Supporting Information

Ruthenium Pincer Complex-Catalyzed Heterocyclic Compatible Alkoxycarbonylation of Alkyl Iodides: Substrate Keep the Catalyst Active

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1. General Remarks

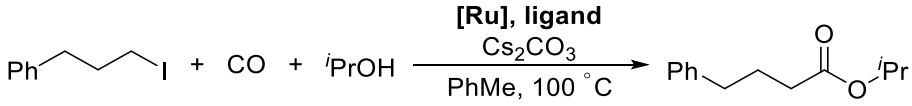
Reagents and solvents: Unless otherwise noted, the chemicals were commercially available from *Sigma-Aldrich, Strem, TCI* or *Alfa Aesar* and were used without further purification. Solvents (anhydrous and under inert atmosphere) were collected from the solvent purification system by M BRAUN and used under standard Schlenk technique.

Purification: The products were isolated from the reaction mixture by column chromatography on silica gel 60, 0.063-0.2 mm, 70-230 mesh (Merck). Gradient flash chromatography was conducted eluting with PE/EA, PE refers to pentane and EA refers to ethyl acetate, they were listed as volume/volume ratios.

Data collection: GC-yields were calculated using hexadecane as internal standard. GC analysis was performed on an Agilent HP-7890A instrument with FID detector and HP-5 capillary column (polydimethylsiloxane with 5% phenyl groups, 30 m, 0.32 mm i.d., 0.25 μm film thickness) using argon as carrier gas. Electron impact (EI) mass spectra were recorded on AMD 402 mass spectrometer (70 eV). The data are given as mass units per charge (m/z). NMR spectra were recorded on Bruker Avance 300 and Bruker ARX 400 spectrometers. Multiplets were assigned as s(singlet), d (doublet), t (triplet), q (quartet), dd (doublet of doublet), m (multiplet) and br. s (broad singlet). Chemical shifts (ppm) are given relative to solvent: references for $CDCl_3$ were 7.26 ppm (^{1}H NMR) and 77.00 ppm (^{13}C NMR). All measurements were carried out at room temperature unless otherwise stated.

NOTE: Carbon monoxide should only be handled in a well-ventilated fume hood. The laboratory should be well-equipped with a CO detector and alarm system.

2. Additional Optimization Information

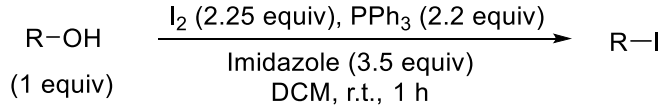


Entry[a]	[Ru]	Ligand	Yield [%][b]
1	$[RuCl_2(cymene)]_2$	-	5
2	$[RuCl_2(cymene)]_2$	Xantphos	16
3	$[RuCl_2(cymene)]_2$	DPEphos	19
4	$[RuCl_2(cymene)]_2$	PPh_3	11
5	$[RuCl_2(cymene)]_2$	DPPE	20
6	$[RuCl_2(cymene)]_2$	DPPD	17
7	$[RuCl_2(cymene)]_2$	DPPP	20

[a] Reaction conditions: **1** (0.2 mmol), **2** (0.6 mmol), [Ru] (2,5 mol%), ligand (5 mol%), Cs_2CO_3 (0.6 mmol), toluene (0.5 mL), CO (10 bar), 100 °C, 12 h. [b] Determined by GC with hexadecane as internal standard.

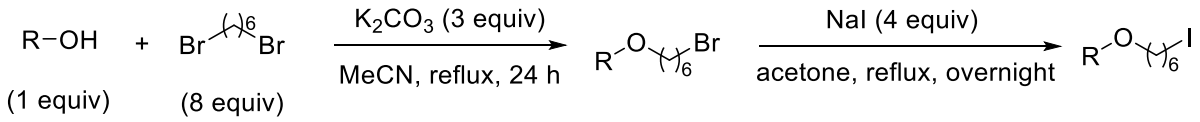
3. Preparation of Substrates

General Procedure A:



A round-bottom flask containing a stirring bar was charged with PPh_3 (2.2 equiv) and DCM (0.2 M). Iodine (2.25 equiv) was slowly added under N_2. The mixture was stirred for 10 min at room temperature. Imidazole (3.5 equiv) was then added to the solution and the mixture was allowed to stir for another 10 min. Then, the alcohol (1 equiv) was added to the suspension drop wise and the reaction was stirred at room temperature. The reaction could be tracked by TLC. After the reaction was completed (about 1 hour), the reaction mixture was quenched with the saturated aqueous solution of Na_2SO_3 (0.2 M). The aqueous and organic layers were separated, and the aqueous layer was extracted with DCM three times. The combined organic layer was dried over Na_2SO_4, filtered, and concentrated in vacuum. The resulting crude product was purified by flash column chromatography on silica gel to give the desired product.

General Procedure B:



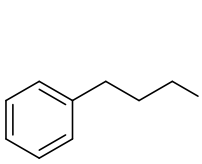
A round-bottom flask containing a stirring bar was charged with the alcohol (1 equiv), 1,6-dibromopropane (8.0 equiv), and CH_3CN (0.3 M). Then K_2CO_3 (9.0 mmol, 3.0 equiv) was added. The reaction mixture was stirred and refluxed for 24 h. After the reaction was completed, the reaction mixture was filtered under reduced pressure and concentrated by rotary evaporator. The crude product was purified by flash column chromatography on silica gel to give the desired intermediate (the alkyl bromide).

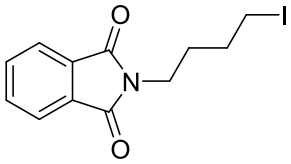
The alkyl bromide (1 equiv) and NaI (4.0 equiv) were dissolved in acetone (0.25 M) and then refluxed overnight. After the reaction was completed, the reaction mixture was quenched with saturated aqueous solution of Na_2SO_3 (0.2 M). The aqueous and organic layers were separated, and the aqueous layer was extracted with DCM three times. The combined organic layers were washed with brine and dried over Na_2SO_4, filtered, and concentrated in vacuum.

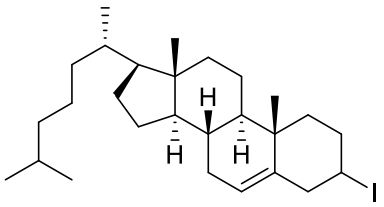
The crude residue was purified by flash column chromatography on silica gel to give the desired product.

The following substrates could be simply synthesized and purified by *General Procedure A* and *B*.

from General Procedure A







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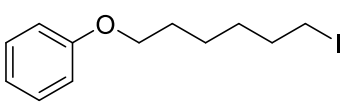
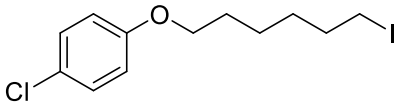
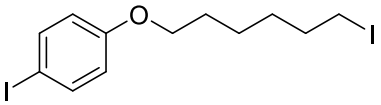
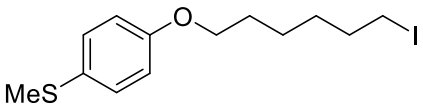
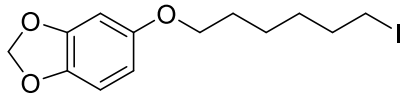
from General Procedure B

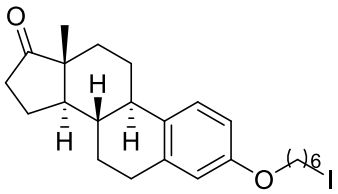


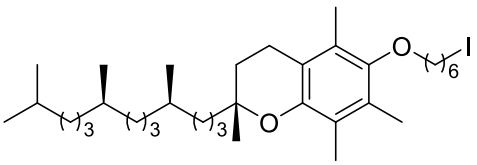




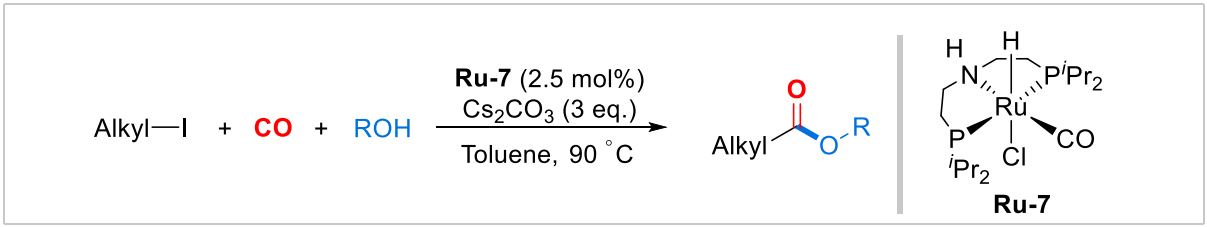








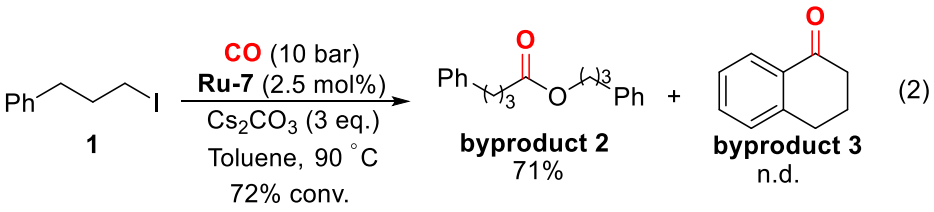
4. General Procedure of the Alkoxycarbonylation



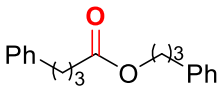
In a glovebox, an oven-dried vial (4 mL) containing a stirring bar was charged with **Ru-7** (0.005 mmol, 2.4 mg), Cs_2CO_3 (0.6 mmol, 195.5 mg), alkyl iodide (0.2 mmol, if it is solid), and alcohol (0.6 mmol, if it is solid). The vial was then sealed with a PTFE/white rubber septum (Wheaton 13 mm Septa) and phenolic cap and removed from the glovebox. Then, alkyl iodide (0.2 mmol, if it is liquid), and alcohol (0.6 mmol, if it is liquid), and toluene (0.5 mL) were added by syringe. The vial was placed in an alloy plate, which was transferred into a 300 mL autoclave of the 4560 series from Parr Instruments. After flushing the autoclave three times with CO, a pressure of 10 bar of CO was adjusted at ambient temperature. Then, the mixture was stirred for 12 h at 90 °C. After the reaction was complete, the autoclave was cooled down to room temperature and the pressure was released carefully. The product was purified by column chromatography on silica gel (pentane/EA), *with $KMnO_4$ solution or ethanol solution of $12MoO_3{\cdot}H_3PO_4$ as the color rendering agent for TLC*, to deliver the desired product.

5. Mechanism Studies

5.1 Control experiments



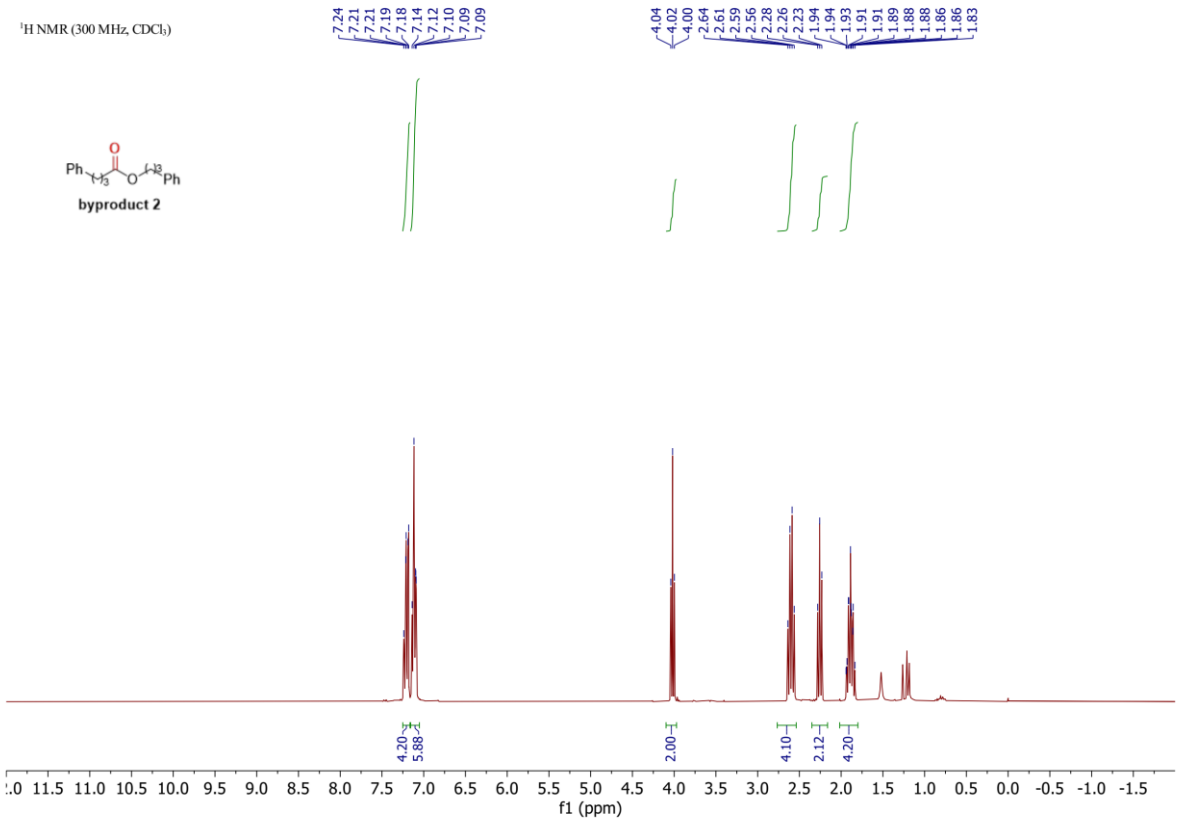
In a glovebox, an oven-dried vial (4 mL) containing a stirring bar was charged with **Ru-7** (0.005 mmol, 2.4 mg), Cs_2CO_3 (0.6 mmol, 195.5 mg), **1** (0.2 mmol, 49 mg). The vial was then sealed with a PTFE/white rubber septum (Wheaton 13 mm Septa) and phenolic cap and removed from the glovebox. Then, toluene (0.5 mL) was added by syringe. The vial was placed in an alloy plate, which was transferred into a 300 mL autoclave of the 4560 series from Parr Instruments. After flushing the autoclave three times with CO, a pressure of 10 bar of CO was adjusted at ambient temperature. Then, the mixture was stirred for 12 h at 90 ℃. After the reaction was complete, the autoclave was cooled down to room temperature and the pressure was released carefully. A proper amount of solution was taken for GC and GC-MS analysis. The product was purified by column chromatography on silica gel (pentane/EA), *with $KMnO_4$ solution or ethanol solution of $12MoO_3{\cdot}H_3PO_4$ as the color rendering agent for TLC*, to deliver the desired product. The result is shown above. The characterization and NMR spectrum of **byproduct 2** are given:

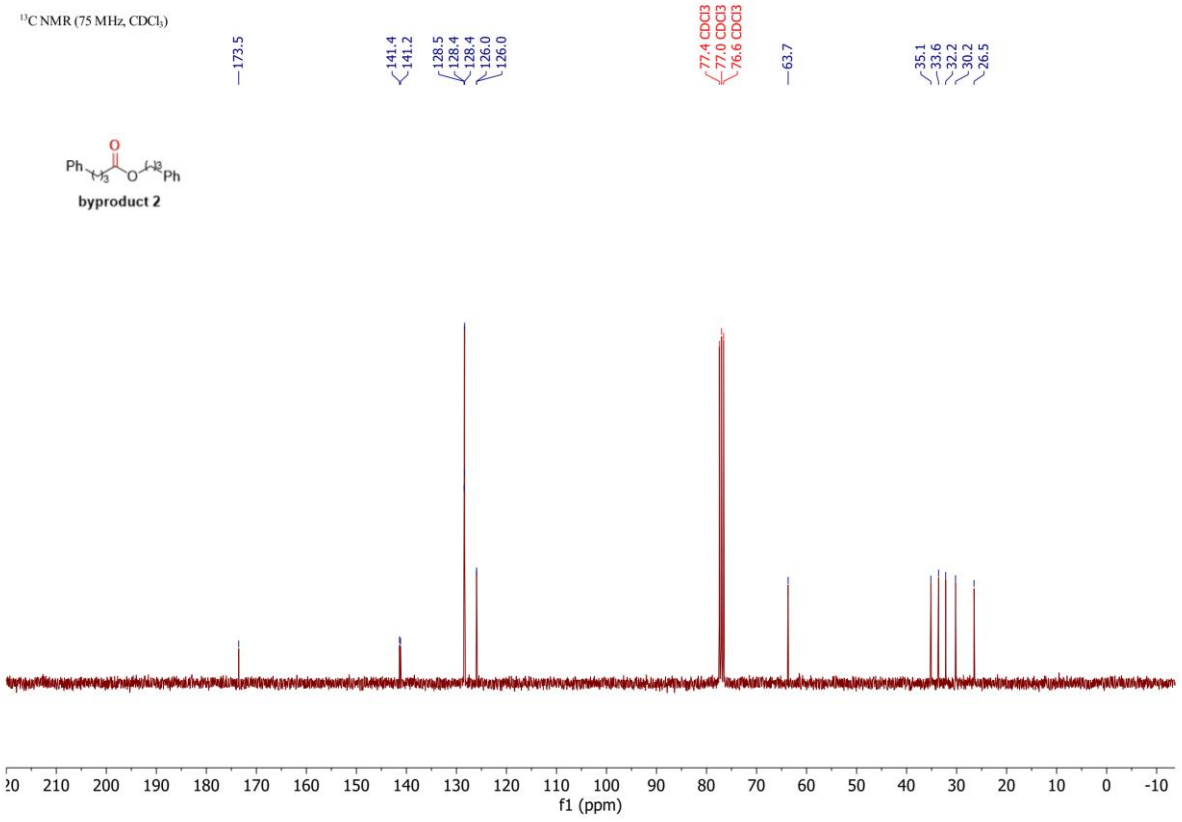


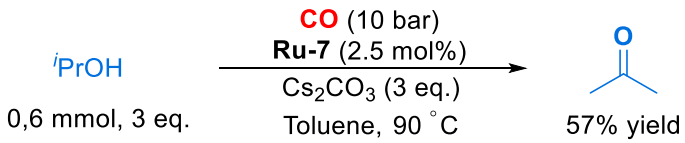
byproduct 2

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.27 – 7.15 (m, 4H), 7.17 – 7.06 (m, 6H), 4.02 (t, J = 6.5 Hz, 2H), 2.60 (q, J = 7.5 Hz, 4H), 2.26 (t, J = 7.5 Hz, 2H), 1.97 – 1.79 (m, 4H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 173.5, 141.4, 141.2, 128.5, 128.4, 128.4, 126.0, 126.0, 63.7, 35.1, 33.6, 32.2, 30.2, 26.5.

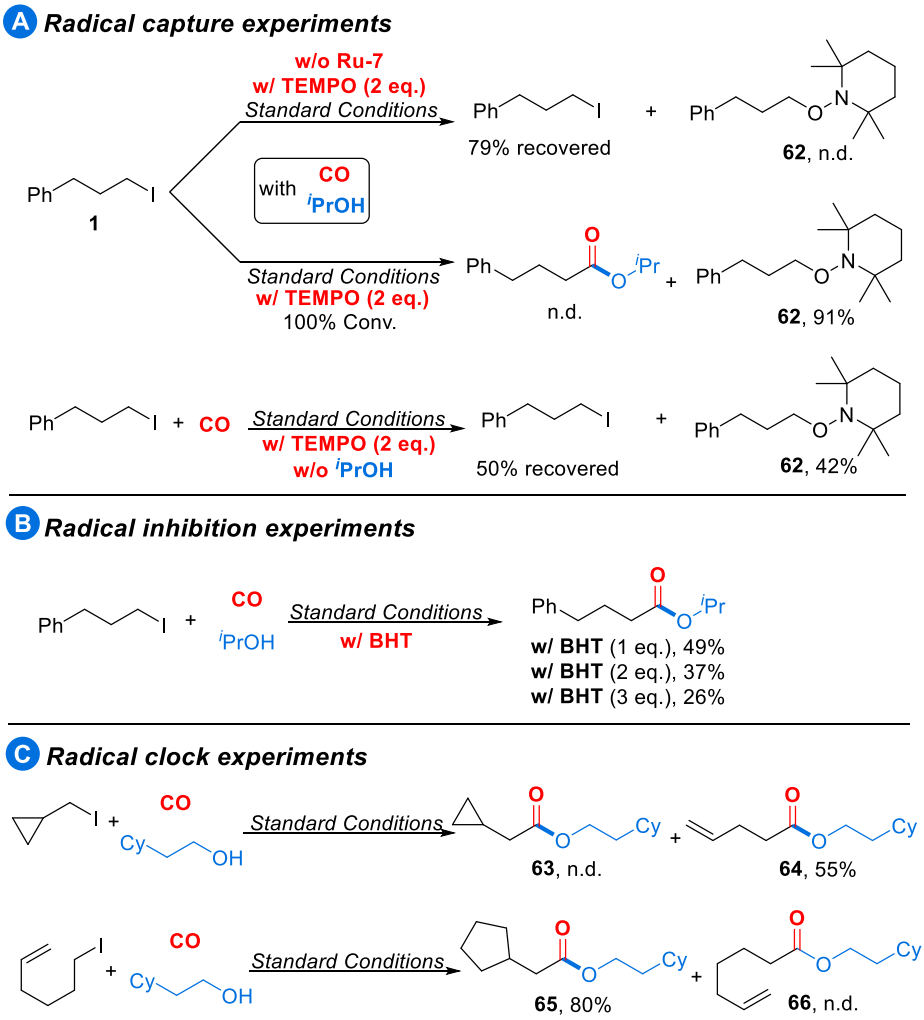

^{1}H NMR (300 MHz, CDCl$_3$)
7.24
7.21
7.21
7.19
7.18
7.14
7.12
7.10
7.09
7.09
4.04
4.02
4.00
2.64
2.61
2.59
2.56
2.28
2.26
2.23
1.94
1.94
1.93
1.91
1.91
1.89
1.88
1.88
1.86
1.86
1.83
byproduct 2
4.20
5.88
2.00
4.10
2.12
4.20
f1 (ppm)


^{13}C NMR (75 MHz, CDCl$_3$)
173.5
141.4
141.2
128.5
128.4
128.4
126.0
126.0
77.4 CDCl3
77.0 CDCl3
76.6 CDCl3
63.7
35.1
33.6
32.2
30.2
26.5
byproduct 2
f1 (ppm)

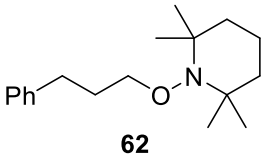


In a glovebox, an oven-dried vial (4 mL) containing a stirring bar was charged with **Ru-7** (0.005 mmol, 2.4 mg), Cs_2CO_3 (0.6 mmol, 195.5 mg), **1** (0.2 mmol, 49 mg). The vial was then sealed with a PTFE/white rubber septum (Wheaton 13 mm Septa) and phenolic cap and removed from the glovebox. Then, toluene (0.5 mL) was added by syringe. The vial was placed in an alloy plate, which was transferred into a 300 mL autoclave of the 4560 series from Parr Instruments. After flushing the autoclave three times with CO, a pressure of 10 bar of CO was adjusted at ambient temperature. Then, the mixture was stirred for 12 h at 90 ℃. After the reaction was complete, the autoclave was cooled down to room temperature and the pressure was released carefully. Then 10 μL of hexadecane was added as internal standard and a proper amount of solution was taken after it was well mixed for GC analysis. The result is shown above.

5.2 Radical capture, inhibition, and clock experiments



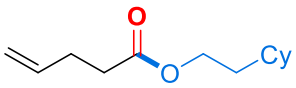
The above reactions were conducted according to the *General Procedure of the Alkoxycarbonylation*, the result was shown above. The characterization and NMR spectrum of **62**, **64**, **65** are given:



62

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.35 – 7.24 (m, 2H), 7.27 – 7.13 (m, 3H), 3.80 (t, J = 6.5 Hz, 2H), 2.78 – 2.67 (m, 2H), 1.96 – 1.80 (m, 2H), 1.54 – 1.29 (m, 6H), 1.16 (s, 6H), 1.14 (s, 6H).

^{13}C NMR (75 MHz, $CDCl_3$) 13C NMR (75 MHz, CDCl3) δ 142.4, 128.3, 128.2, 125.6, 76.1, 59.6, 39.6, 33.0, 32.7, 30.5, 20.1, 17.1.

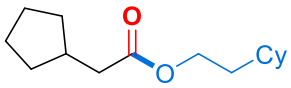


64

^{1}H NMR (300 MHz, $CDCl_3$) δ 5.93 – 5.73 (m, 1H), 5.15 – 4.89 (m, 2H), 4.11 (t, J = 6.9 Hz, 2H), 2.46 – 2.32 (m, 4H), 1.75 – 1.62 (m, 5H), 1.51 (q, J = 6.8 Hz, 2H), 1.42 – 1.13 (m, 4H), 1.01 – 0.84 (m, 2H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 173.2, 136.8, 115.4, 62.7, 36.0, 34.5, 33.6, 33.1, 28.9, 26.5, 26.2.

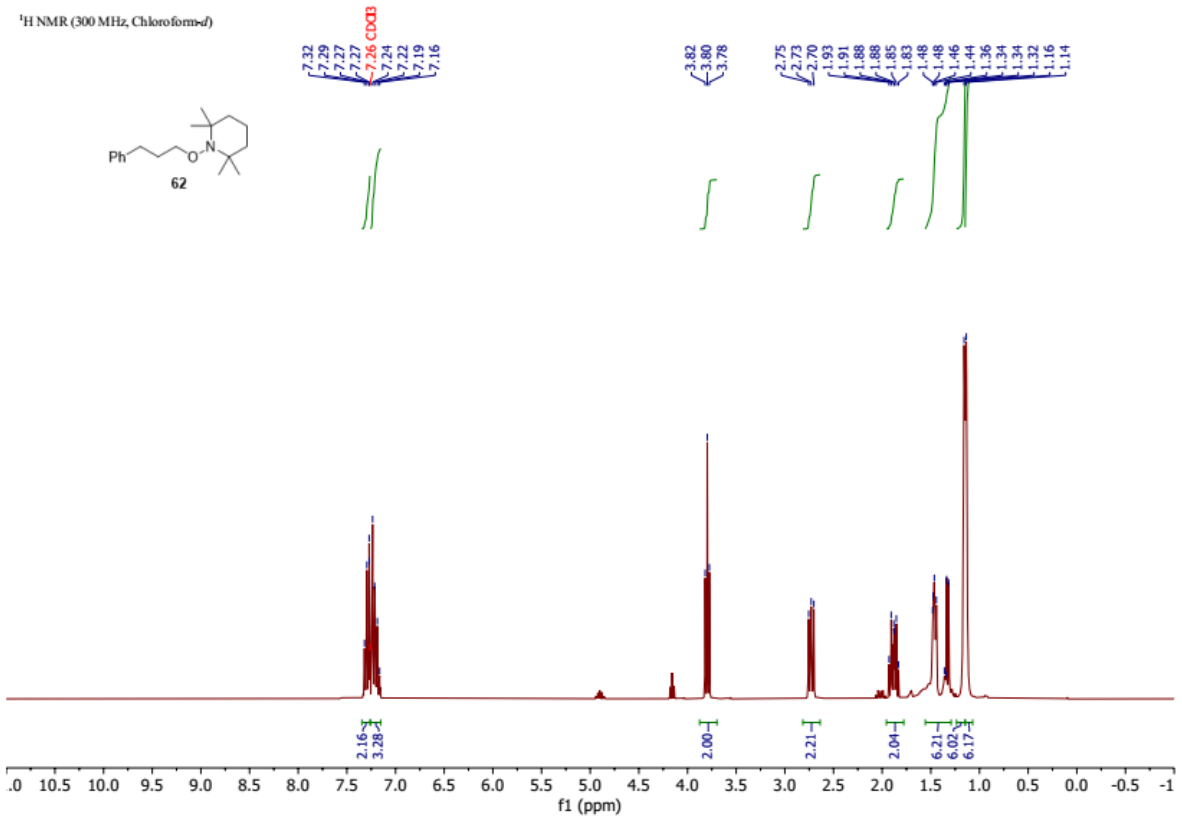
HRMS (ESI-TOF): *m/z* calcd. for $C_{13}H_{22}O_2H^+$ ([M+H$^+$]) 211.1698, found 211.1697.

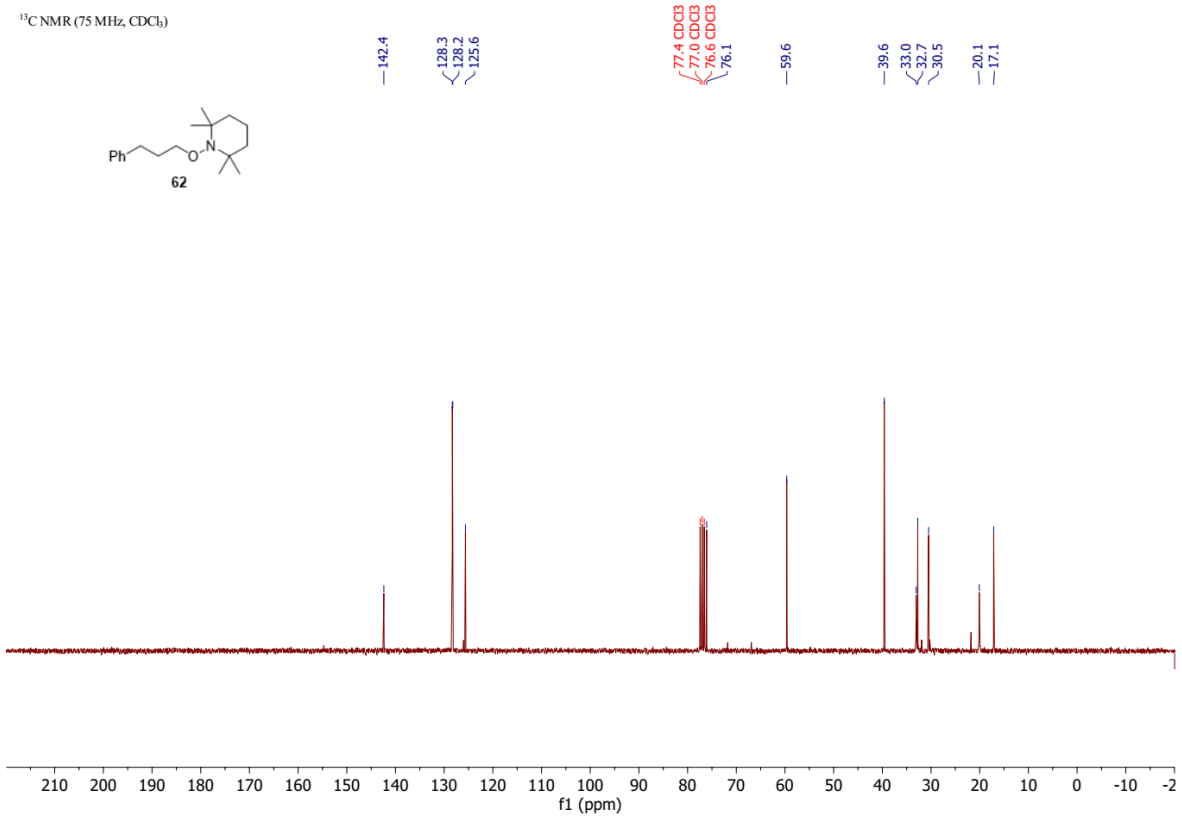


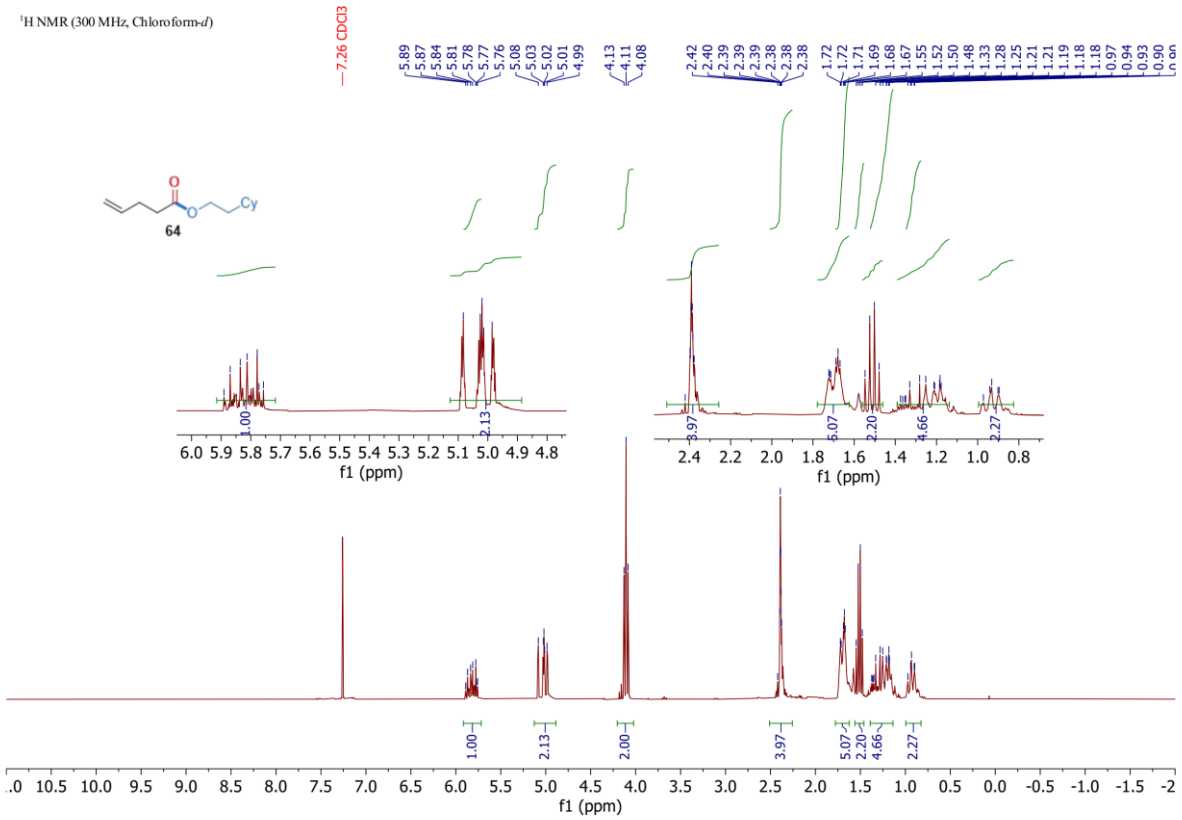
65

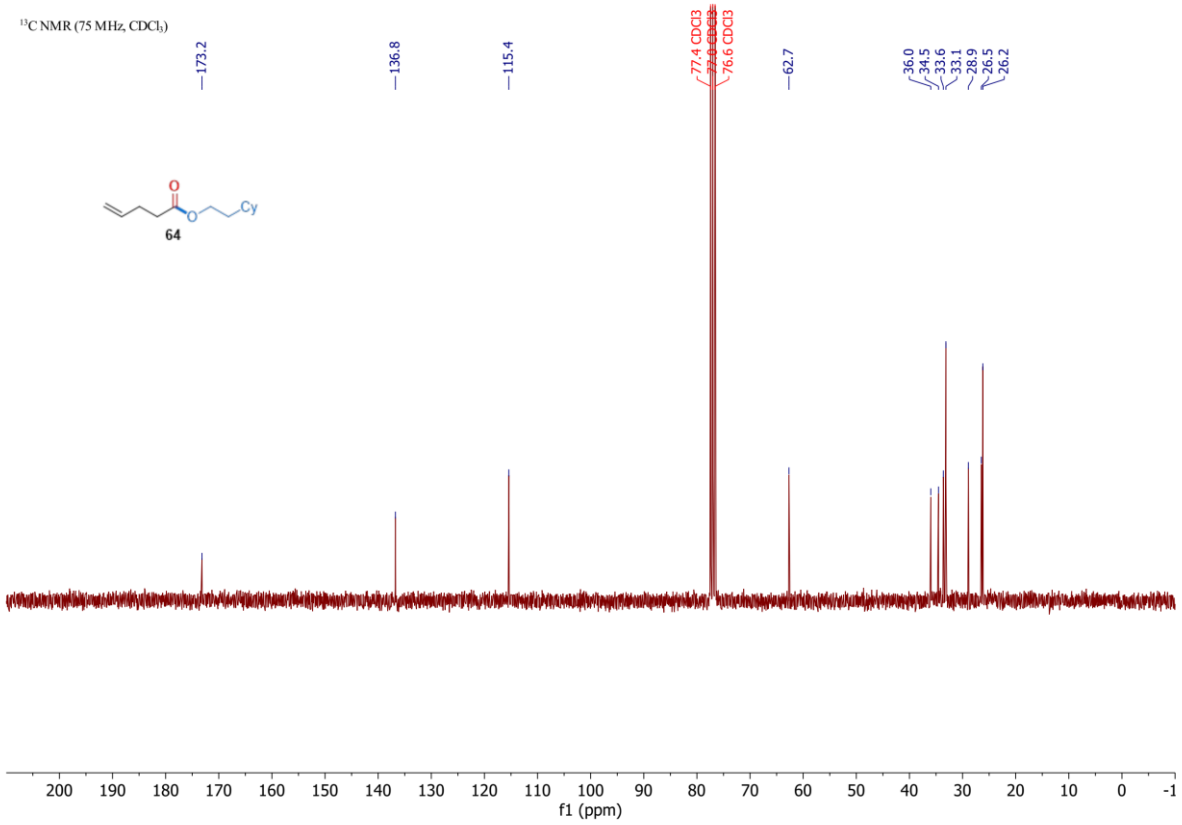
^{1}H NMR (300 MHz, $CDCl_3$) δ 4.09 (t, J = 6.9 Hz, 2H), 2.33 – 2.13 (m, 3H), 1.86 – 1.44 (m, 13H), 1.40 – 1.08 (m, 6H), 1.00 – 0.81 (m, 2H).

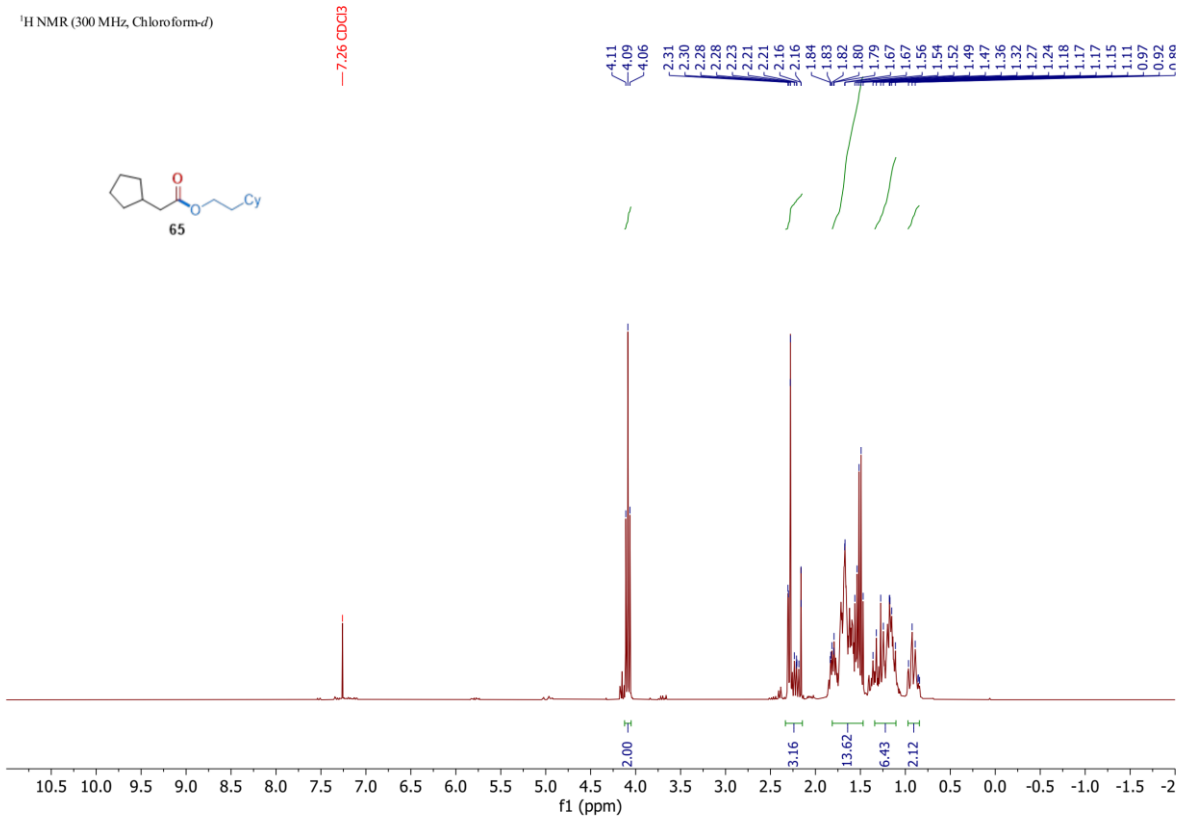
^{13}C NMR (75 MHz, $CDCl_3$) δ 173.5, 62.4, 40.5, 36.5, 36.0, 34.5, 33.1, 32.4, 26.5, 26.2, 25.0.

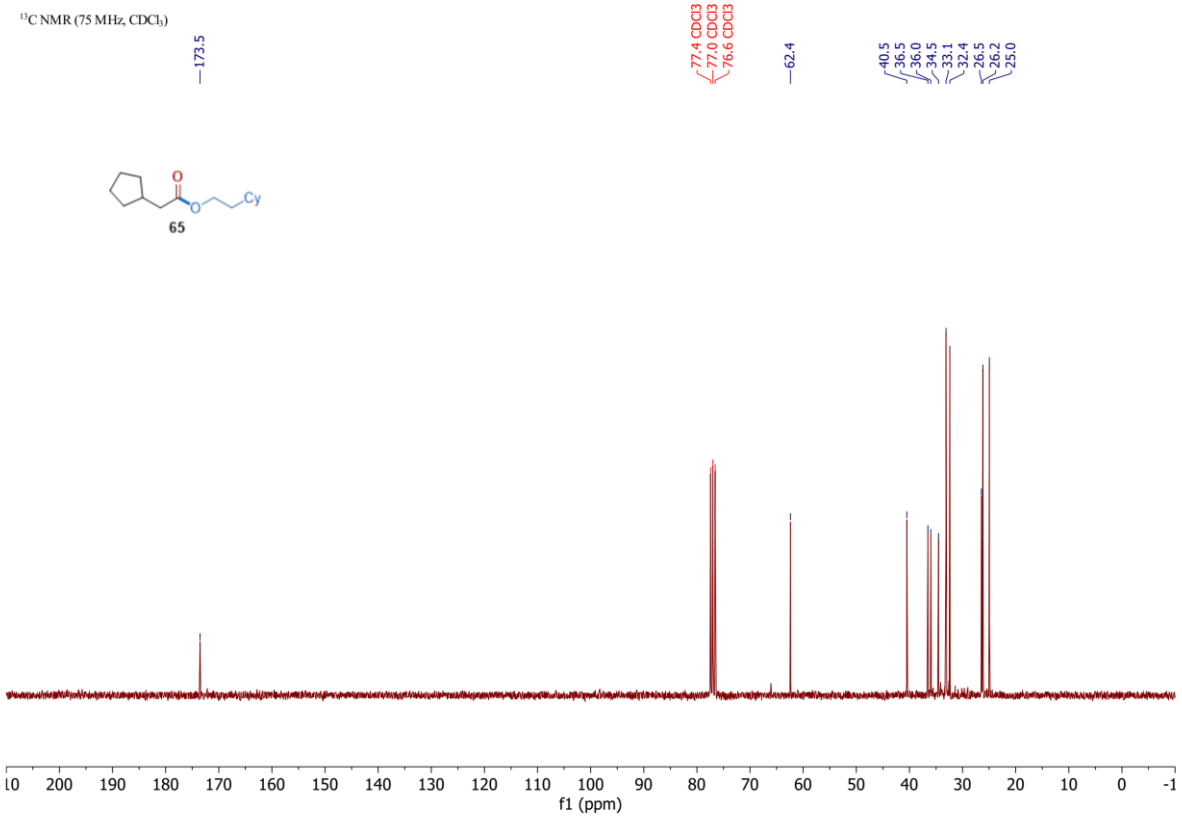

¹H NMR (300 MHz, Chloroform-d)
7.32
7.29
7.27
7.27
7.26 CDCl3
7.24
7.22
7.19
7.16
3.82
3.80
3.78
2.75
2.73
2.70
1.93
1.91
1.88
1.88
1.85
1.83
1.48
1.48
1.46
1.44
1.36
1.34
1.34
1.32
1.16
1.14
Ph
O
N
62
2.16
3.28
2.00
2.21
2.04
6.21
6.02
6.17
f1 (ppm)


¹³C NMR (75 MHz, CDCl3)
142.4
128.3
128.2
125.6
77.4 CDCl3
77.0 CDCl3
76.6 CDCl3
76.1
59.6
39.6
33.0
32.7
30.5
20.1
17.1
Ph
O
N
62
f1 (ppm)

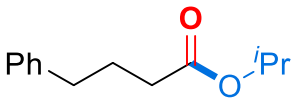

^{1}H NMR (300 MHz, Chloroform-d)
7.26 CDCl3
64
f1 (ppm)


^{13}C NMR (75 MHz, $CDCl_3$)
173.2
136.8
115.4
77.4 CDCl3
76.6 CDCl3
62.7
36.0
34.5
33.6
33.1
28.9
26.5
26.2
64
f1 (ppm)


¹H NMR (300 MHz, Chloroform-d)
7.26 CDCl3
4.11
4.09
4.06
2.31
2.30
2.28
2.28
2.23
2.21
2.21
2.16
2.16
1.84
1.83
1.82
1.80
1.79
1.67
1.67
1.56
1.54
1.52
1.49
1.47
1.36
1.32
1.27
1.24
1.18
1.17
1.17
1.15
1.11
0.97
0.92
O
O
Cy
65
2.00
3.16
13.62
6.43
2.12
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0 -1.5 -2
f1 (ppm)


¹³C NMR (75 MHz, CDCl₃)
173.5
77.4 CDCl3
77.0 CDCl3
76.6 CDCl3
62.4
40.5
36.5
36.0
34.5
33.1
32.4
26.5
26.2
25.0
O
O
Cy
65
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

6. Characterization of the Products



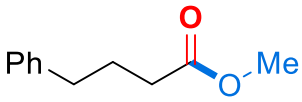
3

Isopropyl 4-phenylbutanoate (3) Prepared according to the general procedure. The crude product was purified by silica gel chromatography (PE/EA = 200:1) to afford the title compound as a colorless oil (33.8 mg, 82% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.33 - 7.25 (m, 2H), 7.24 - 7.15 (m, 3H), 5.02 (hept, *J* = 6.3 Hz, 1H), 2.69 - 2.61 (m, 2H), 2.30 (t, *J* = 7.5 Hz, 2H), 2.01 - 1.88 (m, 2H), 1.24 (s, 3H), 1.23 (s, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 173.1, 141.5, 128.5, 128.4, 126.0, 67.5, 35.2, 34.1, 26.7, 21.9.

HRMS (ESI-TOF): *m/z* calcd. for $C_{13}H_{18}O_2Na^+$ ([M+Na^+]) 229.1204, found 229.1207.



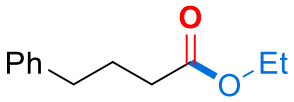
4

Methyl 4-phenylbutanoate (4) Prepared according to the general procedure. The crude product was purified by silica gel chromatography (PE/EA = 200:1) to afford the title compound as a colorless oil (29.9 mg, 84% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.29 (m, 2H), 7.24 - 7.15 (m, 3H), 3.67 (s, 3H), 2.66 (t, 2H), 2.34 (t, *J* = 7.5 Hz, 2H), 1.97 (p, *J* = 7.6 Hz, 2H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 173.9, 141.3, 128.5, 128.4, 126.0, 51.5, 35.1, 33.4, 26.4.

HRMS (ESI-TOF): *m/z* calcd. for $C_{11}H_{14}O_2Na^+$ ([M+Na^+]) 201.0891, found 201.0896.



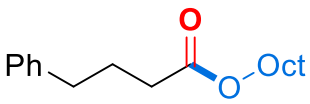
5

Ethyl 4-phenylbutanoate (5) Prepared according to the general procedure. The crude product was purified by silica gel chromatography (PE/EA = 200:1) to afford the title compound as a colorless oil (31.1 mg, 81% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.29 (dd, *J* = 8.0, 6.6 Hz, 2H), 7.24 - 7.16 (m, 3H), 4.13 (q, *J* = 7.2 Hz, 2H), 2.66 (t, 2H), 2.33 (t, *J* = 7.5 Hz, 2H), 2.03 - 1.91 (m, 2H), 1.26 (t, *J* = 7.1 Hz, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 173.5, 141.4, 128.5, 128.3, 125.9, 60.2, 35.1, 33.6, 26.5, 14.2.

HRMS (EI): *m/z* calcd. for $C_{12}H_{16}O_2^{\bullet}$ ([M+•]) 192.11448, found 192.11380.



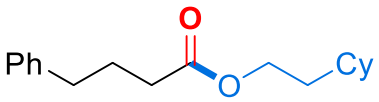
6

Octyl 4-phenylbutanoate (6) Prepared according to the general procedure. The crude product was purified by silica gel chromatography (PE/EA = 200:1) to afford the title compound as a colorless oil (50 mg, 91% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.29 (dd, *J* = 8.1, 6.5 Hz, 2H), 7.24 - 7.16 (m, 3H), 4.07 (t, *J* = 6.7 Hz, 2H), 2.72 - 2.62 (m, 2H), 2.33 (t, *J* = 7.5 Hz, 2H), 1.97 (p, *J* = 7.5 Hz, 2H), 1.71 - 1.57 (m, 2H), 1.42 - 1.24 (m, 10H), 0.89 (t, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 173.6, 141.4, 128.4, 128.3, 125.9, 64.5, 35.1, 33.6, 31.7, 29.2, 29.1, 28.6, 26.5, 25.9, 22.6, 14.0.

HRMS (ESI-TOF): *m/z* calcd. for $C_{18}H_{28}O_2Na^+$ ([M+Na^+]) 299.1986, found 299.1993.



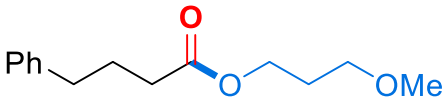
7

2-Cyclohexylethyl 4-phenylbutanoate (7) Prepared according to the general procedure. The crude product was purified by silica gel chromatography (PE/EA = 200:1) to afford the title compound as a colorless oil (45 mg, 82% yield).

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.33 - 7.22 (m, 2H), 7.24 - 7.13 (m, 3H), 4.09 (t, *J* = 6.9 Hz, 2H), 2.70 - 2.59 (t, 2H), 2.31 (t, *J* = 7.4 Hz, 2H), 2.06 - 1.86 (m, 2H), 1.75 - 1.60 (m, 5H), 1.51 (q, *J* = 6.9 Hz, 2H), 1.41 - 1.08 (m, 4H), 1.01 - 0.82 (m, 2H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 173.6, 141.4, 128.5, 128.3, 125.9, 62.6, 36.0, 35.1, 34.5, 33.7, 33.1, 26.5, 26.5, 26.2.

HRMS (ESI-TOF): *m/z* calcd. for $C_{18}H_{26}O_2Na^+$ ([M+Na^+]) 297.1830, found 297.1835.



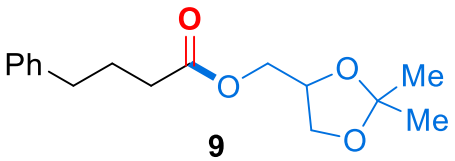
8

3-Methoxypropyl 4-phenylbutanoate (8) Prepared according to the general procedure. The crude product was purified by silica gel chromatography (PE/EA = 200:1) to afford the title compound as a colorless oil (38.5 mg, 82% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.33 - 7.24 (m,21H), 7.23 - 7.15 (m, 3H), 4.16 (t, *J* = 6.5 Hz, 2H), 3.44 (t, *J* = 6.3 Hz, 2H), 3.33 (s, 3H), 2.66 (t, 2H), 2.33 (t, *J* = 7.5 Hz, 2H), 2.02 - 1.86 (m, 4H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 173.4, 141.4, 128.4, 128.3, 125.9, 69.1, 61.5, 58.6, 35.1, 33.6, 28.9, 26.5.

HRMS (ESI-TOF): *m/z* calcd. for $C_{14}H_{20}O_3Na^+$ ([M+Na^+]) 259.1310, found 259.1312.



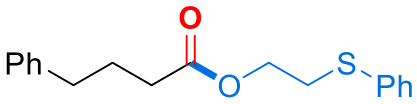
9

(2,2-Dimethyl-1,3-dioxolan-4-yl)methyl 4-phenylbutanoate (9) Prepared according to the general procedure. The crude product was purified by silica gel chromatography (PE/EA = 20:1) to afford the title compound as a colorless oil (46 mg, 83% yield).

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.37 - 7.25 (m, 2H), 7.31 - 7.14 (m, 3H), 4.40 - 4.26 (m, 1H), 4.26 - 4.04 (m, 3H), 3.75 (dd, *J* = 8.5, 6.1 Hz, 1H), 2.68 (t, 2H), 2.40 (t, *J* = 7.6 Hz, 2H), 2.07 - 1.91 (m, 2H), 1.45 (s, 3H), 1.39 (s, 3H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 173.2, 141.2, 128.4, 128.3, 126.0, 109.8, 73.6, 66.3, 64.6, 35.0, 33.3, 26.6, 26.4, 25.3.

HRMS (ESI-TOF): *m/z* calcd. for $C_{16}H_{22}O_4Na^+$ ([M+Na^+]) 301.1415, found 301.1416.



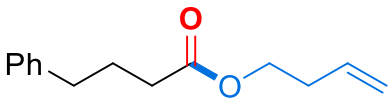
10

(2,2-Dimethyl-1,3-dioxolan-4-yl)methyl 4-phenylbutanoate (10) Prepared according to the general procedure. The crude product was purified by silica gel chromatography (PE/EA = 200:1) to afford the title compound as a colorless oil (47 mg, 78% yield).

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.47 - 7.38 (m, 2H), 7.38 - 7.27 (m, 4H), 7.29 - 7.17 (m, 4H), 4.27 (t, *J* = 6.9 Hz, 2H), 3.17 (t, *J* = 6.9 Hz, 2H), 2.68 (t, 2H), 2.33 (t, *J* = 7.5 Hz, 2H), 2.08 - 1.89 (m, 2H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 173.2, 141.3, 135.1, 129.8, 129.0, 128.5, 128.3, 126.5, 126.0, 62.9, 62.8, 35.0, 33.4, 32.4, 26.3.

HRMS (ESI-TOF): *m/z* calcd. for $C_{18}H_{20}O_2SNa^+$ ([M+Na^+]) 323.1081, found 323.1086.



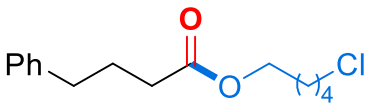
11

But-3-en-1-yl 4-phenylbutanoate (11) Prepared according to the general procedure. The crude product was purified by silica gel chromatography (PE/EA = 200:1) to afford the title compound as a colorless oil (21.8 mg, 50% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.33 - 7.25 (m, 2H), 7.24 - 7.15 (m, 3H), 5.79 (ddt, *J* = 17.0, 10.2, 6.7 Hz, 1H), 5.18 - 5.03 (m, 1H), 4.13 (t, *J* = 6.7 Hz, 2H), 2.70 - 2.61 (m, 2H), 2.39 (qt, *J* = 6.8, 1.4 Hz, 2H), 2.33 (t, *J* = 7.4 Hz, 2H), 1.96 (p, *J* = 7.5 Hz, 2H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 173.5, 141.4, 134.1, 128.5, 128.4, 126.0, 117.2, 63.4, 35.1, 33.6, 33.1, 26.5.

HRMS (ESI-TOF): *m/z* calcd. for $C_{14}H_{18}O_2H^+$ ([M+H^+]) 219.1385, found 219.1389.



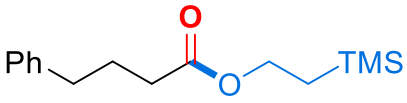
12

5-Chloropentyl 4-phenylbutanoate (12) Prepared according to the general procedure. The crude product was purified by silica gel chromatography (PE/EA = 200:1) to afford the title compound as a colorless oil (48 mg, 90% yield).

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.27 - 7.15 (m, 2H), 7.17 - 7.06 (m, 2H), 4.00 (t, *J* = 6.5 Hz, 2H), 3.46 (t, *J* = 6.6 Hz, 2H), 2.58 (t, 2H), 2.25 (t, *J* = 7.5 Hz, 2H), 1.97 - 1.81 (m, 2H), 1.81 - 1.66 (m, 2H), 1.66 - 1.51 (m, 2H), 1.51 - 1.32 (m, 2H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 173.5, 141.4, 128.5, 128.4, 126.0, 64.0, 44.7, 35.1, 33.6, 32.1, 27.9, 26.5, 23.3.

HRMS (ESI-TOF): *m/z* calcd. for $C_{15}H_{21}O_2ClNa^+$ ([M+Na^+]) 291.1127, found 291.1135.



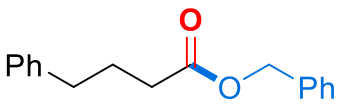
13

2-(Trimethylsilyl)ethyl 4-phenylbutanoate (13) Prepared according to the general procedure. The crude product was purified by silica gel chromatography (PE/EA = 200:1) to afford the title compound as a colorless oil (43 mg, 81% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.33 - 7.25 (m, 2H), 7.24 - 7.15 (m, 3H), 4.21 - 4.10 (m, 2H), 2.70 - 2.62 (m, 2H), 2.32 (t, *J* = 7.5 Hz, 2H), 2.03 - 1.90 (m, 2H), 1.06 - 0.94 (m, 2H), 0.05 (s, 9H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 173.6, 141.4, 128.5, 128.3, 125.9, 62.4, 35.1, 33.8, 26.5, 17.3, -1.5.

HRMS (ESI-TOF): *m/z* calcd. for $C_{15}H_{24}SiO_2Na^+$ ([M+Na^+]) 287.1443, found 287.1437.



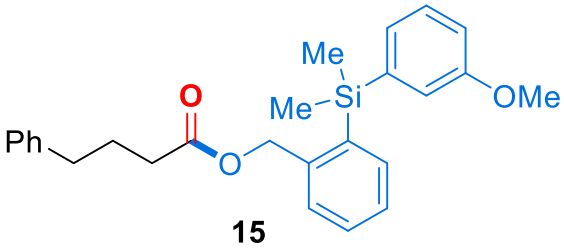
14

Benzyl 4-phenylbutanoate (14) Prepared according to the general procedure. The crude product was purified by silica gel chromatography (PE/EA = 200:1) to afford the title compound as a colorless oil (44 mg, 87% yield).

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.31 - 7.25 (m, 4H), 7.23 - 7.15 (m, 2H), 7.16 - 7.04 (m, 4H), 5.04 (s, 2H), 2.63 - 2.52 (m, 2H), 2.31 (t, *J* = 7.5 Hz, 2H), 1.92 (m, 2H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 173.3, 141.3, 136.0, 128.5, 128.5, 128.4, 128.2, 126.0, 66.1, 35.1, 33.6, 26.5.

HRMS (ESI-TOF): *m/z* calcd. for $C_{17}H_{18}O_2Na^+$ ([M+Na^+]) 277.1204, found 277.1207.



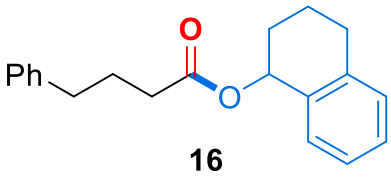
15

2-((3-Methoxyphenyl)dimethylsilyl)benzyl 4-phenylbutanoate (15) Prepared according to the general procedure. The crude product was purified by silica gel chromatography (PE/EA = 50:1) to afford the title compound as a colorless oil (66.9 mg, 80% yield).

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.63 (d, *J* = 6.5 Hz, 1H), 7.52 - 7.39 (m, 3H), 7.36 - 7.28 (m, 3H), 7.27 - 7.16 (m, 3H), 7.12 - 7.04 (m, 2H), 7.01 - 6.88 (m, 1H), 5.07 (s, 2H), 3.82 (s, 3H), 2.65 (t, 2H), 2.27 (t, 2H), 1.95 (t, 2H), 0.66 (d, *J* = 0.6 Hz, 6H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 173.0, 159.0, 141.4, 141.3, 140.1, 137.0, 135.7, 129.8, 129.4, 129.1, 128.4, 128.3, 127.6, 126.2, 125.9, 119.6, 114.2, 66.4, 55.0, 35.1, 33.4, 26.3, -1.1.

HRMS (ESI-TOF): *m/z* calcd. for $C_{26}H_{30}O_3SiNa^+$ ([M+Na^+]) 441.1861, found 441.1866.



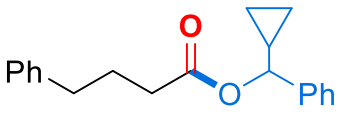
16

1,2,3,4-Tetrahydronaphthalen-1-yl 4-phenylbutanoate (16) Prepared according to the general procedure. The crude product was purified by silica gel chromatography (PE/EA = 200:1) to afford the title compound as a colorless oil (41.2 mg, 70% yield).

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.29 - 7.03 (m, 9H), 5.98 (t, *J* = 4.3 Hz, 1H), 2.90 - 2.67 (m, 2H), 2.65 - 2.54 (m, 2H), 2.31 (t, *J* = 7.5 Hz, 2H), 2.00 - 1.70 (m, 6H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 173.1, 160.7, 141.4, 137.9, 134.6, 129.4, 129.1, 128.5, 128.3, 128.0, 126.0, 125.9, 69.8, 35.1, 34.1, 29.1, 28.9, 26.7, 18.8.

HRMS (ESI-TOF): *m/z* calcd. for $C_{20}H_{22}O_2Na^+$ ([M+Na^+]) 317.1517, found 317.1525.



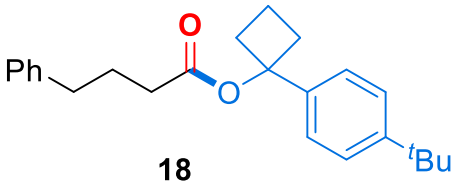
17

Cyclopropyl(phenyl)methyl 4-phenylbutanoate (17) Prepared according to the general procedure. The crude product was purified by silica gel chromatography (PE/EA = 200:1) to afford the title compound as a colorless oil (51.2 mg, 87% yield).

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.33 - 7.16 (m, 7H), 7.14 - 7.04 (m, 3H), 5.17 (d, *J* = 8.7 Hz, 2H), 2.61 - 2.50 (m, 2H), 2.30 (td, *J* = 7.4, 2.5 Hz, 2H), 1.96 - 1.80 (m, 2H), 1.34 - 1.15 (m, 1H), 0.61 - 0.39 (m, 3H), 0.38 - 0.25 (m, 1H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 172.8, 141.5, 140.5, 128.5, 128.4, 127.9, 126.6, 126.0, 79.6, 35.1, 34.0, 26.7, 16.6, 4.1, 3.1.

HRMS (ESI-TOF): *m/z* calcd. for $C_{20}H_{22}O_2Na^+$ ([M+Na^+]) 317.1517, found 317.1513.



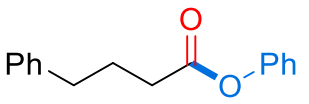
18

1-(4-(*tert*-Butyl)phenyl)cyclobutyl 4-phenylbutanoate (18) Prepared according to the general procedure. The crude product was purified by silica gel chromatography (PE/EA = 200:1) to afford the title compound as a colorless oil (22 mg, 31% yield).

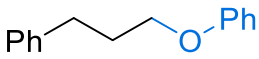
^{1}H NMR (300 MHz, $CDCl_3$) δ 7.37 - 7.23 (m, 4H), 7.24 - 7.14 (m, 2H), 7.15 - 7.00 (m, 3H), 2.68 - 2.42 (m, 6H), 2.18 (t, 2H), 1.94 - 1.58 (m, 4H), 1.23 (s, 9H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 172.0, 150.0, 141.5, 139.5, 128.5, 128.4, 125.9, 125.4, 125.1, 82.1, 35.0, 34.9, 34.5, 34.2, 31.4, 26.5, 14.3.

HRMS (ESI-TOF): *m/z* calcd. for $C_{24}H_{30}O_2Na^+$ ([M+Na^+]) 373.2143, found 373.2142.



20

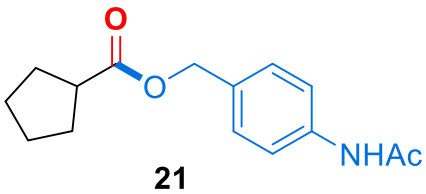


20'

Phenyl 4-phenylbutanoate (20) and **(3-phenoxypropyl)benzene (20')** Prepared according to the general procedure. The crude product was purified by silica gel chromatography (PE/EA = 200:1) to afford the title compounds as colorless oil (43 mg, 29% and 68% yield respectively).

^{1}H NMR (300 MHz, $CDCl_3$) mixture of **20** and **20'**, see the NMR Spectrum.

^{13}C NMR (75 MHz, $CDCl_3$) mixture of **20** and **20'**, see the NMR Spectrum.



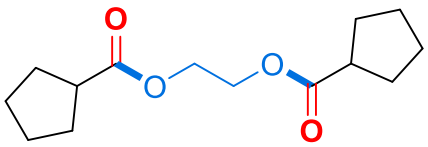
21

4-Acetamidobenzyl cyclopentanecarboxylate (21) Prepared according to the general procedure. The crude product was purified by silica gel chromatography (PE/EA = 3:1) to afford the title compound as a colorless oil (25 mg, 48% yield).

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.49 (d, *J* = 8.5 Hz, 2H), 7.38 (s, 1H), 7.30 (d, *J* = 8.4 Hz, 2H), 5.06 (s, 2H), 2.85 - 2.68 (m, 1H), 2.17 (s, 3H), 2.00 - 1.47 (m, 8H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 176.6, 168.4, 137.7, 132.2, 128.9, 119.8, 65.6, 43.8, 30.0, 25.8, 24.6.

HRMS (ESI-TOF): *m/z* calcd. for $C_{15}H_{19}NO_3Na^+$ ([M+Na^+]) 284.1262, found 284.1257.



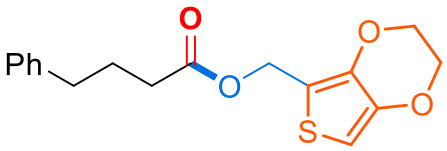
22

Ethane-1,2-diyl dicyclopentanecarboxylate (22) Prepared according to the general procedure. The crude product was purified by silica gel chromatography (PE/EA = 200:1) to afford the title compound as a colorless oil (21 mg, 83% yield).

^{1}H NMR (300 MHz, $CDCl_3$) δ 4.27 (s, 4H), 2.82 - 2.66 (m, 2H), 1.97 - 1.51 (m,16H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 176.5, 62.0, 43.7, 29.9, 25.8.

HRMS (ESI-TOF): *m/z* calcd. for $C_{14}H_{22}O_4Na^+$ ([M+Na^+]) 277.1415, found 277.1414.



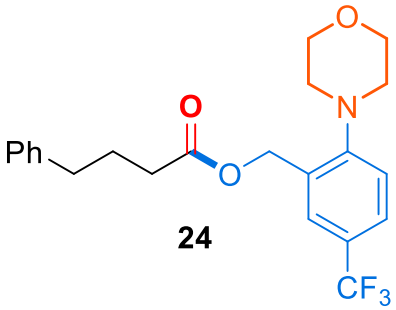
23

(2,3-Dihydrothieno[3,4-*b*][1,4]dioxin-5-yl)methyl 4-phenylbutanoate (23) Prepared according to the general procedure. The crude product was purified by silica gel chromatography (PE/EA = 100:1) to afford the title compound as a light-yellow oil (28 mg, 44% yield).

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.33 - 7.22 (m, 2H), 7.23 - 7.12 (m, 3H), 6.34 (s, 1H), 5.12 (s, 2H), 4.27 - 4.14 (m, 4H), 2.64 (t, 2H), 2.35 (t, *J* = 7.4 Hz, 2H), 2.04 - 1.88 (m, 2H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 173.4, 141.4, 141.2, 140.6, 128.5, 128.4, 126.0, 110.9, 100.1, 64.8, 64.5, 56.7, 35.1, 33.6, 26.5.

HRMS (ESI-TOF): *m/z* calcd. for $C_{17}H_{18}O_4SNa^+$ ([M+Na^+]) 341.0823, found 341.0831.



24

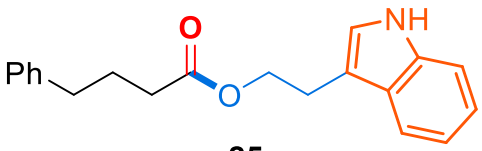
2-Morpholino-5-(trifluoromethyl)benzyl 4-phenylbutanoate (24) Prepared according to the general procedure. The crude product was purified by silica gel chromatography (PE/EA = 100:1) to afford the title compound as a light-yellow oil (67 mg, 82% yield).

δ 7.68 (s, 1H), 7.60 (dd, *J* = 8.5, 1.6 Hz, 1H), 7.37 - 7.25 (m, 2H), 7.26 - 7.17 (m, 4H), 5.27 (s, 2H), 3.94 - 3.81 (m, 4H), 3.03 - 2.93 (m, 4H), 2.70 (t, 2H), 2.45 (t, *J* = 7.4 Hz, 2H), 2.05 (q, *J* = 7.7 Hz, 2H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 173.2, 154.2, 141.1, 131.4, 128.4, 128.4, 126.6 (q, *J* = 3.8 Hz), 126.1, 125.7, 124.1 (q, *J* = 269.3 Hz), 120.1, 119.8, 77.4, 77.0, 76.6, 67.1, 61.5, 52.9, 35.0, 33.5, 26.4.

^{19}F NMR (282 MHz, $CDCl_3$) δ -62.0.

HRMS (ESI-TOF): *m/z* calcd. for $C_{22}H_{24}F_3NO_3H^+$ ([M+H^+]) 408.1786, found 408.1780.



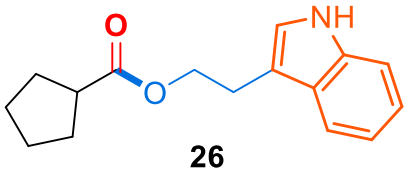
25

2-(1*H*-Indol-3-yl)ethyl 4-phenylbutanoate (25) Prepared according to the general procedure. The crude product was purified by silica gel chromatography (PE/EA = 5:1) to afford the title compound as a light-yellow oil (25.2 mg, 41% yield).

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.92 (s, 1H), 7.60 - 7.51 (m, 1H), 7.32 - 7.22 (m, 1H), 7.25 - 7.10 (m, 2H), 7.15 - 6.99 (m, 5H), 6.94 (d, *J* = 2.4 Hz, 1H), 4.28 (t, *J* = 7.2 Hz, 2H), 3.02 (td, *J* = 7.2, 0.9 Hz, 2H), 2.67 - 2.44 (m, 2H), 2.25 (t, *J* = 7.5 Hz, 2H), 1.95 - 1.76 (m, 2H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 173.5, 141.4, 136.2, 128.5, 128.3, 127.4, 125.9, 122.1, 122.0, 119.4, 118.8, 112.1, 111.1, 64.4, 35.1, 33.7, 26.5, 24.8.

HRMS (ESI-TOF): *m/z* calcd. for $C_{20}H_{21}NO_2Na^+$ ([M+Na$^+$]) 330.1469, found 330.1467.



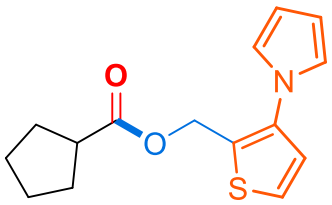
26

2-(1*H*-Indol-3-yl)ethyl cyclopentanecarboxylate (26) Prepared according to the general procedure. The crude product was purified by silica gel chromatography (PE/EA = 5:1) to afford the title compound as a yellow oil (24 mg, 47% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.08 (s, 1H), 7.66 (dd, *J* = 7.9, 0.7 Hz, 1H), 7.36 (d, *J* = 8.1 Hz, 1H), 7.25 - 7.17 (m, 1H), 7.19 - 7.10 (m, 1H), 7.04 (d, *J* = 2.4 Hz, 1H), 4.37 (t, *J* = 7.2 Hz, 2H), 3.11 (t, *J* = 7.2 Hz, 2H), 2.83 - 2.69 (m, 1H), 1.96 - 1.67 (m, 6H), 1.64 - 1.54 (m, 2H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 176.9, 136.1, 127.4, 122.0, 122.0, 119.3, 118.8, 112.1, 111.1, 64.4, 43.9, 30.0, 25.8, 24.8.

HRMS (ESI-TOF): *m/z* calcd. for $C_{16}H_{19}NO_2Na^+$ ([M+Na$^+$]) 280.1313, found 280.1319.



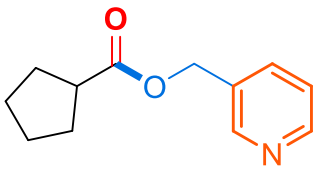
27

(3-(1*H*-Pyrrol-1-yl)thiophen-2-yl)methyl cyclopentanecarboxylate (27) Prepared according to the general procedure. The crude product was purified by silica gel chromatography (PE/EA = 20:1) to afford the title compound as a light-yellow oil (49 mg, 89% yield).

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.34 (d, *J* = 5.3 Hz, 1H), 7.03 (d, *J* = 5.3 Hz, 1H), 6.93 (t, *J* = 2.0 Hz, 2H), 6.33 (t, *J* = 2.0 Hz, 2H), 5.18 (s, 2H), 2.87 - 2.71 (m, 1H), 2.02 - 1.49 (m, 8H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 176.3, 139.1, 126.3, 125.8, 124.4, 121.8, 109.6, 57.6, 43.6, 29.9, 25.8.

HRMS (ESI-TOF): *m/z* calcd. for $C_{15}H_{17}NO_2SNa^+$ ([M+Na$^+$]) 298.0877, found 298.0873.



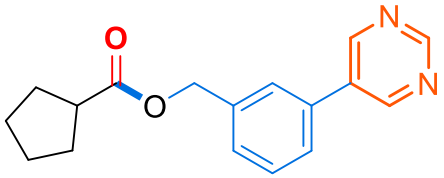
28

Pyridin-3-ylmethyl cyclopentanecarboxylate (28) Prepared according to the general procedure. The crude product was purified by silica gel chromatography (PE/EA = 3:1) to afford the title compound as a light-yellow oil (37 mg, 90% yield).

^{1}H NMR (300 MHz, $CDCl_3$) δ 8.60 - 8.43 (m, 2H), 7.62 (dt, *J* = 7.8, 1.9 Hz, 1H), 7.31 - 7.15 (m, 1H), 5.06 (s, 2H), 2.71 (m, 1H), 1.93 - 1.39 (m, 8H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 176.3, 149.3, 135.8, 131.9, 123.4, 63.4, 43.6, 29.9, 25.7.

HRMS (ESI-TOF): *m/z* calcd. for $C_{12}H_{15}NO_2H^+$ ([M+H$^+$]) 206.1181, found 206.1183.



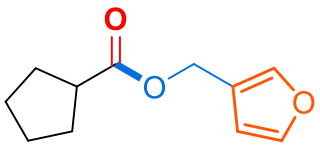
29

3-(Pyrimidin-5-yl)benzyl cyclopentanecarboxylate (29) Prepared according to the general procedure. The crude product was purified by silica gel chromatography (PE/EA = 2:1) to afford the title compound as a light-yellow oil (46 mg, 82% yield).

^{1}H NMR (300 MHz, $CDCl_3$) δ 9.20 (s, 1H), 8.94 (s, 2H), 7.58 - 7.39 (m, 4H), 5.19 (s, 2H), 2.80 (p, *J* = 7.9 Hz, 1H), 2.00 - 1.48 (m, 8H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 176.4, 157.5, 154.9, 137.8, 134.6, 134.0, 129.6, 128.4, 126.6, 126.4, 65.5, 43.7, 30.0, 25.7.

HRMS (ESI-TOF): *m/z* calcd. for $C_{17}H_{18}N_2O_2H^+$ ([M+H$^+$]) 283.1447, found 283.1443.



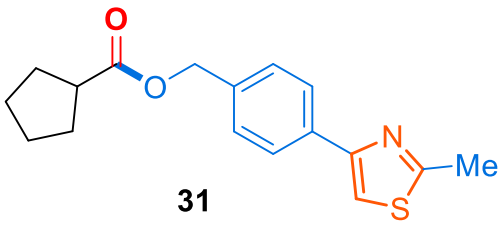
30

Furan-3-ylmethyl cyclopentanecarboxylate (30) Prepared according to the general procedure. The crude product was purified by silica gel chromatography (PE/EA = 100:1) to afford the title compound as a colorless oil (31 mg, 80% yield).

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.49 - 7.42 (m, 1H), 7.42 - 7.35 (m, 1H), 6.41 (dd, *J* = 1.8, 0.9 Hz, 1H), 4.98 (s, 2H), 2.82 - 2.63 (m, 1H), 1.95 - 1.51 (m, 8H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 176.6, 143.3, 141.3, 120.7, 110.4, 57.5, 43.7, 29.9, 25.8.

HRMS (EI): *m/z* calcd. for $C_{11}H_{14}O_3$• ([M+•]) 194.09375, found 194.09389.



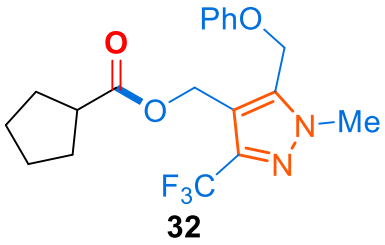
31

4-(2-Methylthiazol-4-yl)benzyl cyclopentanecarboxylate (31) Prepared according to the general procedure. The crude product was purified by silica gel chromatography (PE/EA = 10:1) to afford the title compound as a colorless oil (42 mg, 70% yield).

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.91 - 7.81 (m, 2H), 7.44 - 7.34 (m, 2H), 7.31 (s, 1H), 5.13 (s, 2H), 2.87 - 2.70 (m, 4H), 1.99 - 1.48 (m, 8H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 176.5, 165.9, 154.6, 136.0, 134.3, 128.4, 126.4, 112.5, 77.4, 77.0, 76.6, 65.7, 43.8, 30.0, 25.8, 19.3.

HRMS (ESI-TOF): *m/z* calcd. for $C_{17}H_{19}NO_2SH^+$ ([M+H$^+$]) 302.1215, found 302.1205.



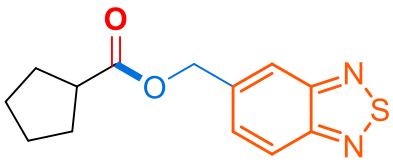
32

(1-Methyl-5-(phenoxymethyl)-3-(trifluoromethyl)-1*H*-pyrazol-4-yl)methyl cyclopentanecarboxylate (32) Prepared according to the general procedure. The crude product was purified by silica gel chromatography (PE/EA = 20:1) to afford the title compound as a colorless oil (70 mg, 92% yield).

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.39 - 7.27 (m, 2H), 7.19 - 7.08 (m, 1H), 6.98 - 6.87 (m, 2H), 4.82 (s, 2H), 3.70 (s, 3H), 2.65 - 2.49 (m, 1H), 1.85 - 1.41 (m, 8H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 176.1, 156.4, 148.4, 139.67 (q, *J* =38.25 Hz), 130.1, 124.2, 120.95 (q, *J* = 268.5), 115.4, 102.2, 102.2, 53.9, 43.5, 35.2, 29.7, 25.7.

^{19}F NMR (282 MHz, $CDCl_3$) δ -62.1.



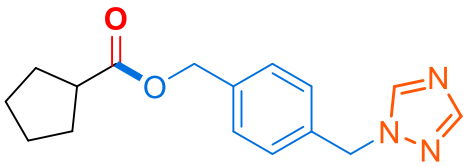
33

Benzo[*c*][1,2,5]thiadiazol-5-ylmethyl cyclopentanecarboxylate (33) Prepared according to the general procedure. The crude product was purified by silica gel chromatography (PE/EA = 20:1) to afford the title compound as a light-yellow oil (37 mg, 71% yield).

^{1}H NMR (300 MHz, $CDCl_3$) δ 8.04 - 7.94 (m, 2H), 7.55 (dd, *J* = 9.0, 1.7 Hz, 1H), 5.28 (s, 2H), 2.93 - 2.76 (m, 1H), 2.02 - 1.53 (m, 8H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 176.4, 154.8, 154.4, 138.2, 129.3, 121.6, 119.7, 65.2, 43.8, 30.0, 25.8.

HRMS (ESI-TOF): *m/z* calcd. for $C_{13}H_{14}N_2O_2SH^+$ ([M+H$^+$]) 263.0854, found 263.0850.



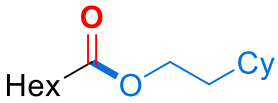
34

4-((1*H*-1,2,4-triazol-1-yl)methyl)benzyl cyclopentanecarboxylate (34) Prepared according to the general procedure. The crude product was purified by silica gel chromatography (DCM/MeOH = 10:1) to afford the title compound as a light-yellow oil (50.2 mg, 88% yield).

^{1}H NMR (300 MHz, $CDCl_3$) δ 8.12 (s, 1H), 7.99 (s, 1H), 7.37 (d, *J* = 8.2 Hz, 2H), 7.27 (d, *J* = 8.4 Hz, 2H), 5.36 (s, 2H), 5.11 (s, 2H), 2.87 - 2.70 (m, 1H), 2.00 - 1.48 (m, 8H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 176.4, 152.0, 143.0, 137.0, 134.3, 128.5, 128.2, 65.3, 53.2, 43.7, 29.9, 25.7.

HRMS (ESI-TOF): *m/z* calcd. for $C_{16}H_{19}N_3O_2H^+$ ([M+H$^+$]) 286.1555, found 286.1558.



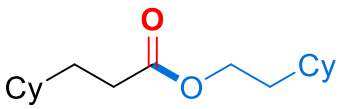
35

2-Cyclohexylethyl 2-oxoheptanoate (35) Prepared according to the general procedure. The crude product was purified by silica gel chromatography (PE/EA = 200:1) to afford the title compound as a colorless oil (44 mg, 92% yield).

^{1}H NMR (300 MHz, $CDCl_3$) δ 4.08 (t, *J* = 6.9 Hz, 2H), 2.27 (t, *J* = 7.5 Hz, 2H), 1.76 - 1.55 (m, 7H), 1.50 (q, *J* = 6.8 Hz, 2H), 1.40 - 1.12 (m, 10H), 1.02 - 0.81 (m, 5H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 174.0, 62.5, 36.0, 34.5, 34.4, 33.1, 31.4, 28.8, 26.4, 26.2, 24.9, 22.5, 14.0.

HRMS (ESI-TOF): *m/z* calcd. for $C_{15}H_{28}O_2Na^+$ ([M+Na$^+$]) 263.1982, found 263.1988.

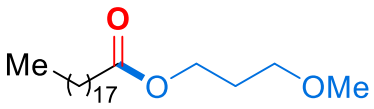


36

2-Cyclohexylethyl 3-cyclohexylpropanoate (36) Prepared according to the general procedure. The crude product was purified by silica gel chromatography (PE/EA = 200:1) to afford the title compound as a colorless oil (48 mg, 90% yield).

^{1}H NMR (300 MHz, $CDCl_3$) δ 4.08 (t, *J* = 6.8 Hz, 2H), 2.29 (t, 2H), 1.69 (m, 10H), 1.57 - 1.44 (m, 4H), 1.38 - 1.12 (m, 8H), 1.02 - 0.78 (m, 4H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 174.3, 62.5, 37.2, 36.0, 34.5, 33.1, 32.9, 32.4, 32.0, 26.5, 26.5, 26.2, 26.2.



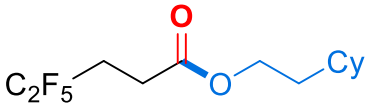
37

3-Methoxypropyl nonadecanoate (37) Prepared according to the general procedure. The crude product was purified by silica gel chromatography (PE/EA = 200:1) to afford the title compound as a colorless oil (56 mg, 76% yield).

^{1}H NMR (300 MHz, $CDCl_3$) δ 4.14 (t, *J* = 6.5 Hz, 2H), 3.43 (t, *J* = 6.3 Hz, 2H), 3.32 (s, 3H), 2.28 (t, *J* = 7.5 Hz, 2H), 1.88 (p, *J* = 6.4 Hz, 2H), 1.59 (dt, *J* = 14.5, 7.2 Hz, 2H), 1.31 - 1.19 (m, 30H), 0.92 - 0.81 (t, 3H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 173.8, 69.1, 61.3, 58.6, 34.3, 31.9, 29.7, 29.6, 29.6, 29.4, 29.3, 29.2, 29.1, 29.0, 25.0, 22.7, 14.1.

HRMS (ESI-TOF): *m/z* calcd. for $C_{23}H_{46}O_3Na^+$ ([M+Na^+]) 393.3339, found 393.3339.



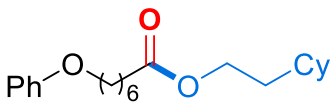
38

2-Cyclohexylethyl 4,4,5,5,5-pentafluoropentanoate (38) Prepared according to the general procedure. The crude product was purified by silica gel chromatography (PE/EA = 200:1) to afford the title compound as a colorless oil (28 mg, 46% yield).

^{1}H NMR (300 MHz, $CDCl_3$) δ 4.15 (t, *J* = 6.9 Hz, 2H), 2.61 (t, 2H), 2.52 - 2.30 (m, 2H), 1.78 - 1.57 (m, 5H), 1.53 (q, *J* = 6.9 Hz, 2H), 1.38 - 1.14 (m, 4H), 1.02 - 0.80 (m, 2H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 171.1, 77.4, 77.0, 76.6, 63.5, 35.8, 34.5, 33.1, 26.4, 26.2 (t, *J* = 22.5 Hz), 26.1, 25.6 (t, *J* = 3.75 Hz)

^{19}F NMR (282 MHz, $CDCl_3$) δ -85.5, -118.8.



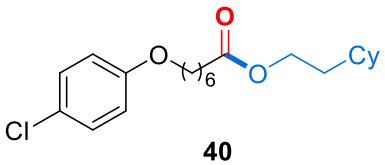
39

2-Cyclohexylethyl 7-phenoxyheptanoate (39) Prepared according to the general procedure. The crude product was purified by silica gel chromatography (PE/EA = 200:1) to afford the title compound as a colorless oil (50 mg, 75% yield).

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.30 (dd, *J* = 8.7, 7.3 Hz, 2H), 7.01 - 6.87 (m, 3H), 4.13 (t, *J* = 6.9 Hz, 2H), 3.98 (t, *J* = 6.5 Hz, 2H), 2.34 (t, *J* = 7.4 Hz, 2H), 1.90 - 1.63 (m, 9H), 1.61 - 1.14 (m, 11H), 1.05 - 0.86 (m, 2H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 173.8, 159.0, 129.3, 120.4, 114.4, 67.6, 62.5, 36.0, 34.5, 34.3, 33.1, 29.1, 28.8, 26.4, 26.2, 25.7, 24.9.

HRMS (ESI-TOF): *m/z* calcd. for $C_{21}H_{32}O_3Na^+$ ([M+Na^+]) 355.2249, found 355.2245.



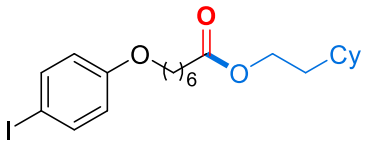
40

2-Cyclohexylethyl 7-(4-chlorophenoxy)heptanoate (40) Prepared according to the general procedure. The crude product was purified by silica gel chromatography (PE/EA = 200:1) to afford the title compound as a colorless oil (52 mg, 71% yield).

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.26 - 7.15 (m, 2H), 6.85 - 6.74 (m, 2H), 4.09 (t, *J* = 6.9 Hz, 2H), 3.90 (t, *J* = 6.4 Hz, 2H), 2.30 (t, *J* = 7.4 Hz, 2H), 1.84 - 1.57 (m, 9H), 1.56 - 1.15 (m, 10H), 1.02 - 0.82 (m, 2H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 173.7, 157.6, 129.2, 125.3, 115.7, 68.0, 62.5, 35.9, 34.5, 34.2, 33.1, 28.9, 28.8, 26.4, 26.2, 25.6, 24.8.

HRMS (ESI-TOF): *m/z* calcd. for $C_{21}H_{31}O_3ClNa^+$ ([M+Na$^+$]) 389.1854, found 389.1859.



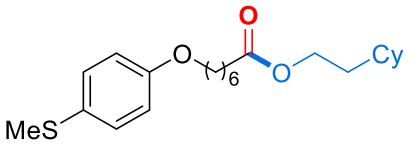
41

2-Cyclohexylethyl 7-(4-iodophenoxy)heptanoate (41) Prepared according to the general procedure. The crude product was purified by silica gel chromatography (PE/EA = 200:1) to afford the title compound as a colorless oil (62.3 mg, 68% yield).

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.59 - 7.48 (m, 2H), 6.72 - 6.61 (m, 2H), 4.10 (t, *J* = 6.9 Hz, 2H), 3.90 (t, *J* = 6.5 Hz, 2H), 2.30 (t, *J* = 7.4 Hz, 2H), 1.84 - 1.13 (m, 19H), 1.01 - 0.82 (m, 2H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 173.8, 158.9, 138.1, 116.9, 82.4, 67.9, 62.6, 36.0, 34.6, 34.3, 33.1, 31.4, 30.2, 28.9, 28.8, 26.5, 26.2, 25.7, 24.9.

HRMS (ESI-TOF): *m/z* calcd. for $C_{21}H_{31}O_3IH^+$ ([M+H$^+$]) 459.1396, found 459.1405.



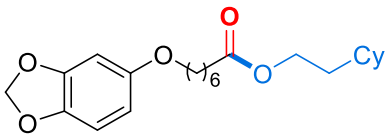
42

2-Cyclohexylethyl 7-(4-(methylthio)phenoxy)heptanoate (42) Prepared according to the general procedure. The crude product was purified by silica gel chromatography (PE/EA = 200:1) to afford the title compound as a colorless oil (45 mg, 60% yield).

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.35 - 7.22 (m, 2H), 6.91 - 6.80 (m, 2H), 4.12 (t, *J* = 6.9 Hz, 2H), 3.94 (t, *J* = 6.5 Hz, 2H), 2.46 (s, 3H), 2.33 (t, *J* = 7.4 Hz, 2H), 1.87 - 1.60 (m, 9H), 1.63 - 1.10 (m, 10H), 1.04 - 0.82 (m, 2H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 173.8, 157.7, 130.2, 128.5, 115.2, 67.9, 62.5, 36.0, 34.5, 34.3, 33.1, 29.0, 28.8, 26.4, 26.2, 25.7, 24.9, 18.1.

HRMS (ESI-TOF): *m/z* calcd. for $C_{22}H_{34}O_3SNa^+$ ([M+Na$^+$]) 401.2121, found 401.2122.



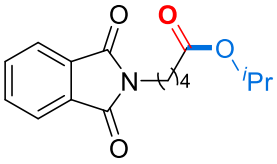
43

2-Cyclohexylethyl 7-(benzo[*d*][1,3]dioxol-5-yloxy)heptanoate (43) Prepared according to the general procedure. The crude product was purified by silica gel chromatography (PE/EA = 50:1) to afford the title compound as a light-yellow oil (69 mg, 92% yield).

^{1}H NMR (300 MHz, $CDCl_3$) δ 6.68 (d, *J* = 8.4 Hz, 1H), 6.47 (d, *J* = 2.5 Hz, 1H), 6.30 (dd, *J* = 8.5, 2.5 Hz, 1H), 5.89 (s, 2H), 4.09 (t, *J* = 6.9 Hz, 2H), 3.86 (t, *J* = 6.4 Hz, 2H), 2.30 (t, *J* = 7.4 Hz, 2H), 1.81 - 1.57 (m, 9H), 1.55 - 1.12 (m, 10H), 1.01 - 0.80 (m, 2H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 173.8, 154.6, 148.1, 141.4, 107.8, 105.6, 101.0, 98.0, 68.7, 62.5, 35.9, 34.5, 34.2, 33.1, 29.1, 28.8, 26.4, 26.1, 25.7, 24.8.

HRMS (ESI-TOF): *m/z* calcd. for $C_{22}H_{32}O_5Na^+$ ([M+Na^+]) 399.2142, found 399.2144.



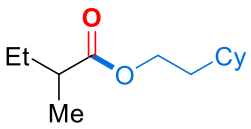
44

Isopropyl 5-(1,3-dioxoisoindolin-2-yl)pentanoate (44) Prepared according to the general procedure. The crude product was purified by silica gel chromatography (PE/EA = 5:1) to afford the title compound as a light-yellow oil (26 mg, 45% yield).

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.87 - 7.79 (m, 2H), 7.76 - 7.64 (m, 2H), 4.98 (hept, *J* = 6.3 Hz, 1H), 3.69 (t, *J* = 6.9 Hz, 2H), 2.38 - 2.26 (m, 2H), 1.80 - 1.57 (m, 4H), 1.22 (s, 3H), 1.20 (s, 3H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 172.7, 168.3, 133.9, 132.1, 123.2, 67.6, 37.5, 34.0, 28.0, 22.2, 21.8.

HRMS (ESI-TOF): *m/z* calcd. for $C_{16}H_{19}NO_4Na^+$ ([M+Na^+]) 312.1211, found 312.1213.

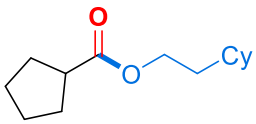


45

2-Cyclohexylethyl 2-methylbutanoate (45) Prepared according to the general procedure. The crude product was purified by silica gel chromatography (PE/EA = 200:1) to afford the title compound as a colorless oil (40 mg, 94% yield).

^{1}H NMR (300 MHz, $CDCl_3$) δ 4.09 (td, *J* = 6.9, 1.0 Hz, 2H), 2.34 (h, *J* = 7.0 Hz, 1H), 1.79 - 1.58 (m, 6H), 1.57 - 1.17 (m, 7H), 1.12 (d, *J* = 7.0 Hz, 3H), 1.01 - 0.78 (m, 5H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 176.8, 62.4, 41.1, 36.0, 34.6, 33.1, 26.8, 26.5, 26.2, 16.6, 11.6.



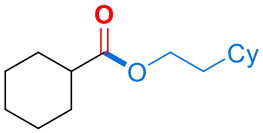
46

2-Cyclohexylethyl cyclopentanecarboxylate (46) Prepared according to the general procedure. The crude product was purified by silica gel chromatography (PE/EA = 200:1) to afford the title compound as a colorless oil (42.6 mg, 95% yield).

^{1}H NMR (300 MHz, $CDCl_3$) δ 4.09 (t, *J* = 6.9 Hz, 2H), 2.79 - 2.62 (m, 1H), 2.00 - 1.57 (m, 11H), 1.55 - 1.43 (m, 2H), 1.43 - 1.13 (m, 4H), 1.01 - 0.82 (m, 2H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 176.9, 62.5, 43.9, 36.0, 34.6, 33.1, 30.0, 26.5, 26.2, 25.8.

HRMS (ESI-TOF): *m/z* calcd. for $C_{14}H_{24}O_2Na^+$ ([M+Na^+]) 247.1673, found 247.1677.



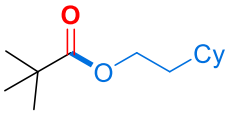
47

2-Cyclohexylethyl cyclohexanecarboxylate (47) Prepared according to the general procedure. The crude product was purified by silica gel chromatography (PE/EA = 200:1) to afford the title compound as a colorless oil (46 mg, 97% yield).

^{1}H NMR (300 MHz, $CDCl_3$) δ 4.07 (t, *J* = 6.8 Hz, 2H), 2.26 (tt, *J* = 11.2, 3.6 Hz, 1H), 1.94 - 1.82 (m, 2H), 1.79 - 1.58 (m, 8H), 1.54 - 1.12 (m, 11H), 1.02 - 0.80 (m, 2H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 176.2, 62.3, 43.2, 36.0, 34.6, 33.1, 29.0, 26.4, 26.2, 25.7, 25.4.

HRMS (ESI-TOF): *m/z* calcd. for $C_{15}H_{26}O_2Na^+$ ([M+Na^+]) 261.1830, found 261.1829.



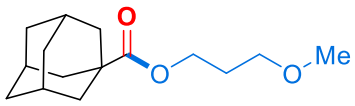
48

2-Cyclohexylethyl pivalate (48) Prepared according to the general procedure. The crude product was purified by silica gel chromatography (PE/EA = 200:1) to afford the title compound as a colorless oil (32 mg, 76% yield).

^{1}H NMR (300 MHz, $CDCl_3$) δ 4.08 (t, *J* = 6.8 Hz, 2H), 1.76 - 1.61 (m, 6H), 1.52 (q, *J* = 6.8 Hz, 2H), 1.43 - 1.21 (m, 3H), 1.19 (s, 9H), 1.00 - 0.83 (m, 2H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 178.7, 62.7, 38.7, 35.9, 34.7, 33.2, 27.2, 26.5, 26.2.

HRMS (ESI-TOF): *m/z* calcd. for $C_{13}H_{24}O_2Na^+$ ([M+Na^+]) 235.1673, found 235.1674.



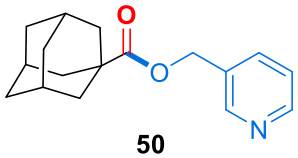
49

3-Methoxypropyl (1-adamantane) carboxylate (49) Prepared according to the general procedure. The crude product was purified by silica gel chromatography (PE/EA = 20:1) to afford the title compound as a colorless oil (20 mg, 40% yield).

^{1}H NMR (300 MHz, $CDCl_3$) δ 4.13 (t, *J* = 6.4 Hz, 2H), 3.44 (t, *J* = 6.4 Hz, 2H), 3.33 (s, 3H), 2.06 - 1.83 (m, 11H), 1.79 - 1.59 (m, 6H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 177.6, 69.2, 61.1, 58.7, 40.7, 38.8, 36.5, 29.0, 27.9.

HRMS (ESI-TOF): *m/z* calcd. for $C_{15}H_{24}O_3H^+$ ([M+H$^+$]) 253.1803, found 253.1804.



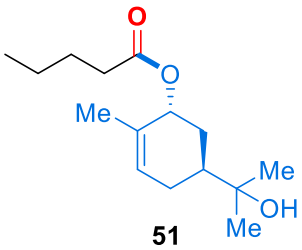
50

Pyridin-3-ylmethyl (1-adamantane) carboxylate (50) Prepared according to the general procedure. The crude product was purified by silica gel chromatography (PE/EA = 3:1) to afford the title compound as a light-yellow oil (25 mg, 46% yield).

^{1}H NMR (300 MHz, $CDCl_3$) δ 8.64 - 8.52 (m, 2H), 7.72 - 7.62 (m, 1H), 7.35 - 7.25 (m, 1H), 5.11 (s, 2H), 2.05 - 1.96 (m, 3H), 1.90 (d, *J* = 3.0 Hz, 6H), 1.78 - 1.61 (m, 6H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 177.3, 149.2, 149.1, 135.7, 132.3, 123.5, 63.2, 40.8, 38.8, 36.4, 27.9.

HRMS (ESI-TOF): *m/z* calcd. for $C_{17}H_{21}NO_2H^+$ ([M+H$^+$]) 272.1650, found 272.1657.



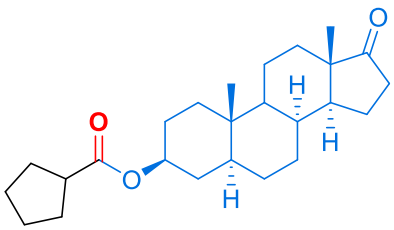
51

(1*R*,5*S*)-5-(2-Hydroxypropan-2-yl)-2-methylcyclohex-2-en-1-yl pentanoate (51) Prepared according to the general procedure. The crude product was purified by silica gel chromatography (PE/EA = 5:1) to afford the title compound as a colorless oil (20 mg, 40% yield).

^{1}H NMR (300 MHz, $CDCl_3$) δ 5.72 (dt, *J* = 5.6, 1.7 Hz, 1H), 5.31 - 5.23 (m, 1H), 2.37 - 2.26 (t, 2H), 2.26 - 2.10 (m, 1H), 1.99 (dq, *J* = 13.9, 2.2 Hz, 1H), 1.92 - 1.52 (m, 7H), 1.53 - 1.26 (m, 4H), 1.18 (s, 3H), 1.17 (s, 3H), 0.91 (t, *J* = 7.3 Hz, 3H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 173.7, 131.0, 127.8, 72.0, 70.5, 39.5, 34.5, 30.0, 27.3, 27.3, 26.8, 26.8, 22.2, 20.6, 13.7.

HRMS (ESI-TOF): *m/z* calcd. for $C_{15}H_{26}O_3Na^+$ ([M+Na$^+$]) 277.1779, found 277.1775.

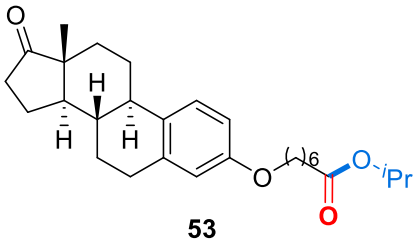


52

(3*S*,5*S*,8*S*,10*S*,13*S*,14*S*)-10,13-Dimethyl-17-oxohexadecahydro-1*H* cyclopenta[a]phenanthren-3-yl cyclopentanecarboxylate (52) Prepared according to the general procedure. The crude product was purified by silica gel chromatography (PE/EA = 20:1) to afford the title compound as a white solid (72 mg, 93% yield).

^{1}H NMR (300 MHz, $CDCl_3$) δ 4.75 - 4.58 (m, 1H), 2.74 - 2.58 (m, 1H), 2.42 (dd, *J* = 19.0, 8.8 Hz, 1H), 2.14 - 1.96 (m, 1H), 1.92 - 0.90 (m, 27H), 0.84 (s, 6H), 0.77 - 0.60 (m, 1H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 221.2, 176.3, 73.0, 54.2, 51.3, 47.7, 44.6, 44.0, 36.7, 35.8, 35.6, 35.0, 33.9, 31.5, 30.8, 30.0, 29.9, 28.2, 27.4, 25.8, 21.7, 20.4, 13.8, 12.2.



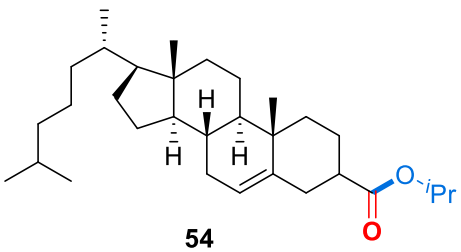
53

Isopropyl 7-(((8*S*,9*R*,13*R*,14*R*)-13-methyl-17-oxo-7,8,9,11,12,13,14,15,16,17-decahydro-6*H*-cyclopenta[a]phenanthren-3-yl)oxy)heptanoate (53) Prepared according to the general procedure. The crude product was purified by silica gel chromatography (PE/EA = 20:1) to afford the title compound as a light-yellow solid (50 mg, 57% yield).

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.18 (d, *J* = 8.1 Hz, 1H), 6.70 (dd, *J* = 8.6, 2.8 Hz, 1H), 6.63 (d, *J* = 2.7 Hz, 1H), 5.00 (hept, *J* = 6.3 Hz, 1H), 3.92 (t, *J* = 6.5 Hz, 2H), 2.88 (dd, *J* = 7.8, 3.2 Hz, 2H), 2.60 - 2.34 (m, 2H), 2.33 - 1.90 (m, 7H), 1.84 - 1.35 (m, 14H), 1.24 (s, 3H), 1.22 (s, 3H), 0.90 (s, 3H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 173.2, 157.1, 137.6, 131.8, 126.2, 114.5, 112.1, 67.7, 67.3, 50.4, 48.0, 43.9, 38.4, 35.8, 34.6, 31.6, 29.6, 29.1, 28.8, 26.5, 25.9, 25.7, 24.9, 21.8, 21.5, 13.8.

HRMS (ESI-TOF): *m/z* calcd. for $C_{28}H_{40}O_4H^+$ ([M+H$^+$]) 441.3005, found 441.3004.

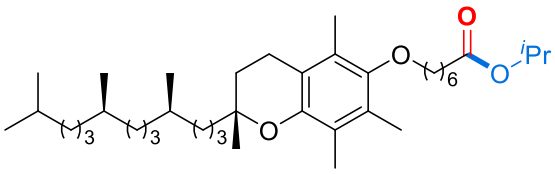


54

Isopropyl (8*R*,9*R*,10*S*,13*S*,14*R*,17*S*)-10,13-dimethyl-17-((*S*)-6-methylheptan-2-yl)-2,3,4,7,8,9,10,11,12,13,14,15,16,17-tetradecahydro-1*H*-cyclopenta[*a*]phenanthrene-3-carboxylate (54) Prepared according to the general procedure. The crude product was purified by silica gel chromatography (PE/EA = 100:1) to afford the title compound as a light-yellow oil (70 mg, 77% yield).

^{1}H NMR (300 MHz, $CDCl_3$) δ 5.39 - 5.30 (m, 1H), 4.99 (p, *J* = 6.3 Hz, 1H), 2.50 - 2.30 (m, 1H), 2.28 - 2.11 (m, 1H), 2.07 - 0.97 (m, 36H), 0.95 - 0.82 (m, 9H), 0.67 (s, 3H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 175.3, 141.1, 120.9, 67.2, 56.8, 56.2, 50.3, 44.9, 42.3, 39.8, 39.5, 38.8, 36.9, 36.2, 35.8, 34.9, 31.9, 31.8, 28.2, 28.0, 25.2, 24.3, 23.8, 22.8, 22.5, 21.8, 20.9, 19.3, 18.7, 11.8.

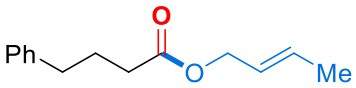


55

Iopropyl 7-(((*R*)-2,5,7,8-tetramethyl-2-((4*R*,8*R*)-4,8,12-trimethyltridecyl)chroman-6-yl)oxy)heptanoate (55) Prepared according to the general procedure. The crude product was purified by silica gel chromatography (PE/EA = 50:1) to afford the title compound as a light-yellow oil (68 mg, 57% yield).

^{1}H NMR (300 MHz, $CDCl_3$) δ 5.02 (hept, *J* = 6.3 Hz, 1H), 3.63 (t, *J* = 6.5 Hz, 2H), 2.58 (t, *J* = 6.8 Hz, 2H), 2.30 (t, *J* = 7.5 Hz, 2H), 2.17 (s, 3H), 2.12 (s, 3H), 2.09 (s, 3H), 1.87 - 1.05 (m, 40H), 0.92 - 0.81 (m, 12H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 173.3, 148.3, 147.6, 127.8, 125.7, 122.7, 117.4, 74.7, 72.9, 67.3, 40.1, 39.4, 37.4, 37.4, 37.3, 34.7, 32.8, 32.7, 31.3, 31.3, 30.2, 29.1, 28.0, 25.9, 25.0, 24.8, 24.8, 24.4, 23.9, 22.7, 22.6, 21.8, 21.0, 20.6, 19.7, 19.7, 12.7, 11.8, 11.8.

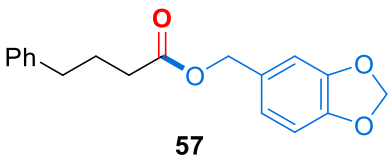


56

(*E*)-But-2-en-1-yl 4-phenylbutanoate (56) Prepared according to the general procedure. The crude product was purified by silica gel chromatography (PE/EA = 200:1) to afford the title compound as a colorless oil (22 mg, 50% yield).

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.26 - 7.15 (m, 2H), 7.17 - 7.06 (m, 3H), 5.83 - 5.57 (m, 1H), 5.62 - 5.40 (m, 1H), 4.47 - 4.38 (m, 2H), 2.63 - 2.52 (t, 2H), 2.26 (t, *J* = 7.5 Hz, 1H), 1.98 - 1.78 (m, 2H), 1.72 - 1.58 (m, 3H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 173.3, 141.4, 131.4, 128.5, 128.4, 125.9, 125.1, 65.1, 35.1, 33.6, 26.5, 17.8.



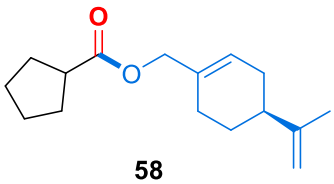
57

Benzo[*d*][1,3]dioxol-5-ylmethyl 4-phenylbutanoate (57) Prepared according to the general procedure. The crude product was purified by silica gel chromatography (PE/EA = 20:1) to afford the title compound as a light-yellow oil (40 mg, 67% yield).

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.36 - 7.25 (m, 2H), 7.27 - 7.14 (m, 3H), 6.93 - 6.74 (m, 3H), 5.98 (s, 2H), 5.03 (s, 2H), 2.67 (t, 2H), 2.39 (t, *J* = 7.5 Hz, 2H), 2.08 - 1.91 (m, 2H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 173.3, 147.8, 147.6, 141.3, 129.7, 128.5, 128.3, 125.9, 122.2, 109.0, 108.2, 101.1, 66.3, 66.1, 35.1, 33.6, 26.4.

HRMS (ESI-TOF): *m/z* calcd. for $C_{18}H_{18}O_4Na^+$ ([M+Na^+]) 321.1102, found 321.1107.



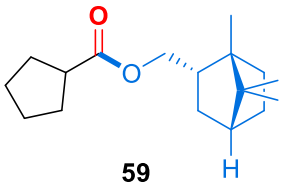
58

(*S*)-(4-(Prop-1-en-2-yl)cyclohex-1-en-1-yl)methyl cyclopentanecarboxylate (58) Prepared according to the general procedure. The crude product was purified by silica gel chromatography (PE/EA = 200:1) to afford the title compound as a colorless oil (45 mg, 91% yield).

^{1}H NMR (300 MHz, $CDCl_3$) δ 5.78 - 5.70 (m, 1H), 4.72 (m, 2H), 4.46 (s, 2H), 2.83 - 2.66 (m, 1H), 2.26 - 1.19 (m, 18H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 176.7, 149.7, 132.9, 125.3, 108.8, 68.2, 43.9, 40.9, 30.5, 30.1, 27.3, 27.2, 26.3, 25.8, 20.8.

HRMS (ESI-TOF): *m/z* calcd. for $C_{16}H_{24}O_2Na^+$ ([M+Na^+]) 271.1673, found 271.1675.

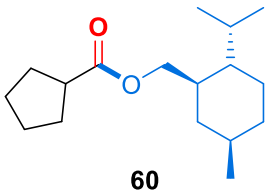


59

((1*S*,2*S*,4*R*)-1,7,7-Trimethylbicyclo[2.2.1]heptan-2-yl)methyl cyclopentanecarboxylate (59) Prepared according to the general procedure. The crude product was purified by silica gel chromatography (PE/EA = 200:1) to afford the title compound as a colorless oil (35 mg, 66% yield).

^{1}H NMR (300 MHz, $CDCl_3$) δ 4.93 - 4.82 (m, 1H), 2.83 - 2.64 (m, 1H), 2.45 - 2.26 (m, 1H), 2.04 - 1.51 (m, 12H), 1.39 - 1.14 (m, 3H), 0.90 (s, 3H), 0.86 (s, 3H), 0.82 (s, 3H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 177.0, 79.3, 48.8, 47.8, 44.9, 44.2, 36.8, 30.1, 29.9, 28.0, 27.1, 25.8, 25.7, 19.7, 18.8, 13.5.

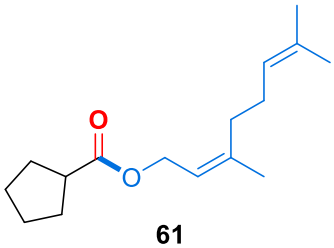


60

((1*R*,2*R*,5*R*)-2-Isopropyl-5-methylcyclohexyl)methyl cyclopentanecarboxylate (60) Prepared according to the general procedure. The crude product was purified by silica gel chromatography (PE/EA = 200:1) to afford the title compound as a colorless oil (32 mg, 60% yield).

^{1}H NMR (300 MHz, $CDCl_3$) δ 4.65 (td, *J* = 10.9, 4.4 Hz, 1H), 2.77 - 2.61 (m, 1H), 2.02 - 0.94 (m, 18H), 0.90 (d, *J* = 1.3 Hz, 3H), 0.88 (d, *J* = 1.9 Hz, 3H), 0.75 (d, *J* = 7.0 Hz, 3H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 176.3, 73.8, 47.1, 44.2, 40.9, 34.3, 31.4, 30.1, 29.9, 26.2, 25.8, 25.8, 23.4, 22.0, 20.8, 16.2.



61

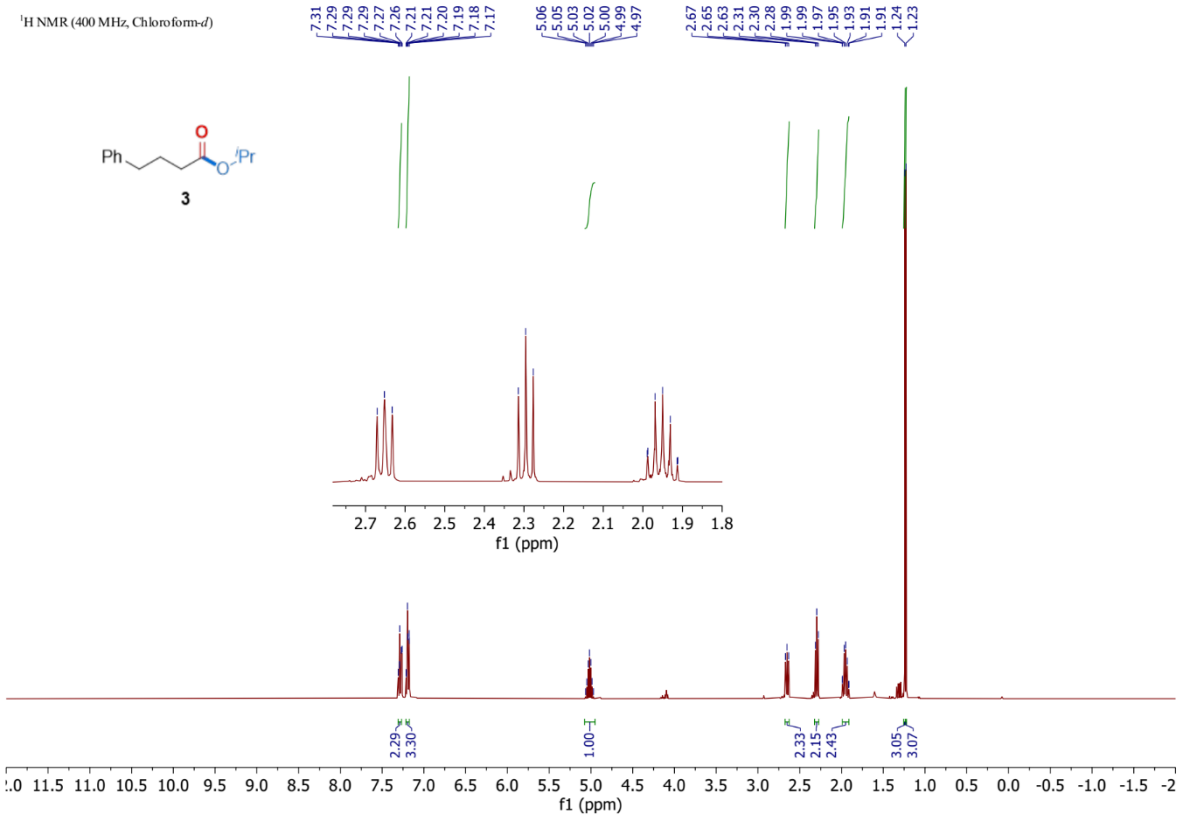
(*Z*)-3,7-Dimethylocta-2,6-dien-1-yl cyclopentanecarboxylate (61) Prepared according to the general procedure. The crude product was purified by silica gel chromatography (PE/EA = 200:1) to afford the title compound as a colorless oil (44 mg, 88% yield).

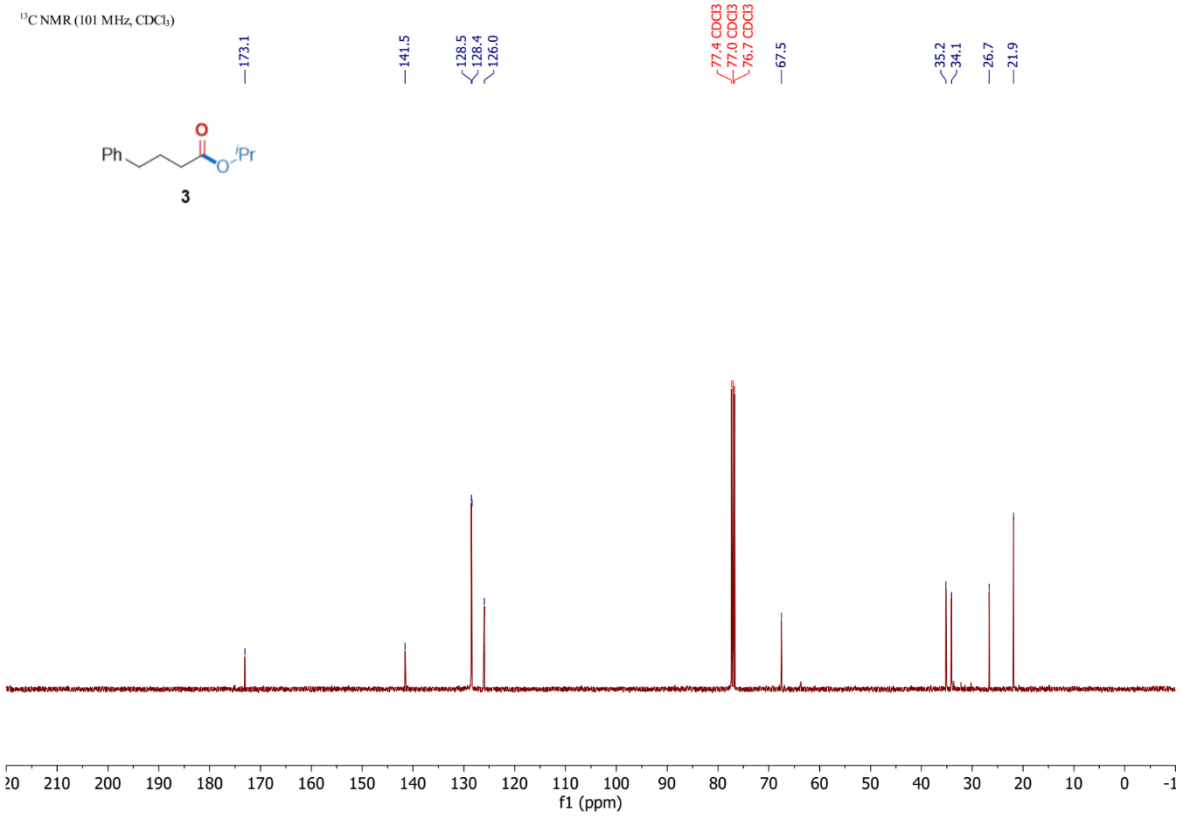
^{1}H NMR (300 MHz, $CDCl_3$) δ 5.42 - 5.28 (m, 1H), 5.08 (m, 1H), 4.58 (d, *J* = 7.1 Hz, 2H), 2.83 - 2.62 (m, 1H), 2.18 - 1.97 (m, 4H), 1.93 - 1.51 (m, 17H).

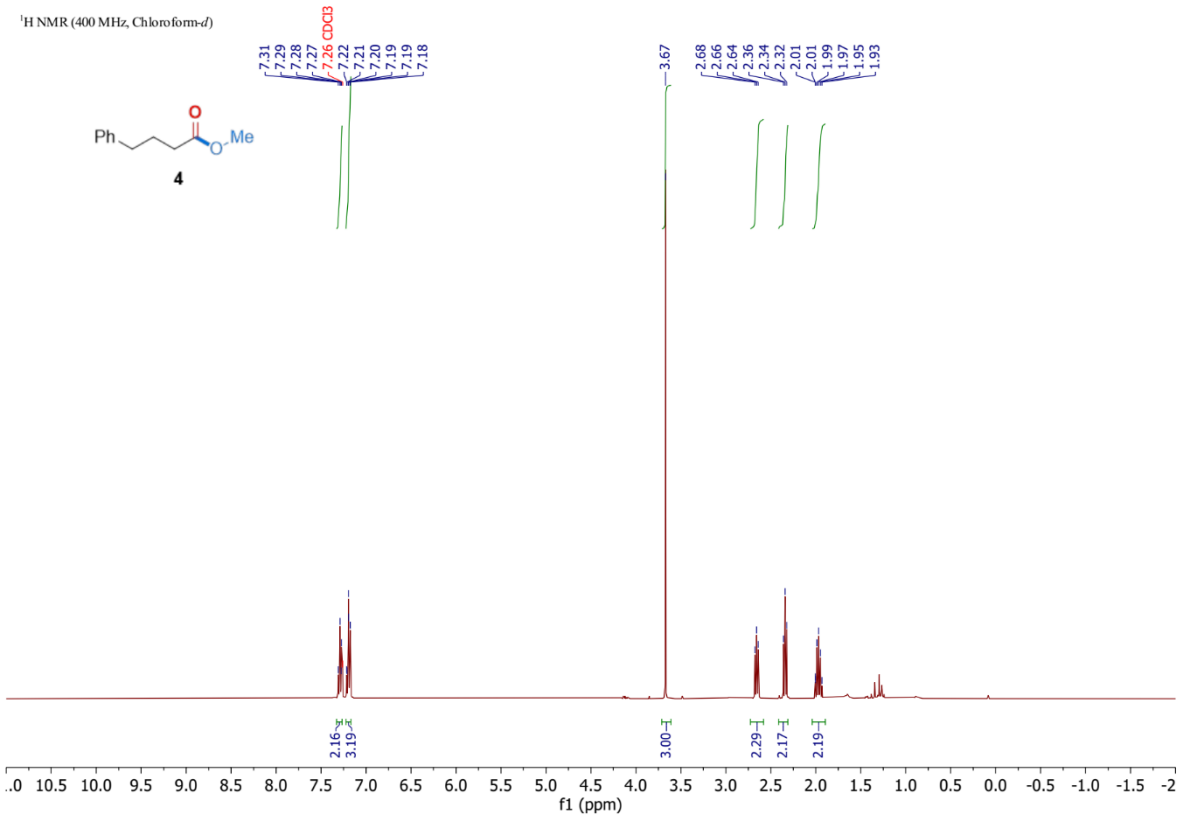
^{13}C NMR (75 MHz, $CDCl_3$) δ 176.9, 141.9, 131.8, 123.8, 118.6, 61.2, 43.9, 39.5, 30.1, 26.3, 25.8, 25.7, 17.7, 16.5.

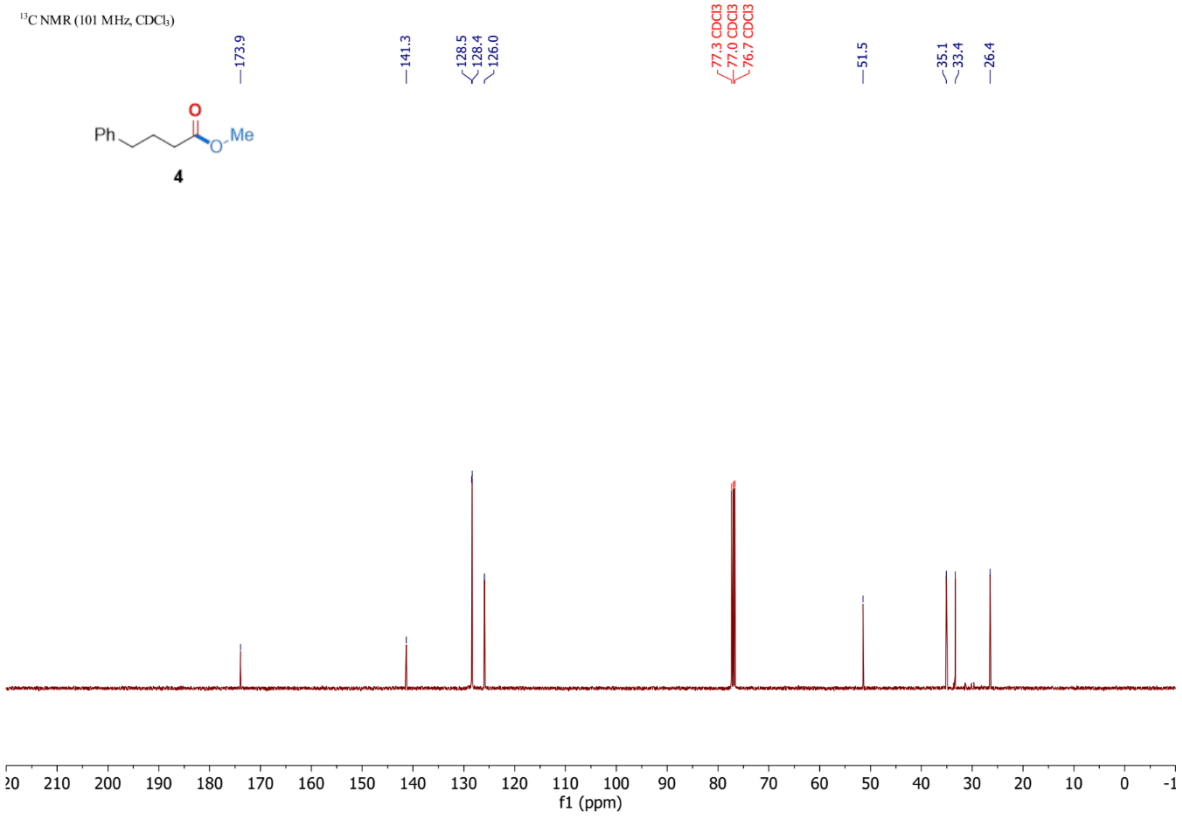
HRMS (ESI-TOF): *m/z* calcd. for $C_{16}H_{26}O_2Na^+$ ([M+Na^+]) 273.1825, found 273.1832.

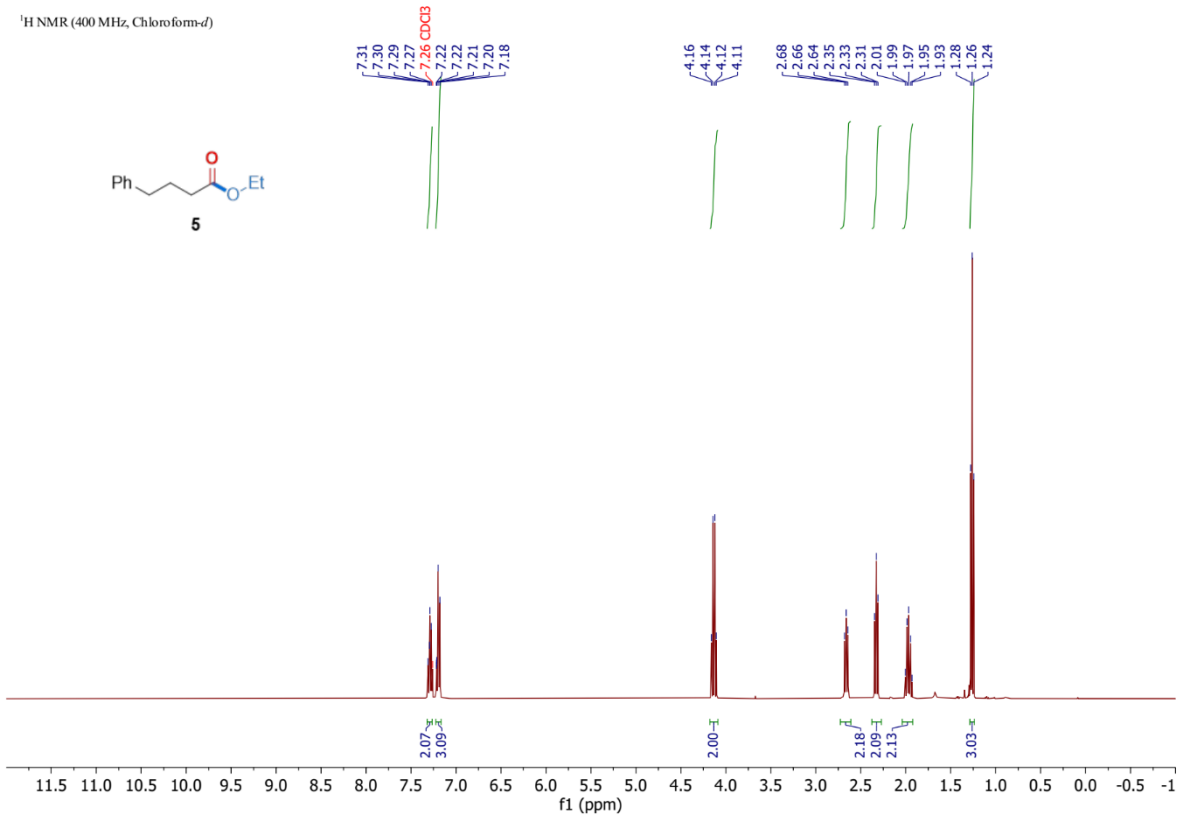
7. NMR Spectrum

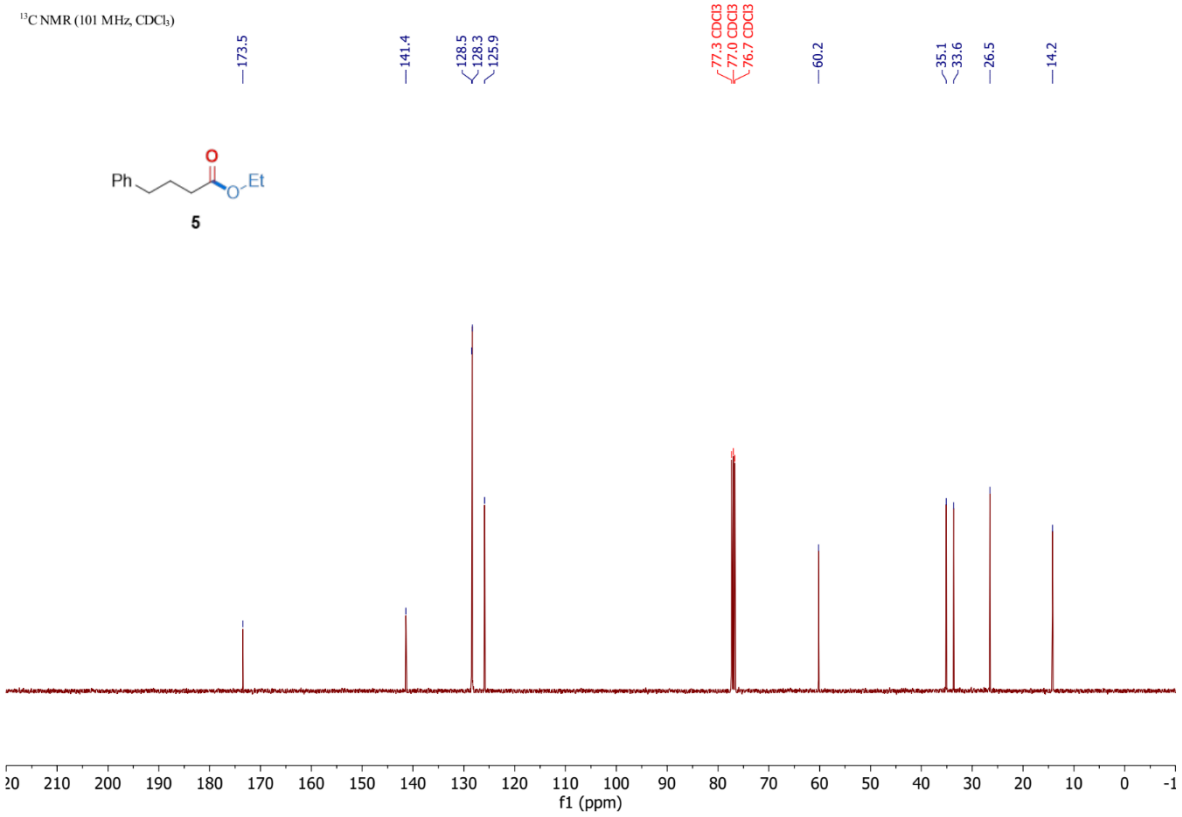




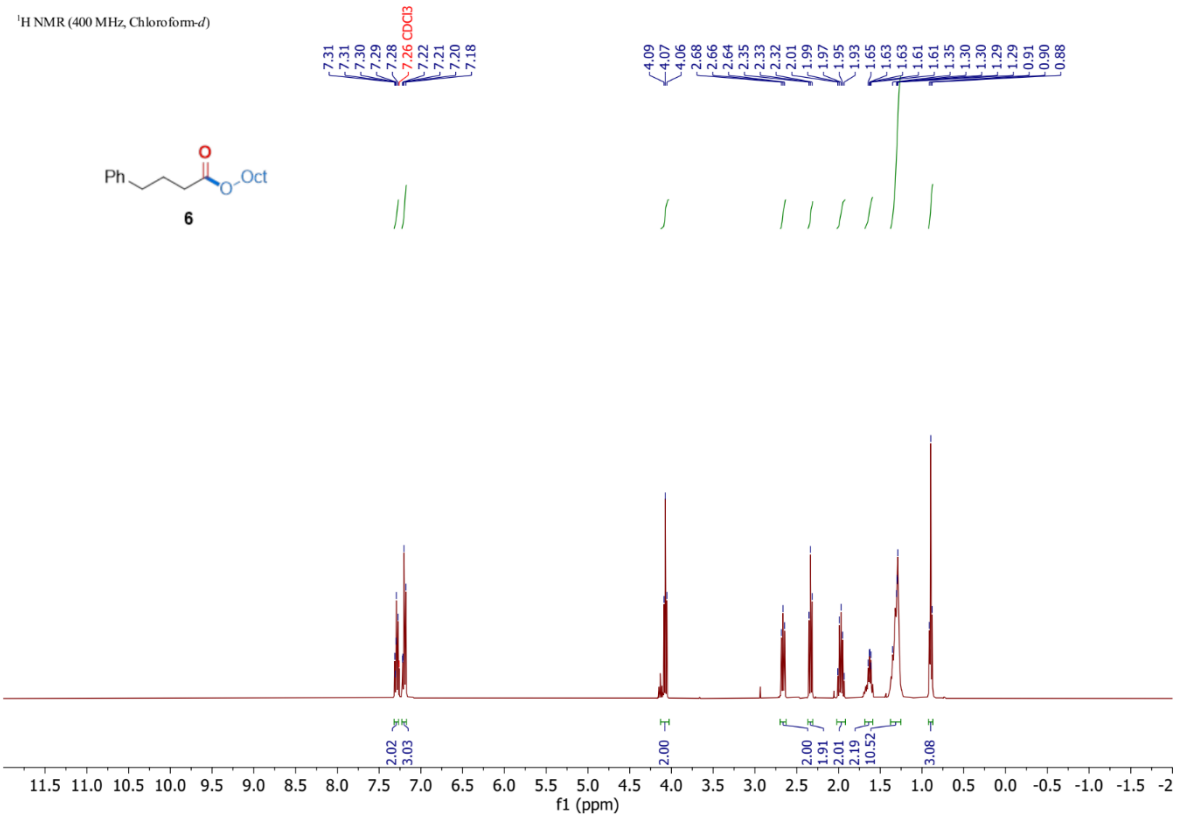

1H NMR (400 MHz, Chloroform-d)
7.31
7.29
7.28
7.27
7.26 CDCl3
7.22
7.21
7.20
7.19
7.19
7.18
3.67
2.68
2.66
2.64
2.36
2.34
2.32
2.01
2.01
1.99
1.97
1.95
1.93
Ph
O
O
Me
4
2.16
3.19
3.00
2.29
2.17
2.19
f1 (ppm)


13C NMR (101 MHz, CDCl3)
173.9
141.3
128.5
128.4
126.0
77.3 CDCl3
77.0 CDCl3
76.7 CDCl3
51.5
35.1
33.4
26.4
Ph
O
O
Me
4
f1 (ppm)

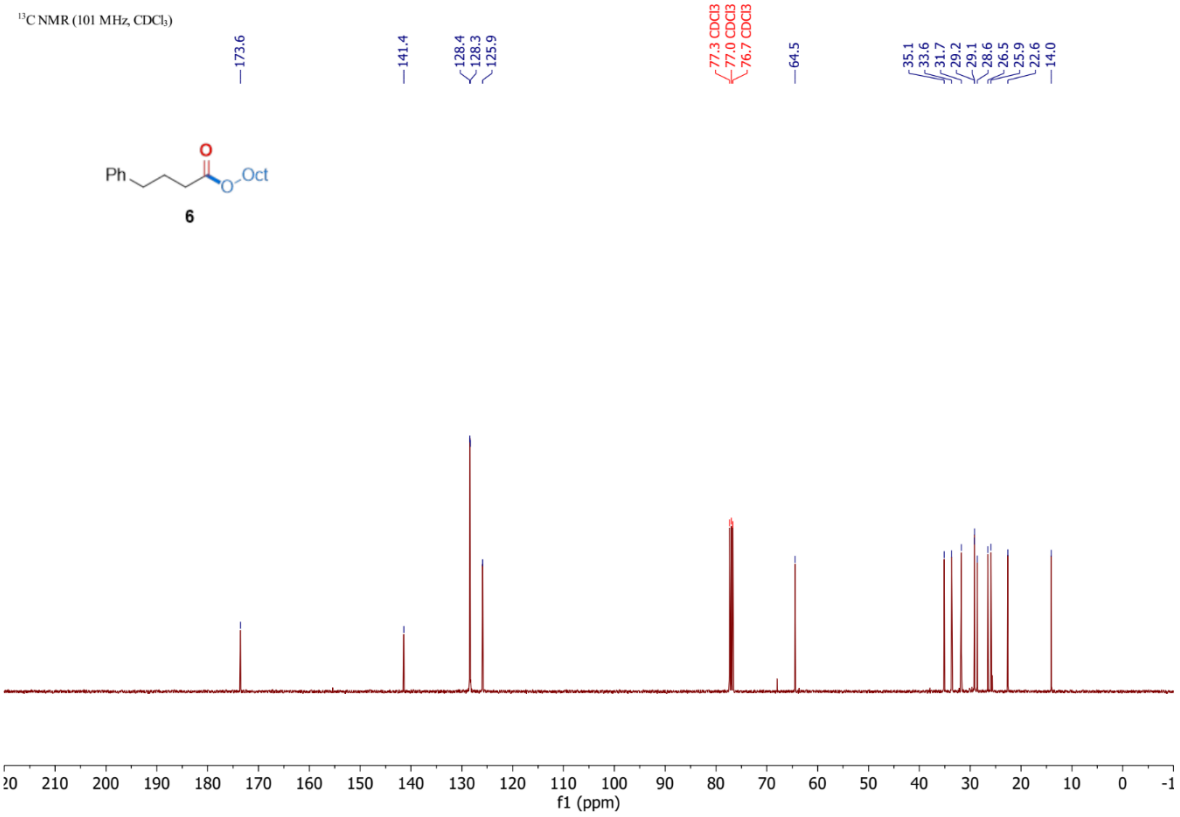

^{1}H NMR (400 MHz, Chloroform-*d*)
7.31
7.30
7.29
7.27
7.26 CDCl3
7.22
7.22
7.21
7.20
7.18
4.16
4.14
4.12
4.11
2.68
2.66
2.64
2.35
2.33
2.31
2.01
1.99
1.97
1.95
1.93
1.28
1.26
1.24
Ph
O
O
Et
5
2.07
3.09
2.00
2.18
2.09
2.13
3.03
11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1
f1 (ppm)

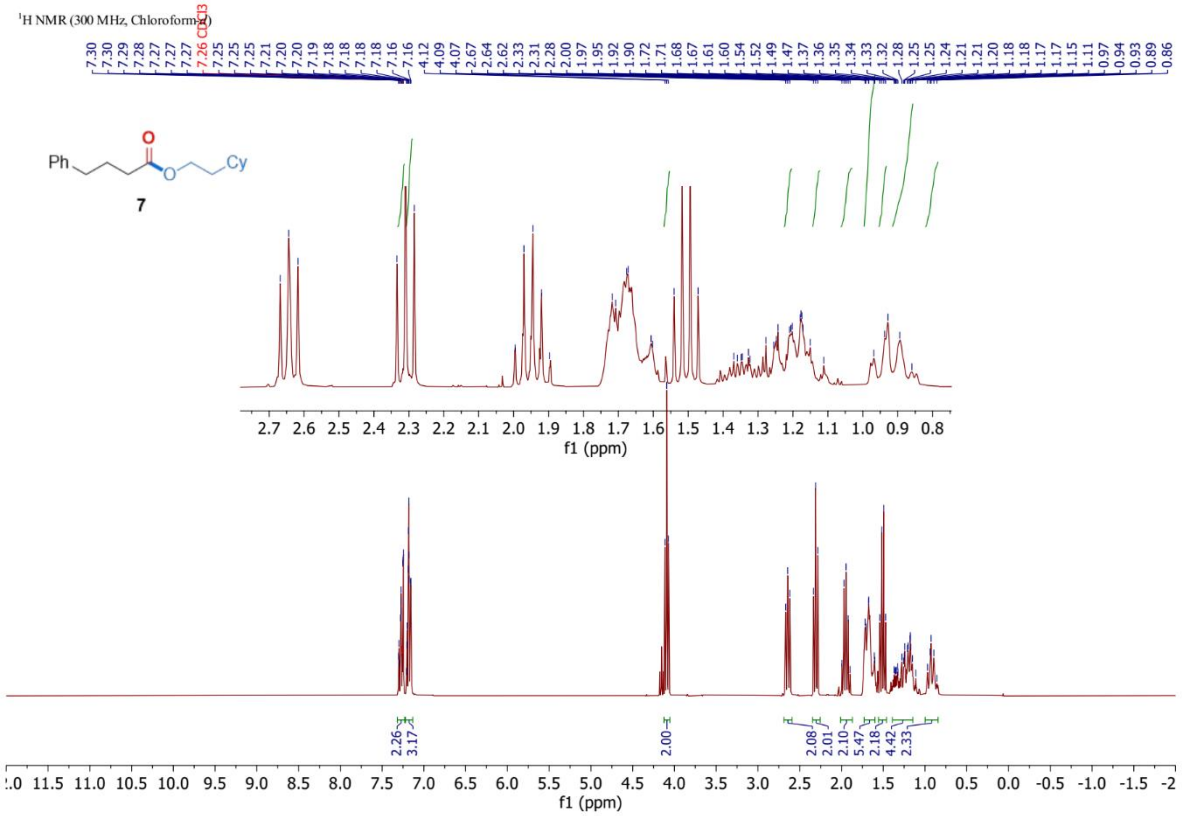

^{13}C NMR (101 MHz, $CDCl_3$)
173.5
141.4
128.5
128.3
125.9
77.3 CDCl3
77.0 CDCl3
76.7 CDCl3
60.2
35.1
33.6
26.5
14.2
Ph
O
O
Et
5
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -1
f1 (ppm)

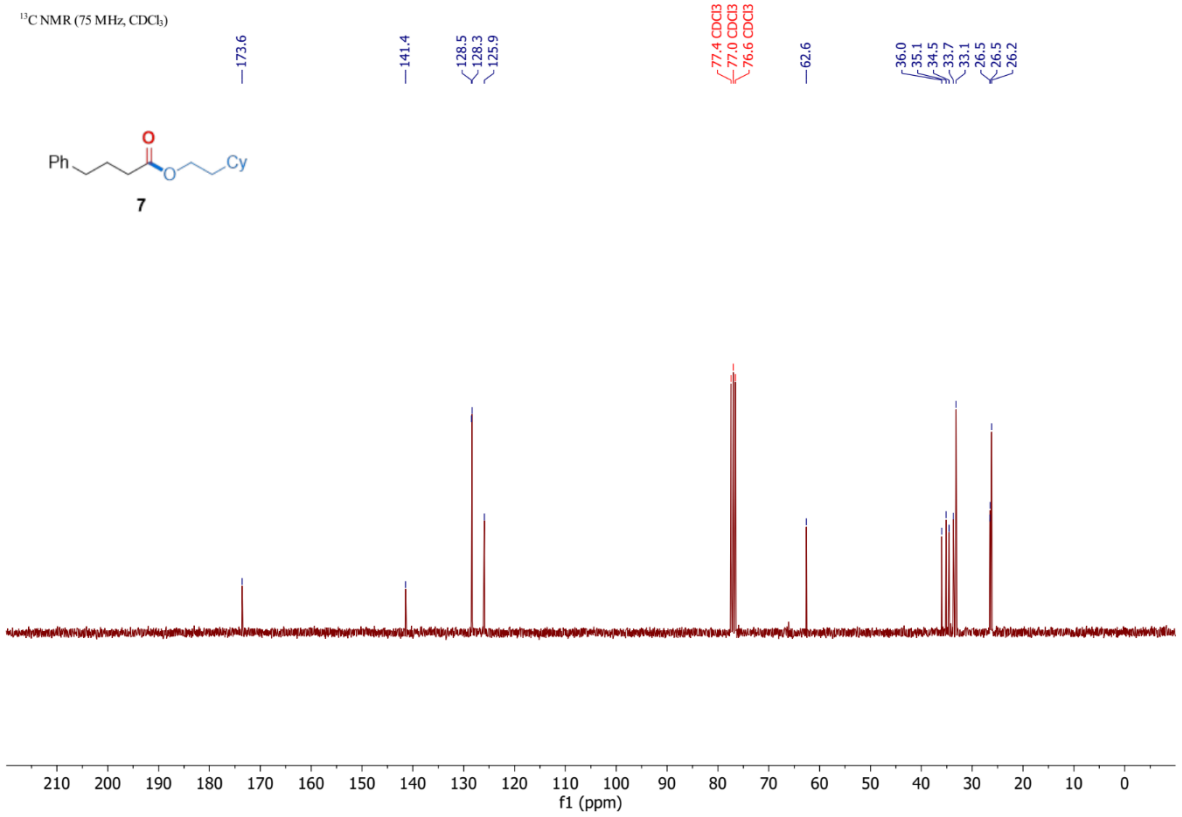
^{1}H NMR (400 MHz, Chloroform-*d*)

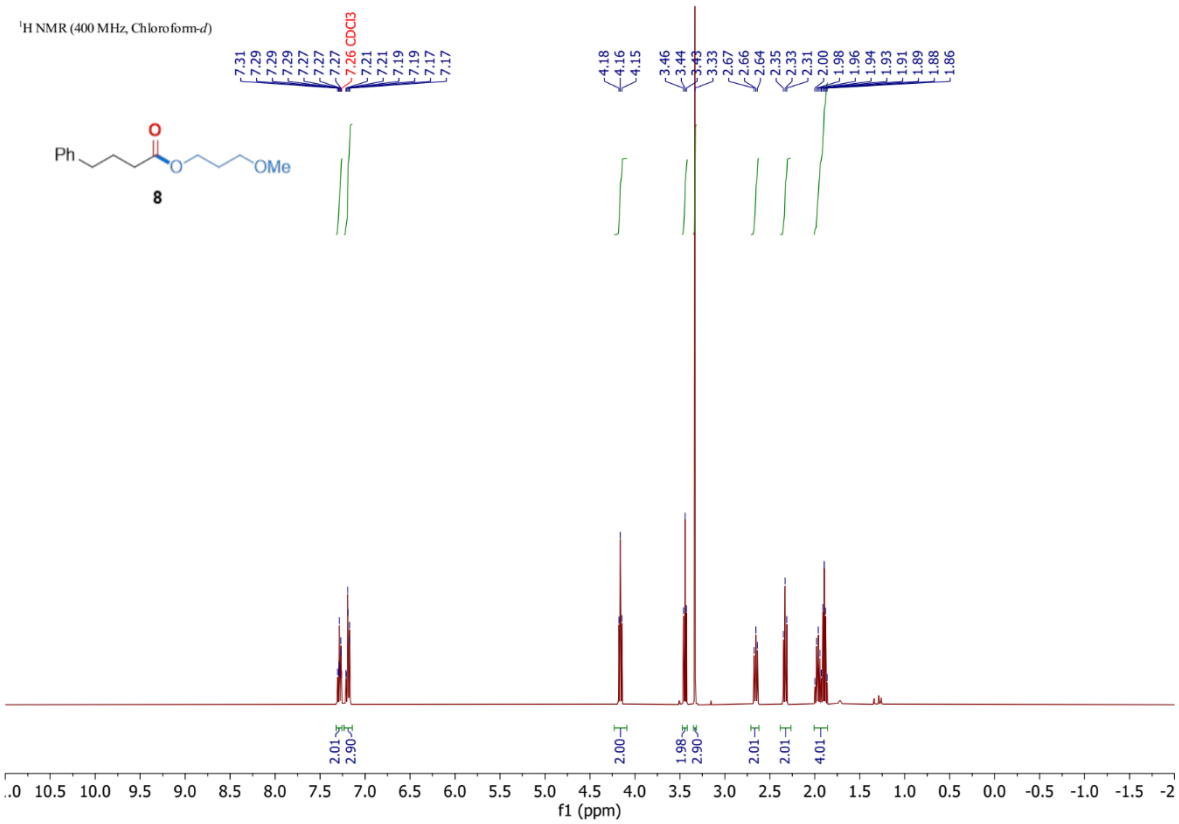


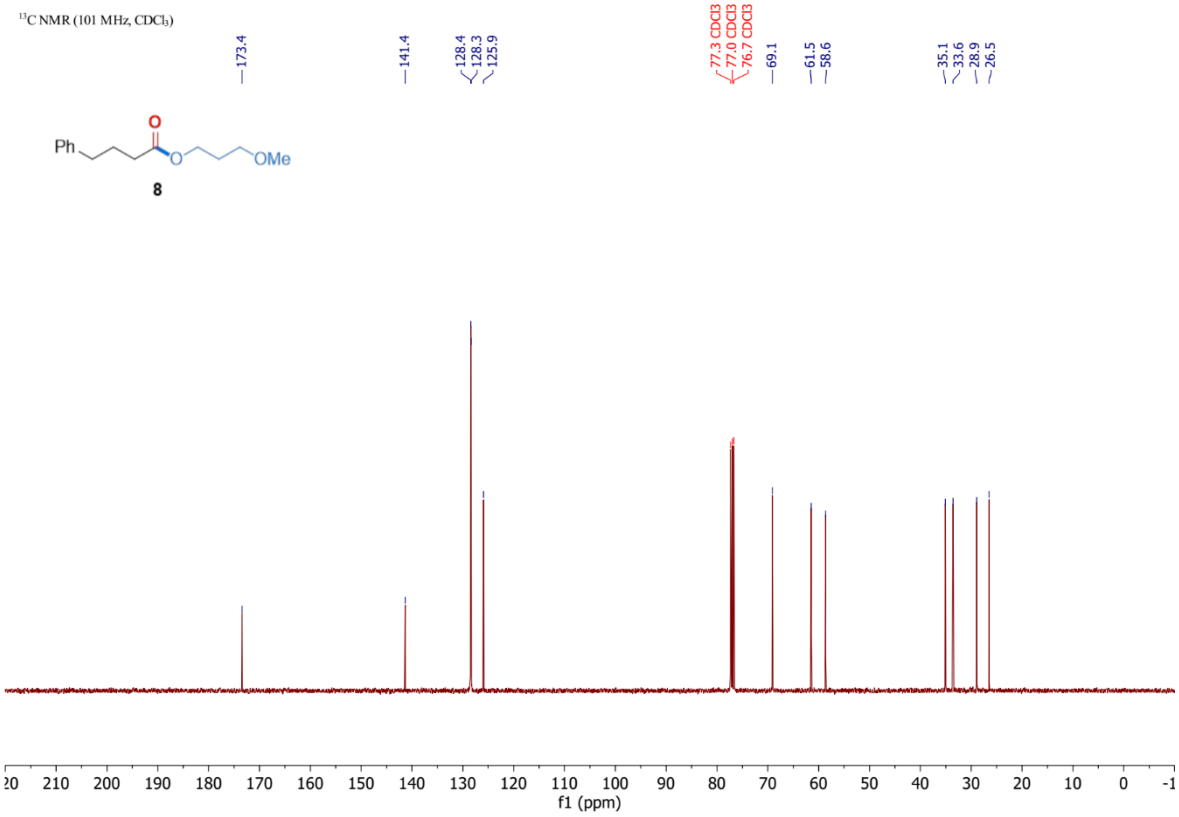
^{13}C NMR (101 MHz, $CDCl_3$)

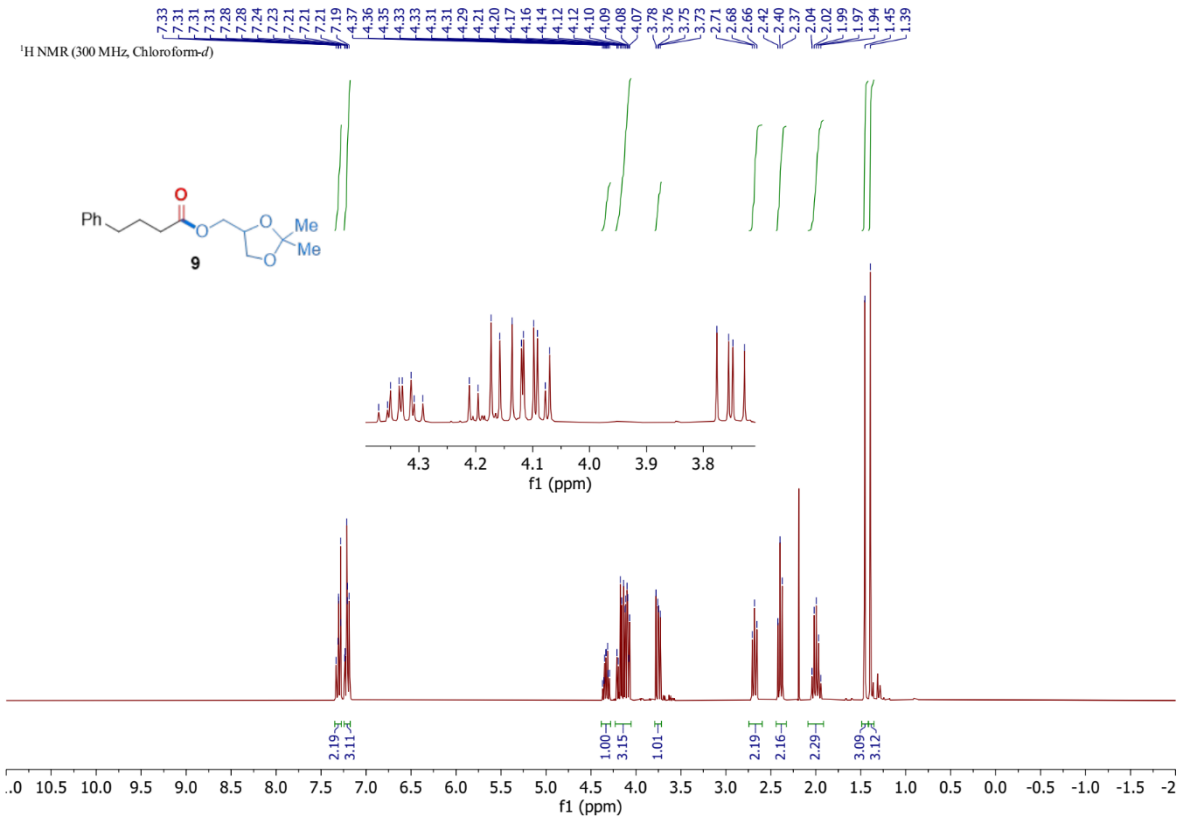


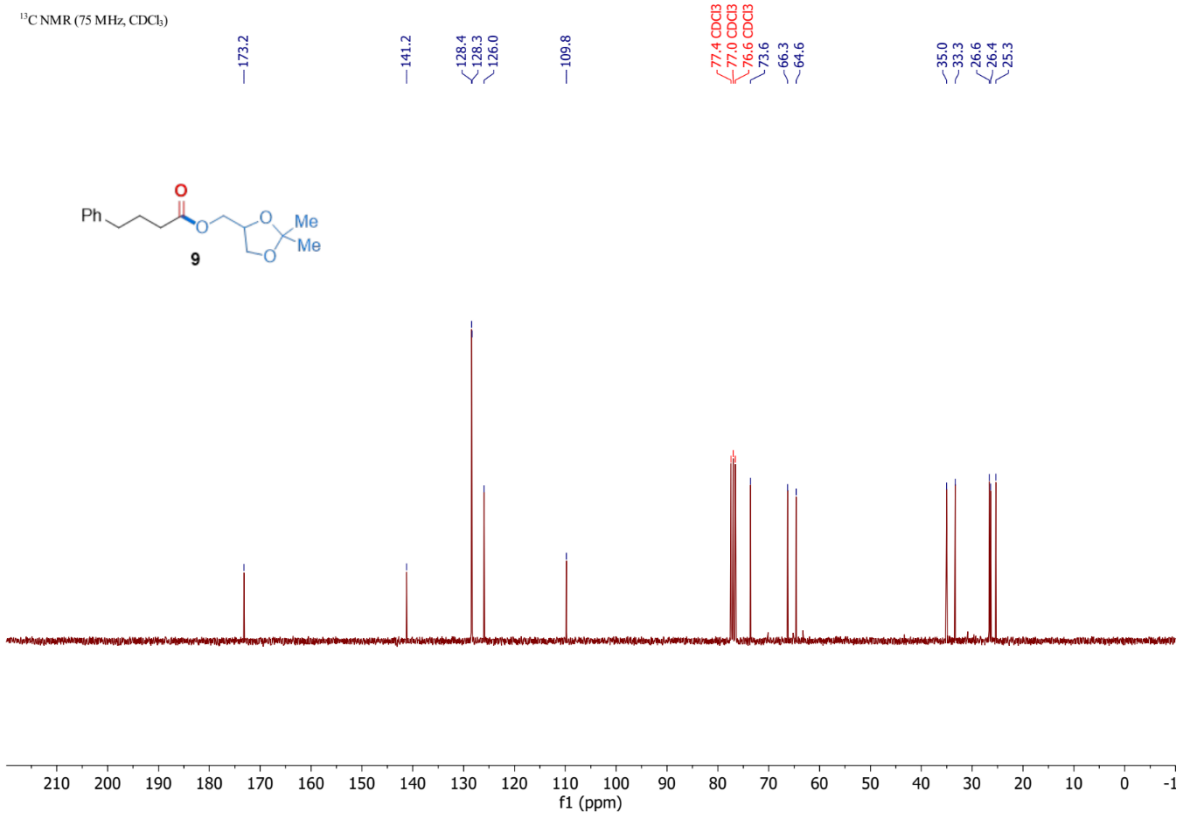

^{1}H NMR (300 MHz, Chloroform-d)
Ph
O
O
Cy
7
f1 (ppm)

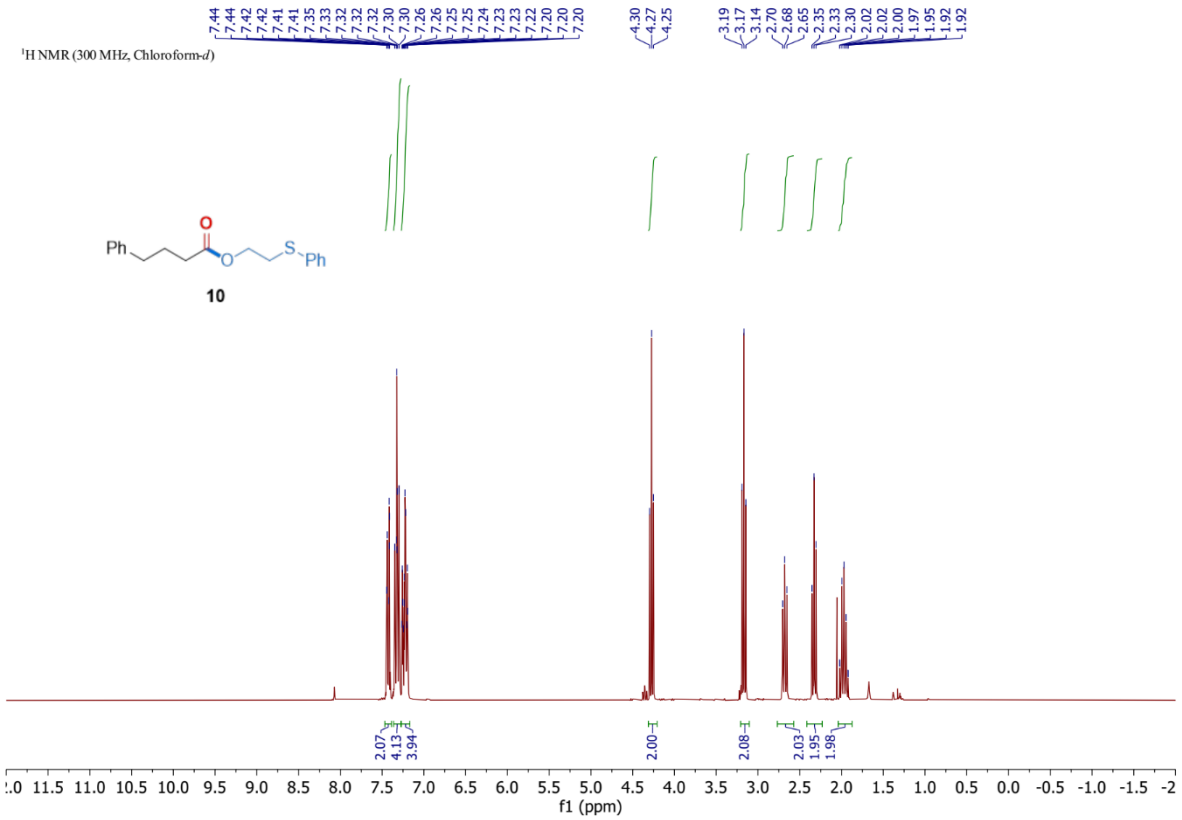

^{13}C NMR (75 MHz, $CDCl_3$)
Ph
O
O
Cy
7
f1 (ppm)

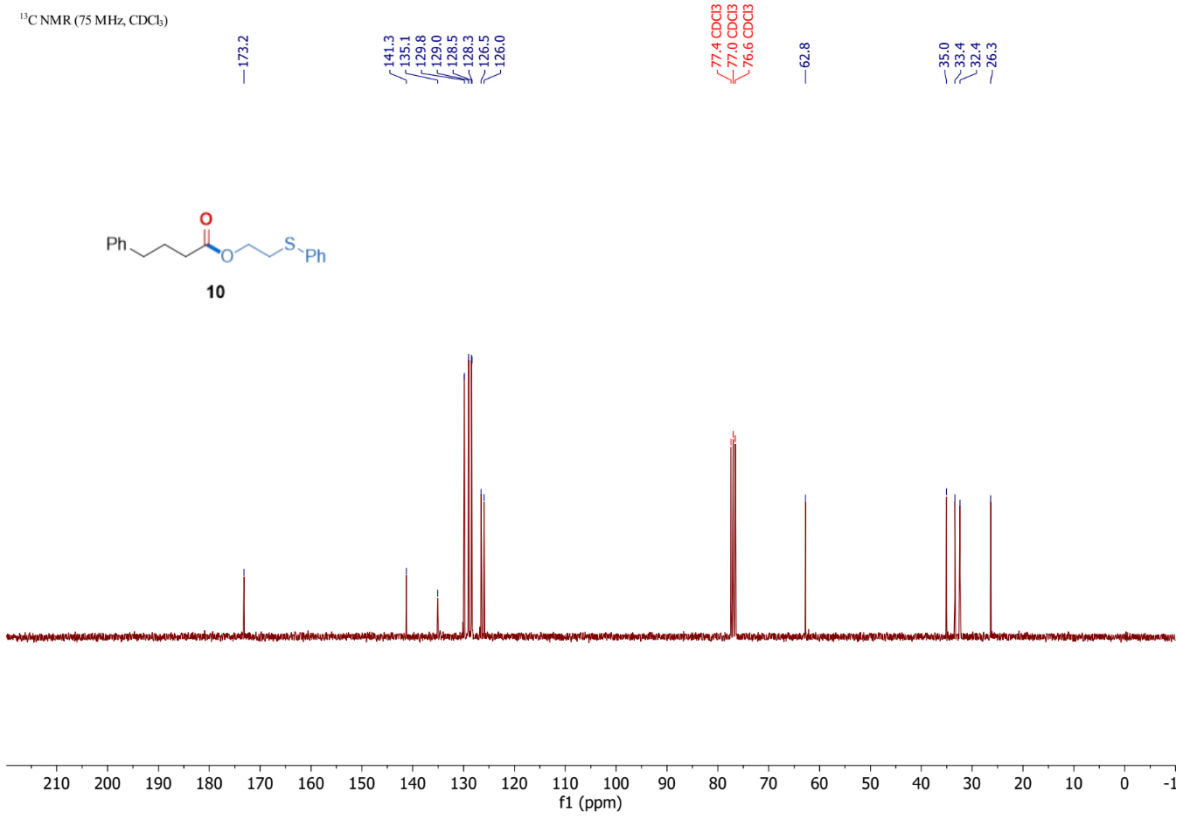

1H NMR (400 MHz, Chloroform-d)
7.31 7.29 7.29 7.29 7.27 7.27 7.27 7.26 CDCl3 7.21 7.21 7.19 7.19 7.17 7.17 7.17
4.18 4.16 4.15 3.46 3.44 3.43 3.33 2.67 2.66 2.64 2.35 2.33 2.31 2.00 1.98 1.96 1.94 1.93 1.91 1.89 1.88 1.86
Ph
O
O
OMe
8
2.01 2.90 2.00 1.98 2.90 2.01 2.01 4.01
f1 (ppm)

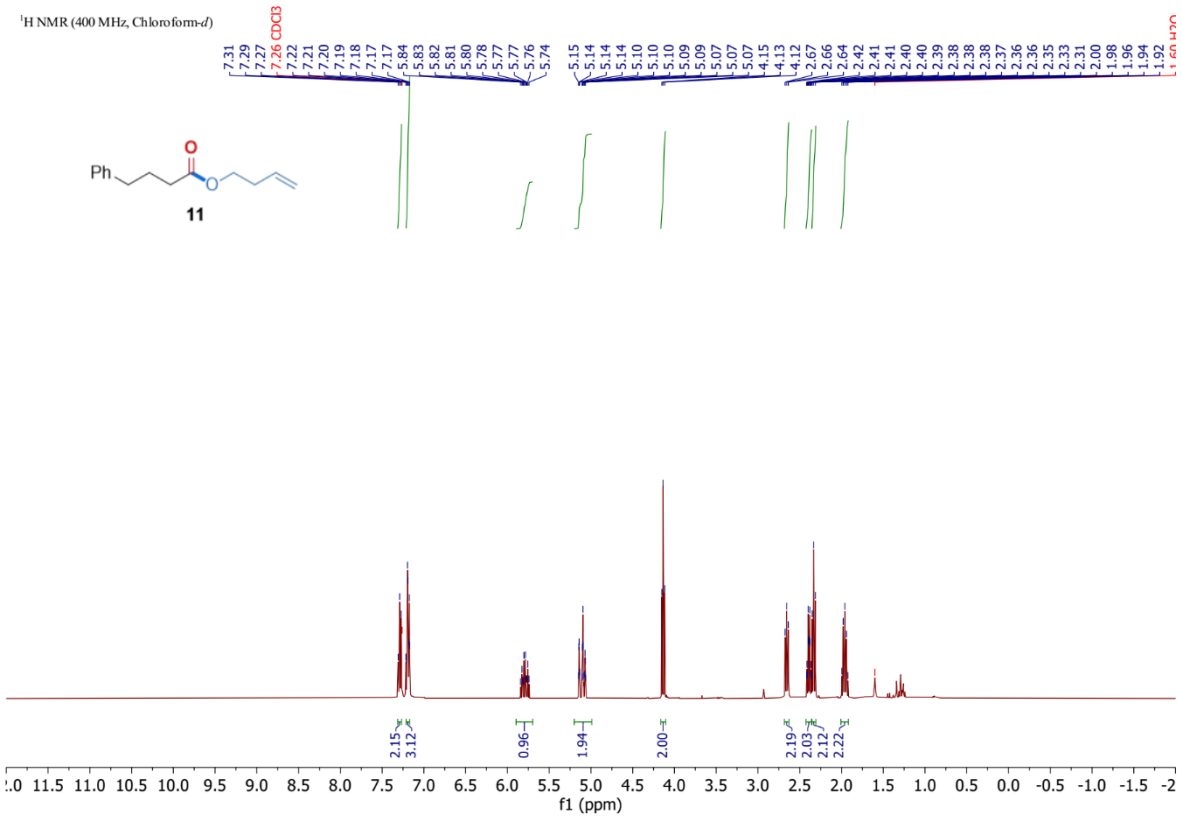

13C NMR (101 MHz, CDCl3)
173.4 141.4 128.4 128.3 125.9 77.3 CDCl3 77.0 CDCl3 76.7 CDCl3 69.1 61.5 58.6 35.1 33.6 28.9 26.5
Ph
O
O
OMe
8
f1 (ppm)

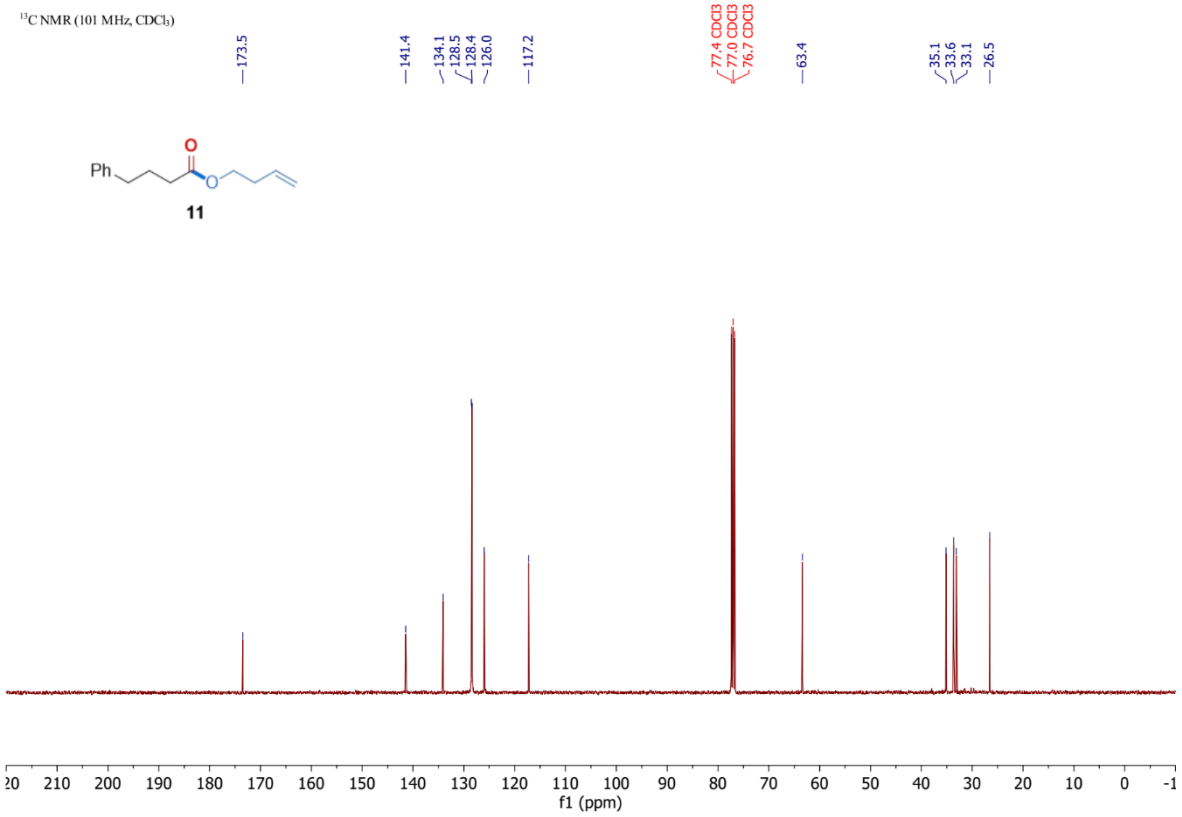

7.33 7.31 7.31 7.31 7.28 7.28 7.24 7.23 7.21 7.21 7.21 7.19 4.37 4.36 4.35 4.33 4.33 4.31 4.31 4.29 4.21 4.20 4.17 4.16 4.14 4.12 4.12 4.10 4.09 4.08 4.07 3.78 3.76 3.75 3.73 2.71 2.68 2.66 2.42 2.40 2.37 2.04 2.02 1.99 1.97 1.94 1.45 1.39
¹H NMR (300 MHz, Chloroform-d)
Ph
O
O
O
Me
Me
9
4.3 4.2 4.1 4.0 3.9 3.8
f1 (ppm)
2.19 3.11 1.00 3.15 1.01 2.19 2.16 2.29 3.09 3.12
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0 -1.5 -2
f1 (ppm)

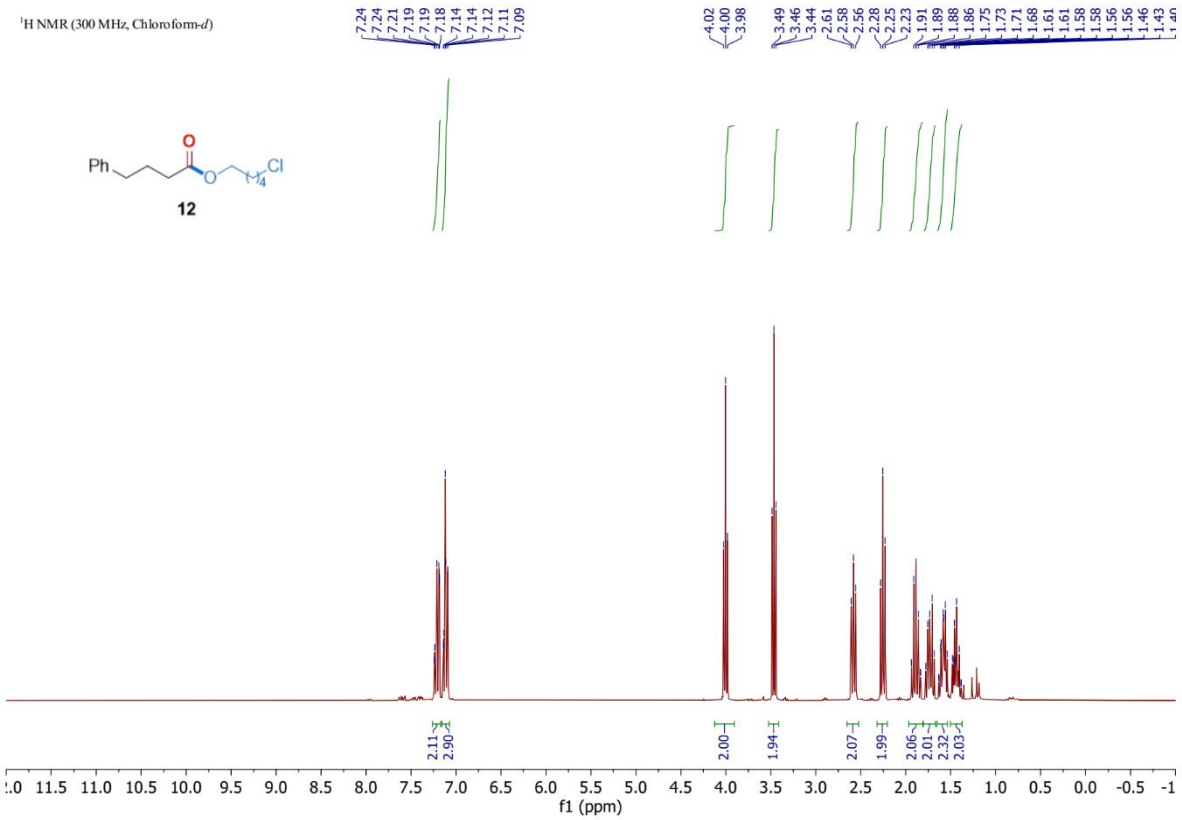

¹³C NMR (75 MHz, CDCl₃)
173.2 141.2 128.4 128.3 126.0 109.8 77.4 CDCl3 77.0 CDCl3 76.6 CDCl3 73.6 66.3 64.6 35.0 33.3 26.6 26.4 25.3
Ph
O
O
O
Me
Me
9
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -1
f1 (ppm)

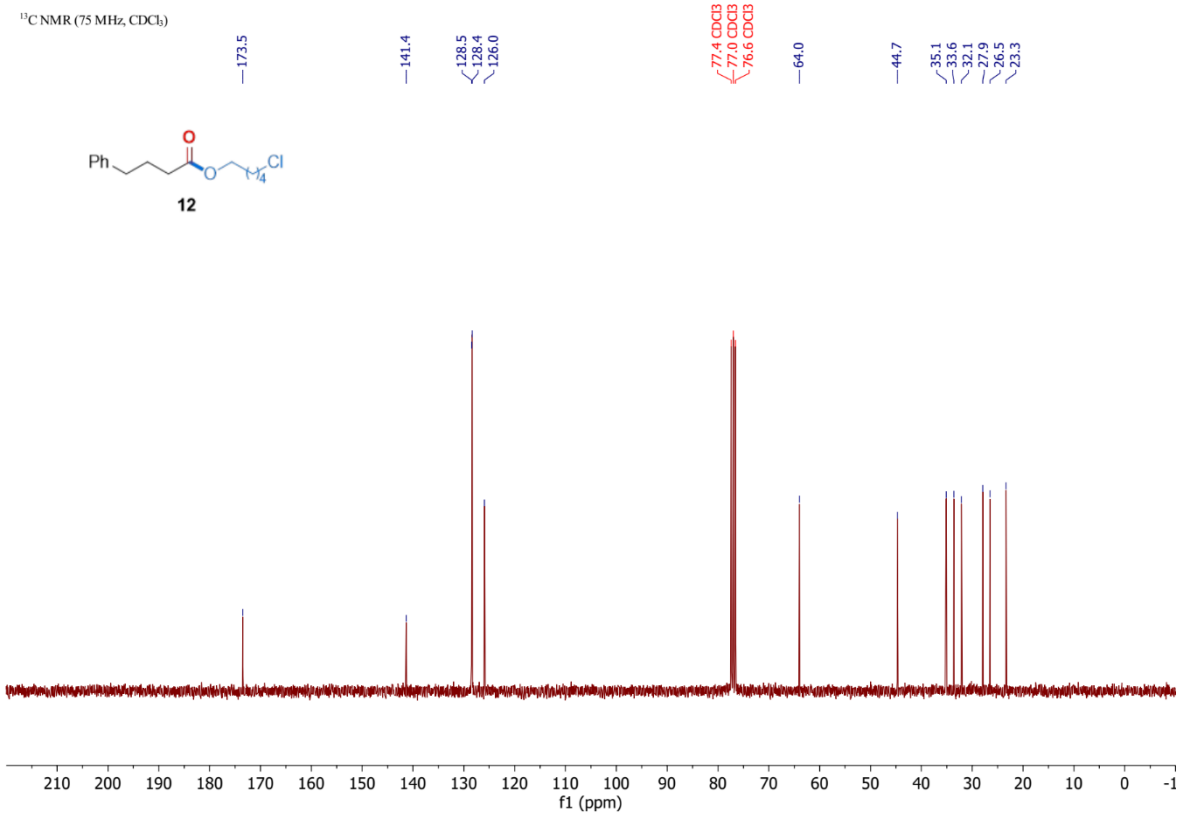

7.44 7.44 7.42 7.42 7.41 7.41 7.35 7.33 7.32 7.32 7.32 7.30 7.30 7.26 7.26 7.25 7.25 7.24 7.23 7.23 7.22 7.20 7.20 7.20
4.30 4.27 4.25
3.19 3.17 3.14 2.70 2.68 2.65 2.35 2.33 2.30 2.02 2.02 2.00 1.97 1.95 1.92 1.92
1H NMR (300 MHz, Chloroform-d)
Ph
O
O
S
Ph
10
2.07 4.13 3.94 2.00 2.08 2.03 1.95 1.98
f1 (ppm)

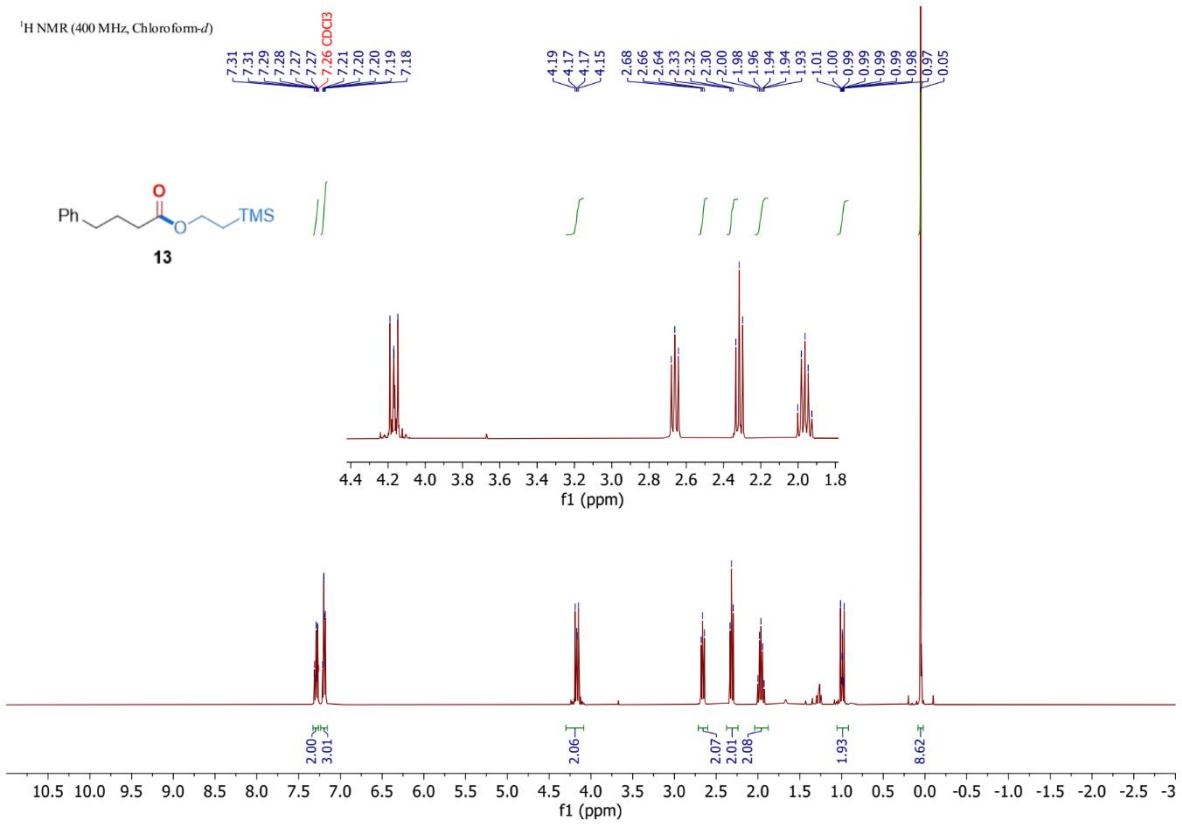

13C NMR (75 MHz, CDCl3)
173.2
141.3 135.1 129.8 129.0 128.5 128.3 126.5 126.0
77.4 CDCl3 77.0 CDCl3 76.6 CDCl3
62.8
35.0 33.4 32.4 26.3
Ph
O
O
S
Ph
10
f1 (ppm)

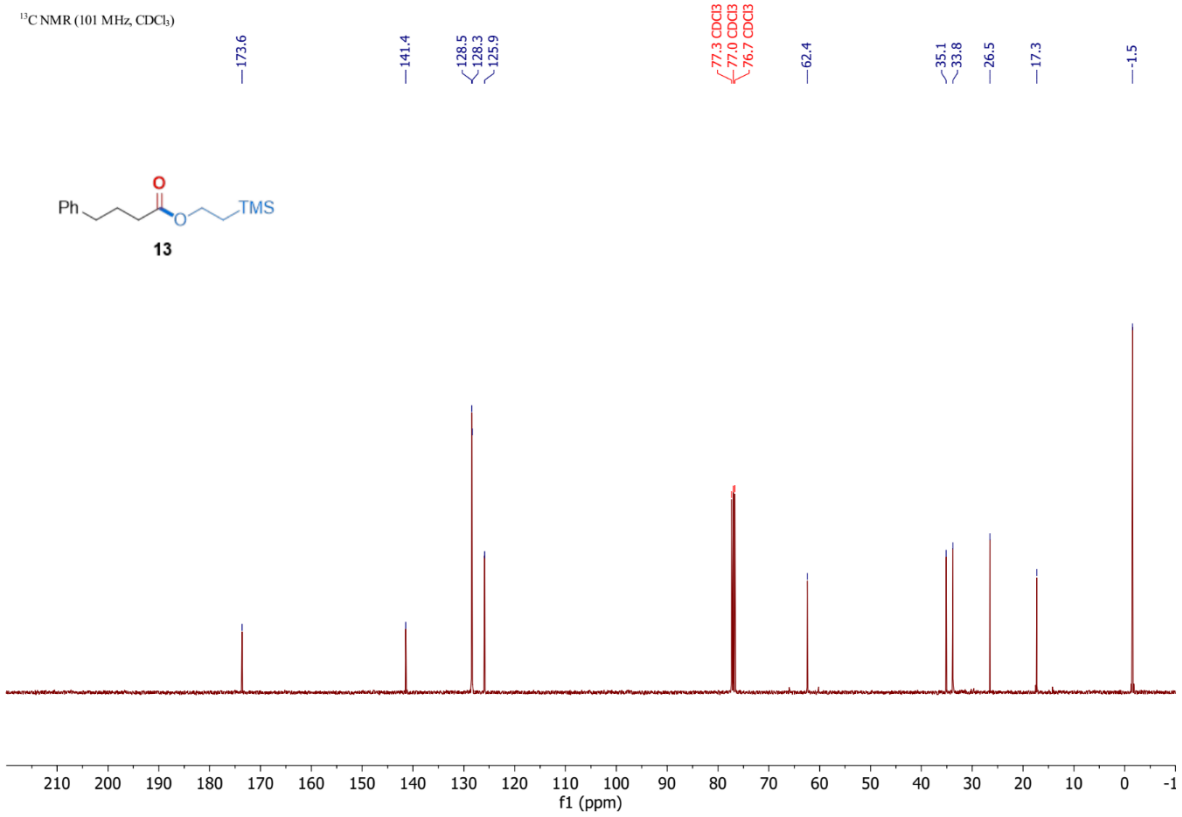

^{1}H NMR (400 MHz, Chloroform-*d*)
7.26 CDCl3
Ph
O
O
11
2.15
3.12
0.96
1.94
2.00
2.19
2.03
2.12
2.22
f1 (ppm)

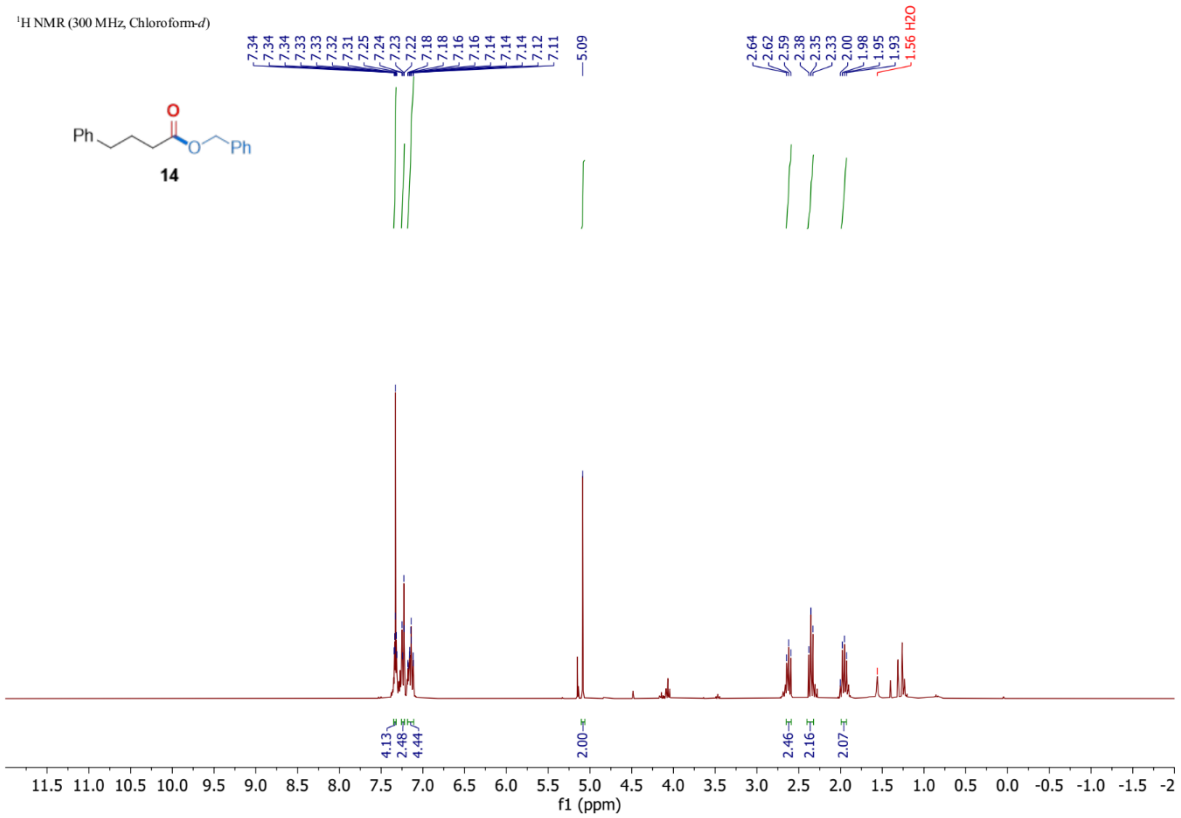

^{13}C NMR (101 MHz, $CDCl_3$)
173.5
141.4
134.1
128.5
128.4
126.0
117.2
77.4 CDCl3
77.0 CDCl3
76.7 CDCl3
63.4
35.1
33.6
33.1
26.5
Ph
O
O
11
f1 (ppm)

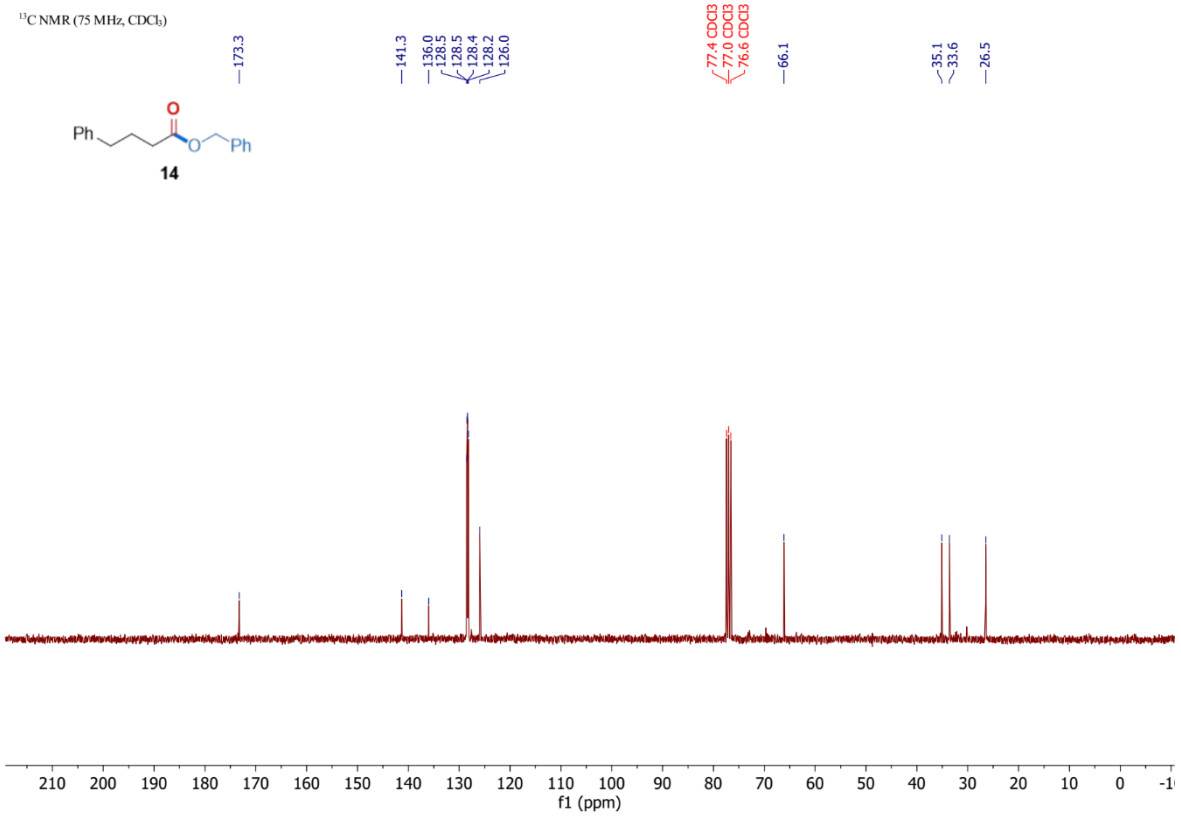

1H NMR (300 MHz, Chloroform-d)
7.24
7.24
7.21
7.19
7.19
7.18
7.14
7.14
7.12
7.11
7.09
4.02
4.00
3.98
3.49
3.46
3.44
2.61
2.58
2.56
2.28
2.25
2.23
1.91
1.89
1.88
1.86
1.75
1.73
1.71
1.68
1.61
1.61
1.58
1.58
1.56
1.56
1.46
1.43
Ph
O
O
Cl
12
2.11
2.90
2.00
1.94
2.07
1.99
2.06
2.01
2.32
2.03
f1 (ppm)

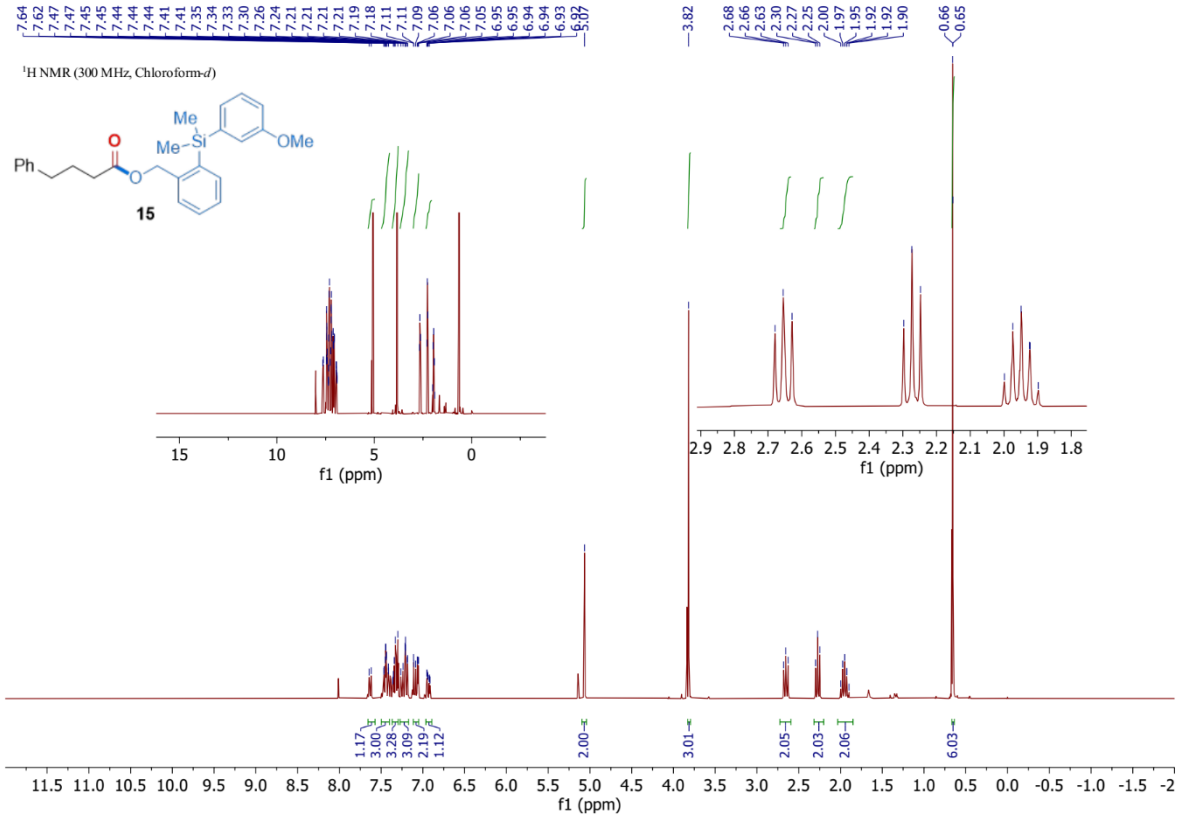

13C NMR (75 MHz, CDCl3)
173.5
141.4
128.5
128.4
126.0
77.4 CDCl3
77.0 CDCl3
76.6 CDCl3
64.0
44.7
35.1
33.6
32.1
27.9
26.5
23.3
Ph
O
O
Cl
12
f1 (ppm)

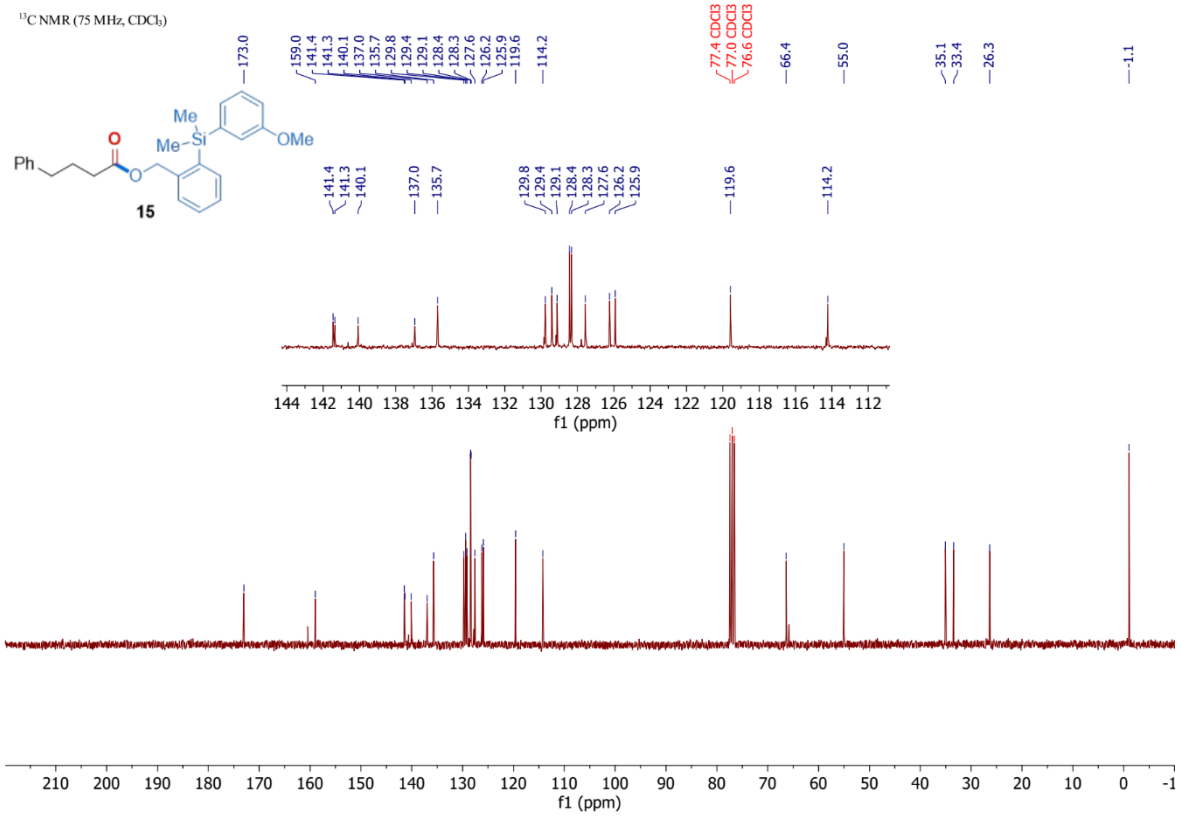

^{1}H NMR (400 MHz, Chloroform-d)
7.31 7.31 7.29 7.28 7.27 7.27 7.26 CDCl3 7.21 7.20 7.20 7.19 7.18
4.19 4.17 4.17 4.15
2.68 2.66 2.64 2.33 2.32 2.30 2.00 1.98 1.96 1.94 1.94 1.93
1.01 1.00 0.99 0.99 0.99 0.99 0.98 0.97 0.05
Ph
O
O
TMS
13
4.4 4.2 4.0 3.8 3.6 3.4 3.2 3.0 2.8 2.6 2.4 2.2 2.0 1.8
f1 (ppm)
2.00 3.01 2.06 2.07 2.01 2.08 1.93 8.62
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0 -1.5 -2.0 -2.5 -3
f1 (ppm)


^{13}C NMR (101 MHz, $CDCl_3$)
173.6
141.4
128.5 128.3 125.9
77.3 CDCl3 77.0 CDCl3 76.7 CDCl3
62.4
35.1 33.8
26.5
17.3
-1.5
Ph
O
O
TMS
13
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -1
f1 (ppm)

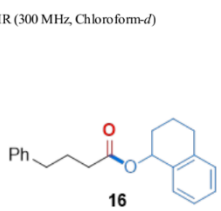

^{1}H NMR (300 MHz, Chloroform-d)
7.34
7.34
7.34
7.33
7.33
7.32
7.31
7.25
7.24
7.23
7.22
7.18
7.18
7.16
7.16
7.14
7.14
7.14
7.12
7.11
5.09
2.64
2.62
2.59
2.38
2.35
2.33
2.00
1.98
1.95
1.93
1.56 H2O
Ph
O
O
Ph
14
4.13
2.48
4.44
2.00
2.46
2.16
2.07
11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0 -1.5 -2
f1 (ppm)


^{13}C NMR (75 MHz, $CDCl_3$)
173.3
141.3
136.0
128.5
128.5
128.4
128.2
126.0
77.4 CDCl3
77.0 CDCl3
76.6 CDCl3
66.1
35.1
33.6
26.5
Ph
O
O
Ph
14
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -1
f1 (ppm)

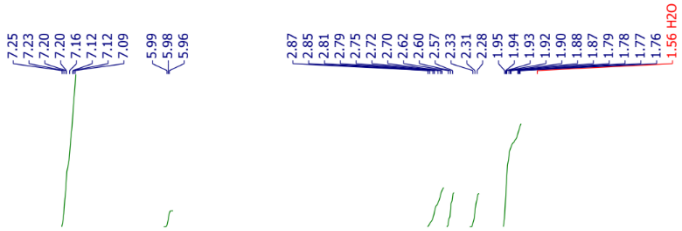

^{1}H NMR (300 MHz, Chloroform-*d*)
Me
Me–Si
OMe
Ph
O
O
15
f1 (ppm)

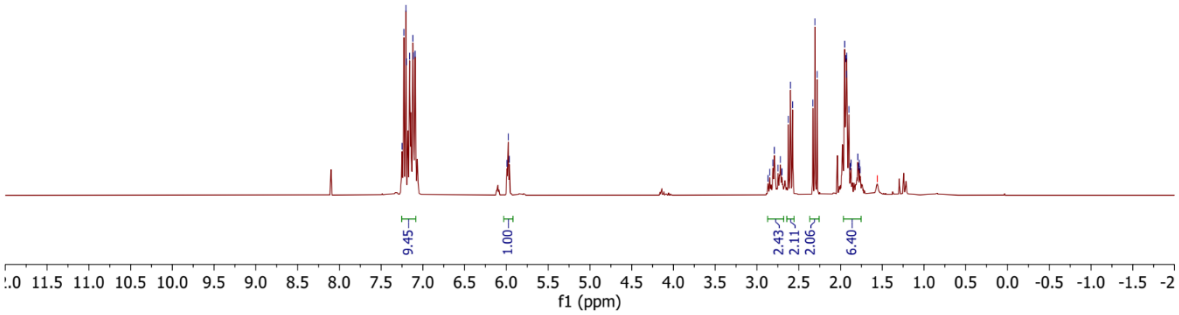

^{13}C NMR (75 MHz, $CDCl_3$)
Me
Me–Si
OMe
Ph
O
O
15
f1 (ppm)

^{1}H NMR (300 MHz, Chloroform-*d*)

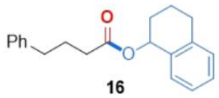


16

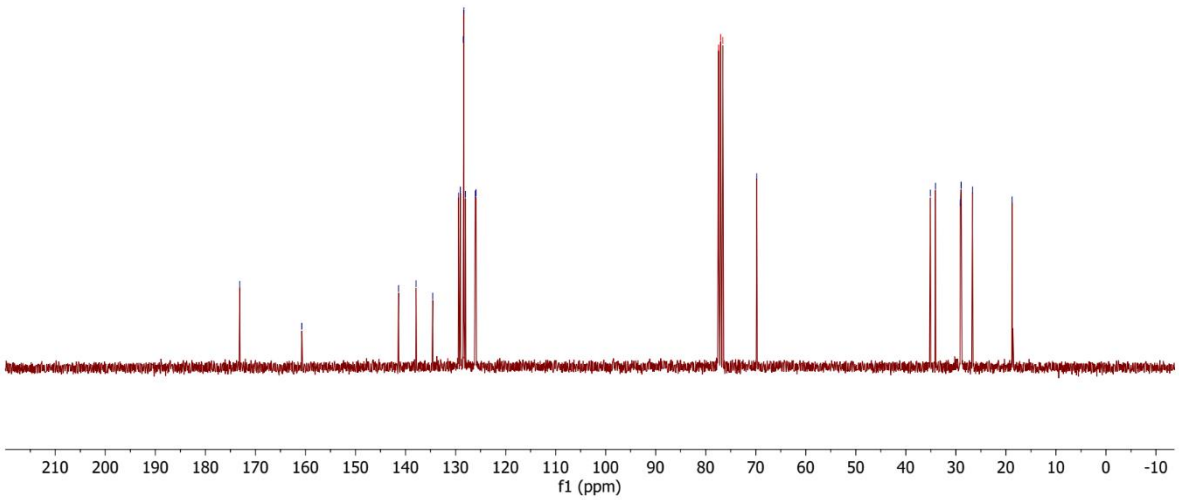


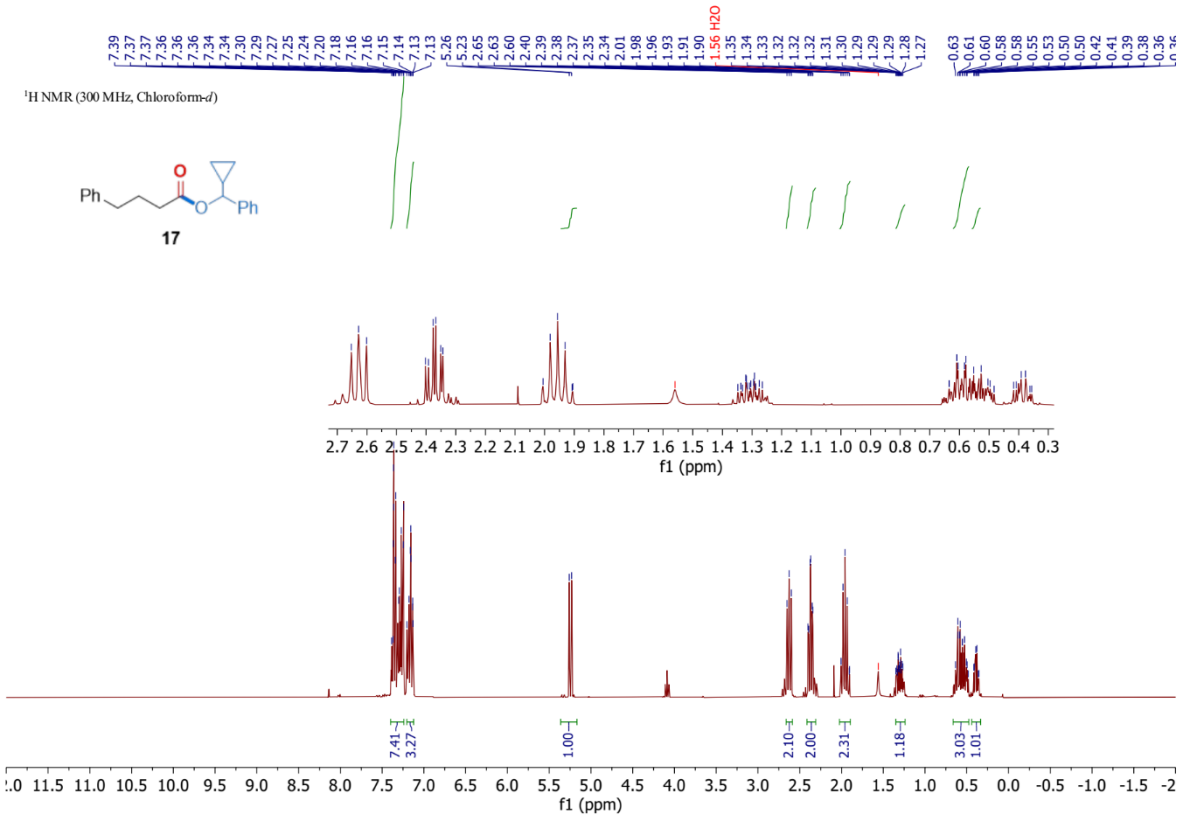


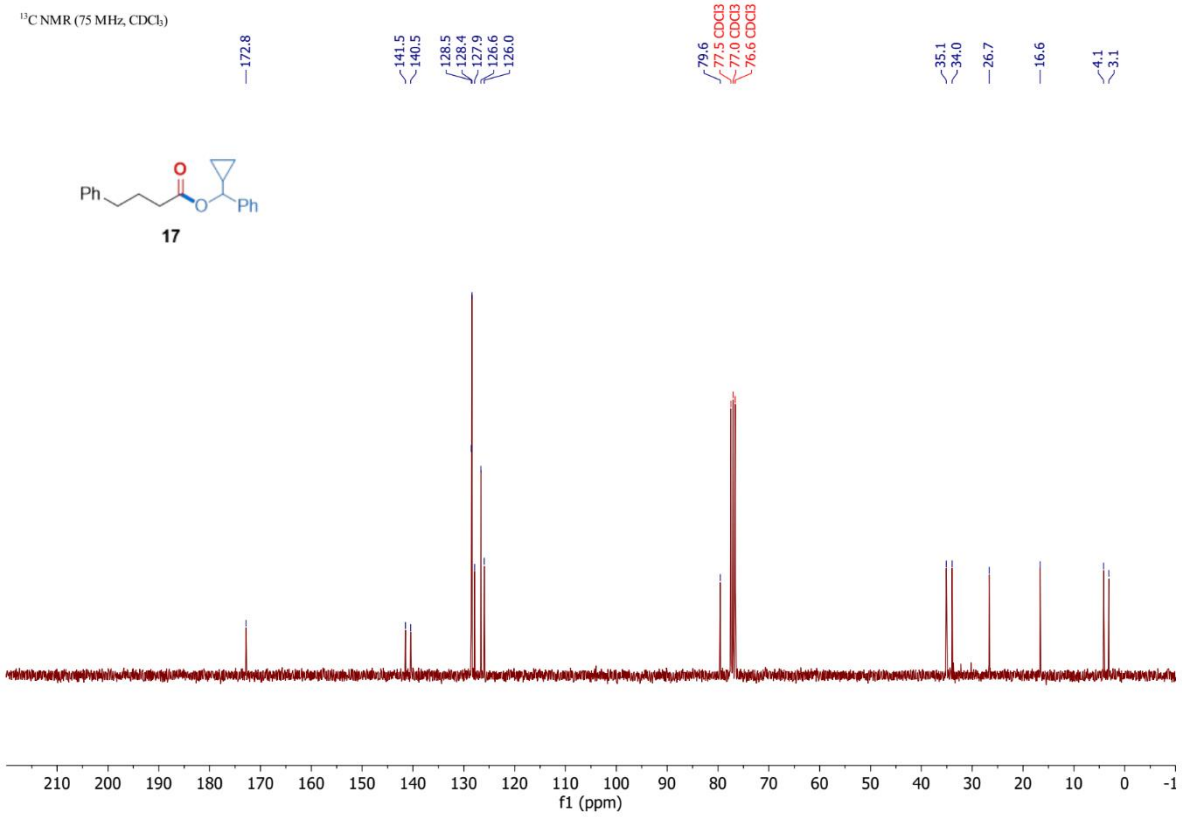
^{13}C NMR (75 MHz, $CDCl_3$)

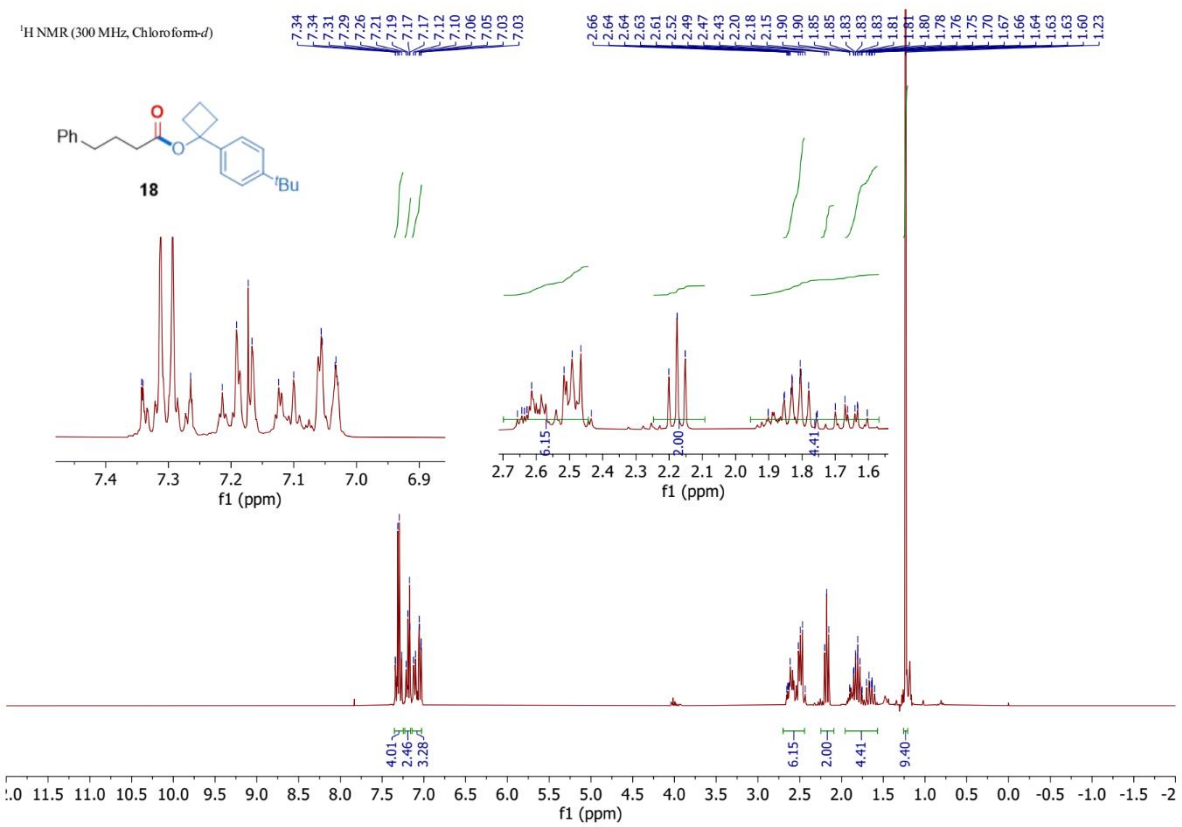


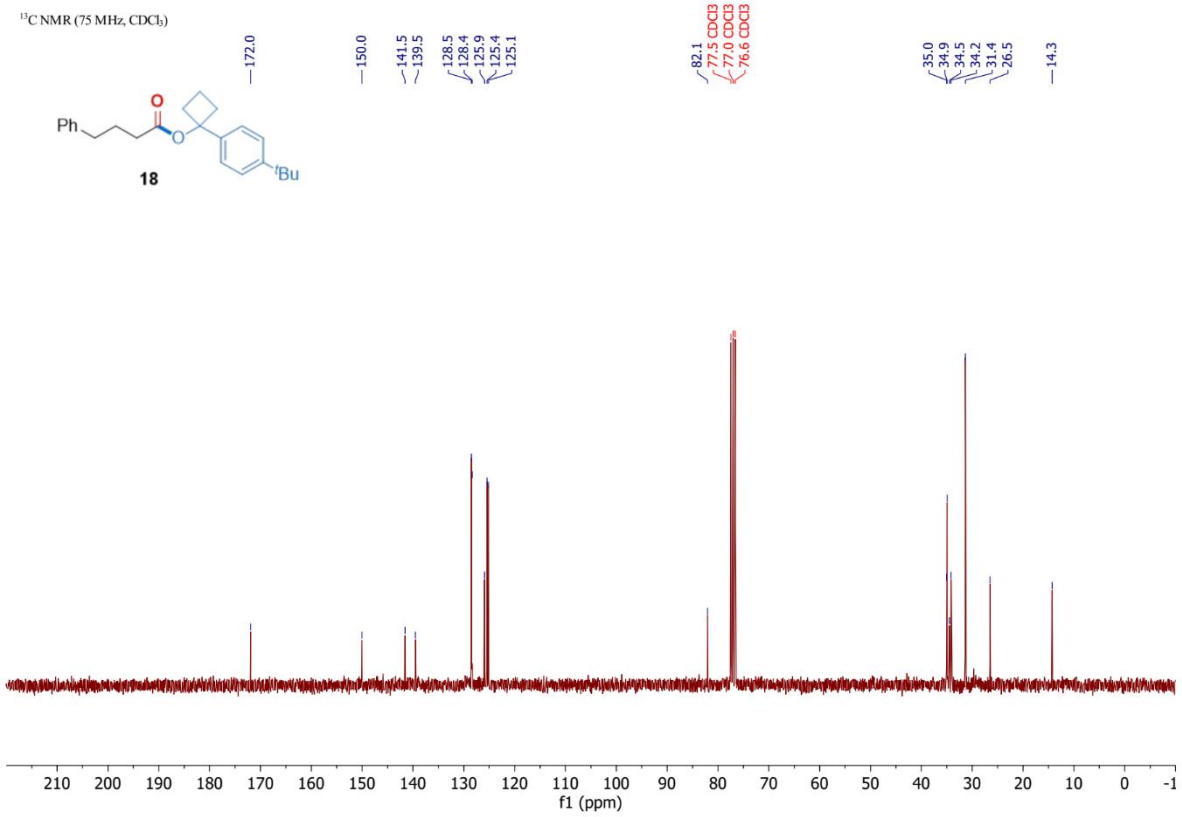
16

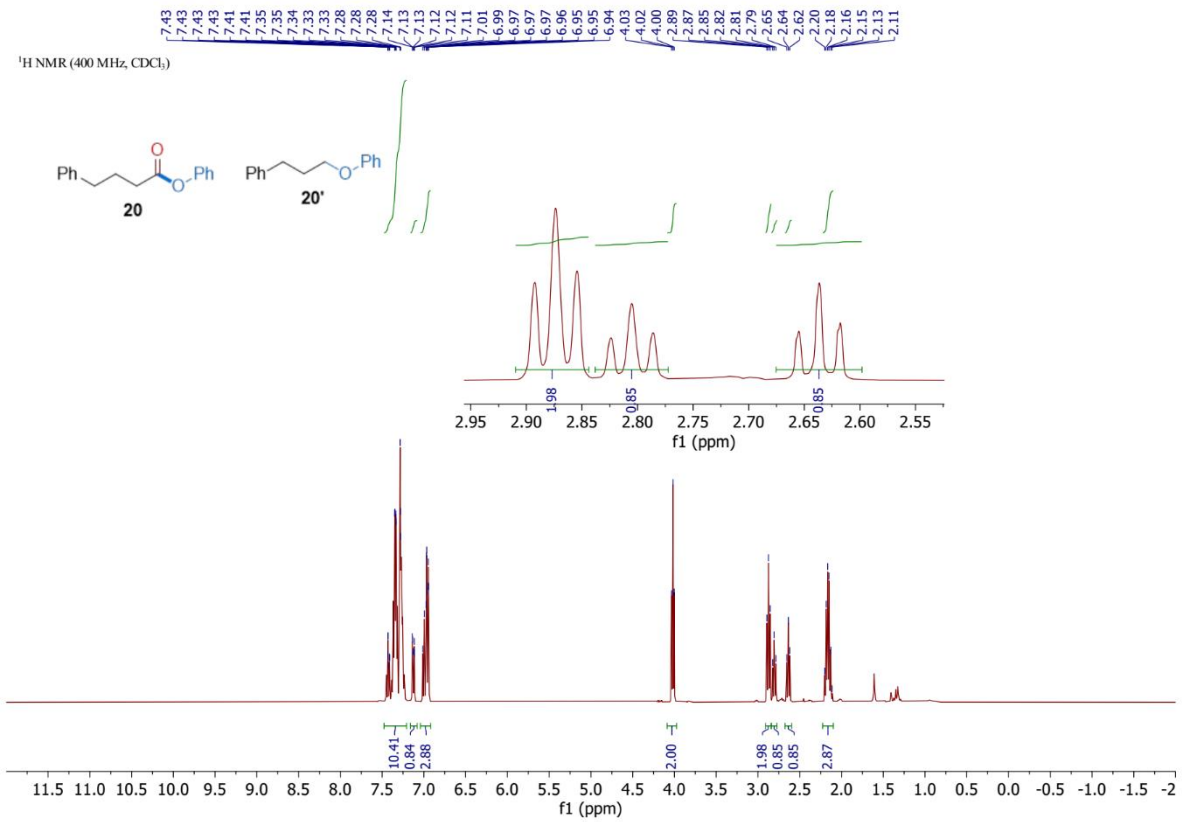


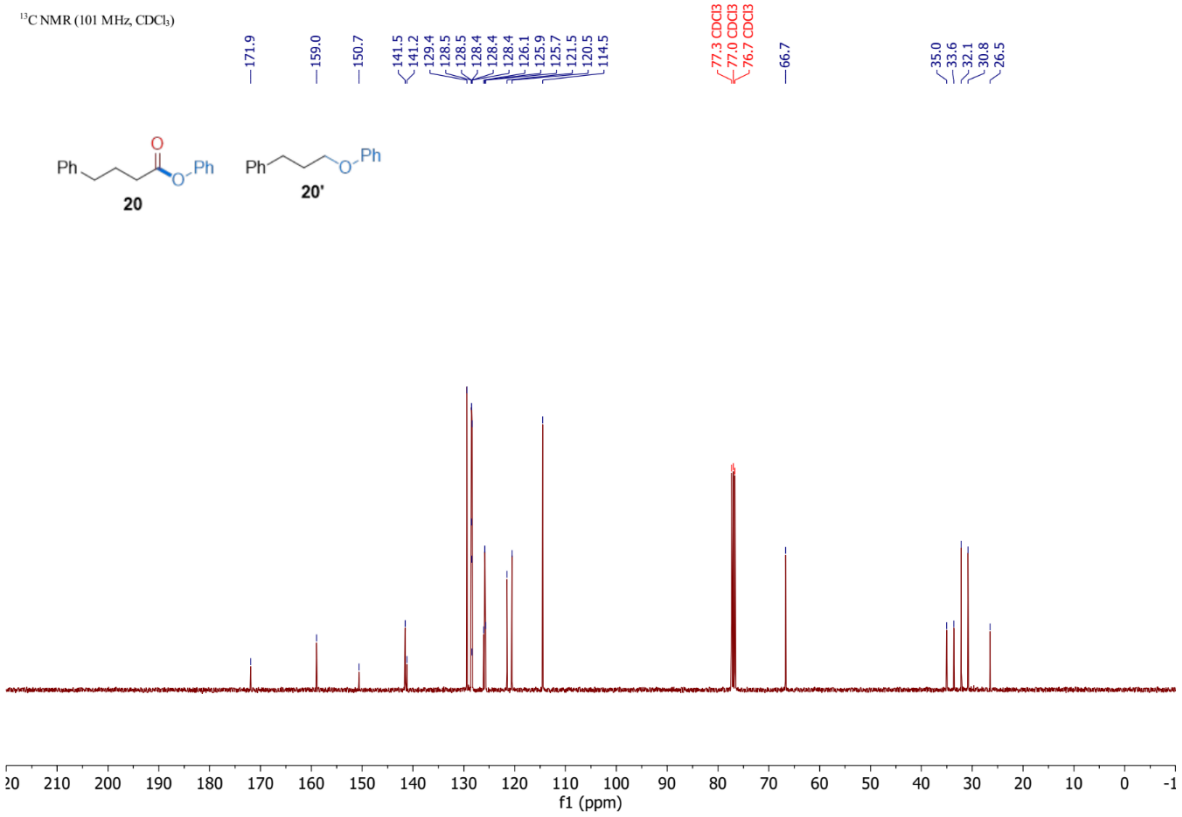

1H NMR (300 MHz, Chloroform-d)
Ph
O
O
Ph
17
1.56 H2O
f1 (ppm)
7.41
3.27
1.00
2.10
2.00
2.31
1.18
3.03
1.01

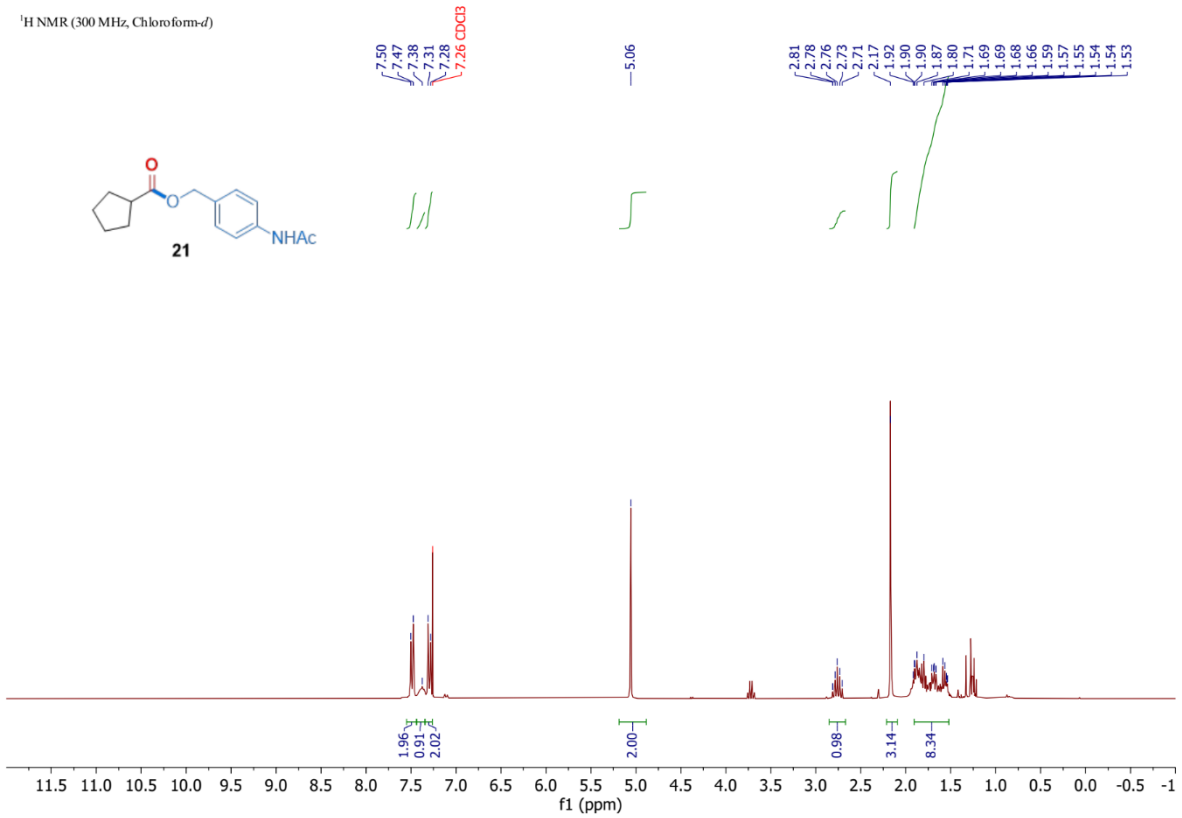

13C NMR (75 MHz, CDCl3)
172.8
141.5
140.5
128.5
128.4
127.9
126.6
126.0
79.6
77.5 CDCl3
77.0 CDCl3
76.6 CDCl3
35.1
34.0
26.7
16.6
4.1
3.1
Ph
O
O
Ph
17
f1 (ppm)

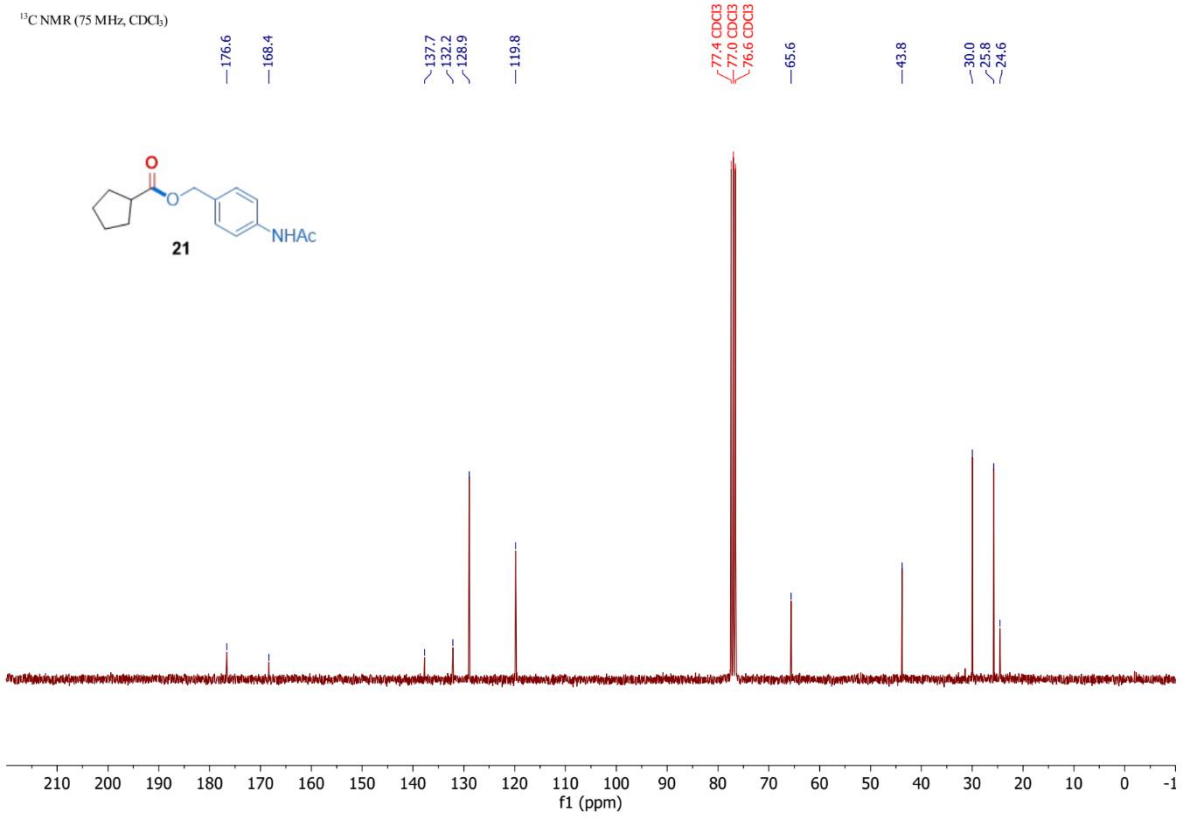

^{1}H NMR (300 MHz, Chloroform-*d*)
Ph
O
O
^{t}Bu
18
f1 (ppm)
4.01
2.46
3.28
6.15
2.00
4.41
9.40


^{13}C NMR (75 MHz, $CDCl_3$)
Ph
O
O
^{t}Bu
18
172.0
150.0
141.5
139.5
128.5
128.4
125.9
125.4
125.1
82.1
77.5 CDCl3
77.0 CDCl3
76.6 CDCl3
35.0
34.9
34.5
34.2
31.4
26.5
14.3
f1 (ppm)

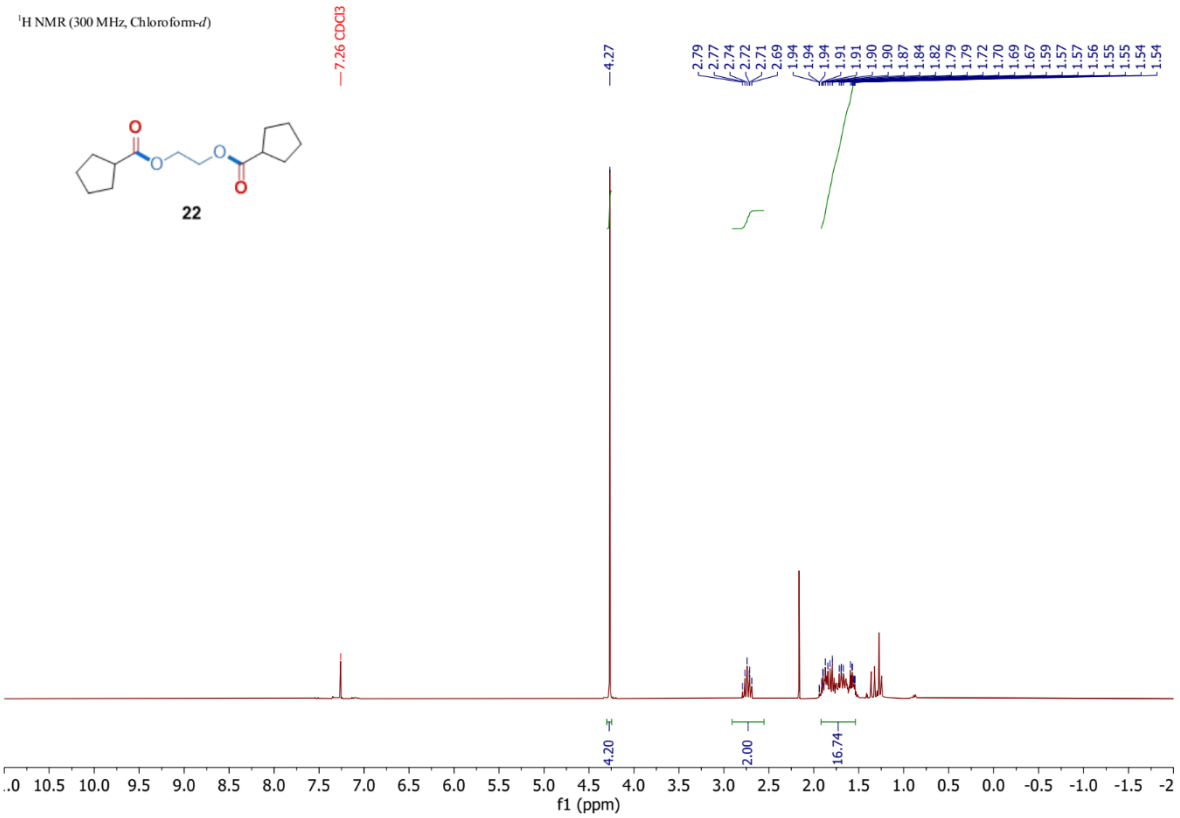

^{1}H NMR (400 MHz, $CDCl_3$)
20
20'
f1 (ppm)

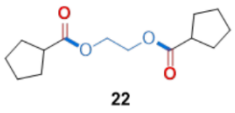

^{13}C NMR (101 MHz, $CDCl_3$)
77.3 CDCl3
77.0 CDCl3
76.7 CDCl3
20
20'
f1 (ppm)


1H NMR (300 MHz, Chloroform-d)
7.50
7.47
7.38
7.31
7.28
7.26 CDCl3
5.06
2.81
2.78
2.76
2.73
2.71
2.17
1.92
1.90
1.90
1.87
1.80
1.71
1.69
1.69
1.68
1.66
1.59
1.57
1.55
1.54
1.54
1.53
O
O
NHAc
21
1.96
0.91
2.02
2.00
0.98
3.14
8.34
11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1
f1 (ppm)


13C NMR (75 MHz, CDCl3)
176.6
168.4
137.7
132.2
128.9
119.8
77.4 CDCl3
77.0 CDCl3
76.6 CDCl3
65.6
43.8
30.0
25.8
24.6
O
O
NHAc
21
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -1
f1 (ppm)

^{1}H NMR (300 MHz, Chloroform-*d*)

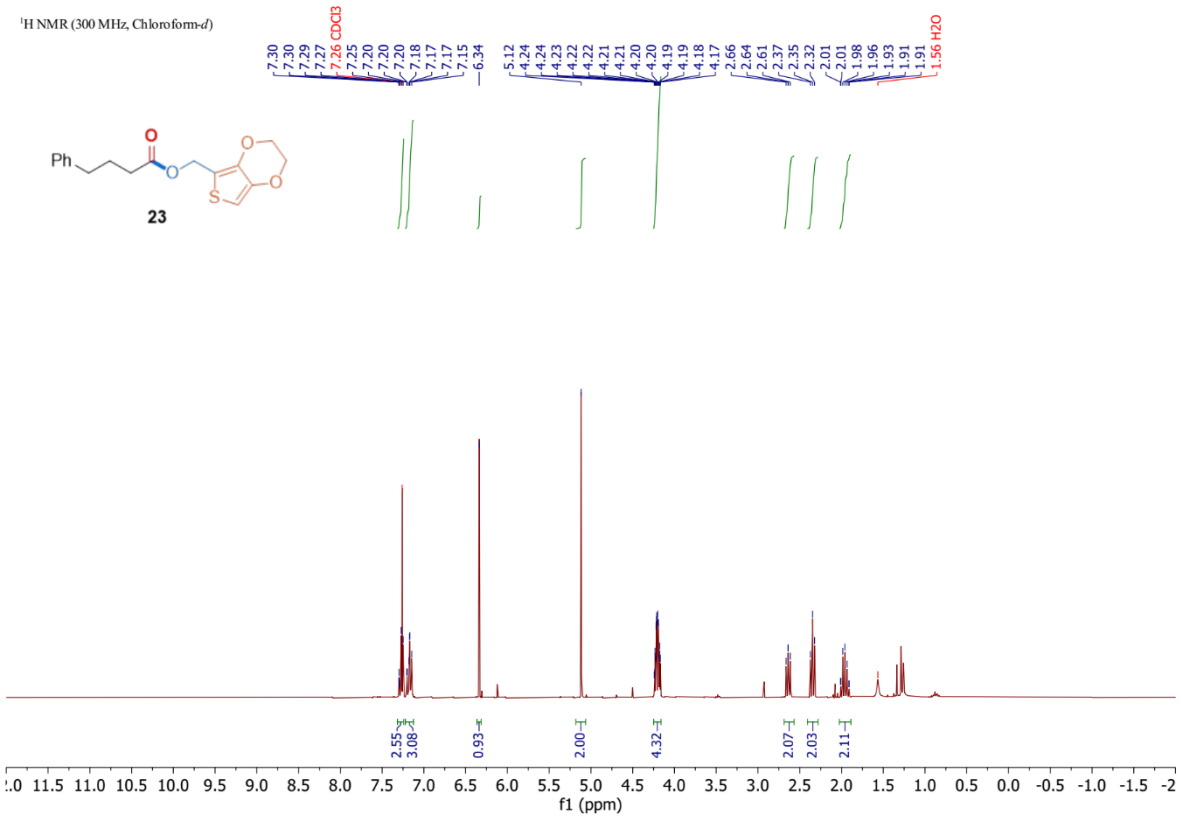


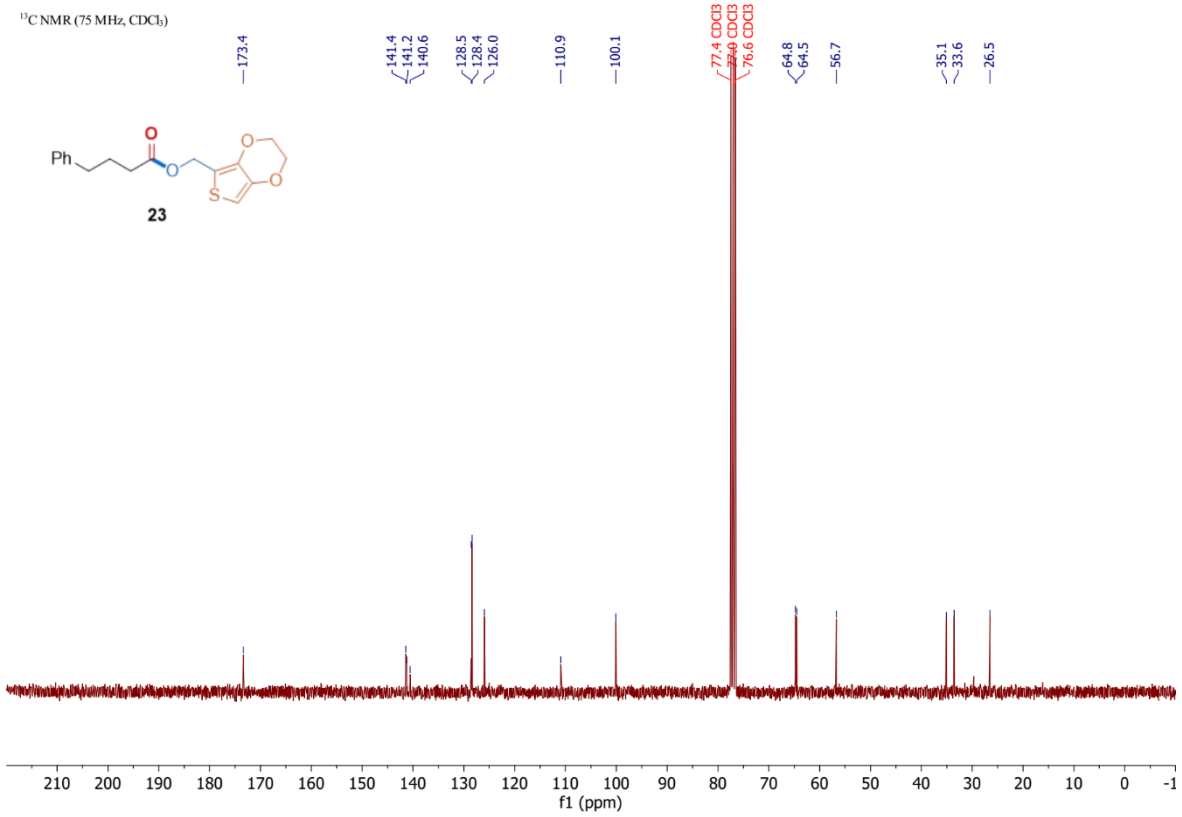


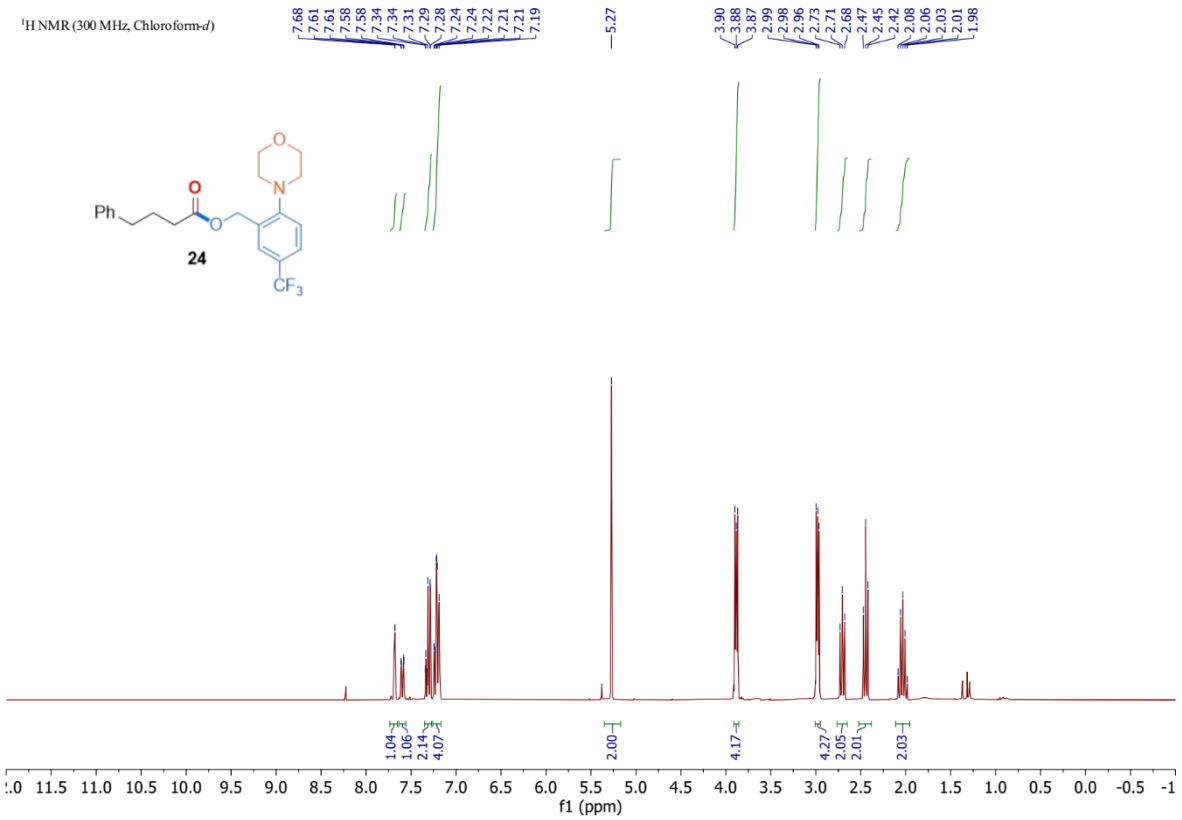
22

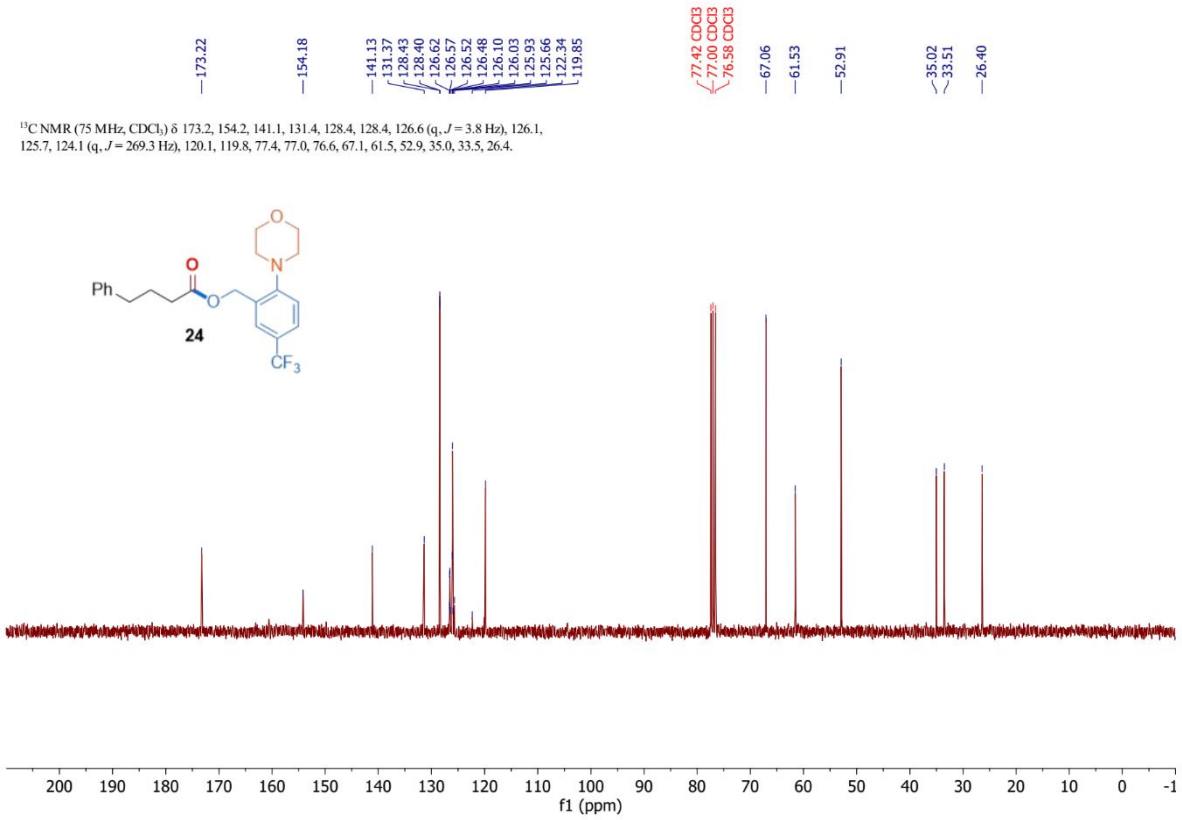
^{13}C NMR (75 MHz, $CDCl_3$)

22


1H NMR (300 MHz, Chloroform-d)
7.30 7.30 7.29 7.27 7.26 CDCl3 7.25 7.20 7.20 7.20 7.18 7.17 7.17 7.15 6.34
5.12 4.24 4.24 4.23 4.22 4.22 4.21 4.21 4.20 4.20 4.19 4.19 4.18 4.17
2.66 2.64 2.61 2.37 2.35 2.32 2.01 2.01 1.98 1.96 1.93 1.91 1.91 1.56 H2O
Ph
O
O
O
S
O
23
2.55 3.08 0.93 2.00 4.32 2.07 2.03 2.11
f1 (ppm)

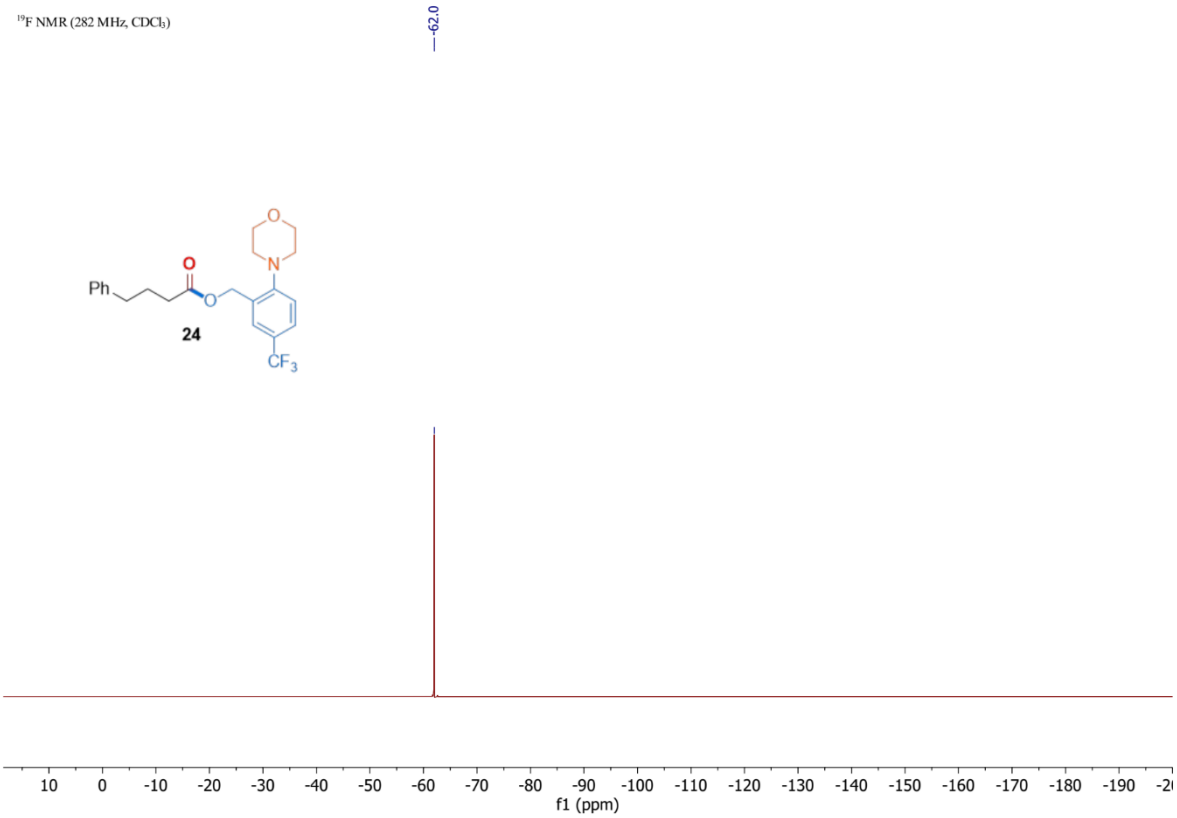

13C NMR (75 MHz, CDCl3)
173.4
141.4 141.2 140.6 128.5 128.4 126.0 110.9 100.1
77.4 CDCl3 77.0 CDCl3 76.6 CDCl3
64.8 64.5 56.7 35.1 33.6 26.5
Ph
O
O
O
S
O
23
f1 (ppm)

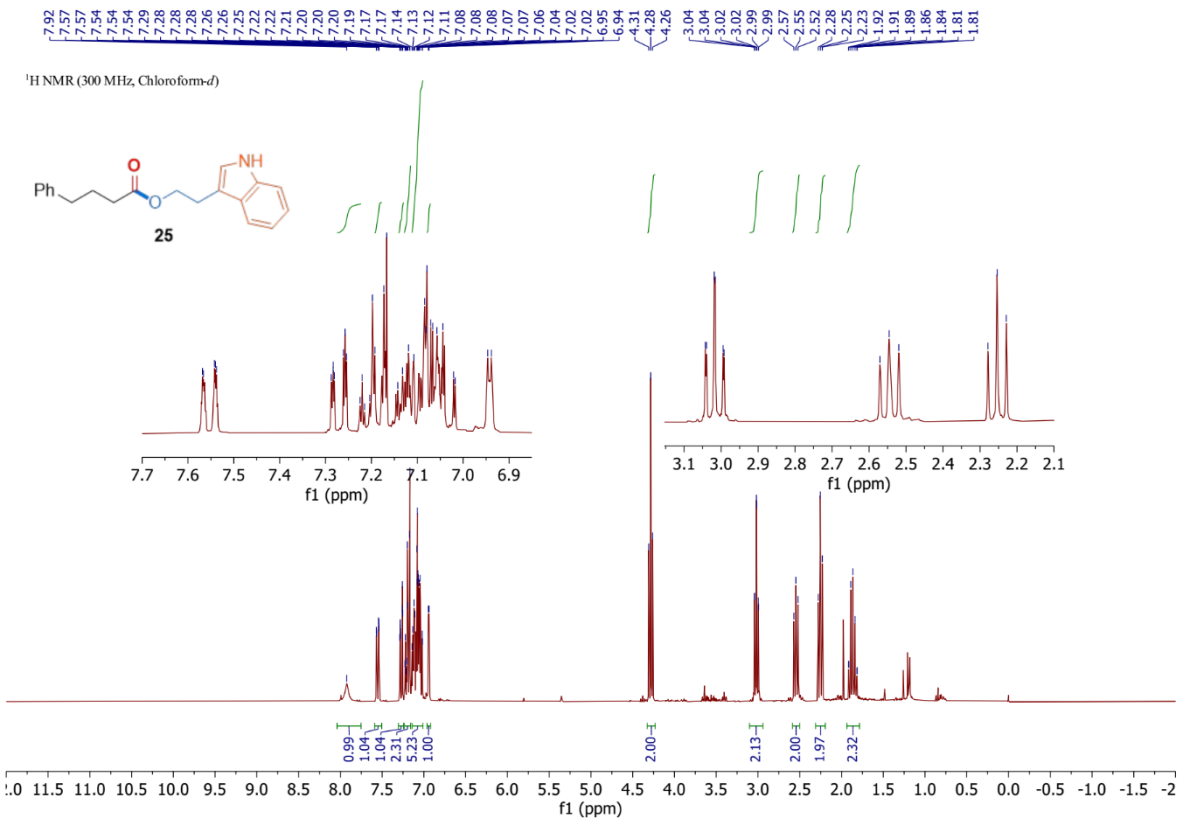


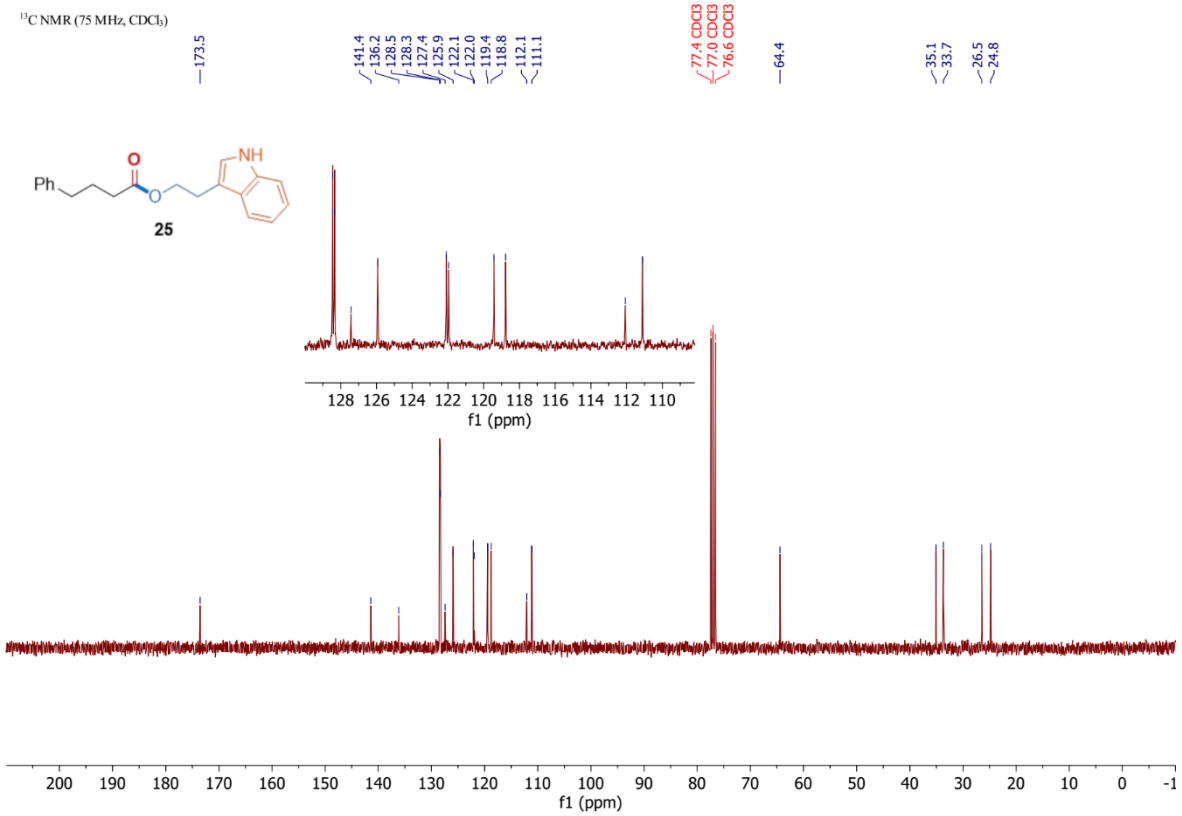


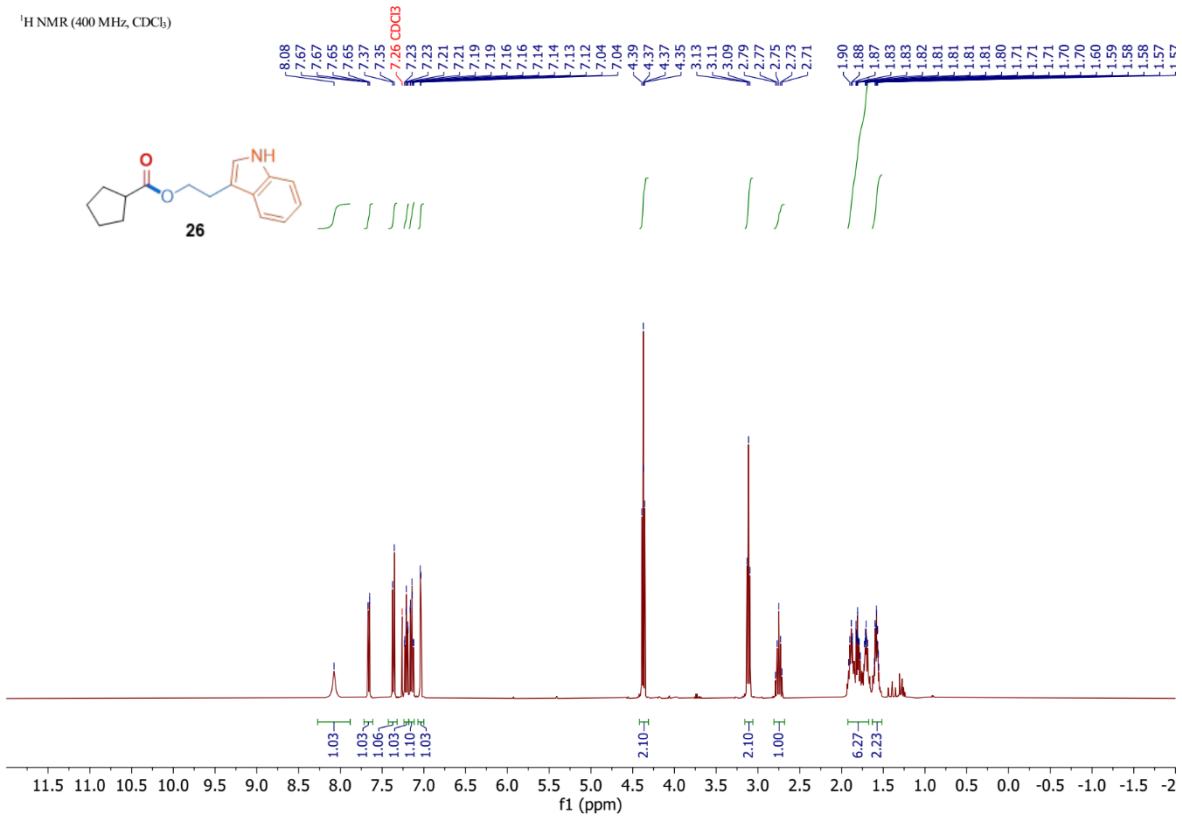
13C NMR (75 MHz, $CDCl_3$) δ 173.2, 154.2, 141.1, 131.4, 128.4, 128.4, 126.6 (q, J = 3.8 Hz), 126.1, 125.7, 124.1 (q, J = 269.3 Hz), 120.1, 119.8, 77.4, 77.0, 76.6, 67.1, 61.5, 52.9, 35.0, 33.5, 26.4.

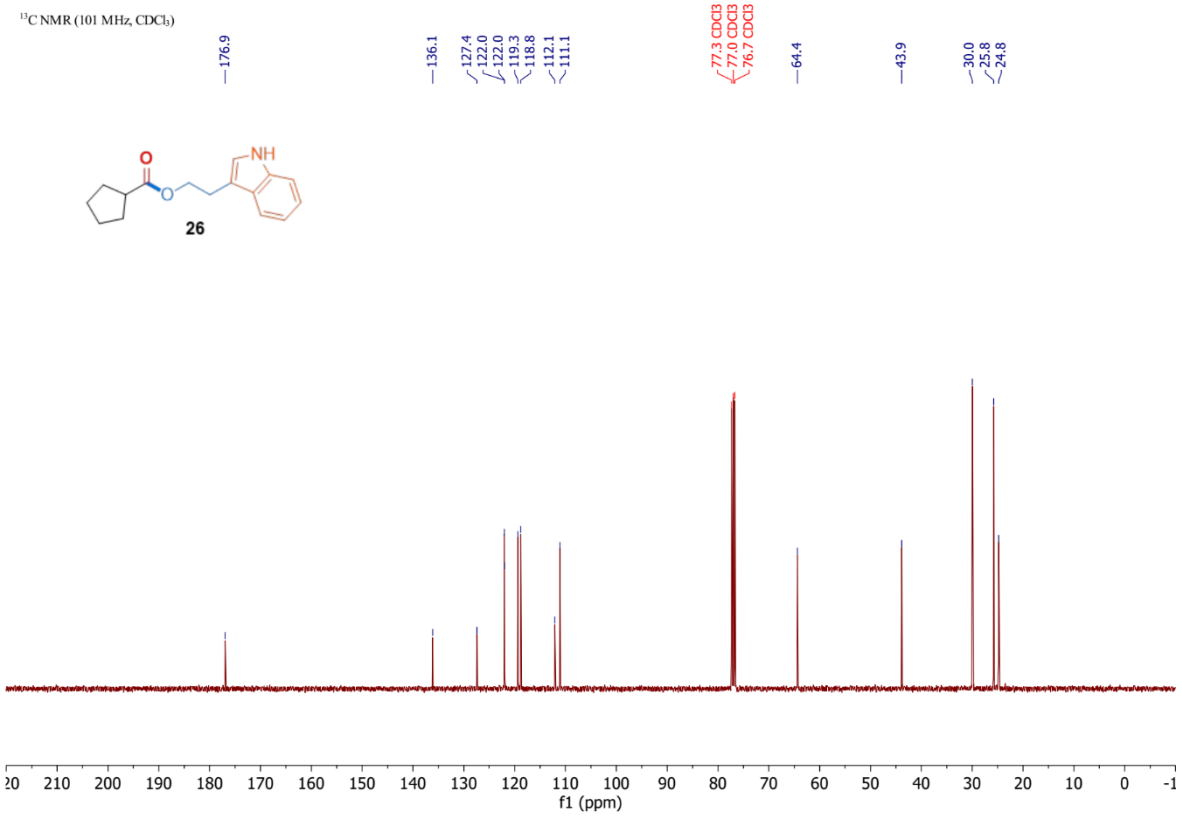
^{19}F NMR (282 MHz, $CDCl_3$)

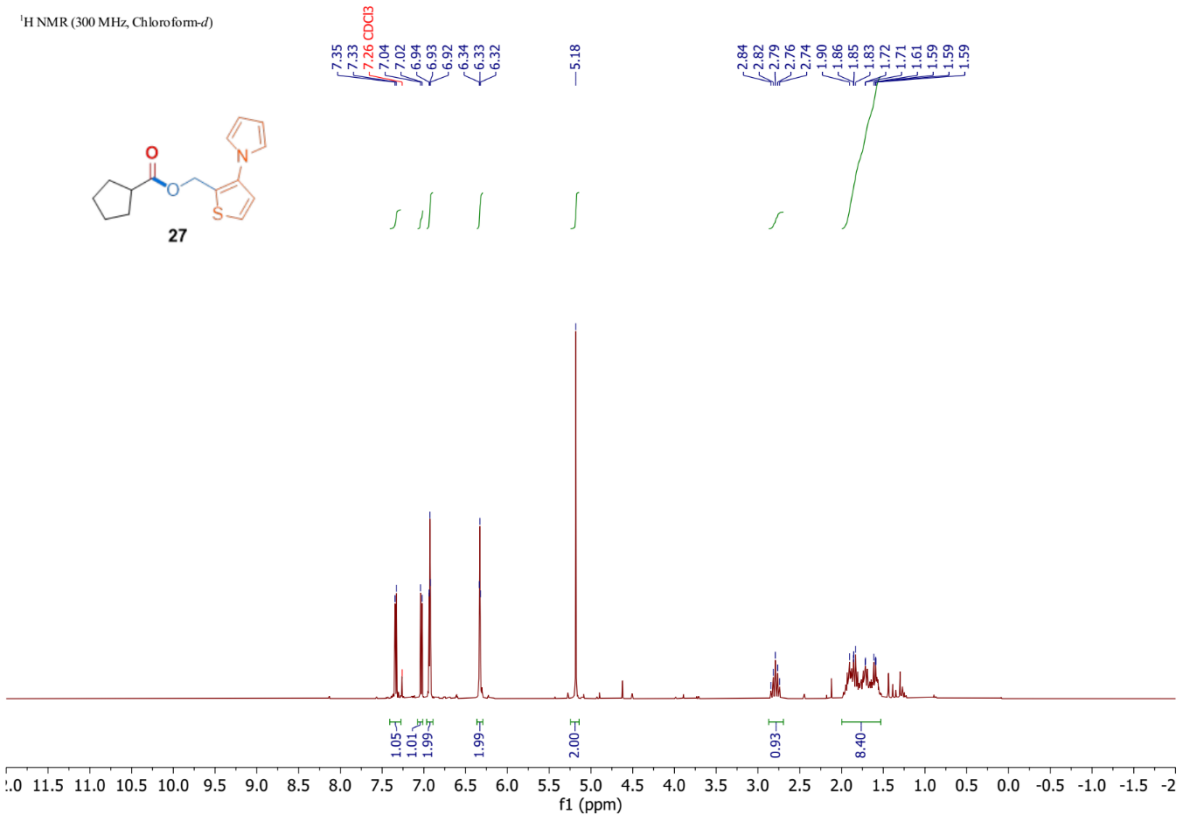


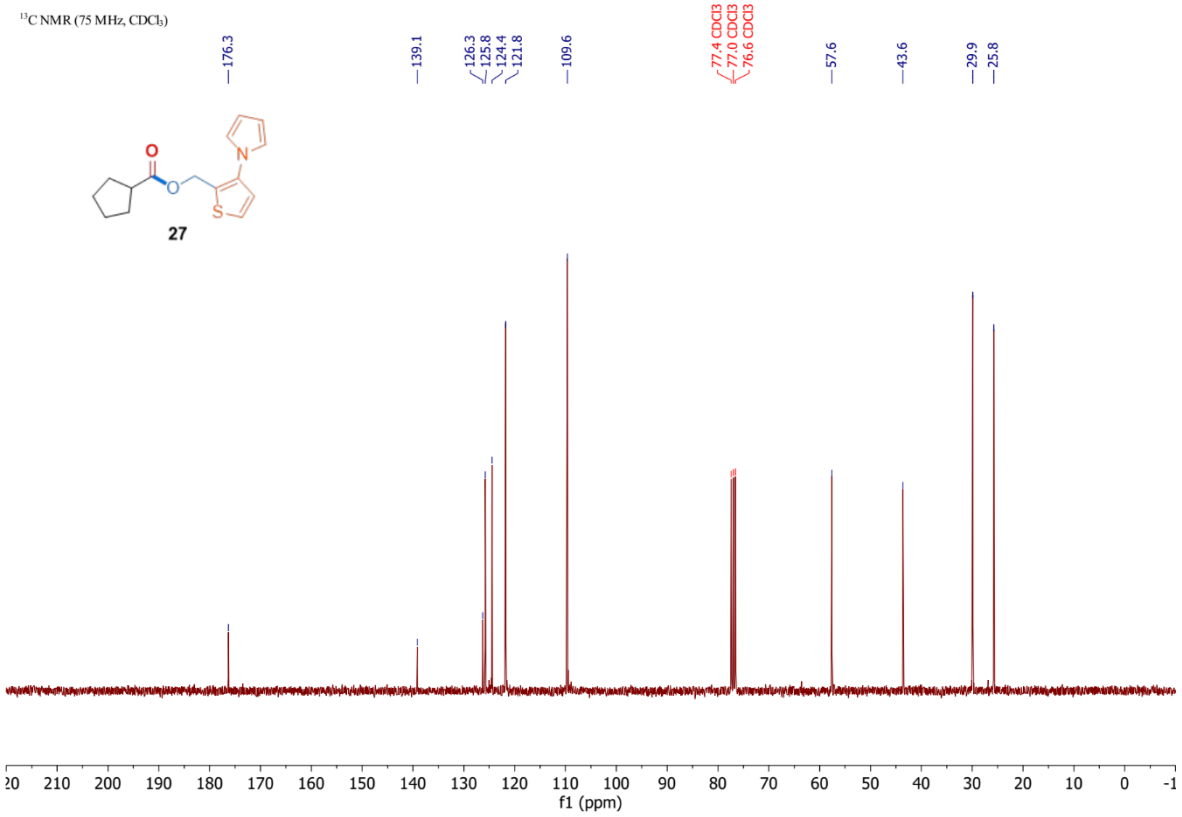

7.92 7.57 7.57 7.54 7.54 7.54 7.29 7.28 7.28 7.28 7.26 7.26 7.25 7.22 7.22 7.21 7.20 7.20 7.20 7.19 7.17 7.17 7.14 7.13 7.12 7.11 7.08 7.08 7.08 7.07 7.07 7.06 7.04 7.02 7.02 6.95 6.94 4.31 4.28 4.26 3.04 3.04 3.02 3.02 2.99 2.99 2.57 2.55 2.52 2.28 2.25 2.23 1.92 1.91 1.89 1.86 1.84 1.81 1.81
1H NMR (300 MHz, Chloroform-d)
Ph
O
NH
O
25
7.7 7.6 7.5 7.4 7.3 7.2 7.1 7.0 6.9
f1 (ppm)
3.1 3.0 2.9 2.8 2.7 2.6 2.5 2.4 2.3 2.2 2.1
f1 (ppm)
0.99 1.04 1.04 2.31 5.23 1.00 2.00 2.13 2.00 1.97 2.32
f1 (ppm)

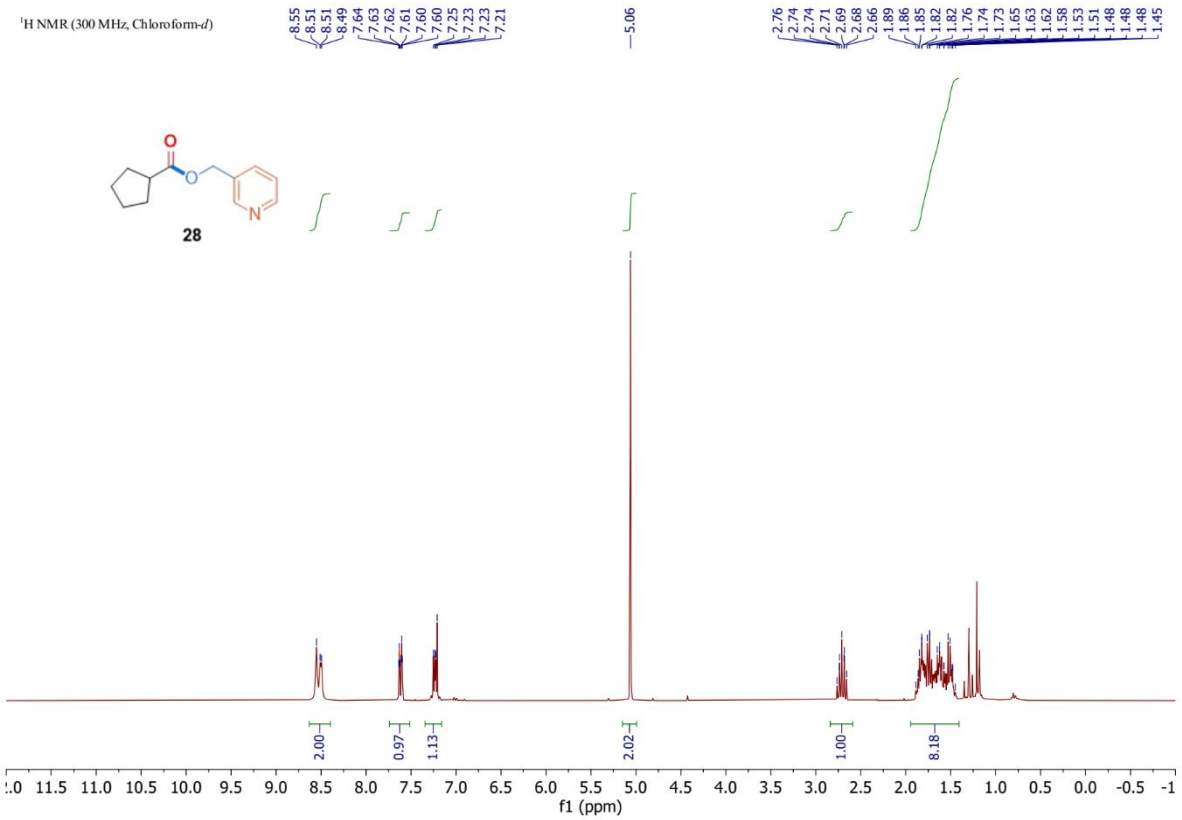

13C NMR (75 MHz, CDCl3)
173.5
141.4 136.2 128.5 128.3 127.4 125.9 122.1 122.0 119.4 118.8 112.1 111.1
77.4 CDCl3
77.0 CDCl3
76.6 CDCl3
64.4
35.1 33.7 26.5 24.8
Ph
O
NH
O
25
128 126 124 122 120 118 116 114 112 110
f1 (ppm)
f1 (ppm)

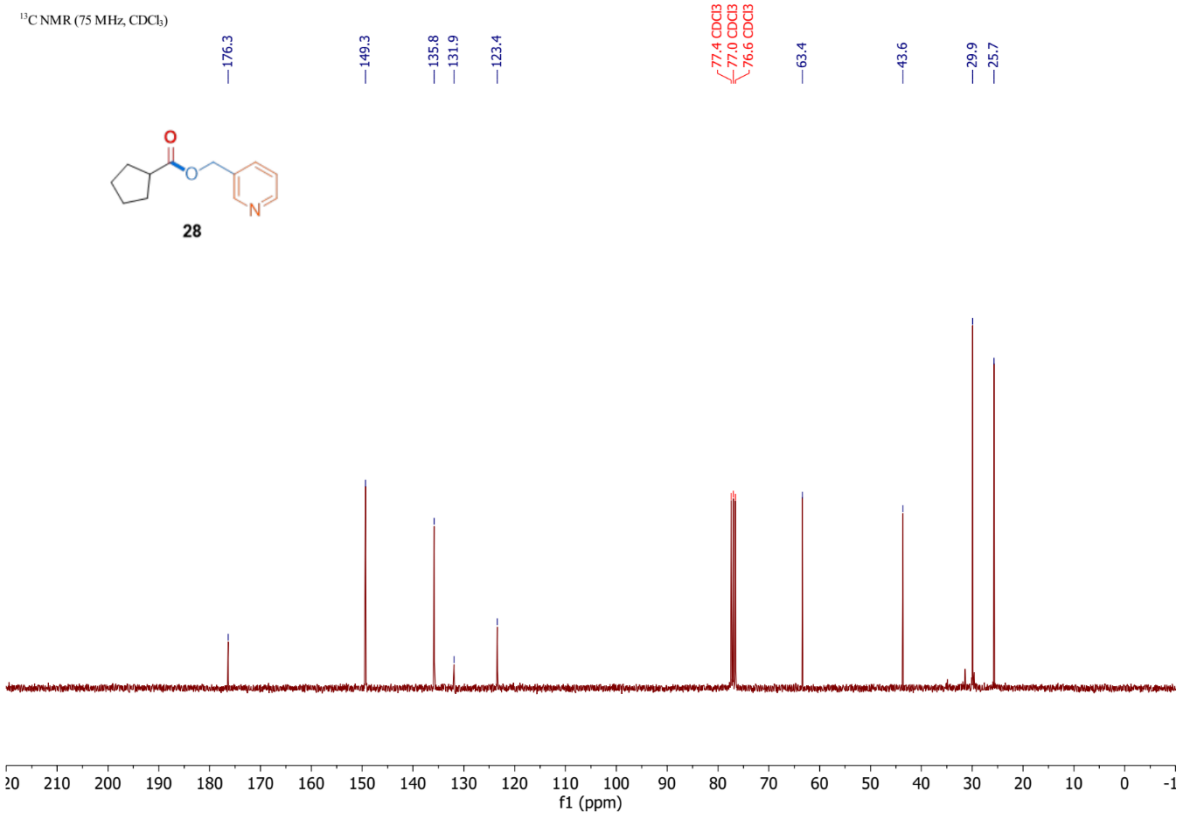

^{1}H NMR (400 MHz, CDCl$_3$)
8.08
7.67
7.67
7.65
7.65
7.37
7.35
7.26 CDCl3
7.23
7.23
7.21
7.21
7.19
7.19
7.16
7.16
7.14
7.14
7.13
7.12
7.04
7.04
4.39
4.37
4.37
4.35
3.13
3.11
3.09
2.79
2.77
2.75
2.73
2.71
1.90
1.88
1.87
1.83
1.83
1.82
1.81
1.81
1.81
1.81
1.80
1.71
1.71
1.71
1.70
1.70
1.60
1.59
1.58
1.58
1.57
O
NH
O
26
1.03
1.03
1.06
1.03
1.10
1.03
2.10
2.10
1.00
6.27
2.23
11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0 -1.5 -2
f1 (ppm)

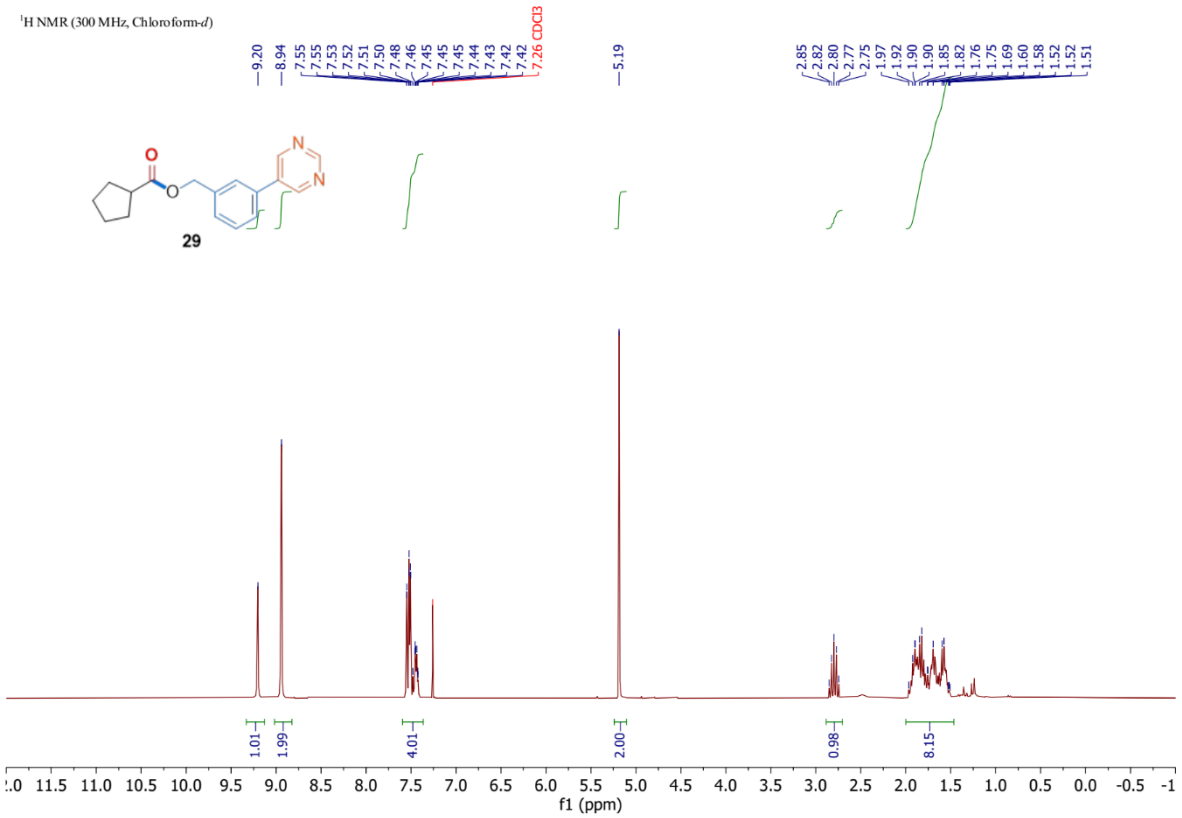

^{13}C NMR (101 MHz, CDCl$_3$)
176.9
136.1
127.4
122.0
122.0
119.3
118.8
112.1
111.1
77.3 CDCl3
77.0 CDCl3
76.7 CDCl3
64.4
43.9
30.0
25.8
24.8
O
NH
O
26
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -1
f1 (ppm)

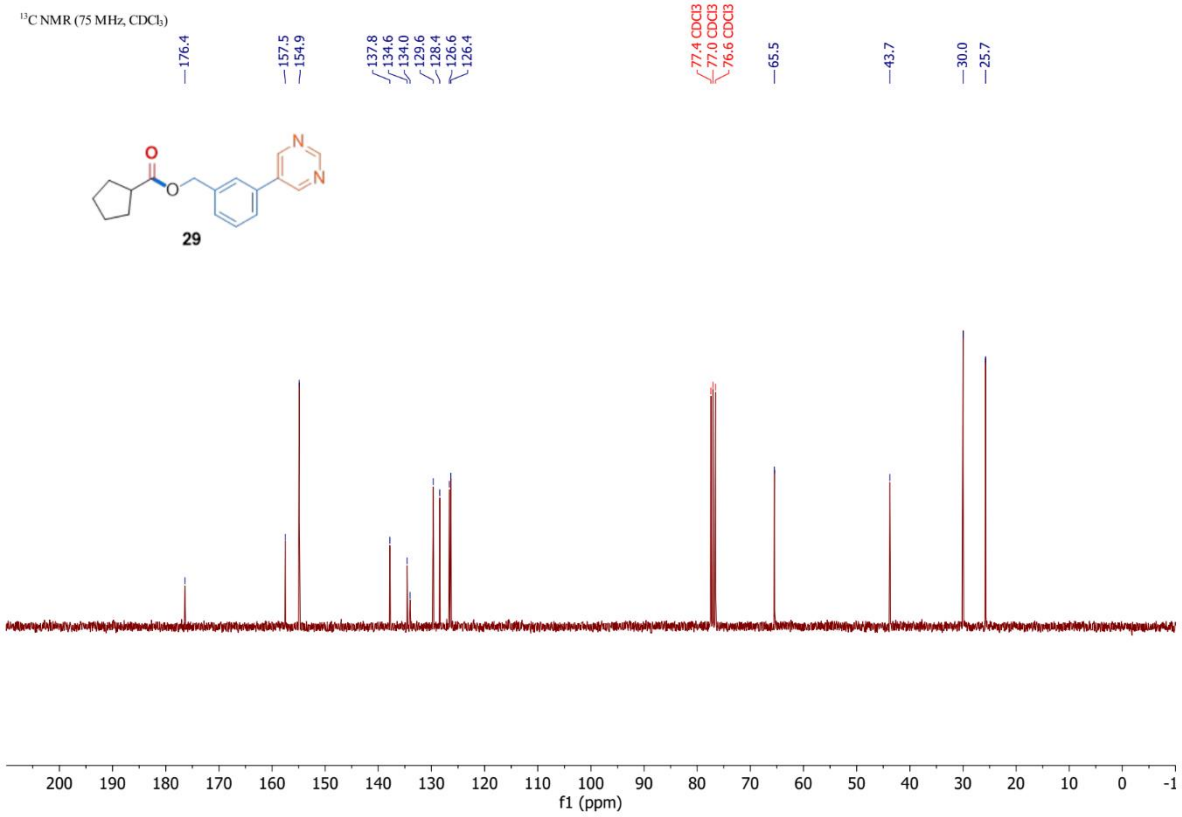

^{1}H NMR (300 MHz, Chloroform-*d*)
7.35
7.33
7.26 CDCl3
7.04
7.02
6.94
6.93
6.92
6.34
6.33
6.32
5.18
2.84
2.82
2.79
2.76
2.74
1.90
1.86
1.85
1.83
1.72
1.71
1.61
1.59
1.59
1.59
27
1.05
1.01
1.99
1.99
2.00
0.93
8.40
f1 (ppm)

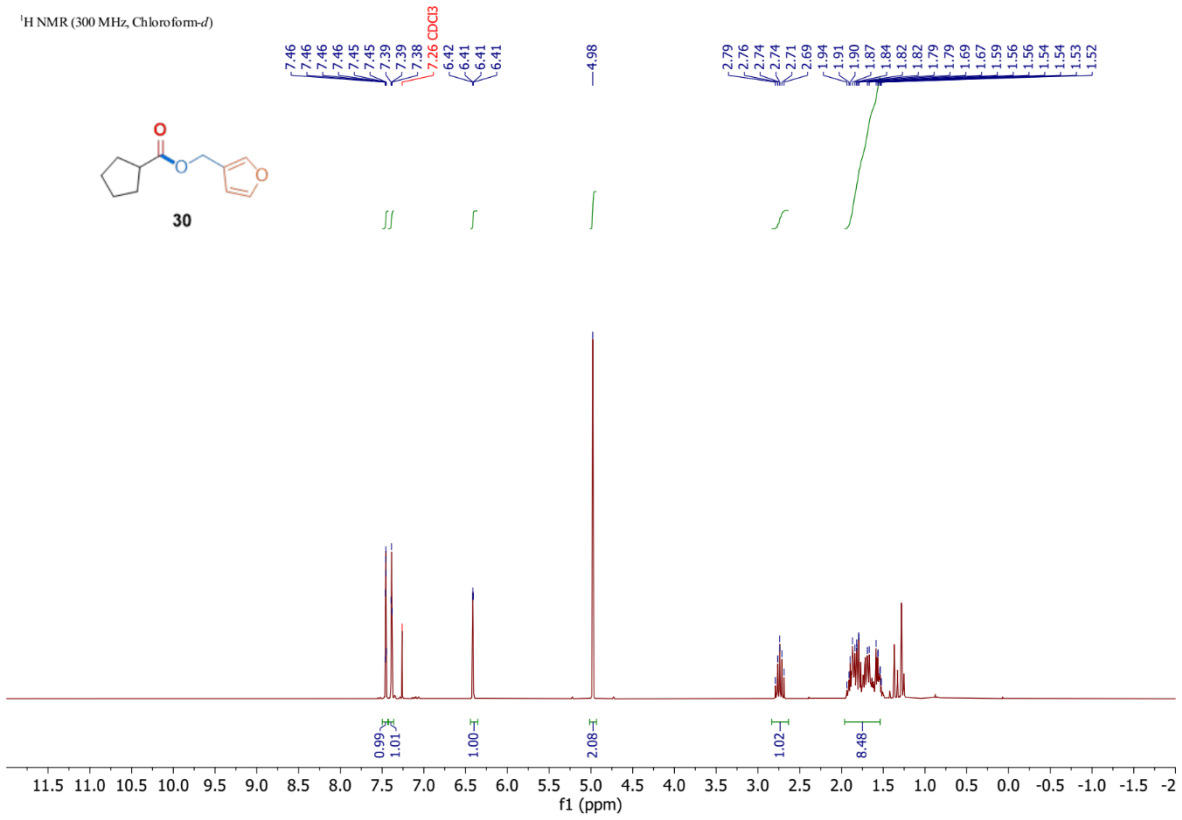

^{13}C NMR (75 MHz, $CDCl_3$)
176.3
139.1
126.3
125.8
124.4
121.8
109.6
77.4 CDCl3
77.0 CDCl3
76.6 CDCl3
57.6
43.6
29.9
25.8
27
f1 (ppm)

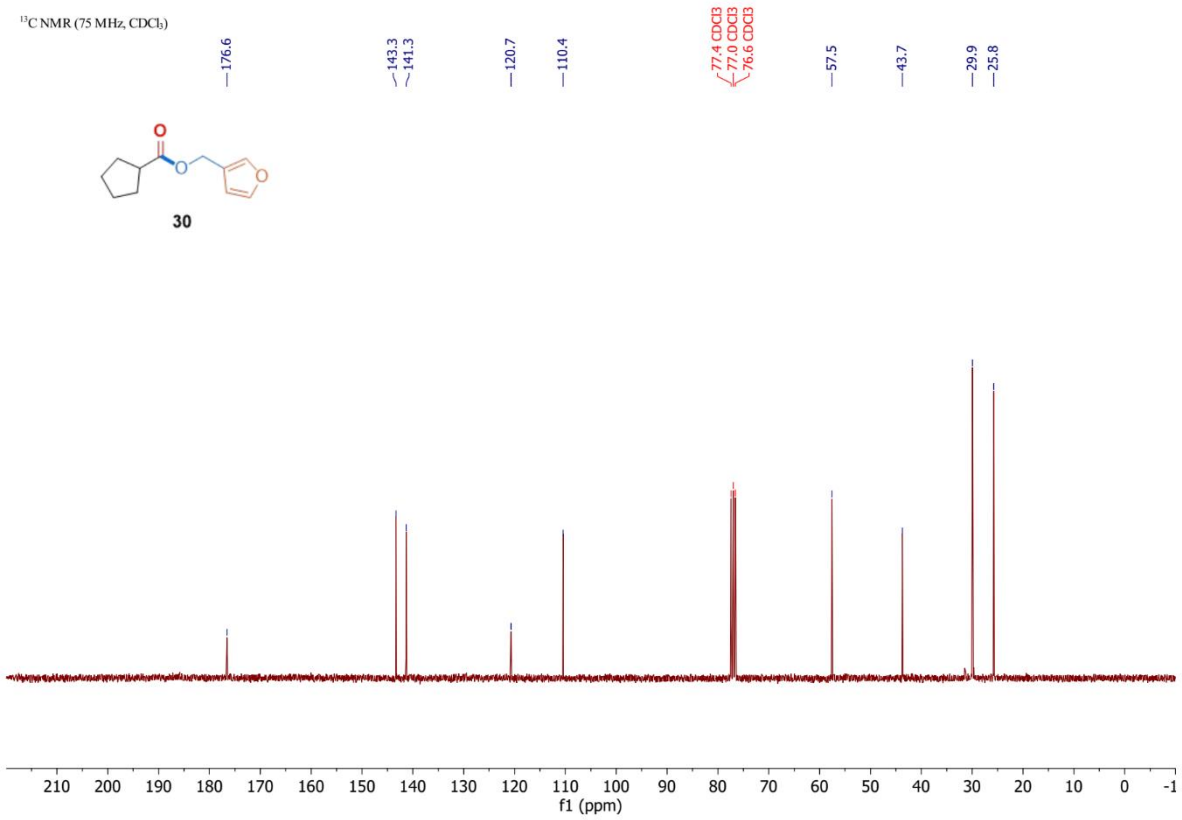

^{1}H NMR (300 MHz, Chloroform-*d*)
8.55
8.51
8.51
8.49
7.64
7.63
7.62
7.61
7.60
7.60
7.25
7.23
7.23
7.21
5.06
2.76
2.74
2.74
2.71
2.69
2.68
2.66
1.89
1.86
1.85
1.82
1.82
1.76
1.74
1.73
1.65
1.63
1.62
1.58
1.53
1.51
1.48
1.48
1.48
1.45
28
2.00
0.97
1.13
2.02
1.00
8.18
f1 (ppm)

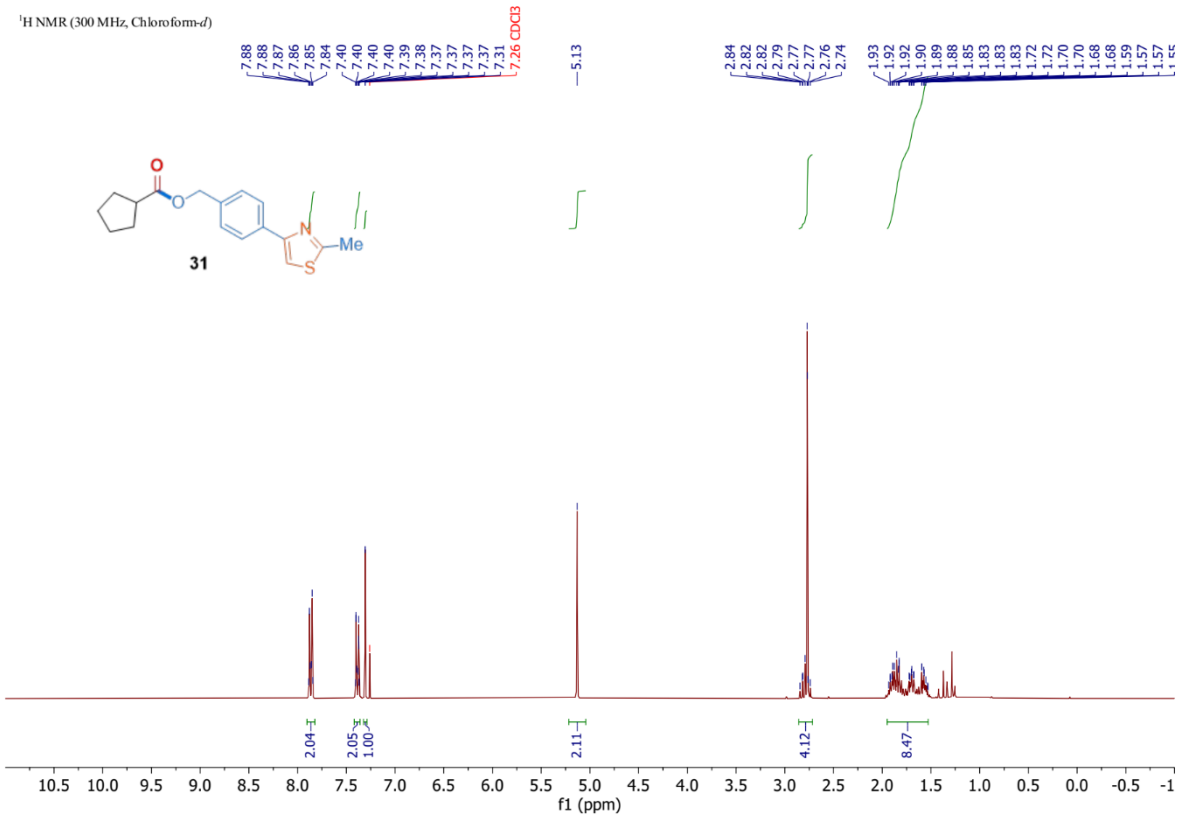

^{13}C NMR (75 MHz, $CDCl_3$)
176.3
149.3
135.8
131.9
123.4
77.4 CDCl3
77.0 CDCl3
76.6 CDCl3
63.4
43.6
29.9
25.7
28
f1 (ppm)

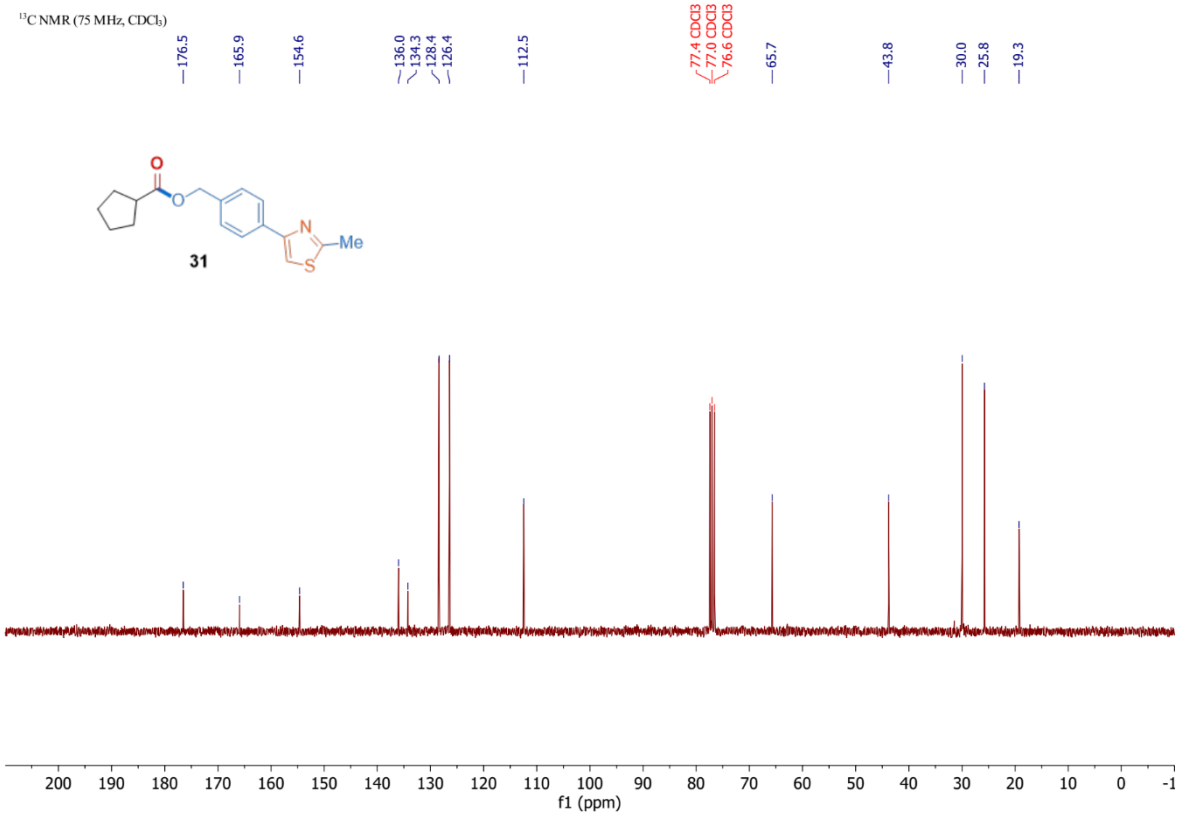

1H NMR (300 MHz, Chloroform-d)
9.20
8.94
7.55
7.55
7.53
7.52
7.51
7.50
7.48
7.46
7.45
7.45
7.45
7.44
7.43
7.42
7.42
7.26 CDCl3
5.19
2.85
2.82
2.80
2.77
2.75
1.97
1.92
1.90
1.90
1.85
1.82
1.76
1.75
1.69
1.60
1.58
1.52
1.52
1.51
O
O
N
N
29
1.01
1.99
4.01
2.00
0.98
8.15
11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1
f1 (ppm)

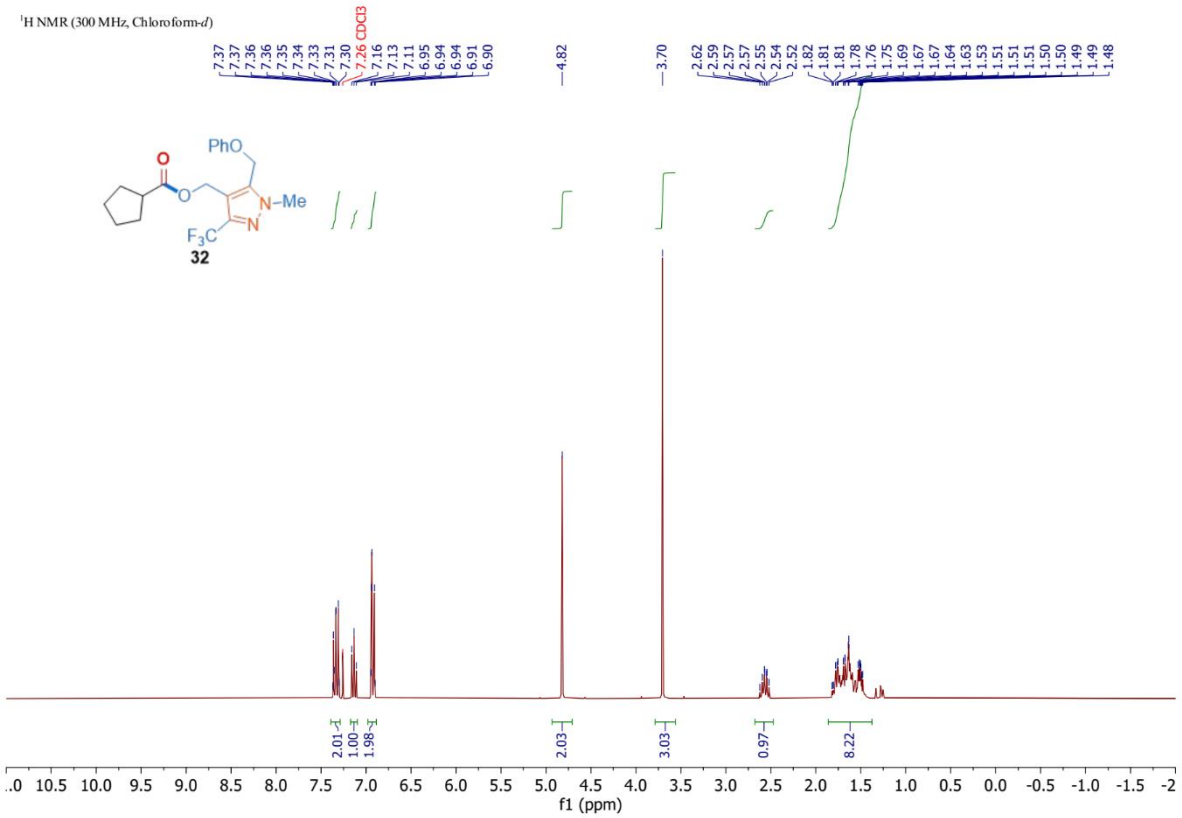

13C NMR (75 MHz, CDCl3)
176.4
157.5
154.9
137.8
134.6
134.0
129.6
128.4
126.6
126.4
77.4 CDCl3
77.0 CDCl3
76.6 CDCl3
65.5
43.7
30.0
25.7
O
O
N
N
29
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -1
f1 (ppm)

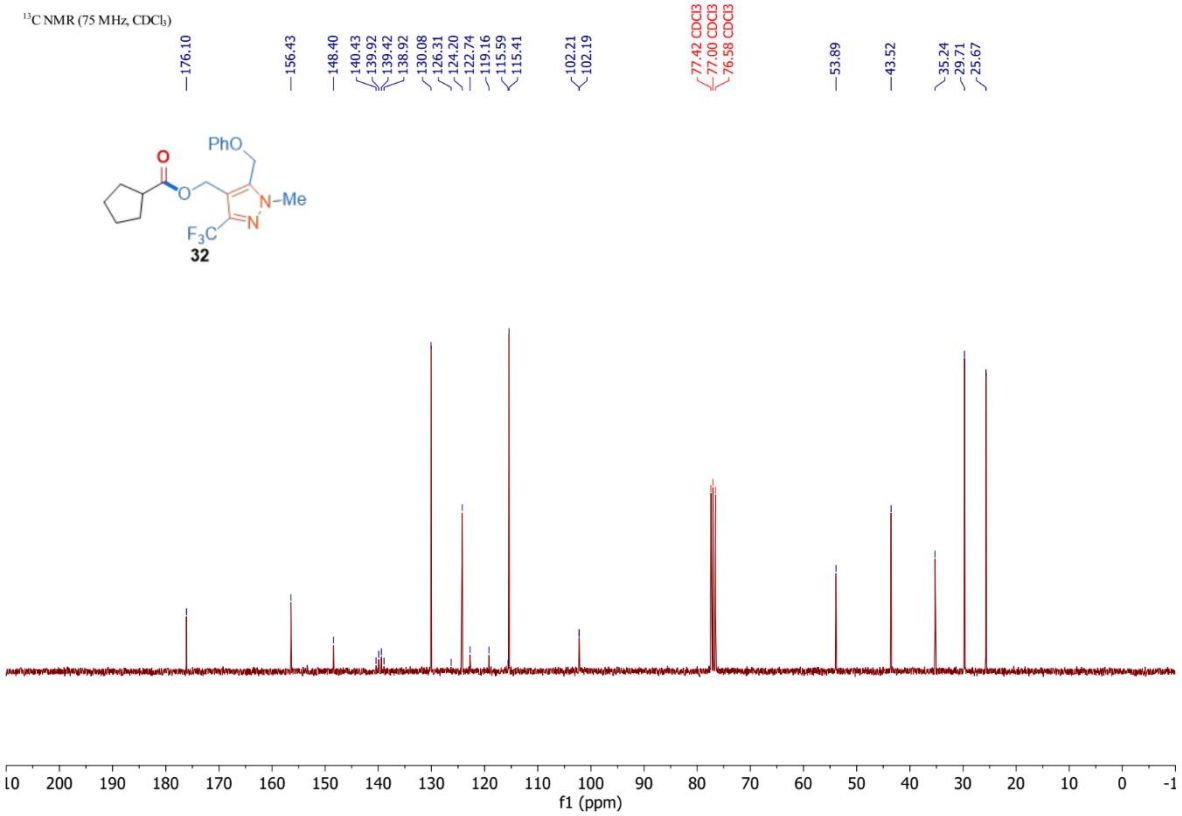

^{1}H NMR (300 MHz, Chloroform-*d*)
7.46 7.46 7.46 7.46 7.45 7.45 7.39 7.39 7.38 7.26 CDCl3 6.42 6.41 6.41 6.41
4.98
2.79 2.76 2.74 2.74 2.71 2.69 1.94 1.91 1.90 1.87 1.84 1.82 1.79 1.79 1.69 1.67 1.59 1.56 1.56 1.54 1.54 1.53 1.52
30
0.99 1.01 1.00 2.08 1.02 8.48
11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0 -1.5 -2
f1 (ppm)


^{13}C NMR (75 MHz, $CDCl_3$)
176.6
143.3 141.3
120.7
110.4
77.4 CDCl3 77.0 CDCl3 76.6 CDCl3
57.5
43.7
29.9
25.8
30
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -1
f1 (ppm)

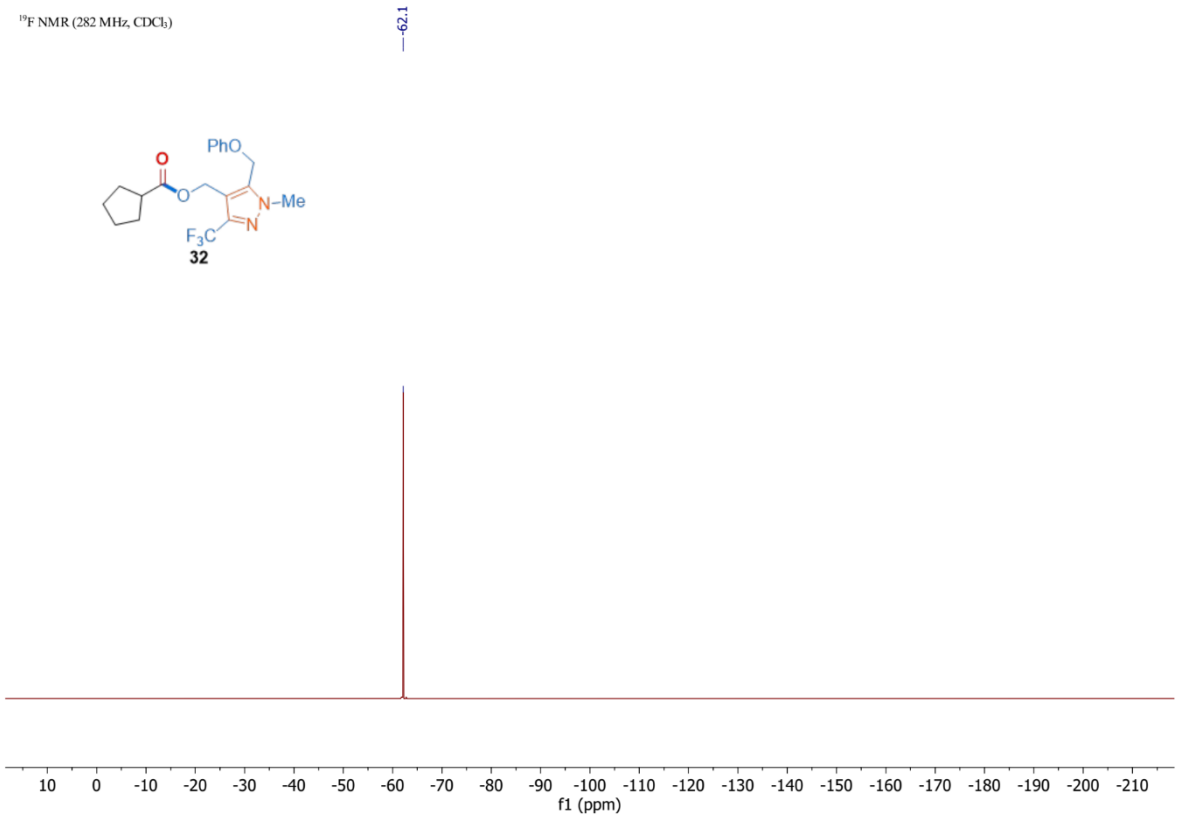

1H NMR (300 MHz, Chloroform-d)
7.88
7.88
7.87
7.86
7.85
7.84
7.40
7.40
7.40
7.40
7.39
7.38
7.37
7.37
7.37
7.37
7.31
7.26 CDCl3
5.13
2.84
2.82
2.82
2.79
2.77
2.77
2.76
2.74
1.93
1.92
1.92
1.90
1.89
1.88
1.85
1.83
1.83
1.83
1.72
1.72
1.70
1.70
1.68
1.68
1.59
1.57
1.57
O
O
N
S
Me
31
2.04
2.05
1.00
2.11
4.12
8.47
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1
f1 (ppm)

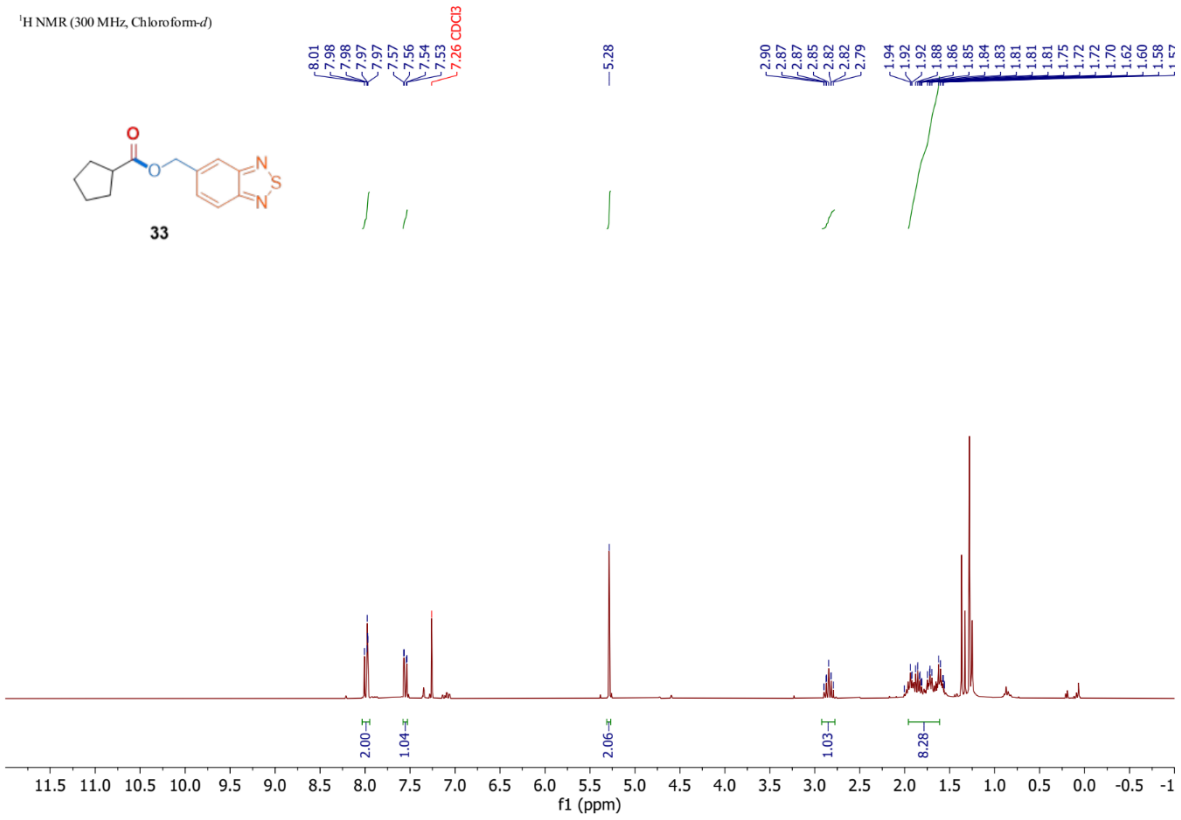

13C NMR (75 MHz, CDCl3)
176.5
165.9
154.6
136.0
134.3
128.4
126.4
112.5
77.4 CDCl3
77.0 CDCl3
76.6 CDCl3
65.7
43.8
30.0
25.8
19.3
O
O
N
S
Me
31
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -1
f1 (ppm)

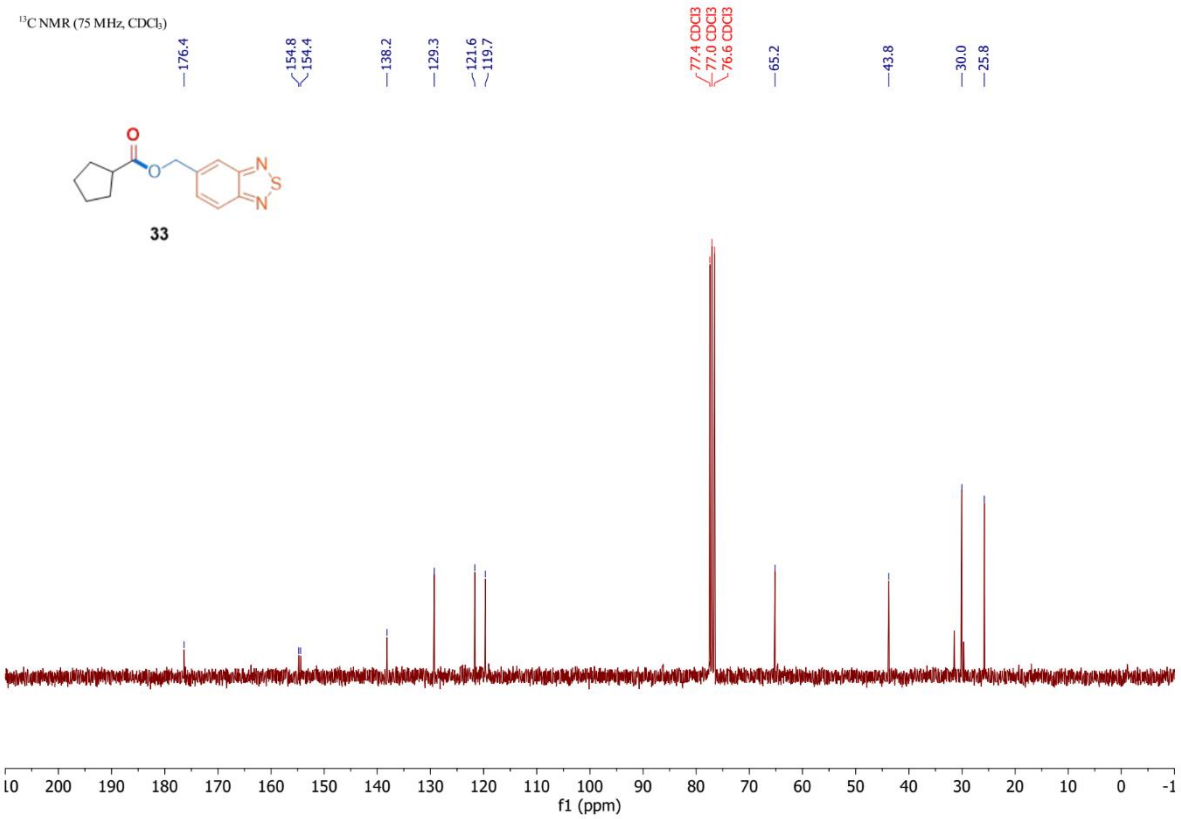

1H NMR (300 MHz, Chloroform-d)
7.37 7.37 7.36 7.36 7.35 7.34 7.33 7.31 7.30 7.26 CDCl3 7.16 7.13 7.11 6.95 6.94 6.94 6.91 6.90
4.82
3.70
2.62 2.59 2.57 2.57 2.55 2.54 2.52 1.82 1.81 1.81 1.78 1.76 1.75 1.69 1.67 1.67 1.64 1.63 1.53 1.51 1.51 1.51 1.50 1.50 1.49 1.49 1.48
PhO
O
N–Me
F3C
N
32
2.01
1.00
1.98
2.03
3.03
0.97
8.22
f1 (ppm)

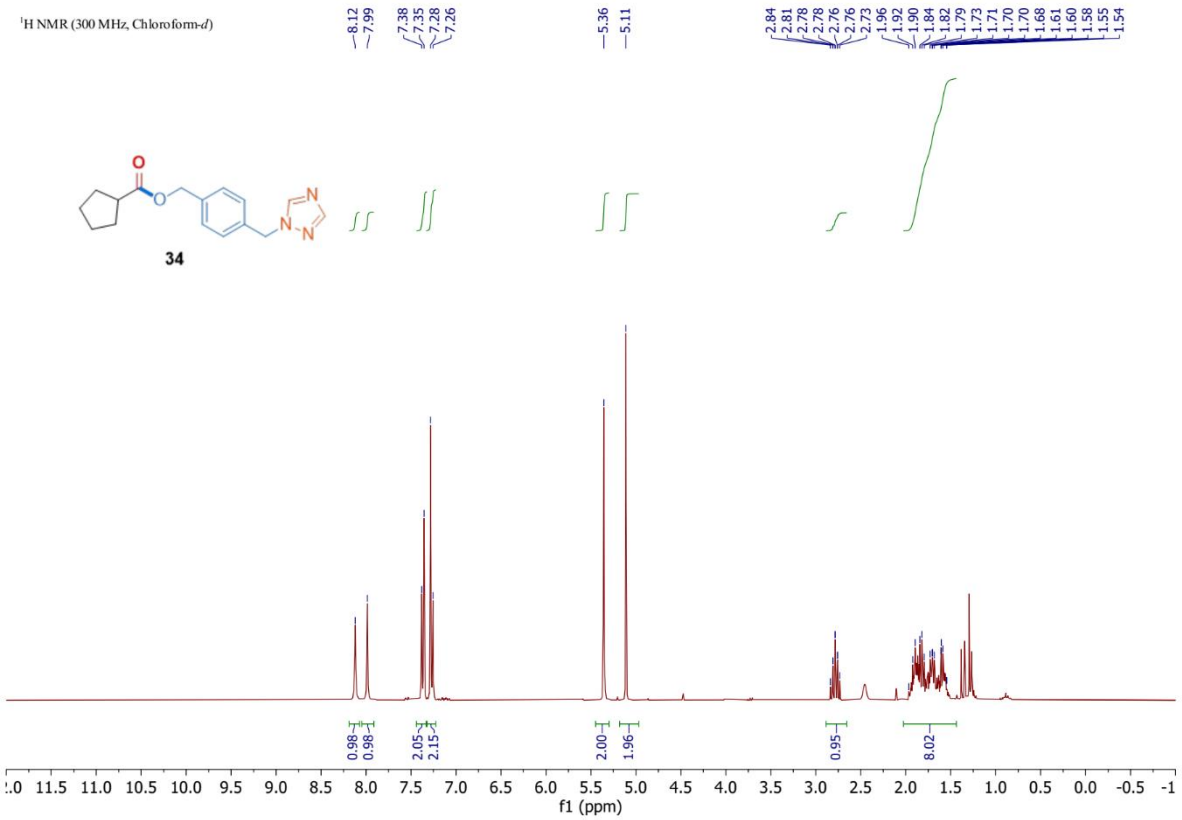

13C NMR (75 MHz, CDCl3)
176.10
156.43
148.40
140.43 139.92 139.42 138.92 130.08 126.31 124.20 122.74 119.16 115.59 115.41
102.21 102.19
77.42 CDCl3 77.00 CDCl3 76.58 CDCl3
53.89
43.52
35.24 29.71 25.67
PhO
O
N–Me
F3C
N
32
f1 (ppm)

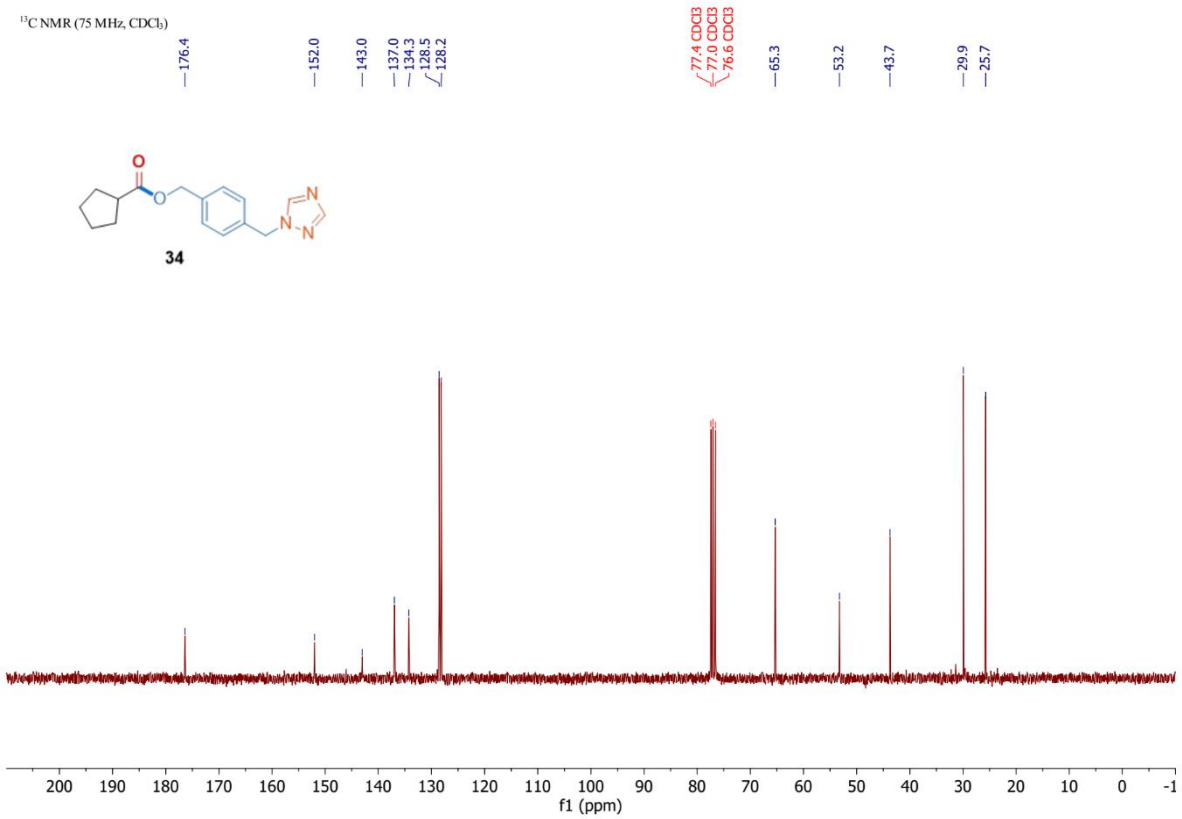
^{19}F NMR (282 MHz, $CDCl_3$)



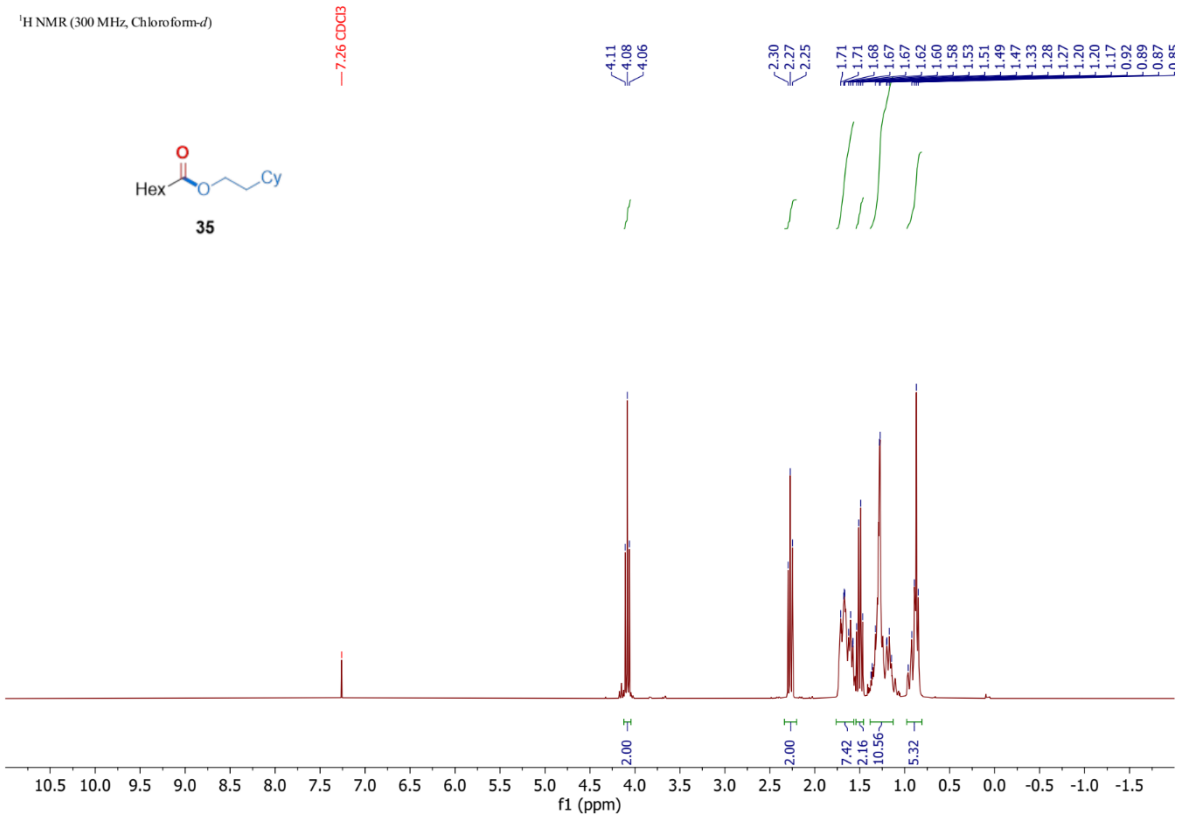

1H NMR (300 MHz, Chloroform-d)
8.01
7.98
7.98
7.97
7.97
7.57
7.56
7.54
7.53
7.26 CDCl3
5.28
2.90
2.87
2.87
2.85
2.82
2.82
2.79
1.94
1.92
1.92
1.88
1.86
1.85
1.84
1.83
1.81
1.81
1.81
1.75
1.72
1.72
1.70
1.62
1.60
1.58
33
2.00
1.04
2.06
1.03
8.28
11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1
f1 (ppm)


13C NMR (75 MHz, CDCl3)
176.4
154.8
154.4
138.2
129.3
121.6
119.7
77.4 CDCl3
77.0 CDCl3
76.6 CDCl3
65.2
43.8
30.0
25.8
33
10 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -1
f1 (ppm)

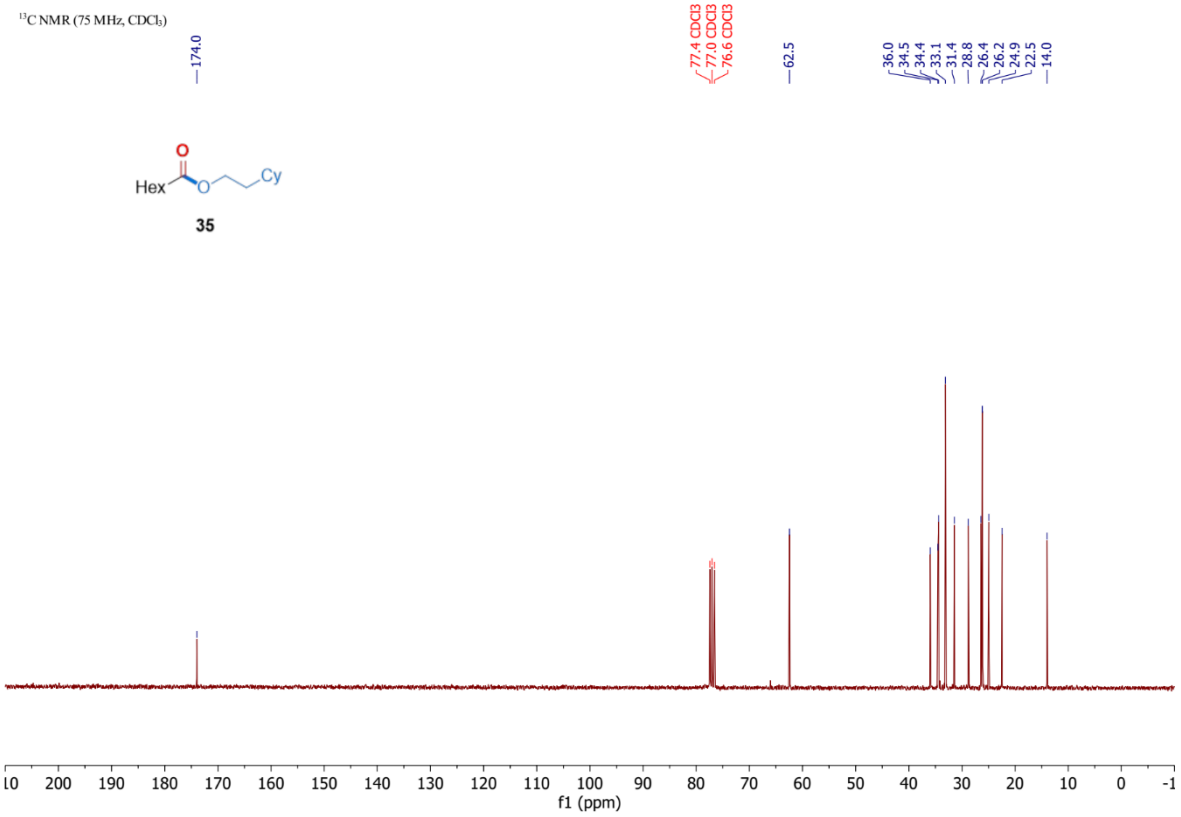

1H NMR (300 MHz, Chloroform-d)
8.12
7.99
7.38
7.35
7.28
7.26
5.36
5.11
2.84
2.81
2.78
2.78
2.76
2.76
2.73
1.96
1.92
1.90
1.84
1.82
1.79
1.73
1.71
1.70
1.70
1.68
1.61
1.60
1.58
1.55
1.54
34
0.98
0.98
2.05
2.15
2.00
1.96
0.95
8.02
f1 (ppm)

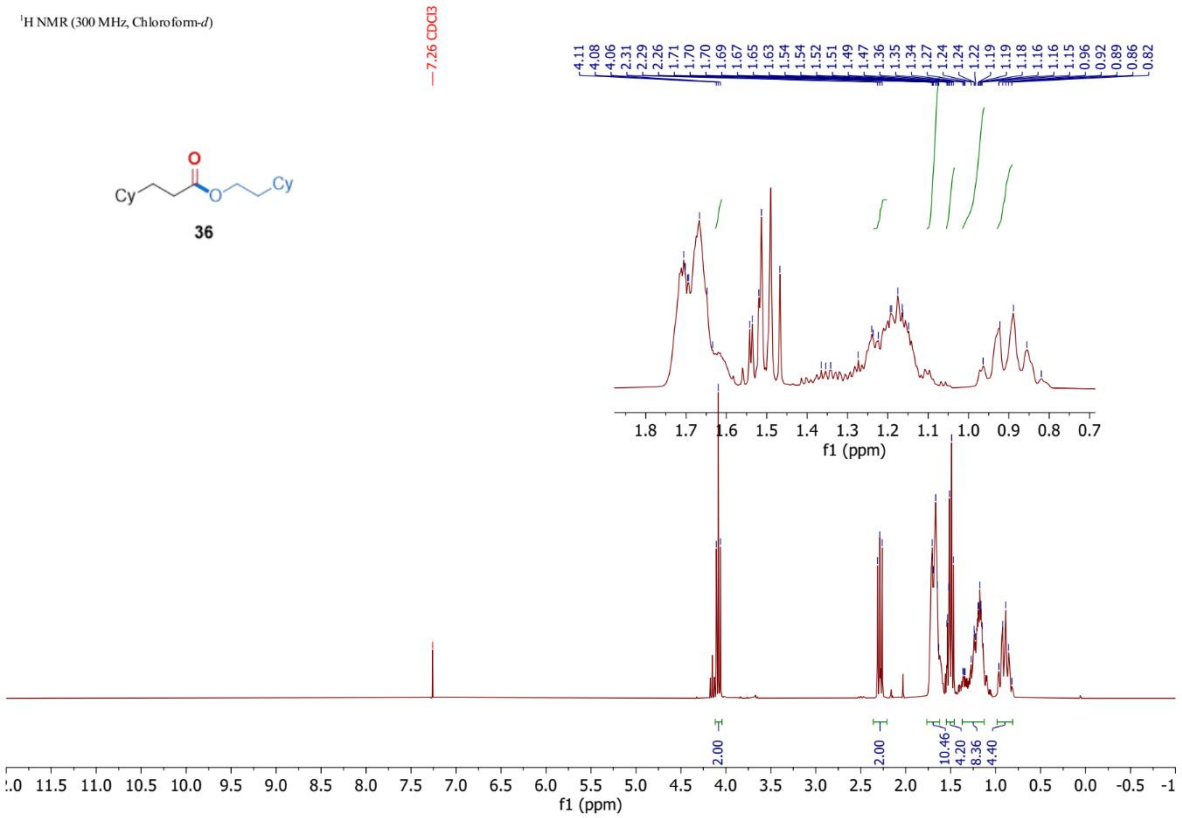

13C NMR (75 MHz, CDCl3)
176.4
152.0
143.0
137.0
134.3
128.5
128.2
77.4 CDCl3
77.0 CDCl3
76.6 CDCl3
65.3
53.2
43.7
29.9
25.7
34
f1 (ppm)

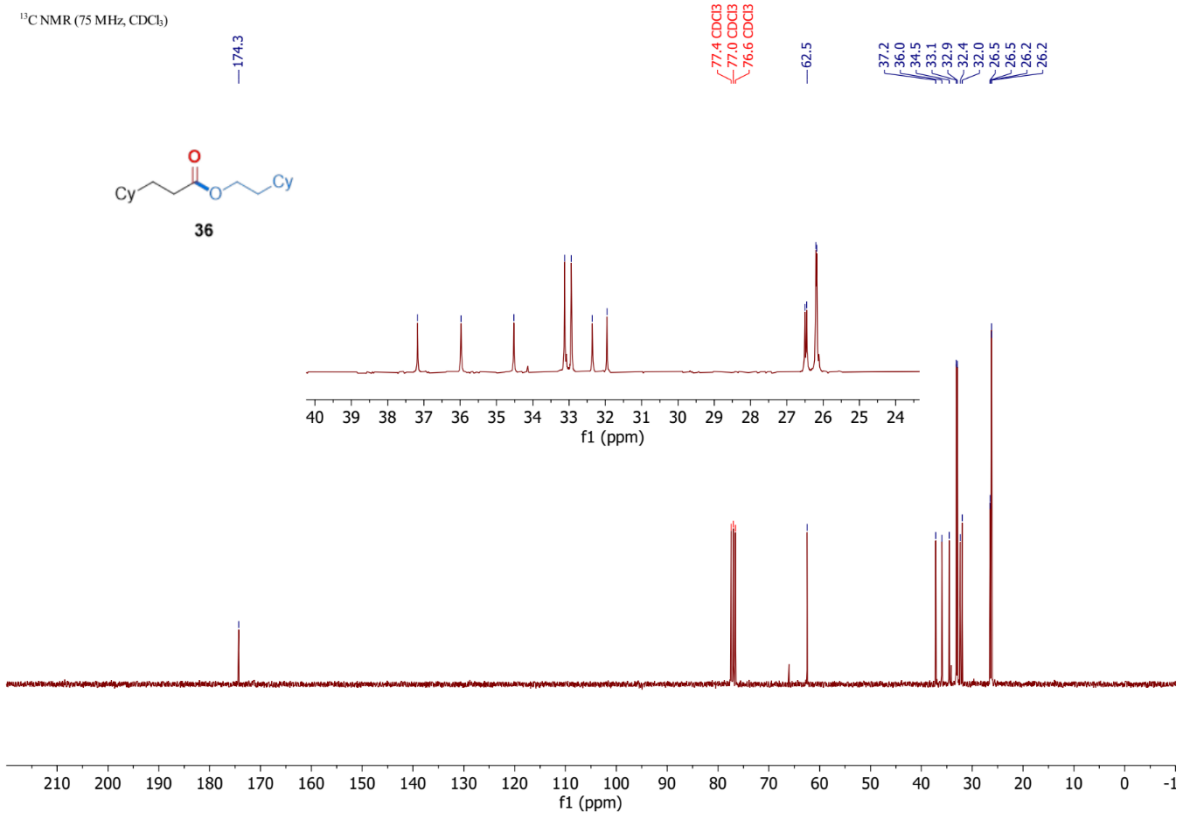
^{1}H NMR (300 MHz, Chloroform-*d*)

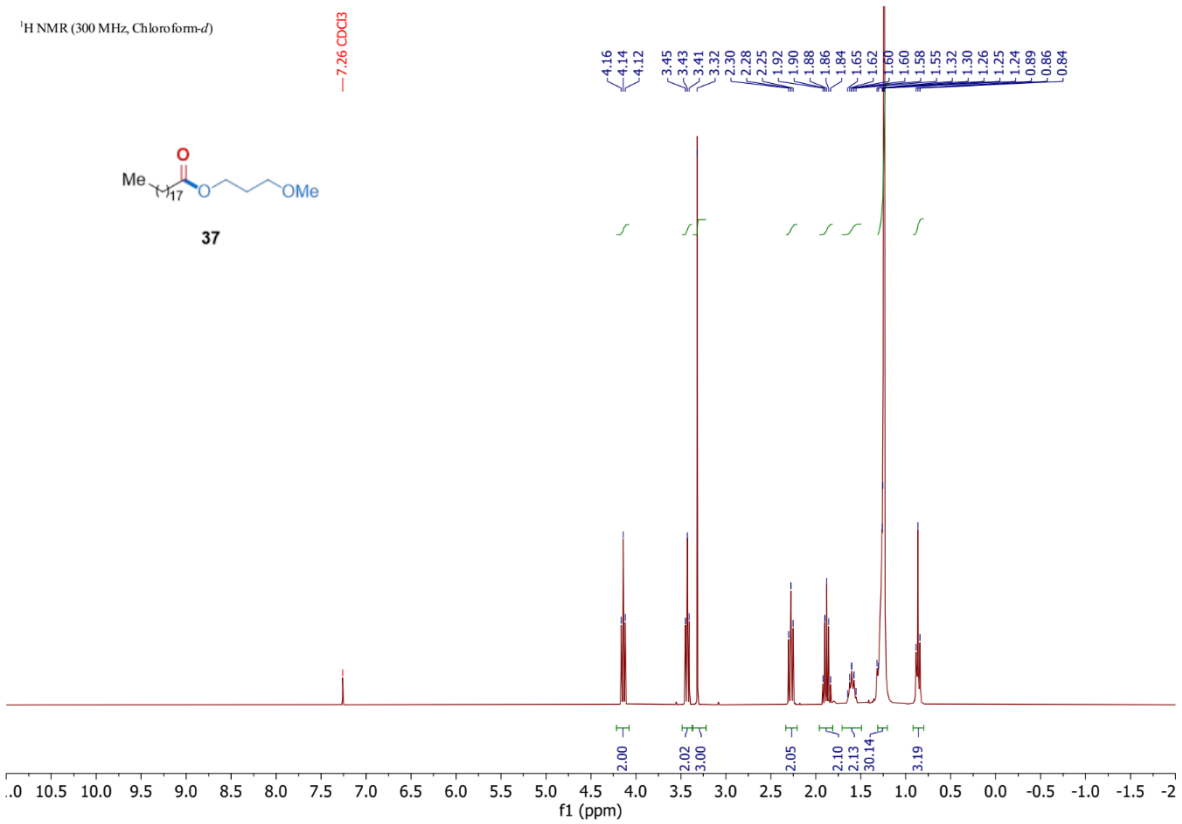


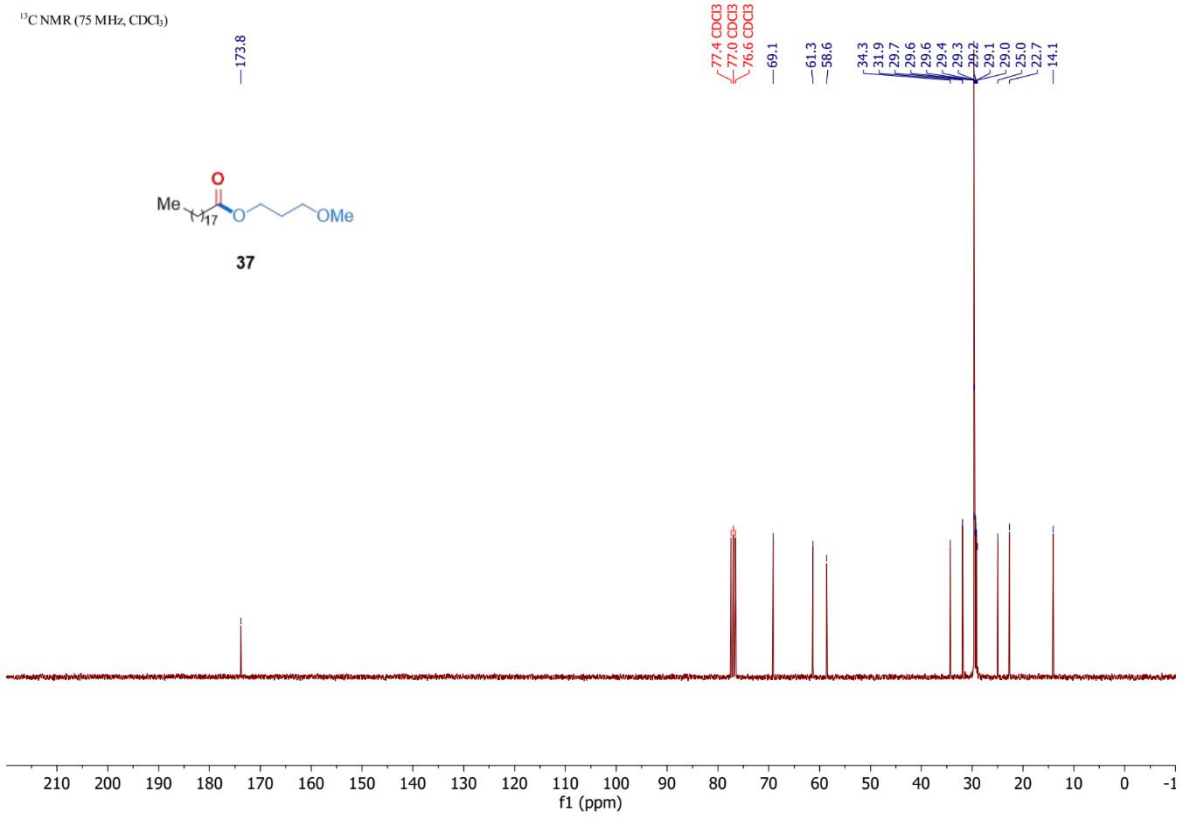
^{13}C NMR (75 MHz, $CDCl_3$)

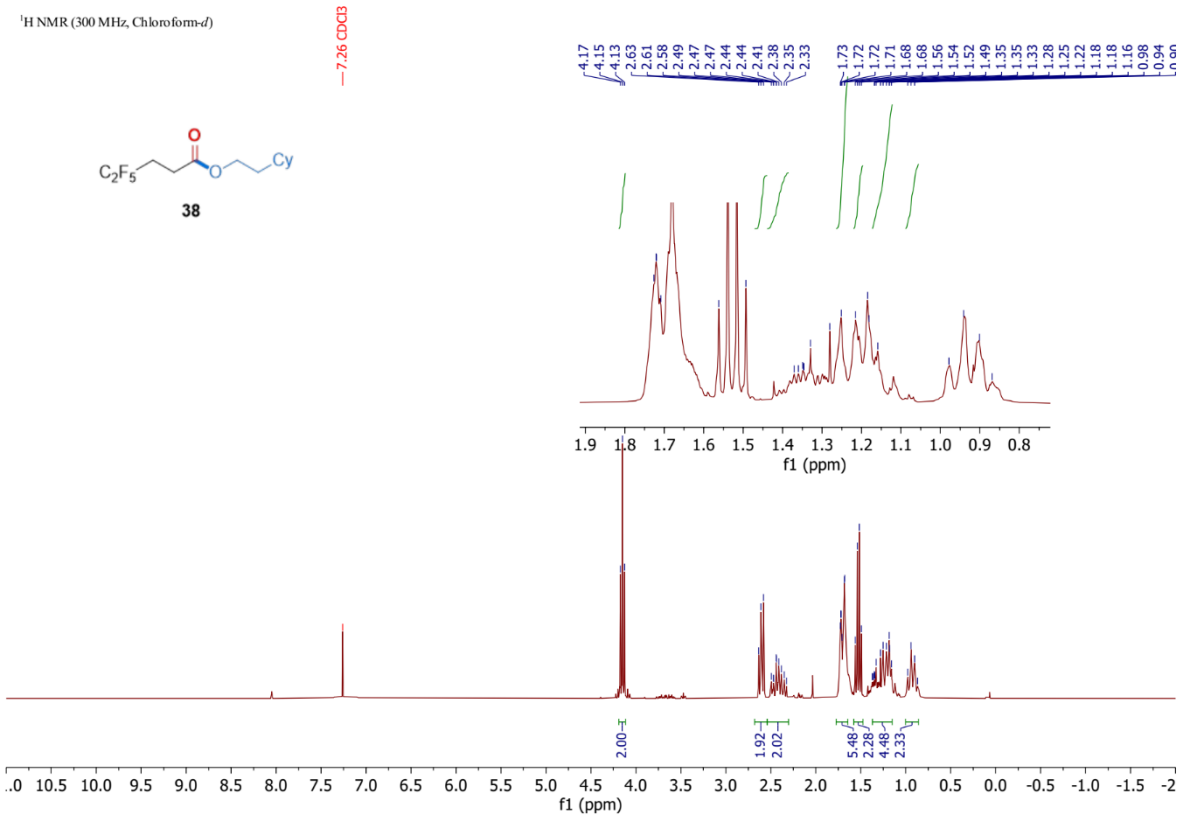


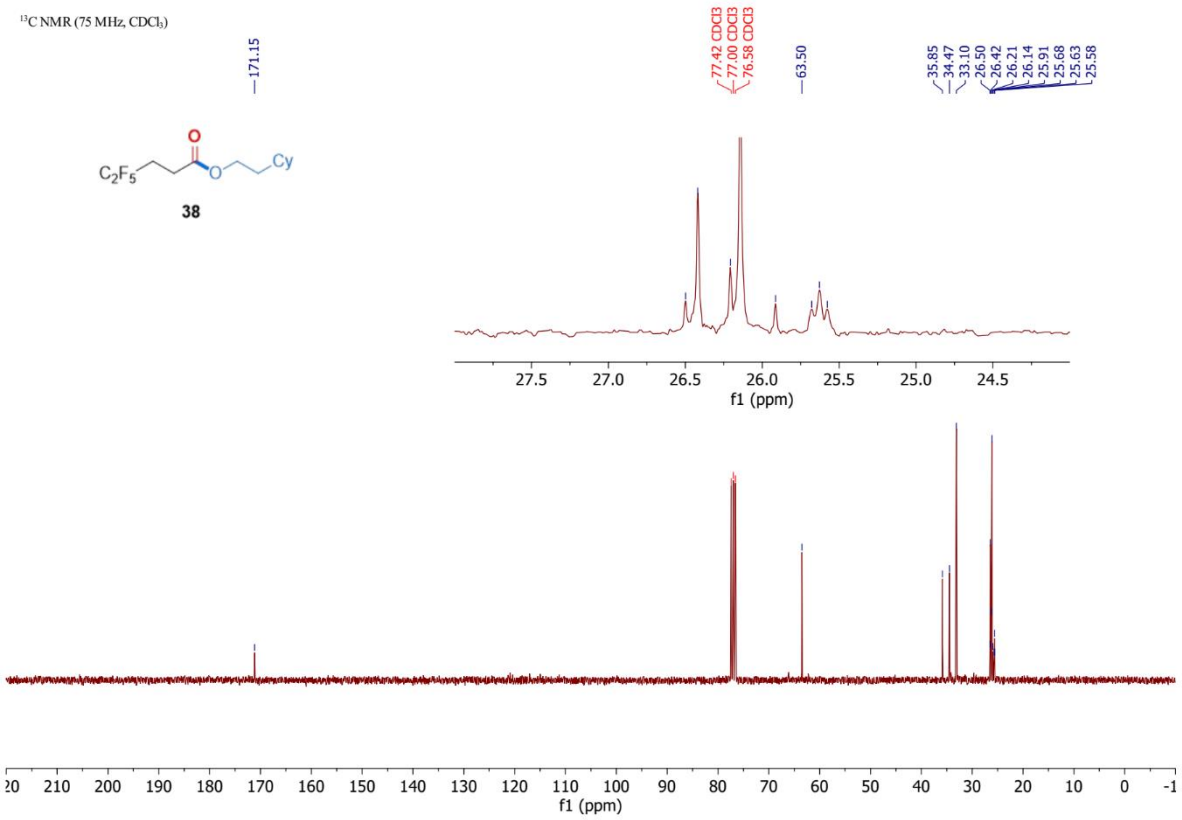

^{1}H NMR (300 MHz, Chloroform-*d*)
7.26 CDCl3
4.11
4.08
4.06
2.31
2.29
2.26
1.71
1.70
1.70
1.69
1.67
1.65
1.63
1.54
1.54
1.52
1.51
1.49
1.47
1.36
1.35
1.34
1.27
1.24
1.24
1.22
1.19
1.19
1.18
1.16
1.16
1.15
0.96
0.92
0.89
0.86
0.82
O
Cy
O
Cy
36
1.8 1.7 1.6 1.5 1.4 1.3 1.2 1.1 1.0 0.9 0.8 0.7
f1 (ppm)
2.00
2.00
10.46
4.20
8.36
4.40
11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1
f1 (ppm)


^{13}C NMR (75 MHz, $CDCl_3$)
174.3
77.4 CDCl3
77.0 CDCl3
76.6 CDCl3
62.5
37.2
36.0
34.5
33.1
32.9
32.4
32.0
26.5
26.5
26.2
26.2
O
Cy
O
Cy
36
40 39 38 37 36 35 34 33 32 31 30 29 28 27 26 25 24
f1 (ppm)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -1
f1 (ppm)

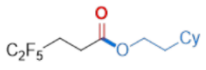

^{1}H NMR (300 MHz, Chloroform-*d*)
7.26 CDCl3
4.16
4.14
4.12
3.45
3.43
3.41
3.32
2.30
2.28
2.25
1.92
1.90
1.88
1.86
1.84
1.65
1.62
1.60
1.60
1.58
1.55
1.32
1.30
1.26
1.25
1.24
0.89
0.86
0.84
Me
17
O
O
OMe
37
2.00
2.02
3.00
2.05
2.10
2.13
30.14
3.19
f1 (ppm)


^{13}C NMR (75 MHz, $CDCl_3$)
173.8
77.4 CDCl3
77.0 CDCl3
76.6 CDCl3
69.1
61.3
58.6
34.3
31.9
29.7
29.6
29.6
29.4
29.3
29.2
29.1
29.0
25.0
22.7
14.1
Me
17
O
O
OMe
37
f1 (ppm)


^{1}H NMR (300 MHz, Chloroform-*d*)
7.26 CDCl3
38
f1 (ppm)

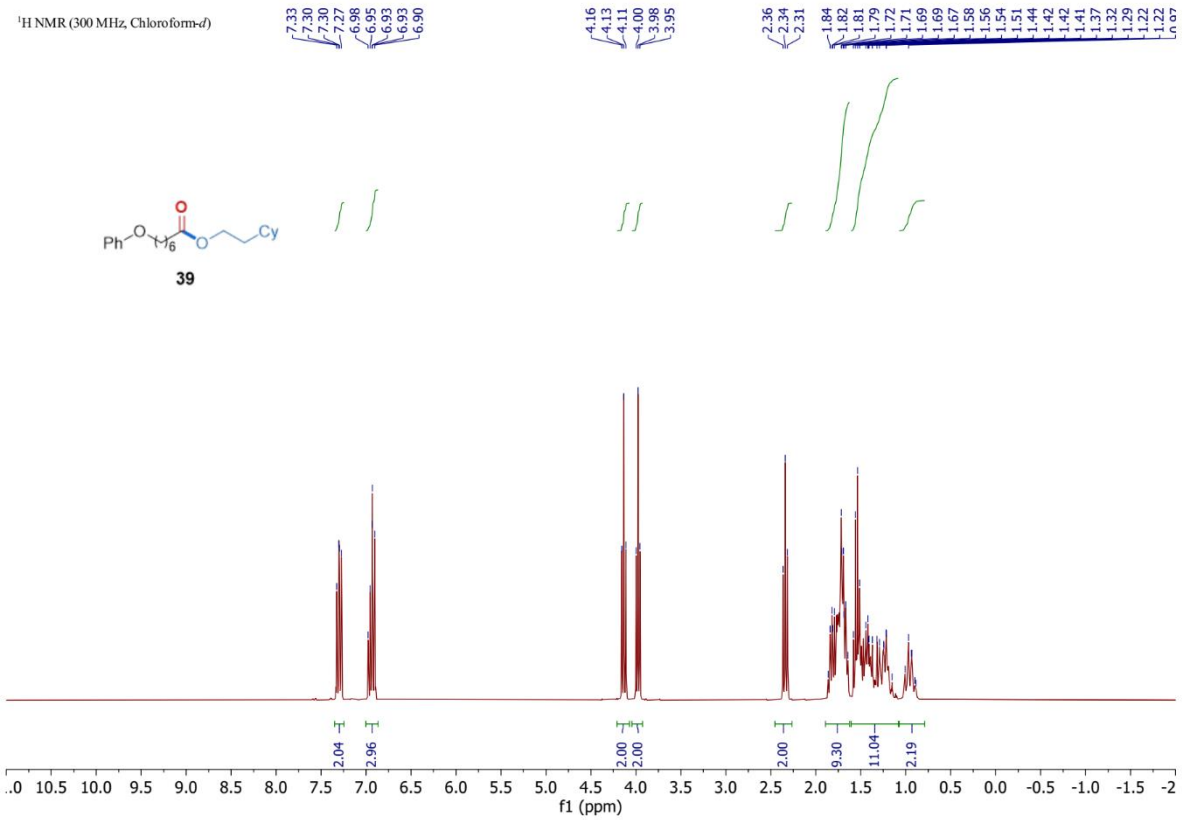

^{13}C NMR (75 MHz, $CDCl_3$)
171.15
77.42 CDCl3
77.00 CDCl3
76.58 CDCl3
63.50
38
f1 (ppm)

^{19}F NMR (282 MHz, $CDCl_3$)



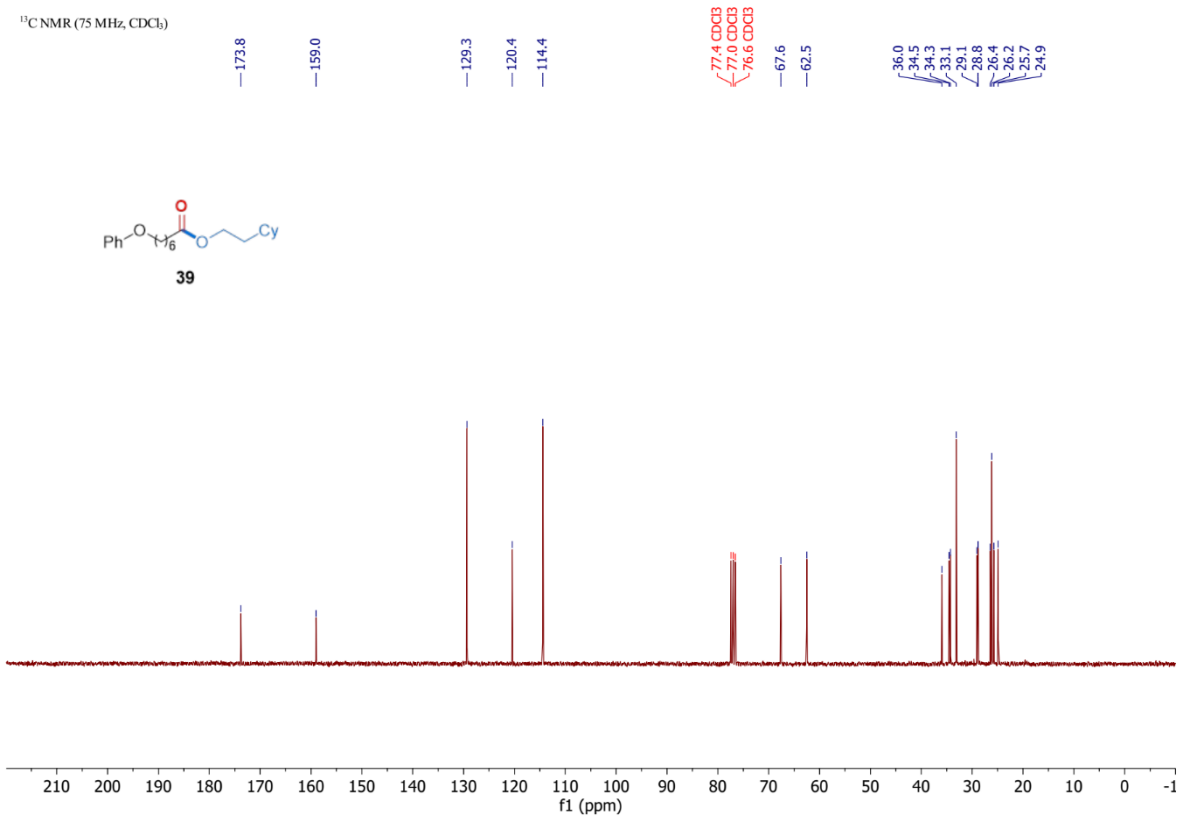
38

^{1}H NMR (300 MHz, Chloroform-*d*)

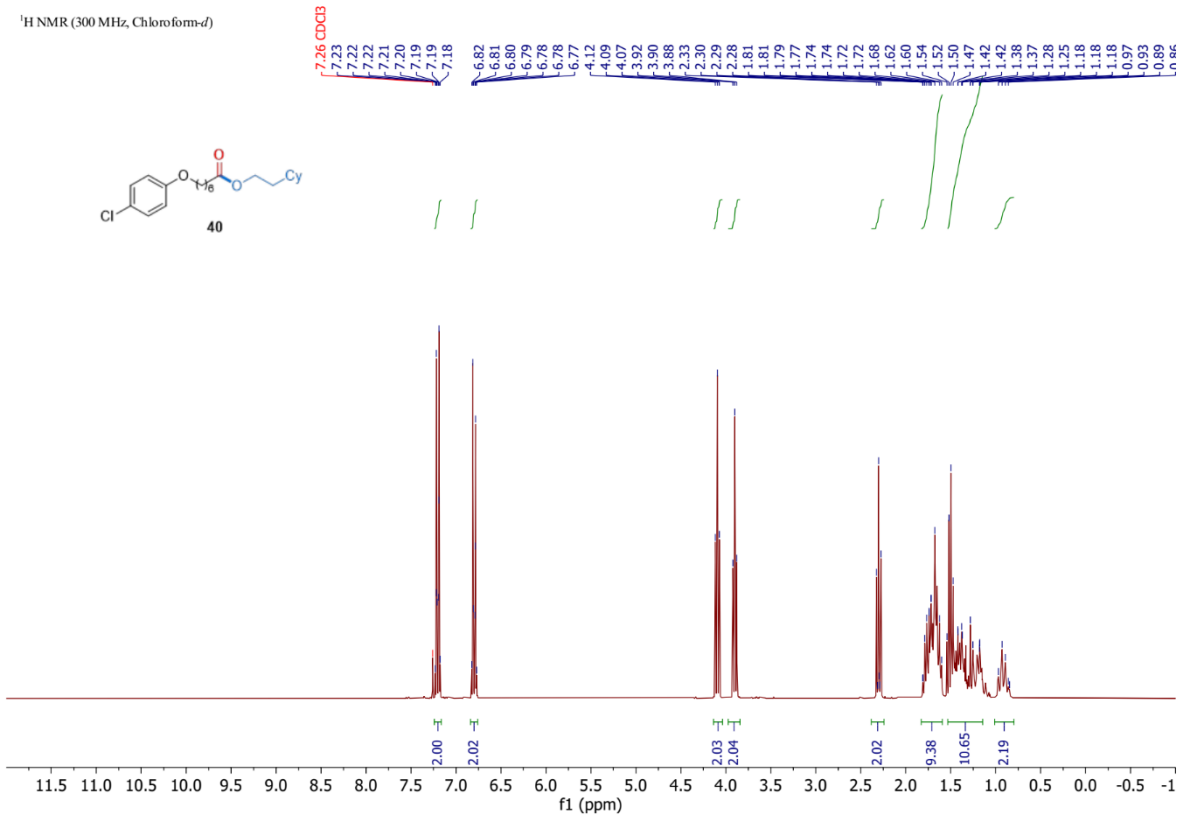


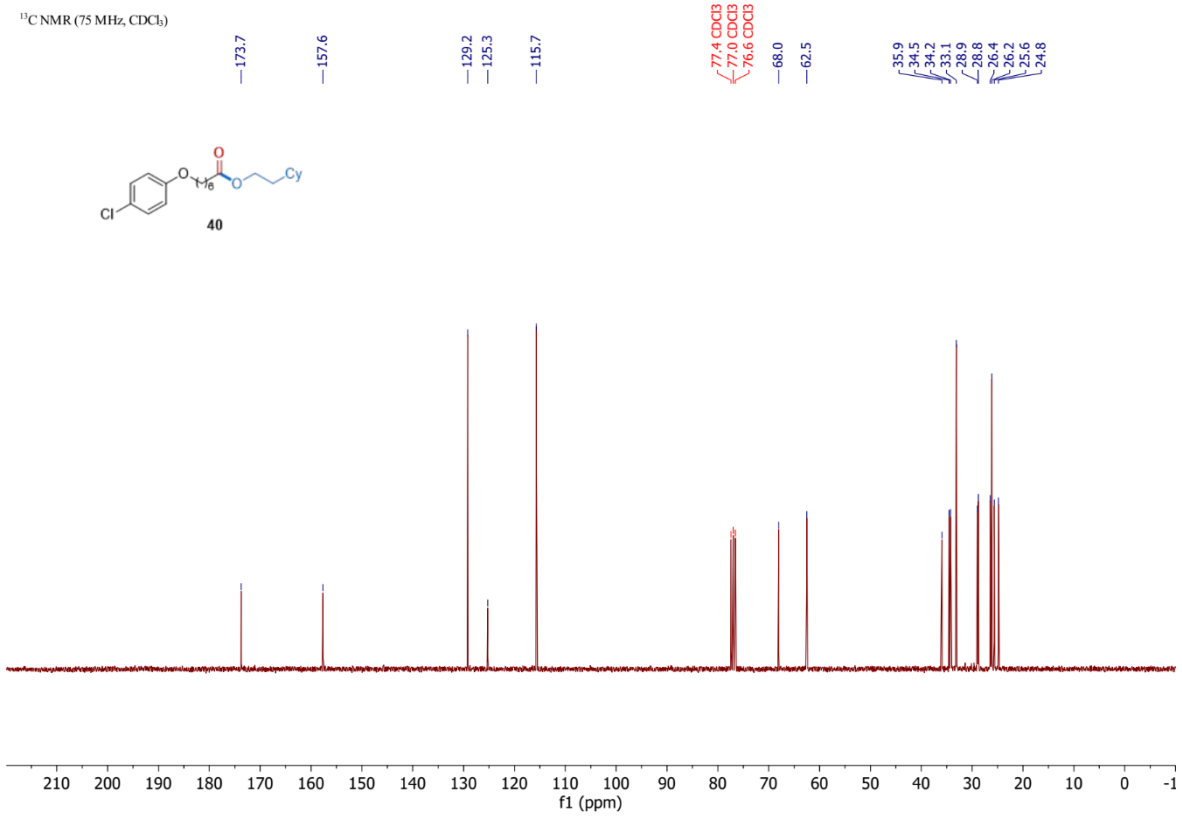
39

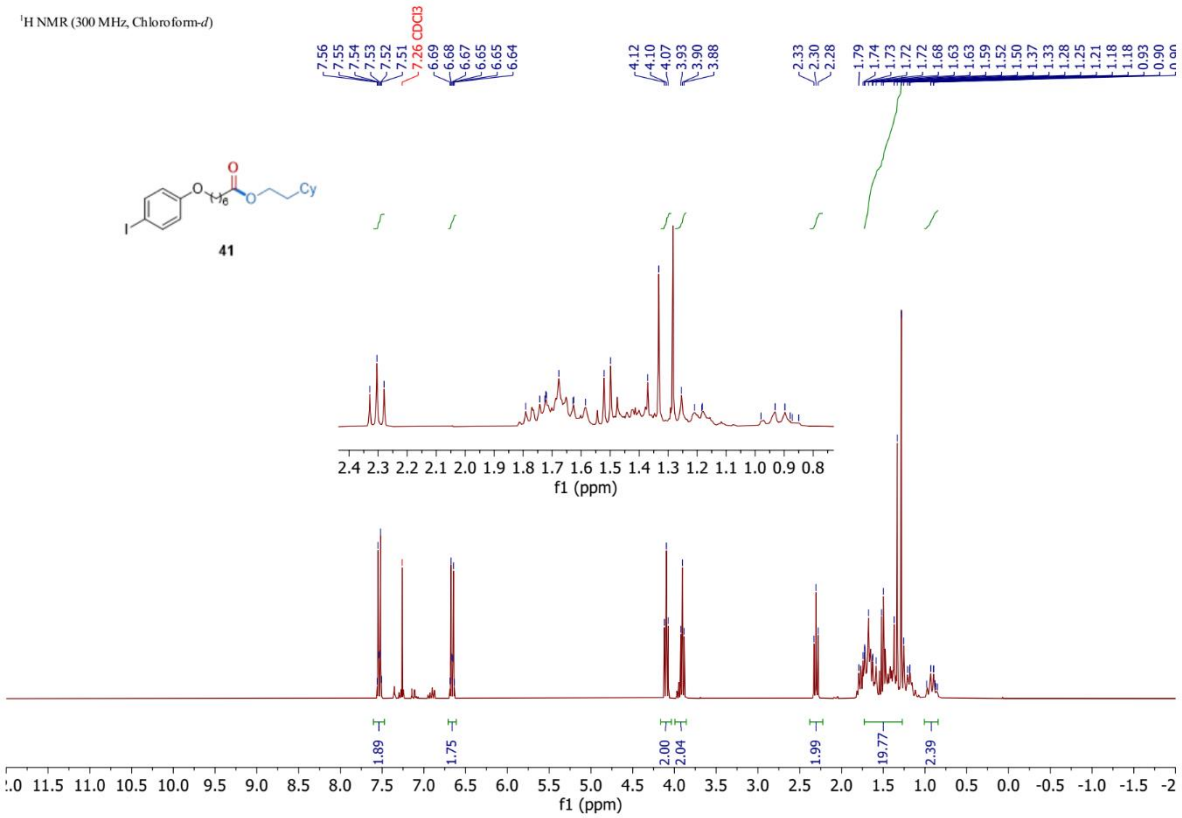
^{13}C NMR (75 MHz, $CDCl_3$)

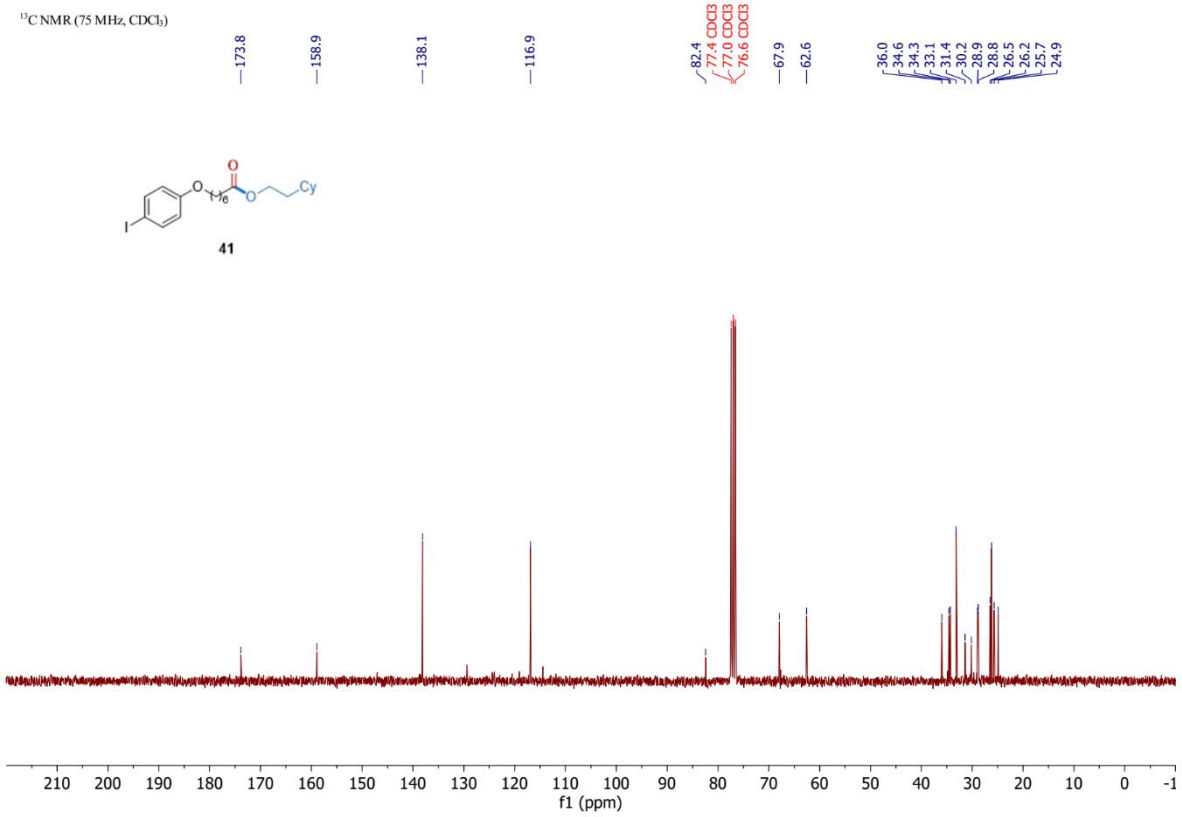


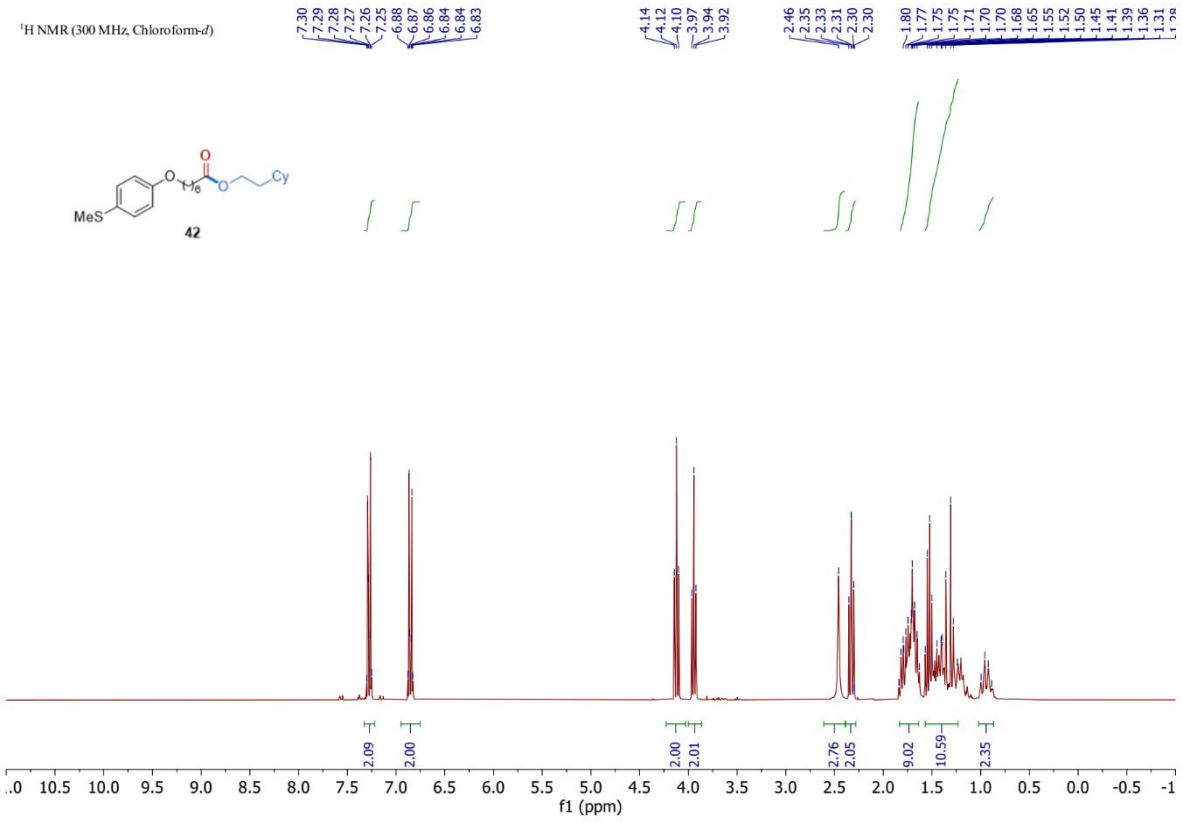
39

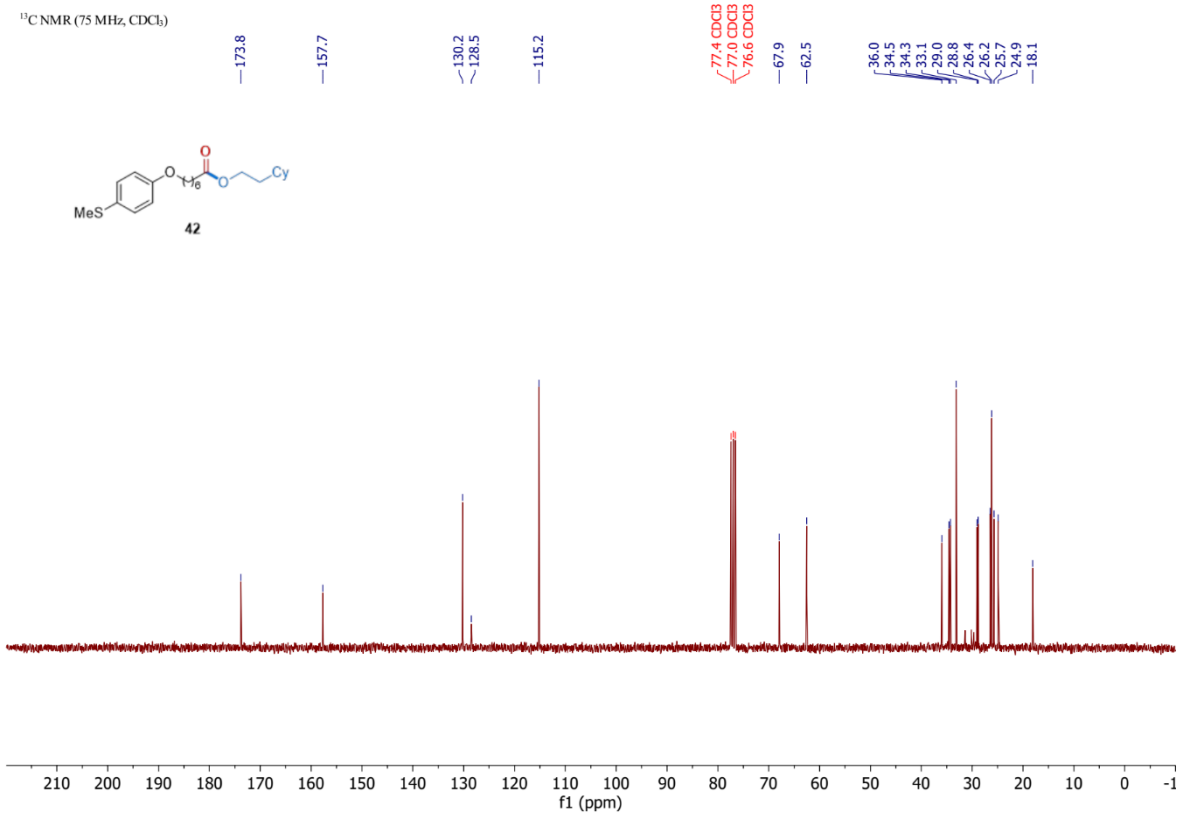

^{1}H NMR (300 MHz, Chloroform-*d*)
7.26 CDCl3
7.23
7.22
7.22
7.21
7.20
7.19
7.19
7.18
6.82
6.81
6.80
6.79
6.78
6.78
6.77
4.12
4.09
4.07
3.92
3.90
3.88
2.33
2.30
2.29
2.28
1.81
1.81
1.79
1.77
1.74
1.74
1.72
1.72
1.72
1.68
1.62
1.60
1.54
1.52
1.50
1.47
1.42
1.42
1.38
1.37
1.28
1.25
1.18
1.18
1.18
0.97
0.93
0.89
Cl
O
Cy
40
2.00
2.02
2.03
2.04
2.02
9.38
10.65
2.19
11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1
f1 (ppm)

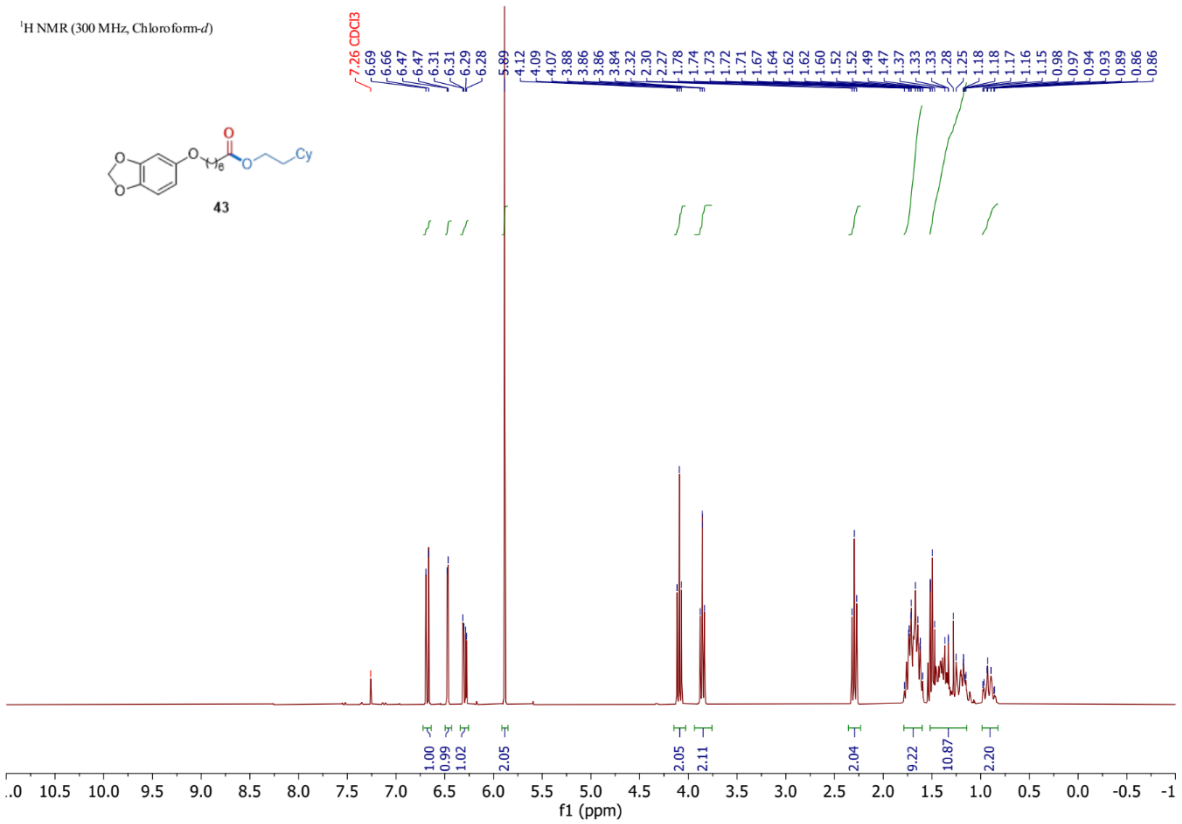

^{13}C NMR (75 MHz, $CDCl_3$)
173.7
157.6
129.2
125.3
115.7
77.4 CDCl3
77.0 CDCl3
76.6 CDCl3
68.0
62.5
35.9
34.5
34.2
33.1
28.9
28.8
26.4
26.2
25.6
24.8
Cl
O
Cy
40
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -1
f1 (ppm)

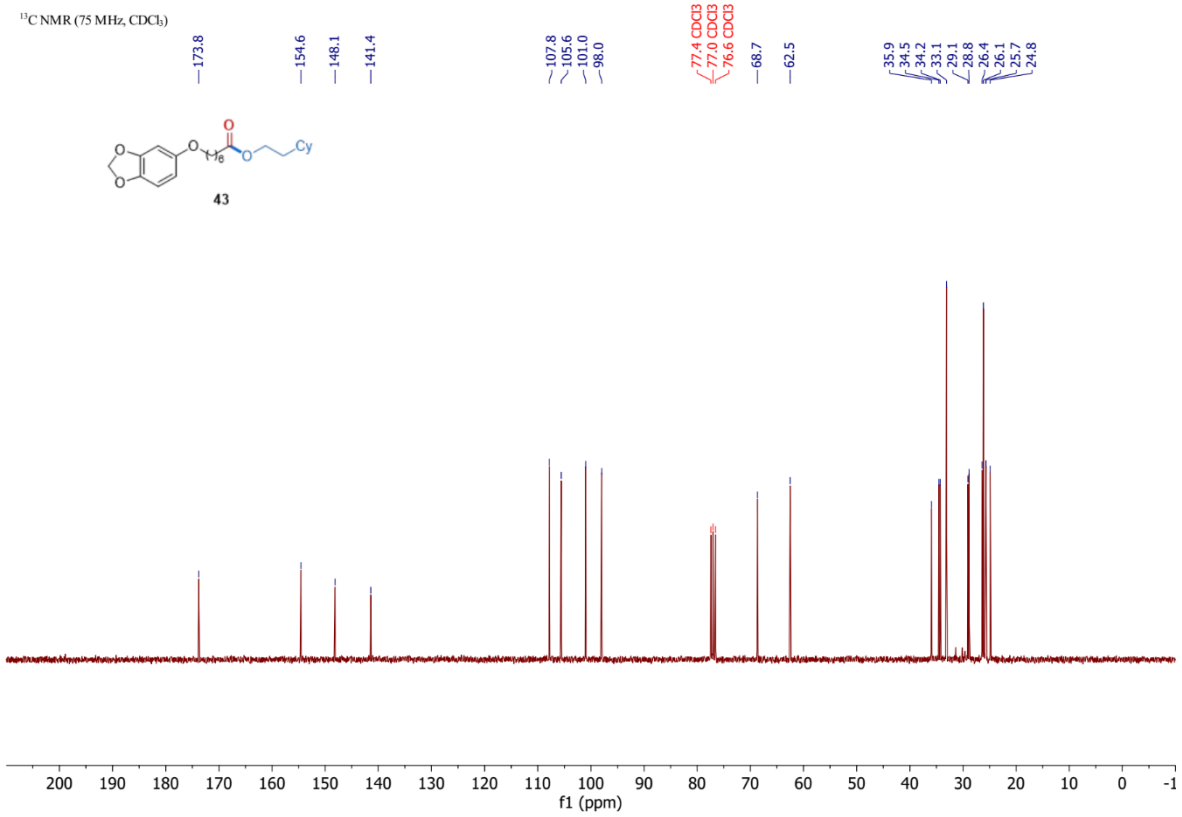

^{1}H NMR (300 MHz, Chloroform-*d*)
7.56 7.55 7.54 7.53 7.52 7.51 7.26 CDCl3 6.69 6.68 6.67 6.65 6.65 6.64
4.12 4.10 4.07 3.93 3.90 3.88
2.33 2.30 2.28
1.79 1.74 1.73 1.72 1.72 1.68 1.63 1.63 1.59 1.52 1.50 1.37 1.33 1.28 1.25 1.21 1.18 1.18 0.93 0.90
O
O
Cy
I
6
41
2.4 2.3 2.2 2.1 2.0 1.9 1.8 1.7 1.6 1.5 1.4 1.3 1.2 1.1 1.0 0.9 0.8
f1 (ppm)
1.89 1.75 2.00 2.04 1.99 19.77 2.39
11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0 -1.5 -2
f1 (ppm)

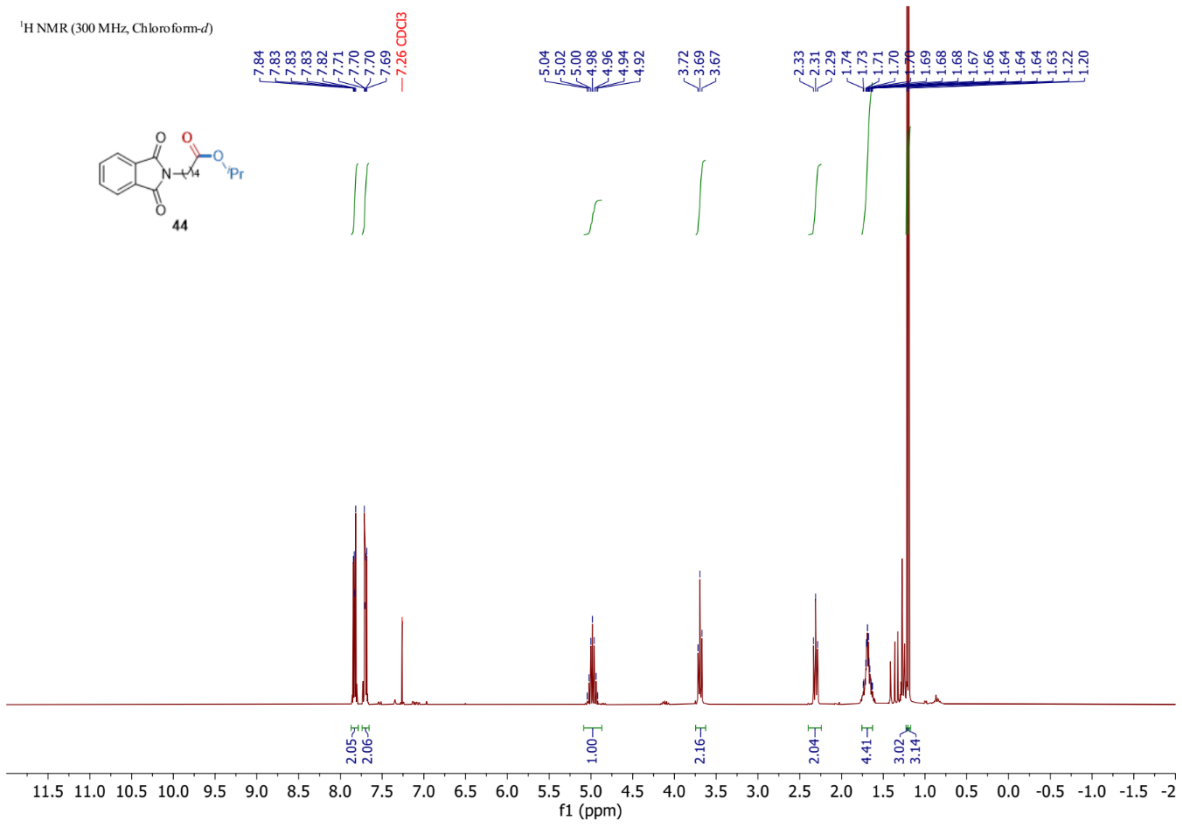

^{13}C NMR (75 MHz, $CDCl_3$)
173.8 158.9 138.1 116.9
82.4 77.4 CDCl3 77.0 CDCl3 76.6 CDCl3
67.9 62.6
36.0 34.6 34.3 33.1 31.4 30.2 28.9 28.8 26.5 26.2 25.7 24.9
O
O
Cy
I
6
41
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -1
f1 (ppm)

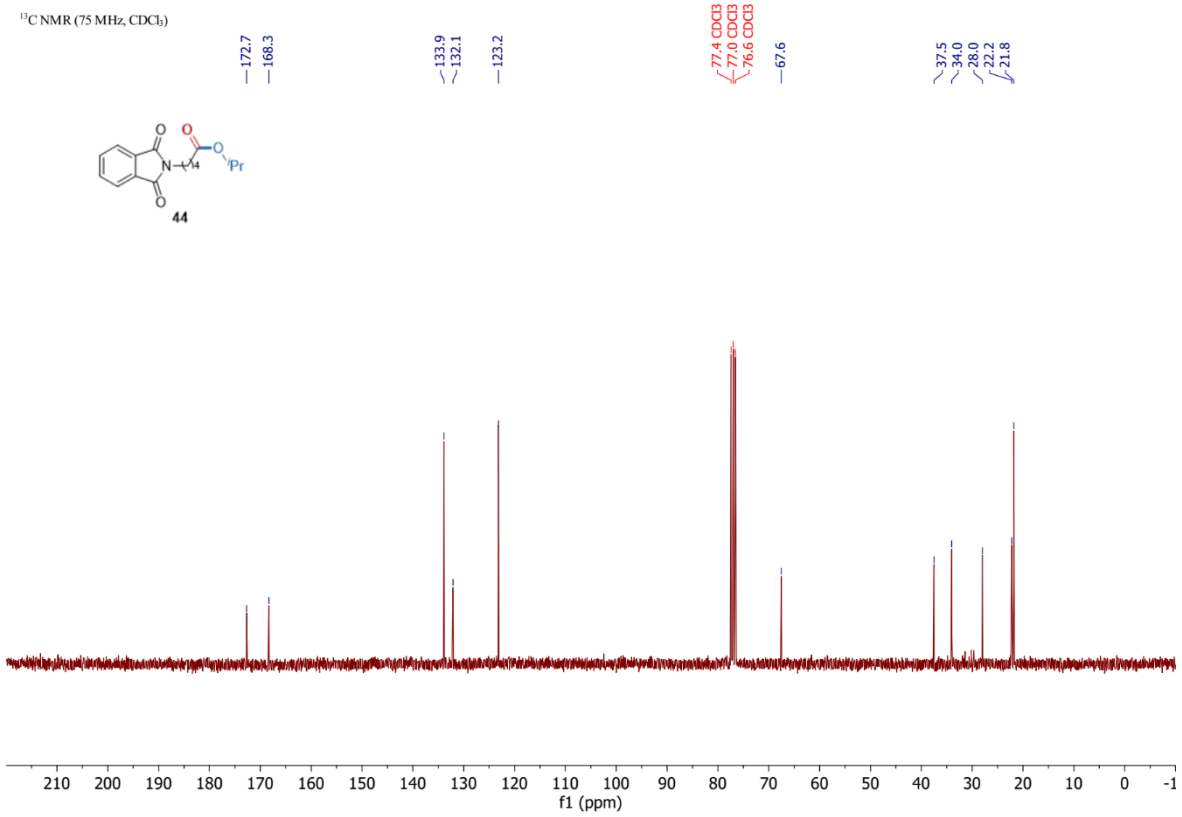

^{1}H NMR (300 MHz, Chloroform-*d*)
7.30 7.29 7.28 7.27 7.26 7.25 6.88 6.87 6.86 6.84 6.84 6.83
4.14 4.12 4.10 3.97 3.94 3.92
2.46 2.35 2.33 2.31 2.30 2.30
1.80 1.77 1.75 1.75 1.71 1.70 1.70 1.68 1.65 1.55 1.52 1.50 1.45 1.41 1.39 1.36 1.31
MeS
42
2.09 2.00 2.00 2.01 2.76 2.05 9.02 10.59 2.35
f1 (ppm)

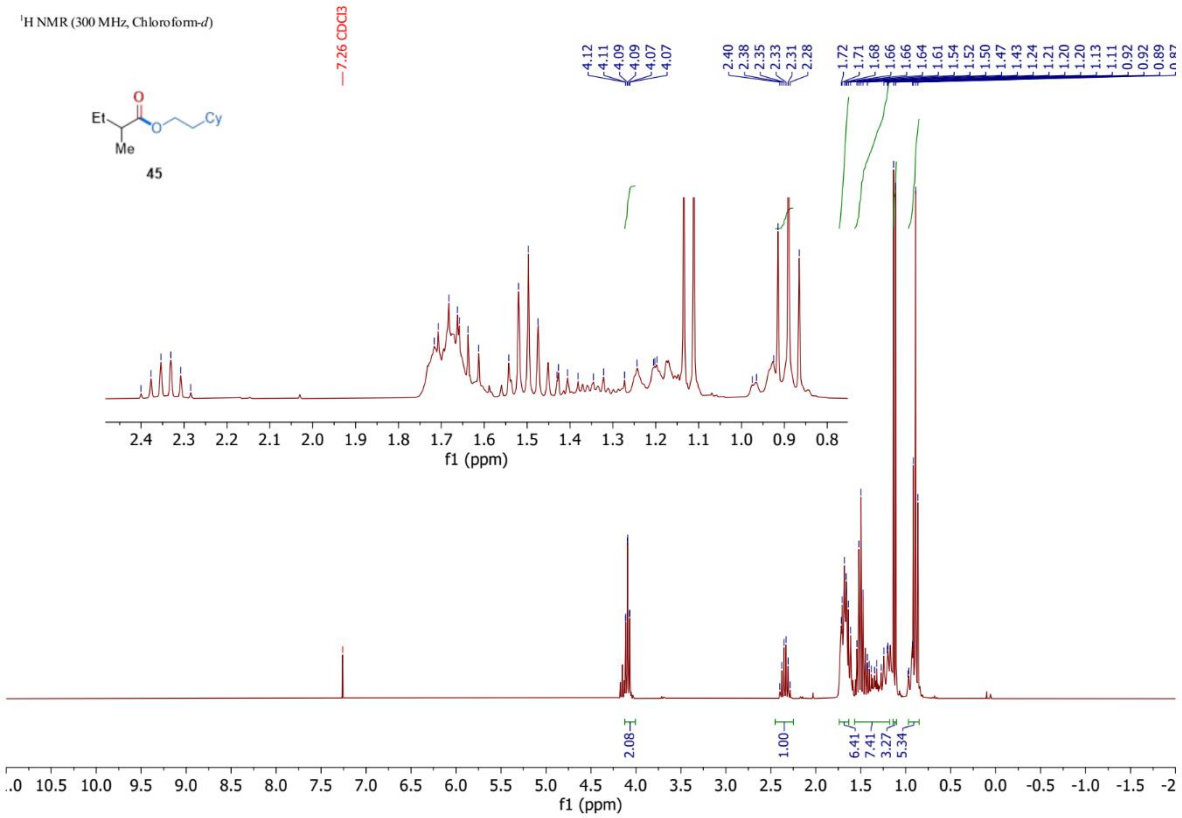

^{13}C NMR (75 MHz, $CDCl_3$)
173.8 157.7 130.2 128.5 115.2 77.4 CDCl3 77.0 CDCl3 76.6 CDCl3 67.9 62.5 36.0 34.5 34.3 33.1 29.0 28.8 26.4 26.2 25.7 24.9 18.1
MeS
42
f1 (ppm)

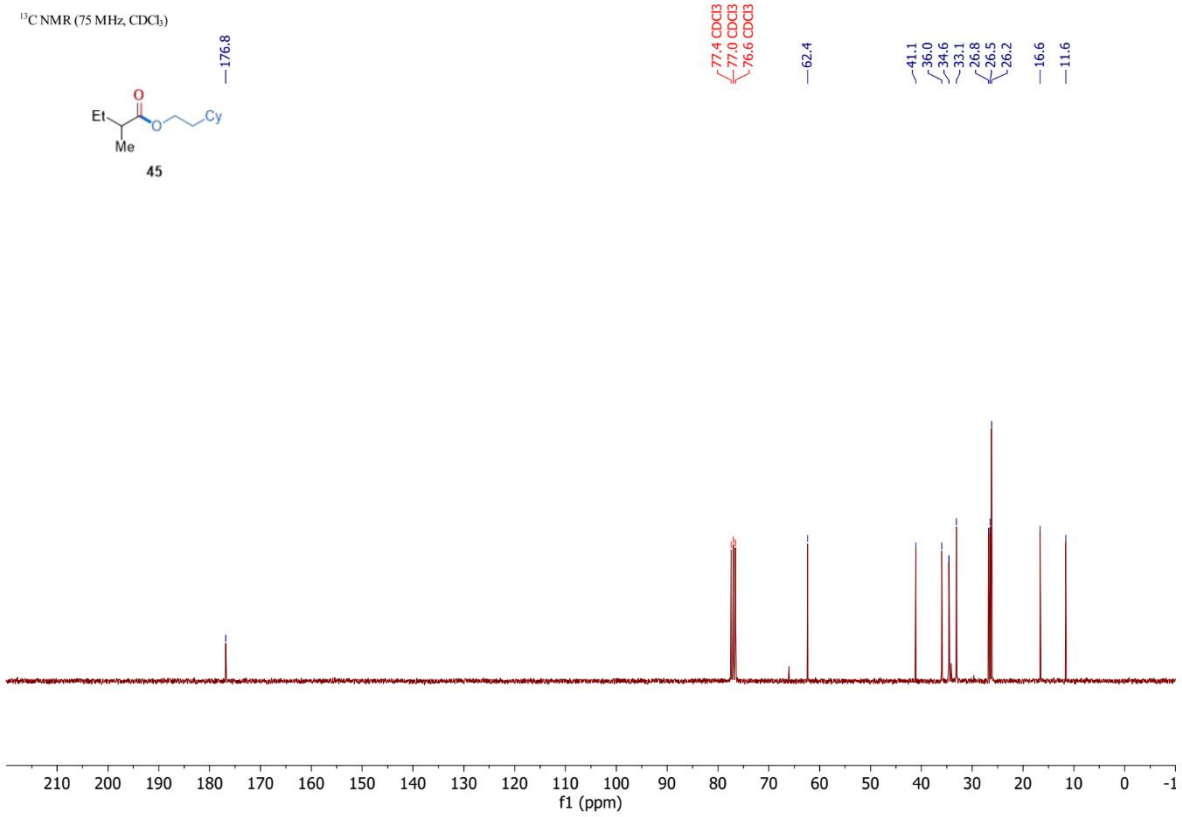

^{1}H NMR (300 MHz, Chloroform-*d*)
7.26 CDCl3
6.69
6.66
6.47
6.47
6.31
6.31
6.29
6.28
5.89
4.12
4.09
4.07
3.88
3.86
3.86
3.84
2.32
2.30
2.27
1.78
1.74
1.73
1.72
1.71
1.67
1.64
1.62
1.62
1.60
1.52
1.52
1.49
1.47
1.37
1.33
1.33
1.28
1.25
1.18
1.18
1.17
1.16
1.15
0.98
0.97
0.94
0.93
0.89
0.86
0.86
O
O
O
Cy
43
1.00
0.99
1.02
2.05
2.05
2.11
2.04
9.22
10.87
2.20
f1 (ppm)

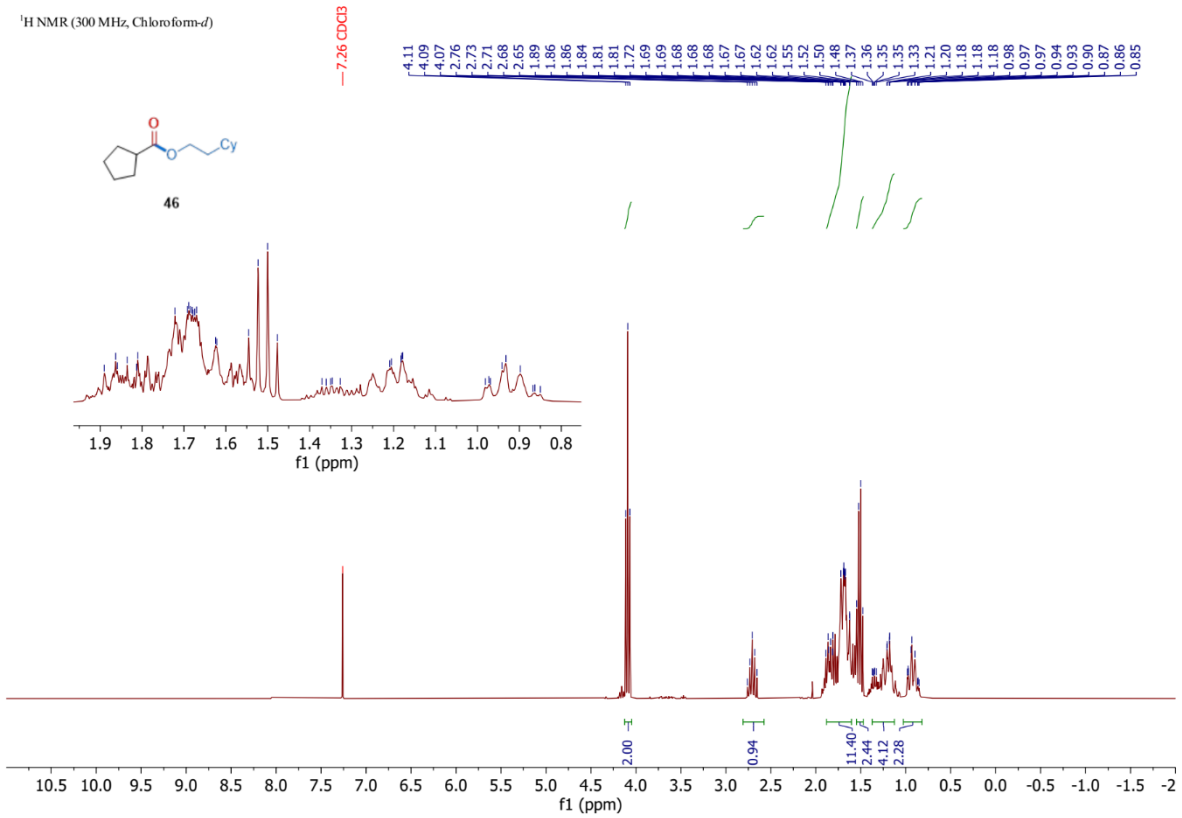

^{13}C NMR (75 MHz, $CDCl_3$)
173.8
154.6
148.1
141.4
107.8
105.6
101.0
98.0
77.4 CDCl3
77.0 CDCl3
76.6 CDCl3
68.7
62.5
35.9
34.5
34.2
33.1
29.1
28.8
26.4
26.1
25.7
24.8
O
O
O
Cy
43
f1 (ppm)

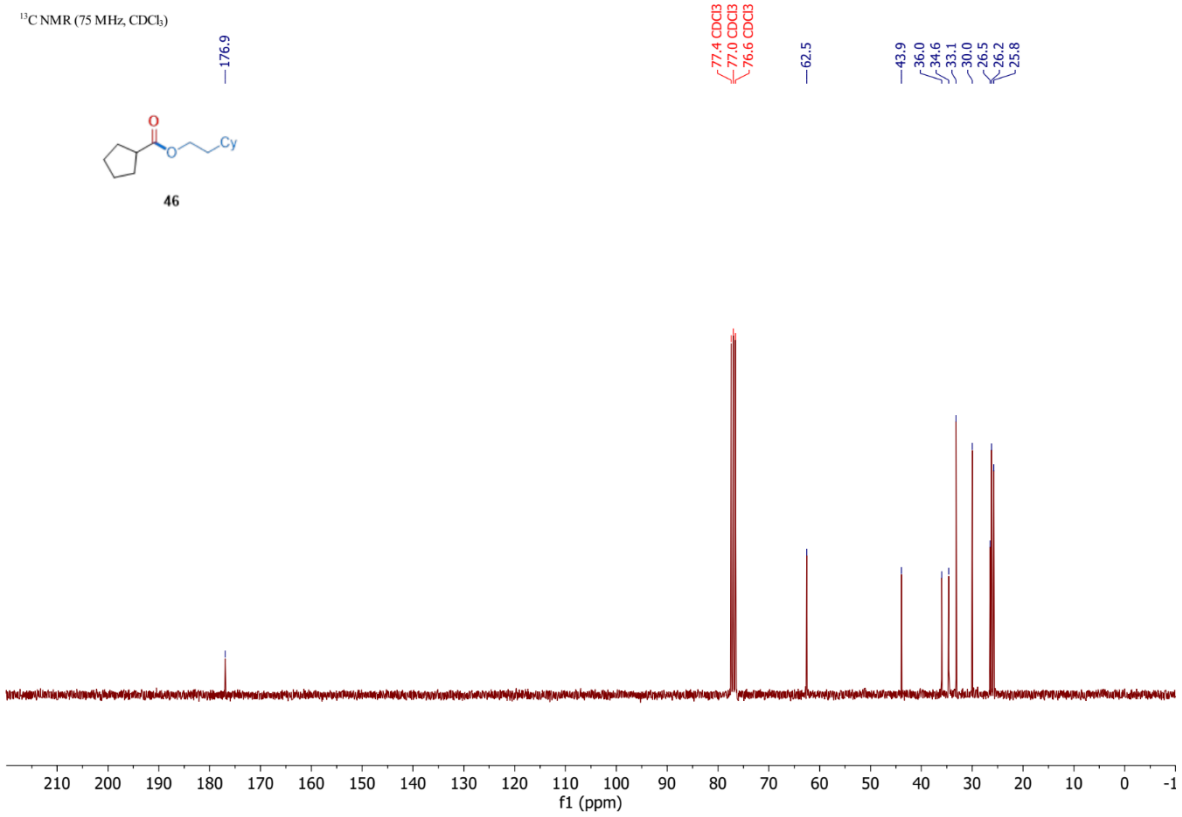

1H NMR (300 MHz, Chloroform-d)
7.84
7.83
7.83
7.83
7.82
7.71
7.70
7.70
7.69
7.26 CDCl3
5.04
5.02
5.00
4.98
4.96
4.94
4.92
3.72
3.69
3.67
2.33
2.31
2.29
1.74
1.73
1.71
1.70
1.70
1.69
1.68
1.68
1.67
1.66
1.64
1.64
1.64
1.63
1.22
1.20
44
2.05
2.06
1.00
2.16
2.04
4.41
3.02
3.14
11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0 -1.5 -2
f1 (ppm)

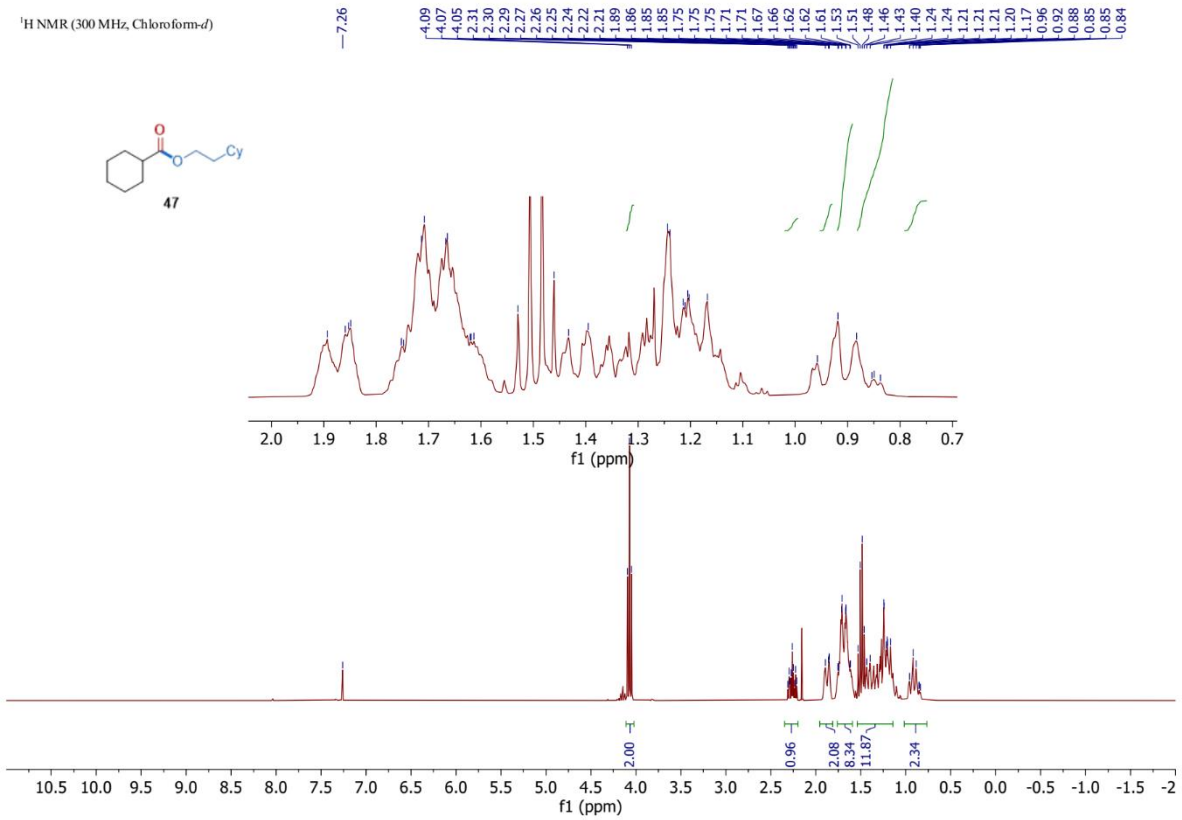

13C NMR (75 MHz, CDCl3)
172.7
168.3
133.9
132.1
123.2
77.4 CDCl3
77.0 CDCl3
76.6 CDCl3
67.6
37.5
34.0
28.0
22.2
21.8
44
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -1
f1 (ppm)

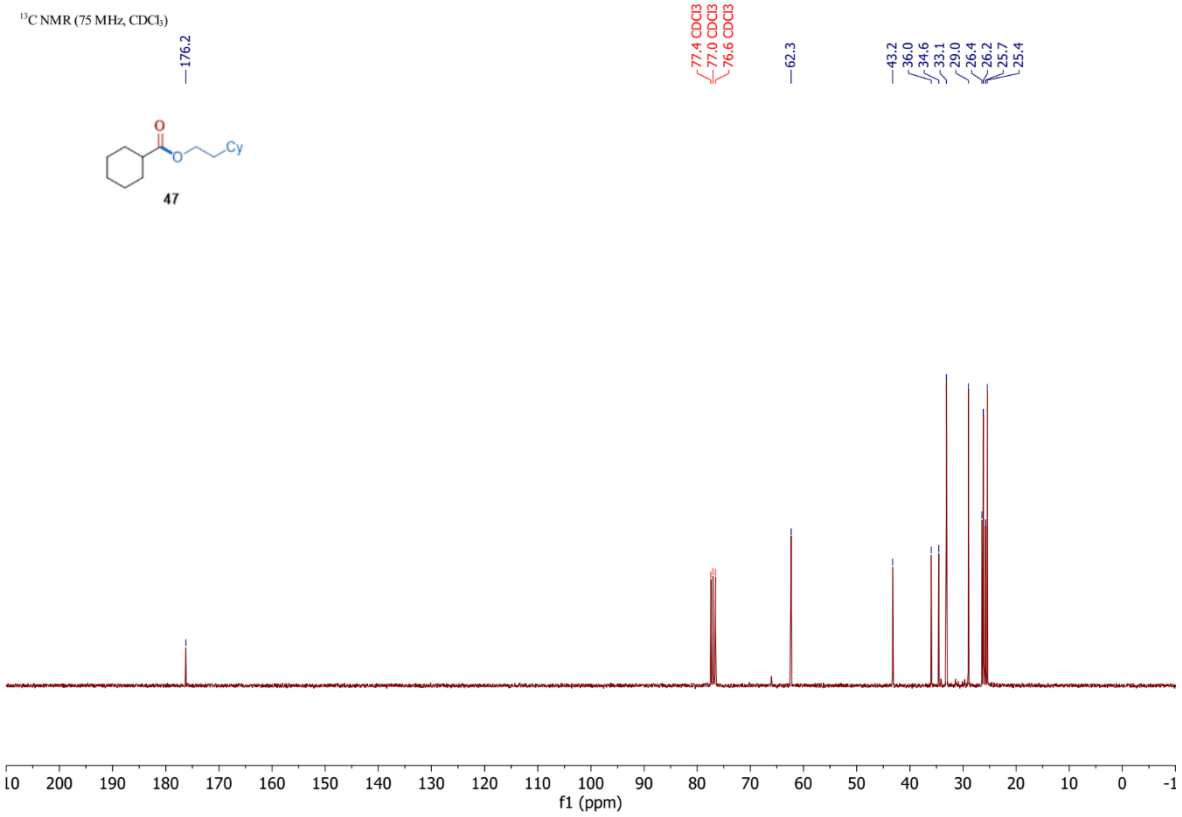

^{1}H NMR (300 MHz, Chloroform-*d*)
7.26 CDCl3
Et
Me
O
Cy
45
f1 (ppm)
2.08
1.00
6.41
7.41
3.27
5.34

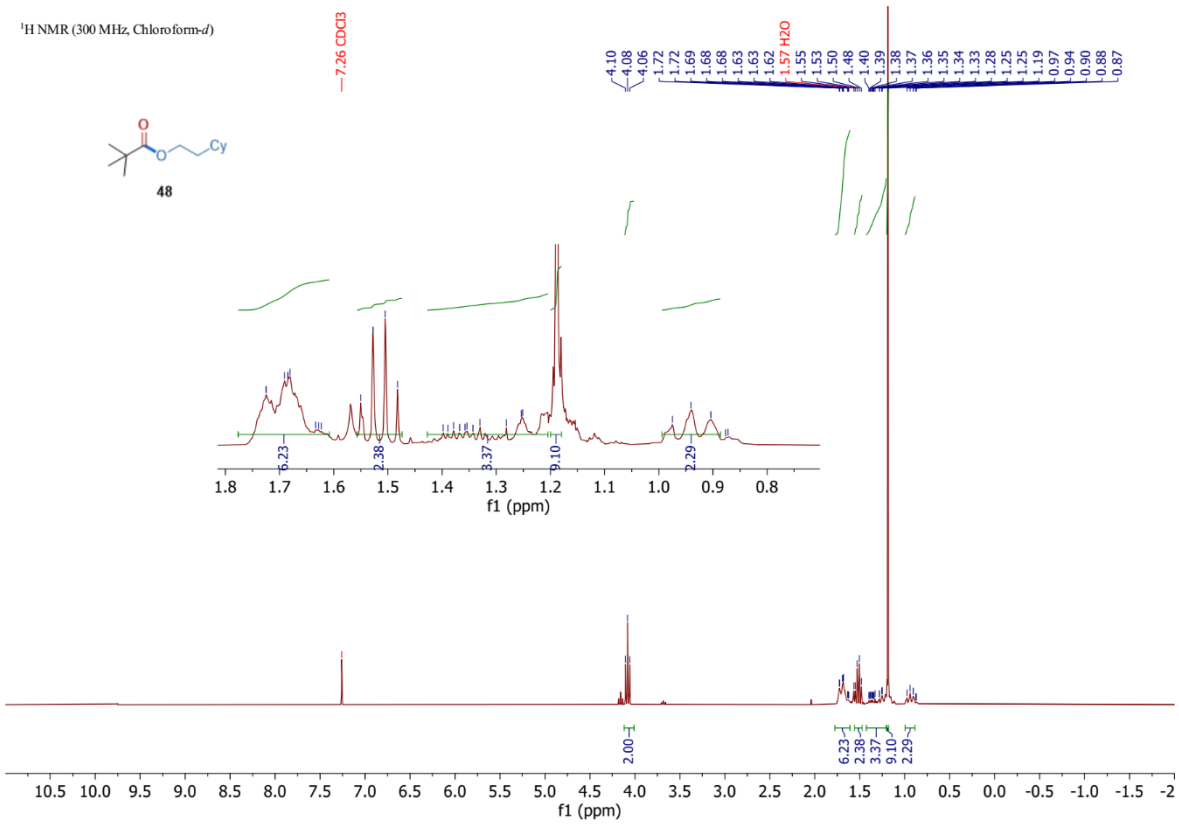

^{13}C NMR (75 MHz, $CDCl_3$)
176.8
77.4 CDCl3
77.0 CDCl3
76.6 CDCl3
62.4
41.1
36.0
34.6
33.1
26.8
26.5
26.2
16.6
11.6
Et
Me
O
Cy
45
f1 (ppm)

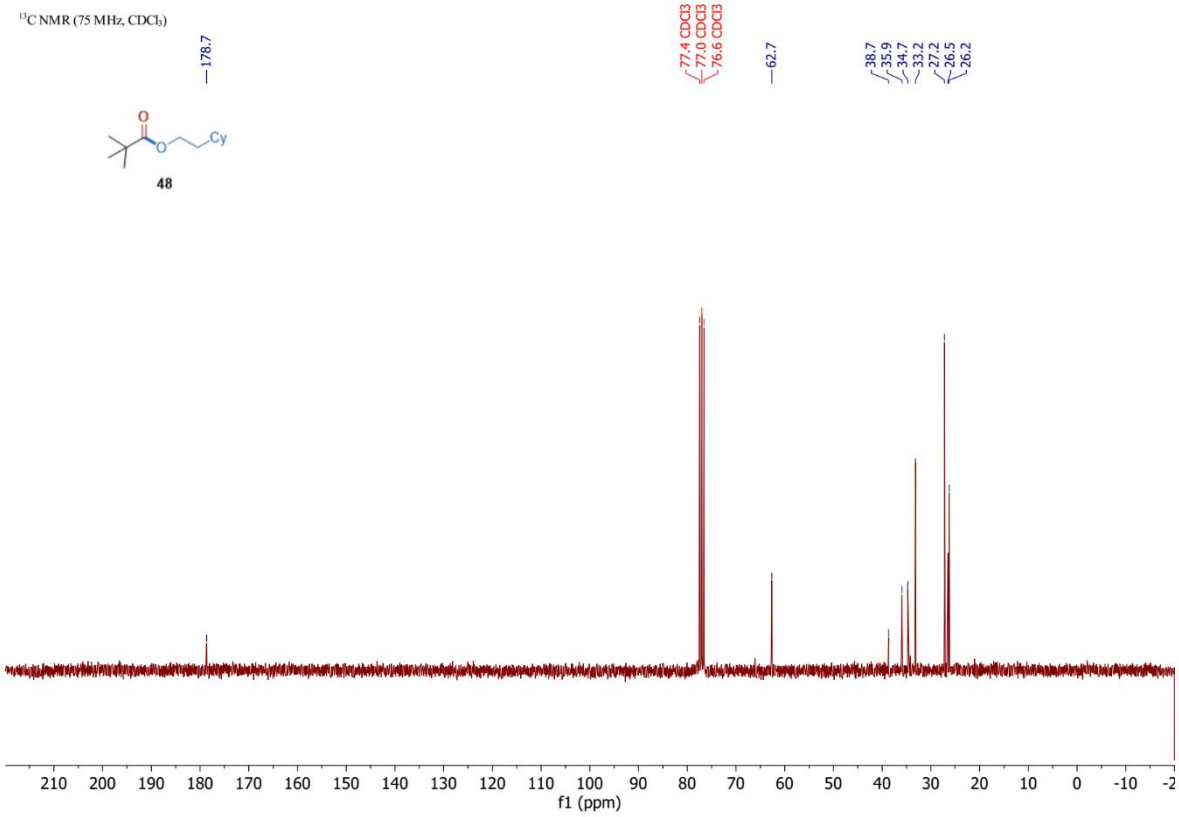

¹H NMR (300 MHz, Chloroform-d)
7.26 CDCl3
4.11 4.09 4.07 2.76 2.73 2.71 2.68 2.65 1.89 1.86 1.86 1.84 1.81 1.81 1.72 1.69 1.69 1.68 1.68 1.68 1.67 1.67 1.62 1.62 1.55 1.52 1.50 1.48 1.37 1.36 1.35 1.35 1.33 1.21 1.20 1.18 1.18 1.18 0.98 0.97 0.97 0.94 0.93 0.90 0.87 0.86 0.85
O
O
Cy
46
1.9 1.8 1.7 1.6 1.5 1.4 1.3 1.2 1.1 1.0 0.9 0.8
f1 (ppm)
2.00
0.94
11.40
2.44
4.12
2.28
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0 -1.5 -2
f1 (ppm)

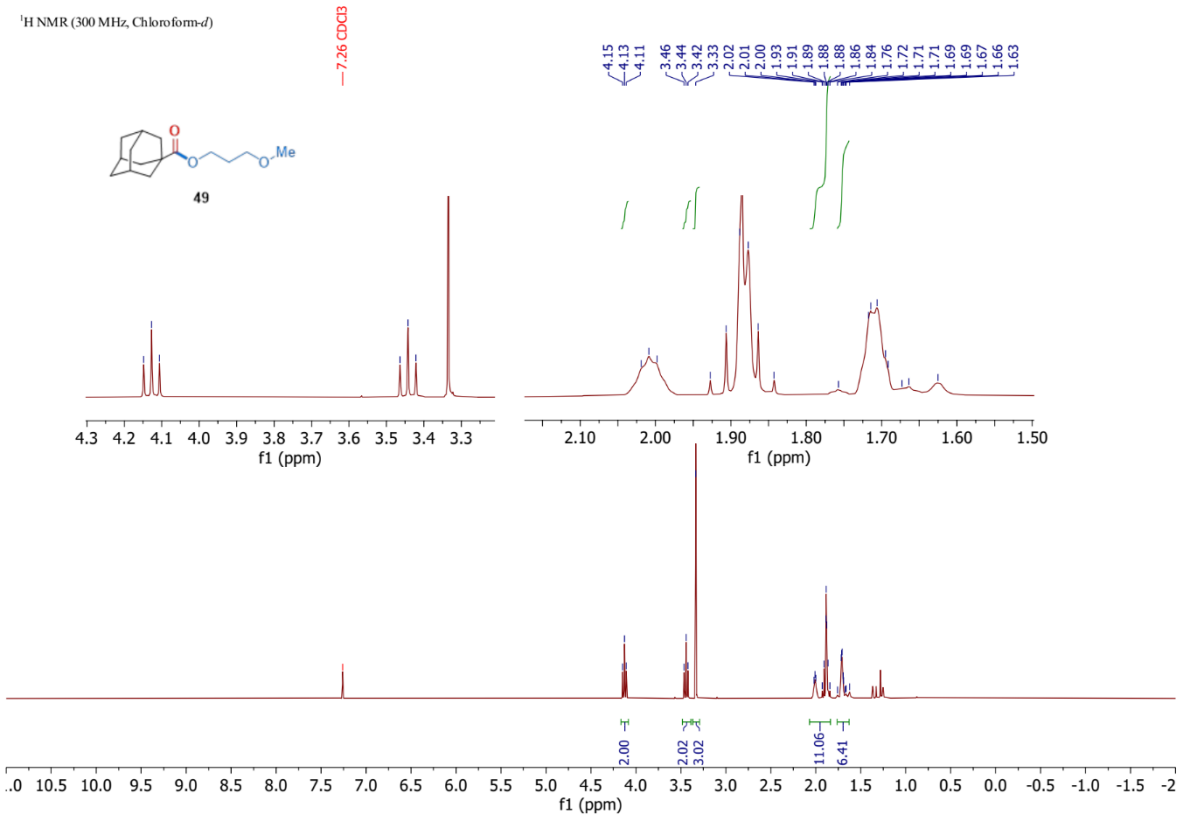

¹³C NMR (75 MHz, CDCl3)
176.9
77.4 CDCl3
77.0 CDCl3
76.6 CDCl3
62.5
43.9
36.0
34.6
33.1
30.0
26.5
26.2
25.8
O
O
Cy
46
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -1
f1 (ppm)

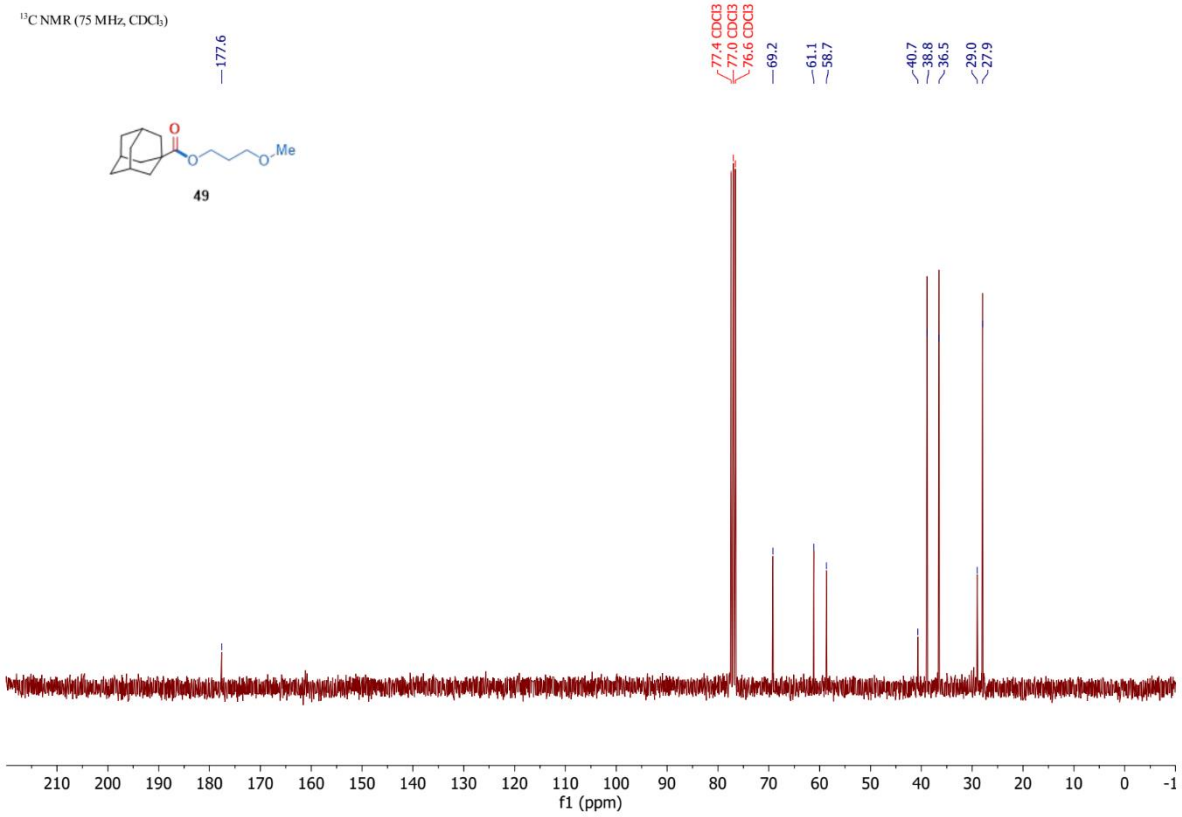

^{1}H NMR (300 MHz, Chloroform-*d*)
7.26
4.09 4.07 4.05 2.31 2.30 2.29 2.27 2.26 2.25 2.24 2.22 2.21 1.89 1.86 1.85 1.85 1.75 1.75 1.75 1.71 1.71 1.67 1.66 1.62 1.62 1.61 1.53 1.51 1.48 1.46 1.43 1.40 1.24 1.24 1.21 1.21 1.21 1.20 1.17 0.96 0.92 0.88 0.85 0.85 0.84
O
O
Cy
47
2.0 1.9 1.8 1.7 1.6 1.5 1.4 1.3 1.2 1.1 1.0 0.9 0.8 0.7
f1 (ppm)
2.00 0.96 2.08 8.34 11.87 2.34
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0 -1.5 -2
f1 (ppm)


^{13}C NMR (75 MHz, $CDCl_3$)
176.2
77.4 CDCl3
77.0 CDCl3
76.6 CDCl3
62.3
43.2
36.0
34.6
33.1
29.0
26.4
26.2
25.7
25.4
O
O
Cy
47
10 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -1
f1 (ppm)

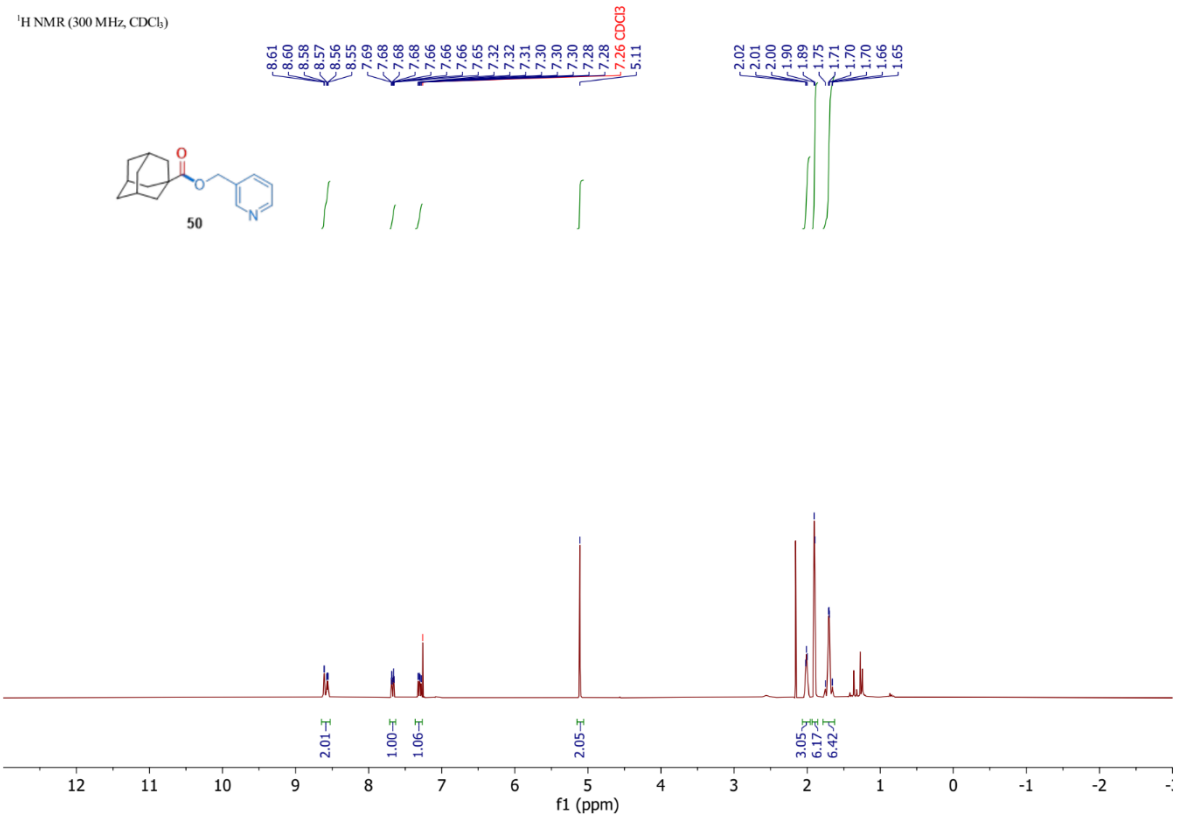

^{1}H NMR (300 MHz, Chloroform-*d*)
7.26 CDCl3
1.57 H2O
48
f1 (ppm)


^{13}C NMR (75 MHz, $CDCl_3$)
178.7
77.4 CDCl3
77.0 CDCl3
76.6 CDCl3
62.7
38.7
35.9
34.7
33.2
27.2
26.5
26.2
48
f1 (ppm)

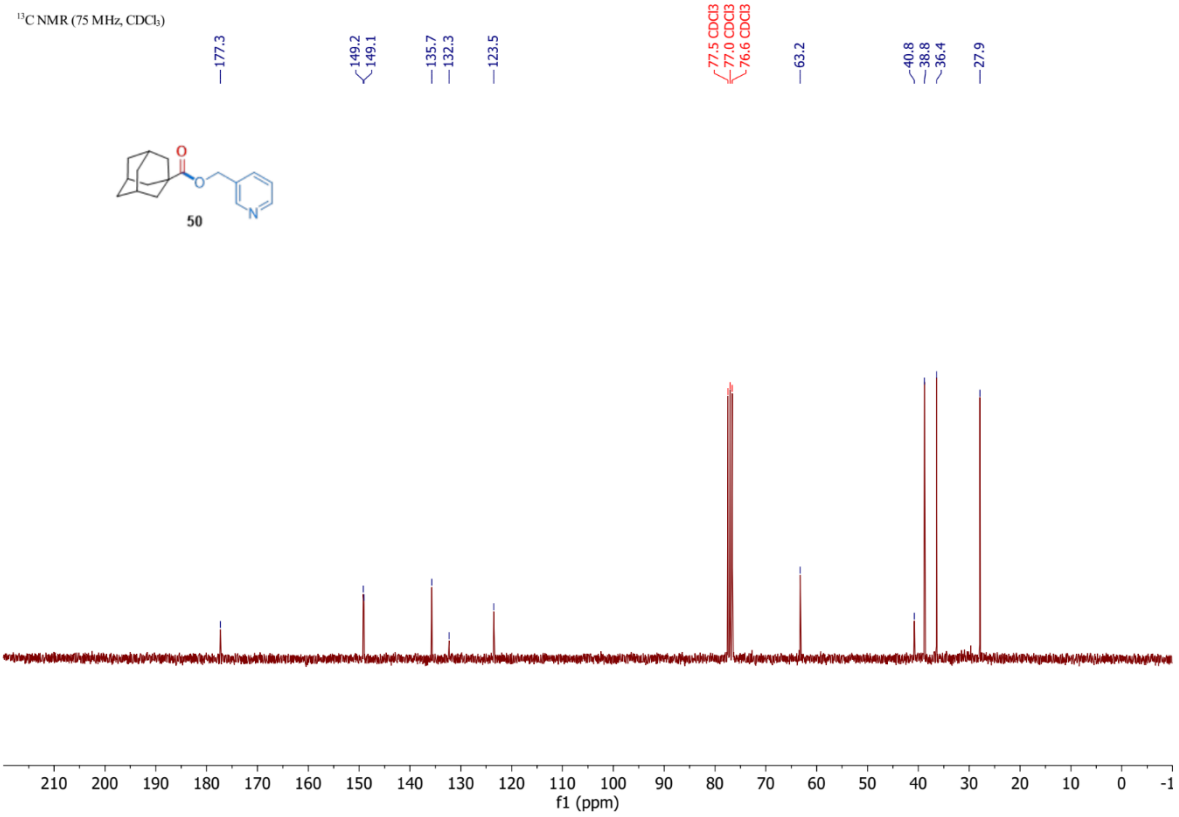

¹H NMR (300 MHz, Chloroform-d)
7.26 CDCl3
4.15
4.13
4.11
3.46
3.44
3.42
3.33
2.02
2.01
2.00
1.93
1.91
1.89
1.88
1.88
1.86
1.84
1.76
1.72
1.71
1.71
1.69
1.69
1.67
1.66
1.63
O
O
O
Me
49
4.3 4.2 4.1 4.0 3.9 3.8 3.7 3.6 3.5 3.4 3.3
f1 (ppm)
2.10 2.00 1.90 1.80 1.70 1.60 1.50
f1 (ppm)
2.00
2.02
3.02
11.06
6.41
.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0 -1.5 -2
f1 (ppm)

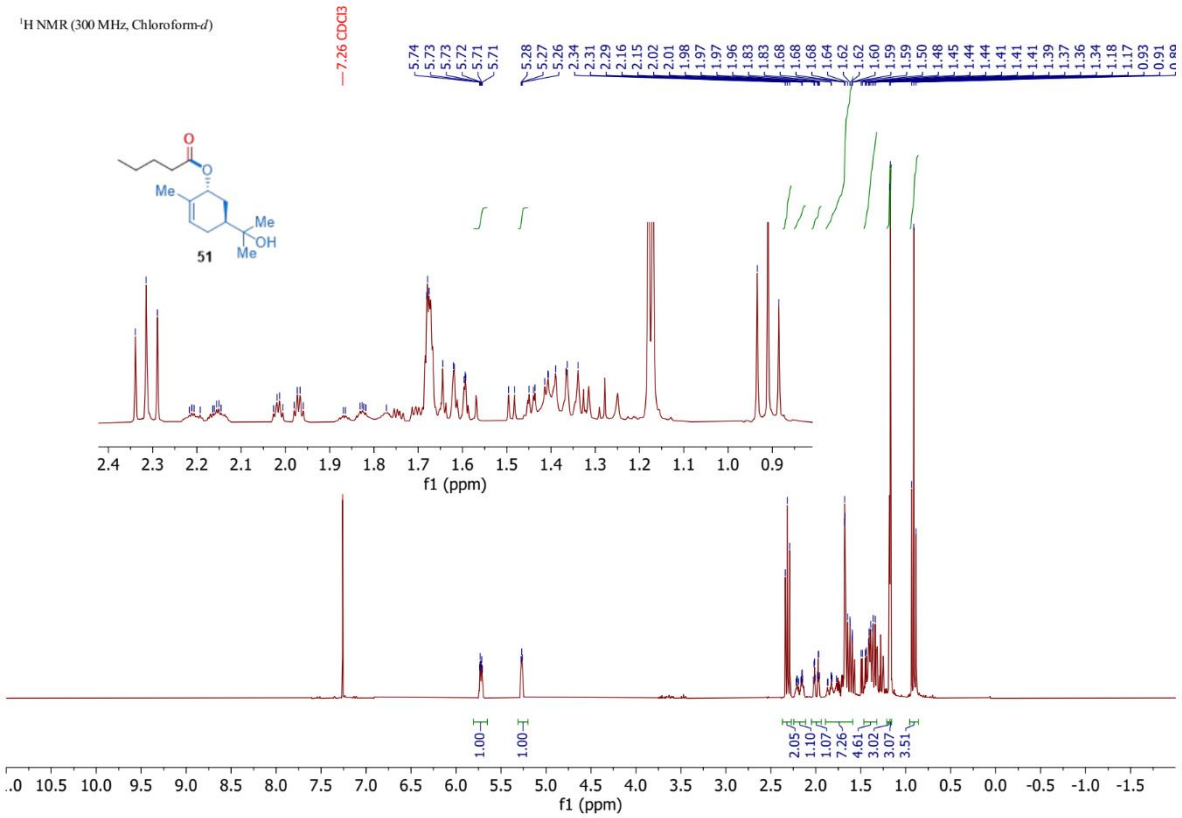

¹³C NMR (75 MHz, CDCl3)
177.6
77.4 CDCl3
77.0 CDCl3
76.6 CDCl3
69.2
61.1
58.7
40.7
38.8
36.5
29.0
27.9
O
O
O
Me
49
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -1
f1 (ppm)

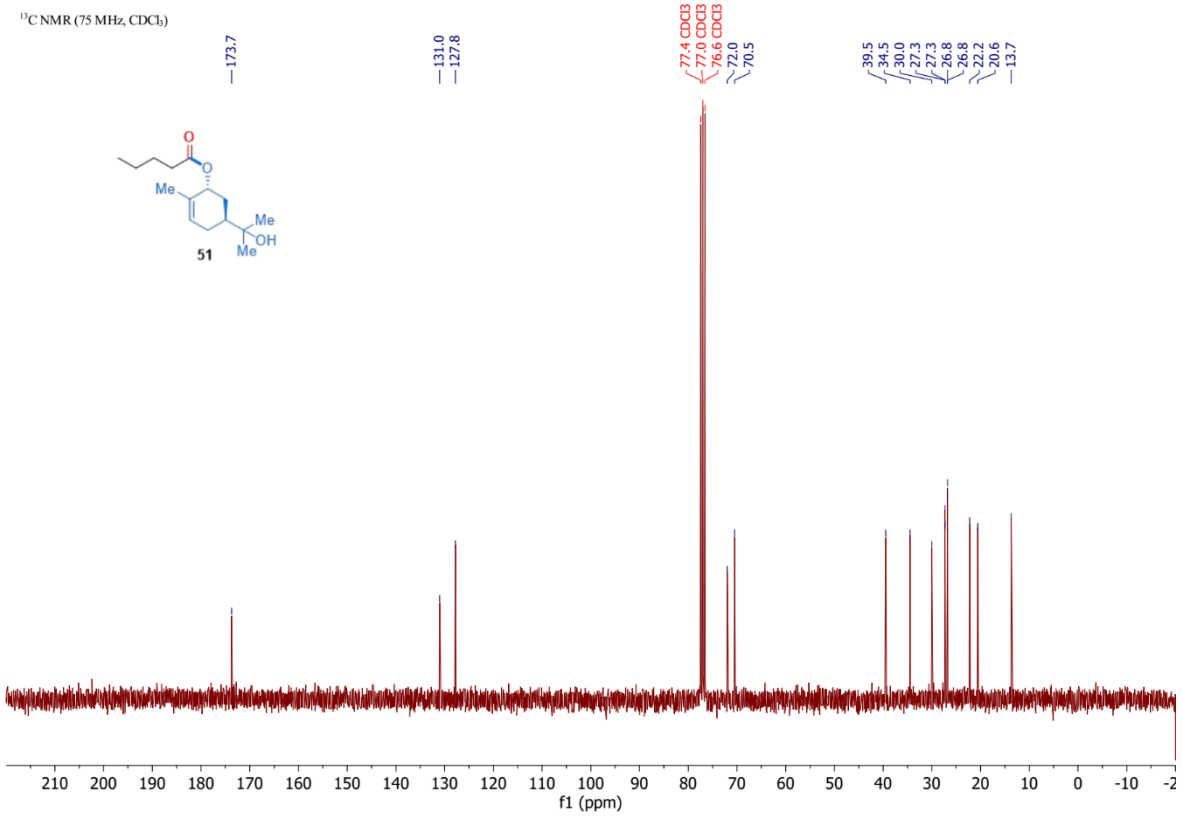
^{1}H NMR (300 MHz, $CDCl_3$)

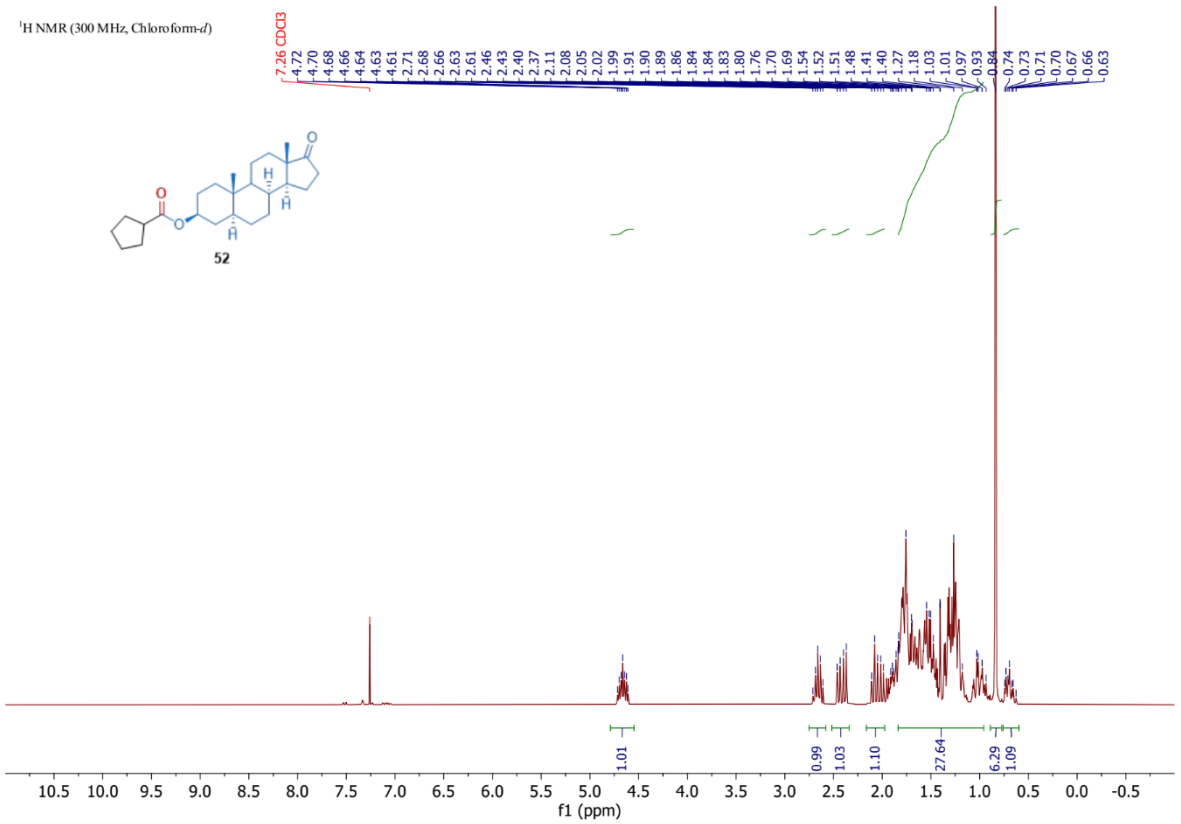


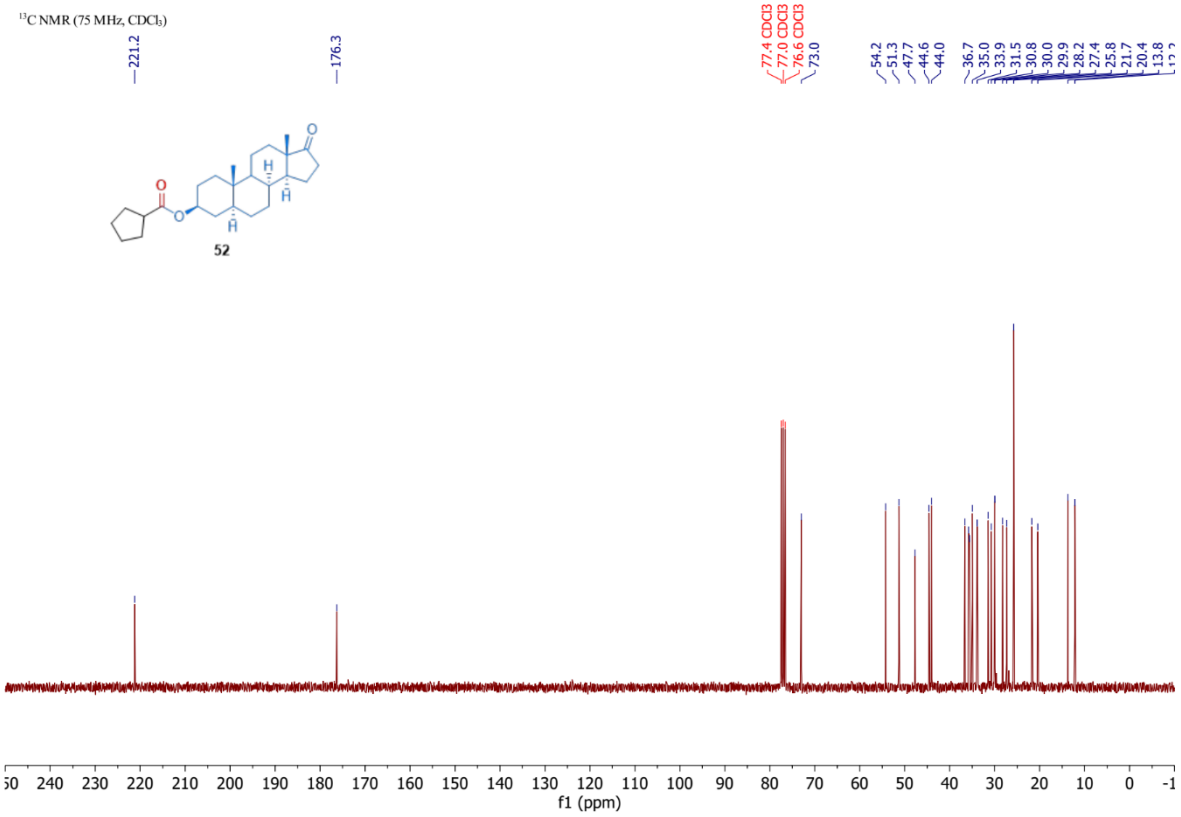
^{13}C NMR (75 MHz, $CDCl_3$)

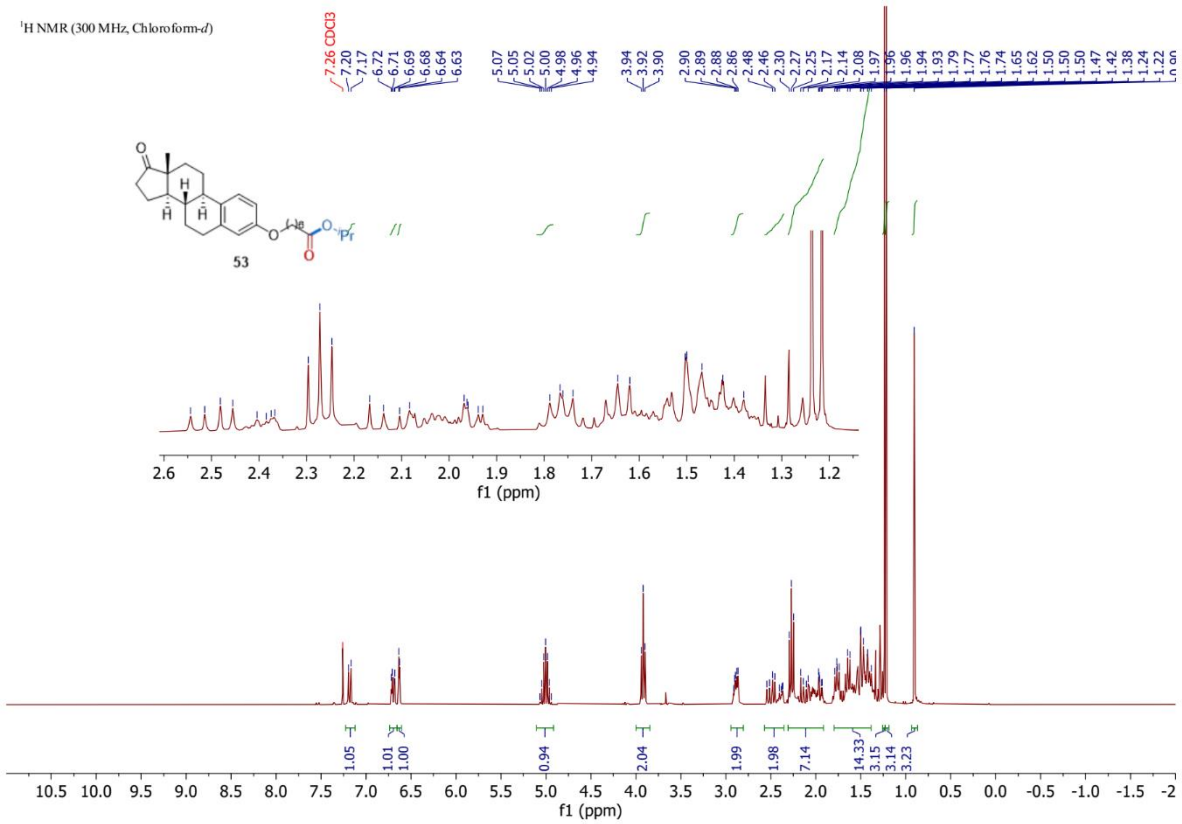


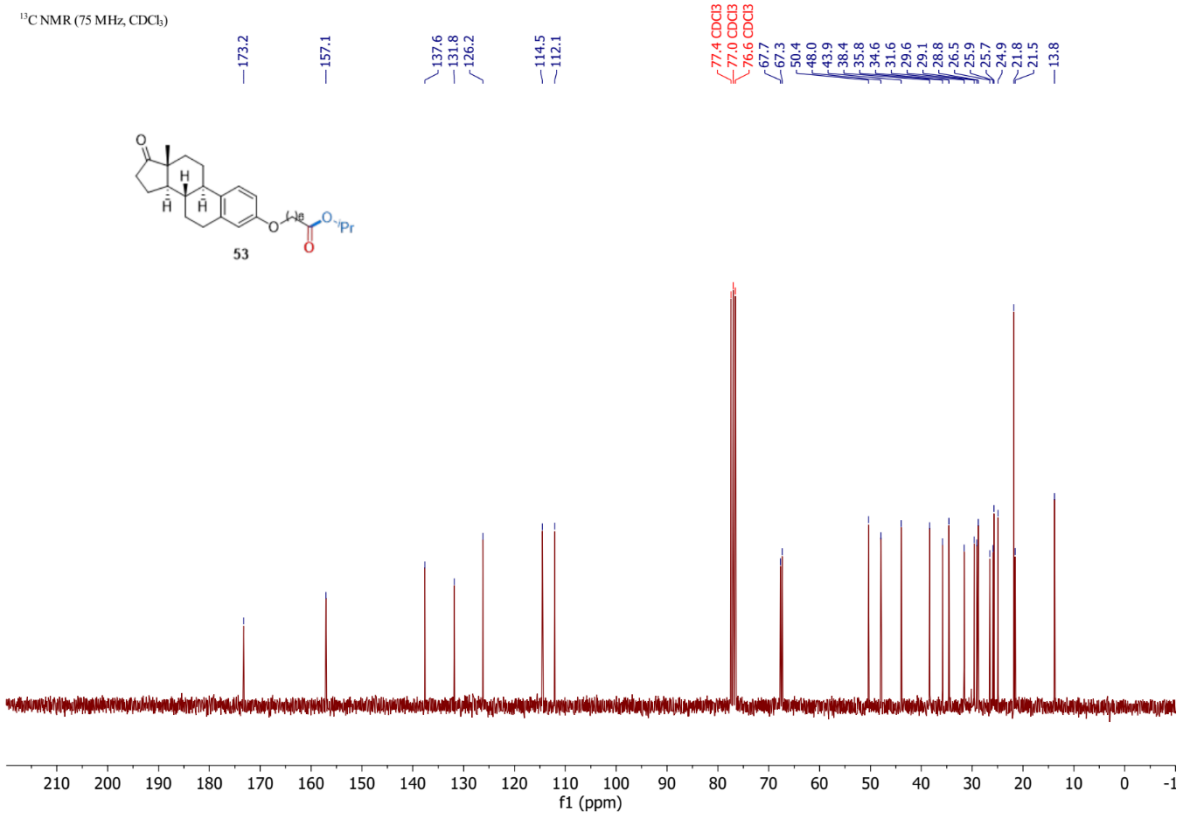

¹H NMR (300 MHz, Chloroform-d)
7.26 CDCl3
51
f1 (ppm)

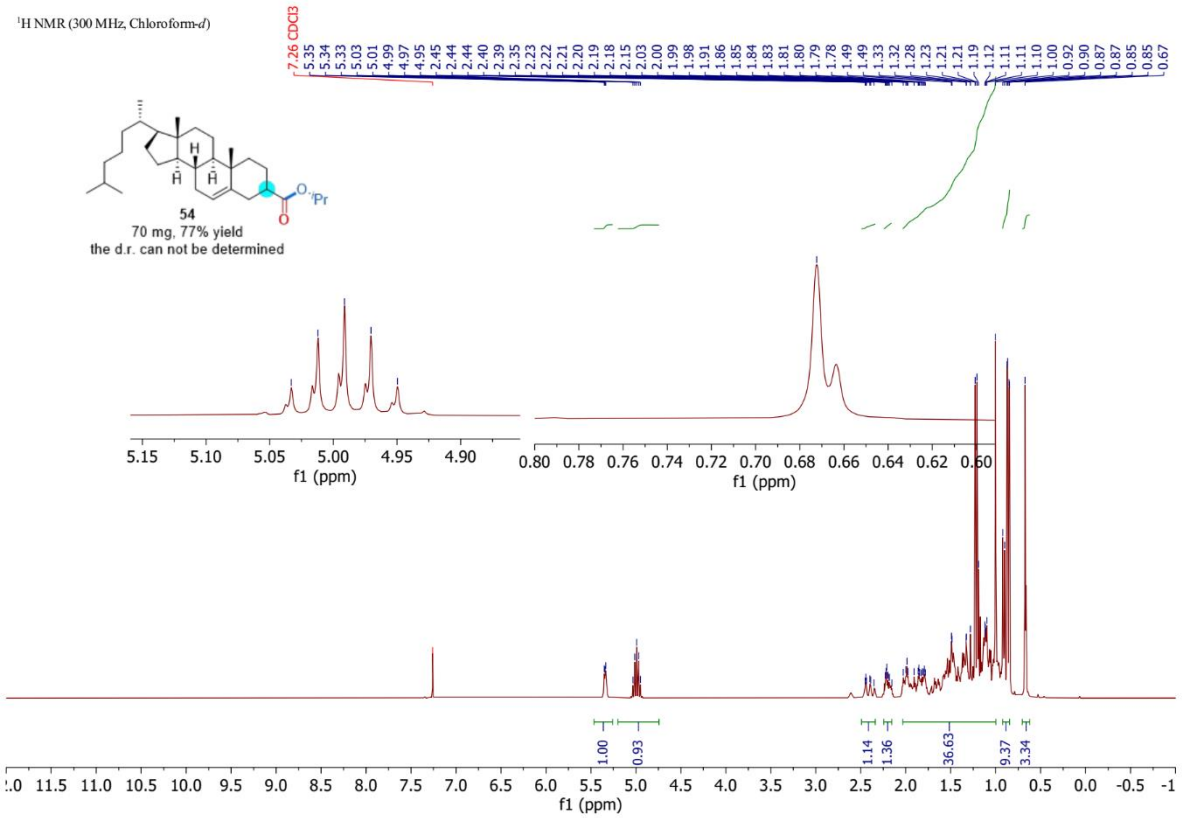

¹³C NMR (75 MHz, CDCl3)
173.7
131.0
127.8
77.4 CDCl3
77.0 CDCl3
76.6 CDCl3
72.0
70.5
39.5
34.5
30.0
27.3
27.3
26.8
26.8
22.2
20.6
13.7
51
f1 (ppm)

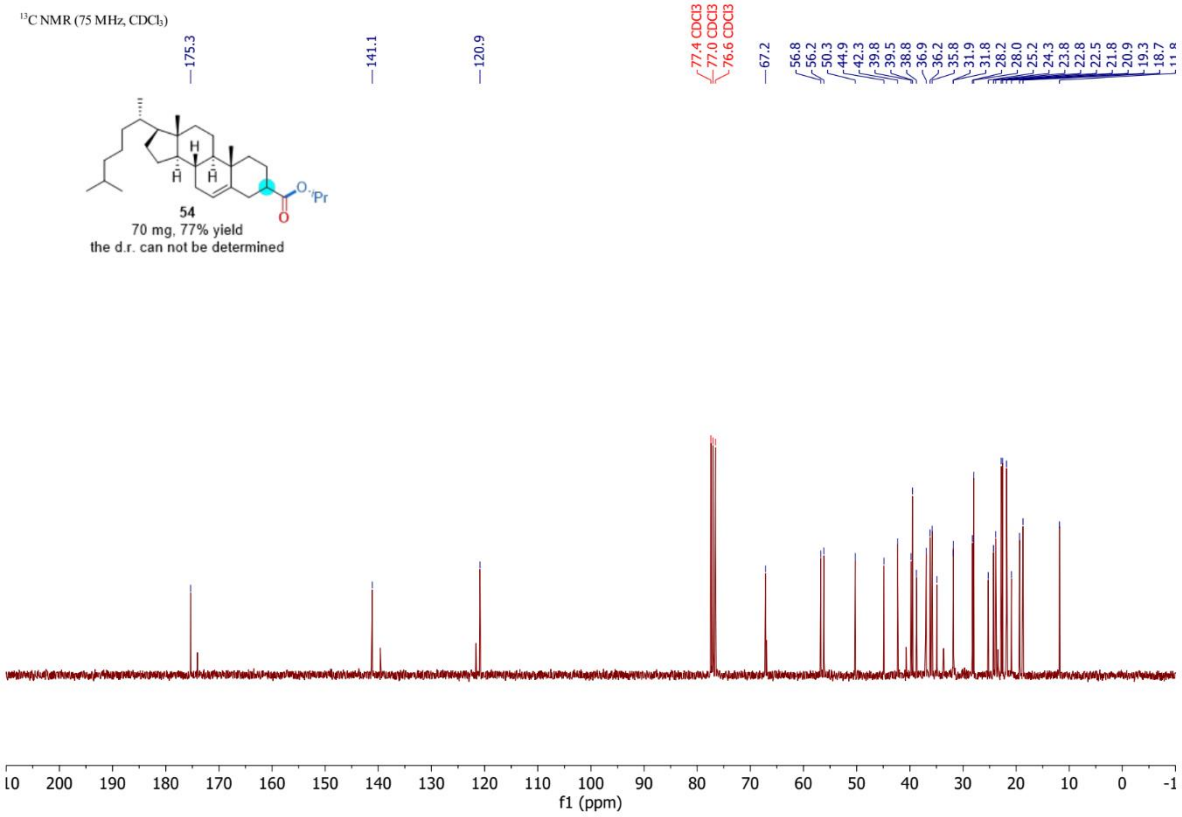

^{1}H NMR (300 MHz, Chloroform-*d*)
7.26 CDCl3
52
1.01
0.99
1.03
1.10
27.64
6.29
1.09
f1 (ppm)

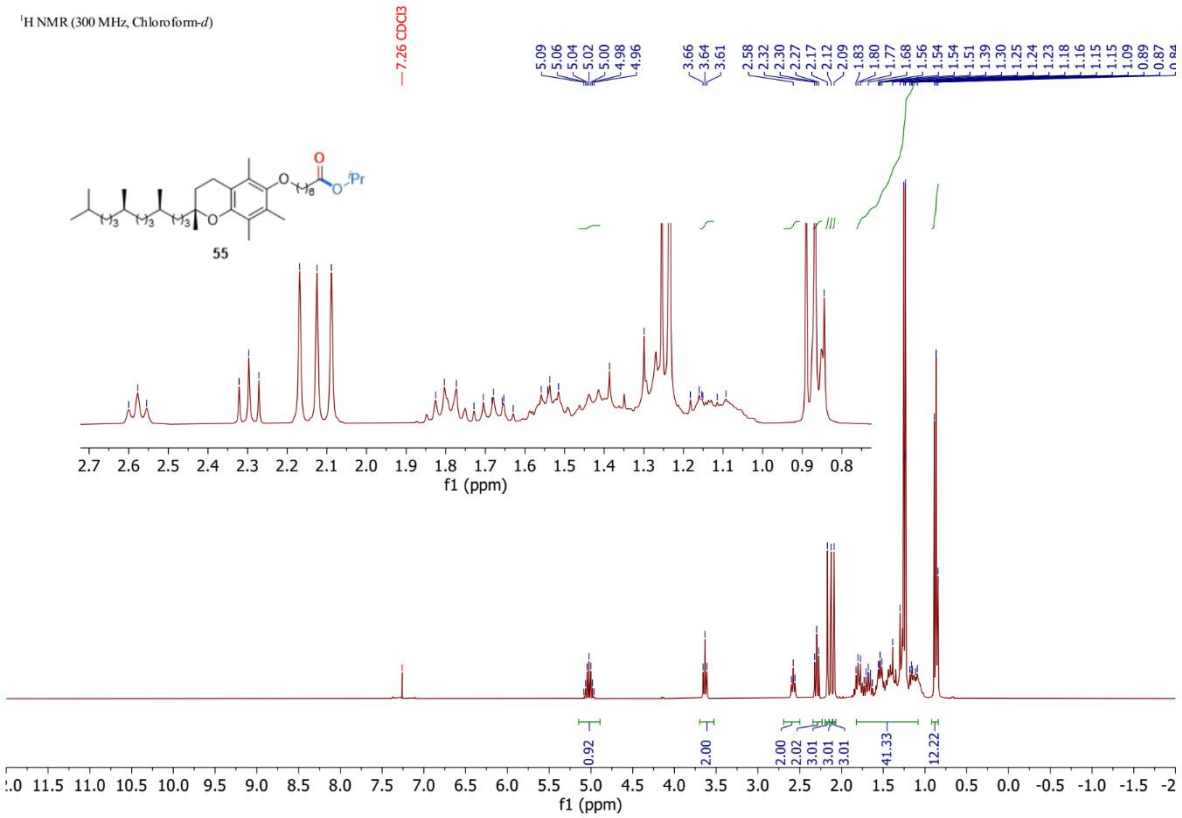

^{13}C NMR (75 MHz, $CDCl_3$)
221.2
176.3
77.4 CDCl3
77.0 CDCl3
76.6 CDCl3
73.0
54.2
51.3
47.7
44.6
44.0
36.7
35.0
33.9
31.5
30.8
30.0
29.9
28.2
27.4
25.8
21.7
20.4
13.8
52
f1 (ppm)

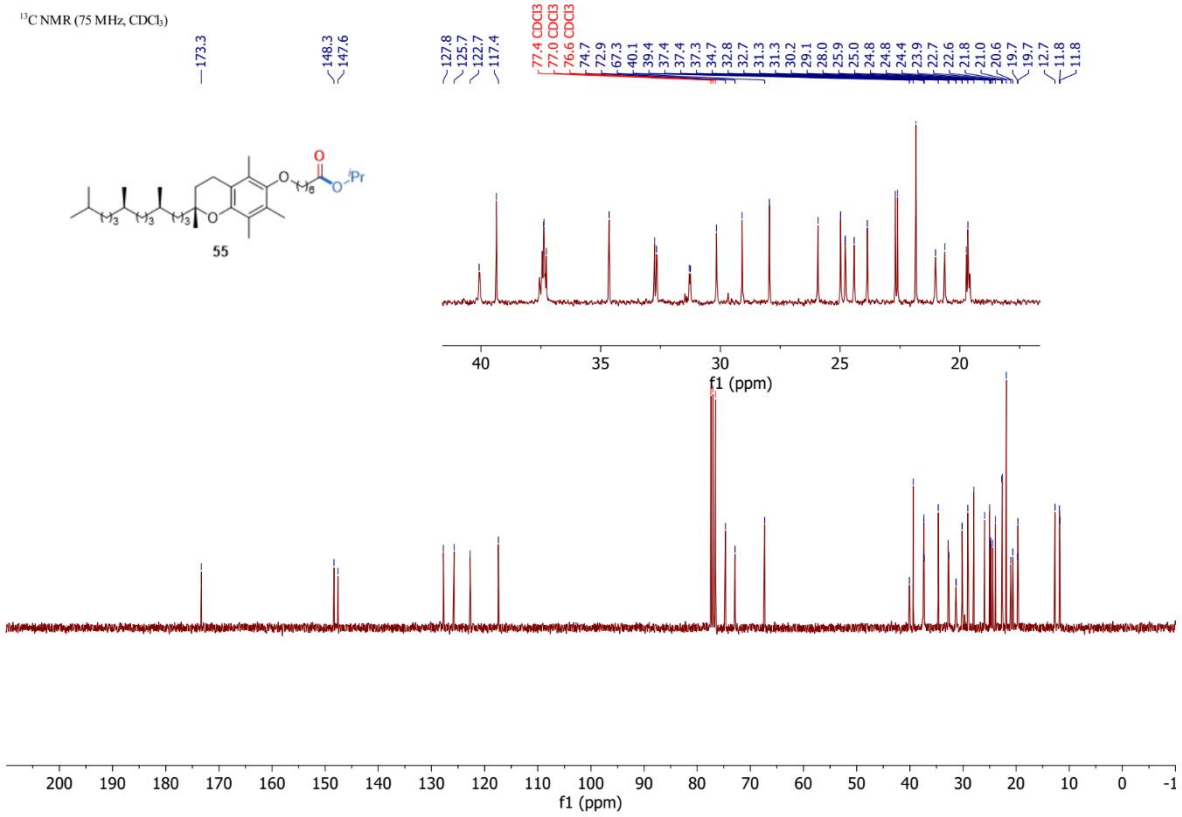

^{1}H NMR (300 MHz, Chloroform-*d*)
7.26 CDCl3
53
f1 (ppm)

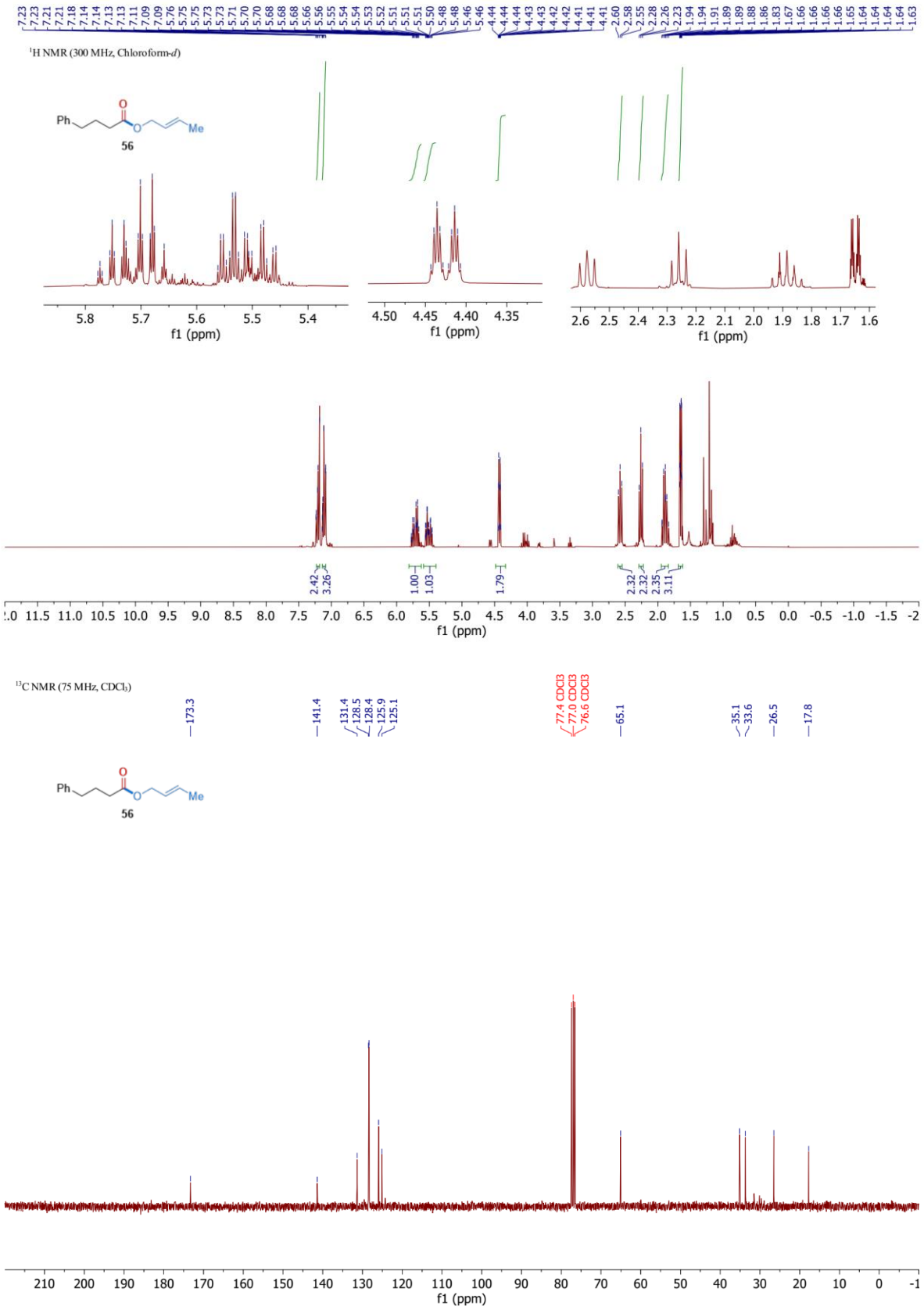

^{13}C NMR (75 MHz, $CDCl_3$)
173.2
157.1
137.6
131.8
126.2
114.5
112.1
77.4 CDCl3
77.0 CDCl3
76.6 CDCl3
53
f1 (ppm)

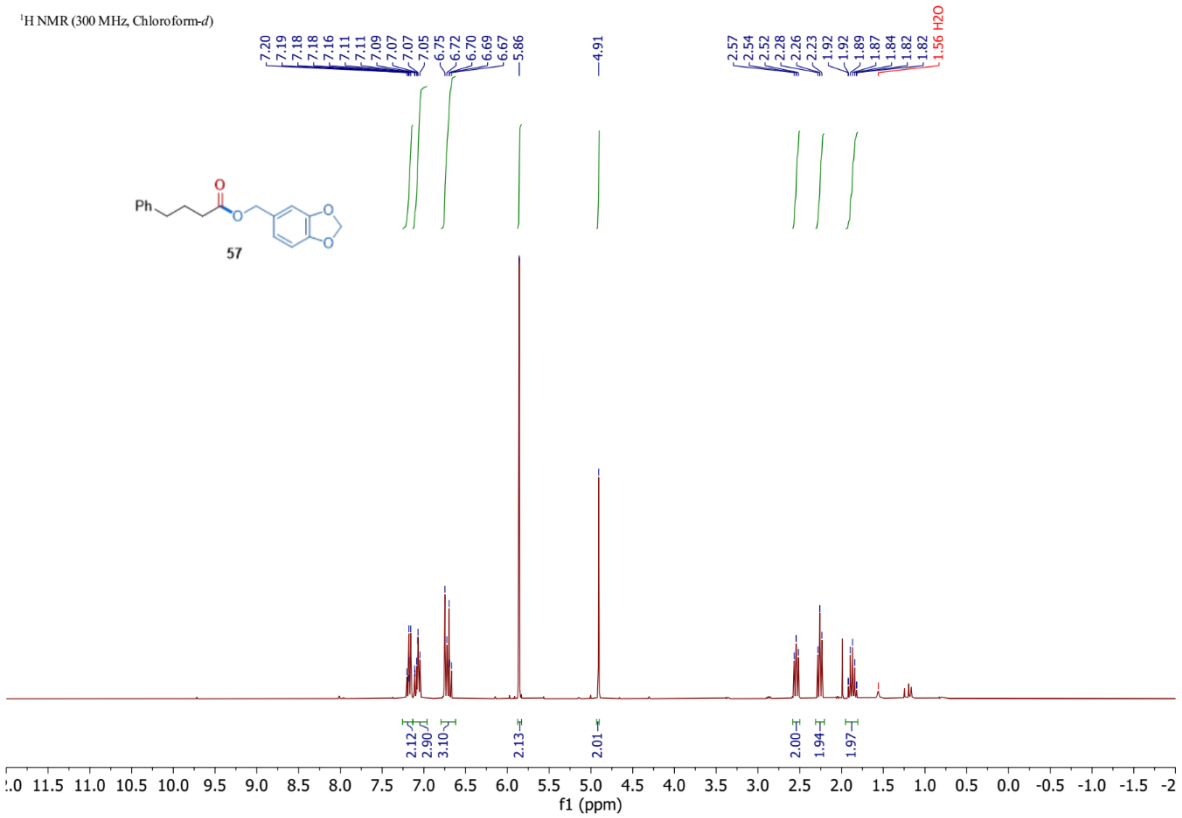

^{1}H NMR (300 MHz, Chloroform-*d*)
7.26 CDCl3
54
70 mg, 77% yield
the d.r. can not be determined
f1 (ppm)

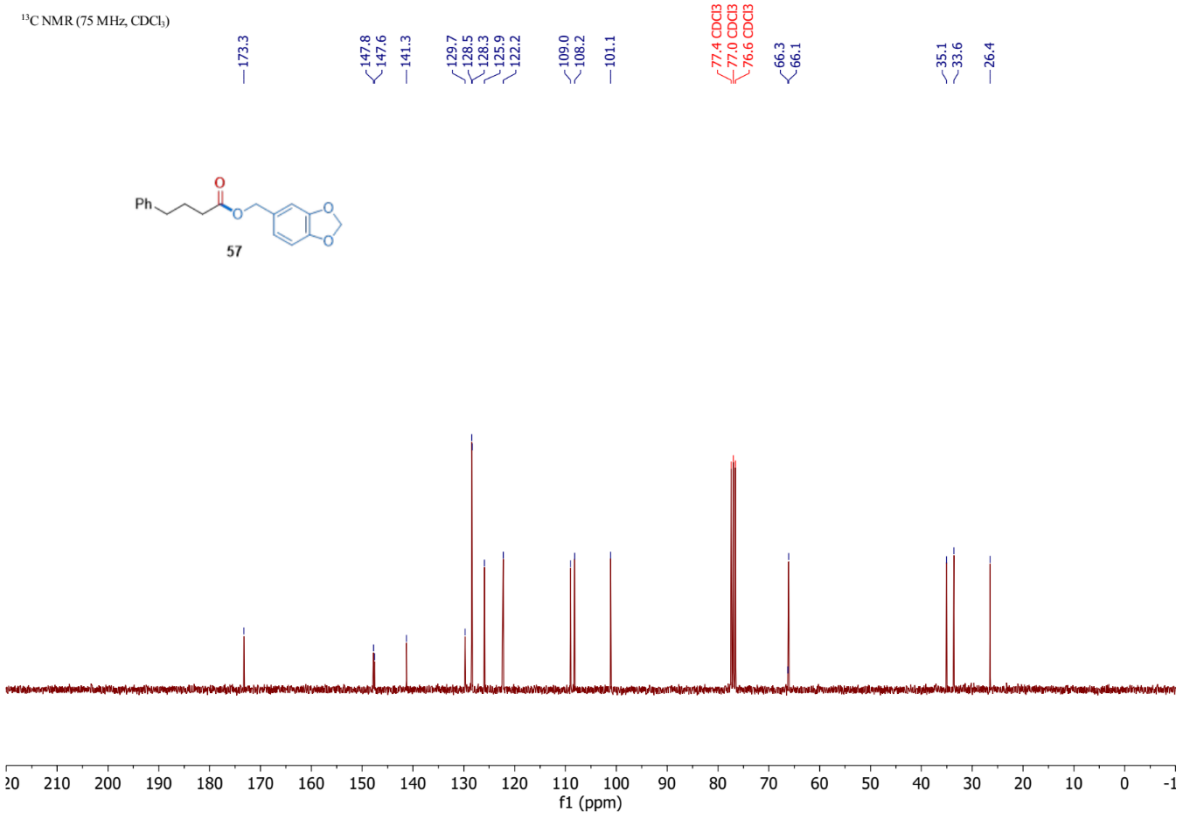

^{13}C NMR (75 MHz, $CDCl_3$)
54
70 mg, 77% yield
the d.r. can not be determined
f1 (ppm)

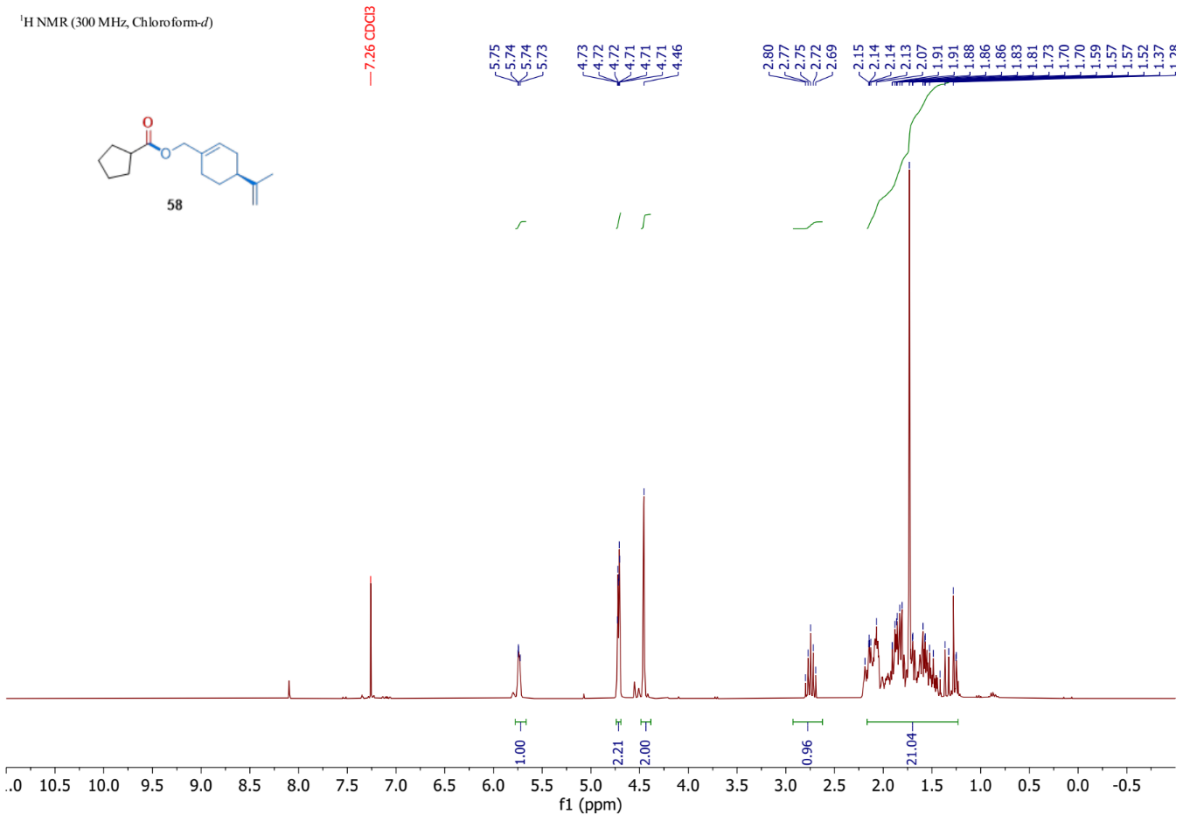

^{1}H NMR (300 MHz, Chloroform-*d*)
7.26 CDCl3
5.09 5.06 5.04 5.02 5.00 4.98 4.96
3.66 3.64 3.61
2.58 2.32 2.30 2.27 2.17 2.12 2.09
1.83 1.80 1.77 1.68 1.56 1.54 1.54 1.51 1.39 1.30 1.25 1.24 1.23 1.18 1.16 1.15 1.15 1.09 0.89 0.87
55
f1 (ppm)
0.92 2.00 2.00 2.02 3.01 3.01 3.01 41.33 12.22
f1 (ppm)

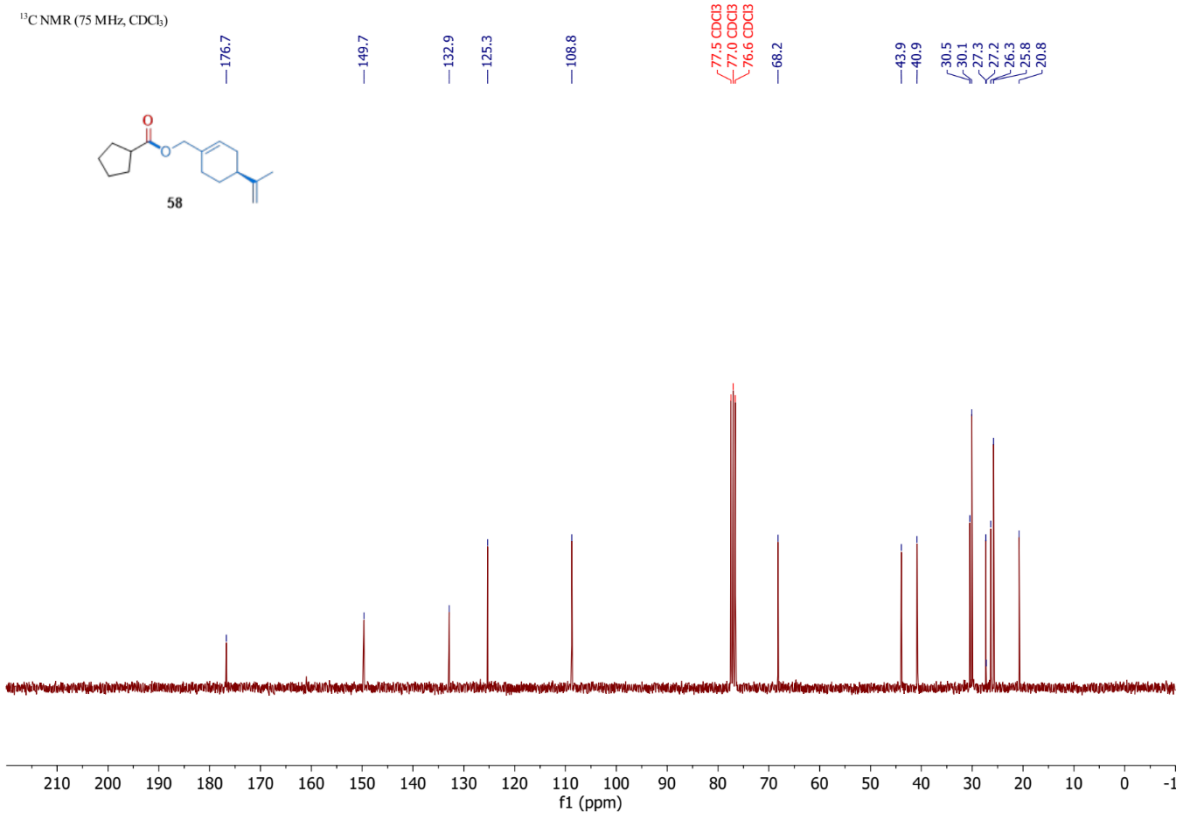

^{13}C NMR (75 MHz, $CDCl_3$)
173.3
148.3 147.6
127.8 125.7 122.7 117.4
77.4 CDCl3 77.0 CDCl3 76.6 CDCl3
74.7 72.9 67.3 40.1 39.4 37.4 37.4 37.3 34.7 32.8 32.7 31.3 31.3 30.2 29.1 28.0 25.9 25.0 24.8 24.8 24.4 23.9 22.7 22.6 21.8 21.0 20.6 19.7 19.7 12.7 11.8 11.8
55
f1 (ppm)
f1 (ppm)

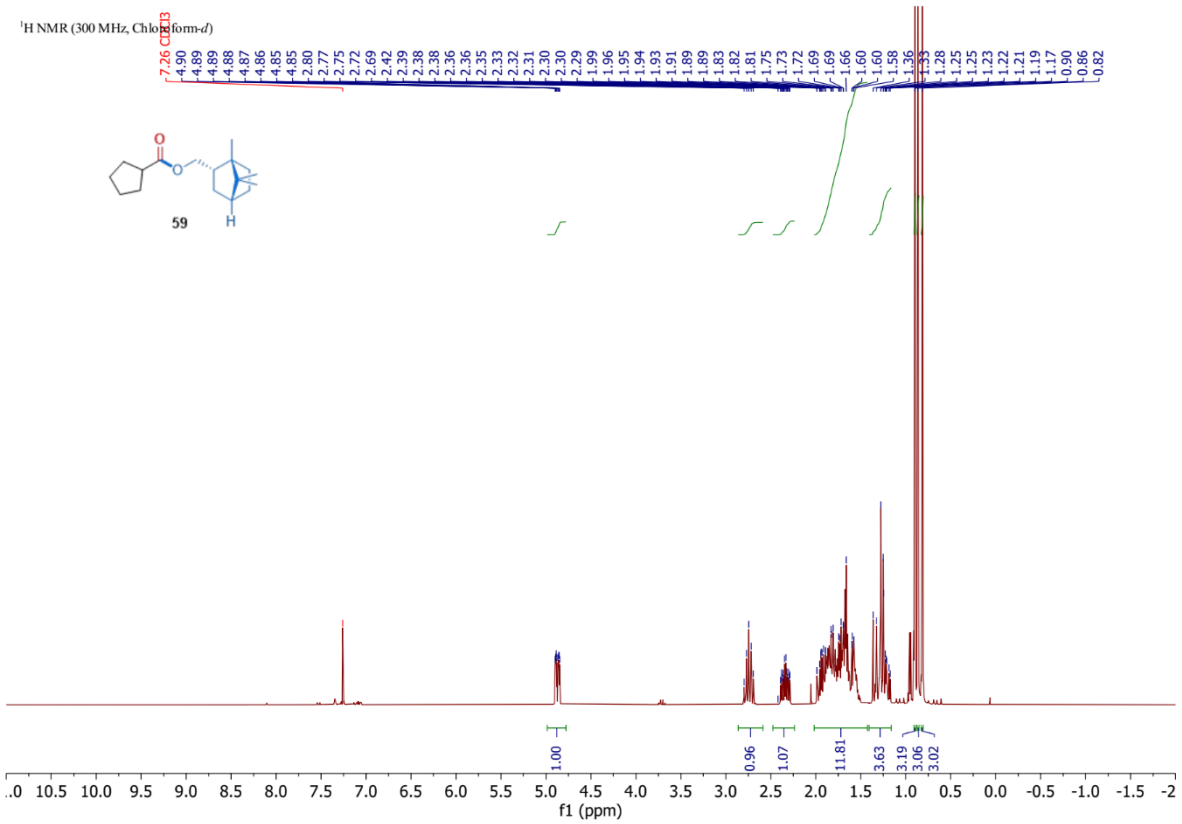

7.23 7.23 7.21 7.21 7.18 7.14 7.14 7.13 7.13 7.11 7.09 7.09 5.76 5.75 5.75 5.73 5.73 5.71 5.70 5.70 5.68 5.68 5.68 5.66 5.56 5.55 5.54 5.54 5.53 5.52 5.51 5.51 5.50 5.48 5.48 5.46 5.46 4.44 4.44 4.44 4.43 4.43 4.42 4.42 4.41 4.41 4.41 2.60 2.58 2.55 2.28 2.26 2.23 1.94 1.94 1.91 1.89 1.89 1.88 1.86 1.83 1.67 1.66 1.66 1.66 1.66 1.65 1.64 1.64 1.64 1.64 1.63
1H NMR (300 MHz, Chloroform-d)
Ph
O
O
Me
56
5.8 5.7 5.6 5.5 5.4
f1 (ppm)
4.50 4.45 4.40 4.35
f1 (ppm)
2.6 2.5 2.4 2.3 2.2 2.1 2.0 1.9 1.8 1.7 1.6
f1 (ppm)
2.42 3.26 1.00 1.03 1.79 2.32 2.32 2.35 3.11
f1 (ppm)
13C NMR (75 MHz, CDCl3)
173.3 141.4 131.4 128.5 128.4 125.9 125.1 77.4 CDCl3 77.0 CDCl3 76.6 CDCl3 65.1 35.1 33.6 26.5 17.8
Ph
O
O
Me
56
f1 (ppm)

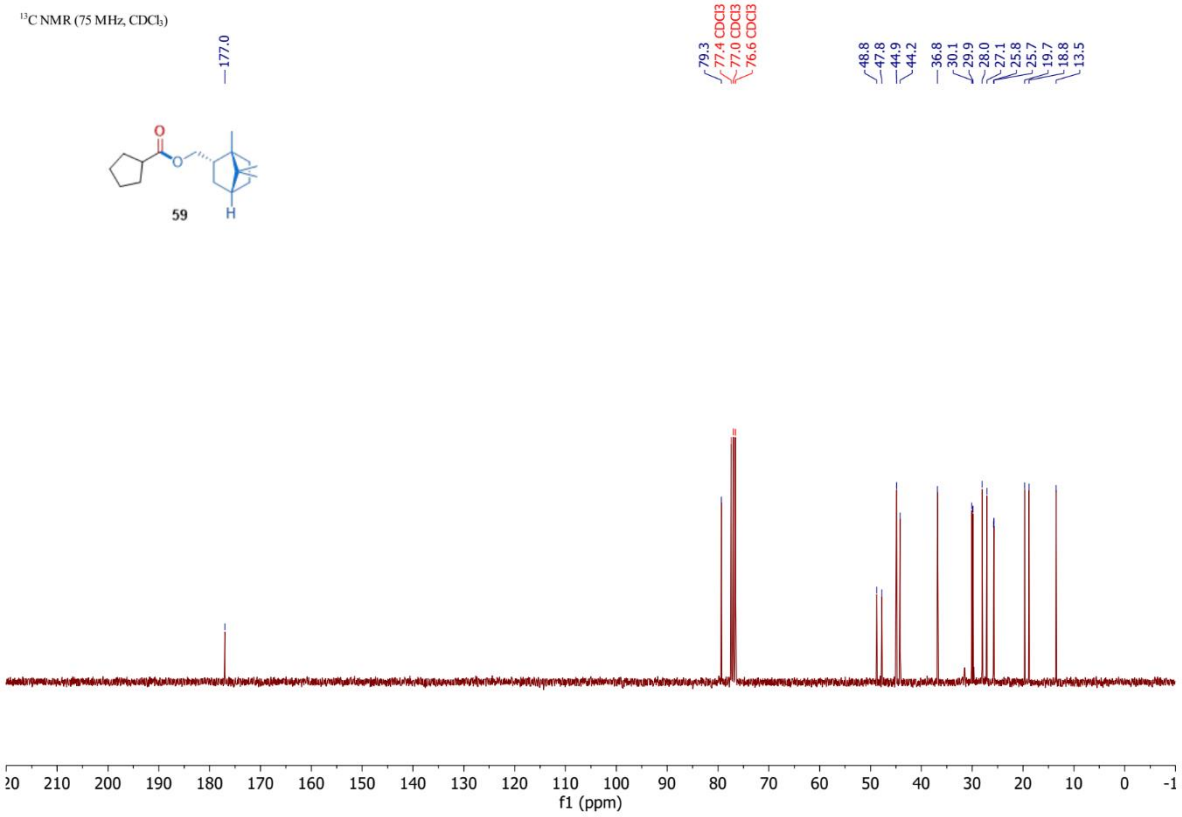

^{1}H NMR (300 MHz, Chloroform-*d*)
7.20
7.19
7.18
7.18
7.16
7.11
7.11
7.09
7.07
7.07
7.05
6.75
6.72
6.70
6.69
6.67
5.86
4.91
2.57
2.54
2.52
2.28
2.26
2.23
1.92
1.92
1.89
1.87
1.84
1.82
1.82
1.56 H2O
Ph
O
O
O
O
57
2.12
2.90
3.10
2.13
2.01
2.00
1.94
1.97
f1 (ppm)

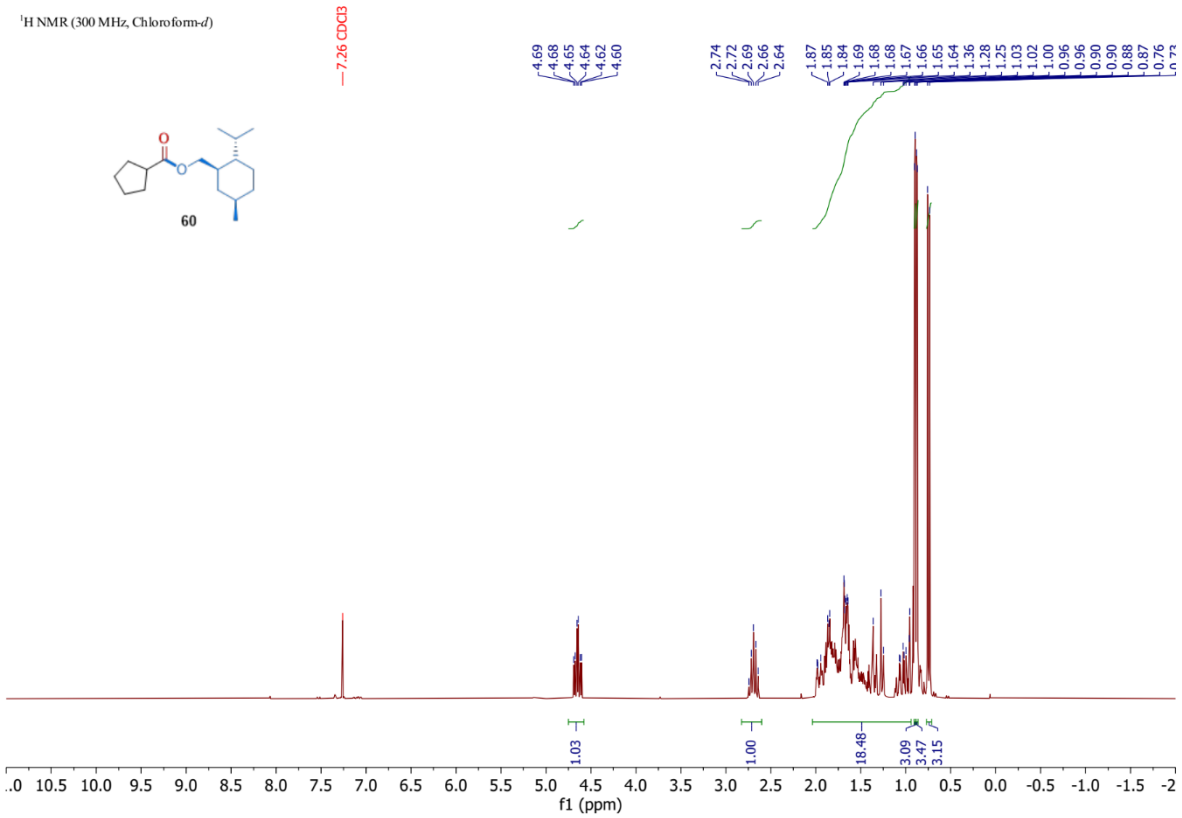

^{13}C NMR (75 MHz, $CDCl_3$)
173.3
147.8
147.6
141.3
129.7
128.5
128.3
125.9
122.2
109.0
108.2
101.1
77.4 CDCl3
77.0 CDCl3
76.6 CDCl3
66.3
66.1
35.1
33.6
26.4
Ph
O
O
O
O
57
f1 (ppm)

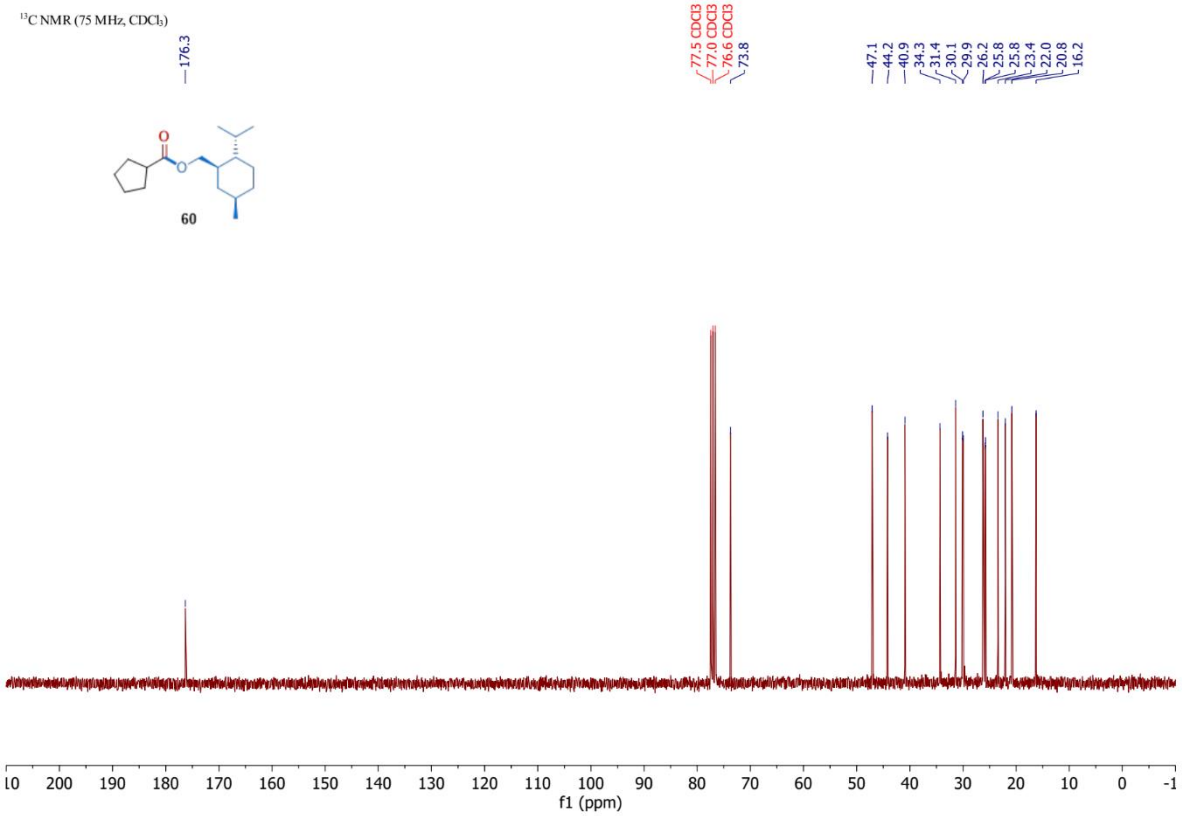

^{1}H NMR (300 MHz, Chloroform-*d*)
7.26 CDCl3
5.75
5.74
5.74
5.73
4.73
4.72
4.72
4.71
4.71
4.71
4.46
2.80
2.77
2.75
2.72
2.69
2.15
2.14
2.14
2.13
2.07
1.91
1.91
1.88
1.86
1.86
1.83
1.81
1.73
1.70
1.70
1.59
1.57
1.57
1.52
1.37
58
1.00
2.21
2.00
0.96
21.04
f1 (ppm)

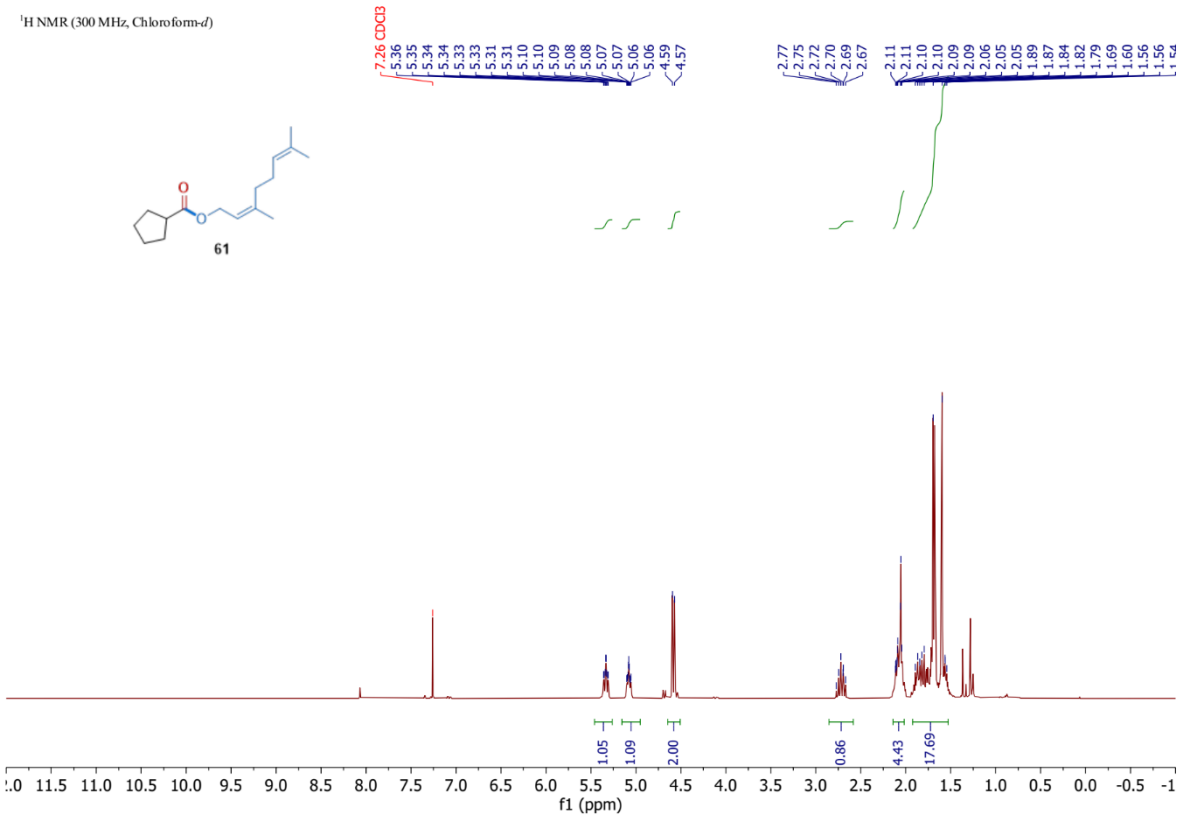

^{13}C NMR (75 MHz, $CDCl_3$)
176.7
149.7
132.9
125.3
108.8
77.5 CDCl3
77.0 CDCl3
76.6 CDCl3
68.2
43.9
40.9
30.5
30.1
27.3
27.2
26.3
25.8
20.8
58
f1 (ppm)

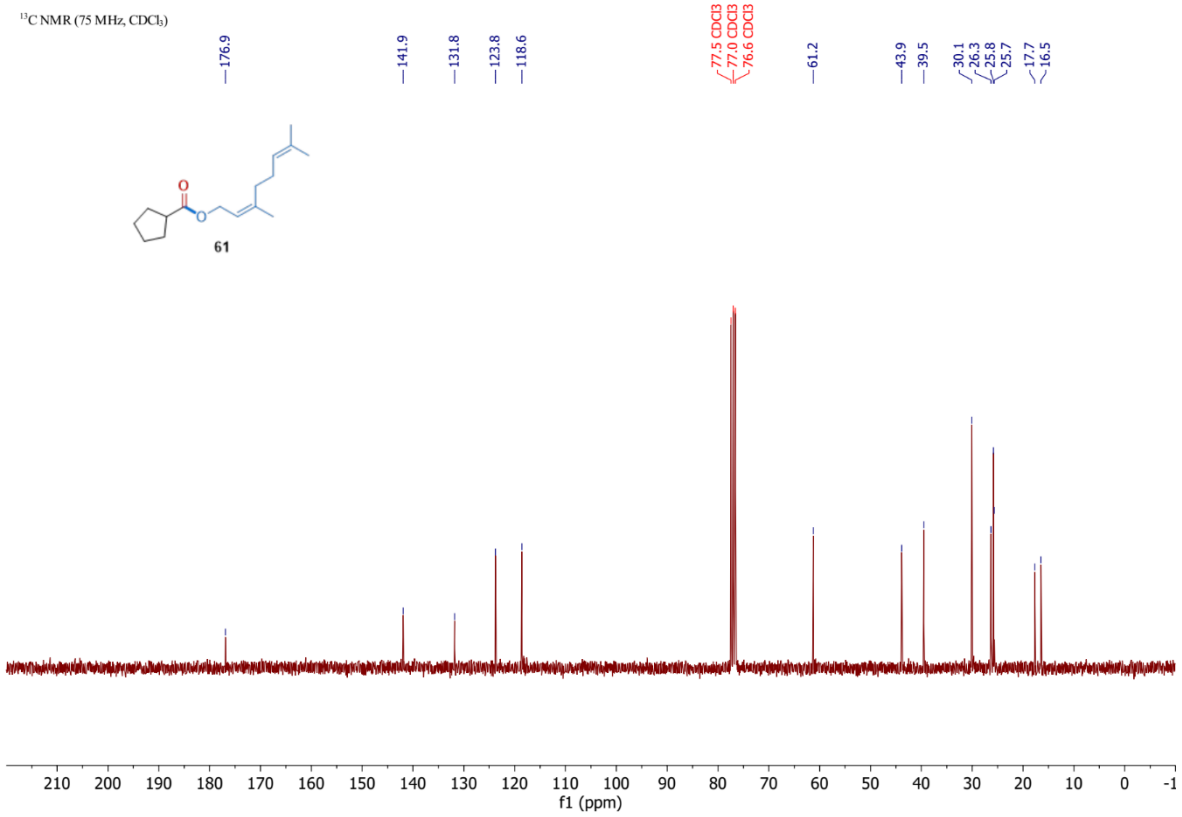

1H NMR (300 MHz, Chloroform-d)
7.26 CDCl3
59
1.00
0.96
1.07
11.81
3.63
3.19
3.06
3.02
f1 (ppm)


13C NMR (75 MHz, CDCl3)
177.0
79.3
77.4 CDCl3
77.0 CDCl3
76.6 CDCl3
48.8
47.8
44.9
44.2
36.8
30.1
29.9
28.0
27.1
25.8
25.7
19.7
18.8
13.5
59
f1 (ppm)


^{1}H NMR (300 MHz, Chloroform-*d*)
7.26 CDCl3
4.69
4.68
4.65
4.64
4.64
4.62
4.60
2.74
2.72
2.69
2.66
2.64
1.87
1.85
1.84
1.69
1.68
1.68
1.67
1.66
1.65
1.64
1.36
1.28
1.25
1.03
1.02
1.00
0.96
0.96
0.90
0.90
0.88
0.87
0.76
60
1.03
1.00
18.48
3.09
3.47
3.15
f1 (ppm)


^{13}C NMR (75 MHz, $CDCl_3$)
176.3
77.5 CDCl3
77.0 CDCl3
76.6 CDCl3
73.8
47.1
44.2
40.9
34.3
31.4
30.1
29.9
26.2
25.8
25.8
23.4
22.0
20.8
16.2
60
f1 (ppm)


^{1}H NMR (300 MHz, Chloroform-*d*)
7.26 CDCl3
5.36
5.35
5.34
5.34
5.33
5.33
5.31
5.31
5.10
5.10
5.09
5.08
5.08
5.07
5.07
5.06
5.06
4.59
4.57
2.77
2.75
2.72
2.70
2.69
2.67
2.11
2.11
2.10
2.10
2.09
2.09
2.06
2.05
2.05
1.89
1.87
1.84
1.82
1.79
1.69
1.60
1.56
1.56
61
1.05
1.09
2.00
0.86
4.43
17.69
f1 (ppm)


^{13}C NMR (75 MHz, $CDCl_3$)
176.9
141.9
131.8
123.8
118.6
77.5 CDCl3
77.0 CDCl3
76.6 CDCl3
61.2
43.9
39.5
30.1
26.3
25.8
25.7
17.7
16.5
61
f1 (ppm)