303 (59), 217 (60), 199 (100), 137 (100), 122 (100), 105 (100). HR-MS (FAB) Calcd for $C_{44}H_{55}O_6Si$ (M^++H): 707.3767. Found: 707.3744.

The above olefin (570 mg, 0.8 mmol) was treated with TBAF (4 mmol) to give (2*S*,5*R*)-2-[(3*R*,5*R*)-6-hydroxy-3-(4-methoxybenzyloxy)-5-methylhexyl]-5-benzoyloxymethyl-3-(methylidene)tetrahydrofuran as a colorless oil (326 mg, 86%). $[\alpha]_D^{25}$ −59.4° (c=0.28, $CHCl_3$). IR (neat) cm^{-1}: 3440, 3080, 3050, 2970, 2950, 2880, 1730, 1670, 1620, 1590, 1520. ^{1}H-NMR ($CDCl_3$) δ: 0.09 (d, 3H, J=6.5 Hz,), 1.59—1.58 (m, 3H), 1.68—1.76 (m, 3H), 1.81—1.91 (m, 1H), 2.49—2.57 (m, 1H), 2.67 (br s, 1H), 2.74—2.83 (m, 1H), 3.37 (dd, 1H, J=7.5, 11.5 Hz), 3.43 (dt, 1H, J=5.0, 11.0 Hz), 3.52—3.59 (m, 1H), 3.78 (s, 3H), 4.31 (dd, 1H, J=4.5, 11.5 Hz), 4.36 (dd, 1H, J=5.5, 11.5 Hz), 4.40—4.46 (m, 1H), 4.42 (d, 1H, J=11.5 Hz), 4.47 (d, 1H, J=11.5 Hz), 4.46—4.53 (m, 1H), 4.90 (dt, 1H, J=2.0, 3.0 Hz), 5.04 (dt, 1H, J=2.0, 2.5 Hz), 6.83—6.88 (m, 2H), 7.22—7.26 (m, 2H), 7.40—7.45 (m, 2H), 7.53—7.57 (m, 1H), 8.02—8.06 (m, 2H). ^{13}C-NMR ($CDCl_3$) δ: 17.18, 28.97, 31.09, 32.13, 35.28, 38.00, 55.27, 66.62, 68.12, 70.39, 75.05, 76.57, 80.65, 105.36, 113.83, 128.36, 129.55, 129.70, 130.01, 130.36, 133.04, 150.27, 159.23, 166.51. FAB-MS m/z (%): 469 (M^++H, 12), 331 (5.1), 307 (5.6), 217 (5.5), 154 (27), 136 (27), 121 (100), 105 (25). HR-MS (FAB) Calcd for $C_{28}H_{37}O_6$ (M^++H): 469.2592. Found: 469.2579.

The above alcohol (300 mg, 0.64 mmol) was treated with TsCl (244 mg, 1.28 mmol), Et_3N (194 mg, 1.92 mmol) and DMAP (20 mg) to give (2*S*,5*R*)-2-[(3*R*,5*R*)-3-(4-methoxybenzyloxy)-6-toluenesulfonyloxy-5-methylhexyl]-5-benzoyloxymethyl-3-(methylidene)tetrahydrofuran, which was immediately subjected to the next reaction. A part of the crude tosylate was chromatographed on a silica gel column (*n*-hexane–EtOAc 2:1) to give a colorless oil. $[\alpha]_D^{23}$ −50.5° (c=0.24, $CHCl_3$). IR (neat) cm^{-1}: 3050, 3020, 2930, 2850, 1730, 1600, 1590, 1585. ^{1}H-NMR ($CDCl_3$) δ: 0.90 (d, 3H, J=6.5 Hz), 1.37—1.48 (m, 2H), 1.50—1.75 (m, 4H), 1.93—2.10 (m, 1H), 2.42 (s, 3H), 2.50—2.57 (m, 1H), 2.75—2.82 (m, 1H), 3.35—3.42 (m, 1H), 3.78 (dd, 1H, J=4.5, 10.5 Hz), 3.79 (s, 3H), 3.85 (dd, 1H, J=4.5, 10.5 Hz), 4.25—4.47 (m, 6H), 4.89 (d, 1H, J=2.5 Hz), 5.04 (d, 1H, J=2.0 Hz), 6.52—6.86 (m, 2H), 7.15—7.23 (m, 2H), 7.27—7.35 (m, 2H), 7.40—7.48 (m, 2H), 7.52—7.58 (m, 1H), 7.72—7.76 (m, 2H), 8.20—8.50 (m, 2H). ^{13}C-NMR ($CDCl_3$) δ: 17.7, 21.8, 29.4, 29.8, 30.9, 35.2, 37.3, 55.5, 66.8, 70.4, 74.9, 75.3, 75.9, 80.8, 105.6, 114.0, 128.1, 128.5, 129.6, 129.9, 130.1, 133.2, 133.3. FAB-MS m/z (%): 623 (M^++H, 6.0), 460 (9.5), 307 (40), 219 (41), 154 (100), 137 (95), 121 (58). HR-MS (FAB) Calcd for $C_{35}H_{43}O_8S$ (M^++H): 623.2681. Found: 623.2687.

The above tosylate was treated with NaCN (157 mg, 3.2 mmol) to give **23b** as a colorless oil (220 mg, 72%). $[\alpha]_D^{25}$ −76.5° (c=0.32, $CHCl_3$). IR (neat) cm^{-1}: 3050, 3020, 2920, 2860, 2230, 1730, 1600, 1590, 1570, 1500. ^{1}H-NMR ($CDCl_3$) δ: 1.06 (d, 3H, J=6.5 Hz), 1.46—1.64 (m, 3H), 1.64—1.76 (m, 3H), 1.90—2.15 (m, 1H), 2.13 (dd, 1H, J=7.0, 16.5 Hz), 2.22 (dd, 1H, J=5.0, 16.5 Hz), 2.51—2.58 (m, 1H), 2.75—2.83 (m, 1H), 3.40—3.48 (m, 1H), 3.79 (s, 3H), 4.32 (ss, 1H, J=5.0, 11.5 Hz), 4.34—4.40 (m, 2H), 4.41—4.46 (m, 2H), 4.49—4.53 (m, 1H), 4.89—4.92 (m, 1H), 5.04—5.06 (m, 1H), 6.84—6.89 (m, 2H), 7.20—7.26 (m, 2H), 7.40—7.45 (m, 2H), 7.53—7.58 (m, 1H), 8.02—8.27 (m, 2H). ^{13}C-NMR ($CDCl_3$) δ: 20.39, 23.70, 26.74, 28.91, 30.71, 35.26, 39.65, 55.29, 66.62, 70.04, 75.09, 77.23, 80.51, 105.41, 113.86, 118.74, 128.36, 129.42, 129.53, 129.69, 130.01, 130.54, 133.05, 150.22, 159.27, 166.48. FAB-MS m/z (%): 478 (M^++H, 7.0), 341 (5.2), 307 (29), 289 (18), 219 (11), 165 (7.2), 154 (100), 136 (75), 121 (39), 107 (22). HR-MS (FAB) Calcd for $C_{29}H_{36}NO_5$ (M^++H): 478.2595. Found: 478.2577.

Methyl (3*R*,5*R*)-7-[(2*S*,5*R*)-3-Methylidene-5-(2-(trimethylsilyl)ethoxymethoxymethyl)tetrahydrofuryl]-5-(4-methoxybenzyloxy)-5-methylheptanoate (5b) 23b (181 mg, 0.38 mmol) was treated with K_2CO_3 (262 mg, 1.89 mmol) in MeOH, and then SEMCl (127 mg, 0.76 mmol) to give (2*S*,5*R*)-2-[(3*R*,5*R*)-6-cyano-3-(4-methoxybenzyloxy)-5-methylhexyl]-3-methylidene-5-[2-(trimethylsilyl)ethoxymethoxymethyl]tetrahydrofuran as a colorless oil (181 mg, 95%). $[\alpha]_D^{25}$ −61.0° (c=0.89, $CHCl_3$). IR (neat) cm^{-1}: 2970, 2950, 2880, 2260, 1670, 1620, 1590, 1520. ^{1}H-NMR ($CDCl_3$) δ: 0.01 (s, 9H), 0.90—0.96 (m, 2H), 1.06 (d, 3H, J=6.5 Hz), 1.45—1.73 (m, 6H), 2.0—2.10 (m, 1H), 2.12 (dd, 1H, J=7.0, 16.5 Hz), 2.21 (dd, 1H, J=5.0, 16.5 Hz), 2.40—2.47 (m, 1H), 2.64—2.72 (m, 1H), 3.39—3.46 (m, 1H), 3.52 (dd, 1H, J=5.0, 10.0 Hz), 3.55 (dd, 1H, J=6.0, 11.0 Hz), 3.59—3.65 (m, 2H), 3.80 (s, 3H), 4.26 (dt, 1H, J=6.0, 11.5 Hz), 4.35 (d, 1H, J=11.5 Hz), 4.40—4.60 (m, 1H), 4.48 (d, 1H, J=11.5 Hz), 4.66—4.72 (m, 2H), 4.86 (dt, 1H, J=2.0, 2.0 Hz), 5.01 (dt, 1H, J=2.0, 2.5 Hz), 6.85—6.89 (m, 2H), 7.22—7.26 (m, 2H). ^{13}C-NMR ($CDCl_3$) δ: −1.39, 18.12, 20.43, 23.72, 26.70, 28.91, 30.65, 35.35, 39.69, 55.30, 65.14, 69.53, 70.06, 75.24, 76.19, 77.23, 80.27, 95.04, 105.18, 113.88, 118.78, 129.55, 130.58, 150.64, 159.27. FAB-MS m/z (%): 504 (M^++H, 12), 446 (4.2), 386 (6.4), 372 (10), 307 (4.1), 236 (24), 209 (8.3), 154 (27), 136 (40), 121 (100), 107 (14), 73 (64). HR-MS (FAB) Calcd for $C_{28}H_{46}NO_5Si$ (M^++H): 504.3147. Found: 504.3156.

The above nitrile (170 mg, 337 μmol) was reduced with DIBAH (675 μmol) to give (2*S*,5*R*)-2-[(3*R*,5*R*)-6-formyl-3-(4-methoxybenzyloxy)-5-methylhexyl]-3-methylidene-5-[2-(trimethylsilyl)ethoxymethoxymethyl]tetrahydrofuran. IR (neat) cm^{-1}: 2940, 2850, 2700, 1720, 1610, 1510. ^{1}H-NMR ($CDCl_3$) δ: 0.02 (s, 9H), 0.96 (d, 3H, J=7.0 Hz), 0.90—1.00 (m, 2H), 1.39 (ddd, 1H, J=4.5, 7.5, 15.0 Hz), 1.50—1.80 (m, 5H), 2.13 (ddd, 1H, J=3.0, 8.0, 16.0 Hz), 2.18—2.28 (m, 1H), 2.35 (ddd, 1H, J=2.0, 5.0, 16.0 Hz), 2.39—2.48 (m, 1H), 2.64—2.72 (m, 1H), 3.42—3.48 (m, 1H), 3.52 (dd, 1H, J=5.0, 10.5 Hz), 3.56 (dd, 1H, J=6.0, 10.5 Hz), 3.61 (d, 1H, J=8.5 Hz), 3.63 (d, 1H, J=9.0 Hz), 3.79 (s, 3H), 4.26 (dt, 1H, J=5.5, 11.5 Hz), 4.34 (d, 1H, J=11.5 Hz), 4.38—4.46 (m, 1H), 4.47 (d, 1H, J=11.5 Hz), 4.70 (s, 2H), 4.87 (dt, 1H, J=2.0, 2.0 Hz), 5.01 (dt, 1H, J=2.0, 2.5 Hz), 6.83—6.87 (m, 2H), 7.22—7.27 (m, 2H), 9.67 (dd, 1H, J=2.0, 3.0 Hz). ^{13}C-NMR ($CDCl_3$) δ: −1.38, 18.14, 20.85, 24.95, 29.15, 30.67, 35.39, 41.20, 50.60, 55.30, 65.14, 69.59, 70.08, 75.86, 76.15, 80.43, 95.08, 105.10, 113.84, 129.48, 130.87, 150.77, 159.22, 202.78. FAB-MS m/z (%): 505 (M^+−H, 6.0), 447 (10), 359 (14), 239 (76), 226 (75), 154 (52), 136 (100), 122 (100). HR-MS (FAB) Calcd for $C_{28}H_{45}O_6Si$ (M^+−H): 505.2986. Found: 505.2958.

The above crude aldehyde was treated with Jones reagent (0.89 mmol) and then diazomethane to give **5b** as a colorless oil (174 mg, 96%). $[\alpha]_D^{29}$ −46.3° (c=0.38, $CHCl_3$). IR (neat) cm^{-1}: 3085, 2960, 2880, 1740, 1670, 1620. ^{1}H-NMR ($CDCl_3$) δ: 0.01 (s, 9H), 0.88—0.96 (m, 2H), 0.94 (d, 3H, J=6.5 Hz), 1.39 (ddd, 1H, J=5.5, 7.0, 13.5 Hz), 1.48—1.74 (m, 5H), 2.06 (dd, 1H, J=8.0, 14.0 Hz), 2.08—2.18 (m, 1H), 2.32 (dd, 1H, J=5.0, 14.0 Hz), 2.39—2.47 (m, 1H), 2.64—2.72 (m, 1H), 3.41—3.47 (m, 1H), 3.52 (dd, 1H, J=5.0, 10.5 Hz), 3.56 (dd, 1H, J=6.0, 10.5 Hz), 3.59—3.64 (m, 2H), 3.64 (s, 3H), 3.78 (s, 3H), 4.25 (ddd, 1H, J=6.0, 7.5, 12.5 Hz), 4.37 (d, 1H, J=11.0 Hz), 4.39—4.44 (m, 1H), 4.45 (d, 1H, J=11.0 Hz), 4.69 (s, 2H), 4.86 (dt, 1H, J=2.0, 2.5 Hz), 5.00 (dt, 1H, J=2.0, 2.5 Hz), 6.83—6.88 (m, 2H), 7.23—7.29 (m, 2H). ^{13}C-NMR ($CDCl_3$) δ: −1.39, 18.12, 20.44, 29.26, 30.69, 35.37, 41.02, 41.24, 51.33, 55.28, 65.12, 69.55,

70.26, 76.09, 76.26, 77.23, 80.48, 95.04, 105.08, 113.77, 129.41, 130.96, 150.78, 159.10, 173.44. FAB-MS *m/z* (%): 537 ($M^+ + H$, 4.1), 535 (3.1), 495 (2.5), 479 (3.9), 447 (2.5), 419 (22), 405 (10), 389 (7.1), 299 (24), 269 (54), 226 (60), 136 (76), 121 (100), 73 (100). HR-MS (FAB) Calcd for $C_{29}H_{49}O_7Si$ ($M^+ + H$): 537.3250. Found: 537.3270.

(2*R*,4*S*,5*S*,6*R*,7*R*,8*S*,10*S*,11*R*,12*R*,14*R*,17*S*,20*R*)-5,7-Bis(*tert*-butyldimethylsilyloxy)-6,12-dimethyl-10-hydroxy-1,2-isopropylidenedioxy-14-(4-methoxybenzyloxy)-11-methoxycarbonyl-18-methylidene-21-[2-(trimethylsilyl)ethoxymethoxy]-4,8; 17,20-diepoxyhenicosane (7b) A 1.63 M solution of *n*-BuLi in *n*-hexane (0.515 ml) was added dropwise to a stirred solution of iso-Pr_2NH (0.125 ml) in THF (1.07 ml) at −78 °C under argon, and stirring was continued for 20 min to prepare 0.5 M LDA solution, from which (186 μl, 93 μmol) was added to a stirred solution of **5b** (50 mg, 93 μmol) in THF (3 ml). After 15 min, a solution of **6** (35 mg, 67.7 μmol) in THF (1 ml) was added, and stirring was continued for 15 min at −78 °C. The reaction mixture was quenched with saturated aqueous NH_4Cl, and extracted with Et_2O. The extract was washed with brine, dried over Na_2SO_4, and evaporated *in vacuo*. The residue was chromatographed on a silica gel column (*n*-hexane–EtOAc 7:1) to give **7b** as a colorless oil (56 mg, 79%). $[\alpha]_D^{22}$ −42.0° (*c* = 0.40, $CHCl_3$). IR (neat) cm^{-1}: 3480, 2975, 2950, 2870, 1740, 1670, 1620, 1595, 1520. ^{1}H-NMR ($CDCl_3$) δ: 0.01 (s, 9H), 0.05 (s, 3H), 0.06 (s, 3H), 0.07 (s, 3H), 0.10 (s, 3H), 0.87 (s, 9H), 0.89 (s, 9H), 0.93 (t, 2H, *J* = 8.5 Hz), 0.90—1.10 (m, 5H), 1.24 (d, 1H, *J* = 7.0 Hz), 1.18—1.28 (m, 1H), 1.37 (s, 3H), 1.41 (s, 3H), 1.42—1.65 (m, 3H), 1.66—1.87 (m, 4H), 2.05—2.18 (m, 2H), 2.37—2.50 (m, 2H), 2.67 (dd, 1H, *J* = 7.0, 15.5 Hz), 2.95 (t, 1H, *J* = 9.0 Hz), 3.38—3.55 (m, 4H), 3.55—3.68 (m, 2H), 3.63 (s, 3H), 3.79 (s, 3H), 3.85 (dd, 1H, *J* = 3.0, 11.0 Hz), 3.92 (d, 1H, *J* = 4.0 Hz), 4.00—4.08 (m, 1H), 4.09—4.20 (m, 2H), 4.22 (dt, 1H, *J* = 5.5, 12.0 Hz), 4.37 (d, 1H, *J* = 11.0 Hz), 4.40 (d, 1H, *J* = 11.0 Hz), 4.35—4.43 (m, 1H), 4.69 (s, 2H), 4.85 (s, 2H), 4.97 (s, 2H), 6.78—6.86 (m, 2H), 7.20—7.28 (m, 2H). ^{13}C-NMR ($CDCl_3$) δ: −4.85, −4.26, −3.22, −3.18, −1.41, 15.24, 17.98, 18.09, 18.27, 18.34, 25.77, 26.12, 26.17, 26.52, 26.67, 29.37, 30.01, 30.87, 35.35, 37.42, 38.90, 40.88, 51.10, 55.25, 57.30, 64.85, 65.09, 69.06, 69.51, 69.99, 70.17, 73.10, 75.91, 76.50, 76.77, 77.23, 77.45, 77.73, 80.67, 95.03, 105.03, 109.73, 113.59, 113.68, 129.68, 131.14, 150.88, 158.98, 174.12. FAB-MS *m/z* (%): 1053 ($M^+ + H$, 5.6), 915 (5.5), 799 (7.6), 739 (11), 459 (12), 327 (21), 315 (63), 231 (100), 137 (100). HR-MS (FAB) Calcd for $C_{55}H_{101}O_{13}Si_3$ ($M^+ + H$): 1053.6550. Found: 1053.6590.

Methyl (2*R*,4*S*,5*S*,6*R*,7*R*,8*S*,10*S*,11*R*,12*R*,14*S*,17*S*,20*R*)-5,7-Bis(*tert*-butyldimethylsilyloxy)-6,12-dimethyl-10-hydroxy-1,2-isopropylidenedioxy-14-(4-methoxybenzyloxy)-18-methylidene-21-[2-(trimethylsilyl)ethoxymethoxy]-4,8; 17,20-diepoxy-11-henicosanecarboxylate (7a) A THF solution of **5a** (117 mg, 0.217 mmol) was treated with 0.5 M LDA (0.434 ml, 0.217 mmol) and coupled with **6** (90 mg, 0.174 mmol) as described for **7b** to give **7a** as a colorless oil (144 mg, 78%). $[\alpha]_D^{19}$ −35.3° (*c* = 0.58, $CHCl_3$). IR (neat) cm^{-1}: 3480, 2970, 2950, 2910, 2870, 1740, 1670, 1620, 1580, 1520. ^{1}H-NMR ($CDCl_3$) δ: 0.01 (s, 3H), 0.02 (s, 9H), 0.04 (s, 3H), 0.05 (s, 3H), 0.06 (s, 3H), 0.86 (s, 9H), 0.89 (s, 9H), 0.85—0.95 (m, 6H), 0.97 (d, 3H, *J* = 7.0 Hz), 1.17—1.31 (m, 3H), 1.31 (s, 3H), 1.32 (s, 3H), 1.33—1.42 (m, 1H), 1.50—1.66 (m, 4H), 1.69—1.88 (m, 3H), 2.09 (ddd, 1H, *J* = 8.0, 11.5, 20.0 Hz), 2.37—2.45 (m, 3H), 2.63—2.72 (m, 1H), 2.95 (t, 1H, *J* = 9.0 Hz), 3.43 (dd, 1H, *J* = 6.0, 10.5 Hz), 3.44—3.52 (m, 2H), 3.53 (d, 1H, *J* = 3.5 Hz), 3.40 (d, 1H, *J* = 4.0 Hz), 3.62 (s, 3H), 3.56—3.66 (m, 3H), 3.86 (ddd, 1H, *J* = 2.5, 6.0, 11.0 Hz), 3.97—4.03 (m, 2H), 4.09—4.19 (m, 2H), 4.20—4.29 (m, 1H), 4.32 (d, 1H, *J* = 11.5 Hz), 4.36—4.44 (m, 1H), 4.48 (d, 1H, *J* = 11.5 Hz), 4.70 (s, 2H), 4.85 (dt, 1H, *J* = 2.0, 2.5 Hz), 4.99 (dt, 1H, *J* = 2.0, 2.5 Hz), 6.81—6.86 (m, 2H), 7.21—7.26 (m, 2H). ^{13}C-NMR ($CDCl_3$) δ: −4.82, −4.24, −3.25, −3.14, −1.38, 15.23, 17.79, 18.01, 18.12, 18.27, 25.80, 26.00, 26.13, 26.57, 26.83, 28.37, 29.65, 30.85, 35.35, 37.07, 38.99, 41.04, 51.00, 55.27, 57.86, 64.52, 65.12, 69.09, 69.53, 69.77, 69.86, 73.17, 75.68, 76.06, 76.50, 77.23, 77.65, 80.58, 95.06, 105.14, 109.80, 113.62, 113.75, 127.65, 129.35, 131.25, 135.64, 150.73, 158.96, 174.17. FAB-MS *m/z* (%): 1052 (M^+, 7.1), 1001 (12), 966 (11), 891 (12), 825 (15), 725 (25), 638 (14), 572 (10), 507 (10), 471 (15), 341 (20), 315 (49), 231 (35), 185 (56), 122 (100). HR-MS (FAB) Calcd for $C_{55}H_{100}O_{13}Si_3$ (M^+): 1052.6472. Found 1052.6410.

(2*R*,4*S*,5*S*,6*R*,7*R*,8*S*,10*S*,12*R*,14*R*,17*S*,20*R*)-5,7-Bis(*tert*-butyldimethylsilyloxy)-1,2-isopropylidenedioxy-14-(4-methoxybenzyloxy)-6,12-dimethyl-11,18-dimethylidene-21-[2-(trimethylsilyl)ethoxymethoxy]-4,8; 17,20-diepoxyhenicosan-10-ol (24b) A solution of **7b** (200 mg, 0.19 mmol) in THF (10 ml) was added to a stirred suspension of $LiAlH_4$ (23 mg, 0.61 mmol) in THF (5 ml) at 0 °C under argon. After 4 h, MeOH and then saturated aqueous $NaHCO_3$ and Celite were added. After removal of insoluble materials, the filtrate was diluted with Et_2O, washed with brine, dried over Na_2SO_4, and evaporated *in vacuo*. The residue was chromatographed on a silica gel column (*n*-hexane–EtOAc 2:1) to give (2*R*,4*S*,5*S*,6*R*,7*R*,-8*S*,10*S*,11*S*,12*R*,14*R*,17*S*,20*R*)-5,7-bis(*tert*-butyldimethylsilyloxy)-11-hydroxymethyl-1,2-isopropylidenedioxy-14-(4-methoxybenzyloxy)-6,12-dimethyl-18-methylidene-21-[2-(trimethylsilyl)ethoxymethoxy]-4,8; 17,20-diepoxyhenicosan-10-ol as a colorless oil (158 mg, 82%). $[\alpha]_D^{20}$ −49.5° (*c* = 0.46, $CHCl_3$). IR (neat) cm^{-1}: 3500, 2970, 2880, 1675, 1620, 1595, 1520. ^{1}H-NMR ($CDCl_3$) δ: 0.02 (s, 9H), 0.03 (s, 3H), 0.07 (s, 3H), 0.08 (s, 3H), 0.09 (s, 3H), 0.87 (s, 9H), 0.91 (s, 9H), 0.95 (d, 4H, *J* = 7.0 Hz), 1.00 (d, 3H, *J* = 6.5 Hz), 1.20—1.28 (m, 1H), 1.36 (s, 3H), 1.41 (s, 3H), 1.45—1.55 (m, 3H), 1.62—1.70 (m, 2H), 1.70—1.78 (m, 3H), 1.83 (d, 1H, *J* = 16.0 Hz), 2.02 (t, 1H, *J* = 11.5 Hz), 2.10—2.18 (m, 1H), 2.39—2.47 (m, 1H), 2.66 (dd, 1H, *J* = 7.0, 16.0 Hz), 3.01 (t, 1H, *J* = 9.0 Hz), 2.96—3.04 (m, 1H), 3.44 (d, 1H, *J* = 5.5 Hz), 3.46 (d, 1H, *J* = 5.5 Hz), 3.48—3.56 (m, 3H), 3.56—3.65 (m, 3H), 3.673.72 (m, 1H), 3.73—3.79 (m, 1H), 3.79 (s, 3H), 3.83 (dd, 1H, *J* = 5.5, 10.0 Hz), 4.06 (dd, 1H, *J* = 5.5, 7.5 Hz), 4.09 (d, 1H, *J* = 4.0 Hz), 4.13—4.19 (m, 2H), 4.24 (dt, 1H, *J* = 6.0, 12.0 Hz), 4.38 (d, 1H, *J* = 18.0 Hz), 4.38—4.41 (m, 1H), 4.42 (d, 1H, *J* = 18.0 Hz), 4.70 (s, 2H), 4.86 (s, 1H), 4.99 (s, 1H), 4.83—4.88 (m, 2H), 7.22—7.25 (m, 2H). ^{13}C-NMR ($CDCl_3$) δ: −4.83, −4.24, −3.13, −2.94, −1.39, 15.33, 17.98, 18.11, 18.31, 18.64, 25.77, 26.04, 26.10, 26.54, 26.67, 29.23, 30.78, 35.33, 36.30, 38.97, 40.95, 50.02, 55.25, 62.86, 65.09, 67.36, 69.31, 69.50, 69.99, 70.15, 73.17, 75.99, 76.79, 77.58, 80.63, 95.03, 105.07, 109.78, 113.72, 129.24, 129.35, 131.02, 150.84, 159.03. FAB-MS *m/z* (%): 1025 ($M^+ + H$, 17), 867 (3.3), 754 (3.4), 711 (4.0), 579 (4.0), 459 (5.9), 341 (13), 315 (30), 231 (58), 185 (43), 136 (59), 122 (100). HR-MS (FAB) Calcd for $C_{54}H_{101}O_{12}Si_3$ ($M^+ + H$): 1025.6601. Found: 1025.6540.

TsCl (233 mg, 1.22 mmol) was added to a stirred solution of the alcohol (417 mg, 0.41 mmol) and pyridine (161 mg, 2.03 mmol) in CH_2Cl_2 (10 ml) at 0 °C. After 10 h at room temperature, the reaction mixture was quenched with MeOH and then H_2O, and extracted with Et_2O. The extract was washed with brine, dried over Na_2SO_4, and evaporated *in vacuo*. The residue was chromatographed on a silica gel column (*n*-hexane–EtOAc 3:1) to give (2*R*,4*S*,5*S*,6*R*,7*R*,8*S*,10*S*,11*S*,12*R*,14*R*,17*S*,20*R*)-5,7-bis(*tert*-butyldimethylsilyloxy)-1,2-isopropylidenedioxy-14-(4-methoxybenzyloxy)-6,12-dimethyl-18-methylidene-11-toluenesulfonyloxymethyl-21-[2-(trimethylsilyl)ethoxymethoxy]-4,8; 17,20-diepoxyhenicosan-10-ol as a colorless oil (432 mg, 90%). $[\alpha]_D^{20}$ −38.8° (*c* = 0.70, $CHCl_3$). IR (neat) cm^{-1}: 3490, 2980, 2940, 2870, 1670, 1620, 1610, 1590, 1520. ^{1}H-NMR ($CDCl_3$) δ: 0.01 (s, 9H), 0.02 (s, 3H), 0.03 (s, 3H), 0.08 (s, 6H), 0.87 (s, 9H), 0.88 (s, 9H), 0.85—0.96 (m, 5H), 0.99 (d, 3H, *J* = 6.0 Hz), 1.11—1.23 (m, 1H), 1.33 (s, 3H), 1.38 (s, 3H), 1.44—1.53 (m, 2H), 1.54—1.75 (m, 6H), 1.78—1.85 (m, 2H), 1.97—2.10 (m, 2H), 2.38—2.47 (m, 1H), 2.42 (s, 3H), 2.62—2.70 (m, 1H), 2.93 (t, 1H, *J* = 9.5 Hz), 3.36—3.47 (m, 1H), 3.44 (dd, 1H, *J* = 6.0, 11.5 Hz), 3.46—3.58 (m, 4H), 3.58—3.65 (m, 4H), 3.61 (dd, 1H, *J* = 6.0, 7.5 Hz), 3.80 (s, 3H), 3.77—3.89 (m, 2H), 3.91—4.08 (m, 3H), 4.09—4.16 (m, 1H), 4.23 (dt, 1H, *J* = 6.5, 12.0 Hz), 4.34 (d, 1H, *J* = 11.0 Hz), 4.35—4.40 (m, 1H), 4.38 (d, 1H, *J* = 11.0 Hz), 4.69 (s, 2H), 4.83—4.87 (m, 1H), 4.95—4.99 (m, 1H), 6.82—6.87 (m, 2H), 7.21—7.25 (m, 2H), 7.28—7.31 (m, 2H), 7.75—7.79 (m, 2H). ^{13}C-NMR ($CDCl_3$) δ: −4.79, −4.24, −3.22, −2.91, −1.39, 15.31, 18.02, 18.12, 18.33, 18.49, 21.65, 25.81, 26.15, 26.35, 26.65, 29.17, 29.23, 30.73, 35.37, 37.73, 38.85, 40.89, 48.45, 55.29, 64.54, 65.11, 69.15, 69.53, 69.70, 70.03, 70.15, 73.15, 75.97, 77.23, 77.52, 77.80, 80.63, 95.06, 105.08, 109.82, 113.66, 113.73, 128.05, 129.41, 129.79, 131.11, 133.12, 144.49, 150.86, 159.03. FAB-MS *m/z* (%): 1179 ($M^+ + H$, 6.8), 1127 (8.8), 1061 (7.2), 985 (13), 753 (12), 677 (17), 409 (19), 315 (70), 241 (95), 147 (98), 122 (100). HR-MS (FAB) Calcd for $C_{61}H_{107}O_{14}SSi_3$ ($M^+ + H$): 1179.6689. Found: 1179.6656.

NaI (559 mg, 3.73 mmol), $NaHCO_3$ (313 mg, 3.73 mmol) and 1,8-diazabicyclo-[5.4.0]undec-7-ene (DBU) (568 mg, 3.73 mmol) were added to a stirred solution of the tosylate (220 mg, 0.186 mmol) in THF (5 ml) at room temperature. The mixture was heated under reflux for 8 h, then cooled to room temperature, quenched with H_2O, and extracted with Et_2O. The extract was washed with brine, dried over Na_2SO_4, and evaporated *in vacuo*. The residue was chromatographed on a silica gel column (*n*-hexane–EtOAc 2:1) to give **24b** as a colorless oil (141 mg, 75%). $[\alpha]_D^{24}$ −55.5° (*c* = 0.25, $CHCl_3$). IR (neat) cm^{-1}: 3500, 2970, 2940, 2870, 2940, 1620, 1520. ^{1}H-NMR ($CDCl_3$) δ: 0.01 (s, 9H), 0.03 (s, 3H), 0.05 (s, 3H), 0.07 (s, 6H), 0.87 (s, 9H), 0.88 (s, 9H), 0.91—0.95 (m, 2H), 0.99 (d, 3H, *J* = 7.0 Hz), 1.06 (d, 3H, *J* = 7.0 Hz), 1.25—1.32 (m, 1H),

1.34 (s, 3H), 1.40 (s, 3H), 1.49—1.57 (m, 1H), 1.58—1.78 (m, 4H), 1.80 (dt, 1H, J=4.0, 15.5 Hz), 1.78—1.89 (m, 1H), 2.00—2.08 (m, 1H), 2.19 (ddd, 1H, J=7.0, 11.0, 15.0 Hz), 2.42 (dd, 1H, J=6.0, 15.0 Hz), 2.50 (dt, 1H, J=6.0, 13.5 Hz), 2.65 (dd, 1H, J=7.0, 15.5 Hz), 2.95 (t, 1H, J=9.5 Hz), 3.43 (dd, 1H, J=7.0, 11.5 Hz), 3.46—3.56 (m, 5H), 3.61 (d, 1H, J=7.0 Hz), 3.63 (d, 1H, J=8.5 Hz), 3.58—3.65 (m, 1H), 3.77 (s, 3H), 3.83 (ddd, 1H, J=2.0, 5.5, 11.5 Hz), 4.04 (dd, 1H, J=5.5, 7.5 Hz), 4.18—4.26 (m, 2H), 4.27—4.32 (m, 1H), 4.35 (d, 1H, J=11.0 Hz), 4.33—4.42 (m, 1H), 4.38 (d, 1H, J=11.0 Hz), 4.68 (s, 2H), 4.84 (s, 2H), 4.97 (s, 1H), 5.07 (s, 1H), 6.81—6.86 (m, 2H), 7.21—7.27 (m, 2H). ^{13}C-NMR ($CDCl_3$) δ: −4.90, −4.25, −3.15, −3.06, −1.44, 15.33, 17.94, 18.06, 22.59, 25.75, 25.96, 26.08, 26.70, 26.80, 29.24, 30.71, 32.56, 35.33, 40.35, 40.86, 41.26, 55.17, 65.03, 68.75, 69.31, 69.49, 69.64, 70.04, 73.18, 75.51, 75.82, 75.97, 80.52, 94.99, 104.97, 108.32, 109.30, 113.65, 129.21, 131.13, 157.72, 158.96. FAB-MS m/z (%): 1007 (M^++H, 2.7), 988 (6.8), 858 (6.5), 711 (7.8), 693 (10), 415 (25), 381 (20), 315 (84), 283 (90), 231 (50), 171 (100). HR-MS (FAB) Calcd for $C_{54}H_{99}O_{11}Si_3$ (M^++H): 1007.6495. Found: 1007.6475.

(2*R*,4*S*,5*S*,6*R*,7*R*,8*S*,10*S*,12*R*,14*S*,17*S*,20*R*)-5,7-Bis(*tert*-butyldimethylsilyloxy)-1,2-isopropylidenedioxy-14-(4-methoxybenzyloxy)-6,12-dimethyl-11,18-dimethylidene-21-[2-(trimethylsilyl)ethoxymethoxy]-4,8; 17,20-diepoxyhenicosan-10-ol (24a) A solution of **7a** (98 mg, 93 μmol) in THF (1.5 ml) was reduced with $LiAlH_4$ (10.5 mg, 279 μmol) in THF as described for **24b** to give (2*R*,4*S*,5*S*,6*R*,7*R*,8*S*,10*S*,11*S*,12*R*,14*S*,17*S*,20*R*)-5,7-bis(*tert*-butyldimethylsilyloxy)-11-hydroxymethyl-1,2-isopropylidenedioxy-14-(4-methoxybenzyloxy)-6,12-dimethyl-18-methylidene-21-[2-(trimethylsilyl) ethoxymethoxy]-4,8; 17,20-diepoxyhenicosane as a colorless oil (84 mg, 88%). $[\alpha]_D^{22}$ −31.2° (c=2.16, $CHCl_3$). IR (neat) cm^{-1}: 3500, 2970, 2950, 2870, 1620, 1520. ^{1}H-NMR ($CDCl_3$) δ: 0.02 (s, 9H), 0.03 (s, 3H), 0.07 (s, 6H), 0.08 (s, 3H), 0.87 (s, 9H), 0.90 (s, 9H), 0.91—0.96 (m, 2H), 0.91 (d, 3H, J=6.5 Hz), 1.00 (d, 3H, J=6.5 Hz), 1.13—1.32 (m, 2H), 1.36 (s, 3H), 1.39 (s, 3H), 1.55—1.88 (m, 6H), 1.98—2.07 (m, 1H), 2.09—2.17 (m, 1H), 2.39—2.45 (m, 1H), 2.63—2.71 (m, 1H), 2.99 (t, 1H, J=9.0 Hz), 3.15 (br s, 1H), 3.45 (dd, 1H, J=5.5, 11.5 Hz), 3.45—3.56 (m, 4H), 3.57—3.64 (m, 3H), 3.69—3.80 (m, 2H), 3.79 (s, 3H), 3.81—3.86 (m, 1H), 4.04 (dd, 1H, J=5.5, 8.0 Hz), 4.03—4.12 (m, 1H), 4.12—4.19 (m, 2H), 4.25 (dt, 1H, J=5.5, 17.5 Hz), 4.33 (d, 1H, J=11.0 Hz), 4.37—4.43 (m, 1H), 4.48 (d, 1H, J=11.0 Hz), 4.70 (s, 2H), 4.85 (dt, 1H, J=2.0, 2.5 Hz), 5.00 (dt, 1H, J=2.0, 2.5 Hz), 6.82—6.86 (m, 2H), 7.21—7.25 (m, 2H). ^{13}C-NMR ($CDCl_3$) δ: −4.79, −4.20, −2.85, −2.80, −1.29, 15.81, 18.14, 18.25, 18.55, 18.78, 25.93, 26.36, 26.82, 26.89, 28.68, 30.19, 31.18, 35.89, 37.35, 39.61, 41.38, 51.15, 54.75, 62.10, 65.13, 67.89, 69.90, 70.01, 70.34, 73.78, 76.42, 76.56, 76.76, 78.20, 80.71, 95.34, 104.80, 109.85, 114.00, 129.53, 131.77, 151.92, 159.55. FAB-MS m/z (%): 1025 (M^++H, 9.4), 909 (4.3), 873 (5.1), 787 (6.7), 712 (10), 415 (16), 341 (26), 327 (15), 315 (69), 231 (80), 185 (100). HR-MS (FAB) Calcd for $C_{54}H_{101}O_{12}Si_3$ (M^++H): 1025.6601. Found: 1025.6640.

The above alcohol (82 mg, 0.08 mmol) was treated with pyridine (31.6 mg, 0.4 mmol) and TsCl (45.7 mg, 0.24 mmol) in CH_2Cl_2 to give (2*R*,4*S*,5*S*,6*R*,7*R*,8*S*,10*S*,11*S*,12*R*,14*S*,17*S*,20*R*)-5,7-bis(*tert*-butyldimethylsilyloxy)-1,2-isopropylidenedioxy-14-(4-methoxybenzyloxy)-6,12-dimethyl-18-methylidene-21-[2-(trimethylsilyl) ethoxymethoxy]-11-toluenesulfonyloxymethyl-4,8; 17,20-diepoxyhenicosan-10-ol as a colorless oil (88 mg, 93%). $[\alpha]_D^{22}$ −32.6° (c=1.80, $CHCl_3$). IR (neat) cm^{-1}: 3450, 2950, 2920, 2880, 1660, 1610, 1595, 1585, 1510. ^{1}H-NMR ($CDCl_3$) δ: −0.01 (s, 3H), 0.02 (s, 9H), 0.03 (s, 3H), 0.06 (s, 3H), 0.08 (s, 3H), 0.78 (d, 3H, J=6.5 Hz), 0.87 (s, 9H), 0.88 (s, 9H), 0.91—0.96 (m, 2H), 0.99 (d, 1H, J=6.5 Hz), 1.08—1.18 (m, 1H), 1.18—1.27 (m, 1H), 1.29 (s, 3H), 1.31 (s, 3H), 1.48—1.80 (m, 8H), 2.00—2.11 (m, 1H), 2.21—2.30 (m, 1H), 2.43 (s, 3H), 2.65—2.71 (m, 1H), 2.91 (t, 1H, J=9.0 Hz), 3.42 (dd, 1H, J=5.5, 10.5 Hz), 3.36—3.44 (m, 1H), 3.46 (t, 1H, J=8.0 Hz), 3.51—3.58 (m, 2H), 3.61 (d, 1H, J=7.5 Hz), 3.63 (d, 1H, J=7.5 Hz), 3.78 (s, 3H), 3.79 (dd, 1H, J=2.0, 3.5 Hz), 3.80—3.95 (m, 2H), 3.96—4.07 (m, 3H), 4.21—4.29 (m, 1H), 4.29 (d, 1H, J=11.0 Hz), 4.29—4.42 (m, 1H), 4.45 (d, 1H, J=11.0 Hz), 4.70 (s, 2H), 4.86 (dt, 1H, J=2.0, 2.5 Hz), 5.00 (dt, 1H, J=2.0, 2.5 Hz), 6.82—6.85 (m, 2H), 7.21—7.25 (m, 2H), 7.28—7.31 (m, 2H), 7.75—7.78 (m, 2H). ^{13}C-NMR ($CDCl_3$) δ: −4.85, −4.28, −3.33, −2.97, −1.43, 15.25, 17.61, 17.96, 18.08, 18.24, 21.58, 25.75, 25.94, 26.10, 26.51, 27.83, 29.56, 30.74, 35.31, 37.83, 38.58, 40.94, 49.29, 55.20, 64.56, 65.07, 69.14, 69.50, 69.82, 73.16, 75.88, 76.02, 76.82, 77.26, 80.48, 95.01, 105.09, 109.76, 113.62, 128.02, 129.33, 129.73, 131.16, 133.16, 144.39, 150.70, 158.95. FAB-MS m/z (%): 1179 (M^++H, 5.8), 1178 (8.3), 1127 (8.8), 1061 (7.2), 985 (13), 677 (18), 315 (80), 283 (55), 241 (95), 122 (100). HR-MS (FAB) Calcd for $C_{61}H_{107}O_{14}SSi_3$ (M^++H): 1179.6689. Found: 1179.6660.

The tosylate (94 mg, 0.08 mmol) was treated with NaI (119 mg, 0.79 mmol), $NaHCO_3$ (134 mg, 1.59 mmol) and DBU (364 mg, 2.39 mmol) in THF to give **24a** as a colorless oil (52 mg, 65%). $[\alpha]_D^{22}$ −51.8° (c=0.80, $CHCl_3$). IR (neat) cm^{-1}: 3470, 2940, 2920, 2850, 1610, 1580, 1510. ^{1}H-NMR ($CDCl_3$) δ: 0.02 (s, 9H), 0.03 (s, 3H), 0.05 (s, 3H), 0.06 (s, 3H), 0.07 (s, 3H), 0.88 (s, 9H), 0.89 (s, 9H), 0.92—0.96 (m, 2H), 0.99 (d, 3H, J=6.5 Hz), 1.03 (d, 3H, J=6.5 Hz), 1.25 (t, 1H, J=7.0 Hz), 1.34 (s, 3H), 1.40 (s, 3H), 1.58—1.72 (m, 5H), 1.80—1.88 (m, 2H), 2.00 (ddd, 1H, J=2.0, 10.0, 12.0 Hz), 2.18 (ddd, 1H, J=7.5, 11.5, 15.0 Hz), 2.41 (d, 1H, J=6.5 Hz), 2.43 (d, 1H, J=6.5 Hz), 2.97 (t, 1H, J=9.5 Hz), 3.45 (dd, 1H, J=5.5, 10.0 Hz), 3.44—3.55 (m, 3H), 3.60—3.66 (m, 3H), 3.78 (s, 3H), 3.84 (ddd, 1H, J=1.5, 5.0, 10.0 Hz), 4.05 (dd, 1H, J=6.0, 8.0 Hz), 4.20—4.27 (m, 2H), 4.30 (d, 1H, J=11.0 Hz), 4.37 (d, 1H, J=11.0 Hz), 4.37—4.43 (m, 1H), 4.42 (d, 1H, J=11.0 Hz), 4.69 (s, 2H), 4.84 (d, 1H, J=1.5 Hz), 4.86 (s, 1H), 4.98 (d, 1H, J=2.0 Hz), 5.06 (s, 1H). ^{13}C-NMR ($CDCl_3$) δ: −4.86, −4.22, −3.20, −2.97, −1.41, 15.33, 17.98, 18.11, 18.30, 21.33, 25.79, 25.99, 26.12, 26.71, 26.76, 29.43, 30.78, 32.74, 35.35, 40.19, 40.97, 41.34, 53.38, 55.22, 65.08, 68.12, 69.45, 69.52, 69.57, 69.75, 73.22, 75.79, 75.98, 76.15, 76.44, 80.04, 95.04, 105.01, 107.76, 109.47, 113.64, 129.28, 131.27, 150.81, 158.07, 158.97. FAB-MS m/z (%): 1007 (M^++H, 6.5), 858 (8.0), 711 (10), 415 (30), 381 (35), 231 (50), 137 (100). HR-MS (FAB) Calcd for $C_{54}H_{99}O_{11}Si_3$ (M^++H): 1007.6495. Found: 1007.6460.

(2*R*,4*S*,5*S*,6*R*,7*R*,8*S*,10*S*,12*R*,14*S*,17*S*,20*R*)-5,7-Bis(*tert*-butyldimethylsilyloxy)-1,2-isopropylidenedioxy-6,12-dimethyl-11,18-dimethylidene-21-[2-(trimethylsilyl)ethoxymethoxy]-4,8; 10,14; 17,20-triepoxyhenicosane (25) Excess TMS-imidazole were added to a stirred solution of **24b** (5.3 mg, 5.3 mmol) in CH_2Cl_2 (1 ml) at room temperature. After 30 min, the reaction mixture was quenched with saturated aqueous $NaHCO_3$, and extracted with Et_2O. The extract was washed with brine, dried over Na_2SO_4, and evaporated *in vacuo*. The residue was chromatographed on a silica gel column (*n*-hexane–EtOAc 5 : 1) to give a silylate as a colorless oil (5.4 mg, 96%).

2,3-Dichloro-5,6-dicyano-1,4-benzoquinone (DDQ) (2.2 mg, 9.7 μmol) was added to a stirred solution of the silylate (5.4 mg, 5μmol) in a mixture of CH_2Cl_2 (1.5 ml) and H_2O (0.3 ml) at room temperature. After 30 min, the reaction mixture was neutralized with saturated aqueous $NaHCO_3$, and extracted with Et_2O. The extract was washed with brine, dried over Na_2SO_4, and evaporated *in vacuo*. The residue was chromatographed on a silica gel column (*n*-hexane–EtOAc 3 : 1) to give an alcohol as a colorless oil (3.6 mg, 75%).

Et_3N (1.5 mg, 15μmol) and methanesulfonic anhydride (Ms_2O) (1.3 mg, 7.5μmol) were added to a stirred solution of the alcohol (3.6 mg, 3.7 μmol) in CH_2Cl_2 (2.0 ml) at 0 °C. After 15 h at room temperature, the reaction mixture was quenched with MeOH and then H_2O, and extracted with Et_2O. The extract was washed with brine, dried over Na_2SO_4, and evaporated *in vacuo*. The residue was chromatographed on a silica gel column (benzene–EtOAc 5 : 1) to give a mesylate as a colorless oil (2.9 mg, 74%).

PPTS (2.7 mg, 10 μmol) was added to a stirred solution of the mesylate (2.2 mg, 2.1 μmol) in a mixture of THF (0.5 ml) and MeOH (0.5 ml) at room temperature. After 30 min, the reaction mixture was quenched with saturated aqueous $NaHCO_3$, and extracted with Et_2O. The extract was washed with brine, dried over Na_2SO_4, and evaporated *in vacuo*. The residue was chromatographed on a silica gel column (benzene–EtOAc 7 : 1) to give (2*R*,4*S*,5*S*,6*R*,7*R*,8*S*,10*S*,12*R*,14*R*,17*S*,20*R*)-5,7-bis(*tert*-butyldimethylsilyloxy)-1,2-isopropylidenedioxy-14-methanesulfonyloxy-6,-12-dimethyl-11,18-dimethylidene-21-[2-(trimethylsilyl)ethoxymethoxy]-4,8; 17,20-diepoxyhenicosan-10-ol as a colorless oil (1.74 mg, 75%). $[\alpha]_D^{17}$ −40.7° (c=0.22, $CHCl_3$). IR (neat) cm^{-1}: 3480, 2940, 2920, 2840, 1655, 1640. ^{1}H-NMR ($CDCl_3$) δ: 0.02 (s, 9H), 0.03 (s, 3H), 0.07 (s, 6H), 0.09 (s, 3H), 0.88 (s, 9H), 0.90 (s, 9H), 0.93 (t, 2H, J=3.5 Hz), 1.00 (d, 3H, J=3.5 Hz), 1.09 (d, 3H, J=3.5 Hz), 1.35—1.43 (m, 1H), 1.38 (s, 3H), 1.43 (s, 3H), 1.36—1.40 (m, 1H), 1.55—1.68 (m, 4H), 1.69—1.89 (m, 5H), 1.90—1.97 (m, 1H), 2.10 (d, 1H, J=5.5 Hz), 2.12—2.19 (m, 1H), 2.40—2.48 (m, 2H), 2.65—2.70 (m, 1H), 3.03 (s, 3H), 3.45 (dd, 1H, J=5.5, 10.5 Hz), 3.48—3.56 (m, 3H), 3.59—3.67 (m, 3H), 3.88 (ddd, 1H, J=1.5, 5.0, 10.0 Hz), 4.08 (dd, 1H, J=6.0, 7.5 Hz), 4.24—4.31 (m, 2H), 4.35—4.40 (m, 1H), 4.41 (br s, 1H), 4.68 (s, 2H), 4.77 (dt, 1H, J=5.5, 11.5 Hz), 4.85 (s, 1H), 4.88 (s, 1H), 5.01 (s, 1H), 5.02 (s, 1H), 5.08 (s, 1H). ^{13}C-NMR ($CDCl_3$) δ: −4.80, −4.12, −2.88, −2.85, −1.26, 15.75, 18.14, 18.27, 18.52, 22.14, 25.95, 26.13, 26.31,

27.13, 27.42, 30.79, 31.46, 32.59, 35.76, 38.64, 40.16, 41.13, 42.50, 65.14, 69.69, 69.93, 73.17, 75.27, 75.73, 75.79, 75.92, 76.50, 77.25, 80.26, 82.18, 95.35, 105.17, 109.56, 151.41. FAB-MS *m/z* (%): 949 ($M^+ - CH_3$, 10), 728 (13), 457 (11), 357 (18), 315 (32), 283 (42), 225 (37), 185 (57), 101 (100). HR-MS (FAB) Calcd for $C_{46}H_{89}O_{12}SSi_3$ ($M^+ - CH_3$): 949.5357. Found: 949.5313.

60% KH (0.11 mg, 1.7 μmol) was added to a stirred solution of the mesylate (1.7 mg) in dimethoxyethane (DME) (0.5 ml) at room temperature. The mixture was warmed to 80 °C, stirred for 30 min, then cooled to room temperature, quenched with saturated aqueous $NaHCO_3$, and extracted with Et_2O. The extract was washed with brine, dried over Na_2SO_4, and evaporated *in vacuo*. The residue was chromatographed on a silica gel column (benzene–EtOAc 5 : 1) to give **25** as a colorless oil (0.6 mg, 39%). ^{1}H-NMR ($CDCl_3$) δ: 0.02 (s, 9H), 0.04 (s, 3H), 0.06 (s, 3H), 0.07 (s, 3H), 0.09 (s, 3H), 0.89 (s, 9H), 0.91 (s, 9H), 0.87—0.96 (m, 3H), 1.00 (d, 3H, J=6.5 Hz), 1.06 (d, 3H, J=6.5 Hz), 1.21 (t, 1H, J=6.5 Hz), 1.32 (s, 3H), 1.38 (s, 3H), 1.40—1.56 (m, 10H), 2.26—2.43 (m, 3H), 2.58 (t, 1H, J=13.0 Hz), 2.67 (dd, 1H, J=7.0, 15.5 Hz), 2.92 (t, 1H, J=9.0 Hz), 3.42—3.57 (m, 5H), 3.57—3.70 (m, 4H), 3.75—3.80 (m, 1H), 4.08 (dd, 1H, J=6.0, 7.5 Hz), 4.32 (dt, 1H, J=7.0, 11.5 Hz), 4.39—4.48 (m, 3H), 4.70 (s, 2H), 4.71 (s, 1H), 4.86 (s, 1H), 4.92 (s, 1H), 5.00 (s, 1H). FAB-MS *m/z* (%): 869 ($M^+ + H$, 12), 802 (10), 622 (13), 472 (15), 415 (20), 315 (35), 283 (30), 225 (30), 185 (32), 147 (55), 129 (80), 101 (100). HR-MS (FAB) Calcd for $C_{46}H_{89}O_9Si_3$ ($M^+ + H$): 869.5814. Found: 869.5820.

(2*R*,4*S*,5*S*,6*R*,7*R*,8*S*,10*R*,12*R*,14*R*,17*S*,20*R*)-5,7-Bis(*tert*-butyldimethylsilyloxy)-1,2-isopropylidenedioxy-14-(4-methoxybenzyloxy)-6,12-dimethyl-11,18-dimethylidene-21-[2-(trimethylsilyl)thoxymethoxy]-4,8; 17,20-diepoxyhenicosan-10-ol (26) Dess–Martin reagent (369 mg, 0.87 mmol) was added to a stirred solution of **24b** (175 mg, 0.17 mmol) in CH_2Cl_2 (10 ml) at room temperature. After 20 min, saturated aqueous $Na_2S_2O_3$ was added until the reaction mixture became a clear solution which was extracted with Et_2O. The extract was washed with brine, dried over Na_2SO_4, and evaporated *in vacuo*. The residue was chromatographed on a silica gel column (*n*-hexane–EtOAc 2 : 1) to give (2*R*,4*S*,5*S*,6*R*,7*R*,8*S*,12*R*,14*R*,17*S*,20*R*)-5,7-bis(*tert*-butyldimethylsilyloxy)-1,2-isopropylidenedioxy-14-(4-methoxybenzyloxy)-6,12-dimethyl-11,18-dimethylidene-10-oxo-21-[2-(trimethylsilyl)ethoxymethoxy]-4,8; 17,20-diepoxyhenicosane as a colorless oil (136 mg, 78%). $[\alpha]_D^{19}$ −44.2° (c=0.32, $CHCl_3$). IR (neat) cm^{-1}: 2980, 2950, 2860, 1690, 1620, 1595, 1520. ^{1}H-NMR ($CDCl_3$) δ: 0.02 (s, 12H), 0.05 (s, 3H), 0.08 (s, 3H), 0.10 (s, 3H), 0.88 (s, 9H), 0.89 (s, 9H), 0.92—0.96 (m, 2H), 1.01 (d, 3H, J=6.5 Hz), 1.04 (d, 3H, J=6.5 Hz), 1.26 (s, 1H), 1.34 (s, 3H), 1.38 (s, 3H), 1.50—1.78 (m, 5H), 2.28—2.35 (m, 1H), 2.38—2.45 (m, 1H), 2.65 (dd, 1H, J=9.5, 16.0 Hz), 2.63—2.69 (m, 1H), 2.93—3.07 (m, 3H), 3.28—3.35 (m, 1H), 3.43 (dd, 1H, J=5.0, 7.0 Hz), 3.45—3.57 (m, 3H), 3.62 (d, 1H, J=7.5 Hz), 3.60—3.65 (m, 1H), 3.63 (d, 1H, J=7.5 Hz), 3.67 (ddd, 1H, J=3.0, 5.5, 11.5 Hz), 3.79 (s, 3H), 3.93—3.98 (m, 2H), 4.24 (dt, 1H, J=6.0, 12.0 Hz), 4.32 (d, 1H, J=11.0 Hz), 4.38 (d, 1H, J=11.0 Hz), 4.32—4.45 (m, 2H), 4.86 (s, 2H), 4.99 (d, 1H, J=1.5 Hz), 5.30 (d, 1H, J=2.0 Hz), 5.67 (s, 1H), 5.94 (s, 1H), 6.83—6.87 (m, 2H), 7.23—7.28 (m, 2H). ^{13}C-NMR ($CDCl_3$) δ: −4.88, −4.10, −3.18, −3.09, −1.39, 15.38, 17.98, 18.12, 18.25, 21.07, 25.82, 25.99, 26.96, 27.82, 29.50, 30.62, 31.35, 35.37, 40.60, 40.71, 41.88, 55.27, 65.11, 68.84, 69.55, 70.17, 70.50, 72.88, 73.03, 73.46, 76.04, 76.30, 77.23, 80.56, 95.06, 105.10, 108.28, 113.73, 122.92, 129.37, 129.46, 131.16, 150.77, 154.30, 159.05, 199.32. FAB-MS *m/z* (%): 1003 ($M^+ - H$, 0.8), 987 (6.4), 867 (21), 603 (16), 415 (22), 341 (40), 315 (39), 283 (73), 225 (59), 185 (45), 171 (53), 115 (100). HR-MS (FAB) Calcd for $C_{54}H_{95}O_{11}Si_3$ ($M^+ - H$): 1003.6187. Found: 1003.6190.

LiI (335 mg, 2.23 mmol) and the ketone (126 mg, 0.12 mmol) were dissolved in Et_2O (30 ml) at −40 °C. $LiAlH_4$ (95 mg, 2.5 mmol) was added to the above solution at −100 °C under argon. After 1 h, the reaction mixture was quenched with MeOH and then 1 N HCl below 0 °C, and extracted with Et_2O. The extract was washed with brine, dried over Na_2SO_4, and evaporated *in vacuo*. The residue was chromatographed on a silica gel column (benzene–EtOAc 7 : 1) to give **26** as a colorless oil (87 mg, 64%). $[\alpha]_D^{25}$ −57.3° (c=0.20, $CHCl_3$). IR (neat) cm^{-1}: 3500, 2950, 2920, 2850, 1610, 1510. ^{1}H-NMR ($CDCl_3$) δ: 0.02 (s, 9H), 0.03 (s, 3H), 0.05 (s, 3H), 0.06 (s, 3H), 0.08 (s, 3H), 0.88 (s, 18H), 0.92—0.97 (m, 2H), 0.99 (d, 3H, J=6.5 Hz), 1.08 (d, 3H, J=6.5 Hz), 1.35 (s, 3H), 1.39 (s, 3H), 1.50—1.77 (m, 7H), 1.80 (ddd, 1H, J=2.5, 5.0, 15.0 Hz), 2.05 (ddd, 1H, J=8.0, 11.0, 15.0 Hz), 2.12 (d, 1H, J=13.5 Hz), 2.32 (dt, 1H, J=7.0, 14.0 Hz), 2.39—2.45 (m, 1H), 2.62—2.70 (m, 1H), 2.94 (t, 1H, J=9.0 Hz), 3.43 (dd, 1H, J=6.0, 11.5 Hz), 3.40—3.45 (m, 1H), 3.46—3.53 (m, 2H), 3.50 (dd, 1H, J=6.0, 10.5 Hz), 3.61 (d, 1H, J=10.0 Hz), 3.63 (d, 1H, J=10.0 Hz), 3.58—3.65 (m, 1H), 3.79 (s, 3H), 3.83—3.90 (m, 1H), 4.05 (dd, 1H, J=6.0, 8.0 Hz), 4.07 (s, 1H), 4.12—4.21 (m, 2H), 4.24 (dt, 1H, J=6.0, 12.0 Hz), 4.35 (d, 1H, J=11.0 Hz), 4.38—4.42 (m, 1H), 4.43 (d, 1H, J=11.0 Hz), 4.69 (s, 2H), 4.85 (d, 1H, J=2.0 Hz), 4.86 (s, 1H), 4.98 (d, 1H, J=2.0 Hz), 5.18 (s, 1H), 6.84—6.86 (m, 2H), 7.24—7.26 (m, 2H). ^{13}C-NMR ($CDCl_3$) δ: −4.87, −4.23, −2.93, −1.41, 15.32, 17.97, 18.10, 18.23, 21.88, 25.71, 25.78, 26.03, 26.82, 29.33, 30.62, 32.79, 35.34, 40.59, 42.49, 55.23, 65.08, 69.51, 69.91, 72.60, 74.94, 75.33, 75.63, 76.01, 80.59, 95.03, 105.02, 109.29, 113.72, 129.02, 131.30, 150.85, 157.55. FAB-MS *m/z* (%): 1004 ($M^+ - H_2$, 4.0), 988 (6.2), 737 (8.0), 693 (10), 472 (11), 415 (25), 341 (55), 315 (85), 171 (100). HR-MS (FAB) Calcd for $C_{54}H_{96}O_{11}Si_3$ ($M^+ - H_2$): 1004.6265. Found: 1004.6248.

(2*R*,4*S*,5*S*,6*R*,7*R*,8*S*,10*R*,12*R*,14*S*,17*S*,20*R*)-5,7-Bis(*tert*-butyldimethylsilyloxy)-1,2-isopropylidenedioxy-6,12-dimethyl-11,18-dimethylidene-21-[2-(trimethylsilyl)ethoxymethoxy]-4,8; 10,14; 17,20-triepoxyhenicosane (27) Excess TMS-imidazole was added to a stirred solution of **26** (63 mg, 0.062 mmol) in CH_2Cl_2 (1 ml) at room temperature. After 30 min, the reaction mixture was quenched with H_2O, and extracted with Et_2O. The extract was washed with brine, dried over Na_2SO_4, and evaporated *in vacuo*. The residue was chromatographed on a silica gel column (*n*-hexane–EtOAc 5 : 1) to give (2*R*,4*S*,5*S*,6*R*,7*R*,8*S*,10*R*,12*R*,14*R*,17*S*,20*R*)-5,7-bis(*tert*-butyldimethylsilyloxy)-1,2-isopropylidenedioxy-14-(4-methoxybenzyloxy)-6,12-dimethyl-11,18-dimethylidene-21-[2-(trimethylsilyl)ethoxymethoxy]-10-trimethylsilyloxy-4,8; 17,20-diepoxyhenicosane as a colorless oil (65 mg, 96%). $[\alpha]_D^{21}$ −40.8° (c=0.25, $CHCl_3$). IR (neat) cm^{-1}: 2970, 2950, 2880, 1620, 1590, 1520. ^{1}H-NMR ($CDCl_3$) δ: 0.02 (s, 9H), 0.04 (s, 3H), 0.06 (s, 3H), 0.09 (s, 3H), 1.00 (s, 9H), 0.92—0.96 (m, 2H), 0.98 (d, 3H, J=6.5 Hz), 1.08 (d, 3H, J=6.5 Hz), 1.34 (s, 3H), 1.39 (s, 3H), 1.50—1.80 (m, 9H), 2.02 (ddd, 1H, J=2.0, 5.0, 14.5 Hz), 2.14 (ddd, 1H, J=5.0, 10.0, 14.5 Hz), 2.23—2.30 (m, 1H), 2.40—2.46 (m, 1H), 2.65—2.71 (m, 1H), 3.09 (t, 1H, J=9.0 Hz), 3.39 (dt, 1H, J=3.0, 8.5 Hz), 3.42—3.58 (m, 5H), 3.62 (d, 1H, J=7.5 Hz), 3.63 (d, 1H, J=7.5 Hz), 3.60—3.68 (m, 1H), 3.79 (s, 3H), 4.03 (dd, 1H, J=6.0, 7.5 Hz), 4.22—4.28 (m, 2H), 4.43 (t, 1H, J=6.0 Hz), 4.39 (d, 1H, J=11.0 Hz), 4.42 (d, 1H, J=11.0 Hz), 4.38—4.42 (m, 1H), 4.70 (s, 2H), 4.85 (s, 2H), 4.98 (s, 1H), 5.07 (s, 1H), 6.84—6.87 (m, 2H), 7.25—7.28 (m, 2H). ^{13}C-NMR ($CDCl_3$) δ: −4.81, −4.02, −3.24, −2.38, −1.30, 0.61, 15.79, 18.13, 18.25, 18.57, 23.76, 25.97, 26.28, 26.43, 27.34, 29.48, 31.90, 32.37, 34.73, 35.83, 39.63, 41.46, 45.47, 65.11, 69.22, 69.61, 69.94, 71.18, 73.54, 73.70, 74.43, 76.37, 77.29, 80.93, 95.32, 104.80, 108.82, 109.90, 127.36, 127.89, 128.53, 151.87, 156.51. FAB-MS *m/z* (%): 1078 (M^+, 0.3), 991 (7.6), 869 (14), 847 (12), 617 (11), 517 (10), 415 (17), 341 (35), 315 (62), 283 (62), 231 (51), 185 (64), 74 (100). HR-MS (FAB) Calcd for $C_{57}H_{106}O_{11}Si_4$ (M^+): 1078.6812. Found: 1165.6815.

DDQ (30 mg, 132 μmol) was added to a solution of the silylate (67 mg, 62 μmol) in a mixture of CH_2Cl_2 (1.5 ml) and H_2O (0.3 ml) at room temperature. After 30 min, the reaction mixture was quenched with saturated aqueous $NaHCO_3$, and extracted with Et_2O. The extract was washed with brine, dried over Na_2SO_4, and evaporated *in vacuo*. The residue was chromatographed on a silica gel column (*n*-hexane–EtOAc 3 : 1) to give (2*R*,4*S*,5*S*,6*R*,7*R*,8*S*,10*R*,12*R*,14*R*,17*S*,20*R*)-5,7-bis(*tert*-butyldimethylsilyloxy)-1,2-isopropylidenedioxy-6,12-dimethyl-11,18-dimethylidene-21-[2-(trimethylsilyl)ethoxymethoxy]-10-trimethylsilyloxy-4,8; 17,20-diepoxyhenicosan-14-ol as a colorless oil (45 mg, 75%). $[\alpha]_D^{18}$ −46.4° (c=0.21, $CHCl_3$). IR (neat) cm^{-1}: 3500, 2970, 2950, 2870, 1670, 1650. ^{1}H-NMR ($CDCl_3$) δ: 0.02 (s, 9H), 0.04 (s, 3H), 0.07 (s, 3H), 0.08 (s, 3H), 0.09 (s, 3H), 0.14 (s, 9H), 0.89 (s, 9H), 0.91 (s, 9H), 0.92—0.96 (m, 2H), 0.98 (d, 3H, J=6.5 Hz), 1.08 (d, 3H, J=6.5 Hz), 1.23—1.27 (m, 1H), 1.33 (s, 3H), 1.38 (s, 3H), 1.45—1.66 (m, 8H), 1.72—1.81 (m, 2H), 2.12 (ddd, 1H, J=4.0, 10.0, 14.5 Hz), 2.34—2.45 (m, 2H), 2.64 (d, 1H, J=4.0 Hz), 2.65—2.71 (m, 1H), 3.00 (t, 1H, J=1.5, 9.5 Hz), 3.43 (dd, 1H, J=6.5, 10.5 Hz), 3.47—3.58 (m, 3H), 3.62 (d, 1H, J=8.5 Hz), 3.63 (d, 1H, J=8.5 Hz), 3.56—3.63 (m, 1H), 3.65—3.69 (m, 1H), 4.06 (dd, 1H, J=5.5, 7.5 Hz), 4.20—4.28 (m, 2H), 4.32 (dd, 1H, J=4.0, 8.5 Hz), 4.41 (br s, 1H), 4.71 (s, 2H), 4.87 (d, 1H, J=2.0 Hz), 4.88 (s, 1H), 4.99 (d, 1H, J=2.0 Hz), 5.12 (s, 1H). FAB-MS *m/z* (%): 958 (M^+, 4.9), 871 (8.3), 801 (12), 738 (12), 551 (12), 473 (18), 341 (38), 315 (59), 231 (59), 199 (51), 185 (79), 157 (100). HR-MS (FAB) Calcd for $C_{49}H_{98}O_{10}Si_4$ (M^+): 958.6242. Found: 958.6272.

Et_3N (40 mg, 0.4 mmol) and Ms_2O (35 mg, 0.2 mmol) were added to a stirred solution of the alcohol (48 mg, 0.05 mmol) in CH_2Cl_2 (5 ml) at 0 °C. After 15 h at room temperature, the reaction mixture was quenched

with MeOH and H_2O, and extracted with Et_2O. The extract was washed with brine, dried over Na_2SO_4, and evaporated *in vacuo*. The residue was chromatographed on a silica gel column (benzene–EtOAc 5 : 1) to give (2*R*,4*S*,5*S*,6*R*,7*R*,8*S*,10*R*,12*R*,14*R*,17*S*,20*R*)-5,7-bis(*tert*-butyldimethylsilyloxy)-1,2-isopropylidenedioxy-14-methanesulfonyloxy-6,12-dimethyl-11,18-dimethylidene-21-[2-(trimethylsilyl)ethoxymethoxy]-10-trimethylsilyloxy-4,8; 17,20-diepoxyhenicosane as a colorless oil (47 mg, 90%). $[\alpha]_D^{17}$ −38.6° (c=0.19, $CHCl_3$). IR (neat) cm^{-1}: 2970, 2940, 2870, 1675, 1650. ^{1}H-NMR ($CDCl_3$) δ: 0.02 (s, 9H), 0.04 (s, 3H), 0.06 (s, 3H), 0.09 (s, 3H), 0.11 (s, 3H), 0.13 (s, 9H), 0.89 (s, 18H), 0.92—0.96 (m, 2H), 0.98 (d, 1H, J=6.5 Hz), 1.10 (d, 1H, J=6.5 Hz), 1.25 (s, 1H), 1.35 (s, 3H), 1.39 (s, 3H), 1.52—1.65 (m, 4H), 1.67—1.80 (m, 4H), 1.83 (t, 1H, J=5.0 Hz), 1.92—1.99 (m, 1H), 2.03 (ddd, 1H, J=2.5, 7.0, 14.0 Hz), 2.13 (ddd, 1H, J=5.0, 10.0, 14.5 Hz), 2.27 (dt, 1H, J=7.0, 14.0 Hz), 2.42—2.48 (m, 1H), 2.64—2.70 (m, 1H), 3.00 (s, 3H), 3.07 (t, 1H, J=9.0 Hz), 3.38 (dt, 1H, J=2.5, 8.5 Hz), 3.43 (dd, 1H, J=5.5, 10.5 Hz), 3.47—3.57 (m, 3H), 3.61 (d, 1H, J=7.5 Hz), 3.62 (d, 1H, J=7.5 Hz), 3.67 (ddd, 1H, J=3.5, 5.5, 9.5 Hz), 4.05 (dd, 1H, J=6.0, 7.5 Hz), 4.22—4.27 (m, 2H), 4.37 (t, 1H, J=6.0 Hz), 4.42 (br s, 1H), 4.69 (s, 2H), 4.77—4.83 (m, 1H), 4.88 (s, 2H), 5.02 (s, 1H), 5.10 (s, 1H). ^{13}C-NMR ($CDCl_3$) δ: −4.79, −3.99, −3.15, −2.33, −1.29, 0.63, 15.81, 18.15, 18.25, 18.56, 21.72, 25.99, 26.33, 26.42, 27.33, 29.24, 30.90, 31.14, 32.07, 35.74, 38.59, 39.11, 41.47, 42.95, 65.13, 69.61, 69.89, 70.84, 73.04, 73.60, 73.72, 74.44, 76.48, 76.95, 80.26, 82.17, 95.34, 105.12, 108.74, 109.62, 128.30, 151.47, 157.03.

PPTS (12 mg, 48 μmol) was added to a stirred solution of the mesylate (47 mg, 45 μmol) in a mixture of THF (3 ml) and MeOH (1 ml) at room temperature. After 30 min, saturated aqueous $NaHCO_3$ was added and the mixture extracted with Et_2O. The extract was washed with brine, dried over Na_2SO_4, and evaporated *in vacuo*. The residue was chromatographed on a silica gel column (benzene–EtOAc 7 : 1) to give (2*R*,4*S*,5*S*,6*R*,7*R*,8*S*,10*R*,12*R*,14*R*,17*S*,20*R*)-5,7-bis(*tert*-butyldimethylsilyloxy)-1,2-isopropylidenedioxy-14-methanesulfonyloxy-6,12-dimethyl-11,18-dimethylidene-21-[2-(trimethylsilyl) ethoxymethoxy]-4,8; 17,20-diepoxyhenicosan-10-ol as a colorless oil (39 mg, 90%). $[\alpha]_D^{17}$ −41° (c=0.22, $CHCl_3$). IR (neat) cm^{-1}: 3480, 2940, 2920, 2840, 1655, 1640. ^{1}H-NMR ($CDCl_3$) δ: 0.02 (s, 9H), 0.03 (s, 3H), 0.06 (s, 3H), 0.07 (s, 3H), 0.09 (s, 3H), 0.88 (s, 18H), 0.93 (t, 2H, J=3.5 Hz), 1.00 (d, 3H, J=3.5 Hz), 1.10 (d, 3H, J=3.5 Hz), 1.26 (s, 1H), 1.37 (s, 3H), 1.44 (s, 3H), 1.36—1.40 (m, 1H), 1.55—1.68 (m, 4H), 1.69—1.89 (m, 5H), 1.90—1.97 (m, 1H), 2.10 (d, 1H, J=5.5 Hz), 2.12—2.19 (m, 1H), 2.27—2.36 (m, 1H), 2.42—2.48 (m, 1H), 2.65—2.70 (m, 1H), 3.00 (s, 3H), 3.45 (dd, 1H, J=5.5, 10.5 Hz), 3.48—3.56 (m, 3H), 3.59—3.67 (m, 3H), 3.88 (ddd, 1H, J=1.5, 5.0, 10.0 Hz), 4.08 (dd, 1H, J=6.0, 7.5 Hz), 4.17—4.25 (m, 1H), 4.41 (br s, 1H), 4.69 (s, 2H), 4.77 (dt, 1H, J=5.5, 11.5 Hz), 4.86 (s, 1H), 4.88 (s, 1H), 5.15 (s, 1H). ^{13}C-NMR (C_6D_6) δ: −4.80, −4.12, −2.88, −2.85, −1.26, 15.75, 18.14, 18.27, 18.52, 22.14, 25.95, 26.13, 26.31, 27.13, 27.42, 30.79, 31.46, 32.59, 35.76, 38.64, 40.16, 41.13, 42.50, 65.14, 69.69, 69.93, 73.17, 75.27, 75.73, 75.79, 75.92, 76.50, 77.25, 80.26, 82.18, 95.35, 105.17, 109.56, 151.41. FAB-MS m/z (%): 949 ($M^+ - CH_3$, 11), 728 (15), 457 (11), 357 (18), 341 (26), 315 (32), 283 (42), 213 (44), 185 (57), 101 (100). HR-MS (FAB) Calcd for $C_{46}H_{89}O_{12}SSi_3$ ($M^+ - CH_3$): 949.5357. Found: 949.5370.

60% KH (2.7 mg, 41 μmol) was added to a stirred solution of the mesylate (39 mg, 0.04 mmol) in DME (1.0 ml) at room temperature. The mixture was heated at 80 °C for 30 min, then cooled to room temperature, quenched with saturated aqueous $NaHCO_3$, and extracted with Et_2O. The extract was washed with brine, dried over Na_2SO_4, and evaporated *in vacuo*. The residue was chromatographed on a silica gel column (benzene–EtOAc 5 : 1) to give **27** as a colorless oil (24.2 mg, 69%). $[\alpha]_D^{18}$ −59.9° (c=0.11, $CHCl_3$). IR (neat) cm^{-1}: 2970, 2940, 2920, 2870, 1675, 1590. ^{1}H-NMR ($CDCl_3$) δ: 0.02 (s, 9H), 0.03 (s, 3H), 0.05 (s, 3H), 0.06 (s, 3H), 0.88 (s, 9H), 0.91 (s, 9H), 0.87—0.96 (m, 2H), 0.98—1.02 (m, 3H), 1.03—1.10 (m, 4H), 1.31 (s, 3H), 1.38 (s, 3H), 1.43—1.58 (m, 2H), 1.59—1.73 (m, 4H), 1.74—1.79 (m, 1H), 2.14—2.30 (m, 2H), 2.30—2.37 (m, 1H), 2.38—2.44 (m, 1H), 2.62—2.69 (m, 1H), 3.03 (t, 1H, J=9.0 Hz), 3.41—3.48 (m, 2H), 3.48—3.57 (m, 4H), 3.59—3.64 (m, 2H), 3.71—3.75 (m, 1H), 3.84 (dd, 1H, J=3.5, 9.0 Hz), 4.02—4.16 (m, 2H), 4.23 (dt, 1H, J=5.5, 12.0 Hz), 4.45 (br s, 1H), 4.68 (t, 2H, J=7.0 Hz), 4.82 (s, 1H), 4.87 (d, 1H, J=1.5 Hz), 4.92 (s, 1H), 4.99 (d, 1H, J=1.5 Hz). ^{13}C-NMR ($CDCl_3$) δ: −4.86, −4.13, −3.33, −2.65, −1.39, 15.42, 17.92, 18.00, 18.12, 18.29, 25.82, 26.12, 26.87, 27.42, 31.26, 31.49, 35.10, 35.41, 36.32, 40.95, 43.51, 65.11, 69.09, 69.61, 70.70, 72.93, 73.34, 73.39, 75.75, 76.02, 77.16, 77.23, 77.89, 80.21, 95.04, 104.66, 105.21, 108.34, 150.57, 150.93. FAB-MS m/z (%): 869 (M^++H, 13), 706 (11), 415 (15), 357 (17), 341 (25), 315 (43), 283 (39), 231 (38), 171 (34), 101 (100). HR-MS (FAB) Calcd for $C_{46}H_{89}O_9Si_3$ (M^++H): 869.5819. Found: 869.5816.

(2*R*,4*S*,5*S*,6*R*,7*R*,8*S*,10*R*,12*R*,14*S*,17*S*,20*R*)-21-Benzoyloxy-1,2-isopropylidenedioxy-6-methyl-11,18-dimethylidene-4,8; 10,14; 17,20-triepoxyhenicosane-5,7-diol (28) a) A 1 M solution of TBAF in THF (0.5 ml, 0.5 mmol) and hexamethylphosphoramide (HMPA) (0.5 ml) were added to a stirred solution of **27** (25 mg, 29 μmol) in THF (0.5 ml) at room temperature. After 5 h at 60 °C, the reaction mixture was cooled to room temperature, quenched with H_2O, and extracted with Et_2O. The extract was washed with brine, dried over Na_2SO_4, and evaporated *in vacuo*. The residue was dissolved in CH_2Cl_2 (1 ml), then pyridine (11 mg, 0.14 mmol) and benzoyl chloride (7.8 mg, 55 μmol) were added at 0 °C during 30 min. The reaction mixture was stirred for 15 min, then quenched with saturated aqueous $NaHCO_3$, and extracted with Et_2O. The extract was washed with brine, dried over Na_2SO_4, and evaporated *in vacuo*. The residue was chromatographed on a silica gel column (*n*-hexane–EtOAc 1 : 1) to give **28** as a colorless oil (17 mg, 93%). $[\alpha]_D^{20}$ −81.2° (c=0.13, $CHCl_3$). IR (neat) cm^{-1}: 3470, 3080, 2970, 2940, 2880, 1930, 1670, 1660, 1620, 1590. ^{1}H-NMR ($CDCl_3$) δ: 0.07 (d, 3H, J=6.5 Hz), 1.12 (d, 1H, J=2.0 Hz), 1.14 (d, 3H, J=6.5 Hz), 1.35 (s, 3H), 1.41 (s, 3H), 1.48—1.78 (m, 7H), 1.93 (ddd, 1H, J=7.5, 10.5, 12.5 Hz), 2.02—2.12 (m, 4H), 2.22—2.28 (m, 4H), 2.50—2.56 (m, 1H), 2.73—2.80 (m, 1H), 3.14 (t, 1H, J=9.5 Hz), 3.26 (br s, 1H), 3.55 (dd, 1H, J=5.0, 10.0 Hz), 3.60—3.64 (m, 1H), 3.63 (t, 1H, J=7.5 Hz), 3.93 (dd, 1H, J=5.0, 9.5 Hz), 3.98 (dd, 1H, J=5.5, 7.5 Hz), 4.08 (dd, 1H, J=6.0, 8.0 Hz), 4.23—4.28 (m, 1H), 4.29 (dd, 1H, J=4.5, 11.5 Hz), 4.36 (dd, 1H, J=4.5, 11.5 Hz), 4.42—4.46 (m, 1H), 4.53 (br s, 1H), 4.84 (s, 1H), 4.92 (d, 1H, J=2.0 Hz), 4.93 (s, 1H), 5.03 (d, 1H, J=2.0 Hz). ^{13}C-NMR ($CDCl_3$) δ: 13.92, 14.08, 18.05, 20.76, 25.70, 26.87, 28.88, 29.10, 30.89, 31.07, 33.58, 34.40, 35.86, 39.39, 42.12, 53.84, 64.58, 69.06, 71.16, 73.03, 73.17, 73.39, 73.74, 75.15, 77.73, 77.80, 79.72, 105.18, 105.21, 108.83, 150.48, 150.88. FAB-MS m/z (%): 615 (M^++H, 9.9), 557 (9.4), 445 (8.5), 378 (5.7), 355 (21), 307 (24), 289 (18), 219 (23), 154 (100). HR-MS (FAB) Calcd for $C_{35}H_{51}O_9$ (M^++H): 615.3536. Found: 615.3542.

b) A 1 M solution of TBAF in THF (1.84 ml, 1.84 mmol) was added to a stirred solution of **31** (180 mg, 0.18 mmol) in THF (5 ml) at room temperature. After 5 h, the reaction mixture was quenched with H_2O, and extracted with Et_2O. The extract was washed with brine, dried over Na_2SO_4, and evaporated *in vacuo*. The residue was dissolved in CH_2Cl_2 (5 ml), then pyridine (73 mg, 0.92 mmol) and benzoyl chloride (52 mg, 0.36 mmol) were added at 0 °C during 30 min. After being stirred 15 min, the reaction mixture was treated as described above to give **28** as a colorless oil (106 mg, 93%).

(2*R*,4*S*,5*S*,6*R*,7*R*,8*S*,10*R*,12*R*,14*S*,17*S*,20*R*)-5,7-Bis(*tert*-butyldimethylsilyloxy)-1,2-isopropylidenedioxy-6-methyl-11,18-dimethylidene-4,8; 10,14; 17,20-triepoxyhenicosan-21-ol (4) 2,6-Lutidine (134 mg, 1.25 mmol) and TBSOTf (144 μl, 0.75 mmol) were added to a stirred solution of **28** (110 mg, 0.18 mmol) in CH_2Cl_2 (3 ml) at 0 °C. After 30 min, the reaction mixture was quenched with saturated aqueous $NaHCO_3$, and extracted with Et_2O. The extract was washed with brine, dried over Na_2SO_4, and evaporated *in vacuo*. The residue was chromatographed on a silica gel column (*n*-hexane–EtOAc 5 : 1) to give a silylate as a colorless oil (137 mg, 91%). $[\alpha]_D^{20}$ −61.6° (c=0.10, $CHCl_3$). IR (neat) cm^{-1}: 2970, 2950, 2870, 1730, 1670, 1640, 1610. ^{1}H-NMR ($CDCl_3$) δ: 0.02 (s, 3H), 0.05 (s, 3H), 0.09 (s, 3H), 0.11 (s, 3H), 0.88 (s, 3H), 0.89—0.92 (m, 1H), 0.90 (s, 3H), 1.00 (d, 3H, J=6.5 Hz), 1.06 (d, 3H, J=6.5 Hz), 1.32 (s, 3H), 1.38 (s, 3H), 1.45—1.58 (m, 2H), 1.59 (d, 1H, J=2.5 Hz), 1.61—1.72 (m, 4H), 1.78 (ddd, 1H, J=2.0, 5.0, 13.5 Hz), 2.21 (dt, 1H, J=5.0, 12.5 Hz), 2.26 (ddd, 1H, J=4.0, 12.0, 15.5 Hz), 2.34 (ddd, 1H, J=2.0, 9.5, 13.0 Hz), 2.48—2.56 (m, 1H), 2.72—2.79 (m, 1H), 3.04 (t, 1H, J=9.5 Hz), 3.44 (dd, 1H, J=6.0, 10.5 Hz), 3.47 (dt, 1H, J=2.5, 9.0 Hz), 3.52 (t, 1H, J=7.0 Hz), 3.54—3.59 (m, 1H), 3.73 (ddd, 1H, J=3.0, 5.5, 12.5 Hz), 3.85 (dd, 1H, J=4.0, 8.5 Hz), 4.04 (t, 1H, J=5.5 Hz), 4.05—4.12 (m, 1H), 4.29 (dd, 1H, J=4.5, 10.5 Hz), 4.35 (dd, 1H, J=5.5, 12.5 Hz), 4.41—4.41 (m, 1H), 4.50—4.56 (m, 1H), 4.83 (s, 1H), 4.90 (d, 1H, J=2.0 Hz), 4.92 (s, 1H), 5.02 (d, 1H, J=2.0 Hz), 7.40—7.45 (m, 2H), 7.54—7.56 (m, 1H), 8.02—8.06 (m, 2H). ^{13}C-NMR ($CDCl_3$) δ: −4.89, −4.15, −3.35, −2.68, 15.41, 17.91, 17.98, 18.27, 25.81, 25.85, 26.11, 26.84, 27.44, 31.29, 31.64, 35.04, 35.33, 36.31, 40.96, 43.49, 66.66, 69.08, 70.74, 72.94, 73.34, 73.40, 74.98, 75.80, 76.75, 77.00, 77.16, 77.26, 77.83, 80.50, 104.65, 105.43, 108.34, 128.31, 129.73, 130.09, 132.96, 150.14, 150.93, 166.50. FAB-MS m/z (%): 843 (M^++H, 2.7), 739 (8.2), 681 (5.6), 417 (5.1), 357 (5.7), 341 (12), 307 (26), 251 (25), 185 (12), 73

(100). HR-MS (FAB) Calcd for $C_{47}H_{79}O_9Si_2$ ($M^+ + H$): 843.5267. Found: 843.5264.

K_2CO_3 (224 mg, 1.62 mmol) was added to a stirred solution of the silylate (137 mg, 0.16 mmol) in MeOH (3 ml) at room temperature. After 15 min, H_2O was added, and the mixture was extracted with Et_2O. The extract was washed with brine, dried over Na_2SO_4, and evaporated *in vacuo*. The residue was chromatographed on a silica gel column (*n*-hexane–EtOAc 2 : 1) to give **4** as a colorless oil (112 mg, 93%). $[\alpha]_D^{20}$ $-85.8°$ ($c=0.07$, $CHCl_3$). IR (neat) cm^{-1}: 3480, 2970, 2950, 2870, 1670, 1655. ^{1}H-NMR ($CDCl_3$) δ: 0.03 (s, 3H), 0.08 (s, 3H), 0.11 (s, 3H), 0.17 (s, 3H), 0.98 (s, 9H), 1.05 (s, 9H), 1.07 (d, 3H, $J=6.5$ Hz), 1.13 (d, 3H, $J=6.5$ Hz), 1.48 (s, 3H), 1.52 (s, 3H), 1.56 (ddd, 1H, $J=2.0$, 4.0, 15.0 Hz), 1.57—1.63 (m, 1H), 1.67 (t, 1H, $J=6.0$ Hz), 1.68—1.77 (m, 1H), 1.78—1.94 (m, 3H), 1.98 (ddd, 1H, $J=5.5$, 8.0, 15.5 Hz), 2.05 (ddd, 1H, $J=4.5$, 9.0, 13.5 Hz), 2.21—2.32 (m, 4H), 2.38 (ddd, 1H, $J=4.5$, 11.0, 15.0 Hz), 2.63 (ddd, 1H, $J=2.5$, 8.5, 11.5 Hz), 3.19 (t, 1H, $J=9.5$ Hz), 3.37 (dd, 1H, $J=5.5$, 11.5 Hz), 3.45 (ddd, 1H, $J=4.0$, 7.0, 11.0 Hz), 3.54 (dd, 1H, $J=6.0$, 10.5 Hz), 3.59—3.64 (m, 1H), 3.75 (dt, 1H, $J=2.5$, 9.0 Hz), 3.77 (t, 1H, $J=9.0$ Hz), 3.97—4.05 (m, 2H), 4.16 (dd, 1H, $J=5.5$, 7.5 Hz), 4.34—4.39 (m, 1H), 4.42—4.46 (m, 1H), 4.84 (d, 1H, $J=2.0$ Hz), 4.88 (d, 1H, $J=2.0$ Hz), 4.97 (s, 1H), 5.23 (s, 1H). ^{13}C-NMR ($CDCl_3$) δ: -4.94, -4.22, -3.39, -2.77, 15.34, 17.86, 17.91, 18.20, 25.75, 25.81, 26.05, 26.77, 27.36, 31.39, 31.47, 34.28, 34.97, 36.22, 40.89, 43.37, 64.30, 69.01, 70.77, 72.87, 73.26, 73.36, 75.90, 77.11, 77.25, 77.71, 80.08, 104.60, 105.20, 108.28, 150.67, 150.85. FAB-MS *m/z* (%): 739 ($M^+ + H$, 8.1), 681 (5.6), 417 (5.2), 357 (5.6), 341 (12), 307 (26), 251 (25), 185 (12), 171 (12), 73 (100). HR-MS (FAB) Calcd for $C_{40}H_{75}O_8Si_2$ ($M^+ + H$): 739.5000. Found: 739.4965.

Methyl (2*R*,4*S*,5*S*,6*S*,7*R*,8*S*,11*RS*,12*R*,14*S*,17*S*,20*R*)-1,2-Diacetoxy-5,7-bis(*tert*-butyldimethylsilyloxy)-14-(4-methoxybenzyloxy)-6,12-dimethyl-18-methylidene-21-[2-(trimethylsilyl)ethoxymethoxy]-10-oxo-4,8; 17,20-diepoxyhenicosane-11-carboxylate (29a, b) Dess–Martin reagent (3.2 g, 7.5 mmol) was added to a stirred solution of **7a** (400 mg, 0.38 mmol) in CH_2Cl_2 (100 ml) at room temperature. After 20 min, saturated aqueous Na_2SO_3 was added, and stirring was continued until the mixture became a clear solution, which was extracted with Et_2O. The extract was washed with brine, dried over Na_2SO_4, and evaporated *in vacuo*. The residue was chromatographed on a silica gel column (*n*-hexane–EtOAc 2 : 1) to give methyl (2*R*,4*S*,5*S*,6*S*,7*R*,8*S*,11*R*,12*R*,14*S*,17*S*,20*R*)-5,7-bis(*tert*-butyldimethylsilyloxy)-1,2-isopropylidenedioxy-6,-12-dimethyl-14-(4-methoxybenzyloxy)-18-methylidene-21-[2-(trimethylsilyl)ethoxymethoxy]-10-oxo-4,8; 17,20-diepoxyhenicosane-11-carboxylate (382 mg, 96%). $[\alpha]_D^{19}$ $-44.7°$ ($c=0.67$, $CHCl_3$). IR (neat) cm^{-1}: 2940, 2920, 2870, 2845, 1740, 1710, 1660, 1605, 1580, 1500. ^{1}H-NMR ($CDCl_3$) δ: 0.01 (s, 12H), 0.02 (s, 3H), 0.04 (s, 3H), 0.06 (s, 3H), 0.85 (s, 9H), 0.88 (s, 9H), 0.82—1.01 (m, 5H), 1.36 (s, 3H), 1.38 (s, 3H), 1.48—1.80 (m, 7H), 2.30 (ddd, 1H, $J=4.5$, 7.0, 10.0 Hz), 2.38—2.47 (m, 1H), 2.53 (dd, 1H, $J=10.0$, 16.0 Hz), 2.49—2.58 (m, 1H), 2.64—2.72 (m, 1H), 2.75 (dd, 1H, $J=2.0$, 16.0 Hz), 2.96 (t, 1H, $J=9.0$ Hz), 3.31 (d, 1H, $J=7.0$ Hz), 3.40 (dd, 1H, $J=6.0$, 11.0 Hz), 3.43—3.50 (m, 2H), 3.52 (d, 1H, $J=3.5$ Hz), 3.53 (d, 1H, $J=4.5$ Hz), 3.58—3.65 (m, 1H), 3.61 (d, 1H, $J=7.5$ Hz), 3.63 (d, 1H, $J=7.5$ Hz), 3.67 (s, 3H), 3.79 (s, 3H), 3.91 (dt, 1H, $J=2.5$, 10.5 Hz), 3.96 (dd, 1H, $J=6.0$, 7.5 Hz), 4.24 (ddd, 1H, $J=4.5$, 11.5, 15.0 Hz), 4.34 (d, 1H, $J=11.5$ Hz), 4.33—4.42 (m, 1H), 4.48 (d, 1H, $J=11.5$ Hz), 4.70 (t, 2H, $J=7.5$ Hz), 4.85 (dt, 1H, $J=2.0$, 2.5 Hz), 4.99 (dt, 1H, $J=2.0$, 2.5 Hz), 6.84—6.88 (m, 2H), 7.23—7.28 (m, 2H). ^{13}C-NMR ($CDCl_3$) δ: -4.91, -4.11, -3.42, -3.15, -1.41, 15.32, 16.89, 17.96, 18.11, 18.18, 25.79, 25.94, 26.91, 27.52, 29.48, 29.98, 30.87, 35.32, 38.89, 40.68, 44.28, 52.03, 55.25, 65.10, 67.13, 68.81, 69.38, 69.50, 72.88, 73.44, 75.29, 75.72, 76.08, 80.35, 95.03, 105.15, 108.24, 113.71, 129.31, 131.10, 150.64, 169.52, 203.20. FAB-MS *m/z* (%): 1051 ($M^+ + H$, 3.3), 855 (14), 823 (15), 781 (16), 723 (17), 473 (21), 369 (21), 317 (24), 315 (100). HR-MS (FAB) Calcd for $C_{55}H_{99}O_{13}Si_3$ ($M^+ + H$): 1051.6399. Found: 1051.6450.

PPTS (1.7 g, 6.8 mmol) was added to a stirred solution of the ketone (366 mg, 0.35 mmol) in MeOH (15 ml) at room temperature. After 6 h, the reaction mixture was quenched with saturated aqueous $NaHCO_3$, and extracted with Et_2O. The extract was washed with brine, dried over Na_2SO_4, and evaporated *in vacuo*. The residual oil was dissolved in CH_2Cl_2 (15 ml), then Et_3N (142 mg, 1.4 mmol), DMAP (20 mg) and Ac_2O (85 mg, 0.83 mmol) were added at room temperature. After being stirred for 15 min, the reaction mixture was quenched with MeOH and then H_2O, and extracted with Et_2O. The extract was washed with brine, dried over Na_2SO_4, and evaporated *in vacuo*. The residue was chromatographed on a silica gel column (*n*-hexane–EtOAc 2 : 1) to give a 1 : 1 mixture of **29a** and **29b** as a colorless oil (294 mg, 77%). A part of the mixture was separated into **29a** and **29b** by rechromatography. **29a**: $[\alpha]_D^{24}$ $-28.9°$ ($c=0.06$, $CHCl_3$). IR (neat) cm^{-1}: 2970, 2950, 2870, 1750, 1730, 1670, 1620, 1595, 1520. ^{1}H-NMR ($CDCl_3$) δ: 0.01 (s, 9H), 0.05 (s, 6H), 0.06 (s, 6H), 0.85 (s, 9H), 0.85 (d, 3H, $J=6.5$ Hz), 0.88 (s, 9H), 0.91—0.96 (m, 2H), 0.98 (d, 3H, $J=6.5$ Hz), 1.22 (ddd, 1H, $J=3.0$, 11.0, 14.5 Hz), 1.45—1.78 (m, 7H), 1.89 (ddd, 1H, $J=3.0$, 9.0, 15.0 Hz), 2.03 (s, 3H), 2.04 (s, 3H), 2.17 (ddd, 1H, $J=5.0$, 11.5, 15.0 Hz), 2.38—2.45 (m, 1H), 2.47—2.55 (m, 1H), 2.59 (dd, 1H, $J=9.5$, 15.5 Hz), 2.62—2.76 (m, 2H), 2.99 (t, 1H, $J=9.5$ Hz), 3.31 (d, 1H, $J=7.5$ Hz), 3.41 (dd, 1H, $J=6.0$, 10.5 Hz), 3.42—3.57 (m, 2H), 3.52 (dd, 1H, $J=3.5$, 5.0 Hz), 3.62 (dd, 2H, $J=7.5$, 9.0 Hz), 3.66 (s, 3H), 3.79 (s, 3H), 3.90 (dt, 1H, $J=2.0$, 9.5 Hz), 4.04 (dd, 1H, $J=5.0$, 13.0 Hz), 4.24 (dt, 1H, $J=5.0$, 12.5 Hz), 4.28 (dd, 1H, $J=4.5$, 7.5 Hz), 4.34 (d, 1H, $J=11.0$ Hz), 4.36—4.42 (m, 1H), 4.48 (d, 1H, $J=11.0$ Hz), 4.69 (s, 2H), 4.85 (d, 1H, $J=2.5$ Hz), 4.98 (d, 1H, $J=2.5$ Hz), 5.21—5.26 (m, 1H), 6.84—6.88 (m, 2H), 7.24—7.27 (m, 2H). ^{13}C-NMR ($CDCl_3$) δ: -4.88, -4.17, -3.27, -3.22, -1.39, 15.20, 16.59, 17.94, 18.12, 18.23, 20.89, 21.22, 24.85, 25.81, 26.03, 29.41, 29.54, 30.71, 35.32, 39.08, 40.56, 43.97, 51.94, 55.27, 63.90, 65.11, 66.83, 69.51, 69.70, 69.86, 70.23, 72.84, 75.15, 75.73, 76.06, 80.45, 95.04, 105.19, 113.70, 129.41, 131.11, 150.66, 159.03, 169.68, 170.23, 170.67, 203.25. FAB-MS *m/z* (%): 1117 ($M^+ + Na + H$, 16), 825 (13), 695 (10), 397 (9.2), 343 (13), 325 (40), 315 (53), 213 (100). HR-MS (FAB) Calcd for $C_{56}H_{98}O_{15}Si_3Na$ ($M^+ + Na + H$): 1117.6111. Found: 1117.6140. **29b**: $[\alpha]_D^{24}$ $-42.6°$ ($c=0.10$, $CHCl_3$). IR (neat) cm^{-1}: 2940, 2920, 2850, 1740, 1710, 1605, 1580, 1505. ^{1}H-NMR ($CDCl_3$) δ: 0.02 (s, 9H), 0.03 (s, 3H), 0.06 (s, 3H), 0.07 (s, 3H), 0.09 (s, 3H), 0.84 (d, 1H, $J=6.5$ Hz), 0.91—0.95 (m, 2H), 0.99 (d, 1H, $J=6.5$ Hz), 1.21—1.29 (m, 2H), 1.46—1.78 (m, 8H), 1.91 (ddd, 1H, $J=2.0$, 9.0, 14.5 Hz), 2.04 (s, 3H), 2.05 (s, 3H), 2.21 (ddd, 1H, $J=5.0$, 11.0, 15.0 Hz), 2.38—2.45 (m, 1H), 2.50—2.60 (m, 1H), 2.59 (dd, 1H, $J=9.5$, 16.5 Hz), 2.63—2.77 (m, 2H), 3.01 (t, 1H, $J=9.5$ Hz), 3.27 (d, 1H, $J=9.5$ Hz), 3.42 (dd, 1H, $J=6.0$, 11.5 Hz), 3.46—3.55 (m, 1H), 3.52 (dd, 1H, $J=3.0$, 5.0 Hz), 3.62 (dd, 2H, $J=7.5$, 9.0 Hz), 3.67 (s, 3H), 3.76—3.82 (m, 1H), 3.79 (s, 3H), 3.92 (dt, 1H, $J=2.5$, 9.0 Hz), 4.04 (dd, 1H, $J=5.0$, 12.5 Hz), 4.21—4.28 (m, 1H), 4.33 (d, 1H, $J=14.0$ Hz), 4.35 (d, 1H, $J=11.0$ Hz), 4.40 (br s, 1H), 4.49 (d, 1H, $J=11.0$ Hz), 4.69 (s, 2H), 4.85 (dt, 1H, $J=2.0$, 2.5 Hz), 4.99 (dt, 1H, $J=2.0$, 2.5 Hz), 5.29—5.35 (m, 1H), 6.84—6.88 (m, 2H), 7.25—7.30 (m, 2H). ^{13}C-NMR ($CDCl_3$) δ: -4.88, -4.17, -3.29, -3.18, -1.39, 15.04, 16.59, 16.88, 17.96, 18.12, 18.25, 20.90, 21.23, 24.85, 25.81, 26.03, 29.52, 30.10, 30.94, 35.32, 39.01, 40.60, 44.02, 52.10, 55.29, 63.92, 65.13, 67.23, 69.33, 69.51, 69.57, 69.88, 72.82, 75.37, 75.59, 76.10, 80.38, 95.04, 105.21, 113.72, 129.33, 129.41, 131.14, 150.64, 159.03, 169.59, 170.24, 172.70, 202.98. FAB-MS *m/z* (%): 1117 ($M^+ + Na + H$, 11), 977 (3.8), 887 (3.0), 827 (5.1), 767 (6.4), 725 (6.5), 516 (7.0), 343 (7.5), 325 (17), 315 (28), 213 (80), 122 (100). HR-MS (FAB) Calcd for $C_{56}H_{98}O_{15}Si_3Na$ ($M^+ + Na + H$): 1117.6111. Found: 1117.6170.

Methyl (2*R*,4*S*,5*S*,6*R*,7*R*,8*S*,10*R*,11*RS*,12*R*,14*S*,17*S*,20*R*)-1,2-Diacetoxy-21-(*tert*-butyldiphenylsilyloxy)-5,7-dihydroxy-6-methyl-18-methylidene-4,8; 10,14; 17,20-triepoxyhenicosane-11-carboxylate (30a, b) Et_3SiH (850 mg, 7.3 mmol) and $BF_3 \cdot Et_2O$ (691 mg, 4.9 mmol) were added to a stirred solution of **29** (267 mg, 0.25 mmol) in CH_3CN (5 ml) at 0 °C. After 5 min, Et_3N and H_2O were added, and the reaction mixture was extracted with Et_2O. The extract was washed with brine, dried over Na_2SO_4, and evaporated *in vacuo*. The residual oil was dissolved in CH_2Cl_2 (5 ml), and imidazole (33 mg, 0.48 mmol) and TBDPSCl (100 mg, 0.36 mmol) were added at 0 °C. After being stirred for 30 min, the reaction mixture was extracted with Et_2O. The extract was washed with brine, dried over Na_2SO_4, and evaporated *in vacuo*. The residue was chromatographed on a silica gel column (*n*-hexane–EtOAc 2 : 1) to give a 1 : 1 mixture of **30a** and **30b** as a colorless oil (179 mg, 88%). A part of the mixture was separated by rechromatography. **30a**: $[\alpha]_D^{25}$ $-33.6°$ ($c=0.54$, $CHCl_3$). IR (neat) cm^{-1}: 3470, 3060, 3040, 2950, 2920, 2850, 1740, 1730, 1720, 1660, 1580. ^{1}H-NMR ($CDCl_3$) δ: 0.94 (d, 3H, $J=6.5$ Hz), 1.03 (s, 9H), 1.10 (d, 3H, $J=6.5$ Hz), 1.32—1.37(m, 1H), 1.52—1.75 (m, 7H), 1.85—2.05 (m, 7H), 2.05 (s, 6H), 2.30 (br s, 1H), 2.44 (t, 1H, $J=3.5$ Hz), 2.52—2.58 (m, 1H), 2.62—2.68 (m, 1H), 2.99 (br s, 1H), 3.05 (t, 1H, $J=9.5$ Hz), 3.33—3.55 (m, 2H), 3.60 (dd, 1H, $J=5.5$, 10.5 Hz), 3.64 (s, 3H), 3.62—3.72 (m, 2H), 3.93 (dt, 1H, $J=5.0$, 10.0 Hz), 4.12—4.20 (m, 2H), 4.25 (dd, 1H, $J=3.0$, 12.0 Hz), 4.42 (br s, 1H), 4.84 (d, 1H, $J=2.5$ Hz), 4.96 (d, 1H, $J=2.5$ Hz), 5.18—5.23 (m, 1H), 7.33—7.41 (m, 6H), 7.63—7.68 (m, 4H). ^{13}C-NMR ($CDCl_3$) δ: 14.07, 14.42, 19.37, 19.47, 21.01, 21.04, 21.39, 26.27, 27.06, 31.51, 31.82,

32.74, 34.74, 35.45, 39.08, 49.95, 51.16, 53.65, 60.62, 64.76, 66.37, 70.43, 71.14, 72.72, 73.22, 73.28, 73.90, 77.06, 77.31, 77.57, 77.92, 78.70, 80.40, 105.03, 127.86, 129.82, 129.85, 133.84, 133.87, 135.84, 151.21, 170.79, 171.07, 172.33. FAB-MS *m/z* (%): 839 ($M^+ + H$, 15), 307 (11), 281 (11), 241 (69), 221 (69), 199 (55), 197 (55), 135 (100). HR-MS (FAB) Calcd for $C_{46}H_{67}O_{12}Si$ ($M^+ + H$): 839.4402. Found: 839.4422. **30b**: $[\alpha]_D^{25}$ $-41.5°$ ($c = 0.38$, $CHCl_3$). IR (neat) cm^{-1}: 3450, 2950, 2920, 2850, 1730, 1660, 1585. ^{1}H-NMR ($CDCl_3$) δ: 0.89 (d, 3H, $J = 6.5$ Hz), 0.95—1.05 (m, 1H), 1.03 (s, 9H), 1.11 (d, 3H, $J = 6.5$ Hz), 1.48—1.68 (m, 5H), 1.83—2.08 (m, 6H), 2.04 (s, 9H), 2.26 (br s, 1H), 2.54—2.59 (m, 1H), 2.63—2.69 (m, 1H), 3.04 (t, 1H, $J = 9.5$ Hz), 3.42—3.58 (m, 4H), 3.61 (dd, 1H, $J = 5.5$, 10.5 Hz), 3.65 (dd, 1H, $J = 5.5$, 10.5 Hz), 3.68 (s, 3H), 3.94 (dt, 1H, $J = 5.0$, 9.0 Hz), 4.12—4.20 (m, 2H), 4.23 (dd, 1H, $J = 3.0$, 12.0 Hz), 4.40 (br s, 1H), 4.83 (d, 1H, $J = 2.5$ Hz), 4.98 (d, 1H, $J = 2.5$ Hz), 5.20—5.24 (m, 1H), 7.33—7.42 (m, 6H), 7.64—7.67 (m, 4H). ^{13}C-NMR ($CDCl_3$) δ: 13.82, 14.12, 19.17, 20.03, 20.70, 21.09, 26.09, 26.75, 31.27, 33.44, 35.08, 36.98, 38.62, 38.80, 51.55, 53.35, 54.90, 60.32, 64.65, 66.09, 70.25, 70.33, 72.60, 72.80, 73.56, 74.87, 77.55, 77.65, 79.93, 104.69, 127.57, 129.53, 129.56, 133.52, 133.55, 135.54, 150.88, 170.46, 170.68, 173.75. FAB-MS *m/z* (%): 839 ($M^+ + H$, 16), 367 (4.5), 307 (8.9), 241 (67), 221 (53), 199 (50), 135 (100). HR-MS (FAB) Calcd for $C_{46}H_{67}O_{12}Si$ ($M^+ + H$): 839.4402. Found: 839.4393.

(2*R*,4*S*,5*S*,6*R*,7*R*,8*S*,10*R*,12*R*,14*S*,17*S*,20*R*)-5,7-Bis(*tert*-butyldimethylsilyloxy)-21-(*tert*-butyldiphemylsilyloxy)-1,2-isopropylidenedioxy-6-methyl-11,18-dimethylidene-4,8; 10,14; 17,20-triepoxyhenicosane (31) K_2CO_3 (267 mg, 1.93 mmol) was added to a stirred solution of **30** (162 mg, 0.19 mmol) in MeOH (5 ml) at room temperature. After 15 min, the reaction mixture was diluted with H_2O, and extracted with CH_2Cl_2. The extract was washed with brine, dried over Na_2SO_4, and evaporated *in vacuo* to leave an oil, which was dissolved in benzene (5 ml). To this solution was added $(MeO)_2CMe_2$ (100 mg, 0.96 mmol) and *dl*-camphorsulfonic acid (CSA) (22 mg, 0.095 mmol) at 0 °C. After being stirred for 30 min, the reaction mixture was neutralized with aqueous $NaHCO_3$ and extracted with Et_2O. The extract was washed with brine, dried over Na_2SO_4, and evaporated *in vacuo*. The residue was chromatographed on a silica gel column (EtOAc) to give the acetonide as a colorless oil (142 mg, 92%). IR (neat) cm^{-1}: 3450, 3060, 3040, 2970, 2950, 2920, 2850, 1660, 1580. FAB-MS *m/z* (%): 795 ($M^+ + H$, 7.2), 737 (4.2), 719 (4.3), 463 (6.5), 341 (6.7), 307 (13), 295 (16), 241 (82), 221 (100). HR-MS (FAB) Calcd for $C_{45}H_{67}O_{10}Si$ ($M^+ + H$): 795.4507. Found: 795.4530.

2,6-Lutidine (124 μl, 1.06 mmol) and TBSOTf (123 μl, 0.64 mmol) were added to a stirred solution of the above acetonide (142 mg, 0.18 mmol) in CH_2Cl_2 (5 ml) at 0 °C. After 15 min, the reaction mixture was quenched with saturated aqueous $NaHCO_3$, and extracted with Et_2O. The extract was washed with brine, dried over Na_2SO_4, and evaporated *in vacuo*. The residue was chromatographed on a silica gel column (*n*-hexane–EtOAc 5 : 1) to give (2*R*,4*S*,5*S*,6*R*,7*R*,8*S*,10*R*,11*RS*,12*R*,14*S*,17*S*,20*R*)-5,7-bis(*tert*-butyldimethylsilyloxy)-21-(*tert*-butyldiphenylsilyloxy)-1,2-isopropylidenedioxy-11-methoxycarbonyl-6-methyl-18-methylidene-4,8; 10,14; 17,20-triepoxyhenicosane as a colorless oil (163 mg, 89%). IR (neat) cm^{-1}: 3055, 3040, 2940, 2910, 2880, 2850, 1730, 1660, 1580. FAB-MS *m/z* (%): 1021 ($M^+ - H$, 4.9), 965 (17), 889 (5.8), 774 (7.6), 549 (8.3), 425 (8.7), 375 (15), 315 (50), 307 (23), 136 (100). HR-MS (FAB) Calcd for $C_{57}H_{93}O_{10}Si_3$ ($M^+ - H$): 1021.6081. Found: 1021.6110.

A solution of the above ester (160 mg, 0.15 mmol) in toluene was added to a stirred 0.94 M solution of DIBAH in *n*-hexane (1.68 ml, 1.58 mmol) diluted with toluene at -78 °C under argon. After 15 min, MeOH and then Rochelle salt were added at room temperature, and extracted with Et_2O. The extract was washed with brine, dried over Na_2SO_4, and evaporated *in vacuo*. The residue was chromatographed on a silica gel column (*n*-hexane EtOAc 3 : 1) to give the alcohol (1 : 1 mixture) as a colorless oil (131 mg, 84%). IR (neat) cm^{-1}: 3450, 3060, 3040, 2940, 2915, 2875, 2850, 1660, 1580. FAB-MS *m/z* (%): 995 ($M^+ + H$, 6.9), 975 (4.0), 937 (4.0), 507 (4.4), 462 (4.1), 393 (4.2), 381 (6.3), 341 (9.1), 315 (24), 199 (100). HR-MS (FAB) Calcd for $C_{56}H_{95}O_9Si_3$ ($M^+ + H$): 995.6289. Found: 995.6254.

Et_3N (132 mg, 1.3 mmol), DMAP (8 mg) and TsCl (124 mg, 0.65 mmol) were added to a stirred solution of the above alcohol (130 mg, 0.13 mmol) in CH_2Cl_2 (3 ml) at 0 °C. After 27 h at room temperature, MeOH and H_2O were added, and the mixture was extracted with Et_2O. The extract was washed with brine, dried over Na_2SO_4, and evaporated *in vacuo*. The residue was chromatographed on a silica gel column (*n*-hexane–EtOAc 5 : 1) to give a tosylate as a colorless oil (150 mg, 100%). IR (neat) cm^{-1}: 3050, 3030, 2940, 2910, 2880, 2840, 1655, 1590. FAB-MS *m/z* (%): 1149 ($M^+ + H$, 8.5), 1034 (10), 901 (9.6), 844 (7.8), 787 (8.5), 729 (7.5), 644 (9.1), 597 (10), 489 (17), 353 (42), 315 (80), 213 (100). HR-MS (FAB) Calcd for $C_{63}H_{101}O_{11}SSi_3$ ($M^+ + H$): 1149.6372. Found: 1149.6320.

NaI (2.7 g, 18.0 mmol), $NaHCO_3$ (1.53 g, 18.2 mmol) and DBU (5.55 g, 36.5 mmol) were added to a stirred solution of the tosylate (420 mg, 0.36 mmol) in THF (10 ml) at room temperature. The reaction mixture was heated under reflux for 36 h, then cooled to room temperature, quenched with H_2O, and extracted with Et_2O. The extract was washed with brine, dried over Na_2SO_4, and evaporated *in vacuo*. The residue was chromatographed on a silica gel column (*n*-hexane–EtOAc 5 : 1) to give **31** as a colorless oil (302 mg, 83%). $[\alpha]_D^{23}$ $-26.7°$ ($c = 0.29$, $CHCl_3$). IR (neat) cm^{-1}: 3060, 3035, 2940, 2920, 2880, 2840, 1655, 1660, 1580. ^{1}H-NMR ($CDCl_3$) δ: 0.03 (s, 3H), 0.05 (s, 3H), 0.09 (s, 3H), 0.11 (s, 3H), 0.88 (s, 9H), 0.90 (s, 9H), 0.82—0.90 (m, 2H), 1.00 (d, 3H, $J = 7.0$ Hz), 1.04 (s, 9H), 1.06 (d, 3H, $J = 7.0$ Hz), 1.00—1.10 (m, 1H), 1.31 (s, 3H), 1.37 (s, 3H), 1.40—1.55 (m, 2H), 1.57—1.70 (m, 5H), 1.78 (ddd, 1H, $J = 2.0$, 4.0, 12.5 Hz), 2.16—2.30 (m, 1H), 2.35 (ddd, 1H, $J = 2.0$, 9.0, 13.5 Hz), 2.53—2.58 (m, 1H), 2.63—2.70 (m, 1H), 3.04 (t, 1H, $J = 9.0$ Hz), 3.43 (dd, 1H, $J = 6.0$, 9.5 Hz), 3.45—5.70 (m, 3H), 3.60 (dd, 1H, $J = 5.0$, 10.0 Hz), 3.67 (dd, 1H, $J = 4.5$, 10.0 Hz), 3.74 (ddd, 1H, $J = 2.5$, 5.5, 10.0 Hz), 3.83 (dd, 1H, $J = 4.0$, 9.0 Hz), 4.03—4.11 (m, 1H), 4.14—4.21 (m, 1H), 4.83 (br s, 1H), 4.92 (s, 1H), 4.96 (d, 1H, $J = 2.0$ Hz), 7.34—7.43 (m, 6H), 7.65—7.68 (m, 4H). ^{13}C-NMR ($CDCl_3$) δ: -4.78, -4.06, -3.24, -2.53, 15.79, 18.10, 18.16, 18.50, 19.99, 25.99, 26.29, 26.35, 27.07, 27.22, 27.63, 32.30, 32.36, 32.40, 35.35, 35.40, 41.53, 43.88, 53.27, 66.71, 66.76, 66.79, 69.25, 71.01, 73.38, 73.56, 74.06, 75.92, 77.49, 77.88, 78.00, 80.59, 104.47, 104.54, 104.61, 108.55, 129.93, 134.10, 136.04, 152.10, 152.19. FAB-MS *m/z* (%): 976 (M^+, 7.2), 861 (7.1), 661 (10), 572 (8.7), 489 (25), 341 (35), 315 (35), 221 (100). HR-MS (FAB) Calcd for $C_{56}H_{92}O_8Si_3$ (M^+): 976.6105. Found: 976.6140.

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