

## Supporting Information

### **Total Synthesis of (–)-Spinosyn A via Carbonylative Macrolactonization**

Yu Bai, Xingyu Shen, Yong Li, and Mingji Dai\*

Department of Chemistry and Center for Cancer Research,  
Purdue University, West Lafayette, IN 47907 (USA)

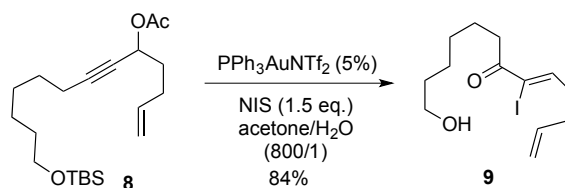
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## Part 1. Experimental Procedures and Analytical Data

**General Methods.** NMR spectra were recorded on ( $^1\text{H}$  at 400 MHz, 500 MHz, 800 MHz and  $^{13}\text{C}$  at 100 MHz, 125 MHz, 200 MHz) Bruker spectrometers. Chemical shifts ( $\delta$ ) were given in ppm with reference to solvent signals [ $^1\text{H}$  NMR:  $\text{CHCl}_3$  (7.26),  $\text{CD}_3\text{OD}$  (3.31);  $^{13}\text{C}$  NMR:  $\text{CDCl}_3$  (77.0)]. Column chromatography was performed on silica gel. All reactions sensitive to air or moisture were conducted under argon or nitrogen atmosphere in dry and freshly distilled solvents, unless otherwise noted. Anhydrous THF, toluene and benzene were distilled over sodium benzophenone ketyl under argon. Anhydrous  $\text{CH}_2\text{Cl}_2$  and  $\text{CHCl}_3$  was distilled over calcium hydride under argon. Anhydrous MeOH was distilled over magnesium under argon. All other solvents and reagents were used as obtained from commercial sources without further purification.

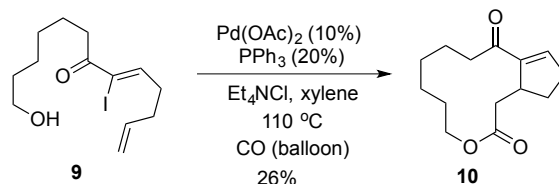
### Experimental Procedures.



To a solution of acetate **8** (300 mg, 0.82 mmol, 1.0 eq.) in 16 mL acetone/ $\text{H}_2\text{O}$  (800/1) was added  $\text{PPh}_3\text{AuNTf}_2$  (32 mg, 0.04 mmol, 0.05 eq.) at  $-15\text{ }^\circ\text{C}$ . The resulting solution was stirred for 5 min before NIS (277 mg, 1.23 mmol, 1.5 eq.) was added. The reaction mixture was stirred for 3 h at the same temperature. Then 0.1 mL  $\text{Et}_3\text{N}$  was added, followed by 5 mL saturated  $\text{Na}_2\text{S}_2\text{O}_3$ . The resulting mixture was extracted with EtOAc for 3 times. The combined organic layers were washed with brine, dried with anhydrous  $\text{Na}_2\text{SO}_4$ , filtered and concentrated to get the crude product, which was purified by column chromatography (EtOAc: Hexane = 1:5 to 1:3) to get product **9** (231 mg, 84%) as a colorless oil.

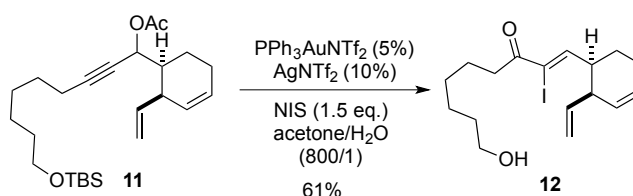
$^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  6.98 (t,  $J$  = 6.7 Hz, 1H), 5.83 (ddt,  $J$  = 16.9, 10.3, 6.5 Hz, 1H), 5.09-5.03 (m, 2H), 3.62 (t,  $J$  = 6.5 Hz, 2H), 2.80 (t,  $J$  = 7.3 Hz, 2H), 2.50 (q,  $J$  = 7.1 Hz, 2H), 2.34 – 2.25 (m, 2H), 1.67 – 1.49 (m, 4H), 1.40 – 1.31 (m, 4H).  $^{13}\text{C}$  NMR (125 MHz,  $\text{CDCl}_3$ )  $\delta$  194.9, 151.0, 136.7, 116.1, 112.7, 62.8, 37.7, 37.0, 32.5, 31.6, 28.9, 25.5, 25.0. IR (neat):

2934, 2862, 1746, 1233, 1099, 1016, 838  $\text{cm}^{-1}$ . HRMS (ESI), calcd for  $\text{C}_{13}\text{H}_{22}\text{IO}_2^+$   $[\text{M}+\text{H}]^+$  337.0659, found 337.0657  $\text{m/z}$ .



To a 25 mL flask was added  $\text{Pd}(\text{OAc})_2$  (1.4 mg, 0.006 mmol, 0.1 eq.),  $\text{PPh}_3$  (3.3 mg, 0.013 mmol, 0.2 eq.),  $\text{Et}_4\text{NCl}$  (30 mg, 0.18 mmol, 3.0 eq.) and 100 mg 4 Å molecular sieves. Then the alcohol (20 mg, 0.02 mmol, 1.0 eq.) dissolved in 6.2 mL xylene was added. The vessel was flushed with CO gas for 5 times. The reaction was heated to 110 °C and stirred for 12 h under a CO gas balloon. The reaction was then cooled down, diluted with toluene, and passed through a pad of celite. The solution was concentrated and purified by column chromatography ( $\text{EtOAc}:\text{Hexane} = 1:50$  to  $1:20$ ) to afford desired product (3.6 mg, 26% yield) as pale yellow liquid.

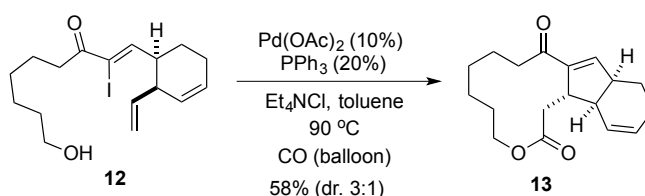
$^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  6.72 – 6.71 (m, 1H), 4.13 (ddd,  $J = 11.0, 8.1, 2.8$  Hz, 1H), 3.93 (ddd,  $J = 10.9, 7.3, 2.7$  Hz, 1H), 3.43 – 3.37 (m, 1H), 3.08 (ddd,  $J = 13.6, 9.1, 3.0$  Hz, 1H), 3.02 (dd,  $J = 13.1, 4.5$  Hz, 1H), 2.68 – 2.60 (m, 1H), 2.48 – 2.42 (m, 1H), 2.31 (dd,  $J = 13.1, 5.0$  Hz, 1H), 2.26 – 2.15 (m, 1H), 2.05 – 1.94 (m, 1H), 1.85 – 1.77 (m, 1H), 1.69 – 1.62 (m, 2H), 1.52 – 1.41 (m, 3H), 1.36 – 1.30 (m, 3H).  $^{13}\text{C}$  NMR (125 MHz,  $\text{CDCl}_3$ )  $\delta$  200.5, 172.8, 146.5, 144.8, 65.9, 41.2, 38.8, 37.5, 32.4, 28.5, 26.0, 25.9, 25.4, 23.9. IR (neat): 2925, 2854, 1728, 1662, 1460, 1438, 1262, 1240, 1061, 999, 948  $\text{cm}^{-1}$ . HRMS (ESI), calcd for  $\text{C}_{14}\text{H}_{21}\text{O}_3^+$   $[\text{M}+\text{H}]^+$  237.1485, found 237.1448  $\text{m/z}$ .



To a solution of **11** (41 mg, 0.098 mmol, 1.0 eq.) in 2 mL acetone/ $\text{H}_2\text{O}$  (800/1) was added  $\text{PPh}_3\text{AuNTf}_2$  (3.9 mg, 0.005 mmol, 0.05 eq.) and  $\text{AgNTf}_2$  (3.8 mg, 0.0098 mmol, 0.1 eq.) at

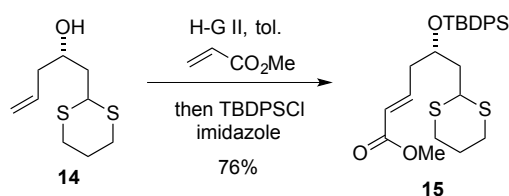
-15 °C. The resulting solution was stirred for 5 min before NIS (33 mg, 0.15 mmol, 1.5 eq.) was added. The reaction mixture was stirred for 3 h at the same temperature. Then 0.1 mL Et<sub>3</sub>N was added, followed by 5 mL saturated Na<sub>2</sub>S<sub>2</sub>O<sub>3</sub>. The resulting mixture was extracted with EtOAc for 3 times. The combined organic layers were washed with brine, dried with anhydrous Na<sub>2</sub>SO<sub>4</sub>, filtered and concentrated to get the crude product, which was purified by column chromatography (EtOAc:Hexane = 1:5 to 1:3) to get the product (23 mg, 61%) as a colorless oil.

<sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>) δ 6.87 (d, *J* = 9.0 Hz, 1H), 5.85 – 5.82 (m, 1H), 5.74 (ddd, *J* = 17.1, 10.2, 7.6 Hz, 1H), 5.64 (ddt, *J* = 10.1, 4.3, 2.1 Hz, 1H), 5.11 (ddd, *J* = 10.2, 1.8, 0.8 Hz, 1H), 5.06 (dt, *J* = 17.1, 1.5 Hz, 1H), 3.63 (t, *J* = 6.6 Hz, 2H), 3.09 – 3.05 (m, 1H), 3.03 – 2.98 (m, 1H), 2.77 (t, *J* = 7.3 Hz, 2H), 2.15 – 2.05 (m, 2H), 1.85 – 1.77 (m, 1H), 1.74 – 1.68 (m, 1H), 1.66 – 1.61 (m, 2H), 1.56 (dq, *J* = 8.0, 6.4 Hz, 2H), 1.44 – 1.29 (m, 5H). <sup>13</sup>C NMR (125 MHz, CDCl<sub>3</sub>) δ 195.1, 153.9, 138.1, 128.1, 127.9, 117.2, 111.7, 63.0, 46.2, 41.6, 37.8, 32.6, 29.1, 25.7, 25.2, 24.0, 23.8. IR (neat): 3400, 2932, 1720, 1352, 1191, 1055 cm<sup>-1</sup>. HRMS (ESI), calcd for C<sub>17</sub>H<sub>26</sub>IO<sub>2</sub><sup>+</sup> [M+H]<sup>+</sup> 389.0972, found 389.0982 m/z.



To a 25 mL flask was added Pd(OAc)<sub>2</sub> (1.2 mg, 0.005 mmol, 0.1 eq.), PPh<sub>3</sub> (3.3 mg, 0.01 mmol, 0.2 eq.), Et<sub>4</sub>NCl (8.5 mg, 0.05 mmol, 1.0 eq.) and 100 mg 4 Å molecular sieves. Then the alcohol (20 mg, 0.05 mmol, 1.0 eq.) dissolved in 5.2 mL toluene was added. The flask was flushed with CO gas for 5 times. The reaction was heated to 90 °C and stirred for 40 h under a CO gas balloon. Then the reaction was cooled down, diluted with toluene, and passed through a pad of celite. The solution was concentrated and the residue was purified by column chromatography (EtOAc:Hexane = 1:20) to afford the major product (6.7 mg, 44%) and minor product (2.3 mg, 14%).

$^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  6.64 (t,  $J = 2.1$  Hz, 1H), 5.81 – 5.73 (m, 2H), 4.14 (ddd,  $J = 10.9, 7.9, 2.6$  Hz, 1H), 3.96 (ddd,  $J = 11.2, 7.5, 2.5$  Hz, 1H), 3.13 – 3.05 (m, 3H), 2.99 (ddt,  $J = 9.9, 4.8, 2.4$  Hz, 1H), 2.75 – 2.70 (m, 1H), 2.44 (dd,  $J = 13.2, 4.9$  Hz, 1H), 2.23 (ddd,  $J = 13.6, 9.5, 3.1$  Hz, 1H), 2.05 – 1.92 (m, 2H), 1.84 – 1.73 (m, 2H), 1.72 – 1.63 (m, 2H), 1.61 – 1.43 (m, 3H), 1.38 – 1.29 (m, 3H).  $^{13}\text{C}$  NMR (125 MHz,  $\text{CDCl}_3$ )  $\delta$  200.9, 172.6, 147.5, 145.4, 128.0, 127.3, 65.9, 47.1, 42.7, 41.5, 38.7, 35.5, 25.8, 25.7, 25.2, 24.8, 23.6, 23.5. IR (neat): 2924, 2860, 1728, 1664, 1450, 1368, 1250, 1159, 1090  $\text{cm}^{-1}$ . HRMS (ESI), calcd for  $\text{C}_{18}\text{H}_{25}\text{O}_3^+ [\text{M}+\text{H}]^+$  289.1798, found 289.1805  $m/z$ .



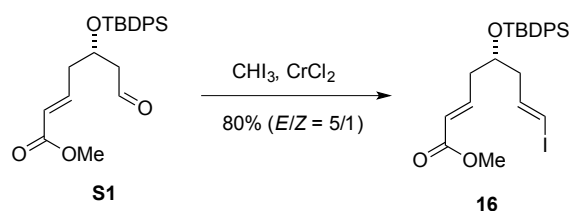
One-pot synthesis of known compound **14**: To a solution of 1,3-dithiane (1.2 g, 10 mmol, 1.0 eq.) in 15 mL THF was added  $n\text{BuLi}$  (4.4 mL, 2.5 M, 11 mmol, 1.1 eq.) at  $-78^\circ\text{C}$ . The resulting solution was stirred at the same temperature for 15 min then raised to  $-20^\circ\text{C}$  for 1 h. The mixture was cooled down to  $-78^\circ\text{C}$  and epichlorohydrin (1.1 mL, 14 mmol, 1.4 eq.) was then added dropwise. The reaction mixture was stirred at  $-78^\circ\text{C}$  for 1 h, then slowly warmed to room temperature and stirred overnight. The reaction mixture was then cooled down to  $-40^\circ\text{C}$  and a solution of  $\text{CuBr}\cdot\text{Me}_2\text{S}$  (124 mg, 0.6 mmol, 0.06 eq.) and vinyl magnesium bromide (40 mL, 0.7 M in THF, 28 mmol, 2.8 eq.) in 20 mL THF was added via cannula at the same temperature. The resulting solution was slowly warmed to room temperature and stirred overnight. Then the reaction was quenched with 0.5 N HCl and extracted with EtOAc for 3 times. The combined organic layers were washed with brine, dried with  $\text{MgSO}_4$ , filtered and concentrated to get the crude product, which was purified by chromatography (EtOAc:Hexane = 1:9 to 1:4) to get **14** (1.29 g, 63% yield).

To a solution of the homoallylic alcohol **14** (50 mg, 0.245 mmol, 1.0 eq.) and methyl acrylate (0.68 mL, 7.46 mmol, 30 eq.) was added 7.7 mL toluene solution of Hoveyda-Grubbs second generation catalyst (7.7 mg, 0.012 mmol, 0.05 eq.) via a syringe



product, which was purified by column chromatography (EtOAc:Hexane = 1:20) to give the product (133 mg, 77%) as colourless oil.

$^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  9.66 (t,  $J$  = 2.1 Hz, 1H), 7.68 – 7.65 (m, 4H), 7.47 – 7.43 (m, 2H), 7.41 – 7.38 (m, 4H), 6.84 (dt,  $J$  = 15.4, 7.5 Hz, 1H), 5.75 (d,  $J$  = 15.7 Hz, 1H), 4.37 – 4.33 (m, 1H), 3.71 (s, 3H), 2.54–2.52 (m, 2H), 2.43 – 2.38 (m, 2H), 1.06 (s, 9H).  $^{13}\text{C}$  NMR (125 MHz,  $\text{CDCl}_3$ )  $\delta$  200.7, 166.3, 143.9, 135.8, 133.2, 133.1, 130.0, 129.9, 127.8, 127.7, 124.0, 67.9, 51.4, 49.9, 39.8, 26.8, 19.2.  $[\alpha]_D^{25} = +158.0^\circ$  ( $c$  1,  $\text{CHCl}_3$ ). IR (neat): 2935, 2858, 1725, 1658, 1430, 1272, 1169, 1108, 1000, 704  $\text{cm}^{-1}$ . HRMS (ESI), calcd for  $\text{C}_{24}\text{H}_{30}\text{NaO}_4\text{Si}^+$   $[\text{M}+\text{Na}]^+$  433.1806, found 433.1804  $m/z$ .

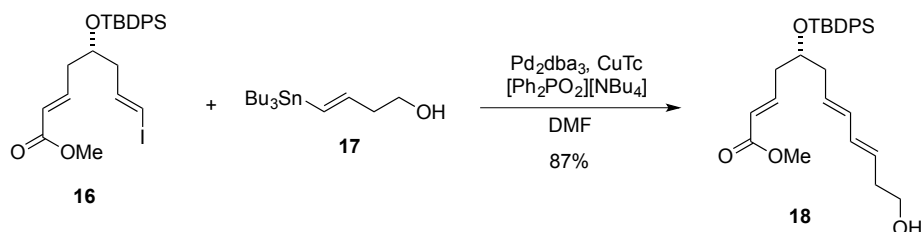


To a solution of the aldehyde (130 mg, 0.32 mmol, 10 eq.) in 5.7 mL THF was added  $\text{CHI}_3$  (250 mg, 0.64 mmol, 2.0 eq.). The resulting solution was bubbled with argon gas for 30 min, then transferred to a flask containing anhydrous  $\text{CrCl}_2$  (390 mg, 3.2 mmol, 10 eq.) via a cannula. The reaction immediately turned to red color. The reaction mixture was stirred at room temperature for 2 h, then poured into a separation funnel containing  $\text{Et}_2\text{O}$  and water. The organic layer was separated and the aqueous layer was extracted with  $\text{Et}_2\text{O}$  for three times. The organic layers were combined, washed with brine, dried with anhydrous  $\text{Na}_2\text{SO}_4$ , filtered and concentrated to get the crude product, which was purified by column chromatography (EtOAc:Hexane = 1:50) to give the product (136 mg, 80%,  $E:Z$  = 5:1) as colorless oil.

$^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.68 – 7.65 (m, 4H), 7.45 – 7.43 (m, 2H), 7.40 – 7.37 (m, 4H), 6.85 (dt,  $J$  = 15.3, 7.4 Hz, 1H), 6.40 (dt,  $J$  = 14.8, 7.5 Hz, 1H), 5.97 – 5.94 (m, 1H), 5.74 (d,  $J$  = 15.6 Hz, 1H), 3.89 – 3.85 (m, 1H), 3.72 (s, 3H), 2.35 – 2.27 (m, 2H), 2.18 – 2.14 (m, 2H), 1.07 (s, 9H).  $^{13}\text{C}$  NMR (125 MHz,  $\text{CDCl}_3$ )  $\delta$  166.6, 144.8, 142.0, 135.9, 133.6, 129.9, 127.8, 127.7, 123.5, 77.6, 70.8, 51.5, 42.8, 39.1, 27.0, 19.3.  $[\alpha]_D^{25} = -13.6^\circ$  ( $c$  0.5,  $\text{CHCl}_3$ ). IR (neat):

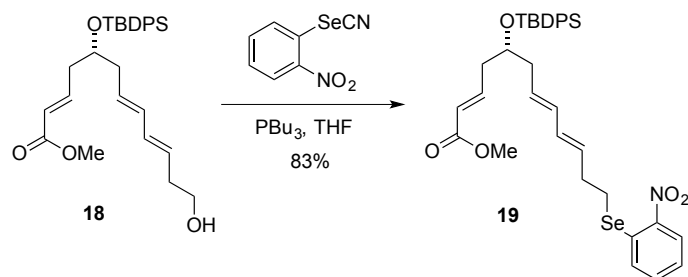


2930, 2858, 1725, 1430, 1270, 1173, 1106, 703  $\text{cm}^{-1}$ . HRMS (ESI), calcd for  $\text{C}_{25}\text{H}_{31}\text{INaO}_3\text{Si}^+$   $[\text{M}+\text{Na}]^+$  557.0979, found 557.0985 m/z.



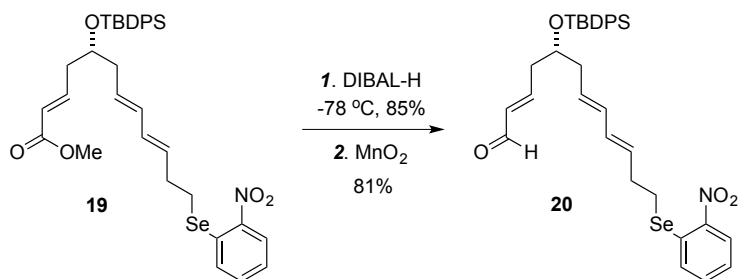
In an Schlenk tube was added  $[\text{Ph}_2\text{PO}_2][\text{NBu}_4]$  (86 mg, 0.264 mmol, 1.6 eq.). The flask was flame dried under vacuum. After the flask cooled to room temperature, the vinyl iodide (86 mg, 0.16 mmol, 1.0 eq.) and the vinyl stannane (84 mg, 0.232 mmol, 1.45 eq.) dissolved in 1.6 mL DMF were added. The resulting solution was bubbled with argon for 15 min before CuTc (38 mg, 0.2 mmol, 1.25 eq.) was added, followed by  $\text{Pd}_2\text{dba}_3$  (7.5 mg, 0.008 mmol, 0.05 eq.). The resulting solution was stirred at room temperature for 2 h then diluted with water and EtOAc. The organic layer was separated and the aqueous layer was extracted with EtOAc for three times. The organic layers were combined, washed with brine, dried with anhydrous  $\text{Na}_2\text{SO}_4$ , filtered and concentrated to get the crude product, which was purified by column chromatography (EtOAc:Hexane = 1:10 to 1:5) to give the product (67 mg, 87%) as colorless oil.

$^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.68 – 7.64 (m, 4H), 7.45 – 7.41 (m, 2H), 7.40 – 7.35 (m, 4H), 6.89 (dt,  $J$  = 15.3, 7.5 Hz, 1H), 6.04 (dd,  $J$  = 15.2, 10.3 Hz, 1H), 5.90 (dd,  $J$  = 15.2, 10.4 Hz, 1H), 5.73 (dd,  $J$  = 15.7, 1.5 Hz, 1H), 5.53 – 5.42 (m, 2H), 3.89 – 3.84 (m, 1H), 3.71 (s, 3H), 3.66 (t,  $J$  = 6.3 Hz, 2H), 2.38 – 2.14 (m, 6H), 1.05 (s, 9H).  $^{13}\text{C}$  NMR (125 MHz,  $\text{CDCl}_3$ )  $\delta$  166.8, 145.6, 135.9, 134.0, 133.8, 133.1, 132.9, 129.7, 129.7, 128.3, 127.6, 127.6, 123.2, 71.9, 62.0, 51.4, 39.8, 39.1, 36.0, 27.0, 19.3.  $[\alpha]_D^{20} = -138.0^\circ$  ( $c$  0.2,  $\text{CHCl}_3$ ). HRMS (ESI), calcd for  $\text{C}_{29}\text{H}_{38}\text{NaO}_4\text{Si}^+$   $[\text{M}+\text{Na}]^+$  501.2432, found 501.2436 m/z.



To a solution of the alcohol (340 mg, 0.71 mmol, 1.0 eq.) in 15 mL THF was added 2-nitrophenyl selenocyanate (442 mg, 1.95 mmol, 2.7 eq.). The resulting solution was bubbled with argon for 30 min before  $\text{PBu}_3$  (0.71 mL, 2.85 mmol, 4.0 eq.) was added dropwise. The reaction mixture was stirred at room temperature for 6 h, then concentrated. The crude product was purified by column chromatography (EtOAc:Hexane = 1:20 to 1:4) to get the product (390 mg, 83%) as a red oil.

$^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  8.30 – 8.28 (m, 1H), 7.68 – 7.64 (m, 4H), 7.53 – 7.51 (m, 2H), 7.45 – 7.41 (m, 2H), 7.39 – 7.35 (m, 4H), 7.31 (ddd,  $J$  = 8.4, 5.0, 3.5 Hz, 1H), 6.90 (dt,  $J$  = 15.3, 7.5 Hz, 1H), 6.04 (dd,  $J$  = 14.9, 10.5 Hz, 1H), 5.89 (dd,  $J$  = 15.2, 10.4 Hz, 1H), 5.74 (dt,  $J$  = 15.7, 1.4 Hz, 1H), 5.58 (dt,  $J$  = 14.6, 6.9 Hz, 1H), 5.48 (dt,  $J$  = 14.9, 7.4 Hz, 1H), 3.89 – 3.85 (m, 1H), 3.72 (s, 3H), 2.96 (t,  $J$  = 7.6 Hz, 2H), 2.53 (q,  $J$  = 7.1 Hz, 2H), 2.36 – 2.14 (m, 4H), 1.06 (s, 9H).  $^{13}\text{C}$  NMR (125 MHz,  $\text{CDCl}_3$ )  $\delta$  166.7, 146.9, 145.6, 135.9, 134.0, 133.8, 133.5, 132.7, 131.9, 130.2, 129.8, 129.7, 129.0, 128.8, 127.7, 127.6, 126.5, 125.4, 123.2, 71.9, 51.4, 39.8, 39.1, 31.4, 27.0, 25.6, 19.3.  $[\alpha]_D^{25}$  =  $-120.0^\circ$  ( $c$  0.5,  $\text{CHCl}_3$ ). IR (neat): 2923, 1691, 1649, 1457, 1371, 1249, 1080, 873  $\text{cm}^{-1}$ . HRMS (ESI), calcd for  $\text{C}_{35}\text{H}_{41}\text{NNaO}_5\text{SeSi}^+$   $[\text{M}+\text{Na}]^+$  686.1811, found 686.1806  $m/z$ .



To a solution of the ester (559 mg, 0.84 mmol, 1.0 eq.) in 15 mL DCM was added DIBAL-H (2.1 mL, 2.1 mmol, 2.5 eq.) at  $-78^\circ\text{C}$ . The resulting solution was stirred at  $-78^\circ\text{C}$  for 2 h. The

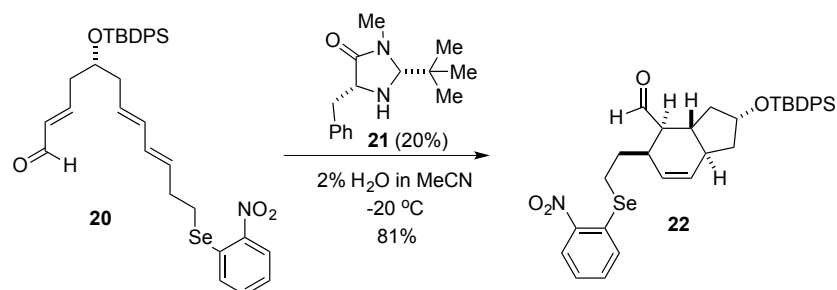
reaction was then quenched with saturated aqueous sodium potassium tartrate solution before it was warmed to room temperature and stirred for overnight. The mixture was poured into a separation funnel containing Et<sub>2</sub>O and water. The two layers were separated and the aqueous layer was extracted with Et<sub>2</sub>O for 3 times. The combined organic layers were washed with brine, dried with anhydrous Na<sub>2</sub>SO<sub>4</sub>, filtered and concentrated to get the crude product, which was purified by column chromatography (EtOAc:Hexane = 1:10 to 1:5) to give the product (459 mg, 85%) as a yellow oil.

<sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>) δ 8.30 – 8.28 (m, 1H), 7.69-7.67 (m, 4H), 7.52 – 7.51 (m, 2H), 7.45 – 7.41 (m, 2H), 7.39 – 7.36 (m, 4H), 7.31 (dt, *J* = 8.4, 4.2 Hz, 1H), 6.06 (dd, *J* = 15.2, 10.3 Hz, 1H), 5.91 (dd, *J* = 15.2, 10.3 Hz, 1H), 5.61 – 5.50 (m, 4H), 4.00 (brs, 2H), 3.85 – 3.80 (m, 1H), 2.97 (t, *J* = 7.6 Hz, 2H), 2.54 (q, *J* = 7.3 Hz, 2H), 2.22.14 (m, 4H), 1.06 (s, 9H). <sup>13</sup>C NMR (125 MHz, CDCl<sub>3</sub>) δ 146.9, 136.0, 134.3, 134.2, 133.5, 132.3, 132.1, 131.6, 129.8, 129.6, 129.5, 129.0, 127.5, 126.5, 125.4, 72.7, 63.7, 39.8, 39.2, 31.4, 29.7, 27.0, 25.6, 19.4. [ $\alpha$ ]<sup>D</sup> = -64.0° (*c* 0.5, CHCl<sub>3</sub>). IR (neat): 3406, 2929, 2857, 1589, 1514, 1463, 1428, 1332, 1303, 1106, 991, 733 cm<sup>-1</sup>. HRMS (ESI), calcd for C<sub>34</sub>H<sub>41</sub>NNaO<sub>4</sub>SeSi<sup>+</sup> [M+Na]<sup>+</sup> 658.1862, found 658.1869 *m/z*.

To a solution of the alcohol (450 mg, 0.71 mmol, 1.0 eq.) in 15 mL DCM was added MnO<sub>2</sub> (3.1 g, 35.6 mmol, 50 eq.). The reaction mixture was stirred at room temperature for 5 h before it was passed through a short pad of celite. The filtrate was concentrated and purified by column chromatography (EtOAc:Hexane = 1:20 to 1:10) to give the product (364 mg, 81%) as a yellow oil.

<sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>) δ 9.39 (d, *J* = 7.9 Hz, 1H), 8.30 – 8.28 (m, 1H), 7.67 – 7.65 (m, 4H), 7.52 – 7.51 (m, 2H), 7.46 – 7.42 (m, 2H), 7.40 – 7.37 (m, 4H), 7.31 (ddd, *J* = 8.4, 5.4, 3.1 Hz, 1H), 6.76 – 6.70 (m, 1H), 6.07 – 5.99 (m, 2H), 5.91 (dd, *J* = 15.2, 10.3 Hz, 1H), 5.60 (dt, *J* = 14.5, 6.9 Hz, 1H), 5.47 (dt, *J* = 15.0, 7.4 Hz, 1H), 3.97 – 3.92 (m, 1H), 2.96 (t, *J* = 7.6 Hz, 2H), 2.54 (q, *J* = 7.1 Hz, 2H), 2.47 – 2.40 (m, 2H), 2.27 – 2.24 (m, 2H), 1.07 (s, 9H). <sup>13</sup>C NMR (125 MHz, CDCl<sub>3</sub>) δ 193.9, 154.9, 146.9, 134.9, 133.8, 133.7, 133.6, 133.5, 132.9, 131.7, 130.5, 129.9, 129.8, 129.0, 128.3, 127.6, 126.5, 125.4, 71.7, 40.1, 39.5, 31.3, 27.0, 25.5,

19.3.  $[\alpha]_D^{25} = -130.0^\circ$  (*c* 0.2, CHCl<sub>3</sub>). IR (neat): 2930, 2857, 1691, 1514, 1333, 1304, 1106, 987, 733 cm<sup>-1</sup>. HRMS (ESI), calcd for C<sub>34</sub>H<sub>39</sub>NNaO<sub>4</sub>SeSi<sup>+</sup> [M+Na]<sup>+</sup> 656.1706, found 656.1708 m/z.



To a solution of the aldehyde (20 mg, 0.032 mmol, 1.0 eq.) in 0.4 ml solvent (2% H<sub>2</sub>O in MeCN) was added the MacMillan catalyst (1.6 mg, 0.0065 mmol, 0.2 eq.), followed by TFA solution (0.1 mL, 0.065 M, 0.2 eq.) at -20 °C. The resulting solution was stirred at this temperature for 72 h before 1% NaHCO<sub>3</sub> solution was added to quench the reaction. The reaction mixture was then warmed to room temperature, stirred for 10 min, then diluted with EtOAc. The two layers were separated and the aqueous layer was extracted with EtOAc for 3 times. The combined organic layers were washed with brine, dried with anhydrous Na<sub>2</sub>SO<sub>4</sub>, filtered and concentrated to get the crude product, which was purified by column chromatography (EtOAc:Hexane = 1:50) to give the product (16.2 mg, 81%) as a single diastereomer.

<sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>):  $\delta$  9.76 (d, *J* = 1.7 Hz, 1H), 8.27 (dd, *J* = 8.3, 1.5 Hz, 1H), 7.67 – 7.62 (m, 4H), 7.52 – 7.49 (m, 1H), 7.44 – 7.40 (m, 3H), 7.39 – 7.35 (m, 4H), 7.30 (ddd, *J* = 8.3, 7.1, 1.3 Hz, 1H), 5.93 (d, *J* = 9.9 Hz, 1H), 5.73 (ddd, *J* = 9.9, 4.2, 2.8 Hz, 1H), 4.46 – 4.43 (m, 1H), 2.98 – 2.93 (m, 2H), 2.88 – 2.83 (m, 1H), 2.82 – 2.77 (m, 1H), 2.46 (dt, *J* = 12.9, 6.6 Hz, 1H), 2.38 – 2.31 (m, 1H), 1.89 – 1.85 (m, 1H), 1.84 – 1.79 (m, 1H), 1.77 – 1.70 (m, 1H), 1.50 – 1.42 (m, 1H), 1.36 – 1.29 (m, 2H), 1.05 (s, 9H). <sup>13</sup>C NMR (125 MHz, CDCl<sub>3</sub>)  $\delta$  203.6, 146.8, 135.6, 134.3, 134.2, 133.6, 132.9, 130.9, 129.5, 129.5, 128.8, 128.4, 127.5, 126.4, 125.4, 73.3, 56.2, 42.7, 39.8, 38.8, 36.8, 31.5, 26.9, 23.6, 19.0.  $[\alpha]_D^{25} = -230.0^\circ$  (*c* 1,

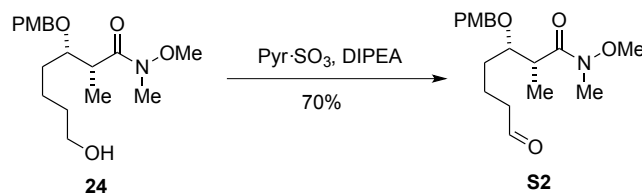


2.5 eq.) was added dropwise. The reaction mixture was slowly warmed to room temperature and stirred overnight. It was then cooled down to 0 °C and quenched with pH 7 buffer. The resulting mixture was extracted with EtOAc for 3 times. The combined organic layers were washed with brine, dried with anhydrous K<sub>2</sub>CO<sub>3</sub>, filtered and concentrated to get the crude product, which was purified by column chromatography (EtOAc:Hexane = 1:50 to 1:10) to get the product (2.1g, 86%) as a colorless oil.

<sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>) δ 7.29 – 7.26 (m, 2H), 6.87 – 6.85 (m, 2H), 4.49 (s, 2H), 3.79 (s, 3H), 3.65 (s, 3H), 3.64 – 3.57 (m, 3H), 3.17 (s, 3H), 3.08 (brs, 1H), 1.60 – 1.45 (m, 5H), 1.44 – 1.34 (m, 1H), 1.24 (d, *J* = 6.9 Hz, 3H), 0.88 (s, 9H), 0.03 (s, 6H). <sup>13</sup>C NMR (125 MHz, CDCl<sub>3</sub>) δ 176.5, 159.2, 130.8, 129.6, 113.8, 80.6, 72.8, 63.2, 61.4, 55.3, 40.2, 33.1, 32.2, 26.0, 21.8, 18.4, 14.4, -5.3. [α]<sup>D</sup> = -108.0° (*c* 0.5, CHCl<sub>3</sub>). IR (neat): 2934, 2859, 1661, 1513, 1463, 1249, 1099, 836, 776 cm<sup>-1</sup>. HRMS (ESI), calcd for C<sub>24</sub>H<sub>44</sub>NO<sub>5</sub>Si<sup>+</sup> [M+H]<sup>+</sup> 454.2983, found 454.2989 m/z.

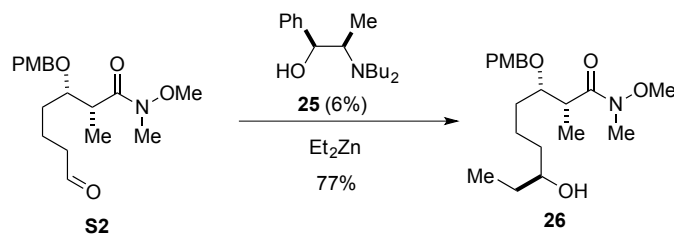
To a solution of the previous product (2.1 g, 4.6 mmol, 1.0 eq.) was added TBAF (6.9 ml, 6.9 mmol, 1.5 eq.) at 0 °C. The resulting solution was stirred at the same temperature for 30 min before it was slowly warmed to room temperature and stirred for 2 h. After that, the reaction was diluted with water and extracted with EtOAc for 5 times. The combined organic layers were washed with brine, dried with anhydrous Na<sub>2</sub>SO<sub>4</sub>, filtered and concentrated to get the crude product, which was purified by column chromatography (EtOAc:Hexane = 1:1, 2:1, 1:0) to get the product (962 mg, 63%) as a colorless oil.

<sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>) δ 7.28 – 7.26 (m, 2H), 6.87 – 6.85 (m, 2H), 4.48 (s, 2H), 3.80 (s, 3H), 3.65 (s, 3H), 3.61 – 3.56 (m, 3H), 3.17 (s, 3H), 3.09 (s, 1H), 1.56 – 1.38 (m, 7H), 1.23 (d, *J* = 6.9 Hz, 3H). <sup>13</sup>C NMR (125 MHz, CDCl<sub>3</sub>) δ 176.4, 159.2, 130.7, 129.6, 113.8, 80.5, 72.7, 62.6, 61.5, 55.3, 40.1, 32.8, 32.7, 32.2, 21.5, 14.5. [α]<sup>D</sup> = -156.0° (*c* 2, CHCl<sub>3</sub>). IR (neat): 3430, 2936, 1642, 1513, 1459, 1383, 1246, 1175, 1059, 1034, 993, 822 cm<sup>-1</sup>. HRMS(ESI), calcd for C<sub>18</sub>H<sub>30</sub>NO<sub>5</sub><sup>+</sup> [M+H]<sup>+</sup> 340.2118, found 340.2121 m/z.



To a solution of the alcohol (961 mg, 2.83 mmol, 1.0 eq.) in 11.4 mL DCM/DMSO (1:1) was added DIPEA (1.49 mL, 8.5 mmol, 3.0 eq.). The resulting solution was stirred for 10 min before the PyrSO<sub>3</sub> complex (1.36 g, 8.5 mmol, 3.0 eq.) dissolved in 5.7 mL DMSO was added. The resulting solution was warmed to room temperature and stirred for 3 h. Then the mixture was cooled to 0 °C and quenched with 0.5 N HCl. The resulting mixture was poured into a separation funnel containing EtOAc and water. The two layers were separated and the aqueous layer was extracted with EtOAc for 3 times. The combined organic layers were washed with brine, dried with anhydrous Na<sub>2</sub>SO<sub>4</sub>, filtered and concentrated to get the crude product, which was purified by column chromatography (EtOAc:Hexane = 1:1 to 2:1) to get the product (666 mg, 70%) as a sticky oil.

<sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>) δ 9.70 (t, *J* = 1.7 Hz, 1H), 7.27 – 7.25 (m, 2H), 6.86 – 6.83 (m, 2H), 4.50 (d, *J* = 10.7 Hz, 1H), 4.46 (d, *J* = 10.7 Hz, 1H), 3.77 (s, 3H), 3.65 (s, 3H), 3.62 – 3.58 (m, 1H), 3.16 (s, 3H), 3.09 (brs, 1H), 2.38 (td, *J* = 7.3, 1.7 Hz, 2H), 1.77 – 1.75 (m, 1H), 1.66 – 1.63 (m, 1H), 1.58 – 1.46 (m, 2H), 1.22 (d, *J* = 6.9 Hz, 3H). <sup>13</sup>C NMR (125 MHz, CDCl<sub>3</sub>) δ 202.4, 176.1, 159.2, 130.5, 129.6, 113.8, 80.2, 72.6, 61.5, 55.3, 43.8, 39.9, 32.3, 32.1, 18.0, 14.5. [α]<sub>D</sub><sup>20</sup> = -176.0° (*c* 0.5, CHCl<sub>3</sub>). IR (neat): 2938, 1723, 1656, 1514, 1460, 1248, 1177, 1063, 1035, 994 cm<sup>-1</sup>. HRMS (ESI), calcd for C<sub>18</sub>H<sub>27</sub>NNaO<sub>5</sub><sup>+</sup> [M+Na]<sup>+</sup> 360.1781, found 360.1782 m/z.

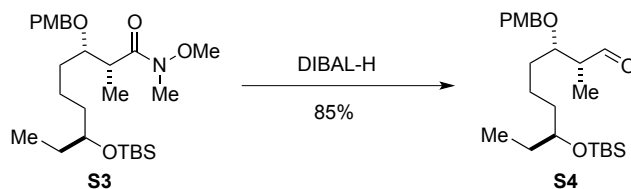


To a solution of the aldehyde (640 mg, 1.90 mmol, 1.0 eq.) in 11.4 mL hexane/toluene (2:1) was added (-)-DBNE (32 μL, 0.12 mmol, 0.06 eq.) at room temperature. The resulting



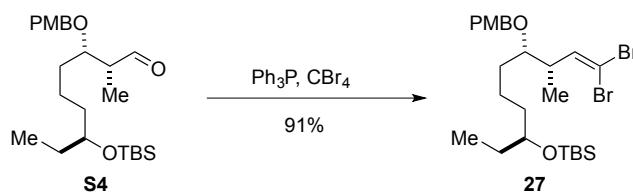


3H), 0.03 (d,  $J = 1.3$  Hz, 6H).  $^{13}\text{C}$  NMR (125 MHz,  $\text{CDCl}_3$ )  $\delta$  176.4, 159.2, 130.8, 129.6, 113.8, 80.7, 73.4, 72.8, 61.4, 55.3, 40.2, 36.8, 33.6, 32.2, 29.7, 25.9, 21.5, 18.2, 14.3, 9.6, -4.4, -4.4. IR (neat): 2932, 2857, 1513, 1462, 1249, 1114, 1042, 834, 776  $\text{cm}^{-1}$ . HRMS (ESI), calcd for  $\text{C}_{26}\text{H}_{47}\text{NNaO}_5\text{Si}^+$   $[\text{M}+\text{Na}]^+$  504.3116, found 504.3104  $m/z$ .



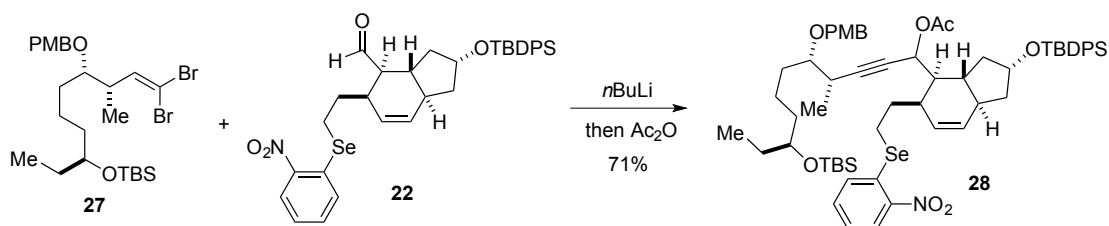
To a solution of the amide (190 mg, 0.39 mmol, 1.0 eq.) in 6 mL THF was added DIBAL-H (0.79 mL, 0.79 mmol, 2.0 eq.) at  $-78$   $^{\circ}\text{C}$ . The resulting solution was stirred at the same temperature for 2 h before it was quenched with 0.1 mL MeOH, followed by saturated aqueous sodium potassium tartrate solution. The mixture was warmed to room temperature and stirred for another 2 h until the two layers are clear. Then the mixture was poured into a separation funnel containing  $\text{Et}_2\text{O}$  and water. The two layers were separated and the aqueous layer was extracted with  $\text{Et}_2\text{O}$  for 3 times. The combined organic layers were washed with brine, dried with anhydrous  $\text{Na}_2\text{SO}_4$ , filtered and concentrated to get the crude product, which was purified by column chromatography ( $\text{EtOAc}:\text{Hexane} = 1:50$  to  $1:20$ ) to give the product (142 mg, 85%) as a colorless oil.

$^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  9.74 (d,  $J = 1.0$  Hz, 1H), 7.22 (d,  $J = 8.5$  Hz, 2H), 6.86 (d,  $J = 8.6$  Hz, 2H), 4.46 (d,  $J = 11.1$  Hz, 1H), 4.43 (d,  $J = 11.1$  Hz, 1H), 3.81 – 3.78 (m, 1H), 3.79 (s, 3H), 3.59 – 3.54 (m, 1H), 2.58 – 2.53 (m, 1H), 1.65 – 1.59 (m, 1H), 1.51 – 1.39 (m, 6H), 1.29 – 1.26 (m, 1H), 1.11 (d,  $J = 7.0$  Hz, 3H), 0.88 (s, 9H), 0.85 (t,  $J = 7.4$  Hz, 3H), 0.03 (d,  $J = 1.3$  Hz, 6H).  $^{13}\text{C}$  NMR (125 MHz,  $\text{CDCl}_3$ )  $\delta$  204.7, 159.2, 130.3, 129.3, 113.7, 78.2, 73.2, 71.4, 55.2, 49.6, 36.4, 32.0, 29.7, 25.9, 21.7, 18.1, 9.5, 8.2, -4.4, -4.5.  $[\alpha]_D^{20} = -248.0^{\circ}$  ( $c$  0.5,  $\text{CHCl}_3$ ). IR (neat): 2933, 2858, 1726, 1514, 1463, 1249, 1046, 834, 774  $\text{cm}^{-1}$ . HRMS (ESI), calcd for  $\text{C}_{24}\text{H}_{43}\text{O}_4\text{Si}^+$   $[\text{M}+\text{H}]^+$  423.2925, found 423.2925  $m/z$ .



To a solution of  $\text{CBr}_4$  (59 mg, 0.18 mmol, 1.5 eq.) in 1 mL DCM was added  $\text{PPh}_3$  (93 mg, 0.35 mmol, 3.0 eq.) in portions at  $-15\text{ }^\circ\text{C}$ . The resulting solution was stirred at the same temperature for 30 min, then cooled down to  $-20\text{ }^\circ\text{C}$ . A 0.5 mL THF solution of the aldehyde (50 mg, 0.12 mmol, 1.0 eq.) was added dropwise. The reaction mixture was stirred at the same temperature for 1 h and then poured into 30 mL hexane (pre-cooled to  $0\text{ }^\circ\text{C}$ ). The mixture was stirred at  $0\text{ }^\circ\text{C}$  for 5 min and then filtrated. The solution was then concentrated and purified by column chromatography (EtOAc:Hexane = 1:50 to 1:20) to give the product (62 mg, 91%) as colorless oil.

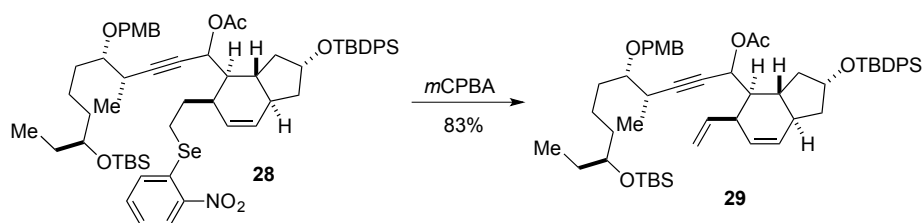
$^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.27 – 7.26 (m, 1H), 6.89 – 6.87 (m, 1H), 6.32 (d,  $J = 9.6\text{ Hz}$ , 1H), 4.47 (d,  $J = 11.1\text{ Hz}$ , 1H), 4.44 (d,  $J = 11.1\text{ Hz}$ , 1H), 3.81 (s, 3H), 3.59 – 3.54 (m, 1H), 3.31 – 3.29 (m, 1H), 2.78 – 2.68 (m, 1H), 1.50 – 1.39 (m, 7H), 1.30 – 1.26 (m, 1H), 1.03 (d,  $J = 6.9\text{ Hz}$ , 3H), 0.89 (s, 9H), 0.86 (t,  $J = 7.4\text{ Hz}$ , 3H), 0.04 (s, 6H).  $^{13}\text{C}$  NMR (125 MHz,  $\text{CDCl}_3$ )  $\delta$  159.2, 141.4, 130.6, 129.5, 113.8, 88.2, 81.1, 73.3, 71.8, 55.3, 41.5, 36.7, 31.7, 29.7, 26.0, 21.6, 18.2, 14.3, 9.6,  $-4.4$ .  $[\alpha]_D^{25} = +53.6^\circ$  ( $c$  0.5,  $\text{CHCl}_3$ ). IR (neat): 2932, 2857, 1513, 1462, 1249, 1114, 1042, 834, 776  $\text{cm}^{-1}$ . HRMS (ESI), calcd for  $\text{C}_{25}\text{H}_{43}\text{Br}_2\text{O}_3\text{Si}^+$   $[\text{M}+\text{H}]^+$  577.1343, found 577.1348  $m/z$ .



To a solution of the dibromoalkene (218 mg, 0.38 mmol, 1.2 eq.) in THF (4 mL) was added 2.5 M  $n\text{BuLi}$  (0.291 mL, 0.73 mmol, 2.3 eq.) at  $-78\text{ }^\circ\text{C}$ . The mixture was stirred at this temperature for 40 min. The aldehyde (200 mg, 0.316 mmol, 1.0 eq) dissolved in 2 mL THF was added dropwise. The resulting solution was stirred at  $-78\text{ }^\circ\text{C}$  for 2 h, before  $\text{Ac}_2\text{O}$  (45  $\mu\text{L}$ ,

0.47 mmol, 1.5 eq.) was added dropwise. The reaction was slowly warmed to 0 °C before 3 mL pyridine was added, followed by Ac<sub>2</sub>O (0.896 mL, 9.48 mmol, 30 eq.) and DMAP (3.9 mg, 0.03 mmol, 0.1 eq.). The result mixture was warmed to room temperature and stirred for another 20 h before it was quenched with aqueous saturated NH<sub>4</sub>Cl and diluted with EtOAc. The two layers were separated and the aqueous layer was extracted with EtOAc for 3 times. The combined organic layers were washed with brine, dried with anhydrous Na<sub>2</sub>SO<sub>4</sub>, filtered and concentrated to get the crude product, which was purified by column chromatography (EtOAc:Hexane = 1:50 to 1:20) to give the desired product in 71% yield as a mixture of diastereomers which cannot be separated.

<sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>) δ 8.27 (dd, *J* = 8.3, 1.4 Hz, 1H), 7.66 – 7.62 (m, 4H), 7.48 – 7.33 (m, 8H), 7.29 – 7.27 (m, 1H), 7.25 – 7.23 (m, 2H), 6.85 – 6.82 (m, 2H), 5.88 – 5.83 (m, 1H), 5.77 – 5.70 (m, 1H), 5.41 (dd, *J* = 4.9, 1.9 Hz, 0.23H), 5.32 (dd, *J* = 9.2, 1.9 Hz, 0.73H), 4.54 – 4.48 (m, 1H), 4.44 – 4.40 (m, 1H), 4.37 – 4.32 (m, 1H), 3.78 (s, 3H), 3.55 – 3.49 (m, 1H), 3.30 – 3.26 (m, 1H), 2.99 – 2.94 (m, 1H), 2.90 – 2.81 (m, 1H), 2.72 – 2.66 (m, 2H), 2.38 – 2.32 (m, 1H), 2.24 (ddd, *J* = 11.2, 9.2, 5.5 Hz, 1H), 2.20 – 2.13 (m, 1H), 2.02 – 1.99 (m, 1H), 1.96 (s, 3H), 1.88 – 1.82 (m, 1H), 1.69 – 1.45 (m, 7H), 1.45 – 1.20 (m, 8H), 1.05 (s, 9H), 0.87 (s, 9H), 0.84 – 0.80 (m, 3H), 0.05-0.00 (m, 6 H). <sup>13</sup>C NMR (125 MHz, CDCl<sub>3</sub>) δ 169.9, 159.1, 146.7, 135.6, 134.5, 134.4, 133.9, 133.5, 130.8, 130.2, 129.5, 129.4, 129.2, 128.9, 127.6, 126.5, 125.2, 113.7, 89.4, 81.5, 77.7, 73.4, 73.3, 71.9, 65.7, 55.3, 45.9, 44.2, 41.5, 40.3, 40.1, 38.3, 36.7, 32.2, 30.1, 29.9, 29.6, 26.9, 26.0, 24.3, 21.2, 21.2, 19.1, 18.2, 16.7, 9.6, -4.5, -4.4. IR (neat): 2937, 2862, 1742, 1514, 1456, 1334, 1239, 1106, 1050, 831, 707 cm<sup>-1</sup>. HRMS (ESI), calcd for C<sub>61</sub>H<sub>83</sub>NNaO<sub>8</sub>SeSi<sub>2</sub><sup>+</sup> [M+Na]<sup>+</sup> 1116.4715, found 1116.4704 m/z.

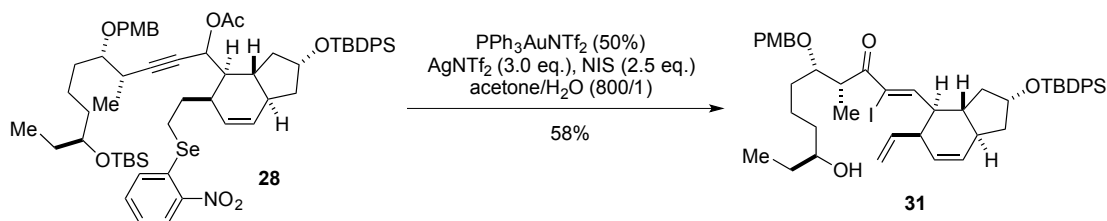


To a solution of the selenide (25 mg, 0.023 mmol, 1.0 eq.) in 2.5 mL THF was added 0.5 mL THF solution of *m*CPBA (6.7 mg, 70% purity, 0.027 mmol, 1.2 eq.) at 0 °C. The resulting



was extracted with EtOAc for 3 times. The combined organic layers were washed with brine, dried with anhydrous Na<sub>2</sub>SO<sub>4</sub>, filtered and concentrated to get the crude product, which was purified by column chromatography (EtOAc:Hexane = 1:100) to afford product (3.3 mg, 28% yield) as a sticky oil and recover the starting material (7.1 mg, 59%).

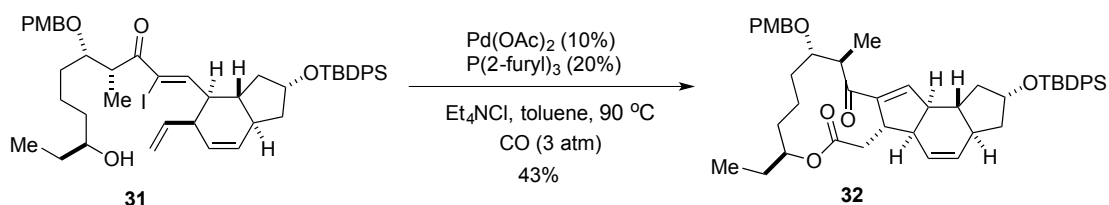
<sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>)  $\delta$  7.67 – 7.64 (m, 4H), 7.41 – 7.34 (m, 6H), 7.25 (d, *J* = 8.6 Hz, 2H), 6.86 (d, *J* = 8.6 Hz, 2H), 5.92 – 5.77 (m, 3H), 4.49 (d, *J* = 10.5 Hz, 1H), 4.40 (d, *J* = 10.5 Hz, 1H), 4.35 (q, *J* = 6.7 Hz, 1H), 3.80 (s, 3H), 3.43 – 3.39 (m, 1H), 3.38 – 3.29 (m, 2H), 2.90 (dd, *J* = 12.9, 4.4 Hz, 1H), 2.54 (dt, *J* = 13.1, 6.7 Hz, 1H), 2.49 – 2.44 (m, 1H), 2.43 – 2.34 (m, 2H), 2.29 (t, *J* = 12.4 Hz, 1H), 2.22 (ddd, *J* = 12.1, 5.8, 2.4 Hz, 1H), 2.06 (s, 3H), 1.99 – 1.95 (m, 1H), 1.88 (dd, *J* = 12.7, 6.6 Hz, 1H), 1.66 – 1.41 (m, 7 H), 1.38 – 1.16 (m, 12H), 1.11 (d, *J* = 6.3 Hz, 3H), 1.05 (s, 9H), 0.95 – 0.86 (m, 2H), 0.85 (s, 9H), 0.67 (t, *J* = 7.4 Hz, 3H), -0.02 (d, *J* = 8.6 Hz, 6H). <sup>13</sup>C NMR (125 MHz, CDCl<sub>3</sub>)  $\delta$  169.4, 159.2, 135.8, 135.7, 134.5, 130.6, 130.2, 129.5, 129.4, 128.6, 127.6, 127.6, 113.8, 83.4, 82.3, 73.3, 73.2, 73.1, 55.3, 46.1, 44.3, 42.0, 41.9, 41.3, 40.7, 37.1, 36.9, 33.0, 29.9, 26.9, 26.0, 21.3, 21.0, 19.0, 18.4, 18.2, 9.3, -4.2, -4.5. [ $\alpha$ ]<sup>D</sup> = -356.0° (*c* 0.1, CHCl<sub>3</sub>). IR (neat): 2928, 1741, 1456, 1371, 1239, 1107, 1051, 829, 704 cm<sup>-1</sup>. MS (ESI): *m/z* 913.8 [M+Na]<sup>+</sup>.



To a solution of the acetate (27 mg, 0.025 mmol, 1.0 eq.) was added AgNTf<sub>2</sub> (29 mg 0.075 mmol, 3.0 eq.) at -15 °C. The resulting solution was stirred at the same temperature for 5 min. NIS (13.9 mg, 0.062 mmol, 2.5 eq.) was then added. The mixture was continuously stirred for 10 min before PPh<sub>3</sub>AuNTf<sub>2</sub> (3 mg, 0.0038 mmol, 0.15 eq.) was added. After 1 h, another portion of PPh<sub>3</sub>AuNTf<sub>2</sub> (3 mg, 0.0038 mmol, 0.15 eq.) was added. The reaction was stirred for another 1 h before another portion of PPh<sub>3</sub>AuNTf<sub>2</sub> (4 mg, 0.0051 mmol, 0.2 eq.) was added. The reaction was warmed to room temperature in 3 h. Then 0.1 mL Et<sub>3</sub>N was added, followed by saturated Na<sub>2</sub>S<sub>2</sub>O<sub>3</sub>. The mixture was stirred for 10 min, then diluted with EtOAc.

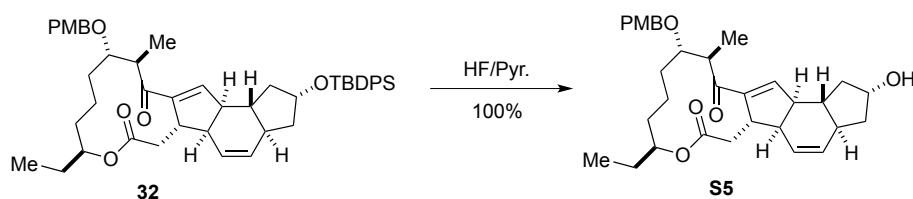
The two layers were separated and the aqueous layer was extracted with EtOAc for 3 times. The combined organic layers were washed with brine, dried with anhydrous Na<sub>2</sub>SO<sub>4</sub>, filtered and concentrated to get the crude product, which was purified by column chromatography (Et<sub>2</sub>O: benzene = 1:20) to afford product (12.2 mg, 58% yield) as a pale yellow liquid.

<sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>) δ 7.65 (d, *J* = 7.2 Hz, 2H), 7.61 (d, *J* = 7.2 Hz, 2H), 7.43 – 7.32 (m, 6H), 7.22 (d, *J* = 8.4 Hz, 2H), 6.81 (d, *J* = 8.4 Hz, 2H), 6.74 (d, *J* = 9.3 Hz, 1H), 5.88 (d, *J* = 9.9 Hz, 1H), 5.61 (dt, *J* = 17.7, 9.3 Hz, 1H), 5.44 (dt, *J* = 9.9, 3.5 Hz, 1H), 5.04 – 4.96 (m, 2H), 4.44 (s, 2H), 4.32 – 4.30 (m, 1H), 3.75 (s, 3H), 3.64 – 3.60 (m, 1H), 3.48 – 3.43 (m, 2H), 3.23 – 3.17 (m, 1H), 3.13 – 3.08 (m, 1H), 2.45 – 2.37 (m, 1H), 1.90 – 1.84 (m, 2H), 1.53 – 1.16 (m, 12H), 1.19 (d, *J* = 6.8 Hz, 3H), 1.04 (s, 9H), 0.89 (t, *J* = 7.4 Hz, 3H). <sup>13</sup>C NMR (125 MHz, CDCl<sub>3</sub>) δ 197.7, 159.2, 153.9, 137.5, 135.7, 134.4, 134.3, 130.3, 130.0, 129.5, 128.8, 127.6, 117.6, 113.8, 111.9, 81.1, 73.1, 73.0, 72.8, 55.3, 52.0, 45.3, 43.6, 42.2, 42.0, 40.4, 39.6, 36.9, 32.9, 30.2, 26.9, 21.7, 19.1, 15.2, 9.9. [α]<sup>D</sup> = –192.0° (*c* 0.1, CHCl<sub>3</sub>). IR (neat): 3457, 2930, 2858, 1676, 1513, 1461, 1248, 1108, 1042, 822, 704 cm<sup>–1</sup>. HRMS (ESI), calcd for C<sub>47</sub>H<sub>62</sub>IO<sub>5</sub>Si<sup>+</sup> [M+H]<sup>+</sup> 861.3406, found 861.3404 *m/z*.

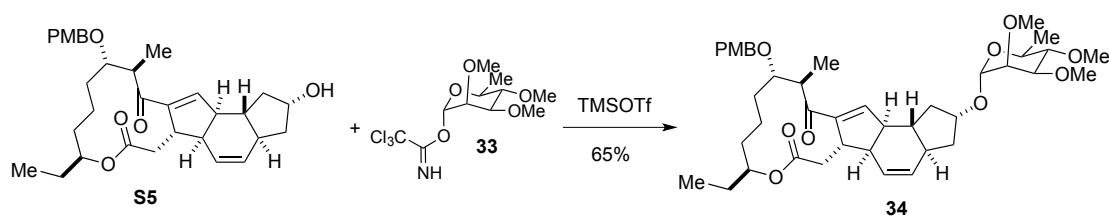


To a 35 mL high pressure vessel was added Pd(OAc)<sub>2</sub> (0.5 mg, 0.002 mmol, 0.1 eq.), P(2-furyl)<sub>3</sub> (1.0 mg, 0.004 mmol, 0.2 eq.), Et<sub>4</sub>NCl (3.3 mg, 0.02 mmol, 1.0 eq) and 80 mg 4 Å molecular sieve. The vinyl iodide (17 mg, 0.02 mmol) dissolved in 1.7 mL toluene was added. The vessel was flushed with CO gas for 5 times. The reaction was heated to 90 °C and stirred for 6 h under 3 atm of CO before it was cooled down and diluted with toluene and passed through a pad of celite. The solution was concentrated and the residue purified by column chromatography (EtOAc:Hexane = 1:50 to 1:20) to afford the desired product (6.5 mg, 43% yield) as pale yellow liquid.

$^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.66 – 7.63 (m, 4H), 7.43 – 7.40 (m, 2H), 7.39 – 7.35 (m, 4H), 7.27 (d,  $J$  = 8.7 Hz, 2H), 6.88 (d,  $J$  = 8.7 Hz, 2H), 6.72 (brs, 1H), 5.84 (d,  $J$  = 9.8 Hz, 1H), 5.74 (dt,  $J$  = 9.8, 2.9 Hz, 1H), 4.68 – 4.64 (m, 1H), 4.52 (d,  $J$  = 10.9 Hz, 1H), 4.39 – 4.34 (m, 2H), 3.81 (s, 3H), 3.53 – 3.51 (m, 1H), 3.48 – 3.44 (m, 1H), 3.33 – 3.23 (m, 1H), 3.07 (dd,  $J$  = 13.3, 5.0 Hz, 1H), 2.99 – 2.98 (m, 1H), 2.92 – 2.87 (m, 1H), 2.40 (dd,  $J$  = 13.3, 3.2 Hz, 1H), 2.32 (app q,  $J$  = 12.1, 1H), 2.19 – 2.03 (m, 1H), 1.91 (dd,  $J$  = 13.0, 7.0 Hz, 1H), 1.68 – 1.30 (m, 8H), 1.20 (d,  $J$  = 6.8 Hz, 3H), 1.12 – 1.11 (m, 1H), 1.05 (s, 9H), 0.93 – 0.87 (m, 1H), 0.82 (t,  $J$  = 7.5 Hz, 3H), 0.77 – 0.72 (m, 1H).  $^{13}\text{C}$  NMR (125 MHz,  $\text{CDCl}_3$ )  $\delta$  203.0, 172.5, 159.2, 147.7, 143.7, 135.7, 134.5, 134.4, 130.7, 129.9, 129.5, 129.4, 128.8, 127.5, 113.8, 80.3, 76.3, 73.7, 71.6, 55.3, 49.7, 47.7, 46.8, 46.6, 41.4, 41.2, 40.6, 40.5, 34.6, 31.8, 30.6, 28.1, 26.9, 20.5, 19.1, 17.4, 9.4.  $[\alpha]_D^{25}$  = -118.0° ( $c$  0.2,  $\text{CHCl}_3$ ). IR (neat): 2926, 2857, 1731, 1662, 1460, 1373, 1250, 1115, 1036, 826, 713  $\text{cm}^{-1}$ . HRMS (ESI), calcd for  $\text{C}_{48}\text{H}_{61}\text{O}_6\text{Si}^+$   $[\text{M}+\text{H}]^+$  761.4232, found 761.4235  $m/z$ .



Hz, 1H), 3.05 – 3.01 (m, 1H), 2.90 (ddt,  $J = 11.4, 8.6, 2.6$  Hz, 1H), 2.42 (dd,  $J = 13.3, 3.1$  Hz, 1H), 2.34 (dt,  $J = 13.4, 7.0$  Hz, 1H), 2.32–2.22 (m, 1H), 1.86 (dd,  $J = 13.3, 6.8$  Hz, 1H), 1.68 – 1.45 (m, 6H), 1.37 – 1.21 (m, 3 H), 1.24 (d,  $J = 7.0$  Hz, 3H), 1.14 – 1.11 (m, 1H), 0.96 – 0.82 (m, 2H), 0.82 (t,  $J = 7.5$  Hz, 3H).  $^{13}\text{C}$  NMR (125 MHz,  $\text{CDCl}_3$ )  $\delta$  203.1, 172.5, 159.2, 147.4, 143.9, 130.7, 129.4, 129.0, 113.8, 80.3, 76.3, 72.4, 71.6, 55.3, 49.6, 47.6, 47.0, 46.8, 41.4, 41.0, 40.7, 40.0, 34.5, 31.7, 30.6, 28.0, 20.5, 17.5, 9.4.  $[\alpha]_D^{25} = -182.0^\circ$  ( $c$  0.2,  $\text{CHCl}_3$ ). IR (neat): 3461, 2830, 2863, 1715, 1670, 1458, 1374, 1247, 1172, 1101, 836, 757  $\text{cm}^{-1}$ . HRMS (ESI), calcd for  $\text{C}_{32}\text{H}_{43}\text{O}_6^+$   $[\text{M}+\text{H}]^+$  523.3054, found 523.3060  $m/z$ .



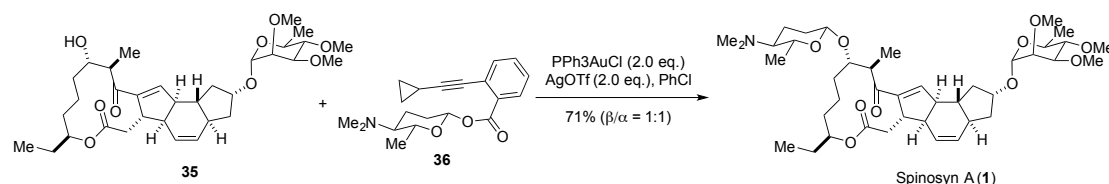
To a solution of the alcohol (3.0 mg, 0.006 mmol) and the glycosyl donor (5.2 mg, 0.014 mmol, 2.0 eq.) in 400  $\mu\text{L}$  DCM was added 50 mg 4Å molecular sieve. The resulting solution was stirred at room temperature for 1 h and then cooled down to  $-30^\circ\text{C}$ . 10  $\mu\text{L}$  TMSOTf solution (0.09 M in DCM, 0.15 eq.) was added. The reaction mixture was stirred at  $-30^\circ\text{C}$  for 24 h and one drop of  $\text{Et}_3\text{N}$  was then added. The mixture was diluted with DCM and warmed to room temperature before it was poured into a separation funnel containing 10 mL DCM and 10 mL brine. The organic layer was separated and the aqueous layer was extracted with DCM for 3 times. The combined organic layers were dried by  $\text{Na}_2\text{SO}_4$ , filtered and separated. The residue was purified by column chromatography (Hexane: EtOAc = 4:1 to 2:1) to afford the desired product (2.7 mg, 65% yield) as an oil.

$^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.27 (d,  $J = 8.7$  Hz, 2H), 6.88 (d,  $J = 8.7$  Hz, 2H), 6.76 (s, 1H), 5.87 (d,  $J = 9.8$  Hz, 1H), 5.82 – 5.75 (m, 1H), 4.85 (d,  $J = 1.8$  Hz, 1H), 4.70 – 4.65 (m, 1H), 4.53 (d,  $J = 10.9$  Hz, 1H), 4.39 (d,  $J = 10.9$  Hz, 1H), 4.31 (app q,  $J = 6.9$  Hz, 1H), 3.81 (s, 3H), 3.55 (s, 3H), 3.50 (s, 3H), 3.55 – 3.52 (m, 1H), 3.50 (s, 3H), 3.49 (s, 3H), 3.48 – 3.44 (m, 2H), 3.36 – 3.27 (m, 1 H), 3.13 – 3.07 (m, 2H), 3.05–3.02 (m, 1H), 2.90 – 2.85 (m, 1H), 2.42 (dd,  $J$





202.7, 172.7, 147.5, 144.4, 129.4, 128.8, 95.5, 82.3, 81.1, 77.7, 77.0, 76.1, 72.8, 68.0, 61.0, 59.0, 57.7, 49.5, 48.1, 47.6, 46.0, 41.5, 41.2, 37.4, 36.3, 34.9, 34.0, 30.0, 28.4, 21.6, 17.8, 15.7, 9.4.  $[\alpha]_D^{25} = -380.0^\circ$  ( $c$  0.2,  $\text{CHCl}_3$ ). IR (neat): 2932, 1738, 1667, 1482, 1370, 1232, 1117, 1025, 844  $\text{cm}^{-1}$ . HRMS (ESI), calcd for  $\text{C}_{33}\text{H}_{50}\text{O}_9$   $[\text{M}+\text{H}]^+$  591.3528, found 591.3520  $m/z$ .



Synthesis of donor **36**: At room temperature, D-forosamine (300 mg, 1.89 mmol, 1.0 eq.) was added to a reaction tube containing 3.1 mL DCM. *Ortho*-cyclopropylethynylbenzoic acid (351 mg, 1.89 mmol, 1.0 eq.), EDCI (468 mg, 2.44 mmol, 1.3 eq.), DMAP (230 mg, 1.89 mmol, 1.0 eq.), and DIPEA (0.66 mL, 3.8 mmol, 2.0 eq.) were added successively. The resulting solution was stirred at room temperature for 20 h, then diluted with EtOAc and water. The reaction mixture was poured into a separation funnel and the two layers were separated. The aqueous layer was extracted with EtOAc for 3 times and the combined organic layer was washed with brine, dried with anhydrous  $\text{Na}_2\text{SO}_4$ , filtered, and concentrated. The crude product was purified by flash chromatography (EtOAc:Hexane = 1:1 to 2:1) to get 242 mg product in 39% yield as a colorless oil.

$^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.93 (dd,  $J = 7.9, 1.4$  Hz, 1H), 7.45 (dd,  $J = 7.8, 1.4$  Hz, 1H), 7.38 (td,  $J = 7.6, 1.4$  Hz, 1H), 7.26 (td,  $J = 7.6, 1.4$  Hz, 1H), 5.88 (dd,  $J = 9.6, 2.4$  Hz, 1H), 3.74 (dq,  $J = 9.3, 6.2$  Hz, 1H), 2.32–2.23 (m, 7H), 2.13 – 2.07 (m, 1H), 1.99 – 1.93 (m, 1H), 1.73 (tdd,  $J = 13.1, 9.5, 4.1$  Hz, 1H), 1.65 – 1.55 (m, 1H), 1.53 – 1.46 (m, 1H), 1.33 (d,  $J = 6.2$  Hz, 3H), 0.87 (d,  $J = 6.7$  Hz, 4H);  $^{13}\text{C}$  NMR (125 MHz,  $\text{CDCl}_3$ )  $\delta$  164.5, 134.2, 131.8, 131.2, 130.6, 126.9, 124.9, 99.5, 95.0, 75.0, 74.5, 64.7, 40.8, 29.8, 19.1, 18.1, 8.8, 0.7;  $[\alpha]_D^{25} = 250.0^\circ$  ( $c$  1,  $\text{CHCl}_3$ ); IR (neat): 2933, 2781, 2230, 1735, 1596, 1566, 1483, 1284, 1242, 1038, 756  $\text{cm}^{-1}$ ; HRMS(ESI), calcd for  $\text{C}_{20}\text{H}_{26}\text{NO}_3$   $[\text{M}+\text{H}]^+$  328.1907, found 328.1905  $m/z$ .

To a flame-dried reaction tube was added 60 mg activated 4Å molecular sieves. The pseudoaglycon (10 mg, 0.017 mmol, 1.0 eq.) and the glycosyl donor (11 mg, 0.034 mmol, 2.0 eq.) dissolved in 0.5 mL PhCl was then added. The resulting solution was stirred for 10 min and PPh<sub>3</sub>AuCl (16.8 mg, 0.034 mmol, 2.0 eq) and AgOTf (8.7 mg, 0.034 mmol, 2.0 eq.) were added. The reaction mixture was stirred at the room temperature for another 1 h, then heated at 50 °C for 24 h. The reaction was cooled down to room temperature and Et<sub>3</sub>N (0.2 mL) was added to quench the reaction. The mixture was diluted with ammonia-saturated DCM and passed through a short pad of celite. The celite pad was washed with ammonia-saturated DCM for two times and the combined organic layers were concentrated. The residue was purified by chromatography (MeOH:DCM = 1:50 to 1:20) to afford product (8.8 mg, 71% yield) as a mixture ( $\beta$ : $\alpha$  = 1:1.07). The two isomers were separated using preparative TLC (THF 8%, CHCl<sub>3</sub> 91%, ammonium hydroxide solution 1%) to provide 4.2 mg spinosyn A with 4.5 mg  $\alpha$ -isomer.

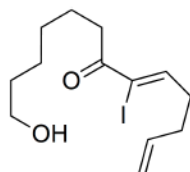
Spinosyn A: <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>)  $\delta$  6.76 (s, 1H), 5.88 (d,  $J$  = 9.7 Hz, 1H), 5.80 (dt,  $J$  = 9.8, 2.9 Hz, 1H), 4.85 (d,  $J$  = 1.8 Hz, 1H), 4.70 – 4.65 (m, 1H), 4.43 – 4.41 (m, 1H), 4.33 – 4.29 (m, 1H), 3.65 – 3.61 (m, 1H), 3.56 (s, 3H), 3.55 – 3.53 (m, 1H), 3.50 (s, 3H), 3.49 (s, 3H), 3.51– 3.45 (m, 4H), 3.32 – 3.26 (m, 1H), 3.15 – 3.10 (m, 2H), 3.03 – 2.99 (m, 1H), 2.89 – 2.84 (m, 1H), 2.40 (dd,  $J$  = 13.3, 3.3 Hz, 1H), 2.28 – 2.16 (m, 3H), 2.24 (s, 6H), 2.00 – 1.97 (m, 1H), 1.92 (dd,  $J$  = 13.4, 7.0 Hz, 1H), 1.87 – 1.83 (m, 1H), 1.81 – 1.74 (m, 1H), 1.57 – 1.20 (m, 11H), 1.28 (d,  $J$  = 6.3 Hz, 3H), 1.26 (d,  $J$  = 6.1 Hz, 3H), 1.18 (d,  $J$  = 6.8 Hz, 3H), 0.95 – 0.86 (m, 1H), 0.82 (t,  $J$  = 7.5 Hz, 3H). <sup>13</sup>C NMR (125 MHz, CDCl<sub>3</sub>)  $\delta$  202.9, 172.5, 147.5, 144.2, 129.3, 128.8, 103.5, 95.4, 82.3, 81.1, 80.6, 77.7, 77.0, 76.6, 76.1, 73.7, 67.9, 64.9, 60.9, 59.0, 57.7, 49.4, 47.7, 47.6, 46.0, 41.5, 41.2, 40.7, 37.4, 36.3, 34.3, 34.2, 31.0, 30.1, 28.4, 21.6, 19.0, 18.4, 17.8, 16.2, 9.4.  $[\alpha]_D^{25}$  = -184.0° ( $c$  0.2, CHCl<sub>3</sub>). IR (neat): 2933, 1721, 1662, 1453, 1373, 1219, 1112, 1040, 992 cm<sup>-1</sup>. HRMS (ESI), calcd for C<sub>41</sub>H<sub>66</sub>NO<sub>10</sub> [M+H]<sup>+</sup> 732.4681, found 732.4676 m/z.

$\alpha$ -isomer: <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>)  $\delta$  6.81 (d,  $J$  = 2.3 Hz, 1H), 5.89 – 5.86 (m, 1H), 5.78 (dt,  $J$  = 9.8, 2.9 Hz, 1H), 4.86 – 4.85 (m, 2H), 4.69 – 4.64 (m, 1H), 4.34 – 4.30 (m, 1H), 3.88 – 3.85 (m, 2H), 3.65 – 3.64 (m, 1H), 3.56 (s, 3H), 3.56 – 3.53 (m, 1H), 3.51 – 3.50 (m, 2H),

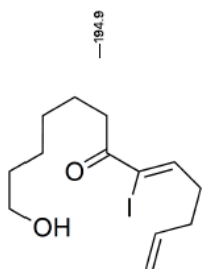
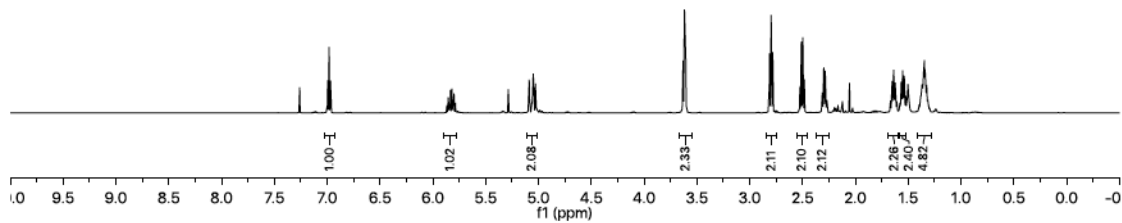
3.50 (s, 3H), 3.50 (s, 3H), 3.47 (dd,  $J = 9.3, 3.2$  Hz, 1H), 3.38 – 3.32 (m, 1H), 3.14 – 3.05 (m, 3H), 2.92 – 2.87 (m, 1H), 2.45 – 2.41 (m, 1H), 2.29 – 2.23 (m, 1H), 2.25 (s, 6H), 2.17 – 2.10 (m, 1H), 1.93 (dd,  $J = 13.4, 7.0$  Hz, 1H), 1.81 – 1.64 (m, 5H), 1.51 – 1.24 (m, 8H), 1.30 (d,  $J = 6.8$  Hz, 3H), 1.28 (d,  $J = 6.2$  Hz, 3H), 1.23 (d,  $J = 6.2$  Hz, 3H), 1.13 – 1.05 (m, 1H), 0.92 – 0.88 (m, 1H), 0.82 (t,  $J = 7.5$  Hz, 3H).  $^{13}\text{C}$  NMR (125 MHz,  $\text{CDCl}_3$ )  $\delta$  202.7, 172.5, 147.1, 143.7, 129.3, 129.2, 95.5, 91.9, 82.3, 81.1, 77.7, 76.2, 76.0, 75.1, 67.9, 67.3, 65.4, 61.0, 59.0, 57.7, 49.6, 47.6, 46.6, 46.3, 41.4, 41.1, 40.6, 37.5, 36.4, 34.7, 30.9, 30.5, 30.4, 28.4, 27.9, 19.8, 19.0, 18.3, 17.8, 14.8, 9.4.  $[\alpha]_D^{25} = -478.0^\circ$  ( $c$  0.2,  $\text{CHCl}_3$ ). IR (neat): 2933, 1721, 1662, 1453, 1373, 1219, 1112, 1040, 992  $\text{cm}^{-1}$ . HRMS (ESI), calcd for  $\text{C}_{41}\text{H}_{66}\text{NO}_{10}$   $[\text{M}+\text{H}]^+$  732.4681, found 732.4676  $m/z$ .

## Part 2. $^1\text{H}$ and $^{13}\text{C}$ NMR Spectra

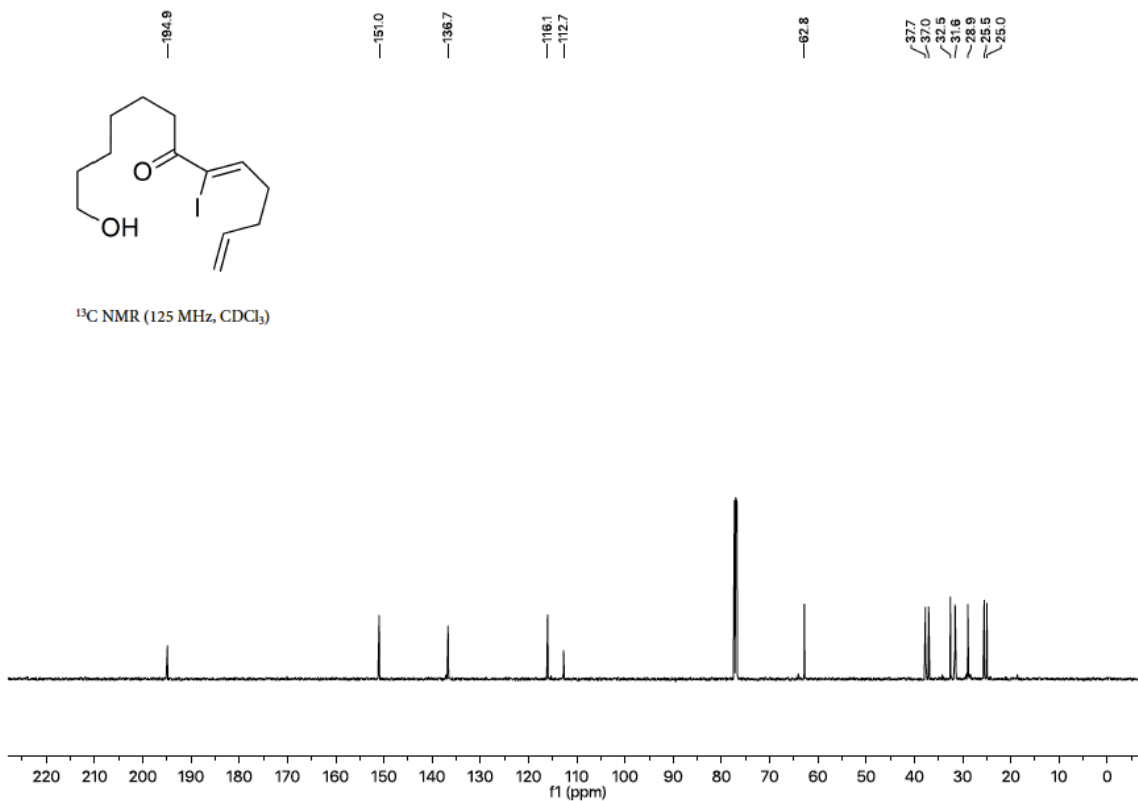
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4.99 4.98 4.97 4.96 4.95 4.94 4.93 4.92 4.91 4.90 4.89 4.88 4.87 4.86 4.85 4.84 4.83 4.82 4.81 4.80 4.79 4.78 4.77 4.76 4.75 4.74 4.73 4.72 4.71 4.70 4.69 4.68 4.67 4.66 4.65 4.64 4.63 4.62 4.61 4.60 4.59 4.58 4.57 4.56 4.55 4.54 4.53 4.52 4.51 4.50 4.49 4.48 4.47 4.46 4.45 4.44 4.43 4.42 4.41 4.40 4.39 4.38 4.37 4.36 4.35 4.34 4.33 4.32 4.31 4.30 4.29 4.28 4.27 4.26 4.25 4.24 4.23 4.22 4.21 4.20 4.19 4.18 4.17 4.16 4.15 4.14 4.13 4.12 4.11 4.10 4.09 4.08 4.07 4.06 4.05 4.04 4.03 4.02 4.01 4.00 3.99 3.98 3.97 3.96 3.95 3.94 3.93 3.92 3.91 3.90 3.89 3.88 3.87 3.86 3.85 3.84 3.83 3.82 3.81 3.80 3.79 3.78 3.77 3.76 3.75 3.74 3.73 3.72 3.71 3.70 3.69 3.68 3.67 3.66 3.65 3.64 3.63 3.62 3.61 3.60 3.59 3.58 3.57 3.56 3.55 3.54 3.53 3.52 3.51 3.50 3.49 3.48 3.47 3.46 3.45 3.44 3.43 3.42 3.41 3.40 3.39 3.38 3.37 3.36 3.35 3.34 3.33 3.32 3.31 3.30 3.29 3.28 3.27 3.26 3.25 3.24 3.23 3.22 3.21 3.20 3.19 3.18 3.17 3.16 3.15 3.14 3.13 3.12 3.11 3.10 3.09 3.08 3.07 3.06 3.05 3.04 3.03 3.02 3.01 3.00 2.99 2.98 2.97 2.96 2.95 2.94 2.93 2.92 2.91 2.90 2.89 2.88 2.87 2.86 2.85 2.84 2.83 2.82 2.81 2.80 2.79 2.78 2.77 2.76 2.75 2.74 2.73 2.72 2.71 2.70 2.69 2.68 2.67 2.66 2.65 2.64 2.63 2.62 2.61 2.60 2.59 2.58 2.57 2.56 2.55 2.54 2.53 2.52 2.51 2.50 2.49 2.48 2.47 2.46 2.45 2.44 2.43 2.42 2.41 2.40 2.39 2.38 2.37 2.36 2.35 2.34 2.33 2.32 2.31 2.30 2.29 2.28 2.27 2.26 2.25 2.24 2.23 2.22 2.21 2.20 2.19 2.18 2.17 2.16 2.15 2.14 2.13 2.12 2.11 2.10 2.09 2.08 2.07 2.06 2.05 2.04 2.03 2.02 2.01 2.00 1.99 1.98 1.97 1.96 1.95 1.94 1.93 1.92 1.91 1.90 1.89 1.88 1.87 1.86 1.85 1.84 1.83 1.82 1.81 1.80 1.79 1.78 1.77 1.76 1.75 1.74 1.73 1.72 1.71 1.70 1.69 1.68 1.67 1.66 1.65 1.64 1.63 1.62 1.61 1.60 1.59 1.58 1.57 1.56 1.55 1.54 1.53 1.52 1.51 1.50 1.49 1.48 1.47 1.46 1.45 1.44 1.43 1.42 1.41 1.40 1.39 1.38 1.37 1.36 1.35 1.34 1.33 1.32 1.31 1.30 1.29 1.28 1.27 1.26 1.25 1.24 1.23 1.22 1.21 1.20 1.19 1.18 1.17 1.16 1.15 1.14 1.13 1.12 1.11 1.10 1.09 1.08 1.07 1.06 1.05 1.04 1.03 1.02 1.01 1.00 0.99 0.98 0.97 0.96 0.95 0.94 0.93 0.92 0.91 0.90 0.89 0.88 0.87 0.86 0.85 0.84 0.83 0.82 0.81 0.80 0.79 0.78 0.77 0.76 0.75 0.74 0.73 0.72 0.71 0.70 0.69 0.68 0.67 0.66 0.65 0.64 0.63 0.62 0.61 0.60 0.59 0.58 0.57 0.56 0.55 0.54 0.53 0.52 0.51 0.50 0.49 0.48 0.47 0.46 0.45 0.44 0.43 0.42 0.41 0.40 0.39 0.38 0.37 0.36 0.35 0.34 0.33 0.32 0.31 0.30 0.29 0.28 0.27 0.26 0.25 0.24 0.23 0.22 0.21 0.20 0.19 0.18 0.17 0.16 0.15 0.14 0.13 0.12 0.11 0.10 0.09 0.08 0.07 0.06 0.05 0.04 0.03 0.02 0.01 0.00 -0.01 -0.02 -0.03 -0.04 -0.05 -0.06 -0.07 -0.08 -0.09 -0.10 -0.11 -0.12 -0.13 -0.14 -0.15 -0.16 -0.17 -0.18 -0.19 -0.20 -0.21 -0.22 -0.23 -0.24 -0.25 -0.26 -0.27 -0.28 -0.29 -0.30 -0.31 -0.32 -0.33 -0.34 -0.35 -0.36 -0.37 -0.38 -0.39 -0.40 -0.41 -0.42 -0.43 -0.44 -0.45 -0.46 -0.47 -0.48 -0.49 -0.50 -0.51 -0.52 -0.53 -0.54 -0.55 -0.56 -0.57 -0.58 -0.59 -0.60 -0.61 -0.62 -0.63 -0.64 -0.65 -0.66 -0.67 -0.68 -0.69 -0.70 -0.71 -0.72 -0.73 -0.74 -0.75 -0.76 -0.77 -0.78 -0.79 -0.80 -0.81 -0.82 -0.83 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$^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )

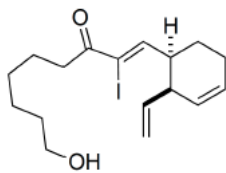


$^{13}\text{C}$  NMR (125 MHz,  $\text{CDCl}_3$ )

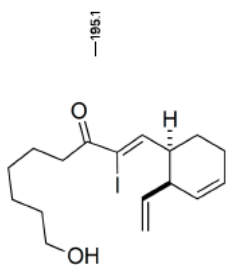
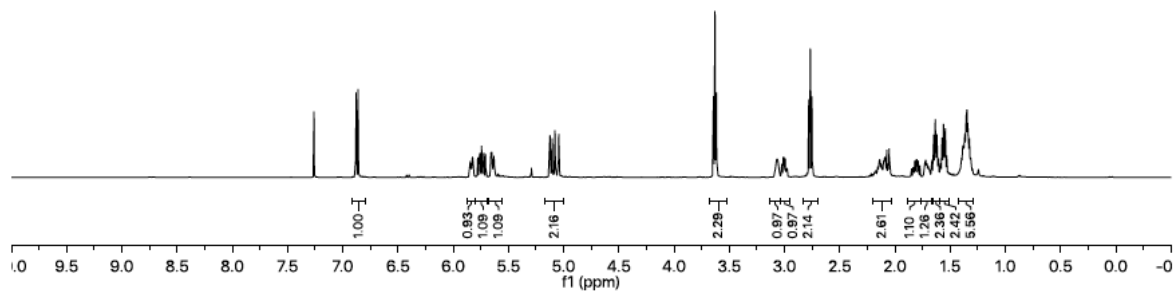




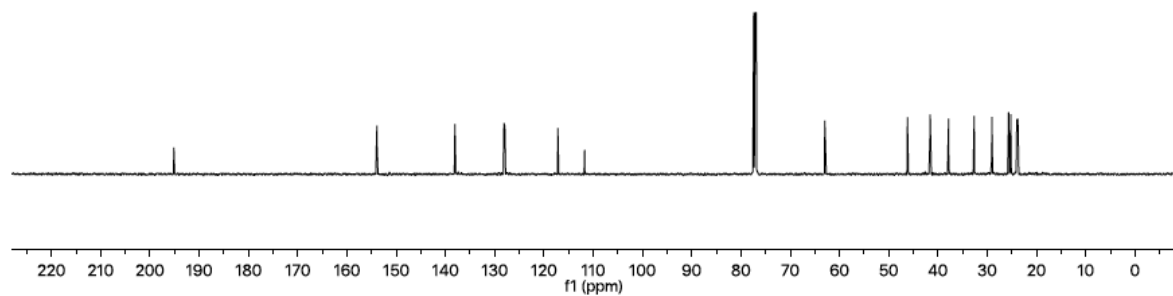
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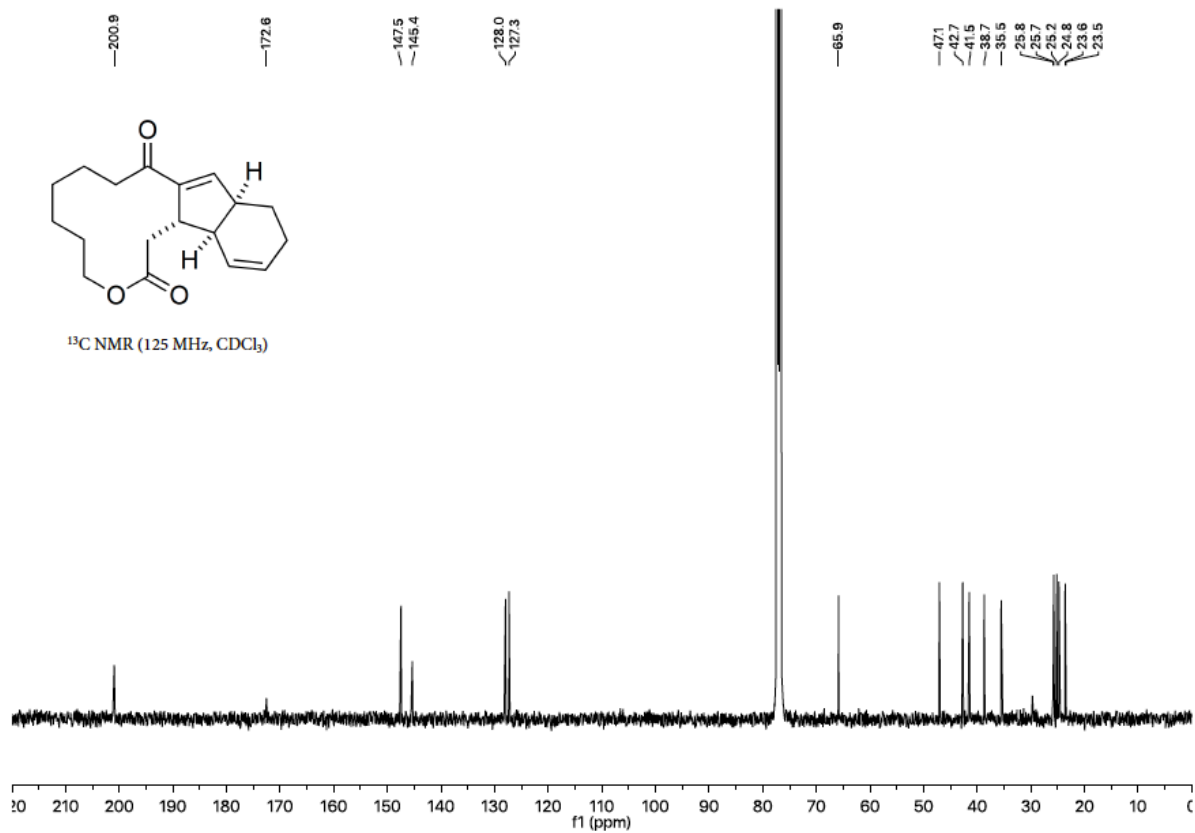
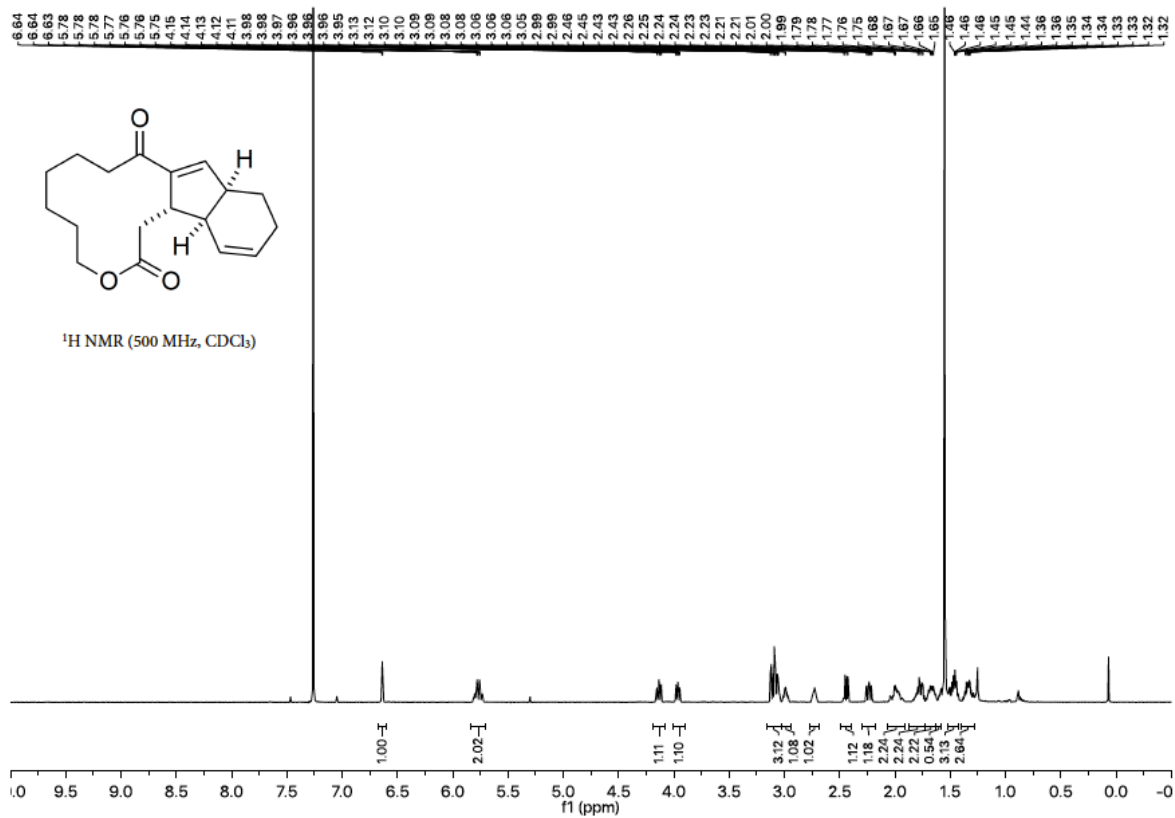


$^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )

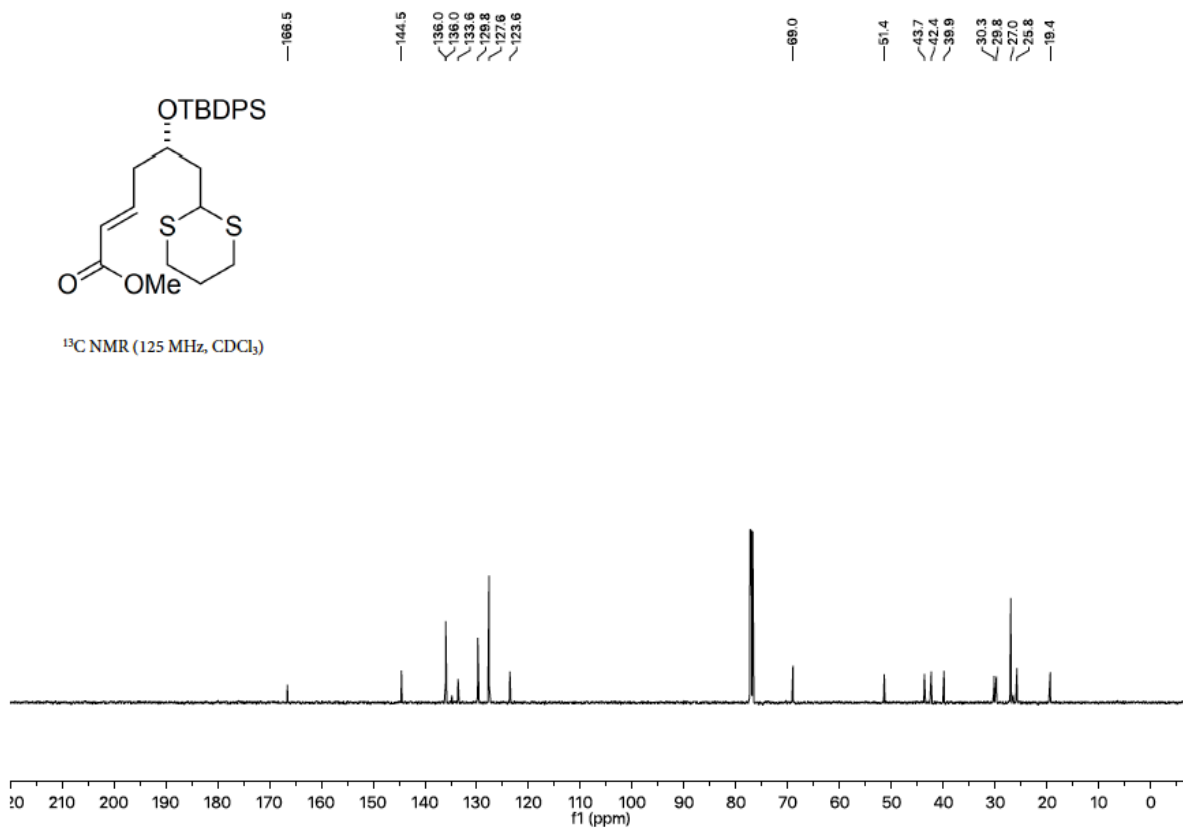
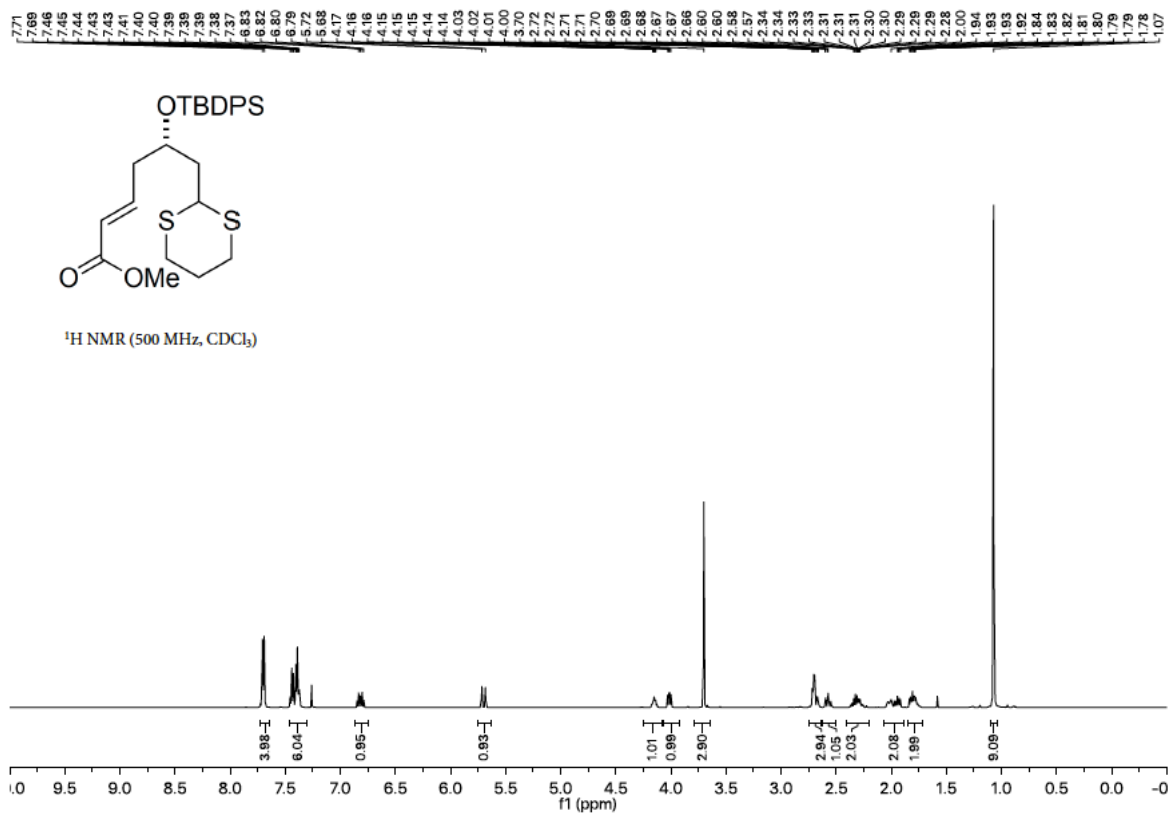


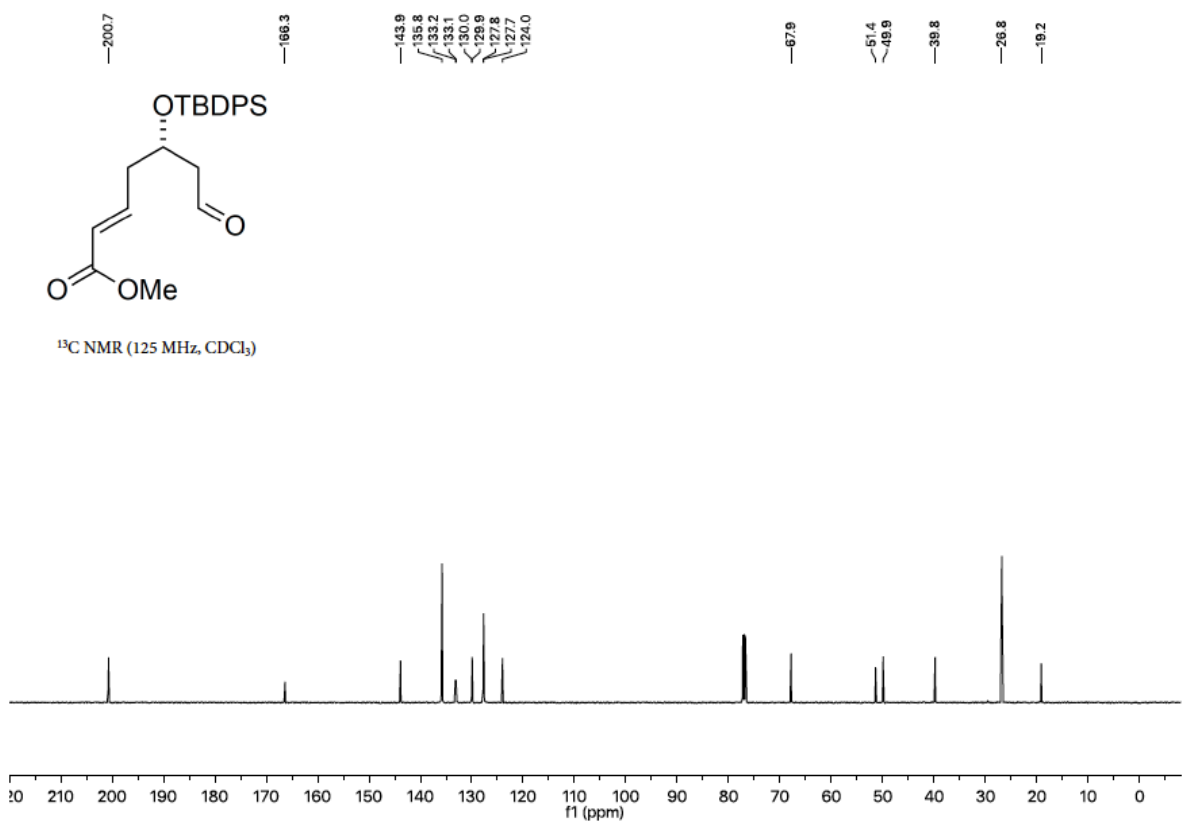
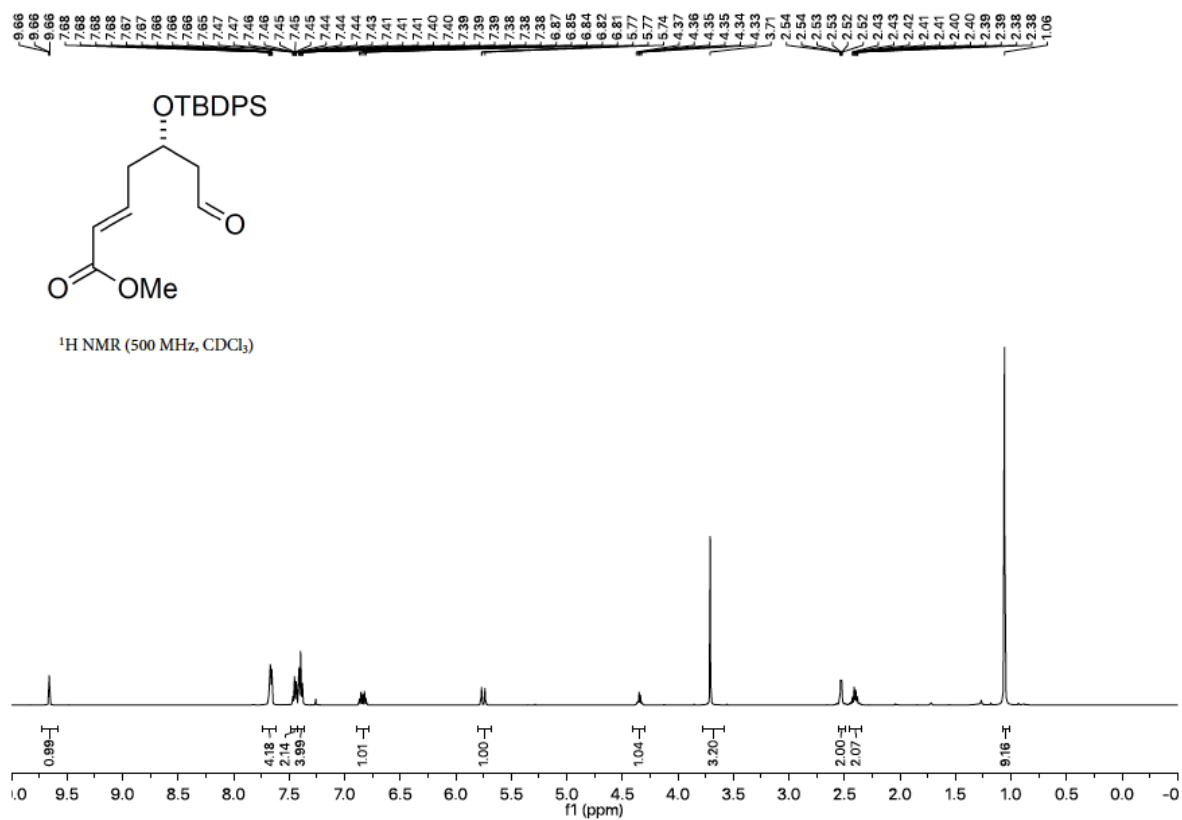
$^{13}\text{C}$  NMR (125 MHz,  $\text{CDCl}_3$ )

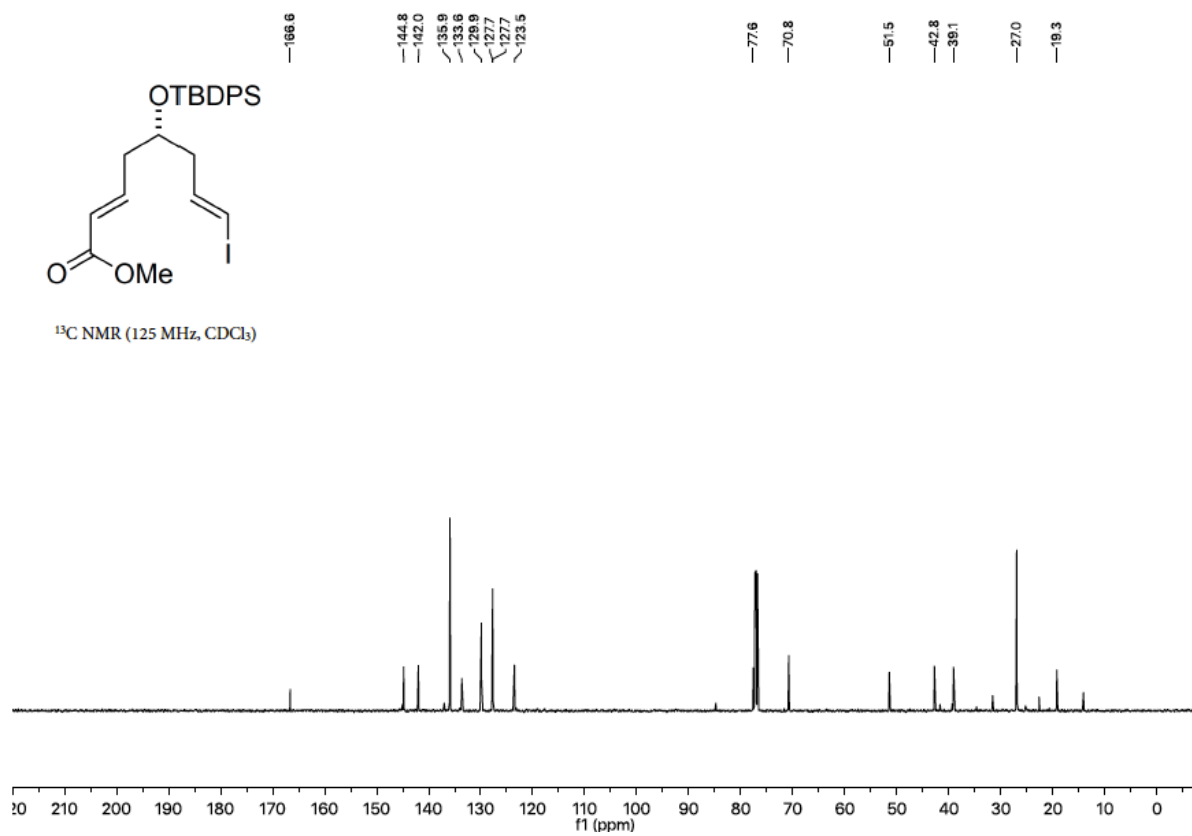
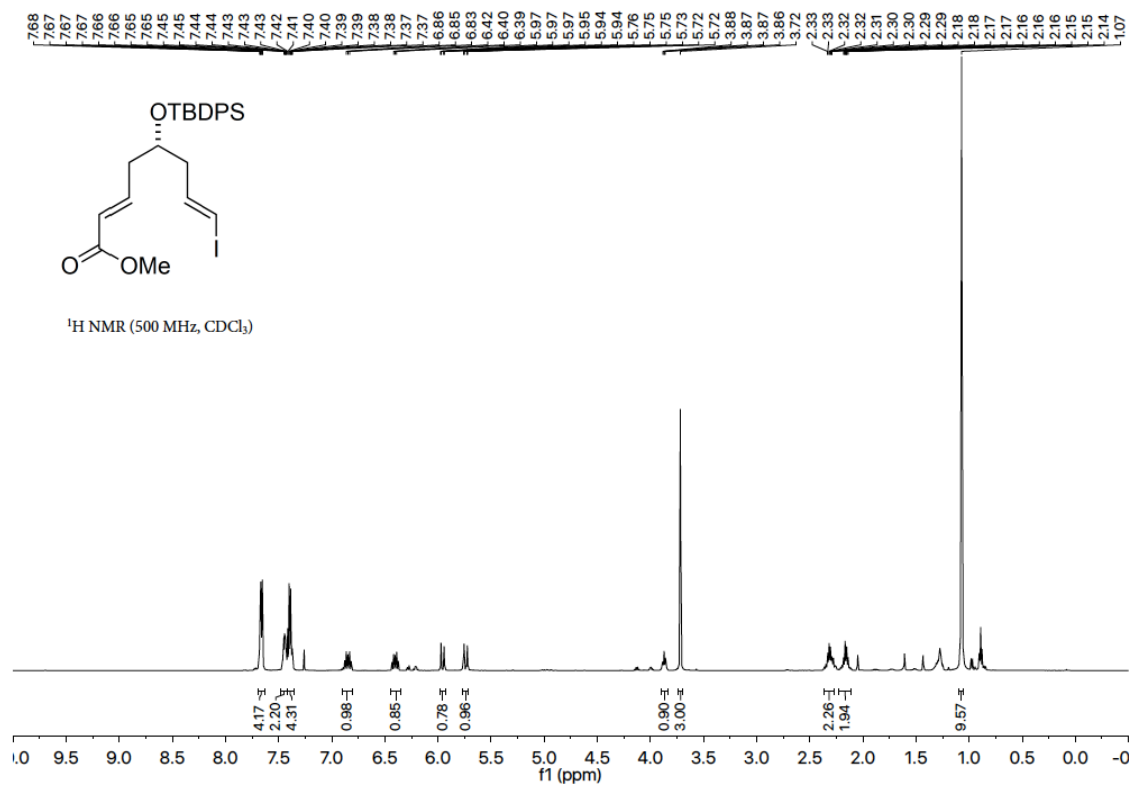


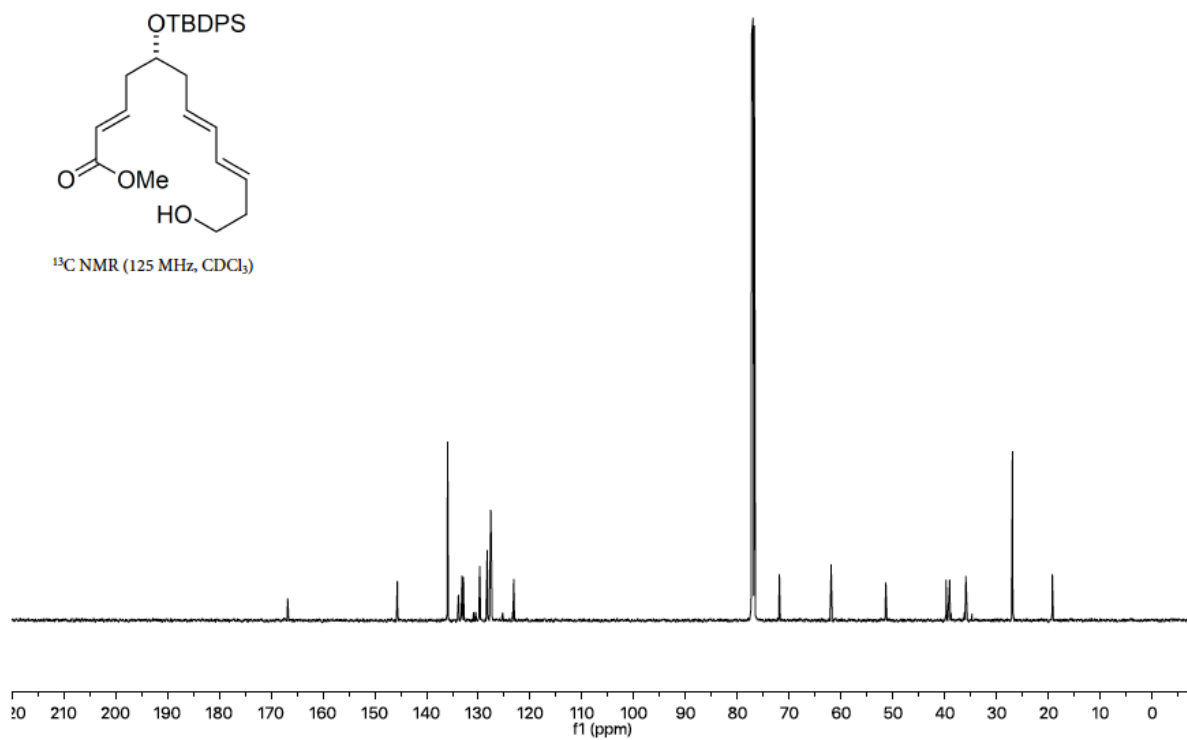
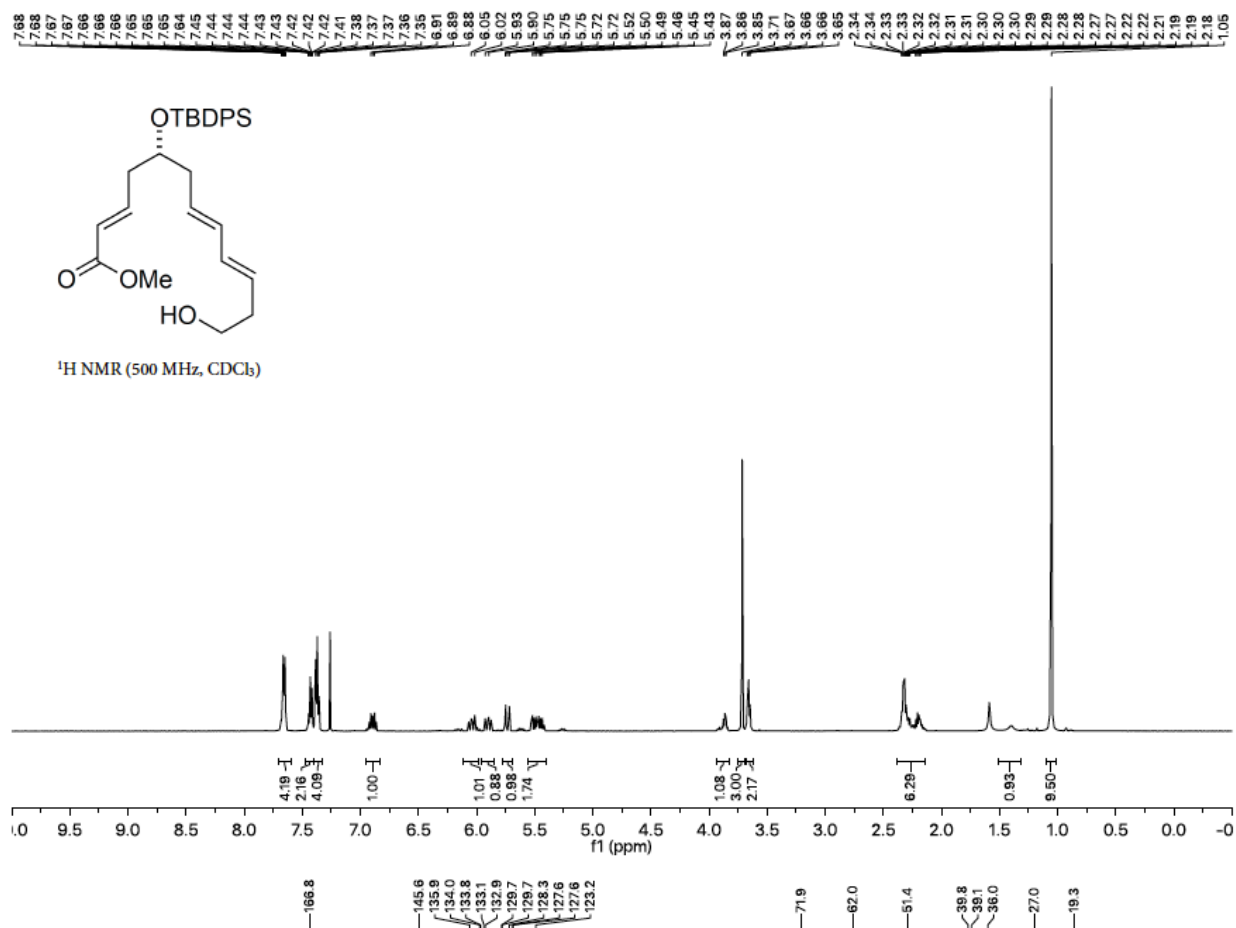


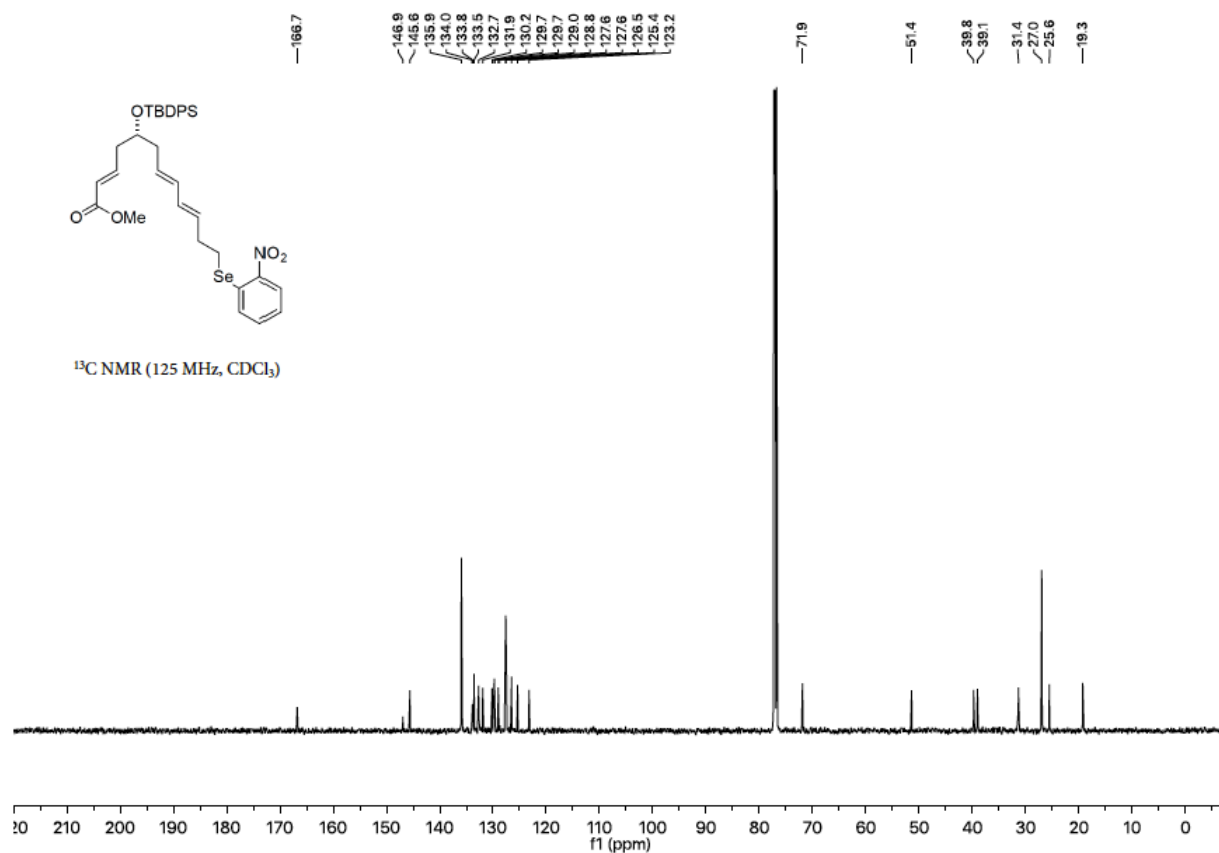
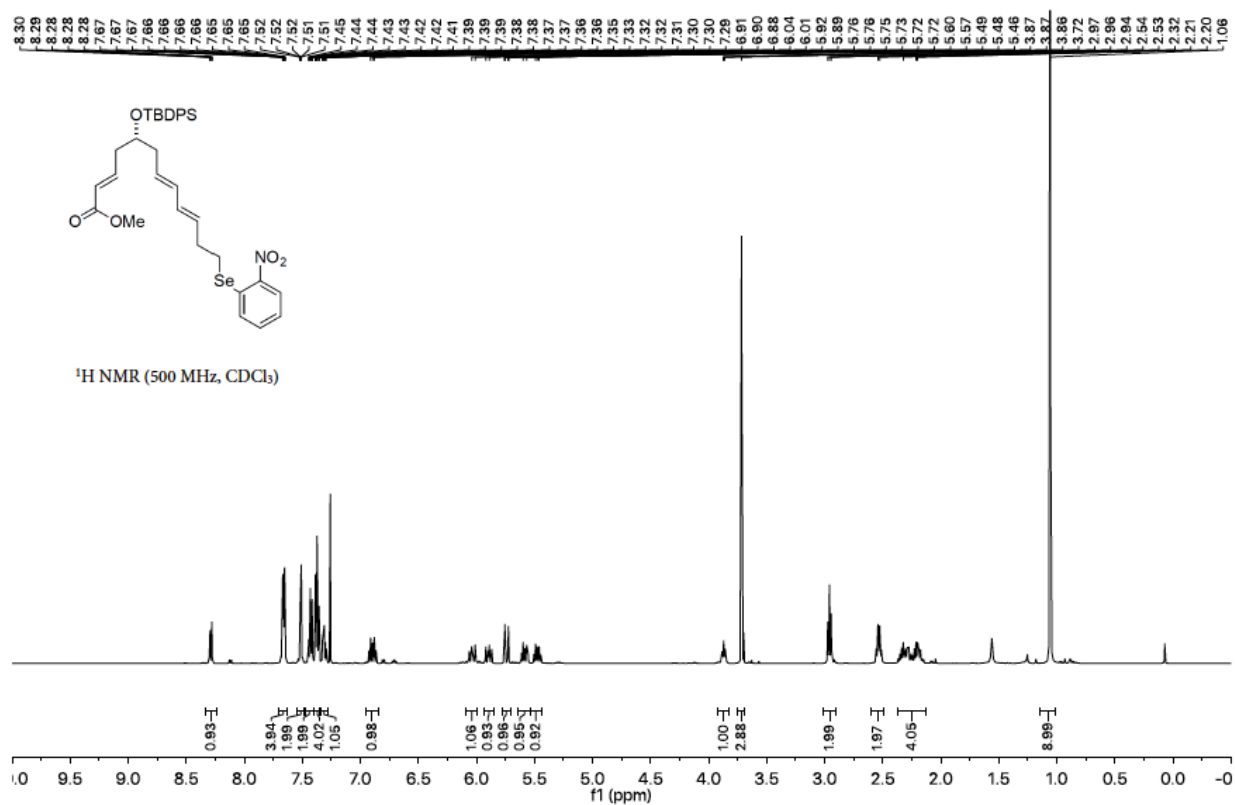




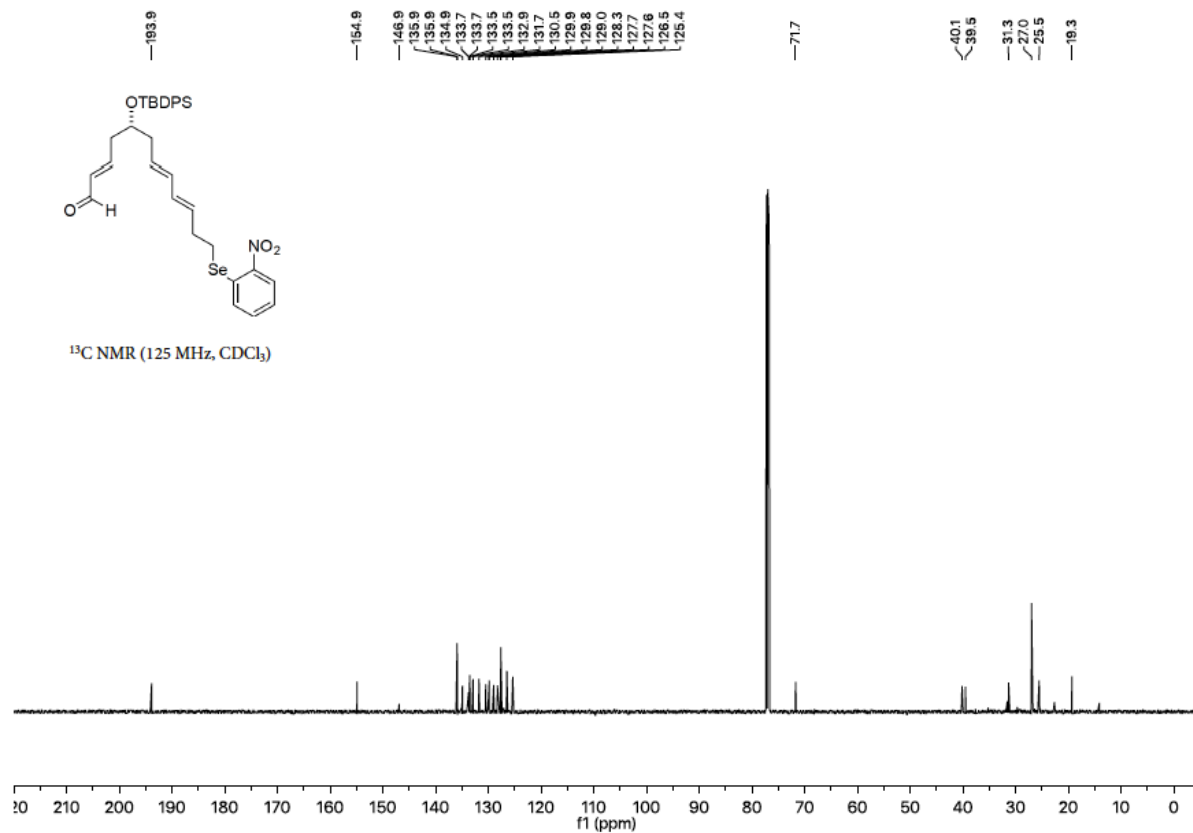
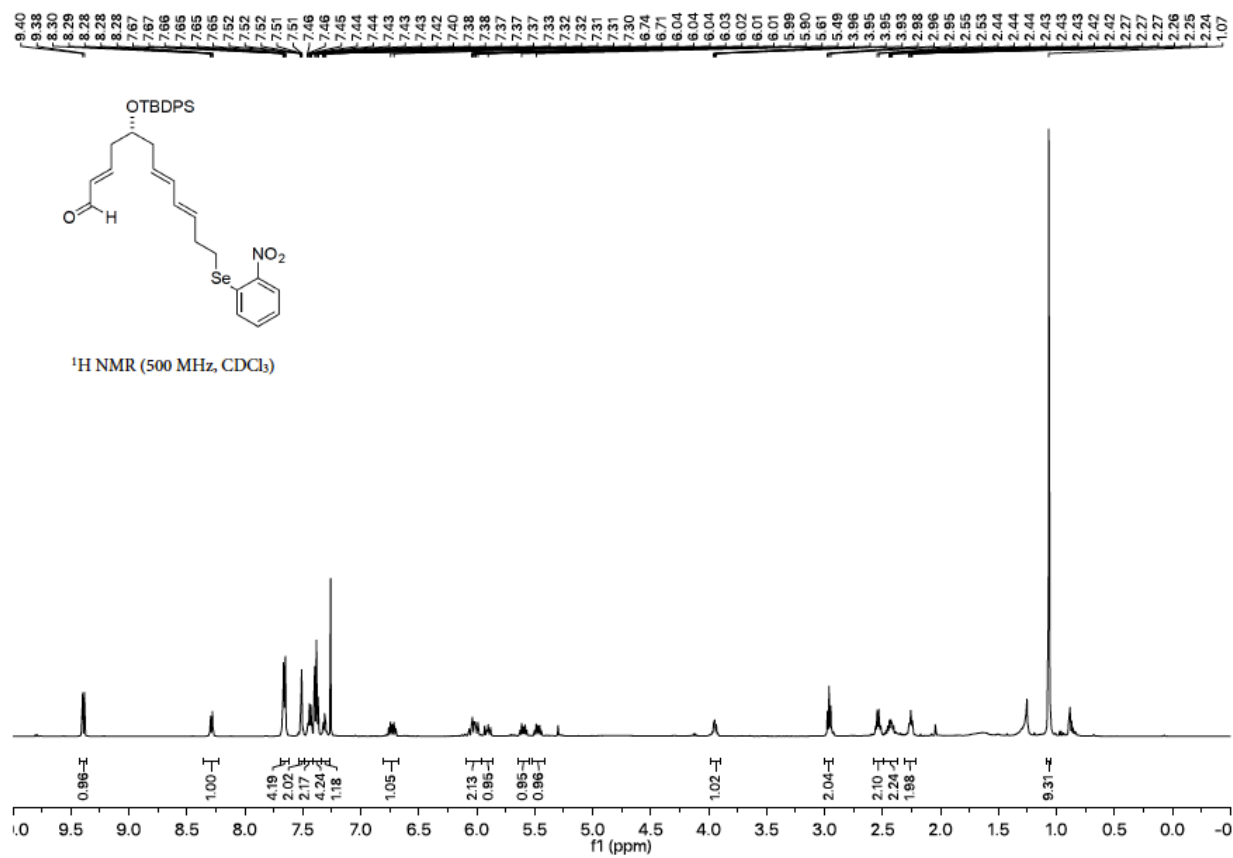


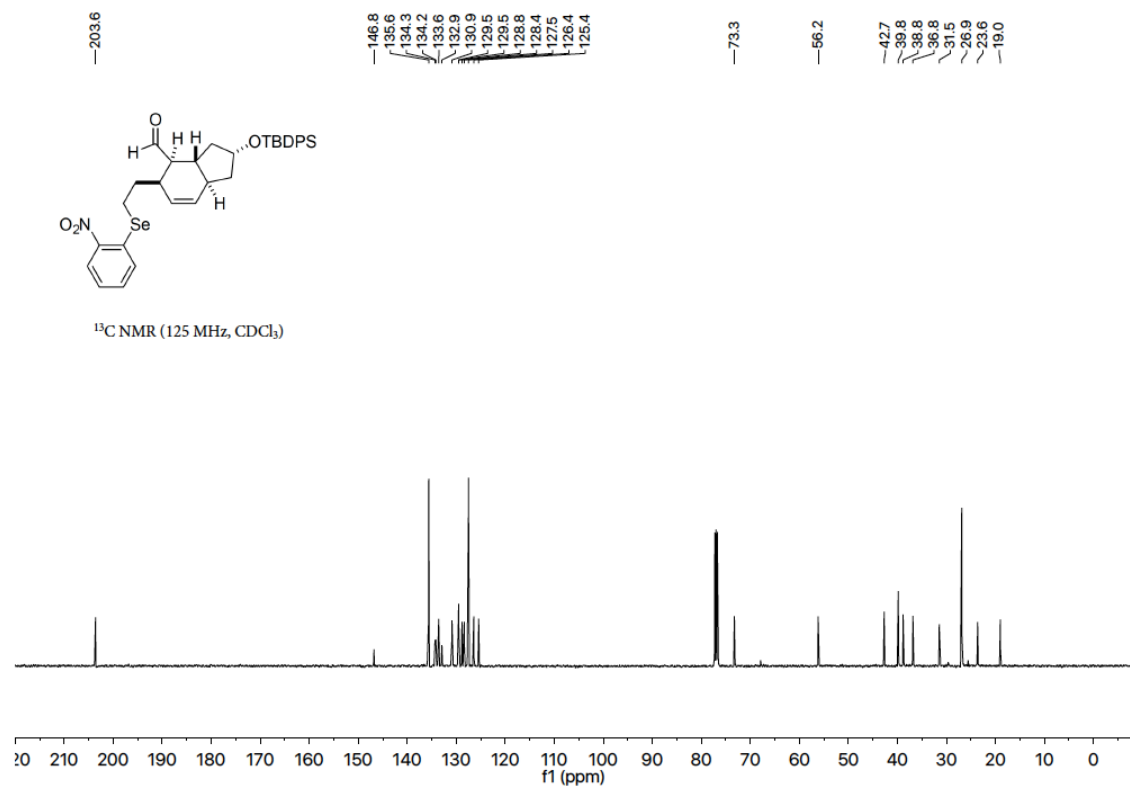
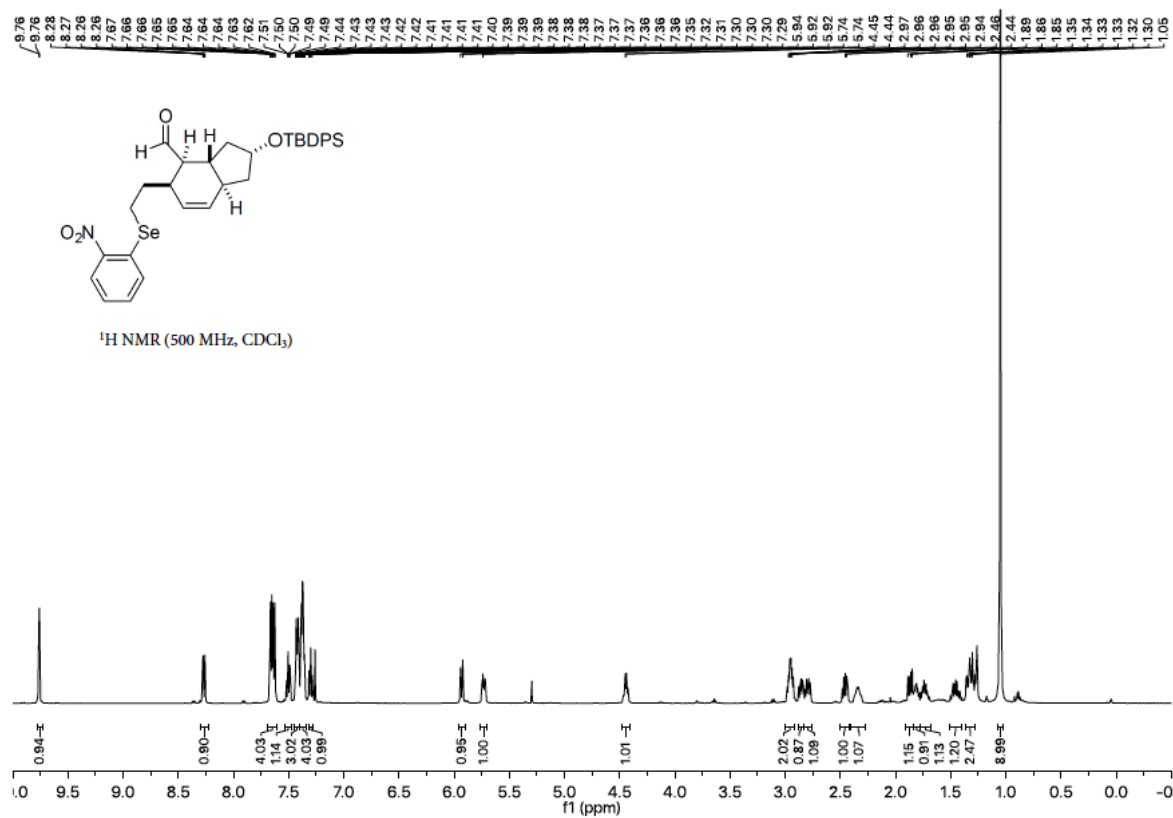




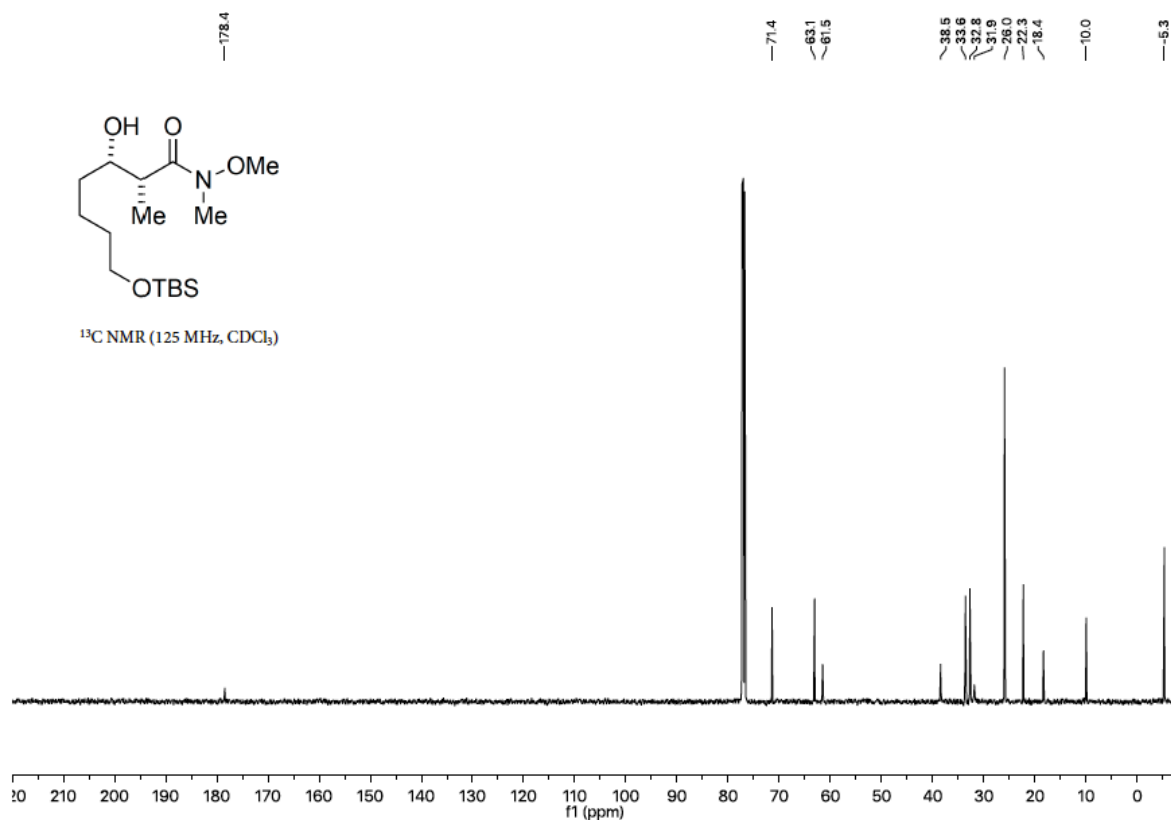
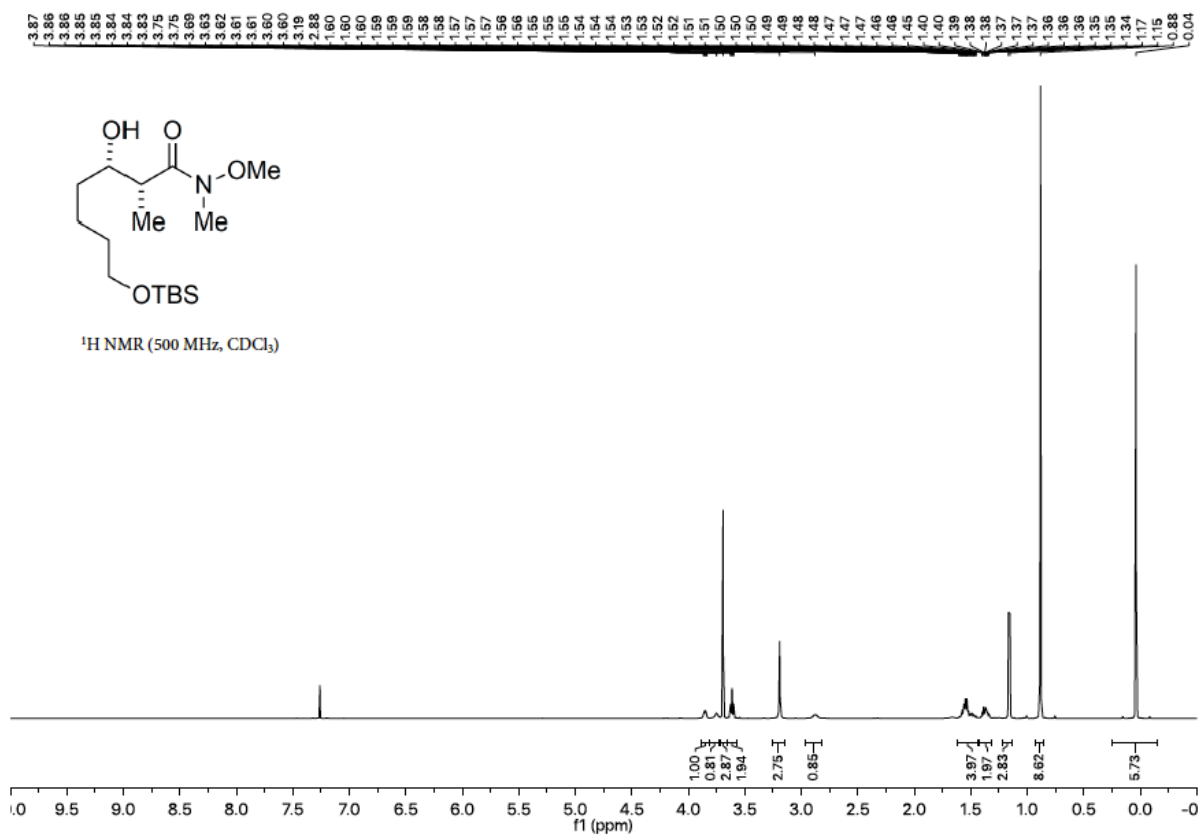


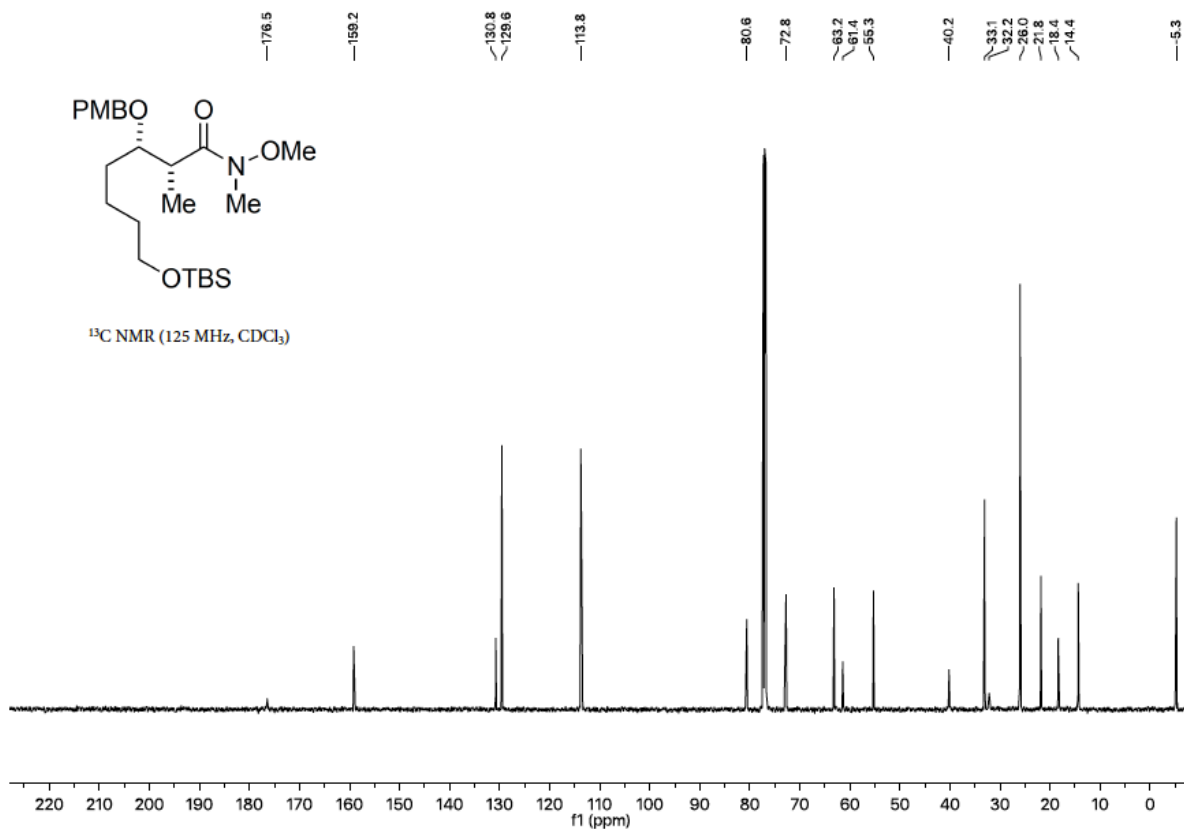
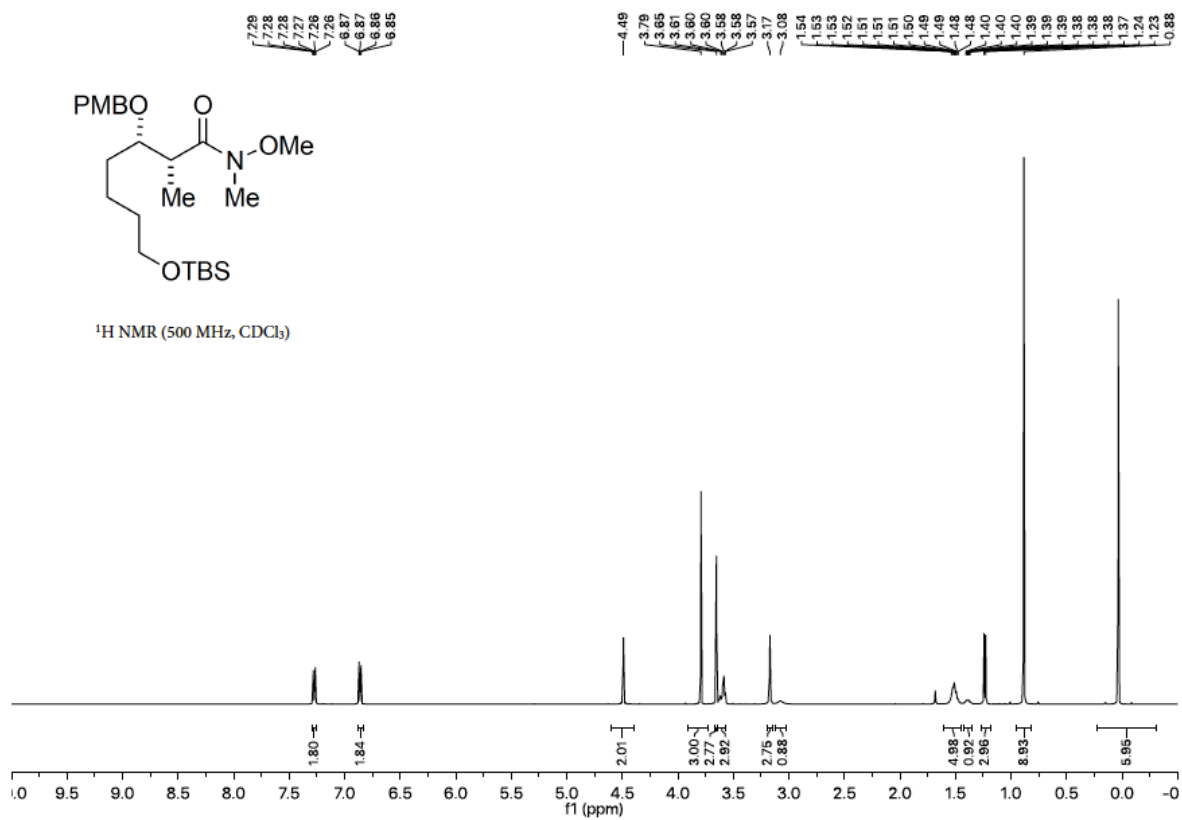


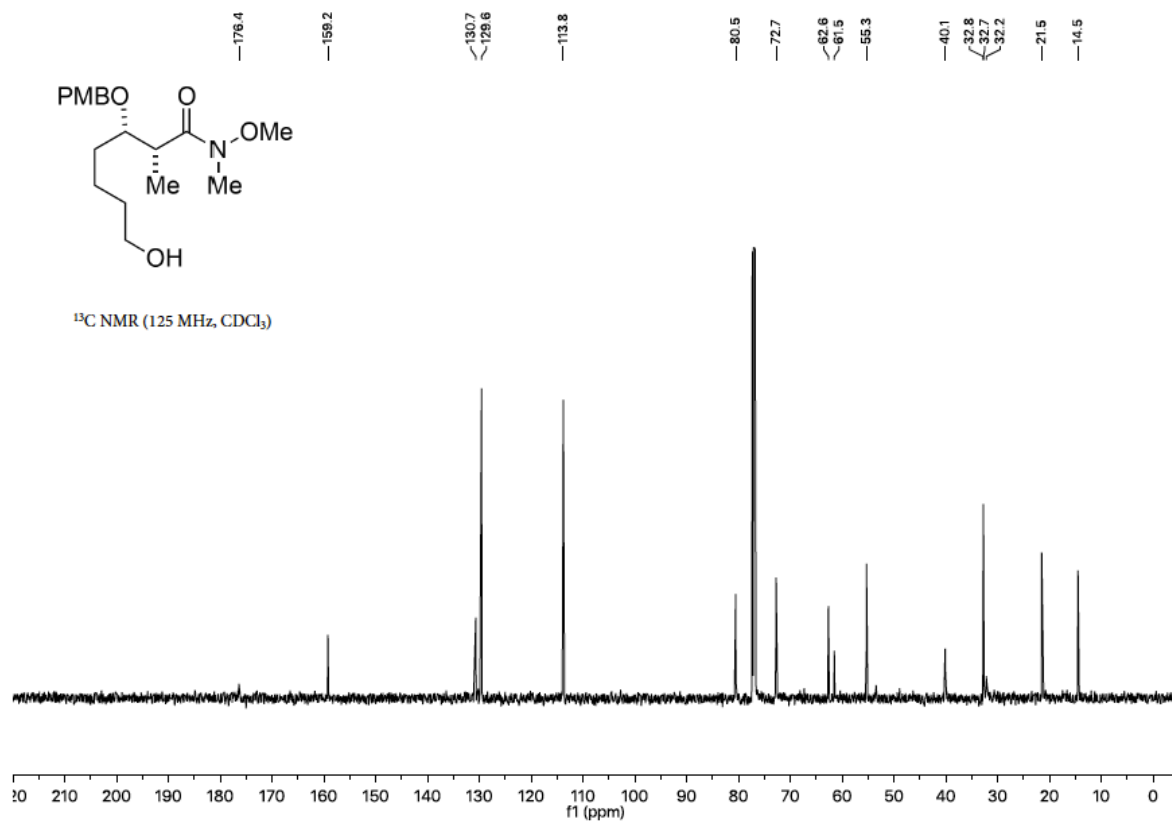
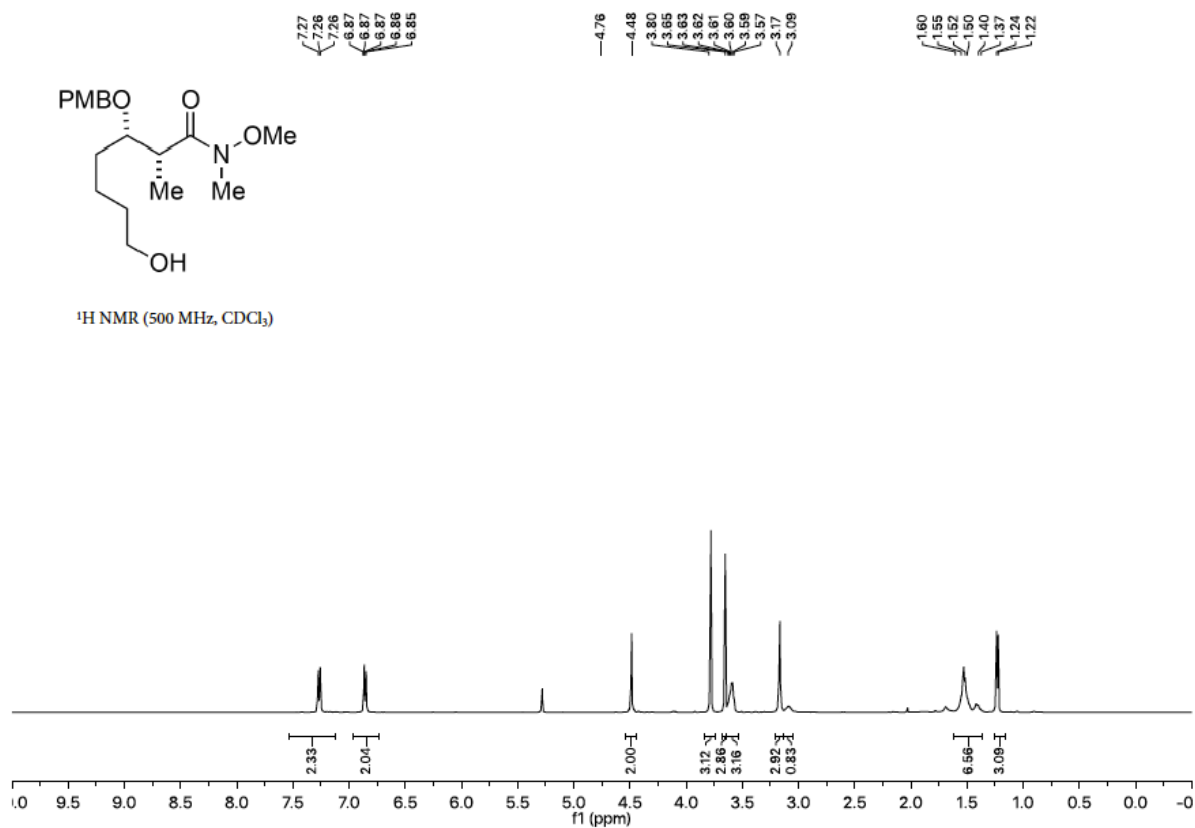


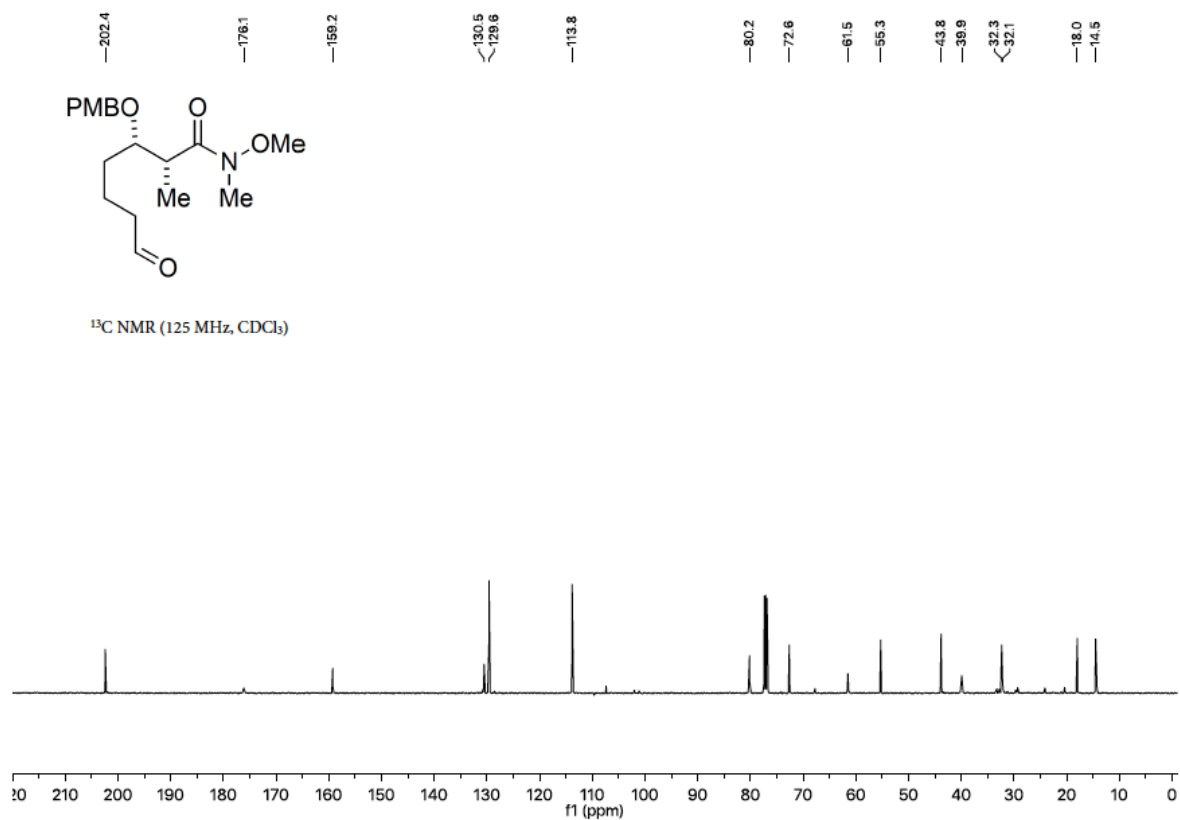
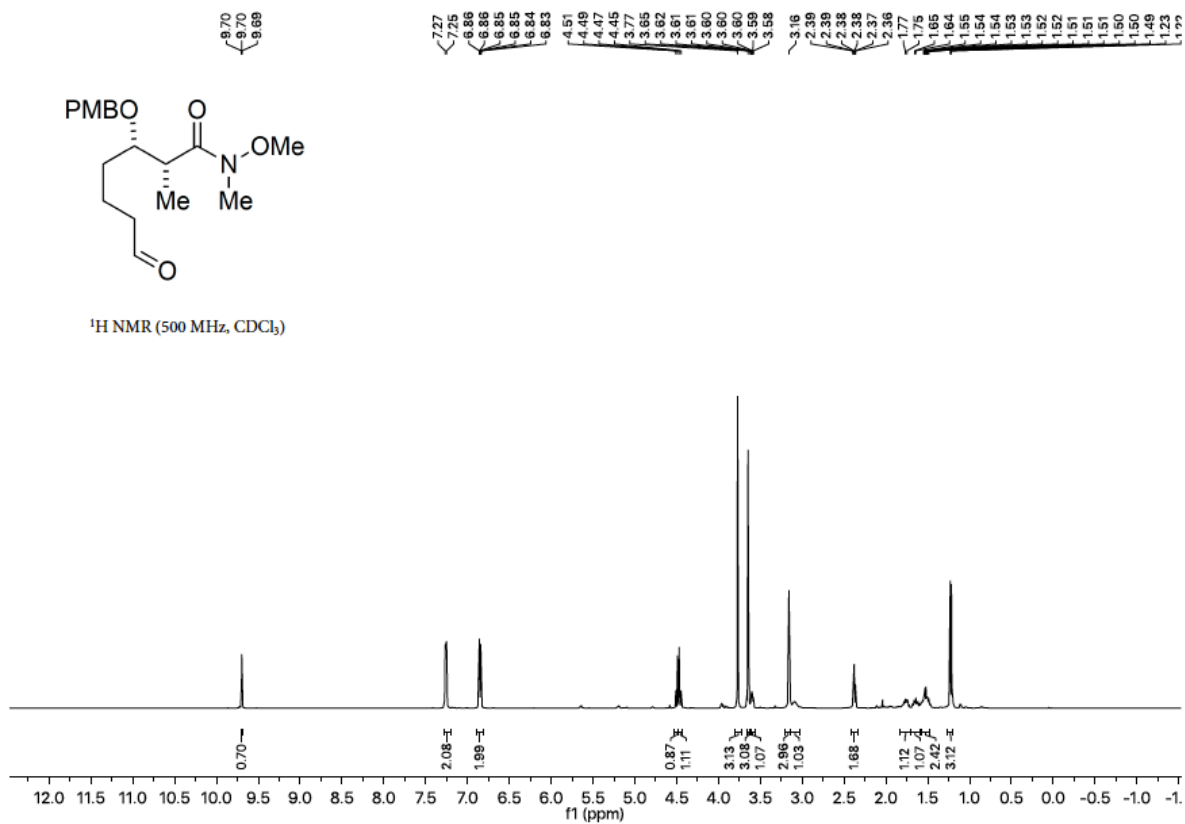


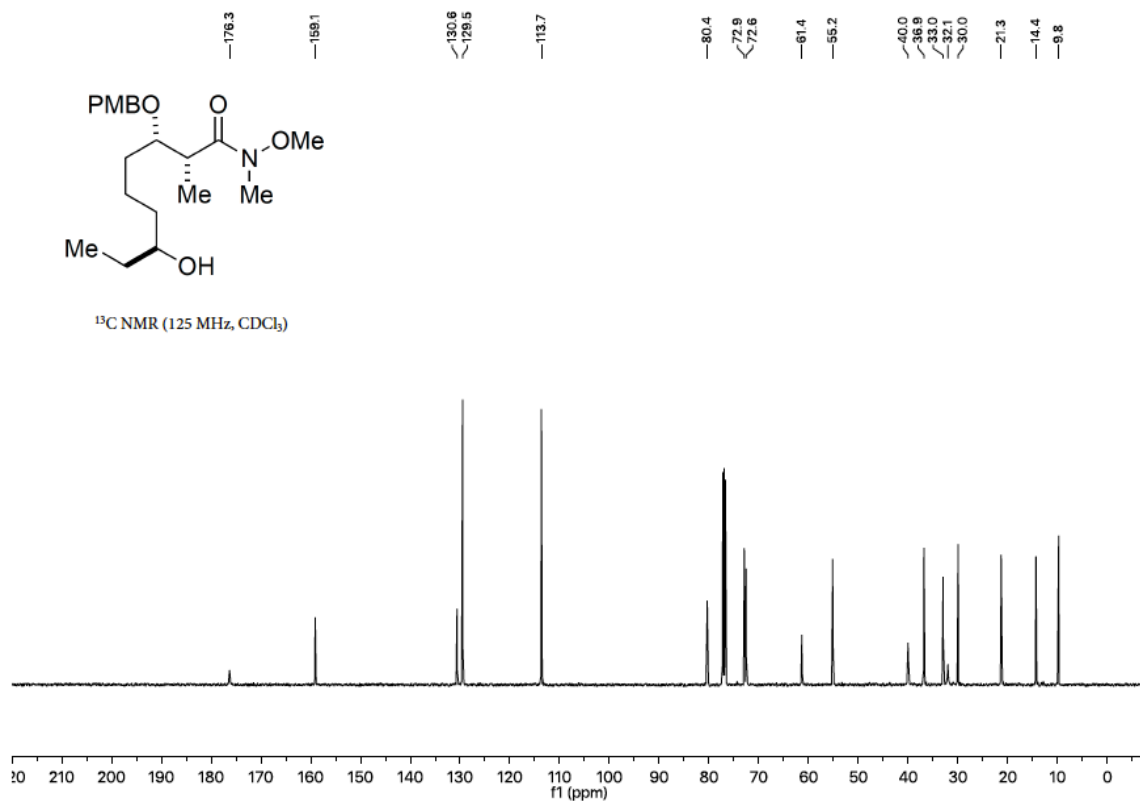
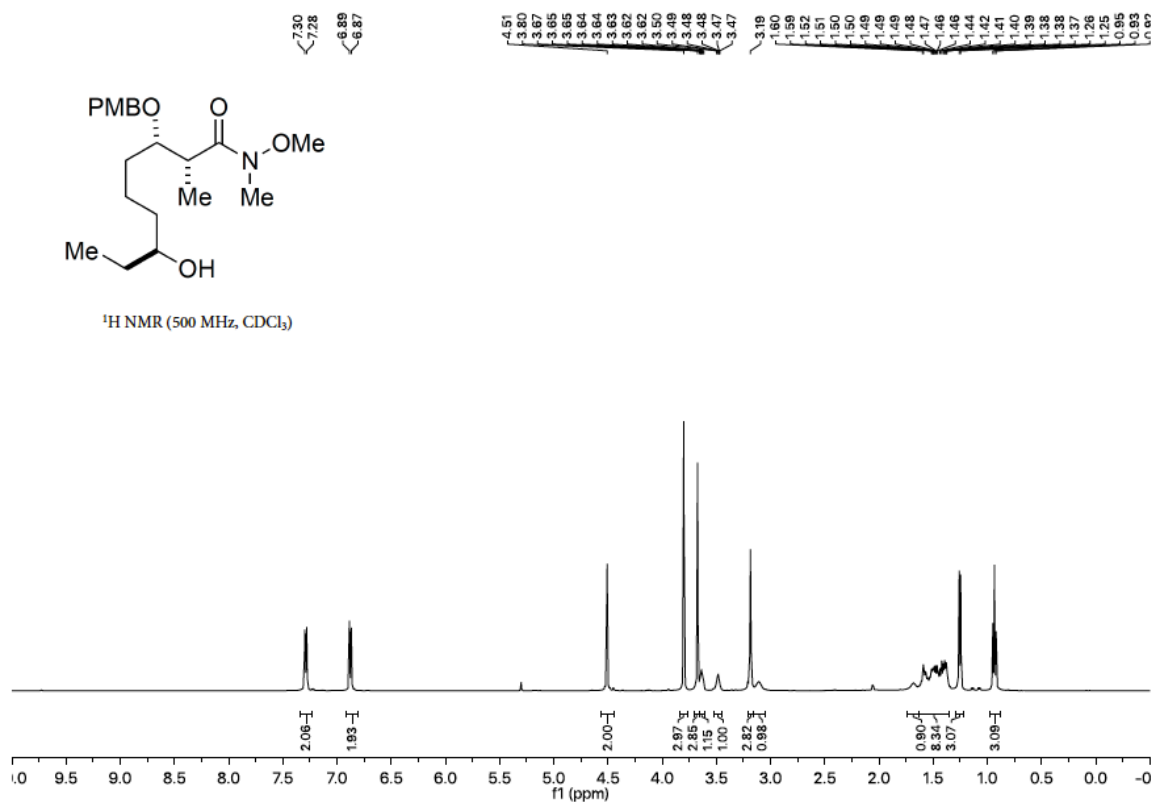


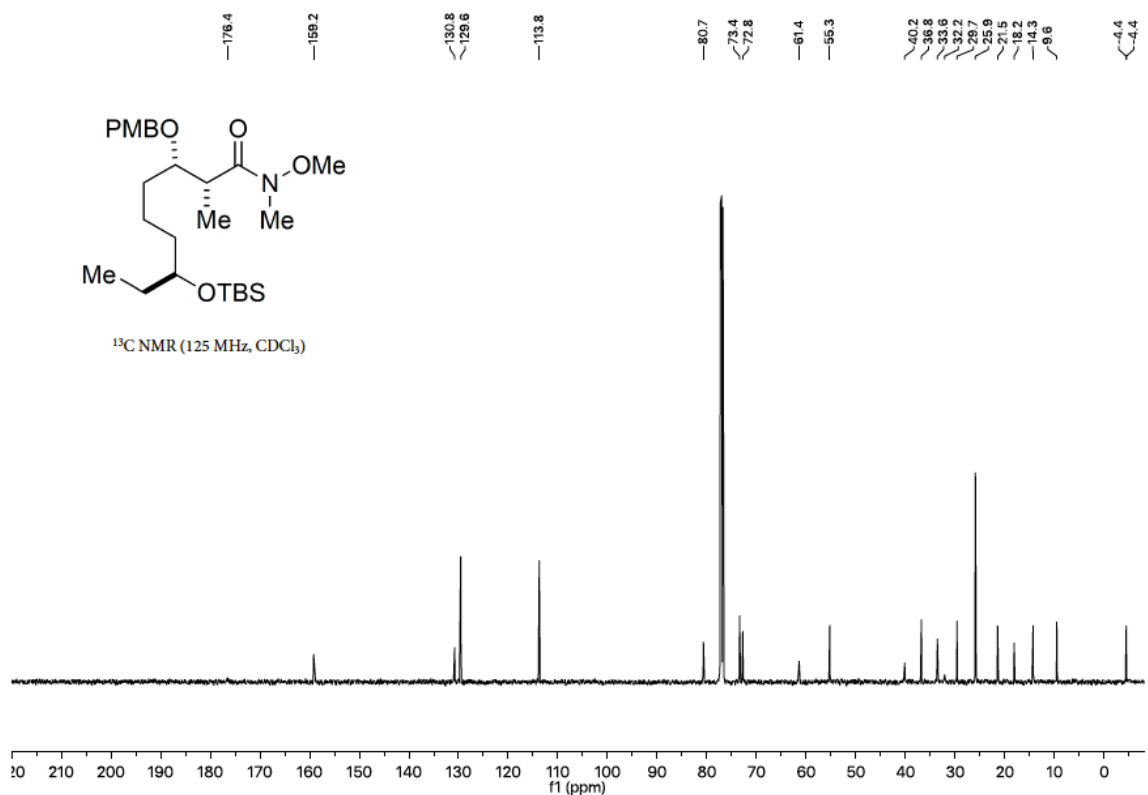
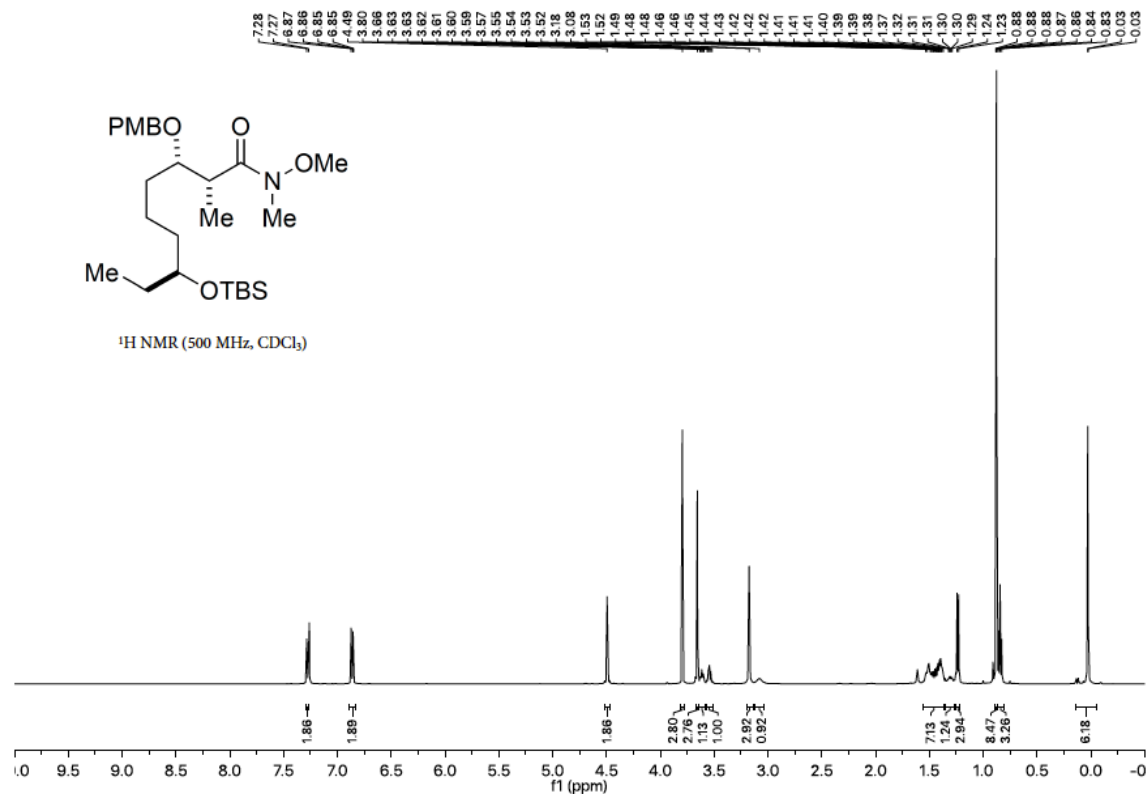




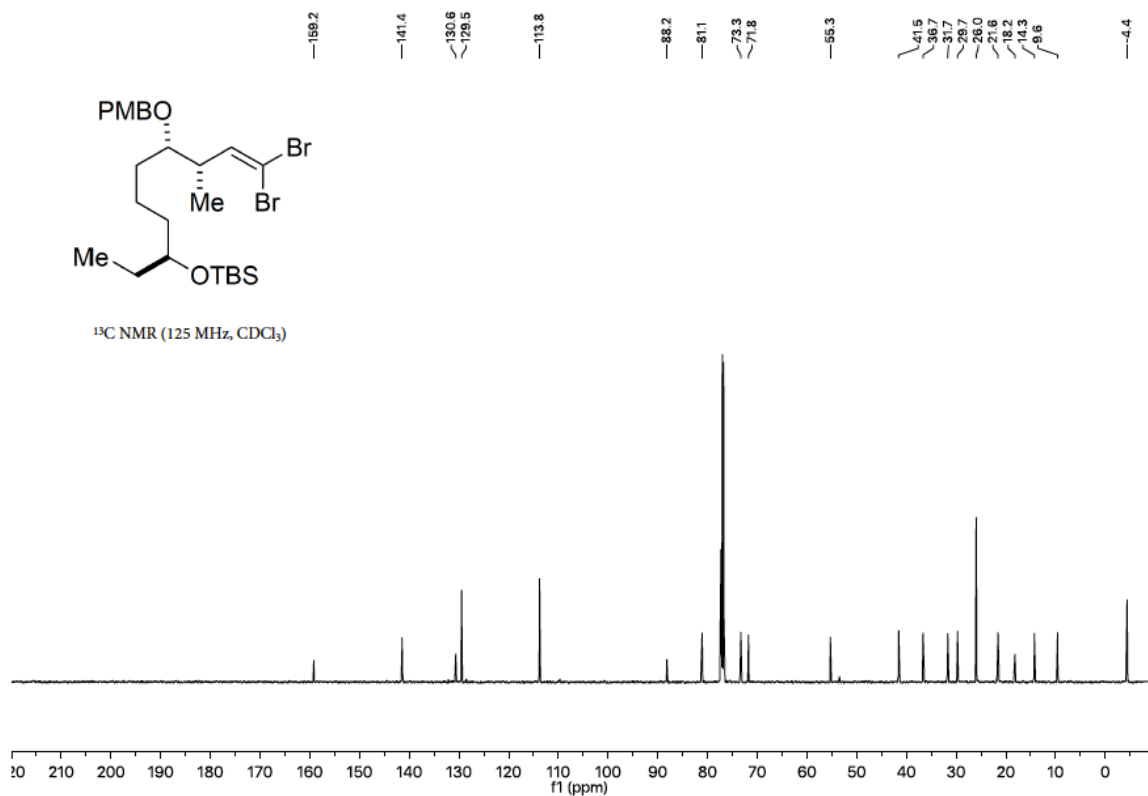
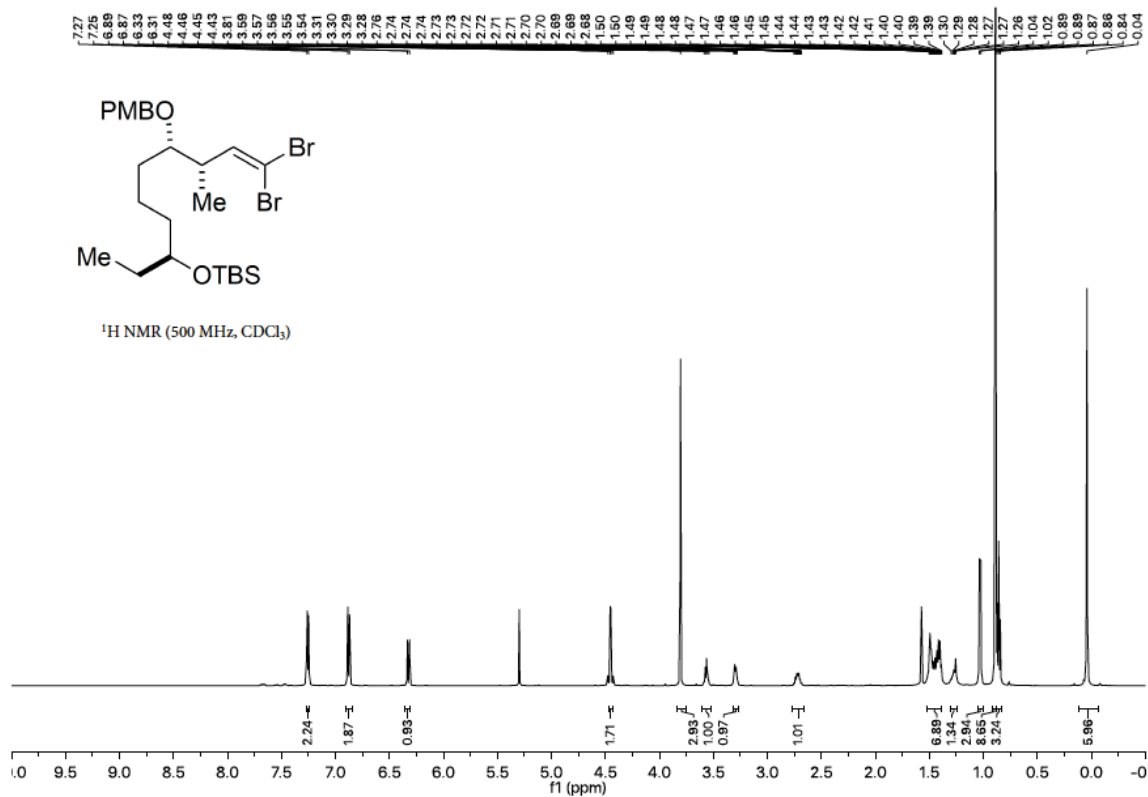






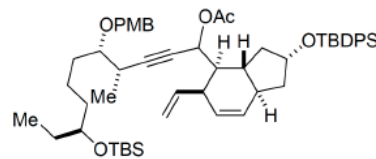
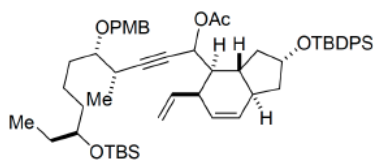


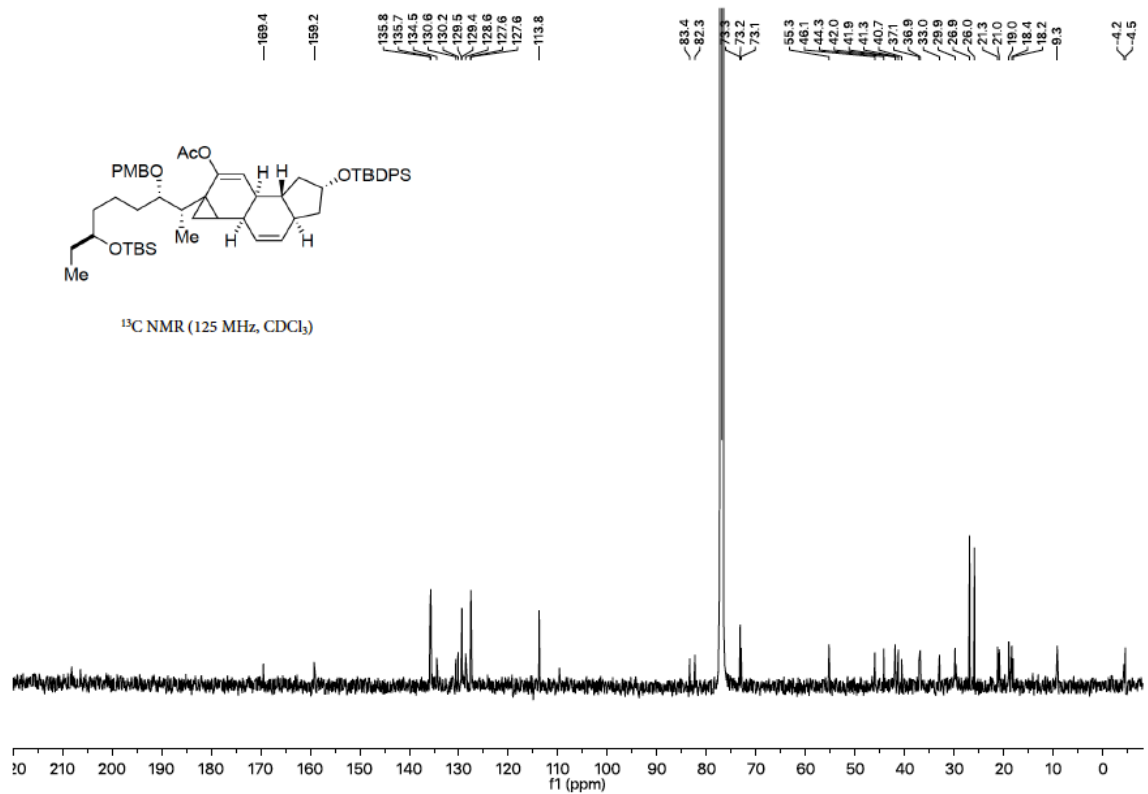
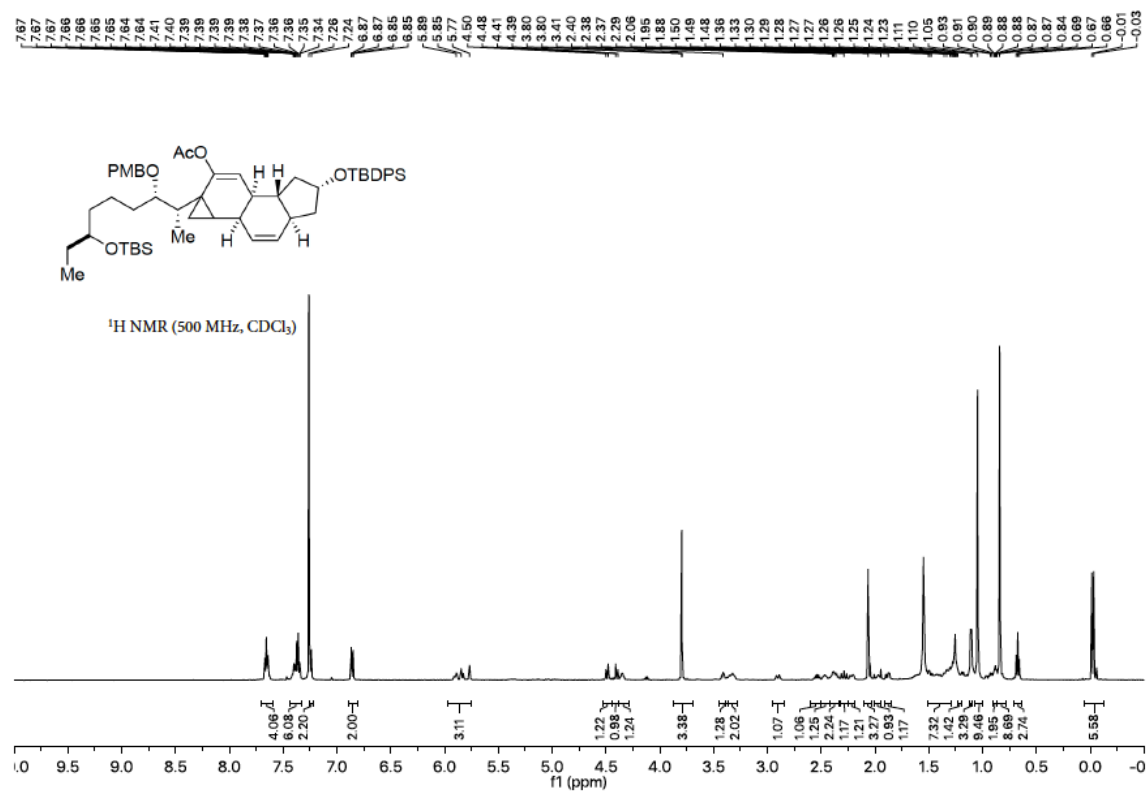


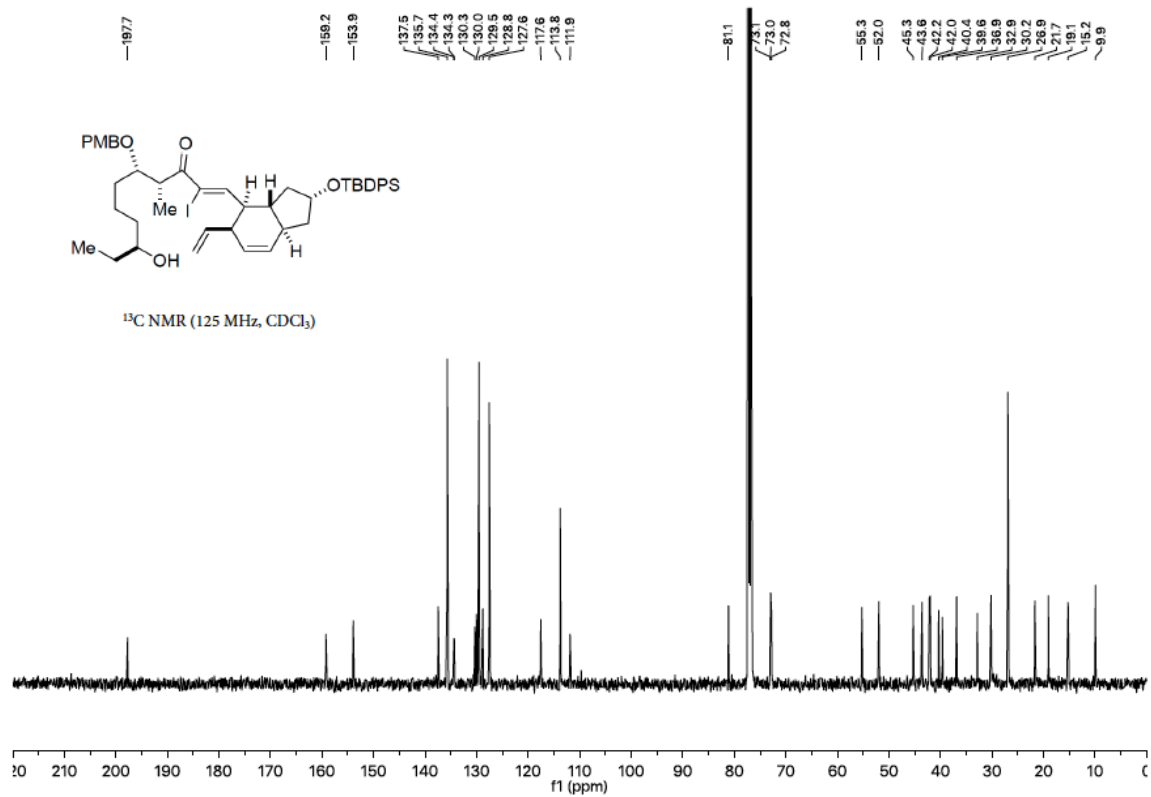
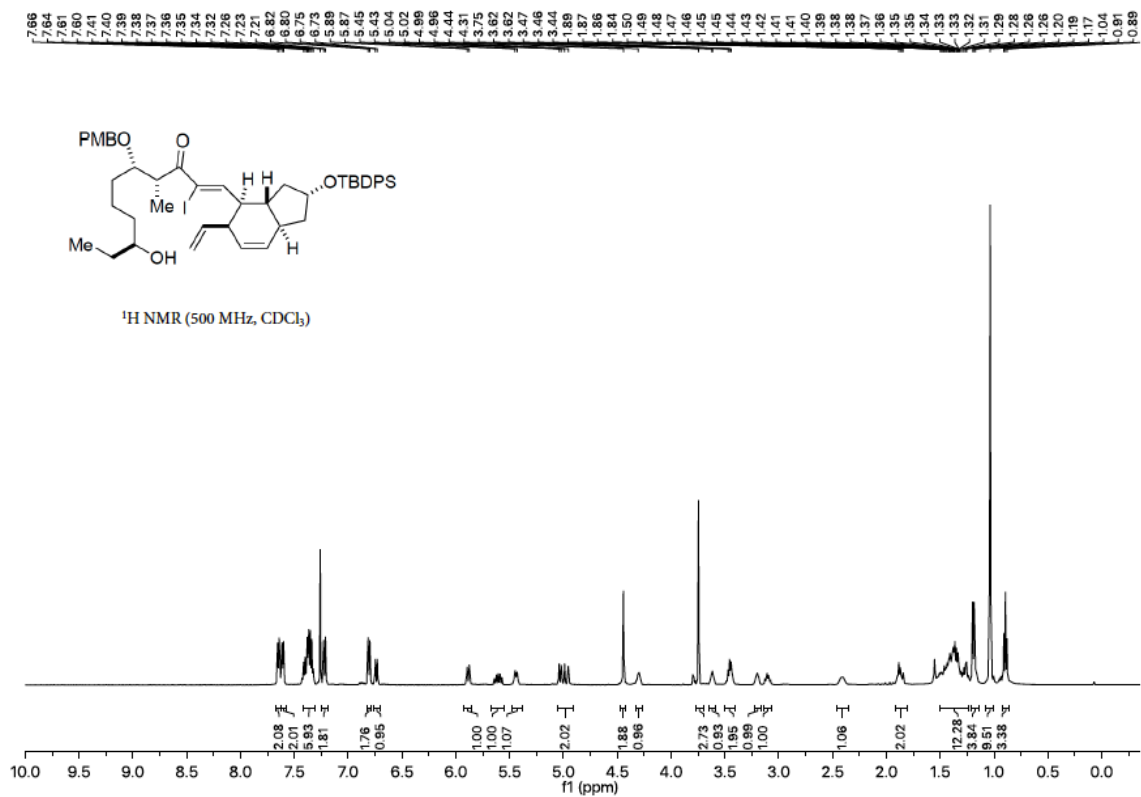


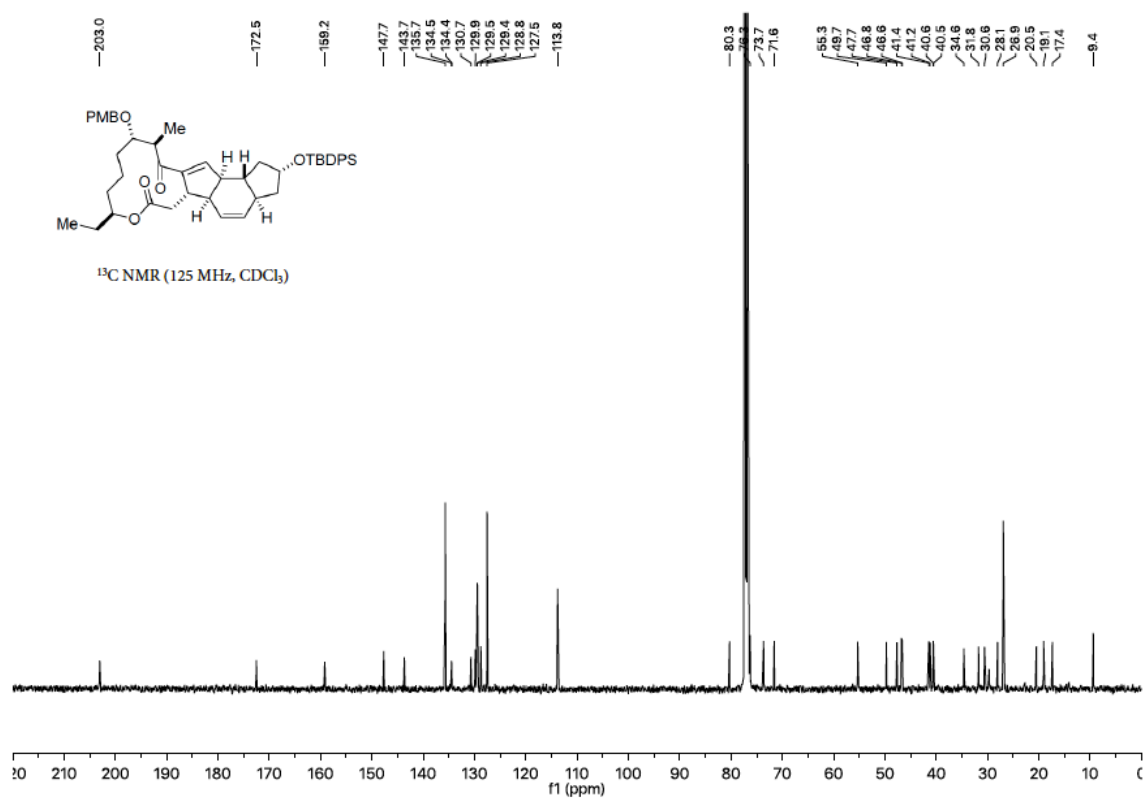
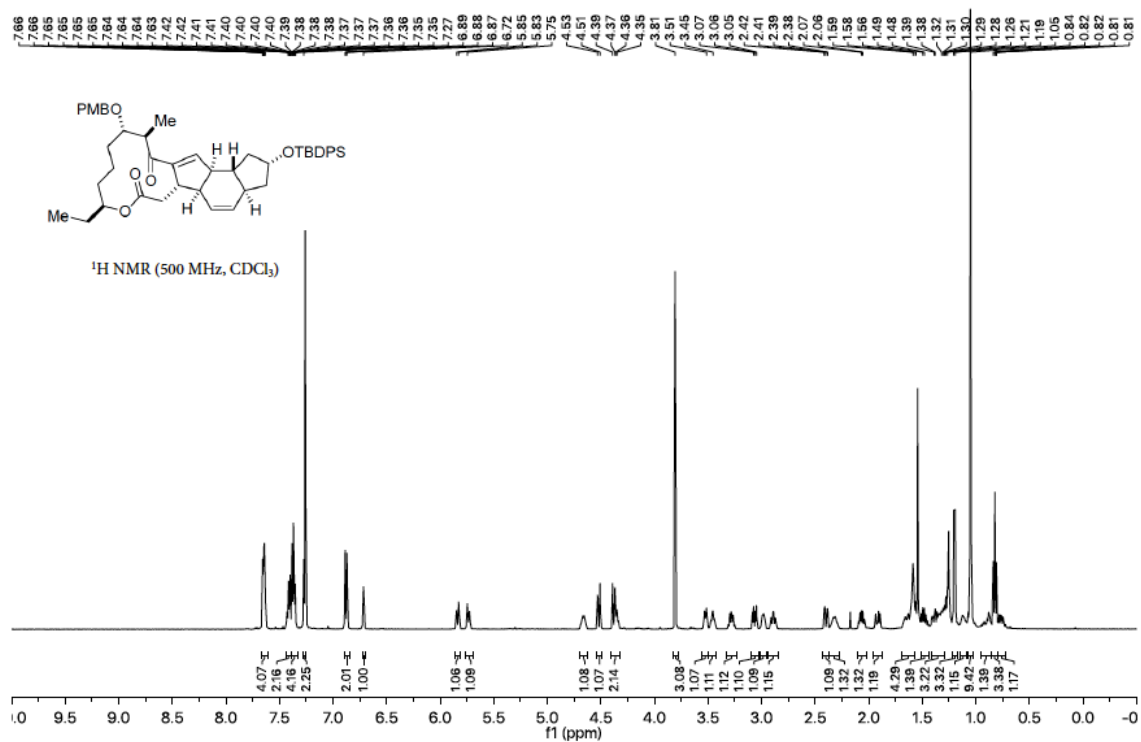


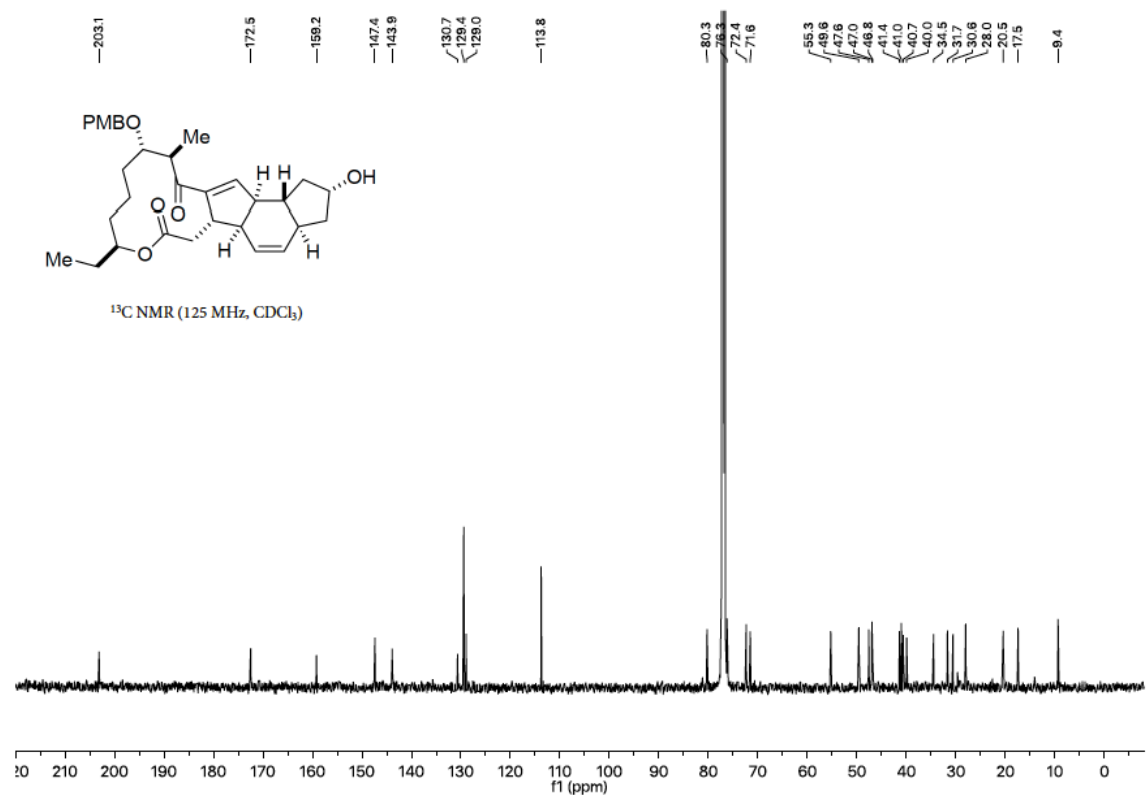
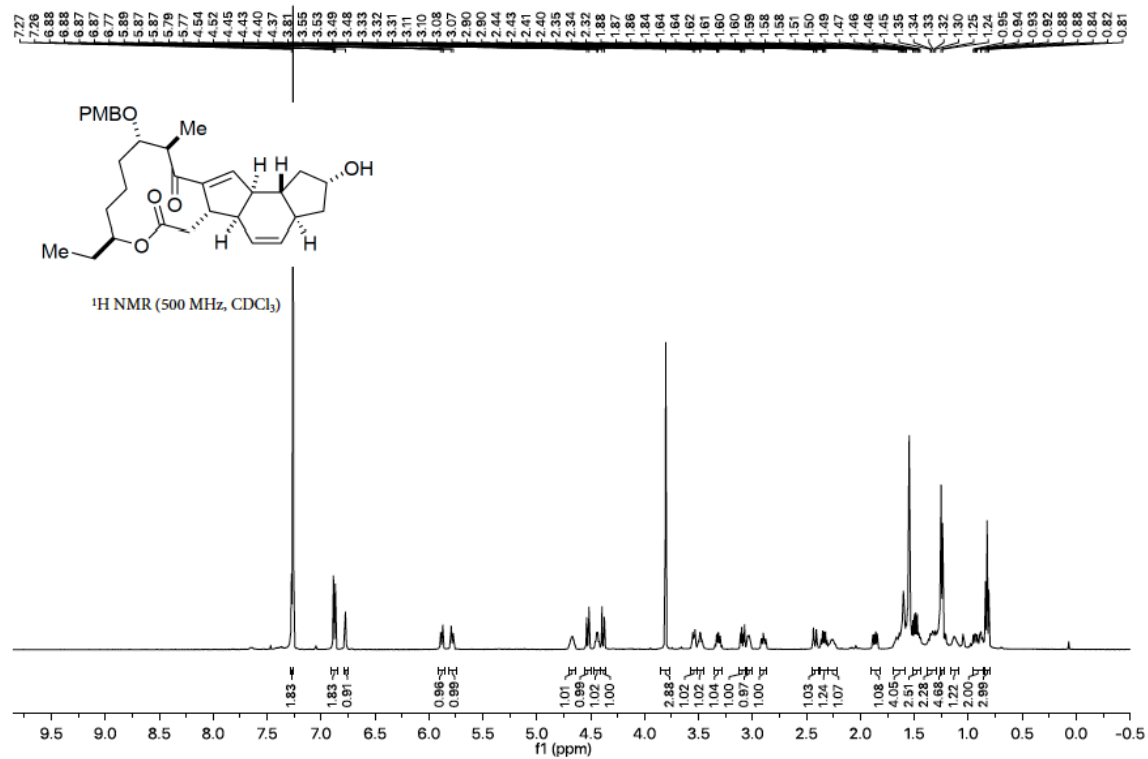


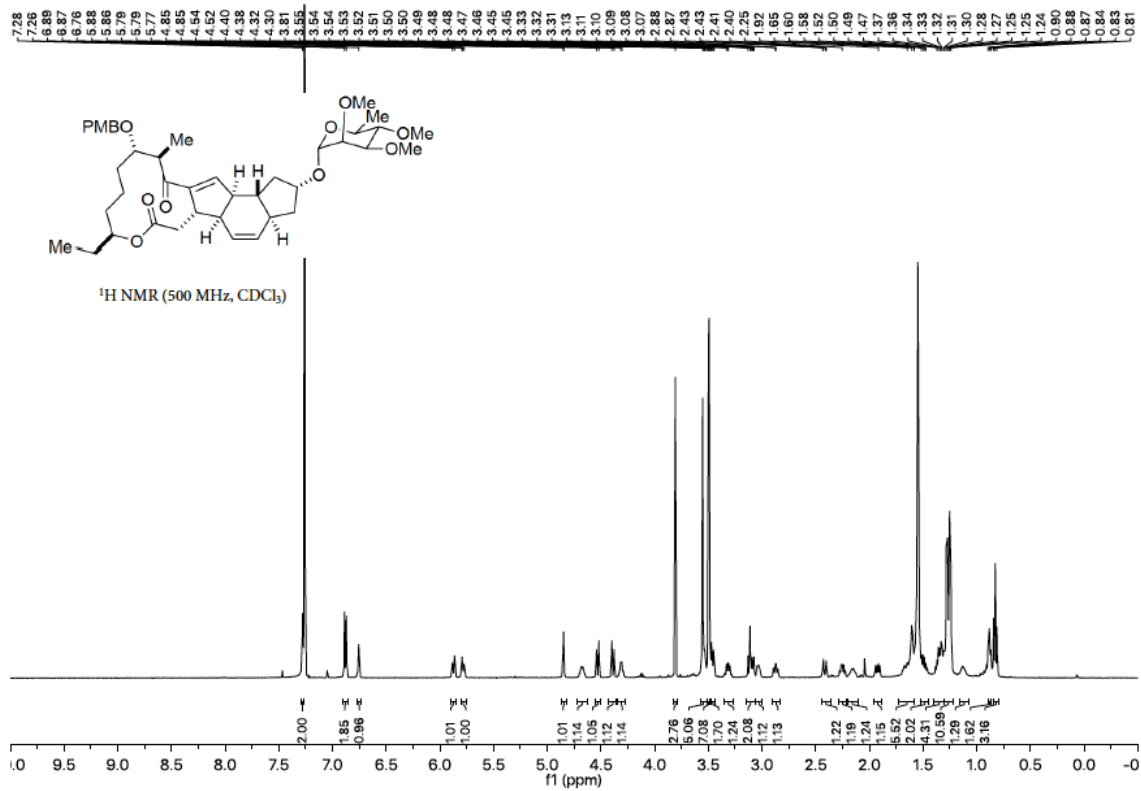




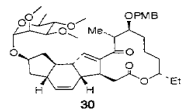




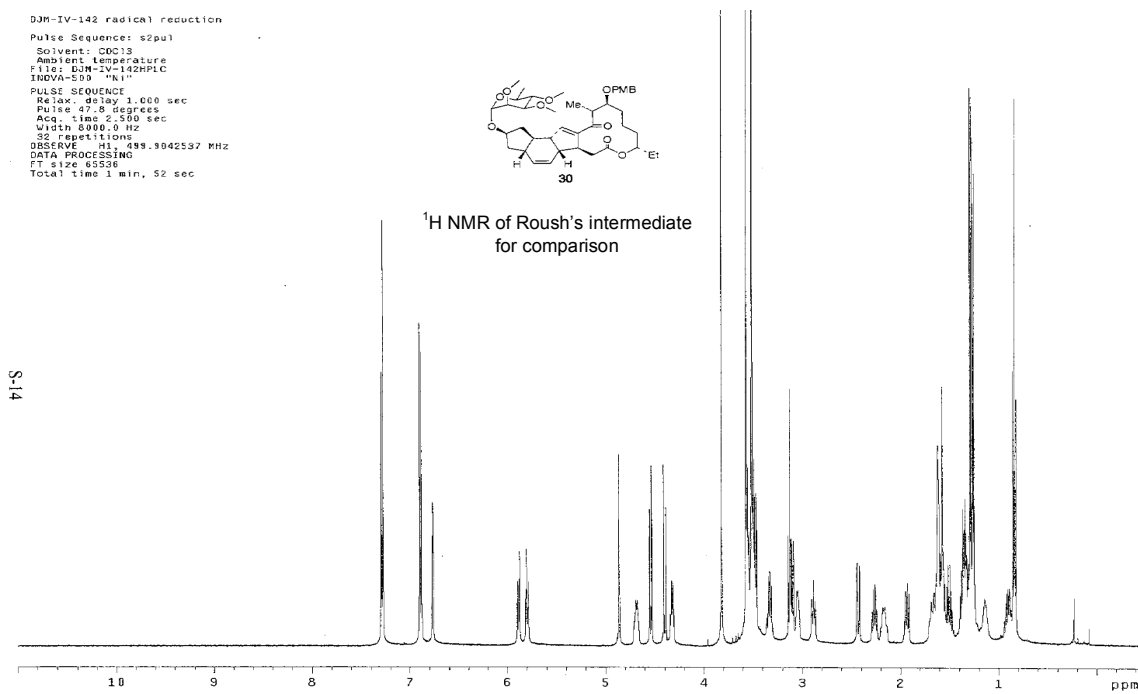


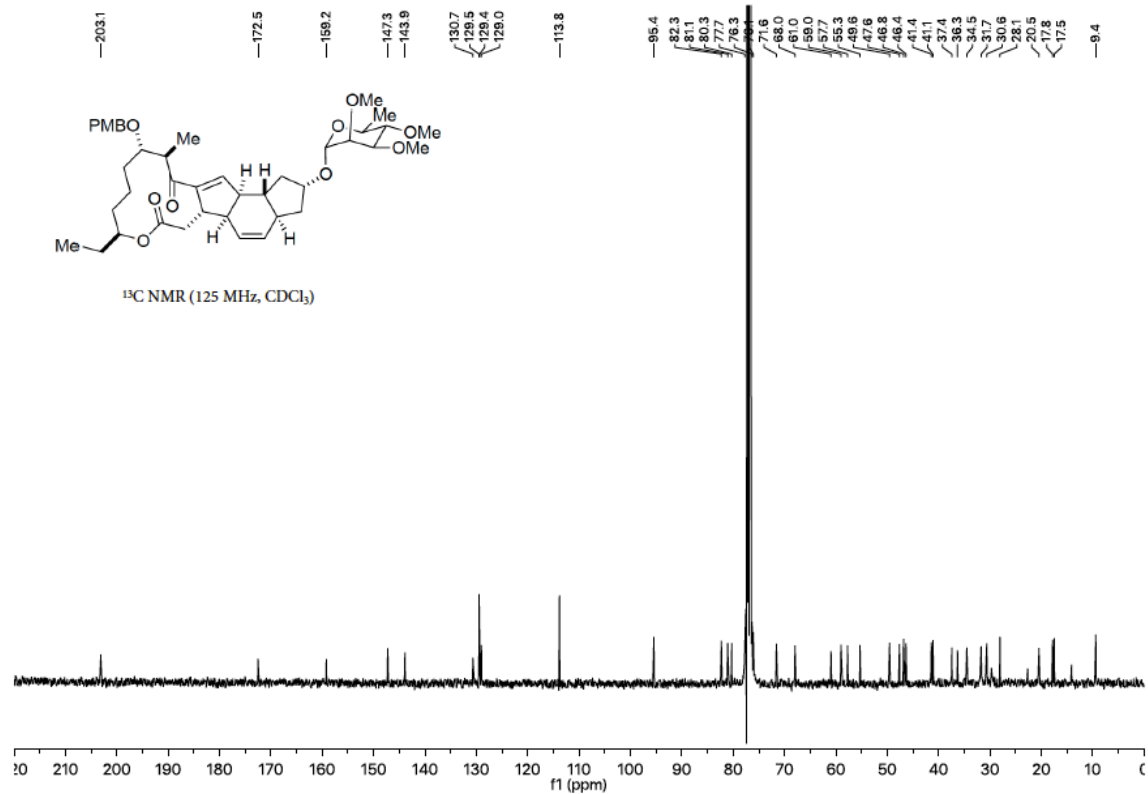


DJM-IV-142 radical reduction  
Pulse Sequence: s2pu1  
Solvent:  $\text{CDCl}_3$   
Ambient Temperature  
File: DJM-IV-142HPLC  
100VA-533 "K1"  
PULSE SEQUENCE  
Relax. delay 1.000 sec  
Pulse 47.8 degrees  
Acq. time 2.500 sec  
Width 8000.0 Hz  
52 repetitions  
OBSERVE F1, 499.9042537 MHz  
DATA PROCESSING  
FT size 65536  
Total time 1 min, 52 sec

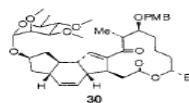


$^1\text{H}$  NMR of Roush's intermediate for comparison

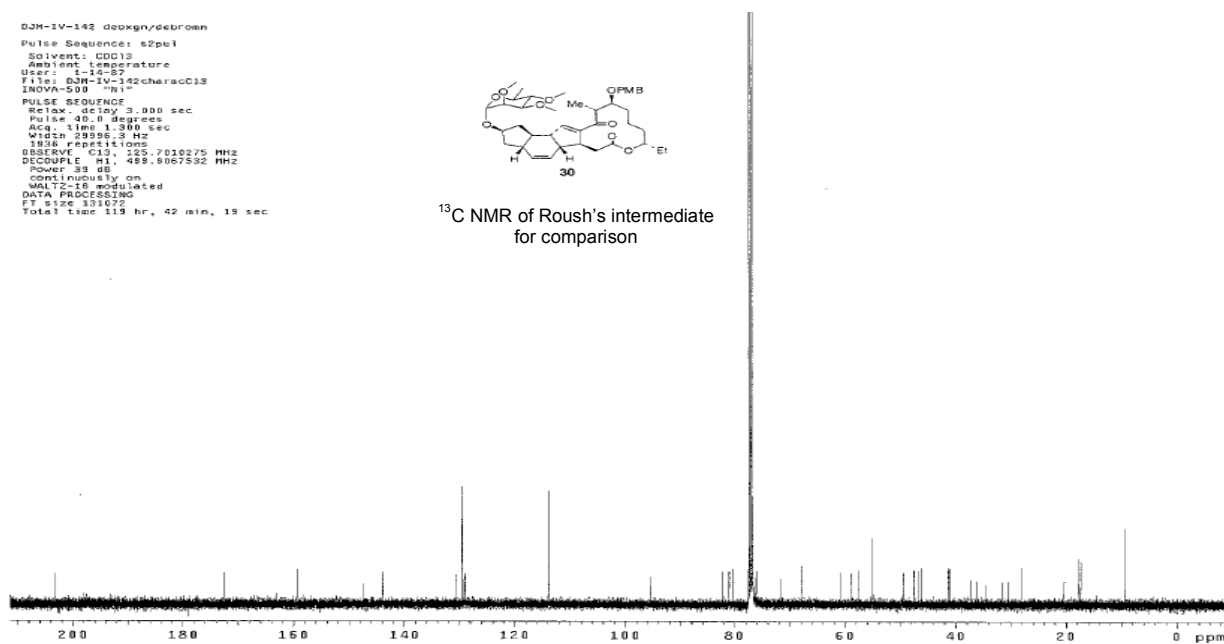




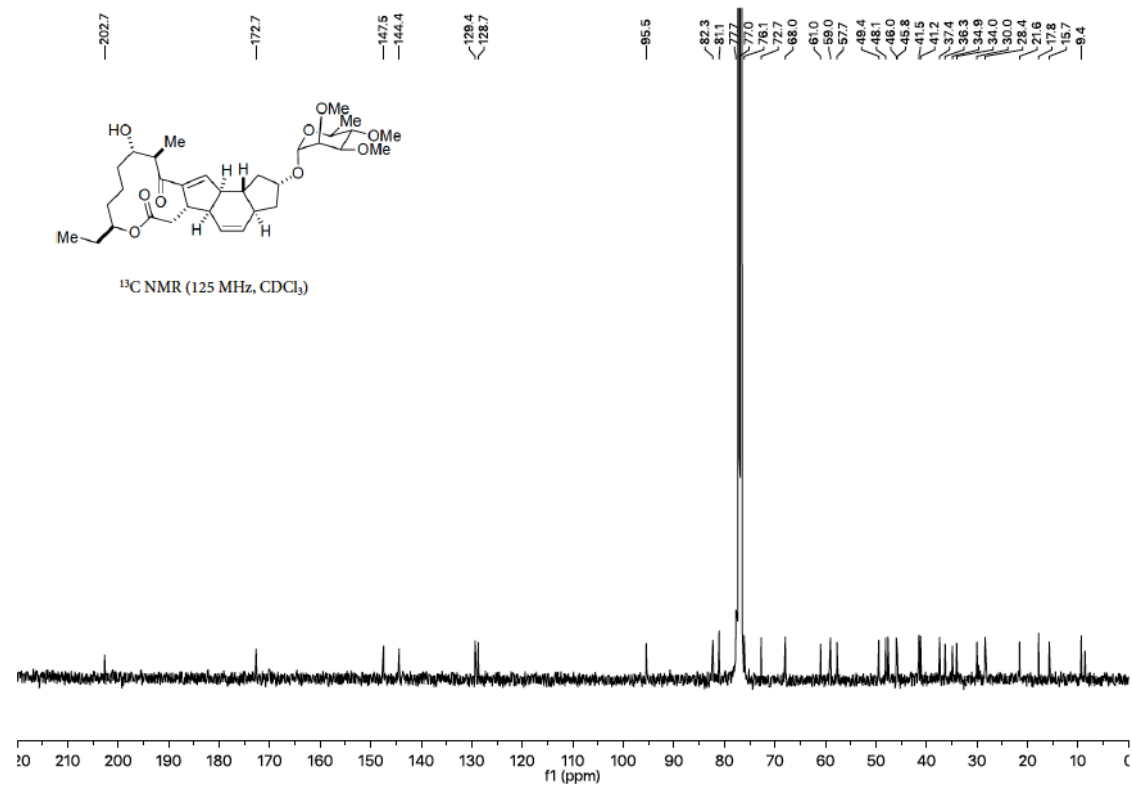
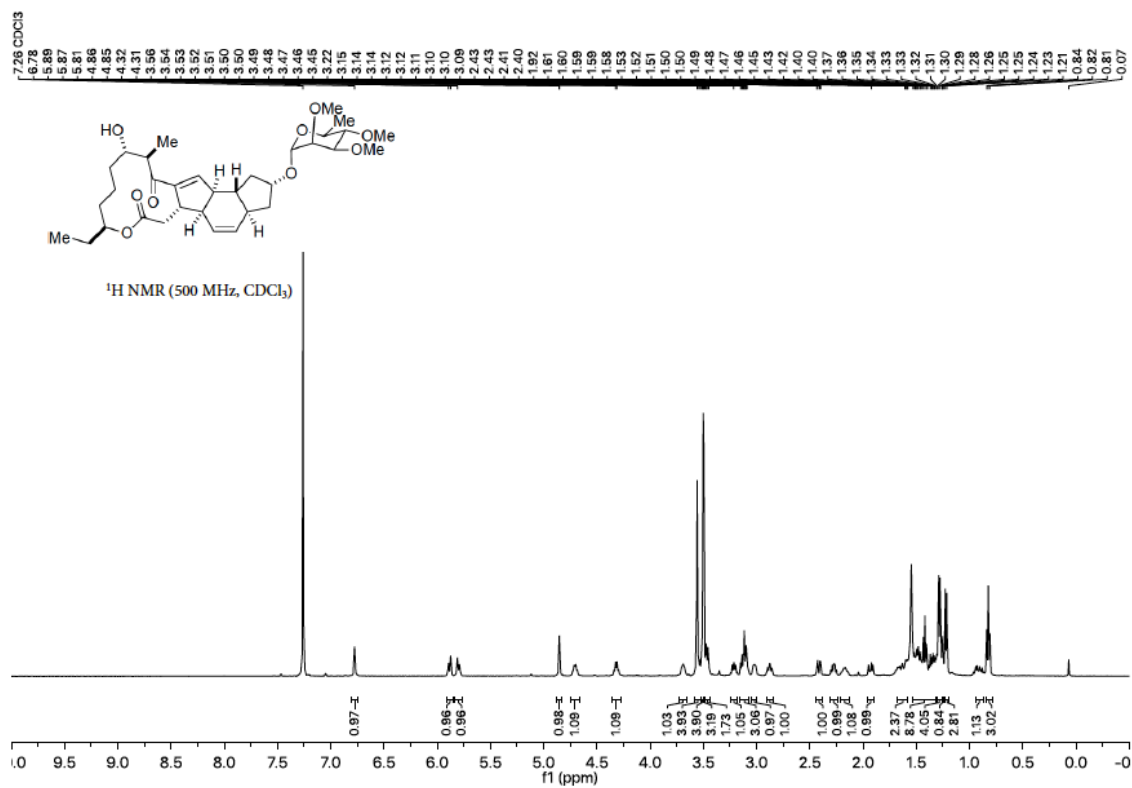
D3M-IV-142 doxgn/eebrom  
 Pulse Sequence: s2pul  
 Solvent:  $\text{CDCl}_3$   
 Ambient Temperature  
 User: 1-15-87  
 File: D3M-IV-142characC13  
 INOVA-500 "R1"  
 PULSE SEQUENCE  
 Relax. delay 3.000 sec  
 Pulse 40.0 degrees  
 Acq. time 1.300 sec  
 Width 23998.3 Hz  
 1856 repetitions  
 OBSRV C13, 125.7018275 MHz  
 DECOUPLE R1, 499.6057582 MHz  
 Power 39 dB  
 Continuously on  
 WALTZ-16 modulated  
 DATA PROCESSING  
 FT size 131072  
 Total time 119 hr, 42 min, 19 sec

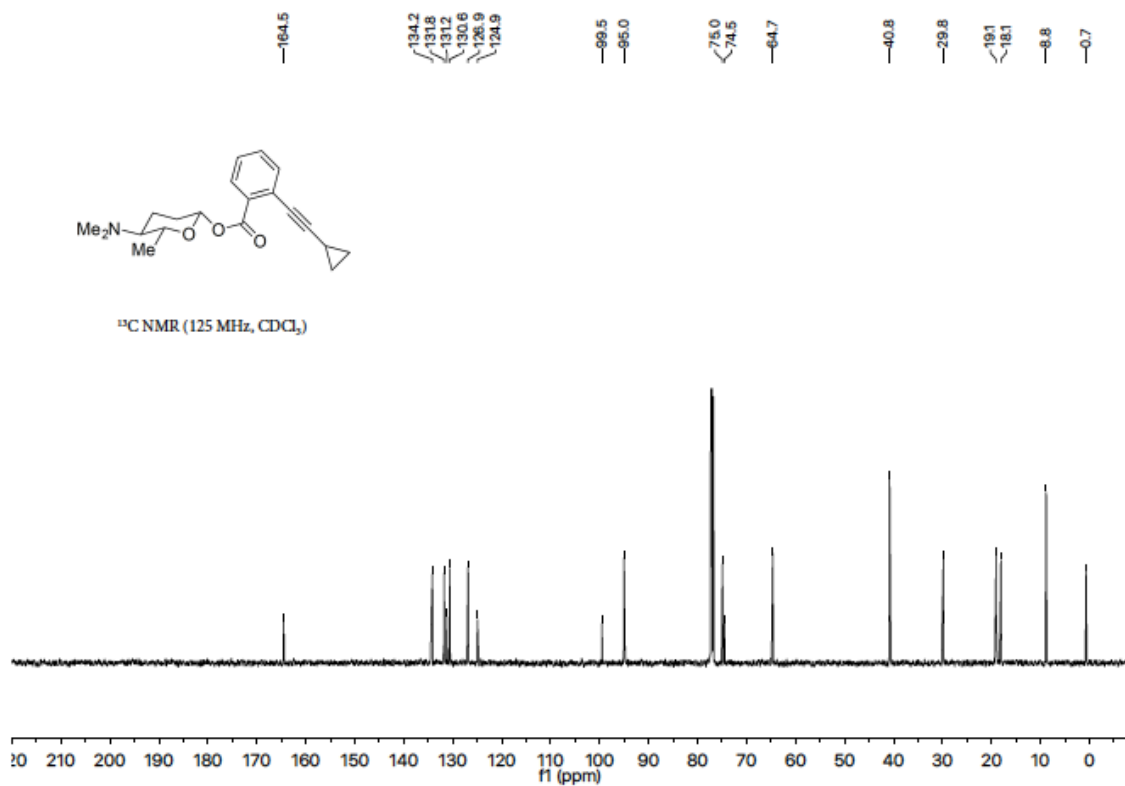
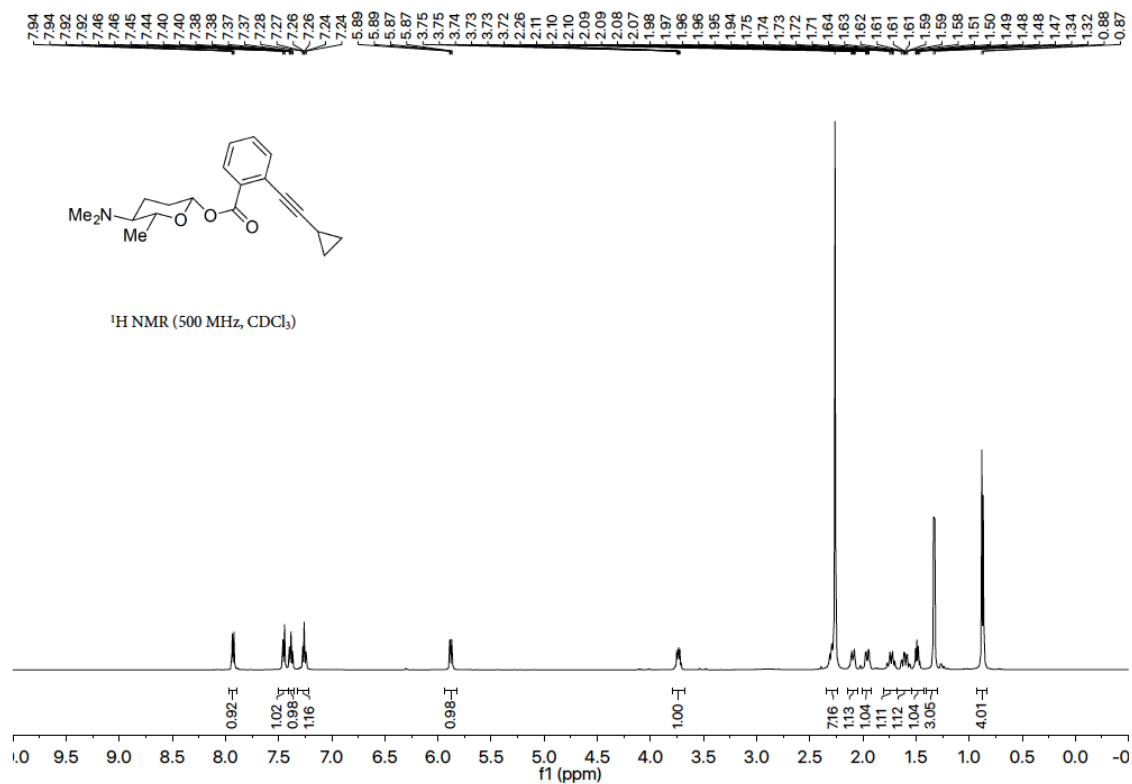


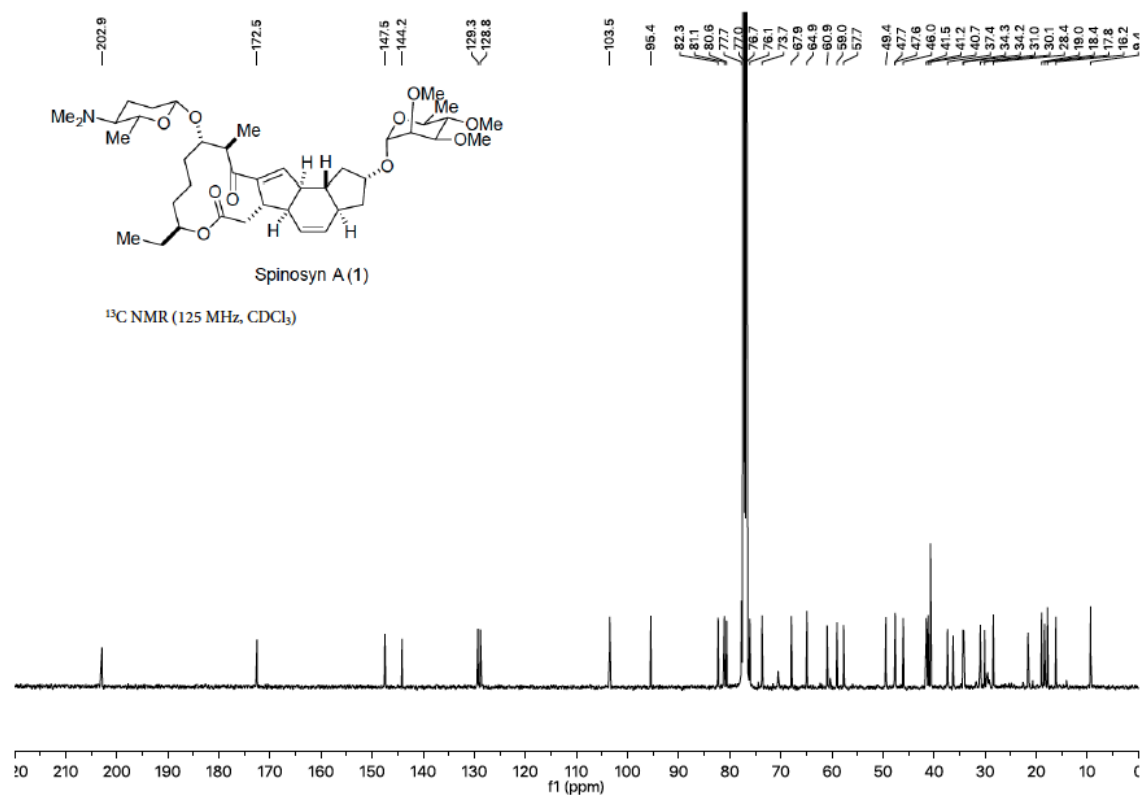
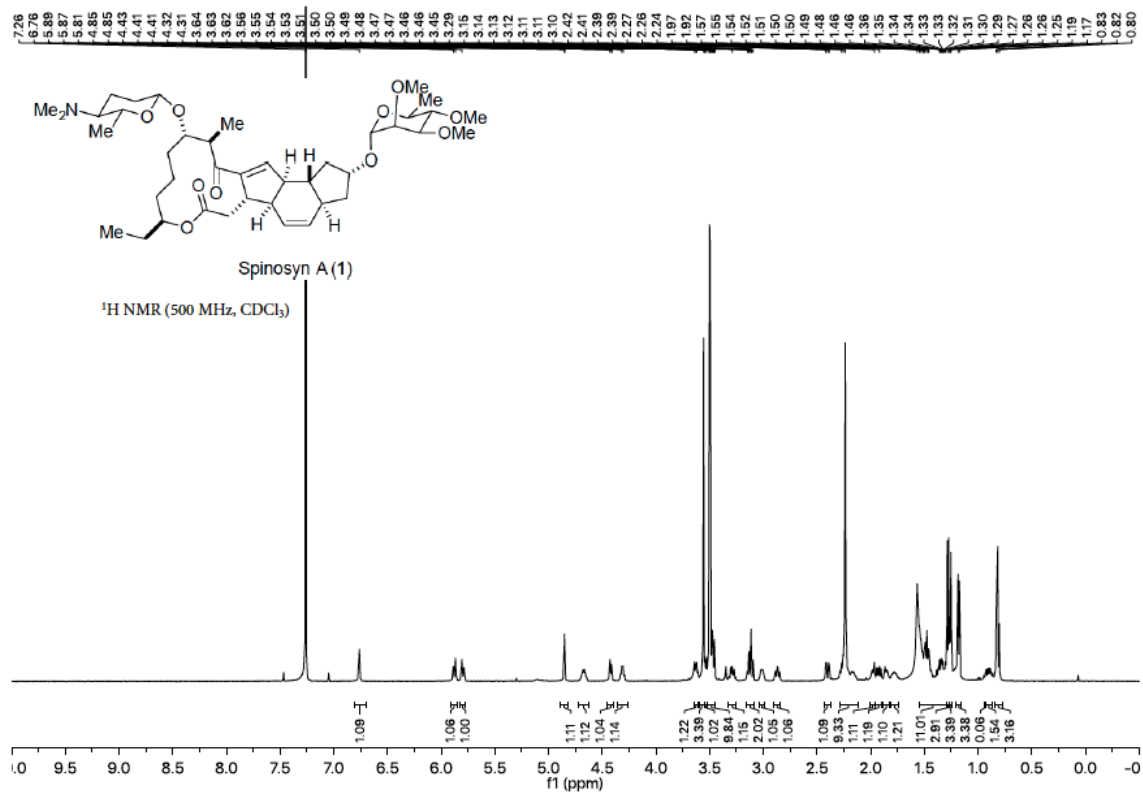
$^{13}\text{C}$  NMR of Roush's intermediate for comparison



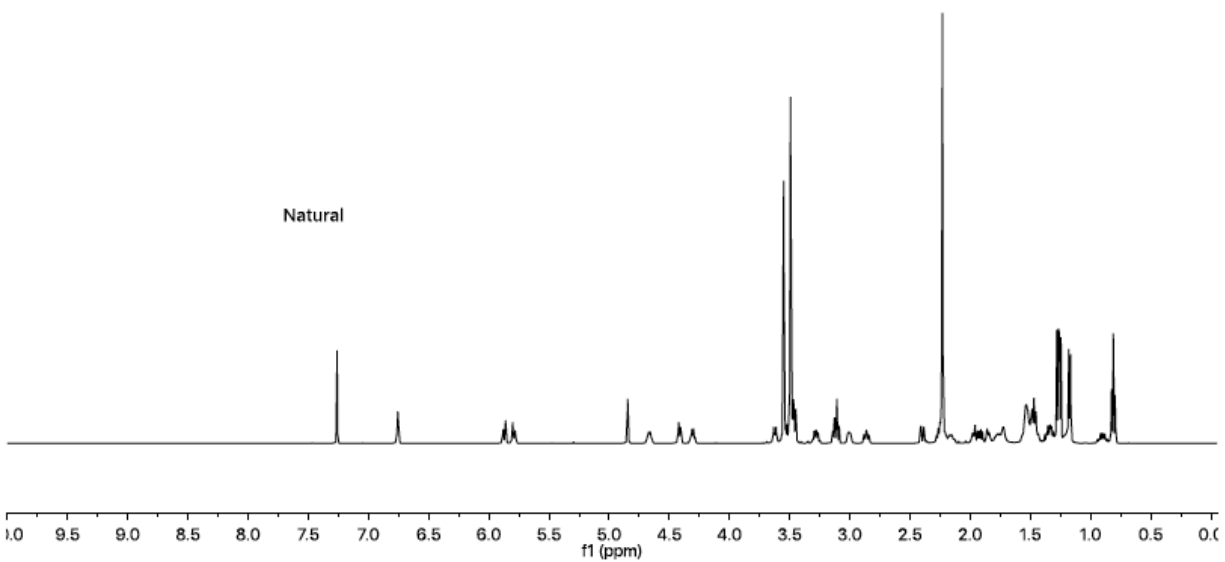
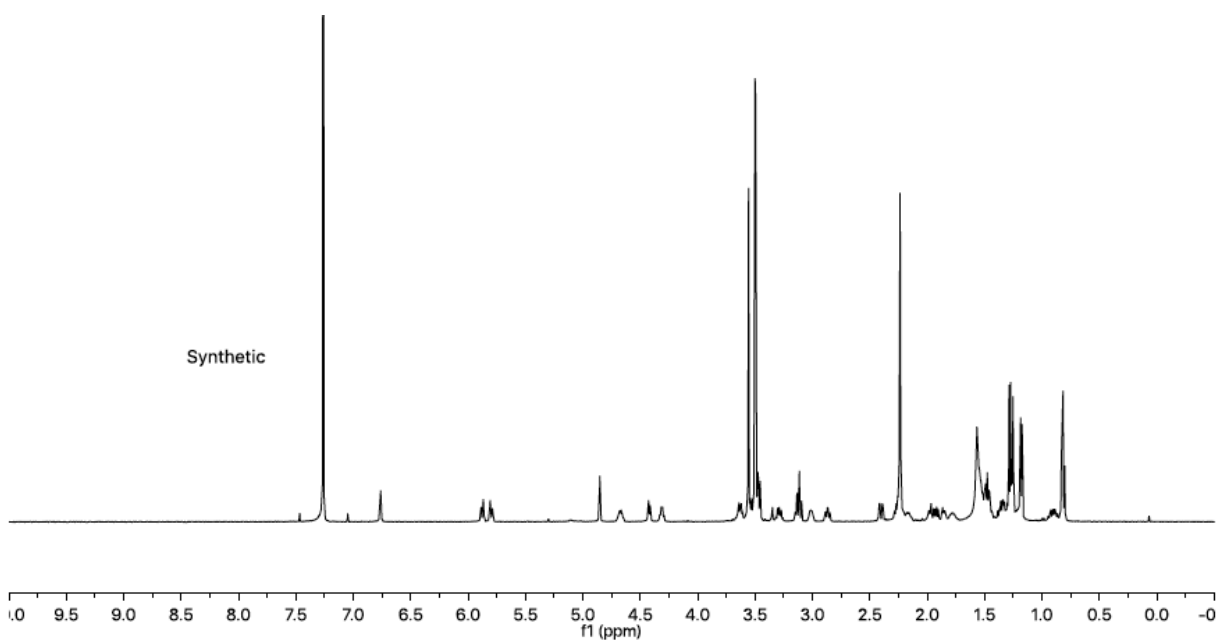








# Synthetic and Natural (-)-Spinosyn A $^1\text{H}$ NMR Spectra Comparison:



# Synthetic and Natural (-)-Spinosyn A <sup>13</sup>C NMR Spectra Comparison:

