Supplementary Information

Towards the Total Synthesis of Mandelalide B: Construction of the Tetrahydrofuran/α-hydroxyl Lactone Fragment

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I. General Information

All reactions were conducted in flame-dried or oven-dried glassware under an atmosphere of dry nitrogen or argon. Oxygen and/or moisture sensitive solids and liquids were transferred appropriately. Solutions were concentrated in vacuo using a rotary evaporator fitted with a water aspirator. Residual solvents were removed under high vacuum (0.1-0.2 mm Hg). All reaction solvents were purified before use: Tetrahydrofuran was distilled from Na/benzophenone; toluene over molten sodium; dichloromethane, dimethylformamide, diethylamine, triethylamine and diisoproylethylamine from CaH_2; and methanol from Mg/I_2. Flash column chromatography was performed using the indicated solvents on E. Qingdao silica gel 60 (230 – 400 mesh ASTM). TLC was carried out using pre-coated sheets (Qingdao silica gel 60-F250, 0.2 mm) and visualized with UV light, iodine, *p*-anisaldehyde stain, ceric ammonium molybdate stain, or phosphomolybdic acid in EtOH, with heating.

II. Spectroscopy, Spectrometry, and Data Collection

Infrared spectra were recorded on a Perkin-Elmer 1600 spectrometer. High-resolution mass spectra (HRMS) were obtained on ABI Q-star Elite and are reported as m/z (relative intensity). Accurate masses are reported for the molecular ion (M+H, M+Na), or a suitable fragment ion. Proton nuclear magnetic resonance (^{1}H NMR) spectra were recorded with Bruker Avance 300 MHz, Avance 400 MHz or Avance 500 MHz spectrometers. Chemical shifts are reported in delta (δ) units, parts per million (ppm) downfield from tetramethylsilane or ppm relative to the center of the singlet at 7.26 ppm for deuteriochloroform. The following abbreviations are used to describe spin multiplicity: s = singlet, d = doublet, t = triplet, q = quartet, qn = quintet, m = multiplet, br = broad, dd = doublet of doublets, dt = doublet of triplets, dq = doublet of quartets, ddd = doublet of doublet of doublets; other combinations are derived from those listed above. Integration and coupling constants were reported in Hertz (Hz). Coupling constants (*J*) are reported in Hertz (Hz) for corresponding solutions. Carbon-13 nuclear magnetic resonance (^{13}C NMR) spectra were recorded with a 75 MHz, a 101 MHz or a 126 MHz spectrometer and were routinely run with broadband decoupling. Chemical shifts are reported in delta (δ) units, ppm relative to the center of the triplet at 77.16 ppm for deuteriochloroform. Optical rotations were recorded on a Rudolph AutoPol-I polarimeter at 589 nm, 50 mm cell and data were reported as follows: optical rotation (*c* (g/100 mL), solvent).

III. Experimental Details and Spectral Data

9 **S1**

Epoxide **9** was prepared according to our previously reported procedures. [1] Synthetic procedures for **S1**: 1-Phenyl-1H-tetrazole-5-thiol (115.9 mg, 0.65 mmol) and then triethylamine (0.12 mL, 0.86 mmol) were added dropwise to a solution of epoxide **9** (113.7 mg, 0.43 mmol) in MeCN (5 mL) at 0 °C. The mixture was stirred at room temperature for 2 h, then heated to 50 °C with stirring. After 10 h, the mixture was cooled to room temperature, then diluted with EtOAc (20 mL) and filtered through a pad of Celite. The filtrate was concentrated in *vacuo* and the residue was purified by flash chromatography on silica gel (EtOAc/hexanes =1:8) to provide **S1** (139.1 mg, 74%) as a colorless oil.

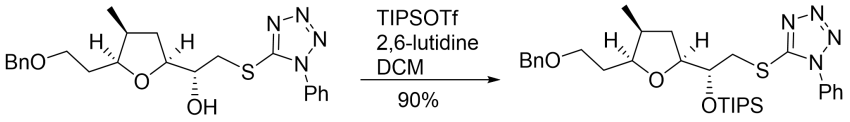
TLC: R_f = 0.4 (silica gel, EtOAc/hexanes = 1:3).

$[\alpha]_D^{20}$ = -48.1 (*c* 3.5, $CHCl_3$).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.59 – 7.47 (m, 5H), 7.34 – 7.26 (m, 4H), 7.25 – 7.18 (m, 1H), 4.48 (s, 2H), 4.05 (ddd, *J* = 10.5, 7.1, 4.0 Hz, 1H), 3.95 (ddd, *J* = 9.8, 6.6, 3.6 Hz, 1H), 3.79 (br s, 1H), 3.66 – 3.50 (m, 4H), 3.30 (dd, *J* = 13.5, 9.0 Hz, 1H), 2.46 – 2.32 (m, 1H), 2.03 (dt, *J* = 12.3, 6.9 Hz, 1H), 1.75 – 1.56 (m, 3H), 0.95 (d, *J* = 7.0 Hz, 3H) ppm.

^{13}C NMR (101 MHz, $CDCl_3$) δ 154.6, 138.0, 133.6, 130.1, 129.7, 128.4, 127.8, 127.6, 123.8, 80.3, 80.1, 73.2, 71.4, 68.4, 38.0, 36.5, 35.1, 31.2, 14.3 ppm.

HRMS (ESI): calculated for $C_{23}H_{29}N_4O_3S^+$ $[M+H]^+$ 441.1955, found 441.1954 ppm.



S1 **S2**

2,6-lutidine (167 μL, 1.45 mmol) and then TIPSOTf (236 μL, 0.88 mmol), dropwise, were added to a solution of compound **S1** (129.0 mg, 0.29 mmol) in DCM (3 mL) at -78 °C. The mixture was slowly warmed to -30 ℃ and stirred for an additional 1.5 h. The reaction was quenched with H_2O (2 mL) at -30 °C, then extracted with EtOAc (50 mL × 3). The combined organic phases were washed sequentially with water (10 mL), citric acid (10% in H_2O, 10 mL), saturated aqueous solution of $NaHCO_3$ (10 mL) and brine (10 mL), dried over anhydrous Na_2SO_4 and concentrated in *vacuo*. The residue was purified by flash chromatography on silica gel (EtOAc/hexanes =1:15) to provide **S2** (155.0 mg, 90%) as a colorless oil.

TLC: R_f = 0.7 (silica gel, EtOAc/hexanes = 1:5).

$[\alpha]_D^{20}$ = -15.2 (*c* 4.0, $CHCl_3$).

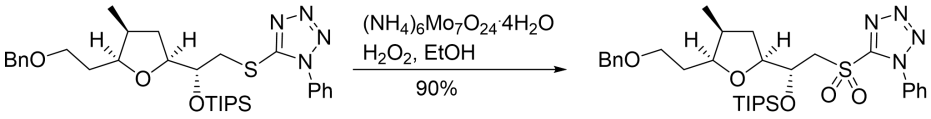
^{1}H NMR (500 MHz, $CDCl_3$) δ 7.61 – 7.49 (m, 5H), 7.36 – 7.29 (m, 4H), 7.29 – 7.24 (m, 1H), 4.49 (s, 2H), 4.19 (dd, *J* = 5.6 Hz, 1H), 3.99 – 3.90 (m, 2H), 3.69 (dd, *J* = 12.8, 5.3 Hz, 1H),

3.65 – 3.51 (m, 3H), 2.40 – 2.28 (m, 1H), 2.11 – 2.02 (m, 1H), 1.76 – 1.66 (m, 2H), 1.64 (s, 1H), 1.50 – 1.40 (m, 1H), 1.16 – 1.08 (m, 3H), 1.06 – 1.02 (m, 18H), 0.95 (d, J = 7.0 Hz, 3H) ppm.

^{13}C NMR (126 MHz, $CDCl_3$) δ 154.9, 138.8, 133.9, 130.1, 129.9, 128.5, 127.8, 127.6, 123.9, 80.6, 78.6, 73.3, 73.0, 68.4, 37.9, 35.8, 35.6, 31.5, 18.3, 15.5, 12.9 ppm.

IR (film): ν_{max} = 2960, 2944, 2926, 2865, 1500, 1464, 1456, 1386, 1246, 1100, 1016, 883, 760, 774, 695, 682 cm^{-1}

HRMS (ESI): calculated for $C_{32}H_{49}N_4O_3SSi^+$ $[M+H]^+$ 597.3289, found 597.3290.



S2 **11a**

A mixture of $(NH4)_6Mo_7O_{24}\cdot 4H_2O$ (56.0 mg, 0.05 mmol) and H_2O_2 (3 mL, 30% in H_2O) was added to a solution of **S2** (99.3 mg, 0.16 mmol) in EtOH (3 mL) at room temperature. The mixture was stirred at room temperature for 24 h, and then extracted with Et_2O (100 mL × 3). The combined organic phases were washed sequentially with water (5 mL × 2) and brine (5 mL × 2), dried over anhydrous Na_2SO_4 and concentrated in *vacuo*. The residue was purified by flash chromatography on silica gel (EtOAc/hexanes =1:15) to provide **11a** (91.3 mg, 90%) as a colorless oil.

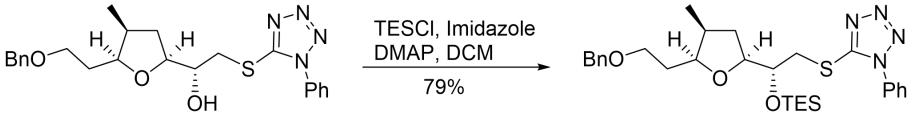
TLC: R_f = 0.5 (silica gel, EtOAc/hexanes = 1:7).

$[\alpha]_D^{20}$ = -27.9 (c 2.2, $CHCl_3$).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.69 – 7.65 (m, 2H), 7.62 – 7.56 (m, 3H), 7.34 – 7.31 (m, 4H), 7.29 – 7.25 (m, 1H), 4.70 – 4.64 (m, 1H), 4.49 (s, 2H), 4.17 (dd, J = 14.5, 4.7 Hz, 1H), 4.03 – 3.90 (m, 3H), 3.61 – 3.52 (m, 2H), 2.40 – 2.29 (m, 1H), 2.11 – 2.01 (m, 1H), 1.73 – 1.63 (m, 2H), 1.42 (ddd, J = 12.6, 9.3, 7.7 Hz, 1H), 1.10 – 1.02 (m, 21H), 0.95 (d, J = 7.0 Hz, 3H) ppm.

^{13}C NMR (101 MHz, $CDCl_3$) δ 154.5, 138.7, 133.3, 131.5, 129.8, 128.5, 127.8, 127.6, 125.4, 79.8, 78.8, 73.3, 68.1, 68.1, 59.6, 35.6, 34.7, 31.4, 18.3, 15.4, 12.9 ppm.

HRMS (ESI) calculated for $C_{32}H_{49}N_4O_5SSi^+$ $[M+H]^+$ 629.3187, found 629.3189.



S1 **S3**

Imidazole (189.0 mg, 2.8 mmol), TESCl (233μL, 1.4 mmol) and DMAP (5.0 mg, 0.05 mmol) were added sequentially to a solution of compound **S1** (153.0 mg, 0.35mmol) in DCM (5 mL) at 0 °C. The mixture was allowed to warmed to room temperature and then stirred for an additional 2 h. The reaction was quenched with a saturated aqueous solution of NH_4Cl (5 mL)

at 0 °C, then extracted with EtOAc (80 mL × 3). The combined organic phases were washed sequentially with saturated aqueous solution of NH_4Cl (8 mL) and brine (8 mL), dried over anhydrous Na_2SO_4 and concentrated in *vacuo*. The residue was purified by flash chromatography on silica gel (EtOAc/hexanes =1:20) to provide **S3** (163.0 mg, 79%) as a colorless oil.

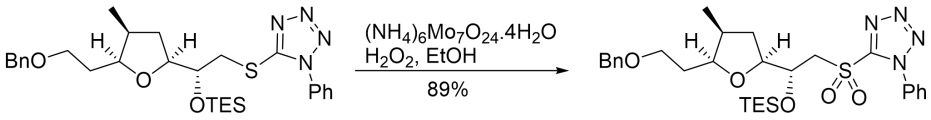
TLC: R_f = 0.7 (silica gel, EtOAc/hexanes = 1:7).

$[\alpha]_D^{20}$ = -34.6 (*c* 10.0, $CHCl_3$).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.60 – 7.49 (m, 5H), 7.36 – 7.29 (m, 4H), 7.29 – 7.23 (m, 1H), 4.50 (s, 2H), 4.04 – 3.90 (m, 3H), 3.67 – 3.57 (m, 3H), 3.43 (dd, *J* = 13.1, 6.8 Hz, 1H), 2.41 – 2.28 (m, 1H), 2.07 – 1.98 (m, 1H), 1.75 – 1.65 (m, 2H), 1.53 – 1.42 (m, 1H), 0.98 – 0.88 (m, 12H), 0.67 – 0.58 (m, 6H) ppm.

^{13}C NMR (101 MHz, $CDCl_3$) δ 154.7, 138.7, 133.8, 130.1, 129.8, 128.4, 127.7, 127.5, 123.8, 80.2, 78.5, 73.2, 72.6, 68.2, 37.4, 36.0, 35.3, 31.3, 15.1, 6.9, 5.1 ppm.

HRMS (ESI) calculated for $C_{29}H_{43}N_4O_3SSi^+$ $[M+H]^+$ 555.2820, found 555.2816.



S3 **11b**

A mixture of $(NH4)_6Mo_7O_{24}\cdot 4H_2O$ (79.5 mg, 0.06 mmol) and H_2O_2 (2 mL, 30% in H_2O) were added to a solution of **S3** (128.0 mg, 0.21 mmol) in EtOH (2 mL) at room temperature. The mixture was stirred at room temperature for 24 h, then extracted with Et_2O (100 mL × 3). The combined organic phases were washed sequentially with water (8 mL × 2) and brine (8 mL × 2), dried over anhydrous Na_2SO_4 and concentrated in *vacuo*. The residue was purified by flash chromatography on silica gel (EtOAc/hexanes =1:15) to provide **11b** (120.0 mg, 89%) as a colorless oil.

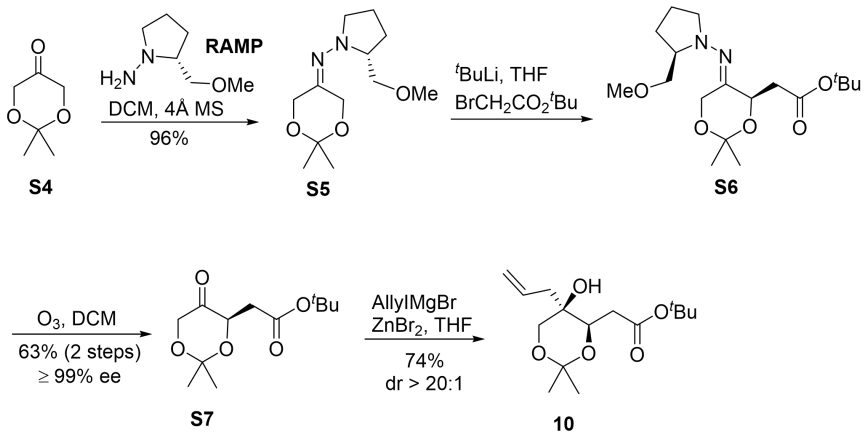
TLC: R_f = 0.5 (silica gel, EtOAc/hexanes = 1:7).

$[\alpha]_D^{20}$ = -30.4 (*c* 2.0, $CHCl_3$).

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.69 – 7.65 (m, 2H), 7.65 – 7.57 (m, 3H), 7.36 – 7.31 (m, 4H), 7.30 – 7.25 (m, 1H), 4.51 (s, 2H), 4.50 – 4.47 (m, 1H), 4.03 – 3.91 (m, 3H), 3.89 (dd, *J* = 14.7, 7.5 Hz, 1H), 3.64 – 3.53 (m, 2H), 2.39 – 2.29 (m, 1H), 2.03 (dt, *J* = 12.5, 7.2 Hz, 1H), 1.73 – 1.63 (m, 2H), 1.38 – 1.29 (m, 1H), 0.94 – 0.88 (m, 12H), 0.60 – 0.52 (m, 6H) ppm.

^{13}C NMR (126 MHz, $CDCl_3$) δ 154.5, 138.7, 133.3, 131.5, 129.8, 128.5, 127.8, 127.6, 125.4, 79.8, 78.9, 73.3, 68.4, 68.1, 59.3, 35.6, 34.8, 31.3, 15.3, 6.9, 4.9 ppm.

HRMS (ESI) calculated for $C_{29}H_{43}N_4O_5SSi^+$ $[M+H]^+$ 587.2718, found 587.2721.



Compound **S5** to **10** were prepared according to literature procedures[2]:

RAMP (8.0 mL, 60.1 mmol) and 4 Å MS (15.0 g) were added to a solution of compound **S4** (8.0 ml, 67.0 mmol) in DCM (200 mL) at room temperature. The mixture was stirred for 15 h before being filtered through a pad of Celite. The filtrate was concentrated in *vacuo* and the residue was purified by flash chromatography on silica gel (EtOAc/hexanes =1:2, with 2% Et_3N) to provide **S5** (13.9 g, 96%) as a colorless oil.

TLC: R_f = 0.5 (silica gel, EtOAc/hexanes = 1:1.5, with 2% Et_3N).
^{1}H NMR (500 MHz, $CDCl_3$) δ 4.50 (dd, *J* = 16.1, 1.1 Hz, 1H), 4.30 (dd, *J* = 3.9, 1.7 Hz, 1H), 4.29 – 4.26 (m, 1H), 4.22 – 4.17 (m, 1H), 3.40 – 3.34 (m, 1H), 3.30 (s, 3H), 3.24 – 3.18 (m, 2H), 3.03 (dt, *J* = 9.2, 6.2 Hz, 1H), 2.46 (dt, *J* = 9.2, 8.1 Hz, 1H), 2.00 – 1.91 (m, 1H), 1.84 – 1.76 (m, 2H), 1.65 – 1.57 (m, 1H), 1.39 (s, 3H), 1.36 (s, 3H) ppm.
^{13}C NMR (126 MHz, $CDCl_3$) δ 160.0, 99.9, 75.5, 66.7, 62.7, 60.4, 59.2, 55.4, 26.8, 24.5, 23.3, 22.8 ppm.
HRMS (ESI): calculated for $C_{12}H_{23}N_2O_3^+$ $[M+H]^+$ 243.1703, found 243.1710

*t*BuLi (16.8 mL, 23.5 mmol, 1.4 M in pentane) was added dropwise to a solution of compound **S5** (5.17 g, 21.3 mmol) in THF (80 mL) at -78 °C, over 15 min. The mixture was stirred for 2 h at -78 °C, then cooled to -100 °C. A solution of *tert*-butyl bromoacetate (3.42 mL, 23.5 mmol) in THF (10 mL) was added. After being stirred for an additional 2 h at -100 °C, the mixture was allowed to warm to room temperature over 15 h. The reaction was quenched with phosphate buffer (30 mL, 0.1 M, pH = 7.0) at 0 °C and then extracted with Et_2O (200 mL × 3). The combined organic phases were washed sequentially with water (50 mL) and brine (50 mL), dried over anhydrous Na_2SO_4 and concentrated in *vacuo* to afford the crude **S6**, which was directly used in next step without further purification.

A mixture of ozone and oxygen was bubbled through a solution of crude **S6** in DCM (200) at -78 °C until the solution became blue (about 2 h). Nitrogen was then bubbled into the solution for 10 min -78 °C, then the reaction mixture was concentrated in *vacuo.* The residue was purified by flash chromatography on silica gel (EtOAc/hexanes =1:8) to provide **S7** (3.28 g, 63%) as a colorless oil.

TLC: R_f = 0.5 (silica gel, EtOAc/hexanes = 1:3).

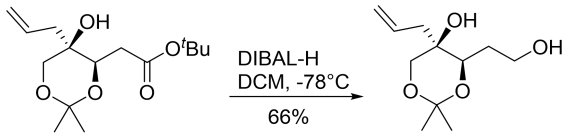
^{1}H NMR (500 MHz, $CDCl_3$) δ 4.61 (ddd, *J* = 7.8, 4.2, 1.5 Hz, 1H), 4.26 (dd, *J* = 17.0, 1.5 Hz, 1H), 3.97 (d, *J* = 17.0 Hz, 1H), 2.74 (dd, *J* = 16.4, 4.3 Hz, 1H), 2.45 (dd, *J* = 16.5, 7.9 Hz, 1H), 1.43 (s, 3H), 1.41 (s, 9H), 1.37 (s, 3H) ppm.
^{13}C NMR (126 MHz, $CDCl_3$) δ 208.1, 169.4, 101.1, 81.1, 72.0, 66.6, 35.6, 28.1, 23.9, 23.7 ppm.
HRMS (ESI): calculated for $C_{12}H_{21}O_5^+$ $[M+H]^+$ 245.1384, found 245.1380

Allylmagnesium bromide (4.3 mL, 0.8 M in Et_2O, 3.5 mmol) was added to a suspension of anhydrous $ZnBr_2$ (1.04 g, 4.6 mmol) in THF (11 mL) at -78 °C. After being stirred for 30 min at -78 °C, the mixture was cooled to -100 °C, and a solution of ketone **S7** (561.5 mg, 2.3 mmol) in THF (11 mL) was added dropwise. The mixture was stirred for an additional 2 h at -100 °C, then quenched with a saturated aqueous solution of NH_4Cl (10 mL) and extracted with Et_2O (100 mL × 3). The combined organic phases were washed sequentially with a saturated aqueous solution of NH_4Cl (10 mL), water (10 mL) and brine (10 mL), dried over anhydrous Na_2SO_4 and concentrated in *vacuo.* The residue was purified by flash chromatography on silica gel (EtOAc/hexanes =1:10) to provide **10** (489.1 mg, 74%) as a colorless oil.

TLC: R_f = 0.5 (silica gel, EtOAc/hexanes = 1:5).

$[\alpha]_D^{20}$ = -0.5 (*c* 1.0, $CHCl_3$).
^{1}H NMR (500 MHz, $CDCl_3$) δ 5.79 (dddd, *J* = 16.8, 10.2, 8.1, 6.7 Hz, 1H), 5.13 – 5.06 (m, 2H), 4.20 (dd, *J* = 9.1, 3.5 Hz, 1H), 3.82 (d, *J* = 12.1 Hz, 1H), 3.50 (d, *J* = 12.0 Hz, 1H), 2.97 (d, *J* = 1.4 Hz, 1H), 2.51 (dd, *J* = 15.5, 3.6 Hz, 1H), 2.39 (dd, *J* = 15.4, 9.0 Hz, 1H), 2.24 – 2.17 (m, 1H), 2.05 (dd, *J* = 14.5, 8.1 Hz, 1H), 1.42 (s, 9H), 1.42 (s, 3H), 1.38 (s, 3H) ppm.
^{13}C NMR (101 MHz, $CDCl_3$) δ 170.8, 131.6, 119.0, 99.1, 80.7, 72.7, 68.4, 68.0, 38.1, 35.9, 29.5, 28.2, 18.4 ppm.

IR (film): ν_{max} = 2979, 2927, 2856, 2359, 1740, 1369, 1313, 1259, 1203, 1155, 1088, 1062, 915, 824, 736 cm^{-1}
HRMS (ESI): calculated for $C_{15}H_{27}O_5^+$ $[M+H]^+$ 287.1853, found 287.1858.



10 **S8**

DIBAL-H (8.32 mL, 8.32 mmol, 1.0 M in hexane) was added dropwise at -78 °C over 5 min to a solution of compound **10** (596.0 mg, 2.08 mmol) in DCM (20 mL). The mixture was warmed to -35 °C gradually and stirred for an additional 5 h. The reaction was quenched with MeOH (1 mL) at -35 °C, then diluted with a saturated aqueous solution of potassium sodium tartrate (20 mL). The mixture was allowed to warm to room temperature and stirred for an additional 1 h. The mixture was extracted with DCM (100 mL × 3). The combined organic phases were washed sequentially with water (10 mL) and brine (10 mL), dried over anhydrous Na_2SO_4 and concentrated in *vacuo*. The residue was purified by flash chromatography on silica gel (EtOAc/hexanes =1:3) to provide **S8** (297.4 mg, 66%) as a

colorless oil.

TLC: R_f = 0.3 (silica gel, EtOAc/hexanes = 1:1).

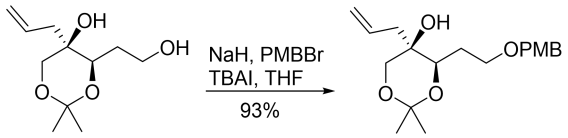
[α]$_D^{20}$ = -5.6 (*c* 1.0, $CHCl_3$).

^{1}H NMR (400 MHz, $CDCl_3$) δ 5.75 (dddd, *J* = 16.8, 10.5, 8.3, 6.5 Hz, 1H), 5.09 (d, *J* = 1.6 Hz, 1H), 5.07 – 5.02 (m, 1H), 3.93 (dd, *J* = 9.5, 2.9 Hz, 1H), 3.80 (d, *J* = 12.0 Hz, 1H), 3.76 – 3.62 (m, 2H), 3.47 (d, *J* = 12.1 Hz, 1H), 3.11 (br s, 1H), 2.74 (br s, 1H), 2.24 (dd, *J* = 14.3, 6.5 Hz, 1H), 2.06 (dd, *J* = 14.3, 8.3 Hz, 1H), 1.92 – 1.80 (m, 1H), 1.78 – 1.67 (m, 1H), 1.41 (s, 3H), 1.39 (s, 3H) ppm.

^{13}C NMR (101 MHz, $CDCl_3$) δ 131.7, 118.9, 98.9, 74.1, 68.4, 68.2, 59.9, 38.2, 30.6, 29.5, 18.6 ppm.

IR (film): ν_{max} = 2928, 2912, 2859, 2358, 1382, 1371, 1201, 1058, 1002, 919, 871, 757 cm^{-1}

HRMS (ESI): calculated for $C_{11}H_{20}NaO_4^+$ $[M+Na]^+$ 239.1259, found 239.1253.



S8 **12**

A solution of **S8** (64.4 mg, 0.3 mmol) in THF (1 mL) at 0 °C was added to a suspension of NaH (36.0 mg, 0.89 mmol, 60% dispersion in mineral oil) in THF (3 mL). After 10 min, a solution of PMBBr (71.8 mg, 0.36 mmol) in THF (1 mL) and TBAI (118.0 mg, 0.3 mmol) were added to the reaction at 0 °C. The resulting mixture was warmed to room temperature gradually and stirred for an additional 3 h. After being quenched with a saturated aqueous solution of NH_4Cl (10 mL) at 0 °C, the reaction mixture was extracted with EtOAc (50 mL × 3). The combined organic phases were washed sequentially with water (10 mL) and brine (10 mL), dried over anhydrous Na_2SO_4 and concentrated in *vacuo*. The residue was purified by flash chromatography on silica gel (EtOAc/hexanes =1:10) to provide **12** (93.4 mg, 93%) as a colorless oil.

TLC: R_f = 0.5 (silica gel, EtOAc/hexanes = 1:3).

[α]$_D^{20}$ = +14.7 (*c* 1.0, $CHCl_3$).

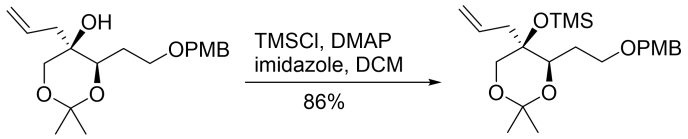
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.30 – 7.24 (m, 2H), 6.92 – 6.86 (m, 2H), 5.90 – 5.75 (m, 1H), 5.13 (d, *J* = 1.2 Hz, 1H), 5.12 – 5.07 (m, 1H), 4.48 (d, *J* = 11.6 Hz, 1H), 4.41 (d, *J* = 11.6 Hz, 1H), 3.95 (dd, *J* = 10.0, 2.5 Hz, 1H), 3.85 – 3.79 (m, 4H), 3.57 – 3.49 (m, 3H), 3.01 (br s, 1H), 2.28 (dd, *J* = 14.3, 6.7 Hz, 1H), 2.10 (dd, *J* = 14.3, 8.2 Hz, 1H), 1.99 – 1.86 (m, 1H), 1.85 – 1.72 (m, 1H), 1.41 (s, 3H), 1.41 (s, 3H) ppm.

^{13}C NMR (101 MHz, $CDCl_3$) δ 159.2, 132.0, 130.8, 129.2, 118.7, 113.8, 98.8, 72.7, 71.7, 68.5, 68.3, 65.9, 55.3, 38.2, 29.5, 28.5, 18.5 ppm.

IR (film): ν_{max} = 2992, 2955, 2862, 1515, 1507, 1248, 1182, 1159, 1095, 1039, 1004, 917, 841,

754 cm^{-1}

HRMS (ESI): calculated for $C_{19}H_{28}NaO_5^+$ $[M+Na]^+$ 359.1834, found 359.1831.



12 **S9**

Imidazole (190.0 mg, 2.78 mmol), TMSCl (120 μL, 1.39 mmol) and DMAP (3.0 mg, 0.03 mmol) were added sequentially at 0 °C to a solution of compound **12** (93.4 mg, 0.28 mmol) in DCM (5 mL). The mixture was allowed to warmed to room temperature and then stirred for an additional 2 h. The reaction was quenched with a saturated aqueous solution of NH_4Cl (5 mL) at 0 °C, and the mixture was extracted with EtOAc (50 mL × 3). The combined organic phases were washed sequentially with saturated aqueous solution of NH_4Cl (8 mL) and brine (8 mL), dried over anhydrous Na_2SO_4 and concentrated in *vacuo*. The residue was purified by flash chromatography on silica gel (EtOAc/hexanes =1:30) to provide **S9** (97.8 mg, 86%) as a colorless oil.

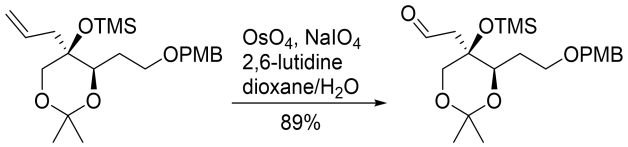
TLC: R_f = 0.5 (silica gel, EtOAc/hexanes = 1:10).

$[\alpha]_D^{20}$ = +16.9 (*c* 1.0, $CHCl_3$).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.32 – 7.25 (m, 2H), 6.94 – 6.86 (m, 2H), 5.82 (dddd, *J* = 17.1, 10.4, 7.8, 6.9 Hz, 1H), 5.14 – 5.11 (m, 1H), 5.11 – 5.06 (m, 1H), 4.50 (d, *J* = 11.6 Hz, 1H), 4.42 (d, *J* = 11.5 Hz, 1H), 3.86 – 3.80 (m, 1H), 3.82 (s, 3H), 3.76 (d, *J* = 12.4 Hz, 1H), 3.64 (d, *J* = 12.3 Hz, 1H), 3.56 (dd, *J* = 8.0, 5.0 Hz, 2H), 2.24 (dd, *J* = 13.8, 6.9 Hz, 1H), 2.13 (dd, *J* = 13.9, 7.9 Hz, 1H), 1.94 – 1.84 (m, 1H), 1.83 – 1.73 (m, 1H), 1.41 (s, 3H), 1.37 (s, 3H), 0.19 (s, 9H) ppm.

^{13}C NMR (101 MHz, $CDCl_3$) δ 159.2, 133.2, 131.0, 129.3, 118.3, 113.8, 98.8, 73.1, 72.7, 72.0, 67.1, 66.7, 55.3, 42.2, 29.0, 28.1, 20.1, 2.6 ppm.

HRMS (ESI) calculated for $C_{22}H_{36}NaO_5Si^+$ $[M+Na]^+$ 431.2230, found 431.2236.



S9 **13**

2,6-Lutidine (49 μL, 0.42 mmol), OsO_4 (0.4 mL, 0.03 mmol/L in ^{t}BuOH) and $NaIO_4$ (179.0 mg, 0.84 mmol) were added sequentially at 0 °C to a solution of compound **S9** (85.4 mg, 0.21 mmol) in 1,4-dioxane (3 mL) and water (1 mL). The mixture was allowed to warmed to room temperature and then stirred for an additional 2 h. The reaction was quenched with a saturated aqueous solution of $Na_2S_2O_3$ (10 mL) at 0 °C, then extracted with EtOAc (80 mL × 3). The combined organic phases were washed sequentially with saturated aqueous solution of

$Na_2S_2O_3$ (8 mL), water (8 mL) and brine (8 mL), dried over anhydrous Na_2SO_4 and concentrated in *vacuo*. The residue was purified by flash chromatography on silica gel (EtOAc/hexanes =1:20) to provide **13** (76.4 mg, 89%) as a colorless oil.

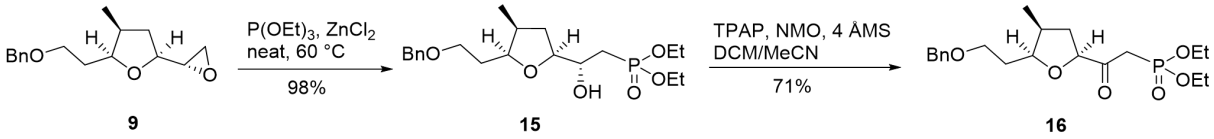
TLC: R_f = 0.4 (silica gel, EtOAc/hexanes = 1:7).

$[\alpha]_D^{20}$ = +10.1 (*c* 1.0, $CHCl_3$).

^{1}H NMR (400 MHz, $CDCl_3$) δ 9.77 (t, *J* = 2.8 Hz, 1H), 7.27 – 7.20 (m, 2H), 6.92 – 6.80 (m, 2H), 4.45 (d, *J* = 11.5 Hz, 1H), 4.38 (d, *J* = 11.6 Hz, 1H), 3.87 – 3.73 (m, 6H), 3.57 – 3.46 (m, 2H), 2.51 (dd, *J* = 15.0, 2.6 Hz, 1H), 2.30 (dd, *J* = 14.9, 3.0 Hz, 1H), 1.84 – 1.72 (m, 2H), 1.39 (s, 3H), 1.35 (s, 3H), 0.18 (s, 9H) ppm.

^{13}C NMR (101 MHz, $CDCl_3$) δ 201.1, 159.2, 130.7, 129.4, 113.8, 99.2, 73.1, 72.8, 72.0, 67.3, 66.2, 55.4, 50.3, 29.3, 28.0, 19.9, 2.4 ppm.

HRMS (ESI) calculated for $C_{21}H_{34}NaO_6Si^+$ $[M+Na]^+$ 433.2022, found 433.2015.



Zinc chloride (4.4 g, 32.2 mmol) was added to a mixture of epoxide **9** (5.7 g, 21.7 mmol) and triethyl phosphite (4.9 mL, 28.3 mmol) at room temperature. The resulting mixture was heated to 60 °C and stirred for an additional 3 h. After being cooled to room temperature, the mixture was diluted with EtOAc (200 mL) and filtered through a pad of Celite. The filtrate was concentrated in *vacuo* and the residue was purified by flash chromatography on silica gel (EtOAc/hexanes =2:1) to provide **15** (8.5 g, 98%) as a colorless oil. **TLC**: R_f = 0.2 (silica gel, EtOAc/hexanes = 2:1).

4-Methylmorpholine-*N*-Oxide (4.0 g, 33.7 mmol), 4 Å MS (34.0 g) and TPAP (395.0 mg, 1.1 mmol) were added sequentially at room temperature to a solution of compound **15** (4.5 g, 11.2 mmol) in DCM (100 mL) and MeCN (20 mL). The mixture was stirred for 6 h at room temperature before concentrated in *vacuo*. The residue was dissolved in EtOAc (300 mL) and filtered through a pad of Celite. The filtrate was concentrated in *vacuo* and the residue was purified by flash chromatography on silica gel (EtOAc/hexanes =1:1) to provide **16** (3.14 g, 71%) as a colorless oil.

TLC: R_f = 0.5 (silica gel, EtOAc/hexanes = 2:1).

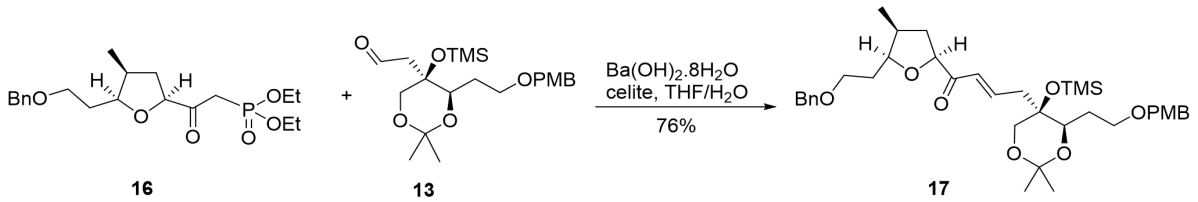
$[\alpha]_D^{20}$ = -53.7 (c 1.0, $CHCl_3$).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.38 – 7.31 (m, 4H), 7.31 – 7.24 (m, 1H), 4.53 (s, 2H), 4.40 – 4.33 (m, 1H), 4.19 – 4.09 (m, 5H), 3.70 – 3.60 (m, 2H), 3.46 (dd, *J* = 22.4, 14.2 Hz, 1H), 3.14 (dd, *J* = 22.0, 14.1 Hz, 1H), 2.39 – 2.26 (m, 2H), 1.84 – 1.72 (m, 3H), 1.33 (td, *J* = 7.0, 2.6 Hz, 3H), 1.33 (td, *J* = 7.0, 2.6 Hz, 3H), 0.87 (d, *J* = 6.7 Hz, 3H) ppm.

^{13}C NMR (101 MHz, $CDCl_3$) δ 203.4(d, J_{C-P} = 6.7 Hz), 138.5, 128.4, 127.7, 127.6, 82.6(d,

$J_{C\text{-}P}$ = 2.3 Hz), 80.1, 73.2, 67.8, 62.5 (dd, $J_{C\text{-}P}$ = 9.7, 6.3 Hz), 37.2(d, $J_{C\text{-}P}$ = 130.8 Hz), 36.3, 35.5, 31.1, 16.4(d, $J_{C\text{-}P}$ = 6.4 Hz), 14.5 ppm.

HRMS (ESI): calculated for $C_{20}H_{32}O_6P^+$ $[M+H]^+$ 399.1931, found 399.1929.



A solution of **16** (3.14 g, 7.8 mmol) in THF (20 mL) was added to a stirred suspension of $Ba(OH)_2$ •$8H_2O$ (2.05 g, 6.5 mmol, preactivated at 300-400 ℃ in *vacuo*) and Celite (2.0 g) in THF (100 mL) at room temperature. After 2 h, a solution of aldehyde **13** (1.86 g, 4.5 mmol) in THF (150 mL) and water (4 mL) was added to the mixture. After being stirred for an additional 4 h, the mixture was diluted with Et_2O (200 mL), quenched with a saturated aqueous solution of $NaHCO_3$ (50 mL) and filtered through a pad of Celite. The filtrate was extracted with Et_2O (150 mL × 3). The combined organic phases were washed sequentially with water (50 mL) and brine (50 mL), dried over anhydrous Na_2SO_4 and concentrated in *vacuo.* The residue was purified by flash chromatography on silica gel (EtOAc/hexanes =1:10) to provide **17** (2.2 g, 76%) as a colorless oil.

TLC: R_f= 0.3 (silica gel, EtOAc/hexanes = 1:5).

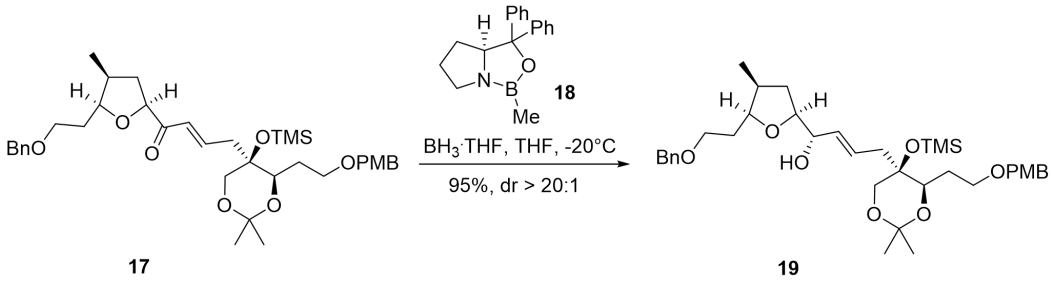
$[\alpha]_D^{20}$ = -21.1 (c 1.0, $CHCl_3$).

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.28 – 7.23 (m, 4H), 7.21 – 7.15 (m, 3H), 6.87 (dt, *J* = 15.6, 7.7 Hz, 1H), 6.81 – 6.76 (m, 2H), 6.42 (d, *J* = 15.8 Hz, 1H), 4.45 (s, 2H), 4.39 – 4.29 (m, 3H), 4.06 – 3.98 (m, 1H), 3.72 – 3.68 (m, 1H), 3.71 (s, 3H), 3.63 – 3.57 (m, 3H), 3.56 – 3.52 (m, 1H), 3.44 (dd, *J* = 7.8, 4.6 Hz, 2H), 2.32 – 2.25 (m, 2H), 2.25 – 2.19 (m, 1H), 2.14 (dd, *J* = 14.1, 8.1 Hz, 1H), 1.76 – 1.58 (m, 5H), 1.30 (s, 3H), 1.25 (s, 3H), 0.79 (d, *J* = 6.8 Hz, 3H), 0.08 (s, 9H) ppm.

^{13}C NMR (101 MHz, $CDCl_3$) δ 199.3, 159.2, 143.2, 138.6, 130.8, 129.3, 128.5, 128.4, 127.8, 127.6, 113.8, 99.1, 81.7, 80.1, 73.8, 73.2, 72.8, 72.3, 68.0, 67.1, 66.4, 55.4, 40.8, 37.4, 35.7, 31.1, 29.1, 27.8, 20.2, 14.7, 2.5 ppm.

IR (film): ν_{max} = 2960, 2929, 2871, 2355, 1775, 1695, 1610, 1514, 1380, 1370, 1277, 1250, 1170, 1100, 1029, 989, 931, 822, 751, 699 cm^{-1}

HRMS (ESI): calculated for $C_{37}H_{54}NaO_8Si^+$ $[M+Na]^+$ 677.3480, found 677.3478.



17 19

BH_3·THF (6.1 mL, 6.1 mmol, 1.0 M in THF) was added to a solution of compound **18** (0.9 mL, 0.9 mmol, 1.0 M in toluene) in THF (20 mL) at -20 °C. After 15 min, a solution of compound **17** (2.0 g, 3.1 mmol) in THF (5 mL) was added dropwise over 10 min. The mixture was stirred at -20 °C. After 30 min, the reaction was quenched with MeOH (5 mL) and the mixture concentrated in *vacuo*. The residue was purified by flash chromatography on silica gel (EtOAc/hexanes =1:10) to provide **19** (1.9 g, 95%, dr >20:1) as a colorless oil.

TLC: R_f = 0.3 (silica gel, EtOAc/hexanes = 1:3).

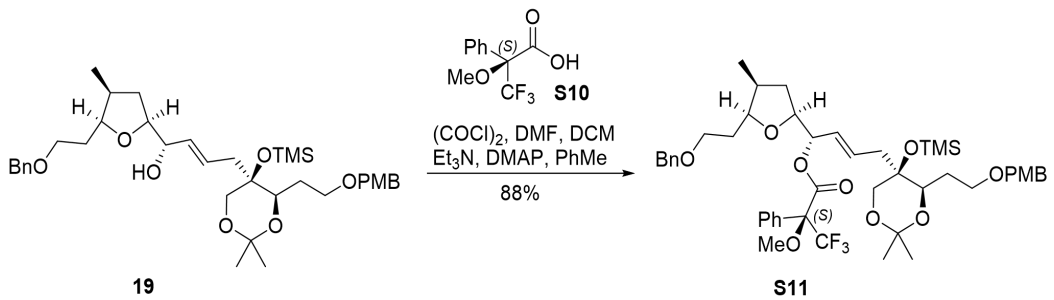
$[\alpha]_D^{20}$ = -9.5 (*c* 1.0, $CHCl_3$).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.37 – 7.31 (m, 4H), 7.30 – 7.23 (m, 3H), 6.89 – 6.84 (m, 2H), 5.71 (dt, *J* = 15.0, 7.3 Hz, 1H), 5.47 (dd, *J* = 15.5, 6.5 Hz, 1H), 4.52 (s, 2H), 4.45 (d, *J* = 11.6 Hz, 1H), 4.38 (d, *J* = 11.6 Hz, 1H), 4.01 (ddd, *J* = 9.1, 6.8, 4.7 Hz, 1H), 3.89 – 3.82 (m, 1H), 3.81 – 3.68 (m, 6H), 3.65 – 3.56 (m, 3H), 3.51 (dd, *J* = 7.8, 4.7 Hz, 2H), 2.75 (d, *J* = 3.9 Hz, 1H), 2.39 – 2.27 (m, 1H), 2.18 (dd, *J* = 14.0, 7.2 Hz, 1H), 2.09 (dd, *J* = 13.9, 7.8 Hz, 1H), 2.01 (dt, *J* = 12.5, 7.3 Hz, 1H), 1.88 – 1.79 (m, 1H), 1.75 – 1.67 (m, 3H), 1.37 (s, 3H), 1.35 – 1.29 (m, 1H), 1.32 (s, 3H), 0.93 (d, *J* = 7.0 Hz, 3H), 0.15 (s, 9H) ppm.

^{13}C NMR (101 MHz, $CDCl_3$) δ 159.2, 138.5, 133.0 130.9, 129.4, 128.4, 127.8, 127.7, 127.6, 113.8, 98.8, 81.8, 79.3, 76.1, 73.3, 72.7, 72.0, 68.2, 67.3, 66.7, 55.4, 40.8, 36.4, 35.9, 31.6, 29.0, 28.1, 20.1, 15.0, 2.6 ppm.

IR (film): ν_{max} = 2958, 2935, 2859, 1513, 1453, 1380, 1367, 1302, 1248, 1180, 1095, 1037, 982, 841, 751, 698 cm^{-1}

HRMS (ESI) calculated for $C_{37}H_{56}NaO_8Si^+$ $[M+Na]^+$ 679.3637, found 679.3637.



19 S11

Oxalyl chloride (100 µL, 1.2 mmol) was added to a solution of acid **S10** (15.0 mg, 0.06 mmol) in DCM (1.5 mL) at 0 °C. After 10 min, a catalytic amount DMF (5 µL, 10% in DCM) was added to the mixture. The resulting mixture was allowed to warmed to room temperature and

stirred for an additional 1 h. The mixture was concentrated in *vacuo* to give the crude acid chloride, which was directly used in the next step without further purification.

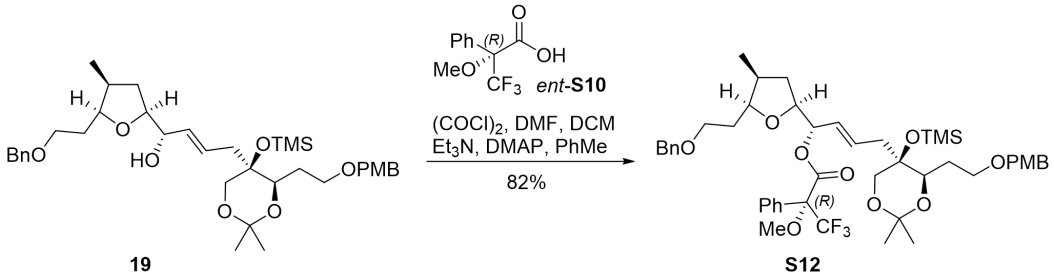
DMAP (1.0 mg, 0.01 mmol) and triethylamine (55 μL, 0.40 mmol) were added to a solution of alcohol **19** (14.0 mg, 0.02 mmol) in toluene (3 mL) at room temperature. The mixture was cooled to 0 °C, and a solution of the previously prepared acid chloride in toluene (1 mL) was added. The resulting mixture was warmed to room temperature and stirred for an additional 2 h before being quenched with a saturated aqueous solution of NH_4Cl (2 mL) at 0 °C. The mixture was extracted with EtOAc (30 mL × 3). The combined organic phases were washed sequentially with water (5 mL) and brine (5 mL), dried over anhydrous Na_2SO_4 and concentrated in *vacuo*. The residue was purified by flash chromatography on silica gel (EtOAc/hexanes =1:10) to provide **S11** (15.3 mg, 88%) as a colorless oil.

TLC: R_f = 0.5 (silica gel, EtOAc/hexanes = 1:5);

$[\alpha]_D^{25}$ = -50.6 (*c* 1.0, $CHCl_3$);

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.61 – 7.56 (m, 2H), 7.38 – 7.30 (m, 8H), 7.26 – 7.22 (m, 2H), 6.88 – 6.85 (m, 2H), 5.85 – 5.75 (m, 1H), 5.41 – 5.30 (m, 2H), 4.47 – 4.42 (m, 3H), 4.38 (d, *J* = 11.5 Hz, 1H), 4.04 (ddd, *J* = 10.4, 6.9, 3.3 Hz, 1H), 3.96 – 3.90 (m, 1H), 3.79 (s, 3H), 3.71 (dd, *J* = 9.7, 2.4 Hz, 1H), 3.61 – 3.54 (m, 6H), 3.53 – 3.48 (m, 3H), 2.37 – 2.29 (m, 1H), 2.19 – 2.13 (m, 1H), 2.07 – 1.99 (m, 2H), 1.80 – 1.67 (m, 3H), 1.38 (s, 3H), 1.31 (s, 3H), 1.28 – 1.23 (m, 2H), 0.94 (d, *J* = 7.0 Hz, 3H), 0.16 (s, 9H) ppm.

HRMS (ESI) calculated for $C_{47}H_{64}F_3O_{10}Si^+$ $[M+H]^+$ 873.4215, found 873.4218.



The synthetic procedures for **S12** was the same as that of **S11**.

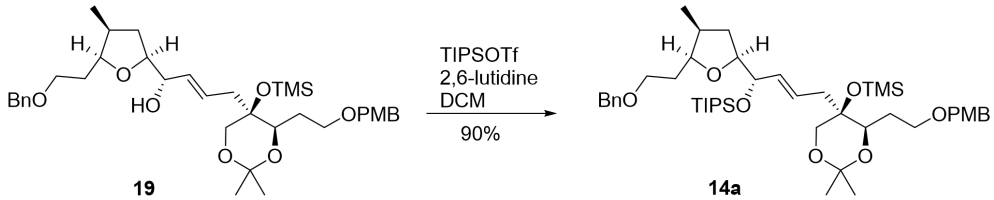
Analytical data for S12: **TLC**: R_f = 0.5 (silica gel, EtOAc/hexanes = 1:5).

$[\alpha]_D^{24}$ = +17.0 (*c* 1.0, $CHCl_3$).

^{1}H NMR (500 MHz, Chloroform-*d*) δ 7.58 – 7.53 (m, 2H), 7.39 – 7.34 (m, 3H), 7.34 – 7.30 (m, 4H), 7.26 – 7.23 (m, 3H), 6.90 – 6.84 (m, 2H), 5.94 – 5.86 (m, 1H), 5.54 (dd, *J* = 15.5, 8.0 Hz, 1H), 5.39 – 5.34 (m, 1H), 4.49 – 4.43 (m, 3H), 4.39 (d, *J* = 11.5 Hz, 1H), 3.97 (ddd, *J* = 10.4, 7.0, 3.1 Hz, 1H), 3.95 – 3.89 (m, 1H), 3.79 (s, 3H), 3.74 (dd, *J* = 9.8, 2.4 Hz, 1H), 3.64 (d, *J* = 12.3 Hz, 1H), 3.57 (d, *J* = 12.4 Hz, 1H), 3.55 – 3.48 (m, 7H), 2.32 – 2.25 (m, 1H), 2.25 – 2.18 (m, 1H), 2.11 – 2.03 (m, 1H), 1.95 – 1.88 (m, 1H), 1.84 – 1.76 (m, 1H), 1.76 – 1.70 (m, 1H), 1.47 – 1.40 (m, 1H), 1.38 (s, 3H), 1.32 (s, 3H), 1.30 – 1.22 (m, 2H), 0.82 (d, *J* = 6.9 Hz,

3H), 0.15 (s, 9H) ppm.

HRMS (ESI) calculated for $C_{47}H_{64}F_3O_{10}Si^+$ $[M+H]^+$ 873.4215, found 873.4216.



19 **14a**

2,6-Lutidine (0.36 mL, 3.2 mmol) and then TIPSOTf (0.53 mL, 2.0 mmol), dropwise, were added to a solution of alcohol **19** (518.0 mg, 0.8 mmol) in DCM (8 mL) at -78 °C. The mixture was slowly warmed to -30 ℃ and stirred for an additional 1.5 h. The reaction was quenched with H_2O (5 mL) at -30 °C, then extracted with EtOAc (100 mL × 3). The combined organic phases were washed sequentially with water (15 mL), citric acid (10% in H_2O, 15 mL), saturated aqueous solution of $NaHCO_3$ (15 mL) and brine (15 mL), dried over anhydrous Na_2SO_4 and concentrated in *vacuo*. The residue was purified by flash chromatography on silica gel (EtOAc/hexanes =1:30) to provide **14a** (576.3 mg, 90%) as a colorless oil.

TLC: R_f = 0.5 (silica gel, EtOAc/hexanes = 1:10).

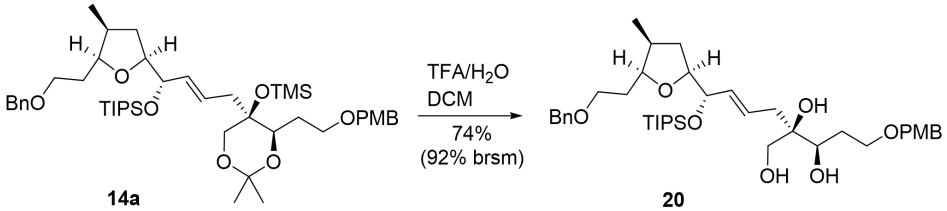
$[\alpha]_D^{20}$ = -18.5 (*c* 1.0, $CHCl_3$).

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.37 – 7.33 (m, 4H), 7.29 – 7.24 (m, 3H), 6.90 – 6.86 (m, 2H), 5.73 – 5.62 (m, 1H), 5.52 (dd, *J* = 15.5, 6.1 Hz, 1H), 4.51 (s, 2H), 4.46 (d, *J* = 11.6 Hz, 1H), 4.40 (d, *J* = 11.6 Hz, 1H), 4.28 (t, *J* = 5.9 Hz, 1H), 3.95 (ddd, *J* = 10.5, 7.2, 3.8 Hz, 1H), 3.84 – 3.78 (m, 2H), 3.80 (s, 3H), 3.72 (d, *J* = 12.5 Hz, 1H), 3.66 – 3.56 (m, 3H), 3.54 – 3.49 (m, 2H), 2.34 – 2.25 (m, 1H), 2.25 – 2.18 (m, 1H), 2.08 (dd, *J* = 14.3, 7.9 Hz, 1H), 1.99 – 1.91 (m, 1H), 1.89 – 1.81 (m, 1H), 1.81 – 1.74 (m, 1H), 1.70 – 1.63 (m, 2H), 1.40 (s, 3H), 1.35 (s, 3H), 1.32 – 1.26 (m, 1H), 1.09 – 1.05 (m, 21H), 0.90 (d, *J* = 7.0 Hz, 3H), 0.17 (s, 9H) ppm.

^{13}C NMR (126 MHz, $CDCl_3$) δ 159.3, 138.8, 133.8, 131.1, 129.3, 128.5, 127.8, 127.6, 126.1, 113.9, 98.7, 82.3, 78.6, 75.5, 73.3, 73.0, 72.8, 72.3, 68.5, 67.4, 66.8, 55.4, 40.8, 35.6, 35.3, 31.6, 29.1, 28.5, 19.8, 18.3, 15.4, 12.7, 2.6 ppm.

IR (film): ν_{max} = 2935, 2866, 1680, 1520, 1448, 1339, 1247, 1202, 1174, 1097, 1034, 882, 820, 765, 700 cm^{-1}

HRMS (ESI) calculated for $C_{46}H_{76}NaO_8Si_2^+$ $[M+Na]^+$ 835.4971, found 835.4978.



14a **20**

A mixture of trifluoroacetic acid (0.1 mL) and H_2O (0.1 mL) was added dropwise at 0 °C to a solution of compound **14a** (695.5 mg, 0.86 mmol) in DCM (5 mL). The mixture was warmed to room temperature gradually and stirred for an additional 1 h. The reaction was quenched with a saturated aqueous solution of $NaHCO_3$ (3 mL) at 0 °C, and extracted with EtOAc (50 mL × 3). The combined organic phases were washed sequentially with water (15 mL) and brine (15 mL), dried over anhydrous Na_2SO_4 and concentrated in *vacuo.* The residue was purified by flash chromatography on silica gel (EtOAc/hexanes =1:10 to 1:3) to provide **20** (444.0 mg, 74%, 92% brsm) as a colorless oil and the recycled **14a** (129.5 mg, 18%).

TLC: R_f = 0.5 (silica gel, EtOAc/hexanes = 1:1).

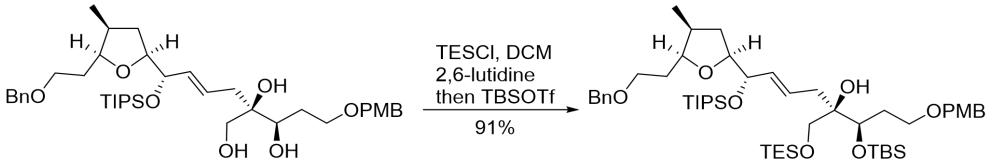
$[\alpha]_D^{20}$ = -25.5 (*c* 1.0, $CHCl_3$).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.25 – 7.22 (m, 4H), 7.20 – 7.16 (m, 1H), 7.15 – 7.11 (m, 2H), 6.80 – 6.75 (m, 2H), 5.59 (dt, *J* = 14.9, 7.3 Hz, 1H), 5.46 (dd, *J* = 15.5, 6.2 Hz, 1H), 4.40 (s, 2H), 4.35 (s, 2H), 4.20 (t, *J* = 5.9 Hz, 1H), 3.83 (ddd, *J* = 9.3, 7.0, 4.4 Hz, 1H), 3.78 – 3.72 (m, 2H), 3.70 (s, 3H), 3.66 – 3.62 (m, 1H), 3.57 – 3.50 (m, 3H), 3.48 – 3.41 (m, 2H), 2.79 (s, 1H), 2.29 – 2.09 (m, 3H), 1.88 – 1.77 (m, 2H), 1.73 – 1.67 (m, 1H), 1.58 – 1.52 (m, 2H), 1.27 – 1.17 (m, 1H), 0.97 – 0.93 (m, 21H), 0.79 (d, *J* = 7.0 Hz, 3H) ppm.

^{13}C NMR (101 MHz, $CDCl_3$) δ 159.5, 138.7, 134.5, 129.7, 129.6, 128.5, 127.8, 127.6, 126.1, 114.1, 82.1, 78.6, 76.7, 75.1, 74.3, 73.3, 73.3, 69.5, 68.5, 67.1, 55.4, 37.4, 35.6, 34.9, 31.5, 30.3, 18.3, 15.3, 12.6 ppm.

IR (film): ν_{max} = 2956, 2939, 2865, 1613, 1587, 1514, 1456, 1379, 1369, 1303, 1249, 1210, 1174, 1097, 1038, 1003, 882, 822, 736, 697 cm^{-1}

HRMS (ESI) calculated for $C_{40}H_{64}NaO_8Si^+$ $[M+Na]^+$ 723.4263, found 723.4265.



20 **21**

2,6-Lutidine (30 μL, 0.3 mmol) and TESCl (6 μL, 0.04 mmol) were added sequentially at 0 °C to a solution of alcohol **20** (19.7 mg, 0.03 mmol) in DCM (2 mL). The mixture was stirred at 0 °C with monitoring by TLC until the substrate was completely consumed (about 3 h). The mixture was then cooled to -78 °C and TBSOTf (11 μL, 0.06 mmol) was added. The mixture was slowly warmed to -30 °C and stirred for an additional 1.5 h. The reaction was quenched with H_2O (2 mL) at -30 °C, then extracted with EtOAc (30 mL × 3). The combined organic phases were washed sequentially with water (5 mL), citric acid (10% in H_2O, 5 mL), saturated aqueous solution of $NaHCO_3$ (5 mL) and brine (5 mL), dried over anhydrous Na_2SO_4 and concentrated in *vacuo*. The residue was purified by flash chromatography on silica gel (EtOAc/hexanes =1:30) to provide **21** (25.7 mg, 92%) as a colorless oil.

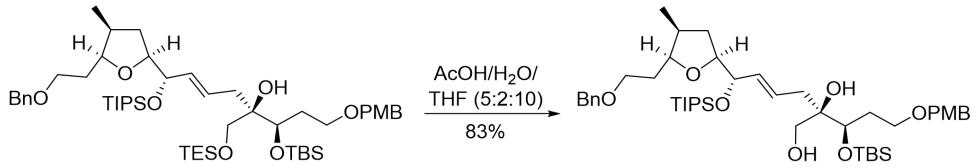
TLC: R_f = 0.5 (silica gel, EtOAc/hexanes = 1:10).

$[\alpha]_D^{20}$ = -16.5 (*c* 3.0, $CHCl_3$).

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.35 – 7.32 (m, 4H), 7.29 – 7.26 (m, 1H), 7.26 – 7.23 (m, 2H), 6.88 – 6.84 (m, 2H), 5.72 (dt, *J* = 14.9, 7.2 Hz, 1H), 5.49 (dd, *J* = 15.5, 6.7 Hz, 1H), 4.50 (d, *J* = 3.2 Hz, 2H), 4.42 (s, 2H), 4.22 (t, *J* = 6.4 Hz, 1H), 3.95 (ddd, *J* = 9.2, 6.9, 4.4 Hz, 1H), 3.84 – 3.78 (m, 2H), 3.80 (s, 3H), 3.67 – 3.42 (m, 7H), 2.38 (dd, *J* = 14.5, 7.0 Hz, 1H), 2.30 – 2.22 (m, 1H), 2.17 (dd, *J* = 14.2, 7.3 Hz, 1H), 1.98 – 1.89 (m, 2H), 1.76 – 1.70 (m, 1H), 1.69 – 1.63 (m, 2H), 1.32 – 1.26 (m, 1H), 1.08 – 1.04 (m, 21H), 0.95 (t, *J* = 7.9 Hz, 9H), 0.88 (d, *J* = 5.1 Hz, 12H), 0.59 (q, *J* = 8.0 Hz, 6H), 0.07 (s, 3H), 0.04 (s, 3H) ppm.

^{13}C NMR (126 MHz, $CDCl_3$) δ 159.3, 138.9, 133.7, 130.9, 129.4, 128.5, 127.8, 127.6, 127.3, 113.9, 82.3, 78.6, 76.2, 76.2, 73.3, 73.2, 72.7, 68.5, 67.4, 65.7, 55.4, 36.1, 35.7, 35.5, 33.2, 31.7, 26.2, 18.5, 18.3, 15.4, 12.7, 6.9, 4.6, -4.1, -4.1 ppm.

HRMS (ESI) calculated for $C_{52}H_{92}NaO_8Si_3^+$ $[M+Na]^+$ 951.5992, found 951.5991.



21 **22**

Compound **21** (101.0 mg, 0.11 mmol) was treated with a mixture of AcOH (1.5 mL), H_2O (0.6 mL) and THF (3.0 mL). The mixture was stirred at room temperature with monitoring by TLC until the substrate was completely consumed (about 12 h). The mixture was then cooled to 0 ℃, slowly quenched with solid $NaHCO_3$ and extracted with EtOAc (100 mL × 3). The combined organic phases were washed sequentially with water (15 mL) and brine (15 mL), dried over anhydrous Na_2SO_4 and concentrated in *vacuo.* The residue was purified by flash chromatography on silica gel (EtOAc/hexanes =1:8) to provide **22** (74.4 mg, 83 %) as a colorless oil.

TLC: R_f = 0.5 (silica gel, EtOAc/hexanes = 1:3).

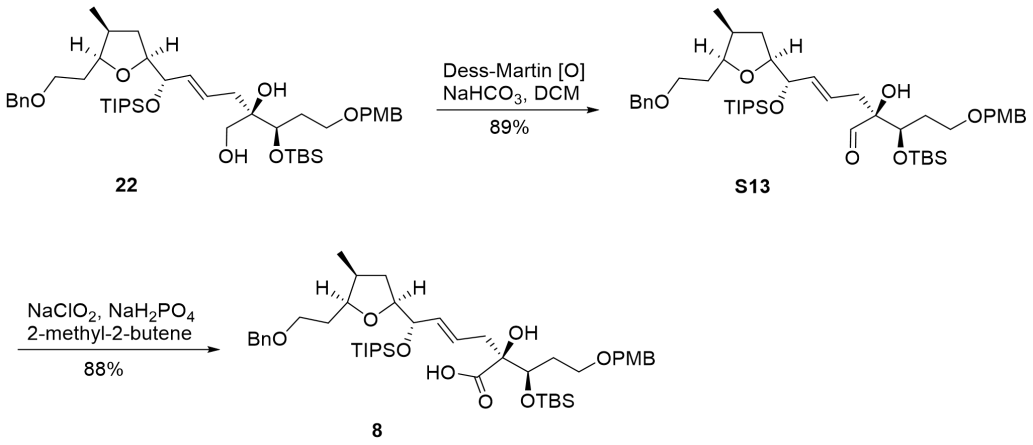
$[\alpha]_D^{20}$ = -20.7 (*c* 3.5, $CHCl_3$).

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.35 – 7.31 (m, 4H), 7.30 – 7.26 (m, 1H), 7.26 – 7.23 (m, 2H), 6.90 – 6.85 (m, 2H), 5.73 (dt, *J* = 15.0, 7.3 Hz, 1H), 5.58 (dd, *J* = 15.5, 6.3 Hz, 1H), 4.50 (d, *J* = 1.8 Hz, 2H), 4.43 (s, 2H), 4.30 (t, *J* = 6.1 Hz, 1H), 3.94 (ddd, *J* = 8.6, 7.1, 5.1 Hz, 1H), 3.88 – 3.81 (m, 2H), 3.80 (s, 3H), 3.67 – 3.60 (m, 2H), 3.60 – 3.55 (m, 1H), 3.54 – 3.48 (m, 3H), 2.38 (dd, *J* = 14.1, 7.3 Hz, 1H), 2.34 – 2.25 (m, 2H), 2.04 – 1.91 (m, 2H), 1.85 – 1.77 (m, 1H), 1.71 – 1.63 (m, 2H), 1.37 – 1.29 (m, 1H), 1.09 – 1.04 (m, 21H), 0.88 (s, 12H), 0.08 (s, 3H), 0.06 (s, 3H) ppm.

^{13}C NMR (126 MHz, $CDCl_3$) δ 159.4, 138.8, 134.5, 130.3, 129.5, 128.5, 127.8, 127.6, 126.6, 114.0, 82.1, 78.6, 75.5, 75.4, 74.1, 73.3, 72.9, 68.5, 66.9, 65.8, 55.4, 37.2, 35.6, 35.2, 33.2, 31.5, 26.1, 18.3, 15.4, 12.7, -4.1, -4.4 ppm.

IR (film): ν_{max} = 2955, 2929, 2864, 1512, 1464, 1457, 1363, 1249, 1093, 1038, 882, 836, 777.4, 735, 697 cm^{-1}

HRMS (ESI) calculated for $C_{46}H_{78}NaO_8Si_2^+$ $[M+Na]^+$ 837.5127, found 837.5126.



$NaHCO_3$ (286.8 mg, 3.41 mmol) and Dess-Martin periodinane (723.8 mg, 1.71 mmol) were added sequentially at 0 °C to a solution of alcohol **22** (1.12 g, 1.38 mmol) in DCM (10 mL). After being stirred for 4 h at room temperature, the reaction mixture was filtered through a pad of silica gel (EtOAc/hexanes =1:10). The filtrate was concentrated in *vacuo* to afford the crude aldehyde **S13** (880.2 mg, 89%).

2-Methyl-2-butene (3 mL, 32 mmol), $NaH_2PO_4{\cdot}2H_2O$ (1.35 g, 8.7 mmol) and $NaClO_2$ (80%, 488 mg, 4.32 mmol) were added sequentially at 0 ºC to a solution of the crude aldehyde **S13** (880.2 mg, 1.08 mmol) in a mixture of *t*BuOH (5 mL) and H_2O (2 mL). The reaction mixture was slowly warmed to room temperature and stirred for an additional 1 h. The mixture was diluted with brine (10 mL) and extracted with EtOAc (100 mL × 3). The combined organic phases were washed with brine (10 mL × 3), dried over anhydrous Na_2SO_4 and concentrated in *vacuo*. The residue was purified by flash chromatography on silica gel (EtOAc/hexanes =1:10) to provide **8** (795.6 mg, 88%) as a colorless oil.

TLC: R_f = 0.4 (silica gel, EtOAc/hexanes = 1:5).

$[\alpha]_D^{20}$ = -31.8 (*c* 3.0, $CHCl_3$).

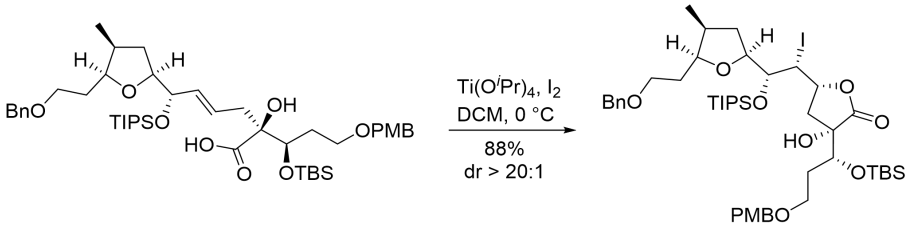
^{1}H NMR (500 MHz, $CDCl_3$) δ 7.35 – 7.31 (m, 4H), 7.30 – 7.26 (m, 1H), 7.25 – 7.22 (m, 2H), 6.90 – 6.86 (m, 2H), 5.66 – 5.59 (m, 1H), 5.51 (dd, *J* = 15.6, 6.0 Hz, 1H), 5.03 (s, 1H), 4.50 (s, 2H), 4.45 (s, 2H), 4.25 (t, *J* = 6.0 Hz, 1H), 4.17 (dd, *J* = 6.0, 3.1 Hz, 1H), 3.95 – 3.89 (m, 1H), 3.81 – 3.76 (m, 1H), 3.80 (s, 3H), 3.72 (td, *J* = 9.2, 4.1 Hz, 1H), 3.67 – 3.61 (m, 1H), 3.59 – 3.53 (m, 1H), 3.51 – 3.45 (m, 1H), 2.49 (dd, *J* = 13.8, 7.0 Hz, 1H), 2.28 (dt, *J* = 13.4, 6.9 Hz, 2H), 2.00 – 1.93 (m, 1H), 1.91 – 1.84 (m, 2H), 1.69 – 1.63 (m, 2H), 1.31 – 1.27 (m, 1H), 1.06 – 1.02 (m, 21H), 0.89 (d, *J* = 7.0 Hz, 3H), 0.86 (s, 9H), 0.06 (s, 3H), 0.05 (s, 3H) ppm.

^{13}C NMR (126 MHz, $CDCl_3$) δ 174.7, 159.7, 138.8, 135.2, 129.6, 129.5, 128.5, 127.8, 127.6,

124.6, 114.1, 82.3, 80.3, 78.6, 75.3, 73.6, 73.3, 73.1, 68.6, 65.1, 55.4, 39.7, 35.7, 35.0, 32.1, 31.6, 26.0, 18.3, 18.2, 15.2, 12.7, -4.2, -5.0 ppm.

IR (film): ν_{max} = 2958, 2927, 2865, 1720, 1613, 1514, 1377, 1363, 1302, 1248, 1174, 1094, 1034, 974, 882, 822, 697 cm^{-1}

HRMS (ESI): calculated for $C_{46}H_{77}O_9Si_2^+$ $[M+H]^+$ 829.5101, found 829.5103.



8 **24**

$Ti(O^iPr)_4$ (2.4 mL, 8.6 mmol) was added to a solution of acid **8** (880.0 mg, 1.06 mmol) in DCM (10 mL) at 0 °C. After 20 min, a solution of iodine (1.1 g, 4.3 mmol) in DCM (20 mL) was added dropwise over 10 min. The mixture was stirred at 0 °C. After 2 h, the reaction was quenched with a saturated aqueous solution of $Na_2S_2O_3$ (20 mL) at 0 °C, then extracted with EtOAc (100 mL × 3). The combined organic phases were washed sequentially with saturated aqueous solution of $NaHCO_3$ (15 mL), water (15 mL) and brine (15 mL), dried over anhydrous Na_2SO_4 and concentrated in *vacuo*. The residue was purified by flash chromatography on silica gel (EtOAc/hexanes =1:10) to provide **24** (846.0 mg, 88%, dr > 20:1) as a colorless oil.

TLC: R_f = 0.6 (silica gel, EtOAc/hexanes = 1:5).

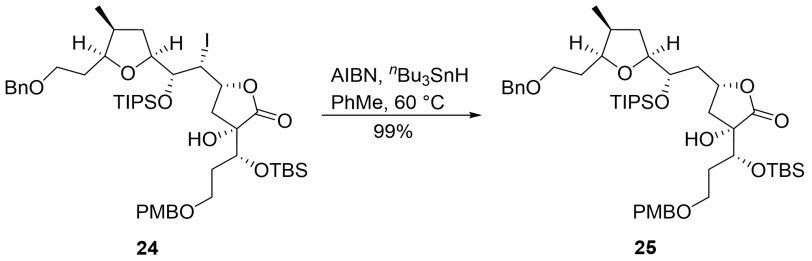
$[\alpha]_D^{20}$ = +11.4 (*c* 2.0, $CHCl_3$).

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.37 – 7.33 (m, 4H), 7.31 – 7.27 (m, 1H), 7.27 – 7.24 (m, 2H), 6.91 – 6.85 (m, 2H), 4.68 (ddd, *J* = 10.4, 7.9, 6.7 Hz, 1H), 4.55 – 4.42 (m, 5H), 3.92 – 3.87 (m, 3H), 3.81 (s, 3H), 3.73 – 3.67 (m, 1H), 3.67 – 3.60 (m, 2H), 3.58 – 3.51 (m, 2H), 3.29 (d, *J* = 8.1 Hz, 1H), 2.85 (dd, *J* = 13.9, 6.9 Hz, 1H), 2.36 – 2.26 (m, 2H), 2.16 – 2.08 (m, 2H), 1.77 – 1.70 (m, 3H), 1.26 – 1.19 (m, 4H), 1.09 (d, *J* = 7.4 Hz, 18H), 0.92 (d, *J* = 7.0 Hz, 3H), 0.89 (s, 9H), 0.09 (s, 3H), 0.07 (s, 3H) ppm.

^{13}C NMR (126 MHz, $CDCl_3$) δ 176.5, 159.5, 138.8, 129.9, 129.6, 128.5, 127.8, 127.7, 114.1, 84.3, 78.6, 78.5, 75.7, 74.4, 74.2, 73.4, 72.8, 68.6, 66.4, 55.4, 43.7, 41.2, 36.9, 35.3, 33.5, 31.7, 29.9, 26.1, 18.6, 16.2, 13.6, -4.3, -4.5 ppm.

IR (film): ν_{max} = 2925, 2913, 2855, 2360, 2337, 1734, 1650, 1560, 1540, 1507, 1465, 1457, 1437, 1261, 1098, 1022, 803 cm^{-1}

HRMS (ESI) calculated for $C_{46}H_{75}INaO_9Si_2^+$ $[M+Na]^+$ 977.3887, found 977.3882.



24 **25**

^{n}Bu$_3$SnH (750 μL, 2.6 mmol) and AIBN (44.0 mg, 0.26 mmol) were added to a solution of iodide **24** (846.0 mg, 0.89 mmol) in toluene (18 mL) at room temperature. The mixture was heated to 60 °C and stirred for an additional 30 min. After being cooled to room temperature, the mixture was quenched with a saturated aqueous solution of NH_4Cl (5 mL) and extracted with EtOAc (100 mL × 3). The combined organic phases were washed sequentially with water (15 mL) and brine (15 mL), dried over anhydrous Na_2SO_4 and concentrated in *vacuo*. The residue was purified by flash chromatography on silica gel (EtOAc/hexanes =1:10) to provide **25** (742.0 mg, 99%) as a colorless oil.

TLC: R_f = 0.4 (silica gel, EtOAc/hexanes = 1:5).

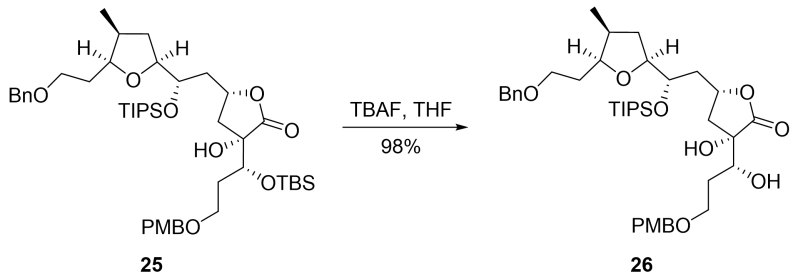
$[\alpha]_D^{20}$ = -18.9 (*c* 1.0, $CHCl_3$).

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.37 – 7.33 (m, 4H), 7.31 – 7.24 (m, 3H), 6.90 – 6.85 (m, 2H), 4.69 (tdd, *J* = 9.4, 6.9, 3.2 Hz, 1H), 4.51 (s, 2H), 4.48 (d, *J* = 11.5 Hz, 1H), 4.43 (d, *J* = 11.5 Hz, 1H), 4.06 (ddd, *J* = 9.4, 6.6, 2.8 Hz, 1H), 3.97 (s, 1H), 3.93 (t, *J* = 5.5 Hz, 1H), 3.91 – 3.87 (m, 1H), 3.80 (s, 3H), 3.70 (dt, *J* = 9.2, 6.7 Hz, 1H), 3.66 – 3.51 (m, 4H), 2.63 (dd, *J* = 13.5, 6.7 Hz, 1H), 2.32 – 2.24 (m, 1H), 2.23 – 2.14 (m, 1H), 2.06 – 1.98 (m, 1H), 1.93 (dd, *J* = 13.5, 8.6 Hz, 1H), 1.87 (ddd, *J* = 14.3, 9.4, 2.8 Hz, 1H), 1.76 – 1.69 (m, 3H), 1.63 (ddd, *J* = 14.2, 9.3, 3.3 Hz, 1H), 1.25 – 1.17 (m, 1H), 1.17 – 1.10 (m, 3H), 1.07 (d, *J* = 6.3 Hz, 18H), 0.91 (d, *J* = 7.0 Hz, 3H), 0.89 (s, 9H), 0.08 (s, 3H), 0.07 (s, 3H) ppm.

^{13}C NMR (126 MHz, $CDCl_3$) δ 177.0, 159.4, 138.7, 130.1, 129.5, 128.5, 127.8, 127.6, 114.0, 81.8, 78.7, 78.5, 73.9, 73.9, 73.3, 72.7, 72.0, 68.5, 66.3, 55.4, 41.2, 39.4, 36.0, 35.4, 33.5, 31.5, 26.0, 18.5, 18.2, 15.8, 13.2, -4.3, -4.5 ppm.

IR (film): ν_{max} = 2956, 2948, 2864, 1780, 1761, 1613, 1514, 1464, 1362, 1303, 1249, 1197, 1112, 1038, 883, 837, 778, 738, 680 cm^{-1}

HRMS (ESI) calculated for $C_{46}H_{76}NaO_9Si_2^+$ $[M+Na]^+$ 851.4920, found 851.4922.



25 **26**

TBAF (5.0 mL, 0.5 mmol, 0.1 M in THF) was added dropwise at -10 °C over 20 min to a

solution of compound **25** (380.0 mg, 0.46 mmol) in THF (10 mL). After being stirred for 2 h at -10 °C, the reaction was quenched with a saturated aqueous solution of NH_4Cl (5 mL) at 0 °C and extracted with EtOAc (50 mL × 3). The combined organic phases were washed sequentially with water (5 mL) and brine (5 mL), dried over anhydrous Na_2SO_4 and concentrated in *vacuo*. The residue was purified by flash chromatography on silica gel (EtOAc/hexanes =1:5) to provide **26** (323.0 mg, 98%) as a colorless oil.

TLC: R_f = 0.7 (silica gel, EtOAc/hexanes = 1:1).

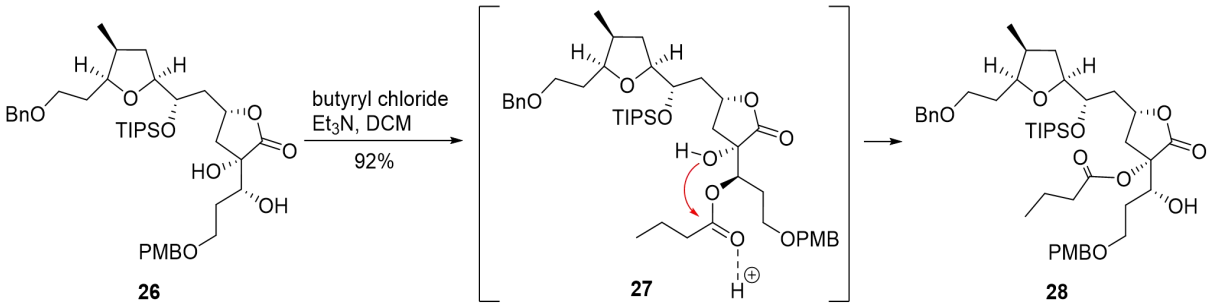
$[\alpha]_D^{20}$ = -40.3 (*c* 1.0, $CHCl_3$).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.38 – 7.34 (m, 4H), 7.33 – 7.25 (m, 3H), 6.93 – 6.87 (m, 2H), 4.86 (dtd, *J* = 10.1, 6.9, 3.2 Hz, 1H), 4.52 (s, 2H), 4.47 (s, 2H), 4.08 (ddd, *J* = 9.3, 6.5, 2.7 Hz, 1H), 4.00 – 3.95 (m, 1H), 3.95 – 3.88 (m, 1H), 3.82 (s, 3H), 3.76 – 3.69 (m, 3H), 3.68 – 3.61 (m, 2H), 3.60 – 3.54 (m, 2H), 2.55 (dd, *J* = 13.5, 7.0 Hz, 1H), 2.36 – 2.25 (m, 1H), 2.07 – 1.94 (m, 3H), 1.91 – 1.81 (m, 2H), 1.74 – 1.58 (m, 3H), 1.28 – 1.20 (m, 1H), 1.19 – 1.11 (m, 3H), 1.10 – 1.06 (m, 18H), 0.93 (d, *J* = 7.0 Hz, 3H) ppm.

^{13}C NMR (101 MHz, $CDCl_3$) δ 177.9, 159.5, 138.7, 129.9, 129.5, 128.5, 127.8, 127.6, 114.0, 81.8, 78.4, 77.1, 75.1, 73.8, 73.3, 73.1, 71.8, 68.4, 67.7, 55.4, 40.7, 39.0, 35.8, 35.4, 31.5, 30.4, 18.4, 15.8, 13.1 ppm.

IR (film): ν_{max} = 2961, 2941, 2927, 2865, 1761, 1613, 1515, 1456, 1374, 1302, 1249, 1203, 1094, 1029, 883, 822, 749, 679 cm^{-1}

HRMS (ESI) calculated for $C_{40}H_{63}O_9Si^+$ $[M+H]^+$ 715.4236, found 715.4233.



Triethylamine (55 μL, 0.40 mmol) and butyryl chloride (10 μL, 0.09 mmol) were added sequentially at 0 °C to a solution of alcohol **26** (53.0 mg, 0.07 mmol) in DCM (2 mL). The mixture was allowed to warmed to room temperature and then stirred for an additional 2 h. The reaction was quenched with a saturated aqueous solution of NH_4Cl (3 mL) at 0 °C, and the mixture was extracted with EtOAc (50 mL × 3). The combined organic phases were washed sequentially with water (5 mL) and brine (5 mL), dried over anhydrous Na_2SO_4 and concentrated in *vacuo*. The residue was purified by flash chromatography on silica gel (EtOAc/hexanes =1:8) to provide **28** (46.0 mg, 81%) as a colorless oil.

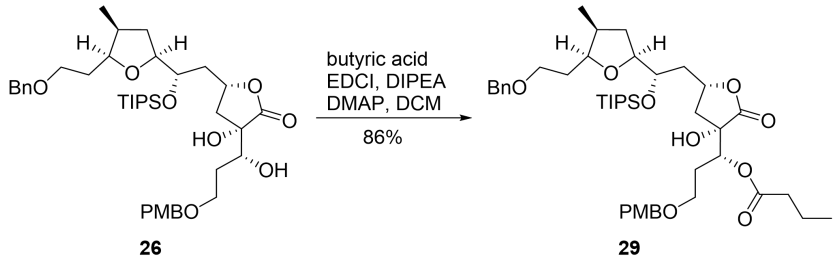
TLC: R_f = 0.5 (silica gel, EtOAc/hexanes = 1:3).

$[\alpha]_D^{20}$ = -10.6 (c 1.0, $CHCl_3$).

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.36 – 7.30 (m, 4H), 7.30 – 7.26 (m, 1H), 7.25 – 7.21 (m, 2H), 6.90 – 6.85 (m, 2H), 4.90 – 4.82 (m, 1H), 4.50 (s, 2H), 4.45 (s, 2H), 4.14 (d, *J* = 10.3 Hz, 1H), 4.05 (ddd, *J* = 9.5, 6.8, 2.8 Hz, 1H), 3.92 – 3.86 (m, 1H), 3.80 (s, 3H), 3.78 – 3.73 (m, 1H), 3.71 – 3.68 (m, 1H), 3.68 – 3.61 (m, 3H), 3.60 – 3.55 (m, 1H), 2.70 (dd, *J* = 13.1, 7.5 Hz, 1H), 2.37 – 2.23 (m, 4H), 2.07 – 1.93 (m, 3H), 1.89 – 1.82 (m, 1H), 1.71 (q, *J* = 6.8 Hz, 2H), 1.66 – 1.61 (m, 3H), 1.28 – 1.20 (m, 1H), 1.17 – 1.09 (m, 3H), 1.06 – 1.03 (m, 18H), 0.94 (t, *J* = 7.4 Hz, 3H), 0.91 (d, *J* = 7.0 Hz, 3H) ppm.

^{13}C NMR (126 MHz, $CDCl_3$) δ 173.0, 172.3, 159.6, 138.8, 129.8, 129.5, 128.5, 127.8, 127.6, 114.1, 82.4, 82.2, 78.5, 75.4, 74.8, 73.3, 73.6, 72.4, 69.0, 68.6, 55.4, 40.8, 36.9, 36.2, 36.1, 35.5, 31.6, 30.1, 18.5, 18.5, 15.9, 13.6, 13.1 ppm.

HRMS (ESI) calculated for $C_{44}H_{68}NaO_{10}Si^+$ $[M+Na]^+$ 807.4474, found 807.4474.



DIPEA (0.3 mL, 1.7 mmol), butyric acid (56 μL, 0.61 mmol), EDCI (162.0 mg, 0.85 mmol) and DMAP (5.0 mg, 0.05 mmol) were added sequentially at 0 °C to a solution of alcohol **26** (440.0 mg, 0.57mmol) in DCM (15 mL). The mixture was allowed to warmed to room temperature and then stirred for an additional 2 h. The reaction was quenched with a saturated aqueous solution of NH_4Cl (5 mL) at 0 °C, and the mixture was extracted with EtOAc (100 mL × 3). The combined organic phases were washed sequentially with water (15 mL) and brine (15 mL), dried over anhydrous Na_2SO_4 and concentrated in *vacuo*. The residue was purified by flash chromatography on silica gel (EtOAc/hexanes =1:8) to provide **29** (384.0 mg, 86%) as a colorless oil.

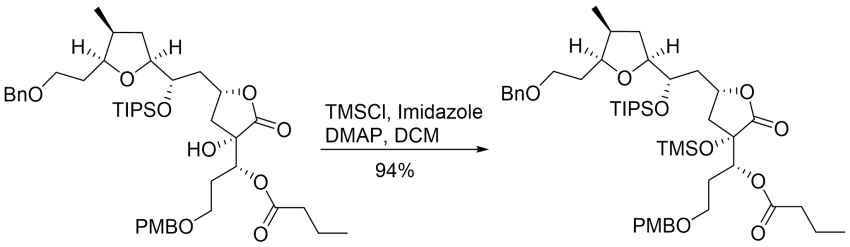
TLC: R_f = 0.5 (silica gel, EtOAc/hexanes = 1:3).

$[\alpha]_D^{20}$ = -18.7 (c 1.0, $CHCl_3$).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.37 – 7.30 (m, 4H), 7.30 – 7.26 (m, 1H), 7.25 – 7.21 (m, 2H), 6.89 – 6.83 (m, 2H), 5.20 (dd, *J* = 7.7, 4.5 Hz, 1H), 4.73 (tdd, *J* = 9.3, 6.3, 3.3 Hz, 1H), 4.50 (s, 2H), 4.48 (d, *J* = 11.6 Hz, 1H), 4.40 (d, *J* = 11.4 Hz, 1H), 4.11 – 4.01 (m, 2H), 3.89 (ddd, *J* = 8.3, 6.9, 5.1 Hz, 1H), 3.79 (s, 3H), 3.69 (dt, *J* = 9.1, 6.7 Hz, 1H), 3.65 – 3.59 (m, 1H), 3.59 – 3.50 (m, 2H), 3.46 (td, *J* = 9.5, 3.8 Hz, 1H), 2.51 (dd, *J* = 13.6, 6.4 Hz, 1H), 2.33 – 2.22 (m, 3H), 2.22 – 2.13 (m, 1H), 2.06 – 1.95 (m, 2H), 1.94 – 1.83 (m, 2H), 1.74 – 1.66 (m, 2H), 1.65 – 1.59 (m, 3H), 1.27 – 1.09 (m, 4H), 1.06 (d, *J* = 6.5 Hz, 18H), 0.92 (t, *J* = 6.4 Hz, 3H), 0.90 (d, *J* = 5.1 Hz, 3H) ppm.

^{13}C NMR (101 MHz, $CDCl_3$) δ 176.2, 173.0, 159.5, 138.7, 129.8, 129.6, 128.5, 127.8, 127.7, 114.0, 81.7, 78.5, 77.4, 74.0, 73.4, 73.3, 73.0, 71.8, 68.5, 66.1, 55.4, 40.8, 40.2, 36.1, 35.9, 35.4, 31.5, 29.8, 18.5, 18.4, 18.4, 15.9, 13.7, 13.2 ppm.

HRMS (ESI) calculated for $C_{44}H_{68}NaO_{10}Si^+$ $[M+Na]^+$ 807.4474, found 807.4476.



29 **S14**

Imidazole (210.0 mg, 3.1mmol), TMSCl (130 μL, 1.55 mmol) and DMAP (5.0 mg, 0.05 mmol) were added sequentially at 0 °C to a solution of compound **29** (304.0 mg, 0.38 mmol) in DCM (4 mL). The mixture was allowed to warmed to room temperature and then stirred for an additional 2 h. The reaction was quenched with a saturated aqueous solution of NH_4Cl (5 mL) at 0 °C, then extracted with EtOAc (80 mL × 3). The combined organic phases were washed sequentially with saturated aqueous solution of NH_4Cl (8 mL) and brine (8 mL), dried over anhydrous Na_2SO_4 and concentrated in *vacuo*. The residue was purified by flash chromatography on silica gel (EtOAc/hexanes =1:20) to provide **S14** (305.0 mg, 94%) as a colorless oil.

TLC: R_f = 0.7 (silica gel, EtOAc/hexanes = 1:7).

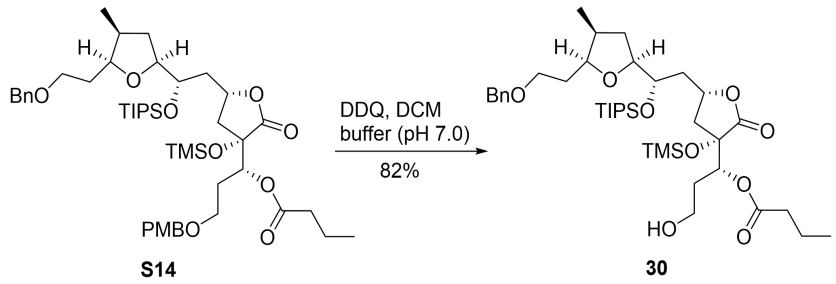
$[\alpha]_D^{20}$ = -21.8 (c 1.0, $CHCl_3$).

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.37 – 7.30 (m, 4H), 7.30 – 7.26 (m, 1H), 7.26 – 7.22 (m, 2H), 6.89 – 6.84 (m, 2H), 5.32 (dd, *J* = 10.2, 2.3 Hz, 1H), 4.67 – 4.58 (m, 1H), 4.50 (s, 2H), 4.39 (s, 2H), 4.07 (ddd, *J* = 9.2, 6.3, 3.0 Hz, 1H), 3.91 (ddd, *J* = 8.7, 6.9, 4.6 Hz, 1H), 3.80 (s, 3H), 3.71 (dt, *J* = 9.1, 6.6 Hz, 1H), 3.66 – 3.54 (m, 2H), 3.50 – 3.43 (m, 1H), 3.42 – 3.36 (m, 1H), 2.64 (dd, *J* = 13.7, 6.5 Hz, 1H), 2.33 – 2.16 (m, 3H), 2.11 – 1.97 (m, 2H), 1.97 – 1.83 (m, 3H), 1.75 – 1.68 (m, 2H), 1.66 – 1.56 (m, 3H), 1.26 – 1.19 (m, 1H), 1.18 – 1.11 (m, 3H), 1.07 (d, *J* = 6.8 Hz, 18H), 0.18 (s, 9H), 0.92 (t, *J* = 7.4 Hz, 3H), 0.92 (d, *J* = 7.0 Hz, 3H) ppm.

^{13}C NMR (126 MHz, $CDCl_3$) δ 174.9, 172.9, 159.3, 138.7, 130.5, 129.5, 128.5, 127.8, 127.6, 113.9, 81.5, 79.3, 78.5, 73.7, 73.4, 73.3, 72.9, 71.6, 68.4, 66.5, 55.4, 42.4, 41.2, 36.2, 35.8, 35.4, 31.5, 29.8, 18.4, 18.4, 18.4, 15.8, 13.8, 13.2, 1.7 ppm.

IR (film): ν_{max} = 2958, 2926, 2857, 2360, 1770, 1729, 1420, 1250, 1173, 1095, 1039, 882, 847, 803, 756, 697 cm^{-1}

HRMS (ESI) calculated for $C_{47}H_{76}NaO_{10}Si_2^+$ $[M+Na]^+$ 879.4869, found 879.4860.



Phosphate buffer (3 mL, 0.1 M, pH = 7.0) and DDQ (216.0 mg, 0.95 mmol) were added sequentially at room temperature to a solution of compound **S14** (370.0 mg, 0.43 mmol) in DCM (9 mL). After being stirred for 2.5 h at room temperature, the reaction mixture was diluted with DCM (200 mL) and transferred to a separation funnel. The organic phases were washed sequentially with a saturated aqueous solution of $Na_2S_2O_3$ (8 mL), a saturated aqueous solution of $NaHCO_3$ (8 mL) and brine (8 mL), dried over anhydrous Na_2SO_4 and concentrated in *vacuo*. The residue was purified by flash chromatography on silica gel (EtOAc/hexanes =1:5) to provide **30** (258.0 mg, 82%) as a colorless oil.

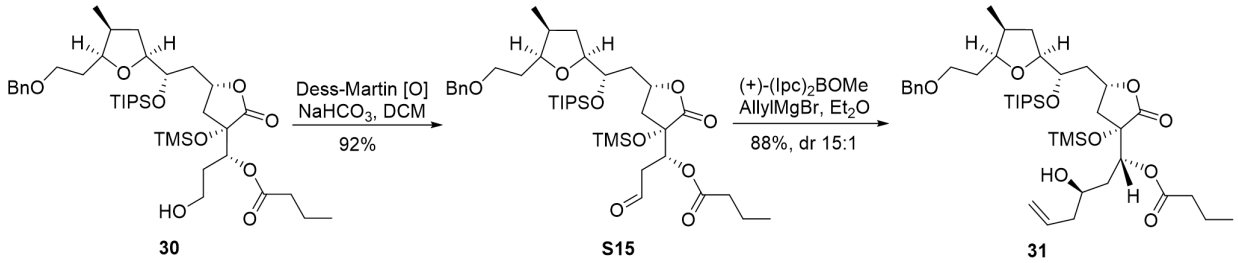
TLC: R_f = 0.5 (silica gel, EtOAc/hexanes = 1:3).

$[\alpha]_D^{20}$ = -19.1 (*c* 1.0, $CHCl_3$).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.37 – 7.31 (m, 4H), 7.31 – 7.26 (m, 1H), 5.21 (dd, *J* = 10.4, 2.4 Hz, 1H), 4.64 (tdd, *J* = 8.9, 7.2, 3.8 Hz, 1H), 4.50 (s, 2H), 4.08 (ddd, *J* = 9.2, 6.3, 3.0 Hz, 1H), 3.89 (ddd, *J* = 8.7, 6.8, 4.6 Hz, 1H), 3.75 – 3.65 (m, 2H), 3.64 – 3.54 (m, 2H), 3.54 – 3.43 (m, 1H), 2.62 (dd, *J* = 13.7, 6.6 Hz, 1H), 2.37 – 2.26 (m, 4H), 2.11 – 1.95 (m, 3H), 1.91 – 1.76 (m, 2H), 1.74 – 1.65 (m, 4H), 1.24 – 1.18 (m, 1H), 1.15 – 1.05 (m, 21H), 0.95 (t, *J* = 7.4 Hz, 3H), 0.91 (d, *J* = 7.0 Hz, 3H), 0.18 (s, 9H) ppm.

^{13}C NMR (101 MHz, $CDCl_3$) δ 174.8, 174.2, 138.7, 128.5, 127.8, 127.7, 81.5, 79.1, 78.5, 73.8, 73.7, 73.3, 71.5, 68.4, 58.5, 42.5, 41.2, 36.2, 35.7, 35.3, 32.3, 31.5, 18.5, 18.4, 18.4, 15.9, 13.8, 13.2, 1.7 ppm.

HRMS (ESI) calculated for $C_{39}H_{68}NaO_9Si_2^+$ $[M+Na]^+$ 759.4294, found 759.4295.



$NaHCO_3$ (202.0 mg, 2.4 mmol) and Dess-Martin periodinane (305.0 mg, 0.72 mmol) were added sequentially at 0 °C to a solution of alcohol **30** (178.0 mg, 0.24 mmol) in DCM (3 mL). The mixture was allowed to warm to room temperature, with stirring. After 30 min, the reaction mixture was directly filtered through a pad of silica gel (EtOAc/hexanes =1:10). The

filtrate was concentrated in *vacuo* to afford the crude aldehyde **S15** (158.0 mg, 92%).

Allylmagnesium bromide (1.6 mL, 0.68 M in Et_2O, 1.0 mmol) was added dropwise at -78 °C over 2 min to a solution of (+)-*B*-methoxydiisopinocampheylborane (408.0 mg, 1.29 mmol) in Et_2O (5 mL). After 15 min, the mixture was warmed to room temperature gradually and stirred for an additional 45 min. Then the mixture was cooled to -78 °C and a solution of crude aldehyde **S15** (158.0 mg, 0.22 mmol) in Et_2O (10 mL) added dropwise over 10 min. After being stirred at -78 °C for 10 h, the reaction was quenched with a saturated aqueous solution of $NaHCO_3$ (5 mL) and H_2O_2 (5 mL, 30% in H_2O). The mixture was stirred for an additional 3 h at room temperature before being extracted with Et_2O (100 mL × 3). The combined organic phases were washed sequentially with water (15 mL) and brine (15 mL), dried over anhydrous Na_2SO_4 and concentrated in *vacuo*. The residue was purified by flash chromatography on silica gel (EtOAc/hexanes =1:10) to provide **31** (150.5 mg, 88%, dr 15:1) as a colorless oil.

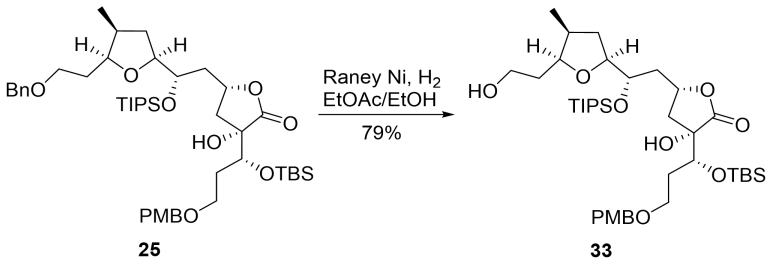
TLC: R_f = 0.3 (silica gel, EtOAc/hexanes = 1:3).

$[\alpha]_D^{20}$ = -19.4 (c 1.0, $CHCl_3$).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.35 – 7.31 (m, 4H), 7.30 – 7.26 (m, 1H), 5.85 – 5.74 (m, 1H), 5.22 (dd, *J* = 8.1, 3.3 Hz, 1H), 5.17 – 5.13 (m, 1H), 5.13 – 5.08 (m, 1H), 4.64 (tdd, *J* = 8.9, 6.6, 3.7 Hz, 1H), 4.49 (s, 2H), 4.07 (ddd, *J* = 9.1, 6.3, 2.9 Hz, 1H), 3.89 (ddd, *J* = 8.8, 6.9, 4.6 Hz, 1H), 3.80 – 3.66 (m, 2H), 3.64 – 3.52 (m, 2H), 2.65 (dd, *J* = 13.8, 6.7 Hz, 1H), 2.34 – 2.25 (m, 4H), 2.21 – 2.08 (m, 2H), 2.05 – 1.92 (m, 3H), 1.87 (ddd, *J* = 14.2, 9.0, 3.0 Hz, 1H), 1.79 – 1.68 (m, 3H), 1.68 – 1.63 (m, 2H), 1.25 – 1.17 (m, 1H), 1.16 – 1.09 (m, 3H), 1.08 – 1.04 (m, 18H), 0.94 (t, *J* = 7.4 Hz, 3H), 0.91 (d, *J* = 7.2 Hz, 3H), 0.18 (s, 9H) ppm.

^{13}C NMR (101 MHz, $CDCl_3$) δ 174.9, 173.4, 138.7, 134.4, 128.5, 127.8, 127.7, 118.6, 81.5, 79.3, 78.5, 74.6, 73.9, 73.3, 71.5, 69.0, 68.4, 42.3, 41.9, 41.2, 36.8, 36.3, 35.7, 35.3, 31.5, 18.4, 18.4, 18.3, 15.9, 13.8, 13.2, 1.7 ppm.

HRMS (ESI) calculated for $C_{42}H_{72}NaO_9Si_2^+$ $[M+Na]^+$ 799.4607, found 799.4607.



25 **33**

Raney nickel (100 mg, dispersed in water, 20-40 mesh) was added in one portion to a solution of compound **25** (98.6 mg, 0.12 mmol) in EtOH (2 mL) and EtOAc (2 mL). The reaction flask was sealed, then placed under a positive pressure of H_2. The mixture was stirred for 24 h at room temperature with monitoring by TLC. When the substrate was completely consumed, the reaction mixture was filtered through a pad of Celite. The filtrate was concentrated in

vacuo and the residue was purified by flash chromatography on silica gel (EtOAc/hexanes =2:1) to provide **33** (70.3 mg, 79%) as a colorless oil.

TLC: R_f = 0.4 (silica gel, EtOAc/hexanes = 1:3).

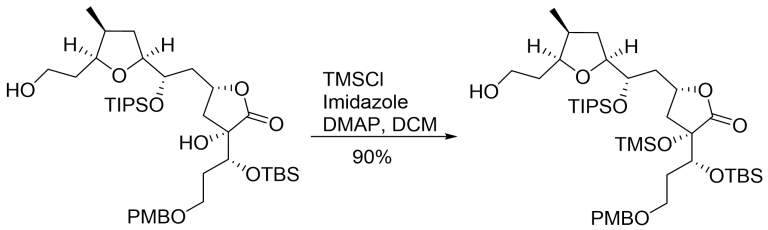
$[\alpha]_D^{25}$ = -24.2 (*c* 0.1, $CHCl_3$).

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.26 – 7.23 (m, 2H), 6.89 – 6.85 (m, 2H), 4.64 (tdd, *J* = 9.6, 8.0, 3.5 Hz, 1H), 4.47 (d, *J* = 11.4 Hz, 1H), 4.42 (d, *J* = 11.5 Hz, 1H), 4.11 (ddd, *J* = 8.7, 5.5, 3.4 Hz, 1H), 3.95 (ddd, *J* = 10.4, 7.1, 3.0 Hz, 1H), 3.92 (t, *J* = 5.6 Hz, 1H), 3.82 – 3.72 (m, 3H), 3.80 (s, 3H), 3.62 – 3.56 (m, 1H), 3.56 – 3.49 (m, 1H), 2.63 (dd, *J* = 13.5, 6.8 Hz, 1H), 2.37 – 2.29 (m, 1H), 2.22 – 2.14 (m, 1H), 2.02 – 1.90 (m, 3H), 1.75 – 1.63 (m, 3H), 1.61 – 1.54 (m, 1H), 1.36 – 1.21 (m, 2H), 1.12 – 1.05 (m, 21H), 0.93 (d, *J* = 7.1 Hz, 3H), 0.88 (s, 9H), 0.07 (s, 3H), 0.06 (s, 3H) ppm.

^{13}C NMR (126 MHz, $CDCl_3$) δ 176.9, 159.5, 130.1, 129.5, 114.0, 81.9, 80.6, 78.7, 74.1, 74.0, 72.7, 71.0, 66.4, 61.7, 55.4, 41.1, 39.5, 35.8, 35.2, 33.5, 33.5, 26.0, 18.4, 18.3, 15.6, 13.2, -4.3, -4.4 ppm.

IR (film): ν_{max} = 3473, 2961, 2928, 2864, 2360, 1775, 1614, 1514, 1464, 1260, 1094, 1017, 882, 836, 802, 780, 680, 668 cm^{-1}

HRMS (ESI) calculated for $C_{39}H_{71}O_9Si_2^+$ $[M+H]^+$ 739.4631, found 739.4635.



33 **34**

Imidazole (545.0 mg, 8.0 mmol), TMSCl (0.35 mL, 4.0 mmol) and DMAP (5.0 mg, 0.05 mmol) were sequentially at 0 °C to a solution of compound **33** (150.0 mg, 0.20 mmol) in DCM (3 mL). The mixture was allowed to warm to room temperature and then stirred for an additional 2 h. The reaction was quenched with a saturated aqueous solution of NH_4Cl (5 mL) at 0 °C, and the mixture was extracted with EtOAc (80 mL × 3). The combined organic phases were washed sequentially with saturated aqueous solution of NH_4Cl (8 mL) and brine (8 mL), dried over anhydrous Na_2SO_4 and concentrated in *vacuo*. The residue was purified by flash chromatography on silica gel (EtOAc/hexanes =1:10) to provide **34** (144.8 mg, 90%) as a colorless oil.

TLC: R_f = 0.3 (silica gel, EtOAc/hexanes = 1:5).

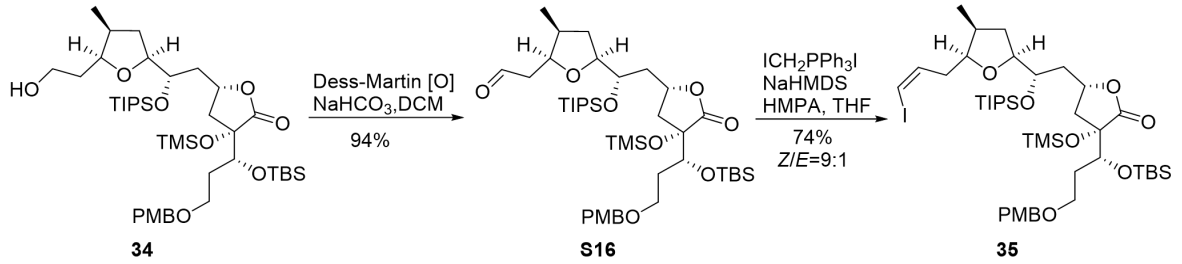
$[\alpha]_D^{25}$ = -44.9 (*c* 2.0, $CHCl_3$).

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.25 – 7.20 (m, 2H), 6.88 – 6.83 (m, 2H), 4.59 (tdd, *J* = 8.9, 7.1, 4.2 Hz, 1H), 4.40 (d, *J* = 11.6 Hz, 1H), 4.37 (d, *J* = 11.5 Hz, 1H), 4.11 (ddd, *J* = 8.8, 5.3, 3.8 Hz, 1H), 3.98 – 3.90 (m, 2H), 3.85 – 3.79 (m, 1H), 3.79 (s, 3H), 3.78 – 3.70 (m, 2H), 3.56

– 3.44 (m, 2H), 2.90 (dd, *J* = 13.9, 7.1 Hz, 1H), 2.38 – 2.28 (m, 1H), 2.19 (br s, 1H), 2.05 – 1.94 (m, 2H), 1.86 – 1.79 (m, 1H), 1.79 – 1.74 (m, 1H), 1.73 – 1.63 (m, 2H), 1.63 – 1.56 (m, 1H), 1.56 – 1.48 (m, 1H), 1.36 – 1.29 (m, 1H), 1.12 – 1.04 (m, 21H), 0.94 (d, *J* = 7.0 Hz, 3H), 0.86 (s, 9H), 0.17 (s, 9H), 0.06 (s, 3H), 0.06 (s, 3H) ppm.

^{13}C NMR (126 MHz, $CDCl_3$) δ 176.6, 159.2, 130.7, 129.3, 113.9, 82.5, 81.6, 80.3, 74.6, 74.3, 72.4, 70.8, 66.8, 61.6, 55.4, 41.4, 39.9, 35.6, 35.1, 33.6, 32.9, 26.2, 18.45, 18.4, 18.4, 15.7, 13.2, 1.9, -3.6, -4.7 ppm.

HRMS (ESI) calculated for $C_{42}H_{79}O_9Si_3^+$ $[M+H]^+$ 811.5026, found 811.5028.



$NaHCO_3$ (120.0 mg, 1.42 mmol) and Dess-Martin periodinane (226.0 mg, 0.53 mmol) were added sequentially at 0 °C to a solution of alcohol **34** (144.8 mg, 0.18 mmol) in DCM (3 mL). After being stirred for 30 min at room temperature, the reaction mixture was directly filtered through a pad of silica gel (EtOAc/hexanes =1:10). The filtrate was concentrated in *vacuo* to afford the crude aldehyde **S16** (134.7 mg, 94%).

NaHMDS (1.0 mL, 1.0 mmol, 1.0 M in THF) was added at 0 ℃ to a stirred suspension of ICH_2PPh_3I (441.0 mg, 0.83 mmol) in THF (5 mL). After 5 min, the mixture was cooled to -60 ℃ and HMPA (70 μL) was added. Then the mixture was cooled to -78 ℃ and a solution of aldehyde **S16** (134.7 mg, 0.17 mmol) in THF (2 mL) was added dropwise over 2 min. The mixture was stirred at -78 ℃. After 1.5 h, the reaction was quenched with a saturated aqueous solution of NH_4Cl (5 mL), then extracted with EtOAc (80 mL × 3). The combined organic phases were washed sequentially with saturated aqueous solution of NH_4Cl (10 mL), water (10 mL) and brine (10 mL), dried over anhydrous Na_2SO_4 and concentrated in *vacuo*. The residue was purified by flash chromatography on silica gel (EtOAc/hexanes =1:30) to provide **35** (117.3 mg, 74%, *Z*/*E* 9:1) as a colorless oil.

TLC: R_f = 0.5 (silica gel, EtOAc/hexanes = 1:10).

$[\alpha]_D^{25}$ = -45.3 (*c* 1.0, $CHCl_3$).

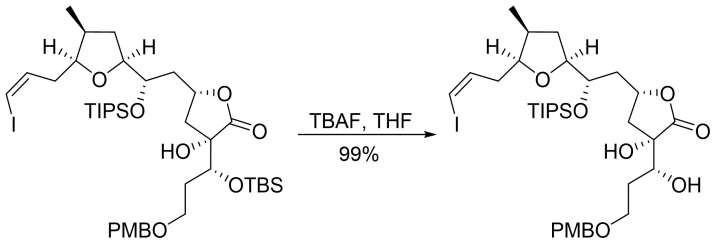
^{1}H NMR (500 MHz, $CDCl_3$) δ 7.26 – 7.21 (m, 2H), 6.88 – 6.83 (m, 2H), 6.33 – 6.19 (m, 2H), 4.62 (tdd, *J* = 9.0, 7.1, 3.7 Hz, 1H), 4.40 (d, *J* = 11.5 Hz, 1H), 4.37 (d, *J* = 11.6 Hz, 1H), 4.09 (ddd, *J* = 9.2, 6.3, 2.8 Hz, 1H), 3.94 (dd, *J* = 9.2, 2.3 Hz, 1H), 3.92 – 3.86 (m, 1H), 3.80 (s, 3H), 3.78 – 3.72 (m, 1H), 3.55 – 3.46 (m, 2H), 2.91 (dd, *J* = 13.9, 7.1 Hz, 1H), 2.40 – 2.28 (m, 1H), 2.27 – 2.17 (m, 2H), 2.07 – 1.99 (m, 1H), 1.91 – 1.84 (m, 1H), 1.84 – 1.73 (m, 2H), 1.68

– 1.61 (m, 1H), 1.57 – 1.48 (m, 1H), 1.31 – 1.22 (m, 1H), 1.16 – 1.08 (m, 3H), 1.08 – 1.04 (m, 18H), 0.98 (d, J = 7.1 Hz, 3H), 0.87 (s, 9H), 0.17 (s, 9H), 0.07 (s, 3H), 0.07 (s, 3H) ppm.

^{13}C NMR (126 MHz, $CDCl_3$) δ 176.7, 159.2, 138.9, 130.7, 129.3, 113.8, 83.5, 82.6, 81.7, 80.1, 74.5, 74.2, 72.3, 71.5, 66.7, 55.4, 41.4, 39.7, 37.0, 35.6, 35.5, 32.9, 26.2, 18.5, 18.5, 18.4, 15.7, 13.2, 2.0, -3.6, -4.7 ppm.

IR (film): ν_{max} = 2954, 2926, 2856, 2380, 1770, 1642, 1457, 1250, 1155, 1121, 1093, 1042, 882, 841, 778, 679 cm^{-1}

HRMS (ESI): calculated for $C_{43}H_{77}INaO_8Si_3^+$ $[M+Na]^+$ 955.3863, found 955.3868.



35 **S17**

TBAF (2.6 mL, 0.26 mmol, 0.1 M in THF) was added dropwise at -10 °C over 20 min to a solution of compound **35** (121.3 mg, 0.13 mmol) in THF (6 mL). After being stirred for 2 h at -10 °C, the reaction was quenched with a saturated aqueous solution of NH_4Cl (5 mL) at 0 °C and extracted with EtOAc (50 mL × 3). The combined organic phases were washed sequentially with water (5 mL) and brine (5 mL), dried over anhydrous Na_2SO_4 and concentrated in *vacuo*. The residue was purified by flash chromatography on silica gel (EtOAc/hexanes =1:5) to provide **S17** (104.0 mg, 99%) as a colorless oil.

TLC: R_f = 0.2 (silica gel, EtOAc/ hexanes = 1:3).

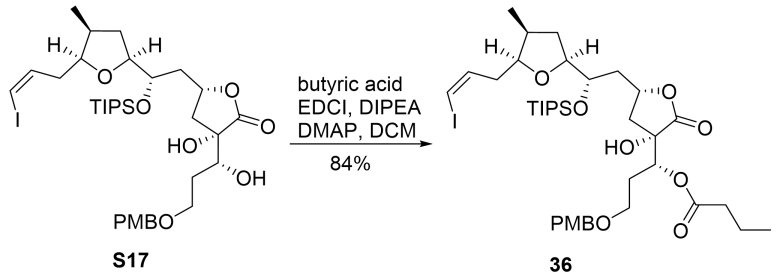
$[\alpha]_D^{26}$ = -10.7 (*c* 1.0, $CHCl_3$).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.26 – 7.21 (m, 2H), 6.92 – 6.83 (m, 2H), 6.34 – 6.20 (m, 2H), 4.83 (dtd, J = 10.0, 7.0, 3.1 Hz, 1H), 4.45 (s, 2H), 4.05 (ddd, J = 9.4, 6.5, 2.7 Hz, 1H), 3.96 (dd, J = 9.6, 2.6 Hz, 1H), 3.93 – 3.86 (m, 1H), 3.80 (s, 3H), 3.74 – 3.68 (m, 2H), 3.67 – 3.62 (m, 1H), 3.47 (s, 1H), 2.53 (dd, J = 13.6, 7.0 Hz, 1H), 2.40 – 2.28 (m, 1H), 2.27 – 2.18 (m, 2H), 2.06 – 1.96 (m, 2H), 1.96 – 1.83 (m, 2H), 1.83 – 1.75 (m, 1H), 1.63 (ddd, J = 14.3, 9.4, 3.3 Hz, 1H), 1.27 – 1.19 (m, 1H), 1.17 – 1.08 (m, 3H), 1.07 – 1.02 (m, 18H), 0.97 (d, J = 7.1 Hz, 3H) ppm.

^{13}C NMR (101 MHz, $CDCl_3$) δ 177.6, 159.2, 138.7, 129.6, 129.2, 113.7, 83.2, 81.7, 79.9, 76.8, 74.7, 73.5, 72.8, 71.4, 67.5, 55.1, 40.3, 38.7, 36.7, 35.4, 35.3, 30.0, 18.2, 18.1, 15.5, 12.8 ppm.

IR (film): ν_{max} = 2940, 2925, 2864, 1780, 1500, 1248, 1202, 1091, 1037, 882, 821, 668 cm^{-1}

HRMS (ESI) calculated for $C_{34}H_{56}IO_8Si^+$ $[M+H]^+$ 747.2784, found 747.2778.



DIPEA (46 μL, 0.26 mmol), butyric acid (10 μL, 0.11 mmol), EDCI (25.3 mg, 0.13 mmol) and DMAP (3 mg, 0.03 mmol) were added sequentially at 0 °C to a solution of alcohol **S17** (66.0 mg, 0.09 mmol) in DCM (2 mL). The mixture was allowed to warmed to room temperature and then stirred for an additional 2 h. The reaction was quenched with a saturated aqueous solution of NH_4Cl (2 mL) at 0 °C, and the mixture was extracted with EtOAc (50 mL × 3). The combined organic phases were washed sequentially with water (10 mL) and brine (10 mL), dried over anhydrous Na_2SO_4 and concentrated in *vacuo*. The residue was purified by flash chromatography on silica gel (EtOAc/hexanes =1:8) to provide **36** (61.8 mg, 84%) as a colorless oil.

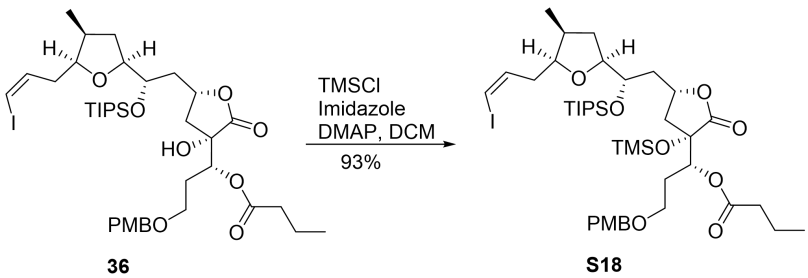
TLC: R_f = 0.5 (silica gel, EtOAc/hexanes = 1:3).

$[\alpha]_D^{24}$ = -21.4 (*c* 1.0, $CHCl_3$).

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.26 – 7.21 (m, 2H), 6.89 – 6.83 (m, 2H), 6.32 – 6.21 (m, 2H), 5.20 (dd, *J* = 7.7, 4.4 Hz, 1H), 4.73 (tdd, *J* = 9.4, 6.4, 3.2 Hz, 1H), 4.48 (d, *J* = 11.4 Hz, 1H), 4.40 (d, *J* = 11.4 Hz, 1H), 4.13 – 4.01 (m, 2H), 3.94 – 3.84 (m, 1H), 3.79 (s, 3H), 3.74 – 3.66 (m, 1H), 3.56 – 3.51 (m, 1H), 3.49 – 3.43 (m, 1H), 2.52 (dd, *J* = 13.6, 6.4 Hz, 1H), 2.37 – 2.28 (m, 1H), 2.28 – 2.14 (m, 5H), 2.06 – 1.97 (m, 2H), 1.92 – 1.83 (m, 2H), 1.66 – 1.58 (m, 3H), 1.27 – 1.22 (m, 1H), 1.17 – 1.10 (m, 3H), 1.08 – 1.04 (m, 18H), 0.97 (d, *J* = 7.1 Hz, 3H), 0.92 (t, *J* = 7.4 Hz, 3H) ppm.

^{13}C NMR (126 MHz, $CDCl_3$) δ 176.1, 173.0, 159.5, 138.9, 129.9, 129.6, 114.0, 83.4, 81.9, 80.2, 73.9, 73.9, 73.3, 73.0, 71.7, 66.1, 55.4, 40.7, 40.2, 37.0, 36.1, 35.8, 35.6, 29.8, 18.5, 18.4, 18.4, 15.8, 13.7, 13.2 ppm.

HRMS (ESI): calculated for $C_{38}H_{61}INaO_9Si^+$ $[M+Na]^+$ 839.3022, found 839.3023.



Imidazole (62.0 mg, 0.91 mmol), TMSCl (39 μL, 0.45 mmol) and DMAP (3.0 mg, 0.03 mmol)

were added sequentially at 0 °C to a solution of compound **36** (61.8 mg, 0.076 mmol) in DCM (2 mL). The mixture was allowed to warmed to room temperature and then stirred for an additional 2 h. The reaction was quenched with a saturated aqueous solution of NH_4Cl (2 mL) at 0 °C, then extracted with EtOAc (50 mL × 3). The combined organic phases were washed sequentially with saturated aqueous solution of NH_4Cl (8 mL) and brine (8 mL), dried over anhydrous Na_2SO_4 and concentrated in *vacuo*. The residue was purified by flash chromatography on silica gel (EtOAc/hexanes =1:10) to provide **S18**(62.7 mg, 93%) as a colorless oil.

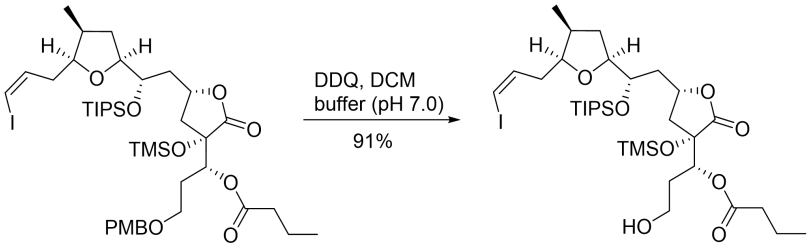
TLC: R_f = 0.7 (silica gel, EtOAc/hexanes = 1:5).

$[\alpha]_D^{23}$ = -35.7 (*c* 1.0, $CHCl_3$).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.25 – 7.20 (m, 2H), 6.89 – 6.82 (m, 2H), 6.32 – 6.21 (m, 2H), 5.30 (dd, *J* = 10.2, 2.3 Hz, 1H), 4.61 (tdd, *J* = 9.3, 6.2, 3.7 Hz, 1H), 4.37 (s, 2H), 4.08 (ddd, *J* = 9.2, 6.3, 3.0 Hz, 1H), 3.95 – 3.84 (m, 1H), 3.79 (s, 3H), 3.73 (dt, *J* = 9.4, 6.5 Hz, 1H), 3.50 – 3.41 (m, 1H), 3.41 – 3.33 (m, 1H), 2.63 (dd, *J* = 13.7, 6.5 Hz, 1H), 2.40 – 2.27 (m, 1H), 2.27 – 2.15 (m, 4H), 2.09 – 1.97 (m, 2H), 1.97 – 1.82 (m, 3H), 1.64 – 1.55 (m, 3H), 1.31 – 1.24 (m, 1H), 1.16 – 1.09 (m, 3H), 1.08 – 1.03 (m, 18H), 0.97 (d, *J* = 7.0 Hz, 3H), 0.90 (t, *J* = 7.4 Hz, 3H), 0.16 (s, 9H) ppm.

^{13}C NMR (75 MHz, $CDCl_3$) δ 174.9, 172.9, 159.2, 138.9, 130.5, 129.5, 113.8, 83.5, 81.7, 80.1, 79.3, 73.6, 73.3, 72.9, 71.3, 66.5, 55.4, 42.3, 40.9, 37.0, 36.2, 35.6, 35.5, 29.8, 18.5, 18.4, 18.4, 15.7, 13.8, 13.1, 1.8 ppm.

HRMS (ESI): calculated for $C_{41}H_{69}INaO_9Si_2^+$ $[M+Na]^+$ 911.3417, found 911.3420.



S18 **37**

Phosphate buffer (1 mL, 0.1 M, pH = 7.0) and DDQ (38.3 mg, 0.17 mmol) were added sequentially at room temperature to a solution of compound **S18** (50.7 mg, 0.057 mmol) in DCM (3 mL). After being stirred for 2.5 h at room temperature, the reaction mixture was diluted with DCM (150 mL) and transferred to a separation funnel. The organic phases were washed sequentially with a saturated aqueous solution of $Na_2S_2O_3$ (8 mL), a saturated aqueous solution of $NaHCO_3$ (8 mL) and brine (8 mL), dried over anhydrous Na_2SO_4 and concentrated in *vacuo*. The residue was purified by flash chromatography on silica gel (EtOAc/hexanes =1:10) to provide **37** (40.2 mg, 91%) as a colorless oil.

TLC: R_f = 0.3 (silica gel, EtOAc/hexanes = 1:5).

$[\alpha]_D^{25}$ = -21.8 (*c* 1.0, $CHCl_3$).

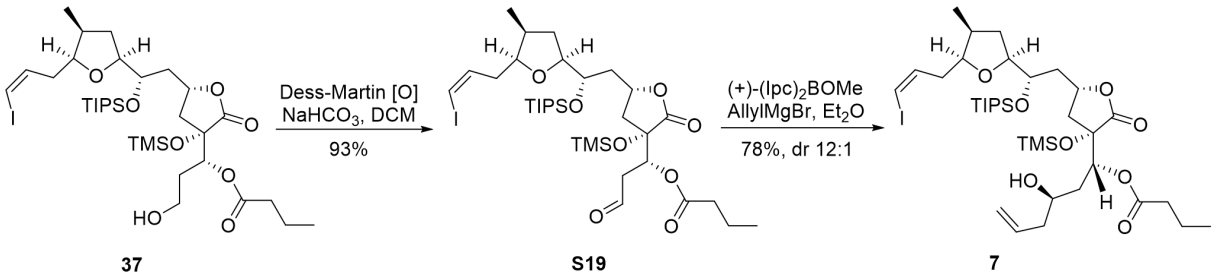
^{1}H NMR (400 MHz, $CDCl_3$) δ 6.33 – 6.21 (m, 2H), 5.21 (dd, *J* = 10.4, 2.4 Hz, 1H), 4.64 (tdd,

J = 9.3, 7.4, 3.5 Hz, 1H), 4.09 (ddd, J = 9.2, 6.3, 2.9 Hz, 1H), 3.96 – 3.85 (m, 1H), 3.77 – 3.63 (m, 2H), 3.53 – 3.43 (m, 1H), 2.61 (dd, J = 13.8, 6.6 Hz, 1H), 2.38 – 2.30 (m, 3H), 2.27 – 2.20 (m, 2H), 2.09 – 1.96 (m, 3H), 1.90 – 1.74 (m, 2H), 1.69 – 1.62 (m, 3H), 1.30 – 1.24 (m, 1H), 1.16 – 1.04 (m, 21H), 0.98 (d, J = 6.9 Hz, 3H), 0.95 (t, J = 7.4 Hz, 3H), 0.18 (s, 9H) ppm.

^{13}C NMR (101 MHz, $CDCl_3$) δ 174.7, 174.2, 138.8, 83.6, 81.7, 80.2, 79.1, 73.7, 73.7, 71.3, 58.5, 42.5, 41.0, 37.0, 36.2, 35.6, 35.5, 32.2, 18.5, 18.5, 18.4, 15.7, 13.8, 13.2, 1.8 ppm.

IR (film): ν_{max} = 2960, 2926, 2866, 1780, 1749, 1559, 1457, 1252, 1170, 1091, 1061, 882, 845, 755 cm^{-1}

HRMS (ESI): calculated for $C_{33}H_{61}INaO_8Si_2^+$ $[M+Na]^+$ 791.2842, found 791.2840.



$NaHCO_3$ (43.9 mg, 0.52 mmol) and Dess-Martin periodinane (66.5 mg, 0.16 mmol) were added sequentially at 0 °C to a solution of alcohol **37** (40.2 mg, 0.05 mmol) in DCM (2 mL). After being stirred for 30 min at room temperature, the reaction mixture was directly filtered through a pad of silica gel (EtOAc/hexanes =1:10). The filtrate was concentrated in *vacuo* to afford the crude aldehyde **S19** (35.6 mg, 93%).

Allylmagnesium bromide (0.23 mL, 1.14 M in Et_2O, 0.26 mmol) was added dropwise at -78 °C over 2 min to a solution of (+)-*B*-methoxydiisopinocampheylborane (99.2 mg, 0.31 mmol) in Et_2O (2.5 mL). After 15 min, the mixture was warmed to room temperature gradually and stirred for an additional 45 min. Then the mixture was recooled to -78 °C and the solution of crude aldehyde **S19** (35.6 mg, 0.05 mmol) in Et_2O (10 mL) was added dropwise over 10 min. After being stirred at -78 °C for 10 h, the reaction was quenched with a saturated aqueous solution of $NaHCO_3$ (2 mL) and H_2O_2 (2 mL, 30% in H_2O). The mixture was stirred for an additional 3 h at room temperature before being extracted with Et_2O (50 mL × 3). The combined organic phases were washed sequentially with water (5 mL) and brine (5 mL), dried over anhydrous Na_2SO_4 and concentrated in *vacuo*. The residue was purified by flash chromatography on silica gel (EtOAc/hexanes =1:10) to provide **7** (28.7 mg, 78%, dr 12:1) as a colorless oil.

TLC: R_f = 0.5 (silica gel, EtOAc/hexanes = 1:5).

$[\alpha]_D^{20}$ = -29.5 (c 1.0, $CHCl_3$).

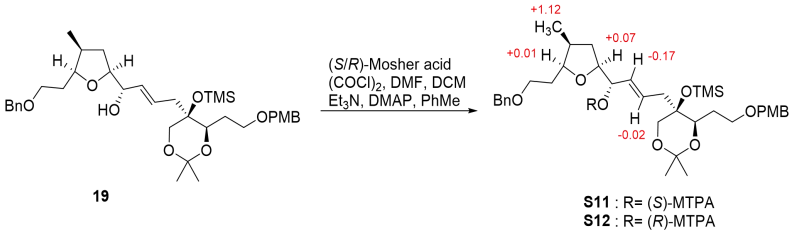
^{1}H NMR (500 MHz, $CDCl_3$) δ 6.31 – 6.24 (m, 2H), 5.86 – 5.75 (m, 1H), 5.22 (dd, *J* = 8.1, 3.3 Hz, 1H), 5.16 – 5.13 (m, 1H), 5.13 – 5.10 (m, 1H), 4.64 (tdd, *J* = 9.3, 6.5, 3.6 Hz, 1H), 4.09 (ddd, *J* = 9.2, 6.3, 2.9 Hz, 1H), 3.93 – 3.87 (m, 1H), 3.79 – 3.70 (m, 2H), 2.65 (dd, *J* = 13.8, 6.6 Hz, 1H), 2.37 – 2.27 (m, 4H), 2.23 (dd, *J* = 7.3, 4.4 Hz, 2H), 2.18 – 2.12 (m, 1H), 2.09 (br s, 1H), 2.05 – 1.94 (m, 3H), 1.89 – 1.83 (m, 1H), 1.78 – 1.71 (m, 1H), 1.67 – 1.61 (m, 3H), 1.30 – 1.23 (m, 1H), 1.15 – 1.09 (m, 3H), 1.08 – 1.05 (m, 18H), 0.98 (d, *J* = 7.0 Hz, 3H), 0.94 (t, *J* = 7.4 Hz, 3H), 0.18 (s, 9H) ppm.

^{13}C NMR (126 MHz, $CDCl_3$) δ 174.8, 173.4, 138.9, 134.4, 118.6, 83.5, 81.7, 80.2, 79.4, 74.6, 73.9, 71.4, 69.0, 42.3, 41.9, 41.2, 37.1, 36.9, 36.4, 35.6, 18.5, 18.4, 18.4, 15.8, 13.8, 13.2, 1.8 ppm.

HRMS (ESI): calculated for $C_{36}H_{65}INaO_8Si_2^+$ $[M+Na]^+$ 831.3155, found 831.3158.

IV. Determination of the Absolute Configurations of CBS Reduction Product

The absolute stereochemistry of the newly generated hydroxyl center of compound **19** was determined by the modified Mosher's method. [3] Compound **19** was converted into (*S*)- and (*R*)-MTPA esters **S11** and **S12**, respectively.



All of the protons of the pairs of Mosher's esters were assigned by ^{1}H NMR. The Δδ values (Δδ = δS−δR) clearly confirmed the desired (*S*)-configuration of the originated hydroxyl center.

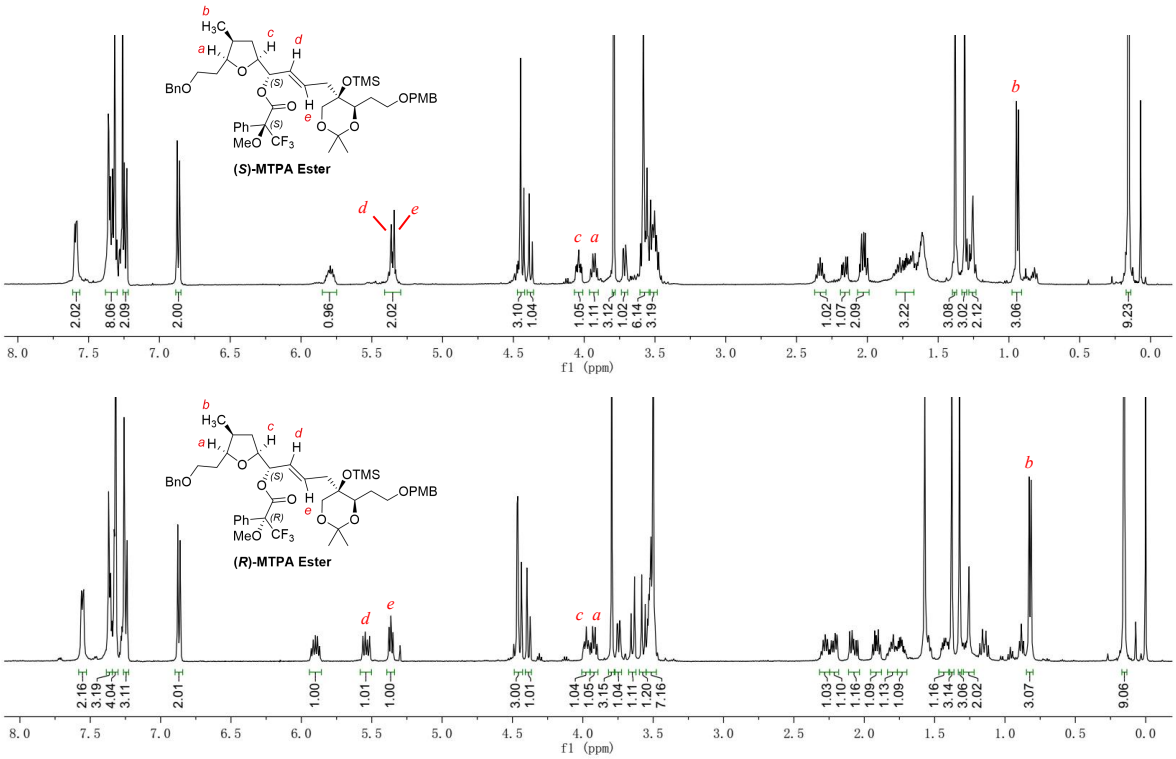


Fig 2. ^{1}H NMR spectrum of the (*S*)-MTPA ester and (*R*)-MTPA ester

V. Determination of the Absolute Configurations of Lactone 25

In order to determine the absolute configurations of the stereogenic centers present in lactone moiety of **25**, the corresponding ^{1}H NMR, ^{13}C NMR, COSY, HSQC, HMBC and NOESY spectra of compound **25** were recorded (Please see Page S-57 to S-61). Analysis of a set of 2D NMR spectra of **25** provided assignments for all of the protons around the lactone moiety as indicated in **Fig. 3**.

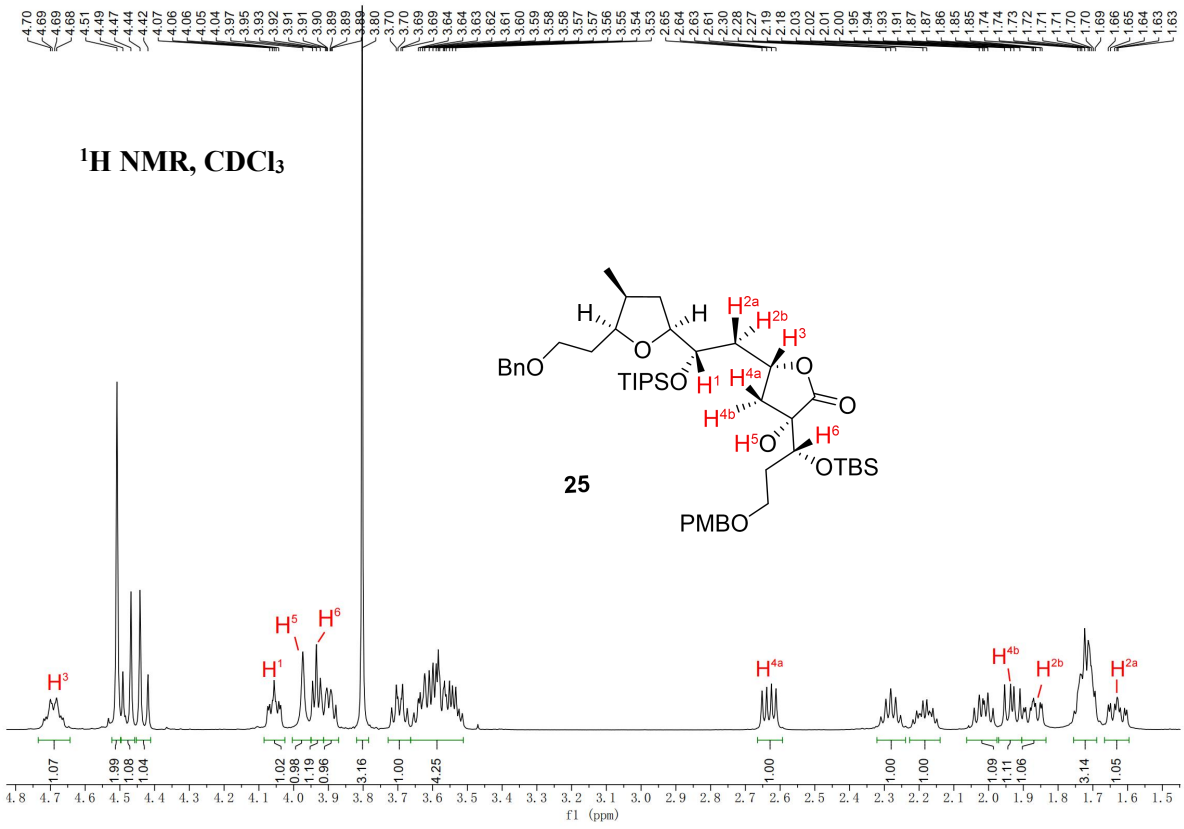


Fig 3. ^{1}H NMR spectrum of lactone **25**

The stereochemistry of the lactone moiety in **25** was assigned based on NOESY spectrum (**Fig. 5**). Key NOE cross-peaks observed in the NOESY spectrum include those between H^3 and H^{2a}, H^3 and H^{4a}, H^3 and H^6, H^{4a} and H^6 (**Fig. 4a**), and between H^{2b} and H^{4b}, H^{4b} and H^5, H^5 and H^{2b} (**Fig. 4b**). No NOESY relationship were observed betweenH^3 and H^{2b}, H^3 and H^{4b}, H^3 and H^5, H^{2a} and H^{4b}, H^{2b} and H^{4a}, H^{4a} and H^5, H^{4b} and H^6. Thus indicated the the iodine induced cyclization installed the correct stereochemistry of lactone **25**.

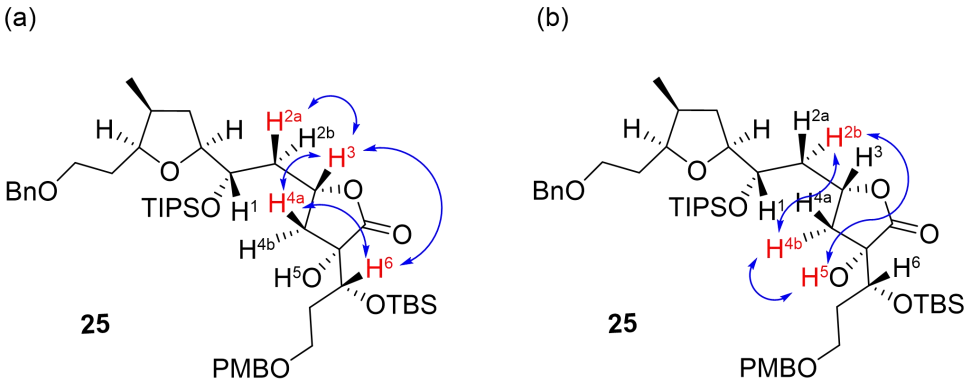


Fig 4. NOESY relationships of the protons around lactone moiety

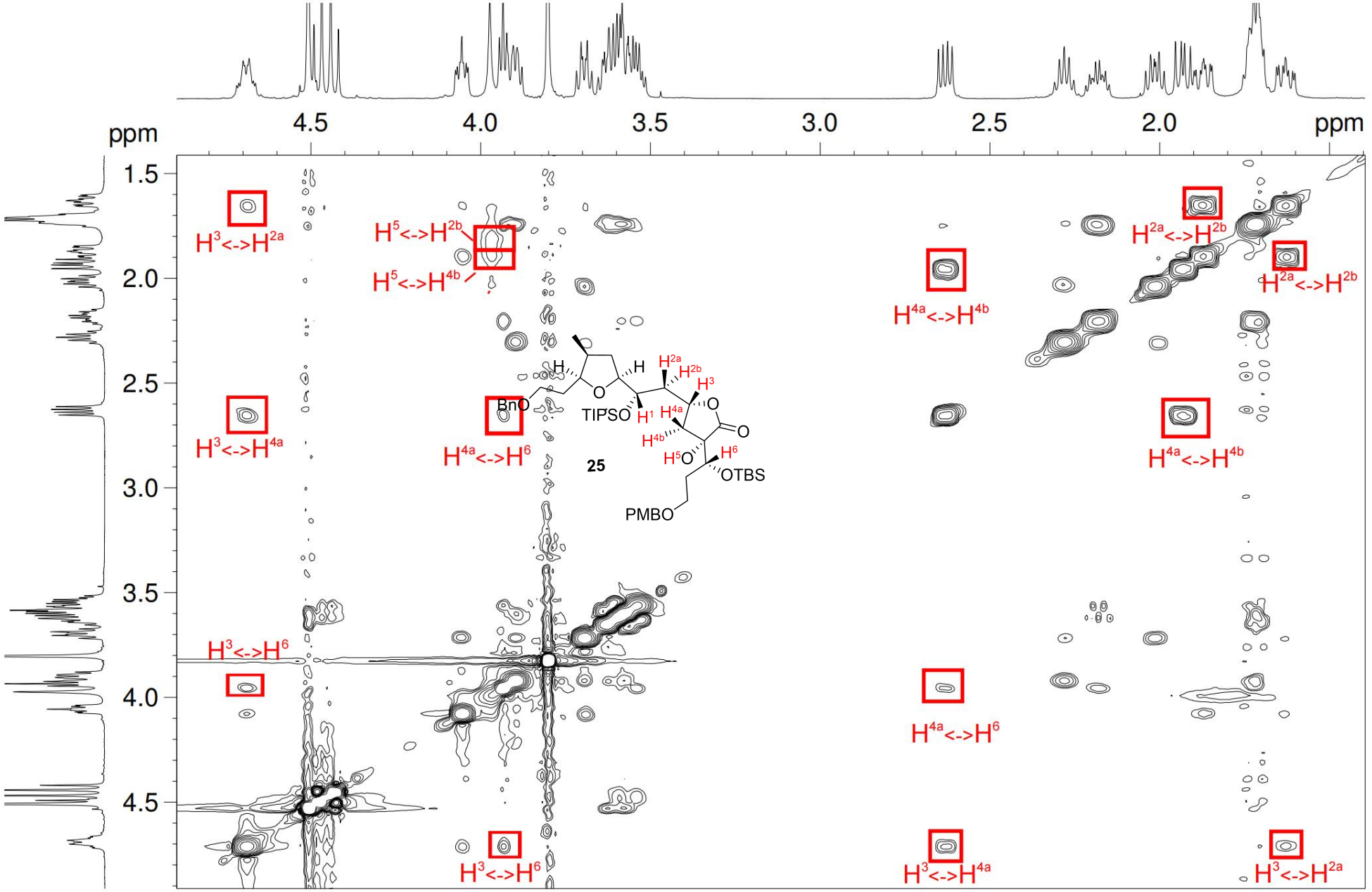
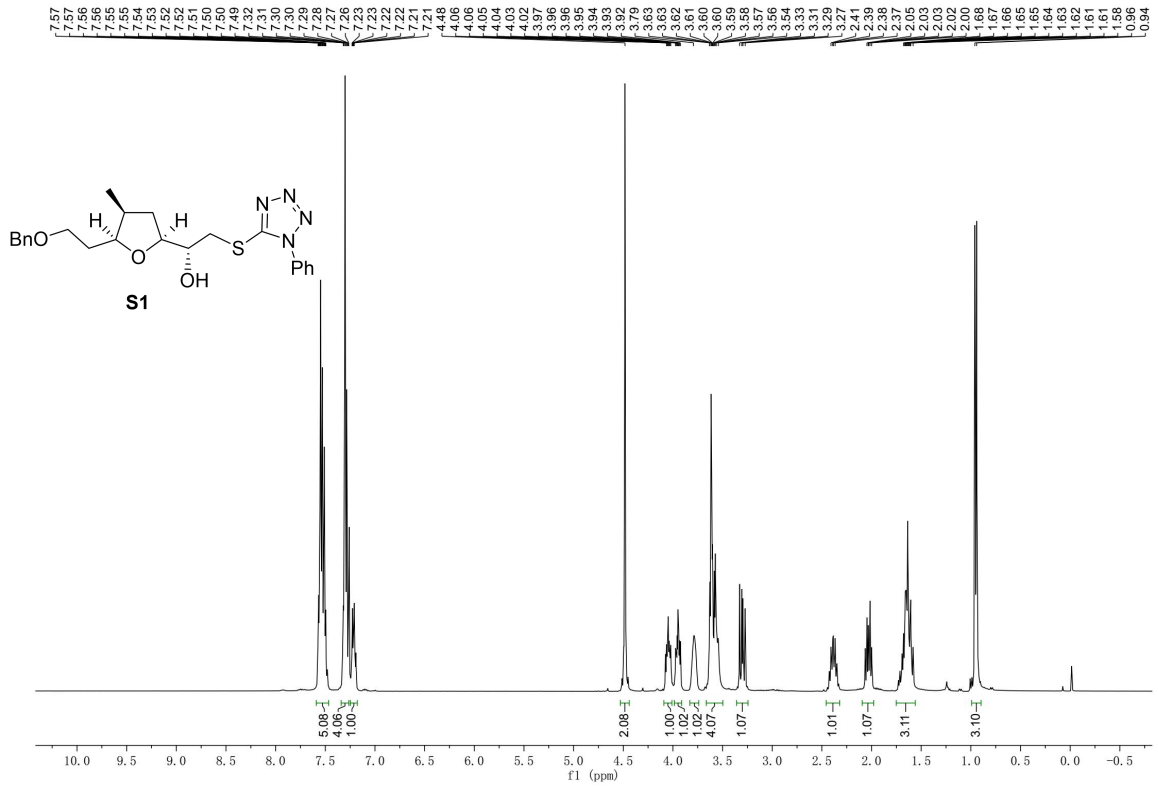


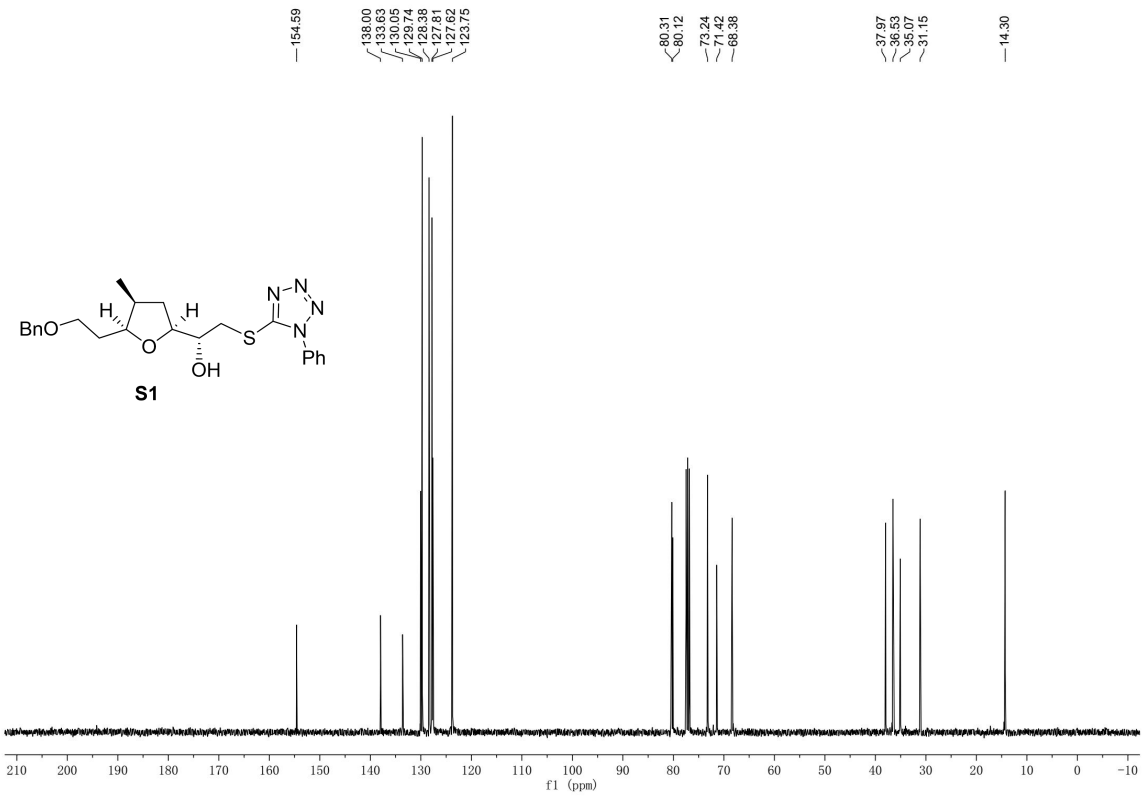
Fig 5. NOESY spectrum of lactone **25**

VI. Copies of ^{1}H and ^{13}C NMR Spectra

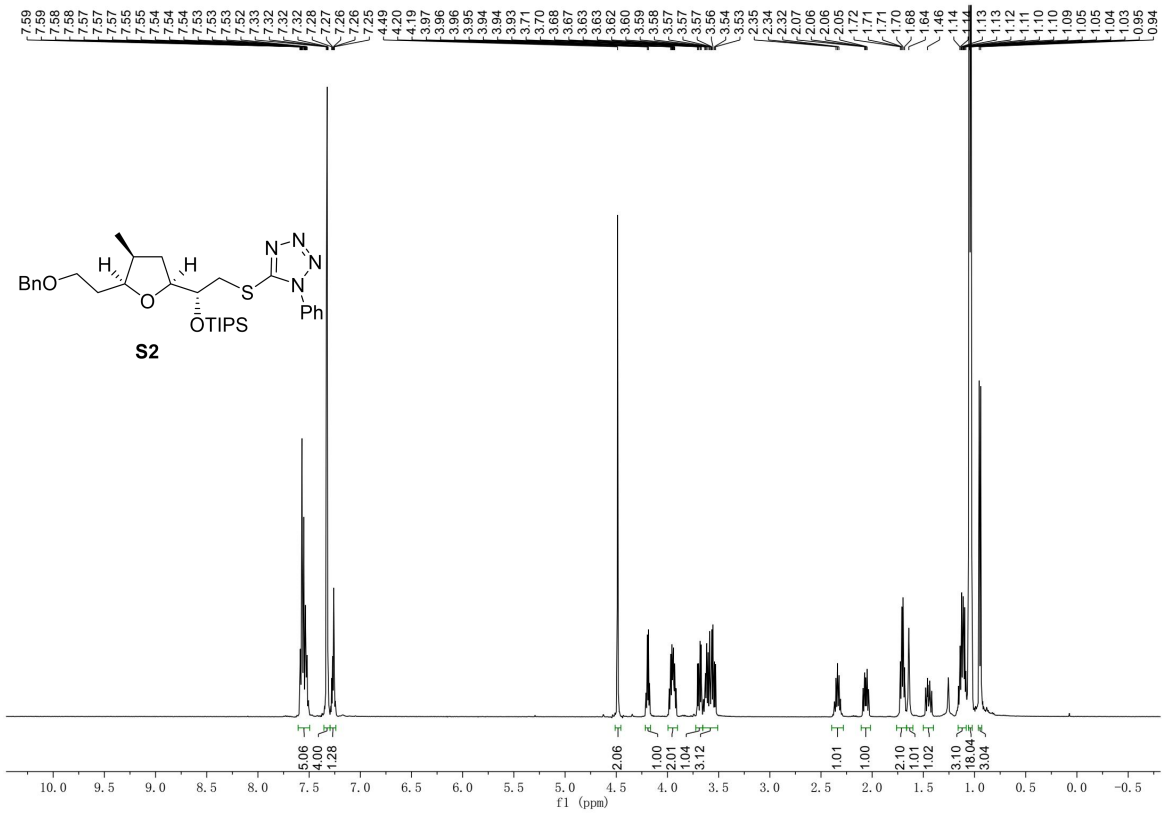
^{1}H NMR ($CDCl_3$, 400M)



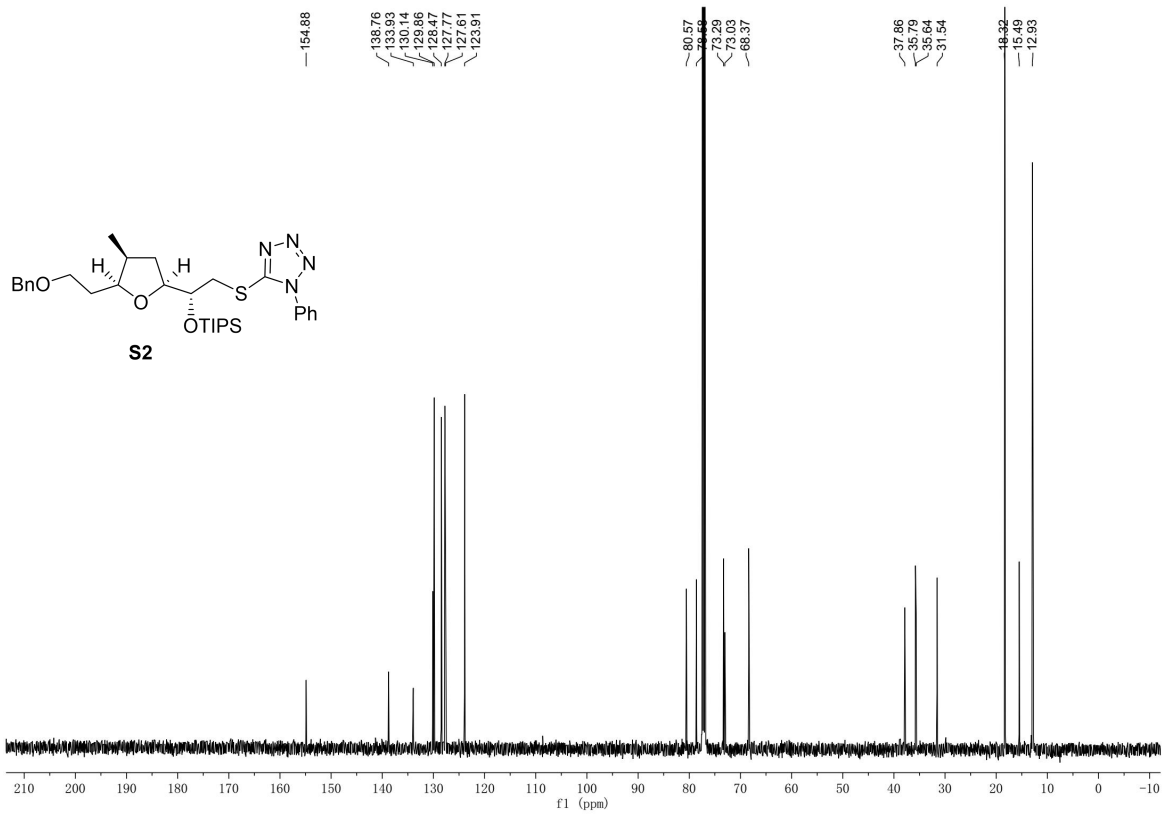
^{13}C NMR ($CDCl_3$, 101M)



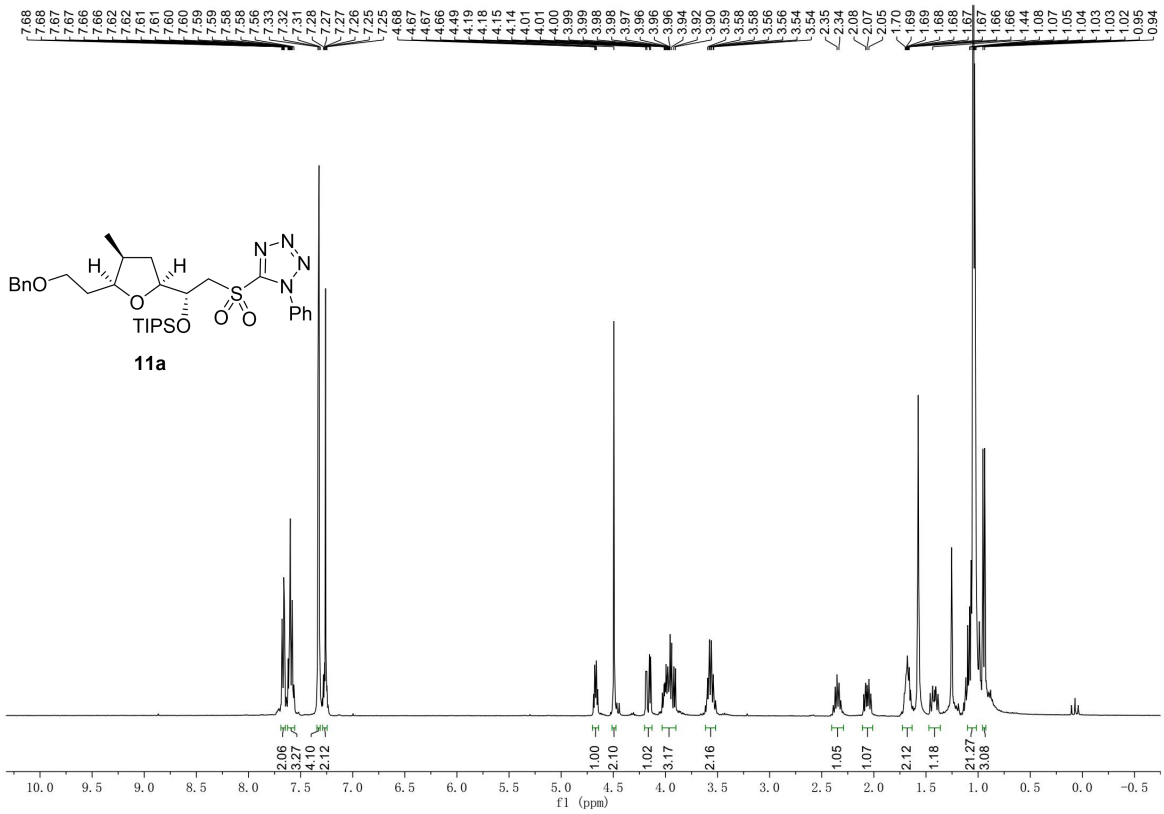
^{1}H NMR ($CDCl_3$, 500M)



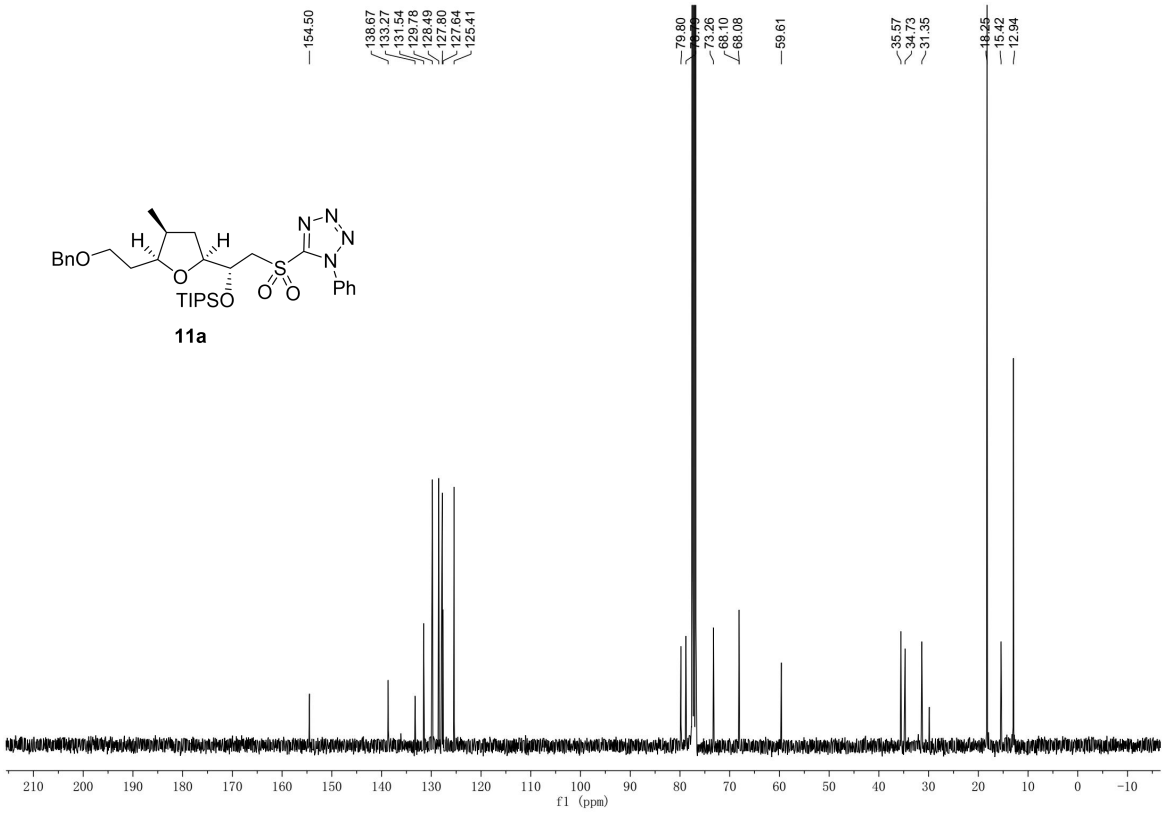
^{13}C NMR ($CDCl_3$, 126M)



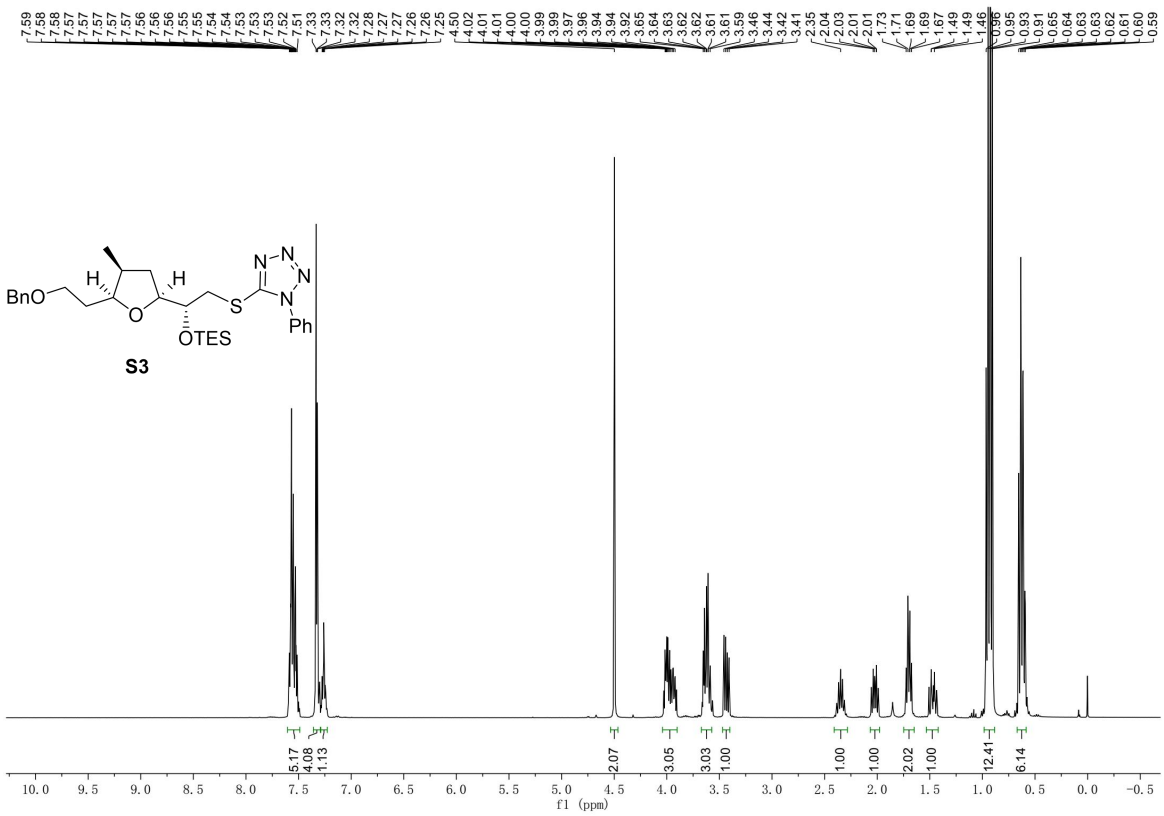
^{1}H NMR ($CDCl_3$, 400M)



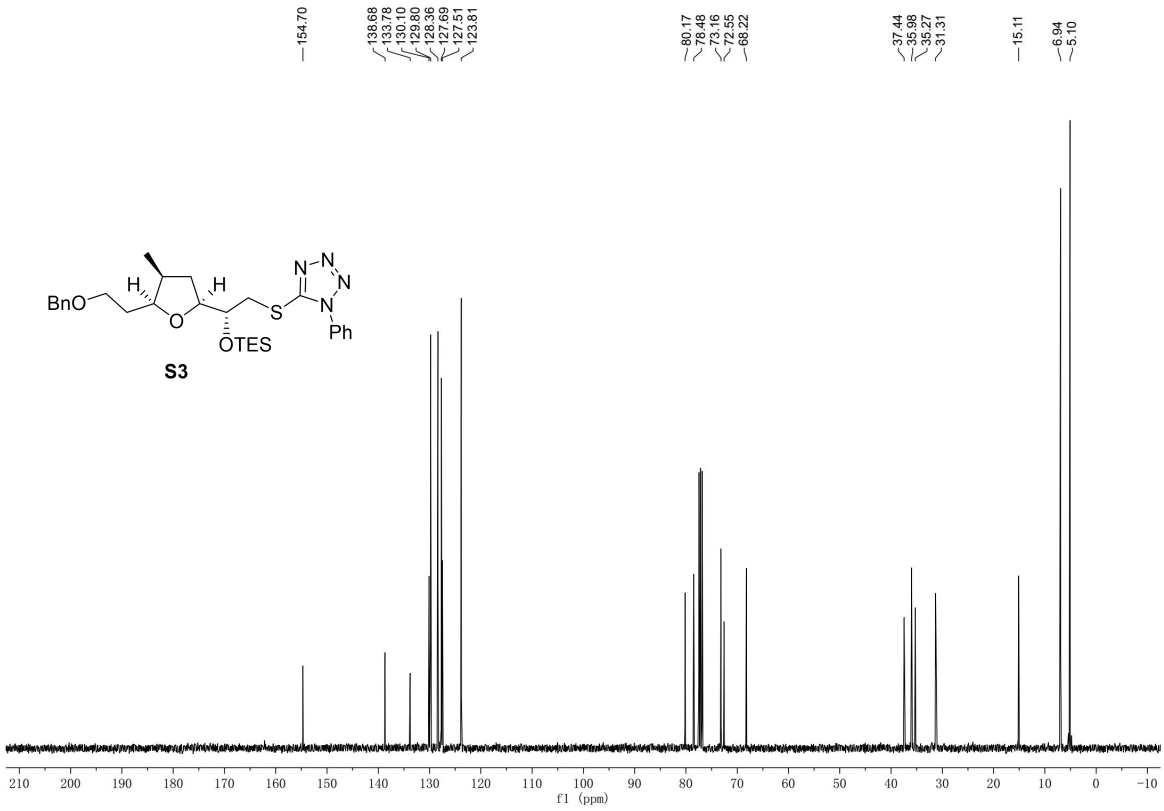
^{13}C NMR ($CDCl_3$, 101M)



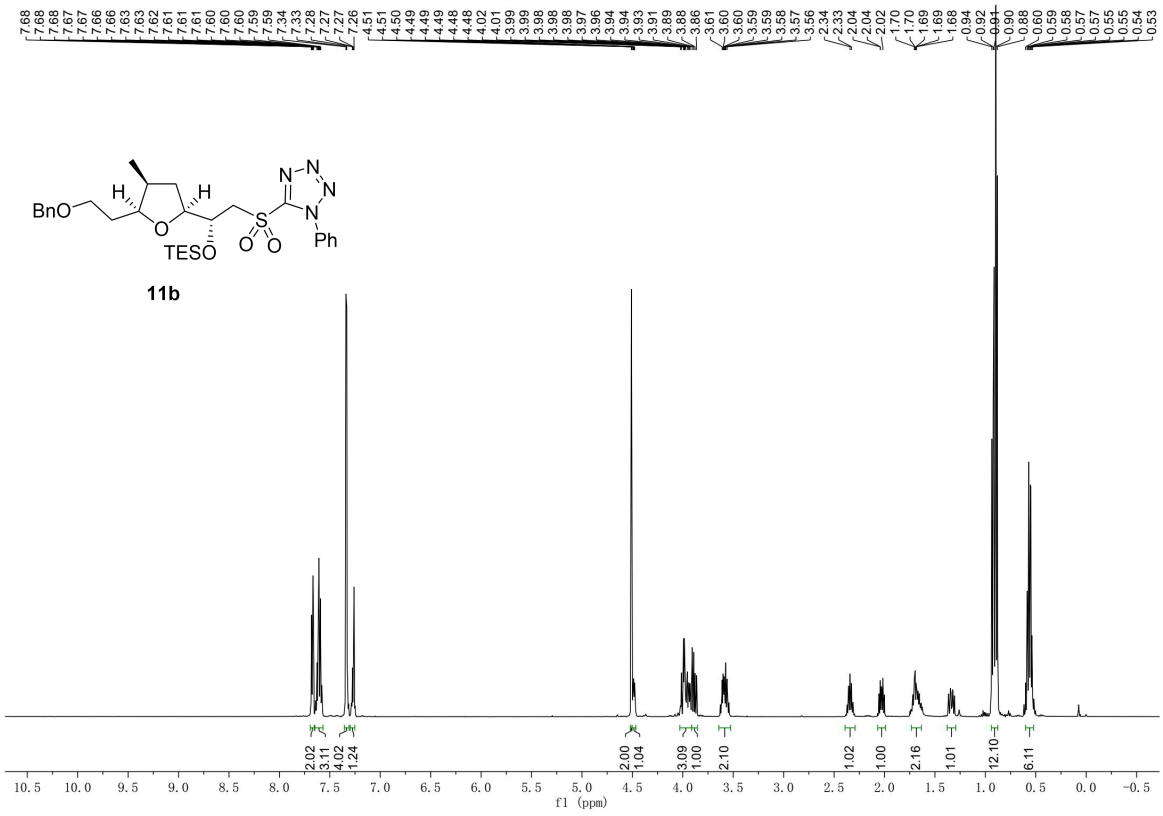
^{1}H NMR ($CDCl_3$, 400M)



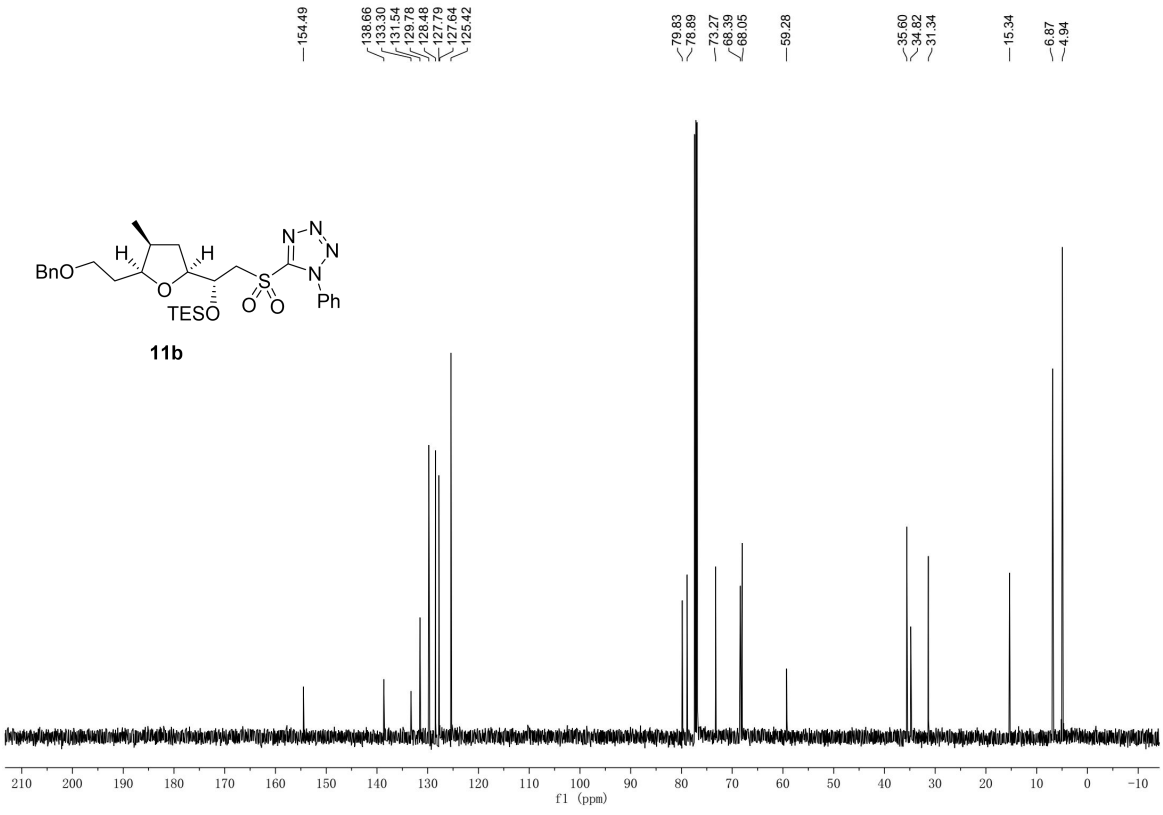
^{13}C NMR ($CDCl_3$, 101M)



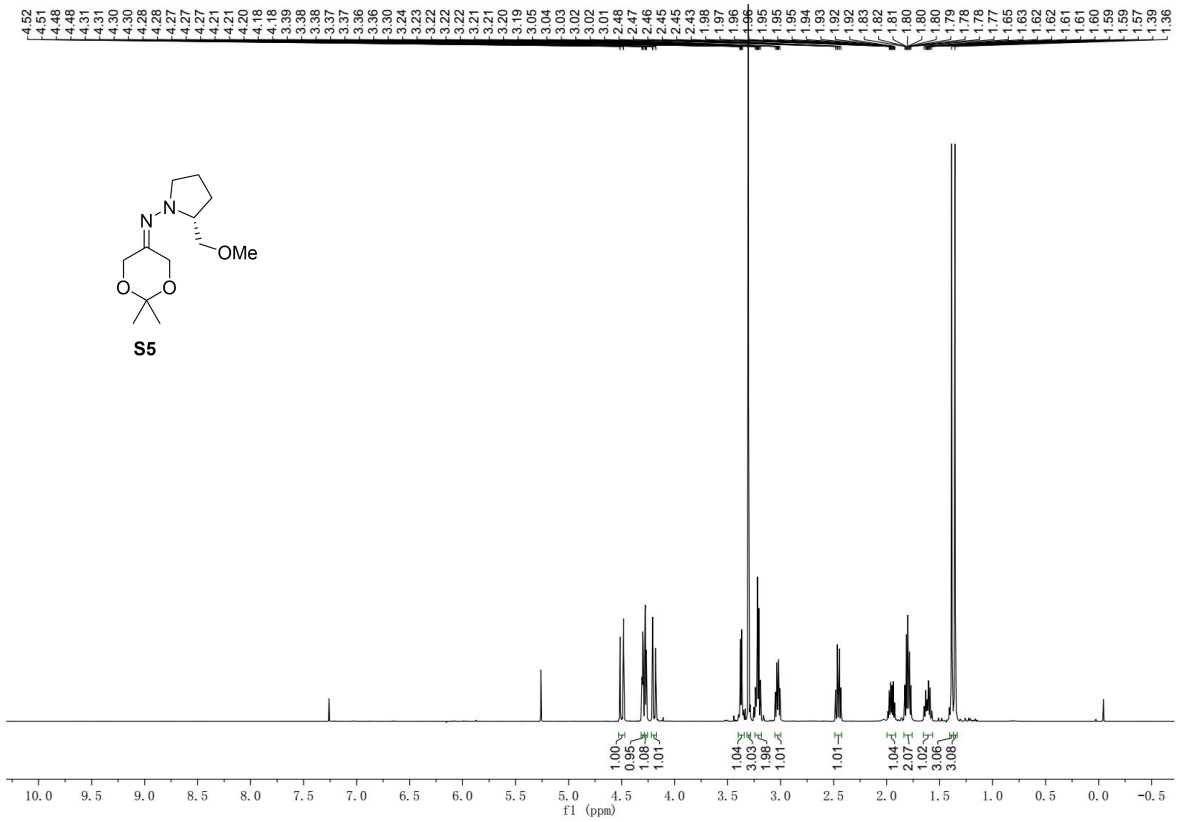
^{1}H NMR ($CDCl_3$, 500M)



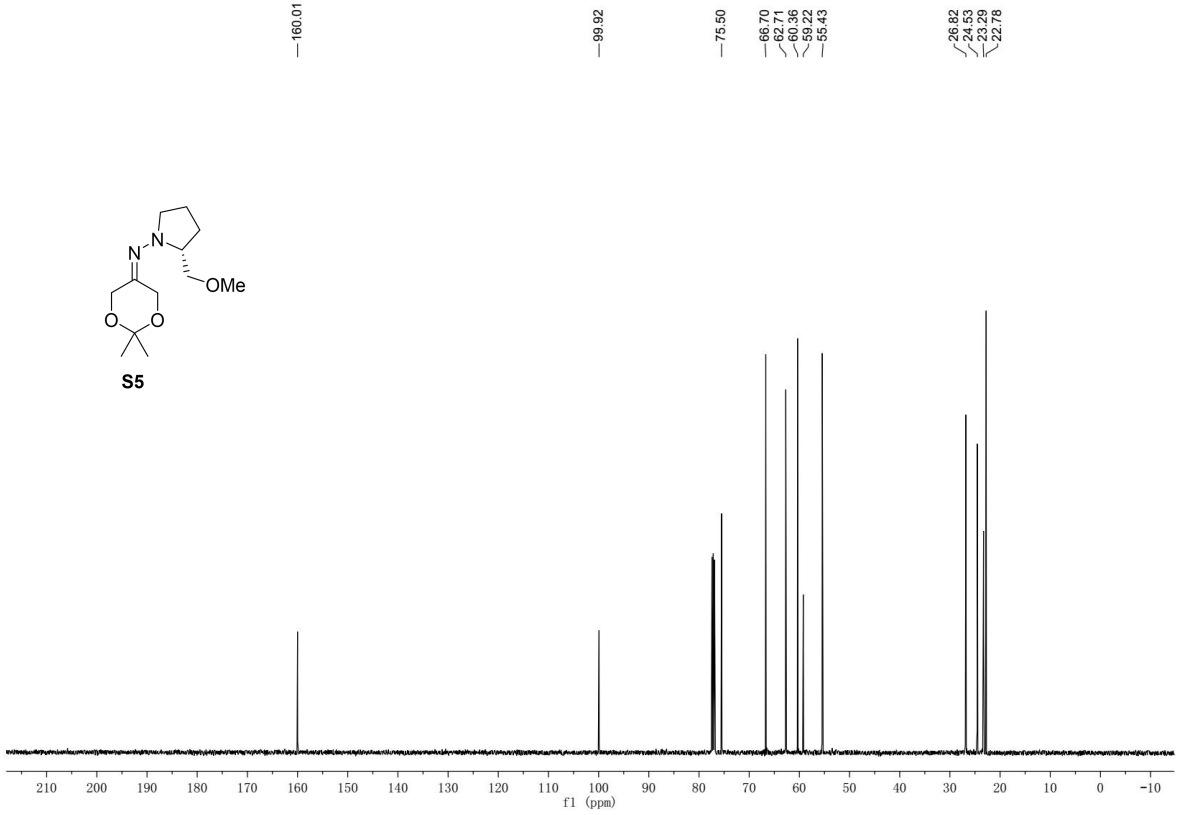
^{13}C NMR ($CDCl_3$, 126M)



^{1}H NMR ($CDCl_3$, 500M)



^{13}C NMR ($CDCl_3$, 126M)



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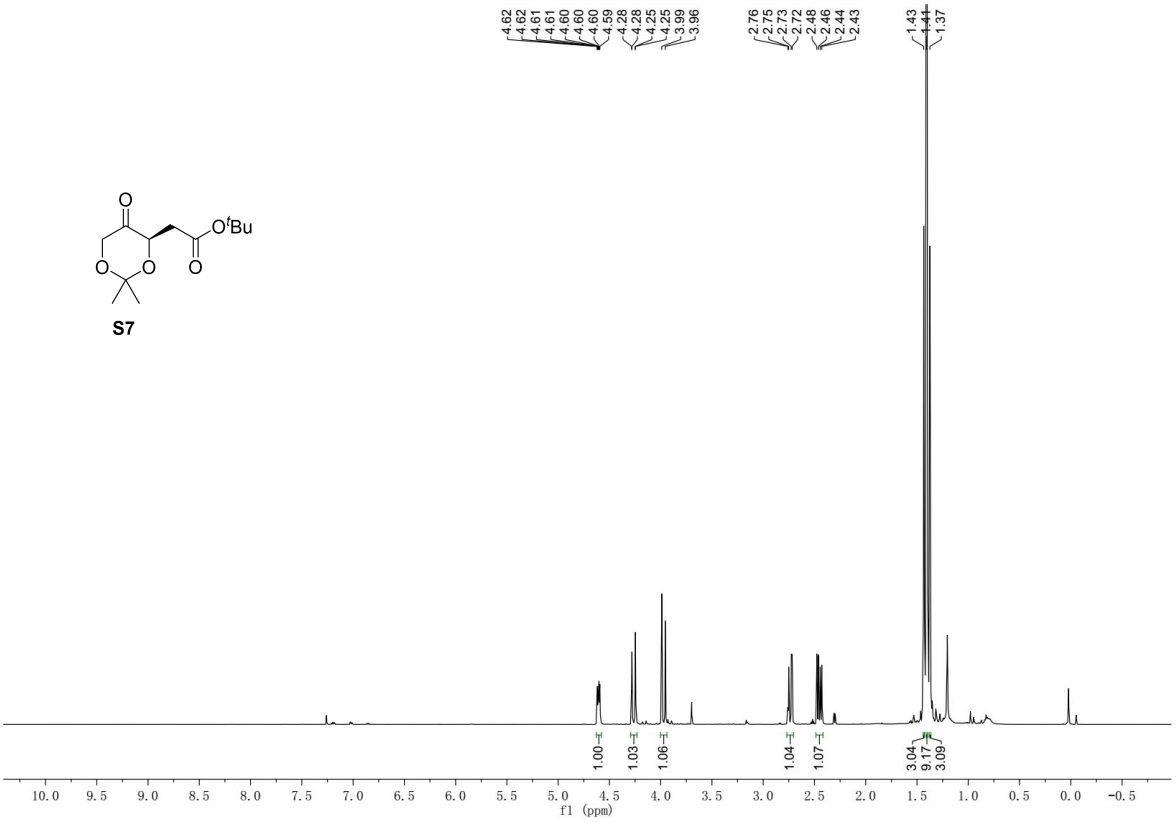
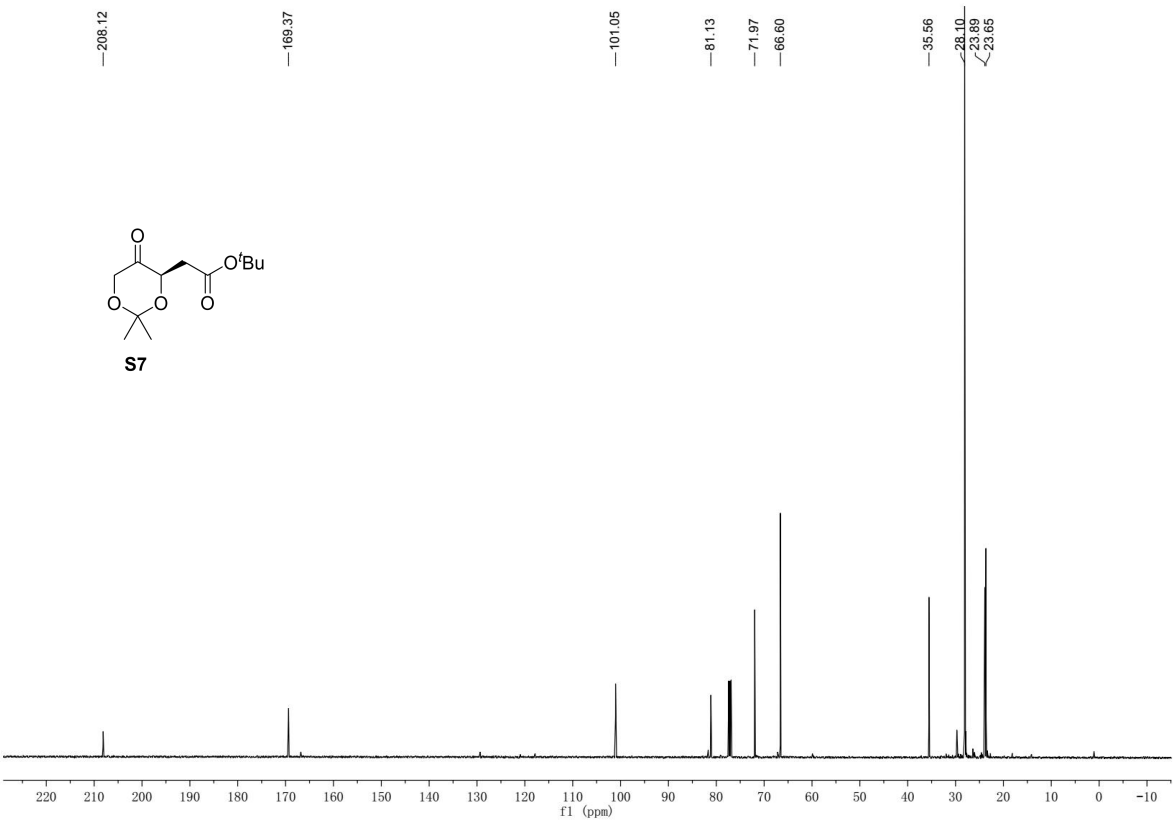
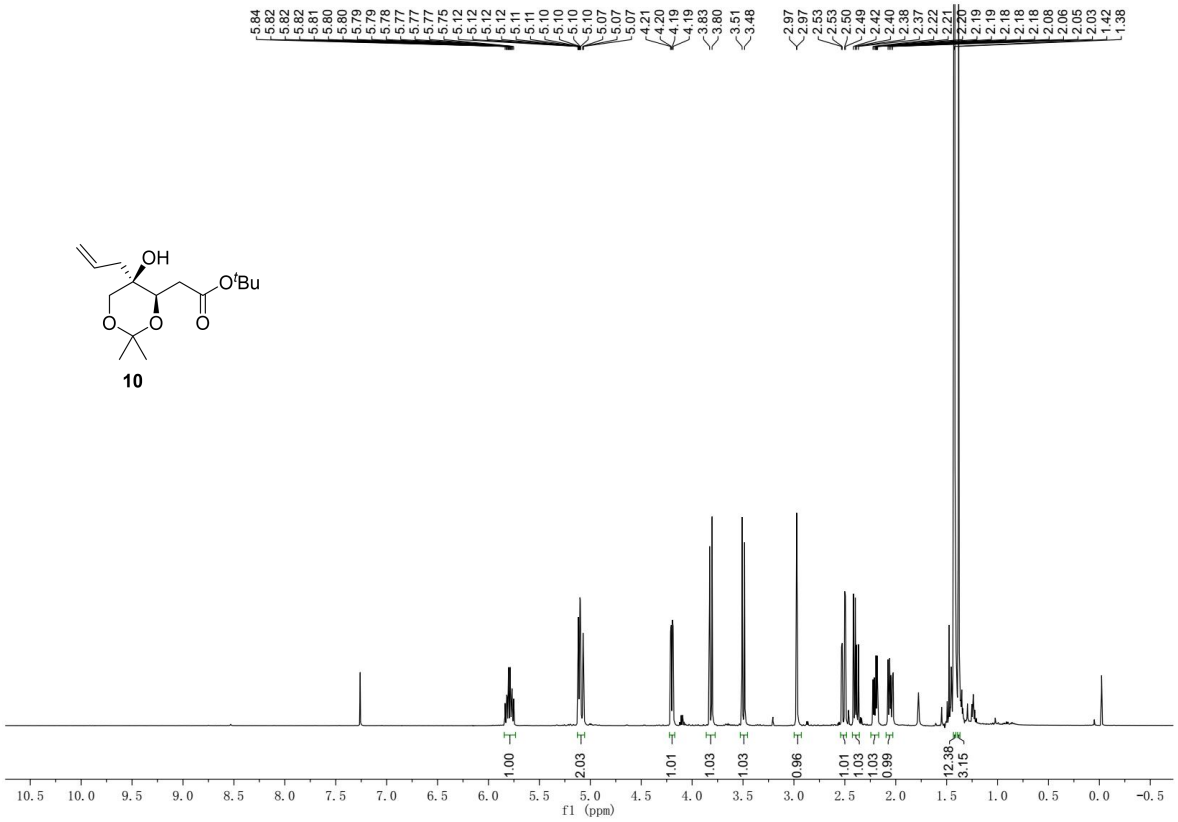


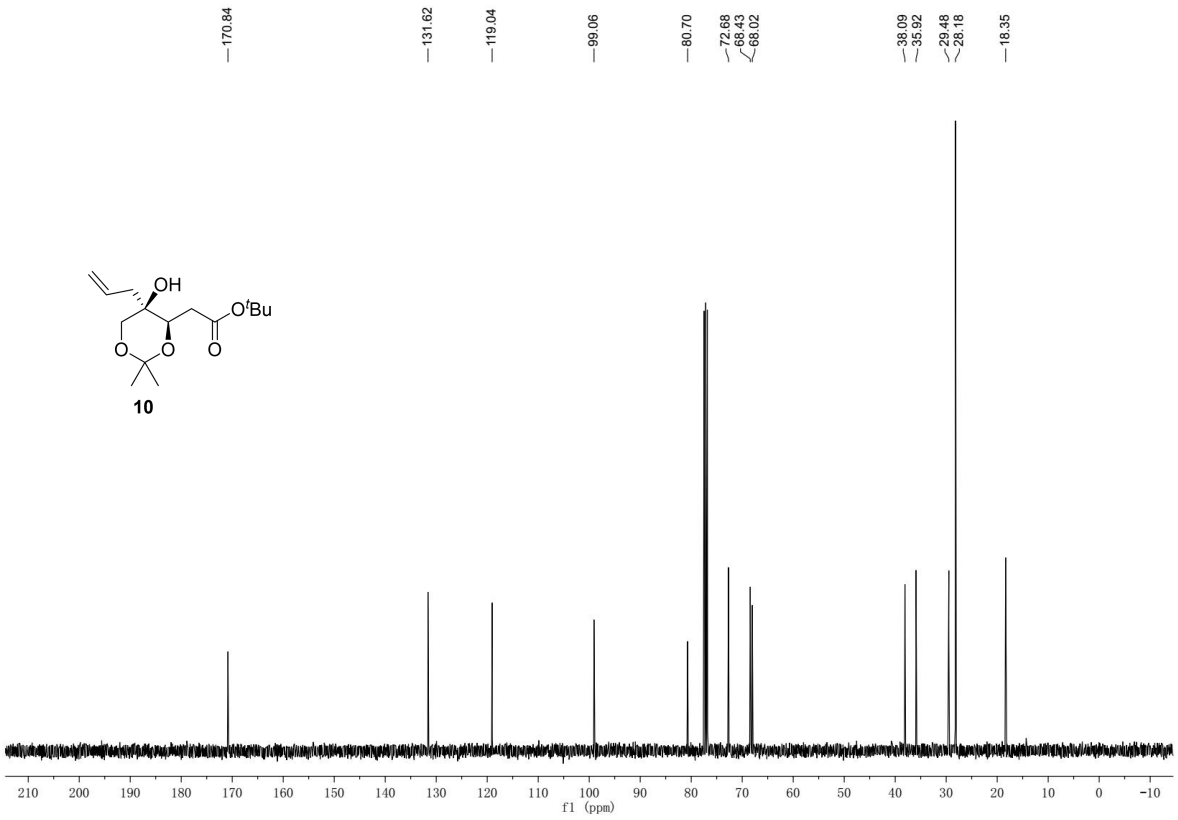
^{13}C NMR ($CDCl_3$, 126M)



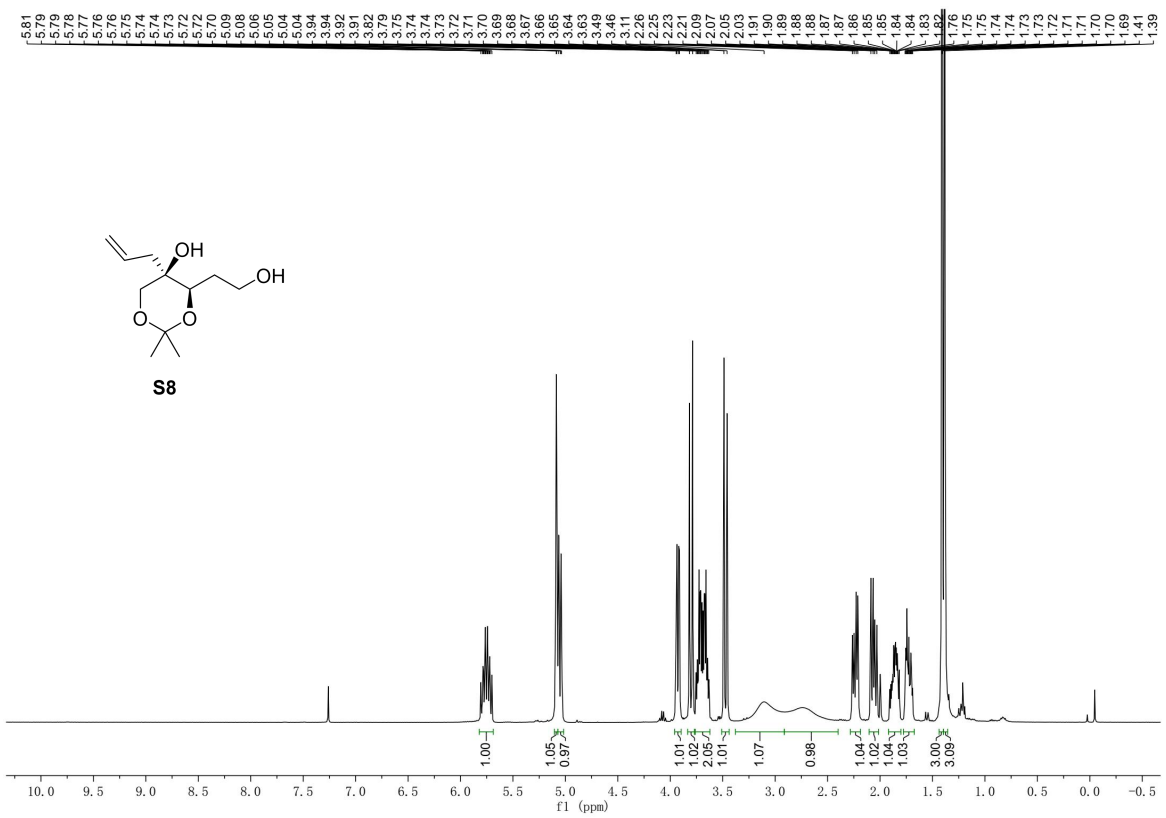
^{1}H NMR ($CDCl_3$, 500M)



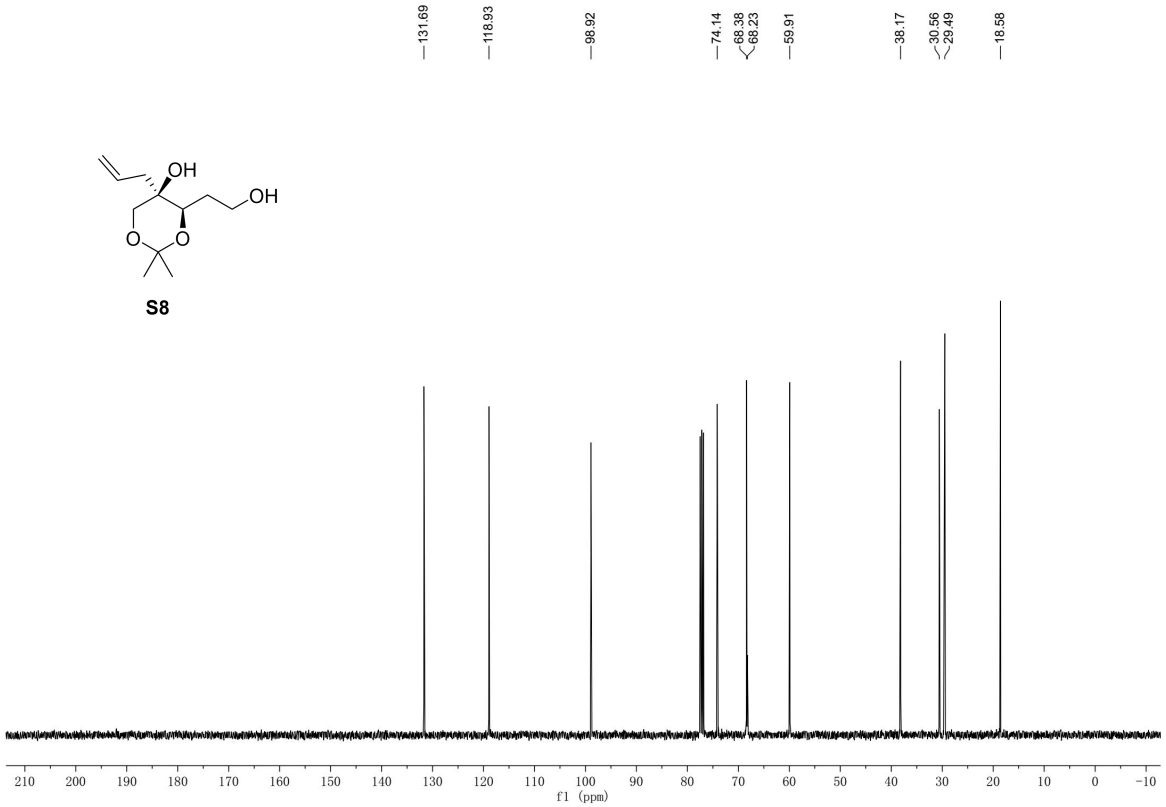
^{13}C NMR ($CDCl_3$, 126M)



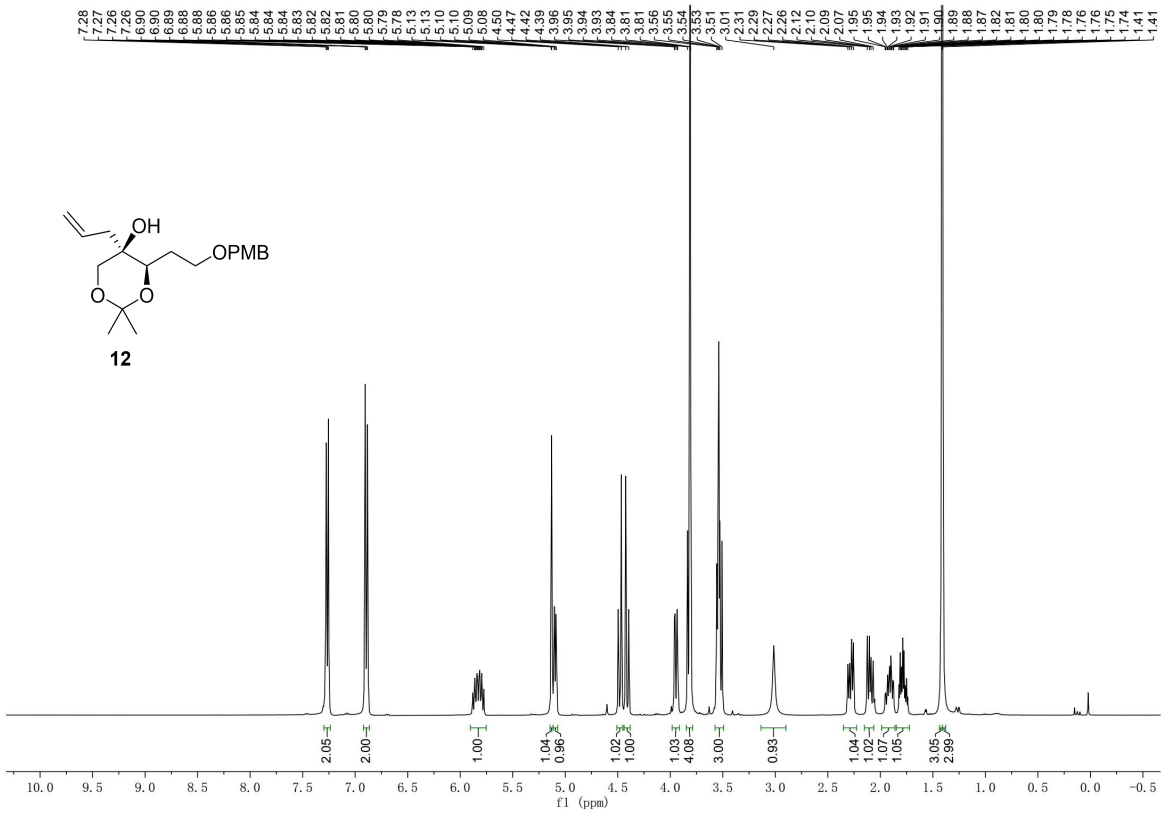
^{1}H NMR ($CDCl_3$, 400M)



^{13}C NMR ($CDCl_3$, 101M)



^{1}H NMR ($CDCl_3$, 400M)



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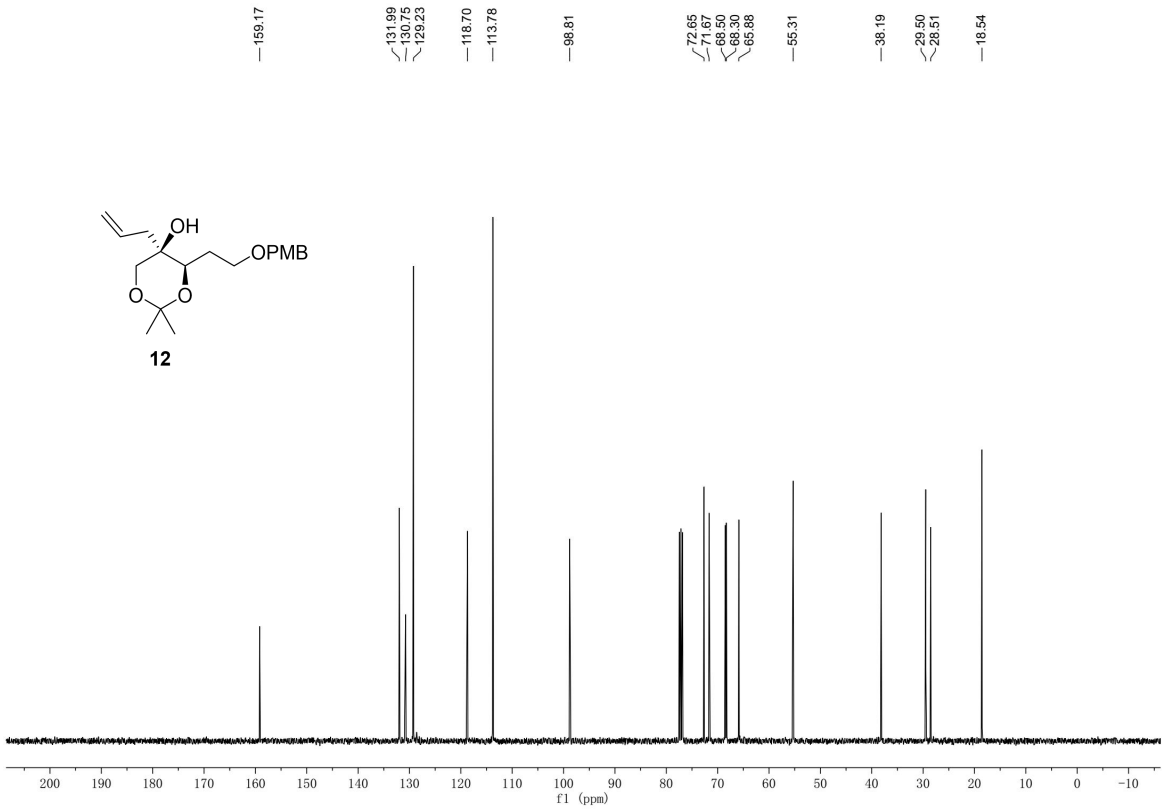

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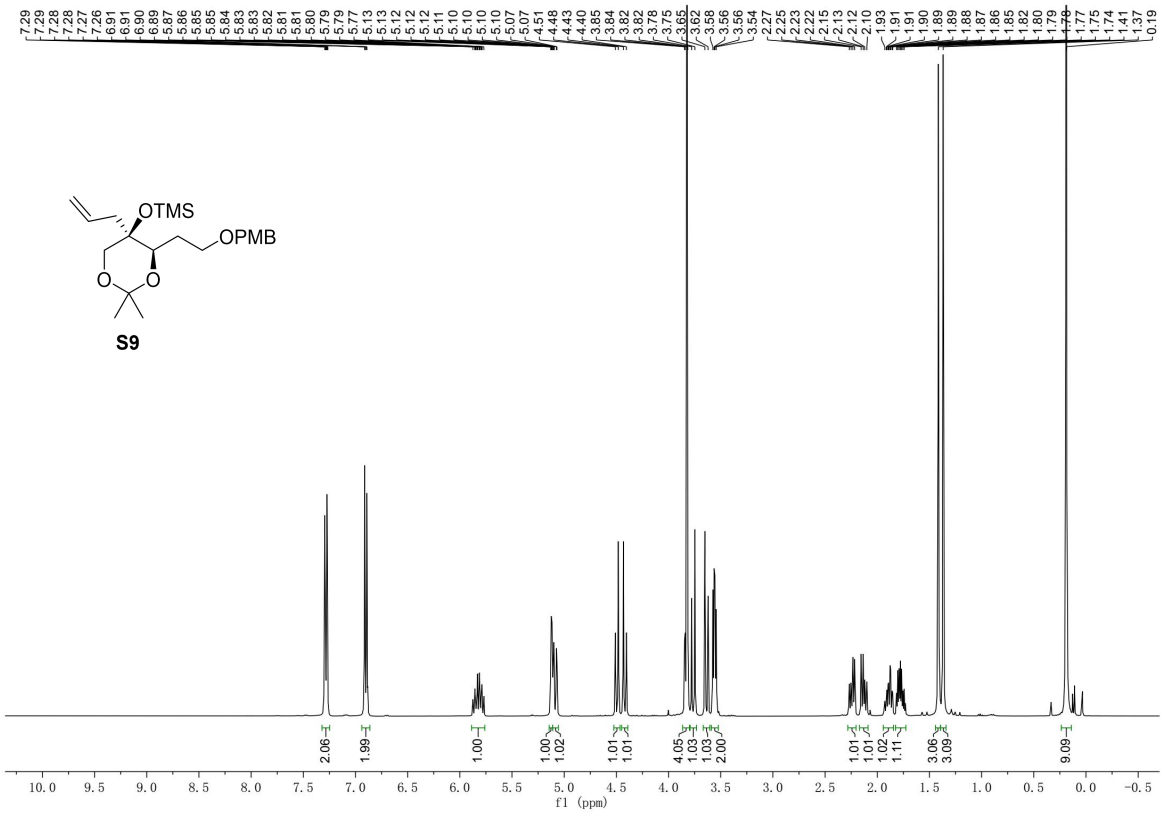

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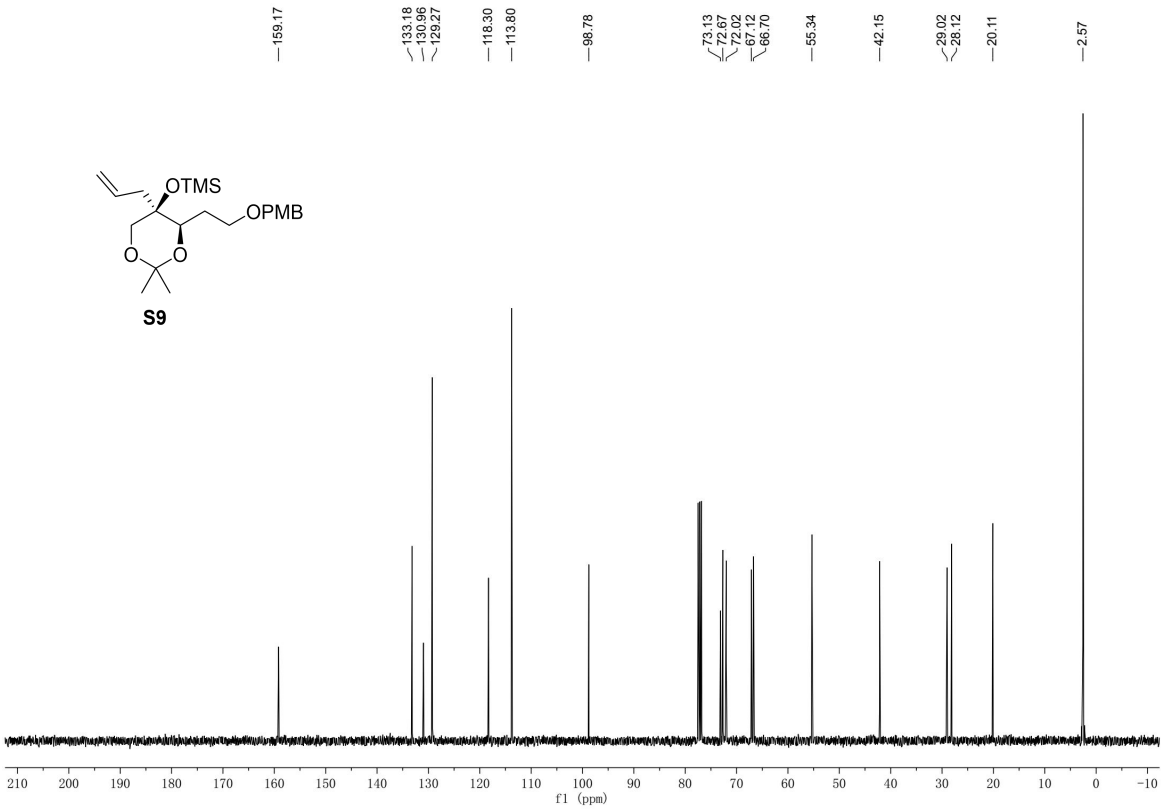

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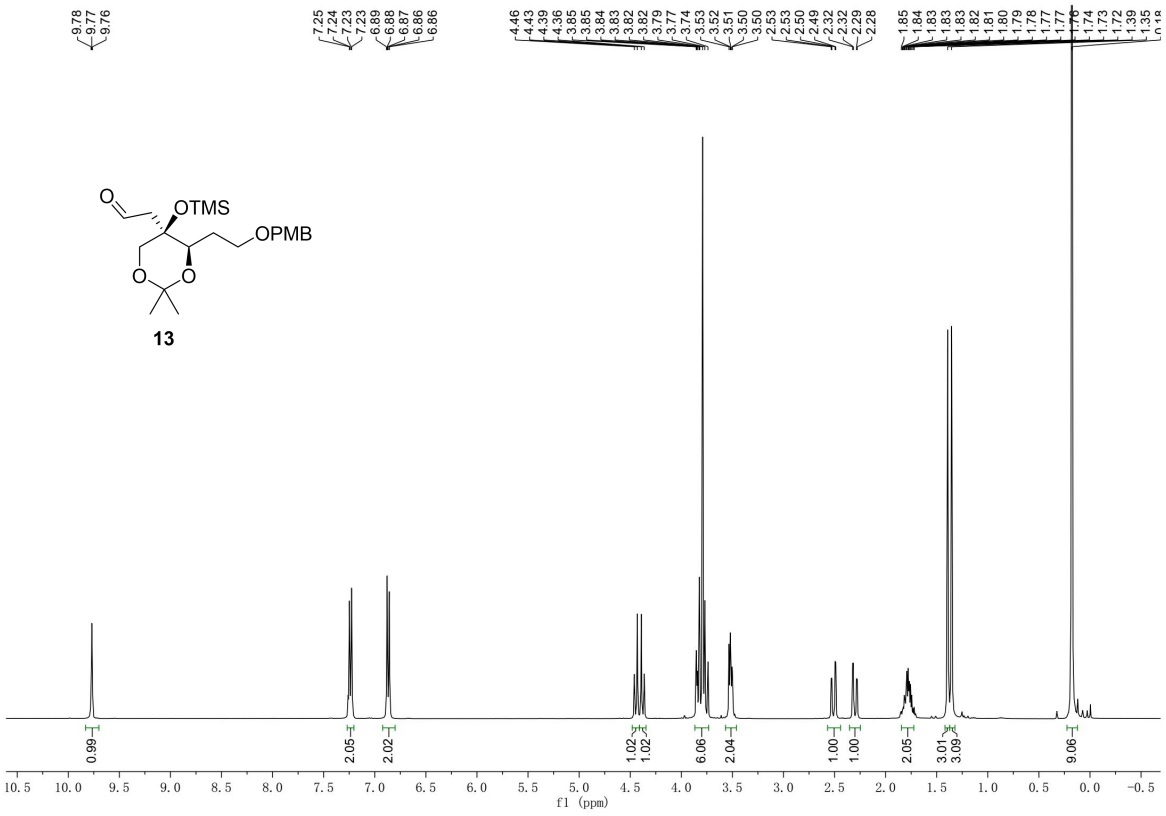

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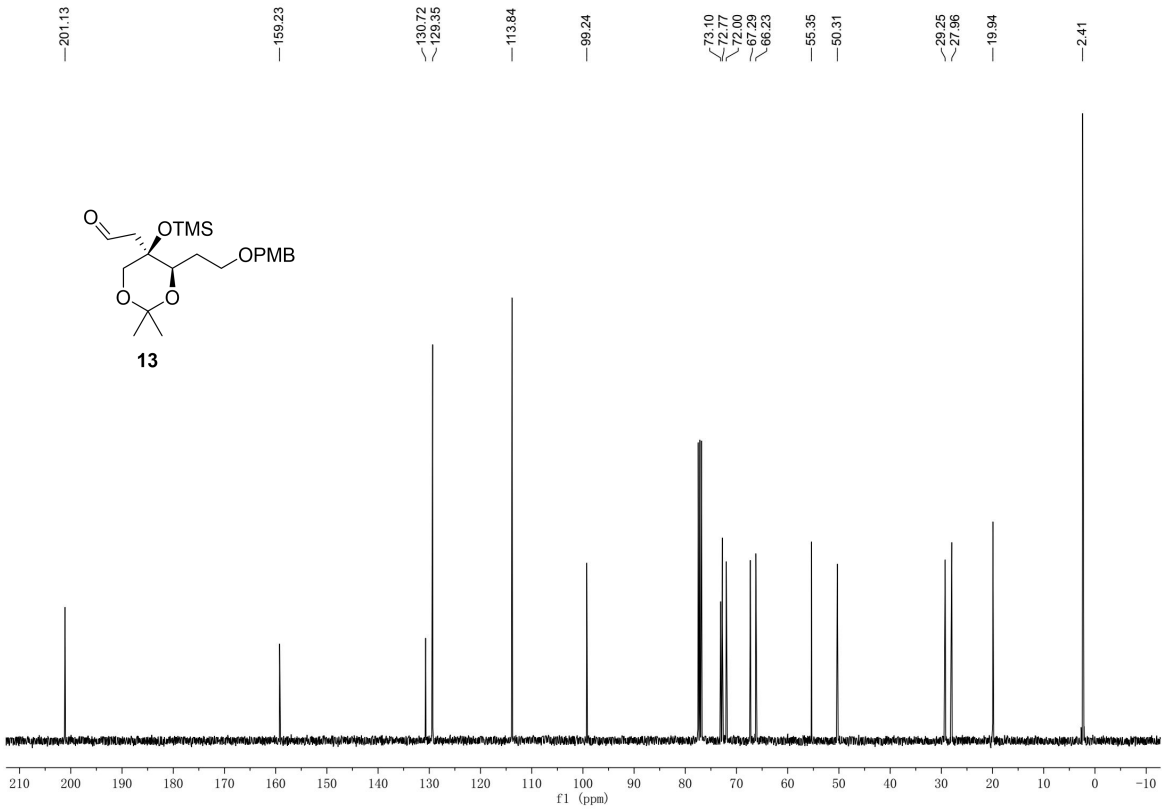

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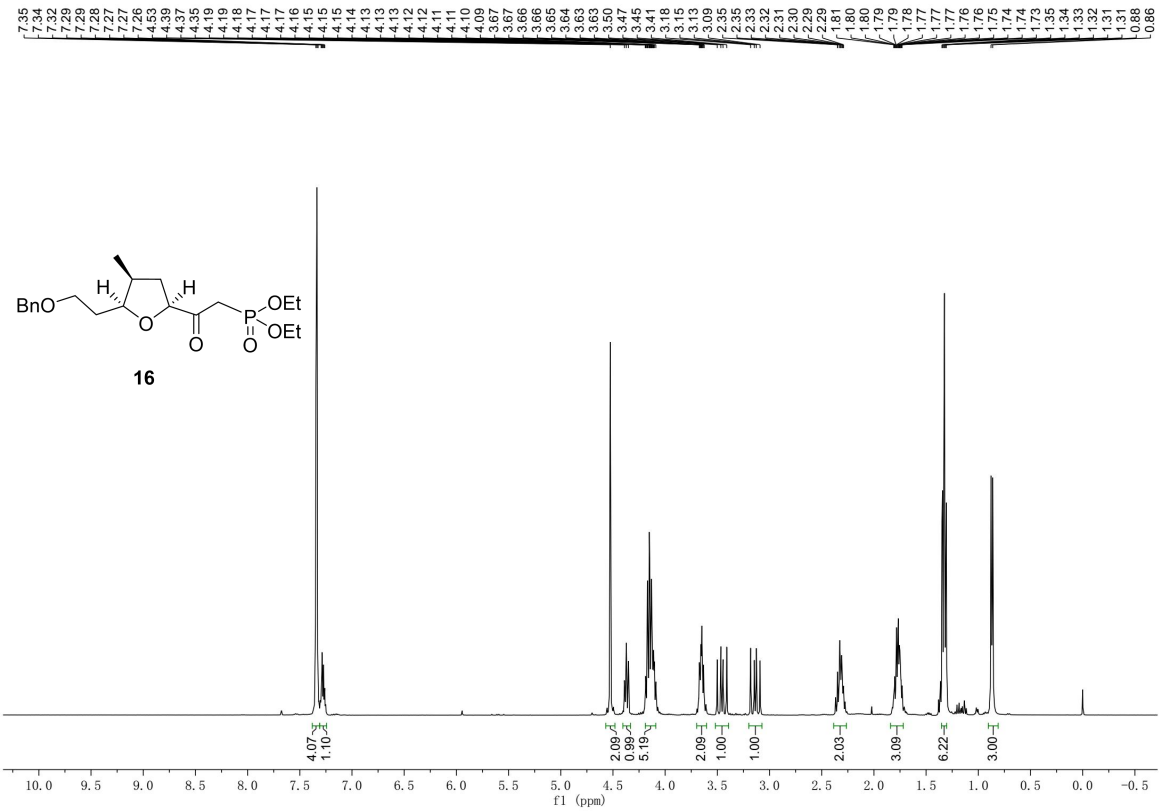
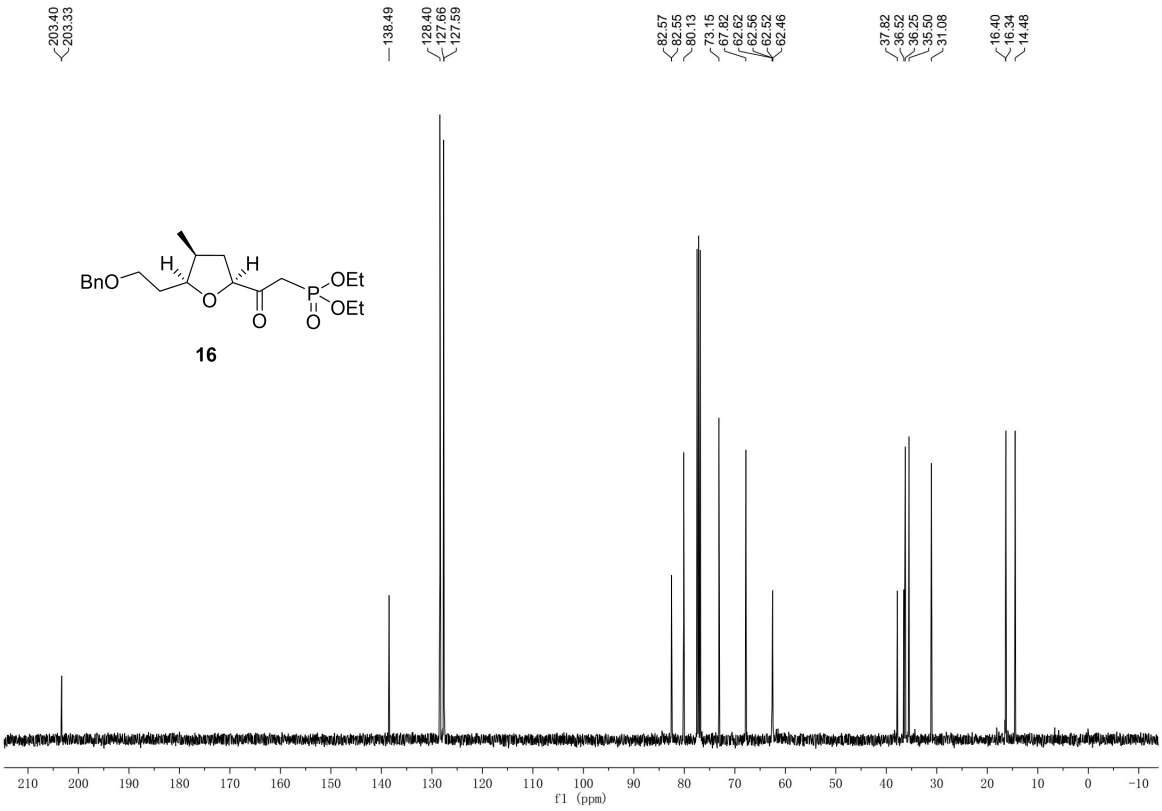
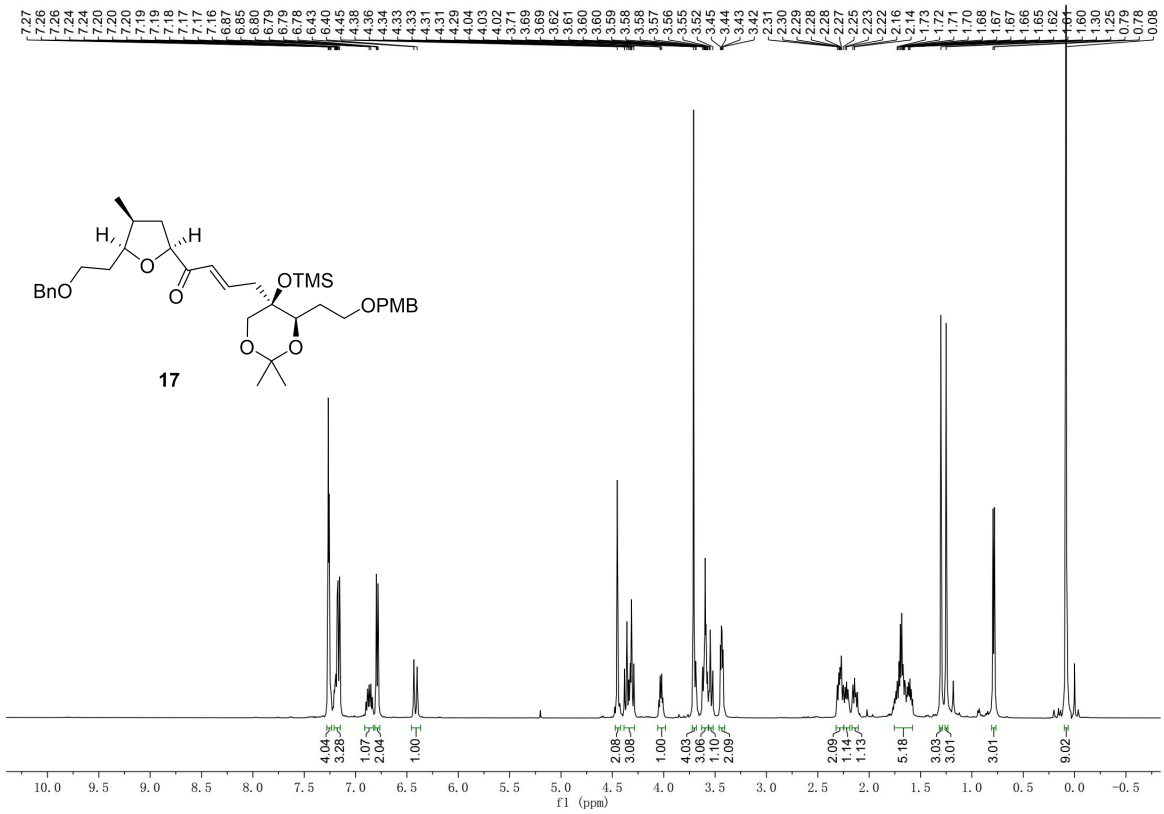


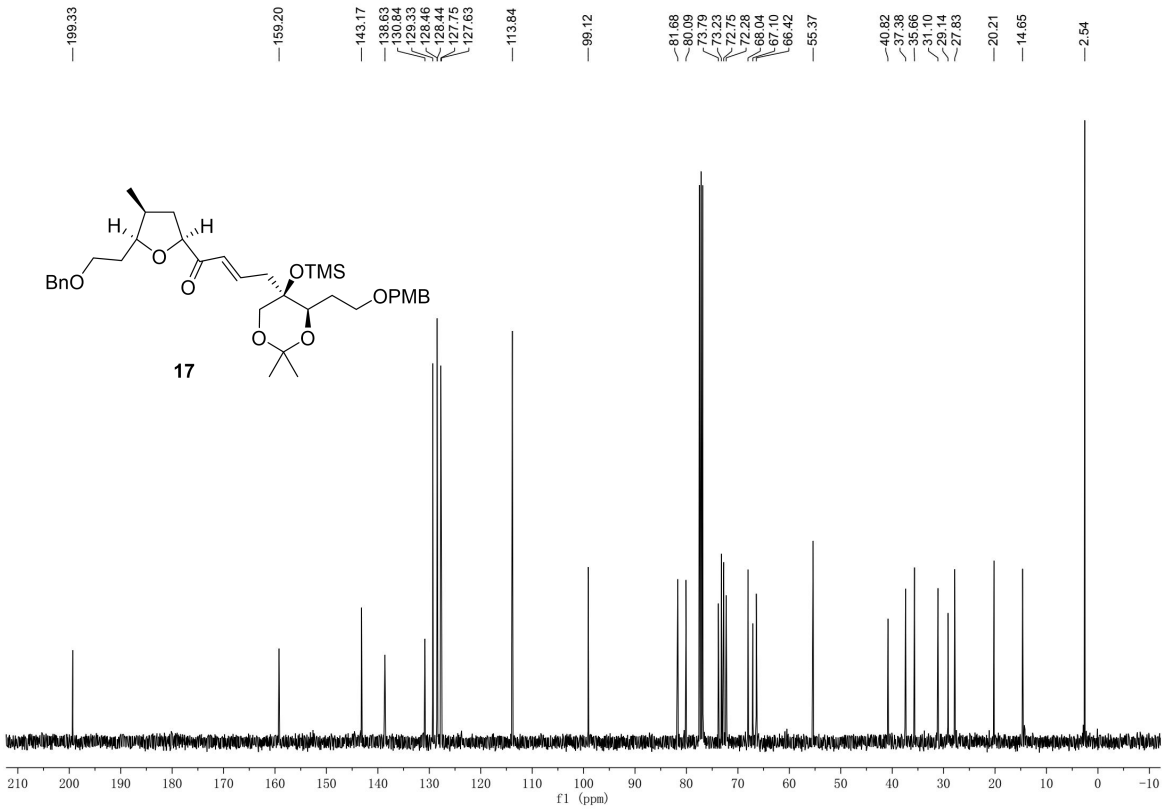
^{13}C NMR ($CDCl_3$, 101M)



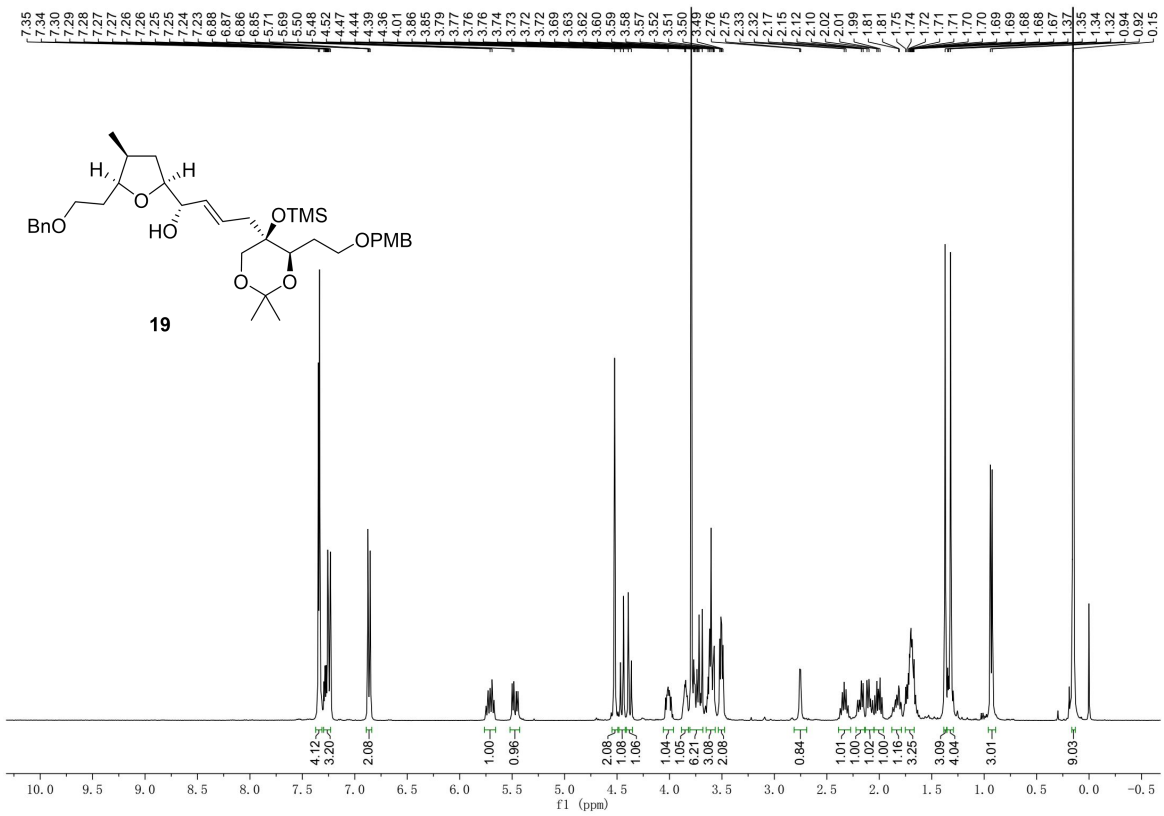
^{1}H NMR ($CDCl_3$, 500M)



^{13}C NMR ($CDCl_3$, 101M)



^{1}H NMR ($CDCl_3$, 400M)



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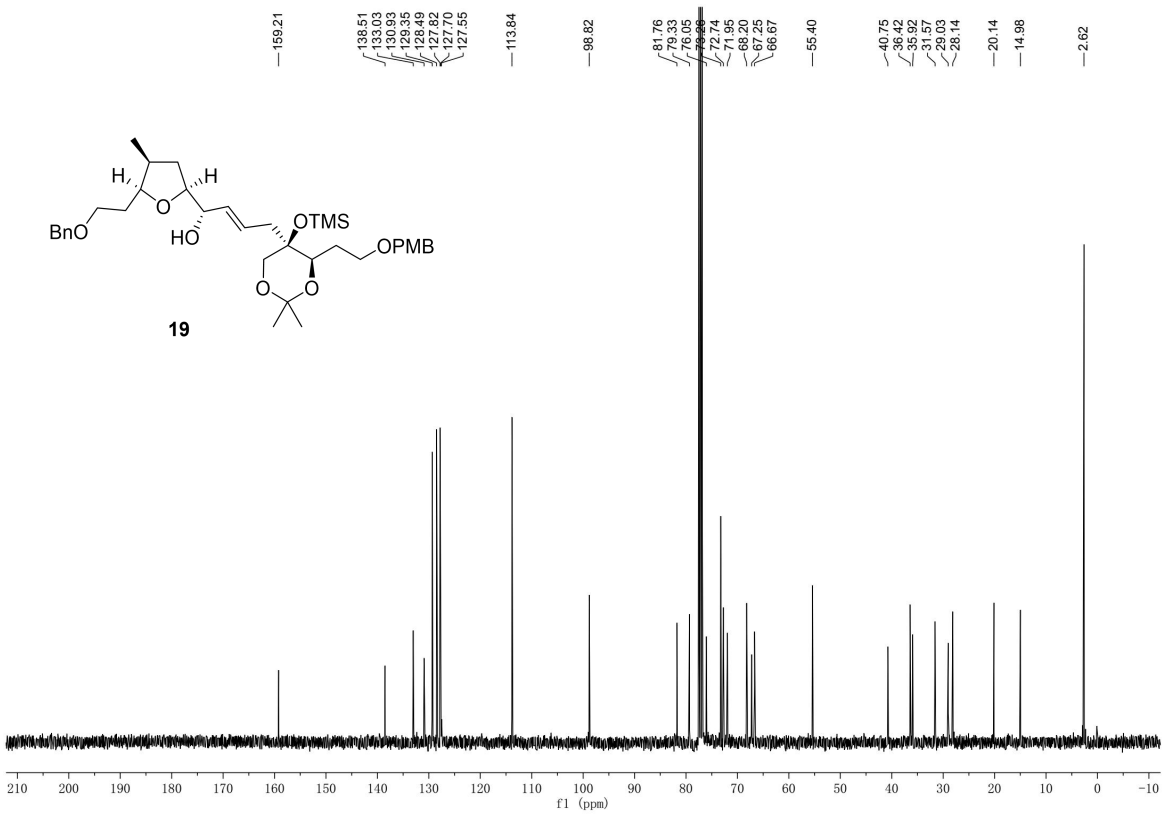

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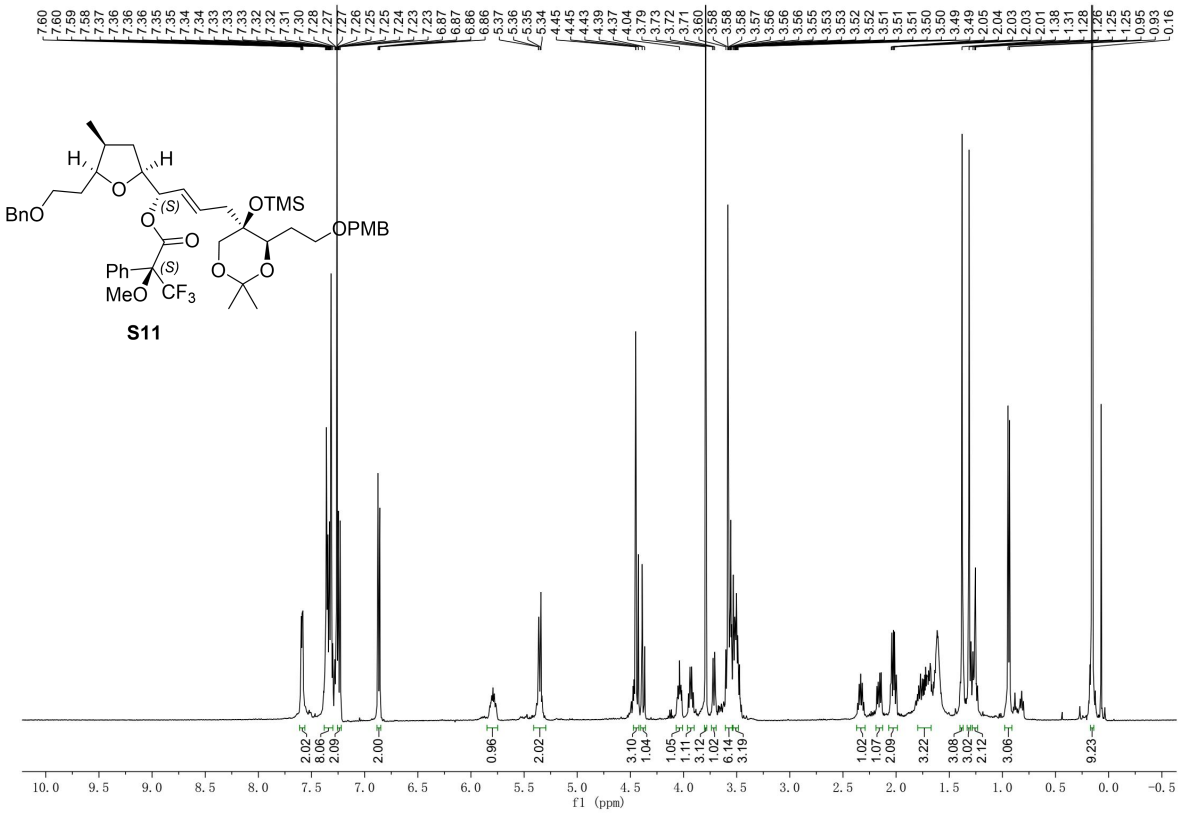

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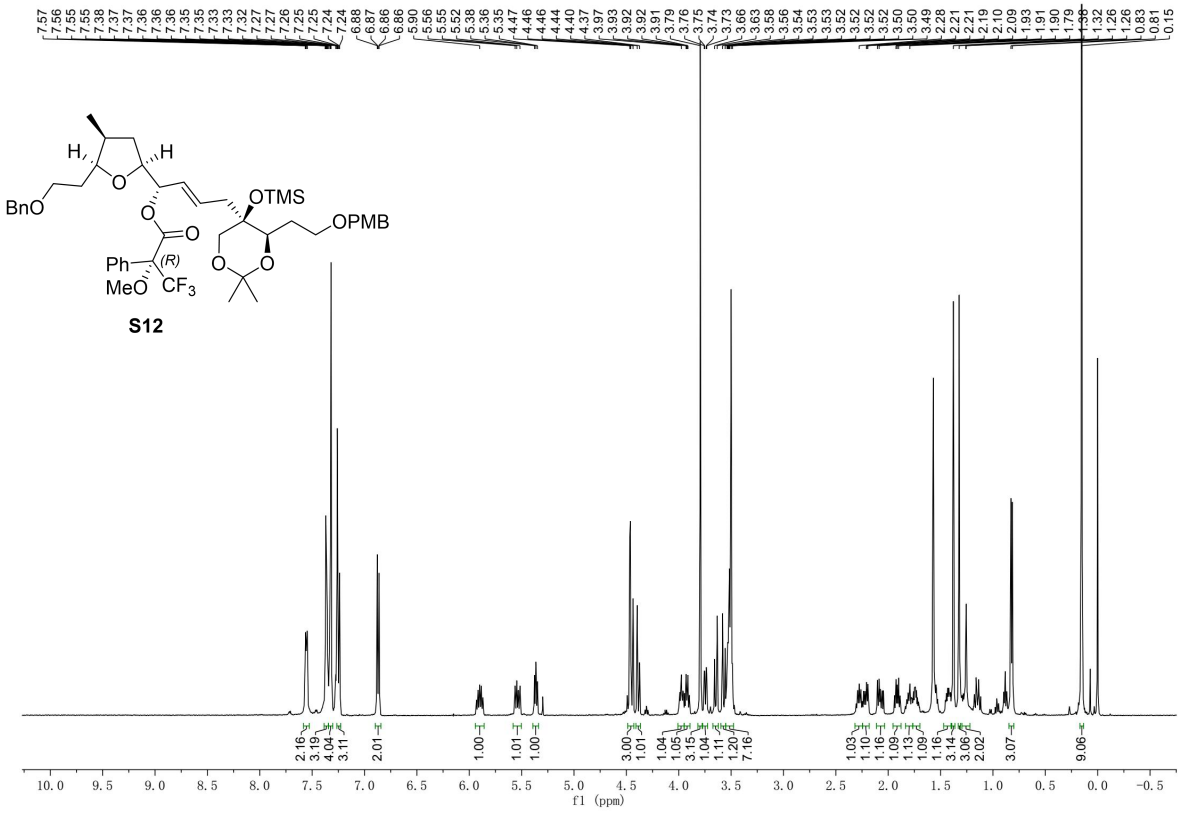

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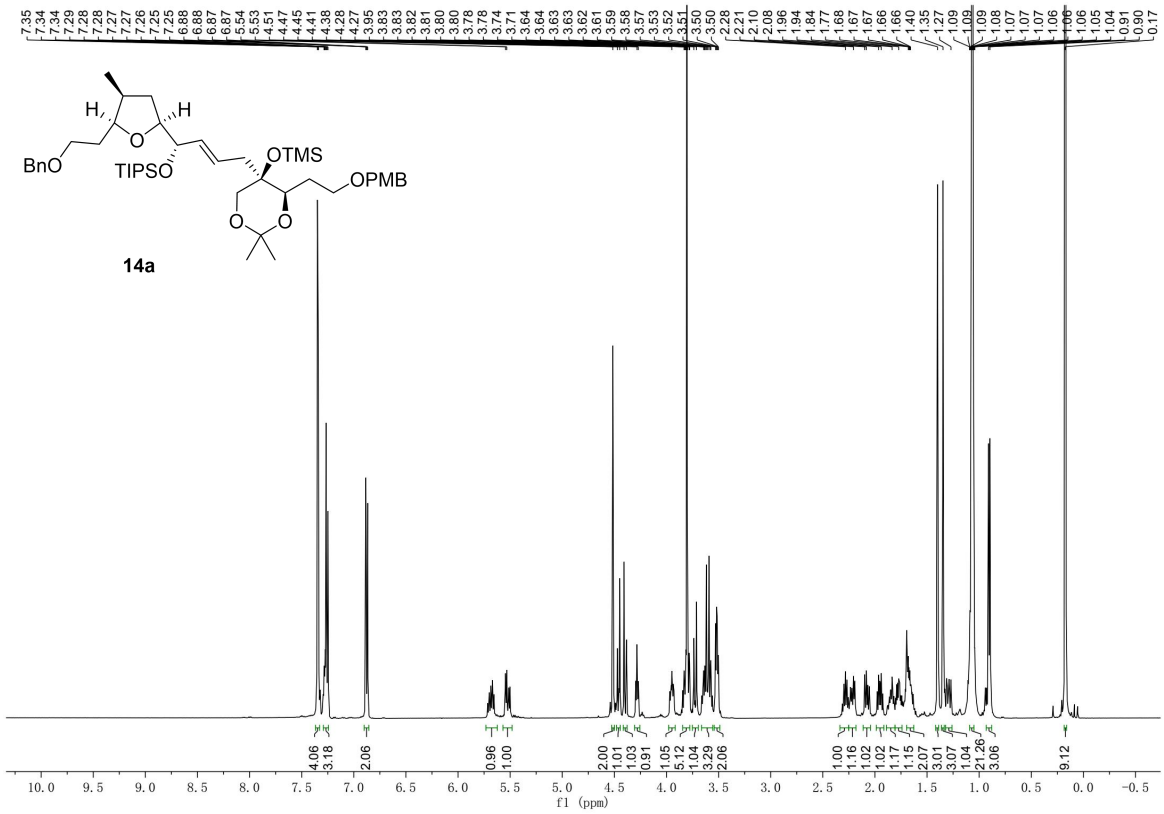
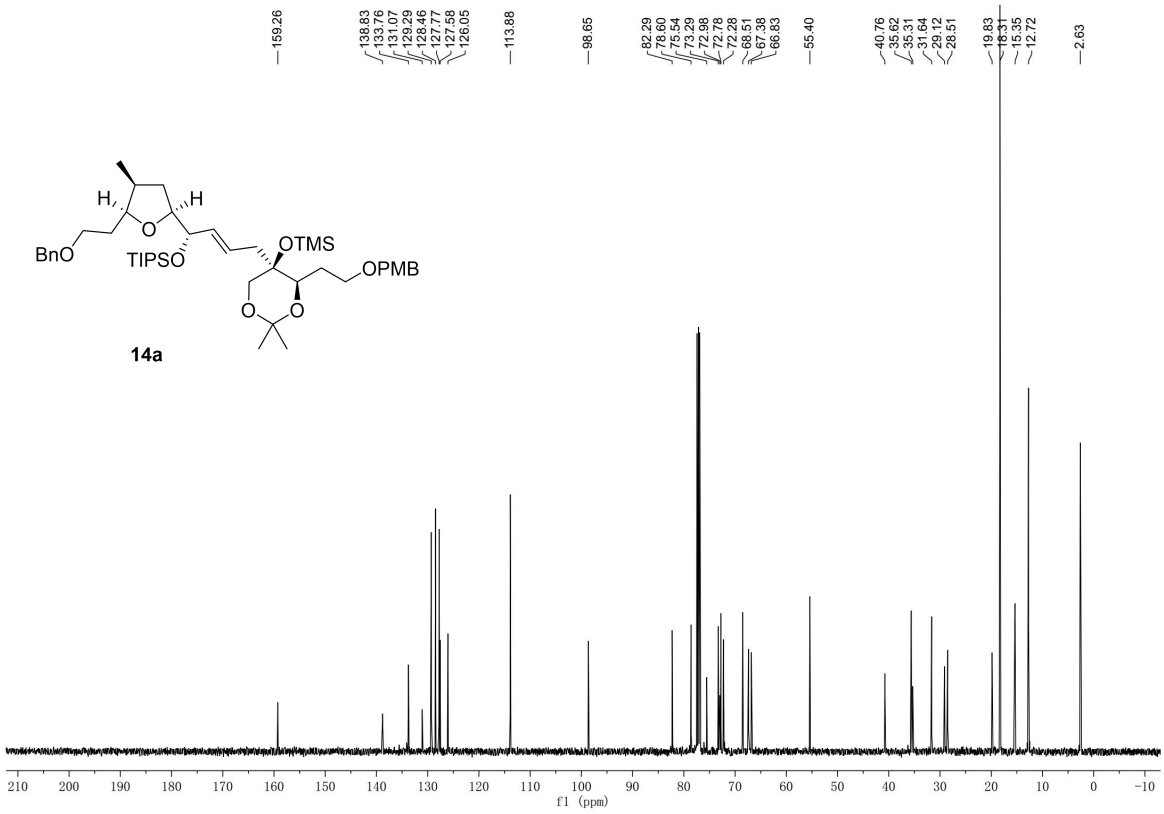
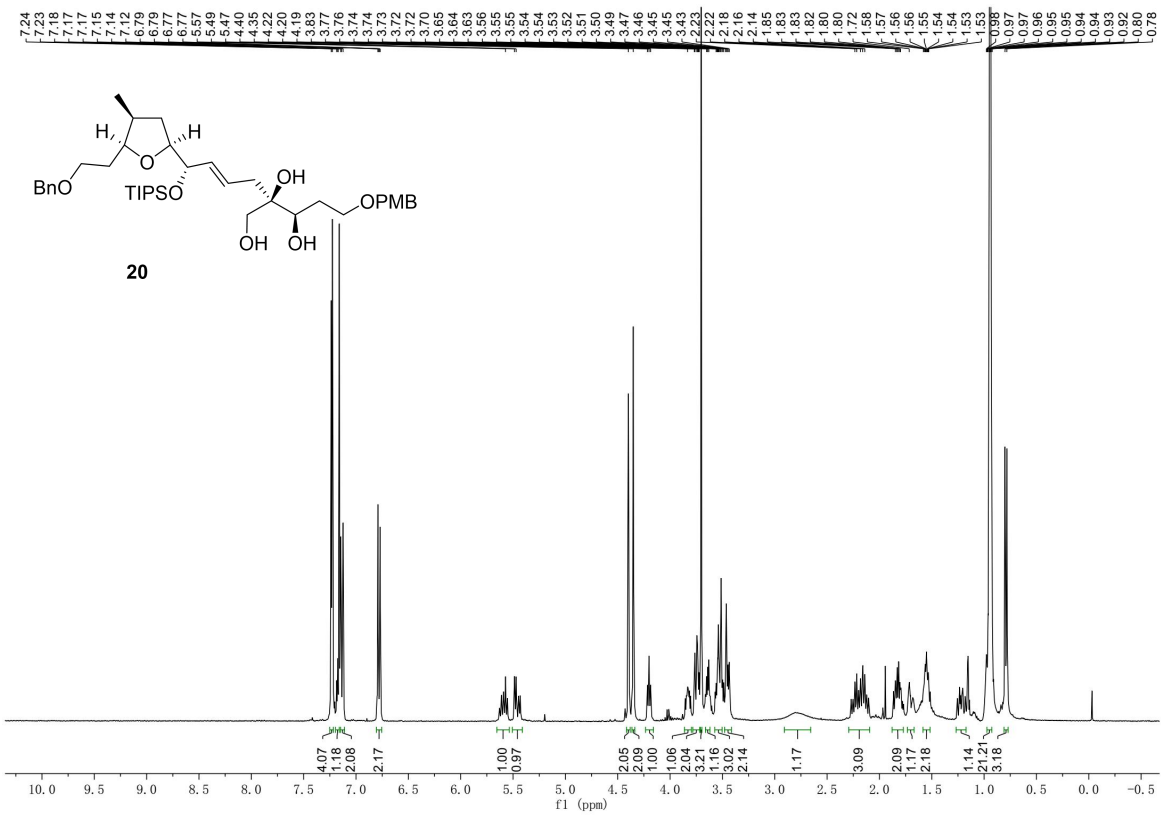


^{13}C NMR ($CDCl_3$, 126M)



^{1}H NMR ($CDCl_3$, 400M)



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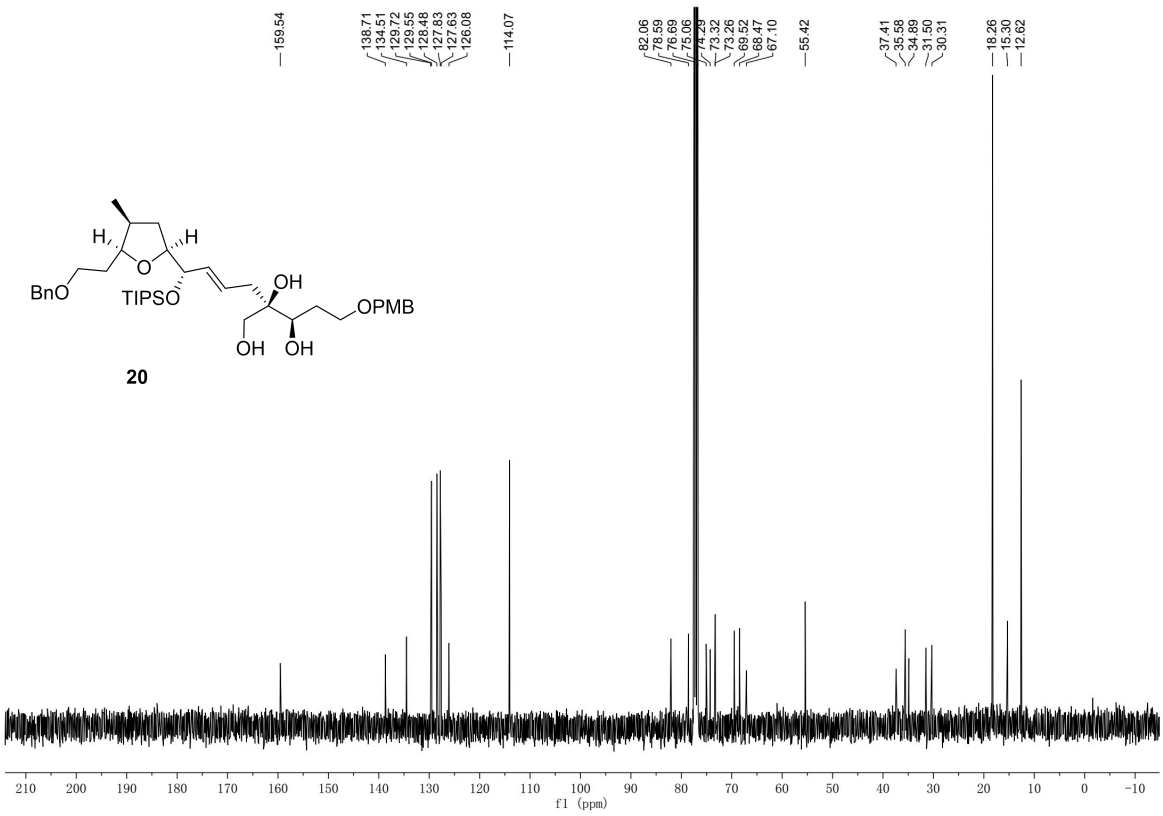

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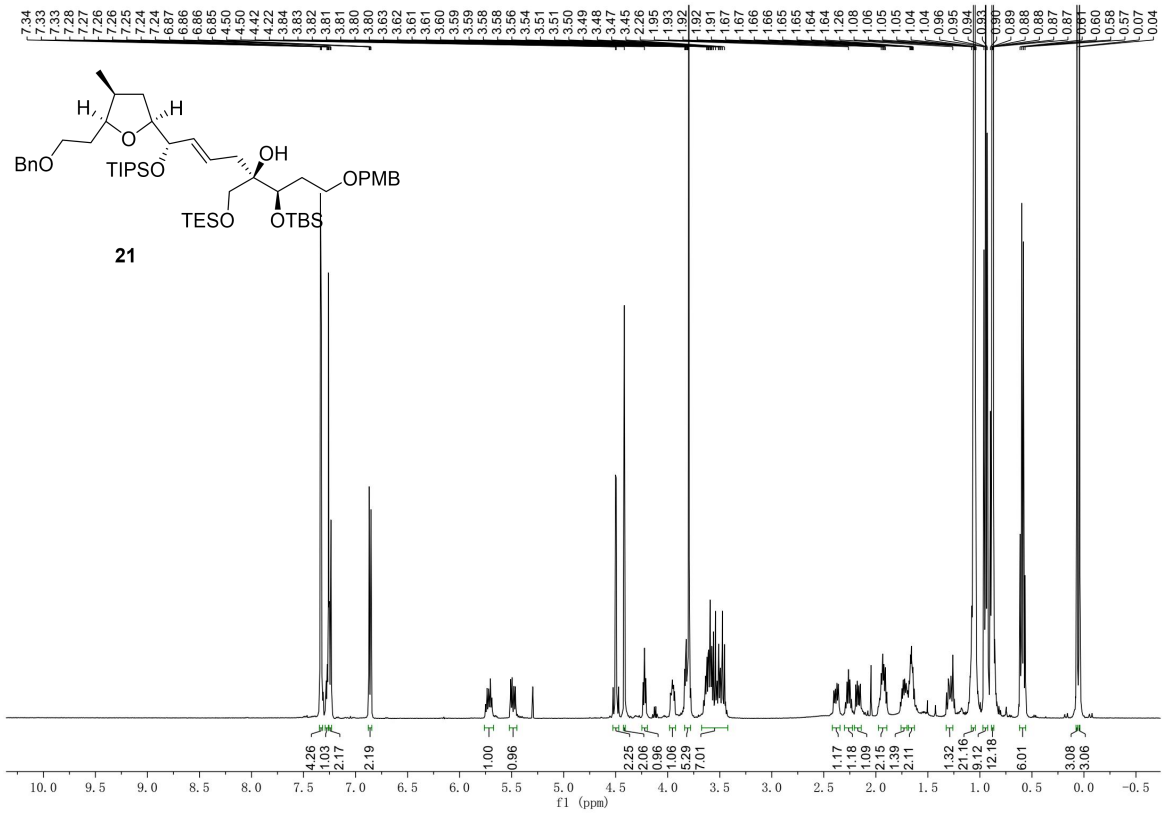

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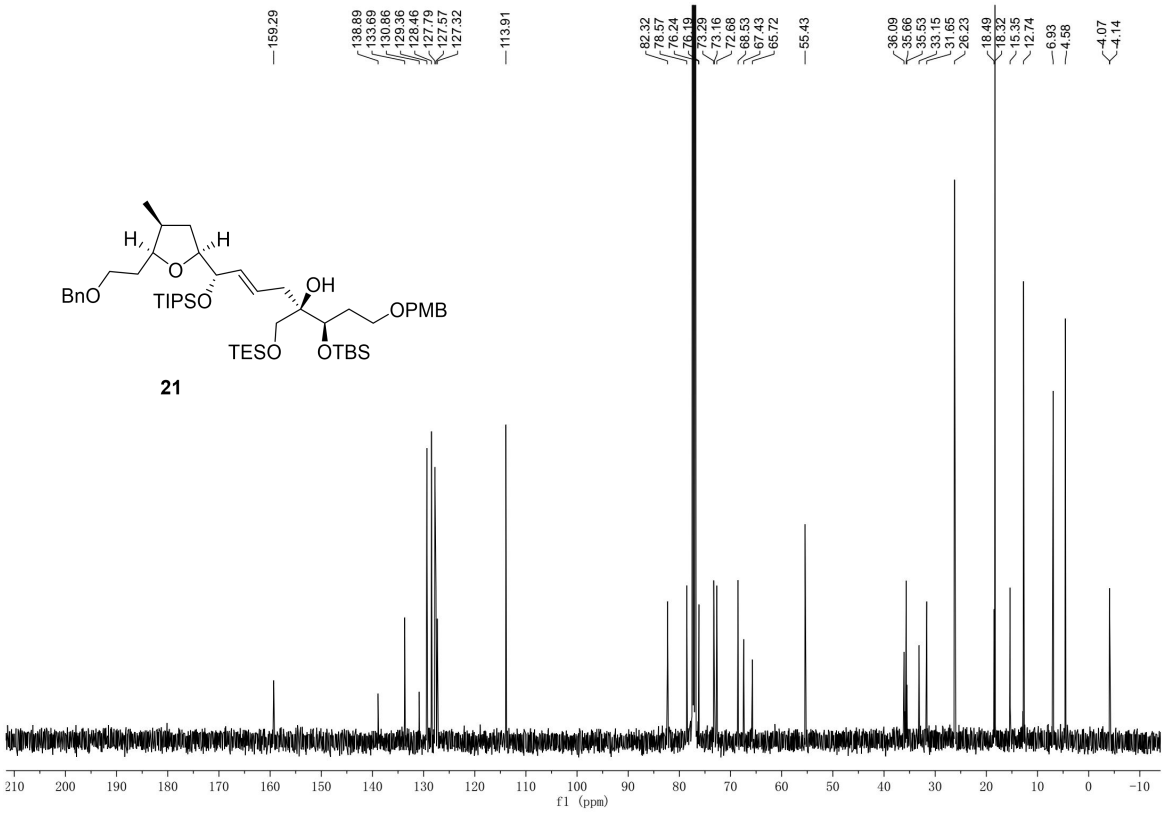

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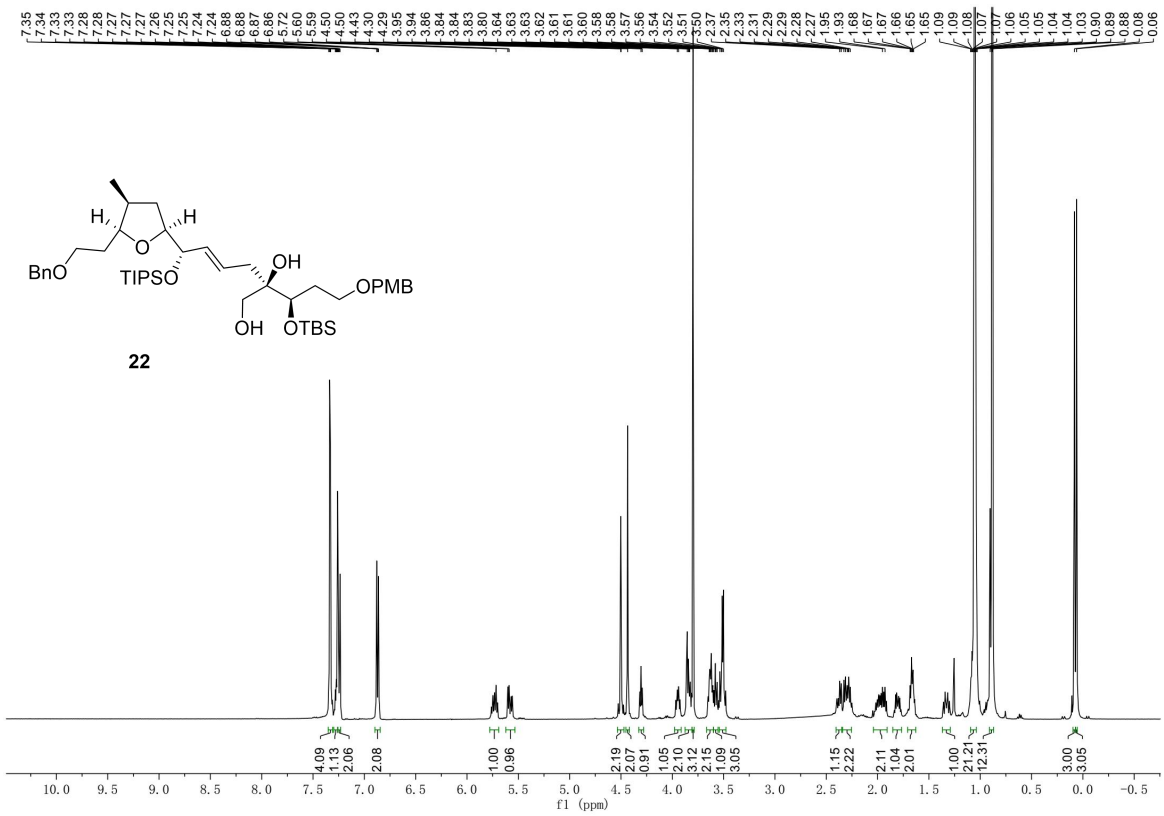

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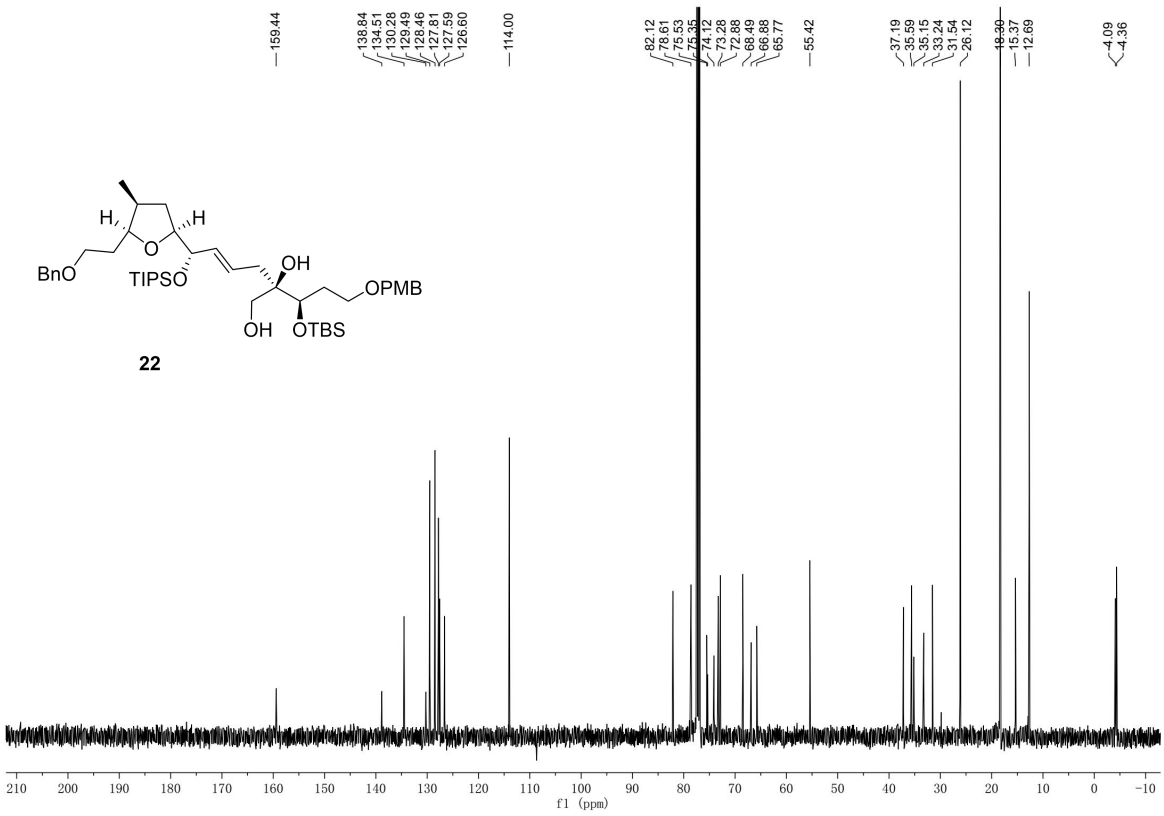

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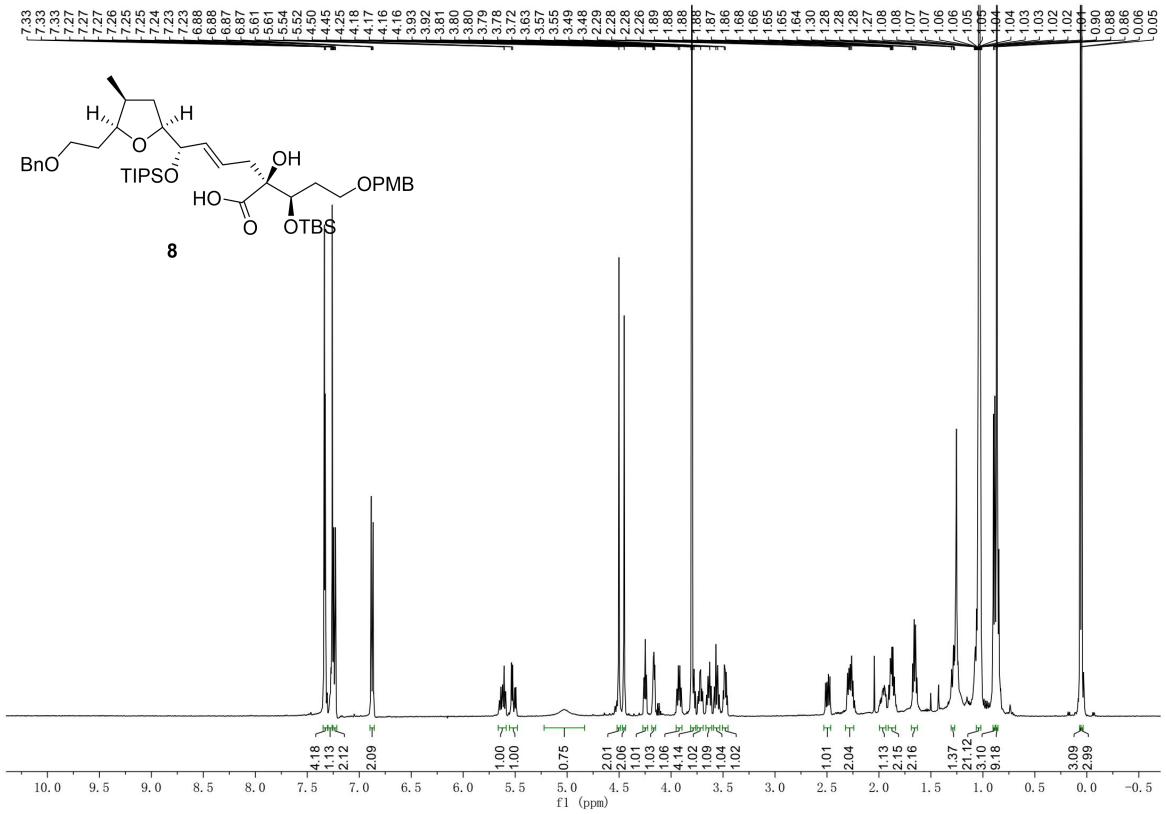

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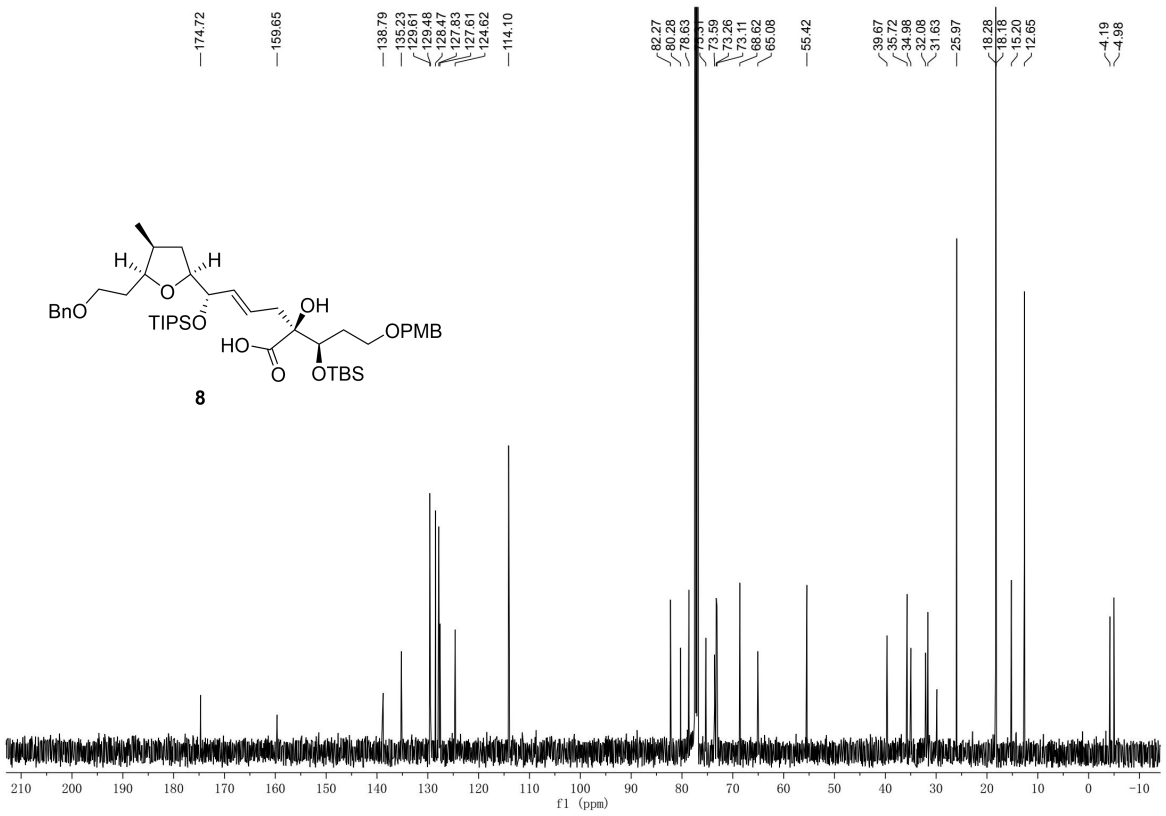

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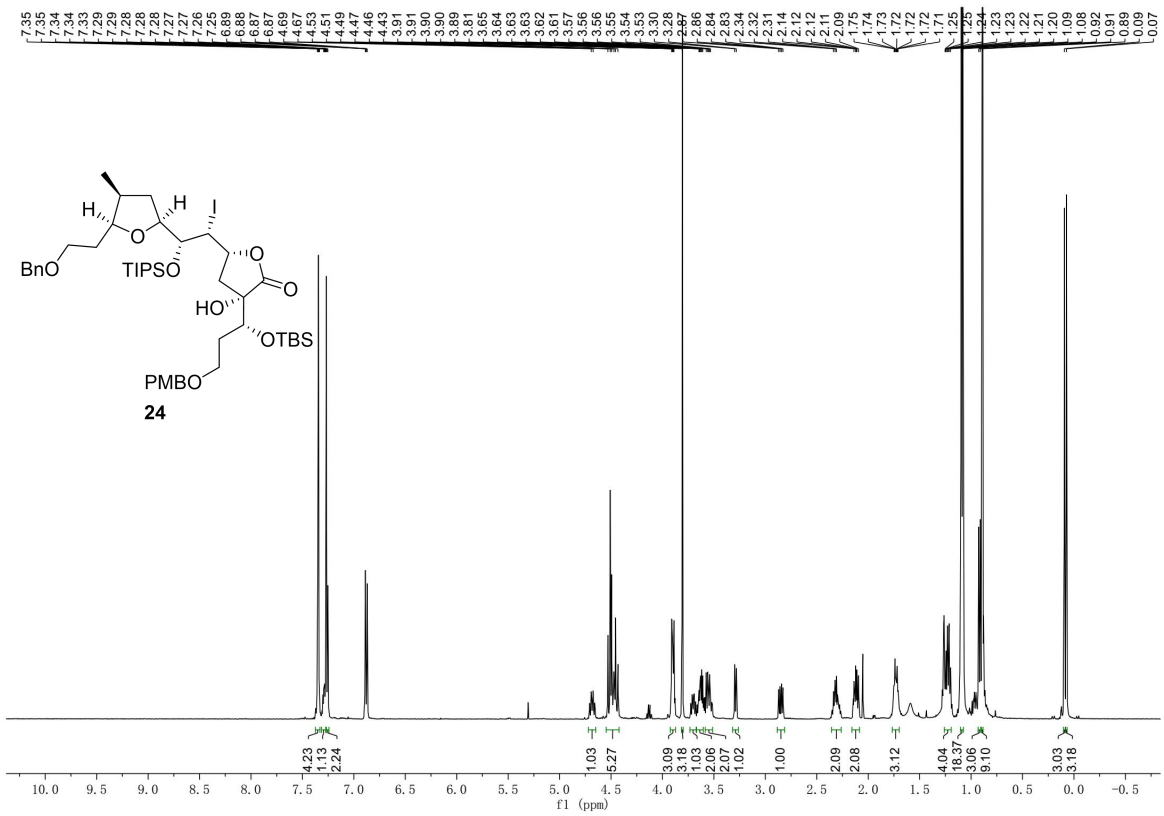
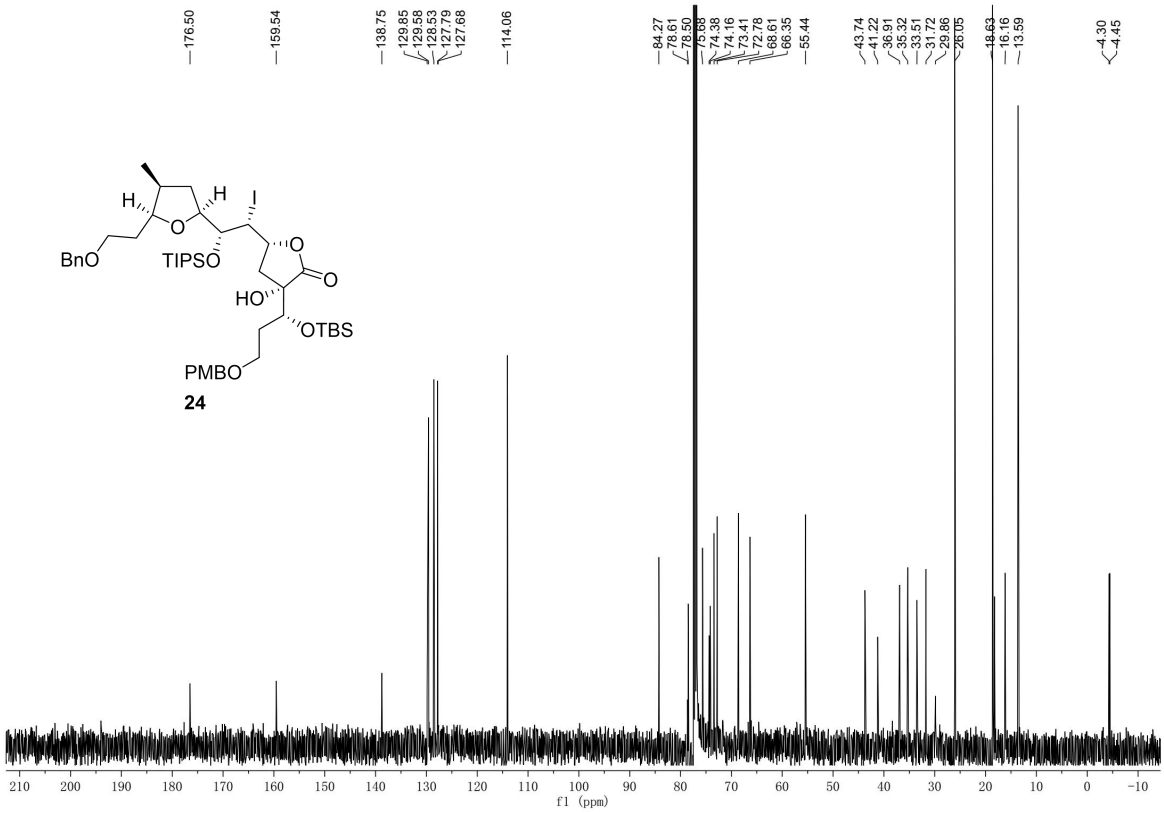
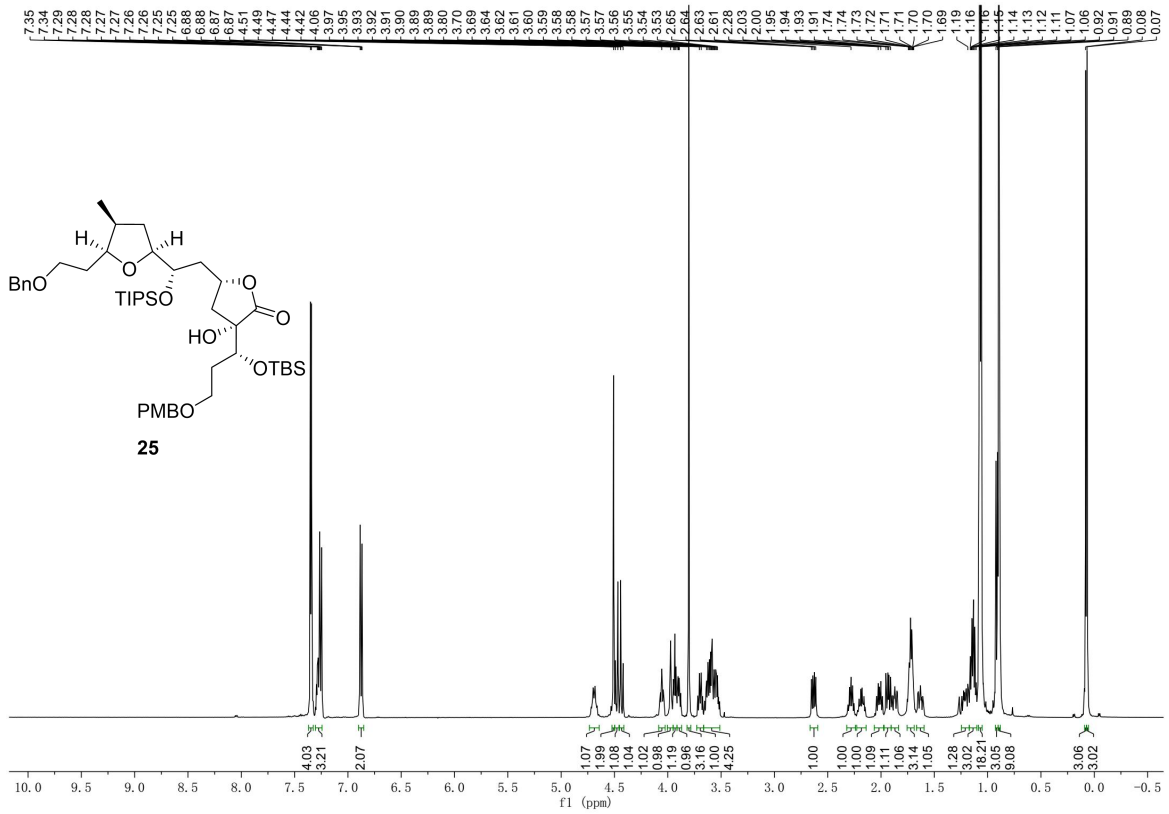


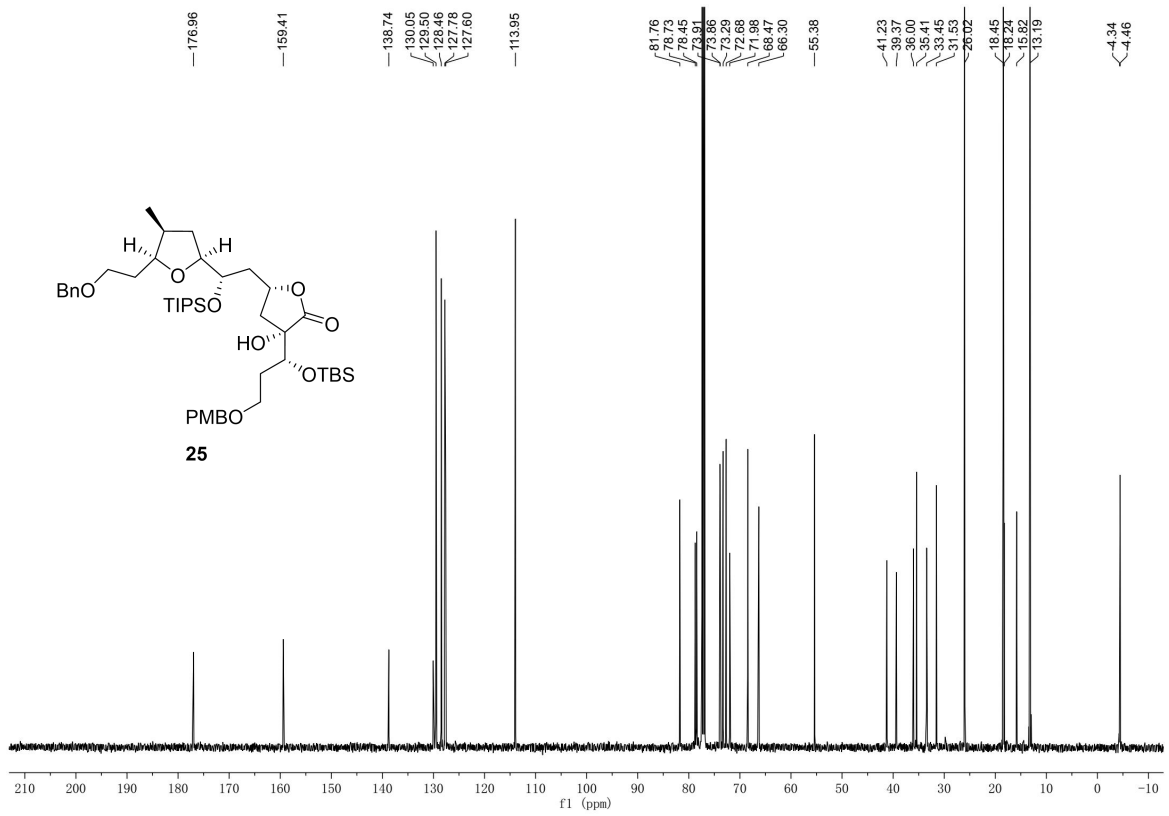
^{13}C NMR ($CDCl_3$, 126M)



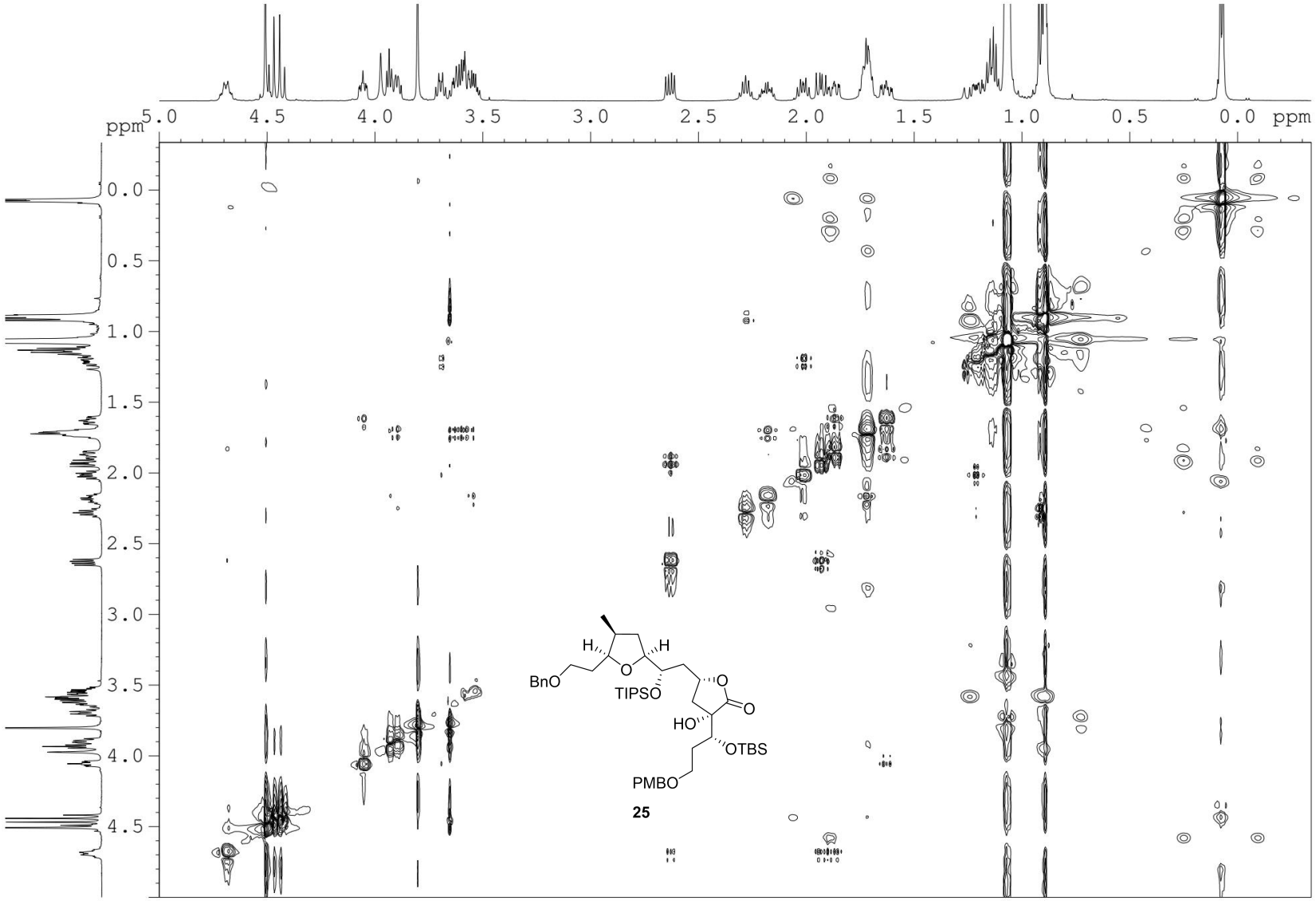
^{1}H NMR ($CDCl_3$, 500M)



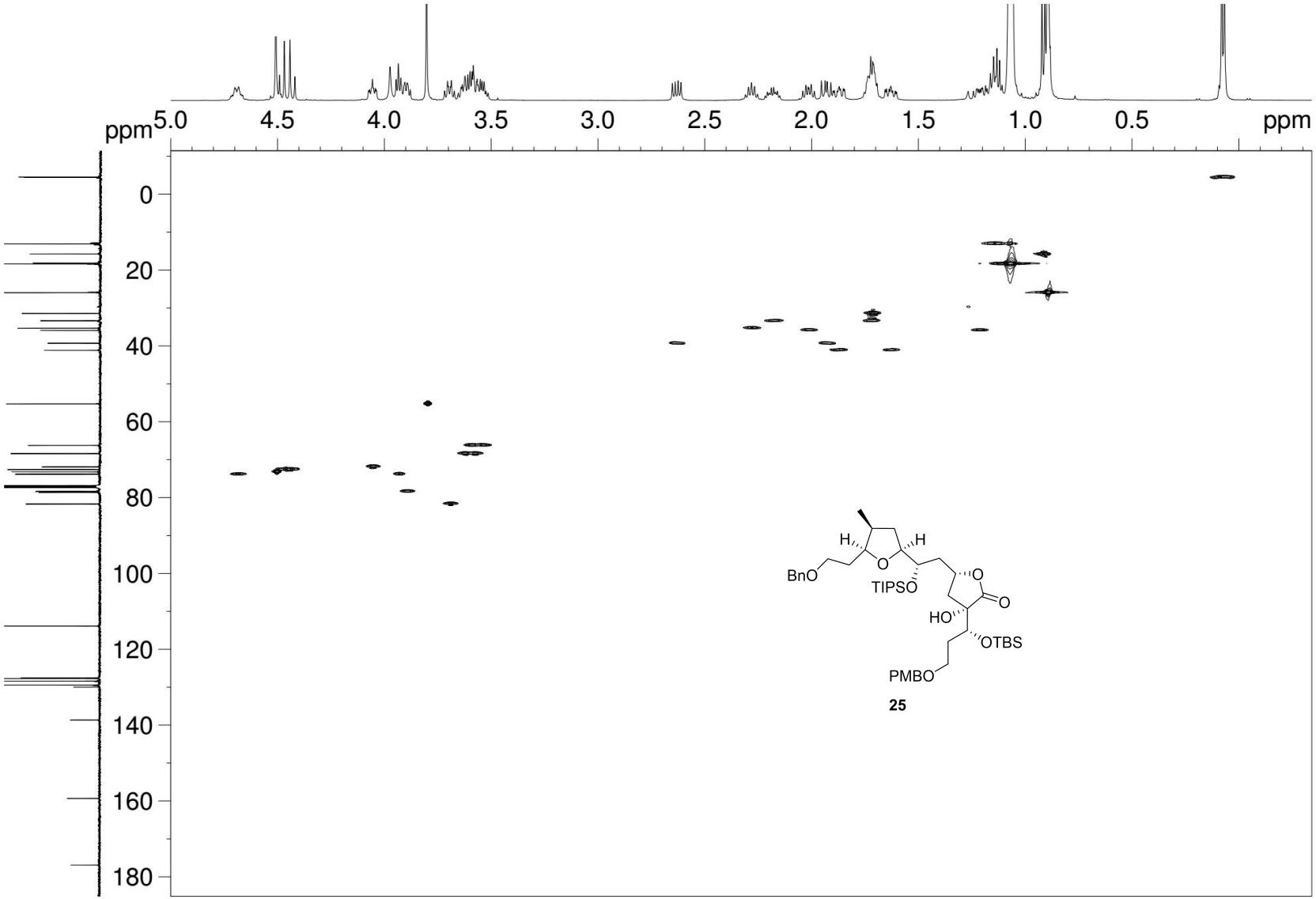
^{13}C NMR ($CDCl_3$, 126M)



COSY ($CDCl_3$, 500M)



HSQC ($CDCl_3$, 500M)



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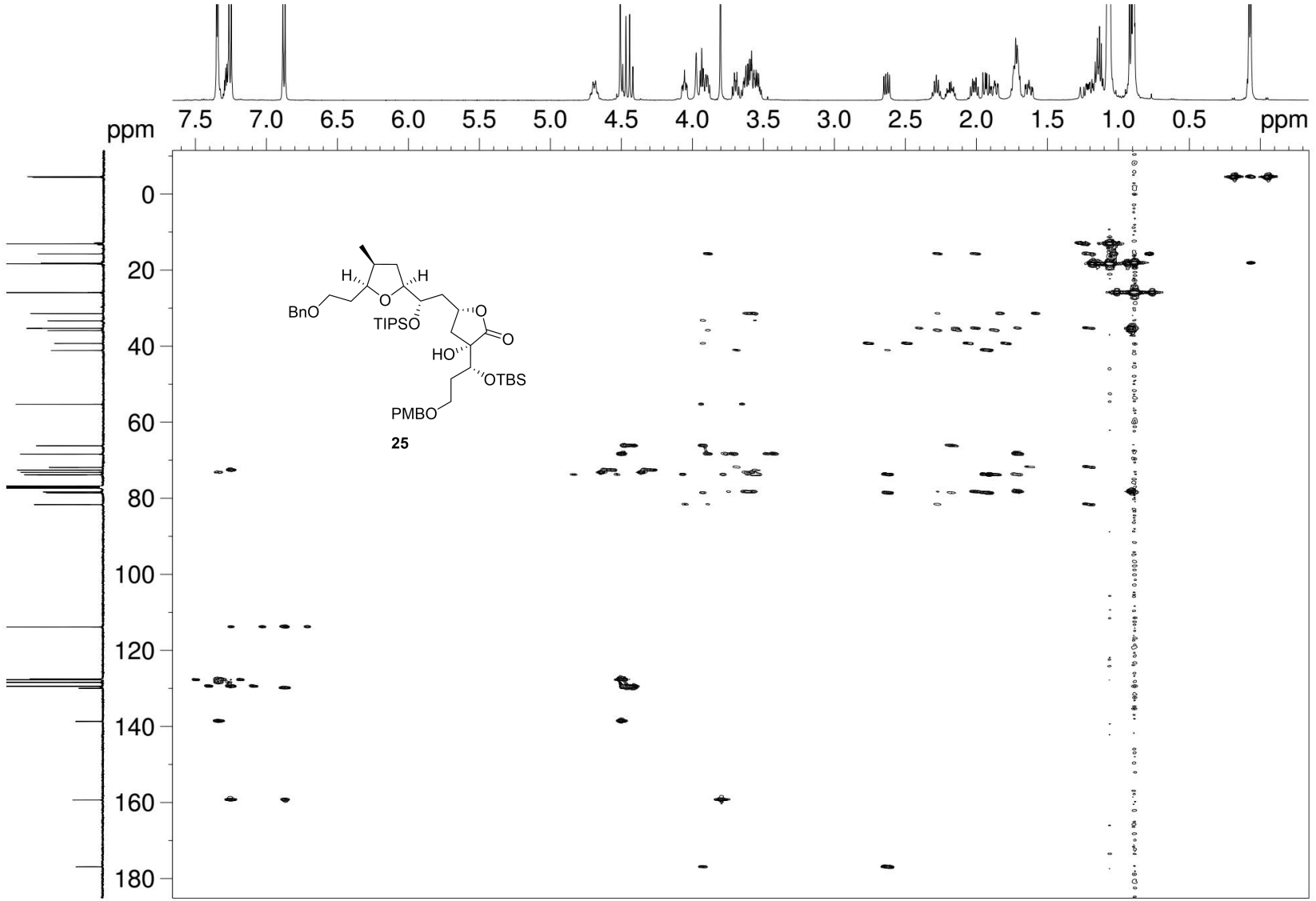
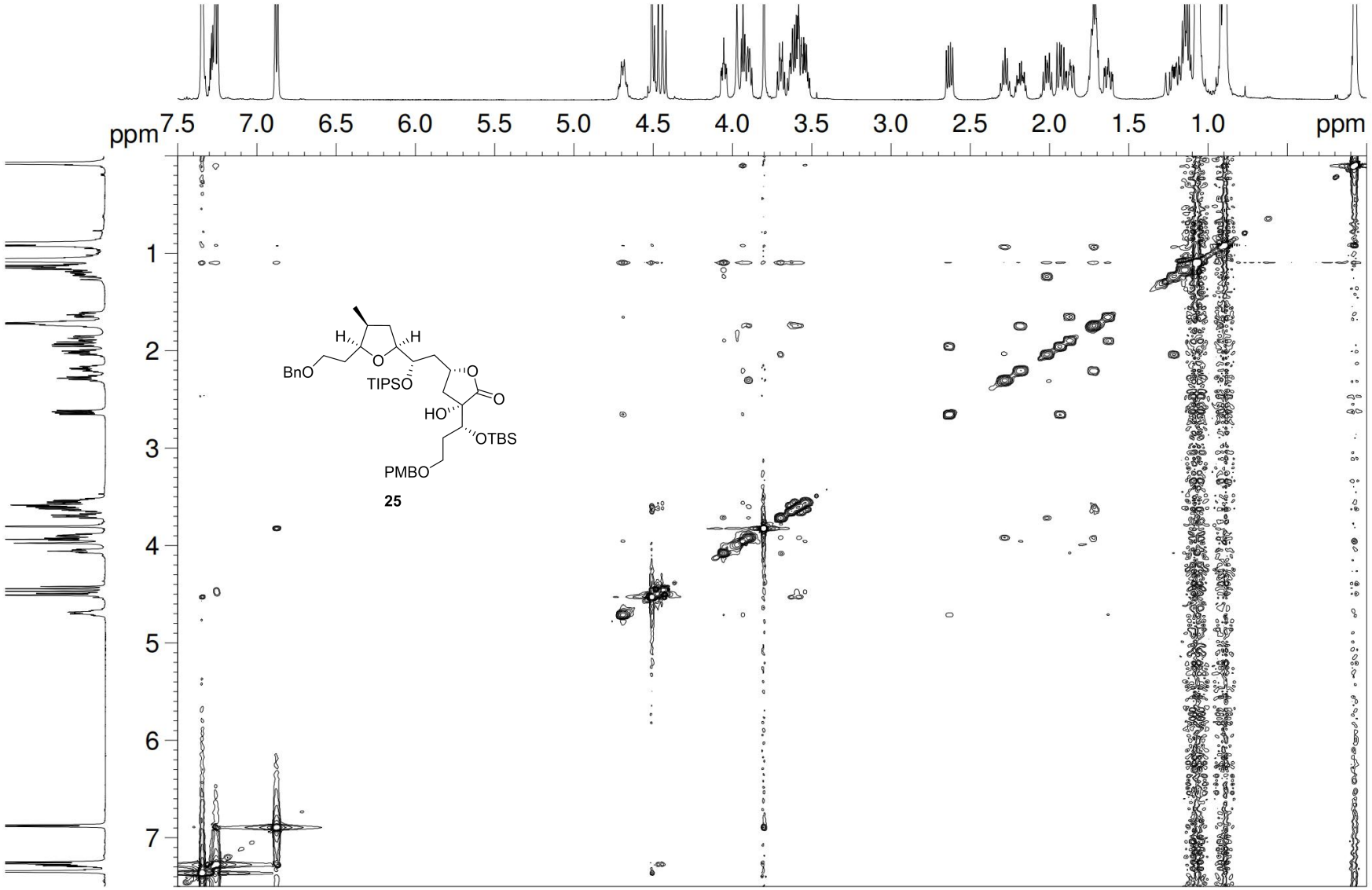
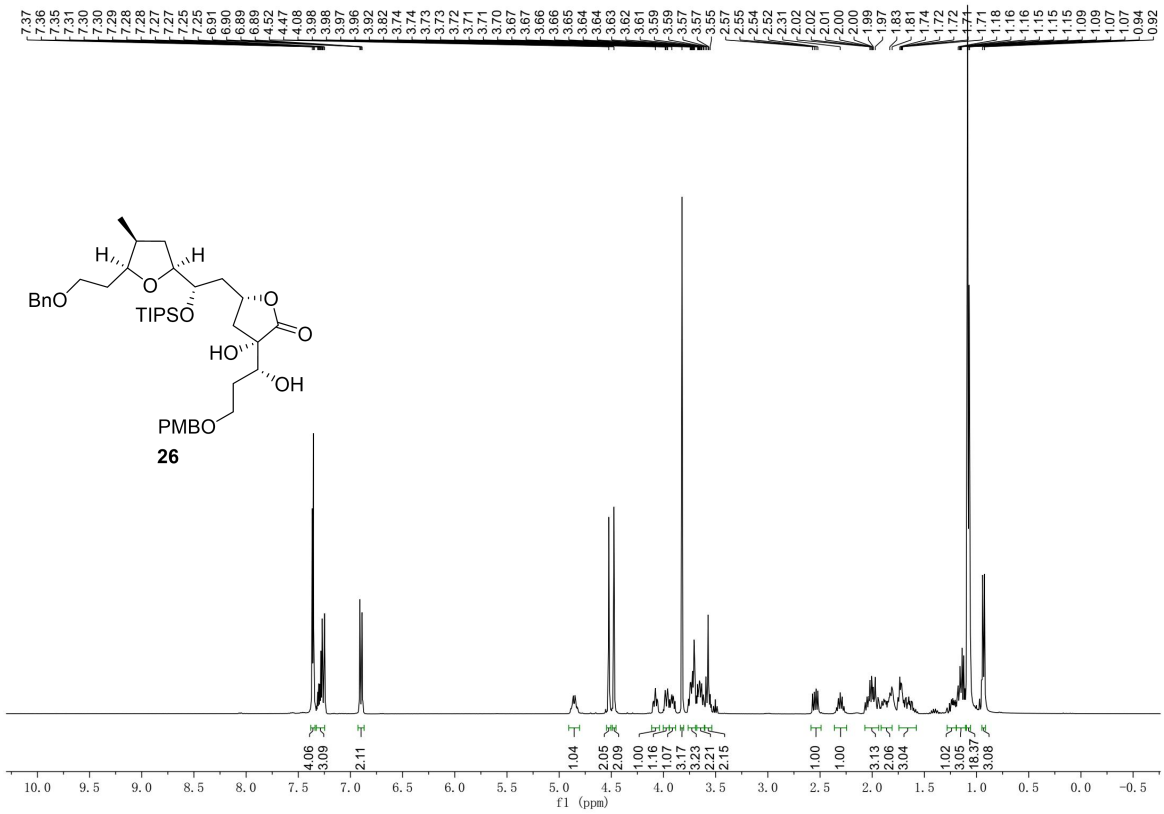


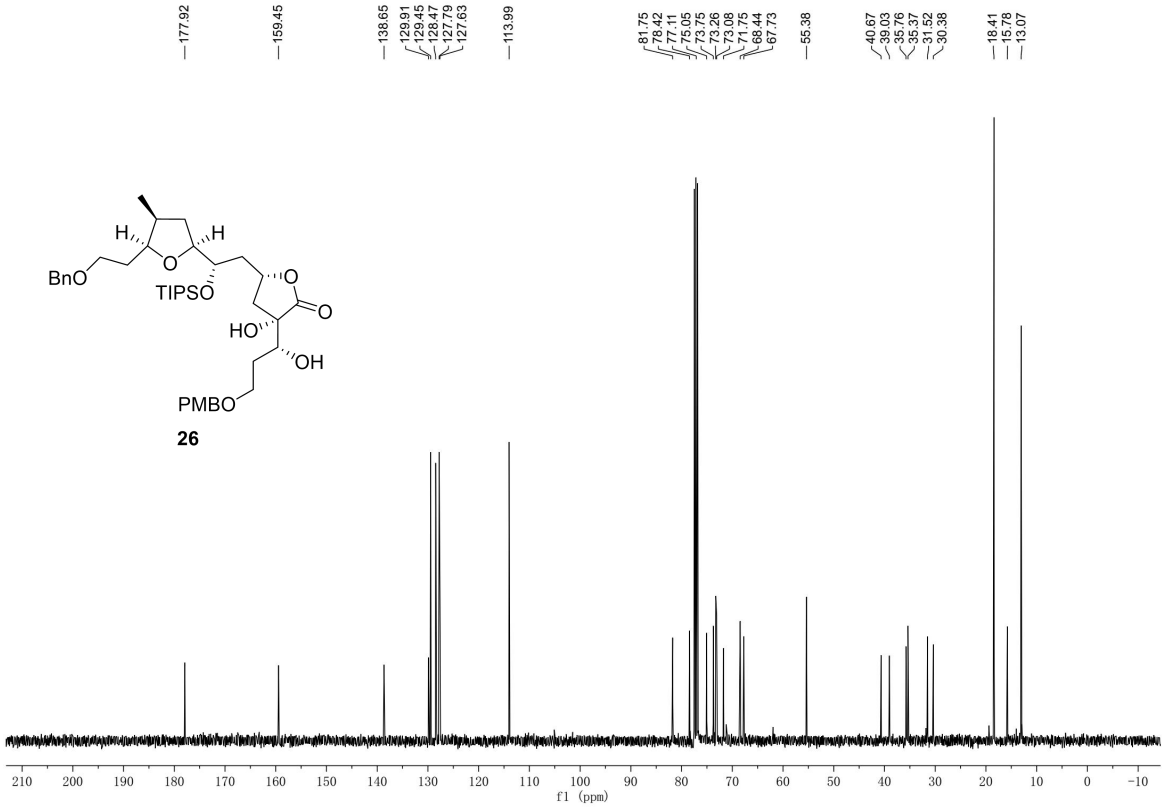
NOESY ($CDCl_3$, 500M)



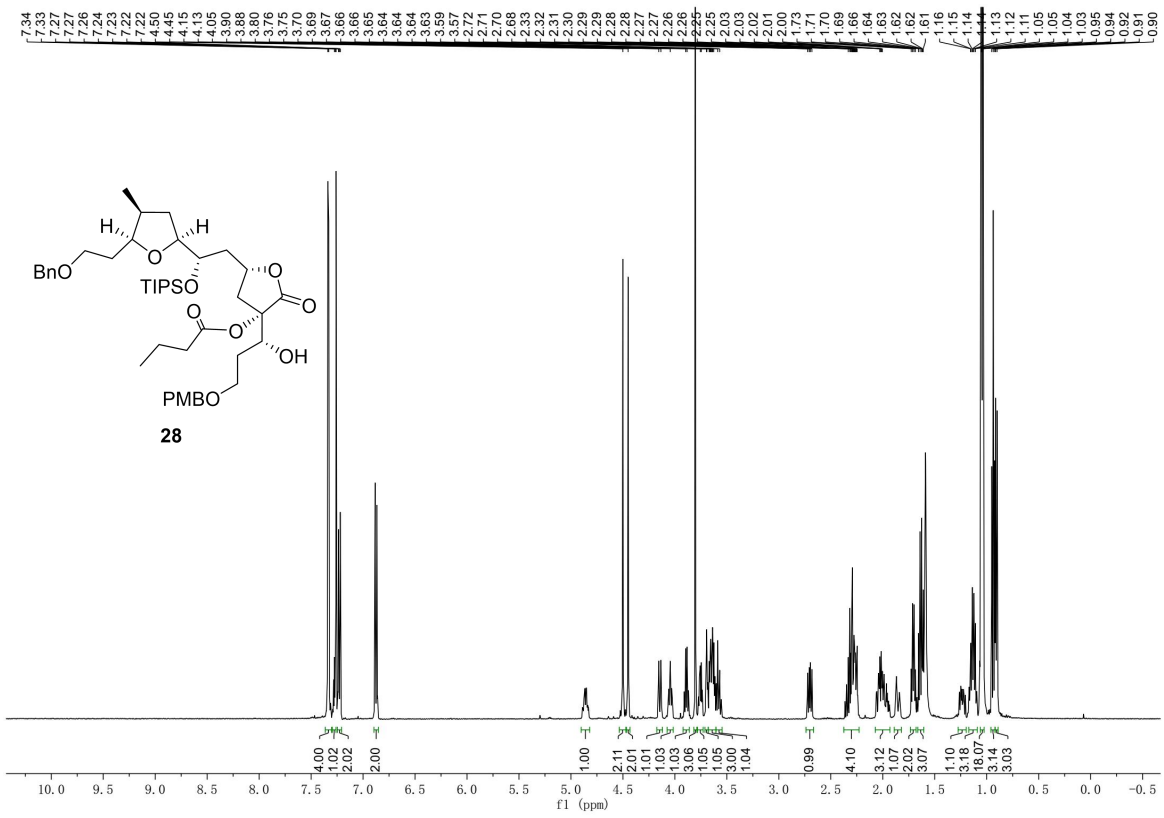
^{1}H NMR ($CDCl_3$, 400M)



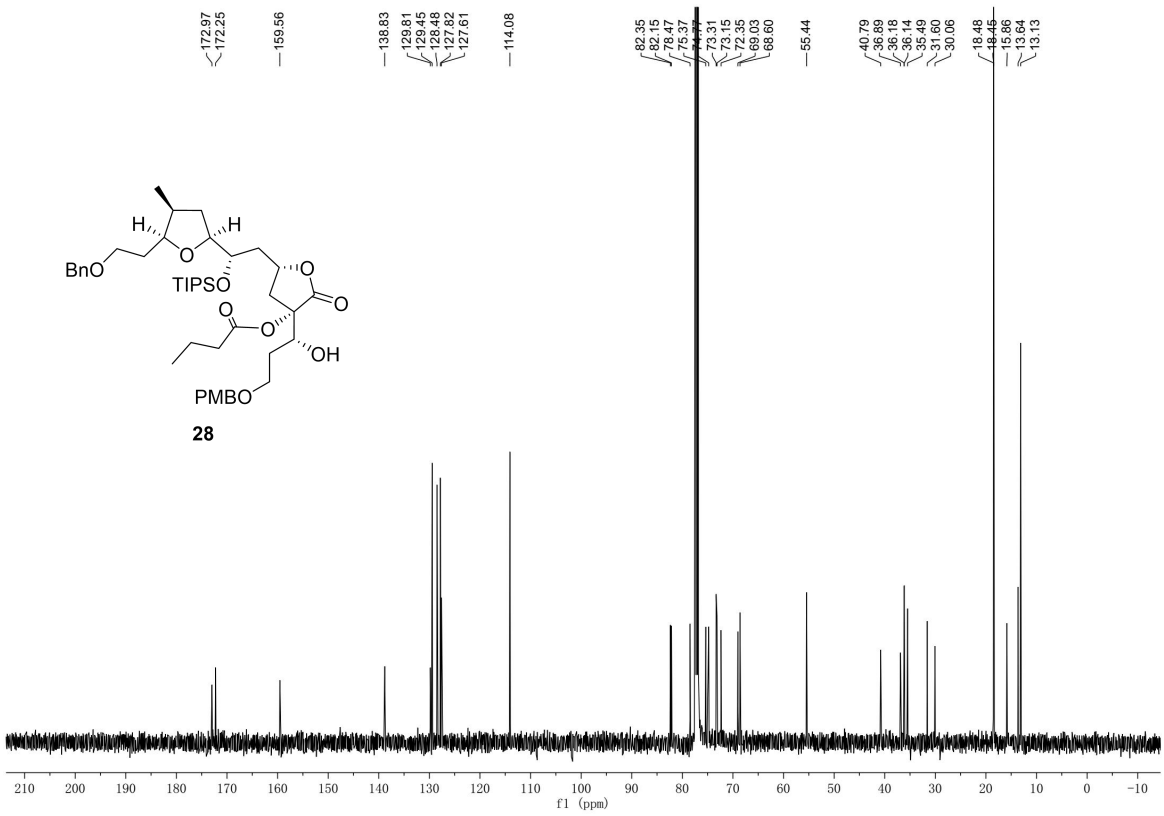
^{13}C NMR ($CDCl_3$, 101M)



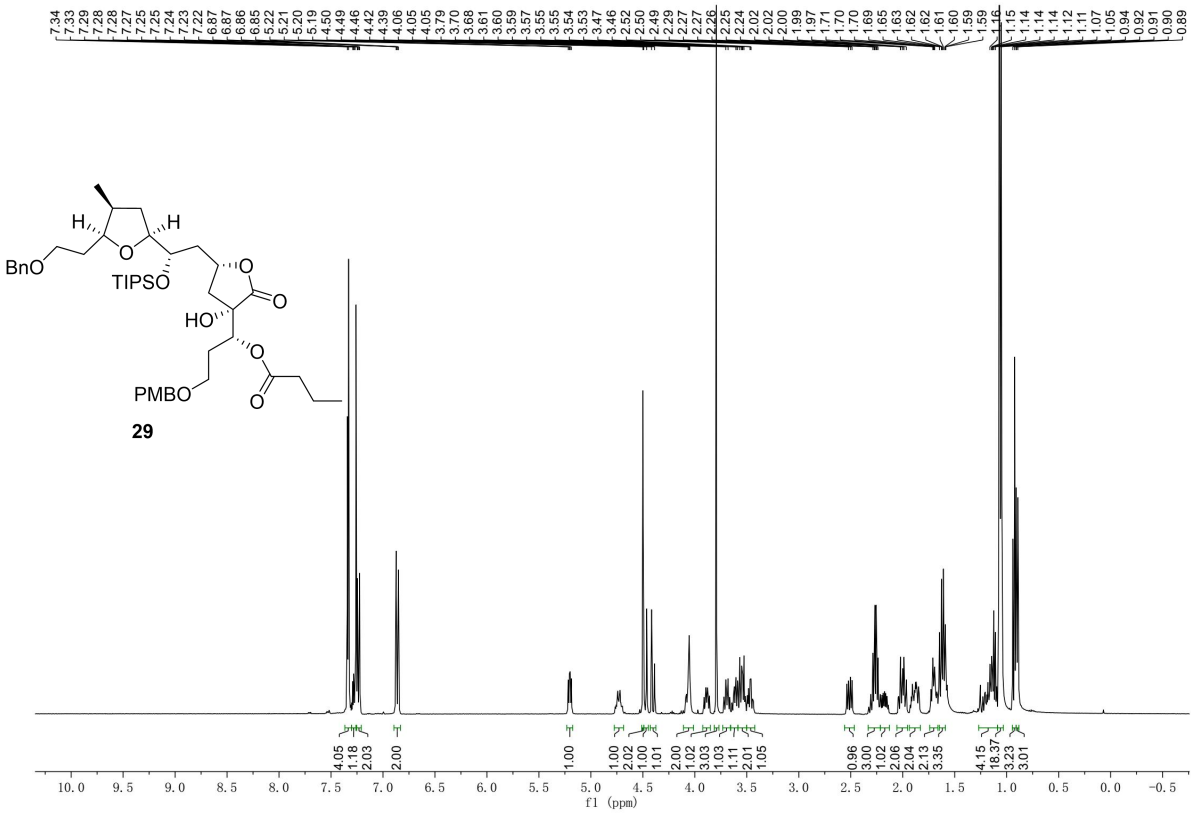
^{1}H NMR ($CDCl_3$, 500M)



^{13}C NMR ($CDCl_3$, 126M)



^{1}H NMR ($CDCl_3$, 400M)



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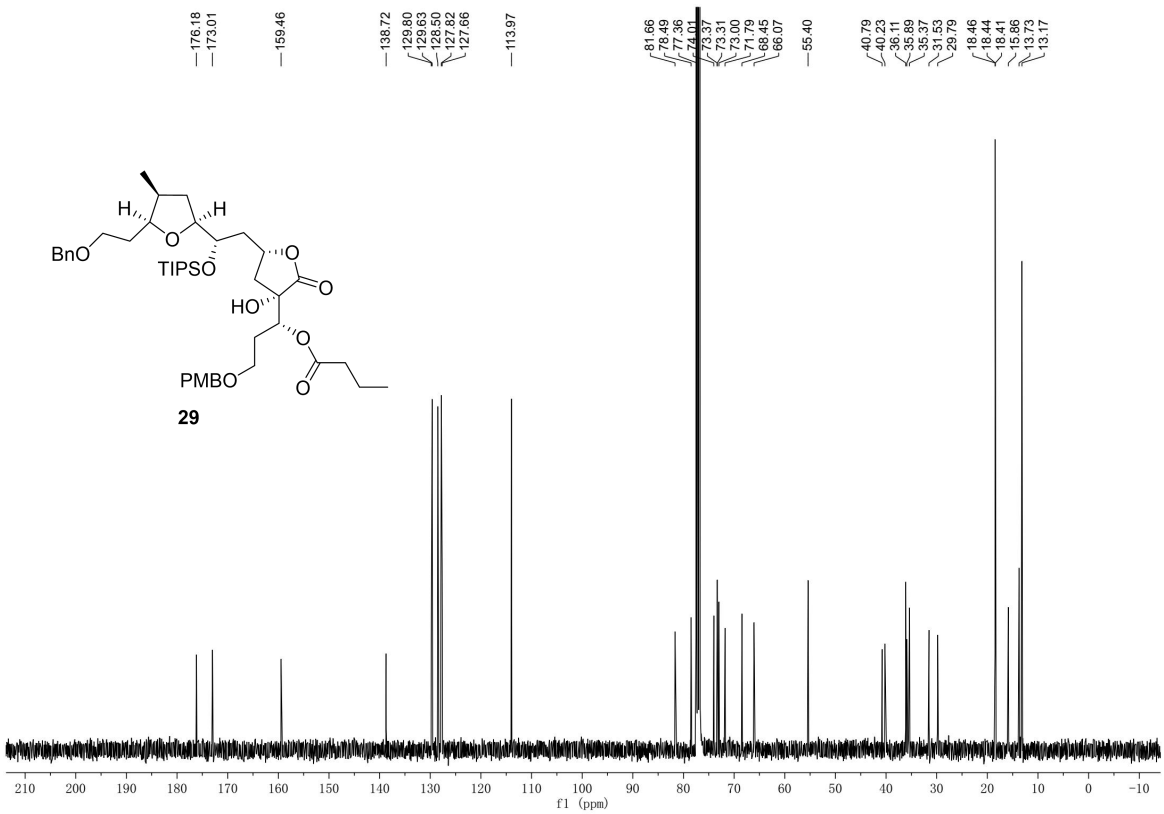

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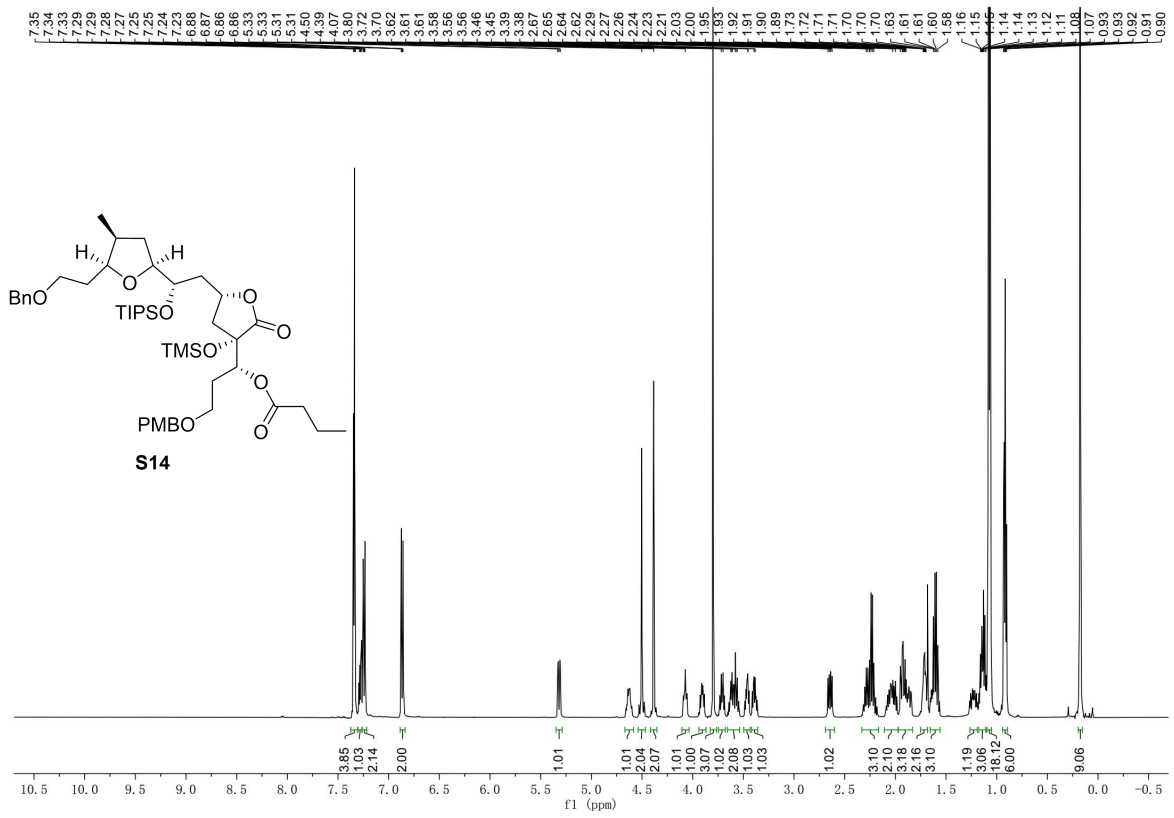
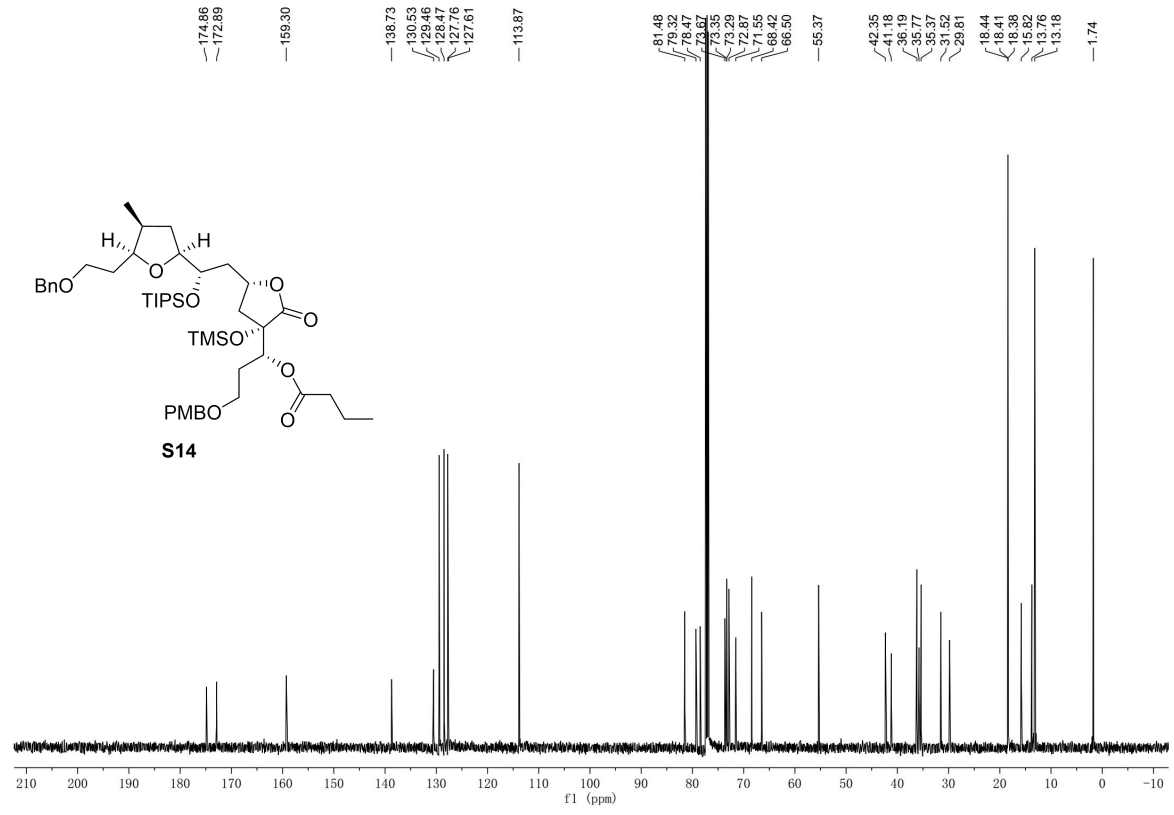


^{13}C NMR ($CDCl_3$, 126 M)



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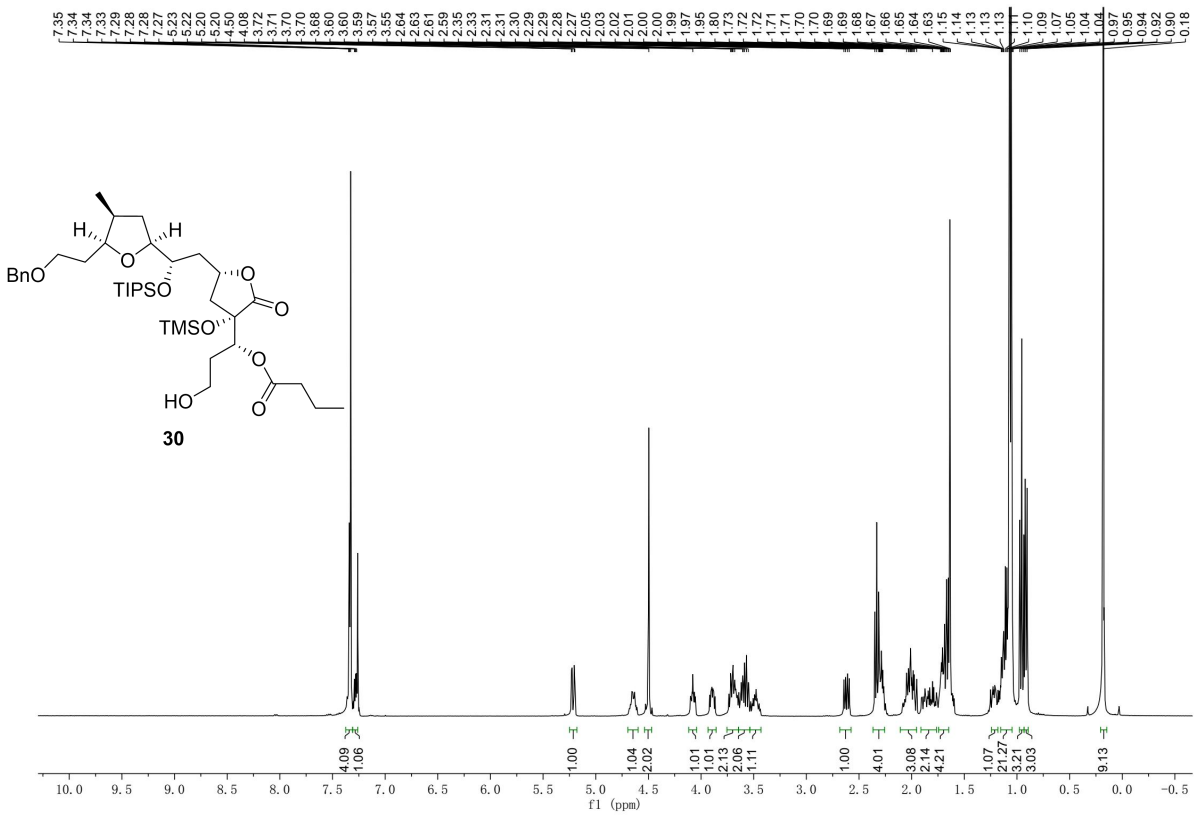
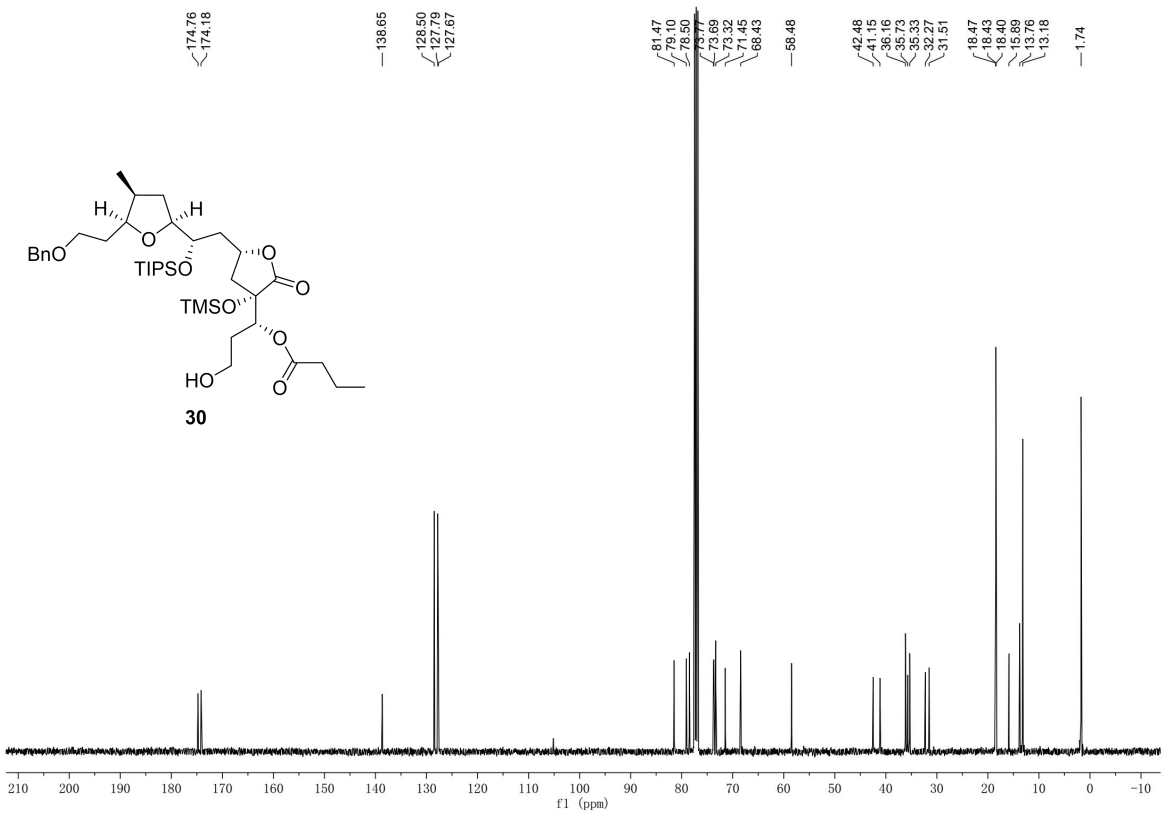


^{13}C NMR ($CDCl_3$, 101 M)



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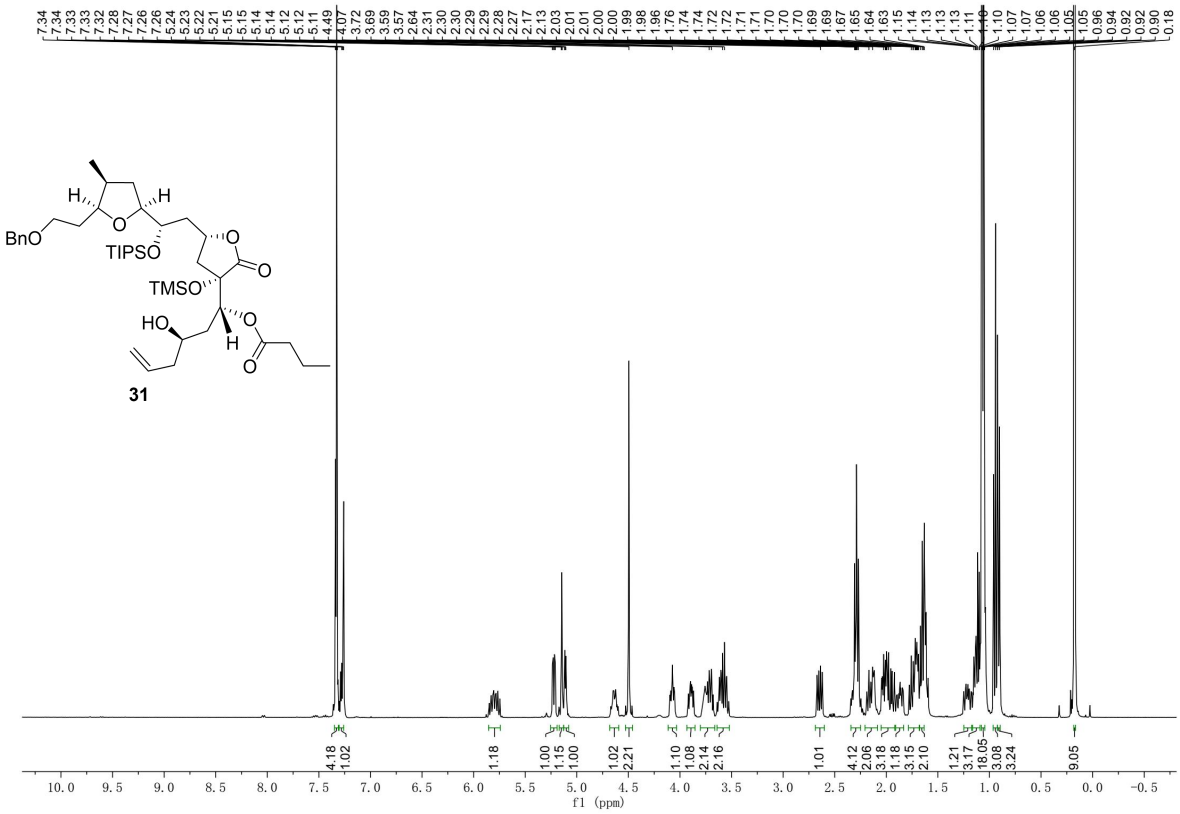
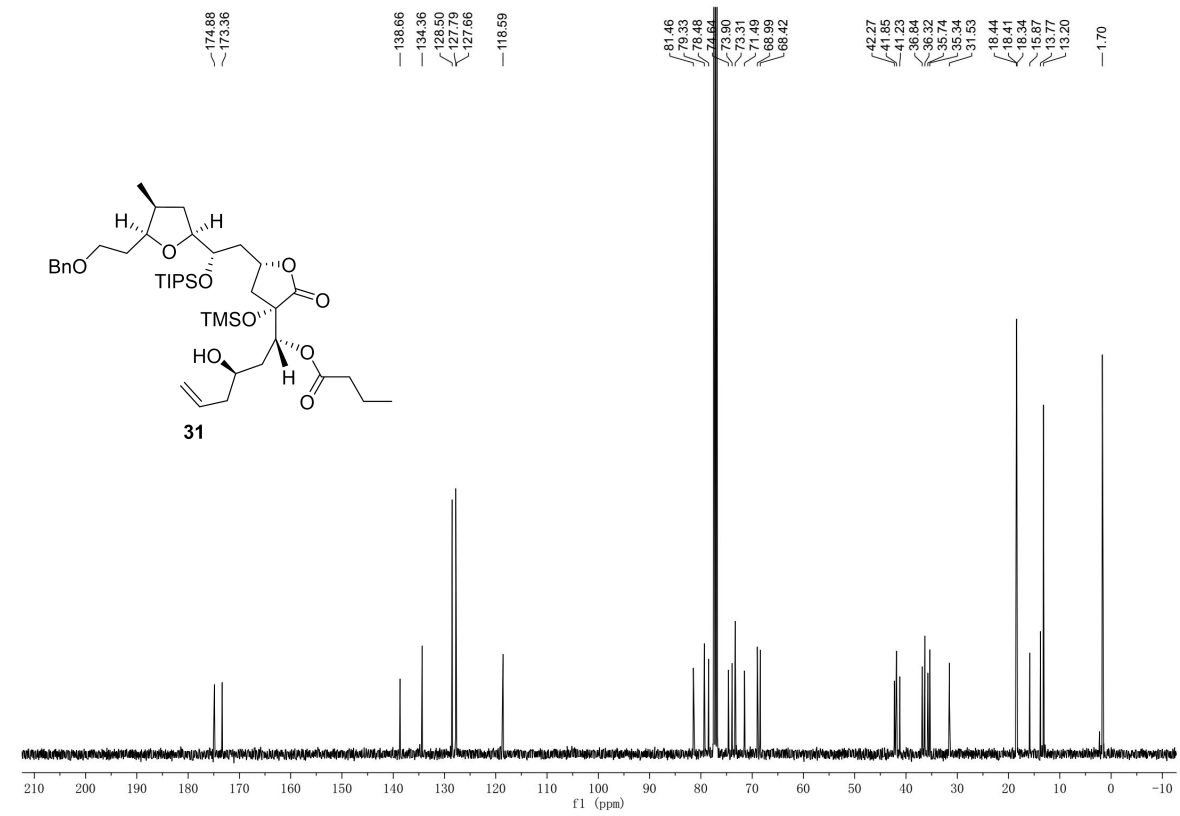
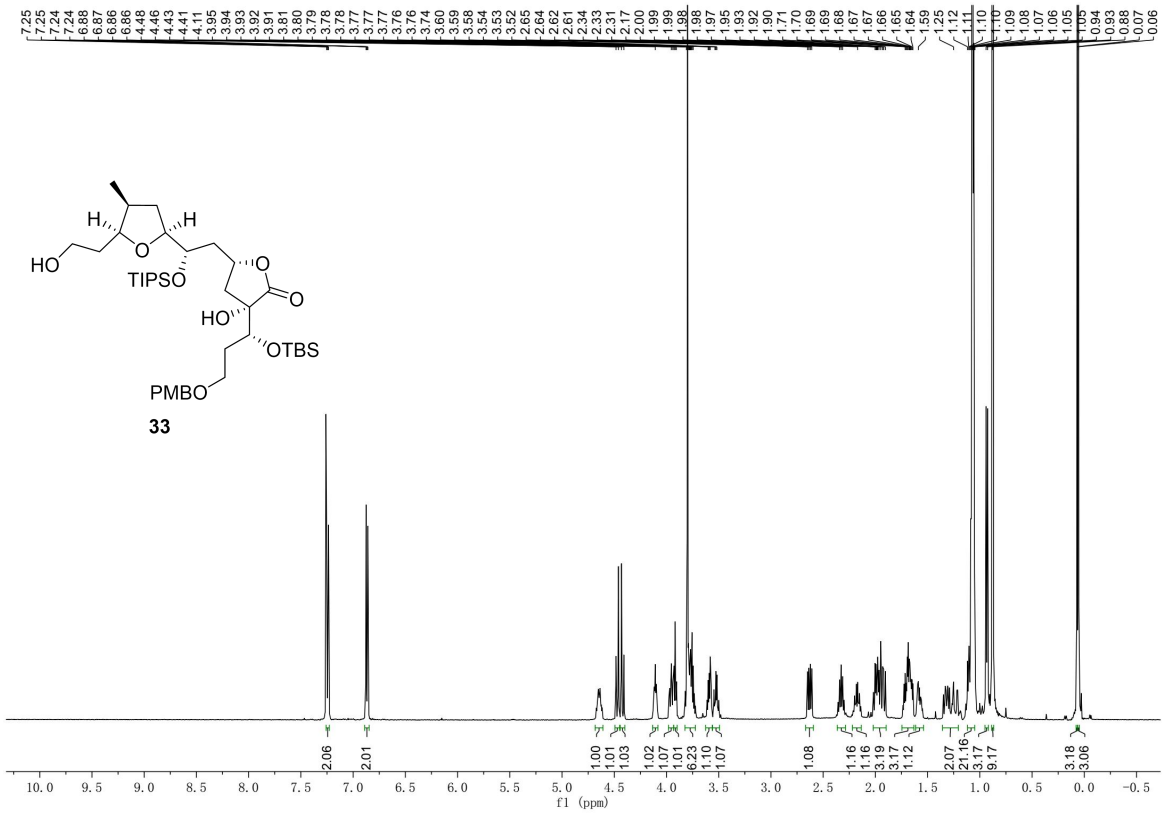


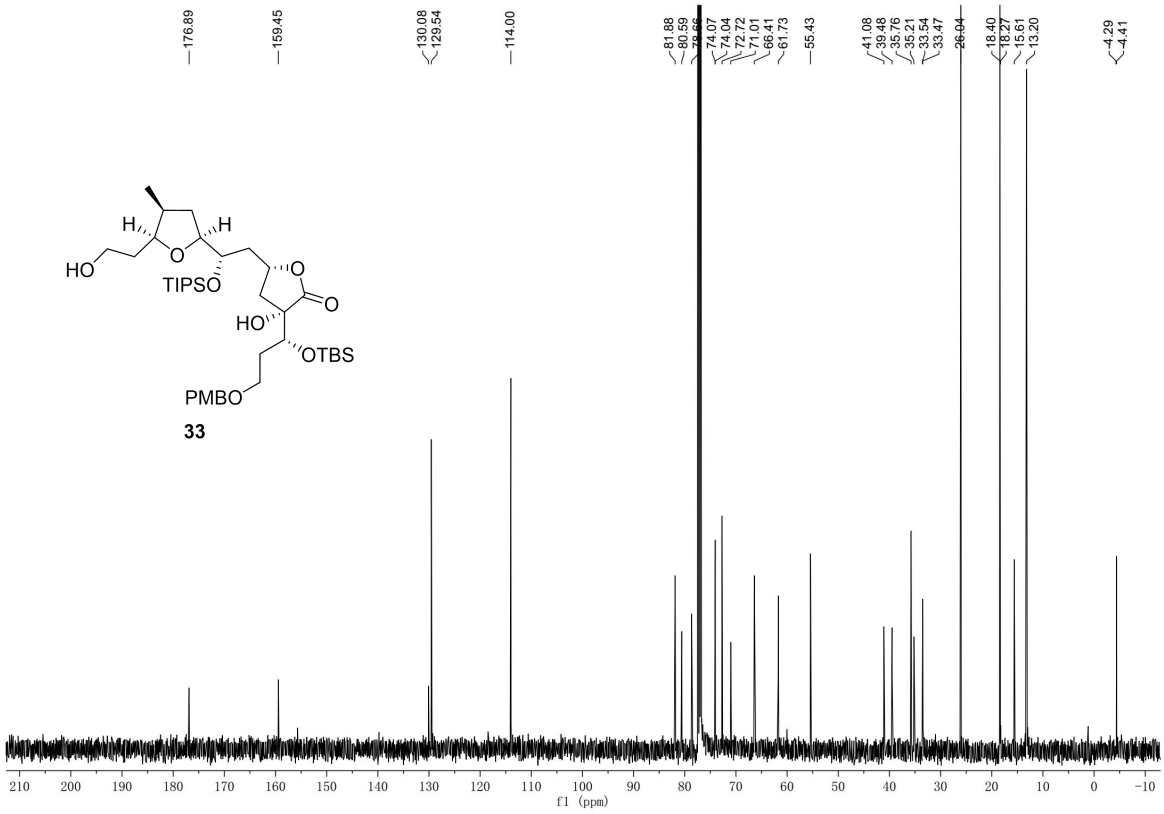
^{13}C NMR ($CDCl_3$, 101 M)



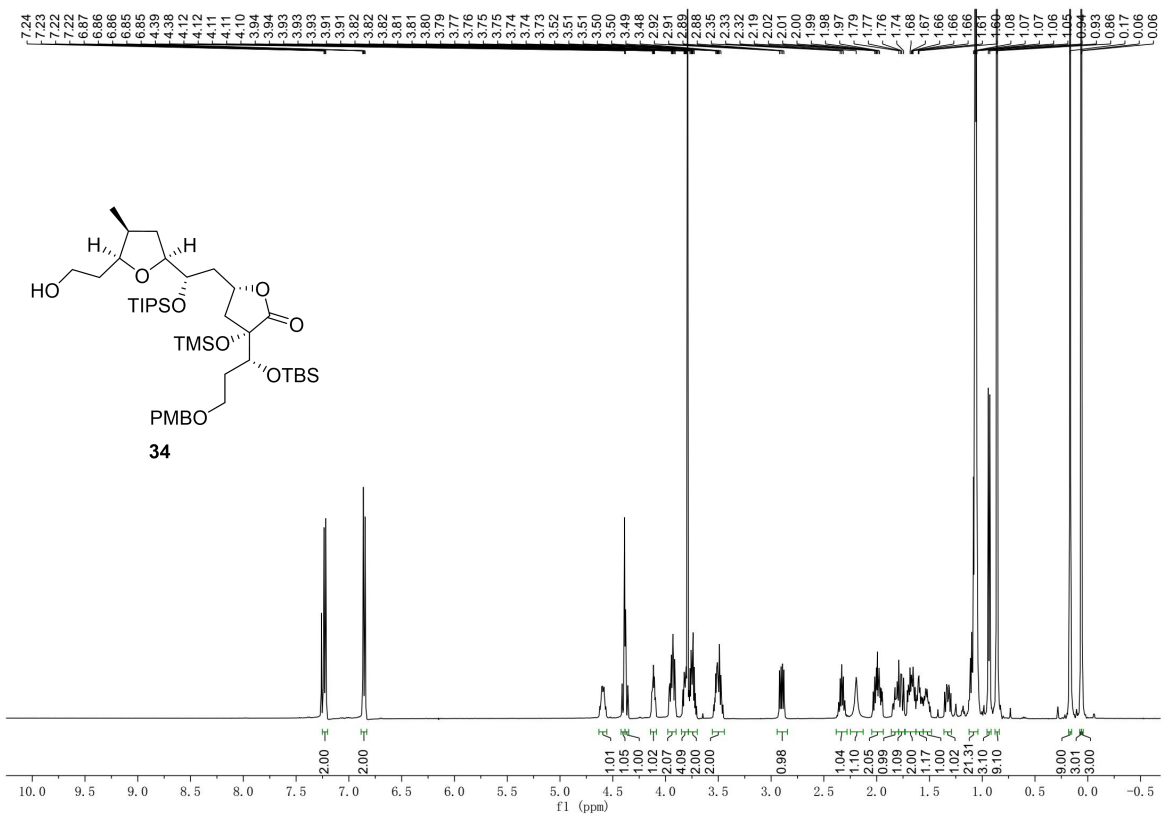
^{1}H NMR ($CDCl_3$, 500M)



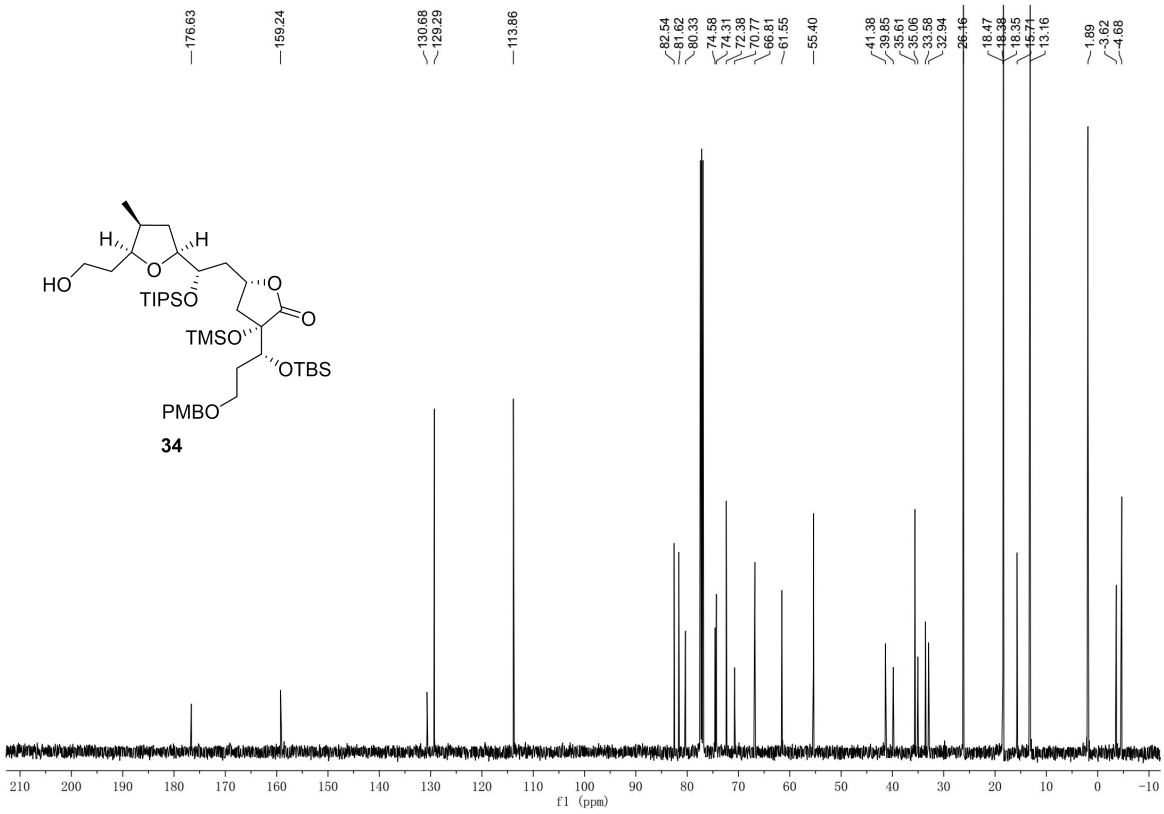
^{13}C NMR ($CDCl_3$, 126 M)



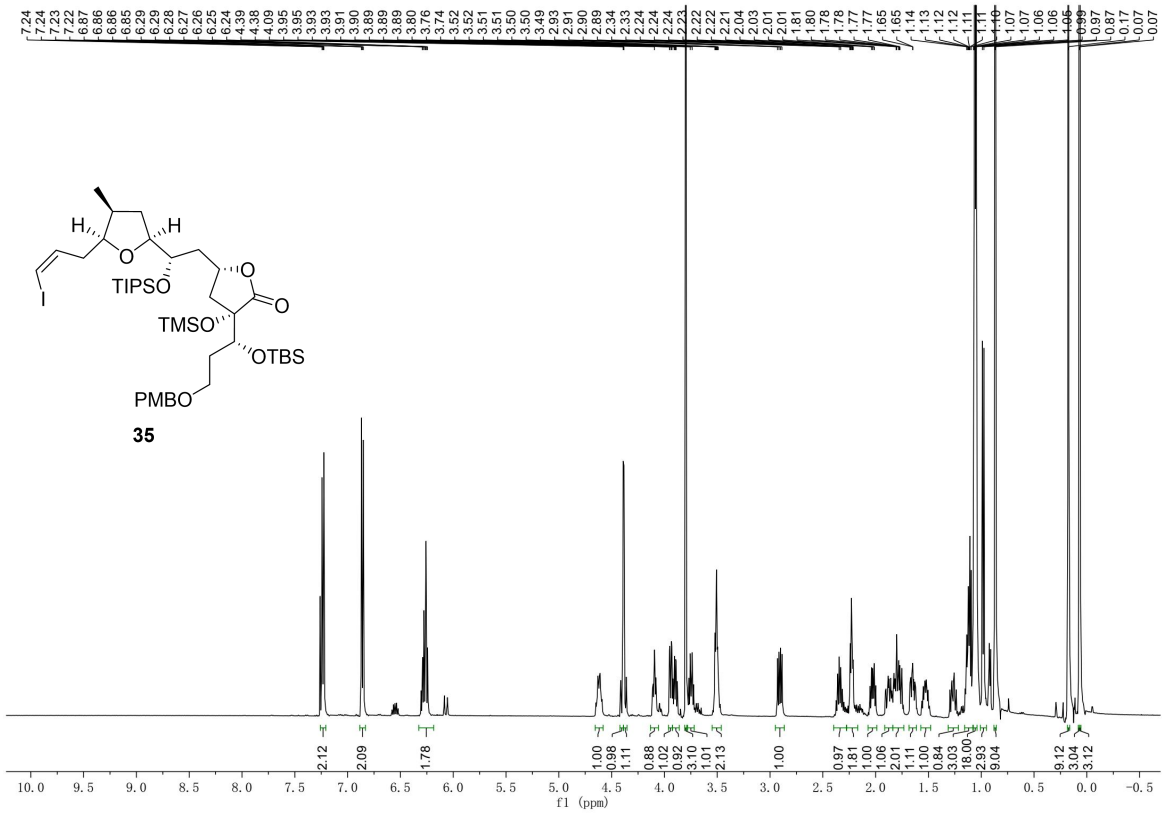
^{1}H NMR ($CDCl_3$, 500M)



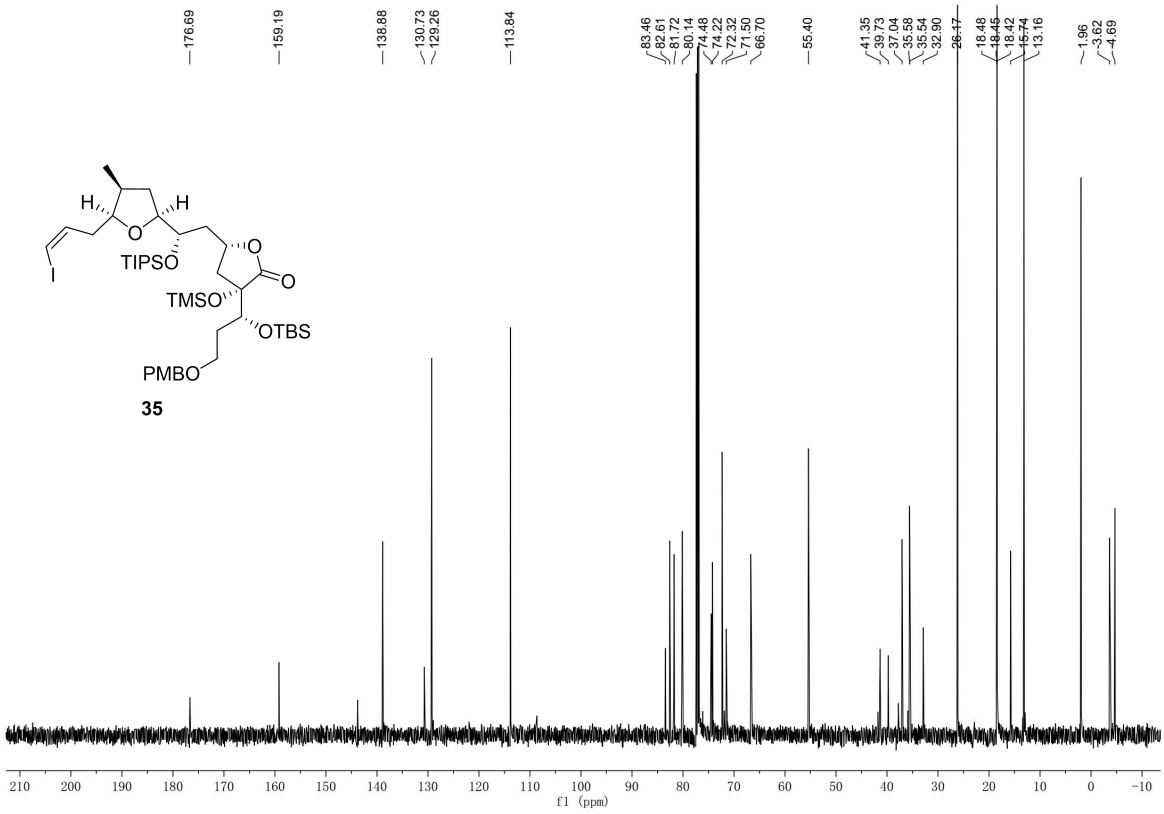
^{13}C NMR ($CDCl_3$, 126 M)



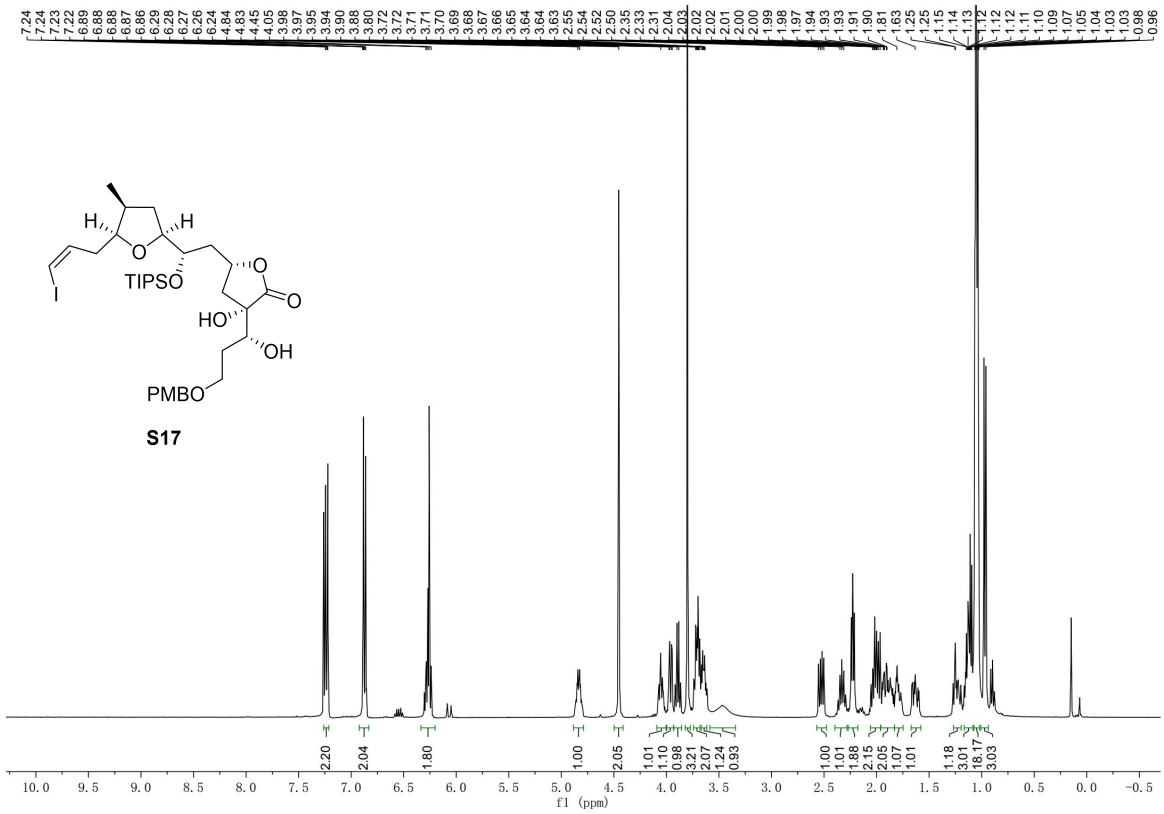
^{1}H NMR ($CDCl_3$, 500M)



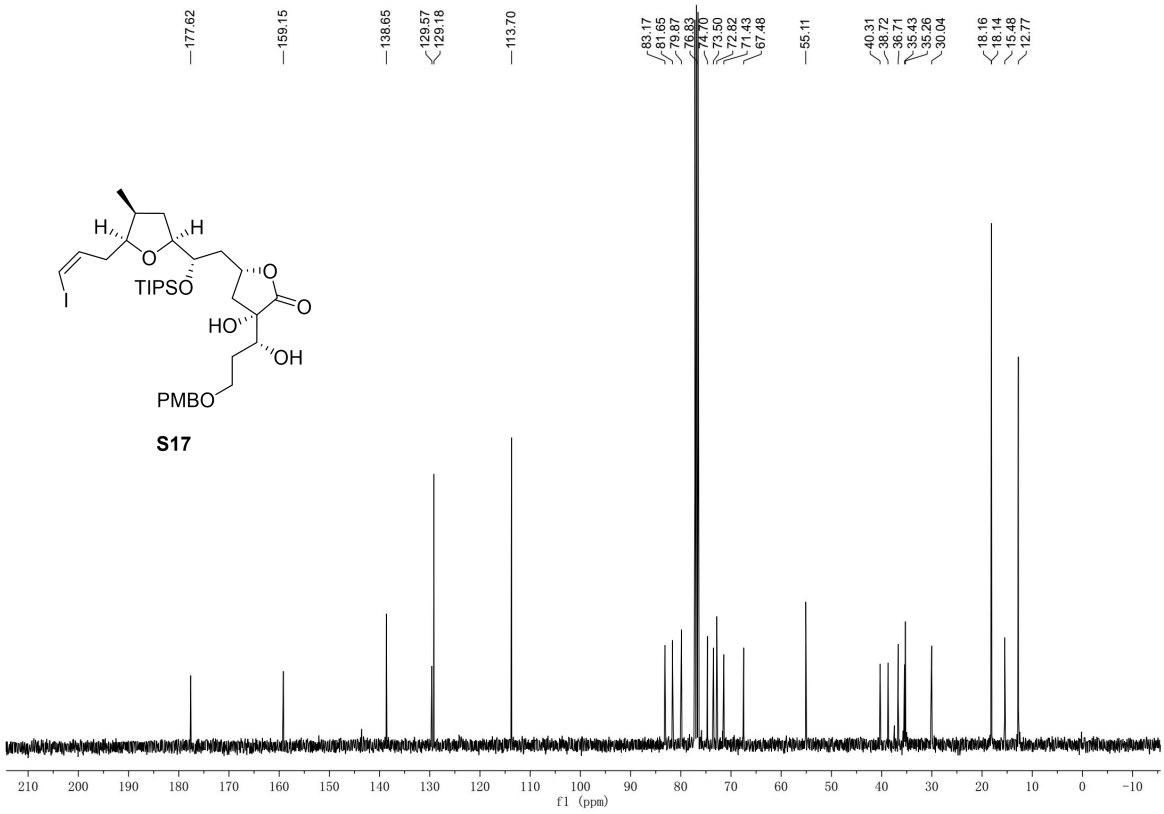
^{13}C NMR ($CDCl_3$, 126 M)



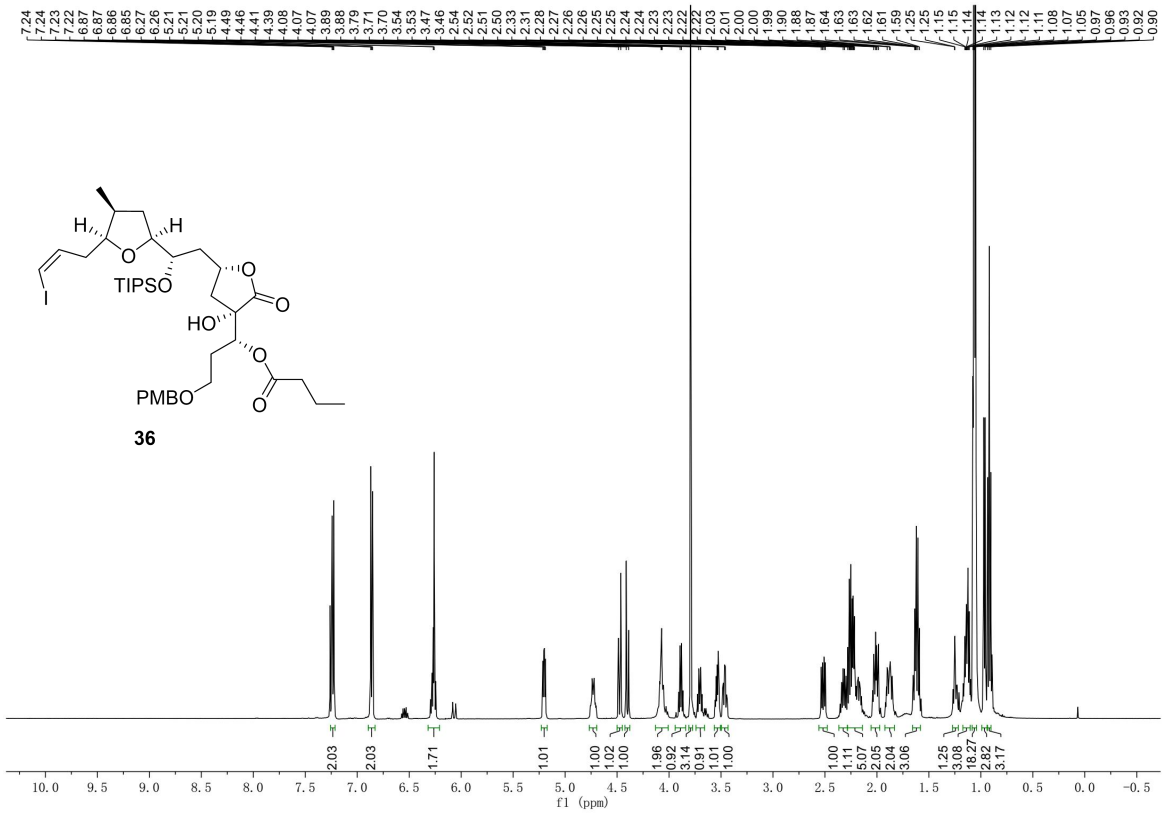
^{1}H NMR ($CDCl_3$, 400M)



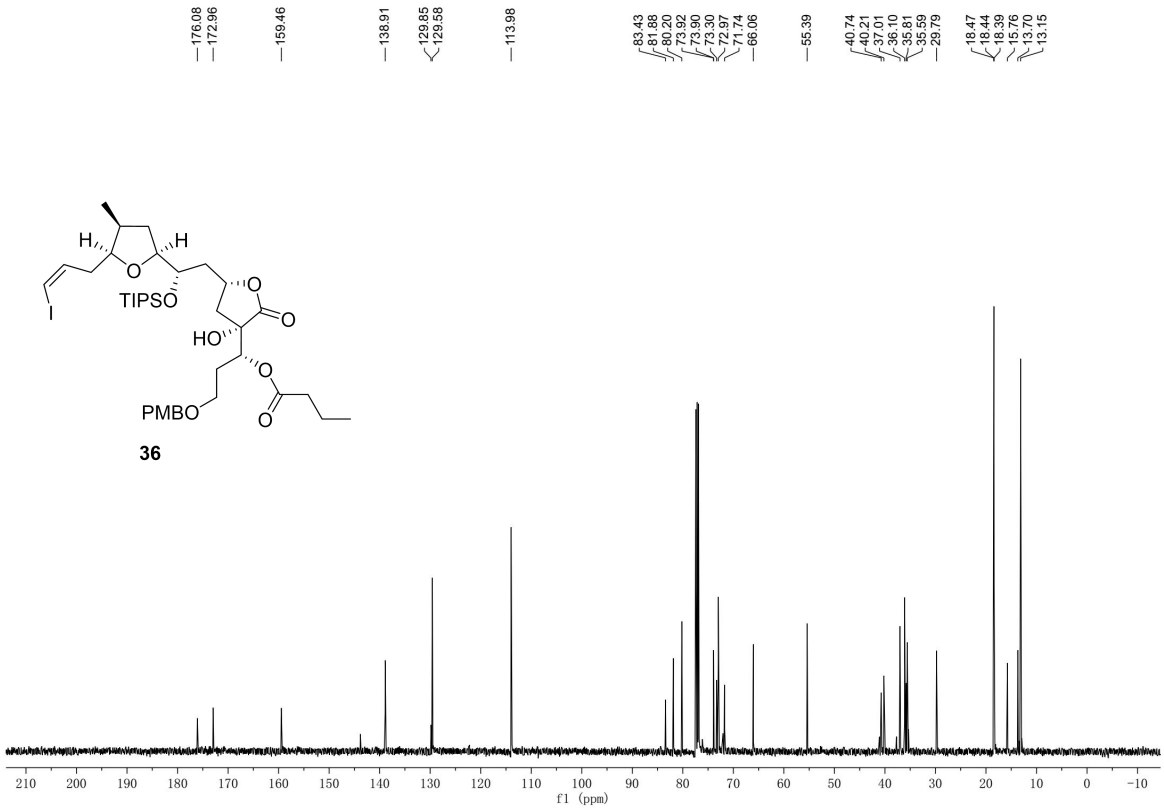
^{13}C NMR ($CDCl_3$, 101 M)



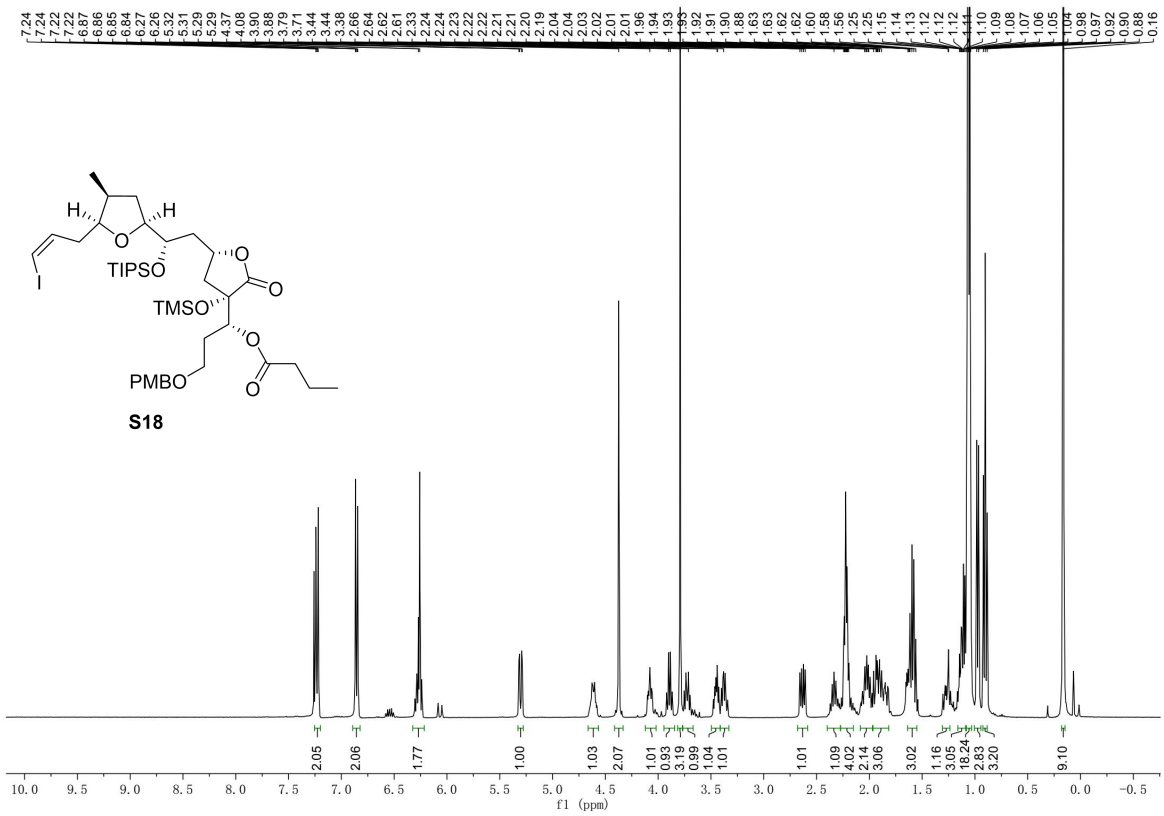
^{1}H NMR ($CDCl_3$, 500M)



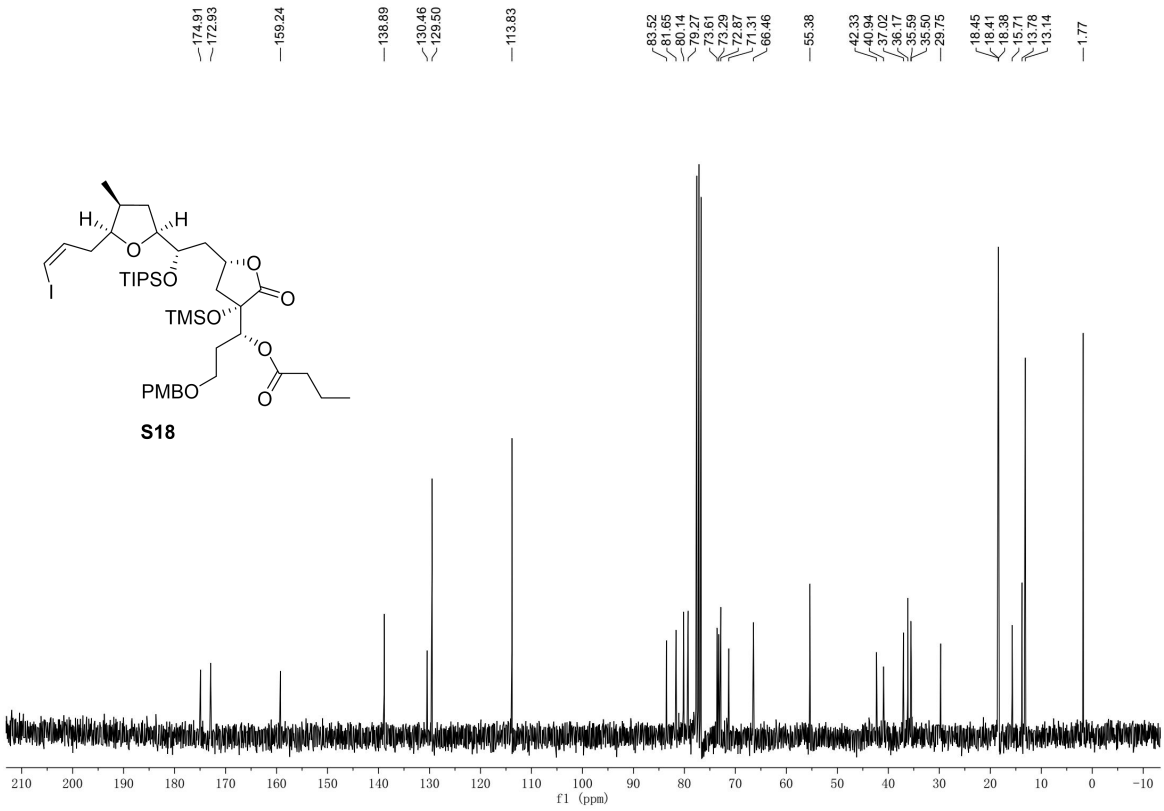
^{13}C NMR ($CDCl_3$, 126 M)



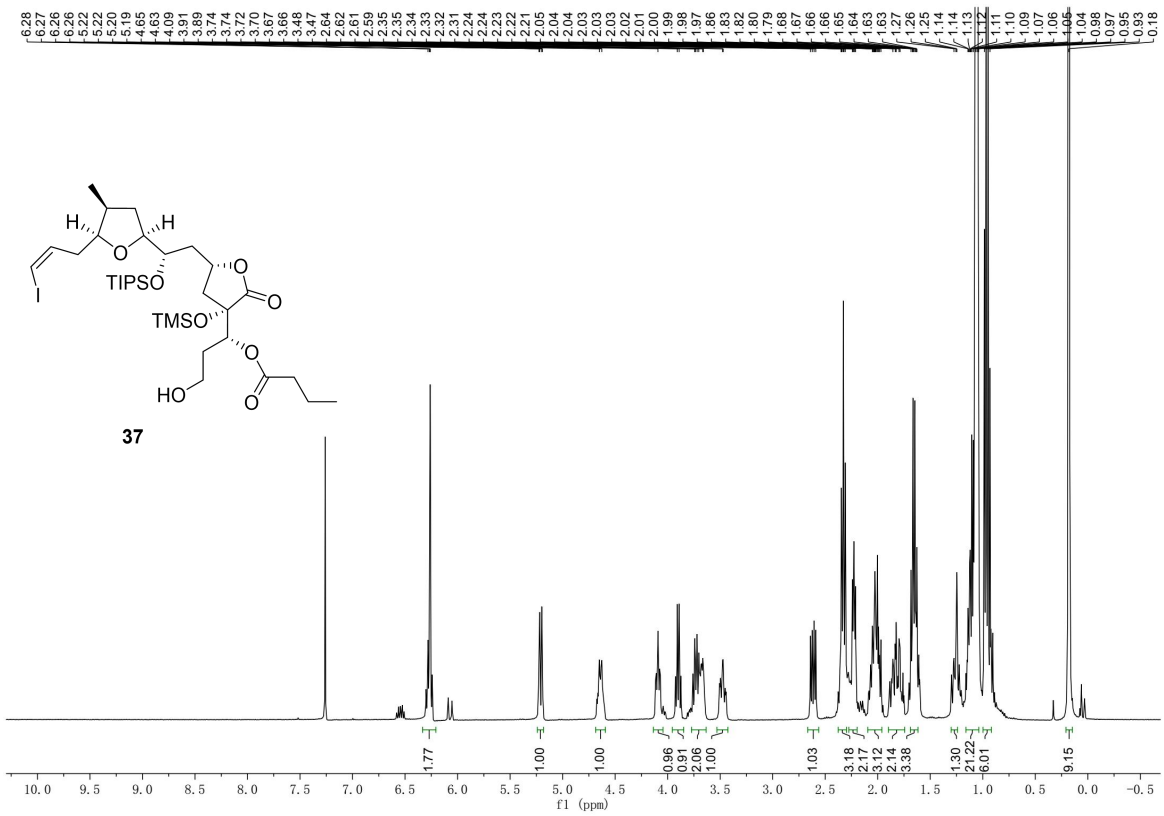
^{1}H NMR ($CDCl_3$, 400M)



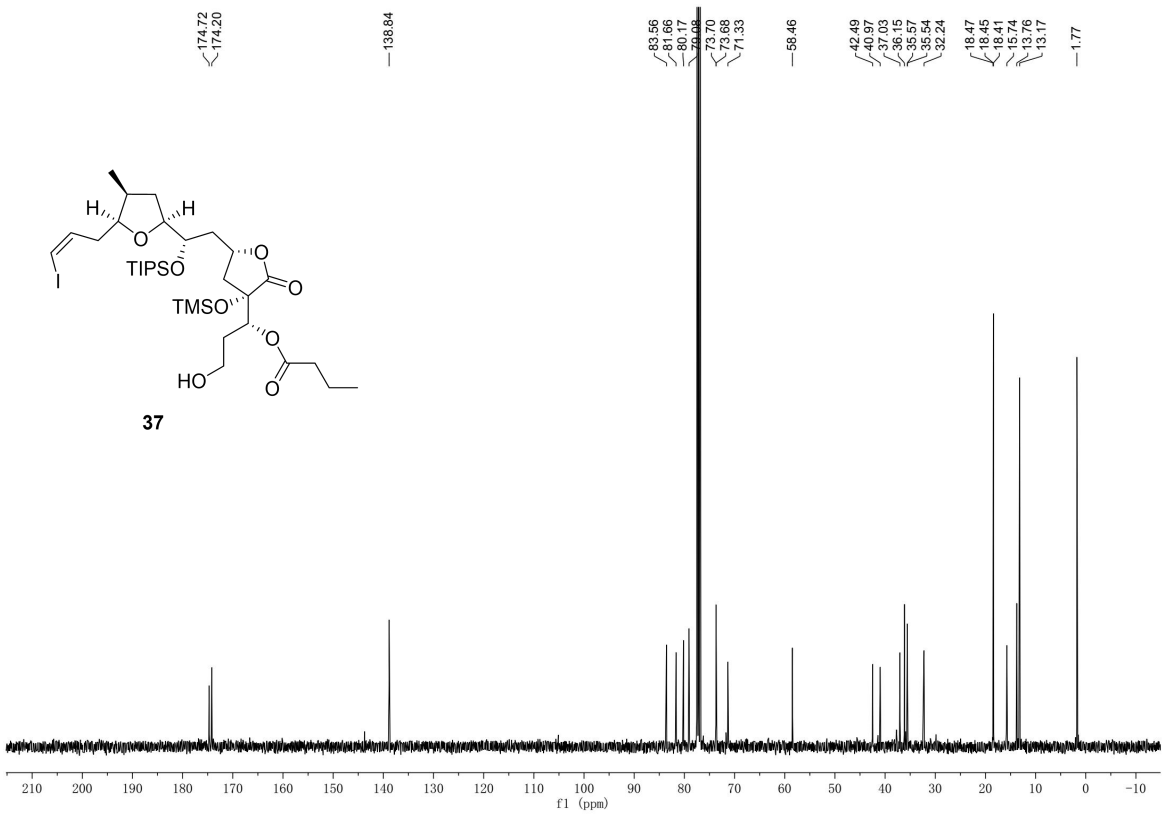
^{13}C NMR ($CDCl_3$, 75 M)



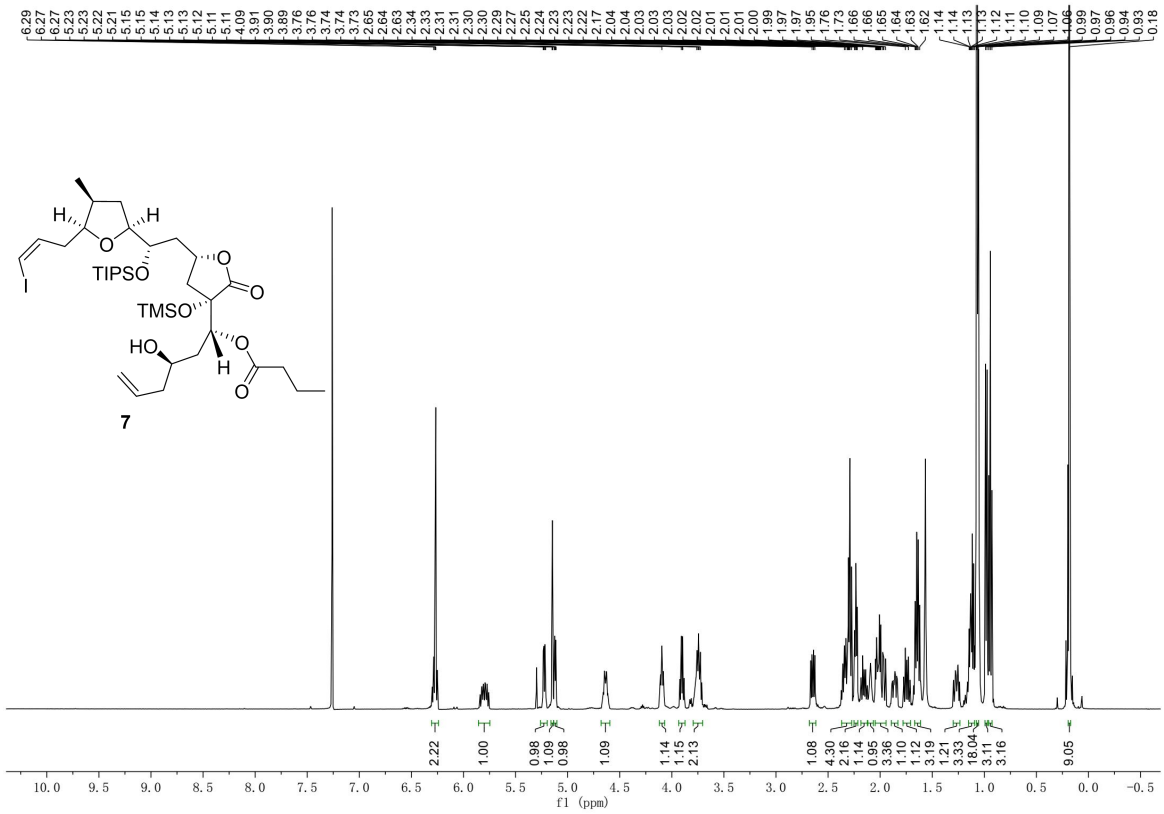
^{1}H NMR ($CDCl_3$, 400M)



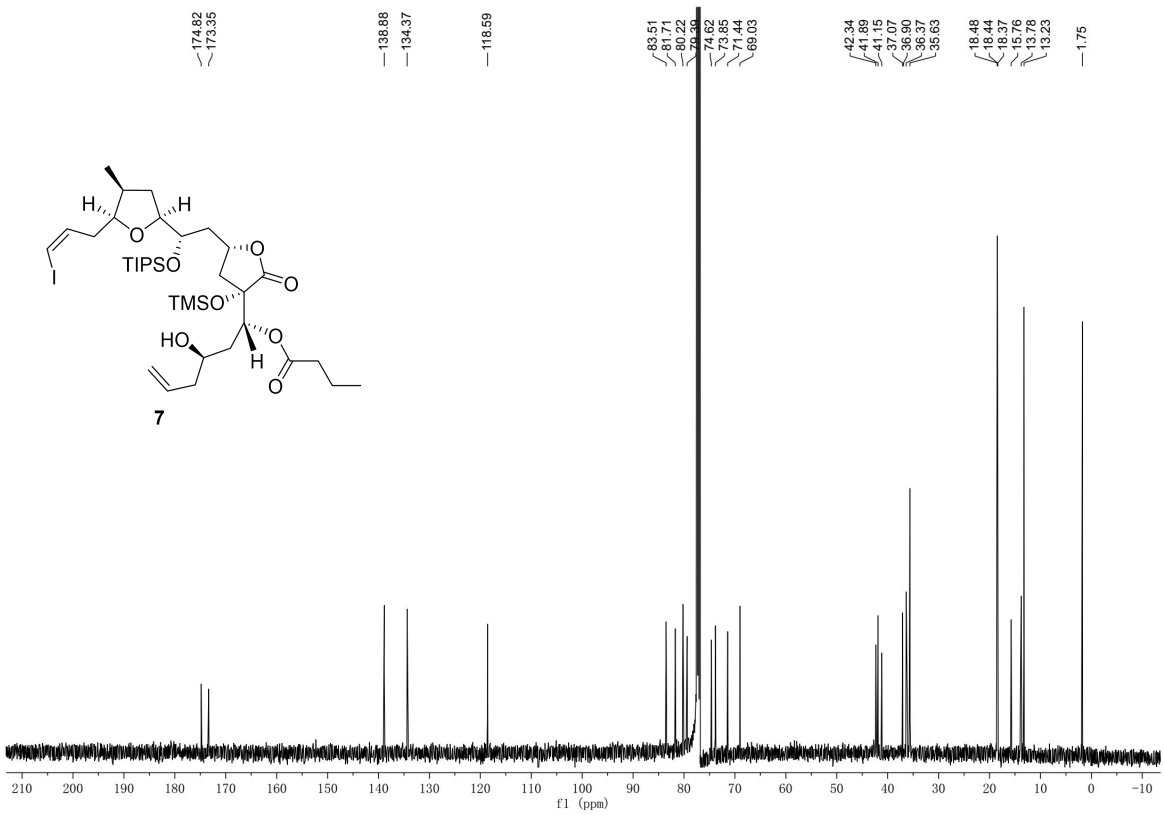
^{13}C NMR ($CDCl_3$, 101 M)



^{1}H NMR ($CDCl_3$, 500M)



^{13}C NMR ($CDCl_3$, 126 M)



VII. References

[1] Lei, H.; Yan, J.; Yu, J.; Liu, Y.; Wang, Z.; Xu, Z.; Ye, T. *Angew. Chem. Int. Ed*. **2014**, *53*, 6533.

[2] a) Enders, D.; Hieronymi, A.; Ridder, A. *Synlett*, **2005**, *2005*, 2391; b) Enders, D.; Breuer, I.; Raabe, G. *Synthesis* **2005**, *2005*, 3517; b) Enders, D.; Hieronymi, A.; Raabe, G. *Synthesis* **2008**, *2008*, 1545.

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