

Enantioselective Intramolecular Openings of Oxetanes Catalyzed by (salen)Co(III) Complexes: Access to Enantioenriched Tetrahydrofurans

Rebecca N. Loy and Eric N. Jacobsen*

*Department of Chemistry and Chemical Biology, Harvard University, 12 Oxford Street,
Cambridge, Massachusetts 02138*

Supporting Information

General Procedures. All oxetane ring-opening reactions were conducted in ½ dram vials with a threaded cap under ambient conditions. All other reactions were performed in flame-dried round bottom flasks with septa under positive nitrogen pressure. Stainless steel cannulae or syringes were used to transfer moisture-sensitive and air-sensitive liquids. Flash chromatography was performed using silica gel 60 (230-400 mesh) from EM Science.

Materials. Commercial reagents were purchased from Sigma-Aldrich, Alfa Aesar, Silicycle and Lancaster and used as received with the following exceptions: dichloromethane, tetrahydrofuran, *tert*-butylmethyl ether and diethyl ether were degassed with argon and then passed through a single column of activated alumina for purification.

Instrumentation. Proton nuclear magnetic resonance (^1H NMR) spectra and carbon nuclear magnetic resonance (^{13}C NMR) spectra were recorded on Varian-Mercury-500 (500 MHz and 125 MHz) or Varian-Mercury-600 (600 MHz). Fluorine nuclear resonances (^{19}F NMR) spectra were recorded on a Varian-Mercury-300 (282 MHz). Chemical shifts for protons are reported in parts per million downfield from tetramethylsilane and are referenced to residual protium in the NMR solvent (CHCl_3 : δ 7.26). Chemical shifts for carbon are reported in parts per million downfield from tetramethylsilane and are referenced to the carbon resonances of the solvent (CDCl_3 : δ 77.16). Chemical shifts for fluorine are reported parts per million and are referenced to the fluorine resonances of $\text{BF}_3\cdot\text{OEt}_2$ (δ -128.4). Data are represented as follows: chemical shift, integration, multiplicity (br = broad, s = singlet, d = doublet, t = triplet, q = quartet, m = multiplet, quint = quintet, sept = septet), coupling constants in Hertz (Hz). Infrared (IR) spectra were obtained using a Mattson Galaxy Series FTIR 3000 spectrophotometer referenced to a polystyrene standard and a Perkin Elmer Spectrum 100 FT-IR Spectrometer. Data are represented as follows: frequency of absorption (cm^{-1}), intensity of absorption (s = strong, m = medium, w = weak). Optical rotations were measured using a 2 mL cell with a 1 dm path length on a Jasco P2000 automatic digital polarimeter. The mass spectral data were obtained at the Harvard University mass spectrometry facility. Chiral HPLC analysis was performed on a Shimadzu VP-series instrument. Chiral GC analysis was performed on an HP 5890 instrument.

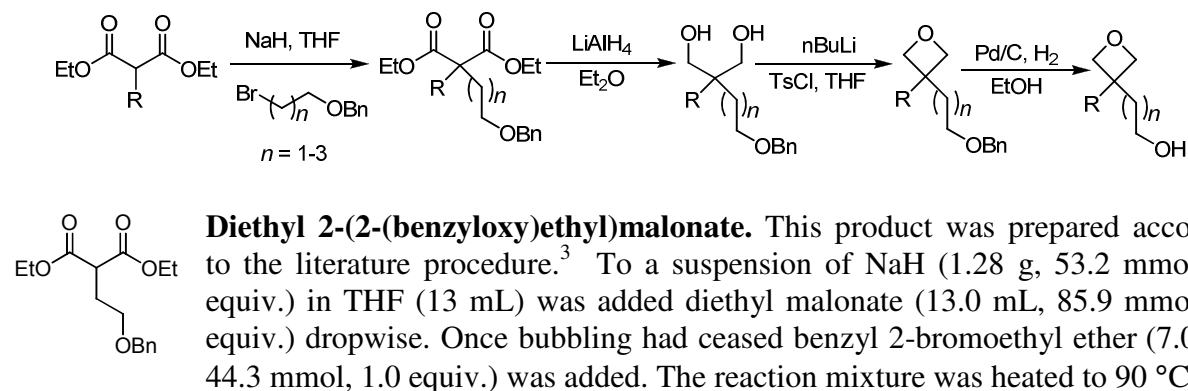
Representative Experimental Procedures.

A) Preparation of catalyst 1-2

1) Catalyst **1** was prepared according to a published procedure.¹ A 50 mL round-bottomed flask equipped with a stir bar was charged with (*R,R*)-(-)-*N,N'*-Bis(3,5-di-*tert*-butylsalicylidene)-1,2-cyclohexanediaminocobalt(II) (933 mg, 1.55 mmol). CH₂Cl₂ (16 mL) was added, and the mixture stirred until complete dissolution had been achieved. Trifluoromethanesulfonic acid (142.5 μ L, 1.61 mmol) was added, and the resulting black solution was stirred vigorously open to the air for 2 h. Solvent was removed via rotary evaporation followed by high vacuum. The solid product was suspended in *n*-pentane and filtered on a Büchner funnel. The cake was washed with *n*-pentane until the filtrate appeared clear. The filtered solid was dissolved in CH₂Cl₂ and filtered through glass wool to remove any insoluble impurities. Solvent was removed under reduced pressure. Isolated 1.10 g of a brown powder containing 9% by mass CH₂Cl₂ by ¹H NMR analysis. The level of hydration of the complex was not determined. The triflate content of the (salen)Co(III) units was estimated by dissolving product (9.2 mg) in pyridine-*d*₅ (1 mL). 4-Fluoroanisole (10 μ L) was added to the solution as an internal standard, and its area was compared to that of the triflate counterion by ¹⁹F NMR analysis. The value observed was 103% of that predicted based on the mass of product employed. The corrected yield was 87%. ¹H NMR (DMSO-*d*₆) δ 7.81 (s, 2H), 7.46 (d, *J* = 2.3 Hz, 2H), 7.43 (d, *J* = 2.3 Hz, 2H), 3.55–3.63 (m, 2H), 3.01–3.10 (m, 2H), 1.95–2.05 (m, 2H), 1.84–1.95 (m, 2H), 1.73 (s, 18H), 1.52–1.62 (m, 2H), 1.29 (s, 18H). ¹³C NMR (DMSO-*d*₆) δ 164.5, 162.0, 141.7, 135.8, 129.1, 128.7, 120.6 (q, *J* = 322.5 Hz), 118.5, 69.2, 35.7, 33.4, 31.4, 30.3, 29.4, 24.2. IR (KBr pellet) ν 2958, 2909, 2869, 1604, 1524, 1464, 1422, 1392, 1361, 1299, 1270, 1250, 1232, 1215, 1177, 1132, 1026, 992, 928, 917, 892, 834, 813, 784, 735, 635, 577, 543, 516, 489, 470, 429 cm⁻¹. MS (ES) *m/z* calcd. for C₃₆H₅₂CoN₂O₂ 603.3, found 603.3 (100%) [M-OTf]⁺; calcd. for C₃₈H₅₅CoN₃O₂ 644.4, found 644.3 (18%) [M-OTf+CH₃CN]⁺.

2) Catalyst **2** was prepared according to a published procedure.²

B) Preparation of Substrates : Method 1

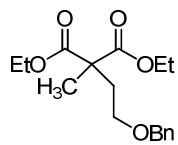


¹ White, D. E. Ph. D. Thesis, Harvard University, Cambridge, Massachusetts, 2005.

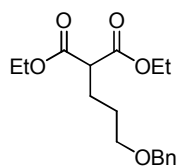
² White, D. E.; Jacobsen, E. N. *Tetrahedron: Asymmetry* **2003**, 14, 3633-3638.

³ Rastetter, W. H.; Phillion, D. P. *J. Org. Chem.* **1981**, 46, 3204-3208.

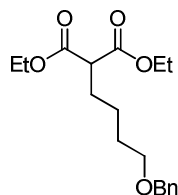
h, at which point the solution was cooled, diluted with Et₂O (100 mL) and extracted with H₂O (100 mL). The aqueous layer was extracted with Et₂O (2 x 100 mL). The combined organic layers were dried over MgSO₄, filtered and concentrated *in vacuo*. The residue obtained was purified by distillation at 0.2 mm Hg and 145-150 °C to yield the product as a colorless oil (11.49 g, 88%). The spectroscopic data is consistent with reported values.³



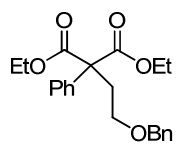
Diethyl 2-(2-(benzyloxy)ethyl)-2-methylmalonate. The general procedure described above was followed using methyl diethyl methylmalonate (9.4 mL, 55.0 mmol, 1.9 equiv.), NaH (0.815 g, 33.9 mmol, 1.2 equiv.) and 3-bromoethyl ether (5.0 mL, 28.3 mmol, 1.0 equiv.). The residue obtained was purified by distillation at 0.04 mm Hg and 134-140°C to yield the product as a colorless oil (8.37 g, 96%). The spectroscopic data is consistent with reported values.⁴



Diethyl 2-(3-(benzyloxy)propyl)malonate. The general procedure described above was followed using diethyl malonate (8.4 mL, 55.0 mmol, 1.9 equiv.), NaH (0.815 g, 33.9 mmol, 1.2 equiv.) and 3-bromopropyl ether (5.0 mL, 28.3 mmol, 1.0 equiv.). The product was purified via distillation at 0.04 mm Hg and 144-149 °C to yield a colorless oil (6.84 g, 75%). IR (thin film, cm⁻¹) 3423 (m), 2982 (m), 2939 (m), 2870 (m), 1680 (s), 1454 (m), 1369 (m), 1277 (m), 1224 (m), 1177 (m), 1097 (m), 1028 (m), 741 (m), 699 (m); ¹H NMR (600 MHz, CDCl₃) δ 7.38-7.30 (4H, m), 7.28 (1H, dd, *J* = 5.9, 2.7 Hz), 4.49 (2H, s), 4.19 (4H, qd, *J* = 7.2, 3.9 Hz), 3.49 (2H, t, *J* = 6.3 Hz), 3.36 (1H, t, *J* = 7.6 Hz), 2.05-1.94 (2 H, m) 1.73-1.60 (2H, m), 1.26 (6H, t, *J* = 7.2 Hz); ¹³C NMR (125 MHz, CDCl₃) δ 169.4, 138.4, 128.3, 127.6, 127.5, 72.8, 69.6, 61.3, 51.7, 27.4, 25.6, 14.0; LRMS (ES+APCI) *m/z*: 309 (100%) [M]⁺.



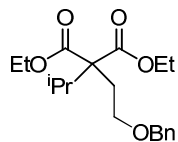
Diethyl 2-(4-(benzyloxy)butyl)malonate. The general procedure described above was followed using diethyl malonate (6.6 mL, 43.7 mmol, 1.5 equiv.), NaH (1.14 g, 45.1 mmol, 1.6 equiv), 4-bromobutyl ether (5.0 mL, 29.1 mmol, 1.0 equiv.) and NaI (87 mg, 0.582 mmol, 0.02 equiv.). The product was purified *via* distillation at 0.04 mm Hg and 150-160 °C to yield a colorless oil (4.35 g, 46%). IR (thin film, cm⁻¹) 2982 (m), 2937 (m), 2865 (m), 1749 (s), 1732 (s), 1454 (m), 1368 (m), 1153 (m), 1098 (m), 1029 (m); ¹H NMR (500 MHz, CDCl₃) δ 7.37-7.31 (4H, m), 7.28 (1H, dd, *J* = 6.1, 2.7 Hz), 4.49 (2H, s), 4.19 (4H, dd, *J* = 6.8, 1.9 Hz), 3.47 (2H, t, *J* = 6.4 Hz), 3.32 (1H, t, *J* = 7.6 Hz), 1.91 (6H, dd, *J* = 8.3, 7.3 Hz), 1.70-1.61 (2H, m), 1.46-1.37 (2H, m), 1.26 (6H, t, *J* = 7.1 Hz); ¹³C NMR (125 MHz, CDCl₃) δ 169.5, 138.6, 128.3, 127.6, 127.5, 72.9, 69.9, 61.3, 52.0, 29.4, 28.5, 24.1, 14.1; LRMS (ESI) *m/z*: 345 (100%) [M+Na]⁺.



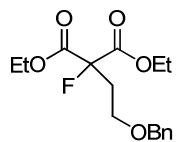
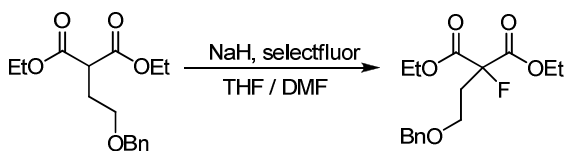
Diethyl 2-(2-(benzyloxy)ethyl)-2-phenylmalonate. The general procedure described above was followed using diethyl phenylmalonate (19.5 mL, 90.2 mmol, 1.9 equiv.), NaH (1.34 g, 55.8 mmol, 1.2 equiv.) and benzyl 2-bromoethyl ether (7.4 mL, 46.5 mmol, 1.0 equiv.) refluxed for 2 d. The product was purified *via* column chromatography (1:1 CH₂Cl₂: hexanes) to yield the product contaminated with 30% diethyl phenylmalonate (15.06 g, 88%). IR (thin film, cm⁻¹) 2981(m), 2937 (w), 2903 (w), 2871 (w), 1732 (s), 1498 (w), 1447 (m), 1366 (m), 1232 (s), 1182 (m), 1099 (m), 1027 (m), 861 (w),

⁴ Kocienski, P.; Todd, M. *J. Chem. Soc. Perkin Trans. I* **1983**, 1783-1789.

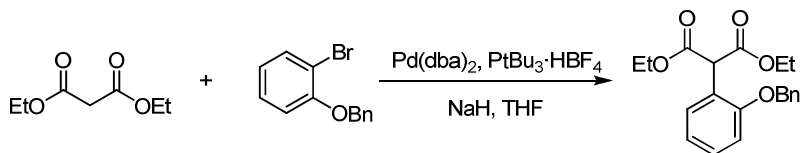
736 (m) 698 (m); ^1H NMR (500 MHz, CDCl_3) δ 7.43 (2H, d, $J = 6.8$ Hz), 7.37-7.27 (7H, m), 4.40 (2H, s), 4.18 (4H, d, $J = 7.3$ Hz), 3.47 (2H, t, $J = 6.8$ Hz), 2.65 (2H, t, $J = 6.6$ Hz), 1.20 (6H, t, $J = 7.1$ Hz); ^{13}C NMR (125 MHz, CDCl_3) δ 170.4, 138.3, 136.6, 128.3, 128.1, 128.0, 127.6, 127.5, 77.2, 72.9, 66.4, 61.6, 60.8, 35.7, 13.9; LRMS (ESI) m/z : 393 (89%) $[\text{M}+\text{Na}]^+$.



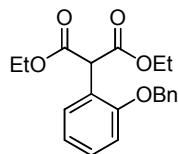
Diethyl 2-(2-(benzyloxy)ethyl)-2-isopropylmalonate. The general procedure described above was followed using diethyl isopropylmalonate (8.0 mL, 38.8 mmol, 1.8 equiv.), NaH (0.931 g, 38.8 mmol, 1.0 equiv.) and 2-bromoethyl ether (3.4 mL, 21.5 mmol, 1.0 equiv.). The product was purified *via* distillation to yield a colorless oil (5.08 g, 70%). IR (thin film, cm^{-1}) 2978 (m), 2938 (w), 2878 (w), 1726 (s), 1454 (m) 1392 (w), 1368 (w) 1227 (m), 1042 (m), 1028 (m), 738 (m), 698 (m); ^1H NMR (600 MHz, CDCl_3) δ 7.36-7.31 (4H, m), 7.30-7.25 (1H, m), 4.46 (2H, s), 4.15 (4H, qd, $J = 7.1$, 5.3 Hz), 3.54 (2H, t, $J = 7.0$ Hz), 2.35 (1H, heptet, $J = 6.8$ Hz), 2.24 (2H, t, $J = 7.0$ Hz), 1.23 (6H, t, $J = 7.0$ Hz), 0.99 (6H, d, $J = 6.7$ Hz); ^{13}C NMR (125 MHz, CDCl_3) δ 170.9, 138.4, 128.3, 127.6, 127.5, 73.0, 66.9, 60.8, 59.9, 33.3, 32.6, 18.6, 14.1; LRMS (ESI) m/z : 359 (100%) $[\text{M}+\text{Na}]^+$.



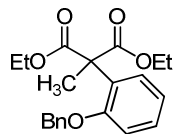
Diethyl 2-(2-(benzyloxy)ethyl)-2-fluoromalonate. The compound was synthesized according to a known procedure that was modified.⁵ To a suspension of NaH (1.17 g, 48.8 mmol, 1.2 equiv) in THF (21 mL) was added diethyl 2-(2-(benzyloxy)ethyl)malonate (11.98 g, 40.7 mmol, 1.0 equiv.). The reaction mixture was stirred at 70 °C for 12 h. The solution was cooled to room temperature and diluted with THF (210 mL) and DMF (210 mL), cooled to 0 °C and selectfluor® was added (15.4 g, 43.4 mmol, 1.1 equiv.). The solution was stirred for 4 h at 0 °C and warmed to room temperature. The reaction mixture was quenched by the addition of H_2O and extracted with Et_2O . The organic layers were dried over MgSO_4 , filtered and concentrated. The product was obtained as a colorless oil after purification *via* column chromatography (CH_2Cl_2) (10.82 g, 85%). IR (thin film, cm^{-1}) 1748 (s), 1455 (w), 1369 (m), 1306 (m), 1274 (m), 1238 (m), 1211 (m), 1155 (w), 1097 (s), 1025 (s), 858 (m), 739 (m), 698 (s); ^1H NMR (500 MHz, CDCl_3) δ 7.37-7.26 (5H, m); 4.45 (2H, s), 4.20 (4H, qt, $J = 7.0$, 3.4 Hz), 3.65 (2H, t, $J = 5.9$ Hz), 2.52 (2H, dt, $J = 22.2$, 6.1 Hz), 1.24 (6H, t, $J = 7.1$ Hz); ^{13}C NMR (125 MHz, CDCl_3) δ 166.2 (d, $J = 26.3$ Hz), 137.9, 128.3, 127.7, 127.6, 110.7, 73.1, 63.9 (d, $J = 3.8$ Hz), 62.5, 34.4 (d, $J = 21.3$ Hz), 13.9; ^{19}F NMR (282.3 MHz, CDCl_3) δ -169.8; LRMS (ESI) m/z : 313 (50%) $[\text{M}+\text{H}]^+$.



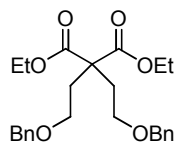
⁵ Lal, G. S. *J. Org. Chem.* **1993**, 58, 2791-2796.



Diethyl 2-(2-(benzyloxy)phenyl)malonate. The compound was synthesized according to a known procedure that was modified.⁶ To a solution of diethyl malonate (5.1 mL, 33.4 mmol, 1.1 equiv) in THF (30 mL) was added NaH (0.839 g, 3.5 mmol) slowly. Once bubbling ceased 1-(benzyloxy)-2-bromobenzene⁷ (7.99 g, 30.4 mmol, 1 equiv), $(t\text{Bu})_3\text{P}\cdot\text{HBF}_4$ (0.348 g, 1.2 mmol 0.04 equiv.), $\text{Pd}(\text{dba})_2$ (0.612 g, 0.67 mmol, 0.02 equiv.) and THF (60 mL) were added. The green reaction mixture was stirred at 70 °C for 36 h. The solution was cooled and filtered through a plug of celite eluting with Et_2O . The filtrate was concentrated and the residue obtained was purified *via* column chromatography (2:1 hexanes: $\text{CH}_2\text{Cl}_2 \rightarrow \text{CH}_2\text{Cl}_2$) to yield the desired product as a yellow solid (contaminated with diethyl malonate) (8.13 g, 78%). IR (thin film, cm^{-1}) 2981 (m), 1753 (s), 1732 (s), 1602 (w), 1590 (w), 1495 (m), 1453 (m), 1367 (m) 1301 (m), 1246 (m), 1226 (m), 1148 (m) 1033 (m), 752 (m) 697 (m); ^1H NMR (600 MHz, CDCl_3) δ 7.27-7.44 (6H, m), 7.00 (1H, td, $J = 7.5, 0.9$ Hz), 6.96 (1H, d, $J = 8.2$ Hz), 5.19 (2H, s), 5.10 (2H, s), 4.21 (4H, qd, $J = 7.0, 2.5$ Hz), 1.25 (6H, t, $J = 7.1$ Hz); ^{13}C NMR (125 MHz, CDCl_3) δ 168.5, 156.0, 136.8, 129.4, 129.3, 128.5, 127.8, 127.1, 122.3, 121.0, 111.9, 70.2, 61.5, 51.6, 14.0. LRMS (ESI) m/z : 365 (97%) $[\text{M}+\text{Na}]^+$.



Diethyl 2-(2-(benzyloxy)phenyl)-2-methylmalonate. The compound was synthesized according to a known procedure that was modified.⁵ To a round bottom flask contained diethyl malonate (5.25 mL, 34.5 mmol, 1.0 equiv.) and 1-(benzyloxy)-2-bromobenzene (10.0 g, 38 mmol, 1.1 equiv.) were added $\text{P}^t\text{Bu}_3\cdot\text{HBF}_4$ (0.400 g, 1.38 mmol, 0.04 equiv.), $\text{Pd}(\text{dba})_2$ (0.632 g, 0.69 mmol, 0.02 equiv.) and K_3PO_4 (33.3 g, 15.7 mmol, 4.6 equiv.) followed by toluene (70 mL). The reaction mixture was heated to 70 °C for 36 h at which point the suspension was cooled and iodomethane (4.3 mL, 69 mmol, 2.0 equiv.) was added. The reaction mixture was stirred for 24 h at 70 °C. The suspension was cooled, additional iodomethane (2.2 mL, 33.5 mmol, 1.0 equiv.) was added and the mixture was stirred for an additional 3 h at 70 °C. The suspension was cooled, filtered through celite and concentrated. The residue obtained was purified *via* column chromatography (1:1 CH_2Cl_2 :hexanes) to yield the product as a white solid (5.50 g, 45%). IR (thin film, cm^{-1}) 3065 (w), 3033 (w), 2983 (m), 2951(w), 2904 (w), 2872 (w), 1731 (s), 1600 (m), 1495 (m), 1448 (m), 1373 (m), 1244 (s), 1106 (s), 1023 (m), 860 (m), 750 (m), 697 (m); ^1H NMR (500 MHz, CDCl_3) δ 7.41-7.35 (4H, m), 7.32 (1H, td, $J = 5.9, 2.4$ Hz), 7.28-7.23 (1H, m), 7.11 (1H, dd, $J = 7.8, 1.5$ Hz), 6.95 (2H, td, $J = 7.3, 0.9$ Hz), 5.08 (2H, s), 4.13 (4H, dq, $J = 19.2, 7.1$ Hz), 1.86 (3H, s), 1.18 (6H, t, $J = 7.1$ Hz); ^{13}C NMR (500 MHz, CDCl_3) δ 171.3, 156.1, 136.8, 129.2, 128.7, 128.4, 127.7, 127.3, 127.0, 120.8, 112.6, 70.3, 61.4, 57.8, 21.8, 13.9; LRMS (ESI) m/z : 379 (94%) $[\text{M}+\text{Na}]^+$.

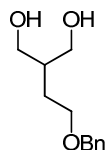


Diethyl 2,2-bis(2-(benzyloxy)ethyl)malonate. The general procedure described above was followed using diethyl malonate (3.4 mL, 22.1 mmol, 1.0 equiv.), NaH (2.12 g, 53.0 mmol, 2.4 equiv.) and 2-bromoethyl ether (7.0 mL, 44.3 mmol, 2.0 equiv.). The product was purified *via* column chromatography (1:4 CH_2Cl_2 :hexanes $\rightarrow\text{CH}_2\text{Cl}_2$) to yield a colorless oil (3.30 g, 35%). IR (thin film, cm^{-1}) 2979 (w), 2863 (m), 1728 (s), 1454 (w), 1366 (w), 1266 (m), 1213 (m), 1191 (m), 1158 (m), 1104 (m),

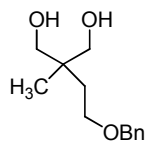
⁶ Beare, N. A.; Hartwig, J. F. *J. Org. Chem.* **2002**, 67, 541-555.

⁷ Zhang, A.; RajanBabu, T. V. *J. Am. Chem. Soc.* **2006**, 128, 54-55.

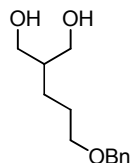
1027 (m); ^1H NMR (600 MHz, CDCl_3) δ 7.36-7.23 (10H, m), 4.42 (4H, s), 4.07 (4H, q, $J = 7.0$ Hz), 3.50 (4H, t, $J = 6.6$ Hz), 2.31 (4H, t, $J = 6.6$ Hz), 1.17 (6H, t, $J = 7.0$ Hz); ^{13}C NMR (500 MHz, CDCl_3) δ 171.3, 138.2, 128.3, 127.6, 127.5, 73.0, 66.2, 61.2, 54.3, 32.4, 13.9; LRMS (ESI) m/z : 451 (92%) $[\text{M}+\text{Na}]^+$.



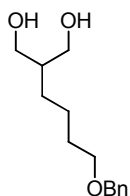
2-(2-(Benzyloxy)ethyl)propane-1,3-diol. This product was prepared according to the literature procedure.³ To a suspension of LiAlH_4 (2.96 g, 78 mmol, 2 equiv.) in Et_2O (15.4 mL) was added a solution of diethyl 2-(2-(benzyloxy)ethyl)malonate (11.49 g, 39 mmol, 1.0 equiv.) in Et_2O (54 mL) dropwise via cannula at 0 °C. The reaction mixture was warmed to rt and stirred for 12 h, at which point H_2O (9 mL), 15% NaOH in H_2O (9 mL) and H_2O (18 mL) were added sequentially to quench the reaction. The mixture was diluted with EtOAc (100 mL), filtered to remove aluminum salts and the filtrate was concentrated. The residue obtained was purified by column chromatography (4:1 EtOAc :hexanes) to yield the product as a colorless oil (4.46 g, 54%). Characterization data were in agreement with literature values.³



2-(2-(Benzyloxy)ethyl)-2-methylpropane-1,3-diol. The general procedure described above was followed using LiAlH_4 (2.06 g, 54.3 mmol, 2.0 equiv.) and diethyl 2-(2-(benzyloxy)ethyl)-2-methylmalonate (8.37 g, 27.2 mmol, 1.0 equiv.) for 12 h. The product was obtained as a colorless oil after column chromatography (4:1 EtOAc :hexanes) (5.65 g, 93%). Characterization data were in agreement with literature values.⁴

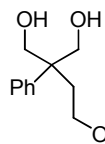


2-(3-(Benzyloxy)propyl)propane-1,3-diol. The general procedure described above was followed using LiAlH_4 (1.61 g, 42.5 mmol, 2.0 equiv.), diethyl 2-(3-(benzyloxy)propyl)malonate (6.84 g, 21.2 mmol, 1.0 equiv.) and Et_2O (42 mL). The product was obtained as a colorless oil after column chromatography (4:1 EtOAc :hexanes) (3.57 g, 75%). Characterization data were in agreement with literature values.⁸

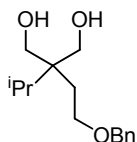


2-(4-(Benzyloxy)butyl)propane-1,3-diol. The general procedure described above was followed using LiAlH_4 (1.61 g, 42.5 mmol, 2.0 equiv.), diethyl 2-(4-(benzyloxy)butyl)malonate (2.05 g, 54 mmol, 1.0 equiv.) and Et_2O (35 mL). The product was obtained as a colorless oil after column chromatography (4:1 EtOAc :hexanes) (2.50 g, 78%). IR (thin film, cm^{-1}) 3371(s), 2933 (s), 2862 (s), 1454 (m), 1265 (m), 1097 (s), 1028 (s), 739 (s), 698 (s); ^1H NMR (500 MHz, CDCl_3) δ 7.38-7.32 (4H, m), 7.29 (1H, td, $J = 6.2, 2.7$ Hz), 4.51 (2H, s), 3.82 (2H, ddd, $J = 10.1, 5.0, 4.9$ Hz), 3.68 (2H, ddd, $J = 4.4, 4.4, 2.9$ Hz), 3.48 (2H, t, $J = 6.6$ Hz), 2.21 (2H, d, $J = 4.4$ Hz), 1.83-1.72 (1H, m), 1.62 (2H, q, $J = 6.8$ Hz), 1.43 (2H, ddd, $J = 15.9, 7.8, 7.6$ Hz), 1.28 (2H, dd, $J = 9.3, 6.8$ Hz); ^{13}C NMR (125 MHz, CDCl_3) δ 138.5, 128.4, 127.7, 127.5, 72.9, 70.1, 66.5, 42.0, 29.9, 27.5, 23.9; LRMS (ESI) m/z : 261 (100%) $[\text{M}+\text{Na}]^+$.

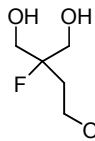
⁸ Schmidt, U.; Lieberknecht, A.; Kazmaier, U.; Griesser, H.; Jung, G.; Metzger, J. *Synthesis* **1991**, 49-55.



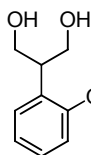
2-(2-(benzyloxy)ethyl)-2-phenylpropane-1,3-diol. The general procedure described above was followed using LiAlH_4 (4.42 g, 117 mmol, 2.9 equiv.), diethyl 2-(2-(benzyloxy)ethyl)-2-phenylmalonate (contaminated with 30% diethyl phenylmalonate) (15.1 g, 41 mmol, 1.0 equiv.) and Et_2O (35 mL). The product was obtained as a colorless oil after column chromatography (4:1 EtOAc: hexanes) (2.49 g, 21%). IR (thin film, cm^{-1}) 3396 (m), 3089 (w), 3060 (w), 3030 (w), 2936 (m), 1738 (w), 1600 (w), 1497 (m), 1454 (m), 1366 (m), 1366 (m), 1309 (w), 1243 (w), 1208 (w), 1095 (m), 1074 (m), 1029 (m), 761 (m), 737 (m), 699 (m); ^1H NMR (600 MHz, CDCl_3) δ 7.39-7.31 (4H, m), 7.31-7.22 (6H, m), 4.44 (2H, s), 4.03-3.88 (4H, m), 3.50 (2H, t, $J = 5.3$ Hz), 2.91-2.81 (2H, m), 2.19 (2H, t, $J = 5.3$ Hz); ^{13}C NMR (125 MHz, CDCl_3) δ 141.5, 137.4, 128.7, 128.5, 127.9, 127.8, 126.8, 126.7, 73.4, 68.6, 66.9, 47.3, 33.0; LRMS (ESI) m/z : 309 (94%) $[\text{M}+\text{Na}]^+$.



2-(2-(Benzyloxy)ethyl)-2-isopropylpropane-1,3-diol. The general procedure described above was followed using LiAlH_4 (1.15 g, 30.2 mmol, 2.0 equiv.), diethyl 2-(2-(benzyloxy)ethyl)-2-isopropylmalonate (5.08 g, 15.1 mmol, 1.0 equiv.) and Et_2O (27 mL). The product was obtained as a colorless oil after column chromatography (4:1 EtOAc: hexanes) (2.77 g, 73%). IR (thin film, cm^{-1}) 3397 (s), 2960 (m), 2879 (m), 1497 (m), 1467 (w), 1387 (w), 1367 (w), 1094 (m), 1029 (m), 737 (m), 689 (m); ^1H NMR (600 MHz, CDCl_3) δ 7.39-7.34 (2H, m), 7.33-7.29 (3H, m), 4.53 (2H, s), 3.67 (2H, dd, $J = 6.4, 4.7$ Hz), 3.64 (4H, q, $J = 5.4$ Hz), 3.17 (2H, t, $J = 6.2$ Hz), 1.82 (2H, t, $J = 5.6$ Hz), 1.77 (1H, heptet, $J = 6.0$ Hz), 0.85 (6H, d, $J = 7.0$ Hz); ^{13}C NMR (125 MHz, CDCl_3) 137.3, 128.6, 128.0, 127.9, 73.5, 67.4, 66.8, 42.7, 30.2, 30.0, 17.2; LRMS (ESI) m/z : 275 (99%) $[\text{M}+\text{Na}]^+$.



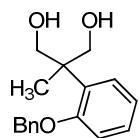
2-(2-(Benzyloxy)ethyl)-2-fluoropropane-1,3-diol. The compound was synthesized according to a known procedure that was modified.⁹ To a suspension of LiAlH_4 (2.16 g, 56.8 mmol, 1.6 equiv.) in THF (60 mL) and toluene (13.5 mL) was added a solution of diethyl 2-(2-(benzyloxy)ethyl)-2-fluoromalonate (10.82 g, 34.6 mmol, 1.0 equiv.) in THF (11 mL) at -78°C . The reaction mixture was slowly warmed to room temperature and stirred for 3 h. The reaction was quenched upon the subsequent addition of H_2O (6 mL), 15% NaOH (6 mL) and H_2O (18 mL). The green suspension was filtered and concentrated. The residue obtained was purified *via* column chromatography (4:1 EtOAc:hexanes) to yield the product as a colorless oil (1.33 g, 17%). IR (thin film, cm^{-1}) 3382 (s), 2933 (m), 2876 (m), 1497 (w), 1454 (m), 1366 (m), 1027 (w), 1095 (m), 1059 (s), 1028 (m), 913 (w), 870 (w), 740 (m), 698 (m); ^1H NMR (500 MHz, CDCl_3) δ 7.39-7.34 (2H, m), 7.34-7.29 (3H, m), 4.54 (2H, s), 3.81-3.68 (4H, m), 3.68-3.63 (2H, m), 2.62-2.50 (1H, m), 2.13-2.00 (3H, m); ^{13}C NMR (125 MHz, CDCl_3) δ 137.1, 128.6, 128.1, 127.9, 97.5 (d, $J = 171.1$ Hz), 73.6, 65.1 (d, $J = 6.4$ Hz), 64.5 (d, $J = 27.3$ Hz), 32.4 (d, $J = 22.8$ Hz); ^{19}F NMR (282 MHz, CDCl_3) δ -150.2; LRMS (ESI) m/z : 251 (99%) $[\text{M}+\text{Na}]^+$.



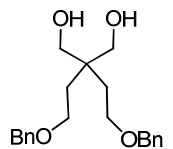
2-(2-(benzyloxy)phenyl)propane-1,3-diol. To a suspension of LiAlH_4 (2.80 g, 47.5 mmol, 2.0 equiv.) in Et_2O (9 mL) was added a solution of diethyl 2-(2-

⁹ Kirsch, P.; Hahn, A.; Fröhlich, R.; Haufe, G. *Eur. J. Org. Chem.* **2006**, 4819-4824.

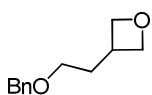
(benzyloxy)phenyl)malonate (8.13 g, 23.8 mmol, 1.0 equiv.) in Et₂O (33 mL) at –30 °C. The reaction mixture was warmed to room temperature and stirred for 12 h. The reaction was quenched by the addition of H₂O (6 mL), 15% NaOH (6 mL) and H₂O (18 mL). The suspension was filtered, concentrated and purified *via* column chromatography (2:1 EtOAc:hexanes → 1:1) to yield the product as a white solid (2.43 g, 39%). IR (thin film, cm^{–1}) 3363 (s), 2938 (w), 2881 (w), 1600 (m), 1586 (m), 1492 (s), 1450 (s), 1382 (w), 1292 (w), 1237 (s), 1121 (w), 1026 (s), 752 (s) 696 (m); ¹H NMR (600 MHz, CDCl₃) δ 7.41 (4H, ddd, *J* = 14.3, 7.3, 7.2 Hz), 7.36–7.31 (1H, m), 7.21 (2H, t, *J* = 7.6 Hz), 7.01–6.92 (2H, m), 5.09 (2H, s), 4.09–3.99 (2H, m), 3.96 (2H, d, *J* = 5.3 Hz), 3.60 (1H, dd, *J* = 12.6, 2.1 Hz), 2.13 (2H, br. s.); ¹³C NMR (125 MHz, CDCl₃) δ 156.4, 136.8, 128.6, 128.5, 128.0, 127.9, 127.7, 127.3, 121.1, 112.1, 70.2, 65.1, 43.3; LRMS (ESI) *m/z*: 281 (100%) [M+Na]⁺.



2-(2-(Benzyloxy)phenyl)-2-methylpropane-1,3-diol. The general procedure described above was followed using LiAlH₄ (1.17 g, 30.9 mmol, 2.0 equiv.), diethyl 2-(2-(benzyloxy)phenyl)-2-methylmalonate (5.50 g, 15.4 mmol, 1.0 equiv.) and Et₂O (27 mL). The product was obtained as a white solid after purification via column chromatography (2:1 EtOAc:hexanes → 1:1) (2.89 g, 69%). IR (thin film, cm^{–1}) 3375 (m), 2932 (m), 2879 (m), 1598 (m), 1491 (m), 1445 (m), 1380 (w), 1231 (s), 1024 (s), 751 (s), 696 (m); ¹H NMR (500 MHz, CDCl₃) δ 7.48 (1H, dd, *J* = 8.3, 1.5 Hz), 7.46–7.38 (4H, m), 7.38–7.33 (1H, m), 7.29–7.21 (1H, m), 7.05–6.97 (2H, m), 5.11 (2H, s), 4.20 (2H, d, *J* = 10.7 Hz), 3.87 (2H, d, *J* = 10.7 Hz), 2.35 (2H, br. s.), 1.31 (3H, s); ¹³C NMR (125 MHz, CDCl₃) δ 157.3, 136.5, 130.4, 129.8, 128.8, 128.2, 128.2, 127.7, 121.4, 112.7, 70.6, 69.7, 45.3, 20.3; LRMS (ESI) *m/z*: 295 (100%) [M+Na]⁺.

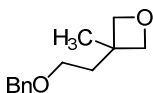


2,2-Bis(2-(benzyloxy)ethyl)propane-1,3-diol. The general procedure described above was followed using LiAlH₄ (0.585 g, 15.4 mmol, 2.0 equiv.), diethyl 2,2-bis(2-(benzyloxy)ethyl)malonate (3.30 g, 7.7 mmol, 1.0 equiv.) and Et₂O (13 mL). The product was obtained as a white solid after purification via column chromatography (1:4 EtOAc:hexanes → EtOAc) (2.21 g, 83%). IR (thin film, cm^{–1}) 3143 (m), 2922 (m), 2867 (m), 1454 (m), 1365 (m), 1092 (s), 1026 (s), 908 (m); ¹H NMR (600 MHz, CDCl₃) δ 7.38–7.32 (4H, m), 7.32–7.27 (6H, m), 4.51 (4H, s), 3.56 (4H, t, *J* = 5.3 Hz), 3.49 (2H, dd, *J* = 7.6, 6.2 Hz), 3.43 (4H, d, *J* = 6.7 Hz), 1.67 (4H, t, *J* = 5.6 Hz); ¹³C NMR (125 MHz, CDCl₃) δ 137.3, 128.5, 127.9, 127.8, 73.5, 77.0, 76.7, 73.5, 66.8, 66.3, 42.0, 32.7; LRMS (ESI) *m/z*: 367 (98%) [M+Na]⁺.

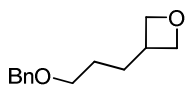


3-(2-(Benzyloxy)ethyl)oxetane. To a solution of 2-(2-(benzyloxy)ethyl)propane-1,3-diol (4.46 g, 21.2 mmol, 1.0 equiv.) in THF (156 mL) was added ⁿBuLi (13.3 mL, 2.5 M in hexanes, 1.0 equiv.) at 0 °C. The reaction mixture was stirred for 30 min at 0 °C, at which point a solution of *p*-toluenesulfonyl chloride in the THF (25 mL) was added via cannula. The reaction mixture was stirred for 1 h at 0 °C and ⁿBuLi (13.3 mL, 2.5 M in hexanes, 1.0 equiv.) was added. The reaction mixture was stirred at 60 °C for 6 h and cooled. The solution was diluted with Et₂O (200 mL) and extracted with H₂O (200 mL). The aqueous layer was extracted with Et₂O (2 x 100 mL). The combined organic layers were dried over MgSO₄, filtered and concentrated. The residue obtained was purified *via* column chromatography (9:1 hexanes:EtOAc) to yield the product as a colorless oil (2.72 g, 67%). IR (thin film, cm^{–1}) 2933

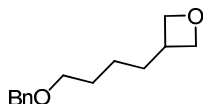
(m), 2863 (s), 1454 (m), 1362 (m), 1100 (s), 977 (w); ^1H NMR (600 MHz, CDCl_3) δ 7.39-7.32 (2H, m), 7.32-7.27 (3H, m), 4.78 (2H, dd, $J = 7.9, 6.0$ Hz), 4.47 (2H, s), 4.44 (2H, t, $J = 6.2$ Hz), 3.44 (2H, t, $J = 6.2$ Hz), 3.15 (1H, dt, $J = 14.3, 7.1$ Hz), 1.99 (2H, dd, $J = 7.5, 1.3$ Hz). ^{13}C NMR (125 MHz, CDCl_3) δ 138.6, 128.6, 127.8, 127.7, 77.9, 73.2, 68.5, 34.0, 33.4; LRMS (ESI) m/z : 215 (100%) $[\text{M} + \text{Na}]^+$.



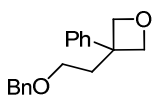
3-(2-(Benzyloxy)ethyl)-3-methyloxetane. The general procedure described above was followed using 2-(2-(benzyloxy)ethyl)-2-methylpropane-1,3-diol (5.65 g, 25.2 mmol, 1.0 equiv.), TsCl (4.80 g, 25.2 mmol, 1.0 equiv.), $^n\text{BuLi}$ (2 x 15.8 mL, 50.4 mmol, 2.0 equiv., 2.5 M solution in hexanes) and THF (205 mL). The product was obtained as a colorless oil after purification *via* column chromatography (9:1 hexanes:EtOAc) (3.71 g, 71%). Characterization data were in agreement with literature values.⁴



3-(3-(Benzyloxy)propyl)oxetane. The general procedure described above was followed using 2-(4-(benzyloxy)propyl)propane-1,3-diol (4.74 g, 21.1 mmol, 1.0 equiv.), TsCl (4.03 g, 21.1 mmol, 1.0 equiv.), $^n\text{BuLi}$ (2 x 13.2 mL, 42.2 mmol, 2.0 equiv., 2.5 M solution in hexanes) and THF (181 mL). The product was obtained as a colorless oil after purification *via* column chromatography (9:1 hexanes:EtOAc) (2.47 g, 57%). IR (thin film, cm^{-1}) 3260 (m), 2940 (s), 2869 (m), 1719 (s), 1453 (s), 1100 (s), 977 (s), 699 (s); ^1H NMR (600 MHz, CDCl_3) δ 7.38-7.31 (4H, m), 7.31-7.27 (1H, m), 4.77 (2H, dd, $J = 7.8, 5.9$ Hz), 4.49 (2H, s), 4.37 (2H, t, $J = 6.2$ Hz), 3.45 (2H, t, $J = 6.4$ Hz), 2.99 (1H, dt, $J = 14.1, 7.1$ Hz), 1.79-1.75 (2H, m), 1.58-1.49 (2H, m); ^{13}C NMR (125 MHz, CDCl_3) δ 138.4, 128.4, 127.6, 127.6, 77.7, 72.9, 69.9, 35.0, 30.4, 27.2; LRMS (ES+APCI): 207 (100%) $[\text{M}]^+$.

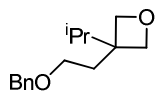


3-(4-(Benzyloxy)butyl)oxetane. The general procedure described above was followed using 2-(4-(benzyloxy)butyl)propane-1,3-diol (2.498 g, 10.5 mmol, 1.0 equiv.), TsCl (2.00 g, 10.5 mmol, 1.0 equiv.), $^n\text{BuLi}$ (2 x 4.2 mL, 21 mmol, 2.0 equiv., 2.5 M solution in hexanes) and THF (85 mL). The product was obtained as a colorless oil after purification *via* column chromatography (9:1 hexanes:EtOAc) (1.59 g, 69%). IR (thin film, cm^{-1}) 2937 (s), 2861 (s), 1719 (m), 1454 (m), 1294 (s), 1185 (s), 1104 (s), 978 (s); ^1H NMR (600 MHz, CDCl_3) δ 7.38-7.31 (4H, m), 7.30-7.26 (1H, m), 4.77 (2H, dd, $J = 7.8, 5.7$ Hz), 4.50 (2H, s), 4.37 (2H, t, $J = 6.2$ Hz), 3.46 (2H, t, $J = 6.4$ Hz), 3.01-2.92 (1H, m), 1.69 (2H, q, $J = 7.6$ Hz), 1.63-1.57 (2H, m), 1.34-1.28 (2H, m); ^{13}C NMR (125 MHz, CDCl_3) δ 129.5, 128.4, 127.6, 127.5, 77.8, 72.9, 70.1, 35.2, 33.6, 29.6, 23.7; LRMS (ESI) m/z : 261 (100%) $[\text{M} + \text{MeCN}]^+$.

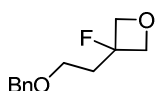


3-(2-(Benzyloxy)ethyl)-3-phenyloxetane. The general procedure described above was followed using 2-(2-(benzyloxy)ethyl)-2-phenylpropane-1,3-diol (2.49 g, 8.68 mmol, 1.0 equiv.), TsCl (1.65 g, 8.68 mmol, 1.0 equiv.), $^n\text{BuLi}$ (2 x 5.4 mL, 21 mmol, 2.0 equiv., 1.6 M solution in hexanes) and THF (73 mL). The product was obtained as a colorless oil after purification *via* column chromatography (9:1 hexanes:EtOAc) (0.929 g, 40%). IR (thin film, cm^{-1}) 2936 (w), 2872 (w), 1717 (m), 1602 (w), 1496 (w), 1451 (w), 1429 (w), 1365 (w), 1301 (s), 1191 (s), 1105 (m), 1074 (m), 1027 (w), 974 (m), 924 (w), 843 (w), 762 (m), 701 (s); ^1H NMR (600 MHz, CDCl_3) δ 7.36-7.30 (4H, m), 7.30-7.25 (3H, m), 7.24 (1H, d, $J = 7.3$ Hz), 7.04 (2H, d, $J = 7.0$ Hz), 5.00 (2H, d, $J = 5.9$ Hz), 4.84 (2H, d, $J = 5.9$ Hz), 4.38 (2H, s), 3.29 (2H, t, $J = 6.3$ Hz), 2.39 (2H, t, $J = 6.5$ Hz); ^{13}C NMR (125 MHz, CDCl_3)

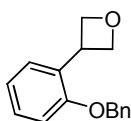
δ 144.6, 138.4, 128.4, 128.3, 127.5, 127.4, 126.3, 125.8, 82.5, 73.0, 67.2, 46.4, 40.5; LRMS (ESI) m/z : 291 (85%) $[M+Na]^+$.



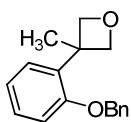
3-(2-(Benzyloxy)ethyl)-3-isopropyloxetane. The general procedure described above was followed using 2-(2-(benzyloxy)ethyl)-2-isopropylpropane-1,3-diol (2.77 g, 11.0 mmol, 1.0 equiv.), TsCl (2.09 g, 11.0 mmol, 1.0 equiv.), nBuLi (2 x 7.3 mL, 22.0 mmol, 2.0 equiv., 1.6 M solution in hexanes) and THF (93 mL). The product was obtained as a colorless oil after purification via column chromatography (9:1 hexanes:EtOAc) (1.86 g, 72%). IR (thin film, cm^{-1}) 2960 (m), 2875 (m), 1718 (m), 1464 (w), 1453 (m), 1389 (w), 1370 (w), 1301 (s), 1191 (s), 1105 (s), 1071 (m), 1027 (w), 972 (s), 843 (m), 749 (m), 713 (m), 698 (s); 1H NMR (600 MHz, $CDCl_3$) δ 7.40-7.33 (5H, m), 7.32-7.28 (1H, m), 4.54 (2H, s), 4.46 (4H, q, $J = 6.0$ Hz), 3.73 (2H, t, $J = 6.9$ Hz), 2.02 (1H, heptet, $J = 7.2$ Hz), 1.91 (2H, t, $J = 6.9$ Hz), 0.91 (6H, d, $J = 6.7$ Hz); ^{13}C NMR (125 MHz, $CDCl_3$) δ 138.4, 128.4, 127.6, 127.5, 79.1, 73.2, 67.2, 44.7, 32.9, 32.2, 16.8. LRMS (ESI) m/z : 257 (100%) $[M+Na]^+$.



3-(2-(Benzyloxy)ethyl)-3-fluorooxetane. The general procedure described above was followed using 2-(2-(benzyloxy)ethyl)-2-fluoropropane-1,3-diol (1.33 g, 5.83 mmol, 1.0 equiv.), TsCl (1.11 g, 5.83 mmol, 1.0 equiv.), nBuLi (2 x 3.6 mL, 11.7 mmol, 2.0 equiv., 1.6 M solution in hexanes) and THF (50 mL). The product was obtained as a colorless oil after purification *via* column chromatography (9:1 hexanes: EtOAc) (0.454 g, 65%). IR (thin film, cm^{-1}) 3385 (m), 2933 (m), 1720 (s), 1636 (m), 1453 (m), 1250 (m), 1132 (m), 1072 (m), 1028 (m), 988 (w), 907 (m), 834 (m), 766 (m), 700 (m); 1H NMR (600 MHz, $CDCl_3$) δ 7.39-7.33 (2H, m), 7.33-7.28 (3H, m), 4.80 (2H, dd, $J = 21.1, 7.9$ Hz), 4.70 (2H, dd, $J = 21.4, 1.2$ Hz), 4.51 (2H, s), 3.66 (2H, t, $J = 6.2$ Hz), 2.25 (2H, dt, $J = 21.9, 6.0$ Hz); ^{13}C NMR (125 MHz, $CDCl_3$) δ 138.1, 128.4, 127.6, 127.4, 93.8, 81.4 (d, $J = 24.6$ Hz), 73.2, 65.2 (d, $J = 3.6$ Hz), 35.0 (d, $J = 22.8$ Hz); ^{19}F NMR (282 MHz, $CDCl_3$) δ -152.1; LRMS (ESI) m/z : 228 (10%) $[M+NH_4]^+$.

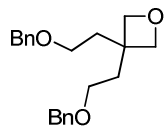


3-(2-(Benzyloxy)phenyl)oxetane. The general procedure described above was followed using 2-(2-(benzyloxy)phenyl)propane-1,3-diol (2.43 g, 9.40 mmol, 1.0 equiv.), TsCl (1.80 g, 9.40 mmol, 1.0 equiv.), nBuLi (2 x 3.8 mL, 18.8 mmol, 2.0 equiv., 2.5 M solution in hexanes) and THF (83 mL). The product was obtained as a white solid after purification *via* column chromatography (19:1 hexanes:EtOAc) (1.59 g, 70%). IR (thin film, cm^{-1}) 2962 (m), 2874 (m), 1602 (m), 1585 (w), 1494 (s), 1450 (s), 1382 (w), 1289 (w), 1242 (s), 1119 (m), 1052 (w), 1014 (m), 978 (m), 912 (w), 851 (w), 751 (s), 697 (m); 1H NMR (600 MHz, $CDCl_3$) δ 7.41-7.38 (4H, m), 7.37-7.32 (1H, m), 7.31 (1H, d, $J = 7.5$ Hz), 7.24 (1H, ddd, $J = 8.2, 7.5, 1.2$ Hz), 7.02 (1H, td, $J = 7.5, 1.0$ Hz), 6.93 (1H, d, $J = 8.4$ Hz), 5.05 (2H, s), 4.99 (2H, dd, $J = 8.6, 5.9$ Hz), 4.88 (2H, dd, $J = 7.7, 5.9$ Hz), 4.61 (1H, q); ^{13}C NMR (125 MHz, $CDCl_3$) δ 156.1, 136.9, 129.8, 128.6, 128.0, 127.8, 127.2, 126.7, 120.9, 111.5, 77.5, 70.0, 35.1; LRMS (ESI) m/z : 262.5 (47%) $[M+Na]^+$.



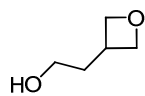
3-(2-(Benzyloxy)phenyl)-3-methyloxetane. The general procedure described above was followed using 2-(2-(benzyloxy)phenyl)-2-methylpropane-1,3-diol (2.89 g, 10.6 mmol, 1.0 equiv.), TsCl (2.02 g, 10.6 mmol, 1.0 equiv.), nBuLi (2 x 6.6 mL, 10.6 mmol, 2.0 equiv., 2.5 M solution in hexanes) and THF (91 mL). The product was obtained as a white solid after purification *via* column chromatography (19:1 hexanes:

EtOAc) (1.62 g, 60%). IR (thin film, cm^{-1}) 2954 (m), 2933 (m), 2869 (m), 1601 (m), 1583 (m), 1499 (s), 1446 (s), 1385 (m), 1300 (w), 1275 (m), 1231 (s), 1084 (m), 1047 (m), 1024 (m), 1013 (m), 966 (s), 911 (s), 850 (m), 822 (m), 745 (s), 703 (s); ^1H NMR (500 MHz, CDCl_3) δ 7.44-7.31 (4H, m), 7.25-7.16 (1H, m), 7.02-6.85 (3H, m), 5.06 (2H, d, $J = 5.0$ Hz), 5.05 (2H, s), 4.51 (2H, d, $J = 6.4$ Hz), 1.74 (3H, s); ^{13}C NMR (125 MHz, CDCl_3) δ 155.4, 136.8, 134.8, 128.6, 128.0, 127.6, 127.3, 126.3, 120.8, 111.6, 82.9, 69.8, 42.7, 26.9; LRMS (ESI) m/z : 277 (36%) $[\text{M}+\text{Na}]^+$.

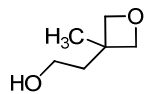


3,3-Bis(2-(benzyloxy)ethyl)oxetane. The general procedure described above was followed using 2,2-bis(2-(benzyloxy)ethyl)propane-1,3-diol (2.21 g, 6.4 mmol, 1.0 equiv.), TsCl (1.22 g, 6.4 mmol, 1.0 equiv.), $^n\text{BuLi}$ (2 x 4.0 mL, 12.8 mmol, 2.0 equiv., 1.5 M solution in hexanes) and THF (54 mL). The product was

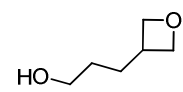
obtained as a colorless oil after purification *via* column chromatography (9:1 hexanes: EtOAc→EtOAc) (1.43 g, 68%). IR (thin film, cm^{-1}) 2929 (m), 2863 (m), 1454 (m), 1364 (m), 1099 (m), 978 (w), 911 (w). ^1H NMR (500 MHz, CDCl_3) δ 7.37-7.27 (10 H, m), 4.48 (4H, s), 4.47 (4H, s), 3.55 (4 H, t, $J = 6.4$ Hz), 2.04 (4H, t, $J = 6.6$ Hz); ^{13}C NMR (125 MHz, CDCl_3) δ 138.3, 128.4, 127.6, 127.4, 82.2, 73.1, 66.8, 40.4, 35.3; LRMS (ESI) m/z : 327 (95%) $[\text{M}+\text{H}]^+$.



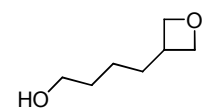
2-(Oxetan-3-yl)ethanol (3a). To a solution of 3-(2-(benzyloxy)ethyl)oxetane (2.72 g, 14.2 mmol, 1.0 equiv.) in EtOH (71 mL) was added 10% Pd/C (0.904 g, 0.85 mmol, 0.06 equiv.). The reaction mixture was purged with hydrogen and stirred under an atmosphere of hydrogen for 2 d. The black suspension was passed through a plug of celite eluting with EtOH, concentrated and the residue was purified *via* column chromatography (4:1 EtOAc/hexanes) and was further purified by kugelrohr distillation to yield the desired product as a colorless oil (1.05 g, 72%). Characterization data were in agreement with literature values.¹⁰



2-(3-Methyloxetan-3-yl)ethanol (3b). The general procedure described above was followed using 3-(2-(benzyloxy)ethyl)-3-methyloxetane (4.61 g, 22.3 mmol, 1.0 equiv.), 10% Pd/C (1.43 g, 1.34 mmol, 0.06 equiv.), EtOH (112 mL). The product was obtained as a colorless oil after column chromatography (4:1 EtOAc:hexanes) and kugelrohr distillation (1.80 g, 70%). Characterization data were in agreement with literature values.⁴



3-(Oxetan-3-yl)propan-1-ol (5). The general procedure described above was followed using 3-(3-(benzyloxy)propyl)oxetane (2.47 g, 12.0 mmol, 1.0 equiv.), 10% Pd/C (0.763 g, 0.72 mmol, 0.06 equiv.) and EtOH (60 mL). The product was obtained as a colorless oil after column chromatography (4:1 EtOAc:hexanes) and kugelrohr distillation (0.774 g, 56%). Characterization data were in agreement with literature values.⁹

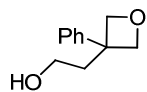


4-(Oxetan-3-yl)butan-1-ol. The general procedure described above was followed using 3-(4-(benzyloxy)butyl)oxetane (1.59 g, 7.20 mmol, 1.0 equiv.), 5% Pd/C (0.920 g, 0.43 mmol, 0.06 equiv.) and EtOH (35 mL). The product was obtained as a colorless oil after column chromatography (4:1

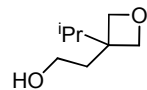
EtOAc:hexanes) (0.487 g, 52%). IR (thin film, cm^{-1}) 3408 (s), 2934 (s), 2863 (s), 1459 (w), 1069

¹⁰ Fuji, K.; Watnabe, Y.; Ohtsubo, T.; Nuruzzaman, M.; Hamajima, Y.; Kohno, M. *Chem. Pharm. Bull.* **1999**, 47, 1334-1337.

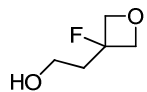
(m) 1040 (m), 977 (s), 853 (w); ^1H NMR (600 MHz, CDCl_3) δ 4.77 (2H, dd, $J = 7.9, 5.9$ Hz) 4.37 (2H, t, $J = 6.2$ Hz), 3.63 (2H, dd, $J = 6.4, 5.3$ Hz), 2.97 (1H, dt, $J = 14.1, 7.0$ Hz), 1.71 (2H, q, $J = 6.0$ Hz), 1.58-1.51 (2H, m), 1.48 (1H, d, $J = 5.3$ Hz), 1.32-1.25 (2H, m); ^{13}C NMR (125 MHz, CDCl_3) δ 77.7, 62.7, 35.2, 33.5, 32.5, 23.2; LRMS (ESI) m/z : 130 (60%) $[\text{M}]^+$.



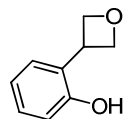
2-(3-Phenyloxetan-3-yl)ethanol (3c). The general procedure described above was followed using 3-(2-(benzyloxy)ethyl)-3-phenyloxetane (0.929 g, 3.46 mmol, 1.0 equiv.), 10% Pd/C (0.221 g, 0.208 mmol, 0.06 equiv.) and EtOH (17 mL). The product was obtained as a colorless oil after column chromatography (4:1 EtOAc:hexanes) (0.493 g, 80%). IR (thin film, cm^{-1}) 3397 (m), 2934 (m), 2875 (m), 1602 (w), 1497 (m), 1447 (m), 1070 (m), 1029 (m), 1045 (m), 971 (s), 922 (m), 825 (w), 761 (s), 700 (s); ^1H NMR (500 MHz, CDCl_3) δ 7.36 (2H, t, $J = 7.9$ Hz), 7.30-7.21 (1H, m), 7.07 (2H, d, $J = 7.1$ Hz), 5.02 (2H, d, $J = 5.7$ Hz), 4.79 (2H, d, $J = 5.5$ Hz), 3.54 (2H, dd, $J = 6.6, 5.0$ Hz), 2.35 (2H, t, $J = 6.5$ Hz), 1.23 (1H, t, $J = 5.0$ Hz); ^{13}C NMR (125 MHz, CDCl_3) δ 144.5, 128.6, 126.5, 125.6, 82.2, 59.7, 46.2, 43.2; LRMS (ESI) m/z : 201 (5%) $[\text{M}+\text{Na}]^+$.



2-(3-Isopropyloxetan-3-yl)ethanol (3d). The general procedure described above was followed using 3-(2-(benzyloxy)ethyl)-3-isopropyloxetane (1.86 g, 7.94 mmol, 1 equiv.), 10% Pd/C (0.507 g, 0.48 mmol, 0.06 equiv.) and EtOH (40 mL). The product was obtained as a colorless oil after column chromatography (4:1 EtOAc:hexanes) and kugelrohr distillation (1.01 g, 88%). IR (thin film, cm^{-1}) 3397 (s), 2959 (s), 2875 (s), 1465 (w), 1389 (m), 1371 (m), 1042 (s), 970 (s), 821 (m), 735 (m); ^1H NMR (600 MHz, CDCl_3) δ 4.52-4.39 (4H, m), 3.97-3.85 (2H, m), 2.02 (1H, heptet, $J = 6.9$ Hz), 1.83 (2H, t, $J = 7.0$ Hz), 1.77-1.70 (1H, m), 0.89 (6H, d, $J = 7.0$ Hz); ^{13}C NMR (125 MHz, CDCl_3) δ 79.3, 59.7, 44.9, 34.6, 33.3, 16.8; LRMS (ESI) m/z : 167 (18%) $[\text{M}+\text{Na}]^+$.

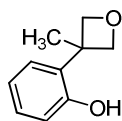


2-(3-Fluorooxetan-3-yl)ethanol (3e). The general procedure described above was followed using 3-(2-(benzyloxy)ethyl)-3-fluorooxetane (0.454 g, 3.78 mmol, 1.0 equiv.), 10% Pd/C (0.241 g, 0.23 mmol, 0.06 equiv.) and EtOH (19 mL). After a reaction time of 24 h, the product was obtained as a colorless oil after purification *via* column chromatography (4:1 EtOAc:hexanes) (0.160 g, 35%). IR (thin film, cm^{-1}) 3406 (s), 2953 (m), 2884 (m), 1475 (w), 1426 (w), 1376 (w), 1359 (w), 1246 (w), 1233 (w), 1152 (w), 1130 (w), 1112 (w), 1055 (m), 969 (s), 878 (m), 841 (m); ^1H NMR (600 MHz, CDCl_3) δ 4.82 (2H, dd, $J = 20.7, 7.5$ Hz), 4.67 (2H, dd, $J = 21.0, 7.5$ Hz), 3.86 (2H, dd, $J = 6.0, 4.0$ Hz), 2.22 (2H, dt, $J = 22.8, 6.0$ Hz), 1.55 (1H, br. s.); ^{13}C NMR (125 MHz, CDCl_3) δ 94.9 (d, $J = 204.8$ Hz), 81.3 (d, $J = 23.8$ Hz), 58.0 (d, $J = 3.6$ Hz), 37.2 (d, $J = 22.8$ Hz); ^{19}F NMR (282 MHz, CDCl_3) δ -151.4; LRMS (ESI) m/z : 102 (90%) $[\text{M}-\text{F}]^+$.

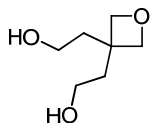


2-(Oxetan-3-yl)phenol (3f). The general procedure described above was followed using 3-(2-(benzyloxy)phenyl)oxetane (1.59 g, 6.6 mmol, 1.0 equiv), 10% Pd/C (0.422 g, 0.40 mmol, 0.06 equiv) and EtOH (33 mL). After a reaction time of 3 h, the product was obtained as a white solid after purification *via* column chromatography (2:1 EtOAc:hexanes) (0.749 g, 76%). IR (thin film, cm^{-1}) 3244 (s), 2966 (m), 2886 (m), 1609 (m), 1594 (m), 1507 (m), 1454 (s), 1381 (w), 1353 (m), 1265 (m), 1240 (m), 1183 (w), 1156 (w), 1110 (m), 1044 (w), 1007 (m), 961 (m), 908 (m), 844 (m), 812 (w), 752 (s); ^1H NMR (500 MHz, CDCl_3) δ 7.22 (1H, d, $J = 7.3$ Hz), 7.15 (1H, td, $J = 7.7, 1.7$ Hz), 6.93 (1H, td, $J = 7.5, 1.2$ Hz),

6.78 (1H, dd, $J = 7.8, 1.0$ Hz), 6.71 (1H, s), 5.14 (2H, dd, $J = 8.3, 5.9$ Hz), 4.90 (2H, t, $J = 6.6$ Hz), 4.43 (1H, quintet, $J = 7.6$ Hz); ^{13}C NMR (125 MHz, CDCl_3) δ 154.0, 128.1, 127.8, 126.9, 120.4, 115.5, 77.6, 36.2; LRMS (ESI) m/z : 157 (100%) $[\text{M}+\text{Li}]^+$.

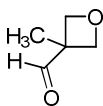
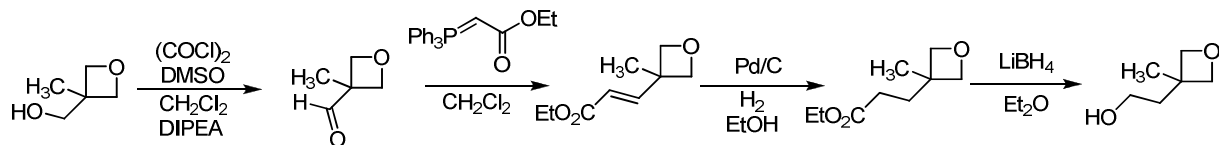


2-(3-Methyloxetan-3-yl)phenol (3g). The general procedure described above was followed using 3-(2-(benzyloxy)phenyl)-3-methyloxetane (1.62 g, 6.36 mmol, 1.0 equiv.), 10% Pd/C (0.406 g, 0.38 mmol, 0.06 equiv.) and EtOH (32 mL). After a reaction time of 3 h, the product was obtained as a white solid after purification *via* column chromatography (2:1 EtOAc:hexanes) (0.945 g, 91%). IR (thin film, cm^{-1}) 3032 (w), 2959 (m), 2929 (m), 2869 (m), 1601 (m), 1583 (w), 1493 (s), 1446 (s), 1381 (w), 1300 (w), 1275 (m), 1229 (s), 1157 (w), 1085 (m), 1021 (m), 975 (s), 912 (m), 823 (m), 751 (s), 697 (m); ^1H NMR (600 MHz, CDCl_3) δ 7.09 (1H, dd, $J = 7.5, 1.6$ Hz), 6.93-6.84 (2H, m), 6.69 (1H, d, $J = 7.3$ Hz), 5.67 (1H, s), 5.09 (2H, d, $J = 5.9$ Hz), 4.61 (2H, d, $J = 6.2$ Hz), 1.74 (3H, s); ^{13}C NMR (125 MHz, CDCl_3) δ 152.8, 132.5, 127.7, 126.5, 120.7, 115.6, 82.9, 42.5, 26.5. LRMS (ESI) m/z : 183 (30%) $[\text{M}+\text{NH}_4]^+$.



2,2'-(Oxetane-3,3-diyl)diethanol (3i). The general procedure described above was followed using 3,3-bis(2-(benzyloxy)ethyl)oxetane (1.43 g, 4.4 mmol, 1.0 equiv.), 10% Pd/C (0.520 g, 0.52 mmol, 0.12 equiv.) and EtOH (22 mL). After a reaction time of 34 h, the product was obtained as a colorless oil after purification *via* column chromatography (EtOAc) (0.385, 60%). IR (thin film, cm^{-1}) 3345 (m), 2931 (w), 2874 (w), 1095 (w), 1018 (w); ^1H NMR (500 MHz, CDCl_3) δ 4.48 (4H, s), 3.76 (4H, t, $J = 6.3$ Hz), 2.30 (2H, br. s.), 2.07-2.03 (4H, m); ^{13}C NMR (125 MHz, CDCl_3) δ 82.1, 59.3, 40.7, 38.1; LRMS (ESI) m/z : 169 (14%) $[\text{M}+\text{Na}]^+$.

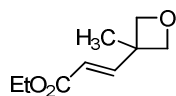
C)



3-Methyloxetane-3-carbaldehyde. The compound was synthesized according to a known procedure that was modified.¹¹ To a solution of oxalyl chloride (6.8 mL, 80.2 mmol, 1.6 equiv.) in CH_2Cl_2 (135 mL) was added DMSO (11.7 mL, 165 mmol, 3.3 equiv.) at -78°C . The reaction mixture was stirred at -78°C for 15 min at which point a solution of (3-methyloxetan-3-yl)methanol (5.0 mL, 50.1 mmol, 1.0 equiv.) in CH_2Cl_2 (108 mL) *via* cannula. The reaction mixture was stirred for an additional 1.5 h at -78°C , at which point diisopropylethylamine (43.7 mL, 251 mmol, 5.0 equiv.) was added and the solution was stirred for 30 min before warming to 0°C for 10 min and then r.t. The reaction mixture was diluted with CH_2Cl_2 (200 mL) and extracted with sat. NH_4Cl (3 x 400 mL). The organic layer was dried

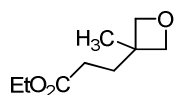
¹¹ Zhu, J.; Munn, R. J.; Nantz, M. H. *J. Am. Chem. Soc.* **2000**, *122*, 2645-2646.

over MgSO_4 , filtered and concentrated. The product was obtained as a colorless oil after purification via column chromatography (4:1 hexanes:EtOAc) (2.17 g, 43%). IR (thin film, cm^{-1}) 2972 (m), 2890 (m), 1730 (s), 1461 (w), 1297 (m), 1173 (m), 969 (m); ^1H NMR (600 MHz, CDCl_3) δ 9.95 (1H, s), 4.87 (2H, d, $J = 6.4$ Hz), 4.50 (2H, d, $J = 6.4$ Hz), 1.48 (3H, s); ^{13}C NMR (125 MHz, CDCl_3) δ 79.4, 49.3, 44.3, 21.5, 17.4; LRMS (ESI) m/z : 102 (100%) $[\text{M}+2\text{H}]^+$.



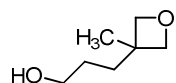
(E)-Ethyl 3-(3-methyloxetan-3-yl)acrylate. To a solution of 3-methyloxetan-3-carbaldehyde (2.17 g, 21.6 mmol, 1.0 equiv.) in CH_2Cl_2 (43 mL) was added (carbethoxymethylene)triphenylphosphorane (8.28 g, 23.8 mmol, 1.1 equiv.) at

0 °C. The reaction mixture was stirred at r.t. for 3 h, at which point the solution was passed through a plug of silica (2:1 hexanes:EtOAc) to yield the product as a yellow oil (3.15 g, 86%). IR (thin film, cm^{-1}) 2965 (m), 2937 (w), 2873 (m), 1720 (s), 1656 (m), 1367 (w), 1312 (m), 1268 (m), 1190 (m), 1037 (m), 985 (m); ^1H NMR (500 MHz, CDCl_3) δ 7.26 (1H, d, $J = 15.6$ Hz), 5.85 (1H, d, $J = 15.6$ Hz), 4.67 (2H, d, $J = 5.9$ Hz), 4.46 (2H, d, $J = 5.9$ Hz), 4.22 (2H, q, $J = 7.2$ Hz), 1.52 (3H, s), 1.30 (3H, t, $J = 6.8$ Hz); ^{13}C NMR (125 MHz, CDCl_3) δ 166.5, 151.1, 119.9, 81.6, 60.5, 41.1, 22.7, 14.2; LRMS (ESI) m/z : 171 (61%) $[\text{M}+\text{H}]^+$.



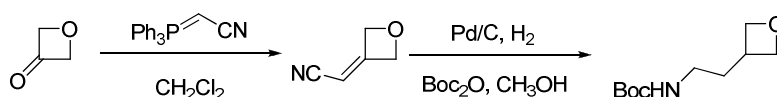
Ethyl 3-(3-methyloxetan-3-yl)propanoate. To a solution of (E)-Ethyl 3-(3-methyloxetan-3-yl)acrylate (1.00 g, 5.88 mmol, 1.0 equiv.) in EtOH (17 mL) was added 5% Pd/C (0.756 g, 0.36 mmol, 0.06 equiv.). The flask was purged

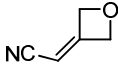
with H_2 and the reaction mixture was stirred under a balloon of H_2 for 24 h. The black suspension was passed through a plug of celite and the filtrate was concentrated. The product was obtained as a colorless oil after purification *via* column chromatography (4:1 hexanes:EtOAc) (0.419 g, 41%). IR (thin film, cm^{-1}) 2962 (m), 2932 (m), 2865 (m), 1736 (s), 1455 (m), 1381 (m), 1300 (m), 1187 (m), 1187 (m), 1026 (w), 980 (m); ^1H NMR (500 MHz, CDCl_3) δ 4.42 (2H, d, $J = 5.9$ Hz), 4.34 (2H, d, $J = 5.9$ Hz), 4.14 (2H, q, $J = 7.2$ Hz), 2.32-2.23 (2H, m), 2.02-1.95 (2H, m), 1.29 (3H, s), 1.26 (3H, t, $J = 7.1$ Hz); ^{13}C NMR (125 MHz, CDCl_3) δ 173.4, 82.3, 60.5, 38.7, 33.7, 29.8, 22.9, 14.2; LRMS (ESI) m/z : 172 (100%) $[\text{M}]^+$.

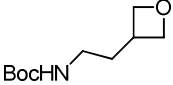


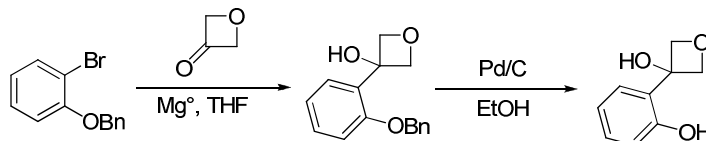
Ethyl 3-(oxetan-3-yl)propanoate. To a suspension of LiBH_4 (0.680 g, 31.2 mmol, 2.0 equiv) in Et_2O (78 mL) at 0 °C was added ethyl 3-(3-methyloxetan-3-yl)propanoate (2.69 g, 15.6 mmol, 1.0 equiv.). The reaction mixture was warmed

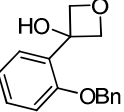
to r.t. and stirred for 14 h, at which point H_2O (100 mL) and Et_2O (100 mL) were added. The aqueous layer was extracted with Et_2O (2 x 100 mL). The combined organic layers were dried over MgSO_4 , filtered and concentrated. The product was obtained as a colorless oil after purification *via* column chromatography (4:1 Et_2O :hexanes \rightarrow Et_2O) (0.91 g, 45%). IR (thin film, cm^{-1}) 3395 (s), 2936 (s), 2869 (s), 1456 (m), 1382 (m), 1301 (m), 1185 (m), 1060 (s), 970 (s), 829 (m); ^1H NMR (600 MHz, CDCl_3) δ 4.42 (2H, d, $J = 5.6$ Hz), 4.35 (2H, d, $J = 5.6$ Hz), 3.66 (2H, q), 1.74-1.65 (2H, m), 1.60-1.46 (3H, m), 1.29 (3H, s); ^{13}C NMR (125 MHz, CDCl_3) δ 82.8, 63.0, 38.9, 35.1, 27.7, 23.1; LRMS (ESI) m/z : 131 (84%) $[\text{M}+\text{H}]^+$.



 **2-(Oxetan-3-ylidene)acetonitrile.** To a solution of 3-oxetanone¹² (0.50 g, 6.94 mmol, 1.0 equiv.) in CH₂Cl₂ (9 mL) was added (triphenylphosphoranylidene)acetonitrile (2.93 g, 9.7 mmol, 1.4 equiv.). The product was obtained as a white solid after column chromatography (2:1 hexanes:EtOAc) (0.188 g, 28%). IR (thin film, cm⁻¹) 3072 (w), 2924 (w), 2857 (w), 2223 (s), 1696 (m), 1438 (m), 1335 (w), 1296 (w), 1120 (w), 994 (m), 959 (s), 917 (m), 862 (s), 781 (m), 723 (w), 698 (w); ¹H NMR (600 MHz, CDCl₃) δ 5.43-5.37 (2H, m), 5.31 (2H, ddd, *J* = 4.6, 2.5, 2.4 Hz), 5.29-5.25 (1H, m); ¹³C NMR (125 MHz, CDCl₃) δ 163.5, 114.1, 90.9, 78.7, 78.5; LRMS (ES+APCI) *m/z*: 95 (100%) [M]⁺.

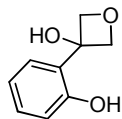
 **tert-Butyl 2-(oxetan-3-yl)ethylcarbamate (7).** To a solution of 2-(oxetan-3-ylidene)acetonitrile (0.188 g, 1.97 mmol, 1.0 equiv.) in MeOH (31 mL) was added di-*tert*-butyl dicarbonate (1.34 g, 6.13 mmol, 3.1 equiv) and 5 % Pd/C (2.39 g, 1.12 mmol, 0.57 equiv.). The reaction mixture was sealed with a septum, purged with H₂ and stirred under a balloon of H₂ for 24 h. The black suspension was filtered through a plug of celite and purified *via* column chromatography (2:1 EtOAc: hexanes) to yield the product as a white solid (0.141 g, 36%). IR (thin film, cm⁻¹) 3329 (m), 2967 (m), 2934 (m), 2868 (m), 1689 (s), 1525 (s), 1454 (w), 1392 (m), 1365 (s), 1274 (s), 1251 (s), 1166 (s), 1040 (w), 1003 (w), 973 (s), 870 (m), 781 (m), 757 (w), 732 (w); ¹H NMR (600 MHz, CDCl₃) δ 4.80 (2H, dd, *J* = 7.6, 6.2 Hz), 4.51 (1H, br s), 4.41 (2H, t, *J* = 6.1 Hz), 3.13-2.99 (3H, m), 1.88 (2H, q, *J* = 7.3 Hz), 1.44 (9H, s); ¹³C NMR (125 MHz, CDCl₃) δ 155.9, 79.3, 77.4, 38.4, 34.2, 33.1, 28.4; LRMS (ESI) *m/z*: 224 (100%) [M+Na]⁺.



 **3-(2-(Benzyloxy)phenyl)oxetan-3-ol (3h).** To a suspension of flame dried Mg⁰ turnings (0.267 g, 11.0 mmol, 1.6 equiv.) in THF (5 mL) was added a solution of 1-(benzyloxy)-2-bromobenzene (0.237 g, 0.90 mmol, 0.13 equiv.) in THF (0.5 mL) and dibromoethane (0.2 mL) to initiate the reaction. Once bubbling had ceased, the remaining 1-(benzyloxy)-2-bromobenzene (2.13 g, 8.1 mmol, 1.2 equiv.) in THF (4.5 mL) was added. The yellow mixture was stirred at r.t. for 30 min and refluxed for 10 min. The solution was diluted with THF (25 mL), cooled to -78 °C and a solution of 3-oxetanone in THF (5 mL) was added. The solution was stirred at -78 °C for 45 min, warmed to r.t. and quenched with sat. aq. NH₄Cl (100 mL). The aqueous layer was extracted with EtOAc (3 x 100mL). The combined organic layers were dried over MgSO₄, filtered and concentrated. The product was obtained as a white solid after purification *via* column chromatography (4:1 hexanes:EtOAc → 1:1) (0.856 g, 48%). IR (thin film, cm⁻¹) 3385 (s), 2945 (m), 2876 (m), 1600 (m), 1493 (s), 1450 (s), 1382 (m), 1294 (m), 1230 (s), 1129 (m), 1025 (m), 1025 (m), 977 (s), 881 (w), 832 (w), 752 (s) 697 (m); ¹H NMR (500 MHz, CDCl₃) δ 7.44-7.37 (4H, m), 7.35-7.28 (2H, m), 7.05-7.02 (2H, m), 5.12 (2H, s), 5.08 (2H, d, *J* = 7.3 Hz), 4.84 (2H, d, *J* = 7.3 Hz), 3.33 (1H, s); ¹³C NMR (125 MHz, CDCl₃)

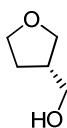
¹² Wuitschik, G.; Rogers-Evans, M.; Müller, K.; Fischer, H.; Wagner, B.; Schuler, F.; Polonchuk, L.; Carreira, E. M. *Angew. Chem. Int. Ed.* **2006**, 45, 7736-7739.

δ 155.9, 136.0, 130.1, 129.6, 128.8, 128.4, 127.5, 126.3, 121.2, 112.2, 82.9, 75.7, 70.3; LRMS (ESI) m/z : 279 (100%) $[M+Na]^+$.



3-(2-Hydroxyphenyl)oxetan-3-ol. To a solution of 3-(2-(benzyloxy)phenyl)oxetan-3-ol (0.256 g, 1.0 mmol, 1.0 equiv.) in EtOH (5 mL) was added 5% Pd/C (0.128 g, 0.06 mmol, 0.06 equiv.). The flask was sealed with a septum and purged with H_2 . The black suspension was stirred under a balloon of H_2 for 3 h, passed through a plug of celite and the filtrate was concentrated *in vacuo*. The residue obtained was purified *via* column chromatography (1:1 hexanes:EtOAc \rightarrow 1:2) to yield the product as a white solid (103 mg, 62%). IR (thin film, cm^{-1}) 3180 (s), 1605 (w), 1456 (m), 1413 (m), 1323 (m), 1297 (m), 1263 (m), 1178 (m), 1133 (m), 1119 (m), 1041 (m), 1028 (m) 958 (m), 933 (m) 895 (m), 837 (s), 762 (s); 1H NMR (600 MHz, $CDCl_3$) δ 7.37 (1H, dd, J = 7.7, 1.4 Hz), 7.25 (1H, dd, J = 7.6, 1.3 Hz), 7.08 (1H, br s), 6.98 (1H, td, J = 7.5, 1.0 Hz), 6.89 (1H, dd, J = 8.1, 0.7 Hz), 5.06 (2H, d, J = 8.1 Hz) 4.92 (2H, d, J = 8.2 Hz), 3.30 (1H, br s); ^{13}C NMR (125 MHz, $CDCl_3$) δ 154.5, 130.0, 125.9, 120.6, 117.2, 110.7, 84.0, 77.2; LRMS (ES+APCI) m/z : 168 (100%) $[M+H]^+$.

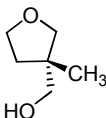
Products



(S)-(Tetrahydrofuran-3-yl)methanol (4a).

Monomer: 2-(Oxetan-3-yl)ethanol (**3a**) (51 mg, 0.5 mmol, 1.0 equiv.) and **1** (3.8 mg, 0.005 mmol, 1 mol%) were added to a vial. The reaction mixture was stirred for 1 h, at which point silicycle metal scavenger DMT (68 mg) and EtOAc (0.5 mL) were added. The suspension was stirred for 1 h, filtered and subjected to purification *via* column chromatography (EtOAc) to yield the product as a colorless oil (47.1 mg, 92%). The enantiomeric excess was determined to be 98% by chiral GC analysis (β -cyclosil, 60 $^{\circ}C$ isothermal, 7 psi) t_r (major) = 42.9 min, t_r (minor) = 45.4 min of the trifluoroacetylated product. $[\alpha]^{24}_D = +24.6^{\circ}$ ($c=1$, $CHCl_3$).¹²

Oligomer: 2-(Oxetan-3-yl)ethanol (**3a**) (51 mg, 0.5 mmol, 1.0 equiv.) and a solution of **2** (0.0408 mg, 5×10^{-5} mmol, 0.01 mol%) in MeCN (83 μL) were added to a vial. The black solution was stirred for 2 h, at which point silicycle DMT scavenger (2 mg) was added to the reaction mixture. The suspension was stirred for 1 h, filtered and subjected to purification *via* column chromatography (EtOAc) to yield the product as a colorless oil (47.5 mg, 93%). The enantiomeric excess was determined to be 96% by chiral GC analysis (β -cyclosil, 60 $^{\circ}C$ isothermal, 7 psi) t_r (major) = 43.2 min, t_r (minor) = 45.5 min of the trifluoroacetylated product. Characterization data were in agreement with literature values.¹³



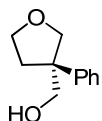
(S)-(3-Methyltetrahydrofuran-3-yl)methanol (4b).

Monomer: 2-(3-Methyloxetan-3-yl)ethanol (**3b**) (58 mg, 0.5 mmol, 1.0 equiv.) and **1** (3.8 mg, 0.005 mmol, 1 mol%) were added to a vial. The reaction mixture was stirred

¹³ Brown, H. C.; Gupta, A. K.; Rangaishenvi, M. V.; Vara Prasad, J. V. N. *Heterocycles* **1989**, 28, 283-294. Absolute configuration assigned based on correlation; $[\alpha]^{24}_D = +23.5^{\circ}$ ($c=0.2$, MeOH) (lit: $[\alpha]^{24}_D = +17.3^{\circ}$ ($c=2.4$, MeOH)).

for 6 h and at which point silicycle metal scavenger DMT (68 mg) and EtOAc (0.5 mL) were added. The suspension was stirred for 1 h, filtered and subjected to purification *via* column chromatography (EtOAc) to yield the product as a colorless oil (51.2 mg, 88%). The enantiomeric excess was determined to be 99% by chiral HPLC (Chiralcel AD-H, 1% isopropanol/hexanes, 1.0 mL/min, 220 nm) $t_r(\text{minor}) = 15.2$ min, $t_r(\text{major}) = 20.4$ min of the benzoylated product. $[\alpha]_D^{24} = +18.6^\circ$ ($c=1$, CHCl_3).

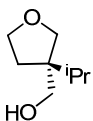
Oligomer: 2-(3-Methyloxetan-3-yl)ethanol (**3b**) (58 mg, 0.5 mmol, 1.0 equiv.) and a solution of **2** (0.0408 mg, 5×10^{-5} mmol, 0.01 mol%) in MeCN (83 μL) were added to a vial. The reaction mixture was stirred for 6 h and at which point silicycle DMT scavenger (2 mg) was added to the reaction mixture. The suspension was stirred for 1 h, filtered and subjected to purification *via* column chromatography (EtOAc) to yield the product as a colorless oil (50.5 mg, 87%). The enantiomeric excess was determined to be 96% by chiral HPLC (Chiralcel AD-H, 1% isopropanol/hexanes, 1.0 mL/min, 220 nm) $t_r(\text{minor}) = 15.1$ min, $t_r(\text{major}) = 20.3$ min of the benzoylated product. $[\alpha]_D^{24} = +17.3^\circ$ ($c=1$, CHCl_3); IR (thin film, cm^{-1}) 3391 (s), 2958 (m), 2871 (m), 1452 (m), 1384 (w), 1155 (m), 1047 (s), 976 (w), 896 (m); ^1H NMR (500 MHz, CDCl_3) δ 3.95-3.81 (2H, m), 3.73 (1H, d, $J = 8.8$ Hz), 3.51 (2H, br s), 3.39 (1H, d, $J = 8.8$ Hz), 1.86 (2H, dd, $J = 12.5, 6.6$ Hz), 1.64 (1H, dd, $J = 8.3, 5.9$ Hz), 1.13 (3H, s); ^{13}C NMR (125 MHz, CDCl_3) δ 76.5, 69.3, 67.9, 44.6, 36.0, 21.3; LRMS (ESI) m/z : 139 (44%) $[\text{M}+\text{Na}]^+$.



(R)-(3-Phenyltetrahydrofuran-3-yl)methanol (4c).

Monomer: A solution of 2-(3-Phenyloxetan-3-yl)ethanol (**3c**) (53.5 mg, 0.3 mmol, 1.0 equiv.) in TBME (50 μL) was treated with **1** (2.3 mg, 0.003 mmol, 1 mol%). The reaction mixture was stirred for 24 h and subsequently treated with silicycle metal scavenger DMT (41 mg) and diluted with EtOAc (0.3 mL). The suspension was stirred for 1 h, filtered and subjected to purification *via* column chromatography (EtOAc) to yield the product as a colorless oil (51.3 mg, 96%). The enantiomeric excess was determined to be 98% by chiral HPLC (Chiralcel AD-H, 3% isopropanol/hexanes, 1.0 mL/min, 220 nm) $t_r(\text{minor}) = 25.4$ min, $t_r(\text{major}) = 26.6$; $[\alpha]_D^{24} = +38.5^\circ$.

Oligomer: (3-Phenyloxetan-3-yl)ethanol (**3c**) (53.5 mg, 0.3 mmol, 1 equiv) and solution of **2** (0.025 mg, 3×10^{-5} mmol, 0.01 mol%) in MeCN (50 μL) were added to a vial. The reaction mixture was stirred for 6 h, at which point silicycle DMT scavenger (2 mg) was added to the reaction mixture. The suspension was stirred for 1 h, filtered and subjected to purification *via* column chromatography (EtOAc) to yield the desire product as a colorless oil (52.2 mg, 98%). The enantiomeric excess was determined to be 99% by chiral HPLC (Chiralcel AD-H, 3% isopropanol/hexanes, 1.0 mL/min, 220 nm) $t_r(\text{minor}) = 15.1$ min, $t_r(\text{major}) = 20.3$ min; $[\alpha]_D^{24} = +40.6^\circ$ ($c=1$, CHCl_3); IR (thin film, cm^{-1}) 3408 (s), 2934 (m), 2874 (m), 1602 (w), 1498 (m), 1447 (m), 1298 (w), 1136 (w), 1072 (s), 976 (m), 903 (m), 766 (m), 701 (s); ^1H NMR (500 MHz, CDCl_3) δ 7.37 (2H, t, $J = 7.6$ Hz), 7.29 (1H, d, $J = 7.8$ Hz), 7.21 (2H, d, $J = 6.8$ Hz), 4.26 (1H, d, $J = 8.8$ Hz), 4.06 (1H, dd, $J = 8.8, 7.3$ Hz), 3.94 (1H, td, $J = 8.9, 5.1$ Hz), 3.85 (1H, d, $J = 8.3$ Hz), 3.69 (2H, d, $J = 6.4$ Hz), 2.35 (1H, ddd, $J = 12.5, 7.6, 4.9$ Hz), 2.22 (1H, ddd, $J = 9.3, 7.3, 2.0$ Hz), 1.49 (1H, t, $J = 6.1$ Hz); ^{13}C NMR (125 MHz, CDCl_3) δ 143.0, 128.7, 127.2, 126.9, 74.3, 69.4, 67.6, 53.4, 33.9. LRMS (ESI) m/z : 201 (7%) $[\text{M}+\text{Na}]^+$.

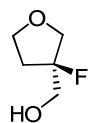


(R)-(3-Isopropyltetrahydrofuran-3-yl)methanol (4d).

Monomer: 2-(3-Isopropyloxetan-3-yl)ethanol (**3d**) (57.7 mg, 0.4 mmol, 1.0 equiv.) and **1** (3.0 mg, 0.004 mmol, 1 mol%) were added to a vial. The reaction mixture was

stirred for 12 h and subsequently treated with silicycle metal scavenger DMT (41 mg) and diluted with EtOAc (0.4 mL). The suspension was stirred for 1 h, filtered and subjected to purification *via* column chromatography (EtOAc) to yield the product as a colorless oil (53.4 mg, 93%). The enantiomeric excess was determined to be 99% by chiral HPLC (Chiralcel AD-H, 1% isopropanol/hexanes, 1.0 mL/min, 254 nm) $t_r(\text{minor}) = 12.6$ min, $t_r(\text{major}) = 13.3$ min of the benzoylated product. $[\alpha]_D^{24} = +25.5^\circ$ ($c=1$, CHCl_3).

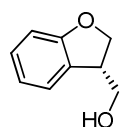
Oligomer: 2-(3-Isopropoxytetrahydrofuran-3-yl)ethanol (**3d**) (57.7 mg, 0.4 mmol, 1.0 equiv.) and a solution of **2** (0.033 mg, 4×10^{-5} mmol, 0.01 mol%) in MeCN (67 μL) were added to a vial. The reaction mixture was stirred for 2 h, at which point silicycle DMT scavenger (2 mg) was added to the reaction mixture. The suspension was stirred for 1 h, filtered and subjected to purification *via* column chromatography (EtOAc) to yield the desire product as a colorless oil (56.2 mg, 97%). The enantiomeric excess was determined to be 99% by chiral HPLC (Chiralcel AD-H, 1% isopropanol/hexanes, 1.0 mL/min, 220 nm) $t_r(\text{minor}) = 12.4$ min, $t_r(\text{major}) = 13.8$ min of the benzoylated product. $[\alpha]_D^{24} = +25.4^\circ$ ($c=1$, CHCl_3); IR (thin film, cm^{-1}) 3404 (s), 2960 (s), 2876 (s), 1466 (m), 1389 (m), 1370 (m), 1301 (s), 1185 (s), 1062 (s), 972 (m), 914 (m); ^1H NMR (600 MHz, CDCl_3) δ 3.89 (1H, dd, $J = 8.5, 7.3$ Hz), 3.79 (1H, t, $J = 7.5$ Hz), 3.76 (1H, d, $J = 9.1$ Hz), 3.68 (1H, d, $J = 10.5$ Hz), 3.60 (1H, d, $J = 10.8$ Hz), 3.55 (1H, d, $J = 9.1$ Hz), 1.84 (1H, ddd, $J = 13.9, 6.9, 6.7$ Hz), 1.77 (2H, t, $J = 7.3$ Hz), 1.71 (1H, br s), 0.95 (6H, dd, $J = 18.5, 7.0$ Hz); ^{13}C NMR (125 MHz, CDCl_3) δ 74.8, 68.5, 66.4, 51.0, 32.6, 32.1, 18.7, 18.6. LRMS (ESI) m/z : 167 (30%) $[\text{M}+\text{Na}]^+$.



(R)-(3-Fluorotetrahydrofuran-3-yl)methanol (4e).

Monomer: 2-(3-Fluorooxetan-3-yl)ethanol (**3e**) (18 mg, 0.15 mmol, 1.0 equiv.) and **1** (1.1 mg, 0.0015 mmol, 1 mol%) were added to a vial. The reaction mixture was stirred for 7 h and subsequently treated with silicycle metal scavenger DMT (20.4 mg) and diluted with EtOAc (0.15 mL). The suspension was stirred for 1 h, filtered and subjected to purification *via* column chromatography (EtOAc) to yield the product as a colorless oil (15.7 mg, 87%). The enantiomeric excess was determined to be 97% by chiral GC analysis (β -cyclosil, 90 $^\circ\text{C}$ isothermal, 21 psi) $t_r(\text{major}) = 6.0$ min, $t_r(\text{minor}) = 6.7$ min of the trifluoroacetylated product. $[\alpha]_D^{24} = +2.3^\circ$ ($c=0.31$, CHCl_3).

Oligomer: (3-Fluorooxetan-3-yl)ethanol (**3e**) (18 mg, 0.15 mmol, 1.0 equiv.) and **2** (0.0123 mg, 1.5×10^{-5} mmol, 0.01 mol%) in MeCN (25 μL) were added to a vial. The reaction mixture was stirred for 7 h, at which point silicycle DMT scavenger (2 mg) was added to the reaction mixture. The suspension was stirred for 1 h, filtered and subjected to purification *via* column chromatography (EtOAc) to yield the product as a colorless oil (13.7 mg, 76%). The enantiomeric excess was determined to be 98% by chiral GC analysis (β -cyclosil, 90 $^\circ\text{C}$ isothermal, 21 psi) $t_r(\text{major}) = 6.0$ min, $t_r(\text{minor}) = 6.7$ min of the trifluoroacetylated product. $[\alpha]_D^{24} = +2.4^\circ$ ($c=0.38$, CHCl_3); IR (thin film, cm^{-1}) 3439 (w), 2957 (s), 2926 (s), 2857 (s), 1726 (s), 1463 (m), 1380 (m), 1275 (s), 1124 (m), 1072 (s), 739 (m), 702 (w); ^1H NMR (500 MHz, CDCl_3) δ 4.07-3.74 (6H, m), 2.29-2.15 (1H, m), 2.10-1.95 (1H, m), 1.70 (1H, br s); ^{13}C NMR (125 MHz, CDCl_3) δ 104.8 (d, $J = 177.5$ Hz), 74.5 (d, $J = 27.4$ Hz), 67.6, 65.4 (d, 26.4 Hz), 35.2 (d, $J = 22.8$ Hz); ^{19}F NMR (282 MHz, CDCl_3) δ -157.9; LRMS (ESI) m/z : 121 (30%) $[\text{M}+\text{H}]^+$.

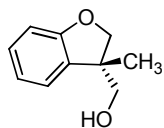


(S)-(2,3-Dihydrobenzofuran-3-yl)methanol (4f).

Monomer: A solution of 2-(oxetan-3-yl)phenol (**3f**) (60.1 mg, 0.4 mmol, 1.0 equiv.) in TBME (67 μL) was treated with **1** (15.1 mg, 0.02 mmol, 5 mol%). The reaction

mixture was stirred for 8 h and subsequently treated with silicycle metal scavenger DMT (272 mg) and diluted with EtOAc (1.0 mL). The suspension was stirred for 1 h, filtered and subjected to purification *via* column chromatography (1:1 hexanes:EtOAc) to yield the product as a colorless oil (56.6 mg, 94%). The enantiomeric excess was determined to be 93% by chiral HPLC (Chiralcel AD-H, 3% isopropanol/hexanes, 1.0 mL/min, 254 nm) $t_r(\text{major}) = \text{min}$, $t_r(\text{minor}) = 36.0 \text{ min}$; $[\alpha]_D^{24} = -17.6^\circ$.

Oligomer: 2-(Oxetan-3-yl)phenol (**3f**) (60.1 mg, 0.4 mmol, 1 equiv) and a solution of **2** (0.033 mg, 4×10^{-5} mmol, 0.01 mol%) in MeCN (67 μL) were added to a vial. The reaction mixture was stirred for 6 h, at which point silicycle DMT scavenger (2 mg) was added to the reaction mixture. The suspension was stirred for 1 h, filtered and subjected to purification *via* column chromatography (1:1 hexanes:EtOAc) to yield the desired product as a colorless oil (53.5 mg, 89%). The enantiomeric excess was determined to be 98% by chiral HPLC (Chiralcel AD-H, 3% isopropanol/hexanes, 1.0 mL/min, 254 nm) $t_r(\text{major}) = 23.0 \text{ min}$, $t_r(\text{minor}) = 26.0 \text{ min}$ $[\alpha]_D^{24} = -19.2^\circ$; IR (thin film, cm^{-1}) 3357 (m), 2891 (w), 1611 (m), 1596 (m), 1481 (s), 1459 (s), 1325 (w), 1301 (w), 1227 (s), 1191 (w), 1162 (w), 1099 (w), 1031 (m), 1016 (m), 955 (m), 855 (m), 834 (m), 802 (w), 747 (s); ^1H NMR (500 MHz, CDCl_3) δ 7.24 (1H, d, $J = 7.3 \text{ Hz}$), 7.17 (1H, t, $J = 7.8 \text{ Hz}$), 6.89 (1H, t, $J = 7.6 \text{ Hz}$), 6.83 (1H, d, $J = 8.3 \text{ Hz}$), 4.65 (1H, t, $J = 9.0 \text{ Hz}$), 4.49 (1H, dd, $J = 9.3, 5.4 \text{ Hz}$), 3.89-3.76 (2H, m), 3.66 (1H, dd, $J = 8.8, 5.9 \text{ Hz}$), 1.54 (1H, br s); ^{13}C NMR (125 MHz, CDCl_3) δ 160.5, 128.9, 127.0, 124.6, 120.5, 109.8, 74.0, 64.9, 44.6. LRMS (ESI) m/z : 173 (24%) $[\text{M}+\text{Na}]^+$.

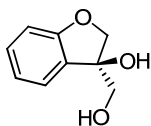


(S)-(3-Methyl-2,3-dihydrobenzofuran-3-yl)methanol (4g).

Monomer: A solution of 2-(3-methyloxetan-3-yl)phenol (**3g**) (49.3 mg, 0.3 mmol, 1.0 equiv.) in TBME (50 μL) was treated with **1** (22.6 mg, 0.03 mmol, 10 mol%).

The reaction mixture was stirred for 8 h and subsequently treated with silicycle metal scavenger DMT (408 mg) and diluted with EtOAc (1.0 mL). The suspension was stirred for 1 h, filtered and subjected to purification *via* column chromatography (1:1 hexanes:EtOAc) to yield the product as a white solid (37.9 mg, 77%). The enantiomeric excess was determined to be 96% by chiral HPLC (Chiralcel AS-H, 2% isopropanol/hexanes, 1.0 mL/min, 254 nm) $t_r(\text{major}) = 19.1 \text{ min}$, $t_r(\text{minor}) = 20.6 \text{ min}$; $[\alpha]_D^{24} = -12.2^\circ$.

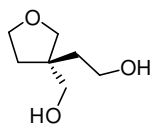
Oligomer: 2-(3-Methyloxetan-3-yl)phenol (**3g**) and a solution of **2** (0.245 mg, 3×10^{-4} mmol, 0.1 mol%) in MeCN (50 μL) were added to a vial. The reaction mixture was stirred for 8 h, at which point silicycle DMT scavenger (4.2 mg) was added to the reaction mixture. The suspension was stirred for 1 h, filtered and subjected to purification *via* column chromatography (1:1 hexanes:EtOAc) to yield the product as a white solid (46.6 mg, 95%). The enantiomeric excess was determined to be 98% by chiral HPLC (Chiralcel AS-H, 2% isopropanol/hexanes, 1.0 mL/min, 254 nm) $t_r(\text{major}) = 18.9 \text{ min}$, $t_r(\text{minor}) = 20.4 \text{ min}$; $[\alpha]_D^{24} = -13.9^\circ$; IR (thin film, cm^{-1}) 3397 (m), 3965 (w), 1598 (m), 1481 (m), 1460 (m), 1191 (m), 1108 (w), 1034 (m), 1016 (m), 974 (m), 908 (s), 832 (m), 731 (s); ^1H NMR (600 MHz, CDCl_3) δ 7.18 (1H, td, $J = 7.8, 1.5 \text{ Hz}$), 7.13 (1H, dd, $J = 7.3, 1.5 \text{ Hz}$), 6.91 (1H, dd, $J = 7.3, 0.9 \text{ Hz}$), 6.83 (1H, d, $J = 7.9 \text{ Hz}$), 4.59 (1H, d, $J = 8.8 \text{ Hz}$), 4.20 (1H, d, $J = 8.8 \text{ Hz}$), 3.69 (1H, dd, $J = 10.8, 5.3 \text{ Hz}$), 3.60 (1H, dd, $J = 10.8, 7.0 \text{ Hz}$), 1.46 (1H, dd, $J = 6.2, 0.6 \text{ Hz}$), 1.38 (3H, s); ^{13}C NMR (125 MHz, CDCl_3) δ 160.3, 131.7, 128.83, 123.0, 120.6, 109.9, 80.1, 69.0, 47.7; LRMS (ESI) m/z : 187 (7%) $[\text{M}+\text{Na}]^+$.



(R)-3-(Hydroxymethyl)-2,3-dihydrobenzofuran-3-ol (4h).

Monomer: A solution of 3-(2-hydroxyphenyl)oxetan-3-ol (**3h**) (49.9 mg, 0.3 mmol, 1.0 equiv.) in TBME (300 μ L) was treated with **1** (22.6 mg, 0.03 mmol, 10 mol%). The reaction mixture was stirred for 96 h and subsequently treated with silicycle metal scavenger DMT (408 mg) and diluted with EtOAc (1.0 mL). The suspension was stirred for 1 h, filtered and subjected to purification *via* column chromatography (4:1 EtOAc:hexanes) to yield the desired product as a white solid (39.2 mg, 79%). The enantiomeric excess was determined to be 84% by chiral HPLC (Chiralcel AD-H, 5% isopropanol/hexanes, 1.2 mL/min, 254 nm) $t_r(\text{minor}) = 28.1$ min, $t_r(\text{major}) = 28.8$ min; $[\alpha]_D^{24} = +25.3^\circ$.

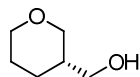
Oligomer: 3-(2-Hydroxyphenyl)oxetan-3-ol (**4h**), **2** (2.5 mg, 0.003 mmol, 1 mol%) and MeCN (300 μ L) were added to a vial. The reaction mixture was stirred for 6 h, at which point silicycle DMT scavenger (40.8 mg) was added to the reaction mixture. The suspension was stirred for 1 h, filtered and subjected to purification *via* column chromatography 4:1 EtOAc:hexanes) to yield the desired product as a white solid (46.9 mg, 94%); $[\alpha]_D^{24} = +22.5^\circ$; IR (thin film, cm^{-1}) 3366 (s), 2924 (w), 1599 (m), 1479 (s), 1464 (s), 1229 (m), 1176 (m), 1111 (w), 1055 (s), 1015 (w), 974 (s), 931 (m), 837 (s), 752 (s); ^1H NMR (600 MHz, CDCl_3) δ 7.37 (1H, d, $J = 7.3$ Hz), 7.32–7.27 (1H, m), 6.95 (1H, t, $J = 7.5$ Hz), 6.88 (1H, d, $J = 8.2$ Hz), 4.55 (1H, d, $J = 10.3$ Hz), 4.44 (1H, d, $J = 10.3$ Hz), 3.94 (1H, dd, $J = 11.1, 5.6$ Hz), 3.85 (1H, dd, $J = 11.1, 6.4$ Hz), 2.51 (1H, s), 2.09 (1H, t, $J = 6.2$ Hz); ^{13}C NMR (125 MHz, CDCl_3) δ 160.6, 131.0, 128.2, 123.9, 121.1, 110.8, 80.5, 67.3; LRMS (ESI) m/z : 189 (5%) $[\text{M}+\text{Na}]^+$.



(S)-2-(3-(Hydroxymethyl)tetrahydrofuran-3-yl)ethanol (4i).

Monomer: 2,2'-(Oxetane-3,3-diyl)diethanol (**3i**) (44 mg, 0.3 mmol, 1.0 equiv.) and **1** (2.3 mg, 0.003 mmol, 1 mol%) were added to a vial. The reaction mixture was stirred for 5 h and at which point silicycle metal scavenger DMT (31 mg) and EtOAc (0.3 mL) were added. The suspension was stirred for 1 h, filtered and subjected to purification *via* column chromatography (9:1 CH_2Cl_2 :MeOH) to yield the product as a colorless oil (38.6 mg, 88%). The enantiomeric excess was determined to be 97% by chiral HPLC (Chiralcel AD, 2% isopropanol/hexanes, 1.0 mL/min, 230 nm) $t_r(\text{minor}) = 32.4$ min, $t_r(\text{major}) = 37.2$ min of the benzoylated product. $[\alpha]_D^{24} = +13.7^\circ$ ($c=0.8$, CHCl_3).

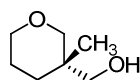
Oligomer: 2,2'-(Oxetane-3,3-diyl)diethanol (**3i**) (44 mg, 0.3 mmol, 1.0 equiv.) and a solution of **2** (0.0245 mg, 3×10^{-5} mmol, 0.01 mol%) in MeCN (50 μ L) were added to a vial. The reaction mixture was stirred for 5 h and at which point silicycle DMT scavenger (2 mg) was added to the reaction mixture. The suspension was stirred for 1 h, filtered and subjected to purification *via* column chromatography (9:1 CH_2Cl_2 :MeOH) to yield the product as a colorless oil (43.2 mg, 98%). The enantiomeric excess was determined to be 99% by chiral HPLC (Chiralcel AD, 2% isopropanol/hexanes, 1.0 mL/min, 230 nm) $t_r(\text{minor}) = 32.4$ min, $t_r(\text{major}) = 37.2$ min of the benzoylated product. $[\alpha]_D^{24} = +14.9^\circ$ ($c=1$, CHCl_3); IR (thin film, cm^{-1}) 3354 (m), 2938 (w), 2870 (w), 1469 (w), 1051 (m), 911 (m); ^1H NMR (600 MHz, CDCl_3) δ 3.90 (2 H, dddd, $J = 8.8, 6.7, 5.9, 2.1$ Hz), 3.81 (2H, t, $J = 5.4$ Hz) 3.77 (1H, d, $J = 8.8$ Hz), 3.61 (2H, dd, $J = 11.1, 5.3$ Hz), 3.49 (1H, d, $J = 8.8$ Hz) 3.17 (1H, br. s.), 2.52 (1H, br. s.), 1.90 (1H, ddd, $J = 6.2, 4.7, 2.1$ Hz) 1.87–1.77 (2H, m), 1.70 (1H, ddd, $J = 12.6, 8.4, 6.6$ Hz); ^{13}C NMR (125 MHz, CDCl_3) δ 75.7, 67.5, 67.3, 60.0, 47.9, 38.9, 34.7; LRMS (ESI) m/z : 147 (44%) $[\text{M}]^+$.



(S)-(Tetrahydro-2H-pyran-3-yl)methanol (6).

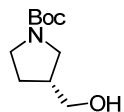
Monomer: 3-(Oxetan-3-yl)propan-1-ol (**5**) (58.0 mg, 0.5 mmol, 1.0 equiv.) and **1** (37.6 mg, 0.05 mmol, 10 mol%) were added to a vial. The reaction mixture was stirred for 96 h and subsequently treated with silicycle metal scavenger DMT (678 mg) and diluted with EtOAc (1.0 mL). The suspension was stirred for 1 h, filtered and subjected to purification *via* column chromatography (EtOAc) to yield the product as a colorless oil (22 mg, 38%). The enantiomeric excess was determined to be 7% by chiral HPLC (Chiralcel AD-H, 1% isopropanol/hexanes, 1.0 mL/min, 254 nm) $t_r(\text{minor}) = 24.1$ min, $t_r(\text{major}) = 31.7$ min of the benzoylated product. $[\alpha]_D^{24} = -0.9^\circ$ ($c=1$, CHCl_3).

Oligomer: 3-(Oxetan-3-yl)propan-1-ol (**5**) (58.0 mg, 0.5 mmol, 1.0 equiv.) and a solution of **2** (2.5 mg, 0.003 mmol, 1 mol%) in MeCN (83 μL) were added to a vial. The reaction mixture was stirred for 96 h, at which point silicycle DMT scavenger (7 mg) was added to the reaction mixture. The suspension was stirred for 1 h, filtered and subjected to purification *via* column chromatography (EtOAc) to yield the desired product as a colorless oil (51.7 mg, 89%). The enantiomeric excess was determined to be 96% by chiral HPLC (Chiralcel AD-H, 1% isopropanol/hexanes, 1.0 mL/min, 254 nm) $t_r(\text{minor}) = 22.6$ min, $t_r(\text{major}) = 26.9$ min of the benzoylated product. $[\alpha]_D^{24} = +18.9^\circ$ ($c=1$, CHCl_3); IR (thin film, cm^{-1}) 3379 (s), 2931 (m), 2851 (m), 1468 (w), 1439 (w), 1386 (w), 1301 (m), 1179 (m), 1082 (s), 1044 (m), 1023 (s), 986 (m), 933 (w), 908 (m), 858 (m), 806 (w); ^1H NMR (600 MHz, CDCl_3) δ 3.97 (1H, ddd, $J = 11.3, 1.9, 1.8$ Hz), 3.85 (1H, dt, $J = 11.1, 3.8$ Hz), 3.58-3.48 (2H, m), 3.43 (1H, dd, $J = 13.2, 11.1$ Hz), 3.28 (1H, dd, $J = 11.1, 9.1$ Hz), 1.89-1.78 (2H, m), 1.67-1.56 (2H, m), 1.49 (1H, br s), 1.33-1.27 (1H, m); ^{13}C NMR (125 MHz, CDCl_3) δ 70.7, 68.5, 64.7, 38.5, 26.0, 25.1; LRMS (ESI) m/z : 173 (24%) $[\text{M}+\text{Na}]^+$.



(S)-(3-Methyltetrahydro-2H-pyran-3-yl)methanol.

Oligomer: Ethyl 3-(oxetan-3-yl)propanoate (52.1 mg, 0.5 mmol, 1.0 equiv.), **2** (3.3 mg, 0.004 mmol, 1 mol%) and MeCN (67 μL) were added to a vial. The reaction mixture was stirred for 96 h, at which point silicycle DMT scavenger (54.2 mg) was added to the reaction mixture. The suspension was stirred for 1 h, filtered and subjected to purification *via* column chromatography (EtOAc) to yield the desired product as a colorless oil (19.9 mg, 38%). The enantiomeric excess was determined to be 44% by chiral GC analysis (β -cyclosil, 90 $^\circ\text{C}$ isothermal, 21 psi) $t_r(\text{major}) = 8.9$ min, $t_r(\text{minor}) = 9.4$ min of the trifluoroacetylated product. $[\alpha]_D^{24} = +2.2^\circ$ ($c=0.8$, CHCl_3); IR (thin film, cm^{-1}) 3383 (s), 2937 (s), 2851 (s), 1468 (m), 1452 (m), 1376 (w), 1301 (m), 1192 (m), 1085 (s), 1033 (s), 1016 (m), 979 (m), 955 (w), 884 (w), 864 (m), 841 (m); ^1H NMR (600 MHz, CDCl_3) δ 3.69 (1H, dd, $J = 10.7, 4.8$ Hz), 3.61-3.52 (3H, m), 3.48 (1H, dd, $J = 10.8, 3.5$ Hz), 3.27 (1H, d, $J = 11.4$ Hz), 1.68 (1H, td, $J = 8.6, 4.4$ Hz), 1.63 (1H, dd, $J = 17.7, 4.3$ Hz), 1.60-1.54 (1H, m), 1.36 (1H, ddd, $J = 13.0, 8.9, 4.4$ Hz), 0.90 (3H, s); ^{13}C NMR (125 MHz, CDCl_3) δ 74.6, 68.5, 68.5, 35.0, 31.7, 22.2, 20.9; LRMS (ESI) m/z : 131 (14%) $[\text{M}+\text{H}]^+$.



(R)-tert-Butyl 3-(hydroxymethyl)pyrrolidine-1-carboxylate (8).

Monomer: *tert*-Butyl 2-(oxetan-3-yl)ethylcarbamate (**7**) (30.2 mg, 0.15 mmol, 1.0 equiv.), **1** (11.3 mg, 0.015 mmol, 10 mol%) and TBME (25 μL) were added to a vial.

The reaction mixture was stirred at 40 °C for 72 h and subsequently treated with silicycle metal scavenger DMT (163 mg) and diluted with EtOAc (0.5 mL). The suspension was stirred for 1 h, filtered and subjected to purification *via* column chromatography (2:1 EtOAc:hexanes) to yield the desired product as a colorless oil (21.7 mg, 72%). The enantiomeric excess was determined to be 50% by chiral GC analysis (γ -TA, 120 °C isothermal, 7 psi) $t_r(\text{minor}) = 8.9$ min, $t_r(\text{major}) = 9.4$ min of the trifluoroacetylated product. $[\alpha]_D^{24} = 6.5^\circ$ ($c=0.9$, CHCl_3).

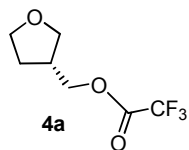
Oligomer: *tert*-Butyl 2-(oxetan-3-yl)ethylcarbamate (**7**) (30.2 mg, 0.15 mmol, 1.0 equiv.), **2** (11.3 mg, 0.015 mmol, 10 mol%) and MeCN (25 μL) were added to a vial. The reaction mixture was stirred at 40 °C for 96 h, at which point silicycle DMT scavenger (54.2 mg) was added to the reaction mixture. The suspension was stirred for 1 h, filtered and subjected to purification *via* column chromatography (EtOAc) to yield the desired product as a colorless oil (21.0 mg, 70%). The enantiomeric excess was determined to be 10% by chiral GC analysis (γ -TA, 120 °C isothermal, 7 psi) $t_r(\text{major}) = 8.9$ min, $t_r(\text{minor}) = 9.4$ min of the trifluoroacetylated product. $[\alpha]_D^{24} = +0.6^\circ$ ($c=0.9$, CHCl_3). Characterization data were in agreement with literature values.¹⁴

Full citation for reference 15a and 15b:

(15) (a) Lyles-Eggleston, M.; Altundas, R.; Xia, J.; Sikazwe, D. M. N.; Fan, P.; Yang, Q.; Li, S.; Zhang, W.; Zhu, X.; Schmidt, A. W.; Vanase-Frawley, M.; Shrihkande, A.; Villalobos, A.; Borne, R. F.; Ablordeppey, S. Y. *J. Med. Chem.* **2004**, 47, 497-508.

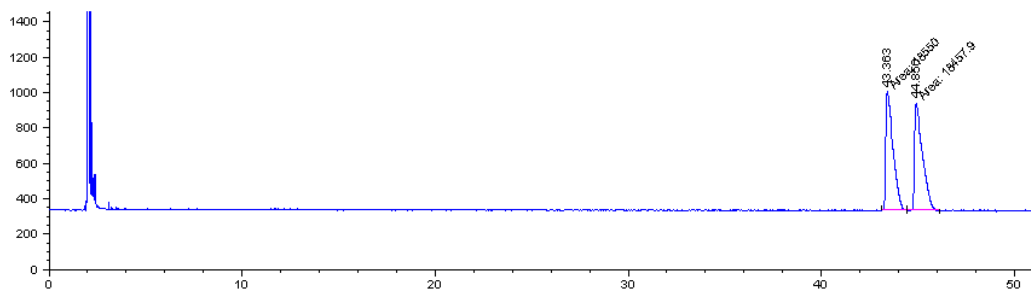
(15) (b) Kuo, E. A.; Hambleton, P. T.; Kay, D. P.; Evans, P. L.; Matharu, S. S.; Little, E.; McDowall, N.; Jones, C. B.; Hedgecock, C. J. R.; Yea, C. M.; Chan, A. W. E.; Hairsine, P. W.; Ager, I. R.; Tully, W. R.; Williamson, R. A.; Westwood, R. *J. Med. Chem.* **1996**, 39, 4608-4621.

¹⁴ Horiuchi, T.; Ohta, T.; Shirakawa, E.; Nozaki, K.; Takaya, H. *J. Org. Chem.* **1997**, 62, 4285-4292.



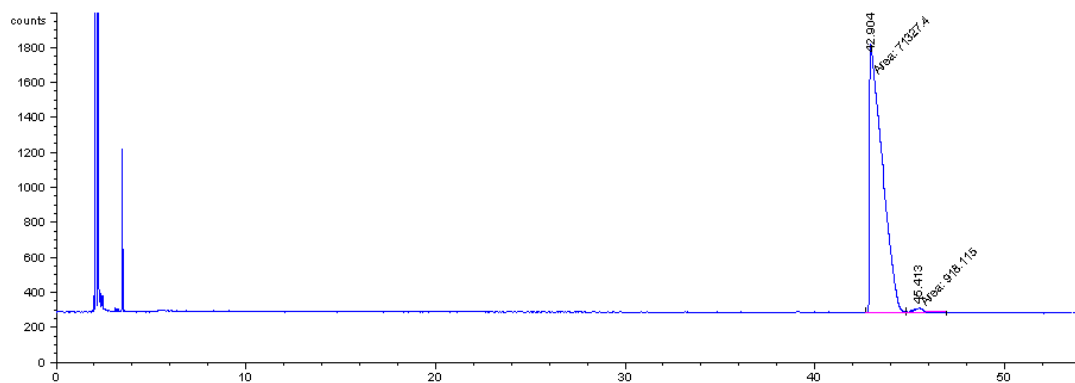
Chiral GC: β -Cyclosil 60 °C isothermal, 7 psi

Racemate



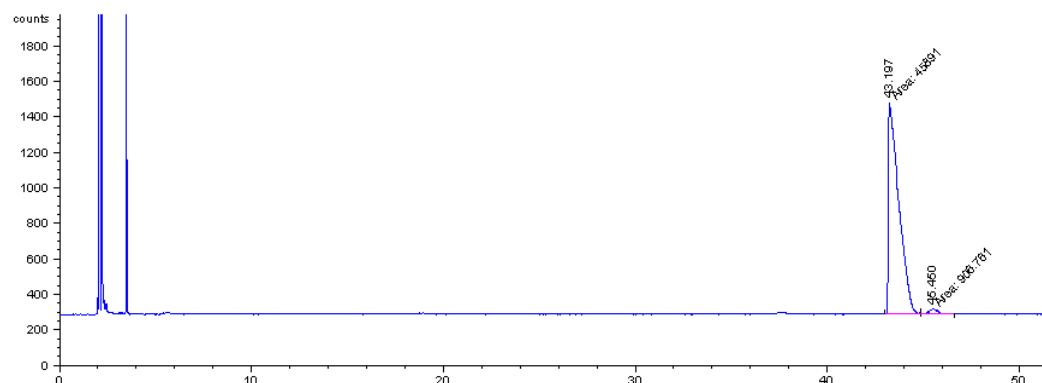
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(R,R)-1 98% ee

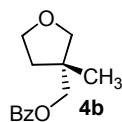


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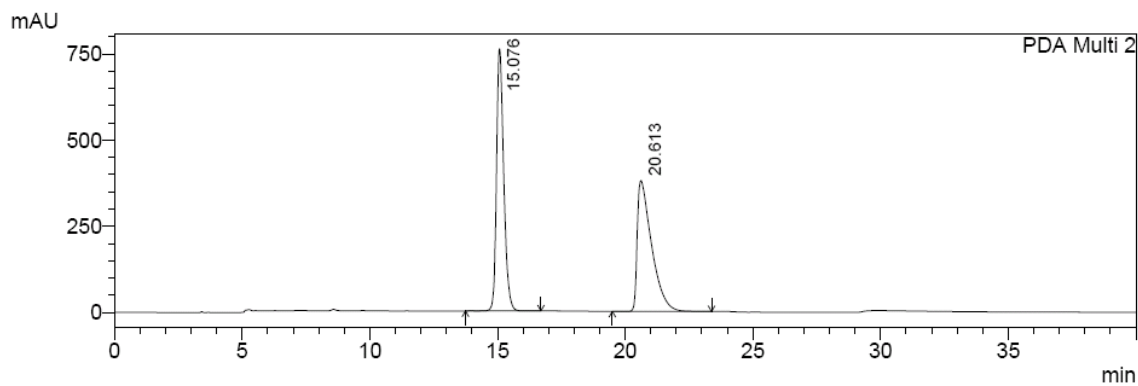
(R,R)-2 96% ee



#	Time	Area	Height	Width	Area%	Symmetry
1	43.197	45891	1192.7	0.6413	98.062	0.112
2	45.45	906.8	27.6	0.548	1.938	0



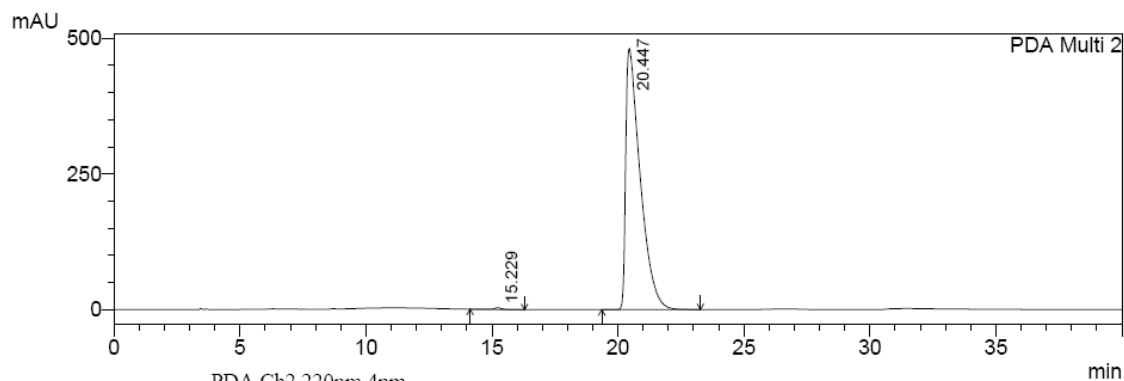
Chiral HPLC, Chiralpak AD-H, 1% isopropanol/hexanes, 1 mL/min, $\lambda = 220$ nm
 Racemic



PDA Ch2 220nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	15.076	14897091	761793	50.066	66.703
2	20.613	14857648	380274	49.934	33.297
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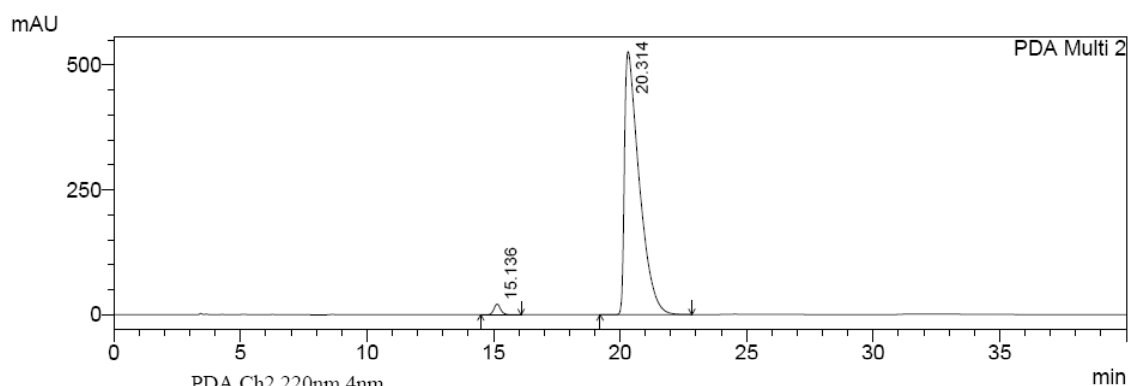
(R,R)-1 99% ee



PDA Ch2 220nm 4nm

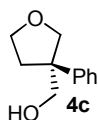
Peak#	Ret. Time	Area	Height	Area %	Height %
1	15.229	48950	3107	0.254	0.642
2	20.447	19191704	481255	99.746	99.358
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(R,R)-2 96% ee

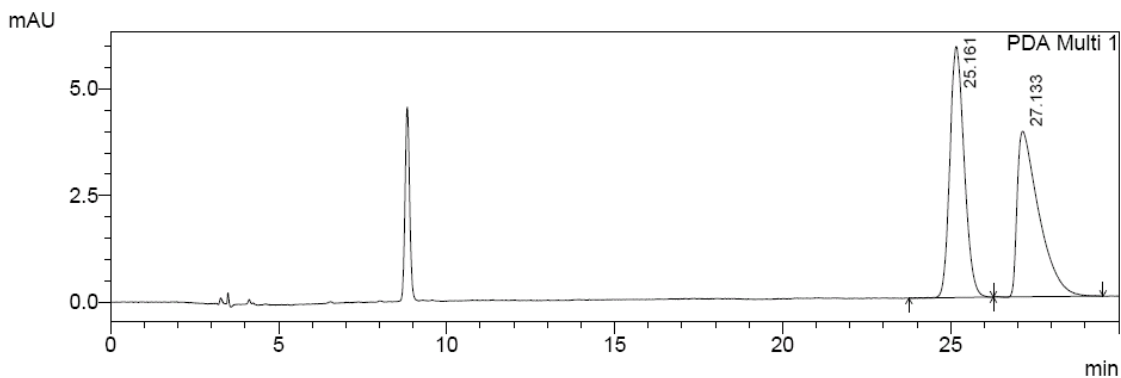


PDA Ch2 220nm 4nm

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1	15.136	392853	21204	1.804	3.869
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Total		21772068	547983	100.000	100.000



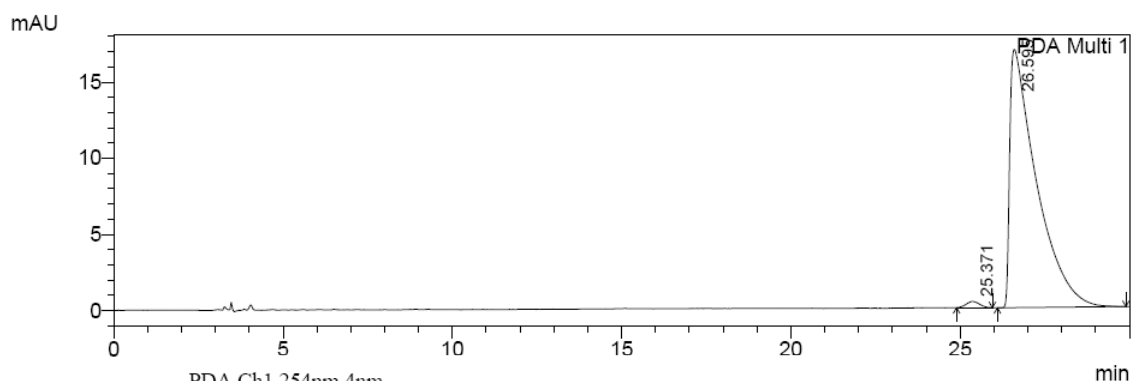
Chiral HPLC, Chiralpak AD-H, 2% isopropanol/hexanes, 1 mL/min, $\lambda = 254$ nm
racemate



PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	25.161	174728	5886	50.017	60.284
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Total		349334	9765	100.000	100.000

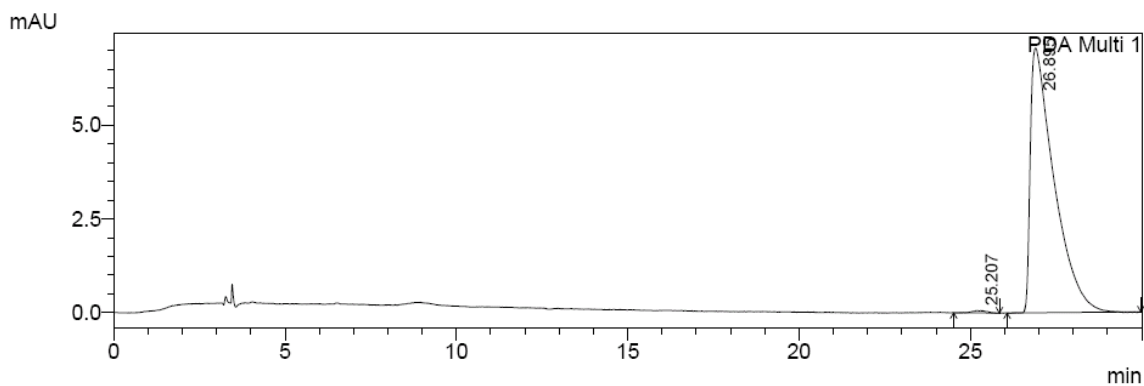
(R,R)-1 98% ee



PDA Ch1 254nm 4nm

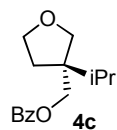
Peak#	Ret. Time	Area	Height	Area %	Height %
1	25.371	10873	403	1.159	2.319
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(R,R)-2 99%

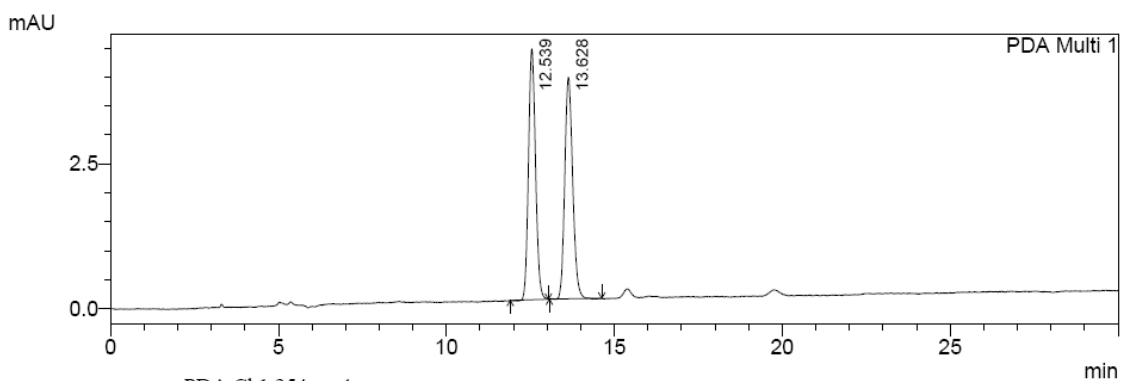


PDA Ch1 254nm 4nm

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2	26.895	338980	7067	99.490	99.186
Total		340719	7125	100.000	100.000



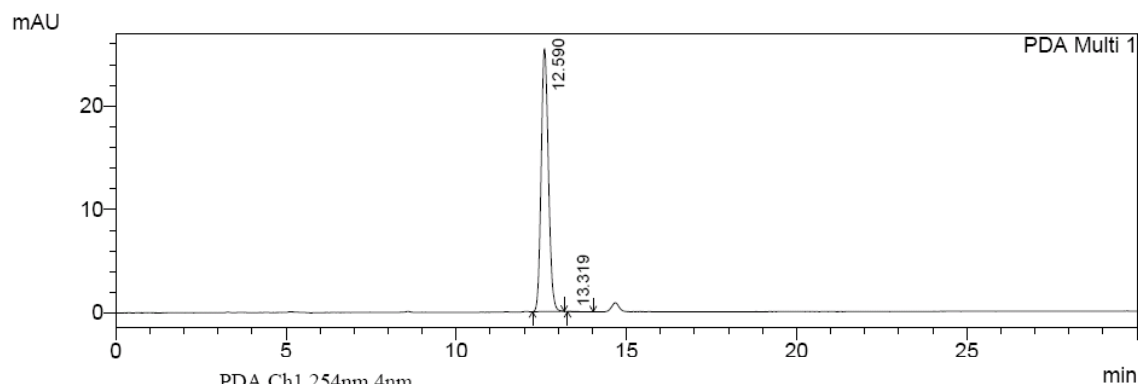
Chiral HPLC, Chiralpak AD-H, 1% isopropanol/hexanes, 1 mL/min, $\lambda = 254$ nm
Racemate



PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	12.539	62821	4332	50.004	53.110
2	13.628	62811	3825	49.996	46.890
Total		125632	8157	100.000	100.000

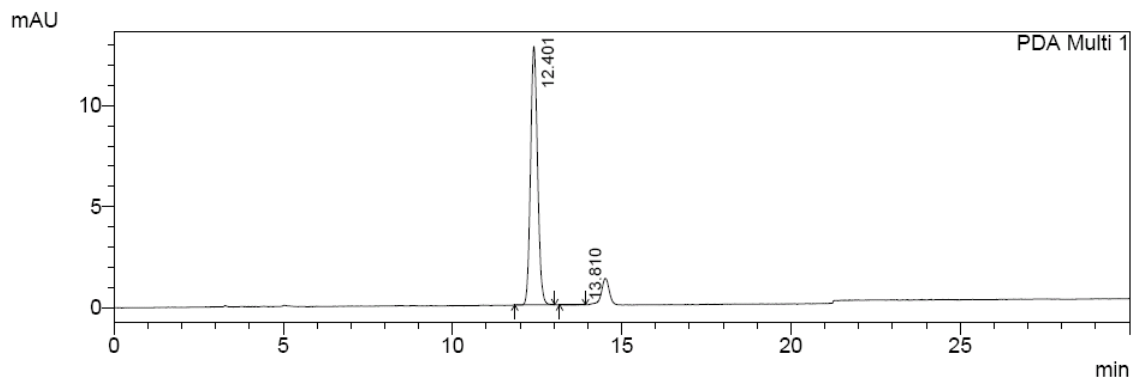
(R,R)-1 99% ee



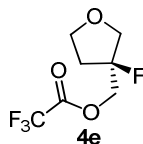
PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	12.590	373816	25432	100.140	99.985
2	13.319	-524	4	-0.140	0.015
Total		373292	25436	100.000	100.000

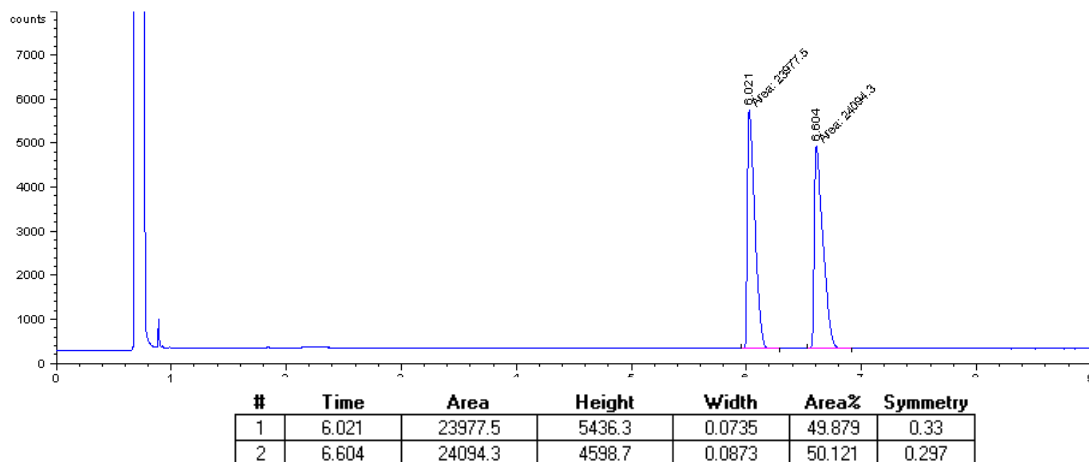
(R,R)-2 99% ee



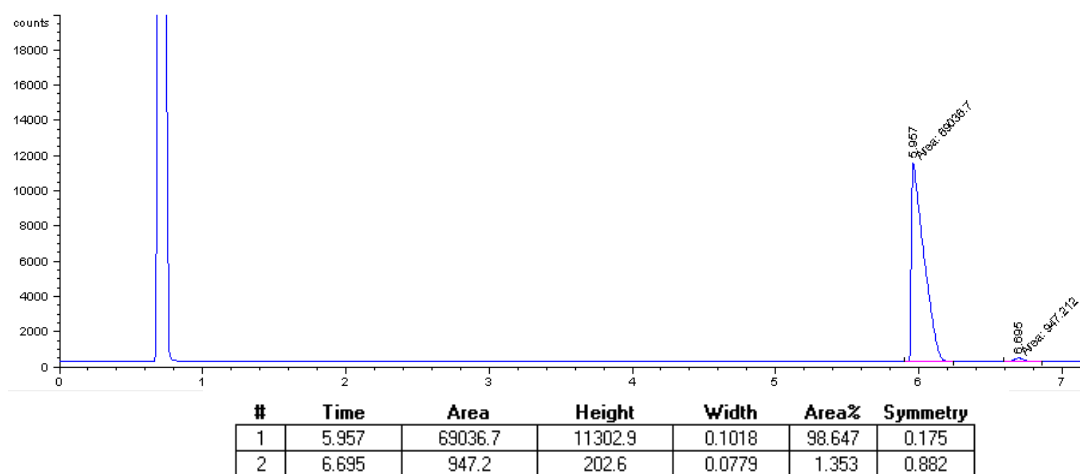
Peak#	Ret. Time	Area	Height	Area %	Height %
1	12.401	184011	12779	100.199	99.994
2	13.810	-365	1	-0.199	0.006
Total		183646	12779	100.000	100.000



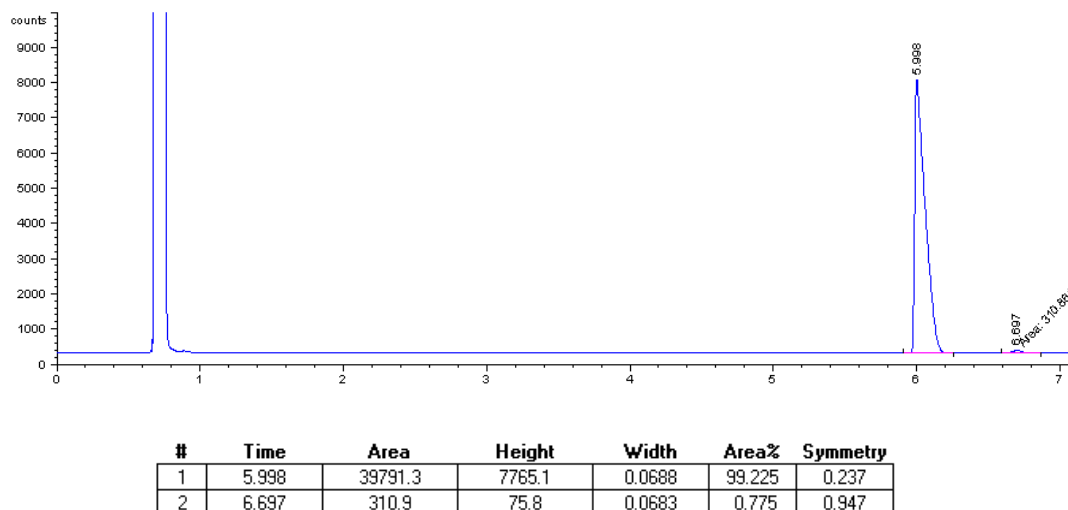
Chiral GC: β -Cyclosil 90 °C isothermal, 21 psi
racemate

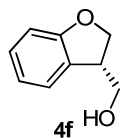


(R,R)-**1** 97% ee

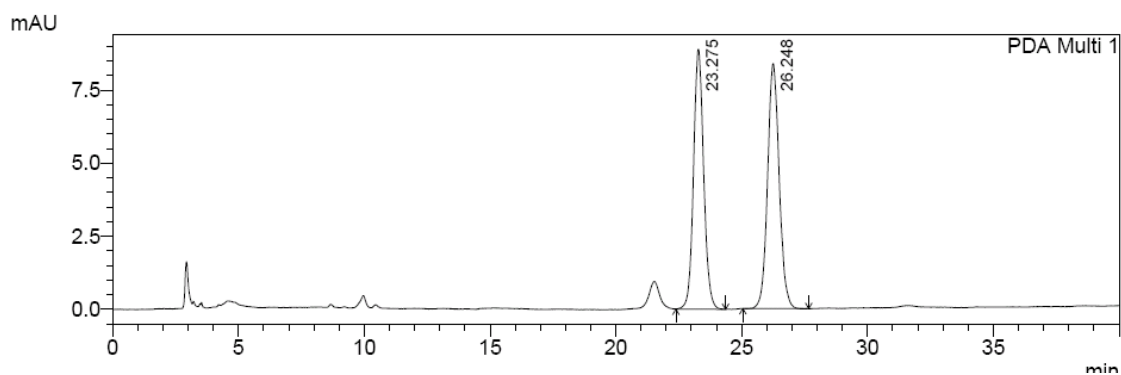


(R,R)-**2** 98% ee





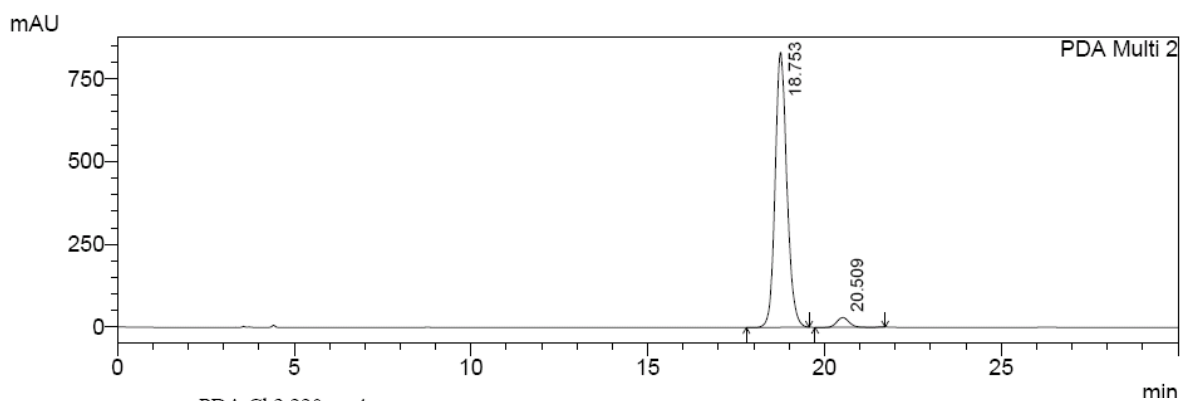
Chiral HPLC, Chiralpak AD-H, 3% isopropanol/hexanes, 1 mL/min, $\lambda = 254$ nm
racemate



PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	23.275	250133	8895	48.183	51.484
2	26.248	268994	8382	51.817	48.516
Total		519127	17277	100.000	100.000

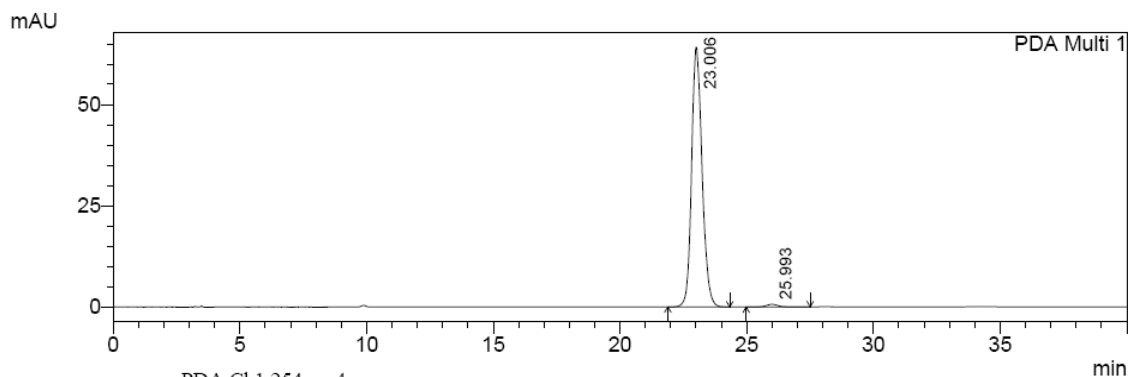
(R,R)-1 93% ee



PDA Ch2 220nm 4nm

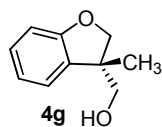
Peak#	Ret. Time	Area	Height	Area %	Height %
1	18.753	19216655	831164	96.605	96.554
2	20.509	675392	29660	3.395	3.446
Total		19892047	860824	100.000	100.000

(R,R)-2 98% ee

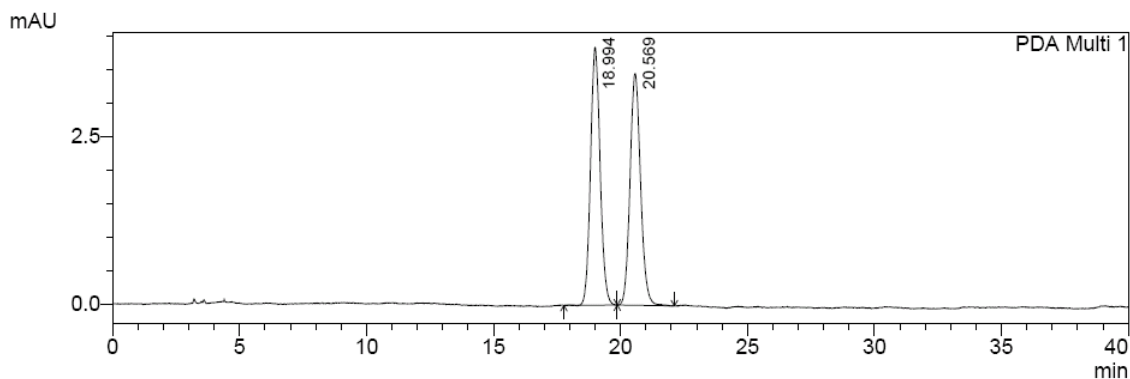


PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	23.006	1850219	64166	98.960	99.000
2	25.993	19447	648	1.040	1.000
Total		1869665	64814	100.000	100.000



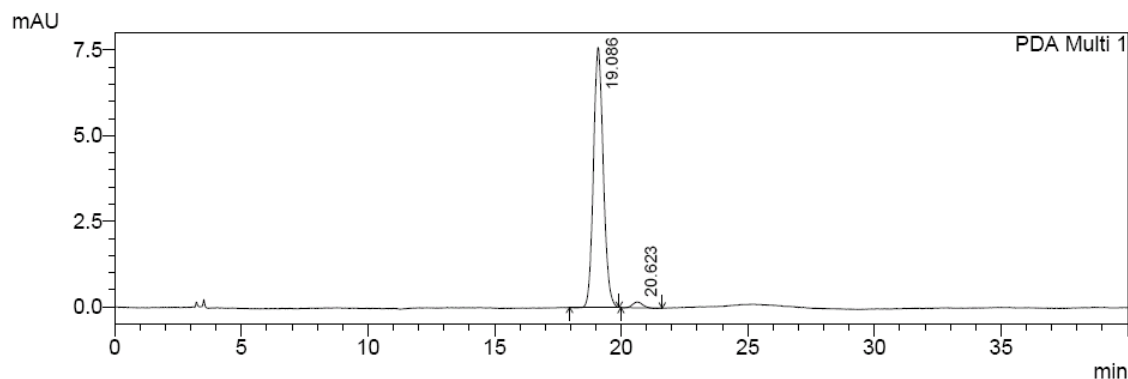
Chiral HPLC, Chiralpak AS-H, 2% isopropanol/hexanes, 1 mL/min, $\lambda = 254$ nm
Racemate



PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	18.994	101594	3858	50.338	52.683
2	20.569	100232	3465	49.662	47.317
Total		201825	7323	100.000	100.000

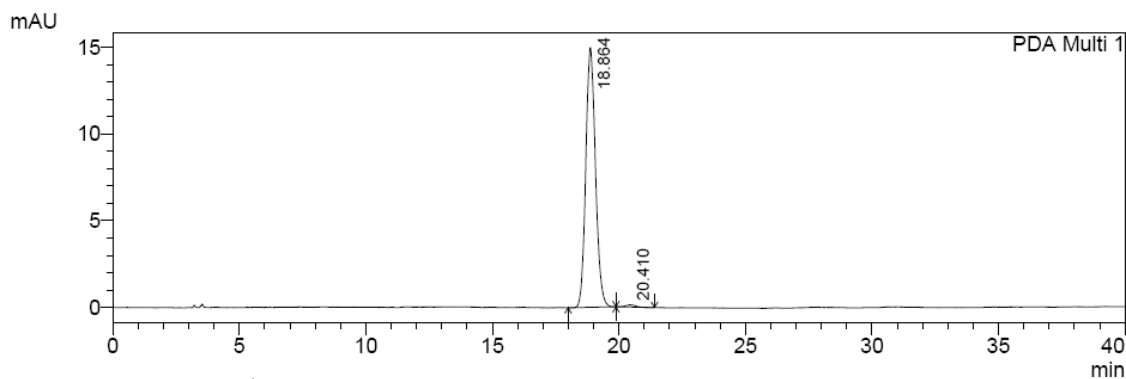
(R,R)-**1** 96% ee



PDA Ch1 254nm 4nm

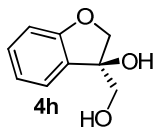
Peak#	Ret. Time	Area	Height	Area %	Height %
1	19.086	204573	7587	97.927	97.810
2	20.623	4330	170	2.073	2.190
Total		208903	7756	100.000	100.000

(R,R)-**2** 98% ee

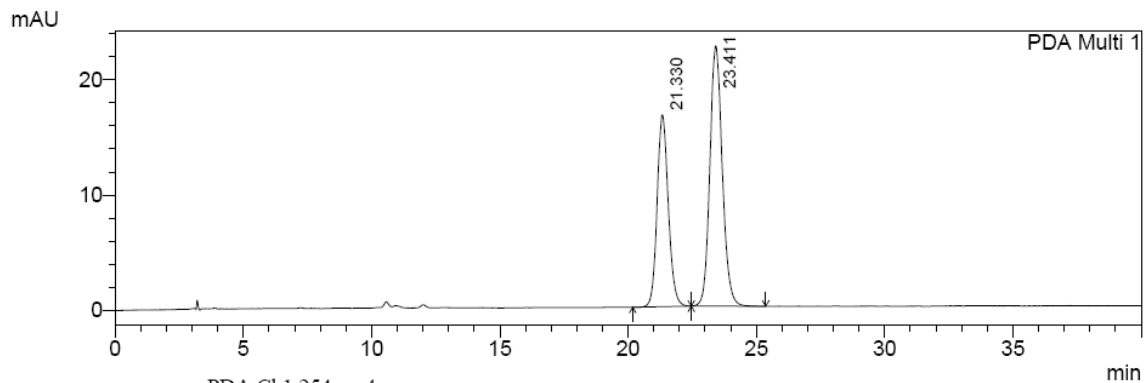


PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	18.864	398421	14971	99.222	99.180
2	20.410	3126	124	0.778	0.820
Total		401547	15095	100.000	100.000



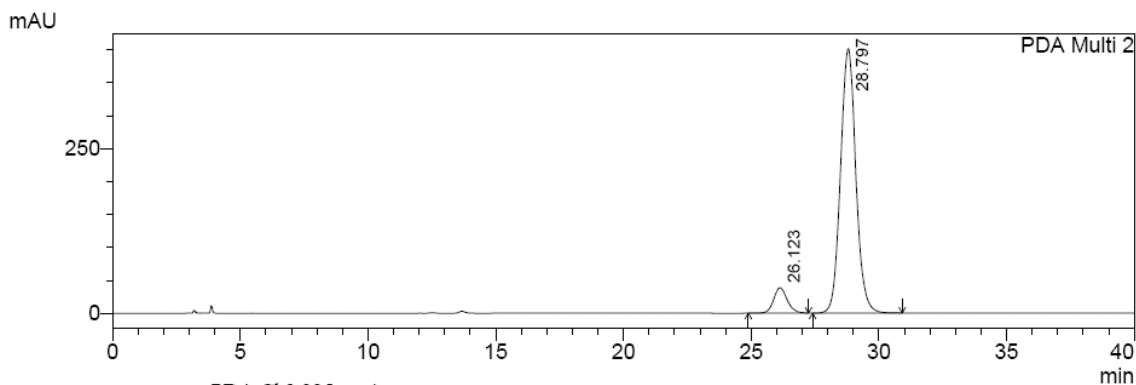
Chiral HPLC, Chiralpak AD-H, 5% isopropanol/hexanes, 1 mL/min, $\lambda = 225$ nm
 Racemate



PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	21.330	504500	16624	39.843	42.423
2	23.411	761730	22563	60.157	57.577
Total		1266229	39188	100.000	100.000

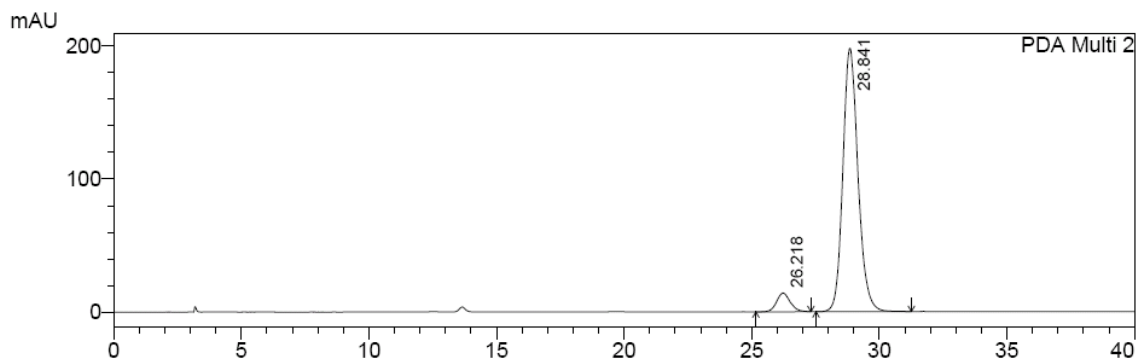
(R,R)-1 84% ee



PDA Ch2 225nm 4nm

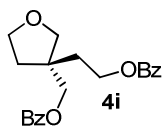
Peak#	Ret. Time	Area	Height	Area %	Height %
1	26.123	1420954	38467	7.824	8.745
2	28.797	16741392	401431	92.176	91.255
Total		18162347	439898	100.000	100.000

(R,R)-2 88% ee

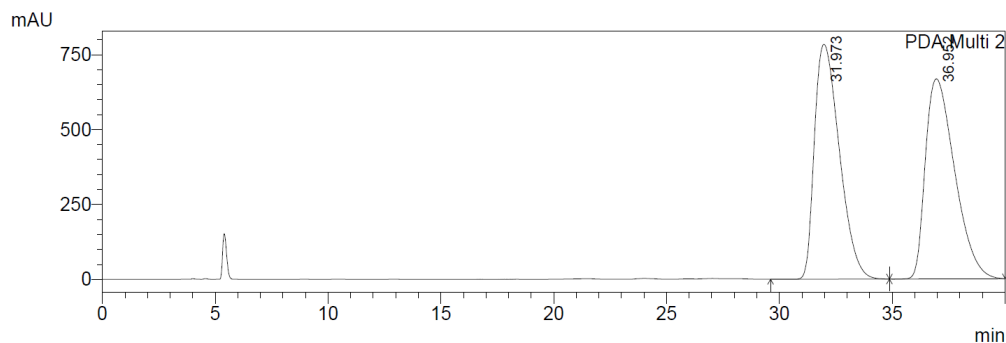


PDA Ch2 225nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	26.218	521418	14061	6.001	6.638
2	28.841	8168038	197750	93.999	93.362
Total		8689456	211811	100.000	100.000



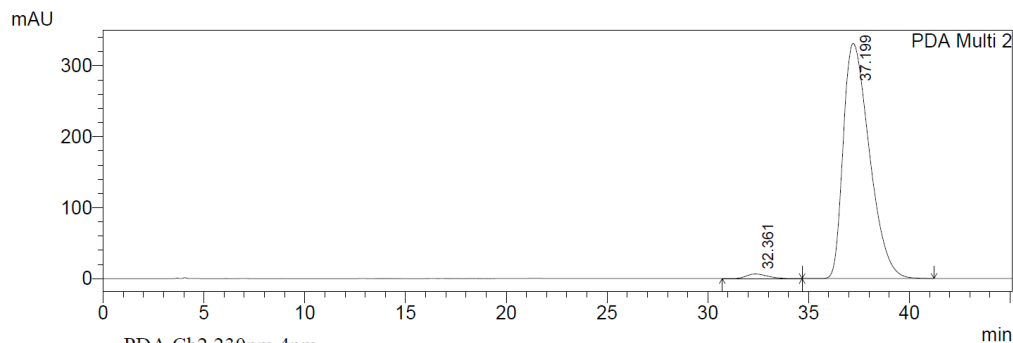
Chiral HPLC, Chiralpak AD, 2% isopropanol/hexanes, 1 mL/min, $\lambda = 230$ nm
Racemate



PDA Ch2 230nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	31.973	60268847	784048	49.955	54.005
2	36.952	60378046	667753	50.045	45.995
Total		120646893	1451801	100.000	100.000

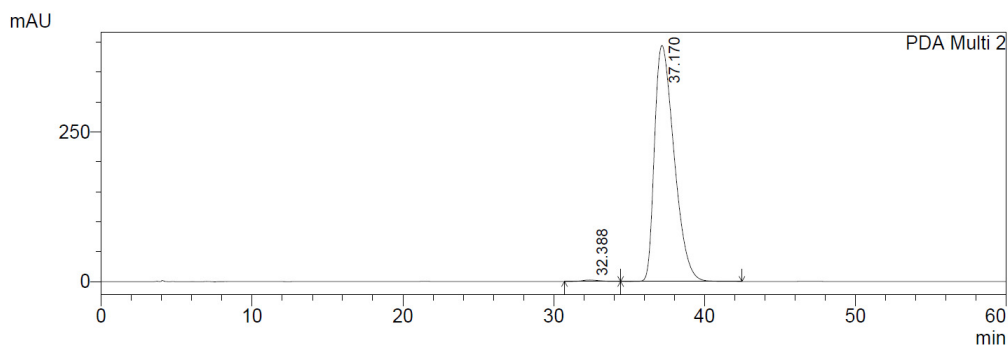
(R,R)-1 97% ee



PDA Ch2 230nm 4nm

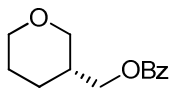
Peak#	Ret. Time	Area	Height	Area %	Height %
1	32.361	470853	6537	1.548	1.934
2	37.199	29954881	331454	98.452	98.066
Total		30425734	337991	100.000	100.000

(R,R)-2 99% ee

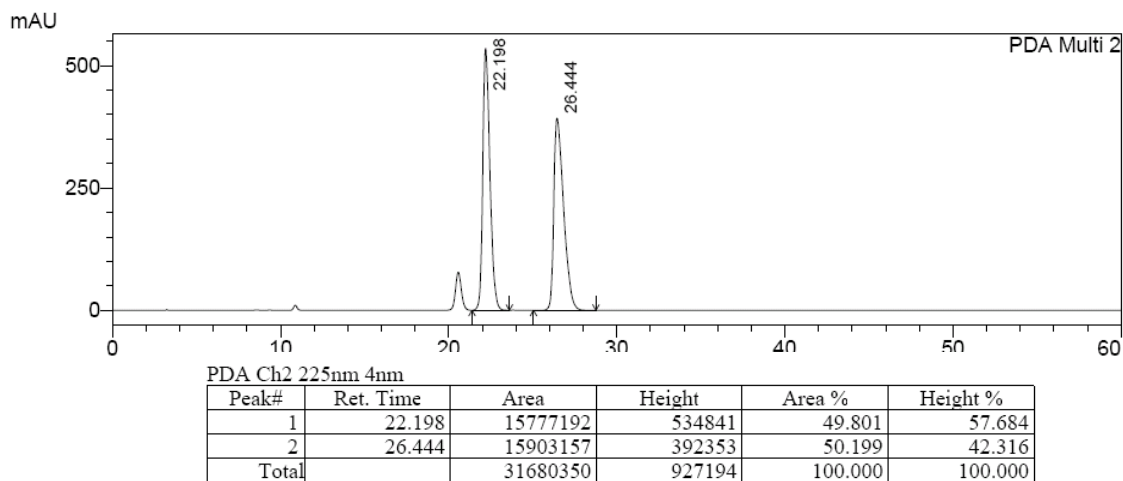


PDA Ch2 230nm 4nm

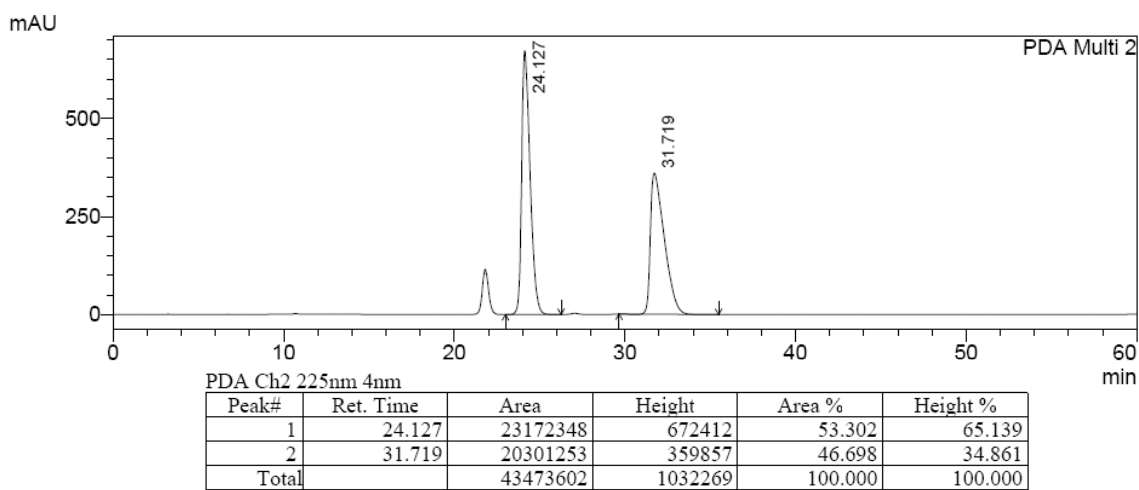
Peak#	Ret. Time	Area	Height	Area %	Height %
1	32.388	176578	2436	0.495	0.615
2	37.170	35509418	393759	99.505	99.385
Total		35685996	396195	100.000	100.000



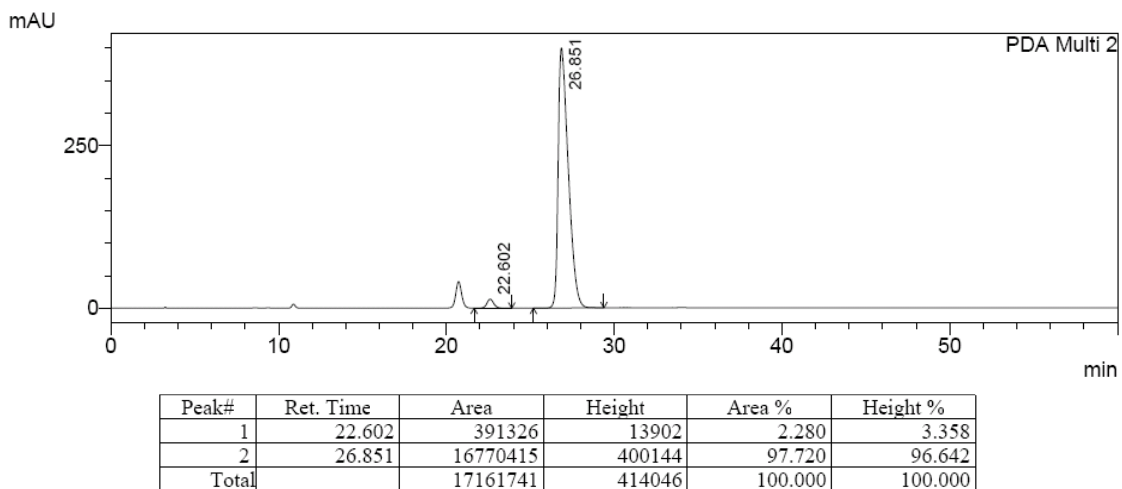
Chiral HPLC, Chiralpak AD-H, 1% isopropanol/hexanes, 1 mL/min, $\lambda = 254$ nm
Racemic

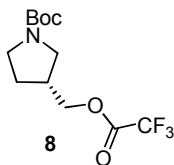


(R,R)-1 -7% ee

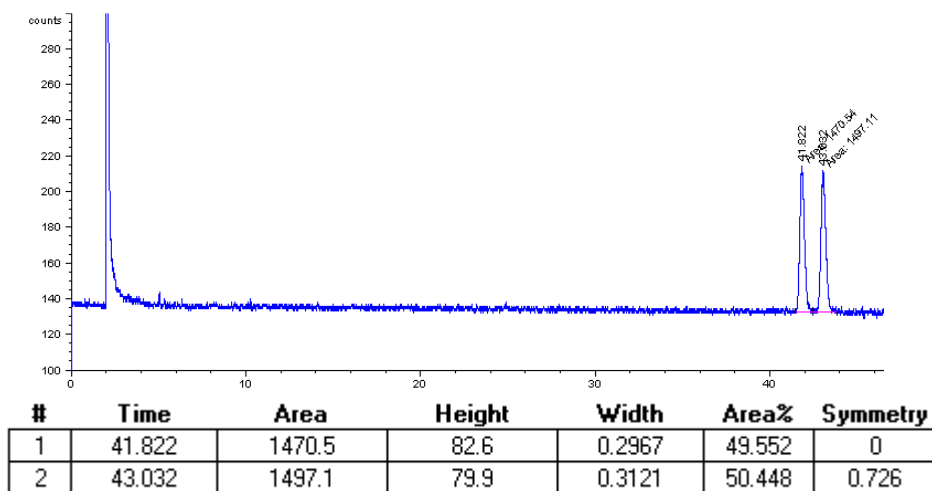


(R,R)-2 96% ee

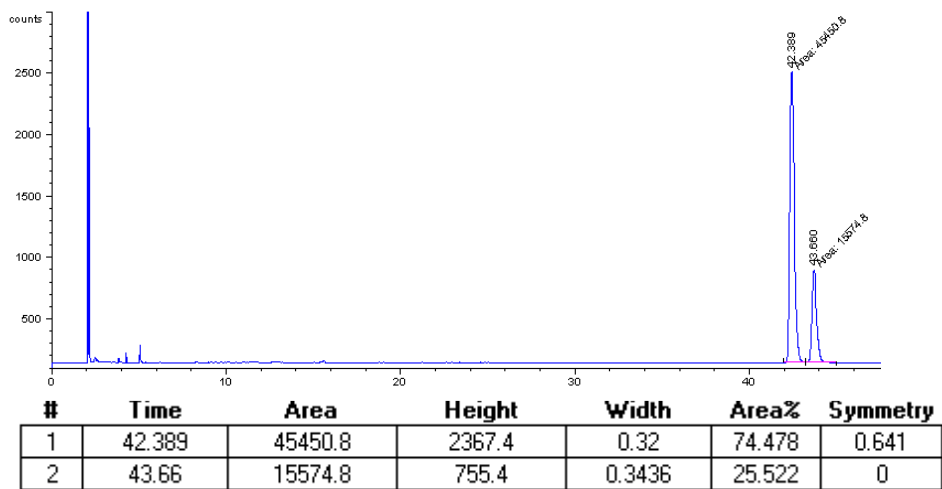




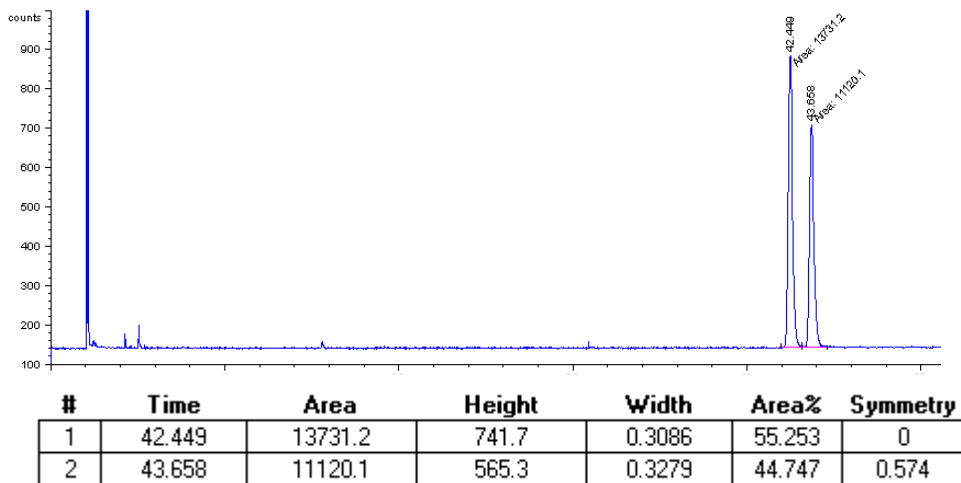
Chiral GC: γ -TA, 120 °C isothermal, 7 psi
Racemic

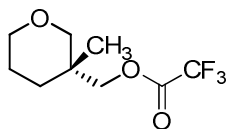


(R,R)-1 50% ee



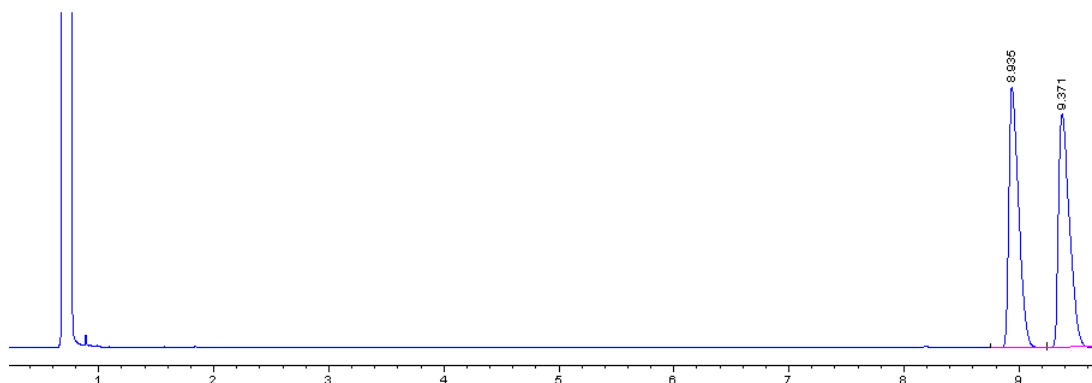
(R,R)-2 10% ee





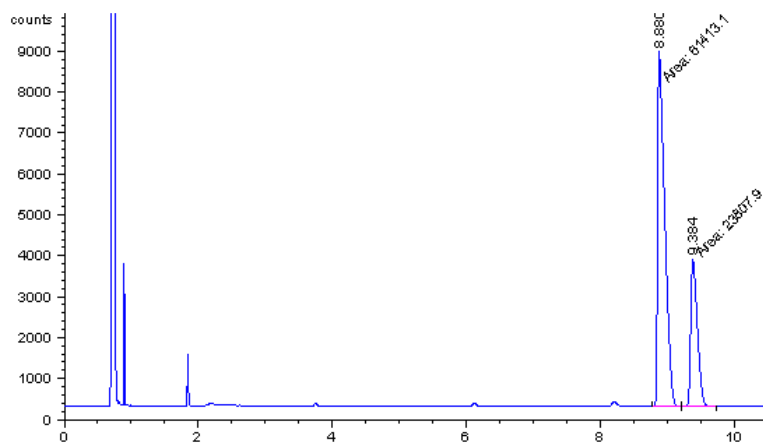
β -Cyclosil 90 °C isothermal, 13 psi

racemic



#	Time	Area	Height	Width	Area%	Symmetry
1	8.935	26056.1	4427.2	0.0907	49.883	0.463
2	9.371	26178.7	3966.8	0.098	50.117	0.462

(R,R)-2 44% ee



#	Time	Area	Height	Width	Area%	Symmetry
1	8.88	61413.1	8679	0.1179	72.063	0.269
2	9.384	23807.9	3591	0.1105	27.937	0.488

