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Support Information

Development of a Metal-free Amine Oxidation Method Utilizing DEAD Chemistry

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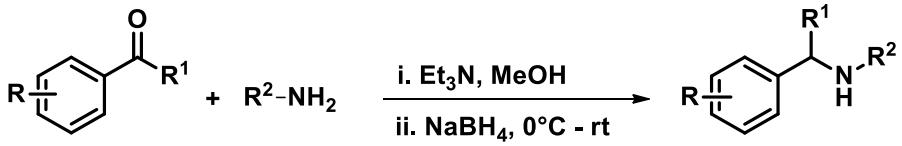
1. Materials and Instrumentation

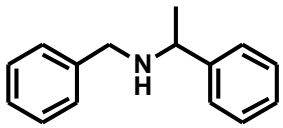
Solvents and chemicals were purchased from Sigma-Aldrich, Fisher Scientific, and Alfa Aesar and used as received. Diethyl azodicarboxylate (DEAD, 97%) was purchased from Alfa Aesar and used as received. Reactions were monitored by TLC and visualized by dual shortwave/longwave UV lamp and subsequently stained with an ethanolic solution of potassium permanganate. Column flash chromatography was performed using gel 60 Å (230−425 mesh). Analytical thin-layer chromatography (TLC) was performed using silica gel aluminum sheets. Yields refer to chromatographically and spectroscopically pure compounds, unless otherwise noted. ^{1}H NMR and ^{13}C NMR spectra were recorded at 300 MHz for ^{1}H and 75.4 MHz for ^{13}C. All signals are reported in ppm with the internal reference of 1.96 ppm or 1.79/118.26 ppm for acetonitrile. Mass spectral data was acquired on a Bruker MALDI-TOF ultafleXtreme.

2. Procedures for Synthesizing Starting Materials

Synthesis of N-alkyl and N-benzylamines



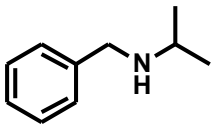
A flame-dried flask was cooled under a stream of argon and then charged with a primary amine (1.0 equiv), carbonyl compound (1.0 equiv), triethylamine (1.4 equiv), and methanol (1 mL for every 2 mmol of amine). This mixture was allowed to stir at rt until the starting material had been completely consumed, as judged by TLC analysis. The solution was then cooled to 0 °C, and $NaBH_4$ (1.1 equiv) was added slowly. The resulting solution was allowed to warm to rt and stirred until the intermediate imine had been completely consumed, as judged by TLC analysis. The reaction mixture was then diluted with water and extracted twice with ethyl acetate. The combined organic layers were dried over anhydrous magnesium sulfate, filtered, and concentrated in vacuo. The crude product was purified by flash chromatography on silica using 30−40% ethyl acetate in hexanes as the eluent.



N-benzyl-1-phenylethanamine (3)

Spectroscopic data match those previously reported.[1]

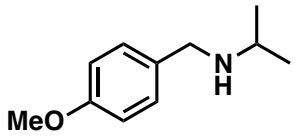
^{1}H NMR (300 MHz, $CDCl_3$): δ 7.46 – 7.39 (m, 4H), 7.39 – 7.26 (m, 6H), 3.88 (q, *J* = 6.6 Hz, 1H), 3.70 (m, *J* = 13.2 Hz, 2H), 1.65 (br s, 1H), 1.43 (d, *J* = 6.6 Hz, 3H). **^{13}C NMR (75 MHz, $CDCl_3$):** δ 145.68, 140.76, 128.54, 128.43, 128.19, 126.99, 126.90, 126.78, 57.58, 51.74, 24.58.



N-benzylpropan-2-amine (5a)

Spectroscopic data match those previously reported.[2]

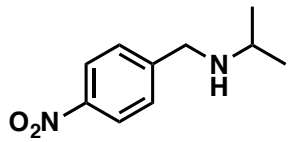
^{1}H NMR (300 MHz, $CDCl_3$): δ 7.34 (m, *J* = 6.4, 2.9 Hz, 4H), 7.32 – 7.23 (m, 1H), 3.81 (s, 2H), 2.89 (hept, *J* = 6.2 Hz, 1H), 1.25 (br s, 1H), 1.13 (d, *J* = 6.2 Hz, 6H). **^{13}C NMR (75 MHz, $CDCl_3$):** δ 140.88, 128.42, 128.13, 126.84, 51.69, 48.12, 22.99.



N-(isopropyl)-4-methoxybenzylamine (5b)

Spectroscopic data match those previously reported.[3]

^{1}H NMR (300 MHz, $CDCl_3$): δ 7.25 (d, *J*=8.6 Hz, 2H), 6.88 (d, *J*=8.6, 2.3 Hz, 2H), 3.81 (s, 3H), 3.74 (s, 2H), 2.86 (hept, *J*=6.2 Hz, 1H), 1.11 (d, *J*=6.2 Hz, 6H). **^{13}C NMR (75 MHz, $CDCl_3$):** δ 158.56, 132.90, 129.27, 113.80, 55.22, 51.02, 48.00, 22.92.

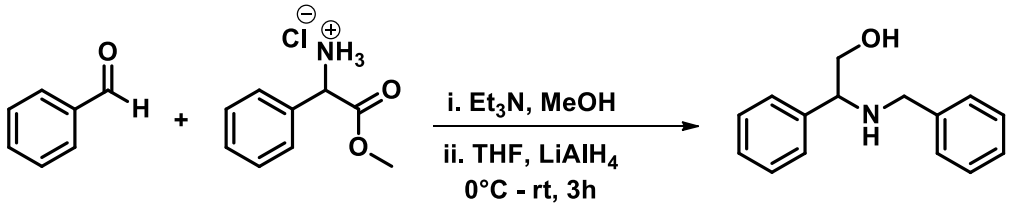


N-(isopropyl)-4-nitrobenzylamine (5c)

Spectroscopic data match those previously reported.[3]

^{1}H NMR (300 MHz, $CDCl_3$): δ 8.16 (d, *J*=8.5 Hz, 2H), 7.51 (d, *J*=8.5 Hz, 2H), 3.89 (s, 2H), 2.85 (hept, *J*=6.3 Hz, 1H), 1.10 (d, *J*=6.3 Hz, 6H). **^{13}C NMR (75 MHz, $CDCl_3$):** δ 148.86, 146.92, 128.60, 123.55, 50.78, 48.44, 22.95.

Synthesis of 2-(benzylamino)-2-phenylethanol (7)

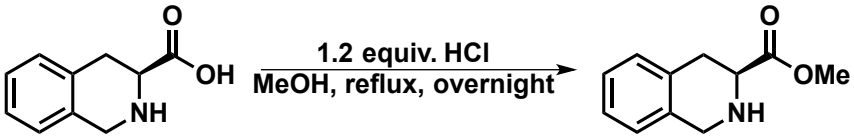


A flame-dried flask was cooled under a stream of argon and then charged with a solution of primary amine (1.0 equiv), aldehyde (1.0 equiv), triethylamine (2.4 equiv), and methanol (1 mL for every 2 mmol of amine). This mixture was allowed to stir at room temperature for 16 hours. After this time, the solvent was removed by vacuum and 7 mL of THF was added. This solution was added at 0°C to another flask filled with $LiAlH_4$ (4 equiv) and 15 mL of THF. This solution was allowed to stir for 3h at room temperature. The reaction mixture was then quenched with a saturated solution of sodium sulfate at 0°C, filtered under vacuum and extracted three times with ethyl acetate, then concentrated in vacuo. The crude product was purified by flash chromatography on silica using 40% ethyl acetate in hexanes as the eluent.

Spectroscopic data match those previously reported.[4]

^{1}H NMR (300 MHz, $CDCl_3$): δ 7.47 – 7.24 (m, 10H), 3.89 – 3.55 (m, 5H), 2.56 (br s, 1H). **^{13}C NMR (75 MHz, $CDCl_3$):** δ 140.53, 140.10, 128.74, 128.50, 128.30, 127.72, 127.40, 127.13, 66.83, 63.86, 51.25. Spectroscopic data match those previously reported.

Synthesis of (S)-methyl-1,2,3,4-tetrahydro-3-isoquinolinecarboxylate (15)

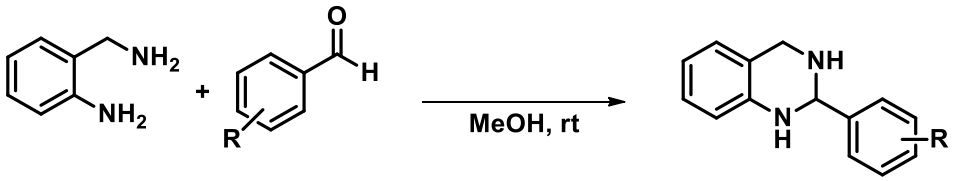


To a round bottom flask, 20 mL of methanol was added. 10 mmol of (S)-1,2,3,4-tetrahydro-3-isoquinolinecarboxylic acid was added to the flask. 0.5 mL of concentrated HCl was added drop-wise. The solution was heated to reflux and run for 16 hours The crude product was brought to pH=10 using saturated sodium carbonate solution. The solution was then extracted 3 times with 15 mL ethyl acetate and the organic phases were then combined and washed with brine. The organic phase was dried with

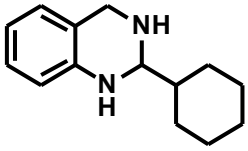
anhydrous magnesium sulfate and the solvent was evaporated in vacuo. Spectroscopic data match those previously reported.[5]

^{1}H NMR (300 MHz, $CDCl_3$): δ. 7.19-7.02 (m, 4H), 4.13 (d, J = 16.4 Hz, 1H), 4.11 (d, J = 16.4 Hz, 1H), 3.79 (s, 3H), 3.76 (dd, *J*=4.8, 5.3 Hz, 1H), 3.14-2.93 (m, 2H), 2.20 (br s, 1H). **^{13}C NMR (75 MHz, $CDCl_3$):** δ 173.53, 134.83, 133.09, 129.16, 126.30, 126.19, 126.09, 55.86, 52.16, 47.34, 31.61.

Synthesis of 2-substituted-1,2,3,4-tetrahydroquinazolines



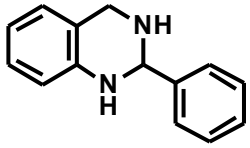
To a solution of the corresponding aldehyde (1 equiv) in dry MeOH (0.18 $molL^{-1}$) was added 2-(aminomethyl)aniline (1 equiv). The reaction was stirred at room temperature until the starting material had been completely consumed, as judged by TLC analysis. The mixture was concentrated in vacuo and the residue was recrystallized providing the desired product.



2-cyclohexyl-1,2,3,4-tetrahydroquinazoline (17a)

Spectroscopic data match those previously reported.[6]

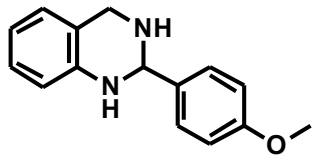
^{1}H NMR (300 MHz, $CDCl_3$): δ 7.07 – 6.98 (m, 1H), 6.91 (d, *J* = 7.4 Hz, 1H), 6.68 (m, 1H), 6.53 (d, *J* = 8.0 Hz, 1H), 4.19 – 4.09 (m, 1H), 3.02 – 3.93 (m, 2H), 2.03 - 1.92 (m, 1H), 1.91 – 1.68 (m, 4H), 1.64 – 1.42 (m, 2H), 1.39 – 1.21 (m, 4H), 1.20 – 1.03 (m, 1H). **^{13}C NMR (75 MHz, $CDCl_3$):** δ 144.09, 127.16, 126.09, 121.82, 117.74, 114.97, 71.07, 46.78, 42.92, 28.30, 28.02, 26.53, 26.22, 26.20.



2-phenyl-1,2,3,4-tetrahydroquinazoline (17b)

Spectroscopic data match those previously reported.[6]

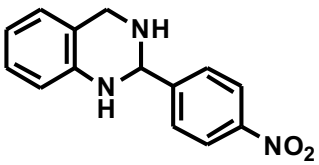
^{1}H NMR (300 MHz, $CDCl_3$): δ 7.54 (m, *J* = 13.9, 5.1 Hz, 2H), 7.48 – 7.36 (m, 3H), 7.08 (t, *J* = 7.6 Hz, 1H), 6.98 (d, *J* = 7.6 Hz, 1H), 6.76 (dd, *J* = 10.5, 4.2 Hz, 1H), 6.61 (d, *J* = 8.0 Hz, 1H), 5.27 (s, 1H), 4.29 (d, *J* = 16.7 Hz, 1H), 4.02 (d, *J* = 16.7 Hz, 1H), 1.96 (br s, 2H). **^{13}C NMR (75 MHz, $CDCl_3$):** δ 143.76, 141.65, 128.78, 128.56, 127.31, 126.62, 126.25, 121.34, 118.20, 115.08, 69.68, 46.54.



2-(4-methoxyphenyl)-1,2,3,4-tetrahydroquinazoline (17c)

Spectroscopic data match those previously reported.[6]

^{1}H NMR (300 MHz, $CDCl_3$): δ 7.52 – 7.41 (m, 2H), 7.16 – 7.02 (m, 1H), 7.01 – 6.90 (m, 3H), 6.80 – 6.69 (m, 1H), 6.60 (d, *J* = 8.0 Hz, 1H), 5.22 (s, 1H), 4.33 – 4.25 (m, 1H), 4.09 – 3.95 (m, 1H), 3.85 (s, 3H). **^{13}C NMR (75 MHz, $CDCl_3$):** δ 159.75, 143.86, 133.95, 127.79, 127.28, 126.24, 121.28, 118.13, 115.03, 114.09, 69.24, 55.37, 46.61.

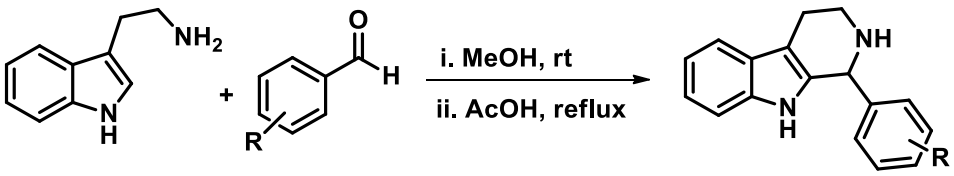


2-(4-nitrophenyl)-1,2,3,4-tetrahydroquinazoline (17d)

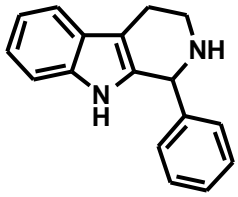
Spectroscopic data match those previously reported.[7]

^{1}H NMR (300 MHz, $CDCl_3$): δ 8.33 – 8.20 (m, 2H), 7.81 – 7.69 (m, 2H), 7.18 – 7.04 (m, 1H), 6.97 (d, *J* = 7.5 Hz, 1H), 6.78 (m, *J* = 7.4, 1.1 Hz, 1H), 6.68 (d, *J* = 8.0 Hz, 1H), 5.39 (s, 1H), 4.20 (d, *J* = 16.8 Hz, 1H), 3.92 (d, *J* = 16.8 Hz, 1H), 2.19 (s, 1H), 1.98 (br s, 1H). **^{13}C NMR (75 MHz, $CDCl_3$):** δ 148.76, 147.94, 142.70, 127.92, 127.56, 126.32, 123.91, 121.43, 118.79, 115.41, 68.44, 45.45.

Synthesis of 1,2,3,4-tetrahydro-β-carbolines



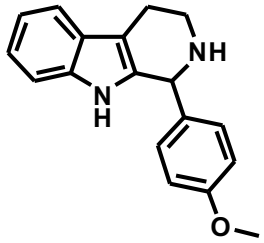
To a solution of the corresponding aldehyde (1 equiv) in dry MeOH (0.18 $molL^{-1}$) was added tryptamine (1 equiv). The reaction was stirred overnight at room temperature, forming a precipitate over this time. The solid was collected by vacuum filtration, washed with MeOH, and dried. The solid was then dissolved in glacial AcOH (0.4 $molL^{-1}$ with respect to initial aldehyde), and brought to reflux for 30 min. The reaction was cooled, diluted with water, made alkaline (pH~12) with 1M NaOH, and extracted into EtOAc (3 x 75 mL). The organic phases were combined, washed with brine, dried with Na_2SO_4, then evaporated in vacuo to give the final products as solids.



1-phenyl-2,3,4,9-tetrahydro-1H-pyrido[3,4-b]indole (19a)

Spectroscopic data match those previously reported.[6]

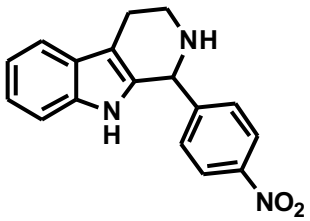
^{1}H NMR (300 MHz, $CDCl_3$): δ 7.69 – 7.53 (m, 2H), 7.46 – 7.30 (m, 5H), 7.22 (m, *J* = 4.4, 3.0 Hz, 1H), 7.16 (m, *J* = 5.4, 3.5 Hz, 1H), 5.18 (s, 1H), 3.48 – 3.32 (m, 1H), 3.27 – 3.09 (m, 1H), 3.05 – 2.77 (m, 2H), 2.01 (br s, 1H). **^{13}C NMR (75 MHz, $CDCl_3$):** δ 141.85, 135.90, 134.53, 128.86, 128.53, 128.22, 127.44, 121.75, 119.43, 118.26, 110.85, 110.26, 58.17, 42.92, 22.58.



1-(4-methoxyphenyl)-2,3,4,9-tetrahydro-1H-pyrido[3,4-b]indole (19b)

Spectroscopic data match those previously reported.[6]

^{1}H NMR (300 MHz, $CDCl_3$): δ 7.63 (s, 1H), 7.60 – 7.53 (m, 1H), 7.31 – 7.20 (m, 3H), 7.16 (m, 2H), 6.94 – 6.85 (m, 2H), 5.14 (s, 1H), 3.84 (s, 3H), 3.39 (m, 1H), 3.14 (m, 1H), 3.04 – 2.77 (m, 2H), 2.19 (br s, 1H). **^{13}C NMR (75 MHz, $CDCl_3$):** δ 159.54, 135.86, 134.88, 133.93, 129.65, 127.48, 121.69, 119.39, 118.23, 114.17, 110.84, 110.15, 57.52, 55.36, 42.95, 22.57.

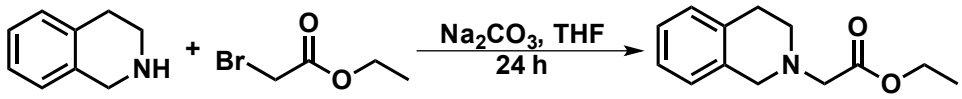


1-(4-nitrophenyl)-2,3,4,9-tetrahydro-1H-pyrido[3,4-b]indole (19c)

Spectroscopic data match those previously reported.[8]

^{1}H NMR (300 MHz, $CDCl_3$): δ 8.20 (d, *J* = 8.7 Hz, 2H), 7.62 – 7.49 (m, 4H), 7.28 (m, 1H), 7.18 (m, 2H), 5.30 (s, 1H), 3.32 (m, 1H), 3.19 (m, 1H), 3.04 – 2.79 (m, 2H), 1.90 (br s, 1H). **^{13}C NMR (75 MHz, $CDCl_3$):** δ 149.38, 147.75, 136.11, 132.71, 129.45, 127.23, 123.97, 122.28, 119.77, 118.47, 110.97, 110.90, 57.19, 42.32, 22.43.

Synthesis of ethyl 3,4-dihydro-2(1H)-isoquinolinylacetate (26)



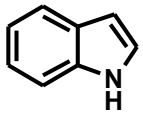
To a round bottom flask, 20 mL THF was added. 12 mmol ground anhydrous sodium carbonate was added. 6 mmol of 1,2,3,4-tetrahydroisoquinoline and 6.6 mmol of ethyl bromoacetate were added to the flask. The solution was stirred vigorously using magnetic bar for 24 hours. The crude product was added with 20 mL of water and extracted 3 times with 15 mL ethyl acetate. The organic portions were combined and washed with brine, dried by anhydrous magnesium sulfate, and evaporated in vacuo to leave title compound without purification.

Spectroscopic data match those previously reported.[9]

^{1}H NMR (300 MHz, $CDCl_3$): δ 7.15-7.00 (m, 4H), 4.23 (q, *J*=7.6 Hz, 2H), 3.82 (s, 2H), 3.43 (s, 2H), 2.98-2.88 (m, 4H), 1.31 (t, *J*=7.6 Hz, 3H). **^{13}C NMR (75 MHz, $CDCl_3$):** δ 170.48, 134.26, 133,84, 128.71, 126.50, 126.18, 125.65, 60.65, 59.11, 55.33, 50.67, 28.93, 14.31.

3. General Procedure for Amine Oxidation

A vial equipped with a magnetic stir bar was charged with amine (1 equiv), azo compound (1.2 or 2.2 equiv., according to the amine used) and acetonitrile (0.4 $molL^{-1}$ with respect to the amine). The resulting solution was stirred at ambient temperature. After the reaction completed by TLC, the solvent was evaporated in vacuo and the reaction was purified via flash chromatography for stable and isolated imine products, or the spectroscopic yield was determined via ^{1}H NMR for unstable imine species.

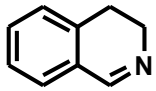


Indole **(12)**

Spectroscopic data match those previously reported.[6]

Prepared according to the general procedure from indole **(9)** (0.2 mmol, 23.8 mg, 1.0 equiv) and DEAD (0.24 mmol, 41.80 mg, 1.2 equiv). Reaction time: 20 min. Purification by flash chromatography (eluent 9:1 hexane:AcOEt) afforded the title compound (22.7 mg collected, 97% yield) as a white solid.

^{1}H NMR (300 MHz, $CDCl_3$): δ 8.13 (br s, 1H), 7.74 – 7.66 (m, 1H), 7.46 – 7.40 (m, 1H), 7.30 – 7.13 (m, 3H), 6.63 – 6.59 (m, 1H). **^{13}C NMR (75 MHz, $CDCl_3$):** δ 135.83, 127.91, 124.21, 122.04, 120.79, 119.88, 111.10, 102.65.

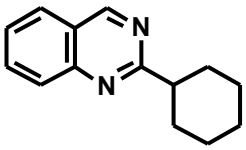


3,4-dihydroisoquinoline **(14)**

Spectroscopic data match those previously reported.[6]

Prepared according to the general procedure from 1,2,3,4-tetrahydroisoquinoline **(11)** (0.2 mmol, 40.0 mg, 1.0 equiv) and DEAD (0.24 mmol, 41.80 mg, 1.2 equiv). Reaction time: 20 min. Purification by flash chromatography (eluent 3:1 hexane:AcOEt) afforded the title compound (20.2 mg collected, 77% yield) as a yellow oil.

^{1}H NMR (300 MHz, $CDCl_3$): δ 8.35 (s, 1H), 7.44 – 7.25 (m, 3H), 7.17 (dd, *J* = 7.1, 0.6 Hz, 1H), 3.79 (m, 2H), 2.87 – 2.67 (m, 2H). **^{13}C NMR (75 MHz, $CDCl_3$):** δ 160.36, 136.36, 131.06, 128.55, 127.44, 127.21, 127.10, 47.43, 25.05.

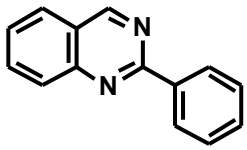


2-cyclohexylquinazoline **(18a)**

Spectroscopic data match those previously reported.[6]

Prepared according to the general procedure from **17a** (0.2 mmol, 43.3 mg, 1.0 equiv) and DEAD (0.44 mmol, 76.63 mg, 2.2 equiv). Reaction time: 1h. Purification by flash chromatography (eluent 7:3 hexane:AcOEt) afforded the title compound (38.2 mg collected, 90% yield) as a pale yellow solid.

^{1}H NMR (300 MHz, $CDCl_3$): δ 9.37 (s, 1H), 8.04 – 7.95 (m, 1H), 7.93 – 7.83 (m, 2H), 7.59 (td, *J* = 7.4, 1.0 Hz, 1H), 3.07 (tt, *J* = 11.7, 3.5 Hz, 1H), 2.18 – 2.03 (m, 2H), 1.98 – 1.69 (m, 5H), 1.59 – 1.24 (m, 3H). **^{13}C NMR (75 MHz, $CDCl_3$):** δ 170.96, 160.40, 150.45, 133.84, 128.08, 127.04, 126.82, 123.30, 47.97, 31.98, 26.35, 26.07.

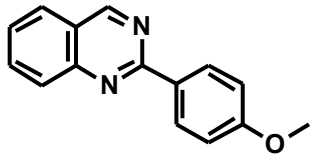


2-phenylquinazoline **(18b)**

Spectroscopic data match those previously reported.[6]

Prepared according to the general procedure from **17b** (0.2 mmol, 42.0 mg, 1.0 equiv) and DEAD (0.44 mmol, 76.63 mg, 2.2 equiv). Reaction time: 1h. Purification by flash chromatography (eluent 7:3 hexane:AcOEt) afforded the title compound (39.2 mg collected, 95% yield) as a pale yellow solid.

^{1}H NMR (300 MHz, $CDCl_3$): δ 9.49 (s, 1H), 8.70 – 8.58 (m, 2H), 8.12 (dd, *J* = 8.3, 0.8 Hz, 1H), 7.99 – 7.87 (m, 2H), 7.69 – 7.47 (m, 4H). **^{13}C NMR (75 MHz, $CDCl_3$):** δ 161.12, 160.52, 150.83, 138.09, 134.12, 130.63, 128.70, 128.66, 128.61, 127.28, 127.14, 123.65.

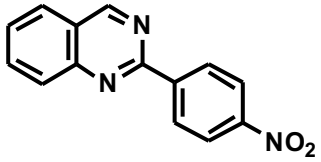


2-(4-methoxyphenyl)quinazoline **(18c)**

Spectroscopic data match those previously reported.[6]

Prepared according to the general procedure from **17c** (0.2 mmol, 48.1 mg, 1.0 equiv)and DEAD (0.44 mmol, 76.63 mg, 2.2 equiv). Reaction time: 1h. Purification by flash chromatography (eluent 7:3 hexane:AcOEt) afforded the title compound (44.9 mg collected, 95% yield) as a yellow solid.

^{1}H NMR (300 MHz, $CDCl_3$): δ 9.44 (d, *J* = 0.7 Hz, 1H), 8.65 – 8.56 (m, 2H), 8.10 – 8.02 (m, 1H), 7.89 (dt, *J* = 7.0, 4.4 Hz, 2H), 7.58 (td, *J* = 7.2, 1.1 Hz, 1H), 7.12 – 7.02 (m, 2H), 3.92 (s, 3H). **^{13}C NMR (75 MHz, $CDCl_3$):** δ 161.87, 160.91, 160.41, 150.89, 134.02, 130.78, 130.24, 128.46, 127.15, 126.80, 123.35, 114.01, 55.41.

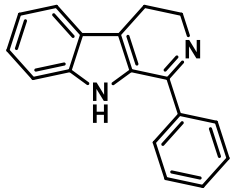


2-(4-nitrophenyl)quinazoline **(18d)**

Spectroscopic data match those previously reported.[10]

Prepared according to the general procedure from **17d** (0.2 mmol, 51.05 mg, 1.0 equiv) and DEAD (0.44 mmol, 76.63 mg, 2.2 equiv). Reaction time: 1h. Purification by flash chromatography (eluent 7:3 hexane:AcOEt) afforded the title compound (40.2 mg collected, 80% yield) as a white solid.

^{1}H NMR (300 MHz, $CDCl_3$): δ 9.53 (d, *J* = 0.6 Hz, 1H), 8.89 – 8.78 (m, 2H), 8.44 – 8.33 (m, 2H), 8.15 (dd, *J* = 8.4, 0.9 Hz, 1H), 8.05 – 7.93 (m, 2H), 7.78 – 7.67 (m, 1H). **^{13}C NMR (75 MHz, $CDCl_3$):** δ 160.73, 158.84, 150.65, 149.23, 143.87, 134.62, 129.42, 128.90, 128.34, 127.24, 123.92, 123.77.

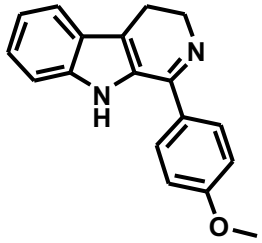


***1-phenyl-4,9-dihydro-3H-pyrido[3,4-b]indole* (20a)**

Spectroscopic data match those previously reported.[6]

Prepared according to the general procedure from **19a** (0.2 mmol, 49.7 mg, 1.0 equiv) and DEAD (0.24 mmol, 41.80 mg, 1.2 equiv). Reaction time: 1h. Purification by flash chromatography (eluent 5:5 hexane:AcOEt) afforded the title compound (33.4 mg collected, 78% yield) as a pale yellow solid.

^{1}H NMR (300 MHz, $CDCl_3$): δ 8.26 (br s, 1H), 7.80 – 7.72 (m, 2H), 7.68 (d, *J* = 7.9 Hz, 1H), 7.54 – 7.47 (m, 3H), 7.40 – 7.34 (m, 1H), 7.32 (dt, *J* = 2.5, 1.3 Hz, 1H), 7.20 (ddd, *J* = 8.0, 6.8, 1.2 Hz, 1H), 4.07 (t, *J* = 8.0 Hz, 2H), 3.00 (t, *J* = 8.0 Hz, 2H). **^{13}C NMR (75 MHz, $CDCl_3$):** δ 159.39, 137.63, 136.54, 129.97, 128.85, 127.84, 127.80, 125.60, 124.60, 120.42, 120.02, 117.87, 112.02, 48.88, 19.29.

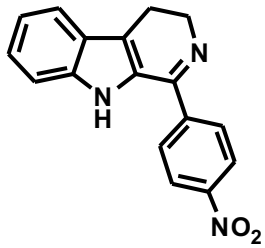


***1-(4-methoxyphenyl)-4,9-dihydro-3H-pyrido[3,4-b]indole* (20b)**

Spectroscopic data match those previously reported.[6]

Prepared according to the general procedure from **19b** (0.2 mmol, 55.7 mg, 1.0 equiv) and DEAD (0.24 mmol, 41.80 mg, 1.2 equiv). Reaction time: 1h. Purification by flash chromatography (eluent 5:5 hexane:AcOEt) afforded the title compound (45.3 mg collected, 82% yield) as a pale yellow solid.

^{1}H NMR (300 MHz, CDCl3): δ 8.84 (br s, 1H), 7.75 (d, *J* = 8.8 Hz, 2H), 7.67 (d, *J* = 8.0 Hz, 1H), 7.44 (d, *J* = 8.3 Hz, 1H), 7.37 – 7.29 (m, 1H), 7.25 – 7.15 (m, 1H), 6.97 (d, *J* = 8.8 Hz, 2H), 4.06 – 3.95 (m, 2H), 3.84 (s, 3H), 3.09 – 2.95 (m, 2H). **^{13}C NMR (75 MHz, $CDCl_3$):** δ 161.79, 159.44, 137.64, 130.10, 128.10, 127.32, 125.43, 125.39, 120.72, 120.22, 119.44, 114.31, 112.48, 55.43, 47.20, 19.33.

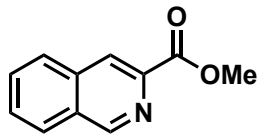


***1-(4-nitrophenyl)-4,9-dihydro-3H-pyrido[3,4-b]indole* (20c)**

Spectroscopic data match those previously reported.[11]

Prepared according to the general procedure from **19c** (0.2 mmol, 58,60 mg, 1.0 equiv) and DEAD (0.24 mmol, 41.80 mg, 1.2 equiv). Reaction time: 1h. Purification by flash chromatography (eluent 6:4 hexane:AcOEt) afforded the title compound (40.8 mg collected, 70% yield) as a yellow crystal solid.

^{1}H NMR (300 MHz, DMSO-d6): δ 11.27 (s, 1H), 8.47 – 8.39 (m, 2H), 8.12 – 8.02 (m, 2H), 7.70 (d, *J* = 7.9 Hz, 1H), 7.48 (d, *J* = 8.2 Hz, 1H), 7.34 – 7.24 (m, 1H), 7.20 – 7.10 (m, 1H), 4.03 (t, *J* = 8.1 Hz, 2H), 2.96 (t, *J* = 8.1, 2H). **^{13}C NMR (75 MHz, DMSO-d6):** δ 157.32, 148.08, 143.30, 137.05, 129.39, 126.97, 124.67, 124.05, 123.59, 119.72, 119.68, 116.87, 112.69, 48.67, 18.73.



***Methyl 3-isoquinolinecarboxylate* (21)**

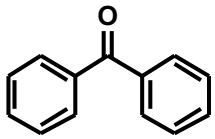
Spectroscopic data match those previously reported.[12]

Prepared according to the general procedure from **15** (1.5 mmol, 286.6 mg, 1.0 equiv.) and DEAD (3.3 mmol, 574.7 mg, 2.2 equiv.). The reaction mixture was allowed to stir for 24 hours. Purification by flash chromatography (eluent 1:1 hexanes:AcOEt) afforded the title compound (267.3 mg collected, 94% yield) as a pale yellow solid.

^{1}H NMR (300 MHz, $CDCl_3$): δ 9.32 (s, 1H), 8.59 (s, 1H), 8.05 (d, *J*=7.7 Hz, 1H), 7.97 (d, *J*=7.9 Hz, 1H), 7.76 (m, 2H), 4.06 (s, 3H). **^{13}C NMR (75 MHz, $CDCl_3$):** δ 160.94, 147.32, 136.16, 130.12, 125.84, 124.60, 124.29, 122.67, 122.35, 118.71, 47.52.

Hydrolysis of Primary Imines

Due to the lability of primary imines, these species were hydrolyzed *in situ* and isolated as the corresponding ketones. The reaction mixture was treated with 1M HCl for 2 hours. And the resulting ketones were separated using flash chromatography.

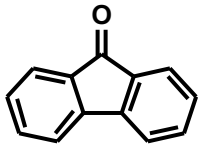


***Benzophenone* (23)**

Spectroscopic data match those previously reported.[15]

Prepared according to the general procedure using the correspondent starting material (0.2 mmol, 36.65 mg, 1.0 equiv), DEAD (0.24 mmol, 41.8 mg, 2.2 equiv), and 0.5 mL of acetonitrile. The reaction mixture was allowed to stir for 1 hour. After this time a solution of 1M HCl was added and allowed to stir for 2 hours. And then the reaction was extracted with DCM (3 times), following by purification using flash column chromatography (eluent 7:3 hexane:AcOEt) afforded the title compound (23.7 mg collected, 65% yield) as an oil.

^{1}H NMR (300 MHz, $CDCl_3$): δ 7.88 – 7.80 (m, 4H), 7.65 – 7.57 (m, 2H), 7.56 – 7.46 (m, 4H). **^{13}C NMR (75 MHz, $CDCl_3$):** δ 196.75, 137.64, 132.44, 130.08, 128.31.



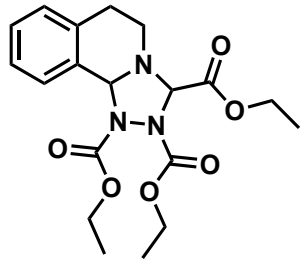
***Fluoren-9-one* (25)**

Spectroscopic data match those previously reported.[16]

Prepared according to the general procedure using the correspondent starting material (0.2 mmol, 36.65 mg, 1.0 equiv), DEAD (0.24 mmol, 41.8 mg, 2.2 equiv), and 0.5 mL of acetonitrile. The reaction mixture was allowed to stir for 1 hour. After this time a solution HCl 1M was added and allowed to stir for 2 hours. And then the reaction was extracted with DCM (3 times), following by

purification using flash column chromatography (eluent 85:15 hexane:AcOEt) afforded the title compound (21.6 mg collected, 60% yield) as a yellow solid.

^{1}H NMR (300 MHz, $CDCl_3$): δ 7.73 – 7.64 (m, 2H), 7.59 – 7.46 (m, 4H), 7.37 – 7.26 (m, 2H). **^{13}C NMR (75 MHz, $CDCl_3$):** δ 193.93, 144.46, 134.70, 134.19, 129.10, 124.34, 120.32.



***3,4,5-triethylcarboxyl-3.4.6-triazatricyclo[7.4.0.0^{2,6}]trideca-1(9),10,12-triene* (28)**

Prepared according to the general procedure from **26** (2.3 mmol, 508.5 mg, 1.0 equiv.) and DEAD (5.0 mmol, 873.8 mg, 2.2 equiv.). The reaction mixture was allowed to stir overnight. Purification by flash column chromatography (eluent 1:1 hexanes:AcOEt) afforded the title compound (74% yield) as viscous yellow liquid.

^{1}H NMR (300 MHz, $CDCl_3$): δ. 7.72 (d, *J*=7.5 Hz, 1H), 7.27-7.18 (m, 2H), 7.08 (d, *J*=7.7 Hz, 1H), 6.12 (s, 1H), 5.45 (s, 1H), 4.38-4.19 (m, 4H), 4.12-3.95 (m, 2H), 3.36-3.28 (m ,1H), 3.04-3.96 (m, 1H), 2.87-2.72 (m, 2H), 1.37-1.29 (m, 6H), 1.05 (t, *J*=7.1 Hz). **^{13}C NMR (75 MHz, $CDCl_3$):** δ 167.96, 158.45, 156.91, 135.33, 132.33, 128.91, 127.83, 127.76, 126.71, 77.01, 74.52, 62.95, 62.87, 61.76, 47.01, 26.23, 14.43, 14.12, 14.01. **MALDI-TOF MS**: calculated for $[M+H]^+$ 392.1753, found $[M+H]^+$ 392.2064.

4. General Procedure for Recovery of Reduced DEAD

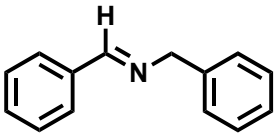
Standard procedure for imine formation followed using 1.0 mmol amine (dibenzylamine **1** or tetrahydroisoquinoline **13**) and 1.2 mmol DEAD in 3 mL CH_3CN. Reaction was stirred for 1.5 hours and CH_3CN was removed with rotary evaporator. The reaction mixture was then dissolved in 5 mL of toluene and placed in the freezer overnight. A solid white precipitate could be observed in the bottom of the flask. The solid was collected, weighed, and characterized by NMR and X-Ray diffraction.

X-Ray structure and unit cell matched that previously reported.[14]

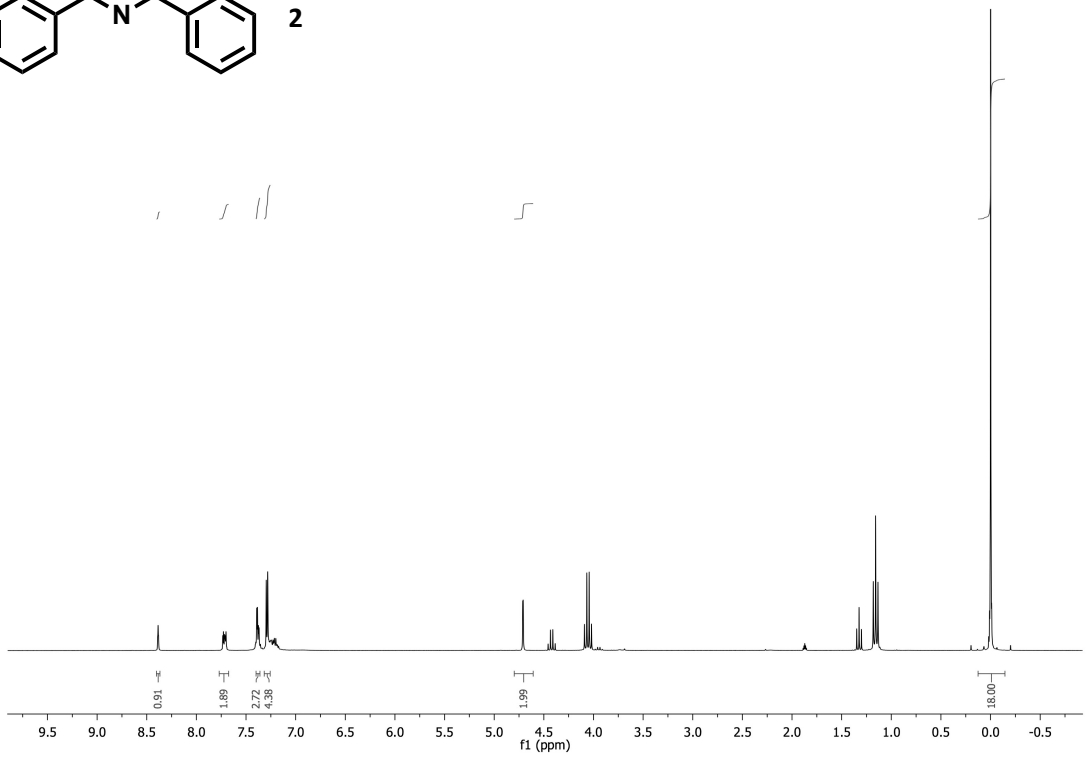
^{1}H NMR (300 MHz, CD_3CN): δ 7.27 (br s, 2H), 4.13 (q, 4H), 1.24 (t, 6H). **^{13}C NMR (75 MHz, CD_3CN):** δ 156.4, 61.2, 13.5.

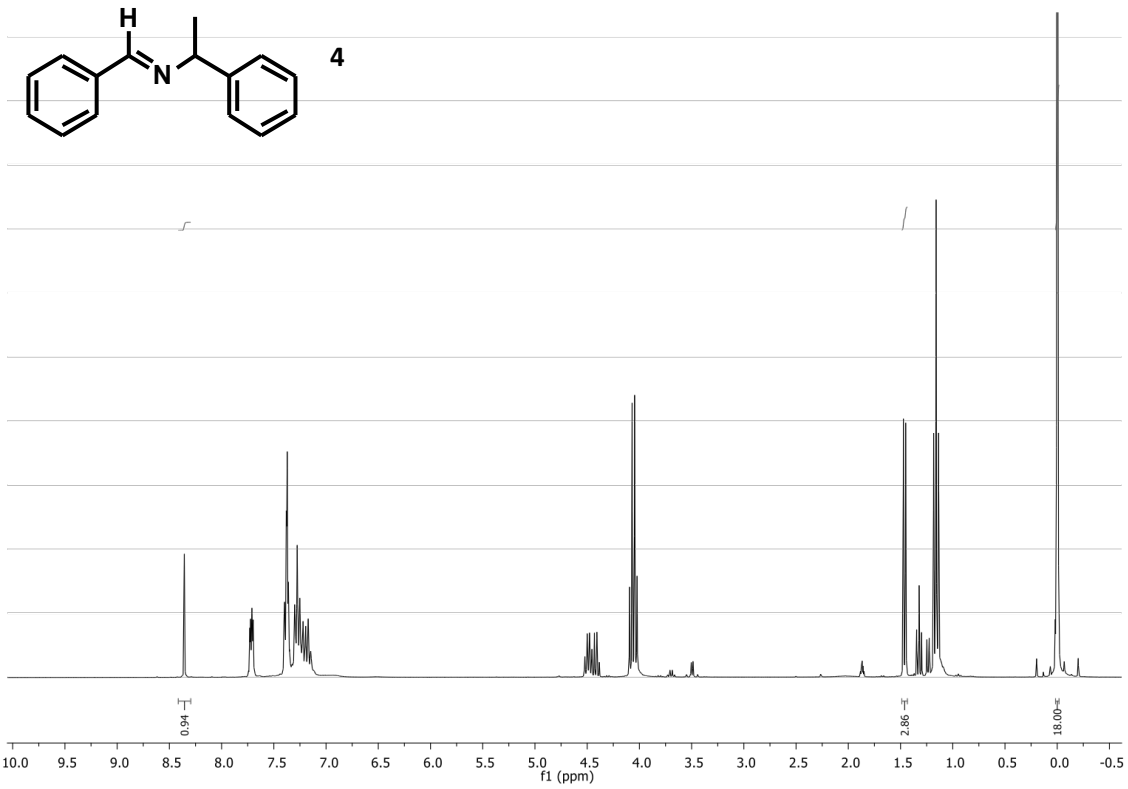
5. Procedure and Spectral Data for NMR Yields

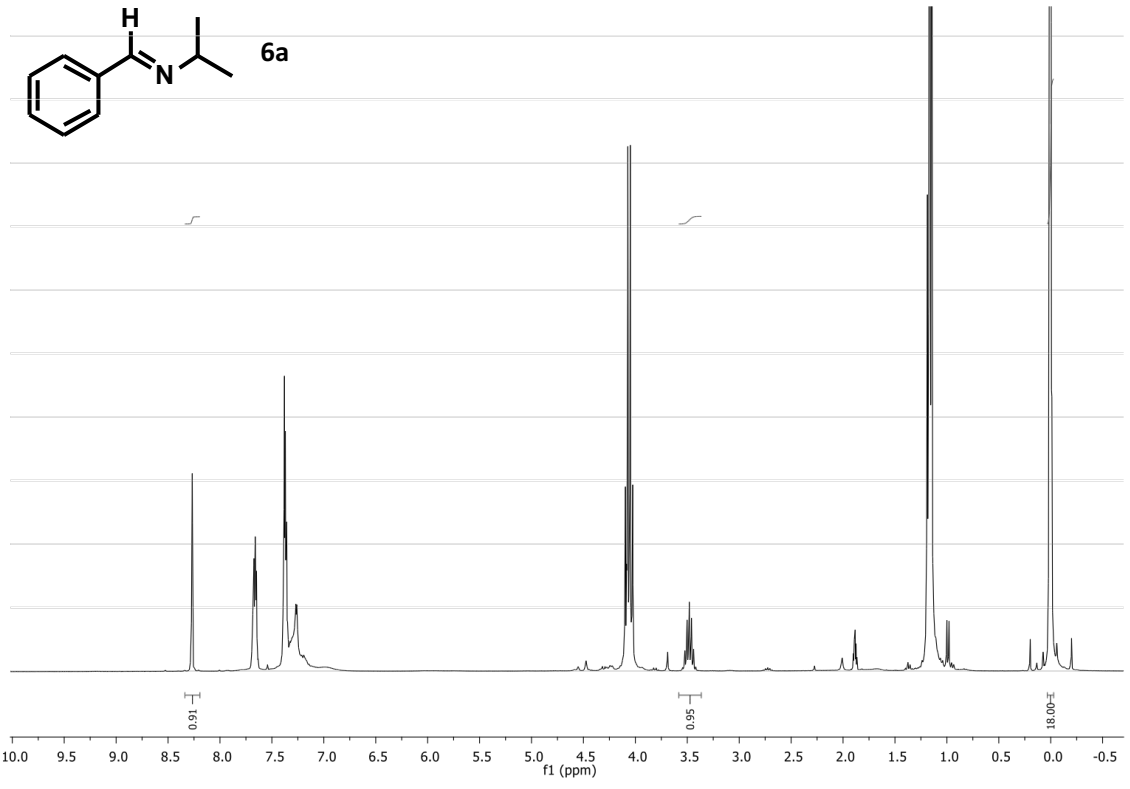
A vial equipped with a magnetic stir bar was charged with amine (0.20 mmol), azo compound (0.24 mmol), hexamethyldisilazane as internal standard (0.20 mmol) and d_3-acetonitrile 0.50mL. The resulting solution was stirred at ambient temperature. Reaction mixture was monitored by NMR after 90 minutes.

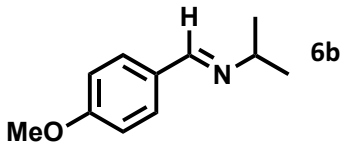


2




H
N
4
0.94
2.86
18.00
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
f1 (ppm)


H
N
6a
0.91
0.95
18.00
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
f1 (ppm)


H
N
MeO

6b

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1.84
1.82
2.91
18.00
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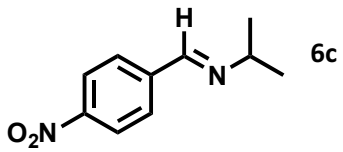
f1 (ppm)


H
N
O2N

6c

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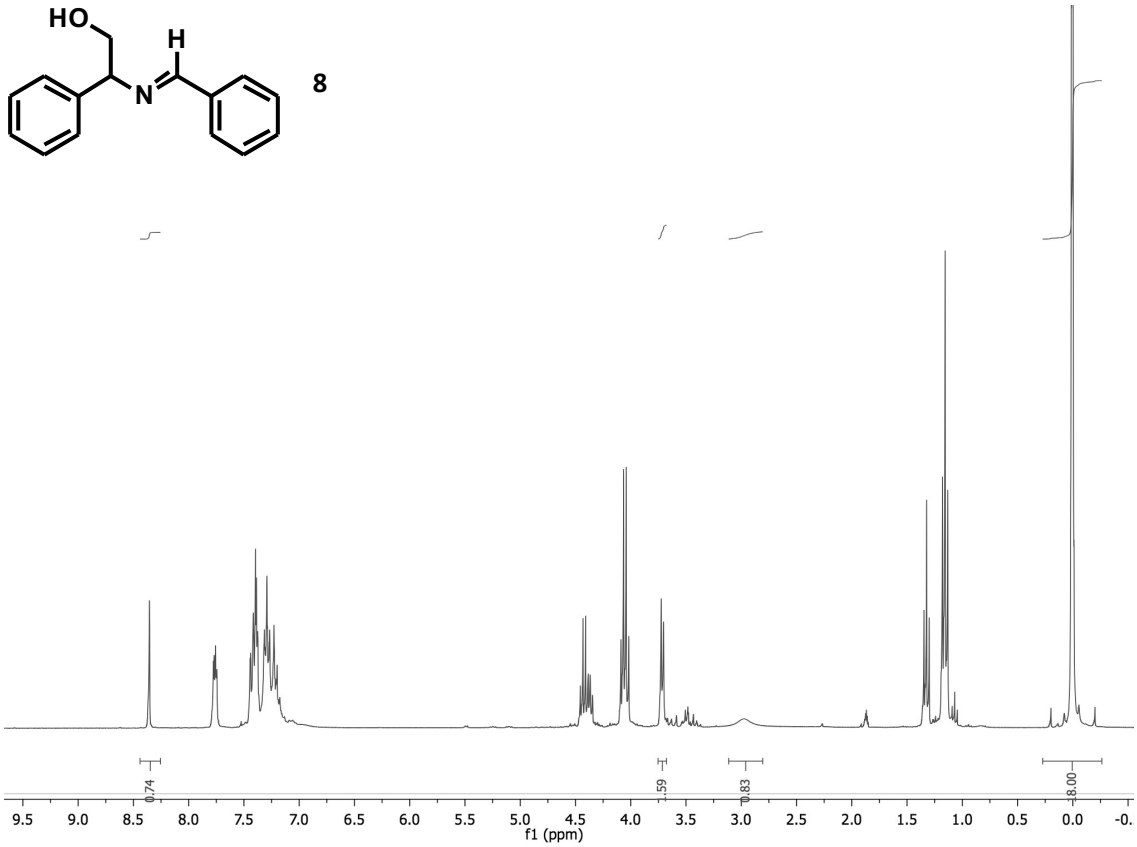
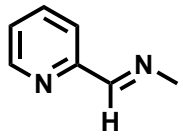
1.73
1.78
0.92
18.00
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)

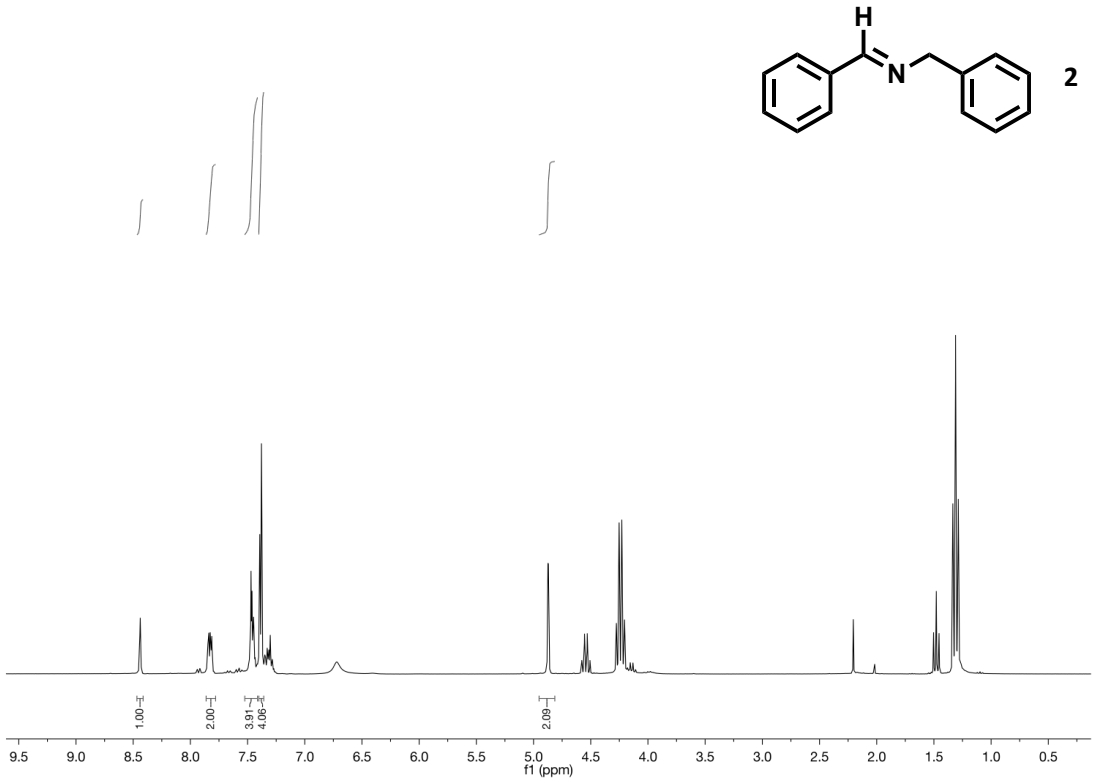

HO
H
N
8
0.74
1.59
0.83
8.00
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.
f1 (ppm)

For the yield of **10**, a round bottom flask equipped with a magnetic stir bar and a condenser was charged with 2-[(methylamino)methyl]pyridine (0.20 mmol), DEAD (0.24 mmol), and hexamethyldisilazane as internal standard (0.20 mmol) and d_3-acetonitrile 0.5mL. The resulting solution was stirred in reflux acetonitrile. Reaction mixture was monitored by NMR after 90 minutes.



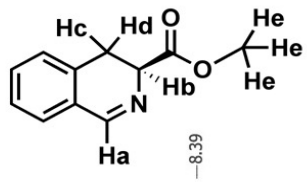
10

For the scaled-up reaction of **1** with DEAD, a round-bottom flask equipped with a magnetic stir bar was charged with **1** (4.00 mmol), DEAD (4.8 mmol) and 10 mL of acetonitrile. The resulting solution was stirred at room temperature for 90 minutes. The solvent was then evaporated *in vacuo*. The resulting mixture was then analyzed by ^{1}H NMR in $CDCl_3$.

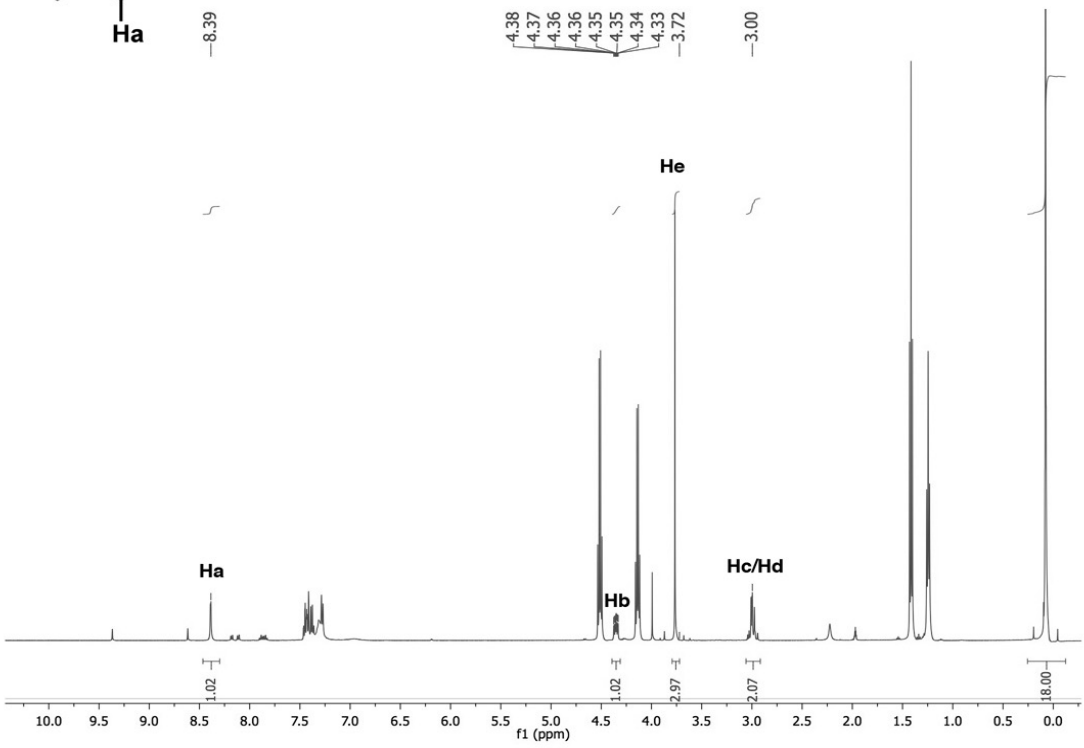


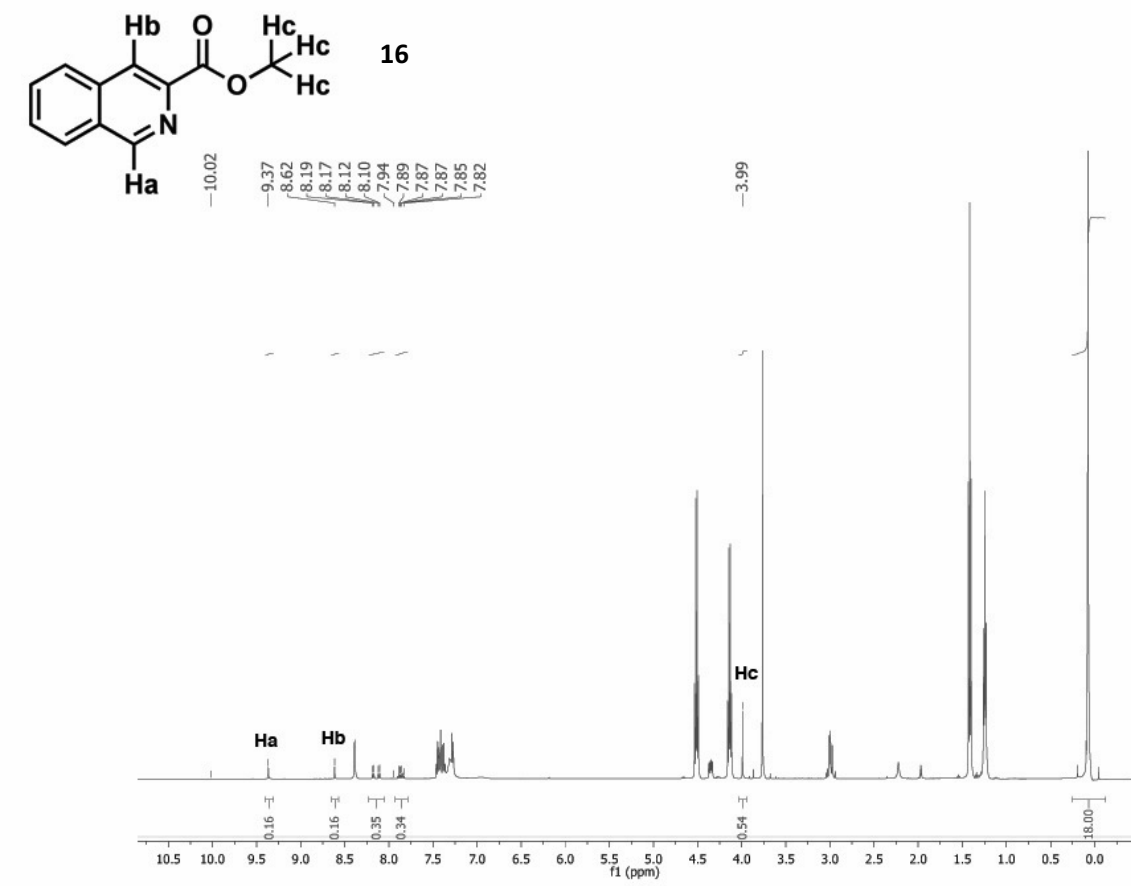
6. Procedure for Monitoring of Formation and Oxidation of 14

A vial equipped with a magnetic stir bar was charged with amine (0.20 mmol), azo compound (0.44 mmol), hexamethyldisilazane as internal standard (0.20 mmol) and d_3-acetonitrile 0.75mL. The resulting solution was stirred at ambient temperature. Reaction mixture was monitored by NMR every 15 min until completion.



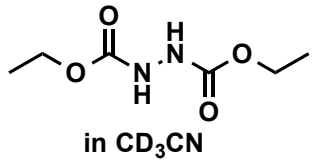
16

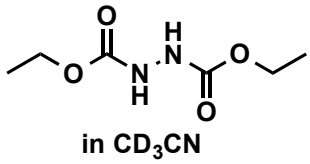


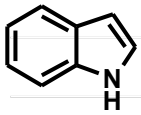

Hb
O
Hc
Hc
Hc
O
N
Ha
16
10.02
9.37
8.62
8.19
8.17
8.12
8.10
7.94
7.89
7.87
7.87
7.85
7.82
3.99
Ha
Hb
Hc
0.16
0.16
0.35
0.34
0.54
18.00
f1 (ppm)

7. NMR Spectra

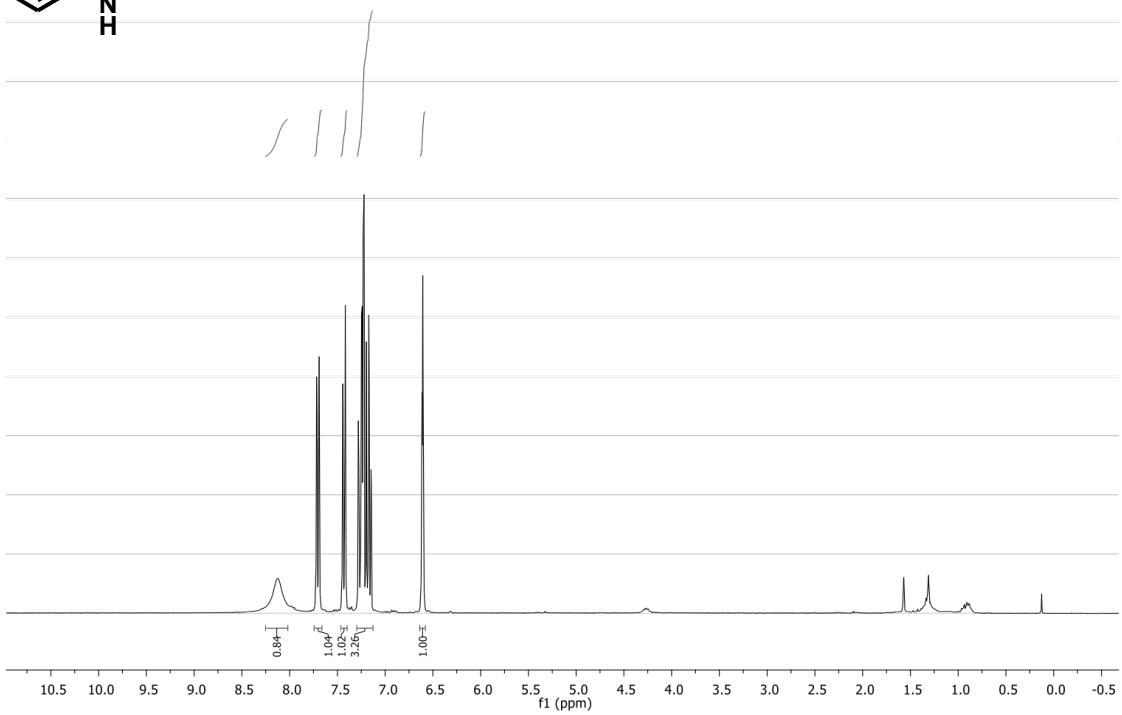
All spectra are run in $CDCl_3$ unless otherwise noted.

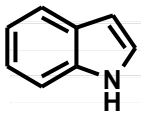






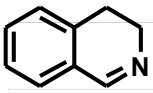
12


0.84
1.04
1.02
3.26
1.00
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
f1 (ppm)

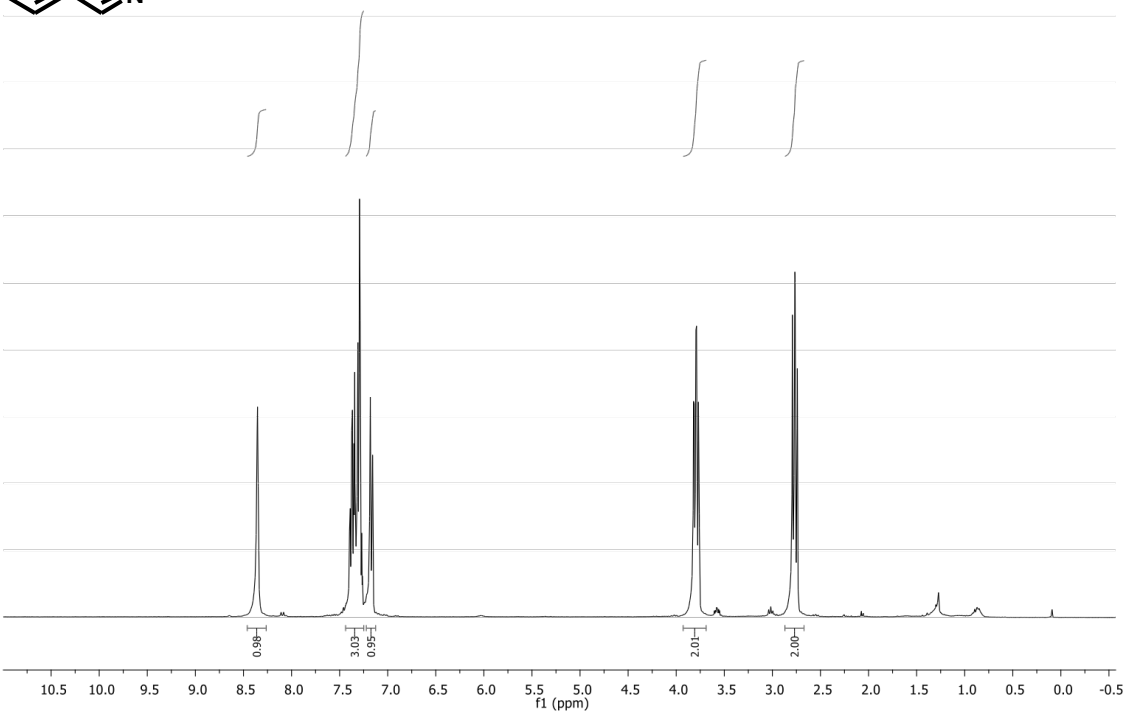


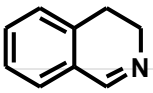
12

135.83
127.91
124.21
123.04
120.79
119.88
111.10
102.65
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)



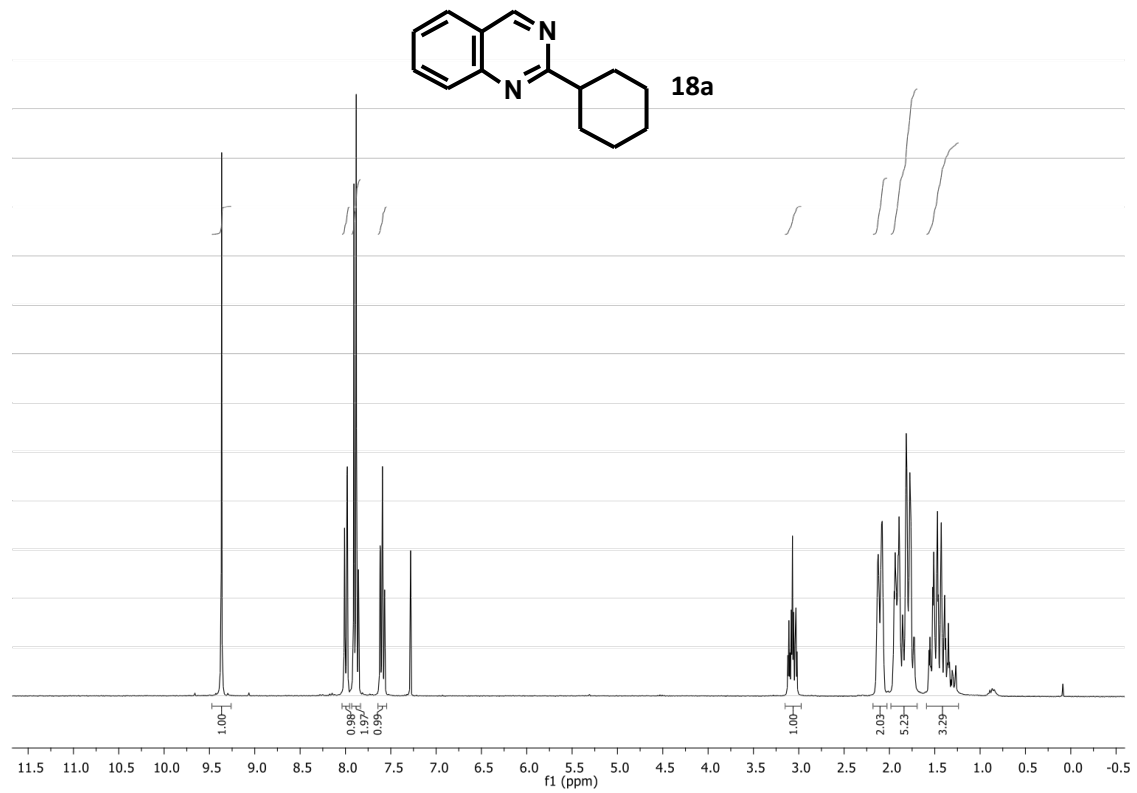
14

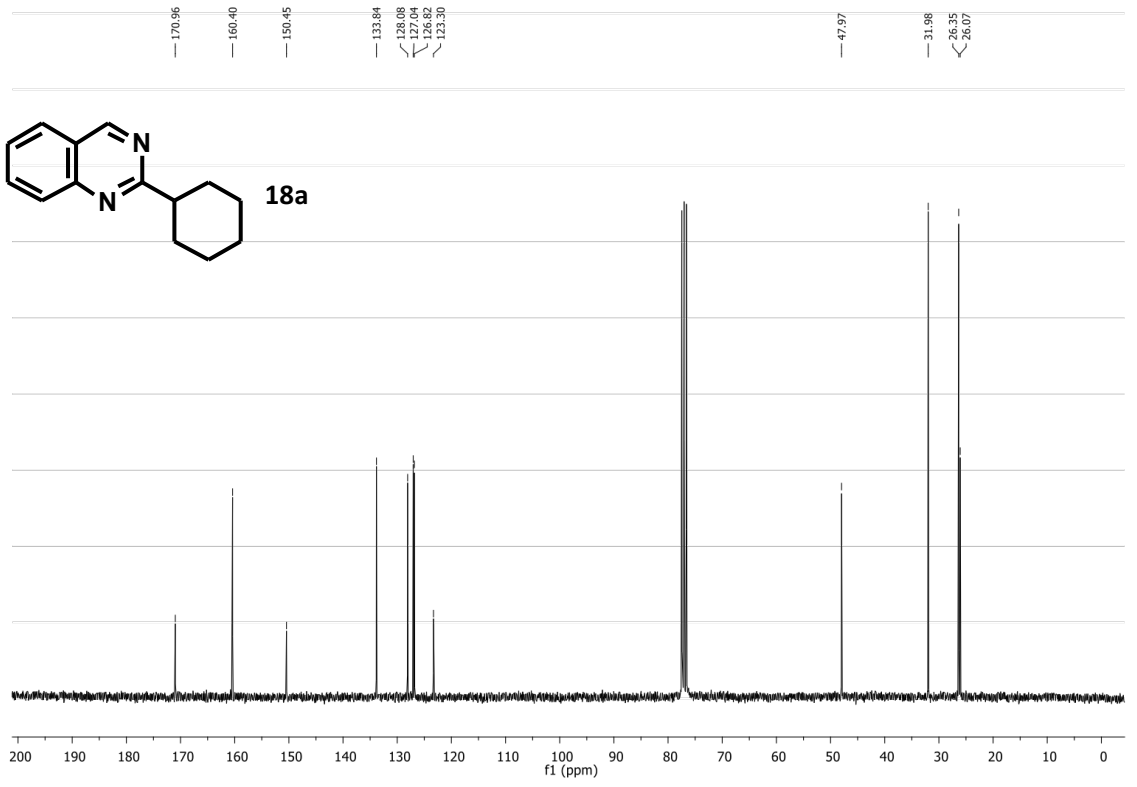

0.98
3.03
0.95
2.01
2.00
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)

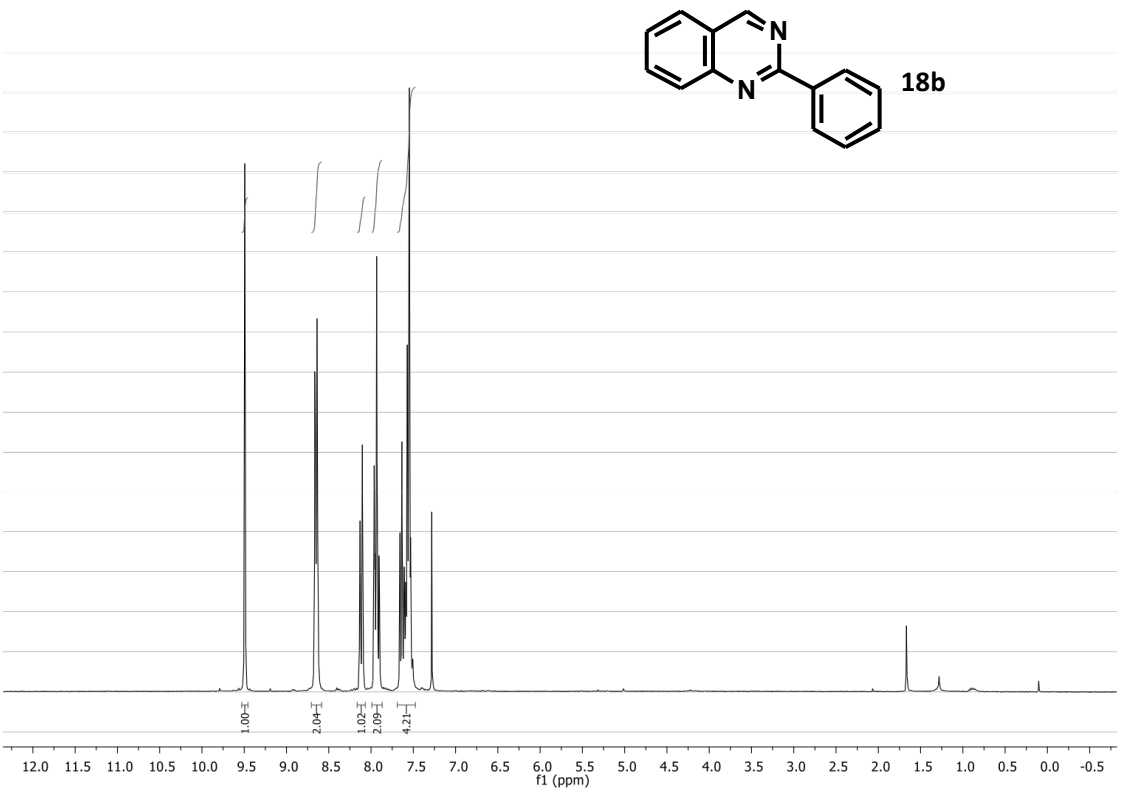


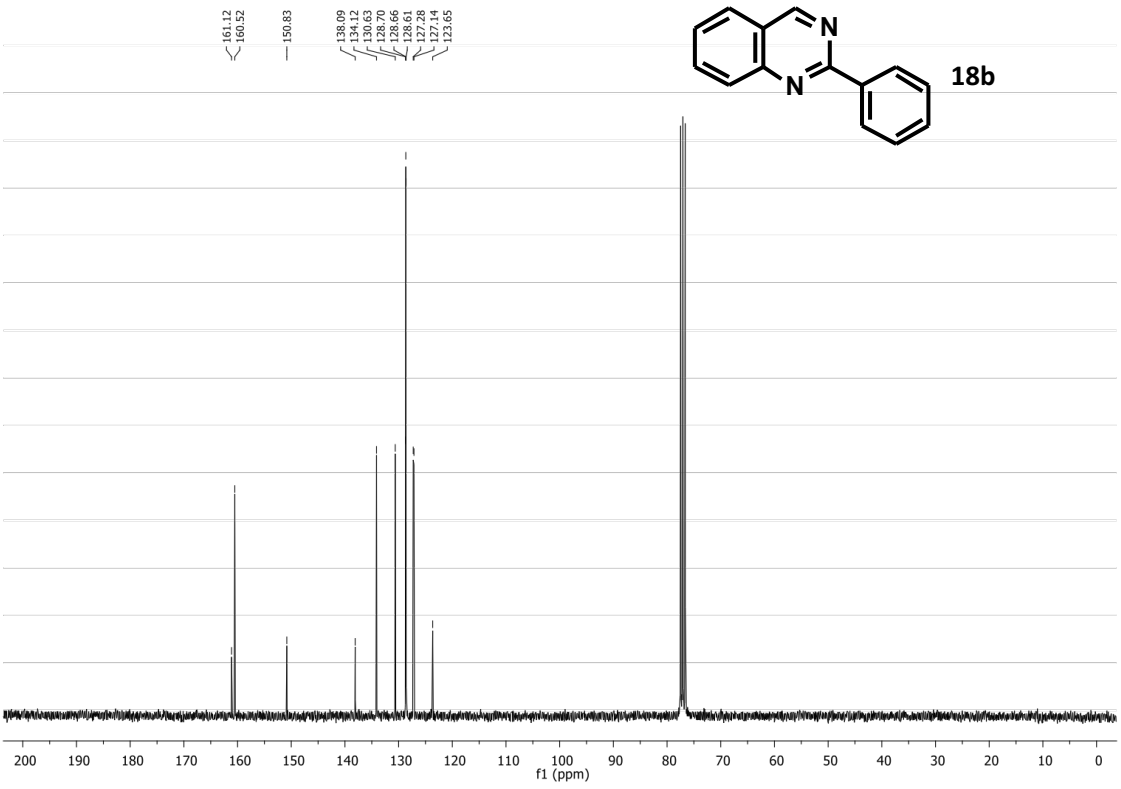
14

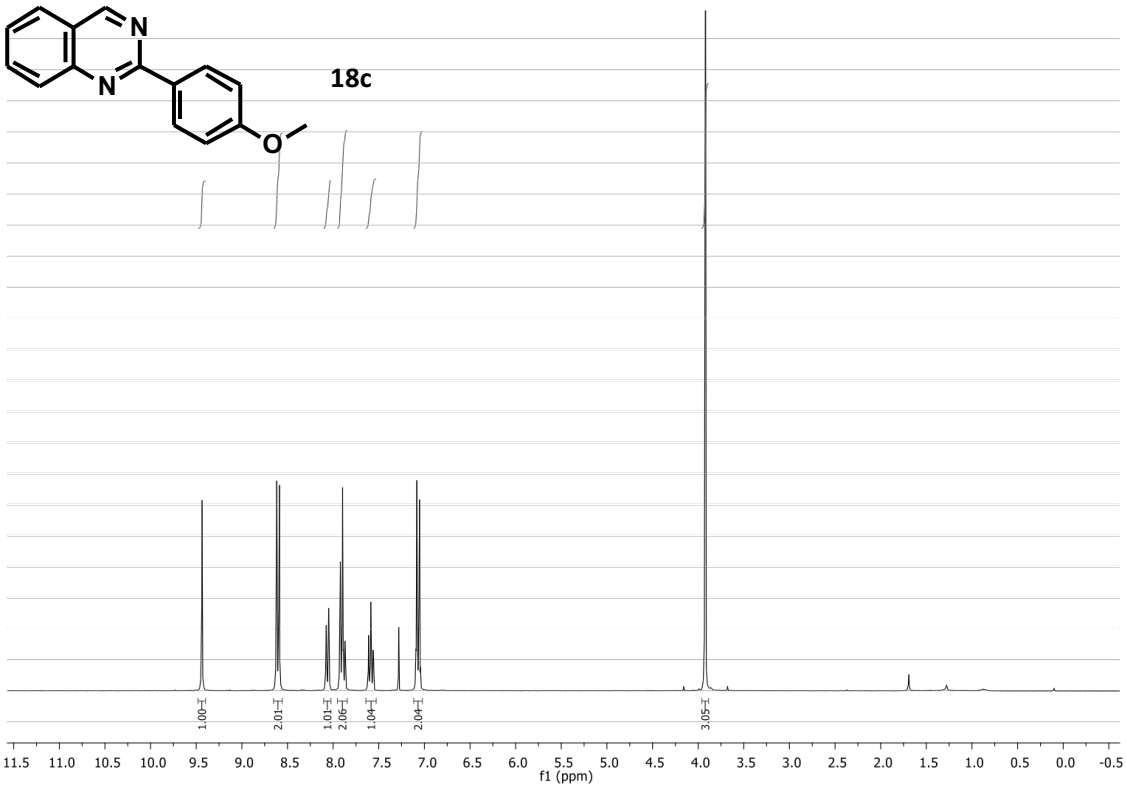
160.36
136.36
131.06
128.55
127.44
127.21
127.10
47.43
25.05
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

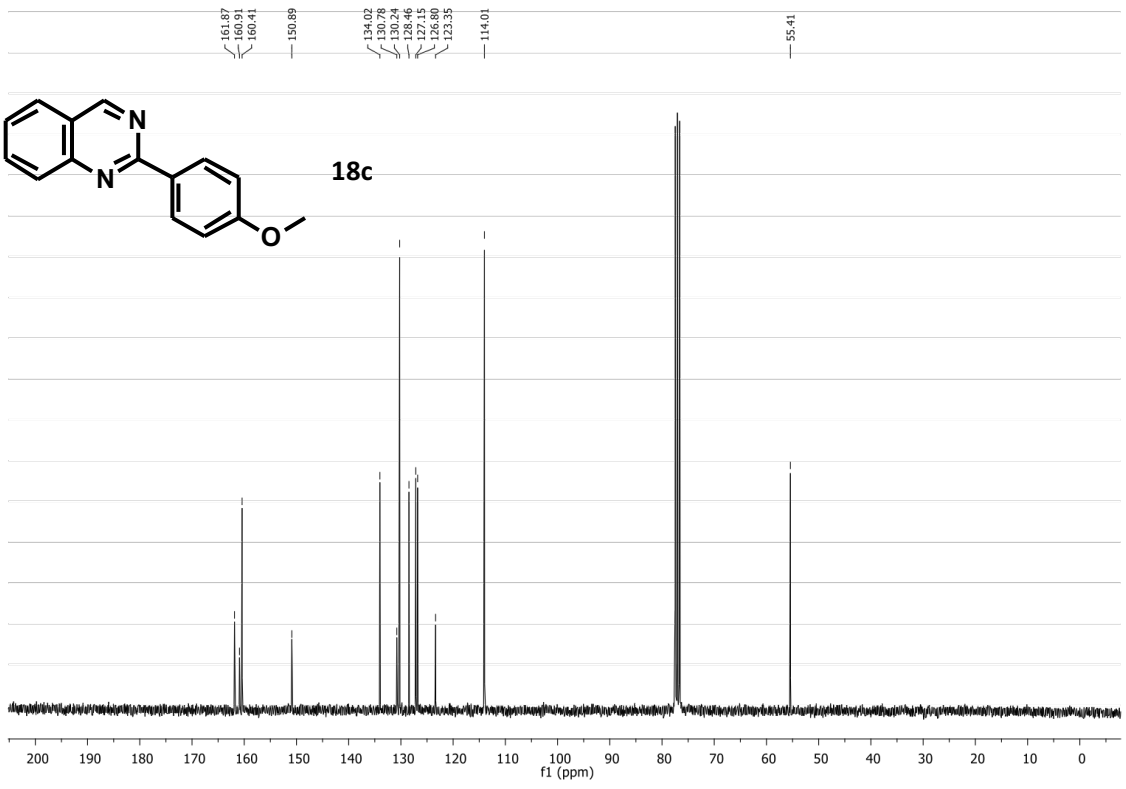

18a
1.00
0.98
1.97
0.99
1.00
2.03
5.23
3.29
11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)

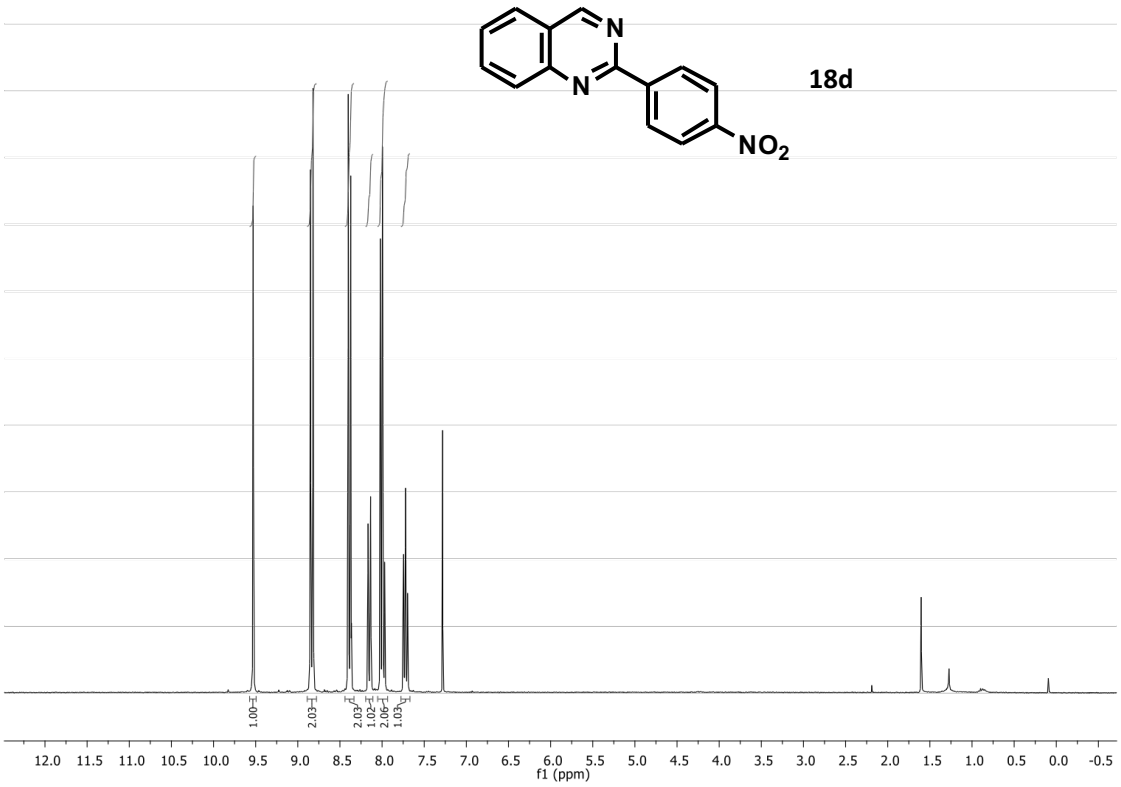

170.96
160.40
150.45
133.84
128.08
127.04
126.82
123.30
47.97
31.98
26.35
26.07
18a
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

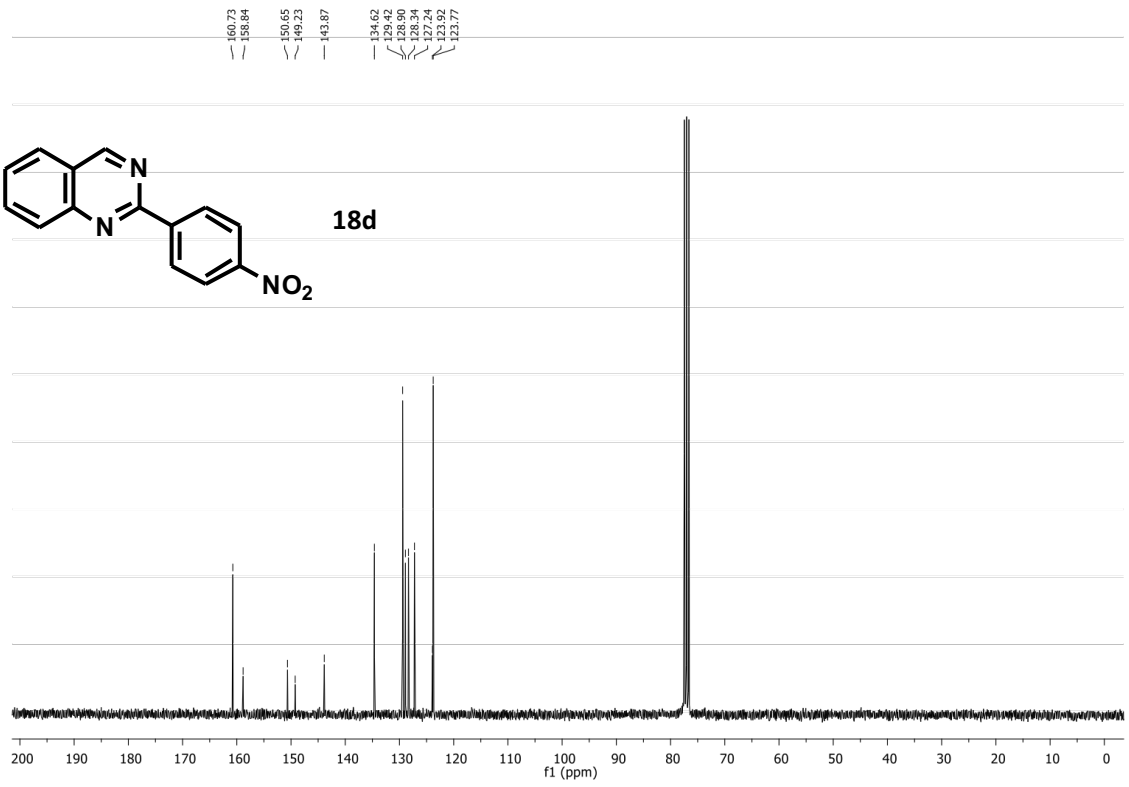

18b
1.00
2.04
1.02
2.09
4.21
f1 (ppm)

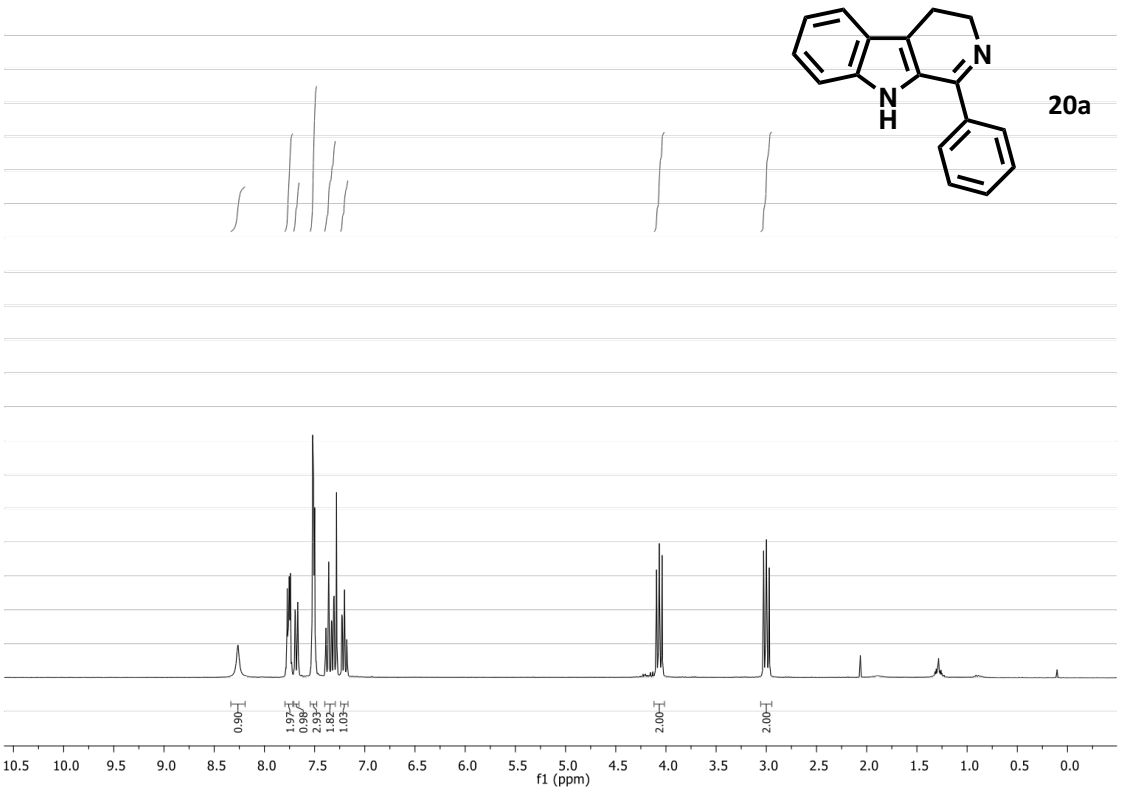

161.12
160.52
150.83
138.09
134.12
130.63
128.70
128.66
128.61
127.28
127.14
123.65
18b
f1 (ppm)

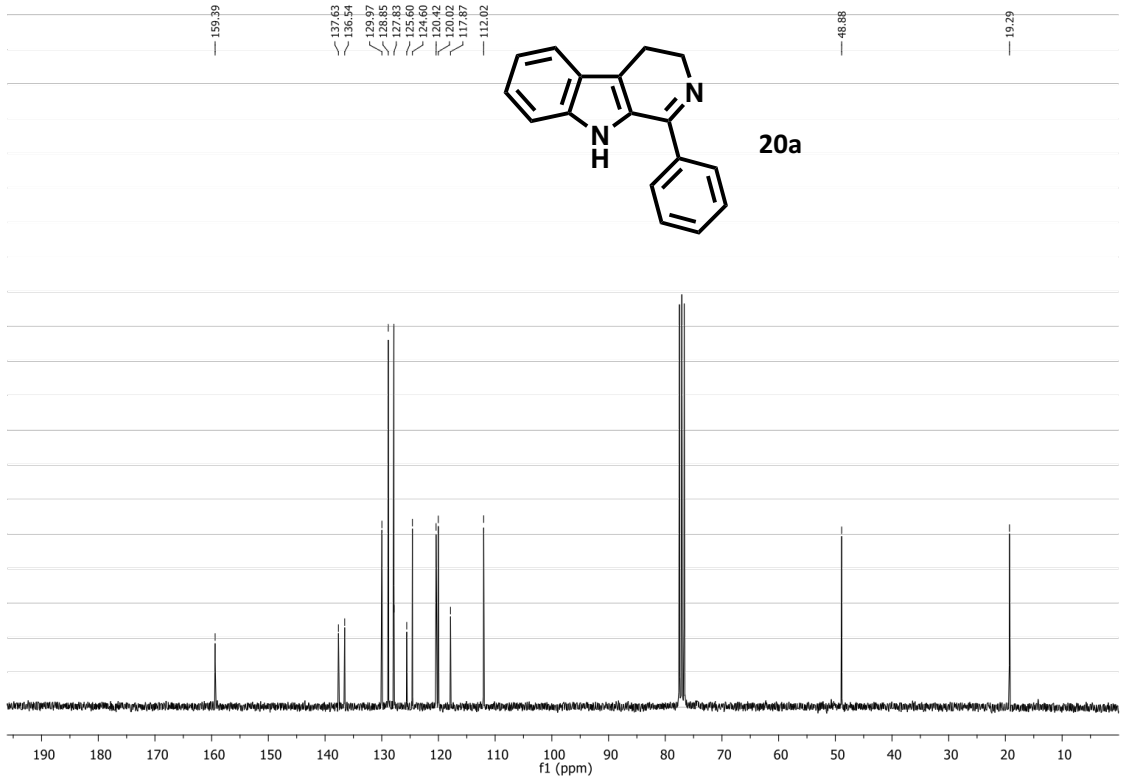

18c
1.00
2.01
1.01
2.06
1.04
2.04
3.05
f1 (ppm)

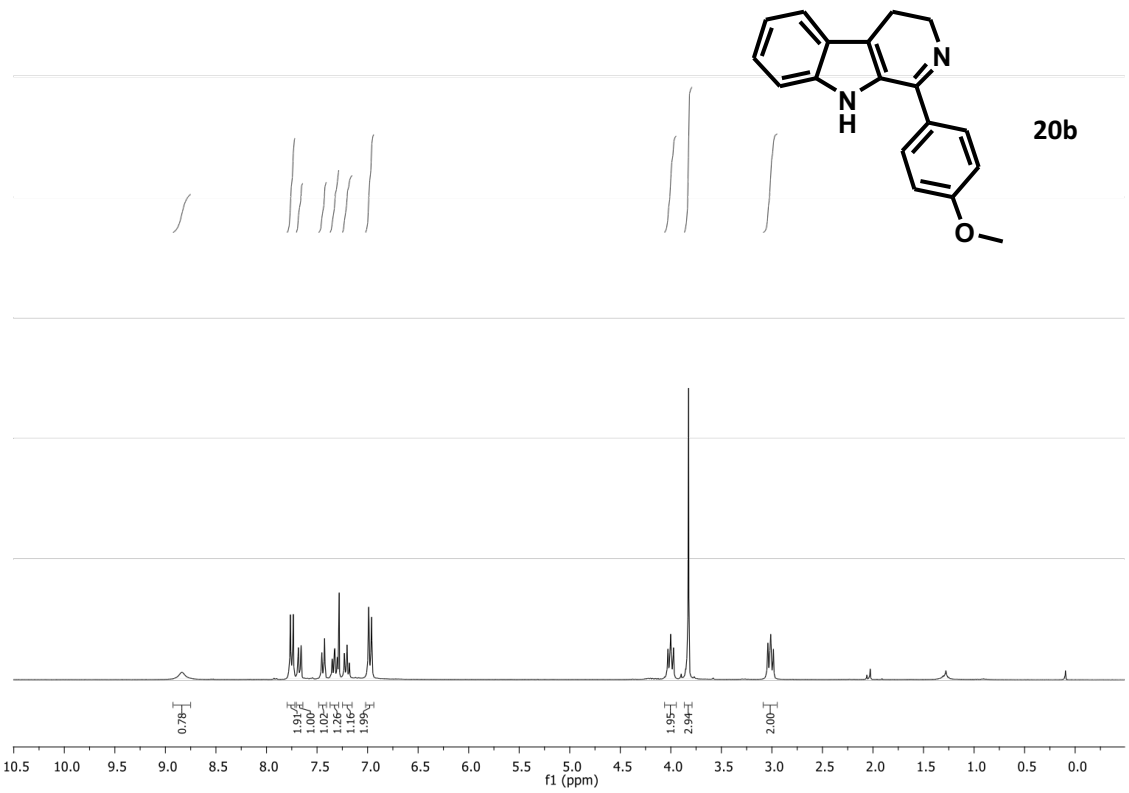

161.87
160.91
160.41
150.89
134.02
130.78
130.24
128.46
127.15
126.80
123.35
114.01
55.41
18c
f1 (ppm)

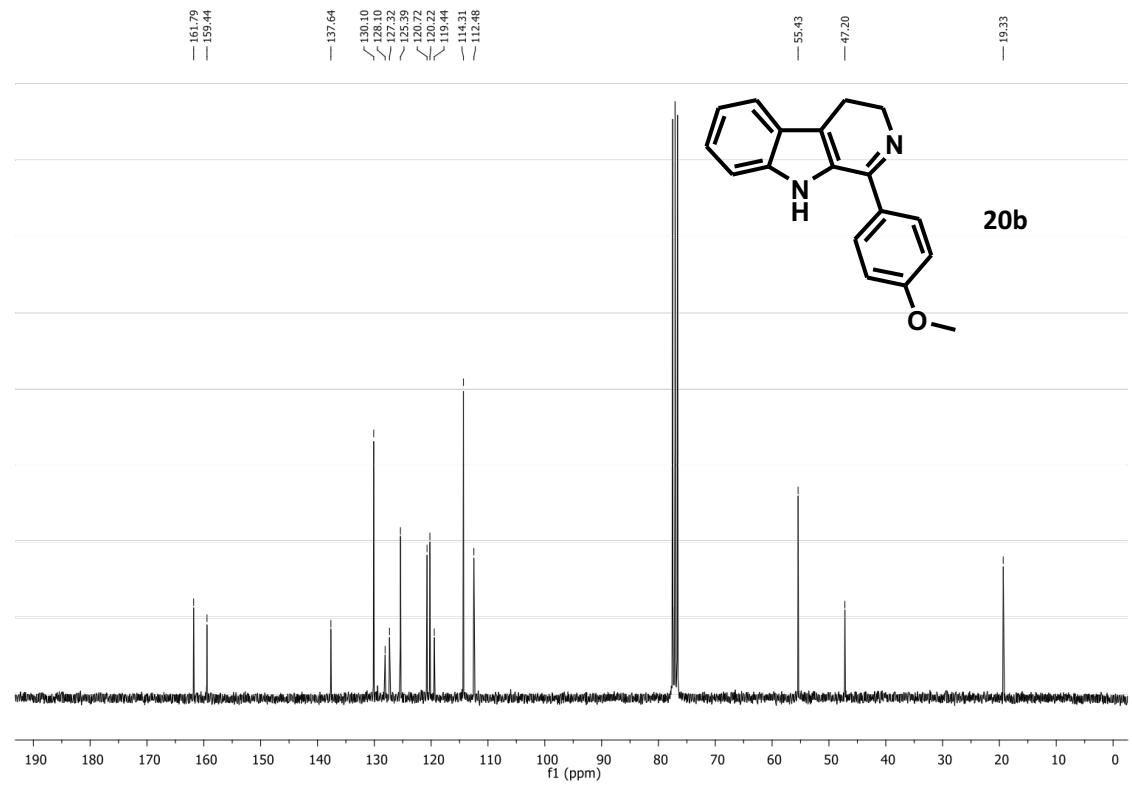

18d
NO2
1.00
2.03
2.03
1.02
2.06
1.03
12.0 11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)

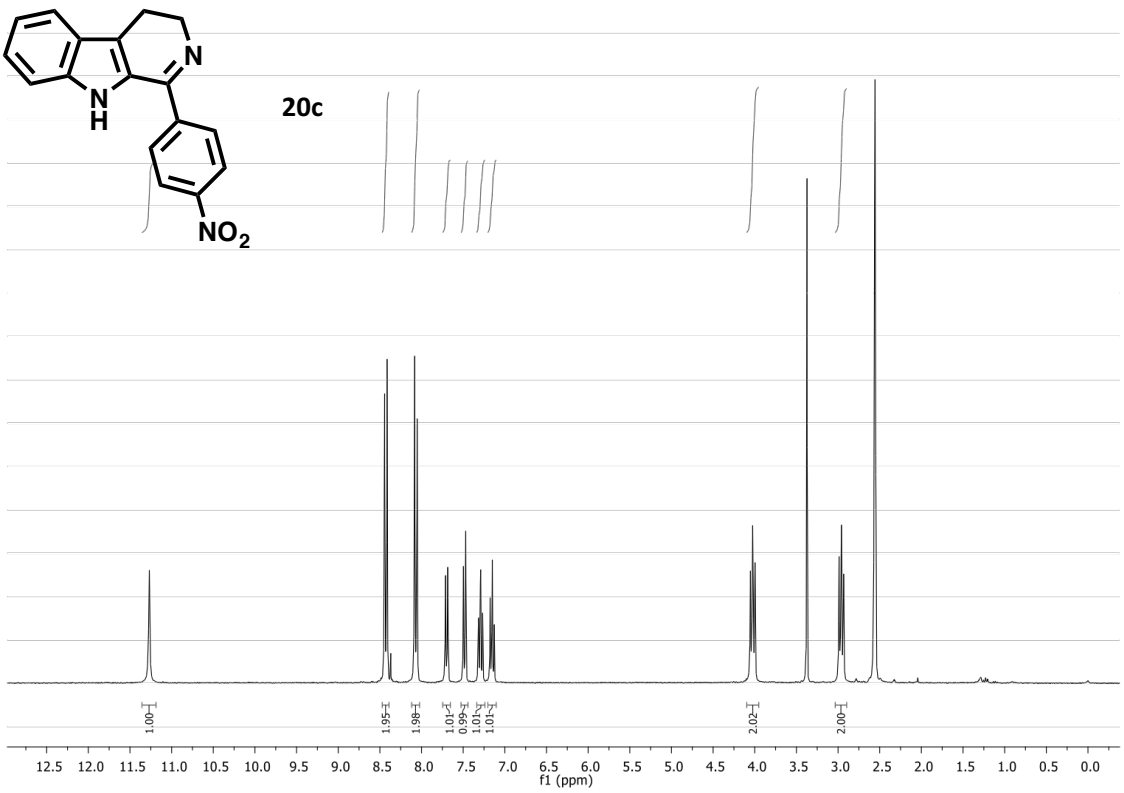

160.73
158.84
150.65
149.23
143.87
134.62
130.42
128.90
128.34
127.24
123.92
123.77
18d
NO2
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

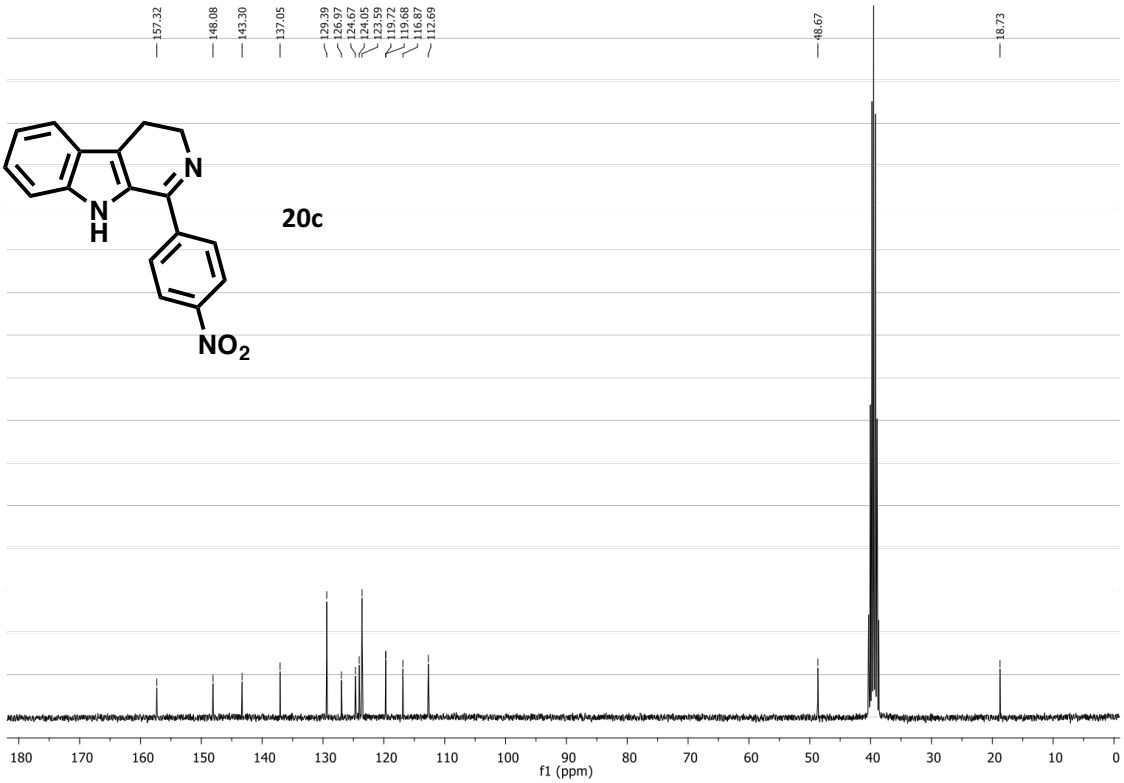

N
N
H
20a
0.90
1.97
0.98
2.93
1.82
1.03
2.00
2.00
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

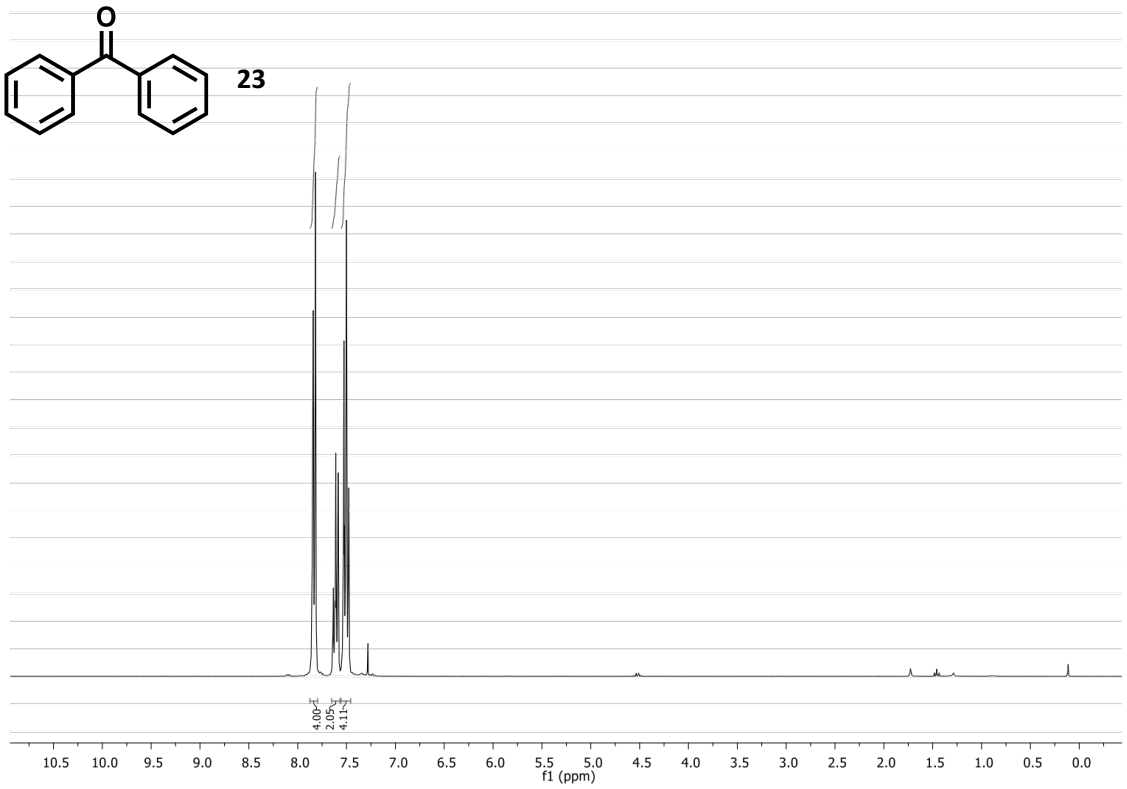

159.39
137.63
136.54
129.97
129.85
127.23
125.60
124.60
120.42
120.02
117.87
112.02
48.88
19.29
N
N
H
20a
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)

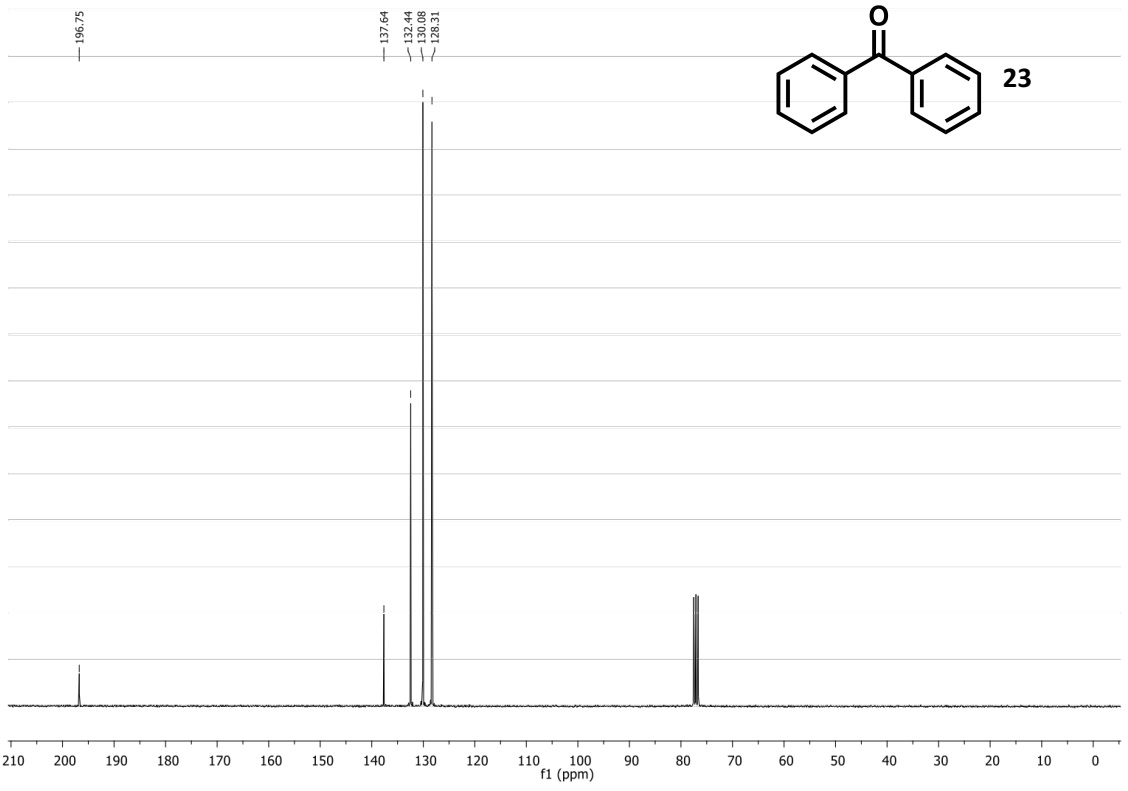

N
H
O
20b
0.78
1.91
1.00
1.02
1.26
1.16
1.99
1.95
2.94
2.00
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

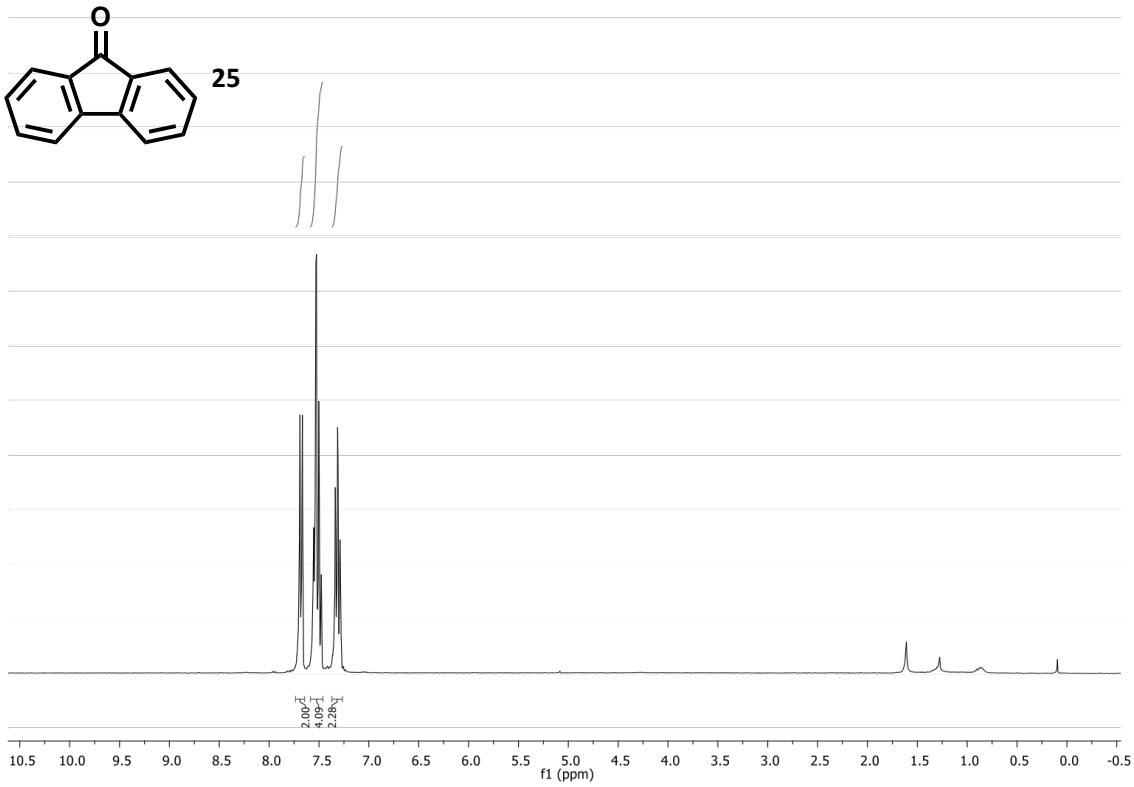

161.79
159.44
137.64
130.10
128.10
127.32
125.39
120.72
120.22
119.44
114.31
112.48
55.43
47.20
19.33
N
H
O
20b
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

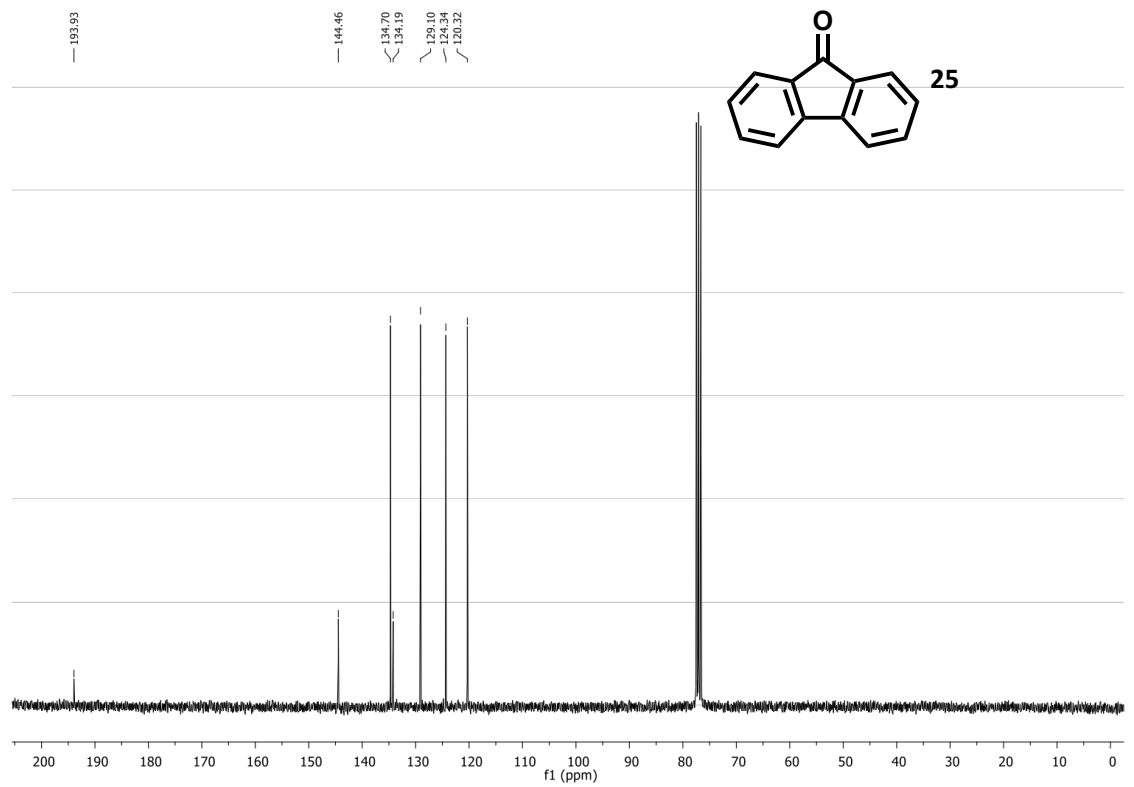

20c
N
N
H
NO2
1.00
1.95
1.98
1.01
0.99
1.01
1.01
2.02
2.00
12.5 12.0 11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

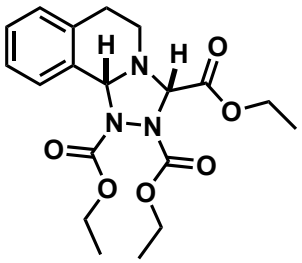

157.32
148.08
143.30
137.05
129.39
126.97
124.67
124.05
123.59
119.72
119.68
116.87
112.69
48.67
18.73
20c
N
N
H
NO2
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


23
4.00
2.05
4.11
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
f1 (ppm)


196.75
137.64
132.44
130.08
128.31
23
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

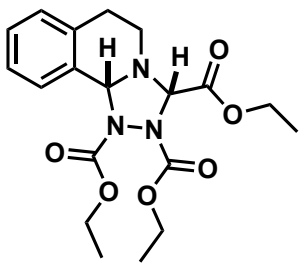

O
25
2.00
4.09
2.28
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)


193.93
144.46
134.70
134.19
129.10
124.34
120.32
O
25
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)



28

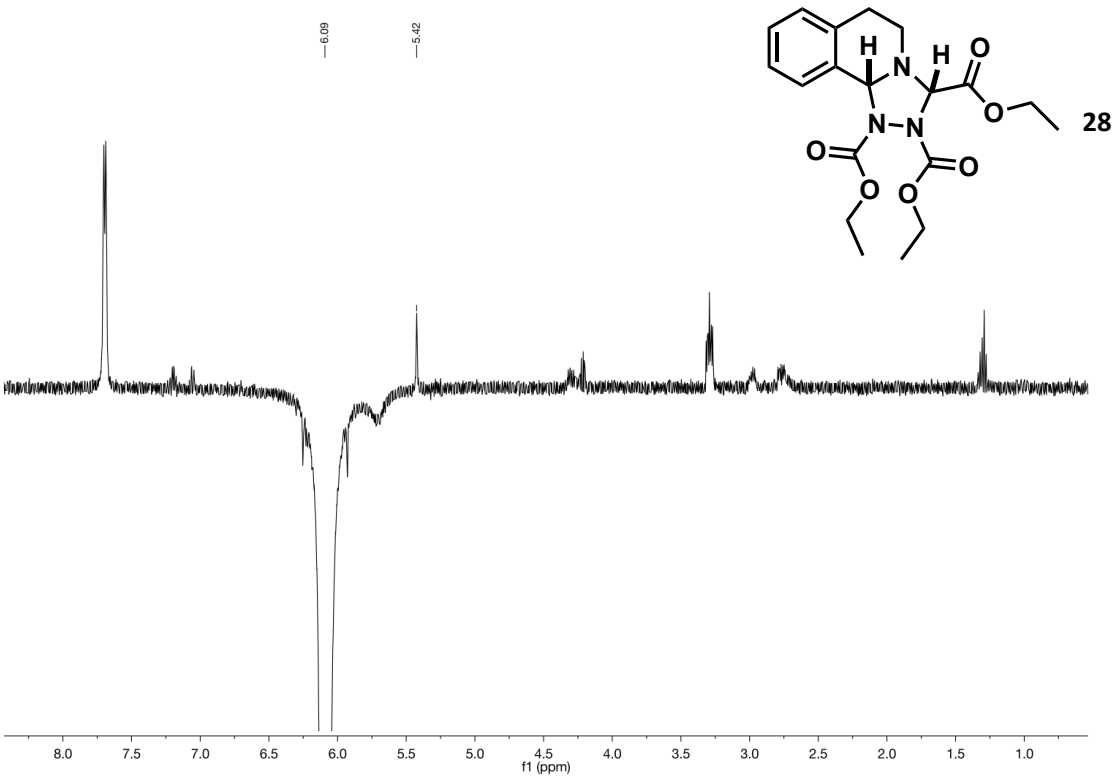
1.00
2.14
1.03
1.00
1.05
4.35
2.07
1.06
1.06
2.10
6.46
3.01
16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 -1 -2 -3 -4
f1 (ppm)

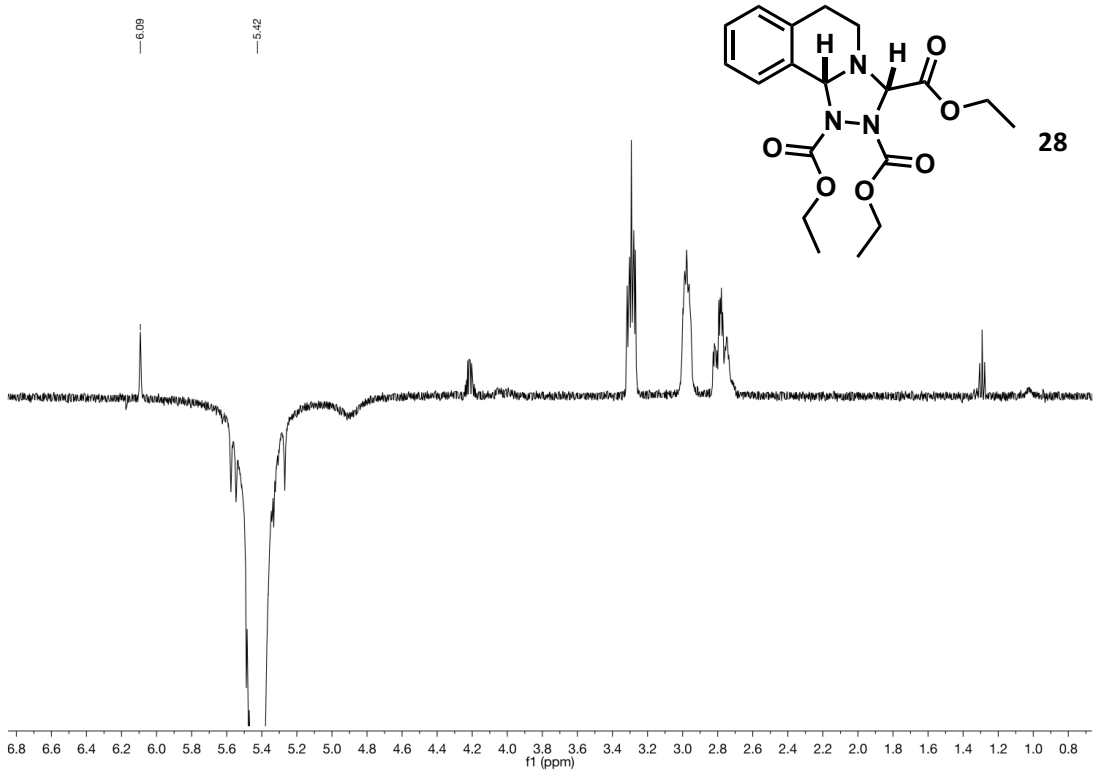


28

167.98
158.45
156.93
135.35
132.36
128.94
127.83
127.77
126.85
126.72
77.00
74.53
62.95
62.88
61.77
47.02
26.36
14.45
14.14
14.04
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

NOE Experiment for Determining the Relative Stereochemistry of **28**





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