Synthesis of a Prenylated and Immunosuppressive Marine Galactosphingolipid with Cyclopropane-Containing Alkyl Chains: (2*S*,3*R*,11*S*,12*R*,2′′′*R*,5′′′*Z*,11′′′*S*,12′′′*R*)-Plakoside A and Its (2*S*,3*R*,11*R*,12*S*,2′′′*R*,5′′′*Z*,11′′′*R*,12′′′*S*) Isomer[‡]

Masanori Seki[a] and Kenji Mori*[a]

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Plakoside A (**1**) {(2*S*,3*R*,11*R**,12*S**)-2-[(2′′′*R*,5′′′*Z*,11′′′*R**,12′′′*S**)-2′′′-hydroxy-11′′′,12′′′-methylene-5′′′-docosenamido]-1-*O*-[2′-*O*-(3′′-methyl-2′′-butenyl)-β-D-galactopyranosyl]-11,12-methylene-1,3-docosanediol} is a prenylated galactosphingolipid isolated as an immunosuppressant from the marine sponge *Plakortis simplex*. (2*S*,3*R*,11*S*,12*R*,2′′′*R*,5′′′*Z*,11′′′*S*,12′′′*R*)-Plakoside A (**1**) has been synthesized by combining the sphingosine part **16**, the α-hydroxy acid part **28**, and the prenylated sugar part **33**. (2*S*,3*R*,11*R*,12*S*,2′′′*R*,5′′′*Z*,11′′′*R*,12′′′*S*)-Plakoside A (**1′**) has also been synthesized.

Introduction

In 1997, Fattorusso and co-workers isolated plakosides A (**1**, Figure 1) and B as metabolites of the Caribbean sponge *Plakortis simplex*.[1] They are structurally unique as glycosphingolipids with a prenylated D-galactose moiety and cyclopropane-containing alkyl chains, and show strong immunosuppressive activity without cytotoxicity. Later, in 2000, plakosides C and D, two similar prenylated glycosphingolipids, were isolated from the marine sponge *Ectyoplasia ferox*.[2]

The unique structure of plakoside A (**1**), together with the fact that only 5 mg of **1** could be secured from 57 g (dry weight) of the sponge,[1] encouraged us to explore a synthetic route to this compound. Since the absolute configuration at the stereogenic centers of the two cyclopropane moieties is unknown, except that they are *cis*-disubstituted cyclopropanes, we decided to synthesize two diastereoisomers of plakoside A, (2*S*,3*R*,11*S*,12*R*,2′′′*R*,5′′′*Z*,11′′′*S*,12′′′*R*)-**1** and (2*S*,3*R*,11*R*,12*S*,2′′′*R*,5′′′*Z*,11′′′*R*,12′′′*S*)-**1′**, anticipating that one of them would be the natural product. We assumed that the two cyclopropane-containing side chains in a given molecule have the same absolute configuration due to the enantioselective biocyclopropanation process. Herein, we describe in detail our syntheses of **1** and **1′**, the synthesis of the former having been reported as a preliminary communication.[3] While our work was in progress,

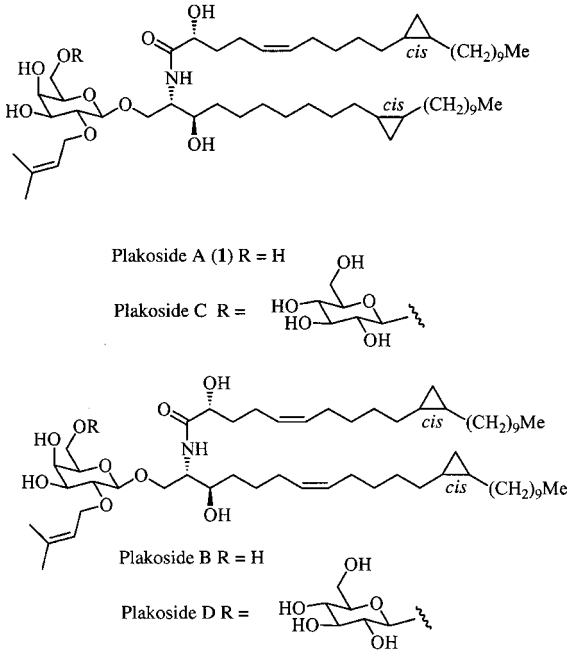

Figure 1. Structures of plakosides A−D

Nicolaou et al. published the synthesis of (2*S*,3*R*,11*R*,12*S*,2′′′*R*,5′′′*Z*,11′′′*R*,12′′′*S*)-plakoside A (**1′**) and (2*S*,3*R*,7*Z*,13*R*,14*S*,2′′′*R*,5′′′*Z*,11′′′*R*,12′′′*S*)-plakoside B.[4]

Results and Discussion

Synthetic Plan

Plakoside A (**1**) can clearly be synthesized by connecting three building blocks, i.e. the sugar part **A**, the sphingosine part **B**, and the hydroxy acid part **C**, as shown in Scheme 1.

[‡] Synthesis of Sphingosine Relatives, XXIII. − Part XXII: H. Takikawa, D. Nozawa, A. Kayo, S. Muto, K. Mori, *J. Chem. Soc., Perkin Trans. 1* **1999**, 2467−2478.

[a] Department of Chemistry, Faculty of Science, Science University of Tokyo,
Kagurazaka 1-3, Shinjuku-ku, Tokyo 162-8601, Japan
Fax: (internat.) + 81-3/3235-2214

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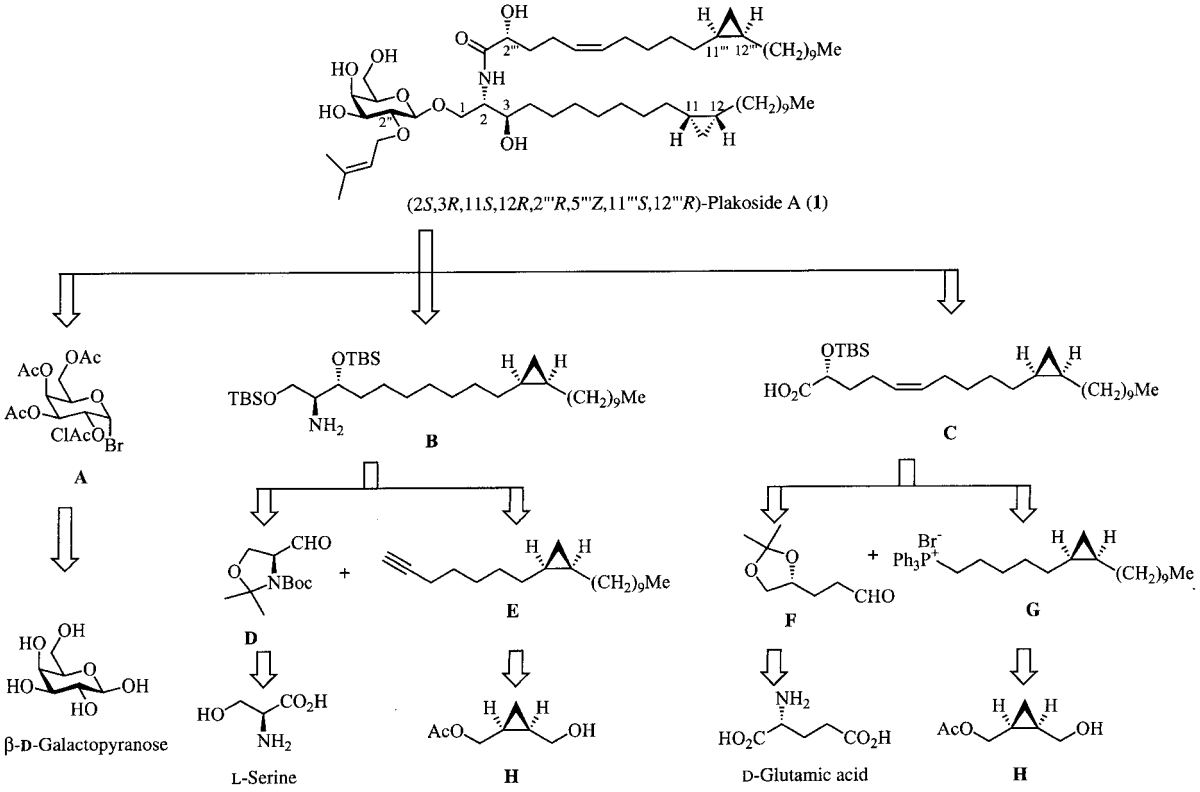


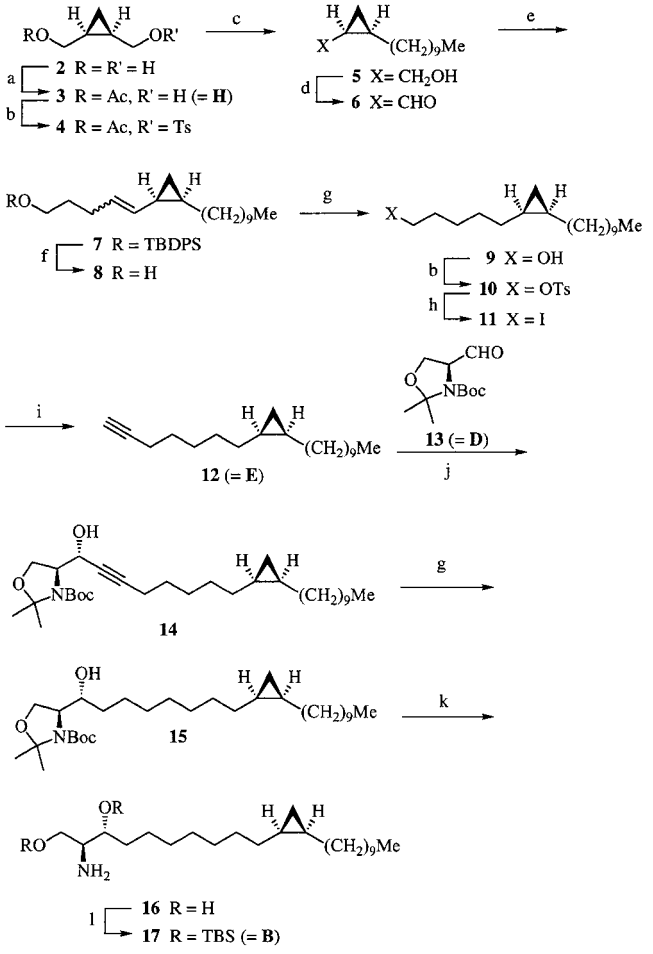
Scheme 1. Retrosynthetic analysis of (2*S*,3*R*,11*S*,12*R*,2′′′*R*,5′′′*Z*,11′′′*S*,12′′′*R*)-plakoside A (**1**)

Our synthesis is based on these disconnections and employs an enzymatic method for the preparation of the key chiral building block, (1*S*,2*R*)-1-acetoxymethyl-2-hydroxymethylcyclopropane (**H**).[5−7] In the Nicolaou synthesis of **1′**, the cyclopropane moieties were constructed by employing the Charette reaction. In our synthetic plan, the sugar part **A** is to be attached at a later stage to the ceramide prepared from **B** and **C**; β-D-galactopyranose serves as the starting material for **A**. The sphingosine part **B** can be constructed by coupling the Garner aldehyde **D** with the alkyne **E** containing a cyclopropane moiety. The chiral starting material **H** can be converted into **E**. The synthesis of the olefinic hydroxy acid part **C** requires coupling of the aldehyde **F** and the Wittig reagent derived from **G**. The aldehyde **F** can be derived from D-glutamic acid, while the cyclopropane-containing phosphonium salt **G** can again be prepared by employing **H**.

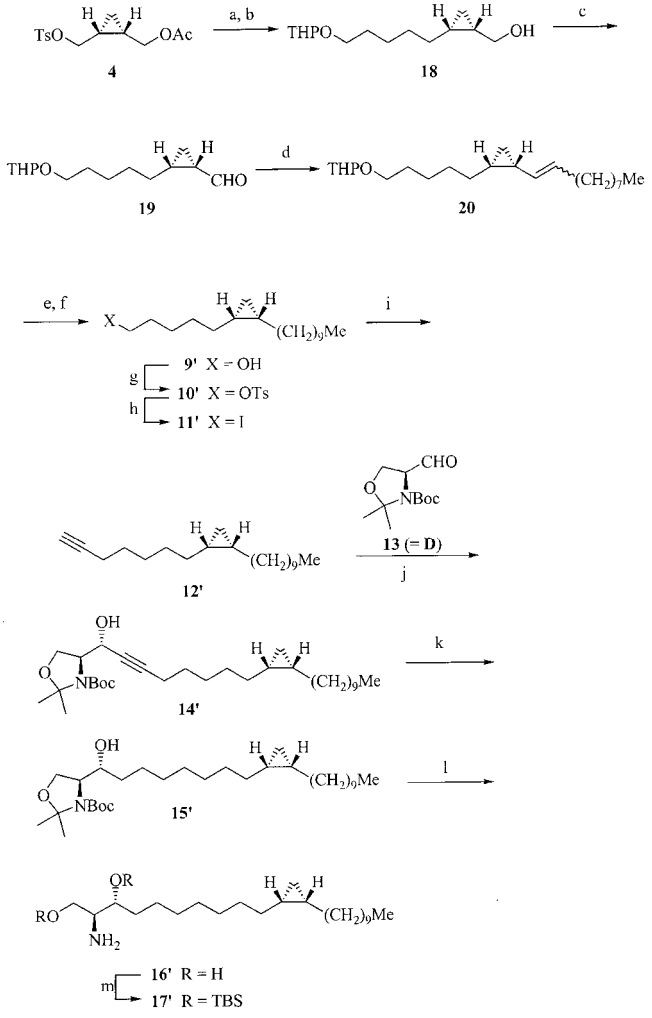
Synthesis of the Sphingosine Part

Scheme 2 summarizes the synthesis of the (11*S*,12*R*)-sphingosine part **16**. Enzymatic acetylation of *meso*-diol **2**[5−7] with vinyl acetate in the presence of lipase AK (Amano) gave monoacetate (1*S*,2*R*)-**3** (= **H**), the enantiomeric purity of which was determined as being > 99.9% *ee* by HPLC analysis (Chiralcel® OD-H). Tosylation of **3** afforded **4**, which was treated with nonylmagnesium bromide under Schlosser conditions[8] to furnish alcohol **5**. Swern oxidation of **5** to give aldehyde **6** was followed by a Wittig reaction with (*tert*-butyldiphenylsilyloxytetramethylene)triphenylphosphorane to yield olefin **7**. Removal of the *tert*-butyldiphenylsilyl (TBDPS) protective group of **7** using tetrabutylammonium fluoride (TBAF) in THF afforded olefinic alcohol **8**, diimide reduction of which provided alcohol **9** leaving the cyclopropane ring intact. Iodide **11** was obtained from **9** via the corresponding tosylate **10**. Treatment of **11** with lithium acetylide−ethylenediamine complex in DMSO afforded alkyne **12** (= **E**). Coupling of **12** with Garner aldehyde **13** (= **D**) derived from (*S*)-serine[9] was executed under the standard conditions[10] to give **14** as the sole product after chromatographic purification. Diimide reduction of **14** afforded **15**. Treatment of **15** with dilute hydrochloric acid yielded sphingosine **16** as its hydrochloride, the hydroxy groups of which were protected as *tert*-butyldimethylsilyl (TBS) ethers by treatment with *tert*-butyldimethylsilyl triflate (TBSOTf) to furnish **17** (= **B**), one of the three building blocks required to construct **1**.

The synthesis of the (11*R*,12*S*)-sphingosine part **16′** is illustrated in Scheme 3. The tosylate **4** was chain-elongated by treatment with 4-(tetrahydropyranyloxy)butylmagnesium bromide under Schlosser conditions,[8] to give **18** after removal of the acetyl group. The alcohol **18** was oxidized under Swern conditions to furnish aldehyde **19**. Treatment of **19** with the Wittig reagent prepared from nonyltriphenylphosphonium bromide gave olefin **20**. Removal of the tetrahydropyranyl (THP) protective group of **20** was followed by diimide reduction to saturate the double bond, giving alcohol **9′**. Further steps leading to (11*R*,12*S*)-**17′** were ex-



Scheme 2. Synthesis of (11*S*,12*R*)-sphingosine part **17** (= **B**); reagents: (a) vinyl acetate, lipase AK (Amano), THF (86%); (b) TsCl, C_5H_5N, CH_2Cl_2; (c) $Me(CH_2)_8MgBr$, Li_2CuCl_4, THF (85%, 2 steps); (d) $(COCl)_2$, DMSO, Et_3N, CH_2Cl_2; (e) $TBDPSO(CH_2)_4PPh_3Br$, *n*BuLi, THF (98%, 2 steps); (f) TBAF, THF (98%); (g) N_2H_4, H_2O_2, EtOH, H_2O (94% for **9**; 89% for **15**); (h) NaI, DMF (90%, 2 steps); (i) $LiC{\equiv}CH{\cdot}H_2N(CH_2)_2NH_2$, DMSO (88%); (j) *n*BuLi, THF, **13** (80%); (k) dil. aq. HCl, MeOH (quant.); (l) TBSOTf, 2,6-lutidine, CH_2Cl_2 (91%)



Scheme 3. Synthesis of (11*R*,12*S*)-sphingosine part **17**′; reagents: (a) $THPO(CH_2)_4MgBr$, Li_2CuCl_4, THF; (b) K_2CO_3, MeOH (85%, 2 steps); (c) $(COCl)_2$, DMSO, Et_3N, CH_2Cl_2 (88%); (d) $Me(CH_2)_8PPh_3Br$, *n*BuLi, THF (98%); (e) TsOH, MeOH, CH_2Cl_2 (97%); (f) N_2H_4, H_2O_2, EtOH, H_2O (98%); (g) TsCl, C_5H_5N, CH_2Cl_2; (h) NaI, DMF (81%, 2 steps); (i) $LiC{\equiv}CH{\cdot}H_2N(CH_2)_2NH_2$, DMSO (88%); (j) *n*BuLi, THF, **13** (85%); (k) N_2H_4, H_2O_2, EtOH, H_2O (85%); (l) dil. aq. HCl, MeOH (85%); (m) TBSOTf, 2,6-lutidine, CH_2Cl_2 (91%)

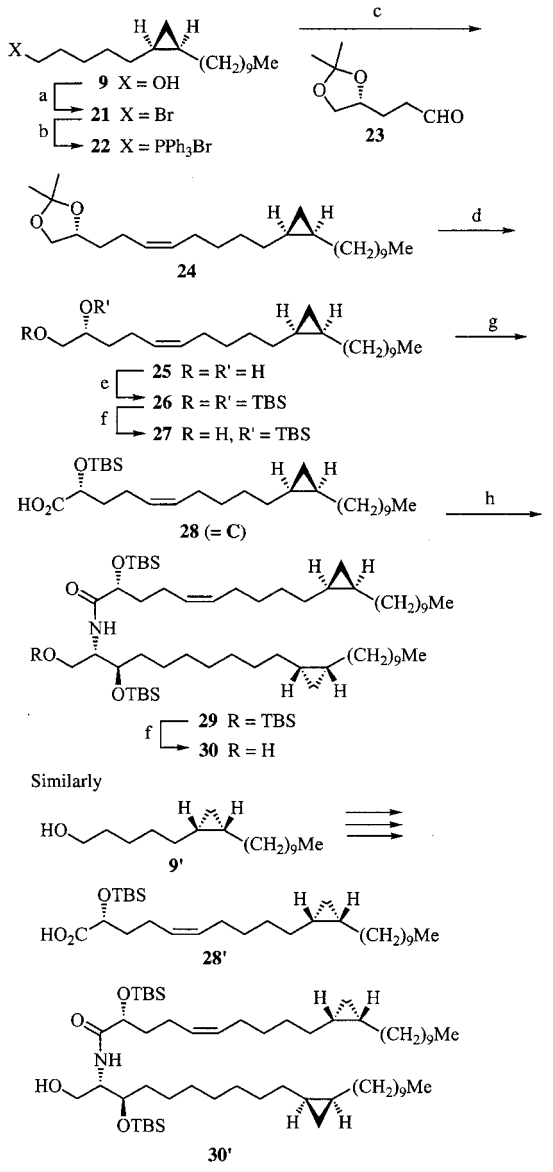
ecuted in the same manner as described for the preparation of (11*S*,12*R*)-**17**.

Synthesis of the Protected Ceramides

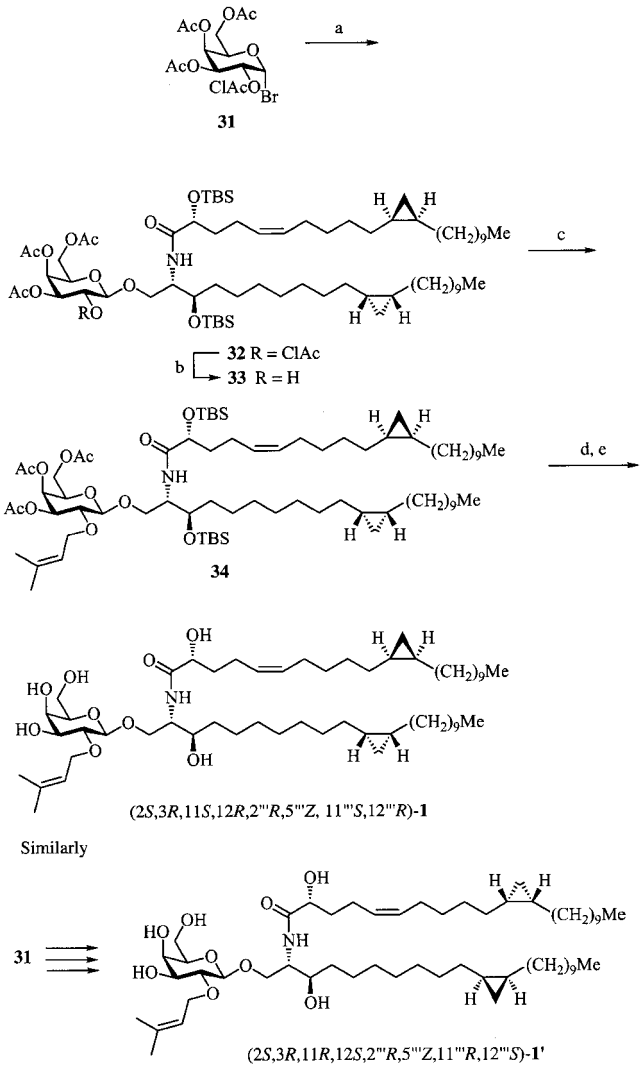
The synthesis of the α-hydroxy acid part **28** (= **C**) or **28**′ and its coupling with the sphingosine part **17** (= **B**) or **17**′ to give the protected ceramide **30** or **30**′ are summarized in Scheme 4. Alcohol **9** was converted to phosphonium salt **22** via the bromide **21**. The Wittig reagent generated from **22** by treatment with sodium hexamethyldisilazide (NaHMDS) reacted with aldehyde **23** (prepared from D-glutamic acid in four steps)[11,12] to give (*Z*)-alkene **24** as the sole product on the basis of its ^{13}C NMR spectroscopic data. Removal of the acetonide protective group of **24** was followed by silylation of the resulting diol **25** to give the bis(TBS) ether **26**. Treatment of **26** with trifluoroacetic acid afforded a mixture of **25**−**27**, from which the mono(TBS) ether **27** could be separated by silica gel chromatography. Two-step oxidation of **27** with Dess−Martin periodinane and sodium chlorite yielded the acid **28** (= **C**). Acylation of the sphingosine part **17** with **28** was executed in the presence of *N*,*N*′-dicyclohexylcarbodiimide (DCC) and 1-hydroxybenzotriazole (HOBt) to furnish the tris(TBS)-protected ceramide **29**. Cleavage of the TBS protective group at C-1 of **29** under acidic conditions afforded **30**, the protected ceramide part. Its (11*R*,12*S*,11′′′*R*,12′′′*S*) diastereomer **30**′ was synthesized in the same manner as described for **30** by starting from (6*R*,7*S*)-**9**′. The hydroxy acid part **28**′ was coupled with **17**′ to give **30**′ after desilylation at C-1.

Synthesis of the Two Diastereomers of Plakoside A

Scheme 5 summarizes the completion of the syntheses of (2*S*,3*R*,11*S*,12*R*,2′′′*R*,11′′′*S*,12′′′*R*)-plakoside A (**1**) and its (2*S*,3*R*,11*R*,12*S*,2′′′*R*,11′′′*R*,12′′′*S*) isomer (**1**′). Pentaace-



Scheme 4. Synthesis of the protected ceramides **30** and **30′**; reagents: (a) CBr_4, PPh_3, CH_2Cl_2 (quant.); (b) PPh_3, MeCN, $NaHCO_3$ (97%); (c) NaHMDS, THF, **23** (80%); (d) dil. aq. HCl, THF (quant.); (e) TBSCl, imidazole, DMF (95%); (f) 10% TFA, THF (39% for **27** with 25% of **25** and 30% recovery of **26**; 49% for **30** and 37% recovery of **29**); (g) i) Dess−Martin periodinane; ii) $NaClO_2$, NaH_2PO_4, 2-methyl-2-butene, *t*BuOH, H_2O (quant. 2 steps); (h) **17**, DCC, HOBt, CH_2Cl_2 (94%)



Scheme 5. Synthesis of (2*S*,3*R*,11*S*,12*R*,2′′′*R*,5′′′*Z*,11′′′*S*,12′′′*R*)-plakoside A (**1**) and its (2*S*,3*R*,11*R*,12*S*,2′′′*R*,5′′′*Z*,11′′′*R*,12′′′*S*) isomer (**1′**); reagents: (a) **31**, $Hg(CN)_2$, $MeNO_2$, C_6H_6 (78%); (b) N_2H_4·AcOH, AcOEt, MeOH (73%); (c) $Me_2C{=}CHCH_2OC(=NH)CCl_3$, BF_3·OEt_2, CH_2Cl_2 (44%); (d) TBAF, THF; (e) NaOMe, MeOH (60%, 2 steps)

tyl β-D-galactopyranose was converted into the known C-2′ monochloroacetyl-protected bromide **31**.[13,14] Glycosidation of ceramide **30** with **31** under conventional Königs−Knorr conditions was followed by selective removal of the chloroacetyl group at C-2′ of **32** with hydrazine acetate[15] to give **33**. Prenylation of **33** with 1-(2,2,2-trichloro-1-iminoethoxy)-3-methyl-2-butene in the presence of boron trifluoride−diethyl ether[16] gave the bis(TBS)- and triacetyl-protected compound **34**. Two-step removal of the protective groups of **34** under conventional conditions gave **1**. The synthetic (2*S*,3*R*,11*S*,12*R*,2′′′*R*,5′′′*Z*,11′′′*S*,12′′′*R*)-plakoside A (**1**), $[\alpha]_D^{22}$ = +8.9 (*c* = 0.065, MeOH) {ref.:[1] $[\alpha]_D^{25}$ = +7 (*c* = 0.5, MeOH)}, showed ^1H and ^{13}C NMR spectroscopic properties in agreement with those reported for the natural product.[1] The overall yield of **1** was 3.7% (**2**→**17**→**1**; 20 steps) or 4.6% (**2** → **9** → **28** → **1**; 21 steps) based on **2**. Similarly, **31** and **30′** afforded (2*S*,3*R*,11*R*,12*S*,2′′′*R*,5′′′*Z*,11′′′*R*,12′′′*S*)-plakoside A (**1′**), $[\alpha]_D^{22}$ = +10.5 (*c* = 0.07, MeOH) {ref.:[4] $[\alpha]_D^{25}$ = +10.4 (*c* = 1.6, MeOH)}, the ^1H and ^{13}C NMR spectra of which are indistinguishable from those of **1** and identical to those reported by Nicolaou et al.[4]

Conclusion

We have accomplished the synthesis of the two diastereomers (**1** and **1′**) of plakoside A. Because **1** and **1′** are indistinguishable by normal spectroscopic methods, and because they have similar chiroptical properties, the absolute config-

uration of the cyclopropane moiety of the naturally occurring plakoside A remains undetermined.

There have been a number of reported examples where two diastereomers with separated stereogenic centers show indistinguishable spectroscopic data, such as in the cases of penazetidine A,[17,18] penaresidin A,[18,19] and sphingofungin D[20] (Figure 2). In these cases, derivatization or degradation of the natural products was necessary to completely resolve the stereochemical assignments.[19,20] We shall attempt to resolve the matter of the stereochemistry after reisolation of the plakosides by Professor Fattorusso.

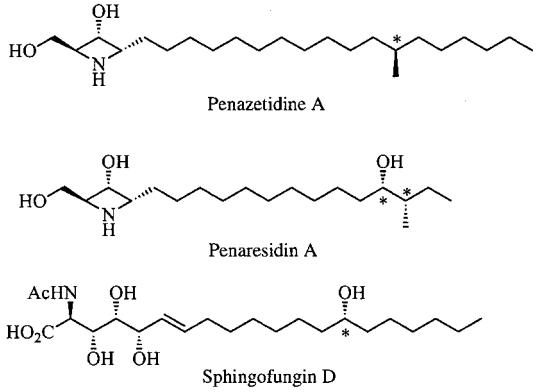


Figure 2. Examples of related natural products with remote stereogenic center(s) denoted by asterisks

Experimental Section

General: IR: Jasco A-102 and Perkin−Elmer 1640. − ^{1}H NMR: Jeol JNM-EX 90A (90 Hz), Jeol JNM-AL300 (300 MHz), and Jeol JNM-LA500 (500 MHz) (TMS at δ = 0.00 or $CHCl_3$ at δ = 7.26 as an internal standard). − ^{13}C NMR: Jeol JNM-LA500 (125 MHz) ($CHCl_3$ at δ = 77.0 as an internal standard). − Optical rotation: Jasco DIP-1000. − MS: Jeol JMS-SX102A. − Column chromatography: Merck Kieselgel 60 Art 1.07734. − TLC: 0.25 mm Merck silica gel plates (60F-254).

(1*S*,2*R*)-1-Acetoxymethyl-2-hydroxymethylcyclopropane (3): To a solution of **2** (21.3 g, 208 mmol) in THF (110 mL) and vinyl acetate (130 mL) was added lipase AK (1.06 g), and the reaction mixture was stirred for 3.5 h at room temperature. This mixture was filtered through Celite and the filtrate was concentrated in vacuo. The residue was chromatographed on silica gel to give **3** (25.8 g, 86%) as a colorless oil; n_D^{25} = 1.4558. − $[\alpha]_D^{21}$ = −19.9 (*c* = 1.65 in $CHCl_3$). − IR(film): $\tilde{\nu}_{max}$ = 3400 cm^{-1} (m, OH), 3080 (w, CH), 1740 (s, C=O), 1240 (s, C−O), 1030 (s, C−O). − ^{1}H NMR (90 MHz, $CDCl_3$): δ = 0.23 (ddd, *J* = 5.3, 5.2, 5.2 Hz, 1 H, 3-H_a), 0.73−0.97 (m, 1 H, 3-H_b), 1.16−1.47 (m, 2 H, 1-, 2-H), 1.79 (br. s, 1 H, OH), 2.09 (s, 3 H, Ac), 3.27−3.51 (m, 1 H, 1′′-H_a), 3.69−3.98 (m, 2 H, 1′-H_a, 1′′-H_b), 4.38−4.59 (m, 1 H, 1′-H_b). − $C_7H_{12}O_3$ (144.2): calcd. C 58.32, H 8.39; found C 58.72, H 8.80.

(2*R*,3*S*)-4-Acetoxy-2,3-methylenebutyl Tosylate (4): To a solution of **3** (3.62 g, 25.1 mmol) in pyridine (20 mL) and CH_2Cl_2 (25 mL), *p*-toluenesulfonyl chloride (7.18 g, 37.7 mmol) was added at 0 °C and the reaction mixture was stirred for 12 h at 4 °C. It was then poured into water and extracted with $CHCl_3$. The combined extracts were washed with dil. aq. HCl, water, and brine. The organic layer was dried with $MgSO_4$ and concentrated in vacuo to give crude tosylate **4** (6.93 g, 93%). This was used in the next Grignard reaction without further purification. − IR(film): $\tilde{\nu}_{max}$ = 3080 cm^{-1} (w, CH), 1740 (s, C=O), 1600 (m, Ar), 1500 (w, Ar), 1370 (s, SO_2), 1240 (s, C−O), 1195 (s, SO_2). − ^{1}H NMR (90 MHz, $CDCl_3$): δ = 0.31 (ddd, *J* = 5.5, 5.5, 5.5 Hz, 1 H, 5-H_a), 0.77−1.01 (m, 1 H, 5-H_b), 1.20−1.41 (m, 2 H, 2-, 3-H), 2.04 (s, 3 H, Ac), 2.44 (s, 3 H, $ArCH_3$), 3.71−4.30 (m, 4 H, 1-, 4-H_2), 7.34 (d, *J* = 8.4 Hz, 2 H, Ar-H), 7.80 (d, *J* = 8.4 Hz, 2 H, Ar-H).

(2*S*,3*R*)-2,3-Methylene-1-tridecanol (5): A solution of nonylmagnesium bromide was prepared from 1-bromononane (14.4 mL, 75.3 mmol) and magnesium (1.92 g, 79.1 mmol) in dry THF (100 mL). The resulting Grignard reagent and Li_2CuCl_4 (0.05 M solution in THF, 8 mL, 0.4 mmol) were then successively added to a solution of tosylate **4** (6.93 g, 23.2 mmol) in dry THF (20 mL) at −78 °C under argon. The stirred mixture was allowed to warm to 4 °C over a period of 12 h. After quenching with saturated aqueous NH_4Cl solution, it was extracted with diethyl ether. The combined extracts were washed with saturated aqueous $NaHCO_3$ solution, water, and brine, dried with $MgSO_4$, and concentrated in vacuo. The residue was chromatographed on silica gel to give **5** (4.51 g, 92%) as a colorless oil; n_D^{25} = 1.4541. − $[\alpha]_D^{19}$ = −20.7 (*c* = 1.04, $CHCl_3$). − IR (film): $\tilde{\nu}_{max}$ = 3340 cm^{-1} (s, OH), 3070 (w, CH), 3005 (m, CH), 1040 (s, C−O). − ^{1}H NMR (400 MHz, $CDCl_3$): δ = −0.040 (ddd, *J* = 5.4, 5.4, 5.2 Hz, 1 H, 14-H_a), 0.70 (ddd, *J* = 8.3, 8.3, 5.2 Hz, 1 H, 14-H_b), 0.85−0.94 (m, 1 H, 3-H), 0.88 (t, *J* = 7.1 Hz, 3 H, 13-H_3), 1.05−1.17 (m, 1 H, 2-H), 1.18−1.62 (m, 18 H, 4-, 5-, 6-, 7-, 8-, 9-, 10-, 11-, 12-H_2), 3.57 (dd, *J* = 11.2, 8.0 Hz, 1 H, 1-H_a), 3.65 (dd, *J* = 11.2, 7.1 Hz, 1 H, 1-H_b). − $C_{14}H_{28}O$ (212.4): calcd. C 79.18, H 13.29; found C 78.96, H 13.22.

(2*S*,3*R*)-2,3-Methylenetridecanal (6): To a stirred solution of oxalyl chloride (2.65 mL, 30.8 mmol) and dimethyl sulfoxide (4.46 mL, 61.6 mmol) in dry CH_2Cl_2 (80 mL), a solution of **5** (3.27 g, 15.4 mmol) in dry CH_2Cl_2 (30 mL) was added dropwise at −78 °C under argon. The reaction mixture was stirred for 1 h at −78 °C. Triethylamine (10.6 mL, 77.0 mmol) was then added and the mixture was stirred for 20 min at 0 °C. It was then poured into saturated aqueous NH_4Cl solution and extracted with $CHCl_3$. The combined extracts were washed with water and brine, dried with $MgSO_4$, and concentrated in vacuo to give **6** (3.25 g, quant.) as a colorless oil. This was employed in the next step without further purification. − IR (film): $\tilde{\nu}_{max}$ = 3070 cm^{-1} (w, CH), 3005 (m, CH), 2720 (m, O=C−H), 1705 (s, C=O). − ^{1}H NMR (400 MHz, $CDCl_3$): δ = 0.82−0.90 (m, 2 H, 3-H, 14-H_a), 0.87 (t, *J* = 7.1 Hz, 3 H, 13-H_3), 1.14−1.71 (m, 19 H, 14-H_b, 4-, 5-, 6-, 7-, 8-, 9-, 10-, 11-, 12-H_2), 1.82−1.89 (m, 1 H, 2-H), 9.34 (d, *J* = 5.6 Hz, 1 H, CHO).

(6*S*,7*R*)-1-(*tert*-Butyldiphenylsilyloxy)-6,7-methylene-4-heptadecene (7): To a stirred solution of 4-(*tert*-butyldiphenylsilyloxy)butyltriphenylphosphonium bromide (13.1 g, 20.0 mmol) in dry THF (60 mL), *n*BuLi (2.54 M solution in hexane, 8.3 mL, 21.1 mmol) was added dropwise at −78 °C under argon. The mixture was stirred for 30 min at room temperature. A solution of aldehyde **6** (3.25 g, 15.5 mmol) in dry THF (20 mL) was then added dropwise to this ylide solution at −78 °C. The stirred mixture was allowed to warm to room temperature over a period of 12 h. It was then poured into saturated aqueous NH_4Cl solution and extracted with diethyl ether. The combined extracts were washed with water and brine, dried with $MgSO_4$, and concentrated in vacuo. The residue was chromatographed on silica gel to give 7.62 g (98%; 2 steps) of **7** (*E*/*Z* = 1:5 as judged by ^{1}H NMR analysis) as a colorless oil; n_D^{24} = 1.5055. − $[\alpha]_D^{20}$ = −39.0 (*c* = 2.45, $CHCl_3$). − IR (film): $\tilde{\nu}_{max}$ = 1645 cm^{-1} (w, C=C), 1590 (m, C=C), 1110 (s). − ^{1}H NMR (500 MHz,

$CDCl_3$): δ = 0.08 (dd, *J* = 8.6, 4.9 Hz, 1 H, 18-H_a), 0.86−0.90 (m, 2 H, 7-H, 18-H_b), 0.88 (t, *J* = 6.7 Hz, 3 H, 17-H_3), 1.04 (s, 9 H, CMe_3), 1.20−1.64 (m, 18 H, 8-, 9-, 10-, 11-, 12-, 13-, 14-, 15-, 16-H_2), 1.56−1.68 (m, 3 H, 2-H_2, 6-H), 2.05−2.12 (m, 3-H_2 of *E* isomer), 2.25 (q, *J* = 7.3 Hz, 3-H_2 of *Z* isomer), 3.66 (t, *J* = 6.4 Hz, 1-H_2 of *E* isomer), 3.70 (t, *J* = 6.4 Hz, 1-H_2 of *Z* isomer), 5.04 (dd like, *J* = 10.7, 9.5 Hz, 5-H of *Z* isomer), 5.16 (m, 5-H of *E* isomer), 5.38 (dt like, *J* = 10.7, 7.3 Hz, 4-H of *Z* isomer), 5.49 (dt like, *J* = 15.3, 7.0 Hz, 4-H of *E* isomer), 7.39 (m, 6 H, Ar-H), 7.67 (m, 4 H, Ar-H). − $C_{34}H_{52}OSi$ (504.9): calcd. C 80.89, H 10.38; found C 81.27, H 10.62.

(6*S*,7*R*)-6,7-Methylene-4-heptadecen-1-ol (8): TBAF (1.00 M solution in THF, 13.0 mL, 13.0 mmol) was added to a stirred solution of **7** (5.06 g, 10.0 mmol) in dry THF (20 mL) at room temperature and the mixture was stirred for 2 h. It was then poured into water and extracted with ethyl acetate. The combined extracts were washed with brine. The organic layer was dried with $MgSO_4$ and concentrated in vacuo. The residue was chromatographed on silica gel to give **8** (2.60 g, 98%, *E*/*Z* = 1:5) as a colorless oil; n_D^{24} = 1.4729. − $[\alpha]_D^{21}$ = −65.0 (*c* = 1.70, $CHCl_3$). − IR (film): $\tilde{\nu}_{max}$ = 3340 cm^{-1} (m, OH), 3070 (w, CH), 1645 (w, C=C), 1060 (m, C−O). − ^1H NMR (400 MHz, $CDCl_3$): δ = 0.08−0.15 (m, 1 H, 18-H_a), 0.79−0.96 (m, 2 H, 7-H, 18-H_b), 0.88 (t, *J* = 6.8 Hz, 3 H, 17-H_3), 1.20−1.42 (m, 18 H, 8-, 9-, 10-, 11-, 12-, 13-, 14-, 15-, 16-H_2), 1.54−1.72 (m, 3 H, 2-H_2, 6-H), 2.11 (m, 3-H_2 of *E* isomer), 2.25 (dq, *J* = 7.3, 1.3 Hz, 3-H_2 of *Z* isomer), 3.66 (t, *J* = 6.4 Hz, 1-H_2 of *E* isomer), 3.69 (t, *J* = 6.6 Hz, 1-H_2 of *Z* isomer), 5.08 (dd like, *J* = 10.7, 9.8 Hz, 5-H of *Z* isomer), 5.22 (dd like, *J* = 15.4, 8.8 Hz, 5-H of *E* isomer), 5.42 (dt like, *J* = 10.7, 7.3 Hz, 4-H of *Z* isomer), 5.53 (dt like, *J* = 15.4, 6.8 Hz, 4-H of *E* isomer). − $C_{18}H_{34}O$ (266.5): calcd. C 81.13, H 12.86; found C 80.93, H 12.95.

(6*S*,7*R*)-6,7-Methylene-1-heptadecanol (9): To a stirred solution of **8** (2.95 g, 11.1 mmol) in 80% aqueous hydrazine monohydrate (8 mL) and EtOH (20 mL), 30% aqueous H_2O_2 (8 mL) was added dropwise over a period of 3 h and the mixture was stirred for 20 h at room temperature. It was then poured into water and extracted with ethyl acetate. The combined extracts were washed with saturated aqueous $FeSO_4$ solution, water, and brine. The organic layer was dried with $MgSO_4$ and concentrated in vacuo. The residue was chromatographed on silica gel to give **9** (2.79 g, 94%) as a colorless oil; n_D^{25} = 1.4602. − $[\alpha]_D^{21}$ = −3.10 (*c* = 1.03, $CHCl_3$). − IR (film): $\tilde{\nu}_{max}$ = 3350 cm^{-1} (m, OH), 3070 (w, CH), 1055 (m, C−O). − ^1H NMR (300 Mz, $CDCl_3$): δ = −0.33 (ddd, *J* = 4.8, 4.5, 4.5 Hz, 1 H, 18-H_a), 0.51−0.62 (m, 1 H, 18-H_b), 0.62−0.73 (m, 2 H, 6-, 7-H), 0.88 (t, *J* = 7.2 Hz, 3 H, 17-H_3), 1.09−1.50 (m, 24 H, 3-, 4-, 5-, 8-, 9-, 10-, 11-, 12-, 13-, 14-, 15-, 16-H_2), 1.51−1.70 (m, 3 H, 2-H_2, OH), 3.64 (t, *J* = 6.6 Hz, 2 H, 1-H_2). − ^{13}C NMR (75.5 MHz, $CDCl_3$): δ = 10.9, 14.1, 15.6, 15.7, 22.7, 25.7, 28.6, 28.7, 29.3, 29.64, 29.66, 29.69, 29.71, 30.0, 30.2, 31.9, 32.8, 63.0. − $C_{18}H_{36}O$ (268.5): calcd. C 80.53, H 13.52; found C 80.49, H 13.81.

(6*S*,7*R*)-6,7-Methyleneheptadecyl Tosylate (10): To a stirred solution of **9** (0.86 g, 3.20 mmol) in CH_2Cl_2 (15 mL) and pyridine (2 mL), *p*-toluenesulfonyl chloride (0.91 g, 4.80 mmol) was added at 0 °C and the reaction mixture was stirred for 12 h at 4 °C. It was then poured into water and extracted with diethyl ether. The combined extracts were washed with dil. aq. HCl, water, and brine. The organic layer was dried with $MgSO_4$ and concentrated in vacuo to give **10** (1.35 g, quant.) as a colorless oil. This was employed in the next step without further purification. − IR (film): $\tilde{\nu}_{max}$ = 3070 cm^{-1} (w, CH), 1600 (m, Ar), 1380 (m, SO_2), 1365 (m, SO_2), 1190 (s), 1175 (s), 815 (m, Ar). − ^1H NMR (300 MHz, $CDCl_3$): δ = −0.36 (dt like, *J* = 8.7, 5.1 Hz, 1 H, 18-H_a), 0.50−0.69 (m, 3 H, 6-, 7-, 18-H_b), 0.88 (t, *J* = 6.9 Hz, 3 H, 17-H_3), 1.00−1.42 (m, 24 H, 3-, 4-, 5-, 8-, 9-, 10-, 11-, 12-, 13-, 14-, 15-, 16-H_2), 1.49−1.71 (m, 2 H, 2-H_2), 2.45 (s, 3 H, ArMe), 4.03 (t, *J* = 6.6 Hz, 2 H, 1-H_2), 7.34 (d, *J* = 8.1 Hz, 2 H, Ar-H), 7.79 (d, *J* = 8.1 Hz, 2 H, Ar-H).

(6*S*,7*R*)-1-Iodo-6,7-methyleneheptadecane (11): To a solution of **10** (1.54 g, 3.64 mmol) in DMF (14 mL) was added NaI (0.72 g, 4.80 mmol) and the mixture was stirred for 5 h at 60 °C. It was then poured into water and extracted with *n*-hexane. The combined extracts were washed with saturated aqueous $Na_2S_2O_3$ solution, water, and brine. The organic layer was dried with $MgSO_4$ and concentrated in vacuo. The residue was chromatographed on silica gel to give **11** (1.23 g, 90%; 2 steps) as a colorless oil. This was employed in the next step without further purification. − IR (film): $\tilde{\nu}_{max}$ = 3070 cm^{-1} (w, CH), 1465 (m, CH), 1380 (w, CH), 1310 (w), 1285 (w), 1025 (m), 730 (m, CH). − ^1H NMR (300 MHz, $CDCl_3$): δ = −0.32 (dd, *J* = 8.7, 4.8 Hz, 1 H, 18-H_a), 0.52−0.71 (m, 1 H, 18-H_b), 0.61−0.71 (m, 2 H, 6-, 7-H), 0.88 (t, *J* = 6.9 Hz, 3 H, 17-H_3), 1.09−1.61 (m, 24 H, 3-, 4-, 5-, 8-, 9-, 10-, 11-, 12-, 13-, 14-, 15-, 16-H_2), 1.78 (quint, *J* = 6.9 Hz, 2 H, 2-H_2), 3.54 (t, *J* = 6.9 Hz, 2 H, 1-H_2).

(8*S*,9*R*)-8,9-Methylene-1-nonadecyne (12): To a solution of **11** (710 mg, 1.88 mmol) in dry DMSO (4 mL), lithium acetylide−ethylenediamine complex (307 mg, 3.01 mmol) was added portionwise at 0 °C. The reaction mixture was stirred for 12 h at room temperature. After quenching with dil. aq. HCl, it was extracted with *n*-hexane. The combined extracts were washed with water and brine. The organic layer was dried with $MgSO_4$ and concentrated in vacuo. The residue was chromatographed on silica gel to give **12** (457 mg, 88%) as a colorless oil; n_D^{23} = 1.4581. − $[\alpha]_D^{21}$ = +0.65 (*c* = 1.33, $CHCl_3$). − IR (film): $\tilde{\nu}_{max}$ = 3340 cm^{-1} (s, C≡CH), 3080 (w, CH), 2150 (w, C≡C). − ^1H NMR (400 MHz, $CDCl_3$): δ = −0.33 (ddd, *J* = 5.1, 5.1, 4.6 Hz, 1 H, 20-H_a), 0.51−0.60 (m, 1 H, 20-H_b), 0.60−0.69 (m, 2 H, 8-, 9-H), 0.88 (t, *J* = 6.6 Hz, 3 H, 19-H_3), 1.06−1.48 (m, 24 H, 5-, 6-, 7-, 10-, 11-, 12-, 13-, 14-, 15-, 16-, 17-, 18-H_2), 1.49−1.57 (m, 2 H, 4-H_2), 1.94 (t, *J* = 2.7 Hz, 1 H, 1-H), 2.19 (dt, *J* = 7.1, 2.7 Hz, 2 H, 3-H_2). − $C_{20}H_{36}$ (276.5): calcd. C 86.88, H 13.12; found C 86.55, H 13.30.

***tert*-Butyl (4*S*,1′*R*,9′*S*,10′*R*)-4-(1′-Hydroxy-9′,10′-methylene-2′-icosynyl)-2,2-dimethyl-1,3-oxazolidine-3-carboxylate (14):** To a stirred solution of **12** (136 mg, 0.49 mmol) in dry THF (5 mL), *n*BuLi solution (1.56 M in *n*-hexane, 0.35 mL, 0.54 mmol) was added dropwise at 0 °C under argon. The resulting solution was stirred for 20 min at 0 °C, then cooled to −78 °C, whereupon a solution of **13** (147 mg, 0.64 mmol) in THF (4 mL) was added dropwise. The reaction was quenched by the addition of saturated aqueous NH_4Cl solution and the mixture was extracted with diethyl ether. The combined extracts were washed with water and brine. The organic layer was dried with $MgSO_4$ and concentrated in vacuo. The residue was chromatographed on silica gel to give **14** (200 mg, 80%) as a colorless oil; n_D^{24} = 1.4723. − $[\alpha]_D^{26}$ = −34.2 (*c* = 1.11, $CHCl_3$). − IR (film): $\tilde{\nu}_{max}$ = 3440 cm^{-1} (m, OH), 3060 (w, CH), 1705 (s, C=O). − ^1H NMR (400 MHz, $CDCl_3$): δ = −0.34 (dd, *J* = 9.5, 4.9 Hz, 1 H, 21′-H_a), 0.52−0.58 (m, 1 H, 21′-H_b), 0.58−0.71 (m, 2 H, 9′-, 10′-H), 0.88 (t, *J* = 6.8 Hz, 3 H, 20′-H_3), 1.10−1.42 (m, 26 H, 5′-, 6′-, 7′-, 8′-, 11′-, 12′-, 13′-, 14′-, 15′-, 16′-, 17′-, 18′-, 19′-H_2), 1.50 (s, 12 H, CMe_3, acetonide), 1.57 (s, 3 H, acetonide), 1.58 (s, 1 H, OH), 2.20 (t, *J* = 7.1 Hz, 2 H, 4′-H_2), 3.83−3.97 (m, 1 H, 5-H_a), 4.00−4.34 (m, 2 H, 5-H_b, 1′-H), 4.48−4.85 (m, 1 H, 4-H). − $C_{31}H_{55}NO_4$ (505.8): calcd. C 73.62, H 10.96, N 2.77; found C 73.24, H 10.72, N 2.71.

***tert*-Butyl (4*S*,1′*R*,9′*S*,10′*R*)-4-(1′-Hydroxy-9′,10′-methyleneicosyl)-2,2-dimethyl-1,3-oxazolidine-3-carboxylate (15):** To a stirred solution of **14** (361 mg, 0.71 mmol) in 80% aqueous hydrazine monohydrate (2.5 mL) and EtOH (30 mL), 34.5% aqueous H_2O_2 (10 mL) was added dropwise over a period of 3 h and the resulting mixture was stirred for 12 h at room temperature. It was then poured into water and extracted with ethyl acetate. The combined extracts were washed with saturated aqueous $FeSO_4$ solution, water, and brine. The organic layer was dried with $MgSO_4$ and concentrated in vacuo. The residue was chromatographed on silica gel to give **15** (324 mg, 89%) as a colorless oil; n_D^{26} = 1.4649. − $[\alpha]_D^{26}$ = −11.4 (*c* = 1.14, $CHCl_3$). − IR (film): $\tilde{\nu}_{max}$ = 3435 cm^{-1} (m, OH), 3055 (w, CH), 1700 (s, C=O). − ^1H NMR (300 MHz, $CDCl_3$): δ = −0.34 (dt, *J* = 9.0, 5.1 Hz, 1 H, 21′-H_a), 0.50−0.60 (m, 1 H, 21′-H_b), 0.60−0.72 (m, 2 H, 9′-, 10′-H), 0.88 (t, *J* = 6.9 Hz, 3 H, 20′-H_3), 1.07−1.45 (m, 32 H, 2′-, 3′-, 4′-, 5′-, 6′-, 7′-, 8′-, 11′-, 12′-, 13′-, 14′-, 15′-, 16′-, 17′-, 18′-, 19′-H_2), 1.49 (s, 12 H, CMe_3, acetonide), 1.59 (br. s, 4 H, acetonide, OH), 3.48−4.16 (m, 4 H, 4-, 1′-H, 5-H_2). − $C_{31}H_{59}NO_4$ (509.8): calcd. C 73.03, H 11.66, N 2.75; found C 73.17, H 11.53, N 2.74.

(2*S*,3*R*,11*S*,12*R*)-2-Amino-11,12-methylenedocosane-1,3-diol Hydrochloride (16): To a stirred solution of **15** (229 mg, 0.45 mmol) in MeOH (4 mL), 3 N HCl (1 mL) was added dropwise and the mixture was heated at 50 °C for 6 h. The solvent was then removed in vacuo to give **16** (180 mg, quant.) as a white solid. This was employed in the next step without further purification. − ^1H NMR (300 MHz, CD_3OD): δ = −0.34 (dd, *J* = 8.7, 5.1 Hz, 1 H, 21′-H_a), 0.55 (m, 1 H, 21′-H_b), 0.64 (m, 2 H, 9′-, 10′-H), 0.88 (t, *J* = 6.9 Hz, 3 H, 20′-H_3), 1.26 (m, 32 H, 2′-, 3′-, 4′-, 5′-, 6′-, 7′-, 8′-, 11′-, 12′-, 13′-, 14′-, 15′-, 16′-, 17′-, 18′-, 19′-H_2), 3.21 (ddd, *J* = 8.4, 8.1, 3.9 Hz, 1 H, 2-H), 3.70 (dd, *J* = 11.4, 8.4 Hz, 1 H, 1-H), 3.75−3.85 (m, 2 H, 1-, 3-H).

(2*S*,3*R*,11*S*,12*R*)-2-Amino-1,3-bis(*tert*-butyldimethylsilyloxy)-11,12-methylenedocosane (17): To a solution of **16** (181 mg, 0.45 mmol) and 2,6-lutidine (0.21 mL, 1.80 mmol) in CH_2Cl_2 (3 mL), TBSOTf (0.31 mL, 1.35 mmol) was added at 0 °C under argon. The mixture was stirred for 30 min at room temperature and then quenched with MeOH. It was subsequently poured into water and extracted with diethyl ether. The combined extracts were washed with water, saturated aqueous $NaHCO_3$ solution, and brine, dried with $MgSO_4$, and concentrated in vacuo. The residue was chromatographed on silica gel to give **17** (252 mg, 94%) as a colorless oil; n_D^{23} = 1.4597. − $[\alpha]_D^{22}$ = −3.92 (*c* = 0.71, $CHCl_3$). − IR (film): $\tilde{\nu}_{max}$ = 3400 cm^{-1} (w, NH), 3055 (w, CH), 1460 (m, CH), 1260 (m, CH), 1095 (m), 840 (m). − ^1H NMR (500 MHz, $CDCl_3$): δ = −0.34 (dd, *J* = 9.3, 5.1 Hz, 1 H, 23-H_a), 0.07 (s, 9 H, SiMe), 0.08 (s, 3 H, SiMe), 0.55 (m, 1 H, 23-H_b), 0.64 (m, 2 H, 11-, 12-H), 0.88 (t, *J* = 7.0 Hz, 3 H, 22-H_3), 0.88 (s, 9 H, CMe_3), 0.89 (s, 9 H, CMe_3), 1.26 (m, 30 H, 5-, 6-, 7-, 8-, 9-, 10-, 13-, 14-, 15-, 16-, 17-, 18-, 19-, 20-, 21-H_2), 1.58 (m, 2 H, 4-H_2), 2.17 (br. s, 2 H, NH_2), 2.98 (m, 1 H, 2-H), 3.51 (dd, *J* = 10.0, 7.8 Hz, 1 H, 1-H_a), 3.71 (dd, *J* = 10.0, 5.1 Hz, 1 H, 1-H_b), 3.74−3.80 (m, 1 H, 3-H). − $C_{35}H_{75}NO_2Si_2$ (598.2): calcd. C 70.28, H 12.64, N 2.34; found C 70.30, H 12.60, N 2.34.

(2*S*,3*R*)-2,3-Methylene-8-tetrahydropyranyloxy-1-octanol (18): A solution of 4-(tetrahydropyranyloxy)butylmagnesium bromide was prepared from 4-(tetrahydropyranyloxy)butyl bromide (30.7 g, 129 mmol) and magnesium (3.48 g, 143 mmol) in dry THF (140 mL). The resulting Grignard reagent and Li_2CuCl_4 (0.05 M solution in THF, 13 mL, 6.5 mmol) were then successively added to a solution of tosylate **4** (8.18 g, 27.4 mmol) in dry THF (20 mL) at −78 °C under argon. The stirred mixture was allowed to warm to 4 °C over a period of 12 h. It was then poured into saturated aqueous NH_4Cl solution and extracted with ethyl acetate. The combined extracts were washed with saturated aqueous $NaHCO_3$ solution, water, and brine, dried with $MgSO_4$, and concentrated in vacuo. The residue was taken up in MeOH (30 mL) and treated with solid K_2CO_3 (2.5 g). The resulting mixture was stirred for 30 min at room temperature. It was then poured into water and extracted with ethyl acetate. The combined extracts were washed with water and brine, dried with $MgSO_4$, and concentrated in vacuo. The residue was chromatographed on silica gel to give **18** (5.62 g, 85%) as a colorless oil; n_D^{26} = 1.4699. − $[\alpha]_D^{21}$ = −14.3 (*c* = 1.25, $CHCl_3$). − IR (film): $\tilde{\nu}_{max}$ = 3425 cm^{-1} (m, OH), 3080 (w, CH), 1025 (m). − ^1H NMR (400 MHz, $CDCl_3$): δ = −0.045 (dt, *J* = 10.2, 5.4 Hz, 1 H, 9-H_a), 0.70 (dt like, *J* = 8.3, 4.6 Hz, 1 H, 9-H_b), 0.81−0.91 (m, 1 H, 3-H), 1.05−1.15 (m, 1 H, 2-H), 1.21−1.88 (m, 14 H, 4-, 5-, 6-, 7-, 3′-, 4′-, 5′-H_2), 3.38 (dt, *J* = 9.5, 6.8 Hz, 1 H, 8-H_a), 3.42−3.53 (m, 1 H, 6′-H_a), 3.56 (dd, *J* = 11.2, 8.0 Hz, 1 H, 1-H_a), 3.65 (dd, *J* = 11.2, 6.6 Hz, 1 H, 1-H_b), 3.73 (dt like, *J* = 9.8, 6.8 Hz, 1 H, 8-H_b), 3.83−3.91 (m, 1 H, 6′-H_b), 4.55−4.59 (m, 1 H, 2′-H). − $C_{14}H_{26}O_3$ (242.4): calcd. C 69.38, H 10.81; found C 69.44, H 10.43.

(2*S*,3*R*)-2,3-Methylene-8-tetrahydropyranyloxyoctanal (19): To a stirred solution of oxalyl chloride (2.66 mL, 30.9 mmol) and dimethyl sulfoxide (4.48 mL, 61.9 mmol) in dry CH_2Cl_2 (60 mL), a solution of **18** (4.96 g, 20.5 mmol) in dry CH_2Cl_2 (30 mL) was added dropwise at −78 °C under argon. Stirring was continued for 1 h at −78 °C. Triethylamine (14.2 mL, 103 mmol) was then added to the reaction mixture and stirring was continued for 20 min at 0 °C. The reaction was subsequently quenched by the addition of saturated aqueous NH_4Cl and the resulting mixture was extracted with $CHCl_3$. The combined extracts were washed with water and brine, dried with $MgSO_4$, and concentrated in vacuo to give **19** (4.36 g, 88%) as a colorless oil. This was employed in the next step without further purification. − IR (film): $\tilde{\nu}_{max}$ = 3070 cm^{-1} (w, CH), 2720 (w, O=C−H), 1705 (s, C=O). − ^1H NMR (90 MHz, $CDCl_3$): δ = 0.78−1.01 (m, 2 H, 9-H_a, 3-H), 1.08−2.03 (m, 16 H, 9-H_b, 2-H, 4-, 5-, 6-, 7-, 3′-, 4′-, 5′-H_2), 3.23−4.01 (m, 4 H, 8-, 6′-H_2), 4.55 (br. s, 1 H, 2′-H), 9.36 (d, *J* = 5.1 Hz, 1 H, CHO).

(6*R*,7*S*)-1-Tetrahydropyranyloxy-6,7-methylene-8-heptadecene (20): To a stirred suspension of nonyltriphenylphosphonium bromide (15.0 g, 32.0 mmol) in dry THF (35 mL), *n*BuLi (2.54 M solution in hexane, 13.2 mL, 33.6 mmol) was added dropwise at −78 °C under argon. The mixture was stirred for 40 min at room temperature. To the resulting ylide solution, a solution of **19** (4.36 g, 18.1 mmol) in dry THF (20 mL) was added dropwise at −78 °C. The resulting mixture was allowed to warm to room temperature and stirring was continued for 12 h. After quenching by the addition of saturated aqueous NH_4Cl solution, the mixture was extracted with diethyl ether. The combined extracts were washed with water and brine, dried with $MgSO_4$, and concentrated in vacuo. The residue was chromatographed on silica gel to give **20** (6.19 g, 98%, *E*/*Z* = 1:4 as judged by ^1H NMR analysis) as a colorless oil; n_D^{24} = 1.4717. − $[\alpha]_D^{19}$ = −46.4 (*c* = 1.65, $CHCl_3$). − IR (film): $\tilde{\nu}_{max}$ = 3070 cm^{-1} (w, CH), 3000 (m, CH), 1645 (w, C=C), 1035 (s). − ^1H NMR (500 MHz, $CDCl_3$): δ = 0.06−0.13 (m, 1 H, 18-H_a), 0.85−0.91 (m, 2 H, 6-H, 18-H_b), 0.88 (t, *J* = 7.0 Hz, 3 H, 17-H_3), 1.21−1.44 (m, 18 H, 5-H_a, 7-H, 3-, 4-, 11-, 12-, 13-, 14-, 15-, 16-H_2), 1.48−1.74 (m, 8 H, 2-, 3′-, 4′-, 5′-H_2), 1.78−1.85 (m, 1 H, 5-H_b), 1.92−2.04 (m, 10-H_2 of *E* isomer), 2.13 (q like, *J* = 7.3 Hz, 10-H_2 of *Z* isomer), 3.38 (ddt, *J* = 9.5, 6.5, 1.5 Hz, 1 H, 1-H_a), 3.46−3.53 (m, 1 H, 6′-H_a), 3.73 (dt, *J* = 9.9, 7.0 Hz, 1 H, 1-H_b), 3.87 (ddd, *J* = 10.7, 7.3, 3.4 Hz, 1 H, 6′-H_b), 4.57 (dd, *J* = 4.3,

2.8 Hz, 1 H, 2′-H), 5.02 (dd like, J = 10.7, 9.5 Hz, 8-H of Z isomer), 5.16 (dd like, J = 15.3, 8.6 Hz, 8-H of E isomer), 5.40 (dt like, J = 10.7, 7.3 Hz, 9-H of Z isomer), 5.51 (dt like, J = 15.3, 6.7 Hz, 9-H of E isomer). − $C_{23}H_{42}O_2$ (350.6): calcd. C 78.80, H 12.08; found C 78.58, H 11.95.

(6*R*,7*S*)-6,7-Methylene-1-heptadecanol (9′): To a solution of **20** (110 mg, 0.314 mmol) in MeOH (2 mL) and CH_2Cl_2 (1 mL) was added *p*-toluenesulfonic acid (2 mg) and the resulting mixture was stirred for 6.5 h at room temperature. It was then poured into water and extracted with ethyl acetate. The combined extracts were washed with water and brine, dried with $MgSO_4$, and concentrated in vacuo. The residue was chromatographed on silica gel to give the deprotected alcohol (81 mg, 97%, E/Z = 1:4 as judged by ^{1}H NMR analysis) as a colorless oil. To a stirred solution of this alcohol (4.24 g, 15.8 mmol) in 80% aqueous hydrazine monohydrate (10 mL) and EtOH (40 mL), 34.5% aqueous H_2O_2 (10 mL) was added dropwise over a period of 3 h and the mixture was stirred for 12 h at room temperature. It was then poured into water and extracted with ethyl acetate. The combined extracts were washed with saturated aqueous $FeSO_4$ solution, water, and brine. The organic layer was dried with $MgSO_4$ and concentrated in vacuo. The residue was chromatographed on silica gel to give **9′** (4.16 g, 98%) as a colorless oil.

(6*R*,7*S*)-6,7-Methylene-8-heptadecen-1-ol: n_D^{24} = 1.4766. − $[\alpha]_D^{21}$ = −60.0 (c = 1.85, $CHCl_3$). − IR (film): $\tilde{\nu}_{max}$ = 3320 cm^{-1} (m, OH), 1055 (m, C−O). − ^{1}H NMR (500 MHz, $CDCl_3$): δ = 0.08−0.13 (m, 1 H, 18-H_a), 0.77−0.94 (m, 2 H, 6-H, 18-H_b), 0.88 (t, J = 7.0 Hz, 3 H, 17-H_3), 1.18−1.50 (m, 19 H, 7-H, 3-, 4-, 5-, 11-, 12-, 13-, 14-, 15-, 16-H_2), 1.51−1.60 (m, 3 H, 2-H_2, OH), 1.99 (q like, J = 7.0 Hz, 10-H_2 of E isomer), 2.14 (q, J = 7.3 Hz, 10-H_2 of Z isomer), 3.64 (t, J = 6.7 Hz, 2 H, 1-H_2), 5.02 (dd like, J = 10.7, 9.5 Hz, 8-H of Z isomer), 5.16 (dd like, J = 15.0, 8.6 Hz, 8-H of E isomer), 5.40 (dt like, J = 10.7, 7.3 Hz, 9-H of Z isomer), 5.51 (dt like, J = 15.3, 7.0 Hz, 9-H of E isomer). − $C_{18}H_{34}O$ (266.5): calcd. C 81.13, H 12.86; found C 81.16, H 13.03.

(6*R*,7*S*)-9′: n_D^{25} = 1.4588. − $[\alpha]_D^{19}$ = +2.42 (c = 2.02, $CHCl_3$). − $C_{18}H_{36}O$ (268.5): calcd. C 80.53, H 13.52; found C 80.45, H 13.25. The IR and NMR spectra are identical to those of **9**.

(6*R*,7*S*)-6,7-Methyleneheptadecyl Tosylate (10′): In the same manner as described above for the conversion of **9** to **10**, **9′** (0.97 g, 3.61 mmol) was converted into 1.69 g (quant.) of **10′**. This was employed in the next step without further purification. The IR and NMR spectra are identical to those of **10**.

(6*R*,7*S*)-1-Iodo-6,7-methyleneheptadecane (11′): In the same manner as described above for the conversion of **10** to **11**, **10′** (1.69 g, 4.00 mmol) was converted into 1.23 g (81%; 2 steps) of **11′**. This was employed in the next step without further purification. The IR and NMR spectra are identical to those of **11**.

(8*R*,9*S*)-8,9-Methylene-1-nonadecyne (12′): In the same manner as described above for the conversion of **11** to **12**, **11′** (1.23 g, 3.25 mmol) was converted into 0.79 g (88%) of **12′**; n_D^{23} = 1.4498. − $[\alpha]_D^{19}$ = −0.24 (c = 1.19, $CHCl_3$). − $C_{20}H_{36}$ (276.5): calcd. C 86.88, H 13.12; found C 86.78, H 13.12. − The IR and NMR spectra are identical to those of **12**.

***tert*-Butyl (4*S*,1′*R*,9′*R*,10′*S*)-4-(1′-Hydroxy-9′,10′-methylene-2′-icosynyl)-2,2-dimethyl-1,3-oxazolidine-3-carboxylate (14′):** In the same manner as described above for the conversion of **12** to **14**, **12′** (0.51 g, 1.84 mmol) was converted into 0.70 g (75%) of **14′**; n_D^{25} = 1.4651. − $[\alpha]_D^{23}$ = −44.7 (c = 0.80, $CHCl_3$). − IR (film): $\tilde{\nu}_{max}$ = 3450 cm^{-1} (m, OH), 3070 (w, CH), 2240 (w, C≡C), 1705 (s, C=O), 1065 (m, C−O). − ^{1}H NMR (500 MHz, $CDCl_3$): δ = −0.33 (dt, J = 9.6, 5.0 Hz, 1 H, 21′-H_a), 0.52−0.59 (m, 1 H, 21′-H_b), 0.61−0.67 (m, 2 H, 9-, 10-H), 0.88 (t, J = 6.9 Hz, 3 H, 20′-H_3), 1.10−1.43 (m, 26 H, 5′-, 6′-, 7′-, 8′-, 11′-, 12′-, 13′-, 14′-, 15′-, 16′-, 17′-, 18′-, 19′-H_2), 1.50 (s, 9 H, CMe_3), 1.51 (s, 3 H, acetonide), 1.58 (s, 4 H, acetonide, OH), 2.20 (t, J = 6.4 Hz, 2 H, 4′-H_2), 3.90 (br. s, 1 H, 5-H_a), 4.02−4.18 (m, 2 H, 5-H_b, 1′-H), 4.46−4.75 (m, 1 H, 4-H). − $C_{31}H_{55}NO_4$ (505.8): calcd. C 73.62, H 10.96, N 2.77; found C 73.48, H 11.04, N 2.94.

***tert*-Butyl (4*S*,1′*R*,9′*R*,10′*S*)-4-(1′-Hydroxy-9′,10′-methyleneicosyl)-2,2-dimethyl-1,3-oxazolidine-3-carboxylate (15′):** In the same manner as described above for the conversion of **14** to **15**, **14′** (550 mg, 1.08 mmol) was converted into 469 mg (85%) of **15′**; n_D^{22} = 1.4648. − $[\alpha]_D^{23}$ = −14.0 (c = 0.97, $CHCl_3$). − IR (film): $\tilde{\nu}_{max}$ = 3450 cm^{-1} (m, OH), 3070 (w, CH), 1700 (s, C=O), 1070 (m, C−O). − ^{1}H NMR (300 MHz, $CDCl_3$): δ = −0.34 (dt, J = 9.0, 5.1 Hz, 1 H, 21′-H_a), 0.52−0.60 (m, 1 H, 21′-H_b), 0.60−0.68 (m, 2 H, 9′-, 10′-H), 0.88 (t, J = 6.9 Hz, 3 H, 20′-H_3), 1.08−1.42 (m, 32 H, 2′-,3′-, 4′-, 5′-, 6′-, 7′-, 8′-, 11′-, 12′-, 13′-, 14′-, 15′-, 16′-, 17′-, 18′-, 19′-H_2), 1.49 (s, 12 H, CMe_3, acetonide), 1.59 (br. s, 4 H, acetonide, OH), 3.44−4.12 (m, 4 H, 4-, 1′-H, 5-H_2). − $C_{31}H_{59}NO_4$ (509.8): calcd. C 73.03, H 11.66, N 2.75; found C 73.27, H 11.92, N 2.85.

(2*S*,3*R*,11*R*,12*S*)-2-Amino-11,12-methylenedocosane-1,3-diol Hydrochloride (16′): In the same manner as described above for the conversion of **15** to **16**, **15′** (380 mg, 0.745 mmol) was converted into 145 mg (85%) of **16′**. This was employed in the next step without further purification. − ^{1}H NMR (400 MHz, CD_3OD): δ = −0.55 to −0.52 (m, 1 H, 21′-H_a), 0.31−0.41 (m, 1 H, 21′-H_b), 0.46 (br. s, 2 H, 9′-, 10′-H), 0.69 (t, J = 7.1 Hz, 3 H, 20′-H_3), 0.82−1.19 (m, 32 H, 2′-, 3′-, 4′-, 5′-, 6′-, 7′-, 8′-, 11′-, 12′-, 13′-, 14′-, 15′-, 16′-, 17′-, 18′-, 19′-H_2), 2.95−3.05 (m, 1 H, 2-H), 3.42−3.53 (m, 1 H, 1-H), 3.58−3.65 (m, 2 H, 1-, 3-H).

(2*S*,3*R*,11*R*,12*S*)-2-Amino-1,3-bis(*tert*-butyldimethylsilyloxy)-11,12-methylenedocosane (17′): In the same manner as described above for the conversion of **16** to **17**, **16′** (297 mg, 0.731 mmol) was converted into 399 mg (91%) of **17′**; n_D^{22} = 1.4590. − $[\alpha]_D^{22}$ = −2.60 (c = 0.54, $CHCl_3$). − IR (film): $\tilde{\nu}_{max}$ = 3400 cm^{-1} (w, NH), 3060 (w, CH), 1465 (m, CH), 1255 (m, CH), 1095 (m), 840 (m). − ^{1}H NMR (500 MHz, $CDCl_3$): δ = −0.34 (dt, J = 9.5, 5.2 Hz, 1 H, 23-H_a), 0.06 (s, 12 H, $SiMe_2$), 0.53−0.58 (m, 1 H, 23-H_b), 0.64 (br. s, 2 H, 11-, 12-H), 0.88 (t, J = 7.0 Hz, 3 H, 22-H_3), 0.89 (s, 9 H, CMe_3), 0.90 (s, 9 H, CMe_3), 1.08−1.41 (m, 30 H, 5-, 6-, 7-, 8-, 9-, 10-, 13-, 14-, 15-, 16-, 17-, 18-, 19-, 20-, 21-H_2), 1.58 (br. s, 4 H, 4-H_2, NH_2), 2.86−2.82 (m, 1 H, 2-H), 3.45 (t like, J = 10.1 Hz, 1 H, 1-H_a), 3.68 (dd, J = 10.1, 4.9 Hz, 1 H, 1-H_b), 3.67−3.73 (m, 1 H, 3-H). − $C_{35}H_{75}NO_2Si_2$ (598.1): calcd. C 70.28, H 12.64, N 2.34; found C 70.18, H 12.83, N 2.38.

(6*S*,7*R*)-1-Bromo-6,7-methyleneheptadecane (21): To a solution of **9** (820 mg, 3.05 mmol) in dry CH_2Cl_2 (10 mL), PPh_3 (963 mg, 3.67 mmol) and CBr_4 (1.22 g, 3.67 mmol) were added portionwise at 0 °C and the mixture was stirred for 1 h at room temperature. After quenching the reaction by the addition of saturated aqueous $NaHCO_3$ solution, the mixture was extracted with *n*-hexane. The combined extracts were washed with water and brine. The organic layer was dried with $MgSO_4$ and concentrated in vacuo. The residue was chromatographed on silica gel to give **21** (1.01 g, quant.) as a colorless oil; n_D^{24} = 1.4735. − $[\alpha]_D^{21}$ = −2.20 (c = 1.65, $CHCl_3$). − IR (film): $\tilde{\nu}_{max}$ = 3080 cm^{-1} (w, CH), 1465 (m, CH), 1245 (w), 1025 (w), 725 (w, CH). − ^{1}H NMR (300 MHz, $CDCl_3$): δ = −0.32

(dt, J = 9.0, 5.1 Hz, 1 H, 18-H_a), 0.53−0.60 (m, 1 H, 18-H_b), 0.60−0.68 (m, 2 H, 6-, 7-H), 0.88 (t, J = 6.9 Hz, 3 H, 17-H_3), 1.08−1.54 (m, 24 H, 3-, 4-, 5-, 8-, 9-, 10-, 11-, 12-, 13-, 14-, 15-, 16-H_2), 1.87 (quint, J = 6.9 Hz, 2 H, 2-H_2), 3.42 (t, J = 6.9 Hz, 2 H, 1-H_2). − $C_{18}H_{35}Br$ (331.4): calcd. C 65.24, H 10.65; found C 65.32, H 10.68.

(6*R*,7*S*)-1-Bromo-6,7-methyleneheptadecane (21′): In the same manner as described above, **9′** (580 mg, 2.16 mmol) was converted into 720 mg (quant.) of **21′**; n_D^{19} = 1.4744. − $[\alpha]_D^{23}$ = +1.72 (c = 1.44, $CHCl_3$). − $C_{18}H_{35}Br$ (331.4): calcd. C 65.24, H 10.65; found C 65.02, H 10.67. − The IR and NMR spectra are identical to those of **21**.

(6*S*,7*R*)-(6,7-Methylene-1-heptadecyl)triphenylphosphonium Bromide (22): To a solution of **21** (1.01 g, 3.05 mmol) in dry MeCN (40 mL) were added $NaHCO_3$ (770 mg, 9.15 mmol) and PPh_3 (1.60 g, 6.10 mmol). The mixture was stirred for 2 d under reflux. It was then concentrated in vacuo and the residue was chromatographed on silica gel to give **22** (1.76 g, 97%) as a colorless oil. This was employed in the next step without further purification. − IR (film): $\tilde{\nu}_{max}$ = 3070 cm^{-1} (m, CH), 1590 (m), 1485 (m), 1440 (s), 1250 (m), 1115 (s), 995 (m), 755 (s, Ar). − ^1H NMR (500 MHz, $CDCl_3$): δ = −0.41 (dt, J = 9.5, 4.9 Hz, 1 H, 18-H_a), 0.47−0.52 (m, 1 H, 18-H_b), 0.52−0.63 (m, 2 H, 6-, 7-H), 0.87 (t, J = 6.7 Hz, 3 H, 17-H_3), 0.97−1.38 (m, 24 H, 3-, 4-, 5-, 8-, 9-, 10-, 11-, 12-, 13-, 14-, 15-, 16-H_2), 1.57−1.80 (m, 2 H, 2-H_2), 3.79−3.89 (m, 2 H, 1-H_2), 7.65−7.72 (m, 6 H, Ar-H), 7.77−7.81 (m, 3 H, Ar-H), 7.83−7.88 (m, 6 H, Ar-H).

(6*R*,7*S*)-(6,7-Methylene-1-heptadecyl)triphenylphosphonium Bromide (22′): In the same manner as described above, **21′** (462 mg, 1.39 mmol) was converted into 791 mg (96%) of **22′**. This was employed in the next step without further purification. The IR and NMR spectra are identical to those of **22**.

(4*R*,3′*Z*,9′*S*,10′*R*)-4-(9′,10′-Methylene-3′-icosenyl)-2,2-dimethyl-1,3-dioxolane (24): To a stirred solution of **22** (331 mg, 0.56 mmol) in dry THF (5 mL), a solution of NaHMDS (1.0 M in THF, 0.56 mL, 0.56 mmol) was added dropwise at 0 °C under argon. The mixture was stirred for 10 min at 0 °C. To the resulting ylide solution, a solution of **23** (238 mg, 1.50 mmol) in dry THF (2 mL) was added dropwise at −78 °C. The stirred mixture was allowed to warm to room temperature over a period of 12 h. After quenching by the addition of saturated aqueous NH_4Cl, the mixture was extracted with diethyl ether. The combined extracts were washed with water and brine, dried with $MgSO_4$, and concentrated in vacuo. The residue was chromatographed on silica gel to give **24** (176 mg, 80%) as a colorless oil; n_D^{24} = 1.4549. − $[\alpha]_D^{23}$ = −8.86 (c = 1.44, $CHCl_3$). − IR (film): $\tilde{\nu}_{max}$ = 3060 cm^{-1} (w, CH), 1455 (m, CH), 1370 (m, CH), 1215 (m), 1155 (m), 1065 (m, C−O), 855 (m). − ^1H NMR (500 MHz, $CDCl_3$): δ = −0.33 (dt, J = 9.5, 5.2 Hz, 1 H, 21′-H_a), 0.52−0.59 (m, 1 H, 21′-H_b), 0.65 (br. s, 2 H, 9′-, 10′-H), 0.88 (t, J = 7.0 Hz, 3 H, 20′-H_3), 1.12−1.46 (m, 24 H, 6′-, 7′-, 8′-, 11′-, 12′-, 13′-, 14′-, 15′-, 16′-, 17′-, 18′-, 19′-H_2), 1.35 (s, 3 H, acetonide), 1.41 (s, 3 H, acetonide), 1.51−1.57 (m, 1 H, 1′-H_a), 1.63−1.73 (m, 1 H, 1′-H_b), 1.94−2.19 (m, 4 H, 2′-, 5′-H_2), 3.52 (t, J = 7.6 Hz, 1 H, 5-H_a), 4.03 (dd, J = 7.6, 6.1 Hz, 1 H, 5-H_b), 4.05−4.12 (m, 1 H, 4-H), 5.32−5.43 (m, 2 H, 3′-, 4′-H). − $C_{26}H_{48}O_2$ (392.7): calcd. C 79.53, H 12.32; found C 79.47, H 12.41.

(4*R*,3*Z*,9′*R*,10′*S*)-4-(9′,10′-Methylene-3′-icosenyl)-2,2-dimethyl-1,3-dioxolane (24′): In the same manner as described above, **22′** (1.83 g, 3.08 mmol) was converted into 1.02 g (84%) of **24′**; n_D^{20} = 1.4661. − $[\alpha]_D^{22}$ = −7.17 (c = 1.44, $CHCl_3$). − IR (film): $\tilde{\nu}_{max}$ = 3055 cm^{-1} (w, CH), 1455 (m, CH), 1370 (m, CH), 1215 (m), 1155 (m), 1065 (m, C−O), 855 (m). − ^1H NMR (500 MHz, $CDCl_3$): δ = −0.33 (dt, J = 9.5, 5.2 Hz, 1 H, 21′-H_a), 0.53−0.58 (m, 1 H, 21′-H_b), 0.65 (br. s, 2 H, 9′-, 10′-H), 0.88 (t, J = 7.0 Hz, 3 H, 20′-H_3), 1.18−1.40 (m, 24 H, 6′-, 7′-, 8′-, 11′-, 12′-, 13′-, 14′-, 15′-, 16′-, 17′-, 18′-, 19′-H_2), 1.35 (s, 3 H, acetonide), 1.41 (s, 3 H, acetonide), 1.50−1.58 (m, 1 H, 1′-H_a), 1.66−1.74 (m, 1 H, 1′-H_b), 1.98−2.18 (m, 4 H, 2′-, 5′-H_2), 3.52 (t, J = 7.6 Hz, 1 H, 5-H_a), 4.03 (dd, J = 7.6, 6.1 Hz, 1 H, 5-H_b), 4.09 (quint, J = 7.0 Hz, 1 H, 4-H), 5.32−5.43 (m, 2 H, 3′-, 4′-H). − $C_{26}H_{48}O_2$ (392.7): calcd. C 79.53, H 12.32; found C 79.55, H 12.23.

(2*R*,5*Z*,11*S*,12*R*)-11,12-Methylene-5-docosene-1,2-diol (25): To a stirred solution of **24** (164 mg, 0.42 mmol) in THF (5 mL), 3 N HCl (1 mL) was added dropwise and the mixture was stirred for 12 h at room temperature. The solvent was then removed in vacuo. The residue was chromatographed on silica gel to give **25** (145 mg, quant.) as a colorless solid; m.p. 32−33 °C. − $[\alpha]_D^{25}$ = −0.91 (c = 1.66, $CHCl_3$). − IR (Nujol): $\tilde{\nu}_{max}$ = 3365 cm^{-1} (m, OH), 3070 (w, CH), 1455 (m, CH), 1320 (m, CH), 1220 (m), 1105 (m), 865 (m). − ^1H NMR (500 MHz, $CDCl_3$): δ = −0.33 (dt, J = 9.5, 5.2 Hz, 1 H, 23-H_a), 0.52−0.59 (m, 1 H, 23-H_b), 0.65 (br. s, 2 H, 11-, 12-H), 0.88 (t, J = 7.0 Hz, 3 H, 22-H_3), 1.10−1.41 (m, 24 H, 8-, 9-, 10-, 13-, 14-, 15-, 16-, 17-, 18-, 19-, 20-, 21-H_2), 1.45−1.56 (m, 2 H, 3-H_2), 1.57−1.61 (m, 2 H, 1-, 2-OH), 1.98−2.22 (m, 4 H, 4-, 7-H_2), 3.46 (dd, J = 11.0, 7.7 Hz, 1 H, 1-H_a), 3.66 (dd, J = 11.0, 3.1 Hz, 1 H, 1-H_b), 3.71−3.77 (m, 1 H, 2-H), 5.34−5.49 (m, 2 H, 5-, 6-H). − $C_{23}H_{44}O_2$ (352.6): calcd. C 78.35, H 12.58; found C 77.96, H 12.76.

(2*R*,5*Z*,11*R*,12*S*)-11,12-Methylene-5-docosene-1,2-diol (25′): In the same manner as described above, **24′** (134 mg, 0.34 mmol) was converted into 113 mg (94%) of **25′**; m.p. 33−34 °C. − $[\alpha]_D^{21}$ = −0.34 (c = 0.48, $CHCl_3$). − IR (Nujol): $\tilde{\nu}_{max}$ = 3365 cm^{-1} (m, OH), 3070 (w, CH), 1455 (m, CH), 1320 (m, CH), 1220 (m), 1105 (m), 865 (m). − ^1H NMR (500 MHz, $CDCl_3$): δ = −0.33 (dt, J = 9.5, 5.2 Hz, 1 H, 23-H_a), 0.52−0.60 (m, 1 H, 23-H_b), 0.65 (br. s, 2 H, 11-, 12-H), 0.88 (t, J = 7.0 Hz, 3 H, 22-H_3), 1.14−1.41 (m, 24 H, 8-, 9-, 10-, 13-, 14-, 15-, 16-, 17-, 18-, 19-, 20-, 21-H_2), 1.47−1.55 (m, 2 H, 3-H_2), 1.96−2.44 (m, 6 H, 1-, 2-OH, 4-, 7-H_2), 3.44 (dd, J = 11.0, 7.7 Hz, 1 H, 1-H_a), 3.65 (dd, J = 11.0, 3.1 Hz, 1 H, 1-H_b), 3.69−3.76 (m, 1 H, 2-H), 5.33−5.49 (m, 2 H, 5-, 6-H). − $C_{23}H_{44}O_2$ (352.6): calcd. C 78.35, H 12.58; found C 78.32, H 12.58.

(2*R*,5*Z*,11*S*,12*R*)-1,2-Bis(*tert*-butyldimethylsilyloxy)-11,12-methylene-5-docosene (26): To a solution of **25** (27 mg, 76.8 μmol) in DMF (2 mL), imidazole (13 mg, 0.19 mmol) and TBSCl (35 mg, 0.23 mmol) were added at 0 °C and the mixture was stirred for 10 h at room temperature. It was then poured into water and extracted with diethyl ether. The combined extracts were washed with water and brine. The organic layer was dried with $MgSO_4$ and concentrated in vacuo to give **26** (41 mg, 95%) as a colorless oil; n_D^{22} = 1.4589. − $[\alpha]_D^{22}$ = +10.7 (c = 0.86, $CHCl_3$). − IR (film): $\tilde{\nu}_{max}$ = 3070 cm^{-1} (w, CH), 1460 (m, CH), 1255 (m), 1110 (m), 840 (m), 780 (m). − ^1H NMR (500 MHz, $CDCl_3$): δ = −0.33 (dt, J = 9.5, 5.2 Hz, 1 H, 23-H_a), 0.045 (s, 3 H, SiMe), 0.049 (s, 3 H, SiMe), 0.060 (s, 3 H, SiMe), 0.064 (s, 3 H, SiMe), 0.52−0.59 (m, 1 H, 23-H_b), 0.64 (br. s, 2 H, 11-, 12-H), 0.88 (t, J = 7.3 Hz, 3 H, 22-H_3), 0.89 (s, 18 H, CMe_3), 1.11−1.46 (m, 24 H, 8-, 9-, 10-, 13-, 14-, 15-, 16-, 17-, 18-, 19-, 20-, 21-H_2), 1.55−1.63 (m, 2 H, 3-H_2), 1.99−2.18 (m, 4 H, 4-, 7-H_2), 3.40 (dd, J = 10.0, 6.4 Hz, 1 H, 1-H_a), 3.53 (dd, J = 10.0, 5.5 Hz, 1 H, 1-H_b), 3.64−3.70 (m, 1 H, 2-H), 5.33−5.41 (m, 2 H, 5-, 6-H). − $C_{35}H_{72}O_2Si_2$ (581.1): calcd. C 72.34, H 12.49; found C 72.07, H 12.69.

(2*R*,5*Z*,11*R*,12*S*)-1,2-Bis(*tert*-butyldimethylsilyloxy)-11,12-methylene-5-docosene (26′): In the same manner as described above, **25′**

(859 mg, 2.44 mmol) was converted into 1.38 g (97%) of **26′**; n_D^{26} = 1.4589. − $[\alpha]_D^{22}$ = +10.8 (*c* = 0.5, $CHCl_3$). − IR (film): $\tilde{\nu}_{max}$ = 3070 cm^{-1} (w, CH), 1460 (m, CH), 1255 (m), 1120 (m), 835 (m), 775 (m). − ^1H NMR (500 MHz, $CDCl_3$): δ = −0.33 (dt, *J* = 9.5, 5.2 Hz, 1 H, 23-H_a), 0.046 (s, 3 H, SiMe), 0.049 (s, 3 H, SiMe), 0.061 (s, 3 H, SiMe), 0.066 (s, 3 H, SiMe), 0.52−0.59 (m, 1 H, 23-H_b), 0.64 (br. s, 2 H, 11-, 12-H), 0.88 (t, *J* = 7.3 Hz, 3 H, 22-H_3), 0.89 (s, 18 H, CMe_3), 1.07−1.49 (m, 24 H, 8-, 9-, 10-, 13-, 14-, 15-, 16-, 17-, 18-, 19-, 20-, 21-H_2), 1.55−1.63 (m, 2 H, 3-H_2), 1.99−2.18 (m, 4 H, 4-, 7-H_2), 3.41 (dd, *J* = 10.0, 6.4 Hz, 1 H, 1-H_a), 3.53 (dd, *J* = 10.0, 5.5 Hz, 1 H, 1-H_b), 3.64−3.69 (m, 1 H, 2-H), 5.33−5.41 (m, 2 H, 5-, 6-H). − $C_{35}H_{72}O_2Si_2$ (581.1): calcd. C 72.34, H 12.49; found C 72.36, H 12.89.

(2*R*,5*Z*,11*S*,12*R*)-2-*tert*-Butyldimethylsilyloxy-11,12-methylene-5-docosen-1-ol (27): To a stirred solution of **26** (146 mg, 0.25 mmol) in THF (4 mL), 10% aq. TFA (1 mL) was added dropwise and the mixture was stirred for 5 h at room temperature. It was then diluted with diethyl ether, washed with saturated aqueous $NaHCO_3$ solution and brine, dried with $MgSO_4$, and concentrated in vacuo. The residue was chromatographed on silica gel to give 46 mg (39%) of **27**, 44 mg (30%) of **26**, and 21 mg (25%) of **25**; n_D^{15} = 1.4705. − $[\alpha]_D^{22}$ = −3.30 (*c* = 0.60, $CHCl_3$). − IR (film): $\tilde{\nu}_{max}$ = 3450 cm^{-1} (m, OH), 3070 (w, CH), 1460 (m, CH), 1260 (m), 1120 (m), 840 (m), 780 (m). − ^1H NMR (400 MHz, $CDCl_3$): δ = −0.33 (dt, *J* = 9.5, 5.2 Hz, 1 H, 23-H_a), 0.090 (s, 6 H, SiMe), 0.52−0.59 (m, 1 H, 23-H_b), 0.64 (br. s, 2 H, 11-, 12-H), 0.88 (t, *J* = 7.1 Hz, 3 H, 22-H_3), 0.90 (s, 9 H, CMe_3), 1.10−1.41 (m, 24 H, 8-, 9-, 10-, 13-, 14-, 15-, 16-, 17-, 18-, 19-, 20-, 21-H_2), 1.49−1.60 (m, 3 H, 3-H_2, OH), 1.97−2.14 (m, 4 H, 4-, 7-H_2), 3.46 (dd, *J* = 11.0, 5.4 Hz, 1 H, 1-H_a), 3.58 (dd, *J* = 11.0, 3.4 Hz, 1 H, 1-H_b), 3.70−3.79 (m, 1 H, 2-H), 5.30−5.41 (m, 2 H, 5-, 6-H). − $C_{29}H_{58}O_2Si$ (466.9): calcd. C 74.61, H 12.52; found C 74.36, H 12.82.

(2*R*,5*Z*,11*R*,12*S*)-2-*tert*-Butyldimethylsilyloxy-11,12-methylene-5-docosen-1-ol (27′): In the same manner as described above, **26′** (502 mg, 0.86 mmol) was converted into 218 mg (54%) of **27′** and 82 mg (27%) of **25′**; n_D^{25} = 1.4648. − $[\alpha]_D^{22}$ = −1.24 (*c* = 0.50, $CHCl_3$). − IR (film): $\tilde{\nu}_{max}$ = 3410 cm^{-1} (m, OH), 3060 (w, CH), 1460 (m, CH), 1255 (m), 1110 (m), 835 (m), 775 (m). − ^1H NMR (300 MHz, $CDCl_3$): δ = −0.33 (dt, *J* = 9.5, 5.1 Hz, 1 H, 23-H_a), 0.095 (s, 6 H, $SiMe_2$), 0.52−0.60 (m, 1 H, 23-H_b), 0.60−0.72 (m, 2 H, 11-, 12-H), 0.88 (t, *J* = 7.1 Hz, 3 H, 22-H_3), 0.91 (s, 9 H, CMe_3), 1.16−1.42 (m, 24 H, 8-, 9-, 10-, 13-, 14-, 15-, 16-, 17-, 18-, 19-, 20-, 21-H_2), 1.50−1.61 (m, 3 H, 3-H_2, OH), 1.97−2.12 (m, 4 H, 4-, 7-H_2), 3.46 (dd, *J* = 11.0, 5.4 Hz, 1 H, 1-H_a), 3.58 (dd, *J* = 11.0, 3.4 Hz, 1 H, 1-H_b), 3.71−3.80 (m, 1 H, 2-H), 5.30−5.41 (m, 2 H, 5-, 6-H). − $C_{29}H_{58}O_2Si$ (466.9): calcd. C 74.61, H 12.52; found C 74.75, H 12.87.

(2*R*,5*Z*,11*S*,12*R*)-2-*tert*-Butyldimethylsilyloxy-11,12-methylene-5-docosenoic Acid (28): To a solution of **27** (134 mg, 0.29 mmol) in dry CH_2Cl_2 (3 mL), Dess−Martin periodinane (158 mg, 0.37 mmol) was added portionwise at 0 °C and the resulting mixture was stirred for 1 h at room temperature. After quenching the reaction by the addition of saturated aqueous $NaHCO_3$ solution and saturated aqueous $Na_2S_2O_3$ solution, the mixture was extracted with diethyl ether. The combined extracts were washed with water and brine. The organic layer was dried with $MgSO_4$ and concentrated in vacuo to give the crude aldehyde (134 mg, quant.). This was employed in the next step without further purification. To a stirred solution of the aldehyde (134 mg, 0.37 mmol) and NaH_2PO_4 (136 mg, 0.87 mmol) in *t*BuOH (8 mL)/H_2O (2 mL)/2-methyl-2-butene (2 mL), sodium chlorite (105 mg, 1.16 mmol) was added at 0 °C and the reaction mixture was stirred for 2 h at room temperature. It was then poured into saturated aqueous NH_4Cl solution and extracted with ethyl acetate. The combined extracts were washed with brine, dried with $MgSO_4$, and concentrated in vacuo to give crude **28** (139 mg, quant.). This was employed in the next step without further purification. − IR (film): $\tilde{\nu}_{max}$ = 3370 cm^{-1} (br, OH), 3060 (w), 1725 (s, C=O), 1460 (m, CH), 1255 (m), 1140 (m), 840 (s), 780 (m). − ^1H NMR (300 MHz, $CDCl_3$): δ = −0.34 to −0.31 (m, 1 H, 23-H_a), 0.15 (s, 3 H, SiMe), 0.16 (s, 3 H, SiMe), 0.51−0.60 (m, 1 H, 23-H_b), 0.60−0.67 (m, 2 H, 11-, 12-H), 0.88 (t, *J* = 6.6 Hz, 3 H, 22-H_3), 0.93 (s, 9 H, CMe_3), 1.08−1.69 (m, 24 H, 8-, 9-, 10-, 13-, 14-, 15-, 16-, 17-, 18-, 19-, 20-, 21-H_2), 1.71−1.89 (m, 2 H, 3-H_2), 1.96−2.20 (m, 4 H, 4-, 7-H_2), 4.34 (t, *J* = 5.1 Hz, 1 H, 2-H), 5.30−5.40 (m, 2 H, 5-, 6-H).

(2*R*,5*Z*,11*R*,12*S*)-2-*tert*-Butyldimethylsilyloxy-11,12-methylene-5-docosenoic Acid (28′): In the same manner as described above, **27′** (75 mg, 0.16 mmol) was converted into 75 mg (quant.) of **28′**. This was employed in the next step without further purification. − IR (film): $\tilde{\nu}_{max}$ = 3370 cm^{-1} (br, OH), 3060 (w), 1725 (s, C=O), 1465 (m, CH), 1255 (m), 1140 (m), 835 (s), 780 (m). − ^1H NMR (500 MHz, $CDCl_3$): δ = −0.34 to −0.31 (m, 1 H, 23-H_a), 0.14 (s, 3 H, SiMe), 0.16 (s, 3 H, SiMe), 0.52−0.59 (m, 1 H, 23-H_b), 0.65 (br. s, 2 H, 11-, 12-H), 0.88 (t, *J* = 6.6 Hz, 3 H, 22-H_3), 0.95 (s, 9 H, CMe_3), 1.08−1.39 (m, 24 H, 8-, 9-, 10-, 13-, 14-, 15-, 16-, 17-, 18-, 19-, 20-, 21-H_2), 1.75−1.92 (m, 2 H, 3-H_2), 2.02−2.23 (m, 4 H, 4-, 7-H_2), 4.32 (t, *J* = 4.9 Hz, 1 H, 2-H), 5.30−5.50 (m, 2 H, 5-, 6-H).

(2*S*,3*R*,11*S*,12*R*,2′*R*,5′*Z*,11′*S*,12′*R*)-1,3,2′-Tris(*tert*-butyldimethylsilyloxy)-11,12-methylene-2-(11′,12′-methylene-5′-docosenoylamido)docosane (29): To a stirred solution of carboxylic acid **28** (139 mg, 0.29 mmol) in dry CH_2Cl_2 (2 mL), DCC (78 mg, 0.38 mmol) and HOBt (47 mg, 0.35 mmol) were added portionwise at 0 °C under argon. The resulting mixture was stirred for 10 min at 0 °C and then a solution of **17** (108 mg, 0.18 mmol) in dry CH_2Cl_2 (1 mL) was added dropwise at the same temperature. The stirred mixture was allowed to warm to room temperature over a period of 4 h. It was then diluted with diethyl ether, washed with water and brine, dried with $MgSO_4$, and concentrated in vacuo. The residue was chromatographed on silica gel to give 185 mg (94%) of **29**; n_D^{20} = 1.4695. − $[\alpha]_D^{23}$ = +7.46 (*c* = 0.17, $CHCl_3$). − IR (film): $\tilde{\nu}_{max}$ = 3430 cm^{-1} (w, NH), 3060 (w, CH), 1685 (s, C=O), 1505 (m), 1465 (m, CH), 1255 (m), 1110 (m), 835 (s), 775 (m). − ^1H NMR (500 MHz, $CDCl_3$): δ = −0.34 (dt, *J* = 9.2, 5.2 Hz, 2 H, 23-, 23′-H_a), 0.04 (s, 3 H, SiMe), 0.05 (s, 6 H, $SiMe_2$), 0.06 (s, 3 H, SiMe), 0.09 (s, 3 H, SiMe), 0.10 (s, 3 H, SiMe), 0.53−0.59 (m, 2 H, 23-, 23′-H_b), 0.64 (br. s, 4 H, 11-, 12-, 11′-, 12′-H), 0.88 (t, *J* = 7.0 Hz, 6 H, 22-, 22′-H_3), 0.88 (s, 18 H, CMe_3), 0.94 (s, 9 H, CMe_3), 1.07−1.68 (m, 54 H, 5-, 6-, 7-, 8-, 9-, 10-, 13-, 14-, 15-, 16-, 17-, 18-, 19-, 20-, 21-, 8′-, 9′-, 10′-, 13′-, 14′-, 15′-, 16′-, 17′-, 18′-, 19′-, 20′-, 21′-H_2), 1.70−1.93 (m, 4 H, 4-, 3′-H_2), 2.01−2.17 (m, 4 H, 4′-, 7′-H_2), 3.67 (dd, *J* = 10.4, 6.5 Hz, 1 H, 1-H_a), 3.71 (dd, *J* = 10.4, 6.1 Hz, 1 H, 1-H_b), 3.82−3.90 (m, 1 H, 3-H), 4.00−4.06 (m, 1 H, 2-H), 4.16 (t, *J* = 5.5 Hz, 1 H, 2′-H), 5.32−5.40 (m, 2 H, 5′-, 6′-H), 6.76 (d, *J* = 8.6 Hz, 1 H, NH). − $C_{64}H_{129}NO_4Si_3$ (1061): calcd. C 72.45, H 12.25, N 1.32; found C 72.16, H 12.06, N 1.60.

(2*S*,3*R*,11*R*,12*S*,2′*R*,5′*Z*,11′*R*,12′*S*)-1,3,2′-Tris(*tert*-butyldimethylsilyloxy)-11,12-methylene-2-(11′,12′-methylene-5′-docosenoylamido)docosane (29′): In the same manner as described above, **16′** (128 mg, 0.21 mmol) was converted into 198 mg (89%) of **29′**; n_D^{21} = 1.4710. − $[\alpha]_D^{22}$ = +14.1 (*c* = 0.44, $CHCl_3$). − IR (film): $\tilde{\nu}_{max}$ = 3430 cm^{-1} (w, NH), 3060 (w, CH), 1685 (s, C=O), 1505 (m), 1465 (m, CH), 1255 (m), 1110 (m), 835 (s), 775 (m). − ^1H NMR

(500 MHz, $CDCl_3$): δ = −0.34 (dt, *J* = 9.5, 4.9 Hz, 2 H, 23-, 23′-H_a), 0.04 (s, 3 H, SiMe), 0.05 (s, 6 H, $SiMe_2$), 0.06 (s, 3 H, SiMe), 0.09 (s, 3 H, SiMe), 0.11 (s, 3 H, SiMe), 0.53−0.58 (m, 2 H, 23-, 23′-H_b), 0.64 (br. s, 4 H, 11-, 12-, 11′-, 12′-H), 0.87 (t, *J* = 7.0 Hz, 6 H, 22-, 22′-H_3), 0.88 (s, 18 H, CMe_3), 0.94 (s, 9 H, CMe_3), 1.09−1.60 (m, 54 H, 5-, 6-, 7-, 8-, 9-, 10-, 13-, 14-, 15-, 16-, 17-, 18-, 19-, 20-, 21-, 8′-, 9′-, 10′-, 13′-, 14′-, 15′-, 16′-, 17′-, 18′-, 19′-, 20′-, 21′-H_2), 1.70−1.93 (m, 4 H, 4-, 3′-H_2), 2.01−2.17 (m, 4 H, 4′-, 7′-H_2), 3.68 (dd, *J* = 10.4, 6.5 Hz, 1 H, 1-H_a), 3.71 (dd, *J* = 10.4, 6.1 Hz, 1 H, 1-H_b), 3.84−3.88 (m, 1 H, 3-H), 4.01−4.57 (m, 1 H, 2-H), 4.16 (t, *J* = 5.5 Hz, 1 H, 2′-H), 5.32−5.39 (m, 2 H, 5′-, 6′-H), 6.76 (d, *J* = 8.3 Hz, 1 H, NH). − $C_{64}H_{129}NO_4Si_3$ (1061): calcd. C 72.45, H 12.25, N 1.32; found C 72.50, H 12.26, N 1.57.

(2*S*,3*R*,11*S*,12*R*,2′*R*,5′*Z*,11′*S*,12′*R*)-3,2′-Bis(*tert*-butyldimethylsilyloxy)-11,12-methylene-2-(11′,12′-methylene-5′-docosenoylamido)-1-docosanol (30): To a stirred solution of **29** (84 mg, 79.2 μmol) in THF (2 mL), 10% aq. TFA (0.2 mL) was added dropwise and the resulting mixture was stirred for 3 h at room temperature. It was then diluted with diethyl ether, washed with saturated aqueous $NaHCO_3$ solution and brine, dried with $MgSO_4$, and concentrated in vacuo. The residue was chromatographed on silica gel to give 37 mg (49%) of **30** and 31 mg (37%) of recovered **29**; n_D^{23} = 1.4719. − $[\alpha]_D^{22}$ = +11.8 (*c* = 0.06, $CHCl_3$). − IR (film): $\tilde{\nu}_{max}$ = 3420 cm^{-1} (w, OH, NH), 3060 (w, CH), 1665 (s, C=O), 1520 (m), 1465 (m, CH), 1255 (m), 1110 (m), 835 (s), 775 (m). − ^1H NMR (500 MHz, $CDCl_3$): δ = −0.33 (dt, *J* = 9.4, 5.2 Hz, 2 H, 23-, 23′-H), 0.08 (s, 3 H, SiMe), 0.10 (s, 6 H, SiMe), 0.11 (s, 3 H, SiMe), 0.12 (s, 3 H, SiMe), 0.53−0.58 (m, 2 H, 23-, 23′-H_b), 0.64 (br. s, 4 H, 11-, 12-, 11′-, 12′-H), 0.88 (t, *J* = 7.3 Hz, 6 H, 22-, 22′-H_3), 0.90 (s, 9 H, CMe_3), 0.95 (s, 9 H, CMe_3), 1.12−1.52 (m, 54 H, 5-, 6-, 7-, 8-, 9-, 10-, 13-, 14-, 15-, 16-, 17-, 18-, 19-, 20-, 21-, 8′-, 9′-, 10′-, 13′-, 14′-, 15′-, 16′-, 17′-, 18′-, 19′-, 20′-, 21′-H_2), 1.74−1.80 (m, 4 H, 4-, 3′-H_2), 1.95−2.17 (m, 4 H, 4′-, 7′-H_2), 3.53 (dd, *J* = 11.7, 2.7 Hz, 1 H, 1-H_a), 3.85−3.92 (m, 2 H, 2-, 3-H), 3.98 (dd, *J* = 11.7, 3.4 Hz, 1 H, 1-H_b), 4.20 (t, *J* = 4.6 Hz, 1 H, 2′-H), 5.34−5.40 (m, 2 H, 5′-, 6′-H), 7.50 (d, *J* = 6.7 Hz, 1 H, NH). − $C_{58}H_{115}NO_4Si_2$ (946.7): calcd. C 73.58, H 12.24, N 1.48; found C 73.27, H 12.31, N 1.63.

(2*S*,3*R*,11*R*,12*S*,2′*R*,5′*Z*,11′*R*,12′*S*)-3,2′-Bis(*tert*-butyldimethylsilyloxy)-11,12-methylene-2-(11′,12′-methylene-5′-docosenoylamido)-1-docosanol (30′): In the same manner as described above, **29′** (131 mg, 0.12 mmol) was converted into 41 mg (35%) of **30′** with 65 mg (50%) of **29′** being recovered; n_D^{20} = 1.4728. − $[\alpha]_D^{25}$ = +13.4 (*c* = 0.47, $CHCl_3$). − IR (film): $\tilde{\nu}_{max}$ = 3420 cm^{-1} (w, OH, NH), 3060 (w, CH), 1665 (s, C=O), 1520 (m), 1465 (m, CH), 1255 (m), 1110 (m), 835 (s), 780 (m). − ^1H NMR (500 MHz, $CDCl_3$): δ = −0.33 (dt, *J* = 9.4, 5.2 Hz, 2 H, 23-, 23′-H), 0.08 (s, 3 H, SiMe), 0.09 (s, 6 H, SiMe), 0.11 (s, 6 H, SiMe), 0.52−0.58 (m, 2 H, 23-, 23′-H_b), 0.64 (br. s, 4 H, 11-, 12-, 11′-, 12′-H), 0.88 (t, *J* = 7.3 Hz, 6 H, 22-, 22′-H_3), 0.89 (s, 9 H, CMe_3), 0.95 (s, 9 H, CMe_3), 1.12−1.52 (m, 54 H, 5-, 6-, 7-, 8-, 9-, 10-, 13-, 14-, 15-, 16-, 17-, 18-, 19-, 20-, 21-, 8′-, 9′-, 10′-, 13′-, 14′-, 15′-, 16′-, 17′-, 18′-, 19′-, 20′-, 21′-H_2), 1.74−1.80 (m, 4 H, 4-, 3′-H_2), 1.95−2.17 (m, 4 H, 4′-, 7′-H_2), 3.52 (dd, *J* = 11.7, 2.7 Hz, 1 H, 1-H_a), 3.85−3.92 (m, 2 H, 2-, 3-H), 3.98 (dd, *J* = 11.7, 3.4 Hz, 1 H, 1-H_b), 4.20 (t, *J* = 4.6 Hz, 1 H, 2′-H), 5.34−5.40 (m, 2 H, 5′-, 6′-H), 7.52 (d, *J* = 7.3 Hz, 1 H, NH). − $C_{58}H_{115}NO_4Si_2$ (946.7): calcd. C 73.58, H 12.24, N 1.48; found C 73.23, H 12.60, N 1.63.

(2*S*,3*R*,11*S*,12*R*,2′′′*R*,5′′′*Z*,11′′′*S*,12′′′*R*)-1-*O*-[3′,4′,6′-Tri-*O*-acetyl-2′-*O*-(2′′-chloroacetyl)-β-D-galactopyranosyl]-3,2′′′-bis(*tert*-butyldimethylsilyloxy)-11,12-methylene-2-(11′′′,12′′′-methylene-5′′′-docosenoylamido)docosane (32): A solution of ceramide **30** (12 mg, 12.7 μmol) in dry benzene (2 mL) and dry nitromethane (2 mL) was heated at 110 °C to remove moisture by azeotropic codistillation with benzene. The mixture was concentrated to a volume of 1 mL and cooled under argon. It was then treated dropwise with a solution of bromo sugar **31** (11.4 mg, 25.4 μmol) in dry nitromethane (0.3 mL) and portionwise with $Hg(CN)_2$ (6.4 mg, 25.4 μmol). The resulting mixture was stirred for 2 h at 90 °C. After cooling, it was diluted with ethyl acetate, washed with water, saturated aqueous $NaHCO_3$ solution, and brine, dried with $MgSO_4$, and concentrated in vacuo. The residue was chromatographed on silica gel to give 13 mg (78%) of **32**; n_D^{23} = 1.4729. − $[\alpha]_D^{22}$ = +4.83 (*c* = 0.07, $CHCl_3$). − IR (film): $\tilde{\nu}_{max}$ = 3425 cm^{-1} (w, NH), 3060 (w, CH), 1755 (vs, C=O), 1675 (s, C=O), 1515 (m), 1465 (m, CH), 1250 (s), 1080 (m), 911 (s), 780 (s), 735 (m). − ^1H NMR (500 MHz, $CDCl_3$): δ = −0.30 to −0.33 (m, 2 H, 23-, 23′′′-H), 0.05 (s, 3 H, SiMe), 0.07 (s, 3 H, SiMe), 0.13 (s, 3 H, SiMe), 0.14 (s, 3 H, SiMe), 0.53−0.58 (m, 2 H, 23-, 23′′′-H), 0.64 (m, 4 H, 11-, 12-, 11′′′-, 12′′′-H), 0.88 (t, *J* = 7.4 Hz, 6 H, 22-, 22′′′-Me), 0.88 (s, 9 H, CMe_3), 0.95 (s, 9 H, CMe_3), 1.11−1.60 (m, 54 H, 5-, 6-, 7-, 8-, 9-, 10-, 13-, 14-, 15-, 16-, 17-, 18-, 19-, 20-, 21-, 8′′′-, 9′′′-, 10′′′-, 13′′′-, 14′′′-, 15′′′-, 16′′′-, 17′′′-, 18′′′-, 19′′′-, 20′′′-, 21′′′-H), 1.62−1.81 (m, 4 H, 4-, 3′′′-H_2), 1.97−2.07 (m, 4 H, 4′′′-, 7′′′-H), 1.98 (s, 3 H, acetyl), 2.05 (s, 3 H, acetyl), 2.14 (s, 3 H, acetyl), 3.65−3.75 (m, 2 H, 2-, 3-H), 3.85 (dd, *J* = 9.0, 9.0 Hz, 1 H, 1-H), 3.91 (t, *J* = 6.1 Hz, 1 H, 5′-H), 4.09−4.22 (m, 4 H, 1-, 2′′′-H, 6′-H_2), 4.14 (s, 2 H, $ClCH_2CO$), 4.51 (d, *J* = 7.7 Hz, 1 H, 1′-H), 5.04 (dd, *J* = 10.7, 3.4 Hz, 1 H, 3′-H), 5.17 (dd, *J* = 10.7, 7.6 Hz, 1 H, 2′-H), 5.30−5.37 (m, 2 H, 5′′′-, 6′′′-H), 5.39 (d, *J* = 3.1 Hz, 1 H, 4′-H), 6.73 (d, *J* = 8.9 Hz, 1 H, NH). − HR-FABMS (positive-ion mode) [$C_{72}H_{133}ClNO_{13}Si_2$]: calcd. 1310.9004; found 1310.8995.

(2*S*,3*R*,11*R*,12*S*,2′′′*R*,5′′′*Z*,11′′′*R*,12′′′*S*)-1-*O*-[3′,4′,6′-Tri-*O*-acetyl-2′-*O*-(2′′-chloroacetyl)-β-D-galactopyranosyl]-3,2′′′-bis(*tert*-butyldimethylsilyloxy)-11,12-methylene-2-(11′′′,12′′′-methylene-5′′′-docosenoylamido)docosane (32′): In the same manner as described above, **30′** (58 mg, 61.3 μmol) was converted into 80 mg (75%) of **32′**; n_D^{23} = 1.4781. − $[\alpha]_D^{22}$ = −0.02 (*c* = 0.20, $CHCl_3$). − IR (film): $\tilde{\nu}_{max}$ = 3420 cm^{-1} (w, NH), 3060 (w, CH), 1755 (vs, C=O), 1680 (s, C=O), 1515 (m), 1465 (m, CH), 1250 (s), 1080 (m), 910 (s), 840 (m), 780 (s). − ^1H NMR (400 MHz, $CDCl_3$): δ = −0.34 (dd, *J* = 9.5, 5.2 Hz, 2 H, 23-, 23′′′-H), 0.05 (s, 3 H, SiMe), 0.07 (s, 3 H, SiMe), 0.13 (s, 3 H, SiMe), 0.14 (s, 3 H, SiMe), 0.53−0.58 (m, 2 H, 23-, 23′′′-H), 0.64 (br. s, 4 H, 11-, 12-, 11′′′-, 12′′′-H), 0.88 (t, *J* = 6.7 Hz, 6 H, 22-, 22′′′-Me), 0.88 (s, 9 H, CMe_3), 0.94 (s, 9 H, CMe_3), 1.11−1.60 (m, 54 H, 5-, 6-, 7-, 8-, 9-, 10-, 13-, 14-, 15-, 16-, 17-, 18-, 19-, 20-, 21-, 8′′′-, 9′′′-, 10′′′-, 13′′′-, 14′′′-, 15′′′-, 16′′′-, 17′′′-, 18′′′-, 19′′′-, 20′′′-, 21′′′-H_2), 1.64−1.82 (m, 4 H, 3′′′-H_2), 1.97−2.07 (m, 4 H, 4′′′-, 7′′′-H_2), 1.98 (s, 3 H, acetyl), 2.05 (s, 3 H, acetyl), 2.14 (s, 3 H, acetyl), 3.65−3.75 (m, 2 H, 2-, 3-H), 3.85 (dd, *J* = 9.0, 9.0 Hz, 1 H, 1-H), 3.91 (t, *J* = 6.1 Hz, 1 H, 5′-H), 4.09−4.22 (m, 4 H, 1-, 2′′′-H, 6′-H_2), 4.14 (s, 2 H, $ClCH_2CO$), 4.51 (d, *J* = 7.8 Hz, 1 H, 1′-H), 5.04 (dd, *J* = 10.5, 3.4 Hz, 1 H, 3′-H), 5.17 (dd, *J* = 10.5, 7.6 Hz, 1 H, 2′-H), 5.30−5.37 (m, 2 H, 5′′′-, 6′′′-H), 5.39 (d, *J* = 3.1 Hz, 1 H, 4′-H), 6.75 (d, *J* = 9.1 Hz, 1 H, NH). − HR-FABMS (positive-ion mode) [$C_{72}H_{133}ClNO_{13}Si_2$]: calcd. 1310.9004; found 1310.9027.

(2*S*,3*R*,11*S*,12*R*,2′′′*R*,5′′′*Z*,11′′′*S*,12′′′*R*)-1-*O*-[3′,4′,6′-Tri-*O*-acetyl-β-D-galactopyranosyl]-3,2′′′-bis(*tert*-butyldimethylsilyloxy)-11,12-methylene-2-(11′′′,12′′′-methylene-5′′′-docosenoylamido)-docosane (33): To a solution of **32** (19 mg, 14.5 μmol) in ethyl acetate (0.3 mL) and MeOH (0.3 mL), H_2NNH_2·AcOH (4.0 mg, 43.5 μmol) was added portionwise and the mixture was stirred for 6 h

at room temperature. It was then diluted with ethyl acetate, washed with brine, dried with $MgSO_4$, and concentrated in vacuo. The residue was chromatographed on silica gel to give 13 mg (73%) of **33**; n_D^{24} = 1.4720. − $[\alpha]_D^{22}$ = −5.11 (*c* = 0.20, $CHCl_3$). − IR (film): $\tilde{\nu}_{max}$ = 3415 cm^{-1} (w, OH, NH), 3060 (w, CH), 1755 (vs, C=O), 1675 (s, C=O), 1520 (m), 1465 (m, CH), 1250 (s), 1080 (m), 840 (s), 780 (s). − ^1H NMR (500 MHz, $CDCl_3$): δ = −0.33 (dt, *J* = 9.5, 5.1 Hz, 2 H, 23-, 23′′′-H), 0.07 (s, 3 H, SiMe), 0.09 (s, 3 H, SiMe), 0.12 (s, 3 H, SiMe), 0.53−0.58 (m, 2 H, 23-, 23′′′-H), 0.65 (br. s, 4 H, 11-, 12-, 11′′′-, 12′′′-H), 0.88 (t, *J* = 7.0 Hz, 6 H, 22-, 22′′′-Me), 0.89 (s, 9 H, CMe_3), 0.94 (s, 9 H, CMe_3), 1.11−1.80 (m, 59 H, 4-, 5-, 6-, 7-, 8-, 9-, 10-, 13-, 14-, 15-, 16-, 17-, 18-, 19-, 20-, 21-, 3′′′-, 8′′′-, 9′′′-, 10′′′-, 13′′′-, 14′′′-, 15′′′-, 16′′′-, 17′′′-, 18′′′-, 19′′′-, 20′′′-, 21′′′-H_2, OH), 1.97−2.07 (m, 4 H, 4′′′-, 7′′′-H_2), 2.03 (s, 3 H, acetyl), 2.04 (s, 3 H, acetyl), 2.10 (s, 3 H, acetyl), 3.68 (dd, *J* = 10.0, 7.6 Hz, 1 H, 2′-H), 3.80−3.92 (m, 4 H, 1-, 2-, 3-, 5′-H), 4.08−4.28 (m, 4 H, 1-, 2′′′-H, 6′-H_2), 4.36 (d, *J* = 7.7 Hz, 1 H, 1′-H), 4.94 (dd, *J* = 10.1, 3.4 Hz, 1 H, 3′-H), 5.28−5.41 (m, 2 H, 5′′′-, 6′′′-H), 5.37 (d, *J* = 3.4 Hz, 1 H, 4′-H), 6.91 (d, *J* = 9.5 Hz, 1 H, NH). − HR-FABMS (positive-ion mode) [$C_{70}H_{132}NO_{12}Si_2$]: calcd. 1234.9288; found 1234.9291.

(2*S*,3*R*,11*R*,12*S*,2′′′*R*,5′′′*Z*,11′′′*R*,12′′′*S*)-1-*O*-[3′,4′,6′-Tri-*O*-acetyl-β-D-galactopyranosyl]-3,2′′′-bis(*tert*-butyldimethylsilyloxy)-11,12-methylene-2-(11′′′,12′′′-methylene-5′′′-docosenoylamido)-docosane (33′): In the same manner as described above, **32′** (60 mg, 45.8 μmol) was converted into 41 mg (74%) of **33′**; n_D^{20} = 1.4770. − $[\alpha]_D^{22}$ = −8.06 (*c* = 0.10, $CHCl_3$). − IR (film): $\tilde{\nu}_{max}$ = 3420 cm^{-1} (w, OH, NH), 3060 (w, CH), 1750 (vs, C=O), 1670 (s, C=O), 1520 (m), 1465 (m, CH), 1250 (s), 1080 (m), 840 (s), 780 (s). − ^1H NMR (500 MHz, $CDCl_3$): δ = −0.33 (ddd, *J* = 5.5, 5.5, 5.2 Hz, 2 H, 23-, 23′′′-H), 0.07 (s, 3 H, SiMe), 0.09 (s, 3 H, SiMe), 0.12 (s, 6 H, SiMe), 0.53−0.58 (m, 2 H, 23-, 23′′′-H), 0.64 (br. s, 4 H, 11-, 12-, 11′′′-, 12′′′-H), 0.88 (t, *J* = 7.7 Hz, 6 H, 22-, 22′′′-Me), 0.89 (s, 9 H, CMe_3), 0.94 (s, 9 H, CMe_3), 1.11−1.80 (m, 58 H, 4-, 5-, 6-, 7-, 8-, 9-, 10-, 13-, 14-, 15-, 16-, 17-, 18-, 19-, 20-, 21-, 3′′′-, 8′′′-, 9′′′-, 10′′′-, 13′′′-, 14′′′-, 15′′′-, 16′′′-, 17′′′-, 18′′′-, 19′′′-, 20′′′-, 21′′′-H_2), 1.97−2.07 (m, 4 H, 4′′′-, 7′′′-H_2), 2.03 (s, 3 H, acetyl), 2.05 (s, 3 H, acetyl), 2.10 (s, 3 H, acetyl), 3.68 (dd, *J* = 9.8, 7.3 Hz, 1 H, 2′-H), 3.85−3.91 (m, 4 H, 1-, 2-, 3-, 5′-H), 4.09−4.22 (m, 4 H, 1-, 2′′′-H, 6′-H_2), 4.36 (d, *J* = 7.7 Hz, 1 H, 1′-H), 4.44 (br. s, 1 H, OH), 4.94 (dd, *J* = 9.8, 3.4 Hz, 1 H, 3′-H), 5.30−5.37 (m, 2 H, 5′′′-, 6′′′-H), 5.39 (d, *J* = 3.1 Hz, 1 H, 4′-H), 6.91 (d, *J* = 9.8 Hz, 1 H, NH). − HR-FABMS (positive-ion mode) [$C_{70}H_{132}NO_{12}Si_2$]: calcd. 1234.9288; found 1234.9268.

(2*S*,3*R*,11*S*,12*R*,2′′′*R*,5′′′*Z*,11′′′*S*,12′′′*R*)-1-*O*-[3′,4′,6′-Tri-*O*-acetyl-2′-*O*-(3′′-methyl-2′′-butenyl)-β-D-galactopyranosyl]-3,2′′′-bis(*tert*-butyldimethylsilyloxy)-11,12-methylene-2-(11′′′,12′′′-methylene-5′′′-docosenoylamido)docosane (34): To a solution of **33** (13 mg, 10.5 μmol) and 1-(2,2,2-trichloro-1-iminoethoxy)-3-methyl-2-butene (17 mg, 31.6 μmol) in dry CH_2Cl_2 (0.3 mL), a solution of $BF_3{\cdot}Et_2O$ (0.4 μL, 3.2 μmol) in dry CH_2Cl_2 (0.1 mL) was added dropwise at −20 °C under argon. After stirring for 1 h at −20 °C, the solution was neutralized with saturated aqueous $NaHCO_3$ solution, washed with brine, dried with $MgSO_4$, and concentrated in vacuo. The residue was chromatographed on silica gel to give 6 mg (44%) of **34** along with recovered **33** (6.5 mg, 50%); n_D^{23} = 1.4738. − $[\alpha]_D^{21}$ = +3.64 (*c* = 0.05, $CHCl_3$). − IR (film): $\tilde{\nu}_{max}$ = 3425 cm^{-1} (w, NH), 3060 (w, CH), 1755 (vs, C=O), 1680 (s, C=O), 1515 (m), 1465 (m, CH), 1250 (s), 1080 (m), 840 (s), 780 (s). − ^1H NMR (500 MHz, $CDCl_3$): δ = −0.33 (dt, *J* = 9.0, 4.9 Hz, 2 H, 23-, 23′′′-H), 0.05 (s, 3 H, SiMe), 0.07 (s, 3 H, SiMe), 0.12 (s, 3 H, SiMe), 0.15 (s, 3 H, SiMe), 0.55−0.62 (m, 2 H, 23-, 23′′′-H), 0.62−0.65 (m, 4 H, 11-, 12-, 11′′′-, 12′′′-H), 0.86 (t, *J* = 6.3 Hz, 6 H, 22-, 22′′′-Me), 0.88 (s, 9 H, CMe_3), 0.96 (s, 9 H, CMe_3), 1.05−1.62 (m, 54 H, 5-, 6-, 7-, 8-, 9-, 10-, 13-, 14-, 15-, 16-, 17-, 18-, 19-, 20-, 21-, 8′′′-, 9′′′-, 10′′′-, 13′′′-, 14′′′-, 15′′′-, 16′′′-, 17′′′-, 18′′′-, 19′′′-, 20′′′-, 21′′′-H), 1.64−1.80 (m, 4 H, 4-, 3′′′-H_2), 1.68 (s, 3 H, 5′′-Me), 1.73 (s, 3 H, 4′′-Me), 2.01 (s, 3 H, acetyl), 2.02 (s, 3 H, acetyl), 2.11 (s, 3 H, acetyl), 2.00−2.12 (m, 4 H, 4′′′-, 7′′′-H_2), 3.41 (dd, *J* = 10.3, 8.2 Hz, 1 H, 2′-H), 3.60−3.65 (m, 1 H, 1-H), 3.75−3.83 (m, 2 H, 3-, 5′-H), 4.00−4.16 (m, 5 H, 1-H, 1′′-, 6′-H_2), 4.24−4.32 (m, 2 H, 2-H, 2′′′-H), 4.39 (d, *J* = 7.9 Hz, 1 H, 1′-H), 4.87 (dd, *J* = 10.3, 3.7 Hz, 1 H, 3′-H), 5.30−5.38 (m, 4 H, 4′-, 2′′-, 5′′′-, 6′′′-H), 6.81 (d, *J* = 9.1 Hz, 1 H, NH). − HR-FABMS (positive-ion mode) [$C_{75}H_{140}NO_{12}Si_2$]: calcd. 1302.9914; found 1302.9928.

(2*S*,3*R*,11*R*,12*S*,2′′′*R*,5′′′*Z*,11′′′*R*,12′′′*S*)-1-*O*-[3′,4′,6′-Tri-*O*-acetyl-2′-*O*-(3′′-methyl-2′′-butenyl)-β-D-galactopyranosyl]-3,2′′′-bis(*tert*-butyldimethylsilyloxy)-11,12-methylene-2-(11′′′,12′′′-methylene-5′′′-docosenoylamido)docosane (34′): In the same manner as described above, **33′** (11 mg, 8.91 μmol) was converted into 5 mg (43%) of **34′** with 5 mg (44%) of **33′** being recovered; n_D^{24} = 1.4765. − $[\alpha]_D^{22}$ = +3.51 (*c* = 0.07, $CHCl_3$). − IR (film): $\tilde{\nu}_{max}$ = 3425 cm^{-1} (w, NH), 3060 (w, CH), 1755 (vs, C=O), 1680 (s, C=O), 1515 (m), 1465 (m, CH), 1250 (s), 1080 (m), 840 (s), 780 (s). − ^1H NMR (500 MHz, $CDCl_3$): δ = −0.34 (dt, *J* = 9.4, 5.2 Hz, 2 H, 23-, 23′′′-H), 0.05 (s, 3 H, SiMe), 0.07 (s, 3 H, SiMe), 0.12 (s, 3 H, SiMe), 0.15 (s, 3 H, SiMe), 0.55−0.62 (m, 2 H, 23-, 23′′′-H), 0.62−0.65 (m, 4 H, 11-, 12-, 11′′′-, 12′′′-H), 0.88 (t, *J* = 7.0 Hz, 6 H, 22-, 22′′′-Me), 0.88 (s, 9 H, CMe_3), 0.96 (s, 9 H, CMe_3), 1.05−1.62 (m, 54 H, 5-, 6-, 7-, 8-, 9-, 10-, 13-, 14-, 15-, 16-, 17-, 18-, 19-, 20-, 21-, 8′′′-, 9′′′-, 10′′′-, 13′′′-, 14′′′-, 15′′′-, 16′′′-, 17′′′-, 18′′′-, 19′′′-, 20′′′-, 21′′′-H), 1.68 (s, 3 H, 5′′-Me), 1.73 (s, 3 H, 4′′-Me), 1.55−1.76 (m, 4 H, 4-, 3′′′-H), 2.01 (s, 3 H, acetyl), 2.03 (s, 3 H, acetyl), 2.11 (s, 3 H, acetyl), 2.00−2.12 (m, 4 H, 4′′′-, 7′′′-H_2), 3.41 (dd, *J* = 10.3, 8.2 Hz, 1 H, 2′-H), 3.60−3.65 (dd, *J* = 9.8, 4.3 Hz, 1 H, 1-H), 3.75−3.83 (m, 2 H, 3-, 5′-H), 4.00−4.16 (m, 5 H, 1-H, 1′′-, 6′-H_2), 4.21−4.30 (m, 2 H, 2-, 2′′′-H), 4.39 (d, *J* = 7.9 Hz, 1 H, 1′-H), 4.87 (dd, *J* = 10.3, 3.7 Hz, 1 H, 3′-H), 5.30−5.38 (m, 4 H, 4′-, 2′′-, 5′′′-, 6′′′-H), 6.81 (d, *J* = 8.9 Hz, 1 H, NH). − HR-FABMS (positive-ion mode) [$C_{75}H_{140}NO_{12}Si_2$]: calcd. 1302.9914; found 1302.9929.

Plakoside A {(2*S*,3*R*,11*S*,12*R*,2′′′*R*,11′′′*S*,12′′′*R*,5′′′*Z*)-1-*O*-[2′-*O*-(3′′-Methyl-2′′-butenyl)-β-D-galactopyranosyl]-11,12-methylene-2-(11′′′,12′′′-methylene-5′′′-docosenoylamido)-1,3-docosanediol} (1): TBAF (7.8 mg, 29.9 μmol) was added portionwise to a stirred solution of **34** (13 mg, 9.98 μmol) in THF (0.6 mL) and the resulting mixture was stirred at 40 °C for 10 h. The mixture was then diluted with $CHCl_3$, washed with brine, dried with $MgSO_4$, and concentrated in vacuo to give the crude alcohol (10 mg). This was employed in the next step without further purification. NaOMe (0.1 mg, 1.9 μmol) was added portionwise to a stirred solution of the alcohol (10 mg) in MeOH (0.4 mL) and the resulting mixture was stirred for 30 min at room temperature. The solvent was then removed in vacuo. The residue was chromatographed on silica gel to give **1** (5.7 mg, 60%; 2 steps) as an amorphous solid; $[\alpha]_D^{22}$ = +8.86 (*c* = 0.065, MeOH). − ^1H NMR (500 MHz, C_5D_5N): δ = −0.23 (dt, *J* = 9.2, 4.8 Hz, 2 H, 23-, 23′′′-H), 0.62−0.68 (m, 2 H, 23-, 23′′′-H), 0.68−0.75 (m, 4 H, 11-, 12-, 11′′′-, 12′′′-H), 0.86 (t, *J* = 7.0 Hz, 6 H, 22-, 22′′′-Me), 1.15−1.50 (m, 54 H, 5-, 6-, 7-, 8-, 9-, 10-, 13-, 14-, 15-, 16-, 17-, 18-, 19-, 20-, 21-, 8′′′-, 9′′′-, 10′′′-, 13′′′-, 14′′′-, 15′′′-, 16′′′-, 17′′′-, 18′′′-, 19′′′-, 20′′′-, 21′′′-H), 1.58 (s, 6 H, 4′′-, 5′′-Me), 1.57−1.65 (m, 1 H, 5-H), 1.85−1.97 (m, 3 H, 4-H_2, 5-H), 2.13−2.15 (m, 3 H, 3′′′-H, 7′′′-H_2),

2.30−2.38 (m, 1 H, 3′′′-H), 2.55−2.65 (m, 2 H, 4′′′-H_2), 3.94 (t, J = 6.0 Hz, 1 H, 5′-H), 4.02−4.10 (m, 3 H, 1-, 2′-, 3′-H), 4.18−4.23 (m, 1 H, 3-H), 4.35−4.43 (m, 2 H, 6′-H_2), 4.48 (d, J = 3.0 Hz, 1 H, 4′-H), 4.58 (dd, J = 11.9, 7.3 Hz, 1 H, 1′′-H), 4.60−4.64 (m, 1 H, 2′′′-H), 4.70−4.76 (m, 2 H, 1′′-, 2-H), 4.74 (d, J = 7.4 Hz, 1 H, 1′-H), 4.81 (dd, J = 10.1, 4.9 Hz, 1 H, 1-H), 5.48−5.55 (m, 1 H, 6′′′-H), 5.58−5.63 (m, 1 H, 5′′′-H), 5.67−5.71 (m, 1 H, 2′′-H), 6.50−6.70 (m, 3 H, 3 × OH), 7.80 (br. s, 1 H, OH), 8.27 (d, J = 9.5 Hz, 1 H, NH). − ^{13}C NMR (126 MHz, C_5D_5N): δ = 11.4, 14.3, 16.1, 18.1, 22.9, 23.8, 25.7, 26.6, 27.7, 29.1, 29.9−30.1, 32.1, 34.9, 35.8, 54.4, 62.2, 69.6, 69.9, 70.3, 71.2, 71.9, 74.5, 77.0, 79.8, 105.5, 123.1, 129.7, 130.9, 135.0, 174.9. − HR-FABMS (negative-ion mode) [$C_{57}H_{104}NO_9$]: calcd. 946.7684; found 946.7692.

Plakoside A {(2*S*,3*R*,11*R*,12*S*,2′′′*R*,11′′′*R*,12′′′*S*,5′′′*Z*)-1-*O*-[2′-*O*-(3′′-Methyl-2′′-butenyl)-β-D-galactopyranosyl]-11,12-methylene-2-(11′′′,12′′′-methylene-5′′′-docosenoylamido)-1,3-docosanediol} (1′): In the same manner as described above, **34′** (16 mg, 12.3 μmol) was converted into 7.6 mg (65%; 2 steps) of **1′**; $[\alpha]_D^{23}$ = +10.5 (c = 0.07, MeOH). − ^{1}H NMR (500 MHz, C_5D_5N): δ = −0.23 (dt, J = 9.1, 5.1 Hz, 2 H, 23-, 23′′′-H), 0.62−0.68 (m, 2 H, 23-, 23′′′-H), 0.68−0.75 (m, 4 H, 11-, 12-, 11′′′-, 12′′′-H), 0.85 (t, J = 7.0 Hz, 6 H, 22-, 22′′′-Me), 1.15−1.50 (m, 54 H, 5-, 6-, 7-, 8-, 9-, 10-, 13-, 14-, 15-, 16-, 17-, 18-, 19-, 20-, 21-, 8′-, 9′-, 10′-, 13′-, 14′-, 15′-, 16′-, 17′-, 18′-, 19′-, 20′-, 21′-H), 1.58 (s, 6 H, 4′′-, 5′′-Me), 1.57−1.65 (m, 1 H, 5-H), 1.85−1.97 (m, 3 H, 4-H_2, 5-H), 2.13−2.15 (m, 3 H, 3′′′-H, 7′′′-H_2), 2.30−2.38 (m, 1 H, 3′′′-H), 2.55−2.65 (m, 2 H, 4′′′-H), 3.94 (t, J = 6.1 Hz, 1 H, 5′-H), 4.02−4.10 (m, 3 H, 1-, 2′-, 3′-H), 4.18−4.23 (m, 1 H, 3-H), 4.35−4.43 (m, 2 H, 6′-H_2), 4.48 (s, 1 H, 4′-H), 4.60−4.64 (m, 2 H, 1′′-, 2′′′-H), 4.70−4.76 (m, 2 H, 1′′-, 2-H), 4.74 (d, J = 7.4 Hz, 1 H, 1′-H), 4.81 (dd, J = 10.1, 4.9 Hz, 1 H, 1-H), 5.48−5.55 (m, 1 H, 6′′′-H), 5.58−5.63 (m, 1 H, 5′′′-H), 5.67−5.71 (m, 1 H, 2′′-H), 6.50−6.70 (m, 3 H, 3 × OH), 7.80 (m, 1 H, OH), 8.27 (d, J = 9.5 Hz, 1 H, NH). − ^{13}C NMR (126 MHz, C_5D_5N): δ = 11.4, 14.3, 16.2, 18.1, 22.9, 23.8, 25.7, 26.6, 27.7, 29.0, 29.9−30.1, 32.1, 34.9, 35.8, 54.4, 62.2, 69.6, 69.9, 70.3, 71.1, 71.9, 74.5, 77.0, 79.8, 105.6, 123.1, 129.7, 130.9, 135.3, 174.9. −These ^{1}H and ^{13}C NMR spectroscopic data are virtually identical to those of **1**. − HR-FABMS (negative-ion mode) [$C_{57}H_{104}NO_9$]: calcd. 946.7684; found 946.7706.[21]

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[21] Supporting information for this article [^{1}H and ^{13}C NMR spectra of Plakoside A (**1**)] is available; see footnote first page.

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