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# Supporting Information

69451 Weinheim, Germany

# Synthesis of Nitrogen Heterocycles by the Ring Opening Reaction of Pyridinium Salts

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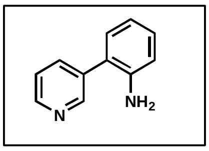
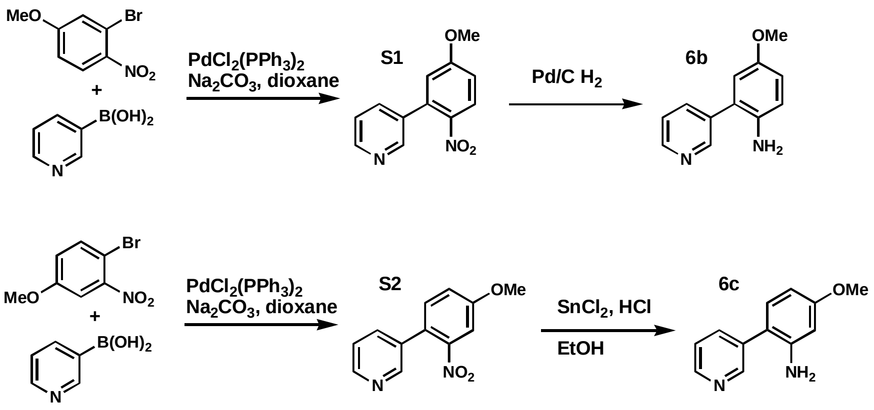
## Experimental Procedures

## $^{1}H$- and $^{13}C$-NMR Spectra

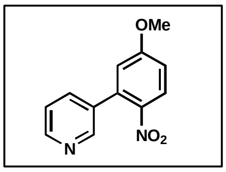
**General Experimental Information:** All reactions were performed under an inert atmosphere of Argon unless otherwise noted. Melting points were determined on a Mel-Temp apparatus and are uncorrected. $^1$H and $^{13}$C NMR spectra were obtained on a Bruker Avance 500 MHz spectrometer. Chemical shifts are reported in ppm referenced to the internal solvent peaks of methanol-$d_4$ and DMSO-$d_6$, at 3.31 ppm and 2.50 ppm for $^1$H NMR and 49.15 ppm and 39.51 ppm for $^{13}$C NMR, respectively. IR spectra were obtained on a Perkin-Elmer Spectrum RX 1 FT-IR spectrophotometer using NaCl plates unless noted otherwise. TLC analysis was performed on EMD Silica Gel 60 $F_{254}$ precoated glass plates. Mass spectrometry data was obtained on a Micromass LCT instrument using the ionization method indicated.



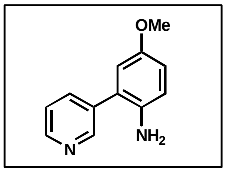
**General Procedure for Suzuki Cross Coupling (conditions are unoptimized): 2-Pyridin-3-yl-phenylamine (6a)** To a 1 L round bottom flask equipped with a magnetic stir bar was added degassed 1,4-dioxane (350 mL). 3-Pyridylboroxin (18.3 g, 58.0 mmol), 2-bromoaniline (25 g, 145.0 mmol), and *trans*-dichlorobis-(triphenylphosphine) palladium (II) (5.1 g, 7.3 mmol) were added sequentially and the mixture stirred at room temperature for 30 minutes. Aqueous $Na_2CO_3$ (435.0 mL, 435.0 mmol) was added as a 1.0 M solution and the reaction was heated to reflux and stirred for 12 hours, at which point the reaction was concentrated in vacuo. The crude product was dissolved in EtOAc and washed with saturated NaCl and dried over anhydrous $Na_2SO_4$. Purification via silica gel column chromatography (40% – 60% EtOAc/hexanes) afforded known **6a** as a light yellow oil (18.75 g, 76%): All spectroscopic data are in accord with literature values. Rebstock, A.; Mongin, F.; Trécourt, F.; Quéquiner, G. *Org. Biomol. Chem.* **2003**, *1,* 3064-3068.



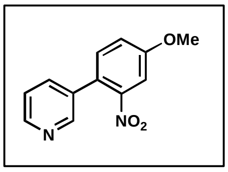
**Scheme 1. Synthesis of Pyridylanilines 6b and 6c.**



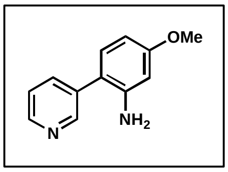
**3-(5-Methoxy-2-nitrophenyl)-pyridine (S1)** As described in the general procedure 3-pyridylboronic acid (1.0 g, 8.1 mmol), 3-iodo-4-nitroanisole (2.0 g, 7.3 mmol), *trans*-dichlorobis-(triphenylphosphine) palladium (II) (280 mg, 0.08 mmol) and 1,4-dioxane (40 mL) were allowed to stir at room temperature for 20 min before addition of aqueous $Na_2CO_3$ (24.3 mL, 24.3 mmol); the mixture was heated to reflux for 12 hours. Purification via silica gel chromatography (40%-70% EtOAc/hexanes) afforded known **S1** as a pale yellow crystalline solid (1.41 g, 85%): mp 87-89 $^{o}$C (EtOAc); $^{1}$H NMR (500 MHz, $CD_3OD$, 298 K) $\delta$ 8.60 (d, $J$ = 5.0 Hz, 1 H), 8.52 (d, $J$ = 2.2 Hz, 1 H), 8.17 (d, $J$ = 9.1 Hz, 1 H), 7.84 (d, $J$ = 8.5 Hz, 1 H), 7.54 (dd, $J$ = 5.0, 7.8 Hz, 1 H), 7.18 (dd, $J$ = 2.8, 9.1 Hz, 1 H), 7.00 (d, $J$ = 2.8 Hz, 1 H), 3.97 (s, 3 H); $^{13}$C NMR (125 MHz, $CD_3OD$, 298 K) $\delta$ 164.8, 149.5, 149.0, 142.9, 137.9, 137.0, 136.9, 128.8, 125.1, 118.7, 115.4, 56.9; IR (KBr) 1575.9, 1503.3, 1300.9, 1223.1 cm$^{-1}$; TLC $R_f$ = 0.25 (1:1 EtOAc:hexanes); LRMS (ESI) *m/z* (relative intensity): 231 (100) ; HRMS (CI) *m/z* calcd for $C_{12}H_{11}N_2O_3$ $[M+H]^+$, 231.0770, found 231.0768.



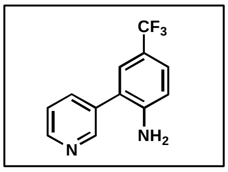
**4-Methoxy-6-pyridin-3-ylphenylamine (6b)** To a 50 mL round bottom flask equipped with a magnetic stir bar was added 3-(5-methoxy-2-nitrophenyl)-pyridine (500 mg, 2.2 mmol), 10 wt% palladium on activated carbon (230 mg, 0.22 mmol), and methanol (20 mL). The flask was purged with argon and finally vacuum before the mixture was vigorously stirred and hydrogen gas was introduced via balloon. The reaction mixture stirred at room temperature for 2 hours before being flushed with argon, diluted with EtOAc, and filtered through a pad of celite. The filter cake was washed with EtOAc and the combined filtrate and washings were dried over $Na_2SO_4$ and concentrated in vacuo. The crude residue was passed through a silica gel plug (75% EtOAc/hexanes – 100% EtOAc) to afford pure **6b** as an off-white crystalline solid (286 mg, 65%): mp 133-134 $^{o}$C (EtOAc); $^{1}$H NMR (500 MHz, $CD_3OD$, 298 K) $\delta$ 8.64 (d, $J$ = 2.2 Hz, 1 H), 8.54 (d, $J$ = 5.0 Hz, 1 H), 7.97 (dt, $J$ = 1.7, 7.8 Hz, 1 H), 7.54 (dd, $J$ = 5.0, 7.8 Hz, 1 H), 6.84 (m, 2 H), 6.71 (d, $J$ = 2.6 Hz, 1 H), 3.77 (s, 3 H); $^{13}$C NMR (125 MHz, $CD_3OD$, 298 K) $\delta$ 154.6, 150.4, 148.7, 139.5, 139.0, 137.9, 126.2, 125.5, 119.3, 116.7, 116.6, 56.3; IR (KBr) 3403.8, 1476.2, 1409.9, 1284.1, 1211.3 cm$^{-1}$; TLC $R_f$ = 0.25 (100% EtOAc); LRMS (ESI) *m/z* (relative intensity): 201 (100); HRMS (CI) *m/z* calcd for $C_{12}H_{13}N_2O$ $[M+H]^+$, 201.1028, found 201.1023.



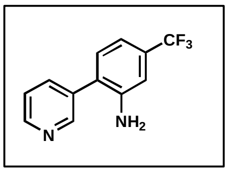
**3-(4-Methoxy-2-nitrophenyl)-pyridine (S2)** As described in the general procedure, 3-pyridylboronic acid (200 mg, 1.6 mmol), 4-iodo-3-nitroanisole (404 mg, 1.4 mmol), *trans*-dichlorobis-(triphenylphosphine) palladium (II) (56 mg, 0.08 mmol) and 1,4-dioxane (8 mL) were allowed to stir at room temperature for 20 min before addition of aqueous $Na_2CO_3$ (4.8 mL, 4.8 mmol), the mixture was heated to reflux for 4 hours. Purification via silica gel chromatography (20%-60% EtOAc/hexanes) afforded known **S2** as a mustard yellow solid (242 mg, 73%): $^1$H NMR (500 MHz, $CD_3OD$, 298 K) δ 8.54 (d, *J* = 5.0 Hz, 1 H), 8.46 (s, 1 H), 7.78 (d, *J* = 7.8 Hz, 1 H), 7.56 (d, *J* = 2.5 Hz, 1 H), 7.48 (dd, *J* = 5.0, 7.8 Hz, 1 H), 7.43 (d, *J* = 8.5 Hz, 1 H), 7.32 (dd, *J* = 2.5, 8.5 Hz, 1 H), 3.92 (s, 3 H); $^{13}$C NMR (125 MHz, $CD_3OD$, 298 K) δ 161.8, 151.1, 149.3, 149.2, 138.1, 136.1, 134.4, 125.7, 125.2, 120.2, 111.0, 56.8. All spectroscopic data are in accord with literature values. Shigyo, H.; Sato, S.; Shibuya, K.; Takahashi, Y.; Yamaguchi, T.; Sonoki, H.; Ohta, T. *Chem. Pharm. Bull.* **1993**, *41*, 1573-1582. $^1$H NMR data was compiled on a 200 MHz spectrometer, therefore $^1$H NMR data compiled on a 500 MHz spectrometer is provided.



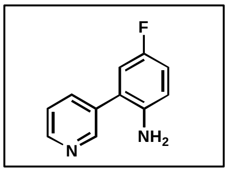
**5-Methoxy-2-pyridin-3-ylphenylamine (6c)** To a 50 mL round bottom flask equipped with a magnetic stir bar was added 3-(4-methoxy-2-nitrophenyl)-pyridine (400 mg, 1.7 mmol) and absolute ethanol (10 mL). Tin (II) chloride (323 mg, 1.7 mmol) and concentrated HCl (2 mL) were added sequentially and the reaction was heated to 100 $^o$C and allowed to stir for 1.5 hours. The reaction mixture was cooled to room temperature and poured into 25 mL 1 N NaOH and extracted with EtOAc (3 x 40 mL). The combined organics were washed with brine, dried over anhydrous $Na_2SO_4$, filtered and concentrated in vacuo. The crude residue was purified via silica gel chromatography (60% EtOAc/hexanes – 100% EtOAc) affording known **6c** as a pale yellow crystalline solid (164 mg, 48%): All spectroscopic data are in accord with literature values. Shigyo, H.; Sato, S.; Shibuya, K.; Takahashi, Y.; Yamaguchi, T.; Sonoki, H.; Ohta, T. *Chem. Pharm. Bull.* **1993**, *41*, 1573-1582, and references therein.



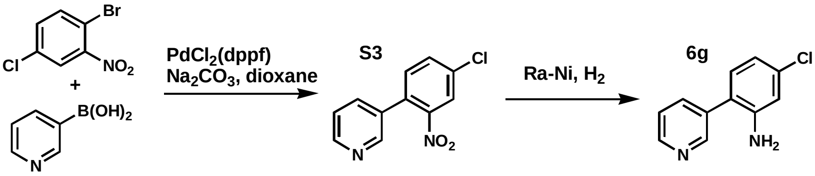
**2-Pyridin-3-yl-4-trifluoromethylphenylamine (6d)** As described in the general procedure, 3-pyridylboronic acid (500 mg, 4.1 mmol), 4-amino-3-bromobenzotrifluoride (888 mg, 3.7 mmol), *trans*-dichlorobis-(triphenylphosphine) palladium (II) (147 mg, 0.21 mmol), and aqueous $Na_2CO_3$ (12.3 mL, 12.3 mmol) were refluxed in 1,4-dioxane (30 mL) for 12 hours. Purification via silica gel chromatography (30%-50% EtOAc/hexanes) afforded **6d** as a pale yellowish white solid (702 mg, 80%): mp 127-129 $^{o}$C (EtOAc); $^{1}$H NMR (500 MHz, DMSO-$d_6$, 298 K) δ 8.58 (d, $J$ = 1.7 Hz, 1 H), 8.54 (dd, $J$ = 1.7, 4.8 Hz, 1 H), 7.82 (dt, $J$ = 1.9, 3.9, 7.9 Hz, 1 H), 7.44 (dd, $J$ = 4.7, 7.9 Hz, 1 H), 7.36 (dd, $J$ = 2.1, 8.5 Hz, 1 H), 7.22 (d, $J$ = 1.9 Hz, 1 H), 6.85 (d, $J$ = 8.5 Hz, 1 H), 5.64 (br s, 2 H); $^{13}$C NMR (125 MHz, DMSO-$d_6$, 298 K) δ 149.3, 148.4, 136.4, 134.0, 127.3 (q, $J$ = 4 Hz), 125.9 (q, $J$ = 4 Hz), 125.1 (q, $J$ = 269 Hz), 123.9, 121.5, 116.2 (q, $J$ = 32 Hz), 114.9; IR (KBr) 3160.6, 1653.4, 1267.1, 713.3 cm$^{-1}$; TLC $R_f$ = 0.65 (100% EtOAc); LRMS (ESI) *m/z* (relative intensity): 239 (100); HRMS (CI) *m/z* calcd for $C_{12}H_9N_2F_3$ $[M+H]^+$, 239.0796, found 239.0797.



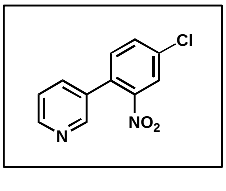
**2-Pyridin-3-yl-5-trifluoromethylphenylamine (6e)** As described in the general procedure 3-pyridylboronic acid (250 mg, 2.0 mmol), 3-amino-4-bromobenzotrifluoride (258 μL, 1.8 mmol), *trans*-dichlorobis-(triphenylphosphine) palladium (II) (70 mg, 0.1 mmol), and aqueous $Na_2CO_3$ (6.0 mL, 6.0 mmol) were heated to reflux in 1,4-dioxane for 24 hours. Purification via silica gel chromatography (50% EtOAc/hexanes – 100% EtOAc) afforded known **6e** as a dark brown oil (389 mg, 91%): All spectroscopic data are accord with literature values. Shigyo, H.; Sato, S.; Shibuya, K.; Takahashi, Y.; Yamaguchi, T.; Sonoki, H.; Ohta, T. *Chem. Pharm. Bull.* **1993**, *41*, 1573-1582, and references therein.



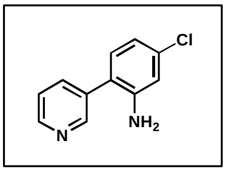
**4-Fluoro-2-pyridin-3-ylphenylamine (6f)** As described in the general procedure, 3-pyridylboronic acid (500 mg, 4.1 mmol), 2-bromo-4-fluoroaniline (421 μL, 3.7 mmol), *trans*-dichlorobis-(triphenylphosphine) palladium (II) (147 mg, 0.21 mmol), and aqueous $Na_2CO_3$ (12.3 mL, 12.3 mmol) were heated to reflux in 1,4-dioxane (20 mL) for 12 hours. Purification via silica gel chromatography (40% EtOAc/hexanes – 100% EtOAc) afforded **6f** as a brown solid (512 mg, 74%): mp 99-101 $^{o}$C (EtOAc); $^{1}$H NMR (500 MHz, DMSO-$d_6$, 298 K) δ 8.63 (d, *J* = 1.8 Hz, 1 H), 8.55 (dd, *J* = 1.6, 4.8 Hz, 1 H), 7.87 (dt, *J* = 1.9, 7.8, 9.5 Hz, 1 H), 7.46 (dd, *J* = 4.8, 7.4 Hz, 1 H), 6.95 (dt, *J* = 3.0, 8.3, 8.6 Hz, 1 H), 6.90 (dd, *J* = 3.0, 9.5 Hz, 1 H), 6.78 (dd, *J* = 5.1, 8.6 Hz, 1 H), 4.80 (br s, 2 H); $^{13}$C NMR (125 MHz, DMSO-$d_6$, 298 K) δ 154.7 (d, *J* = 230 Hz), 149.3, 148.2, 142.2, 136.2, 132.0 (d, *J* = 4 Hz), 123.7, 123.0 (d, *J* = 8 Hz), 116.5 (d, *J* = 8 Hz), 116.2 (d, *J* = 22 Hz), 115.4 (*J* = 22 Hz); IR (KBr) 3333.0, 3212.2, 1624.6, 1501.3, 1403.7, 1270.2, 1172.6, 1018.4 cm$^{-1}$; TLC $R_f$ = 0.50 (100% EtOAc); LRMS (ESI) *m/z* (relative intensity): 189 (100); HRMS (CI) *m/z* calcd for $C_{11}H_9N_2F$ $[M+H]^+$, 189.0828, found 189.0820.



**Scheme 2: Synthesis of Aniline 6g**

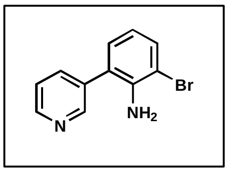


**3-(4-Chloro-2-nitro-phenyl)-pyridine (S3)** As described in the general procedure, 3-pyridylboronic acid (283 mg, 2.32 mmol), 2-bromo-5-chloro-nitrobenzene (500 mg, 2.11 mmol), dichloro[1,1'-bis(diphenylphosphino)ferrocene] palladium (II) (86 mg, 0.11 mmol), and aqueous $Na_2CO_3$ (6.33 mL, 6.33 mmol) were heated to reflux in 1,4-dioxane (40 mL) for 12 hours. Purification via silica gel chromatography (50% EtOAc/hexanes) afforded **S3** as a beige solid (488 mg, 98%): $^1$H NMR (500 MHz, DMSO-$d_6$, 298 K) δ 8.64 (dd, *J* = 1.6, 4.8 Hz, 1 H), 8.57 (d, *J* = 2.3 Hz, 1 H), 8.26 (d, *J* = 2.2 Hz, 1 H), 7.92 (dd, *J* = 2.2, 8.3 Hz, 1 H), 7.81 (dq, *J* = 1.7, 7.9 Hz, 1 H), 7.66 (d, *J* = 8.3 Hz, 1 H), 7.50 (dd, *J* = 4.8, 7.9 Hz, 1 H); $^{13}$C NMR (125 MHz, DMSO-$d_6$, 298 K) δ 149.9, 149.0, 148.1, 135.6, 133.8, 133.7, 133.2, 132.2, 131.0, 124.4, 123.6. All spectroscopic data are in accord with literature values. Shigyo, H.; Sato, S.; Shibuya, K.; Takahashi, Y.; Yamaguchi, T.; Sonoki, H.; Ohta, T. *Chem. Pharm. Bull.* **1993**, *41*, 1573-1582.

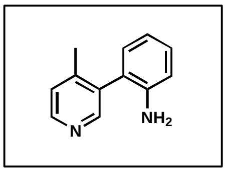


**3-Chloro-6-pyridin-3-ylphenylamine (6g)** To a 50 mL round bottom flask equipped with a magnetic stir bar was added 3-(4-chloro-2-nitrophenyl)-pyridine (200 mg, 0.853 mmol) and methanol (5 mL). Raney nickel (2 mL of commercial slurry) was added. The reaction placed under an atmosphere of $H_2$ and allowed to stir for 6 hours. The reaction mixture was filtered through a pad of Celite and rinsed with MeOH (50 mL). The filtrate and washings were dried over anhydrous $Na_2SO_4$, filtered and concentrated in vacuo. The crude residue was purified via silica gel chromatography (40% EtOAc/hexanes – 60% EtOAc) affording known **6g** as a pale yellow oil (130 mg, 75%): $^1$H NMR (500 MHz, DMSO-$d_6$, 298 K) δ 8.57 (d, *J* = 2.3 Hz, 1 H), 8.54 (dd, *J* = 1.6, 4.5 Hz, 1 H), 7.80 (dt, *J* = 1.7, 7.9 Hz, 1 H), 7.45 (ddd, *J* = 0.8, 4.8, 7.8 Hz, 1 H), 7.00 (d, *J* = 8.1 Hz, 1 H), 6.82 (d, *J* = 2.1 Hz, 1 H), 6.64 (dd, *J* = 2.1, 8.1 Hz, 1 H), 5.23 (s, 2 H); $^{13}$C NMR (125 MHz, DMSO-$d_6$, 298 K) δ 149.3, 148.0, 147.2, 136.2, 134.3, 133.2, 131.8, 123.7, 121.0, 116.1, 114.3. All spectroscopic data is in accord with literature values. Shigyo, H.; Sato, S.;

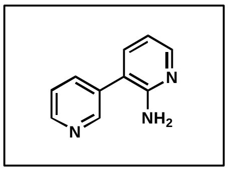
Shibuya, K.; Takahashi, Y.; Yamaguchi, T.; Sonoki, H.; Ohta, T. *Chem. Pharm. Bull.* **1993**, *41*, 1573-1582.



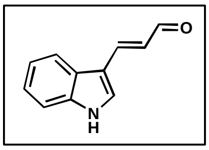
**2-Bromo-6-pyridin-3-ylphenylamine (6h)** As described in the general procedure, 3-pyridylboronic acid (250 mg, 2.0 mmol), 2,6-dibromoaniline (451 mg, 1.8 mmol), *trans*-dichlorobis-(triphenylphosphine) palladium (II) (140 mg, 0.2 mmol), and aqueous $Na_2CO_3$ (6.0 mL, 6.0 mmol) were heated to reflux in 1,4-dioxane (10 mL) for 12 hours. Purification via silica gel chromatography (50% EtOAc/hexanes – 100% EtOAc) afforded **6h** as an orange crystalline solid (146 mg, 42%): mp 102-105 $^{o}$C (EtOAc); $^1$H NMR (500 MHz, $CD_3OD$, 298 K) δ 8.59 (s, 1 H), 8.53 (d, *J* = 4.8 Hz, 1 H), 7.92 (d, *J* = 7.8 Hz, 1 H), 7.52 (dd, *J* = 4.8, 7.8 Hz, 1 H), 7.45 (d, *J* = 6.7 Hz, 1 H), 7.03 (d, *J* = 7.5 Hz, 1 H), 6.68 (dd, *J* = 7.5 Hz, 1 H); $^{13}$C NMR (125 MHz, $CD_3OD$, 298 K) δ 150.4, 149.2, 143.9, 139.0, 137.5, 134.0, 131.1, 125.9, 125.6, 119.9, 110.9; IR (KBr) 3446.0, 1637.2, 1450.9, 1407.1, 1283.7, 1054.6 cm$^{-1}$; TLC $R_f$ = 0.55 (100% EtOAc); LRMS (ESI) *m/z* (relative intensity): 249 (100); HRMS (CI) *m/z* calcd for $C_{11}H_{10}N_2Br$ $[M+H]^+$, 249.0027, found 249.0035.



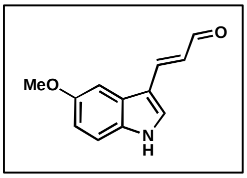
**2-(4-Methylpyridin-3-yl)-phenylamine (11)** As described in the general procedure, 4-picoline-3-boronic acid (200 mg, 1.46 mmol), 2-bromoaniline (251 mg, 1.46 mmol), dichloro[1,1’-bis(diphenylphosphino)ferrocene] palladium (II) (60 mg, 0.073 mmol) and aqueous $Na_2CO_3$ (4.38 mL, 4.38 mmol) were heated to reflux in 1,4-dioxane (10 mL) for 14 hours. Purification via silica gel chromatography (40%-60% EtOAc/hexanes) afforded pure **11** as a pale yellow oil (260 mg, 97%): $^1$H NMR (500 MHz, DMSO-$d_6$, 298 K) δ 8.44 (d, *J* = 5.0 Hz, 1 H), 8.27 (s, 1 H), 7.34 (d, *J* = 5.0 Hz, 1 H), 7.12 (dt, *J* = 1.6, 7.3 Hz, 1 H), 6.88 (dd, *J* = 1.5, 7.5 Hz, 1 H), 6.78 (dd, *J* = 1.0, 8.1 Hz, 1 H), 6.65 (dt, *J* = 1.2, 7.4 Hz, 1 H), 4.61 (s, 2 H), 2.21 (s, 3 H); $^{13}$C NMR (125 MHz, DMSO-$d_6$, 298 K) δ 150.0, 148.2, 145.8, 145.7, 135.1, 130.0, 128.7, 125.0, 121.8, 116.1, 114.7, 18.8; IR (thin film) 3372.6, 1648.6, 1555.2 cm$^{-1}$; TLC $R_f$ = 0.28 (100% EtOAc); LRMS (ESI) *m/z* (relative intensity): 185 (100); HRMS (CI) *m/z* calcd for $C_{12}H_{13}N_2$ $[M+H]^+$, 185.1079, found 185.1073.



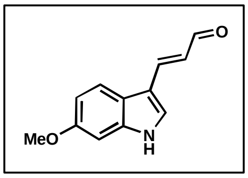
**[3,3']-Bipyridinyl-2-ylamine (13)** As described in the general procedure, 3-pyridylboronic acid (196 mg, 1.61 mmol), 2-amino-3-bromopyridine (250 mg, 1.45 mmol), *trans*-dichlorobis-(triphenylphosphine) palladium (II) (66 mg, 0.081 mmol), and aqueous $Na_2CO_3$ (4.8 mL, 4.8 mmol) were heated to reflux in 1,4-dioxane (8 mL) for 12 hours. Purification via silica gel chromatography (40% EtOAc/hexanes – 100% EtOAc) afforded **13** as a pale yellow solid (189 mg, 76%): mp 89-91 °C (EtOAc); $^1$H NMR (500 MHz, DMSO-$d_6$, 298 K) δ 8.59 (d, *J* = 2.3 Hz, 1 H), 8.53 (dd, *J* = 1.5, 4.8 Hz, 1 H), 7.95 (dd, *J* = 1.6, 4.8 Hz, 1 H), 7.83 (dt, *J* = 2.1, 7.8 Hz, 1 H), 7.45 (dd, *J* = 4.8, 7.8 Hz, 1 H), 7.35 (dd, *J* = 1.7, 7.3 Hz, 1 H), 6.65 (dd, *J* = 4.8, 7.3 Hz, 1 H), 5.69 (s, 2 H); $^{13}$C NMR (125 MHz, DMSO-$d_6$, 298 K) δ 156.8, 149.2, 148.3, 147.8, 138.0, 138.1, 134.1, 123.8, 117.1, 113.1; IR (KBr) 3331.1, 3176.1, 1644.7, 1570.8 cm$^{-1}$; TLC $R_f$ = 0.25 (100% EtOAc); LRMS (ESI) *m/z* (relative intensity): 172 (100); HRMS (CI) *m/z* calcd for $C_{10}H_{10}N_3$ $[M+H]^+$, 172.0875, found 172.0879.



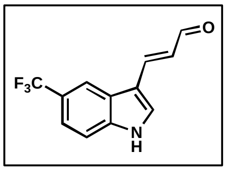
**General Procedure for Cyanogen Bromide Mediated Pyridine Ring Opening: (E)-3-(1*H*-Indol-3-yl)-propenal (7a)** To a 100 mL round bottom flask equipped with a magnetic stir bar was added 2-pyridin-3-ylphenylamine (1.05 g, 6.2 mmol) and absolute ethanol (55.0 mL). The light yellow solution was heated to 40 °C before the addition of cyanogen bromide (1.31 g, 12.4 mmol) as a solution in EtOH (5 mL). After 20 minutes, 10% aqueous ammonium chloride (20.0 mL) was added to the dark red solution, which was allowed to stir at 40 °C for 3 hrs. The crude reaction mixture was concentrated in vacuo, the residue was taken up in EtOAc, washed with saturated $NaHCO_3$, concentrated in vacuo, preloaded onto silica gel and purified via flash chromatography (40% – 60% EtOAc/hexanes) to afford pure known **7a** as a orange solid (695 mg, 70%): mp 108-110 °C (EtOAc); $^1H$ NMR (500 MHz, $CD_3OD$, 298 K) δ 9.53 (d, *J* = 8.1 Hz, 1 H), 8.71 (d, *J* = 15.7 Hz, 1 H), 7.89 (d, *J* = 7.1 Hz, 1 H), 7.83 (s, 1 H), 7.49 (d, *J* = 7.2 Hz, 1 H), 7.30 – 7.23 (m, 2 H), 6.75 (dd, *J* = 8.1, 15.7 Hz, 1 H); $^{13}C$ NMR (125 MHz, $CD_3OD$, 298 K) δ 196.8, 150.9, 139.6, 133.9, 126.7, 124.4, 124.1, 122.9, 121.2, 114.6, 113.5; IR (KBr) 3252.2, 2237.5, 1651.3, 1608.8 $cm^{-1}$; TLC $R_f$ = 0.80 (100% EtOAc); LRMS (ESI) *m/z* (relative intensity): 172 (100); HRMS (CI) *m/z* calcd for $C_{11}H_{10}NO$ $[M+H]^+$, 172.0762, found 172.0760.



**(E)-3-(5-Methoxy-1*H*-indol-3-yl)-propenal (7b)** As described in the general procedure, to 4-methoxy-6-pyridin-3-ylphenylamine (10 mg, 0.05 mmol) in absolute ethanol (10 mL) at room temperature was added BrCN (11 mg, 0.10 mmol) as a solution in ethanol (100 μL). The initially bright yellow solution became a deep orange color and after 1 hour 10% aqueous ammonium chloride (2 mL) was added as a single portion. The reaction mixture was allowed to stir for an additional hour before purification via column chromatography on silica gel (30%-50% EtOAc) afforded **7b** as a dark orange-red solid (7.3 mg, 73%): mp 131-134 °C (EtOAc); $^1H$ NMR (500 MHz, $CD_3OD$, 298 K) δ 9.53 (d, *J* = 8.1 Hz, 1 H), 7.93 (d, *J* = 15.7 Hz, 1 H), 7.82 (s, 1 H), 7.40 (d, *J* = 8.9 Hz, 1 H), 7.36 (d, *J* = 2.1 Hz, 1 H), 6.95 (dd, *J* = 2.1, 8.9 Hz, 1 H), 6.75 (dd, *J* = 8.1, 15.7 Hz, 1 H), 3.92 (s, 3 H); $^{13}C$ NMR (125 MHz, $CD_3OD$, 298 K) δ 196.7, 157.4, 151.2, 134.4, 134.1, 127.4, 123.5, 114.5, 114.3, 114.2, 103.4, 56.4; IR (KBr) 3248.1, 1643.4, 1601.9, 1503.3, 1430.7, 1119.3; TLC $R_f$ = 0.75 (100% EtOAc); LRMS (ESI) *m/z* (relative intensity): 202 (100); HRMS (CI) *m/z* calcd for $C_{12}H_{11}NO_2Na$ $[M+Na]^+$, 224.0687, found 224.0684.

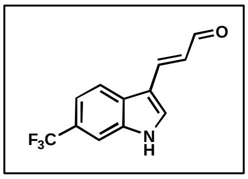


**(E)-3-(6-Methoxy-1*H*-indol-3-yl)-propenal (7c)** As described in the general procedure, to 5-methoxy-2-pyridin-3-ylphenylamine (20 mg, 0.10 mmol) in absolute ethanol (1 mL) at 45 °C was added BrCN (21 mg, 0.20 mmol), and after 20 minutes, 10% aqueous ammonium chloride (1 mL). The reaction was stirred at this temperature for 2 hours. Purification via preparatory thin layer chromatography on silica gel (100 % EtOAc) afforded **7c** as an orange solid (16.1 mg, 80 %): mp 126-128 °C (EtOAc); $^1H$ NMR (500 MHz, $CD_3OD$, 298 K) δ 9.50 (d, *J* = 8.1 Hz, 1 H), 7.85 (d, *J* = 15.6 Hz, 1 H), 7.75 (d, *J* = 8.7 Hz, 1 H), 7.72 (s, 1 H), 7.00 (d, *J* = 2.3 Hz, 1 H), 6.90 (dd, *J* = 2.3, 8.7 Hz, 1 H), 6.70 (dd, *J* = 8.1, 15.6 Hz, 1 H), 3.87 (s, 3 H); $^{13}C$ NMR (125 MHz, $CD_3OD$, 298 K) δ 196.7, 158.8, 151.1, 140.6, 133.4, 123.8, 121.9, 121.2, 114.8, 112.6, 96.7, 56.1; IR (KBr) 3279.8, 1654.7, 1606.2, 1517.8, 1450.9, 1131.1 $cm^{-1}$; TLC $R_f$ = 0.75 (100% EtOAc); LRMS (ESI) *m/z* (relative intensity): 202 (100); HRMS (CI) *m/z* calcd for $C_{12}H_{12}NO_2$ $[M+H]^+$, 202.0868, found 202.0869.

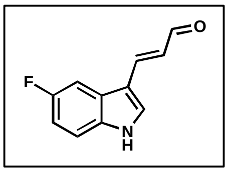


**(E)-3-(5-Trifluoromethyl-1*H*-indol-3-yl)-propenal (7d)** As described in the general procedure, to 2-pyridin-3-yl-4-trifluoromethylphenylamine (20 mg, 0.084 mmol) in absolute ethanol (1 mL) at 45 °C was added BrCN (18 mg, 0.17 mmol) as a solution in absolute ethanol (300 μL), and after 20 minutes, 10% aqueous ammonium chloride (2 mL). The reaction was stirred at this temperature for 2 hours. The crude residue was purified via silica gel chromatography (30% – 50% EtOAc/hexanes) affording **7d** as a yellow solid (12.6 mg, 63%): mp 118-120 °C (EtOAc); $^1H$ NMR (500 MHz, $CD_3OD$, 298 K) δ 9.54 (d, *J* = 7.9

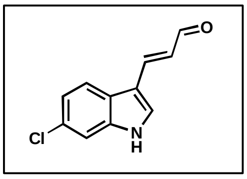
Hz, 1 H), 8.15 (s, 1 H), 7.99 (s, 1 H), 7.61 (d, *J* = 8.2 Hz, 1 H), 7.51 (d, *J* = 8.5 Hz, 1 H), 6.71 (dd, *J* = 7.9, 15.8 Hz, 1 H); $^{13}$C NMR (125 MHz, $CDCl_3$, 298 K) δ 196.6, 149.2, 140.9, 134.7, 126.8 (q, *J* = 270 Hz), 126.3, 125.4, 124.9 (q, *J* = 32 Hz), 120.9 (q, *J* = 4 Hz), 118.3 (q, *J* = 4 Hz), 115.0, 114.2; IR (KBr) 3185.8, 1664.2, 1160.8, 1109.0 cm$^{-1}$; TLC $R_f$ = 0.80 (100% EtOAc); LRMS (ESI) *m/z* (relative intensity): 240 (100); HRMS (CI) *m/z* calcd for $C_{12}H_8F_3NONa$ [M+Na]$^+$, 262.0456, found 262.0455.



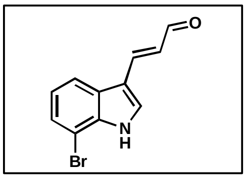
**(E)-3-(6-Trifluoromethyl-1*H*-indol-3-yl)-propenal (7e)** As described in the general procedure, to 2-pyridin-3-yl-5-trifluoromethylphenylamine (33.6 mg, 0.14 mmol) in absolute ethanol (1.4 mL) at 45 °C was added BrCN (29.6 mg, 0.28 mmol), and after 20 minutes, 10% aqueous ammonium chloride (1 mL). The reaction stirred at this temperature for 2 hours. Purification via preparatory thin layer chromatography on silica gel (100% EtOAc) afforded **7e** as a pale yellow solid (26.1 mg, 78%): mp 123-125 °C (EtOAc); $^1$H NMR (500 MHz, $CD_3OD$, 298 K) δ 9.58 (d, *J* = 7.9 Hz, 1 H), 8.06 (d, *J* = 8.4 Hz, 1 H), 8.04 (s, 1 H), 7.94 (d, *J* = 15.8 Hz, 1 H), 7.80 (s, 1 H), 7.50 (d, *J* = 8.4 Hz, 1 H), 6.79 (dd, *J* = 7.9, 15.8 Hz, 1 H); $^{13}$C NMR (125 MHz, $CD_3OD$, 298 K) δ 196.6, 149.4, 138.4, 135.6, 129.2, 126.6 (q, *J* = 269 Hz), 126.0 (q, *J* = 31 Hz), 125.5, 121.6, 119.1 (q, *J* = 4 Hz), 114.5, 110.9 (q, *J* = 4 Hz); IR (KBr) 3427.5, 2338.4, 2091.8, 1645.2, 1326.7, 1116.1 cm$^{-1}$; TLC $R_f$ = 0.80 (100% EtOAc); LRMS (ESI) *m/z* (relative intensity): 240 (100); HRMS (CI) *m/z* calcd for $C_{12}H_8F_3NONa$ [M+Na]$^+$, 262.0456, found 262.0461.



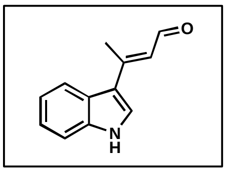
**(E)-3-(5-Fluoro-1*H*-indol-3-yl)-propenal (7f)** As described in the general procedure, to 4-fluoro-2-pyridin-3-ylphenylamine (20 mg, 0.11 mmol) in absolute ethanol (1 mL) at 45 °C was added BrCN (23.5 mg, 0.22 mmol) as a solution in absolute ethanol (300 μL), and after 20 minutes, 10% aqueous ammonium chloride (2 mL). The reaction was stirred at this temperature for 2 hours. The crude residue was purified via silica gel chromatography (30%-60% EtOAc/hexanes) affording **7f** as a yellow solid (13 mg, 65%): mp 120-122 °C (EtOAc); $^1$H NMR (500 MHz, $CD_3OD$, 298 K) δ 9.47 (d, *J* = 7.8 Hz, 1 H), 7.85 (d, *J* = 15.7 Hz, 1 H), 7.85 (s, 1 H), 7.53 (dd, *J* = 2.4, 9.9 Hz, 1 H), 7.42 (dd, *J* = 4.5, 8.8 Hz, 1 H), 7.01 (dt, *J* = 2.4, 8.9, 15.7 Hz, 1 H), 6.63 (dd, *J* = 7.8, 15.7 Hz, 1 H); $^{13}$C NMR (125 MHz, $CD_3OD$, 298 K) δ 196.6, 160.6 (d, *J* = 235 Hz), 150.3, 136.0, 135.1, 127.2 (d, *J* = 11 Hz), 124.3, 117.9, 114.5 (d, *J* = 11 Hz), 112.4 (d, *J* = 25 Hz), 106.3 (d, *J* = 25 Hz); IR (KBr) 3175.9, 2916.0, 2187.5, 1608.2, 1121.9 cm$^{-1}$; TLC $R_f$ = 0.82 (100% EtOAc); LRMS (ESI) *m/z* (relative intensity): 190 (100); HRMS (CI) *m/z* calcd for $C_{11}H_9NOF$ $[M+H]^+$, 190.0668, found 190.0670.



**(E)-3-(6-Chloro-1*H*-indol-3-yl)-propenal (7g)** As described in the general procedure, to 3-chloro-6-pyridin-3-ylphenylamine (13 mg, 0.064 mmol) in absolute ethanol (1 mL) at 45 °C was added BrCN (13.4 mg, 0.127 mmol) as a solution in absolute ethanol (300 μL), and after 20 minutes, 10% aqueous ammonium chloride (1 mL). The reaction was stirred at this temperature for 2 hours. The crude residue was purified via silica gel chromatography (30%-40% EtOAc/hexanes) afforded **7g** as an oily yellow solid (9.6 mg, 74%): $^1$H NMR (500 MHz, $CD_3OD$, 298 K) δ 9.54 (d, *J* = 8.0 Hz, 1 H), 7.91 – 7.84 (m, 3 H), 7.49 (s, 1 H), 7.22 (dd, *J* = 1.9, 8.5 Hz, 1 H), 6.72 (dd, *J* = 8.0, 15.7 Hz, 1 H); $^{13}$C NMR (125 MHz, $CD_3OD$, 298 K) δ 196.6, 149.9, 139.9, 134.3, 130.2, 125.4, 124.9, 123.2, 122.2, 114.6, 113.4; IR ($CH_2Cl_2$) 3294.0, 1654.5, 1606.4, 1570.3, 1508.6, 1122.3 cm$^{-1}$; TLC $R_f$ = 0.87 (100% EtOAc); LRMS (ESI) *m/z* (relative intensity): 206 (100), 228 (40); HRMS (CI) *m/z* calcd for $C_{11}H_8NOClNa$ $[M+Na]^+$, 228.0192, found 228.0194.

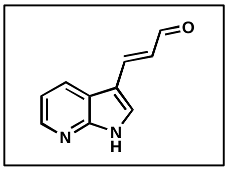


**(E)-3-(7-Bromo-1*H*-indol-3-yl)-propenal (7h)** As described in the general procedure, to 2-bromo-6-pyridin-3-yl-phenylamine (25 mg, 0.10 mmol) in absolute ethanol (1 mL) at 45 °C was added BrCN (21 mg, 0.20 mmol) as a solution in absolute ethanol (100 μL), and after 20 minutes, 10% aqueous ammonium chloride (1 mL). The reaction was stirred at this temperature for 2 hours. Purification via preparatory thin layer chromatography on silica gel (100% EtOAc) afforded **7h** as a yellow solid (19.9 mg, 80%): mp 154-156 °C (EtOAc); $^1$H NMR (500 MHz, $CD_3OD$, 298 K) δ 9.52 (d, *J* = 7.9 Hz, 1 H), 7.87 (s, 1 H), 7.86 (d, *J* = 15.7 Hz, 1 H), 7.85 (d, *J* = 7.9 Hz, 1 H), 7.40 (d, *J* = 7.6 Hz, 1 H), 7.12 (t, *J* = 7.8 Hz, 1 H), 6.71 (dd, *J* = 7.9, 15.7 Hz, 1 H); $^{13}$C NMR (125 MHz, $CD_3OD$, 298 K) δ 196.7, 149.8, 137.9, 133.9, 128.3, 127.0, 125.3, 123.9, 120.5, 115.4, 106.6; IR (KBr) 3424.1, 2106.6, 1654.6, 1508.6, 1438.1, 1115.9 cm$^{-1}$; TLC $R_f$ = 0.80 (100% EtOAc); LRMS (ESI) *m/z* (relative intensity): 250 (60), 272 (100); HRMS (CI) *m/z* calcd for $C_{11}H_8NOBrNa$ $[M+Na]^+$, 271.9687, found 271.9691.

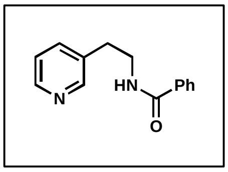


**(E)-3-(1*H*-Indol-3-yl)-but-2-enal (12)** As described in the general procedure, to 2-(4-methyl-pyridin-3-yl)-phenylamine (10 mg, 0.054 mmol) in absolute ethanol (500 μL) at 45 °C was added BrCN (11.4 mg, 0.11 mmol) as a solution in absolute ethanol (100 μL), and after 20 minutes, 10% aqueous ammonium chloride (300 μL). The reaction was stirred at this temperature for 2 hours. The crude residue was purified via silica gel chromatography (30% – 35% EtOAc/hexanes) afforded **12** as a yellow glassy solid (6.7 mg, 67%): mp 137-139 °C (EtOAc); $^1$H NMR (500 MHz, $CD_3OD$, 298 K) δ 10.10 (d, *J* = 8.4 Hz, 1 H), 7.91 (d, *J* = 9.2 Hz, 1 H), 7.89 (s, 1 H), 7.45 (d, *J* = 8.2 Hz, 1 H), 7.22 – 7.18 (m, 2 H), 6.79 (d, *J* = 8.4 Hz, 1

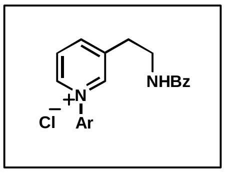
H), 2.67 (s, 3 H); $^{13}$C NMR (125 MHz, $CD_3OD$, 298 K) δ 193.6, 157.9, 138.7, 130.6, 126.2, 124.0, 123.4, 122.6, 121.9, 113.5, 16.8; IR (KBr) 3400.4, 1627.1, 1565.6, 1384.0, 1166.0 cm$^{-1}$; TLC $R_f$ = 0.45 (50% EtOAc/hexanes); LRMS (ESI) *m/z* (relative intensity): 186 (100), 208 (30); HRMS (CI) *m/z* calcd for $C_{12}H_{11}NONa$ [M+Na]$^+$, 208.0738, found 208.0735.



**(E)-3-(1*H*-Pyrrolo[2,3-*b*]pyridin-3-yl)-propenal (14)** As described in the general procedure, to [3,3']-bipyridin-2-ylamine (20 mg, 0.12 mmol) in absolute ethanol (1 mL) at 70 °C was added BrCN (25 mg, 0.24 mmol) as a solution in absolute ethanol (100 μL), and after 20 minutes, 10% aqueous ammonium chloride (1 mL). The reaction was stirred at this temperature for 2 hours. The crude residue was purified via silica gel chromatography (30% – 40% EtOAc/hexanes) to afford **14** as a light yellow solid (17.3 mg, 87%): mp 208-210 °C (MeOH); $^1$H NMR (500 MHz, $CD_3OD$, 298 K) δ 9.58 (d, *J* = 8.0 Hz, 1 H), 8.37 (dd, *J* = 1.5, 8.0 Hz, 1 H), 8.34 (dd, *J* = 1.5, 4.8 Hz, 1 H), 7.99 (s, 1 H), 7.89 (d, *J* = 15.8 Hz, 1 H), 7.31 (dd, *J* = 4.8, 8.0 Hz, 1 H), 6.77 (dd, *J* = 8.0, 15.8 Hz, 1 H); $^{13}$C NMR (125 MHz, $CD_3OD$, 298 K) δ 196.6, 150.9, 149.4, 145.2, 133.9, 130.5, 125.8, 119.6, 118.8, 113.3; IR ($CH_2Cl_2$) 3390.4, 1614.5, 1575.1, 1370.8 cm$^{-1}$; TLC $R_f$ = 0.81 (100% EtOAc); LRMS (ESI) *m/z* (relative intensity): 173 (100); HRMS (CI) *m/z* calcd for $C_{10}H_8N_2ONa$ [M+Na]$^+$, 195.0534, found 195.0541.

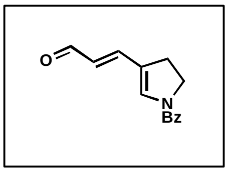


***N*-(2-Pyridin-3-yl-ethyl)-benzamide (16)** To a flame dried 25 mL round bottom flask equipped with a magnetic stir bar was added benzoyl chloride (190 μL, 1.64 mmol), triethylamine (450 μL, 3.28 mmol) and dry dichloromethane (7 mL). This mixture was cooled to 0 °C before the dropwise addition of 3-(2-ethylamino)-pyridine (200 μL, 1.64 mmol). The reaction mixture stirred at ice bath temperature for 1 hour, at which time TLC indicated consumption of the starting material. The reaction mixture was warmed to room temperature and poured into 20 mL of saturated $NaHCO_3$ and extracted with $CH_2Cl_2$ (3 x 30 mL). The combined organics were dried over anhydrous $Na_2SO_4$, filtered and concentrated in vacuo to afford crude **16**. The residue was purified via silica gel chromatography (4% MeOH/$CHCl_3$) to afford pure **16** as an off-white solid (370 mg, quantitative): mp 80-82 $^{o}$C (MeOH); $^{1}$H NMR (500 MHz, $CD_3OD$, 298 K) δ 8.43 (d, *J* = 1.9 Hz, 1 H), 8.37 (dd, *J* = 1.5, 4.9 Hz, 1 H), 7.77 – 7.73 (m, 3 H), 7.50 (dd, *J* = 5.5, 9.2 Hz, 1 H), 7.42 (dd, *J* = 5.7, 7.8 Hz, 2 H), 7.36 (dd, *J* = 4.9, 7.8 Hz, 1 H), 3.62 (dd, *J* = 7.0, 7.2 Hz, 2 H), 2.97 (dd, *J* = 7.0, 7.2 Hz, 2 H); $^{13}$C NMR (125 MHz, $CD_3OD$, 298 K) δ 170.5, 150.6, 148.2, 139.0, 137.2, 135.8, 132.8, 129.7, 128.3, 125.4, 42.1, 33.7; IR (KBr) 3435.9, 1645.9 cm$^{-1}$; TLC $R_f$ = 0.33 (10% MeOH/$CHCl_3$); LRMS (ESI) *m/z* (relative intensity): 227 (100); HRMS (CI) *m/z* calcd for $C_{14}H_{15}N_2O$ $[M+H]^+$, 227.1184, found 227.1175.



**3-(2-Benzoylaminoethyl)-1-(2,4-dinitrophenyl)-pyridinium chloride (17)** To a 25 mL round bottom flask equipped with a magnetic stir bar was added *N*-(2-pyridin-3-ylethyl)-benzamide (100 mg, 0.442 mmol), 1-chloro-2,4-dinitrobenzene (90 mg, 0.442 mmol), and 1-butanol (225 µL). The reaction mixture was heated to 100 $^{o}$C for 3 hours. The resultant yellow solution was cooled and concentrated in vacuo to afford analytically pure pyridinium salt **17** as a golden yellow powder (189 mg, quantitative): mp 184-186 $^{o}$C (EtOAc); $^{1}$H NMR (500 MHz, $D_2O$, 298 K) δ 9.35 (d, *J* = 2.4 Hz, 1 H), 9.10 (s, 1 H), 9.03 (d, *J* = 6.1 Hz, 1 H), 8.90 (d, *J* = 8.2 Hz, 1 H), 8.86 (dd, *J* = 2.4, 8.7 Hz, 1 H), 8.30 (dd, *J* = 6.3, 8.1 Hz, 1 H), 8.06 (d, *J* = 8.7 Hz, 1 H), 7.69 (d, *J* = 7.4 Hz, 2 H), 7.64 (t, *J* = 7.4 Hz, 1 H), 7.52 (t, *J* = 7.7, 2 H), 3.89 – 3.85 (m, 2 H), 3.37 – 3.28 (m, 2 H); $^{13}$C NMR (125 MHz, $D_2O$, 298 K) δ 170.8, 149.7, 149.6, 144.7, 143.6, 142.7, 141.4, 138.6, 133.1, 132.4, 131.0, 130.6, 128.9, 128.8, 128.1, 127.0, 126.9, 122.7, 39.4, 32.3; IR (KBr)

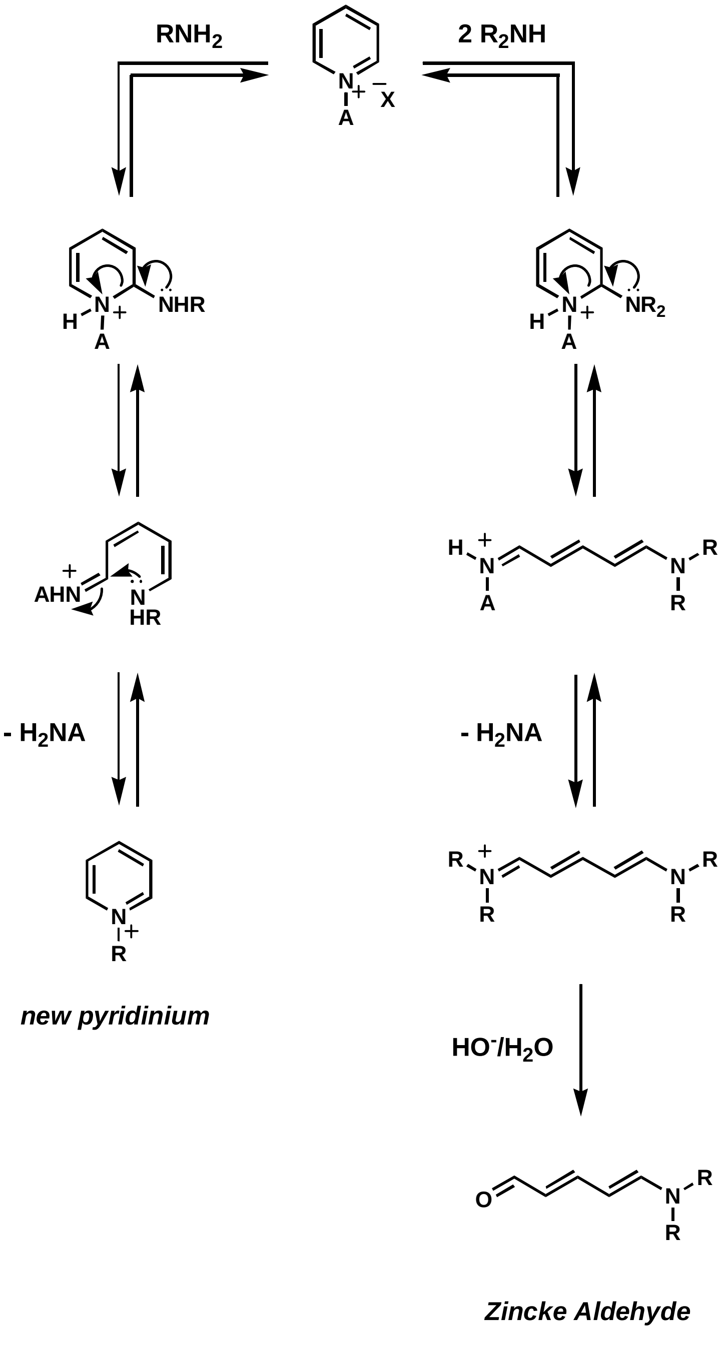
3434.8, 1647.3 cm$^{-1}$; LRMS (ESI) *m/z* (relative intensity): 393 (100); HRMS (CI) *m/z* calcd for $C_{20}H_{17}N_4O_5^+$ [M]$^+$, 393.1199, found 393.1206.



**3-(1-Benzoyl-4,5-dihydro-1*H*-pyrrol-3-yl)-propenal (18)** To an uncapped 2 dram vial equipped with a stir bar was added pyridinium salt **17** (30.0 mg, 0.070 mmol) and absolute EtOH (0.60 mL). The resultant suspension was warmed to 50 °C and stirred until complete dissolution of the salt before the addition of dimethylamine (40 wt % solution in water, 34.5 μL, 0.280 mmol). The yellow solution became a deep brown-red viscous mixture immediately upon dimethylamine addition. After 20 minutes at 50 °C, the viscosity had diminished and the color had faded to a bright red. The reaction mixture was allowed to cool to ambient temperature, and was concentrated *in vacuo*. Water (6 mL) was added, which resulted in the precipitation of most of the dinitroaniline; this mixture was filtered through conical filter paper rinsing with water. 1.0 N NaOH (1 equiv., 70 μL) was added to the yellow aqueous solution, which was subsequently extracted with $CH_2Cl_2$ (3 x 15 mL). The combined organics were dried over anhydrous $Na_2SO_4$, filtered, and concentrated in vacuo to afford crude **18** as an orange viscous oil. Purification by silica gel chromatography (3:1 pentane/EtOAc to elute remaining dinitroaniline byproduct, then 65:35 pentane/EtOAc) afforded pure **18** as a pale yellow solid (9.0 mg, 57%): $^1$H NMR (500 MHz, $CD_3OD$, 298 K) δ 9.49 (d, *J* = 8.0 Hz, 1 H), 7.61-7.58 (m, 3 H), 7.56-7.54 (m, 3 H), 7.23 (br s, 1 H), 6.02 (dd, *J* = 8.0, 15.3 Hz, 1 H), 4.17-4.12 (m, 2 H), 2.93 (dd, *J* = 8.8, 9.1 Hz, 2 H); $^{13}$C NMR (125 MHz, $CD_3OD$, 298 K) δ 195.6, 169.9, 148.6, 139.7, 136.0, 132.6, 130.0, 129.1, 128.4, 125.9, 30.9, 27.7; IR (KBr) 1710.4, 1537.3 cm$^{-1}$; TLC $R_f$ = 0.60 (70% EtOAc/hexanes); LRMS (ESI) *m/z* (relative intensity): 228 (100); HRMS (CI) *m/z* calcd for $C_{14}H_{13}NO_2Na$ [M+Na]$^+$, 250.0844, found 250.0850.

Note: the mass balance for this reaction is good; the major byproduct is the substituted acyclic Zincke aldehyde that corresponds to the hydrolyzed form of intermediate **19**. We are currently attempting to find conditions that completely suppress the formation of this undesired product.

Mechanism:


RNH$_2$
2 R$_2$NH
X
A
H
NHR
NR$_2$
AHN
HR
H
A
R
R
- H$_2$NA
- H$_2$NA
R
R
R
R
R
new pyridinium
HO$^-$/H$_2$O
O
R
R
Zincke Aldehyde

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