# Synthesis of Quaternary α-Perfluoroalkyl Lactams via Electrophilic Perfluoroalkylation

Dmitry Katayev, a Jiří Václavík, a Fabian Brüning, a Bruno Commare, a and Antonio Togni* a

*a Department of Chemistry and Applied Biosciences, Swiss Federal Institute of Technology, ETH Zürich, CH-8093 Zürich, Switzerland; Fax (+41) 632 13 10; e-mail: togni@inorg.chem.ethz.ch; homepage: www.tognigroup.ethz.ch

b Institute of Organic Chemistry and Biochemistry, v.v.i., Academy of Sciences of the Czech Republic, Flemingovo nám. 2, 166 10 Prague, Czech Republic

## Supporting Information

### Content

<table>
<thead>
<tr>
<th>Topic</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>General techniques and chemicals</td>
<td>S2</td>
</tr>
<tr>
<td>Synthesis of 2e</td>
<td>S2</td>
</tr>
<tr>
<td>Synthesis of 2g</td>
<td>S3</td>
</tr>
<tr>
<td>Synthesis of 2i</td>
<td>S5</td>
</tr>
<tr>
<td>Synthesis of 2j</td>
<td>S6</td>
</tr>
<tr>
<td>Synthesis of 2k</td>
<td>S8</td>
</tr>
<tr>
<td>General procedure for the synthesis of α-substituted γ-, δ- and ε-lactams</td>
<td>S9</td>
</tr>
<tr>
<td>General procedure for synthesis of lactam ketene silyl amides (KSAs)</td>
<td>S11</td>
</tr>
<tr>
<td>General procedures 1, 2 and 3 for α-trifluoromethylation of KSAs</td>
<td>S14</td>
</tr>
<tr>
<td>General procedure for α-perfluoroalkylation of KSA 4a</td>
<td>S18</td>
</tr>
<tr>
<td>Synthesis of 10</td>
<td>S21</td>
</tr>
<tr>
<td>References</td>
<td>S22</td>
</tr>
<tr>
<td>Crystallographic details</td>
<td>S23</td>
</tr>
<tr>
<td>¹H-, ¹³C- and ¹⁹F NMR spectra</td>
<td>S24</td>
</tr>
</tbody>
</table>
General techniques and chemicals

General techniques. All reactions were performed in a flame-dried glassware under argon atmosphere containing a Teflon-coated stir bar and dry septum. Solvents were purified and dried by standard procedures prior to use. IR spectra were measured on Thermo Scientific Nicolet 6700 IR spectrometer equipped with ATR cell. $^1$H and $^{13}$C NMR spectra were recorded on Bruker DPX-300 (operating at 300.1 MHz and 75.5 MHz, respectively), Bruker DPX-400 (operating at 400.1 MHz and 100.6 MHz, respectively) and Bruker DPX-500 (operating at 500.1 MHz and 126 MHz, respectively) and $^{19}$F NMR spectra on Bruker DPX-300 (at 282 MHz), Bruker DPX-400 (at 376 MHz) and Bruker DPX-500 (at 471 MHz). Shifts are relative to TMS as an external standard for $^1$H and $^{13}$C NMR spectra and calibrated against the solvent residual peak.$^{[1]}$ Mass spectra were measured by the MS service of the Labor für organische Chemie der ETH Zürich, Switzerland, and elemental analyses by the Mikroelementaranalytisches Laboratorium der ETH Zürich. TLC plates were obtained from Merck (silica gel 60 F$_{254}$). Melting points were measured on a Büchi Melting Point B-540. TLC visualisation was performed either by fluorescence quenching at 254 nm or by staining with aqueous K$_2$MnO$_4$ solution followed by heating. Chromatographic purification was (if not otherwise specified carried out) either by dry column vacuum chromatography (DCVC) according to procedure by Pedersen et al.$^{[2]}$ applying gradient elution from hexane to hexane: EtOAc (3:1) mixtures using TLC grade silica gel (Silica gel 60, dry column vacuum chromatography (DCVC) according to procedure by Pedersen et al.$^{[2]}$ applying gradient elution from hexane to hexane: EtOAc (3:1) mixtures using TLC grade silica gel (Silica gel 60, particle size 20–45 µm, Carl-Roth) or by flash chromatography using standard silica gel (Silica gel 60, particle size 43–63 µm, Fluka).

Chemicals. 1-Trifluoromethyl-1,3-dihydro-3,3-dimethyl-1,2-benziodoxole,$^{[3]}$ N-trimethylsilylbis(trifluoromethanesulfonylimide,$^{[4]}$ catalysts 5$^{[5]}$ 6$^{[5]}$ and 7$^{[5]}$ were prepared according to previously reported procedures. Chlorotrimethylsilane (99%), BH$_3$:Me$_2$S in THF (10 M), n-BuLi in hexanes (1.6 M) and diisopropylamine (99%) were obtained from Aldrich. Precursors of reagents 2b–f and 2h (R-CF$_2$CF$_2$Br) were obtained from CF Plus Chemicals (Brno, Czech Republic). Reagents 1, 2a ($R_1$ = CF$_3$),$^{[7]}$ 2b–d, 2f and 2h$^{[8]}$ were prepared according to previously reported procedures. Unless otherwise noted, commercially available chemicals were used as received.

Synthesis of new hypervalent iodine(III)-R$_R$ reagents (2e, 2g, 2i–k).

Synthesis of 2e.

Step 1: Synthesis of (2-(2-(1,3-Dioxolan-2-yl)phenoxy)-1,1,2,2-tetrafluoroethyl)trimethylsilane.

A flame-dried 100-mL Schlenk flask equipped with rubber septum and magnetic stirring bar was charged under Ar atmosphere subsequently with 2-(2-(2-bromo-1,1,2,2-tetrafluoroethoxy)phenyl)-1,3-dioxolane (880 mg, 2.50 mmol, 1 equiv), trimethylchlorosilane (1.3 mL, 10 mmol, 4 equiv) and anhydrous THF (20 mL). The solution was cooled to −65 °C (acetone/dry ice bath). A solution of i-PrMgCl•LiCl (1.3 M in THF, 2.6 mL, 3.0 mmol, 1.2 equiv) was added dropwise via syringe, and the reaction mixture was stirred for 5 h at −60 °C to rt. THF was removed on a rotary evaporator, water (30 mL) was added, and the product was extracted to a diethyl ether/hexane 1:1 mixture (3 × 25 mL). The combined organic fractions were washed with water (2 × 20 mL) and brine (2 × 20 mL). After drying with anhydrous sodium sulfate, filtering and concentrating to dryness, the product was obtained as a colorless oil. The ratio of product and the protodesilylated compound was 94:6 and the product was used further without purification.

Yield: 806 mg (90%). $R_1 = 0.33$ (EtOAc:hexane 1:10). $^1$H NMR (300 MHz, CDCl$_3$) δ 0.25 (s, 3H), 3.88 – 4.11 (m, 4H), 5.97 (s, 1H), 7.17 – 7.32 (m, 3H), 7.56 (m, 1H). $^{13}$C NMR (75 MHz, CDCl$_3$) δ -4.4 (m),
Step 2: Synthesis of 1-(2-(2-(1,3-dioxolan-2-yl)phenoxy)-1,1,2,2-tetrafluoroethyl)-3,3-dimethyl-1,3-dihydro-1λ3-benzo[d][1,2]iiodaoxole (2e).

A flame-dried 100-mL Schlenk flask equipped with rubber septum and magnetic stirring bar was charged under Ar atmosphere with 1-fluoro-3,3-dimethyl-1,3-dihydro-1λ3-benzo[d][1,2]iiodaoxole (1.16 g, 3.70 mmol, 2 equiv) and anhydrous CH3CN (20 mL). The solution was cooled to −30 °C (acetone/dry ice bath). Tetrabutylammonium difluorotriphenylsilicate (20.0 mg, 0.04 mmol, 0.02 equiv) was added as solid, followed by the addition of a solution of (2-(2-(1,3-dioxolan-2-yl)phenoxy)-1,1,2,2-tetrafluoroethyl)-trimethylsilane (700 mg, 1.86 mmol, 90% purity, 1 equiv) in anhydrous CH3CN (6 mL) over a period of 30 min at −25 °C. The mixture was stirred at −25 °C to rt for 5 h. The solvent was removed on a rotary evaporator and the mixture was anchored on Celite® (2 g). The product was isolated by flash column chromatography (gradient elution from hexane to EtOAc) as an oily yellow liquid.

Yield: 642 mg (66%). Rf = 0.31 (EtOAc:hexane 1:2). 1H NMR (300 MHz, CDCl3) δ 1.50 (s, 6H), 3.99 – 4.13 (m, 4H), 6.06 (s, 1H), 7.30 – 7.41 (m, 5H), 7.49 (m, 1H), 7.65 (m, 1H), 7.77 (m, 1H). 13C NMR (75 MHz, CDCl3) δ 30.8, 65.3, 76.3, 98.8, 111.0, 111.5 (tt, J = 37.6, 38.1 Hz), 117.4 (tt, J = 278.5, 26.1 Hz), 121.4 (t, J = 1.5 Hz), 126.6, 127.3, 127.6, 129.2 (t, J = 5.2 Hz), 129.4, 130.3, 130.3, 130.7, 147.2, 150.0. 19F NMR (282 MHz, CDCl3) δ −97.2 (br s, 2F), −84.1 (td, JIF = 4.6 Hz, JHF = 1.5 Hz, 2F). IR (ATR, neat): 3062, 2971, 2924, 2897, 1725, 1607, 1588, 1564, 1488, 1461, 1452, 1438, 1376, 1358, 1302, 1269, 1246, 1177, 1161, 1106, 1071, 994, 958, 896, 870, 802, 749, 718, 664, 647 cm−1. HRMS (MALDI) calcd (m/z) for C29H29F2I2O6: [M+H+] 527.0337, found: 527.0336.

Synthesis of 2g.
Step 1: Synthesis of methyl 4-(3-bromo-2,2,3,3-tetrafluoropropyl)benzoate.

A solution of methyl 4-formylbenzoate (1.86 g, 11.4 mmol, 1 equiv) in EtOH (15 mL) was added with stirring dropwise to a solution of hydrazine hydrate (0.643 mL, 11.4 mmol, 1 equiv) in EtOH (15 mL) and the mixture was stirring at 25 °C for 12 h. Then freshly purified CuCl (112 mg, 1.14 mmol, 0.1 equiv) and 1,2-ethylenediamine (3.79 mL, 56.8 mmol, 5 equiv) were added. After 10 min, BrCF2CF2Br (6.78 mL, 56.8 mmol, 5 equiv) was added dropwise and the reaction mixture was stirred at 50 °C for 5 h. After cooling, reaction mixture was quenched with hydrochloric acid (1 M, 20 mL). Reaction products were extracted with DCM (5 × 30 mL) and combined organic layers were washed with a saturated solution of NaCl (20 mL) and dried over MgSO4, filtered and evaporated under vacuum. The crude residue was purified by flash chromatography on silica gel (EtOAc/Hexane 0.5:9.5) to afford a white solid (1.39 g, 4.22 mmol, 37%).

Rf = 0.63 (SiO2; EtOAc:Hexane 1:4; UV). M.p. = 45 °C. 1H NMR (300 MHz, CDCl3) δ 3.43 (t, J = 18.0 Hz, 2H), 3.92 (s, 3H), 7.38 (d, J = 8.1 Hz, 2H), 7.38 (d, J = 8.1 Hz, 2H), 8.03 (d, J = 8.3 Hz, 2H).
$^{13}$C NMR (75.5 MHz, CDCl$_3$) δ 36.83 (t, $J_{CF} = 22.7$ Hz), 52.33, 115.92 (tt, $J_{CF} = 255$ Hz, $J_{CF} = 31.5$ Hz), 117.65 (tt, $J_{CF} = 312$ Hz, $J_{CF} = 39.5$ Hz), 129.93, 130.21, 130.93, 134.76, 166.79. $^{19}$F NMR (282 MHz, CDCl$_3$) δ −110.20 (t, $J = 3.6$ Hz), −65.10 (t, $J = 3.6$ Hz). IR (ATR, neat): 2954, 1716, 1615, 1435, 1281, 1244, 1110, 1078, 904, 889, 865, 619 cm$^{-1}$. HRMS (ESI+) calcd (m/z) for C$_{11}$H$_{13}$N$_2$O$_5$F$_2$: [M+NH$_4$]$^+$ 346.0060 [M$_{Br79}$] and 348.0041 [M$_{Br81}$], found: 346.0054 [M$_{Br79}$] and 348.0042 [M$_{Br81}$]. Anal. Calcd. for C$_{11}$H$_{13}$O$_7$F$_2$: Br C, 39.17; H, 2.76; F, 23.11; Br, 24.07.

**Step 2: Synthesis of methyl 4-(2,2,3,3-tetrafluorooxor-3-(trimethylsilyl)propyl)benzoate.**

To a solution of methyl 4-(3-bromo-2,2,3,3-tetrafluoropropyl)benzoate (1.13 g, 3.43 mmol, 1 eq) in dry THF (25 mL) under Ar, were added successively at −78 °C trimethylsilyl chloride (1.31 mL, 10.3 mmol, 3 equiv) and dropwise i-PrMgCl•LiCl (1.3 M in THF, 3.17 mL, 4.12 mmol, 1.2 equiv). The reaction mixture was allowed to warm up overnight until 25 °C, then quenched by addition of water (30 mL). The organic and aqueous layers were separated and the aqueous layer was extracted with EtOAc (3 × 30 mL). The combined organic layers were washed with a saturated solution of NaCl (30 mL), dried over MgSO$_4$, filtered, and evaporated under vacuum. The crude residue was purified by flash chromatography on silica gel (EtOAc/Hexane 0.5:9.5) to afford a white solid (941 mg, 2.92 mmol, 85 %).

**Step 3: Synthesis of methyl 4-(3-(3,3-dimethyl-1H)-1(3H)-yl)-2,2,3,3-tetrafluoropropyl)benzoate (2g).**

To a solution of 1-fluoro-3,3-dimethyl-1,3-dihydro-1H-3-benzo[d][1,2]iodaoxol-1(3H)-yl]-2,2,3,3-tetrafluoropropyl)benzoate (662 mg, 2.05 mmol, 1 equiv) in dry MeCN (10 mL), was added dropwise at −35 °C a solution of methyl 4-(2,2,3,3-tetrafluoroor-3-(trimethylsilyl)propyl)benzoate (662 mg, 2.05 mmol, 1 equiv) in dry MeCN (20 mL). The reaction mixture was stirred for 30 min at −35 °C and 2 h at 25 °C. The reaction mixture was evaporated to dryness with Celite® and subjected to flash chromatography (EtOAc/Hexane 1:1) to afford yellowish oil (545 mg, 1.1 mmol, 52 %).
1278, 1180, 1106, 1060, 961, 869, 754, 729, 621 cm⁻¹. **HRMS (ESI+)** calcd (m/z) for C₂₉H₂₆O₂F₄I: [M+H]+ 511.0388, found 511.0384.

**Synthesis of 2i.**

**Step 1: Synthesis of 7-(2-bromo-1,1,2,2-tetrafluoroethoxy)-4-methyl-2H-chromen-2-one.**

To a suspension of sodium hydride (60%, washed with pentane, 2.49 g, 14 mmol, 1.5 equiv) in dry DMF (60 mL) under Ar, was added at 0 °C a solution of 7-hydroxy-4-methyl-2H-chromen-2-one (7.3 g, 41.5 mmol, 1 equiv) in dry DMF (20 mL). The reaction mixture was cooled to −50 °C and TBAI (2.3 g, 6.22 mmol, 0.15 equiv) and BrCF₂CF₂Br (1.4 mL, 11.7 mmol, 1.25 equiv) were added dropwise. The reaction mixture was allowed to warm up to 25 °C overnight. The reaction was quenched by hydrochloric acid (1 M, 20 mL). The organic and aqueous layers were separated and the aqueous layer was extracted with EtOAc (3 mL, 11.5 mmol, 3 equiv) and dropwise i-PrMgCl•LiCl (1.3 M in THF, 8.85 mL). The combined organic layers were washed several times with water (30 mL) and a saturated solution of NaCl (30 mL), dried over MgSO₄, filtered and evaporated under vacuum. The crude residue was purified by flash chromatography on silica gel (EtOAc/Hexane 2:8) to afford white solid (3.41 g, 9.60 mmol, 23%)

R₇ = 0.49 (SiO₂; EtOAc/Hexane 2:3; UV). **M.p.** = 58 °C. **¹H NMR** (300 MHz, CDCl₃) δ 2.37 (d, J = 1.4 Hz, 3H), 6.20 (d, J = 1.4 Hz, 1H), 7.03 − 7.16 (m, 2H), 7.56 (d, J = 8.6 Hz, 1H). **¹³C NMR** (75.5 MHz, CDCl₃) δ 18.70, 110.01, 113.27 (t, JᵥCF = 312 Hz, JᵥCF = 44.2 Hz), 115.11, 115.86 (t, JᵥCF = 277 Hz, JᵥCF = 32.4 Hz), 117.32, 118.69, 126.05, 150.92 (t, JᵥCF = 1.4 Hz), 151.71, 154.20, 160.01. **¹⁹F NMR** (282 MHz, CDCl₃) δ −86.11 (t, J = 4.5 Hz), −68.25 (t, J = 4.9 Hz). **IR** (ATR, neat): 2973, 1736, 1620, 1517, 1479, 1437, 1346, 1278, 1263, 1125, 1095, 984, 927, 878, 786, 711, 620 cm⁻¹. **HRMS** (ESI+) calcd (m/z) for C₁₂H₁₀O₂F₄Br: [M+H]+ 354.9587 [MBr⁷⁹] and 356.9568[MBr⁸¹], found 354.9586 [MBr⁷⁹] and 356.9566 [MBr⁸¹].

**Step 2: Synthesis of 4-methyl-7-(1,1,2,2-tetrafluoroethoxy)-2H-chromen-2-one.**

To a solution of 7-(2-bromo-1,1,2,2-tetrafluoroethoxy)-4-methyl-2H-chromen-2-one (3.41 g, 9.6 mmol, 1 equiv) in dry THF (50 mL) under Ar, were added successively at −78 °C trimethylsilyl chloride (3.66 mL, 28.8 mmol, 3 equiv) and dropwise 1,1,2,2-tetramethyldisilylethoxy (1.3 M in THF, 8.85 mL, 11.5 mmol, 1.2 equiv). The reaction mixture was allowed to warm up overnight until 25 °C, then quenched by addition of water (30 mL). The organic and aqueous layers were separated and the aqueous layer was extracted with EtOAc (3 × 40 mL). The combined organic layers were washed with a saturated solution of NaCl (30 mL), dried over MgSO₄, filtered and evaporated under vacuum. The crude residue was purified by flash chromatography on silica gel (EtOAc/Hexane 2:8) to afford white solid (1.1 g, 3.05 mmol, 70%).

R₇ = 0.59 (SiO₂; EtOAc/Hexane 2:3; UV). **M.p.** = 87 °C. **¹H NMR** (300 MHz, CDCl₃) δ 0.31 (s, 9H), 2.42 (d, J = 1.4 Hz, 3H), 6.24 (d, J = 1.4 Hz, 1H), 7.05 − 7.21 (m, 2H), 7.59 (d, J = 8.6 Hz, 1H). **¹³C NMR** (75.5 MHz, CDCl₃) δ −4.27, 18.72, 109.75, 114.74, 117.25, 118.03, 119.39 (t, JᵥCF = 277 Hz, JᵥCF = 27.7 Hz), 120.49 (t, JᵥCF = 272 Hz, JᵥCF = 39.7 Hz), 125.83, 151.75, 151.85, 154.27, 160.27. **¹⁹F NMR** (282 MHz, CDCl₃) δ −129.99 (t, J = 4.3 Hz), −85.05 (t, J = 4.4 Hz). **IR** (ATR, neat): 2973, 1736, 1620, 1302, 1174, 1132, 1082, 1039, 848, 765, 628 cm⁻¹. **HRMS** (ESI+) calcd (m/z) for C₁₃H₁₂O₂F₄Si: [M+H]+ 349.0878, found 349.0878.

**S5 | P a g e**
Step 3: Synthesis of 7-(2-(3,3-Dimethyl-1λ3-benzo[d][1,2]iodoxol-1(3H)-yl)-1,1,2,2-tetrafluoroethyl)-4-methyl-2H-chromen-2-one (2i).

To a solution of 1-fluoro-3,3-dimethyl-1,3-dihydro-1λ3-benzo[d][1,2]iodoxole (1.34 g, 4.81 mmol, 2 equiv) and TBAT (12.9 mg, 0.024 mmol, 0.01 equiv) in dry MeCN (20 mL) under Ar, was added dropwise at −35 °C a solution of 4-methyl-7-(1,1,2,2-tetrafluoro-2-(trimethylsilyl)ethoxy)-2H-chromen-2-one (837 mg, 2.40 mmol, 1 equiv) in dry MeCN (10 mL). The reaction mixture was stirring 30 min at −35 °C and 2 h at 25 °C. The reaction mixture was evaporated to dryness with Celite® and subjected to flash chromatography (EtOAc/Hexane 4:1) to afford yellowish oil (1.0 g, 1.86 mmol, 78%).

Rf = 0.39 (SiO2; EtOAc/Hexane 4:1; UV). M.p. = 132 °C. 1H NMR (400 MHz, CDCl3) δ 1.47 (s, 6H), 2.40 (d, J = 1.3 Hz, 3H), 6.24 (d, J = 1.4 Hz, 1H), 7.08 – 7.20 (m, 2H), 7.30 – 7.47 (m, 2H), 7.48 (td, J = 7.4, 0.9 Hz, 1H), 7.59 (d, J = 8.6 Hz, 1H), 7.69 (d, J = 4.2 Hz, 1H). 13C NMR (100 MHz, CDCl3) δ 18.72, 30.87, 76.66, 109.82, 111.06 (tt, JCF = 337 Hz, JCF = 37.9 Hz), 111.08, 114.99, 117.18, 117.46 (tt, JCF = 279 Hz, JCF = 26.7 Hz), 118.44, 125.96, 127.51, 128.81, 111.08, 114.99, 117.18, 117.46 (tt, JCF = 279 Hz, JCF = 26.7 Hz), 118.44, 125.96, 127.51, 128.81 (t, JCF = 5.3 Hz), 129.55, 130.52, 149.89, 151.06, 151.65, 154.19, 160.4. 19F NMR (376 MHz, CDCl3) δ = −97.50 (t, J = 3.8 Hz), −84.35 (t, J = 4.1 Hz). IR (ATR, neat): 2970, 1727, 1615, 1389, 1303, 1179, 1108, 1092, 869, 756, 748, 602 cm−1. HRMS (ESI+) calcd (m/z) for C21H18O2F4BrS: [M+H]+ 537.0180, found 537.0176.

Synthesis of 2j.

Step 1: Synthesis of 7-((2-bromo-1,1,2,2-tetrafluoroethyl)thio)-4-methyl-2H-chromen-2-one.

To a suspension of sodium hydride (60%, washed with pentane, 562 mg, 14 mmol, 1.5 equiv) in dry DMF (20 mL) under Ar, was added at 0 °C a solution of 7-mercapto-4-methyl-2H-chromen-2-one (1.8 g, 9.36 mmol, 1 equiv) in dry DMF (10 mL). The reaction mixture was cooled to −50 °C and BrCF2CF2Br (1.4 mL, 11.7 mmol, 1.25 equiv) was added dropwise. The reaction mixture was allowed to warm up to 25 °C overnight. The reaction was quenched with hydrochloric acid (1 M, 20 mL). The organic and aqueous layers were separated and the aqueous layer was extracted with Ether (3 × 50 mL). The combined organic layers were washed several times with water (30 mL) and a saturated solution of NaCl (30 mL), dried over MgSO4, filtered and evaporated under vacuum. The crude residue was purified by flash chromatography on silica gel (EtOAc/Hexane 2:8) to afford a white solid (2.17 g, 5.85 mmol, 63%).

Rf = 0.54 (SiO2; EtOAc/Hexane 3:7; UV). M.p. = 99 °C. 1H NMR (300 MHz, CDCl3) δ 2.46 (t, J = 1.4 Hz, 3H), 6.37 (s, J = 1.5 Hz, 1H), 7.51 – 7.64 (m, 3H). 13C NMR (75.5 MHz, CDCl3) δ 18.75, 116.47 (t, JCF = 313 Hz, JCF = 39.9 Hz), 116.98, 122.03, 122.18 (tt, JCF = 292 Hz, JCF = 34.2 Hz), 125.18, 125.34, 127.48 (tt, JCF = 2.7 Hz), 132.16, 151.45, 153.29, 159.74. 19F NMR (282 MHz, CDCl3) δ -84.51 (t, J = 8.1 Hz), -62.41 (t, J = 8.0 Hz). IR (ATR, neat): 3059, 1721, 1601, 1395, 1383, 1168, 1107, 1092, 950, 777, 614 cm−1. HRMS (ESI+) calcd (m/z) for C12H16O3F4BrS: [M+H]+ 370.9359 [MBr79] and 372.9339[MBr81], found 370.9360 [MBr79] and 372.9339 [MBr81].
Step 2: Synthesis of 4-methyl-7-((1,1,2,2-tetrafluoro-2-(trimethylsilyl)ethyl)(thio)-2H-chromen-2-one.

To a solution of 7-(2-bromo-1,1,2,2-tetrafluoroethyl)(thio)-4-methyl-2H-chromen-2-one (1.63 g, 4.39 mmol, 1 equiv) in dry THF (35 mL) under Ar. were added successively at −78 °C trimethylsilyl chloride (1.67 mL, 13.2 mmol, 3 equiv) and dropwise i-PrMgCl•LiCl (1.3 M in THF, 4.05 mL, 5.27 mmol, 1.2 equiv). The reaction mixture was allowed to warm up overnight until 25 °C, then quenched by addition of water (30 mL). The organic and aqueous layers were separated and the aqueous layer was extracted with EtOAc (3 × 40 mL). The combined organic layers were washed with a saturated solution of NaCl (30 mL), dried over MgSO₄, filtered and evaporated under vacuum. The crude residue was purified by flash chromatography on silica gel (EtOAc/Hexane 1:9) to afford yellowish oil (516 mg, 0.93 mmol, 39%).

Rᵣ = 0.56 (SiO₂; EtOAc/Hexane 3:7; UV). M.p. = 81 °C. ¹H NMR (300 MHz, CDCl₃) δ 0.27 (s, 9H), 2.44 (d, J = 1.3 Hz, 3H), 6.33 (d, J = 1.4 Hz, 1H), 7.50 – 7.66 (m, 3H). ¹³C NMR (75.5 MHz, CDCl₃) δ 4.02, 18.73, 116.46, 121.28, 122.60 (tt, JCF = 273 Hz, JC,F = 45.5 Hz), 124.79, 124.94, 127.22 (tt, JC,F = 283 Hz, JCF = 32.8 Hz), 129.26, 131.94, 151.55, 153.21, 160.03. ¹⁹F NMR (282 MHz, CDCl₃) δ −121.68 (t, J = 4.9 Hz), −81.70 (t, J = 4.9 Hz). IR (ATR, neat): 3062, 1720, 1601, 1394, 1387, 1258, 1171, 1063, 1042, 823, 787, 747, 709, 631, 613 cm⁻¹. HRMS (ESI+) calcd (m/z) for C₁₇H₁₄O₃F₄SSi: [M+H]⁺ 365.0649, found 365.0644. Anal. Calcd. for C₁₇H₁₄O₃F₄SSi: C 49.44, H 4.43, F 20.85, S 8.80. F 20.78, S, 8.69.

Step 3: Synthesis of 7-((2-(3,3-Dimethyl-1H)-1λ³-benzo[d][1,2]iodaoxol-1(3H)-yl)-1,1,2,2-tetrafluoroethyl)(thio)-4-methyl-2H-chromen-2-one (2j).

To a solution of 1-fluoro-3,3-dimethyl-1,3-dihydro-1λ³-benzo[d][1,2]iodaoxole (1.40 g, 4.75 mmol, 2 equiv) and TBAT (13.2 mg, 0.024 mmol, 0.01 equiv) in dry MeCN (20 mL) under Ar. was added dropwise at −35 °C a solution of 4-methyl-7-((1,1,2,2-tetrafluoro-2-(trimethylsilyl)ethyl)(thio)-2H-chromen-2-one (865 mg, 2.37 mmol, 1 equiv) in dry MeCN (10 mL). The reaction mixture was stirring 30 min at −35 °C and 2 h at 25 °C. The reaction mixture was evaporated to dryness with Celite® and subjected to flash chromatography (EtOAc/Hexane 1:1) to afford yellowish oil (516 mg, 0.93 mmol, 39%).

Rᵣ = 0.33 (SiO₂; EtOAc/Hexane 1:1; UV). M.p.: 111 °C. ¹H NMR (400 MHz, CDCl₃) δ 1.46 (s, 6H), 2.44 (d, J = 1.3 Hz, 3H), 6.35 (d, J = 1.4 Hz, 1H), 7.32 – 7.40 (m, 2H), 7.48 (td, J = 7.3 Hz, J = 0.9 Hz, 1H), 7.56 (td, J = 6.7 Hz, J = 3.4 Hz, 2H), 7.60–7.66 (m, 2H). ¹³C NMR (100 MHz, CDCl₃) δ 18.74, 30.88, 76.69, 111.27, 114.19 (tt, JCF = 338 Hz, JCF = 47.6 Hz), 116.76, 121.74, 124.81 (tt, JCF = 285 Hz, JCF = 28.9 Hz), 124.98, 125.22, 127.50, 127.96, 128.94 (t, JCF = 5.3 Hz), 129.61, 130.50, 132.04, 150.04, 151.52, 153.25, 159.82. ¹⁹F NMR (376 MHz, CDCl₃) δ −89.89 (bs, −81.31 (t, J = 5.8 Hz). IR (ATR, neat): 2970, 1725, 1598, 1396, 1174, 1093, 1072, 964, 950, 879, 769, 718, 629, 608 cm⁻¹. HRMS (ESI+) calcd (m/z) for C₁₉H₁₈O₃F₄I: [M+H]⁺ 552.9952, found 552.9948.
Synthesis of 2k.
Step 1: Synthesis of triethyl(perfluoroethyl)silane.

Anhydrous diethyl ether (150 mL) was cooled down to –78 °C (acetone/dry ice bath). Pentafluoroethane (15.6 g, 130 mmol, 2 equiv) was condensed to the solution. A solution of n-BuLi (2.5 M in hexanes, 26 mL, 65 mmol, 1 equiv) was added carefully so that the internal temperature did not exceed –60 °C. After stirring for 1 h, a solution of triethylchlorosilane (10.9 mL, 65 mmol, 1 equiv) in diethyl ether (5 mL) was added within 5 min. The mixture was allowed to warm up to rt 1 h and then concentrated near dryness. A little amount of pentane was added to finish precipitation of LiCl. The suspension was filtered and concentrated to dryness, affording the crude product. The product was distilled in vacuo to give a colourless oil.

Yield: 11.4 g (75%). \( R_f = 0.56 \) (EtOAc:hexane 1:1). \(^1\)H NMR (300 MHz, CDCl₃) \( \delta \) 0.83 (q, \( J = 7.9 \) Hz, 6H), 1.04 (t, \( J = 7.9 \) Hz, 9H). \(^1\)C NMR (75 MHz, CDCl₃) \( \delta \) 9.0 (m), 120.6 (1) (tq, \( J = 272.5, 42.2 \) Hz), 120.6 (4) (qt, \( J = 284.5, 30.4 \) Hz). \(^1\)F NMR (282 MHz, CDCl₃) \( \delta \) -127.4 (br s, 2F), -82.9 (br s, 2F). \( \text{IR (ATR, neat):} \) 2964, 2948, 2886, 1565, 1452, 120.6(1), 118.9, 111.1 (m), 118.9 (qt, \( J = 285.2, 28.6 \) Hz), 127.5, 128.5 (m), 129.7, 130.6, 149.7 (m). \(^1\)H NMR (471 MHz, CDCl₃) \( \delta \) –99.78 (br s, 2F), –81.80 (br s, 2F). \( \text{IR (ATR, neat):} \) 3137, 3068, 2975, 2962, 2931, 2920, 2860, 1565, 1462, 1452, 1438, 1375, 1357, 1303, 1268, 1249, 1178, 1160, 1119, 1063, 1040, 999, 959, 897, 869, 750, 729, 717, 647. \( \text{HRMS (ESI) calcd (m/z) for} \) \( C_{11}H_{13}SiF_3O: [M+H^+] 380.9769, \) found: 380.9776.

Step 2: Synthesis of 3,3-dimethyl-1-(perfluoroethyl)-1,3-dihydro-1H,1,3-benzo[d][1,2]iodaoxole (2k).

A flame-dried 100-mL Schlenk flask equipped with rubber septum and magnetic stirring bar was charged under Ar atmosphere with 1-fluoro-3,3-dimethyl-1,3-dihydro-1H,1,3-benzo[d][1,2]iodaoxole (4.69 g, 16.7 mmol, 2 equiv) and anhydrous CH₂CN (43 mL). The solution was cooled to –35 °C (acetone/dry ice bath). A solution of tetrabutylammonium difluorotriphenylsilicate (93.0 mg, 0.17 mmol, 0.02 equiv) in anhydrous CH₂CN (2 mL) was added at once, followed by the addition of a solution of triethyl(perfluoroethyl)silane (2.00 g, 8.37 mmol, 1 equiv) in anhydrous CH₂CN (5 mL) over a period of 30 min at –35 °C. The mixture was stirred at –35 °C to rt for 1 h. The solvent was removed on a rotary evaporator, yielding a yellow oil, which was treated with pentane (10 mL). The resulting suspension was filtered through a glass frit containing layers of Celite®, neutral activated alumina and Celite®, and washed with pentane (5 × 10 mL). The filtrate was concentrated on a rotary evaporator and dried in vacuo affording a white solid.

Yield: 2.30 g (72%). \( R_f = 0.25 \) (EtOAc:hexane 1:10). \( M_p. = 68.8–71.2 ^\circ C \). \(^1\)H NMR (500 MHz, CDCl₃) \( \delta \) 1.49 (s, 6H), 7.37 – 7.42 (m, 2H), 7.52 (m, 1H), 7.56 (m, 1H). \(^1\)C NMR (126 MHz, CDCl₃) \( \delta \) 30.7, 77.0, 109.2 (tq, \( J = 334.8, 43.1 \) Hz), 111.1 (m), 118.9 (qt, \( J = 285.2, 28.6 \) Hz), 127.5, 128.5 (m), 129.7, 130.6, 149.7 (m). \(^1\)F NMR (471 MHz, CDCl₃) \( \delta \) –99.78 (br s, 2F), –81.80 (br s, 2F). \( \text{IR (ATR, neat):} \) 3137, 3068, 2975, 2962, 2931, 2920, 2860, 1565, 1462, 1452, 1438, 1375, 1357, 1303, 1268, 1249, 1178, 1160, 1119, 1063, 1040, 999, 959, 897, 869, 750, 729, 717, 647. \( \text{HRMS (ESI) calcd (m/z) for} \) \( C_{11}H_{13}SiF_3O: [M+H^+] 380.9769, \) found: 380.9776.

General procedure for the synthesis of α-substituted γ-, δ- and ε-lactams.

A flame-dried 100-mL Schlenk flask equipped with rubber septum and magnetic stirring bar was charged under Ar atmosphere subsequently with diisopropylamine (0.96 mL, 6.82 mmol, 1.1 equiv) and anhydrous THF (10 mL). To this well-stirred solution held at –18°C (ice/salt bath) was added within 5 minutes via a syringe a solution of n-BuLi (1.6 M in hexanes, 6.51 mmol, 1.05 equiv). The resulting
solution was stirred at this temperature for 15 minutes, then the solution was cooled to –78°C (acetone/dry ice bath). A solution of the selected lactam (6.2 mmol, 1 equiv) in anhydrous THF (5 mL) was introduced dropwise via a syringe within 5 minutes. Lithiation was conducted for 90 minutes, then the solution of the corresponding alkylbromide (6.82 mmol, 1.1 equiv) in THF (5 mL) was slowly introduced. The resultant reaction mixture was stirred overnight allowing to gradually reach rt and the n was quenched with sat. NaHCO$_3$ solution. The aqueous phase was extracted with EtOAc (3×30 mL), washed with brine, dried over Na$_2$SO$_4$, concentrated to dryness and subjected to dry column vacuum chromatography, applying gradient elution from hexane to hexane/EtOAc (3:1) to give the corresponding pure product.

3-Benzyl-1-methylpyrroolidin-2-one (3a). [CAS: 53101-33-0]

Yield 84%, colorless oil. $^1$H NMR (300 MHz, CDCl$_3$): δ 7.35 – 7.30 (m, 2H), 7.27 – 7.20 (m, 3H), 3.30 – 3.21 (m, 2H), 3.12 (td, J = 9.2, 3.8 Hz, 1H), 2.87 (s, 3H), 2.79 – 2.67 (m, 2H), 2.13 – 2.02 (m, 1H), 1.83 – 1.71 (m, 1H). $^{13}$C NMR (75 MHz, CDCl$_3$): δ 24.1, 29.7, 37.2, 43.4, 47.6, 126.3, 128.4, 129.0, 139.5, 175.9.

1,3-Dibenzylpyrroolidin-2-one (3b). [CAS: 178371-86-3]

Yield 87%, colorless oil. $^1$H NMR (300 MHz, CDCl$_3$) δ 1.72 – 1.90 (m, 1H), 2.03 – 2.14 (m, 1H), 2.69 – 2.98 (m, 2H), 3.01 – 3.26 (m, 2H), 3.26 – 3.43 (m, 1H), 4.49 (d, 15.0 Hz, 1H), 4.54 (d, 15.0 Hz, 1H), 7.19 – 7.50 (m, 10H). $^{13}$C NMR (75 MHz, CDCl$_3$) δ 24.2, 37.2, 43.8, 44.9, 46.9, 126.4, 127.6, 128.2, 128.6, 128.8, 129.2, 136.6, 139.5, 175.9.

3-Benzyl-1-((benzyloxy)methyl)pyrroolidin-2-one (3c).

Yield 70%, colorless oil. $^1$H NMR (300 MHz, CDCl$_3$) δ 1.50 – 1.70 (m, 1H), 1.86 – 1.98 (m, 1H), 2.49 – 2.72 (m, 2H), 3.15 (dd, J = 13.0, 3.2 Hz, 1H), 3.18 – 3.33 (m, 2H), 4.39 (d, J = 12.0 Hz, 1H), 4.44 (d, J = 12.0 Hz, 1H), 4.74 (d, J = 10.5 Hz, 1H), 4.80 (d, J = 10.6 Hz, 1H), 7.04 – 7.40 (m, 10H). $^{13}$C NMR (75 MHz, CDCl$_3$) δ 176.9, 139.3, 138.0, 129.1, 128.5, 128.4, 127.8, 126.4, 72.9, 70.8, 44.1, 43.9, 36.8, 24.3.

IR (ATR, neat): 2933, 1690, 1453, 1264, 1062, 737, 696 cm$^{-1}$. HRMS (ESI) calcd (m/z) for C$_{19}$H$_{21}$NO$_2$Na: [M+Na$^+$] 318.1464, found: 318.1467.

$t$-Butyl 3-benzyl-2-oxopyrroloidine-1-carboxylate (3d). [CAS: 178371-86-3]

Yield 91%, colorless oil. $^1$H NMR (300 MHz, CDCl$_3$) δ 1.60 (s, 9H), 1.71 – 1.85 (m, 1H), 2.00 – 2.16 (m, 1H), 2.73 (dd, J = 13.5, 9.8 Hz, 1H), 2.79 – 2.94 (m, 1H), 3.35 (dd, J = 13.6, 3.7 Hz, 1H), 3.53 – 3.62 (m, 1H), 3.69 – 3.76 (m, 1H), 7.24 – 7.40 (m, 5H). $^{13}$C NMR (75 MHz, CDCl$_3$) δ 23.8, 23.9, 36.5, 44.4, 45.6, 82.9, 126.5, 128.6, 129.0, 138.9, 150.4, 175.2.

1-Methyl-3-phenylpyrroloidin-2-one (3e). [CAS: 54520-82-0]

Yield 37%, white solid. M.p. = 62.8-64.0 °C. $^1$H NMR (200 MHz, CDCl$_3$) δ 1.97 – 2.31 (m, 1H), 2.38 – 2.68 (m, 1H), 2.96 (s, 3H), 3.30 – 3.58 (m, 2H), 3.67 (t, J = 8.8 Hz, 1H), 7.07 – 7.49 (m, 5H). $^{13}$C NMR (50 MHz, CDCl$_3$) δ 28.0, 30.1, 47.7, 48.0, 126.9, 127.9, 128.7, 140.0, 174.9.
3-Benzyl-1-methylpiperidin-2-one (3f). [CAS: 37129-04-7]

Yield 67%, colorless oil. \(^1\)H NMR (300 MHz, CDCl\(_3\)) \(\delta \) 1.40 – 1.62 (m, 1H), 1.64 – 2.01 (m, 3H), 2.52 – 2.78 (m, 2H), 3.03 (s, 3H), 3.24 – 3.42 (m, 2H), 3.52 (dd, \(J = 12.9, 3.1 \text{ Hz}, 1H\)), 7.20 – 7.31 (m, 3H), 7.33 – 7.39 (m, 2H). \(^13\)C NMR (50 MHz, CDCl\(_3\)) \(\delta \) 21.5, 25.8, 35.0, 37.9, 43.4, 50.2, 126.0, 128.3, 129.2, 140.3, 172.0.

3-Benzyl-1-methylazepan-2-one (3g). [CAS: 57724-11-5]

Yield 76%, colorless oil. \(^1\)H NMR (300 MHz, CDCl\(_3\)) \(\delta \) 1.30 – 1.63 (m, 3H), 1.70 – 1.85 (m, 2H), 1.87 – 2.02 (m, 1H), 2.64 (dd, \(J = 14.1, 8.7 \text{ Hz}, 1H\)), 2.80 – 2.97 (m, 1H), 3.06 (s, 3H), 3.20 (dd, \(J = 15.4, 5.8 \text{ Hz}, 1H\)), 3.32 (dd, \(J = 14.0, 5.6 \text{ Hz}, 1H\)), 3.70 (dd, \(J = 15.2, 9.9 \text{ Hz}, 1H\)), 7.22 – 7.33 (m, 5H). \(^13\)C NMR (75 MHz, CDCl\(_3\)) \(\delta \) 27.0, 29.2, 29.4, 36.0, 38.3, 45.5, 50.5, 126.0, 128.4, 129.4, 141.1, 176.7.

3-(2-Methoxyethyl)-1-methylpyrrolidin-2-one (3h).

Yield 56%, yellowish oil. \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta \) 2.90 (dd, \(J = 13.7, 9.4 \text{ Hz}, 1H\)), 3.18 (s, 3H), 3.53 (dd, \(J = 13.7, 4.5 \text{ Hz}, 1H\)), 3.74 (dd, \(J = 9.5, 4.5 \text{ Hz}, 1H\)), 6.77 (t, \(J = 6.7 \text{ Hz}, 2H\)), 6.94 (t, \(J = 7.5 \text{ Hz}, 1H\)), 7.12 – 7.38 (m, 6H). \(^13\)C NMR (101 MHz, CDCl\(_3\)) \(\delta \) 26.1, 36.9, 47.1, 107.9, 122.0, 124.5, 126.6, 127.9, 128.3, 128.4, 129.4, 138.0, 144.2, 177.0. IR (ATR, neat): 2869, 1698, 1432, 1400, 1264, 1113, 933, 714 cm\(^{-1}\). HRMS (El) calcd (m/z) for C\(_9\)H\(_{18}\)NO\(_2\): [M+H\(^{+}\)] 158.1176, found: 158.1177.

3-Allyl-1-methylpyrrolidin-2-one (3i). [CAS: 40296-20-6]

Yield 67%, yellowish oil. \(^1\)H NMR (300 MHz, CDCl\(_3\)) \(\delta \) 1.55 – 1.86 (m, 1H), 2.02 – 2.29 (m, 2H), 2.35 – 2.69 (m, 2H), 2.82 (s, 3H), 3.10 – 3.44 (m, 2H), 4.89 – 5.23 (m, 2H), 5.66 – 5.82 (m, 1H). \(^13\)C NMR (75 MHz, CDCl\(_3\)) \(\delta \) 23.9, 29.7, 35.6, 41.2, 47.7, 116.8, 135.7, 176.0.

1-Methyl-3-(trimethylsilyl)pyrrolidin-2-one (3j). [CAS: 72578-86-0]

Yield 71%, colorless oil. \(^1\)H NMR (300 MHz, CDCl\(_3\)) \(\delta \) 0.09 (s, 9H), 1.77 – 2.07 (m, 2H), 2.09 – 2.39 (m, 1H), 2.79 (s, 3H), 3.21 – 3.33 (m, 2H). \(^13\)C NMR (75 MHz, CDCl\(_3\)) \(\delta \) 2.6, 20.3, 29.6, 32.7, 49.3, 177.25.

1-Methyl-3-(prop-2-yn-1-yl)pyrrolidin-2-one (3k). [CAS: 1616976-81-8]

Yield 56%, yellowish oil. \(^1\)H NMR (300 MHz, CDCl\(_3\)) \(\delta \) 1.80 – 2.04 (m, 2H), 2.17 – 2.31 (m, 1H), 2.32 – 2.46 (m, 1H), 2.49 – 2.67 (m, 2H), 2.81 (s, 3H), 3.23 – 3.40 (m, 2H). \(^13\)C NMR (75 MHz, CDCl\(_3\)) \(\delta \) 20.54, 23.86, 29.80, 40.73, 47.57, 69.67, 81.51, 174.56.

3-Benzyl-1-methyl-3,4-dihydroquinolin-2(1H)-one (3l).

Yield 86, colorless oil. \(^1\)H NMR (300 MHz, CDCl\(_3\)) \(\delta \) 2.56 – 2.75 (m, 2H), 2.80 – 3.00 (m, 2H), 3.39 (dd, \(J = 13.6, 3.9 \text{ Hz}, 1H\)), 3.47 (s, 3H), 7.02 – 7.19 (m, 3H), 7.21 – 7.42 (m, 6H). \(^13\)C NMR (126 MHz, CDCl\(_3\)) \(\delta \) 29.4, 29.9, 35.6, 42.5, 114.5, 122.9, 125.1, 126.4, 127.5, 128.2, 128.5, 129.2, 139.2, 140.3, 172.1. IR (ATR, neat): 3025, 2945, 1663, 1601, 1470, 1366, 1269, 1162, 1078, 751, 734, 698 cm\(^{-1}\). HRMS (El) calcd (m/z) for C\(_{17}\)H\(_{14}\)NO: [M+H\(^{+}\)] 252.1383, found: 252.1386.
General procedure for synthesis of lactam ketene silyl amides (KSAs).

A flame-dried 50-mL Schlenk flask equipped with rubber septum and magnetic stirring bar was charged under Ar atmosphere subsequently with disopropylamine (0.686 g, 0.95 mL, 6.78 mmol, 1.1 equiv) and anhydrous THF (10 mL). To this well-stirred solution held at –18 °C (ice-salt bath) was added a solution of n-BuLi (1.6M in hexanes, 4.45 mL, 1.15 equiv) via a syringe within 2 minutes. The resulting solution was stirred at this temperature for 30 minutes, then the solution was cooled to –78 °C. A solution of the selected lactam (6.165 mmol, 1 equiv) in anhydrous THF (5 mL) was introduced dropwise via a syringe within 2 minutes. Lithiation was conducted for 60 minutes, then neat trimethylchlorosilane (1.138 g, 1.35 mL, 10.48 mmol, 1.7 equiv) was introduced at once. The resultant reaction mixture was stirred overnight allowing to gradually reach rt. The turbid solution was concentrated in vacuo in Schlenk flask (external cold trap). To the resulting white slurry an anhydrous pentane (10 mL) was introduced and the mixture was stirred for 10 minutes. The resulting suspension was filtered into second, oven-dried Schlenk flask using a syringe filter (PTFE membrane, 3 cm diameter) under argon atmosphere and washed with dry pentane (3 mL). The clear filtrate was concentrated in vacuo (external cold trap) to give the desired ketene silyl amide (KSA). KSAs were stored in parafilm-sealed Schlenk flask in a freezer at –20 °C.

4-Benzyl-1-methyl-5-((trimethylsilyl)oxy)-2,3-dihydro-1H-pyrrole (4a). [CAS: 223714-06-5]

Using the general procedure, compound 4a was synthesized from 3a (1167 mg, 6.17 mmol) and TMSCl (1.33 mL, 10.5 mmol). 4a was obtained as colorless oil (1605 mg, 6.14 mmol, 99.6%). 1H NMR (400 MHz, CDCl3) δ 0.29 (s, 9H), 2.19 (t, J = 8.4 Hz, 2H), 2.46 (s, 3H), 2.96 (t, J = 8.4 Hz, 2H), 3.36 (s, 2H), 7.21 (dd, J = 16.5, 8.4 Hz, 3H), 7.30 (t, J = 7.3 Hz, 2H). 13C NMR (75 MHz, CDCl3) δ 0.0, 27.4, 32.2, 37.8, 52.2, 88.8, 124.98, 127.6, 127.9, 140.6, 151.4.

1,4-Dibenzyl-5-((trimethylsilyl)oxy)-2,3-dihydro-1H-pyrrole (4b).

Using the general procedure, compound 4b was synthesized from 3b (500 mg, 1.69 mmol) and TMSCl (0.36 mL, 2.88 mmol). 4b was obtained as colorless oil (610 mg, 1.66 mmol, 99%). 1H NMR (400 MHz, CDCl3) δ 0.32 (s, 9H), 2.18 (t, J = 8.5 Hz, 2H), 2.89 (t, J = 8.5 Hz, 2H), 3.40 (s, 2H), 3.94 (s, 2H), 7.20 – 7.37 (m, 10H). 13C NMR (101 MHz, CDCl3) δ 0.6, 27.9, 32.7, 49.9, 55.1, 89.6, 125.6, 126.8, 128.1, 128.2, 128.3, 128.5, 139.1, 141.2, 150.9. IR (ATR, neat): 2956, 2825, 1684, 1493, 1371, 1267, 1085, 865, 840, 750, 696 cm–1. Anal. calcd. for C23H27NOSi: C 74.32, H 8.17, N 4.18 found: C 74.37, H 8.11, N 4.16.

4-Benzyl-1-((benzylxoy)methyl)-5-((trimethylsilyl)oxy)-2,3-dihydro-1H-pyrrole (4c).

Using the general procedure, compound 4c was synthesized from 3c (300 mg, 1.02 mmol) and TMSCl (0.22 mL, 1.73 mmol). 4c was obtained as colorless oil (360 mg, 0.98 mmol, 96%). 1H NMR (500 MHz, CD3CN) δ 0.21 (s, 9H), 2.16 – 2.27 (m, 2H), 3.26 – 3.32 (m, 4H), 4.40 (s, 2H), 4.50 (s, 2H), 7.16 – 7.19 (m, 2H), 7.25 – 7.37 (m, 8H). 13C NMR (126 MHz, CDCl3) δ 0.5, 27.9, 32.7, 45.53, 70.2, 78.1, 89.7, 125.6, 127.4, 127.6, 128.2, 128.3, 128.5, 138.8, 140.99, 148.45. IR (ATR, neat): 2953, 1693, 1494, 1452, 1378, 1351, 1051, 866, 841, 696 cm–1. Anal. calcd. for C22H28NO2Si: C 71.89, H 7.95, N 3.81 found: C 71.68, H 8.25, N 3.59.
-Butyl 4-benzyl-5-((trimethylsilyl)oxy)-2,3-dihydro-1H-pyrrole-1-carboxylate (4d).

Using the general procedure, compound 4d was synthesized from 3d (1006 mg, 3.65 mmol) and TMSCl (0.79 mL, 6.21 mmol). 4d was obtained as colorless oil (1200 mg, 3.45 mmol, 95%). *H NMR (400 MHz, CDCl3) δ 0.29 (s, 9H), 1.50 (s, 9H), 2.12 – 2.30 (m, 2H), 3.37 (s, 2H), 3.57 – 3.83 (m, 2H), 7.15 – 7.22 (m, 3H), 7.26 – 7.32 (m, 2H). *C NMR (101 MHz, CDCl3) δ 0.3, 26.2, 28.5, 32.3, 44.9, 79.5, 96.4, 125.9, 128.3, 128.5, 140.0, 142.7, 151.5. IR (ATR, neat): 2975, 1744, 1716, 1494, 1390, 1293, 1248, 1153, 1103, 839, 697 cm⁻¹. Anal. calcd. for C19H30NO5Si: C 65.67, H 8.41, N 4.03 found: C 65.44, H 8.58, N 4.21.

1-Methyl-4-phenyl-5-((trimethylsilyl)oxy)-2,3-dihydro-1H-pyrrole (4e).

Using the general procedure, compound 4e was synthesized from 3e (1000 mg, 5.21 mmol) and TMSCl (1.23 mL, 9.7 mmol). 4e was obtained as colorless oil (1379 mg, 5.57 mmol, 98%). *H NMR (400 MHz, CDCl3) δ 0.23 (s, 9H), 2.58 (s, 3H), 2.70 (t, J = 8.5 Hz, 2H), 3.13 (t, J = 8.5 Hz, 2H), 7.00 (t, J = 7.3 Hz, 1H), 7.27 (t, J = 7.8 Hz, 2H), 7.36 (d, J = 7.3 Hz, 2H). *C NMR (101 MHz, CDCl3) δ 0.4, 27.5, 37.6, 51.9, 91.1, 122.7, 124.2, 127.9, 137.5, 154.1. IR (ATR, neat): 2947, 1683, 1628, 1494, 1445, 1300, 1248, 839, 755, 715 cm⁻¹. Anal. calcd. for C14H21NO5Si: C 67.96, H 8.56, N 5.66 found: C 67.85, H 8.51, N 5.51.

5-Benzyl-1-methyl-6-((trimethylsilyl)oxy)-1,2,3,4-tetrahydropyridine (4f). [CAS: 223714-12-3]

Using the general procedure, compound 4f was synthesized from 3f (1000 mg, 4.92 mmol) and TMSCl (1.06 mL, 8.36 mmol). 4f was obtained as colorless oil (1350 mg, 4.9 mmol, 99%). *H NMR (400 MHz, CDCl3) δ 0.24 (s, 9H), 1.52 – 1.69 (m, 2H), 1.85 (t, J = 6.5 Hz, 2H), 2.56 (s, 3H), 2.88 – 2.99 (m, 2H), 3.38 (s, 2H), 7.05 – 7.43 (m, 5H). *C NMR (101 MHz, CDCl3) δ 0.2, 18.9, 26.2, 36.6, 39.0, 51.5, 95.6, 125.4, 128.0, 128.7, 142.2, 147.8.

6-Benzyl-1-methyl-7-((trimethylsilyl)oxy)-2,3,4,5-tetrahydro-1H-azepine (4g).

Using the general procedure, compound 4g was synthesized from 3g (700 mg, 3.22 mmol) and TMSCl (0.7 mL, 5.48 mmol). 4g was obtained as colorless oil (875 mg, 3.02 mmol, 94%). *H NMR (300 MHz, CDCl3) δ 0.26 (s, 9H), 1.55 – 1.71 (m, 3H), 1.77 (p, J = 6.4 Hz, 2H), 1.89 – 2.07 (m, 2H), 2.71 (s, 3H), 3.22 (t, J = 6.1 Hz, 2H), 3.37 (s, 2H), 7.10 – 7.54 (m, 5H). *C NMR (75 MHz, CDCl3) δ 0.0, 25.0, 28.2, 36.2, 38.4, 50.6, 101.1, 125.1, 127.8, 128.5, 142.1, 149.7. IR (ATR, neat): 2924, 1659, 1451, 1353, 1247, 1116, 1047, 875, 836, 749, 698 cm⁻¹. Anal. calcd. for C17H27NOSi: C 70.53, H 9.40, N 4.84 found: C 70.48, H 9.38, N 4.76.

4-(2-Methoxyethyl)-1-methyl-5-((trimethylsilyl)oxy)-2,3-dihydro-1H-pyrrole (4h).

Using the general procedure, compound 4h was synthesized from 3h (800 mg, 5.09 mmol) and TMSCl (1.1 mL, 8.65 mmol). 4h was obtained as colorless oil (1100 mg, 4.8 mmol, 94%). *H NMR (400 MHz, CDCl3) δ 0.24 (s, 9H), 2.28 (t, J = 7.9 Hz, 4H), 2.38 (s, 3H), 2.92 (t, J = 8.3 Hz, 2H), 3.34 (s, 3H), 3.38 (t, J = 7.4 Hz, 2H). *C NMR (101 MHz, CDCl3) δ 0.4, 26.9, 28.2, 38.3, 52.8, 58.4, 72.0, 87.0, 152.0. IR (ATR, neat): 2873, 1687, 1452, 1401, 1249, 1113, 1041, 839, 754 cm⁻¹. Anal. calcd. for C19H32NO5Si: C 56.02, H 9.78, N 5.71 found: C 56.11, H 9.84, N 5.63.
4-Allyl-1-methyl-5-(((trimethylsilyl)oxy)-2,3-dihydro-1H-pyrrrole (4i).

Using the general procedure, compound 4i was synthesized from 3i (1000 mg, 7.18 mmol) and TMSCI (1.55 mL, 12.2 mmol). 4i was obtained as colorless oil (1442 mg, 6.82 mmol, 95%). \(^\text{1}^\text{H} NMR\) (400 MHz, CDCl\(_3\)) \(\delta\) 0.25 (s, 9H), 2.25 (t, \(J = 8.4 \text{ Hz}\), 2H), 2.40 (s, 3H), 2.75 (d, \(J = 6.4 \text{ Hz}\), 2H), 2.94 (t, \(J = 8.4 \text{ Hz}\), 2H), 4.94 – 5.00 (m, 1H), 5.04 (dq, \(J = 17.1, 1.7 \text{ Hz}\), 1H), 5.76 (ddd, \(J = 16.5, 10.0, 6.4 \text{ Hz}\), 1H). \(^\text{13}^\text{C} NMR\) (101 MHz, CDCl\(_3\)) \(\delta\) 0.4, 28.0, 31.0, 38.3, 52.8, 88.4, 114.4, 137.2, 151.4. IR (ATR, neat): 2952, 1694, 1500, 1434, 1401, 1248, 977, 907, 838, 752, 665 cm\(^{-1}\). \textit{Anal.} calcd. for C\(_{11}\)H\(_24\)NOSi: C 62.50, H 10.01, N 6.63 found: C 62.73, H 10.21, N 6.43.

1-Methyl-4-((trimethylsilyl)-5-(((trimethylsilyl)oxy)-2,3-dihydro-1H-pyrrrole (4j).

Using the general procedure, compound 4j was synthesized from 3j (1000 mg, 5.84 mmol) and TMSCI (1.26 mL, 9.92 mmol). 4j was obtained as colorless oil (1380 mg, 5.67 mmol, 97%). \(^\text{1}^\text{H} NMR\) (400 MHz, CDCl\(_3\)) \(\delta\) 0.06 (s, 9H), 0.24 (s, 9H), 2.30 (t, \(J = 8.5 \text{ Hz}\), 2H), 2.43 (s, 3H), 3.00 (t, \(J = 8.5 \text{ Hz}\), 2H). \(^\text{13}^\text{C} NMR\) (101 MHz, CDCl\(_3\)) \(\delta\) -0.4, 0.6, 28.5, 38.0, 54.9, 82.4, 162.3. IR (ATR, neat): 2954, 1675, 1605, 1499, 1398, 1297, 1246, 1109, 1052, 832, 750, 708 cm\(^{-1}\). \textit{HRMS} (EI) calcd (m/z) for C\(_{11}\)H\(_{26}\)NOSi: [M+H\(^+\)] 244.1547, found: 244.1545.

1-Methyl-5-(((trimethylsilyl)oxy)-4-(3-((trimethylsilyl)prop-2-yn-1-yl)-2,3-dihydro-1H-pyrrrole (4k).

Using the general procedure, compound 4k was synthesized from 3k (1000 mg, 7.29 mmol) and TMSCI (3.24 mL, 25.5 mmol). 4k was obtained as colorless oil (1922 mg, 6.83 mmol, 94%). \(^\text{1}^\text{H} NMR\) (500 MHz, CDCl\(_3\)) \(\delta\) 0.11 (s, 9H), 0.23 (s, 9H), 2.34 (d, \(J = 8.3 \text{ Hz}\), 1H), 2.37 (s, 3H), 2.93 (s, 2H), 2.95 (d, \(J = 8.3 \text{ Hz}\), 1H). \(^\text{13}^\text{C} NMR\) (126 MHz, CDCl\(_3\)) \(\delta\) 0.1, 0.4, 17.8, 27.7, 38.0, 52.5, 83.6, 85.0, 105.5, 151.7. IR (ATR, neat): 2956, 2175, 1920, 1689, 1500, 1403, 1247, 163, 1033, 835, 757, 696 cm\(^{-1}\). \textit{Anal.} calcd. for C\(_{16}\)H\(_{35}\)NOSi: C 59.73, H 9.67, N 4.97 found: C 59.43, H 9.53, N 4.77.

3-Benzyl-2-(((trimethylsilyl)oxy)-1,4-dihydroquinoline (4l).

Using the general procedure, compound 4l was synthesized from 3l (500 mg, 1.99 mmol) and TMSCI (0.43 mL, 3.38 mmol). 4l was obtained as colorless oil (650 mg, 1.98 mmol, 99%). \(^\text{1}^\text{H} NMR\) (400 MHz, CDCl\(_3\)) \(\delta\) 0.27 (s, 9H), 3.18 (s, 3H), 3.34 (s, 2H), 3.47 (s, 2H), 6.77 (d, \(J = 8.1 \text{ Hz}\), 1H), 6.84 (dd, \(J = 7.4, 1.0 \text{ Hz}\), 1H), 6.93 (d, \(J = 6.5 \text{ Hz}\), 1H), 7.01 – 7.36 (m, 7H). \(^\text{13}^\text{C} NMR\) (101 MHz, CDCl\(_3\)) \(\delta\) 0.4, 31.1, 33.0, 36.6, 88.1, 113.3, 120.5, 123.6, 125.9, 126.5, 128.2, 128.4, 128.7, 140.8, 142.3, 143.5. IR (ATR, neat): 2954, 1682, 1600, 1493, 1361, 1329, 1263, 1122, 1087, 839, 747, 698 cm\(^{-1}\). \textit{Anal.} calcd. for C\(_{20}\)H\(_{26}\)NOSi: C 74.25, H 7.79, N 4.33 found: C 74.13, H 7.98, N 4.44.

General procedures for \(\alpha\)-trifluoromethylation of KSAs.

**General procedure 1, TMSNTf\(_2\)-catalyzed:** In a flame-dried 10 mL Schlenk flask equipped with rubber septum and magnetic stirring bar, selected trimethylsilyl ketene amide (1.3 mmol) was weighed out under argon. The trimethyl silyl ketene amide was dissolved by addition of 1 mL anhydrous DCM and cooled to -78 °C (dry ice/acetone bath). Solution of TMSNTf\(_2\) in DCM (0.32, 32 \(\mu\)L, 0.01 mmol,
0.01 equiv) was added via a microsyringe at once. To the resulting well-stirred solution was added solid 1-trifluoromethyl-1,3-dihydro-3,3-dimethyl-1,2-benziodoxole 2a (331 mg, 1 mmol, 1 equiv). The mixture was allowed to reach rt overnight (19 h) with stirring. The reaction mixture was directly subjected to chromatographic purification.

**General procedure 2, one-pot procedure:** A flame-dried 25 mL Schlenk flask equipped with rubber septum and magnetic stirring bar was charged subsequently with diisopropylamine (0.2 mL, 1.4 mmol, 1.4 equiv) and 2 ml of dry THF under argon flow. The solution was cooled to -18 °C with an ice/salt bath and a solution of n-BuLi (1.6 M in THF, 0.93 mL, 1.5 mmol, 1.5 equiv) was added dropwise. The formed LDA was stirred for 15 minutes, then cooled to -78 °C and the selected lactam (3a-I) (1.30 mmol, 1.30 equiv) in 1 mL of THF was added dropwise via syringe. Lithiation was proceeded for 2 hours at -78 °C, then TMSCl (0.28 mL, 2.2 mmol, 2.2 equiv) was added. The mixture was allowed to reach rt overnight (17 h) with stirring. The mixture was again cooled to -78 °C and reagent 2a (333 mg, 1.0 mmol, 1.0 equiv) and TMSNTf₂ (0.15 M in DCM, 0.067 mL, 0.01 mmol, 0.01 equiv) were added and the mixture was stirred for another 19 hours while warming to rt. To the reaction mixture were then added water (10 mL) and EtOAc (10 mL), the aqueous phase was separated and extracted with EtOAc (3×15 mL). The combined organic layers were washed with brine, dried over MgSO₄ and concentrated under vacuum. The crude product was purified by column chromatography (Hexane/EtOAc, 3:1).

**General procedure 3, non-catalyzed:** In a flame-dried 10 mL Schlenk flask equipped with rubber septum and magnetic stirring bar, selected trimethylsilyl ketene amide (4a-I) (1.3 mmol, 1.3 equiv) was weighed out under argon. The trimethyl silyl ketene amide was dissolved by addition of 1 mL anhydrous DCM and cooled to -78 °C (dry ice/acetone bath). To the resulting well-stirred solution was added solid 1-trifluoromethyl-1,3-dihydro-3,3-dimethyl-1,2-benziodoxole 2a (331 mg, 1 mmol, 1 equiv). The mixture was allowed to reach rt overnight (19 h) with stirring. The reaction mixture was directly subjected to chromatographic purification.

**3-Benzyl-1-methyl-3-(trifluoromethyl)pyrrolidin-2-one (8a).**

Using **general procedure 1**, compound 8a was synthesized from 4a (340 mg, 1.30 mmol) and 2a (330 mg, 1.00 mmol). 8a was obtained as yellow oil (242 mg, 0.94 mmol, 94%). **General procedure 2:** 82% yield. **General procedure 3:** 67% yield. ¹H NMR (300 MHz, CDCl₃) δ 1.83 – 2.02 (m, 2H), 2.03 – 2.20 (m, 1H), 2.51 (s, 3H), 2.62 (d, J = 13.2 Hz, 1H), 2.80 – 2.90 (m, 1H), 3.31 (d, J = 13.2 Hz, 1H), 6.99 – 7.05 (m, 2H), 7.07 – 7.16 (m, 3H). ¹³C NMR (75 MHz, CDCl₃) δ 21.2 (d, J = 1.6 Hz), 28.0, 34.7 (q, J = 2.4 Hz), 43.8, 52.4 (q, J = 24.9 Hz), 124.49 (q, J = 282.0 Hz), 125.6, 126.6, 128.3, 132.6, 167.5. ¹⁹F NMR (282 MHz, CDCl₃) δ – 73.88. IR (ATR, neat): 2892, 1691, 1496, 1455, 1404, 1315, 1261, 1162, 1132, 1090, 1064, 1027, 926, 768, 702, 685 cm⁻¹. HRMS (EI) calcd (m/z) for C₁₃H₁₅NOF₃: [M⁺] 257.1022, found: 257.1024.

**1,3-Dibenzyl-3-(trifluoromethyl)pyrrolidin-2-one (8b).**

Using **general procedure 1**, compound 8b was synthesized from 4b (439 mg, 1.30 mmol) and 2a (330 mg, 1.00 mmol). 8b was obtained as colorless oil (293 mg, 0.88 mmol, 88%). **General procedure 2:** 69% yield. ¹H NMR (400 MHz, CDCl₃) δ 2.04 – 2.19 (m, 1H), 2.19 – 2.38 (m, 3H), 2.85 (d, J = 13.2 Hz, 1H), 2.93 – 3.10 (m, 1H), 3.59 (d, J = 13.2 Hz, 1H), 4.26 (d, J = 14.8 Hz, 1H), 4.47 (d, J = 14.7 Hz, 1H), 6.91 – 7.10 (m, 2H), 7.19 – 7.33 (m, 12H). ¹³C NMR (101 MHz, CDCl₃) δ 22.8 (d, J = 1.9 Hz), 36.2 (q, J = 2.4 Hz), 43.1, 47.0, 54.6 (q, J = 24.6 Hz), 126.5 (q, J = 282.4 Hz), 127.4, 127.7, 128.0, 128.5, 128.6, 130.5, 134.4, 135.4, 169.2 (d, J = 1.8 Hz). ¹⁹F NMR (376 MHz, CDCl₃) δ – 73.8. IR (ATR, neat): 3031, 2933, 1695, 1495, 1454, 1268, 1190, 1071, 771, 698, 618 cm⁻¹. HRMS (ESI) calcd (m/z) for C₁₈H₁₉NOF₃: [M+H⁺] 334.1413, found: 334.1414.
3-Benzyl-1-((benzyloxy)methyl)-3-(trifluoromethyl)pyrrolidin-2-one (8c).

Using general procedure 1, compound 8c was synthesized from 4c (478 mg, 1.30 mmol) and 2a (330 mg, 1.00 mmol). 8c was obtained as colorless oil (334 mg, 0.92 mmol, 92%). General procedure 2: 84% yield. 1H NMR (400 MHz, CDCl3) δ 2.12 – 2.26 (m, 1H), 2.28 – 2.41 (m, 1H), 2.64 (td, J = 9.3, 5.2 Hz, 1H), 2.88 (d, J = 13.4 Hz, 1H), 3.31 (td, J = 9.3, 5.4 Hz, 1H), 3.55 (d, J = 13.4 Hz, 1H), 4.27 (d, J = 11.6 Hz, 1H), 4.38 (d, J = 11.6 Hz, 1H), 4.62 (d, J = 10.7 Hz, 1H), 4.84 (d, J = 10.7 Hz, 1H), 7.25 – 7.39 (m, 10H). 13C NMR (101 MHz, CDCl3) δ 22.2 – 23.6 (m), 36.1 (q, J = 2.2 Hz), 42.5, 55.1 (q, J = 24.6 Hz), 70.4, 72.6, 126.5 (q, J = 283.8 Hz), 127.6, 127.9, 128.0, 128.4, 128.6, 130.5, 134.3, 137.3, 170.3 (d, J = 1.6 Hz). 19F NMR (376 MHz, CDCl3) δ –73.65. IR (ATR, neat): 3031, 2936, 1705, 1455, 1275, 1161, 1070, 777, 731, 698 cm⁻¹. HRMS (ESI) calcld (m/z) for C20H21NO3F: [M+H⁺] 364.1519, found: 364.1522.

t-Butyl 3-benzyl-2-oxo-3-(trifluoromethyl)pyrrolidine-1-carboxylate (8d).

Using general procedure 1, compound 8d was synthesized from 4d (452 mg, 1.30 mmol) and 2a (330 mg, 1.00 mmol). 8d was obtained as a white solid (295 mg, 0.86 mmol, 86%). General procedure 2: 71% yield. M.p. 68.7-70.1 °C. 1H NMR (300 MHz, CDCl3) δ 1.14 (s, 9H), 1.97 – 2.14 (m, 1H), 2.18 – 2.34 (m, 1H), 2.56 – 2.72 (m, 1H), 2.88 (d, J = 13.4 Hz, 1H), 3.33 – 3.59 (m, 2H), 7.21 – 7.34 (m, 5H). 13C NMR (75 MHz, CDCl3) δ 22.0 (q, J = 1.7 Hz), 27.9, 37.0 (q, J = 2.4 Hz), 42.8, 56.0 (q, J = 25.0 Hz), 83.5, 125.8 (q, J = 282.5 Hz), 127.8, 128.7, 130.2, 133.8, 149.4, 169.0 (q, J = 2.25 Hz). 19F NMR (282 MHz, CDCl3) δ -73.47. IR (ATR, neat): 2979, 1782, 1742, 1723, 1369, 1279, 1190, 1117, 934, 777, 702 cm⁻¹. HRMS (ESI) calcld (m/z) for C17H21NO3F: [M+H⁺] 344.1468, found: 344.1468.

1-Methyl-3-phenyl-3-(trifluoromethyl)pyrrolidin-2-one (8e).

Using general procedure 1, compound 8e was synthesized from 4e (322 mg, 1.30 mmol) and 2a (330 mg, 1.00 mmol). 8e was obtained as a yellow solid (221 mg, 0.91 mmol, 91%). General procedure 2: 61% yield. General procedure 3: 35% yield. 1H NMR (300 MHz, CDCl3) δ 2.16 – 2.59 (m, 1H), 2.57 – 2.74 (m, 1H), 2.84 (s, 3H), 3.07 – 3.21 (m, 1H), 3.27 (td, J = 9.2, 3.4 Hz, 1H), 7.15 – 7.39 (m, 3H), 7.49 – 7.67 (m, 2H). 13C NMR (50 MHz, CDCl3) δ 28.5 (q, J = 1.5 Hz), 30.1, 45.5, 56.7 (q, J = 26.0 Hz), 125.4 (q, J = 280.0 Hz), 128.1 (d, J = 1.0 Hz), 128.7, 128.74, 133.34 (q, J = 1.5 Hz), 168.86 (q, J = 2.0 Hz). 19F NMR (282 MHz, CDCl3) δ -71.20. IR (ATR, neat): 2886, 1695, 1499, 1449, 1434, 1405, 1307, 1260, 1219, 1145, 1070, 1035, 1014, 976, 937, 905, 764, 700, 665 cm⁻¹. HRMS (ESI) calcld (m/z) for C17H14FNO3: [M+H⁺] 244.0944, found: 244.0944.

3-Benzyl-1-methyl-3-(trifluoromethyl)piperidin-2-one (8f).

Using general procedure 1, compound 8f was synthesized from 4f (358 mg, 1.30 mmol) and 2a (330 mg, 1.00 mmol). 8f was obtained as colorless oil (264 mg, 0.97 mmol, 97%). General procedure 2: 72% yield. General procedure 3: 81% yield. 1H NMR (300 MHz, CDCl3) δ 1.06 – 1.25 (m, 1H), 1.55 – 1.74 (m, 1H), 1.75 – 1.90 (m, 2H), 1.90 – 2.07 (m, 1H), 2.68 (d, J = 13.2 Hz, 1H), 2.84 – 2.92 (m, 1H), 2.88 (s, 3H), 3.06 – 3.25 (m, 1H), 3.62 (d, J = 13.2 Hz, 1H), 7.05 – 7.18 (m, 2H), 7.15 – 7.27 (m, 3H). 13C NMR (75 MHz, CDCl3) δ 19.3, 26.4 (q, J = 2.0 Hz), 35.8, 38.9 (q, J = 2.5 Hz), 49.9, 52.0 (q, J = 22.3 Hz), 126.8 (q, J = 283.5 Hz), 127.2, 128.4, 130.5, 135.6, 165.8 (1, J = 1.5 Hz). 19F NMR (282 MHz, CDCl3) δ -71.14. IR (ATR, neat): 2941, 1644, 1497, 1455, 1402, 1364, 1335, 1258, 1194, 1153, 1132, 1081, 1029, 974, 766, 741, 702, 668 cm⁻¹. HRMS (EI) calcld (m/z) for C14H16NO3F: [M⁺] 271.1179, found: 271.1181.
3-Benzyl-1-methyl-3-(trifluoromethyl)azepan-2-one (8g).

Using general procedure 1, compound 8g was synthesized from 4g (376 mg, 1.30 mmol) and 2a (330 mg, 1.00 mmol). 3g was obtained as colorless oil (279 mg, 0.978 mmol, 98%). General procedure 2: 65% yield. General procedure 3: 72% yield.

\[ ^1H \text{NMR} \ (300 \text{ MHz, CDCl}_3) \delta 0.69 – 0.86 \ (m, 1H), 1.30 – 1.50 \ (m, 3H), 1.80 \ (dd, J = 7.5, 2.9 Hz, 2H), 2.63 \ (d, J = 13.1 Hz, 1H), 2.83 \ (dt, J = 15.3, 4.8 Hz, 1H), 2.89 \ (s, 3H), 3.34 – 3.58 \ (m, 1H), 3.74 \ (d, J = 13.1 Hz, 1H), 7.14 \ (d, J = 3.1 Hz, 5H). \]

\[ ^13C \text{NMR} \ (50 \text{ MHz, CDCl}_3) \delta 19.2, 24.1, 25.9 \ (q, J = 1.5 Hz), 29.8, 38.3, 40.4 \ (q, J = 2.5 Hz), 46.5, 57.5 \ (q, J = 24.5 Hz), 127.2 \ (q, J = 283.5 Hz), 127.0, 128.2, 130.9, 135.9, 167.8. \]

\[ ^19F \text{NMR} \ (282 \text{ MHz, CDCl}_3) \delta –71.23. \text{IR} \ (\text{ATR, neat}): 2939, 1639, 1495, 1471, 1395, 1370, 1321, 1252, 1210, 1194, 1194, 1108, 1088, 1058, 1030, 1005, 760, 742, 703, 656 \text{ cm}^{-1}. \text{HRMS} \ (\text{EI}) \text{calcd (m/z) for C}_{15}H_{16}NOF_3: [M+H]^+ 286.1413, \text{found: 286.1418}. \]

3-(2-Methoxyethyl)-1-methyl-3-(trifluoromethyl)pyrrolidin-2-one (8h).

Using general procedure 1, compound 8h was synthesized from 4h (298 mg, 1.30 mmol) and 2a (330 mg, 1.00 mmol). 8h was obtained as colorless oil (202 mg, 0.897 mmol, 90%). General procedure 2: 82% yield. \[ ^1H \text{NMR} \ (400 \text{ MHz, CDCl}_3) \delta 1.94 – 2.05 \ (m, 1H), 2.15 – 2.27 \ (m, 1H), 2.31 \ (t, J = 7.1 Hz, 2H), 2.88 \ (s, 3H), 3.25 – 3.31 \ (m, 4H), 3.35 \ (t, J = 7.6 Hz, 1H), 3.31 – 3.55 \ (m, 4H). \]

\[ ^13C \text{NMR} \ (101 \text{ MHz, CDCl}_3) \delta 24.4 \ (q, J = 1.01 Hz), 30.3, 30.6, 46.3, 52.1 \ (q, J = 25.3 Hz), 58.8, 68.6, 126.8 \ (q, J = 282.3 Hz), 169.63 \ (q, J = 2.02 Hz). \]

\[ ^19F \text{NMR} \ (376 \text{ MHz, CDCl}_3) \delta –73.82. \text{IR} \ (\text{ATR, neat}): 2891, 1737, 1698, 1437, 1373, 1240, 1183, 1111, 1044, 684 \text{ cm}^{-1}. \text{HRMS} \ (\text{ESI}) \text{calcd (m/z) for C}_{15}H_{16}NOF_3: [M+H]^+ 226.1049, \text{found: 226.1053}. \]

3-Allyl-1-methyl-3-(trifluoromethyl)pyrrolidin-2-one (8i).

Using general procedure 1, compound 8i was synthesized from 4i (275 mg, 1.30 mmol) and 2a (330 mg, 1.00 mmol). 8i was obtained as colorless oil (177.6 mg, 0.857 mmol, 86%). General procedure 2: 77% yield. \[ ^1H \text{NMR} \ (300 \text{ MHz, CDCl}_3) \delta 2.02 – 2.19 \ (m, 1H), 2.19 – 2.47 \ (m, 2H), 2.72 \ (dd, J = 13.7, 6.1 Hz, 1H), 2.85 \ (s, 3H), 3.21 \ (td, J = 9.4, 4.7 Hz, 1H), 3.26 – 3.42 \ (m, 1H), 5.05 – 5.27 \ (m, 2H), 5.50 – 5.72 \ (m, 1H). \]

\[ ^13C \text{NMR} \ (75 \text{ MHz, CDCl}_3) \delta 23.3 \ (q, J = 1.8 Hz), 30.0, 35.4 \ (q, J = 2.3 Hz), 46.1, 52.8 \ (q, J = 25.0 Hz), 120.6, 126.5 \ (q, J = 282.3 Hz), 131.2, 169.2 \ (q, J = 1.9 Hz). \]

\[ ^19F \text{NMR} \ (282 \text{ MHz, CDCl}_3) \delta –73.54. \text{IR} \ (\text{ATR, neat}): 2924, 1695, 1643, 1504, 1441, 1406, 1341, 1262, 1169, 1129, 1097, 1070, 1029, 998, 925, 706, 666 \text{ cm}^{-1}. \text{HRMS} \ (\text{ESI}) \text{calcd (m/z) for C}_{16}H_{18}NOF_3: [M^+] 227.0886, \text{found: 227.0870}. \]

1-Methyl-3-(trifluoromethyl)-3-(trimethylsilyl)pyrrolidin-2-one (8j).

Using general procedure 1, compound 8j was synthesized from 4j (317 mg, 1.30 mmol) and 2a (330 mg, 1.00 mmol). 8j was obtained as colorless oil (223 mg, 0.932 mmol, 93%). General procedure 2: 83% yield. \[ ^1H \text{NMR} \ (500 \text{ MHz, CDCl}_3) \delta 0.19 \ (s, 9H), 2.11 – 2.22 \ (m, 1H), 2.30 – 2.42 \ (m, 1H), 2.86 \ (s, 3H), 3.20 – 3.31 \ (m, 1H), 3.39 – 3.50 \ (m, 1H). \]

\[ ^13C \text{NMR} \ (126 \text{ MHz, CDCl}_3) \delta -3.1, 22.2 \ (q, J = 3.1 Hz), 29.9, 46.2 \ (q, J = 26.3 Hz), 47.1, 127.8 \ (q, J = 279.3 Hz), 170.2 \ (q, J = 4.0 Hz). \]

\[ ^19F \text{NMR} \ (471 \text{ MHz, CDCl}_3) \delta –62.96. \text{IR} \ (\text{ATR, neat}): 2958, 1678, 1506, 1402, 1304, 1250, 1161, 1123, 1080, 843, 700 \text{ cm}^{-1}. \text{HRMS} \ (\text{ESI}) \text{calcd (m/z) for C}_{16}H_{21}NOF_3Si: [M+H]^+ 240.1026, \text{found: 240.1028}. \]
1-Methyl-3-(trifluoromethyl)-3-(3-(trimethylsilyl)prop-2-yn-1-yl)pyrrolidin-2-one (8k).

Using general procedure 1, compound 8k was synthesized from 4k (366 mg, 1.30 mmol) and 2a (330 mg, 1.00 mmol). 8k was obtained as colorless oil (202.5 mg, 0.73 mmol, 73%). General procedure 2: 54% yield. 1H NMR (300 MHz, CDCl3) δ 0.11 (s, 9H), 2.38 (dd, J = 7.9, 6.5 Hz, 2H), 2.59 (d, J = 16.7 Hz, 1H), 2.89 (s, 2H), 2.93 (d, J = 16.9 Hz, 1H), 3.38 (t, J = 7.2 Hz, 2H). 13C NMR (75 MHz, CDCl3) δ 0.0, 23.5 (q, J = 3.1 Hz), 24.1 (q, J = 1.6 Hz), 30.2, 46.5, 52.7 (q, J = 25.5 Hz), 88.3, 100.0, 125.9 (q, J = 282.3 Hz), 168.5 (q, J = 1.8 Hz). 19F NMR (282 MHz, CDCl3) δ –74.01. IR (ATR, neat): 2960, 2182, 1703, 1504, 1455, 1434, 1406, 1346, 1317, 1249, 1184, 1162, 1137, 1103, 1037, 839, 759, 688, 640 cm⁻¹. HRMS (ESI) calcld (m/z) for C12H18NOSiF3: [M⁺] 277.1105, found: 277.1109.

3-Benzyl-1-methyl-3-(trifluoromethyl)-3,4-dihydroquinolin-2(1H)-one (8l).

Using general procedure 1, compound 8l was synthesized from 4l (421 mg, 1.30 mmol) and 2a (330 mg, 1.00 mmol). 8l was obtained as a white solid (277 mg, 0.867 mmol, 87%). General procedure 2: 74% yield. M.p. 71.5–72.5 °C. 1H NMR (400 MHz, CDCl3) δ 2.92 – 3.11 (m, 2H), 3.23 (d, J = 16.2 Hz, 1H), 3.31 (s, 1H), 3.37 (d, J = 13.4 Hz, 3H), 6.91 (d, J = 8.1 Hz, 1H), 7.10 (d, J = 7.4 Hz, 3H), 7.12 – 7.35 (m, 5H). 13C NMR (101 MHz, CDCl3) δ 30.1, 30.2 (q, J = 3.0 Hz), 51.9 (q, J = 23.2 Hz), 114.3, 121.8, 126.3 (q, J = 284.4 Hz), 123.5, 127.4, 127.9, 128.1, 128.4, 130.5, 134.3, 138.9, 165.8. 19F NMR (376 MHz, CDCl3) δ –70.55. IR (ATR, neat): 2963, 1736, 1669, 1602, 1466, 1421, 1373, 1238, 1152, 1077, 1041, 965, 901, 751, 735, 698 cm⁻¹. HRMS (ESI) calcld (m/z) for C18H17NO3F: [M⁺] 320.1257, found: 320.1258.

General procedure for α-perfluoroalkylation of KSA 4a.

In a flame-dried 10 mL Schlenk flask equipped with rubber septum and magnetic stirring bar, ketene silyl amide (KSA) 4a (282 mg, 0.78 mmol, 1.3 equiv) was weighed out under Ar. KSA 4a was dissolved by addition of 1 mL anhydrous DCM and the resulting mixture was cooled to –78 °C (dry ice/acetone bath). Solution of TMSNTf₂ in DCM (0.2 M, 6.0 μmol, 0.01 equiv) was added via a microsyringe at once followed by addition of the selected reagent 2b–k (0.6 mmol, 1 equiv). The mixture was allowed to reach rt overnight (19 h) with stirring. After evaporation of the solvent at reduced pressure the crude product was purified by column chromatography (Hexane/EtOAc, 3:1).

3-Benzyl-1-methyl-3-(1,1,2,2-tetrafluoro-2-(phenylthio)ethyl)pyrrolidin-2-one (9ab).

Using the general procedure, compound 9ab was synthesized from 4a (204 mg, 0.78 mmol) and 2b (282 mg, 0.66 mmol). 9ab was obtained as a white solid (217 mg, 0.55 mmol, 91%). M.p. = 70.7–72.5 °C. 1H NMR (400 MHz, CDCl3) δ 1.95 – 2.14 (m, 2H), 2.37 – 2.52 (m, 1H), 2.64 (s, 3H), 2.88 – 3.03 (m, 2H), 3.56 (d, J = 13.1 Hz, 1H), 7.18 – 7.27 (m, 2H), 7.24 – 7.34 (m, 4H), 7.39 – 7.46 (m, 2H), 7.46 – 7.53 (m, 1H), 7.70 (d, J = 7.2 Hz, 2H). 13C NMR (101 MHz, CDCl3) δ 23.0 (p, J = 3.4 Hz), 29.9, 37.0 (p, J = 3.3 Hz), 45.7, 54.3 (t, J = 20.6 Hz), 118.05 (tt, J = 260.6, 32.3 Hz), 124.1, 126.6 (tt, J = 290.9, 40.4 Hz), 127.4, 128.3, 129.2, 130.6, 134.8, 138.7, 138.4, 170.1. 19F NMR (376 MHz, CDCl3) δ –111.19 (ddd, JCF = 275.9, 6.2, 2.3 Hz, 1F), –109.04 (ddd, JCF = 276.1, 6.1, 2.2 Hz, 1F), –81.45 (d, JCF = 220.5 Hz, 1F), –80.63 (dd, JCF = 220.6, 5.6 Hz, 1F). IR (ATR, neat): 2899, 1690, 1507, 1455, 1406, 1346, 1100, 1087, 946, 749, 729, 691 cm⁻¹. HRMS (MALDI) calcld (m/z) for C20H19NOSF3Na: [M+Na⁺] 420.1016, found: 420.1018.
3-Benzyl-1-methyl-3-(1,1,2,2-tetrafluoro-2-(4-methoxyphenoxy)ethyl)pyrrolidin-2-one (9ac).

Using the general procedure, compound 9ac was synthesized from 4a (204 mg, 0.78 mmol) and 2c (291 mg, 0.6 mmol). 9ac was obtained as colorless oil (218 mg, 0.53 mmol, 88%). $^1$H NMR (300 MHz, CDCl$_3$) δ 1.94 – 2.11 (m, 2H), 2.38 – 2.53 (m, 1H), 2.57 (s, 3H), 2.81 – 3.08 (m, 2H), 3.53 (d, J = 13.2 Hz, 1H), 3.72 (s, 3H), 6.74 – 6.84 (m, 2H), 7.02 – 7.10 (m, 2H), 7.11 – 7.24 (m, 5H). $^{13}$C NMR (75 MHz, CDCl$_3$) δ 23.1, 29.9, 37.0, 45.9, 53.9 (t, J = 20.2 Hz), 55.6, 114.6, 116.4 (tt, J = 260.6, 34.2 Hz), 118.1 (tt, J = 276.9, 34.2 Hz), 123.0, 127.3, 128.3, 130.6, 135.1, 142.2 (t, J = 1.9 Hz), 158.0, 170.2. $^{19}$F NMR (282 MHz, CDCl$_3$) δ -118.52 (dd, J$_{CF}$ = 271.6, 4.9 Hz, 1F), -116.44 (dd, J$_{CF}$ = 271.6, 5.8 Hz, 1F), -80.85 (dd, J$_{CF}$ = 143.9, 5.7 Hz, 1F), -79.97 (dd, J$_{CF}$ = 143.9, 5.2 Hz, 1F). IR (ATR, neat): 2937, 1694, 1505, 1455, 1278, 1173, 1055, 1029, 1018, 876, 728, 702, 645 cm$^{-1}$. HRMS (MALDI) calcld (m/z) for C$_{21}$H$_{21}$NO$_3$F$_3$Na: [M+Na$^+$] 434.1350, found: 434.1353.

3-Benzyl-3-(2-(4-bromophenoxy)-1,1,2,2-tetrafluoroethyl)-1-methylpyrrolidin-2-one (9ad).

Using the general procedure, compound 9ad was synthesized from 4a (204 mg, 0.78 mmol) and 2d (320 mg, 0.6 mmol). 9ad was obtained as colorless oil (223 mg, 0.485 mmol, 81%). $^1$H NMR (400 MHz, CDCl$_3$) δ 2.07 – 2.18 (m, 2H), 2.48 – 2.62 (m, 1H), 2.68 (s, 3H), 2.98 (s, 1H), 3.04 (dd, J = 9.0, 6.1 Hz, 1H), 3.63 (d, J = 13.1 Hz, 1H), 7.11 – 7.18 (m, 2H), 7.22 – 7.34 (m, 5H), 7.49 – 7.57 (m, 2H). $^{13}$C NMR (101 MHz, CDCl$_3$) δ 23.03 (d, J = 3.03 Hz), 29.9, 36.9 (p, J = 2.02 Hz), 45.8, 53.8 (t, J = 20.2 Hz), 116.2 (tt, J = 260.9, 34.1 Hz), 117.9 (tt, J = 280.8, 29.3 Hz), 119.8, 123.5, 127.4, 128.3, 130.6, 132.8, 134.9, 147.9 (t, J = 2.02 Hz), 169.9. $^{19}$F NMR (376 MHz, CDCl$_3$) δ -118.28 (dd, J$_{CF}$ = 272.5, 4.7 Hz, 1F), -116.36 (dd, J$_{CF}$ = 272.6, 5.0 Hz, 1F), -80.87 (dd, J$_{CF}$ = 143.0, 5.0 Hz, 1F), -79.92 (dd, J$_{CF}$ = 143.3, 4.3 Hz, 1F). IR (ATR, neat): 2887, 1694, 1483, 1455, 1403, 1327, 1183, 1067, 1056, 1011, 877, 782, 729, 702 cm$^{-1}$. HRMS (MALDI) calcld (m/z) for C$_{26}$H$_{18}$NO$_3$F$_3$NaBr: [M+Na$^+$] 482.0349, found: 482.0349.

3-(2-(1,3-Dioxolan-2-yl)phenoxy)-1,1,2,2-tetrafluoroethyl)-3-benzyl-1-methylpyrrolidin-2-one (9ae).

Using the general procedure, compound 9ae was synthesized from 4a (204 mg, 0.78 mmol) and 2e (316 mg, 0.6 mmol). 9ae was obtained as colorless oil (240 mg, 0.53 mmol, 88%). $^1$H NMR (300 MHz, CDCl$_3$) δ 1.86 – 2.16 (m, 2H), 2.49 (dd, J = 9.0, 5.9 Hz, 1H), 2.54 (s, 3H), 2.91 (td, J = 9.2, 3.2 Hz, 1H), 2.99 (d, J = 13.1 Hz, 1H), 3.51 (d, J = 13.1 Hz, 1H), 3.84 – 4.14 (m, 4H), 6.01 (s, 1H), 7.08 – 7.45 (m, 8H), 7.57 (dd, J = 7.9, 1.7 Hz, 1H). $^{13}$C NMR (75 MHz, CDCl$_3$) δ 23.1 (t, J = 3.0 Hz), 29.9, 36.81 – 36.93 (m), 45.9, 53.9 (d, J = 20.2 Hz), 65.4, 98.7, 116.4 (tt, J = 260.3, 34.5 Hz), 118.3 (tt, J = 277.5, 33.7 Hz), 121.6, 126.6, 127.3, 127.7, 128.3, 130.3, 130.6, 130.8, 135.1, 147.4, 170.1. $^{19}$F NMR (282 MHz, CDCl$_3$) δ -118.52 (dt, J$_{CF}$ = 271.7, 3.2 Hz, 1F), -116.26 (dt, J$_{CF}$ = 271.8, 3.2 Hz, 1F), -79.49 (bs, 2F). IR (ATR, neat): 2887, 1695, 1455, 1403, 1326, 1110, 1068, 1019, 964, 942, 755, 729, 702 cm$^{-1}$. HRMS (MALDI) calcld (m/z) for C$_{23}$H$_{23}$NO$_3$F$_3$Na: [M+Na$^+$] 476.1455, found: 476.1454.
Ethyl 4-(2-(3-benzyl-1-methyl-2-oxypyrrolidin-3-yl)-1,1,2,2-tetrafluoroethoxy)benzoate (9af).

Using the general procedure, compound 9af was synthesized from 4a (204 mg, 0.78 mmol) and 2f (316 mg, 0.6 mmol). 9af was obtained as colorless oil (210 mg, 0.46 mmol, 77%). 1H NMR (300 MHz, CDCl₃) δ 1.47 (t, J = 7.1 Hz, 3H), 2.08 – 2.29 (m, 2H), 2.52 – 2.70 (m, 1H), 2.73 (s, 3H), 2.96 – 3.28 (m, 2H), 3.69 (d, J = 13.1 Hz, 1H), 4.46 (q, J = 7.1 Hz, 2H), 7.28 – 7.38 (m, 7H), 8.11 – 8.21 (m, 2H). 13C NMR (126 MHz, CDCl₃) δ 14.3, 23.0, 29.9, 36.9, 45.8, 53.8 (t, J = 20.2 Hz), 61.2, 116.2 (tt, J = 261.1, 33.9 Hz), 118.1 (tt, J = 279.6, 34.5 Hz), 127.4, 128.3, 128.6, 130.6, 131.4, 134.9, 165.5, 170.0. 19F NMR (282 MHz, CDCl₃) δ –118.33 (dd, Jₐ₋₁ = 272.7, 4.3, 2.2 Hz, 1F), –116.27 (dd, Jₐ₋₂ = 272.7, 4.8 Hz, 1F), –80.85 (dd, Jₐ₋₃ = 143.1, 3.4 Hz, 1F), –79.77 (dd, Jₐ₋₄ = 142.9, 4.1 Hz, 1F). IR (ATR, neat): 2979, 1696, 1605, 1503, 1404, 1274, 1162, 1098, 1056, 908, 753, 729, 702 cm⁻¹. HRMS (MALDI) calcd (m/z) for C₂₃H₂₃NO₅F₄Na⁺ [M+Na⁺] 476.1455, found: 476.1456.

Methyl 4-(3-(3-benzyl-1-methyl-2-oxypyrrolidin-3-yl)-2,2,3,3-tetrafluoropropyl)benzoate (9ag).

Using the general procedure, compound 9ag was synthesized from 4a (204 mg, 0.78 mmol) and 2g (316 mg, 0.6 mmol). 9ag was obtained as colorless oil (210 mg, 0.46 mmol, 91%). 1H NMR (400 MHz, CDCl₃) δ 2.07 (q, J = 9.5 Hz, 2H), 2.47 (p, J = 9.8 Hz, 1H), 2.64 (s, 3H), 2.89 – 3.03 (m, 2H), 3.36 – 3.63 (m, 3H), 3.94 (s, 3H), 7.16 – 7.34 (m, 5H), 7.41 (d, J = 8.0 Hz, 2H), 8.03 (d, J = 8.2 Hz, 2H). 13C NMR (126 MHz, CDCl₃) δ 22.8, 29.8, 36.9, 37.5 (t, J = 23.2 Hz), 45.8, 52.1, 53.9 (t, J = 20.2 Hz), 118.0 (tt, J = 260.6, 34.3 Hz), 119.6 (tt, J = 253.5, 38.4 Hz), 127.3, 128.3, 129.5, 129.6, 130.6, 131.1, 135.0, 135.9, 166.8, 170.42 (d, J = 4.04 Hz). 19F NMR (282 MHz, CDCl₃) δ –114.61 (dd, Jₐ₋₁ = 279.4, 13.3 Hz), –112.86 (dd, Jₐ₋₂ = 279.3, 14.3 Hz), –109.11 (dd, Jₐ₋₃ = 261.5, 13.5 Hz), –107.76 (dd, Jₐ₋₄ = 261.4, 14.4 Hz). IR (ATR, neat): 2952, 1720, 1692, 1455, 1278, 1182, 1084, 1066, 1039, 907, 772, 759, 702, 646 cm⁻¹. HRMS (MALDI) calcd (m/z) for C₂₃H₂₃NO₅F₄Na⁺ [M+Na⁺] 455.1952, found: 455.1950.

3-Benzyl-1-methyl-3-(1,1,2,2-tetrafluoro-2-(1H-pyrazol-1-yl)ethyl)pyrrolidin-2-one (9ah).

Using the general procedure, compound 9ah was synthesized from 4a (204 mg, 0.78 mmol) and 2h (257 mg, 0.6 mmol). 9ah was obtained as colorless oil (175 mg, 0.49 mmol, 82%). 1H NMR (300 MHz, CDCl₃) δ 1.81 – 2.10 (m, 2H), 2.17 – 2.35 (m, 1H), 2.52 (s, 3H), 2.63 (d, J = 13.0 Hz, 1H), 2.88 (td, J = 9.3, 3.1 Hz, 1H), 3.32 (d, J = 13.0 Hz, 1H), 6.34 – 6.49 (m, 1H), 7.03 – 7.30 (m, 5H), 7.72 (d, J = 22.8 Hz, 2H). 13C NMR (75 MHz, CDCl₃) δ 22.6 (p, J = 3.2 Hz), 29.8, 35.2 – 38.0 (m), 45.7, 54.0 (t, J = 20.2 Hz), 108.4, 114.5 (tt, J = 268.5, 35.3 Hz), 117.9 (tt, J = 261.0, 38.2 Hz), 127.4, 128.3, 129.5, 130.5, 134.6, 142.6, 169.0 – 170.3 (m). 19F NMR (282 MHz, CDCl₃) δ –116.69 (dt, Jₐ₋₁ = 276.2, 5.5 Hz, 1F), –114.15 (dt, Jₐ₋₂ = 275.9, 4.0 Hz, 1F), –93.74 (dt, Jₐ₋₃ = 219.3, 4.0 Hz, 1F), –91.57 (dt, Jₐ₋₄ = 219.2, 5.0 Hz, 1F). IR (ATR, neat): 2887, 1693, 1421, 1392, 1340, 1160, 1122, 1088, 918, 758, 730, 702, 633 cm⁻¹. HRMS (MALDI) calcd (m/z) for C₁₇H₁₇N₂OF₂: [M+NH₄⁺] 373.1646, found: 373.1646.
3-Benzyl-1-methyl-3-(1,1,2,2-tetrafluoro-2-((4-methyl-2-oxo-2H-chromen-7-yl)oxy)ethyl)-pyrrolidin-2-one (9ai).

Using the general procedure, compound 9ai was synthesized from 4a (204 mg, 0.78 mmol) and 2i (322 mg, 0.6 mmol). 9ai was obtained as colorless oil (220 mg, 0.47 mmol, 79%). 1H NMR (300 MHz, CDCl3) δ 1.88 – 2.19 (m, 2H), 2.37 (s, 3H), 2.40 – 2.54 (m, 1H), 2.59 (s, 3H), 2.90 (d, J = 13.1 Hz, 1H), 2.94 – 3.05 (m, 1H), 3.54 (d, J = 13.1 Hz, 1H), 6.16 – 6.27 (m, 1H), 7.08 – 7.27 (m, 7H), 7.50 – 7.62 (m, 1H). 13C NMR (75 MHz, CDCl3) δ 18.7, 23.0, 29.9, 36.9, 45.8, 53.9 (t, J = 20.2 Hz), 110.0, 114.9, 116.2 (tt, J = 260.2, 33.7 Hz), 117.5, 118.1 (tt, J = 279.0, 34.5 Hz), 118.3, 125.8, 127.5, 128.4, 130.6, 134.8, 151.2, 151.7, 154.1, 160.1, 169.9. 19F NMR (282 MHz, CDCl3) δ −118.1 (dt, JCF = 273.2, 3.2 Hz, 1F), −116.1 (dd, JCF = 237.5, 2.8, 0.9 Hz, 1F), −80.98 (ddd, JCF = 142.6, 4.7, 2.4 Hz), −79.90 (ddd, JCF = 143.1, 5.1, 2.8 Hz, 1F). IR (ATR, neat): 2933, 1730, 1694, 1627, 1613, 1496, 1404, 1223, 1177, 1110, 1068, 1055, 1016, 979, 869, 748, 702 cm⁻¹. HRMS (MALDI) calcd (m/z) for C22H29NO3F4Na: [M+Na⁺] 486.1299, found: 486.1298.

3-Benzyl-1-methyl-3-(1,1,2,2-tetrafluoro-2-((4-methyl-2-oxo-2H-chromen-7-yl)thio)ethyl)-pyrrolidin-2-one (9aj).

Using the general procedure, compound 9aj was synthesized from 4a (204 mg, 0.78 mmol) and 2j (331 mg, 0.6 mmol). 9aj was obtained as colorless oil (220 mg, 0.46 mmol, 76%). 1H NMR (300 MHz, CDCl3) δ 1.99 – 2.25 (m, 2H), 2.35 – 2.51 (m, 1H), 2.53 (s, 3H), 2.69 (s, 3H), 2.97 (d, J = 13.1 Hz, 1H), 2.98 – 3.11 (m, 1H), 3.60 (d, J = 13.1 Hz, 1H), 6.40 – 6.49 (m, 1H), 7.25 – 7.37 (m, 6H), 7.63 – 7.73 (m, 2H). 13C NMR (126 MHz, CDCl3) δ 18.6, 22.9, 29.8, 37.0, 45.7, 54.2 (t, J = 20.2 Hz), 116.5, 117.9 (tt, J = 262.1, 32.7 Hz), 121.5, 124.99, 125.01, 125.6 (tt, J = 292.3, 41.6 Hz), 127.4, 128.3, 128.5, 130.5, 132.2, 134.6, 151.5, 153.1, 159.9, 169.88 (d, J = 2.5 Hz). 19F NMR (282 MHz, CDCl3) δ −110.80 (ddd, JCF = 276.5, 5.9, 2.7 Hz), −108.6 (ddd, JCF = 276.5, 5.9, 2.7 Hz), −80.9 (ddd, JCF = 220.1, 5.6, 2.3 Hz, 1F), −79.87 (ddd, JCF = 220.3, 5.7, 2.4 Hz). IR (ATR, neat): 2886, 2247, 1722, 1690, 1624, 1602, 1495, 1397, 1385, 1173, 1075, 990, 909, 726, 702, 672 cm⁻¹. HRMS (MALDI) calcd (m/z) for C22H29NO3F4Na: [M+Na⁺] 502.1070, found: 502.1069.

3-Benzyl-1-methyl-3-(perfluoroethyl)pyrrolidin-2-one (9ak).

Using the general procedure, compound 9ak was synthesized from 4a (204 mg, 0.78 mmol) and 2k (228 mg, 0.6 mmol). 9ak was obtained as white solid (175 mg, 0.57 mmol, 95%). M.p. = 65.5–66.3 °C. 1H NMR (300 MHz, CDCl3) δ 1.77 – 2.00 (m, 2H), 2.08 – 2.29 (m, 1H), 2.47 (s, 3H), 2.67 (d, J = 13.1 Hz, 1H), 2.73 – 2.88 (m, 1H), 3.35 (d, J = 13.1 Hz, 1H), 6.98 – 7.09 (m, 2H), 7.06 – 7.16 (m, 3H). 13C NMR (101 MHz, CDCl3) δ 22.8 (p, J = 2.7 Hz), 29.9, 35.2 – 38.7 (m, 45.6, 53.4 (t, J = 19.8 Hz), 115.4 (tq, J = 260.3, 36.1 Hz), 119.4 (qt, J = 288.7, 37.3 Hz), 127.6, 128.4, 130.4, 134.3, 169.2. 19F NMR (282 MHz, CDCl3) δ −119.42 (d, JCF = 278.6 Hz, 1F), −117.27 (d, JCF = 278.6 Hz, 1F), −78.39 (s, 3F). IR (ATR, neat): 2893, 1693, 1496, 1455, 1360, 1333, 1177, 1114, 1074, 1059, 964, 878, 747, 731, 701, 686 cm⁻¹. HRMS (MALDI) calcd (m/z) for C14H14NONaF5: [M+Na⁺] 330.0888, found: 330.0885.
Synthesis of 3-benzyl-1-methyl-3-(perfluoroethyl)pyrrolidine (10).

A flame-dried 25-mL Schlenk flask equipped with rubber septum and magnetic stirring bar was charged under Ar atmosphere subsequently with diisopropylamine (57.1 mg, 0.564 mmol, 1.43 equiv) and anhydrous THF (2 mL). To this well-stirred solution held at −18°C (ice/salt bath) was added a solution of n-BuLi (1.6 M in hexanes, 0.539 mmol, 1.36 equiv) via a syringe. The resulting solution was stirred at this temperature for 15 minutes, then the solution was cooled to −78°C. A solution of lactam 3a (0.513 mmol, 1.3 equiv) in anhydrous THF (1 mL) was introduced dropwise via a syringe within 1 minute. Lithiation was conducted for 60 minutes, then neat trimethylchlorosilane (0.1 mL, 0.789 mmol, 2 equiv) was introduced at once. The resultant reaction mixture was stirred for 6 h allowing to gradually reach rt. After the reaction mixture was cooled to −78°C and the solution of TMSNTf$_2$ in DCM (0.2 M, 3.95 mmol, 0.01 equiv) was added via a microsyringe at once followed by addition of solid 3,3-dimethyl-1-(perfluoroethyl)-1,3-dihydro-1H-benzo[d][1,2]iodaoxole (2k) (150 mg, 0.395 mmol, 1 equiv). The mixture was allowed to reach rt overnight 19 h with stirring. The final solution was cooled to 0°C and BH$_3$·Me$_2$S (10 M in THF, 1.28 mmol, 3.25 equiv) was added dropwise over 5 minutes and after removal of the cooling bath the mixture was refluxed for 3 h. The reaction mixture was then cooled to rt and the excess of BH$_3$ was eliminated by dropwise addition of MeOH (1 mL). After removal of the solvent at reduced pressure the crude was purified by column chromatography (Hexane/EtOAc, 5:1) giving 82 mg (71%) of pure product 10 as colorless oil. $^1$H NMR (500 MHz, CDCl$_3$) $\delta$ 1.96 – 2.10 (m, 3H), 2.18 – 2.25 (m, 4H), 2.40 – 2.51 (m, 1H), 2.65 – 2.73 (m, 1H), 2.89 – 2.98 (m, 2H), 3.03 (d, $J = 13.9$ Hz, 1H), 7.22 – 7.41 (m, 5H). $^{13}$C NMR (126 MHz, CDCl$_3$) $\delta$ 30.9, 39.3, 41.6, 51.3 (t, $J = 18.9$ Hz), 55.5, 60.1 (m), 117.5 (tq, $J = 257.2$, 35.2 Hz), 120.0 (qt, $J = 288.1$, 37.9 Hz), 126.9, 128.1, 131.3, 136.1. $^{19}$F NMR (471 MHz, CDCl$_3$) $\delta$ –116.9 (d, $J_{CF} = 273.2$ Hz, 1F), –116.2 (d, $J_{CF} = 277.9$ Hz, 1F), –77.6 (s, 3F). IR (ATR, neat): 2942, 2792, 1484, 1454, 1333, 1196, 1141, 1089, 1033, 989, 758, 700 cm$^{-1}$. HRMS (ESI) calcd (m/z) for C$_{14}$H$_{17}$NF$_5$: [M+H$^+$]+ 294.1276, found: 294.1280.

References.

Crystallographic details.

Crystallographic data and details of the structure refinement of compound 9ak

Bond precision:  
\[ C-C = 0.0046 \text{ Å} \]

Wavelength: \( 0.71073 \)

Cell:
\[ a=8.4914(8) \quad b=10.2896(9) \quad c=15.2108(13) \]
\[ \alpha=89.626(3) \quad \beta=85.989(3) \quad \gamma=89.673(3) \]

Temperature: 103 K

Volume: \( 1325.7(2) \text{ Å}^3 \)  

Space group: \( P -1 \)  

Hall group: \( -P 1 \)  

Moiety formula: \( C_{14}H_{14}F_5N_0 \)  

Sum formula: \( C_{14}H_{14}F_5N_0 \)  

\( \text{Mr} \): 307.26  

\( D, g \text{ cm}^{-3} \): 1.539  

\( Z \): 4  

\( \mu \text{ (mm}^{-1}) \): 0.145  

\( F_{000} \): 632.0  

\( F_{000}' \): 632.51  

\( h,k,l_{\text{max}} \): 10,12,18  

\( N_{\text{ref}} \): 4678  

\( T_{\text{min},T_{\text{max}}} \): 0.947,0.965  

\( T_{\text{min}} \): 0.933

Correction method: # Reported T Limits: \( T_{\text{min}}=0.848 \quad T_{\text{max}}=0.931 \)

AbsCorr = MULTI-SCAN

Data completeness: 1.037  

\( \theta_{\text{max}} \): 25.018  

\( R(\text{reflections}) = 0.0505(3873) \)  

\( wR^2(\text{reflections}) = 0.1129(4852) \)  

\( S = 1.162 \)

CCDC 1442867

![Crystal structure diagram]
2-(2-(1,3-Dioxolan-2-yl)phenoxy)-1,1,2,2-tetrafluoroethyl)trimethylsilane

$^1$H NMR (300 MHz, CDCl$_3$)
$^{13}$C NMR (75 MHz, CDCl$_3$)
$^{19}$F NMR (282 MHz, CDCl$_3$)
1-(2-(2-(1,3-dioxolan-2-yl)phenoxy)-1,1,2,2-tetrafluoroethyl)-3,3-dimethyl-1,3-dihydro-1\(^{3}\)-benzo[\(d\)][1,2]iodaoxole (2e)

\(^1\)H NMR (300 MHz, CDCl\(_3\))
$^{13}$C NMR (75 MHz, CDCl$_3$)
$^{19}$F NMR (282 MHz, CDCl$_3$)
Methyl 4-(3-bromo-2,2,3,3-tetrafluoropropyl)benzoate

$^1$H NMR (300 MHz, CDCl$_3$)
$^{13}$C NMR (75.5 MHz, CDCl$_3$)
$^{19}$F NMR (282 MHz, CDCl$_3$)
Methyl 4-(2,2,3,3-tetrafluoro-3-(trimethylsilyl)propyl)benzoate

$^1$H NMR (300 MHz, CDCl$_3$)
$^{13}$C NMR (75.5 MHz, CDCl$_3$)
$^{19}$F NMR (282 MHz, CDCl$_3$)
Methyl 4-(3-(3,3-dimethyl-1\(^3\)-benzo[d][1,2]iodaoxol-1(3\(H\))-yl)-2,2,3,3-tetrafluoropropyl)benzoate (2g)

\(^1\)H NMR (400 MHz, CDCl\(_3\))
$^{13}$C NMR (100 MHz, CDCl$_3$)
$^{19}$F NMR (376 MHz, CDCl$_3$)
7-(2-Bromo-1,1,2,2-tetrafluoroethoxy)-4-methyl-2H-chromen-2-one

$^1$H NMR (300 MHz, CDCl$_3$)
$^{13}$C NMR (75.5 MHz, CDCl$_3$)
$^{19}$F NMR (282 MHz, CDCl$_3$)
4-Methyl-7-(1,1,2,2-tetrafluoro-2-(trimethylsilyl)ethoxy)-2H-chromen-2-one

$^1$H NMR (300 MHz, CDCl$_3$)
$^{13}$C NMR (75.5 MHz, CDCl$_3$)
$^{19}$F NMR (282 MHz, CDCl$_3$)
7-(2-(3,3-Dimethyl-1 $\lambda^3$-benzo[$d$][1,2]iodoxol-1(3$H$)-yl)-1,1,2,2-tetrafluoroethoxy)-4-methyl-2$H$-chromen-2-one (2i)

$^1$H NMR (400 MHz, CDCl$_3$)
$^{13}$C NMR (100 MHz, CDCl$_3$)
$^{19}$F NMR (376 MHz, CDCl$_3$)
7-((2-Bromo-1,1,2,2-tetrafluoroethyl)thio)-4-methyl-2H-chromen-2-one

$^1$H NMR (300 MHz, CDCl$_3$)
$^{13}$C NMR (75.5 MHz, CDCl$_3$)
$^{19}$F NMR (282 MHz, CDCl$_3$)
4-Methyl-7-((1,1,2,2-tetrafluoro-2-(trimethylsilyl)ethyl)thio)-2H-chromen-2-one

$^1$H NMR (300 MHz, CDCl$_3$)
$^{13}$C NMR (75.5 MHz, CDCl$_3$)
$^{19}$F NMR (282 MHz, CDCl$_3$)
7-((2-(3,3-Dimethyl-1\(\lambda^3\)-benzo[\(d\])[1,2]iodaoxol-1(3\(H\))-yl)-1,1,2,2-tetrafluoroethyl)thio)-4-methyl-2\(H\)-chromen-2-one (2j)

\(^1\)H NMR (400 MHz, CDCl\(_3\))
$^{13}$C NMR (100 MHz, CDCl$_3$)
$^{19}\text{F NMR (376 MHz, CDCl}_3$)
Triethyl(perfluoroethyl)silane

$^1$H NMR (300 MHz, CDCl$_3$)
$^{13}$C NMR (300 MHz, CDCl$_3$)
$^{19}$F NMR (300 MHz, CDCl$_3$)
3,3-Dimethyl-1-(perfluoroethyl)-1,3-dihydro-1\textsuperscript{\lambda}3-benzo[d][1,2]iodaoxole (2k)

\textsuperscript{1}H NMR (500 MHz, CDCl\textsubscript{3})
$^{13}$C NMR (126 MHz, CDCl$_3$)
$^{19}$F NMR (471 MHz, CDCl$_3$)
3-Benzyl-1-methylpyrrolidin-2-one (3a)

$^1$H NMR (300 MHz, CDCl$_3$)
$^{13}$C NMR (75 MHZ, CDCl$_3$)

![NMR Spectrum]

- 175.50
- 168.48
- 168.40
- 128.38
- 128.36
- 67.37
- 33.03
- 29.76
- 29.10
1,3-Dibenzylypyrrolidin-2-one (3b)

$^1$H NMR (300 MHz, CDCl$_3$)
$^{13}$C NMR (75 MHz, CDCl$_3$)
3-Benzyl-1-((benzyloxy)methyl)pyrrolidin-2-one (3c)

$^1$H NMR (300 MHz, CDCl$_3$)
$^{13}$C NMR (75 MHz, CDCl$_3$)
t-Butyl 3-benzyl-2-oxopyrrolidine-1-carboxylate (3d)

$^1$H NMR (300 MHz, CDCl$_3$)
$^{13}$C NMR (75 MHz, CDCl$_3$)
1-Methyl-3-phenylpyrrolidin-2-one (3e)

$^1$H NMR (200 MHz, CDCl$_3$)
$^{13}$C NMR (50 MHz, CDCl$_3$)
3-Benzyl-1-methylpiperidin-2-one (3f)

$^1$H NMR (300 MHz, CDCl$_3$)
$^{13}$C NMR (50 MHz, CDCl$_3$)
3-Benzyl-1-methylazepan-2-one (3g)

$^1$H NMR (300 MHz, CDCl$_3$)
$^{13}$C NMR (75 MHz, CDCl$_3$)
3-(2-Methoxyethyl)-1-methylpyrrolidin-2-one (3h)

$^1$H NMR (400 MHz, CDCl$_3$)
$^{13}$C NMR (101 MHz, CDCl₃)
3-Allyl-1-methylpyrrolidin-2-one (3i)

$^1$H NMR (300 MHz, CDCl$_3$)
$^{13}$C NMR (75 MHz, CDCl$_3$)
1-Methyl-3-(trimethylsilyl)pyrrolidin-2-one (3j)

$^1$H NMR (300 MHz, CDCl$_3$)
$^{13}$C NMR (75 MHz, CDCl$_3$)
1-Methyl-3-(prop-2-yn-1-yl)pyrrolidin-2-one (3k)

$^1$H NMR (300 MHz, CDCl$_3$)
$^{13}$C NMR (75 MHz, CDCl$_3$)
3-Benzyl-1-methyl-3,4-dihydroquinolin-2(1H)-one (31)

$^1$H NMR (300 MHz, CDCl$_3$)
$^{13}$C NMR (126 MHz, CDCl$_3$)
4-Benzyl-1-methyl-5-((trimethylsilyl)oxy)-2,3-dihydro-1H-pyrrole (4a)

$^1$H NMR (400 MHz, CDCl$_3$)
$^{13}\text{C NMR (75 MHZ, CDCl}_3\text{)}$
1,4-Dibenzyl-5-((trimethylsilyl)oxy)-2,3-dihydro-1H-pyrrole (4b)

$^1$H NMR (400 MHz, CDCl$_3$)
$^{13}$C NMR (101 MHz, CDCl$_3$)
4-Benzyl-1-((benzyloxy)methyl)-5-((trimethylsilyl)oxy)-2,3-dihydro-1H-pyrrole (4c)

$^1$H NMR (500 MHz, CDCl$_3$)
$^{13}$C NMR (125 MHz, CDCl$_3$)
t-Butyl 4-benzyl-5-((trimethylsilyl)oxy)-2,3-dihydro-1H-pyrrole-1-carboxylate (4d)

$^1$H NMR (400 MHz, CDCl$_3$)
$^{13}$C NMR (101 MHz, CDCl$_3$)
1-Methyl-4-phenyl-5-((trimethylsilyl)oxy)-2,3-dihydro-1H-pyrrole (4e)

$^1$H NMR (400 MHz, CDCl$_3$)
$^{13}$C NMR (101 MHz, CDCl$_3$)
5-Benzyl-1-methyl-6-((trimethylsilyl)oxy)-1,2,3,4-tetrahydropyridine (4f)

$^1$H NMR (400 MHz, CDCl$_3$)
$^{13}$C NMR (101 MHz, CDCl$_3$)
6-Benzyl-1-methyl-7-((trimethylsilyl)oxy)-2,3,4,5-tetrahydro-1H-azepine (4g)

\[ 1^H \text{NMR (300 MHz, CDCl}_3) \]
$^{13}$C NMR (75 MHz, CDCl$_3$)
4-(2-Methoxyethyl)-1-methyl-5-((trimethylsilyl)oxy)-2,3-dihydro-1H-pyrrole (4h)

$^1$H NMR (400 MHz, CDCl₃)
$^{13}$C NMR (101 MHz, CDCl$_3$)
4-Allyl-1-methyl-5-((trimethylsilyl)oxy)-2,3-dihydro-1H-pyrrole (4i)

$^1$H NMR (400 MHz, CDCl$_3$)
$^{13}$C NMR (101 MHz, CDCl$_3$)
1-Methyl-4-(trimethylsilyl)-5-((trimethylsilyl)oxy)-2,3-dihydro-1H-pyrrole (4j)

$^1$H NMR (400 MHz, CDCl$_3$)
$^{13}$C NMR (101 MHz, CDCl$_3$)
1-Methyl-5-((trimethylsilyl)oxy)-4-(3-(trimethylsilyl)prop-2-yn-1-yl)-2,3-dihydro-1H-pyrrole (4k)

$^1$H NMR (500 MHz, CDCl$_3$)
$^{13}$C NMR (126 MHz, CDCl$_3$)
3-Benzyl-2-((trimethylsilyl)oxy)-1,4-dihydroquinoline (4I)

$^1$H NMR (400 MHz, CDCl$_3$)
$^{13}$C NMR (100 MHz, CDCl$_3$)
3-Benzyl-1-methyl-3-(trifluoromethyl)pyrrolidin-2-one (8a)

$^1$H NMR (300 MHz, CDCl$_3$)
$^{13}$C NMR (75 MHz, CDCl$_3$)
$^{19}$F NMR (282 MHz, CDCl$_3$)
1,3-Dibenzyl-3-(trifluoromethyl)pyrrolidin-2-one (8b)

$^{1}$H NMR (400 MHz, CDCl$_3$)
$^{13}$C NMR (101 MHz, CDCl$_3$)
$^{19}$F NMR (376 MHz, CDCl₃)
3-Benzyl-1-((benzyloxy)methyl)-3-(trifluoromethyl)pyrrolidin-2-one (8c)

$^1$H NMR (400 MHz, CDCl$_3$)
$^{13}$C NMR (101 MHz, CDCl$_3$)
$^{19}$F NMR (376 MHz, CDCl$_3$)
t-Butyl 3-benzyl-2-oxo-3-(trifluoromethyl)pyrrolidine-1-carboxylate (8d)

$^1$H NMR (300 MHz, CDCl$_3$)
$^{13}$C NMR (75 MHz, CDCl$_3$)
$^{19}$F NMR (282 MHz, CDCl$_3$)
1-Methyl-3-phenyl-3-(trifluoromethyl)pyrrolidin-2-one (8e)

$^1$H NMR (300 MHz, CDCl$_3$)
$^{13}$C NMR (50 MHz, CDCl$_3$)
$^{19}$F NMR (282 MHz, CDCl$_3$)
3-Benzyl-1-methyl-3-(trifluoromethyl)piperidin-2-one (8f)

$^1$H NMR (300 MHz, CDCl$_3$)
$^{13}$C NMR (75 MHz, CDCl$_3$)
$^{19}\text{F NMR (282 MHz, CDCl}_3\text{)}$
3-Benzyl-1-methyl-3-(trifluoromethyl)azepan-2-one (8g)

$^1$H NMR (300 MHz, CDCl$_3$)
$^{13}$C NMR (50 MHz, CDCl$_3$)
$^{19}$F NMR (282 MHz, CDCl$_3$)
3-(2-Methoxyethyl)-1-methyl-3-(trifluoromethyl)pyrrolidin-2-one (8h)

$^1$H NMR (400 MHz, CDCl$_3$)
$^{13}$C NMR (101 MHz, CDCl$_3$)
$^{19}$F NMR (376 MHz, CDCl$_3$)
3-Allyl-1-methyl-3-(trifluoromethyl)pyrrolidin-2-one (8i)

$^1$H NMR (300 MHz, CDCl$_3$)
$^{13}$C NMR (75 MHz, CDCl$_3$)
$^{19}$F NMR (282 MHz, CDCl$_3$)
1-Methyl-3-(trifluoromethyl)-3-(trimethylsilyl)pyrrolidin-2-one (8j)

$^1$H NMR (500 MHz, CDCl$_3$)
$^{13}$C NMR (126 MHz, CDCl$_3$)
$^{19}\text{F NMR (471 MHz, CDCl}_3\text{)}$
1-Methyl-3-(trifluoromethyl)-3-(3-(trimethylsilyl)prop-2-yn-1-yl)pyrrolidin-2-one (8k)

$^1$H NMR (300 MHz, CDCl$_3$)
$^{13}$C NMR (75 MHz, CDCl$_3$)
$^{19}\text{F NMR } (282 \text{ MHz, CDCl}_3)$
3-Benzyl-1-methyl-3-(trifluoromethyl)-3,4-dihydroquinolin-2(1H)-one (8l)

$^1$H NMR (400 MHz, CDCl$_3$)

![NMR Spectrum]
$^{13}$C NMR (101 MHz, CDCl$_3$)
$^{19}$F NMR (376 MHz, CDCl$_3$)
3-Benzyl-1-methyl-3-(1,1,2,2-tetrafluoro-2-(phenylthio)ethyl)pyrrolidin-2-one (9ab)

$^1$H NMR (400 MHz, CDCl$_3$)
$^{13}$C NMR (101 MHz, CDCl$_3$)
$^{19}$F NMR (376 MHz, CDCl$_3$)
3-Benzyl-1-methyl-3-(1,1,2,2-tetrafluoro-2-(4-methoxyphenoxy)ethyl)pyrrolidin-2-one (9ac)

$^1$H NMR (300 MHz, CDCl$_3$)
$^{13}$C NMR (75 MHz, CDCl$_3$)
\[^{19}\text{F} \text{NMR (282 MHz, CDCl}_3\text{)}\]
3-Benzyl-3-(2-(4-bromophenoxy)-1,1,2,2-tetrafluoroethyl)-1-methylpyrrolidin-2-one (9ad)

$^1$H NMR (400 MHz, CDCl$_3$)
$^{13}$C NMR (101 MHz, CDCl$_3$)
$^{19}$F NMR (376 MHz, CDCl$_3$)
3-(2-(2-(1,3-Dioxolan-2-yl)phenoxy)-1,1,2,2-tetrafluoroethyl)-3-benzyl-1-methylpyrrolidin-2-one (9ae)

$^1$H NMR (300 MHz, CDCl$_3$)
$^{13}$C NMR (75 MHz, CDCl$_3$)
$^{19}$F NMR (282 MHz, CDCl$_3$)
Ethyl 4-(2-(3-benzyl-1-methyl-2-oxopyrrolidin-3-yl)-1,1,2,2-tetrafluoroethoxy)benzoate (9af).

$^1$H NMR (300 MHz, CDCl$_3$)
$^{13}$C NMR (126 MHz, CDCl$_3$)
$^{19}$F NMR (282 MHz, CDCl₃)
Methyl 4-(3-(3-benzyl-1-methyl-2-oxopyrrolidin-3-yl)-2,2,3,3-tetrafluoropropyl)benzoate (9ag)

$^1$H NMR (400 MHz, CDCl$_3$)
$^{13}$C NMR (101 MHz, CDCl$_3$)
$^{19}$F NMR (376 MHz, CDCl$_3$)
3-Benzyl-1-methyl-3-(1,1,2,2-tetrafluoro-2-(1H-pyrazol-1-yl)ethyl)pyrrolidin-2-one (9ah)

$^1$H NMR (300 MHz, CDCl$_3$)
$^{13}$C NMR (75 MHz, CDCl$_3$)
$^{19}$F NMR (282 MHz, CDCl$_3$)
3-Benzyl-1-methyl-3-(1,1,2,2-tetrafluoro-2-((4-methyl-2-oxo-2H-chromen-7-yl)oxy)ethyl)pyrrolidin-2-one (9ai).

$^1$H NMR (300 MHz, CDCl$_3$)
$^{13}$C NMR (75 MHz, CDCl$_3$)
$^{19}$F NMR (282 MHz, CDCl$_3$)
3-Benzyl-1-methyl-3-(1,1,2,2-tetrafluoro-2-((4-methyl-2-oxo-2H-chromen-7-yl)thio)ethyl)pyrrolidin-2-one (9aj)

$^1$H NMR (300 MHz, CDCl$_3$)
$^{13}$C NMR (126 MHz, CDCl$_3$)
$^{19}$F NMR (282 MHz, CDCl$_3$)
3-Benzyl-1-methyl-3-(perfluoroethyl)pyrrolidin-2-one (9ak)

$^1$H NMR (300 MHz, CDCl$_3$)
$^{13}$C NMR (101 MHz, CDCl$_3$)
$^{19}$F NMR (282 MHz, CDCl$_3$)
3-Benzyl-1-methyl-3-(perfluoroethyl)pyrrolidine (10)

$^1$H NMR (500 MHz, CDCl$_3$)
$^{13}$C NMR (126 MHz, CDCl$_3$)
$^{19}$F NMR (471 MHz, CDCl$_3$)