Supporting Information

Symbiotic Reagent Activation: Oppenauer Oxidation of Magnesium Alkoxides by Silylglyoxylate Triggers Second-Stage Aldolization

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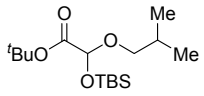
General Information. Infrared (IR) spectra were obtained using a Nicolet 560-E.S.P. infrared spectrometer. Proton and carbon nuclear magnetic resonance spectra (^{1}H and ^{13}C NMR) were recorded on the following instruments: Bruker model Avance 400 (^{1}H NMR at 400 MHz and ^{13}C NMR at 100 MHz) and Varian Gemini 300 (^{1}H NMR at 300 MHz and ^{13}C at 75 MHz) spectrometers with solvent resonance as the internal standard (^{1}H NMR: $CDCl_3$ at 7.24 ppm and ^{13}C NMR: $CDCl_3$ at 77.0 ppm). ^{1}H NMR data are reported as follows: chemical shift, multiplicity (s = singlet, d = doublet, t = triplet, q = quartet, quint = quintet, sep = septet, m = multiplet), coupling constants (Hz), and integration. Combustion analyses were performed by Atlantic Microlab Inc., Norcross, GA. Analytical thin layer chromatography (TLC) was performed on Whatman 0.25 mm silica gel 60 plates. Visualization was accomplished with UV light and aqueous ceric ammonium nitrate molybdate solution followed by heating. Purification of the reaction products was carried out by flash chromatography using Sorbent Technologies silica gel 60 (32-63 μm). All alcohols for general procedure **(A)** were distilled from magnesium prior to use. All alcohols for general procedure **(C)** were distilled from sodium prior to use. Aldehydes were extracted from an aq. sat. $NaHCO_3$ solution with ether, concentrated, and distilled. THF was distilled from sodium and benzophenone. Analytical chromatography was performed on a Berger Supercritical Fluid Chromatograph (SFC) model FCM 1100/1200 equipped with an Agilent 1100 series UV-Vis detector. Silylglyoxylate **1** was prepared according to the literature procedure.[1] Yields and diastereomer ratios are reported for a specific experiment and as a result may differ slightly from those found in the tables, which are averages of at least two experiments.

Representative Procedure (A) for the optimization of reaction conditions (Table 1). A dry round-bottomed flask with a magnetic stir bar was charged with alcohol (1.5 equiv) and 2 mL of solvent. To the resulting solution, ethylmagnesium bromide (1.0 M in THF) (2.0 equiv) was added *via* syringe at 0 °C under an argon atmosphere. The reaction temperature was allowed to warm to 25 °C for 5 min. To the reaction solution was added dropwise *via* cannula the silylglyoxylate (1.0 equiv., ca. 0.4 mmol) in 2 mL of solvent. The reaction was stirred for 10 min before 5 mL of a saturated NH_4Cl solution and 15 mL of Et_2O were added. The organic layer was separated and the aqueous layer

was extracted with two 10 mL portions of Et_2O. The organic extracts were combined, dried (Na_2SO_4), and the solvent was removed with a rotary evaporator. To the crude product was added a known quantity of 1,3,5-trimethoxybenzene as the internal standard, and the yield and the diastereomer ratio of the reaction were determined by ^{1}H NMR spectroscopy.



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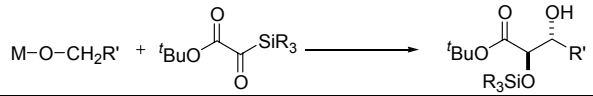
***tert*-Butyl-2-*tert*-butyldimethylsilyloxy-2-isobutoxyacetate (11).** Analytical data for title compound: **IR** (thin film, cm^{-1}) 2957, 2930, 2858, 1755, 1472, 1367, 1254, 1130, 1072, 839, 782; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 4.94 (s, 1H), 3.32 (ABX, J_{AB} = 8.8 Hz, J_{AX} = 6.8 Hz, 2H), 1.87 (sep, J = 6.8 Hz, 1H), 1.48 (s, 9H), 0.92 (s, 9H), 0.91 (d, 6H, one peak overlapped with 0.92 peak), 0.135 (s, 3H), 0.131 (s, 3H); **^{13}C NMR** (75 MHz, $CDCl_3$) 168.0, 93.9, 81.6, 73.2, 28.4, 27.9, 25.63, 25.56, 19.3, 18.2, 17.5, -4.6, -4.8; For ^{1}H NMR spectrum, see the Appendix.

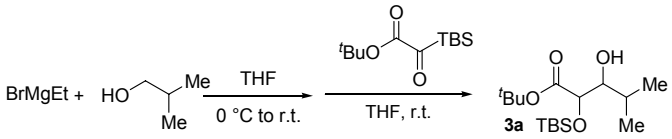
Table S1. Evaluation of Reaction Variables



entry	^{i}BuO–M	^{t}BuO$_2$CC(O)SiR$_3$	solvent	yield[a]	*d.r.*[b]
1	Me_2AlCl (1 equiv)/ ^{i}BuOH (1 equiv)	^{t}BuO$_2$CC(O)TBS	THF	0%	n.a.
2	Me_2AlCl (0.5 equiv)/ ^{i}BuOH (1 equiv)	^{t}BuO$_2$CC(O)TBS	THF	42%	5:1
3	^{i}BuO–MgCl	^{t}BuO$_2$CC(O)TBS	THF	≈70%	4.8:1
4	^{i}BuO–MgI	^{t}BuO$_2$CC(O)TBS	THF	<20%	1:1
5	(^{i}PrO)$_4$Ti	^{t}BuO$_2$CC(O)TBS	THF	<10%	n.d.
6	^{i}BuO–MgBr	^{t}BuO$_2$CC(O)TES	THF	30%	4.4:1
7	^{i}BuO–MgBr	^{t}BuO$_2$CC(O)TIPS	THF	35%	3.7:1
8	^{i}BuO–MgBr	^{t}BuO$_2$CC(O)TBS	Dioxane	26%	2.0:1
9	^{i}BuO–MgBr	^{t}BuO$_2$CC(O)TBS	CH_2Cl_2	24%	8.0:1
10	^{i}BuO–MgBr	^{t}BuO$_2$CC(O)TBS	Et_2O	36%	6.0:1
11	^{i}BuO–MgBr	^{t}BuO$_2$CC(O)TBS	Toluene	34%	7.0:1
12	^{i}BuO–MgBr	^{t}BuO$_2$CC(O)TBS	MTBE/THF (1:2)	76%	7.6:1
13	^{i}BuO–MgBr	^{t}BuO$_2$CC(O)TBS	MTBE	83%	5.6:1
14	^{i}BuO–MgBr	^{t}BuO$_2$CC(O)TBS	2-MeTHF	n.r.	n.a.
15	^{i}BuO–MgBr	^{t}BuO$_2$CC(O)TBS	2-MeTHF/THF (1:2)	56%	7.4:1
16	^{i}BuO–MgBr	^{t}BuO$_2$CC(O)TBS	Dioxane/THF (1:2)	31%	2.8:1
17	^{i}BuO–MgBr	^{t}BuO$_2$CC(O)TBS	THF/Et_2O (2:1)	69%	9.1:1
18	^{i}BuO–MgBr	^{t}BuO$_2$CC(O)TBS	THF/toluene (2:1)	57%	10:1
19	^{i}BuO–MgBr	^{t}BuO$_2$CC(O)TBS	THF/CH_2Cl_2 (2:1)	>95%	10.6:1

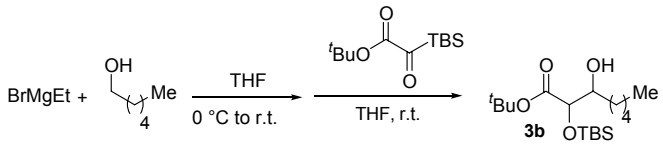
[a] ^{1}H NMR yield versus an internal standard. [b] Determined by ^{1}H NMR spectroscopy.

General procedure (B) for tandem Oppenauer oxidation/Brook rearrangement/aldolization (Table 2). A dry round bottomed flask with a magnetic stir bar was charged with alcohol (1.5 equiv), and 1-2 mL of solvent. To the resulting solution, ethylmagnesium bromide (1.0 M in THF) (1.75-2.0 equiv) was added *via* syringe at 0 °C under an argon atmosphere. The reaction temperature was allowed to warm to 25 °C for 5 min. To the reaction solution was added dropwise *via* cannula the silylglyoxylate (1.0 equiv, ca. 0.4 mmol) in 1-2 mL of solvent. The reaction was stirred at the same temperature for 10 min before 5 mL of a saturated NH_4Cl solution and 15 mL of Et_2O or CH_2Cl_2 were added. The organic layer was separated and the aqueous layer was extracted with two 10 mL portions of Et_2O or CH_2Cl_2. The organic extracts were combined and dried (Na_2SO_4). Concentration of the organic phase by rotary evaporation afforded the crude product which was purified by flash chromatography using the specified solvent system.

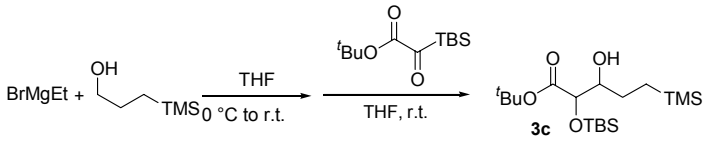


***tert*-Butyl-2-*tert*-butyldimethylsilyloxy-3-hydroxy-4-methylbutanoate (3a).** The title compound was prepared according to General Procedure **B** using 100 mg (0.41 mmol) of *tert*-butyl *tert*-butyldimethylsilylglyoxylate in 1:1 (v/v) THF/CH_2Cl_2 (1 mL), 46 mg (0.60 mmol) of isobutanol in 1:1 (v/v) THF/CH_2Cl_2 (1 mL), and 0.7 mL (0.7 mmol) of EtMgBr (1 M in THF). The crude product was extracted with CH_2Cl_2 and purified by flash chromatography with 15:1 hexanes/EtOAc to afford 123 mg (95%) of the product as a clear oil (10:1 ratio of two diastereomers). Analytical data for title compound: **IR** (thin film, cm^{-1}) 3502 (br), 2962, 2936, 2859, 1750, 1473, 1392, 1368, 1289, 1253, 1144, 1005, 940, 877, 840, 778; **^{1}H NMR** (300 MHz, $CDCl_3$) (major diastereomer) δ 4.11 (d, *J* = 5.1 Hz, 1H), 3.46 (dd, *J* = 6.0, 5.1 Hz, 1H), 2.37 (br s, 1H), 1.81 (sep, *J* = 6.6 Hz, 1H), 1.46 (s, 9H), 0.96 (d, *J* = 6.9 Hz, 3H), 0.94 (d, *J* = 6.9 Hz, 3H), 0.89 (s, 9H), 0.082 (s, 3H), 0.051 (s, 3H); **^{13}C NMR** (75 MHz, $CDCl_3$) (major diastereomer) δ 171.0, 81.6, 78.7, 74.1, 29.5, 28.0, 25.7, 19.6, 18.2, 17.5, -4.7, -5.4; TLC (10:1 hexanes/EtOAc) R_f of major

diastereomer 0.25, R_f of minor diastereomer 0.30; **Anal.** Calcd. for $C_{16}H_{34}O_4Si$: C, 60.33; H, 10.76. Found: C, 60.31; H, 10.78.

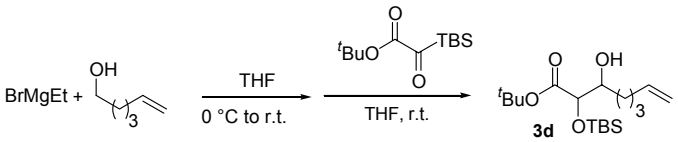


***tert*-Butyl-2-*tert*-butyldimethylsilyloxy-3-hydroxyoctanoate (3b).** The title compound was prepared according to General Procedure **B** using 100 mg (0.41 mmol) of *tert*-butyl *tert*-butyldimethylsilylglyoxylate in 1:1 (v/v) THF/CH_2Cl_2 (1 mL), 63 mg (0.61 mmol) of hexanol in 1:1 (v/v) THF/CH_2Cl_2 (1 mL), and 0.7 mL (0.7 mmol) of EtMgBr (1 M in THF). The crude product was extracted with CH_2Cl_2 and purified by flash chromatography with 17:1 hexanes/EtOAc to afford 126 mg (89%) of the product as a clear oil (7.5:1 ratio of two diastereomers). Analytical data for title compound: **IR** (thin film, cm^{-1}) 3476 (br), 2955, 2930, 2858, 1750, 1472, 1368, 1254, 1145, 874, 838, 780; **^{1}H NMR** (400 MHz, $CDCl_3$) (major diastereomer) δ 4.03 (d, J = 4.4 Hz, 1H), 3.74 (br m, 1H), 2.25 (br s, 1H), 1.46 (s, 9H), 1.48-1.40 (underneath the peak of 1.46, 2H) 1.36-1.33 (m, 6H), 0.89 (s, 9H), 0.87 (t, J = 6.8 Hz, 3H), 0.085 (s, 3H), 0.048 (s, 3H); **^{13}C NMR** (100 MHz, $CDCl_3$) (major diastereomer) δ 170.8, 81.5, 75.7, 73.5, 31.9, 31.7, 28.0, 25.7, 25.3, 22.5, 18.2, 14.0, -4.7, -5.4; TLC (15:1 hexanes/EtOAc) R_f 0.25; **Anal.** Calcd. for $C_{18}H_{38}O_4Si$: C, 62.38; H, 11.05. Found: C, 62.75; H, 10.93.

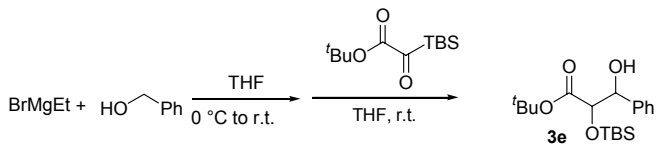


***tert*-Butyl-2-*tert*-butyldimethylsilyloxy-3-hydroxy-5-trimethylsilylpentanoate (3c).** The title compound was prepared according to General Procedure **B** using 100 mg (0.41 mmol) of *tert*-butyl *tert*-butyldimethylsilylglyoxylate in 1:1 (v/v) THF/CH_2Cl_2 (1 mL), 81 mg (0.61 mmol) of 3-trimethylsilylpropanol in 1:1 (v/v) THF/CH_2Cl_2 (1 mL), and 0.7 mL (0.7 mmol) of EtMgBr (1 M in THF). The crude product was extracted with CH_2Cl_2 and purified by flash chromatography with 17:1 hexanes/EtOAc to afford 130 mg (84%) of the product as a clear oil (5:1 ratio of two diastereomers). Analytical data for title

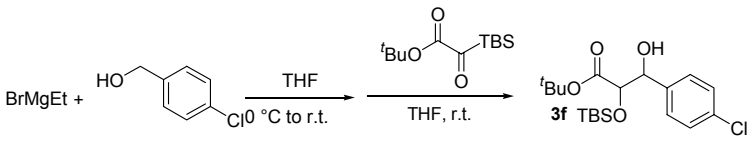
compound: **IR** (thin film, cm^{-1}) 3495 (br), 2952, 2930, 2859, 1748, 1724, 1472, 1368, 1250, 1146, 862, 838, 779; **^{1}H NMR** (300 MHz, $CDCl_3$) (major diastereomer) δ 4.04 (d, *J* = 4.5 Hz, 1H), 3.66 (quint, *J* = 4.5 Hz, 1H), 2.33 (br s, 1H), 1.45 (s, 9H), 0.90 (s, 9H), 0.75-0.63 (m, 2H), 0.50-0.38 (m, 2H), 0.085 (s, 3H), 0.050 (s, 3H), -0.035 (s, 9H); **^{13}C NMR** (75 MHz, $CDCl_3$) (major diastereomer) δ 170.9, 81.5, 76.0, 75.4, 28.0, 26.4, 25.7, 18.2, 12.1, -1.86, -4.7, -5.4; TLC (15:1 hexanes/EtOAc) R_f 0.25; **Anal.** Calcd. for $C_{18}H_{40}O_4Si_2$: C, 57.39; H, 10.70. Found: C, 57.71; H, 10.51.



***tert*-Butyl-2-*tert*-butyldimethylsilyloxy-3-hydroxyoct-7-enoate (3d).** The title compound was prepared according to General Procedure **B** using 95 mg (0.39 mmol) of *tert*-butyl *tert*-butyldimethylsilylglyoxylate in THF (2 mL), 58 mg (0.58 mmol) of hex-5-en-1-ol in THF (2 mL), and 0.78 mL (0.78 mmol) of EtMgBr (1 M in THF). The crude product was extracted with Et_2O and purified by flash chromatography with 17:1 hexanes/EtOAc to afford 84 mg (63%) of the product as a clear oil (5:1 ratio of two diastereomers). Analytical data for title compound: **IR** (thin film, cm^{-1}) 3562, 3493 (br), 3077, 2952, 2931, 2859, 1750, 1725, 1472, 1368, 1253, 1144, 871, 838, 780; **^{1}H NMR** (400 MHz, $CDCl_3$) (major diastereomer) δ 5.77 (dddd, *J* = 17.2, 10.4, 6.8, 6.8 Hz, 1H), 4.99 (ddd, *J* = 17.2, 2.0, 1.6 Hz, 1H), 4.92 (ddd, *J* = 10.4, 1.6, 0.8 Hz, 1H), 4.03 (d, *J* = 4.8 Hz, 1H), 3.81-3.70 (m, 1H), 2.26 (br s, 1H), 2.11-2.00 (m, 2H), 1.65-1.40 (m, 4H), 1.45 (s, 9H), 0.90 (s, 9H), 0.087 (s, 3H), 0.049 (s, 3H); **^{13}C NMR** (100 MHz, $CDCl_3$) (major diastereomer) δ 170.6, 138.4, 114.4, 81.4, 75.5, 73.1, 33.4, 31.2, 27.8, 25.5, 24.7 18.1, -5.0, -5.6; TLC (15:1 hexanes/EtOAc) R_f 0.25; **Anal.** Calcd. for $C_{18}H_{36}O_4Si$: C, 62.74; H, 10.53. Found: C, 62.92; H, 10.66.

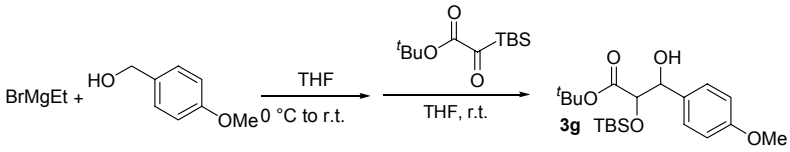


***tert*-Butyl-2-*tert*-butyldimethylsilyloxy-3-hydroxy-3-phenylpropanoate (3e).** The title compound was prepared according to General Procedure **B** using 93 mg (0.38 mmol) of *tert*-butyl *tert*-butyldimethylsilylglyoxylate in THF (2 mL), 62 mg (0.57 mmol) of benzyl alcohol in THF (2 mL), and 0.76 mL (0.76 mmol) of EtMgBr (1 M in THF). The crude product was extracted with Et_2O and purified by flash chromatography with 15:1 hexanes/EtOAc to afford 121 mg (90%) of the product as a clear oil (1.2:1 ratio of two diastereomers). Analytical data for title compound: **IR** (thin film, cm^{-1}) 3479 (br), 2954, 2931, 2895, 2858, 1744, 1472, 1368, 1255, 1136, 1056, 876, 837, 780, 700; **^{1}H NMR** (300 MHz, $CDCl_3$) (inseparable diastereomers) δ 7.42-7.22 (m, 10H; two diastereomers), 4.95 (dd, *J* = 6.9, 3.9 Hz, 1H; minor diastereomer), 4.85 (dd, *J* = 6.0, 3.6 Hz, 1H; major diastereomer), 4.182 (d, *J* = 3.9 Hz, 1H; minor diastereomer), 4.179 (d, *J* = 6.0 Hz, 1H; major diastereomer), 3.11 (d, *J* = 3.6 Hz, 1H; major diastereomer), 3.08 (d, *J* = 6.9 Hz, 1H; minor diastereomer), 1.42 (s, 9H; minor diastereomer), 1.38 (s, 9H; major diastereomer), 0.85 (s, 9H; major diastereomer), 0.83 (s, 9H; minor diastereomer), 0.009 (s, 3H; major diastereomer), -0.027 (s, 3H; minor diastereomer), -0.181 (s, 3H; major diastereomer), -0.187 (s, 3H; minor diastereomer); **^{13}C NMR** (75 MHz, $CDCl_3$) (inseparable diastereomers) δ 170.8, 170.5, 140.4, 139.9, 127.9, 127.8, 127.6, 127.2, 126.3, 81.7, 76.4, 75.6, 75.4, 75.2, 27.8, 25.63, 25.57, 25.52, 25.4, 18.1, 18.0, -5.0, -5.2, -5.8 (two coincident resonances in the 126-128 ppm region, two coincident resonances in the 75-82 ppm region, two coincident resonances in the 18-28 ppm region, and two coincident resonances in the -6 to -5 region) TLC (10:1 hexanes/EtOAc) R_f 0.25; **Anal.** Calcd. for $C_{19}H_{32}O_4Si$: C, 64.73; H, 9.15. Found: C, 64.70; H, 9.24.



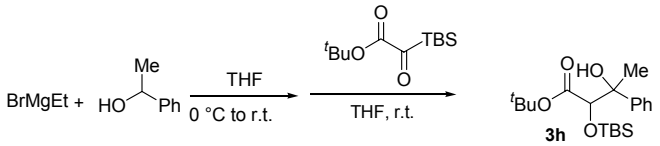
***tert*-Butyl-2-*tert*-butyldimethylsilyloxy-3-hydroxy-3-(4-chloro)phenylpropanoate (3f).** The title compound was prepared according to General Procedure **B** using 99 mg

(0.41 mmol) of *tert*-butyl *tert*-butyldimethylsilylglyoxylate in THF (2 mL), 87 mg (0.61 mmol) of 4-chlorobenzyl alcohol (2 mL), and 0.82 mL (0.82 mmol) of EtMgBr (1 M in THF). The crude product was extracted with Et_2O and purified by flash chromatography with 12:1 hexanes/EtOAc to afford 130 mg (82%) of the product as a clear oil (1:1 ratio of two diastereomers). Analytical data for title compound: **IR** (thin film, cm^{-1}) 3471 (br), 2957, 2930, 2887, 2858, 1743, 1492, 1472, 1368, 1253, 1136, 1091, 877, 837, 780; **^{1}H NMR** (400 MHz, $CDCl_3$) (inseparable diastereomers) δ 7.33-7.24 (m, 8H), 4.87 (dd, *J* = 6.4, 3.6 Hz, 1H), 4.79 (dd, *J* = 5.6, 3.2 Hz, 1H), 4.11 (d, *J* = 4.0 Hz, 1H), 4.10 (d, *J* = 6.0 Hz, 1H), 3.18 (d, *J* = 3.2 Hz, 1H), 3.10 (d, *J* = 7.2 Hz, 1H), 1.39 (s, 9H), 1.35 (s, 9H), 0.83 (s, 9H), 0.80 (s, 9H), -0.01 (s, 3H), -0.04 (s, 3H), -0.19 (s, 3H), -0.21 (s, 3H); **^{13}C NMR** (100 MHz, $CDCl_3$) (inseparable diastereomers) δ 170.6, 170.4, 139.0, 138.5, 133.5, 133.3, 128.6, 128.1, 128.0, 127.8, 82.00, 81.98, 76.9, 76.3, 74.8, 74.7, 28.0, 27.84, 27.81, 25.7, 25.6, 25.5, 18.09, 18.04, -5.1, -5.2, -5.7, -5.8; TLC (10:1 hexanes/EtOAc) R_f 0.25; **Anal.** Calcd. for $C_{19}H_{31}ClO_4Si$: C, 58.97; H, 8.07. Found: C, 59.21; H, 8.14.

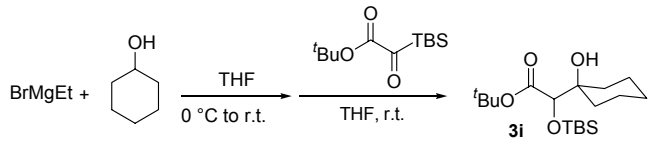


***tert*-Butyl-2-*tert*-butyldimethylsilyloxy-3-hydroxy-3-(4-methoxy)phenylpropanoate (3g).** The title compound was prepared according to General Procedure **B** using 96 mg (0.39 mmol) of *tert*-butyl *tert*-butyldimethylsilylglyoxylate in THF (2 mL), 81 mg (0.59 mmol) of 4-methoxybenzyl alcohol in THF (2 mL), and 0.78 mL (0.78 mmol) of EtMgBr (1 M in THF). The crude product was extracted with Et_2O and purified by flash chromatography with 11:1 hexanes/EtOAc to afford 126 mg (85%) of the product as a clear oil (1:1 ratio of two diastereomers). Analytical data for title compound: **IR** (thin film, cm^{-1}) 3492 (br), 2959, 2930, 2858, 1738, 1613, 1514, 1472, 1367, 1303, 1250, 1137, 1037, 876, 833, 780, 733; **^{1}H NMR** (300 MHz, $CDCl_3$) (inseparable diastereomers) δ 7.33-7.22 (m, 4H), 6.90-6.81 (m, 4H), 4.84 (br t, 1H), 4.77 (br d, *J* = 5.7 Hz, 1H), 4.14 (d, *J* = 6.3 Hz, 1H), 4.11 (d, *J* = 4.2 Hz), 3.783 (s, 3H), 3.780 (s, 3H), 3.00 (br s, 2H), 1.38 (s, 9H), 1.37 (s, 9H), 0.84 (s, 18H), -0.008 (s, 3H), -0.026 (s, 3H), -0.15 (s, 3H), -0.18 (s, 3H); **^{13}C NMR** (75 MHz, $CDCl_3$) (inseparable diastereomers) δ 170.9, 170.6,

159.3, 159.2, 132.3, 132.2, 128.4, 127.7, 113.5, 113.4, 81.66, 81.62, 76.4, 75.2, 74.9, 55.3, 55.2, 27.8, 25.7, 25.5, 25.4, 18.13, 18.06, -5.6, -5.8 (two coincident resonances in the 74-78 ppm region, three coincident resonances in the 25-28 ppm region, and two coincident resonances in the -5 to -6 ppm region); TLC (10:1 hexanes/EtOAc) R_f 0.18; **Anal.** Calcd. for $C_{20}H_{34}O_5Si$: C, 62.79; H, 8.96. Found: C, 62.92; H, 8.96.



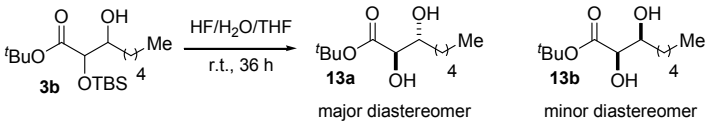
***tert*-Butyl-2-*tert*-butyldimethylsilyloxy-3-hydroxy-3-phenylbutanoate (3h).** The title compound was prepared according to General Procedure **B** using 103 mg (0.42 mmol) of *tert*-butyl *tert*-butyldimethylsilylglyoxylate in THF (2 mL), 77 mg (0.63 mmol) of 1-phenylethanol in THF (2 mL), and 0.84 mL (0.84 mmol) of EtMgBr. The crude product was extracted with Et_2O and purified by flash chromatography with 17:1 hexanes/EtOAc to afford 103 mg (67%) of the product as a clear oil (2.5:1 ratio of two diastereomers). Analytical data for title compound: **IR** (thin film, cm^{-1}) 3483 (br), 2955, 2932, 2895, 2859, 1742, 1472, 1368, 1258, 1132, 1068, 876, 838, 781, 700; **^{1}H NMR** (300 MHz, $CDCl_3$) (major diastereomer) δ 7.55-7.40 (m, 2H), 7.34-7.20 (m, 3H), 4.20 (s, 1H), 3.74 (s, 1H), 1.55 (s, 3H), 1.33 (s, 9H), 0.85 (s, 9H), -0.014 (s, 3H), -0.154 (s, 3H); **^{13}C NMR** (75 MHz, $CDCl_3$) (major diastereomer) δ 171.3, 145.6, 128.0, 127.1, 125.8, 82.3, 79.6, 76.1, 28.0, 26.4, 25.9, 18.2, -5.1, -5.8 TLC (10:1 hexanes/EtOAc) R_f 0.28; Calcd. for $C_{20}H_{34}O_4Si$: C, 65.53; H, 9.35. Found: C, 65.57; H, 9.31.



***tert*-Butyl 2-*tert*-butyldimethylsilyloxy-2-(1-hydroxycyclohexyl) acetate (3i).** The title compound was prepared according to General Procedure **B** using 103 mg (0.42 mmol) of *tert*-butyl *tert*-butyldimethylsilylglyoxylate in THF (2 mL), 63 mg (0.63 mmol) of cyclohexanol in THF (2 mL), and 0.84 mL (0.84 mmol) of EtMgBr (1 M in THF). The crude product was extracted with Et_2O and purified by flash chromatography with 17:1 hexanes/EtOAc to afford 98 mg (68%) of the product as white crystals. Analytical data

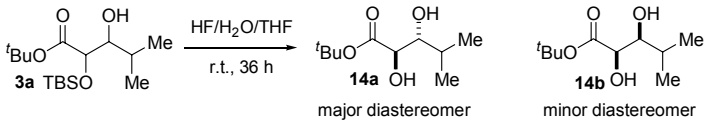
for title compound: **IR** (thin film, cm^{-1}) 3573, 3505 (br), 2936, 2856, 1745, 1723, 1472, 1367, 1252, 1130, 877, 838, 778; **^{1}H NMR** (300 MHz, $CDCl_3$) δ 3.86 (s, 1H), 2.69 (s, 1H), 1.70-1.11 (m, 10H), 1.48 (s, 9H), 0.88 (s, 9H), 0.077 (s, 3H), 0.058 (s, 3H); **^{13}C NMR** (75 MHz, $CDCl_3$) δ 171.1, 81.6, 78.2, 72.9, 33.8, 33.4, 28.0, 25.8, 25.7, 21.7, 21.6, 22.5, 18.1, -4.9, -5.4; TLC (15:1 hexanes/EtOAc) R_f 0.25; mp 56.5-58.5 °C; **Anal.** Calcd. for $C_{18}H_{36}O_4Si$: C, 62.74; H, 10.53. Found: C, 62.67; H, 10.41.

General Procedure (C) for TBS ether deprotection (stereochemical proofs for Table 2). A round-bottomed flask with a magnetic stir bar was charged with silyloxy ester **3** (1.0 equiv) and 4 mL of THF. To the resulting solution was added 1 mL of HF solution (49% in H_2O) at 25 °C. The reaction was stirred at the same temperature for 36 h. The reaction was carefully poured into a saturated $NaHCO_3$ solution, and then 15 mL of Et_2O were added. The organic layer was separated and the aqueous layer was extracted with two 15 mL portions of Et_2O. The organic extracts were combined, dried (Na_2SO_4), and the solvent was removed with a rotary evaporator. The crude product was purified by flash chromatography using the specified solvent system.

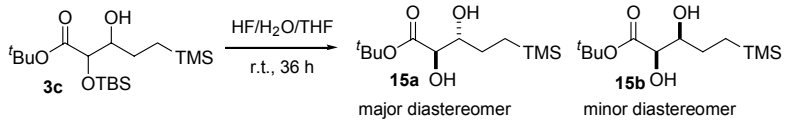


***tert*-Butyl-2,3-dihydroxyoctanoate (13).** The title compound was prepared according to General Procedure **C** using 95 mg (0.27 mmol) of silyloxy ester **3b** as a 4:1 ratio of two diastereomers, 5 mL of THF, and 1 mL of HF solution (49% in H_2O). The crude product was purified by flash chromatography with 4:1 hexanes/EtOAc to afford 44 mg (67%) of major diastereomer **13a** and 11 mg (16%) of minor diastereomer **13b** as a clear oil. Analytical data for major diastereomer **13a**: **^{1}H NMR** (400 MHz, $CDCl_3$) δ 4.10 (dd, J = 5.6, 4.0 Hz, 1H), 3.85-3.76 (m, 1H), 3.14 (d, J = 5.6 Hz, 1H), 2.29 (d, J = 6.8 Hz, 1H), 1.49 (s, 9H), 1.44-1.22 (m, 8H), 0.88 (t, J = 6.8 Hz, 3H); **^{13}C NMR** (100 MHz, $CDCl_3$) δ 172.0, 83.1, 74.0, 73.2, 31.7, 31.5, 28.0, 25.4, 22.5, 14.0; TLC (3:1 hexanes/EtOAc) R_f 0.20. Analytical data for minor diastereomer **13b**: **^{1}H NMR** (400 MHz, $CDCl_3$) δ 3.96 (dd, J = 3.6, 2.0 Hz, 1H), 3.87-3.77 (br m, 1H), 3.07 (d, J = 4.8 Hz, 1H), 1.84 (d, J = 9.2

Hz, 1H), 1.58 (m, 2H), 1.51 (s, 9H), 1.38-1.28 (m, 6H), 0.90 (t, J = 6.8 Hz, 3H); **^{13}C NMR** (100 MHz, $CDCl_3$) δ 172.9, 83.1, 73.1, 72.7, 33.9, 31.7, 28.0, 25.4, 22.6, 14.0; TLC (3:1 hexanes/EtOAc) R_f 0.30. Both ^{1}H NMR and ^{13}C NMR data for minor diastereomer **13b** exactly match with *syn tert*-butyl-2,3-dihydroxyoctanoate reported in the literature.[2] For ^{1}H NMR data for both diastereomers, see the Appendix.

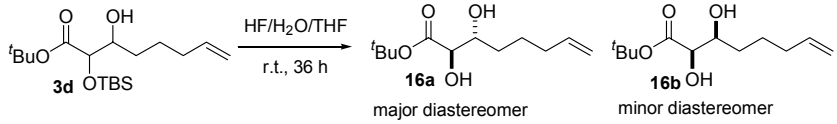


***tert*-Butyl-2,3-dihydroxy-4-methylpentanoate (14).** The title compound was prepared according to General Procedure **C** using 66 mg (0.21 mmol) of silyloxy ester **3a**, 4 mL of THF, and 1 mL of HF solution (49% in H_2O). The crude product was purified by flash chromatography with 5:1 hexanes/EtOAc to afford 24 mg (56%) of two diastereomers **14a** and **14b** as a clear oil. Analytical data for major diastereomer **14a**: **IR** (thin film, cm^{-1}) 3433 (br), 2980, 2935, 2873, 1729, 1475, 1394, 1369, 1252, 1163, 1082, 1054, 848; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 4.12 (d, J = 4.0 Hz, 1H), 3.44 (dd, J = 7.6, 4.4 Hz, 1H), 3.27 (s (br), 1H), 2.56 (s (br), 1H), 1.95-1.80 (m, 1H), 1.49 (s, 9H), 1.00 (d, J = 6.8 Hz, 3H), 0.97 (d, J = 6.8 Hz, 3H); **^{13}C NMR** (100 MHz, $CDCl_3$) δ 172.4, 83.3, 78.8, 72.4, 30.1, 28.0, 19.2, 18.6; TLC (5:1 hexanes/EtOAc) R_f 0.20.



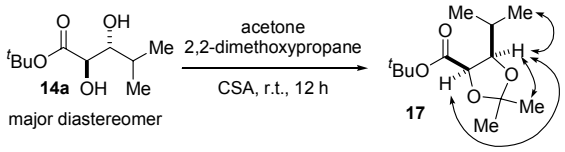
***tert*-Butyl-2,3-dihydroxy-5-trimethylsilylpentanoate (15).** The title compound was prepared according to General Procedure **C** using 66 mg (0.18 mmol) of silyloxy ester **3c**, 4 mL of THF, and 1 mL of HF solution (49% in H_2O). The crude product was purified by flash chromatography with 5:1 hexanes/EtOAc to afford 24 mg (52%) of major diastereomer **15a** and 10 mg (22%) of minor diastereomer **15b** as a clear oil. Analytical data for major diastereomer **15a**: **IR** (thin film, cm^{-1}) 3436 (br), 2979, 2947,

1726, 1458, 1394, 1368, 1254, 1163, 1076, 860, 756; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 4.12 (dd, *J* = 5.2, 4.0 Hz, 1H), 3.76-3.67 (m, 1H), 3.09 (d, *J* = 5.6 Hz, 1H), 2.22 (d, *J* = 6.0 Hz, 1H), 1.55-1.42 (m, 2H), 1.50 (s, 9H), 0.73 (ddd, *J* = 14.0, 11.6, 5.2 Hz, 1H), 0.46 (ddd, *J* = 14.0, 12.4, 5.2 Hz, 1H), -0.1 (s, 9H); **^{13}C NMR** (100 MHz, $CDCl_3$) δ 172.1, 83.2, 75.8, 73.6, 28.1, 26.1, 12.4, -1.8; TLC (5:1 hexanes/EtOAc) R_f 0.22.

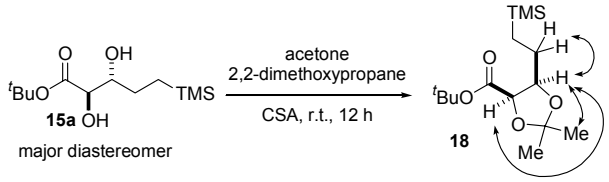


***tert*-Butyl-2,3-dihydroxyoct-7-enoate (16).** The title compound was prepared according to General Procedure **C** using 46 mg (0.13 mmol) of silyloxy ester **3d**, 3 mL of THF, and 1 mL of HF solution (49% in H_2O). The crude product was purified by flash chromatography with 7:1 hexanes/EtOAc to afford 19 mg (61%) of major diastereomer **16a** and 4 mg (13%) of minor diastereomer **16b** as a clear oil. Analytical data for major diastereomer **16a**: **IR** (thin film, cm^{-1}) 3437 (br), 3077, 2979, 2935, 2861, 1731, 1641, 1458, 1394, 1369, 1254, 1162, 1131, 1082, 909, 849; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 5.80 (ddt, *J* = 10.4, 6.8, 6.8 Hz, 1H), 5.05-4.93 (m, 2H), 4.10 (dd, *J* = 5.2, 4.0 Hz, 1H), 3.85-3.77 (m, 1H), 3.09 (d, *J* = 5.2 Hz, 1H), 2.22 (d, *J* = 6.8 Hz, 1H), 2.14-2.04 (m, 2H), 1.68-1.38 (m, 4H), 1.50 (s, 9H); **^{13}C NMR** (100 MHz, $CDCl_3$) δ 172.0, 138.4, 114.8, 83.3, 73.9, 73.0, 33.5, 31.0, 28.0, 24.9; TLC (7:1 hexanes/EtOAc) R_f 0.17.

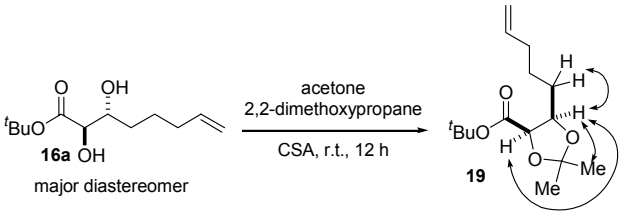
General Procedure (D) for ketalization. The major diastereomer of the dihydroxy ester (**14a**, **15a** or **16a**) (1.0 equiv) was dissolved in 3 mL of a 1:1 mixture of 2,2-dimethoxypropane:acetone and was treated with (±)-10-camphorsulfonic acid (CSA) (0.5 equiv). After 12 h, the reaction was partitioned between H_2O (5 mL) and Et_2O (5 mL). The organic layer was dried ($MgSO_4$) and concentrated to give the crude acetonide product which was purified by flash chromatography using the indicated solvent system.



2,2-Dimethyl-5-isopropyl-[1,3]dioxolane-4-carboxylic acid *tert*-butyl ester (17). The title compound was prepared according to General Procedure **D** using 23 mg (0.11 mmol) of the major diastereomer of dihydroxy ester **14a**, 3 mL of a 1:1 mixture of 2,2-dimethoxypropane:acetone and 12 mg (0.05 mmol) of CSA. The crude product was purified by flash chromatography with 15:1 hexanes/EtOAc to afford 25 mg (93%) of ketal **17** as a clear oil. Analytical data for major diastereomer **17**: **IR** (thin film, cm^{-1}) 2971, 2938, 2876, 1750, 1724, 1458, 1368, 1246, 1214, 1153, 1088, 877; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 4.42 (d, *J* = 6.4 Hz, 1H), 3.85 (dd, *J* = 9.6, 6.4 Hz, 1H), 1.80-1.71 (m, 1H), 1.61 (s, 3H), 1.48 (s, 9H), 1.35 (s, 3H), 1.03 (d, *J* = 6.4 Hz, 3H), 0.99 (d, *J* = 6.8 Hz, 3H); **^{13}C NMR** (100 MHz, $CDCl_3$) δ 169.9, 109.9, 84.1, 81.7, 77.5, 28.7, 28.0, 26.7, 25.7, 20.1, 19.5; TLC (10:1 hexanes/EtOAc) R_f 0.30. See the Appendix for ^{1}H NMR and NOESY spectra of **17**.

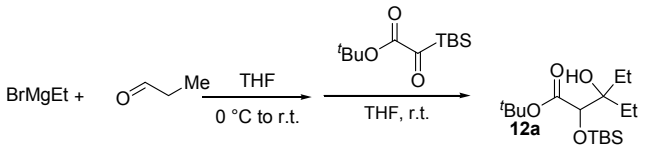


2,2-Dimethyl-5-(2-trimethylsilylethyl)-[1,3]dioxolane-4-carboxylic acid *tert*-butyl ester (18). The title compound was prepared according to General Procedure **D** using 24 mg (0.09 mmol) of the major diastereomer of dihydroxy ester **15a**, 3 mL of a 1:1 mixture of 2,2-dimethoxypropane:acetone and 10 mg (0.04 mmol) of CSA. The crude product was purified by flash chromatography with 15:1 hexanes/EtOAc to afford 23 mg (85%) of ketal **18** as a clear oil. Analytical data for major diastereomer **18**: **IR** (thin film, cm^{-1}) 2981, 2953, 1754, 1724, 1368, 1249, 1216, 1157, 1092, 859, 838; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 4.43 (d, *J* = 6.8 Hz, 1H), 4.21 (ddd, *J* = 8.4, 6.8, 4.8 Hz, 1H), 1.60-1.40 (m, 2H), 1.60 (s, 3H), 1.48 (s, 9H), 1.32 (s, 3H), 0.74 (ddd, *J* = 14.0, 12.4, 5.2 Hz, 1H), 0.56 (ddd, *J* = 14.0, 12.4, 5.2 Hz, 1H), -0.1 (s, 9H); **^{13}C NMR** (100 MHz, $CDCl_3$) δ 169.5, 110.0, 81.8, 80.6, 77.7, 28.1, 27.1, 25.7, 24.8, 13.2, -1.8; TLC (10:1 hexanes/EtOAc) R_f 0.20. See the Appendix for ^{1}H NMR and NOESY spectra of **18**.

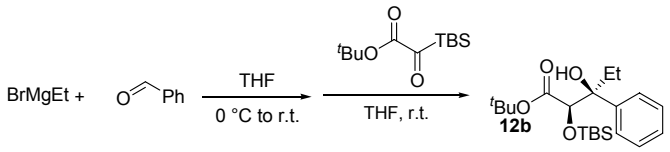


2,2-Dimethyl-5-(pent-4-enyl)-[1,3]dioxolane-4-carboxylic acid *tert*-butyl ester (19). The title compound was prepared according to General Procedure **D** using 19 mg (0.08 mmol) of the major diastereomer of dihydroxy ester **16a**, 3 mL of a 1:1 mixture of 2,2-dimethoxypropane:acetone and 9 mg (0.04 mmol) of CSA. The crude product was purified by flash chromatography with 15:1 hexanes/EtOAc to afford 18 mg (82%) of ketal **19** as a clear oil. Analytical data for major diastereomer **19**: **IR** (thin film, cm^{-1}) 3078, 2981, 2938, 2870, 1752, 1724, 1641, 1458, 1368, 1251, 1215, 1158, 1092, 911, 878, 846; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 5.79 (ddt, *J* = 10.0, 6.8, 6.8 Hz, 1H), 5.06-4.93 (m, 2H), 4.41 (d, *J* = 6.8 Hz, 1H), 4.33-4.23 (m, 1H), 2.14-2.06 (m, 2H), 1.68-1.46 (m, 4H), 1.59, (s, 3H), 1.47 (s, 9H), 1.35 (s, 3H); **^{13}C NMR** (100 MHz, $CDCl_3$) δ 169.5, 138.3, 114.9, 110.1, 81.9, 77.8, 77.6, 33.6, 29.7, 28.1, 27.1, 25.7, 25.6; TLC (10:1 hexanes/EtOAc) R_f 0.30. See the Appendix for ^{1}H NMR and NOESY spectra of **19**.

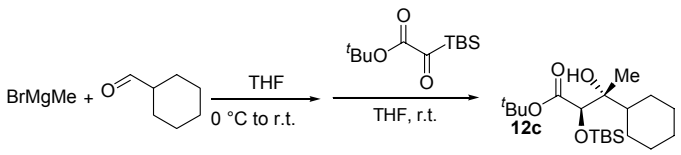
General procedure (E) for reactions in Table 3. A dry round bottomed flask with a magnetic stir bar was charged with aldehyde (1.5 equiv), and 2 mL of THF. To the resulting solution, alkylmagnesium bromide (1.0 M in THF) (2.0 equiv) was added *via* syringe at 0 °C under an argon atmosphere. The reaction temperature was allowed to warm to 25 °C for 5 min. To the reaction solution was added dropwise *via* cannula silylglyoxylate (1.0 equiv, ca. 0.4 mmol) in 2 mL of THF. The reaction was stirred at the same temperature for 10 min before 5 mL of a saturated NH_4Cl solution and 15 mL of Et_2O were added. The organic layer was separated and the aqueous layer was extracted with two 10 mL portions of Et_2O. The organic extracts were combined and dried (Na_2SO_4). Concentration of the organic phase by rotary evaporation afforded the crude product which was purified by flash chromatography using the specified solvent system.



***Tert*-butyl 2-(*tert*-butyldimethylsilyloxy)-3-ethyl-3-hydroxypentanoate (12a).** The title compound was prepared according to General Procedure **E** using 100 mg (0.41 mmol) of *tert*-butyl *tert*-butyldimethylsilylglyoxylate in THF (2 mL), 36 mg (0.61 mmol) of propanal in THF (2 mL), and 0.82 mL (0.82 mmol) of EtMgBr (1 M in THF). The crude product was purified by flash chromatography with 30:1-20:1 hexanes/EtOAc to afford 93 mg (68%) of the product as a clear oil. Analytical data for title compound: **IR** (thin film, cm^{-1}) 3567 (br), 2961, 2936, 2887, 2860, 1746, 1472, 1393, 1369, 1253, 1159, 1131, 876, 839, 780; **^{1}H NMR** (300 MHz, $CDCl_3$) δ 3.98 (s, 1H), 2.68 (s, 1H), 1.4-1.6 (m, 4H), 1.47 (s, 9H), 0.86-0.91 (m, 6H), 0.91 (s, 9H), 0.06 (s, 3H), 0.04 (s, 3H); **^{13}C NMR** (100 MHz, $CDCl_3$) δ 171.0, 81.7, 76.2, 75.8, 28.0, 27.2, 26.8, 25.7, 18.1, 7.7, 7.6, -4.7, -5.4; TLC (20:1 hexanes/EtOAc) R_f 0.26; **Anal.** Calcd. for $C_{17}H_{36}O_4Si$: C, 61.40; H, 10.91. Found: C, 61.05; H, 10.90.



***Tert*-butyl-2-(*tert*-butyldimethylsilyloxy)-3-hydroxy-3-phenylpentanoate (12b).** The title compound was prepared according to General Procedure **E** using 100 mg (0.41 mmol) of *tert*-butyl *tert*-butyldimethylsilylglyoxylate in THF (2 mL), 65 mg (0.61 mmol) of benzaldehyde in THF (2 mL), and 0.82 mL (0.82 mmol) of EtMgBr (1 M in THF). The crude product was purified by flash chromatography with 30:1-20:1 hexanes/EtOAc to afford 127 mg (81%) of the product as a clear oil (2:1 ratio of two diastereomers). Analytical data for title compound: **IR** (thin film, cm^{-1}) 3463 (br), 2961, 2932, 2857, 1741, 1694, 1368, 1255, 1137, 876, 839, 780; **^{1}H NMR** (400 MHz, $CDCl_3$) (major diastereomer) δ 7.17-7.46 (m, 5H), 4.17 (s, 1H), 3.73 (d, J = 1.2 Hz, 1 H), 1.98 (sep, J = 7.2 Hz, 2H), 1.27 (s, 9H), 0.84 (s, 9H), 0.70 (t, J = 7.2 Hz, 3H), 0.08 (s, 3H), 0.04 (s, 3H); **^{13}C NMR** (100 MHz, $CDCl_3$) (major diastereomer) δ 127.7, 126.2, 82.1, 79.3, 31.1, 27.7, 25.6, 7.5, -5.0, -5.7; TLC (20:1 hexanes/EtOAc) R_f (both diastereomers) 0.33; **Anal**. Combustion analysis failed. For ^{1}H NMR spectrum, see the Appendix.



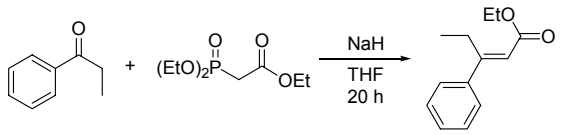
***Tert*-butyl 2-(*tert*-butyldimethylsilyloxy)-3-cyclohexyl-3-hydroxybutanoate (12c).** The title compound was prepared according to General Procedure **E** using 100 mg (0.41 mmol) of *tert*-butyl *tert*-butyldimethylsilylglyoxylate in THF (2 mL), 69 mg (0.61 mmol) of cyclohexylcarbaldehyde in THF (2 mL), and 0.82 mL (0.82 mmol) of EtMgBr (1 M in THF). The crude product was purified by flash chromatography with 30:1-20:1 hexanes/EtOAc to afford 102 mg (67%) of the product as a clear oil (3.5:1 ratio of two diastereomers). Analytical data for title compound: **IR** (thin film, cm^{-1}) 3481 (br), 2928, 2857, 1745, 1723, 1472, 1368, 1257, 1144, 839, 778; **^{1}H NMR** (400 MHz, $CDCl_3$) (major diastereomer) δ 4.01 (s, 1H), 1.60-1.94 (m, 6H), 1.48 (s, 9H), 1.09 (s, 3H), 0.91 (s, 9H), 0.06 (s, 3H), 0.04 (s, 3H); **^{13}C NMR** (100 MHz, $CDCl_3$) (major diastereomer) δ 171.3, 81.7, 76.1, 44.1, 26.8, 26.7, 26.6, 25.7, 20.4, 18.1, -5.0, -5.7; TLC (20:1 hexanes/EtOAc) R_f (both diastereomers) 0.33; **Anal.** Calcd. for $C_{20}H_{40}O_4Si$: C, 64.47; H, 10.82. Found: C, 64.25; H, 10.89.

General procedure (F) for Horner-Wadsworth-Emmons reactions (step 1 of stereochemical proof for Table 3). A dry round bottomed flask with a magnetic stir bar was charged phosphonoacetate ester (1.0 equiv), and 5 mL of THF. To the resulting solution, sodium hydride (1.1 equiv) was added in one portion. The solution was stirred at room temperature for 30 minutes. To the reaction solution was added dropwise *via* cannula the ketone (1.0 equiv.) in 5 mL of THF. The resulting solution was stirred for 20 h. The product was then extracted from an aq. sat. $NaHCO_3$ solution with 15 mL of ether. The organic layer was separated and the aqueous layer was extracted with two 10 mL portions of Et_2O. The organic extracts were combined and dried ($MgSO_4$). Concentration of the organic phase by rotary evaporation afforded the crude product, which was purified by flash chromatography using the specified solvent system.

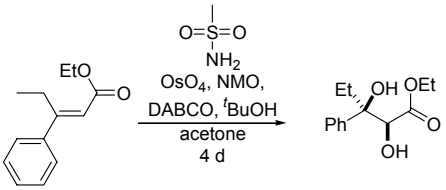
General procedure (G) for lithium aluminum hydride reductions. A dry round bottomed flask with a magnetic stir bar was charged lithium aluminum hydride (5.0 equiv), and 5 mL of THF at 0 ºC. To the resulting solution the ester was added dropwise

(1.0 equiv) in 5 mL of THF. The solution was warmed to room temperature and stirred for 1.5 hours. To the solution was added X μL of H_2O where X is equivalent to the number of mg of lithium aluminum hydride used in the reaction. This was followed by the addition of X μL 15% NaOH solution and then 5X μL of additional H_2O. The solid precipitates were filtered. Concentration of the organic phase by rotary evaporation afforded the crude product, which was purified by flash chromatography using the specified solvent system.

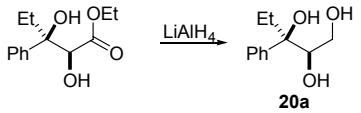
General procedure (H) for dihydroxylations. A dry round bottomed flask with a magnetic stir bar was charged with alkene (1.0 equiv), DABCO (0.3 equiv), 4-methylmorpholine N-oxide (2 equiv), methanesulfonamide (1 equiv) and acetone (20 ml). The solution was cooled to 0 °C and potassium osmate dihydrate (0.15 equiv in 1 mL H_2O) was added dropwise followed by addition of t-BuOH (1.5 mL). The reaction was allowed to stir for 4 days and progress was monitored by TLC. When all starting material was consumed the homogenous solution was stirred with Na_2SO_3 for 2 hours. The solution was then extracted with three 20 mL portions of CH_2Cl_2. Concentration of the organic phase by rotary evaporation afforded the crude product which was purified by flash chromatography using the specified solvent system.



(*E*)-ethyl 3-phenylpent-2-enoate. The title compound was prepared according to General Procedure **F** using 1 g (7.5 mmol) of propiophenone, 1.69 g (7.5 mmol) of triethylphosphonoacetate, 199 mg NaH (8.3 mmol) and 10 mL of THF. The crude product was purified by flash chromatography with 20:1 hexanes/ether to afford 346 mg (24%) of the product as a clear oil. Analytical data for title compound: **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.34-7.44 (m, 5H), 6.0 (s, 1H), 4.2 (q, J = 7.2 Hz, 2H), 3.09 (q, J = 7.2 Hz, 2H), 1.30 (t, J = 7.2 Hz, 3H), 1.06 (t, J = 7.2 Hz, 3H); TLC (20:1 hexanes/ether) R_f (E) 0.29; the ^{1}H NMR spectrum matched that reported previously.[3]



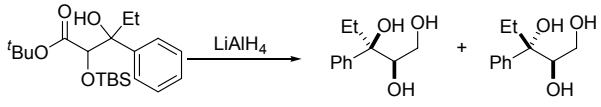
Ethyl 2,3-dihydroxy-3-phenylpentanoate. The title compound was prepared according to General Procedure **H** using 100 mg (0.53 mmol) of alkene, 29 mg (0.08 mmol) of potassium osmate dihydrate, 18 mg (0.15 mmol) of DABCO, 123 mg (1.05 mmol) of NMO, 50 mg (0.53 mmol) of methanesulfonamide, 1.5 mL ^{t}BuOH and 20 mL of acetone. The crude product was purified by flash chromatography with 5:1 hexanes/ether to afford 100 mg (80%) of the product as a clear oil. Analytical data for title compound: **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.20-7.46 (m, 5H), 4.35 (s, 1H), 4.15 (q, J = 7.2 Hz, 2H), 1.99 (dq, J = 7.2 Hz, 1H), 1.93 (dq, J = 7.2 Hz, 1H) 1.14 (t, J = 7.2 Hz, 3H), 0.80 (t, J = 7.2 Hz, 3H).



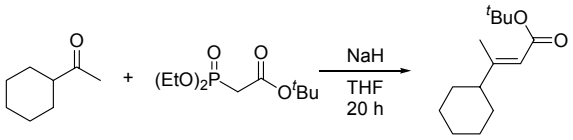
20a

3-phenylpentane-1,2,3-triol (20a). The title compound was prepared according to General Procedure **G** using 100 mg (0.26 mmol) of diol, 50 mg (1.3 mmol) of lithium aluminum hydride, and 1.5 mL of THF. The crude product was purified by flash chromatography with ethyl acetate to afford 35 mg (56%) of the product as a clear oil. Analytical data for title compound: **IR** (thin film, cm^{-1}) 3410 (br), 2969, 2939, 2881, 1647, 1600, 1447, 1071, 1026, 702; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.2-7.40 (m, 5H), 3.77-3.85 (m, 3H), 3.12 (s, 1H), 2.62-2.68 (m, 2H), 1.83 (q, J = 9.6 Hz, 2H), 0.67 (t, J = 9.6 Hz, 3H); **^{13}C NMR** (100 MHz, $CDCl_3$) δ 143.1, 128.67, 128.54, 128.48, 126.1, 125.9, 79.4, 63.1, 30.5, 7.8; TLC (ethyl acetate) R_f 0.37; CSP-SFC analysis: Chiralpak AS, 0-10% MeOH (ramp 0.5%/min), 1.5 mL/min, 150 bar, 40 °C, 240 nm, t_r 19.8, 20.3 min; **Anal.** Calcd. for $C_{11}H_{16}O_3$: C, 67.32; H, 8.22. Found: C, 67.03; H, 8.24.

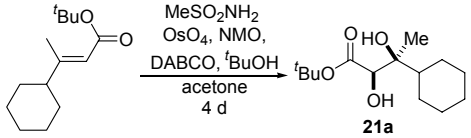
This material was compared (using SFC analysis) to the mixture of **20a/20b** prepared from reduction of **12b**. See the Appendix for the SFC traces.



3-phenylpentane-1,2,3-triol (20a/b). The title compound was prepared according to General Procedure **G** using 115 mg (0.30 mmol) of **12b**, 57 mg (1.5 mmol) of lithium aluminum hydride, and 1.5 mL of THF. The crude product was purified by flash chromatography with ethyl acetate to afford 45 mg (63%) of the product as a clear oil. Analytical data for title compound: **^{1}H NMR** (400 MHz, $CDCl_3$) (major diastereomer) δ 7.2-7.40 (m, 5H), 3.77-3.85 (m, 3H), 3.12 (s, 1H), 2.62-2.68 (m, 2H), 1.83 (q, J = 9.6 Hz, 2H), 0.67 (t, J = 9.6 Hz, 3H); TLC (ethyl acetate) R_f 0.37; CSP-SFC analysis: Chiralpak AS, 0-10% MeOH. (ramp 0.5%/min), 1.5 mL/min, 150 bar, 40 °C, 240 nm, t_r(major) 20.0, 20.6 min, t_r(minor) 17.6, 19.1 min; **Anal.** See above.

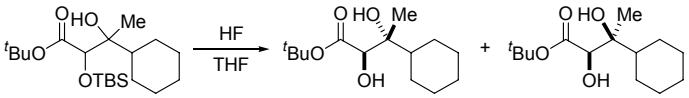


(*E*)-*tert*-Butyl 3-cyclohexylbut-2-enoate. The title compound was prepared according to General Procedure **F** using 0.67 g (5.3 mmol) of ketone, 1.34 g (5.3 mmol) of *tert*-Butyl diethyl phosphonoacetate, 146 mg of NaH (6.1 mmol) and 10 mL of THF. The crude product was purified by flash chromatography with 99:1-20:1 hexanes/ether to afford 760 mg (64%) of the product *E* isomer, as a clear oil. Analytical data for title compound: **IR** (thin film, cm^{-1}) 3500 (br), 2977, 2928, 2854, 1720, 1642, 1450, 1366, 1237, 1142; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 5.54 (s, 1H), 2.07 (s, 3H), 1.64-1.94 (m, 6H), 1.45 (s, 9H), 1.1-1.29 (m, 5H), **^{13}C NMR** (100 MHz, $CDCl_3$) δ 166.9, 163.1, 115.7, 79.3, 49.0, 31.3, 30.8, 28.3, 26.5, 26.4, 17.1; TLC (20:1 hexanes/ether) R_f (E) 0.30. For the NOESY spectrum, see the Appendix.

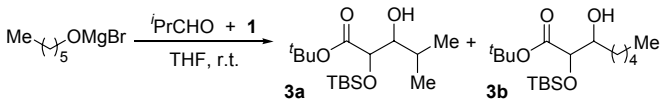


***Tert*-butyl 3-cyclohexyl-2,3-dihydroxybutanoate (21a).** The title compound was prepared according to General Procedure **H** using 200 mg (0.89 mmol) of alkene, 49 mg

(0.13 mmol) of potassium osmate dihydrate, 30 mg (0.15 mmol) of DABCO, 209 mg (1.05 mmol) of NMO, 84 mg (0.53 mmol) of methanesulfonamide, 2.6 mL ^{t}BuOH and 34 mL of acetone. The crude product was purified by flash chromatography with 5:1 hexanes/ether to afford 147 mg (64%) of the product as a clear oil. Analytical data for title compound: **IR** (thin film, cm^{-1}) 3378 (br), 2974, 2919, 2851, 1729, 1367, 1151; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 4.04 (d, *J* = 6.8 Hz, 1H), 3.09 (d, *J* = 6.8 Hz, 1H), 2.23 (s, 1H), 1.62-1.88 (m, 6H) 1.50 (s, 9H), 1.13-1.24 (m, 5H), 1.08 (s, 3H); **^{13}C NMR** (100 MHz, $CDCl_3$) δ 74.17, 44.0, 28.06, 27.8, 26.7, 26.6, 26.5, 26.2, 19.3; TLC (10:1 hexanes:EtOAc) R_f 0.2; **Anal.** Combustion analysis failed. For the ^{1}H NMR spectrum, see the Appendix.

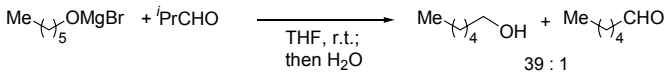


***Tert*-butyl 3-cyclohexyl-2,3-dihydroxybutanoate (21a/b).** The title compound was prepared by adding 22 mg (0.06 mmol) of **12c**, 2 mL HF (49% aq.) and 2 mL of THF to a round bottom flask. The solution was stirred overnight and the crude product was isolated as a clear oil. Upon comparison of the ^{1}H NMR spectrum with the spectrum of **21a** derived from dihydroxylation of the (*E*)-alkene, it was determined that the major isomer had the *anti* orientation. ^{1}H NMR data for **21b** (400 MHz, $CDCl_3$) (major diastereomer) δ 3.99 (d, *J* = 6.4 Hz, 1H), 3.07 (m, 1H), 2.23 (s, 1H), 1.62-1.88 (m, 6H) 1.51 (s, 9H), 1.13-1.24 (m, 5H), 1.11(s, 3H); TLC (10:1 hexanes:EtOAc) R_f 0.2.

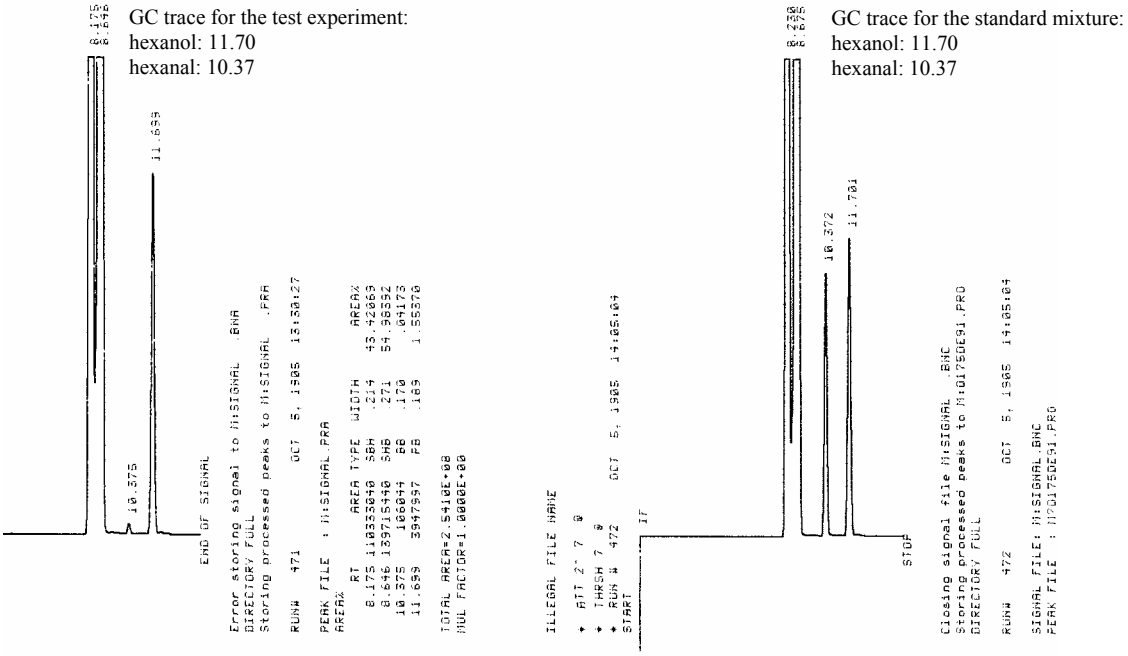


Crossover experiment. A dry round-bottomed flask with a magnetic stir bar was charged with 51 mg (0.50 mmol) of hexanol, and 2 mL of THF. To the resulting solution, 0.66 mL (0.66 mmol) of EtMgBr (1 M in THF) was added *via* syringe at 0 °C under Ar. The reaction temperature was allowed to warm to 25 °C for 5 min. To the reaction solution was added dropwise *via* cannula 81 mg (0.33 mmol) of *tert*-butyl *tert*-butyldimethylsilylglyoxylate and 28 mg (0.40 mmol) of isobutyraldehyde in 2 mL of

THF. The reaction was stirred at the same temperature for 5 min before 5 mL of a saturated NH_4Cl solution and 15 mL of Et_2O were added. The organic layer was separated and the aqueous layer was extracted with two 10 mL portions of Et_2O. The organic extracts were combined, dried (Na_2SO_4), and the solvent was removed with a rotary evaporator. The product ratio (**3a**:**3b**) was determined by ^1H NMR spectroscopy. For ^1H NMR data, see the Appendix.

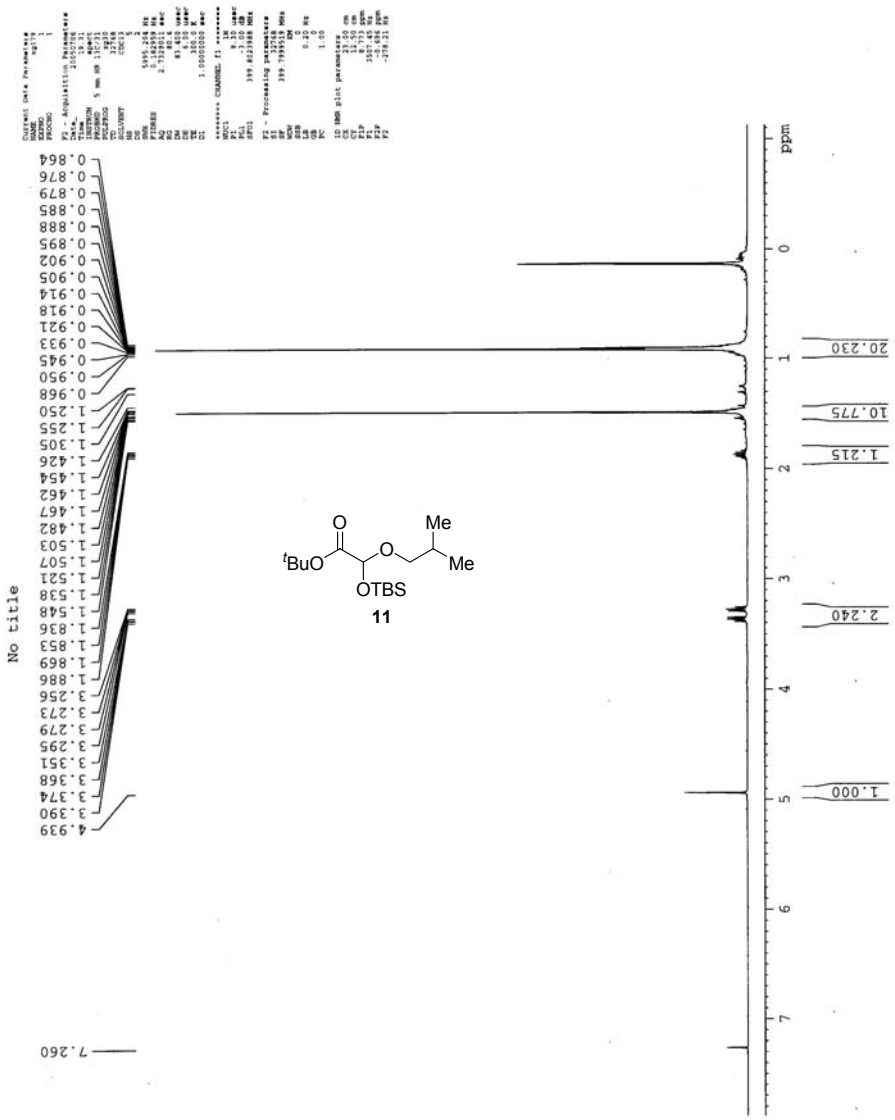


Control experiment for the crossover study. A dry round-bottomed flask with a magnetic stir bar was charged with 54 mg (0.53 mmol) of hexanol, and 2 mL of THF. To the resulting solution, 0.70 mL (0.70 mmol) of EtMgBr (1 M in THF) was added *via* syringe at 0 °C under an argon atmosphere. The reaction was allowed to warm to 25 °C for 5 min. To the reaction solution was added *via* cannula 38 mg (0.53 mmol) of isobutyraldehyde in 2 mL of THF. The reaction was stirred at the same temperature for 3 min before 5 mL of a saturated NH_4Cl solution and 15 mL of Et_2O were added. The organic layer was separated, washed (H_2O and brine), and dried (Na_2SO_4). The organic solution was examined directly by gas chromatography (oven temperature = 120 °C; run time = 15 min).



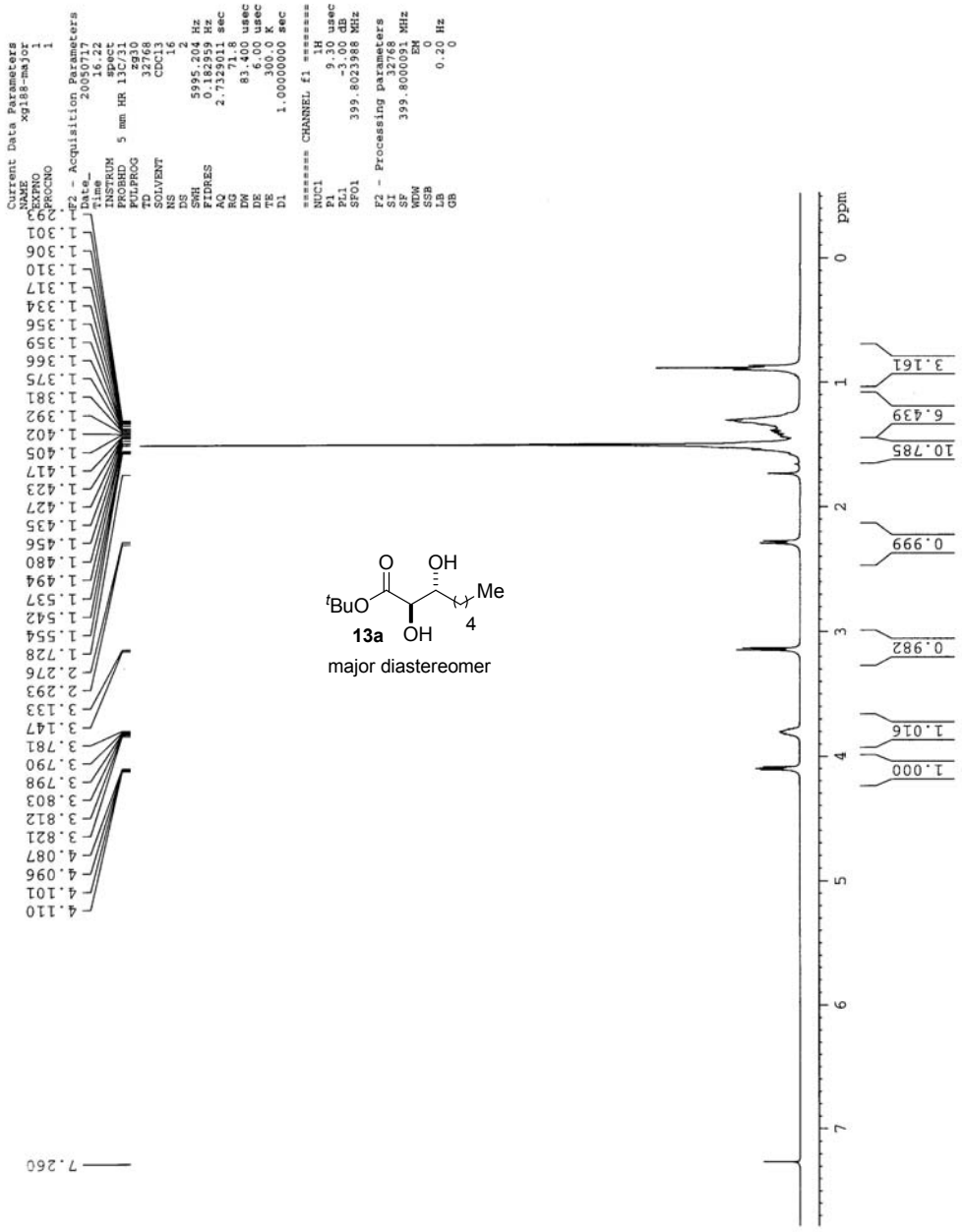
Appendix

^{1}H NMR in $CDCl_3$ for **11**

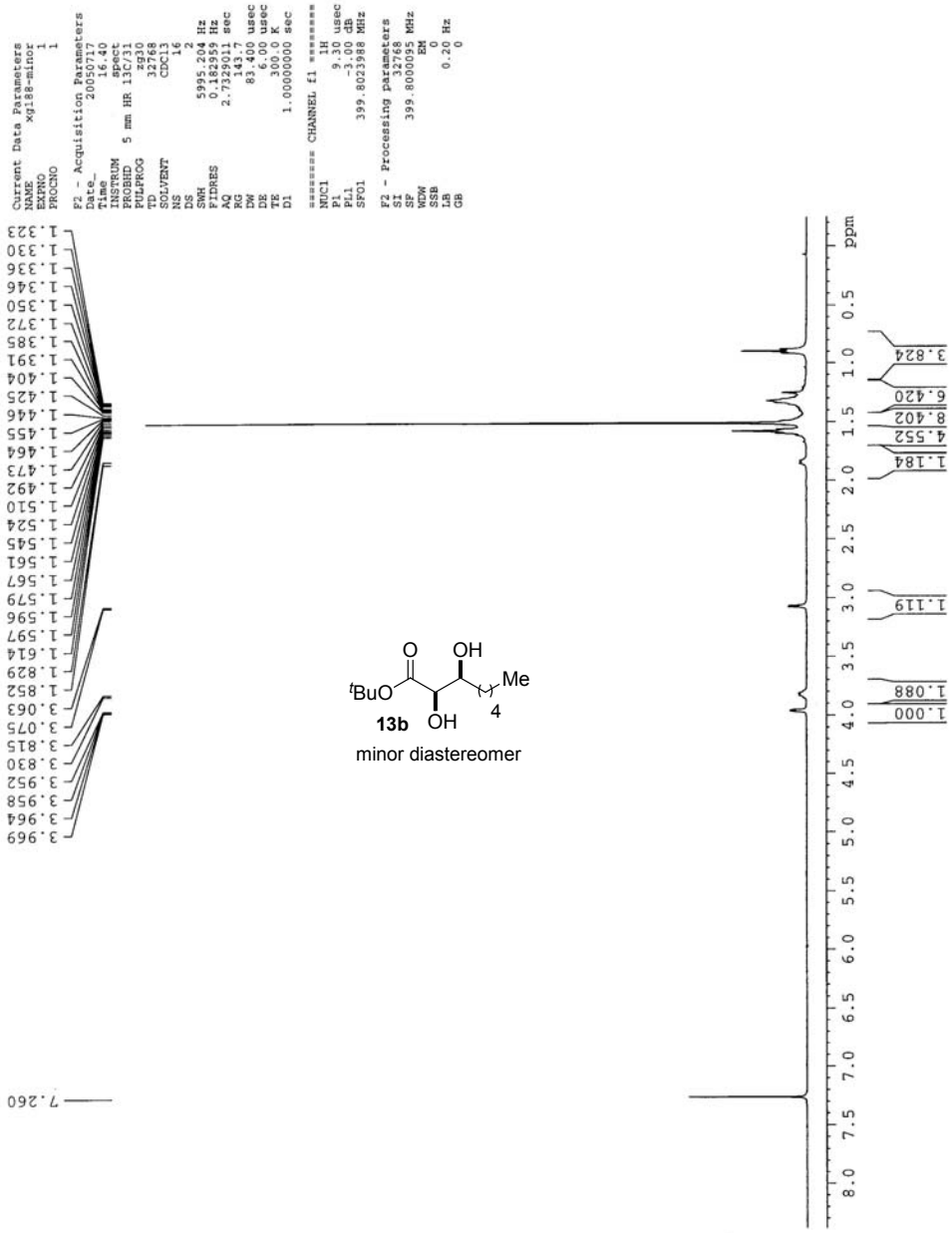


Identification of Relative Stereochemistry of Both Diastereomers.

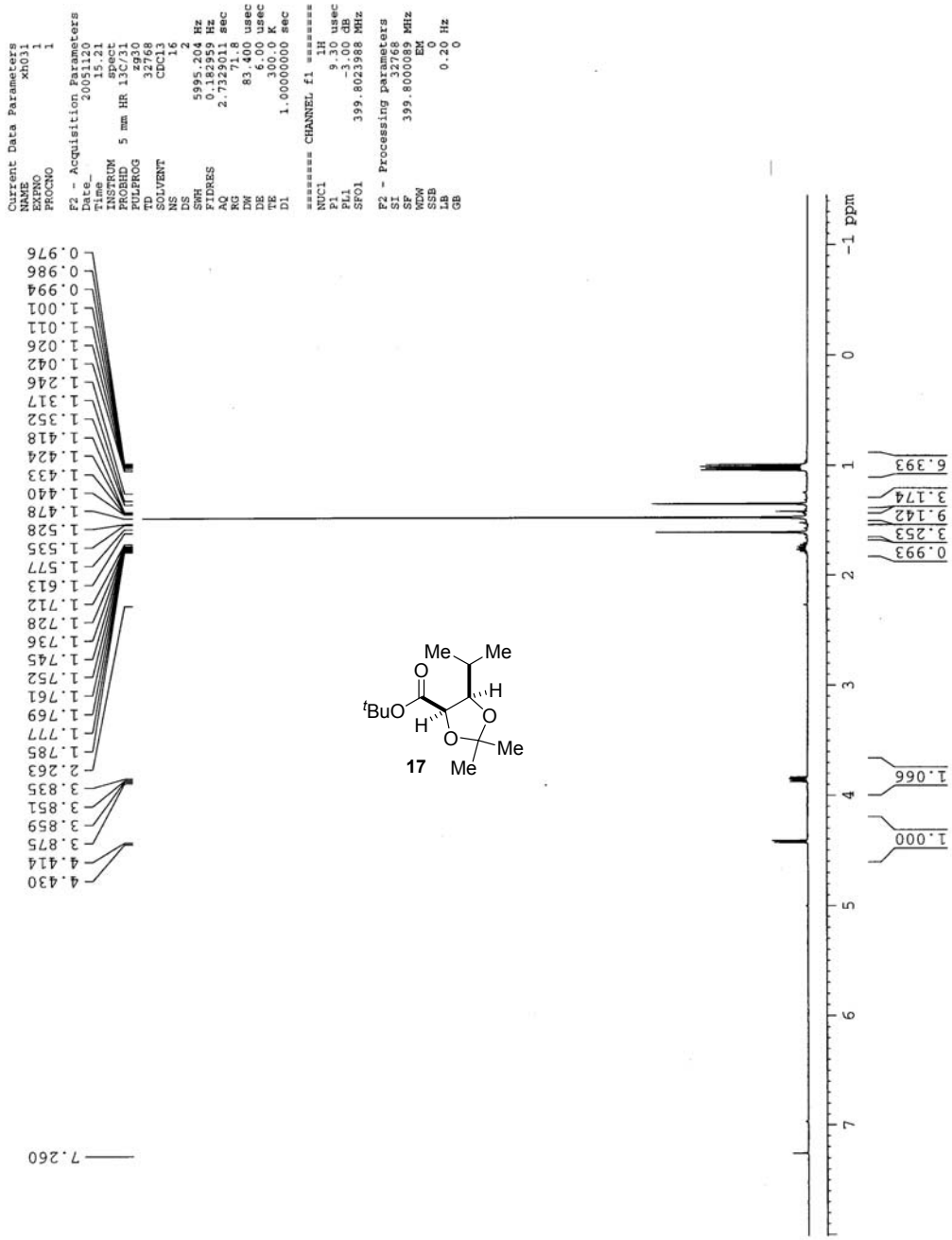
^{1}H NMR in $CDCl_3$ for major diastereomer **13a**



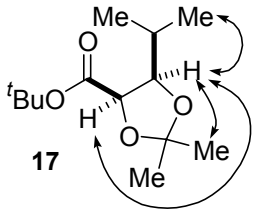
^{1}H NMR in $CDCl_3$ for minor diastereomer **13b**



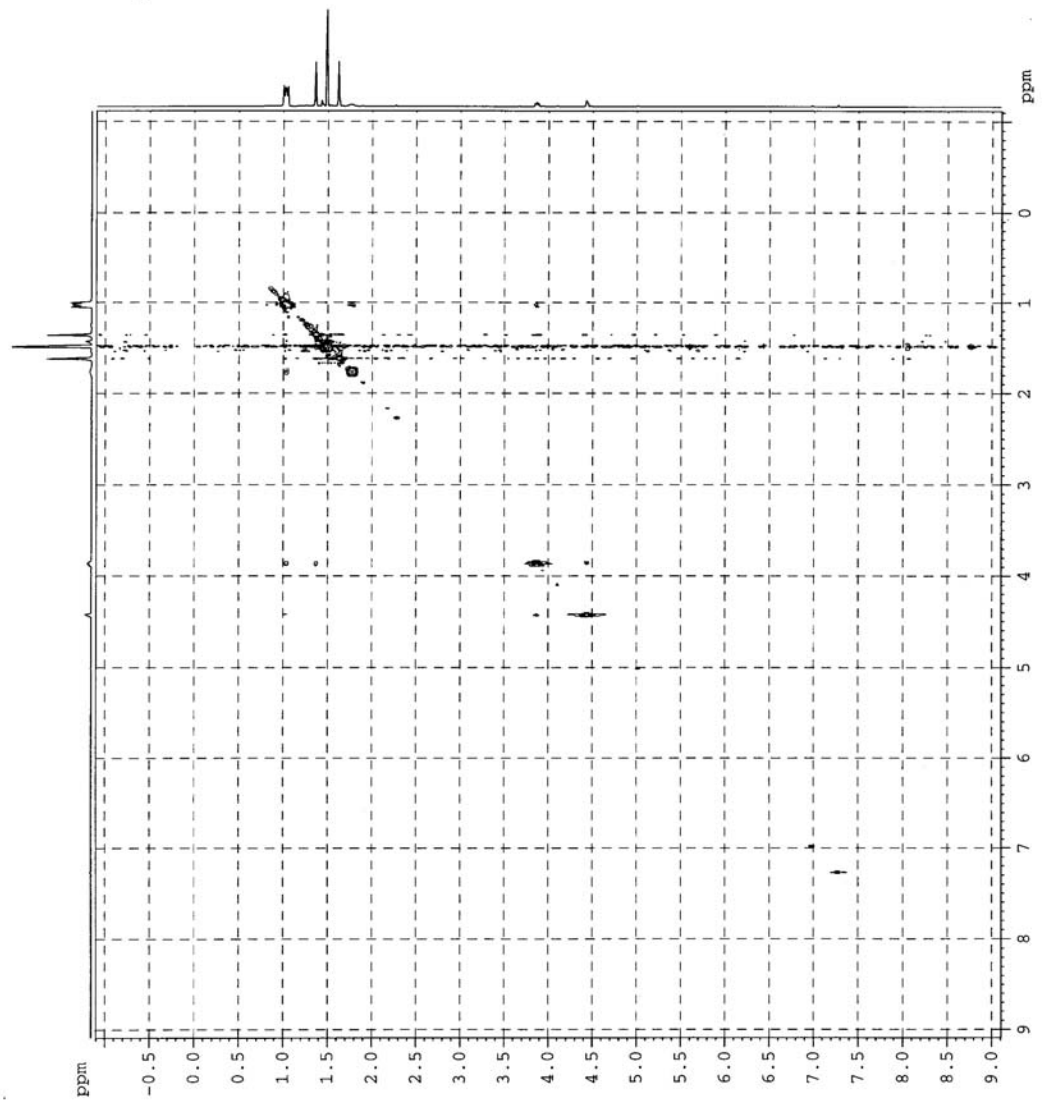
^{1}H NMR in $CDCl_3$ for **17**



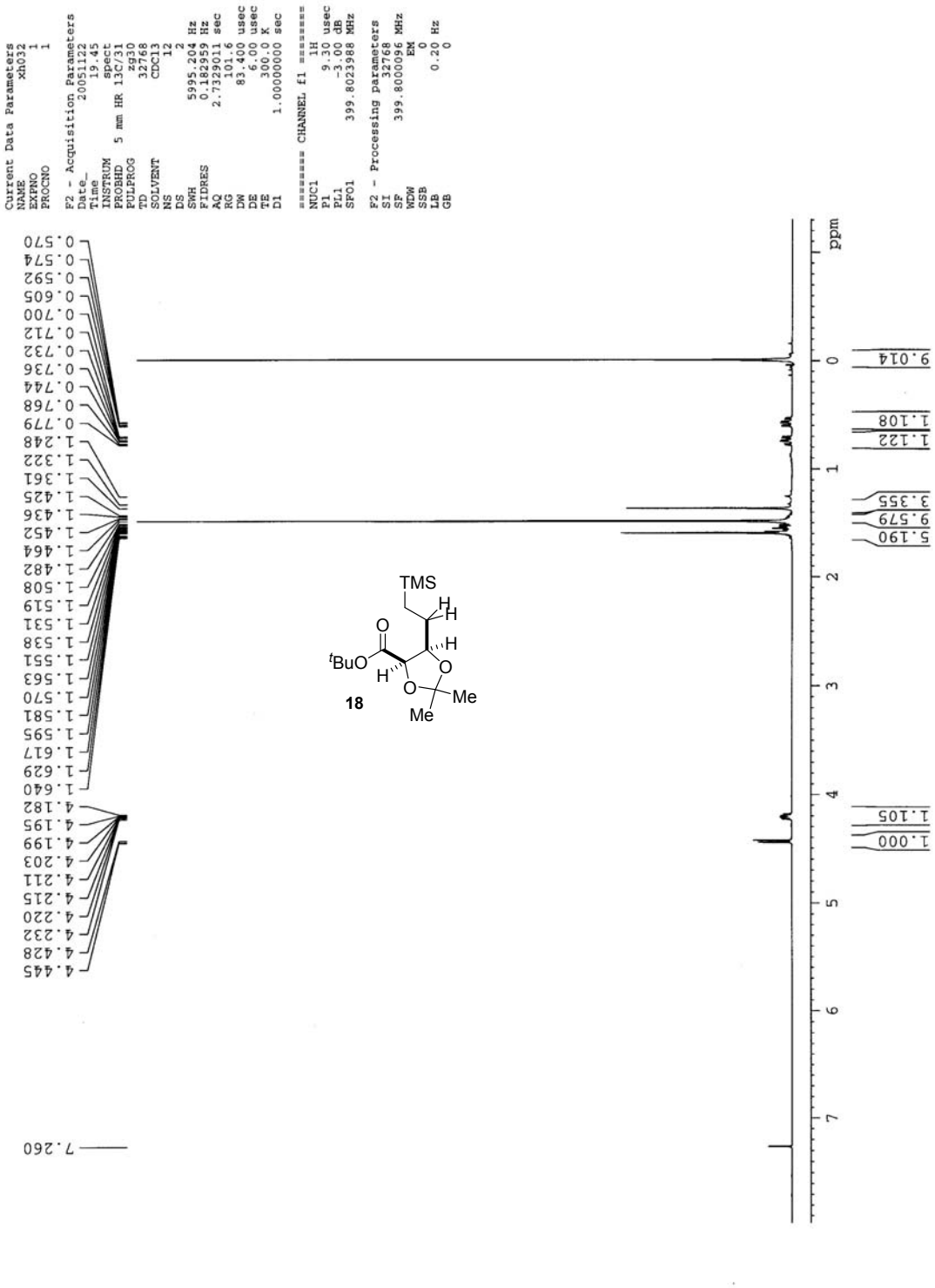
NOESY in $CDCl_3$ for **17**



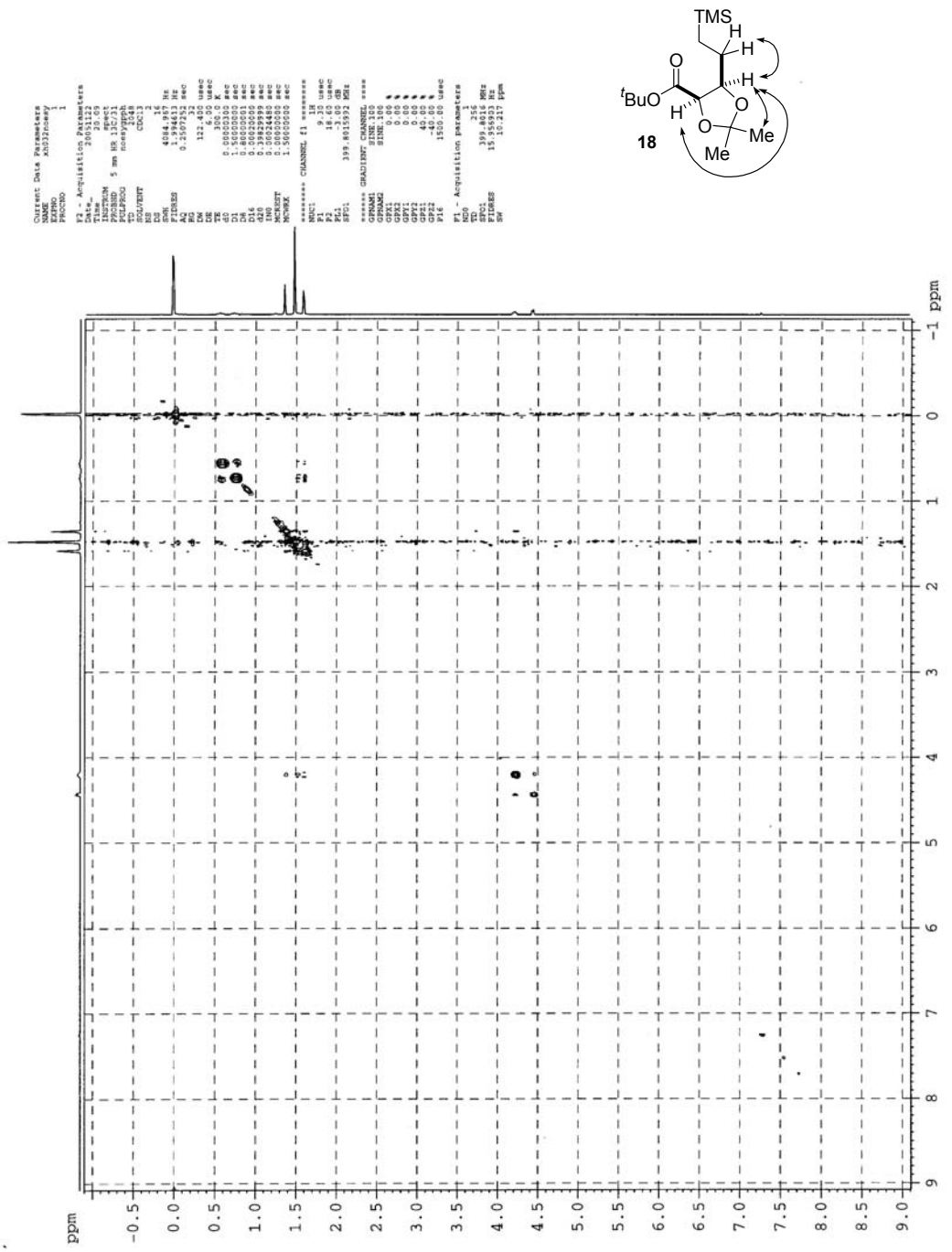
17



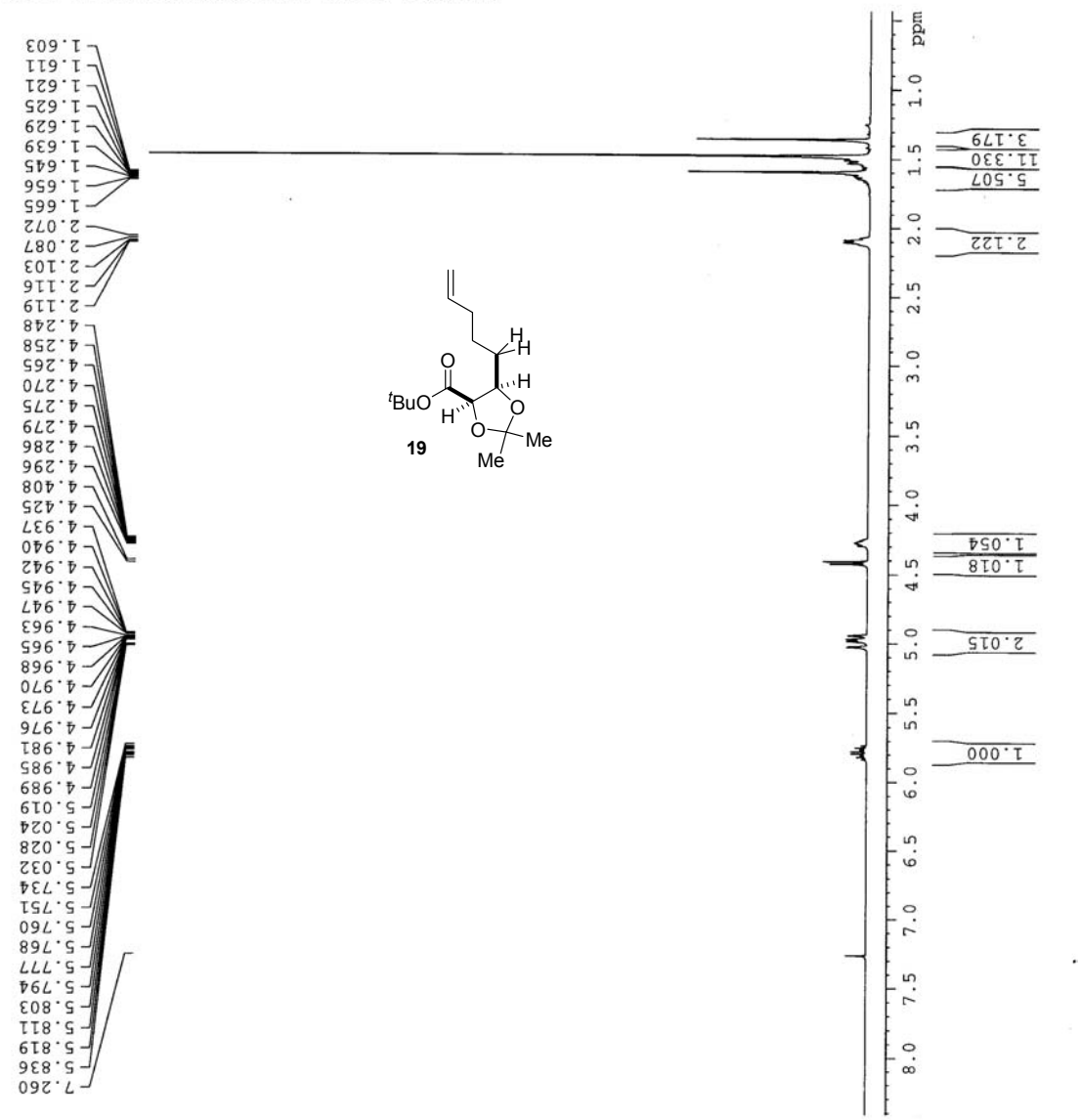
^{1}H NMR in $CDCl_3$ for **18**



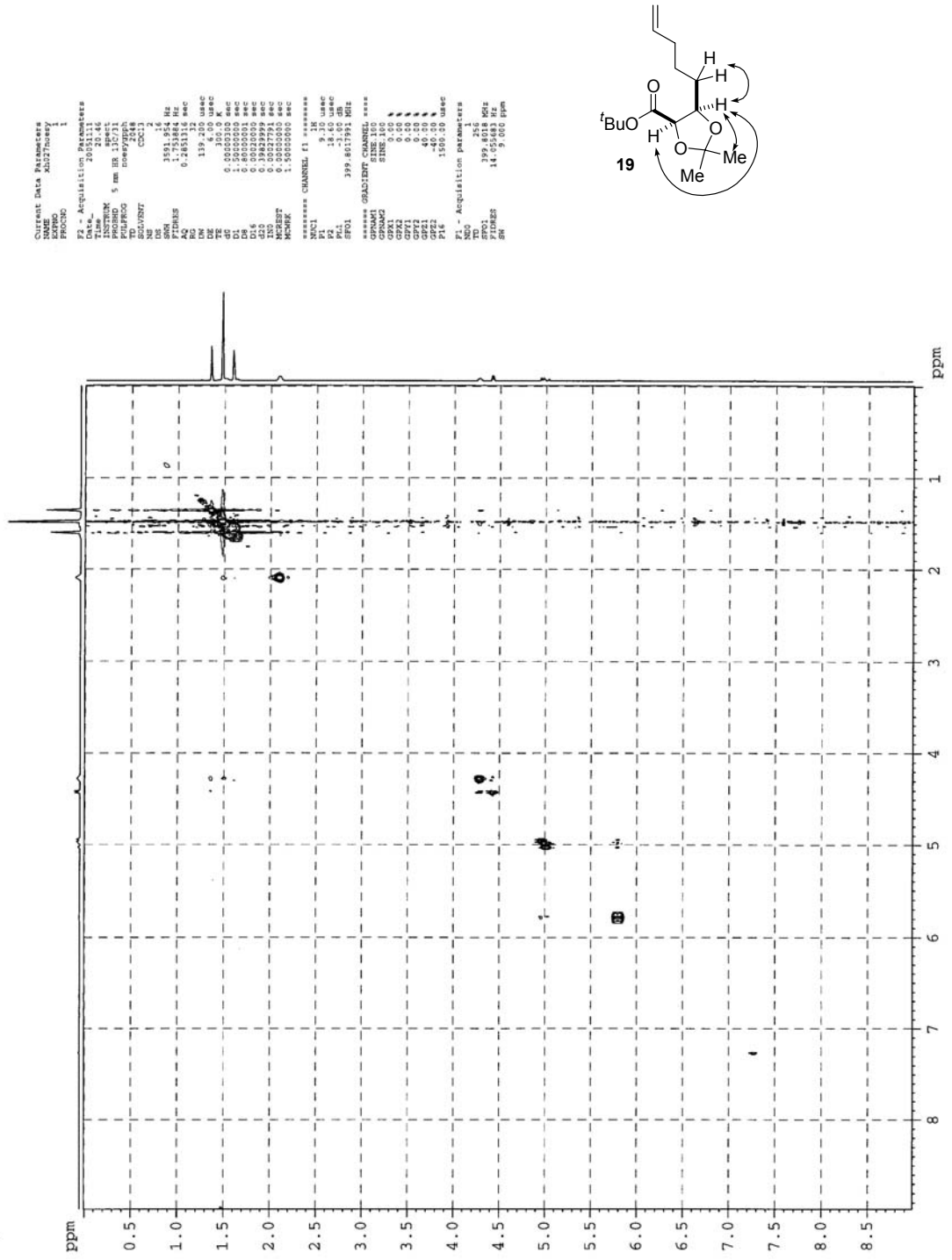
NOESY NMR in $CDCl_3$ for **18**



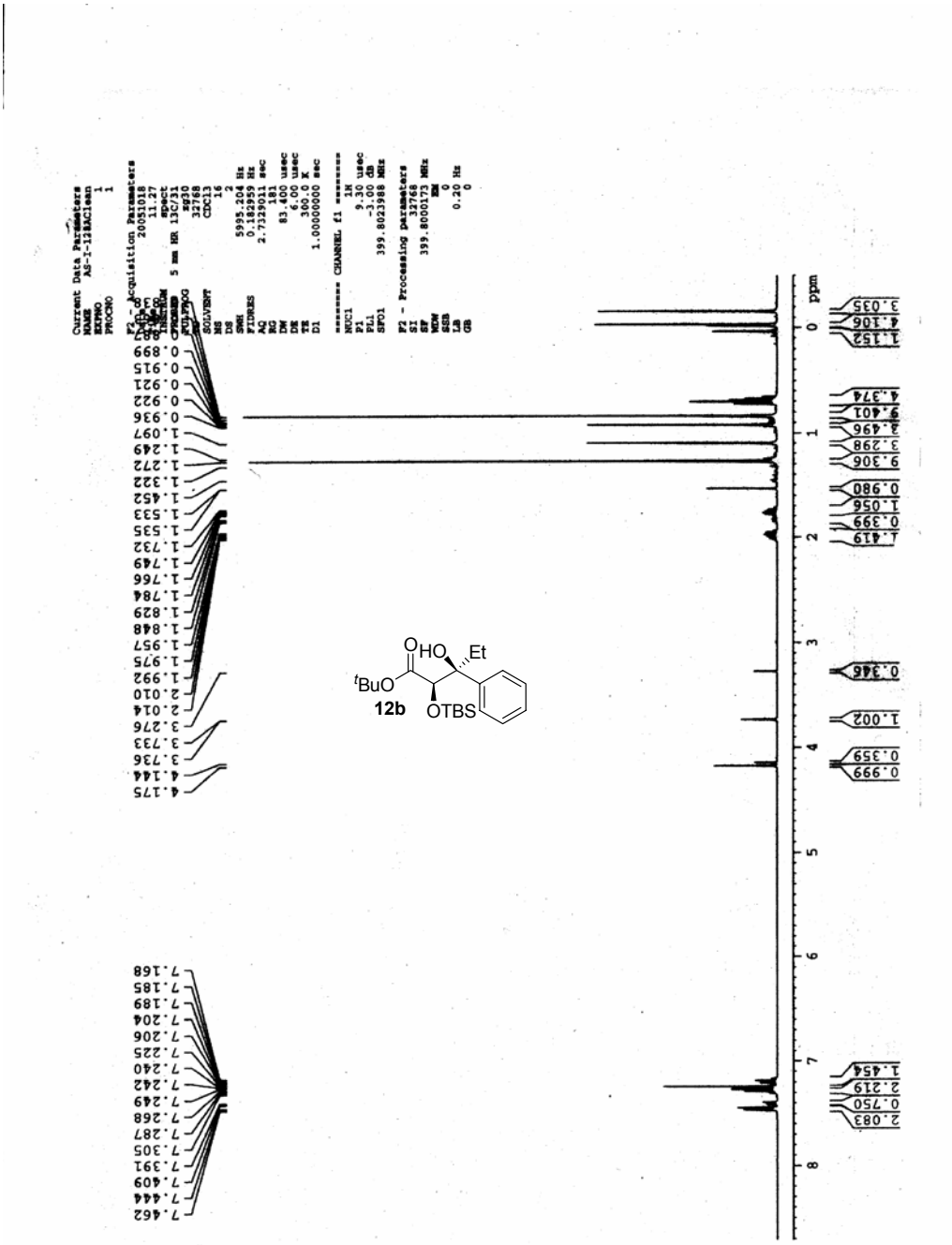
^{1}H NMR in $CDCl_3$ for **19**



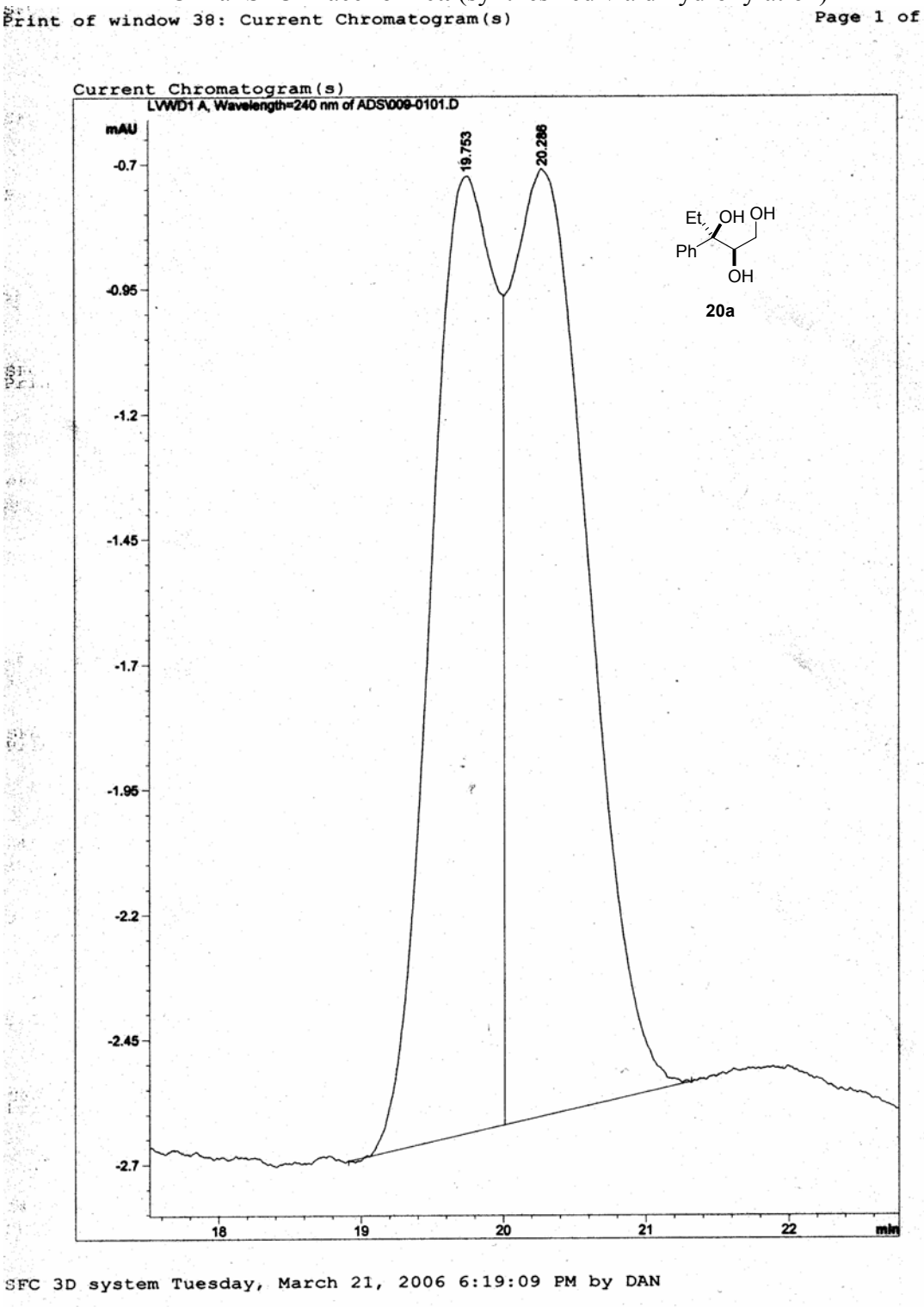
NOESY NMR in $CDCl_3$ for **19**



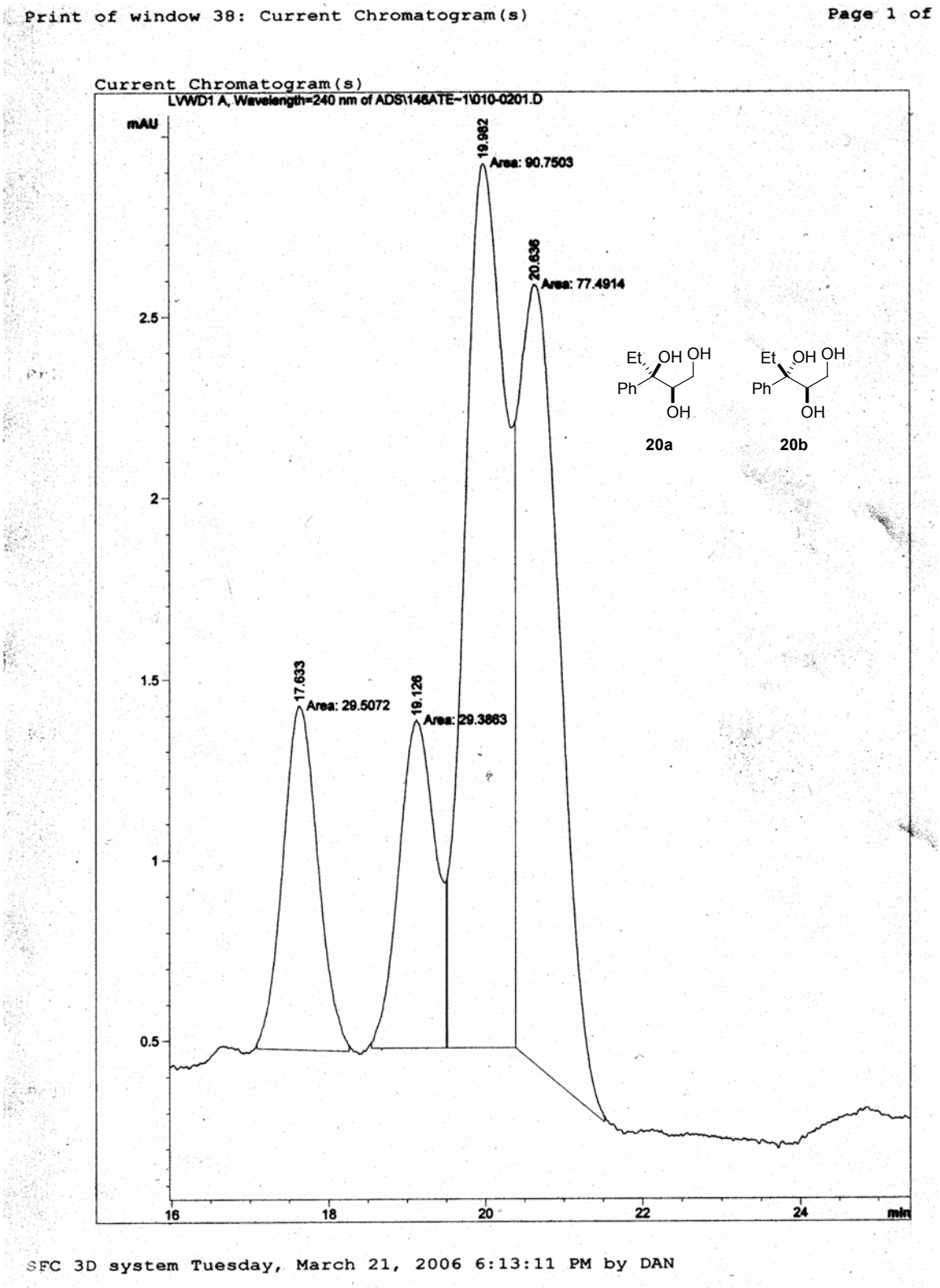
^{1}H NMR in $CDCl_3$ for **12b**



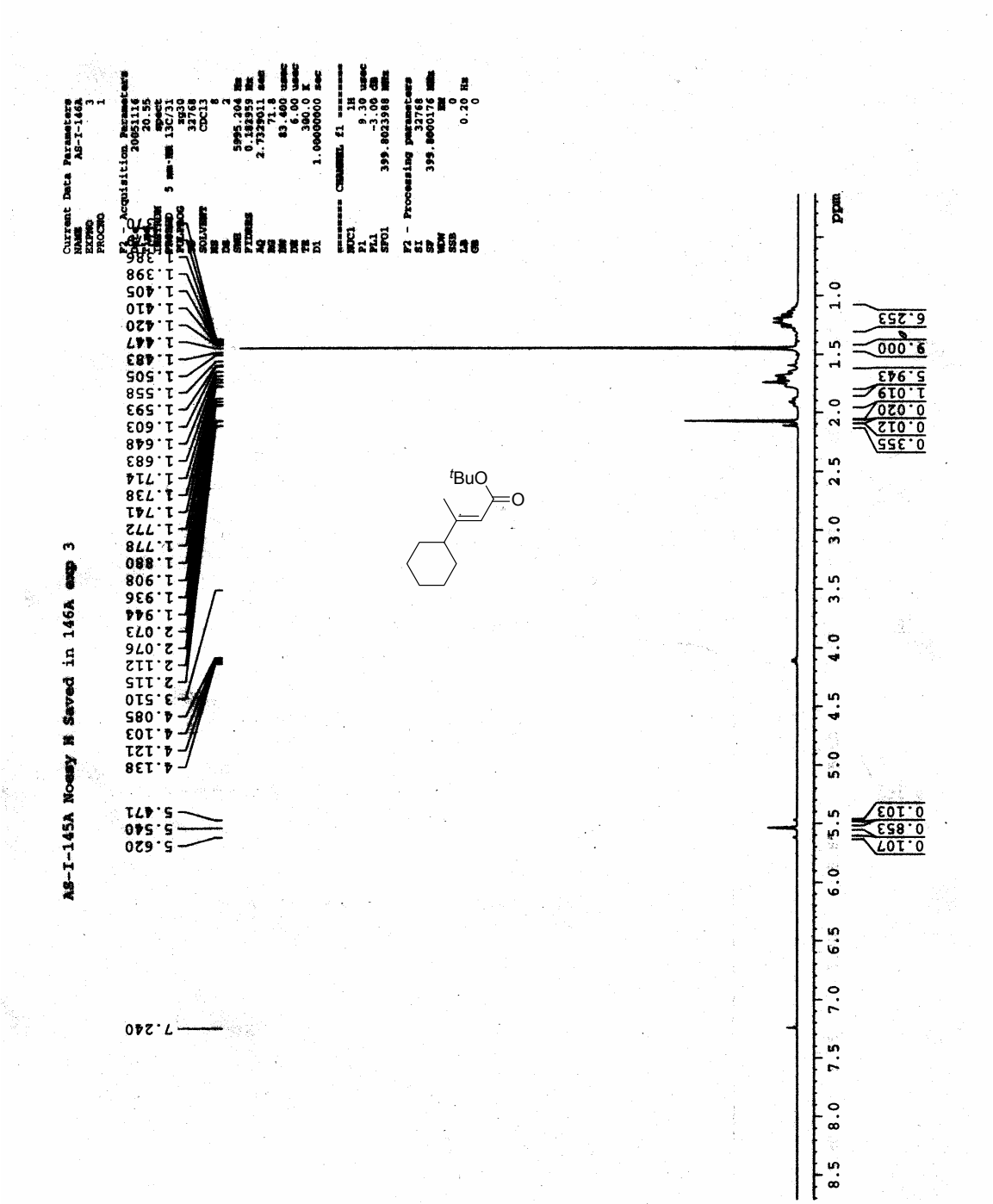
Chiral SFC Trace for **20a** (synthesized via dihydroxylation)



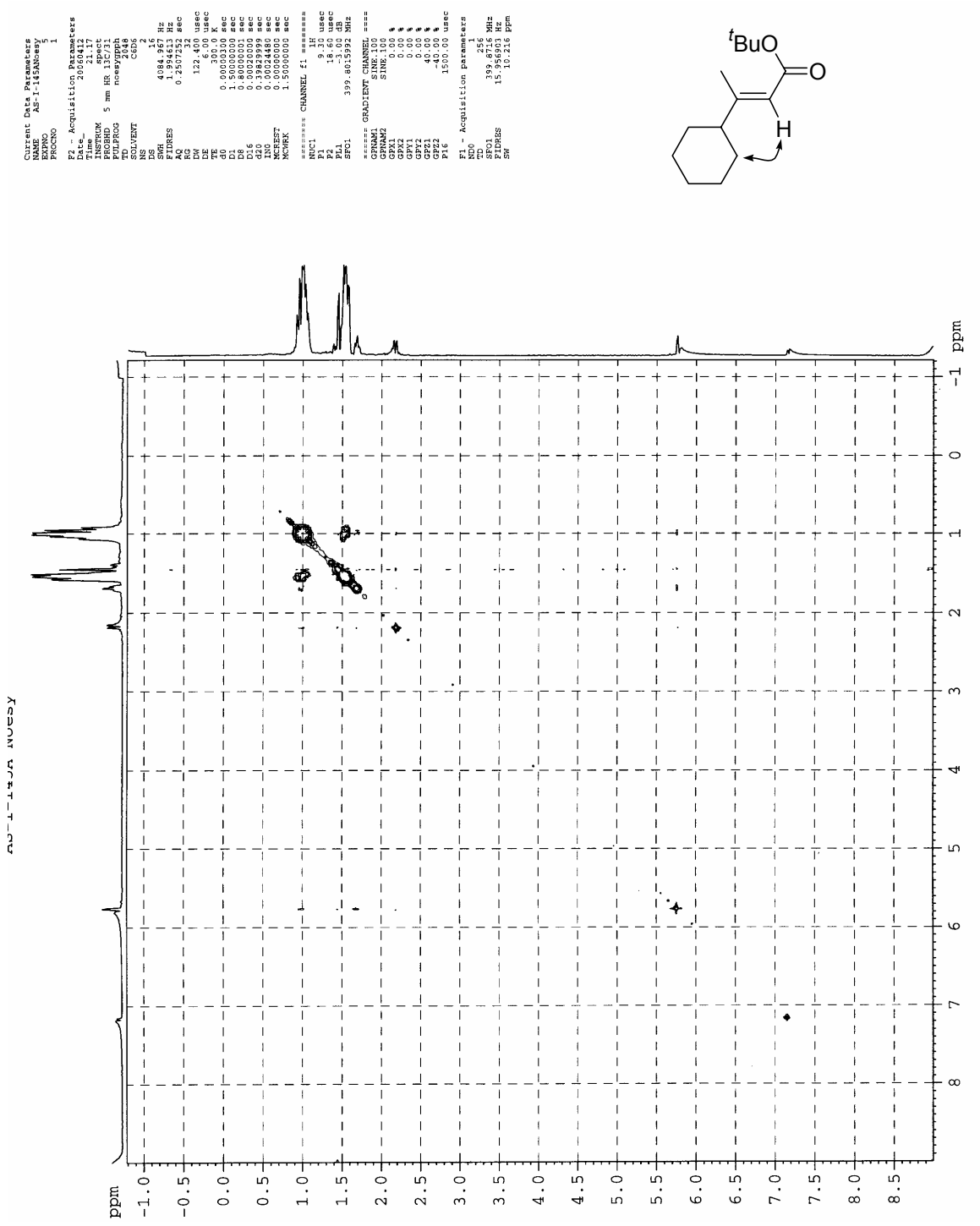
Chiral SFC Trace for **20a** and **20b** derived from **12b**



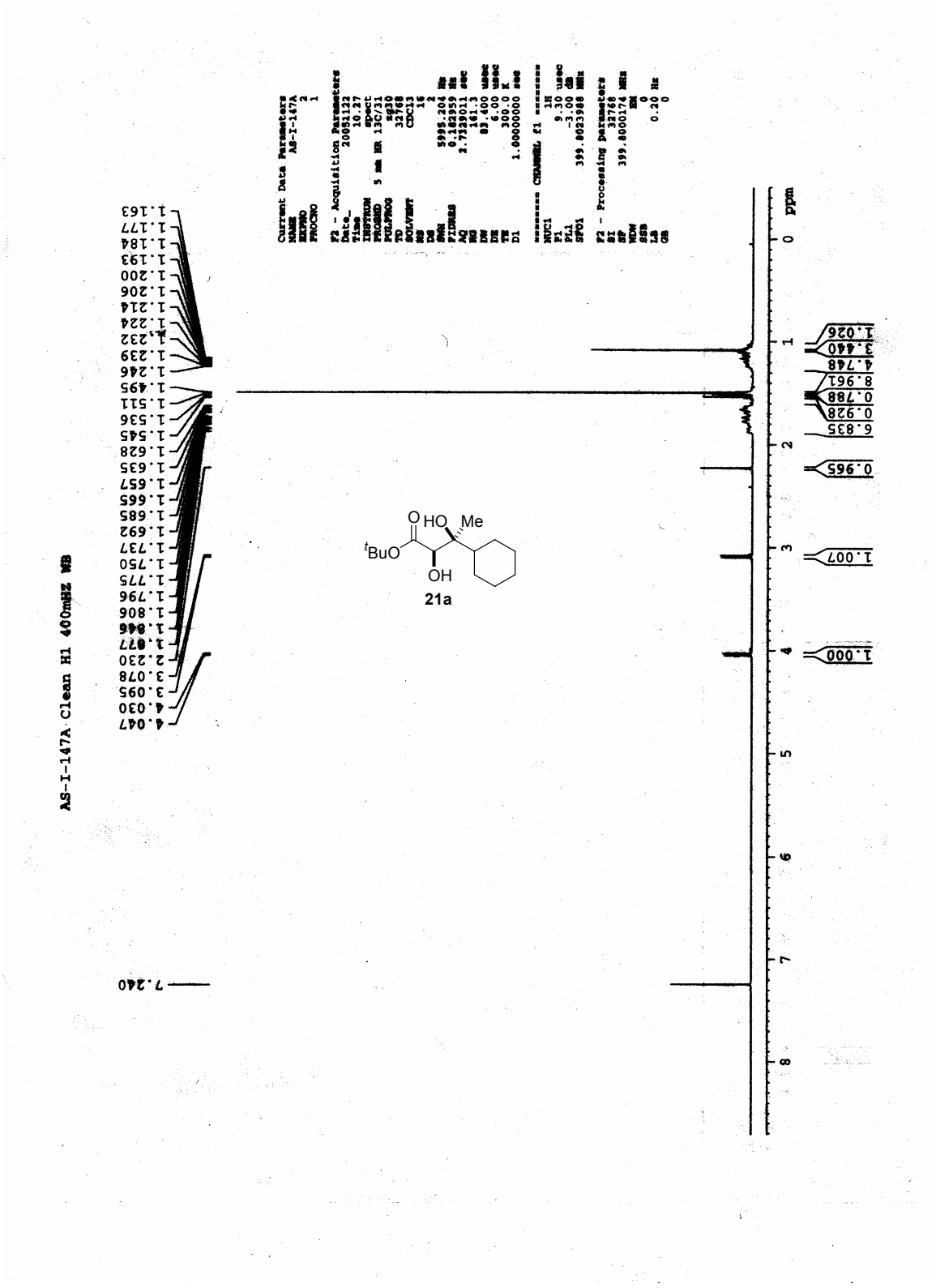
^{1}H NMR in $CDCl_3$ of (*E*)-*tert*-butyl 3-cyclohexylbut-2-enoate



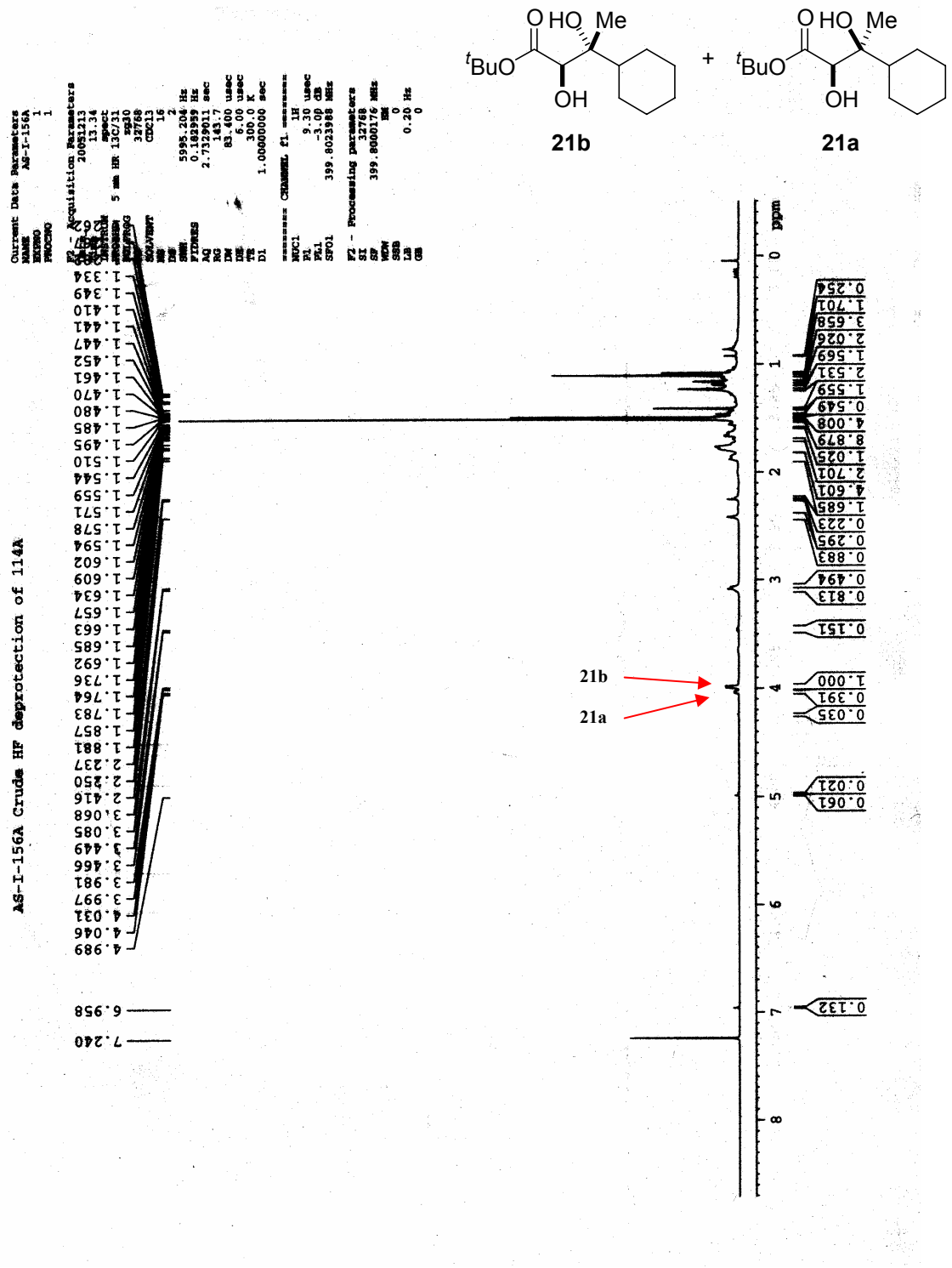
NOESY in $CDCl_3$ of (*E*)-*tert*-butyl 3-cyclohexylbut-2-enoate



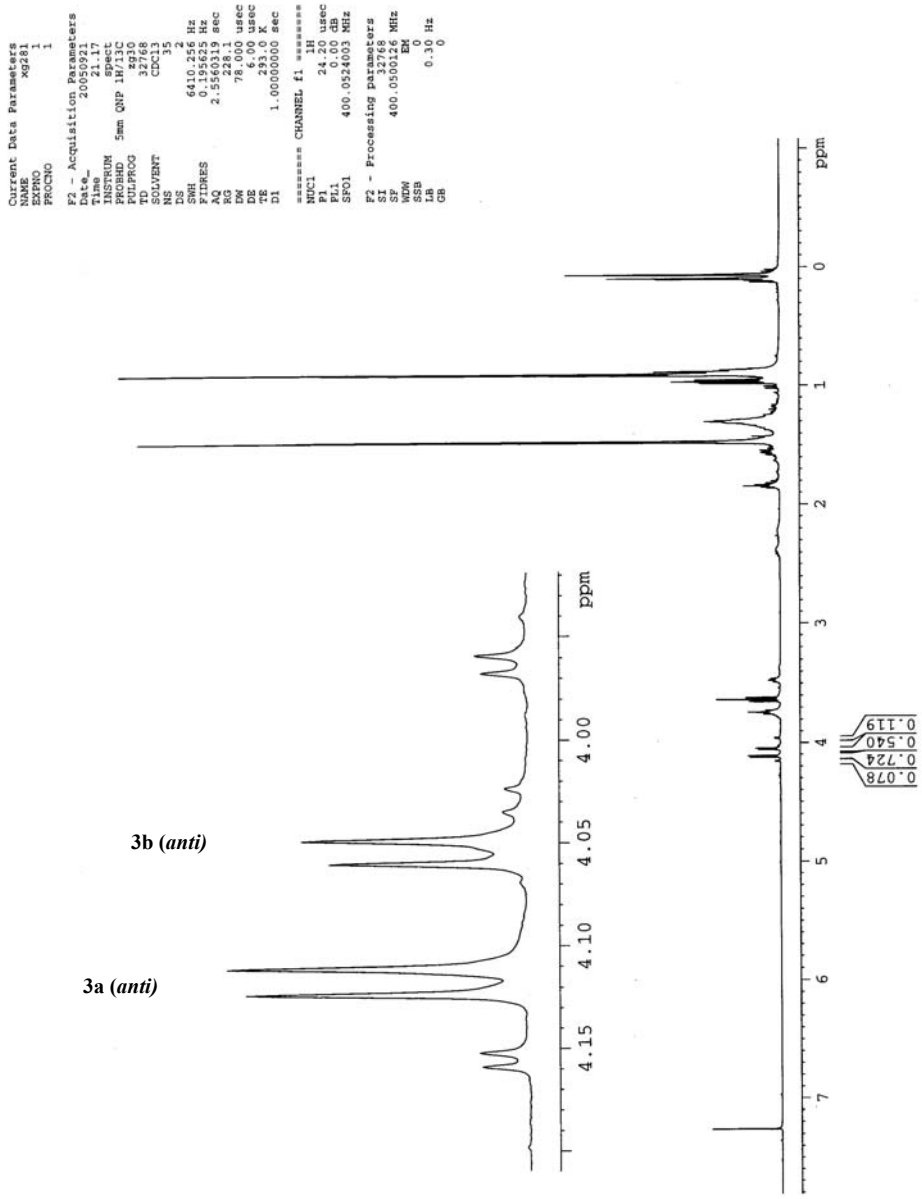
^{1}H NMR in $CDCl_3$ of **21a** derived from dihydroxylation of (*E*)-*tert*-butyl 3-cyclohexylbut-2-enoate



^{1}H NMR in $CDCl_3$ of **21a** and **21b** derived from **12c**



^{1}H NMR spectrum to evaluate crossover



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