
Publisher's PDF, also known as Version of record
License (if available): CC BY
Link to published version (if available): 10.1021/jacs.7b07830

Link to publication record in Explore Bristol Research
PDF-document

**University of Bristol - Explore Bristol Research**

**General rights**

This document is made available in accordance with publisher policies. Please cite only the published version using the reference above. Full terms of use are available: http://www.bristol.ac.uk/pure/about/ebr-terms
Transition Metal Free C-N Bond Forming
Dearomatizations and Aryl C-H Aminations by In Situ
Release of a Hydroxylamine-Based Aminating Agent

Joshua J. Farndon†, Xiaofeng Ma†, and John F. Bower*,†
†School of Chemistry, University of Bristol, Bristol, BS8 1TS, United Kingdom

Supporting Information

Table of Contents

General Experimental Details ****************************S2
Experimental Procedures and Data ****************************S3
Control experiments ********************S88
Copies of ¹H and ¹³C NMR for Novel Compounds ****************************S91
References ****************************S183
General Experimental Details. Starting materials were purchased from commercial sources (Acros, Aldrich, Alfa Aesar) and used without further purification unless otherwise stated. Anhydrous 2,2,2-trifluoroethanol was obtained by drying over 4Å molecular sieves while other anhydrous solvents were obtained by passage through drying columns supplied by Anhydrous Engineering Ltd. The removal of solvents in vacuo was achieved using both a Büchi rotary evaporator (bath temperatures up to 45 °C) at a pressure of either 15 mmHg (diaphragm pump) or 0.1 mmHg (oil pump), as appropriate, and a high vacuum line at r.t.. Reactions requiring anhydrous conditions were run under a dry atmosphere of nitrogen or argon; glassware was either flame dried immediately prior to use or placed in an oven (200 °C) for at least 2 h and allowed to cool either in a desiccator or under an atmosphere of nitrogen or argon; liquid reagents, solutions or solvents were added via syringe through rubber septa. Flash column chromatography was performed using silica gel (Aldrich 40-63 μm, 230-400 mesh). Thin layer chromatography was performed using aluminium backed 60F254 silica plates. Visualisation was achieved by UV fluorescence or a basic KMnO₄ solution and heat. Proton nuclear magnetic resonance were recorded on a Varian or Jeol spectrometer at 400 MHz or 500 MHz while ¹³C NMR spectra were recorded at 100 MHz. Chemical shifts (δ) are given in parts per million (ppm) and referenced to the appropriate residual solvent peak. Peaks are described as singlets (s), doublets (d), triplets (t), quartets (q), quintets (qn), sextets (s), multiplets (m) and broad (br.). Coupling constants (J) are quoted to the nearest 0.1 Hz. Assignments of ¹H NMR and ¹³C NMR signals were made, where possible, using COSY, HSQC, HMBC, NOE and TOCSY experiments. Mixtures of isomers which could not be separated (e.g. diastereomers and/or rotamers) have been characterized together and are referred to as A and B. Numbering systems for NMR signal assignments are specified on the structure and are not related to those used for the compound names. In situ yields were determined by integration of the ¹H NMR of the crude material employing 1,3,5-trimethoxybenzene or 1,4-dinitrobenzene as internal standard. Mass spectra were determined by the University of Bristol mass spectrometry service using a Bruker Daltonics FT-ICR-MS Apex 4e 7.0T FT-MS. Infrared spectra were recorded on a Perkin Elmer Spectrum Two FTIR spectrometer as either neat films or solids. Abbreviations used are: w (weak), m (medium), s (strong) and br (broad). Melting points were determined using a Reichert melting point table and temperature controller and are uncorrected.
Experimental procedures and Data

General procedure A for TBS protection of phenol

To a solution of alcohol (1.0 eq.) in DMF (approx. 2mL/mmol) at 0 °C was added imidazole (3.3 eq.) and tert-butyldimethylsilyl chloride (2.2 eq.). The reaction was stirred at r.t. and monitored by TLC. Upon completion, the reaction was quenched by addition of H2O and the organic phase extracted with hexane, dried over Na2SO4 and concentrated in vacuo. To the crude reaction mixture was added MeOH (1 mL/mmol), THF (1 mL/mmol) and aq. K2CO3 (2.0 eq.) After stirring for 12 h the reaction was quenched with aq. 1 M HCl at 0 °C (until pH approx. 3). The mixture was extracted with Et2O (3 × 20 mL), dried over Na2SO4, filtered and concentrated in vacuo. The crude reaction mixture was purified by flash column chromatography.

General procedure B for reduction of carboxylic acid/ester to alcohol using LiAlH4

To a solution of carboxylic acid/ester (1.0 eq.) in anhydrous THF or Et2O (approx. 5 mL/mmol) at 0 °C was added LiAlH4 (equivalents specified) dropwise. The reaction was stirred at r.t. and monitored by TLC. Upon completion, the reaction mixture was cooled to 0 °C before addition of water (1 mL/g of LiAlH4), 15% aq. NaOH (1 mL/g LiAlH4) and a final portion of water (3 mL/g of LiAlH4). The mixture was filtered through Celite® and washed with CH2Cl2. The phases were separated and the aqueous phase extracted with CH2Cl2 (2 × 10 mL). The combined organic extracts were dried over Na2SO4, filtered and concentrated in vacuo to afford the crude product which was purified by flash column chromatography.

General procedure C for preparation of hydroxylamine derivatives by Mitsunobu reaction

Diisopropyl azodicarboxylate (1.2 eq.) was added at 0 °C to a stirring solution of triphenylphosphine (1.2 eq.) in anhydrous THF (approx. 2mL/mmol) under a nitrogen atmosphere. After 30 min stirring at this temperature a solution of alcohol (1.0 eq.) and amine nucleophile (1.2 eq.) in anhydrous THF (approx. 2mL/mmol) were added. The reaction was stirred at 0 °C for 1 h after which it was stirred at r.t. and monitored by TLC. Upon completion, the reaction mixture was concentrated in vacuo and purified by flash column chromatography.
**General procedure D** for removal of silyl protecting group with TBAF/AcOH

To a solution of silyl ether (1.0 eq.) in THF (approx. 20mL/mmol) at 0 °C was added a solution of 1:1 TBAF/AcOH (equivalents specified, 0.1 M in THF). The reaction mixture was stirred at r.t. and monitored by TLC. Upon completion, the reaction mixture was quenched with water (10 mL), extracted with EtOAc (2 × 10 mL), washed with sat. aq. NaHCO₃ (10 mL) and brine (10 mL), dried over Na₂SO₄, filtered and the concentrated *in vacuo*. The crude product was purified by flash column chromatography.

**General procedure E** for intramolecular dearomatizing amination

To a stirring solution of Boc-protected amino substrate (1.0 eq.) in anhydrous 2,2,2,2-trifluoroethanol (0.1 M) at 0 °C was added trifluoroacetic acid (2.0 eq.). After stirring for 2 h at 0°C the reaction was warmed to r.t. and monitored by TLC. Upon completion, the reaction mixture was concentrated *in vacuo* and purified by flash column chromatography, with a small amount of Et₃N (<1%) added to the appropriate eluent. In cases where the product was unstable the TFA salt was obtained by re-acidification with TFA.

**General procedure F** for formation of unsaturated esters by Wittig reaction

Aldehyde (1.0 eq.) and methyl 2-(triphenyl-phosphaneylidene) acetate or ethyl 2-(triphenyl-phosphaneylidene) acetate (1.5 eq.) in CH₂Cl₂ (approx. 1 mL/mmol) were stirred at r.t. overnight and monitored by TLC. Upon completion, the reaction mixture was concentrated *in vacuo* and purified by flash column chromatography.

**General procedure G** for alkene hydrogenation with Pd/C

A solution of alkene (1.0 eq.) in MeOH or EtOH or EtOAc (approx. 5 mL/mmol) was purged with argon before the addition of 10 wt. % Pd/C (5-10 mol%). The flask was fitted with a balloon of hydrogen and stirred at r.t. overnight and monitored by TLC. Upon completion, the reaction mixture was filtered over a bed of Celite® washing with the appropriate solvent and concentrated *in vacuo* to afford the product.

**General Procedure H** for preparation of Weinreb amides from Carboxylic acids

To a solution of carboxylic acid (1.0 eq.) in anhydrous CH₂Cl₂ under nitrogen at 0 °C was added *N*,*O*-dimethylhydroxylamine hydrochloride (1.4 eq.), Et₃N (1.4 eq.), 4-dimethylaminopyridine (1.4 eq.), and *N*,*N’*-dicyclohexylcarbodiimide (1.4 eq.). The solution was stirred at r.t. overnight and then filtered through Celite, eluting with EtOAc. The filtrate
was washed sequentially with 1 M aq. HCl (10 mL) and sat. aq. NaHCO₃ (10 mL). The combined organic extracts were dried over MgSO₄, filtered and concentrated in vacuo. The crude product was purified by flash column chromatography.

**General procedure I for reduction of carboxylic acids to alcohols via anhydride**

To a solution of carboxylic acid (1.0 eq.) and triethylamine (1.0 eq.) in THF (10 mL/mmol) at -5 °C was added a solution of ethyl chloroformate (1.0 eq.) in THF (1 mL/mmol) dropwise maintaining a temperature below 0 °C. The reaction was stirred at the same temperature for 1 h and filtered to remove the white precipitate that formed, washing with THF (10 mL). The filtrate was added dropwise to a solution of NaBH₄ (2.5 eq.) in H₂O (approx. 2 mL/mmol) at -5 °C. The reaction was stirred at r.t. overnight and monitored by TLC. Upon completion, the reaction was acidified to approx. pH 3 with aq. 1 M HCl. The layers were separated and the aqueous layer extracted with Et₂O (3 × 10 mL). The combined organic extracts were washed with aq. 1 M NaOH (10 mL) and H₂O (10 mL), dried over MgSO₄, filtered and concentrated in vacuo. The crude product was purified by flash column chromatography.

**tert-Butyl (tosyloxy)carbamate (4)**

\[
\begin{align*}
\text{H}_3\text{N}^-\text{OH} & \quad \text{Boc} \\
& \quad \text{H}_3\text{N}^-\text{OTs} \\
& \quad \text{Boc}
\end{align*}
\]

The title compound was prepared according to a literature procedure.²

*The spectroscopic properties were consistent with the data available in the literature.*²

**3-(4-((tert-Butyldimethylsilyl)oxy)phenyl)propanoic acid**³

**General procedure A:** 3-(4-Hydroxyphenyl)propanoic acid (8.30 g, 50.0 mmol), *tert*-butyldimethylsilyl chloride (16.5 g, 110.0 mmol) and imidazole (11.25 g, 165.0 mmol) in DMF
(100 mL) were employed. Purification by flash column chromatography (25 % EtOAc/hexane) afforded the title compound (10.8 g, 77 %) as a colorless solid; m.p.: 69 - 71 °C (EtOAc/hexane); Rf = 0.2 (20 % EtOAc/hexane); vmax / cm⁻¹ (solid) 2926 (m), 2882 (m), 2855 (m), 1714 (s), 1509 (s), 1249 (s), 1213 (s); ¹H NMR (400 MHz, CDCl₃) δ 10.30 (1H, br s, COOH), 7.06 (2H, d, J = 8.3 Hz, ArCH), 6.77 (2H, d, J = 8.3 Hz, ArCH), 2.89 (2H, t, J = 7.6 Hz, C3-H₂), 2.65 (2H, t, J = 7.3 Hz, C2-H₂), 0.99 (9H, s, TBS (CH₃)₃), 0.19 (6H, s, TBS (CH₃)₂); ¹³C NMR (101 MHz, CDCl₃) δ 179.4 (C₁), 154.2 (ArC), 133.0 (ArC), 129.3 (2 x ArCH), 120.2 (2 x ArCH), 36.1 (C2), 30.0 (C3), 25.8 (TBS (CH₃)₃), 18.3 (TBS Si(CH₃)₃), - 4.3 (TBS Si(CH₃)₂). HRMS (ESI⁺) Calculated for C₁₅H₂₅O₃Si: 281.1567. Found [M+H]⁺: 281.1580. The title compound has been described only in a patent.³

3-(4-((tert-Butyldimethylsilyl)oxy)phenyl)propan-1-ol⁴

General procedure B: 3-(4-((tert-Butyldimethylsilyl)oxy)phenyl)propanoic acid (1.40 g, 5.0 mmol) and 2.0 eq. LiAlH₄ (1M in THF) in anhydrous Et₂O were employed. Purification by flash column chromatography (25 % EtOAc/hexane) afforded the title compound (0.99 g, 74 %) as a colorless oil Rf = 0.6 (33 % EtOAc/hexane); vmax / cm⁻¹ (film) 3339 (br m), 2929 (s), 2885 (s), 2858 (s), 1609 (m), 1508 (s), 1250 (s); ¹H NMR (400 MHz, CDCl₃) δ 7.04 (2H, d, J = 8.0 Hz), 6.75 (2H, d, J = 8.0 Hz), 3.64-3.68 (2H, m), 2.64 (2H, t, J = 7.4 Hz), 1.86 (2H, m), 1.35, (1H, br s), 0.98 (9H, s), 0.18 (6H, s); ¹³C NMR (101 MHz, CDCl₃) δ 153.7, 134.4, 129.2, 119.9, 62.3, 34.4, 31.2, 25.7, 18.2, -4.4. Spectroscopic properties were consistent with the data available in the literature.⁴
**General procedure C**: 3-(4-((tert-butyldimethylsilyl)oxy)phenyl)propan-1-ol (0.79 g, 3.00 mmol), PPh$_3$ (0.94 g, 3.60 mmol), DIAD (0.71 mL, 3.60 mmol) and TsONHBoc (1.03 g, 3.60 mmol) in THF (12 mL) were employed. Purification by flash column chromatography (10 % EtOAc/hexane) afforded silyl-5a (1.49 g, 93 %) as a pale yellow oil; R$_f$ = 0.5 (20 % EtOAc/hexane); $\nu_{\text{max}}$ / cm$^{-1}$ (film) 2955 (m), 2930 (m), 2858 (m), 1753 (m), 1720 (s), 1509 (s), 1382 (s), 1368 (s), 1251 (s), 1154 (s); $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 7.84 (2H, d, $J$ = 8.3 Hz, Ts ArCH$_2$), 7.33 (2H, d, $J$ = 8.3 Hz, Ts ArCH$_2$), 7.00 (2H, d, $J$ = 8.4 Hz, C$_5$H), 6.74 (2H, d, $J$ = 8.4 Hz, C$_6$H), 3.60 (2H, app. br s, C$_1$H$_2$), 2.52 (2H, t, $J$ = 7.8 Hz, C$_3$H$_2$), 2.45 (3H, s, Ts CH$_3$), 1.95 - 1.85 (2H, m, C$_2$H$_2$), 1.22 (9H, s, Boc (CH$_3$)$_3$), 0.98 (9H, s, TBS (CH$_3$)$_3$), 0.18 (6H, s, TBS (CH$_3$)$_2$); $^{13}$C NMR (101 MHz, CDCl$_3$) $\delta$ 155.5 (C=O), 153.8 (C$_7$), 145.6 (Ts ArC), 133.7 (C$_4$), 131.3 (Ts ArC), 129.6 (2 × Ts ArCH), 129.5 (2 × Ts ArCH), 129.1 (C$_5$), 120.0 (C$_6$), 83.2 (Boc C(CH$_3$)$_3$), 52.6 (C$_1$), 32.0 (C$_3$), 27.6 (Boc (CH$_3$)$_3$), 27.5 (C$_2$), 25.7 (TBS (CH$_3$)$_3$), 21.7 (Ts CH$_3$), 18.2 (TBS Si(CH$_3$)$_3$), -4.4 (TBS Si(CH$_3$)$_2$); HRMS (ESI$^+$) Calculated for C$_{27}$H$_{41}$NNaO$_6$Si: 558.2316. Found [M+Na]$^+$: 558.2313.

**tert-Butyl (3-(4-hydroxyphenyl)propyl)(tosyloxy)carbamate (5a)**
General procedure D: tert-Butyl (3-(4-((tert-butyldimethylsilyl)oxy)phenyl)propyl)(tosyloxy)carbamate (silyl-5a) (0.69 g, 1.28 mmol) and 1:1 TBAF/HOAc solution (0.1 M in THF, 1.28 mmol) in THF (20 mL) were employed. Purification by flash column chromatography (20 % EtOAc/hexane) afforded 5a (0.35 g, 60 %) as a colorless solid; m.p.: 63 - 65 °C (EtOAc/hexane); Rf = 0.2 (20 % EtOAc/hexane); νmax / cm⁻¹ (solid) 3426 (m, br), 2982 (m), 2934 (m), 1721 (s), 1515 (s), 1369 (s), 1191 (s), 1177 (s), 1152 (s); ¹H NMR (400 MHz, CDCl₃) δ 7.83 (2H, d, J = 8.3 Hz, Ts ArC=H), 7.32 (2H, d, J = 8.3 Hz, Ts ArC=H), 6.98 (2H, d, J = 8.4 Hz, C₅-H), 6.75 (2H, d, J = 8.4 Hz, C₆-H), 5.75 (1H, br s, OH), 3.60 (2H, app. br s, C₁-H), 2.50 (2H, t, J = 7.8 Hz, C₃-H₂), 2.44 (3H, s, Ts CH₃), 1.97 – 1.80 (2H, m, C₂-H₂), 1.23 (9H, s, Boc (CH₃)₃); ¹³C NMR (101 MHz, CDCl₃) δ 155.7 (C=O), 154.1 (C₇), 145.9 (Ts ArC), 132.8 (C₄), 131.0 (Ts ArC), 129.6 (2× Ts ArC=H), 129.5 (2× Ts ArCH), 129.3 (C₅), 115.3 (C₆), 83.6 (Boc C(CH₃)₃), 52.6 (C₁), 31.9 (C₃), 27.7 (C₂), 27.6 (Boc (CH₃)₃), 21.7 (Ts, CH₃); HRMS (ESI⁺) Calculated for C₂₁H₂₇NNaO₆S: 444.1451. Found [M+Na⁺]: 444.1434.

1-Azaspiro[4.5]deca-6,9-dien-8-one trifluoroacetate (7a)

General procedure E: tert-Butyl (3-(4-hydroxyphenyl)propyl)(tosyloxy)carbamate (5a) (60.7 mg, 0.14 mmol) and TFA (22 μL, 0.28 mmol) in TFE (1.4 mL) were stirred at r.t. for 24 h. Purification of the product by flash column chromatography (EtOAc) afforded 7a (29.0 mg, 77 %) as a yellow solid; m.p.: 100 - 102 °C (EtOAc/hexane); Rf = 0.1 (5 % MeOH/CH₂Cl₂); νmax / cm⁻¹ (solid) 1651 (s), 1633 (s), 1426 (m), 1400 (m), 1192 (s), 1175 (s), 1130 (s); ¹H NMR (400 MHz, CD₃OD) δ 7.11 (2H, d, J = 10.3 Hz, C₅-H), 6.43 (2H, d, J = 10.3 Hz, C₆-H), 3.64 (2H, t, J = 7.4 Hz, C₁-H₂), 2.42 - 2.34 (2H, m, C₂-H₂), 2.30 - 2.25 (2H, m, C₃-H₂). The signals corresponding to the NH₂ were not observed. ¹³C NMR (101 MHz, CD₃OD) δ 185.3 (C₇), 144.5 (C₅), 131.7 (C₆), 64.5 (C₁), 46.6 (C₁), 37.8 (C₃), 24.8 (C₂). The signals corresponding
to the trifluoroacetate group could not be resolved due to their weak intensity. HRMS (ESI\(^+\))
Calculated for C\(_9\)H\(_{12}\)NO: 150.0913. Found [M+H]\(^+\): 150.0908.

Methyl \((E)\)-3-(4-(benzylxy)-3,5-dimethylphenyl)acrylate

\[
\text{Me} \quad \text{OH} \quad \text{Me} \quad \text{Me} \quad \text{Me} \\
\text{C} \quad \text{H} \quad \text{C} \quad \text{H} \quad \text{C} \\
\text{O} \quad \text{Me} \\
\]

\[
\text{Me} \quad \text{OBn} \quad \text{Me} \quad \text{Me} \quad \text{Me} \\
\text{C} \quad \text{H} \quad \text{C} \quad \text{H} \quad \text{C} \\
\text{O} \quad \text{Me} \\
\]

**General procedure F:** 4-(Benzylxy)-3,5-dimethylbenzaldehyde (2.40 g, 10.0 mmol) and methyl 2-(triphenyl-phosphane)acetate (5.00 g, 15.0 mmol) in CH\(_2\)Cl\(_2\) (15 mL) were employed. Purification by flash column chromatography (gradient, eluent 10 - 20 % EtOAc/hexane) afforded the title compound (2.85 g, 96 %) as a colorless oil; R\(_f\) = 0.6 (20 % EtOAc/hexane); \(\nu_{\text{max}} / \text{cm}^{-1}\) (film) 1713 (s), 1632 (m), 1434 (m), 1265 (s), 1143 (s); \(^1\)H NMR \(\delta\) 7.63 (1H, d, \(J = 16.0 \text{ Hz}, \text{C3-H}\)), 7.50 - 7.46 (2H, m, ArCH), 7.46 - 7.33 (3H, m, ArCH), 7.23 (2H, s, C5-H), 6.36 (1H, d, \(J = 16.0 \text{ Hz}, \text{C2-H}\)), 4.83 (2H, s, OCH\(_2\)), 3.81 (3H, s, CH\(_3\)), 2.32 (6H, s, C7-H3); \(^{13}\)C NMR (101 MHz, CDCl\(_3\)) \(\delta\) 167.7 (C1), 157.9 (C8), 144.8 (C3), 137.4 (PhC), 131.9 (C6), 130.2 (C4), 129.0 (C5), 128.7 (2 × PhCH), 128.2 (PhCH), 127.9 (2 × PhCH), 116.6 (C2), 74.2 (OCH\(_2\)), 51.7 (OCH\(_3\)), 16.6 (C7); HRMS (ESI\(^+\)) Calculated for C\(_{19}\)H\(_{20}\)NaO\(_3\): 319.1305. Found [M+Na]\(^+\): 319.1311.

Methyl 3-(4-hydroxy-3,5-dimethylphenyl)propanoate\(^5\)

\[
\text{Me} \quad \text{OBn} \quad \text{Me} \quad \text{Me} \quad \text{Me} \\
\text{C} \quad \text{H} \quad \text{C} \quad \text{H} \quad \text{C} \\
\text{O} \quad \text{Me} \\
\]

\[
\text{Me} \quad \text{OH} \quad \text{Me} \quad \text{Me} \quad \text{Me} \\
\text{C} \quad \text{H} \quad \text{C} \quad \text{H} \quad \text{C} \\
\text{O} \quad \text{Me} \\
\]

**General procedure G:** Methyl \((E)\)-3-(4-(benzylxy)-3,5-dimethylphenyl)acrylate (2.37 g, 8.00 mmol) and 10 wt.% Pd/C (10 mol %) in MeOH (50 mL) were employed to afford the title compound (1.66 g, 99 %) as a colorless solid, which was used without further purification; m.p. 66 - 68 °C (EtOAc/hexane); R\(_f\) = 0.4 (20 % EtOAc/hexane); \(\nu_{\text{max}} / \text{cm}^{-1}\) (solid) 3492 (s,
br), 2952 (m), 2928 (m), 1723 (s), 1277 (s), 1174 (s), 1151 (s); $^1$H NMR (400 MHz, CDCl$_3$) δ 6.81 (2H, s, C$_5$-H), 4.55 (1H, br s, O-H), 3.67 (3H, s, OCH$_3$), 2.82 (2H, t, $J = 7.8$ Hz, C$_3$-H$_2$), 2.58 (2H, t, $J = 7.8$ Hz, C$_2$-H$_2$), 2.22 (6H, s, C$_7$-H$_3$); $^{13}$C NMR (101 MHz, CDCl$_3$) 173.7, 150.7, 132.2, 128.5, 123.2, 51.7, 36.3, 30.3, 16.0, HRMS. (ESI$^+$) Calculated for C$_{12}$H$_{16}$NaO$_3$: 231.0992. Found [M+Na]$^+$: 231.1002. The title compound has been described only in a patent.

Methyl 3-((tert-butyldimethylsilyl)oxy)-3,5-dimethylphenylpropanoate

To a solution of methyl 3-(4-hydroxy-3,5-dimethylphenyl)propanoate (1.33 g, 6.00 mmol) in CH$_2$Cl$_2$ (10 mL) and DMF (12 mL) was added tert-butyldimethylsilyl chloride (1.8 g, 12.0 mmol) and imidazole (0.82 g, 12.0 mmol) at 0 °C. The reaction was stirred at r.t. overnight and quenched with H$_2$O (50 mL) and the organic phase extracted with CH$_2$Cl$_2$ (3 x 15 mL), washed with brine (15 mL), dried over MgSO$_4$, filtered and concentrated in vacuo. Purification by flash column chromatography (10 % EtOAc/hexane) afforded the title compound (1.22 g, 63 %) as a colorless oil; R$_f$ = 0.6 (25 % EtOAc/hexane); $\nu_{\text{max}}$/cm$^{-1}$ (film) 2953 (m), 2930 (m), 1740 (s), 1484 (m), 1473 (m), 1253 (s), 1228 (s), 1153 (s); $^1$H NMR (400 MHz, CDCl$_3$) δ 6.79 (2H, s, C$_5$-H), 3.67 (3H, s, OCH$_3$), 2.81 (2H, t, $J = 7.8$ Hz, C$_3$-H$_2$), 2.58 (2H, t, $J = 7.8$ Hz, C$_2$-H$_2$), 2.18 (6H, s, C$_7$-H$_3$), 1.03 (9H, s, TBS (CH$_3$)$_3$), 0.18 (6H, s, TBS (CH$_3$)$_2$); $^{13}$C NMR (101 MHz, CDCl$_3$) δ 173.7 (C1), 150.6 (C8), 133.1 (C4), 128.6 (C5), 128.6 (C6), 51.7 (OCH$_3$), 36.2 (C2), 30.3 (C3), 26.3 (TBS (CH$_3$)$_3$), 18.9 (TBS C(CH$_3$)$_3$), 18.0 (C7), -2.8 (TBS Si(CH$_3$)$_2$); HRMS (ESI$^+$) Calculated for C$_{18}$H$_{30}$NaO$_3$Si: 345.1856. Found [M+Na]$^+$: 345.1870.
3-(4-((tert-Butyldimethylsilyl)oxy)-3,5-dimethylphenyl)propan-1-ol\(^6\)

General procedure B: Methyl 3-(4-((tert-butyldimethylsilyl)oxy)-3,5-dimethylphenyl)propanoate (0.96 mg, 3.0 mmol) and 2.0 eq. LiAlH\(_4\) (1 M in THF) in anhydrous Et\(_2\)O were employed. The crude product was filtered through a plug of silica and washed with EtOAc to afford the title compound (0.69 mg, 80 \%) as a pale yellow oil; \(R_f = 0.2\) (25 \% EtOAc/hexane); \(\nu_{\text{max}}\) / cm\(^{-1}\) (film) 3345 (br m), 2929 (m), 2858 (m), 1483 (s), 1472 (s), 1252 (s), 1227 (s), 1152 (s); \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta 6.79\) (2H, s), 3.66 (2H, t, \(J = 6.4\) Hz), 2.57 (2H, t, \(J = 7.5\) Hz), 2.18 (6H, s), 1.89-1.81 (2H, m), 1.29 (1H, br s), 1.03 (9H, s), 0.18 (6H, s); \(^13\)C NMR (101 MHz, CDCl\(_3\)) \(\delta 150.1, 134.2, 128.6, 128.3, 62.5, 34.3, 31.2, 26.1, 18.7, 17.8, -3.0. Spectroscopic properties were consistent with the data available in the literature.\(^6\)

**tert-Butyl (3-(4-((tert-butyldimethylsilyl)oxy)-3,5-dimethylphenyl)propyl)(tosyloxy) carbamate**

General procedure C: 3-(4-((tert-Butyldimethylsilyl)oxy)-3,5-dimethylphenyl)propan-1-ol (0.53 g, 1.80 mmol), PPh\(_3\) (0.58 g, 2.20 mmol), DIAD (0.43 mL, 2.20 mmol) and TsONHBoc (0.63 g, 2.20 mmol) in anhydrous THF (8 mL) were employed. Purification by flash column chromatography (10 \% EtOAc/hexane) afforded the title compound (0.88 g, 87 \%) as a colorless oil; \(R_f = 0.55\) (20 \% EtOAc/hexane); \(\nu_{\text{max}}\) / cm\(^{-1}\) (film) 2955 (m), 2930 (m), 1722 (s), 1473 (m), 1483 (m), 1383 (s), 1369 (s), 1230 (s), 1191 (s), 1179 (s), 1154 (s); \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta 7.84\) (2H, d, \(J = 8.3\) Hz, Ts ArC\(_H\)), 7.32 (2H, d, \(J = 8.3\) Hz, Ts ArC\(_H\)), 6.75 (2H, s, C\(_5\)-H), 3.61 (2H, app. br s, C\(_1\)-H\(_2\)), 2.46-2.42 (5H, m, overlapping C\(_3\)-H\(_2\) and Ts CH\(_3\)),
2.18 (6H, s, C7-H3) 1.93-1.81 (2H, m, C2-H2), 1.21 (9H, s, Boc (CH3)3), 1.03 (9H, s, TBS (CH3)3), 0.17 (6H, s, TBS Si(CH3)2); 13C NMR (101 MHz, CDCl3) δ 155.6 (Boc C=O), 150.4 (C8), 145.7 (Ts ArC), 133.7 (C4), 131.4 (Ts ArC), 129.8 (2 × Ts ArCH), 129.6 (2 × Ts ArCH), 128.7 (C5), 128.5 (C6), 83.2 (Boc C(CH3)3), 52.9 (C1), 32.1 (C3), 27.8 (C2), 27.7 (Boc (CH3)3), 26.3 (TBS (CH3)3), 21.9 (Ts CH3), 18.9 (TBS C(CH3)3), 18.0 (C7), -2.8 (TBS (CH3)2); HRMS (ESI+) Calculated for C29H45NNaO6Si: 586.2629. Found [M+Na]+: 586.2648.

tert-Butyl (3-(4-hydroxy-3,5-dimethylphenyl)propyl)(tosyloxy)carbamate (5b)

General procedure D: tert-Butyl (3-(4-((tert-butyldimethylsilyl)oxy)-3,5-dimethylphenyl)propyl) (tosyloxy)carbamate (0.45 g, 0.80 mmol) and 1:1 TBAF/HOAc solution (0.1 M in THF, 0.88 mmol) in THF (16 mL) were employed. Purification by flash column chromatography (gradient, eluent 20 - 33 % EtOAc/hexane) afforded 5b (0.31 g, 87 %) as a colorless, viscous oil; Rf = 0.3 (20 % EtOAc/hexane); v max / cm⁻¹ (film) 3530 (br m), 2979 (m), 2930 (m), 1721 (s), 1597 (m), 1489 (m), 1370 (s), 1192 (s), 1177 (s), 1152 (s); ¹H NMR (400 MHz, CDCl3) δ 7.84 (2H, d, J = 8.3 Hz, Ts ArCH), 7.32 (2H, d, J = 8.3 Hz, Ts ArCH), 6.77 (2H, s, C5-H), 4.49 (1H, s, OH), 3.62 (2H, app. br s, C1-H2), 2.44 (5H, m, overlapping C3-H2 and Ts CH3), 2.21 (6H, s, C7-H3), 1.93-1.85 (2H, m, C2-H2), 1.20 (9H, s, Boc (CH3)3); 13C NMR (101 MHz, CDCl3) δ 155.6 (Boc C=O), 150.5 (C8), 145.8 (Ts ArC), 132.8 (C4), 131.4 (Ts ArC), 129.8 (2 × Ts ArCH), 129.6 (2 × Ts ArCH), 128.5 (C5), 123.0 (C6), 83.3 (Boc C(CH3)3), 52.8 (C1), 32.1 (C3), 27.9 (C2), 27.7 (Boc (CH3)3), 21.8 (Ts CH3), 16.0 (C7); HRMS (ESI+) Calculated for C23H31NNaO6S: 472.1764. Found [M+Na]+: 472.1767.
7,9-Dimethyl-1-azaspiro[4.5]deca-6,9-dien-8-one (7b)

General procedure E: tert-Butyl (3-(4-hydroxy-3,5-dimethylphenyl)propyl)(tosyloxy) carbamate (5b) (89.8 mg, 0.20 mmol) and TFA (31.0 μL, 0.40 mmol) in TFE (2 mL) were employed. After stirring at r.t. for 22 h, purification by flash column chromatography (EtOAc) afforded 7b (30.0 mg, 85%) as a pale yellow/orange solid; m.p.: 110 - 113 °C (EtOAc/hexane); Rf = 0.1 (EtOAc); νmax / cm⁻¹ (film) 3318 (m), 2970 (m), 2946 (m), 2917 (m), 2882 (m), 1664 (s), 1623 (s), 1369 (m), 1222 (m); ¹H NMR (400 MHz, CDCl₃) δ 6.60 (2H, s, C₅-H), 3.19 (2H, t, J = 6.9 Hz, C₁-H₂), 2.04-1.96 (2H, m, C₂-H₂), 1.87-1.84 (9H, m, overlapping C₃-H₂, C₇-H₃ and NH); ¹³C NMR (101 MHz, CDCl₃) δ 187.2 (C₈), 147.7 (C₅), 132.7 (C₆), 60.4 (C₄), 46.1 (C₁), 36.7 (C₃), 25.5 (C₂), 16.0 (C₇); HRMS (ESI⁺) Calculated for C₁₁H₁₆NO: 178.1226. Found [M+H]⁺: 178.1228.

Ethyl 3-(3-bromo-4-hydroxyphenyl)propanoate⁷

A solution of bromine (0.25 mL, 4.75 mmol) in acetic acid (20 mL) was slowly added to a stirring solution of ethyl 3-(4-hydroxyphenyl)propionate (1.84 g, 9.50 mmol) at r.t. The
reaction mixture was stirred for 6 h then diluted with EtOAc (80 mL) and washed with brine (2 x 30 mL). The organic extracts were dried over anhydrous MgSO₄, filtered and concentrated in vacuo. Purification by flash column chromatography (5% EtOAc/PhMe) afforded the title compound (1.14 g, 44%) as a pale yellow solid; Rₚ = 0.3 (5% EtOAc/PhMe); νₘₐₓ / cm⁻¹ (solid) 3357 (br m), 2977 (m), 2936 (m), 1727 (s), 1704 (s), 1496 (s), 1289 (s), 1254 (s), 1180 (s), 1156 (s), 1039 (s); ¹H NMR (400 MHz, CDCl₃) 7.29 (1H, d, J = 2.0 Hz), 7.03 (1H, dd, J = 8.2, 2.0 Hz), 6.91 (1H, d, J = 8.2 Hz), 4.11 (2H, q, J = 7.2 Hz), 2.85 (2H, t, J = 8.5 Hz), 2.56 (2H, t, J = 7.6 Hz), 1.22 (3H, t, J = 7.2 Hz); ¹³C NMR (101 MHz, CDCl₃) δ 172.7, 150.7, 134.2, 131.6, 129.1, 116.0, 110.0, 60.5, 36.0, 29.8, 14.2. Spectroscopic properties are consistent the data available in the literature.⁷

**Ethyl 3-(3-bromo-4-((tert-butyldimethylsilyl)oxy)phenyl)propanoate**

To a solution of ethyl 3-(3-bromo-4-hydroxyphenyl)propanoate (1.08 g, 3.95 mmol) in DMF (5 mL) was added tert-butyldimethylsilyl chloride (0.71 g, 4.74 mmol) and imidazole (0.67 g, 9.88 mmol) and the reaction was stirred at r.t. overnight. To the reaction was added water (25 mL) and the organic phase extracted with CH₂Cl₂ (2 x 20 mL). The combined organic extracts were washed with brine (20 mL), dried over MgSO₄, filtered and concentrated in vacuo. Purification by flash column chromatography (5% EtOAc/hexane) afforded the title compound (1.43 g, 93%) as a colorless oil; Rₚ = 0.6 (5% EtOAc/hexane); νₘₐₓ / cm⁻¹ (film) 2956 (m), 2930 (m), 1734 (s), 150.1 (s), 133.2 (s), 128.2 (s), 120.2 (s), 115.2 (s), 60.6 (OCH₂CH₃), 36.1 (C2), 29.9 (C3), 25.9 (TBS (CH₃)₃), 18.5 (TBS SiC(CH₃)₃), 14.4 (OCH₂CH₃), -4.11 (TBS Si(CH₃)₂); HRMS (ESI⁺) Calculated for C₁₇H₂₇⁷⁶BrNaO₃Si: 409.0805. Found [M+Na]⁺: 409.0816.
3-(3-Bromo-4-((tert-butyl(dimethyl)silyl)oxy)phenyl)propan-1-ol

To a solution of ethyl 3-(3-bromo-4-((tert-butyl(dimethyl)silyl)oxy)phenyl)propanoate (1.03 g, 2.66 mmol) in anhydrous THF (15 mL) at -15 °C was added 0.75 eq. LiAlH$_4$ (1M in THF) and the reaction was stirred at the same temperature for 25 min. Then to the reaction mixture was added water (0.5 mL), aq. 1 M NaOH (0.2 mL) and water (1 mL). The reaction mixture was warmed to r.t., filtered through Celite® and washed with CH$_2$Cl$_2$. The filtrate was dried over Na$_2$SO$_4$, filtered and concentrated in vacuo. Purification by flash column chromatography (20 % EtOAc/hexane) afforded the title compound (0.80 g, 87 %) as a colorless oil; R$_f$ = 0.2 (20 % EtOAc/hexane); $\nu$_max/cm$^{-1}$ (film) 3327 (br m), 2930 (m), 2858 (m), 1492 (s), 1280 (s), 1253 (s); $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 7.34 (1H, d, J = 2.2 Hz, C$_9$-H), 6.97 (1H, dd, J = 8.2, 2.2 Hz, C$_5$-H), 6.77 (1H, dd, J = 8.2, 0.8 Hz, C$_6$-H), 3.63 (2H, t, J = 6.5 Hz, C$_1$-H$_2$), 2.60 (2H, t, J = 7.5 Hz, C$_3$-H$_2$), 1.87-1.80 (2H, m, C$_2$-H$_2$), 1.51 (1H, br s, OH), 1.03 (9H, s, TBS (CH$_3$)$_3$), 0.22 (6H, s, TBS (CH$_3$)$_2$); $^{13}$C NMR (101 MHz, CDCl$_3$) $\delta$ 150.7 (C$_7$), 136.1 (C$_4$), 133.2 (C$_9$), 128.3 (C$_5$), 120.2 (C$_6$), 115.2 (C$_8$), 62.1 (C$_1$), 34.2 (C$_2$), 31.0 (C$_3$), 25.9 (TBS (CH$_3$)$_3$), 18.5 (TBS C(CH$_3$)$_3$), -4.1 (TBS Si(CH$_3$)$_2$); HRMS (ESI$^+$) Calculated for C$_{15}$H$_{25}$BrNaO$_2$Si: 367.0699. Found [M+Na]$^+$: 367.0701.

tert-Butyl (3-(3-bromo-4-((tert-butyl(dimethyl)silyl)oxy)phenyl)propyl) (tosyloxy) carbamate

General procedure C: 3-(3-Bromo-4-((tert-butyl(dimethyl)silyl)oxy)phenyl)propan-1-ol (0.69 g, 2.00 mmol), PPh$_3$ (0.63 g, 2.40 mmol), DIAD (0.47 mL, 2.40 mmol) and TsONHBoc (0.69
g, 2.40 mmol) in anhydrous THF were employed. Purification by flash column chromatography (gradient eluent 5 \%- 10 \% EtOAc/hexane) afforded the title compound (1.12 g, 91 \%) as a colorless oil; R_f = 0.6 (20 \% EtOAc/hexane); \nu_{\text{max}} / \text{cm}^{-1} (film) 2955 (m), 2930 (m), 2858 (m), 1720 (s), 1493 (s), 1381 (s), 1368 (s), 1288 (s), 1254 (s), 1178 (s); \textsuperscript{1}H NMR (400 MHz, CDCl$_3$) \delta 7.83 (2H, d, J = 8.2 Hz, Ts ArCH$_2$), 7.32 (2H, d, J = 8.0 Hz, Ts ArCH$_2$), 7.29 (1H, d, J = 2.1 Hz, C$_9$H), 6.94 (1H, dd, J = 8.3, 2.2 Hz, C$_5$H), 6.77 (1H, d, J = 8.6 Hz, C$_6$H), 3.58 (2H, app. br s, C$_1$H$_2$), 2.49 (2H, t, J = 7.8 Hz, C$_3$H$_2$), 2.44 (3H, s, Ts CH$_3$), 1.95-1.87 (2H, m, C$_2$H$_2$), 1.22 (9H, s, Boc (CH$_3$)$_3$), 1.03 (9H, s, TBS (CH$_3$)$_3$), 0.23 (6H, s, Si(CH$_3$)$_2$); \textsuperscript{13}C NMR (101 MHz, CDCl$_3$) \delta 155.6 (C=O), 150.9 (C$_7$), 145.8 (Ts ArC), 135.4 (C$_4$), 133.1 (C$_9$), 131.4 (Ts ArC), 129.8 (2 \times Ts ArCH$_2$), 129.7 (2 \times Ts ArCH$_2$), 128.2 (C$_5$), 120.2 (C$_6$), 115.2 (C$_8$), 83.4 (Boc C(CH$_3$)$_3$), 52.6 (C$_1$), 31.8 (C$_3$), 27.8 (Boc (CH$_3$)$_3$), 27.5 (C$_2$), 25.9 (TBS (CH$_3$)$_3$), 21.8 (Ts CH$_3$), 18.5 (TBS SiC(CH$_3$)$_3$), -4.1 (TBS Si(CH$_3$)$_2$); HRMS (ESI\textsuperscript{+}) Calculated for C$_{27}$H$_{40}$BrNNaO$_6$Si: 636.1421. Found [M+Na]\textsuperscript{+}: 636.1422.

tert-Butyl (3-(3-bromo-4-hydroxyphenyl)propyl)(tosyloxy)carbamate (5c)

**General procedure D:** tert-Butyl (3-(3-bromo-4-((tert-butyldimethylsilyl)oxy)phenyl)propyl)(tosyloxy)carbamate (0.61 g, 1.00 mmol) and 1:1 solution of TBAF/AcOH (0.1 M in THF, 1.00 mmol) in THF (20 mL) were employed. Purification by flash column chromatography (20 \% EtOAc/hexane) afforded 5c (0.48 g, 96 \%) as a colorless solid; m.p.: 93 - 95 °C (EtOAc/hexane); R_f = 0.25 (20 \% EtOAc/hexane); \nu_{\text{max}} / \text{cm}^{-1} (solid) 3416 (br s), 2945 (m), 1682 (s), 1371 (s), 1361 (s), 1180 (s), 1158 (s); \textsuperscript{1}H NMR (400 MHz, CDCl$_3$) \delta 7.83 (2H, d, J = 8.3 Hz, Ts ArCH$_2$), 7.32 (2H, d, J = 8.1 Hz, Ts ArCH$_2$), 7.25 (1H, d, J = 2.2 Hz, C$_9$H), 7.00 (1H, dd, J = 8.3, 2.1 Hz, C$_5$H), 5.43 (1H, d, J = 8.3 Hz, C$_6$H), 5.43 (1H, s, OH), 3.59 (2H, app. br s, C$_1$H$_2$), 2.50 (2H, t, J = 7.8 Hz, C$_3$H$_2$), 2.44 (3H, s, Ts CH$_3$), 1.91-1.87 (2H, m, C$_2$H$_2$), 1.21 (9H, s, Boc (CH$_3$)$_3$); \textsuperscript{13}C NMR (101 MHz, CDCl$_3$) \delta 155.6 (C=O), 150.6 (C$_7$), 145.9...
(Ts ArC), 134.9 (C4), 131.6 (C9), 131.3 (Ts ArC), 129.8 (2 × Ts ArCH), 129.7 (2 × Ts ArCH), 129.2 (C5), 116.1 (C6), 110.1 (C8), 83.5 (Boc C(CH3)_3), 52.5 (C1), 31.7 (C3), 27.8 (Boc (CH3)_3), 27.6 (C2), 21.8 (Ts CH3); HRMS (ESI+) Calculated for C_{21}H_{26}^{79}BrNO_6S: 522.0556. Found [M+Na]^+: 522.0555.

7-bromo-1-azaspiro[4.5]deca-6,9-dien-8-one trifluoroacetate (7c) and 6-Bromo-1,2,3,4-tetrahydroquinolin-7-ol (8c)

General procedure E: tert-Butyl (3-(3-bromo-4-hydroxyphenyl)propyl)(tosyloxy)carbamate (5c) (75.06 mg, 0.15 mmol) and TFA (22.9 μL, 0.30 mmol) in TFE (1.5 mL) were employed. After stirring at r.t. for 45 h, purification by flash column chromatography (EtOAc) afforded the title compounds 7c (22.0 mg, 43 %) as a red/brown oil and 8c (8.8 mg, 19 %) as a brown oil.

Data for 7c; Rf = 0.1 (EtOAc); ν_{max} / cm^{-1} (film, CDCl3) 2924 (m), 1675 (s), 1407 (w), 1200 (s), 1134 (m), 1066 (m); ^1H NMR (400 MHz, CD3OD) δ 7.63 (1H, d, J = 3.0 Hz, C9-H), 7.14 (1H, dd, J = 10.0, 3.0 Hz, C5-H), 6.55 (1H, d, J = 10.1 Hz, C6-H), 3.64 (2H, t, J = 6.9 Hz, C1-H2), 2.41-2.30 (4H, m, C2-H2, C3-H2). The signals corresponding to the NH2 were not observed. ^13C NMR (101 MHz, CD3OD) δ 178.1 (C7), 144.7 (C9), 144.6 (C5), 130.3 (C6), 128.3 (C8), 66.9 (C4), 46.7 (C1), 37.4 (C3), 24.8 (C2). The signals corresponding to the trifluoroacetate group could not be resolved due to their weak intensity. HRMS (ESI+) Calculated for C_{9}H_{11}^{79}BrNO: 228.0019. Found [M]^+: 228.0019.

Data for 8c; Rf = 0.7 (EtOAc); ν_{max} / cm^{-1} (film) 3389 (m), 3197 (m), 2957 (m), 2918 (m), 2850 (m); ^1H NMR (400 MHz, CDCl3) δ 6.97 (1H, s, C5-H), 6.16 (1H, s, C8-H), 3.27-3.24 (2H, m, C1-H2), 2.66 (2H, t, J = 6.4 Hz, C3-H2), 1.91-1.85 (2H, m, C2-H2); ^13C NMR (101 MHz, CDCl3) δ 150.8 (C7), 145.1 (C9), 131.7 (C5), 115.8 (C4), 100.8 (C8), 96.6 (C6), 41.7 (C1),

Methyl 3-(3-bromo-4-hydroxyphenyl)propanoate

To a solution of methyl 3-(4-hydroxyphenyl)propanoate (4.50 g, 25.0 mmol) in AcOH (20 mL) was slowly added a solution of Br₂ (1.3 mL, 25.0 mmol) in AcOH (15 mL). The reaction was stirred at r.t. until completion by TLC analysis. The reaction was diluted with EtOAc (20 mL) and washed with brine (20 mL), dried over Na₂SO₄, filtered, and the solvent removed in vacuo. Purification by flash column chromatography (20% EtOAc/hexane) afforded the title compound (2.98 g, 46%) as a colorless solid; Rf = 0.2 (20% EtOAc/hexane); ¹H NMR (400 MHz, CDCl₃) δ 7.30 (1H, d, J = 2.1 Hz), 7.05 (1H, dd, J = 8.3, 2.0 Hz), 6.93 (1H, d, J = 8.3 Hz), 3.67 (3H, s), 2.86 (2H, t, J = 7.7 Hz), 2.59 (2H, dd, J = 8.6, 6.7 Hz); ¹³C NMR (101 MHz, CDCl₃) δ 173.2, 150.8, 134.3, 131.7, 129.2, 116.1, 110.1, 51.8, 35.8, 29.7. Spectroscopic properties were consistent with the data available in the literature.

Methyl 3-(3-bromo-4-((tert-butyldimethylsilyl)oxy)phenyl)propanoate

To a solution of methyl 3-(4-hydroxyphenyl)propanoate (2.94 g, 11.3 mmol) in DMF (5 mL) was added tert-butyldimethylsilyl chloride (2.05 g, 13.6 mmol) and imidazole (1.93 g, 28.4 mmol) and the reaction was stirred at r.t. overnight. To the reaction was added water (25
mL) and the organic phase was extracted with CH$_2$Cl$_2$ (2 × 20 mL). The combined organic phases were washed with brine (20 mL), dried over MgSO$_4$, filtered and concentrated in vacuo. Purification by flash column chromatography (20 % EtOAc/hexane) afforded the title compound (3.53 g, 84 %) as a colorless oil; $R_f = 0.4$ (20 % EtOAc/hexane); $\nu_{max}$/cm$^{-1}$ (film) 2952 (m), 2930 (m), 1738 (s), 1492 (s), 1253 (s); $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 7.35 (1H, d, $J = 2.2$ Hz, C$_{10}$-H), 7.04-6.93 (1H, m, C$_6$-H), 6.78 (1H, d, $J = 8.2$ Hz, C$_7$-H), 3.67 (3H, s, C$_1$-H$_3$), 2.85 (2H, t, $J = 7.8$ Hz, C$_4$-H$_2$), 2.58 (2H, t, $J = 7.8$ Hz, C$_3$-H$_2$), 1.03 (9H, s, TBS (CH$_3$)$_3$), 0.23 (6H, s, TBS Si(CH$_3$)$_2$); $^{13}$C NMR (101 MHz, CDCl$_3$) $\delta$ 173.3 (C$_2$), 151.1 (C$_8$), 134.8 (C$_5$), 133.2 (C$_{10}$), 128.2 (C$_6$), 120.2 (C$_7$), 115.3 (C$_9$), 51.8 (C$_1$), 35.8 (C$_4$), 29.9 (C$_3$), 25.9 (TBS (CH$_3$)$_3$), 18.5 (TBS C(CH$_3$)$_3$), -4.1 (TBS Si(CH$_3$)$_2$). HRMS (ESI$^+$) Calculated for C$_{16}$H$_{25}$BrNaO$_3$Si: 395.0648. Found [M+Na]$^+$: 395.0647.

Methyl 3-(4-((tert-butyldimethylsilyl)oxy)-3-cyclopropylphenyl)propanoate

Methyl 3-(3-bromo-4-((tert-butyldimethylsilyl)oxy)phenyl)propanoate (1.12 g, 3.00 mmol), cyclopropylboronic acid (0.77 g, 9.00 mmol), K$_3$PO$_4$ (3.82 g, 18.0 mmol) and tetrakis(triphenylphosphine)palladium (0) (Pd(PPh$_3$)$_4$) (346 mg, 0.30 mmol) in 20:1 toluene/H$_2$O (0.1 M) were heated at 95 ºC overnight, under an atmosphere of N$_2$, and monitored by GC-MS. Upon completion, the reaction was cooled to r.t. and filtered through Celite® washing with EtOAc. The crude reaction mixture was then washed with water and the organic layer was dried over Na$_2$SO$_4$, filtered and concentrated in vacuo. Purification by flash column chromatography (5 % EtOAc/hexane) afforded the title compound (0.81 g, 80 %) as a pale yellow oil; $R_f = 0.5$ (20 % EtOAc/hexane); $\nu_{max}$/cm$^{-1}$ (film) 2953 (m), 2930 (m), 2897 (m), 2858 (m), 1739 (s), 1498 (s), 1255 (s); $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 6.85 (1H, dd, $J = 8.2$, 2.3 Hz, C$_6$-H), 6.70 (1H, d, $J = 8.2$ Hz, C$_7$-H), 6.62 (1H, d, $J = 2.2$ Hz, C$_{10}$-H), 3.67 (3H, s, C$_1$-H$_3$), 2.84 (2H, t, $J = 8.0$ Hz, C$_4$-H$_2$), 2.57 (2H, t, $J = 8.0$ Hz, C$_3$-H$_2$), 2.13 (1H, tt, $J = 8.7$, 5.4 Hz, C$_{11}$-H), 1.03, (9H, s, TBS (CH$_3$)$_3$), 0.93 - 0.87 (2H, m, C$_{12}$/C$_{13}$-H$_2$), 0.64 - 0.60 (2H, m, C$_{12}$/C$_{13}$-H$_2$), 0.23 (6H, s, TBS Si(CH$_3$)$_2$); $^{13}$C NMR (101 MHz, CDCl$_3$) $\delta$ 173.6 (C$_2$), 152.9
3-(4-((tert-Butyldimethylsilyl)oxy)-3-cyclopropylphenyl)propan-1-ol

General procedure B: Methyl 3-(4-((tert-butyldimethylsilyl)oxy)-3-cyclopropylphenyl)propanoate (0.67 g, 2.00 mmol) and 2.0 eq. LiAlH₄ (1 M in THF) in anhydrous Et₂O were employed. Purification by flash column chromatography (20 % EtOAc/hexane) afforded the title compound (0.48 g, 78 %) as a colorless oil; Rf = 0.2 (20 % EtOAc/hexane); ν_max / cm⁻¹ (film) 3334 (m, br), 2953 (m), 2929 (m), 2885 (m), 2857 (m), 1496 (s), 1254 (s); ¹H NMR (400 MHz, CDCl₃) δ 6.84 (1H, dd, J = 8.1, 2.3 Hz, C₅-H), 6.70 (1H, d, J = 8.1 Hz, C₆-H), 6.61 (1H, d, J = 2.2 Hz, C₉-H), 3.65 (2H, t, J = 6.4 Hz, C₁-H₂), 2.59 (2H, dd, J = 8.6, 6.8 Hz, C₃-H₂), 2.12 (1H, tt, J = 8.7, 5.4 Hz, C₁₀-H), 1.88 - 1.79 (2H, m, C₂-H₂), 1.40 (1H, br s, O-H), 1.03 (9H, s, TBS (CH₃)₃), 0.92 - 0.88 (2H, m, C₁₁/C₁₂-H₂), 0.64 - 0.60 (2H, m, C₁₁/C₁₂-H₂), 0.23 (6H, s, TBS Si(CH₃)₂); ¹³C NMR (101 MHz, CDCl₃) δ 152.6 (C₇), 134.4 (C₄), 134.1 (C₈), 125.8 (C₅), 124.9 (C₉), 118.6 (C₆), 62.5 (C₁), 34.6 (C₂), 31.6 (C₃), 26.0 (TBS (CH₃)₃), 18.4 (TBS C(CH₃)₃), 10.1 (C₁₀), 8.2 (C₁₁,C₁₂), -4.1 (TBS Si(CH₃)₂). HRMS (ESI⁺) Calculated for C₁₈H₃₀NaO₂Si: 329.1907. Found [M+Na]⁺: 329.1940.

tert-Butyl (3-(4-((tert-butyldimethylsilyl)oxy)-3-cyclopropylphenyl)propyl)(tosyloxy) carbamate
General procedure C: 3-(4-((tert-Butyldimethylsilyl)oxy)-3-cyclopropylphenyl)propan-1-ol (0.43 g, 1.40 mmol), PPh₃ (0.44 g, 1.68 mmol), DIAD (0.33 mL, 1.68 mmol) and TsONHBoc (0.48 g, 1.68 mmol) in anhydrous THF (6 mL) were employed. Purification by flash column chromatography (5 % EtOAc/hexane) afforded the title compound (0.77 g, 96 %) as a colorless solid; Rₜ = 0.5 (20 % EtOAc/hexane); νₘₐₓ / cm⁻¹ (solid) 2949 (m), 2928 (m), 2883 (m), 2857 (m), 1712 (s), 1504 (m); ¹H NMR (400 MHz, CDCl₃) δ 7.84 (2H, d, J = 8.3 Hz, Ts ArC≡H), 7.33 (2H, d, J = 8.1 Hz, Ts ArC≡H), 6.80 (1H, dd, J = 8.1, 2.1 Hz, C₅-H), 6.68 (1H, d, J = 8.2 Hz, C₆-H), 6.57 (1H, d, J = 2.2 Hz, C₉-H), 3.60 (2H, app. br s, C₁₂-H₂), 2.49 - 2.44 (5H, m, C₃-H₂ and Ts C≡H₃), 2.15 - 2.08 (1H, m, C₁₀-H), 1.94 - 1.83 (2H, m, C₂-H₂), 1.22 (9H, s, Boc (CH₃)₃), 1.03 (9H, s, TBS (CH₃)₃), 1.03 (9H, s, TBS (CH₃)₃), 0.92 - 0.86 (2H, m, C₁₁/C₁₂-H₂), 0.64 - 0.60 (2H, m, C₁₁/C₁₂-H₂), 0.22 (6H, s, TBS Si(CH₃)₂); ¹³C NMR (101 MHz, CDCl₃) δ 155.6 (C=O), 152.7 (C₇), 145.7 (Ts ArC), 134.1 (C₈), 133.7 (C₄), 131.4 (Ts ArC), 129.8 (2 × Ts CH), 129.6 (2 × Ts C≡H), 125.7 (C₅), 124.8 (C₉), 118.6 (C₆), 83.2 (Boc C(CH₃)₃), 52.8 (C₁), 32.3 (C₃), 27.7 (C₂), 27.7 (Boc (CH₃)₃) 26.0 (TBS (CH₃)₃), 21.8 (Ts CH₃), 18.4 (TBS C(CH₃)₃), 10.1 (C₁₀), 8.2 (C₁₁,C₁₂), -4.1 (TBS Si(CH₃)₂). HRMS (ESI⁺) Calculated for C₃₀H₄₅NNaO₆Si: 598.2629. Found [M+Na]⁺: 598.2615.

**tert-Butyl (3-(3-cyclopropyl-4-hydroxyphenyl)propyl)(tosyloxy)carbamate (5d)**

![Diagram of 5d](image)

General procedure D: tert-Butyl (3-(4-((tert-butyldimethylsilyl)oxy)-3-cyclopropylphenyl)propyl) (tosyloxy)carbamate (0.58 g, 1.00 mmol) and 1:1 TBAF/AcOH solution (0.1 M in THF, 1.00 mmol) in THF (20 mL) were employed. Purification by flash column chromatography (20 % EtOAc/hexane) afforded 5d (0.37 g, 81 % yield) as a colorless solid; m.p.: 82 - 83 °C (EtOAc/hexane); Rₜ = 0.2 (20 % EtOAc/hexane); νₘₐₓ / cm⁻¹ (solid) 3472 (m, br), 2988 (m), 2930 (m), 1693 (s); ¹H NMR (400 MHz, CDCl₃) δ 7.84 (2H, d, J = 8.1 Hz, Ts ArC≡H), 7.33 (2H, d, J = 8.0 Hz, Ts ArC≡H), 6.90 (1H, dd, J = 8.2, 2.1 Hz, C₅-H), 6.86 (1H,
d, $J = 2.2$ Hz, C9-H), 6.76 (1H, d, $J = 8.1$ Hz, C6-H), 5.35 (1H, s, OH), 3.61 (2H, app. br s, C1-H2), 2.48 (2H, t, $J = 7.8$ Hz, C3-H2), 2.45 (3H, s, Ts CH3), 1.95 - 1.84 (2H, m, C2-H2), 1.83 - 1.76 (1H, m, C10-H), 1.21 (9H, s, Boc (CH3)3), 0.98 - 0.93 (2H, m, C11/C12-H2), 0.66 - 0.63 (2H, m, C11/C12-H2); $^{13}$C NMR (101 MHz, CDCl3) δ 155.6 (C=O), 153.7 (C7), 145.8 (Ts ArC), 132.9 (C4), 131.4 (Ts, ArC), 129.8 (2× Ts, ArCH), 129.6 (2× Ts, ArCH), 128.5 (C9), 127.5 (C5), 127.5 (C8), 114.6 (C6), 83.3 (Boc C(CH3)3), 52.8 (C1), 32.2 (C3), 27.8 (C2), 27.7 (Boc (CH3)3), 21.8 (Ts CH3), 9.5 (C10), 5.6 (C11/C12). HRMS (ESI+) Calculated for C24H31NNaO6S: 484.1764. Found [M+Na]+: 484.1750.

7-Cyclopropyl-1-azaspiro[4.5]deca-6,9-dien-8-one trifluoroacetate (7d) and 6-cyclopropyl-1,2,3,4-tetrahydroquinolin-7-ol (8d)

General procedure E: tert-Butyl (3-(3-cyclopropyl-4-hydroxyphenyl)propyl)(tosyloxy) carbamate (5d) (92.3 mg, 0.20 mmol) and TFA (31.0 μL, 0.40 mmol) in TFE (2 mL) were employed. After stirring at r.t. for 24 h, purification by flash column chromatography (EtOAc) afforded the title compounds 7d (32.1 mg, 53 %) and 8d (12.8 mg, 34 %) as yellow solids.

Data for 7d: m.p.: 99 - 101 °C (EtOAc/hexane); Rf = 0.1 (EtOAc); $\nu_{\text{max}}$ / cm$^{-1}$ (solid) 2962 (m), 1667 (s), 1643 (s); $^1$H NMR (400 MHz, CD3OD) δ 7.07 (1H, dd, $J = 10.0$, 3.1 Hz, C5-H), 6.49 (1H, d, $J = 3.0$ Hz, C9-H), 6.43 (1H, dd, $J = 10.1$, 1.3 Hz, C6-H), 3.66 - 3.56 (2H, m, C1-H2), 2.38 - 2.31 (2H, m, C2-H2), 2.23 - 2.19 (2H, m, C3-H2), 1.94 - 1.88 (1H, m, C10-H), 0.91 - 0.87 (2H, m, C11/C12-H2), 0.65 - 0.62 (2H, m, C11/C12-H2). The signals corresponding to the NH$_2$ were not observed. $^{13}$C NMR (101 MHz, CD3OD) δ 185.4 (C7), 144.5 (C8), 143.9 (C5), 134.6 (C9), 131.7 (C6), 64.9 (C4), 46.3 (C1), 37.8 (C3), 24.8 (C2), 10.0 (C10), 8.0 (C11/C12), 7.9 (C11/C12). The signals corresponding to the trifluoroacetate group could not be resolved due to their weak intensity. HRMS (ESI+) Calculated for C12H16NO: 190.1226. Found [M]+: 190.1230.

S22
Data for \textbf{8d}: m.p.: 108 - 110 °C (EtOAc/hexane); R\textsubscript{f} = 0.4 (EtOAc); \nu\textsubscript{max} / cm\textsuperscript{-1} (solid) 3306 (m), 2932 (m), 1614 (m); \textsuperscript{1}H NMR (400 MHz, CDCl\textsubscript{3}) \delta 6.68 (1H, s, C\textsubscript{5-H}), 6.04 (1H, s, C\textsubscript{8-H}), 5.10 (1H, br s, OH), 3.27 - 3.22 (2H, m, C\textsubscript{1-H}), 2.66 (2H, t, J = 6.4 Hz, C\textsubscript{3-H}), 1.93 - 1.87 (2H, m, C\textsubscript{2-H}), 1.69 - 1.62 (1H, m, C\textsubscript{10-H}), 0.89 - 0.84 (2H, m, C\textsubscript{11/C12-H}), 0.57 - 0.53 (2H, m, C\textsubscript{11/C12-H}). \textsuperscript{13}C NMR (101 MHz, CDCl\textsubscript{3}) 154.4 (C\textsubscript{7}), 144.5 (C\textsubscript{9}), 130.1 (C\textsubscript{5}), 116.3 (C\textsubscript{6}), 113.4 (C\textsubscript{4}), 100.1 (C\textsubscript{4}), 100.1 (C\textsubscript{6}), 26.4 (C\textsubscript{3}), 22.7 (C\textsubscript{2}), 8.7 (C\textsubscript{10}), 5.2 (C\textsubscript{11/C12}); HRMS (ESI\textsuperscript{+}) Calculated for C\textsubscript{12}H\textsubscript{16}NO: 190.1226. Found [M+H]\textsuperscript{+}: 190.1228.

\textbf{Methyl 3-(6-((\textit{tert}-butyldimethylsilyl)oxy)-[1,1'-biphenyl]-3-yl)propanoate}

Methyl 3-(3-bromo-4-((\textit{tert}-butyldimethylsilyl)oxy)phenyl)propanoate (1.12 g, 3.00 mmol), phenylboronic acid (1.09 g, 9.00 mmol), K\textsubscript{2}CO\textsubscript{3} (1.40 g, 10.2 mmol) and dichloro [1,1'-bis(di-\textit{tert}-butylphosphino)ferrocene] palladium(II) (Pd(dtbpf)Cl\textsubscript{2}) (97.8 mg, 0.15 mmol) in 5:1 PhMe/MeOH (0.12 M) were heated at 110 °C overnight, under an atmosphere of N\textsubscript{2}, and monitored by GC-MS. Upon completion, the reaction was cooled to r.t. and filtered through Celite\textsuperscript{®} washing with EtOAc. The crude reaction mixture was then washed with water and the organic layer dried over Na\textsubscript{2}SO\textsubscript{4}, filtered and concentrated in vacuo. Purification by flash column chromatography (5 % EtOAc/hexane) afforded the title compound (0.93 g, 84 %) as a pale yellow oil; R\textsubscript{f} = 0.5 (20 % EtOAc/hexane); \nu\textsubscript{max} / cm\textsuperscript{-1} (film) 2952 (m), 2929 (m), 2896 (m), 2857 (m), 1737 (s), 1486 (s), 1253 (s); \textsuperscript{1}H NMR (440 MHz, CDCl\textsubscript{3}) \delta 7.49 - 7.45 (2H, m, PhC\textsubscript{H}), 7.39 - 7.33 (2H, m, PhC\textsubscript{H}), 7.31 - 7.26 (1H, m, PhC\textsubscript{H}), 7.13 (1H, d, J = 2.3 Hz, C\textsubscript{9-H}), 7.03 (1H, dd, J = 8.3, 2.4 Hz, C\textsubscript{5-H}), 6.82 (1H, d, J = 8.2 Hz, C\textsubscript{6-H}), 3.67 (3H, s, OC\textsubscript{H}), 2.93 (2H, t, J = 7.9 Hz, C\textsubscript{3-H}), 2.63 (2H, t, J = 7.9 Hz, C\textsubscript{2-H}), 0.81 (9H, s, TBS (CH\textsubscript{3})\textsubscript{3}), -0.07 (6H, s, TBS Si(CH\textsubscript{3})\textsubscript{2}); \textsuperscript{13}C NMR (101 MHz, CDCl\textsubscript{3}) \delta 173.6 (C\textsubscript{1}), 151.1 (C\textsubscript{7}), 139.2 (C\textsubscript{8}), 133.6 (Ph\textsubscript{C}), 133.5 (C\textsubscript{4}), 130.8 (C\textsubscript{9}), 129.9 (2 \times PhCH\textsubscript{2}), 128.1 (C\textsubscript{5}), 127.9 (2 \times PhCH\textsubscript{2}), 126.9 (PhCH\textsubscript{2}), 120.5 (C\textsubscript{6}), 51.7 (OCH\textsubscript{3}), 36.1 (C\textsubscript{2}), 30.4 (C\textsubscript{3}), 25.7 (TBS (CH\textsubscript{3})\textsubscript{3}), 18.2 (TBS Si(CH\textsubscript{3})\textsubscript{3}), -4.5 (TBS Si(CH\textsubscript{3})\textsubscript{2}); HRMS (ESI\textsuperscript{+}) Calculated for C\textsubscript{22}H\textsubscript{30}NaO\textsubscript{5}: 393.1856. Found [M+Na]\textsuperscript{+}: 393.1856.

S23
3-(6-((tert-Butyldimethylsilyl)oxy)-[1,1'-biphenyl]-3-yl)propan-1-ol

**General procedure B:** Methyl 3-(6-((tert-butyl(dimethyl) silyl)oxy)-[1,1'-biphenyl]-3-yl)propanoate (0.74 g, 2.00 mmol) and 2.0 eq LiAlH₄ (1 M in THF) in anhydrous Et₂O were employed. Purification by flash column chromatography (20% EtOAc/hexane) afforded the title compound (0.60 g, 87%) as a colorless oil; Rᶠ = 0.2 (20% EtOAc/hexane); νmax/cm⁻¹ (film) 3338 (m, br), 2929 (m), 2857 (m), 2884 (m), 1485 (s), 1256 (s); ¹H NMR (400 MHz, CDCl₃) δ 7.52 - 7.47 (2H, m, PhCH), 7.40 - 7.34 (2H, m, PhCH), 7.32 - 7.26 (1H, m, PhCH), 7.14 (1H, d, J = 2.3 Hz, C₉-H), 7.04 (1H, dd, J = 8.2, 2.4 Hz, C₅-H), 6.84 (1H, d, J = 8.2 Hz, C₆-H), 3.69 (2H, t, J = 6.4 Hz, C₁-H₂), 2.69 (2H, t, J = 7.7 Hz, C₃-H₂), 1.94 - 1.87 (2H, m, C₃-H₂), 1.38 (1H, br s, OH), 0.82 (9H, s, TBS (CH₃)₃), -0.06 (6H, s, TBS Si(CH₃)₂). ¹³C NMR (101 MHz, CDCl₃) δ 150.8 (C₇), 139.3 (C₈), 134.9 (C₄), 133.4 (PhC), 130.9 (C₉), 129.9 (2 × PhCH), 128.2 (C₅), 127.9 (2 × PhCH), 126.8 (PhCH), 120.4 (C₆), 62.5 (C₁), 34.5 (C₂), 31.4 (C₃), 25.7 (TBS (CH₃)₃), 18.2 (TBS Si(CH₃)₃), -4.5 (TBS Si(CH₃)₂); HRMS (ESI⁺) Calculated for C₂₁H₃₀NaO₂Si: 365.1907. Found [M+Na]⁺: 365.1924.

**tert-Butyl(3-(6-((tert-butyl(dimethyl)silyl)oxy)-[1,1'-biphenyl]-3-yl)propyl)(tosyloxy) carbamate**

**General procedure C:** 3-(6-((tert-Butyldimethylsilyl)oxy)-[1,1'-biphenyl]-3-yl)propan-1-ol (54a) (0.48 g, 1.40 mmol), PPh₃ (0.44 g, 1.68 mmol), DIAD (0.33 ml, 1.68 mmol) and TsONHBoc (0.48 g, 1.68 mmol) in anhydrous THF (6 mL) were employed. Purification by flash column chromatography (5% EtOAc/hexane) afforded the title compound (0.74 g, 87%)
as a colorless solid; m.p.: 95 - 96 °C (EtOAc/hexane); Rf = 0.5 (EtOAc/hexane); νmax / cm⁻¹ (solid) 2985 (m), 2955 (m), 2937 (m), 1715 (s), 1365 (s); ¹H NMR (400 MHz, CDCl₃) δ 7.85 (2H, d, J = 8.2 Hz, Ts ArCH), 7.50-7.47 (2H, m, PhCH), 7.40 - 7.26 (5H, m, 3 × PhCH, 2 × Ts ArCH), 7.09 (1H, d, J = 2.3 Hz, C9-H), 7.01 (1H, dd, J = 8.2, 2.3 Hz, C5-H), 6.82 (1H, d, J = 8.2 Hz, C6-H), 3.64 (2H, app. br s, C1-H), 2.57 (2H, t, J = 7.8 Hz, C3-H), 2.44 (3H, s, Ts CH₃), 2.01 - 1.88 (2H, m, C2-H), 1.21 (9H, s, Boc (CH₃)₃), 0.81 (9H, s, TBS (CH₃)₃), -0.08 (6H, s, TBS Si(CH₃)₂). ¹³C NMR (101 MHz, CDCl₃) δ 155.5 (C=O), 150.9 (C₇), 145.8 (Ts ArC), 139.3 (PhC), 134.2 (C4), 133.4 (C8), 131.4 (Ts ArC), 130.8 (C9), 129.9 (2 × PhCH), 129.8 (2 × Ts ArCH), 129.6 (2 × Ts ArCH), 128.1 (C5), 127.9 (2 × PhCH), 126.8 (PhCH), 120.4 (C6), 83.3 (Boc C(CH₃)₃), 52.8 (C1), 32.2 (C3), 27.8 (Boc (CH₃)₃), 27.7 (C2), 25.7 (TBS (CH₃)₃), 21.8 (Ts CH₃), 18.2 (TBS Si(CH₃)₃), -4.5 (TBS Si(CH₃)₂); HRMS (ESI⁺) Calculated for C₃₃H₄₅NNaO₆SSi: 634.2629. Found [M+Na]⁺: 634.2609.

tert-Butyl (3-(6-hydroxy-[1,1'-biphenyl]-3-yl)propyl)(tosyloxy)carbamate (5e)

**General procedure D:** tert-Butyl(3-(6-((tert-butyldimethylsilyl)oxy)-[1,1'-biphenyl]-3-yl)propyl) (tosyloxy)carbamate (0.61 g, 1.00 mmol) and 1:1 TBAF/AcOH solution (0.1 M in THF, 1.00 mmol) in THF (20 mL) were employed. Purification by flash column chromatography (20 % EtOAc/petroleum ether) afforded 5e (0.41 g, 82 %) as a colorless solid; m.p.: 108 - 110 °C (EtOAc/hexane); Rf = 0.2 (20 % EtOAc/hexane); νmax / cm⁻¹ (film) 3467 (m, br), 2980 (m), 2930 (m), 1719 (s), 1368 (s), 1176 (s), 1151 (s); ¹H NMR (400 MHz, CDCl₃) δ 7.84 (2H, d, J = 8.4 Hz, Ts ArCH), 7.51 - 7.46 (4H, m, PhCH), 7.42 - 7.36 (1H, m, PhCH), 7.32 (2H, d, J = 8.0 Hz, Ts ArCH), 7.07 - 7.03 (2H, m C5, C9-H), 6.90 (1H, d, J = 8.2 Hz, C6-H), 5.17 (1H, s, OH), 3.65 (2H, app. br s, C1-H), 2.57 (2H, t, J = 7.8 Hz, C3-H), 2.44 (3H, s, Ts CH₃), 2.01 - 1.87 (2H, m, C2-H), 1.22 (9H, s, Boc (CH₃)₃). ¹³C NMR (101 MHz, CDCl₃) δ 155.6 (C=O), 150.8 (C7), 145.8 (Ts ArC), 137.3 (PhC), 133.5 (C4), 131.4 (Ts ArC), 130.1 (C9), 129.8 (2 × PhCH), 129.7 (2 × Ts ArCH), 129.4 (2 × Ts ArCH), 129.2 (2 × PhCH), 129.0
(C5), 128.1 (C8), 127.9 (PhCH), 115.9 (C6), 83.4 (Boc C(CH₃)₃), 52.7 (C1), 32.1 (C3), 27.7 (Boc (CH₃)₃), 27.7 (C2), 21.8 (Ts CH₃); HRMS (ESI⁺) Calculated for C₂₇H₃₁NNaO₆S: 520.1764. Found [M+Na]⁺: 520.1766.

7-Phenyl-1-azaspiro[4.5]deca-6,9-dien-8-one trifluoroacetate (7e) and 6-Phenyl-1,2,3,4-tetrahydroquinolin-7-ol (8e)

**General procedure E**: tert-Butyl (3-(6-hydroxy-[1,1'-biphenyl]-3-yl)propyl)(tosyloxy) carbamate (5e) (74.6 mg, 0.15 mmol) and TFA (23 μL, 0.30 mmol) in anhydrous TFE (1.5 mL) were employed. After stirring at r.t. for 46 h, purification by flash column chromatography (EtOAc) afforded the title compounds 7e (26.0 mg, 51 %) and 8e (11.7 mg, 35 %) as yellow solids.

Data for 7e: m.p.: 136 - 138 °C (EtOAc/hexane); Rf = 0.1 (5% MeOH/CH₂Cl₂); νmax / cm⁻¹ (film) 3374 (m, br), 2975 (m), 1665 (s), 1640 (s); ¹H NMR (400 MHz, CD₃OD) δ 7.46 - 7.37 (5H, m, PhC₆H), 7.14 (1H, dd, J = 10.0, 3.3 Hz, C₅-H), 7.09 (1H, d, J = 3.2 Hz, C₈-H), 6.52 (1H, d, J = 10.0 Hz, C₆-H), 3.70-3.63 (2H, m, C₁-H₂), 2.45-2.30 (4H, m, C₂-H₂, C₃-H₂). The signals corresponding to the NH₂ were not observed. ¹³C NMR (101 MHz, CD₃OD) δ 184.4 (C₇), 143.6 (C₅), 142.1 (C₈), 141.0 (C₆), 135.6 (PhC), 132.2 (C₆), 130.0 (2 × PhCH), 129.9 (PhCH), 129.2 (2 × PhCH), 65.2 (C₄), 46.5 (C₁), 37.9 (C₃), 24.9 (C₂). The signals corresponding to the trifluoroacetate group could not be resolved due to their weak intensity. HRMS (ESI⁺) Calculated for C₁₅H₁₆NO: 226.1226. Found [M⁺]: 226.1229.

Data for 8e: m.p.: 91 - 94 °C (EtOAc/hexane); Rf = 0.4 (5% MeOH/CH₂Cl₂); νmax / cm⁻¹ (solid) 3405 (br m), 2925 (m), 2852 (m), 1622 (s), 1488 (s), 1160 (s); ¹H NMR (400 MHz, CDCl₃) δ 7.46 - 7.40 (4H, m, PhC₆H), 7.33 - 7.28 (1H, m, PhCH), 6.84 (1H, s, C₅-H), 6.11 (1H, s, C₈-H), 4.98 (1H, br s), 4.04 (1H, br s), 3.32 - 3.29 (2H, m, C₁-H₂), 2.73 (2H, t, J = 6.4 Hz, C₃-H₂), 1.97 - 1.91 (2H, m, C₂-H₂); ¹³C NMR (101 MHz, CDCl₃) δ 151.3 (C₇), 145.4 (C₉), 137.7
(PhC), 130.8 (C5), 129.1 (2 × PhCH), 128.9 (2 × PhCH), 126.8 (PhCH), 117.3 (C6), 114.2 (C4), 100.5 (C8), 41.9 (C1), 26.2 (C3), 22.4 (C2); HRMS (ESI⁺) Calculated for C₁₅H₁₆NO: 226.1226. Found [M+H]⁺: 226.1232.

Ethyl (E)-3-(4-hydroxy-2-methoxyphenyl)acrylate

General procedure F: 4-Hydroxy-2-methoxybenzaldehyde (3.04 g, 20.0 mmol) and ethyl 2-(triphenyl-phosphaneylidene) acetate (10.5 g, 30.0 mmol) in CH₂Cl₂ (20 mL) were employed. Purification by flash column chromatography (20 % EtOAc/pentane) afforded the title compound (3.54 g, 80 %) as a colorless solid; m.p.: 144 - 146 °C (EtOAc/hexane); Rₕ = 0.2 (20 % EtOAc/hexane); νmax / cm⁻¹ (solid) 3322 (br m), 1675 (s); ¹H NMR (400 MHz, (CD₃)₂CO) δ 7.88 (1H, d, J = 16.0 Hz, C₃-H), 7.50 (1H, d, J = 8.4 Hz, C₁₀-H), 6.53 (1H, d, J = 2.3 Hz, C₇-H), 6.49 (1H, dd, J = 8.4, 2.3 Hz, C₉-H), 6.39 (1H, d, J = 16.0 Hz, C₂-H) 4.18 (2H, q, J = 7.1 Hz, OCH₂), 3.88 (3H, s, C₆), 1.27 (3H, t, J = 7.1 Hz, CH₂CH₃); ¹³C NMR (101 MHz, (CD₃)₂CO) δ 168.0 (C₁), 162.1 (C₈), 161.0 (C₆), 140.5 (C₃), 131.2 (C₁₀), 115.8 (C₄), 115.8 (C₂), 108.9 (C₉), 100.0 (C₇), 60.4 (OCH₃), 56.0 (C₆), 14.8 (CH₂CH₃); HRMS (ESI⁺) Calculated for C₁₂H₁₄NaO₄: 245.0784. Found [M+Na]⁺: 245.0784.

Ethyl 3-(4-hydroxy-2-methoxyphenyl)propanoate⁹

General procedure G: Ethyl (E)-3-(4-hydroxy-2-methoxyphenyl)acrylate (2.22 g, 10.0 mmol) and 10 wt.% Pd/C (5 mol%) in EtOH (30 mL) were employed. Purification by Flash column chromatography (20% EtOAc/hexane) afforded the title compound (1.80 g, 80%) as a colorless solid; Rₕ = 0.2 (20 % EtOAc/hexane); ¹H NMR (400 MHz, CDCl₃) δ 6.94 (2H, d, J =
8.0 Hz), 6.38 (1H, d, J = 2.4 Hz), 6.31 (1H, dd, J = 8.0, 2.4 Hz), 4.13 (2H, q, J = 7.2 Hz), 3.74 (3H, s), 2.85 (2H, t, J = 8.0 Hz), 2.57 (2H, t, J = 8.0 Hz), 1.24 (3H, t, J = 7.2 Hz); $^{13}$C NMR (101 MHz, CDCl$_3$) δ 174.3, 158.6, 155.8, 130.4, 120.7, 106.7, 99.0, 60.6, 55.3, 34.8, 25.6, 14.30. Spectroscopic properties were consistent with the data available in the literature.$^9$

**Ethyl 3-((tert-butyldimethylsilyl)oxy)-2-methoxyphenylpropanoate**

![Structure of Ethyl 3-((tert-butyldimethylsilyl)oxy)-2-methoxyphenylpropanoate](image)

Ethyl 3-((4-hydroxy-2-methoxyphenyl)propanoate (1.68 g, 7.50 mmol), tert-butyldimethylsilyl chloride (1.36 g, 9.00 mmol), and imidazole (1.28 g, 18.75 mmol) in DMF (15 mL) were employed. Purification by flash column chromatography (20 % EtOAc/pentane) afforded the title compound (1.31 g, 52 %) as a colorless oil; $R_f = 0.4$ (20 % EtOAc/hexane); $^1$H NMR (400 MHz, CDCl$_3$) δ 6.95 (1H, d, J = 8.7 Hz, C$_{10}$H$_3$), 6.36 - 6.32 (2H, m, C$_{7}$H$_2$, C$_{9}$H$_2$), 4.11 (2H, q, J = 7.1 Hz, OC$_2$H$_4$), 3.77 (3H, s, C$_6$H$_3$), 2.85 (2H, t, J = 7.8 Hz, C$_3$H$_2$), 2.55 (2H, t, J = 7.8 Hz, C$_2$H$_2$), 1.23 (3H, t, J = 7.1 Hz, CH$_2$CH$_3$), 0.98 (9H, s, TBS (CH$_3$)$_3$), 0.20 (6H, s, TBS Si(CH$_3$)$_2$); $^{13}$C NMR (101 MHz, CDCl$_3$) δ 173.6 (C$_1$), 158.3 (C$_5$), 155.4 (C$_8$), 130.1 (C$_{10}$), 121.8 (C$_4$), 111.3 (C$_9$), 103.4 (C$_7$), 60.3 (OCH$_2$), 55.3 (C$_6$), 34.7 (C$_2$), 25.9 (TBS (CH$_3$)$_3$), 25.7 (C$_3$), 18.3 (TBS Si(CH$_3$)$_3$), 14.4 (CH$_2$CH$_3$), -4.3 (TBS Si(CH$_3$)$_2$); HRMS (ESI$^+$) Calculated for C$_{18}$H$_{30}$NaO$_4$Si: 361.1806. Found [M+Na]$^+$: 361.1821.

**3-(4-((tert-Butyldimethylsilyl)oxy)-2-methoxyphenyl)propan-1-ol**

![Structure of 3-(4-((tert-Butyldimethylsilyl)oxy)-2-methoxyphenyl)propan-1-ol](image)

**General procedure B:** Ethyl 3-(4-((tert-butyldimethylsilyl)oxy)-2-methoxyphenyl)propanoate (1.01 g, 3.00 mmol) and 1.5 eq. LiAlH$_4$ (1M in THF) in anhydrous Et$_2$O (15 mL) were employed. Purification by flash column chromatography (33 %
EtOAc/hexane) afforded the title compound (0.65 mg, 73 %) as a colorless oil; \( R_t = 0.3 \) (33 % EtOAc/hexane); \( \nu_{\text{max}} / \text{cm}^{-1} \) (film) 3351 (br m), 2952 (m), 2857 (m), 1607 (m), 1503 (s); \(^1\)H NMR (400 MHz, CDCl\(_3\)) \( \delta 6.95 \) (1H, d, \( J = 8.4 \) Hz, C\( ^{10} \)-H), 6.40 - 6.36 (2H, m, C\( ^{7} \)-H, C\( ^{9} \)-H), 3.79 (3H, s, C\( ^{6} \)-H\(_3\)), 3.58 (2H, t, \( J = 6.2 \) Hz, C\( ^{1} \)-H\(_2\)), 2.64 (2H, t, \( J = 7.3 \) Hz, C\( ^{3} \)-H\(_2\)), 1.84 - 1.74 (3H, m, C\( ^{2} \)-H\(_2\), OH), 0.99 (9H, s, TBS (CH\(_3\))\(_3\)), 0.20 (6H, s, TBS Si(CH\(_3\))\(_2\)); \(^{13}\)C NMR (101 MHz, CDCl\(_3\)) \( \delta 158.2 \) (C\( ^{5} \)), 155.6 (C=O), 155.2 (C\( ^{8} \)), 145.7 (Ts ArC), 131.5 (Ts ArC), 130.3 (C\( ^{10} \)), 122.4 (C\( ^{4} \)), 112.8 (C\( ^{7} \)), 103.5 (C\( ^{7} \)), 53.1 (C\( ^{1} \)), 52.8 (Boc (CH\(_3\))\(_3\)), 26.7 (C\( ^{3} \)), 26.1 (C\( ^{2} \)), 25.9 (TBS (CH\(_3\))\(_3\)), 21.8 (Ts CH\(_3\)), 18.4 (TBS Si(CH\(_3\))\(_3\)), -4.2 (TBS Si(CH\(_3\))\(_2\)); HRMS (ESI\(^{+}\)) Calculated for C\(_{16}\)H\(_{28}\)NaO\(_3\)Si: 319.1700. Found [M+Na]\(^{+}\): 319.1707.

**tert-Butyl (3-(4-((tert-butyldimethylsilyloxy)-2-methoxyphenyl) propyl)(tosyloxy) carbamate**

![Diagram](https://example.com/diagram.png)

**General procedure C:** 3-(4-((tert-Butyldimethylsilyloxy)-2-methoxy phenyl)propan-1-ol (0.53 g, 1.80 mmol), PPh\(_3\) (0.56 g, 2.16 mmol), DIAD (0.42 mL, 2.16 mmol) and TsONHBoc (0.62 g, 2.16 mmol) in anhydrous THF (10 mL) were employed. Purification by flash column chromatography afforded the title compound (0.94 g, 92 %) as a colorless oil; \( R_t = 0.5 \) (33 % EtOAc/hexane); \( \nu_{\text{max}} / \text{cm}^{-1} \) (film) 2955 (m), 2930 (m), 1721 (s), 1504 (s), 1158 (s); \(^1\)H NMR (400 MHz, CDCl\(_3\)) \( \delta 7.84 \) (2H, d, \( J = 8.3 \) Hz, Ts ArC\( ^{1} \)-H), 7.32 (2H, d, \( J = 8.3 \) Hz, Ts ArC\( ^{9} \)-H), 6.90 (1H, d, \( J = 8.0 \) Hz, C\( ^{10} \)-H), 6.36 - 6.33 (2H, m, C\( ^{7} \), C\( ^{9} \)-H\(_2\)), 3.75 (3H, s, C\( ^{6} \)-H\(_3\)), 3.69 - 3.48 (2H, m, C\( ^{1} \)-H\(_2\)), 2.49 (2H, t, \( J = 8.0 \) Hz, C\( ^{3} \)-H\(_2\)), 2.44 (3H, s, Ts CH\(_3\)), 1.94 - 1.78 (2H, m, C\( ^{2} \)-H\(_2\)), 1.22 (9H, s, Boc (CH\(_3\))\(_3\)), 0.99 (9H, s, TBS (CH\(_3\))\(_3\)), 0.20 (6H, s, TBS Si(CH\(_3\))\(_2\)); \(^{13}\)C NMR (101 MHz, CDCl\(_3\)) \( \delta 158.2 \) (C\( ^{5} \)), 155.2 (C\( ^{8} \)), 131.5 (Ts ArC), 130.3 (2×Ts ArC), 129.8 (2×Ts ArC), 129.6 (2×Ts ArC), 122.4 (C\( ^{4} \)), 112.8 (C\( ^{7} \)), 103.5 (C\( ^{7} \)), 83.2 (Boc C(CH\(_3\))\(_3\)), 55.3 (C\( ^{6} \)), 53.1 (C\( ^{1} \)), 27.8 (Boc (CH\(_3\))\(_3\)), 26.7 (C\( ^{3} \)), 26.1 (C\( ^{2} \)), 25.9 (TBS (CH\(_3\))\(_3\)), 21.8 (Ts CH\(_3\)), 18.4 (TBS Si(CH\(_3\))\(_3\)), -4.2 (TBS Si(CH\(_3\))\(_2\)); HRMS (ESI\(^{+}\)) Calculated for C\(_{28}\)H\(_{43}\)NNaO\(_3\)Si: 588.2422. Found [M+Na]\(^{+}\): 588.2419.
** tert-Butyl (3-(4-hydroxy-2-methoxyphenyl)propyl)(tosyloxy)carbamate (5f) **

![Diagram of 5f]

**General procedure D:** tert-Butyl (3-(4-((tert-butyldimethylsilyl)oxy)-2-methoxyphenyl)propyl)(tosyloxy)carbamate (0.56 g, 1.00 mmol) and 1:1 TBAF/AcO\textsubscript{H} solution (0.1 M in THF, 1.00 mmol) in THF (20 mL) were employed. Purification by flash column chromatography (33 % EtOAc/hexane) afforded 5f (0.38 g, 84 %) as a colorless viscous oil; R\textsubscript{f} = 0.25 (33 % EtOAc/hexane); \nu\textsubscript{max} / cm\textsuperscript{-1} (film) 3422 (br m), 2936 (m), 1720 (m), 1368 (s); \textsuperscript{1}H NMR (400 MHz, CDCl\textsubscript{3}) \delta 7.84 (2H, d, J = 8.3 Hz, Ts Ar\textsubscript{C}H), 7.32 (2H, d, J = 8.3 Hz, Ts Ar\textsubscript{C}H), 6.90 (1H, d, J = 8.0 Hz, C\textsubscript{10}-H), 6.38 (1H, d, J = 2.4 Hz, C\textsubscript{7}-H), 6.32 (1H, dd, J =8.0, 2.4 Hz, C\textsubscript{9}-H\textsubscript{2}), 4.67 (1H, br s, OH), 3.76 (3H, s, C\textsubscript{6}-H\textsubscript{3}), 3.70 - 3.48 (2H, m, C\textsubscript{1}-H\textsubscript{2}), 2.48 (2H, t, J = 7.7 Hz, C\textsubscript{3}-H\textsubscript{2}), 2.43 (3H, s, Ts CH\textsubscript{3}), 1.94 - 1.78 (2H, m, C\textsubscript{2}-H\textsubscript{2}), 1.22 (9H, s, Boc (CH\textsubscript{3})\textsubscript{3}); \textsuperscript{13}C NMR (101 MHz, CDCl\textsubscript{3}) \delta 158.5 (C\textsubscript{5}), 155.7 (C=O), 155.3 (C\textsubscript{8}), 145.7 (Ts Ar\textsubscript{C}), 131.4 (Ts Ar\textsubscript{C}), 130.1 (C\textsubscript{10}), 129.8 (2 \times Ts Ar\textsubscript{CH}), 129.6 (2 \times Ts Ar\textsubscript{CH}), 121.7 (C\textsubscript{4}), 106.6 (C\textsubscript{9}), 98.9 (C\textsubscript{7}), 83.3 (Boc C(CH\textsubscript{3})\textsubscript{3}), 55.4 (C\textsubscript{6}), 53.1 (C\textsubscript{1}), 27.8 (Boc (CH\textsubscript{3})\textsubscript{3}), 26.7 (C\textsubscript{3}), 26.1 (C\textsubscript{2}), 21.8 (Ts CH\textsubscript{3}); HRMS (ESI\textsuperscript{+}) Calculated for C\textsubscript{22}H\textsubscript{29}NNaO\textsubscript{7}S: 474.1557. Found [M+Na]\textsuperscript{+}: 474.1566.

** 6-Methoxy-1-azaspiro[4.5]deca-6,9-dien-8-one trifluoroacetate (7f) **

![Diagram of 7f]

**General procedure E:** tert-Butyl (3-(4-hydroxy-2-methoxyphenyl)propyl)(tosyloxy)carbamate (5f) (67.7 mg, 0.15 mmol) and TFA (23 \μL) in TFE (1.5 mL) were stirred at r.t. for 39 h until completion by TLC analysis. Purification by flash column chromatography (EtOAc)
afforded 7f (32.6 mg, 74 %) as a viscous yellow oil; \( R_f = 0.1 \) (5 % MeOH/CH\(_2\)Cl\(_2\)); \( \nu_{\max} / \text{cm}^{-1} \) (film) 2987 (m), 2901 (m), 1665 (s), 1636 (m), 1602 (s); \( ^1\)H NMR (400 MHz, CD\(_3\)OD) \( \delta \) 6.93 (1H, d, \( J = 10.0 \) Hz, C10-H), 6.29 (1H, dd, \( J = 10.0, 1.6 \) Hz, C9-H), 5.79 (1H, d, \( J = 1.6 \) Hz, C7-H), 3.89 (3H, s, C6-H3), 3.66 - 3.54 (2H, m, C1-H2), 2.53 - 2.46 (1H, m, C3-H), 2.40 - 2.22 (3H, m, C3-H', C2-H2). The signals corresponding to the NH\(_2\) were not observed. \( ^{13}\)C NMR (400 MHz, CD\(_3\)OD) \( \delta \) 187.4 (C8), 171.2 (C5), 141.4 (C10), 130.0 (C9), 104.2 (C7), 65.6 (C4), 57.6 (C6), 48.7 (C1), 38.0 (C3), 26.0 (C2). The signals corresponding to the trifluoroacetate group could not be resolved due to their weak intensity. HRMS (ESI\(^+\)) Calculated for C\(_{10}\)H\(_{14}\)NO\(_2\): 180.1019. Found [M+H]\(^+\): 180.1021.

**Ethyl (E)-3-(4-hydroxyphenyl)acrylate\(^{10}\)**

![Chemical structure](image)

**General procedure F:** 4-Hydroxybenzaldehyde (4.88 g, 40.0 mmol) and ethyl (triphenylphosphoranylidene)acetate (20.9 g, 60.0 mmol) in CH\(_2\)Cl\(_2\) (40 mL) were employed. Purification by flash column chromatography (20 % EtOAc/hexane) afforded the title compound (6.56 g, 85 %) as a colorless solid; \( R_f = 0.5 \) (33 % EtOAc/hexane); \( ^1\)H NMR (400 MHz, CDCl\(_3\)) \( \delta \) 7.64 (1H, d, \( J = 16.0 \) Hz), 7.42 (2H, d, \( J = 8.6 \) Hz), 6.86 (2H, d, \( J = 8.3 \) Hz), 6.30 (1H, d, \( J = 16.0 \) Hz), 6.14 (1H, br s), 4.27 (2H, q, \( J = 7.1 \) Hz), 1.34 (3H, t, \( J = 7.1 \) Hz); \( ^{13}\)C NMR (101 MHz) \( \delta \) 168.1, 158.1, 144.9, 132.4, 130.1, 127.2, 116.1, 115.5, 115.1, 60.8, 14.5. Spectroscopic properties were consistent with the data available in the literature.\(^{10}\)

**Ethyl (E)-3-(4-((tert-butyldimethylsilyl)oxy)phenyl)acrylate\(^{11}\)**

![Chemical structure](image)
To a solution of Ethyl \((E)-3-(4\text{-hydroxyphenyl})\text{acrylate}\) (3.84 g, 20.0 mmol) in DMF (20 mL) were added \textit{tert}-butyldimethylsilyl chloride (3.60 g, 24.0 mmol) and imidazole (3.40 g, 50.0 mmol) and the reaction was stirred overnight at r.t. until completion by TLC analysis. Purification by flash column chromatography (20 % EtOAc/ hexane) afforded the title compound (5.13 g, 84 %) as a colorless oil; \(R_f = 0.4\) (10 % EtOAc/hexane); \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta 7.63\) (1H, d, \(J = 16.0\) Hz), \(7.41\) (2H, d, \(J = 8.6\) Hz), \(6.83\) (2H, d, \(J = 8.5\) Hz), \(6.30\) (1H, d, \(J = 16.0\) Hz), \(4.25\) (2H, q, \(J = 7.3\) Hz), \(1.33\) (3H, t, \(J = 7.3\) Hz), \(0.98\) (9H, s, TBS (C\(_3\)H\(_3\))\(_3\)), \(0.22\) (6H, s, TBS Si(C\(_3\)H\(_3\))\(_2\)); \(^{13}\)C NMR (101 MHz, CDCl\(_3\)) \(\delta 167.5, 157.9, 144.4, 129.8, 127.9, 120.6, 116.1, 60.4, 25.8, 18.4, 14.5, -4.2\). Spectroscopic properties were consistent with the data available in the literature. \(^{11}\)

Ethyl 3-(4-((\textit{tert}-butyldimethylsilyl)oxy)phenyl)pentanoate

\[
\begin{align*}
\text{CuI (2.86 g, 15.0 mmol) in anhydrous Et}_2\text{O (60 mL) was stirred under nitrogen at room temperature until a suspension was observed. The mixture was cooled to -20 °C and EtMgBr (3.0 M solution in Et}_2\text{O, 37.5 mmol) was added. After stirring for 5 min, a solution of ethyl (\(E\))-3-(4-((\textit{tert}-butyldimethylsilyl)oxy)phenyl)acrylate (4.6 g, 15.0 mmol) in anhydrous Et}_2\text{O (15 mL) was added dropwise over 1 h. After stirring at -20 °C for 4 h, MeOH (15 mL) and sat. aq. NH\(_4\)Cl (60 mL) were sequentially added and the mixture was warmed to r.t. After extracting with Et}_2\text{O (3 \times 20 mL), the combined organic extracts were dried over anhydrous Na}_2\text{SO}_4, filtered and concentrated in vacuo. Purification by flash column chromatography (20 % EtOAc/hexane) afforded the title compound (4.36 g, 86 %) as a pale yellow oil; \(R_f = 0.5\) (10 % EtOAc/hexane); \(v_{\text{max}} / \text{cm}^{-1}\) (film) 2958 (m), 2930 (m), 2858 (m), 1735 (s), 1509 (s), 1252 (s), 1165 (m); \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta 7.02\) (2H, d, \(J = 8.4\) Hz, C\(_7\)-H), \(6.75\) (2H, d, \(J = 8.6\) Hz, C\(_8\)-H), \(4.02\) (2H, q, \(J = 7.1\) Hz, OCH\(_2\)CH\(_3\)), \(2.97 - 2.89\) (1H, m, C\(_3\)-H), \(2.59\) (1H, dd, \(J = 14.9, 7.0\) Hz, C\(_8\)-H), \(2.50\) (1H, dd, \(J = 14.8, 8.3\) Hz, C\(_2\)-H\(_1\)), \(1.73 - 1.61\) (1H, m, C\(_4\)-H\(_1\)), \(1.59 - 1.49\) (1H, m, C\(_4\)-H\(_2\)), \(1.12\) (3H, t, \(J = 7.1\) Hz, OCH\(_2\)CH\(_3\)), \(0.97\) (9H, s, TBS (CH\(_3\))\(_3\)), \(0.77\) (3H, t \(J = 7.3\) Hz, C\(_5\)-H\(_3\)), \(0.18\) (6H, s, TBS Si(CH\(_3\))\(_2\)); \(^{13}\)C NMR (101 MHz, CDCl\(_3\)) \(\delta 172.7\) (C\(_1\),
3-(4-((tert-Butyldimethylsilyl)oxy)phenyl)pentan-1-ol

**General procedure B:** Ethyl 3-(4-((tert-butyldimethylsilyl)oxy)phenyl)pentanoate (4.10 g, 12.2 mmol), 1.0 eq. LiAlH₄ (1M in THF) and anhydrous Et₂O were employed. The title compound (3.03 g, 84 %) was obtained as a colorless oil which was used without further purification; Rₚ = 0.3 (20 % EtOAc/hexane); νₘₕₐₓ / cm⁻¹ (film) 3354 (br m), 2956 (m), 2929 (m), 2858 (m), 1607 (m), 1508 (s), 1253 (s); ¹H NMR (400 MHz, CDCl₃) δ 7.00 (2H, d, J = 8.4 Hz, C₇-H), 6.76 (2H, d, J = 8.5 Hz, C₈-H), 3.55 - 3.43 (2H, m, C₁-H₂), 2.55 - 2.47 (1H, m, C₃-H), 1.94 - 1.87 (1H, m, C₂-H), 1.79 - 1.72 (1H, m, C₂-H'), 1.70 - 1.61 (1H, m, C₄-H), 1.57 - 1.49 (1H, m, C₄-H'), 0.98 (9H, s, TBS (CH₃)₃), 0.77 (3H, t, J = 7.4 Hz, C₅-H), 0.19 (6H, s, TBS Si(CH₃)₂); ¹³C NMR (101 MHz, CDCl₃) δ 154.0 (C₉), 137.6 (C₆), 128.6 (C₇), 120.0 (C₈-H), 61.5 (C₁), 43.7 (C₃), 39.6 (C₂), 30.1 (C₄), 25.8 (TBS C(CH₃)₃), 18.3 (TBS C(CH₃)₃), 12.2 (C₅), -4.3 (TBS Si(CH₃)₂); HRMS (ESI⁺) Calculated for C₁₇H₃₀NaO₂Si: 317.1907. Found [M+Na⁺]: 317.1917.

tert-Butyl (3-(4-((tert-butyldimethylsilyl)oxy)phenyl)pentyl)(tosyloxy)carbamate

**General procedure C:** 3-(4-((tert-Butyldimethylsilyl)oxy)phenyl)pentan-1-ol (2.94 g, 10.0 mmol), PPh₃ (3.15 g, 12.0 mmol mmol), DIAD (2.36 mL, 12.0 mmol) and TsONHBoc (3.44
g, 12.0 mmol) in anhydrous THF (40 mL) were employed. Purification by flash column chromatography (5 % EtOAc/hexane) afforded the title compound (5.35 g, 95 %) as a colorless oil; Rf = 0.6 (20 % EtOAc/hexane); νmax / cm⁻¹ (film) 2962 (m), 2931 (m), 1721 (s), 1509 (s), 1382 (s), 1369 (s), 1253 (s), 1191 (s), 1155 (s); ¹H NMR (400 MHz, CDCl₃) δ 7.78 (2H, d, J = 8.2 Hz, Ts ArCH), 7.28 (2H, d, J = 8.2 Hz, Ts ArCH), 6.93 (2H, d, J = 8.4 Hz, C7-H), 6.74 (2H, J = 8.4 Hz, C8-H), 3.48 - 3.19 (2H, m, C1-H2), 2.42 (3H, s, Ts C6-H3), 2.33 - 2.26 (1H, m, C3-H), 1.94 (1H, app. br s, C2-H), 1.94 (1H, app. br s, C2-H'), 1.66 - 1.57 (1H, m, C4-H), 1.53 - 1.43 (1H, m, C4-H'), 1.22 (9H, s, Boc (CH₃)₃), 0.98 (9H, s, TBS (CH₃)₃), 0.73 (3H, t, J = 7.3 Hz, C5-H3), 0.18 (6H, s, TBS Si(CH₃)₂); ¹³C NMR (101 MHz, CDCl₃) 155.5 (Boc C=O), 154.0 (C9), 145.7 (Ts ArC), 136.9 (C6), 131.4 (Ts ArC), 129.7 (2 × Ts ArCH), 129.6 (2 × Ts ArCH), 128.4 (C7), 120.0 (C8) 83.2 (Boc C(CH₃)₃), 52.0 (C1), 44.6 (C3), 32.0 (C2), 30.1 (C4), 27.8 (Boc (CH₃)₃), 25.8 (TBS C(CH₃)₃), 21.8 (Ts CH₃), 18.3 (TBS C(CH₃)₃), 12.1 (C5), -4.3 (TBS (CH₃)₂); HRMS (ESI⁺) Calculated for C₂₉H₄₅NO₆SSi: 586.2629. Found [M+Na]+: 586.2628.

**tert-Butyl (3-(4-hydroxyphenyl)pentyl)(tosyloxy)carbamate (5g)**

![Diagram of 5g]

**General procedure D:** *tert*-Butyl (3-(4-((tert-butylidimethylsilyl)oxy)phenyl)pentyl) (tosyloxy)carbamate (2.82 g, 5.0 mmol) and 1:1 TBAF/HOAc (0.1 M in THF, 5.0 mmol) in THF (50 mL) were employed. Purification by flash column chromatography (20 % EtOAc/hexane) afforded 5g (1.80 g, 80 %) as a colorless solid; m.p.: 93 - 95 °C (EtOAc/hexane); Rf = 0.4 (33 % EtOAc/hexane); νmax / cm⁻¹ (film) 3436 (br m), 2965 (m), 2930 (m), 1720 (s), 1514 (s), 1368 (s), 1191 (s), 1177 (s), 1153 (s); ¹H NMR (400 MHz, CDCl₃) δ 7.77 (2H, d, J = 8.0 Hz, Ts ArCH), 7.28 (2H, d, J = 8.1 Hz, Ts ArCH), 6.95 (2H, d, J = 8.5 Hz C7-H), 6.74 (2H, d, J = 8.5 Hz, C8-H), 4.93 (1H, br s, OH), 3.51 - 3.16 (2H, app. br s, C1-H2), 2.42 (3H, Ts CH₃), 2.34 - 2.27 (1H, m, C3-H), 1.95 (1H, app. br s, C2-H), 1.77 (1H, app. br
s, C2-H'), 1.66 - 1.54 (1H, m, C4-H), 1.52 - 1.43 (1H, m, C4-H'), 1.22 (9H, s, Boc (CH3)3), 0.73 (3H, t, J = 7.3 Hz, C5-H3); 13C NMR (101 MHz, CDCl3) δ 155.6 (C=O), 154.1 (C9), 145.8 (Ts ArC), 136.3 (C6), 131.3 (Ts ArC), 129.7 (2 × Ts ArCH), 129.6 (2 × Ts ArCH), 128.7 (C7), 115.4 (C8), 83.4 (Boc C(CH3)3), 51.9 (C1), 44.5 (C3), 32.0 (C2), 30.1 (C4), 27.8 (Boc (CH3)3), 21.8 (Ts CH3), 12.05 (C5); HRMS (ESI+) Calculated for C23H31NNaO6S: 472.1764. Found [M+H]+: 472.1763.

4-Ethyl-1-azaspiro[4.5]deca-6,9-dien-8-one trifluoroacetate (7g)

General procedure E: tert-Butyl (3-(4-hydroxyphenyl)pentyl)tosyloxy carbamate (5g) (89.9 mg, 0.20 mmol) and TFA (31 μL, 0.40 mmol) in anhydrous TFE (2 mL) were employed. Purification by flash column chromatography (EtOAc) afforded 7g (40.0 mg, 69%) as a red/brown oil; Rf = 0.1 (5 % MeOH/CH2Cl2); νmax / cm⁻¹ 2966 (m), 1673 (s), 1636 (m), 1404 (m), 1201 (s), 1134 (s); 1H NMR (400 MHz, CDCl3) δ 6.93 (1H, dd, J = 10.3, 3.2 Hz, C7-H), 6.78 (1H, dd, J = 10.6, 3.2 Hz, C7-H'), 6.43 - 6.36 (2H, m, C8-H2), 3.62 - 3.45 (2H, m, C1-H2), 2.53 - 2.44 (1H, m, C3-H), 2.40 - 2.31 (1H, m, C2-H), 1.93 - 1.81 (1H, m, C2-H'), 1.31 - 1.23 (1H, m, C4-H), 1.14 - 1.05 (1H, m, C4-H'), 0.91 (3H, J = 7.4 Hz, C5-H3); The signals corresponding to the NH2 were not observed. 13C (101 MHz, CDCl3) δ 183.5 (C=O), 143.7 (C7), 139.6 (C7'), 132.4 (C8), 132.0 (C8'), 65.5 (C6), 50.8 (C3), 43.4 (C1), 29.3 (C2), 21.5 (C4), 12.5 (C5); The signals corresponding to the trifluoroacetate group could not be resolved due to their weak intensity. HRMS (ESI+) Calculated for C11H16NO+: 178.1226. Found [M+H]+: 178.1225.
4-Ethyl-1,2,3,4-tetrahydroquinolin-7-ol (8g)

To a solution of tert-Butyl (3-(4-hydroxyphenyl)pentyl)(tosyloxy)carbamate (5g) (67.4 mg, 0.15 mmol) in anhydrous TFE (2.3 mL, 0.067 M) at r.t. was added TFA (1.7 μL, 0.022 mmol). The reaction was heated to 60 °C and stirred overnight monitoring by TLC analysis. Purification by flash column chromatography (gradient, eluent 33 % EtOAc/hexane – 100 % EtOAc (a small amount < 1% Et3N was added to the eluent)) afforded 8g (20.4 mg, 77 %) as a yellow oil; Rf = 0.5 (EtOAc); v_max/cm⁻¹ (film) 3145 (m, br), 2971 (m), 1618 (m), 1467 (m), 1238 (m); ¹H NMR (400 MHz, CDCl₃) δ 6.55 (1H, s, C₁₀-H), 6.49 (1H, d, J = 8.0 Hz, C₈-H), 6.41 (1H, d, J = 8.5 Hz, C₇-H), 4.20 (2H, br s), 3.28 - 3.16 (2H, m, C₅-H₂), 2.62 - 2.56 (1H, m, C₃-H), 1.95 - 1.87 (1H, m, C₄-H), 1.80 - 1.67 (2H, m, C₄-H', C₂-H), 1.56 - 1.45 (1H, m, C₂-H'), 0.96 (3H, t, J = 7.4 Hz, C₁-H₃); ¹³C NMR (101 MHz, CDCl₃) δ 147.7 (C₉), 138.1 (C₆), 127.9 (C₁₁), 116.0 (C₇), 115.9 (C₁₀), 114.2 (C₈), 39.3 (C₅), 37.2 (C₃), 29.4 (C₂), 26.2 (C₄), 11.7 (C₁). HRMS (ESI⁺) Calculated for C₁₁H₁₆NO: 178.1226. Found [M+H]⁺: 178.1227.

The regiochemistry of the compound was confirmed by nOe analysis as shown on the compound structure. nOes were observed between C₁₀-H and C₃-H and C₁₀-H and C₂-H₂.

3-(4-((tert-Butyldimethylsilyl)oxy)phenyl)-N-methoxy-N-methylpropanamide¹²

General procedure H: 3-(4-((tert-Butyldimethylsilyl)oxy)phenyl)propanoic acid (2.40 g, 8.57 mmol), N,O-dimethylhydroxylamine hydrochloride (1.17 g, 12.0 mmol), Et₃N (1.67 mL,
12.0 mmol), 4-dimethylaminopyridine (1.46 g, 12.0 mmol), and N,N'-dicyclohexylcarbodiimide (2.48 g, 12.0 mmol) were employed. Purification by flash column chromatography (20 % EtOAc/hexane) afforded the title compound (1.97 g, 71%) as a colorless oil; R<sub>f</sub> = 0.2 (33 % EtOAc/hexane); ν<sub>max</sub> / cm<sup>-1</sup> 2955 (m), 2930 (m), 2857 (m), 1665 (s), 1509 (s), 1250 (s), 1169 (m); <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) δ 7.06 (2H, d, J = 8.0 Hz), 6.75 (2H, d, J = 8.0 Hz), 3.57 (3H, s), 3.16 (3H, s), 2.88 (2H, t, J = 7.6 Hz), 2.71 - 2.67 (2H, m), 0.97 (9H, s), 0.17 (6H, s); <sup>13</sup>C NMR (101 MHz, CDCl<sub>3</sub>) δ 173.7, 153.8, 133.9, 129.2, 119.9, 61.1, 33.9, 32.1, 29.9, 25.6, 18.1, -4.4. Spectroscopic properties were consistent with the data available in the literature.<sup>12</sup>

4-(4-((tert-Butyldimethylsilyl)oxy)phenyl)butan-2-one<sup>13</sup>

![Chemical structure](image)

To a solution of 3-(4-((tert-Butyldimethylsilyl)oxy)phenyl)-N-methoxy-N-methylpropanamide (0.69 g, 2.15 mmol) in anhydrous THF (5 mL) at 0 ºC was added methylmagnesium bromide (3 M in Et<sub>2</sub>O, 1.43 mL, 4.30 mmol) dropwise over 5 min. The reaction mixture was stirred at r.t. for 1.5 h and then a solution of sat. aq. NH<sub>4</sub>Cl (5 mL) was added. The aqueous phase was extracted with EtOAc (3 × 5mL) and the combined organic layers were washed with brine (10 mL), dried over Na<sub>2</sub>SO<sub>4</sub> and concentrated in vacuo to afford the title compound (0.60 g, 99%) as a colorless oil, which was used without further purification; R<sub>f</sub> = 0.6 (33 % EtOAc/hexane); ν<sub>max</sub> / cm<sup>-1</sup> 2955 (m), 2930 (m), 2857 (m), 1716 (s), 1610 (m), 1509 (s), 1361 (m), 1251 (s), 1159 (m), 1168 (m); <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) δ 7.02 (2H, d, J = 8.0 Hz), 6.75 (2H, d, J = 8.0 Hz), 2.85 - 2.68 (4H, m), 2.12 (3H, s), 0.98 (9H, s), 0.18 (6H, s); <sup>13</sup>C NMR (101 MHz, CDCl<sub>3</sub>) δ 208.2, 153.9, 133.6, 129.2, 119.9, 61.1, 33.9, 32.1, 29.9, 25.6, 18.1, -4.4. Spectroscopic properties were consistent with the data available in the literature.<sup>13</sup>
4-(4-((tert-Butyldimethylsilyl)oxy)phenyl)butan-2-ol \(^{14}\)

To a solution of 4-(4-((tert-butyldimethylsilyl)oxy)phenyl)butan-2-one (0.56 g, 2.14 mmol) in MeOH (10 mL) was slowly added NaBH\(_4\) (0.16 g, 4.28 mmol) at 0 °C. After stirring for 45 min at this temperature the reaction was quenched by addition of water (10 mL) and extracted with Et\(_2\)O (3 × 10 mL). The combined organic extracts were washed with brine (10 mL), dried over MgSO\(_4\), filtered and concentrated \textit{in vacuo} to afford the title compound (0.55 g, 92 \%) as a colorless oil which was used without further purification; \(R_f = 0.5\) (33 \% EtOAc/hexane); \(\nu_{\text{max}} / \text{cm}^{-1}\) (film) 3339 (m, br), 2957 (m), 2929 (m), 2857 (m), 1609 (m), 1508 (s), 1250 (s), 1168 (m); \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 7.05 (2H, d, \(J = 8.4\) Hz), 6.76 (2H, d, \(J = 8.4\) Hz), 3.86 - 3.77 (1H, m), 2.72 - 2.57 (2H, m), 1.80 - 1.69 (2H, m), 1.65 - 1.54 (1H, br s), 1.22 (3H, d, \(J = 6.2\) Hz), 0.99 (9H, s), 0.19 (6H, s); \(^{13}\)C NMR (101 MHz, CDCl\(_3\)) \(\delta\) 153.6, 134.7, 129.2, 119.9, 67.5, 41.0, 31.3, 25.7, 23.6, 18.2, -4.4. Spectroscopic properties were consistent with the data available in the literature.\(^ {14}\)

tert-Butyl (4-(4-((tert-Butyldimethylsilyl)oxy)phenyl)butan-2-yl)(tosyloxy)carbamate

\textbf{General procedure C:} 4-(4-((tert-Butyldimethylsilyl)oxy)phenyl)butan-2-ol (0.22 g, 0.77 mmol), PPh\(_3\) (0.24 g, 0.92 mmol), DIAD (0.18 mL, 0.92 mmol) and TsONHBoc (0.26 g, 0.92 mmol) in anhydrous THF (3 mL) were employed. Purification by flash column chromatography (10 \% EtOAc/hexane) afforded the title compound (0.34 g, 75 \%) as a colorless oil; \(R_f = 0.6\) (20 \% EtOAc/hexane); \(\nu_{\text{max}} / \text{cm}^{-1}\) (film) 2954 (m), 2930 (m), 2857 (m), 1721 (m), 1509 (s), 1368 (m), 1251 (s); \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 7.86 (2H, d, \(J = 8.4\) Hz, Ts ArC\(_{\text{H}}\)), 7.32 (2H, d, \(J = 8.4\) Hz, Ts ArC\(_{\text{H}}\)), 7.01 (2H, d, \(J = 8.4\) Hz, C\(_6\)-H), 6.73 (2H, d, \(J = \text{S38} \))
8.4 Hz, C7-H), 3.97 (1H, app. sextet, J = 6.8 Hz, C2-H), 2.61 - 2.57 (2H, m, C4-H2), 2.43 (3H, s, Ts CH3), 2.06 - 1.97 (1H, m, C3-H2), 1.74 - 1.66 (1H, m, C3-H'), 1.27 (9H, s, Boc (CH3)3), 1.21 (3H, d, J = 6.8 Hz, C1-H3), 0.97 (9H, s, TBS (CH3)3), 0.17 (6H, s, TBS Si(CH3)2); 13C NMR (101 MHz, CDCl3) δ 156.4 (C=O), 153.8 (C8), 145.6 (Ts ArC), 134.4 (C5), 131.9 (Ts ArC), 129.7 (2 × Ts ArCH), 129.6 (2 × Ts ArCH), 129.3 (C6), 119.9 (C7), 83.4 (Boc C(CH3)3), 60.8 (C2), 32.2 (C3), 29.8 (C4), 27.8 (Boc (CH3)3), 25.8 (TBS (CH3)3), 21.8 (Ts CH3), 18.3 (TBS Si(CH3)3), 17.4 (C1), -4.4 (TBS Si(CH3)2); HRMS (ESI+) Calculated for C28H43NNaO6S: 572.2473. Found [M+Na]+: 572.2465.

tert-Butyl (4-(4-hydroxyphenyl)butan-2-yl)(tosyloxy)carbamate (5h)

General procedure D: tert-Butyl (4-(4-((tert-butylidimethylsilyloxy)phenyl)butan-2-yl)(tosyloxy) carbamate (0.32 g, 0.58 mmol) and 1:1 TBAF/HOAc solution (0.1 M in THF, 0.58 mmol) in THF (20 mL) were employed. Purification by flash column chromatography (20 % EtOAc/hexane) afforded 5h (0.19 g, 75 %) as a colorless oil; Rf = 0.2 (20% EtOAc/hexane); νmax / cm⁻¹ (film) 3477 (br m), 2979 (m), 1721 (s), 1515 (s), 1369 (s), 1191 (s), 1177 (s), 1156 (s); 1H NMR (400 MHz, CDCl3) δ 7.85 (2H, d, J = 8.5 Hz, Ts ArC), 7.31 (2H, d, J = 8.5 Hz, Ts ArC), 7.01 (2H, d, J = 7.8 Hz, C6-H), 6.74 (2H, d, J = 8.3 Hz, C7-H), 5.14 (1H, br s, OH), 3.97 (1H, app. sextet, J = 7.2 Hz, C2-H), 2.58 (2H, t, J = 7.5 Hz, C4-H2), 2.42 (3H, s, Ts CH3), 2.05 - 1.95 (1H, m, C3-H), 1.73-1.60 (1H, m, C3-H'), 1.27 (9H, s, Boc (CH3)3), 1.20 (3H, d, J = 6.8 Hz, C1-H3); 13C NMR (101 MHz, CDCl3) δ 156.5 (C=O) 153.9 (C8), 145.7 (Ts ArC), 133.7 (C5), 131.8 (Ts ArC), 129.7 (2 × Ts ArCH), 129.6 (2 × Ts ArCH), 129.5 (C6), 115.3 (C7), 83.6 (Boc C(CH3)3), 60.8 (C2), 36.0 (C3) 32.1 (C4), 27.8 (Boc C(CH3)3), 21.8 (Ts CH3), 17.4 (C1); HRMS (ESI+) Calculated for C22H29NNaO6S: 458.1608. Found [M+Na]+: 458.1597.
2-Methyl-1-azaspiro[4.5]deca-6,9-dien-8-one trifluoroacetate (7h)

General procedure E: tert-Butyl (4-(4-hydroxyphenyl)butan-2-yI)(tosyloxy)carbamate (5h) (93.0 mg, 0.21 mmol) and TFA (32 μL, 0.42 mmol) in TFE (2.1 mL) were stirred at r.t. for 24 h. Purification by flash column chromatography (EtOAc) afforded 7h (34.0 mg, 58 %) as a yellow/brown oil; \( R_f = 0.1 \) (5% MeOH/CH₂Cl₂); \( \nu_{\text{max}} / \text{cm}^{-1} \) (film, CDCl₃) 2922 (m), 1667 (s), 1635 (m), 1393 (m), 1173 (s), 1133 (s); \( ^1\text{H NMR} \) (400 MHz, CDCl₃) \( \delta \) 9.80 (2H, br s, NH₂), 7.04 (1H, dd, \( J = 10.2, 3.2 \) Hz, C₅-H), 6.95 (1H, dd, \( J = 10.3, 3.2 \) Hz, C₅-H'), 6.33 - 6.32 (1H, m, C₆-H), 6.31 - 6.29 (1H, m, C₆-H'), 4.05 - 3.96 (1H, m, C₁-H), 2.47 - 2.39 (1H, m, C₂-H), 2.36 - 2.29 (1H, m, C₃-H), 2.24 - 2.17 (1H, m, C₃-H'), 2.08 - 1.98 (1H, m, C₂-H'), 1.46 (3H, d, \( J = 6.6 \) Hz, CH₃); \( ^{13}\text{C NMR} \) (101 MHz, CDCl₃) \( \delta \) 183.6 (C₇), 143.6 (C₅), 143.0 (C₅), 130.5 (C₆), 130.4 (C₆), 63.2 (C₄), 57.2 (C₁), 37.1 (C₃), 32.0 (C₂), 17.5 (CH₃); HRMS (ESI⁺) Calculated for C₁₀H₁₄NO: 164.1070. Found [M+H]⁺: 164.1068.

3-(4-((tert-Butyldimethylsilyl)oxy)naphthalen-1-yl)propan-1-ol

General procedure B: Ethyl (E)-3-(4-((tert-butyldimethylsilyl)oxy)naphthalen-1-yl)acrylate (1.64 g, 4.59 mmol, 1.0 eq.) and 2.0 eq. LiAlH₄ (1.0 M in THF) in anhydrous THF (10 mL) were employed. Purification by flash chromatography (gradient, elution 20 - 33 % EtOAc/hexane) afforded the title compound (0.77 g, 53 %) as a colorless oil; \( R_f = 0.6 \) (33% EtOAc/hexane); \( \nu_{\text{max}} / \text{cm}^{-1} \) (film) 2988 (s), 2901 (s), 1394 (m), 1275 (m), 1260 (m), 1075 (s), 1066 (s), 1057 (s), 750 (s); \( ^1\text{H NMR} \) (400 MHz, CDCl₃) \( \delta \) 8.27 – 8.19 (1H, m), 7.99 (1H, dd, \( J \)
= 8.1, 1.5 Hz), 7.53 – 7.45 (2H, m), 7.18 (1H, d, J = 7.7 Hz), 6.79 (1H, d, J = 7.7 Hz), 3.74 (2H, t, J = 6.4 Hz), 3.10 (2H, dd, J = 8.6, 6.7 Hz), 2.08 – 1.90 (2H, m), 1.10 (9H, s), 0.29 (6H, s); 13C NMR (101 MHz, CDCl3) δ 150.4, 133.1, 130.6, 128.4, 126.2, 126.0, 124.9, 123.9, 123.5, 112.2, 62.7, 33.8, 28.9, 26.1, 26.0, 18.6, -4.1; HRMS (ESI+) Calculated for C19H28NaO2Si: 339.1751. Found [M+Na]+: 339.1763.

tert-Butyl (3-(4-((tert-butyldimethylsilyl)oxy)naphthalen-1-yl)propyl)(tosyloxy)carbamate

To a solution of alcohol (0.75 g, 2.36 mmol), TsONHBoc (0.82 g, 2.84 mmol, 1.2 eq.) and PPh3 (0.93 g, 2.84 mmol, 1.2 eq.) in anhydrous THF (16 mL) at 0 °C was added a solution of DIAD (0.70 mL, 2.84 mmol, 1.2 eq.) in anhydrous THF (5 mL) dropwise under Argon atmosphere. The reaction mixture was stirred at r.t. overnight before being concentrated in vacuo and loaded directly onto silica gel for purification by flash chromatography (gradient, elution 20 % PhMe/hexane - 100% PhMe) to afford the title compound (1.12 g, 81 %) as a colorless solid; m.p.: 87 - 89 °C (EtOAc/hexane); Rf = 0.7 (33% EtOAc/hexane); νmax / cm⁻¹ (solid) 2972 (s), 1722 (m), 1393 (s), 1259 (m), 1156 (m), 1075 (s), 750 (s); 1H NMR (400 MHz, CDCl3) δ 8.25 – 8.15 (1H, m), 7.95 – 7.87 (1H, m), 7.84 (2H, d, J = 8.4 Hz), 7.48 (2H, ddd, J = 16.6, 8.1, 6.8, 1.5 Hz), 7.30 (2H, d, J = 7.8 Hz), 7.13 (1H, d, J = 7.7 Hz), 6.77 (1H, d, J = 7.7 Hz), 3.70 (2H, s), 2.97 (2H, t, J = 7.8 Hz), 2.43 (3H, s), 2.16 – 1.89 (2H, m), 1.19 (9H, s), 1.10 (9H, s), 0.28 (6H, s); 13C NMR (101 MHz, CDCl3) δ 155.6, 150.6, 145.8, 133.0, 131.4, 129.8, 129.8, 129.6, 128.4, 126.3, 125.9, 124.9, 123.7, 123.5, 112.1, 83.4, 53.1, 29.7, 27.7, 27.1, 26.1, 21.8, 18.6, -4.1; HRMS (ESI+) Calculated for C31H43NNaO6Si: 608.2473. Found [M+Na]+: 608.2473.
**General procedure D:** tert-Butyl (3-(4-((tert-butyldimethylsilyl)oxy)naphthalen-1-yl)propyl)(tosyloxy)carbamate (5i) (0.97 g, 1.66 mmol) and 1:1 TBAF/AcOH solution (1.0 M in THF, 1.66 mmol) in THF (17 mL) were employed. Purification by flash column chromatography (gradient, eluent 20 - 30% EtOAc/hexane) afforded 5i (0.53 g, 67%) as a viscous colorless oil; Rf = 0.4 (33% EtOAc/hexane); νmax / cm⁻¹ (film) 3417 (br, m), 2980 (m), 2871 (m), 1720 (s), 1589 (m), 1370 (s), 1191 (s), 1178 (s), 1151 (s), 763 (s); ¹H NMR (400 MHz, CDCl₃) δ 8.23 (1H, d, J = 7.9 Hz), 7.91 (1H, d, J = 8.2 Hz), 7.83 (2H, d, J = 8.1 Hz), 7.54 – 7.43 (2H, m), 7.29 (2H, d, J = 8.1 Hz), 7.08 (1H, d, J = 7.6 Hz), 6.73 (1H, d, J = 7.6 Hz), 3.70 (2H, s), 2.95 (2H, t, J = 7.9 Hz), 2.42 (3H, s), 2.03 (2H, q, J = 12.1, 8.4 Hz), 1.19 (9H, s); ¹³C NMR (101 MHz, CDCl₃) δ 155.7, 150.5, 145.8, 145.8, 132.8, 132.8, 131.3, 129.8, 129.6, 126.5, 125.8, 125.0, 124.9, 123.7, 122.6, 108.2, 83.5, 53.0, 29.6, 27.7, 27.1, 21.8; HRMS (ESI⁺) Calculated for C₂₅H₂₉NNaO₆S: 494.1608. Found [M+Na]⁺: 494.1603.

**General procedure E:** tert-Butyl (3-(4-hydroxynaphthalen-1-yl)propyl)(tosyloxy)carbamate (5i) (70.7 mg, 0.150 mmol) and TFA (23 µL, 0.30 mmol) in anhydrous TFE (1.5 mL) were stirred at r.t. for 22 h. Purification by flash column chromatography (EtOAc) afforded 7i (14.3...
mg, 30 %) as a yellow/brown solid; Rf = 0.1 (5 % MeOH/CH2Cl2); νmax / cm−1 (solid) 2987 (m), 2971 (m), 1665 (s), 1601 (m); 1H NMR (400 MHz, CD3OD) δ 8.19 (1H, d, J = 7.7 Hz, C9-H), 7.88 - 7.82 (2H, m, C11-H, C12-H), 7.67 (1H, ddd, J = 8.1, 6.1, 2.3 Hz, C10-H), 7.25 (1H, d, J = 10.3 Hz, C5-H), 6.61 (1H, d, J = 10.3 Hz, C6-H), 3.84 - 3.72 (2H, m, C1-H2), 2.71 - 2.62 (1H, m, C3-H), 2.57 - 2.48 (3H, m, C3-H1, C2-H2). The signals corresponding to the NH2 were not observed. 13C NMR (101 MHz, CDCl3) δ 184.0 (C7), 144.5 (C5), 140.5 (C13), 135.4 (C11), 132.1 (C8), 131.1 (C10), 130.7 (C6), 128.1 (C9), 127.7 (C12), 65.9 (C4), 47.7 (C1), 41.2 (C3), 25.8 (C2). The signals corresponding to the trifluoroacetate group could not be resolved due to their weak intensity. HRMS (ESI+) Calculated for C13H14NO: 200.1069. Found [M+H]+: 200.1074.

(E)-3-(4-Hydroxy-3-methoxyphenyl)acrylic acid

Vanillin (3.04 g, 20.0 mmol) and malonic acid (2.30 g, 22.0 mmol) were added to a solution of aniline (0.22 mL, 2.36 mmol) and pyridine (2.43 mL, 30.0 mmol) in toluene (5 mL). The solution was stirred at refluxing temperature for 2 h. The mixture was cooled to r.t. and neutralised with an aq. 25 % solution of K2CO3 (12 mL) followed by careful addition of concentrated HCl (until pH = 3). The resulting precipitate was filtered and washed with ice cold H2O (10 mL) to afford the title compound (3.0 g, 77 %) as a yellow solid which was used without further purification; Rf = 0.5 (33 % EtOAc); 1H NMR (440 MHz, CD3OD) δ 7.60 (1H, d, J = 15.8 Hz), 7.18 (1H, d, J = 2.0 Hz), 7.07 (1H, dd, J = 8.2, 2.0 Hz), 6.81 (1H, d, J = 8.2 Hz), 6.31 (1H, d, J = 15.8 Hz), 3.90 (3H, s); 13C NMR (101 MHz, CD3OD) δ 171.0, 150.5, 149.4, 146.9, 127.8, 123.9, 116.5, 115.9, 111.7, 56.4. Spectroscopic properties were consistent with the data available in the literature.
Methyl 3-(4-hydroxy-3-methoxyphenyl)propanoate$^{16}$

![Diagram of chemical structure]

**General procedure G:** (E)-3-(4-Hydroxy-3-methoxyphenyl)acrylic acid (1.94 g, 10.0 mmol) and 10 wt.% Pd/C (5 mol%) in 5:1 EtOAc/MeOH (60 mL) were employed. Purification by flash column chromatography (50 % EtOAc/hexane) afforded the title compound (1.66 g, 80 %) as a yellow oil; $R_f = 0.4$ (33 % EtOAc/hexane); $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 6.83 (1H, d, $J$ = 7.9 Hz), 6.72 - 6.66 (2H, m), 5.57 (1H, s), 3.86 (3H, s), 3.67 (3H, s), 2.88 (2H, t, $J$ = 7.8 Hz), 2.60 (2H, t, $J$ = 7.8 Hz); $^{13}$C NMR (101 MHz, CDCl$_3$) $\delta$ 173.5, 146.4, 144.1, 132.5, 120.9, 114.5, 111.0, 55.9, 51.7, 36.2, 30.7. *Spectroscopic properties were consistent with the data available in the literature.*$^{16}$

Methyl 3-(4-((tert-butyldimethylsilyl)oxy)-3-methoxyphenyl)propanoate

![Diagram of chemical structure]

Methyl 3-(4-hydroxy-3-methoxyphenyl)propanoate (1.55 g, 7.40 mmol), tert-butyldimethylsilyl chloride (1.34 g, 8.90 mmol) and imidazole (0.65 g, 9.60 mmol) in 2.5:1 CH$_2$Cl$_2$/DMF (35 mL) were stirred at r.t. overnight and monitored by TLC. Upon completion, the reaction was quenched by addition of H$_2$O (50 mL), extracted with CH$_2$Cl$_2$ (3 x 20 mL), washed with brine (20 mL), dried over MgSO$_4$, filtered and concentrated *in vacuo*. Purification by flash column chromatography (gradient 20 - 33 % EtOAc/hexane) afforded the title compound (1.85 g, 77 %) as a pale yellow oil; $R_f = 0.7$ (33 % EtOAc/hexane); $\nu_{max}$ / cm$^{-1}$ (film) 2952 (m), 2930 (m), 2857 (m), 1738 (s), 1512 (s); $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 6.74 (1H, d, $J$ = 8.0 Hz, C$_6$-H), 6.67 (1H, d, $J$ = 2.0 Hz, C$_9$-H), 6.62 (1H, dd, $J$ = 8.0 Hz, 2.0 Hz, C$_5$-H), 3.77 (3H, s, C$_{10}$-H$_3$), 3.65 (3H, s, CO$_2$CH$_3$), 2.87 (2H, t, $J$ = 7.4 Hz, C$_3$-H$_2$), 2.59 (2H, t, $J$ = 7.4 Hz, C$_2$-H$_2$), 0.98 (9H, s, TBS (CH$_3$)$_3$), 0.13 (6H, s, TBS Si(CH$_3$)$_2$); $^{13}$C NMR (101 MHz,
CDCl$_3$ δ 173.5 (C8), 150.9 (C1), 143.5 (C7), 134.1 (C4), 120.9 (C6), 120.4 (C5) 112.5 (C9), 55.5 (C10), 51.6 (CO$_2$CH$_3$), 36.1 (C2), 30.8 (C3), 25.8 (TBS (CH$_3$)$_3$), 18.5 (TBS Si(CH$_3$)$_3$), -4.6 (TBS Si(CH$_3$)$_2$). HRMS (ESI$^+$) Calculated for C$_{17}$H$_{28}$NaO$_4$Si: 347.1649. Found [M+Na]$^+$: 347.1661.

3-(4-((tert-Butyldimethylsilyl)oxy)-3-methoxyphenyl)propan-1-ol

General procedure B: Methyl 3-(4-((tert-butyldimethylsilyl)oxy)-3-methoxyphenyl)propanoate (1.71 g, 5.00 mmol) and 2.0 eq. LiAlH$_4$ (1.0 M in THF) in anhydrous Et$_2$O (25 mL) were employed to afford the title compound (1.34 g, 90 %) as a pale yellow oil which was used without further purification; R$_f$ = 0.3 (33 % EtOAc/hexane); $\nu_{\max}$ / cm$^{-1}$ (film) 3357 (m br), 2930 (m), 2857 (m), 1511 (s); $^1$H NMR (400 MHz, CDCl$_3$) δ 6.74 (1H, d, $J = 8.0$ Hz, C$_6$-H), 6.67 (1H, d, $J = 2.0$ Hz, C$_9$-H), 6.62 (1H, dd, $J = 8.0$, 2 Hz, C$_5$-H), 3.78 (3H, s, C$_{10}$-H$_3$), 3.65 (2H, t, $J = 6.4$ Hz, C$_1$-H$_2$), 2.63 (2H, t, $J = 7.4$ Hz, C$_3$-H$_2$), 1.89 - 1.82 (2H, m, C$_2$-H$_2$), 0.98 (9H, s, TBS (CH$_3$)$_3$), 0.13 (6H, s, TBS Si(CH$_3$)$_2$); $^{13}$C NMR (101 MHz, CDCl$_3$) δ 150.8 (C8), 143.2 (C7), 135.3 (C5), 120.8 (C6), 120.5 (C5), 112.6 (C9), 62.5 (C1), 55.6 (C10), 34.4 (C2), 31.9 (C3), 25.8 (TBS (CH$_3$)$_3$), 18.5 (TBS Si(CH$_3$)$_3$), -4.6, (TBS Si(CH$_3$)$_2$). HRMS (ESI$^+$) Calculated for C$_{16}$H$_{28}$NaO$_3$Si: 319.1700. Found [M+Na]$^+$: 319.1710.

tert-Butyl (3-(4-((tert-butyldimethylsilyl)oxy)-3-methoxyphenyl)propyl)(tosyloxy) carbamate

General procedure C: 3-(4-((tert-Butyldimethylsilyl)oxy)-3-methoxyphenyl)propan-1-ol (0.59 g, 2.00 mmol), PPh$_3$ (0.63 g, 2.40 mmol), DIAD (0.47 mL, 2.40 mmol) and TsONHBoc
(0.69 g, 2.40 mmol) in anhydrous THF (10 mL) were employed. Purification by flash column chromatography (10 % EtOAc/hexane) afforded the title compound (0.94 g, 83 %) as a colorless oil; Rf = 0.5 (20 % EtOAc/hexane); v_max / cm⁻¹ (film) 2954 (m), 2930 (m), 2857 (m), 1720 (m), 1512 (s); ¹H NMR (400 MHz, CDCl₃) 7.84 (2H, d, J = 8.3 Hz, Ts ArCH), 7.32 (2H, d, J = 8.3 Hz, Ts ArCH), 6.74 (1H, d, J = 8.0 Hz, C6-H), 6.66 (1H, d, J = 2.0 Hz, C9-H), 6.59 (1H, dd, J = 8.0, 2.0 Hz, C5-H), 3.79 (3H, s, C10-H), 3.62 (2H, app. br s, C1-H), 2.52 (2H, t, J = 7.8 Hz, C3-H2), 2.45 (3H, s, Ts CH₃), 1.98 - 1.87 (2H, m, C2-H2), 1.22 (9H, s, Boc (CH₃)₃), 0.99 (9H, s, TBS (CH₃)₃), 0.14 (6H, s, TBS Si(CH₃)₂); ¹³C NMR (101 MHz, CDCl₃) δ 155.6 (C=O), 145.8 (Ts ArC), 143.3 (C7), 134.7 (C4), 131.4 (Ts ArC), 129.8 (2 × Ts ArC), 129.7 (2 × Ts ArC), 120.8 (C6), 120.5 (C5), 122.5 (C9) 83.3 (Boc C(CH₃)₃), 55.6 (C10), 52.8 (C1), 32.6 (C3), 27.8 (Boc (CH₃)₃), 27.6 (C2), 25.9 (TBS (CH₃)₃), 21.8 (Ts CH₃), 18.6 (TBS Si(CH₃)₃), -4.5 (TBS Si(CH₃)₂). HRMS (ESI⁺) Calculated for C₂₈H₄₃NNaO₇Si: 588.2422. Found [M+Na]⁺: 588.2432.

tert-Butyl (3-(4-hydroxy-3-methoxyphenyl)propyl)(tosyloxy)carbamate (5j)

**General procedure D:** tert-Butyl (3-((tert-butyldimethylsilyl)oxy)-3-methoxyphenyl) propyl)(tosyloxy)carbamate (0.57 g, 1.0 mmol), and 1:1 TBAF/AcOH solution (0.1 M in THF, 1.0 mmol) in THF (20 mL) were employed. Purification by flash column chromatography (20 % EtOAc/hexane) afforded 5j (0.28 g, 62 %) as a colorless solid; m.p.: 82 - 84 °C (EtOAc/hexane); Rf = 0.4 (33 % EtOAc/hexane); v_max / cm⁻¹ (solid) 3505 (m, br), 2989 (m), 2964 (m), 2935 (m), 1749 (s), 1514 (m), 1153 (s); ¹H NMR (400 MHz, CDCl₃) δ 7.84 (2H, d, J = 8.2 Hz, Ts ArCH), 7.33 (2H, d, J = 8.1 Hz, Ts ArCH), 6.82 (1H, d, J = 8.0 Hz, C6-H), 6.69 (1H, d, J = 1.9 Hz, C9-H), 6.64 (1H, dd, J = 8.0, 1.9 Hz, C5-H), 5.47 (1H, s, OH), 3.89 (3H, s, C10-H), 3.60 (2H, app. br s, C1-H), 2.53 (2H, t, J = 7.6 Hz, C3-H2), 2.45 (3H, s, Ts CH₃), 1.97 - 1.87 (2H, m, C2-H2), 1.22 (9H, s, Boc (CH₃)₃); ¹³C NMR (101 MHz, CDCl₃) δ 155.6 (C=O), 146.5 (C8) 145.8, (Ts ArC), 143.9 (C7), 133.1 (C4), 131.3 (Ts ArC), 129.8 (2 × Ts ArC).
ArCH), 129.6 (2 × Ts ArCH), 120.9 (C5), 114.3 (C6), 110.9 (C9), 83.3 (Boc C(CH₃)₃), 56.1 (C10), 52.6 (C1), 32.6 (C3), 27.7 (Boc C(CH₃)₃), 27.7 (C2) 21.8 (Ts CH₃). HRMS (ESI⁺) Calculated for C₂₂H₂₉NNaO₇S: 474.1557. Found [M+Na⁺]: 474.1551.

7-Methoxy-1-azaspiro[4.5]deca-6,9-dien-8-one trifluoroacetate (7j) and 7-methoxy-1,2,3,4-tetrahydroquinolin-6-ol (8j)

General procedure E: tert-Butyl (3-(4-hydroxy-3-methoxyphenyl)propyl)(tosyloxy) carbamate (5j) (67.7 mg, 0.15 mmol) and TFA (23 μL) in TFE (1.5 mL) were stirred at r.t. for 40 h. Upon completion, the reaction mixture was concentrated in vacuo. An in situ yield was obtained by ¹H NMR analysis against 1,3,5-trimethoxybenzene as an internal standard; a 27 % yield of 7j and 62 % yield of 8j were observed. Purification by flash column chromatography (EtOAc) afforded 8j (14.9 mg, 55 %) as a yellow solid, however, 7j could not be isolated cleanly.

Data for 7j: from NMR analysis of crude material: ¹H NMR (400 MHz, CD₃OD) δ 7.11 (1H, dd, J = 10.0, 2.9 Hz, C5-H), 6.46 (1H, d, J = 10.0 Hz, C6-H), 6.03 (1H, d, J = 2.9 Hz, C10-H), 3.75 (3H, s, C9-H₂), 3.68 - 3.60 (2H, m, C1-H₂), 2.46-2.43 (2H, m, C2-H₂), 2.33 - 2.27 (2H, m, C3-H₂); ¹³C NMR (101 MHz, CD₃OD) δ 180.8 (C7), 153.5 (C8), 144.3 (C5), 131.3 (C6), 111.5 (C10), 66.6 (C4), 56.0 (C9) 46.1 (C1) 38.2 (C3), 24.7 (C2);

Data for 8j: m.p.: 76 - 78 °C (EtOAc/hexane); Rₜ = 0.7 (EtOAc); νmax / cm⁻¹ (solid) 3383 (br m), 3324 (br m), 2926 (m), 1508 (s), 1464 (m), 1443 (m); ¹H NMR (400 MHz, CDCl₃) δ 6.50 (1H, s, C5-H), 6.14 (1H, s, C9-H), 3.79 (3H, s, C8-H₃), 3.25 - 3.20 (2H, m, C1-H₂), 2.68 (2H, t, J = 6.5 Hz, C3-H₂), 1.94-1.88 (2H, m, C2-H₂); ¹³C NMR (101 MHz, CDCl₃) δ 144.7 (C6), 139.3 (C10), 139.1 (C7), 113.1 (C5), 112.7 (C4), 101.7 (C9), 57.0 (C8), 42.3 (C1), 26.7 (C3), 22.8 (C2); HRMS (ESI⁺) Calculated for C₁₀H₁₄NO₂: 180.1019. Found [M+H⁺]:180.1027.
6-Methylchroman-2-one

General procedure G: 6-Methylcoumarin (4.80 g, 30.0 mmol) and 5 mol% Pd/C (10 wt. %, 1.50 mmol), in EtOAc (30 mL) were employed. Purification by flash column chromatography afforded the title compound (3.40 g, 70 %) as a colorless solid; Rf = 0.4 (20 % EtOAc/hexane); 1H NMR (400 MHz, CDCl3) δ 7.04 (1H, dd, J = 8.1, 1.9 Hz), 6.99 (1H, s), 6.93 (1H, d, J = 8.2 Hz), 2.98 - 2.93 (2H, m), 2.79 - 2.73 (2H, m), 2.31 (3H, s); 13C NMR (101 MHz, CDCl3) δ 168.9, 149.9, 134.0, 128.8, 128.5, 122.4, 116.7, 29.4, 23.8, 20.8. Spectroscopic properties were consistent with the data available in the literature.

3-(2-((tert-Butyldimethylsilyl)oxy)-5-methylphenyl)propanoic acid

To a solution of 6-methylchroman-2-one (1.74 g, 10.0 mmol) in THF (50 mL) was added an aq. 1 M solution of LiOH (33.0 mmol, 58 mL). After stirring at r.t. overnight the pH was acidified to approx. 3 with aq. 1 M HCl. The product was extracted with EtOAc (2 × 20 mL), dried over Na2SO4, filtered and concentrated in vacuo. The crude product was dissolved in DMF (20 mL) and cooled to 0 °C before tert-butyldimethylsilyl chloride (3.32 g, 22.0 mmol) and imidazole (2.24 g, 33.0 mmol) were added. After being stirred at r.t. overnight the reaction was quenched by addition of H2O (50 mL) and the product was extracted with hexane (3 × 20 mL), dried over MgSO4, filtered and concentrated in vacuo. To the crude product in MeOH (10 mL) and THF (10 mL) was added aq. K2CO3 (20.0 mmol, 2.76 g in 30 mL H2O). After stirring at r.t. overnight the reaction was cooled to 0 °C and quenched with aq. 1 M HCl (30 mL). The mixture was extracted with Et2O (3 × 20 mL), dried over Na2SO4, filtered and concentrated in vacuo. Purification by flash column chromatography (20 % EtOAc/hexane) afforded the title compound (1.60 g, 54 %) as a colorless solid; m.p.: 49 - 51 °C (EtOAc/hexane); Rf = 0.4 (20 % EtOAc/hexane); νmax / cm⁻¹ (solid) 2961 (m), 2948 (m), 2948 (m), 2900 (m), 1702 (s), 1499 (m), 1252 (s); 1H NMR (400 MHz, CDCl3) δ 6.97 (1H, d, J = 2.5 Hz, C5-H), 6.89 (1H, dd, J = 8.3, 2.3 Hz, C8-H), 6.69 (1H, d, J = 8.3 Hz, C9-H), 2.89 (2H, t, J = 7.8 Hz, C3-H2), 2.65 (2H, t, J = 7.9 Hz, C2-H2), 2.26 (3H, s, C7-H3), 1.01 (9H, s, TBS (CH3)3), 0.23 (6H, s, TBS
Si(CH₃)₂); ¹³C NMR (101 MHz, CDCl₃) δ 179.3 (C₁), 151.5 (C₁₀), 130.9 (C₅), 130.5 (C₄), 130.4 (C₆), 128.0, (C₈) 118.3 (C₉), 34.3 (C₂), 26.2 (C₃), 25.9 (TBS (C₃H₃)₃), 20.7 (C₇), 18.4 (TBS C(CH₃)₃), -4.0 (TBS Si(CH₃)₂); HRMS (ESI⁺) Calculated for C₁₆H₂₇O₃Si: 295.1724. Found [M+H]⁺: 295.1739.

3-(2-((tert-Butyldimethylsilyl)oxy)-5-methylphenyl)propan-1-ol

![Chemical structure](image)

**General procedure I:** 3-(2-((tert-Butyldimethylsilyl)oxy)-5-methylphenyl)propanoic acid (1.25 g, 4.26 mmol), Et₃N (0.59 mL, 4.26 mmol), ethylchloroformate (0.41 mL, 4.26 mmol) and NaBH₄ (0.40 g, 10.6 mmol) in THF (30 mL) and H₂O (15 mL) were employed. Purification by flash column chromatography (20 % EtOAc/hexane) afforded the title compound (0.83 mg, 60 %) as a colorless oil; Rf = 0.35 (20 % EtOAc/hexane); νmax / cm⁻¹ (film) 3334 (m, br), 2953 (m), 2929 (m), 2885  (m), 2858 (m), 1498 (s), 1253 (s); ¹H NMR (400 MHz, CDCl₃) δ 6.94 (1H, d, J = 2.3 Hz, C₅-H), 6.86 (1H, d, J = 2.3 Hz, C₈-H), 6.68 (1H, d, J = 8.1 Hz, C₉-H), 6.36 (1H, dd, J = 8.2, 2.3 Hz, C₈-H), 6.68 (1H, d, J = 8.1 Hz, C₉-H), 3.61 (2H, t, J = 6.4 Hz, C₁-H₂), 2.65 (2H, t, J = 7.4 Hz, C₃-H₂), 2.25 (3H, s, C₇-H₃), 1.99 - 1.70 (2H, m, C₂-H₂), 1.01 (9H, s, TBS (CH₃)₃), 0.22 (6H, s, TBS Si(CH₃)₂); ¹³C NMR (400 MHz, CDCl₃) δ 151.3 (C₁₀), 131.9 (C₄), 131.1 (C₅), 130.6 (C₆), 127.4 (C₈), 118.5 (C₉), 62.4 (C₁), 33.3 (C₂), 26.6 (C₃), 26.0 (TBS (CH₃)₃), 20.7 (C₇), 18.4 (TBS C(CH₃)₃), -4.0 (TBS Si(CH₃)₂). Spectroscopic properties were consistent with the data available in the literature.

tert-Butyl(3-(2-((tert-butyldimethylsilyl)oxy)-5-methylphenyl)propyl)(tosyloxy) carbamate

![Chemical structure](image)

**General procedure C:** 3-(2-((tert-Butyldimethylsilyl)oxy)-5-methylphenyl)propan-1-ol (0.87 g, 1.58 mmol), PPh₃ (0.50 g, 1.90 mmol), DIAD (0.37 mL, 1.90 mmol) and TsONHBoc (0.54 g, 1.90 mmol) were employed. Purification by flash column chromatography (10 % EtOAc/hexane) afforded the title compound (0.71 mg, 65 %) as a colorless oil; Rf = 0.6 (20 %
EtOAc/hexane; \( \nu_{\text{max}} / \text{cm}^{-1} \) (film) 2957 (m), 2929 (m), 2859 (m), 1721 (m), 1499 (m); \(^1\)H NMR (400 MHz, CDCl\(_3\)) \( \delta \) 7.84 (2H, d, \( J = 8.3 \) Hz, Ts ArCH), 7.31 (2H, d, \( J = 8.3 \) Hz, Ts ArCH), 6.92 (1H, d, \( J = 2.3 \) Hz, C\(_5\)-H), 6.85 (1H, dd, \( J = 8.1, 2.3 \) Hz, C\(_8\)-H), 6.66 (1H, d, \( J = 8.1 \) Hz, C\(_9\)-H), 3.62 (2H, app. br s, C\(_1\)-H), 2.51 (2H, t, \( J = 7.8 \) Hz, C\(_3\)-H), 2.43 (3H, s, Ts CH\(_3\)), 2.25 (3H, s, C\(_7\)-H), 1.96 - 1.84 (2H, m, C\(_2\)-H), 1.20 (9H, s, Boc (CH\(_3\))\(_3\)), 1.01 (9H, s, TBS (CH\(_3\))\(_3\)); \(^{13}\)C NMR (101 MHz, CDCl\(_3\)) \( \delta \) 155.5 (C=O), 151.3 (C\(_{10}\)), 145.6 (Ts ArC), 145.7 (Ts ArC), 131.3 (C\(_5\)), 130.8 (C\(_6\)), 129.6 (2 × Ts ArCH), 127.5 (C\(_8\)), 118.3 (C\(_9\)), 83.1 (Boc C(CH\(_3\))\(_3\)), 52.9 (C\(_1\)), 27.7 (Boc (CH\(_3\))\(_3\)), 26.1 (C\(_2\)), 25.9 (TBS (CH\(_3\))\(_3\)), 21.8 (Ts CH\(_3\)), 20.6 (C\(_7\)), 18.3 (TBS Si(CH\(_3\))\(_3\)), -4.1 (TBS Si(CH\(_3\))\(_2\)); HRMS (ESI\(^+\)) Calculated for C\(_{28}\)H\(_{43}\)NNaO\(_6\)S: 572.2473. Found [M+Na\(^+\)]: 572.2477.

**tert-Butyl (3-(2-hydroxy-5-methylphenyl)propyl)(tosyloxy)carbamate (5k)**

![Chemical Structure](image)

**General procedure D:** *tert-Butyl (3-(2-((tert-butyldimethylsilyl)oxy)-5-methylphenyl)propyl) (tosyloxy)carbamate* (0.44 g, 0.80 mmol) and 1:1 TBAF/AcOH solution (0.1 M in THF, 0.80 mmol) in THF (16 mL) were employed. Purification by flash column chromatography (gradient, eluent 20 – 33 % EtOAc/hexane) afforded **5k** (0.27 g, 77%) as a colorless solid; m.p.: 107 - 108 °C (EtOAc/hexane); \( R_f = 0.2 \) (20 % EtOAc/hexane); \( \nu_{\text{max}} / \text{cm}^{-1} \) (solid) 3447 (m), 2986 (m), 1685 (s), 1509 (m), 1382 (s); \(^1\)H NMR (400 MHz, CDCl\(_3\)) \( \delta \) 7.85 (2H, d, \( J = 8.3 \) Hz, Ts ArCH), 7.33 (2H, d, \( J = 8.1 \) Hz, Ts ArCH), 7.03 - 6.81 (2H, m, C\(_8\)-H, C\(_9\)-H), 6.64 (1H, d, \( J = 8.0 \) Hz, C\(_5\)-H), 4.99 (1H, s, OH), 3.65 (2H, br s, C\(_1\)-H), 2.56 (2H, t, \( J = 7.8 \) Hz, C\(_3\)-H), 2.44 (3H, s, Ts CH\(_3\)), 2.24 (3H, s, C\(_7\)-H), 2.0 - 1.89 (2H, m, C\(_2\)-H), 1.21 (9H, s, Boc (CH\(_3\))\(_3\)); \(^{13}\)C NMR (101 MHz, CDCl\(_3\)) \( \delta \) 155.8 (C=O), 151.4 (C\(_{10}\)), 145.7 (Ts ArC), 131.3 (Ts ArC), 130.8 (C\(_5\)), 129.9 (C\(_6\)) 129.8 (2 × Ts ArCH), 129.6 (2 × Ts ArCH), 127.8 (C\(_8\)), 127.0 (C\(_4\)), 115.4 (C\(_9\)), 83.5 (Boc C(CH\(_3\))\(_3\)), 53.0 (C\(_1\)), 27.7 (Boc (CH\(_3\))\(_3\)), 27.2 (C\(_3\)), 26.3 (C\(_2\)), 21.8 (Ts CH\(_3\)), 20.6 (C\(_7\)); HRMS (ESI\(^+\)) Calculated for C\(_{22}\)H\(_{26}\)NNaO\(_6\)S: 458.1608. Found [M+Na\(^+\)]: 458.1608.
9-Methyl-1-azaspiro[4.5]deca-7,9-dien-6-one tosylate (7k)

**General procedure E:** tert-Butyl (3-(2-hydroxy-5-methylphenyl)propyl)(tosyloxy)carbamate (5k) (25.2 mg, 0.06 mmol) and TFA (8.9 μL, 0.12 mmol) in anhydrous TFE (0.57 mL) were employed. Upon completion, the reaction mixture was concentrated in vacuo to afford 7k as a brown solid. *An in situ yield was obtained by ¹H NMR against 1,4-dinitrobenzene as an internal standard; a yield of 91% was obtained.*

Rf = 0.1 (5 % MeOH/CH₂Cl₂); νmax / cm⁻¹ (solid) 3447 (m, br), 2970 (m), 2923 (m), 1673 (m), 1655 (m), 1606 (m); ¹H NMR (400 MHz, CDCl₃) δ 9.31 (1H, br s, NH), 8.16 (1H, br s, NH), 7.71 (2H, d, J = 8.0 Hz, Ts ArCH), 7.18 (2H, d, J = 7.9 Hz, Ts ArCH), 6.83 (1H, dd, J = 10.0, 2.2 Hz, C₈-H), 6.34 (1H, br s, C₅-H), 6.07 (1H, d, J = 10 Hz, C₉-H), 3.72 (2H, br s, C₁-H₂), 2.36 (3H, s, Ts CH₃), 2.24 - 2.05 (4H, m, C₂-H₂, C₃-H₂), 1.83 (3H, s, C₇-H₃); ¹³C NMR (101 MHz, CDCl₃) δ 197.6 (C₁₀), 147.1 (C₈), 141.3 (Ts ArC), 140.4 (Ts ArC), 132.6 (C₆), 131.4 (C₅), 129.2 (Ts ArCH), 126.0 (Ts ArCH), 123.9 (C₉), 72.5 (C₄), 48.2 (C₁), 37.2 (C₂/C₃), 22.6 (C₂/C₃), 21.5 (Ts CH₃), 20.9 (C₇); HRMS (ESI⁺) Calculated for C₁₀H₁₄NO: 164.1070. Found [M⁺]: 164.1071.

Ethyl (E)-3-(2-hydroxy-4-methoxyphenyl)acrylate

**General procedure F:** 2-Hydroxy-4-methoxybenzaldehyde (1.80 g, 12.0 mmol) and ethyl 2-(triphenyl-phosphaneylidene) acetate (6.27 g, 18.0 mmol) in CH₂Cl₂ (15 mL) were employed. Purification by flash column chromatography (20 % EtOAc/hexane) afforded the title compound (2.73 g, quant.) as a colorless solid; Rf = 0.3 (20 % EtOAc/hexane); ¹H NMR (400 MHz, (CD₃)₂CO) δ 9.13 (1H, s), 7.93 (1H, d, J = 16.1 Hz), 7.54 (1H, d, J = 8.4 Hz), 6.53 - 6.50 (2H, m), 6.48 (1H, d, J = 16.1 Hz), 4.18 (2H, q, J = 7.1 Hz), 3.79 (3H, s), 1.27 (3H, t, J = 7.1 Hz); ¹³C NMR (101 MHz, CDCl₃) δ 170.0, 163.6, 158.9, 140.7, 131.2, 116.1, 115.6, 107.2, 102.3, 60.4, 55.7, 14.8. *Spectroscopic properties were consistent with the data available in the literature.*
Ethyl 3-(2-hydroxy-4-methoxyphenyl)propanoate\textsuperscript{20}

\[ \text{HO-CH-C(}O\text{-CH}_3) \]

\[ \text{MeO} \quad \text{MeO} \]

\[ \text{H} \quad \text{H} \]

\[ \text{OH} \quad \text{OH} \]

\[ \text{OEt} \quad \text{OEt} \]

**General procedure G:** Ethyl (E)-3-(2-hydroxy-4-methoxyphenyl)acrylate (2.22 g, 10.0 mmol) and 10 wt.% Pd/C (5 mol%) in EtOH (30 mL) were employed to afford the title compound (2.21 g, 99 %) as an off-white solid; \( R_f = 0.2 \) (20 % EtOAc/hexane); \( ^1\text{H NMR} \) (400 MHz, CDCl\(_3\)) \( \delta \) 7.50 (1H, s), 6.97 (1H, d, \( J = 8.3 \) Hz), 6.48 - 6.40 (2H, m), 4.14 (2H, q, \( J = 7.2 \) Hz), 3.75 (3H, s), 2.79 - 2.89 (2H, m), 2.63 - 2.73 (2H, m), 1.24 (3H, t, \( J = 7.2 \) Hz); \( ^{13}\text{C NMR} \) (101 MHz, CDCl\(_3\)) \( \delta \) 176.1, 159.7, 155.4, 131.1, 119.7, 106.9, 102.9, 61.5, 55.4, 35.6, 24.1, 14.2. Spectroscopic properties were consistent with the data available in the literature.\textsuperscript{20}

Ethyl 3-(2-((tert-butyldimethylsilyl)oxy)-4-methoxyphenyl)propanoate

\[ \text{HO-CH-C(}O\text{-CH}_3) \]

\[ \text{MeO} \quad \text{MeO} \]

\[ \text{H} \quad \text{H} \]

\[ \text{OH} \quad \text{OH} \]

\[ \text{OEt} \quad \text{OEt} \]

Ethyl 3-(2-hydroxy-4-methoxyphenyl)propanoate (1.68 g, 7.50 mmol), tert-butyldimethylsilyl chloride (1.36 g, 9.00 mmol), and imidazole (1.28 g, 18.75 mmol) in DMF (15 mL) were employed. Purification by flash column chromatography (20 % EtOAc/pentane) afforded the title compound (1.59 g, 63 %) as a colorless oil; \( R_f = 0.5 \) (20 % EtOAc/hexane); \( \nu_{max} / \text{cm}^{-1} \) (film) 2955 (m), 2931 (m), 2858 (m), 1733 (s), 1611 (s), 1505 (s); \( ^1\text{H NMR} \) (400 MHz, CDCl\(_3\)) \( \delta \) 7.04 (1H, d, \( J = 8.3 \) Hz, C\(_5\)-H), 6.44 (1H, dd, \( J = 8.3, 2.5 \) Hz, C\(_6\)-H), 6.38 (1H, d, \( J = 2.5 \) Hz, C\(_9\)-H), 4.12 (2H, q, \( J = 7.1 \) Hz, OCH\(_2\)), 3.75 (3H, s, C\(_8\)-H\(_3\)), 2.84 (2H, dd, \( J = 8.9, 7.0 \) Hz, C\(_3\)-H\(_2\)), 2.54 (2H, dd, \( J = 8.9, 7.0 \) Hz, C\(_2\)-H\(_2\)), 1.23 (3H, t, \( J = 7.1 \) Hz, CH\(_2\)CH\(_3\)), 1.02 (9H, s, TBS (CH\(_3\))\(_3\)), 0.25 (6H, s, TBS Si(CH\(_3\))\(_2\)); \( ^{13}\text{C NMR} \) (101 MHz, CDCl\(_3\)) \( \delta \) 173.4 (C=O), 159.1 (C\(_7\)), 154.5 (C\(_{10}\)), 130.4 (C\(_5\)), 123.7 (C\(_4\)), 105.7 (C\(_6\)/C\(_9\)), 105.6 (C\(_6\)/C\(_9\)), 60.3 (OCH\(_2\)), 55.4 (C\(_8\)), 34.9 (C\(_2\)), 25.9 (TBS (CH\(_3\))\(_3\)), 25.8 (C\(_3\)), 18.3 (TBS Si(CH\(_3\))\(_2\)), 14.4 (CH\(_2\)CH\(_3\)), -4.0 (TBS Si(CH\(_3\))\(_2\)); HRMS (ESI\(^{+}\)) Calculated for C\(_{18}\)H\(_{30}\)NaO\(_4\)Si: 361.1806. Found [M+Na\(^+\)]: 361.1820.
A solution of ethyl 3-(2-((tert-butyldimethylsilyl)oxy)-4-methoxyphenyl)propanoate (1.01 g, 3.0 mmol) in anhydrous THF (15 mL) was cooled to -78 °C before 2.0 eq. DIBALH (1 M in CH₂Cl₂) was added dropwise to maintain the temperature of the reaction mixture below -75 °C. The reaction was stirred at this temperature for 4 h and then warmed to 0 °C and stirred for an additional 2 h. The reaction mixture was diluted with EtOAc (10 mL) and quenched with Rochelle’s salt (10 mL). The mixture was filtered through Celite® and washed with EtOAc. The phases were separated and the aqueous phase extracted with EtOAc (10 mL). The combined organic extracts were dried over Na₂SO₄, filtered and concentrated in vacuo. Purification by flash column chromatography (33 % EtOAc/hexane) afforded the title compound (0.44 g, 50 %) as a colorless oil; Rₜ = 0.3 (33 % EtOAc/hexane); ¹H NMR (400 MHz, CDCl₃) δ 7.03 (1H, d, J = 8.4 Hz), 6.47 (1H, dd, J = 8.4, 2.4 Hz), 6.39 (1H, d, J = 2.4 Hz), 3.76 (3H, s), 3.61 (2H, t, J = 6.4 Hz), 2.62 (2H, t, J = 7.2 Hz), 1.85 - 1.77 (2H, m), 1.64 (1H, br s), 1.01 (9H, s), 0.25 (6H, s); ¹³C NMR (101 MHz, CDCl₃) δ 158.8, 154.4, 130.6, 124.7, 106.1, 105.7, 62.4, 55.4, 33.4, 25.9, 25.8, 18.4, -4.0. Spectroscopic properties were consistent with the data available in the literature.²¹

**tert-Butyl (3-(2-((tert-butyldimethylsilyl)oxy)-4-methoxyphenyl)propyl)(tosyloxy) carbamate**

**General procedure C**: 3-(2-((tert-butyldimethylsilyl)oxy)-4-methoxyphenyl)propan-1-ol (0.44 g, 1.50 mmol), PPh₃ (0.47 g, 1.80 mmol), DIAD (0.35 mL, 1.80 mmol) and TsONHBoc (0.52 g, 1.80 mmol) in anhydrous THF (6 mL) were employed. Purification by flash column chromatography (10% EtOAc/hexane) afforded the title compound (0.82 g, 96 %) as a colorless oil; Rₜ = 0.5 (33 % EtOAc/hexane); ν_max / cm⁻¹ (film) 2955 (m), 2931 (m), 1720 (s), 1504 (s), 1160 (s); ¹H NMR (400 MHz, CDCl₃) δ 7.84 (2H, d, J = 8.3 Hz, Ts ArC₉H₅), 7.31 (2H, d, J = 8.3 Hz, Ts ArC₉H₅), 7.00 (1H, d, J = 8.3 Hz, C₅-H), 6.44 (1H, dd, J = 8.3, 2.5 Hz, C₆-H), 6.36 (1H, d, J = 2.5 Hz, C₉-H), 3.75 (3H, s, C₈-H₃), 3.71 - 3.49 (2H, m, C₁-H₂), 2.49 (2H, t, J = 7.7
Hz, C3-H2), 2.43 (3H, s, Ts CH3), 1.95 - 1.81 (2H, m, C2-H2), 1.21 (9H, s, Boc (CH3)3), 1.01 (9H, s, TBS (CH3)3), 0.24 (6H, s, TBS Si(CH3)2); 13C NMR (101 MHz, CDCl3) δ 158.8 (C7), 155.5 (C=O), 154.3 (C10), 145.6 (Ts ArC), 131.4 (Ts ArC), 130.3 (C5), 129.7 (2 × Ts ArCH), 129.6 (2 × Ts ArCH), 124.1 (C4), 105.7 (C6), 105.5 (C9), 83.1 (Boc C(CH3)3), 55.3 (C8), 52.8 (C1), 27.7 (Boc (CH3)3), 27.0 (C3), 26.2 (C2), 25.9 (TBS (CH3)3), 21.8 (Ts CH3), 18.3 (TBS Si(CH3)2), -4.1 (TBS Si(CH3)2); HRMS (ESI+) Calculated for C28H43NNaO7SSi: 588.2422. Found [M+Na]+: 588.2426.

tert-Butyl (3-(2-hydroxy-4-methoxyphenyl)propyl)(tosyloxy)carbamate (5l)

![Chemical Structure](image)

**General procedure D:** tert-Butyl (3-(2-((tert-butyldimethylsilyl)oxy)-4-methoxyphenyl)propyl) (tosyloxy)carbamate (0.56 g, 1.00 mmol) and 1:1 TBAF/AcOH solution (0.1 M in THF, 0.1 mmol) in THF (20 mL) were employed. Purification by flash column chromatography (33 % EtOAc/hexane) afforded 5l (0.30 g, 68 %) as a colorless, viscous oil; Rf = 0.2 (33 % EtOAc/hexane); νmax / cm⁻¹ (film) 3422 (br s), 2936 (m), 1720 (m), 1508 (m), 1368 (s); 1H NMR (400 MHz, CDCl3) δ 7.85 (2H, d, J = 8.0 Hz, Ts ArC-H), 7.33 (2H, d, J = 8.0 Hz, Ts ArC-H), 6.98 (1H, d, J = 8.3 Hz, C5-H), 6.42 (1H, dd, J = 8.3, 2.4 Hz, C6-H), 6.36 (1H, d, J = 2.4 Hz, C9-H), 5.37 (1H, br s, OH), 3.75 (3H, s, C8-H3), 3.72 - 3.53 (2H, m, C1-H2), 2.54 (2H, t, J = 7.7 Hz, C3-H2), 2.44 (3H, s, Ts CH3), 1.98 - 1.85 (2H, m, C2-H2), 1.22 (9H, s, Boc (CH3)3); 13C NMR (101 MHz, CDCl3) δ 159.3 (C7), 156.0 (C=O), 154.6 (C10), 145.9 (Ts ArC), 131.4 (Ts ArC), 130.7 (C5), 130.0 (2 × Ts ArCH), 129.7 (2 × Ts ArCH), 119.6 (C4), 106.1 (C6), 102.1 (C9), 83.6, 55.5 (C8), 53.0 (C1), 27.8 (Boc (CH3)3), 26.6 (C2/C3), 26.5 (C2/C3), 21.8 (Ts CH3); HRMS (ESI+) Calculated for C22H20NNaO7S: 474.1557. Found [M+Na]+: 474.1560.
8-Methoxy-1-azaspiro[4.5]deca-7,9-dien-6-one trifluoroacetate (7l)

General procedure E: tert-Butyl (3-(2-hydroxy-4-methoxyphenyl)propyl)(tosyloxy) carbamate (5l) (67.7 mg, 0.15 mmol) and TFA (23 μL, 0.30 mmol) in TFE (1.5 mL) were stirred at r.t. for 25 h. Purification by flash column chromatography (EtOAc) afforded 7l (34.1 mg, 78 %) as a yellow oil; Rf = 0.1 (5 % MeOH/CH2Cl2); νmax / cm⁻¹ (film) 2987 (m), 2901 (m), 1672 (s), 1634 (m); ¹H NMR (400 MHz, CD3OD) δ 6.69 (1H, d, J = 10.1 Hz, C5-H), 6.36 (1H, dd, J = 10.1, 2.2 Hz, C6-H), 5.63 (1H, d, J = 2.2 Hz, C9-H), 3.88 (3H, s, C8-H), 3.69 - 3.54 (2H, m, C1-H, C3-H). The signals corresponding to the NH₂ were not observed. ¹³C NMR (101 MHz, CD3OD) δ 196.9 (C10), 173.1 (C7), 138.5 (C5), 125.5 (C6), 98.8 (C9), 71.4 (C4), 57.5 (C8), 48.5 (C1), 39.4 (C3), 24.2 (C2). The signals corresponding to the trifluoroacetate group could not be resolved due to their weak intensity. HRMS (ESI⁺) Calculated for C₁₀H₁₄NO₂: 180.1019. Found [M+H]⁺: 180.1011.

1-(Allyloxy)naphthalene

The title compound was prepared according to a literature procedure. Spectroscopic properties were consistent with the data available in the literature.

2-Allylnaphthalen-1-ol

The title compound was prepared according to a literature procedure.
Spectroscopic properties were consistent with the data available in the literature.\textsuperscript{24}

\(((2\text{-Allylnaphthalen}-1\text{-yl})\text{oxy})(\text{tert-butyldimethylsilane})\text{)}\text{\textsuperscript{24}}

The title compound was prepared according to a literature procedure.\textsuperscript{22}

Spectroscopic properties were consistent with the data available in the literature.\textsuperscript{22}

\(3\text{-}(1\text{-}((\text{tert-Butyldimethylsilyl})\text{oxy})\text{naphthalen}-2\text{-yl})\text{propan-1-ol}\text{)}\text{\textsuperscript{22}}

The title compound was prepared according to a literature procedure.\textsuperscript{22}

Spectroscopic properties were consistent with the data available in the literature.\textsuperscript{22}

tert-Butyl \((3\text{-}(1\text{-}((\text{tert-Butyldimethylsilyl})\text{oxy})\text{naphthalen}-2\text{-yl})\text{propyl})\text{(tosyloxy)}\) carbamate

**General procedure C**: 3-(1-((tert-Butyldimethylsilyl)oxy)naphthalen-2-yl)propan-1-ol (0.47 g, 1.50 mmol), PPh\(_3\) (0.47 g, 1.80 mmol), DIAD (0.35 mL, 1.80 mmol) and TsONHBoc (0.52 g, 1.80 mmol) in anhydrous THF (8 mL) were employed. Purification by flash column chromatography (10 % EtOAc/hexane) afforded the title compound as a colorless, viscous oil (0.67 g, 76 %); \(R_f = 0.4\) (20 % EtOAc/hexane); \(|\nu_{\text{max}}| / \text{cm}^{-1}\) (film) 2955 (m), 2930 (m), 2895 (m), 2858 (m), 1720 (s), 1382 (s), 1369 (s); \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 8.06 - 8.02 (1H, m, ArC\(\text{H}\)), 7.80 (2H, d, \(J = 8.4\) Hz, Ts ArC\(\text{H}\)), 7.78 - 7.74 (1H, m, ArCH), 7.46 - 7.37 (3H, m, ArCH), 7.28 - 7.22 (3H, m, Ts ArCH, ArCH), 3.71 - 3.43 (2H, m, C\(1\text{-H}_{2}\)), 2.73 (2H, t, \(J = 7.7\) Hz, C\(3\text{-H}_{2}\)), 2.39 (3H, s, Ts CH\(_3\)), 1.99 - 1.88 (2H, m, C\(2\text{-H}_{2}\)), 1.19 (9H, s, Boc (CH\(_3\))\(_3\)), 1.11 (9H, s, TBS (CH\(_3\))\(_3\)), 0.17 (6H, s, TBS Si(CH\(_3\))\(_2\)); \(^{13}\)C NMR (101 MHz, CDCl\(_3\)) \(\delta\) 155.6 (C=O), S56
148.3 (C5), 145.7 (Ts ArC), 133.8 (ArC), 131.4 (Ts ArC), 129.7 (2 × Ts ArCH) 129.6 (2 × Ts ArCH), 128.2 (ArC), 128.1 (ArCH), 127.7 (ArCH), 126.2 (C4), 125.4 (ArCH), 124.9 (ArCH), 123.2 (ArCH), 121.8 (ArCH), 83.3 (Boc C(CH3)3), 52.8 (C1), 27.7 (Boc (CH3)3), 27.6 (C3), 26.4 (C2), 26.3 (TBS (CH3)3), 18.9 (TBS Si(CH3)3), -3.0 (TBS Si(CH3)2);


**tert-Butyl (3-(1-hydroxynaphthalen-2-yl)propyl)(tosyloxy)carbamate (5m)**

![Chemical structure of 5m](image)

**General procedure D:*** tert-Butyl (3-(1-((tert-butyldimethylsilyl)oxy)naphthalen-2-yl)propyl) (tosyloxy)carbamate (0.56 g, 0.97 mmol) and 1:1 TBAF/AcOH solution (0.1 M in THF, 0.97 mmol) in THF (20 mL) were employed. Purification by flash column chromatography (20 % EtOAc/hexane) afforded 5m (0.31 g, 68 %) as a pale yellow solid; m.p.: 107 - 109 °C (EtOAc/hexane); Rf = 0.2 (20 % EtOAc/hexane); νmax / cm⁻¹ (solid) 3485 (m), 2970 (m), 2942 (m), 2882 (m), 1729 (s), 1385 (s); ¹H NMR (400 MHz, CDCl₃) δ 8.18 - 8.15 (1H, m, ArCH), 7.85 (2H, d, J = 8.3 Hz, Ts ArCH), 7.77 (1H, dd, J = 8.1, 1.4 Hz, ArCH), 7.49 - 7.41 (2H, m, ArCH), 7.39 (1H, d, J = 8.4 Hz, ArCH), 7.30 (2H, d, J = 8.3 Hz, Ts ArCH), 7.22 (1H, d, J = 8.4 Hz, ArCH), 6.07 (1H, br s, OH), 3.69 (2H, t, J = 6.5 Hz, C1-H2), 2.81 (2H, t, J = 7.5 Hz, C3-H2), 2.43 (3H, s, Ts CH₃), 2.10-2.00 (2H, m, C2-H2), 1.24 (9H, s, Boc (CH3)3); ¹³C NMR (101 MHz, CDCl₃) δ 156.4 (C=O), 148.8 (C5), 146.0 (Ts ArC), 133.6 (ArC), 131.3 (Ts ArC), 129.8 (2 × Ts ArCH), 129.7 (2 × Ts ArCH), 128.8 (ArCH), 127.7 (ArCH), 125.7 (ArCH), 125.4 (ArC), 125.0 (ArC), 121.5 (ArCH), 120.5 (ArCH), 120.3 (ArC), 84.0 (Boc C(CH3)3), 52.9 (C1), 27.7 (Boc (CH3)3), 27.3 (C3), 27.2 (C2), 21.8 (Ts CH₃); HRMS (ESI+) Calculated for C25H29NNaO6S: 494.1607. Found [M+Na]+: 494.1614.

**1H-spiro[naphthalene-2,2'-pyrrolidin]-1-one (7m)**

![Chemical structure of 7m](image)
General procedure E: tert-Butyl (3-(1-hydroxynaphthalen-2-yl)propyl)(tosyloxy)carbamate (5m) (70.7 mg, 0.15 mmol) and TFA (23 μL, 0.3 mmol) in 30:1 anhydrous TFE/CH₂Cl₂ (1.5 mL) were stirred at r.t. for 26 h. Purification by flash column chromatography (gradient eluent 50 % EtOAc/hexane – 100 % EtOAc) afforded 7m (11.4 mg, 38 %) as a yellow/brown solid; m.p.: 57 - 60 °C (EtOAc/hexane); Rf = 0.1 (EtOAc); νmax / cm⁻¹ (solid) 2920 (m), 2851 (m), 1674 (s), 1595 (s), 1371 (s); ¹H NMR (400 MHz, CDCl₃) δ 7.94 (1H, d, J = 7.7 Hz, C₇-H), 7.56 - 7.51 (1H, m, C₉-H), 7.34 - 7.29 (1H, m, C₈-H), 7.17 (1H, d, J = 7.5 Hz, C₁₀-H), 6.43 (1H, d, J = 10.0 Hz, C₁₂-H), 6.25 (1H, d, J = 10.0 Hz, C₁₃-H), 3.41 - 3.33 (1H, m, C₁-H'), 3.13 - 3.05 (1H, m, C₁-H'), 2.40 (1H, br s, NH), 2.11 - 2.06 (1H, m, C₃-H), 1.92 - 1.78 (3H, m, C₃-H', C₂-H₂); ¹³C NMR (101 MHz, CDCl₃) δ 203.7 (C₅), 139.8 (C₁₃), 138.2 (C₁₁), 134.7 (C₉), 129.0 (C₆), 127.9 (C₈), 127.3 (C₇), 127.2 (C₁₀), 123.3 (C₁₂), 70.2 (C₄), 48.4 (C₁), 38.9 (C₃), 25.9 (C₂); HRMS (ESI⁺) Calculated for C₁₃H₁₄NO: 200.1069. Found [M+H]⁺: 200.1079.

1,2-Dihydro-3H-naphtho[2,1-b]pyran-3-one

The compound was prepared according to a literature procedure. Spectroscopic properties were consistent with the data available in the literature.

3-(2-((tert-Butyldimethylsilyl)oxy)naphthalen-1-yl)propanoic acid

To a solution of 1,2-Dihydro-3H-naphtho[2,1-b]pyran-3-one (7.90 g, 37.0 mmol) in THF (200 mL) was added aq. 1 M LiOH (125 mL). After stirring at r.t. overnight the pH was acidified to approx. 3 with 1 M HCl. The product was extracted with EtOAc (50 mL), dried over Na₂SO₄, filtered and concentrated in vacuo. The crude product was dissolved in DMF (20 mL) and tert-butylidimethylsilyl chloride (12.2 g, 81.4 mmol) and imidazole (8.30 g, 122.1 mmol) were added at 0 °C. After being stirred at r.t. overnight the reaction was quenched by addition of H₂O and the product was extracted with hexane, dried over MgSO₄, filtered and concentrated.
in vacuo. To the crude product in MeOH (30 mL) and THF (30 mL) was added aq. K₂CO₃ (74.0 mmol, 10.2 g in 100 mL H₂O). After stirring for 5 h the reaction was quenched with aq. 1 M HCl (100 mL) at 0 °C. The mixture was extracted with Et₂O, dried over Na₂SO₄, filtered and concentrated in vacuo. Purification by flash column chromatography (20 % EtOAc/hexane) afforded the title compound (8.10 g, 66 %) as a pale yellow solid; m.p.: 94 - 96 °C (EtOAc/hexane); Rf = 0.3 (33 % EtOAc/hexane); νmax / cm⁻¹ (solid) 2957 (m), 2928 (m), 2900 (m), 2857 (m), 1699 (s); [1H NMR (400 MHz, CDCl₃) δ 7.97 (1H, d, J = 8.5 Hz, ArCH), 7.79 (1H, d, J = 7.8 Hz, ArCH), 7.65 (1H, d, J = 8.5 Hz, ArCH), 7.51 (1H, t, J = 7.7 Hz, ArCH), 7.36 (1H, t, J = 7.5 Hz, ArCH), 7.11 (1H, d, J = 8.9 Hz, ArCH), 3.43 (2H, t, J = 8.5 Hz, C₂-H₂), 2.67 (2H, t, J = 8.5 Hz, C₃-H₂), 1.08 (9H, s, TBS (CH₃)₃), 0.31 (6H, s, TBS Si(CH₃)₂); 13C NMR (101 MHz, CDCl₃) δ 179.3 (C=O), 150.8 (ArC), 133.0 (ArC), 129.5 (ArC), 128.6 (ArCH), 127.9 (ArCH), 126.5 (ArCH), 123.4 (ArCH), 123.1 (ArC), 122.8 (ArCH), 120.2 (ArCH), 33.9 (C1), 25.8 (TBS (CH₃)₃), 21.0 (C2), 18.3 (TBS Si(CH₃)₃), 3.9 (TBS Si(CH₃)₂); HRMS (ESI⁺) Calculated for C₁₉H₂₆NaO₃Si: 353.1543. Found [M+Na]⁺: 353.1551.

3-(2-(tert-Butyldimethylsilyloxy)naphthalen-1-yl)propan-1-ol²²

**General procedure I:** 3-(2-((tert-Butyldimethylsilyl)oxy)naphthalen-1-yl)propanoic acid (1.65 g, 5.00 mmol), Et₃N (0.70 mL, 5.00 mmol), ethyl chloroformate (0.54 g, 5.00 mmol) and NaBH₄ (0.47 g, 12.5 mmol) in THF (50 mL) and H₂O (20 mL) were employed. Purification by flash column chromatography (20 % EtOAc/hexane) afforded the title compound (1.19 g, 75 %) as a colorless oil; Rf = 0.6 (33 % EtOAc/hexane); νmax / cm⁻¹: (film) 3336 (m, br), 2953 (m), 2929 (m), 2882 (m), 2857 (m), 1622 (m), 1594 (m), 1465 (m), 1264 (m), 1241 (s); [1H NMR (400 MHz, CDCl₃) δ 8.00 (1H, d, J = 8.1 Hz), 7.79 (1H, d, J = 8.4 Hz), 7.63 (1H, d, J = 8.6 Hz), 7.48 (1H, t, J = 7.8 Hz), 7.35 (1H, t, J = 7.2 Hz), 7.12 (1H, d, J = 9.0 Hz), 3.63 (2H, t, J = 5.9 Hz), 3.20 (2H, t, J = 6.7 Hz), 2.53 (1H, br s), 1.95 (2H, qn, J = 7.4 Hz), 1.10 (9H, s), 0.31 (6H, s); 13C NMR (101 MHz, CDCl₃) δ 150.6, 133.4, 129.9, 128.6, 127.4, 126.3, 124.7, 123.6, 123.5, 120.6, 62.2, 32.5, 26.0, 21.5, 18.5, -3.8. Spectroscopic properties were consistent with the data available in the literature.²²
**tert-Butyl (3-(2-((tert-butyldimethylsilyloxy)naphthalen-1-yl)propyl) (tosyloxy) carbamate**

![Chemical Structure]

To a solution of 3-(2-((tert-butyldimethylsilyloxy)naphthalen-1-yl)propan-1-ol (0.63 g, 2.00 mmol), *tert*-butyl (tosyloxy)carbamate (0.56 g, 3.00 mmol) and PPh$_3$ (1.05 g, 4.00 mmol) in anhydrous PhMe:THF (3:1, 8 mL/mmol) at 0°C was added a solution of DIAD (0.78 mL, 4.00 mmol) in anhydrous PhMe (2 mL/mmol) dropwise. The reaction was stirred at r.t. until completion by TLC analysis (4 h). The reaction mixture was concentrated *in vacuo* and purification by flash column chromatography (gradient 20 – 25 % EtOAc/hexane) afforded the title compound (0.74 g, 63%) as a colorless solid; m.p.: 79 - 80°C (EtOAc/hexane); R$_f$ = 0.7 (33 % EtOAc/hexane); $\nu$$_{max}$/ cm$^{-1}$ (solid) 2961 (m), 2927 (m), 2857 (m), 1709 (s), 1596 (m), 1466 (m), 1368 (s), 1240 (s), 1174 (s), 1164 (s), 1153 (s), 1087 (m); $^1$H NMR (400 MHz, CDCl$_3$) δ 7.86 (1H, d, $J$ = 8.6 Hz, ArC$_\text{H}$), 7.82 (2H, d, $J$ = 8.3 Hz, ArC$_\text{H}$), 7.75 (1H, d, $J$ = 8.2 Hz, ArC$_\text{H}$), 7.59 (1H, d, $J$ = 8.8 Hz, ArC$_\text{H}$), 7.47 - 7.43 (1H, m, ArC$_\text{H}$), 7.33 (1H, ddd, $J$ = 8.1, 6.8, 1.1 Hz, ArC$_\text{H}$), 7.27 (2H, d, $J$ = 8.2 Hz, ArC$_\text{H}$), 7.05 (1H, d, $J$ = 8.8 Hz, ArC$_\text{H}$), 3.71 (2H, br s, C$_1$-H$_2$), 3.02 (2H, t, $J$ = 7.9 Hz, C$_3$-H$_2$), 2.42 (3H, s, Ts CH$_3$), 1.98 - 1.89 (2H, m, C$_2$-H$_2$), 1.16 (9H, s, Boc (CH$_3$)$_3$), 1.07 (9H, s, TBS (CH$_3$)$_3$), 0.27 (6H, s, Si(CH$_3$)$_2$); $^{13}$C NMR (101 MHz, CDCl$_3$) δ 155.5 (C=O), 150.6 (ArC), 145.6 (Ts ArC), 133.3 (ArC), 131.5 (Ts ArC), 129.7 (2 × Ts ArC), 129.6 (ArC), 129.5 (2 × Ts ArC), 128.6 (ArCH), 127.5 (ArCH), 126.4 (ArCH), 124.2 (ArC), 123.3 (ArCH), 123.2 (ArCH), 120.3 (ArCH), 83.1 (Boc C(CH$_3$)$_3$), 53.1 (C1), 27.6 (Boc (CH$_3$)$_3$), 26.1 (C2), 26.0 (TBS (CH$_3$)$_3$), 22.7 (C3), 21.8 (Ts CH$_3$), 18.4 (TBS C(CH$_3$)$_3$), -3.8 (TBS Si(CH$_3$)$_2$); HRMS (ESI$^+$) Calculated for C$_{31}$H$_{43}$NNaO$_6$Si: 608.2473. Found [M+Na]$^+$: 608.2456.

**tert-butyl (3-(2-hydroxynaphthalen-1-yl)propyl)(tosyloxy)carbamate (5n)**

![Chemical Structure]
**General procedure D:** *tert-Butyl (3-(2-((tert-butyldimethylsilyl)oxy)naphthalen-1-yl)propyl)(tosyloxy) carbamate* (0.16 g, 0.28 mmol) and 1:1 TBAF/AcOH solution (0.1 M in THF, 0.28 mmol) in THF were employed. Purification by flash column chromatography (33 % EtOAc/hexane) afforded 5n (0.11 g, 84 %) as a pale yellow solid; m.p.: 55 - 57 °C (EtOAc/hexane); Rf = 0.35 (33 % EtOAc/hexane); ν̇ₘₐₓ / cm⁻¹ 3359 (m, br), 2931 (m), 1721 (s), 1369 (s), 1191 (s), 1178 (s), 1154 (s); ¹H NMR (400 MHz, CDCl₃) δ 7.88 - 7.83 (3H, m, Ts ArC─H, ArC─H), 7.77 (1H, d, J = 8.1 Hz, ArC─H), 7.62 (1H, d, J = 8.8 Hz, ArCH), 7.47 (1H, ddd, J = 8.3, 6.9, 1.4 Hz, ArCH), 7.35 - 7.29 (3H, m, Ts ArC─H, ArC─H), 7.07 (1H, d, J = 8.8 Hz, ArC─H), 5.60 (1H, br s, OH), 3.79 - 3.70 (2H, m, C₁-H₂), 3.07 (2H, t, J = 7.8 Hz, C₃-H₂), 2.44 (3H, s, Ts C─H₃), 2.08 - 1.97 (2H, m, C₂-H₂), 1.20 (9H, s, Boc (CH₃)₃); ¹³C NMR (101 MHz, CDCl₃) δ 156.1 (C=O), 151.1 (ArC), 145.9 (Ts ArC), 133.2 (ArC), 131.3 (Ts ArC), 129.7 (2 × Ts ArC), 129.7 (2 × Ts ArC), 129.5 (ArC), 128.8 (ArC), 128.1 (ArCH), 126.6 (ArCH), 123.1 (ArCH), 118.8 (ArC), 118.1 (ArCH), 83.6 (Boc (CH₃)₃), 53.2 (C₁), 27.7 (Boc (CH₃)₃), 26.4 (C₂), 22.2 (C₃) 21.8 (Ts CH₃); HRMS (ESI⁺) Calculated for C₂₅H₂₉NNaO₆S: 494.1608. Found [M+Na]⁺: 494.1598.

**2H-spiro[naphthalene-1,2'-pyrrolidin]-2-one (7n)**

![Diagram](image)

**General procedure E:** *tert-Butyl (3-(2-hydroxynaphthalen-1-yl)propyl)(tosyloxy)carbamate* (5n) (117.9 mg, 0.25 mmol), TFA (38 μL, 0.50 mmol) and TFE (2.5 mL) were employed. After stirring at r.t. for 38 h, purification by flash column chromatography (50 % EtOAc/hexane) afforded 7n (38.8 mg, 78 %) as a viscous yellow oil; Rf = 0.25 (33 % EtOAc/hexane); ν̇ₘₐₓ / cm⁻¹ (film) 3339 (m), 2965 (m), 2866 (m), 1671 (s); ¹H NMR (400 MHz, CDCl₃) δ 7.66 (1H, dd, J = 7.7, 0.9 Hz, C₆-H), 7.41 - 7.34 (2H, m, C₁₁-H and C₇-H), 7.29 - 7.21 (2H, m, C₈-H and C₉-H), 6.17 (1H, d, J = 9.9 Hz, C₁₂-H), 3.45 (1H, dt, J = 10.3, 6.4 Hz, C₁-H), 3.28 (1H, dt, J = 10.2, 6.4 Hz, C₁-H'), 2.34 - 2.22 (1H, m, C₃-H), 1.96 - 1.69 (3H, m, C₂-H₃, C₃-H'); ¹³C NMR (101 MHz, CDCl₃) δ 205.1, (C=O), 148.8 (C₅), 144.8 (C₁₁), 130.1 (C₇), 129.2
(C8), 129.1 (C10), 127.0 (C9), 126.0 (C6), 123.6 (C12), 73.9 (C4), 49.9 (C1), 42.9 (C3), 25.6 (C2); HRMS (ESI⁺) Calculated for C13H13NNaO: 222.0889. Found [M+Na]⁺: 222.0883.

1,2-Dihydro-9-methoxy-3H-naphtho[2,1-b]pyran-3-one²⁶

![Chemical structure](image)

The title compound was prepared according to a literature procedure.²⁵

*Spectroscopic properties were consistent with the data available in the literature.*²⁶

3-(2-((tert-Butyldimethylsilyl) oxy)-7-methoxynaphthalen-1-yl)propanoic acid

![Chemical structure](image)

To a solution of 1,2-dihydro-9-methoxy-3H-naphtho[2,1-b]pyran-3-one (1.71 g, 7.50 mmol) in THF (75 mL) was added aq. 1 M LiOH (44.0 mL, 24.8 mmol). After stirring at r.t. overnight the pH was acidified to approx. 3 with aq. 1 M HCl. The product was extracted with EtOAc (50 mL), dried over Na₂SO₄, filtered and concentrated *in vacuo*. The crude product was dissolved in DMF (15 mL) and tert-butyldimethylsilylsilyl chloride (2.50 g, 16.5 mmol) and imidazole (1.68 g, 24.8 mmol) were added at 0 °C. After being stirred at r.t. overnight the reaction was quenched by addition of H₂O and the product was extracted with hexane, dried over MgSO₄, filtered and concentrated *in vacuo*. To the crude product in MeOH (7.5 mL) and THF (7.5 mL) was added aq. K₂CO₃ (22 mL, 15.0 mmol). After stirring overnight at r.t., the reaction was quenched with aq. 1 M HCl (20 mL) at 0 °C. The organic phase was extracted with Et₂O (3 × 10 mL), dried over Na₂SO₄, filtered and concentrated *in vacuo*. Purification by flash column chromatography (20 % EtOAc/hexane) afforded the title compound (1.77 g, 65 %) as a yellow solid; m.p.: 113 - 115 °C (EtOAc/hexane); Rₜ = 0.5 (33 % EtOAc/hexane); νₘₐₓ / cm⁻¹ (solid) 3675 (w), 2958 (m), 2927 (m), 1703 (s), 1627 (m), 1514 (s), 1264 (s), 1231 (s), 1037 (s); ¹H NMR (CDCl₃) δ 7.68 (1H, d, J = 8.9 Hz, ArCH), 7.56 (1H, d, J = 8.8 Hz, ArCH), 7.24 (1H, d, J = 2.4 Hz, ArCH), 7.02 (1H, dd, J = 8.9, 2.4 Hz, ArCH), 6.95 (1H, d, J = 8.8 Hz, ArCH), 3.95 (3H, s, OCH₃), 3.43 - 3.26 (2H, m, C3-H₂), 2.76 - 2.56 (2H, m, C2-H₂), 1.97 (9H, s, TBS (CH₃)₃), 0.29 (6H, s, TBS (Si(CH₃)₂); ¹³C NMR (101 MHz, CDCl₃) δ 178.9 (C=O), S62
158.3 (ArC), 151.4 (ArC), 134.3 (ArC), 130.1 (ArCH), 127.6 (ArCH), 124.8 (ArC), 122.1 (ArC), 117.6 (ArCH), 115.7 (ArCH), 101.7 (ArCH), 55.3 (OCH₃), 33.5 (C₂), 25.8 (TBS(CH₃)₃), 21.1 (C₃), 18.3 (TBS Si(CH₃)₃), -3.9 (TBS Si(CH₃)₂); HRMS (-ve ion) Calculated for C₂₀H₂₇O₄Si: 359.1684. Found [M-H]: 359.1685.

3-(2-((tert-Butyldimethylsilyl)oxy)-7-methoxynaphthalen-1-yl)propan-1-ol²²

![Diagram](3-(2-((tert-Butyldimethylsilyl)oxy)-7-methoxynaphthalen-1-yl)propan-1-ol)

**General procedure I:** 3-(2-((tert-Butyldimethylsilyl)oxy)-7-methoxynaphthalen-1-yl)propanoic acid (1.08 g, 3.00 mmol), ethylchloroformate (0.29 mL, 3.00 mmol), Et₃N (0.42 mL, 3.00 mmol), and NaBH₄ (0.28 g, 7.50 mmol) were employed. Purification by flash column chromatography (20 % EtOAc/ hexane) afforded the title compound (0.68 g, 65 %) as a pale yellow oil; Rₛ = 0.25 (20 % EtOAc/hexane); ν max / cm⁻¹ (film) 3370 (br m), 2953 (m), 2930 (m), 2884 (m), 2857 (m), 1624 (s), 1513 (s), 1461 (s), 1230 (s); ¹H NMR (400 MHz, CDCl₃) δ 7.67 (1H, d, J = 8.9 Hz), 7.53 (1H, d, J = 8.8 Hz), 7.02 (1H, dd, J = 8.9, 2.4 Hz), 6.94 (1H, d, J = 8.8 Hz), 3.93 (3H, s), 3.59 (2H, t, J = 6.1 Hz), 3.14 (2H, t, J = 7.2 Hz), 2.06-1.77 (3H, m), 1.05 (9H, s), 0.27 (6H, s); ¹³C NMR (101 MHz, CDCl₃) δ 158.0, 151.2, 134.5, 130.0, 127.0, 125.1, 123.4, 117.9, 115.6, 102.5, 62.0, 55.3, 31.9, 25.9, 21.5, 18.4, -3.9; HRMS (ESI⁺) Calculated for C₂₀H₃₀NaO₄Si: 369.1856. Found [M+Na]⁺: 369.1855. *Spectroscopic properties were consistent with the data available in the literature.*²²

**tert-Butyl (2-(2-((tert-butyldimethylsilyl)oxy)-7-methoxynaphthalen-1-yl)ethyl)(tosyloxycarbamate**

![Diagram](tert-Butyl (2-(2-((tert-butyldimethylsilyl)oxy)-7-methoxynaphthalen-1-yl)ethyl)(tosyloxycarbamate)

**General procedure C:** 3-(2-((tert-Butyldimethylsilyl)oxy)-7-methoxynaphthalen-1-yl)propan-1-ol (0.40 g, 1.15 mmol), PPh₃ (0.36 g, 1.38 mmol), DIAD (0.27 mL, 1.38 mmol) and TsONHBoc (0.40 mg, 1.38 mmol) in anhydrous THF (5 mL) were employed. Purification by flash column chromatography (10 % EtOAc/hexane) afforded the title compound (0.48 g,
68 %) as a colorless oil; Rₚ = 0.5 (20 % EtOAc/hexane); νmax / cm⁻¹ (film) 2956 (m), 2930 (m), 2900 (m), 2859 (m), 1721 (s), 1623 (s), 1513 (s), 1381 (s), 1368 (s), 1231 (s), 1178 (s), 1152 (s); ¹H NMR (400 MHz, CDCl₃) δ 7.82 (2H, d, J = 8.2 Hz, Ts ArCH), 7.65 (1H, d, J = 8.9 Hz, ArCH), 7.51 (1H, d, J = 8.8 Hz, ArCH), 7.30 (2H, d, J = 8.1 Hz, Ts ArCH), 7.16 (1H, d, J = 2.4 Hz, ArCH), 7.00 (1H, dd, J = 8.9, 2.4 Hz, ArCH), 6.90 (1H, d, J = 8.8 Hz, ArCH), 3.96 (3H, s, OCH₃), 3.73 (2H, app. br s, C1-H₂), 2.96 (2H, t, J = 8.1 Hz, C3-H₂), 2.42 (3H, s, Ts CH₃), 1.96 (2H, qn J = 7.5 Hz, C2-H₂), 1.16 (9H, s, Boc (CH₃)₃), 1.05 (9H, s, TBS (CH₃)₃), 0.25 (6H, s, TBS (Si(CH₃)₂); ¹³C NMR (101 MHz, CDCl₃) δ 158.2 (ArC), 155.4 (C=O), 151.2 (ArC), 145.7 (Ts ArC), 134.5 (ArC), 131.4 (Ts ArC), 13.0 (ArCH), 129.7 (2× Ts ArCH), 129.6 (2× Ts ArCH), 127.2 (ArCH), 124.9 (ArC), 123.2 (ArC), 117.7 (ArCH), 116.0 (ArCH), 101.9 (ArCH), 83.2 (Boc C(CH₃)₃), 55.5 (OCH₃), 52.9 (C1), 27.6 (Boc (CH₃)₃), 26.0 (TBS (CH₃)₃), 25.8 (C2), 22.9 (C3), 21.8 (Ts CH₃), 18.4 (TBS C(CH₃)₃), -3.8 (TBS Si(CH₃)₂); HRMS (ESI⁺) Calculate for C₃₂H₄₅NNaO₇Si: 638.2578. Found [M+Na]⁺: 638.2560.

tert-Butyl (3-(2-hydroxy-7-methoxynaphthalen-1-yl)propyl)(tosyloxy)carbamate (5o)

**General procedure D:** tert-Butyl (2-((tert-butyldimethylsilyl)oxy)-7-methoxynaphthalen-1-yl) ethyl)(tosyloxy)carbamate (0.30 g, 0.50 mmol) and 1:1 TBAF/AcOH solution (0.1 M in THF, 0.50 mmol) in THF (10 mL) were employed. Purification by flash column chromatography (gradient, eluent 20 – 33 % EtOAc/hexane) afforded 5o (0.13 g, 51 %) as a pale yellow solid; Rₚ = 0.2 (20 % EtOAc/hexane); ¹H NMR (400 MHz, CDCl₃) δ 7.84 (2H, d, J = 8.1 Hz, Ts ArCH), 7.65 (1H, d, J = 8.9 Hz, ArCH), 7.54 (1H, d, J = 8.7 Hz, ArCH), 7.32 (2H, d, J = 8.0 Hz, Ts ArCH), 7.14 (1H, d, J = 2.3 Hz, ArCH), 6.99 (1H, dd, J = 8.9, 2.4 Hz, ArCH), 6.89 (1H, d, J = 8.7 Hz, ArCH), 5.34 (1H, br s, OH), 3.95 (3H, s, OCH₃), 3.76 (2H, br s, C1-H₂), 3.00 (2H, t, J = 7.8 Hz, C3-H₂), 2.43 (3H, s, Ts CH₃), 2.07 - 2.00 (2H, m, C2-H₂), 1.19 (9H, s, Boc (CH₃)₃); ¹³C NMR (101 MHz, CDCl₃) δ 158.4 (ArC), 155.9 (C=O), 151.3 (ArC), 145.7 (Ts ArC), 134.3 (ArC), 131.2 (Ts ArC), 130.1 (ArCH) 129.6 (2× Ts ArCH), 129.5 (2× Ts ArCH), 127.7 (ArCH), 124.7 (ArC), 117.7 (ArCH), 115.4 (ArCH), 115.3 (ArCH), 101.7 (ArCH), 83.5 (Boc C(CH₃)₃), 55.3 (OCH₃), 52.9 (C1), 27.5 (Boc (CH₃)₃), 25.8
(C2), 22.2 (C3), 21.7 (Ts CH3); HRMS (ESI+) Calculated for C26H31NNaO2S: 524.1713. Found [M+Na]+: 524.1708.

7-methoxy-2H-spiro[naphthalene-1,2'-pyrrolidin]-2-one (7o)

![Chemical structure](image)

**General procedure E:** tert-Butyl (3-(2-hydroxy-7-methoxynaphthalen-1-yl)propyl)(tosyloxy) carbamate (5o) (50.2 mg, 0.10 mmol), TFA (15 μL, 0.20 mmol) and TFE (1 mL) were employed. After stirring at r.t. for 48 h, purification by flash column chromatography (gradient, eluent 50% EtOAc/hexane – EtOAc) afforded 7o (17.4 mg, 76%) as a yellow oil; Rf = 0.2 (EtOAc); νmax / cm⁻¹ (film) 3340 (m), 2963 (m), 2942 (m), 2865 (m), 1666 (s), 1601 (s), 1555 (m), 1279 (s), 1224 (s); ¹H NMR (400 MHz, CDCl3) δ 7.32 (1H, d, J = 9.8 Hz, C11-H), 7.23 (1H, d, J = 2.6 Hz, C6-H), 7.19 (1H, d, J = 8.3 Hz, C9-H), 6.75 (1H, dd, J = 8.3, 2.6 Hz, C8-H), 6.03 (1H, d, J = 9.8 Hz, C12-H), 3.85 (3H, s, OCH3), 3.44 (1H, dt, J = 10.2, 6.3 Hz, C1-H), 3.27 (1H, dt, J = 10.2, 6.3 Hz, C1-H'), 2.92 (1H, br s, NH), 2.30 - 2.23 (1H, m, C3-H), 1.93 - 1.72 (3H, m, C3-H' and C2-H2); ¹³C NMR (101 MHz, CDCl3) δ 204.9 (C13), 161.5 (C7), 151.2 (C5), 144.7 (C11), 130.9 (C9), 122.4 (C10), 120.8 (C12), 112.2 (C6), 112.0 (C8), 74.1 (C4), 55.4 (CH3), 49.9 (C1), 43.2 (C3), 25.1 (C2); HRMS (ESI+) Calculated for C14H15NNaO2: 252.0995. Found [M+Na]+: 252.1002.

2-(Cinnamyl oxy)naphthalene²⁷

![Chemical structure](image)

The title compound was prepared according to a literature procedure.²⁷

*Spectroscopic properties were consistent with the data available in the literature.*²⁷
1-(1-Phenylallyl)naphthalen-2-ol

The title compound was prepared according to a literature procedure. Spectroscopic properties were consistent with the data available in the literature.

tert-Butyldimethyl((1-(1-phenylallyl)naphthalen-2-yl)oxy)silane

To a solution of 1-(1-phenylallyl)naphthalen-2-ol (1.40 g, 5.30 mmol), in DMF (10 mL) was added tert-butyldimethylsilyl chloride (0.97 g, 6.45 mmol) and imidazole (0.91 g, 13.4 mmol) and the reaction mixture was stirred at r.t. overnight until completion by TLC analysis. The reaction was quenched with water (50 mL) and extracted with CH₂Cl₂ (3 × 20 mL). The organic phase was washed with brine (20 mL), dried over Na₂SO₄, filtered and concentrated in vacuo. Purification by flash column chromatography (4% EtOAc/hexane) afforded the title compound (1.37 g, 69 %) as a pale-yellow oil; Rf = 0.4 (20 % EtOAc/hexane); νmax / cm⁻¹ (film) 2955 (m), 2928 (m), 1622 (m), 1586 (m), 1463 (m), 1253 (m), 1236 (m); ¹H NMR (400 MHz, CDCl₃) δ 7.75 (1H, d, J = 7.9 Hz, ArCH), 7.70 - 7.63 (2H, m, ArCH), 7.25 - 7.13 (8H, m, ArCH), 6.64 (1H, ddd, J = 17.3, 10.1, 7.5 Hz, C₂-H), 5.91 (1H, d, J = 7.6 Hz, C₃-H) 5.28 - 5.16 (2H, m, C₁-H₂), 0.99 (9H, s, TBS (CH₃)₃), 0.23 (6H, d, J = 7.3 Hz, TBS Si(CH₃)₂); ¹³C NMR (101 MHz, CDCl₃) δ 151.4 (ArC), 143.7 (ArC), 138.9 (C₂), 132.9 (ArC), 130.4 (ArC), 128.7 (ArCH), 128.6 (ArCH), 128.3 (2 × ArCH), 127.6 (2 × ArCH), 126.0 (ArC), 125.7 (2 × ArCH), 125.5 (ArCH), 123.2 (ArCH), 120.6 (ArCH), 117.5 (C₁), 45.4 (C₃), 26.0 (TBS (CH₃)₃), 18.5 (TBS Si(CH₃)₃), -3.6 (TBS Si(CH₃)₂); HRMS (ESI⁺) Calculated for C₂₅H₃₇NaOSi: 397.1958. Found [M+Na]⁺: 397.1972.
3-(2-(tert-Butyldimethylsilyl)oxy)naphthalen-1-yl)-3-phenylpropan-1-ol

This compound was prepared according to a literature procedure.\textsuperscript{22}

$\nu_{\text{max}}$ cm\textsuperscript{-1} (film) 3447 (m, br), 2952 (m), 2929 (m), 2857 (m), 1595 (m), 1463 (m), 1237 (m); 
$^1$H NMR (400 MHz, CDCl\textsubscript{3}) $\delta$ 7.78 - 7.74 (1H, m), 7.76 - 7.68 (1H, m), 7.66 - 7.57 (1H, m), 7.32 - 7.24 (5H, m), 7.21 - 7.15 (3H, m), 5.37 (1H, dd, $J$ = 11.4, 4.7 Hz, C3-H), 3.62 - 3.53 (1H, m, C1-H'), 3.37 - 3.27 (1H, m, C1-H), 2.87 - 2.79 (1H, m, C2-H), 2.55 - 2.46 (1H, m, C2-H'), 2.28 (1H, br s, OH), 1.03 (9H, s, TBS (CH\textsubscript{3})\textsubscript{3}), 0.37 (3H, s, TBS Si(CH\textsubscript{3})), 0.25 (3H, s, TBS Si(CH\textsubscript{3})); $^{13}$C NMR (101 MHz, CDCl\textsubscript{3}) $\delta$ 151.6 (Ar C), 144.6 (Ar C), 132.8 (Ar C), 128.5 (Ar C), 128.8 (Ar CH), 128.7 (Ar CH), 128.3 (2 $\times$ Ar CH), 127.1 (2 $\times$ Ar CH), 125.7 (Ar CH), 125.7 (Ar CH), 123.5 (Ar CH), 120.2 (Ar CH) 61.5 (C1), 36.4 (C3), 34.9 (C2) 25.9 (TBS (CH\textsubscript{3})\textsubscript{3}), 18.4 (TBS Si(C(CH\textsubscript{3}))\textsubscript{3}), -3.44 (TBS Si(CH\textsubscript{3})), -3.83 (TBS Si(CH\textsubscript{3}));

HRMS (ESI\textsuperscript{+}) Calculated for C\textsubscript{25}H\textsubscript{33}NaO\textsubscript{2}Si: 415.2064. Found [M+Na]\textsuperscript{+}: 415.2061.

tert-Butyl (3-(2-hydroxynaphthalen-1-yl)-3-phenylpropyl)(tosyloxy)carbamate (5p)

General procedure C and D: 3-(2-(tert-Butyldimethylsilyl)oxy)naphthalen-1-yl)-3-phenylpropan-1-ol (0.27 g, 0.69 mmol), PPh\textsubscript{3} (0.22 g, 0.832 mmol), DIAD (0.16 mL, 0.83 mmol) and TsONHBoc (0.24 mg, 0.83 mmol) in anhydrous THF (4 mL) were employed. The product was purified by flash column chromatography (10 % EtOAc/hexane) to afford the desired product (0.40 g) which could not be obtained cleanly so was used crude in the next step using 1:1 TBAF/AcOH solution (0.1 M in THF, 0.60 mmol) in THF (12 mL). Purification by flash column chromatography (33 % EtOAc/hexane) afforded 5p (0.26 g, 71% over 2 steps) as
an off-white solid; m.p.: 75 - 78 °C (EtOAc/hexane); Rf = 0.1 (20 % EtOAc/hexane); νmax / cm⁻¹
1 (film) 3410 (m, br), 2978 (m), 1721 (m), 1373 (s); ¹H NMR (400 MHz, CDCl₃) δ 7.99 - 7.89
(1H, m, ArCH), 7.79 - 7.70 (3H, m, ArCH), 7.66 (1H, d, J = 8.8 Hz, ArCH), 7.46 - 7.37 (1H,
m, ArCH), 7.35 - 7.26 (9H, m, ArCH), 7.00 (1H, d, J = 8.8 Hz, ArCH), 5.11 (1H, br s, OH),
4.99 (1H, t, J = 8.1 Hz, C₃-H), 3.73 - 3.61 (1H, m, C₁-H), 3.42-3.15 (1H,m, C₁-H'), 2.84-2.51
(2H, m, C₂-H₂), 2.37 (3H, s, Ts CH₃), 1.15 (9H, s, Boc (CH₃)₃); ¹³C NMR (101 MHz, CDCl₃)
δ 155.6 (C=O), 151.9 (Ar), 145.7 (Ts Ar), 142.9 (Ar), 133.2 (Ar), 131.3 (Ts Ar), 129.8
(Ar), 129.7 (2 x Ts ArCH), 129.6 (2 x Ts ArCH), 129.2 (ArCH), 129.0 (ArCH), 128.9
(ArCH), 127.5 (ArCH), 126.8 (ArCH), 126.6 (ArCH), 123.3 (ArCH), 121.3 (Ar), 119.2
(ArCH), 83.6 (Boc C(CH₃)₃), 52.3 (C1), 38.4 (C3), 28.0 (C2), 27.7 (Boc (CH₃)₃), 21.8 (Ts

3'-phenyl-2H-spiro[naphthalene-1,2'-pyrrolidin]-2-one (7p)

General procedure E: tert-Butyl (3-(2-hydroxynaphthalen-1-yl)-3-phenylpropyl)(tosyloxy)
carbamate (5p) (53.2 mg, 0.097 mmol) and TFA (15.0 µL, 0.19 mmol) in anhydrous TFE (1
mL) were employed. After stirring at r.t. for 22 h and purification by flash column
chromatography (20% EtOAc/hexane) 7p (19.2 mg, 72 %) was obtained as a 1:1 mixture of
diastereomers A and B and as a pale-yellow solid. The diastereomers could not be separated
by column chromatography.

Data for mixture of diastereomers A + B: Rf = 0.5 (50% EtOAc/hexane); νmax / cm⁻¹ (solid)
2961 (m), 2864 (m), 1650 (s); ¹H NMR (400 MHz, CDCl₃) δ 7.85 (1H, d, J = 7.8 Hz, C₆-H,
B), 7.68 (1H, d, J = 7.8 Hz, C₆-H, A), 7.47 (1H, td, J = 7.6, 1.4 Hz, C₇-H, B), 7.38 (1H, td, J =
7.6, 1.3 Hz, C₇-H, A), 7.30 - 7.25 (1H, m, C₈-H, B), 7.18 - 7.09 (5H, m, 3 × PhCH, B, C₈-H,
A, C₉-H, B), 7.05 - 7.00 (1H, m, PhCH, A), 6.93 - 6.90 (2H, m, 2 × PhCH, A), 6.85 - 6.81 (2H,
m, C₉-H, A, C₁₁-H, A), 6.77 (1H, d, J = 9.9 Hz, C₁₁-H, B), 6.71 - 6.68 (2H, m, 2 × PhCH, B),
6.52 - 6.48 (2H, m, 2 × PhCH, A), 6.03 (1H, d, J = 9.8 Hz, C₁₂-H, A), 5.44 (1H, d, J = 9.9 Hz,
C₁₂-H, B), 3.69 (1H, ddd, J = 10.7, 8.1 Hz, C₁-H, B), 3.56 - 3.49 (2H, m, C₁-H₂, A), 3.40 -
3.25 (3H, m, C3-H, A+B, C1-H', B), 2.69 (2H, br s, NH, A+B), 2.57 - 2.46 (1H, m, C2-H, B), 2.44 - 2.33 (1H, m, C2-H, A), 2.22 - 1.26 (1H, m, C2-H', A), 2.04 - 1.98 (1H, m, C2-H', B); ^13^C NMR (101 MHz, CDCl₃) δ 205.8 (C13, B), 205.2 (C13, A), 174.2 (C4), 173.7 (PhC, B), 136.9 (PhC, A), 130.9 (C10, A), 130.5 (C10, B), 130.5 (C7, B), 129.3 (C7, A), 129.2 (2 × PhCH A), 128.7 (C9, A), 128.6 (PhCH, B), 128.1 (PhCH, B), 128.0 (C6, A), 127.6 (2 × PhCH, B), 127.3 (C8, B), 127.4 (C8, A/ C9, B), 127.3 (C8, A/ C9, B), 127.0 (PhCH, A), 126.9 (2 × PhCH, A), 126.8 (C6, B), 124.9 (C12, B), 124.1 (C12, A), 78.1 (C4, A), 77.2 (C4, B), 64.5 (C3, A/B), 61.8 (C3, A/B), 48.3 (C1, B), 47.3 (C1, A), 32.0 (C2, A), 30.0 (C2, B); HRMS (ESI⁺) Calculated for C₁₉H₁₇N NaO: 298.1202. Found [M+Na]⁺: 298.1200.

3-(2-((tert-Butyldimethylsilyl)oxy)naphthalen-1-yl)-N-methoxy-N-methylpropanamide

**General procedure H:** 3-(2-((tert-Butyldimethylsilyl)oxy)naphthalen-1-yl)propanoic acid (2.64 g, 8.00 mmol), N,O-dimethylhydroxylamine hydrochloride (1.09 g, 11.2 mmol), Et₃N (1.56 mL, 11.2 mmol), 4-dimethylaminopyridine (1.37 g, 11.2 mmol), and N,N’-dicyclohexylcarbodiimide (2.31 g, 11.2 mmol) were employed. Purification by flash column chromatography (20 % EtOAc/hexane) afforded 3-(2-((tert-butyldimethylsilyl)oxy)naphthalen-1-yl)-N-methoxy-N-methylpropanamide (2.20 g, 74 %) as a pale yellow oil; Rᵣ = 0.7 (33 % EtOAc/hexane); v max / cm⁻¹ 2954 (m), 2930 (m), 2857 (m), 1664 (s), 1594 (m), 1466 (s), 1379 (m), 1242 (s), 1072 (m); ^1H NMR (400 MHz, CDCl₃) 8.02 (1H, d, J = 8.5 Hz, ArCH) δ 7.78 (1H, d, J = 8.4 Hz, ArCH), 7.64 (1H, d, J = 8.9 Hz, ArCH), 7.51 - 7.47 (1H, m, ArCH), 7.37 - 7.32 (1H, m, ArCH), 7.11 (1H, d, J = 8.8 Hz, ArCH), 3.59 (3H, s, C2-H₃), 3.41 (2H, t, J = 8.1 Hz, C5-H₂), 3.21 (3H, s, C1-H₁), 2.73 (2H, t, J = 8.1 Hz, C4-H₄), 1.07 (9H, s, TBS (CH₃)₃), 0.30 (6H, s, TBS Si(CH₃)₂); ^13^C NMR (101 MHz, CDCl₃) δ 174.2 (C3) 150.7 (ArC), 133.2 (ArC), 129.5 (ArC), 128.5 (ArCH), 127.5 (ArCH), 126.3 (ArCH), 124.3 (ArC), 123.3 (ArCH), 123.1 (ArCH), 120.3 (ArCH), 61.2 (C2), 32.3 (C4), 31.9 (C1), 25.8 (TBS (CH₃)₃),
To a solution of 3-(2-((tert-butyldimethylsilyl)oxy)naphthalen-1-yl)-N-methoxy-N-methyl propanamide (0.94 g, 2.50 mmol) in anhydrous THF (6 mL) at 0 °C was added methylmagnesium bromide (3 M in Et₂O, 1.6 mL, 5.0 mmol) dropwise over 5 min. The reaction mixture was stirred at r.t. for 1 h until completion by TLC analysis. The reaction mixture was quenched by addition of sat. aq. NH₄Cl (5 mL) and the aqueous phase was extracted with EtOAc (3 × 5mL). The combined organic extracts were washed with brine (10 mL), dried over Na₂SO₄ and concentrated in vacuo to afford the title compound (0.61 g, 74 %) as a pale yellow oil which was used without further purification; Rᵣ = 0.8 (33 % EtOAc/hexane); νₑₓₘₐₓ / cm⁻¹ 2954 (m), 2929 (m), 2893 (m), 2857 (m), 1713 (s), 1622 (m), 1594 (m), 1466 (s), 1360 (m), 1242 (s), 1161 (m), 1075 (m); ¹H NMR (400 MHz, CDCl₃) δ 7.91 (1H, d, J = 8.5 Hz, ArCH), 7.79 (1H, d, J = 8.4 Hz, ArCH), 7.64 (1H, d, J = 8.8 Hz, ArCH), 7.49 (1H, ddd, J = 8.4, 6.8, 1.4 Hz, ArCH), 7.35 (1H, ddd, J = 8.0, 6.8, 1.1 Hz, ArCH), 7.10 (1H, d, J = 8.8 Hz, ArCH), 3.33 (2H, t, J = 8.2 Hz, C₄-H₂), 2.74 (2H, t, J = 8.2 Hz, C₃-H₂), 2.18 (3H, s, C₁-H₃), 1.06 (9H, s, TBS (CH₃)₃), 0.29 (6H, s, TBS Si(CH₃)₂); ¹³C NMR (101 MHz, CDCl₃) δ 208.5 (C₂), 150.6 (ArC), 133.0 (ArC), 129.5 (ArC), 128.6 (ArCH), 127.5 (ArCH), 126.4 (ArCH), 123.9 (ArC), 123.4 (ArCH), 122.9 (ArCH), 120.2 (ArCH), 43.5 (C₃), 29.9 (C₁), 25.8 (TBS (CH₃)₃), 19.9 (C₄), 18.3 (TBS C(CH₃)₃), -3.9 (TBS Si(CH₃)₂); HRMS (ESI⁺) Calculated for C₂₀H₂₈NaO₂Si: 351.1750. Found [M+Na]⁺: 351.1753.

4-(2-((tert-butyldimethylsilyl)oxy)naphthalen-1-yl)butan-2-ol
To a solution of 4-(2-((tert-butyldimethylsilyl)oxy)naphthalen-1-yl)butan-2-one (0.56 g, 1.70 mmol) in MeOH (10 mL) was slowly added NaBH₄ (0.13 mg, 3.40 mmol) at 0 °C. The reaction was stirred at this temperature for 1.5 h until complete by TLC analysis. The reaction was quenched by addition of water (10 mL) and extracted with Et₂O (3 × 10 mL). The combined organic extracts were washed with brine (10 mL), dried over MgSO₄, filtered and the solvent removed in vacuo to afford the title compound (0.49 g, 87 %) as a pale yellow oil which was used without further purification.; R_f = 0.6 (33 % EtOAc/hexane); ν_max / cm⁻¹ 3360 (m br), 2957 (m), 2928 (m), 2884 (m), 2857 (m), 1622 (m), 1594 (m), 1465 (m), 1241 (s); ¹H NMR (400 MHz, CDCl₃) δ 7.97 (1H, d, J = 8.4 Hz), 7.78 (2H, d, J = 8.3 Hz), 7.62 (1H, d, J = 8.8 Hz), 7.48 (1H, ddd, J = 8.4, 6.8, 1.4 Hz), 7.35 (1H, ddd, J = 8.0, 6.8, 1.1 Hz), 7.10 (1H, d, J = 8.9 Hz), 3.73-3.65 (1H, m, C₂-H), 3.27-3.13 (2H, m, C₄-H₂), 2.29 (1H, br s, OH), 1.87 - 1.74 (2H, m, C₃-H₂), 1.19 (3H, d, J = 6.2 Hz, C₁-H), 1.06 (9H, s, TBS (CH₃)₃), 0.29 (6H, s, TBS Si(C₃H₃)₂); ¹³C NMR (101 MHz, CDCl₃) δ 150.3 (Ar C), 133.2 (Ar C), 129.8 (Ar C), 128.5 (Ar C), 126.3 (Ar C), 125.8 (Ar C), 124.8 (Ar C), 124.9 (Ar C), 123.5 (Ar C), 123.4 (Ar C), 120.5 (Ar C), 67.1 (C₂), 38.9 (C₃), 25.9 (TBS (CH₃)₃), 23.1 (C₄), 21.6 (C₁), 18.4 (TBS Si(CH₃)₃), -3.9 (TBS Si(CH₃)₂); HRMS (ESI⁺) Calculated for C₂₀H₃₀NaO₂Si: 353.1907. Found [M+Na]⁺: 353.1894.

tert-Butyl (4-(2-hydroxynaphthalen-1-yl)butan-2-yl)(tosyloxy)carbamate (5q)

**General procedure C and D:** 4-(2-((tert-butyldimethylsilyl)oxy)naphthalen-1-yl)butan-2-ol (0.22 g, 0.77 mmol), PPh₃ (0.24 g, 0.92 mmol), DIAD (0.18 mL, 0.92 mmol) and TsONHBoc (0.26 g, 0.92 mmol) in anhydrous THF (3 mL) were employed. The desired product could not be obtained pure so to the crude product in THF (5 mL) was added a solution of TBAF (1M in THF, 1.06 mL, 1.06 mmol) at 0 °C. The reaction mixture was stirred at this temperature for 1.5 h until complete by TLC. The reaction mixture was quenched with sat. aq. NH₄Cl (5 mL) and extracted with EtOAc (3 × 5 mL). The combined organic extracts were washed with brine (10 mL), dried over MgSO₄, filtered and concentrated in vacuo. Purification by flash column
chromatography (gradient 20 – 33 % EtOAc/hexane) afforded 5q (0.32 g, 69 %) as a colorless solid; Rf = 0.4 (33 % EtOAc/hexane); v_{max}/\text{cm}^{-1} (solid) 3461 (m), 2975 (m), 1688 (s), 1386 (s); 1H NMR (400 MHz, CD_{3}OD) δ 7.83 (3H, d, J = 8.3, Ts ArCH, ArCH), 7.72 (1H, d, J = 8.1 Hz, ArCH), 7.58 (1H, d, J = 8.8 Hz, ArCH), 7.42 - 7.33 (3H, m, ArCH), 7.24 (1H, t, J = 7.5 Hz, ArCH), 7.09 (1H, d, J = 8.8 Hz, ArCH), 4.00 (1H, sextet, J = 6.9 Hz, C_2-H), 3.03 (2H, dd, J = 9.3, 6.6 Hz, C_4-H_2), 2.38 (3H, s, Ts C_3H), 1.94 - 1.83 (1H, m, C_3-H'), 1.77 - 1.66 (1H, m, C_3-H'), 1.27 (3H, d, J = 6.7 Hz, C_1-H_3), 1.20 (9H, s, Boc (CH_3)_3); 13C NMR (101 MHz, CD_{3}OD) δ 157.9 (C=O), 153.3 (Ar C), 147.4 (Ts Ar C), 134.7 (Ar C), 132.9 (Ar C), 130.8 (2 × Ts Ar CH), 130.7 (2 × Ts Ar CH), 130.4 (Ar C), 129.5 (Ar CH), 128.5 (Ar CH), 127.1 (Ar CH), 123.7 (Ar CH), 123.4 (Ar CH), 120.3 (Ar C), 118.6 (Ar CH), 84.7 (Boc C(CH_3)_3), 62.8 (C_2), 35.2 (C_3), 27.9 (Boc (CH_3)_3), 22.8 (C_4), 21.6 (Ts CH_3), 17.8 (C_1); HRMS (ESI^+) Calculated for C_{26}H_{31}NNaO_6Si: 508.1764. Found [M+Na]^+: 508.1756.

5'-Methyl-2H-spiro[naphthalene-1,2'-pyrrolidin]-2-one (7q)

\[
\begin{align*}
5q & \quad \text{Me} \quad \text{N} \quad \text{Boc} \\
\text{OH} & \quad \text{OTs}
\end{align*}
\]

General procedure E: tert-Butyl (4-(4-hydroxyphenyl)butan-2-yl)(tosyloxy)carbamate (5q) (97.1 mg, 0.20 mmol) and TFA (30 μL, 0.4 mmol) in 5:1 TFE/CH_2Cl_2 (3 mL) were stirred at r.t. for 48 h. Purification by flash column chromatography (20 – 33 % EtOAc/hexane – 100 % EtOAc) afforded 7q (23.0 mg, 54 %) as a 1.5:1 mixture of diastereomers A and B and as a yellow solid.

Rf = 0.5 (2:1 EtOAc/hexane); v_{max}/\text{cm}^{-1} 3337 (s), 2963 (s), 2916 (s), 2850 (s), 1668 (s), 1084 (s); HRMS (ESI^+) Calculated for C_{14}H_{15}NNaO: 236.1046. Found [M+Na]^+: 236.1046.

Data for the major diastereomer: m.p.: 89 - 90 °C (EtOAc/hexane); 1H NMR (400 MHz, CDCl_3) δ 7.67 (1H, d, J = 7.8 Hz, C_7-H), 7.41 - 7.35 (2H, m, C_8-H, C_12-H), 7.26 - 7.24 (2H, m, C_9-H, C_10-H), 6.18 (1H, d, J = 9.9 Hz, C_13-H), 3.63 - 3.55 (1H, m, C_2-H), 2.42 (1H, br s, NH) overlapping 2.45 - 2.39 (1H, ddd, J = 12.9, 7.0, 2.8 Hz, C_4-H), 1.92 - 1.86 (1H, dddd, J = 11.5, 6.4, 5.1, 2.8 Hz, C_3-H), 1.82 - 1.74 (1H, ddd, J = 13.0, 10.8, 6.2 Hz, C_4-H').
m, C3-H') overlapping 1.39 (3H, d, J = 6.2 Hz, C1-H3); 13C NMR (101 MHz, CDCl3) δ 204.3 (C4), 149.1 (C6), 144.6 (C12), 130.4 (C8), 129.1 (C10), 128.9 (C11), 126.9 (C9), 125.8 (C7), 123.4 (C13), 74.8 (C5), 58.2 (C2), 42.9 (C4), 33.3 (C3), 20.2 (C1).

Data for the minor diastereomer: 1H NMR (400 MHz, CDCl3) δ 7.85 (1H, dd, J = 7.8, 1.0 Hz), 7.42 - 7.32 (2H, m, C8-H, C12-H), 7.28 - 7.22 (2H, m, C9-H, C10-H), 6.15 (1H, d, J = 9.9 Hz, C13-H), 3.76 - 3.67 (1H, m, C2-H), 2.72 (1H, br s, NH), 2.25 (1H, ddd, J = 12.4, 10.1, 6.8 Hz, C4-H), 1.90 (1H, dddd, J = 12.4, 6.8, 5.7, 3.5 Hz, C3-H), 1.81 (1H, ddd, J = 12.4, 6.8, 3.5 Hz, C4-H'), 1.53 (1H, dddd, J = 11.8, 10.0, 8.9, 6.9 Hz, C3-H'), 1.33 (3H, d, J = 6.2 Hz, C1-H3); 13C NMR (101 MHz, CDCl3) δ 206.5 (C14), 149.2 (C6), 144.4 (C12), 130.0 (C8), 129.5 (C10), 129.2 (C11), 127.1 (C9), 126.6 (C7), 124.0 (C13), 74.0 (C5), 55.9 (C2), 42.7 (C4), 32.6 (C3), 22.3 (C1).

The stereochemistry of the major diastereomer was determined unambiguously by X-ray crystallography.

1-(2-Phenylacetyl)-1-azaspiro[4.5]deca-6,9-dien-8-one (9a)

![Diagram of the molecule](image)

A solution of 1-Azaspiro[4.5]deca-6,9-dien-8-one trifluoroacetate (7a) (19.2 mg, 0.073 mmol) in anhydrous THF (0.36 mL) under an atmosphere of nitrogen was cooled to 0 °C and phenylacetyl chloride (19.4 μL, 0.147 mmol) and K3PO4 (62.2 mg, 0.293 mmol) were added.
The reaction was warmed to r.t. and stirred overnight and monitored by TLC. Upon completion, the reaction was quenched with water (1 mL) and extracted with EtOAc (3 × 2 mL). The combined organic extracts were dried over Na$_2$SO$_4$, filtered and concentrated in vacuo. Purification by flash column chromatography (gradient, eluent 50 % EtOAc/pentane – 100 % EtOAc) afforded 9a (12.2 mg, 63 %) as a 3:1 mixture of rotamers A+B and as a colorless, viscous oil; R$_f$ = 0.3 (3 % MeOH/CH$_2$Cl$_2$); $\nu_{max}$ / cm$^{-1}$ (film) 3029 (m), 2972 (m), 2881 (m), 1659 (s), 1622 (s), 1395 (s); $^1$H NMR (400 MHz, CDCl$_3$) δ 7.35 - 7.10 (5H, m, 5 × PhCH$_3$, A + B), 6.95 (0.50 H, d, $J$ = 10.0 Hz, 0.50 × C5-H, B), 6.76 (1.50 H, d, $J$ = 10.0 Hz, 1.50 × C5-H, A), 6.32 (0.50 H, d, $J$ = 10.0 Hz, 0.50 × C6-H, B), 6.25 (1.50 H, d, $J$ = 10.0 Hz, 1.5 × C6-H, A), 3.65 (1.50 H, s, 1.50 × C9-H$_2$, A), 3.43 (0.50 H, s, 0.50 × C9-H$_2$, B), 2.25 (0.50 H, t, $J$ = 6.9 Hz, 0.50 × C3-H$_2$, B), 2.12 - 1.99 (3.5 H, m, 3.5 H × C2 + C3-H$_2$, A + B); $^{13}$C NMR (101 MHz, CDCl$_3$) δ 185.4 (C7, A), 184.4 (C7, B), 170.7 (C8, B), 169.5 (C8, A), 51.2 (C5, B) 150.7 (C5, A), 134.8 (PhC, B), 134.2 (PhC, A), 129.4 (PhCH, B), 129.4 (PhCH, A), 128.9 (2 × PhCH, A), 128.7 (PhCH$_3$, B), 128.5 (C6, B), 128.3 (C6, A), 127.1 (PhCH$_3$, A), 126.9 (PhCH$_3$, B), 62.7 (C4, A), 62.0 (C4, B), 49.0 (C1, B), 48.5 (C1, A), 42.8 (C9, A), 42.0 (C3, B), 39.9 (C9, B), 38.9 (C3, A), 24.5 (C2, A), 22.6 (C2, B); HRMS (ESI$^+$) Calculated for C$_{17}$H$_{18}$NO$_2$: 268.1332. Found [M+H]$^+$: 268.1325.

(6R*, 6aS*, 10aS*)-6-Phenyl-2,3,6a,7-tetrahydro-1H,5H-pyrrolo[2,1-i]indole-5,8(6H)-dione (10a)

![Diagram]

To a solution of 1-(2-phenylacetyl)-1-azaspiro[4.5]deca-6,9-dien-8-one (9a) (26.7 mg, 0.10 mmol) in anhydrous THF (1 mL) at -78 °C and under an atmosphere of nitrogen was added 1.5 eq. lithium bis(trimethylsilyl)amide (1.0 M in THF, 0.15 mL, 0.15 mmol). The reaction was stirred at this temperature for 2 h and monitored by TLC. Upon completion, the reaction mixture was warmed to 0 °C and quenched with sat. aq. NH$_4$Cl (0.3 mL) and extracted with EtOAc (3 × 5 mL). The combined organic extracts were washed with brine (5 mL), dried over
anhydrous Na₂SO₄, filtered and concentrated in vacuo. Purification by flash column chromatography (EtOAc) afforded 10a (17.9 mg, 67 %, > 20:1 d.r.) as a colorless oil; Rᵣ = 0.4 (3 % MeOH/CH₂Cl₂); νmax / cm⁻¹ (film) 2920 (m), 1677 (br s), 1395 (s); ¹H NMR (400 MHz, CDCl₃) δ 7.39 - 7.27 (3H, m, PhCH), 7.15 - 7.11 (2H, m, PhCH), 6.64 (1H, dd, J = 10.3, 1.9 Hz, C₉-H), 6.13 (1H, dd, J = 10.3, 1.1 Hz, C₁₀-H), 3.97 (1H, ddd, J = 12.4, 7.3, 5.2 Hz, C₅-H), 3.68 (1H, d, J = 12.2 Hz, C₃-H), 3.28 - 3.20 (1H, m, C₅-H'), 2.71 - 2.62 (2H, m, C₂-H, C₁-H), 2.49 - 2.43 (1H, m, C₁-H'), 2.32 - 2.21 (1H, m, C₆-H), 2.19 - 2.11 (1H, m, C₆-H'), 2.10 - 2.02 (2H, m, C₇-H₂); ¹³C NMR (101 MHz, CDCl₃) δ 196.0 (C₁₁), 173.5 (C₄), 146.9 (C₉), 135.7 (PhC), 129.2 (2 × PhCH), 129.0 (2 × PhCH), 128.0 (C₁₀), 127.8 (PhCH), 65.3 (C₈), 56.3 (C₃), 51.5 (C₂), 42.7 (C₅), 36.3 (C₁), 35.6 (C₇), 26.3 (C₆). HRMS (ESI⁺) Calculated for C₁₇H₁₇NNaO₂: 290.1151. Found [M+Na]⁺: 290.1155.

The relative stereochemistry of this compound was determined by nOe experiments as indicated on the compound structure. nOes were observed between C₃-H and C₉-H.

4-Ethyl-1-(2-phenylacetyl)-1-azaspiro[4.5]deca-6,9-dien-8-one (9g)

The title compound was prepared using the same procedure as for 9a using 4-Ethyl-1-azaspiro[4.5]deca-6,9-dien-8-one salt (7g) (43.7 mg, 0.15 mmol), 2.5 eq. phenylacetyl chloride (26 μL, 0.2 mmol) and K₃PO₄ (67.9 mg, 0.32 mmol) in anhydrous THF (1 mL). Purification by flash column chromatography (gradient, eluent 50% EtOAc/pentane – 100% EtOAc) afforded 9g (18.7 mg, 79 %) as a 2.3:1 mixture of rotamers A:B and a colorless oil; Rᵣ = 0.3 (3 % MeOH/CH₂Cl₂); νmax / cm⁻¹ (film) 2962 (m), 2930 (m), 2876 (m), 1660 (s), 1623 (s), 1454 (m), 1397 (s), 1384 (s), 719 (m); ¹H NMR (400 MHz, CDCl₃) δ 7.33 - 7.17 (4.40 H, m, Ph₄C, A+B), 7.13 - 7.10 (0.60 H, m, 2 × Ph₄B, B), 6.82 - 6.70 (0.60 H, m, 0.60 × C₇-H, B), 6.67 (0.70 H, dd, J = 10.0, 3.0 Hz, 0.70 × C₇-H, A), 6.57 (0.70 H, dd, J = 10.0, 3.0 Hz, 0.70 × C₇-H, A), 6.40 - 6.34 (0.60 H, m, 0.60 × C₈-H, B), 6.34 - 6.26 (1.40 H, m, 1.40 × C₈-H, A), 4.09 (0.3 H, dd, J = 12.3, 8.1 Hz, 0.3 × C₁-H), 3.82 (0.7 H, t, J = 9.2 Hz, 0.7 × C₁-H), 3.65 - 3.52
(2.40 H, m, 2.40 × C1-H', A+B, C11-H2, A), 3.43 (0.6 H, d, J = 4.6 Hz, 0.6 × C11-H2, B), 2.31 - 2.25 (1H, m, C2-H, A+B), 2.23 - 2.14 (0.30 H, m, 0.30 × C3-H, B), 2.02 - 1.95 (0.70 H, m, 0.70 × C3-H, A), 1.76 - 1.64 (0.70 H, m, 0.70 × C2-H', A), 1.63 - 1.55 (0.3 H, m, 0.30 × C2-H', B), 1.27 - 1.17 (1H, m, C4-H, A+B), 1.06 - 0.95 (1H, m, C4-H', A+B), 0.93 - 0.84 (3H, m, C5-H3, A+B); \(^{13}\)C NMR (101 MHz, CDCl3) δ 185.8 (C9, A), 184.7 (C9, B), 170.6 (C10, B), 169.5 (C10, A), 152.1 (C7, A), 152.0 (C7, B), 147.8 (C7, B), 146.4 (C7, A), 134.8 (PhC, B), 134.1 (PhC, A), 130.4 (C8, A), 129.9 (C8, B), 129.6 (C8, B), 129.3 (PhCH, B), 128.9 (PhCH, A+B), 128.7 (PhCH, A+B), 128.3 (PhCH, A+B), 128.2 (C8, A), 126.9 (PhCH, A+B), 126.7 (PhCH, B), 65.7 (C6, A), 65.5 (C6, B), 53.5 (C3, B), 50.6 (C3, A), 47.4 (C1, B), 47.3 (C1, A), 42.5 (C11, A), 40.1 (C11, B), 29.9 (C2, A), 27.8 (C2, B), 21.3 (C4, A+B), 12.5 (C5, A+B); HRMS (ESI\(^+\)) Calculated for C\(_{19}\)H\(_{21}\)NNaO\(_2\): 318.1464. Found [M+Na\(^+\)]: 318.1472.

\((1R^*, 6R^*, 6aS^*, 10aS^*) and (1S^*, 6R^*, 6aS^*, 10aS^*)-1-Ethyl-6-phenyl-2,3,6a,7-tetrahydro-1H,5H-pyrrolo[2,1-i]indole-5,8(6H)-dione (10g)\)

The title compound was prepared using the same procedure as for 10a employing 4-ethyl-1-(2-phenylacetyl)-1-azaspiro[4.5]deca-6,9-dien-8-one (9g) (29.5 mg, 0.100 mmol) and 1.5 eq. lithium bis(trimethylsilyl)amide (1 M in THF) in anhydrous THF (1 mL). Purification by flash column chromatography (50 % EtOAc/hexane) afforded 10g (16.6 mg, 56 %) as a 3:1 mixture of diastereomers A and B and as a colorless solid.

R\(_f\) = 0.6 (3% MeOH/CH\(_2\)Cl\(_2\)); \(\nu_{max}\) / cm\(^{-1}\) (solid) 2963 (m), 2929 (m), 2877 (m), 1693 (s), 1675 (s), 1394 (s); HRMS (ESI\(^+\)) Calculated for C\(_{19}\)H\(_{21}\)NNaO\(_2\): 318.1464. Found [M+Na\(^+\)]: 318.1469.

Data for the major diastereomer A: m.p. 194 °C (EtOAc/hexane); \(^1\)H NMR (400 MHz, CDCl3) δ 7.36 - 7.32 (2H, m, PhCH\(_3\)), 7.30 - 7.24 (1H, m, PhCH\(_3\)), 7.15 - 7.12 (2H, m, PhCH\(_3\)), 6.62 (1H,
Data for the minor diastereomer B: $^1$H NMR (400 MHz, CDCl₃) δ 7.38 - 7.32 (2H, m, PhCH), 7.32 - 7.28 (1H, m, PhCH), 7.14 - 7.10 (2H, m, PhCH), 6.58 (1H, dd, J = 10.2, 1.9 Hz, C10-H), 6.16 (1H, dd, J = 10.2, 0.9 Hz, C11-H), 4.05 (1H, ddd, J = 10.8, 7.3, 2.7 Hz, C4-H), 3.62 (1H, d, J = 12.3 Hz, C3-H), 3.14 - 3.06 (1H, m, C4-H'), 2.76 (1H, dd, J = 12.4, 5.7 Hz, C2-H), 2.56 - 2.41 (2H, m, C1-H₂), 2.33 - 2.25 (1H, m, C5-H), 2.17 - 2.08 (1H, m, C6-H), 1.78 - 1.68 (1H, m, C7-H), 1.64 - 1.55 (1H, m, C5-H'), 1.47 - 1.35 (1H, m, C7-H'), 1.03 (3H, t, J = 7.3 Hz, C8-H₃); $^{13}$C NMR (101 MHz, CDCl₃) δ 196.1 (C=O), 174.6 (C=O), 148.8 (C₁₀), 135.8 (PhC), 129.4 (2 × PhCH), 129.0 (2 × PhCH), 128.2 (C₁₁), 127.9 (PhCH), 66.4 (C₉), 55.6 (C₃), 48.9 (C₆), 46.3 (C₂), 42.9 (C₄), 36.2 (C₁), 31.9 (C₅), 22.4 (C₇), 13.2 (C₈).

The relative stereochemistry of the minor diastereomer was determined by nOe experiments as indicated on the compound structure; nOes were observed between C2-H and C7-H₂ and between C6-H and C10-H. The major diastereomer was determined unambiguously by X-ray crystallography.
(1R*, 6aR*, 10aS*) and (1S*, 6aR*, 10aS*)-1-Ethyl-6-phenyl-2,3,6a,7-tetrahydro-1H,5H-benzo[d]pyrrolo[1,2-c]imidazole-5,8(6H)-dione (11g)

A solution of 4-ethyl-1-azaspiro[4.5]deca-6,9-dien-8-one trifluoroacetate (45.0 mg, 0.154 mmol) in anhydrous CH₂Cl₂ (0.77 mL, 0.2 M) was cooled to 0 °C and phenyl isocyanate (34.0 μL, 0.308 mmol) and Et₃N (86.0 μL, 0.618 mmol) was added. The reaction was stirred at this temperature for 2 h before warming to r.t. and stirring overnight, monitoring by TLC. Upon completion, the reaction mixture was quenched with sat. aq. NH₄Cl (1 mL) and extracted with EtOAc (3 × 5 mL). The combined organic extracts were washed with brine (5 mL), dried over Na₂SO₄, filtered and concentrated in vacuo. Purification by flash column chromatography (33 % EtOAc/hexane) afforded 11g (34.1 mg, 75 %) as a colorless solid. A mixture of diastereomers A and B were obtained in a 4:1 ratio.

R<sub>t</sub> = 0.6 (3 % MeOH/CH₂Cl₂); ν<sub>max</sub> / cm<sup>-1</sup> (solid) 2965 (m), 2926 (m), 2885 (m), 1692 (s), 1683 (s), 1380 (s); HRMS (ESI<sup>+</sup>) Calculated for C₁₈H₂₀N₂NaO₂: 319.1417. Found [M+Na]<sup>+</sup>: 319.1426.

Data for the major diastereomer A: m.p.: 148 - 151 °C (EtOAc/hexane); <sup>1</sup>H NMR (400 MHz, CDCl₃) δ 7.37 - 7.30 (4H, m, PhCH), 7.17 - 7.11 (1H, m, PhCH), 6.57 (1H, d, J = 10.3 Hz, C7-H), 6.21 (1H, d, J = 10.3 Hz, C8-H), 4.57 (1H, app. t, J = 6.2 Hz, C11-H), 3.87 - 3.78 (1H, m, C1-H), 3.43 - 3.35 (1H, m, C1-H'), 2.84 (1H, dd, J = 16.3, 5.8 Hz, C10-H), 2.66 (1H, dd, J = 16.3, 7.0 Hz, C10-H'), 2.45 - 2.36 (1H, m, C2-H), 2.08 - 1.98 (1H, m, C3-H), 1.88 - 1.76 (1H, m, C2-H'), 1.54 - 1.44 (1H, m, C4-H), 1.39 - 1.28 (1H, m, C4-H'), 0.99 (3H, t, J = 7.4 Hz, C5-H₃); <sup>13</sup>C NMR (101 MHz, CDCl₃) δ 195.6 (C9), 159.4 (C14), 142.4 (C7), 137.3 (PhC), 129.6
(C8), 129.3 (PhCH), 125.1 (PhCH), 122.2 (PhCH), 64.8 (C6), 58.6 (C12), 50.1 (C3), 43.9 (C1), 39.6 (C11), 30.9 (C2), 25.6 (C4), 13.2 (C5).

The minor diastereomer could not be isolated in a pure form.

Data for minor diastereomer B: Characteristic peaks only: \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 6.48 (1H, d, \(J = 10.2\) Hz, C7-H), 6.14 (1H, d, \(J = 10.2\) Hz, C8-H), 4.51 - 4.48 (1H, m, C11-H'), 3.94 - 3.87 (1H, m, C1-H'), 3.20 (1H, td, \(J = 11.5, 5.0\) Hz, C1-H'), 2.78 (1H, dd, \(J = 17.5, 4.8\) Hz, C10-H'), 2.57 (1H, dd, \(J = 17.7, 2.8\) Hz, C10-H').

The relative stereochemistry of the major diastereomer of this compound was determined by nOe experiments as indicated on the compound structure. nOes were observed between C3-H and C11-H and between C4-H\(_2\) and C7-H.

9-Methyl-1-(2-phenylacetyl)-1-azaspiro[4.5]deca-7,9-dien-6-one

![Chemical structure](image)

The title compound was prepared using the same procedure as for 9a employing 9-Methyl-1-azaspiro[4.5]deca-7,9-dien-6-one tosylate (0.150 mmol), phenylacetyl chloride (40.0 \(\mu\)L, 0.300 mmol) and K\(_3\)PO\(_4\) (127.4 mg, 0.600 mmol) in anhydrous THF (0.75 mL). Purification by flash column chromatography (EtOAc) afforded the title compound (34.0 mg, 81\%) as a 9:1 mixture of rotamers A:B and as a yellow oil; \(R_f = 0.4\) (3 \% MeOH/CH\(_2\)Cl\(_2\)); \(\nu_{\text{max}}/\text{cm}^{-1}\) (film) 2972 (m), 2878 (m), 1675 (s), 1642 (s), 1406 (s); \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 7.32 - 7.27 (2H, m, PhCH\(_2\), A+B), 7.25 - 7.20 (2.90H, m, PhCH\(_2\), A+B), 7.13 - 7.09 (0.10H, m, 0.10 × PhCH\(_2\), A), 6.93 (0.10H, dd, \(J = 9.8, 2.4\) Hz, 0.10 × C8-H, B), 6.82 (0.90H, dd, \(J = 9.9, 2.4\) Hz, 0.90 × C8-H, A), 6.18 - 6.09 (1.10H, m, 1.00 × C9-H, A+B, 0.10 × C5-H, B), 5.90 - 5.87 (0.90H, m, 0.90 × C5-H, A), 3.97 - 3.91 (0.10H, m, 0.1 × C1-H, B), 3.78 - 3.69 (0.9H, m, 0.90 × C1-H, A), 3.67 - 3.60 (2.8H, m, 1.00 × C1-H', A+B, 1.80 × C12-H\(_2\), A), 3.12 (0.20H, m, 0.20 × C12-H\(_2\), B), 2.28 - 2.22 (0.10H, m, 0.10 × C3-H, B), 2.21 - 2.12 (1H, m, 0.90 × C2-H, A, C3-H', B), 2.10 - 1.95 (2.30H, m, 1.00 × C3-H', A+B, 1.00 × C2-H', A+B, 0.30 × C7-H\(_3\), B), 1.92 (2.70H, s, C7-H\(_3\), A), 1.89 - 1.82 (1H, m, 0.90 × C3-H, A, 0.10 × C2-H, B); \(^{13}\)C NMR (101 MHz, CDCl\(_3\)) \(\delta\)
(6R*, 6aS*)-6a-Hydroxy-9-methyl-6-phenyl-2,3,6a-tetrahydro-1H,5H-pyrrolo[2,1-i]indol-5-one (12k)

The title compound was prepared using the same procedure as for 10a employing 9-methyl-1-(2-phenylacetyl)-1-azaspiro[4.5]deca-7,9-dien-6-one (28.1 mg, 0.10 mmol) and 1.5 eq. lithium bis(trimethylsilyl)amide (1.0 M in THF) in anhydrous THF (1 mL). Purification by flash column chromatography afforded 12k (18.9 mg, 67 %, > 15:1 d.r.) as a colorless solid; m.p.: 150 - 152 °C (EtOAc/hexane); Rf = 0.5 (3% MeOH/CH2Cl2); νmax / cm⁻¹ (solid) 3356 (br m), 2969 (m), 2942 (m), 2880 (m), 1673 (s), 1402 (s); ¹H NMR (400 MHz, CDCl₃) δ 7.38 - 7.31 (3H, m, PhC₆H₄), 7.28 - 7.24 (2H, m, PhC₆H₄), 5.78 (1H, dd, J = 9.8, 1.5 Hz, C₈-H), 5.53 (1H, m, C₅-H), 5.38 (1H, d, J = 9.8 Hz, C₉-H), 4.27 (1H, s, C₁₁-H), 3.89 (1H, ddd, J = 12.1, 7.7, 4.7 Hz, C₁-H), 3.16 (1H, ddd, J = 11.8, 7.7, 1.3 Hz, C₁-H'), 2.54 (1H, ddd, J = 12.9, 8.4, 6.1 Hz, C₃-H), 2.07 - 1.97 (1H, m, C₂-H), 1.95 - 1.87 (1H, m, C₂-H'), 1.85 (1H, d, J = 1.5 Hz, C₇-H'), 1.44 (1H, dt, J = 12.9, 7.3 Hz, C₃-H'), ¹³C NMR (101 MHz, CDCl₃) δ 172.8 (C₁₂), 134.2 (2 × PhCH), 131.3 (C₉), 131.2 (PhC), 128.6 (2 × PhCH), 128.6 (C₆), 128.0 (PhCH), 127.0 (C₅), 126.7 (C₈), 79.1 (C₁₀), 72.7 (C₄), 61.6 (C₁₁), 42.9 (C₁), 30.6 (C₃), 26.2 (C₂), 21.2 (C₇); HRMS (ESI⁺) Calculated for C₁₈H₁₉NNaO₂: 304.1308. Found [M+Na]⁺: 304.1322.

The relative stereochemistry of this compound was determined unambiguously using X-ray crystallography.
A solution of 9-Methyl-1-azaspiro[4.5]deca-7,9-dien-6-one tosylate (7k) (0.15 mmol) in anhydrous CH$_2$Cl$_2$ (0.2 M) was cooled to 0 °C and 1.1 eq. phenyl isocyanate (18 μL, 0.17 mmol) and Et$_3$N (84 μL, 0.60 mmol) were added. The reaction was stirred at this temperature for 3 h then heated to 40 °C and stirred overnight, monitoring by TLC analysis. Upon completion, the reaction mixture was cooled to r.t., quenched with sat. aq. NH$_4$Cl (1 mL) and extracted with EtOAc (3 × 5 mL). The combined organic phases were washed with brine (5 mL), dried over Na$_2$SO$_4$, filtered and concentrated in vacuo. Purification by flash column chromatography (1% MeOH/CH$_2$Cl$_2$) afforded 11k (28.9 mg, 68 %) as a colorless solid; m.p.: 110 - 113 °C (EtOAc/hexane); R$_f$ = 0.6 (3 % MeOH/CH$_2$Cl$_2$); ν$_{max}$ / cm$^{-1}$ (solid) 2987 (m), 2953 (m), 2923 (m), 2870 (s), 2855 (s), 1693 (s); $^1$H NMR (400 MHz, CDCl$_3$) δ 7.40 - 7.35 (4H, m, PhCH$_2$), 7.21 - 7.16 (1H, m, PhCH$_2$), 7.05 - 7.00 (1H, m, C8-H), 7.00 - 6.95 (1H, m, C9-H), 5.59 - 5.55 (1H, m, C8-H), 4.74 (1H, s, C5-H), 3.94 - 3.87 (1H, m, C1-H), 3.68 - 3.60 (1H, m, C9-H), 2.88 (1H, ddd, J = 12.2, 9.0, 6.5 Hz, C1-H$^\prime$), 2.79 - 2.70 (2H, m, C9-H$^\prime$, C3-H), 2.00 - 1.85 (2H, m, C2-H$_2$), 1.55 - 1.46 (1H, m, C3-H$^\prime$), 1.41 (3H, s, C7-H$_3$); $^{13}$C NMR (101 MHz, CDCl$_3$) δ 204.6 (C10), 161.5 (C11), 138.9 (PhC), 134.4 (C6), 129.3 (2 × PhCH), 125.8 (PhCH), 123.9 (2 × PhCH), 121.6 (C8), 70.9 (C4), 66.5 (C5), 45.9 (C1), 36.5
(C9), 29.4 (C3), 23.7 (C2), 22.6 (C7); HRMS (ESI+) Calculated for C_{17}H_{18}N_{2}NaO_{2}: 305.1260. Found [M+Na]⁺: 305.1273.

The relative stereochemistry was determined using nOe analysis as indicated on the compound structure. An nOe was observed between C5-H and C3-H2.

3-(3-Methoxyphenyl)propan-1-ol¹

![Chemical structure of 3-(3-Methoxyphenyl)propan-1-ol]

**General procedure 2:** 3-(3-Methoxyphenyl)propanoic acid (0.54 g, 3.00 mmol) and 2.0 eq. LiAlH₄ (1 M in THF) in anhydrous Et₂O were employed to afford the title compound (0.34 mg, 68 %) as a pale yellow oil which was used without further purification; ¹H NMR (400 MHz, CDCl₃) δ 7.23 - 7.19 (1H, m), 6.82 - 6.79 (1H, m), 6.77 - 6.73 (2H, m), 3.80 (3H, s), 3.66 (2H, t, J = 6.5 Hz), 2.71 - 2.67 (2H, m), 2.14 (1H, br s), 1.92 - 1.85 (2H, m). Spectroscopic properties were consistent with the data available in the literature.¹

_tert-_Butyl (3-(3-methoxyphenyl)propyl)(tosyloxy)carbamate (13a)¹

![Chemical structure of tert-Butyl (3-(3-methoxyphenyl)propyl)(tosyloxy)carbamate (13a)]

**General procedure C:** 3-(3-Methoxyphenyl)propan-1-ol (0.24 mg, 1.50 mmol), PPh₃ (0.47 mg, 1.80 mmol), DIAD (0.35 mL, 1.80 mmol) and TsONHBoc (517 mg, 1.80 mmol) in anhydrous THF (8 mL) were employed. Purification by flash column chromatography (gradient, eluent 5 - 10% EtOAc/hexane) afforded 13a (0.53 g, 81 %) as a colorless, viscous oil; Rf = 0.5 (33% EtOAc/hexane); ¹H NMR (400 MHz, CDCl₃) δ 7.83 (2H, d, J = 8.4 Hz), 7.32 (2H, d, J = 8.4 Hz), 7.19 (1H, t, J = 7.8 Hz), 6.80 - 6.69 (3H, m), 3.79 (3H, s), 3.62 (2H, br s), 2.57 (2H, t, J = 7.8 Hz), 2.44 (3H, s), 1.95 (2H, br s), 1.21 (9H, s); ¹³C NMR (101 MHz, CDCl₃) δ 159.7, 155.4, 145.7, 142.7, 131.2, 129.7, 129.5, 129.4, 120.7, 113.9, 111.4, 83.2, 55.1, 52.6, 32.8, 27.6, 27.3, 21.7. Spectroscopic properties were consistent with the data available in the literature.¹
6-Methoxy-1,2,3,4-tetrahydroquinoline (14a)\(^1\)

![Chemical Structure](image1)

**General procedure E:** tert-Butyl (3-(3-methoxyphenyl)propyl)(tosyloxy)carbamate (13a) (87.1 mg, 0.20 mmol), TFA (31.0 μL, 0.40 mmol) in TFE (2 mL) were employed. After stirring at r.t. for 40 h, purification by flash column chromatography (gradient, eluent 10 - 25% EtOAc/hexane) afforded 14a (26.0 mg, 80 %) as a pale yellow oil; \( R_f = 0.45 \) (33 % EtOAc/hexane); \(^1\)H NMR (400 MHz, CDCl\(_3\)) \( \delta \) 6.63 - 6.54 (2H, m), 6.46 (1H, d, \( J = 8.5 \) Hz), 3.73 (3H, s), 3.37 (1H, br s), 3.27 - 3.24 (2H, m), 2.76 (2H, t, \( J = 6.5 \) Hz), 1.97 - 1.89 (2H, m); \(^{13}\)C NMR (101 MHz, CDCl\(_3\)) \( \delta \) 151.9, 138.8, 122.9, 115.6, 114.9, 112.9, 55.8, 42.3, 27.2, 22.4. Spectroscopic properties were consistent with the data available in the literature.\(^1\)

tert-Butyl (3-phenylpropyl)(tosyloxy)carbamate (13b)\(^1\)

![Chemical Structure](image2)

**General procedure C:** 3-Phenylpropan-1-ol (0.20 g, 1.50 mmol), PPh\(_3\) (0.47 g, 1.80 mmol), DIAD (0.36 mL, 1.80 mmol) and TsONHBoc (0.52 g, 1.80 mmol) in anhydrous THF (6 mL) were employed. Purification by flash column chromatography (10 % EtOAc/hexane) afforded 13b (0.52 g, 85 %) as a viscous colorless oil; \( R_f = 0.7 \) (33% EtOAc/hexane); \( \nu_{\text{max}} / \text{cm}^{-1} \) (film) 2981 (m), 2932 (m), 2865 (m), 1718 (s), 1598 (m), 1454 (m), 1368 (s), 1294 (m), 1191 (s), 1151 (s), 1177 (s), 1089 (m); \(^1\)H NMR (400 MHz, CDCl\(_3\)) \( \delta \) 7.85 (2H, d, \( J = 8.3 \) Hz), 7.35 - 7.31 (2H, m), 7.31 - 7.26 (2H, m), 7.22 - 7.15 (3H, m), 3.63 (2H, br s), 2.60 (2H, t, \( J = 7.8 \) Hz), 2.45 (3H, s), 2.02 - 1.91 (2H, m), 1.23 (9H, s); \(^{13}\)C NMR (101 MHz, CDCl\(_3\)) \( \delta \) 155.4, 145.7, 141.1, 131.2, 129.7, 129.5, 128.4, 128.3, 126.0, 83.2, 52.6, 32.8, 27.6, 27.4, 21.7. Spectroscopic properties were consistent with the data available in the literature.\(^1\)
1,2,3,4-Tetrahydroquinoline (14b)\(^1\)

![Chemical structure of 14b](image)

**General procedure E**: tert-Butyl (3-phenylpropyl)(tosyloxy)carbamate (13b) (0.12 g, 0.30 mmol) and TFA (46.0 µL, 0.60 mmol) in TFE (3 mL) were employed. After stirring at r.t. for 24 h, purification by flash column chromatography (33 % EtO/hexane) afforded 14b (26.0 mg, 65 %) as a yellow oil; R\(_f\) = 0.7 (33% EtOAc/hexane); \(\nu_{\text{max}}\)/cm\(^{-1}\) (film); \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 6.99 - 6.95 (2H, m), 6.62 (1H, t, \(J = 7.3\) Hz), 6.48 (1H, d, \(J = 7.9\) Hz), 3.80 (1H, br s), 3.31 (2H, \(t, J = 5.4\) Hz), 2.78 (2H, \(t, J = 6.5\) Hz), 2.01 - 1.90 (2H, m); \(^{13}\)C NMR (101 MHz, CDCl\(_3\)) \(\delta\) 144.8, 129.5, 126.7, 121.4, 116.9, 114.2, 41.9, 26.9, 22.2. Spectroscopic properties were consistent with the data available in the literature.\(^1\)

3-(2-Bromophenyl)propan-1-ol\(^1\)

![Chemical structure of 3-(2-Bromophenyl)propanoic acid](image)

To a solution of ethyl 3-(2-bromophenyl)propanoic acid (0.92 g, 4.00 mmol) in anhydrous THF (20 mL) at -10 °C was added 0.75 eq. LiAlH\(_4\) (1 M in THF) and the reaction was stirred at the same temperature for 30 min. To the reaction mixture was added water (0.5 mL), aq. 1 M NaOH (0.2 mL) and a further portion of water (1 mL). The reaction mixture was warmed to room temperature, filtered through Celite® and washed with CH\(_2\)Cl\(_2\). The phases were separated and the aqueous phase washed with CH\(_2\)Cl\(_2\). The combined organic extracts were dried over Na\(_2\)SO\(_4\), filtered and concentrated *in vacuo* to afford the title compound as a colorless oil (0.16 g, 19 %) which was used without further purification; \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 7.53 (1H, d, \(J = 8.0\) Hz), 7.26 - 7.21 (2H, m), 7.09 - 7.02 (1H, m), 3.70 (2H, \(t, J = 6.4\) Hz), 2.83 (2H, \(t, J = 7.80\) Hz), 1.94 - 1.85 (2H, m), 1.54 (1H, br s); \(^{13}\)C NMR (101 MHz, CDCl\(_3\)) \(\delta\) 141.1, 132.8, 130.4, 127.6, 127.5, 124.4, 62.1, 32.7, 32.4. Spectroscopic properties were consistent with the data available in the literature.\(^1\)
**tert-Butyl(3-(2-bromophenyl)propyl)(tosyloxy)carbamate (13c)**

![Chemical Structure](image)

**General procedure C:** 3-(2-Bromophenyl)propan-1-ol (0.16 g, 0.74 mmol), PPh₃ (0.23 g, 0.88 mmol), DIAD (0.17 mL, 0.88 mmol) and TsONHBoc (0.25 g, 0.88 mmol) in anhydrous THF (4 mL) were employed. Purification by flash column chromatography (10% EtOAc/hexane) afforded 13c (0.26 g, 72%) as a colorless solid; Rf = 0.6 (20% EtOAc); 1H NMR (400 MHz, CDCl₃) δ 7.86 (2H, d, J = 8.3 Hz), 7.52 (2H, dd, J = 7.9, 1.1 Hz), 7.33 (2H, d, J = 8.1 Hz), 7.24 - 7.19 (2H, m), 7.06 (1H, ddd, J = 7.9, 6.6, 2.4 Hz), 3.66 (2H, br s), 2.71 (2H, t, J = 7.9 Hz), 2.45 (3H, s), 1.99 - 1.90 (2H, m), 1.23 (9H, s); 13C NMR (101 MHz, CDCl₃) δ 155.5, 145.8, 140.6, 132.9, 131.4, 130.3, 129.8, 129.7, 127.9, 127.6, 124.5, 83.4, 52.7, 33.3, 27.8, 26.2, 21.9. *Spectroscopic properties were consistent with the data available in the literature.*

**3-(2-(Trifluoromethyl)phenyl)propan-1-ol**

![Chemical Structure](image)

**General procedure E:** 3-(2-(Trifluoromethyl)phenyl)propanoic acid (0.55 g, 2.50 mmol) and 1.0 eq. LiAlH₄ (1.0 M in THF) in anhydrous THF were employed to afford the title compound (0.38 g, 75%) as a colorless oil which was used without further purification; 1H NMR (400 MHz, CDCl₃) δ 7.61 (1H, d, J = 7.9 Hz), 7.45 (1H, t, J = 7.6 Hz), 7.34 (1H, d, J = 7.7 Hz), 7.27 (1H, t, J = 7.6 Hz), 3.71 (2H, t, J = 6.4 Hz), 2.87 (2H, t, J = 7.9 Hz), 1.93 (1H, br s), 1.92 - 1.85 (2H, m); 13C NMR (101 MHz, CDCl₃) δ 140.7, 131.7, 131.0, 128.5, 125.9, 123.3, 120.6, 62.2, 34.5, 28.9. *Spectroscopic properties were consistent with the data available in the literature.*
**tert-Butyl (tosyloxy)(3-(2-(trifluoromethyl)phenyl)propyl)carbamate (13d)**

![Chemical Structure](image)

**General procedure C:** 3-(2-(Trifluoromethyl)phenyl)propan-1-ol (0.20 g, 1.00 mmol), PPh₃ (0.32 g, 1.20 mmol), DIAD (0.24 mL, 1.20 mmol) and TsONHBOc (0.35 mg, 1.20 mmol) in anhydrous THF (5 mL) were employed. Purification by flash column chromatography (10% EtOAc/hexane) afforded 3d (0.45 mg, 95%) as a colorless oil; R₇ = 0.5 (20% EtOAc/hexane); ^1^H NMR (400 MHz, CDCl₃) δ 7.85 (2H, d, J = 8.3 Hz), 7.60 (2H, d, J = 7.9 Hz), 7.47 (1H, t, J = 7.6 Hz), 7.33 (2H, d, J = 8.3 Hz), 7.31 - 7.27 (1H, m), 3.67 (2H, br s), 2.75 (2H, t, J = 8.1 Hz), 2.44 (3H, s), 2.01 - 1.90 (2H, m), 1.23 (9H, s); ^13^C NMR (101 MHz, CDCl₃) δ 155.5, 145.8, 140.1, 132.0, 131.3, 130.9, 129.8, 129.7, 128.5, 126.3, 126.1, 83.5, 52.9, 29.7, 27.9, 27.7, 21.8. Spectroscopic properties were consistent with the data available in the literature.¹

**Methyl (3-(4-((tert-butyldimethylsilyl)oxy)phenyl)propyl)(tosyloxy)carbamate**

![Chemical Structure](image)

**General procedure C:** 3-(4-((tert-Butyldimethylsilyl)oxy)phenyl)propan-1-ol (0.53 g, 2.00 mmol), PPh₃ (0.63 g, 2.40 mmol), DIAD (0.47 mL, 2.40 mmol) and methyl (tosyloxy)carbamate (0.59 g, 2.40 mmol) in anhydrous THF (8 mL) were employed. Purification by flash column chromatography (10% EtOAc/hexane) afforded the title compound (0.93 g, 94%) as a colorless oil; R₇ = 0.4 (20% EtOAc/hexane); νmax / cm⁻¹ (film) 2955 (m), 2930 (m), 2858 (m), 1728 (s), 1509 (s), 1253 (s); ^1^H NMR (400 MHz, CDCl₃) δ 7.83 (2H, d, J = 8.1 Hz, Ts ArC₅H), 7.33 (2H, d, J = 8.1 Hz, Ts ArCH₆), 6.99 (2H, d, J = 8.1 Hz, C5-H), 6.74 (2H, d, J = 8.1 Hz, C6-H), 3.58 (2H, app. br s, C1-H₅), 3.47 (3H, s, OCH₃), 2.51 (2H, t, J = 7.8 Hz, C3-H₂), 2.45 (3H, s, Ts CH₃), 1.94 - 1.85 (2H, m, C2-H₂), 0.98 (9H, s, TBS (CH₃)₃), 0.18 (6H, s, TBS Si(CH₃)₂); ^13^C NMR (101 MHz, CDCl₃) δ 157.2 (C=O), 153.9 (C7), 146.0 (Ts ArC), 133.6 (C4), 131.2 (Ts ArC), 129.7 (2 x Ts ArCH), 129.6 (2 x Ts ArCH), 129.2
(C5), 120.1 (C6), 53.7 (OCH3), 52.7 (C1), 32.0 (C3), 27.7 (C2), 25.8 (TBS (CH3)3), 21.9 (Ts CH3), 18.3 (TBS Si(CH3)3), -4.3 (TBS Si(CH3)2); HRMS (ESI+) Calculated for C24H35NNaO6S: 516.1847. Found [M+Na]+: 516.1851.

Methyl (3-(4-hydroxyphenyl)propyl)(tosyloxy)carbamate (15)

General procedure D: Methyl (3-(4-((tert-butyldimethylsilyl)oxy)phenyl)propyl)(tosyloxy) carbamate (490 mg, 1.00 mmol) and 1.1 eq. 1:1 TBAF/AcOH solution (0.1 M in THF, 11 mL, 1.1 mmol) in THF (20 mL) were employed. Purification by flash column chromatography (gradient 20 – 33 % EtOAc/hexane) afforded 15 (289 mg, 76 %) as a viscous, colorless oil; Rf = 0.1 (20 % EtOAc/hexane); ν max / cm -1 (film) 3431 (m, br), 3023 (m), 2956 (m), 1726 (m), 1514 (m), 1175 (s); 1H NMR (400 MHz, CDCl3) δ 7.82 (2H, d, J = 8.2 Hz, Ts ArCH), 7.33 (2H, d, J = 8.2 Hz, Ts ArCH), 6.99 (2H, d, J = 8.1 Hz, C5-H), 6.74 (2H, d, J = 8.1 Hz, C6-H), 4.88 (1H, s, OH), 3.59 (2H, br s, C1-H2), 2.51 (2H, t, J = 7.8 Hz, C3-H2), 2.45 (3H, s, OCH3), 1.95 - 1.85 (2H, m, C2-H2); 13C NMR (101 MHz, CDCl3) δ 157.3 (C=O), 154.0 (C7), 146.1 (Ts ArC), 133.0 (C4), 131.1 (Ts ArC), 129.7 (2 x Ts ArCH), 129.6 (2 x Ts ArCH), 129.5 (C5), 115.4 (C6), 53.8 (OCH3), 52.7 (C1), 31.9 (C3), 27.8 (C2), 21.9 (Ts CH3); HRMS (ESI+) Calculated for C18H21NNaO6S: 402.0982. Found [M+Na]+: 402.0984.

tert-butyl pent-4-en-1-yl(tosyloxy)carbamate (17)

General procedure C: 4-Penten-1-ol (0.17 g, 2.00 mmol), PPh3 (0.63 g, 2.40 mmol), DIAD (0.47 mL, 2.40 mmol) and TsONHBoc (0.69 g, 2.40 mmol) in anhydrous THF (15 mL) were
employed. Purification by flash column chromatography (10% EtOAc/hexane) afforded 17 (0.47 g, 66%) as a colorless crystalline solid; m.p.: 47-50 °C (EtOAc/hexane); Rf = 0.5 (33% EtOAc/hexane); νmax / cm⁻¹ (film) 2977 (m), 1715 (s), 1365 (s), 1355 (s), 1177 (s), 1154 (s); ¹H NMR (400 MHz, CDCl₃) δ 7.85 (2H, d, J = 8.3 Hz, Ts ArCH), 7.34 (2H, d, J = 8.2 Hz, Ts ArCH), 5.81 - 5.71 (1H, m, C₁-H₂), 2.45 (3H, s, Ts CH₃), 2.07 - 2.00 (2H, m, C₃-H₂), 1.77 - 1.66 (2H, m, C₂-H₂), 1.22 (9H, s, Boc (CH₃)₃); ¹³C NMR (101 MHz, CDCl₃) δ 155.6 (Boc C=O), 145.8 (Ts ArC), 137.4 (C₄), 131.4 (Ts ArC) 129.8 (Ts ArCH), 129.7 (Ts ArCH), 115.4 (C₅), 52.6 (C₁), 30.7 (C₃), 27.7 (Boc (CH₃)₃), 25.0 (C₂), 21.8 (Ts CH₃); HRMS (ESI⁺) Calculated for C₁₇H₂₅NNaO₅S: 378.1346. Found [M+Na]⁺: 378.1346.

Selected control reactions and solvent screen

Table 1. Solvent investigation

<table>
<thead>
<tr>
<th>Entry</th>
<th>Solvent (0.1 M)</th>
<th>Time (h)</th>
<th>Yield (%) a</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>TFE</td>
<td>24</td>
<td>77</td>
</tr>
<tr>
<td>2</td>
<td>EtOH</td>
<td>24</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>Toluene</td>
<td>24</td>
<td>40</td>
</tr>
<tr>
<td>4</td>
<td>THF</td>
<td>24</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>CH₂Cl₂</td>
<td>24</td>
<td>41</td>
</tr>
<tr>
<td>6</td>
<td>EtOAc</td>
<td>24</td>
<td>0</td>
</tr>
<tr>
<td>7</td>
<td>1,4-Dioxane</td>
<td>24</td>
<td>0</td>
</tr>
<tr>
<td>8</td>
<td>MeCN</td>
<td>24</td>
<td>8</td>
</tr>
<tr>
<td>9</td>
<td>2-propanol</td>
<td>24</td>
<td>0</td>
</tr>
<tr>
<td>10</td>
<td>MeOH</td>
<td>24</td>
<td>0</td>
</tr>
</tbody>
</table>

a In situ yield determined by ¹H NMR against 1,3,5-trimethoxybenzene internal standard.
Table 2. Effect of increased temperature on the reaction

![Chemical structure of 5a and 7a with reaction conditions](image)

<table>
<thead>
<tr>
<th>Entry</th>
<th>Temp (°C)</th>
<th>Time</th>
<th>Yield (%)&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>40</td>
<td>15 h</td>
<td>78</td>
</tr>
<tr>
<td>2</td>
<td>60</td>
<td>10 h</td>
<td>74</td>
</tr>
<tr>
<td>3</td>
<td>80</td>
<td>8 h</td>
<td>44</td>
</tr>
</tbody>
</table>

<sup>a</sup>In situ yield determined by <sup>1</sup>H NMR against 1,3,5-trimethoxybenzene internal standard.

Table 2. Results of investigation into possible radical based mechanism

![Chemical structure of 5a and 7a with reaction conditions](image)

<table>
<thead>
<tr>
<th>Entry</th>
<th>TFA (mol%)</th>
<th>Additive (100 mol%)</th>
<th>Temp (°C)</th>
<th>Time (h)</th>
<th>Yield (%)&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>200</td>
<td>none</td>
<td>0 - r.t.</td>
<td>24</td>
<td>77</td>
</tr>
<tr>
<td>2</td>
<td>200</td>
<td>none</td>
<td>0 - r.t.</td>
<td>24</td>
<td>79&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>3</td>
<td>200</td>
<td>TEMPO</td>
<td>0 - r.t.</td>
<td>24</td>
<td>14</td>
</tr>
<tr>
<td>4</td>
<td>300</td>
<td>TEMPO</td>
<td>0 - r.t.</td>
<td>24</td>
<td>30</td>
</tr>
<tr>
<td>5</td>
<td>300</td>
<td>TEMPO</td>
<td>40</td>
<td>42</td>
<td>58</td>
</tr>
<tr>
<td>6</td>
<td>200</td>
<td>BHT</td>
<td>0 - r.t.</td>
<td>24</td>
<td>46</td>
</tr>
<tr>
<td>7</td>
<td>300</td>
<td>BHT</td>
<td>40</td>
<td>22</td>
<td>69</td>
</tr>
<tr>
<td>8</td>
<td>200</td>
<td>none</td>
<td>0 - r.t.</td>
<td>24</td>
<td>78&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<sup>a</sup>In situ yield determined by <sup>1</sup>H NMR against 1,3,5-trimethoxybenzene internal standard. <sup>b</sup>Reaction performed using distilled TFE and TFA. <sup>c</sup>Reaction performed in the absence of light.
Table 4. Dienone-phenol rearrangement control reactions

<table>
<thead>
<tr>
<th>Entry</th>
<th>TFA (mol%)</th>
<th>TFE (M)</th>
<th>Temp (°C)</th>
<th>Time (h)</th>
<th>Yield (%)$^a$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>15</td>
<td>0.1</td>
<td>r.t.</td>
<td>48</td>
<td>50</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td>0.1</td>
<td>60</td>
<td>25</td>
<td>57</td>
</tr>
</tbody>
</table>

$^a$In situ yield determined by $^1$H NMR against 1,3,5-trimethoxybenzene internal standard.
3-(4-((tert-Butyldimethylsilyl)oxy)phenyl)propanoic acid
**tert-Butyl (3-(4-((tert-butyldimethylsilyl)oxy)phenyl)propyl)(tosyloxy)carbamate (silyl-5a)**

[Chemical structure image]

**NMR Spectra**

**Proton NMR**

- ppm values range from 0.0 to 11.0
- Peaks at various ppm values indicate the presence of different chemical environments.

**Carbon NMR**

- ppm values range from 20.0 to 230.0
- Peaks at various ppm values indicate the presence of different chemical environments.

S92
tert-Butyl (3-(4-hydroxyphenyl)propyl)(tosyloxy)carbamate (5a)
1-Azaspiro[4.5]deca-6,9-dien-8-one trifluoroacetate (7a)
Methyl (E)-3-(4-(benzyloxy)-3,5-dimethylphenyl)acrylate
Methyl 3-(4-hydroxy-3,5-dimethylphenyl)propanoate
Methyl 3-(4-((tert-butyldimethylsilyl)oxy)-3,5-dimethylphenyl)propanoate
*tert*-Butyl(3-(4-((tert-butyldimethylsilyl)oxy)-3,5-dimethylphenyl)propyl)(tosyloxy) carbamate
tert-Butyl (3-(4-hydroxy-3,5-dimethylphenyl)propyl)(tosyloxy)carbamate (5b)
7,9-Dimethyl-1-azaspiro[4.5]deca-6,9-dien-8-one (7b)
Ethyl 3-(3-bromo-4-((tert-butyldimethylsilyl)oxy)phenyl)propanoate
3-(3-Bromo-4-((tert-butyldimethylsilyl)oxy)phenyl)propan-1-ol
*tert*-Butyl(3-(3-bromo-4-((*tert*-butyldimethylsilyl)oxy)phenyl)propyl)(tosyloxy)carbamate
tert-Butyl (3-(3-bromo-4-hydroxyphenyl)propyl)(tosyloxy)carbamate (5c)
7-Bromo-1-azaspiro[4.5]deca-6,9-dien-8-one trifluoroacetate (7c)
6-Bromo-1,2,3,4-tetrahydroquinolin-7-ol (8c)
Methyl 3-(3-bromo-4-((tert-butyldimethylsilyl)oxy)phenyl)propanoate
Methyl 3-((tert-butyldimethylsilyl)oxy)-3-cyclopropylphenyl)propanoate
3-(4-((tert-Butyldimethylsilyl)oxy)-3-cyclopropylphenyl)propan-1-ol
**tert-Butyl (3-(4-((tert-butyldimethylsilyl)oxy)-3-cyclopropylphenyl)propyl)(tosyloxy) carbamate**

![NMR Spectra](image-url)
tert-Butyl (3-(3-cyclopropyl-4-hydroxyphenyl)propyl)(tosyloxy)carbamate (5d)
7-Cyclopropyl-1-azaspiro[4.5]deca-6,9-dien-8-one trifluoroacetate (7d)
6-cyclopropyl-1,2,3,4-tetrahydroquinolin-7-ol (8d)
Methyl3-(6-((tert-butyldimethylsilyl)oxy)-[1,1'-biphenyl]-3-yl)propanoate
3-(6-((tert-Butyldimethylsilyl)oxy)-[1,1'-biphenyl]-3-yl)propan-1-ol
tert-Butyl(3-(6-((tert-butyldimethylsilyl)oxy)-[1,1'-biphenyl]-3-yl)propyl)(tosyloxy)carbamate
 tert-Butyl (3-(6-hydroxy-[1,1'-biphenyl]-3-yl)propyl)(tosyloxy)carbamate (5e)
7-Phenyl-1-azaspiro[4.5]deca-6,9-dien-8-one trifluoroacetate (7e)
6-Phenyl-1,2,3,4-tetrahydroquinolin-7-ol (8e)
Ethyl (E)-3-(4-hydroxy-2-methoxyphenyl)acrylate
Ethyl 3-(4-((tert-butyldimethylsilyl)oxy)-2-methoxyphenyl)propanoate

\[
\text{OTBS} \quad \text{OMe} \\
\text{O} \quad \text{OEt}
\]
3-(4-((tert-Butyldimethylsilyl)oxy)-2-methoxyphenyl)propan-1-ol
tert-Butyl (3-(4-((tert-butyldimethylsilyl)oxy)-2-methoxyphenyl)propyl)(tosyloxy) carbamate

tert-Butyl (3-(4-hydroxy-2-methoxyphenyl)propyl)(tosyloxy)carbamate (5f)

S124
6-Methoxy-1-azaspiro[4.5]deca-6,9-dien-8-one trifluoroacetate (7f)
Ethyl 3-((tert-butyldimethylsilyl)oxy)phenyl)pentanoate
3-(4-((tert-Butyldimethylsilyl)oxy)phenyl)pentan-1-ol
** tert-Butyl (3-(4-((tert-butyldimethylsilyl)oxy)phenyl)pentyl)(tosyloxy)carbamate **

![Chemical Structure](image)

![NMR Spectrogram](image1)

![NMR Spectrogram](image2)
**tert-Butyl (3-(4-hydroxyphenyl)pentyl)(tosyloxy)carbamate (5g)**

![NMR Spectra](image_url)

---

*S129*
4-Ethyl-1-azaspiro[4.5]deca-6,9-dien-8-one trifluoroacetate (7g)
4-Ethyl-1,2,3,4-tetrahydroquinolin-7-ol (8g)
**tert-Butyl (4-(4-((tert-butyldimethylsilyl)oxy)phenyl)butan-2-yl)(tosyloxy)carbamate**

![Chemical structure image]

**S132**
**tert-Butyl (4-(4-hydroxyphenyl)butan-2-yl)(tosyloxy)carbamate (5h)**

[Chemical structure diagram]

**S133**
2-Methyl-1-azaspiro[4.5]deca-6,9-dien-8-one trifluoroacetate (7h)
3-(4-((tert-Butyldimethylsilyl)oxy)naphthalen-1-yl)propan-1-ol

[Chemical structural formula and NMR spectra]
tert-Butyl (3-((tert-butyl(dimethyl)silyl)oxy)naphthalen-1-yl)propyl(tosyloxy)carbamate
**tert-Butyl (3-(4-hydroxynaphthalen-1-yl)propyl(tosyloxy)carbamate (5i)**

![Chemical structure image](image-url)
4H-spiro[naphthalene-1,2'-pyrrolidin]-4-one trifluoroacetate (7i)
Methyl 3-(4-((tert-butyldimethylsilyl)oxy)-3-methoxyphenyl)propanoate
3-(4-((tert-Butyldimethylsilyl)oxy)-3-methoxyphenyl)propan-1-ol
tert-Butyl (3-(4-((tert-butyldimethylsilyl)oxy)-3-methoxyphenyl)propyl)(tosyloxy) carbamate
$\text{tert-Butyl (3-(4-hydroxy-3-methoxyphenyl)propyl)(tosyloxy)carbamate (5j)}$
7-methoxy-1,2,3,4-tetrahydroquinolin-6-ol (8j)
3-(2-((tert-Butyldimethylsilyl)oxy)-5-methylphenyl)propanoic acid
tert-Butyl(3-(2-((tert-butyldimethylsilyl)oxy)-5-methylphenyl)propyl)(tosyloxy) carbamate

\[
\text{Me} \quad \text{OTBS} \quad \text{N} \quad \text{OTs} \\
\text{Boc}
\]
*tert*-Butyl (3-(2-hydroxy-5-methylphenyl)propyl)(tosyloxy)carbamate (5k)
9-Methyl-1-azaspiro[4.5]deca-7,9-dien-6-one tosylate (7k)
Ethyl 3-((tert-butyldimethylsilyl)oxy)-4-methoxyphenyl)propanoate
tert-Butyl (3-(2-((tert-butyldimethylsilyl)oxy)-4-methoxyphenyl)propyl)(tosyloxy) carbamate

![Chemical Structure Image]

S149
**tert-Butyl (3-(2-hydroxy-4-methoxyphenyl)propyl)(tosyloxy)carbamate (5l)**

![NMR spectrum](https://example.com/nmr_spectrum.png)
8-Methoxy-1-azaspiro[4.5]deca-7,9-dien-6-one trifluoroacetate (7l)
**tert-Butyl (3-(1-((tert-butyldimethylsilyl)oxy)naphthalen-2-yl)propyl)(tosyloxy) carbamate**

![NMR Spectra of ter-t-Butyl (3-(1-((tert-butyldimethylsilyl)oxy)naphthalen-2-yl)propyl)(tosyloxy) carbamate](image-url)
**tert-Butyl (3-(1-hydroxynaphthalen-2-yl)propyl)(tosyloxy)carbamate (5m)**

![Chemical Structure Diagram]

**NMR Spectra**

- **1H NMR**
  - Resonance at 7.65 ppm
  - Resonance at 7.49 ppm

- **13C NMR**
  - Resonance at 132.2 ppm
  - Resonance at 128.6 ppm

**Additional Information**

- Single pulse decoupled gated NOE
- Spectral data provided for chemical shifts and coupling constants.
1H-spiro[naphthalene-2,2'-pyrrolidin]-1-one (7m)
3-(2-((tert-Butyldimethylsilyl)oxy)naphthalen-1-yl)propanoic acid
tert-Butyl(3-((tert-butyldimethylsilyl)oxy)naphthalen-1-yl)propyl)(tosyloxy) carbamate
tert-butyl (3-(2-hydroxynaphthalen-1-yl)propyl)(tosyloxy)carbamate (5n)
$2H$-spiro[naphthalene-1,2'-pyrrolidin]-2-one (7n)
3-((tert-Butyldimethylsilyl)oxy)-7-methoxynaphthalen-1-yl)propanoic acid
tert-Butyl (2-(2-((tert-butyldimethylsilyl)oxy)-7-methoxynaphthalen-1-yl)ethyl)(tosyloxy)carbamate
tert-Butyl (3-(2-hydroxy-7-methoxynaphthalen-1-yl)propyl)(tosyloxy)carbamate (5o)
7-methoxy-2H-spiro[naphthalene-1,2'-pyrrolidin]-2-one (7o)
tert-Butyldimethyl((1-(1-phenylallyl)naphthalen-2-yl)oxy)silane
3-(2-((tert-Butyldimethylsilyl)oxy)naphthalen-1-yl)-3-phenylpropan-1-ol

[Chemical structure image]

[1H NMR spectrum image]

[13C NMR spectrum image]
**tert-Butyl (3-(2-hydroxynaphthalen-1-yl)-3-phenylpropyl)(tosyloxy)carbamate (5p)**

![Structural diagram of tert-Butyl (3-(2-hydroxynaphthalen-1-yl)-3-phenylpropyl)(tosyloxy)carbamate (5p)](image_url)
3'-phenyl-2H-spiro[naphthalene-1,2'-pyrrolidin]-2-one (7p)
3-(2-((tert-Butyldimethylsilyloxy)naphthalen-1-yl)-N-methoxy-N-methylpropanamide
4-(2-((tert-Butyldimethylsilyl)oxy)naphthalen-1-yl)butan-2-one

![NMR spectrum of the compound](image)
4-(2-((tert-Butyldimethylsilyl)oxy)naphthalen-1-yl)butan-2-ol
tert-Butyl (4-(2-hydroxynaphthalen-1-yl)butan-2-yl)(tosyloxy)carbamate (5q)
5'-Methyl-2H-spiro[naphthalene-1,2'-pyrrolidin]-2-one (7q)
1-(2-Phenylacetyl)-1-azaspiro[4.5]deca-6,9-dien-8-one (9a)
(6R*, 6aS*, 10aS*)-6-phenyl-2,3,6a,7-tetrahydro-1H,5H-pyrrolo[2,1-i]indole-5,8(6H)-dione (10a)
4-Ethyl-1-(2-phenylacetyl)-1-azaspiro[4.5]deca-6,9-dien-8-one (9g)
(1R*, 6R*, 6aS*, 10aS*)-1-Ethyl-6-phenyl-2,3,6a,7-tetrahydro-1H,5H-pyrrolo[2,1-i]indole-5,8(6H)-dione (10g)
(1R*, 6aR*, 10aS*)-1-Ethyl-6-phenyl-2,3,6a,7-tetrahydro-1H,5H-benzo[d]pyrrolo[1,2-c]imidazole-5,8(6H)-dione (11g)
9-methyl-1-(2-phenylacetyl)-1-azaspiro[4.5]deca-7,9-dien-6-one
(6R,6aS)-6a-Hydroxy-9-methyl-6-phenyl-2,3,6,6a-tetrahydro-1H,5H-pyrrolo[2,1-i]indol-5-one (12k)
7-methyl-6-phenyl-2,3,6a,9-tetrahydro-1H,5H-benzo[d]pyrrolo[1,2-c]imidazole-5,10(6H)-dione (11k)
Methyl (3-(4-((tert-butyldimethylsilyl)oxy)phenyl)propyl)(tosyloxy)carbamate
Methyl (3-(4-hydroxyphenyl)propyl)(tosyloxy)carbamate (15)
**tert-Butyl pent-4-en-1-yl(tosyloxy)carbamate (17)**

\[ \text{Boc} \quad \text{OTs} \]

[Chemical structure image]

[Proton NMR spectrum image]

[Carbon NMR spectrum image]
References


