

**A Three Component Coupling Strategy for
Tetrahydrofuran Synthesis: Application of the
Diisopropyl Tartrate Modified (*E*)- γ -
(Dimethylphenylsilyl)-allylboronate as an α,γ -Allyl
Dianion Equivalent**

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SUPPORTING INFORMATION

Experimental details for the [3+2] annulations and tabulated spectroscopic data for tetrahydrofurans **12-21** (13 pages). This material is available free of charge via the Internet at <http://pubs.acs.org>. See any current masthead page for ordering information.

General Procedure for the $\text{BF}_3 \cdot \text{OEt}_2$ Catalyzed [3+2] Annulation Reactions:

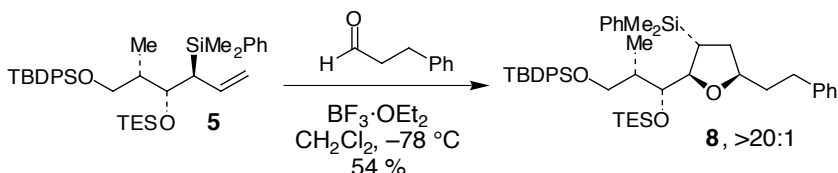
A solution of the allylsilane (0.49 mmol) and aldehyde (0.98 mmol) in 1 mL of anhydrous CH_2Cl_2 was cooled to -78°C . $\text{BF}_3 \cdot \text{OEt}_2$ (0.25 mmol) was then added dropwise via syringe. The mixture was stirred at -78°C for 15 hours after which time the reaction was quenched via the addition of Et_3N (0.5 mL) and subsequently warmed to room temperature. The mixture was diluted with ethyl acetate and washed with NaHCO_3 (satd.), and then brine. The organic phase was dried over Na_2SO_4 , filtered, and concentrated in vacuo. The crude product was purified by flash column chromatography.

General Procedure for the SnCl_4 Catalyzed [3+2] Annulation Reactions with α -(Benzyloxy)acetaldehyde:

A solution of the allylsilane (0.49 mmol) and aldehyde (0.98 mmol) in 1 mL of anhydrous CH_2Cl_2 was cooled to -55°C . SnCl_4 (0.25 mmol) was then added dropwise via syringe. The mixture was stirred at -55°C for 18 hours after which time the reaction was quenched via the addition of Et_3N (0.5 mL) and allowed to warm to room temperature. The mixture was diluted with ethyl acetate and hexanes, and washed with NaHCO_3 (satd.) and then brine. The organic phase was dried over Na_2SO_4 , then filtered, and concentrated in vacuo. The crude product was purified by flash column chromatography (hexanes/ethyl acetate).

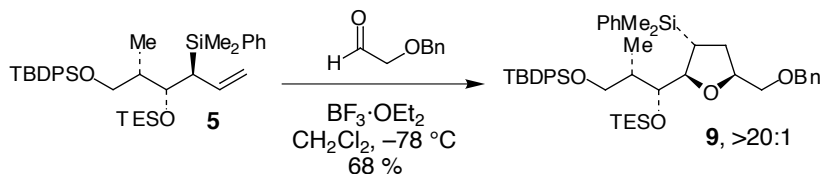
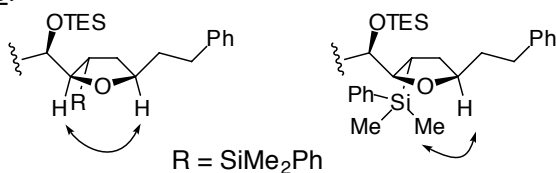
General Procedure for the SnCl_4 Catalyzed [3+2] Annulation Reactions with Ethyl Glyoxylate, Methyl Pyruvate, and 2,3-Butanedione:

A solution of the allylsilane (0.54 mmol) and carbonyl electrophile (1.08 mmol) in 1 mL of anhydrous CH_2Cl_2 was cooled to -78°C . SnCl_4 (0.25 mmol) was then added dropwise via syringe. The mixture was stirred at -78°C for 30 minutes after which time the reaction was quenched via the addition of Et_3N (0.4 mL) and subsequently warmed to room temperature. The mixture was diluted with ethyl acetate and hexanes, and washed with NaHCO_3 (satd.) and brine. The organic phase was then dried over Na_2SO_4 . The crude product was purified by flash column chromatography (hexanes/ethyl acetate).



(2R,3R,5S,1'R,2'S)-2-[1-(triethylsilanyloxy)-2-methyl-3-(*tert*-butyl-diphenyl-silanyloxy)-propyl]-3-(dimethylphenylsilyl)-5-ethyl-2-phenyl-tetrahydrofuran (8): $[\alpha]_D^{26.2} -13.6$ (c 1.4, CH_2Cl_2); ^1H NMR (500 MHz, CDCl_3) δ 7.67-7.08 (m, 20 H), 3.93 (dd, $J = 7.1, 4.4$ Hz, 1 H), 3.71 (dd, $J = 10.1, 6.7$ Hz, 1 H), 3.66-3.59 (m, 2 H), 3.49 (dd, $J = 10.1, 7.0$ Hz, 1 H), 2.66-2.60 (m, 1 H), 2.54-2.48 (m, 1 H), 1.86-1.76 (m, 3 H), 1.66-1.53 (m, 3 H), 1.06 (s, 9 H), 0.92 (t, $J = 7.9$ Hz, 9 H), 0.75 (d, $J = 6.8$ Hz, 3 H), 0.59-0.57 (m, 6 H), 0.31 (s, 3 H), 0.30 (s, 3 H); ^{13}C NMR (100 MHz, CDCl_3) δ 142.5, 137.8, 135.60, 135.59, 134.16, 134.13, 133.9, 129.45, 129.44, 129.1, 128.4, 128.2, 127.8, 127.54, 127.51, 125.5, 81.8, 78.7, 75.1, 66.3, 40.6, 37.4, 34.6, 32.8, 26.9, 26.5, 19.3, 12.3, 7.2, 5.4, -3.6, -4.1; IR (thin film) 3070, 2955, 2876, 1889, 1604, 1590, 1496, 1472, 1456, 1428, 1389, 1362, 1250, 1186, 1138, 1112, 1065, 1008, 952 cm^{-1} ; HRMS (FAB) calcd for $\text{C}_{46}\text{H}_{66}\text{O}_3\text{Si}_3\text{Na}$, 773.4218 m/z ($\text{M}+\text{Na}^+$); observed, 773.4253 m/z . *Anal.* Calcd for $\text{C}_{46}\text{H}_{66}\text{O}_3\text{Si}_3$; C, 73.54; H, 8.85. Found: C, 73.46; H, 8.78.

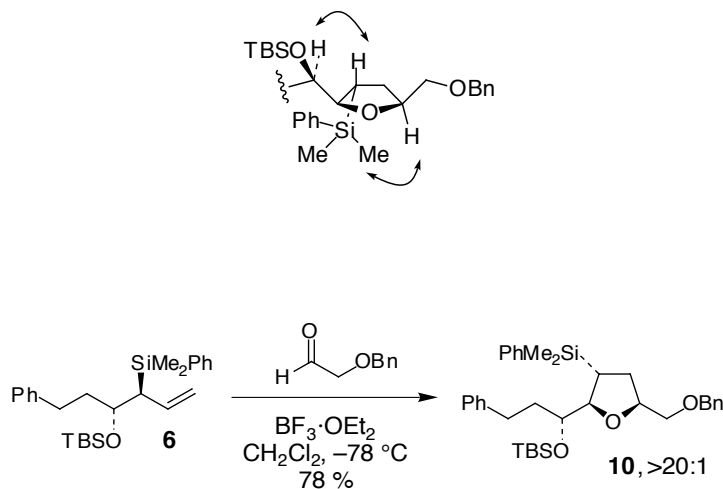
Observed nOe's for 8:



(2R,3R,5S,1'R,2'S)-2-[1-(triethylsilanyloxy)-2-methyl-3-(*tert*-butyldiphenyl-silanyloxy)propyl]-3-(dimethylphenylsilyl)-5-benzoyloxymethyl-tetrahydrofuran

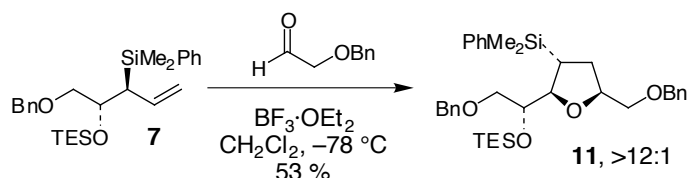
(9): $[\alpha]_D^{26.2}$ -21.1 (*c* 2.6, CH_2Cl_2); ^1H NMR (500 MHz, CDCl_3) δ 7.71-7.29 (m, 20 H), 4.53 (A of AB, J = 12.0 Hz, 1 H), 4.45 (B of AB, J = 12.0 Hz, 1 H), 4.04-3.94 (m, 2 H), 3.69 (dd, J = 10.1, 6.5 Hz, 1 H), 3.61 (dd, J = 3.7, 3.7 Hz, 1 H), 3.51 (dd, J = 10.0, 6.8 Hz, 1 H), 3.44-3.36 (m, 2 H), 1.88-1.82 (m, 3 H), 1.60-1.57 (m, 1 H), 1.10 (s, 9 H), 0.94 (t, J = 7.9 Hz, 9 H), 0.79 (d, J = 7.1 Hz, 3 H), 0.59 (q, J = 8.1 Hz, 6 H), 0.37 (s, 3 H), 0.36 (s, 3 H); ^{13}C NMR (100 MHz, CDCl_3) δ 138.5, 137.7, 135.63, 135.60, 134.2, 133.9, 129.5, 129.1, 128.2, 127.9, 127.6, 127.54, 127.51, 127.4, 82.7, 78.0, 74.9, 73.2, 73.1, 66.4, 40.6, 32.1, 26.9, 25.9, 19.3, 12.5, 7.1, 5.4, -3.7, -4.2; IR (thin film) 3070, 3050, 2956, 2933, 2875, 1956, 1886, 1820, 1590, 1496, 1488, 1472, 1455, 1428, 1390, 1362, 1307, 1251, 1189, 1139, 1112, 1008, 952, 921 cm^{-1} ; HRMS (FAB) calcd for $\text{C}_{44}\text{H}_{66}\text{O}_4\text{Si}_3\text{Na}$, 789.4167 m/z ($\text{M}+\text{Na}^+$); observed, 789.4180 m/z . *Anal.* Calcd for $\text{C}_{44}\text{H}_{66}\text{O}_4\text{Si}_3$; C, 72.01; H, 8.67. Found: C, 71.85; H, 8.57.

nOe data for 9:



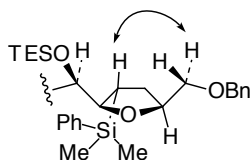
(2R,3R,5S,1'R)-2-[1-(*tert*-butyldimethylsilyloxy)-3-phenyl-propyl]-3-(dimethyl-phenylsilyl)-5-benzyloxymethyl-tetrahydrofuran (10). $[\alpha]_D^{27.4}$ -17.7 (*c* 2.0, CH_2Cl_2); ^1H NMR (500 MHz, CDCl_3) δ 7.48-7.17 (m, 15 H), 4.60 (A of AB, J = 12.2 Hz, 1 H), 4.52 (B of AB, J = 12.2 Hz, 1 H), 4.11-4.06 (m, 1 H), 4.03 (dd, J = 8.8, 2.0 Hz, 1 H), 3.51-3.48 (m, 1 H), 3.48-3.38 (m, 2 H), 2.72-2.60 (m, 2 H), 2.08-2.01 (m, 1 H), 1.90 (m, 2 H), 1.79-1.72 (m, 1 H), 1.71-1.66 (m, 1 H), 0.92 (s, 9 H), 0.35 (s, 3 H), 0.33 (s, 3 H), 0.01 (s, 3 H), -0.01 (s, 3H); ^{13}C NMR (125 MHz, CDCl_3) δ 142.2, 138.5, 137.7, 133.9, 129.1, 128.31, 128.29,

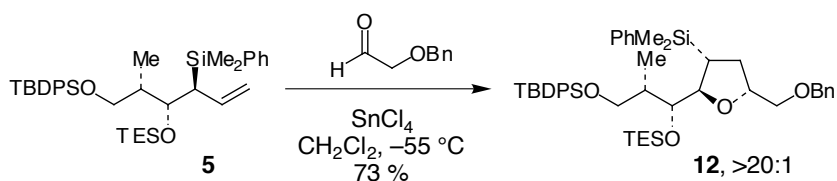
128.28, 127.8, 127.6, 127.4, 125.7, 83.3, 77.2, 73.2, 72.9, 72.8, 35.8, 32.1, 26.1, 24.5, 18.2, -3.8, -4.1, -4.4; IR (thin film) 3087, 3067, 3027, 2955, 2929, 2894, 2857, 1948, 1879, 1810, 1604, 1588, 1496, 1472, 1454, 1428, 1408, 1388, 1361, 1336, 1310, 1252, 1114, 1097, 1075, 1029, 1006, 981, 938, 921 cm^{-1} ; HRMS (FAB) calcd for $\text{C}_{35}\text{H}_{50}\text{O}_3\text{Si}_2\text{Na}$, 597.3196 m/z ($\text{M}+\text{Na}$)⁺; observed, 597.3195 m/z . *Anal.* Calcd for $\text{C}_{35}\text{H}_{50}\text{O}_3\text{Si}_2$; C, 73.12; H, 8.77. Found: C, 72.86; H, 8.72.



(2R,3R,5S,1'R)-2-[1-(triethylsilanyloxy)-2-benzyloxyethyl]-3-(dimethylphenylsilyl)-5-benzyloxymethyl-tetrahydrofuran (11). $[\alpha]_{\text{D}}^{27.0}$ -11.0 (*c* 2.9, CH_2Cl_2); ^1H NMR (400 MHz, CDCl_3) δ 7.52-7.50 (m, 2 H), 7.40-7.27 (m, 13 H), 4.59 (A of AB, J = 12.1 Hz, 1H), 4.49 (B of AB, J = 12.1 Hz, 1 H), 4.48 (ap. s, 2 H), 4.09-4.03 (m, 2 H), 3.66 (ddd, J = 6.7, 5.0, 1.7 Hz, 1 H), 3.60 (dd, J = 9.5, 5.1 Hz, 1 H), 3.47-3.34 (m, 3 H), 1.95-1.83 (m, 2 H), 1.77-1.67 (m, 1 H), 0.91 (t, J = 7.9 Hz, 9 H), 0.60-0.49 (m, 6 H), 0.36 (s, 3 H), 0.35 (s, 3 H); ^{13}C NMR (100 MHz, CDCl_3) δ 138.6, 138.5, 137.6, 133.9, 129.1, 128.3, 128.2, 127.8, 127.6, 127.5, 127.4, 127.3, 82.7, 77.4, 73.2, 73.09, 73.05, 72.7, 72.3, 32.0, 24.4, 7.0, 5.1, -3.9, -4.3; IR (thin film) 3068, 3030, 1950, 1879, 1808, 1588, 1496, 1454, 1428, 1412, 1366, 1309, 1250, 1204, 1098, 1011, 978 cm^{-1} ; HRMS (CI, NH_3) calcd for $\text{C}_{35}\text{H}_{51}\text{O}_4\text{Si}_2$ 591.3326 m/z ($\text{M} + \text{H}$)⁺; observed, 591.3316 m/z . *Anal.* Calcd for $\text{C}_{35}\text{H}_{50}\text{O}_4\text{Si}_2$; C, 71.14; H, 8.53. Found: C, 70.92; H, 8.55.

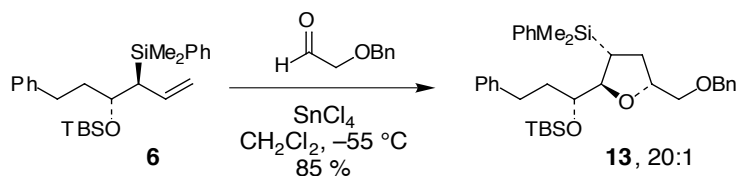
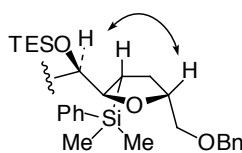
nOe data for 11:





(2R,3R,5R,1'R,2'S)-2-[1-(triethylsilanyloxy)-2-methyl-3-(*tert*-butyldiphenyl-silanyloxy)propyl]-3-(dimethylphenylsilyl)-5-benzyloxymethyl-tetrahydrofuran (12). $[\alpha]_{\text{D}}^{26.2} -9.3$ (*c* 2.2, CH_2Cl_2); ^1H NMR (500 MHz, C_6D_6) δ 7.79-7.76 (m, 4 H), 7.43-7.41 (m, 2 H), 7.27-7.13 (m, 13 H), 7.09-7.05 (m, 1 H), 4.39-4.34 (m, 2 H), 4.18 (dd, $J = 5.6, 5.6$ Hz, 1 H), 4.14-4.11 (m 1 H), 3.89 (dd, $J = 10.0, 7.1$ Hz, 1 H), 3.78 (dd, $J = 4.8, 2.3$ Hz, 1 H), 3.69 (dd, $J = 9.9, 6.7$ Hz, 1 H), 3.49-3.46 (m, 1 H), 3.38-3.35 (m, 1 H), 1.96-1.87 (m, 2 H), 1.59-1.51 (m, 2 H), 1.19 (s, 9 H), 1.03 (t, $J = 9.0, 7.7$ Hz, 9 H), 0.83 (d, $J = 6.8$ Hz, 3 H), 0.73-0.68 (m, 6 H), 0.25 (s, 3 H), 0.24 (s, 3 H); ^{13}C NMR (100 MHz, C_6D_6) δ 139.3, 138.1, 136.04, 136.03, 134.49, 134.45, 134.2, 129.9, 129.4, 128.5, 128.2, 128.0, 127.7, 127.5, 82.8, 78.1, 75.1, 74.3, 73.5, 72.9, 67.0, 40.0, 33.5, 27.3, 27.2, 19.5, 12.2, 7.5, 6.0, -4.06, -4.11; IR (thin film) 3070, 3050, 2956, 2933, 2910, 2875, 2859, 1956, 1887, 1821, 1590, 1496, 1488, 1472, 1455, 1428, 1414, 1390, 1362, 1331, 1305, 1251, 1137, 1112, 1029, 1008, 974, 945, 920 cm^{-1} ; HRMS (FAB) calcd for $\text{C}_{44}\text{H}_{66}\text{O}_4\text{Si}_3\text{Na}$, 789.4167 m/z ($\text{M}+\text{Na}^+$); observed, 789.4152 m/z . *Anal.* Calcd for $\text{C}_{44}\text{H}_{66}\text{O}_4\text{Si}_3$; C, 72.01; H, 8.67. Found: C, 71.89; H, 8.50.

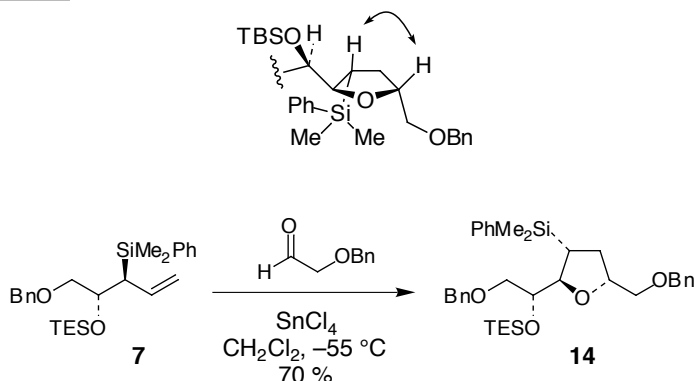
Observed nOe for 12:



(2R,3R,5R,1'R)-2-[1-(*tert*-butyldimethylsilanyloxy)-3-phenylpropyl]-3-(dimethylphenylsilyl)-5-benzyloxymethyl-tetrahydrofuran (13). $[\alpha]_{\text{D}}^{27.0} -8.6$ (*c* 4.1, CH_2Cl_2); ^1H NMR (500 MHz, CDCl_3) δ 7.51-7.16 (m, 15 H), 4.62 (A of AB, $J = 12.2$ Hz, 1 H),

4.58 (B of AB, $J = 12.2$ Hz, 1 H), 4.17-4.10 (m, 1 H), 4.06 (dd, $J = 8.7, 1.8$ Hz, 1 H), 3.54-3.37 (m, 1 H), 3.51-3.48 (m, 1 H), 3.46-3.40 (m, 1 H), 2.71-2.58 (m, 2 H), 2.10-2.03 (m, 2 H), 1.89-1.70 (m, 2 H), 1.58-1.52 (m, 1 H), 0.94 (s, 9 H), 0.35 (s, 3 H), 0.34 (s, 3 H), 0.06 (s, 3 H), 0.02 (s, 3 H); ^{13}C NMR (100 MHz, C_6D_6) δ 142.6, 139.3, 138.0, 134.2, 129.4, 128.67, 128.65, 128.5, 128.1, 127.7, 127.5, 126.0, 83.1, 78.9, 74.5, 73.4, 73.0, 36.6, 33.6, 32.6, 26.9, 26.3, 18.5, -3.9, -4.02, -4.04, -4.3; IR (thin film) 3087, 3067, 3027, 2955, 2928, 2887, 2857, 1949, 1879, 1810, 1604, 1589, 1496, 1472, 1454, 1428, 1408, 1388, 1361, 1305, 1252, 1115, 1073, 1029, 1006, 977, 939, 924, 909 cm^{-1} ; HRMS (CI, NH_3) calcd for $\text{C}_{35}\text{H}_{54}\text{NO}_3\text{Si}_2$, 592.3642 m/z ($\text{M} + \text{NH}_4$) $^+$; observed, 592.3626 m/z . *Anal.* Calcd for $\text{C}_{35}\text{H}_{50}\text{O}_3\text{Si}_2$; C, 73.12; H, 8.77. Found: C, 73.40; H, 8.77.

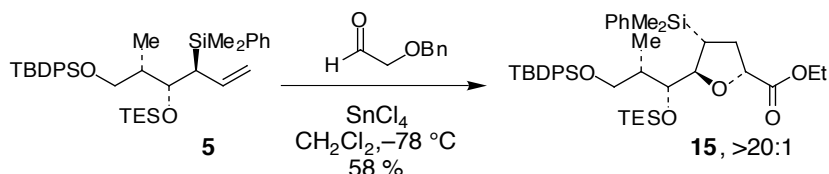
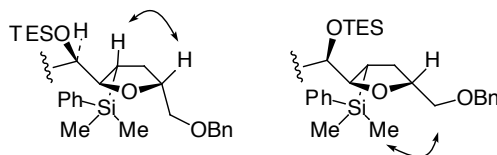
nOe observed for **13**:



(2R,3R,5R,1'R)-2-[1-(triethylsilyloxy)-2-benzyloxyethyl]-3-(dimethylphenylsilyl)-5-benzyloxymethyl-tetrahydrofuran (14**).** $[\alpha]_{\text{D}}^{27.0}$ -4.5 (c 3.3, CH_2Cl_2); ^1H NMR (500 MHz, CDCl_3) δ 7.6-7.5 (m, 2 H), 7.41-7.30 (m, 13 H), 4.60 (A of AB, $J = 12.0$ Hz, 1 H), 4.57 (B of AB, $J = 12.0$ Hz, 1 H), 4.54-4.49 (m, 2 H), 4.16-4.11 (m, 2 H), 3.66-3.33 (m, 2 H), 3.56-3.46 (m, 3 H), 2.09 (ddd, $J = 12.3, 7.8, 5.1$ Hz, 1 H), 1.83 (ddd, $J = 12.3, 8.4, 8.4$ Hz, 1 H), 1.58-1.51 (m, 1 H), 0.96 (t, $J = 7.9$ Hz, 9 H), 0.65-0.56 (m, 6 H), 0.383 (s, 3 H), 0.377 (s, 3 H); ^{13}C NMR (100 MHz, CDCl_3) δ 138.6, 137.7, 133.8, 129.1, 128.21, 128.15, 127.8, 127.6, 127.44, 127.37, 127.29, 81.8, 78.9, 73.6, 73.2, 73.1, 73.0, 72.6, 33.1, 26.3, 6.9, 5.2, -4.0, -4.5; IR (thin film) 3089, 3068, 3030, 2955, 2910, 2875, 2733, 1950, 1879, 1811, 1605, 1588, 1496, 1454, 1428, 1413, 1364, 1305, 1250, 1205, 1099, 1028, 1009, 965, 921 cm^{-1} ; HRMS (CI, NH_3)

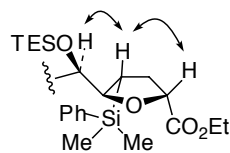
calcd for $C_{35}H_{54}NO_4Si_2$, 608.3591 m/z ($M + NH_4$)⁺; observed, 608.3596 m/z . *Anal.* Calcd for $C_{35}H_{50}O_4Si_2$; C, 71.14; H, 8.53. Found: C, 71.35; H, 8.60.

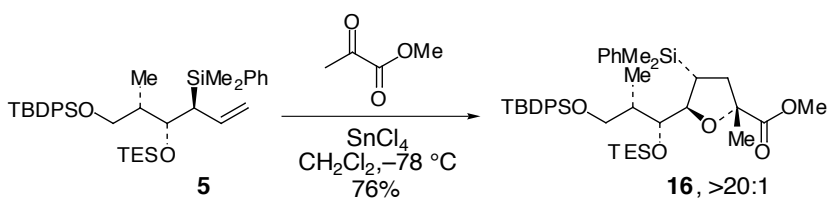
nOe's observed for **14**:



(1R,4'R,5'R,1''R,2''S)-1-[5-[1-(triethylsilyloxy)-2-methyl-3-(*tert*-butyl-diphenylsilyloxy)propyl]-4-(dimethylphenylsilyl)-tetrahydrofuran-2-yl]-formic acid ethyl ester (15**).** $[\alpha]_D^{26.2}$ -4.1 (c 1.9, CH_2Cl_2); 1H NMR (500 MHz, C_6D_6) δ 7.79-7.76 (m, 4 H), 7.40-7.38 (m, 2 H), 7.25-7.14 (m, 9 H), 4.42 (dd, J = 8.5, 6.8 Hz, 1 H), 4.33 (dd, J = 8.3, 3.9 Hz, 1 H), 3.92-3.86 (m, 3 H), 3.79-3.73 (m, 2 H), 2.25-2.19 (m, 1 H), 2.01-1.94 (m, 2 H), 1.63-1.57 (m, 1 H), 1.18 (s, 9 H), 0.99 (t, J = 7.9 Hz, 9 H), 0.93 (d, J = 6.8 Hz, 3 H), 0.88 (t, J = 7.1 Hz, 3 H), 0.68-0.61 (m, 6 H), 0.25 (s, 3 H), 0.23 (m, 3 H); ^{13}C NMR (100 MHz, C_6D_6) δ 137.7, 136.04, 136.03, 136.01, 134.43, 134.42, 134.1, 129.9, 129.5, 128.19, 127.98, 83.9, 77.2, 74.9, 66.8, 60.4, 40.6, 34.5, 27.3, 27.2, 19.5, 14.1, 12.9, 7.4, 5.9, -4.0, -4.3; IR (thin film) 3136, 3071, 3050, 2957, 2933, 2910, 2876, 1957, 1888, 1821, 1755, 1734, 1590, 1487, 1472, 1463, 1428, 1414, 1390, 1376, 1252, 1197, 1140, 1112, 1008, 976, 938, 920 cm^{-1} ; HRMS (FAB) calcd for $C_{41}H_{62}O_5Si_3Na$, 741.3803 m/z ($M+Na$)⁺; observed, 741.3796 m/z . *Anal.* Calcd for $C_{41}H_{62}O_5Si_3$; C, 68.47; H, 8.69. Found: C, 68.61; H, 8.44.

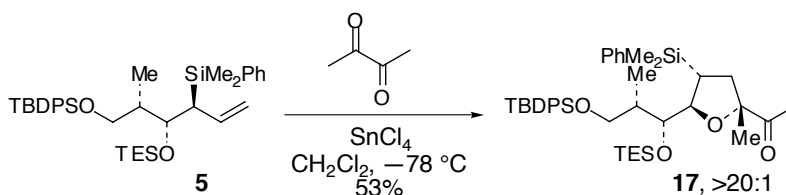
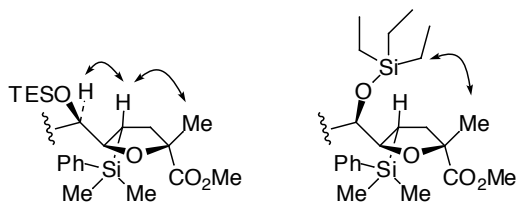
nOe's observed for **15**:





(1R,4'R,5'R,1''R,2''S)-1-[5-[1-(triethylsilanyloxy)-2-methyl-3-(*tert*-butyl-diphenylsilanyloxy)propyl]-4-(dimethylphenylsilyl)-2-methyltetrahydrofuran-2-yl]-formic acid methyl ester (16). $[\alpha]_D^{26.2} -16.0$ (c 1.7, CH_2Cl_2); ^1H NMR (500 MHz, CDCl_3) δ 7.69-7.67 (m, 4 H), 7.48-7.34 (m, 11 H), 4.10 (dd, $J = 10.3, 2.2$ Hz, 1 H), 3.74 (dd, $J = 10.3, 5.1$ Hz, 1 H), 3.63-3.61 (m, 1 H), 3.60 (s, 3 H), 3.55 (dd, $J = 10.3, 7.8$ Hz, 1 H), 2.15 (dd, $J = 12.7, 10.7$ Hz, 1 H), 1.96 (m, 1 H), 1.86 (dd, $J = 12.8, 9.6$ Hz, 1 H), 1.71 (m, 1 H), 1.26 (s, 3 H), 1.09 (s, 9 H), 0.95 (m, 12 H), 0.58 (q, $J = 7.9$ Hz, 6 H), 0.34 (s, 3 H), 0.32 (s, 3 H); ^{13}C NMR (100 MHz, CDCl_3) δ 137.7, 135.6, 134.2, 134.1, 133.9, 129.41, 129.39, 129.1, 127.8, 127.50, 127.48, 84.6, 82.4, 73.9, 66.2, 51.8, 40.7, 40.3, 26.9, 26.1, 24.8, 19.3, 13.7, 7.1, 5.4, -3.3, -4.5; IR (thin film) 3071, 3050, 2956, 2877, 1957, 1894, 1820, 1738, 1590, 1488, 1472, 1462, 1428, 1391, 1372, 1252, 1189, 1143, 1113, 1063, 1008, 938 cm^{-1} ; HRMS (FAB) calcd for $\text{C}_{41}\text{H}_{62}\text{O}_5\text{Si}_3\text{Na}$, 741.3803 m/z ($\text{M}+\text{Na}^+$); observed, 741.3778 m/z . *Anal.* Calcd for $\text{C}_{41}\text{H}_{62}\text{O}_5\text{Si}_3$; C, 68.47; H, 8.69. Found: C, 68.71; H, 8.44.

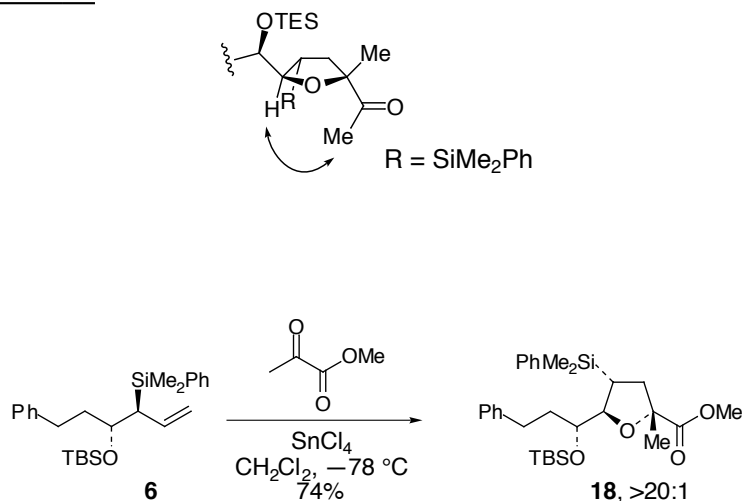
Observed nOe's for 16:



(1R,4'R,5'R,1''R,2''S)-1-[5-[1-(triethylsilanyloxy)-2-methyl-3-(*tert*-butyl-diphenyl-silanyloxy)-propyl]-4-(dimethylphenylsilyl)-2-methyltetrahydrofuran-2-

yl]-methyl ketone (17). $[\alpha]_{435}^{26.2} +12.8$ (*c* 1.7, CH₂Cl₂); ¹H NMR (500 MHz, CDCl₃) δ 7.70-7.68 (m, 4 H), 7.48-7.36 (m, 11 H), 4.02 (d, *J* = 8.5 Hz, 1 H), 3.83 (dd, *J* = 10.0, 4.6 Hz, 1 H), 3.54-3.51 (m, 2 H), 2.04-1.94 (m, 1 H), 2.0-1.9 (m, 4 H), 1.82-1.75 (m, 2 H), 1.14 (s, 3 H), 1.10 (s, 9 H), 0.96-0.94 (m, 12 H), 0.58 (q, *J* = 7.9 Hz, 6 H), 0.34 (m, 6 H); ¹³C NMR (100 MHz, CDCl₃) δ 137.1, 135.6, 134.12, 134.10, 133.9, 129.44, 129.42, 129.3, 127.9, 127.49, 127.47, 87.8, 83.4, 74.2, 66.1, 41.7, 38.4, 26.9, 26.3, 24.7, 23.7, 19.30, 19.29, 14.1, 7.1, 5.4, -3.9, -4.1; IR (thin film) 3071, 3050, 2957, 2877, 1957, 1888, 1821, 1716, 1590, 1488, 1472, 1462, 1428, 1415, 1390, 1362, 1352, 1306, 1252, 1187, 1142, 1112, 1061, 1008, 957, 939 cm⁻¹; HRMS (FAB) calcd for C₄₁H₆₂O₄Si₃Na, 725.3854 *m/z* (M+Na)⁺; observed, 725.3873 *m/z*. *Anal.* Calcd for C₄₁H₆₂O₄Si₃; C, 70.03; H, 8.89. Found: C, 69.95; H, 8.77

nOe observed for 17:

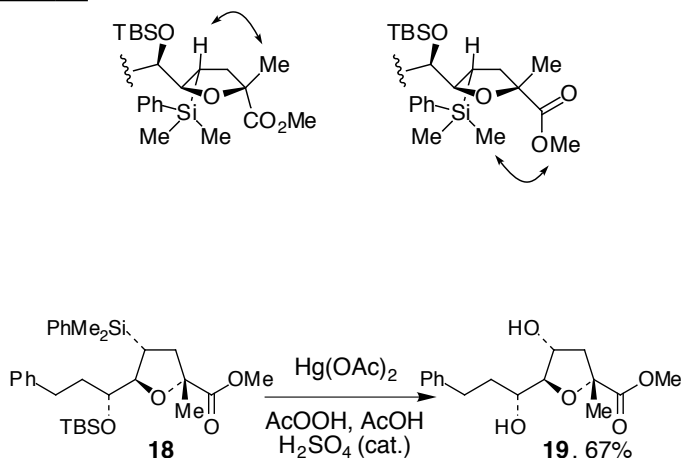


(1R,4'R,5'R,1''R)-1-[5-[1-(*tert*-butyldimethylsilanyloxy)-3-phenylpropyl]-4-(dimethylphenylsilyl)-2-methyltetrahydrofuran-2-yl]-formic acid methyl ester

(18). $[\alpha]_{\text{D}}^{27.4} -12.4$ (*c* 2.0, CH₂Cl₂); ¹H NMR (500 MHz, CDCl₃) δ 7.45-7.21 (m, 10 H), 4.15 (d, *J* = 10.7 Hz, 1 H), 3.72 (s, 3 H), 3.61 (t, *J* = 6.7 Hz, 1 H), 2.72-2.69 (m, 2 H), 2.18 (app. t, *J* = 12.2 Hz, 1 H), 2.12-2.05 (m, 1 H), 1.94 (dd, *J* = 12.6, 8.7, 1 H), 1.89-1.80 (m, 2 H), 1.43 (s, 3 H), 0.94 (s, 9 H), 0.34 (s, 3 H), 0.33 (s, 3 H), 0.05 (s, 3 H), 0.02 (s, 3 H); ¹³C NMR (125 MHz, CDCl₃) δ 176.2, 142.2, 137.5, 133.8, 129.1, 128.32, 128.30, 127.8, 125.7, 84.9, 81.9, 71.7, 52.0, 40.6, 35.7, 32.2, 26.0, 25.9, 25.5, 25.0, 18.2, -3.5, -4.18, -4.19, -4.8; IR (thin film) 3086,

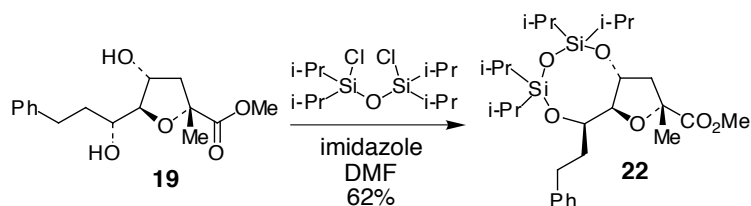
3069, 3026, 2954, 2930, 2894, 2857, 2738, 2708, 1953, 1881, 1738, 1604, 1590, 1496, 1472, 1456, 1428, 1408, 1389, 1370, 1253, 1190, 1164, 1119, 1076, 1051, 998, 939 cm^{-1} ; HRMS (FAB) calcd for $\text{C}_{30}\text{H}_{46}\text{O}_4\text{Si}_2\text{Na}$, 549.2832 m/z ($\text{M}+\text{Na}^+$); observed, 549.2813 m/z .

nOe's observed for **18**:



(1R,4'R,5'S,1''R)-1-[5-[1-hydroxy-3-phenylpropyl]-4-hydroxy-2-methyl-tetrahydrofuran-2-yl]-formic acid methyl ester (19**).** $[\alpha]_{\text{D}}^{25.4} -13.2$ (c 2.1, CHCl_3); ^1H NMR (500 MHz, CDCl_3) δ 7.29-7.26 (m, 2 H), 7.22-7.17 (m, 3 H), 4.24-4.23 (m, 1 H), 3.93 (dd, $J = 4.5, 3.1$ Hz, 1 H), 3.76 (s, 3 H), 3.55 (dd, $J = 11.2, 6.1$ Hz, 1 H), 2.90-2.84 (m, 1 H), 2.76-2.6 (m, 2 H), 2.37 (dd, $J = 13.9, 1.7$ Hz, 1 H), 2.10-1.98 (m, 2 H), 1.88-1.84 (m, 2 H), 1.51 (s, 3 H); ^{13}C NMR (100 MHz, CDCl_3) δ 175.8, 141.7, 128.5, 128.4, 125.8, 90.7, 83.8, 74.3, 71.1, 52.6, 46.0, 35.5, 31.8, 24.4; IR (thin film) 3444, 3085, 3062, 3026, 2981, 2951, 2862, 1951, 1734, 1603, 1496, 1455, 1373, 1300, 1206, 1178, 1130, 1068, 1042, 988 cm^{-1} ; HRMS (CI, NH_3) calcd for $\text{C}_{16}\text{H}_{26}\text{NO}_5$, 312.1811 m/z ($\text{M} + \text{NH}_4^+$); observed, 312.1801.

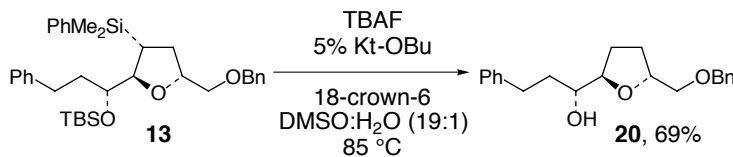
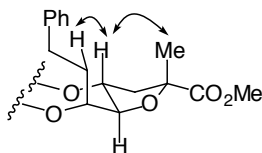
The stereochemistry of **19** was confirmed by conversion to the disiloxane derivative **22**.



To a solution of the diol **19** (45 mg, 0.15 mmol) in 1 ml of anhydrous DMF was added imidazole (90 mg, 0.67 mmol). To this stirring solution was added 1,3-dichloro-1,1,3,3-

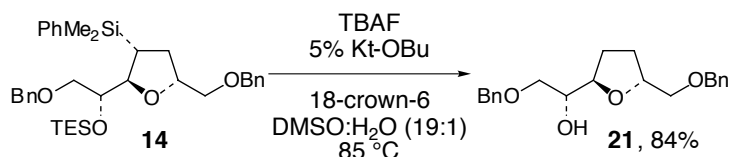
tetraisopropyldisiloxane (53 μ L, 0.17 mmol). The solution was stirred at ambient temperature for 41 h, after which time the solution was diluted with ethyl acetate, and washed with NaHCO_3 (sat.) followed by brine. The organic layer was dried over Na_2SO_4 and concentrated via rotary evaporator, providing an oil which was purified by flash column chromatography (40 g of silica eluted with 20 : 1 hexanes-ethyl acetate). The purified product 51 mg (62%) was isolated as a colorless oil: ^1H NMR (500 MHz, CDCl_3) δ 7.28–7.25 (m, 2H), 7.21–7.15 (m, 3H), 4.48 (ddd, J = 6.7, 3.5, 3.4 Hz, 1 H), 4.17 (dd, J = 4.2, 4.2 Hz, 1 H), 4.07 (ddd, J = 8.9, 4.8, 4.2 Hz, 1 H), 3.73 (s, 3 H), 2.89–2.83 (m, 1 H), 2.72–2.66 (m, 1 H), 2.52 (dd, J = 13.2, 7.1 Hz, 1 H), 1.59–1.49 (m, 1 H), 1.48 (s, 3 H), 1.10–0.93 (m, 28 H); ^{13}C NMR (100 MHz, CDCl_3) δ 175.2, 142.1, 128.5, 128.3, 125.7, 88.9, 83.0, 71.0, 70.0, 52.2, 45.7, 33.0, 31.9, 24.8, 17.5, 17.4, 17.1, 16.9, 16.8, 13.7, 13.6, 13.1, 12.3; IR (thin film) 3027, 2946, 2896, 2868, 1756, 1740, 1604, 1497, 1464, 1386, 1290, 1250, 1203, 1136, 1112, 1056, 1034 cm^{-1} ; HRMS (CI, NH_3) calcd for $\text{C}_{28}\text{H}_{49}\text{O}_6\text{Si}_2$, 537.3067 m/z ($\text{M} + \text{H}$) $^+$; observed, 537.3047 m/z .

Observed nOe's for **22**:



(2R,5R,1'R)-2-[1-hydroxy-3-phenylpropyl]-5-benzyloxymethyl-tetrahydrofuran (20**).** $[\alpha]_{\text{D}}^{27.0} +18.2$ (c 1.3, CH_2Cl_2); ^1H NMR (500 MHz, CDCl_3) δ 7.35–7.17 (m, 10 H), 4.61 (A of AB, J = 12.2 Hz, 1 H), 4.57 (B of AB, J = 12.2 Hz, 1 H), 4.19–4.15 (m, 1 H), 3.87 (dd, J = 14.2, 6.6 Hz, 1 H), 3.48 (d, J = 5.1 Hz, 2 H), 3.45–3.41 (m, 1 H), 2.93–2.87 (m, 1 H), 2.74–2.68 (m, 1 H), 2.49 (d, J = 4.2 Hz, 1 H), 2.03–1.92 (m, 2 H), 1.81–1.58 (m, 4 H); ^{13}C NMR

(100 MHz, CDCl₃) δ 142.2, 138.3, 128.5, 128.35, 128.31, 127.63, 127.57, 125.7, 82.7, 78.3, 73.4, 73.2, 72.8, 35.3, 31.9, 28.9, 28.1; IR (thin film) 3460, 3086, 3062, 3027, 2919, 2863, 1950, 1874, 1808, 1603, 1496, 1454, 1403, 1367, 1308, 1260, 1204, 1178, 1076, 1029, 929 cm⁻¹; HRMS (CI, NH₃) calcd for C₂₁H₃₀NO₃, 344.2226 *m/z* (M + NH₄)⁺; observed, 344.2222 *m/z*.



(2R,5R,1'R)-2-[1-hydroxy-2-benzyloxyethyl]-5-benzyloxymethyl-tetrahydrofuran (21). $[\alpha]_{\text{D}}^{27.0}$ -4.1 (*c* 1.4, CH₂Cl₂); ¹H NMR (500 MHz, CDCl₃) δ 7.36-7.28 (m, 10 H), 4.61-4.55 (m, 4 H), 4.24-4.19 (m, 1 H), 4.06-4.03 (m, 1 H), 3.70 (s (br), 1 H), 3.55-3.54 (m, 2 H), 3.49-3.48 (m, 2 H), 2.57 (s(br), 1 H), 2.07-1.93 (m, 2 H), 1.84-1.67 (m, 2 H); ¹³C NMR (100 MHz, CDCl₃) δ 138.3, 138.1, 128.35, 128.31, 127.67, 127.62, 127.60, 127.52, 79.6, 78.5, 73.5, 73.3, 72.74, 72.71, 71.9, 28.8, 27.9; IR (thin film) 3453, 3088, 3063, 3030, 2915, 2863, 1954, 1875, 1815, 1496, 1454, 1365, 1310, 1255, 1206, 1077, 1028, 910 cm⁻¹; HRMS (CI, NH₃) calcd for C₂₁H₃₀NO₄, 360.2175 *m/z* (M + NH₄)⁺; observed 360.2157 *m/z*.