Electronic Supplementary Material (ESI) for Organic Chemistry Frontiers.

Supporting Information

Brønsted acid and Lewis acid co-promoted Cascade Cyclization Reaction and Application to Total Synthesis of Erysotramidine

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Contents:

1. General information 2

2. Preparation and characterization of starting materials 3

3. General procedure for the cascade cyclization reaction 13

4. Characterization data for the products 15

5. Total Synthesis of Erysotramidine 20

6. References 29

7. NMR Spectra of New Compounds 30

1. General information

Solvents were purified and dried by standard methods prior to use. All commercially available reagents were used without further purification unless otherwise noted. Oxygen-sensitive and moisture-sensitive reactions were carried out under argon atmosphere. Column chromatography was generally performed on silica gel (200-300 mesh) and reactions were monitored by thin layer chromatography (TLC) using silica gel GF254 plates with UV light to visualize the course of reaction.

High-resolution mass spectral analysis (HRMS) data were measured on a Bruker APEXII mass spectrometer by means of the electrospray ionization (ESI) technique. ^{1}H NMR and ^{13}C NMR spectra were recorded on 400MHz and 600 MHz spectrometers. Chemical shifts are reported as δ values relative to internal chloroform (δ 7.26 for ^{1}H NMR and 77.0 for ^{13}C NMR) or relative to internal tetramethylsilane (δ 0.0 for ^{1}H NMR). Substrates were purchased from TCI, Energy Chemical or Alfa Aesar and used as received. Oil bath was used as heat source for reactions above room temperature.

2. Preparation and characterization of starting materials

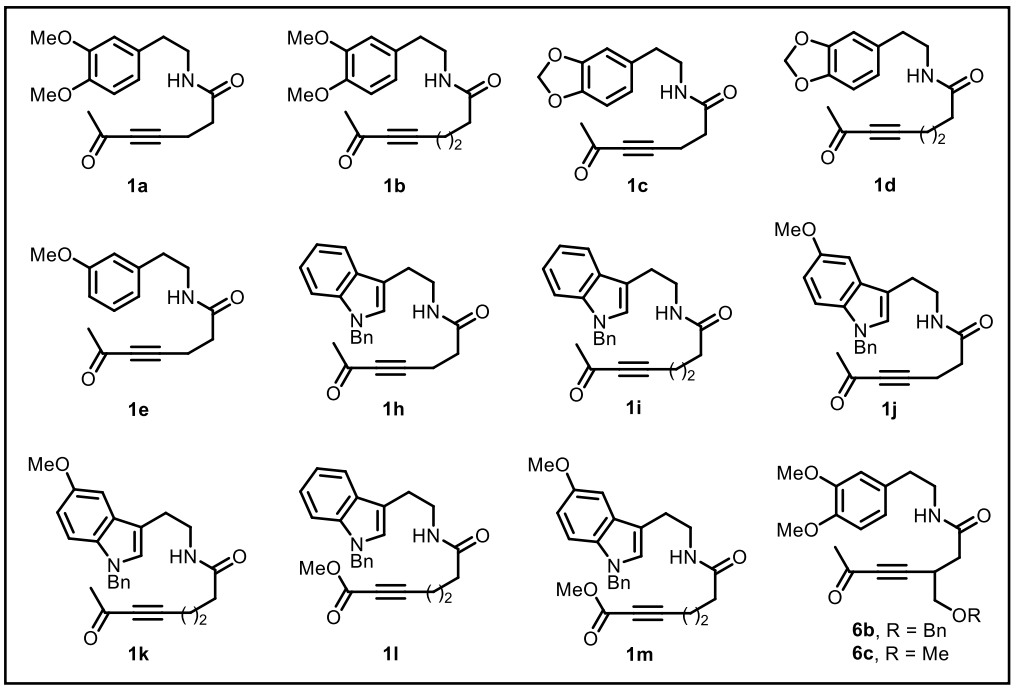


Figure. SI-1 Prepared substrates

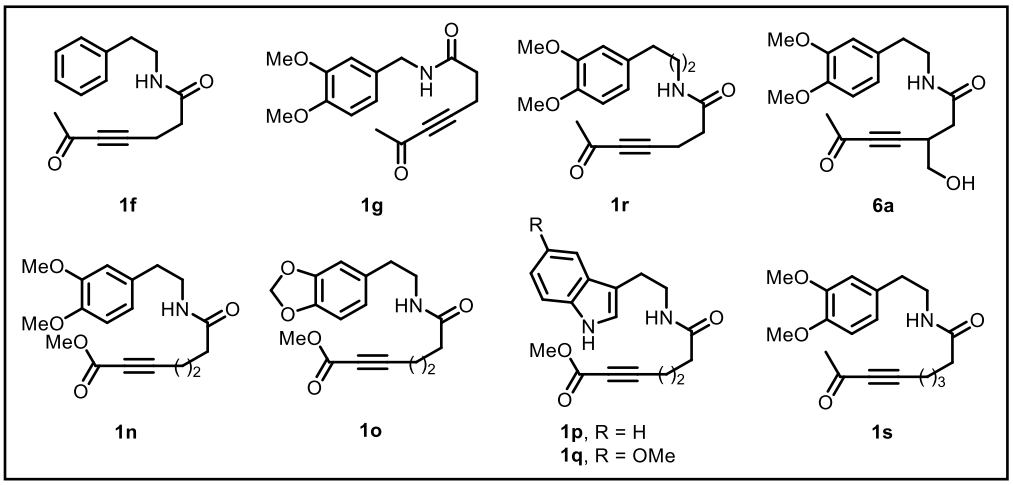
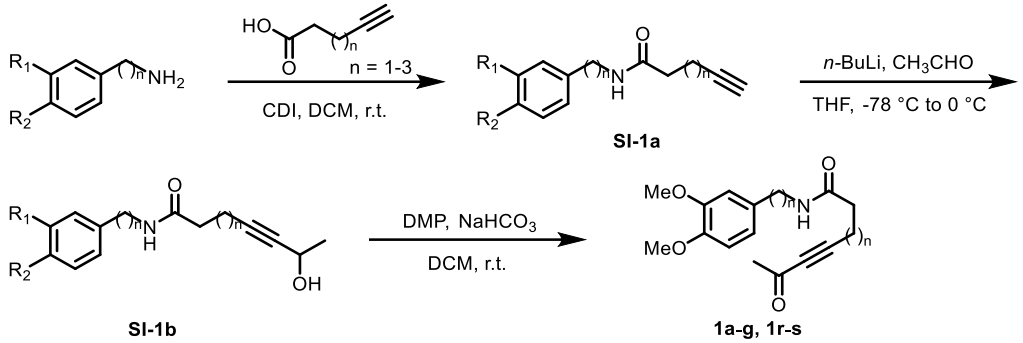


Figure. SI-2 Failed substrates

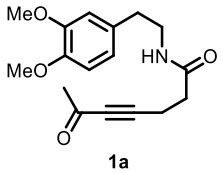
General procedure for the substrates 1a-g and 1r-s:



A mixture of alkynic acid (10.0 mmol, 1.0 equiv.) and CDI (12.0 mmol, 1.2 equiv.) in DCM (50 mL) was stirred at room temperature for 0.5 h. Then phenylamine (15.0 mmol, 1.5 equiv.) was added to the mixture, the reaction was stirred at room temperature until completion (monitored by TLC). The solvent was evaporated under reduced pressure and the residue was purified through silica gel column chromatography (petroleum ether/ethyl acetate, 1/1) to afford **SI-1a**, yield 93-97%.

The compound **SI-1a** (4.1 mmol, 1.0 equiv.) was dissolved in THF (40 mL) under Ar, *n*-BuLi in hexane (2.5 M, 8.2 mmol, 2.1 equiv.) was added to the solution dropwise at -78 °C. Then added CH_3CHO (20.5 mmol, 5.0 equiv.) to the mixture after 0.5 h, and the reaction was raised to the room temperature after another 0.5 h, the mixture was stirred at this temperature for 12 h. Quenched with saturated NH_4Cl aqueous, the mixture was diluted with water and extracted with EtOAc, washed with brine, dried over anhydrous sodium sulfate and concentrated under reduced pressure. The residue was purified by silica gel column chromatography (petroleum ether/ethyl acetate, 1/1; petroleum ether/ethyl acetate/DCM/MeOH, 10/10/10/1) to afford **SI-1b**, yield 52-63%, brsm 91-97%.

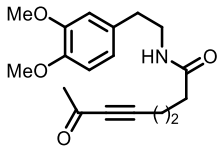
The compound **SI-1b** (2.5 mmol, 1.0 equiv.) was dissolved in DCM (25 mL), $NaHCO_3$ (7.6 mmol, 3.0 equiv.) and DMP (3.8 mmol, 1.5 equiv.) was added to the reaction and the mixture was stirred at room temperature until completion (monitored by TLC). Then $Na_2S_2O_3$ aqueous was added to the mixture and stirred until the solution was clear, the mixture was diluted with water and extracted with EtOAc, washed with brine, dried over anhydrous sodium sulfate and concentrated under reduced pressure. The residue was purified by silica gel column chromatography (petroleum ether/ethyl acetate, 1/1) to afford **1a-g** and **1r-s**, yield 87-92%.



1a

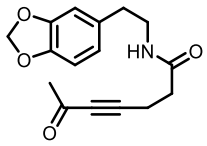
Substrate *N*-(3,4-dimethoxyphenethyl)-6-oxohept-4-ynamide (1a) was obtained as a white solid. Mp: 72-73 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 6.81 (d, J = 8.4 Hz, 1H), 6.73 (d, J = 6.8 Hz, 2H), 5.63 (s, 1H), 3.87 (s, 3H), 3.87 (s, 3H), 3.52 (q, J = 6.8 Hz, 2H), 2.77 (t, J = 7.2 Hz, 2H), 2.70 (t, J = 7.2 Hz, 2H), 2.39 (t, J = 7.2 Hz, 2H),

2.30 (s, 3H); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 184.6, 170.0, 149.1, 147.7, 131.1, 120.6, 111.8, 111.4, 91.8, 81.6, 55.9, 55.9, 40.8, 35.2, 34.3, 32.6, 15.1; **HRMS ESI** Calcd for $C_{17}H_{21}NO_4$ $[M+H]^+$: 304.1543, Found: 304.1544.



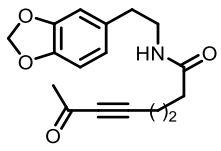
1b

Substrate *N*-(3,4-dimethoxyphenethyl)-7-oxooct-5-ynamide (1b) was obtained as a colorless oil. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 6.77 (d, J = 8.8 Hz, 1H), 6.68 (d, J = 6.0 Hz, 2H), 5.77 (s, 2H), 3.82 (s, 3H), 3.81 (s, 3H), 3.45 (q, J = 6.8 Hz, 2H), 2.72 (t, J = 6.8 Hz, 2H), 2.36 (t, J = 6.8 Hz, 2H), 2.26 (s, 3H), 2.21 (t, J = 7.2 Hz, 2H), 1.88 – 1.81 (m, 2H); **^{13}C NMR** (101 MHz, $CDCl_3$) δ184.7, 171.6, 1489, 147.5, 131.1, 120.5, 111.7, 111.2, 92.7, 81.7, 55.8, 55.7, 40.5, 35.1, 34.7, 32.6, 23.3, 18.1; **HRMS ESI** Calcd for $C_{18}H_{23}NO_4$ $[M+H]^+$: 318.1700, Found: 318.1699.



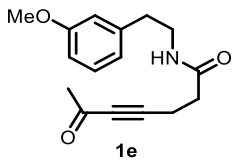
1c

Substrate *N*-(2-(benzo[d] [1,3] dioxol-5-yl) ethyl)-6-oxohept-4-ynamide (1c) was obtained as a white solid. Mp: 81-82 ºC. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 6.71 (d, J = 7.6 Hz, 1H), 6.65 (s, 1H), 6.60 (d, J = 6.8 Hz, 1H), 5.90 (s, 2H), 5.87 (s, 1H), 3.44 (q, J = 6.4 Hz, 2H), 2.70 (t, J = 6.8 Hz, 2H), 2.66 (t, J = 7.2 Hz, 2H), 2.38 (t, J = 7.6 Hz, 2H), 2.27 (s, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 184., 170.1, 147.7, 146.1, 132.3, 121.5, 108.9, 108.3, 100.8, 92.0, 81.4, 40.8, 35.2, 34.1, 32.6, 15.0; **HRMS ESI** Calcd for $C_{16}H_{17}NO_4$ $[M+H]^+$: 288.1230, Found: 288.1231.



1d

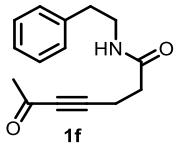
Substrate *N*-(2-(benzo[d] [1,3] dioxol-5-yl) ethyl)-7-oxooct-5-ynamide (1d) was obtained as a colorless oil. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 6.74 (d, J = 7.6 Hz, 1H), 6.67 (d, J = 1.6 Hz, 1H), 6.63 (d, J = 8.0 Hz, 1H), 5.94 (s, 2H), 5.61 (s, 1H), 3.47 (q, J = 6.4 Hz, 2H), 2.72 (t, J = 6.8 Hz, 2H), 2.41 (t, J = 6.8 Hz, 2H), 2.31 (s, 1H), 2.25 (t, J = 7.2 Hz, 2H), 1.92 – 1.85 (m, 2H); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 184.9, 171.6, 147.9, 146.2, 132.5, 121.6, 109.0, 108.4, 100.9, 92.8, 81.9, 40.7, 35.4, 34.8, 32.8, 23.3, 18.3; **HRMS ESI** Calcd for $C_{17}H_{19}NO_4$ $[M+H]^+$: 302.1387, Found: 302.1388.



1e

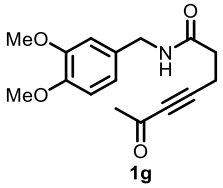
Substrate *N*-(3-methoxyphenethyl)-6-oxohept-4-ynamide (1e) was obtained as

a white solid. Mp: 61-62 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.22 (t, J = 8.0 Hz, 1H), 6.77 (dd, J = 8.0, 2.4 Hz, 2H), 6.73 (s, 1H), 5.88 (s, 1H), 3.79 (s, 3H), 3.52 (q, J = 6.8 Hz, 2H), 2.80 (t, J = 7.2 Hz, 2H), 2.69 (t, J = 7.2 Hz, 2H), 2.40 (t, J = 7.6 Hz, 2H), 2.30 (s, 3H); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 184.7, 170.0, 159.7, 140.2, 129.6, 120.9, 114.4, 111.6, 92.0, 81.4, 55.1, 40.5, 35.5, 34.1, 32.6, 15.0; **HRMS ESI** Calcd for $C_{16}H_{19}NO_3$ $[M+H]^+$: 274.1438, Found: 274.1436.



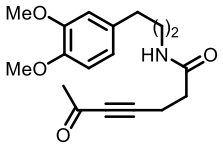
1f

Substrate 6-oxo-*N*-phenethylhept-4-ynamide (1f) was obtained as a colorless oil. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.36 – 7.29 (m, 4H), 7.29 – 7.24 (m, 1H), 5.90 (s, 1H), 5.13 (p, J = 7.2 Hz, 1H), 2.70 (t, J = 7.6 Hz, 2H), 2.46 – 2.38 (m, 2H), 2.26 (s, 3H), 1.49 (d, J = 6.8 Hz, 3H); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 186.6, 169.6, 143.4, 128.7, 127.5, 126.1, 91.9, 81.6, 49.0, 34.4, 32.7, 21.7, 15.2; **HRMS ESI** Calcd for $C_{15}H_{17}NO_2$ $[M+H]^+$: 244.1332, Found: 244.1331.



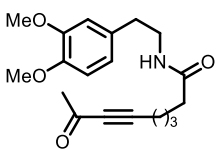
1g

Substrate *N*-(3,4-dimethoxybenzyl)-6-oxohept-4-ynamide (1g) was obtained as a colorless oil. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 6.84 – 6.79 (m, 3H), 6.34 (t, J = 6.0 Hz, 1H), 4.36 (d, J = 5.6 Hz, 2H), 3.85 (s, 6H), 2.72 (t, J = 7.6 Hz, 2H), 2.47 (t, J = 7.6 Hz, 2H), 2.28 (s, 1H); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 184.9, 170.1, 149.0, 148.4, 130.6, 120.1, 111.2, 111.1, 92.1, 81.6, 55.9, 55.9, 43.6, 34.2, 32.7, 15.2; **HRMS ESI** Calcd for $C_{16}H_{19}NO_4$ $[M+H]^+$: 290.1387, Found: 290.1386.



1r

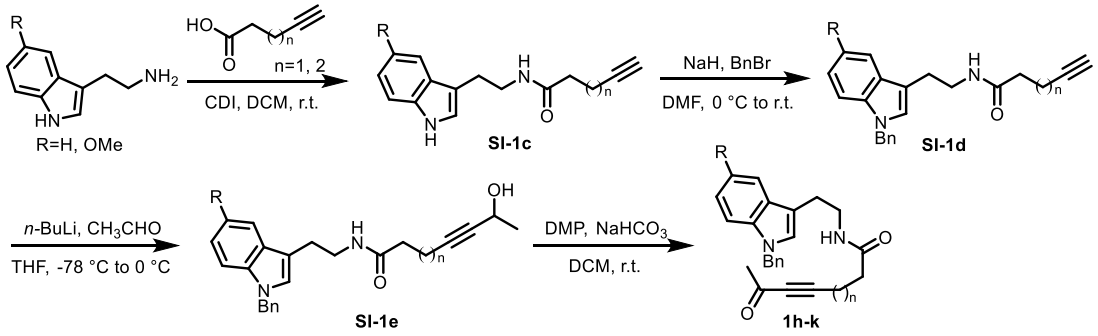
Substrate *N*-(3-(3,4-dimethoxyphenyl)propyl)-6-oxohept-4-ynamide (1r) was obtained as a colorless oil. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 6.79 (d, J = 8.4 Hz, 1H), 6.72 – 6.69 (m, 2H), 5.86 (s, 1H), 3.87 (s, 3H), 3.85 (s, 3H), 3.30 (q, J = 7.2 Hz, 2H), 2.70 (t, J = 7.6 Hz, 2H), 2.60 (t, J = 7.6 Hz, 2H), 2.40 (t, J = 7.6 Hz, 2H), 2.29 (s, 3H), 1.82 (p, J = 7.6 Hz, 2H); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 184.6, 170.0, 148.8, 147.2, 133.9, 120.1, 111.6, 111.2, 92.0, 81.5, 55.8, 55.7, 39.2, 34.2, 32.7, 32.6, 31.2, 15.1; **HRMS ESI** Calcd for $C_{18}H_{23}NO_4$ $[M+H]^+$: 318.1700, Found: 318.1699.



1s

Substrate *N*-(3,4-dimethoxyphenethyl)-8-oxonon-6-ynamide (1s) was obtained as a colorless oil. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 6.81 (d, J = 8.4 Hz, 1H), 6.73 (dd, J = 5.2, 2.0 Hz, 2H), 5.78 (s, 1H), 3.86 (s, 3H), 3.86 (s, 3H), 3.50 (q, J = 6.8 Hz, 2H), 2.76 (t, J = 7.2 Hz, 2H), 2.37 (t, J = 6.8 Hz, 2H), 2.31 (s, 3H), 2.17 (t, J = 7.6 Hz, 2H), 1.73 (p, J = 7.6 Hz, 2H), 1.62 – 1.55 (m, 2H); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 184.8, 172.2, 148.9, 147.5, 131.2, 120.5, 111.8, 111.2, 93.3, 81.5, 77.2, 55.8, 55.7, 40.5, 35.7, 35.1, 32.6, 26.9, 24.7, 18.6; **HRMS ESI** Calcd for $C_{19}H_{25}NO_4$ $[M+H]^+$: 332.1857, Found: 332.1859.

General procedure for the substrates 1h-k:



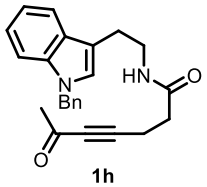
A mixture of alkynic acid (3.0 mmol, 1.0 equiv.) and CDI (3.6 mmol, 1.2 equiv.) in DCM (30 mL) was stirred at room temperature for 0.5 h. Then tryptamine (4.5 mmol, 1.5 equiv.) was added to the mixture, the reaction was stirred at room temperature until completion (monitored by TLC). The solvent was evaporated under reduced pressure and the residue was purified by silica gel column chromatography (petroleum ether/ethyl acetate, 1/1) to afford **SI-1c**, yield 89-92%.

The compound **SI-1c** (2.6 mmol, 1.0 equiv.) was dissolved in DMF (25 mL), NaH (5.8 mmol, 2.2 equiv.) was added to the mixture under 0 ℃, the mixture was stirred at this temperature for 0.5 h, then added BnBr (2.9 mmol, 1.1 equiv.) dropwise to the mixture, raised to room temperature and the reaction was stirred at this temperature until completion (monitored by TLC). Quenched with saturated NH_4Cl aqueous, the mixture was diluted with water and extracted with Et_2O, washed with brine, dried over anhydrous sodium sulfate and concentrated under reduced pressure. The residue was purified by silica gel column chromatography (petroleum ether/ethyl acetate, 3/1) to afford **SI-1d**, yield 76-87%.

The compound **SI-1d** (2.0 mmol, 1.0 equiv.) was dissolved in THF (50 mL) under Ar, *n*-BuLi in hexane (2.5 M, 4.3 mmol, 2.1 equiv.) was added to the solution dropwise at -78 ℃. Then added CH_3CHO (10.0 mmol, 5.0 equiv.) to the mixture after 0.5 h, and the reaction was raised to the room temperature after another 0.5 h, the mixture was stirred at this temperature for 12 h. Quenched with saturated NH_4Cl aqueous, the mixture was diluted with water and extracted with EtOAc, washed with brine, dried over anhydrous sodium sulfate and concentrated under reduced pressure. The residue was purified by silica gel column chromatography (petroleum ether/ethyl acetate, 1/1; petroleum ether/ethyl acetate/DCM/MeOH, 10/10/10/1) to afford **SI-1e**, yield 51-63%,

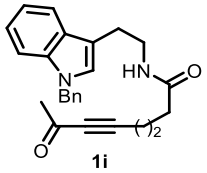
brsm 90-95%.

The compound **SI-1e** (0.8 mmol, 1.0 equiv.) was dissolved in DCM (10 mL), $NaHCO_3$ (2.4 mmol, 3 equiv.) and DMP (1.2 mmol, 1.5 equiv.) was added to the reaction and the mixture was stirred at room temperature until completion (monitored by TLC). Then $Na_2S_2O_3$ aqueous was added to the mixture and stirred until the solution was clear, the mixture was diluted with water and extracted with EtOAc, washed with brine, dried over anhydrous sodium sulfate and concentrated under reduced pressure. The residue was purified by silica gel column chromatography (petroleum ether/ethyl acetate, 1/1) to afford **1h-k**, yield 85-91%.



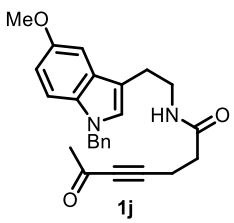
1h

Substrate *N*-(2-(1-benzyl-1H-indol-3-yl) ethyl)-6-oxohept-4-ynamide (1h) was obtained as a light-yellow solid. Mp: 105-106 ºC. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.61 (d, J = 8.0 Hz, 1H), 7.33 – 7.28 (m, 4H), 7.22 – 7.18 (m, 1H), 7.15 – 7.11(m, 3H), 6.98 (s, 1H), 5.29 (s, 2H), 3.60 (q, J = 6.4 Hz, 2H), 2.98 (t, J = 6.8 Hz, 2H), 2.67 (t, J = 7.6 Hz, 2H), 2.33 (t, J = 7.2 Hz, 2H), 2.27 (s, 3H); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 184.8, 169.9, 137.5, 136.7, 128.7, 127.8, 127.6, 126.8, 126.2, 122.0, 119.2, 118.8, 111.9, 109.89, 92.0, 81.5, 49.8, 39.8, 34.2, 32.7, 25.2, 15.1; **HRMS ESI** Calcd for $C_{24}H_{24}N_2O_2$ $[M+H]^+$: 373.1911, Found: 373.1913.



1i

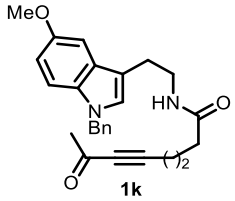
Substrate *N*-(2-(1-benzyl-1H-indol-3-yl) ethyl)-7-oxooct-5-ynamide (1i) was obtained as a light-yellow solid. Mp: 83-84 ºC. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.61 (d, J = 7.6 Hz, 1H), 7.33 – 7.25 (m, 3H), 7.22 – 7.17 (m, 1H), 7.15 – 7.09 (m, 3H), 6.96 (s, 1H), 5.57 (s, 1H), 5.28 (s, 2H), 3.60 (q, J = 6.4 Hz, 2H), 2.97 (t, J = 6.8 Hz, 2H), 2.39 (t, J = 68 Hz, 2H), 2.29 (s, 3H), 2.21 (t, J = 7.2 Hz, 2H), 1.90 – 1.83 (m, 2H); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 184.8, 171.6, 137.5 136.8, 128.8, 128.0, 127.6, 126.8, 126.1, 122.0, 119.2, 118.9, 112.1, 109.8, 92.7, 81.9, 49.9, 39.8, 34.9, 32.7, 25.3, 23.3, 18.3; **HRMS ESI** Calcd for $C_{25}H_{26}N_2O_2$ $[M+H]^+$: 387.2067, Found: 387.2066.



1j

Substrate *N*-(2-(1-benzyl-5-methoxy-1H-indol-3-yl)ethyl)-6-oxohept-4-ynamide (1j) was obtained as a light-yellow solid. Mp: 102-103 ºC. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.32 – 7.25 (m, 3H), 7.16 (d, J = 8.8 Hz, 1H), 7.11 – 7.09 (m, 2H), 7.03 (d, J

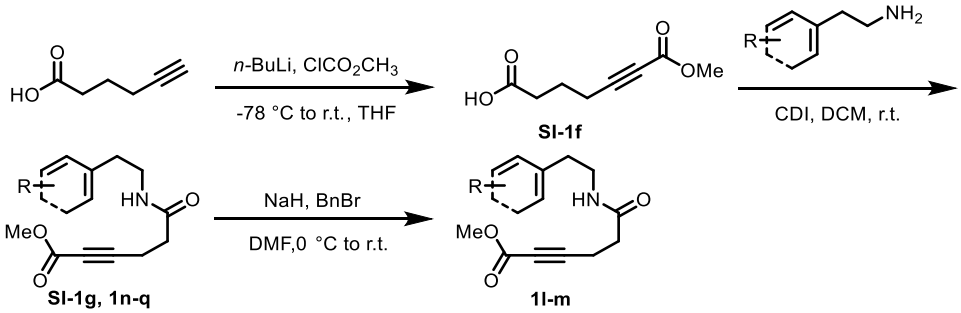
= 2.4 Hz, 1H), 6.95 (s, 1H), 6.85 (dd, *J* = 8.8, 2.4 Hz, 1H), 5.59 (s, 1H), 5.24 (s, 2H), 3.86 (s, 3H), 3.60 (q, *J* = 6.8 Hz, 2H), 2.94 (t, *J* = 7.2 Hz, 2H), 2.67 (t, *J* = 7.2 Hz, 2H), 2.33 (t, *J* = 7.2 Hz, 2H), 2.26 (s, 3H); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 184.6, 169.9, 154.0, 137.6, 132.1, 128.7, 128.2, 127.6, 126.8, 126.8, 112.2, 111.3, 110.7, 100.7, 91.9, 81.6, 55.9, 50.1, 39.7, 34.4, 32.6, 25.2, 15.1; **HRMS ESI** Calcd for $C_{25}H_{26}N_2O_3$ [M+H]$^+$: 403.2016, Found: 403.2017.



1k

Substrate *N*-(2-(1-benzyl-5-methoxy-1H-indol-3-yl)ethyl)-7-oxooct-5-ynamid e (1k) was obtained as a light-yellow solid. Mp: 81-82 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.31 – 7.25 (m, 3H), 7.16 (d, *J* = 8.8 Hz, 1H), 7.11 – 7.09 (m, 2H), 7.03 (d, *J* = 2.8 Hz, 1H), 6.94 (s, 1H), 6.84 (dd, *J* = 8.8, 2.4 Hz, 1H), 5.58 (s, 1H), 5.24 (s, 2H), 3.85 (s, 3H), 3.59 ((q, *J* = 6.8 Hz, 2H), 2.94 (t, *J* = 7.2 Hz, 2H), 2.39 (t, *J* = 6.8 Hz, 2H), 2.28 (s, 3H), 2.21 (t, *J* = 7.2 Hz, 2H),1.90 – 1.84 (m, 2H); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 184.8, 171.5, 154.0, 137.6, 132.1, 128.7, 128.3, 127.6, 126.8, 126.8, 126.72, 112.2, 111.5, 110.6, 100.2, 92.7, 81.9, 55.9, 50.1, 39.6, 34.9, 32.7, 25.3, 23.3, 18.3; **HRMS ESI** Calcd for $C_{26}H_{28}N_2O_3$ [M+H]$^+$: 417.2173, Found: 417.2171.

General procedure for the substrates 1l-q:

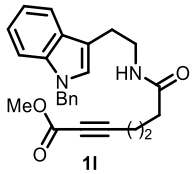


Hex-5-ynoic acid (2.0 mmol, 1.0 equiv.) was dissolved in THF (20 mL) under Ar, *n*-BuLi in hexane (2.5 M, 4.2 mmol, 2.1 equiv.) was added to the solution dropwise at -78 ℃, Then added $ClCO_2CH_3$ (6.0 mmol, 3.0 equiv.) to the mixture after 0.5 h, and the reaction was raised to the room temperature after another 3 h, the mixture was stirred at this temperature until completion (monitored by TLC). Quenched with 1 N HCl aqueous and regulate pH 2~3, the mixture was diluted with water and extracted with EtOAc, washed with brine, dried over anhydrous sodium sulfate and concentrated under reduced pressure. The residue was purified by silica gel column chromatography (petroleum ether/ethyl acetate, 5/1) to afford **SI-1f**, yield 76%.

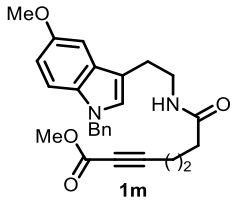
A mixture of **SI-1f** (1.0 mmol, 1.0 equiv.) and CDI (1.2 mmol, 1.2 equiv.) in DCM (10 mL) was stirred at room temperature for 0.5 h. Then arylethylamine (1.5 mmol, 1.5 equiv.) was added to the mixture, the reaction was stirred at room temperature until completion (monitored by TLC). The solvent was evaporated under reduced pressure

and the residue was purified by silica gel column chromatography (petroleum ether/ethyl acetate, 1/1) to afford **SI-1g** and **1n-q**, yield 90-93%.

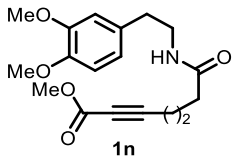
The compound **SI-1g** (1.7 mmol, 1.0 equiv.) was dissolved in DMF (17 mL), NaH (3.7 mmol, 2.2 equiv.) was added to the mixture under 0 ℃, the mixture was stirred at this temperature for 0.5 h, then add BnBr (1.9 mmol, 1.1 equiv.) dropwise to the mixture, raised to room temperature and the reaction was stirred at this temperature until completion (monitored by TLC). Quenched with saturated NH_4Cl aqueous, the mixture was diluted with water and extracted with Et_2O, washed with brine, dried over anhydrous sodium sulfate and concentrated under reduced pressure. The residue was purified by silica gel column chromatography (petroleum ether/ethyl acetate, 3/1) to afford **1l-m** as a colorless oil, yield 75-83%.



Substrate Methyl 7-((2-(1-benzyl-1H-indol-3-yl)ethyl)amino)-7-oxohept-2-ynoate (1l) was obtained as a light-yellow solid. Mp: 108-109 ºC. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.76 (d, J = 6.8 Hz, 1H), 7.32 – 7.25 (m, 4H), 7.20 – 7.10 (m, 4H), 7.00 (s, 1H), 5.47 (s, 1H), 5.27 (s, 2H), 4.10 – 4.01 (m, 2H), 3.70 (s, 3H), 3.25 (t, J = 6.4 Hz, 2H), 3.01 (t, J = 8.0 Hz, 2H), 2.56 (t, J = 6.4 Hz, 2H), 1.79 (p, J = 6.4 Hz, 2H); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 170.3, 167.9, 155.9, 137.5, 136.5, 128.7, 128.0, 127.5, 126.8, 126.0, 121.9, 119.2, 119.1, 111.7, 109.6, 96.0, 51.0, 49.9, 43.6, 33.4, 25.9, 22.4, 18.4; **HRMS ESI** Calcd for $C_{25}H_{26}N_2O_3$ $[M+H]^+$: 403.2016, Found: 403.2017.

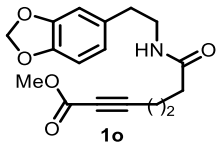


Substrate Methyl 7-((2-(1-benzyl-5-methoxy-1H-indol-3-yl)ethyl)amino)-7-oxohept-2-ynoate (1m) was obtained as a light-yellow solid. Mp: 104-105 ºC. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.38 – 7.25 (m, 4H), 7.21 (d, J = 2.4 Hz, 1H), 7.14 – 7.09 (m, 3H), 6.99 (s, 1H), 6.83 (dd, J = 8.8, 2.4 Hz, 1H), 5.51 (s, 1H), 5.24 (s, 2H), 4.03 – 3.99 (m, 2H), 3.90 (s, 3H), 3.69 (s, 3H), 3.26 (t, J = 6.4 Hz, 2H), 3.00 – 2.96 (m, 2H), 2.58 (t, J = 6.4 Hz, 2H), 1.81 (p, J = 6.4 Hz, 2H); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 170.4, 167.9, 156.0, 154.0, 137.6, 131.8, 128.7, 128.3, 127.6, 126.8, 126.71, 112.4, 111.1, 110.6, 100.4, 96.0, 55.7, 50.9, 50.1, 43.6, 33.5, 26.0, 22.4, 18.5; **HRMS ESI** Calcd for $C_{26}H_{28}N_2O_4$ $[M+H]^+$: 433.2122, Found: 433.2120.



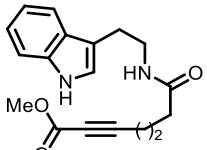
Substrate Methyl 7-((3,4-dimethoxyphenethyl) amino)-7-oxohept-2-ynoate (1n) was obtained as a white solid. Mp: 74-75 ºC. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 6.82

(d, *J* = 8.8 Hz, 1H), 6.73 (d, *J* = 7.2 Hz, 2H), 5.59 (s, 1H), 3.87 (s, 3H), 3.76 (s, 3H), 3.51 (d, *J* = 6.8 Hz, 2H), 2.76 (t, *J* = 6.8 Hz, 2H), 2.39 (t, *J* = 6.8 Hz, 2H), 2.28 (d, *J* = 7.2 Hz, 2H), 1.90 (p, *J* = 7.2 Hz, 2H); **^{13}C NMR** (101 MHz, $CDCl_3$) *δ* 171.5, 154.0, 149.0, 147.7, 131.2, 120.6, 111.8, 111.4, 88.6, 73.5, 55.9, 55.9, 52.6, 40.6, 35.2, 34.7, 23.1, 17.9; **HRMS ESI** Calcd for $C_{18}H_{23}NO_5$ $[M+H]^+$: 334.1649, Found: 334.1647.



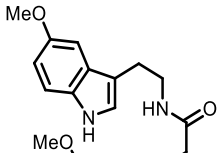
1o

Substrate Methyl7-((2-(benzo[d][1,3]dioxol-5-yl)ethyl)amino)-7-oxohept-2-ynoate (1o) was obtained as a white solid. Mp: 81-82 ºC. **^{1}H NMR** (400 MHz, $CDCl_3$) *δ* 6.75 (d, *J* = 8.0 Hz, 1H), 6.68 (d, *J* = 1.6 Hz, 1H), 6.63 (dd, *J* = 7.6, 1.6 Hz, 1H), 5.94 (s, 2H), 5.56 (s, 1H), 3.76 (s, 3H), 3.47 (q, *J* =6.8 Hz, 2H), 2.73 (t, *J* = 7.2 Hz, 2H), 2.39 (t, *J* = 6.8 Hz, 2H), 2.26 (t, *J* = 7.6 Hz, 2H), 1.89 (p, *J* = 6.8 Hz, 2H); **^{13}C NMR** (101 MHz, $CDCl_3$) *δ* 171.5, 154.1, 147.8, 146.2, 132.4, 121.6, 109.0, 108.4, 100.9, 88.6, 52.6, 40.7, 35.3, 34.7, 23.1, 17.9; **HRMS ESI** Calcd for $C_{17}H_{19}NO_5$ $[M+Na]^+$: 340.1155, Found: 340.1154.



1p

Substrate Methyl 7-((2-(1H-indol-3-yl) ethyl) amino)-7-oxohept-2-ynoate (1p) was obtained as a colorless oil. **^{1}H NMR** (400 MHz, $CDCl_3$) *δ* 8.58 (s, 1H), 7.57 (dd, *J* = 7.6, 12 Hz, 1H), 7.36 (dt, *J* = 8.0, 1.2 Hz, 1H), 7.21 – 7.17 (m, 1H), 7.12 – 7.08 (m, 1H), 6.99 (d, *J* = 2.0 Hz, 1H), 5.70 (t, *J* = 5.6 Hz, 1H), 3.75 (s, 3H), 3.56 (q, *J* = 6.4 Hz, 2H), 2.94 (t, *J* = 6.8 Hz, 2H), 2.34 (t, *J* = 6.8 Hz, 2H), 2.17 (t, *J* = 7.2 Hz, 2H), 1.84 (p, *J* = 7.2 Hz, 2H). **^{13}C NMR** (101 MHz, $CDCl_3$) *δ* 171.6, 154.2, 136.3, 127.1, 122.3, 121.9, 119.2, 118.5, 112.4, 111.3, 88.81, 73.3, 52.6, 39.6, 34.6, 25.1, 23.0, 17.8; **HRMS ESI** Calcd for $C_{18}H_{20}N_2O_3$ $[M+H]^+$: 313.1547, Found: 313.1546.

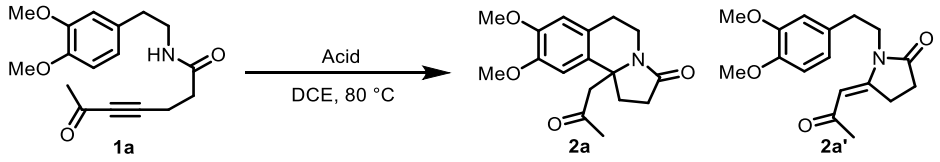


1q

Substrate Methyl 7-((2-(5-methoxy-1H-indol-3-yl)ethyl)amino)-7-oxohept-2-ynoate (1q) was obtained as a colorless oil. **^{1}H NMR** (400 MHz, $CDCl_3$) *δ* 8.26 (s, 1H), 7.26 (d, *J* = 8.8 Hz, 1H), 7.02 (d, *J* = 2.4 Hz, 1H), 7.01 (d, *J* = 2.4 Hz, 1H), 6.86 (dd, *J* = 8.8, 2.4 Hz, 1H), 5.64 (s, 1H), 3.85 (s, 3H), 3.75 (s, 3H), 3.58 (q, *J* = 6.4 Hz, 2H), 2.93 (t, *J* = 6.8 Hz, 2H), 2.36 (t, *J* = 6.8 Hz, 2H), 2.22 (t, *J* = 7.2 Hz, 2H), 1.87 (p, *J* = 7.2 Hz, 2H); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 171.6, 154.2, 154.0, 131.6, 127.6, 123.0, 112.3, 112.3, 112.0, 100.4, 88.8, 73.5, 55.9, 52.6, 39.4, 34.7, 25.2, 23.1, 17.9; **HRMS ESI** Calcd for $C_{19}H_{22}N_2O_4$ $[M+H]^+$: 343.1652, Found: 343.1650.

3. General procedure for the tandem reaction

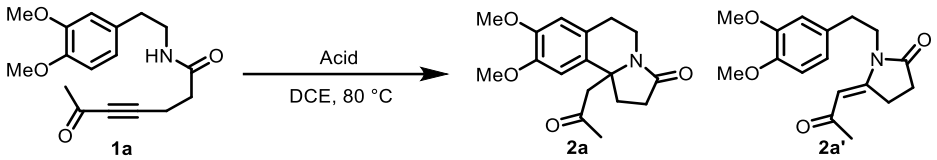
Table SI-1a Optimization of the reaction conditions.[a, b]



Entry	Acid (equiv.)	Time (h)	Product	yield
1[c]	TfOH (1.0)	2	N.R.	—
2[c]	H_3PO_4 (1.0)	2	N.R.	—
3[c]	TFA (1.0)	2	N.R.	—
4	*p*-TsOH·H_2O (1.0)	2	**2-21a′**	93%
5[d]	*p*-TsOH·H_2O (1.0); BF_3·Et_2O (3.0)	2, 2	**2-21a**	81%
6[d]	BF_3·Et_2O (3.0)		Complex	—
7	*p*-TsOH·H_2O (0.1)	2	**2-21a′**	13%
8	*p*-TsOH·H_2O (0.2)	2	**2-21a′**	27%
9[e]	*p*-TsOH·H_2O (0.1)	2	**2-21a′**	13%
10[e]	*p*-TsOH·H_2O (0.2)	2	**2-21a′**	29%
11[d]	*p*-TsOH·H_2O (1.0); BF_3·Et_2O (1.0)	2, 24	**2-21a**	78%

[a]Reaction conditions: **1a** (0.1 mmol, 1.0 equiv.), acid, DCE (4 mL, 0.025M), then BF_3·Et_2O. [b]The yield was determined upon isolation of the target product. [c]The starting material was recovered. [d]BF_3·Et_2O was added under 0 °C, then raised to 30 °C. [e]In high concentration (0.1 M).

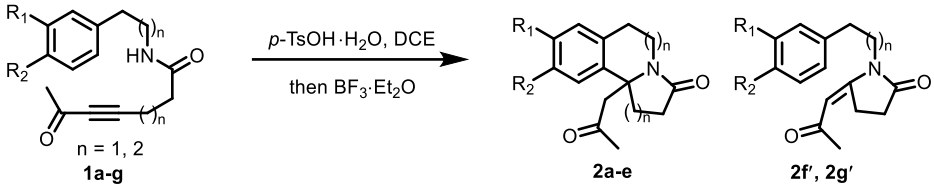
Table SI-1b Optimization of the reaction conditions.[a, b]



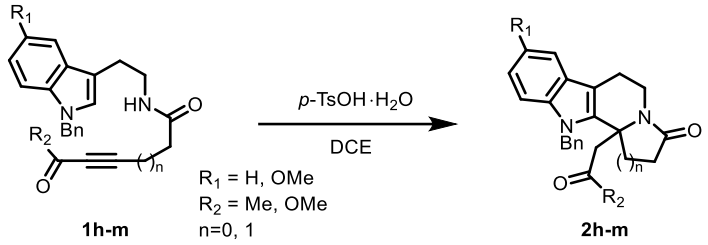
Entry	Solvent	Temp. (°C)	Time	yield
1	DCE	50	5	83%
2	DCE	30	15	85%
3	DCM	30	15	84%
4	$CHCl_3$	30	15	85%
5[c]	MeCN	30	23	N.R.
6[c]	THF	30	15	N.R.

[a]Reaction conditions: **1a** (0.1 mmol, 1.0 equiv.), *p*-TsOH·H_2O (0.1 mmol, 1.0 equiv.), solvent (4 mL), BF_3·Et_2O (0.3 mmol, 3.0 equiv.). [b]The yield was determined upon

isolation of the target product. [c]The starting material was recovered.

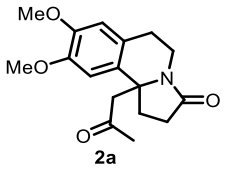


The compound **1a-g** (0.1 mmol, 1.0 equiv.) was dissolved in DCE (4 mL), added *p*-TsOH·H_2O (0.1 mmol, 1.0 equiv.) to the mixture and stirred at 50 ℃ until the material disappeared (monitored by TLC). Then the mixture was cooled to 0 ℃ and added $BF_3{\cdot}Et_2O$ dropwise for 2 h. The reaction was quenched with saturated $NaHCO_3$ aqueous, the mixture was diluted with water and extracted with DCM, washed with brine, dried over anhydrous sodium sulfate and concentrated under reduced pressure. The residue was purified by silica gel column chromatography (petroleum ether/ethyl acetate/DCM/MeOH, 10/10/10/1) to afford **2a-e** and **2f′**, **2g′**, **2r′** as a colorless oil.



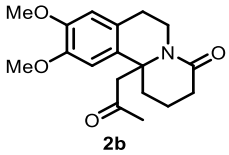
The compound **1h-m** (0.1 mmol, 1.0 equiv.) was dissolved in DCE (4 mL), added *p*- TsOH·H_2O (0.1mmol, 1.0 equiv.) to the mixture and stirred at 30 ℃ until completion (monitored by TLC). Then the reaction was quenched with saturated $NaHCO_3$ aqueous, the mixture was diluted with water and extracted with DCM, washed with brine, dried over anhydrous sodium sulfate and concentrated under reduced pressure. The residue was purified by silica gel column chromatography (petroleum ether/ethyl acetate/DCM/MeOH, 10/10/10/1) to afford **2h-m** as a light-yellow oil.

4. Characterization data for the products



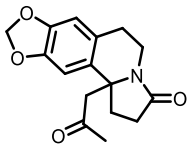
2a

Substrate 8,9-dimethoxy-10b-(2-oxopropyl)-1,5,6,10-btetrahydropyrrolo [2,1 -a] isoquinolin-3(2H)-one (2a), yield 88%. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 6.60 (s, 1H), 6.58 (s, 1H), 4.33 (ddd, J = 13.6, 6.8, 2.0 Hz, 1H), 3.86 (s, 6H),3.21 –3.13 (m, 1H), 2.98 – 2.91 (m, 2H), 2.90 – 2.84 (m, 2H), 2.75 – 2.69 (m, 1H), 2.66 – 2.57 (m, 1H), 2.44 – 2.36 (m, 1H), 2.21 – 2.12 (m, 1H), 2.05 (s, 3H); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 206.6, 173.3, 148.1, 147.9, 133.1, 124.6, 111.5, 108.0, 62.7, 56.0, 55.8, 52.0, 34.4, 32.4, 31.7, 30.6, 27.4; **HRMS ESI** Calcd for $C_{17}H_{21}NO_4$ $[M+H]^+$: 304.1543, Found: 304.1544.



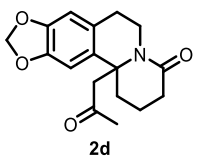
2b

Substrate 9,10-dimethoxy-11b-(2-oxopropyl)-1,2,3,6,7,11b-hexahydro-4H-py rido[2,1-a] isoquinolin-4-one (2b), yield 65%. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 6.71 (s, 1H), 6.59 (s, 1H), 4.94 (ddd, J = 12.8, 5.6, 2.0 Hz, 1H), 3.86 (s, 3H), 3.83 (s, 3H), 3.12 (d, J = 14.0 Hz, 1H), 3.05 – 2.85 (m, 4H), 2.69 – 2.63 (m, 1H), 2.58 – 2.52 (m, 1H), 2.43 – 2.35 (m, 1H), 2.01 (s, 3H), 1.93 – 1.84 (m, 1H), 1.83 – 1.77 (m, 1H); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 206.8, 169.7, 148.0, 147.5, 132.4, 126.4, 111.5, 108.7, 60.6, 56.0, 55.8, 51.9, 35.9, 34.3, 32.8, 32.0, 28.3, 16.9; **HRMS ESI** Calcd for $C_{18}H_{23}NO_4$ $[M+H]^+$: 318.1700, Found: 318.1699.



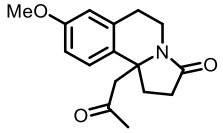
2c

Substrate 11b-(2-oxopropyl)-1,5,6,11b-tetrahydro-1,3]dioxolo[4,5-g]pyro-lo [2,1-a] isoquinolin-3(2H)-one (2c), yield 78%. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 6.60 (s, 1H), 6.56 (s, 1H), 5.94 – 5.92 (m, 2H), 4.28 (ddd, J = 13.3, 7.0, 2.0 Hz, 1H), 3.19 – 3.12 (m, 1H), 2.98 (d, J = 14.8 Hz, 1H), 2.93 – 2.83 (m, 2H), 2.81 – 2.75 (m, 1H), 2.73 – 2.67 (m, 1H), 2.66 – 2.56 (m, 1H), 2.38 (ddd, J = 17.0, 7.6, 2.4 Hz, 1H), 2.17 – 2.08 (m, 1H), 2.06 (s, 3H); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 206.2, 173.3, 146.6, 146.6, 134.3, 125.7, 108.7, 105.0, 101.0, 62.8, 52.2, 34.4, 32.2, 32.1, 30.6, 27.9; **HRMS ESI** Calcd for $C_{16}H_{17}NO_4$ $[M+H]^+$: 288.1230, Found: 288.1231.



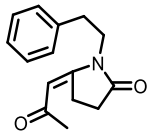
2d

Substrate 12b-(2-oxopropyl)-1,2,3,6,7,12b-hexahydro-4H- [1,3] dioxolo[4,5-g]pyrido[2,1-a]isoquinolin-4-one (2d), yield 68%. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 6.69 (s, 1H), 6.57 (s, 1H), 5.94 – 5.92 (m, 2H), 4.87 (ddd, J = 13.0, 5.6, 2.4 Hz, 1H), 3.07 – 2.95 (m, 3H), 2.94 – 2.85 (m, 1H), 2.75 – 2.70 (m, 1H), 2.67 – 2.62 (m, 1H), 2.57 – 2.50 (m, 1H), 2.43 – 2.34 (m, 1H), 2.03 (s, 3H), 1.92 – 1.68 (m, 4H); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 206.3, 169.8, 146.5, 146.5, 133.6, 127.7, 108.8, 105.4, 101.1, 60.9, 52.3, 36.1, 34.7, 32.6, 31.9, 28.8, 16.9; **HRMS ESI** Calcd for $C_{17}H_{19}NO_4$ $[M+H]^+$: 302.1387, Found: 302.1388.



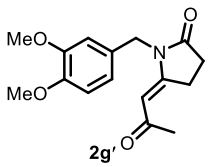
2e

Substrate8-methoxy-10b-(2-oxopropyl)1,5,6,10btetrahydropyrrolo[2,1a]-isoquin-olin-3(2H)-one (2e), yield 81%. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.05 (d, J = 8.4 Hz, 1H), 6.79 (dd, J = 8.6, 2.8 Hz, 1H), 6.64 (s, 1H), 4.30 (ddd, J = 13.2, 6.8, 2.0 Hz, 1H), 3.79 (s, 3H), 3.19 (td, J = 12.0, 4.8 Hz, 1H), 3.00 – 2.91 (m, 2H), 2.88 – 2.76 (m, 3H), 2.67 – 2.58 (m, 1H), 2.38 (ddd, J = 17.0, 10.2, 2.0 Hz, 1H), 2.19 – 2.10 (m, 1H), 2.03 (s, 3H); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 206.4, 173.4, 158.2, 133.8, 133.5, 126.2, 113.5, 113.2, 62.5, 55.2, 52.2, 34.3, 32.2, 32.0, 30.6, 28.1; **HRMS ESI** Calcd for $C_{16}H_{19}NO_3$ $[M+H]^+$: 274.1438, Found: 274.1436.**HRMS ESI** Calcd for $C_{17}H_{21}NO_3$ $[M+H]^+$: 288.1594, Found: 288.1591.



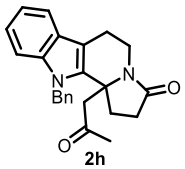
2f′

Substrate (*E*)-5-(2-oxopropylidene)-1-phenethylpyrrolidin-2-one (2f′), yield 93%. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.34 – 7.30 (m, 2H), 7.27 – 7.21 (m, 3H), 5.64 (t, J = 2.0 Hz, 1H), 3.77 – 3.74 (m, 2H), 3.25 – 3.21 (m, 2H), 2.88 – 2.84 (m, 2H), 2.52 – 2.48 (m, 2H), 2.19 (s, 3H); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 196.8, 177.1, 159.4, 137.6, 128.6, 128.6, 126.8, 99.5, 41.7, 32.5, 31.6, 27.6, 25.5; **HRMS ESI** Calcd for $C_{15}H_{17}NO_2$ $[M+H]^+$: 244.1332, Found: 244.1331.



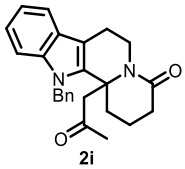
2g′

Substrate (*E*)-1-(3,4-dimethoxybenzyl)-5-(2-oxopropylidene)pyrrolidin-2-on e (2g′), yield 91%. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 6.82 (dd, J = 6.4 Hz, J = 2.4 Hz, 1H), 6.78 – 6.76 (m, 2H), 5.71 (t, J = 2.0 Hz, 1H), 4.67 (s, 2H), 3.87 (s, 3H), 3.87 (s, 3H), 3.28 (ddd, J = 9.6, 5.2, 2.0 Hz, 2H), 2.65 – 2.62 (m, 2H), 2.14 (s, 3H); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 196.8, 177.6, 159.2, 149.2, 148.6, 127.2, 119.5, 110.9, 110.4, 100.7, 55.9, 55.8, 44.0, 31.6, 27.8, 25.6; **HRMS ESI** Calcd for $C_{16}H_{19}NO_4$ $[M+H]^+$: 290.1387, Found: 290.1386.



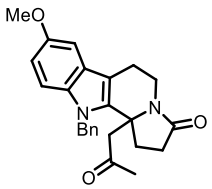
2h

Substrate 11-benzyl-11b-(2-oxopropyl)-1,2,5,6,11,11b-hexahydro-3H-indolizi -no-[8,7-b] indol-3-one (2h), yield 81%. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.55 – 7.51 (m, 1H), 7.30 – 7.23 (m, 3H), 7.17 – 7.12 (m, 2H), 7.09 – 7.06 (m, 1H), 6.88 – 6.86 (m, 2H), 5.46 – 5.35(m, 2H), 4.58 (ddd, J = 13.4, 6.0, 1.2 Hz, 1H), 3.21 – 3.11 (m, 2H), 2.99 – 2.85 (m, 2H), 2.75 – 2.61 (m, 3H), 2.40 – 2.33 (m, 1H), 2.28 – 2.20 (m, 1H), 2.02 (s, 3H); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 205.6, 173.2, 137.6, 137.1, 136.9, 128.9, 127.5, 126.3, 125.5, 122.6, 120.0, 118.7, 110.1, 107.7, 61.5, 50.2, 47.7, 34.8, 32.1, 30.8, 29.6, 21.0; **HRMS ESI** Calcd for $C_{24}H_{24}N_2O_2$ $[M+H]^+$: 373.1911, Found: 373.1913.



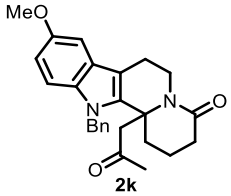
2i

Substrate 12-benzyl-12b-(2-oxopropyl)-2,3,6,7,12,12b-hexahydroindolo[2,3-a] qu-inolizin-4(1H)-one (2i), yield 76%. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.58 – 7.51 (m, 1H), 7.29 – 7.23 (m, 3H), 7.17 – 7.12 (m, 2H), 7.10 – 7.06 (m, 1H), 6.88 – 6.86 (m, 2H), 5.52 – 5.42 (m, 2H), 5.15 – 5.11 (m, 1H), 3.26 (d, J = 14.8 Hz, 1H), 3.11 – 2.94 (m, 2H), 2.88 (d, J = 14.4 Hz, 1H), 2.82 – 2.77 (m, 1H), 2.55 – 2.43 (m, 2H), 2.37 – 2.29 (m, 1H), 2.13 – 2.04 (m, 4H), 1.64 – 1.45 (m, 2H); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 205.6, 170.7, 137.8, 137.1, 137.1, 128.8, 127.4, 126.2, 125.4, 122.8, 120.0, 118.6, 111.2, 110.0, 60.6, 51.7, 48.5, 37.3 33.1, 32.5, 32.1, 21.3, 17.1; **HRMS ESI** Calcd for $C_{25}H_{26}N_2O_2$ $[M+H]^+$: 387.2067, Found: 387.2066.



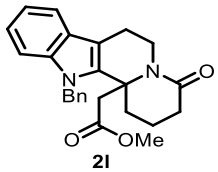
2j

Substrate 11-benzyl-8-methoxy-11b-(2-oxopropyl)-1,2,5,6,11,11b-hexahydro - 3H-indolizino[8,7-b] indol-3-one (2j), yield 60%. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.30 – 7.23 (m, 3H), 6.96 – 6.94 (m, 2H), 6.86 (dd, J = 7.8, 1.6 Hz, 2H), 6.79 (dd, J = 8.8, 2.4 Hz, 1H), 5.41 – 5.32 (m, 2H), 4.58 (ddd, J = 13.4, 6.2, 1.2 Hz, 1H), 3.85 (s, 1H), 3.20 – 3.07 (m, 2H), 2.95 – 2.82 (m, 2H), 2.74 – 2.61 (m, 3H), 2.41 – 2.36 (m, 1H), 2.26 – 2.22 (m, 1H), 2.03 (s, 3H); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 205.7, 173.3, 154.5, 138.2, 137.1, 132.2, 128.9, 127.6, 126.7, 125.5, 112.6, 111.0, 107.3, 100.6, 61.6, 55.9, 50.3, 47.9, 34.9, 32.1, 30.9, 29.6, 21.1; **HRMS ESI** Calcd for $C_{25}H_{26}N_2O_3$ $[M+H]^+$: 403.2016, Found: 403.2017.



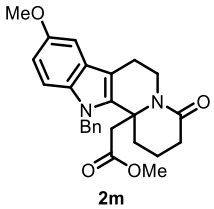
2k

Substrate12-benzyl-9-methoxy-12b-(2-oxopropyl)-2,3,6,7,12,12b-hexahydr-oindo-lo[2,3-a] quinolizin-4(1H)-one (2k), yield 62%. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.29 – 7.20 (m, 2H), 6.98 – 6.94 (m, 2H), 6.87 – 6.85 (m, 2H), 6.80 (dd, J = 8.8, 2.4 Hz, 1H), 5.48 – 5.38 (m, 2H), 5.13 (ddd, J = 12.8, 5.2, 1.2 Hz, 1H), 3.85 (s, 3H), 3.25 (d, J = 14.4 Hz, 1H), 3.07 (td, J = 12.0, 4.0 Hz, 1H), 2.99 – 2.91 (m, 2H), 2.87 (d, J = 14.4 Hz, 1H), 2.75 (ddd, J = 15.0, 4.0, 1.2 Hz, 1H), 2.54 – 2.43 (m, 2H), 2.38 – 2.30 (m, 1H), 2.10 – 2.03 (m, 4H), 1.64 – 1.47 (m, 2H); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 170.7, 154.4, 137.6, 137.3, 132.9, 128.8, 127.4, 126.4, 125.4, 112.8, 110.9, 110.8, 100.3, 60.6, 55.8, 51.7, 48.6, 37.3, 33.1, 32.5, 32.1, 21.4, 17.1; **HRMS ESI** Calcd for $C_{26}H_{28}N_2O_3$ $[M+H]^+$: 417.2173, Found: 417.2171.



2l

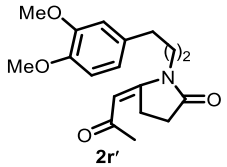
Substrate Methyl 2-(12-benzyl-4-oxo-1,2,3,4,7,12-hexahydroindolo[2,3-a] quin-olizin-12b(6H)-yl) acetate (2l), yield 81%. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.58 – 7.51 (m, 1H), 7.32 – 7.23 (m, 3H), 7.17 – 7.11 (m, 2H), 7.08 – 7.03 (m, 1H), 6.90 (dd, J = 8.0, 1.6 Hz, 2H), 5.52 – 5.41 (m, 2H), 5.09 (ddd, J = 13.0, 5.4, 1.2 Hz, 1H), 3.62 (s, 3H), 3.17 – 3.09 (m, 2H), 2.99 – 2.91 (m, 2H), 2.87 (d, J = 14.0 Hz, 1H), 2.77 (ddd, J = 15.6, 4.0, 1.2 Hz, 1H), 2.60 – 2.53 (m, 1H), 2.47 – 2.30 (m, 2H), 2.15 – 2.08 (m, 1H), 1.69 – 1.59 (m, 1H), 1.56 – 1.47 (m, 1H); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 170.4, 169.9, 137.8, 137.1, 137.1, 128.8, 127.4, 126.2, 125.4, 122.7, 119.9, 118.6, 111.3, 110.0, 60.0, 52.0, 48.6, 44.6, 37.1, 33.6, 32.4, 21.3, 17.0; **HRMS ESI** Calcd for $C_{25}H_{26}N_2O_3$ $[M+H]^+$: 403.2016, Found: 403.2017.



2m

Substrate Methy l2-(12-benzyl-9-methoxy-4-oxo-1,2,3,4,7,12-hexahydroin-dolo-[2,3-a] quin-olizin-12b(6H)-yl) acetate (2m), yield 60%. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.30 – 7.27 (m, 1H), 7.26 – 7.21 (m, 2H), 6.98 – 6.87 (m, 4H), 6.79 (dd, J = 8.8, 2.4 Hz, 1H), 5.42 (d, J = 4.0 Hz, 2H), 5.09 (ddd, J = 13.2, 5.4, 1.2 Hz, 1H), 3.85 (s, 3H), 3.62 (s, 3H), 3.16 – 3.09 (m, 2H), 2.97 – 2.88 (m, 1H), 2.85 (d, J = 15.4 Hz, 1H), 2.75 – 2.69 (m, 1H), 2.55 (ddd, J = 14.0, 8.0, 3.2 Hz, 1H), 2.47 – 2.30 (m, 2H), 2.11 (ddd, J = 13.6, 10.0, 3.6 Hz, 1H), 1.66 – 1.59 (m, 1H), 1.57 – 1.48 (m, 1H); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 170.4, 170.0, 154.4, 137.7, 137.3, 133.0, 128.9, 127.4, 126.5,

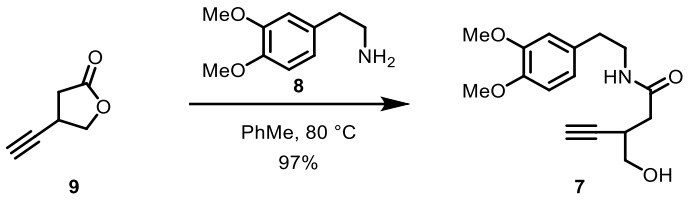
125.4, 112.8, 110.9, 110.9, 100.4, 60.1, 55.9, 52.1, 48.7, 44.6, 37.1, 33.6, 32.4, 21.4, 17.0; **HRMS ESI** Calcd for $C_{26}H_{28}N_2O_4$ $[M+H]^+$: 433.2122, Found: 433.2120.



2r′

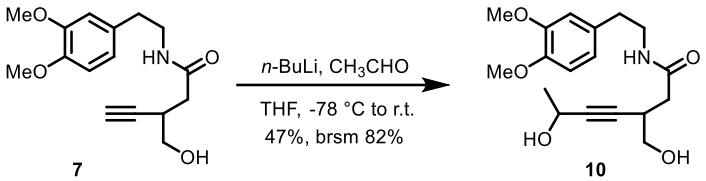
Substrate (*E*)-1-(3-(3,4-dimethoxyphenyl)propyl)-5-(2-oxopropylidene)pyrolidin-2-one (1r′), yield 93%. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 6.82 (d, J = 8.8 Hz, 1H), 6.75 (dd, J = 6.4, 2.0 Hz, 2H), 5.49 (s, 1H), 3.88 (s, 3H), 3.86 (s, 3H), 3.54 (t, J = 7.2 Hz, 2H), 3.20 (td, J = 7.0, 2.0 Hz, 2H), 2.62 (t, J = 7.6 Hz, 2H), 2.51 – 2.47 (m, 2H), 2.15 (s, 3H), 1.89 (p, J = 7.2 Hz, 2H); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 196.6, 177.2, 159.5, 148.8, 147.3, 133.1, 120.0, 111.5, 111.1, 99.4, 55.8, 55.7, 39.7, 32.4, 31.4, 27.6, 27.5, 25.5; **HRMS ESI** Calcd for $C_{18}H_{23}NO_4$ $[M+H]^+$: 318.1700, Found: 318.1699.

5. Total Synthesis of Erysotramidine



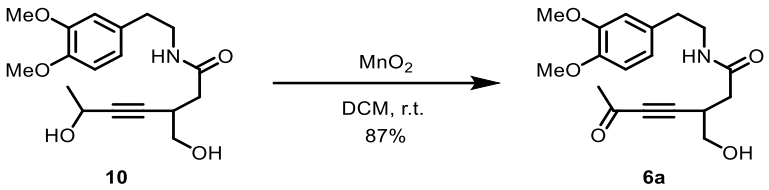
The compound **9**[1] (0.6 g, 5.5 mmol, 1.0 equiv.) was dissolved in toluene (55 mL), added 3,4-dimethoxyphenethylamine **8** (1.8 mL/2.0 g, 11.0 mmol, 2.0 equiv.), the mixture was heated to 80 ℃ until completion (monitored by TLC). The solvent was evaporated under reduced pressure and the residue was purified by silica gel column chromatography (petroleum ether/ethyl acetate/DCM/MeOH, 10/10/10/1) to afford the product **7**, yield 97%.

Substrate *N*-(3,4-dimethoxyphenethyl)-3-(hydroxymethyl) pent-4-ynamide (7) was obtained as a light-yellow solid. Mp: 71-72°C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 6.81 (d, J = 8.0 Hz, 1H), 6.74 (d, J = 7.2 Hz, 2H), 6.10 (t, J = 5.6 Hz, 1H), 3.87 (s, 3H), 3.86 (s, 3H), 3.72 – 3.62 (m, 2H), 3.51 (q, J = 6.8 Hz, 2H), 3.39 (t, J = 6.4, 1H), 3.06 – 3.00 (m, 1H), 2.77 (t, J = 6.8 Hz, 2H), 2.45 (qd, J = 14.4, 6.8 Hz, 2H), 2.13 (d, J = 2.4 Hz, 1H); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 170.8, 148.8, 147.5, 131.0, 120.5, 111.7, 111.1, 83.5, 71.3, 64.5, 55.8, 55.8, 40.8, 38.5, 35.0, 31.3; **HRMS ESI** Calcd for $C_{16}H_{21}NO_4$ $[M+H]^+$: 292.1543, Found: 292.1542.



The compound **7** (2.0 g, 6.8 mmol, 1.0 equiv.) was dissolved in THF (70 mL) under Ar, *n*-BuLi in hexane (2.5 M, 8.7 mL, 21.8 mmol, 3.2 equiv.) was added to the solution dropwise at -78 ℃. Then added CH_3CHO (6.8 mL, 34.0 mmol, 5 equiv.) to the mixture after 0.5 h, and the reaction was raised to the room temperature after another 0.5 h, the mixture was stirred at this temperature for 12 h. Quenched with saturated NH_4Cl aqueous, the mixture was diluted with water and extracted with EtOAc, washed with brine, dried over anhydrous sodium sulfate and concentrated under reduced pressure. The residue was purified by silica gel column chromatography (petroleum ether/ethyl acetate, 1/1; petroleum ether/ethyl acetate/DCM/MeOH, 10/10/10/2) to afford the product **10** as a light-yellow oil**,** yield 47%, brsm 82%.

Substrate *N*-(3,4-dimethoxyphenethyl)-6-hydroxy-3-(hydroxymethyl)hept-4 -yna-mide (10). ^{1}H NMR (400 MHz, $CDCl_3$) δ 6.80 (d, J = 8.4 Hz, 1H), 6.73 (d, J = 5.2 Hz, 2H), 6.40 (q, J = 5.2 Hz, 1H), 4.45 (q, J = 6.4 Hz, 1H), 3.86 (s, 3H), 3.85 (s, 3H), 3.63 (d, J = 5.2 Hz, 2H), 3.48 (q, J = 6.8 Hz, 2H), 3.01 (p, J = 6.0, 4.4 Hz, 1H), 2.76 (t, J = 7.2 Hz, 2H), 2.41 (qd, J = 14.4, 6.4 Hz, 2H), 1.37 (d, J = 6.8 Hz, 3H); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 171.5, 149.0, 147.7, 131.2, 120.7, 112.0, 111.4, 85.6, 83.2, 64.5, 57.9, 55.9, 41.0, 38.7, 35.2, 31.7, 24.4; **HRMS ESI** Calcd for $C_{18}H_{25}NO_5$ $[M+H]^+$: 336.1805, Found: 336.1806.

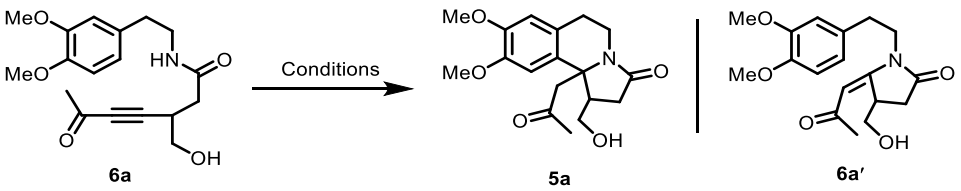


10 6a

The compound **10** (70mg, 0.2 mmol, 1.0 equiv.) was dissolved in DCM (5 mL), then MnO_2 (696mg, 8.0 mmol, 40.0 equiv.) was added to the mixture and the reaction was stirred at room temperature until completion (monitored by TLC). The mixture filtered through a plug of celite, washed with DCM and concentrated under reduced pressure. The residue was purified by silica gel column chromatography (petroleum ether/ethyl acetate, 1/1.5) to afford the product **6a** as a light-yellow oil**,** yield 87%.

Substrate *N*-(3,4-dimethoxyphenethyl)-3-(hydroxymethyl)-6-oxohept-4-yna - mide (6a). ^{1}H NMR (400 MHz, $CDCl_3$) δ 6.81 (d, J = 8.4 Hz, 1H), 6.73 (dd, J = 5.4 Hz, J = 2.0 Hz, 2H), 6.11 – 6.05 (m, 1H), 3.87 (s, 3H), 3.86 (s, 3H), 3.76 – 3.68(m, 2H), 3.51 (q, J = 6.8 Hz, 2H), 3.22 (p, J = 6.4, 6.0 Hz, 1H), 2.77 (t, J = 7.2 Hz, 2H), 2.49 (qd, J = 14.6, 6.8 Hz, 2H), 2.31 (s, 3H); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 184.7, 170.2, 149.0, 147.6, 131.0, 120.6, 111.8, 111.3, 92.3, 82.8, 63.8, 55.8, 55.8, 40.9, 37.7, 35.1, 32.7, 31.6; **HRMS ESI** Calcd for $C_{18}H_{23}NO_5$ $[M+H]^+$: 334.1649, Found: 334.1648.

Table SI-2 Optimization of the reaction conditions. [a,b]



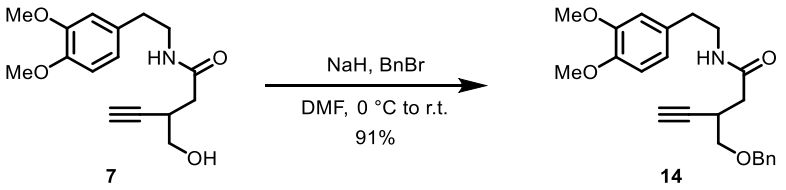
6a 5a 6a′

Entry	Conditions	Results
1	1 equiv. *p*-TsOH·H_2O, 30 °C, DCM	93% **6a′**
2	1 equiv. *p*-TsOH·H_2O, 50 °C, DCM	91% **6a′**
3	1 equiv. *p*-TsOH·H_2O, 30 °C, DCE	94% **6a′**
4	1 equiv. *p*-TsOH·H_2O, 50 °C, DCE	92% **6a′**
5	1 equiv. *p*-TsOH·H_2O, 80 °C, DCE	Complex
6	1.5 equiv. *p*-TsOH·H_2O, 30 °C, DCE	91% **6a′**
7[c]	1 equiv. *p*-TsOH·H_2O, 30 °C, DCE; 3equiv. BF_3·Et_2O	90% **6a′**

[a]Reaction conditions: **6a** (0.1 mmol, 1.0 equiv.), acid (0.1 mmol, 1.0 equiv.), solvent (4 mL). [b]The yield was determined upon isolation of the target product. [c]BF_3·Et_2O (0.3 mmol, 3.0 equiv.) was added to the mixture until the material disappeared (monitored by TLC); reaction temperature was from 0 °C to 60 °C.

Substrate (*E*)-1-(3,4-dimethoxyphenethyl)-4-(hydroxymethyl)-5-(2-oxopropy lidene)pyrrolidin-2-one (6a′) was obtained as a light-yellow oil; **^{1}H NMR** (400 MHz,

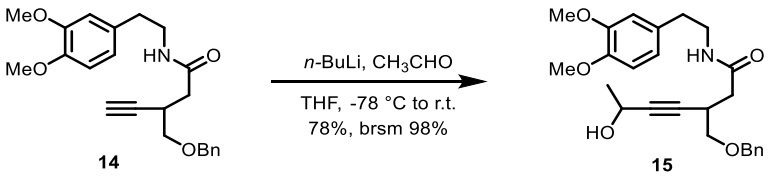
$CDCl_3$) δ 6.79 (d, J = 8.86 Hz, 1H), 6.72 (dd, J = 6.4, 2.0 Hz, 2H), 6.15 (t, J = 5.4 Hz, 1H), 5.28 (s, 1H), 4.55 (dd, J = 11.2, 5.6 Hz, 1H), 4.06 (dd, J = 12.8, 11.2 Hz, 1H), 3.86 (s, 3H), 3.84 (s, 3H), 3.47 (q, J = 6.4, 2H), 2.89 (td, J = 12.4, 5.6 Hz, 1H), 2.74 (t, J = 6.8 Hz, 2H), 2.57 (dd, J = 15.0, 5.6 Hz, 1H), 2.13 (dd, J = 15.0, 6.8 Hz, 1H), 1.99 (s, 3H); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 193.8, 175.0, 170.5, 149.0, 147.6, 131.3, 120.6, 111.9, 111.3, 104.2, 71.36, 55.9, 55.8, 40.8, 40.6, 35.2, 32.7, 20.9; **HRMS ESI** Calcd for $C_{18}H_{23}NO_5$ $[M+H]^+$: 334.1649, Found: 334.1648.



7 14

The compound **7** (7.93 g, 27.2 mmol, 1.0 equiv.) was dissolved in DMF (270 mL), NaH (1.30 g, 32.6 mmol, 1.2 equiv.) was added to the mixture under 0 ℃, the mixture was stirred at this temperature for 0.5 h, then added BnBr (3.55 mL, 29.9 mmol, 3 equiv.) dropwise to the mixture, raised to room temperature and the reaction was stirred at this temperature until completion (monitored by TLC). Quenched with saturated NH_4Cl aqueous, the mixture was diluted with water and extracted with Et_2O, washed with brine, dried over anhydrous sodium sulfate and concentrated under reduced pressure. The residue was purified by silica gel column chromatography (petroleum ether/ethyl acetate, 2/1) to afford the product **14** as a yellow oil, 91%.

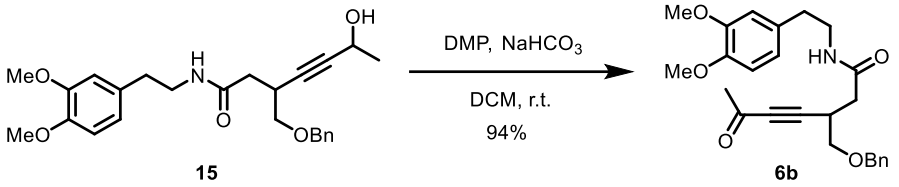
Substrate 3-((benzyloxy)methyl)-*N*-(3,4-dimethoxyphenethyl)pent-4-yna-m ide (14). ^{1}HNM R (400 MHz, $CDCl_3$) δ 7.36 – 7.28 (m, 5H), 6.79 (d, J = 8.0 Hz, 0H), 6.72 (d, J = 7.2 Hz, 2H), 5.81 (q, J = 4.8 Hz, 1H), 4.53 (s, 2H), 3.86 (s, 3H), 3.85 (s, 3H), 3.57 – 3.43 (m, 4H), 3.20 – 3.13 (m, 1H), 2.73 (t, J = 6.8Hz, 2H), 2.50 (dd, J = 14.4, 6.0 Hz, 1H), 2.34 (dd, J = 14.4, 8.4 Hz, 0H), 2.10 (d, J = 2.4 Hz, 1H); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 170.1, 148.6, 147.2, 137.6, 131.1, 128.1, 127.4, 127.3, 120.3, 111.6, 111.0, 83.7, 72.7, 71.3, 70.4, 55.6, 55.5, 40.5, 38.4, 34.9, 28.8; **HRMS ESI** Calcd for $C_{23}H_{27}NO_4$ $[M+H]^+$: 382.2013, Found: 382.2015.



14 15

The compound **14** (0.77g, 2.0 mmol, 1.0 equiv.) was dissolved in THF (25 mL) under Ar, *n*-BuLi in hexane (2.5 M, 1.7 mL, 4.2 mmol, 2.1 equiv.) was added to the solution dropwise at -78 ℃. Then added CH_3CHO in THF (0.6 mL, 10.0 mmol, 5 equiv.) to the mixture after 0.5 h, and the reaction was raised to the room temperature after another 0.5 h, the mixture was stirred at this temperature for 12 h. Quenched with saturated NH_4Cl aqueous, the mixture was diluted with water and extracted with EtOAc, washed with brine, dried over anhydrous sodium sulfate and concentrated under reduced pressure. The residue was purified by silica gel column chromatography (petroleum ether/ethyl acetate, 1/1; petroleum ether/ethyl acetate/DCM/MeOH, 10/10/10/1) to afford the product **15** as a yellow oil**,** yield 59%, brsm 98%.

Substrate 3-((benzyloxy)methyl)-*N*-(3,4-dimethoxyphenethyl)-6-hydroxyhpt -4-ynamide (15). **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.36 – 7.28 (m, 5H), 6.79 (d, J = 8.8 Hz, 1H), 6.73 – 6.70 (m, 2H), 5.96 – 5.93 (m, 1H), 4.51 (s, 2H), 4.45 (q, J = 7.6, 6.8 Hz, 1H), 3.86 (s, 3H), 3.84 (s, 3H), 3.56 – 3.43 (m, 4H), 3.14 (qd, J = 7.2, 2.0 Hz, 1H), 2.73 (t, J = 7.2 Hz, 2H), 2.49 (dd, J = 14.0, 5.6 Hz, 1H), 2.30 (dd, J = 14.2, 8.0 Hz, 1H), 1.38 (d, J = 6.4 Hz, 3H); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 170.7, 149.0, 147.6, 137.8, 131.3, 128.4, 127.7, 127.6, 111.9, 111.4, 85.0, 83.3, 72.9, 71.7, 58.1, 55.9, 55.8, 40.7, 39.0, 35.2, 29.3, 29.3, 24.4; **HRMS ESI** Calcd for $C_{25}H_{31}NO_5$ $[M+H]^+$: 426.2275, Found: 426.2274.

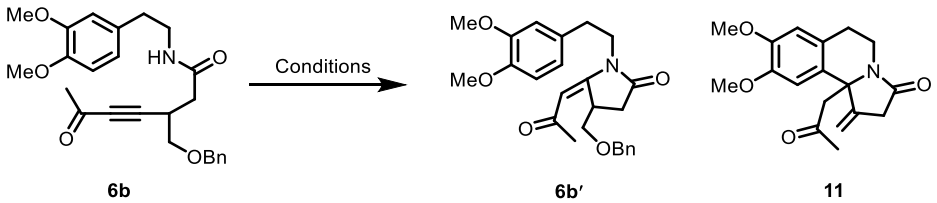


15 **6b**

The compound **15** (1.59 g, 3.7 mmol, 1.0 equiv.) was dissolved in DCM (30 mL), $NaHCO_3$ (0.94g, 11.2 mmol, 3.0 equiv.) and DMP (2.37 g, 5.60 mmol, 1.5 equiv.) was added to the reaction and the mixture was stirred at room temperature until completion (monitored by TLC). Then $Na_2S_2O_3$ aqueous was added to the mixture and stirred until the solution was clear, the mixture was diluted with water and extracted with EtOAc, washed with brine, dried over anhydrous sodium sulfate and concentrated under reduced pressure. The residue was purified by silica gel column chromatography (petroleum ether/ethyl acetate, 1/1) to afford the product **6b** as a yellow oil**,** yield 94%.

3-((benzyloxy)methyl)-*N*-(3,4-dimethoxyphenethyl)-6-oxohept-4-ynamide (6b). **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.37 – 7.28 (m, 5H), 6.79 (d, J = 8.8 Hz, 1H), 6.72 – 6.70 (m, 2H), 5.72 (t, J = 6.0 Hz, 1H), 4.52 (s, 1H), 3.86 (s, 1H),3.85 (s, 1H), 3.60 – 3.53 (m, 2H), 3.50 – 3.43 (m, 2H), 3.40 – 3.34 (m, 1H), 2.73 (t, J = 7.2 Hz, 2H), 2.52 (dd, J = 14.8, 6.4 Hz, 1H), 2.38 (dd, J = 14.6, 7.2 Hz, 1H), 2.30 (s, 3H); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 184.4, 169.6, 149.0, 147.6, 137.6, 131.1, 128.4, 127.8, 127.6, 120.5, 111.8, 111.3, 92.4, 82.3, 73.1, 70.5, 55.8, 55.8, 40.7, 37.8, 35.1, 32.7, 29.4; **HRMS ESI** Calcd for $C_{25}H_{29}NO_5$ $[M+H]^+$: 424.2118, Found: 424.2121.

Table SI-3 Optimization of the reaction conditions. [a,b]



6b **6b′** **11**

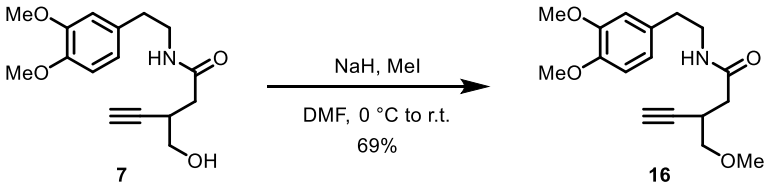
Entry	Conditions	Results
1	1 equiv. *p*-TsOH·H_2O, 30 °C, DCE	17% **6b′**, 11% **11**
2	1 equiv. *p*-TsOH, 30 °C, DCE	13% **6b′**, 8% **11**

3	1 equiv. $TfOH·H_2O$, 30 ℃, DCE	N.R.
4	1 equiv. *p*-$TsOH·H_2O$, 30 ℃, DCM	17% **6b′**, 15% **11**
5	1 equiv. *p*-$TsOH·H_2O$, 50 ℃, DCM	15% **6b′**, 8% **11**
6	1 equiv. *p*-$TsOH·H_2O$, 30 ℃, THF	N.R.
7	1 equiv. *p*-$TsOH·H_2O$, 30 ℃, MeOH	N.R.
8	1 equiv. *p*-$TsOH·H_2O$, 30 ℃, *i*-PrOH	N.R.

[a]Reaction conditions: **6b** (0.1 mmol, 1.0 equiv.), acid (0.1 mmol, 1.0 equiv.), solvent (4 mL). [b]The yield was determined upon isolation of the target product.

Substrate (*E*)-4-((benzyloxy)methyl)-1-(3,4-dimethoxyphenethyl)-5-(2-oxop ropylidene) pyrrolidin-2-one (6b′) was obtained as a yellow oil. **^{1}H NMR** (600 MHz, $CDCl_3$) δ 7.33 – 7.30 (m, 2H), 7.26 – 7.24 (m, 3H), 6.78 (d, J = 9.0 Hz, 1H), 6.73 (dd, J = 5.6, 1.8 Hz, 2H), 5.60 (s, 1H), 4.50 (d, J = 12.6 Hz, 1H), 4.45 (d, J = 12.0 Hz, 1H), 4.06 (dt, J = 10.2, 5.4 Hz, 1H), 3.88 (s, 3H), 3.85 (s, 3H), 3.80 (ddd, J = 13.8, 8.4, 6.6 Hz, 1H), 3.68 (dd, J = 9.0, 3.6 Hz, 2H), 3.63 (ddd, J = 14.1, 9.6, 6.0 Hz, 1H), 3.56 (dd, J = 9.0, 5.4 Hz, 1H), 2.80 – 2.72 (m, 2H), 2.58 – 2.57 (m, 3H), 2.18 (s, 3H); **^{13}C NMR** (151 MHz, $CDCl_3$) δ 196.2, 176.3, 161.0, 149.1, 147.9, 138.0, 130.4, 128.3, 127.6, 127.5, 120.7, 112.0, 111.3, 99.9, 72.9, 71.6, 55.9, 55.9, 41.7, 37.3, 32.6, 32.2, 31.9; **HRMS ESI** Calcd for $C_{25}H_{29}NO_5$ $[M+H]^+$: 424.2118, Found: 424.2121.

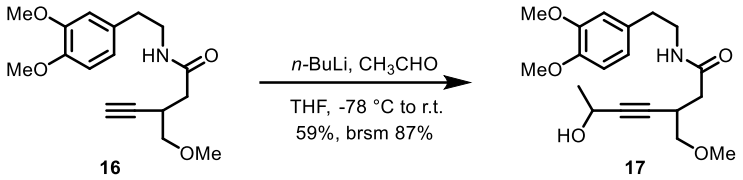
Substrate 8,9-dimethoxy-1-methylene-10b-(2-oxopropyl)-1,5,6,10b-tetrahyd -ropyrrolo [2,1-a] isoquinolin-3(2H)-one (11) was obtained as a light-yellow oil. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 6.88 (s, 1H), 6.56 (s, 1H), 5.52 (t, J = 2.4 Hz, 1H), 5.33 (d, J = 2.8 Hz, 1H), 4.41 (ddd, J = 13.2, 7.0, 2.0 Hz, 1H), 3.87 (s, 3H), 3.85 (s, 3H), 3.36 – 3.29 (m, 1H), 3.16 – 3.14 (m, 3H), 3.13 – 3.08 (m, 1H), 3.05 – 3.00 (m, 1H), 2.67 – 2.62 (m, 1H), 2.10 (s, 3H); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 204.1, 172.1, 148.4, 147.4, 144.8, 130.0, 125.8, 111.9, 110.4, 108.0, 65.8, 56.0, 55.8, 52.8, 37.8, 34.8, 31.3, 27.1.; **HRMS ESI** Calcd for $C_{18}H_{21}NO_4$ $[M+H]^+$: 316.1543, Found: 316.1541.



The compound **7** (1.9 g, 6.5 mmol, 1.0 equiv.) was dissolved in DMF (65 mL), NaH (0.3 g, 7.8 mmol, 1.2 equiv.) was added to the mixture under 0 ℃, the mixture was stirred at this temperature for 0.5 h, then added MeI (2.0 mL/4.6 g, 32.5 mmol, 5 equiv.) dropwise to the mixture, raised to room temperature and the reaction was stirred at this temperature until completion (monitored by TLC). Quenched with saturated NH_4Cl aqueous, the mixture was diluted with water and extracted with Et_2O, washed with brine, dried over anhydrous sodium sulfate and concentrated under reduced pressure. The residue was purified by silica gel column chromatography (petroleum ether/ethyl acetate, 2/1) to afford the product **16** as a yellow oil, 69%.

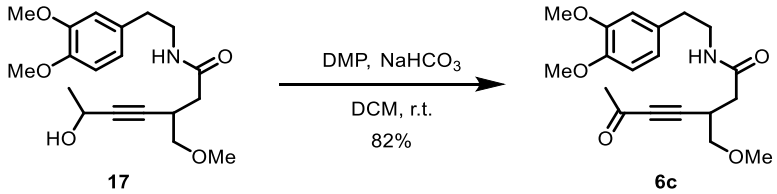
Substrate *N*-(3,4-dimethoxyphenethyl)-3-(methoxymethyl) pent-4-ynamide

(16). ^{1}H NMR (400 MHz, $CDCl_3$) δ 6.79 (d, J = 8.4 Hz, 1H), 6.73 (d, J = 7.2 Hz, 2H), 5.76 (s, 1H), 3.86 (s, 3H), 3.85 (s, 3H), 3.51 (qd, J = 7.0, 2.4 Hz, 2H), 3.46 – 3.39 (m, 2H), 3.34 (s, 3H), 3.16 – 3.08 (m, 1H), 2.76 (t, J = 7.2 Hz, 2H), 2.44 (dd, J = 14.4, 6.0 Hz, 1H), 2.31 (dd, J = 14.4, 8.0 Hz, 1H), 2.09 (d, J = 2.4 Hz, 1H); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 170.3, 149.0, 147.7, 131.2, 120.6, 111.8, 111.3, 83.9, 74.0, 70.6, 58.9, 55.9, 55.8, 40.7, 38.7, 35.2, 28.9; **HRMS ESI** Calcd for $C_{17}H_{23}NO_4$ $[M+H]^+$: 306.1700, Found: 306.1698.



The compound **16** (0.76g, 2.5 mmol, 1.0 equiv.) was dissolved in THF (25 mL) under Ar, *n*-BuLi in hexane (2.5 M, 2.1 mL, 5.3 mmol, 2.1 equiv.) was added to the solution dropwise at -78 °C. Then added CH_3CHO in THF (5 M, 2.5 mL, 12.5 mmol, 5 equiv.) to the mixture after 0.5 h, and the reaction was raised to the room temperature after another 0.5 h, the mixture was stirred at this temperature for 12 h. Quenched with saturated NH_4Cl aqueous, the mixture was diluted with water and extracted with EtOAc, washed with brine, dried over anhydrous sodium sulfate and concentrated under reduced pressure. The residue was purified by silica gel column chromatography (petroleum ether/ethyl acetate, 1/1; petroleum ether/ethyl acetate/DCM/MeOH, 10/10/10/1) to afford the product **17** as a yellow oil**,** yield 59%, brsm 87%.

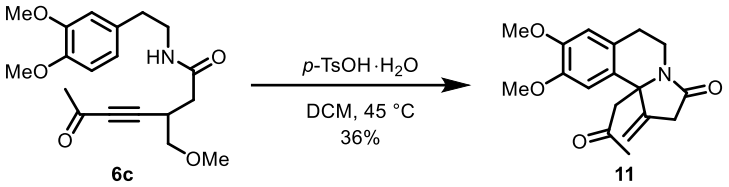
Substrate *N*-(3,4-dimethoxyphenethyl)-6-hydroxy-3-(methoxymethyl)hept-4-ynamide (17). ^{1}H NMR (400 MHz, $CDCl_3$) δ 6.80 (d, J = 8.8 Hz, 1H), 6.73 (d, J = 6.4 Hz, 2H), 5.93 (s, 1H), 4.45 (q, J = 6.8 Hz, 1H), 3.86 (s, 3H), 3.85 (s, 3H), 3.50 (q, J = 6.8 Hz, 2H), 3.44 – 3.35 (m, 2H), 3.32 (s, 3H), 3.11 (q, J = 5.6 Hz, 1H), 2.76 (t, J = 6.8 Hz, 2H), 2.43 (dd, J = 14.4, 5.6 Hz, 1H), 2.27 (dd, J = 14.2, 8.0 Hz, 1H), 1.37 (d, J = 6.8 Hz, 3H); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 170.7, 149.0, 147.6, 131.3, 120.6, 111.9, 111.3, 84.9, 83.4, 74.2, 58.8, 58.1, 55.9, 55.8, 40.7, 38.9, 35.2, 29.1, 29.1, 24.4; **HRMS ESI** Calcd for $C_{19}H_{27}NO_5$ $[M+H]^+$: 350.1962, Found: 350.1959.



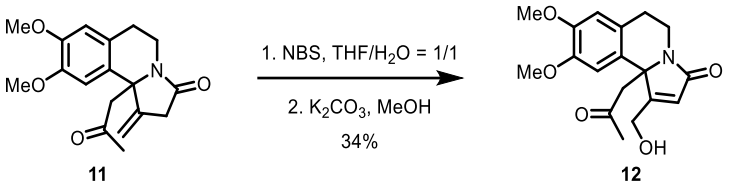
The compound **17** (0.51 g, 1.5 mmol, 1.0 equiv.) was dissolved in DCM (15 mL), $NaHCO_3$ (0.37g, 4.5 mmol, 3.0 equiv.) and DMP (0.93 g, 2.3 mmol, 1.5 equiv.) was added to the reaction and the mixture was stirred at room temperature until completion (monitored by TLC). Then $Na_2S_2O_3$ aqueous was added to the mixture and stirred until the solution was clear, the mixture was diluted with water and extracted with EtOAc, washed with brine, dried over anhydrous sodium sulfate and concentrated under reduced pressure. The residue was purified by silica gel column chromatography (petroleum ether/ethyl acetate, 1/1) to afford the product **6c** as a yellow oil**,** yield 82%.

Substrate *N*-(3,4-dimethoxyphenethyl)-3-(methoxymethyl)-6-oxohept-4-yna -

mide (6c).[1]H NMR (400 MHz, $CDCl_3$) δ 6.79 (d, J = 8.4 Hz, 1H), 6.71 (d, J = 6.4 Hz, 2H), 5.75 (d, J = 6.8 Hz, 1H), 3.85 (s, 3H), 3.84 (s, 3H), 3.52 – 3.44 (m, 4H), 3.35-3.28 (m, 4H), 2.75 (t, J = 7.2 Hz, 2H), 2.47 (dd, J = 14.8, 6.4 Hz, 1H), 2.35 (dd, J = 14.4, 7.6 Hz, 1H), 2.29 (s, 3H); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 184.5, 169.6, 148.9, 147.6, 131.0, 120.5, 111.7, 111.2, 92.4, 82.2, 73.0, 58.9, 55.8, 55.8, 40.7, 37.7, 35.1, 32.7, 29.2; **HRMS ESI** Calcd for $C_{19}H_{25}NO_5$ $[M+H]^+$: 348.1805, Found: 348.1804.



The compound **6c** (194 mg, 0.56 mmol, 1.0 equiv.) was dissolved in DCE (10 mL), added *p*-TsOH·H_2O (144 mg, 0.75 mmol, 1.0 equiv.) to the mixture and stirred at 45 °C until completion (monitored by TLC). Then the reaction was quenched with saturated $NaHCO_3$ aqueous, the mixture was diluted with water and extracted with DCM, washed with brine, dried over anhydrous sodium sulfate and concentrated under reduced pressure. The residue was purified by silica gel column chromatography (petroleum ether/ethyl acetate/DCM/MeOH, 10/10/10/1) to afford the product **11** as a light-yellow oil, yield 36%.

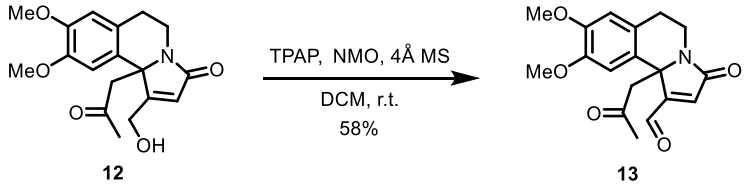


The compound **10** (136 mg, 0.43 mmol, 1.0 equiv.) was dissolved in mixed solvents THF/H_2O = 1/1 (5 mL), then NBS (92 mg, 0.52 mmol, 1.2 equiv.) was added to the mixture and stirred at room temperature until completion (monitored by TLC). Then the reaction was quenched with saturated $NaHCO_3$ aqueous, the mixture was diluted with water and extracted with EtOAc, washed with brine, dried over anhydrous sodium sulfate and concentrated under reduced pressure to afford crude product which was used in the next reaction without further purification.

The crude product (10 mg, 0.025 mmol, 1.0 equiv.) was dissolved in MeOH (2 mL), K_2CO_3 (5 mg, 0.038 mmol, 1.5 equiv.) was added to the mixture and stirred at room temperature for 0.5 h. Then the mixture was diluted with water and extracted with EtOAc, washed with brine, dried over anhydrous sodium sulfate and concentrated under reduced pressure. The residue was purified by silica gel column chromatography (petroleum ether/ethyl acetate, 1/1 to 1/2) to afford the product **12** as a light-yellow oil, 34%.[2]

Substrate1-(hydroxymethyl)-8,9-dimethoxy-10b-(2-oxopropyl)-6,10b-dihydropyrrolo [2,1-a] isoquinolin-3(5H)-one (12). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.28 (s, 1H), 6.61 (s, 1H), 5.93 (s, 1H), 4.77 (d, J = 14.8 Hz, 1H), 4.66 – 4.60 (m, 1H), 4.52 (dd, J = 13.6, 6.0 Hz, 1H), 4.11 – 4.07 (m, 1H), 3.91 (s, 3H), 3.86 (s, 3H), 3.31 – 3.21 (m, 2H), 2.98 – 2.89 (m, 1H), 2.64 (dd, J = 15.8, 4.0 Hz, 1H), 2.17 (s, 2H); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 209.3 , 170.8, 164.4, 148.5, 148.2, 126.9, 126.0, 123.1,

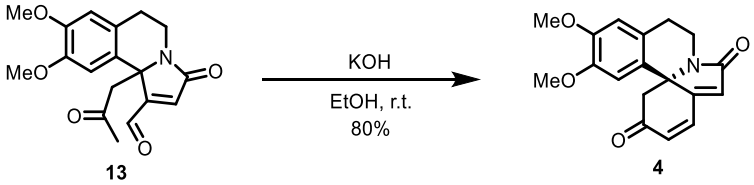
111.9, 109.3, 60.1, 56.1, 55.9, 51.9, 35.5, 32.9, 29.7, 29.2; **HRMS ESI** Calcd for $C_{18}H_{21}NO_5$ $[M+H]^+$: 332.1492, Found: 332.1491.



12 13

The compound **12** (27 mg, 0.08 mmol, 1.0 equiv.) was dissolved in DCM (2 mL), added NMO (28 mg, 0.24 mmol, 3.0 equiv.) and 4 Å MS to the reaction under 0 ℃. Then TPAP (3mg, 0.008mmol, 0.1equiv.) was added to the mixture after 10 minutes and stirred at room temperature until completion (monitored by TLC). After the reaction is completed, the solvent was evaporated under reduced pressure and the residue was purified by silica gel column chromatography (petroleum ether/ethyl acetate, 1/1) to afford the product **13** as a light-yellow oil, 58%.

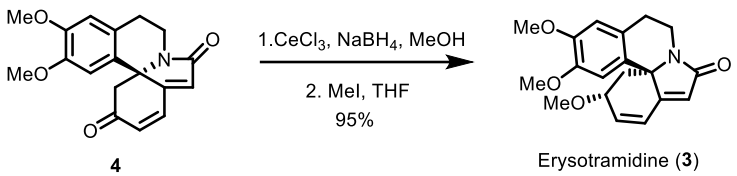
Substrate 8,9-dimethoxy-3-oxo-10b-(2-oxopropyl)-3,5,6,10b-tetrahydropyrrolo [2,1-a] isoquinoline-1-carbaldehyde (13). ^{1}H NMR (400 MHz, $CDCl_3$) δ 10.06 (s, 1H), 7.38 (s, 1H), 6.90 (s, 1H), 6.59 (s, 1H), 4.53 – 4.48 (m, 1H), 3.85 (s, 3H), 3.84 (s, 3H), 3.57 (d, J = 15.6 Hz, 1H), 3.29 (d, J = 16.0 Hz, 1H), 3.27 – 3.21 (m, 1H), 3.05 – 2.96 (m, 1H), 2.67 (dd, J = 16.0, 4.4 Hz, 1H), 2.06 (s, 3H); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 203.3, 188.3, 168.6, 157.9, 148.5, 147.9, 140.7, 126.9, 125.2, 111.8, 110.1, 66.8, 55.9, 55.8, 49.6, 35.6, 31.7, 28.5; **HRMS ESI** Calcd for $C_{18}H_{19}NO_5$[M+H] $^+$: 330.1336, Found: 330.1338.



13 4

The compound **13** (7 mg, 0.02mmol, 1.0 equiv.) was dissolved in EtOH (1 mL), then KOH (6 mg, 0.10mmol, 10.0 equiv.) was added to the mixture and and stirred at room temperature until completion (monitored by TLC). Quenched with saturated NH_4Cl aqueous, the mixture was diluted with water and extracted with EtOAc, washed with brine, dried over anhydrous sodium sulfate and concentrated under reduced pressure, the residue was purified by silica gel column chromatography (petroleum ether/ethyl acetate, 1/2) to afford the product **4** as a colorless oil, yield 80%.

Substrate (*S*)-11,12-dimethoxy-8,9-dihydro-1H-indolo [7a,1-a] isoquinoline-2, 6-dione (4). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.76 (dd, J = 10.0, 1.2 Hz, 1H), 6.85 (s, 1H), 6.66 (s, 1H), 6.42 (d, J = 10.0 Hz, 1H), 6.38 (s, 1H), 4.21 (ddd, J = 13.2, 6.6, 4.8 Hz, 1H), 3.84 (s, 3H), 3.72 (s, 3H), 3.40 (ddd, J = 13.0, 8.0, 5.6 Hz, 1H), 3.27 (d, J = 14.8 Hz, 1H), 3.03 (ddd, J = 16.0, 8.8, 6.8 Hz, 1H), 2.86 – 2.79 (m, 2H).**^{13}C NMR** (101 MHz, $CDCl_3$) δ 195.2, 169.7, 154.8, 148.8, 147.3, 138.5, 131.9, 128.1, 126.0, 125.6, 112.5, 107.9, 67.7, 55.9, 55.9, 52.5, 36.9, 27.7; **HRMS ESI** Calcd for $C_{18}H_{17}NO_4$[M+H] $^+$: 312.1230, Found: 312.1227.



4 Erysotramidine (**3**)

A 10-mL sealed tube with a magnetic stir bar was charged with **4** (6 mg, 0.016 mmol, 1.0 equiv.) and $CeCl_3 \cdot 7H_2O$ (18 mg, 0.048 mmol, 3.0 equiv.) in MeOH (1 mL). Then $NaBH_4$ (2 mg, 0.048 mmol, 3.0 equiv.) was added to the mixture at 0 ℃. The mixture was stirred for 5 min and quenched with water (1 mL). Then the mixture was extracted with DCM, washed with brine, dried over anhydrous sodium sulfate and concentrated under reduced pressure to afford crude alcohol which was used in the next reaction without further purification.

A 10-mL sealed tube with a magnetic stir bar was charged with the crude product (5 mg, 0.016 mmol, 1.0 equiv), KOH (9 mg, 0.160 mmol, 10.0 equiv) and Et_4NBr (7 μl, 0.048 mmol, 5.0 equiv) in THF (1 mL). Then CH_3I (10 μl, 0.160 mmol, 10 equiv) was added to the mixture and stirred at room temperature until completion (monitored by TLC). The reaction was quenched with water (1 mL) and extracted with DCM, washed with brine, dried over anhydrous sodium sulfate and concentrated under reduced pressure. The residue was purified by silica gel column chromatography (petroleum ether/ethyl acetate, 1/1) to afford the product Erysotramidine (**3**) as a colorless oil, yield 95%.[3-5]

Substrate (13bS)-2,11,12-trimethoxy-1,2,8,9-tetrahydro-6H-indolo [7a,1-a] isoquinolin-6-one (3). ^{1}H NMR (400 MHz, $CDCl_3$) δ 6.91 (dd, J = 10.0, 2.4 Hz, 1H), 6.80 (s, 1H), 6.72 (s, 1H), 6.33 (dt, J = 10.4, 1.6 Hz, 1H), 6.03 (s, 1H), 4.01 (ddd, J = 12.8, 8.4, 7.2 Hz, 1H), 3.87 (s, 3H), 3.84 – 3.83 (m, 1H), 3.77 (s, 3H), 3.62 (ddd, J = 12.8, 7.2, 5.6 Hz, 1H), 3.35 (s, 3H), 3.13 – 3.05 (m, 1H), 3.03 – 2.98 (m, 1H), 2.81 (ddd, J = 11.6, 5.2, 1.2 Hz, 1H), 1.72 (dd, J = 11.6, 10.0 Hz, 1H); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 171.0, 157.0, 148.6, 147.0, 136.3, 128.7, 126.6, 124.2, 120.3, 112.2, 108.2, 74.9, 66.4, 56.4, 56.1, 55.9, 41.4, 37.3, 27.1.

6. References

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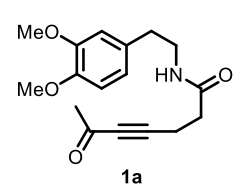
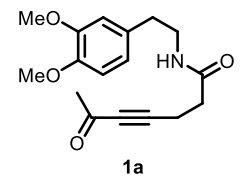
5 L′Homme, C., Ménard, M.-A., Canesi, S. *J. Org. Chem.* **2014**, *79* (17), 8481–8485.

7. NMR Spectra of New Compound



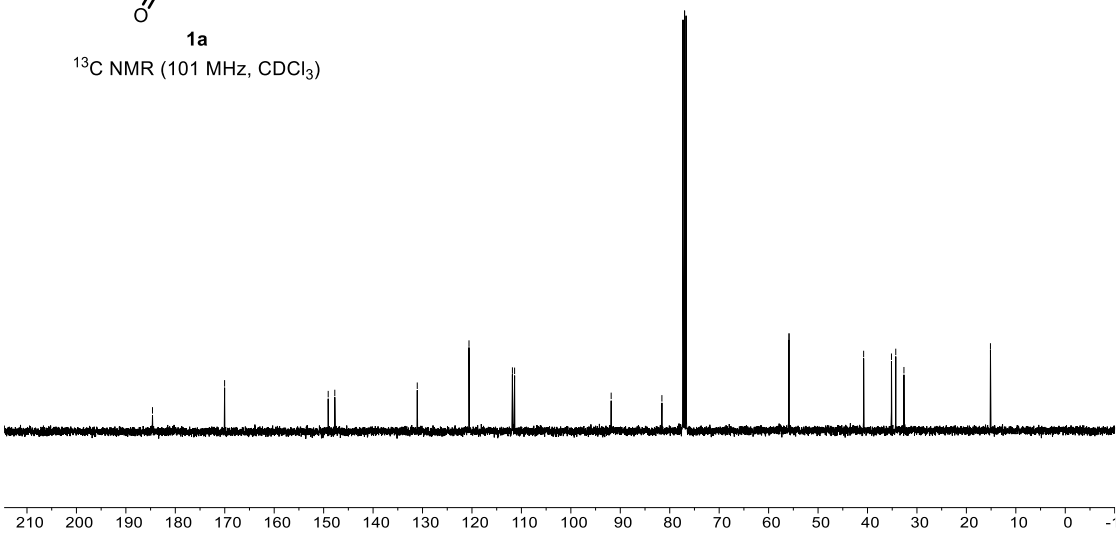
1a

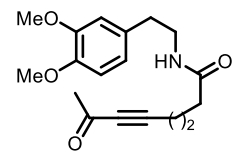
^{1}H NMR (400 MHz, $CDCl_3$)



1a

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



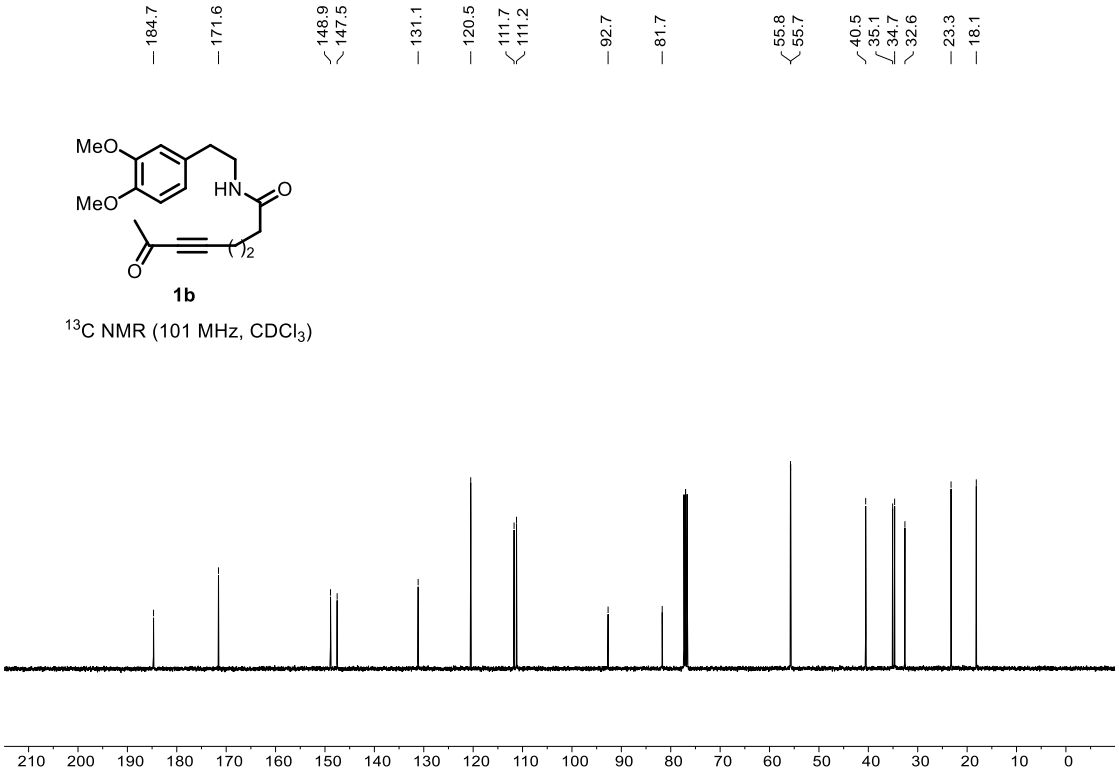


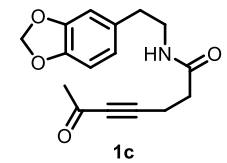
1b

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

1b

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





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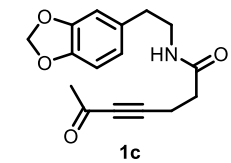

1c

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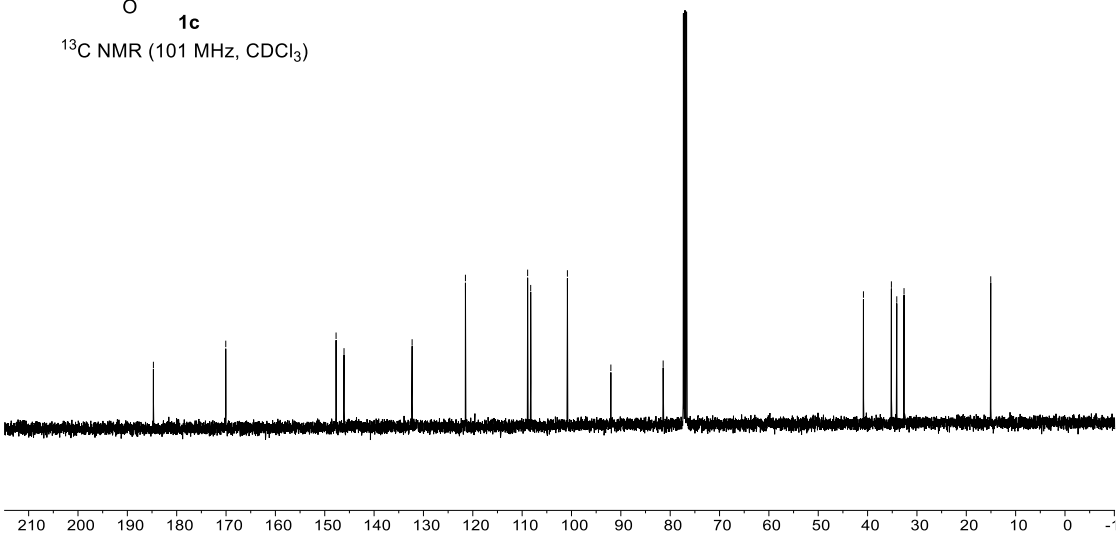

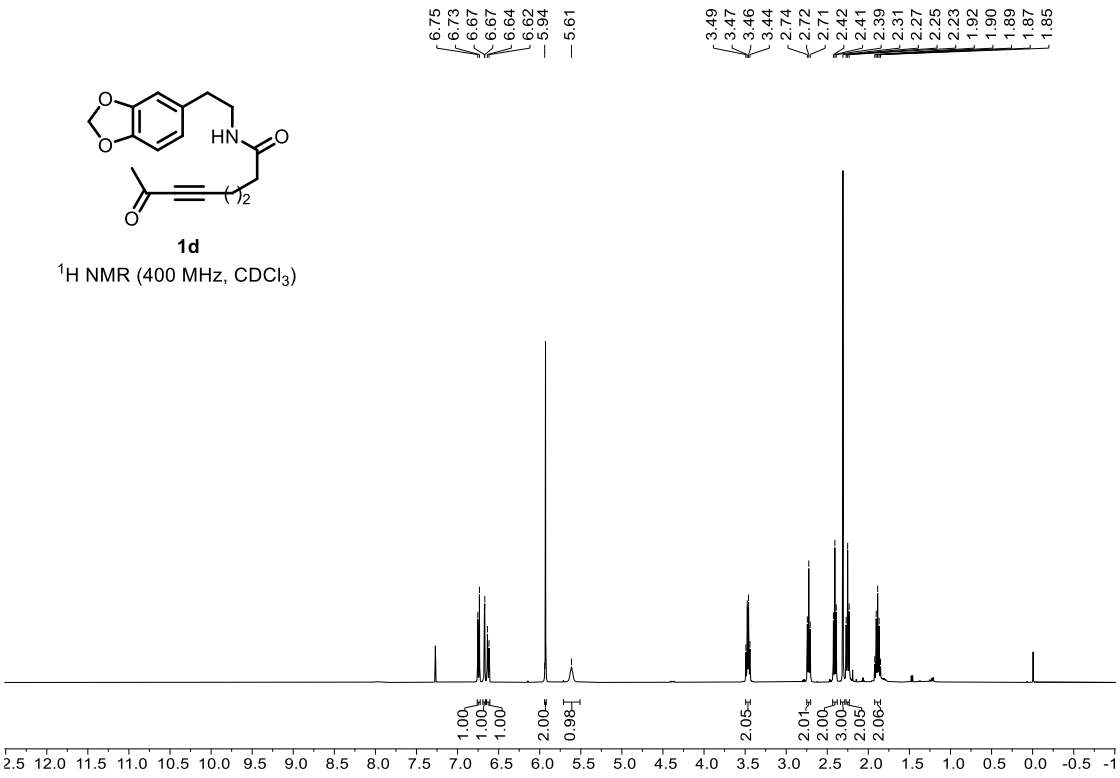

1d

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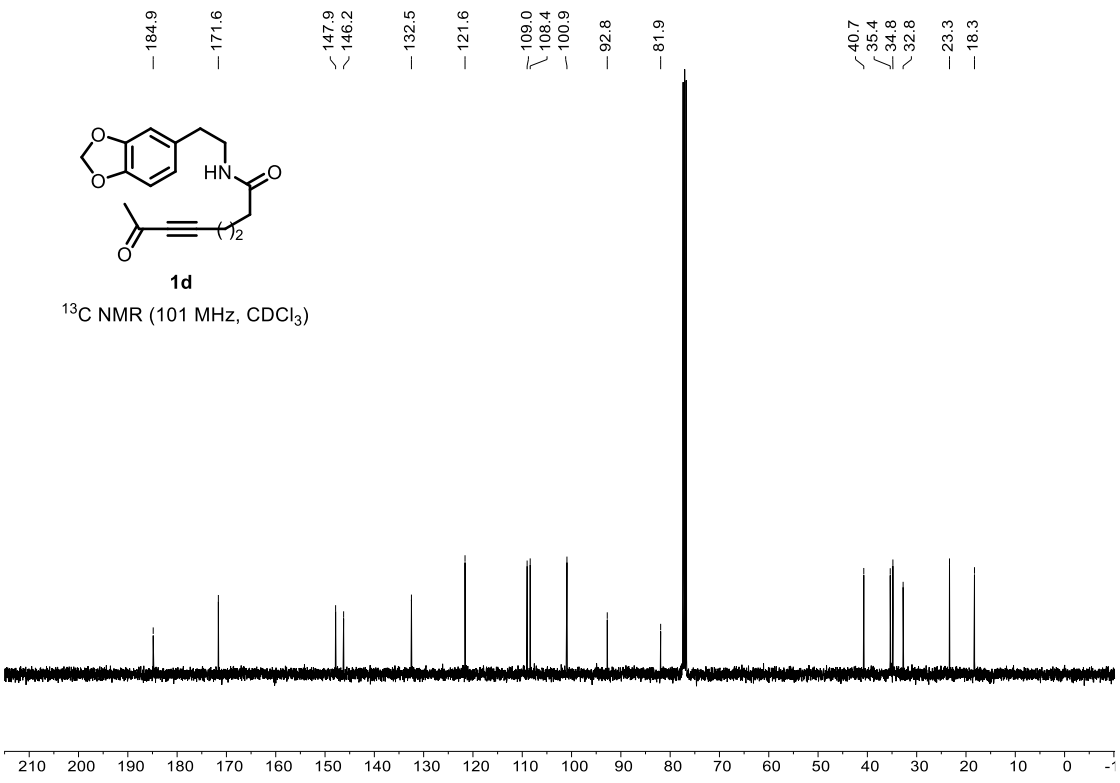

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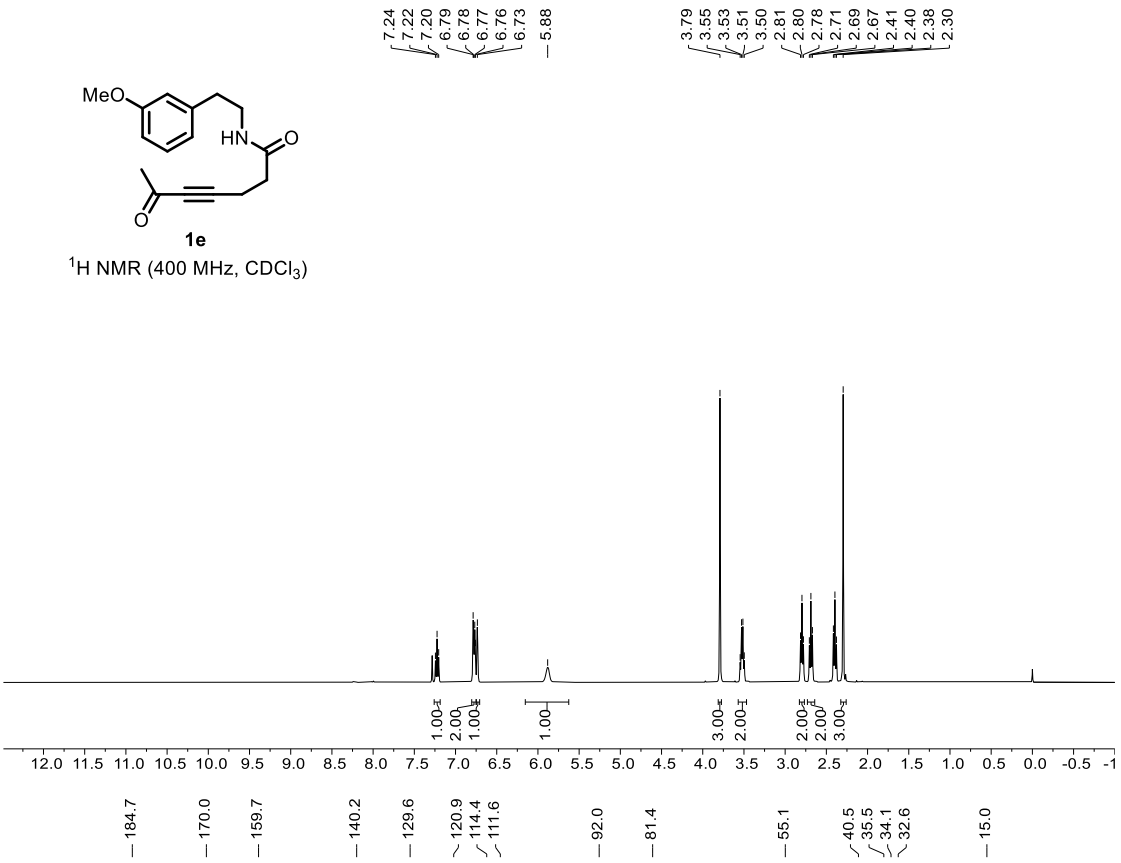
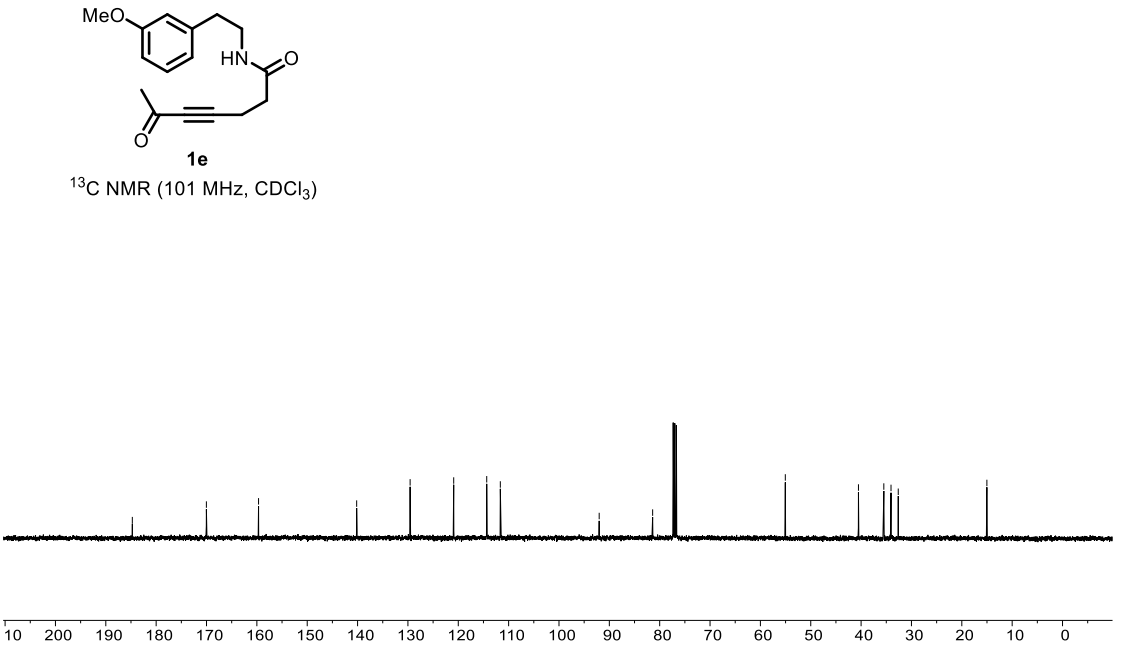


1e

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



1e

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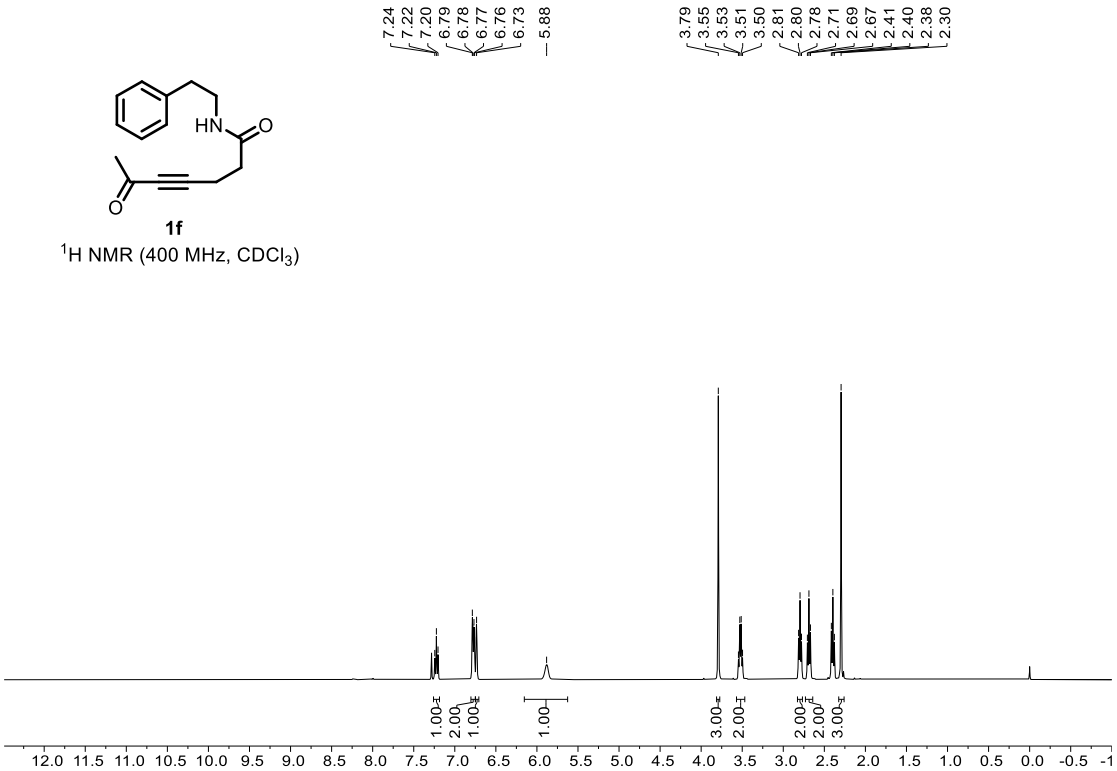

1f

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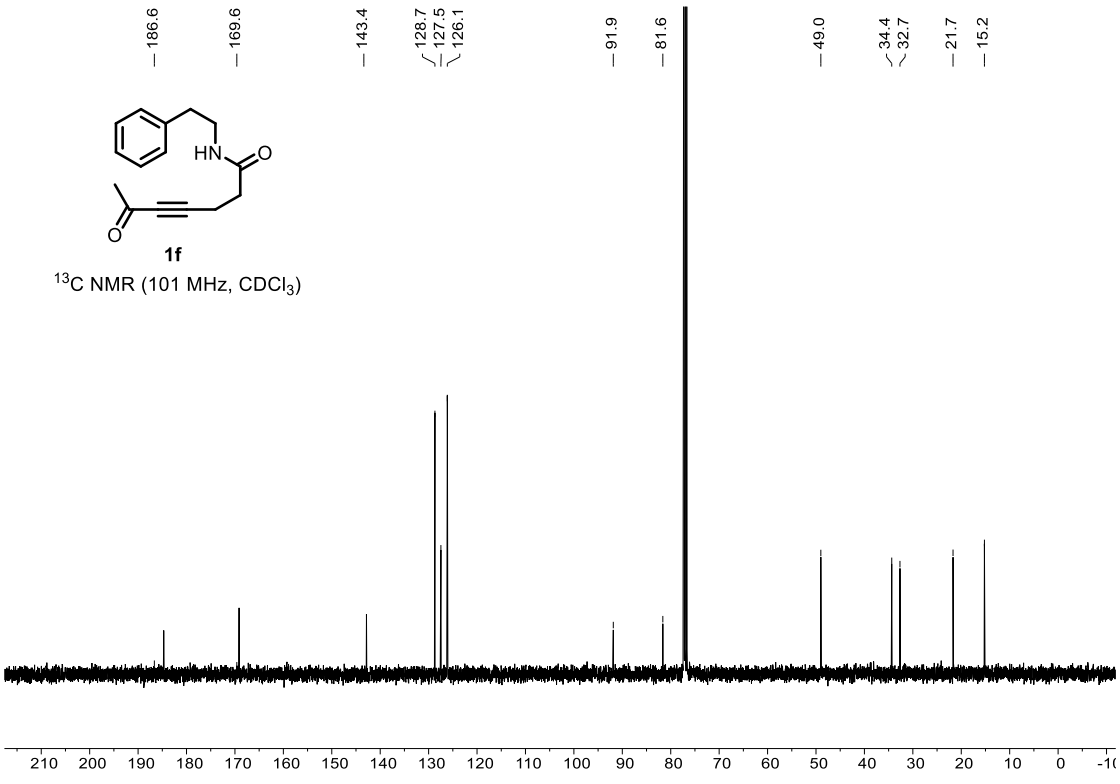

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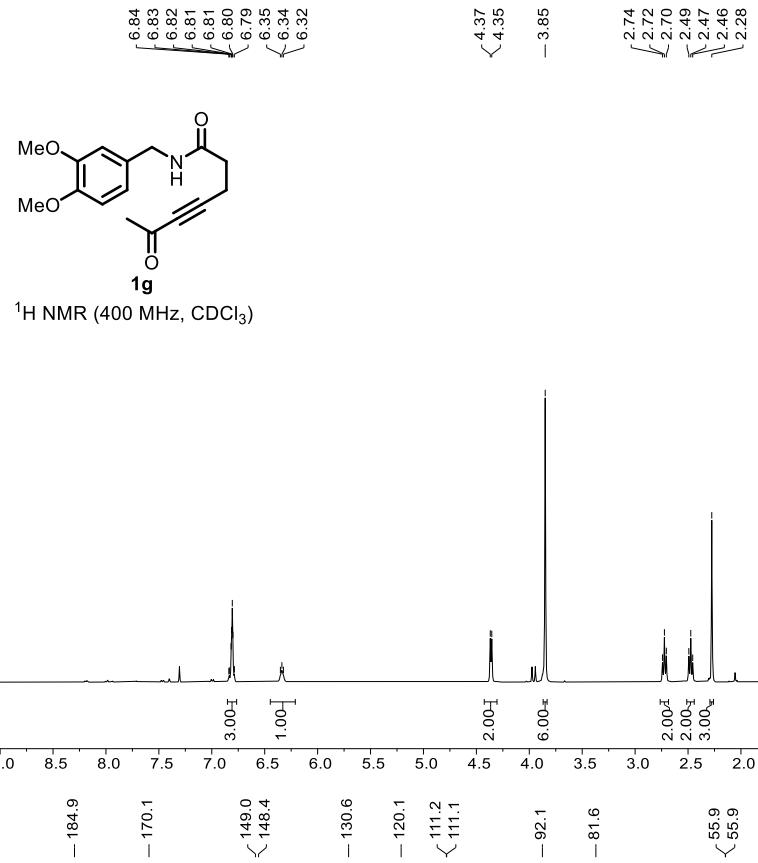

1g

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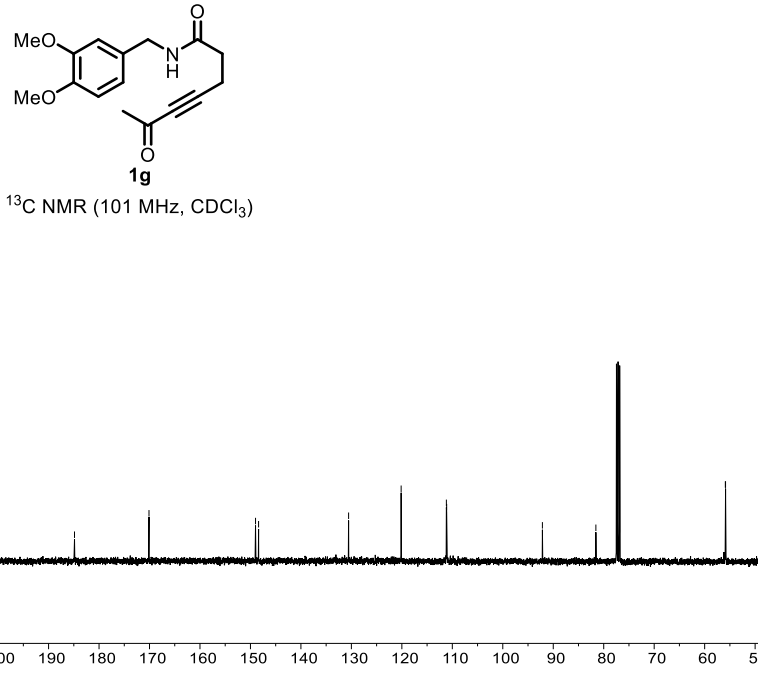

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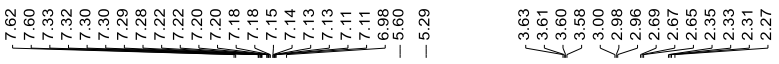

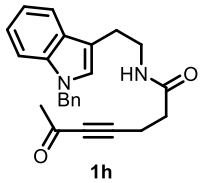

1h

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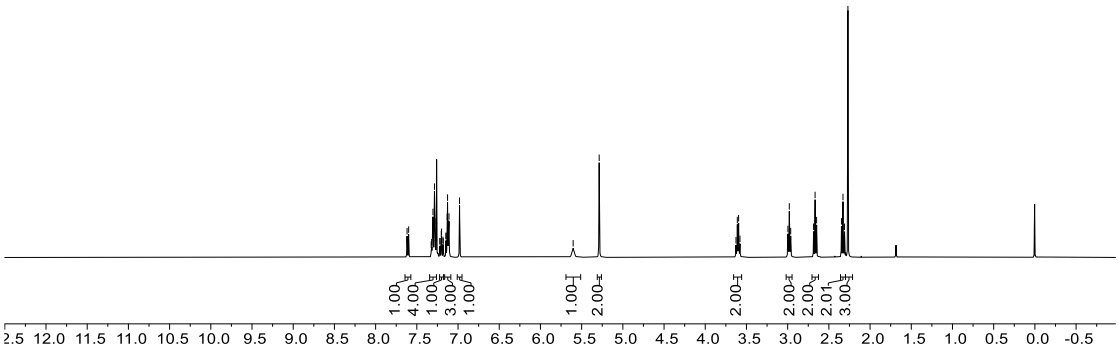

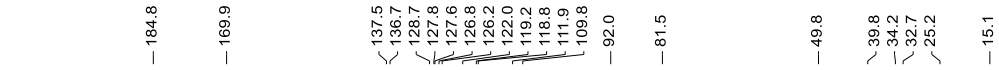

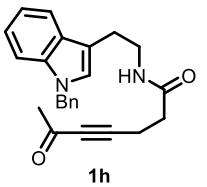

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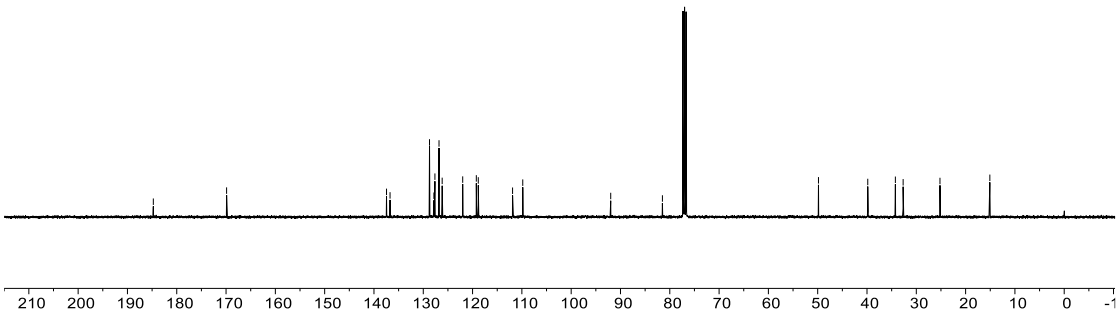

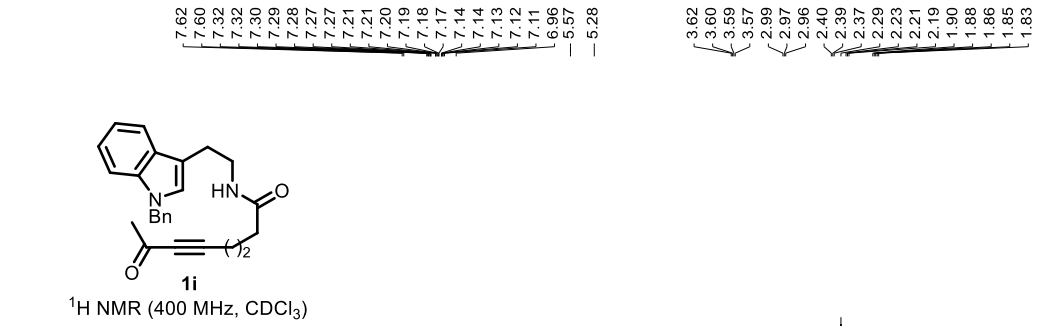

1i

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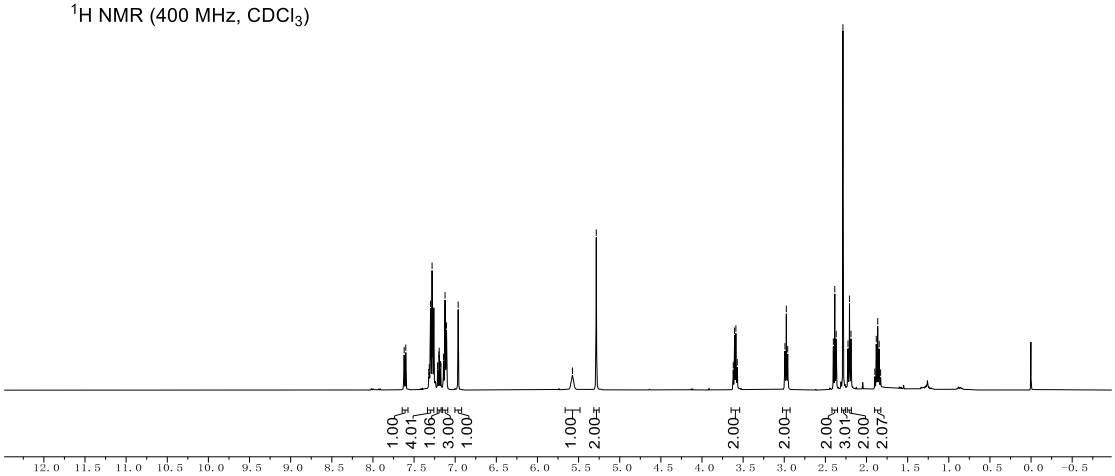

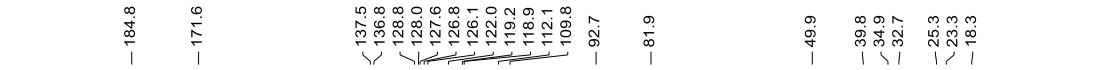

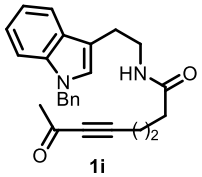

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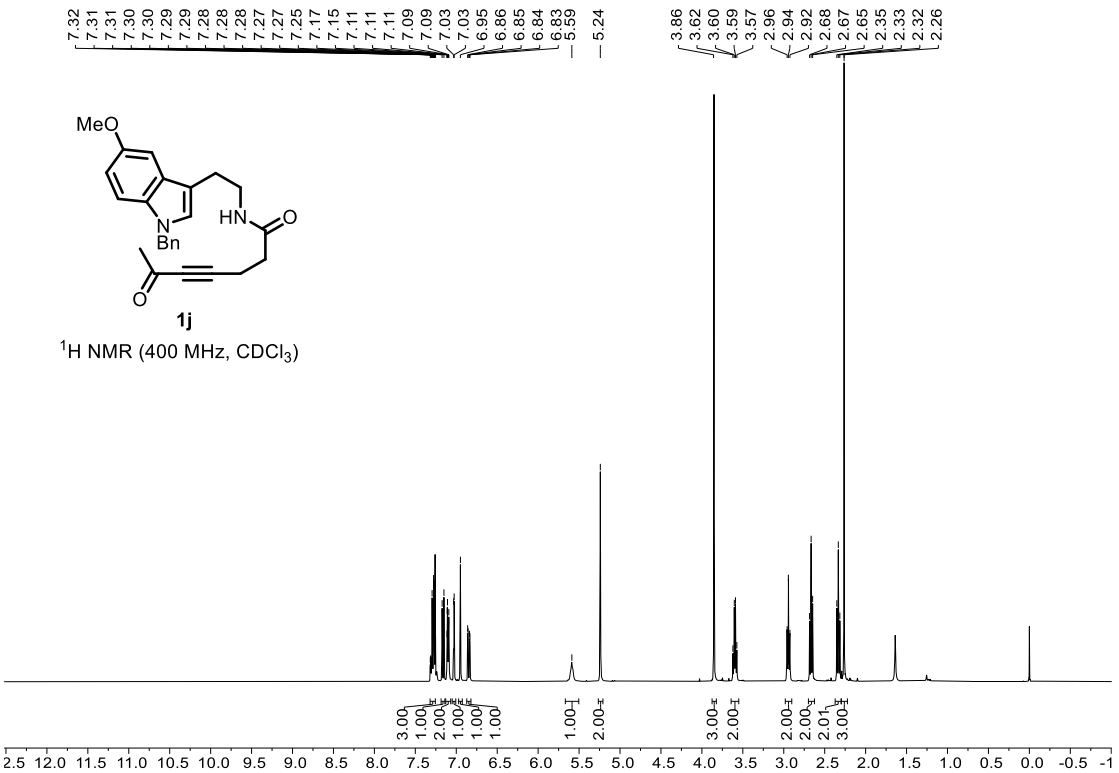

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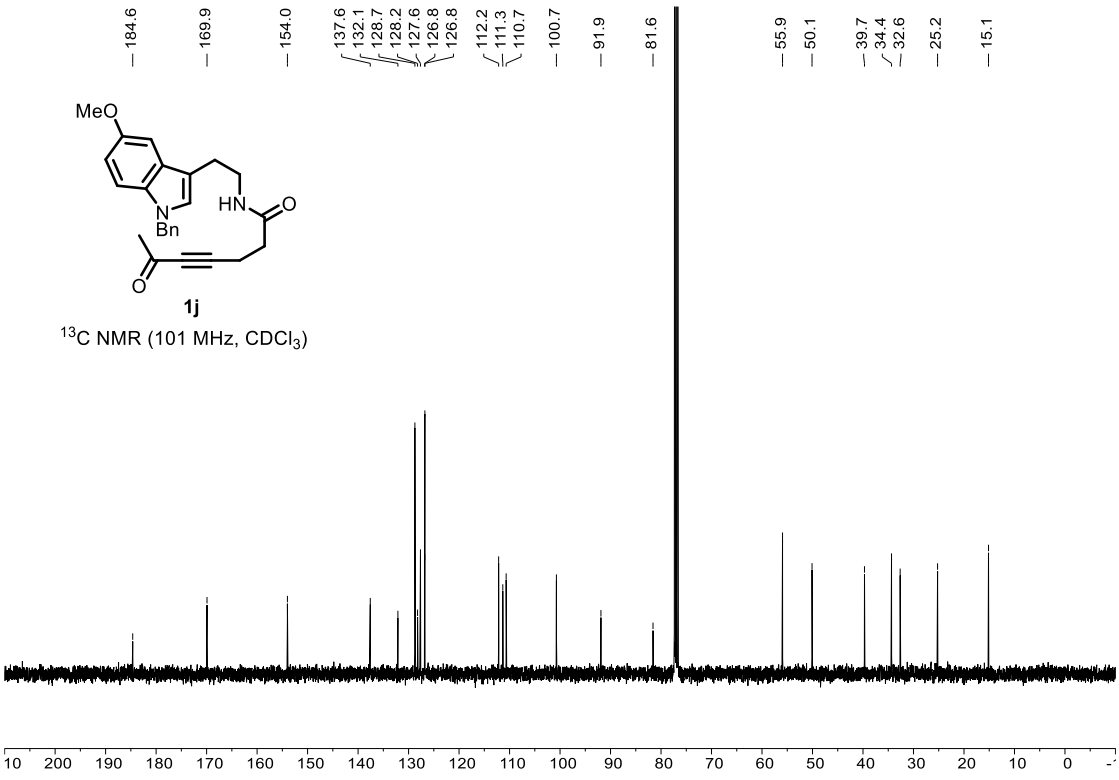

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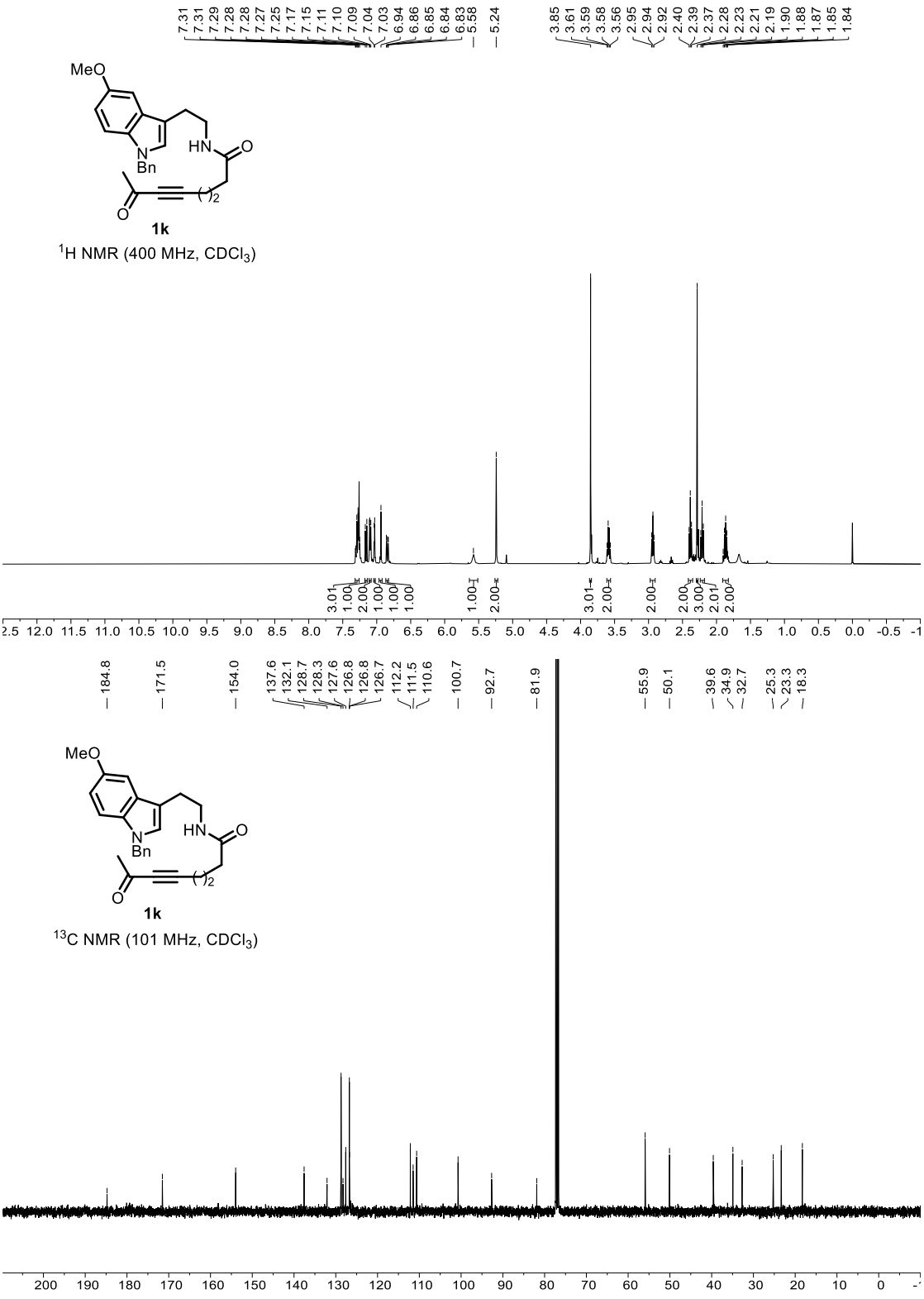
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1k
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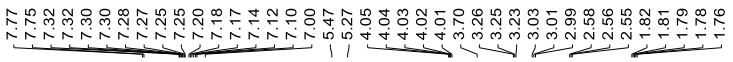

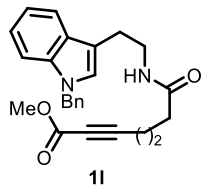

1l

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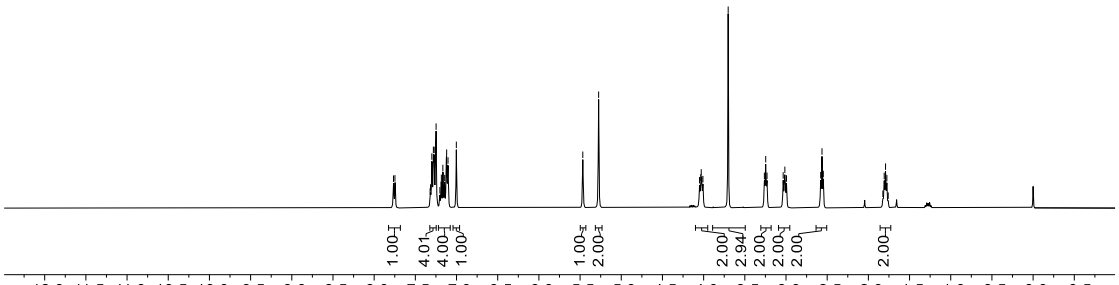

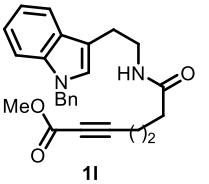

1l

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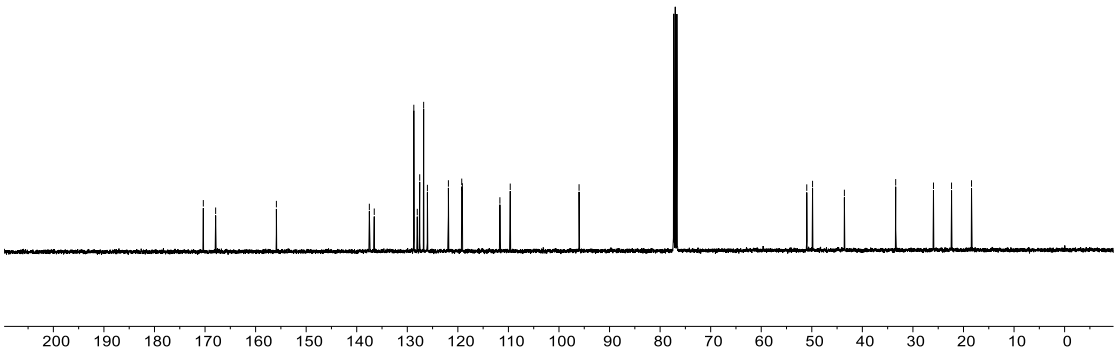
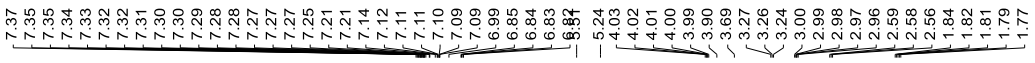
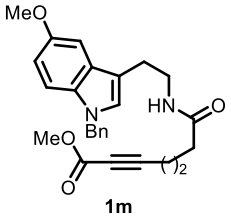
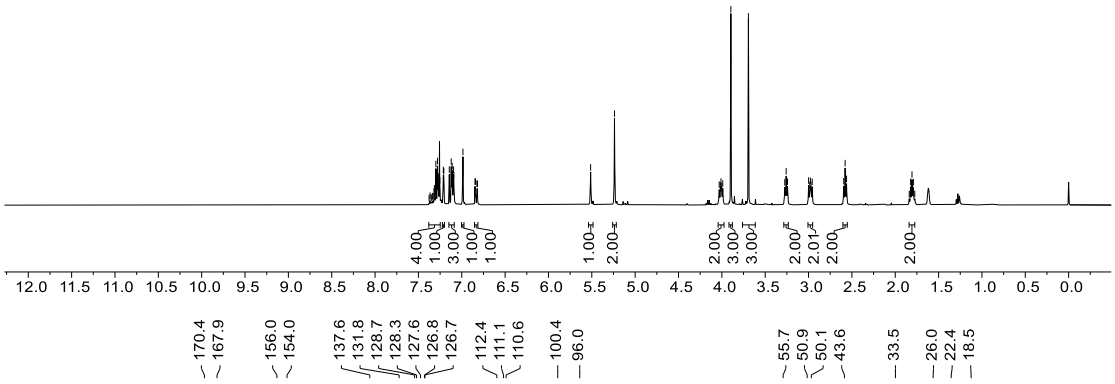


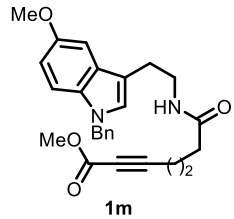




1m

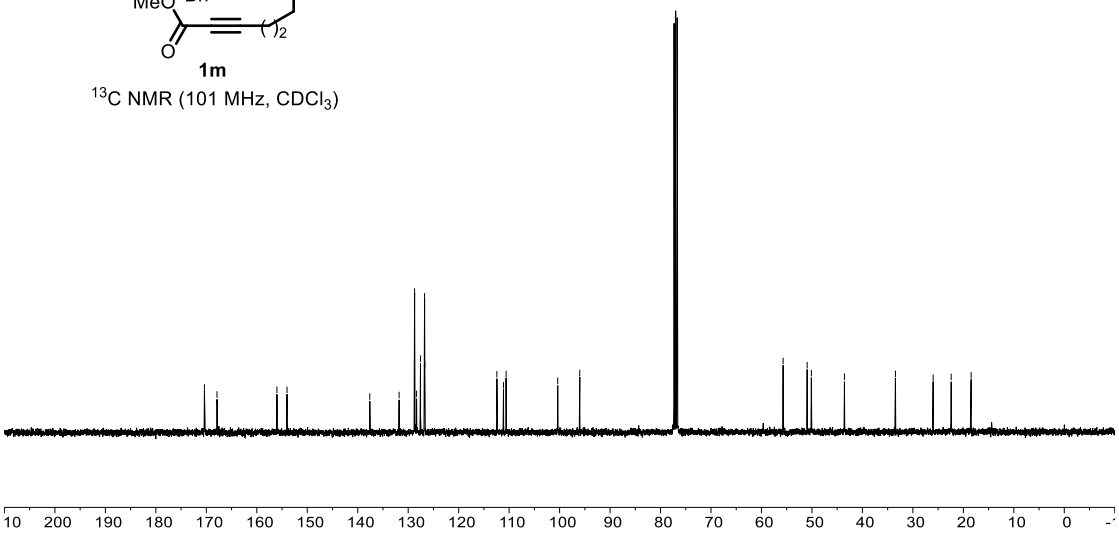
^{1}H NMR (400 MHz, $CDCl_3$)

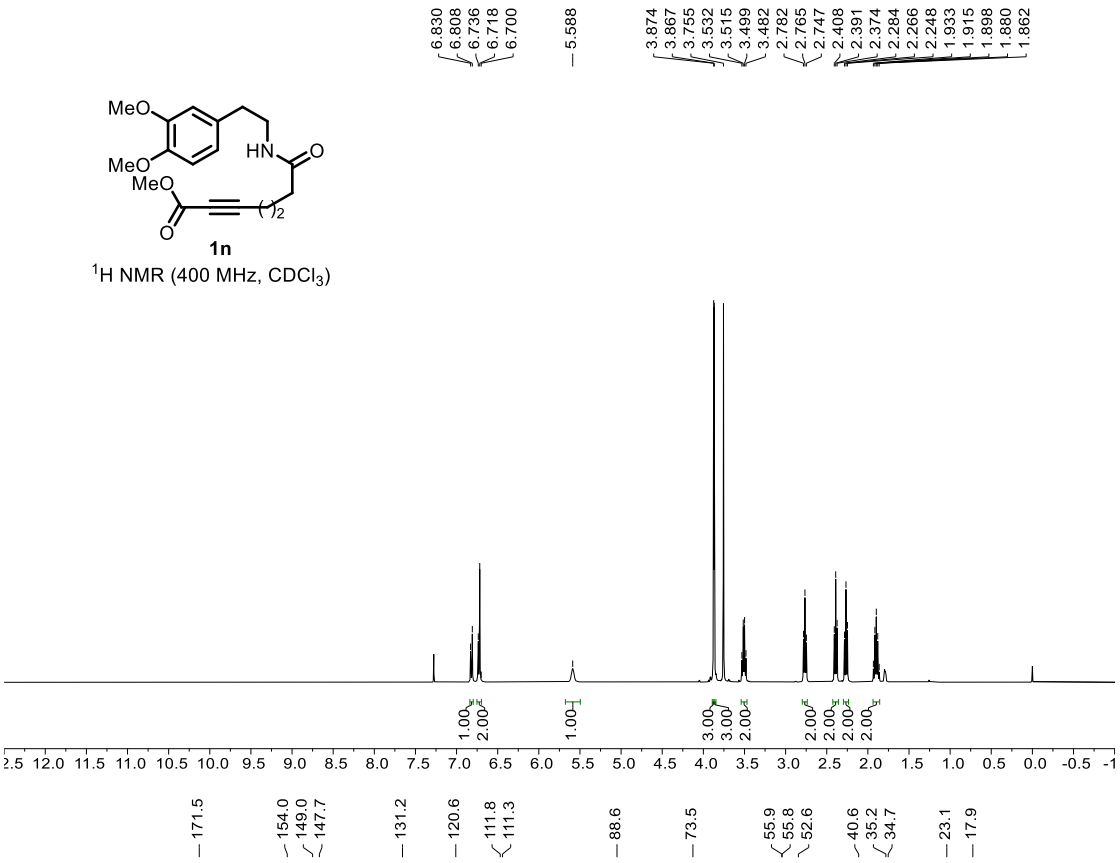




1m

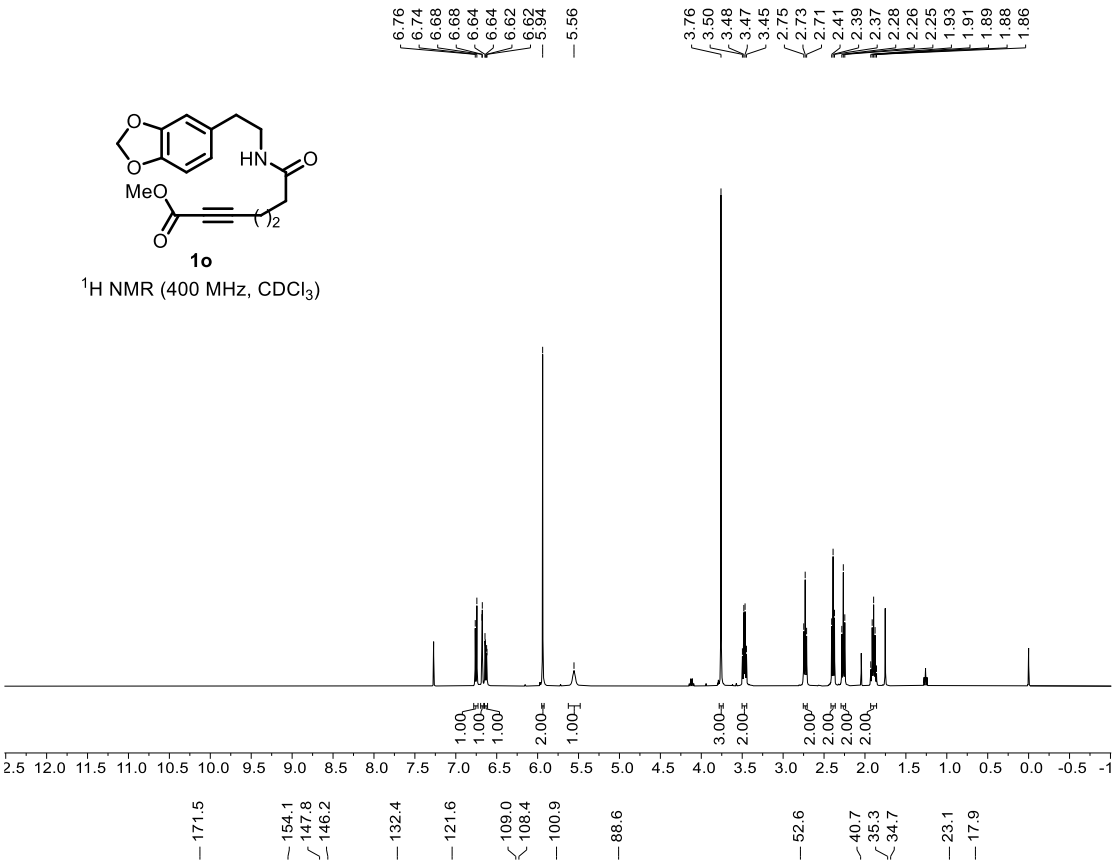
^{13}C NMR (101 MHz, $CDCl_3$)





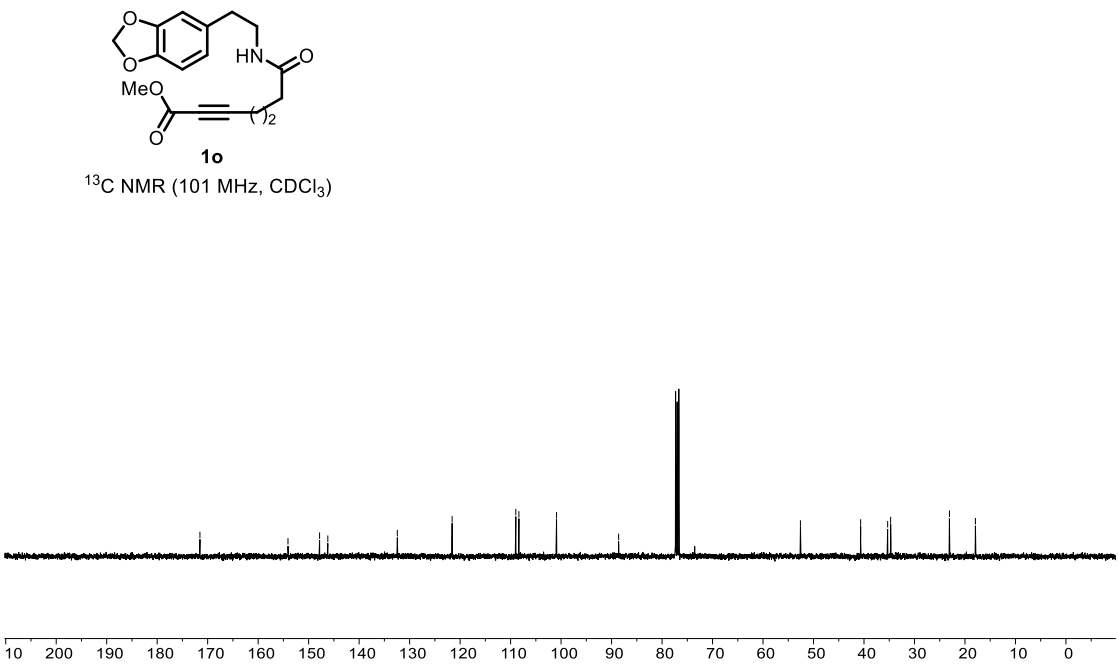
^{1}H NMR (400 MHz, $CDCl_3$)

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



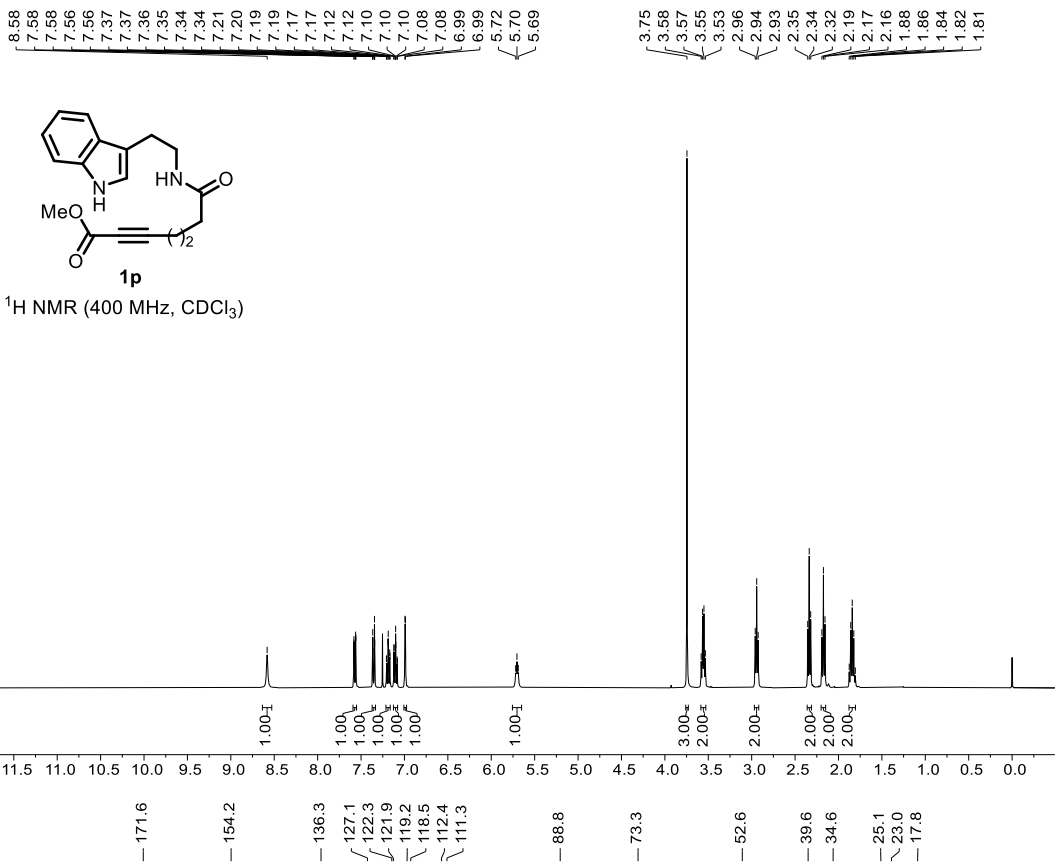
1o

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



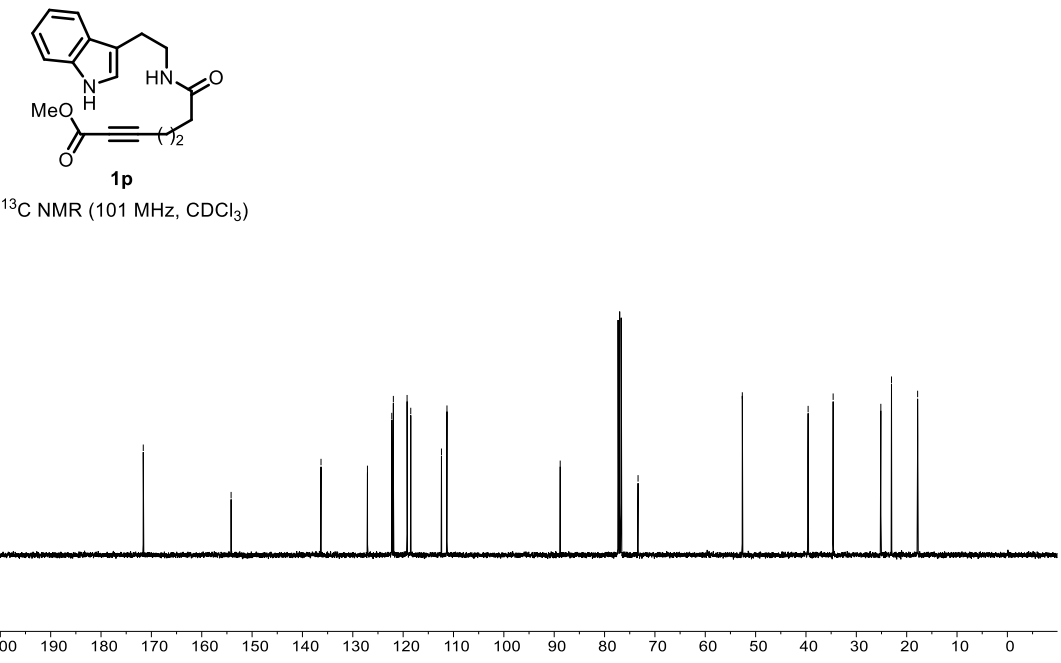
1o

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



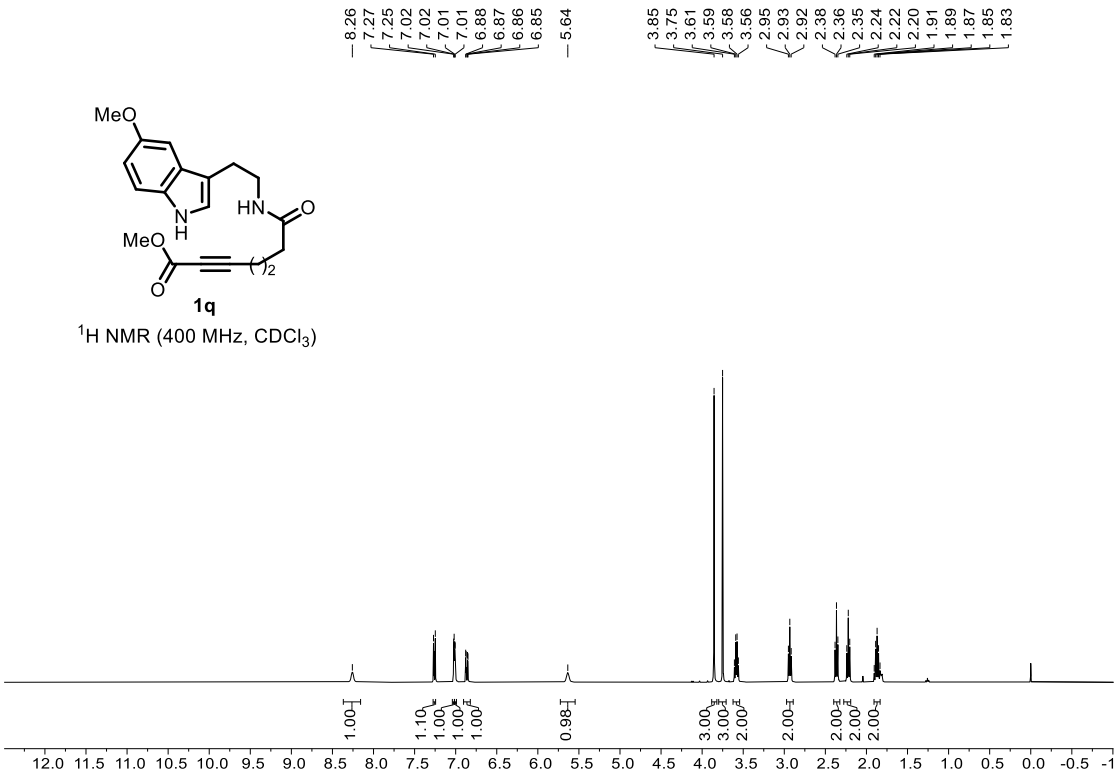
1p

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



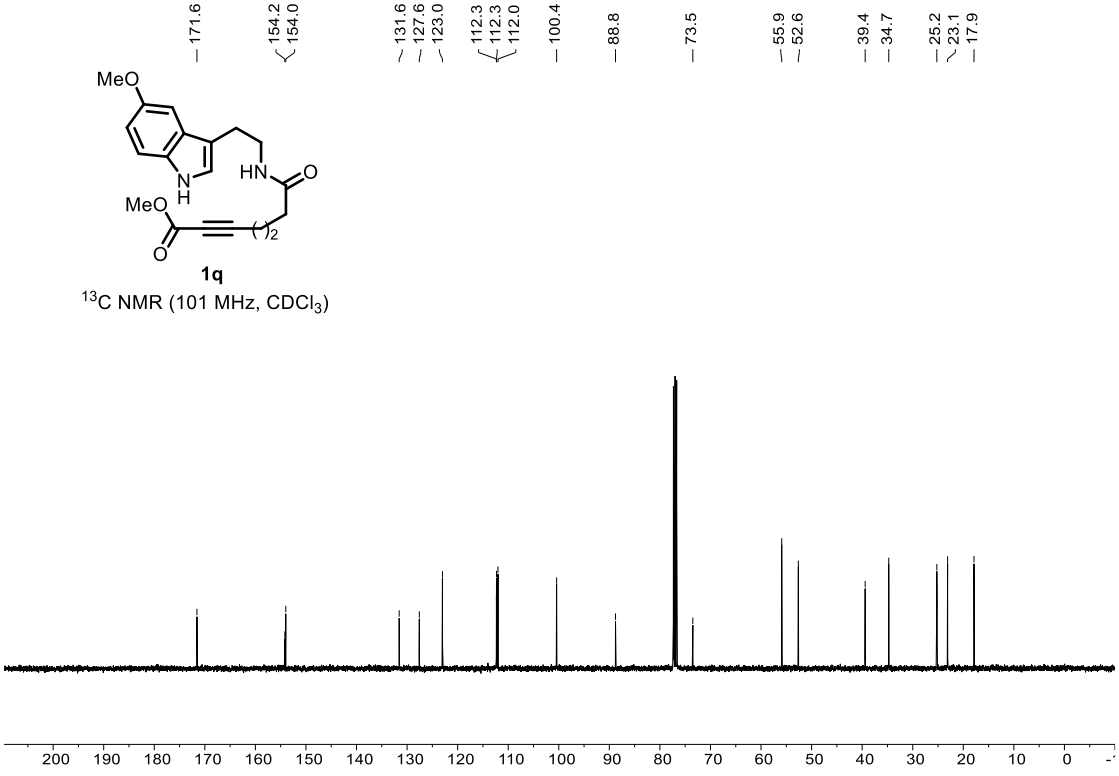
1p

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



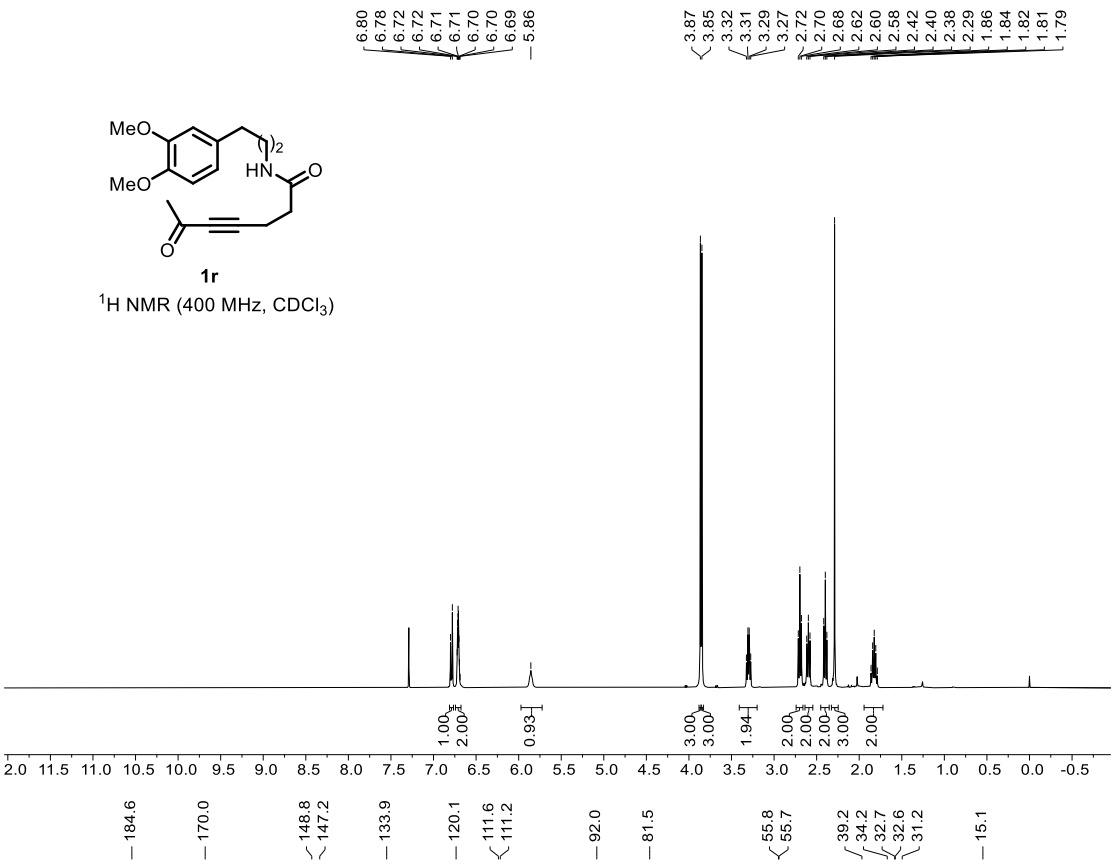
1q

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



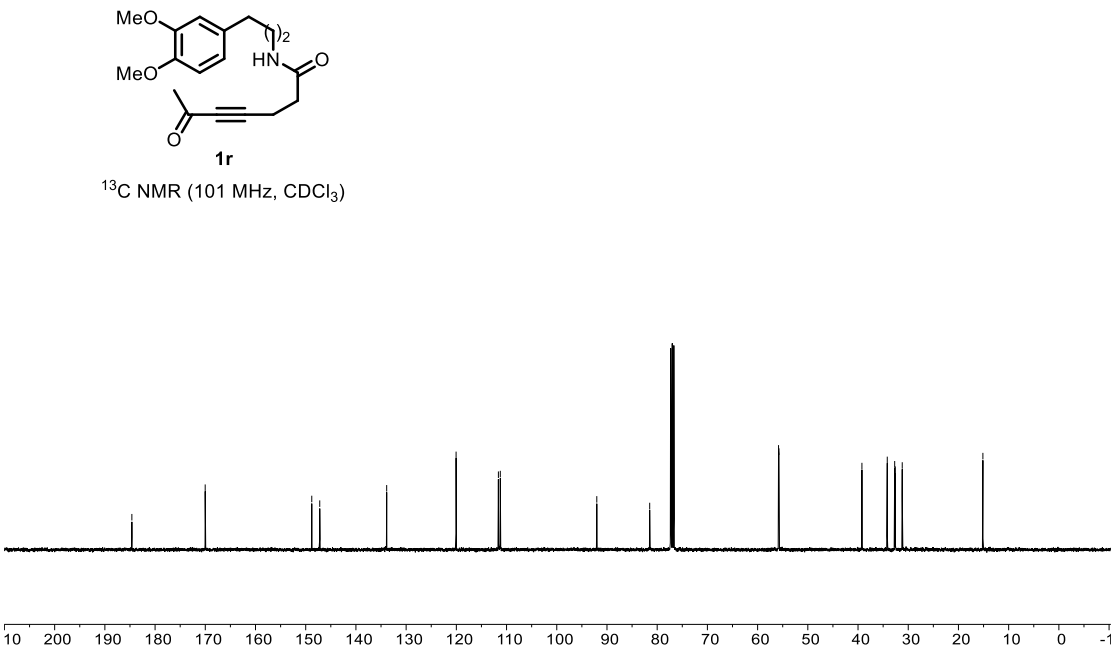
1q

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



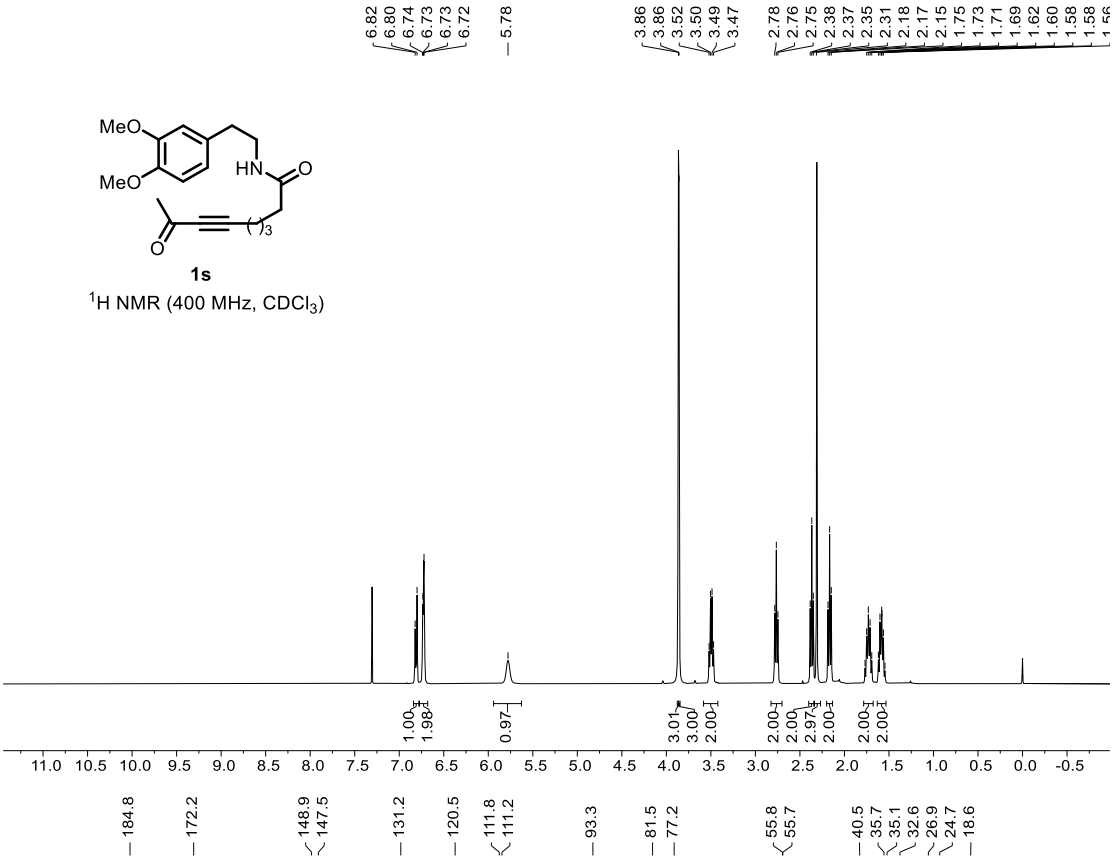
1r

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



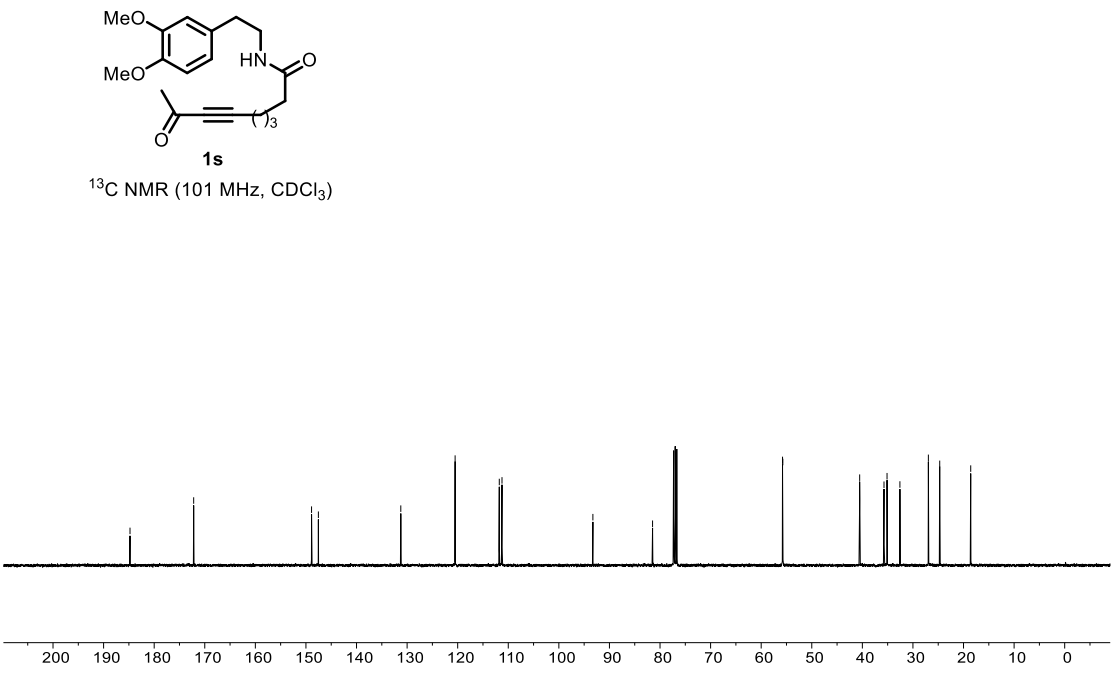
1r

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



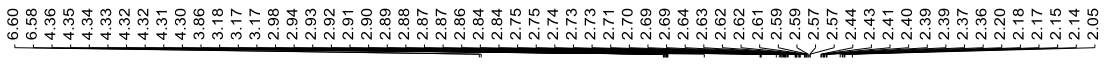
1s

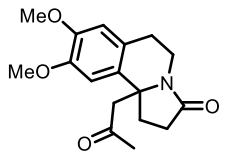
^{1}H NMR (400 MHz, $CDCl_3$)



1s

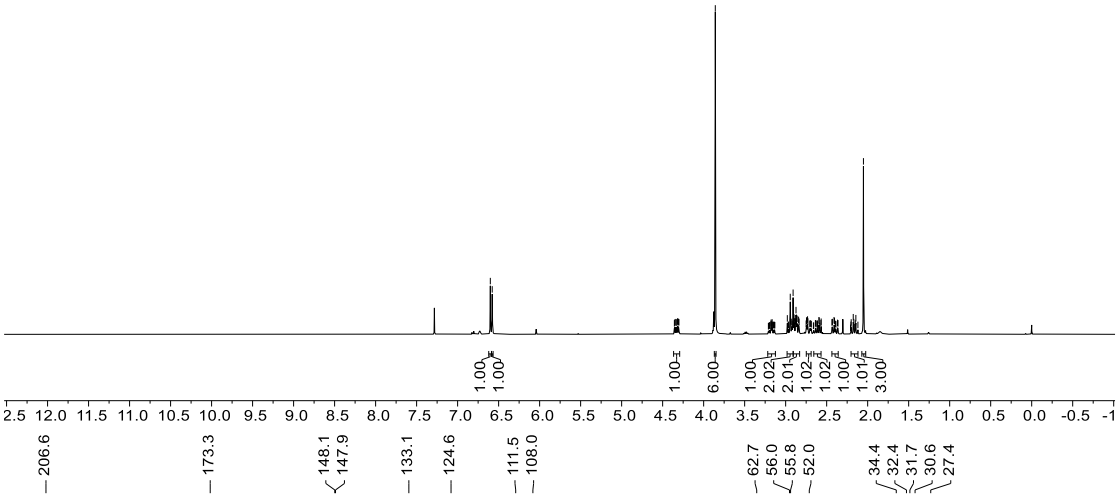
^{13}C NMR (101 MHz, $CDCl_3$)

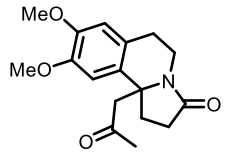




2a

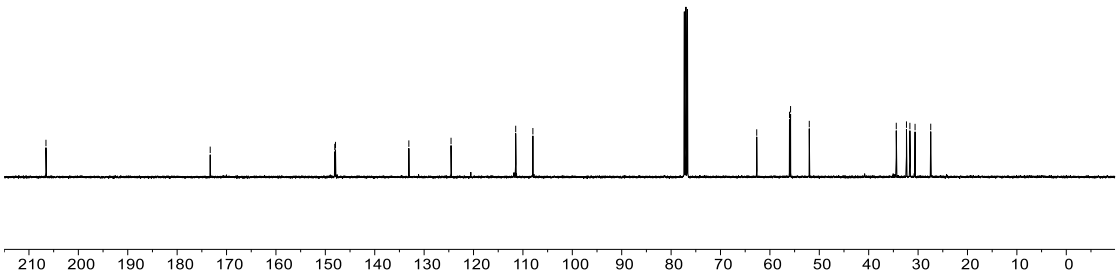
^{1}H NMR (400 MHz, $CDCl_3$)

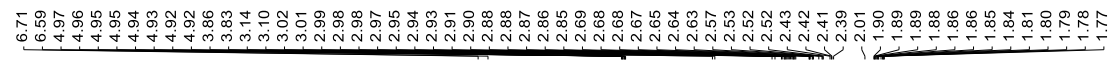


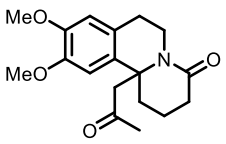


2a

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

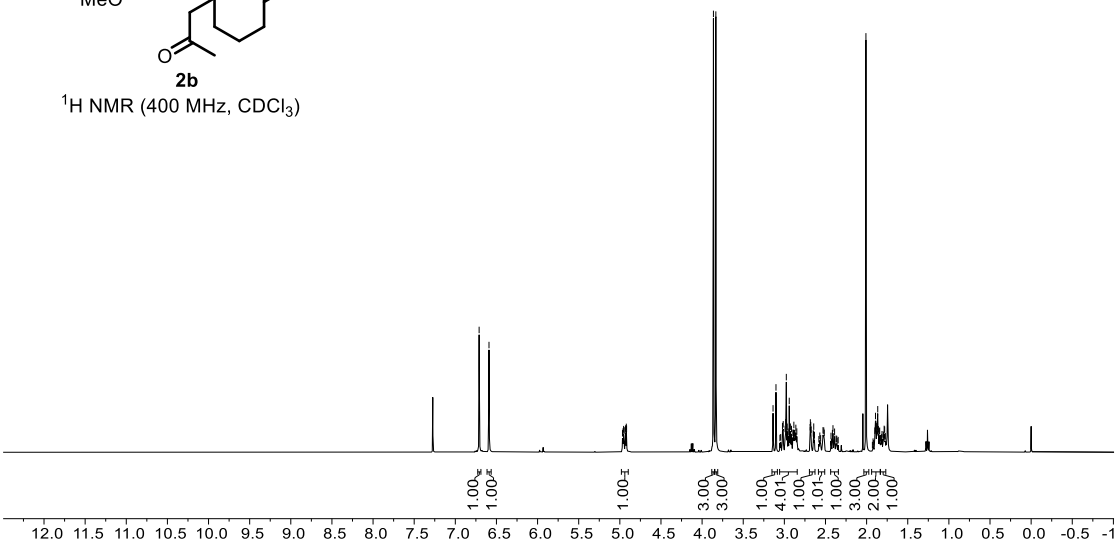


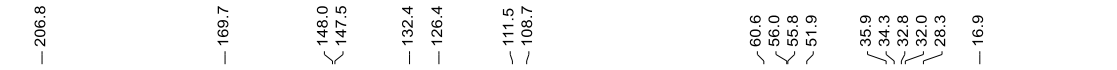


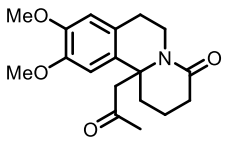


2b

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

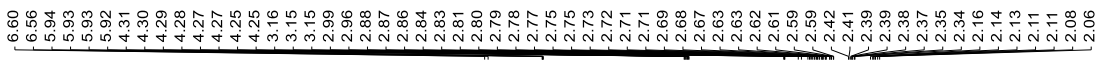


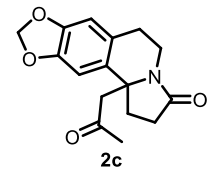




2b

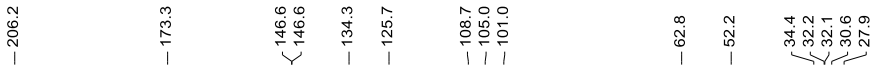
^{13}C NMR (101 MHz, $CDCl_3$)

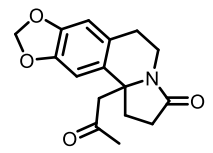




2c

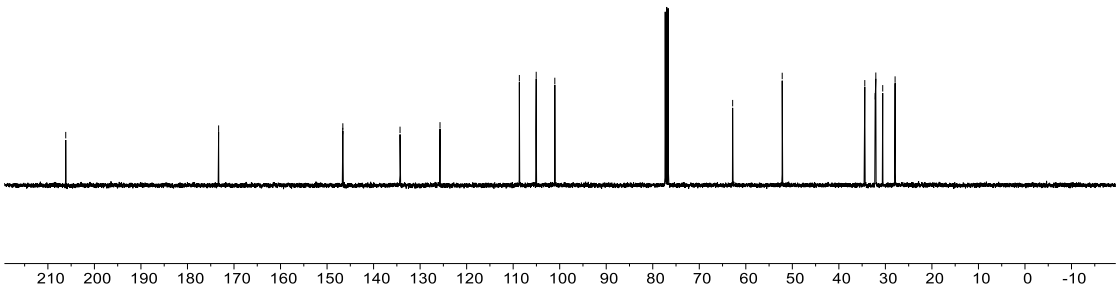
^{1}H NMR (400 MHz, $CDCl_3$)

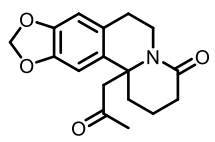




2c

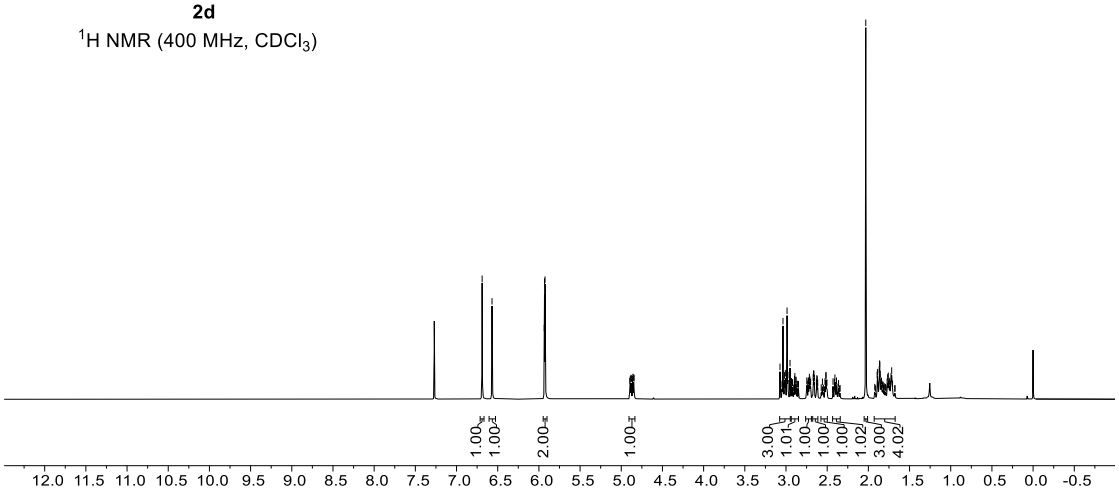
^{13}C NMR (101 MHz, $CDCl_3$)

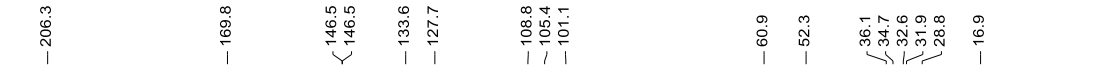


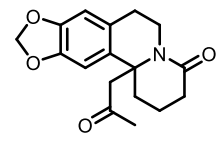


2d

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

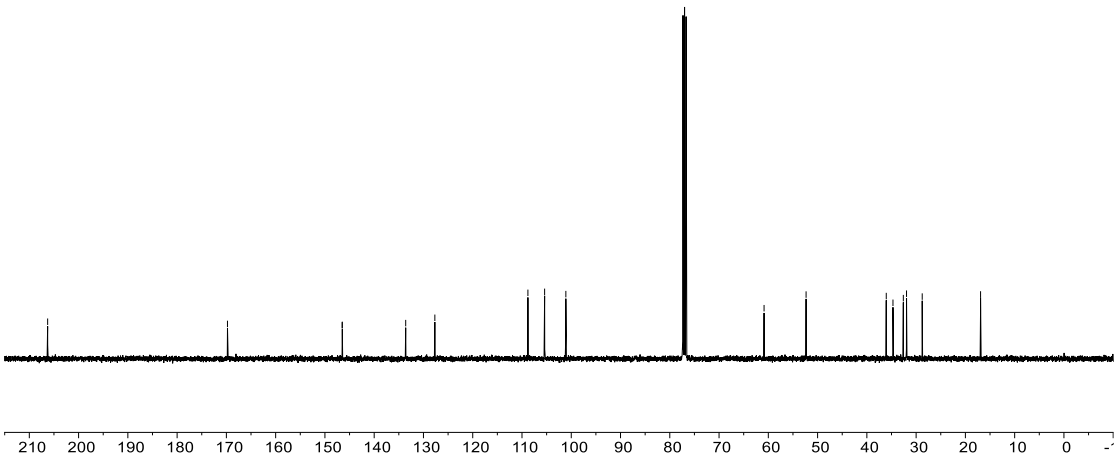


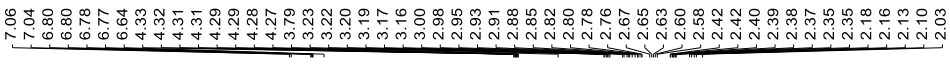


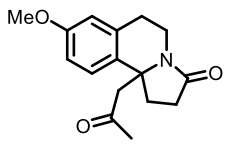


2d

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

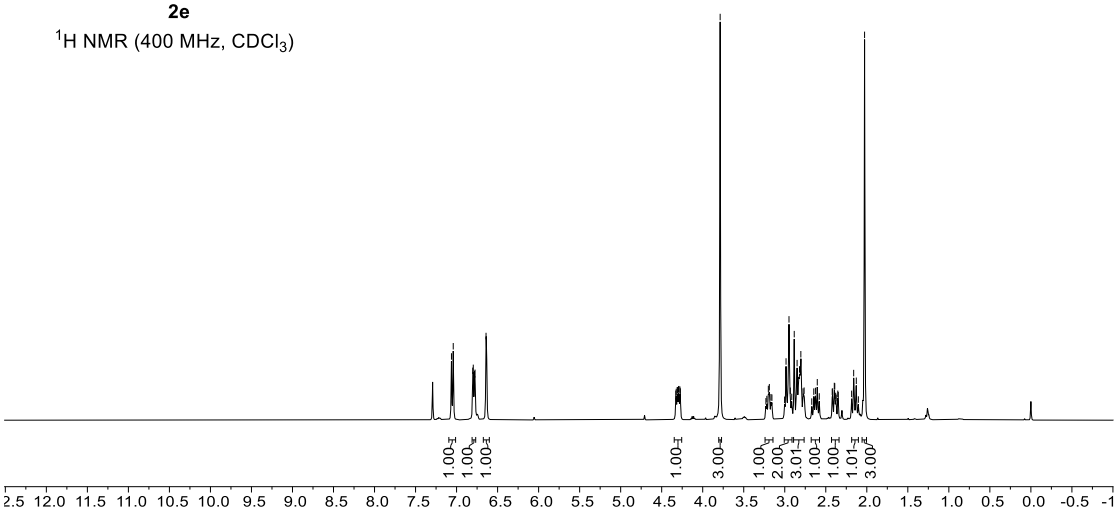


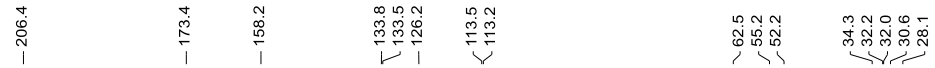


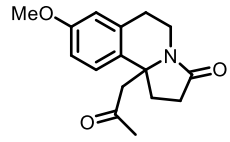


2e

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

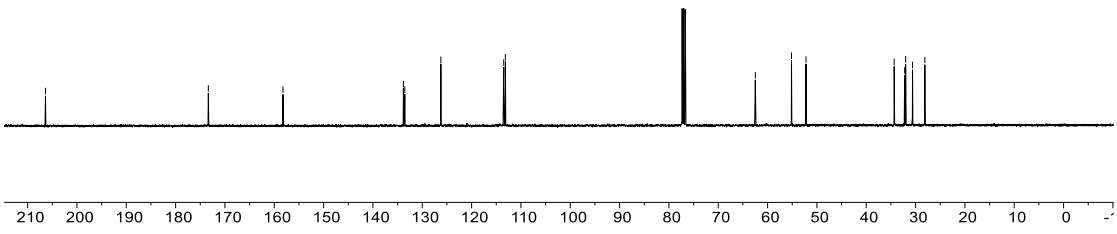


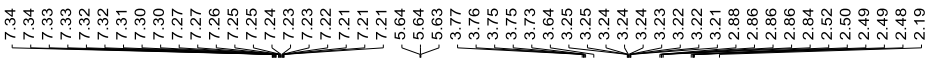


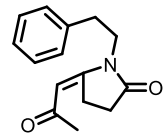


2e

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

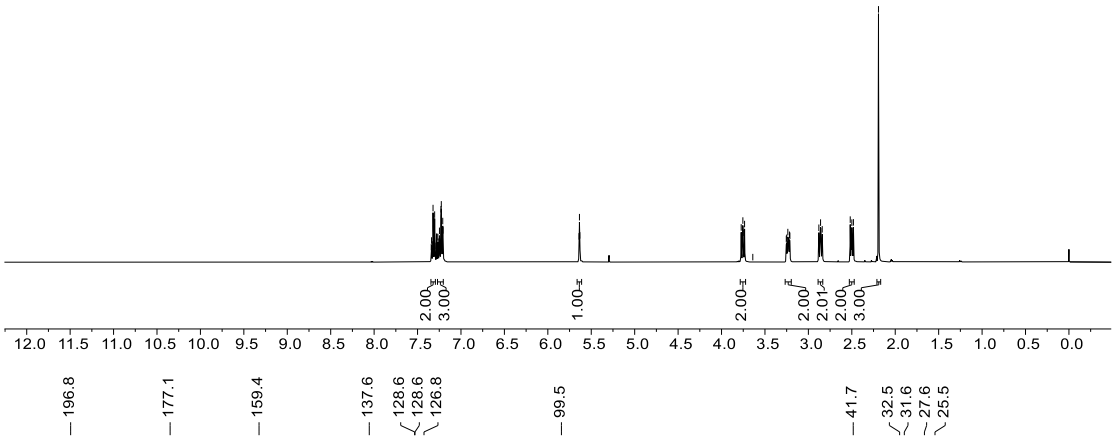


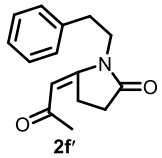




2f′

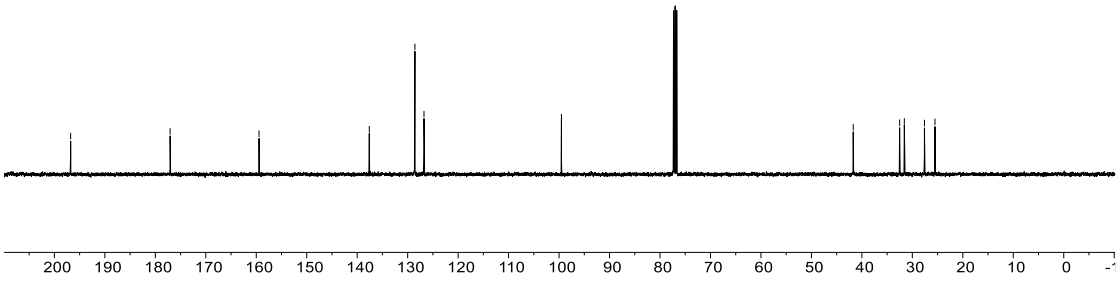
^{1}H NMR (400 MHz, $CDCl_3$)

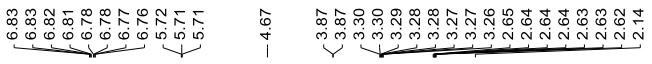


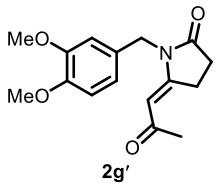


2f′

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

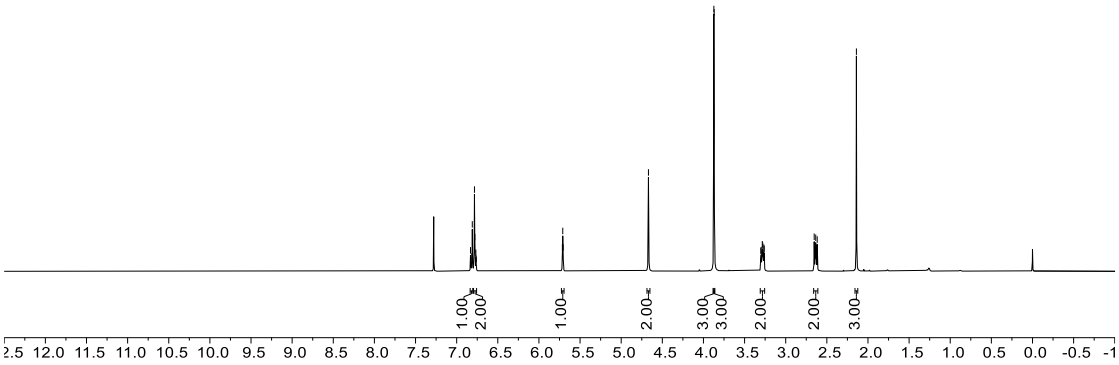


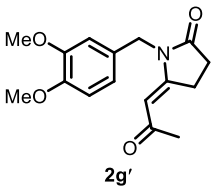




2g′

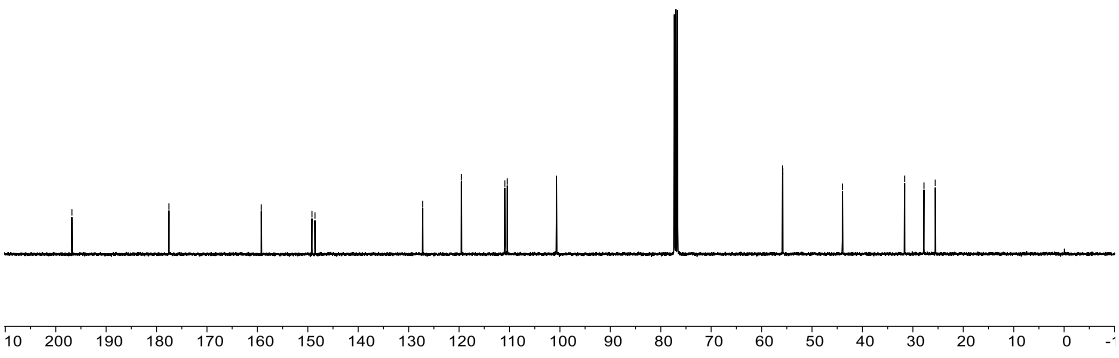
^{1}H NMR (400 MHz, $CDCl_3$)

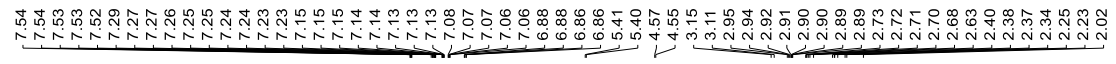


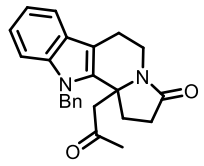


2g′

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

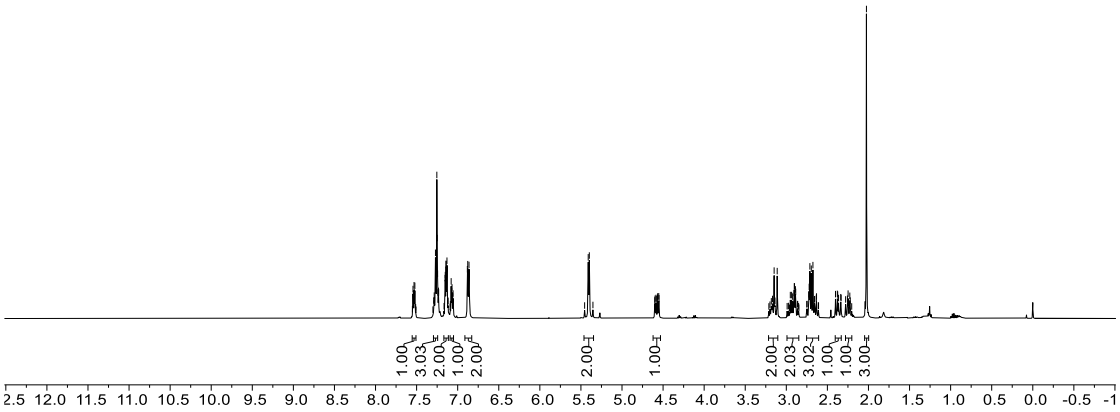


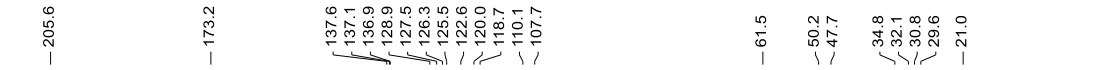


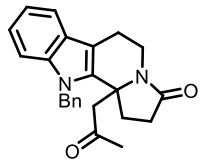


2h

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

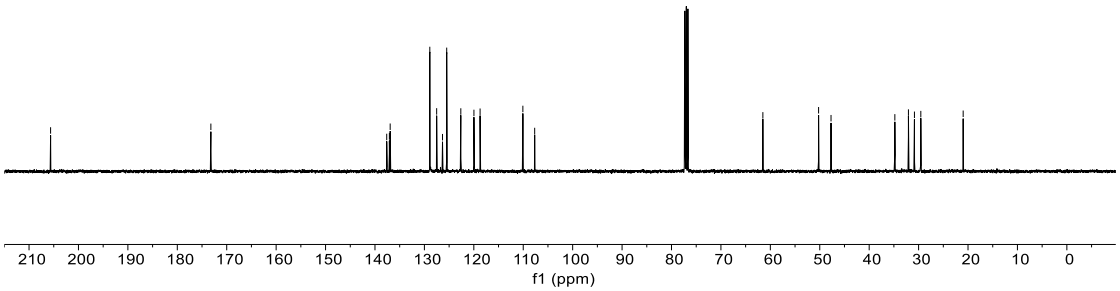


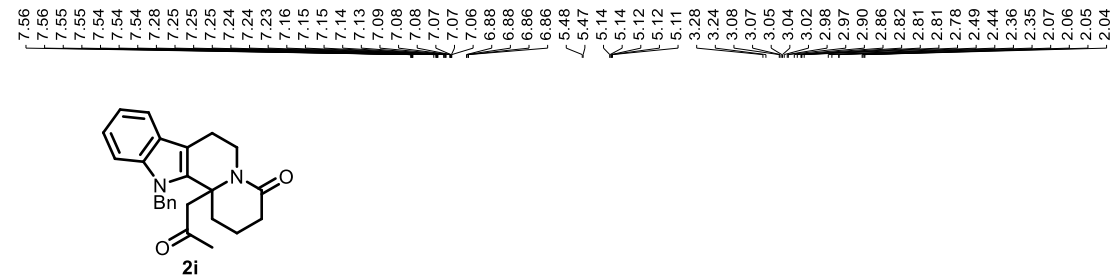




2h

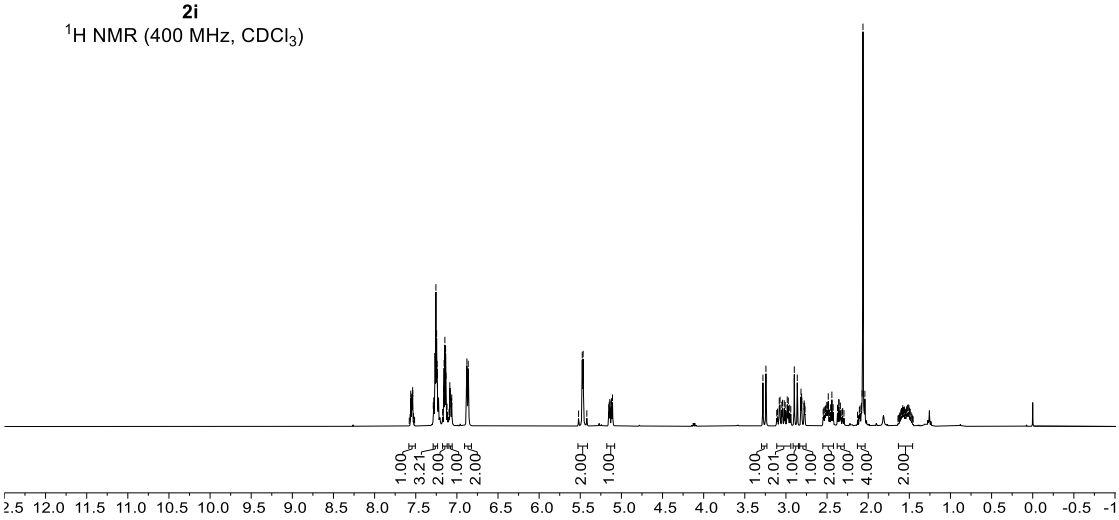
^{13}C NMR (101 MHz, $CDCl_3$)

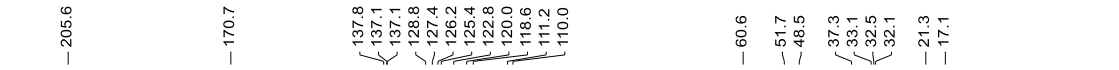


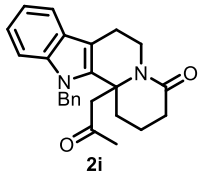


2i

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

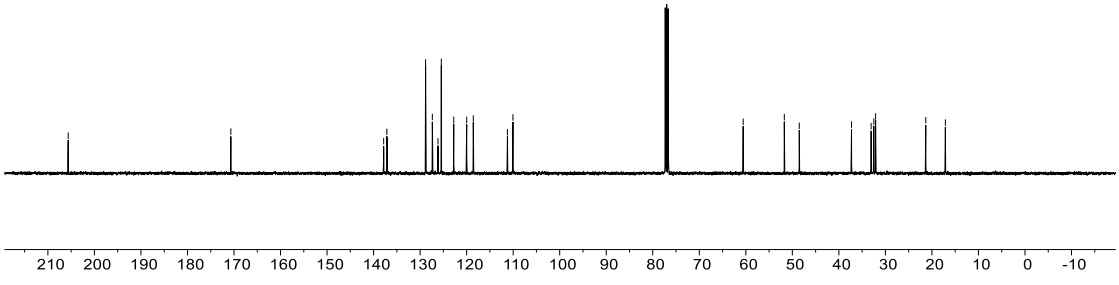


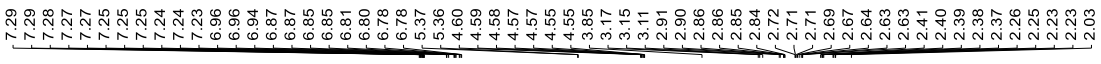


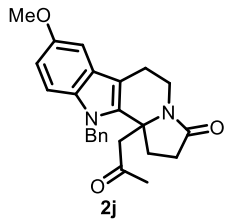


2i

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

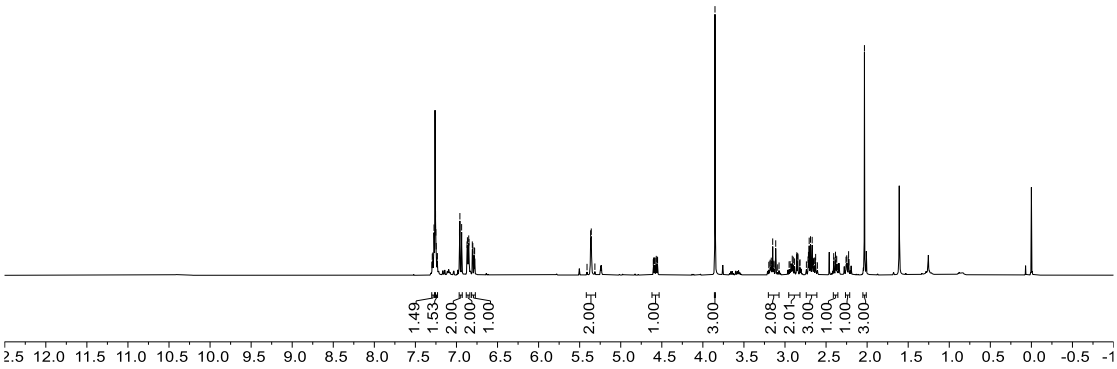


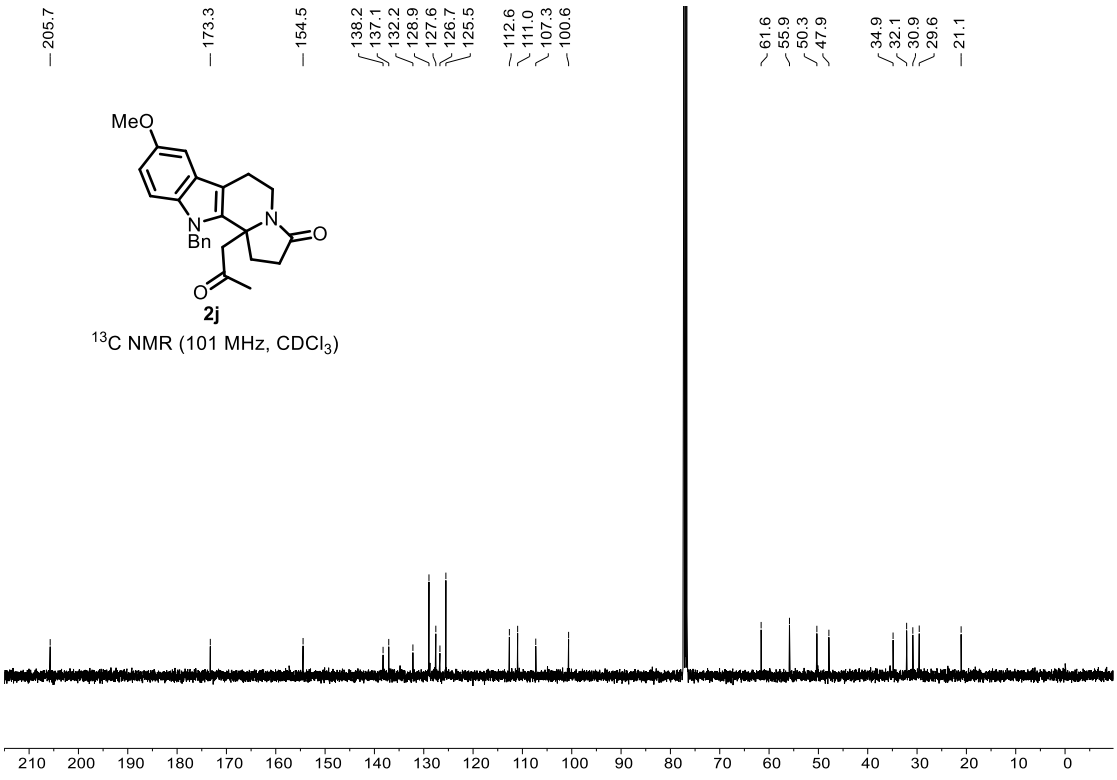




2j

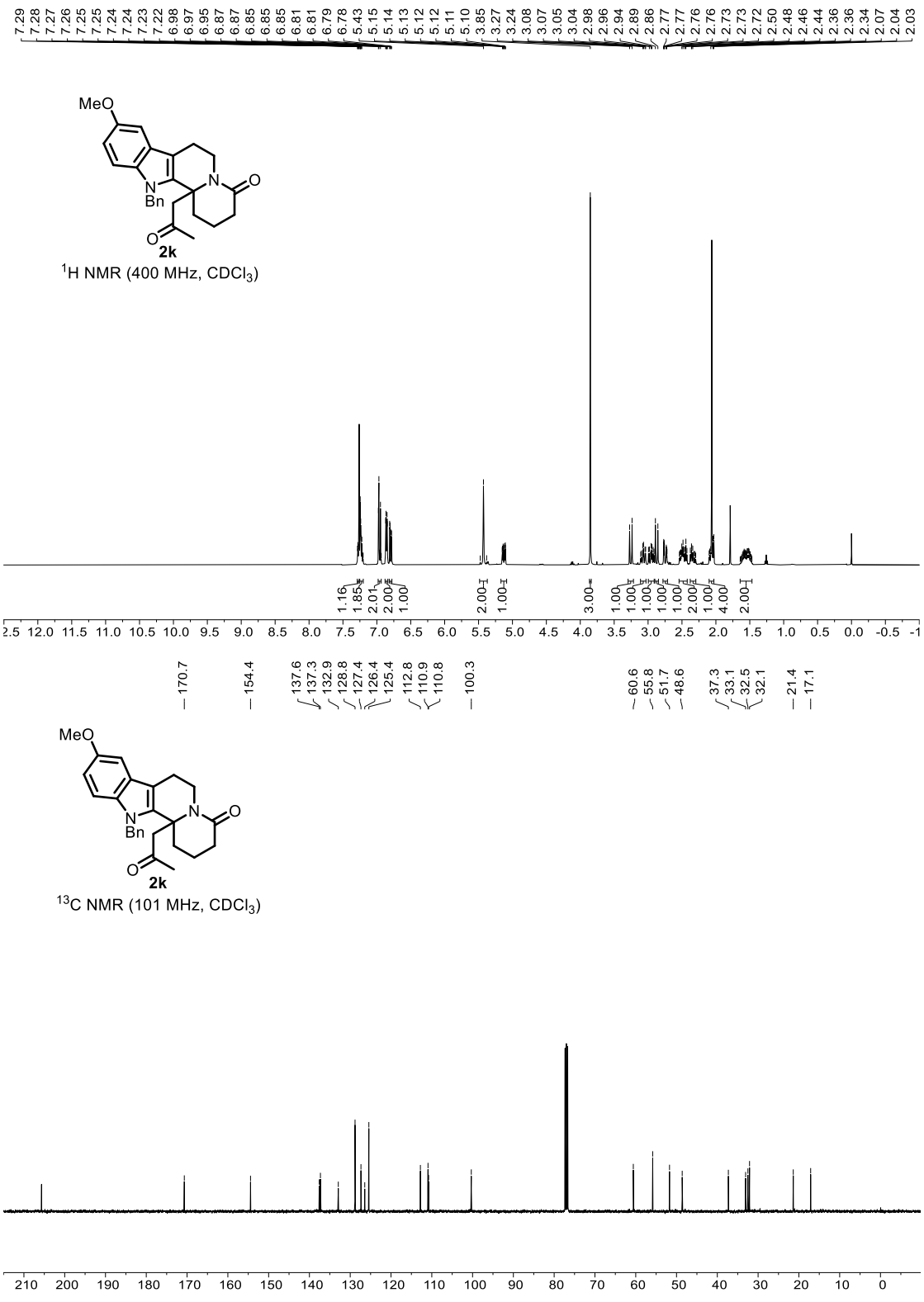
^{1}H NMR (400 MHz, $CDCl_3$)

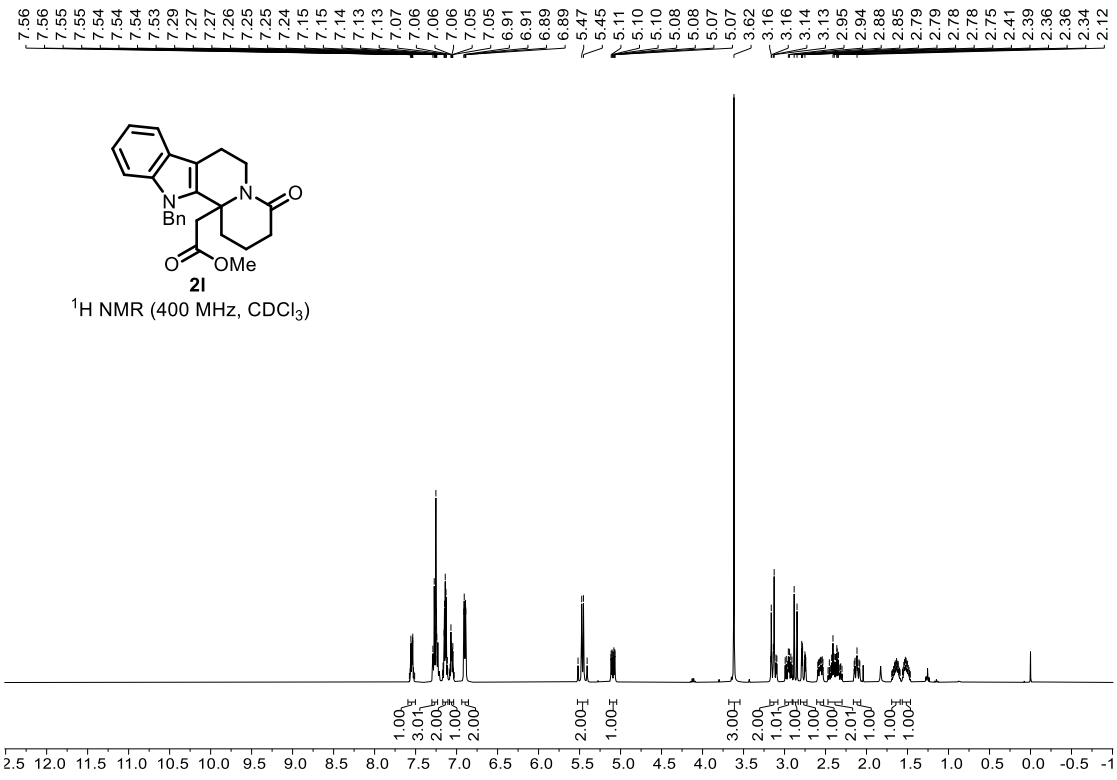




2j

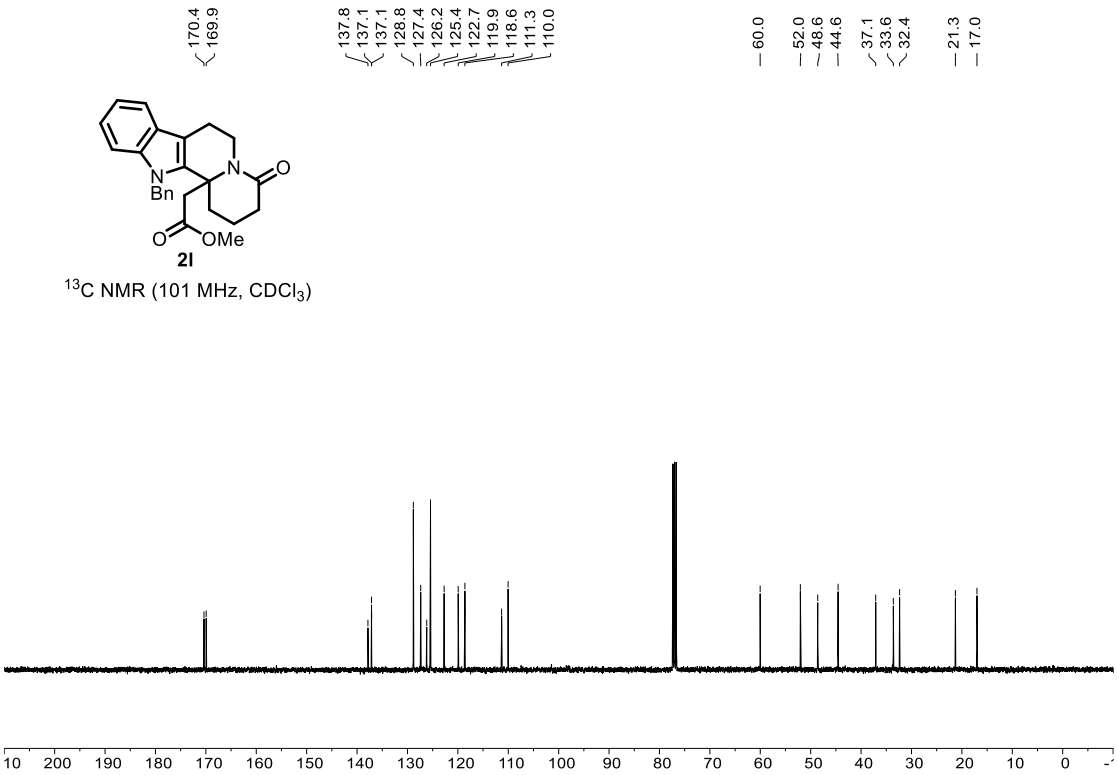
^{13}C NMR (101 MHz, $CDCl_3$)


7.29 7.28 7.27 7.26 7.25 7.25 7.24 7.24 7.23 7.22 6.98 6.97 6.95 6.87 6.87 6.85 6.85 6.85 6.81 6.81 6.79 6.78 5.43 5.15 5.14 5.13 5.12 5.12 5.11 5.10 3.85 3.27 3.24 3.08 3.07 3.05 3.04 2.98 2.96 2.94 2.89 2.86 2.77 2.77 2.76 2.76 2.73 2.73 2.72 2.50 2.48 2.46 2.44 2.36 2.36 2.34 2.07 2.04 2.03
MeO
N
Bn
N
O
O
2k
1H NMR (400 MHz, CDCl3)
1.16 1.85 2.01 2.00 1.00 2.00 1.00 3.00 1.00 1.00 1.00 1.00 2.00 1.00 4.00 2.00
2.5 12.0 11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1
170.7 154.4 137.6 137.3 132.9 128.8 127.4 126.4 125.4 112.8 110.9 110.8 100.3 60.6 55.8 51.7 48.6 37.3 33.1 32.5 32.1 21.4 17.1
MeO
N
Bn
N
O
O
2k
13C NMR (101 MHz, CDCl3)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0



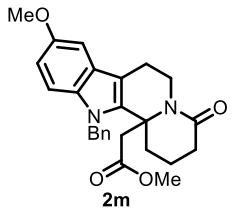
2l

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



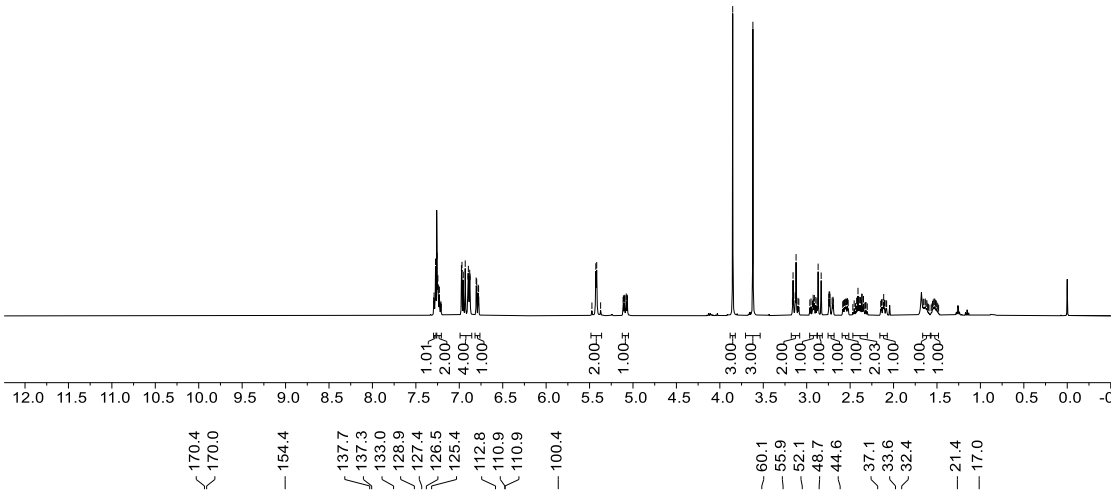
2l

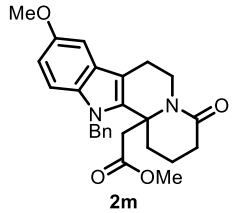
^{13}C NMR (101 MHz, $CDCl_3$)



2m

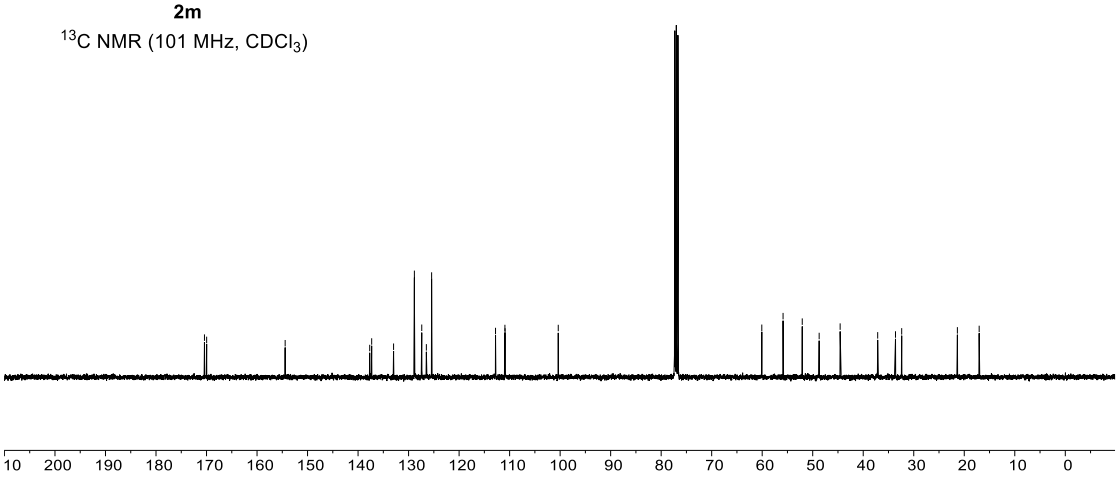
^{1}H NMR (400 MHz, $CDCl_3$)

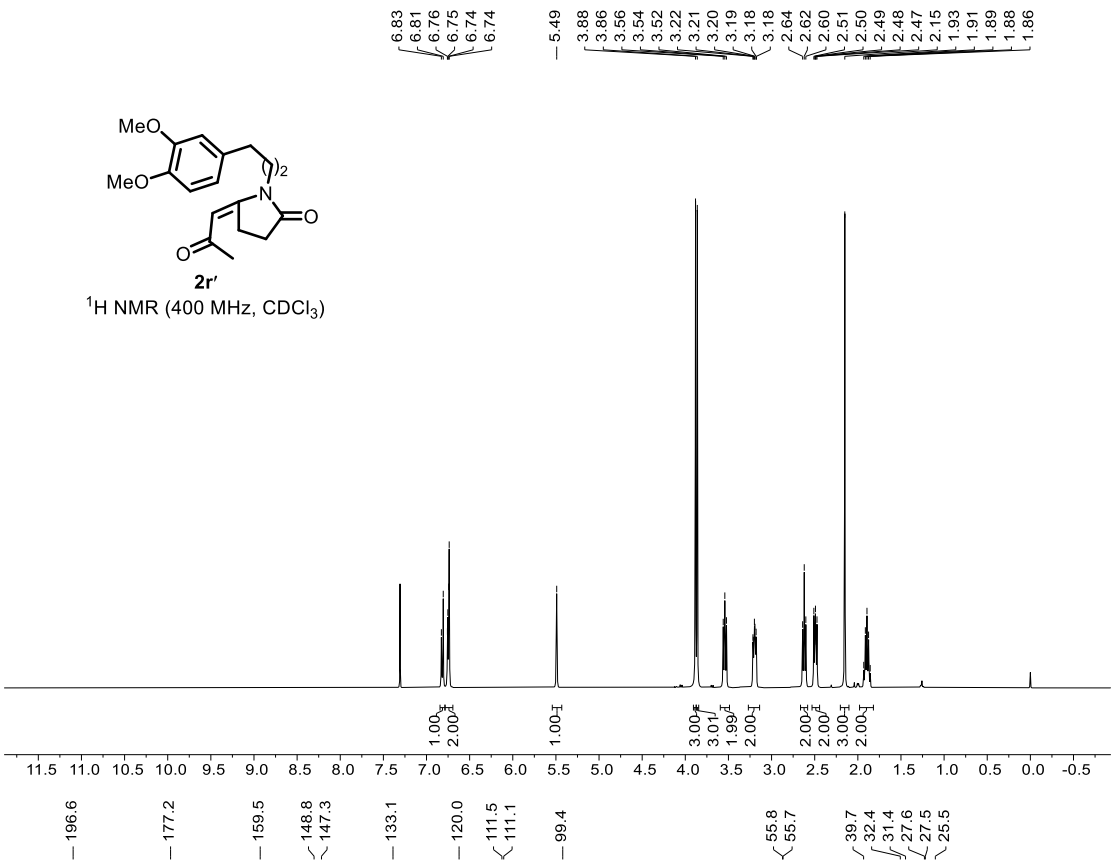


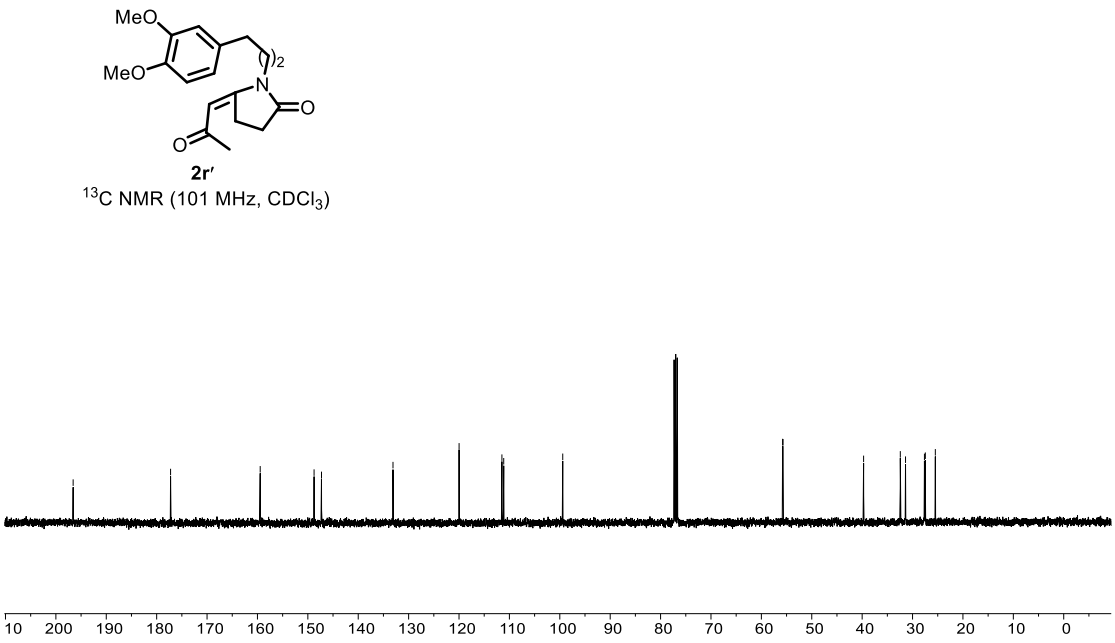


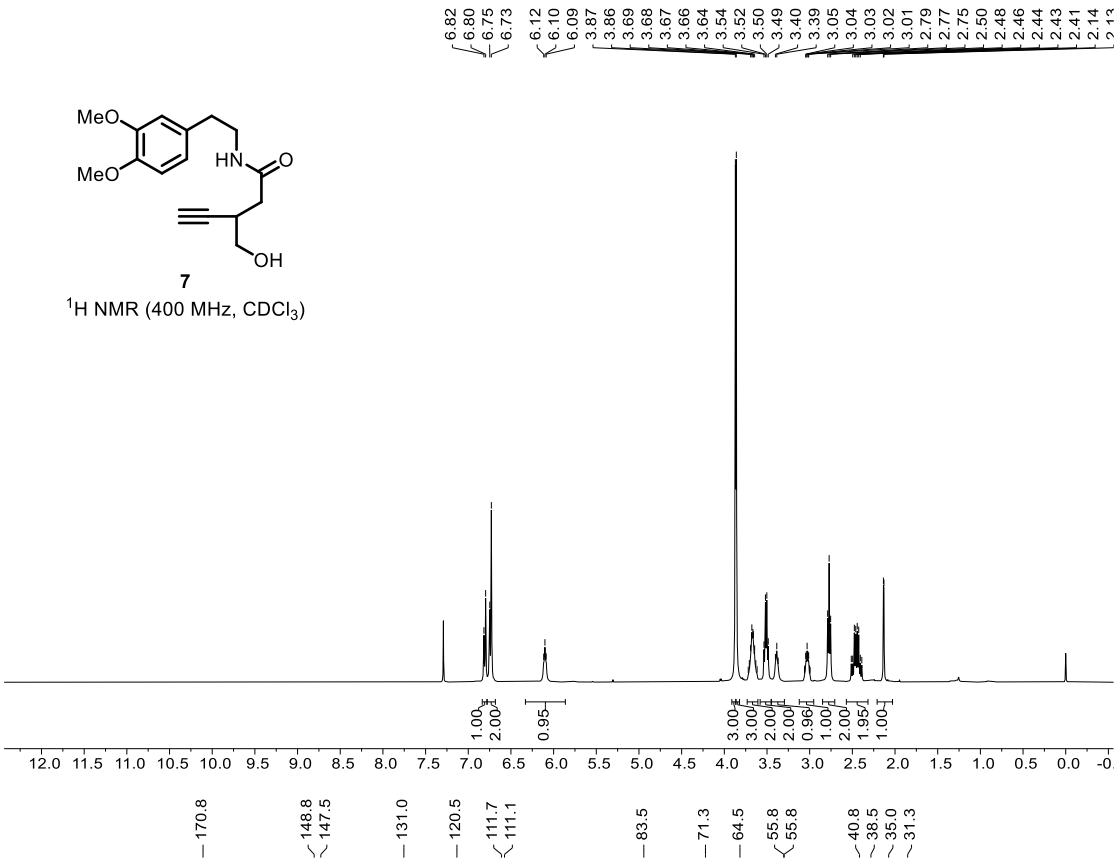
2m

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



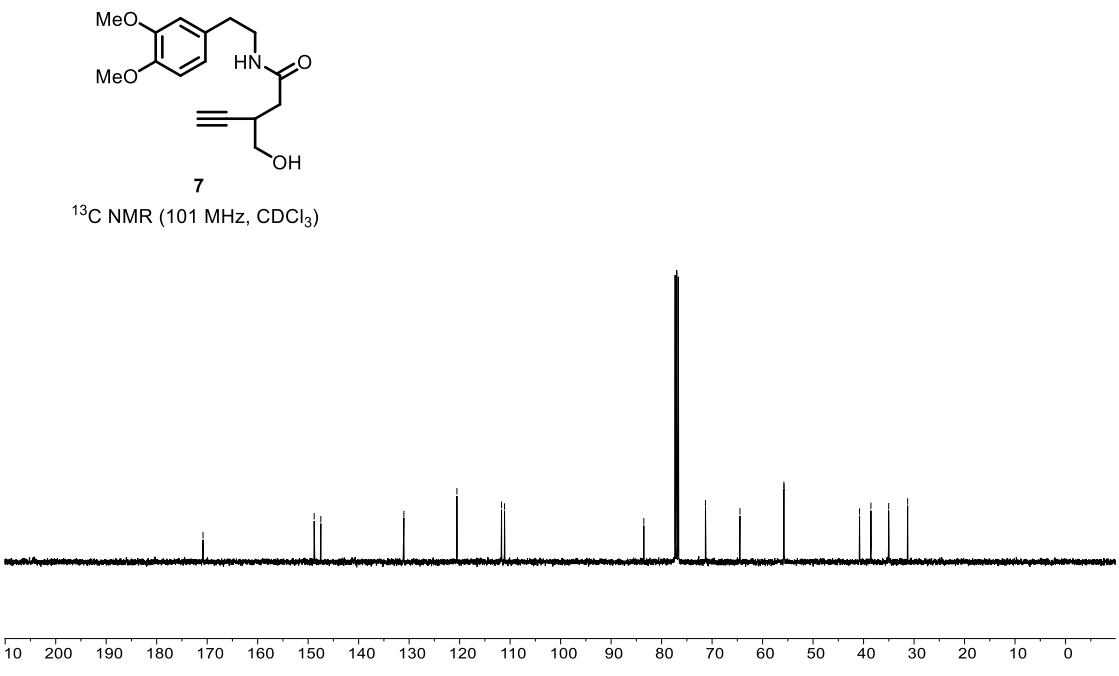

6.83
6.81
6.76
6.75
6.74
6.74
5.49
3.88
3.86
3.56
3.54
3.52
3.22
3.21
3.20
3.19
3.18
3.18
2.64
2.62
2.60
2.51
2.50
2.49
2.48
2.47
2.15
1.93
1.91
1.89
1.88
1.86
MeO
MeO
N
O
O
2r′
1H NMR (400 MHz, CDCl3)
1.00
2.00
1.00
3.00
3.01
1.99
2.00
2.00
2.00
3.00
2.00
11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5


196.6
177.2
159.5
148.8
147.3
133.1
120.0
111.5
111.1
99.4
55.8
55.7
39.7
32.4
31.4
27.6
27.5
25.5
MeO
MeO
N
O
O
2r′
13C NMR (101 MHz, CDCl3)
10 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0



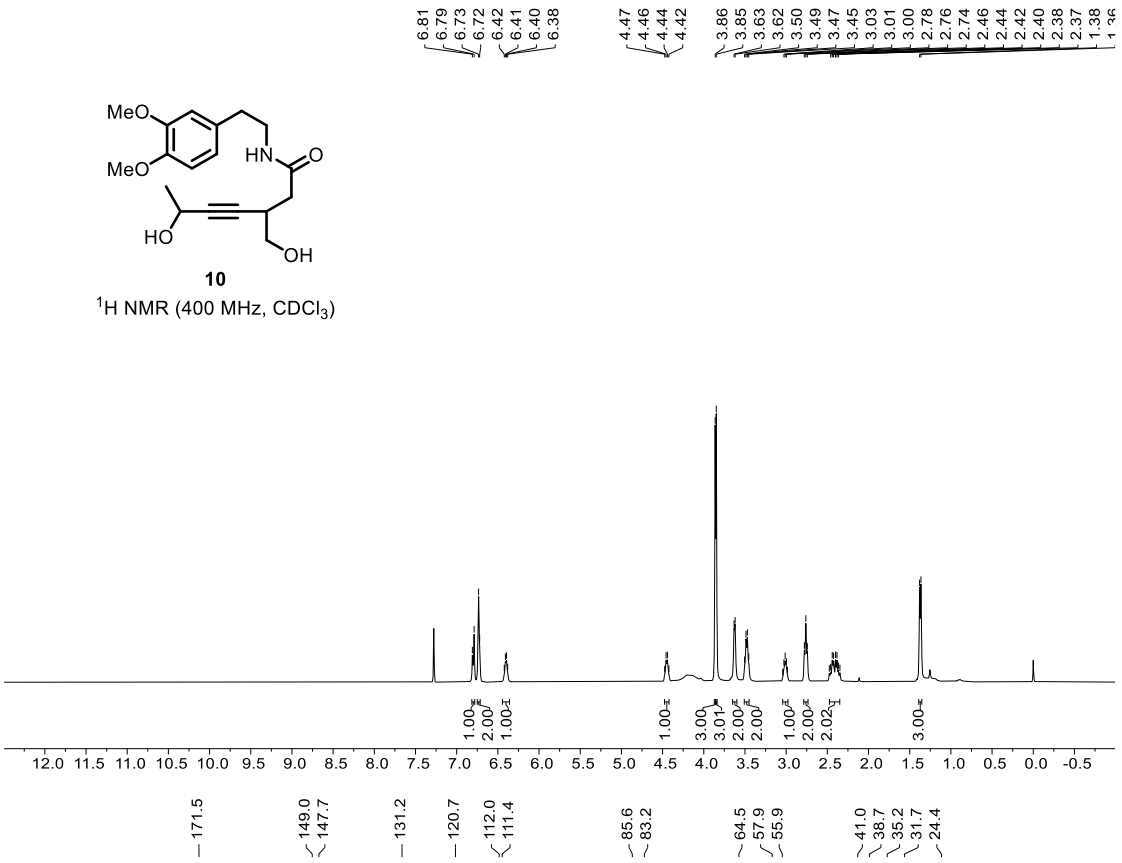
7

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



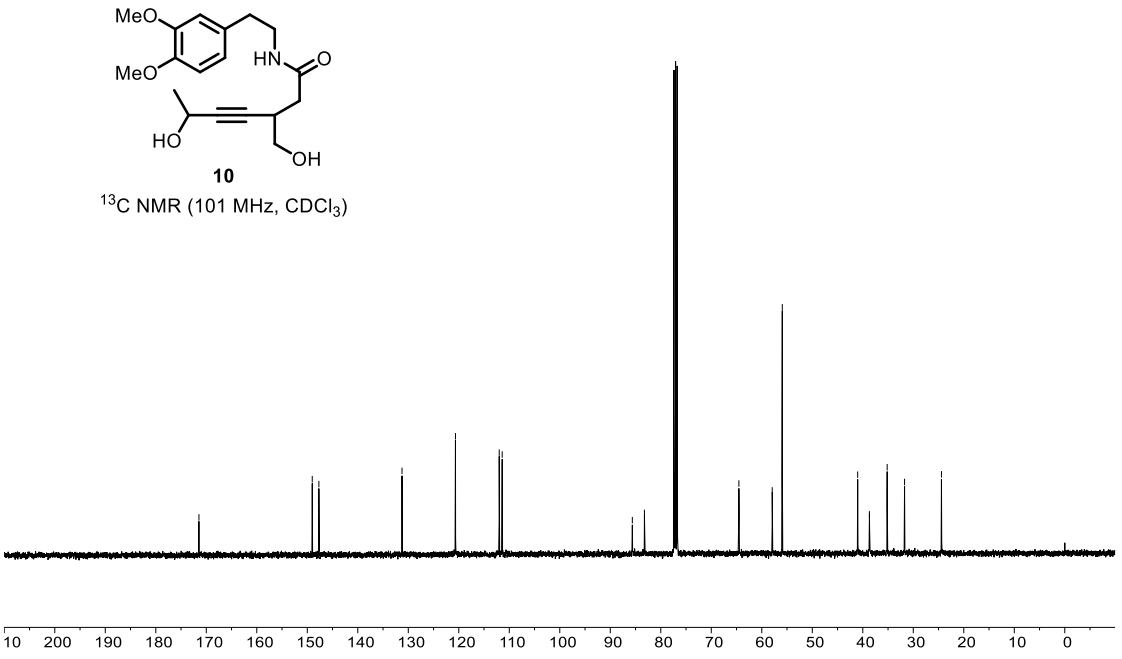
7

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



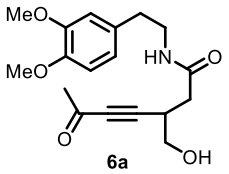
10

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



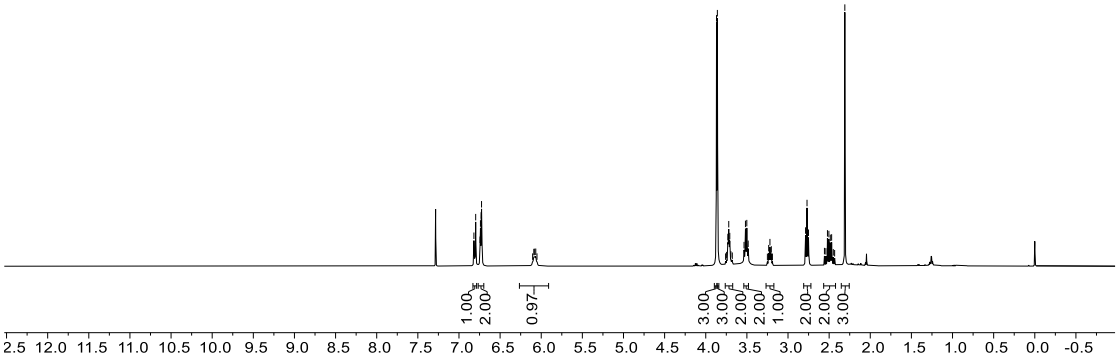
10

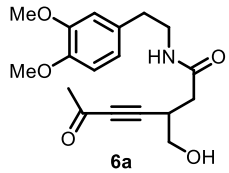
^{13}C NMR (101 MHz, $CDCl_3$)



6a

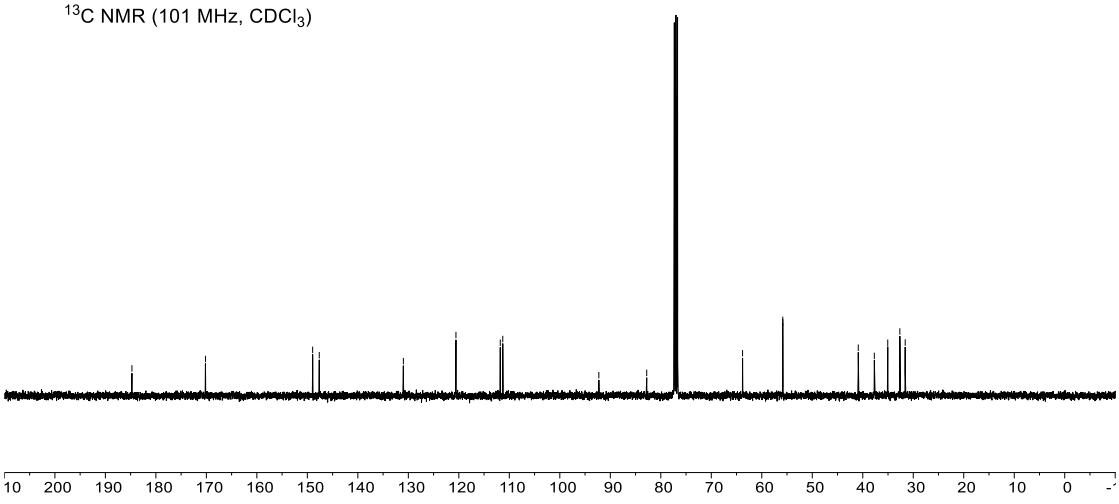
^{1}H NMR (400 MHz, $CDCl_3$)

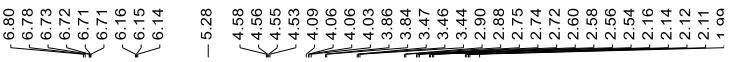


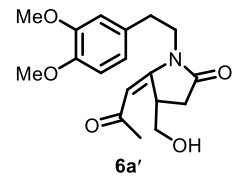


6a

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

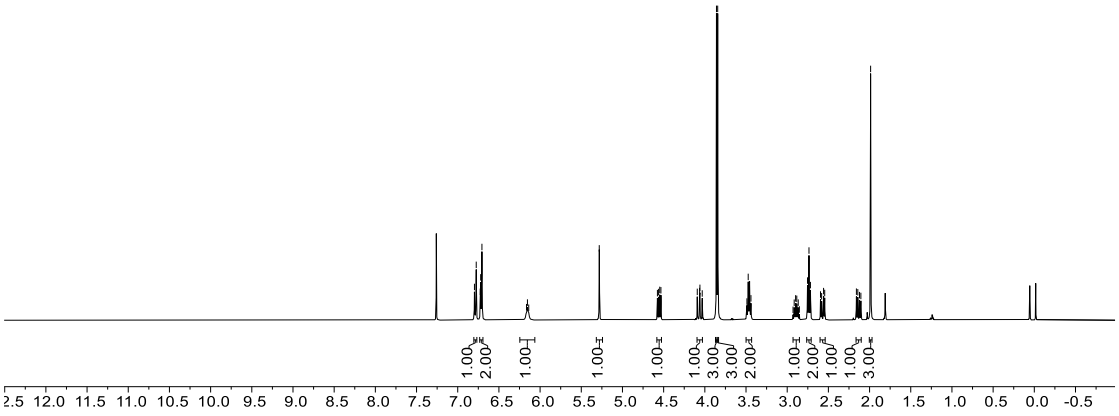


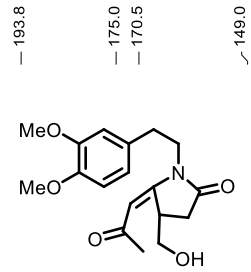




6a′

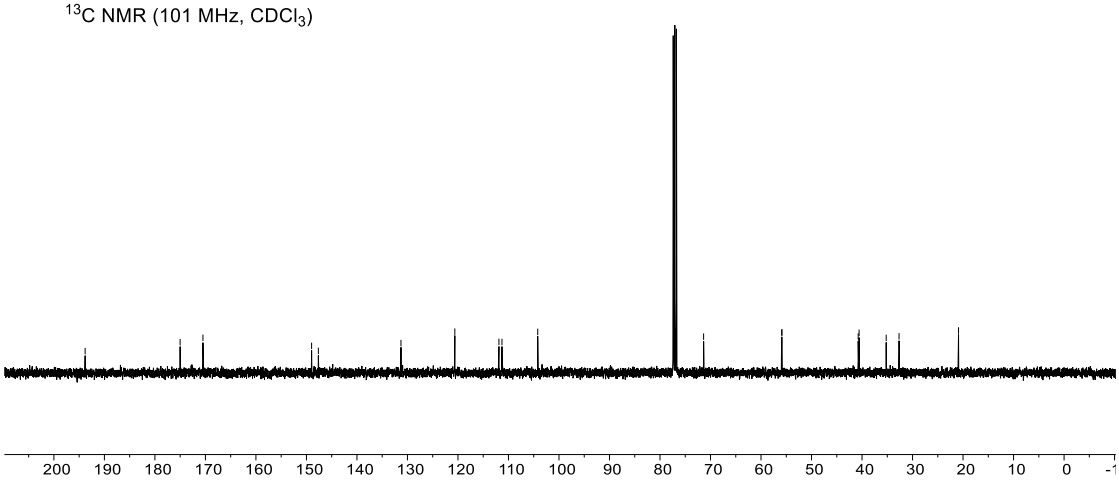
^{1}H NMR (400 MHz, $CDCl_3$)

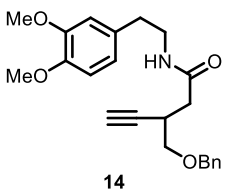




6a′

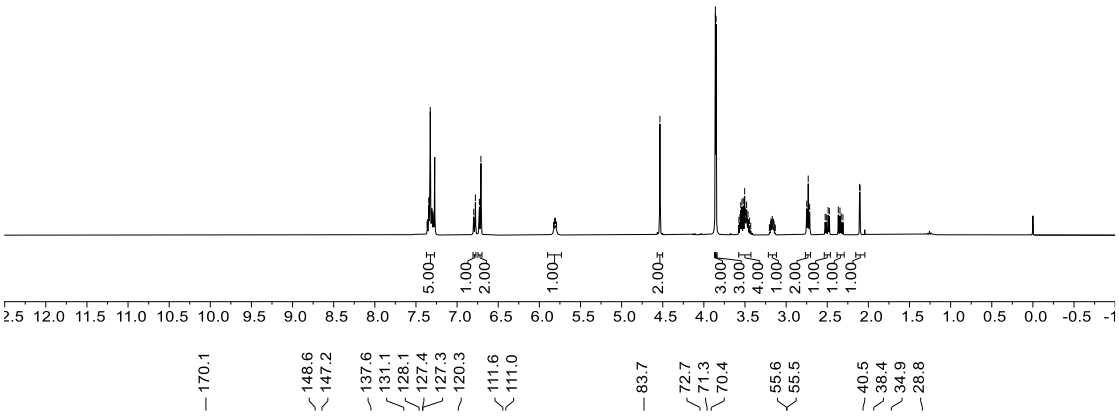
^{13}C NMR (101 MHz, $CDCl_3$)

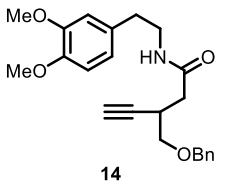




14

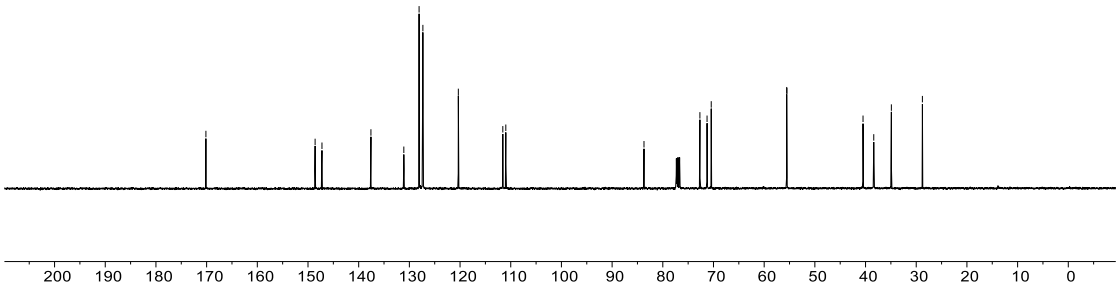
^{1}H NMR (400 MHz, $CDCl_3$)

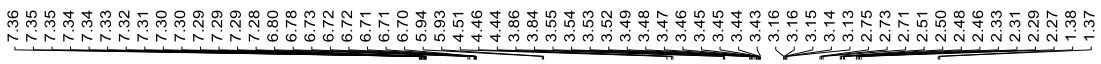


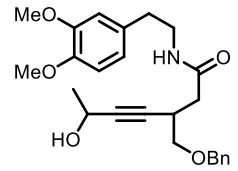


14

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

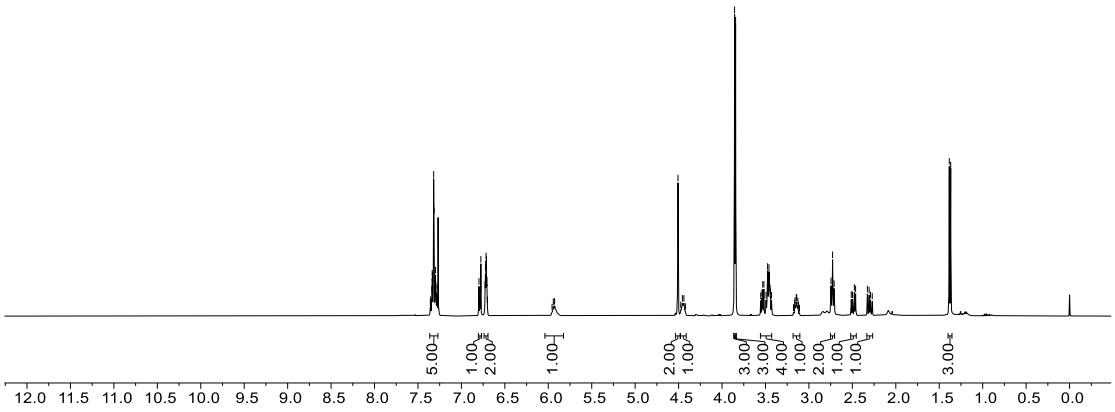


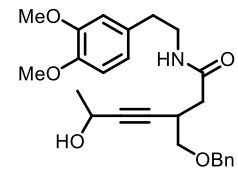




15

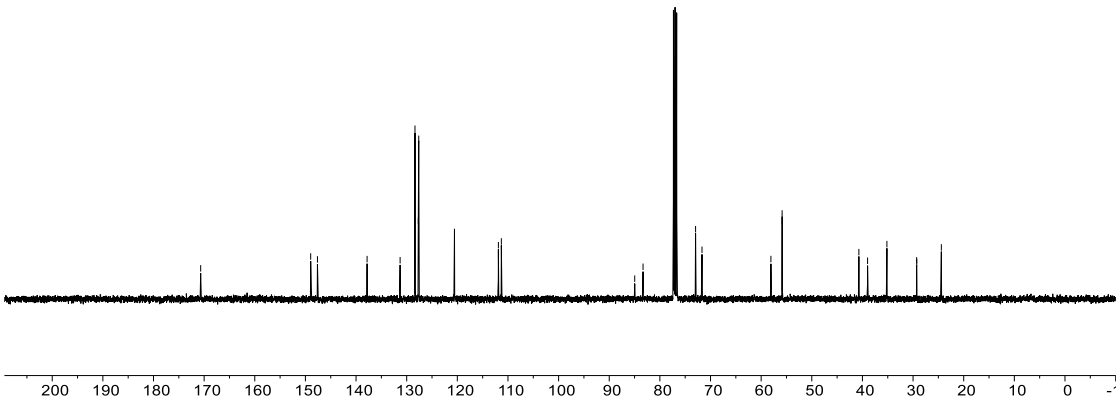
^{1}H NMR (400 MHz, $CDCl_3$)

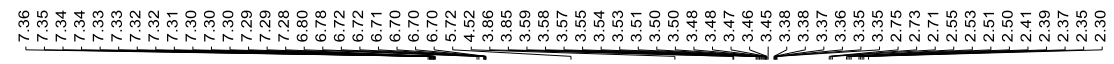


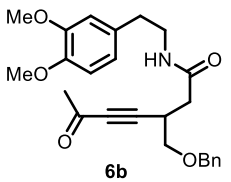


15

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

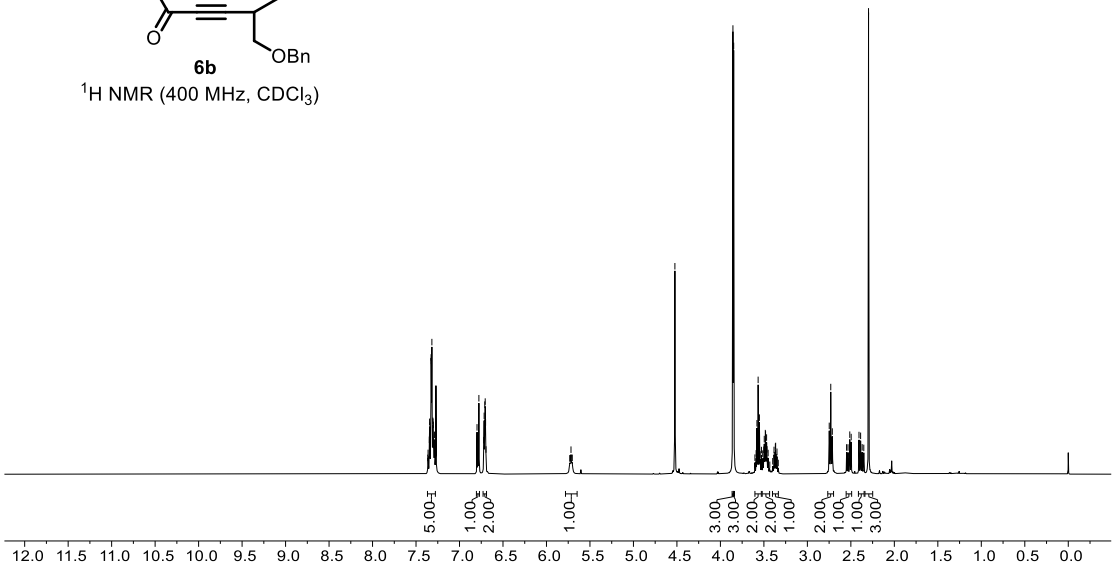


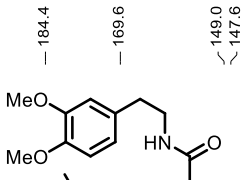




6b

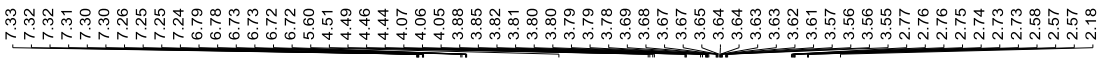
^{1}H NMR (400 MHz, $CDCl_3$)

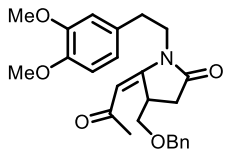




6b

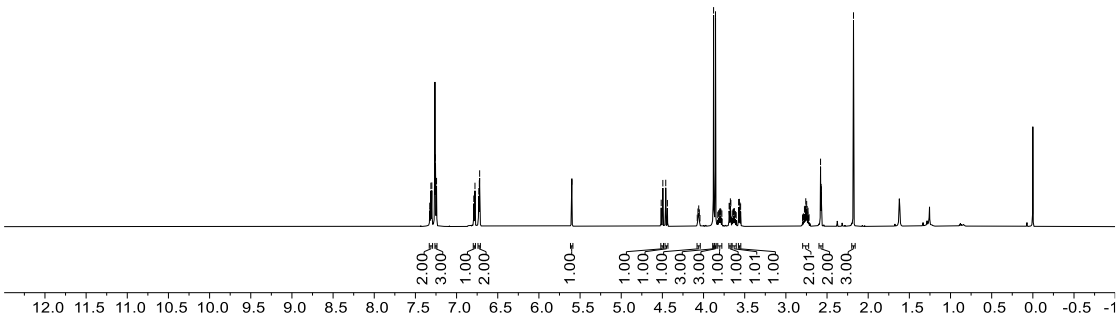
^{13}C NMR (101 MHz, $CDCl_3$)

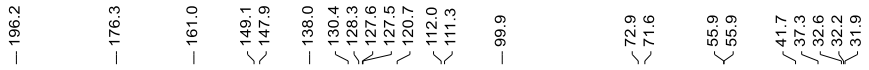


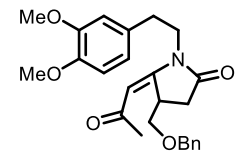


6b′

^{1}H NMR (600 MHz, $CDCl_3$)

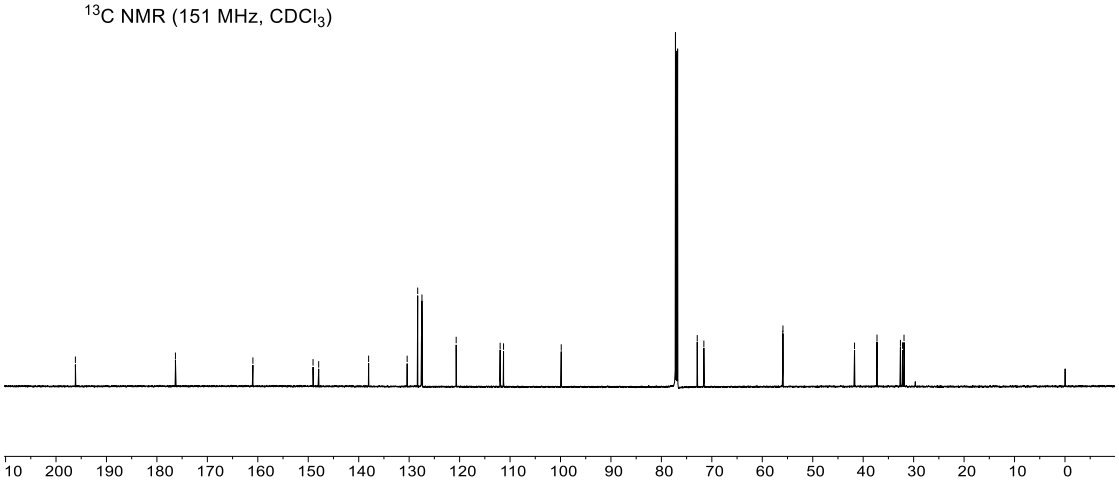


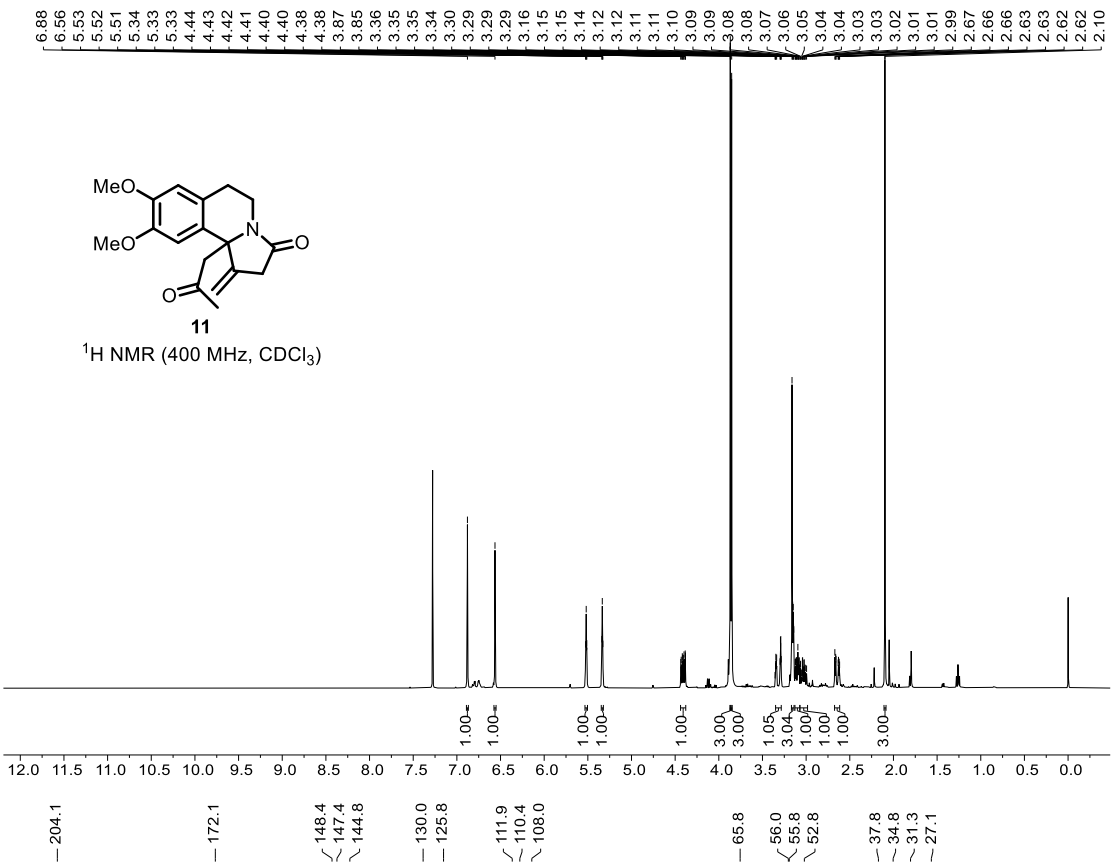




6b′

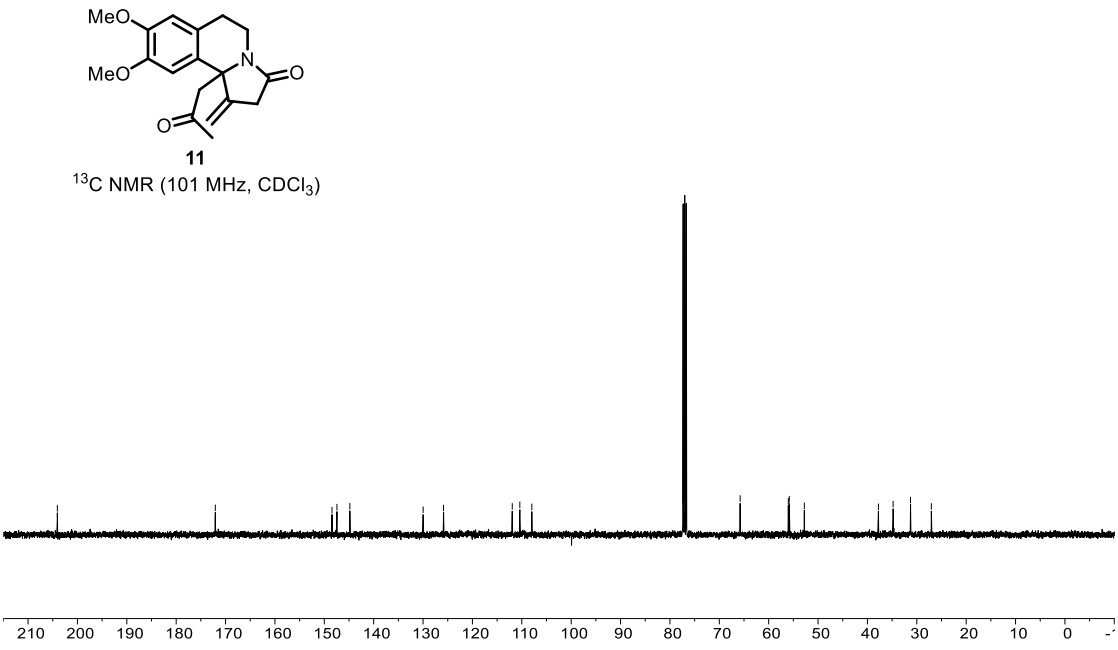
^{13}C NMR (151 MHz, $CDCl_3$)





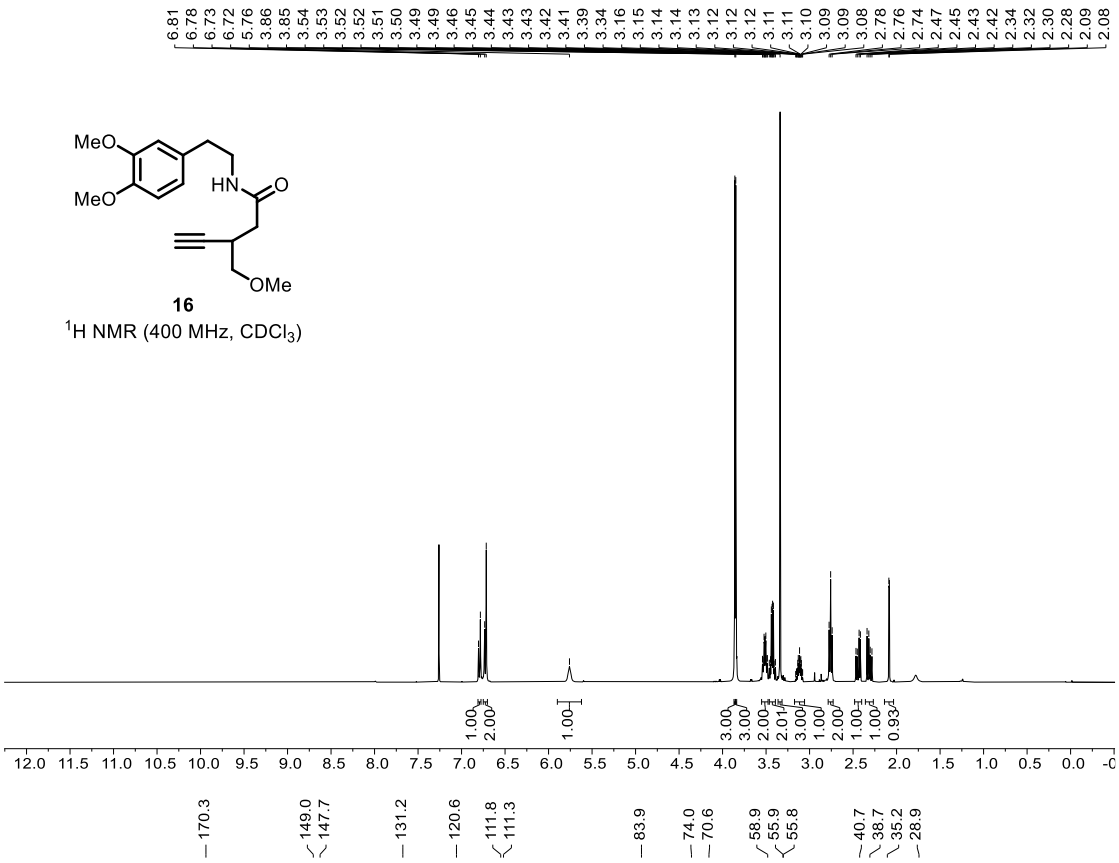
11

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



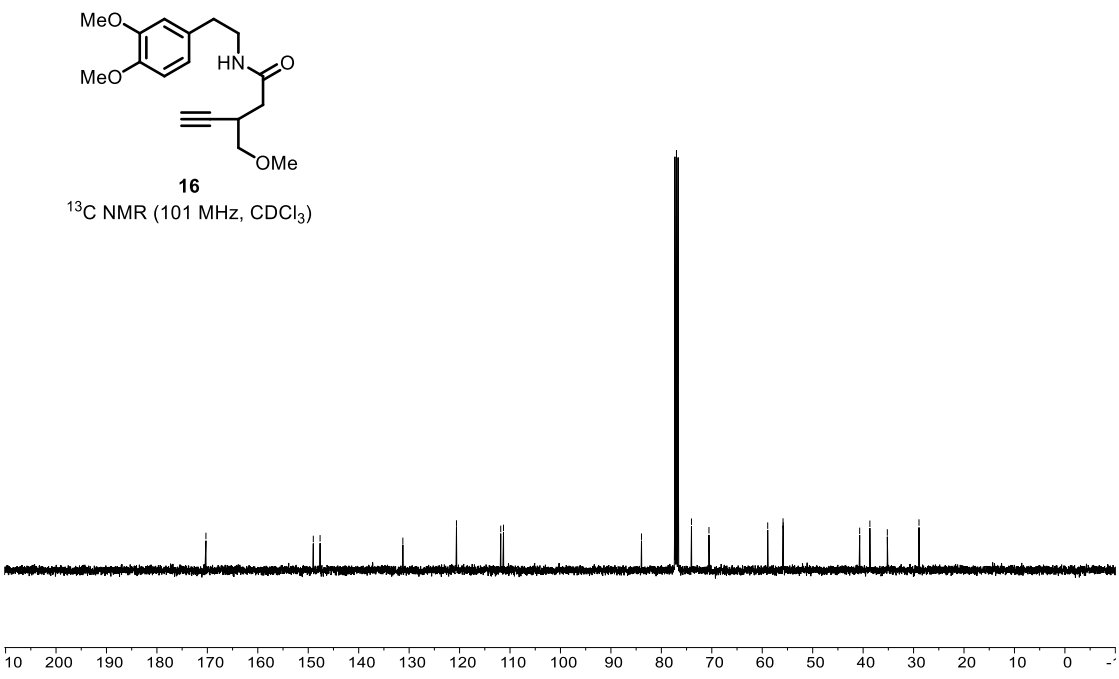
11

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



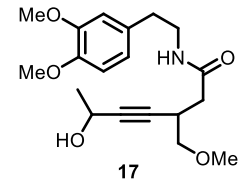
16

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



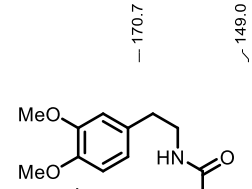
16

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



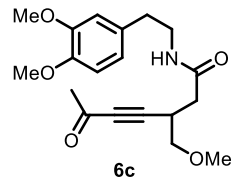
17

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



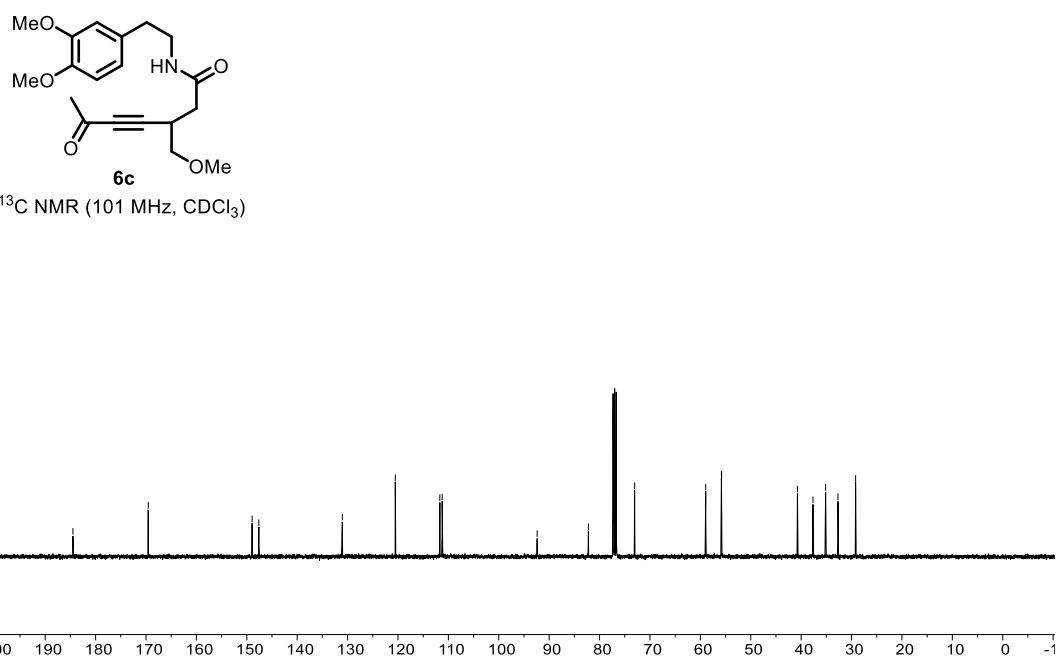
17

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



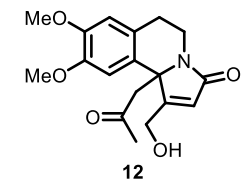
6c

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



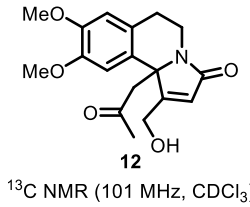
6c

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



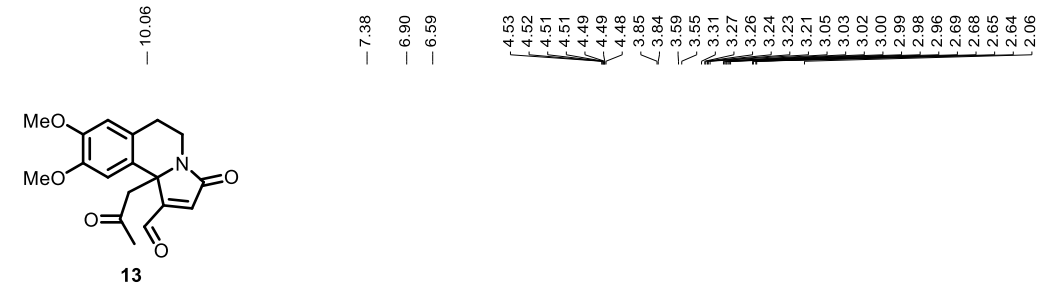
12

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



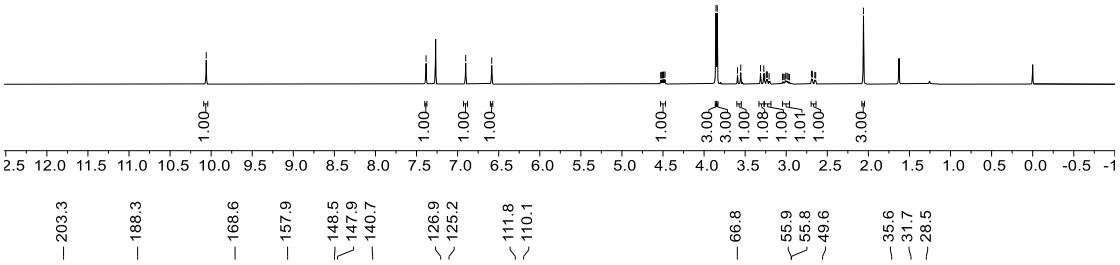
12

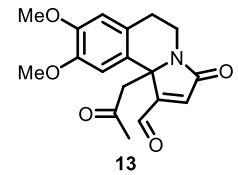
^{13}C NMR (101 MHz, $CDCl_3$)



13

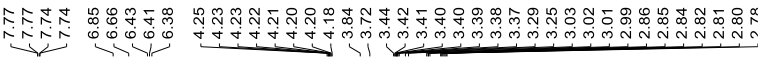
^{1}H NMR (400 MHz, $CDCl_3$)

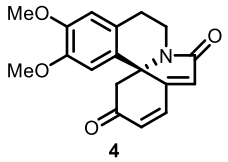




13

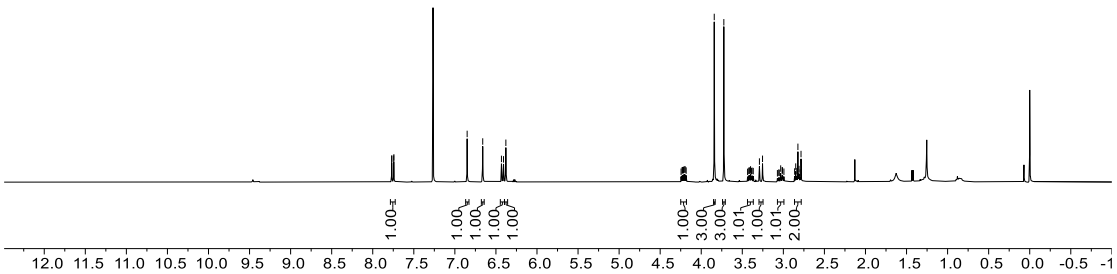
^{13}C NMR (101 MHz, $CDCl_3$)

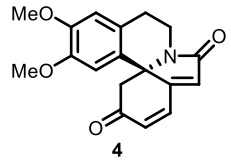




4

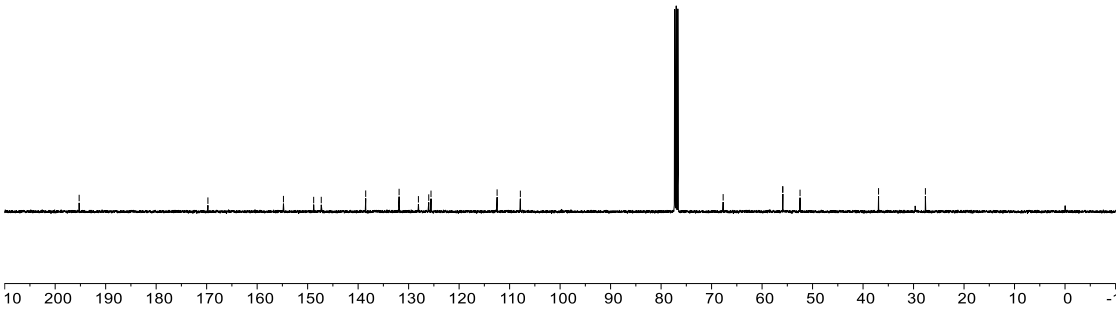
^{1}H NMR (400 MHz, $CDCl_3$)

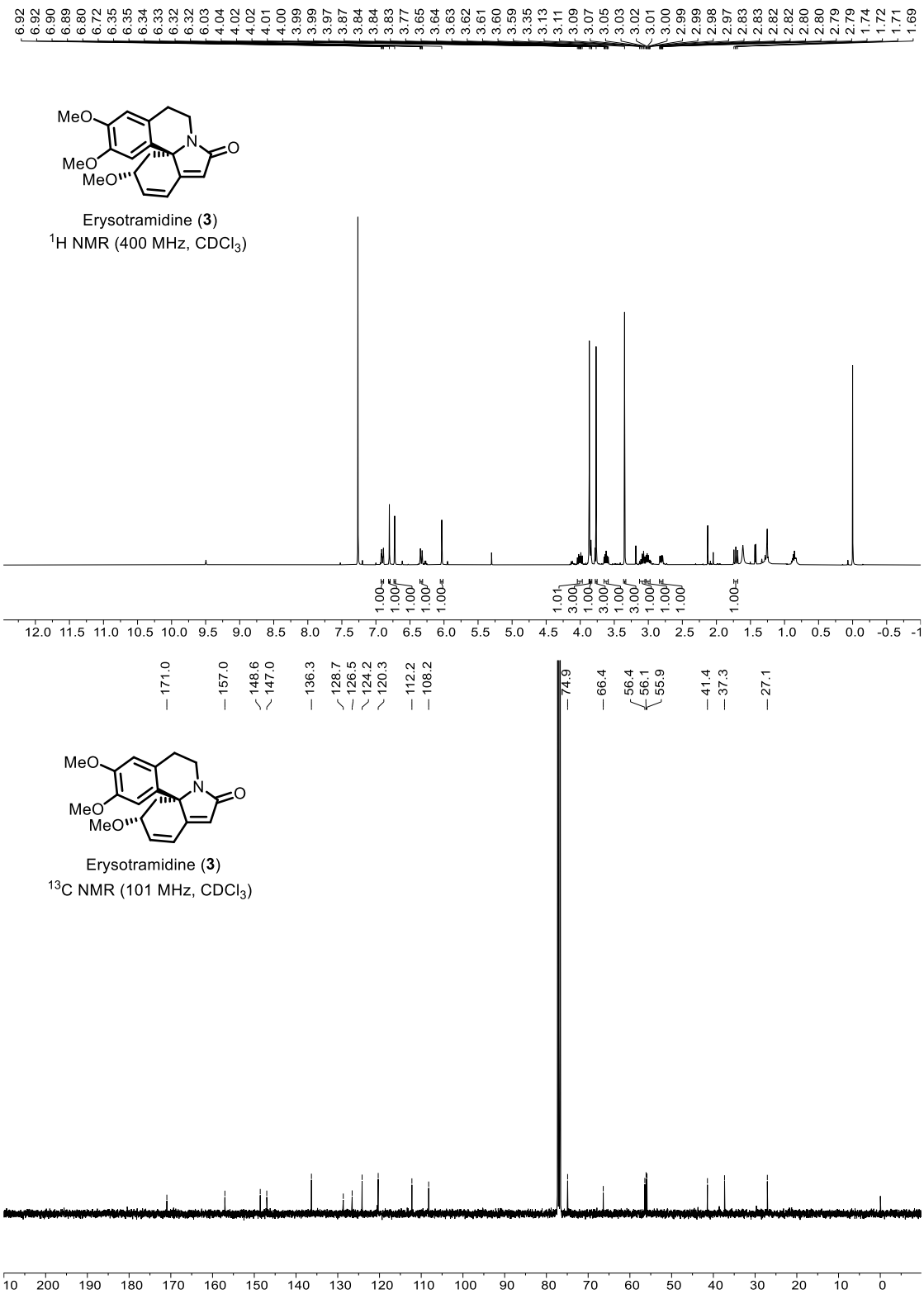




4

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




MeO
MeO
MeO
N
O
Erysotramidine (3)
1H NMR (400 MHz, CDCl3)
Erysotramidine (3)
13C NMR (101 MHz, CDCl3)