Green Oxidant H₂O₂ as a Hydrogen Atom Transfer Reagent for Visible Light-Mediated Minisci Reaction

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I. General Information

Commercial reagents, lepidine, cyclohexane, hydrogen peroxide (H$_2$O$_2$, 29-32% in water), hydrochloric acid (HCl, 36-38% in water), and MeCN were purchased from J&K, TCI, Alfa Aesar, and used directly without purification. All heteroarenes, alkanes, ethers and other reagents were utilized directly from commercial suppliers. Organic solutions were concentrated under reduced pressure on a Büchi rotary evaporator with a recirculating cooling system. Chromatographic purification of products was accomplished by flash chromatography on silica gel (Santai, 230-400 mesh). Thin layer chromatography (TLC) was performed on Huanghai 0.4-0.5 mm silica gel plates. Visualization of the developed chromatogram was performed by fluorescence quenching. $^1$H and $^{13}$C NMR spectra were recorded on a Bruker UltraShield Plus 400 MHz (101 MHz) instrument, and are internally referenced to residual protio solvent signals (note: CDCl$_3$ referenced at 7.26 and 77.0 ppm respectively). Data for $^1$H NMR are reported as follows: chemical shift (δ ppm), multiplicity (s = singlet, d = doublet, t = triplet, q = quartet, m = multiplet, dd = doublet of doublets, dt = doublet of triplets, br = broad), coupling constant (Hz) and integration. Data for $^{13}$C NMR are reported in terms of chemical shift and no special nomenclature is used for equivalent carbons. IR spectra were recorded on a Perkin Elmer Spectrum 100 FTIR spectrometer and are reported in wavenumbers (cm$^{-1}$). High resolution mass spectra were obtained at National Center for Organic Mass Spectrometry in Shanghai Institute of Organic Chemistry, Chinese Academy of Sciences on a Thermo Fisher Scientific LTQ FTICR-MS instrument with electrospray ionization method.
II. Preliminary Mechanistic Studies

**Figure S1.** Radical quenching experiments.

<table>
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<tr>
<th>Entry</th>
<th>Radical Scavenger</th>
<th>Product 1</th>
<th>Yield [%]</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>TEMPO, 1.0 equiv., [0.10 M]</td>
<td>1</td>
<td>9%</td>
</tr>
<tr>
<td>2</td>
<td>TEMPO, 1.5 equiv., [0.15 M]</td>
<td>0</td>
<td>0%</td>
</tr>
</tbody>
</table>

Yield determined by $^1$H NMR using 1,3-benzodioxole as the internal standard.

**Figure S2.** Control experiments.

<table>
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<tr>
<th>entry</th>
<th>solvent</th>
<th>acid</th>
<th>wavelength</th>
<th>Yield [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>acetone</td>
<td>2 equiv TFA</td>
<td>427 nm</td>
<td>7</td>
</tr>
<tr>
<td>2</td>
<td>acetone</td>
<td>2 equiv HCl</td>
<td>427 nm</td>
<td>40</td>
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<tr>
<td>3</td>
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<td>427 nm</td>
<td>29</td>
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<tr>
<td>4</td>
<td>MeCN</td>
<td>2 equiv HCl</td>
<td>427 nm</td>
<td>87</td>
</tr>
<tr>
<td>5</td>
<td>MeCN</td>
<td>none</td>
<td>427 nm</td>
<td>0</td>
</tr>
<tr>
<td>6</td>
<td>MeCN</td>
<td>2 equiv HCl</td>
<td>390 nm</td>
<td>60</td>
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<td>7</td>
<td>MeCN</td>
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<td>73</td>
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<td>456 nm</td>
<td>32</td>
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<tr>
<td>9</td>
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<td>2 equiv HCl</td>
<td>dark</td>
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<td>MeCN</td>
<td>2 equiv HCl</td>
<td>dark, 50 °C</td>
<td>0</td>
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<tr>
<td>11$^b$</td>
<td>MeCN</td>
<td>2 equiv HCl</td>
<td>427 nm</td>
<td>87</td>
</tr>
<tr>
<td>12$^c$</td>
<td>MeCN</td>
<td>2 equiv HCl</td>
<td>427 nm</td>
<td>0</td>
</tr>
</tbody>
</table>

$^a$Yields determined by $^1$H NMR using 1,3-benzodioxole as the internal standard. $^b$At 2 mmol scale, isolated yield. $^c$1.5 equiv of TEMPO added. LED = light-emitting diode.
III. Reaction Setup

Figure S3. Reaction setup with a magnetic stirrer, two Kessil 40 W 427 nm or 390 nm LED lamps, two mini fans and four reaction vials.

Kessil PR160_Spectrum
IV. Experimental Procedures and Product Characterization

**General Procedure for the Oxidative Alkylation:** To an 8 mL vial equipped with a Teflon septum and a magnetic stir bar was charged heteroarene (0.50 mmol, 1.0 equiv.), 5.0 mL of MeCN, and hydrogen peroxide (H₂O₂, 29-32% in water, 0.1 mL, 1.0 mmol, 2.0 equiv.). The reaction mixture was degassed by sparging with nitrogen for 10 min with an outlet needle, and added with hydrochloric acid (HCl, 36-38% in water, 86.0 µL, 1.0 mmol, 2.0 equiv.), alkane (10.0 mmol, 20.0 equiv.), then irradiated with Kessil 40 W 427 nm LEDs (approximately 8 cm away from the light source) under two mini fans at room temperature. Upon reaction completion as judged by TLC and LCMS (18 hours), the reaction mixture was diluted with 1 M NaOH aqueous solution (10 mL) and 1 M Na₂S₂O₃ aqueous solution (10 mL), and extracted with CH₂Cl₂ (3×20 mL), dried over Na₂SO₄, and concentrated in vacuo. Purification of the crude product by flash chromatography on silica gel using the indicated solvent system afforded the desired product.

**Representative example at 2 mmol scale:** To a 40 mL vial equipped with a Teflon septum and a magnetic stir bar was charged lepidine (286.4 mg, 2.0 mmol, 1.0 equiv.), 20.0 mL of MeCN, and hydrogen peroxide (H₂O₂, 29-32% in water, 0.4 mL, 4.0 mmol, 2.0 equiv.). The reaction mixture was degassed by sparging with nitrogen for 10 min with an outlet needle, and added with hydrochloric acid (HCl, 36-38% in water, 344.0 µL, 4.0 mmol, 2.0 equiv.), alkane (4.4 mL, 40.0 mmol, 20.0 equiv.), then irradiated with Kessil 40 W 427 nm LEDs (approximately 8 cm away from the light source) under two mini fans at room temperature for 18 h. The reaction mixture was diluted with 1 M NaOH aqueous solution (40 mL) and 1 M Na₂S₂O₃ aqueous solution (40 mL), and extracted
with CH₂Cl₂ (3×80 mL), dried over Na₂SO₄, and concentrated in vacuo. Purification of the crude product by flash chromatography (10% ethyl acetate/hexanes) on silica gel provided the desired product 2-cyclohexyl-4-methylquinoline as a colorless oil (388.5 mg, 87% yield).

2-Cyclohexyl-4-methylquinoline (3): According to the general procedure, lepidine (71.6 mg, 0.50 mmol, 1.0 equiv.), 5.0 mL of MeCN, H₂O₂ (0.1 mL, 1.0 mmol, 2.0 equiv.), HCl (86.0 µL, 1.0 mmol, 2.0 equiv.), cyclohexane (1.10 ml, 10.0 mmol, 20.0 equiv.) were used. After 18 hours, the reaction mixture was subjected to the workup procedure outlined in the general procedure and purified by flash chromatography (10% ethyl acetate/hexanes) to provide the title compound as a colorless oil (98.0 mg, 87% yield). ¹H NMR (400 MHz, CDCl₃) δ 8.05 (d, J = 8.4 Hz, 1H), 7.93 (d, J = 8.3 Hz, 1H), 7.66 (ddd, J = 8.4, 6.9, 1.5 Hz, 1H), 7.48 (ddd, J = 8.2, 6.8, 1.3 Hz, 1H), 7.16 (s, 1H), 2.88 (tt, J = 12.0, 3.4 Hz, 1H), 2.67 (s, 3H), 2.07 – 1.96 (m, 2H), 1.94 – 1.84 (m, 2H), 1.83 – 1.74 (m, 1H), 1.62 (qd, J = 12.4, 2.9 Hz, 2H), 1.47 (qt, J = 12.6, 3.1 Hz, 2H), 1.35 (tt, J = 12.6, 3.3 Hz, 1H); ¹³C NMR (101 MHz, CDCl₃) δ 166.44, 147.52, 144.20, 129.39, 128.88, 126.97, 125.30, 123.50, 120.17, 47.54, 32.77, 26.50, 26.06, 18.79. Spectra data are consistent with those reported in the literature: Angew. Chem. Int. Ed. 2013, 52, 3267–3271.
2-Cyclopentyl-4-methylquinoline (4): According to the general procedure, lepidine (71.6 mg, 0.50 mmol, 1.0 equiv.), 5.0 mL of MeCN, H$_2$O$_2$ (0.1 mL, 1.0 mmol, 2.0 equiv.), HCl (86.0 µL, 1.0 mmol, 2.0 equiv.), cyclopentane (0.90 ml, 10.0 mmol, 20.0 equiv.) were used. After 18 hours, the reaction mixture was subjected to the workup procedure outlined in the general procedure and purified by flash chromatography (10% ethyl acetate/hexanes) to provide the title compound as a colorless oil (85.6 mg, 81% yield). $^1$H NMR (400 MHz, Chloroform-$d$) δ 8.06 (d, $J$ = 8.4 Hz, 1H), 7.89 (d, $J$ = 8.3 Hz, 1H), 7.64 (ddd, $J$ = 8.4, 6.9, 1.5 Hz, 1H), 7.46 (ddd, $J$ = 8.2, 6.8, 1.3 Hz, 1H), 7.15 (s, 1H), 3.33 (p, J = 8.6 Hz, 1H), 2.64 (s, 3H), 2.22 – 2.11 (m, 2H), 1.95 – 1.81 (m, 4H), 1.81 – 1.69 (m, 2H); $^{13}$C NMR (101 MHz, CDCl$_3$) δ 165.73, 147.38, 143.94, 129.32, 128.76, 126.81, 125.20, 123.38, 120.51, 48.66, 33.43, 25.91, 18.65. Spectra data are consistent with those reported in the literature: Org. Lett. 2017, 19, 6594-6597.

![Chemical Structure](image)

2-Cycloheptyl-4-methylquinoline (5): According to the general procedure, lepidine (71.6 mg, 0.50 mmol, 1.0 equiv.), 5.0 mL of MeCN, H$_2$O$_2$ (0.1 mL, 1.0 mmol, 2.0 equiv.), HCl (86.0 µL, 1.0 mmol, 2.0 equiv.), cycloheptane (1.20 ml, 10.0 mmol, 20.0 equiv.) were used. After 18 hours, the reaction mixture was subjected to the workup procedure outlined in the general procedure and purified by flash chromatography (10% ethyl acetate/hexanes) to provide the title compound as a colorless oil (91.0 mg, 76% yield). $^1$H NMR (400 MHz, CDCl$_3$) δ 8.04 (d, $J$ = 8.4 Hz, 1H), 7.92 – 7.86 (m, 1H), 7.63 (ddd, $J$ = 8.4, 6.8, 1.5 Hz, 1H), 7.45 (ddd, $J$ = 8.2, 6.8, 1.3 Hz, 1H), 7.11 (s, 1H), 3.03 (tt, J = 10.5,
3.5 Hz, 1H), 2.63 (s, 3H), 2.10 – 1.97 (m, 2H), 1.90 – 1.76 (m, 4H), 1.76 – 1.68 (m, 2H), 1.68 – 1.56 (m, 4H); $^{13}$C NMR (101 MHz, CDCl$_3$) $\delta$ 167.88, 147.20, 144.15, 129.25, 128.73, 126.74, 125.12, 123.33, 120.10, 49.41, 34.89, 27.80, 27.29, 18.63. Spectra data are consistent with those reported in the literature: Org. Lett. 2019, 21, DOI: acs.orglett.9b01439.

2-Cyclooctyl-4-methylquinoline (6): According to the general procedure, lepidine (71.6 mg, 0.50 mmol, 1.0 equiv.), 5.0 mL of MeCN, H$_2$O$_2$ (0.1 mL, 1.0 mmol, 2.0 equiv.), HCl (86.0 µL, 1.0 mmol, 2.0 equiv.), cyclooctane (1.30 ml, 10.0 mmol, 20.0 equiv.) were used. After 18 hours, the reaction mixture was subjected to the workup procedure outlined in the general procedure and purified by flash chromatography (10% ethyl acetate/hexanes) to provide the title compound as a colorless oil (86.2 mg, 68% yield). $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 8.06 (d, $J$ = 8.4 Hz, 1H), 7.89 (d, $J$ = 8.3 Hz, 1H), 7.64 (ddd, $J$ = 8.4, 6.8, 1.5 Hz, 1H), 7.45 (ddd, $J$ = 8.2, 6.8, 1.3 Hz, 1H), 7.11 (s, 1H), 3.11 (tt, $J$ = 9.8, 3.6 Hz, 1H), 2.64 (s, 3H), 2.05 – 1.93 (m, 2H), 1.93 – 1.77 (m, 4H), 1.77 – 1.54 (m, 8H); $^{13}$C NMR (101 MHz, CDCl$_3$) $\delta$ 168.66, 147.23, 144.17, 129.33, 128.78, 126.76, 125.18, 123.39, 120.53, 47.40, 33.39, 26.49, 26.30, 26.04, 18.71. Spectra data are consistent with those reported in the literature: Org. Lett. 2019, 21, DOI: acs.orglett.9b01635.
2-(Bicyclo[2.2.1]heptan-2-yl)-4-methylquinoline (7): According to the general procedure, lepidine (71.6 mg, 0.50 mmol, 1.0 equiv.), 5.0 mL of MeCN, H₂O₂ (0.1 mL, 1.0 mmol, 2.0 equiv.), HCl (86.0 µL, 1.0 mmol, 2.0 equiv.), bicyclo[2.2.1]heptane (721.3 mg, 7.5 mmol, 15.0 equiv.) were used. After 18 hours, the reaction mixture was subjected to the workup procedure outlined in the general procedure and purified by flash chromatography (20% ethyl acetate/hexanes) to provide the title compound as a colorless oil (87.8 mg, 74% yield). ¹H NMR (400 MHz, CDCl₃) δ 8.06 (dd, J = 8.4, 1.3 Hz, 1H), 7.92 (dd, J = 8.3, 1.4 Hz, 1H), 7.65 (ddd, J = 8.4, 6.9, 1.5 Hz, 1H), 7.48 (ddd, J = 8.2, 6.8, 1.3 Hz, 1H), 7.18 (s, 1H), 3.01 (dd, J = 8.8, 5.5 Hz, 1H), 2.66 (s, 3H), 2.59 – 2.54 (d, J = 1.9 Hz, 1H), 2.45 – 2.39 (s, 1H), 2.31 – 2.21 (m, 1H), 1.79 – 1.56 (m, 4H), 1.52 – 1.44 (m, 1H), 1.38 – 1.31 (m, 1H), 1.22 – 1.16 (m, 1H); ¹³C NMR (101 MHz, CDCl₃) δ 165.45, 147.35, 143.65, 129.60, 128.71, 126.66, 125.21, 123.39, 121.47, 49.96, 42.98, 36.68, 36.18, 36.00, 30.46, 29.09, 18.70. Spectra data are consistent with those reported in the literature: Org. Lett. 2019, 21, DOI: acs.orglett.9b01635.

2-(Adamantan-1-yl)-4-methylquinoline (8): According to the general procedure, lepidine (71.6 mg, 0.50 mmol, 1.0 equiv.), 5.0 mL of MeCN, H₂O₂ (0.1 mL, 1.0 mmol, 2.0 equiv.), HCl (86.0 µL, 1.0 mmol, 2.0 equiv.), Adamantane (1.02 g, 7.5 mmol, 15.0 equiv.) were used. After 18 hours, the reaction mixture was subjected to the workup procedure outlined in the general procedure and purified by flash chromatography (20% ethyl acetate/hexanes) to provide the title compounds as a white solid (58.3 mg, 42%
yield). $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 8.08 (d, $J = 8.4$ Hz, 1H), 7.94 (d, $J = 8.3$ Hz, 1H), 7.66 (ddd, $J = 8.4$, 6.8, 1.5 Hz, 1H), 7.49 (ddd, $J = 8.2$, 6.8, 1.3 Hz, 1H), 7.33 (s, 1H), 2.69 (s, 3H), 2.16 (s, 3H), 2.13 (s, 6H), 1.84 (s, 6H); $^{13}$C NMR (101 MHz, CDCl$_3$) $\delta$ 168.64, 147.46, 143.54, 129.87, 128.59, 126.66, 125.28, 123.38, 118.48, 41.75, 39.50, 36.85, 28.80, 18.95; HRMS (ESI) m/z calculated for C$_{20}$H$_{24}$N $[(M+H)^+]$ 278.1903, found 278.1901. IR (film) 2902, 2846, 1595, 1552, 1505, 1444, 1412, 1340, 1309, 757 cm$^{-1}$.

Spectra data are consistent with those reported in the literature: Org. Lett. 2019, 21, DOI: acs.orglett.9b01439.

2-(Hexan-2-yl)-4-methylquinoline (9a) and 2-(Hexan-3-yl)-4-methylquinoline (9b):

According to the general procedure, lepidine (71.6 mg, 0.50 mmol, 1.0 equiv.), 5.0 mL of MeCN, H$_2$O$_2$ (0.1 mL, 1.0 mmol, 2.0 equiv.), HCl (86.0 $\mu$L, 1.0 mmol, 2.0 equiv.), hexane (1.30 ml, 10.0 mmol, 20.0 equiv.) were used. After 18 hours, the reaction mixture was subjected to the workup procedure outlined in the general procedure and purified by flash chromatography (10% ethyl acetate/hexanes) to provide the title compounds as a colorless oil mixture of 50.1 mg, 44% total yield (28% yield for 9a; 16% yield for 9b).

Compound 9a: $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 8.06 (d, $J = 8.3$ Hz, 1H), 7.95 (d, $J = 8.3$ Hz, 1H), 7.66 (ddd, $J = 8.4$, 6.8, 1.4 Hz, 1H), 7.49 (ddd, $J = 8.2$, 6.9, 1.3 Hz, 1H), 7.14 (s, 1H), 3.03 (h, $J = 7.0$ Hz, 1H), 2.68 (s, 3H), 1.88 – 1.57 (m, 3H), 1.37 – 1.25 (m, 2H), 1.35 (d, $J = 7.0$ Hz, 3H), 1.24 – 1.12 (m, 1H), 0.85 (t, $J = 7.0$ Hz, 3H); $^{13}$C NMR (101 MHz,
CDCl₃) δ 166.91, 147.50, 144.23, 129.45, 128.87, 126.99, 125.34, 123.53, 120.10, 42.89, 36.77, 29.93, 22.80, 20.78, 18.84, 14.00. Spectra data are consistent with those reported in the literature: *Org. Lett.* 2019, 21, DOI: acs.orglett.9b01635.

Compound 9b: ¹H NMR (400 MHz, CDCl₃) δ 8.08 (d, J = 8.3 Hz, 1H), 7.95 (d, J = 8.3 Hz, 1H), 7.66 (ddd, J = 8.4, 6.8, 1.4 Hz, 1H), 7.49 (ddd, J = 8.2, 6.9, 1.3 Hz, 1H), 7.10 (s, 1H), 2.83 (p, J = 7.2 Hz, 1H), 2.68 (s, 3H), 1.88 – 1.57 (m, 2H), 1.37 – 1.25 (m, 3H), 1.24 – 1.12 (m, 1H), 0.86 (t, J = 7.0 Hz, 3H), 0.82 (t, J = 7.0 Hz, 3H); ¹³C NMR (101 MHz, CDCl₃) δ 165.78, 147.54, 143.95, 129.50, 128.80, 127.00, 125.30, 123.53, 120.65, 50.27, 37.66, 28.51, 20.82, 18.84, 14.23, 12.21. Spectra data are consistent with those reported in the literature: *Org. Lett.* 2019, 21, DOI: acs.orglett.9b01635.

4-Methyl-2-(oxetan-2-yl)quinoline (10): According to the general procedure, lepidine (71.6 mg, 0.50 mmol, 1.0 equiv.), 5.0 mL of MeCN, H₂O₂ (0.1 mL, 1.0 mmol, 2.0 equiv.), HCl (86.0 µL, 1.0 mmol, 2.0 equiv.), trimethylene oxide (0.65 ml, 10.0 mmol, 20.0 equiv.) were used. After 18 hours, the reaction mixture was subjected to the workup procedure outlined in the general procedure and purified by flash chromatography (40% ethyl acetate/hexanes) to provide the title compound as a colorless oil (45.8 mg, 46% yield). ¹H NMR (400 MHz, CDCl₃) δ 8.05 (d, J = 8.4 Hz, 1H), 7.98 (d, J = 8.3 Hz, 1H), 7.68 (ddd, J = 8.3, 6.9, 1.3 Hz, 1H), 7.67 (s, 1H), 7.53 (ddd, J = 8.3, 6.9, 1.3 Hz, 1H), 5.98 (dd, J = 8.4, 6.9 Hz, 1H), 4.92 (td, J = 8.0, 5.9 Hz, 1H), 4.77 (dt, J = 9.1, 6.0 Hz, 1H), 3.19 (ddt, J = 11.2, 8.4, 6.0 Hz, 1H), 2.80 (ddt, J = 11.3, 9.2, 7.3 Hz, 1H), 2.74 (s,
3H); $^{13}$C NMR (101 MHz, CDCl$_3$) $\delta$ 162.52, 147.30, 145.48, 129.58, 129.33, 127.52, 126.09, 123.75, 118.21, 83.62, 69.20, 29.02, 18.93; HRMS (ESI) m/z calculated for C$_{13}$H$_{14}$ON [(M+H)$^+$] 200.1070, found 200.1069. IR (film) 3062, 2885, 1601, 1562, 1508, 1448, 1412, 1348, 1306, 1226, 1038, 980 760 cm$^{-1}$. Spectra data are consistent with those reported in the literature: *Org. Lett.* **2019**, 21, DOI: acs.orglett.9b01635.

4-Methyl-2-(tetrahydrofuran-2-yl)quinoline (11): According to the general procedure, lepidine (71.6 mg, 0.50 mmol, 1.0 equiv.), 5.0 mL of MeCN, H$_2$O$_2$ (0.1 mL, 1.0 mmol, 2.0 equiv.), HCl (86.0 µL, 1.0 mmol, 2.0 equiv.), tetrahydrofuran (0.91 mL, 10.0 mmol, 20.0 equiv.) were used. After 18 hours, the reaction mixture was subjected to the workup procedure outlined in the general procedure and purified by flash chromatography (20% ethyl acetate/hexanes) to provide the title compound as a colorless oil (69.3 mg, 65% yield). $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 8.05 (d, $J$ = 8.4 Hz, 1H), 7.96 (d, $J$ = 8.3 Hz, 1H), 7.68 (ddd, $J$ = 8.4, 6.8, 1.4 Hz, 1H), 7.52 (ddd, $J$ = 8.2, 6.8, 1.3 Hz, 1H), 7.44 (s, 1H), 5.14 (t, $J$ = 6.9 Hz, 1H), 4.21 – 4.13 (m, 1H), 4.07 – 3.99 (m, 1H), 2.70 (s, 3H), 2.56 – 2.45 (m, 1H), 2.11 – 1.98 (m, 3H); $^{13}$C NMR (101 MHz, CDCl$_3$) $\delta$ 163.03, 147.21, 144.97, 129.44, 129.11, 127.40, 125.78, 123.65, 118.53, 82.00, 69.22, 33.30, 25.93, 18.87. Spectra data are consistent with those reported in the literature: *Synlett*, **2016**, 27, 1282-1286.
4-Methyl-2-(tetrahydro-2H-pyran-2-yl)quinoline (12): According to the general procedure, lepidine (71.6 mg, 0.50 mmol, 1.0 equiv.), 5.0 mL of MeCN, H₂O₂ (0.1 mL, 1.0 mmol, 2.0 equiv.), HCl (86.0 µL, 1.0 mmol, 2.0 equiv.), tetrahydro-2H-pyran (1.10 ml, 10.0 mmol, 20.0 equiv.) were used. After 18 hours, the reaction mixture was subjected to the workup procedure outlined in the general procedure and purified by flash chromatography (20% ethyl acetate/hexanes) to provide the title compound as a colorless oil (76.1 mg, 67% yield). ¹H NMR (400 MHz, CDCl₃) δ 8.05 (d, J = 8.4 Hz, 1H), 7.93 (d, J = 8.3 Hz, 1H), 7.65 (ddd, J = 8.4, 6.8, 1.4 Hz, 1H), 7.48 (ddd, J = 8.3, 6.8, 1.3 Hz, 1H), 7.45 (s, 1H), 4.59 (dd, J = 11.1, 2.3 Hz, 1H), 4.24 – 4.15 (m, 1H), 3.67 (td, J = 11.6, 2.5 Hz, 1H), 2.67 (s, 3H), 2.09 (dt, J = 12.5, 2.1 Hz, 1H), 2.00 – 1.91 (m, 1H), 1.80 – 1.68 (m, 2H), 1.67 – 1.52 (m, 2H); ¹³C NMR (101 MHz, CDCl₃) δ 161.99, 146.99, 144.86, 129.46, 128.93, 127.37, 125.70, 123.50, 118.67, 81.47, 68.75, 32.65, 25.73, 23.60, 18.70. Spectra data are consistent with those reported in the literature: Angew. Chem. Int. Ed. 2015, 54, 1565-1569.

2-(1,4-Dioxan-2-yl)-4-methylquinoline (13): According to the general procedure, lepidine (71.6 mg, 0.50 mmol, 1.0 equiv.), 5.0 mL of MeCN, H₂O₂ (0.1 mL, 1.0 mmol, 2.0 equiv.), HCl (86.0 µL, 1.0 mmol, 2.0 equiv.), 1,4-dioxane (0.94 ml, 10.0 mmol, 20.0
equiv.) were used. After 18 hours, the reaction mixture was subjected to the workup procedure outlined in the general procedure and purified by flash chromatography (20% ethyl acetate/hexanes) to provide the title compound as a white solid (86.0 mg, 75% yield). 

$^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 8.05 (d, $J = 8.3$ Hz, 1H), 7.93 (d, $J = 8.3$ Hz, 1H), 7.66 (ddd, $J = 8.4$, 6.8, 1.4 Hz, 1H), 7.50 (ddd, $J = 8.3$, 6.8, 1.3 Hz, 1H), 7.43 (s, 1H), 4.87 (dd, $J = 10.1$, 2.9 Hz, 1H), 4.22 (dd, $J = 11.6$, 3.0 Hz, 1H), 4.03 – 3.91 (m, 2H), 3.84 – 3.71 (m, 2H), 3.61 (dd, $J = 11.6$, 10.1 Hz, 1H), 2.67 (s, 3H); $^{13}$C NMR (101 MHz, CDCl$_3$) $\delta$ 157.67, 147.11, 145.00, 129.62, 129.11, 127.44, 126.05, 123.53, 118.95, 78.60, 70.94, 66.91, 66.26, 18.68. Spectra data are consistent with those reported in the literature: Synlett, 2016, 27, 1282-1286.

4-Methyl-2-(1,3,5-trioxan-2-yl)quinoline (14): According to the general procedure, lepidine (71.6 mg, 0.50 mmol, 1.0 equiv.), 5.0 mL of MeCN, H$_2$O$_2$ (0.1 mL, 1.0 mmol, 2.0 equiv.), HCl (86.0 µL, 1.0 mmol, 2.0 equiv.), 1,3,5-trioxane (675 mg, 7.5 mmol, 15.0 equiv.) were used. After 18 hours, the reaction mixture was subjected to the workup procedure outlined in the general procedure and purified by flash chromatography (20% ethyl acetate/hexanes) to provide the title compound as a white solid (41.6 mg, 36% yield). 

$^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 8.14 (d, $J = 8.4$ Hz, 1H), 8.01 (d, $J = 8.3$ Hz, 1H), 7.72 (ddd, $J = 8.4$, 6.8, 1.5 Hz, 1H), 7.66 (s, 1H), 7.59 (ddd, $J = 8.3$, 6.9, 1.3 Hz, 1H), 6.08 (s, 1H), 5.45 – 5.37 (m, 4H), 2.75 (s, 3H); $^{13}$C NMR (101 MHz, CDCl$_3$) $\delta$ 154.77, 146.99, 145.99, 130.10, 129.48, 128.36, 126.96, 123.72, 118.83, 102.12, 93.69, 18.90.

![Image](https://via.placeholder.com/150)

**2-(1-Ethoxyethyl)-4-methylquinoline (15):** According to the general procedure, lepidine (71.6 mg, 0.50 mmol, 1.0 equiv.), 5.0 mL of MeCN, H₂O₂ (0.1 mL, 1.0 mmol, 2.0 equiv.), HCl (86.0 µL, 1.0 mmol, 2.0 equiv.), ethoxyethane (1.04 ml, 10.0 mmol, 20.0 equiv.) were used. After 18 hours, the reaction mixture was subjected to the workup procedure outlined in the general procedure and purified by flash chromatography (10% ethyl acetate/hexanes) to provide the title compound as a colorless oil (92.9 mg, 77% yield). ¹H NMR (400 MHz, CDCl₃) δ 8.06 (d, J = 8.4 Hz, 1H), 7.98 (d, J = 8.3 Hz, 1H), 7.69 (ddd, J = 8.4, 6.8, 1.4 Hz, 1H), 7.54 (ddd, J = 8.3, 6.9, 1.3 Hz, 1H), 7.44 (s, 1H), 4.67 (q, J = 6.6 Hz, 1H), 3.51 (dq, J = 9.3, 7.0 Hz, 1H), 3.41 (dq, J = 9.3, 7.0 Hz, 1H), 2.73 (s, 3H), 1.53 (d, J = 6.6 Hz, 3H), 1.23 (t, J = 7.0 Hz, 3H); ¹³C NMR (101 MHz, CDCl₃) δ 163.95, 147.10, 145.26, 129.45, 129.16, 127.62, 125.96, 123.68, 118.26, 79.67, 64.61, 22.66, 18.98, 15.45. Spectra data are consistent with those reported in the literature: *Synlett*, **2016**, 27, 1282-1286.

![Image](https://via.placeholder.com/150)

**4-Methyl-2-(1-propoxypropyl)quinoline (16):** According to the general procedure, lepidine (71.6 mg, 0.50 mmol, 1.0 equiv.), 5.0 mL of MeCN, H₂O₂ (0.1 mL, 1.0 mmol,
2.0 equiv.), HCl (86.0 µL, 1.0 mmol, 2.0 equiv.), 1-propoxypropane (1.39 ml, 10.0 mmol, 20.0 equiv.) were used. After 18 hours, the reaction mixture was subjected to the workup procedure outlined in the general procedure and purified by flash chromatography (10% ethyl acetate/hexanes) to provide the title compound as a colorless oil (86.4 mg, 71% yield). \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 8.06 (d, \(J = 8.4\) Hz, 1H), 7.95 (d, \(J = 7.9\) Hz, 1H), 7.66 (ddd, \(J = 8.4, 6.9, 1.5\) Hz, 1H), 7.50 (ddd, \(J = 8.2, 6.9, 1.3\) Hz, 1H), 7.40 (s, 1H), 4.40 (dd, \(J = 7.9, 5.5\) Hz, 1H), 3.34 (td, \(J = 6.6, 1.6\) Hz, 2H), 2.69 (s, 3H), 1.95 – 1.74 (m, 2H), 1.61 (h, \(J = 7.1\) Hz, 2H), 0.99 (t, \(J = 7.4\) Hz, 3H), 0.90 (t, \(J = 7.4\) Hz, 3H); \(^{13}\)C NMR (101 MHz, CDCl\(_3\)) \(\delta\) 163.31, 147.09, 144.72, 129.44, 128.95, 127.53, 125.78, 123.57, 118.71, 85.16, 71.21, 29.92, 23.02, 18.84, 10.55, 10.19. Spectra data are consistent with those reported in the literature: Eur. J. Org. Chem. 2015, 2015, 4973-4981.

![Chemical Structure](image)

**2-(1-Butoxybutyl)-4-methylquinoline (17):** According to the general procedure, lepidine (71.6 mg, 0.50 mmol, 1.0 equiv.), 5.0 mL of MeCN, H\(_2\)O\(_2\) (0.1 mL, 1.0 mmol, 2.0 equiv.), HCl (86.0 µL, 1.0 mmol, 2.0 equiv.), 1-butoxybutane (1.70 ml, 10.0 mmol, 20.0 equiv.) were used. After 18 hours, the reaction mixture was subjected to the workup procedure outlined in the general procedure and purified by flash chromatography (10% ethyl acetate/hexanes) to provide the title compound as a colorless oil (74.6 mg, 55% yield). \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 8.07 (d, \(J = 8.4\) Hz, 1H), 7.97 (d, \(J = 8.2\) Hz, 1H), 7.68 (ddd, \(J = 8.4, 6.8, 1.4\) Hz, 1H), 7.52 (ddd, \(J = 8.3, 6.9, 1.3\) Hz, 1H), 7.41 (s, 1H), 4.48 (dd, \(J = 8.5, 4.9\) Hz, 1H), 3.37 (t, \(J = 6.6\) Hz, 2H), 2.71 (s, 3H), 1.89 – 1.77 (m, 1H),
1.77 – 1.66 (m, 1H), 1.63 – 1.50 (m, 3H), 1.46 – 1.33 (m, 3H), 0.93 (t, J = 7.4 Hz, 3H),
0.88 (t, J = 7.4 Hz, 3H); ¹³C NMR (101 MHz, CDCl₃) δ 163.63, 147.14, 144.84, 129.51,
129.02, 127.59, 125.84, 123.64, 118.73, 83.85, 69.30, 39.20, 31.98, 19.31, 19.13, 18.92,
13.97, 13.82. Spectra data are consistent with those reported in the literature: *Synlett*,
2016, 27, 1282-1286.

2-(tert-Butoxymethyl)-4-methylquinoline (18): According to the general procedure,
lepidine (71.6 mg, 0.50 mmol, 1.0 equiv.), 5.0 mL of MeCN, H₂O₂ (0.1 mL, 1.0 mmol,
2.0 equiv.), HCl (86.0 µL, 1.0 mmol, 2.0 equiv.), 2-methoxy-2-methylpropane (1.19 ml,
10.0 mmol, 20.0 equiv.) were used. After 18 hours, the reaction mixture was subjected to
the workup procedure outlined in the general procedure and purified by flash
chromatography (10% ethyl acetate/hexanes) to provide the title compound as a colorless
oil (55.0 mg, 48% yield); ¹H NMR (400 MHz, CDCl₃) δ 8.02 (d, J = 8.4 Hz, 1H), 7.94 (d,
J = 7.8 Hz, 1H), 7.65 (ddd, J = 8.4, 6.8, 1.5 Hz, 1H), 7.52 – 7.45 (m, 2H), 4.71 (s, 2H),
2.68 (s, 3H), 1.32 (s, 9H); ¹³C NMR (101 MHz, CDCl₃) δ 160.18, 147.07, 144.69,
129.21, 129.02, 127.37, 125.68, 123.61, 119.99, 73.91, 65.93, 27.60, 18.76; HRMS (ESI)
m/z calculated for C₁₅H₂₀NO [(M+H)⁺] 230.1539, found 230.1538. IR (film) 2974, 2931,
1603, 1565, 1509, 1448, 1390, 1363, 1250, 1194, 1096, 758 cm⁻¹.
(4-Methylquinolin-2-yl)methanol (19): According to the general procedure, lepidine (71.6 mg, 0.50 mmol, 1.0 equiv.), 5.0 mL of MeCN, H$_2$O$_2$ (0.1 mL, 1.0 mmol, 2.0 equiv.), HCl (86.0 µL, 1.0 mmol, 2.0 equiv.), methanol (0.30 ml, 7.5 mmol, 15.0 equiv.) were used. After 18 hours, the reaction mixture was subjected to the workup procedure outlined in the general procedure and purified by flash chromatography (50% ethyl acetate/hexanes) to provide the title compound as a white solid (60.6 mg, 70% yield). $^1$H NMR (400 MHz, CDCl$_3$) δ 8.06 (d, $J = 8.4$ Hz, 1H), 7.95 (d, $J = 8.3$ Hz, 1H), 7.69 (ddd, $J = 8.4$, 6.9, 1.5 Hz, 1H), 7.54 (ddd, $J = 8.3$, 6.9, 1.3 Hz, 1H), 7.11 (s, 1H), 4.86 (s, 2H), 4.55 (br s, 1H), 2.67 (s, 3H); $^{13}$C NMR (101 MHz, CDCl$_3$) δ 158.69, 146.45, 145.09, 129.41, 129.08, 127.57, 126.05, 123.79, 118.96, 64.03, 18.79. Spectra data are consistent with those reported in the literature: *Org. Lett.* 2018, 20, 3229-3232.

![Diagram of 4-Methylquinolin-2-yl)methanol](image)

1-(4-Methylquinolin-2-yl)ethan-1-ol (20): According to the general procedure, lepidine (71.6 mg, 0.50 mmol, 1.0 equiv.), 5.0 mL of MeCN, H$_2$O$_2$ (0.1 mL, 1.0 mmol, 2.0 equiv.), HCl (86.0 µL, 1.0 mmol, 2.0 equiv.), ethanol (0.44 ml, 7.50 mmol, 15.0 equiv.) were used. After 18 hours, the reaction mixture was subjected to the workup procedure outlined in the general procedure and purified by flash chromatography (30% ethyl acetate/hexanes) to provide the title compound as a white solid (59.0 mg, 63% yield). $^1$H NMR (400 MHz, CDCl$_3$) δ 8.07 (d, $J = 8.4$ Hz, 1H), 7.97 (d, $J = 8.3$ Hz, 1H), 7.71 (ddd, $J = 8.4$, 6.9, 1.4 Hz, 1H), 7.55 (ddd, $J = 8.2$, 6.9, 1.3 Hz, 1H), 7.18 (s, 1H), 5.14 (br s, 1H), 4.99 (q, $J = 6.6$ Hz, 1H), 2.71 (s, 3H), 1.57 (d, $J = 6.6$ Hz, 3H); $^{13}$C NMR (101 MHz,
CDCl$_3$) δ 162.44, 146.02, 145.32, 129.42, 129.19, 127.41, 126.09, 123.69, 118.53, 68.58, 24.04, 18.91. Spectra data are consistent with those reported in the literature: *Org. Lett.* **2011**, *13*, 4581-4583.

**1-(4-Methylquinolin-2-yl)propan-1-ol (21):** According to the general procedure, lepidine (71.6 mg, 0.50 mmol, 1.0 equiv.), 5.0 mL of MeCN, H$_2$O$_2$ (0.1 mL, 1.0 mmol, 2.0 equiv.), HCl (86.0 µL, 1.0 mmol, 2.0 equiv.), 1-Propanol (0.75 ml, 10.0 mmol, 20.0 equiv.) were used. After 18 hours, the reaction mixture was subjected to the workup procedure outlined in the general procedure and purified by flash chromatography (15% ethyl acetate/hexanes) to provide the title compound as a colorless oil (53.3 mg, 53% yield). $^1$H NMR (400 MHz, CDCl$_3$) δ 8.07 (d, $J = 8.4$ Hz, 1H), 7.97 (d, $J = 8.3$ Hz, 1H), 7.70 (ddd, $J = 8.4$, 6.9, 1.4 Hz, 1H), 7.55 (ddd, $J = 8.2$, 6.9, 1.3 Hz, 1H), 7.17 (s, 1H), 5.03 (br s, 1H), 4.83 (dd, $J = 7.1$, 4.2 Hz, 1H), 2.70 (s, 3H), 2.03 – 1.94 (m, 1H), 1.76 (dp, $J = 14.5$, 7.3 Hz, 1H), 0.98 (t, $J = 7.4$ Hz, 3H); $^{13}$C NMR (101 MHz, CDCl$_3$) δ 161.50, 146.06, 145.09, 129.36, 129.21, 127.44, 126.05, 123.70, 118.88, 73.31, 30.83, 18.91, 9.28; HRMS (ESI) m/z calculated for C$_{13}$H$_{16}$ON [(M+H)$^+$] 202.1226, found 202.1226. IR (film) 3370, 2965, 2931, 2875, 1603, 1567, 1509, 1449, 1411, 1095, 1050, 760 cm$^{-1}$.

3-Fluoro-1-(4-methylquinolin-2-yl)propan-1-ol (22): According to the general procedure, lepidine (71.6 mg, 0.50 mmol, 1.0 equiv.), 5.0 mL of MeCN, H$_2$O$_2$ (0.1 mL, 1.0 mmol, 2.0 equiv.), HCl (86.0 µL, 1.0 mmol, 2.0 equiv.), 3-fluoropropan-1-ol (0.75 ml, 10.0 mmol, 20.0 equiv.) were used. After 18 hours, the reaction mixture was subjected to the workup procedure outlined in the general procedure and purified by flash chromatography (20% ethyl acetate/hexanes) to provide the title compound as a colorless oil (44.9 mg, 41% yield). $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 8.07 (d, $J = 7.9$ Hz, 1H), 7.99 (d, $J = 8.3$ Hz, 1H), 7.72 (ddd, $J = 8.4, 6.9, 1.5$ Hz, 1H), 7.57 (ddd, $J = 8.3, 6.8, 1.3$ Hz, 1H), 7.20 (s, 1H), 5.03 (dd, $J = 9.0, 3.3$ Hz, 1H), 4.92 – 4.74 (m, 1H), 4.74 – 4.55 (m, 1H), 2.72 (s, 3H), 2.47 – 2.28 (m, 1H), 2.06 – 1.90 (m, 1H); $^{13}$C NMR (101 MHz, CDCl$_3$) $\delta$ 160.71, 146.12, 145.57, 129.58, 129.19, 127.59, 126.30, 123.80, 118.73, 81.12 (d), 68.73 (d), 39.02 (d), 18.95; HRMS (ESI) m/z calculated for C$_{18}$H$_{26}$N$_3$ [(M+H)$^+$] 284.2121, found 284.2119. IR (film) 3344, 2918, 2850, 1603, 1508, 1452, 1412, 1384, 1336, 1229, 1104, 1034, 760 cm$^{-1}$.

2-Methyl-1-(4-methylquinolin-2-yl)propan-1-ol (23a) and 2-Methyl-2-(4-methylquinolin-2-yl)propan-1-ol (23b): According to the general procedure, lepidine (71.6 mg, 0.50 mmol, 1.0 equiv.), 5.0 mL of MeCN, H$_2$O$_2$ (0.1 mL, 1.0 mmol, 2.0 equiv.), 3-fluoropropan-1-ol (0.75 ml, 10.0 mmol, 20.0 equiv.) were used. After 18 hours, the reaction mixture was subjected to the workup procedure outlined in the general procedure and purified by flash chromatography (20% ethyl acetate/hexanes) to provide the title compounds as colorless oils.
equiv.), HCl (86.0 µL, 1.0 mmol, 2.0 equiv.), 2-methylpropan-1-ol (0.92 ml, 10.0 mmol, 20.0 equiv.) were used. After 18 hours, the reaction mixture was subjected to the workup procedure outlined in the general procedure and purified by flash chromatography (20% ethyl acetate/hexanes) to provide the title compounds as an oil mixture of 62.4 mg, 58% total yield (33% yield for 23a; 25% yield for 23b). HRMS (ESI) m/z calculated for C_{14}H_{18}NO [(M+H)^+] 216.1383, found 216.1381. IR (film) 3385, 2961, 2871, 1603, 1560, 1448, 1411, 1051, 1018, 759 cm⁻¹.

Compound 23a: ¹H NMR (400 MHz, CDCl₃) δ 8.04 (d, J = 8.3 Hz, 1H), 7.92 (d, J = 8.4 Hz, 1H), 7.68 – 7.60 (m, 1H), 7.54 – 7.45 (m, 1H), 7.13 (s, 1H), 5.02 (br s, 1H), 4.68 (d, J = 3.6 Hz, 1H), 2.65 (s, 3H), 2.21 – 2.08 (m, 1H), 1.11 (d, J = 6.9 Hz, 3H), 0.73 (d, J = 6.8 Hz, 3H); ¹³C NMR (101 MHz, CDCl₃) δ 161.08, 145.91, 144.74, 129.18, 129.14, 127.34, 125.92, 123.60, 119.21, 76.74, 34.53, 19.83, 18.79, 15.47.

Compound 23b: ¹H NMR (400 MHz, CDCl₃) δ 7.95 (d, J = 8.4 Hz, 1H), 7.90 (d, J = 8.4 Hz, 1H), 7.68 – 7.60 (m, 1H), 7.54 – 7.45 (m, 1H), 7.24 (s, 1H), 3.86 (s, 2H), 2.65 (s, 3H), 1.37 (s, 6H); ¹³C NMR (101 MHz, CDCl₃) δ 168.20, 145.96, 145.02, 129.24, 129.16, 126.54, 125.83, 123.41, 119.38, 71.71, 41.50, 25.54, 18.87.

1-(4-Methylquinolin-2-yl)cyclobutan-1-ol (24): According to the general procedure, lepidine (71.6 mg, 0.50 mmol, 1.0 equiv.), 5.0 mL of MeCN, H₂O₂ (0.1 mL, 1.0 mmol, 2.0 equiv.), HCl (86.0 µL, 1.0 mmol, 2.0 equiv.), cyclobutanol (0.78 ml, 10.0 mmol, 20.0 equiv.) were used. After 18 hours, the reaction mixture was subjected to the workup
procedure outlined in the general procedure and purified by flash chromatography (10% ethyl acetate/hexanes) to provide the title compound as a light yellow solid (25.6 mg, 24% yield). \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 8.05 (d, \(J = 8.4\) Hz, 1H), 7.98 (d, \(J = 7.8\) Hz, 1H), 7.70 (ddd, \(J = 8.4, 6.9, 1.5\) Hz, 1H), 7.60 – 7.50 (m, 2H), 6.13 (br s, 1H), 2.77 (s, 3H), 2.72 – 2.54 (m, 4H), 2.25 – 2.10 (m, 1H), 2.08 – 1.95 (m, 1H); \(^1^3\)C NMR (101 MHz, CDCl\(_3\)) \(\delta\) 163.65, 146.00, 145.24, 129.52, 129.24, 127.20, 126.10, 123.54, 117.28, 75.46, 37.44, 19.16, 13.30; HRMS (ESI) m/z calculated for C\(_{18}\)H\(_{26}\)N\(_3\) [(M+H)+] 284.2121, found 284.2119. IR (film) 3374, 2985, 2936, 1603, 1562, 1508, 1447, 1408, 1249, 1151, 1124, 1088, 759 cm\(^{-1}\).

1-(4-Methylquinolin-2-yl)propane-1,3-diol (25): According to the general procedure, lepidine (71.6 mg, 0.50 mmol, 1.0 equiv.), 5.0 mL of MeCN, H\(_2\)O\(_2\) (0.1 mL, 1.0 mmol, 2.0 equiv.), HCl (86.0 \(\mu\)L, 1.0 mmol, 2.0 equiv.), propane-1,3-diol (0.72 ml, 10.0 mmol, 20.0 equiv.) were used. After 18 hours, the reaction mixture was subjected to the workup procedure outlined in the general procedure and purified by flash chromatography (50% ethyl acetate/hexanes) to provide the title compound as a white solid (69.5 mg, 64% yield). \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 8.02 (d, \(J = 8.4\) Hz, 1H), 7.95 (d, \(J = 8.2\) Hz, 1H), 7.68 (t, \(J = 7.6\) Hz, 1H), 7.53 (t, \(J = 7.4\) Hz, 1H), 7.25 (s, 1H), 5.11 (dd, \(J = 8.9, 3.6\) Hz, 1H), 3.91 (t, \(J = 5.6\) Hz, 2H), 2.67 (s, 3H), 2.24–2.12 (m, 1H), 1.98 – 1.85 (m, 1H); \(^1^3\)C NMR (101 MHz, CDCl\(_3\)) \(\delta\) 161.36, 146.03, 145.61, 129.48, 129.01, 127.45, 126.18, 123.71, 118.65, 72.17, 60.54, 39.70, 18.87; HRMS (ESI) m/z calculated for C\(_{13}\)H\(_{16}\)NO\(_2\)
[(M+H)⁺] 218.1176, found 218.1174. IR (film) 3385, 2925, 1691, 1603, 1567, 1510, 1447, 1413, 1054, 909, 760 cm⁻¹.

2-(tert-Butyl)-4-methylquinoline (26): According to the general procedure, lepidine (71.6 mg, 0.50 mmol, 1.0 equiv.), 5.0 mL of MeCN, H₂O₂ (0.1 mL, 1.0 mmol, 2.0 equiv.), HCl (86.0 µL, 1.0 mmol, 2.0 equiv.), pivalaldehyde (1.09 ml, 10.0 mmol, 20.0 equiv.) were used. After 18 hours, the reaction mixture was subjected to the workup procedure outlined in the general procedure and purified by flash chromatography (10% ethyl acetate/hexanes) to provide the title compound as a colorless oil (95.7 mg, 96% yield). ¹H NMR (400 MHz, CDCl₃) δ 8.09 (d, J = 8.4 Hz, 1H), 7.95 (d, J = 8.3 Hz, 1H), 7.67 (ddd, J = 8.4, 6.9, 1.5 Hz, 1H), 7.50 (ddd, J = 8.3, 6.8, 1.3 Hz, 1H), 7.37 (s, 1H), 2.70 (s, 3H), 1.49 (s, 9H); ¹³C NMR (101 MHz, CDCl₃) δ 168.86, 147.22, 143.59, 129.86, 128.65, 126.49, 125.34, 123.33, 118.84, 37.86, 30.08, 18.91. Spectra data are consistent with those reported in the literature: Org. Lett. 2018, 20, 3229-3232.

2-Ethyl-4-methylquinoline (27): According to the general procedure, lepidine (71.6 mg, 0.50 mmol, 1.0 equiv.), 5.0 mL of MeCN, H₂O₂ (0.1 mL, 1.0 mmol, 2.0 equiv.), HCl (86.0 µL, 1.0 mmol, 2.0 equiv.), propionaldehyde (0.72 ml, 10.0 mmol, 20.0 equiv.) were used. After 18 hours, the reaction mixture was subjected to the workup procedure
outlined in the general procedure and purified by flash chromatography (10% ethyl acetate/hexanes) to provide the title compound as a colorless oil (47.9 mg, 59% yield). $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 8.05 (d, $J = 8.3$ Hz, 1H), 7.94 (d, $J = 8.3$ Hz, 1H), 7.66 (ddd, $J = 8.4$, 6.9, 1.5 Hz, 1H), 7.49 (ddd, $J = 8.2$, 6.8, 1.3 Hz, 1H), 7.15 (s, 1H), 2.95 (q, $J = 7.7$ Hz, 2H), 2.67 (s, 3H), 1.38 (t, $J = 7.7$ Hz, 3H); $^{13}$C NMR (101 MHz, CDCl$_3$) $\delta$ 163.64, 147.56, 144.39, 129.20, 129.02, 126.75, 125.39, 123.54, 121.50, 32.13, 18.66, 14.02. Spectra data are consistent with those reported in the literature: *Org. Lett.* 2018, 20, 3229-3232.

![28](image)

**4-Chloro-2-cyclohexylquinoline (28):** According to the general procedure, 4-chloroquinoline (81.8 mg, 0.50 mmol, 1.0 equiv.), 5.0 mL of MeCN, H$_2$O$_2$ (0.1 mL, 1.0 mmol, 2.0 equiv.), HCl (86.0 µL, 1.0 mmol, 2.0 equiv.), cyclohexane (1.10 ml, 10.0 mmol, 20.0 equiv.) were used. After 24 hours, the reaction mixture was subjected to the workup procedure outlined in the general procedure and purified by flash chromatography (10% ethyl acetate/hexanes) to provide the title compound as a colorless oil (103.3 mg, 84% yield). $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 8.14 (d, $J = 8.4$ Hz, 1H), 8.04 (d, $J = 8.2$ Hz, 1H), 7.69 (ddd, $J = 8.5$, 6.9, 1.5 Hz, 1H), 7.52 (ddd, $J = 8.2$, 6.9, 1.2 Hz, 1H), 7.39 (s, 1H), 2.86 (tt, $J = 12.0$, 3.5 Hz, 1H), 2.05 – 1.95 (m, 2H), 1.92 – 1.82 (m, 2H), 1.81 – 1.70 (m, 1H), 1.65 – 1.51 (m, 2H), 1.50 – 1.37 (m, 2H), 1.36 – 1.23 (m, 1H); $^{13}$C NMR (101 MHz, CDCl$_3$) $\delta$ 166.64, 148.53, 142.46, 130.01, 129.18, 126.44, 124.98,
123.73, 119.66, 47.25, 32.55, 26.31, 25.88. Spectra data are consistent with those reported in the literature: *Org. Lett.* 2018, 20, 4686-4690.

![Chemical Structure 29](image)

**2-Chloro-4-cyclohexylquinoline (29):** According to the general procedure, 2-chloroquinoline (81.8 mg, 0.50 mmol, 1.0 equiv.), 5.0 mL of MeCN, H₂O₂ (0.1 mL, 1.0 mmol, 2.0 equiv.), HCl (86.0 µL, 1.0 mmol, 2.0 equiv.), cyclohexane (1.10 ml, 10.0 mmol, 20.0 equiv.) were used. After 24 hours, the reaction mixture was subjected to the workup procedure outlined in the general procedure and purified by flash chromatography (10% ethyl acetate/hexanes) to provide the title compound as a white solid (116.7 mg, 95% yield). 

$^1$H NMR (400 MHz, CDCl₃) δ 7.99 (dd, J = 8.4, 1.6 Hz, 2H), 7.66 (ddd, J = 8.4, 6.8, 1.4 Hz, 1H), 7.51 (ddd, J = 8.3, 6.8, 1.3 Hz, 1H), 7.22 (s, 1H), 3.24 (tt, J = 11.4, 3.0 Hz, 1H), 2.00 – 1.92 (m, 2H), 1.92 – 1.86 (m, 2H), 1.86 – 1.78 (m, 1H), 1.56 – 1.41 (m, 4H), 1.36 – 1.24 (m, 1H); $^{13}$C NMR (101 MHz, CDCl₃) δ 156.78, 150.93, 148.02, 129.79, 129.33, 126.39, 125.45, 123.02, 118.54, 38.93, 33.24, 26.62, 25.99. Spectra data are consistent with those reported in the literature: *Angew. Chem. Int. Ed.* 2013, 52, 3267-3271.

![Chemical Structure 30](image)

**2-Cyclohexyl-4-methoxyquinoline (30):** According to the general procedure, 4-methoxyquinoline (79.6 mg, 0.50 mmol, 1.0 equiv.), 5.0 mL of MeCN, H₂O₂ (0.1 mL,
1.0 mmol, 2.0 equiv.), HCl (86.0 µL, 1.0 mmol, 2.0 equiv.), cyclohexane (1.10 ml, 10.0 mmol, 20.0 equiv.) were used. After 24 hours, the reaction mixture was subjected to the workup procedure outlined in the general procedure and purified by flash chromatography (10% ethyl acetate/hexanes) to provide the title compound as a colorless oil (51.9 mg, 43% yield). $^1$H NMR (400 MHz, CDCl$_3$) δ 8.12 (d, $J$ = 8.3 Hz, 1H), 7.98 (d, $J$ = 8.3 Hz, 1H), 7.63 (ddd, $J$ = 8.4, 6.8, 1.5 Hz, 1H), 7.41 (ddd, $J$ = 8.2, 6.9, 1.2 Hz, 1H), 6.63 (s, 1H), 4.01 (s, 3H), 2.87 (tt, $J$ = 12.0, 3.4 Hz, 1H), 2.11 – 1.95 (m, 2H), 1.94 – 1.82 (m, 2H), 1.82 – 1.74 (m, 1H), 1.62 (qd, $J$ = 12.4, 3.1 Hz, 2H), 1.53 – 1.40 (m, 2H), 1.40 – 1.28 (m, 1H); $^{13}$C NMR (101 MHz, CDCl$_3$) δ 168.05, 162.36, 148.55, 129.47, 128.28, 124.62, 121.46, 120.16, 97.84, 55.34, 48.13, 32.83, 26.46, 26.01. Spectra data are consistent with those reported in the literature: Org. Lett. 2019, 21, DOI: acs.orglett.9b01635.

4-Bromo-1-cyclohexylisoquinoline (31): According to the general procedure, 4-bromoisooquinoline (104.0 mg, 0.50 mmol, 1.0 equiv.), 5.0 mL of MeCN, H$_2$O$_2$ (0.1 mL, 1.0 mmol, 2.0 equiv.), HCl (86.0 µL, 1.0 mmol, 2.0 equiv.), cyclohexane (1.10 ml, 10.0 mmol, 20.0 equiv.) were used. After 18 hours, the reaction mixture was subjected to the workup procedure outlined in the general procedure and purified by flash chromatography (10% ethyl acetate/hexanes) to provide the title compound as a colorless oil (105.9 mg, 73% yield). $^1$H NMR (400 MHz, CDCl$_3$) δ 8.65 (s, 1H), 8.22 (d, $J$ = 8.5 Hz, 1H), 8.18 (d, $J$ = 8.4 Hz, 1H), 7.76 (ddd, $J$ = 8.3, 6.8, 1.2 Hz, 1H), 7.64 (ddd, $J$ = 8.3,
6.9, 1.3 Hz, 1H), 3.52 (tt, $J = 11.7, 3.2$ Hz, 1H), 2.02 – 1.88 (m, 4H), 1.86 – 1.75 (m, 3H), 1.60 – 1.45 (m, 2H), 1.44 – 1.33 (m, 1H); $^{13}$C NMR (101 MHz, CDCl$_3$) $\delta$ 165.31, 143.52, 134.87, 130.79, 127.71, 127.57, 126.83, 125.05, 117.50, 41.44, 32.50, 26.75, 26.12.


6-Cyclohexylphenanthridine (32): According to the general procedure, phenanthridine (89.6 mg, 0.50 mmol, 1.0 equiv.), 5.0 mL of MeCN, H$_2$O$_2$ (0.1 mL, 1.0 mmol, 2.0 equiv.), HCl (86.0 µL, 1.0 mmol, 2.0 equiv.), cyclohexane (1.10 ml, 10.0 mmol, 20.0 equiv.) were used. After 24 hours, the reaction mixture was subjected to the workup procedure outlined in the general procedure and purified by flash chromatography (5% ethyl acetate/hexanes) to provide the title compound as a colorless oil (112.4 mg, 86% yield). $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 8.65 (d, $J = 8.2$ Hz, 1H), 8.54 (d, $J = 8.1$ Hz, 1H), 8.32 (d, $J = 8.2$ Hz, 1H), 8.14 (d, $J = 8.1$ Hz, 1H), 7.81 (t, $J = 7.6$ Hz, 1H), 7.70 (q, $J = 6.7$ Hz, 2H), 7.61 (t, $J = 7.6$ Hz, 1H), 3.62 (tt, $J = 11.3, 3.4$ Hz, 1H), 2.14 – 2.03 (m, 2H), 2.03 – 1.89 (m, 4H), 1.89 – 1.81 (m, 1H), 1.63 – 1.51 (m, 2H), 1.50 – 1.41 (m, 1H); $^{13}$C NMR (101 MHz, CDCl$_3$) $\delta$ 165.27, 143.83, 132.98, 129.89, 129.88, 128.35, 127.03, 126.10, 125.59, 124.69, 123.31, 122.54, 121.78, 41.95, 32.26, 26.85, 26.28. Spectra data are consistent with those reported in the literature: *J. Org. Chem.* 2018, 83, 10015-10024.
**1,4-Dicyclohexylphthalazine (33):** According to the general procedure, phthalazine (65.1 mg, 0.50 mmol, 1.0 equiv.), 5.0 mL of MeCN, H₂O₂ (0.1 mL, 1.0 mmol, 2.0 equiv.), HCl (86.0 µL, 1.0 mmol, 2.0 equiv.), cyclohexane (1.10 ml, 10.0 mmol, 20.0 equiv.) were used. After 18 hours, the reaction mixture was subjected to the workup procedure outlined in the general procedure and purified by flash chromatography (20% ethyl acetate/hexanes) to provide the title compound as a yellow solid (136.7 mg, 43% yield). ¹H NMR (400 MHz, CDCl₃) δ 8.10 (dd, J = 6.3, 3.4 Hz, 2H), 7.78 (dd, J = 6.3, 3.3 Hz, 2H), 3.41 (tt, J = 11.2, 3.6 Hz, 2H), 2.06 – 1.96 (m, 4H), 1.96 – 1.83 (m, 8H), 1.96 – 1.83 (m, 2H), 1.80 – 1.71 (m, 4H), 1.39 – 1.26 (m, 2H); ¹³C NMR (101 MHz, CDCl₃) δ 161.57, 130.94, 124.70, 123.96, 40.22, 32.14, 26.69, 26.06. Spectra data are consistent with those reported in the literature: *Angew. Chem. Int. Ed.* **2013**, *52*, 3267-3271.

**4-Chloro-2-cyclohexyl-6,7-dimethoxyquinazoline (34):** According to the general procedure, 4-chloro-6,7-dimethoxyquinazoline (112.3 mg, 0.50 mmol, 1.0 equiv.), 5.0 mL of MeCN, H₂O₂ (0.1 mL, 1.0 mmol, 2.0 equiv.), HCl (86.0 µL, 1.0 mmol, 2.0 equiv.), cyclohexane (1.10 ml, 10.0 mmol, 20.0 equiv.) were used. After 24 hours, the reaction mixture was subjected to the workup procedure outlined in the general procedure and purified by flash chromatography (50% ethyl acetate/hexanes) to provide the title
compound as a colorless oil (104.4 mg, 68% yield). $^1$H NMR (400 MHz, CDCl$_3$) δ 7.30 (s, 1H), 7.24 (s, 1H), 4.01 (s, 6H), 2.89 (tt, $J = 11.8, 3.5$ Hz, 1H), 2.08 – 1.95 (m, 2H), 1.90 – 1.81 (m, 2H), 1.75 – 1.61 (m, 3H), 1.45 – 1.24 (m, 3H); $^{13}$C NMR (101 MHz, CDCl$_3$) δ 168.87, 159.09, 156.44, 150.52, 149.34, 117.31, 106.65, 102.70, 56.50, 56.28, 47.30, 31.80, 26.19, 25.86; HRMS (ESI) m/z calculated for C$_{16}$H$_{20}$O$_2$N$_2$Cl [(M+H)$^+$] 307.1208, found 307.1206; IR (film) 2924, 2848, 1619, 1570, 1501, 1416, 1293, 1239, 1220, 1162, 848 cm$^{-1}$. Spectra data are consistent with those reported in the literature: *Org. Lett. 2019, 21*, DOI: acs.orglett.9b01635.

![35](image)

**2-Chloro-3-cyclohexylquinoxaline (35):** According to the general procedure, 2-chloroquinoxaline (82.3 mg, 0.50 mmol, 1.0 equiv.), 5.0 mL of MeCN, H$_2$O$_2$ (0.1 mL, 1.0 mmol, 2.0 equiv.), HCl (86.0 µL, 1.0 mmol, 2.0 equiv.), cyclohexane (1.10 ml, 10.0 mmol, 20.0 equiv.) were used. After 24 hours, the reaction mixture was subjected to the workup procedure outlined in the general procedure and purified by flash chromatography (10% ethyl acetate/hexanes) to provide the title compound as a white solid (40.7 mg, 33% yield). $^1$H NMR (400 MHz, CDCl$_3$) δ 8.08 – 8.00 (m, 1H), 8.00 – 7.92 (m, 1H), 7.76 – 7.64 (m, 2H), 3.34 (tt, $J = 11.6, 3.3$ Hz, 1H), 2.07 – 1.97 (m, 2H), 1.97 – 1.86 (m, 2H), 1.85 – 1.76 (m, 1H), 1.70 (qd, $J = 12.6, 3.2$ Hz, 2H), 1.48 (qt, $J = 12.7, 3.3$ Hz, 2H), 1.35 (qt, $J = 12.8, 3.3$ Hz, 1H); $^{13}$C NMR (101 MHz, CDCl$_3$) δ 159.09, 147.40, 141.11, 140.55, 129.77 (2C), 128.74, 128.00, 42.49, 31.20, 26.34, 25.90. Spectra
data are consistent with those reported in the literature: *Angew. Chem. Int. Ed.* 2013, 52, 3267-3271.

![Image of compound 36](image)

**4-Chloro-2-cyclohexyl-6-methylpyridine (36):** According to the general procedure, 4-chloro-2-methylpyridine (63.8 mg, 0.50 mmol, 1.0 equiv.), 5.0 mL of MeCN, H₂O₂ (0.1 mL, 1.0 mmol, 2.0 equiv.), HCl (86.0 µL, 1.0 mmol, 2.0 equiv.), cyclohexane (1.10 ml, 10.0 mmol, 20.0 equiv.) were used. The reaction mixture was irradiated under 390 nm blue LEDs, after 24 hours, subjected to the workup procedure outlined in the general procedure and purified by flash chromatography (10% ethyl acetate/hexanes) to provide the title compound as a colorless oil (67.1 mg, 64% yield). ¹H NMR (400 MHz, CDCl₃) δ 6.96 (s, 2H), 2.64 (ddt, J = 11.5, 6.7, 3.4 Hz, 1H), 2.49 (s, 3H), 1.99 – 1.90 (m, 2H), 1.86 – 1.78 (m, 2H), 1.77 – 1.68 (m, 1H), 1.47 – 1.31 (m, 4H), 1.31 – 1.22 (m, 1H); ¹³C NMR (101 MHz, CDCl₃) δ 167.64, 158.94, 144.21, 120.71, 117.91, 46.50, 32.85, 26.42, 25.95, 24.35. Spectra data are consistent with those reported in the literature: *Org. Lett.* 2019, 21, DOI: acs.orglett.9b01635.

![Image of compound 37](image)

**3-Chloro-4-cyclohexyl-6-methylpyridazine (37):** According to the general procedure, 3-chloro-6-methylpyridazine (64.3 mg, 0.50 mmol, 1.0 equiv.), 5.0 mL of MeCN, H₂O₂
(0.1 mL, 1.0 mmol, 2.0 equiv.), HCl (86.0 µL, 1.0 mmol, 2.0 equiv.), cyclohexane (1.10 ml, 10.0 mmol, 20.0 equiv.) were used. The reaction mixture was irradiated under 390 nm blue LEDs, after 18 hours, subjected to the workup procedure outlined in the general procedure and purified by flash chromatography (20% ethyl acetate/hexanes) to provide the title compound as a light yellow solid (86.4 mg, 82% yield). $^1$H NMR (400 MHz, CDCl$_3$) δ 7.14 (s, 1H), 2.82 (tt, $J$ = 11.8, 2.9 Hz, 1H), 2.63 (s, 3H), 1.95 – 1.81 (m, 4H), 1.81 – 1.72 (m, 1H), 1.42 (qt, $J$ = 12.7, 3.5 Hz, 2H), 1.35 – 1.19 (m, 3H); $^{13}$C NMR (101 MHz, CDCl$_3$) δ 159.63, 155.42, 145.46, 125.98, 39.53, 31.72, 26.15, 25.65, 21.50. Spectra data are consistent with those reported in the literature: *J. Heterocyclic Chem.* 1991, 28, 583-587.

6-Chloro-4-cyclohexylpyridazin-3-amine (38a) and 6-Chloro-5-cyclohexylpyridazin-3-amine (38b): According to the general procedure, 6-chloropyridazin-3-amine (64.8 mg, 0.50 mmol, 1.0 equiv.), 5.0 mL of MeCN, H$_2$O$_2$ (0.1 mL, 1.0 mmol, 2.0 equiv.), HCl (86.0 µL, 1.0 mmol, 2.0 equiv.), cyclohexane (1.10 ml, 10.0 mmol, 20.0 equiv.) were used. After 18 hours, the reaction mixture was subjected to the workup procedure outlined in the general procedure and purified by flash chromatography (50% ethyl acetate/hexanes) to provide the title compounds as a white solid (70.9 mg, 67% yield for 38a) and a white solid (14.8 mg, 14% yield for 38b).

Compound 38a: $^1$H NMR (400 MHz, CDCl$_3$) δ 7.03 (s, 1H), 5.58 (br s, 2H), 2.30 (tt, $J$ = 11.4, 3.0 Hz, 1H), 1.97 – 1.82 (m, 4H), 1.82 – 1.73 (m, 1H), 1.45 – 1.20 (m, 5H); $^{13}$C
NMR (101 MHz, CDCl₃) δ 158.18, 147.90, 135.88, 125.07, 37.89, 31.09, 26.22, 25.77; HRMS (ESI) m/z calculated for C₁₀H₁₅N₃Cl [(M+H)+] 212.0949, found 212.0949. IR (film) 3377, 3312, 3176, 2933, 2853, 1658, 1625, 1599, 1456, 1209, 1150, 962 cm⁻¹. Spectra data are consistent with those reported in the literature: Tetrahedron Lett. 2015, 56, 6791-6794.

Compound 38b: ¹H NMR (400 MHz, CDCl₃) δ 6.64 (s, 1H), 5.06 (br s, 2H), 2.75 (tt, J = 11.9, 3.0 Hz, 1H), 1.96 – 1.82 (m, 4H), 1.82 – 1.75 (m, 1H), 1.49 – 1.35 (m, 2H), 1.30 – 1.20 (m, 3H); ¹³C NMR (101 MHz, CDCl₃) δ 159.71, 148.73, 147.27, 113.86, 39.73, 31.86, 26.28, 25.83; HRMS (ESI) m/z calculated for C₁₀H₁₅N₃Cl [(M+H)+] 212.0949, found 212.0948. IR (film) 3318, 3160, 2930, 2855, 1658, 1635, 1581, 1533, 1438, 1344, 1107, 935 cm⁻¹.

2-Chloro-4-cyclohexyl-5-fluoro-pyrimidine (39a) and 2-Chloro-4,6-dicyclohexyl-5-fluoropyrimidine (39b): According to the general procedure, 2-chloro-5-fluoropyrimidine (68.3 mg, 0.50 mmol, 1.0 equiv.), 5.0 mL of MeCN, H₂O₂ (0.1 mL, 1.0 mmol, 2.0 equiv.), HCl (86.0 µL, 1.0 mmol, 2.0 equiv.), cyclohexane (1.10 ml, 10.0 mmol, 20.0 equiv.) were used. The reaction mixture was irradiated under 390 nm blue LEDs, after 18 hours, subjected to the workup procedure outlined in the general procedure and purified by flash chromatography (10% ethyl acetate/hexanes) to provide the title compounds as a colorless oil (54.7 mg, 51% yield for 39a) and a white solid (26.7 mg, 18% yield for 39b).
Compound 39a: $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 8.31 (d, $J = 1.4$ Hz, 1H), 3.05 – 2.92 (m, 1H), 1.91 – 1.76 (m, 4H), 1.76 – 1.69 (m, 1H), 1.69 – 1.57 (m, 2H), 1.44 – 1.22 (m, 3H). $^{13}$C NMR (101 MHz, CDCl$_3$) $\delta$ 165.60 (d), 155.25 (d), 155.07 (d), 146.02 (d), 39.32 (d), 30.24 (d), 25.87, 25.45; HRMS (ESI) m/z calculated for C$_{16}$H$_{23}$N$_2$ClF [(M+H)$^+$] 215.0746, found 215.0745. IR (film) 2932, 2855, 1578, 1450, 1413, 1344, 1202, 923, 780, 658 cm$^{-1}$.

Compound 39b: $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 3.02 – 2.91 (m, 2H), 1.92 – 1.82 (m, 4H), 1.82 – 1.70 (m, 6H), 1.70 – 1.58 (m, 4H), 1.44 – 1.25 (m, 6H); $^{13}$C NMR (101 MHz, CDCl$_3$) $\delta$ 164.09 (d), 154.53 (d), 154.00, 151.43, 39.12 (d), 30.43 (d), 26.01, 25.55. HRMS (ESI) m/z calculated for C$_{16}$H$_{23}$N$_2$ClF [(M+H)$^+$] 297.1528, found 297.1527. IR (film) 2931, 2852, 1589, 1453, 1405, 1362, 1308, 1254, 1008, 924 cm$^{-1}$.

4-Chloro-2-cyclohexyl-6-methylpyrimidine (40): According to the general procedure, 4-chloro-6-methylpyrimidine (64.3 mg, 0.50 mmol, 1.0 equiv.), 5.0 mL of MeCN, H$_2$O$_2$ (0.1 mL, 1.0 mmol, 2.0 equiv.), HCl (86.0 µL, 1.0 mmol, 2.0 equiv.), cyclohexane (1.10 ml, 10.0 mmol, 20.0 equiv.) were used. The reaction mixture was irradiated under 390 nm blue LEDs, after 24 hours, subjected to the workup procedure outlined in the general procedure and purified by flash chromatography (20% ethyl acetate/hexanes) to provide the title compound as a white solid (80.0 mg, 76% yield). $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 6.98 (s, 1H), 2.77 (tt, $J = 11.9$, 3.5 Hz, 1H), 2.44 (s, 3H), 1.98 – 1.86 (m, 2H), 1.84 – 1.75 (m, 2H), 1.72 – 1.64 (m, 1H), 1.58 (qd, $J = 12.4$, 2.9 Hz, 2H), 1.39 – 1.21 (m, 3H); $^{13}$C
NMR (101 MHz, CDCl₃) δ 175.22, 168.50, 160.87, 117.74, 47.23, 31.56, 26.00, 25.71, 23.86. Spectra data are consistent with those reported in the literature: *Org. Lett.* **2019**, 21, DOI: acs.orglett.9b01635.

![Image of compound 41](image)

**4-Chloro-6-cyclohexyl-2-(methylthio)pyrimidine (41):** According to the general procedure, 4-chloro-2-(methylthio)pyrimidine (121.4 mg, 0.5 mmol, 1.0 equiv.), 5.0 mL of MeCN, H₂O₂ (0.1 mL, 1.0 mmol, 2.0 equiv.), HCl (86.0 µL, 1.0 mmol, 2.0 equiv.), cyclohexane (1.10 ml, 10.0 mmol, 20.0 equiv.) were used. The reaction mixture was irradiated under 390 nm blue LEDs, after 18 hours, subjected to the workup procedure outlined in the general procedure and purified by flash chromatography (10% ethyl acetate/hexanes) to provide the title compound as a colorless oil (104.4 mg, 86% yield).

¹H NMR (400 MHz, CDCl₃) δ 6.81 (s, 1H), 2.58 (tt, J = 11.6, 3.3 Hz, 1H), 2.54 (s, 3H), 1.96 – 1.87 (m, 2H), 1.87 – 1.78 (m, 2H), 1.78 – 1.70 (m, 1H), 1.53 – 1.41 (m, 2H), 1.41 – 1.30 (m, 2H), 1.29 – 1.19 (m, 1H); ¹³C NMR (101 MHz, cdcl₃) δ 176.50, 172.82, 160.82, 113.48, 45.65, 31.67, 26.00, 25.72, 14.20; HRMS (ESI) m/z calculated for C₁₁H₁₆N₂ClS [(M+H)⁺] 243.0717, found 243.0716. IR (film) 2928, 2853, 1552, 1449, 1371, 1323, 1275, 1230, 1131, 930, 826 cm⁻¹.

![Image of compound 42](image)
4-Cyclohexyl-2-methoxy-6-methylpyrimidine (42): According to the general procedure, 2-methoxy-4-methylpyrimidine (62.1 mg, 0.50 mmol, 1.0 equiv.), 5.0 mL of MeCN, H₂O₂ (0.1 mL, 1.0 mmol, 2.0 equiv.), HCl (86.0 µL, 1.0 mmol, 2.0 equiv.), cyclohexane (1.10 ml, 10.0 mmol, 20.0 equiv.) were used. The reaction mixture was irradiated under 390 nm blue LEDs, after 18 hours, subjected to the workup procedure outlined in the general procedure and purified by flash chromatography (20% ethyl acetate/hexanes) to provide the title compound as a colorless oil (59.8 mg, 58% yield). ¹H NMR (400 MHz, CDCl₃) δ 6.59 (s, 1H), 3.93 (s, 3H), 2.49 (tt, J = 11.8, 3.4 Hz, 1H), 2.36 (s, 3H), 1.90 – 1.82 (m, 2H), 1.82 – 1.74 (m, 2H), 1.72 – 1.64 (m, 1H), 1.46 (qd, J = 12.2, 2.5 Hz, 2H), 1.38 – 1.26 (m, 2H), 1.26 – 1.15 (m, 1H); ¹³C NMR (101 MHz, CDCl₃) δ 176.83, 169.10, 165.25, 111.42, 54.25, 45.56, 31.74, 26.10, 25.81, 23.87. Spectra data are consistent with those reported in the literature: Org. Lett. 2019, 21, DOI: acs.orglett.9b01635.

3-Cyclohexylbenzo[b]thiophene-2-carbaldehyde (43): According to the general procedure, benzo[b]thiophene-2-carbaldehyde (81.1 mg, 0.5mmol, 1.0 equiv.), 5.0 mL of MeCN, H₂O₂ (0.1 mL, 1.0 mmol, 2.0 equiv.), HCl (86.0 µL, 1.0 mmol, 2.0 equiv.), cyclohexane (1.10 ml, 10.0 mmol, 20.0 equiv.) were used. The reaction mixture was irradiated under 390 nm blue LEDs, after 18 hours, subjected to the workup procedure outlined in the general procedure and purified by flash chromatography (10% ethyl acetate/hexanes) to provide the title compound as a light yellow oil (55.0 mg, 45% yield).
1H NMR (400 MHz, CDCl₃) δ 10.49 (s, 1H), 8.08 (d, J = 8.2 Hz, 1H), 7.86 (d, J = 8.0 Hz, 1H), 7.52 – 7.43 (m, 1H), 7.40 (dd, J = 8.2, 7.0, 1.2 Hz, 1H), 3.54 (p, J = 8.1 Hz, 1H), 2.07 – 1.92 (m, 6H), 1.92 – 1.84 (m, 1H), 1.58 – 1.35 (m, 3H); 13C NMR (101 MHz, CDCl₃) δ 184.26, 152.08, 142.79, 138.92, 138.01, 127.77, 125.58, 124.31, 123.45, 39.43, 33.58, 27.03, 25.97; HRMS (EI) m/z calculated for C₁₅H₁₆O₅S [M+] 244.0922, found 244.0929; IR (film) 2922, 2852, 1684, 1655, 1613, 1518, 1201, 759, 726 cm⁻¹.

2-(2-Cyclohexyl-4-methylthiazol-5-yl)ethanol (44): According to the general procedure, 2-(4-methylthiazol-5-yl)ethanol (71.6 mg, 0.50 mmol, 1.0 equiv.), 5.0 mL of MeCN, H₂O₂ (0.1 mL, 1.0 mmol, 2.0 equiv.), HCl (86.0 µL, 1.0 mmol, 2.0 equiv.), cyclohexane (1.10 ml, 10.0 mmol, 20.0 equiv.) were used. The reaction mixture was irradiated under 390 nm blue LEDs, after 18 hours, subjected to the workup procedure outlined in the general procedure and purified by flash chromatography (50% ethyl acetate/hexanes) to provide the title compound as a light yellow oil (46.2 mg, 41% yield).

1H NMR (400 MHz, CDCl₃) δ 3.77 (t, J = 6.5 Hz, 2H), 2.92 (t, J = 6.5 Hz, 2H), 2.86 (tt, J = 11.5, 3.6 Hz, 1H), 2.55 (br s, 1H), 2.29 (s, 3H), 2.09 – 2.03 (m, 2H), 1.84 – 1.76 (m, 2H), 1.72 – 1.67 (m, 1H), 1.49 – 1.29 (m, 4H), 1.28 – 1.19 (m, 1H); 13C NMR (101 MHz, CDCl₃) δ 173.82, 147.64, 125.80, 62.82, 42.55, 33.75, 29.79, 26.06, 25.71, 14.80. Spectra data are consistent with those reported in the literature: Org. Lett. 2019, 21, DOI: acs.orglett.9b01635.
2-Cyclohexyl-1-methyl-1H-benzo[d]imidazole (45): According to the general procedure, 1-methyl-1H-benzo[d]imidazole (66.1 mg, 0.50 mmol, 1.0 equiv.), 5.0 mL of MeCN, H$_2$O$_2$ (0.1 mL, 1.0 mmol, 2.0 equiv.), HCl (86.0 µL, 1.0 mmol, 2.0 equiv.), cyclohexane (1.10 ml, 10.0 mmol, 20.0 equiv.) were used. The reaction mixture was irradiated under 390 nm blue LEDs, after 18 hours, subjected to the workup procedure outlined in the general procedure and purified by flash chromatography (50% ethyl acetate/hexanes) to provide the title compound as a white solid (44.9 mg, 41% yield). $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 7.72 – 7.65 (m, 1H), 7.24 – 7.20 (m, 1H), 7.20 – 7.13 (m, 2H), 3.66 (s, 3H), 2.78 (tt, $J$ = 11.8, 3.5 Hz, 1H), 1.98 – 1.89 (m, 2H), 1.89 – 1.81 (m, 2H), 1.80 – 1.68 (m, 3H), 1.43 – 1.26 (m, 3H); $^{13}$C NMR (101 MHz, CDCl$_3$) $\delta$ 158.80, 141.72, 135.25, 122.06, 121.90, 118.92, 108.87, 36.31, 31.23, 29.53, 26.24, 25.68. Spectra data are consistent with those reported in the literature: Org. Lett. 2017, 19, 6594-6597.

6-Chloro-8-cyclohexylimidazo[1,2-b]pyridazine (46): According to the general procedure, 6-chloroimidazo[1,2-b]pyridazine (76.8 mg, 0.50 mmol, 1.0 equiv.), 5.0 mL of MeCN, H$_2$O$_2$ (0.1 mL, 1.0 mmol, 2.0 equiv.), HCl (86.0 µL, 1.0 mmol, 2.0 equiv.), cyclohexane (1.10 ml, 10.0 mmol, 20.0 equiv.) were used. After 18 hours, the reaction
mixture was subjected to the workup procedure outlined in the general procedure and purified by flash chromatography (20% ethyl acetate/hexanes) to provide the title compounds as a white solid (69.5 mg, 59% yield). $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 7.87 (d, $J = 1.2$ Hz, 1H), 7.70 (d, $J = 1.3$ Hz, 1H), 6.84 (d, $J = 0.8$ Hz, 1H), 3.34 (tt, $J = 11.6$, 3.9 Hz, 1H), 2.12 – 2.01 (m, 2H), 1.93 – 1.83 (m, 2H), 1.83 – 1.76 (m, 1H), 1.58 – 1.43 (m, 4H), 1.36 – 1.25 (m, 1H); $^{13}$C NMR (101 MHz, CDCl$_3$) $\delta$ 148.04, 147.31, 137.87, 133.09, 117.16, 114.55, 38.70, 31.99, 26.20, 25.91. Spectra data are consistent with those reported in the literature: Angew. Chem. Int. Ed. 2017, 56, 12336-12339.

4-cyclohexyl-7H-pyrrolo[2,3-d]pyrimidine (47a) and 2,4-dicyclohexyl-7H-pyrrolo[2,3-d]pyrimidine (47b): According to the general procedure, 7H-pyrrolo[2,3-d]pyrimidine (59.5 mg, 0.5 mmol, 1.0 equiv.), 5.0 mL of MeCN, H$_2$O$_2$ (0.1 mL, 1.0 mmol, 2.0 equiv.), HCl (86.0 µL, 1.0 mmol, 2.0 equiv.), cyclohexane (1.10 ml, 10.0 mmol, 20.0 equiv.) were used. The reaction mixture was irradiated under 390 nm blue LEDs, after 18 hours, subjected to the workup procedure outlined in the general procedure and purified by flash chromatography (50% ethyl acetate/hexanes) to provide the title compounds as a white solid (44.3 mg, 44% yield for 47a) and a white solid (24.1 mg, 17% yield for 47b).

Compound 47a: $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 12.07 (s, 1H), 8.86 (s, 1H), 7.35 (d, $J = 3.6$ Hz, 1H), 6.64 (d, $J = 3.6$ Hz, 1H), 3.11 (tt, $J = 11.8$, 3.5 Hz, 1H), 2.06 – 1.94 (m, 2H), 1.94 – 1.87 (m, 2H), 1.87 – 1.70 (m, 3H), 1.54 – 1.30 (m, 3H); $^{13}$C NMR (101 MHz,
CDCl₃) δ 167.23, 151.62, 150.77, 124.79, 99.73, 44.30, 31.57, 26.42, 25.98;
HRMS (ESI) m/z calculated for C₁₂H₁₆N₃ [(M+H)⁺] 202.1339, found 202.1337. IR (film) 3132, 2925, 2852, 1588, 1505, 1425, 1348, 1254, 1110, 899, 733 cm⁻¹.

Compound 47b: ¹H NMR (400 MHz, CDCl₃) δ 11.41 (s, 1H), 7.24 (dd, J = 3.6, 2.0 Hz, 1H), 6.61 (dd, J = 3.6, 1.6 Hz, 1H), 3.15 – 2.87 (m, 2H), 2.16 – 2.05 (m, 2H), 1.98 – 1.68 (m, 12H), 1.56 – 1.33 (m, 6H); ¹³C NMR (101 MHz, CDCl₃) δ 167.12, 167.05, 152.59, 123.60, 113.88, 99.85, 47.50, 45.20, 32.58, 31.59, 26.45 (2C), 26.23, 26.09; HRMS (ESI) m/z calculated for C₁₈H₂₆N₃ [(M+H)⁺] 284.2121, found 284.2119. IR (film) 3116, 2928, 2850, 1604, 1574, 1501, 1450, 1396, 1295, 1254, 1114, 896 cm⁻¹.

2,6-Dichloro-8-cyclohexyl-7-methyl-7H-purine (48): According to the general procedure, 2,6-dichloro-7-methyl-7H-purine (101.5 mg, 0.50 mmol, 1.0 equiv.), 5.0 mL of MeCN, H₂O₂ (0.1 mL, 1.0 mmol, 2.0 equiv.), HCl (86.0 µL, 1.0 mmol, 2.0 equiv.), cyclohexane (1.10 ml, 10.0 mmol, 20.0 equiv.) were used. The reaction mixture was irradiated under 390 nm blue LEDs, after 18 hours, subjected to the workup procedure outlined in the general procedure and purified by flash chromatography (50% ethyl acetate/hexanes) to provide the title compound as a white solid (122.6 mg, 86% yield). ¹H NMR (400 MHz, CDCl₃) δ 4.05 (s, 3H), 2.88 (tt, J = 11.6, 3.4 Hz, 1H), 1.96 – 1.86 (m, 4H), 1.83 – 1.72 (m, 3H), 1.46 – 1.30 (m, 3H); ¹³C NMR (101 MHz, CDCl₃) δ 167.54, 162.81, 152.30, 142.01, 122.68, 36.45, 33.26, 32.06, 30.76, 25.74, 25.39. Spectra data are
consistent with those reported in the literature: *Org. Lett.* 2019, 21, DOI: acs.orglett.9b01635.

![Chemical Structure](image)

**5,7-Dichloro-2-cyclohexyl-4-(4-fluorophenoxy)quinoline (49):** According to the general procedure, 5,7-dichloro-4-(4-fluorophenoxy)quinoline (154.1 mg, 0.50 mmol, 1.0 equiv.), 5.0 mL of MeCN, H₂O₂ (0.1 mL, 1.0 mmol, 2.0 equiv.), HCl (86.0 µL, 1.0 mmol, 2.0 equiv.), cyclohexane (1.10 ml, 10.0 mmol, 20.0 equiv.) were used. After 24 hours, the reaction mixture was subjected to the workup procedure outlined in the general procedure and purified by flash chromatography (10% ethyl acetate/hexanes) to provide the title compound as a colorless oil (136.7 mg, 70% yield). 

\[(\text{ Organic Compound })\]

\[\text{1H NMR (400 MHz, CDCl}_3\text{)} \delta 7.93 (d, J = 2.1 Hz, 1H), 7.45 (d, J = 2.1 Hz, 1H), 7.18 – 7.04 (m, 4H), 6.53 (s, 1H), 2.68 (tt, J = 11.7, 3.4 Hz, 1H), 1.94 – 1.84 (m, 2H), 1.84 – 1.76 (m, 2H), 1.75 – 1.67 (m, 1H), 1.50 – 1.30 (m, 4H), 1.29 – 1.18 (m, 1H); \]

\[\text{13C NMR (101 MHz, CDCl}_3\text{)} \delta 169.42, 162.18, 159.73 (d), 151.29, 150.25 (d), 134.59, 129.77, 128.44, 127.41, 121.84 (d), 116.90 (d), 116.88, 105.66, 47.12, 32.24, 26.21, 25.77.\]

3-(Cyclopropylmethoxy)-N-(3,5-dichloro-2,6-dicyclohexylypyridin-4-yl)-4-
(difluoromethoxy)benzamide (50): According to the general procedure, 3-
(cyclopropylmethoxy)-N-(3,5-dichloropyridin-4-yl)-4-(difluoromethoxy)benzamide
(201.6 mg, 0.50 mmol, 1.0 equiv.), 5.0 mL of MeCN, H₂O₂ (0.1 mL, 1.0 mmol, 2.0
equiv.), HCl (86.0 µL, 1.0 mmol, 2.0 equiv.), cyclohexane (1.10 ml, 10.0 mmol, 20.0
equiv.) were used. After 18 hours, the reaction mixture was subjected to the workup
procedure outlined in the general procedure and purified by flash chromatography (20%
ethyl acetate/hexanes) to provide the title compound as a white solid (136.1 mg, 48%
yield). ¹H NMR (400 MHz, CDCl₃) δ 7.89 (s, 1H), 7.57 (d, J = 2.1 Hz, 1H), 7.45 (dd, J =
8.2, 2.0 Hz, 1H), 7.21 (d, J = 8.2 Hz, 1H), 6.72 (t, J = 75.0 Hz, 1H), 3.91 (d, J = 6.9 Hz,
2H), 3.12 (tt, J = 11.3, 3.3 Hz, 2H), 1.89 – 1.71 (m, 10H), 1.70 – 1.57 (m, 4H), 1.47 –
1.25 (m 7H), 0.72 – 0.59 (m, 2H), 0.40 – 0.29 (m, 2H); ¹³C NMR (101 MHz, cdcl₃) δ
164.17, 160.57, 150.67, 143.45, 138.65, 131.35, 124.57, 122.11, 119.81, 115.67 (t),
114.07, 74.01, 42.31, 31.20, 26.34, 25.97, 9.93, 3.19; HRMS (ESI) m/z calculated for
C₂₉H₃₅O₃N₂Cl₂F₂ [(M+H)⁺] 567.1987, found 567.1987. IR (film) 3245, 2929, 2853,
1660, 1605, 1591, 1548, 1493, 1291, 1200, 1139, 1061 cm⁻¹.

(2R,3S)-3-(6-cyclohexyl-5-fluoropyrimidin-4-yl)-2-(2,4-difluorophenyl)-1-(1H-1,2,4-
triazol-1-yl)butan-2-ol (51): According to the general procedure, (2R,3S)-2-(2,4-
difluorophenyl)-3-(5-fluoropyrimidin-4-yl)-1-(1H-1,2,4-triazol-1-yl)butan-2-ol (174.7
mg, 0.50 mmol, 1.0 equiv.), 5.0 mL of MeCN, H₂O₂ (0.1 mL, 1.0 mmol, 2.0 equiv.), HCl
(86.0 µL, 1.0 mmol, 2.0 equiv.), cyclohexane (1.10 ml, 10.0 mmol, 20.0 equiv.) were used. The reaction mixture was irradiated under 390 nm blue LEDs, after 18 hours, subjected to the workup procedure outlined in the general procedure and purified by flash chromatography (50% ethyl acetate/hexanes) to provide the title compound as a white solid (146.3 mg, 57% yield). ^1H NMR (400 MHz, CDCl$_3$) $\delta$ 8.80 (d, $J$ = 1.8 Hz, 1H), 7.99 (s, 1H), 7.65 – 7.54 (m, 1H), 7.52 (s, 1H), 6.86 – 6.78 (m, 2H), 6.76 (br s, 1H), 4.70 (d, $J$ = 14.2 Hz, 1H), 4.28 (d, $J$ = 14.1 Hz, 1H), 4.10 (q, $J$ = 6.9 Hz, 1H), 3.15 – 3.02 (m, 1H), 1.93 – 1.77 (m, 5H), 1.72 – 1.60 (m, 2H), 1.49 – 1.29 (m, 3H), 1.07 (d, $J$ = 7.1 Hz, 3H); ^13C NMR (101 MHz, CDCl$_3$) $\delta$ 164.00, 163.88, 163.03, 162.89, 161.51, 161.39, 159.77, 159.66, 157.80, 157.65, 157.32, 157.20, 154.62, 152.75, 152.65, 152.00, 150.68, 143.92, 130.68, 130.63, 130.59, 130.53, 123.64, 123.61, 123.53, 123.49, 111.62, 111.59, 111.42, 111.39, 104.29, 104.03, 104.01, 103.76, 77.32, 77.00, 76.68, 57.54, 57.50, 39.07, 36.31, 36.25, 30.69, 30.47, 26.04, 26.01, 25.64, 16.20; HRMS (ESI) m/z calculated for C$_{22}$H$_{25}$ON$_5$F$_3$ [(M+H)$^+$] 432.2006, found 432.1997. IR (film) 3312, 2934, 2855, 1618, 1593, 1501, 1451, 1410, 1272, 1136, 966, 850, 738 cm$^{-1}$. 
V. NMR Spectra

[Diagram of NMR spectra with peak assignments and chemical structures]

Me

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[Assignments and chemical shifts for the NMR spectra]