Enantioselective Cascade Reaction between α,β-Unsaturated Carbonyls and Malonic Half-thioesters: Rapid Access to Chiral δ-lactones

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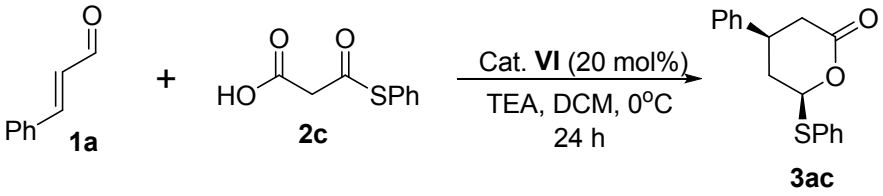
Supporting Information

Contents:

1. General Information

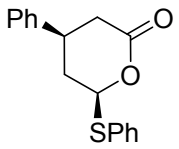
Chemicals and solvents were purchased from commercial suppliers and used as received. ^{1}H and ^{13}C NMR spectra were recorded on a Bruker ACF300 (300 MHz) or AMX500 (500 MHz) spectrometer. Chemical shifts were reported in parts per million (ppm), and the residual solvent peak was used as an internal reference: proton (chloroform δ 7.26), carbon (chloroform δ 77.0) or tetramethylsilane (TMS δ 0.00) was used as a reference. Multiplicity was indicated as follows: s (singlet), d (doublet), t (triplet), q (quartet), m (multiplet), dd (doublet of doublet), bs (broad singlet). Coupling constants were reported in Hertz (Hz). Low resolution mass spectra were obtained on a Finnigan/MAT LCQ spectrometer in ESI mode, and a Finnigan/MAT 95XL-T mass spectrometer in EI mode. All high resolution mass spectra were obtained on a Finnigan/MAT 95XL-T spectrometer. For thin layer chromatography (TLC), Merck pre-coated TLC plates (Merck 60 F254) were used, and compounds were visualized with a UV light at 254 nm. Flash chromatography separations were performed on Merck 60 (0.040-0.063 mm) mesh silica gel. The enantiomeric excesses of products were determined by chiral phase HPLC analysis. Optical rotations were recorded on Jasco DIP-1000 polarimeter.

2. Experimental Procedure for Decarboxylative Reaction of MAHTs to Enals

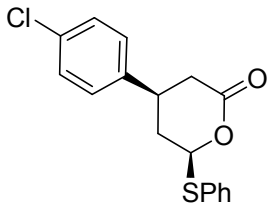


Typical procedure for the decarboxylative reaction:

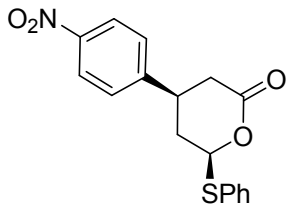
To a solution of cinnamaldehyde **1a** (26.4 mg, 25.2 uL, 0.2 mmol,) in DCM (0.5 mL) was added catalyst **V** (25.6 mg, 0.04 mmol) at 0 °C. After 40 min, malonic acid half thioester **2c** (98.1 mg, 0.5 mmol) was added in one portion. Then, TEA (50.5 mg, 69.6 uL, 0.5 mmol) in 0.5 mL DCM was added dropwise *via* syringe in 10 min at 0 °C. The resulting reaction mixture was kept stirring at 0°C for 24 h. The crude product was purified by silica gel flash chromatography, eluted by hexane/EtOAc = 10:1 to afford the desired product **3ac** as white solid (46.7 mg, 82% yield).



(4*S*,6*S*)-4-phenyl-6-(phenylthio)tetrahydro-2*H*-pyran-2-one (3ac) (Table 2, entry 1). 46.7 mg, 82% yield; White solid; ^{1}H NMR (500 MHz, $CDCl_3$) δ (ppm): 7.61 – 7.59 (m, 2H), 7.36 (ddd, *J* = 7.7, 4.0, 1.7 Hz, 5H), 7.30 – 7.26 (m, 1H), 7.17 – 7.16 (m, 2H), 5.74 (dd, *J* = 11.3, 4.1 Hz, 1H), 3.19 (tt, *J* = 12.3, 4.4 Hz, 1H), 2.88 (ddd, *J* = 17.7, 5.1, 2.3 Hz, 1H), 2.58 – 2.51 (m, 2H), 2.04 – 1.97 (m, 1H); ^{13}C NMR (125 MHz, $CDCl_3$) δ (ppm): 169.4, 141.5, 133.3, 131.8, 129.2, 129.1, 128.6, 127.5, 126.4, 86.3, 37.4, 37.2, 36.3; HRMS (EI) calcd for $C_{17}H_{16}O_2S$ 284.0871, found 284.0876; HPLC (Chiralpak IC, *i*-propanol/hexane = 20/80, flow rate 1.0 mL/min, λ = 254 nm): t_R (major) = 28.2 min, t_R (minor) = 23.0 min, *ee* = 92%; $[\alpha]^{25}_D$ = -96.6 (*c* = 1.08 in DCM).

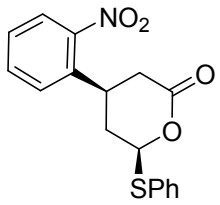


(4*S*,6*S*)-4-(4-chlorophenyl)-6-(phenylthio)tetrahydro-2*H*-pyran-2-one (3bc) (Table 2, entry 2). 52.9 mg, 83% yield; White solid; ^{1}H NMR (500 MHz, $CDCl_3$) δ (ppm): 7.60 – 7.58 (m, 2H), 7.38 – 7.34 (m, 3H), 7.34 – 7.31 (m, 2H), 7.11 – 7.09 (m, 2H), 5.72 (dd, *J* = 11.3, 4.1 Hz, 1H), 3.17 (tt, *J* = 12.2, 4.5 Hz, 1H), 2.86 (ddd, *J* = 17.6, 5.1, 2.2 Hz, 1H), 2.56 – 2.46 (m, 2H), 2.00 – 1.93 (m, 1H); ^{13}C NMR (125 MHz, $CDCl_3$) δ (ppm): 169.1, 134.0, 133.3, 133.3, 131.6, 129.2, 129.2, 128.7, 127.8, 86.2, 37.1, 36.9, 36.1; HRMS (EI) calcd for $C_{17}H_{15}O_2ClS$ 318.0481, found 318.0486; HPLC (Chiralpak IC, *i*-propanol/hexane = 20/80, flow rate 1.0 mL/min, λ = 254 nm): t_R (major) = 28.4 min, t_R (minor) = 24.7 min, *ee* = 94%; $[\alpha]^{25}_D$ = -52.7 (*c* = 1.05 in DCM).

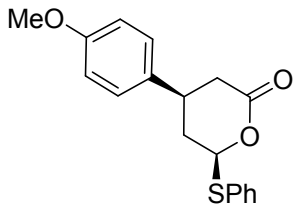


(4*S*,6*S*)-4-(4-nitrophenyl)-6-(phenylthio)tetrahydro-2*H*-pyran-2-one (3cc) (Table 2, entry 3). 57.3 mg, 87% yield; White solid; ^{1}H NMR (500 MHz, $CDCl_3$) δ (ppm): 8.21 (d, *J* = 8.7 Hz, 2H), 7.60 – 7.58 (m, 2H), 7.37 – 7.34 (m, 5H), 5.74 (dd, *J* = 11.1, 4.1 Hz, 1H), 3.35 (tt, *J* =12.1, 4.5 Hz, 1H), 2.90 (ddd, *J* = 17.5, 5.2, 2.2 Hz, 1H), 2.61 – 2.51 (m, 2H), 2.02 (dt, *J* = 13.8, 11.7 Hz, 1H); ^{13}C NMR (125 MHz, $CDCl_3$) δ (ppm): 168.5, 148.7, 147.3, 133.4, 131.3, 129.2, 128.8, 127.5, 124.3, 86.0, 37.3, 36.6, 35.7; HRMS (EI) calcd for $C_{17}H_{15}O_4NS$ 329.0722, found 329.0723; HPLC (Chiralpak IA, *i*-propanol/hexane = 20/80, flow rate 1.0 mL/min, λ = 254 nm): t_R (major) = 36.5 min, t_R (minor) = 26.9 min, *ee* = 95%;

$[\alpha]^{25}_D$ = -68.8 (*c* = 0.97 in DCM).

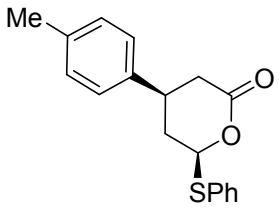


(4*S*,6*S*)-4-(2-nitrophenyl)-6-(phenylthio)tetrahydro-2*H*-pyran-2-one (3dc) (Table 2, entry 4). 52.0 mg, 79% yield; Colorless oil; ^{1}H NMR (500 MHz, $CDCl_3$) δ (ppm): 7.87 (d, *J* = 8.1 Hz, 1H), 7.64 (t, *J* = 7.6 Hz, 1H), 7.59 (dd, *J* = 6.4, 2.8 Hz, 2H), 7.44 (t, *J* = 7.7 Hz, 1H), 7.37 – 7.35 (m, 4H), 5.74 (dd, *J* = 11.3, 3.8 Hz, 1H), 3.79 (td, *J* = 11.6, 5.8 Hz, 1H), 2.99 (ddd, *J* = 17.5, 5.3, 1.8 Hz, 1H), 2.64 – 2.54 (m, 2H), 2.03 (dd, *J* = 25.3, 11.7 Hz, 1H); ^{13}C NMR (125 MHz, $CDCl_3$) δ (ppm): 168.7, 149.3, 136.0, 133.7, 133.3, 131.4, 129.2, 128.7, 128.3, 127.4, 124.9, 86.0, 36.5, 35.9, 32.2; HRMS (EI) calcd for $C_{17}H_{15}O_4NS$ 329.0722, found 329.0734; HPLC (Chiralpak IA, *i*-propanol/hexane = 10/90, flow rate 1.0 mL/min, λ = 254 nm): t_R (major) = 30.4 min, t_R (minor) = 34.1 min, *ee* = 96%; $[\alpha]^{25}_D$ = -57.2 (*c* = 1.00 in DCM).

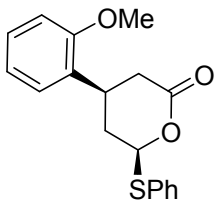


(4*S*,6*S*)-4-(4-methoxyphenyl)-6-(phenylthio)tetrahydro-2*H*-pyran-2-one (3ec) (Table 2, entry 5). 51.7 mg, 82% yield; White solid; ^{1}H NMR (500 MHz, $CDCl_3$) δ (ppm): 7.59 (dd, *J* = 6.4, 3.2 Hz, 2H), 7.35 (dd, *J* = 4.9, 1.9 Hz, 3H), 7.10 – 7.04 (m, 2H), 6.90 – 6.87 (m, 2H), 5.72 (dd, *J* = 11.3, 4.1 Hz, 1H), 3.80 (s, 3H), 3.13 (tt, *J* = 12.6, 3.8 Hz, 1H), 2.86 (ddd, *J* = 17.7, 5.1, 2.3 Hz, 1H), 2.55 – 2.46 (m, 2H), 2.00 – 1.92 (m, 1H); ^{13}C NMR (125 MHz, $CDCl_3$) δ (ppm): 169.6, 158.8, 133.6, 133.2, 131.80, 129.2,

128.6, 127.4, 114.4, 86.4, 55.3, 37.5, 36.7, 36.5; HRMS (EI) calcd for $C_{18}H_{18}O_3S$ 314.0977, found 314.0987; HPLC (Chiralpak IC, *i*-propanol/hexane = 20/80, flow rate 1.0 mL/min, λ = 254 nm): t_R (major) = 42.9 min, t_R (minor) = 38.0 min, *ee* = 88%; $[\alpha]^{25}_D$ = -74.7 (*c* = 0.91 in DCM).

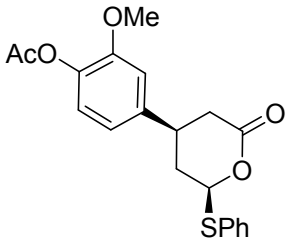


(4*S*,6*S*)-6-(phenylthio)-4-p-tolyltetrahydro-2*H*-pyran-2-one (3fc) (Table 2, entry 6). 48.6 mg, 81% yield; Colorless oil; ^{1}H NMR (500 MHz, $CDCl_3$) δ (ppm): 7.60 (dd, *J* = 6.4, 3.1 Hz, 2H), 7.38 – 7.33 (m, 3H), 7.16 (d, *J* = 8.0 Hz, 2H), 7.05 (d, *J* = 8.0 Hz, 2H), 5.73 (dd, *J* = 11.3, 4.1 Hz, 1H), 3.15 (tt, *J* = 12.0, 4.4 Hz, 1H), 2.86 (ddd, *J* = 17.7, 5.1, 2.3 Hz, 1H), 2.55 – 2.48 (m, 2H), 2.34 (s, 3H), 2.02 – 1.94 (m, 1H); ^{13}C NMR (125 MHz, $CDCl_3$) δ (ppm): 169.6, 138.6, 137.2, 133.2, 131.8, 129.7, 129.1, 128.6, 126.2, 86.5, 37.3, 37.1, 36.4, 21.0; HRMS (EI) calcd for $C_{18}H_{18}O_2S$ 298.1028, found 298.1028; HPLC (Chiralpak IC, *i*-propanol/hexane = 20/80, flow rate 1.0 mL/min, λ = 254 nm): t_R (major) = 25.8 min, t_R (minor) = 22.5 min, *ee* = 93%; $[\alpha]^{25}_D$ = -35.2 (*c* = 1.05 in DCM).

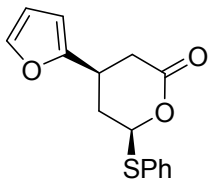


(4*S*,6*S*)-4-(2-methoxyphenyl)-6-(phenylthio)tetrahydro-2*H*-pyran-2-one (3gc) (Table 2, entry 7). 58.3 mg, 93% yield; Colorless oil; ^{1}H NMR (500 MHz, $CDCl_3$) δ (ppm): 7.63 – 7.59 (m, 2H), 7.36 – 7.33 (m, 3H), 7.26 (td, *J* = 8.0, 1.7 Hz, 1H), 7.06 (dd, *J* = 7.5, 1.6 Hz, 1H), 6.94 (td, *J* = 7.5, 0.9 Hz, 1H), 6.88 (d, *J* = 8.2 Hz, 1H), 5.74 (dd, *J* = 11.4, 3.9 Hz, 1H), 3.81 (s, 3H), 3.53 (tt, *J* = 12.0, 4.7, 1H),

2.87 (ddd, J = 17.6, 5.4, 2.1 Hz, 1H), 2.57 (dd, J = 17.6, 11.7 Hz, 1H), 2.49 (dtd, J = 13.8, 3.9, 2.1 Hz, 1H), 2.11 – 2.03 (m, 1H); ^{13}C NMR (125 MHz, $CDCl_3$) δ (ppm): 170.2, 156.8, 133.1, 132.1, 129.6, 129.1, 128.4, 128.4, 126.5, 120.8, 110.7, 86.4, 55.2, 35.5, 34.5, 32.0; HRMS (EI) calcd for $C_{18}H_{18}O_3S$ 314.0977, found 314.0977; HPLC (Chiralpak IC, *i*-propanol/hexane = 20/80, flow rate 1.0 mL/min, λ = 254 nm): t_R (major) = 20.6 min, t_R (minor) = 24.6 min, *ee* = 94%; $[\alpha]^{25}_D$ = -25.3 (*c* = 1.37 in DCM).

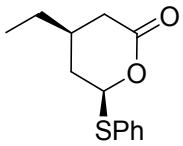


2-methoxy-4-((4*S*,6*S*)-2-*oxo*-6-(phenylthio)tetrahydro-2*H*-pyran-4-yl)phenyl acetate (3hc) (Table 2, entry 8). 60.8 mg, 82% yield; White solid; ^{1}H NMR (500 MHz, $CDCl_3$) δ (ppm): 7.61 – 7.58 (m, 2H), 7.37 – 7.34 (m, 3H), 7.02 – 6.99 (m, 1H), 6.73 (dd, J = 6.7, 1.9 Hz, 2H), 5.72 (dd, J = 11.3, 4.1 Hz, 1H), 3.82 (s, 3H), 3.18 (tt, J = 12.2, 4.4 Hz, 1H), 2.88 (ddd, J = 17.6, 5.1, 2.2 Hz, 1H), 2.60 – 2.47 (m, 2H), 2.31 (s, 3H), 2.04 – 1.91 (m, 1H); ^{13}C NMR (125 MHz, $CDCl_3$) δ (ppm): 169.3, 169.0, 151.4, 140.4, 138.9, 133.3, 131.6, 129.2, 128.7, 123.2, 118.3, 110.7, 86.2, 55.9, 37.3, 37.2, 36.3, 20.6; HRMS (EI) calcd for $C_{20}H_{20}O_5S$ 372.1031, found 372.1024; HPLC (Chiralpak IA, *i*-propanol/hexane = 10/90, flow rate 1.0 mL/min, λ = 254 nm): t_R (major) = 36.7 min, t_R (minor) = 40.9 min, *ee* = 92%; $[\alpha]^{25}_D$ = -31.6 (*c* = 1.34 in DCM).

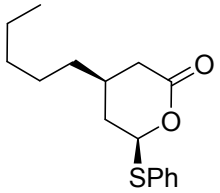


(4*S*,6*S*)-4-(furan-2-yl)-6-(phenylthio)tetrahydro-2*H*-pyran-2-one (3ic) (Table 2, entry 9). 43.8 mg,

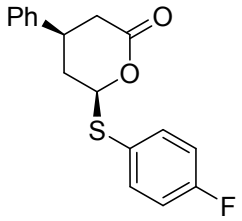
80% yield; White solid; ^{1}H NMR (500 MHz, $CDCl_3$) δ (ppm): 7.59 – 7.58 (m, 2H), 7.35 – 7.33 (m, 4H), 6.31 (dd, *J* = 3.2, 1.9 Hz, 1H), 6.06 (d, *J* = 3.2 Hz, 1H), 5.70 (dd, *J* = 11.3, 4.0 Hz, 1H), 3.32 (tt, *J* = 11.8, 4.6 Hz, 1H), 2.94 (ddd, *J* = 17.7, 5.3, 2.1 Hz, 1H), 2.66 (dtd, *J* = 14.1, 4.0, 2.2 Hz, 1H), 2.57 (dd, *J* = 17.7, 11.9 Hz, 1H), 1.95 (dt, *J* = 14.1, 11.6 Hz, 1H); ^{13}C NMR (125 MHz, $CDCl_3$) δ (ppm): 168.8, 154.4, 142.1, 133.4, 131.6, 129.2, 128.7, 110.3, 105.0, 86.0, 34.2, 33.9, 31.2; HRMS (EI) calcd for $C_{15}H_{14}O_3S$ 274.0664, found 274.0667; HPLC (Chiralpak IC, *i*-propanol/hexane = 20/80, flow rate 1.0 mL/min, λ = 254 nm): t_R (major) = 23.3 min, t_R (minor) = 19.0 min, *ee* = 91%; $[\alpha]^{25}_D$ = -67.7 (*c* = 0.96 in DCM).



(4*S*,6*S*)-4-ethyl-6-(phenylthio)tetrahydro-2*H*-pyran-2-one (3jc) (Table 2, entry 10). 33.4 mg, 71% yield; Colorless oil; ^{1}H NMR (500 MHz, $CDCl_3$) δ (ppm): 7.58 – 7.56 (m, 2H), 7.35 – 7.32 (m, 3H), 5.59 (dd, *J* = 11.2, 4.0 Hz, 1H), 2.68 (ddd, *J* = 17.5, 5.2, 2.0 Hz, 1H), 2.36 (dtd, *J* = 13.9, 4.0, 2.2 Hz, 1H), 2.05 (dd, *J* = 17.5, 11.6 Hz, 1H), 1.91 – 1.82 (m, 1H), 1.48 (dt, *J* = 13.9, 11.4 Hz, 1H), 1.37 (p, *J* = 7.3, 2H), 0.93 (t, *J* = 7.4 Hz, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ (ppm): 170.1, 133.0, 132.1, 129.1, 128.4, 86.4, 35.9, 34.8, 33.3, 28.7, 10.7; HRMS (EI) calcd for $C_{13}H_{16}O_2S$ 236.0871, found 236.0870; HPLC (Chiralpak IC, *i*-propanol/hexane = 10/90, flow rate 1.0 mL/min, λ = 254 nm): t_R (major) = 35.2 min, t_R (minor) = 40.4 min, *ee* = 94%; $[\alpha]^{25}_D$ = -11.9 (*c* = 0.86 in DCM).

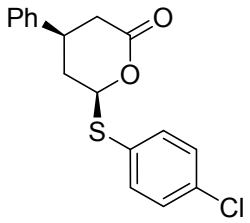


(4*S*,6*S*)-4-pentyl-6-(phenylthio)tetrahydro-2*H*-pyran-2-one (3kc) (Table 2, entry 11). 38.2 mg, 69% yield; Colorless oil; ^{1}H NMR (500 MHz, $CDCl_3$) δ (ppm): 7.57 – 7.55 (m, 2H), 7.34 – 7.32 (m, 3H), 5.59 (dd, *J* = 11.3, 4.0 Hz, 1H), 2.67 (ddd, *J* = 17.4, 5.0, 2.0 Hz, 1H), 2.37 – 2.32 (m, 2H), 2.05 (dd, *J* = 17.4, 11.6 Hz, 1H), 1.95 – 1.91 (m, 1H), 1.48 (dt, *J* = 13.8, 11.4 Hz, 1H), 1.37 – 1.26 (m, 8H), 0.88 (t, *J* = 7.0 Hz, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ (ppm): 170.1, 133.0, 132.1, 129.1, 128.4, 86.4, 36.2, 35.8, 35.2, 31.7, 31.6, 25.9, 22.5, 14.0; HRMS (EI) calcd for $C_{16}H_{22}O_2S$ 278.1341, found 278.1341; HPLC (Chiralpak IC, *i*-propanol/hexane = 20/80, flow rate 1.0 mL/min, λ = 254 nm): t_R (major) = 18.1 min, t_R (minor) = 20.7 min, *ee* = 94%; $[\alpha]^{25}_D$ = -20.6 (*c* = 0.89 in DCM).

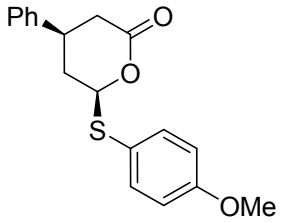


(4*S*,6*S*)-6-(4-fluorophenylthio)-4-phenyltetrahydro-2*H*-pyran-2-one (3ad) (Table 2, entry 12). 51.6 mg, 85% yield; White solid; ^{1}H NMR (500 MHz, $CDCl_3$) δ (ppm): 7.62 – 7.59 (m, 2H), 7.36 (dd, *J* = 10.3, 4.7 Hz, 2H), 7.30 – 7.27 (m, 1H), 7.17 – 7.15 (m, 2H), 7.08 – 7.04 (m, 2H), 5.65 (dd, *J* = 11.3, 4.1 Hz, 1H), 3.19 (tt, *J* = 12.0, 4.4 Hz, 1H), 2.88 (ddd, *J* = 17.7, 5.1, 2.3 Hz, 1H), 2.56 – 2.50 (m, 2H), 1.96 (ddd, *J* = 13.9, 12.2, 11.4 Hz, 1H); ^{13}C NMR (125 MHz, $CDCl_3$) δ (ppm): 169.4, 164.3, 162.3, 141.4, 136.2, 136.2, 129.1, 127.5, 126.5, 126.4, 116.4, 116.2, 86.4, 37.4, 37.2, 36.2; HRMS (EI) calcd for $C_{17}H_{15}O_2FS$ 302.0777, found 302.0777; HPLC (Chiralpak IC, *i*-propanol/hexane = 20/80, flow rate

1.0 mL/min, λ = 254 nm): t_R (major) = 22.7 min, t_R (minor) = 16.6 min, *ee* = 91%; $[\alpha]^{25}_D$ = -76.2 (*c* = 1.01 in DCM).

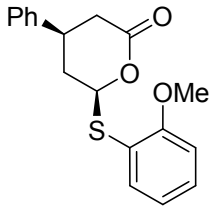


(4*S*,6*S*)-6-(4-chlorophenylthio)-4-phenyltetrahydro-2*H*-pyran-2-one (3ae) (Table 2, entry 13). 50.6 mg, 79% yield; White solid; ^{1}H NMR (500 MHz, $CDCl_3$) δ (ppm): 7.54 – 7.52 (m, 2H), 7.38 – 7.31 (m, 4H), 7.29 (d, *J* = 7.5 Hz, 1H), 7.17 (d, *J* = 7.5 Hz, 2H), 5.69 (dd, *J* = 11.3, 4.1 Hz, 1H), 3.19 (tt, *J* = 12.3, 4.4 Hz, 1H), 2.89 (ddd, *J* = 17.7, 5.1, 2.2 Hz, 1H), 2.58 – 2.52 (m, 2H), 1.98 (dt, *J* = 13.8, 11.9 Hz, 1H); ^{13}C NMR (125 MHz, $CDCl_3$) δ (ppm): 169.3, 141.4, 135.1, 134.7, 130.2, 129.4, 129.1, 127.6, 126.4, 86.1, 37.4, 37.2, 36.3; HRMS (EI) calcd for $C_{17}H_{15}O_2ClS$ 318.0481, found 318.0485; HPLC (Chiralpak IC, *i*-propanol/hexane = 20/80, flow rate 1.0 mL/min, λ = 254 nm): t_R (major) = 23.8 min, t_R (minor) = 18.0 min, *ee* = 92%; $[\alpha]^{25}_D$ = -90.1 (*c* = 1.05 in DCM).

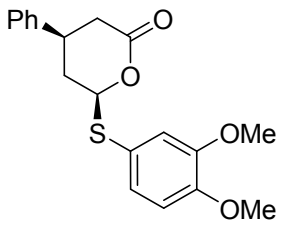


(4*S*,6*S*)-6-(4-methoxyphenylthio)-4-phenyltetrahydro-2*H*-pyran-2-one (3af) (Table 2, entry 14). 53.6 mg, 85% yield; White solid; ^{1}H NMR (500 MHz, $CDCl_3$) δ (ppm): 7.56 – 7.53 (m, 2H), 7.35 (dd, *J* = 10.3, 4.7 Hz, 2H), 7.28 (dt, *J* = 3.9, 1.6 Hz, 1H), 7.15 (d, *J* = 7.2 Hz, 2H), 6.90 – 6.88 (m, 2H), 5.59 (dd, *J* = 11.2, 4.1 Hz, 1H), 3.82 (s, 3H), 3.16 (tt, J = 12.0, 4.5 Hz, 1H), 2.85 (ddd, *J* = 17.7, 5.1, 2.3 Hz, 1H), 2.53 – 2.45 (m, 2H), 1.94 (ddd, *J* = 13.9, 12.3, 11.4 Hz, 1H); ^{13}C NMR (125 MHz, $CDCl_3$) δ

(ppm): 169.6, 160.6, 141.7, 136.4, 129.0, 127.4, 126.4, 121.5, 114.7, 86.7, 55.4, 37.4, 37.2, 36.3; HRMS (EI) calcd for $C_{18}H_{18}O_3S$ 314.0977, found 314.0978; HPLC (Chiralpak IC, *i*-propanol/hexane = 20/80, flow rate 1.0 mL/min, λ = 254 nm): t_R (major) = 43.3 min, t_R (minor) = 28.1 min, *ee* = 92%; $[\alpha]^{25}_D$ = -60.3 (*c* = 1.08 in DCM).

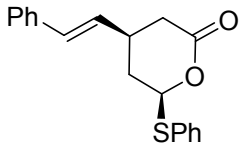


(4*S*,6*S*)-6-(2-methoxyphenylthio)-4-phenyltetrahydro-2*H*-pyran-2-one (3ag) (Table 2, entry 15). 52.7 mg, 84% yield; Colorless oil; ^{1}H NMR (500 MHz, $CDCl_3$) δ (ppm): 7.61 (dd, *J* = 7.6, 1.6 Hz, 1H), 7.37 – 7.27 (m, 4H), 7.21 – 7.18 (m, 2H), 6.97 (td, *J* = 7.5, 1.1 Hz, 1H), 6.91 (d, *J* = 8.2 Hz, 1H), 5.87 (dd, *J* = 10.9, 4.3 Hz, 1H), 3.89 (s, 3H), 3.20 (tt, *J* = 12.6, 4.4 Hz, 1H), 2.88 (ddd, *J* = 17.5, 5.0, 2.3 Hz, 1H), 2.63 – 2.56 (m, 2H), 2.05 (ddd, *J* = 14.0, 12.2, 11.0 Hz, 1H); ^{13}C NMR (125 MHz, $CDCl_3$) δ (ppm): 169.6, 158.4, 141.7, 134.4, 130.0, 129.0, 127.4, 126.4, 121.4, 119.9, 111.1, 84.5, 55. 9, 37.4, 37.3, 36.0; HRMS (EI) calcd for $C_{18}H_{18}O_3S$ 314.0977, found 314.0979; HPLC (Chiralpak IA, *i*-propanol/hexane = 20/80, flow rate 1.0 mL/min, λ = 254 nm): t_R (major) = 11.1 min, t_R (minor) = 13.1 min, *ee* = 94%; $[\alpha]^{25}_D$ = -67.5 (*c* = 0.96 in DCM).

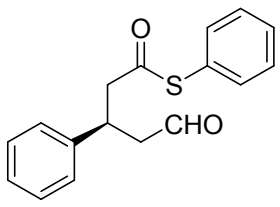


(4*S*,6*S*)-6-(3,4-dimethoxyphenylthio)-4-phenyltetrahydro-2*H*-pyran-2-one (3ah) (Table 2, entry 16). 54.8 mg, 80% yield; Colorless oil; ^{1}H NMR (500 MHz, $CDCl_3$) δ (ppm): 7.35 (dd, *J* = 10.2, 4.7 Hz,

2H), 7.30 – 7.25 (m, 2H), 7.19 (dd, *J* = 8.3, 2.1 Hz, 1H), 7.16 – 7.13 (m, 3H), 6.85 (d, *J* = 8.3 Hz, 1H), 5.63 (dd, *J* = 11.2, 4.2 Hz, 1H), 3.89 (s, 6H), 3.20 – 3.13 (m, 1H), 2.85 (ddd, *J* = 17.7, 5.1, 2.3 Hz, 1H), 2.55 – 2.43 (m, 2H), 1.94 (ddd, *J* = 13.9, 12.3, 11.3 Hz, 1H); ^{13}C NMR (125 MHz, $CDCl_3$) δ (ppm): 169.6, 150.1, 149.1, 141.6, 129.0, 127.9, 127.4, 126.4, 121.7, 117.7, 111.4, 86.6, 56.1, 55.9, 37.3, 37.21, 36.3; HRMS (EI) calcd for $C_{19}H_{20}O_4S$ 344.1082, found 344.1081; HPLC (Chiralpak IA, *i*-propanol/hexane = 5/95, flow rate 1.0 mL/min, λ = 254 nm): t_R (major) = 46.4 min, t_R (minor) = 52.4 min, *ee* = 92%; $[\alpha]^{25}_D$ = -61.1 (*c* = 0.99 in DCM).



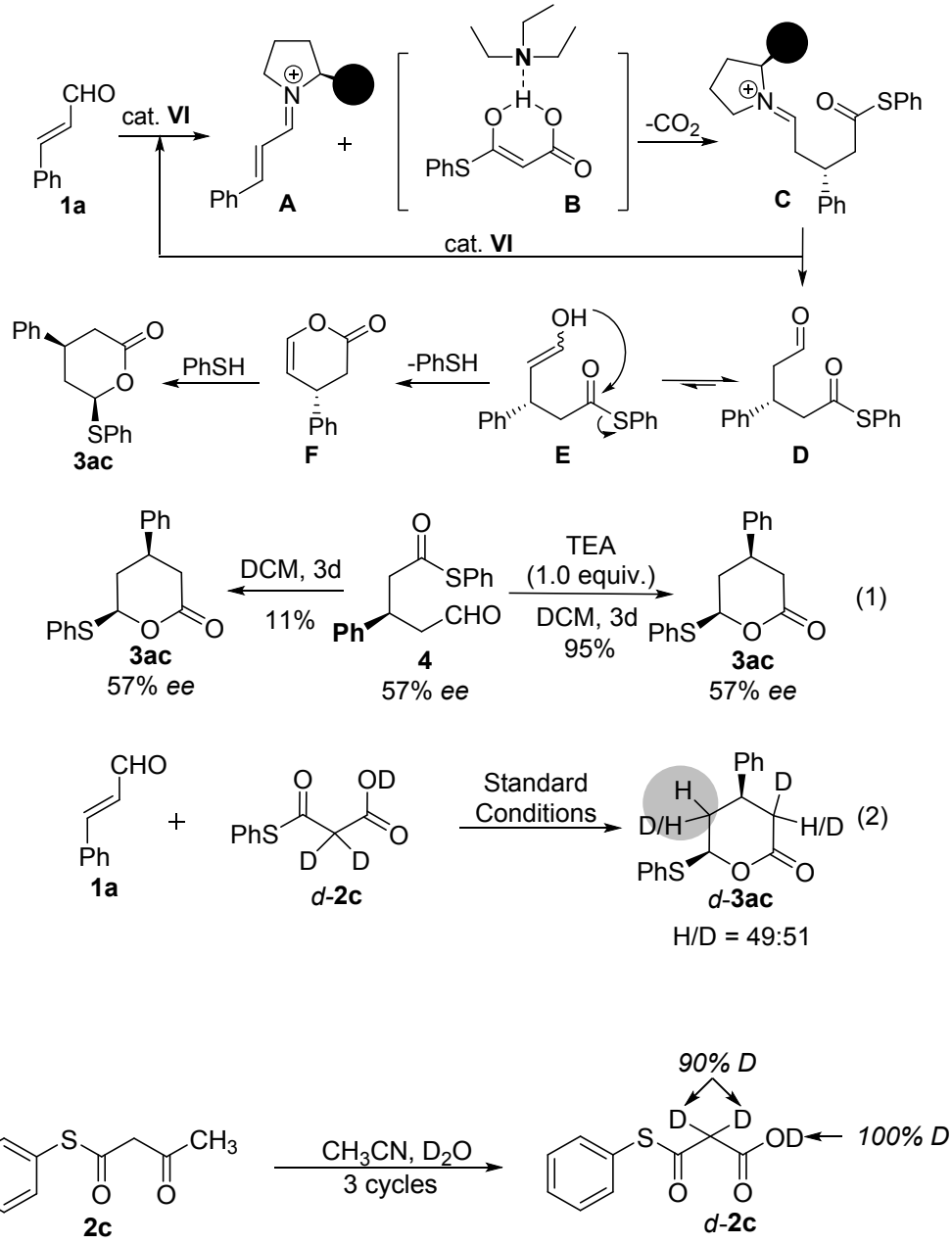
(4*S*,6*S*)-6-(phenylthio)-4-styryltetrahydro-2*H*-pyran-2-one (3lc) (Table 2, entry 17). 46.2 mg, 74% yield; Pale yellow oil; ^{1}H NMR (500 MHz, $CDCl_3$) δ (ppm): 7.55 (dd, *J* = 6.5, 2.9 Hz, 2H), 7.31 – 7.21 (m, 8H), 6.39 (d, *J* = 15.9 Hz, 1H), 5.97 (dd, *J* = 15.9, 7.0 Hz, 1H), 5.63 (dd, *J* = 11.2, 4.0 Hz, 1H), 2.82 – 2.72 (m, 2H), 2.42 (ddd, *J* = 13.9, 6.1, 3.8 Hz, 1H), 2.29 (dd, *J* = 17.2, 11.4 Hz, 1H), 1.72 (dt, *J* = 13.8, 11.5 Hz, 1H); ^{13}C NMR (125 MHz, $CDCl_3$) δ (ppm): 169.2, 136.3, 133.3, 131.7, 130.8, 129.9, 129.2, 128.7, 128.6, 127.9, 126.2, 86.1, 35.7, 35.1, 35.1; HRMS (EI) calcd for $C_{19}H_{18}O_2S$ 310.1028, found 310.1035; HPLC (Chiralpak IC, *i*-propanol/hexane = 20/80, flow rate 1.0 mL/min, λ = 254 nm): t_R (major) = 36.6 min, t_R (minor) = 29.6 min, *ee* = 80%; $[\alpha]^{25}_D$ = -48.2 (*c* = 0.78 in DCM).



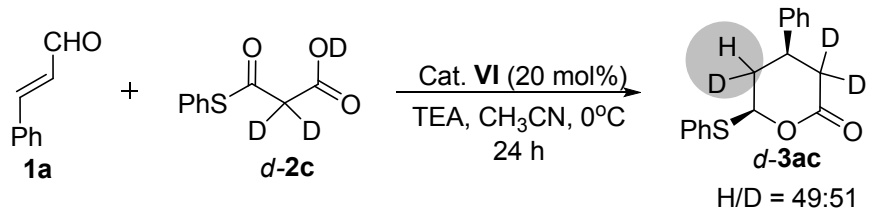
(*R*)-S-phenyl 5-*oxo*-3-phenylpentanethioate (4). Colorless oil; ^{1}H NMR (500 MHz, $CDCl_3$) δ (ppm): 9.74 (s, 1H), 7.47 – 7.45 (m, 3H), 7.42 – 7.38 (m, 4H), 7.34 – 7.31 (m, 3H), 3.95 – 3.86 (m, 1H), 3.09 (d, *J* = 7.2 Hz, 2H), 3.00 – 2.89 (m, 2H); ^{13}C NMR (125 MHz, $CDCl_3$) δ (ppm): 200.4, 195.6, 141.8, 134.4, 129.5, 129.2, 128.8, 127.4, 127.2, 49.5, 49.0, 36.7; HRMS (EI) calcd for $C_{17}H_{16}O_2S$ 284.0871, found 284.0878.

3. Proposed Mechanism

Our proposed mechanism is illustrated in Scheme below. Initially, malonic half-thioester **2a** reacts with triethyl amine to form the intermediate **B** and follow to attack the iminium intermediate **A**. A subsequent decarboxylation triggers the formation of the Michael addition intermediate **C**. A hydrolysis of intermediate **C** would lead to a recycle of cat.**VI** and generates the intermediate **D**. The intermediate **D** undergoes a sequence of tautomerization, cyclization and nucleophilic addition to afford the product **3ac**. As proof of this mechanism, we set out to investigate the key intermediate **4**. As indicated in eqn. (2), the synthesized compound **4** was found to be an active intermediate and could generate **3ac** under weak base or base-free condition (95% and 11% yield, respectively) and gave no loss of *ee*. Meanwhile, we found that this process did not require Cat. **IV**. This result suggests that the compound **4** may involve in this transformation as a potential key intermediate. To further understand this mechanism, we then investigated the proton transfer in the process of **3ac** formation. we conducted an isotopic experiment using deuterated half-thioester *d*-**2c** to react with cinnamaldehyde **1a** under standard conditions. ^{1}H NMR analysis of *d*-**3ac** demonstrated the isotope labelling of two protons located at α-position of carbonyl group is ab. 49:51 (eqn. (2)). It suggests that the water (generated from the condensation of cinnamaldehyde **1a** and cat. **VI**), functionalized as a potential proton source, is not involved in Michael addition step.



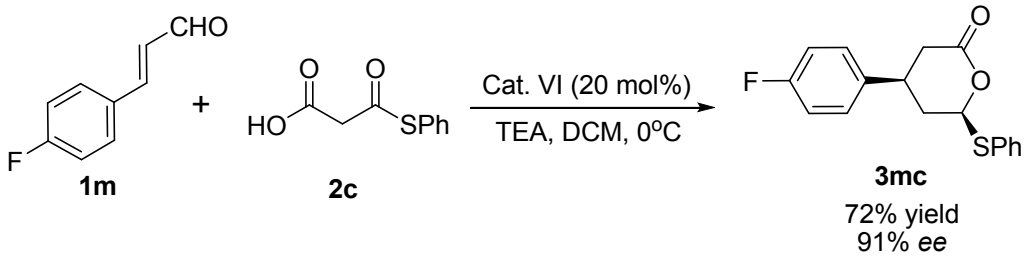
490.6 mg (2.5 mmol) of malonic acid half thioester (MAHT) **2c** was placed into a 50 mL flask and 5.0 mL of acetonitrile was added. When the MAHT **2c** has dissolved, 6.0 mL D_2O was added and the solution was stirred for 6 hours under nitrogen. The solvent was removed under vaccum and the process was repeated two more tie s to yield 473.2 mg (95% yield) of the product *d*-**2c**.[1] ^{1}H NMR (500 MHz, $CDCl_3$) δ (ppm): 7.46 – 7.42 (m, 5H), 3.70 (s, 0.2H); ^{13}C NMR (125 MHz, $CDCl_3$) δ (ppm): 189.9, 170.5, 134.4, 130.0, 129.4, 126.4, 48.0 (t, 1C, J = 20.5 Hz).



To a solution of cinnamaldehyde **1a** (66.1 mg, 62.9 uL, 0.5 mmol,) in CH_3CN (2.5 mL) was added catalyst **VI** (64.0 mg, 0.1 mmol) at 0 °C. After 40 min, *d*-**2c** (249.0 mg, 1.25 mmol) was added in one portion. Then, TEA (126.2 mg, 173.9 uL, 1.25 mmol) was added dropwise at 0 °C. The resulting reaction mixture was kept stirring at 0°C for 24 h. The crude product was purified by silica gel flash chromatography, eluted by hexane/EtOAc = 10:1 to afford the desired product *d*-**3ac** as white solid (89.1 mg, 62% yield). ^{1}H NMR (500 MHz, $CDCl_3$) δ(ppm): 7.60 (dd, *J* = 6.4, 3.2 Hz, 2H), 7.40 – 7.32 (m, 5H), 7.28 (t, *J* = 7.4 Hz, 1H), 7.16 (d, *J* = 7.6 Hz, 2H), 5.74 (dd, *J* = 11.2, 4.0 Hz, 1H), 3.23 – 3.14 (m, 1H), 2.88 (dd, *J* = 17.7, 5.0 Hz, 0.49H), 2.59 – 2.49 (m, 1H), 2.04 – 1.97 (m, 0.49H); ^{13}C NMR (125 MHz, $CDCl_3$) δ (ppm): 169.5, 141.5, 133.3, 131.8, 129.2, 129.1, 128.6, 127.5, 126.4, 86.3, 86.3, 86.3, 86. 2, 37.4, 37.3, 37.2, 36.3.

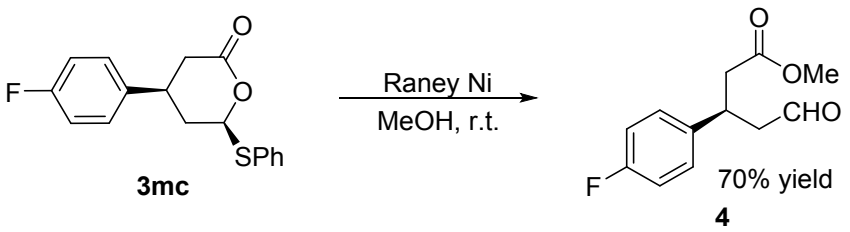
4. Application

Synthesis of (-)-Paroxetine



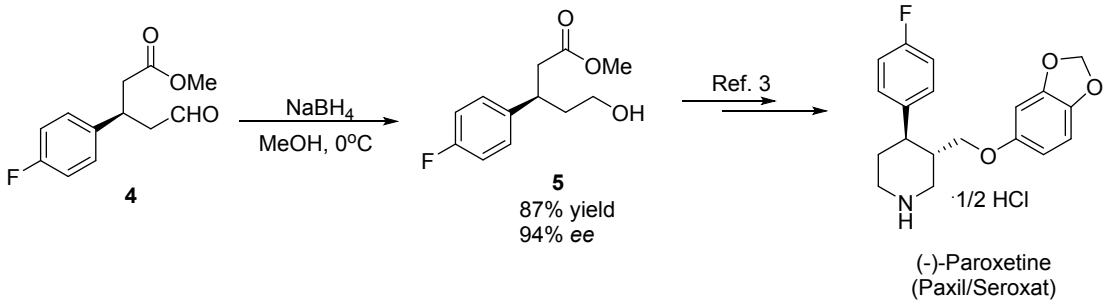
To a solution of 4-fluorocinnamaldehyde **1m** (300.1 mg, 2.0 mmol,) in DCM (5.0 mL) was added catalyst **VI** (238.8 mg, 0.4 mmol) at 0 °C. After 40 min, malonic acid half thioester **2c** (981.1 mg, 5.0 mmol) was added in one portion. Then, TEA (695.6 uL, 5.0 mmol) in 5.0 mL DCM was added

dropwise *via* syringe at 0 °C. The resulting reaction mixture was kept stirring at 0°C for 24 h. The crude product was purified by silica gel flash chromatography, eluted by hexane/EtOAc = 10:1 to afford the desired product **3mc** as a white solid (436.2 mg, 72% yield, 91% *ee*).^{1}H NMR (500 MHz, $CDCl_3$) δ = 7.59 (dd, *J* = 6.2, 2.8 Hz, 2H), 7.39 – 7.33 (m, 3H), 7.13 (dd, *J* = 8.5, 5.3 Hz, 2H), 7.04 (t, *J* = 8.6 Hz, 2H), 5.72 (dd, *J* = 11.2, 4.1 Hz, 1H), 3.18 (ddd, *J* = 12.3, 8.4, 4.5 Hz, 1H), 2.87 (ddd, *J* = 17.6, 5.0, 2.1 Hz, 1H), 2.57 – 2.46 (m, 2H), 1.97 (dd, *J* = 25.7, 11.8 Hz, 1H); ^{13}C NMR (125 MHz, $CDCl_3$) δ = 169.2, 163.0, 161.0, 137.3, 137.3, 133.4, 131.7, 129.2, 128.7, 128.0, 127.9, 116.1, 115.9, 86.2, 37.4, 36.8, 36.4; HRMS (EI) calcd for $C_{17}H_{15}FO_2S$ 302.0777, found 302.0771; HPLC (Chiralpak IC, *i*-propanol/hexane = 20/80, flow rate 1.0 mL/min, λ = 254 nm): t_R (minor) = 23.4 min, t_R (major) = 25.8 min, *ee* = 91%; $[\alpha]^{25}_D$ = -78.2 (*c* = 1.51 in DCM).



3mc **4**

Compound **3mc** (302.36mg, 1.0 mmol) was added to a suspension of Raney Ni (0.3 g) in absolute MeOH (5.0 mL). The mixture was stirred for 10 hours at room temperature, before the Raney Ni was removed by filtration through a celite pad. Then the catalyst was washed with absolute MeOH (3 × 10 mL) and the filtrate was concentrated under reduced pressure. The crude product was purified by silica gel column chromatography (hexane–EtOAc = 6:1) to afford the compound **4** as a colorless oil (156.1 mg, 70% yield). ^{1}H NMR (300 MHz, $CDCl_3$) δ = 9.64 (t, *J* = 1.5 Hz, 1H), 7.23 – 7.12 (m, 2H), 7.03 – 6.94 (m, 2H), 3.78 – 3.68 (m, 1H), 3.58 (s, 3H), 2.88 – 2.71 (m, 2H), 2.71 – 2.56 (m, 2H); ^{13}C NMR (75 MHz, $CDCl_3$) δ = 200.3, 171.8, 163.3, 160.0, 138.1, 138.1, 128.8, 128.7, 115.7, 115.4, 51.6, 49.4, 40.6, 35.3; HRMS (EI) calcd for $C_{12}H_{13}FO_3$ 224.0849, found 224.0841.



Sodium borohydride (11.3 mg, 0.3 mmol) was added into a solution of compound **4** (44.8 mg, 0.20 mmol) in MeOH (2.0 mL) at 0°C. The reaction mixture was stirred at 0°C for 10 min. Then water (1 mL) was added to quench this reaction. The mixture was extracted with CH_2Cl_2 and the combined organic layers were dried with $MgSO_4$. Filtration and evaporation of the solvent gave a residue which was purified by silica gel column chromatography (hexane–EtOAc = 3:1) to afford the product **5** as a colorless oil (39.4 mg, 87% yield, 94% *ee*). ^{1}H NMR (500 MHz, CD_3OD) δ = 7.25 – 7.22 (m, 2H), 7.02 – 6.99 (m, 2H), 3.54 (s, 3H), 3.42 (ddd, *J* = 11.0, 6.9, 5.3 Hz, 1H), 3.37 – 3.32 (m, 1H), 3.31 – 3.24 (m, 1H), 2.70 (dd, *J* = 15.2, 6.4 Hz, 1H), 2.59 (dd, *J* = 15.2, 9.0 Hz, 1H), 1.94 – 1.87 (m, 1H), 1.82 – 1.76 (m, 1H); ^{13}C NMR (125 MHz, CD_3OD) δ = 174.3, 164.0, 162.1, 140.8, 140.8, 130.3, 130.3, 116.1, 116.0, 60.5, 51.9, 42.3, 39.9, 39.3; HRMS (EI) calcd for $C_{12}H_{15}FO_3$ 226.1005, found 226.0999; HPLC (Chiralpak OB-H, *i*-propanol/hexane = 10/90, flow rate 0.8 mL/min, λ = 254 nm): t_R (major) = 11.1 min, t_R (minor) = 14.1 min, *ee* = 94%; $[\alpha]^{25}_D$ = -16.0 (*c* = 1.06 in DCM).

Reference:

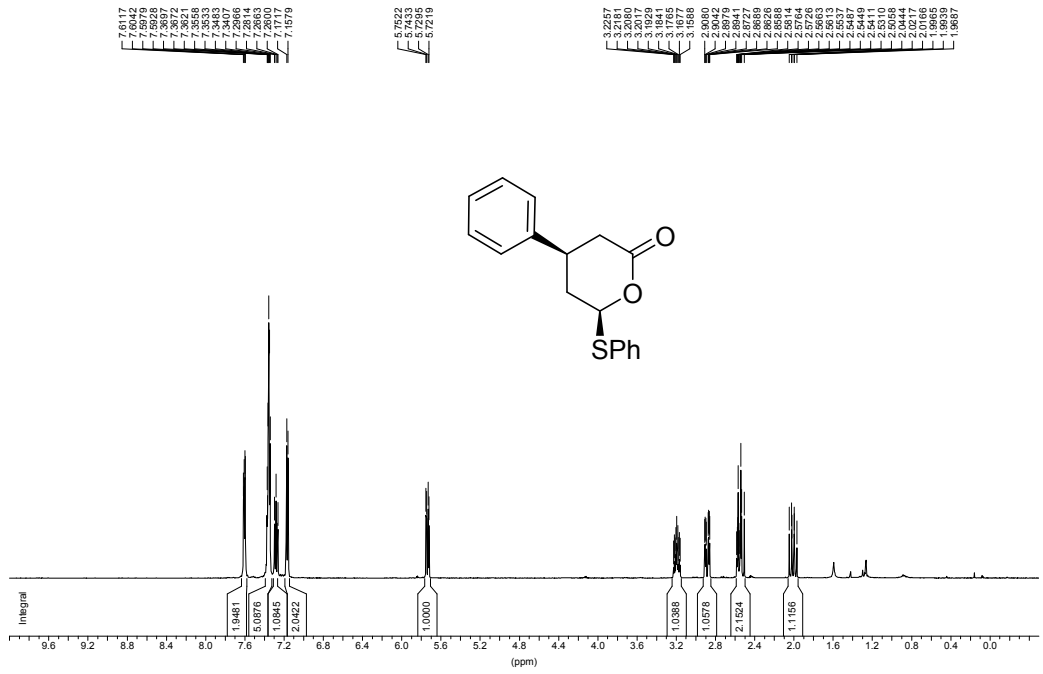
[1] K. C. Fortner, M. D. Shair *J. Am. Chem. Soc.* **2007**, *129*, 1032.

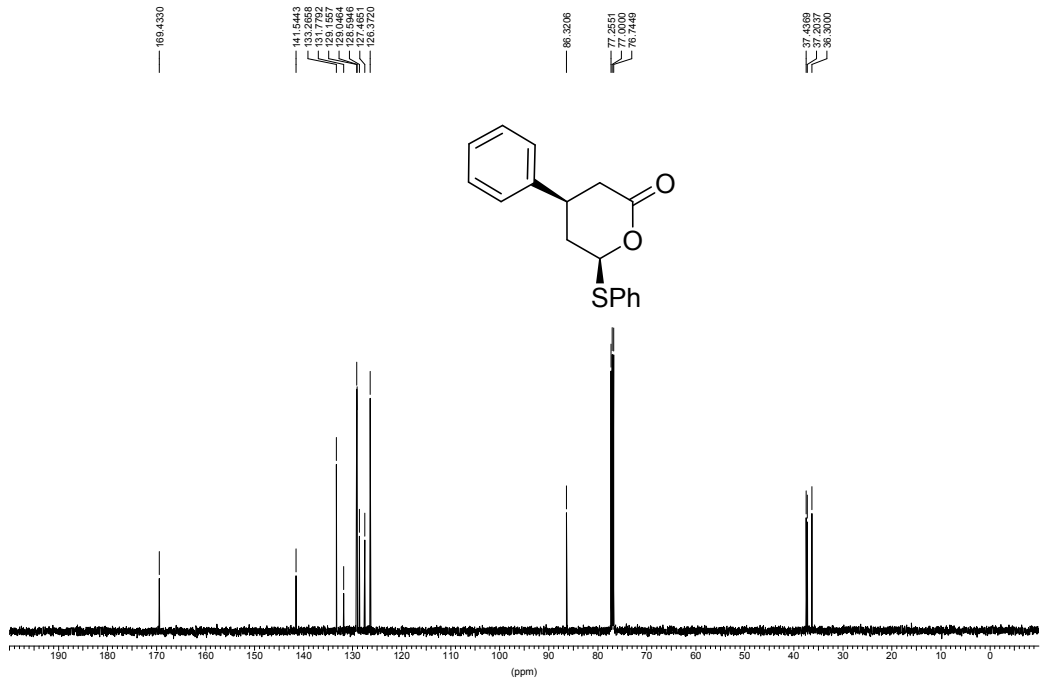
[2] a) H. Shimizu, S. Fukuda, S. Sugiyama, T. Satoh *Synthesis* **2009**, *8*, 1323–1335; b) M. Ochiai, K. Nishide, M. Node, E. Fujita *Chem. Lett.* 1981, 283–284.

[3] M. S. Yu, I. Lantos, Z.-Q. Peng, J. Yu, T. Cacchio *Tetrahedron Lett.* **2000**, *41*, 5647–5651.

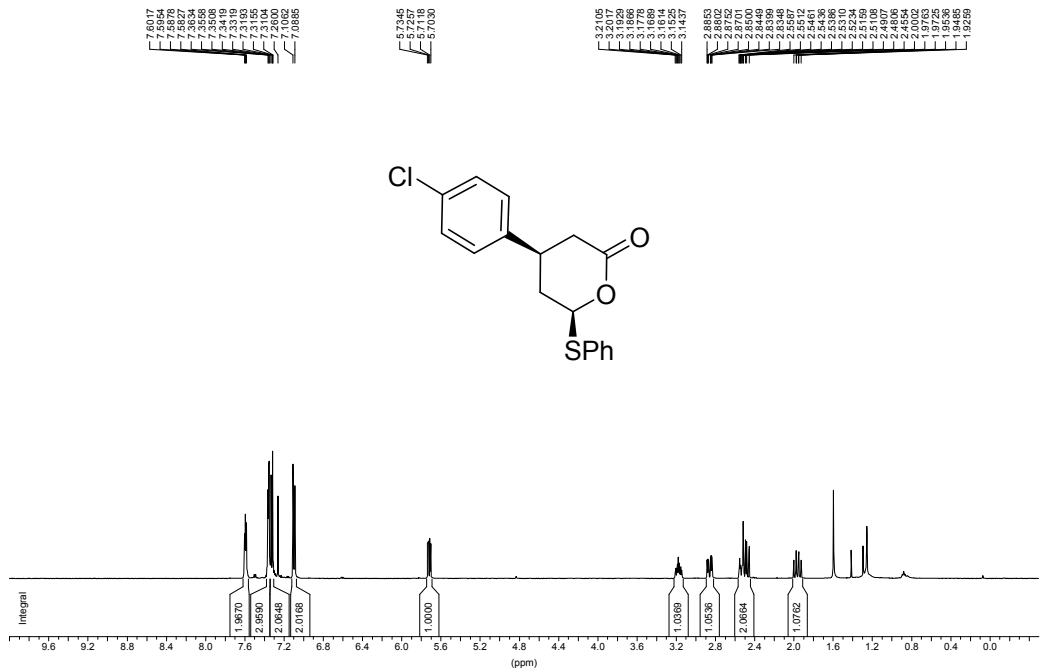
5. HPLC and NMR Spectra

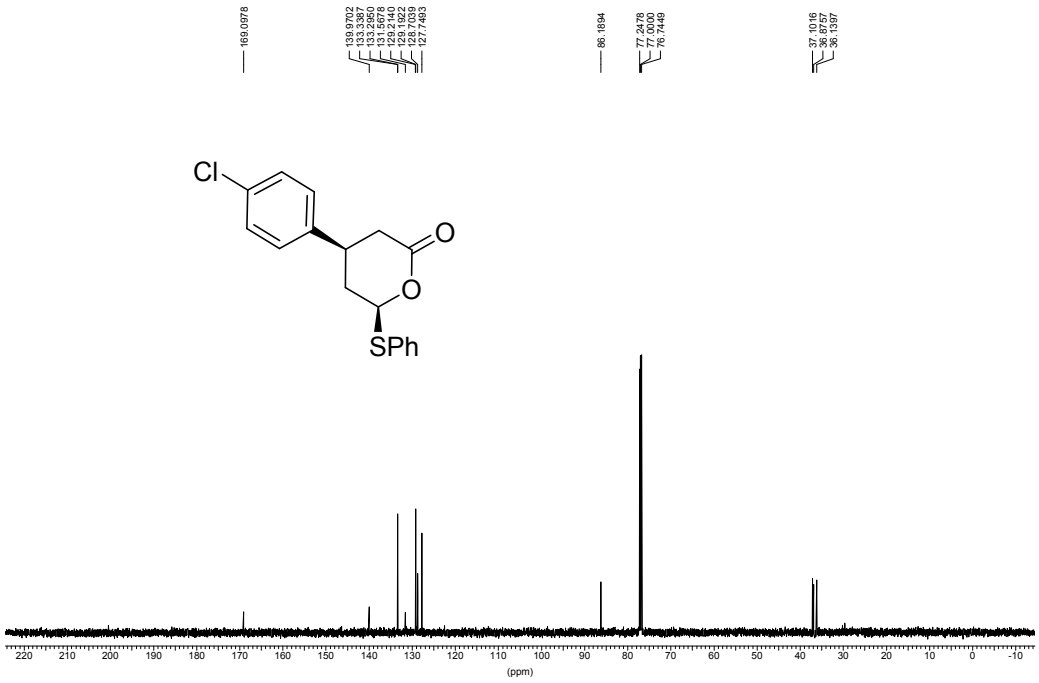
Compound 3ac



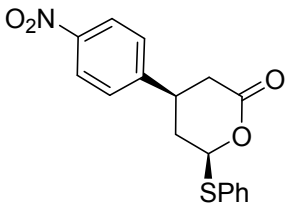


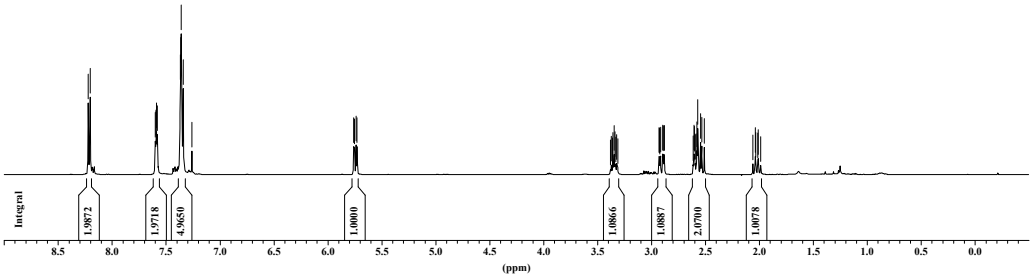
Compound 3bc

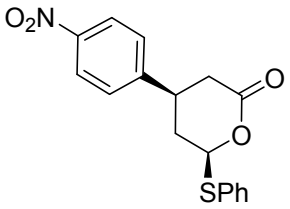


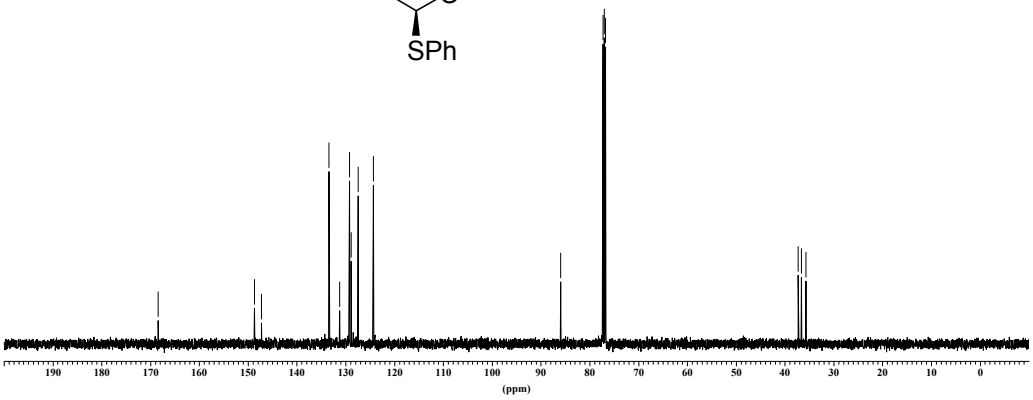


Compound 3cc

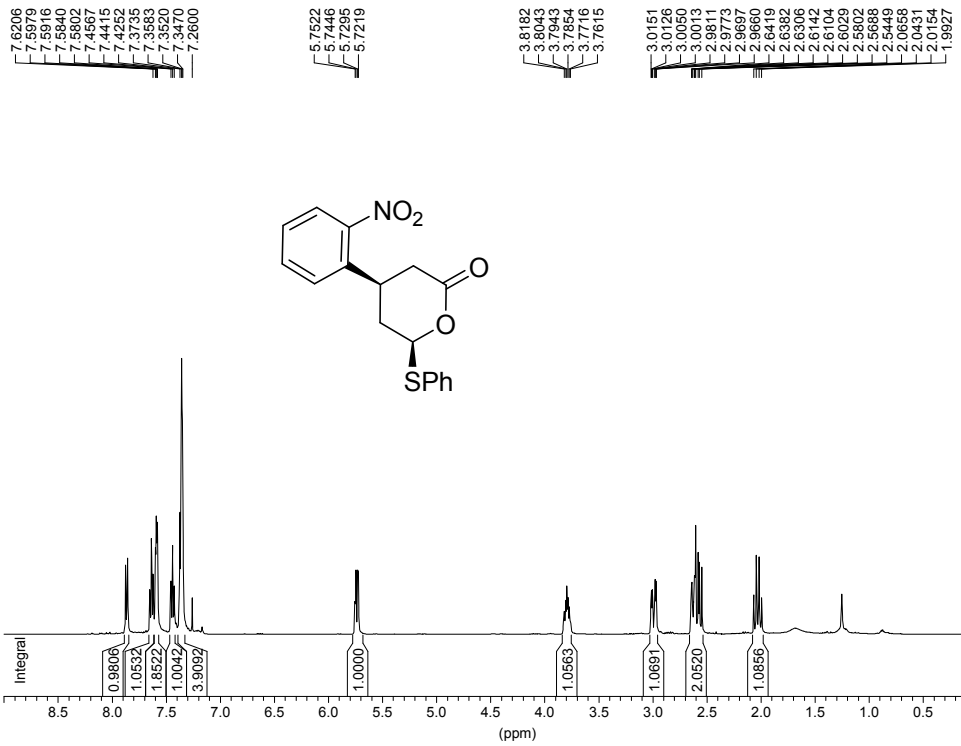


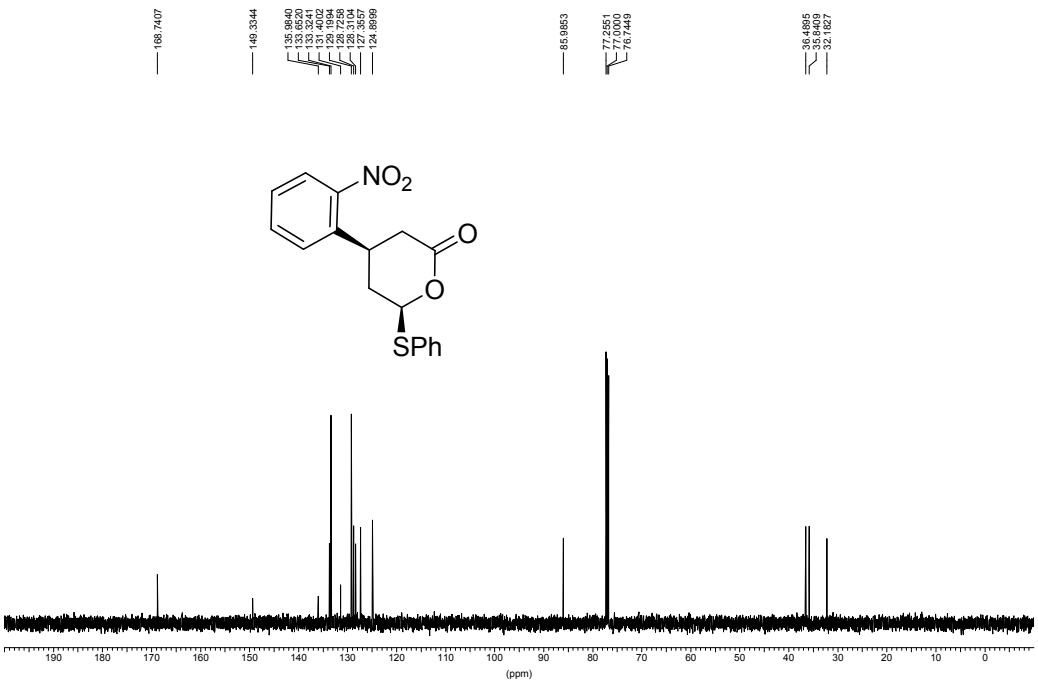




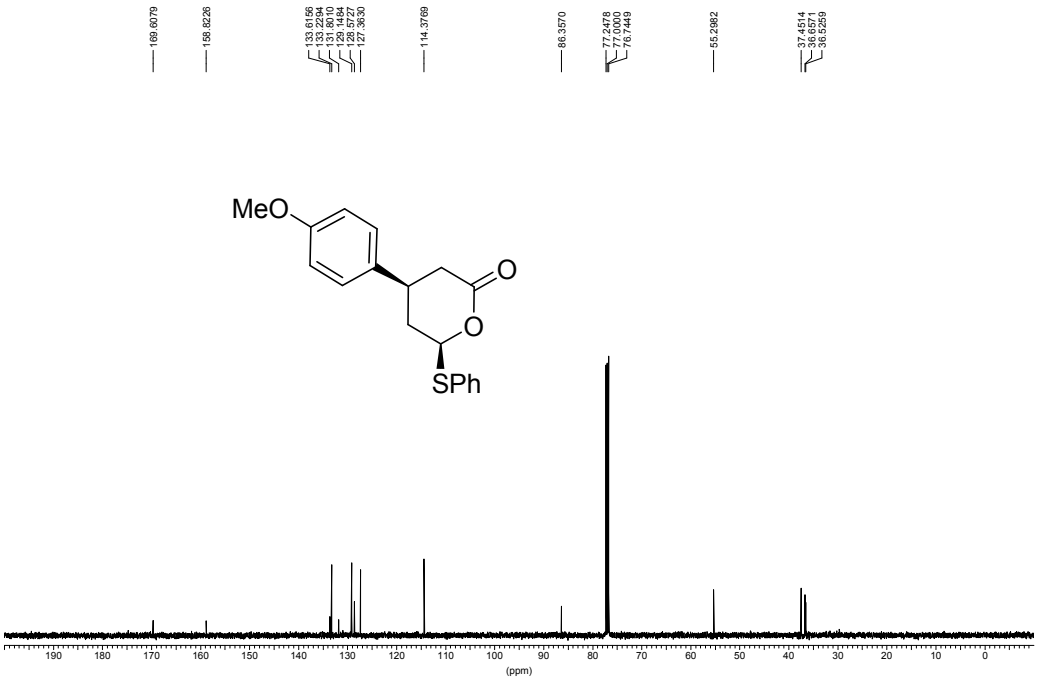


Compound 3dc

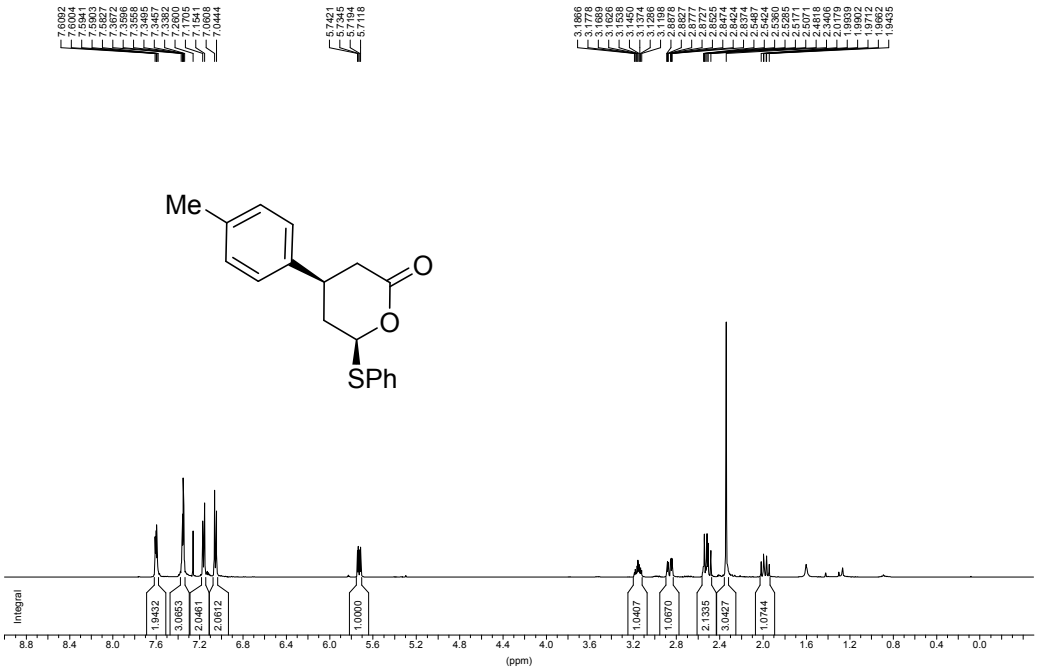


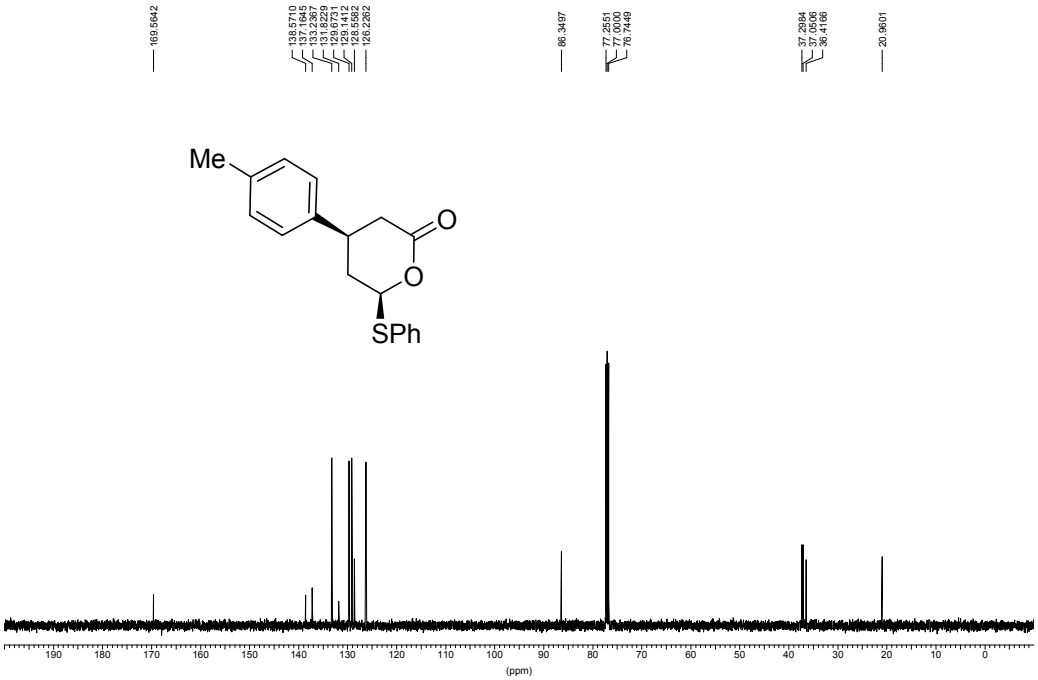


Compound 3ec

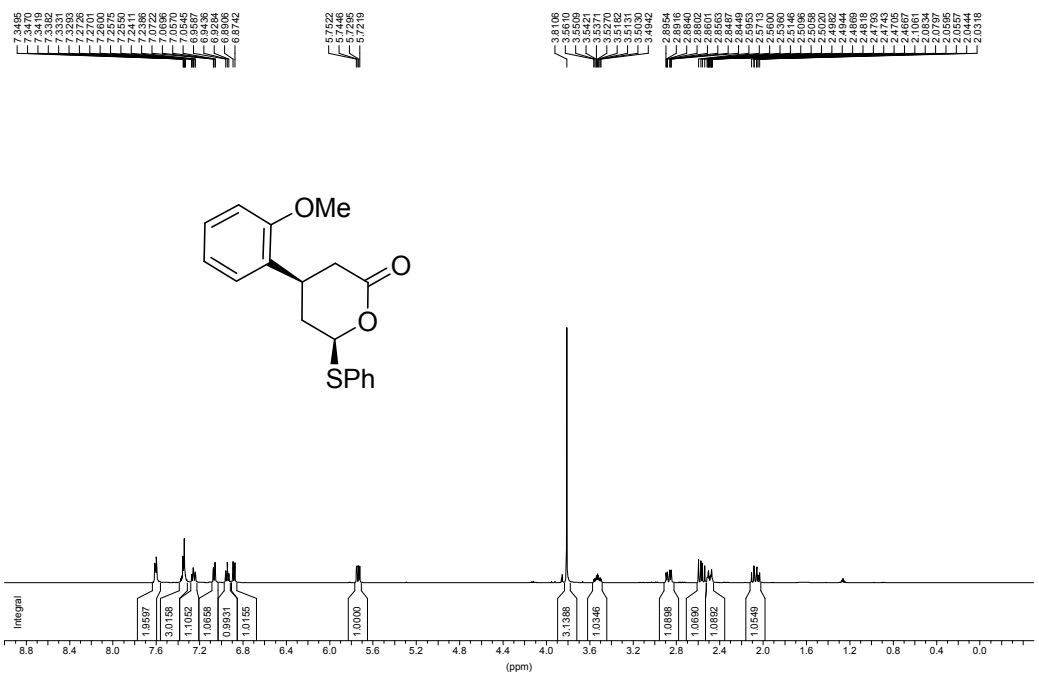


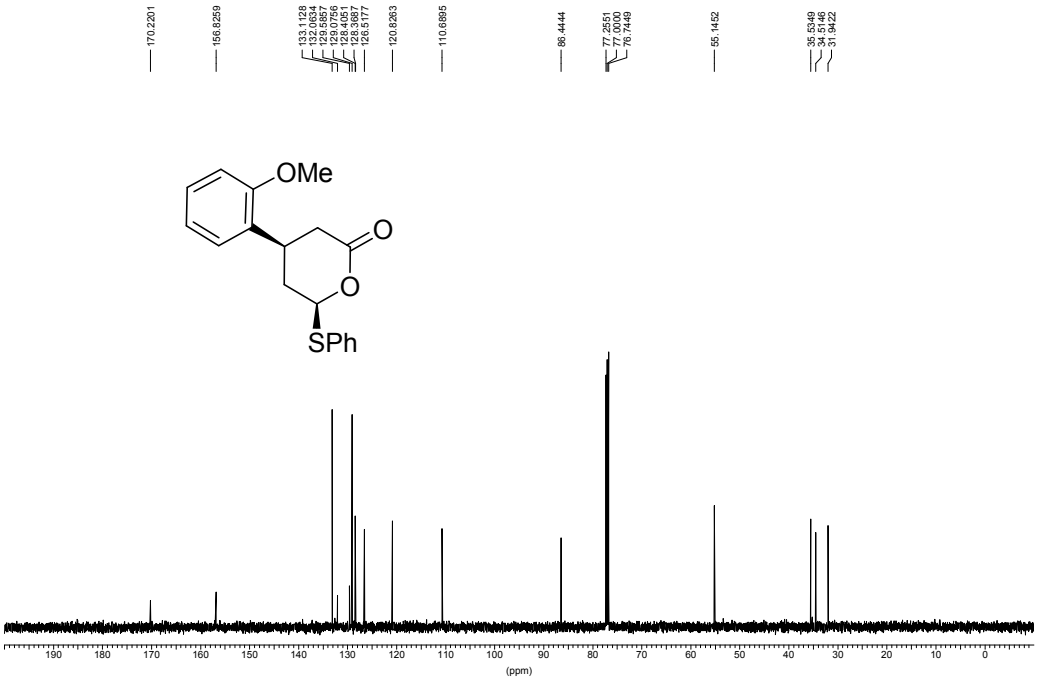
Compound 3fc



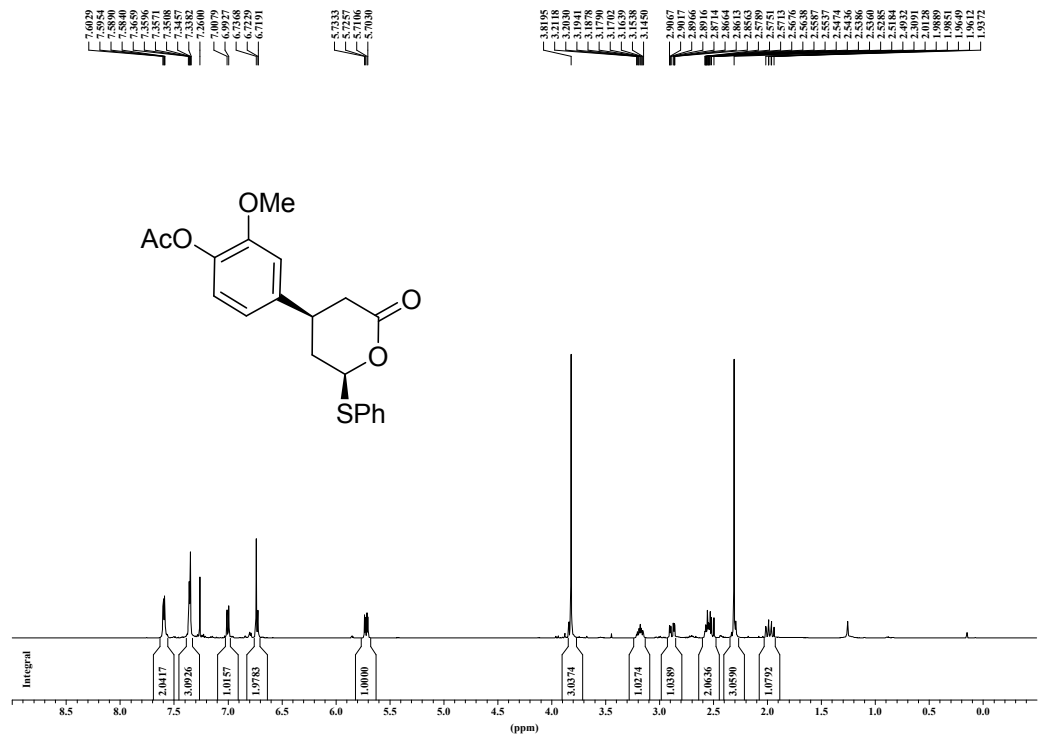


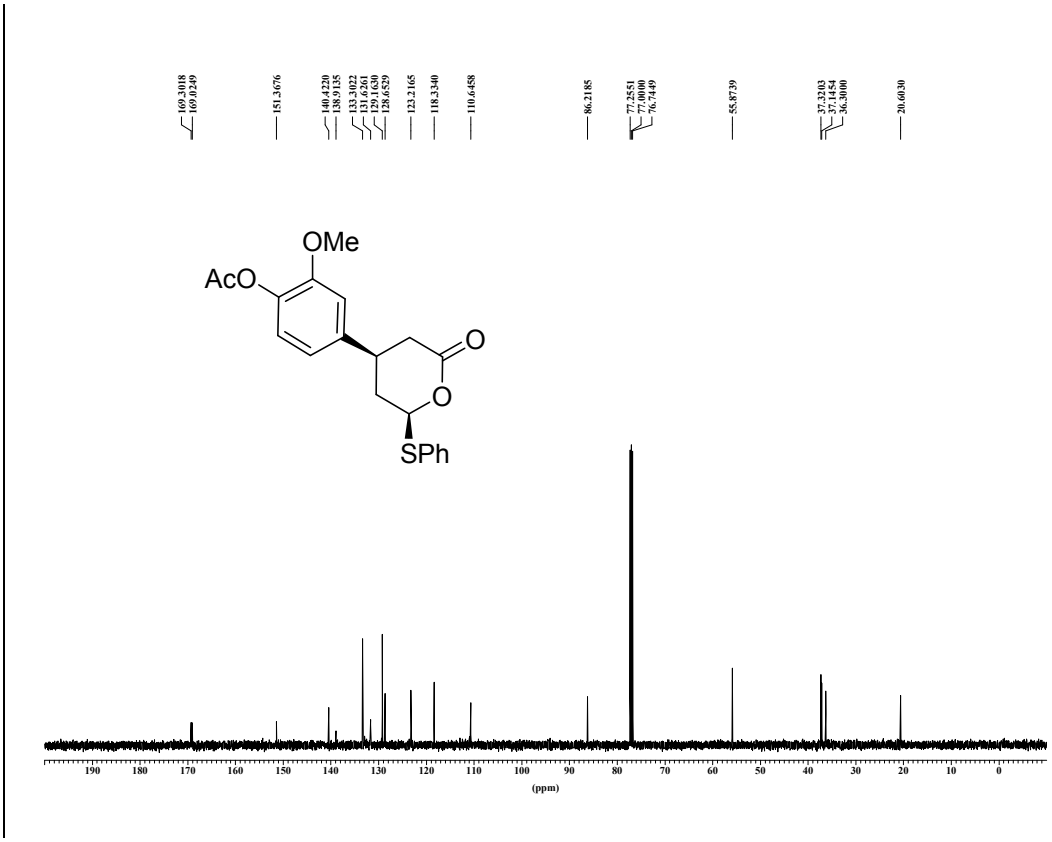
Compound 3gc



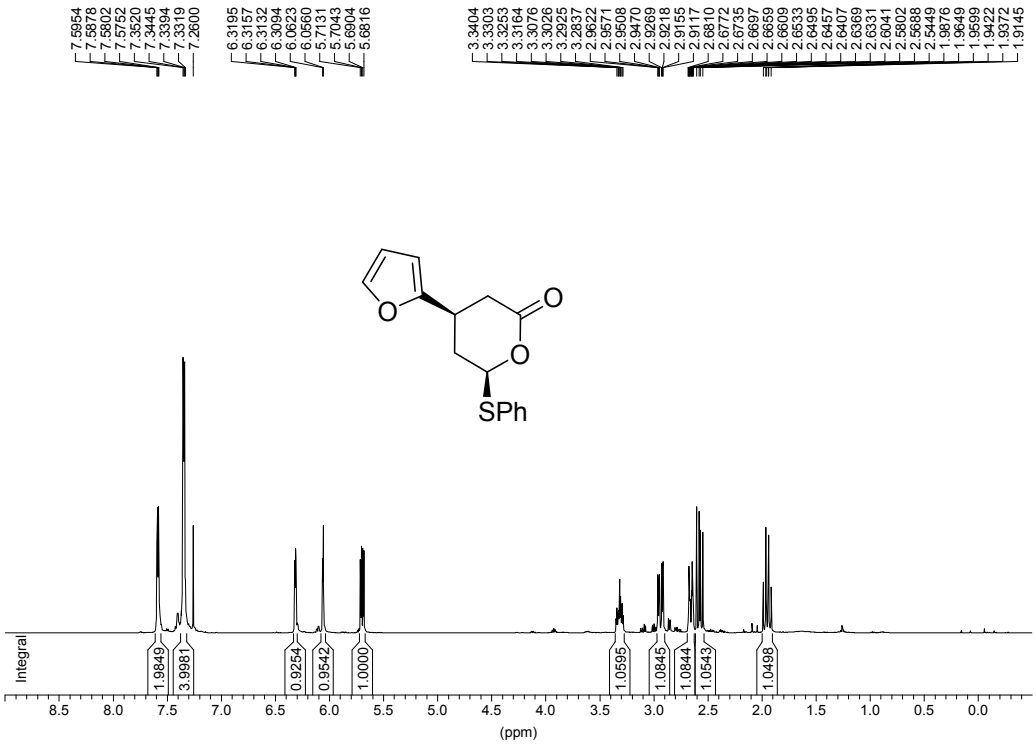


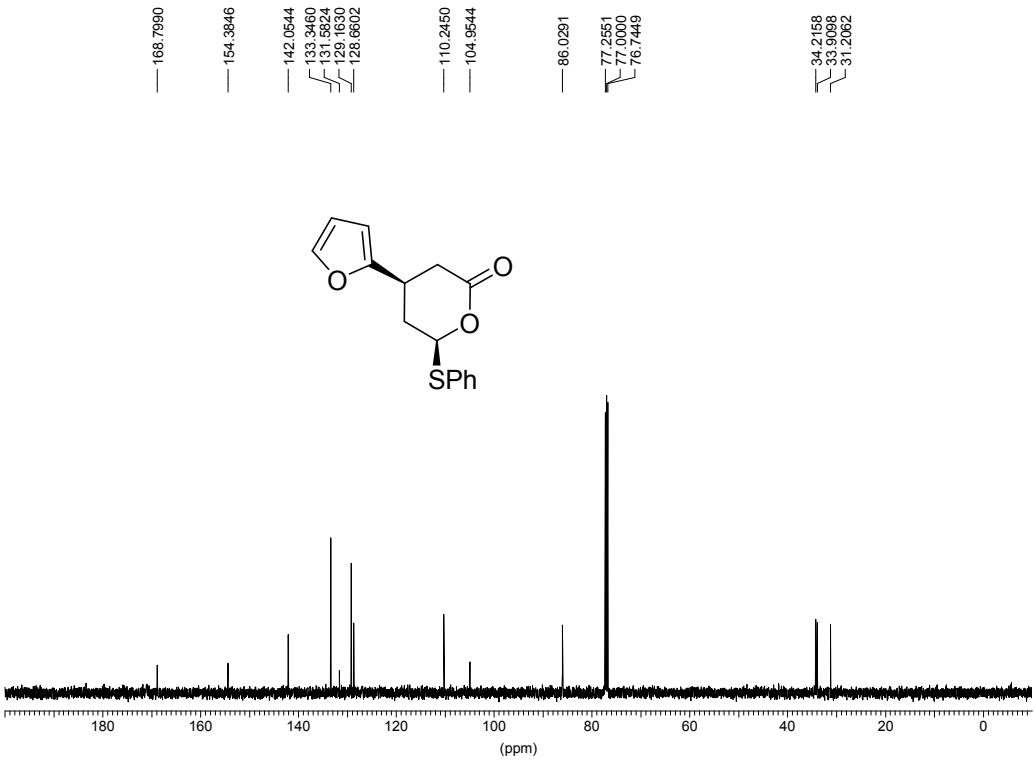
Compound 3hc


OMe
AcO
O
O
SPh
Integral
(ppm)

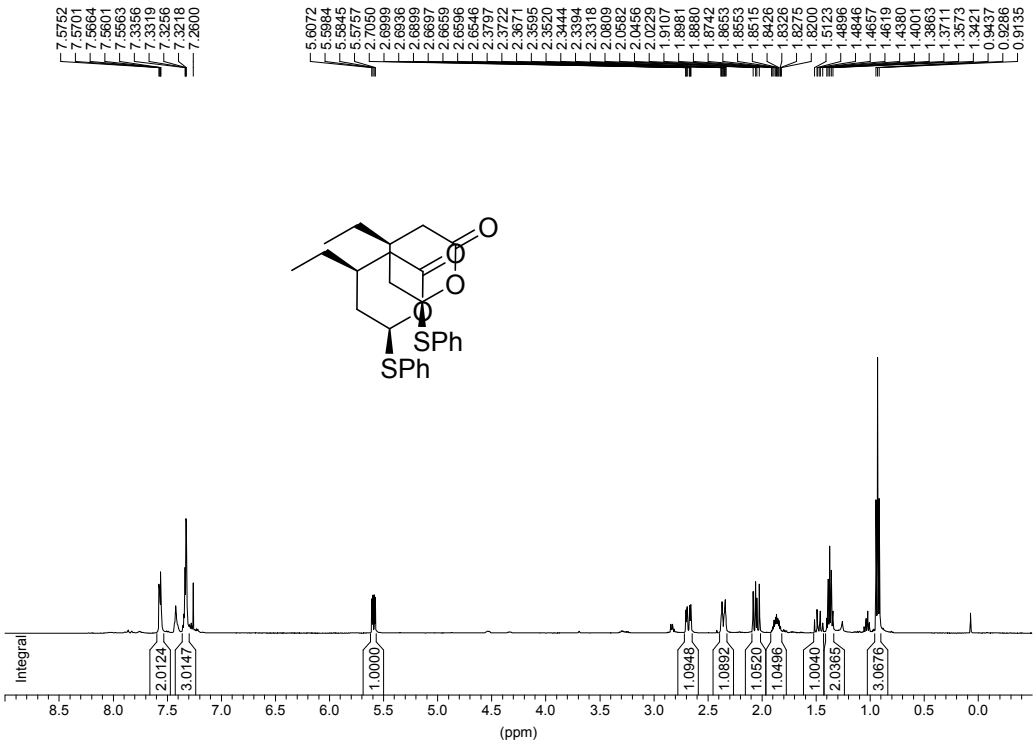

OMe
AcO
O
O
SPh
(ppm)

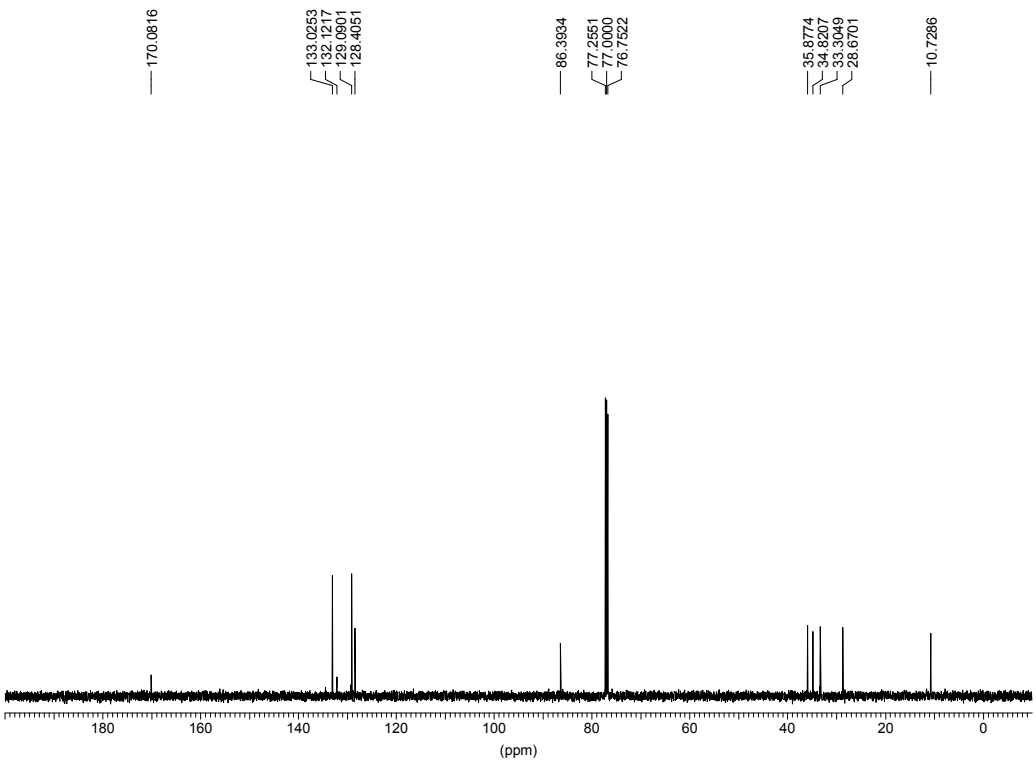
Compound 3ic



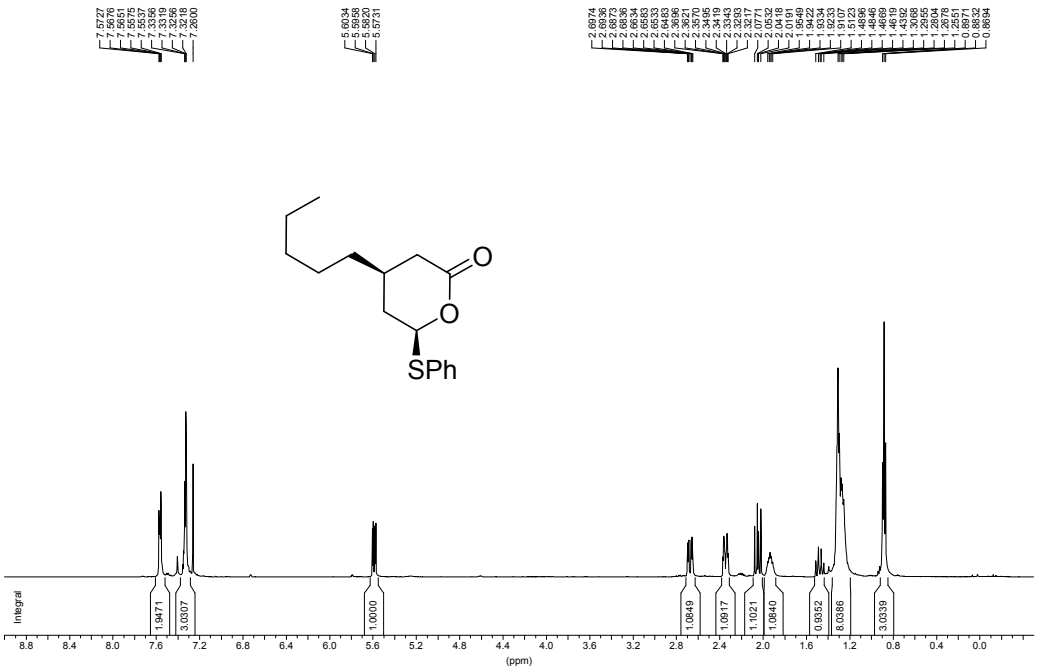


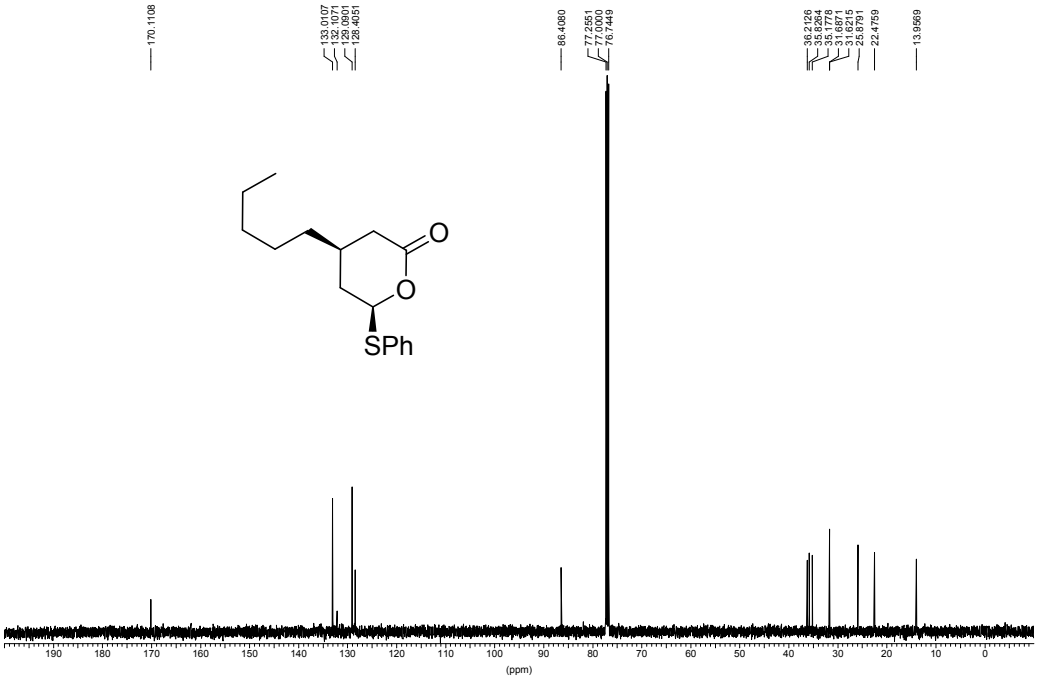
Compound 3jc



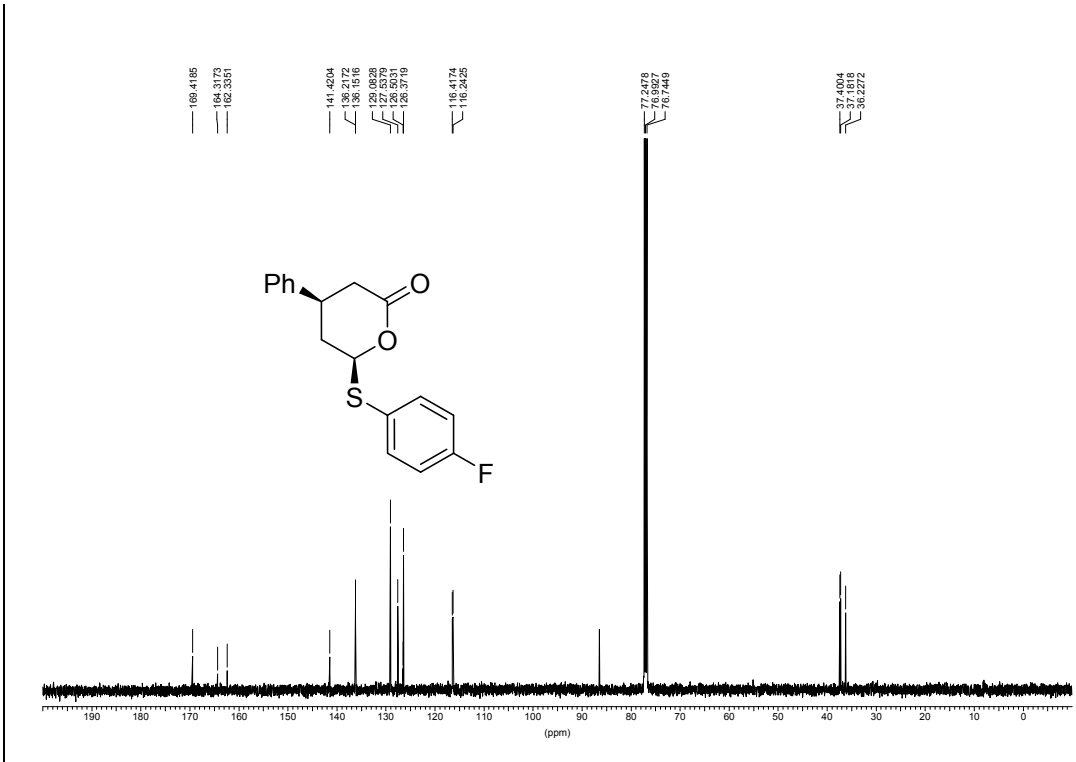


Compound 3kc

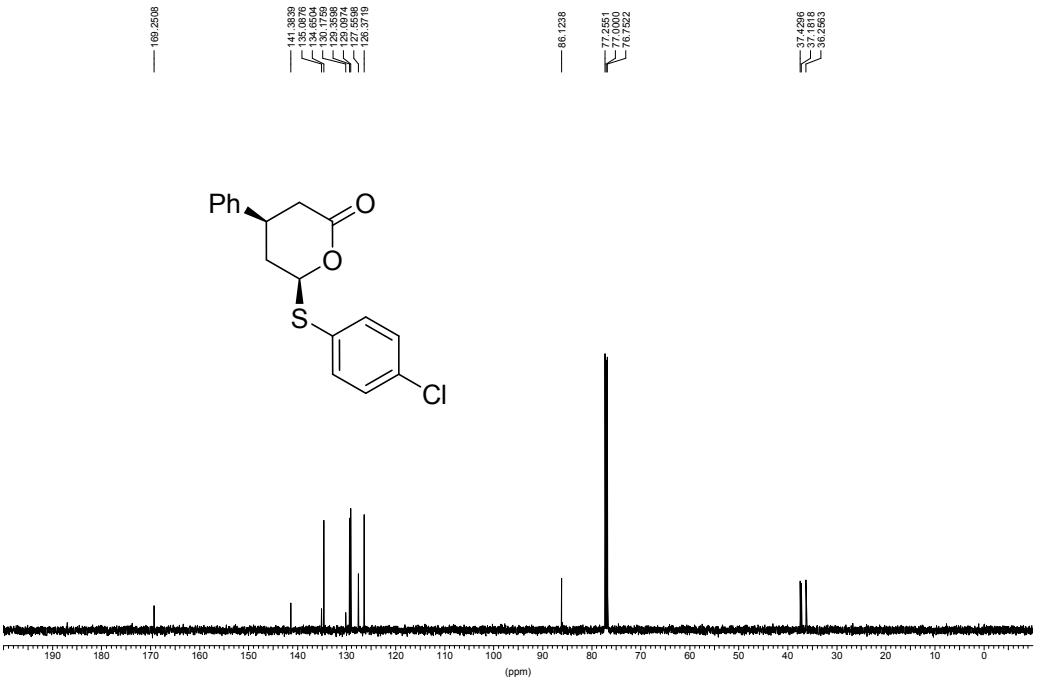




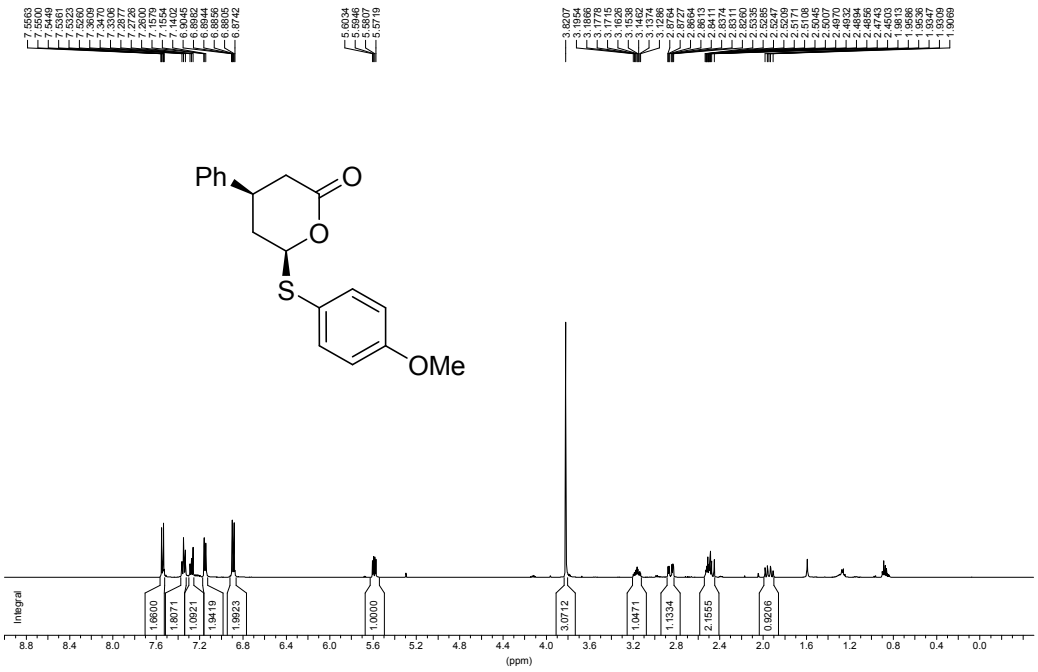
Compound 3ad

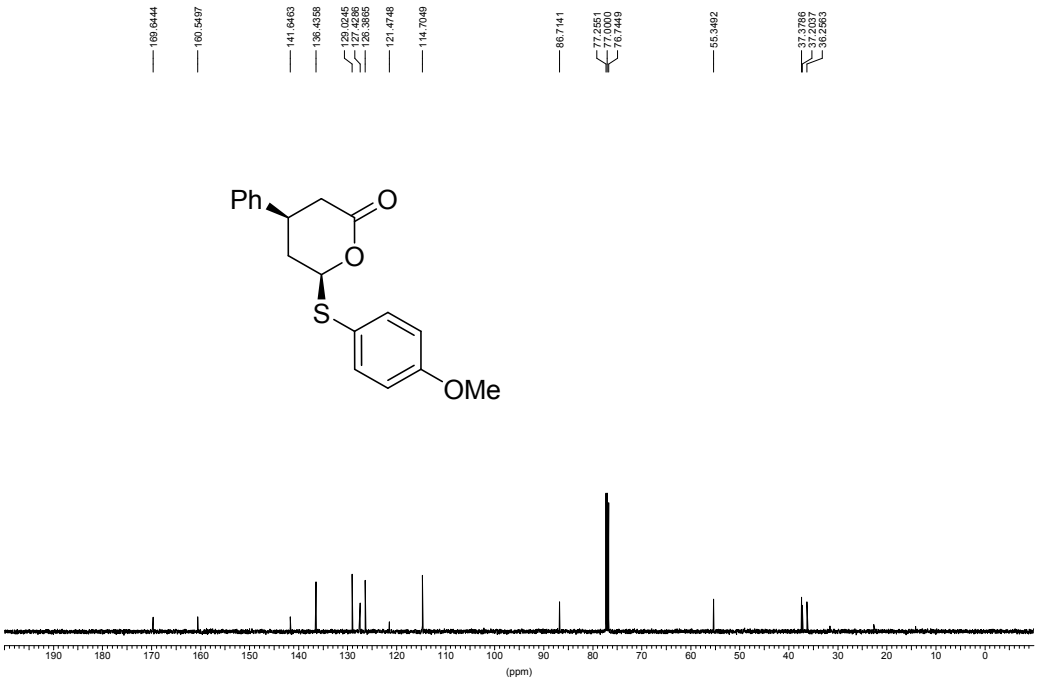


Compound 3ae

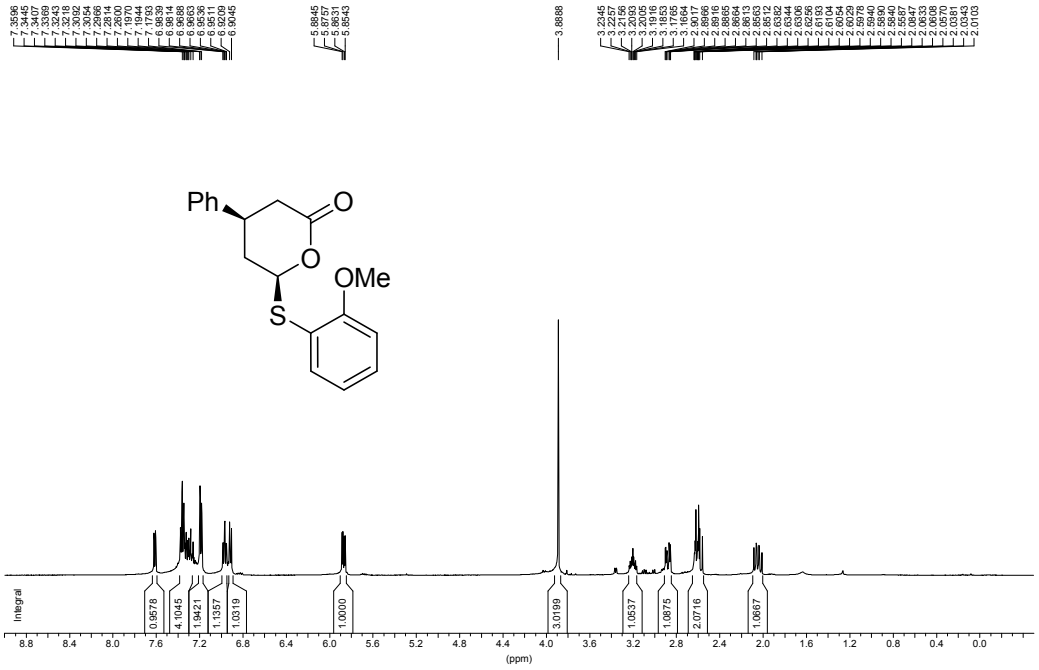


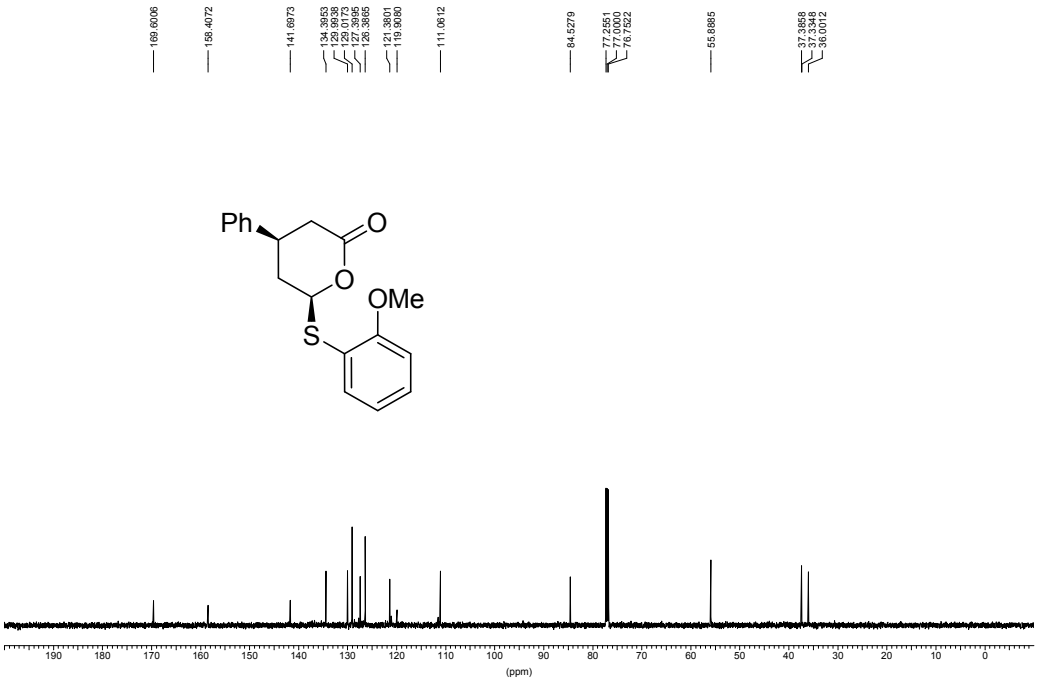
Compound 3af



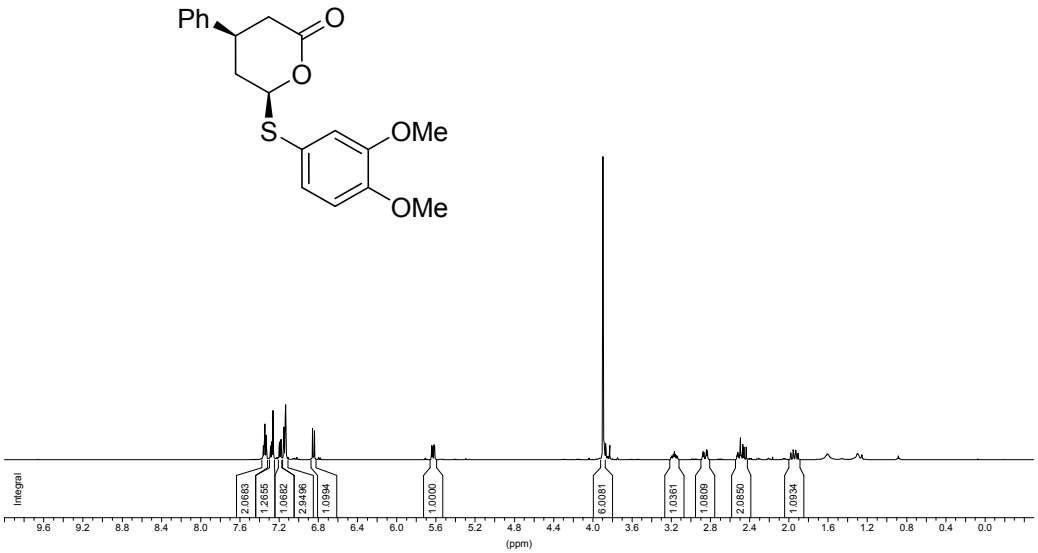


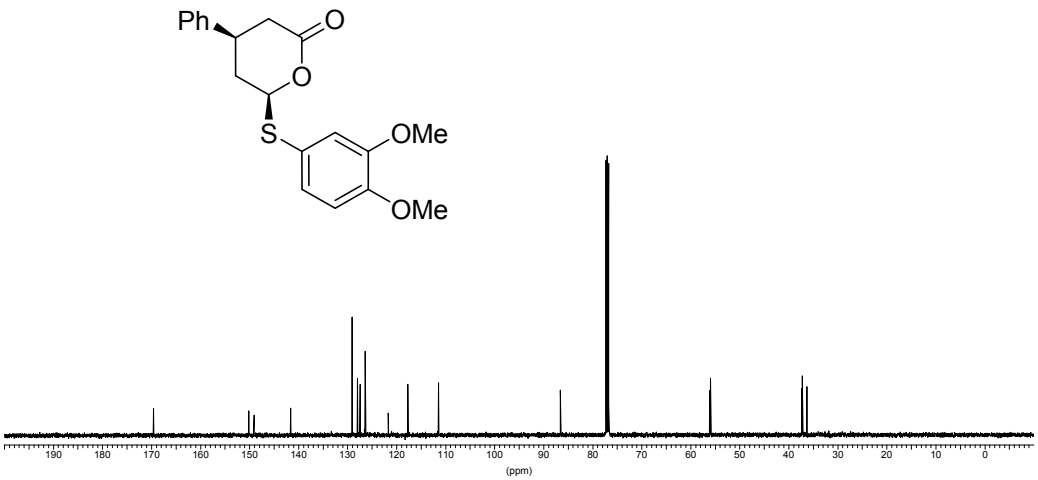
Compound 3ag



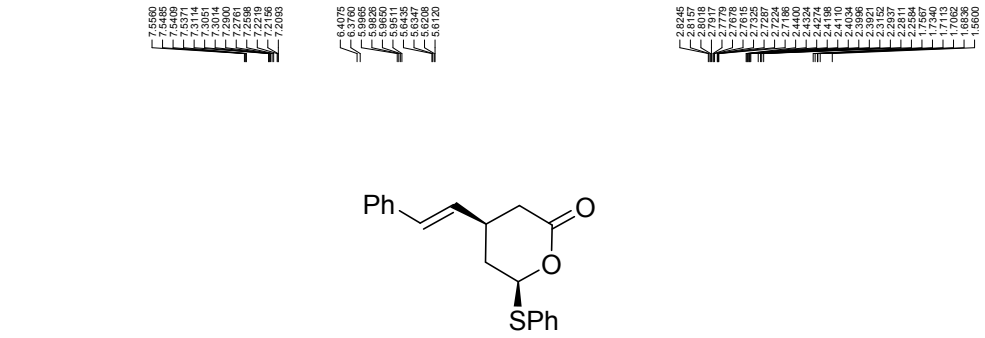


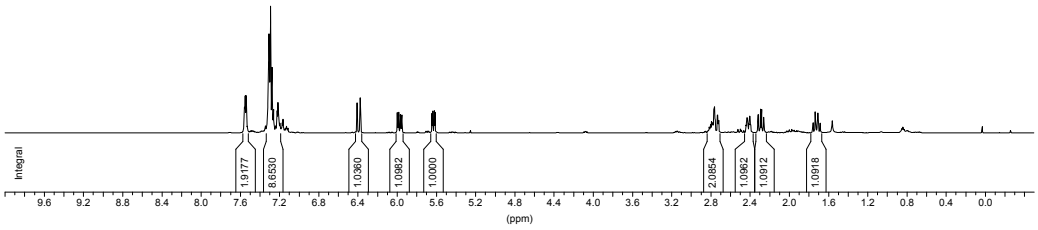
Compound 3ah

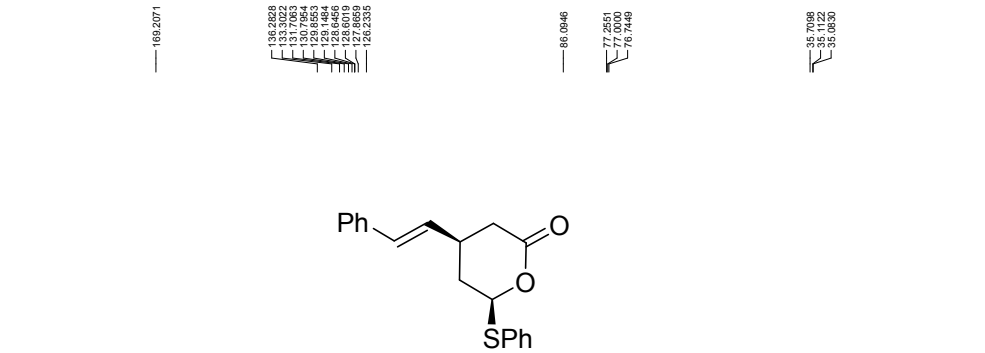




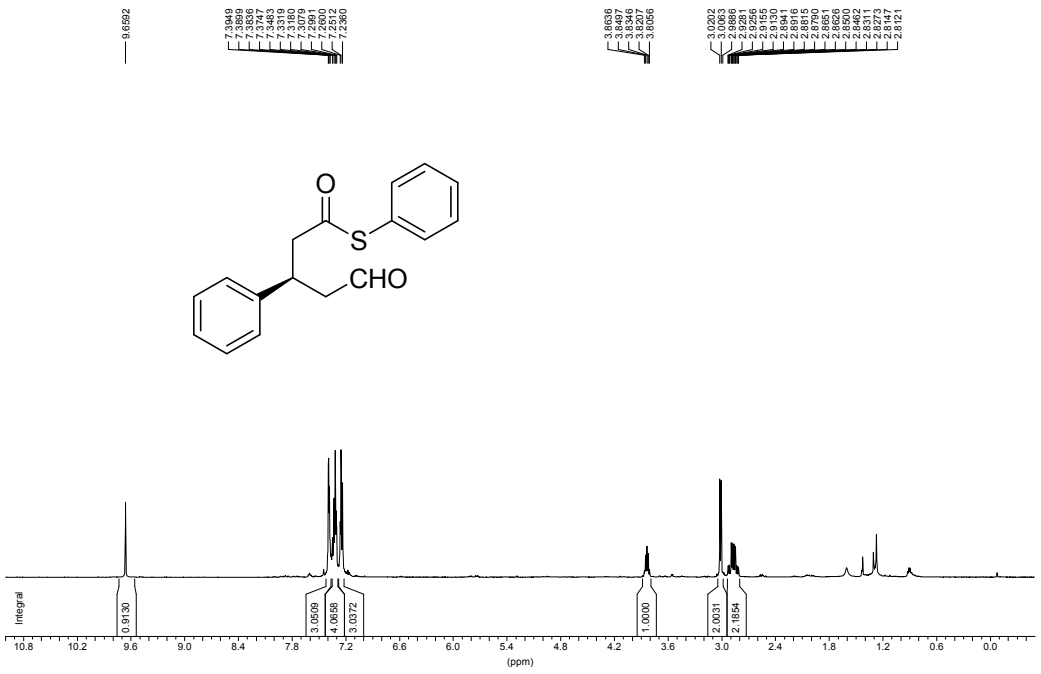
Compound 3lc

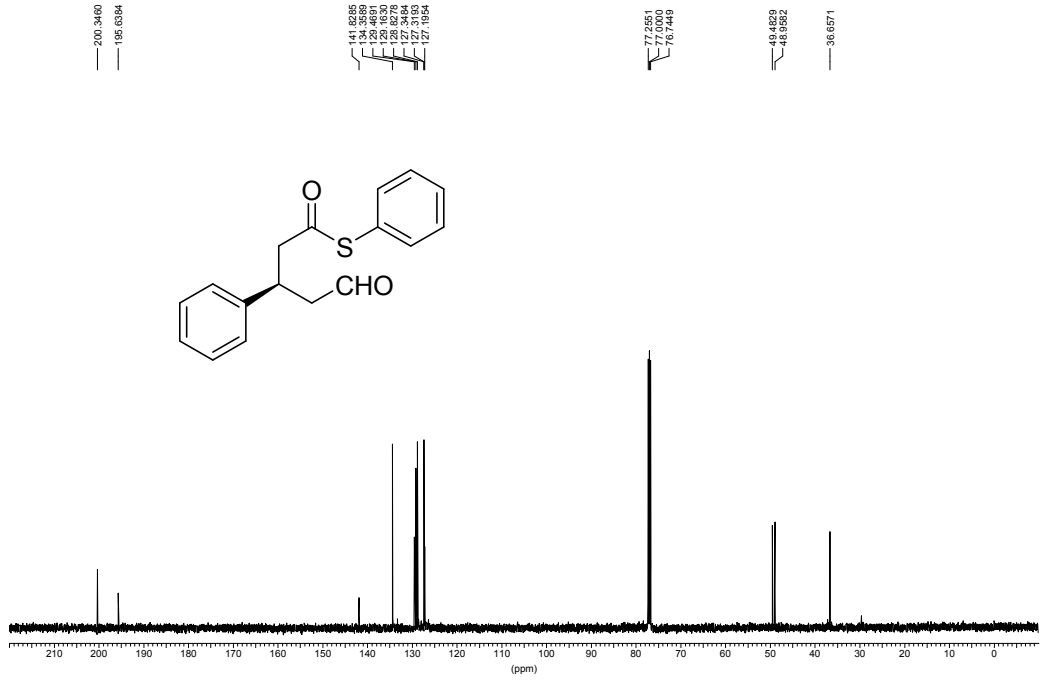




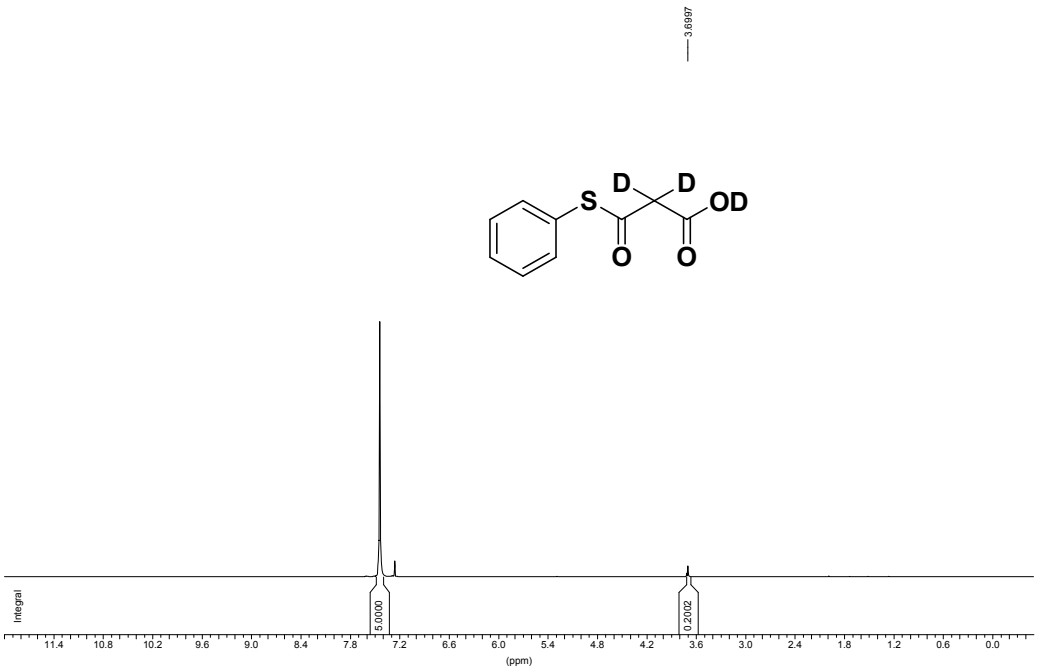


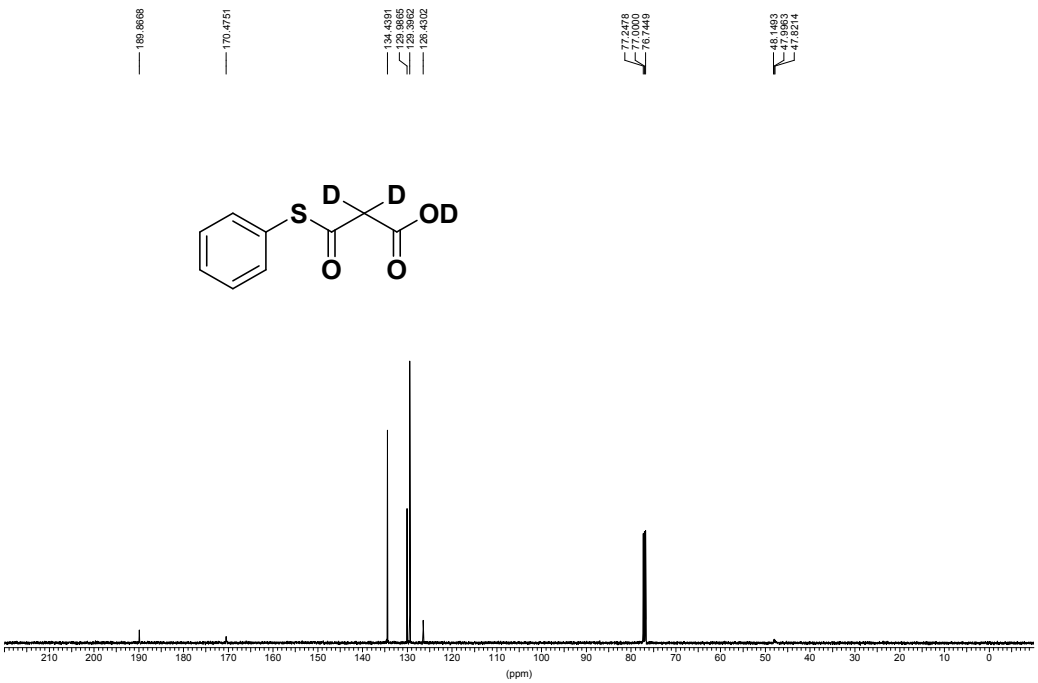
Compound 4


9.6592
7.3949
7.3889
7.3866
7.3747
7.3483
7.3319
7.3190
7.3079
7.2991
7.2600
7.2572
7.2360
3.8636
3.8497
3.8346
3.8207
3.8056
3.0202
3.0063
2.9886
2.9281
2.9155
2.9130
2.8941
2.8815
2.8790
2.8651
2.8500
2.8462
2.8371
2.8273
2.8147
2.8121
O
S
CHO
Integral
0.9130
3.0509
4.0658
3.0372
1.0000
2.0031
2.1854
(ppm)

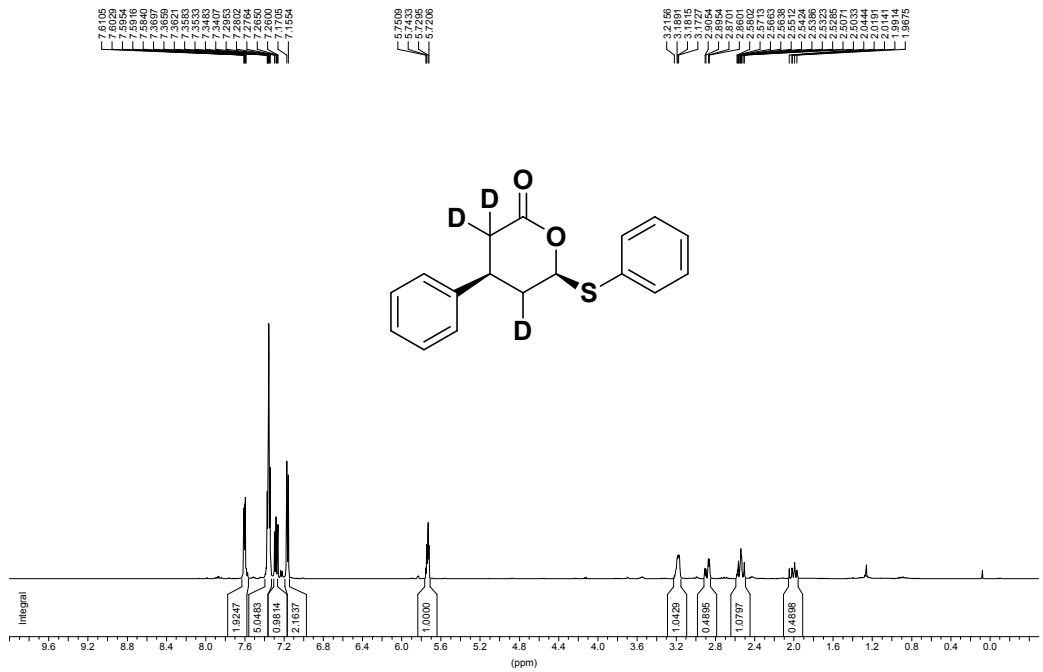

200.3460
195.6384
141.8285
134.3589
129.4451
129.1630
128.8278
127.3484
127.3155
127.1954
77.2551
77.0000
76.7449
49.4829
48.9582
36.6571
O
S
CHO
(ppm)

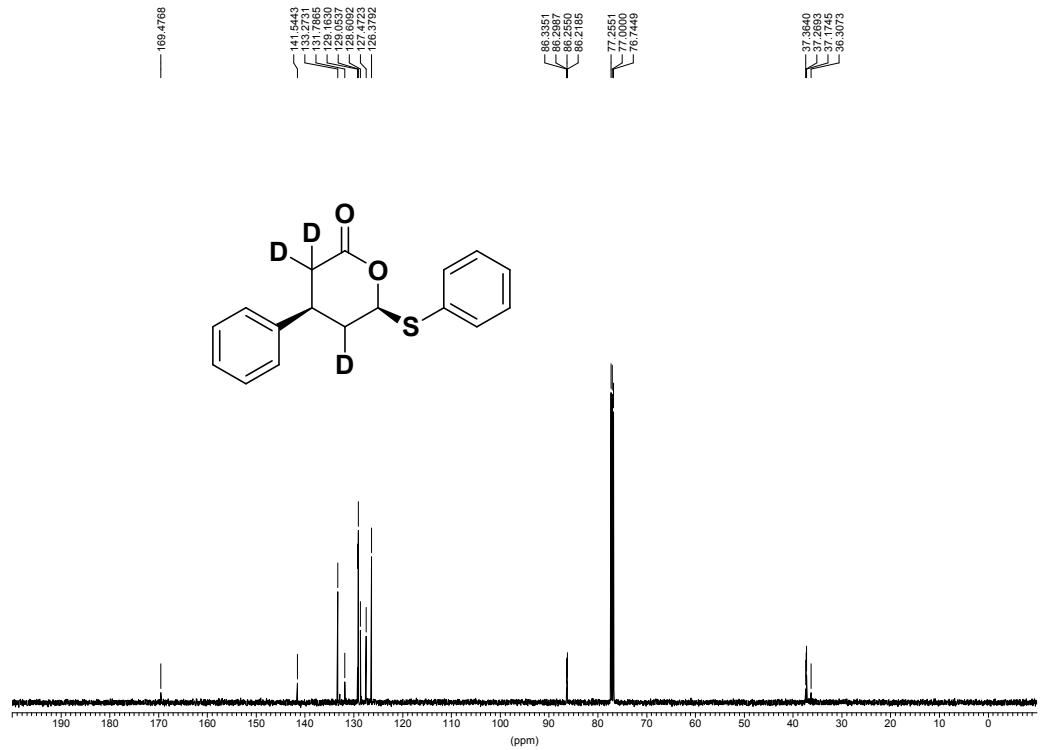
Compound *d*-2c



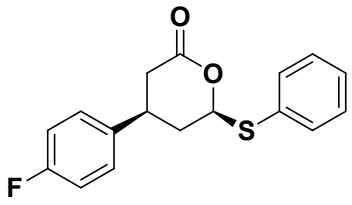


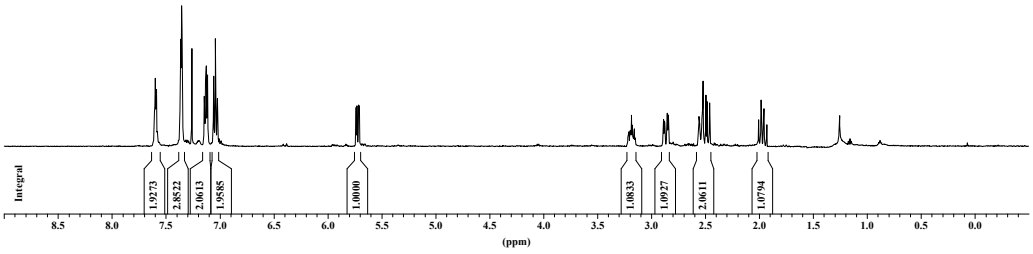
Compound *d*-3ac

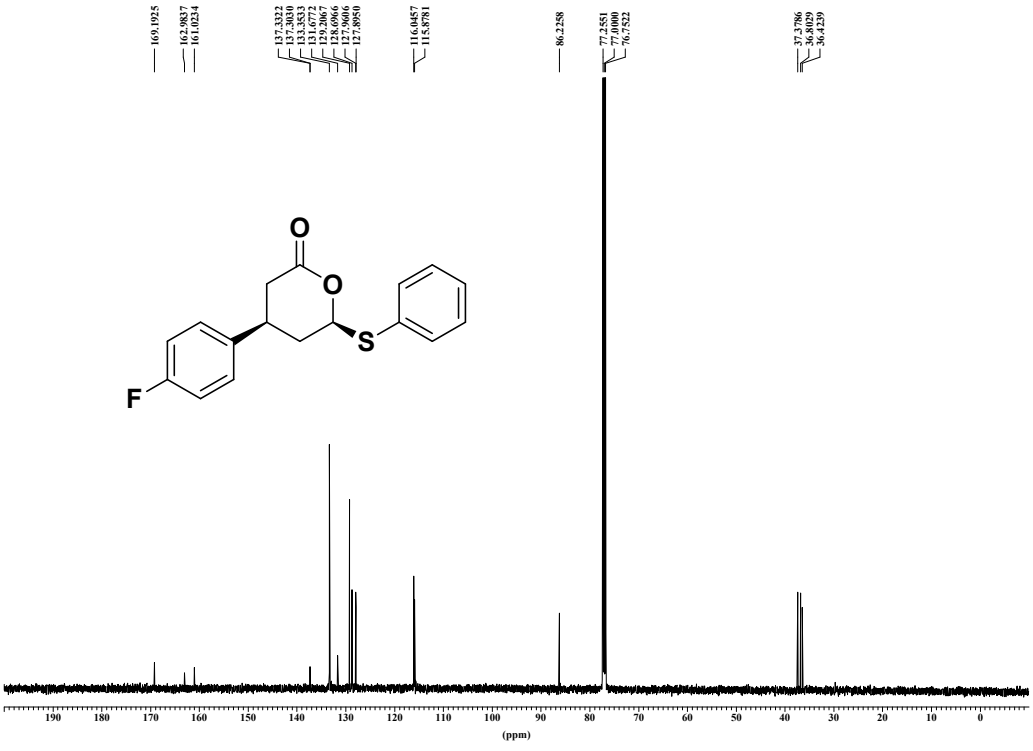




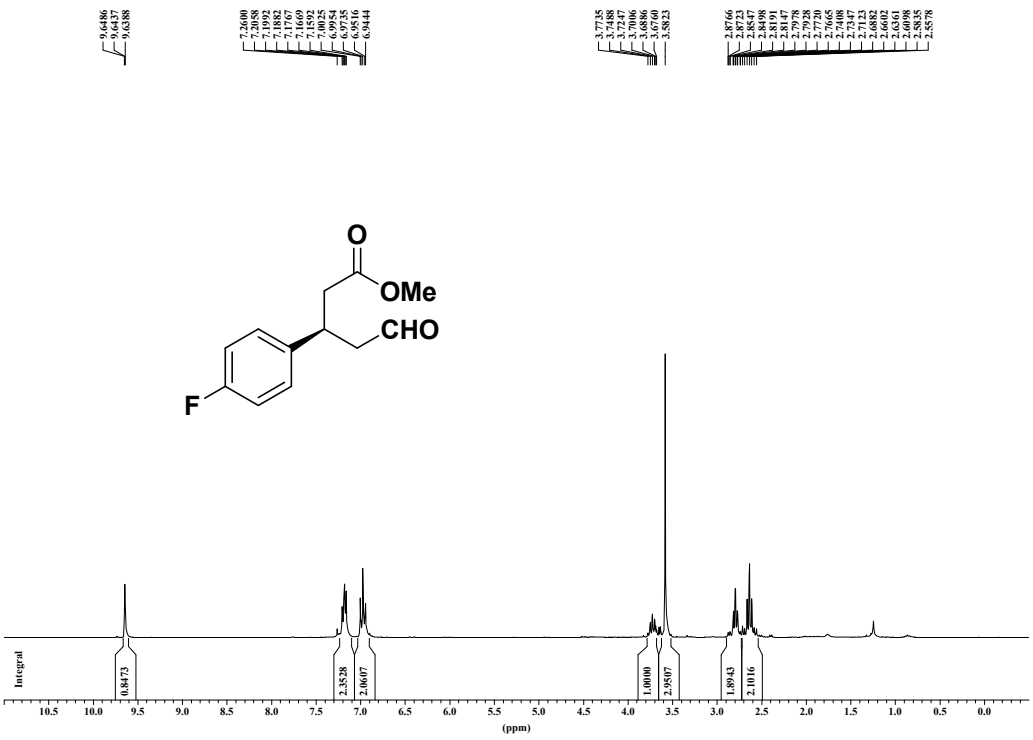
Compound 3mc

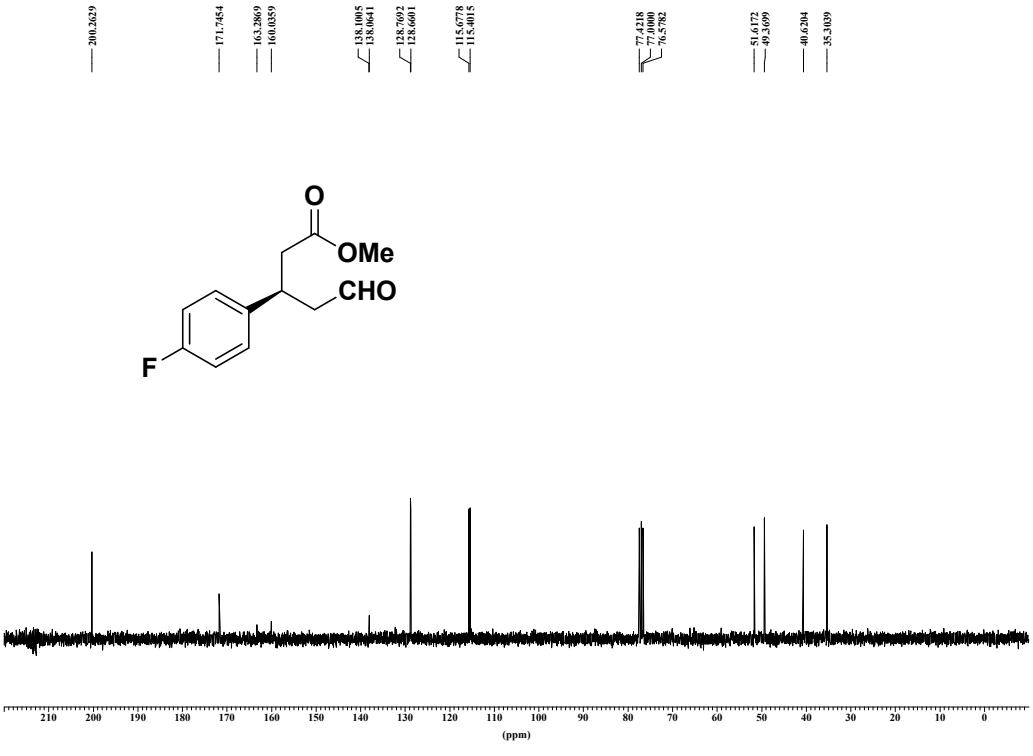




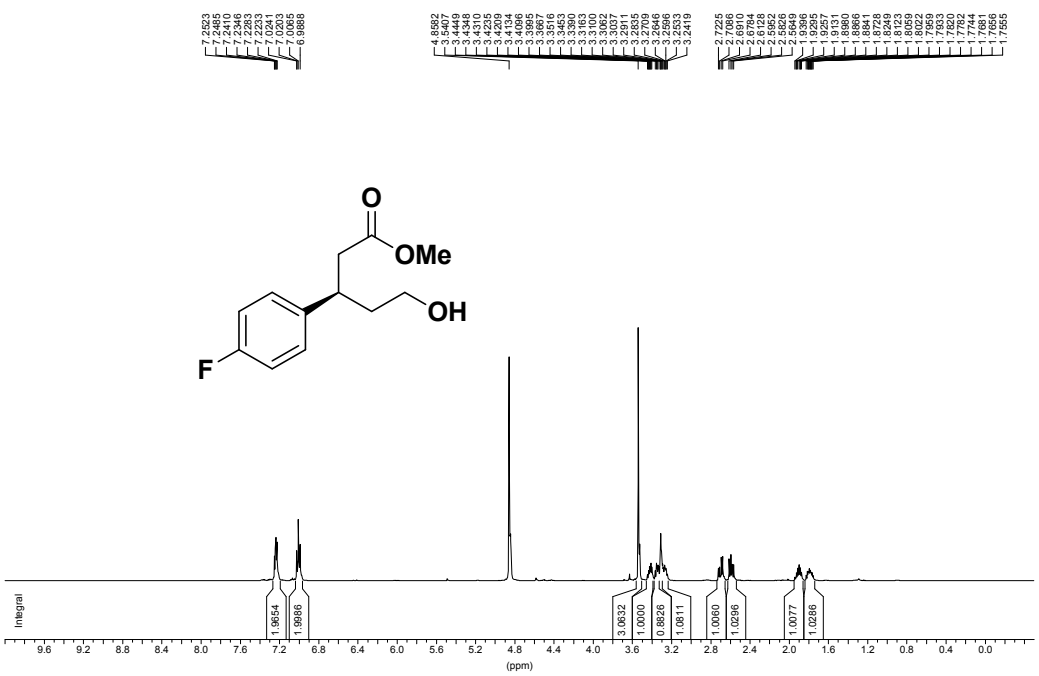


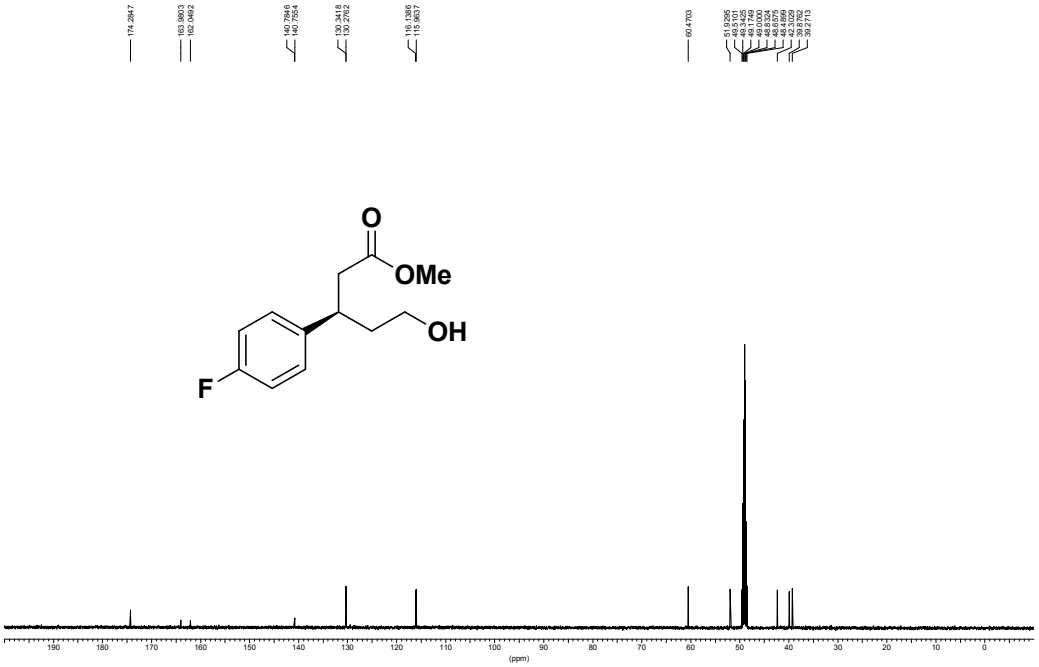
Compound 5


9.6486
9.6437
9.6388
7.2600
7.2098
7.1992
7.1882
7.1767
7.1669
7.1552
7.0025
6.9954
6.9735
6.9516
6.9444
3.7735
3.7488
3.7247
3.7006
3.6886
3.6760
3.5823
2.8766
2.8723
2.8547
2.8498
2.8410
2.8147
2.7978
2.7928
2.7720
2.7665
2.7468
2.7347
2.7123
2.6882
2.6661
2.6361
2.6098
2.5835
2.5578
O
OMe
CHO
F
Integral
0.8473
2.3528
2.0607
1.0000
2.9507
1.8943
2.1016
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
(ppm)


200.2629
171.7454
163.2869
160.0359
138.1005
138.0641
128.7692
128.6601
115.6778
115.4015
77.4218
77.0000
76.5782
51.6172
49.3699
40.6204
35.3039
O
OMe
CHO
F
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
(ppm)

Compound 6

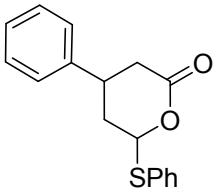

O
OMe
OH
F
Integral
1.9654
1.9886
3.0632
1.0000
0.8826
1.0811
1.0060
1.0296
1.0077
1.0286
(ppm)


O
OMe
OH
F
(ppm)

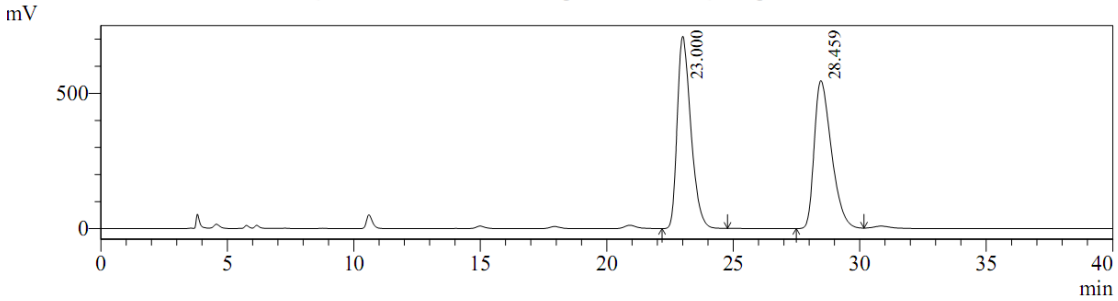
Racemic 3ac

==== Shimadzu LCsolution Analysis Report ====

C:\Users\User\Desktop\LC data\Ren Qiao\rq638.lcd
Acquired by : Admin
Sample Name : RQD252
Sample ID : RQ
Data File Name : rq638.lcd
Method File Name : 20%IPA, 1ml-min, 60min.lcm
Batch File Name :
Report File Name : Default.lcr
Description :IC column ;20%IPA ;1ml/min



Chromatogram
RQD252 C:\Users\User\Desktop\LC data\Ren Qiao\rq638.lcd



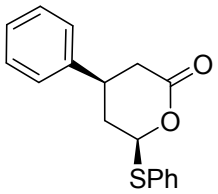
Detector A Ch1 254nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	23.000	26608734	710566	50.861	56.523
2	28.459	25708355	546556	49.139	43.477
Total		52317088	1257122	100.000	100.000

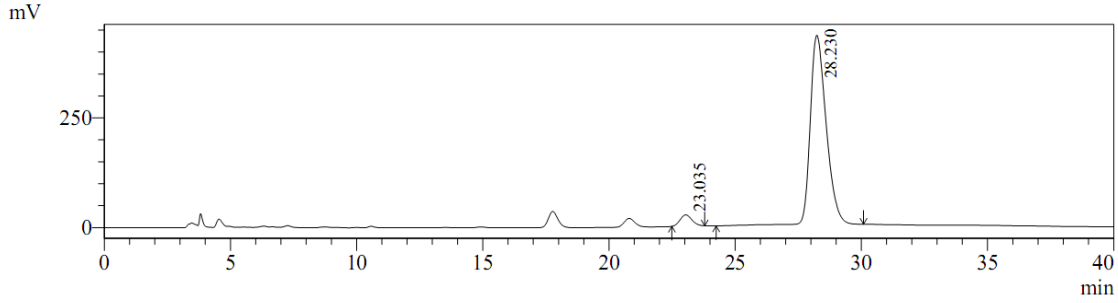
Enantiomeric enriched 3ac

==== Shimadzu LCsolution Analysis Report ====

C:\Users\User\Desktop\LC data\Ren Qiao\rq586.lcd
Acquired by : Admin
Sample Name : RQD203
Sample ID : RQ
Data File Name : rq586.lcd
Method File Name : 20%IPA, 1ml-min, 60min.lcm
Batch File Name :
Report File Name : Default.lcr
Description :IC column ;20%IPA ;1ml/min



Chromatogram
RQD203 C:\Users\User\Desktop\LC data\Ren Qiao\rq586.lcd



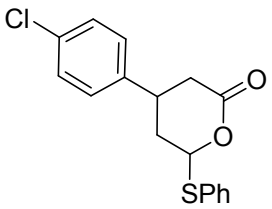
Detector A Ch1 254nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	23.035	833667	25663	4.195	5.609
2	28.230	19038519	431887	95.805	94.391
Total		19872186	457551	100.000	100.000

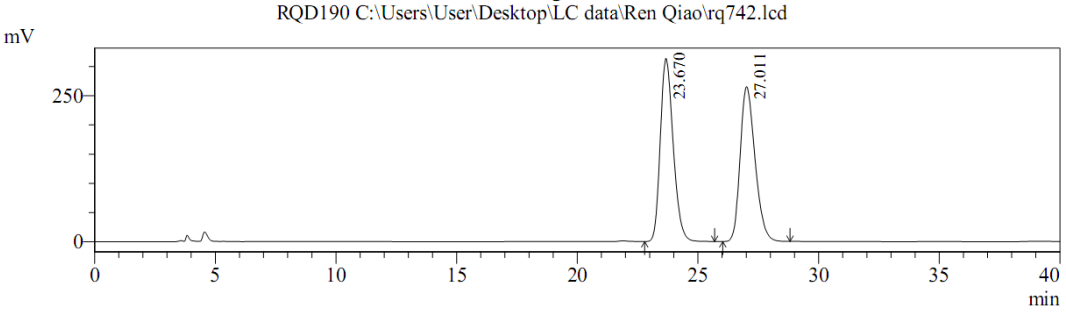
Racemic 3bc

==== Shimadzu LCsolution Analysis Report ====

C:\Users\User\Desktop\LC data\Ren Qiao\rq742.lcd
Acquired by : Admin
Sample Name : RQD190
Sample ID : RQ
Data File Name : rq742.lcd
Method File Name : 20%IPA, 1ml-min, 60min.lcm
Batch File Name :
Report File Name : Default.lcr
Description :IC column ;20%IPA ;1ml/min



Chromatogram
RQD190 C:\Users\User\Desktop\LC data\Ren Qiao\rq742.lcd



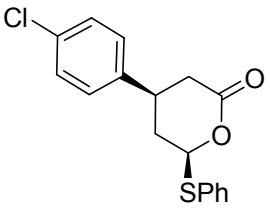
Detector A Ch1 254nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	23.670	11687653	314066	50.718	54.201
2	27.011	11356696	265383	49.282	45.799
Total		23044349	579448	100.000	100.000

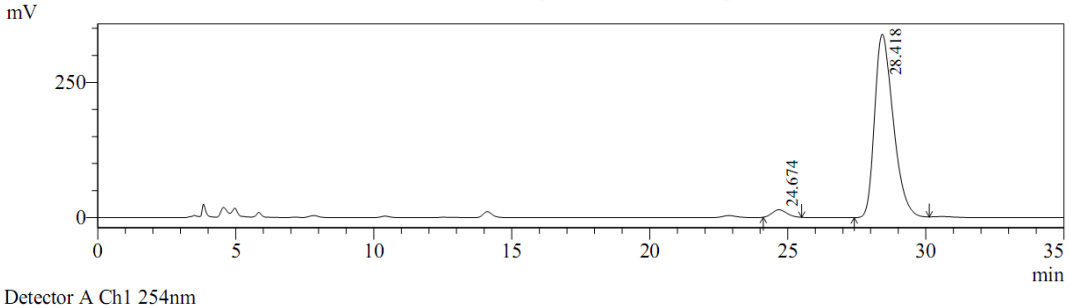
Enantiomeric enriched 3bc

==== Shimadzu LCsolution Analysis Report ====

C:\Users\User\Desktop\LC data\Ren Qiao\rq610.lcd
Acquired by : Admin
Sample Name : RQD230
Sample ID : RQ
Data File Name : rq610.lcd
Method File Name : 20%IPA, 1ml-min, 60min.lcm
Batch File Name :
Report File Name : Default.lcr
Description :IC column ;20%IPA ;1ml/min



Chromatogram
RQD230 C:\Users\User\Desktop\LC data\Ren Qiao\rq610.lcd



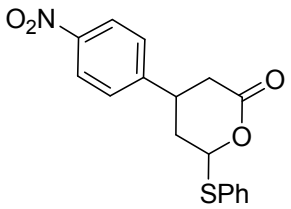
Detector A Ch1 254nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	24.674	512728	13923	3.128	3.947
2	28.418	15880707	338856	96.872	96.053
Total		16393436	352779	100.000	100.000

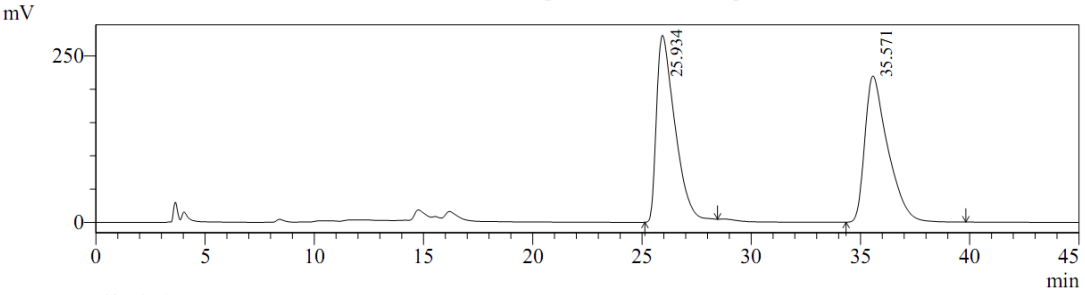
Racemic 3cc

==== Shimadzu LCsolution Analysis Report ====

C:\Users\User\Desktop\LC data\Ren Qiao\rq655.lcd
Acquired by : Admin
Sample Name : RQD268
Sample ID : RQ
Data File Name : rq655.lcd
Method File Name : 20%IPA, 1ml-min, 60min.lcm
Batch File Name :
Report File Name : Default.lcr
Description :IA column ;20%IPA ;1ml/min



Chromatogram
RQD268 C:\Users\User\Desktop\LC data\Ren Qiao\rq655.lcd



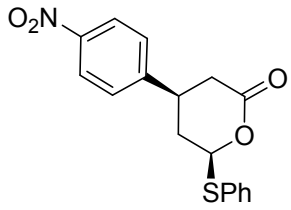
Detector A Ch1 254nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	25.934	16188135	279649	50.162	56.033
2	35.571	16083455	219426	49.838	43.967
Total		32271590	499075	100.000	100.000

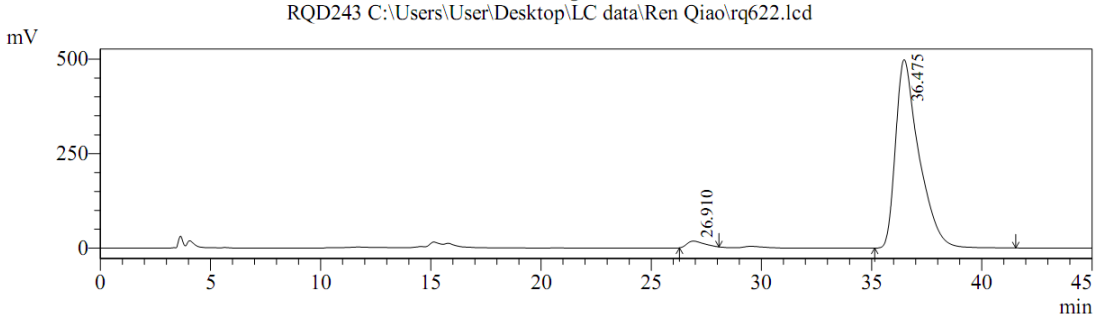
Enantiomeric enriched 3cc

==== Shimadzu LCsolution Analysis Report ====

C:\Users\User\Desktop\LC data\Ren Qiao\rq622.lcd
Acquired by : Admin
Sample Name : RQD243
Sample ID : RQ
Data File Name : rq622.lcd
Method File Name : 20%IPA, 1ml-min, 60min.lcm
Batch File Name :
Report File Name : Default.lcr
Description :IA column ;20%IPA ;1ml/min



Chromatogram
RQD243 C:\Users\User\Desktop\LC data\Ren Qiao\rq622.lcd



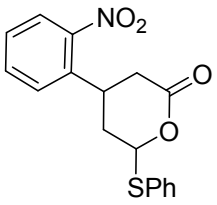
Detector A Ch1 254nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	26.910	897338	17032	2.382	3.302
2	36.475	36767452	498801	97.618	96.698
Total		37664790	515834	100.000	100.000

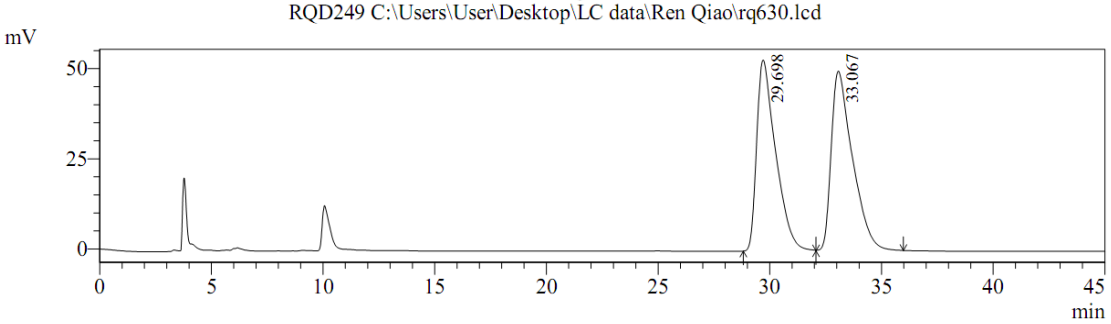
Racemic 3dc

==== Shimadzu LCsolution Analysis Report ====

C:\Users\User\Desktop\LC data\Ren Qiao\rq630.lcd
Acquired by : Admin
Sample Name : RQD249
Sample ID : RQ
Data File Name : rq630.lcd
Method File Name : 10%IPA, 1ml-min, 40min.lcm
Batch File Name :
Report File Name : Default.lcr
Description :IA column ;10%IPA ;1ml/min



Chromatogram
RQD249 C:\Users\User\Desktop\LC data\Ren Qiao\rq630.lcd



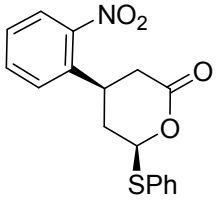
Detector A Ch1 254nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	29.698	3127544	52949	48.780	51.536
2	33.067	3283933	49793	51.220	48.464
Total		6411476	102743	100.000	100.000

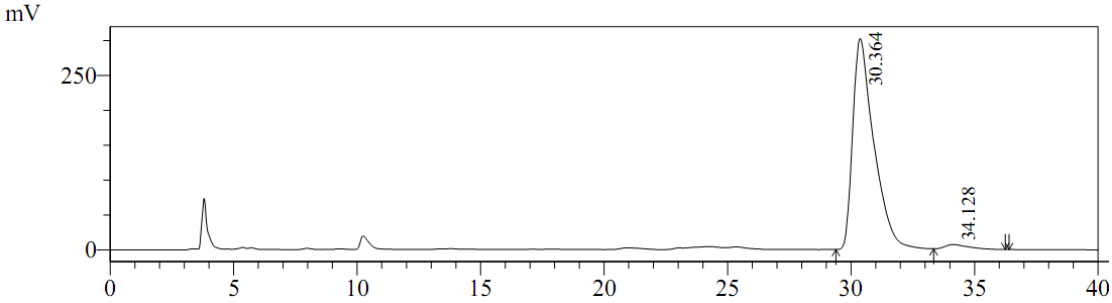
Enantiomeric enriched 3dc

==== Shimadzu LCsolution Analysis Report ====

C:\Users\User\Desktop\LC data\Ren Qiao\rq631.lcd
Acquired by : Admin
Sample Name : RQD244
Sample ID : RQ
Data File Name : rq631.lcd
Method File Name : 10%IPA, 1ml-min, 40min.lcm
Batch File Name :
Report File Name : Default.lcr
Description :IA column ;10%IPA ;1ml/min



Chromatogram
RQD244 C:\Users\User\Desktop\LC data\Ren Qiao\rq631.lcd



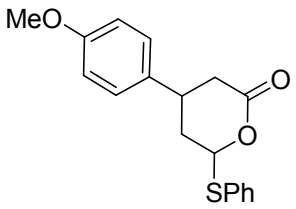
Detector A Ch1 254nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	30.364	18182150	302361	97.820	97.935
2	34.128	405160	6375	2.180	2.065
Total		18587311	308735	100.000	100.000

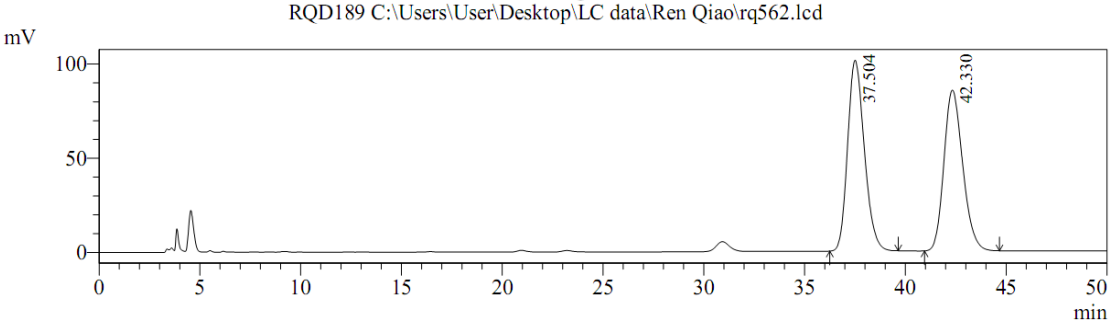
Racemic 3ec

==== Shimadzu LCsolution Analysis Report ====

C:\Users\User\Desktop\LC data\Ren Qiao\rq562.lcd
Acquired by : Admin
Sample Name : RQD189
Sample ID : RQ
Data File Name : rq562.lcd
Method File Name : 20%IPA, 1ml-min, 60min.lcm
Batch File Name :
Report File Name : Default.lcr
Description :IC column ;20%IPA ;1ml/min



Chromatogram
RQD189 C:\Users\User\Desktop\LC data\Ren Qiao\rq562.lcd



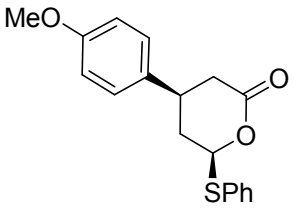
Detector A Ch1 254nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	37.504	5838647	101256	51.328	54.254
2	42.330	5536554	85378	48.672	45.746
Total		11375202	186634	100.000	100.000

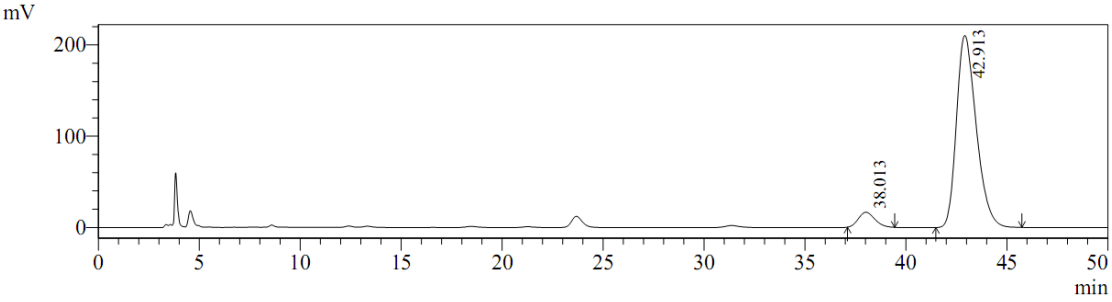
Enantiomeric enriched 3ec

==== Shimadzu LCsolution Analysis Report ====

C:\Users\User\Desktop\LC data\Ren Qiao\rq609.lcd
Acquired by : Admin
Sample Name : RQD229
Sample ID : RQ
Data File Name : rq609.lcd
Method File Name : 20%IPA, 1ml-min, 60min.lcm
Batch File Name :
Report File Name : Default.lcr
Description :IC column ;20%IPA ;1ml/min



Chromatogram
RQD229 C:\Users\User\Desktop\LC data\Ren Qiao\rq609.lcd



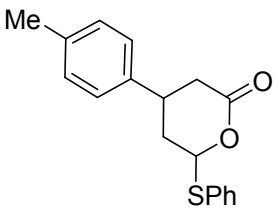
Detector A Ch1 254nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	38.013	926540	16419	6.075	7.233
2	42.913	14323915	210569	93.925	92.767
Total		15250455	226989	100.000	100.000

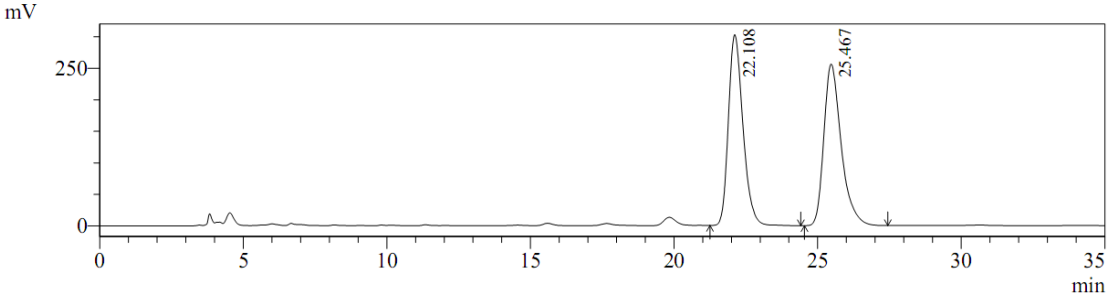
Racemic 3fc

==== Shimadzu LCsolution Analysis Report ====

C:\Users\User\Desktop\LC data\Ren Qiao\rq611.lcd
Acquired by : Admin
Sample Name : RQD226
Sample ID : RQ
Data File Name : rq611.lcd
Method File Name : 20%IPA, 1ml-min, 60min.lcm
Batch File Name :
Report File Name : Default.lcr
Description :IC column ;20%IPA ;1ml/min



Chromatogram
RQD226 C:\Users\User\Desktop\LC data\Ren Qiao\rq611.lcd



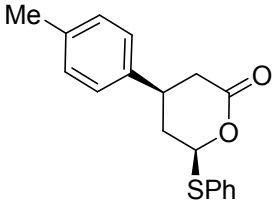
Detector A Ch1 254nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	22.108	10637781	302769	49.696	54.152
2	25.467	10767997	256339	50.304	45.848
Total		21405778	559109	100.000	100.000

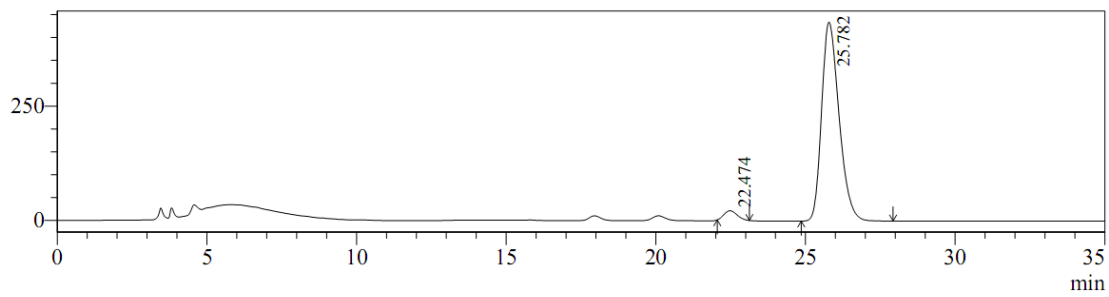
Enantiomeric enriched 3fc

==== Shimadzu LCsolution Analysis Report ====

C:\Users\User\Desktop\LC data\Ren Qiao\rq617.lcd
Acquired by : Admin
Sample Name : RQD233
Sample ID : RQ
Data File Name : rq617.lcd
Method File Name : 20%IPA, 1ml-min, 60min.lcm
Batch File Name :
Report File Name : Default.lcr
Description :IC column ;20%IPA ;1ml/min



Chromatogram
RQD233 C:\Users\User\Desktop\LC data\Ren Qiao\rq617.lcd



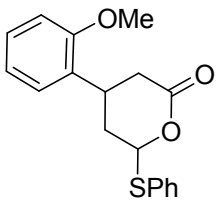
Detector A Ch1 254nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	22.474	624113	20526	3.423	4.507
2	25.782	17609350	434892	96.577	95.493
Total		18233463	455418	100.000	100.000

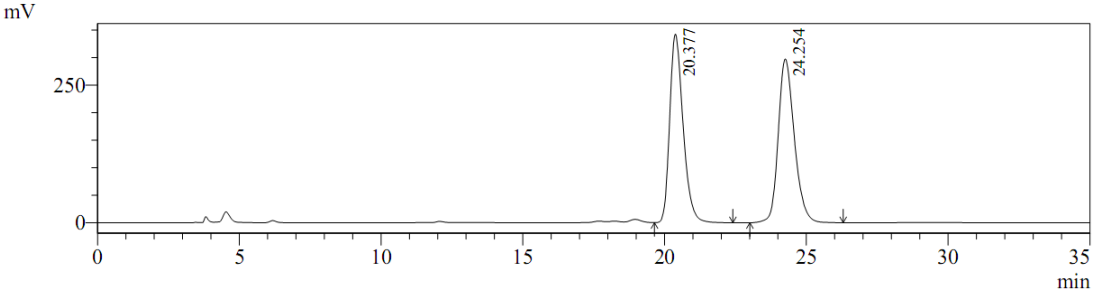
Racemic 3gc

==== Shimadzu LCsolution Analysis Report ====

C:\Users\User\Desktop\LC data\Ren Qiao\rq612.lcd
Acquired by : Admin
Sample Name : RQD227
Sample ID : RQ
Data File Name : rq612.lcd
Method File Name : 20%IPA, 1ml-min, 60min.lcm
Batch File Name :
Report File Name : Default.lcr
Description :IC column ;20%IPA ;1ml/min



Chromatogram
RQD227 C:\Users\User\Desktop\LC data\Ren Qiao\rq612.lcd



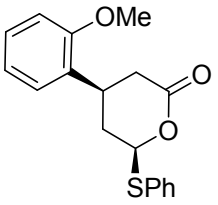
Detector A Ch1 254nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	20.377	11241962	342514	48.986	53.521
2	24.254	11707407	297450	51.014	46.479
Total		22949369	639964	100.000	100.000

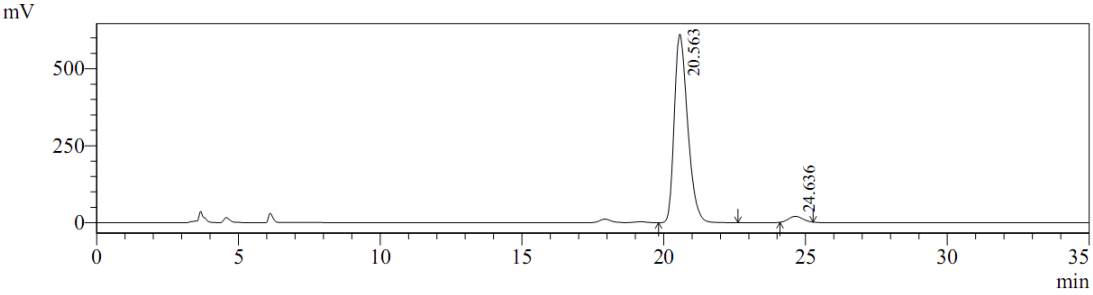
Enantiomeric enriched 3gc

==== Shimadzu LCsolution Analysis Report ====

C:\Users\User\Desktop\LC data\Ren Qiao\rq618.lcd
Acquired by : Admin
Sample Name : RQD234
Sample ID : RQ
Data File Name : rq618.lcd
Method File Name : 20%IPA, 1ml-min, 60min.lcm
Batch File Name :
Report File Name : Default.lcr
Description :IC column ;20%IPA ;1ml/min



Chromatogram
RQD234 C:\Users\User\Desktop\LC data\Ren Qiao\rq618.lcd



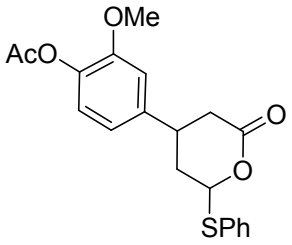
Detector A Ch1 254nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	20.563	20067047	612236	96.845	96.949
2	24.636	653794	19268	3.155	3.051
Total		20720841	631504	100.000	100.000

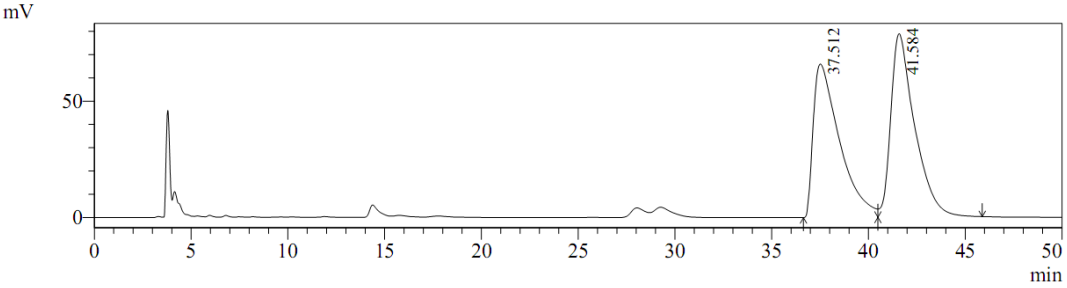
Racemic 3hc

==== Shimadzu LCsolution Analysis Report ====

C:\Users\User\Desktop\LC data\Ren Qiao\rq644.lcd
Acquired by : Admin
Sample Name : RQD259
Sample ID : RQ
Data File Name : rq644.lcd
Method File Name : 10%IPA, 1ml-min, 40min.lcm
Batch File Name :
Report File Name : Default.lcr
Description :la column ;10%IPA ;1ml/min



Chromatogram
RQD259 C:\Users\User\Desktop\LC data\Ren Qiao\rq644.lcd



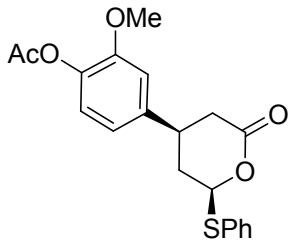
Detector A Ch1 254nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	37.512	6206159	65957	47.896	45.568
2	41.584	6751432	78786	52.104	54.432
Total		12957592	144743	100.000	100.000

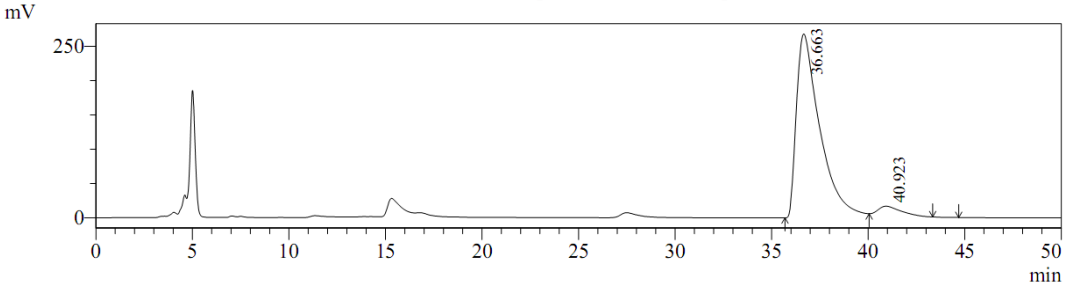
Enantiomeric enriched 3hc

==== Shimadzu LCsolution Analysis Report ====

C:\Users\User\Desktop\LC data\Ren Qiao\rq646.lcd
Acquired by : Admin
Sample Name : RQD260
Sample ID : RQ
Data File Name : rq646.lcd
Method File Name : 10%IPA, 1ml-min, 40min.lcm
Batch File Name :
Report File Name : Default.lcr
Description :la column ;10%IPA ;1ml/min



Chromatogram
RQD260 C:\Users\User\Desktop\LC data\Ren Qiao\rq646.lcd



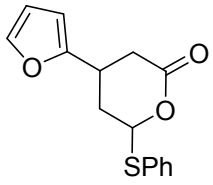
Detector A Ch1 254nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	36.663	23362226	268178	96.062	95.617
2	40.923	957630	12292	3.938	4.383
Total		24319856	280470	100.000	100.000

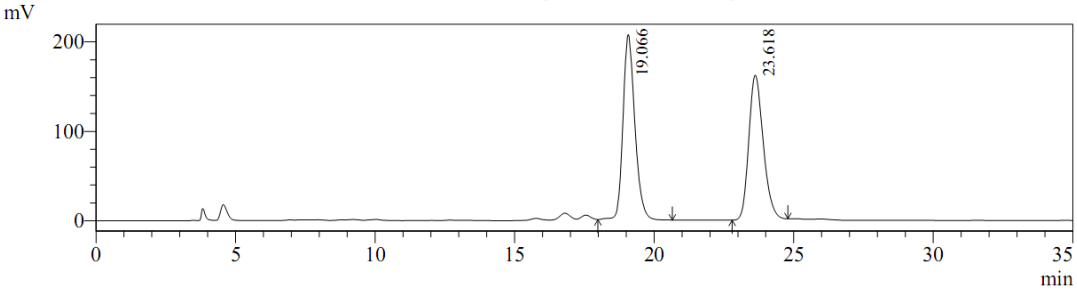
Racemic 3ic

==== Shimadzu LCsolution Analysis Report ====

C:\Users\User\Desktop\LC data\Ren Qiao\rq615.lcd
Acquired by : Admin
Sample Name : RQD231
Sample ID : RQ
Data File Name : rq615.lcd
Method File Name : 20%IPA, 1ml-min, 60min.lcm
Batch File Name :
Report File Name : Default.lcr
Description :IC column ;20%IPA ;1ml/min



Chromatogram
RQD231 C:\Users\User\Desktop\LC data\Ren Qiao\rq615.lcd



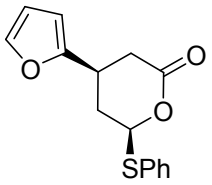
Detector A Ch1 254nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	19.066	6118370	207003	51.335	56.172
2	23.618	5800037	161515	48.665	43.828
Total		11918408	368517	100.000	100.000

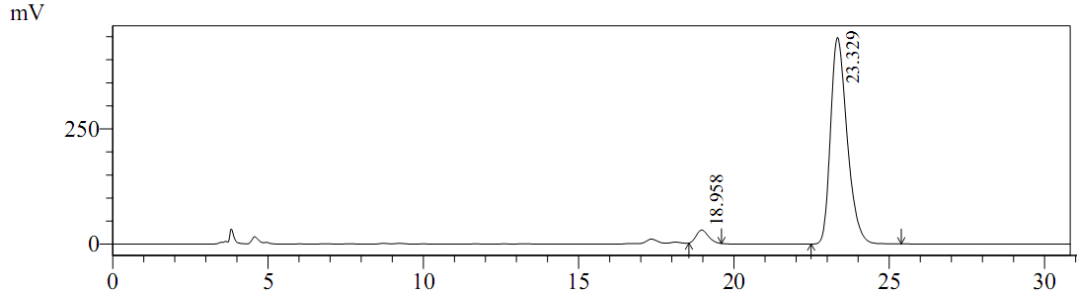
Enantiomeric enriched 3ic

==== Shimadzu LCsolution Analysis Report ====

C:\Users\User\Desktop\LC data\Ren Qiao\rq625.lcd
Acquired by : Admin
Sample Name : RQD246
Sample ID : RQ
Data File Name : rq625.lcd
Method File Name : 20%IPA, 1ml-min, 60min.lcm
Batch File Name :
Report File Name : Default.lcr
Description :IC column ;20%IPA ;1ml/min



Chromatogram
RQD246 C:\Users\User\Desktop\LC data\Ren Qiao\rq625.lcd



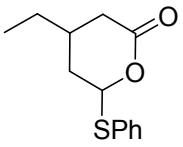
Detector A Ch1 254nm

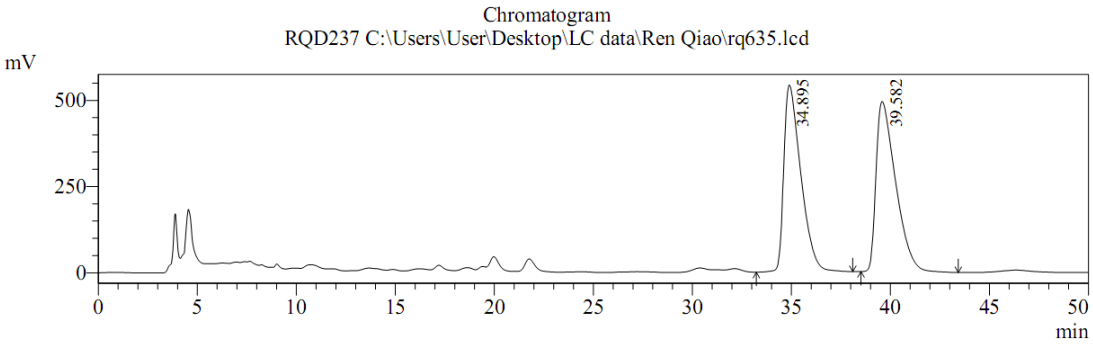
Peak#	Ret. Time	Area	Height	Area %	Height %
1	18.958	771693	28567	4.441	5.990
2	23.329	16604305	448316	95.559	94.010
Total		17375998	476883	100.000	100.000

Racemic 3jc

==== Shimadzu LCsolution Analysis Report ====

C:\Users\User\Desktop\LC data\Ren Qiao\rq635.lcd
Acquired by : Admin
Sample Name : RQD237
Sample ID : RQ
Data File Name : rq635.lcd
Method File Name : 10%IPA, 1ml-min, 40min.lcm
Batch File Name :
Report File Name : Default.lcr
Description :IC column ;10%IPA ;1ml/min





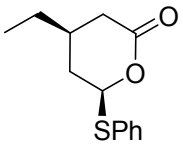
Detector A Ch1 254nm

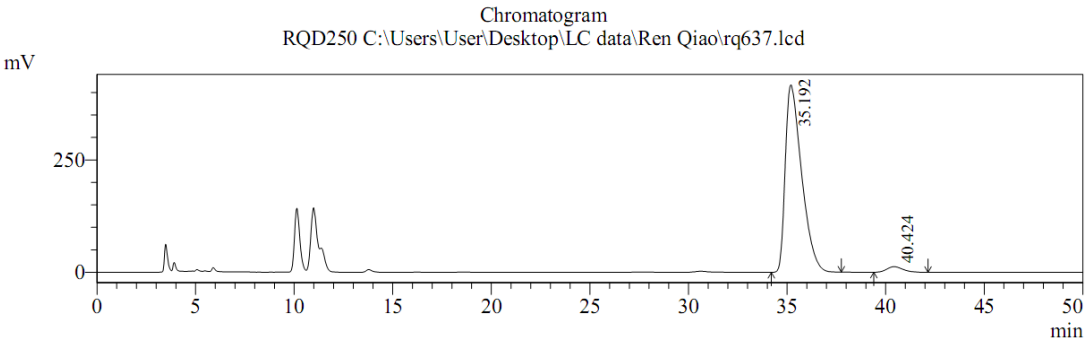
Peak#	Ret. Time	Area	Height	Area %	Height %
1	34.895	32378652	542495	48.831	52.346
2	39.582	33928905	493863	51.169	47.654
Total		66307557	1036357	100.000	100.000

Enantiomeric enriched 3jc

==== Shimadzu LCsolution Analysis Report ====

C:\Users\User\Desktop\LC data\Ren Qiao\rq637.lcd
Acquired by : Admin
Sample Name : RQD250
Sample ID : RQ
Data File Name : rq637.lcd
Method File Name : 10%IPA, 1ml-min, 40min.lcm
Batch File Name :
Report File Name : Default.lcr
Description :IC column ;10%IPA ;1ml/min





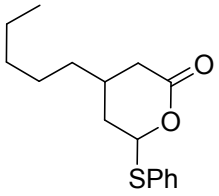
Detector A Ch1 254nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	35.192	23985943	416814	97.144	97.099
2	40.424	705063	12453	2.856	2.901
Total		24691005	429267	100.000	100.000

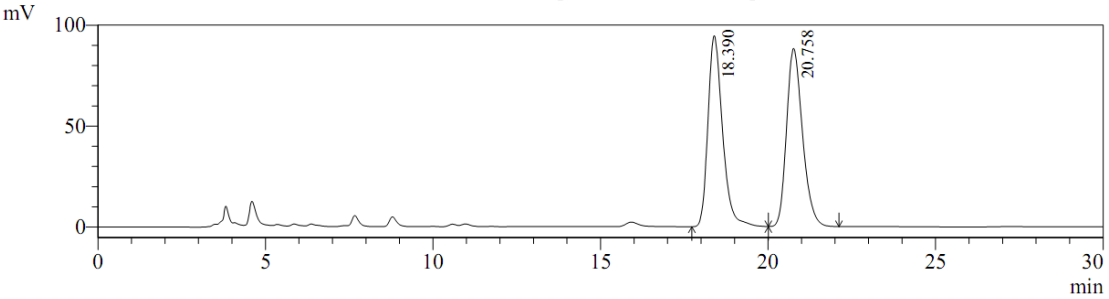
Racemic 3kc

==== Shimadzu LCsolution Analysis Report ====

C:\Users\User\Desktop\LC data\Ren Qiao\rq624.lcd
Acquired by : Admin
Sample Name : RQD239
Sample ID : RQ
Data File Name : rq624.lcd
Method File Name : 20%IPA, 1ml-min, 60min.lcm
Batch File Name :
Report File Name : Default.lcr
Description :IC column ;20%IPA ;1ml/min



Chromatogram
RQD239 C:\Users\User\Desktop\LC data\Ren Qiao\rq624.lcd



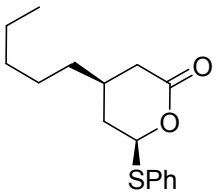
Detector A Ch1 254nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	18.390	2859785	94585	49.460	51.736
2	20.758	2922266	88237	50.540	48.264
Total		5782051	182822	100.000	100.000

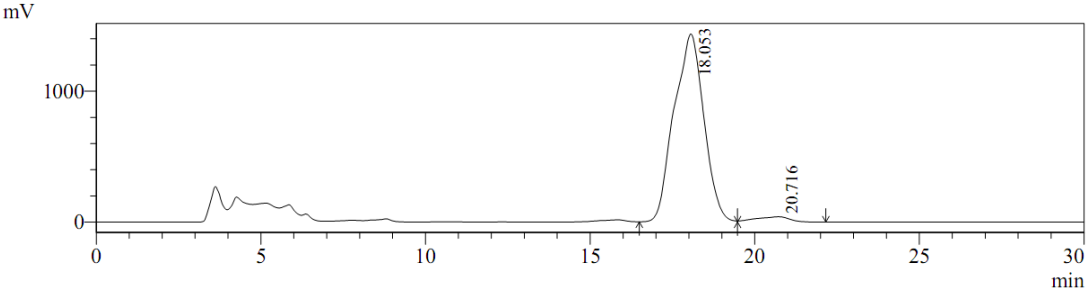
Enantiomeric enriched 3kc

==== Shimadzu LCsolution Analysis Report ====

C:\Users\User\Desktop\LC data\Ren Qiao\rq626.lcd
Acquired by : Admin
Sample Name : RQD248
Sample ID : RQ
Data File Name : rq626.lcd
Method File Name : 20%IPA, 1ml-min, 60min.lcm
Batch File Name :
Report File Name : Default.lcr
Description :IC column ;20%IPA ;1ml/min



Chromatogram
RQD248 C:\Users\User\Desktop\LC data\Ren Qiao\rq626.lcd



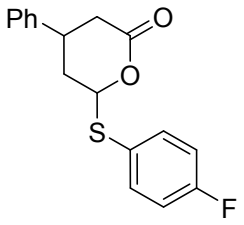
Detector A Ch1 254nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	18.053	90445869	1435152	96.960	97.271
2	20.716	2835578	40270	3.040	2.729
Total		93281446	1475421	100.000	100.000

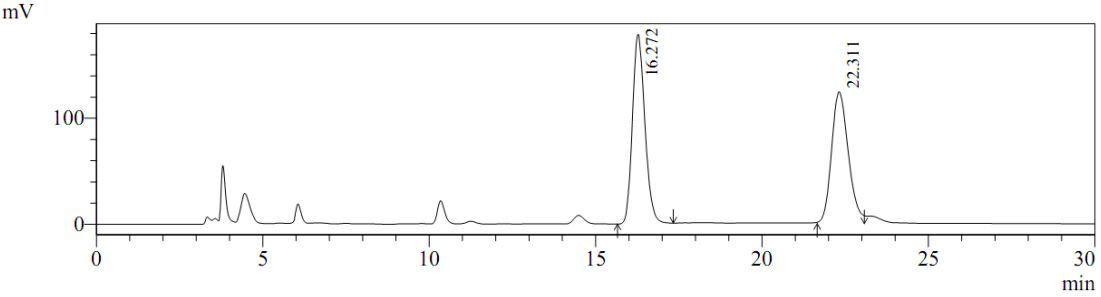
Racemic 3ad

==== Shimadzu LCsolution Analysis Report ====

C:\Users\User\Desktop\LC data\Ren Qiao\rq576.lcd
Acquired by : Admin
Sample Name : RQD197
Sample ID : RQ
Data File Name : rq576.lcd
Method File Name : 20%IPA, 1ml-min, 60min.lcm
Batch File Name :
Report File Name : Default.lcr
Description :IC column ;20%IPA ;1ml/min



Chromatogram
RQD197 C:\Users\User\Desktop\LC data\Ren Qiao\rq576.lcd



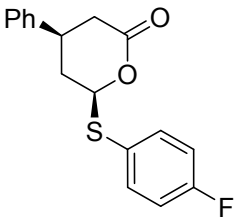
Detector A Ch1 254nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	16.272	4630889	178695	51.427	58.966
2	22.311	4373877	124353	48.573	41.034
Total		9004766	303048	100.000	100.000

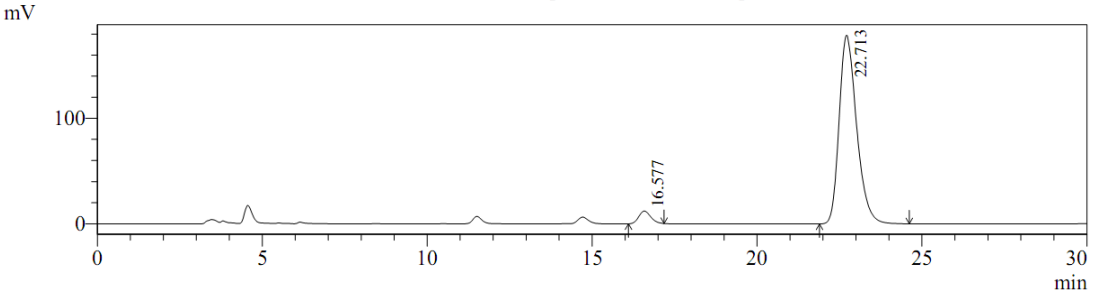
Enantiomeric enriched 3ad

==== Shimadzu LCsolution Analysis Report ====

C:\Users\User\Desktop\LC data\Ren Qiao\rq596.lcd
Acquired by : Admin
Sample Name : RQD213
Sample ID : RQ
Data File Name : rq596.lcd
Method File Name : 20%IPA, 1ml-min, 60min.lcm
Batch File Name :
Report File Name : Default.lcr
Description :IC column ;20%IPA ;1ml/min



Chromatogram
RQD213 C:\Users\User\Desktop\LC data\Ren Qiao\rq596.lcd



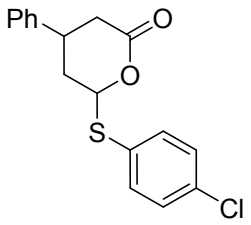
Detector A Ch1 254nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	16.577	301209	12005	4.368	6.287
2	22.713	6594935	178957	95.632	93.713
Total		6896144	190963	100.000	100.000

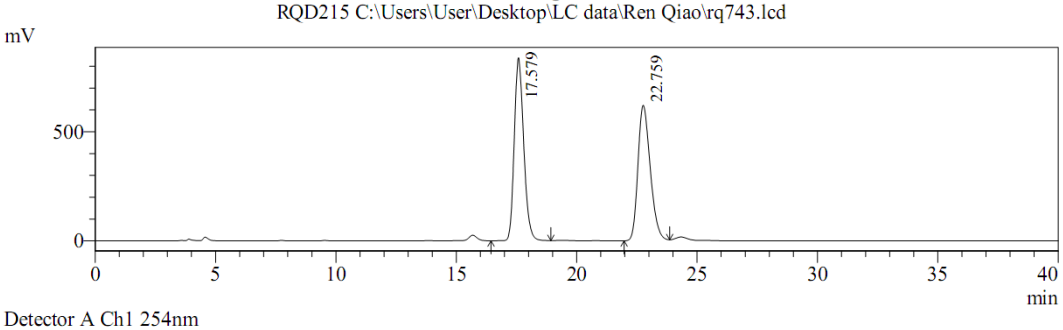
Racemic 3ae

==== Shimadzu LCsolution Analysis Report ====

C:\Users\User\Desktop\LC data\Ren Qiao\rq743.lcd
Acquired by : Admin
Sample Name : RQD215
Sample ID : RQ
Data File Name : rq743.lcd
Method File Name : 20%IPA, 1ml-min, 60min.lcm
Batch File Name :
Report File Name : Default.lcr
Description :IC column ;20%IPA ;1ml/min



Chromatogram
RQD215 C:\Users\User\Desktop\LC data\Ren Qiao\rq743.lcd



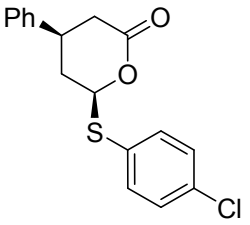
Detector A Ch1 254nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	17.579	22830209	838955	51.070	57.543
2	22.759	21873188	619012	48.930	42.457
Total		44703397	1457967	100.000	100.000

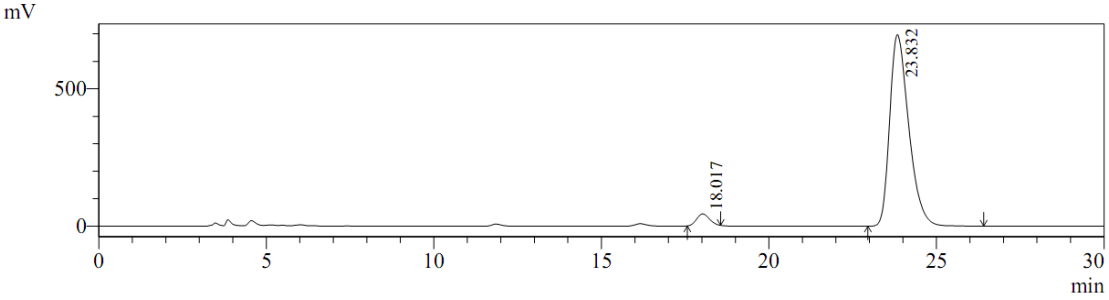
Enantiomeric enriched 3ae

==== Shimadzu LCsolution Analysis Report ====

C:\Users\User\Desktop\LC data\Ren Qiao\rq601.lcd
Acquired by : Admin
Sample Name : RQD217
Sample ID : RQ
Data File Name : rq601.lcd
Method File Name : 20%IPA, 1ml-min, 60min.lcm
Batch File Name :
Report File Name : Default.lcr
Description :IC column ;20%IPA ;1ml/min



Chromatogram
RQD217 C:\Users\User\Desktop\LC data\Ren Qiao\rq601.lcd



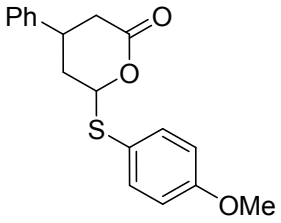
Detector A Ch1 254nm

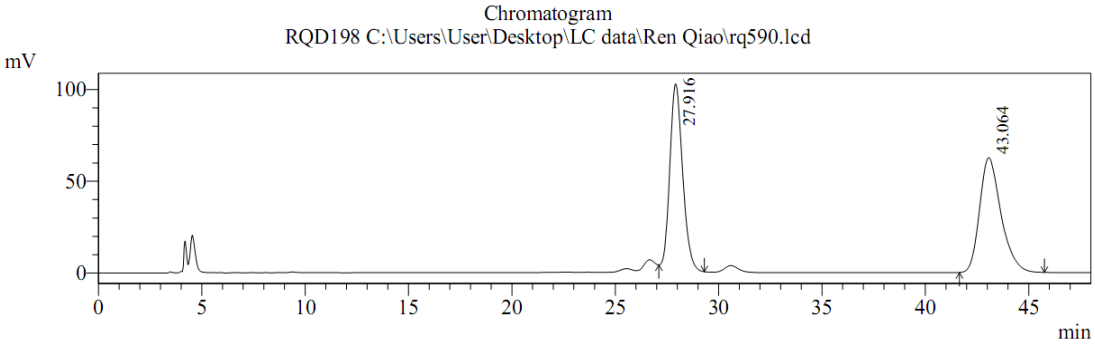
Peak#	Ret. Time	Area	Height	Area %	Height %
1	18.017	1135894	43070	3.957	5.818
2	23.832	27566808	697248	96.043	94.182
Total		28702702	740318	100.000	100.000

Racemic 3af

==== Shimadzu LCsolution Analysis Report ====

C:\Users\User\Desktop\LC data\Ren Qiao\rq590.lcd
Acquired by : Admin
Sample Name : RQD198
Sample ID : RQ
Data File Name : rq590.lcd
Method File Name : 20%IPA, 1ml-min, 60min.lcm
Batch File Name :
Report File Name : Default.lcr
Description :IC column ;20%IPA ;1ml/min





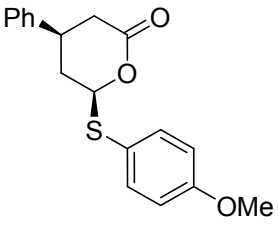
Detector A Ch1 254nm

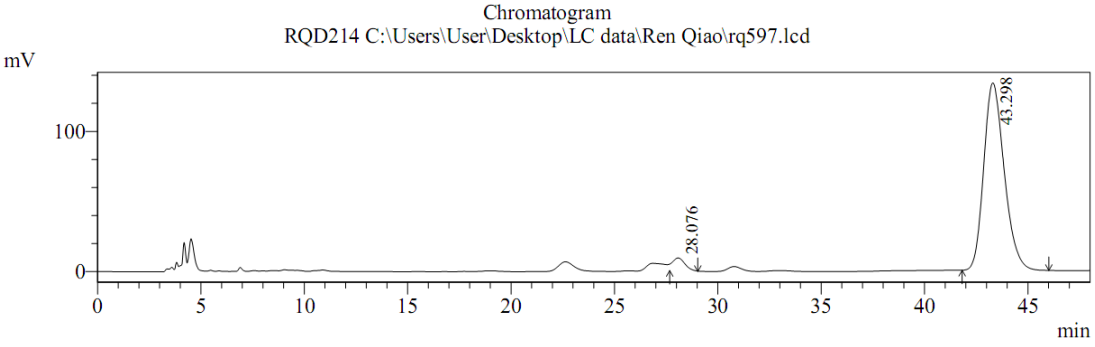
Peak#	Ret. Time	Area	Height	Area %	Height %
1	27.916	4224521	99983	48.393	61.528
2	43.064	4505142	62517	51.607	38.472
Total		8729663	162500	100.000	100.000

Enantiomeric enriched 3af

==== Shimadzu LCsolution Analysis Report ====

C:\Users\User\Desktop\LC data\Ren Qiao\rq597.lcd
Acquired by : Admin
Sample Name : RQD214
Sample ID : RQ
Data File Name : rq597.lcd
Method File Name : 20%IPA, 1ml-min, 60min.lcm
Batch File Name :
Report File Name : Default.lcr
Description :IC column ;20%IPA ;1ml/min





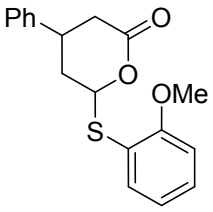
Detector A Ch1 254nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	28.076	392577	9216	4.082	6.449
2	43.298	9225059	133679	95.918	93.551
Total		9617636	142895	100.000	100.000

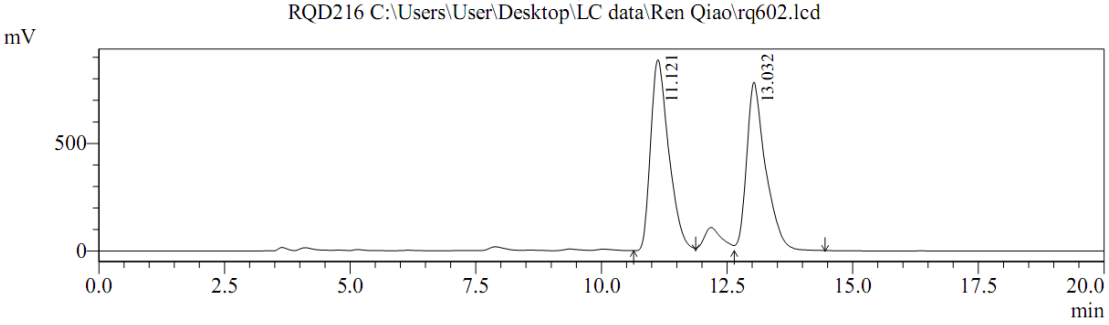
Racemic 3ag

==== Shimadzu LCsolution Analysis Report ====

C:\Users\User\Desktop\LC data\Ren Qiao\rq602.lcd
Acquired by : Admin
Sample Name : RQD216
Sample ID : RQ
Data File Name : rq602.lcd
Method File Name : 20%IPA, 1ml-min, 60min.lcm
Batch File Name :
Report File Name : Default.lcr
Description :IA column ;20%IPA ;1ml/min



Chromatogram
RQD216 C:\Users\User\Desktop\LC data\Ren Qiao\rq602.lcd



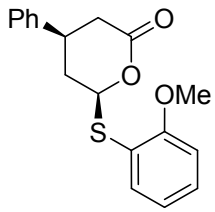
Detector A Ch1 254nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	11.121	22384221	887664	51.888	53.124
2	13.032	20755478	783270	48.112	46.876
Total		43139698	1670934	100.000	100.000

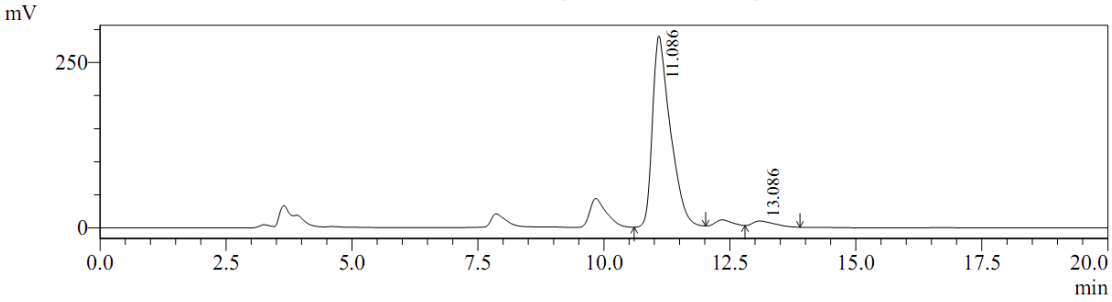
Enantiomeric enriched 3ag

==== Shimadzu LCsolution Analysis Report ====

C:\Users\User\Desktop\LC data\Ren Qiao\rq603.lcd
Acquired by : Admin
Sample Name : RQD218
Sample ID : RQ
Data File Name : rq603.lcd
Method File Name : 20%IPA, 1ml-min, 60min.lcm
Batch File Name :
Report File Name : Default.lcr
Description :IA column ;20%IPA ;1ml/min



Chromatogram
RQD218 C:\Users\User\Desktop\LC data\Ren Qiao\rq603.lcd



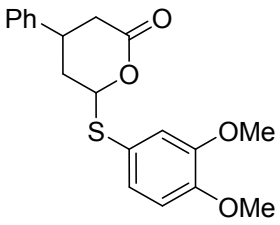
Detector A Ch1 254nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	11.086	7098812	288673	97.104	97.392
2	13.086	211710	7731	2.896	2.608
Total		7310521	296404	100.000	100.000

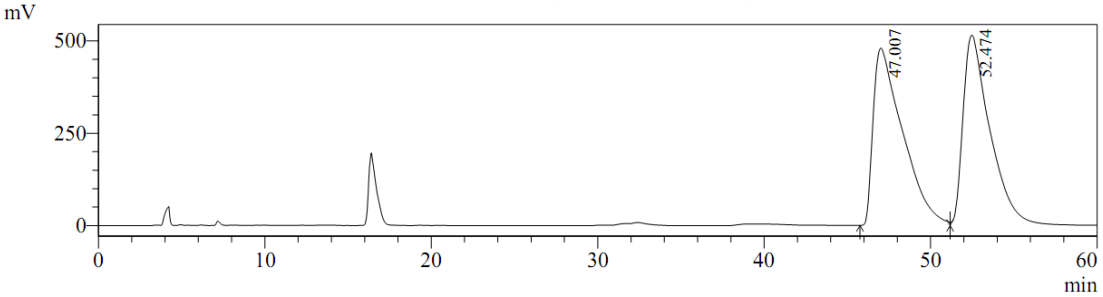
Racemic 3ah

==== Shimadzu LCsolution Analysis Report ====

C:\Users\User\Desktop\LC data\Ren Qiao\rq606.lcd
Acquired by : Admin
Sample Name : RQD220
Sample ID : RQ
Data File Name : rq606.lcd
Method File Name : 5%IPA, 1ml-min, 60min.lcm
Batch File Name :
Report File Name : Default.lcr
Description :IA column ;5%IPA ;1ml/min



Chromatogram
RQD220 C:\Users\User\Desktop\LC data\Ren Qiao\rq606.lcd



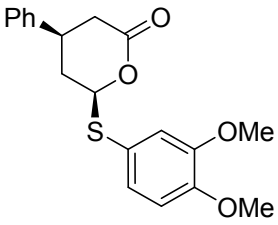
Detector A Ch1 254nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	47.007	59266757	479863	50.548	48.225
2	52.474	57980817	515184	49.452	51.775
Total		117247574	995047	100.000	100.000

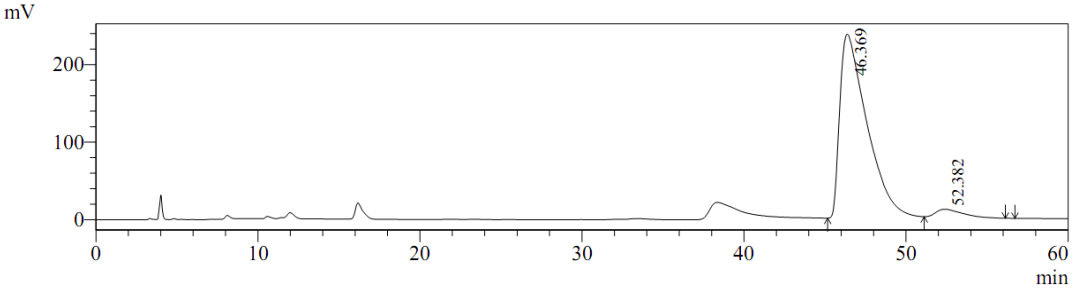
Enantiomeric enriched 3ah

==== Shimadzu LCsolution Analysis Report ====

C:\Users\User\Desktop\LC data\Ren Qiao\rq608.lcd
Acquired by : Admin
Sample Name : RQD222
Sample ID : RQ
Data File Name : rq608.lcd
Method File Name : 5%IPA, 1ml-min, 60min.lcm
Batch File Name :
Report File Name : Default.lcr
Description :IA column ;5%IPA ;1ml/min



Chromatogram
RQD222 C:\Users\User\Desktop\LC data\Ren Qiao\rq608.lcd



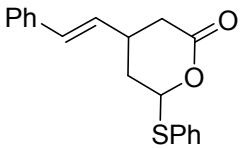
Detector A Ch1 254nm

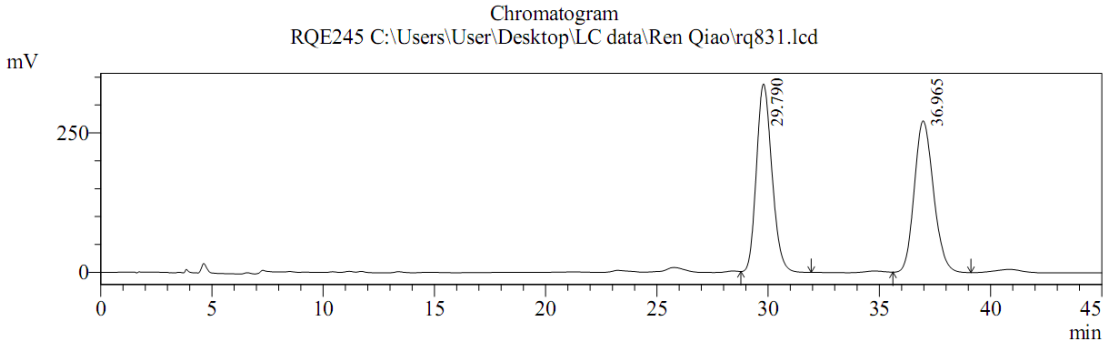
Peak#	Ret. Time	Area	Height	Area %	Height %
1	46.369	28065007	237134	96.206	95.909
2	52.382	1106878	10116	3.794	4.091
Total		29171885	247250	100.000	100.000

Racemic 3lc

==== Shimadzu LCsolution Analysis Report ====

C:\Users\User\Desktop\LC data\Ren Qiao\rq831.lcd
Acquired by : Admin
Sample Name : RQE245
Sample ID : RQ
Data File Name : rq831.lcd
Method File Name : 20%IPA, 1ml-min, 60min.lcm
Batch File Name :
Report File Name : Default.lcr
Description :IC column with IC guard column ;20%IPA ;1 ml/min





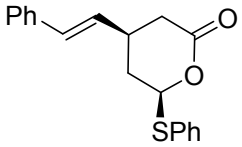
Detector A Ch1 254nm

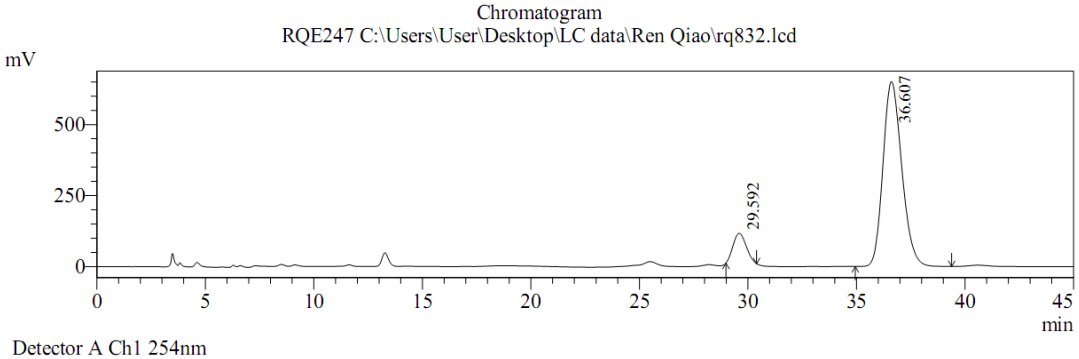
Peak#	Ret. Time	Area	Height	Area %	Height %
1	29.790	16257114	336926	49.968	55.364
2	36.965	16278012	271643	50.032	44.636
Total		32535126	608569	100.000	100.000

Enantiomeric enriched 3lc

==== Shimadzu LCsolution Analysis Report ====

C:\Users\User\Desktop\LC data\Ren Qiao\rq832.lcd
Acquired by : Admin
Sample Name : RQE247
Sample ID : RQ
Data File Name : rq832.lcd
Method File Name : 20%IPA, 1ml-min, 60min.lcm
Batch File Name :
Report File Name : Default.lcr
Description :IC column with IC guard column ;20%IPA ;1 ml/min





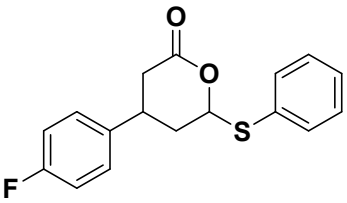
Detector A Ch1 254nm

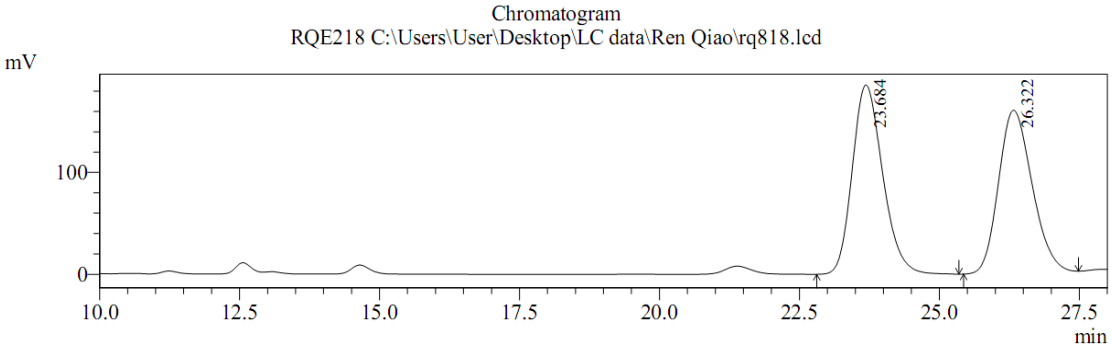
Peak#	Ret. Time	Area	Height	Area %	Height %
1	29.592	4457856	105749	10.216	13.976
2	36.607	39179395	650924	89.784	86.024
Total		43637250	756674	100.000	100.000

Racemic 3mc

==== Shimadzu LCsolution Analysis Report ====

C:\Users\User\Desktop\LC data\Ren Qiao\rq818.lcd
Acquired by : Admin
Sample Name : RQE218
Sample ID : RQ
Data File Name : rq818.lcd
Method File Name : 20%IPA, 1ml-min, 60min.lcm
Batch File Name :
Report File Name : Default.lcr
Description :IC column with IC guard column ;20%IPA ;1.0 ml/min





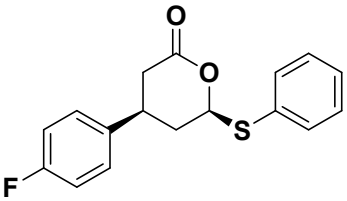
Detector A Ch1 254nm

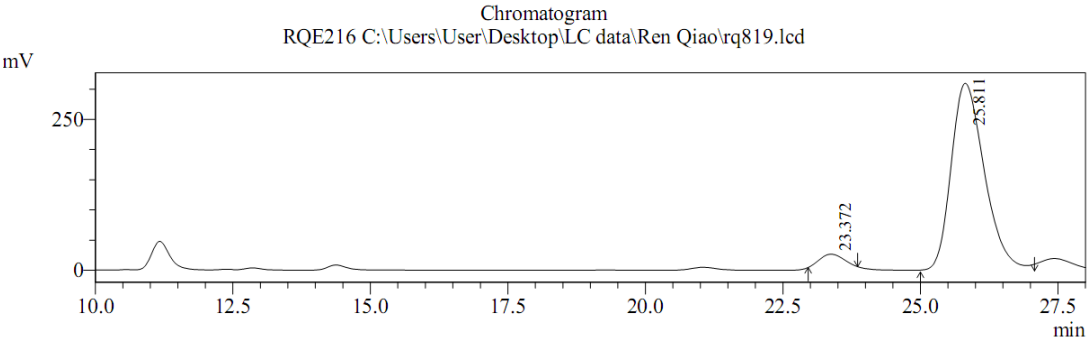
Peak#	Ret. Time	Area	Height	Area %	Height %
1	23.684	7026566	185963	51.415	53.779
2	26.322	6639880	159827	48.585	46.221
Total		13666446	345790	100.000	100.000

Enantiomeric enriched 3mc

==== Shimadzu LCsolution Analysis Report ====

C:\Users\User\Desktop\LC data\Ren Qiao\rq819.lcd
Acquired by : Admin
Sample Name : RQE216
Sample ID : RQ
Data File Name : rq819.lcd
Method File Name : 20%IPA, 1ml-min, 60min.lcm
Batch File Name :
Report File Name : Default.lcr
Description :IC column with IC guard column ;20%IPA ;1.0 ml/min





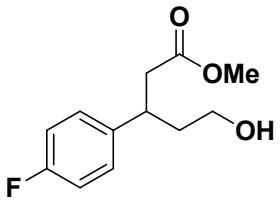
Detector A Ch1 254nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	23.372	639316	21563	4.590	6.471
2	25.811	13290067	311654	95.410	93.529
Total		13929383	333216	100.000	100.000

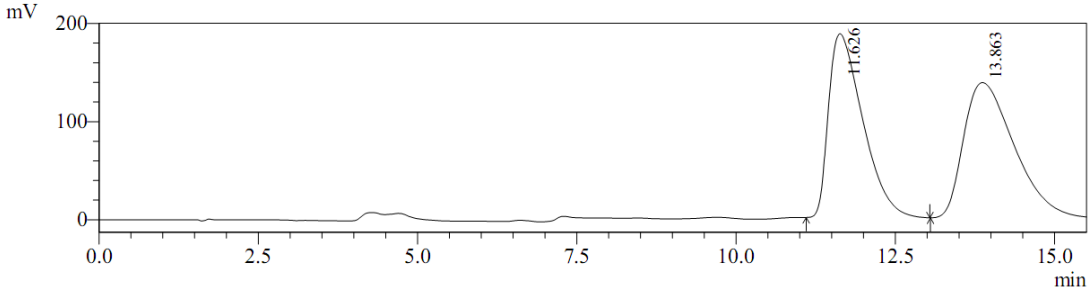
Racemic 6

==== Shimadzu LCsolution Analysis Report ====

C:\Users\User\Desktop\LC data\Ren Qiao\rq823.lcd
Acquired by : Admin
Sample Name : RQE220
Sample ID : RQ
Data File Name : rq823.lcd
Method File Name : 10%IPA, 0.8ml-min, 60min.lcm
Batch File Name :
Report File Name : Default.lcr
Description :OB column with IC guard column ;10%IPA ;0.8 ml/min



Chromatogram
RQE220 C:\Users\User\Desktop\LC data\Ren Qiao\rq823.lcd



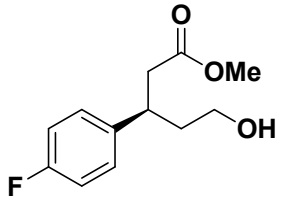
Detector A Ch1 254nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	11.626	7002163	187405	48.057	57.625
2	13.863	7568298	137812	51.943	42.375
Total		14570461	325217	100.000	100.000

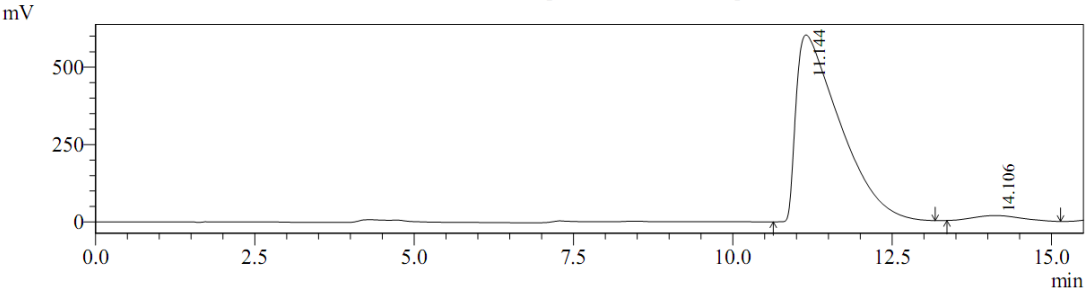
Enantiomeric enriched 18

==== Shimadzu LCsolution Analysis Report ====

C:\Users\User\Desktop\LC data\Ren Qiao\rq824.lcd
Acquired by : Admin
Sample Name : RQE222
Sample ID : RQ
Data File Name : rq824.lcd
Method File Name : 10%IPA, 0.8ml-min, 60min.lcm
Batch File Name :
Report File Name : Default.lcr
Description :OB column with IC guard column ;10%IPA ;0.8 ml/min



Chromatogram
RQE222 C:\Users\User\Desktop\LC data\Ren Qiao\rq824.lcd



Detector A Ch1 254nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	11.144	28971570	602648	97.036	97.183
2	14.106	885070	17468	2.964	2.817
Total		29856640	620116	100.000	100.000