Experimental Section

1*H*-Pyrrolo[2,3-b]pyridine 7-oxide (**1**)

The procedure described in *Benoît, S.; Gingras, S. Processes for the preparation of antiviral 7-azaindole derivatives. U.S. Provisional Patent 60/367,401, 2003* was followed. ^{1}H NMR (400 MHz, DMSO-d_6) δ ppm 12.45 (1H, br. s), 8.11 (1H, d, J = 4.0 Hz), 7.63 (1H, d, J =8.0 Hz), 7.44 (1H, s), 7.05 (1H, t, J = 8.0 Hz), 6.57 (1H, s). LCMS (solvent A : 10% acetonitrile-90% water + 5mM NH_4OAC; solvent B: 90% acetonitrile-10% water + 5mM NH_4OAC, with 0% B to 100% B in 2 minutes gradient. Column Premisphere C18-HC 4.6 x 30 mm, UV: 220 nm; Micromass ZMD 2000, ESI) m/z 176 ($M+CH_3CN+H^+$), retention time = 0.28 min. Purity = 95%.

4-Chloro-1*H*-pyrrolo[2,3-b]pyridine (**2**)

Compound (**2**) was prepared according to the procedure described in *Benoît, S.; Gingras, S. Processes for the preparation of antiviral 7-azaindole derivatives. U.S. Provisional Patent 60/367,401, 2003*.

Allyl-(1*H*-pyrrolo[2,3-b]pyridin-4-yl)-amine (**3a**)

(Reference: *Journal of Organic Chemistry,* **2000**, *65*, 1158-1174)

A 350-mL oven-dried resealable flask capped with a rubber septum was evacuated and backfilled with argon. The flask was charged with 4-chloro-1*H*-pyrrolo[2,3-b]pyridine (**2**) (20 gr, 131 mmol), sodium tert-butoxide (35.2 gr, 367 mmol), $Pd(OAc)_2$ (589 mg, 2.62 mmol), (*o*-biphenyl)PCy_2 (1.83 gr, 5.24 mmol) and evacuated and backfilled with Argon. 1,4-Dioxane (250 mL) and *N*-allylamine (29 mL, 393 mmol) were added and argon was bubbled through the mixture for 20 minutes. The septum was replaced with a Teflon® screwcap, the flask was sealed and the mixture was heated at 100°C for 16 hours. The mixture was cooled to room temperature, diluted with diethyl ether (500 mL), filtered through Celite® and concentrated *in vacuo*. The resulting oil was dissolved in dichloromethane (250 mL), washed twice with water, dried over Na_2SO_4, filtered and concentrated *in vacuo* to give allyl-(1*H*-pyrrolo[2,3-b]pyridin-4-yl)-amine (**3a**) as brown gum. ^{1}H NMR (400 MHz, DMSO-d_6) δ (ppm) 11.14 (1H, br. s), 7.78 (1H, d, J = 5.3 Hz), 7.04 (1H, d, J = 2.5 Hz), 6.82 (1H, m), 6.54 (1H, d, J = 3.1 Hz), 6.06 (1H, d, J = 5.3 Hz), 5.98-5.87 (1H, m), 5.22 (1H, d, J = 16.2 Hz), 5.11 (1H, d, J = 10.4 Hz), 3.87 (2H, m). LCMS (solvent A : 10% acetonitrile-90% water + 0.05% TFA; solvent B: 90% acetonitrile-10% water + 0.05% TFA, with 0% B to 100% B in 2 minutes gradient. Column Premisphere C18-HC 4.6 x 30 mm, UV: 220 nm; Micromass ZMD 2000, ESI) m/z 174 ($M+H^+$), retention time = 0.99 min. Purity = 85%.

1*H*-Pyrrolo[2,3-b]pyridin-4-ylamine (**3b)**

(Reference: *Tetrahedron Letters,* **1998**, *39*, 1313-1316)

An 500 mL oven-dried round-bottom flask equipped with a condenser was evacuated and backfilled with Argon. The flask was charged with allyl-(1*H*-pyrrolo[2,3-b]pyridin-4-yl)-amine (**3a**) (22.69 gr, 131 mmoles), ethanol (262 mL), 10 % palladium on charbon (15 gr) and methanesulfonic acid (8.5 mL, 131 mmoles) then, heated at 105°C for 72 hours. The mixture was cooled to room temperature, filtered through Celite® and concentrated *in vacuo*. The resulting oil was purified by SCX-silica column (300 gr): wash with methanol (3 X 500 mL) and collected by eluting a solution of 2M ammonia in methanol (3 X 500 mL) to give 13.15 gr (75 % over two steps) of 1*H*-pyrrolo[2,3-b]pyridin-4-ylamine (**3b**) as bown solid. ^{1}H NMR (400 MHz, DMSO-d_6) δ (ppm) 11.18 (1H, br. s), 7.73 (1H, d, J = 5.3 Hz), 7.03 (1H, d, J = 3.3 Hz), 6.48 (1H, d, J = 3.5 Hz), 6.14 (1H, d, J = 5.3 Hz), 6.11 (2H, s). ^{13}C NMR (100.62 MHz, DMSO-d_6) δ (ppm) 149.57, 148.02, 143.81, 120.76, 107.44, 99.36, 97.96. LCMS (solvent A : 10% acetonitrile-90% water + 5mM NH_4OAc; solvent B: 90% acetonitrile-10% water + 5mM NH_4OAc, with 0% B to 100% B in 2 minutes gradient. Column Premisphere C18-HC 4.6 x 30 mm, UV: 220 nm; Micromass ZMD 2000, ESI) m/z 134 ($M+H^+$), retention time = 0.22 min. Purity = 96%. MS (Finigan TSQ 7000, ESI) *m/z* 134 $(M+H)^+$. HRMS (LSIMS) calculated for: $C_7H_7N_3$ 134.0718 ($M+H^+$), found: 134.0714.

4-Fluoro-1*H*-pyrrolo[2,3-b]pyridine (**4a**)

An 500 mL round-bottom flask was charged with 1*H*-pyrrolo[2,3-b]pyridin-4-ylamine (**3b**) (10.3 gr, 77 mmoles) and dissolved in a 48 % wt aqueous solution of tetrafluoroboric acid (155 mL). The mixture was cooled to 0°C and sodium nitrite (5.87 gr, 85.1 mmoles) in water (15 mL) was added dropwise. The mixture was allowed to reach room temperature and stirred for 22 hours. Ethyl acetate was added (500 mL), the mixture was cooled at 0°C, neutralized with sodium hydrogen carbonate solid (careful) and layers were separated. The aqueous layer was extracted twice with ethyl acetate (2 X 300mL), the organic layers were combined and concentrated *in vacuo*. The resulting solid was triturated with 250 mL of ethyl acetate, filtered and the filtrate was washed with a solution of 1N sodium hydroxide (2 X 200 mL). The organic layer was dried over Na_2SO_4, filtered and concentrated *in vacuo* to give 4.67 gr (44 %) of 4-fluoro-1*H*-pyrrolo[2,3-b]pyridine (**4a**) as a tan solid. Mp: 111.6°C. ^{1}H NMR (400 MHz, DMSO-d_6) δ (ppm) 12.02 (1H, br. s), 8.20 (1H, dd, J = 5.3, 8.4 Hz), 7.50 (1H, t, J = 2.2 Hz), 6.92 (1H, dd, J = 5.3, 10.3 Hz), 6.51 (1H, dd, J = 1.5, 3.3 Hz). ^{13}C NMR (100.62 MHz, DMSO-d_6) δ (ppm) 161.27 (d, J_{C-F} = 259.9 Hz), 152.06 (d, J_{C-F} = 12.2 Hz), 144.46 (d, J_{C-F} = 6.2 Hz), 126.3, 108.30 (d, J_{C-F} = 17.7 Hz), 101.76 (d, J_{C-F} = 14.6 Hz), 95.59. HPLC (solvent A : 10% acetonitrile-90% water + 0.05% TFA; solvent B: 90% acetonitrile-10% water + 0.05% TFA, with 0% B to 100% B in 8 minutes gradient. Column Zorbax SB C18 4.6 x 75 mm, UV: 220 nm; retention time = 1.82 min. Purity = 98.4%. LCMS (solvent A : 10% acetonitrile-90% water + 5mM NH_4OAc; solvent B: 90% acetonitrile-10% water + 5mM NH_4OAc, with 0% B to 100% B in 2 minutes gradient. Column Premisphere C18-HC 4.6 x 30 mm, UV: 220 nm; Micromass ZMD 2000, ESI) m/z 135

($M-H^+$), retention time = 1.30 min. Purity = 96.8%. MS (Finigan TSQ 7000, ESI) *m/z* 137 $(M+H)^+$. Anal. Calcd. for: $C_7H_5N_2F$: C, 61.78; H, 3.70; N, 20.58. Found: C, 62.02; H, 4.00; N, 20.29. HRMS (LSIMS) calculated for: $C_7H_5FN_2$ 136.0436 (M^+), found: 136.0437.

4-Chloro-1H-pyrrolo[2,3-b]pyridine 7-oxide **(5a)**

4-Chloro-1H-pyrrolo[2,3-b]pyridine **(2)** (1.22 gr, 8.03 mmoles) was diluted in acetone (35 mL) and *m*-chloroperbenzoic acid (2.15 gr, 77%, 9.55 mmoles) was added portionwise at 0°C. The reaction mixture was stirred at 23°C for 3 hours then concentrated *in vacuo*. The resulting solid was poured in 5 mL of water and an aqueous solution of potassium carbonate (4.44 mL, 3.62 M, 16.07 mmoles) was added. The mixture was stirred for 16 hours, cooled to 0°C, filtered, washed with water (30 mL) and dried *in vacuo* to afford 843 mg of 4-chloro-1H-pyrrolo[2,3-b]pyridine 7-oxide **(5a)** (62%). ^{1}H NMR (DMSO d_6, 400 MHz): δ (ppm) 12.82 (broad s, 1H), 8.13 (d, 1H, J = 6.8 Hz), 7.54 (s, 1 H), 7.19 (d, 1 H, J = 6.6 Hz), 6.58 (s, 1 H). HPLC (solvent A : 10% acetonitrile-90% water + 0.05% TFA; solvent B: 90% acetonitrile-10% water + 0.05% TFA, with 0% B to 100% B in 8 minutes gradient. Column Zorbax SB C18 4.6 x 75 mm, UV: 220 nm; retention time = 2.74 min. Purity = 94.1%. LCMS (solvent A : 10% acetonitrile-90% water + 5mM NH_4OAc; solvent B: 90% acetonitrile-10% water + 5mM NH_4OAc, with 0% B to 100% B in 2 minutes gradient. Column Premisphere C18-HC 4.6 x 30 mm, UV: 220 nm; Micromass ZMD 2000, ESI) m/z 169 ($M+H^+$), retention time = 0.99 min. Purity = 94.0%.

7-Benzyl-4-chloro-1H-pyrrolo[2,3-b]pyridin-7-ium bromide **(5b)**

4-Chloro-1*H*-pyrrolo[2,3-b]pyridine (**2**) (500 mg, 3.28 mmoles) and benzyl bromide (468 µL, 3.93 mmoles) were placed in benzene (6.6 mL). The mixture was heated at 80°C for 3.5 hours. The mixture was cooled to R.T. and concentrated *in vacuo*. The crude material was stirred in diethyl ether (25 mL) and filtered to afford 1.05 gr (99 %) of the 7-benzyl-4-chloro-1H-pyrrolo[2,3-b]pyridin-7-ium bromide **(5b)**. ^{1}H NMR ($CDCl_3$, 400 MHz): δ (ppm) 14.97 (s, 1 H), 7.97 (d, 1 H, J = 6.8 Hz), 7.84 (t, 1 H, J = 3.0 Hz), 7.59-7.55 (m, 2H), 7.43-7.39 (m, 3H), 7.37 (d, 1H, J = 6.6 Hz), 6.88 (dd, 1H, J = 1.8, 3.6 Hz), 6.38 (s, 2H). LCMS (solvent A : 10% acetonitrile-90% water + 0.05% TFA; solvent B: 90% acetonitrile-10% water + 0.05% TFA, with 0% B to 100% B in 2 minutes gradient. Column Primesphere C18-HC 4.6 x 30 mm, UV: 220 nm; Micromass ZMD 2000, ESI) m/z 243 ($M+H^+$), retention time = 1.21 min. Purity = 83 %.

4-Bromo-1H-pyrrolo[2,3-b]pyridine 7-oxide **(5c)**

4-Bromo-1H-pyrrolo[2,3-b]pyridine (**6**) (100 mg, 0.5 mmol) was diluted in ethyl acetate (3 mL) and a solution of peracetic acid in acetic acid (32 %, 213 µL, 1.0 mmol) was added dropwise. The reaction mixture was agitated at R.T. for 3 days. The solution was neutralized with an aqueous solution of potassium carbonate (slowly) then filtered and

dried *in vacuo* to afford 100 mg (94 %) of 4-bromo-1H-pyrrolo[2,3-b]pyridine 7-oxide **(5c)** as a beige solid. ^{1}H NMR (DMSO-d_6, 400 MHz): δ (ppm) 7.97 (d, 1 H, J = 6.6 Hz), 7.53 (d, 1 H, J = 3.0 Hz), 7.21 (d, 1H, J = 6.3 Hz), 6.44 (d, 1H, J = 3.0 Hz). LCMS (solvent A : 10% acetonitrile-90% water + 0.05% NH_4OAc; solvent B: 90% acetonitrile-10% water + 0.05% NH_4OAc, with 0% B to 100% B in 2 minutes gradient. Column Primesphere C18-HC 4.6 x 30 mm, UV: 220 nm; Micromass ZMD 2000, ESI) m/z 213 ($M+H^+$), retention time = 1.08 min. Purity = 83 %.

4-Bromo-1*H*-pyrrolo[2,3-b]pyridine **(6)**

1H-Pyrrolo[2,3-b]pyridine 7-oxide (**2**) (50 gr, 373 mmoles) and tetramethylammonium bromide (86 gr, 559 mmoles) were placed in DMF (500 mL). The mixture was cooled to 0°C and methanesulfonic anhydride (130 g, 746 mmoles) was added portionwise. The suspension was allowed to reach 23°C and stirred for 4 hours. Mixture was poured in water (1 L) and the solution was neutralized with an aqueous solution of 50 % sodium hydroxide (pH = 7). Water (2 L) was added and the mixture was cooled to 10°C for 30 min. The solid formed was filtered and washed with cooled water (1L) then, dissolved in a mixture of dichloromethane / methanol (4:1), dried over $MgSO_4$, filtered and concentrated *in vacuo* to afford 40 gr (54%) of 4-bromo-1*H*-pyrrolo[2,3-b]pyridine **(6)**. ^{1}H NMR (400 MHz, DMSO-d_6) δ (ppm) 12.05 (1H, br. s), 8.06 (1H, d, J = 5.3 Hz), 7.59 (1H, t, J = 2.8 Hz), 7.31 (1H, d, J = 5.1 Hz), 6.40 (1H, d, J = 2.8 Hz). ^{13}C NMR (100.62 MHz, DMSO-d_6) δ (ppm) 148.17, 143.01, 127.26, 123.55, 120.80, 118.34, 99.43. HPLC (solvent A : 10% acetonitrile-90% water + 0.05% TFA; solvent B: 90% acetonitrile-10% water + 0.05% TFA, with 0% B to 100% B in 8 minutes gradient. Column Zorbax SB C18 4.6 x 75 mm, UV: 220 nm; retention time = 3.36 min. Purity = 98.0%. LCMS (solvent A : 10% acetonitrile-90% water + 5mM NH_4OAc; solvent B: 90% acetonitrile-10% water + 5mM NH_4OAc, with 0% B to 100% B in 2 minutes gradient. Column Premisphere C18-HC 4.6 x 30 mm, UV: 220 nm; Micromass ZMD 2000, ESI) m/z 197 ($M+H^+$), retention time = 1.47 min. Purity = 94.6%. MS (Finigan TSQ 7000, ESI) *m/z* 197 $(M+H)^+$. HRMS (LSIMS) calculated for: $C_7H_5BrN_2$ 195.9636 (M^+), found: 195.9641.

4-Bromo-1-triisopropylsilanyl-1*H*-pyrrolo[2,3-b]pyridine **(7)**

A 500-mL oven-dried resealable flask capped with a rubber septum was evacuated and backfilled with argon. The flask was charged with 4-bromo-1*H*-pyrrolo[2,3-b]pyridine **(6)** (40 gr, 203 mmoles) and THF (400 mL). The mixture was cooled to 0°C and sodium hydride (60%, washed with hexanes, 8.9 gr, 223 mmoles) was added portionwise. After 15 minutes, chloro-triisopropylsilane (443.4 mL, 203 mmoles) was added, the septum was replaced with a Teflon® screwcap, the flask was sealed and heated at 80°C for 3 hours. The reaction mixture was cooled down to R.T., neutralized with a saturated aqueous solution of ammonium chloride (500 mL) and extracted twice with hexanes (2 X 800 mL). Combined organic layers were dried over magnesium sulfate and concentrated

in vacuo to afford 71.1 gr (99%) of 4-bromo-1-triisopropylsilanyl-1*H*-pyrrolo[2,3-b]pyridine **(7)**. ^{1}H NMR (400 MHz, DMSO-d_6) δ (ppm) 8.07 (1H, d, J = 5.1 Hz), 7.55 (1H, d, J = 3.5 Hz), 7.4 (1H, d, J = 5.0 Hz), 6.56 (1H, d, J = 3.3 Hz), 1.82 (3H, septu., J = 7.6 Hz), 1.01 (18H, d, J = 7.6 Hz). ^{13}C NMR (100.62 MHz, DMSO-d_6) δ (ppm) 152.95, 142.67, 132.68, 123.38, 123.11, 118.96, 102.72, 17.78, 11.40. HPLC (solvent A : 10% acetonitrile-90% water + 0.05% TFA; solvent B: 90% acetonitrile-10% water + 0.05% TFA, with 0% B to 100% B in 8 minutes gradient. Column Zorbax SB C18 4.6 x 75 mm, UV: 220 nm; retention time = 11.50 min. Purity = 95.2%. LCMS (solvent A : 10% acetonitrile-90% water + 5mM NH_4OAc; solvent B: 90% acetonitrile-10% water + 5mM NH_4OAc, with 0% B to 100% B in 2 minutes gradient. Column Premisphere C18-HC 4.6 x 30 mm, UV: 220 nm; Micromass ZMD 2000, ESI) m/z 353 ($M+H^+$), retention time = 3.63 min. Purity = 98.8%. Anal. Calcd. for: $C_{16}H_{25}BrN_2Si$: C, 54.38; H, 7.13; N, 7.92. Found: C, 54.39; H, 7.32; N, 7.84. HRMS (LSIMS) calculated for: $C_{16}H_{25}BrN_2Si$ 352.0970 (M^+), found: 352.0982.

4-Fluoro-1-triisopropylsilanyl-1*H*-pyrrolo[2,3-b]pyridine **(8)**

An 250 mL oven-dried round-bottom flask was evacuated and backfilled with argon. The flask was charged 4-bromo-1-triisopropylsilanyl-1*H*-pyrrolo[2,3-b]pyridine (**7**) (1.4 gr, 3.96 mmoles), THF (25 mL) and the mixture was cooled to –78°C. A solution of *tert*-butyllithium (1.7 M in pentane, 4.66 mL, 7.92 mmoles) was added dropwise and after 5 minutes, *N*-fluorobenzenesulfonimide (1.25g, 3.96 mmoles) was added. After 45 minutes, a saturated aqueous solution of ammonium chloride (20 mL) was added and the mixture was allowed to reach room temperature. Water was added (40 mL) and the aqueous layer was extracted with hexanes (3 X 100 mL). Combined organic layers were washed with water, dried over $MgSO_4$, filtered and concentrated *in vacuo*. The crude material was purified by flash chromatography eluting a mixture of 100 % hexanes to give 970 mg (84 %) of 4-fluoro-1-triisopropylsilanyl-1*H*-pyrrolo[2,3-b]pyridine **(8)**. ^{1}H NMR (400 MHz, DMSO-d_6) δ (ppm) 8.22 (1H, dd, J = 5.6, 8.3 Hz), 7.51 (1H, d, J = 3.6 Hz), 6.98 (1H, dd, J = 4.1, 10.1 Hz), 6.69 (1H, d, J = 3.5 Hz), 1.86 (3H, septu., J = 7.6 Hz), 1.04 (18H, d, J = 7.6 Hz). LCMS (solvent A : 10% acetonitrile-90% water + 0.05% TFA; solvent B: 90% acetonitrile-10% water + 0.05% TFA, with 0% B to 100% B in 2 minutes gradient. Column Premisphere C18-HC 4.6 x 30 mm, UV: 220 nm; Micromass ZMD 2000, ESI) m/z 293 ($M+H^+$), retention time = 3.17 min. Purity = 94%. Anal. Calcd. for: $C_{16}H_{25}BrN_2Si$: C, 54.38; H, 7.13; N, 7.92. Found: C, 54.39; H, 7.32; N, 7.84.