$Na_2 \cdot 2H_2O$ (1.94 g, 5.2 mmol). After the usual workup, an oil was obtained (0.64 g), which was chromatographed. Elution with 7:3 C_6H_6–$CHCl_3$ gave **19,20-dihydro-16-epivinoxine acetate (15)**: 50 mg (6%); IR ($CHCl_3$) 1730 (CO); NMR 1.0 (t, J = 7 Hz, 3 H, H-18), 2.0 (s, 3 H, CH_3CO), 3.6 (s, 3 H, OCH_3), 3.9 (apparent t, 1 H, H-3), 4.1 (t, J = 6 Hz, 2 H, H-6), 4.8 (s, 1 H, H-16), 6.1 (s, 1 H, H-7), 6.9–7.2 (m, 3 H, indole), 7.3–7.7 (m, 1 H, H-9). For the oxalate: mp 142–143 °C (acetone). Anal. Calcd for $C_{24}H_{30}N_2O_8$: C, 60.73; H, 6.37; N, 5.98. Found: C, 60.56; H, 6.39; N, 5.76. Elution with 1:9 C_6H_6–$CHCl_3$ afforded **19,20-dihydro-16-epivinoxine (16)**: 40 mg (5%); IR ($CHCl_3$) 1730 (CO), 3200–3600 (OH); NMR 1.0 (t, J = 7 Hz, 3 H, H-18), 3.6 (t, J = 6 Hz, 2 H, H-6), 3.6 (s, 3 H, OCH_3), 3.9 (apparent t, 1 H, H-3), 4.8 (s, 1 H, H-16), 6.15 (s, 1 H, H-7), 6.9–7.2 (m, 3 H, indole), 7.3–7.7 (m, 1 H, H-9). For the oxalate: mp 162–163 °C (acetone–C_6H_6). Anal. Calcd for $C_{22}H_{22}N_2O_7 \cdot {}^1/_4C_6H_6$: C, 62.40; H, 6.58; N, 6.19. Found: C, 62.12; H, 6.94; N, 5.86.

19,20-Dihydro-16-epivinoxine (16). A solution of the acetate **15** (50 mg, 0.13 mmol) in methanolic hydrogen chloride (2.5 N, 5 mL) was stirred at room temperature for 5 h. The solvent was evaporated and the resulting oily residue was dissolved in water, basified with Na_2CO_3 solution, and extracted with Et_2O. Evaporation of the dried extracts gave **16**: 40 mg (90%).

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A Short, Flexible Route to Symmetrically and Unsymmetrically Substituted Diphoshatidylglycerols (Cardiolipins)

John F. W. Keana,* Masato Shimizu, and Karen K. Jernstedt

Department of Chemistry, University of Oregon, Eugene, Oregon 97403

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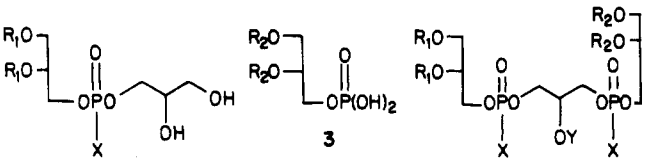
Phosphatidylglycerol methyl esters **2a,b** undergo selective phosphorylation on the primary alcohol with phosphatidic acid **3a** to give, after methylation of the crude product for purposes of purification and then didemethylation, symmetrically substituted DPG **5a** and unsymmetrically substituted DPG **5b**, respectively, in moderate overall yield.

The ready availability of chemically well-defined complex lipids is important to many areas of biochemical and biomedical research. The diphoshatidylglycerols (DPGs, also called cardiolipins) constitute a class of complex phospholipids occurring mainly in the heart and skeletal muscles, usually associated with membranes of subcellular fractions showing high metabolic activity, for example, the mitochondria.[1,2] The several synthetic approaches described to date[1,3,4] have led to symmetrically substituted DPGs. We report herein a versatile synthetic approach that leads to either symmetrically or unsymmetrically substituted, chemically well-defined DPGs. This approach allows for the preparation of DPGs that bear, for example, a biophysical probe (nitroxide spin-label, fluorescent label, etc.) in one of the four chains. Only one such labeled DPG, a nitroxide spin-labeled derivative, has been described to date.[5] This was derived in low overall yield from natural cardiolipin (a mixture) by a somewhat difficult to control hydrolysis with a phospholipase A_2 followed by reesterification with a nitroxide spin-labeled fatty acid.

Our approach involves the coupling of a phosphatidylglycerol (PG) methyl ester with a phosphatidic acid (PA) as the key step. Several synthetic routes to chemically well-defined PGs and PAs have been described.[4] That many naturally derived as well as synthetic PGs and PAs are also available commercially enhances their value as starting materials for DPG synthesis.

In the event, L-α-phosphatidyl-DL-glycerol (dipalmitoyl) **1a** (NH_4^+ salt) was converted into methyl ester **2a** by acidification followed by treatment with diazomethane.



1, X = $O^-NH_4^+$
2, X = OCH_3

4, X = OCH_3, Y = H
5, X = O^-Na^+, Y = H
6, X = OCH_3, Y = Ac

a, R_1 = R_2 = palmitoyl
b, R_1 = oleoyl, R_2 = palmitoyl
c, R_1R_2 = mixture of long chain saturated and unsaturated acyl groups

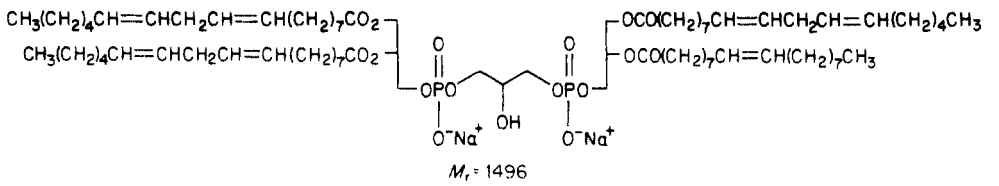
Ester **2a** underwent a selective TPS-promoted phosphorylation[6] on the primary alcohol group with L-α-phosphatidic acid (dipalmitoyl) **3a**. To facilitate purification, the crude monomethyl ester product was methylated with diazomethane to give dimethyl ester **4a**. Ester **4a** underwent selective didemethylation with NaI in hot 2-butanone,[7] giving the symmetrically substituted DPG **5a**.

In order to confirm the position of phosphorylation of **2a** natural cardiolipin (**5c**) was converted into dimethyl ester **4c**,[8] a portion of which was acetylated to give **6c**.

(1) For a review, see: Ioannou, P.; Golding, B. T. *Prog. Lipid Res.* **1979**, *17*, 279.
(2) Semin, B. K.; Saraste, M.; Wikstrom, M. *Biochim. Biophys. Acta* **1984**, *769*, 15. Thompson, D. A.; Ferguson-Miller, S. *Biochemistry* **1983**, *22*, 3178.
(3) Ramirez, F.; Ioannou, P. V.; Maracek, J. F.; Dodd, G. H.; Golding, B. T. *Tetrahedron* **1977**, *33*, 599.
(4) Longmuir, K. J.; Martin, O. C.; Pagano, R. E. *Chem. Phys. Lipids* **1985**, *36*, 197. For a review, see: Eibl, H. *Chem. Phys. Lipids* 1980, *26*, 405.
(5) Cable, M. B.; Jacobus, J.; Powell, G. L. *Proc. Natl. Acad. Sci. U.S.A.* **1978**, *75*, 1227.
(6) TPS = 2,4,6-triisopropylbenzenesulfonyl chloride. See: Dang, Q. Q.; Stoffel, W. *Chem. Phys. Lipids* **1983**, *33*, 33.
(7) McMillen, D. A.; Volwerk, J. J.; Ohishi, J.; Erion, M.; Keana, J. F. W.; Jost, P. C.; Griffith, O. H. *Biochemistry* **1986**, *25*, 182.

0022-3263/86/1951-2297$01.50/0

Chart I



Similar acetylation of **4a** gave **6a**. The highly characteristic 360-MHz ^1H NMR spectra of **4c**, **5c**, and **6c** were essentially identical, except for the additional resonances due to vinyl and allylic protons in the natural series, with those of **4a**, **5a**, and **6a**, respectively.[9,10]

The scheme is easily modified to accommodate the synthesis of unsymmetrically substituted DPGs. Thus, L-α-phosphatidyl-DL-glycerol (dioleoyl) **1b** (NH_4^+ salt) was converted into methyl ester **2b** and then condensed as above with **3a** to give, after methylation of the product, **4b**. **4b** was didemethylated as above to give unsymmetrically substituted DPG **5b**.[11]

The synthesis of a nitroxide spin-labeled DPG as well as other biophysically labeled DPGs is now in progress following this approach and will be reported elsewhere.

Experimental Section

^1H NMR spectra were obtained either on a Nicolet 360-MHz or a GE 300-MHz spectrometer in $CDCl_3$ unless otherwise stated. Chemical shifts are reported in δ units with Me_4Si as an internal standard. J values are in hertz. Abbreviations used are as follows: singlet = s; doublet = d; triplet = t; multiplet = m; broad = br. Elemental analyses were determined at MicAnal (Tucson, AZ). Analytical TLC was performed on silica gel 60 F_{254} (Merck) using the following developing systems: (1) Et_2O–MeOH (95:5); (2) $CHCl_3$–MeOH–H_2O (65:25:4); (3) $CHCl_3$–MeOH–NH_4OH (75:25:4); (4) $CHCl_3$–MeOH–AcOH–H_2O (25:15:4:2). The R_f values of compounds observed with solvent systems 1, 2, 3, and 4 were shown as $R_{f\text{-}1}$, $R_{f\text{-}2}$, $R_{f\text{-}3}$, and $R_{f\text{-}4}$, respectively. Spots were detected either with I_2 vapor or with a phosphomolybdate spray. Preparative TLC was carried out by using silica gel GF (Analtech, 1000 μm). Chromatography was performed on silica gel (Baker, 60–200 mesh). All eluting solvents used were deoxygenated with dry N_2 gas. Reactions were routinely run under an N_2 atmosphere.

1,2-Dipalmitoyl-*sn*-glycero-3-[phospho-*rac*-(1-glycerol)] Methyl Ester (2a). L-α-Phosphatidyl-DL-glycerol (dipalmitoyl) **1a** (NH_4^+ salt, 50.0 mg, 0.067 mmol, Sigma Co.) was dissolved in 40 mL of $CHCl_3$/MeOH/H_2O (127:63:10; v/v/v) and the solution was transferred to two centrifuge tubes and then cooled to 0 °C in an ice bath. Cold 0.1 N HCl (4 mL) was added to each tube, and the mixture was mixed vigorously for 2 min and then centrifuged for a few minutes. The acidic upper layer was removed and the lower layer was washed twice with 4 mL of cold $CHCl_3$/MeOH/H_2O (3:48:47; v/v/v). The combined organic phase (about 30 mL) was concentrated to half their original volume with the aid of N_2 flow at 25 °C.

To the stirred, cold (0 °C, ice bath) concentrated solution was added an excess of ethereal diazomethane (freshly prepared from 0.538 g of Diazald) over a period of 10 min, and the resulting yellow solution was stirred for an additional 30 min at 0 °C. The excess diazomethane was removed with an N_2 sweep, and the colorless solvent was evaporated off by rotary evaporator, yielding a crude product (65 mg), which was purified by preparative TLC (95:5 Et_2O/MeOH) to afford **2a** (44.7 mg, 90%) as a waxy solid: ^1H NMR δ 0.88 (6 H, t, J = 6.8, terminal CH_3), 1.25 (48 H, br s, aliphatic protons), 1.61 (4 H, m, CH_2CCO_2), 2.31 (2 H, t, J = 8.1, CH_2CO_2), 2.34 (2 H, t, J = 7.7, CH_2CO_2), 3.61–3.75 (2 H, m), 3.79 and 3.80 (3 H, each d, J = 11.3 and 11.2, $POCH_3$), 3.88–3.97 (1 H, m), 4.10–4.28 (5 H, m), 4.34 (1 H, m, CH_AH_BOCO), 5.26 (1 H, m, CHOCO).

1,3-Bis[(1,2-dipalmitoyl-*sn*-glycero-3)phosphoryl]glycerol Dimethyl Ester (4a). 1,2-Dipalmitoyl-*sn*-glycero-3-phosphoric acid **3a** (33.1 mg, 0.051 mmol, Sigma Co.) and **2a** (75.0 mg, 0.102 mmol) were dissolved in 1.0 mL of dry pyridine, and to the mixture was added a solution of TPS (46.6 mg, 0.153 mmol) in 0.5 mL of dry pyridine. The reaction mixture was stirred for 8 h at 25 °C and cooled to 0 °C in an ice bath. An excess of TPS was hydrolyzed with 1.0 mL of water, and the solvents were evaporated off under reduced pressure to give a crude product (280.0 mg) which was dissolved in 80 mL of $CHCl_3$/MeOH/H_2O (127:63:10). The solution was washed with 20 mL of cold 0.1 N HCl and $CHCl_3$/MeOH/H_2O (3:48:47; 3 × 16 mL). The organic layer was concentrated to a small volume and treated with an excess of ethereal diazomethane (freshly prepared from 1.075 g of Diazald) for 30 min at 0 °C. After evaporation of the solvent in vacuo, the residue (85.5 mg) was purified by preparative TLC (95:5 Et_2O/MeOH) to afford **4a** (34.0 mg, 48% based on **3a**) as a waxy solid: $R_{f\text{-}1}$ 0.45; ^1H NMR δ 0.88 (12 H, t, J = 7.0, terminal CH_3), 1.25 (96 H, br s, aliphatic protons), 1.61 (8 H, m, CH_2CCO_2), 2.32 (4 H, t, J = 8.0, CH_2CO_2), 2.34 (4 H, t, J = 8.0, CH_2CO_2), 3.80 (3 H, d, J = 11.3, $POCH_3$), 3.81 (3 H, d, J = 11.2, $POCH_3$), 4.05–4.27 (11 H, m), 4.34 (2 H, dd, J = 4.1 and 12.6, CH_AH_BOCO), 5.25 (2 H, m, CHOCO). Anal. Calcd for $C_{17}H_{146}O_{17}P_2$: C, 65.18; H, 10.65. Found: C, 65.21; H, 10.76.

1,3-Bis(1,2-dipalmitoyl-*sn*-glycerol-3-phoshoryl)glycerol Disodium Salt (5a). To a stirred solution of **4a** (22.0 mg, 0.016 mmol) in 1.0 mL of dry methyl ethyl ketone was added NaI (6.0 mg, 0.040 mmol), and the reaction mixture was refluxed for 30 min and cooled to 25 °C. The resulting suspension was transferred to a centrifuge tube, cooled to 0 °C, and then centrifuged for a few minutes. The supernatant was removed and the precipitate was washed three times with 0.3 mL of fresh, cold methyl ethyl ketone to provide analytically pure disodium salt **5a** (20.0 mg, 90%) as a white powder: mp 195–197 °C; $R_{f\text{-}2}$ 0.29; $R_{f\text{-}3}$ 0.19 and 0.22; $R_{f\text{-}4}$ 0.79; ^1H NMR δ 0.88 (12 H, t, J = 6.8, terminal CH_3), 1.26 (96 H, br s, aliphatic protons), 1.58 (8 H, m, CH_2CCO_2), 2.30 (8 H, m, CH_2CO_2), 3.83–4.06 (9 H, m), 4.13–4.24 (2 H, m), 4.34–4.48 (2 H, m), 5.23 (2 H, m). Anal. Calcd for $C_{73}H_{140}O_{17}P_2Na_2 \cdot 2H_2O$:

(8) Powell, G. L.; Marsh, D. *Biochemistry* **1985**, *24*, 2902.

(9) Several features of the ^1H NMR ($CDCl_3$) spectra in this series deserve further comment. The CH_3O group of **2a** appears as a doublet at δ 3.79 ($J_{P,H}$ = 11.3 Hz) and a doublet at 3.80 ($J_{P,H}$ = 11.2 Hz), indicating that **2a** is a 1:1 mixture of diastereomers. (For the ^1H NMR spectrum of the dimethyl ester of **3a**, see: Bruzik, K.; Tsai, M.-D. *J. Am. Chem. Soc.* **1984**, *106*, 747.) Synthetic DPG dimethyl ester **4a** likewise shows a two-doublet pattern for the CH_3O groups at δ 3.80 and 3.81, similar to that observed for naturally derived **4c** (doublets at δ 3.79 and 3.81). However, a complex multiplet centered at δ 3.79 is observed for the CH_3O protons in acetates **6a,c**. The acetate protons in **6a** appear as two singlets at δ 2.107 and 2.124 in a ratio of 3:4 while in naturally derived **6c** they appear as two singlets at δ 2.106 and 2.123 in a ratio of 2:5. These data, taken together with the TLC data described in footnote 10, indicate that our synthetic DPG **5a** is a mixture (likely of little consequence for envisaged biophysical studies with monolabeled DPGs) of two (or possibly more) diastereomers involving the P atoms and the center OH group (the P atoms in cardiolipin are nonequivalent: Powell, G. L.; Jacobus, J. *Biochemistry* **1974**, *106*, 4024).

(10) The silica gel TLC analytical behavior (single spot) of **4a** and naturally derived **4c** were identical under all conditions examined. While **5a** and **5c** both showed single spots of similar R_f in acidic or neutral solvent developing systems, under basic conditions (4:25:75 NH_4OH/MeOH/$CHCl_3$) **5a** showed two close spots (R_f 0.19 and 0.22) suggestive of the presence of two diastereomers (see also the NMR data in footnote 9). Natural **5c** showed a single spot (R_f 0.22) in this solvent system. Interestingly, didemethylation (see **5a**) of **4c** (derived from natural cardiolipin) gave back cardiolipin **5c** (71%) which also showed a two-spot TLC behavior identical with that of **5a** under basic TLC conditions. Remethylation of this sample of **5c** gave back **4c** (85%), which again showed single spot behavior under all conditions, as did a sample of **4a** prepared by remethylation (99%) of **5a**.

(11) Silica gel column chromatography rather than preparative TLC was employed in the purification steps for the oleoyl series owing to susceptibility of the unsaturated side chain toward oxidation under preparative TLC conditions. The NMR and TLC behavior of **4b** and **5b** paralleled that observed with **4a** and **5a**, respectively.

C, 61.15; H, 10.12. Found: C, 61.46; H, 10.00.

Cardiolipin Dimethyl Ester (4c). Natural cardiolipin disodium salt **5c** (34.0 mg, 0.023 mmol,* Sigma, Co.) was converted to the corresponding free acid by using the same procedure as described in preparation of **2a**. For convenience, the structure for cardiolipin in Chart I was employed. An excess of ethereal diazomethane (from 1.075 g of Diazald) was added to the stirred solution of the free acid at 0 °C, and the mixture was stirred for 30 min. After evaporation of the solvent, the residue (36.0 mg) was purified by preparative TLC (95.5 Et_2O/MeOH), yielding a pure **4c** (28.0 mg, 83%) as a pale yellow viscous oil: $R_{f\text{-}1}$ 0.45; ^1H NMR δ 0.89 (t, J = 6.8, terminal CH_3), 1.35 (br s, aliphatic protons), 1.61 (m, CH_2CCO_2), 2.05 (4 lines, allylic CH_2), 2.32 (t, J = 8.0, CH_2CO_2), 2.34 (t, J = 8.1, CH_2CO_2), 2.77 (3 lines, =$CHCH_2CH$=), 3.79 (3 H, d, J = 11.2, $POCH_3$), 3.81 (3 H, d, J = 11.2, $POCH_3$), 4.03–4.28 (m), 4.33 (2 H, dd, J = 4.1 and 12.0, CH_AH_BOCO), 5.25 (2 H, m, CHOCO), 5.28–5.44 (m, olefinic protons).

Reconversion of 4c to Its Sodium Salt (5c'). By the same procedure as described for the preparation of **5a**, a mixture of **4c** (14.0 mg, 9.5 μmol), NaI (3.6 mg, 23.7 μmol), and dry methyl ethyl ketone (0.8 mL) was refluxed for 30 min. Evaporation of the solvent afforded a semisolid residue (16.0 mg), which was purified by preparative TLC (65:25:4 $CHCl_3$/MeOH/H_2O) to give **5c'** (10.1 mg, 71%) (see below) as a pale yellow oil: $R_{f\text{-}2}$ 0.29; $R_{f\text{-}3}$ 0.22 and 0.28.

Cardiolipin Dimethyl Ester Acetate (6c). To a cold (0 °C, ice bath), stirred solution of **4c** (26.0 mg, 17.6 μmol) in 0.5 mL of dry pyridine was added acetyl chloride (3.0 mg, 37.6 μmol), and the reaction mixture was stirred for 6 h at 0 °C. The solvent was evaporated to dryness in vacuo, yielding a waxy residue (36.8 mg). This was purified by preparative TLC (98:2 $CHCl_3$/MeOH) to afford the acetate **6c** (13.4 mg, 50%) as a viscous oil: ^1H NMR δ 0.89 (t, J = 6.9, terminal CH_3), 1.26 (br s, aliphatic protons), 1.62 (m, CH_2CCO_2), 2.05 (4 lines, allylic protons), 2.106 and 2.123 (2:5, 3 H, each s, $OCOCH_3$), 2.32 (t, J = 7.8, CH_2CO_2), 2.34 (t, J = 7.9, CH_2CO_2), 2.77 (3 lines, =$CHCH_2CH$=), 3.79 (6 H, m, $POCH_3$), 4.11–4.30 (m), 4.30–4.38 (m), 5.17–5.28 (3 H, m, CHOCO and C*H*OAc), 5.28–5.45 (m, olefinic protons).

2-Acetyl-1,3-bis[(1,2-dipalmitoyl-*sn*-glycero-3)-phosphoryl]glycerol Dimethyl Ester (6a). The procedure used to prepare **6c** was adapted. The dimethyl ester **4a** (18.3 mg, 0.013 mmol) was acetylated with acetyl chloride (1.6 mg, 0.020 mmol) in 0.5 mL of dry pyridine. The crude product (27.8 mg) was purified by column chromatography over silica gel (1.1 g). Elution with Et_2O gave **6a** (10.9 mg, 58%) as a waxy solid: ^1H NMR δ 0.88 (12 H, t, J = 7.0, terminal CH_3), 1.26 (96 H, br s, aliphatic protons), 1.61 (8 H, m, CH_2CCO_2), 2.107 and 2.124 (3:4, 3 H, each s, $OCOCH_3$), 2.32 (4 H, t, J = 7.8, CH_2CO_2), 2.34 (4 H, t, J = 7.8, CH_2CO_2), 3.79 (6 H, m, $POCH_3$), 4.11–4.28 (10 H, m), 4.28–4.38 (2 H, m), 5.17–5.30 (3 H, m, CHOCO and C*H*OAc).

Remethylation of 5a. By the same procedure as described for the preparation of **2a**, **5a** (10.0 mg, 0.007 mmol) was methylated. After workup, the crude product (10.4 mg) was purified by preparative TLC (95:5 Et_2O/MeOH), yielding **4a** (9.8 mg, 99%), which was identical with **4a** obtained above by comparison of their ^1H NMR spectra and TLC ($R_{f\text{-}1}$ 0.45).

Remethylation of 5c'. The compound **5c'** (10.0 mg, 6.7 μmol based on disodium salt) was remethylated as described in preparation of **2a**, affording a crude product (11.0 mg), which was purified by preparative TLC (95:5 Et_2O/MeOH) to give **4c** (8.4 mg, 85%), the ^1H NMR spectrum and TLC ($R_{f\text{-}1}$ 0.45) of which were identical with those of **4c** obtained above.

1,2-Dioleoyl-*sn*-glycerol-3-[phospho-*rac*-(1-glycerol)] Methyl Ester (2b). This compound was prepared in a manner similar to that employed for the synthesis of **2a**. L-α-Phosphatidyl-DL-glycerol (dioleoyl) (**1b**) (NH_4^+ salt, 22.0 mg, 0.028 mmol, Sigma Co.) was converted to its free acid, which was treated with an excess of ethereal diazomethane (from 0.538 g of Diazald). The crude product (23.2 mg) was chromatographed over silica gel (1.0 g) with $CHCl_3$ containing 1% MeOH as an eluent to yield **2b** (17.5 mg, 80%) as a colorless viscous oil: ^1H NMR δ 0.88 (6 H, t, J = 6.8, terminal CH_3), 1.27 and 1.30 (40 H, each br s, aliphatic protons), 1.61 (4 H, m, CH_2CCO_2), 2.01 (8 H, m, allylic CH_2), 2.32 (2 H, t, J = 8.0, CH_2CO_2), 2.34 (2 H, t, J = 7.8, CH_2CO_2), 3.62–3.75 (2 H, m), 3.79 and 3.81 (3 H, each d, J = 11.3 and 11.4, $POCH_3$), 3.89–3.98 (1 H, m), 4.10–4.28 (5 H, m), 4.33 (1 H, m, CH_AH_BOCO), 5.26 (1 H, m, CHOCO), 5.29–5.42 (4 H, m, olefinic protons).

1,3-Bis[(1,2-dioleoyl-*sn*-glycero-3)phosphoryl]glycerol Dimethyl Ester (4b). By the same procedure as described for preparation of **4a**, a mixture of **2b** (39.0 mg, 0.049 mmol), **3a** (16.1 mg, 0.025 mmol), TPS (22.5 mg, 0.074 mmol), and dry pyridine (1.0 mL) was stirred for 7.5 h at 25 °C, and then the crude products were treated with diluted acid followed by ethereal diazomethane. After workup, the residue (54.3 mg) was purified by column chromatography on silica gel (2.2 g). Elution with $CHCl_3$ containing 1% MeOH gave **4b** (15.7 mg, 44% based on **3a**) as a colorless oil: $R_{f\text{-}1}$ 0.45; ^{1} NMR δ 0.87 (12 H, t, J = 6.4, terminal CH_3), 1.25 and 1.30 (88 H, each br s, aliphatic protons), 1.61 (8 H, m, CH_2CCO_2), 2.01 (8 H, m, allylic CH_2), 2.31 (4 H, t, J = 7.5, CH_2CO_2), 2.34 (4 H, t, J = 7.9, CH_2CO_2), 3.80 (3 H, d, J = 11.5, $POCH_3$), 3.81 (3 H, d, J = 11.5, $POCH_3$), 4.00–4.28 (11 H, m), 4.34 (2 H, dd, J = 3.9 and 12.0, CH_AH_BOCO), 5.24 (2 H, m, CHOCO), 5.30–5.38 (4 H, m, olefinic protons).

1-(1,2-Dipalmitoyl-*sn*-glycero-3-phosphoryl)-3-(1,2-dioleoyl-*sn*-glycero-3-phosphoryl)glycerol Disodium Salt (5b). In a same manner as described for **5a**, **4b** (15.0 mg, 0.011 mmol) was treated with NaI (3.9 mg, 0.026 mmol) in dry methyl ethyl ketone (0.5 mL). The mixture was cooled to 0 °C, and the resulting powder was separated from the solvent by centrifugation under 0 °C. The precipitate was washed twice with cold methyl ethyl ketone (0.1 mL) to provide **5b** (11.5 mg, 76%) as a white powder: $R_{f\text{-}2}$ 0.29; $R_{f\text{-}3}$ 0.19 and 0.22; $R_{f\text{-}4}$ 0.79; ^1H NMR δ 0.88 (12 H, t, J = 6.6, terminal CH_3), 1.26 and 1.28 (88 H, each br s, aliphatic protons), 1.58 (8 H, m, CH_2CCO_2), 2.01 (8 H, m, allylic CH_2), 2.30 (8 H, m, CH_2CO_2), 3.82–4.05 (9 H, m), 4.12–4.24 (2 H, m), 4.35–4.47 (2 H, m), 5.23 (2 H, m, CHOCO), 5.28–5.39 (4 H, m, olefinic protons). Anal. Calcd for $C_{77}H_{144}O_{17}P_2Na_2 \cdot 3H_2O$: C, 61.49; H, 10.05. Found: C, 61.71; H, 10.05.

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