Support Information

Formal C-H Alkylation of (Hetero)Arenes via one-pot Halogenation and Nickel-Catalyzed Cross-Electrophile Coupling Strategy

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Content

1. General Considerations and Instrumentation

Unless otherwise noted, all the substrates and reagents were purchased from commercial suppliers and used without further purification. NMR spectra were recorded at AVANCE NEO 500M and the chemical shifts were recorded in ppm relative to deuterated solvent ($CDCl_3$). Data were reported as follows: chemical shift, multiplicity (s = singlet, d = doublet, t = triplet, q = quartet, m = multiplet), coupling constants (Hz), integration. ^{13}C NMR data were collected at 126 MHz with complete proton decoupling. High resolution mass spectroscopy (HR-MS) was performed on Thermo Q Exactive Plus (FTMS ESI) mass spectrometer and acetonitrile were used to dissolve the sample. Column chromatography was carried out on silica gel (200-300 mesh).

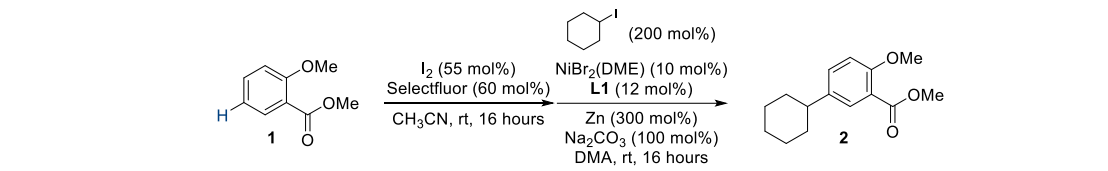
2. Optimization and General Procedure for the One-pot Arene C-H Alkylation Reaction

2.1 General Procedure for the Reaction Optimization

An oven-dried 10 mL reaction tube equipped with a magnetic stir bar was charged with I_2 (28 mg, 0.11 mmol, 0.55 equiv.) and Selectfluor (43 mg, 0.12 mmol, 0.6 equiv.), followed by CH_3CN (1 mL) and 2-methoxybenzoate (29 μL, 0.2 mmol, 1.0 equiv.) via syringe. The reaction mixture was allowed to stir at room temperature for 16 h, and then directly remove CH_3CN under reduced pressure. To this residue was then added nickel catalyst (0.1 equiv.), ligand (0.12 equiv.), metal reductant (3.0 equiv.), Na_2CO_3 (if used, 21 mg, 1.0 equiv.) and DMA (1 mL). The reaction mixture was then evacuated and backfill with argon 3 times, and then allowed to stirred at room temperature for 16 hours. After the completion of the reaction, the reaction mixture was filtered through a pad of celite and washed with EtOAc (3×10 mL). The filtrate was washed with H_2O (3×10 mL) and brine (10 mL), dried over anhydrous Na_2SO_4 and concentrated under reduced pressure to afford crude product. The reaction yield was determined by ^{1}HNMR analysis using 1,3-benzodioxole as internal standard.

2.2 Optimization Data for one-pot C-H alkylation of arene

Table S1. Optimization for the C-H alkylation reaction.[a]



entry	Variation from standard condition	Yield[a,b]
1	None	93%(92% [c])
2	$NiCl_2$·glyme instead of $NiBr_2$(DME)	90%
3	NiI_2 instead of $NiBr_2$(DME)	51%
4	$Ni(acac)_2$ instead of $NiBr_2$(DME)	78%
5	**L2-L8** instead of **L1**	trace-89%
6	150 mol% iodocyclohexane instead of 200 mol%	74%
7	120 mol% iodocyclohexane instead of 200 mol%	66%
8	without Na_2CO_3	85%
9	Mn instead of Zn	37%

10	without removing CH_3CN	48%
11	bromocyclohexane instead of iodocyclohexane	trace
12	LiBr/Selectfluor instead of I_2/Selectfluor	trace
13	120 mol% NIS instead of I_2/Selectfluor	19%

[a] standard conditions: **1** (0.2 mmol, 100 mol%), I_2 (0.11 mmol, 55mol%) and Selectfluor (0.12 mmol, 60 mol%) in CH_3CN (1 mL) for 16 hours, then remove CH_3CN and added nickel catalyst (0.02 mmol, 10 mol%), ligand (0.024 mmol, 12 mol%), Zn (0.6 mmol, 300 mol%), Na_2CO_3 (0.2 mmol, 100 mol%), Iodocyclohexane (0.24-0.4 mmol, 120-200 mol%) and DMA (1 mL), stirred for 16 hours. [b] ^{1}HNMR yield using 1,3-benzodioxole as internal standard. [c] isolated yield.

2.3 General Procedure for the One-pot Arene C-H Alkylation Reaction

General Procedure A-for electron-rich and neutral aromatics

An oven-dried 10 mL reaction tube equipped with a magnetic stir bar was charged with I_2 (28 mg, 0.11 mmol, 0.55 equiv.), Selectfluor (43 mg, 0.12 mmol, 0.6 equiv.), and arene substrate (0.2 mmol, 1.0 equiv.), followed by CH_3CN (1 mL). The reaction mixture was allowed to stir at room temperature for 16 h, and then directly remove CH_3CN under reduced pressure. To this residue was added $NiBr_2$(DME) (6.2 mg, 0.02 mmol, 0.1 equiv.), **L1** (5.7 mg, 0.024 mmol, 0.12 equiv.), Zn (39 mg, 0.6 mmol, 3.0 equiv.), Na_2CO_3 (21 mg, 0.2 mmol, 1.0 equiv.) and DMA (1 mL). The reaction mixture was then evacuated and backfill with argon 3 times, and allowed to stirred at room temperature for 16 hours. For product with small and moderate polarity (In general, eluent less polar than 40-50% EtOAc in Petroleum Ether is safe, no DMA been eluted out), the reaction mixture was directly loaded to flash column chromatography for purification. For polar product, the reaction mixture was filtered through a pad of celite and washed with EtOAc (3×10 mL). The resulting filtrate was washed with H_2O (3×10 mL) and brine (10 mL), dried over anhydrous Na_2SO_4 and concentrated under reduced pressure to afford crude product, which was purified by flash column chromatography to afford the pure product.

General Procedure B-for electron-deficient aromatics

An oven-dried 10 mL reaction tube equipped with a magnetic stir bar was charged with I_2 (28 mg, 0.11 mmol, 0.55 equiv.), Selectfluor (43 mg, 0.12 mmol, 0.6 equiv.), $Sc(OTf)_3$ (49 mg, 0.1 mmol, 0.5 equiv.) and arene substrate (0.2 mmol, 1.0 equiv.), followed by CH_3CN/HFIP (1:4, 1.5 mL). The reaction mixture was allowed to stir at room temperature for 24 h, and then directly remove solvent under reduced pressure. To this residue was then added $NiBr_2$(DME) (6.2 mg, 0.02 mmol, 0.1 equiv.), **L1** (5.7 mg, 0.024 mmol, 0.12 equiv.), Zn (39 mg, 0.6 mmol, 3.0 equiv.), Na_2CO_3 (21 mg, 0.2 mmol,

1.0 equiv.) and DMA (1 mL). The reaction mixture was then evacuated and backfill with argon 3 times, and then allowed to stirred at room temperature for 16 hours. For product with small and moderate polarity (In general, eluent less polar than 40-50% EtOAc in Petroleum Ether is safe, no DMA been eluted out), the reaction mixture was directly loaded to flash column chromatography for purification. For polar product, the reaction mixture was filtered through a pad of celite and washed with EtOAc (3×10 mL). The resulting filtrate was washed with H_2O (3×10 mL) and brine (10 mL), dried over anhydrous Na_2SO_4 and concentrated under reduced pressure to afford crude product, which was purified by flash column chromatography to afford the pure product.

General Procedure C-for electron-deficient aromatics that with neighboring steric hindrance.

An oven-dried 10 mL reaction tube equipped with a magnetic stir bar was charged with I_2 (28 mg, 0.11 mmol, 0.55 equiv.), Selectfluor (43 mg, 0.12 mmol, 0.6 equiv.), $Sc(OTf)_3$ (49 mg, 0.1 mmol, 0.5 equiv.) and arene substrate (0.2 mmol, 1.0 equiv.), followed by CH_3CN/HFIP (1:4, 1.5 mL). The reaction mixture was allowed to stir at room temperature for 24 h, and then directly remove solvent under reduced pressure. To this residue was then added $NiBr_2$(DME) (6.2 mg, 0.02 mmol, 0.1 equiv.), **L5** (4.4 mg, 0.024 mmol, 0.12 equiv.), Zn (39 mg, 0.6 mmol, 3.0 equiv.), Na_2CO_3 (21 mg, 0.2 mmol, 1.0 equiv.), MgCl2 (19 mg, 0.2 mmol, 1.0 equiv.) and DMA (1 mL). The reaction mixture was then evacuated and backfill with argon 3 times, and then allowed to stirred at room temperature for 16 hours. For product with small and moderate polarity (In general, eluent less polar than 40-50% EtOAc in Petroleum Ether is safe, no DMA been eluted out), the reaction mixture was directly loaded to flash column chromatography for purification. For polar product, the reaction mixture was filtered through a pad of celite and washed with EtOAc (3×10 mL). The resulting filtrate was washed with H_2O (3×10 mL) and brine (10 mL), dried over anhydrous Na_2SO_4 and concentrated under reduced pressure to afford crude product, which was purified by flash column chromatography to afford the pure product.

3. Control experiments

3.1 Possibility of forming fluorobenzene type byproducts by Ni/Selectfluor

We did not observe any fluorobenzene type byproducts in the reaction. In general, any residual iodine present in the reaction is rapidly consumed upon stirring with zinc, as evidenced by the

disappearance of the characteristic iodine color within a few minutes of mixing with Zn. Given that iodide and Selectfluor immediately generate the characteristic iodine color, we believe that excess Selectfluor is also rapidly consumed by zinc.

To confirm whether fluorine-containing aromatic compounds were formed in our reaction, we conducted a control experiment in which a model substrate was treated with Selectfluor, Ni catalyst, ligand, Zn, and the mixture was stirred overnight. No corresponding fluorinated aromatic compound was detected, and the model substrate was fully recovered after the reaction (Figure S1).

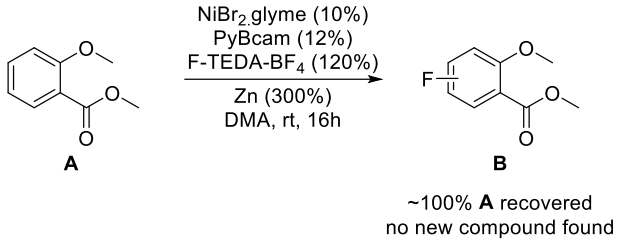


Figure S1. Control experiment for possibility of forming fluorobenzene

3.2 preliminary reactivity studies for engaging alkyl bromide for this reaction

Secondary alkyl bromides were not effective under standard reaction conditions, as replacing iodocyclohexane with bromocyclohexane led to only trace amounts of the product. We originally noted this in Table 1, entry 11.

To gain further insight into the reactivity of alkyl bromides, we used primary alkyl bromides in combination with an iodide source such as TBAI, and found that primary alkyl bromides (*n*-Butyl bromide) could participate in the reaction in moderate yield. However, secondary alkyl bromides still failed to afford the product efficiently, even in the presence of an iodide source (Figure S2). Overall, these data suggested that alkyl bromide can participated in this reaction, but more optimization of the reaction condition is required.

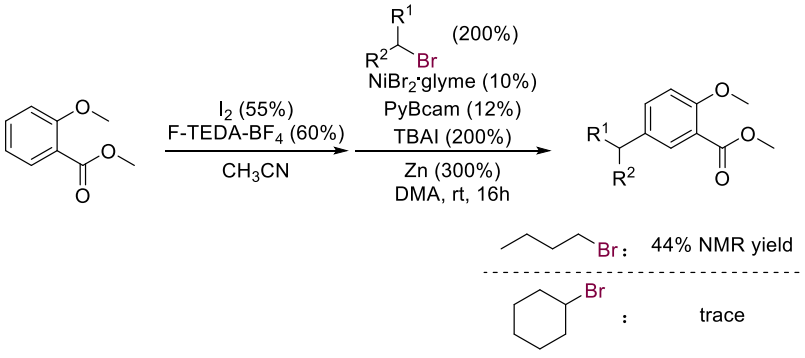


Figure S2. Preliminary studies for engaging alkyl bromides

3.3 comparison between one-pot protocol and using purified aryl iodine intermediate

To compare the efficiency of one-pot protocol and using purified aryl iodine intermediate, we conducted the standard iodination reaction and isolated the iodo intermediate, which then subjected it to the same coupling conditions. The product was obtained in a yield similar to that of the one-pot procedure (Figure S3, 91% versus 92% isolated yield). This control experiment suggests that the reaction can be performed with the same efficiency of those using the isolated pure intermediate, thus saving the resources and time required for work-up and purification of the iodo intermediate. We have added the result of this control experiment to Table 1 and commented on this issue in the revised manuscript.

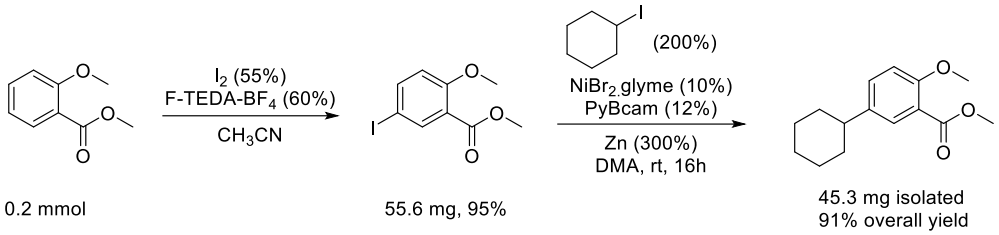


Figure S3. Control experiments using purified aryl iodine intermediate

4. Regioselectivity determination and limitations of this method

In general, most substrates underwent selective iodination at the most electron-rich and least sterically hindered site, providing the foundation for the overall good regioselectivity. Based on the proposed mechanism of the iodination step, the oxidative activation of I_2 by Selectfluor is key to the reaction. Therefore, when the Selectfluor/I_2 complex, which is of significant size, approaches the arene for iodination, this bulky complex might preferentially interact with an electron-rich site that poses the least steric hindrance, which explain the good selectivity observed in this reaction. The regioselectivity pattern based on our experimental observations is summarized below (Figure S4).

For mono- and disubstituted arenes, the reaction generally gave good regioselectivity governed by both electronic and steric factors. For arenes bearing electron-donating groups, the electron-rich site with the least steric hindrance was generally the site of iodination. For electron-deficient arenes, mono-substituted and 1,4-disubstituted substrates generally proceeded with good regioselectivity when iodination occurred. However, 1,2-disubstituted arenes bearing alkyl groups and electron-withdrawing groups generally afforded mixtures of isomers, with the least sterically hindered site

being the major site of iodination.

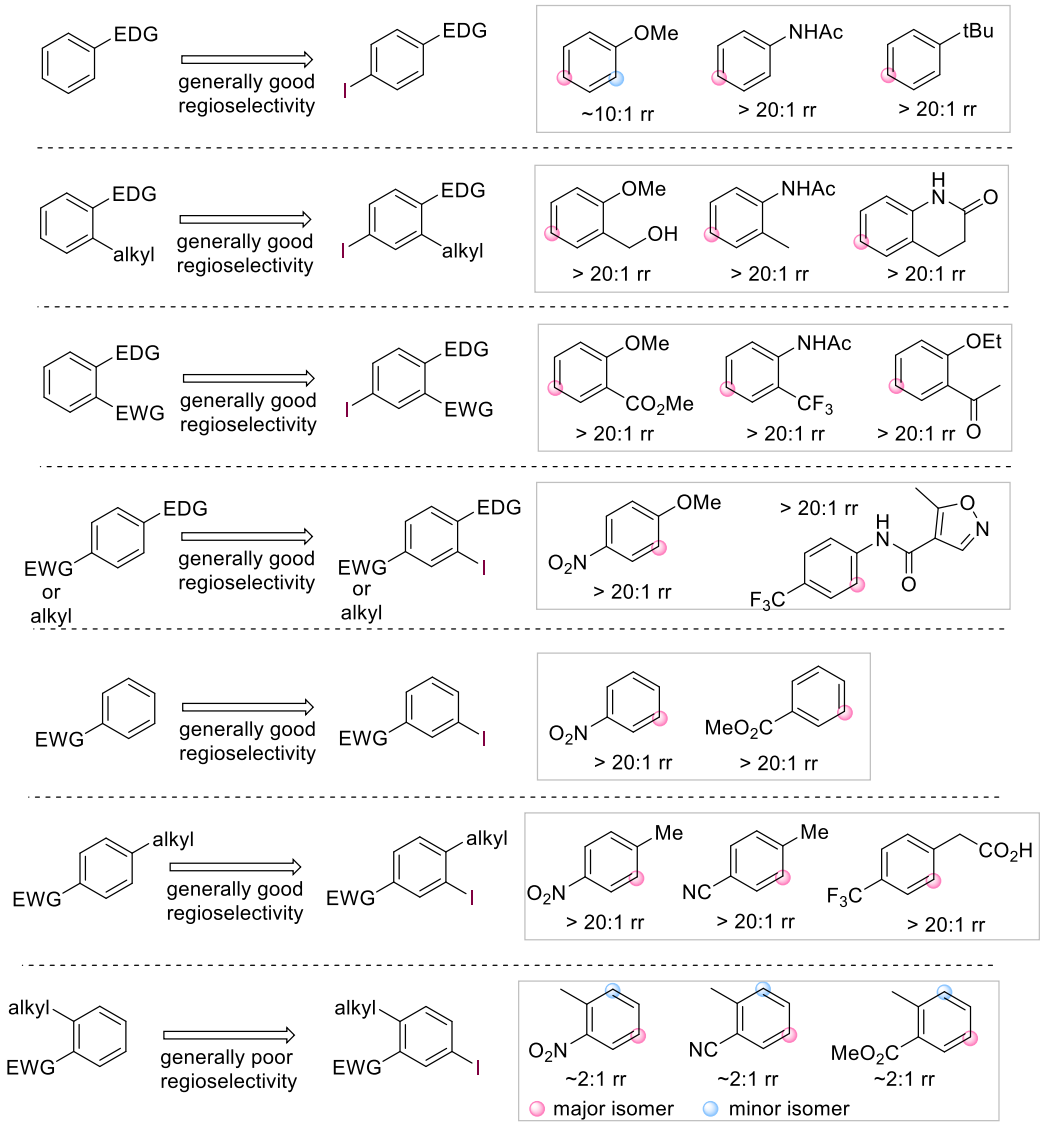
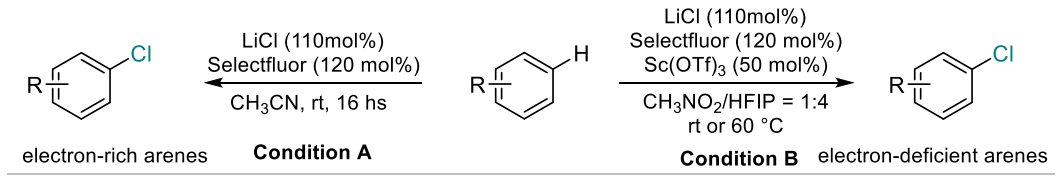
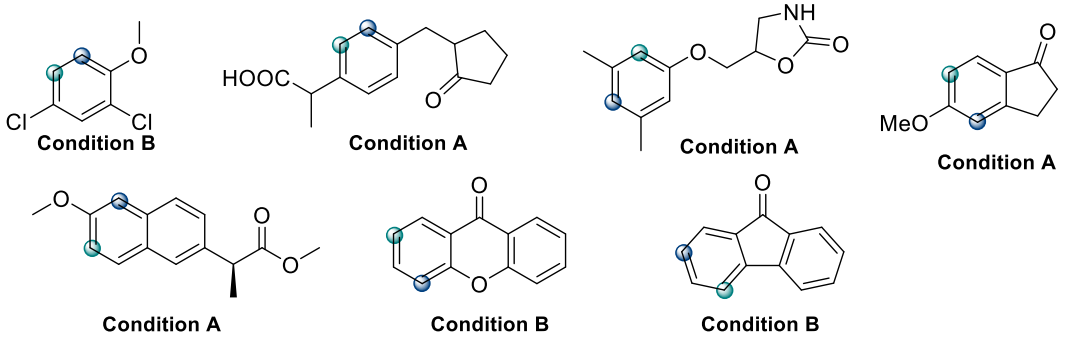


Figure S4. Summarized regioselectivity pattern based on our experimental observations

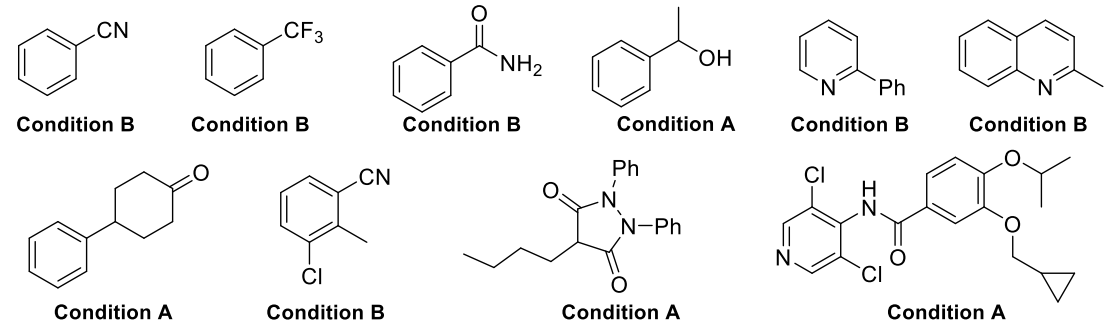
For substrates bearing more than three substituents, the situation becomes more complex. Our observations indicate that when the directing effects of the substituents are largely coincident, the reaction can proceed with good selectivity. Conversely, when the directing effects are conflicting, the reaction may be sluggish and can afford a mixture of isomers. Moreover, it is very challenging to predict whether a given substrate will be successful based solely on structural analysis. Below, we list the unsuccessful substrates that have been tested, categorized as follows: (a) limited regioselectivity, (b) low iodination yield, and (c) successful iodination but failure to afford appreciable amounts of the alkylation product, to afford reader more information about the scope and limitation of this method (Figure S5).



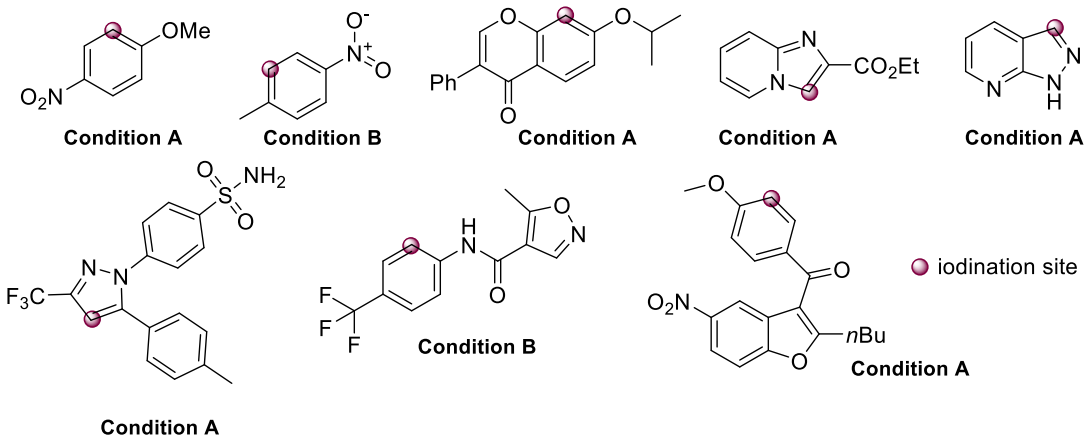
a) substrates with limited regioselectivity



b) substrates with low iodination yield



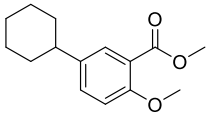
c) substrates with good iodination but low cross-coupling yield or incompatible with reaction conditions



The NO_2 group was not compatible, formed coupling products but underwent reduction under the reductive coupling conditions. Other substrates formed iodo intermediate but failed to participated in cross coupling reaction effectively.

Figure S5. Limitations of this method

5. Spectra Characterizations of Compounds



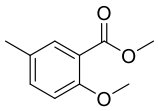
methyl 5-cyclohexyl-2-methoxybenzoate (2)

This compound was prepared using methyl 2-methoxybenzoate (29 μL, 0.2 mmol) and iodocyclohexane (52 μL, 0.4 mmol) according to the General Procedure A. After purification by column chromatography (SiO_2: 2%~10% ethyl acetate in petroleum ether), the title compound was isolated as a colorless oil (45.8 mg, 92% yield).

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.63 (d, J = 2.4 Hz, 1H), 7.29 (dd, J = 8.5, 2.4 Hz, 1H), 6.90 (d, J = 8.6 Hz, 1H), 3.88 (s, 3H), 3.87 (s, 3H), 2.51 – 2.41 (m, 1H), 1.89 – 1.78 (m, 4H), 1.78 – 1.69 (m, 1H), 1.42 – 1.33 (m, 4H), 1.27 – 1.19 (m, 1H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 167.1, 157.4, 140.0, 131.9, 130.0, 119.8, 112.2, 56.2, 52.1, 43.6, 34.6, 26.9, 26.2.

HRMS (ESI): m/z calcd for $C_{15}H_{21}O_3^+$ $[M + H]^+$: 249.1485; found: 249.1484.

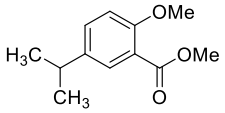


methyl 2-methoxy-5-methylbenzoate (3a)

This compound was prepared using methyl 2-methoxybenzoate (29 μL, 0.2 mmol) and Methyl iodide (62μL, 1.0 mmol) according to the General Procedure A. After purification by column chromatography (SiO_2: 5%~20% ethyl acetate in petroleum ether), the title compound was isolated as a colorless oil (11.4 mg, 32% yield).

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.60 (br s, 1H), 7.28 – 7.24 (m, 1H), 6.87 (d, J = 8.5 Hz, 1H), 3.88 (s, 3H), 3.87 (s, 3H), 2.30 (s, 3H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 167.0, 157.2, 134.1, 132.1, 129.6, 119.8, 112.2, 56.3, 52.1, 20.4.



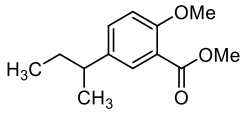
methyl 5-isopropyl-2-methoxybenzoate (3b)

This compound was prepared using methyl 2-methoxybenzoate (29 μL, 0.2 mmol) and 2-iodopropane (40μL, 0.4 mmol) according to the General Procedure A. After purification by column chromatography (SiO_2: 5%~15% ethyl acetate in petroleum ether), the title compound was isolated as a colorless oil (34.7 mg, 83% yield).

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.64 (d, J = 2.4 Hz, 1H), 7.32 (dd, J = 8.6, 2.4 Hz, 1H), 6.90 (d, J = 8.6 Hz, 1H), 3.89 (s, 3H), 3.87 (s, 3H), 2.92 – 2.84 (m, 1H), 1.23 (d, J = 7.0 Hz, 6H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 167.1, 157.4, 140.7, 131.5, 129.6, 119.8, 112.2, 56.3, 52.1, 33.3, 24.1.

HRMS (ESI): m/z calcd for $C_{12}H_{17}O_3^+$ [M + H]$^+$: 209.1172; found: 209.1171.



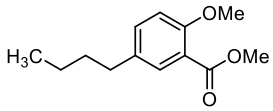
methyl 5-(sec-butyl)-2-methoxybenzoate (3c)

This compound was prepared using methyl 2-methoxybenzoate (29 μL, 0.2 mmol) and 2-iodobutane (46μL, 0.4 mmol) according to the General Procedure A. After purification by column chromatography (SiO_2: 5%~15% ethyl acetate in petroleum ether), the title compound was isolated as a colorless oil (36.5 mg, 82% yield).

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.59 (d, *J* = 2.4 Hz, 1H), 7.27 (dd, *J* = 8.7, 2.4 Hz, 1H), 6.90 (d, *J* = 8.5 Hz, 1H), 3.89 (s, 3H), 3.88 (s, 3H), 2.60 – 2.53 (m, 1H), 1.59 – 1.53 (m, 2H), 1.21 (d, *J* = 6.9 Hz, 3H), 0.80 (t, *J* = 7.4 Hz, 3H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 167.1, 157.4, 139.5, 132.1, 130.2, 119.8, 112.2, 56.2, 52.1, 40.8, 31.3, 22.0, 12.3.

HRMS (ESI): m/z calcd for $C_{13}H_{19}O_3^+$ [M + H]$^+$: 223.1329; found: 223.1327.



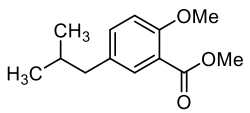
methyl 5-butyl-2-methoxybenzoate (3d)

This compound was prepared using methyl 2-methoxybenzoate (29 μL, 0.2 mmol) and 1-iodobutane (46μL, 0.4 mmol) according to the General Procedure A. After purification by column chromatography (SiO_2: 5%~15% ethyl acetate in petroleum ether), the title compound was isolated as a colorless oil (39.0 mg, 88% yield).

^{1}H NMR (500 MHz, CDCl3) δ 7.60 (d, *J* = 2.5 Hz, 1H), 7.27 (dd, *J* = 8.6, 2.4 Hz, 1H), 6.89 (d, *J* = 8.4 Hz, 1H), 3.89 (s, 3H), 3.88 (s, 3H), 2.56 (t, *J* = 7.8 Hz, 2H), 1.61 – 1.54 (m, 2H), 1.37 – 1.30 (m, 2H), 0.92 (t, *J* = 7.4 Hz, 3H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 167.0, 157.4, 134.7, 133.5, 131.5, 119.8, 112.2, 56.2, 52.1, 34.6, 33.8, 22.4, 14.0.

HRMS (ESI): m/z calcd for $C_{13}H_{19}O_3^+$ [M + H]$^+$: 223.1329; found: 223.1328.



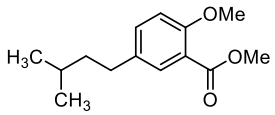
methyl 5-isobutyl-2-methoxybenzoate (3e)

This compound was prepared using methyl 2-methoxybenzoate (29 μL, 0.2 mmol) and isobutyl iodide (46 μL, 0.4 mmol) according to the General Procedure A. After purification by column chromatography (SiO_2: 5%~15% ethyl acetate in petroleum ether), the title compound was isolated as a colorless oil (36.1 mg, 81% yield).

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.56 (d, J = 2.4 Hz, 1H), 7.23 (dd, J = 8.5, 2.4 Hz, 1H), 6.88 (d, J = 8.5 Hz, 1H), 3.88 (s, 3H), 3.88 (s, 3H), 2.42 (d, J = 7.2 Hz, 2H), 1.86 – 1.78 (m, 1H), 0.88 (d, J = 6.7 Hz, 6H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 167.1, 157.4, 134.2, 133.5, 132.1, 119.7, 112.0, 56.2, 52.1, 44.3, 30.3, 22.3.

HRMS (ESI): m/z calcd for $C_{13}H_{19}O_3^+$ $[M + H]^+$: 223.1329; found: 223.1328.



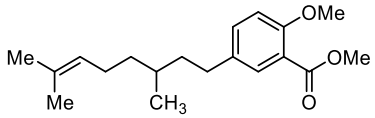
methyl 5-isopentyl-2-methoxybenzoate (3f)

This compound was prepared using methyl 2-methoxybenzoate (29 μL, 0.2 mmol) and 1-iodo-3-methylbutane (53μL, 0.4 mmol) according to the General Procedure A. After purification by column chromatography (SiO_2: 5%~15% ethyl acetate in petroleum ether), the title compound was isolated as a colorless oil (44.1 mg, 93% yield).

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.60 (d, J = 2.4 Hz, 1H), 7.27 (dd, J = 8.4, 2.5 Hz, 1H), 6.88 (d, J = 8.5 Hz, 1H), 3.88 (s, 3H), 3.87 (s, 3H), 2.56 (t, J = 9.6 Hz, 2H), 1.60 – 1.53 (m, 1H), 1.47 (q, J = 7.3 Hz, 2H), 0.92 (d, J = 6.6 Hz, 6H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 167.0, 157.3, 134.9, 133.4, 131.4, 119.8, 112.2, 56.2, 52.1, 40.9, 32.7, 27.7, 22.6.

HRMS (ESI): m/z calcd for $C_{14}H_{21}O_3^+$ $[M + H]^+$: 237.1485; found: 237.1482.



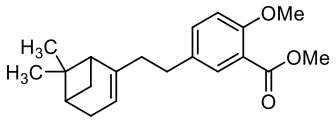
methyl 5-(3,7-dimethyloct-6-en-1-yl)-2-methoxybenzoate (3g)

This compound was prepared using methyl 2-methoxybenzoate (29 μL, 0.2 mmol) and 8-iodo-2,6-dimethyloct-2-ene (107 mg, 0.4 mmol) according to the General Procedure A. After purification by column chromatography (SiO_2: 5%~10% ethyl acetate in petroleum ether), the title compound was isolated as a colorless oil (57.7 mg, 95% yield).

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.61 (d, J = 2.6 Hz, 1H), 7.27 (dd, J = 8.5, 2.4 Hz, 1H), 6.89 (d, J = 8.5 Hz, 1H), 5.15 – 5.04 (m, 1H), 3.89 (s, 3H), 3.88 (s, 3H), 2.65 – 2.47 (m, 2H), 2.05 – 1.90 (m, 2H), 1.68 (s, 3H), 1.64 – 1.54 (m, 4H), 1.50 – 1.33 (m, 3H), 1.22 – 1.12 (m, 1H), 0.93 (d, J = 6.2 Hz, 3H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 167.0, 157.3, 134.9, 133.4, 131.4, 131.2, 124.9, 119.8, 112.2, 56.2, 52.1, 39.0, 37.0, 32.4, 32.2, 25.8, 25.6, 19.6, 17.7.

HRMS (ESI): m/z calcd for $C_{19}H_{29}O_3^+$ [M + H]$^+$: 305.2111; found: 305.2110.



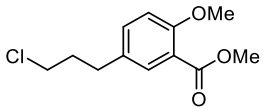
methyl 5-(2-(6,6-dimethylbicyclo[3.1.1]hept-2-en-2-yl)ethyl)-2-methoxybenzoate (3h)

This compound was prepared using methyl 2-methoxybenzoate (29 μL, 0.2 mmol) and 2-(2-iodoethyl)-6,6-dimethylbicyclo[3.1.1]hept-2-ene (111 mg, 0.4 mmol) according to the General Procedure A. After purification by column chromatography (SiO_2: 5%~10% ethyl acetate in petroleum ether), the title compound was isolated as a colorless oil (59.1 mg, 94% yield).

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.61 (d, *J* = 2.5 Hz, 1H), 7.27 (dd, *J* = 8.7, 2.3 Hz, 1H), 6.88 (d, *J* = 8.5 Hz, 1H), 5.21 (d, *J* = 3.5 Hz, 1H), 3.88 (s, 3H), 3.87 (s, 3H), 2.61 (t, *J* = 8.0 Hz, 2H), 2.38 – 2.33 (m, 1H), 2.29 – 2.12 (m, 4H), 2.10 – 2.03 (m, 2H), 1.28 (s, 3H), 1.14 (d, *J* = 8.5 Hz, 1H), 0.83 (s, 3H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 167.0, 157.4, 147.7, 134.3, 133.5, 131.5, 119.7, 116.6, 112.1, 56.2, 52.1, 46.0, 40.9, 38.9, 38.1, 32.8, 31.7, 31.4, 26.5, 21.3.

HRMS (ESI): m/z calcd for $C_{20}H_{27}O_3^+$ [M + H]$^+$: 315.1955; found: 315.1956.



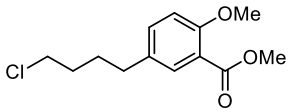
methyl 5-(3-chloropropyl)-2-methoxybenzoate (3i)

This compound was prepared using methyl 2-methoxybenzoate (29 μL, 0.2 mmol) and 1-Chloro-3-iodopropane (43 μL, 0.4 mmol) according to the General Procedure A. After purification by column chromatography (SiO_2: 5%~15% ethyl acetate in petroleum ether), the title compound was isolated as a colorless oil (42.4 mg, 87% yield).

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.61 (d, *J* = 2.5 Hz, 1H), 7.29 (dd, *J* = 8.6, 2.4 Hz, 1H), 6.91 (d, *J* = 8.5 Hz, 1H), 3.88 (s, 3H), 3.88 (s, 3H), 3.51 (t, *J* = 6.4 Hz, 2H), 2.74 (t, *J* = 7.5 Hz, 2H), 2.08 – 2.02 (m, 2H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 166.9, 157.7, 133.7, 132.4, 131.6, 120.1, 112.4, 56.2, 52.2, 44.2, 34.1, 31.7.

HRMS (ESI): m/z calcd for $C_{12}H_{16}ClO_3^+$ [M + H]$^+$: 243.0782; found: 243.0783.



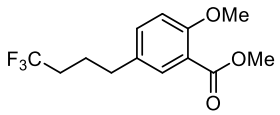
methyl 5-(4-chlorobutyl)-2-methoxybenzoate (3j)

This compound was prepared using methyl 2-methoxybenzoate (29 μL, 0.2 mmol) and 4-chlorobutyl iodide (49 μL, 0.4 mmol) according to the General Procedure A. After purification by column chromatography (SiO_2: 5%~15% ethyl acetate in petroleum ether), the title compound was isolated as a colorless oil (47.6 mg, 93% yield).

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.60 (d, J = 2.4 Hz, 1H), 7.29 – 7.24 (m, 1H), 6.90 (d, J = 8.5 Hz, 1H), 3.88 (s, 3H), 3.87 (s, 3H), 3.53 (t, J = 6.2 Hz, 2H), 2.60 (t, J = 7.2 Hz, 2H), 1.82 – 1.71 (m, 4H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 166.9, 157.5, 133.6, 133.4, 131.5, 119.9, 112.3, 56.2, 52.1, 44.9, 34.0, 32.1, 28.7.

HRMS (ESI): m/z calcd for $C_{13}H_{18}ClO_3^+$ $[M + H]^+$: 257.0939; found: 257.0936.



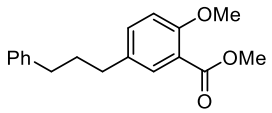
methyl 2-methoxy-5-(4,4,4-trifluorobutyl)benzoate (3k)

This compound was prepared using methyl 2-methoxybenzoate (29 μL, 0.2 mmol) and 1,1,1-trifluoro-4-iodobutane (52 μL, 0.4 mmol) according to the General Procedure A. After purification by column chromatography (SiO_2: 5%~15% ethyl acetate in petroleum ether), the title compound was isolated as a colorless oil (52.0 mg, 94% yield).

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.60 (d, J = 2.4 Hz, 1H), 7.27 (dd, J = 8.4, 2.5 Hz, 1H), 6.92 (d, J = 8.5 Hz, 1H), 3.89 (s, 3H), 3.88 (s, 3H), 2.64 (t, J = 7.6 Hz, 2H), 2.13 – 2.00 (m, 2H), 1.89 – 1.83 (m, 2H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 166.8, 157.8, 133.4, 132.5, 131.5, 127.2 ($J_{C\text{-}F}$ = 276.5 Hz), 120.1, 112.4, 56.2, 52.2, 33.6, 33.1($J_{C\text{-}F}$ = 28.5 Hz), 23.7 ($J_{C\text{-}F}$ = 2.9 Hz).

HRMS (ESI): m/z calcd for $C_{13}H_{16}F_3O_3^+$ $[M + H]^+$: 277.1046; found: 277.1045.



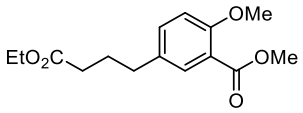
methyl 2-methoxy-5-(3-phenylpropyl)benzoate (3l)

This compound was prepared using methyl 2-methoxybenzoate (29 μL, 0.2 mmol) and 3-iodo-1-phenylpropane (64 μL, 0.4 mmol) according to the General Procedure A. After purification by column chromatography (SiO_2: 5%~15% ethyl acetate in petroleum ether), the title compound was isolated as a colorless oil (52.9 mg, 93% yield).

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.61 (d, J = 2.3 Hz, 1H), 7.31 – 7.23 (m, 3H), 7.17 (d, J = 7.6 Hz, 3H), 6.89 (d, J = 8.5 Hz, 1H), 3.88 (s, 3H), 3.87 (s, 3H), 2.66 – 2.58 (m, 4H), 1.97 – 1.89 (m, 2H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 167.0, 157.4, 142.2, 134.0, 133.5, 131.5, 128.5, 128.4, 125.9, 119.8, 112.2, 56.2, 52.1, 35.4, 34.3, 33.1.

HRMS (ESI): m/z calcd for $C_{18}H_{21}O_3^+$ [M + H]$^+$: 285.1485; found: 285.1485.



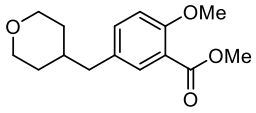
methyl 2-methoxy-5-(4-methoxy-4-oxobutyl)benzoate (3m)

This compound was prepared using methyl 2-methoxybenzoate (29 μL, 0.2 mmol) and Ethyl 4-iodobutyrate (60 μL, 0.4 mmol) according to the General Procedure A. After purification by column chromatography (SiO_2: 5%~20% ethyl acetate in petroleum ether), the title compound was isolated as a colorless oil (50.5 mg, 90% yield).

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.60 (d, *J* = 2.4 Hz, 1H), 7.30 – 7.25 (m, 1H), 6.89 (d, *J* = 8.5 Hz, 1H), 4.11 (q, *J* = 7.1 Hz, 2H), 3.87 (s, 3H), 3.87 (s, 3H), 2.60 (t, *J* = 7.6 Hz, 2H), 2.29 (t, *J* = 7.5 Hz, 2H), 1.99 – 1.86 (m, 2H), 1.24 (t, *J* = 7.1 Hz, 3H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 173.5, 166.9, 157.6, 133.6, 133.2, 131.6, 119.9, 112.3, 60.4, 56.2, 52.1, 34.1, 33.6, 26.6, 14.3.

HRMS (ESI): m/z calcd for $C_{15}H_{21}O_5^+$ [M + H]$^+$: 281.1384; found: 281.1382.



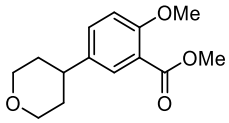
methyl 2-methoxy-5-((tetrahydro-2H-pyran-4-yl)methyl)benzoate (3n)

This compound was prepared using methyl 2-methoxybenzoate (29 μL, 0.2 mmol) and 4-(Iodomethyl)tetrahydro-2H-pyran (55 μL, 0.4 mmol) according to the General Procedure A. After purification by column chromatography (SiO_2: 5%~20% ethyl acetate in petroleum ether), the title compound was isolated as a colorless oil (50.3 mg, 95% yield).

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.56 (d, *J* = 2.4 Hz, 1H), 7.22 (dd, *J* = 8.6, 2.3 Hz, 1H), 6.88 (d, *J* = 8.5 Hz, 1H), 3.92 (dd, *J* = 11.7, 4.3 Hz, 2H), 3.87 (s, 3H), 3.86 (s, 3H), 3.31 (t, *J* = 11.7 Hz, 2H), 2.48 (d, *J* = 7.2 Hz, 2H), 1.75 – 1.62 (m, 1H), 1.55 – 1.47 (m, 2H), 1.35 – 1.23 (m, 2H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 166.9, 157.6, 134.2, 132.1, 131.9, 119.8, 112.1, 68.1, 56.2, 52.1, 42.4, 37.2, 32.9.

HRMS (ESI): m/z calcd for $C_{15}H_{21}O_4^+$ [M + H]$^+$: 265.1434; found: 265.1435.



methyl 2-methoxy-5-(tetrahydro-2H-pyran-4-yl)benzoate (3o)

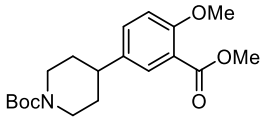
This compound was prepared using methyl 2-methoxybenzoate (29 μL, 0.2 mmol) and 4-iodotetrahydro-2H-pyran (48 μL, 0.4 mmol) according to the General Procedure A. After

purification by column chromatography (SiO_2: 5%~20% ethyl acetate in petroleum ether), the title compound was isolated as a colorless oil (34.6 mg, 69% yield).

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.64 (d, *J* = 2.5 Hz, 1H), 7.31 (dd, *J* = 8.6, 2.4 Hz, 1H), 6.93 (d, *J* = 8.6 Hz, 1H), 4.09 –4.03 (m), 3.88 (s, 3H), 3.88 (s, 3H), 3.54 – 3.45 (m, 2H), 2.76 – 2.67 (m, 1H), 1.82 – 1.71 (m, 4H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 166.9, 157.7, 137.7, 131.7, 130.0, 120.0, 112.4, 68.4, 56.2, 52.1, 40.6, 34.1.

HRMS (ESI): m/z calcd for $C_{14}H_{19}O_4^+$ $[M + H]^+$: 251.1278; found: 251.1275.



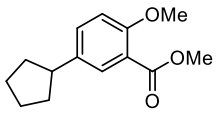
***tert*-butyl 4-(4-methoxy-3-(methoxycarbonyl)phenyl)piperidine-1-carboxylate (3p)**

This compound was prepared using methyl 2-methoxybenzoate (29 μL, 0.2 mmol) and N-Boc-4-iodopiperidine (125 mg, 0.4 mmol) according to the General Procedure A. After purification by column chromatography (SiO_2: 5%~25% ethyl acetate in petroleum ether), the title compound was isolated as a colorless oil (38.4 mg, 55% yield).

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.62 (d, *J* = 2.4 Hz, 1H), 7.29 (dd, *J* = 8.6, 2.4 Hz, 1H), 6.91 (d, *J* = 8.6 Hz, 1H), 4.23 (s, 2H), 3.88 (s, 6H), 2.77 (t, *J* = 13.3 Hz, 2H), 2.61 (tt, *J* = 12.2, 3.7 Hz, 1H), 1.83 – 1.75 (m, 2H), 1.64 – 1.52 (m, 2H), 1.47 (s, 9H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 166.9, 157.8, 154.9, 137.6, 131.8, 130.0, 120.0, 112.4, 79.6, 56.2, 52.1, 44.8, 41.7, 33.3, 28.6.

HRMS (ESI): m/z calcd for $C_{19}H_{28}NO_5^+$ $[M + H]^+$: 350.1962; found: 350.1961.



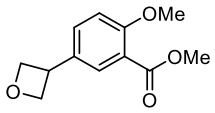
methyl 5-cyclopentyl-2-methoxybenzoate (3q)

This compound was prepared using methyl 2-methoxybenzoate (29 μL, 0.2 mmol) and Iodocyclopentane (46 μL, 0.4 mmol) according to the General Procedure A. After purification by column chromatography (SiO_2: 5%~15% ethyl acetate in petroleum ether), the title compound was isolated as a colorless oil (28.1 mg, 60% yield).

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.66 (d, *J* = 2.4 Hz, 1H), 7.33 (dd, *J* = 8.6, 2.4 Hz, 1H), 6.90 (d, *J* = 8.6 Hz, 1H), 3.89 (s, 3H), 3.88 (s, 3H), 3.00 – 2.88 (m, 1H), 2.09 – 1.99 (m, 2H), 1.85 – 1.74 (m, 2H), 1.72 – 1.62 (m, 2H), 1.58 – 1.48 (m, 2H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 167.1, 157.4, 138.3, 132.2, 130.2, 119.8, 112.2, 56.3, 52.1, 45.0, 34.7, 25.5.

HRMS (ESI): m/z calcd for $C_{14}H_{19}O_3^+$ [M + H]$^+$: 235.1329; found: 235.1327.



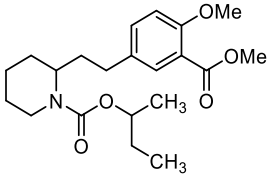
methyl 2-methoxy-5-(oxetan-3-yl)benzoate (3r)

This compound was prepared using methyl 2-methoxybenzoate (29 μL, 0.2 mmol) and 3-iodooxetane (34 μL, 0.4 mmol) according to the General Procedure A. After purification by column chromatography (SiO_2: 5%~20% ethyl acetate in petroleum ether), the title compound was isolated as a colorless oil (19.6 mg, 44% yield).

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.81 (d, *J* = 2.5 Hz, 1H), 7.52 (dd, *J* = 8.6, 2.5 Hz, 1H), 6.99 (d, *J* = 8.6 Hz, 1H), 5.05 (dd, *J* = 8.4, 6.1 Hz, 2H), 4.73 (t, *J* = 6.4 Hz, 2H), 4.24 – 4.15 (m, 1H), 3.90 (s, 3H), 3.90 (s, 3H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 166.7, 158.3, 133.4, 131.9, 130.2, 120.3, 112.6, 79.0, 56.3, 52.2, 39.6.

HRMS (ESI): m/z calcd for $C_{12}H_{15}O_4^+$ [M + H]$^+$: 223.0965; found: 223.0966.



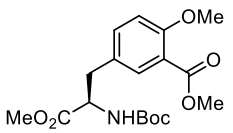
sec-butyl 2-(4-methoxy-3-(methoxycarbonyl)phenethyl)piperidine-1-carboxylate (3s)

This compound was prepared using methyl 2-methoxybenzoate (29 μL, 0.2 mmol) and sec-butyl 2-(2-iodoethyl)piperidine-1-carboxylate (136 mg, 0.4 mmol) according to the General Procedure A. After purification by column chromatography (SiO_2: 5%~25% ethyl acetate in petroleum ether), the title compound was isolated as a colorless oil (71.8 mg, 95% yield).

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.59 (d, *J* = 2.5 Hz, 1H), 7.31 – 7.24 (m, 1H), 6.88 (d, *J* = 8.5 Hz, 1H), 4.75 (q, *J* = 6.3 Hz, 1H), 4.31 (br s, 1H), 4.09 – 3.96 (m, 1H), 3.87 (s, 3H), 3.86 (s, 3H), 2.81 (t, *J* = 12.6 Hz, 1H), 2.61 – 2.41 (m, 2H), 2.05 – 1.90 (m, 1H), 1.76 – 1.47 (m, 8H), 1.46 – 1.32 (m, 1H), 1.19 (d, *J* = 6.0 Hz, 3H), 0.88 (td, *J* = 7.4, 4.5 Hz, 3H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 166.9, 157.5, 155.7, 133.9, 133.4, 131.3, 119.9, 112.2, 72.8, 56.2, 52.1, 50.4, 39.0, 31.9, 31.7, 29.2, 28.5, 25.6, 19.9, 19.1, 9.8.

HRMS (ESI): m/z calcd for $C_{21}H_{32}NO_5^+$ [M + H]$^+$: 378.2275; found: 378.2270.



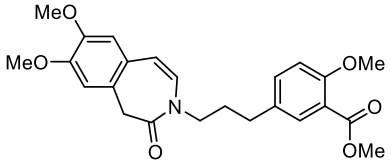
methyl (R)-5-(2-((tert-butoxycarbonyl)amino)-3-methoxy-3-oxopropyl)-2-methoxybenzoate (3t)

This compound was prepared using methyl 2-methoxybenzoate (29 μL, 0.2 mmol) and methyl (S)-2-((tert-butoxycarbonyl)amino)-3-iodopropanoate (132 mg, 0.4 mmol) according to the General Procedure A. After purification by column chromatography (SiO_2: 10%~30% ethyl acetate in petroleum ether), the title compound was isolated as a colorless oil (57.4 mg, 78% yield).

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.54 (s, 1H), 7.21 (dd, *J* = 8.5, 2.4 Hz, 1H), 6.89 (d, *J* = 8.5 Hz, 1H), 5.00 (d, *J* = 8.2 Hz, 1H), 4.52 (q, *J* = 6.6 Hz, 1H), 3.86 (s, 3H), 3.85 (s, 3H), 3.69 (s, 3H), 3.11 – 2.91 (m, 2H), 1.39 (s, 9H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 172.3, 166.5, 158.4, 155.1, 134.4, 132.6, 127.8, 119.9, 112.3, 80.1, 56.1, 54.6, 52.4, 52.1, 37.4, 28.4.

HRMS (ESI): m/z calcd for $C_{18}H_{25}NNaO_7^+$ $[M + Na]^+$: 390.1523; found: 390.1520.



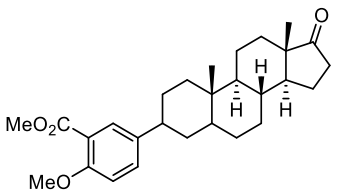
methyl 5-(3-(7,8-dimethoxy-2-oxo-1,2-dihydro-3H-benzo[d]azepin-3-yl)propyl)-2-methoxybenzoate (3u)

This compound was prepared using methyl 2-methoxybenzoate (29 μL, 0.2 mmol) and 3-(3-iodopropyl)-7,8-dimethoxy-1,3-dihydro-2H-benzo[d]azepin-2-one (155 mg, 0.4 mmol) according to the General Procedure A. After purification by column chromatography (SiO_2: 30%~75% ethyl acetate in petroleum ether), the title compound was isolated as a colorless oil (80.7 mg, 95% yield).

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.51 (d, *J* = 2.4 Hz, 1H), 7.16 (dd, *J* = 8.6, 2.4 Hz, 1H), 6.82 (d, *J* = 8.5 Hz, 1H), 6.76 (s, 1H), 6.70 (s, 1H), 6.31 (d, *J* = 9.1 Hz, 1H), 6.12 (d, *J* = 9.1 Hz, 1H), 3.86 (s, 3H), 3.84 (s, 6H), 3.82 (s, 3H), 3.55 (t, *J* = 7.4 Hz, 2H), 3.39 (s, 2H), 2.44 (t, *J* = 7.9 Hz, 2H), 1.80 – 1.74 (m, 2H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 167.6, 166.8, 157.4, 149.9, 148.0, 133.3, 133.1, 131.3, 128.3, 126.4, 124.8, 119.7, 117.3, 112.1, 111.2, 109.5, 56.1, 56.0, 52.0, 47.7, 43.2, 31.7, 30.2.

HRMS (ESI): m/z calcd for $C_{24}H_{28}NO_6^+$ $[M + H]^+$: 426.1911; found: 426.1909.



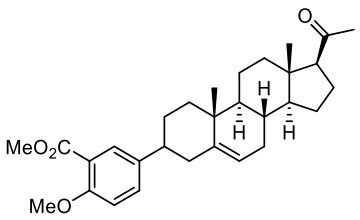
methyl 5-((8R,9S,10S,13S,14S)-10,13-dimethyl-17-oxohexadecahydro-1H-cyclopenta[a]phenanthren-3-yl)-2-methoxybenzoate (3v)

This compound was prepared using methyl 2-methoxybenzoate (29 μL, 0.2 mmol) and (8R,9S,10S,13S,14S)-3-iodo-10,13-dimethylhexadecahydro-17H-cyclopenta[a]phenanthren-17-one (160 mg, 0.4 mmol) according to the General Procedure A. After purification by column chromatography (SiO_2: 5%~10% ethyl acetate in petroleum ether), the title compound was isolated as a colorless oil (80.7 mg, 92% yield).

^{1}H NMR (500 MHz, CDCl3) δ 7.62 (d, *J* = 2.4 Hz, 1H), 7.29 (dd, *J* = 8.5, 2.4 Hz, 1H), 6.88 (d, J = 8.6 Hz, 1H), 3.87 (s, 3H), 3.85 (s, 3H), 2.55 – 2.46 (m, 1H), 2.42 (dd, J = 19.2, 8.8 Hz, 1H), 2.07 – 2.02 (m, 1H), 1.95 – 1.88 (m, 1H), 1.84 – 1.74 (m, 3H), 1.72 –1.65 (m, 2H), 1.60 – 1.42 (m, 5H), 1.33 – 1.23 (m, 6H), 1.11 – 0.97 (m, 2H), 0.87 (s, 3H), 0.85 (s, 3H), 0.79 – 0.72 (m, 1H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 167.1, 157.4, 139.3, 131.9, 129.8, 119.8, 112.1, 56.2, 54.7, 52.1, 51.6, 47.9, 47.1, 43.7, 38.9, 36.6, 36.0, 35.9, 35.2, 31.7, 31.0, 29.9, 28.6, 21.8, 20.4, 13.9, 12.6.

HRMS (ESI): m/z calcd for $C_{28}H_{39}O_4^+$ $[M + H]^+$: 439.2843; found: 439.2839.



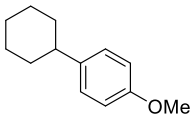
methyl 5-((8S,9S,10R,13S,14S,17S)-17-acetyl-10,13-dimethyl-2,3,4,7,8,9,10,11,12,13,14,15,16,17-tetradecahydro-1H-cyclopenta[a]phenanthren-3-yl)-2-methoxybenzoate (3w)

This compound was prepared using methyl 2-methoxybenzoate (29 μL, 0.2 mmol) and 1-((8S,9S,10R,13S,14S,17S)-3-iodo-10,13-dimethyl-2,3,4,7,8,9,10,11,12,13,14,15,16,17-tetradecahydro-1H-cyclopenta[a]phenanthren-17-yl)ethan-1-one (171 mg, 0.4 mmol) according to the General Procedure A. After purification by column chromatography (SiO_2: 5%~10% ethyl acetate in petroleum ether), the title compound was isolated as a colorless oil (70.6 mg, 76% yield).

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.64 (d, *J* = 2.4 Hz, 1H), 7.31 (dd, *J* = 8.5, 2.4 Hz, 1H), 6.90 (d, *J* = 8.6 Hz, 1H), 5.37 – 5.29 (m, 1H), 3.88 (s, 3H), 3.87 (s, 3H), 2.58 – 2.44 (m, 2H), 2.43 – 2.32 (m, 1H), 2.23 – 2.11 (m, 2H), 2.12 (s, 3H), 2.10 – 1.93 (m, 3H), 1.77 – 1.45 (m, 9H), 1.28 – 1.14 (m, 3H), 1.10 – 1.04 (m, 1H), 1.06 (s, 3H), 0.64 (s, 3H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 209.7, 167.1, 157.5, 142.8, 138.8, 131.8, 129.8, 120.0, 119.9, 112.2, 63.8, 57.1, 56.2, 52.1, 50.4, 44.7, 44.1, 40.7, 39.9, 39.0, 37.0, 32.0, 31.9, 31.7, 30.1, 24.6, 22.9, 21.1, 19.7, 13.4.

HRMS (ESI): m/z calcd for $C_{30}H_{41}O_4^+$ $[M + H]^+$: 465.2999; found: 465.3000.

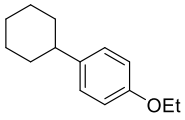


1-cyclohexyl-4-methoxybenzene (5a)

This compound was prepared using anisole (22μL, 0.2 mmol) and iodocyclohexane (52 μL, 0.4 mmol) according to the General Procedure A. After purification by column chromatography (SiO_2: 1%~5% ethyl acetate in petroleum ether), the title compound was isolated as a colorless oil (33.1 mg, 87% yield).

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.14 (d, *J* = 8.6 Hz, 2H), 6.85 (d, *J* = 8.7 Hz, 2H), 3.80 (s, 3H), 2.50 –2.41 (m, 1H), 1.91 – 1.80 (m, 4H), 1.79 – 1.71 (m, 1H), 1.45 – 1.33 (m, 4H), 1.29 – 1.23 (m, 1H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 157.8, 140.5, 127.8, 113.8, 55.4, 43.8, 34.9, 27.1, 26.3.

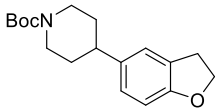


1-cyclohexyl-4-ethoxybenzene (5b)

This compound was prepared using phenetole (25 μL, 0.2 mmol) and iodocyclohexane (52 μL, 0.4 mmol) according to the General Procedure A. After purification by column chromatography (SiO_2: 1%~5% ethyl acetate in petroleum ether), the title compound was isolated as a colorless oil (33.8 mg, 83% yield).

^{1}H NMR (500 MHz, $CDCl_3$) δ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.13 (d, *J* = 8.7 Hz, 2H), 6.84 (d, *J* = 8.6 Hz, 2H), 4.02 (q, *J* = 7.0 Hz, 2H), 2.50 –2.41 (m, 1H), 1.91 – 1.79 (m, 4H), 1.79 – 1.71 (m, 1H), 1.45 – 1.37 (m, 7H), 1.29 – 1.23 (m, 1H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 157.1, 140.4, 127.7, 114.4, 63.5, 43.8, 34.9, 27.1, 26.3, 15.1.



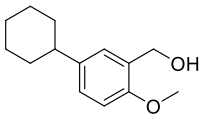
tert-butyl 4-(2,3-dihydrobenzofuran-5-yl)piperidine-1-carboxylate (5c)

This compound was prepared using 2,3-dihydrobenzofuran (23μL, 0.2 mmol) and iodocyclohexane (52 μL, 0.4 mmol) according to the General Procedure A. After purification by column chromatography (SiO_2: 5%~15% ethyl acetate in petroleum ether), the title compound was isolated as a colorless oil (27.9 mg, 46% yield).

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.04 (s, 1H), 6.93 (dd, *J* = 8.2, 2.0 Hz, 1H), 6.71 (d, *J* = 8.2 Hz, 1H), 4.54 (t, *J* = 8.6 Hz, 2H), 4.23 (br s, 2H), 3.18 (t, *J* = 8.7 Hz, 2H), 2.87 – 2.69 (m, 2H), 2.62 – 2.52 (m, 1H), 1.78 (d, *J* = 13.2 Hz, 2H), 1.63 – 1.51 (m, 2H), 1.48 (s, 9H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 158.7, 155.0, 138.2, 127.2, 126.4, 123.3, 109.2, 79.5, 71.3, 44.1, 42.3, 33.8, 30.0, 28.6.

HRMS (ESI): m/z calcd for $C_{18}H_{26}NO_3^+$ [M + H]$^+$: 304.1907; found: 304.1906.



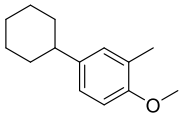
(5-cyclohexyl-2-methoxyphenyl)methanol (5d)

This compound was prepared using 2-methoxybenzyl alcohol (23μL, 0.2 mmol) and iodocyclohexane (52 μL, 0.4 mmol) according to the General Procedure A. After purification by column chromatography (SiO_2: 10%~20% ethyl acetate in petroleum ether), the title compound was isolated as a colorless oil (35.4 mg, 80% yield).

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.14 – 7.08 (m, 2H), 6.82 (d, *J* = 8.2 Hz, 1H), 4.67 (s, 2H), 3. 84 (s, 3H), 2.50 – 2.40 (m, 1H), 1.89 – 1.80 (m, 4H), 1.78 – 1.71 (m, 1H), 1.45 – 1.33 (m, 4 H), 1.29 – 1.23 (m, 1H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 155.7, 140.6, 128.8, 127.5, 127.0, 110.2, 62.6, 55.5, 43.9, 34.8, 27.1, 26.3.

HRMS (ESI): m/z calcd for $C_{14}H_{19}O^+$ [M + H−H_2O]$^+$: 203.1430; found: 203.1431.

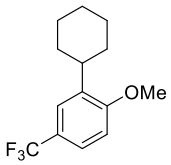


4-cyclohexyl-1-methoxy-2-methylbenzene (5e)

This compound was prepared using 1-methoxy-2-methylbenzene (25mg, 0.2 mmol) and iodocyclohexane (52 μL, 0.4 mmol) according to the General Procedure A. After purification by column chromatography (SiO_2: 1%~5% ethyl acetate in petroleum ether), the title compound was isolated as a colorless oil (30.5 mg, 75% yield).

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.03 – 6.90 (m, 2H), 6.77 (d, *J* = 8.9 Hz, 1H), 3.82 (s, 3H), 2. 46 – 2.38 (m, 1H), 2.22 (s, 3H), 1.91 – 1.78 (m, 4H), 1.80 – 1.70 (m, 1H), 1.44 – 1.35 (m, 4 H), 1.39 – 1.21 (dt, *J* = 12.4, 3.9 Hz, 1H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 156.0, 140.1, 129.4, 126.4, 124.8, 109.9, 55.5, 43.9, 34.9, 27.1, 26.4, 16.5.

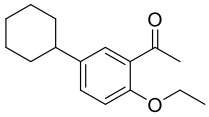


2-cyclohexyl-1-methoxy-4-(trifluoromethyl)benzene (5f)

This compound was prepared using 4-(trifluoromethyl)anisole (28 μL, 0.2 mmol) and iodocyclohexane (52 μL, 0.4 mmol) according to the General Procedure A. After purification by column chromatography (SiO_2: 1%~5% ethyl acetate in petroleum ether), the title compound was isolated as a colorless oil (28.5 mg, 55% yield).

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.45 – 7.39 (m, 2H), 6.88 (d, *J* = 9.0 Hz, 1H), 3.87 (s, 3H), 3.02 – 2.92 (m, 1H), 1.91 – 1.80 (m, 4H), 1.80 – 1.71 (m, 1H), 1.48 – 1.35 (m, 4H), 1.30 – 1.23 (m, 1H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 159.3, 137.0, 124.9 ($J_{C\text{-}F}$ = 271.1Hz), 124.1 ($J_{C\text{-}F}$ = 3.9 Hz), 123.8 ($J_{C\text{-}F}$ = 3.7 Hz), 122.7 ($J_{C\text{-}F}$ = 32.1 Hz), 110.0, 55.7, 36.9, 33.1, 27.1, 26.4.



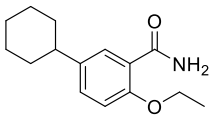
1-(5-cyclohexyl-2-ethoxyphenyl)ethan-1-one (5g)

This compound was prepared using 2'-ethoxyacetophenone (33mg, 0.2 mmol) and iodocyclohexane (52 μL, 0.4 mmol) according to the General Procedure A. After purification by column chromatography (SiO_2: 5%~10% ethyl acetate in petroleum ether), the title compound was isolated as a colorless oil (45.9 mg, 93% yield).

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.59 (d, *J* = 2.4 Hz, 1H), 7.27 (dd, *J* = 8.5, 2.5 Hz, 1H), 6.86 (d, *J* = 8.5 Hz, 1H), 4.10 (q, *J* = 7.0 Hz, 2H), 2.63 (s, 3H), 2.51 – 2.42 (m, 1H), 1.88 – 1.77 (m, 4H), 1.77 – 1.69 (m, 1H), 1.46 (t, *J* = 7.0 Hz, 3H), 1.41 –1.33 (m, 4H), 1.27 – 1.20 (m, 1H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 200.3, 156.8, 140.2, 132.1, 128.6, 128.1, 112.4, 64.2, 43.6, 34.6, 32.2, 26.9, 26.2, 15.0.

HRMS (ESI): m/z calcd for $C_{16}H_{23}O_2^+$ $[M + H]^+$: 247.1693; found: 247.1690.



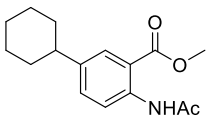
5-cyclohexyl-2-ethoxybenzamide (5h)

This compound was prepared using methyl 2-ethoxybenzamide (33mg, 0.2 mmol) and iodocyclohexane (52 μL, 0.4 mmol) according to the General Procedure A. After purification by column chromatography (SiO_2: 20%~40% ethyl acetate in petroleum ether), the title compound was isolated as a colorless oil (38.4mg, 78% yield).

^{1}H NMR (500 MHz, $CDCl_3$) δ 8.06 (d, *J* = 2.5 Hz, 1H), 7.91 (s, 1H), 7.27 (dd, *J* = 8.4, 2.4 Hz, 1H), 6.88 (d, *J* = 8.5 Hz, 1H), 6.33 (s, 1H), 4.16 (q, *J* = 7.0 Hz, 2H), 2.54 –2.44 (m, 1H), 1.89 – 1.77 (m, 4H), 1.75 – 1.67 (m, 1H), 1.48 (t, *J* = 7.0 Hz, 3H), 1.44 – 1.32 (m, 4H), 1.27 – 1.20 (m, 1H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 167.7, 155.6, 140.9, 131.6, 130.7, 120.5, 112.4, 64.9, 43.7, 34.5, 26.9, 26.2, 15.0.

HRMS (ESI): m/z calcd for $C_{15}H_{22}NO_2^+$ $[M + H]^+$: 248.1645; found: 248.1646.



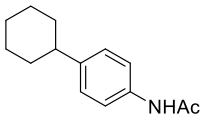
methyl 2-acetamido-5-cyclohexylbenzoate (5i)

This compound was prepared using methyl N-acetylanthranilate (39 mg, 0.2 mmol) and iodocyclohexane (52 μL, 0.4 mmol) according to the General Procedure A but using 80 mol% Selectfluor. After purification by column chromatography (SiO_2: 20%~40% ethyl acetate in petroleum ether), the title compound was isolated as a colorless oil (41.4 mg, 79% yield).

^{1}H NMR (500 MHz, $CDCl_3$) δ 10.92 (s, 1H), 8.58 (d, *J* = 8.6 Hz, 1H), 7.84 (d, *J* = 2.3 Hz, 1H), 7.38 (dd, *J* = 8.7, 2.3 Hz, 1H), 3.92 (s, 3H), 2.52 – 2.43 (m, 1H), 2.21 (s, 3H), 1.88 – 1. 79 (m, 4H), 1.78 – 1.70 (m, 1H), 1.42 – 1.33 (m, 4H), 1.28 – 1.21 (m, 1H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 169.0, 142.4, 139.6, 133.4, 128.8, 120.6, 114.9, 52.3, 43.9, 34.4, 26.9, 26.1, 25.5.

HRMS (ESI): m/z calcd for $C_{16}H_{22}NO_3^+$ $[M + H]^+$: 276.1594; found: 276.1592.

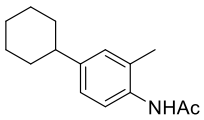


N-(4-cyclohexylphenyl)acetamide (5j)

This compound was prepared using Acetanilide (27 mg, 0.2 mmol) and iodocyclohexane (52 μL, 0.4 mmol) according to the General Procedure A. After purification by column chromatography (SiO_2: 30%~50% ethyl acetate in petroleum ether), the title compound was isolated as a colorless oil (37.4 mg, 86% yield).

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.49 (s, 1H), 7.39 (d, *J* = 8.0 Hz, 2H), 7.14 (d, *J* = 8.1 Hz, 2H), 2.49 – 2.40 (m, 1H), 2.14 (s, 3H), 1.89 – 1.79 (m, 4H), 1.74 (d, *J* = 12.8 Hz, 1H), 1.42 –1.33 (m, 4H), 1.29 – 1.22 (m, 1H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 168.5, 144.4, 135.7, 127.3, 120.3, 44.1, 34.6, 27.0, 26.2, 24.6.



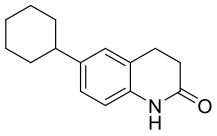
N-(4-cyclohexyl-2-methylphenyl)acetamide (5k)

This compound was prepared using 2-methylacetanilide (30 mg, 0.2 mmol) and iodocyclohexane (52 μL, 0.4 mmol) according to the General Procedure A. After purification by column chromatography (SiO_2: 40%~60% ethyl acetate in petroleum ether), the title compound was isolated as a colorless oil (41.1 mg, 89% yield).

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.53 (d, *J* = 8.6 Hz, 1H), 7.10 (s, 1H), 7.05 – 7.00 (m, 2H), 2.49 – 2.37 (m, 1H), 2.21 (s, 3H), 2.15 (s, 3H), 1.87 – 1.79 (m, 4H), 1.74 (d, *J* = 12.7 Hz, 1H), 1.42 – 1.33 (m, 4H), 1.28 – 1.21 (m, 1H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 168.6, 145.6, 133.3, 130.1, 129.0, 125.1, 124.1, 44.2, 34.6, 27.0, 26.2, 24.2, 18.0.

HRMS (ESI): m/z calcd for $C_{15}H_{22}NO^+$ $[M + H]^+$:232.1696; found: 232.1695.

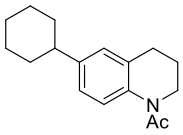


6-cyclohexyl-3,4-dihydroquinolin-2(1H)-one (5l)

This compound was prepared using 2-methylacetanilide (30 mg, 0.2 mmol) and iodocyclohexane (52 μL, 0.4 mmol) according to the General Procedure A. After purification by column chromatography (SiO_2: 30%~50% ethyl acetate in petroleum ether), the title compound was isolated as a colorless oil (39.1 mg, 85% yield).

^{1}H NMR (500 MHz, $CDCl_3$) δ 8.90 (s, 1H), 7.03 – 6.95 (m, 2H), 6.75 (d, *J* = 8.1 Hz, 1H), 2.94 (t, *J* = 7.5 Hz, 2H), 2.63 (t, *J* = 7.5 Hz, 2H), 2.49 – 2.38 (m, 1H), 1.89 – 1.78 (m, 4H), 1.78 – 1.70 (m, 1H), 1.42 – 1.34 (m, 4H), 1.28 – 1.22 (m, 1H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 172.1, 143.3, 135.2, 126.4, 125.9, 123.6, 115.5, 44.1, 34.7, 30.9, 27.0, 26.2, 25.6.

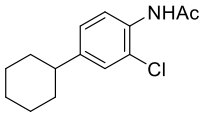


1-(6-cyclohexyl-3,4-dihydroquinolin-1(2H)-yl)ethan-1-one (5m)

This compound was prepared using 1-(3,4-dihydroquinolin-1(2H)-yl)ethan-1-one (35 mg, 0.2 mmol) and iodocyclohexane (52 μL, 0.4 mmol) according to the General Procedure A. After purification by column chromatography (SiO_2: 20%~40% ethyl acetate in petroleum ether), the title compound was isolated as a colorless oil (40.2 mg, 78% yield).

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.05 – 6.94 (m, 3H), 3.77 (t, *J* = 6.7 Hz, 2H), 2.69 (t, *J* = 6.6 Hz, 2H), 2.51 – 2.40 (m, 1H), 2.22 (s, 3H), 1.99 – 1.90 (m, 2H), 1.90 – 1.78 (m, 4H), 1.74 (d, *J* = 12.9 Hz, 1H), 1.38 (t, *J* = 10.6 Hz, 4H), 1.29 – 1.22 (m, 1H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 169.2, 144.3, 138.1, 134.1, 127.3, 124.4, 123.9, 44.0, 42.1, 33.9, 27.0, 26.9, 26.1, 24.1, 21.9



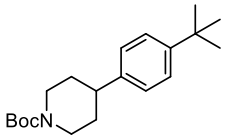
N-(2-chloro-4-cyclohexylphenyl)acetamide (5n)

This compound was prepared using N-(2-chlorophenyl)acetamide (34 mg, 0.2 mmol) and iodocyclohexane (52 μL, 0.4 mmol) according to the General Procedure A. After purification by column chromatography (SiO_2: 20%~40% ethyl acetate in petroleum ether), the title compound was isolated as a colorless oil (24.7 mg, 49% yield).

^{1}H NMR (500 MHz, $CDCl_3$) δ 8.20 (d, *J* = 8.5 Hz, 1H), 7.52 (s, 1H), 7.20 (s, 1H), 7.10 (dd, *J* = 8.5, 2.1 Hz, 1H), 2.50 – 2.38 (m, 1H), 2.22 (s, 3H), 1.88 – 1.79 (m, 4H), 1.78 – 1.68 (m, 1H), 1.42 – 1.31 (m, 4H), 1.28 – 1.21 (m, 1H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 168.3, 145.2, 132.3, 127.3, 126.3, 122.7, 121.9, 43.9, 34.4, 26.9, 26.1, 24.9.

HRMS (ESI): m/z calcd for $C_{14}H_{19}ClNO^+$ $[M + H]^+$:252.1150; found: 252.1151.

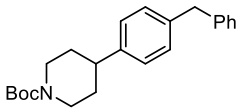


tert-butyl 4-(4-(tert-butyl)phenyl)piperidine-1-carboxylate (5o)

This compound was prepared using *tert*-butylbenzene (31 μL, 0.2 mmol) and N-Boc-4-iodopiperidine (125 mg, 0.4 mmol) according to the General Procedure A. After purification by column chromatography (SiO_2: 5%~15% ethyl acetate in petroleum ether), the title compound was isolated as a colorless oil (27.9 mg, 44% yield).

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.33 (d, *J* = 8.0 Hz, 2H), 7.14 (d, *J* = 8.0 Hz, 2H), 4.33 – 4.12 (m, 2H), 2.86 – 2.72 (m, 2H), 2.62 (tt, *J* = 12.2, 3.7 Hz, 1H), 1.86 – 1.78 (d, *J* = 13.1 Hz, 2H), 1.67 – 1.57 (m, 2H), 1.48 (s, 9H), 1.31 (s, 9H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 155.1, 149.2, 142.9, 126.5, 125.5, 79.5, 42.3, 34.5, 33.3, 31.5, 28.6.



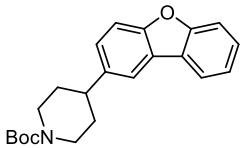
tert-butyl 4-(4-benzylphenyl)piperidine-1-carboxylate (5p)

This compound was prepared using diphenylmethane (34 mg, 0.2 mmol) and N-Boc-4-iodopiperidine (125 mg, 0.4 mmol) according to the General Procedure A. After purification by column chromatography (SiO_2: 5%~15% ethyl acetate in petroleum ether), the title compound was isolated as a colorless oil (30.3 mg, 43% yield).

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.29 (t, *J* = 7.6 Hz, 2H), 7.24 – 7.16 (m, 3H), 7.16 – 7.09 (m, 4H), 4.32 – 4.16 (m, 2H), 3.96 (s, 2H), 2.87 – 2.71 (m, 2H), 2.61 (tt, *J* = 12.1, 3.6 Hz, 1H), 1.85 – 1.76 (m, 2H), 1.62 – 1.55 (m, 2H), 1.49 (s, 9H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 155.0, 143.7, 141.3, 139.3, 129.1, 129.1, 128.6, 127.0, 126.2, 79.5, 44.3, 42.4, 41.7, 33.4, 28.6.

HRMS (ESI): m/z calcd for $C_{23}H_{30}NO_2^+$ $[M + H]^+$:352.2271; found: 352.2266.

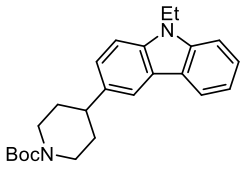


tert-butyl 4-(dibenzo[b,d]furan-2-yl)piperidine-1-carboxylate (5q)

This compound was prepared using dibenzo[b,d]furan (34 mg, 0.2 mmol) and N-Boc-4-iodopiperidine (125 mg, 0.4 mmol) according to the General Procedure A. After purification by column chromatography (SiO_2: 5%~15% ethyl acetate in petroleum ether), the title compound was isolated as a colorless oil (32.2 mg, 46% yield).

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.93 (d, *J* = 7.7 Hz, 1H), 7.78 (d, *J* = 1.9 Hz, 1H), 7.55 (d, *J* = 8.2 Hz, 1H), 7.50 (d, *J* = 8.5 Hz, 1H), 7.44 (t, *J* = 7.8 Hz, 1H), 7.34 (t, *J* = 7.4 Hz, 1H), 7.30 (dd, *J* = 8.6, 2.0 Hz, 1H), 4.40 – 4.16 (m, 2H),, 2.94 – 2.77 (m, 3H), 1.96 – 1.85 (m, 2 H), 1.79 – 1.67 (m, 2H), 1.51 (s, 9H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 156.7, 155.1, 155.0, 140.6, 127.2, 126.3, 124.4, 124.3, 122.8, 120.6, 118.5, 111.8, 111.6, 79.6, 42.9, 33.9, 28.6.



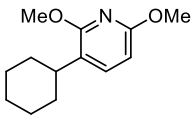
tert-butyl 4-(9-ethyl-9H-carbazol-3-yl)piperidine-1-carboxylate (5r)

This compound was prepared using 9-ethyl-9H-carbazole (39 mg, 0.2 mmol) and N-Boc-4-iodopiperidine (125 mg, 0.4 mmol) according to the General Procedure A. After purification by column chromatography (SiO_2: 5%~15% ethyl acetate in petroleum ether), the title compound was isolated as a colorless oil (39.4 mg, 52% yield).

^{1}H NMR (500 MHz, $CDCl_3$) δ 8.09 (d, *J* = 7.7 Hz, 1H), 7.95 (d, *J* = 1.6 Hz, 1H), 7.49 – 7.44 (m, 1H), 7.40 (d, *J* = 8.2 Hz, 1H), 7.38 – 7.31 (m, 2H), 7.23 (t, *J* = 7.4 Hz, 1H), 4.43 – 4.21 (m, 4H), 2.98 – 2.79 (m, 3H), 1.99 – 1.89 (m, 2H), 1.84 – 1.71 (m, 2H), 1.53 (s, 9H), 1.43 (t, *J* = 7.2 Hz, 3H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 155.1, 140.4, 138.9, 136.6, 125.7, 124.8, 123.1, 122.9, 120.4, 118.7, 118.2, 108.5, 108.5, 79.5, 44.6, 42.9, 37.7, 34.1, 28.7, 14.0.

HRMS (ESI): m/z calcd for $C_{24}H_{31}N_2O_2^+$ $[M + H]^+$:379.2380; found: 379.2378.



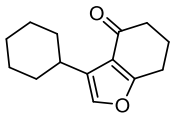
3-cyclohexyl-2,6-dimethoxypyridine (5s)

This compound was prepared using 2,6-dimethoxypyridine (28 mg, 0.2 mmol) and iodocyclohexane (52 μL, 0.4 mmol) according to the General Procedure A. After purification by column chromatography (SiO_2: 1%~5% ethyl acetate in petroleum ether), the title compound was isolated as a colorless oil (31.9 mg, 72% yield).

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.35 (d, *J* = 8.0 Hz, 1H), 6.25 (d, *J* = 8.0 Hz, 1H), 3.93 (s, 3 H), 3.89 (s, 3H), 2.73 (tt, *J* = 11.8, 2.9 Hz, 1H), 1.86 – 1.77 (m, 4H), 1.77 – 1.69 (m, 1H), 1. 44 – 1.37 (m, 2H), 1.30 – 1.21 (m, 3H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 160.9, 159.8, 137.8, 121.2, 99.9, 53.6, 53.3, 36.4, 33.1, 27.1, 26.5.

HRMS (ESI): m/z calcd for $C_{13}H_{20}NO_2^+$ $[M + H]^+$:222.1489; found: 222.1487.



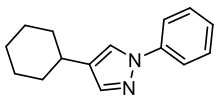
3-cyclohexyl-6,7-dihydrobenzofuran-4(5H)-one (5t)

This compound was prepared using 6,7-Dihydro-4(5H)-benzofuranone (27 mg, 0.2 mmol) and iodocyclohexane (52 μL, 0.4 mmol) according to the General Procedure A. After purification by column chromatography (SiO_2: 10%~20% ethyl acetate in petroleum ether), the title compound was isolated as a colorless oil (13.1 mg, 30% yield).

^{1}H NMR (500 MHz, $CDCl_3$) δ 6.22 (s, 1H), 2.83 (t, *J* = 6.3 Hz, 2H), 2.63 – 2.51 (m, 1H), 2.46 (dd, *J* = 7.2, 5.7 Hz, 2H), 2.15 (p, *J* = 6.4 Hz, 2H), 2.03 – 1.95 (m, 2H), 1.83 – 1.75 (m, 2H), 1.73 – 1.66 (m, 1H), 1.39 – 1.32 (m, 4H), 1.27 – 1.21 (m, 1H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 195.0, 165.9, 161.6, 121.8, 99.4, 37.7, 37.1, 31.4, 26.1, 25.9, 23.5, 22.8.

HRMS (ESI): m/z calcd for $C_{14}H_{19}O_2^+$ $[M + H]^+$: 219.1380; found: 219.1380.

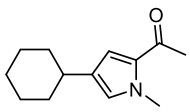


4-cyclohexyl-1-phenyl-1H-pyrazole (5u)

This compound was prepared using 1-phenyl-1H-pyrazole (29 mg, 0.2 mmol) and iodocyclohexane (52 μL, 0.4 mmol) according to the General Procedure A. After purification by column chromatography (SiO_2: 2%~10% ethyl acetate in petroleum ether), the title compound was isolated as a colorless oil (39.9 mg, 88% yield).

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.73 (s, 1H), 7.69 (d, *J* = 8.0 Hz, 2H), 7.61 (s, 1H), 7.46 (t, *J* = 7.9 Hz, 2H), 7.32 – 7.26 (m, 1H), 2.63 – 2.53 (m, 1H), 2.08 – 1.97 (m, 2H), 1.90 – 1.81 (m, 2H), 1.79 – 1.72 (m, 1H), 1.47 – 1.36 (m, 4H), 1.31 – 1.25 (m, 1H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 140.5, 139.7, 130.4, 129.5, 126.1, 123.5, 118.9, 34.5, 34.2, 26.5, 26.2.



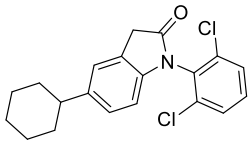
1-(4-cyclohexyl-1-methyl-1H-pyrrol-2-yl)ethan-1-one (5v)

This compound was prepared using 2-acetyl-1-methylpyrrole (25 mg, 0.2 mmol) and iodocyclohexane (52 μL, 0.4 mmol) according to the General Procedure A. After purification by column chromatography (SiO_2: 10%~30% ethyl acetate in petroleum ether), the title compound was isolated as a colorless oil (24.2 mg, 59% yield).

^{1}H NMR (500 MHz, $CDCl_3$) δ 6.78 (d, J = 2.0 Hz, 1H), 6.60 (d, J = 2.0 Hz, 1H), 3.88 (s, 3H), 2.44 – 2.36 (s, 4H), 1.95 – 1.88 (m, 2H), 1.83 – 1.75 (m, 2H), 1.74 – 1.67 (m, 1H), 1.35 – 1.25 (m, 5H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 188.6, 130.5, 130.4, 128.0, 117.6, 37.6, 36.0, 34.7, 27.2, 26.7, 26.3.

HRMS (ESI): m/z calcd for $C_{13}H_{20}NO^+$ $[M + H]^+$: 206.1539; found: 206.1540.



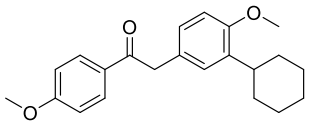
5-cyclohexyl-1-(2,6-dichlorophenyl)indolin-2-one (5w)

This compound was prepared using 1-(2,6-dichlorophenyl)indolin-2-one (56 mg, 0.2 mmol) and iodocyclohexane (52 μL, 0.4 mmol) according to the General Procedure A. After purification by column chromatography (SiO_2: 20%~40% ethyl acetate in petroleum ether), the title compound was isolated as a colorless oil (49.1 mg, 68% yield).

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.50 (d, J = 8.2 Hz, 2H), 7.36 (t, J = 8.1 Hz, 1H), 7.20 (s, 1H), 7.02 (d, J = 8.1 Hz, 1H), 6.32 (d, J = 8.0 Hz, 1H), 3.75 (s, 2H), 2.56 – 2.40 (m, 1H), 1.93 – 1.80 (m, 4H), 1.80 – 1.70 (m, 1H), 1.47 – 1.33 (m, 4H), 1.29 – 1.24 (m, 1H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 173.9, 143.3, 141.3, 135.6, 130.8, 129.1, 126.2, 124.3, 123.5, 109.0, 44.4, 36.0, 34.9, 27.0, 26.2.

HRMS (ESI): m/z calcd for $C_{20}H_{20}Cl_2NO^+$ $[M + H]^+$:360.0916; found: 360.0914.



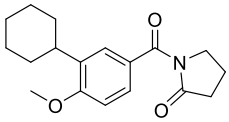
2-(3-cyclohexyl-4-methoxyphenyl)-1-(4-methoxyphenyl)ethan-1-one (5x)

This compound was prepared using Deoxyanisoin (51 mg, 0.2 mmol) and iodocyclohexane (52 μL, 0.4 mmol) according to the General Procedure A. After purification by column chromatography (SiO_2: 5%~15% ethyl acetate in petroleum ether), the title compound was isolated as a colorless oil (38.4 mg, 57% yield).

^{1}H NMR (500 MHz, $CDCl_3$) δ 8.00 (d, J = 8.5 Hz, 2H), 7.09 (d, J = 2.3 Hz, 1H), 7.04 (dd, J = 8.3, 2.2 Hz, 1H), 6.92 (d, J = 8.5 Hz, 2H), 6.79 (d, J = 8.3 Hz, 1H), 4.16 (s, 2H), 3.85 (s, 3H), 3.79 (s, 3H), 2.98 – 2.86 (m, 1H), 1.86 – 1.77 (m, 4H), 1.77 – 1.71 (m, 1H), 1.46 – 1.33 (m, 4H), 1.29 – 1.23 (m, 1H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 196.8, 163.5, 155.7, 136.5, 131.0, 129.9, 127.9, 127.3, 126.8, 113.8, 110.6, 55.6, 44.8, 36.9, 33.3, 27.2, 26.5.

HRMS (ESI): m/z calcd for $C_{22}H_{27}O_3^+$ [M + H]$^+$: 339.1955; found: 339.1551.



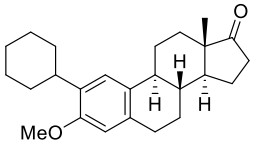
1-(3-cyclohexyl-4-methoxybenzoyl)pyrrolidin-2-one (5y)

This compound was prepared using Aniracetam (44 mg, 0.2 mmol) and iodocyclohexane (52 μL, 0.4 mmol) according to the General Procedure A. After purification by column chromatography (SiO_2: 40%~60% ethyl acetate in petroleum ether), the title compound was isolated as a colorless oil (30.7 mg, 51% yield).

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.56 – 7.49 (m, 2H), 6.82 (d, *J* = 8.4 Hz, 1H), 3.93 (t, *J* = 7.0 Hz, 2H), 3.86 (s, 3H), 2.99 – 2.88 (m, 1H), 2.61 (t, *J* = 8.0 Hz, 2H), 2.17 – 2.09 (m, 2H), 1.87 – 1.78 (m, 4H), 1.74 (d, *J* = 13.1 Hz, 1H), 1.45 – 1.34 (m, 4H), 1.28 – 1.23 (m, 1H).

13C NMR (126 MHz, CDCl3) δ 174.6, 170.6, 160.4, 135.5, 129.4, 128.8, 125.8, 109.1, 55.6, 47.1, 36.8, 33.6, 33.0, 27.1, 26.5, 17.9.

HRMS (ESI): m/z calcd for $C_{18}H_{24}NO_3^+$ [M + H]$^+$:302.1751; found: 302.1749.



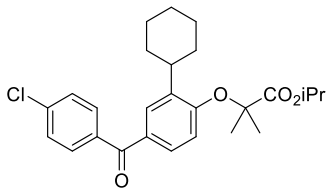
(8R,9S,13S,14S)-2-cyclohexyl-3-methoxy-13-methyl-6,7,8,9,11,12,13,14,15,16-decahydro-17H-cyclopenta[a]phenanthren-17-one (5z)

This compound was prepared using Estrone 3-methyl ether (57 mg, 0.2 mmol) and iodocyclohexane (52 μL, 0.4 mmol) according to the General Procedure A. After purification by column chromatography (SiO_2: 5%~20% ethyl acetate in petroleum ether), the title compound was isolated as a colorless oil (45.5 mg, 62% yield).

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.13 (s, 1H), 6.59 (s, 1H), 3.80 (s, 3H), 2.99 – 2.82 (m, 3H), 2.56 – 2.41 (m, 2H), 2.37 – 2.22 (m, 1H), 2.19 – 1.93 (m, 4H), 1.87 – 1.71 (m, 5H), 1.69 – 1.45 (m, 6H), 1.45 – 1.36 (m, 4H), 1.26 (d, *J* = 7.1 Hz, 1H), 0.92 (s, 3H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 154.9, 134.5, 133.9, 131.5, 123.8, 110.9, 55.6, 50.5, 48.2, 44.3, 38.6, 36.9, 36.0, 33.6, 31.8, 29.7, 27.3, 26.8, 26.5, 26.2, 21.7, 14.0.

HRMS (ESI): m/z calcd for $C_{25}H_{35}O_2^+$ [M + H]$^+$:367.2632; found: 367.2633.



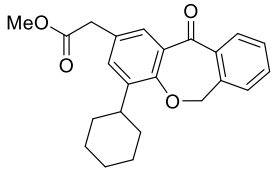
isopropyl 2-(4-(4-chlorobenzoyl)-2-cyclohexylphenoxy)-2-methylpropanoate (5aa)

This compound was prepared using Fenofibrate (72 mg, 0.2 mmol) and iodocyclohexane (52 μL, 0.4 mmol) according to the General Procedure A. After purification by column chromatography (SiO_2: 3%~10% ethyl acetate in petroleum ether), the title compound was isolated as a colorless oil (48.8 mg, 55% yield).

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.74 – 7.64 (m, 3H), 7.48 (dd, *J* = 8.6, 2.3 Hz, 1H), 7.46 – 7.41 (m, 2H), 6.64 (d, *J* = 8.5 Hz, 1H), 5.06 (p, *J* = 6.3 Hz, 1H), 3.02 – 2.93 (m, 1H), 1.93 – 1.81 (m, 4H), 1.79 – 1.72 (m, 1H), 1.67 (s, 6H), 1.45 – 1.35 (m, 4H), 1.27 – 1.25 (m, 1H), 1.18 (d, *J* = 6.3 Hz, 6H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 194.8, 173.4, 157.3, 138.3, 138.2, 136.9, 131.3, 130.0, 129.4, 129.2, 128.6, 114.2, 79.4, 69.4, 37.6, 33.0, 27.2, 26.4, 25.6, 21.7.

HRMS (ESI): m/z calcd for $C_{26}H_{32}ClO_4^+$ $[M + H]^+$:443.1984; found: 443.1982.



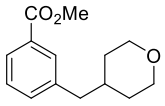
methyl 2-(4-cyclohexyl-11-oxo-6,11-dihydrodibenzo[b,e]oxepin-2-yl)acetate (5ab)

This compound was prepared using methyl 2-(11-oxo-6,11-dihydrodibenzo[b,e]oxepin-2-yl)acetate (57 mg, 0.2 mmol) and iodocyclohexane (52 μL, 0.4 mmol) according to the General Procedure A. After purification by column chromatography (SiO_2: 5%~20% ethyl acetate in petroleum ether), the title compound was isolated as a colorless oil (27.7 mg, 38% yield).

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.98 (d, *J* = 2.3 Hz, 1H), 7.92 (d, *J* = 7.7 Hz, 1H), 7.55 (t, *J* = 7.5 Hz, 1H), 7.46 (t, *J* = 7.5 Hz, 1H), 7.39 – 7.32 (m, 2H), 5.21 (s, 2H), 3.71 (s, 3H), 3.63 (s, 2H), 3.07 – 2.95 (m, 1H), 1.839 – 1.79 (m, 4H), 1.79 – 1.72 (m, 1H), 1.45 – 1.33 (m, 4H), 1.26 – 1.21 (m, 1H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 191.2, 172.2, 158.3, 140.3, 139.5, 136.4, 133.6, 132.7, 130.0, 129.8, 129.2, 127.5, 125.9, 74.4, 52.2, 40.5, 37.3, 33.4, 27.1, 26.4.

HRMS (ESI): m/z calcd for $C_{23}H_{25}O_4^+$ $[M + H]^+$: 365.1747; found: 365.1749.

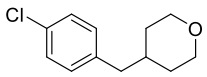


methyl 3-((tetrahydro-2H-pyran-4-yl)methyl)benzoate (7a)

This compound was prepared using methyl benzoate (25μL, 0.2 mmol) and 4-(Iodomethyl)tetrahydro-2H-pyran (55 μL, 0.4 mmol) according to the General Procedure B. After purification by column chromatography (SiO_2: 1%~10% ethyl acetate in petroleum ether), the title compound was isolated as a colorless oil (37.1 mg, 79% yield).

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.87 (d, *J* = 6.9 Hz, 1H), 7.83 (s, 1H), 7.39 – 7.29 (m, 2H), 3.96 – 3.90 (m, 5H), 3.32 (t, *J* = 11.8 Hz, 2H), 2.59 (d, *J* = 7.2 Hz, 2H), 1.85 – 1.72 (m, 1H), 1.56 – 1.47 (m, 2H), 1.38-1.27 (m, 2H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 167.4, 140.6, 133.9, 130.2, 128.4, 127.4, 68.1, 52.2, 43.3, 37.2, 33.0.

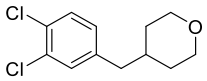


4-(4-chlorobenzyl)tetrahydro-2H-pyran (7b)

This compound was prepared using chlorobenzene (25μL, 0.2 mmol) and 4-(Iodomethyl)tetrahydro-2H-pyran (55 μL, 0.4 mmol) according to the General Procedure B. After purification by column chromatography (SiO_2: 1%~5% ethyl acetate in petroleum ether), the title compound was isolated as a colorless oil (25.3 mg, 60% yield).

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.24 (d, *J* = 7.9 Hz, 2H), 7.07 (d, *J* = 7.9 Hz, 2H), 3.94 (dd, *J* = 11.9, 4.4 Hz, 2H), 3.32 (t, *J* = 11.9 Hz, 2H), 2.51 (d, *J* = 7.2 Hz, 2H), 1.76 – 1.67 (m, 1H), 1.58 – 1.49 (m, 2H), 1.37 – 1.27 (m, 2H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 138.7, 131.8, 130.6, 128.5, 68.1, 42.9, 37.2, 33.0.

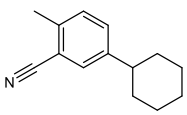


4-(3,4-dichlorobenzyl)tetrahydro-2H-pyran (7c)

This compound was prepared using 1,2-dichlorobenzene (29mg, 0.2 mmol) and 4-(Iodomethyl)tetrahydro-2H-pyran (55 μL, 0.4 mmol) according to the General Procedure B. After purification by column chromatography (SiO_2: 1%~5% ethyl acetate in petroleum ether), the title compound was isolated as a colorless oil (23.4 mg, 48% yield).

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.34 (d, *J* = 8.2 Hz, 1H), 7.24 (s, 1H), 6.97 (d, *J* = 8.1 Hz, 1H), 3.94 (dd, *J* = 11.6, 4.4 Hz, 2H), 3.33 (t, *J* = 11.8 Hz, 2H), 2.49 (d, *J* = 7.2 Hz, 2H), 1.77 – 1.69 (m, 1H), 1.56 – 1.49 (m, 2H), 1.37 – 1.27 (m, 2H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 140.5, 132.3, 131.0, 130.3, 130.1, 128.7, 68.0, 42.7, 37.1, 32.9.



5-cyclohexyl-2-methylbenzonitrile (7d)

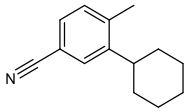
This compound was prepared using 2-methylbenzonitrile (24 mg, 0.2 mmol) and iodocyclohexane (52 μL, 0.4 mmol) according to the General Procedure B. After purification by column

chromatography (SiO_2: 1%~5% ethyl acetate in petroleum ether), the title compound was isolated as a mixture of two isomers (23.1 mg, 58% yield).

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.42 (s, 1H), 7.31 (d, *J* = 8.0 Hz, 1H), 7.21 (d, *J* = 7.9 Hz, 1H), 2.53 – 2.43 (s, 4H), 1.84 (d, *J* = 8.3 Hz, 4H), 1.75 (d, *J* = 13.1 Hz, 1H), 1.43 – 1.33 (m, 4H), 1.28 – 1.21 (m, 1H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 146.4, 139.3, 131.6, 130.9, 130.3, 118.7, 112.6, 43.8, 34.3, 26.8, 26.1, 20.1.

HRMS (ESI): m/z calcd for $C_{14}H_{18}N^+$ $[M + H]^+$:200.1434; found: 200.1435.



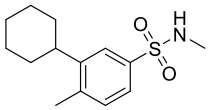
3-cyclohexyl-4-methylbenzonitrile (7e)

This compound was prepared using 4-methylbenzonitrile (24 mg, 0.2 mmol) and iodocyclohexane (52 μL, 0.4 mmol) according to the General Procedure C. After purification by column chromatography (SiO_2: 1%~5% ethyl acetate in petroleum ether), the title compound was isolated as yellow solids (25.2 mg, 63% yield).

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.48 (s, 1H), 7.36 (d, *J* = 7.8 Hz, 1H), 7.20 (d, *J* = 7.8 Hz, 1H), 2.75 – 2.65 (m, 1H), 2.38 (s, 3H), 1.92 – 1.84 (m, 2H), 1.82 – 1.74 (m, 3H), 1.43 – 1.34 (m, 4H), 1.30 – 1.24 (m, 1H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 147.3, 141.2, 131.0, 129.5, 129.2, 119.7, 110.0, 40.1, 33.5, 27.0, 26.2, 19.8.

HRMS (ESI): m/z calcd for $C_{14}H_{18}N^+$ $[M + H]^+$:200.1434; found: 200.1434.



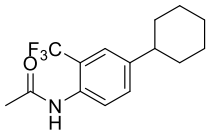
3-cyclohexyl-N,4-dimethylbenzenesulfonamide (7f)

This compound was prepared using N,4-dimethylbenzenesulfonamide (37 mg, 0.2 mmol) and iodocyclohexane (52 μL, 0.4 mmol) according to the General Procedure C. After purification by column chromatography (SiO_2: 10%~30% ethyl acetate in petroleum ether), the title compound was isolated as a yellow solid (31.0 mg, 58% yield).

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.69 (s, 1H), 7.56 (d, *J* = 7.9 Hz, 1H), 7.26 (d, *J* = 8.0 Hz, 1H), 4.45 (q, *J* = 5.6 Hz, 1H), 2.80 – 2.68 (m, 1H), 2.64 (d, *J* = 5.4 Hz, 3H), 2.39 (s, 3H), 1.92 – 1.82 (m, 2H), 1.83 –1.73 (m, 3H), 1.49 – 1.35 (m, 4H), 1.30 – 1.26 (m, 1H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 147.4, 140.9, 136.4, 131.0, 124.5, 124.4, 40.3, 33.5, 29.5, 27.1, 26.2, 19.6.

HRMS (ESI): m/z calcd for $C_{14}H_{22}NO_2S^+$ $[M + H]^+$: 268.1366; found: 268.1364.



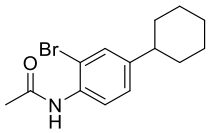
N-(4-cyclohexyl-2-(trifluoromethyl)phenyl)acetamide (7g)

This compound was prepared using N-(2-(trifluoromethyl)phenyl)acetamide (41 mg, 0.2 mmol) and iodocyclohexane (52 μL, 0.4 mmol) according to the General Procedure B. After purification by column chromatography (SiO_2: 20%~30% ethyl acetate in petroleum ether), the title compound was isolated as a yellow solid (40.6 mg, 71% yield).

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.97 (d, J = 8.4 Hz, 1H), 7.42 (s, 1H), 7.40 – 7.30 (m, 2H), 2.58 – 2.46 (m, 1H), 2.19 (s, 3H), 1.91 – 1.80 (m, 4H), 1.80 – 1.71 (m, 1H), 1.43 – 1.35 (m, 5H), 1.27 – 1.22 (m, 1H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 168.6, 145.0, 132.8, 131.3, 125.4, 124.4, 123.2, 120.8 ($J_{C\text{-}F}$ = 28.9 Hz), 44.1, 34.4, 26.8, 26.1, 24.6.

HRMS (ESI): m/z calcd for $C_{15}H_{19}F_3NO^+$ $[M + H]^+$:286.1413; found: 286.1412.



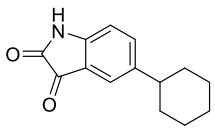
N-(2-bromo-4-cyclohexylphenyl)acetamide (7h)

This compound was prepared using N-(2-bromophenyl)acetamide (43 mg, 0.2 mmol) and iodocyclohexane (52 μL, 0.4 mmol) according to the General Procedure B. After purification by column chromatography (SiO_2: 10%~20% ethyl acetate in petroleum ether), the title compound was isolated as a yellow solid (26.1 mg, 44% yield).

^{1}H NMR (500 MHz, $CDCl_3$) δ 8.17 (d, J = 8.4 Hz, 1H), 7.50 (s, 1H), 7.37 (s, 1H), 7.14 (d, J = 8.5 Hz, 1H), 2.49 – 2.38 (m, 1H), 2.22 (s, 3H), 1.90 – 1.80 (m, 4H), 1.77 – 1.69 (m, 1H), 1.40 – 1.30 (m, 4H), 1.27 – 1.21 (m, 1H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 168.3, 145.8, 133.4, 130.5, 127.0, 122.2, 113.5, 43.9, 34.5, 26.9, 26.1, 24.9.

HRMS (ESI): m/z calcd for $C_{14}H_{19}BrNO^+$ $[M + H]^+$:296.0645; found: 296.0646.



5-cyclohexylindoline-2,3-dione (7i)

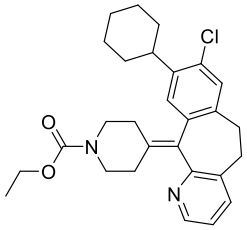
This compound was prepared using indoline-2,3-dione (30 mg, 0.2 mmol) and iodocyclohexane (52 μL, 0.4 mmol) according to the General Procedure B. After purification by column chromatography

(SiO_2: 20%~40% ethyl acetate in petroleum ether), the title compound was isolated as a yellow solid (19.8 mg, 43% yield).

^{1}H NMR (500 MHz, $CDCl_3$) δ 8.63 (s, 1H), 7.47 (s, 1H), 7.44 – 7.37 (m, 1H), 6.86 (d, *J* = 8.0 Hz, 1H), 2.52 – 2.40 (m, 1H), 1.92 – 1.80 (m, 4H), 1.75 (d, *J* = 13.1 Hz, 1H), 1.42 – 1.32 (m, 4H), 1.28 – 1.19 (m, 1H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 183.6, 160.1, 147.4, 144.5, 137.7, 124.0, 118.3, 112.4, 43.9, 34.4, 26.8, 26.0.

HRMS (ESI): m/z calcd for $C_{14}H_{16}NO_2^+$ $[M + H]^+$:230.1176; found: 230.1177.



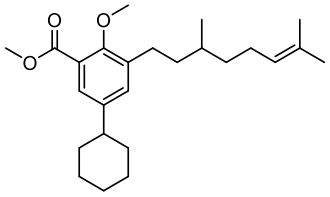
ethyl 4-(8-chloro-9-cyclohexyl-5,6-dihydro-11H-benzo[5,6]cyclohepta[1,2-b]pyridin-11-ylidene)piperidine-1-carboxylate (7j)

This compound was prepared using Loratadine (77 mg, 0.2 mmol) and iodocyclohexane (52 μL, 0.4 mmol) according to the General Procedure C. After purification by column chromatography (SiO_2: 20%~40% ethyl acetate in petroleum ether), the title compound was isolated as a yellow solid (29.8 mg, 32% yield).

^{1}H NMR (500 MHz, $CDCl_3$) δ 8.40 (d, *J* = 4.8 Hz, 1H), 7.45 (d, *J* = 7.6 Hz, 1H), 7.13 (s, 1H), 7.11 – 7.07 (m, 2H), 4.14 (q, *J* = 7.0 Hz, 2H), 3.92 – 3.74 (m, 2H), 3.38 – 3.32 (m, 2H), 3.18 – 3.06 (m, 2H), 2.97 – 2.87 (m, 1H), 2.85 – 2.73 (m, 2H), 2.52 – 2.41 (m, 1H), 2.42 – 2.33 (m, 2H), 2.32 – 2.23 (m, 1H), 1.88 – 1.72 (m, 5H), 1.46 – 1.34 (m, 3H), 1.28 –1.23 (m, 5H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 158.0, 155.6, 146.8, 142.4, 137.3, 137.2, 136.3, 134.9, 133.8, 132.3, 130.1, 128.7, 122.4, 61.5, 45.0, 44.9, 40.3, 33.3, 31.6, 31.4, 30.9, 30.7, 27.0, 26.3, 14.8

HRMS (ESI): m/z calcd for $C_{28}H_{34}ClN_2O_2^+$ $[M + H]^+$:465.2303; found: 465.2306.



methyl 5-cyclohexyl-3-(3,7-dimethyloct-6-en-1-yl)-2-methoxybenzoate (8a)

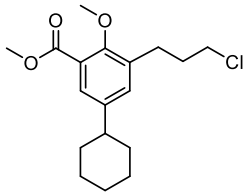
This compound was prepared using methyl 5-cyclohexyl-2-methoxybenzoate (50 mg, 0.2 mmol) and 8-iodo-2,6-dimethyloct-2-ene (107 mg, 0.4 mmol) according to the General Procedure A, but using I_2 (56 mg, 0.22 mmol, 1.1 equiv.) and Selectfluor (85 mg, 0.24 mmol, 1.2 equiv.). After

purification by column chromatography (SiO_2: 5%~10% ethyl acetate in petroleum ether), the title compound was isolated as a colorless oil (48.0 mg, 62% yield).

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.47 (s, 1H), 7.17 (s, 1H), 5.10 (t, *J* = 7.3 Hz, 1H), 3.91 (s, 3H), 3.80 (s, 3H), 2.69 – 2.56 (m, 2H), 2.49 –2.41 (m, 1H), 2.07 – 1.91 (m, 2H), 1.90 – 1.79 (m, 4H), 1.74 (d, *J* = 13.0 Hz, 1H), 1.68 (s, 3H), 1.62 –1.55 (m, 4H), 1.53 –1.46 (m, 1H), 1.45 – 1.34 (m, 6H), 1.27 – 1.16 (m, 2H), 0.96 (d, *J* = 6.4 Hz, 3H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 167.4, 156.3, 143.4, 137.4, 132.9, 131.2, 127.3, 125.0, 124.1, 62.4, 52.2, 44.0, 38.3, 37.1, 34.6, 32.7, 27.7, 27.0, 26.2, 25.9, 25.7, 19.6, 17.8.

HRMS (ESI): m/z calcd for $C_{25}H_{39}O_3^+$ $[M + H]^+$:387.2894; found: 387.2893.



methyl 3-(3-chloropropyl)-5-cyclohexyl-2-methoxybenzoate (8b)

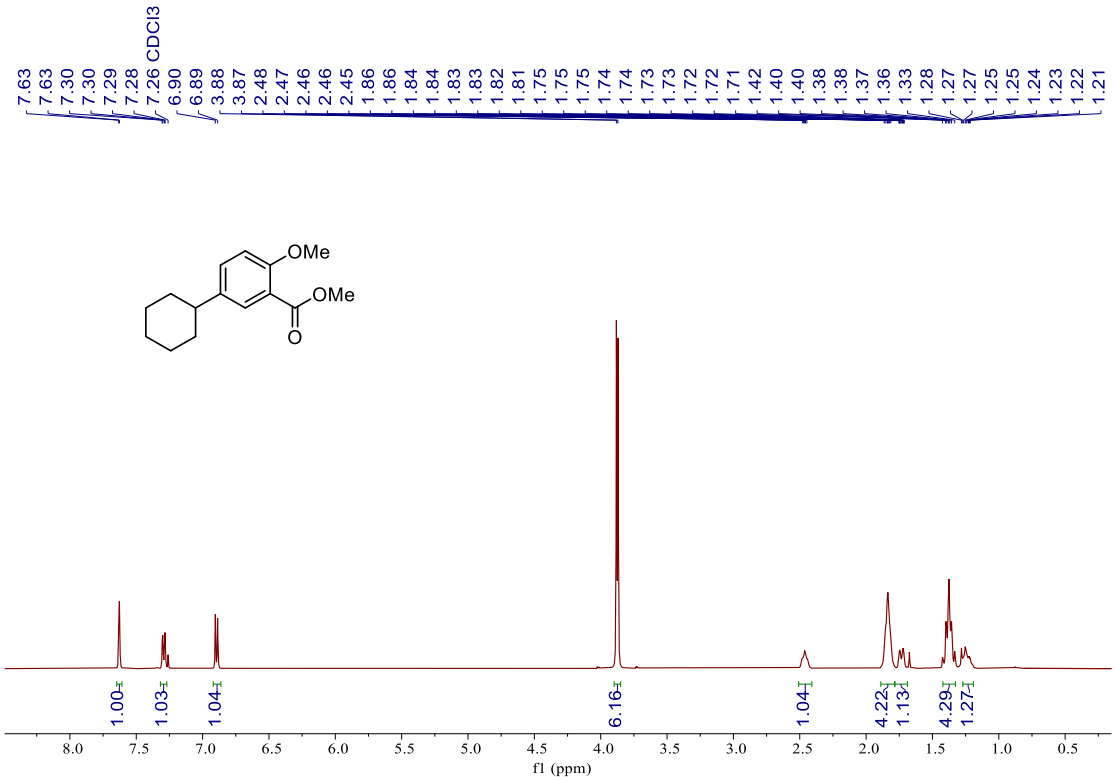
This compound was prepared using methyl 5-cyclohexyl-2-methoxybenzoate (50 mg, 0.2 mmol) and 1-Chloro-3-iodopropane (43 μL, 0.4 mmol) according to the General Procedure A, but using I_2 (56 mg, 0.22 mmol, 1.1 equiv.) and Selectfluor (85 mg, 0.24 mmol, 1.2 equiv.). After purification by column chromatography (SiO_2: 5%~10% ethyl acetate in petroleum ether), the title compound was isolated as a colorless oil (37.7 mg, 58% yield).

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.51 (s, 1H), 7.20 (s, 1H), 3.91 (s, 3H), 3.81 (s, 3H), 3.54 (t, *J* = 6.4 Hz, 2H), 2.80 (t, *J* = 7.5 Hz, 2H), 2.52 – 2.42 (m, 1H), 2.11 – 2.05 (m, 2H), 1.90 – 1.79 (m, 4H), 1.78 – 1.70 (m, 1H), 1.45 – 1.31 (m, 5H).

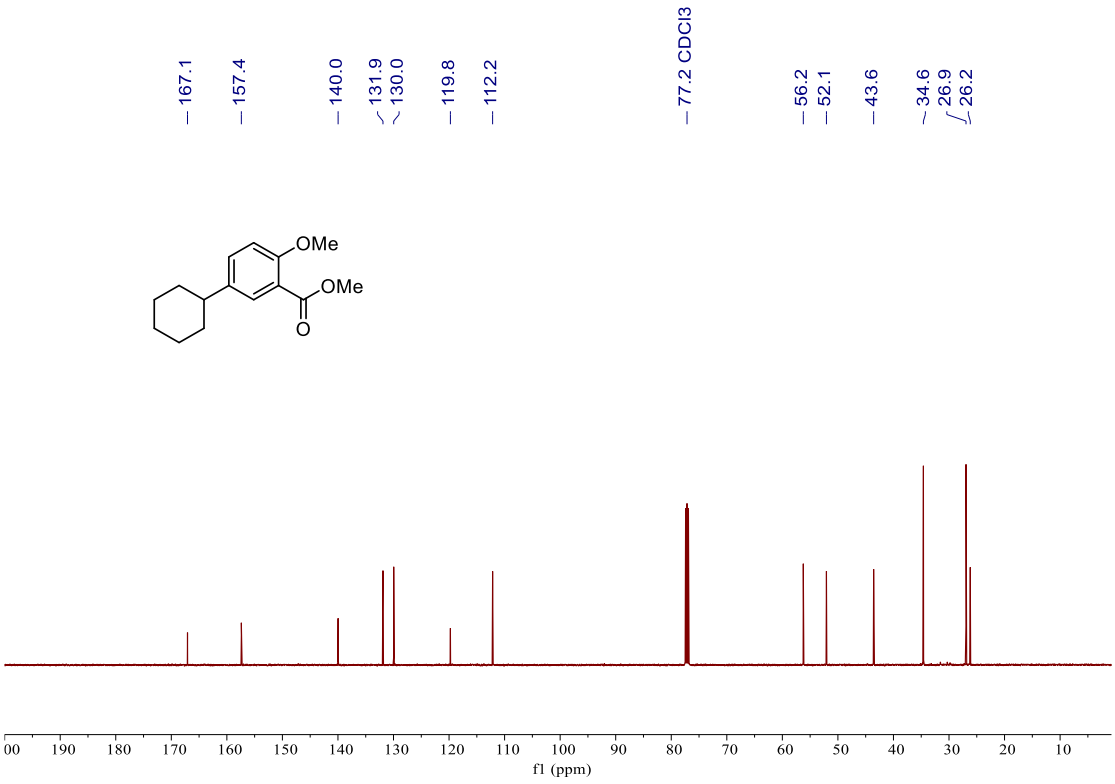
^{13}C NMR (126 MHz, $CDCl_3$) δ 167.2, 156.5, 143.6, 135.0, 133.2, 128.0, 124.3, 62.4, 52.3, 44.7, 43.9, 34.5, 33.3, 27.6, 26.9, 26.2.

HRMS (ESI): m/z calcd for $C_{18}H_{26}ClO_3^+$ $[M + H]^+$:325.1565; found: 325.1566.

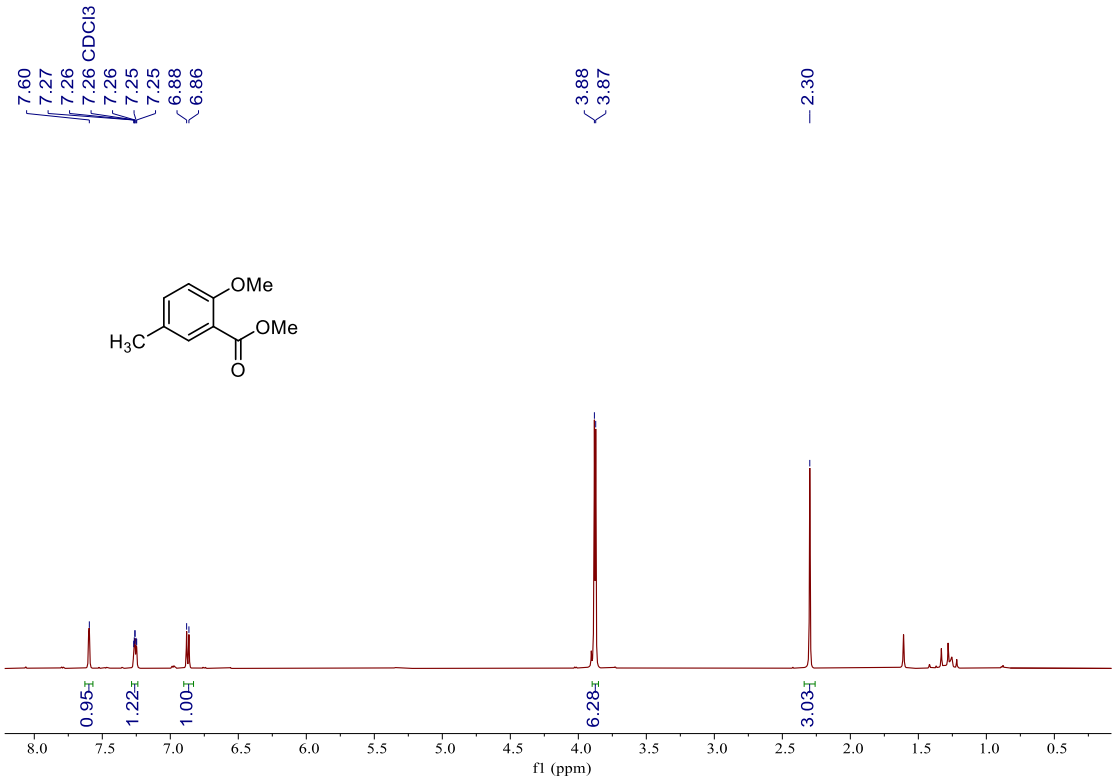
6. Spectra of Compounds



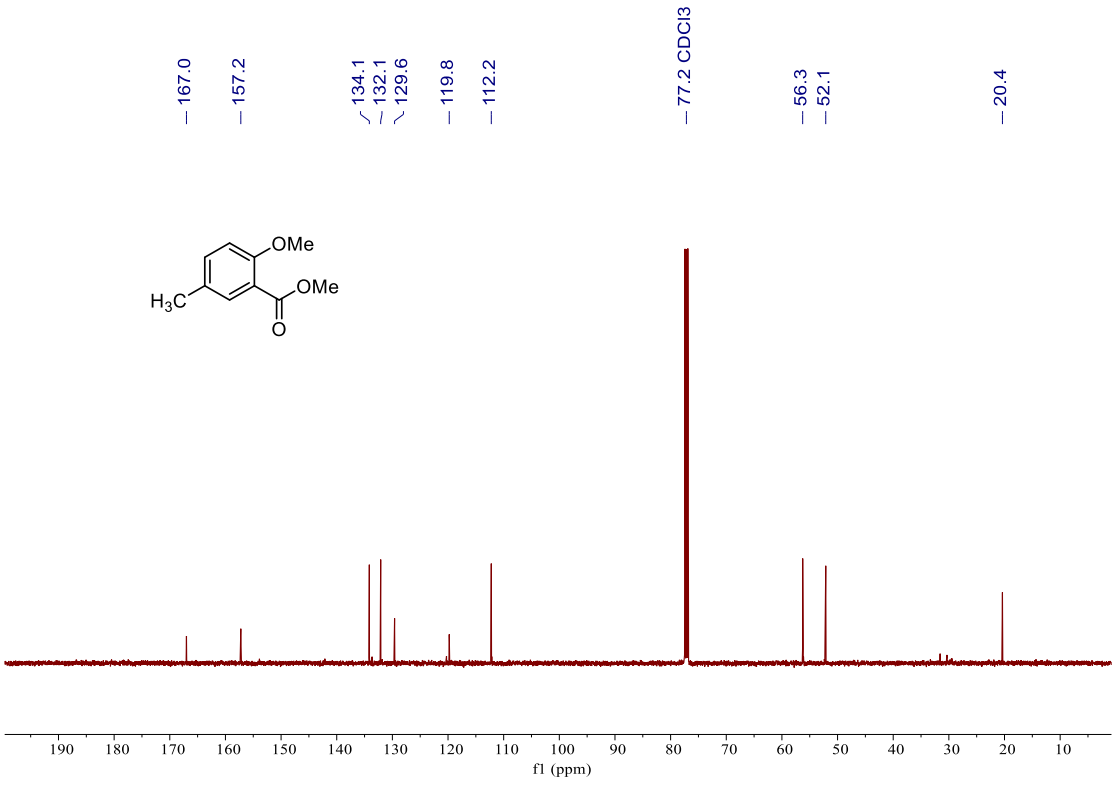
2, ^{1}H NMR (500 MHz, $CDCl_3$)



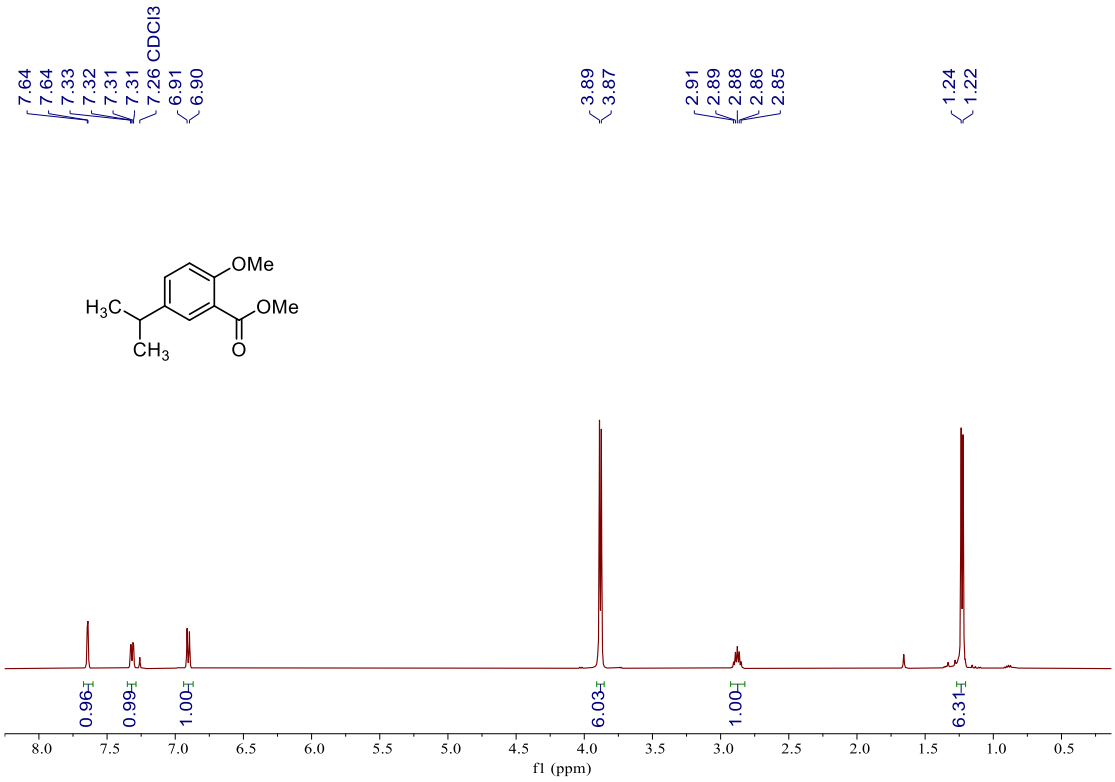
2, ^{13}C NMR (126 MHz, $CDCl_3$)



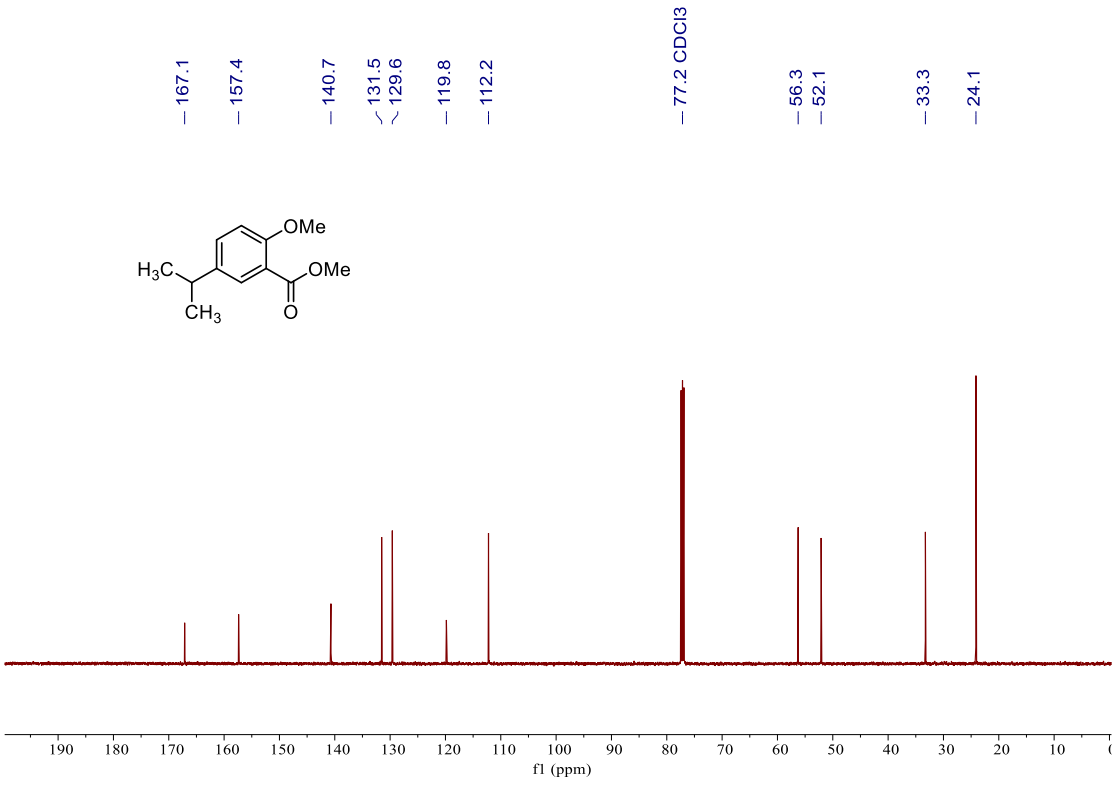
3a, ^{1}H NMR (500 MHz, $CDCl_3$)



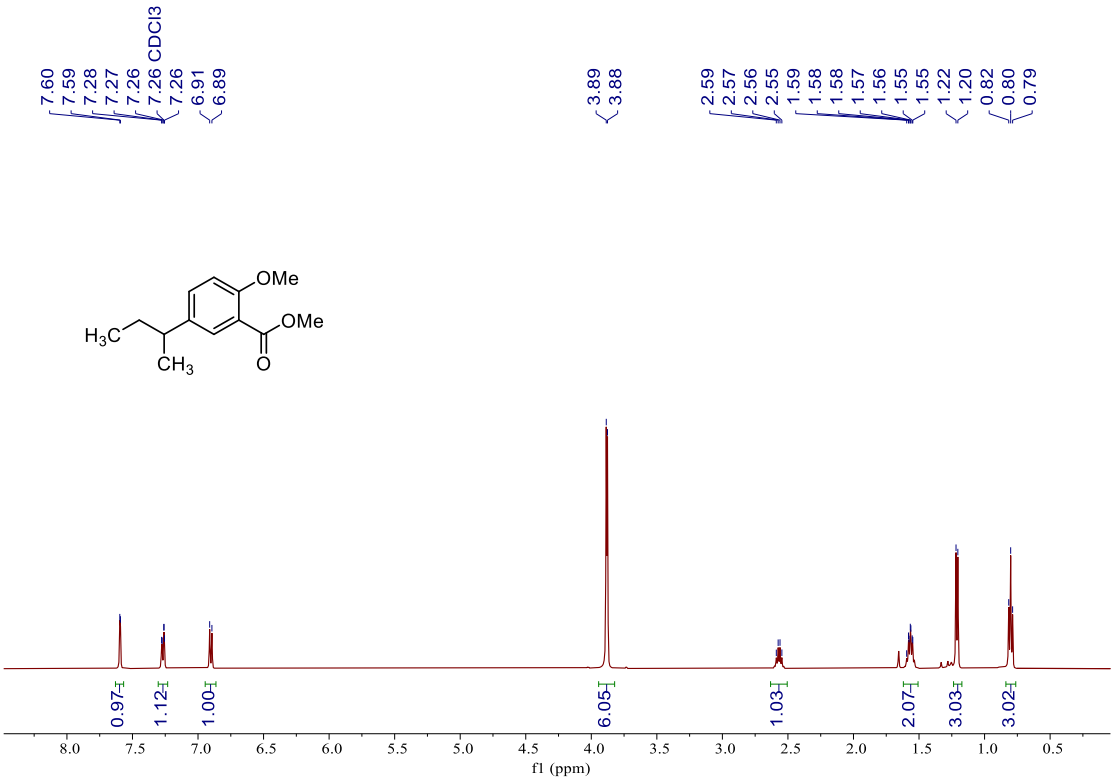
3a, ^{13}C NMR (126 MHz, $CDCl_3$)



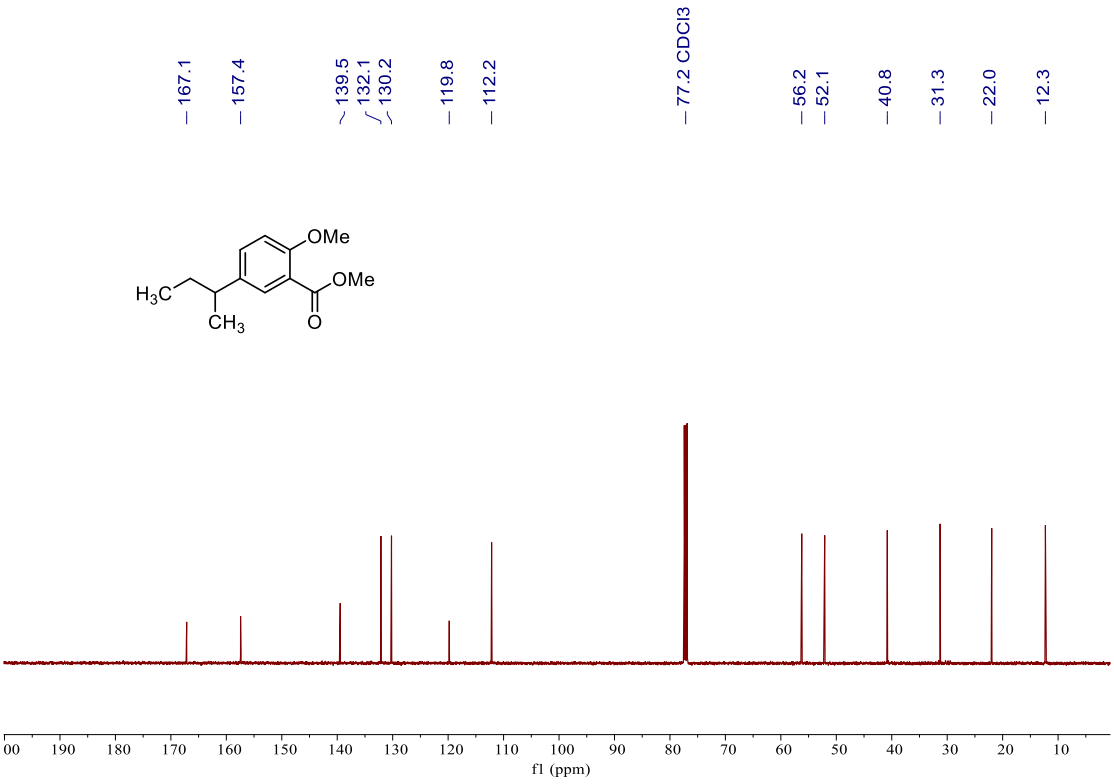
3b, ^{1}H NMR (500 MHz, $CDCl_3$)



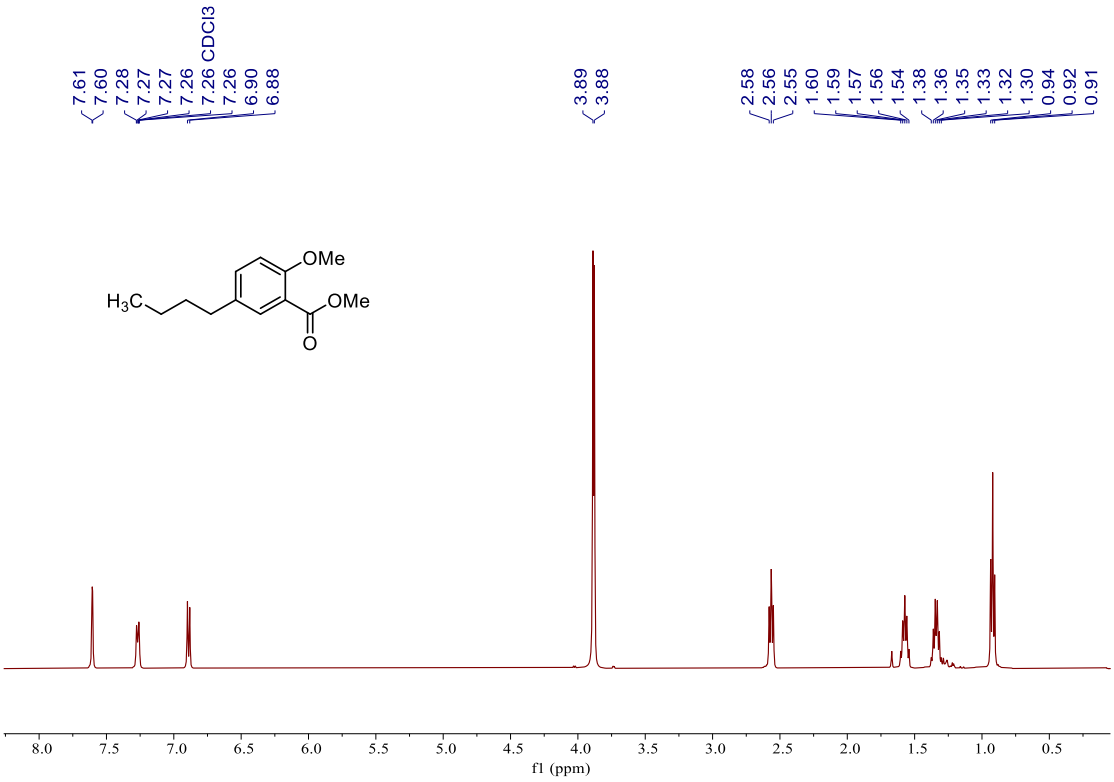
3b, ^{13}C NMR (126 MHz, $CDCl_3$)



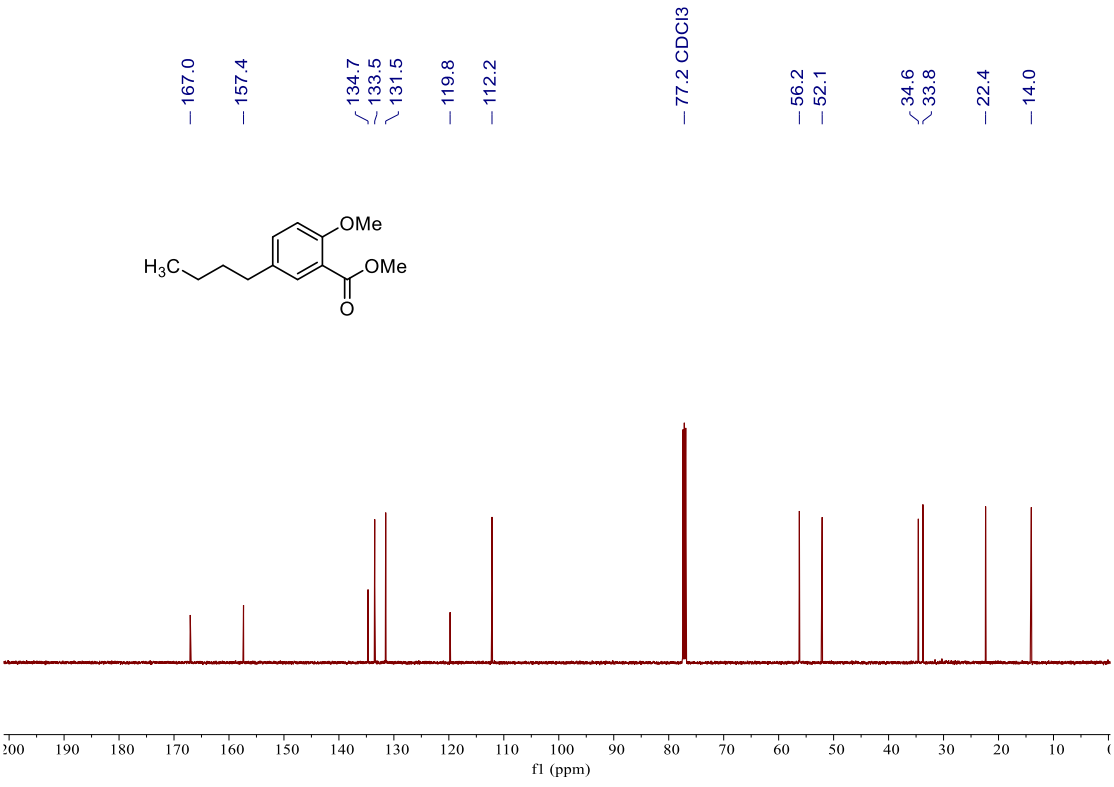
3c, ^{1}H NMR (500 MHz, $CDCl_3$)



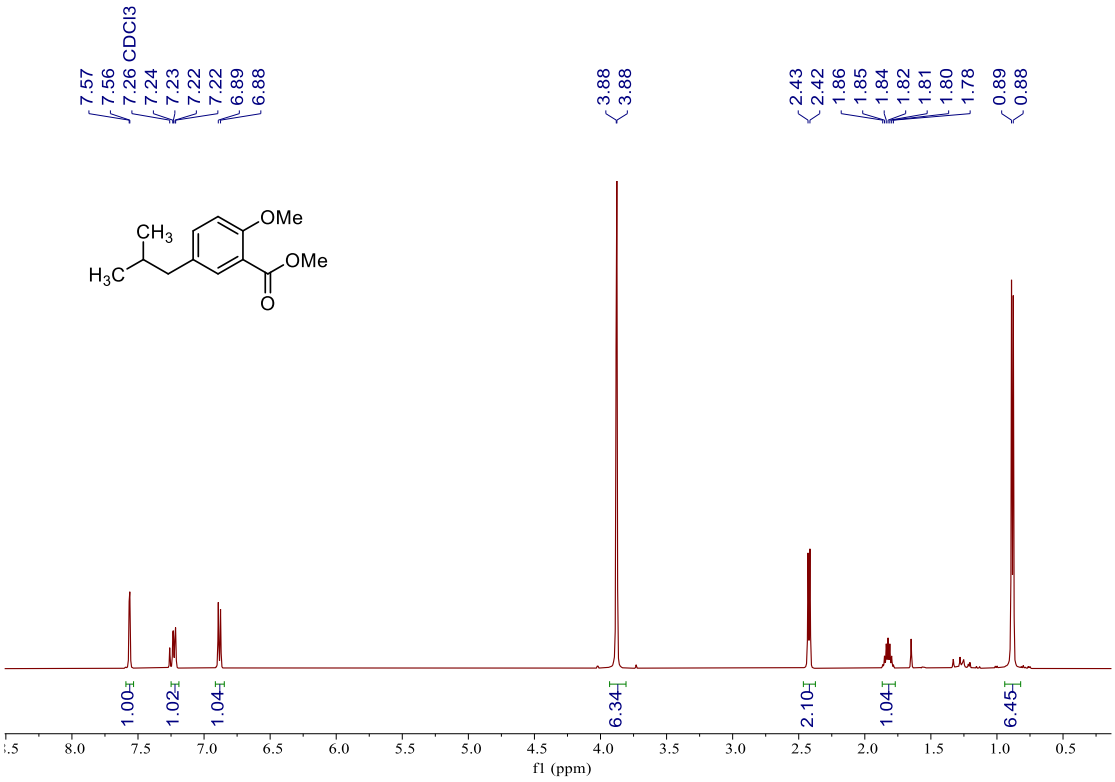
3c, ^{13}C NMR (126 MHz, $CDCl_3$)



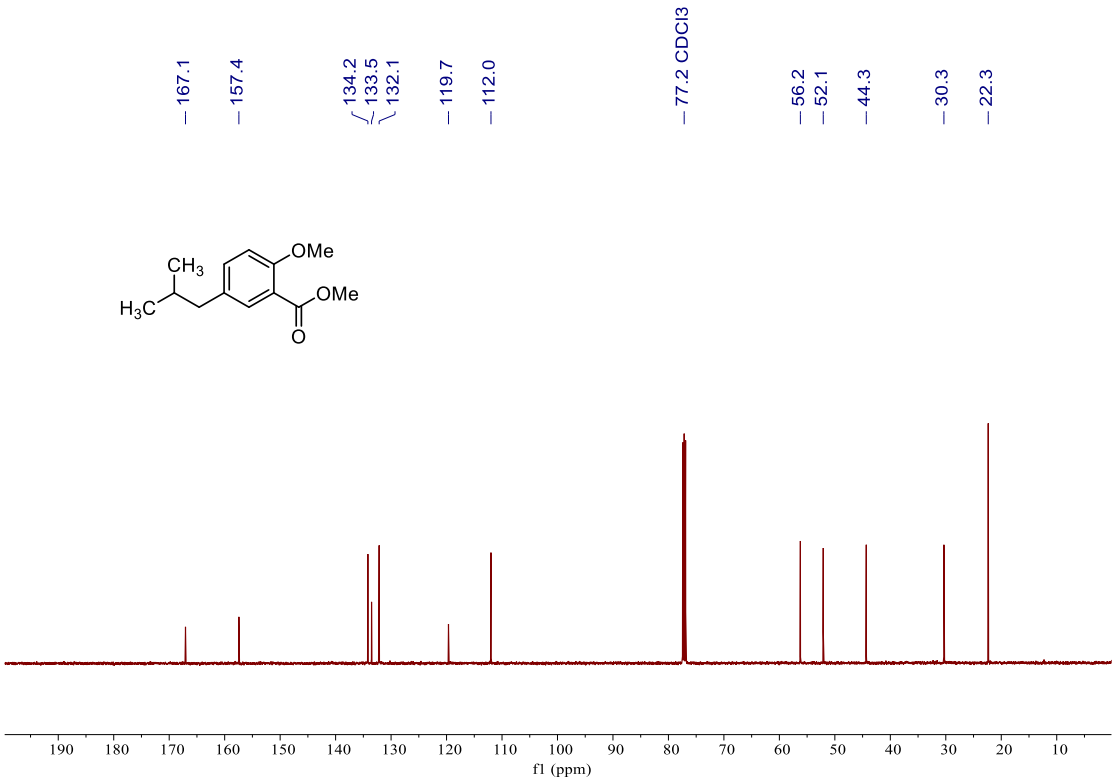
3d, ^{1}H NMR (500 MHz, $CDCl_3$)



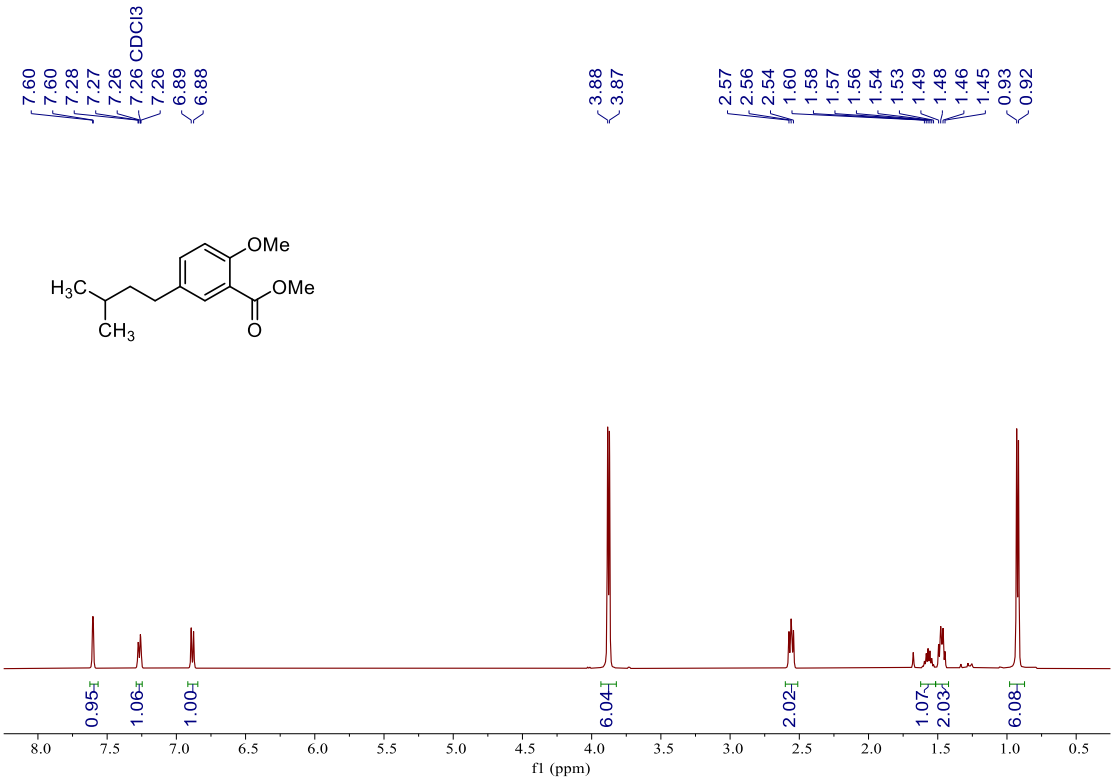
3d, ^{13}C NMR (126 MHz, $CDCl_3$)



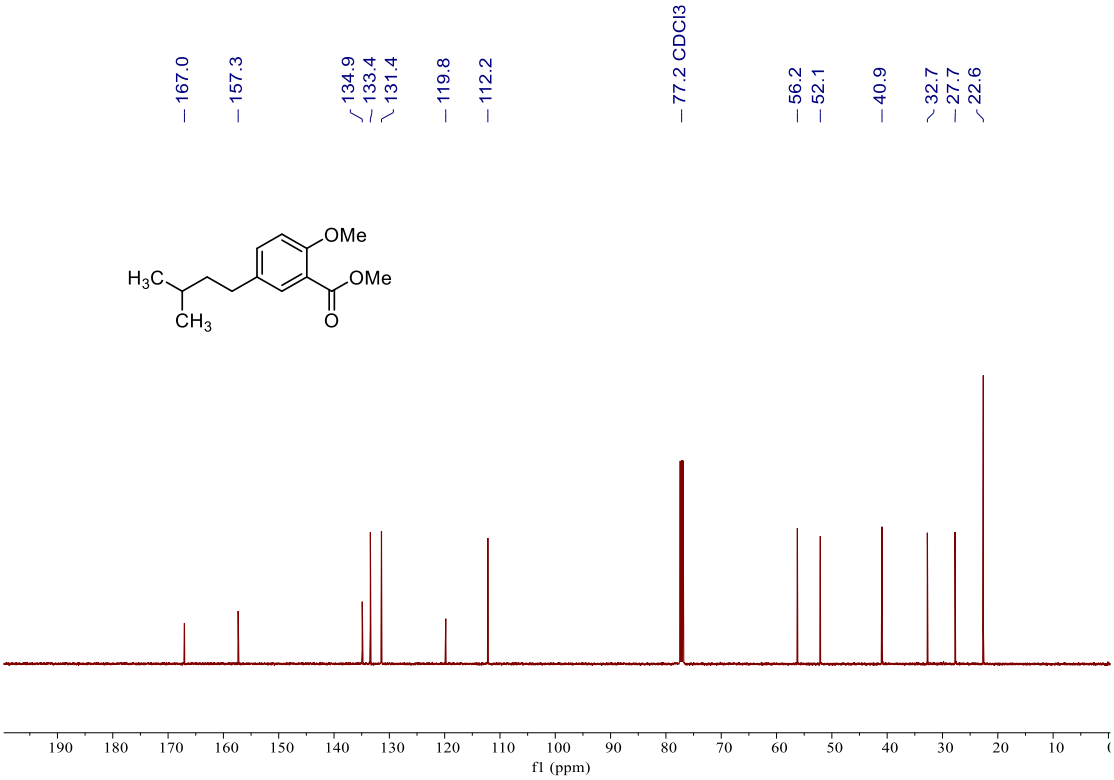
3e, ^{1}H NMR (500 MHz, $CDCl_3$)



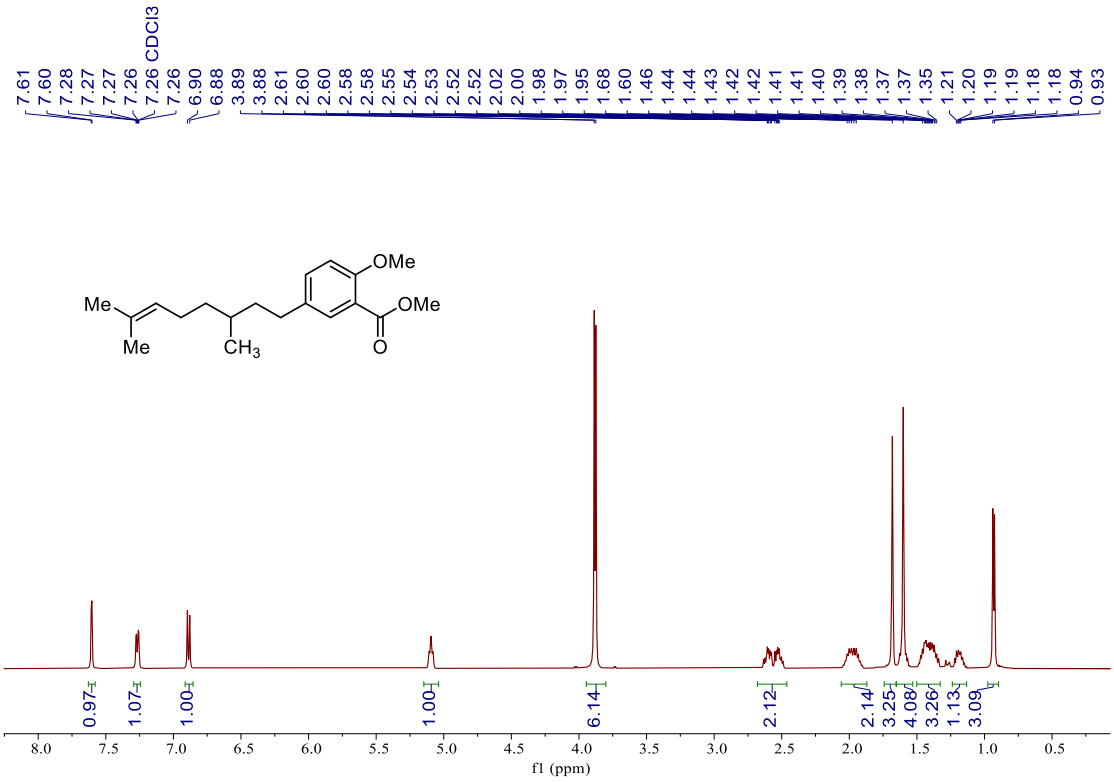
3e, ^{13}C NMR (126 MHz, $CDCl_3$)



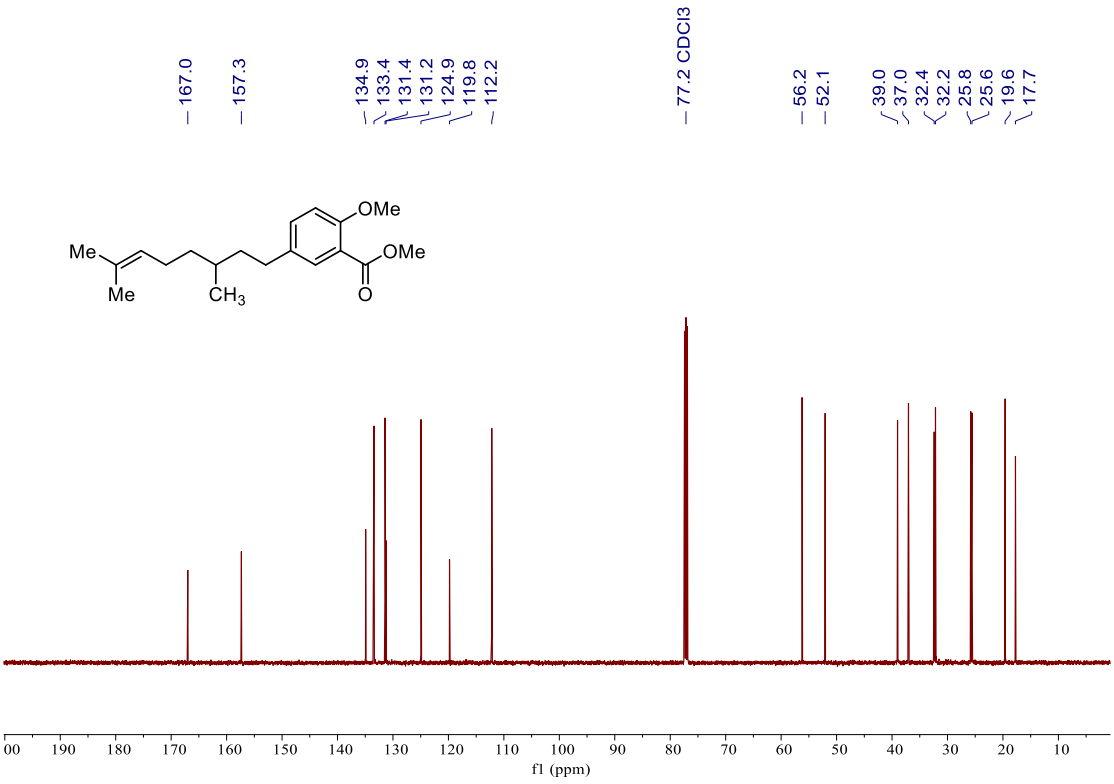
3f, ^{1}H NMR (500 MHz, $CDCl_3$)



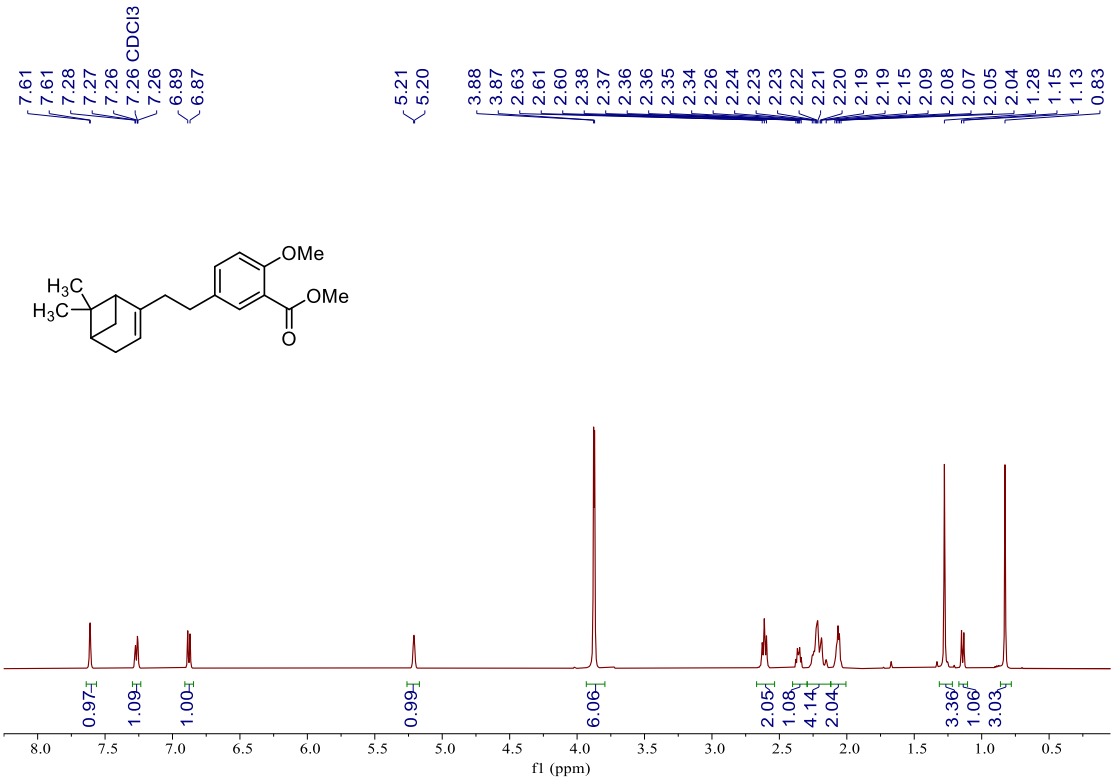
3f, ^{13}C NMR (126 MHz, $CDCl_3$)



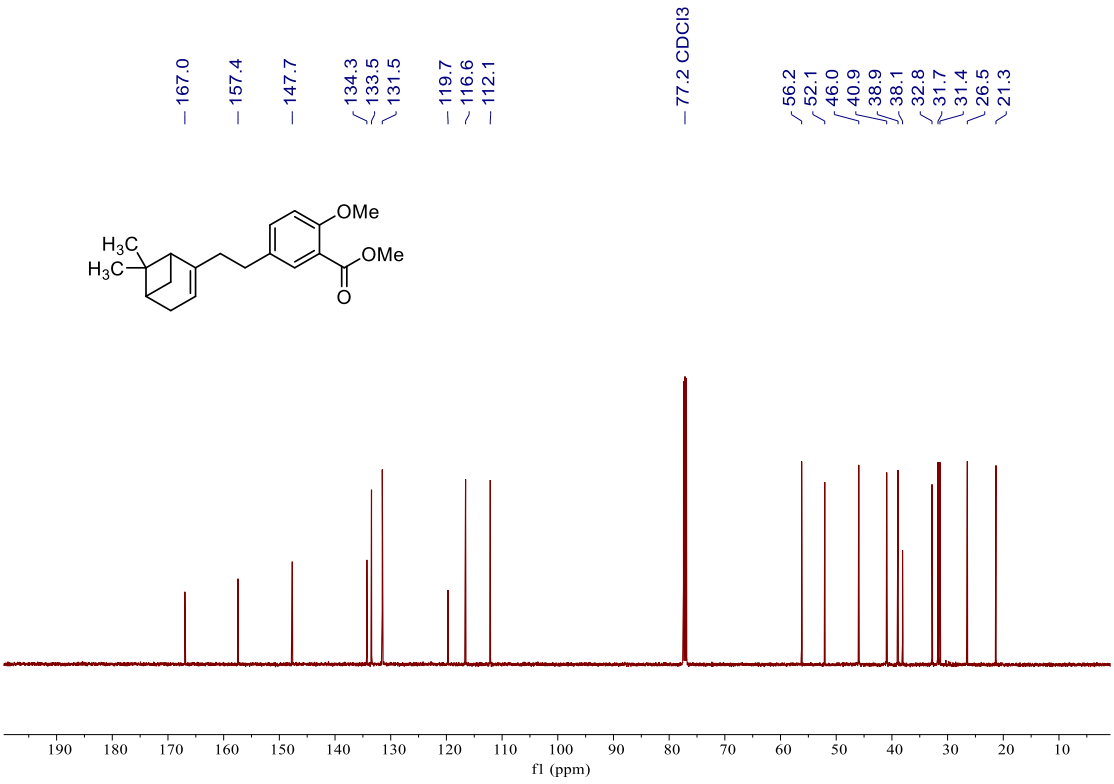
3g, ^{1}H NMR (500 MHz, $CDCl_3$)



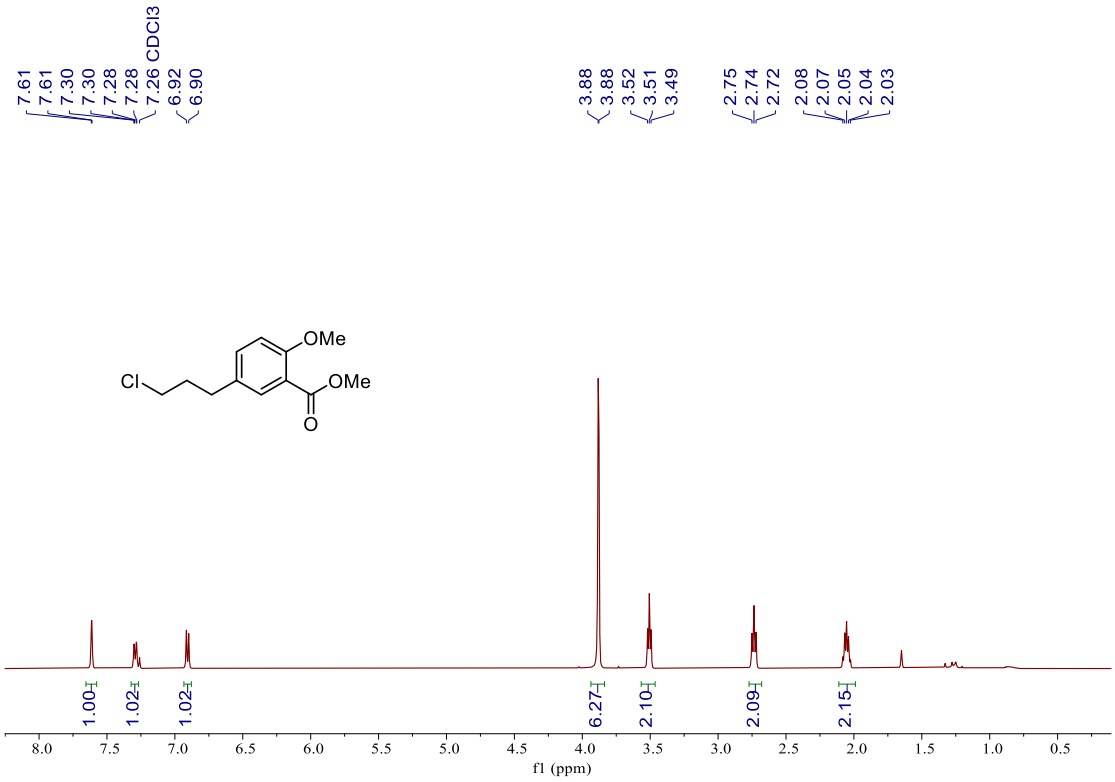
3g, ^{13}C NMR (126 MHz, $CDCl_3$)



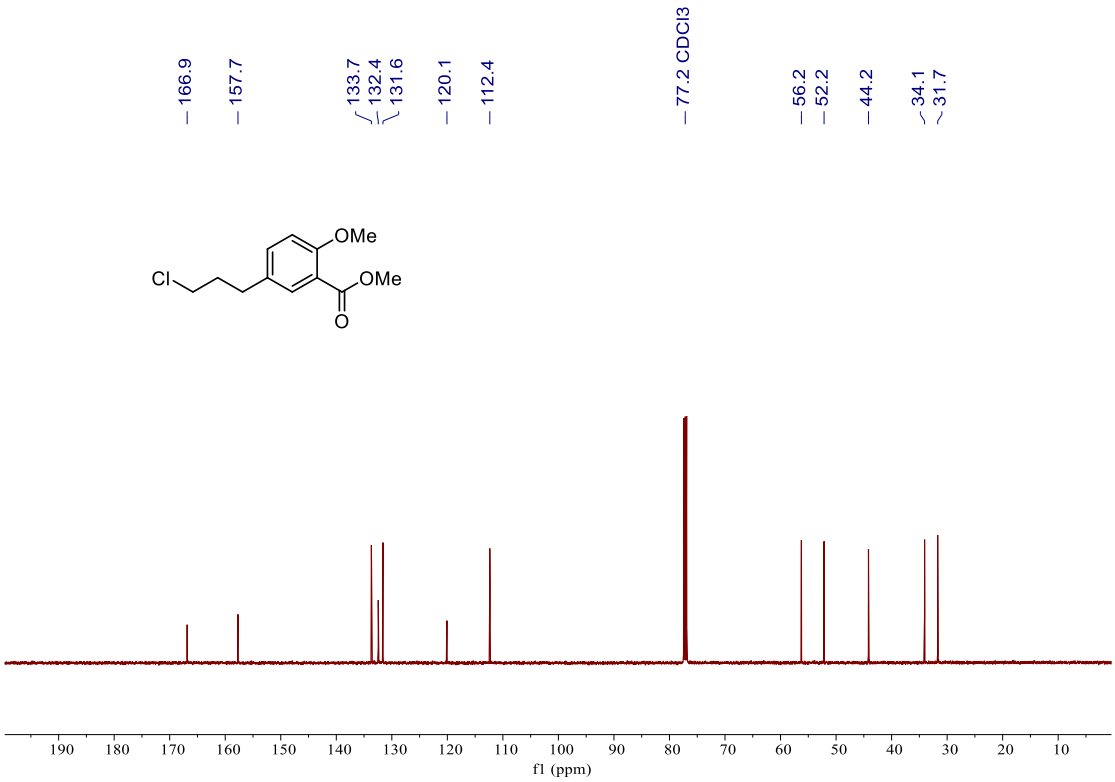
3h, ^{1}H NMR (500 MHz, $CDCl_3$)



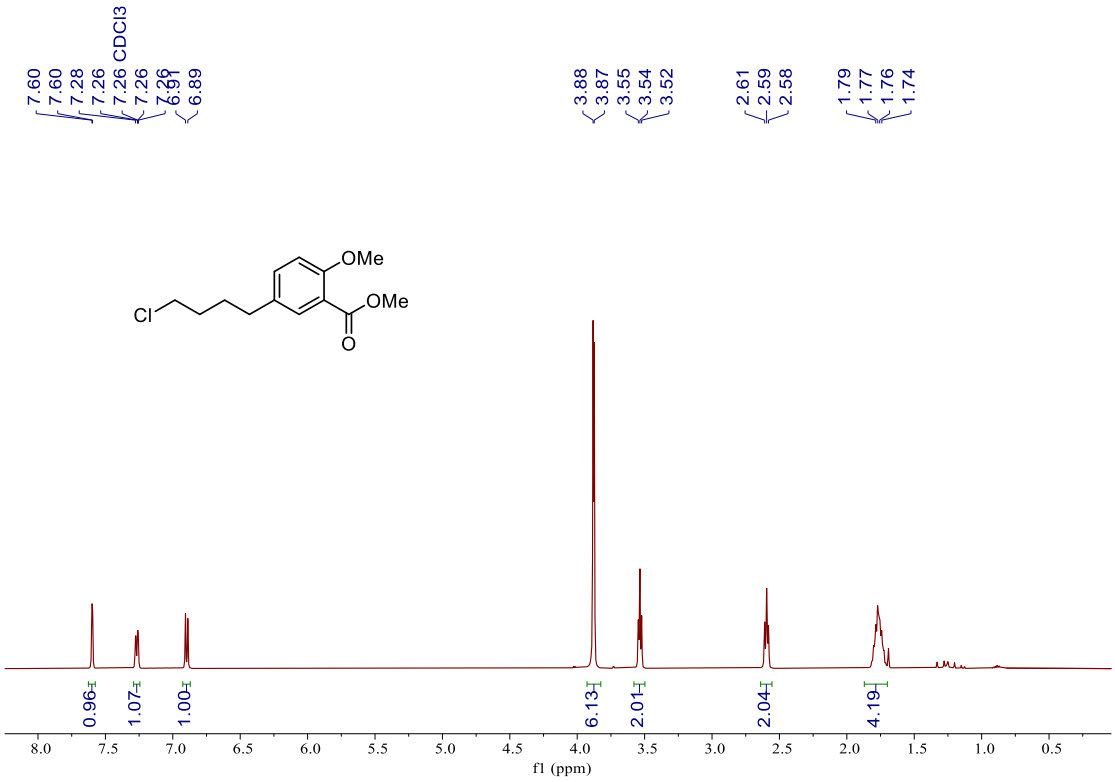
3h, ^{13}C NMR (126 MHz, $CDCl_3$)



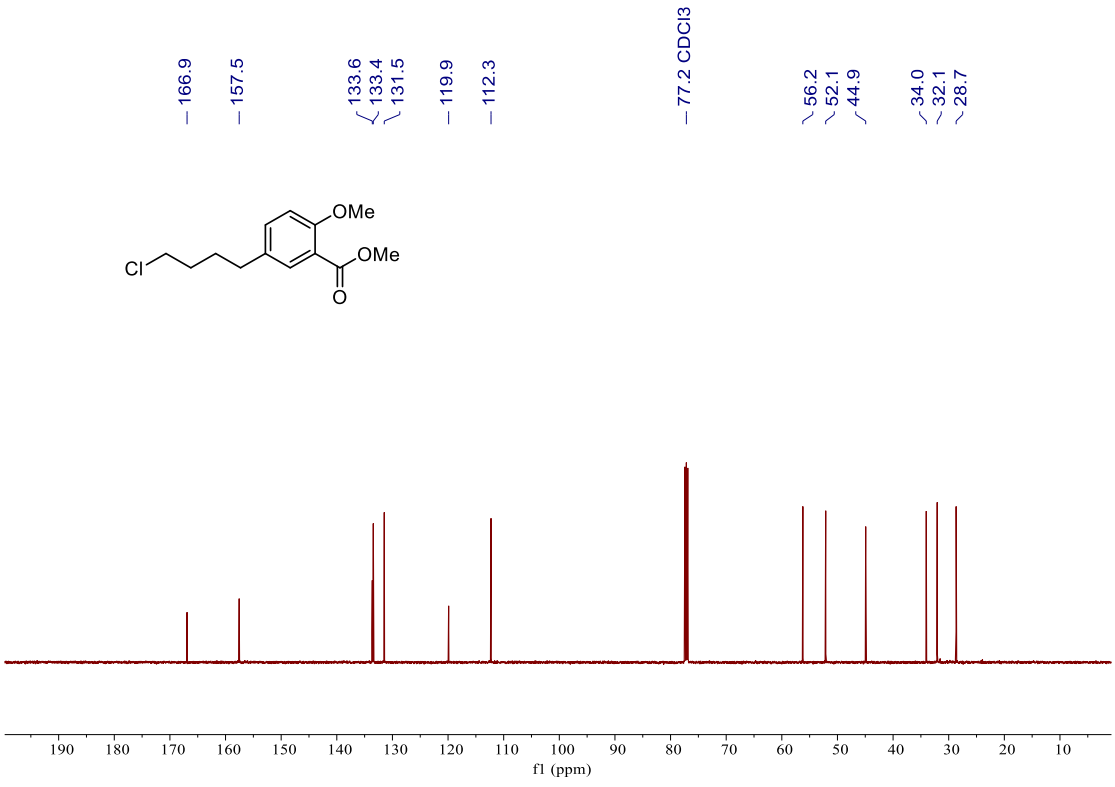
3i, ^{1}H NMR (500 MHz, $CDCl_3$)



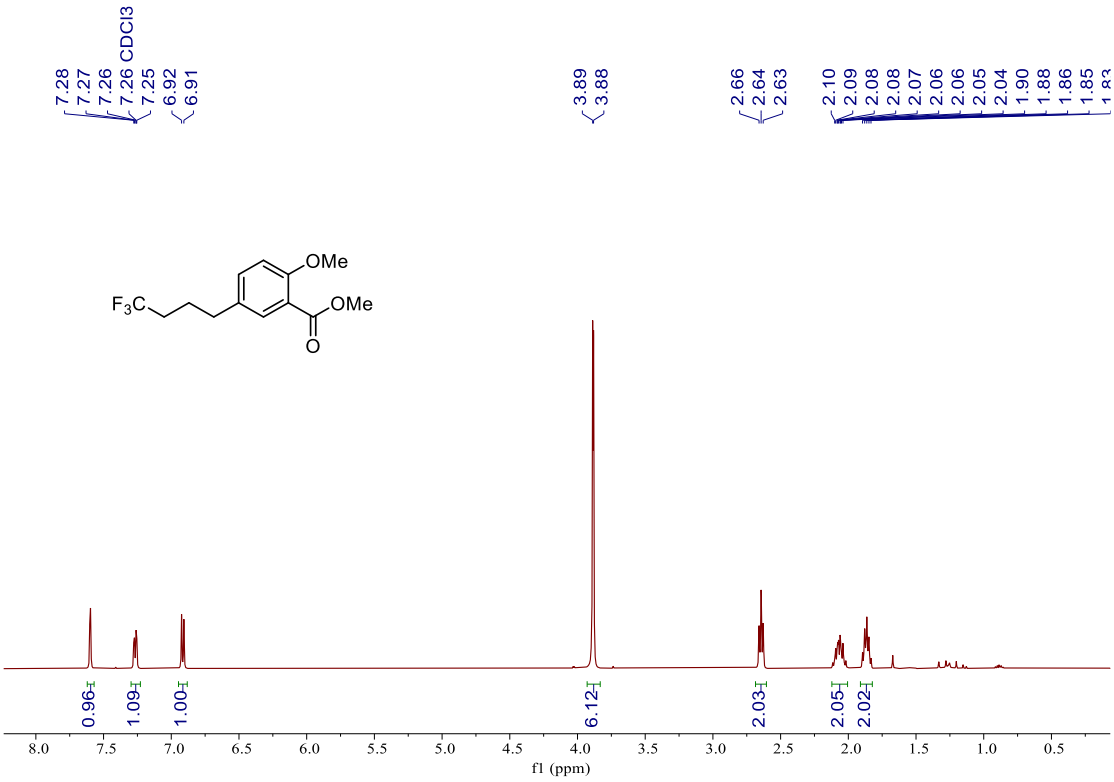
3i, ^{13}C NMR (126 MHz, $CDCl_3$)



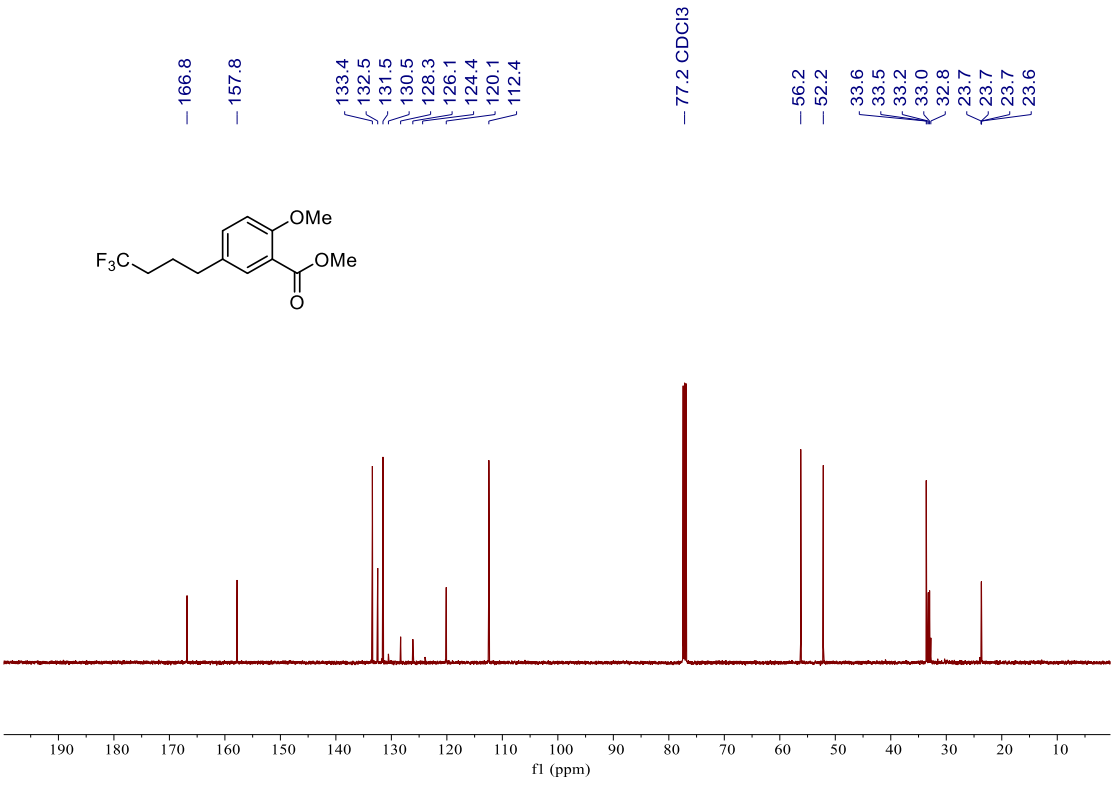
3j, ^{1}H NMR (500 MHz, $CDCl_3$)



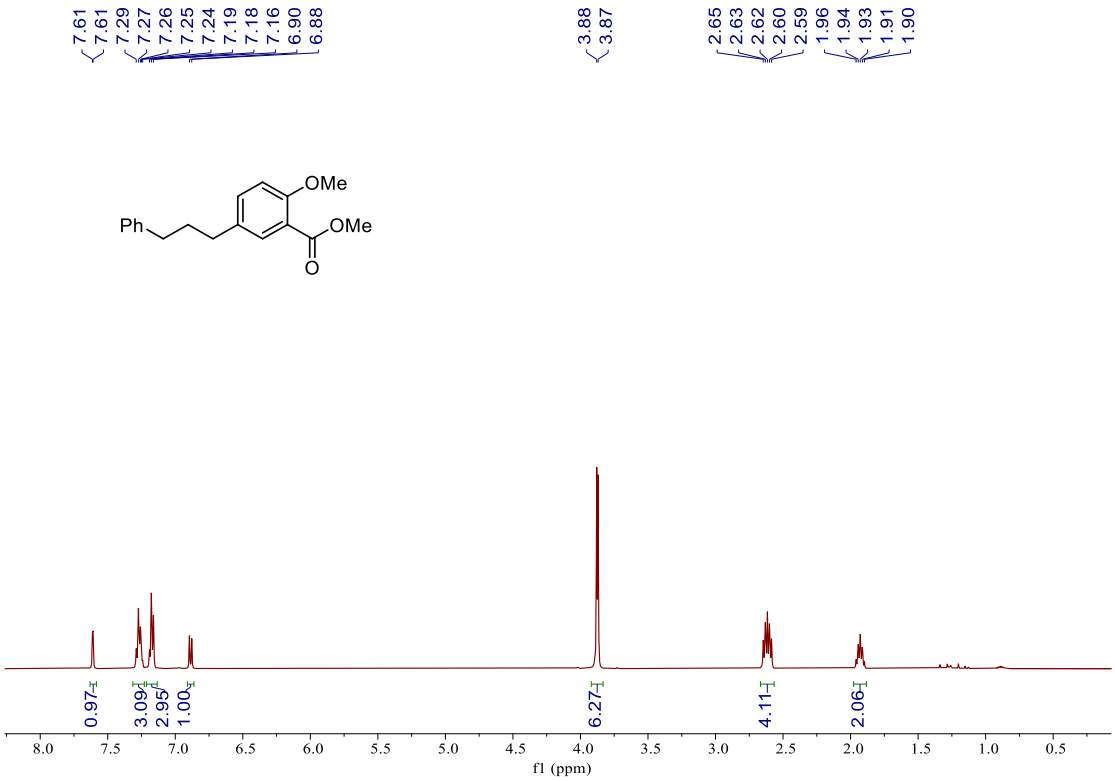
3j, ^{13}C NMR (126 MHz, $CDCl_3$)



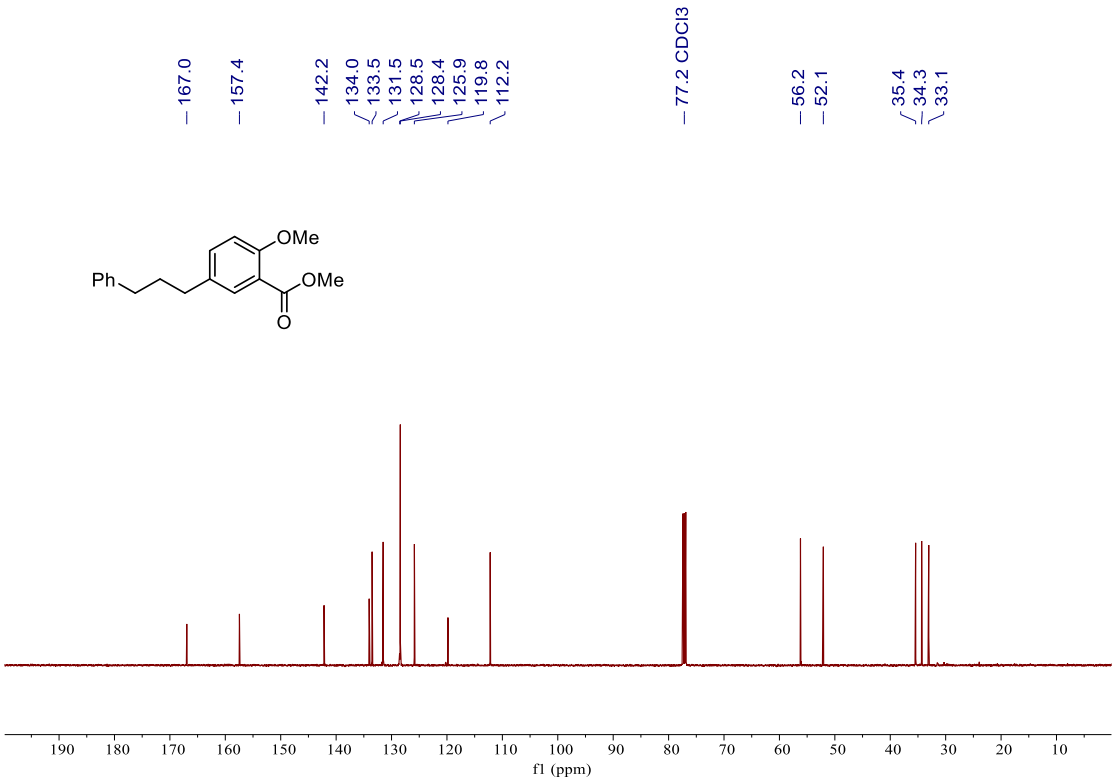
3k, ^{1}H NMR (500 MHz, $CDCl_3$)



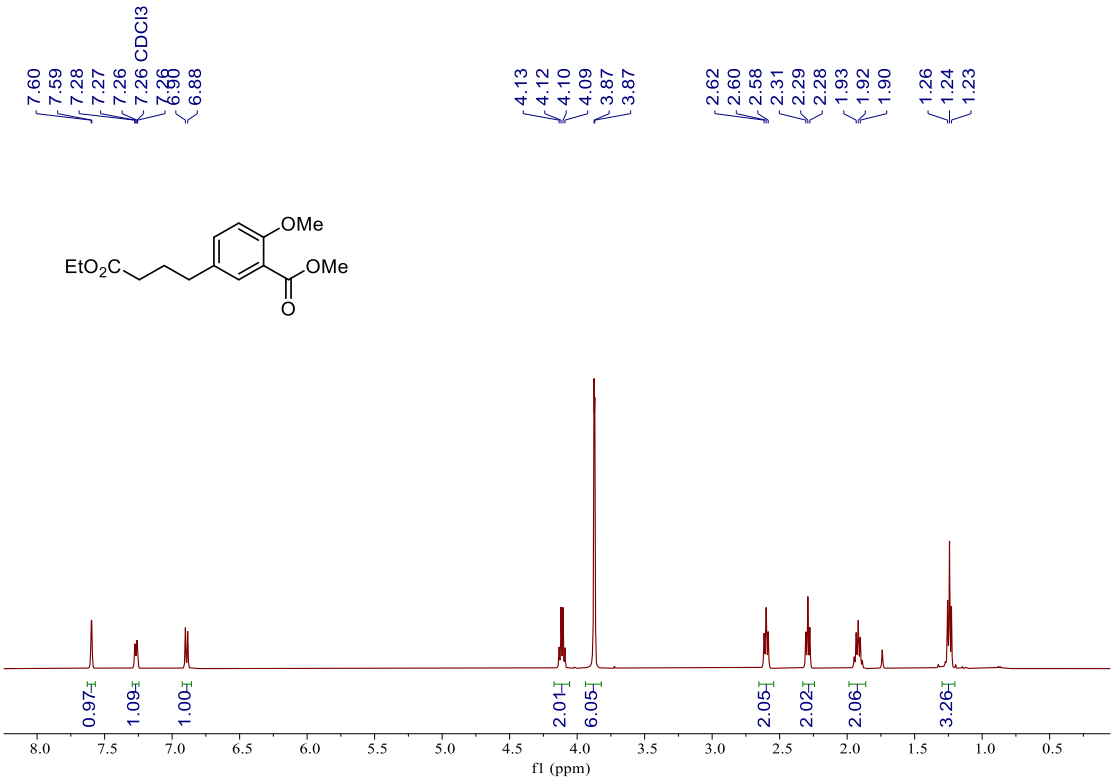
3k, ^{13}C NMR (126 MHz, $CDCl_3$)



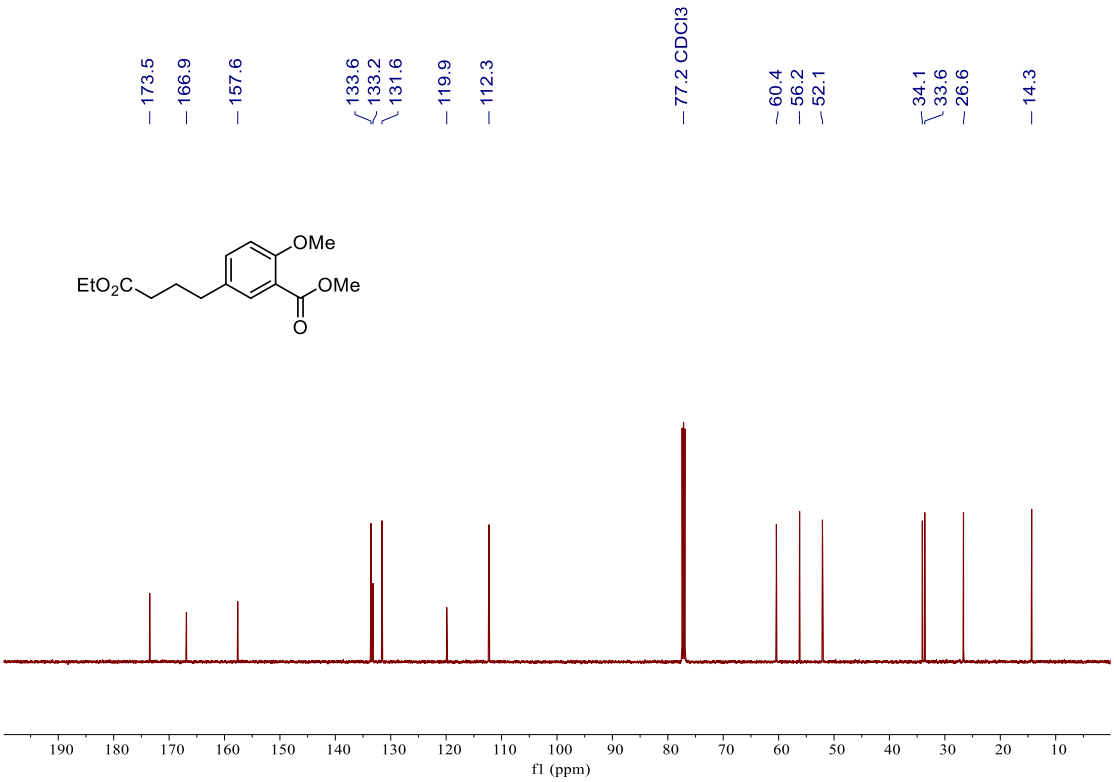
3l, ^{1}H NMR (500 MHz, $CDCl_3$)



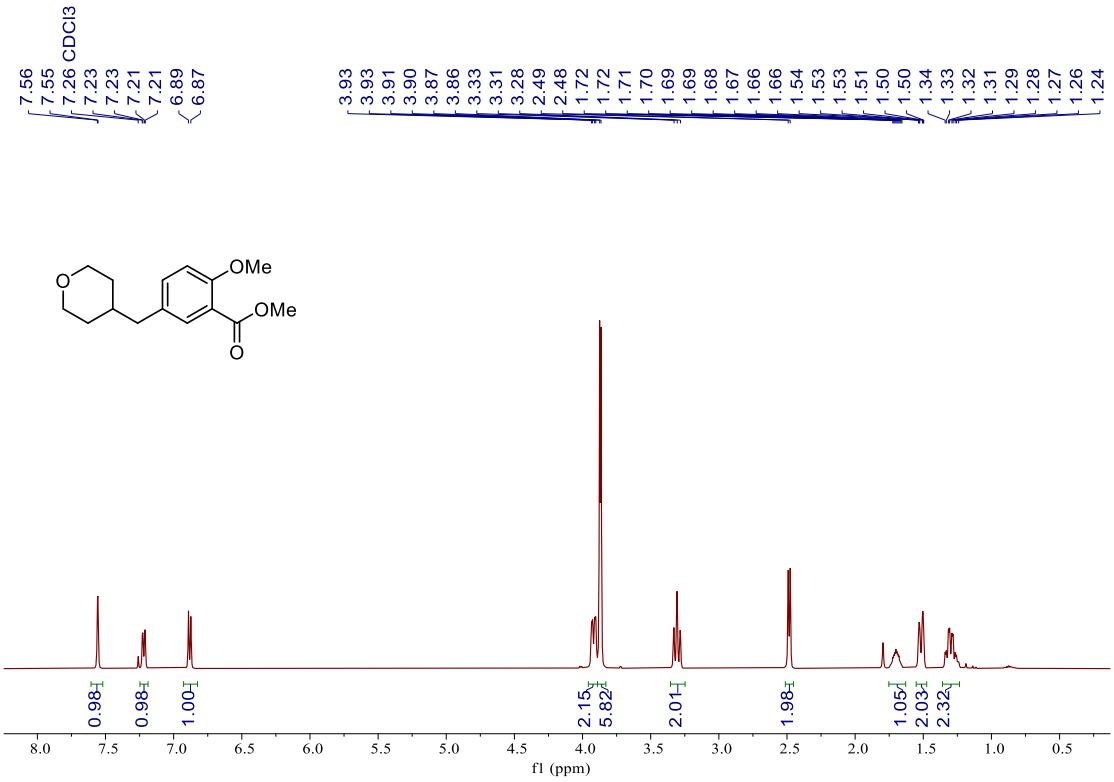
3l, ^{13}C NMR (126 MHz, $CDCl_3$)



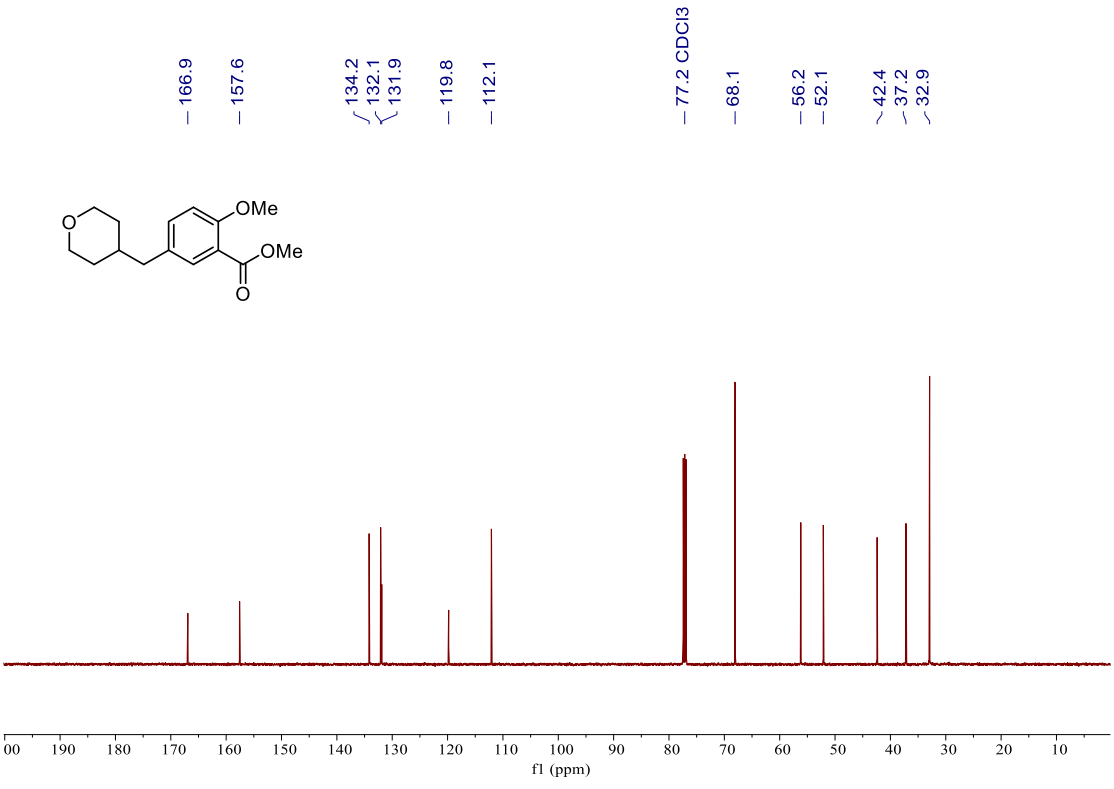
3m, ^{1}H NMR (500 MHz, $CDCl_3$)



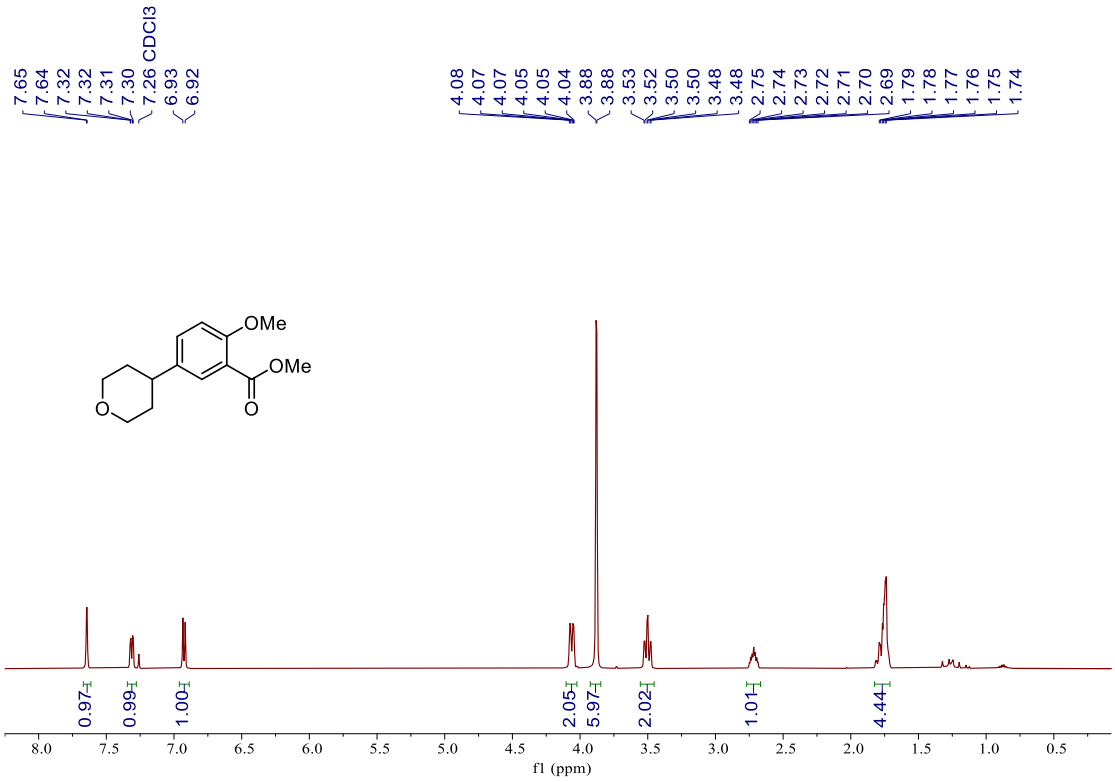
3m, ^{13}C NMR (126 MHz, $CDCl_3$)



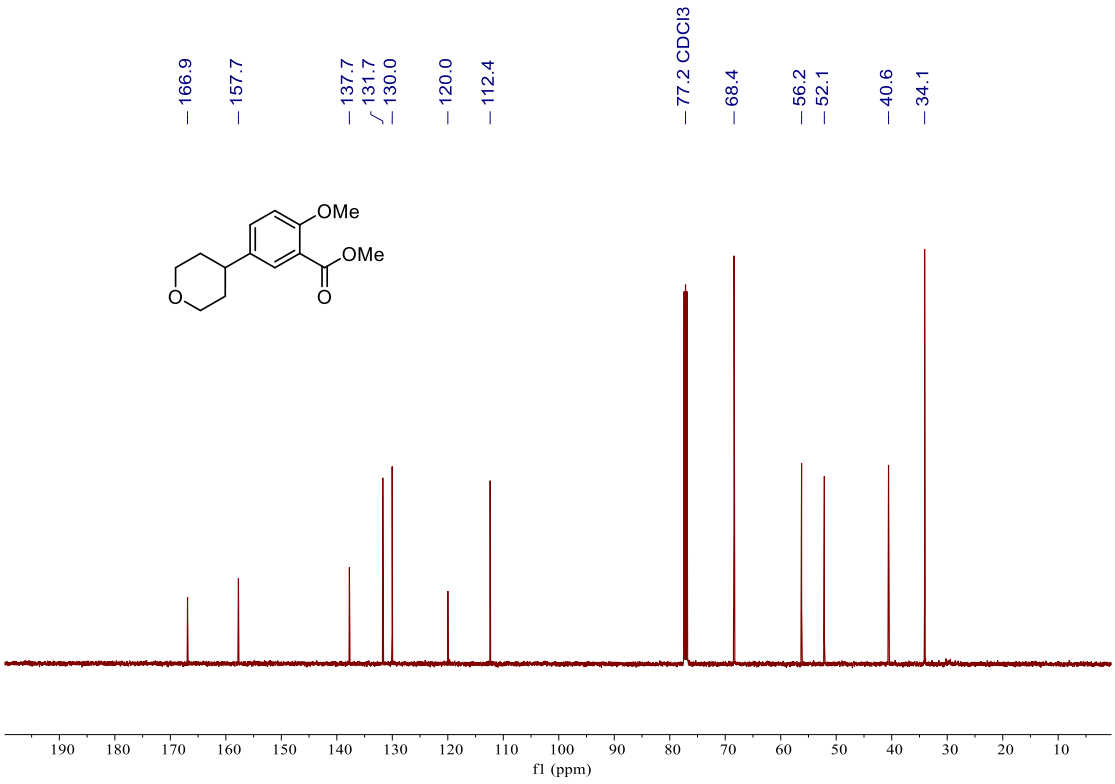
3n, ^{1}H NMR (500 MHz, $CDCl_3$)



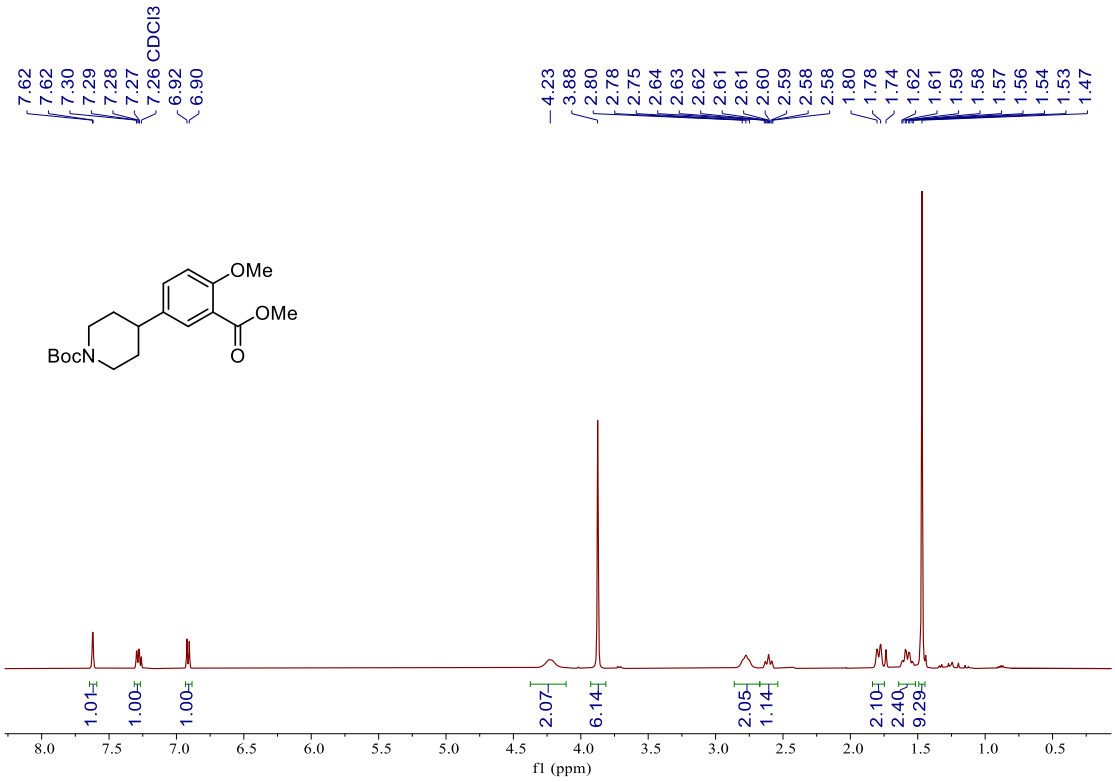
3n, ^{13}C NMR (126 MHz, $CDCl_3$)



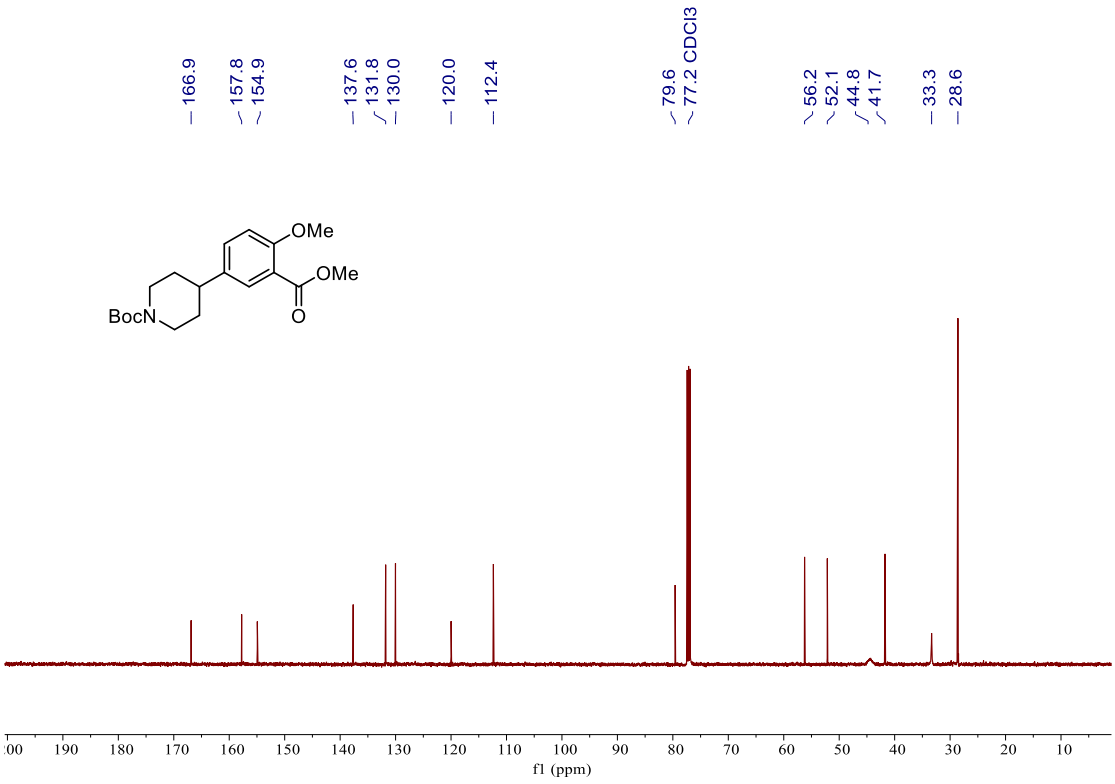
3o, ^{1}H NMR (500 MHz, $CDCl_3$)



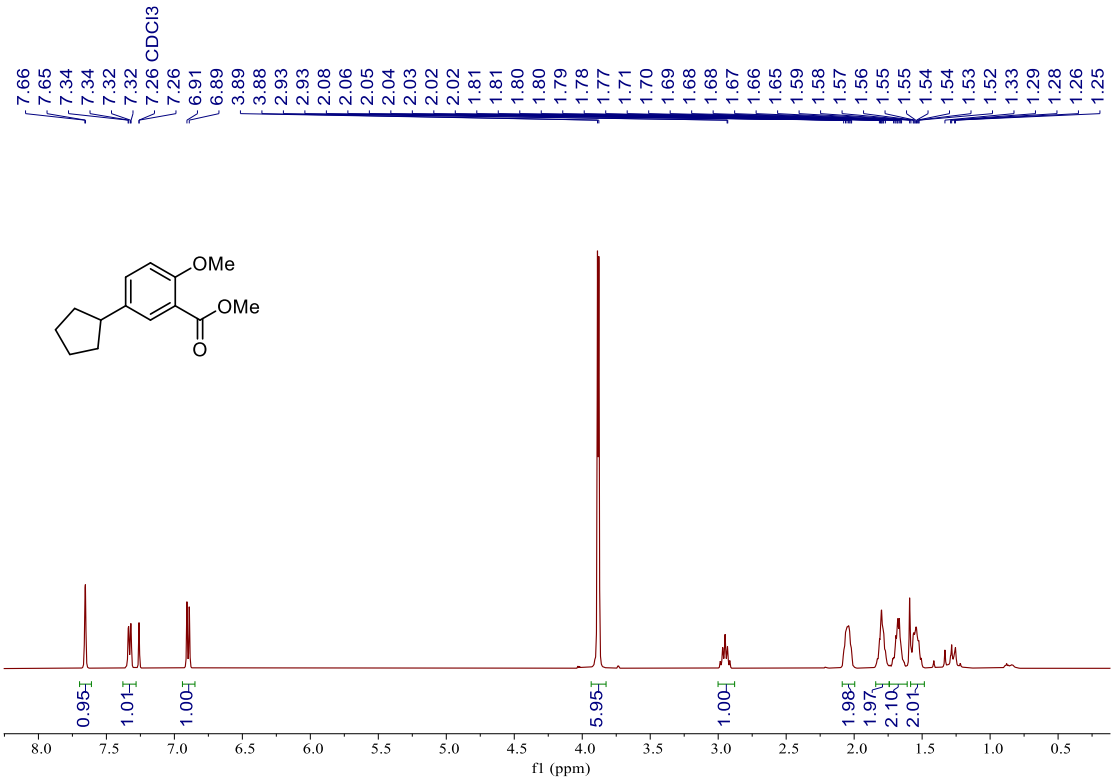
3o, ^{13}C NMR (126 MHz, $CDCl_3$)



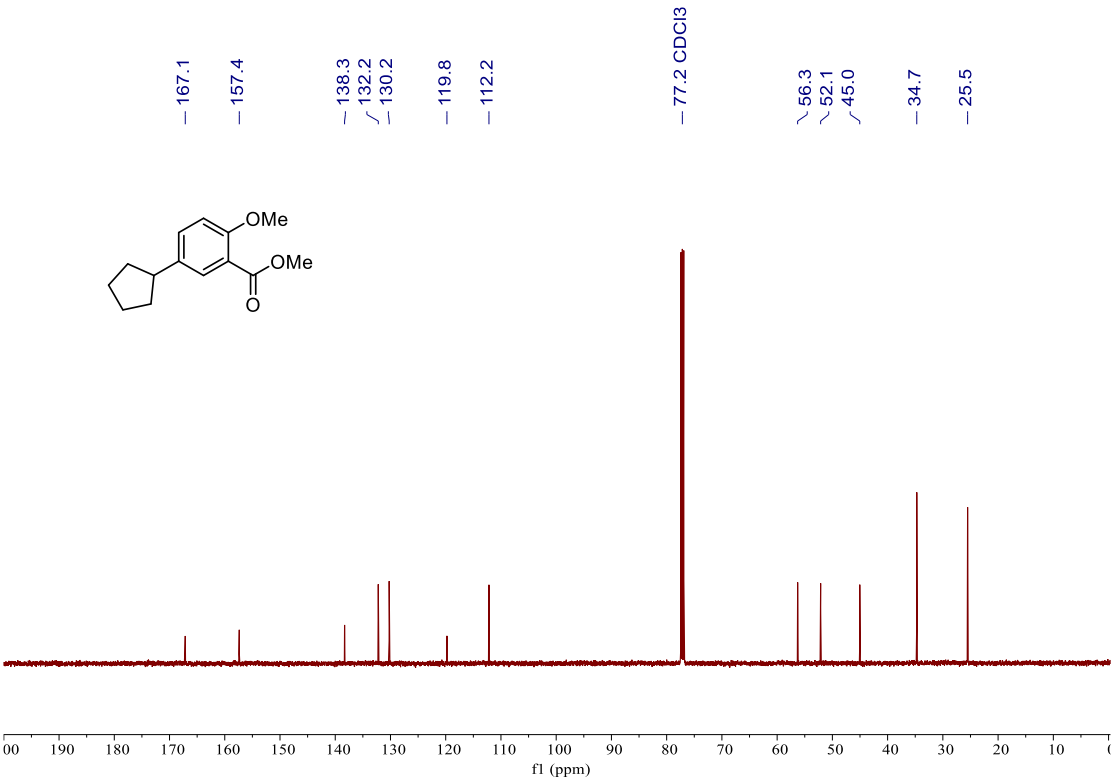
3p, ^{1}H NMR (500 MHz, $CDCl_3$)



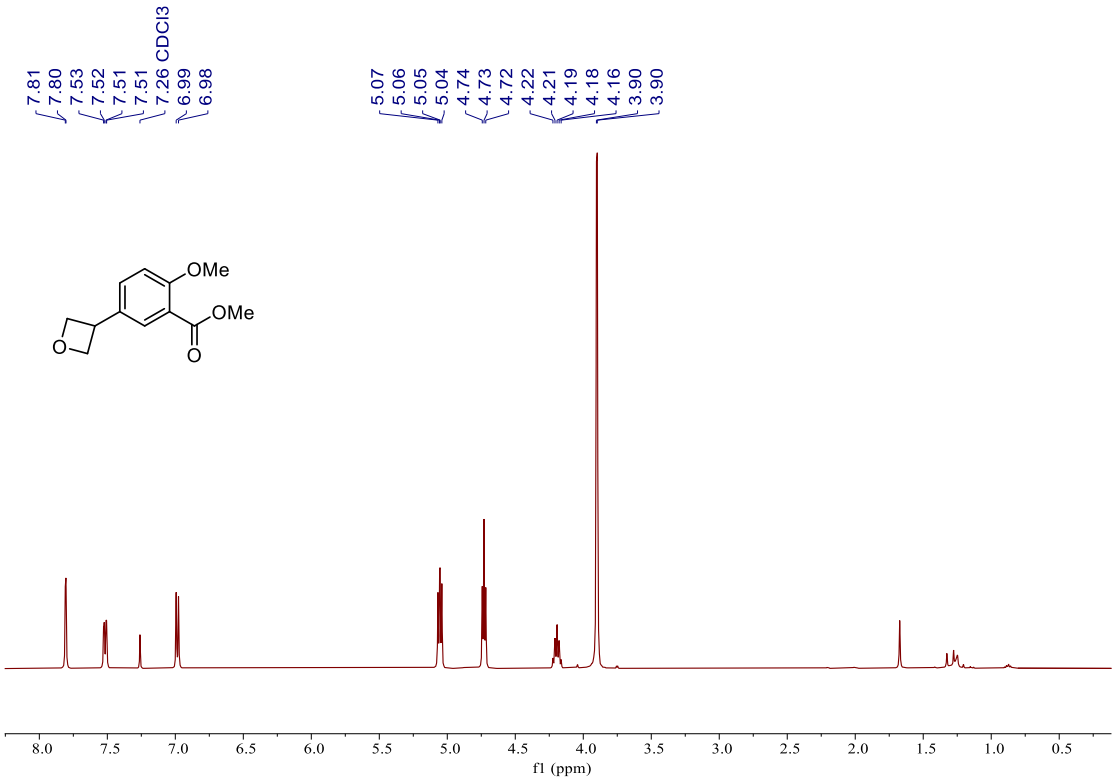
3p, ^{13}C NMR (126 MHz, $CDCl_3$)



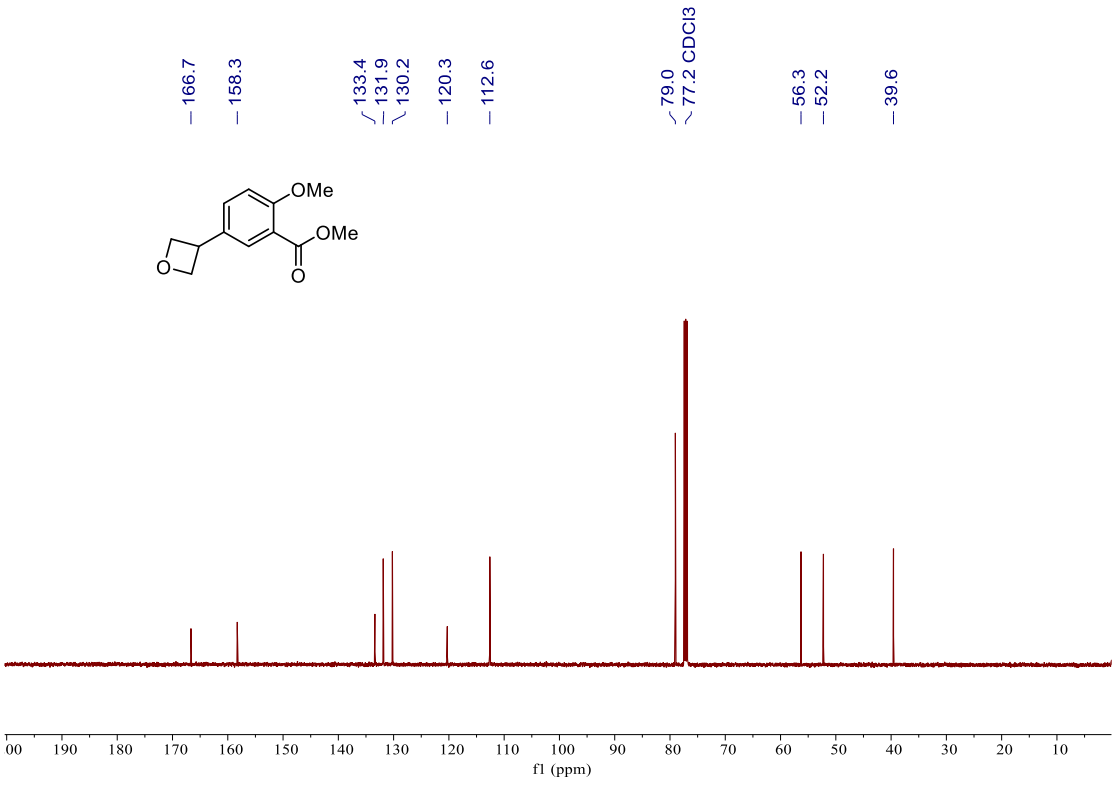
3q, ^{1}H NMR (500 MHz, $CDCl_3$)



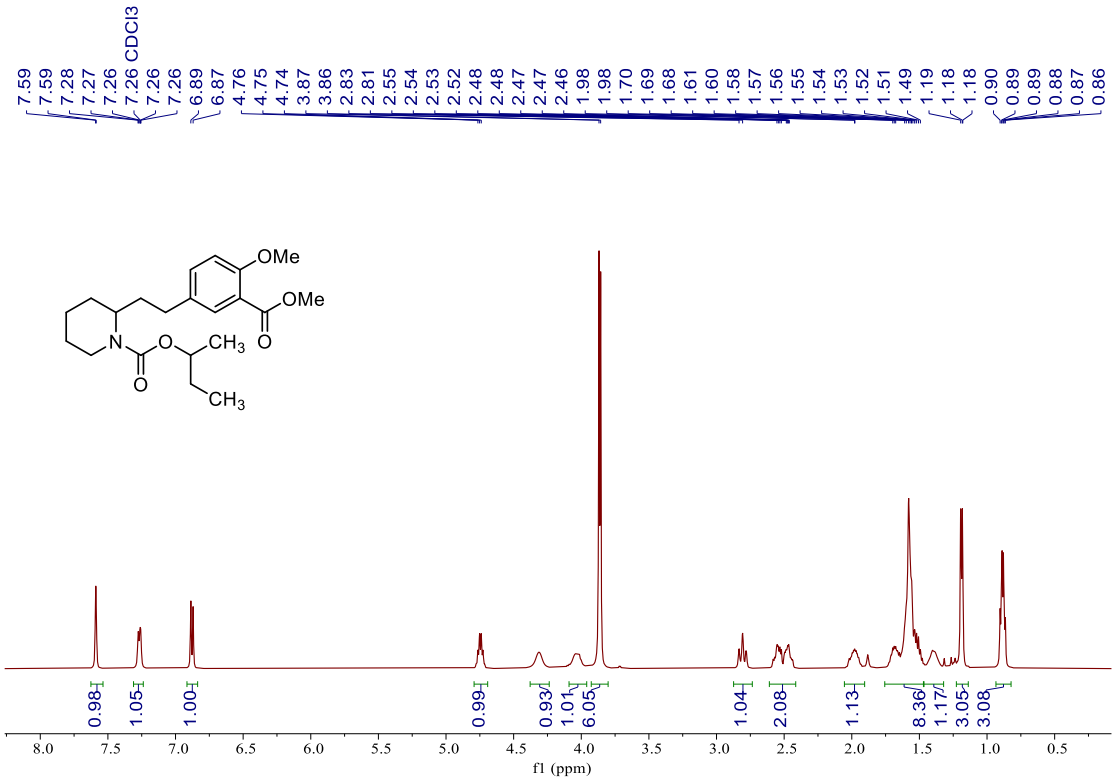
3q, ^{13}C NMR (126 MHz, $CDCl_3$)



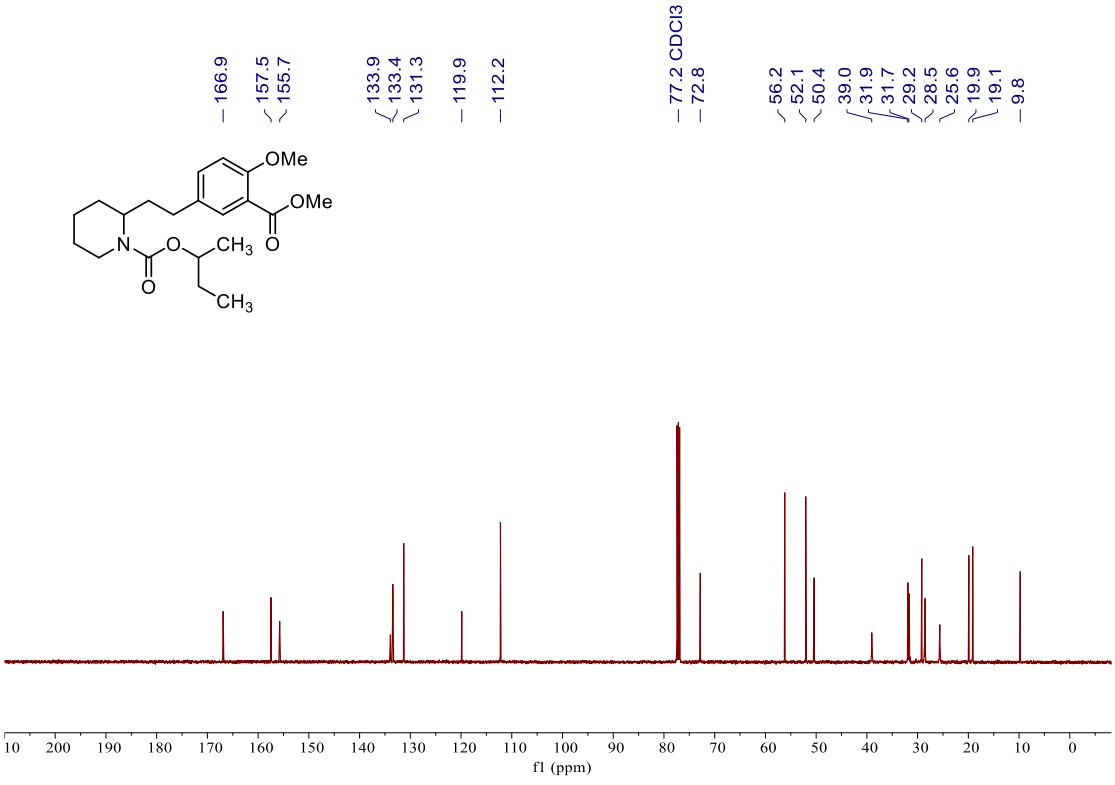
3r, ^{1}H NMR (500 MHz, $CDCl_3$)



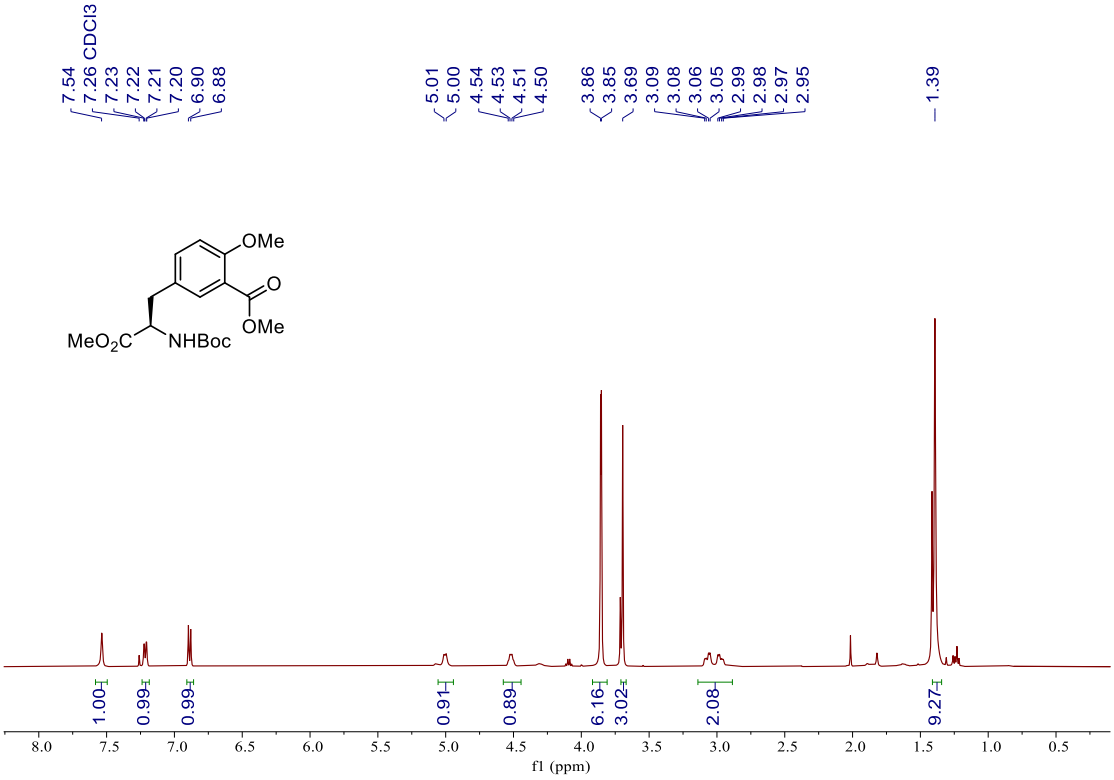
3r, ^{13}C NMR (126 MHz, $CDCl_3$)



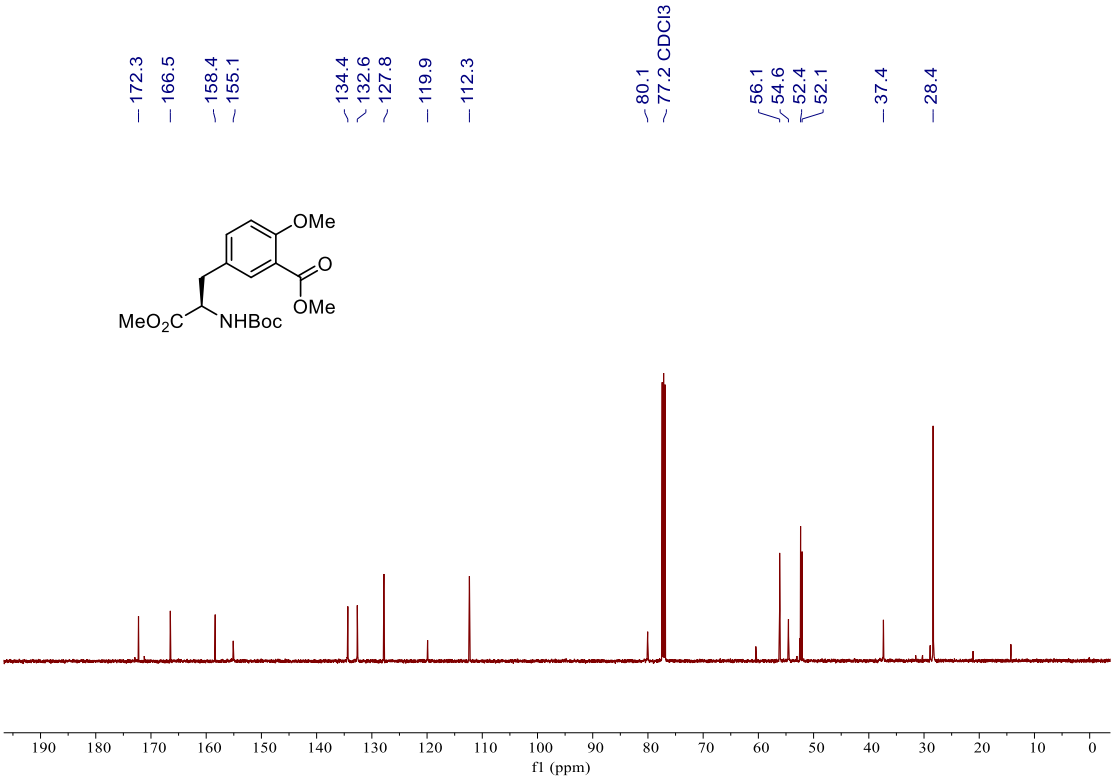
3s, ^{1}H NMR (500 MHz, $CDCl_3$)



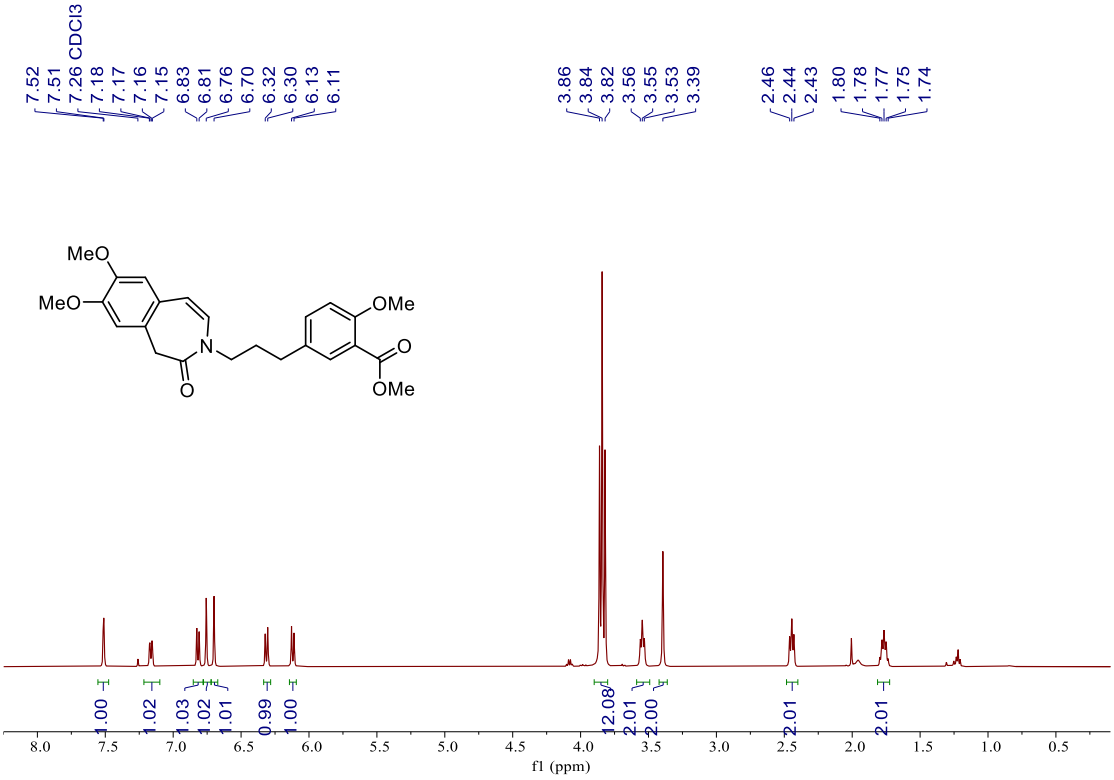
3s, ^{13}C NMR (126 MHz, $CDCl_3$)



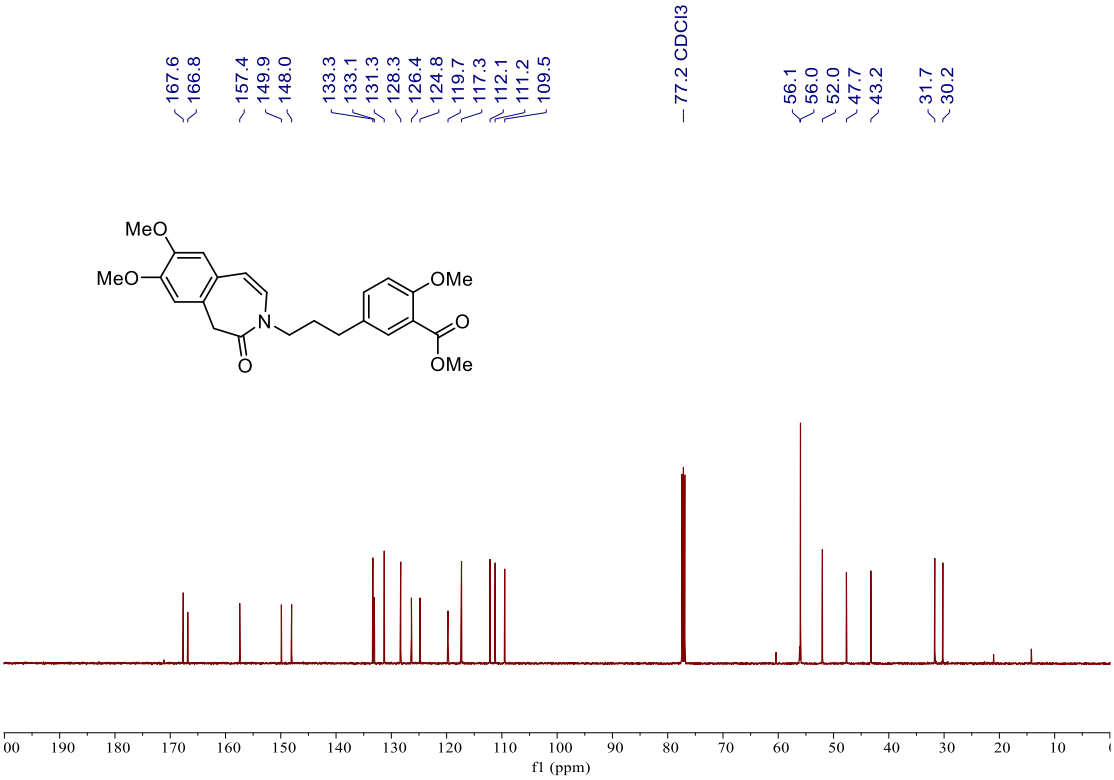
3t, ^{1}H NMR (500 MHz, $CDCl_3$)



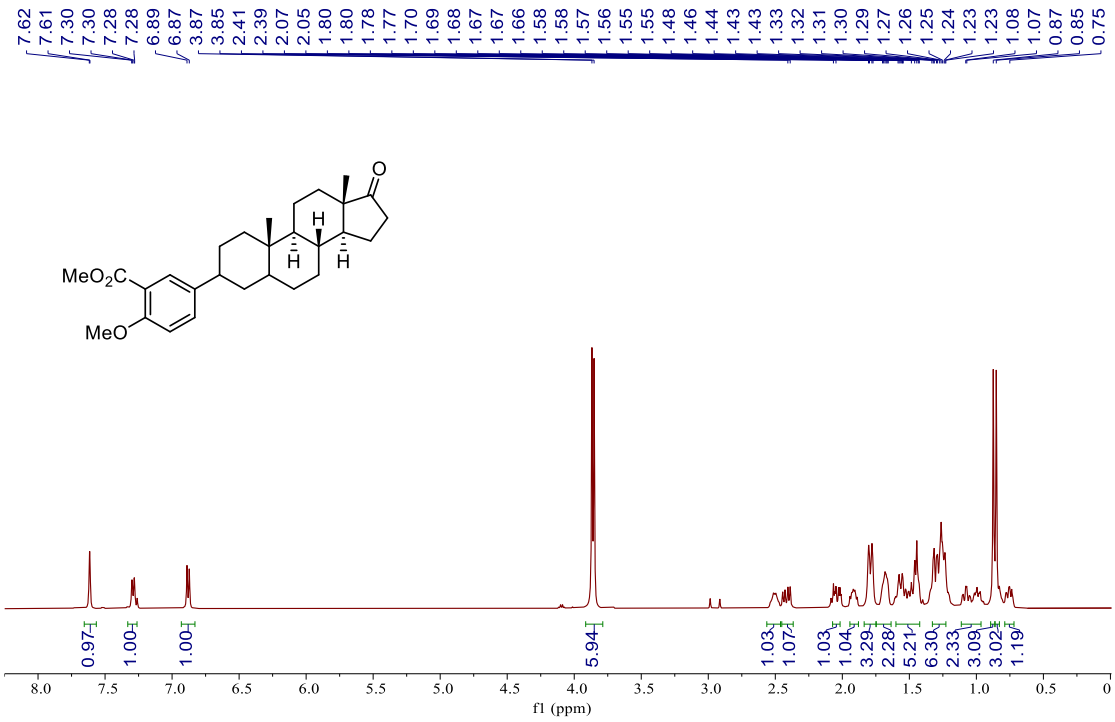
3t, ^{13}C NMR (126 MHz, $CDCl_3$)



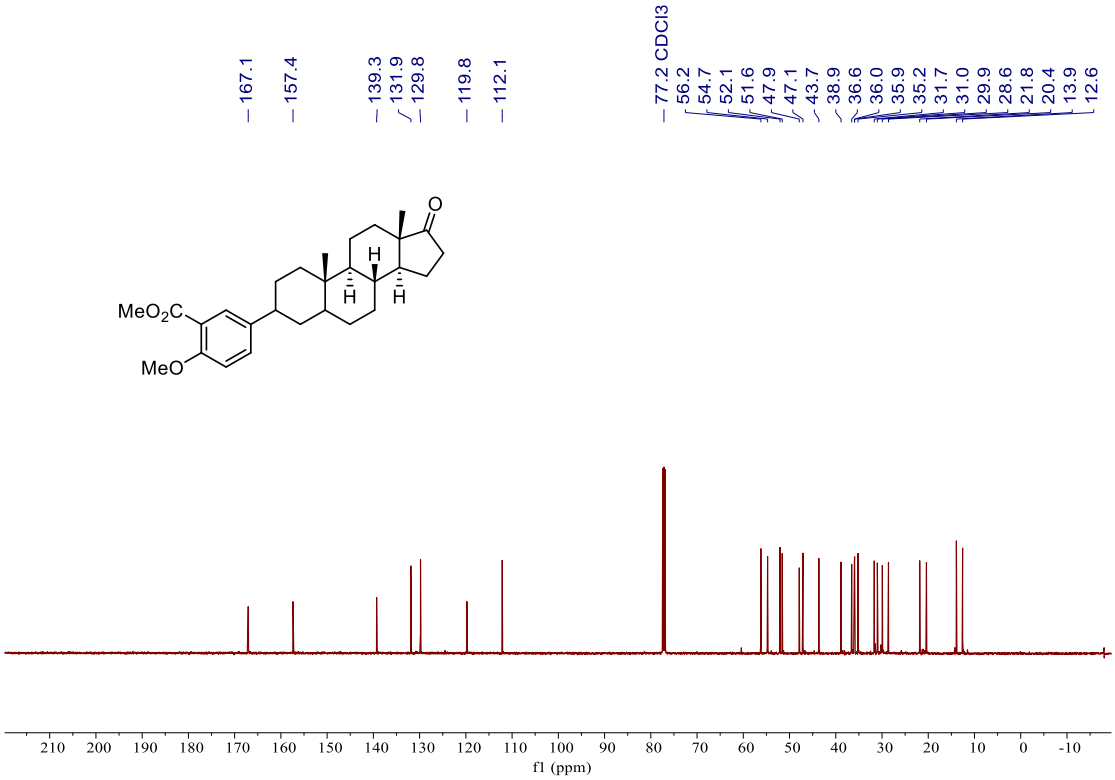
3u, ^{1}H NMR (500 MHz, $CDCl_3$)



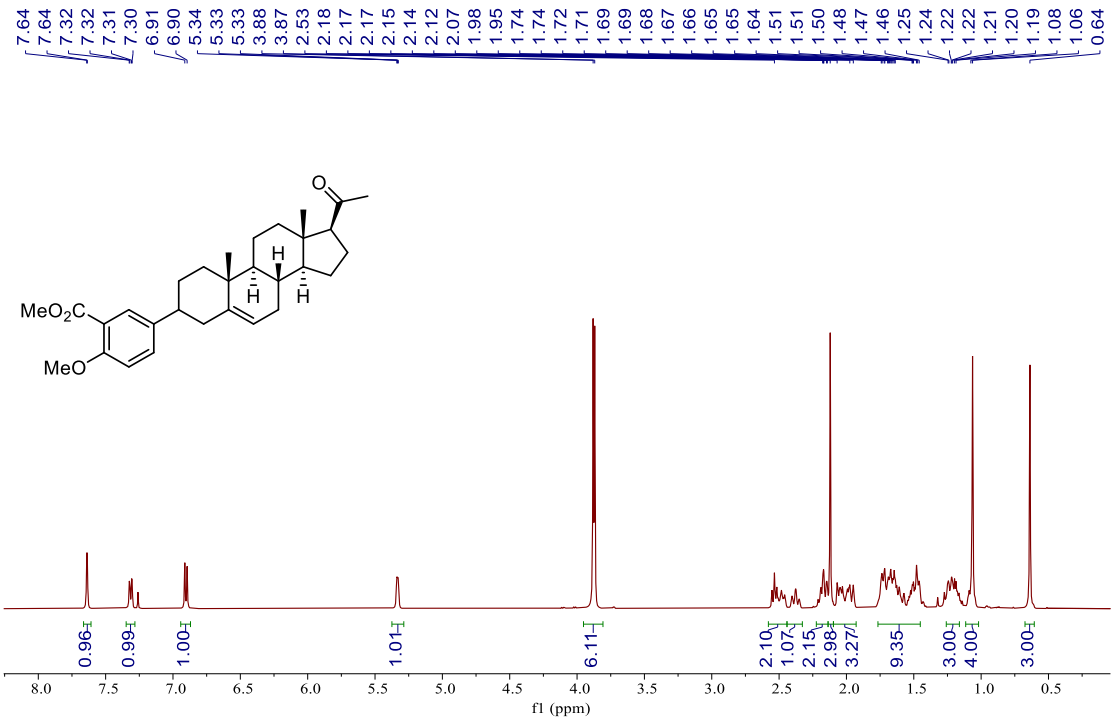
3u, ^{13}C NMR (126 MHz, $CDCl_3$)



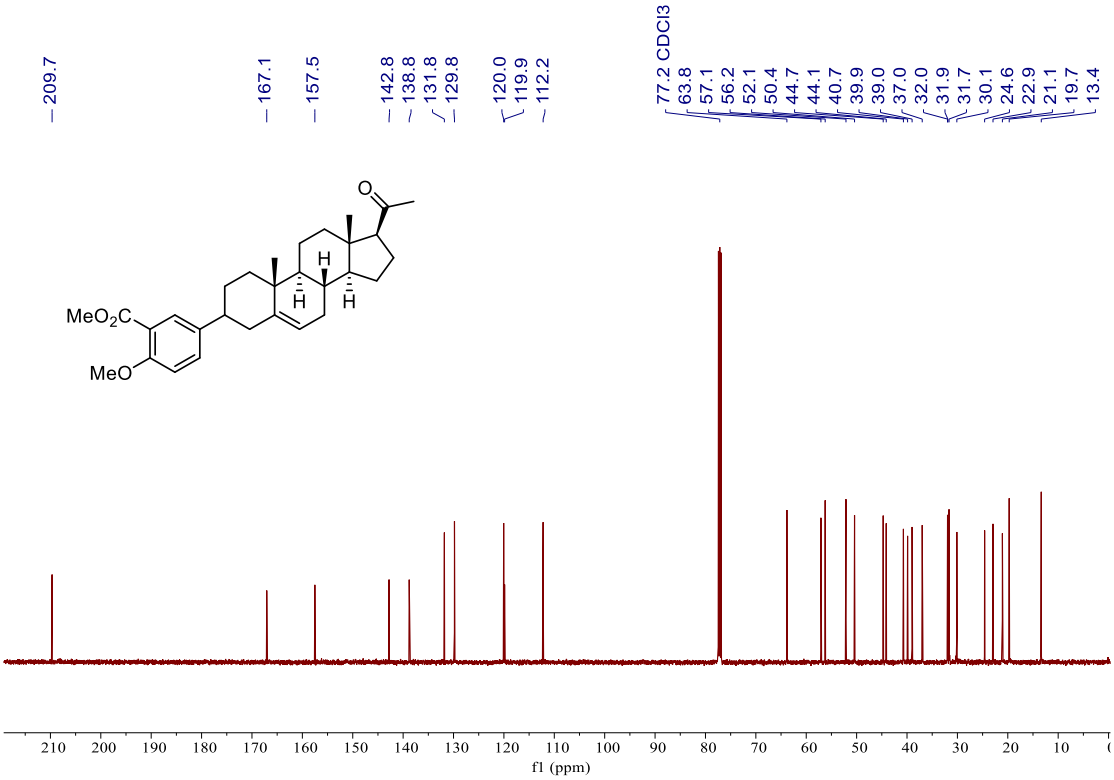
3v, ^{1}H NMR (500 MHz, $CDCl_3$)



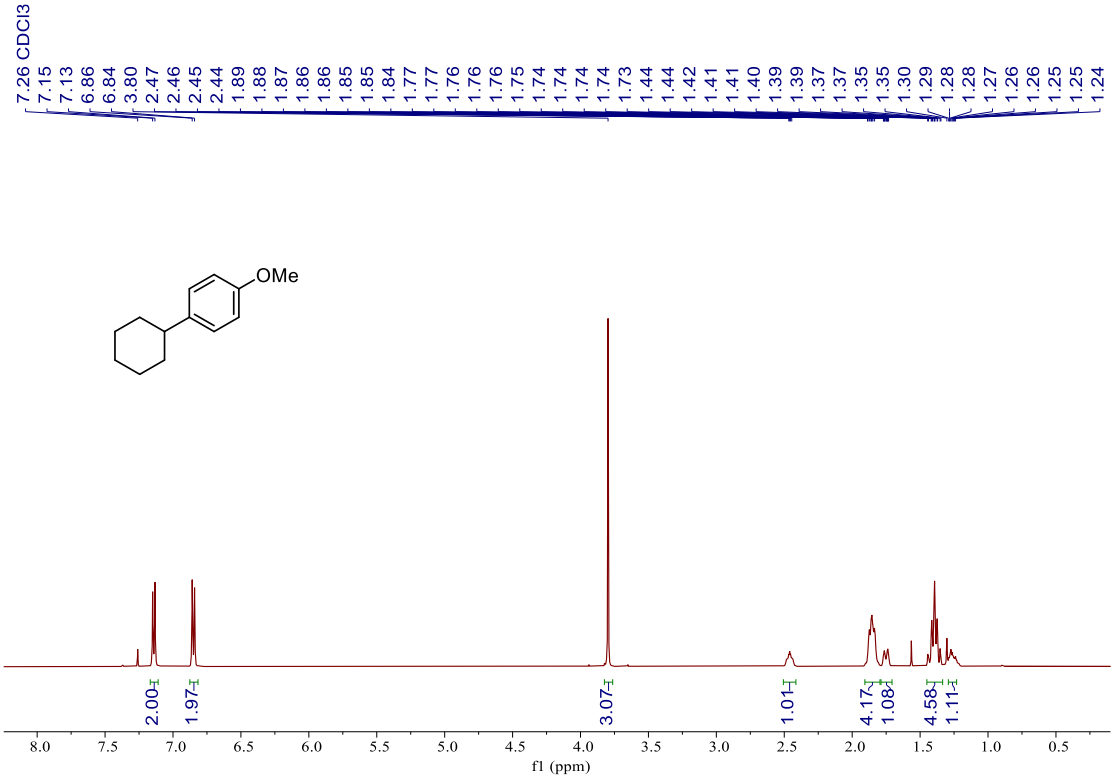
3v, ^{13}C NMR (126 MHz, $CDCl_3$)



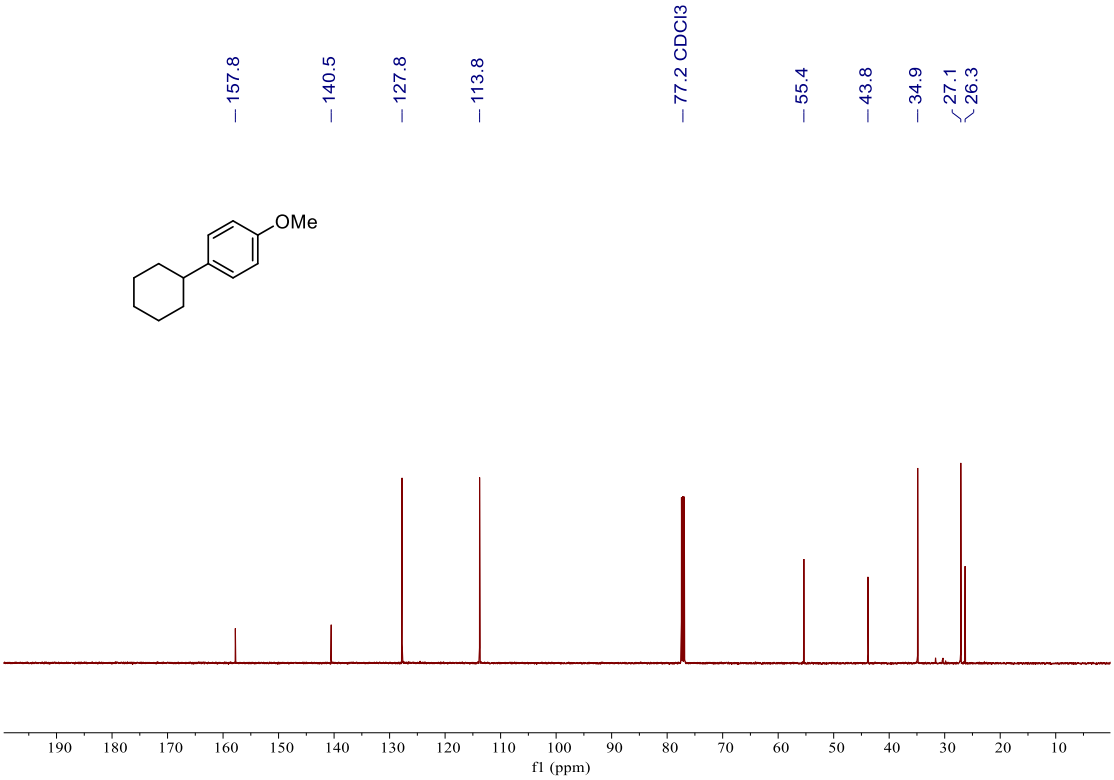
3w, ^{1}H NMR (500 MHz, $CDCl_3$)



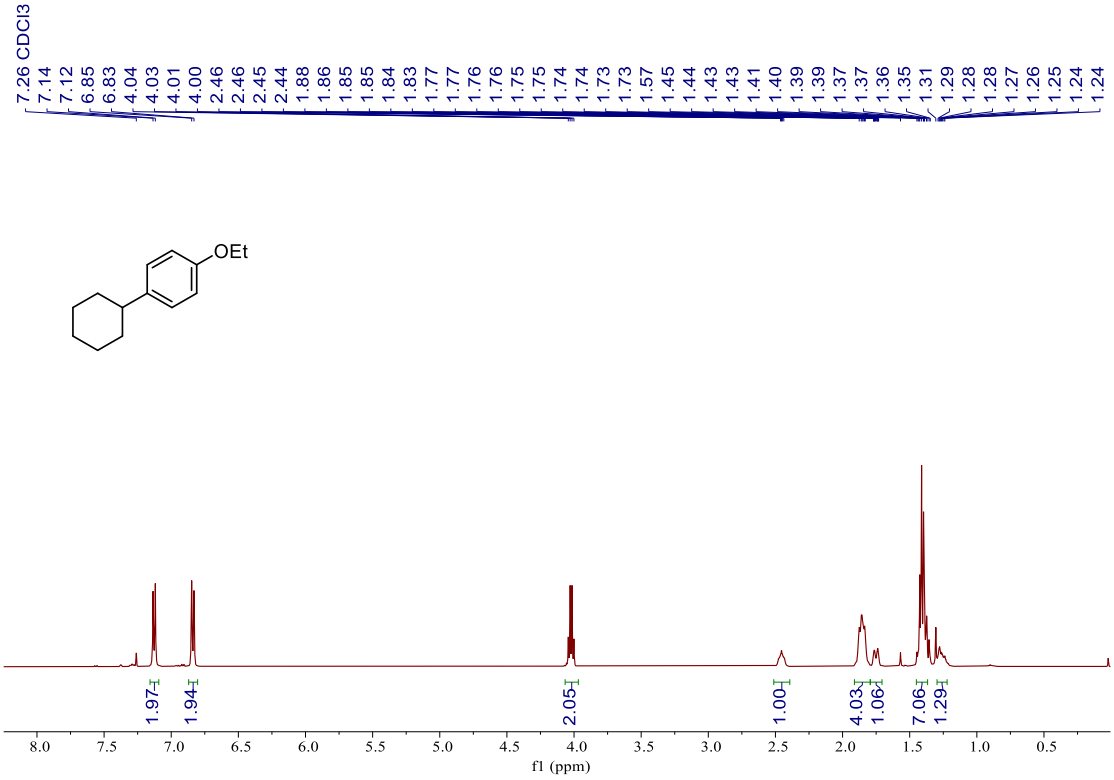
3w, ^{13}C NMR (126 MHz, $CDCl_3$)



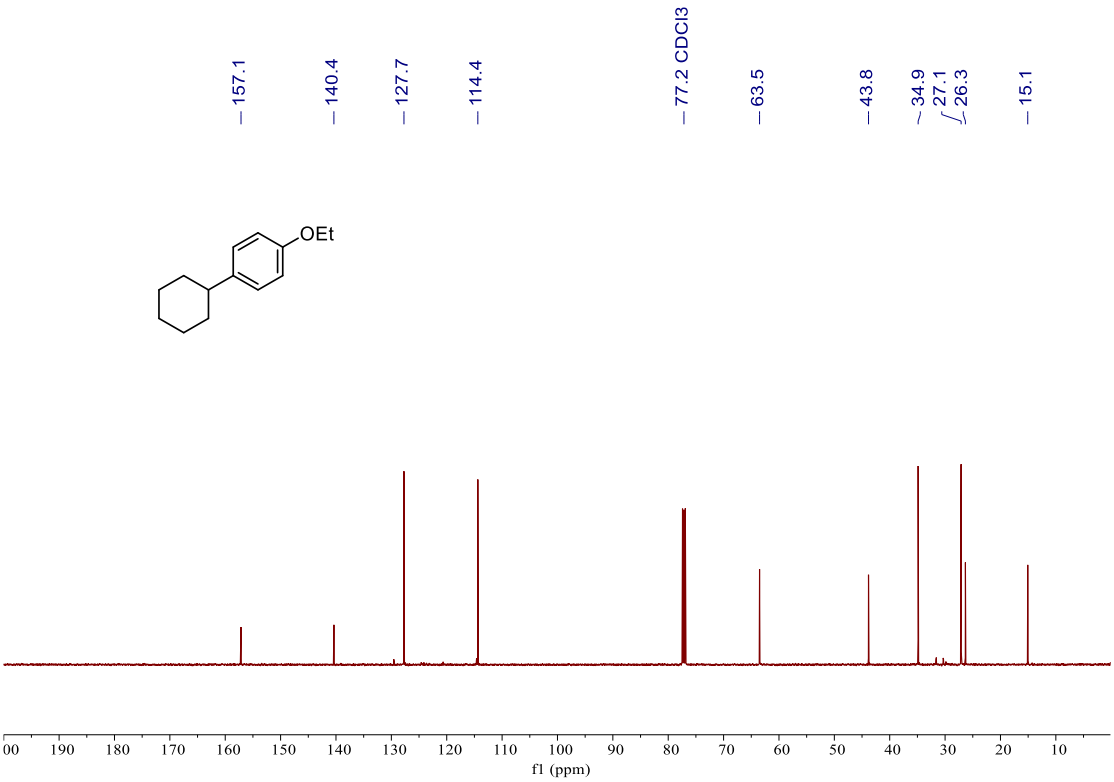
5a, ^{1}H NMR (500 MHz, $CDCl_3$)



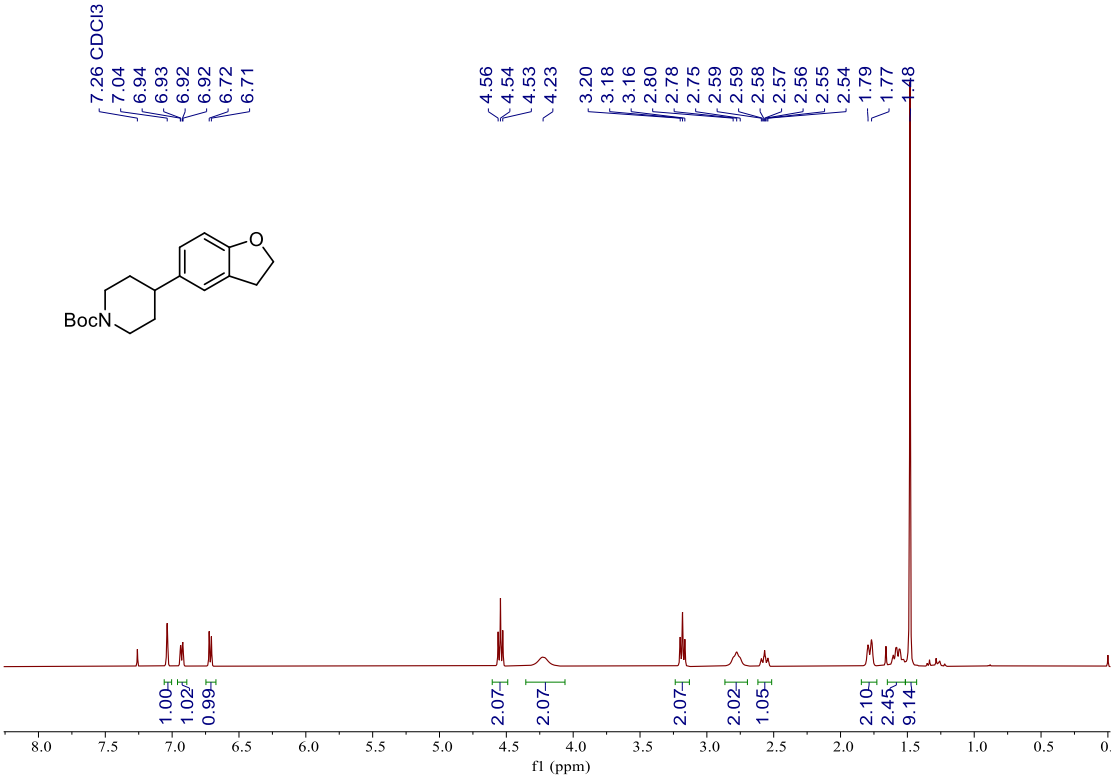
5a, ^{13}C NMR (126 MHz, $CDCl_3$)



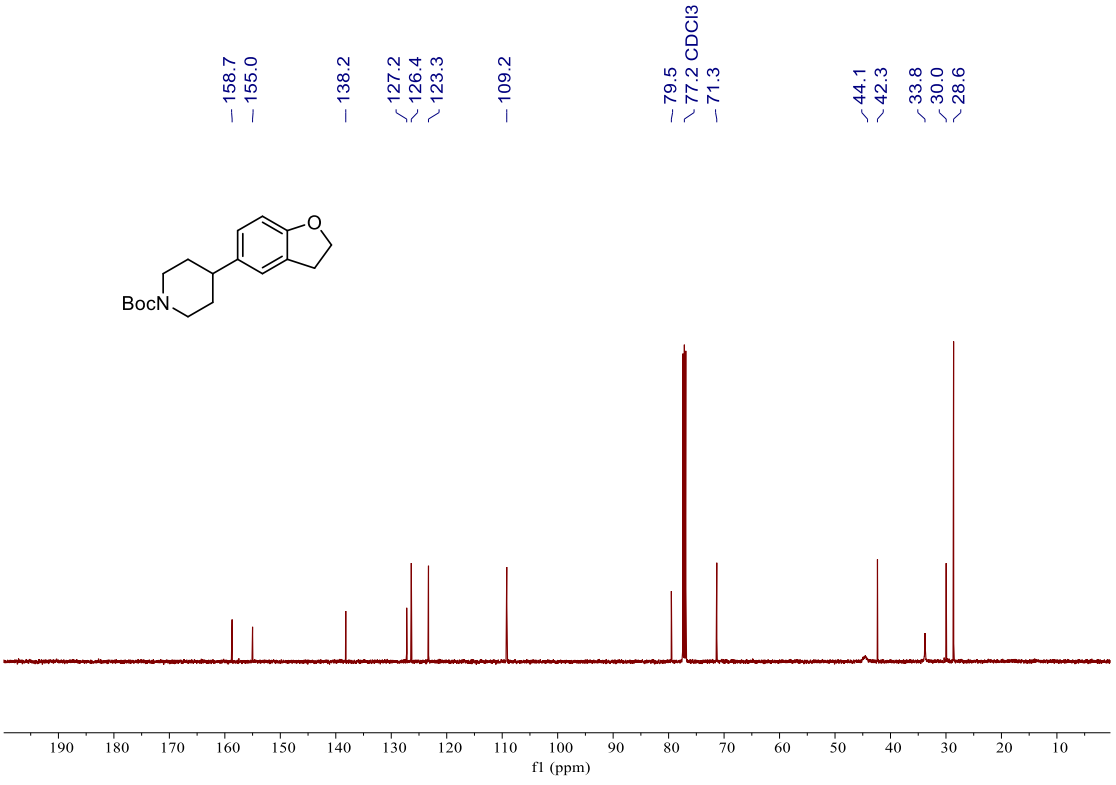
5b, ^{1}H NMR (500 MHz, $CDCl_3$)



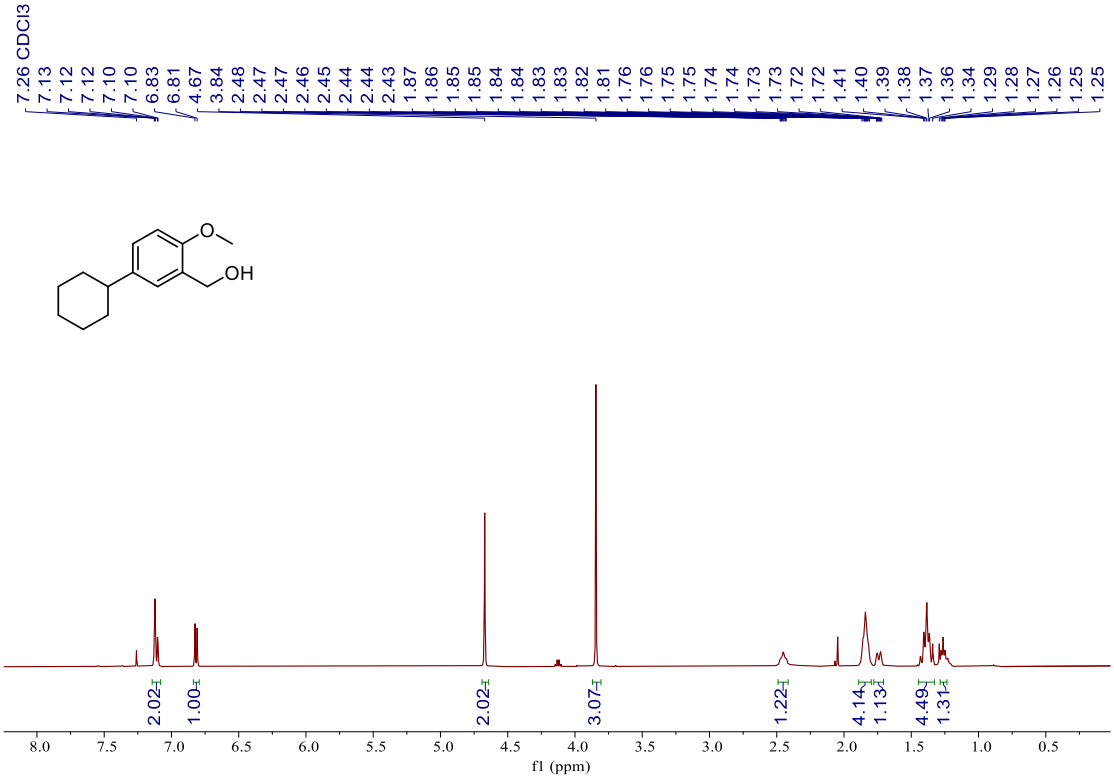
5b, ^{13}C NMR (126 MHz, $CDCl_3$)



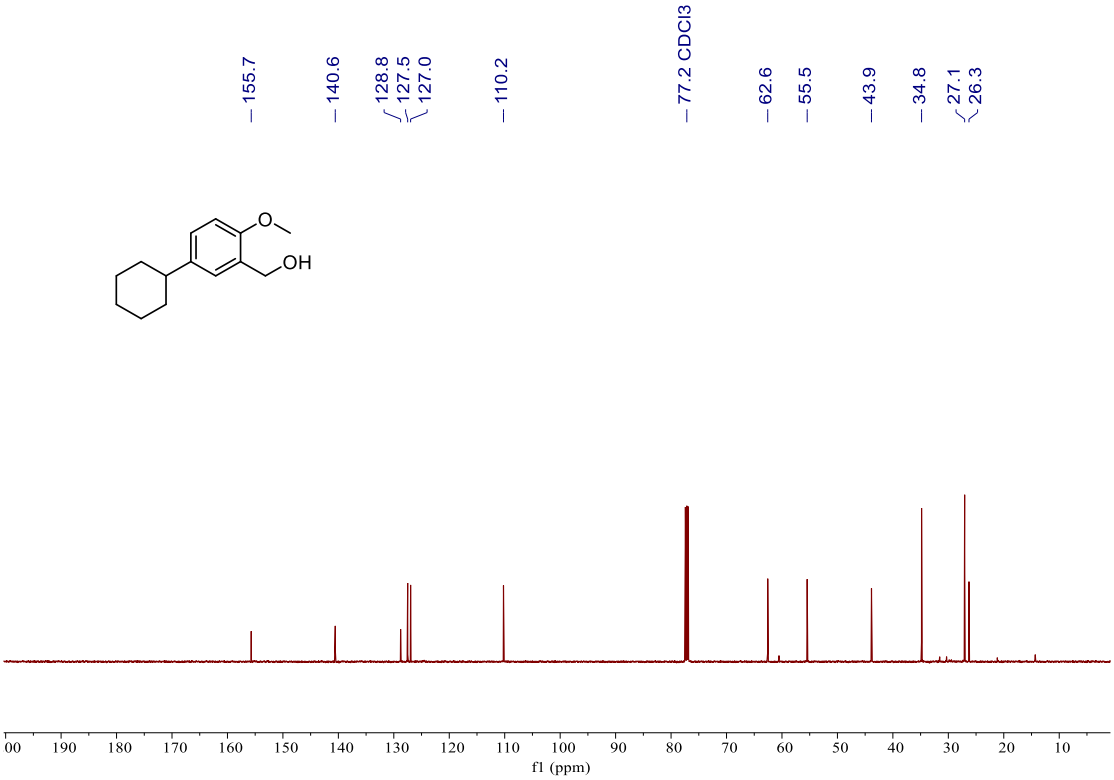
5c, ^{1}H NMR (500 MHz, $CDCl_3$)



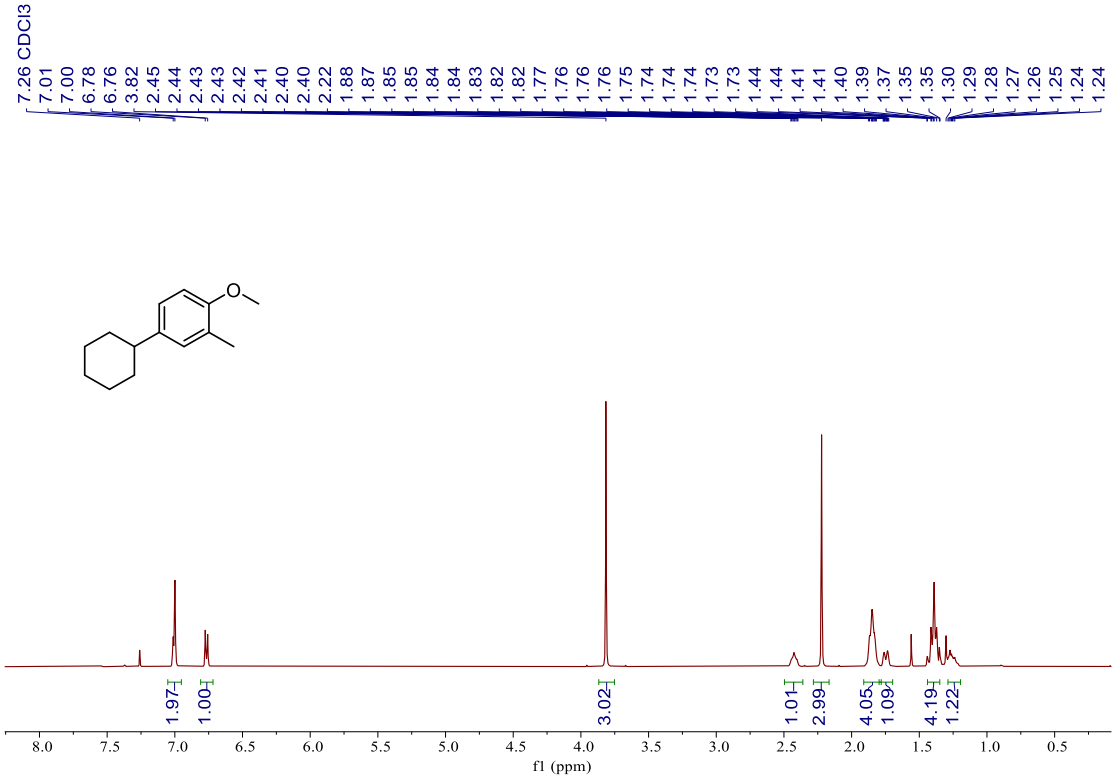
5c, ^{13}C NMR (126 MHz, $CDCl_3$)



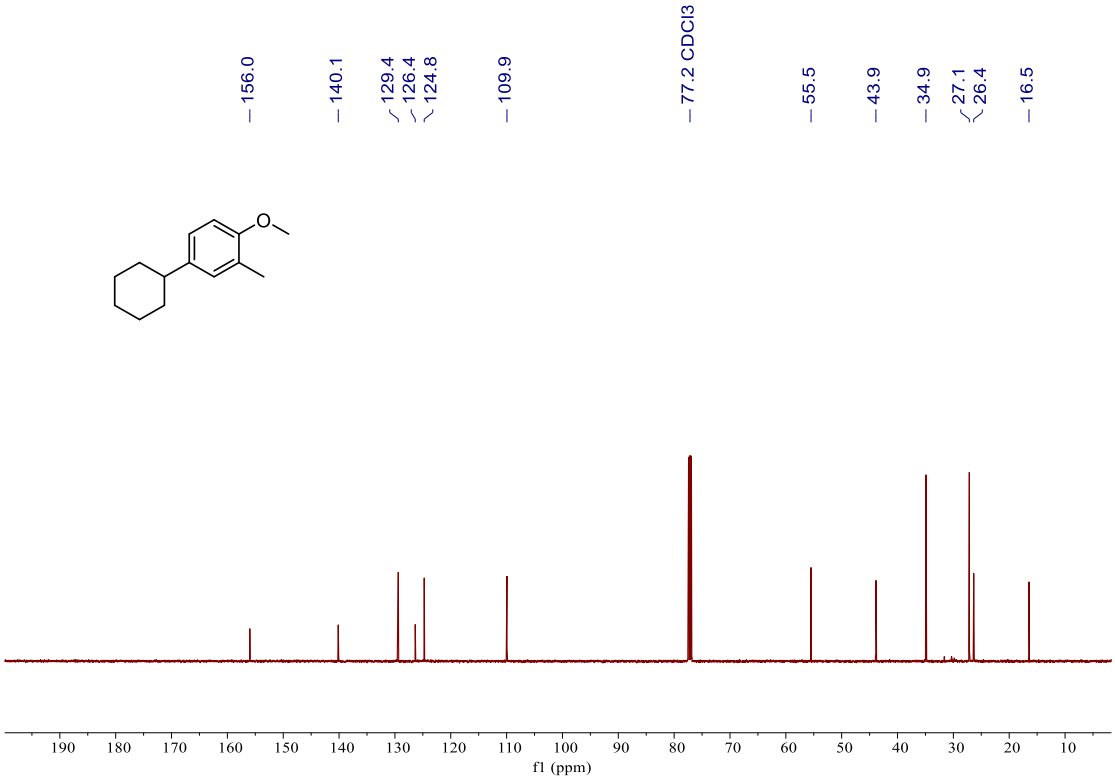
5d, ^{1}H NMR (500 MHz, $CDCl_3$)



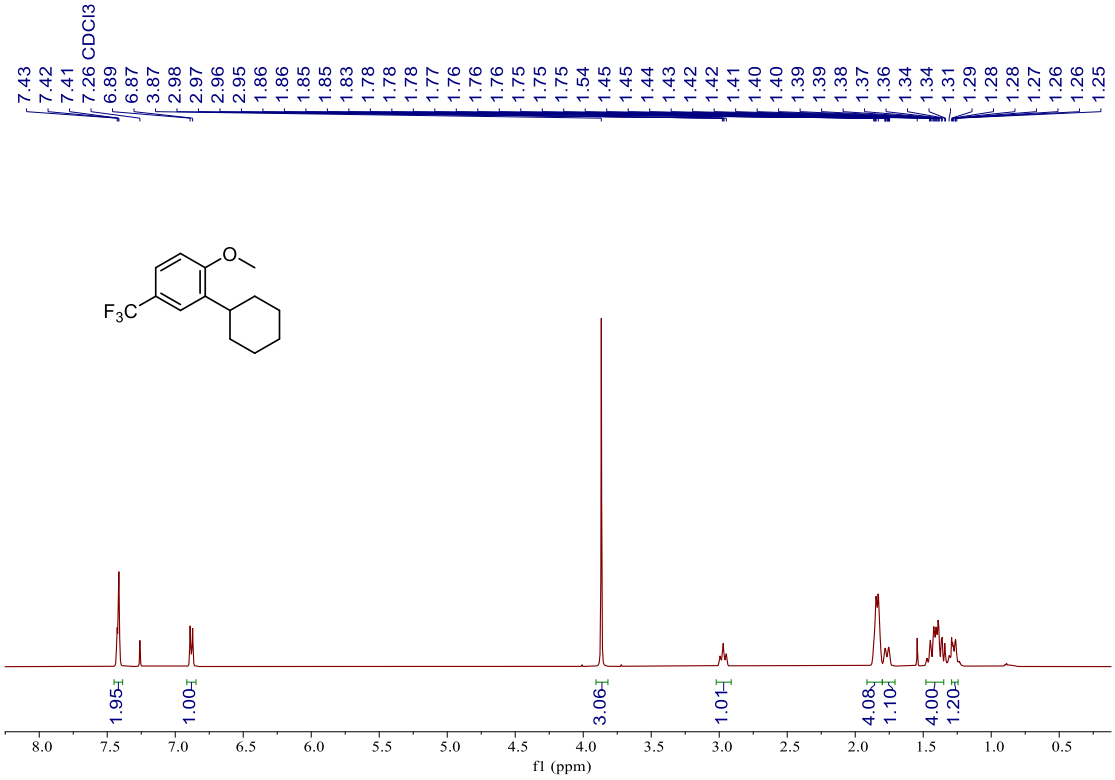
5d, ^{13}C NMR (126 MHz, $CDCl_3$)



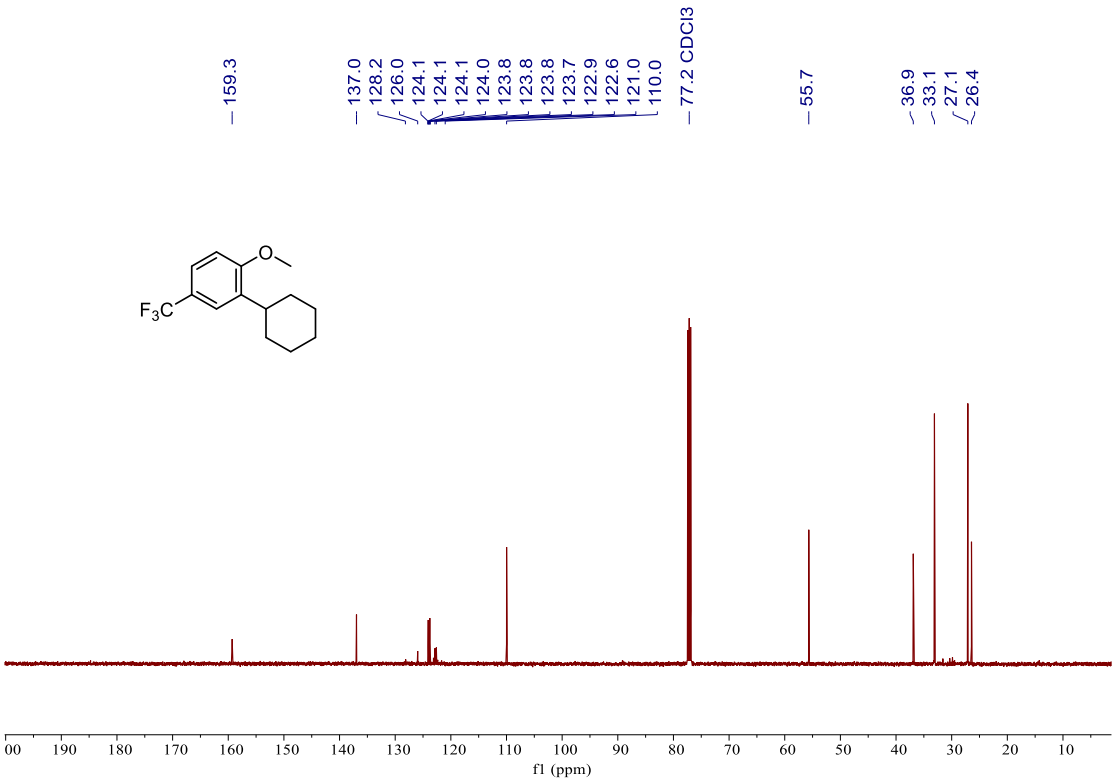
5e, ^{1}H NMR (500 MHz, $CDCl_3$)



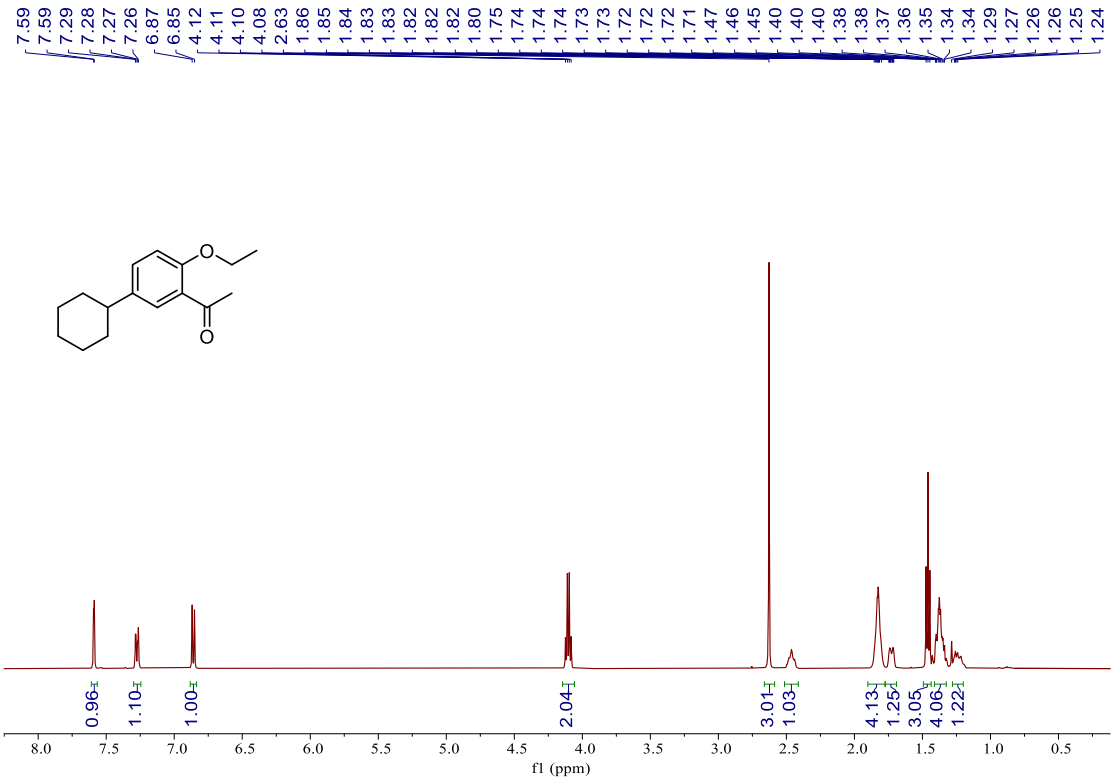
5e, ^{13}C NMR (126 MHz, $CDCl_3$)



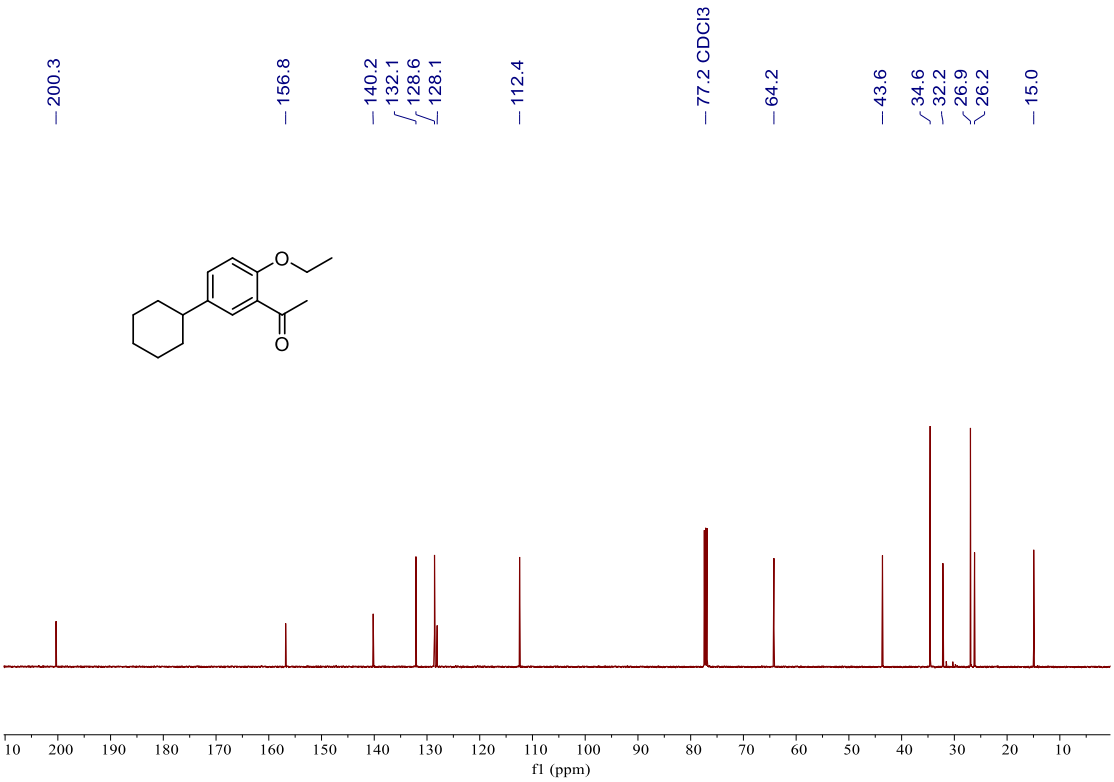
5f, ^{1}H NMR (500 MHz, $CDCl_3$)



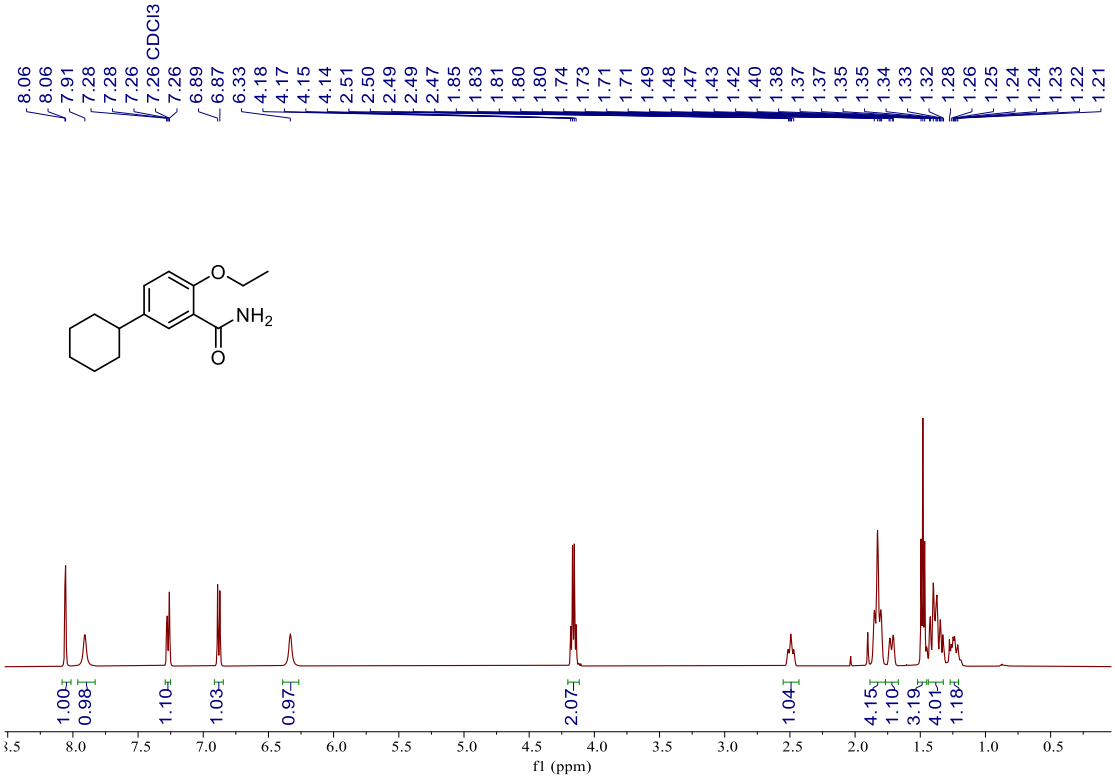
5f, ^{13}C NMR (126 MHz, $CDCl_3$)



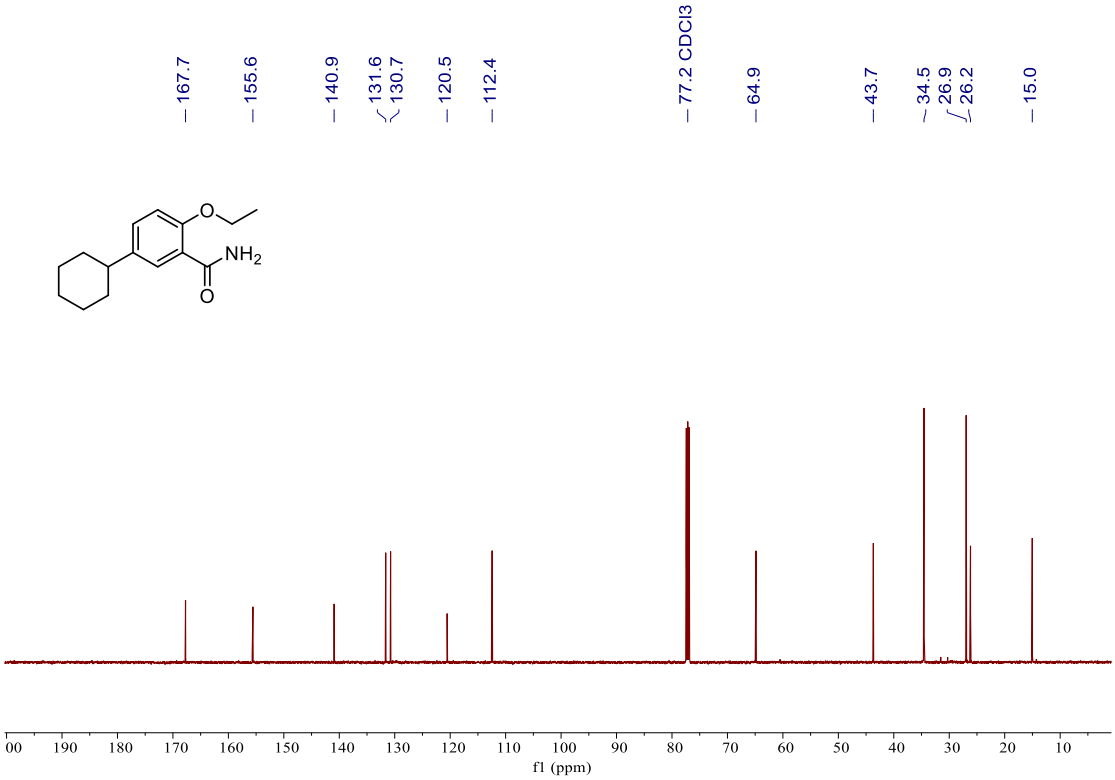
5g, ^{1}H NMR (500 MHz, $CDCl_3$)



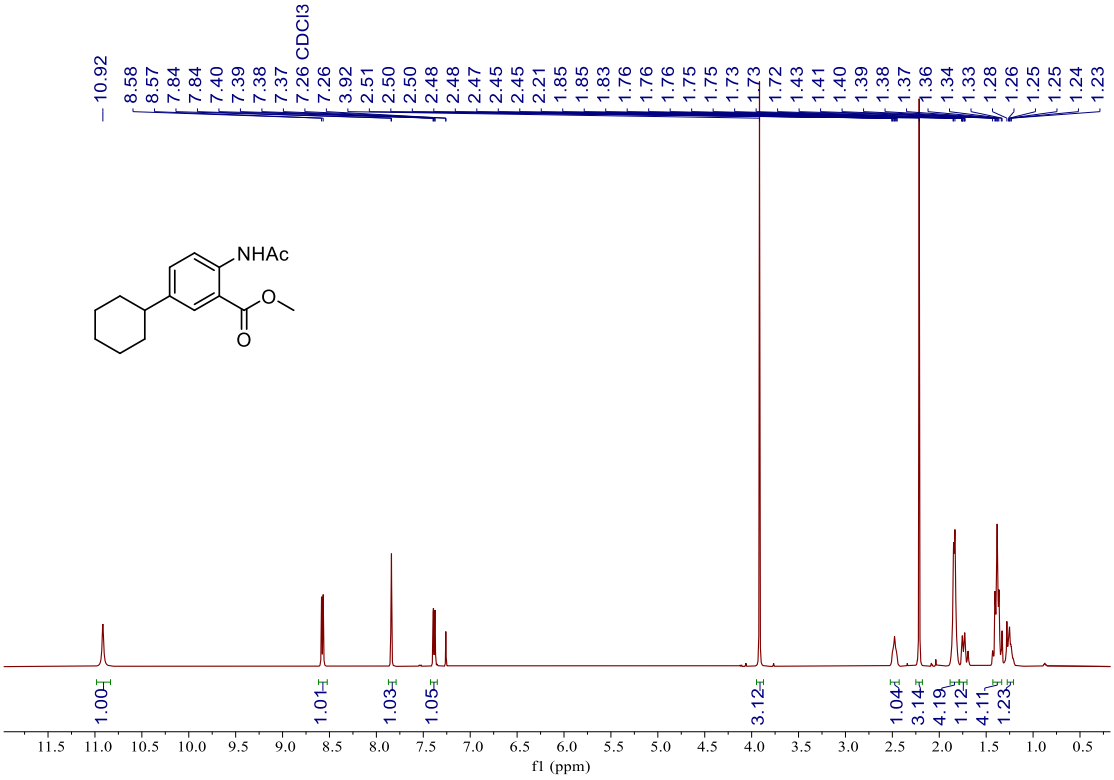
5g, ^{13}C NMR (126 MHz, $CDCl_3$)



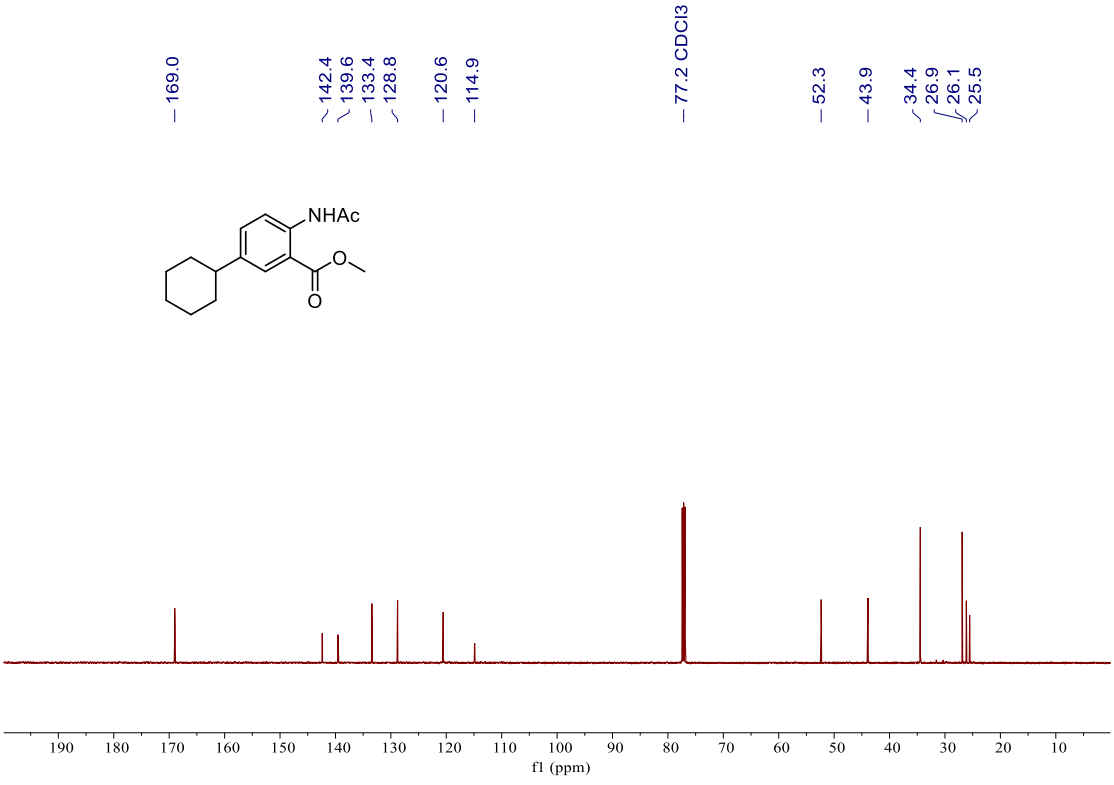
5h, ^{1}H NMR (500 MHz, $CDCl_3$)



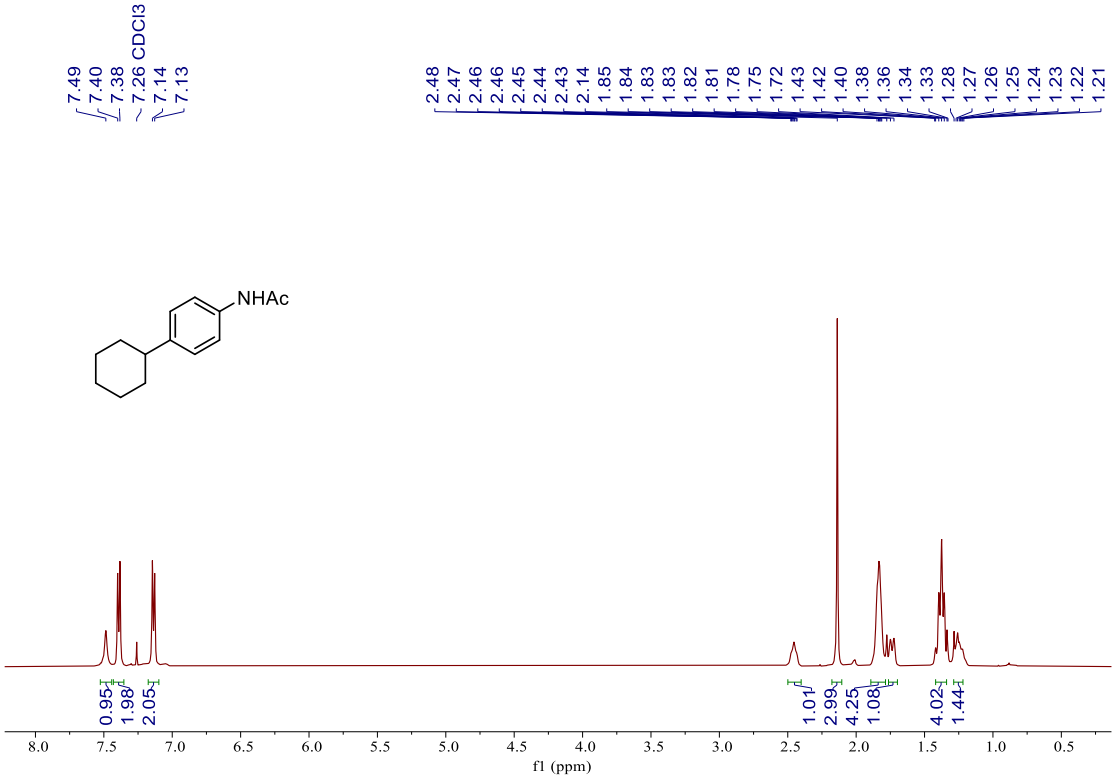
5h, ^{13}C NMR (126 MHz, $CDCl_3$)



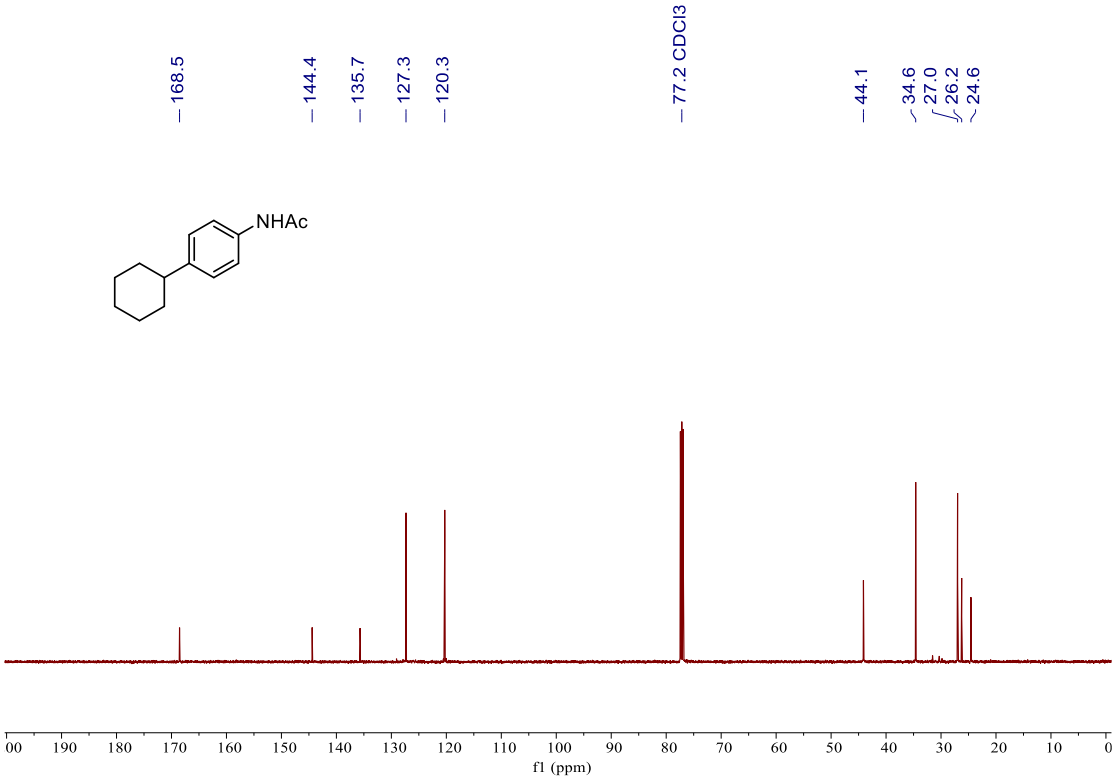
5i, ^{1}H NMR (500 MHz, $CDCl_3$)



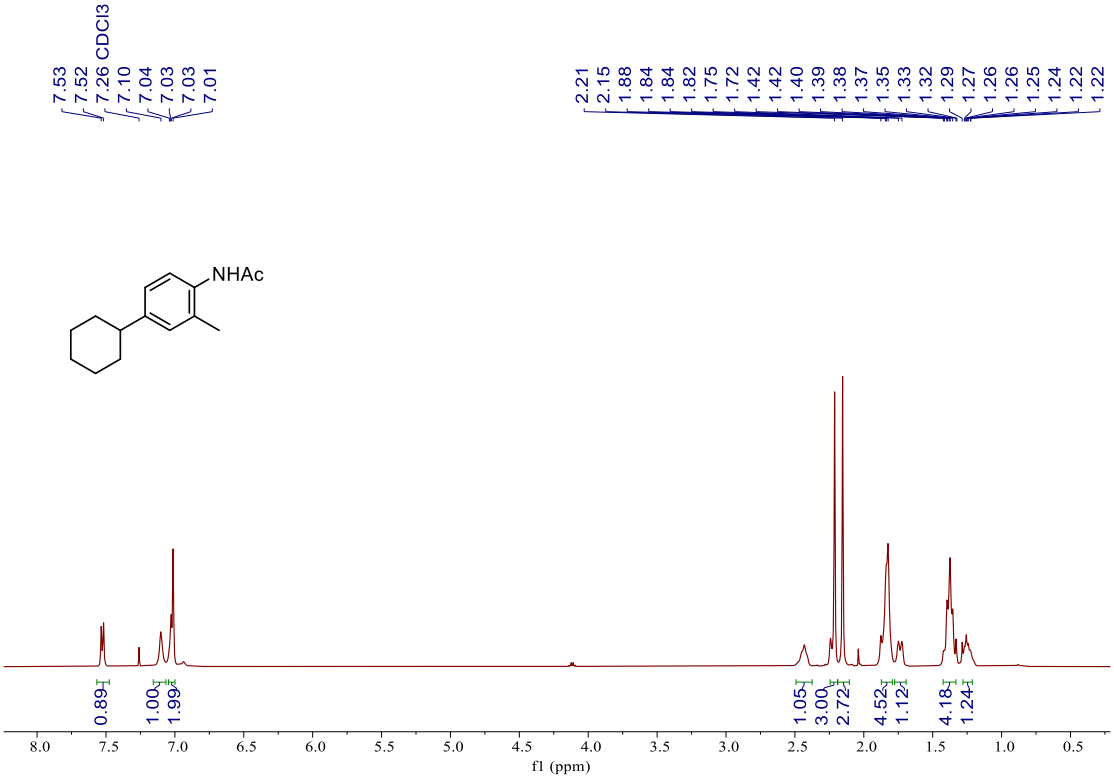
5i, ^{13}C NMR (126 MHz, $CDCl_3$)



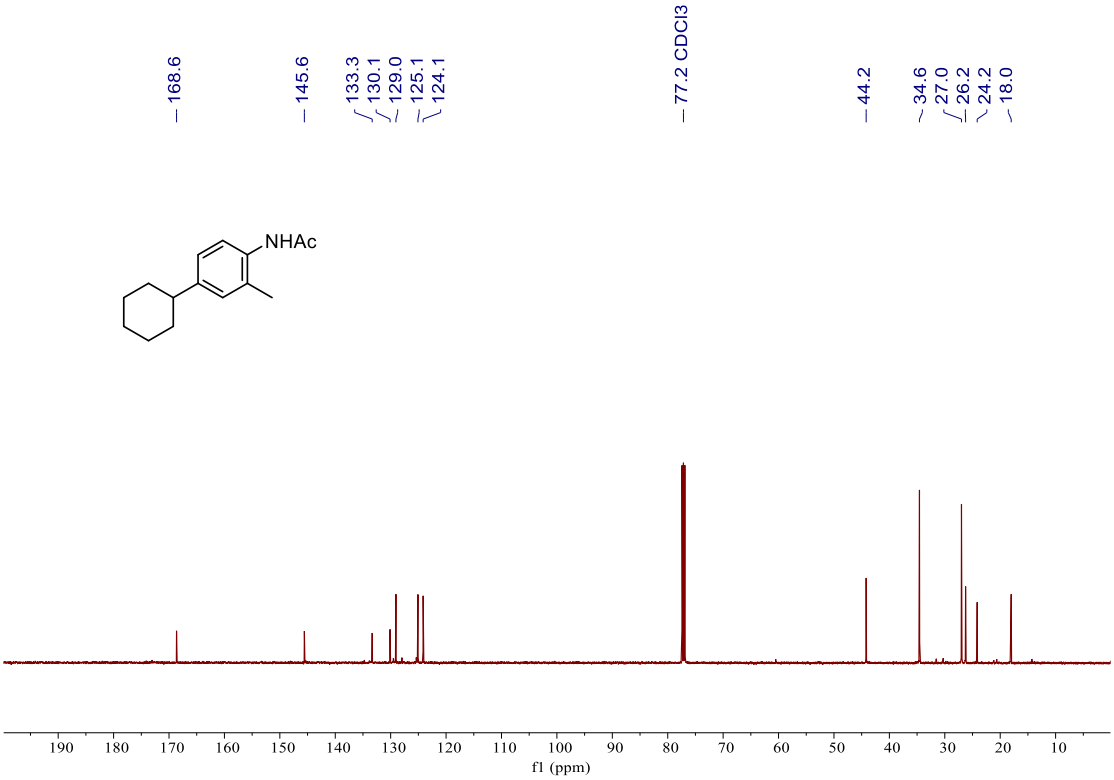
5j, ^{1}H NMR (500 MHz, $CDCl_3$)



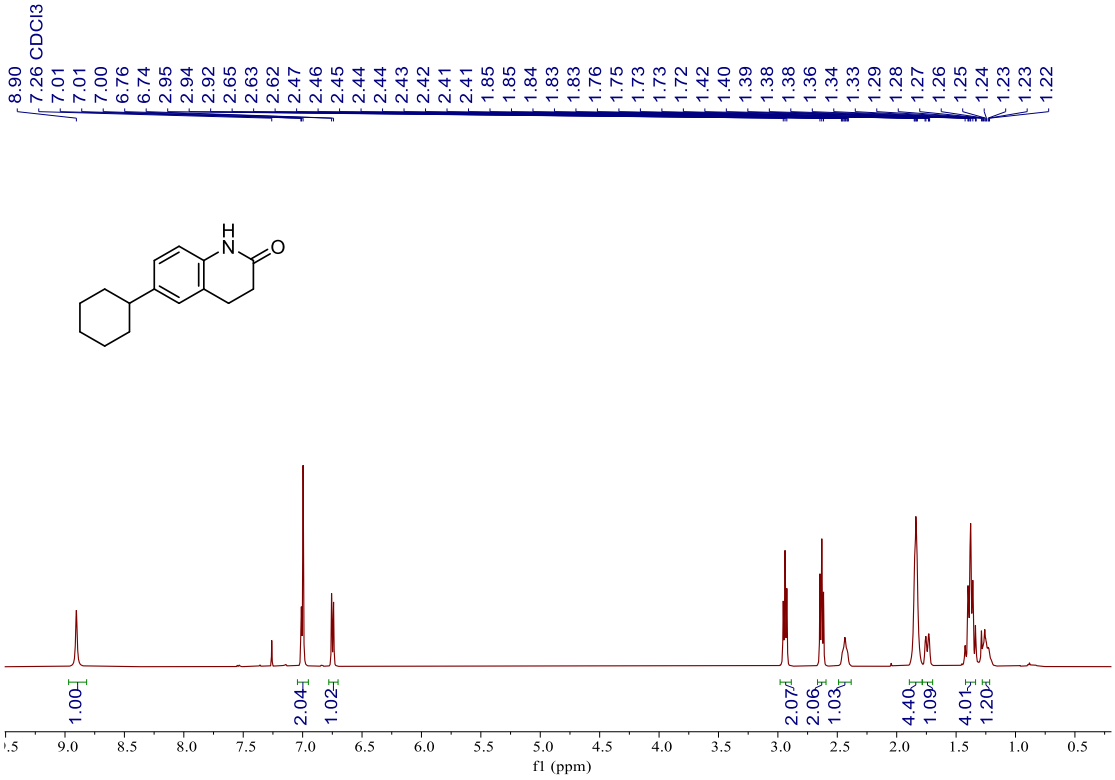
5j, ^{13}C NMR (126 MHz, $CDCl_3$)



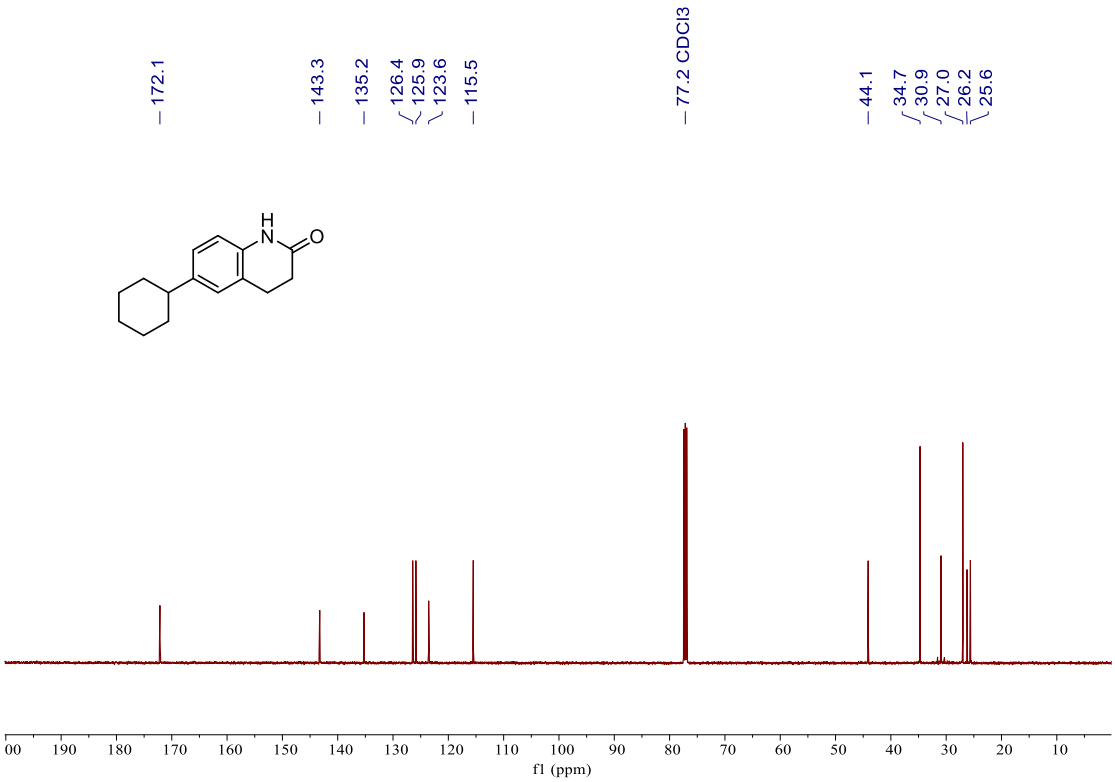
5k, ^{1}H NMR (500 MHz, $CDCl_3$)



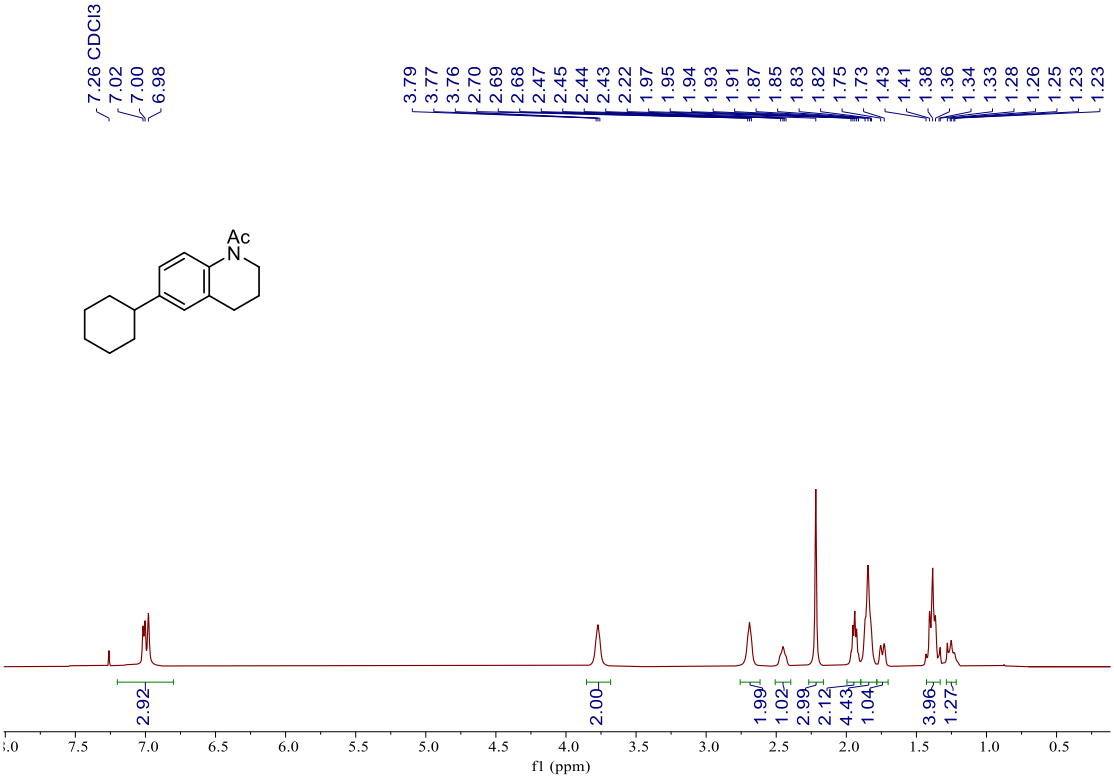
5k, ^{13}C NMR (126 MHz, $CDCl_3$)



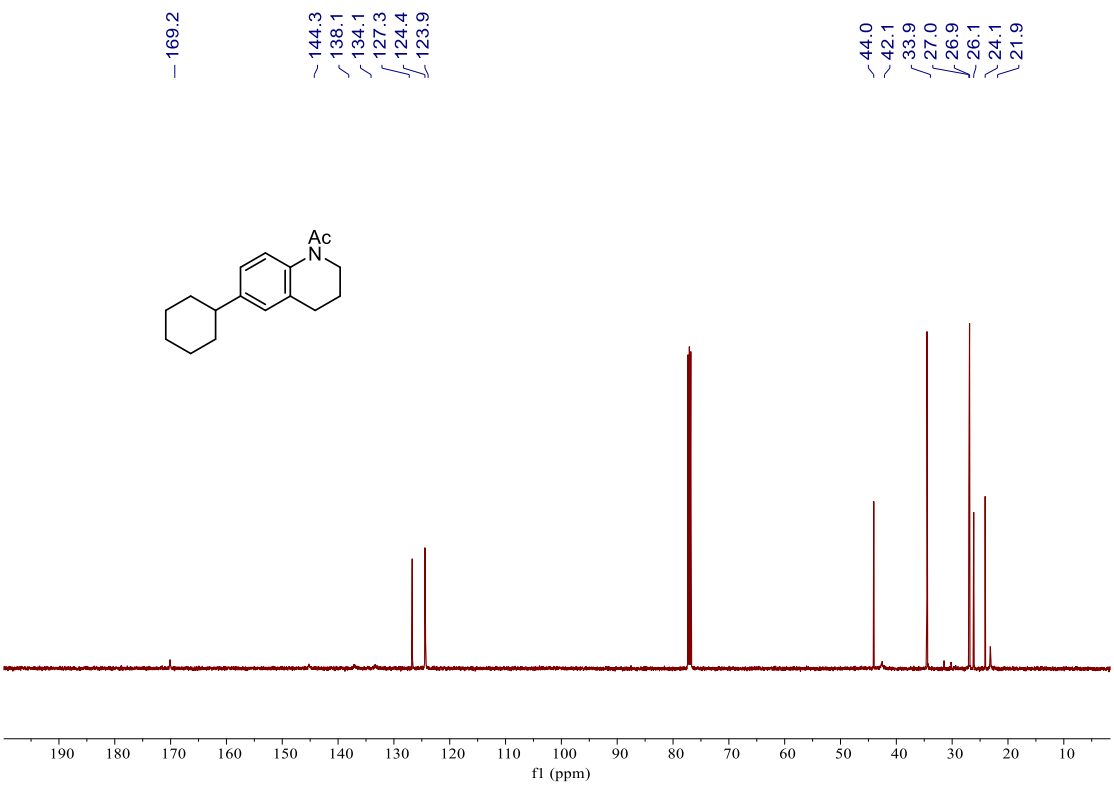
5l, ^{1}H NMR (500 MHz, $CDCl_3$)



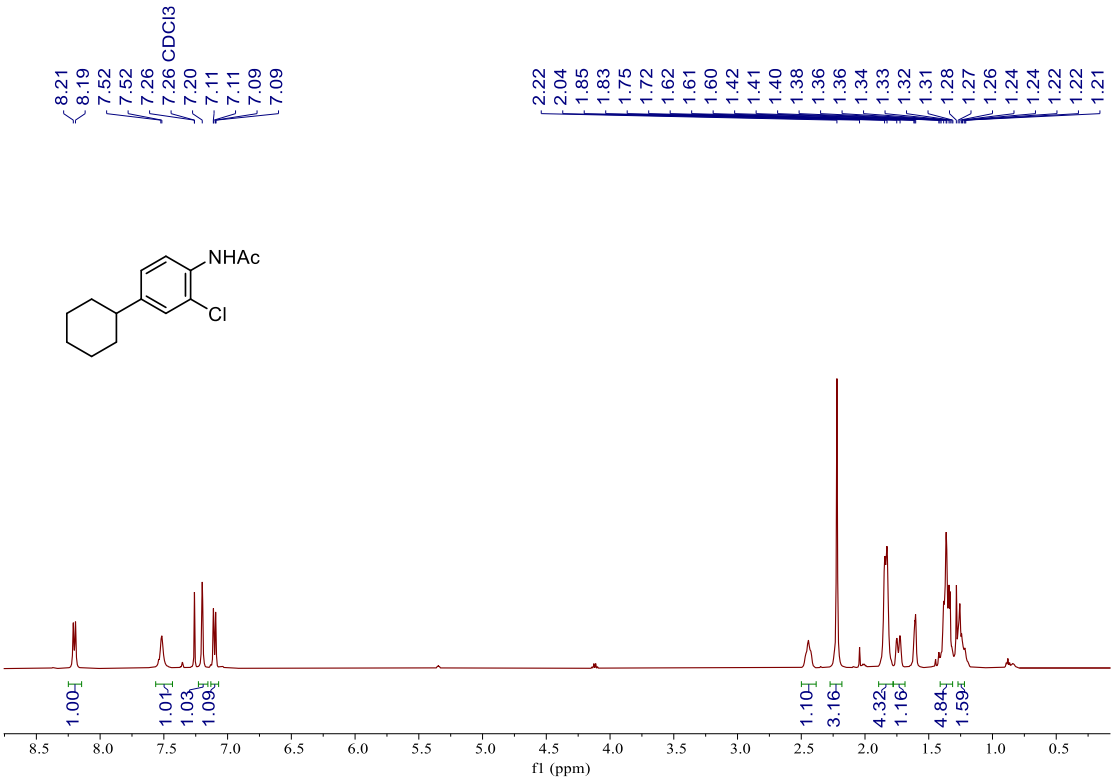
5l, ^{13}C NMR (126 MHz, $CDCl_3$)



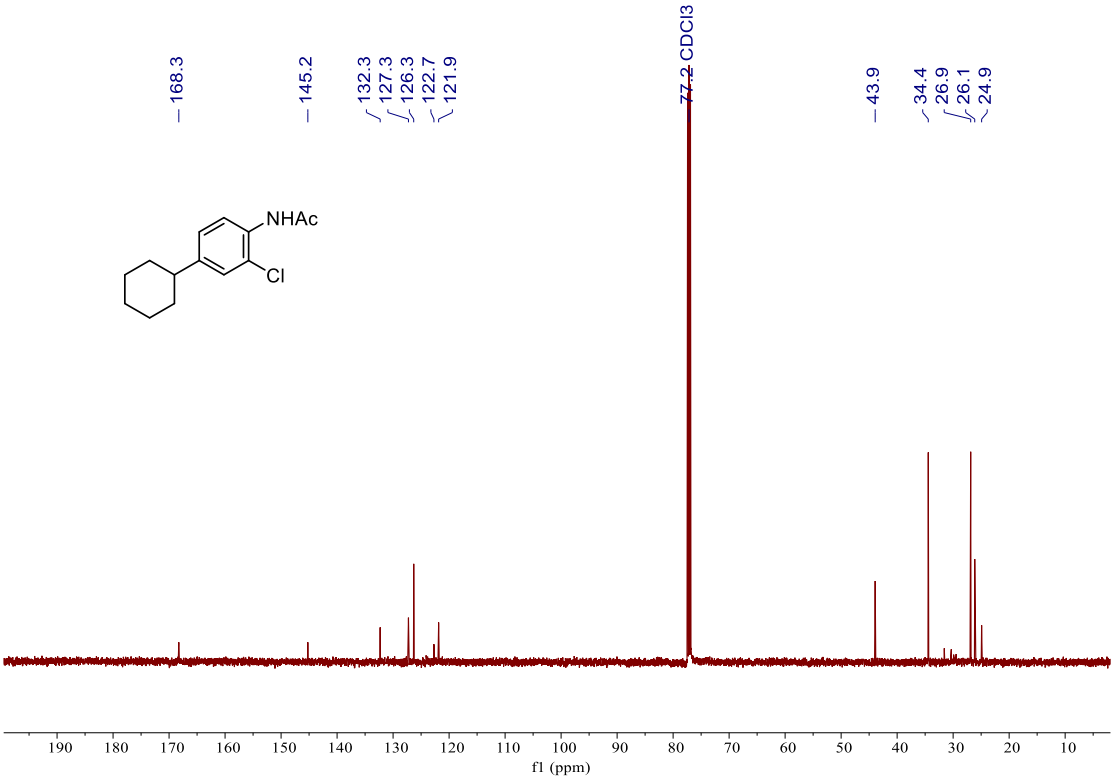
5m, ^{1}H NMR (500 MHz, $CDCl_3$)



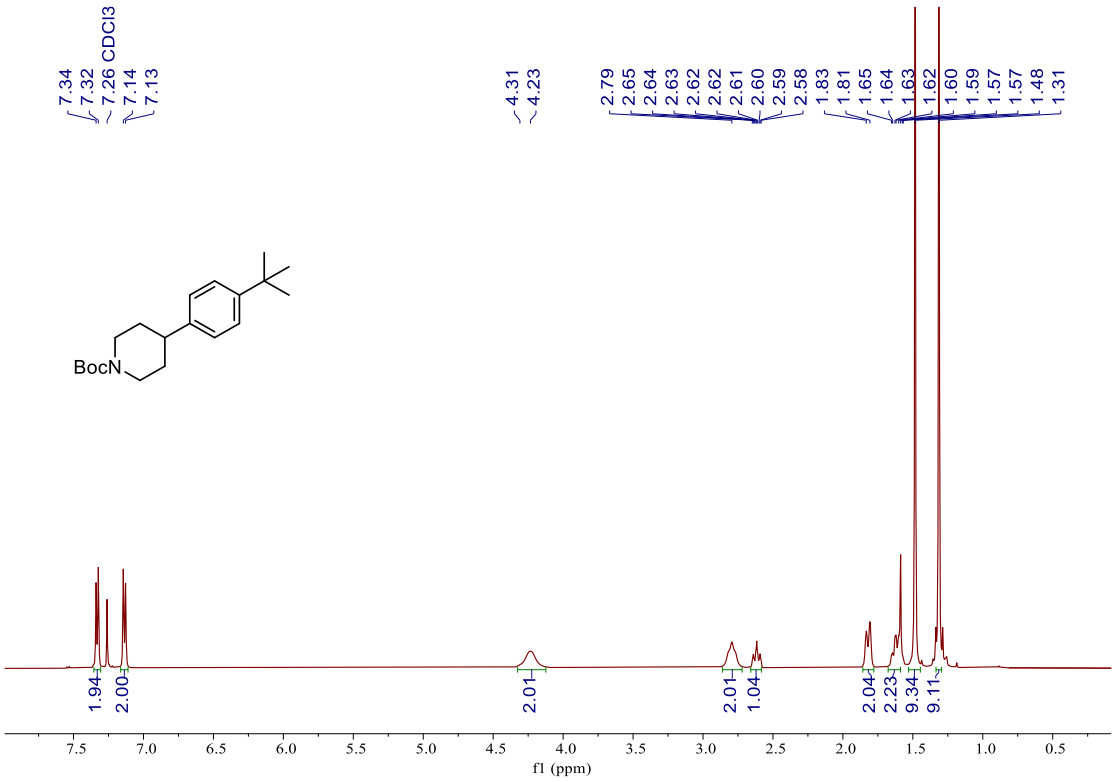
5m, ^{13}C NMR (126 MHz, $CDCl_3$)



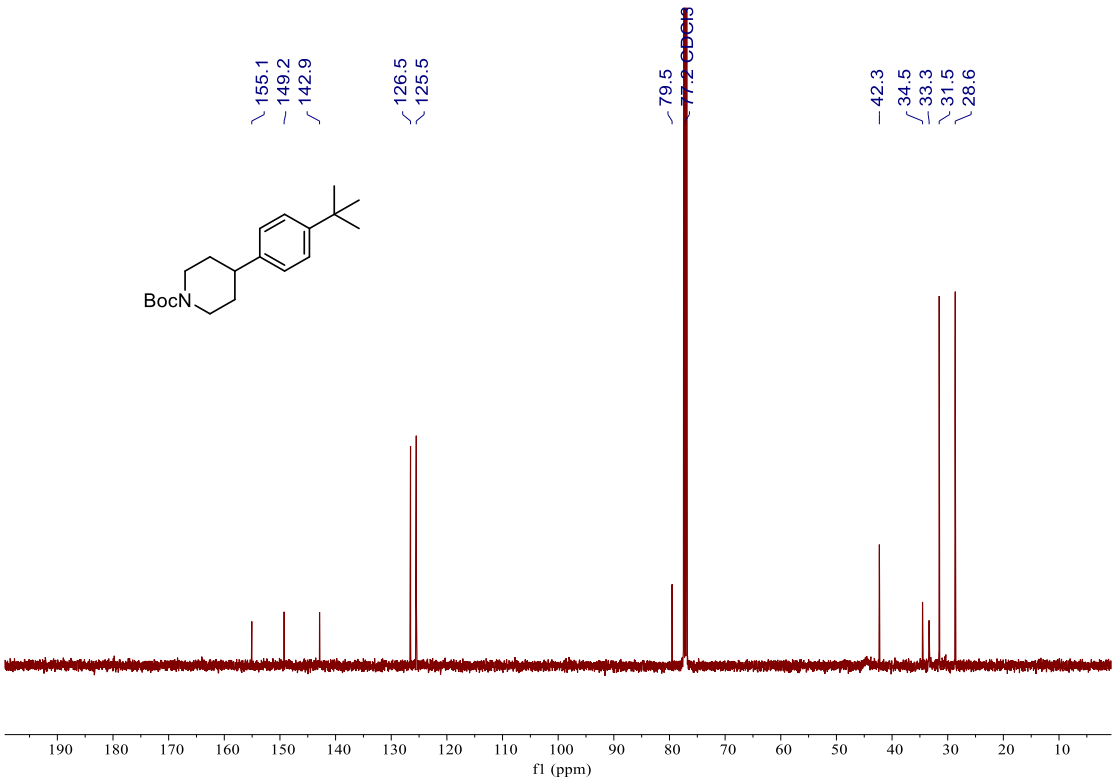
5n, ^{1}H NMR (500 MHz, $CDCl_3$)



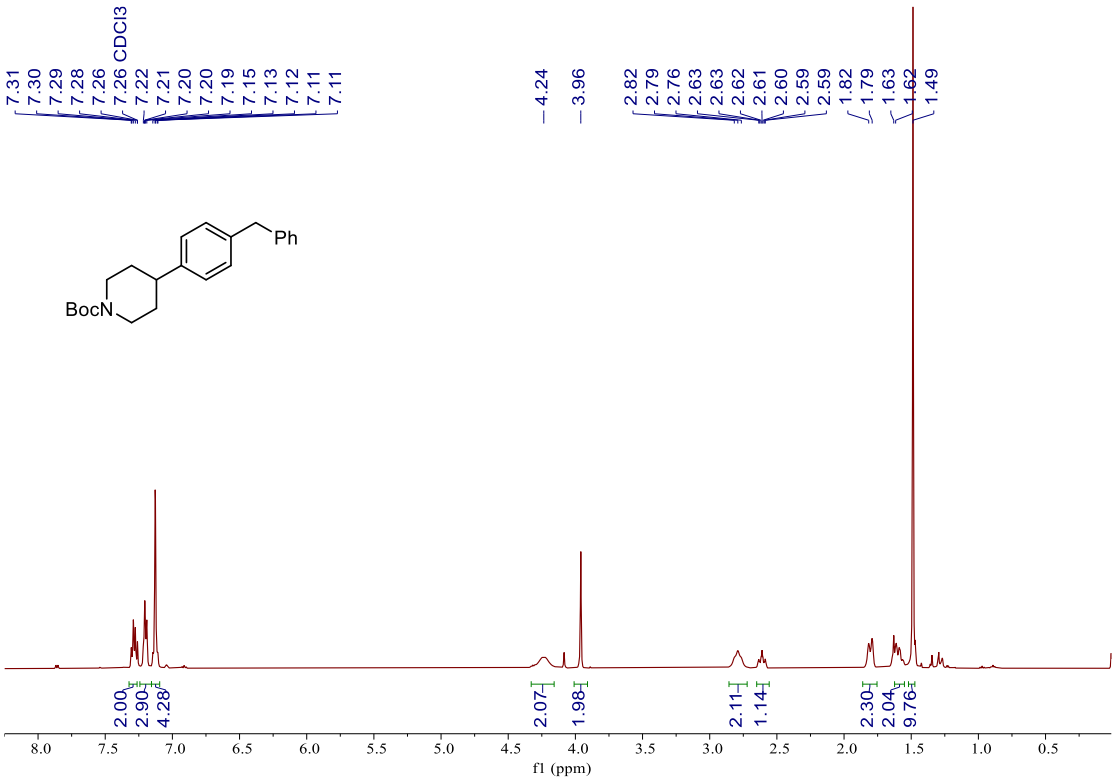
5n, ^{13}C NMR (126 MHz, $CDCl_3$)



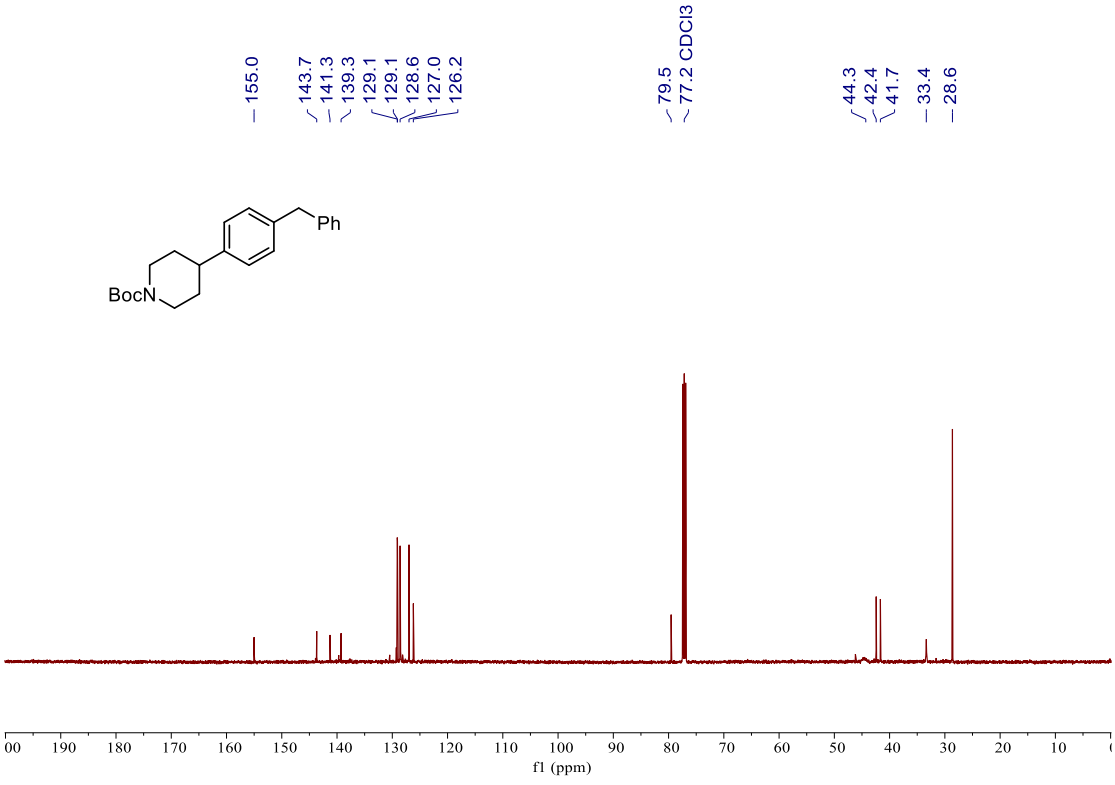
5o, ^{1}H NMR (500 MHz, $CDCl_3$)



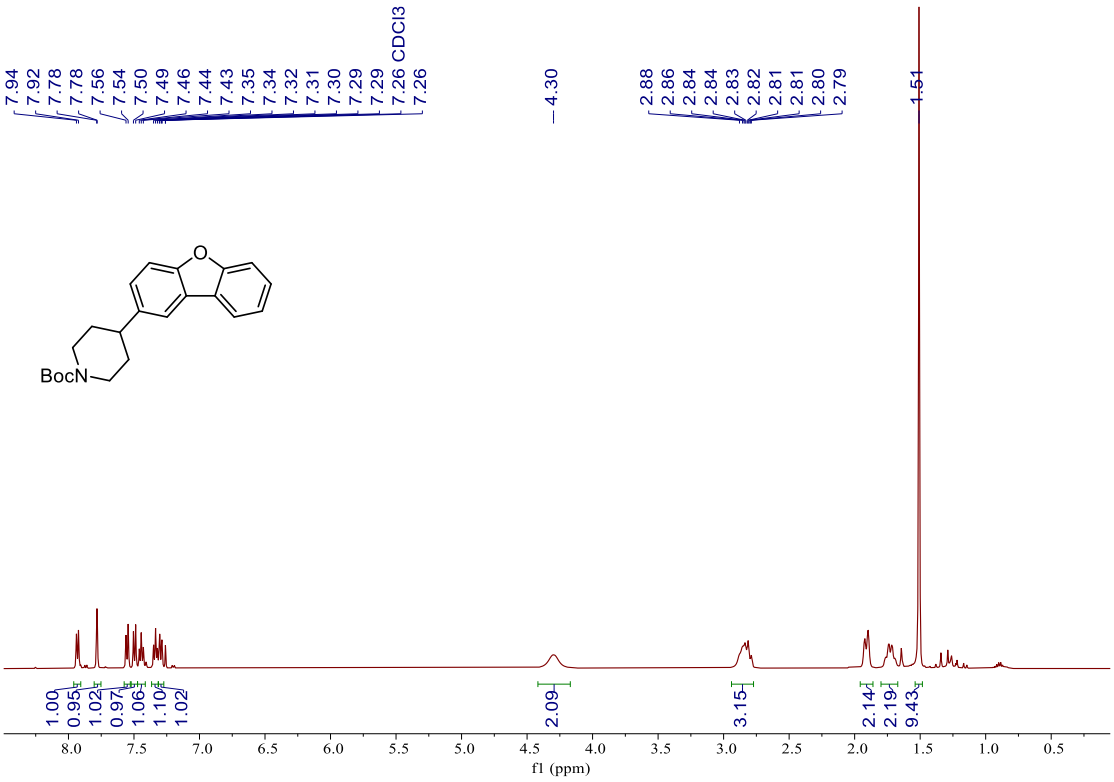
5o, ^{13}C NMR (126 MHz, $CDCl_3$)



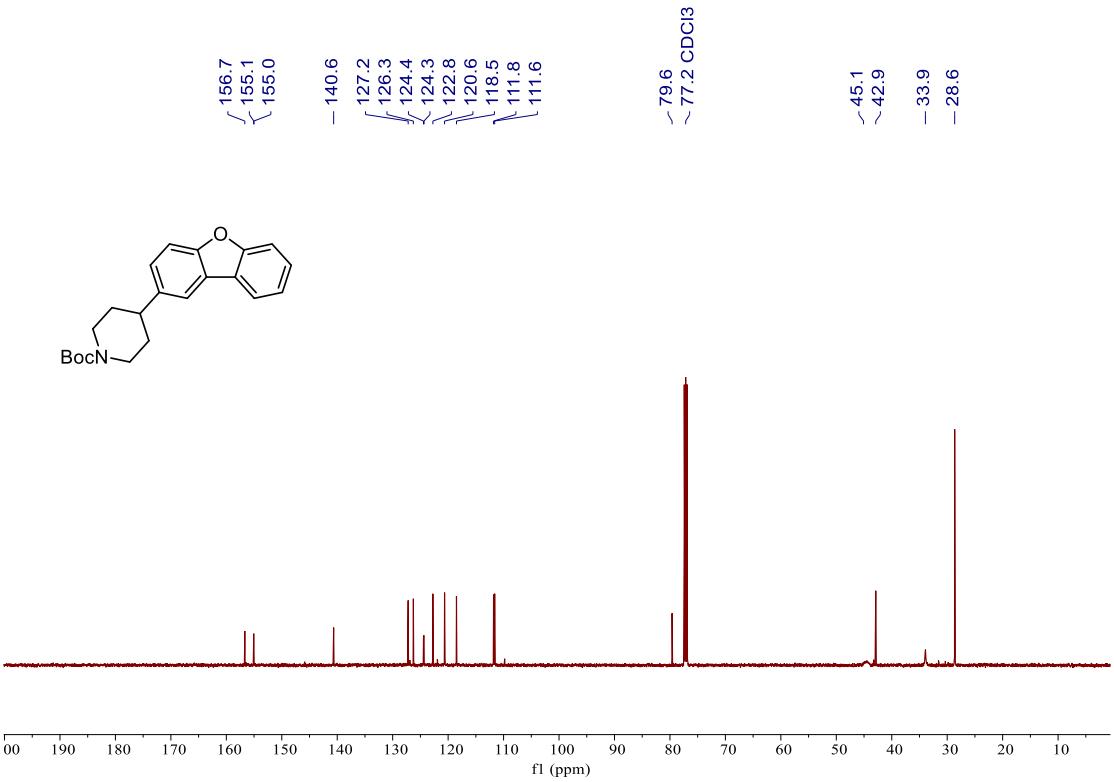
5p, ^{1}H NMR (500 MHz, $CDCl_3$)



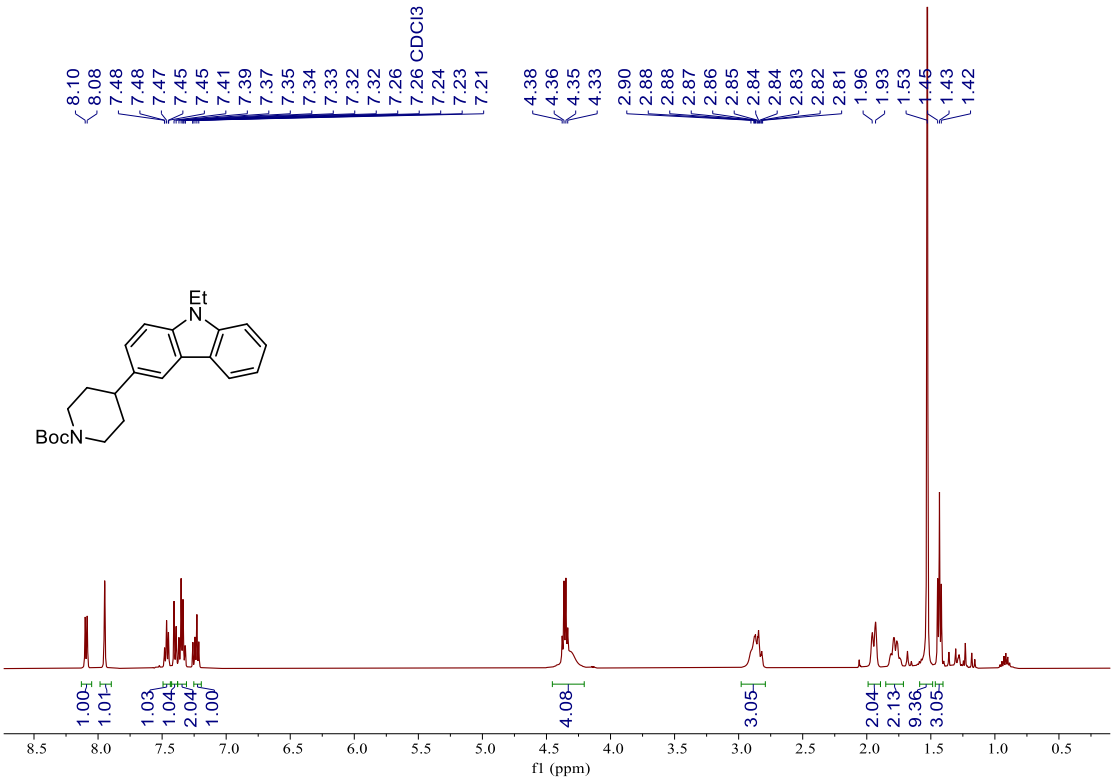
5p, ^{13}C NMR (126 MHz, $CDCl_3$)



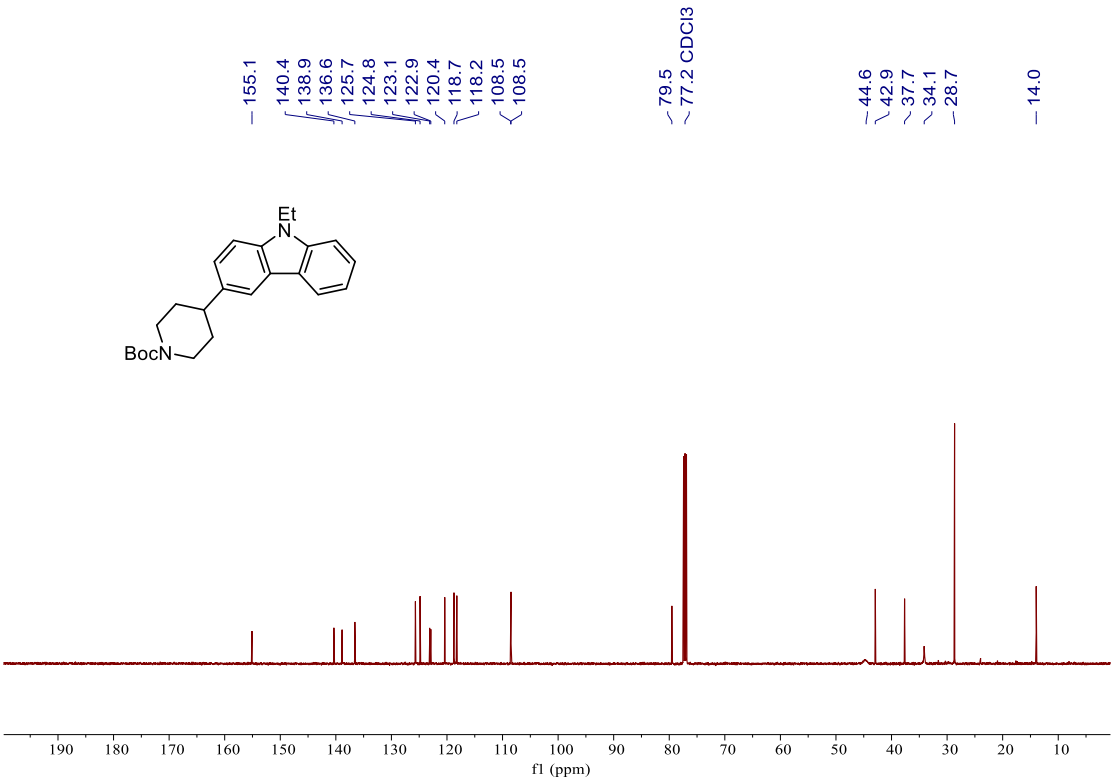
5q, ^{1}H NMR (500 MHz, $CDCl_3$)



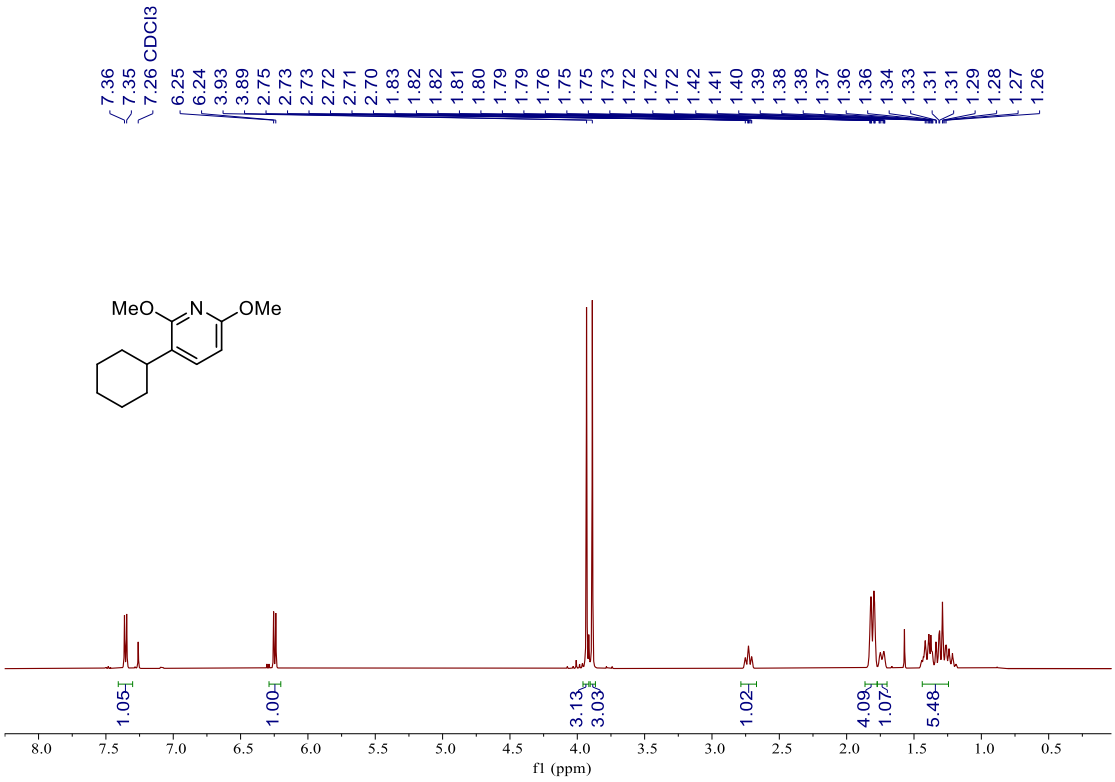
5q, ^{13}C NMR (126 MHz, $CDCl_3$)



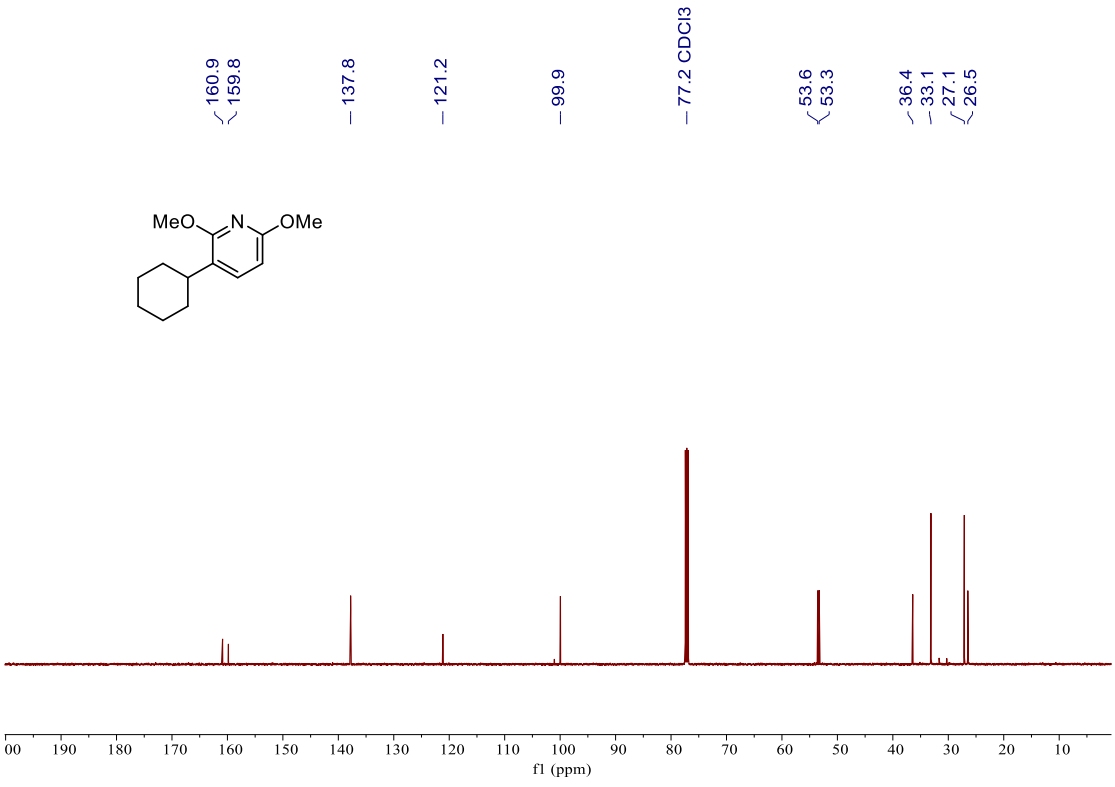
5r, ^{1}H NMR (500 MHz, $CDCl_3$)



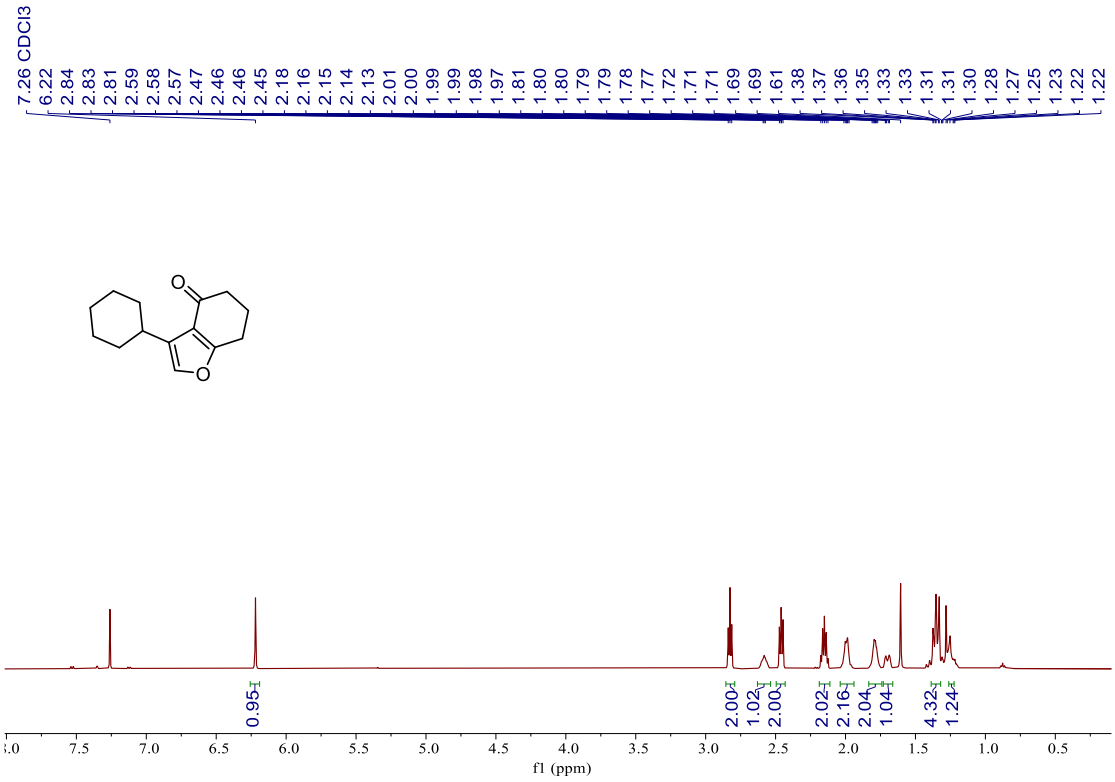
5r, ^{13}C NMR (126 MHz, $CDCl_3$)



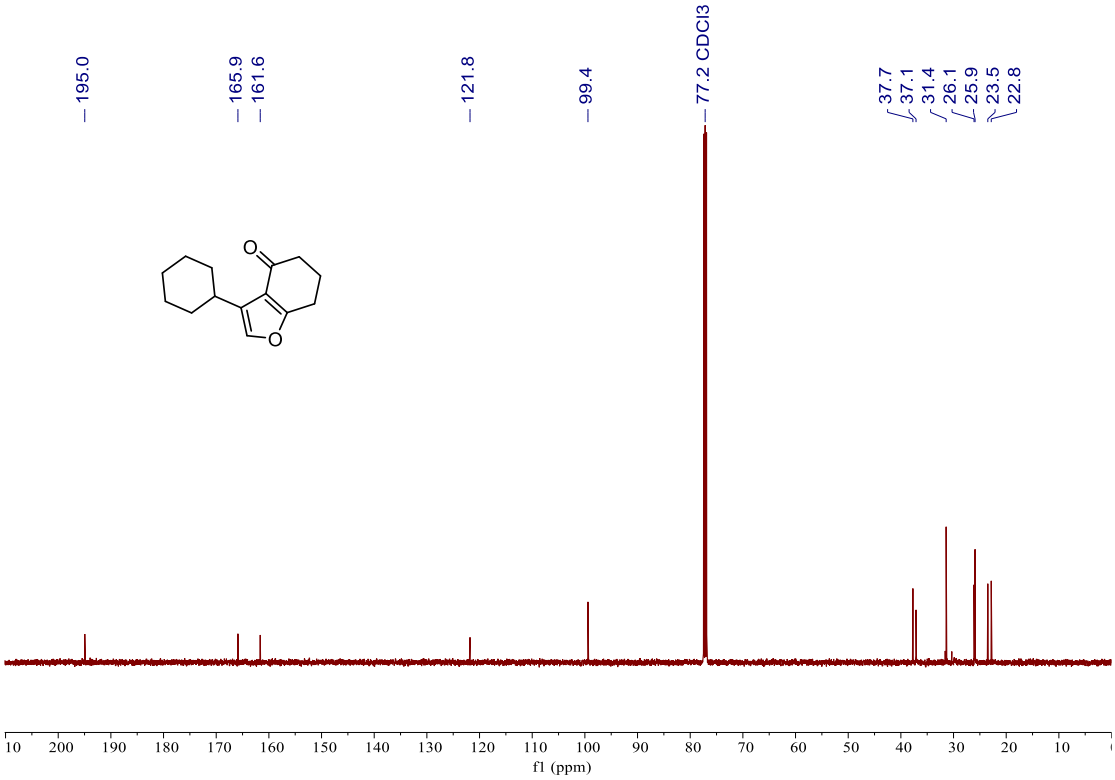
5s, ^{1}H NMR (500 MHz, $CDCl_3$)



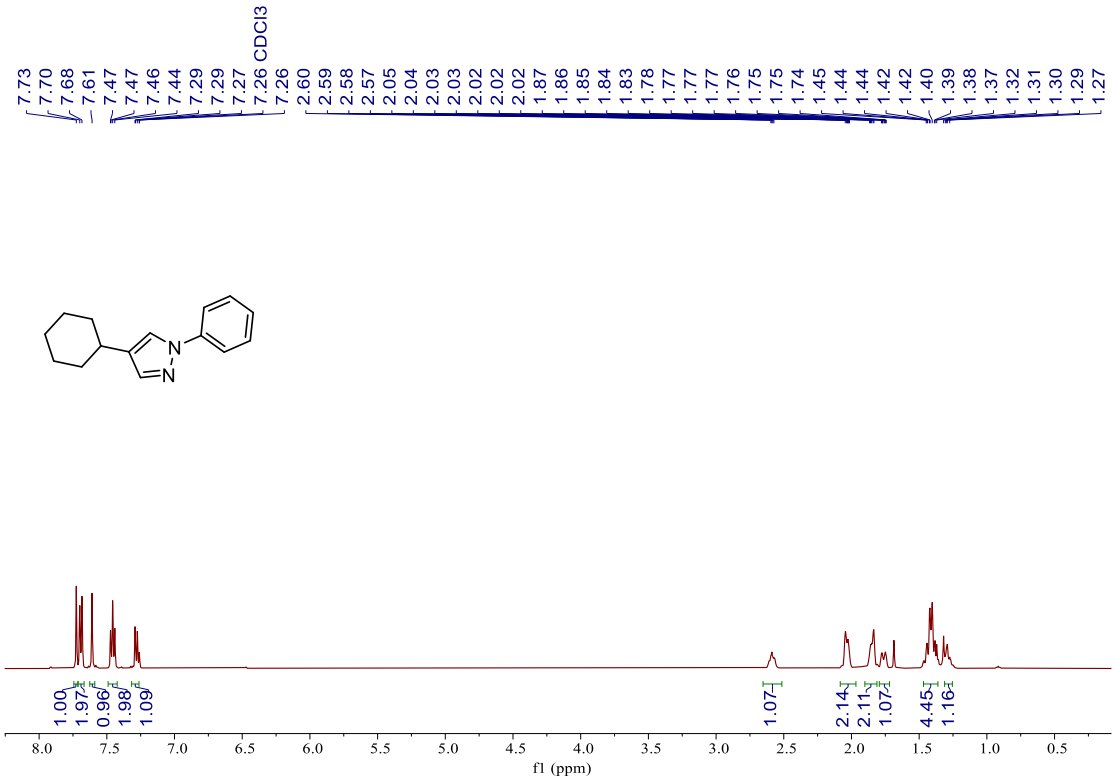
5s, ^{13}C NMR (126 MHz, $CDCl_3$)



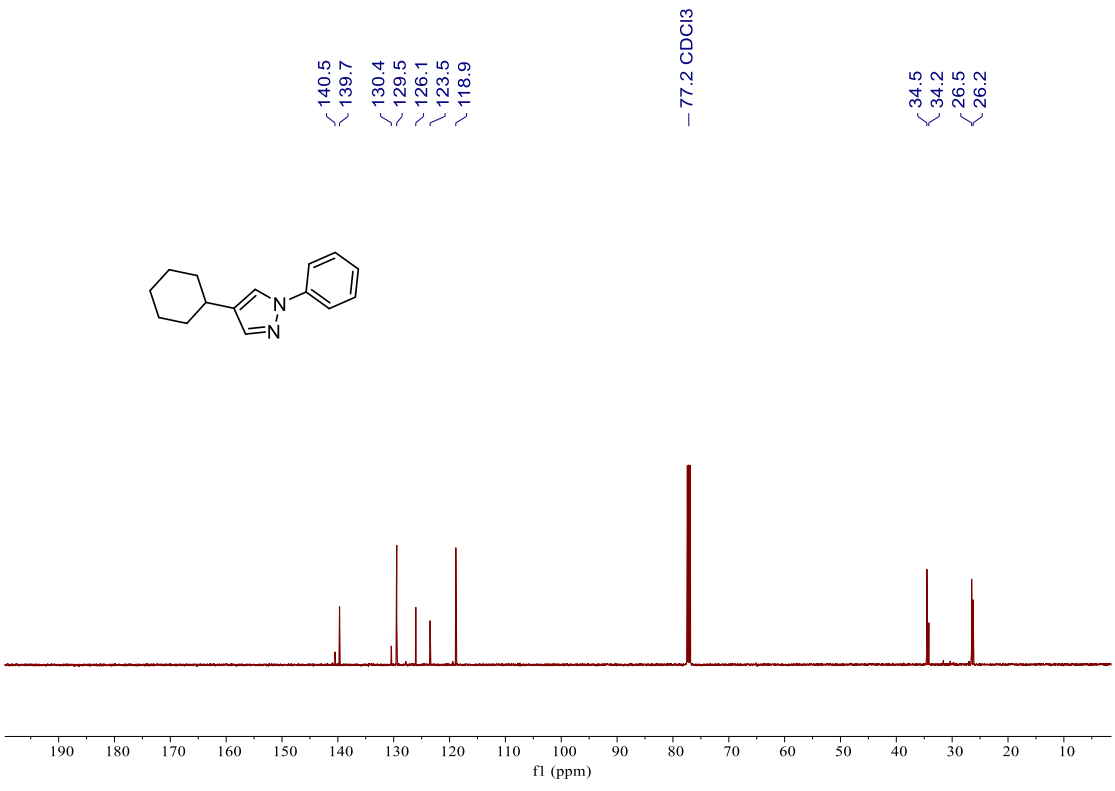
5t, ^{1}H NMR (500 MHz, $CDCl_3$)



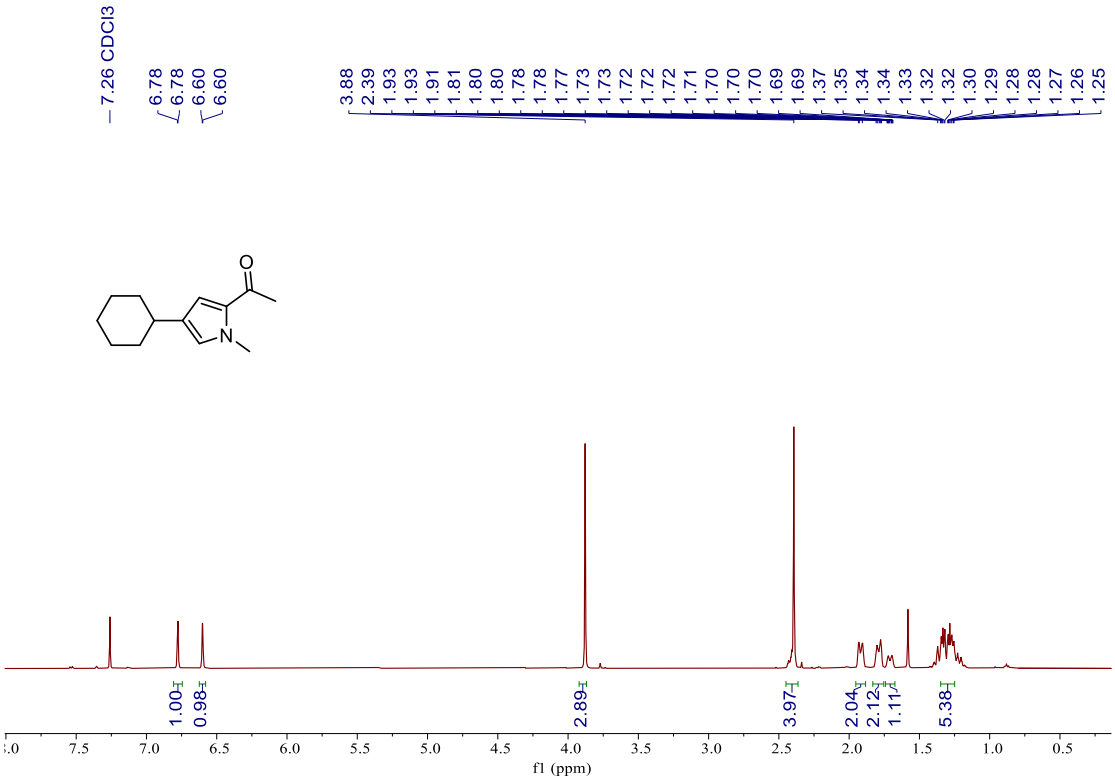
5t, ^{13}C NMR (126 MHz, $CDCl_3$)



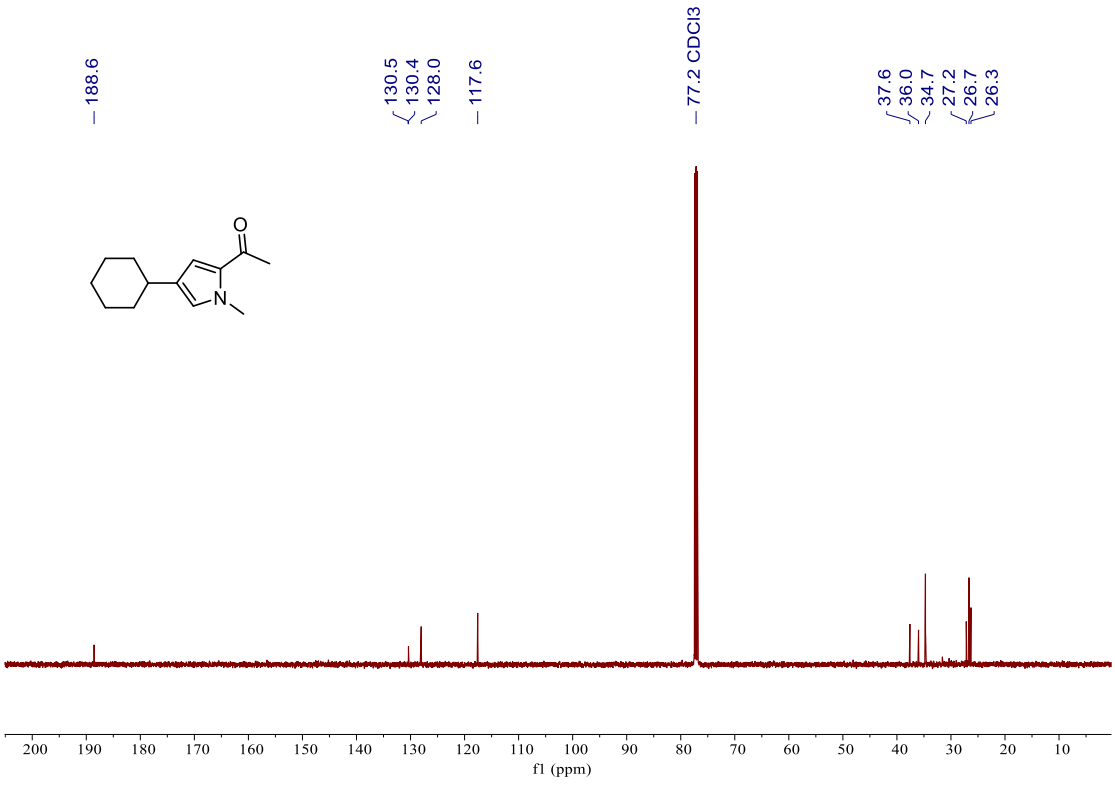
5u, ^{1}H NMR (500 MHz, $CDCl_3$)



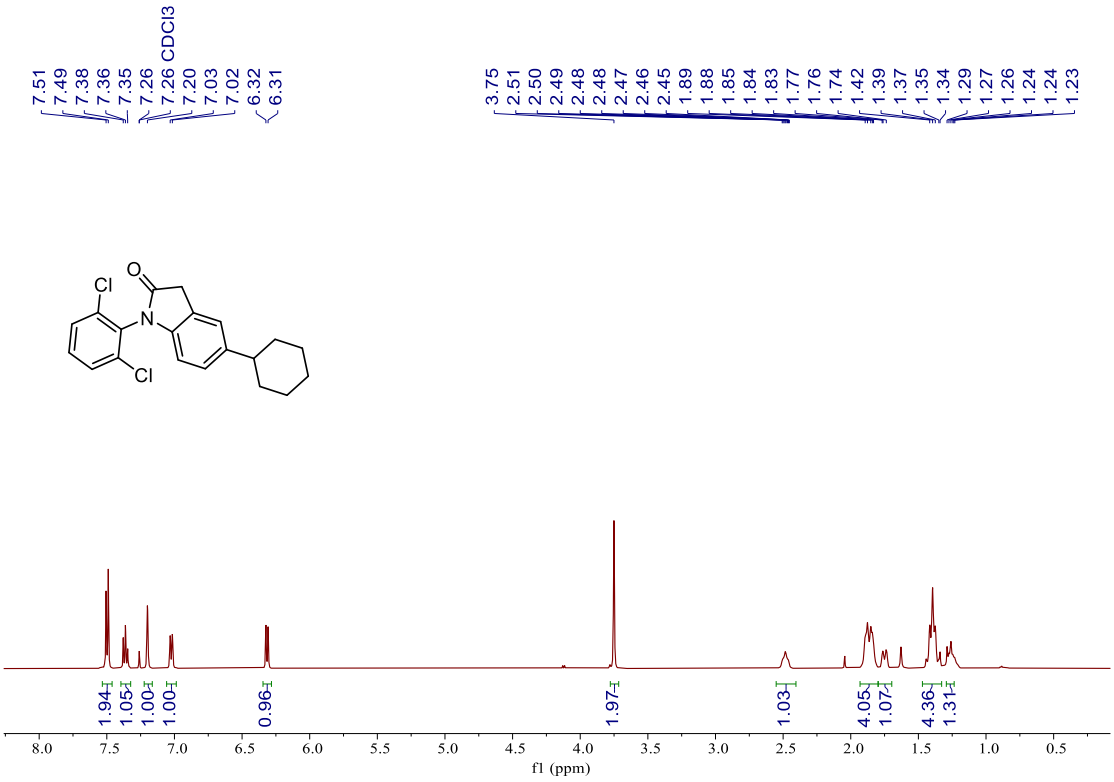
5u, ^{13}C NMR (126 MHz, $CDCl_3$)



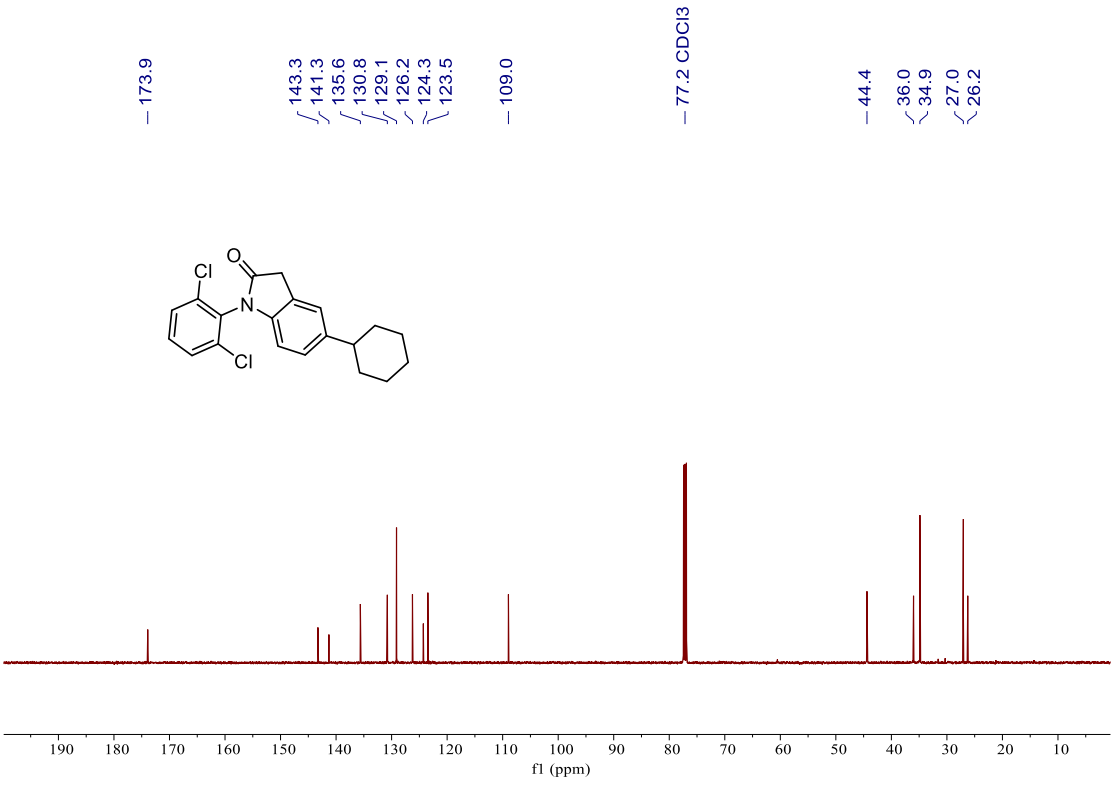
5v, ^{1}H NMR (500 MHz, $CDCl_3$)



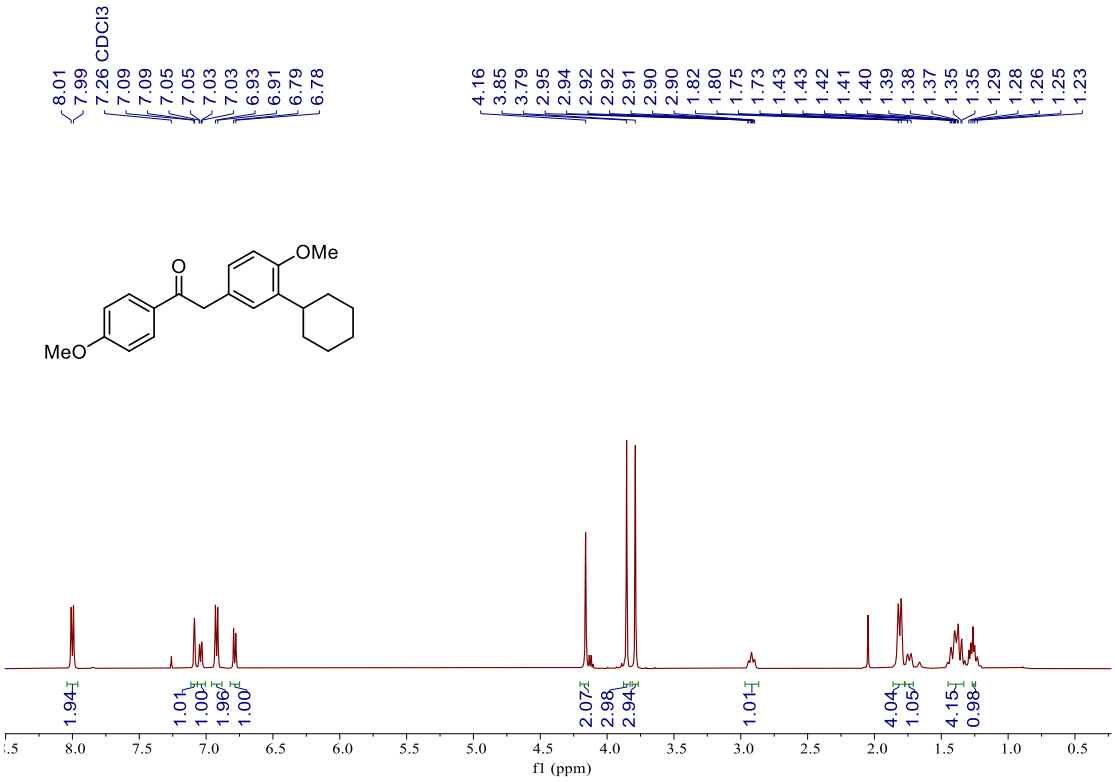
5v, ^{13}C NMR (126 MHz, $CDCl_3$)



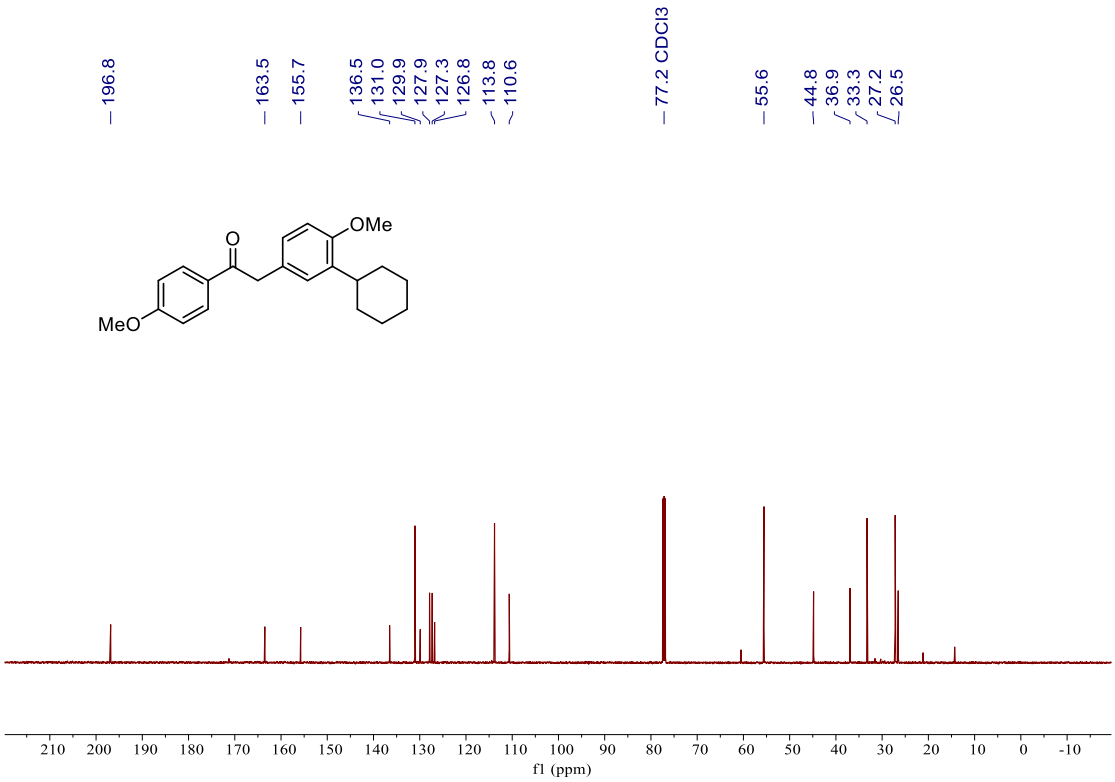
5w, ^{1}H NMR (500 MHz, $CDCl_3$)



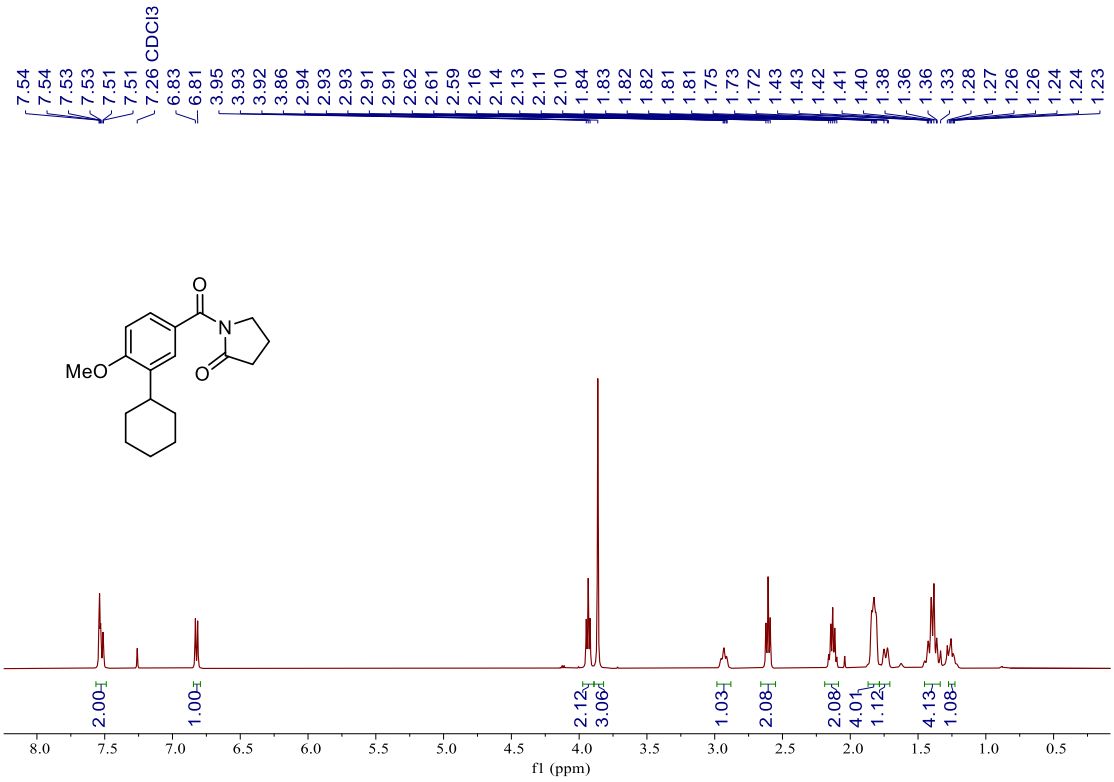
5w, ^{13}C NMR (126 MHz, $CDCl_3$)



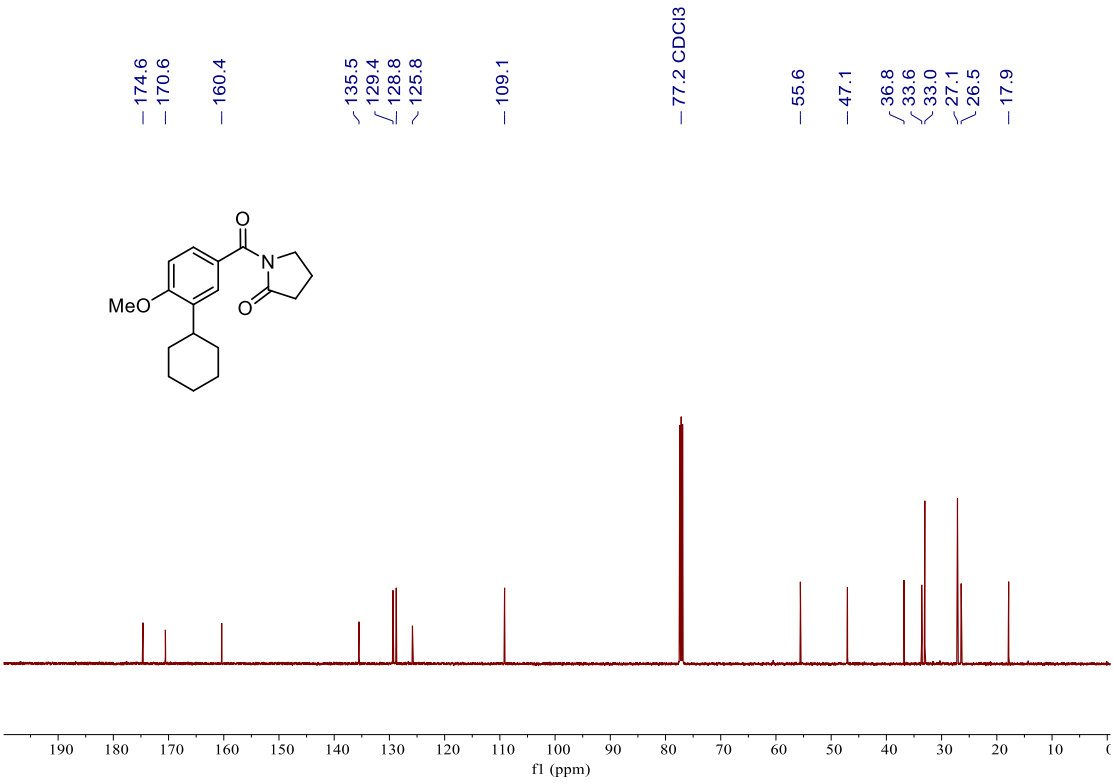
5x, ^{1}H NMR (500 MHz, $CDCl_3$)



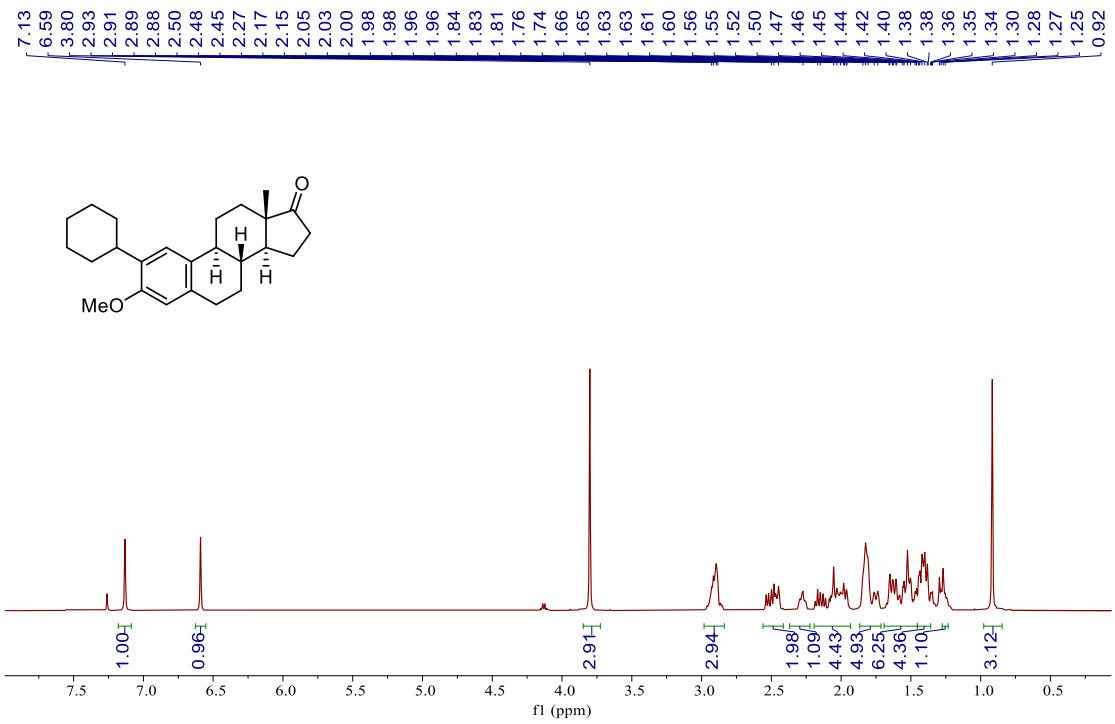
5x, ^{13}C NMR (126 MHz, $CDCl_3$)



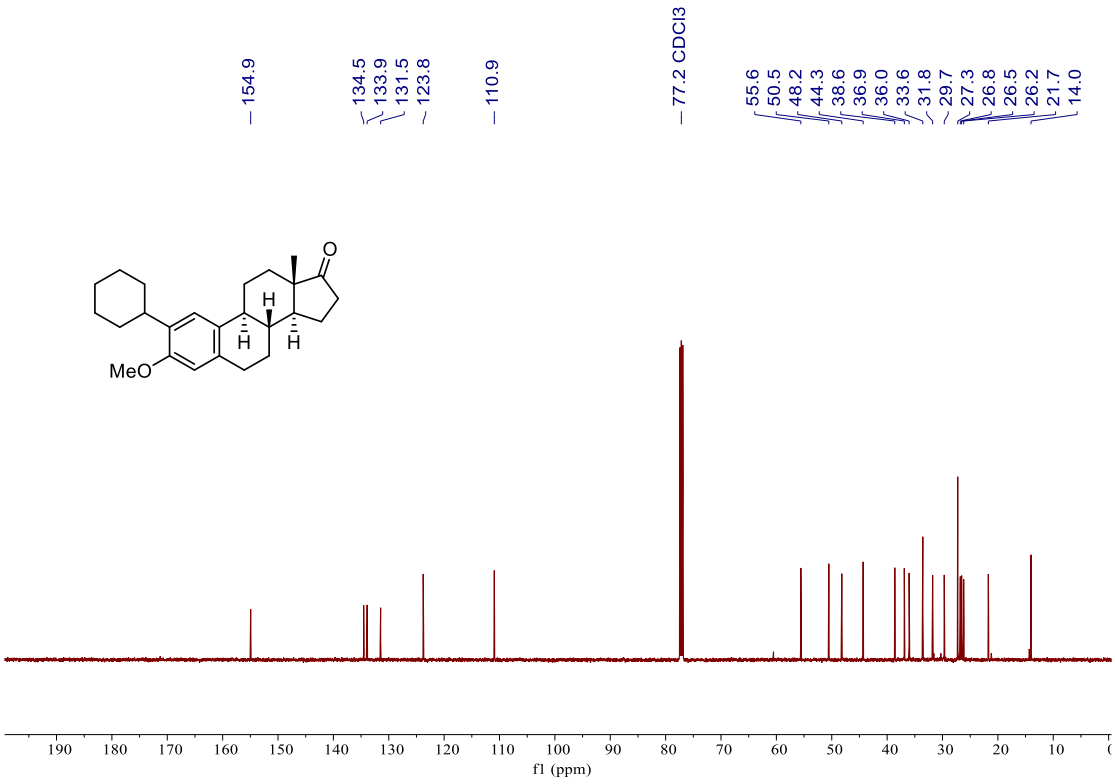
5y, ^{1}H NMR (500 MHz, $CDCl_3$)



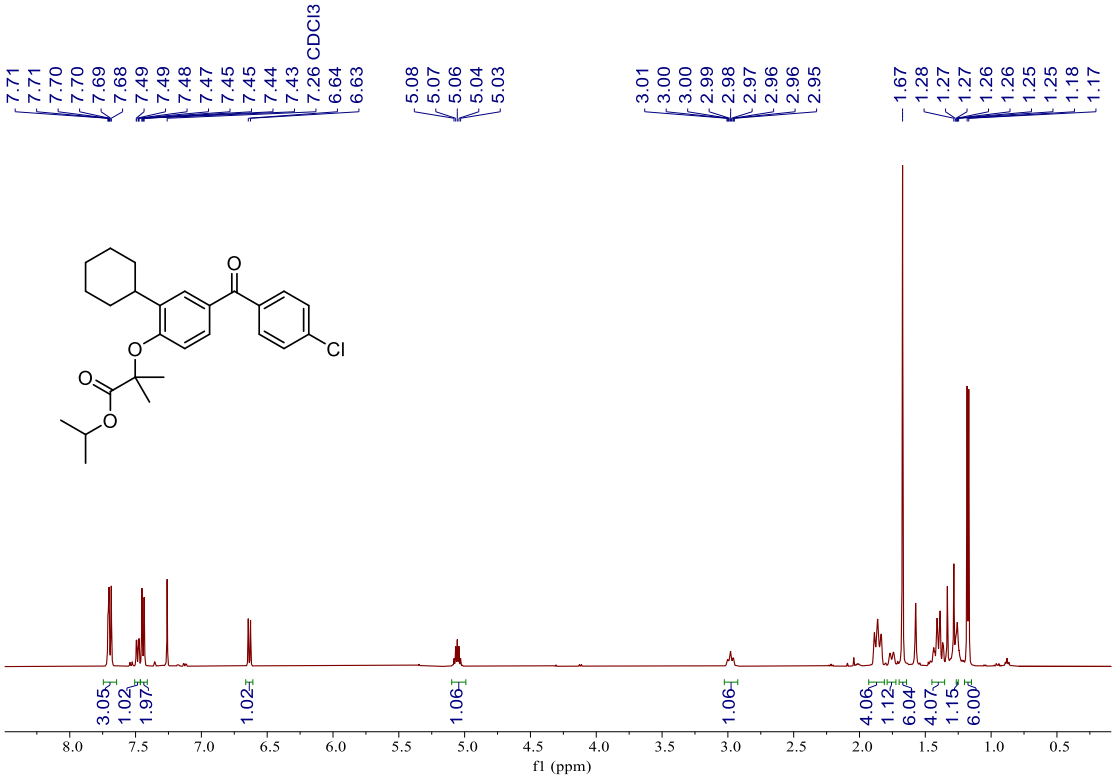
5y, ^{13}C NMR (126 MHz, $CDCl_3$)



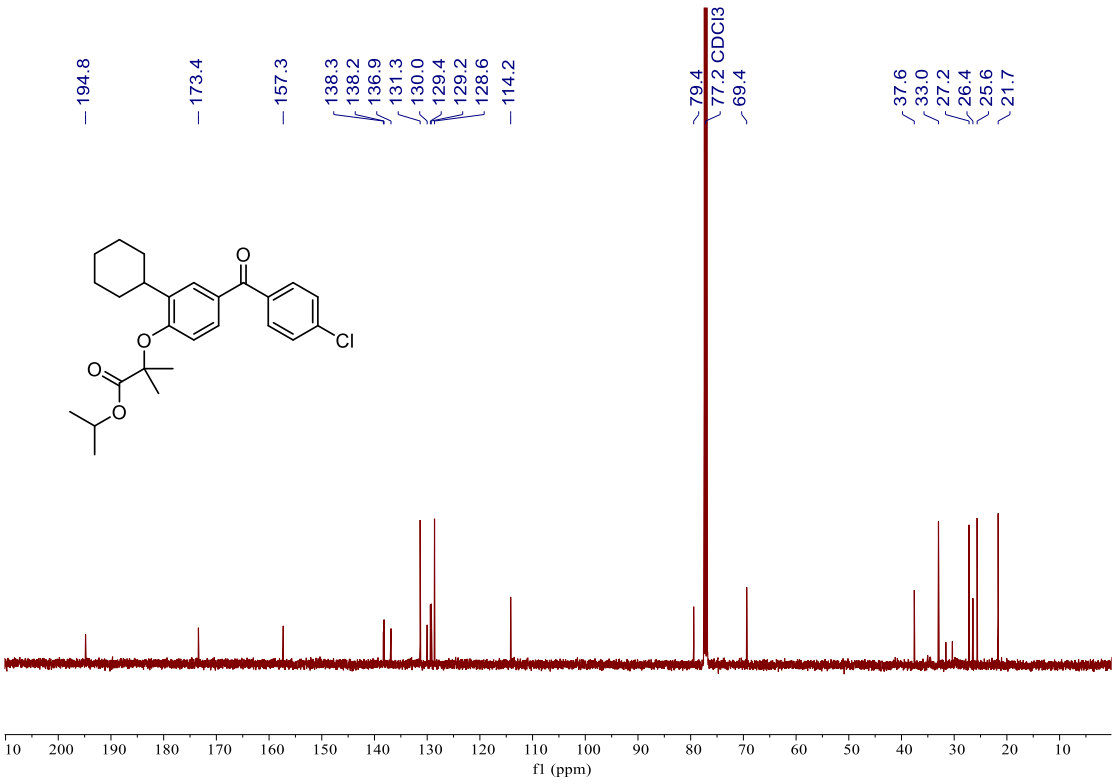
5z, ^{1}H NMR (500 MHz, $CDCl_3$)



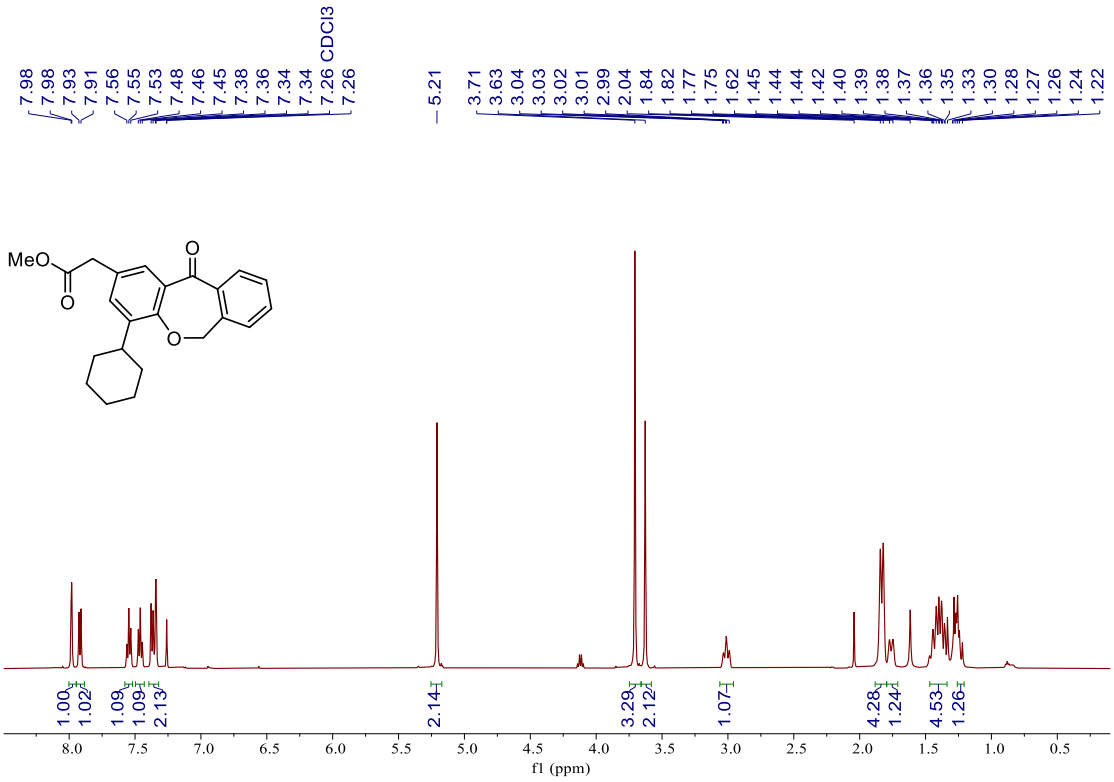
5z, ^{13}C NMR (126 MHz, $CDCl_3$)



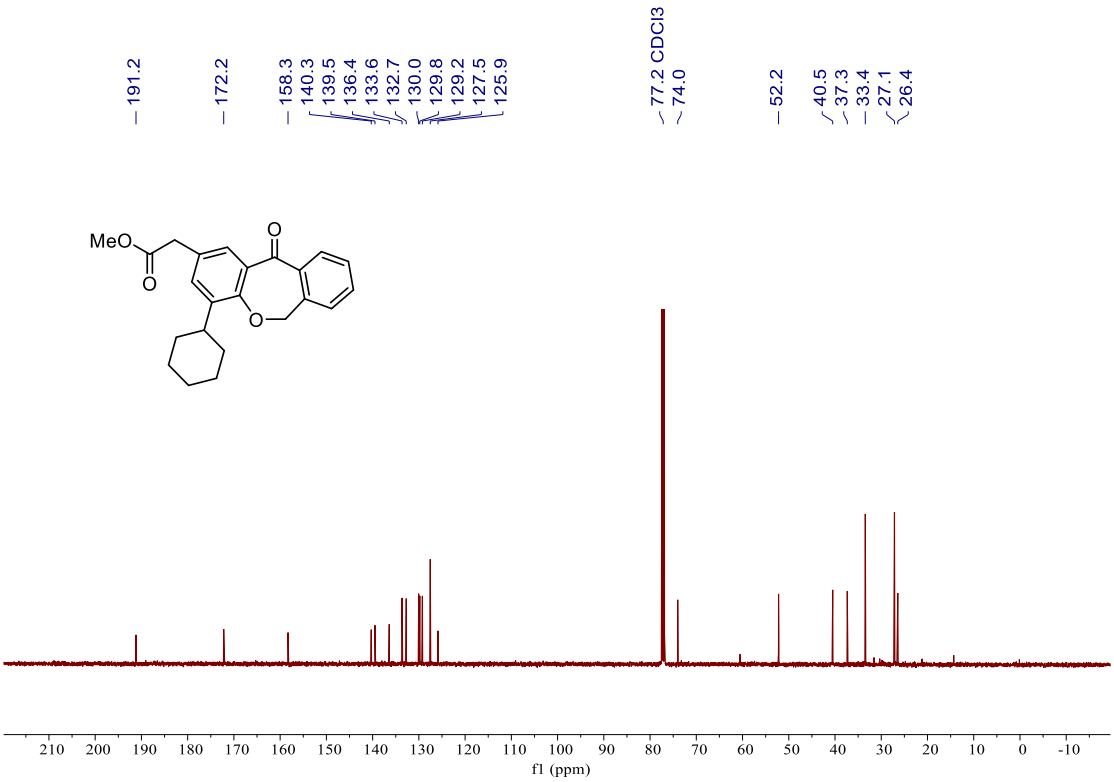
5aa, ^{1}H NMR (500 MHz, $CDCl_3$)



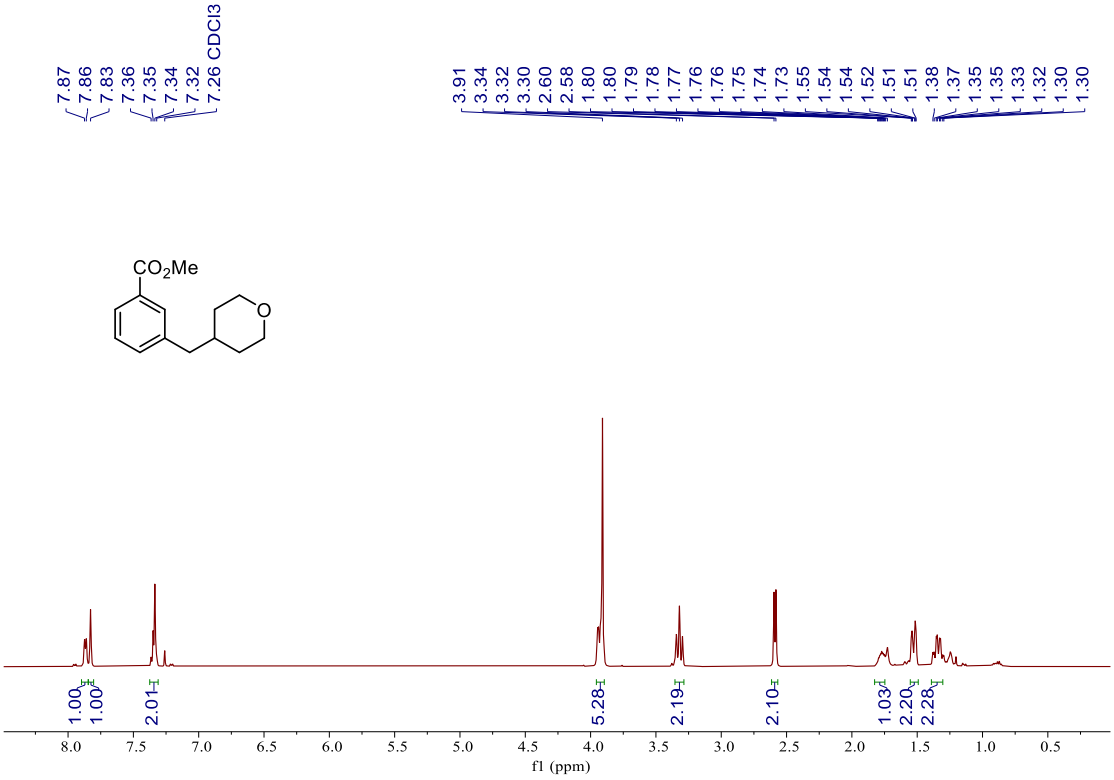
5aa, ^{13}C NMR (126 MHz, $CDCl_3$)



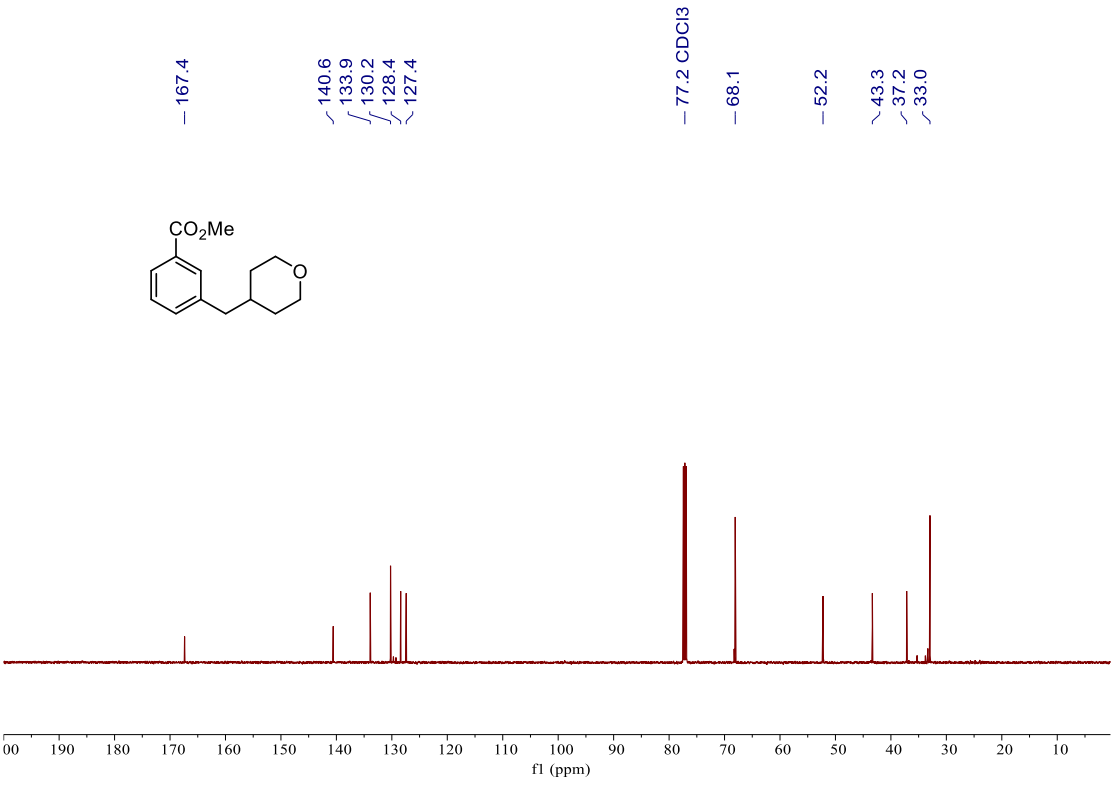
5ab, ^{1}H NMR (500 MHz, $CDCl_3$)



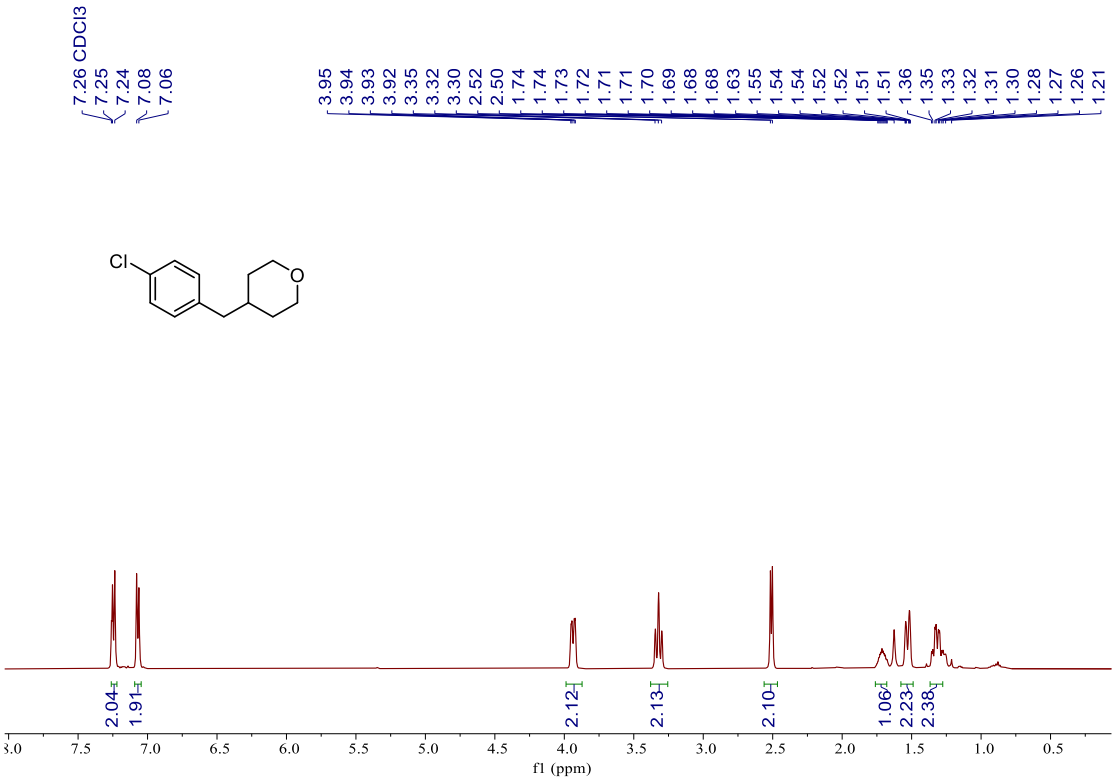
5ab, ^{13}C NMR (126 MHz, $CDCl_3$)



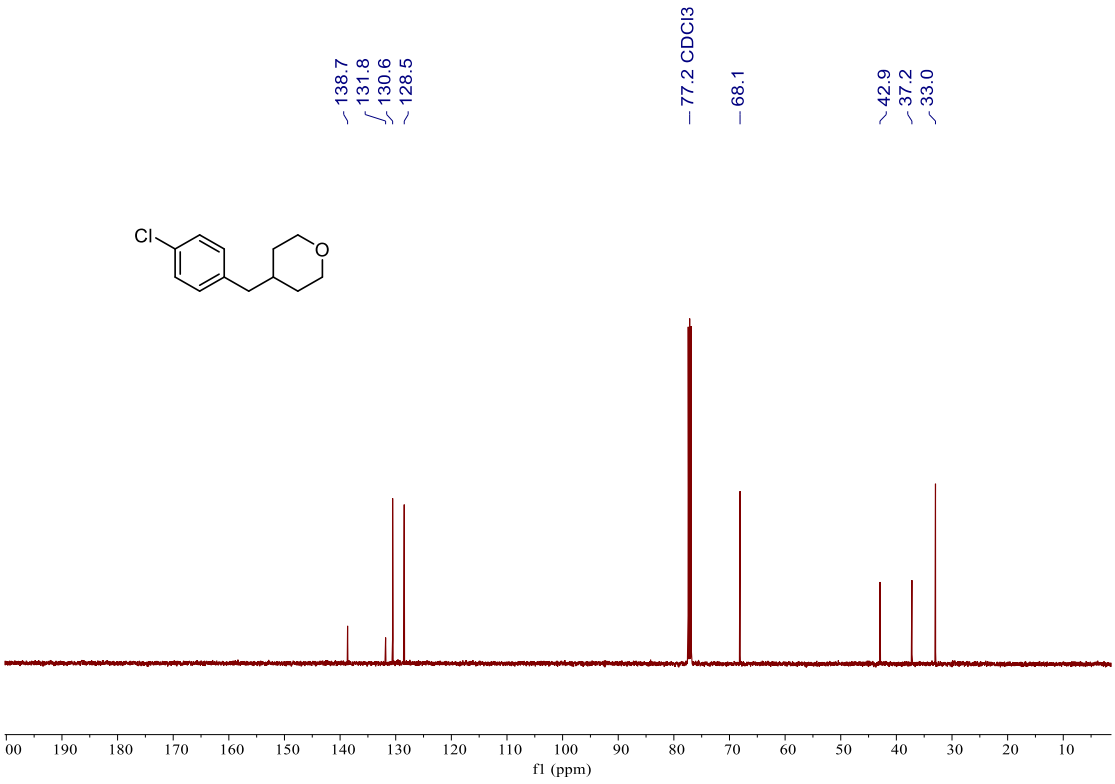
7a, ^{1}H NMR (500 MHz, $CDCl_3$)



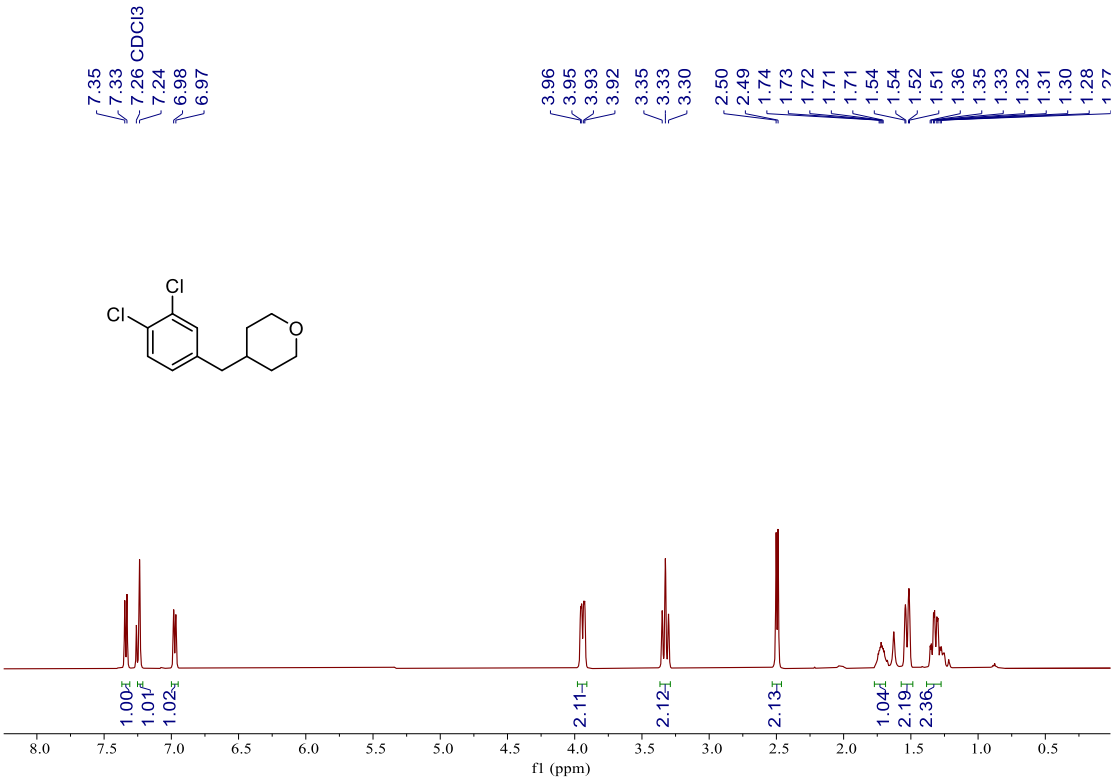
7a, ^{13}C NMR (126 MHz, $CDCl_3$)



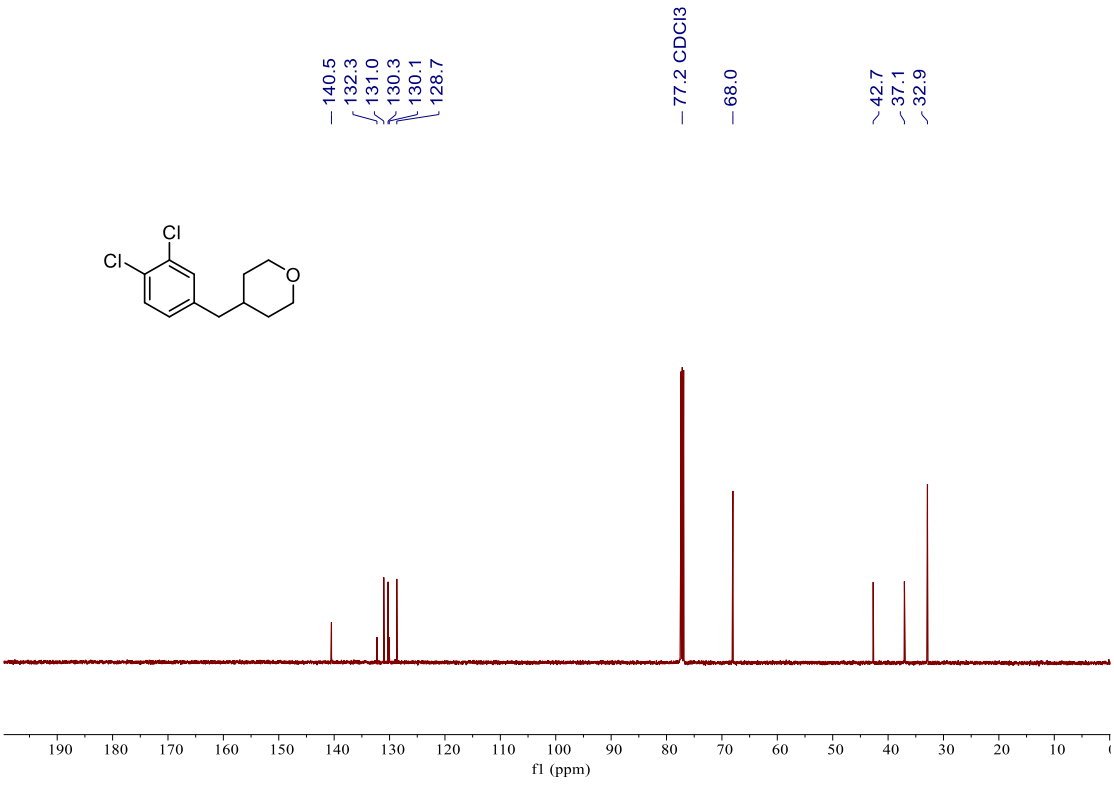
7b, ^{1}H NMR (500 MHz, $CDCl_3$)



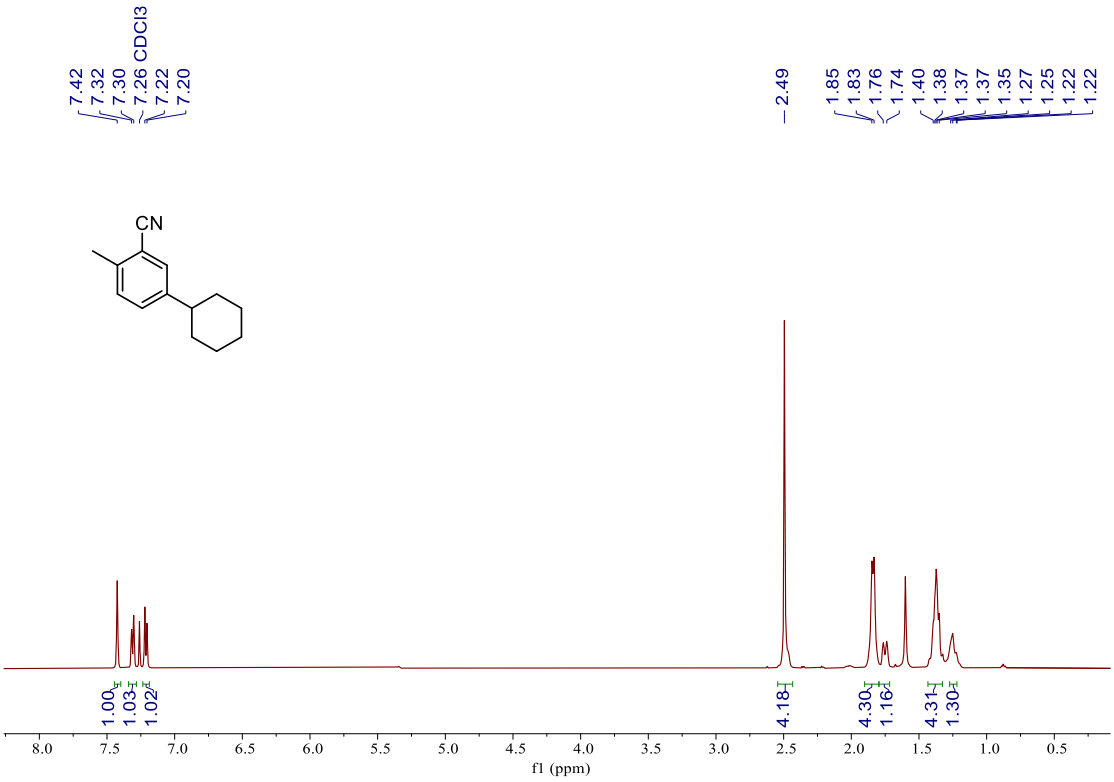
7b, ^{13}C NMR (126 MHz, $CDCl_3$)



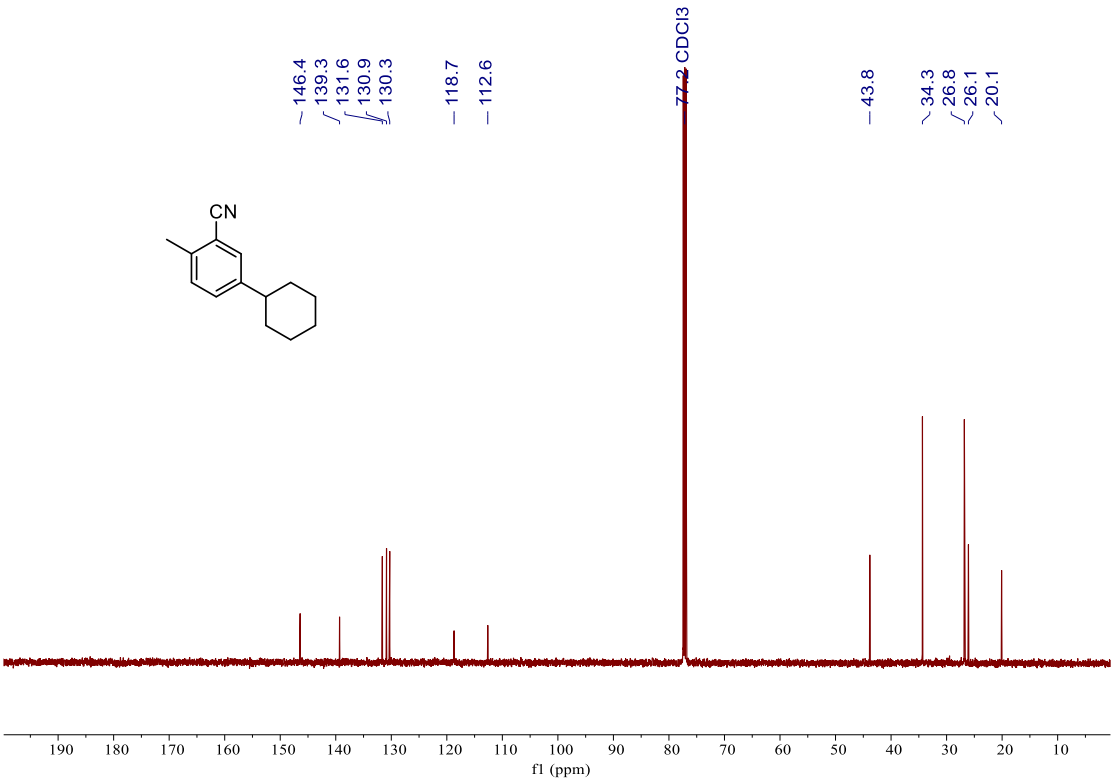
7c, ^{1}H NMR (500 MHz, $CDCl_3$)



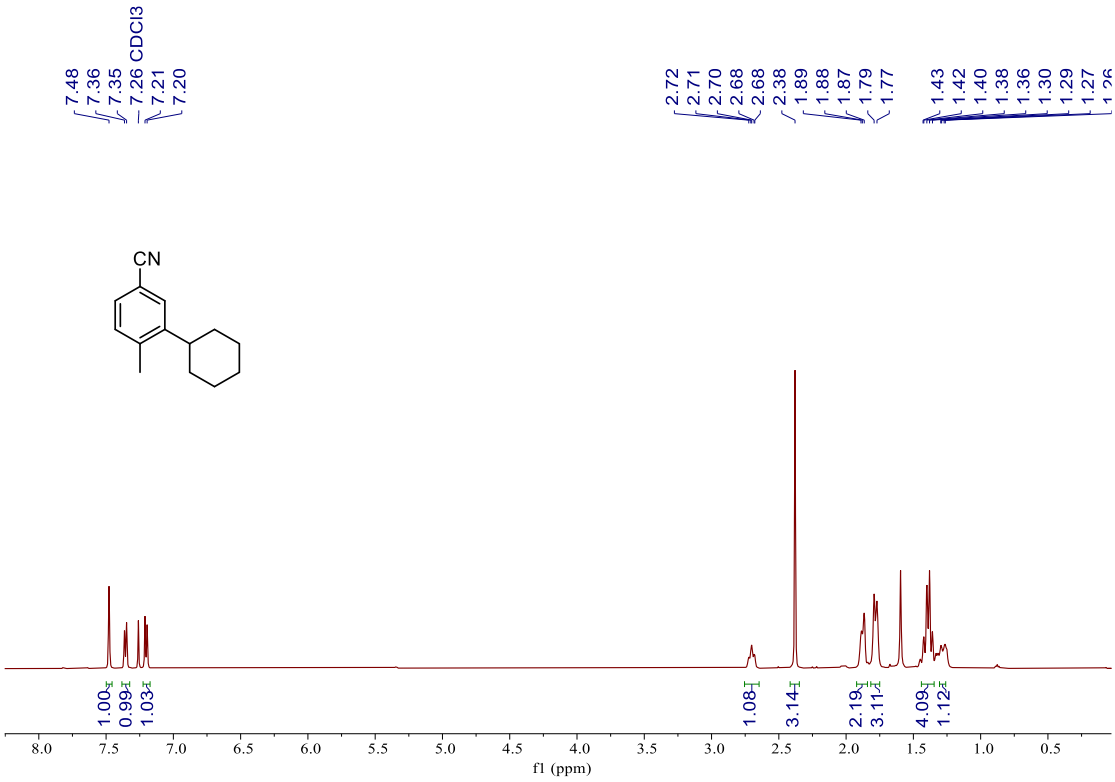
7c, ^{13}C NMR (126 MHz, $CDCl_3$)



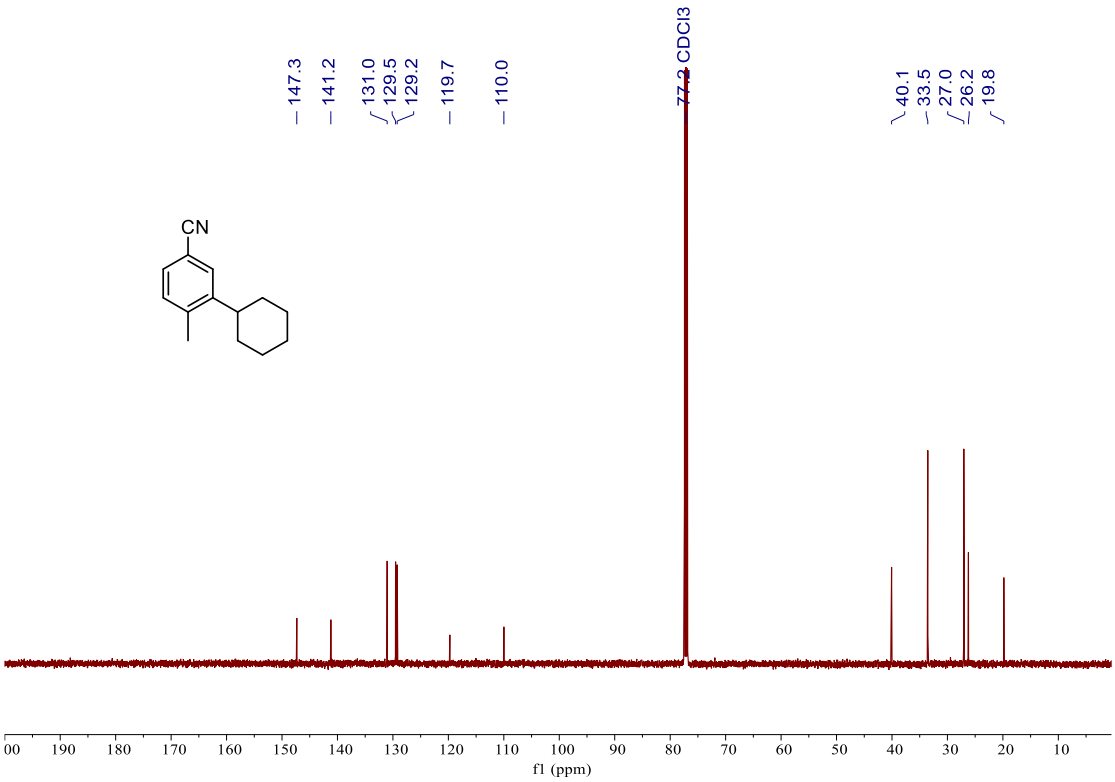
7d, ^{1}H NMR (500 MHz, $CDCl_3$)



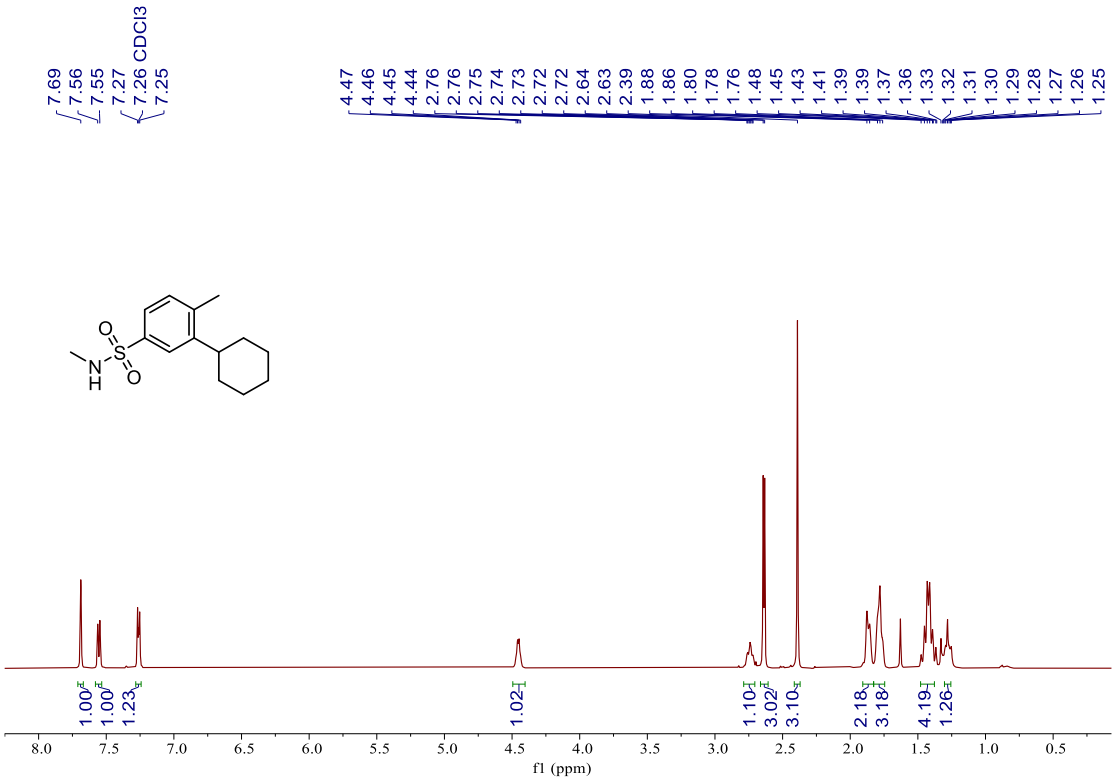
7d, ^{13}C NMR (126 MHz, $CDCl_3$)



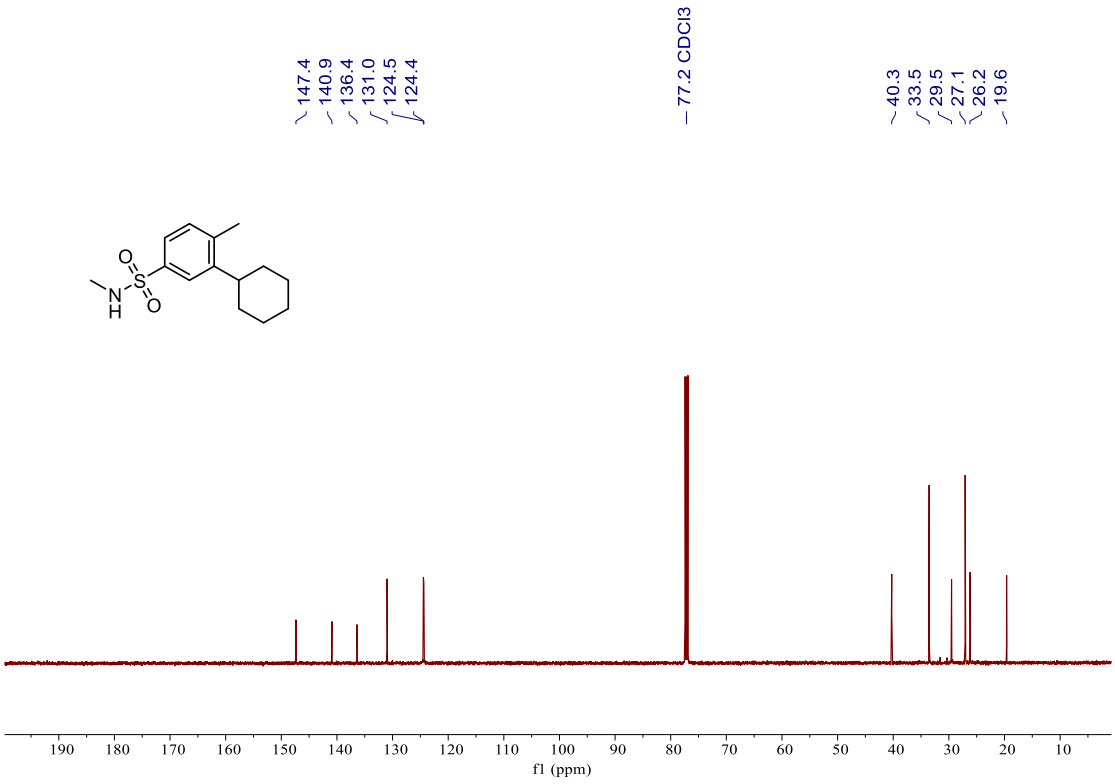
7e, ^{1}H NMR (500 MHz, $CDCl_3$)



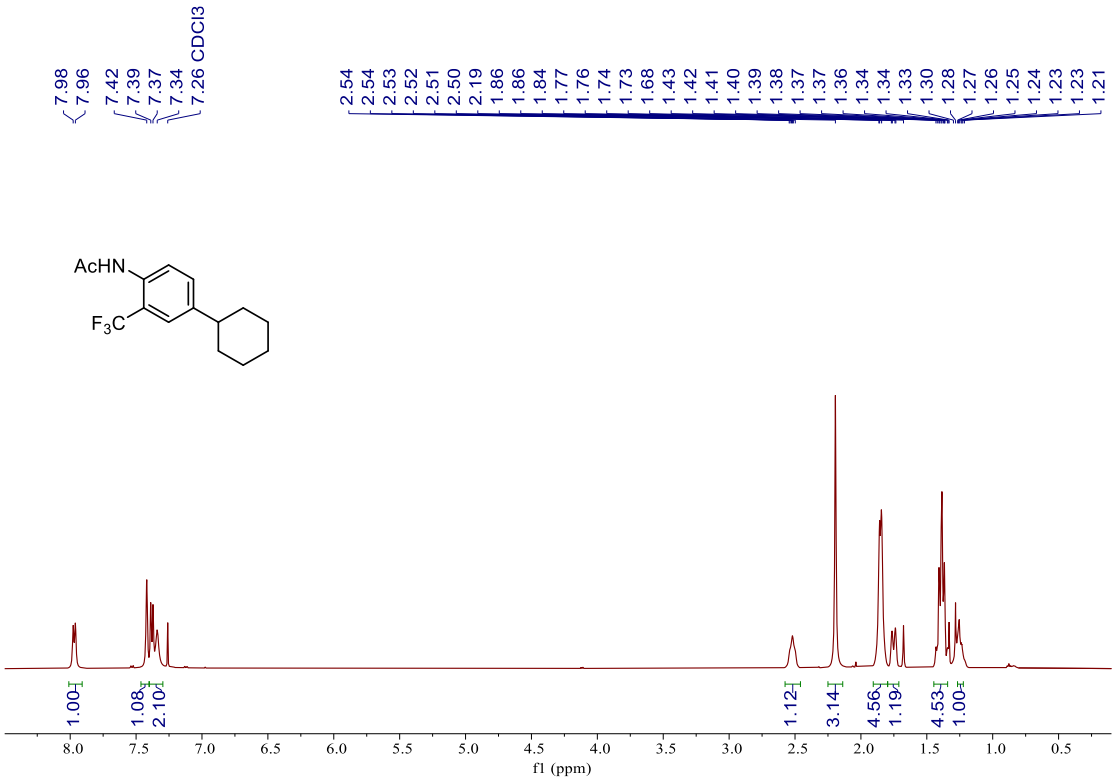
7e, ^{13}C NMR (126 MHz, $CDCl_3$)



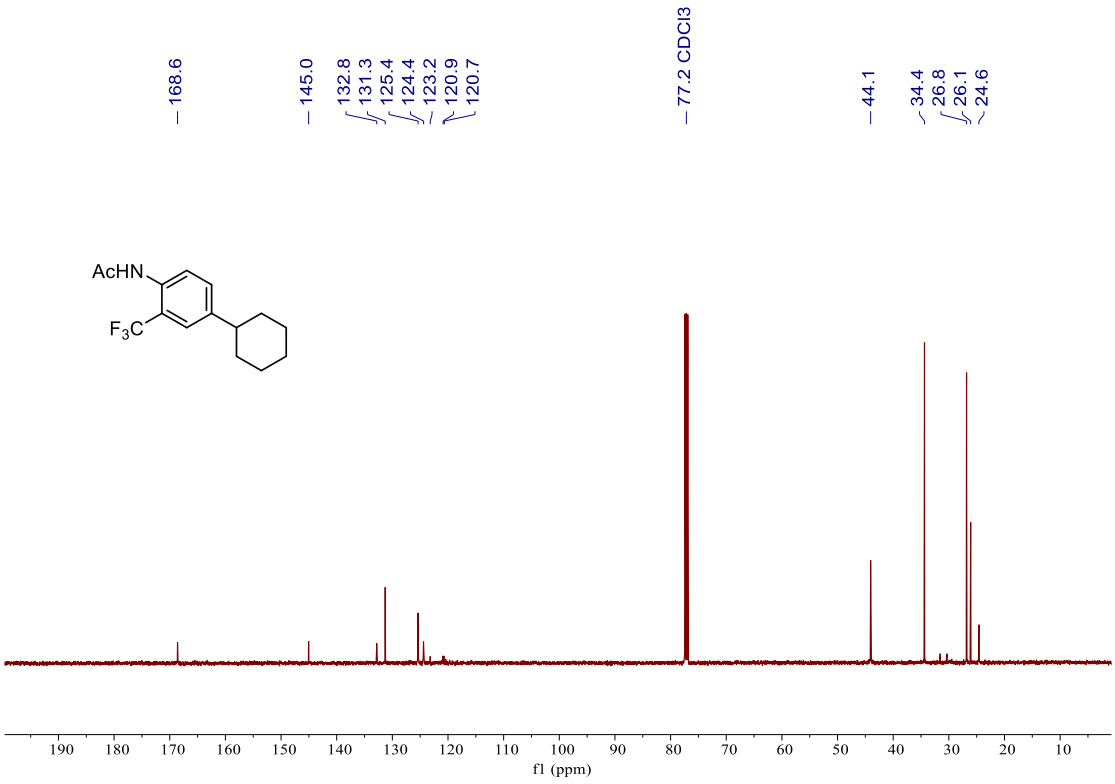
7f, ^{1}H NMR (500 MHz, $CDCl_3$)



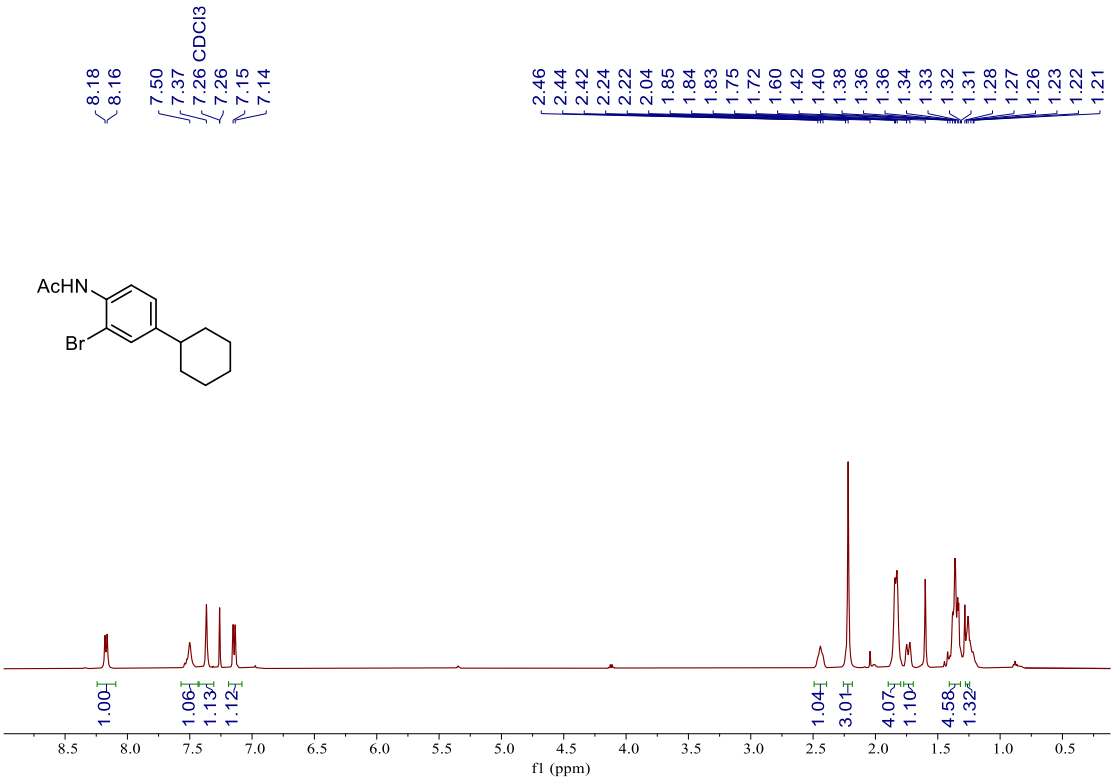
7f, ^{13}C NMR (126 MHz, $CDCl_3$)



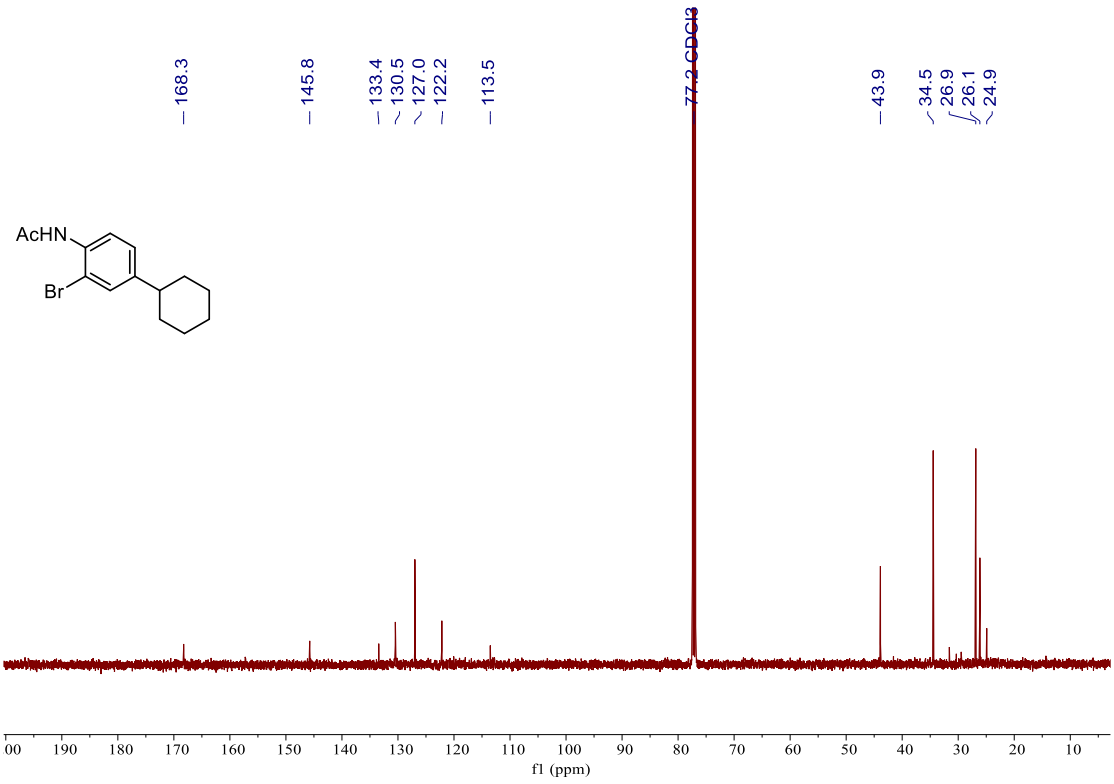
7g, ^{1}H NMR (500 MHz, $CDCl_3$)



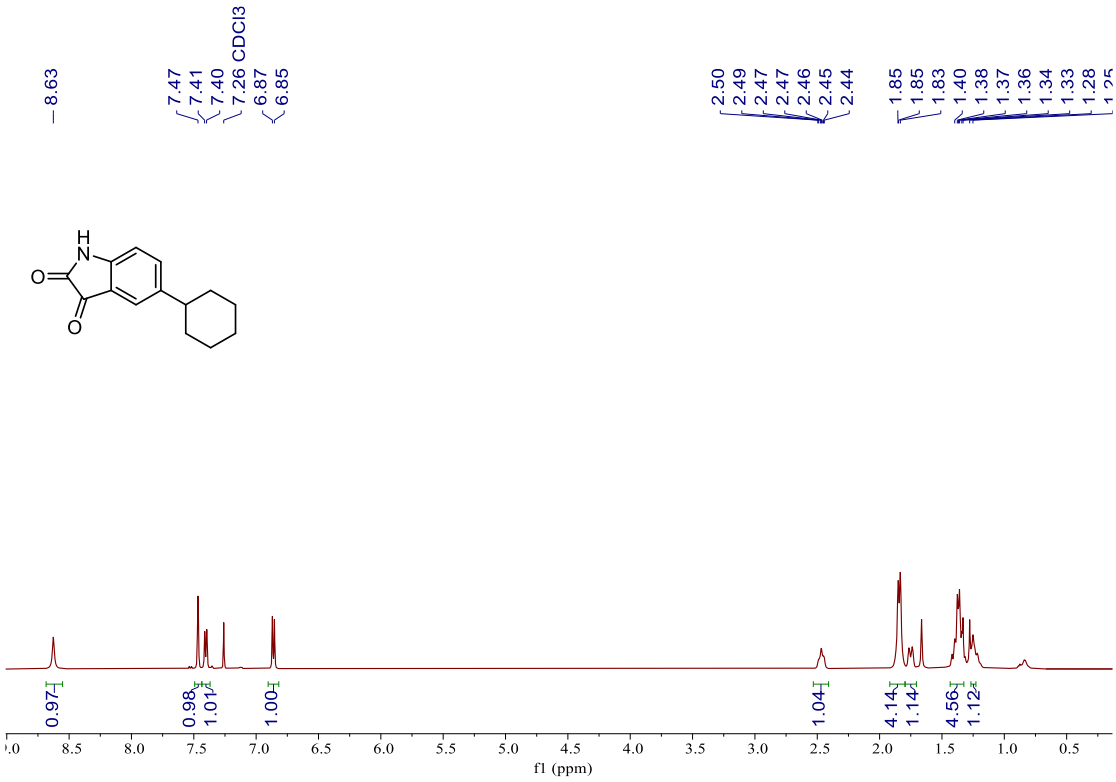
7g, ^{13}C NMR (126 MHz, $CDCl_3$)



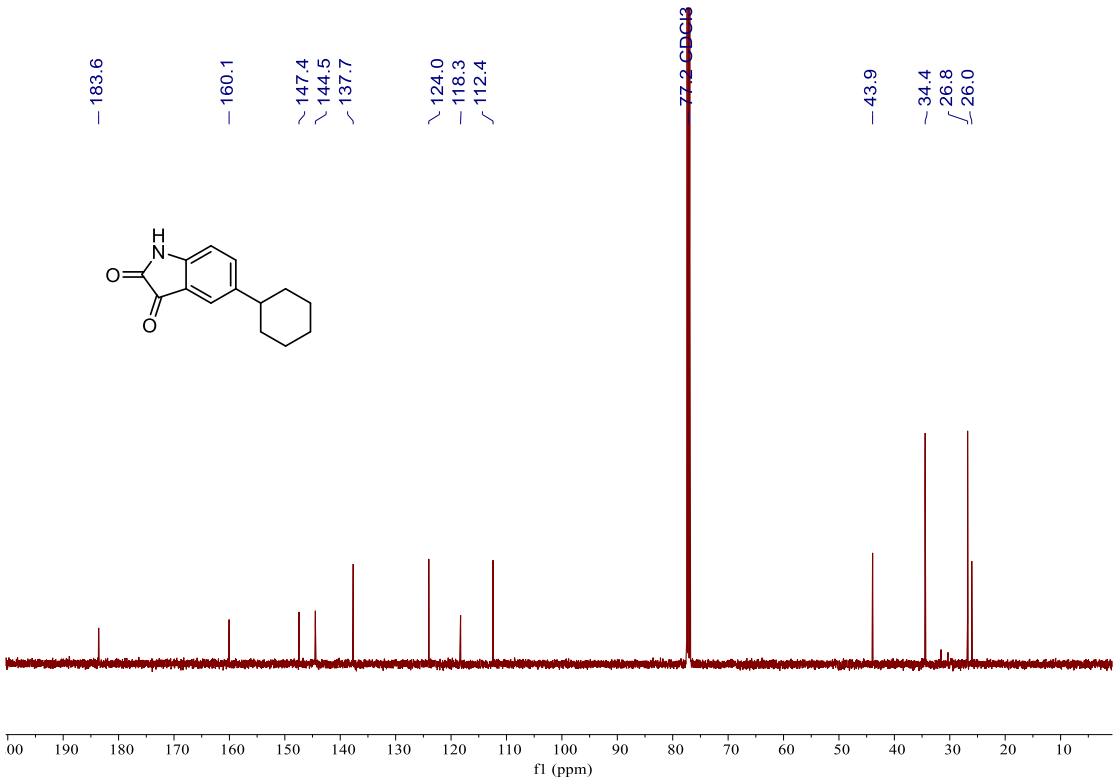
7h, ^{1}H NMR (500 MHz, $CDCl_3$)



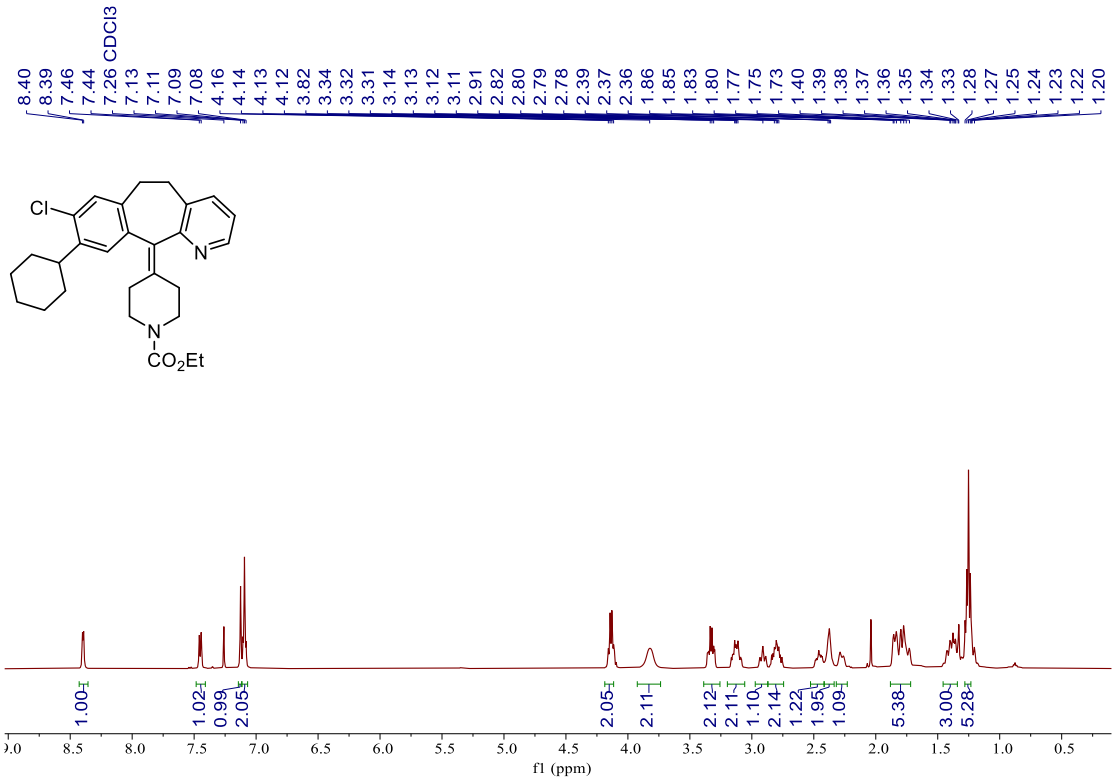
7h, ^{13}C NMR (126 MHz, $CDCl_3$)



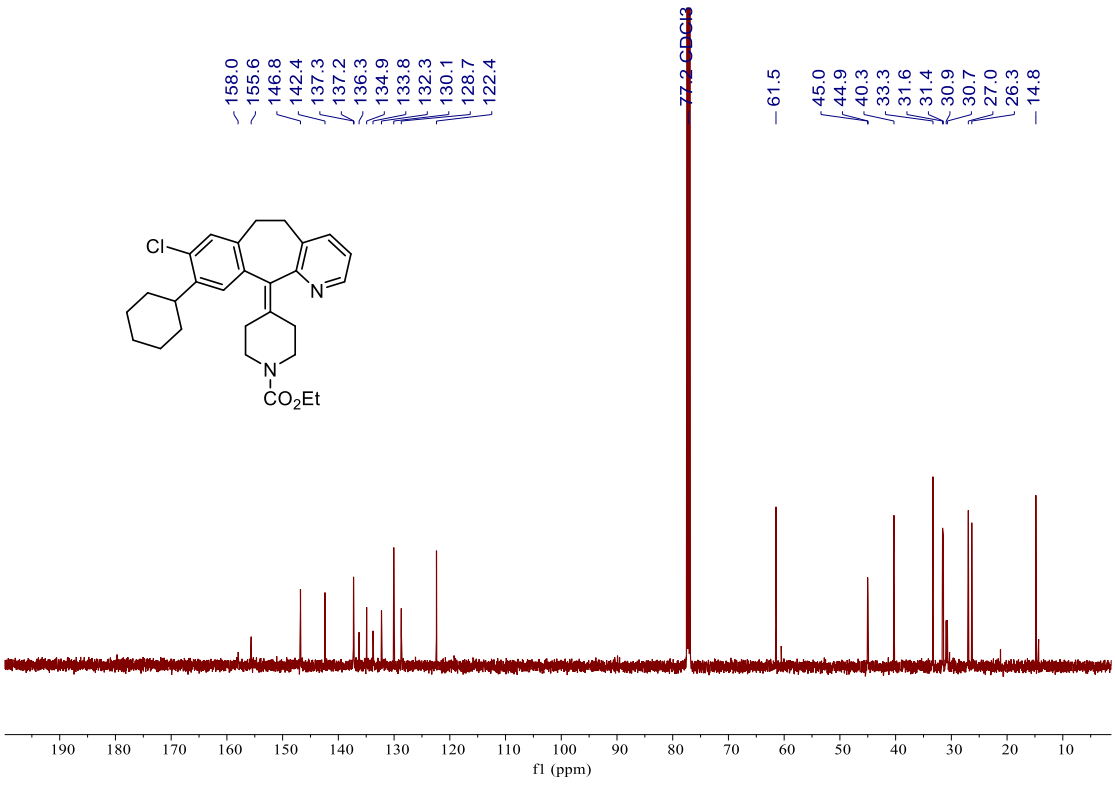
7i, ^{1}H NMR (500 MHz, $CDCl_3$)



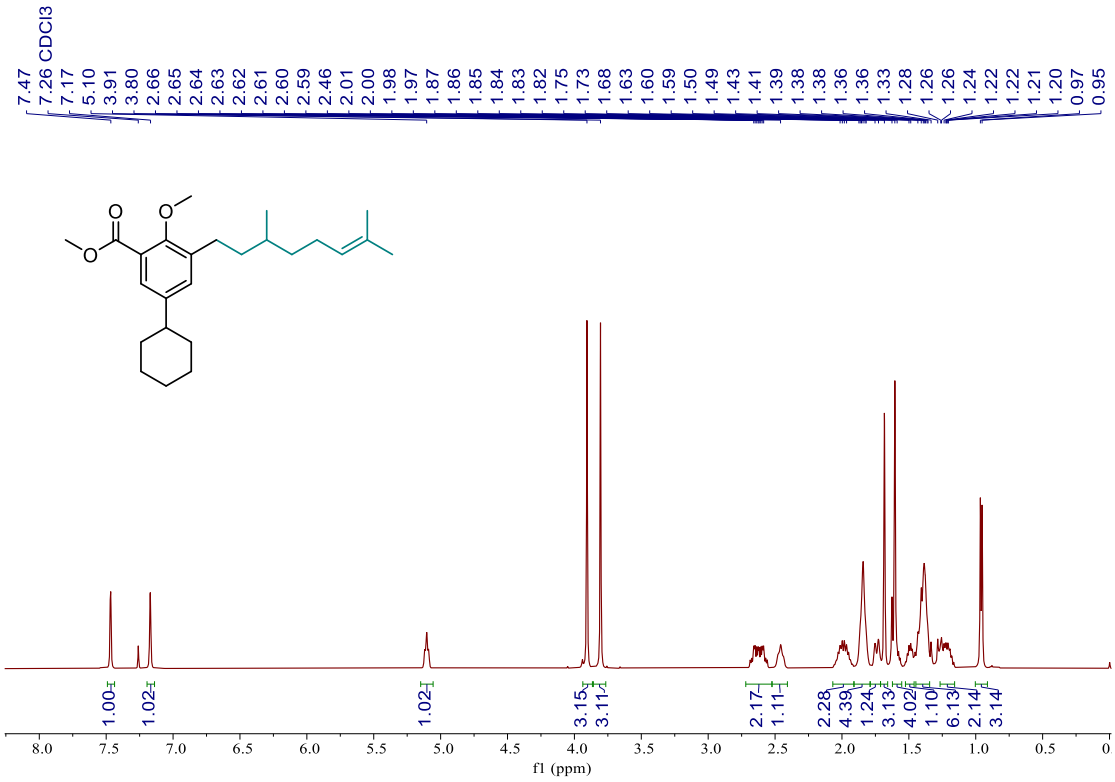
7i, ^{13}C NMR (126 MHz, $CDCl_3$)



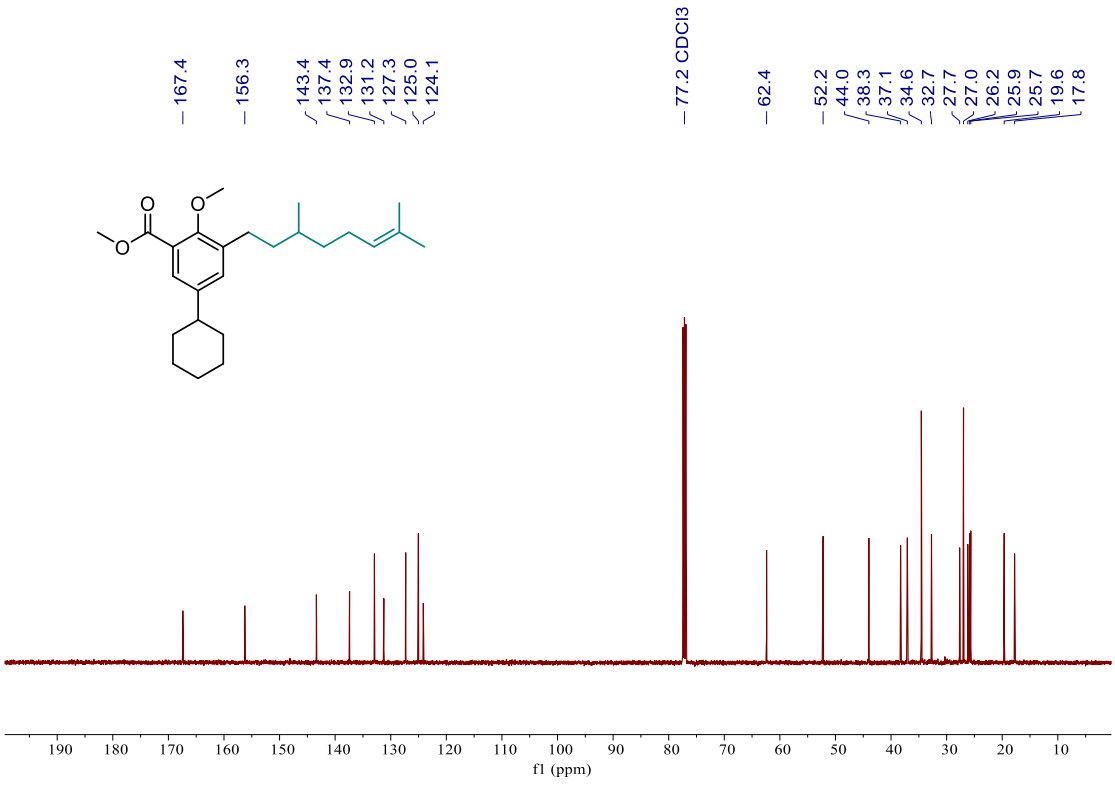
7j, ^{1}H NMR (500 MHz, $CDCl_3$)



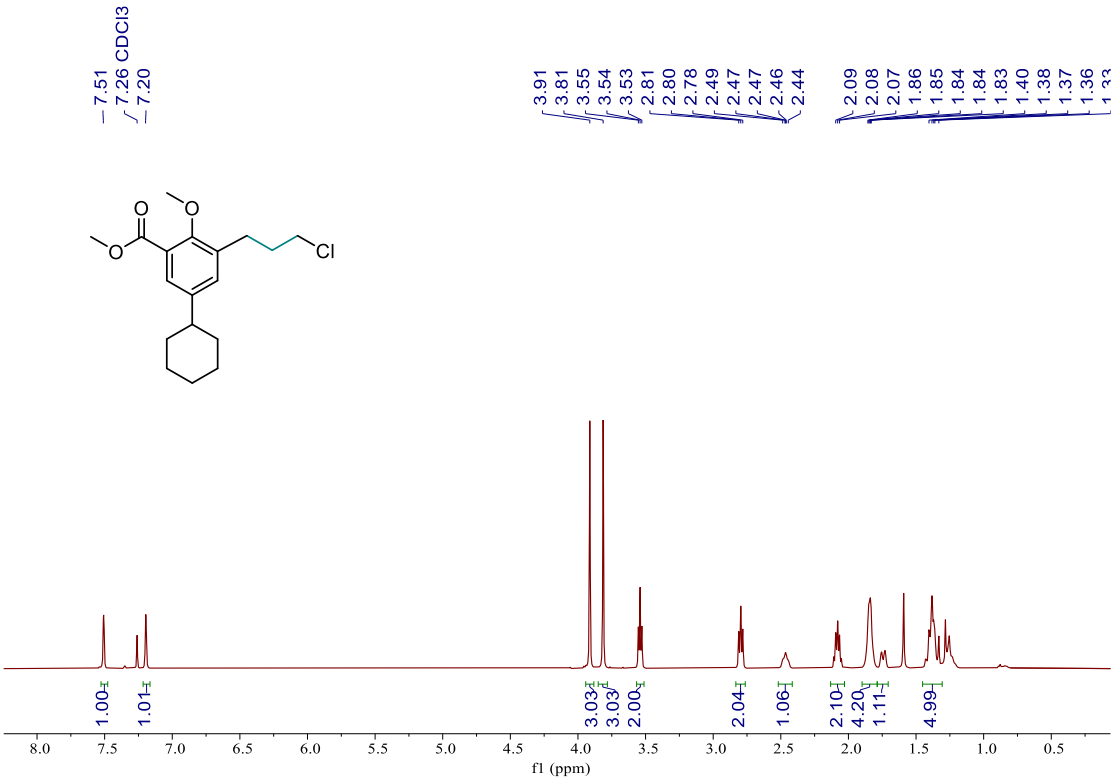
7j, ^{13}C NMR (126 MHz, $CDCl_3$)



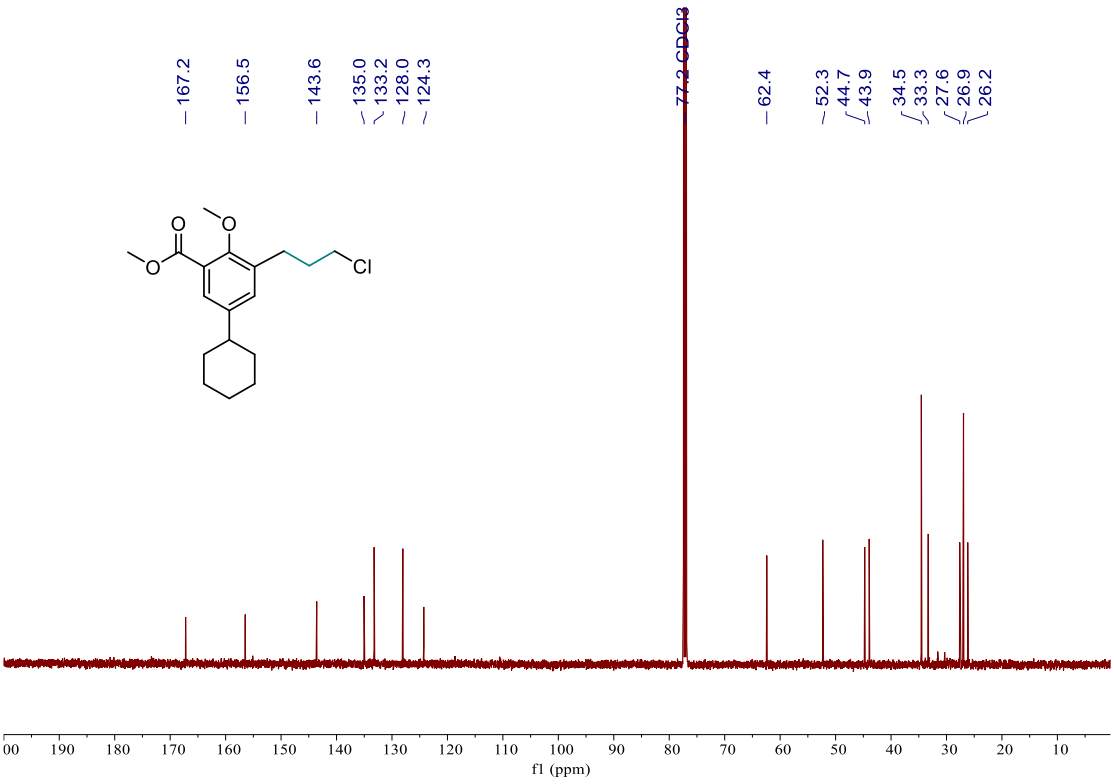
8a, ^{1}H NMR (500 MHz, $CDCl_3$)



8a, ^{13}C NMR (126 MHz, $CDCl_3$)



8b, ^{1}H NMR (500 MHz, $CDCl_3$)



8b, ^{13}C NMR (126 MHz, $CDCl_3$)