Exploiting reagent evolution in samarium-mediated reaction cascades: application in a tag removal-cyclisation approach to spirooxindole scaffolds

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General Experimental

All experiments were performed under an atmosphere of nitrogen using anhydrous solvents, unless stated otherwise. Glassware for inert atmosphere reactions was oven-dried and cooled under a flow of nitrogen. THF was freshly distilled from sodium/benzophenone, CH$_2$Cl$_2$ and Et$_3$N were freshly distilled from CaH$_2$. Petroleum ether refers to the fraction of petroleum ether boiling in the range 40-60 ºC. All other solvents and reagents were purchased from commercial sources and used as supplied. Except where indicated otherwise, imines were prepared according to literature procedures.

$^1$H NMR and $^{13}$C NMR spectra were recorded on a 400 MHz or 500 MHz spectrometer, with chemical shift values being reported in parts per million (ppm) relative to residual CHCl$_3$ ($\delta_H = 7.27$) and CDCl$_3$ ($\delta_C = 77.0$) as internal standards unless otherwise stated. All coupling constants (J) are reported in Hertz (Hz). NMR assignments were made with the aid of COSY, HMQC, DEPT135 and DEPT90 experiments.

Low resolution and high resolution mass spectra were obtained using positive or negative electrospray ionisation (ES). Infrared spectra were recorded using an FTIR spectrometer as evaporated films or neat using sodium chloride windows. Melting points are uncorrected. Optical rotations (Sodium D line) are reported as unitless numbers for which the concentration c is in g/100 mL.

Routine TLC analysis was carried out on aluminium sheets coated with silica gel 60 F254, 0.2 mm thickness. Plates were visualised by UV (254 mm) and/or by staining with aqueous potassium permanganate, ethanolic $p$-anisaldehyde or ethanolic phosphomolybdic acid. Column chromatography was carried out using 35–70μ, 60A silica gel.

Fluorous solid-phase extraction (FSPE) was performed using fluorous silica gel packed in a glass column. Crude products were dry-loaded onto silica gel and transferred onto the fluorous column. Elution with 40% water in MeCN (3 column volumes) provided the non-fluorous components of the mixture, then elution with
MeCN (3 column volumes) provided the fluorous components of the mixture. Fluorous columns were re-used up to 30 times. **FSPE** can be used to purify or part-purify all reactions involving fluorous-tagged starting materials.

**General procedure A: Preparation of acetoxyamides using acetoxyacetic acid**  
EDCI.HCl (1.5 eq), HOBt.H₂O (0.2 eq) and acetoxyacetic acid (1.0 eq) were added to a stirred solution of amine (1.0 eq, 20.8 mmol) in CH₂Cl₂ (40 mL) at room temperature under nitrogen. The resulting solution was stirred at room temperature for 12-48 h, then a 1N aqueous solution of HCl (20 mL) and CH₂Cl₂ (20 mL) were added. The layers were separated, and the aqueous layer was extracted with CH₂Cl₂ (2 × 20 mL). The combined organic layers were washed with a 1N aqueous solution of HCl (20 mL), dried (MgSO₄) and evaporated under reduced pressure to give the crude product.

**General procedure B: Preparation of acetoxyamides using acetoxyacetyl chloride**  
Acetoxyacetyl chloride (1.1 eq) was added dropwise to a stirred solution of amine (1.0 eq, 32.6 mmol) and Et₃N (1.1 eq) in CH₂Cl₂ (100 mL) at 0 °C under nitrogen. The resulting solution was allowed to warm to room temperature, then stirred at room temperature for 12 h. A saturated aqueous solution of NaHCO₃ (100 mL) was added and the layers were separated. The aqueous layer was extracted with CH₂Cl₂ (2 × 50 mL) and the combined organic layers were dried (MgSO₄) and evaporated under reduced pressure to give the crude product.

**General procedure C: Preparation of hydroxyamides**  
K₂CO₃ (4.0 eq) was added to a stirred solution of acetoxyamide (1.0 eq, 17.1 mmol) in MeOH (30 mL) and water (15 mL) at room temperature. The resulting suspension was stirred at room temperature for 12 h, then was evaporated under reduced pressure. The resulting mixture was adjusted to pH7 using a 1N aqueous solution of HCl, and CH₂Cl₂ (30 mL) was added. The layers were separated, and the aqueous layer was extracted with CH₂Cl₂ (2 × 30 mL). The combined organic layers were dried (MgSO₄) and evaporated under reduced pressure to give the crude product.
General procedure D: Preparation of glyoxamides
A solution of DMSO (2.0 eq) in CH$_2$Cl$_2$ (2 mL) was added dropwise to a stirred solution of oxalyl chloride (1.1 eq) in CH$_2$Cl$_2$ (20 mL) at −78 °C under nitrogen. The resulting solution was stirred at −78 °C for 15 min, then a solution of hydroxyamide (1.0 eq, 8.88 mmol) in CH$_2$Cl$_2$ (20 mL) was added dropwise at −78 °C via cannula. The resulting solution was stirred at −78 °C for 30 min, then Et$_3$N (5.0 eq) was added dropwise at −78 °C. The mixture was allowed to warm to room temperature and stirred at room temperature for 3 h. A saturated aqueous solution of NaHCO$_3$ (30 mL) and CH$_2$Cl$_2$ (30 mL) were added, and the layers were separated. The aqueous layer was extracted with CH$_2$Cl$_2$ (2 × 30 mL), and the combined organic layers were dried (MgSO$_4$) and evaporated under reduced pressure to give the crude glyoxamide, which was used directly in the next step without further purification.

General procedure E: Tag introduction–Cyclisation: Preparation of fluorous-tagged oxindoles
Fluorous thiol (C$_8$F$_{17}$CH$_2$CH$_2$SH, 0.7 eq) was added to a solution of crude glyoxamide (1.0 eq, 8.88 mmol) in CH$_2$Cl$_2$ (50 mL) at room temperature under nitrogen. The resulting solution was stirred at room temperature for 16 h, then trifluoroacetic anhydride (9.0 eq) was added. After stirring at room temperature for 1 h, BF$_3$⋅OEt$_2$ (5.0 eq) was added, and the resulting solution was stirred at room temperature for 4 h. The mixture was slowly and carefully quenched with a saturated aqueous solution of NaHCO$_3$ (until gas evolution ceased). CH$_2$Cl$_2$ (50 mL) was added and the layers were separated. The aqueous layer was extracted with CH$_2$Cl$_2$ (2 × 50 mL) and the combined organic layers were dried (MgSO$_4$) and evaporated under reduced pressure to give the crude product. **FSPE was used for purification.**

General procedure F: Tag introduction–Cyclisation: Preparation of fluorous-tagged oxindoles for (alternative procedure employing glyoxamides containing electron-rich aromatic rings)
Fluorous thiol (C$_8$F$_{17}$CH$_2$CH$_2$SH, 1.0 eq) was added to a solution of crude glyoxamide (1.0 eq, 4.48 mmol) in CH$_2$Cl$_2$ (40 mL) at room temperature under nitrogen. The resulting solution was stirred at room temperature for 1 h, then trifluoroacetic anhydride (2.0 eq) was added, and the resulting solution was stirred at room
temperature for 16 h. The mixture was slowly and carefully quenched with a saturated aqueous solution of NaHCO₃ (until gas evolution ceased). CH₂Cl₂ (20 mL) was added and the layers were separated. The aqueous layer was extracted with CH₂Cl₂ (2 × 40 mL) and the combined organic layers were dried (MgSO₄) and evaporated under reduced pressure to give the crude product. **FSPE was used for purification.**

**General procedure G: Preparation of alkylated fluorous-tagged oxindoles**

* cis-1,4-Dichlorobut-2-ene (1.5 eq) and K₂CO₃ (5.0 eq) were added to a stirred solution of fluorous-tagged oxindole (1.0 eq, 1.55 mmol) in DMF (30 mL) at room temperature under nitrogen. The resulting suspension was stirred for 5-12 h at room temperature, then water (30 mL) and EtOAc (50 mL) were added. The layers were separated, and the organic layer was washed with water (2 × 30 mL), dried (MgSO₄) and evaporated under reduced pressure to give the crude product. **FSPE was used for purification.**

**General procedure H: Preparation of samarium diiodide (SmI₂)**

Samarium diiodide was prepared by a modification of the procedure of Imamoto and Ono.¹ Samarium powder (2.00 g, 13.8 mmol, 1.2 eq) was added to an oven-dried round-bottomed flask and the flask was sealed and flushed with nitrogen gas for 20 min. THF (110 ml) was added and the resulting suspension bubbled with nitrogen gas for 15 min. Finally, iodine (2.80 g, 10.8 mmol, 1 eq) was added and the flask flushed again with nitrogen gas for 10 min. The flask was covered in aluminium foil and heated at 60 °C for 18 hours. The approx 0.1 M solution was allowed to cool to room temperature and then used directly.

**General procedure I: Preparation of spirooxindoles**

In a sealable tube, a solution of alkylated fluorous-tagged oxindole (1.0 eq, 0.12 mmol) in THF (4 mL) was deoxygenated by bubbling through nitrogen gas for 30 min. Then, SmI₂ (2.0 eq. of a 0.1 M solution in THF) was added dropwise over 20 min (using a syringe pump) at room temperature under nitrogen. On completion of the addition, a solution of imine (2.0 eq.) in THF (1 mL) was added, and the tube was sealed. The resulting suspension was heated at 80 °C in an oil bath for 12-18 h, and then allowed to cool to room temperature. A saturated aqueous solution of Na₂S₂O₃
(10 mL) and CH₂Cl₂ (10 mL) were added, and the layers were separated. The aqueous layer was extracted with CH₂Cl₂ (2 × 10 mL), and the combined organic layers were washed with a saturated aqueous solution of NaHCO₃ (10 mL), dried (MgSO₄) and evaporated under reduced pressure to give the crude product. Generally, FSPE was used to remove fluorous disulfide by-product and to part-purify spirooxindole products. In some cases, further purification by recrystallisation or chromatography on silica gel was used to isolate single isomers for characterisation.

**General procedure J: Preparation of spirooxindole aldehydes**

OsO₄ (0.1 eq. of a 2.5% (w/v) solution in tert-butanol) and NMO (3.0 eq.) were added to a stirred suspension of spirooxindole (0.20 mmol) in acetone (12 mL) and water (1.5 mL) at room temperature under nitrogen. The resulting suspension was stirred at room temperature for 60 h, then a saturated aqueous solution of Na₂S₂O₃ (10 mL) and CH₂Cl₂ (10 mL) were added. The layers were separated, and the aqueous layer was extracted with CH₂Cl₂ (2 × 15 mL). The combined organic layers were dried (MgSO₄) and evaporated under reduced pressure to give the crude diol product. The crude product was dissolved in THF (10 mL) and water (2 mL), then NaIO₄ (1.5 eq.) was added. The resulting suspension was heated at reflux for 2 h then allowed to cool to room temperature. Et₂O (20 mL) and water (10 mL) were added and the layers were separated. The aqueous layer was extracted with Et₂O (2 × 10 mL) and the combined organic layers were dried (MgSO₄) and evaporated under reduced pressure to give the crude product.

**General procedure K: Preparation of spirooxindole methyl esters**

Oxidant solution [1.6 mL; freshly prepared from NaClO₂ (300 mg) and NaH₂PO₄·H₂O (300 mg) in water (2 mL)] was added in one portion to a stirred solution of aldehyde (0.17 mmol) in tert-butanol (4 mL), MeCN (4 mL) and 2-methyl-2-butene (2 mL) at room temperature. The resulting solution was stirred for 2 h at room temperature, then water (10 mL) and CH₂Cl₂ (20 mL) were added. The layers were separated, and the aqueous layer was extracted with CH₂Cl₂ (2 × 20 mL). The combined organic layers were washed with water (20 mL), dried (MgSO₄) and evaporated under reduced pressure to give the crude carboxylic acid product. The crude product was dissolved in anhydrous MeOH (8 mL) and trimethylsilyldiazomethane (1.5 mL of a 2.0M
solution in hexanes, 5.0 eq.) was added dropwise at room temperature under nitrogen. The resulting solution was stirred at room temperature for 2 h, then evaporated under reduced pressure to give the crude product.

**General procedure L: Preparation of spirooxindole amines**

Nitrogen gas was bubbled (15 min) through a solution of N-benzyl amine (0.08 mmol) in a 0.05M solution of HCl in MeOH (8 mL; 50 mL stock solution of 0.05 M HCl in MeOH freshly prepared by diluting 208 µL 12M HCl with MeOH). Pd(OH)$_2$ (8 mg, 20% wt.) was added, and the resulting suspension was stirred under an atmosphere of H$_2$ (1 atm) for 5 min then filtered through a plug of Celite, washing with MeOH. Et$_3$N (5 drops) was added, and the resulting solution was evaporated under reduced pressure. The residue was dissolved in EtOAc (10 mL), water (5 mL) was added and the layers were separated. The aqueous layer was extracted with EtOAc (2 × 5 mL). The combined organic layers were dried (MgSO$_4$) and evaporated under reduced pressure to give the crude product.

**General procedure M: Preparation of N-Troc prolinylspirooxindoles**

A solution of N-Troc (S)-prolinyl chloride$^2$ (1.0 or 3.0 eq.; freshly prepared from N-Troc (S)-proline)$^3$ in CH$_2$Cl$_2$ (3 mL) was added dropwise at 0 °C to a stirred solution of amine (0.15 mmol) and Et$_3$N (0.9 mmol) in CH$_2$Cl$_2$ (12 mL) under nitrogen. The resulting solution was allowed to warm to room temperature and stirred for 12 h, then CH$_2$Cl$_2$ (10 mL) and a saturated aqueous solution of NaHCO$_3$ (10 mL) were added. The layers were separated, and the aqueous layer was extracted with CH$_2$Cl$_2$ (2 × 10 mL). The combined organic layers were dried (MgSO$_4$) and evaporated under reduced pressure to give the crude product.

**General procedure N: Preparation of diketopiperazines**

Zn dust (100 eq) was added to a stirred suspension of N-Troc amide (0.07 mmol) in THF (4 mL), MeOH (4 mL) and a saturated aqueous solution of NH$_4$Cl (4 mL) at room temperature. The resulting suspension was stirred at room temperature for 24 h, filtered through Celite, and the filter cake was washed well with EtOAc. Water (10 mL) was added and the layers were separated. The aqueous layer was extracted with
EtOAc (2 × 15 mL) and the combined organic layers were dried (MgSO₄) and evaporated under reduced pressure to give the crude product.
Synthesis of fluorous-tagged oxindoles:

2-Acetoxy-N-(2,4-dimethoxybenzyl)-N-(3-methoxyphenyl)acetamide S1

NEt₃ (2.21 mL, 15.9 mmol, 1.1 eq) and acetoxyacetyl chloride (2.04 g, 15.9 mmol, 1.0 eq) were added sequentially to a solution of 2,4-dimethoxybenzyl)-(3-methoxyphenyl)-amine (3.69 g, 13.6 mmol, 1.0 eq) in CH₂Cl₂ (24.4 mL) at room temperature under nitrogen. The resulting mixture was stirred at room temperature for 4 h before water (20 mL) and CH₂Cl₂ (10 mL) were added. The layers were separated, and the aqueous layer was extracted with CH₂Cl₂ (2 × 20 mL). The combined organic layers were dried (Na₂SO₄) and evaporated under reduced pressure to give the crude product. Purification by flash column chromatography on silica gel eluting with 20% EtOAc in hexane gave S1 (5.32 g, 14.2 mmol, 100%) as a light yellow oil. ¹H NMR (300 MHz, CDCl₃): δ 7.25-7.16 (m, 2H; 2 × Ar-CH), 6.84 (dd, J = 8.4, 2.3 Hz, 1H, Ar-CH), 6.64 (d, J = 7.7 Hz, 1H; Ar-CH), 6.59 (s, 1H; Ar-CH), 6.41 (dd, J = 8.4, 2.3 Hz, 1H; Ar-CH), 6.33 (d, J = 2.3 Hz, 1H; Ar-CH), 6.31 (d, J = 2.3 Hz, 1H; Ar-CH), 4.86 (s, 2H; OCH₂), 4.40 (s, 2H, NCH₂), 3.78 (s, 3H; OCH₃), 3.73 (s, 3H; OCH₃), 3.56 (s, 3H; OCH₃), 2.15 (s, 3H; C(O)CH₃); ¹³C NMR (75 MHz, CDCl₃): δ 170.6 (C=O), 166.3 (C=O), 160.4 (Ar-C), 160.3 (Ar-C), 158.6 (Ar-C), 141.5 (Ar-C), 131.3 (Ar-CH), 130.0 (Ar-CH), 120.5 (Ar-
CH), 117.4 (Ar-C), 114.1 (Ar-CH), 113.8 (Ar-CH), 104.1 (Ar-CH), 98.3 (Ar-CH), 61.8 (NCH$_2$), 55.4 (OCH$_3$), 55.3 (OCH$_3$), 55.1 (OCH$_3$), 47.2 (CH$_2$O), 20.6 (C(O)CH$_3$); IR (film): $\nu$$_{max}$ 2932, 2830, 1742 (C=O), 1671 (C=O), 1585, 1506, 1485, 1451, 1437, 1420, 1407, 1369, 1284, 1263, 1217, 1205, 1154, 1126, 1080, 1029, 932, 837, 783, 705; MS (ES+): $m$/z (%) 396 (100, [M + Na]$^+$); HRMS (ES+): $m$/z: calcld for C$_{20}$H$_{23}$NO$_6$Na: 396.1418 [M + Na]$^+$; found: 396.1401.

2-Acetoxy-N-(4-methoxybenzyl)-N-phenylacetamide S2

Using general procedure A, EDCI-HCl (5.97 g, 31.2 mmol), HOBr$_2$O$_2$ (562 mg, 4.16 mmol), acetoxyacetic acid (2.45 g, 20.8 mmol) and (4-methoxybenzyl)phenylamine (4.43 g, 20.8 mmol) in CH$_2$Cl$_2$ (40 mL) gave the crude product. Purification by flash column chromatography on silica gel eluting with 30% EtOAc in petroleum ether gave S2 (5.56 g, 17.7 mmol, 85%) as a white solid, m.p. (hexanes-Et$_2$O) 62–65 °C; $^1$H NMR (400 MHz, CDCl$_3$): $\delta$ 7.37-7.33 (m, 3H; 3 $\times$ Ar-CH), 7.10 (d, $J$ = 8.8 Hz, 2H; 2 $\times$ Ar-CH), 7.03-7.01 (m, 2H; 2 $\times$ Ar-CH), 6.79 (d, $J$ = 8.8 Hz, 2H; 2 $\times$ Ar-CH), 4.81 (s, 2H; CH$_2$N), 4.34 (s, 2H; CH$_2$O), 3.78 (s, 3H; OCH$_3$), 2.15 (s, 3H; CH$_3$); $^{13}$C NMR (100 MHz, CDCl$_3$): $\delta$ 170.6 (C=O), 166.4 (C=O), 159.0 (Ar-C), 140.0 (Ar-C), 130.3 (Ar-CH), 129.8 (Ar-CH), 128.8 (Ar-C), 128.7 (Ar-CH), 128.4 (Ar-CH), 113.7 (Ar-CH), 61.8 (CH$_2$O), 55.2 (OCH$_3$), 52.6 (CH$_2$N), 20.6 (CH$_3$); IR (film): $\nu$$_{max}$ 2997, 2947, 2936, 2835, 1748 (C=O), 1681 (C=O), 1613, 1594, 1513, 1494, 1435, 1406, 1371, 1298, 1245, 1225, 1175, 1085, 1022, 1015, 844, 820, 699 cm$^{-1}$; MS (ES+): $m$/z (%) 336 (100, [M + Na]$^+$); HRMS (ES+): $m$/z: calcld for C$_{18}$H$_{19}$NO$_4$: 336.1206 [M + Na]$^+$; found: 336.1216.

2-Acetoxy-N-(3-methoxyphenyl)-N-propylacetamide S3
Using general procedure B, acetoxyacetyl chloride (3.86 mL, 35.9 mmol), Et₃N (5.00 mL, 35.9 mmol) and N-propyl-3-methoxyaniline⁵ (5.39 g, 32.6 mmol) in CH₂Cl₂ (100 mL) gave the crude product. Purification by flash column chromatography on silica gel eluting with 30% EtOAc in petroleum ether gave S3 (8.22 g, 31.0 mmol, 95%) as a colorless oil, ¹H NMR (400 MHz, CDCl₃): δ 7.32 (t, J = 8.2 Hz, 1H; Ar-CH), 6.91 (dd, J = 8.2, 2.1 Hz, 1H; Ar-CH), 6.81-6.78 (m, 1H; Ar-CH), 6.74 (t, J = 2.1 Hz, 1H; Ar-CH), 4.35 (s, 2H; CH₃), 2.21 (s, 3H; CH₃), 1.52 (sextet, J = 7.6 Hz, 2H; CH₂CH₃), 0.87 (t, J = 7.6 Hz, 3H; CH₃); ¹³C NMR (100 MHz, CDCl₃): δ 170.5 (C=O), 166.1 (C=O), 160.6 (Ar-C), 141.5 (Ar-C), 130.6 (Ar-CH), 126.6 (Ar-CH), 113.96 (Ar-CH), 113.88 (Ar-CH), 61.6 (CH₂O), 55.4 (OCH₃), 20.7 (CH₂CH₃), 20.5 (CH₃), 11.1 (CH₂CH₃); IR (film): νmax 2964, 2935, 2878, 1747 (C=O), 1680 (C=O), 1601, 1490, 1452, 1432, 1416, 1372, 1227, 1136, 1046, 847, 707 cm⁻¹; MS (ES+): m/z (%): 288 (50, [M + Na⁺]), 266 (100, [M + H⁺]); HRMS (ES+): m/z: calcd for C₁₄H₁₉NO₄: 288.1206 [M + Na⁺]; found: 288.1214.

2-Acetoxy-N-(4-methoxybenzyl)-N-(3-methoxyphenyl)acetamide S4

Using general procedure A, EDCI.HCl (9.40 g, 49.2 mmol), HOBt.H₂O (0.60 g, 4.10 mmol), acetoxyacetic acid (4.80 g, 41.0 mmol) and N-(4-methoxybenzyl)-3-methoxyaniline⁶ (5.00 g, 20.5 mmol) in CH₂Cl₂ (31 mL) gave the crude product. Purification by flash column chromatography on silica gel eluting with 20% EtOAc in petroleum ether gave S3 (6.13 g, 17.9 mmol, 87%) as a white powder, m.p. (EtOAc/hexane) 87–89 °C; ¹H NMR (400 MHz, CDCl₃) δ 7.25 (t, J = 8.1 Hz, 1H; Ar-CH), 7.12 (d, J = 8.8 Hz, 2H; 2 × Ar-CH), 6.88 (dd, J = 8.1, 2.5 Hz, 1H; Ar-CH), 6.80 (d, J = 8.8 Hz, 2H; 2 × Ar-CH), 6.61 (dd, J = 8.1, 1.0 Hz, 1H; Ar-CH), 6.54 (d, J = 2.3 Hz, 1H; Ar-CH), 4.80 (s, 2H; CH₂N), 4.39 (s, 2H; CH₂O), 3.79 (s, 3H; OCH₃), 3.73 (s, 3H; OCH₃), 2.16 (s, 3H; CH₃); ¹³C NMR (100 MHz, CDCl₃) δ 170.6 (C=O), 166.3 (C=O), 160.4 (Ar-C), 159.0 (Ar-C), 141.1 (Ar-C), 130.5 (2 × Ar-CH), 130.3 (Ar-CH), 128.5 (Ar-C), 113.9 (Ar-CH), 113.7 (Ar-CH), 113.3 (2 × Ar-CH), 61.7 (CH₂O), 55.4

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(OCH$_3$), 55.2 (OCH$_3$), 52.6 (CH$_2$N), 20.6 (CH$_3$); IR (film): $\nu_{\text{max}}$ 1754 (C=O), 1673 (C=O), 1588, 1513, 1492, 1407, 1244, 1198, 1172, 1025, 820, 703 cm$^{-1}$; MS (ES+): $m/z$ (%): 366 (100, [M + Na]$^+$); HRMS (ES+): $m/z$: calcd for C$_{19}$H$_{21}$NO$_5$: 366.1305 [M + Na$^+$]; found: 366.1312.

**2-Acetoxy-N-benzyl-N-(3-methoxyphenyl)acetamide S5**

![Chemical structure](image)

Using general procedure B, acetoxyacetyl chloride (0.79 mL, 7.30 mmol), Et$_3$N (1.02 mL, 7.30 mmol) and N-benzyl-3-methoxyaniline$^8$ (1.42 g, 6.64 mmol) in CH$_2$Cl$_2$ (30 mL) gave the crude product. Purification by flash column chromatography on silica gel eluting with 30% EtOAc in petroleum ether gave S5 (1.71 g, 5.45 mmol, 82%) as a white solid, m.p. (Et$_2$O) 69–72 °C; $^1$H NMR (400 MHz, CDCl$_3$): $\delta$ 7.31-7.20 (m, 6H; 6 × Ar-CH), 6.88 (ddd, J = 8.0, 2.5, 0.9 Hz, 1H; Ar-CH), 6.64 (dd, J = 8.0, 0.9 Hz, 1H; Ar-CH), 6.55-6.54 (m, 1H; Ar-CH), 4.87 (s, 2H; CH$_2$N), 4.42 (s, 2H; CH$_2$O), 3.72 (s, 3H; OCH$_3$), 2.16 (s, 3H; CH$_3$); $^{13}$C NMR (100 MHz, CDCl$_3$): $\delta$ 170.6 (C=O), 166.5 (C=O), 160.5 (Ar-C), 141.7 (Ar-C), 136.8 (Ar-C), 130.5 (Ar-CH), 128.9 (Ar-CH), 128.4 (Ar-CH), 127.5 (Ar-CH), 120.4 (Ar-CH), 114.4 (Ar-CH), 113.8 (Ar-CH), 61.7 (CH$_2$O), 55.3 (OCH$_3$), 53.2 (CH$_2$N), 20.6 (CH$_3$); IR (film): $\nu$ 2966, 2940, 2928, 1743 (C=O), 1672 (C=O), 1426, 1412, 1285, 1241, 1219, 1159, 1076, 1044, 1006 cm$^{-1}$; MS (ES+): $m/z$ (%): 336 (100, [M + Na]$^+$); HRMS (ES+): $m/z$: calcd for C$_{15}$H$_{19}$NO$_4$: 336.1206 [M + Na$^+$]; found: 336.1206.

**2-Hydroxy-N-(2,4-dimethoxybenzyl)-N-(3-methoxyphenyl)acetamide S6**

![Chemical structure](image)
Using general procedure C, acetoxyamide S4 (5.32 g, 14.3 mmol) and K₂CO₃ (7.90 g, 57.2 mmol) in MeOH (44 mL) and water (22 mL) gave hydroxyamide S6 (4.48 g, 13.5 mmol, 94%) as a colorless oil, ^1^H NMR (500 MHz, CDCl₃): δ 7.21 (t, J = 8.5 Hz, 1H; Ar-CH), 7.14 (d, J = 8.5 Hz, 1H; Ar-CH), 6.85 (dd, J = 8.5, 2.5 Hz, 1H; Ar-CH), 6.57 (d, J = 8.5 Hz, 1H; Ar-CH), 6.50 (t, J = 2.5 Hz, 1H; Ar-CH), 6.41 (dd, J = 8.5, 2.5 Hz, 1H; Ar-CH), 6.50 (t, J = 2.5 Hz, 1H; Ar-CH), 4.90 (s, 2H; NCH₂), 3.82 (d, J = 4.4 Hz, 2H; CH₂OH), 3.78 (s, 3H; OCH₃), 3.73 (s, 3H; OCH₃), 3.57 (s, 3H; OCH₃), 3.45 (t, J = 4.4 Hz, 1H; CH₂OH); ^1^C NMR (125 MHz, CDCl₃): δ 171.6 (C=O), 160.5 (Ar-C), 160.2 (Ar-C), 158.6 (Ar-C), 140.6 (Ar-C), 131.3 (Ar-CH), 130.0 (Ar-CH), 120.5 (Ar-CH), 117.0 (Ar-C), 114.1 (Ar-CH), 113.9 (Ar-CH), 104.0 (Ar-CH), 98.3 (Ar-CH), 60.5 (CH₂OH), 55.3 (2 × OCH₃), 55.1 (OCH₃), 47.6 (CH₂N); IR (film): ν max 3429 (OH), 2993, 2937, 2835, 1650 (C=O), 1599, 1587, 1504, 1485, 1453, 1434, 1376, 1312, 1281, 1261, 1205, 1156, 1126, 1087, 1029, 990, 932, 922, 832, 781, 749, 700; MS (ES+): m/z (%): 354 (100, [M + Na]⁺); HRMS (ES+): m/z: calcd for C₁₈H₂₁NO₅Na: 354.1312 [M + Na]⁺; found: 354.1318.

2-Hydroxy-N-(4-methoxybenzyl)-N-phenylacetamide S7

![Chemical structure of 2-Hydroxy-N-(4-methoxybenzyl)-N-phenylacetamide S7](image)

Using general procedure C, acetoxyamide S2 (5.37 g, 17.1 mmol) and K₂CO₃ (9.48 g, 68.6 mmol) in MeOH (30 mL) and water (15 mL) gave hydroxyamide S7 (4.58 g, 16.9 mmol, 98%) as a white solid, m.p. (Et₂O) 74−76 °C; ^1^H NMR (500 MHz, CDCl₃): δ 7.37-7.33 (m, 3H; 3 × Ar-CH), 7.11 (d, J = 8.5 Hz, 2H; 2 × Ar-CH), 6.96-6.92 (m, 2H; 2 × Ar-CH), 6.81 (d, J = 8.5 Hz, 2H; 2 × Ar-CH), 4.86 (s, 2H; CH₂N), 3.79 (s, 3H; OCH₃), 3.77 (s, 2H; CH₂O); ^1^C NMR (125 MHz, CDCl₃): δ 171.7 (C=O), 159.1 (Ar-C), 139.2 (Ar-C), 130.3 (Ar-CH), 129.8 (Ar-CH), 128.7 (Ar-C), 128.4 (Ar-CH), 113.8 (Ar-CH), 60.5 (CH₂O), 55.2 (OCH₃), 53.0 (CH₂N); IR (film): ν max 3434 (OH), 2930, 2835, 1659 (C=O), 1611, 1594, 1513, 1494, 1379, 1298, 1245, 1175, 1097, 1029, 1015, 999, 817, 699 cm⁻¹; MS (ES+): m/z (%):
2-Hydroxy-N-(3-methoxyphenyl)-N-propylacetamide S8

Using general procedure C, acetoxyamide S3 (7.91 g, 29.8 mmol) and K₂CO₃ (16.5 g, 0.1 mol) in MeOH (60 mL) and water (30 mL) gave hydroxyamide S8 (6.56 g, 29.4 mmol, 98%) as an off-white solid, m.p. (Et₂O) 50–53 °C; ¹H NMR (400 MHz, CDCl₃): δ 7.35 (t, J = 8.2 Hz, 1H; Ar-CH), 6.94 (dd, J = 8.2, 1.9 Hz, 1H; Ar-CH), 6.76–6.74 (m, 1H; Ar-CH), 6.69 (t, J = 1.9 Hz, 1H; Ar-CH), 3.81 (s, 2H; CH₂O), 3.72–3.68 (m, 2H; CH₂N), 1.57 (sextet, J = 7.5 Hz, 2H; CH₂CH₃), 0.92 (t, J = 7.5 Hz, 3H, CH₃); ¹³C NMR (100 MHz, CDCl₃): δ 172.6 (C=O), 160.6 (Ar-C), 140.6 (Ar-C), 130.6 (Ar-CH), 120.2 (Ar-CH), 113.99 (Ar-CH), 113.98 (Ar-CH), 60.4 (CH₃O), 55.4 (OCH₃), 51.2 (CH₂N), 20.9 (CH₂CH₃), 11.1 (CH₃); IR (film): ν max 3436 (OH), 2965, 2930, 1659 (C=O), 1601, 1490, 1456, 1384, 1313, 1289, 1249, 1211, 1100, 1046, 706 cm⁻¹; MS (ES+): m/z (%) 246 (35, [M + Na]⁺), 224 (100, [M + H]⁺); HRMS (ES+): m/z: calcd for C₁₂H₁₇NO₃: 246.1101 [M + Na⁺]; found: 246.1101.

2-Hydroxy-N-(4-methoxybenzyl)-N-(3-methoxyphenyl)acetamide S9

Using general procedure C, acetoxyamide S4 (6.00 g, 17.4 mmol) and K₂CO₃ (9.60 g, 69.9 mmol) in MeOH (53 mL) and water (27 mL) gave hydroxyamide S9 (5.38 g, 100%) as a colorless oil, ¹H NMR (400 MHz, CDCl₃): δ 7.28 (t, J = 8.1 Hz, 1H; Ar-CH), 7.15 (d, J = 8.8 Hz, 2H; 2 × Ar-CH), 6.92 (dd, J = 8.1, 2.5 Hz, 1H; Ar-CH), 6.83 (d, J = 8.8 Hz, 2H; 2 × Ar-CH), 6.55 (dd, J = 8.1, 0.8 Hz, 1H; Ar-CH), 6.48 (t, J = 2.5 Hz, 1H; Ar-CH).
Hz, 1H; Ar-CH), 4.86 (s, 2H; CH₂N), 3.85 (s, 2H; CH₂O), 3.81 (s, 3H; OCH₃), 3.75 (s, 3H; OCH₃), 3.45 (br s, 1H; OH); ¹³C NMR (100 MHz, CDCl₃): δ 166.3 (C=O), 160.4 (Ar-C), 159.1 (Ar-C), 140.3 (Ar-C), 130.4 (Ar-CH), 130.3 (Ar-CH), 128.7 (Ar-CH), 120.4 (Ar-C), 114.3 (Ar-CH), 113.9 (Ar-CH), 113.7 (Ar-CH), 60.4 (CH₂O), 55.3 (OCH₃), 55.2 (OCH₃), 52.8 (CH₂N); IR (film): νmax 3427 (OH), 2926, 2863, 1715 (C=O), 1627, 1513, 1463, 1379, 1348, 1248, 1160, 1039, 921, 883 cm⁻¹; MS (ES+): m/z (%): 324 (100, [M + Na]+); HRMS (ES+): m/z: calcd for C₁₇H₁₉NO₄: 324.1204 [M + H⁺]; found: 324.1206.

N-Benzyl-2-Hydroxy-N-(3-methoxyphenyl)acetamide S10

Using general procedure C, acetoxyamide S5 (3.58 g, 11.4 mmol) and K₂CO₃ (6.31 g, 45.7 mol) in MeOH (40 mL) and water (20 mL) gave hydroxyamide S10 (3.09 g, 11.4 mmol, 100%) as a colorless oil, ¹H NMR (400 MHz, CDCl₃): δ 7.24-7.12 (m, 6H; 6 × Ar-CH), 6.82 (ddd, J = 8.3, 2.2, 0.8 Hz, 1H; Ar-CH), 6.48 (ddd, J = 7.8, 2.2, 0.8 Hz, 1H; Ar-CH), 6.38 (t, J = 2.2 Hz, 1H; Ar-CH), 4.83 (s, 2H; CH₂N), 3.78 (d, J = 4.4 Hz, 2H; CH₂O), 3.64 (s, 3H; OCH₃), 3.34 (t, J = 4.4 Hz, 1H; OH); ¹³C NMR (100 MHz, CDCl₃): δ 171.8 (C=O), 160.4 (Ar-C), 140.3 (Ar-C), 136.6 (Ar-C), 130.4 (Ar-CH), 128.9 (Ar-CH), 128.4 (Ar-CH), 127.7 (Ar-CH), 120.3 (Ar-CH), 114.4 (Ar-CH), 113.8 (Ar-CH), 60.4 (CH₂O), 55.3 (OCH₃), 53.4 (CH₂N); IR (film): νmax 3440 (OH), 2936, 2837, 1653 (C=O), 1598, 1587, 1488, 1377, 1314, 1285, 1238, 1164, 1095, 1077, 1028, 993 cm⁻¹; MS (ES+): m/z (%): 294 (100, [M + Na]+); HRMS (ES+): m/z: calcd for C₁₆H₁₇NO₃: 294.1101 [M + Na⁺]; found: 294.1098.

6-Methoxy-3-(3,3,4,4,5,5,6,7,7,8,8,9,9,10,10,10-heptadecafluorodecylsulfanyl)-1-(2,4-dimethoxybenzyl)-1,3-dihydroindol-2-one 9
Using general procedure D, DMSO (1.00 mL, 13.4 mmol), oxalyl chloride (0.60 mL, 7.30 mmol), a solution of hydroxyamide S6 (2.20 g, 6.70 mmol) in CH₂Cl₂ (22.3 mL) and Et₃N (3.39 mL, 33.5 mmol) in CH₂Cl₂ (22.3 mL) gave the crude glyoxamide product, which was used in the next step without further purification.

Using general procedure F, fluorous thiol (C₈F₁₇CH₂CH₂SH, 2.00 mL, 6.70 mmol), TFAA (1.90 mL, 13.4 mmol) and the crude glyoxamide, in CH₂Cl₂ (44.5 mL) gave the crude product as a 6:1 mixture of regioisomers (by ¹H NMR spectroscopy). Purification by FSPE gave 9 (4.40 g, 5.56 mmol, 82%) as yellow oil. Further purification by flash column chromatography on silica gel eluting with 100% CH₂Cl₂ gave the major regioisomer as a white powder, m.p. (CH₂Cl₂) 93-95 °C; ¹H NMR (400 MHz, CDCl₃, major regioisomer): δ 7.24 (d, J = 8.1 Hz, 1H; Ar-CH), 7.15 (d, J = 8.6 Hz, 1H; Ar-CH), 6.55 (dd, J = 8.1, 2.4 Hz, 1H; Ar-CH), 6.52 (d, J = 2.4 Hz, 1H; Ar-CH), 6.46 (d, J = 2.4 Hz, 1H; Ar-CH), 6.41 (dd, J = 8.6, 2.4 Hz, 1H; Ar-CH), 4.91 (d, J = 15.6 Hz, 1H; CH₄H₃N), 4.79 (d, J = 15.6 Hz, 1H; CH₄H₃N), 4.34 (s, 1H; CH₃), 3.88 (s, 3H; OCH₃), 3.76 (s, 6H; 2 × OCH₃), 3.04-2.96 (m, 1H; SCH₂H₂), 2.77-2.86 (m, 1H; SCH₂H₂), 2.49-2.33 (m, 2H; SCH₂H₂); ¹³C NMR (100 MHz, CDCl₃, major regioisomer): δ 175.8 (C=O), 161.0 (ArC), 160.5 (ArC), 157.9 (ArC), 144.8 (ArC), 129.7 (ArC), 125.5 (ArC), 116.5 (ArC), 116.0 (ArC), 107.0 (ArC), 104.4 (ArC), 98.5 (ArC), 97.4 (ArC), 97.4 (ArC), 55.4 (2 × OCH₃), 55.3 (OCH₃), 44.6 (CH₃), 38.1 (NCH₂), 31.9 (t, J = 22.2 Hz; CH₂C₈F₁₇); 20.9 (t, J = 3.7 Hz; SCH₂); IR (film): νmax 2932, 2830, 1742, 1715 (C=O), 1613, 1587, 1508, 1462, 1372, 1237, 1203, 1145, 1129, 1110, 1030, 832, 749, 705, 665, 651; MS (ES+): m/z (%): 814 (100, [M + Na]⁺); HRMS (ES+): m/z: calcd for C₂₀H₂₂NO₄F₁₇SNa: 814.0890 [M + Na]⁺; found: 814.0926.

3-(3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10-Heptadecafluorodecysulfanyl)-1-(4-methoxybenzyl)-1,3-dihydroindol-2-one S11
Using general procedure D, DMSO (1.3 mL, 17.8 mmol), oxaly chloride (0.9 mL, 9.76 mmol), a solution of hydroxyamide S7 (2.41 g, 8.88 mmol) in CH₂Cl₂ (20 mL) and Et₃N (6.2 mL, 44.38 mmol) in CH₂Cl₂ (20 mL) gave the crude glyoxamide product, which was used in the next step without further purification.

Using general procedure E, fluorous thiol (C₈F₁₇CH₂CH₂SH, 1.8 mL, 6.21 mmol), the crude glyoxamide, trifluoroacetic anhydride (11.1 mL, 79.9 mmol) and BF₃·OEt₂ (5.6 mL, 44.4 mmol) in CH₂Cl₂ (50 mL) gave the crude product. Purification by FSPE gave S11 (2.81 g, 3.84 mmol, 62%) as a yellow oil. ¹H NMR (500 MHz, CDCl₃): δ 7.38 (d, J = 7.6 Hz, 1H; Ar-CH), 7.26 (d, J = 8.7 Hz, 2H; 2 × Ar-CH), 7.23 (t, J = 7.6 Hz, 1H; Ar-CH), 7.07 (t, J = 7.6 Hz, 1H; Ar-CH), 6.85 (d, J = 8.7 Hz, 1H; 2 × Ar-CH), 6.78 (d, J = 7.6 Hz, 1H; Ar-CH), 4.91 (d, J = 15.5 Hz, 1H; NCH₂CH₂C₆H₅OCH₃), 4.82 (d, J = 15.5 Hz, 1H; NCH₂CH₂C₆H₅OCH₃), 4.40 (s, 1H; CHS), 3.77 (s, 3H; OCH₃), 3.04-2.98 (m, 1H; CH₃H₅S), 2.85-2.79 (m, 1H; CH₃H₅S), 2.46-2.35 (m, 2H; CH₂C₈F₁₇); ¹³C NMR (100 MHz, CDCl₃): δ 175.0 (C=O), 159.2 (Ar-C), 143.1 (Ar-C), 129.3 (Ar-CH), 128.7 (Ar-CH), 127.4 (Ar-C), 125.14 (Ar-CH), 125.06 (Ar-C), 123.0 (Ar-CH), 114.2 (Ar-CH), 109.4 (Ar-CH), 55.2 (OCH₃), 44.8 (CHS), 43.5 (NCH₂C₆H₅OMe), 31.8 (t, J = 22.0 Hz; CH₂C₈F₁₇), 21.0 (t, J = 4.6 Hz, CH₂S); IR (film): νmax 2952, 2930, 2908, 2835, 1712 (C=O), 1614, 1513, 1485, 1466, 1435, 1357, 1345, 1242, 1214, 1150, 1113, 1088, 1029, 954, 898, 755 cm⁻¹; MS (ES⁺): m/z (%):754 (25, [M + Na⁺]); HRMS (ES⁺): m/z: calcd for C₂₆H₁₈F₁₇NO₂S: 754.0680 [M + Na⁺]; found: 754.0672.

3-(3,3,4,4,5,6,6,7,7,8,8,9,9,10,10,10-Heptadecafluorodecysulfanyl)-6-methoxy-1-propyl-1,3-dihydroindol-2-one S12
Using general procedure D, DMSO (636 µL, 8.96 mmol), oxaly chloride (430 µL, 4.93 mmol), a solution of hydroxyamide S8 (1.00 g, 4.48 mmol) in CH₂Cl₂ (15 mL) and Et₃N (3.12 mL, 22.4 mmol) in CH₂Cl₂ (30 mL) gave the crude glyoxamide product, which was used in the next step without further purification. Using general procedure F, fluorous thiol (C₈F₁₇CH₂CH₂SH, 1.28 mL, 4.48 mmol), TFAA (1.25 mL, 8.96 mmol) and the crude glyoxamide, in CH₂Cl₂ (40 mL) gave the crude product (as a 5:1 mixture of regioisomers (by ¹H NMR spectroscopy)). Purification by FSPE gave S12 (2.50 g, 3.66 mmol, 82%) as a 5:1 mixture of regioisomers (by ¹H NMR spectroscopy) as a brown oil. Further purification by flash column chromatography on silica gel eluting with CH₂Cl₂ gave the major regioisomer as a white solid, m.p. (Et₂O) 59–60 °C; ¹H NMR (400 MHz, CDCl₃): δ 7.27 (d, J = 8.2 Hz, 1H; Ar-CH), 6.59 (dd, J = 8.2, 2.3 Hz, 1H; Ar-CH), 6.43 (d, J = 2.3 Hz, 1H; Ar-CH), 4.29 (s, 1H; CHS), 3.84 (s, 3H; OCH₃), 3.69 (dt, J = 13.9, 7.3 Hz, 1H; CH₂H₂N), 3.62 (dt, J = 13.9, 7.3, 1H; CH₂H₂N), 3.00-2.92 (m, 1H; CH₂H₂S), 2.84-2.76 (m, 1H; CH₂H₂S), 2.47-2.33 (m, 2H; CH₂C₈F₁₇), 1.71 (sextet, J = 7.3 Hz, 2H; CH₂CH₃), 0.98 (t, J = 7.3 Hz, 3H; CH₃); ¹³C NMR (100 MHz, CDCl₃): δ 175.6 (C=O), 161.0 (Ar-C), 144.8 (Ar-C), 125.9 (Ar-CH), 116.8 (Ar-C), 106.4 (Ar-CH), 96.9 (Ar-CH), 55.6 (OCH₃), 44.5 (CHS), 41.9 (CH₂N), 31.9 (t, J = 21.1 Hz; CH₂C₈F₁₇), 20.8 (t, J = 4.6 Hz, CH₂S), 20.7 (CH₂CH₃), 11.3 (CH₃); IR (film): νmax 2972, 2941, 1715 (C=O), 1626, 1600, 1504, 1463, 1367, 1243, 1207, 1150, 1104 cm⁻¹; MS (ES+): m/z (%): 706 (100, [M + Na]⁺); HRMS (ES+): m/z: calcld for C₂₅H₁₈F₁₇NO₂S: 706.0679 [M + Na]⁺; found: 706.0678 and the minor regioisomer as a white solid, m.p. (Et₂O) 65–67 °C; ¹H NMR (400 MHz, CDCl₃): δ 7.32-7.27 (m, 1H; Ar-CH), 6.64 (d, J = 8.6 Hz, 1H; Ar-CH), 6.52 (d, J = 7.8 Hz, 1H; Ar-CH), 4.36 (s, 1H; CHS), 3.90 (s, 3H; OCH₃), 3.71 (dt, J = 14.1, 7.3 Hz, 1H; CH₂H₂N), 3.61 (dt, J = 14.1, 7.3 Hz, 1H; CH₂H₂N), 3.02 (ddd, J = 13.4, 10.1, 6.3 Hz, 1H; CH₂H₂S), 2.88 (ddd, J = 13.4, 10.6, 6.0 Hz, 1H; CH₂H₂S), 2.48-2.34 (m, 2H; CH₂C₈F₁₇), 1.71 (sextet, J = 7.3 Hz, 2H; CH₂CH₃), 0.97 (t, J = 7.3 Hz, 3H; CH₃); ¹³C NMR (100 MHz,
6-Methoxy-3-(3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10-heptadecafluorodecylsulfanyl)-1-p-methoxybenzyl-1,3-dihydroindol-2-one S13

Using general procedure D, DMSO (1.41 mL, 19.9 mmol), oxalyl chloride (0.96 mL, 11.0 mmol), a solution of hydroxyamide S9 (3.00 g, 9.96 mmol) in CH2Cl2 (9.5 mL) and Et3N (6.93 mL, 49.8 mmol) in CH2Cl2 (77.9 mL) gave the crude glyoxamide product, which was used in the next step without further purification.

Using general procedure F, fluorous thiol (C8F17CH2CH2SH, 2.62 mL, 9.96 mmol), TFAA (2.81 mL, 19.9 mmol) and the crude glyoxamide, in CH2Cl2 (77.9 mL) gave the crude product as a 5:1 mixture of regioisomers (by 1H NMR spectroscopy). Purification by FSPE gave S13 (6.08 g, 7.98 mmol, 89%) as yellow oil. Further recrystallisation gave the major regioisomer as a white powder, m.p. (MeOH) 100-103 °C; 1H NMR (400 MHz, CDCl3, major regioisomer): δ 7.19-7.16 (m, 3H; 3 × Ar-CH), 6.76 (d, J = 8.6 Hz, 2H; Ar-CH), 6.48 (dd, J = 8.1, 2.3 Hz, 1H; Ar-CH), 6.28 (d, J = 2.3 Hz, 1H; Ar-CH), 4.80 (d, J = 15.4 Hz, 1H; NCH3H8C8H4OCH3), 4.69 (d, J = 15.4 Hz, 1H; NCH3H8C8H4OCH3), 4.27 (s, 1H; CHS), 3.69 (s, 3H; OCH3), 3.67 (s, 3H; OCH3), 2.96-2.89 (m, 1H; CH3H8S), 2.77-2.70 (m, 1H; CH3H8S), 2.38-2.29 (m, 2H; CH2C8F17); 13C NMR (100 MHz, CDCl3, major regioisomer): δ 175.7 (C=O), 160.9 (Ar-C), 159.2 (Ar-C), 144.4 (Ar-C), 128.7 (Ar-CH), 127.4 (Ar-C), 125.8 (Ar-CH), 116.7 (Ar-C), 114.2 (Ar-CH), 106.7 (Ar-CH), 97.6 (Ar-CH), 55.4 (OCH3), 55.2
Using general procedure D, DMSO (514 µL, 7.25 mmol), oxalyl chloride (348 µL, 3.99 mmol), a solution of hydroxyamide S10 (983 mg, 3.62 mmol) in CH₂Cl₂ (15 mL) and Et₃N (2.50 mL, 18.1 mmol) in CH₂Cl₂ (15 mL) gave the crude glyoxamide product, which was used in the next step without further purification.

Using general procedure F, C₈F₁₇CH₂CH₂SH (1.00 mL, 3.62 mmol), TFAA (1.01 mL, 7.25 mmol) and the crude glyoxamide, in CH₂Cl₂ (40 mL) gave the crude product as a 5:1 mixture of regioisomers (by ¹H NMR spectroscopy). Purification by FSPE gave oxindole S14 (2.07 g, 2.83 mmol, 78%) as a 5:1 mixture of regioisomers (by ¹H NMR spectroscopy) as a brown oil. Further purification by flash column chromatography on silica gel eluting with CH₂Cl₂ gave the major regioisomer as a white solid, m.p. (Et₂O) 80–82 °C; ¹H NMR (400 MHz, CDCl₃): δ 7.35-7.26 (m, 6H; 6 × Ar-CH), 6.57 (dd, J = 8.0, 2.0 Hz, 1H; Ar-CH), 6.33 (d, J = 2.0 Hz, 1H; Ar-CH), 4.94 (d, J = 15.5 Hz, 1H; NCH₃H₃Bp), 4.85 (d, J = 15.5 Hz, 1H; NCH₃H₃Bp), 4.38 (s, 1H; CHS), 3.75 (s, 3H; OCH₃), 3.04 (ddd, J = 13.1, 9.6, 6.8 Hz, 1H; CH₃H₃Bp), 2.85 (ddd, J = 13.1, 9.8, 6.3 Hz, 1H; CH₃H₃Bp), 2.50-2.37 (m, 2H; CH₂C₈F₁₇); ¹³C NMR (100 MHz, CDCl₃): δ 175.8 (C=O), 161.0 (Ar-C), 144.4 (Ar-C), 135.4 (Ar-C), 128.9 (Ar-CH), 127.8 (Ar-CH), 127.3 (Ar-CH), 125.9 (Ar-CH), 116.7 (Ar-C), 106.8 (Ar-CH), 97.5 (Ar-CH), 55.4 (OCH₃), 44.5 (NCH₂Ph), 44.0 (CHS), 31.9 (t, J = 21.7 Hz; CH₂C₈F₁₇),
21.0 (CH$_2$S); IR (film): $\nu$ 2944, 1715 (C=O), 1621, 1498, 1375, 1337, 1274, 1242, 1200, 1145, 1112, 1084, 1028 cm$^{-1}$; MS (ES+): $m/z$: calcd for C$_{26}$H$_18$F$_{17}$NO$_2$S: 754.0680 [M + Na$^+$]; found: 754.0672.

**6-Methoxy-3-(3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,10-heptadecafluorodecylsulfanyl)-1,3-dihydroindol-2-one S15**

![Structure of S15](image)

A solution of oxindole 9 (3.59 g, 4.49 mmol) and anisole (19.5 mL, 180 mmol, 40 eq) in CH$_2$Cl$_2$ (66.2 mL) and TFA (66.2 mL) was heated at 50 °C for 48 h, then allowed to cool to room temperature. The mixture was then slowly and carefully quenched with a saturated aqueous solution of NaHCO$_3$ (until gas evolution ceased). CH$_2$Cl$_2$ (50 mL) was added and the layers were separated. The aqueous layer was extracted with CH$_2$Cl$_2$ (2 × 50 mL) and the combined organic layers were dried (Na$_2$SO$_4$) and evaporated under reduced pressure to give the crude product. Purification by FSPE gave S15 (2.31 g, 3.60 mmol, 82%) as a white powder, m.p. (Hexane/EtOAc) 91-94 °C, $^1$H NMR (400 MHz, CDCl$_3$): $\delta$ 7.80 (s, 1H; NH), 7.27 (d, $J = 8.3$ Hz, 1H; Ar-CH), 6.61 (dd, $J = 8.3$, 2.3 Hz, 1H; Ar-CH), 6.47 (d, $J = 2.3$ Hz, 1H; Ar-CH), 4.31 (s,
1H; CHS), 3.81 (s, 3H; OCH₃), 3.01-2.93 (m, 1H; SCH₃H₂B), 2.85-2.77 (m, 1H; SCH₃H₃B), 2.49-2.34 (m, 2H; SCH₂CH₂); ¹³C NMR (100 MHz, CDCl₃): δ 178.0 (C=O), 161.0 (Ar-C), 142.3 (Ar-C), 126.1 (Ar-CH), 117.1 (Ar-C), 108.1 (Ar-CH), 97.3 (Ar-CH), 55.5 (OCH₃), 45.3 (CHS), 31.8 (t, J = 22.2 Hz; CH₂C₈F₁₇), 20.8 (SCH₂); IR (film): νmax 3206 (NH), 2920, 1706 (C=O), 1623, 1506, 1457, 1335, 1235, 1198, 1145, 1113, 1030, 955, 827, 703, 649; MS (ES+): m/z (%): 664 (100, [M + Na]+); HRMS (ES+): m/z: calcld for C₁₉H₁₂NO₂F₁₇SNa: 664.0209 [M + Na]+; found: 664.0220.

3-(4-Chlorobut-2-yl)-3-(3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,10-heptadecfluorodecysulfanyl)-6-methoxy-1,3-dihydropyridol-2-one 10

 cis-1,4-Dichlorobut-2-ene (825 μL of a 1.0 M solution in DMF, 0.83 mmol) and K₂CO₃ (434 mg, 3.14 mmol) were added sequentially to a stirred solution of S15 (504 mg, 0.79 mmol) in DMF (10 mL) at room temperature under nitrogen. The resulting suspension was stirred for 45 min at room temperature, then water (30 mL) and EtOAc (50 mL) were added. The layers were separated, and the organic layer was washed with water (2 × 30 mL), dried (MgSO₄) and evaporated under reduced pressure to give the crude product. Purification by FSPE gave alkylated oxindole 10 (418 mg, 0.57 mmol, 73%) as a yellow oil; ¹H NMR (400 MHz, CDCl₃): δ 9.44 (s, 1H; NH), 7.22 (d, J = 8.3 Hz, 1H; Ar-CH), 6.63 (dd, J = 8.3, 2.3 Hz, 1H; Ar-CH), 6.55 (d, J = 2.3 Hz, 1H; Ar-CH), 5.72-5.60 (m, 1H; =CHCH₂Cl), 5.39-5.32 (m, 1H; =CHCH₂C), 4.03 (d, J = 7.8 Hz, 2H; CH₂Cl), 3.80 (s, 3H; OCH₃), 2.95 (ddd, J = 14.2, 8.5, 1.3 Hz, 1H; CH₃H₃B), 2.78 (ddd, J = 14.2, 6.9, 0.8 Hz, 1H; CH₃H₃B), 2.65 (t, J = 8.2 Hz, 2H; SCH₂), 2.32-2.07 (m, 2H; SCH₂CH₂); ¹³C NMR (100 MHz, CDCl₃): δ 179.7 (C=O), 161.1 (Ar-C), 141.6 (Ar-C), 129.7 (C¼CH₂CH=), 126.2 (C¼CH₂CH=), 125.1 (Ar-CH), 120.0 (Ar-C), 108.6 (Ar-CH), 97.4 (Ar-CH), 55.5 (OCH₃), 54.6 (C-C=O), 38.9 (CH₂Cl), 33.3 (CH₂C), 31.4 (t, J = 22.2 Hz; CH₂C₈F₁₇), 19.9 (t, J = 2.8
5-Bromo-3-(4-chlorobut-2-enyl)-3-(3,3,4,4,5,5,6,7,7,8,8,9,9,10,10,10-
heptadecafluorodecylsulfanyl)-1-propyl-1,3-dihydroindol-2-one 11

Using general procedure G, 5-bromo-3-((3,3,4,4,5,5,6,7,7,8,8,9,9,10,10,10-
heptadecafluorodecyl(thio)-1-propyl)indolin-2-one\(^9\) (1.26 g, 1.72 mmol, \(87\%\)) as a pale brown oil, \(^1\)H NMR (400 MHz, CDCl\(_3\)): \(\delta 7.48-7.44\) (m, 2H; 2 × Ar-CH), 6.76 (d, \(J = 8.3\) Hz, 1H; Ar-CH), 5.69-5.62 (m, 1H; =CH), 5.29-5.22 (m, 1H; =CH), 4.07 (ddd, \(J = 11.8, 8.3, 1.0\) Hz, 1H; =CH\(_2\)CH\(_2\)Cl), 3.97 (ddd, \(J = 11.8, 7.3, 0.8\) Hz, 1H; =CH\(_2\)N\(_{2}\)F\(_{17}\)Cl), 3.72-3.59 (m, 2H; NCH\(_2\)CH\(_2\)), 2.97 (ddd, \(J = 14.1, 8.6, 1.2\) Hz, 1H; =CH\(_2\)N\(_{2}\)F\(_{17}\)Cl), 2.79-2.59 (m, 3H; =CH\(_2\)N\(_{2}\)F\(_{17}\)Cl and CH\(_2\)S), 2.28-2.15 (m, 2H; CH\(_2\)N\(_{2}\)F\(_{17}\)Cl), 1.67 (sextet, \(J = 7.3\) Hz, 2H; CH\(_2\)N\(_{2}\)F\(_{17}\)Cl), 0.95 (t, \(J = 7.3\) Hz, 3H; CH\(_3\)\(_3\)) \(^{13}\)C NMR (100 MHz, CDCl\(_3\)): \(\delta = 175.3\) (C=O), 141.6 (Ar-C), 132.4 (Ar-CH), 130.5 (Ar-C), 130.1 (=CH), 127.4 (Ar-CH), 125.7 (=CH), 115.7 (Ar-C), 110.2 (Ar-CH), 53.6 (C-C=O), 42.0 (NCH\(_2\)CH\(_2\)), 38.8 (CH\(_2\)Cl), 33.3 (=CHCH\(_2\)C), 31.5 (t, \(J = 22.0\) Hz; CH\(_2\)N\(_{2}\)F\(_{17}\)Cl), 20.7 (CH\(_2\)N\(_{2}\)F\(_{17}\)Cl), 19.7 (t, \(J = 4.6\) Hz; CH\(_2\)S), 11.3 (CH\(_3\)\(_3\)) IR (film): \(\nu_{\text{max}}\) 2971, 2922, 1731 (C=O), 1482, 1197, 1138 cm\(^{-1}\); MS (ES+): \(m/z\) calculated for C\(_{23}\)H\(_{16}\)NO\(_2\)F\(_{17}\)S: 841.9769 [M + Na\(^+\)]; found: 841.9764.
3-(4-Chlorobut-2-enyl)-3-(3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,10-heptadecafluorodecylsulfanyl)-1-(4-methoxybenzyl)-1,3-dihydroindol-2-one 12

Using general procedure G, oxindole S11 (1.13 g, 1.55 mmol), cis-1,4-dichlorobut-2-ene (0.23 mL, 1.86 mmol) and K₂CO₃ (1.07 g, 7.75 mmol) in DMF (30 mL) gave the crude product. Purification by FSPE gave alkylated oxindole 12 (976 mg, 1.19 mmol, 77%) as a yellow oil, ¹H NMR (400 MHz, CDCl₃): δ 7.35 (dd, J = 7.6, 0.8 Hz, 1H; Ar-CH), 7.26-7.21 (m, 3H; 3 × Ar-CH), 7.10 (td, J = 7.6, 1.0 Hz, 1H; Ar-CH), 6.85-6.79 (m, 3H; 3 × Ar-CH), 5.66-5.58 (m, 1H; =CH), 5.31-5.23 (m, 1H; =CH), 4.91 (d, J = 15.4 Hz, 1H; NCH₃CH₃C₆H₄OMe), 4.78 (d, J = 15.4 Hz, 1H; NCH₃CH₃C₆H₄OMe), 4.07 (ddd, J = 12.1, 8.3, 1.0 Hz, 1H; =CHCH₃CH₃Cl), 3.98 (dd, J = 12.1, 7.0 Hz, 1H; =CHCH₃CH₃Cl), 3.77 (s, 3H; OCH₃), 3.03 (ddd, J = 14.1, 8.8, 1.2 Hz, 1H; =CHCH₃CH₃Cl), 2.83 (ddd, J = 14.1, 6.8, 1.2 Hz, 1H; =CHCH₃CH₃Cl), 2.71-2.62 (m, 2H; CH₂S), 2.23-2.09 (m, 2H; CH₂C₆F₁₇); ¹³C NMR (100 MHz, CDCl₃): δ 176.0 (C=O), 159.2 (Ar-C), 142.3 (Ar-C), 129.8 (=CH), 129.5 (Ar-CH), 128.8 (Ar-CH), 128.2 (Ar-C), 127.4 (Ar-C), 126.3 (=CH), 124.1 (Ar-CH), 123.2 (Ar-CH), 114.1 (Ar-CH), 109.5 (Ar-CH), 55.1 (OCH₃), 53.8 (C-C=O), 43.5 (NCH₂C₆H₄OCH₃), 38.9 (=CHCH₃Cl), 33.4 (=CHCH₃Cl), 31.4 (t, J = 22.0 Hz; CH₂C₆F₁₇), 19.7 (t, J = 3.7 Hz, CH₂S); IR (film): νmax 3030, 2946, 2924, 1712 (C=O), 1617, 1516, 1485, 1466, 1441, 1348, 1295, 1244, 1206, 1175, 1144, 1035, 953, 747, 646 cm⁻¹; MS (ES+): m/z (%): 844 (30, [¹⁷ClM + Na⁺]), 842 (100, [¹⁵ClM + Na⁺]); HRMS (ES+): m/z: calcd for C₂₆H₂₃NO₂ClF₁₇S: 842.0759 [M + Na⁺]; found: 794.0748.

3-(4-Chlorobut-2-enyl)-3-(3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,10-heptadecafluorodecylsulfanyl)-1-propyl-1,3-dihydroindol-2-one 13
Using general procedure G, 3-((3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,10-heptadecafluorodecyl)thio)-1-propyldolin-2-one\(^9\) (4.80 g, 7.70 mmol), \textit{cis}-1,4-dichlorobut-2-ene (1.21 mL, 11.5 mmol) and K\(_2\)CO\(_3\) (1.43 g, 38.4 mmol) in DMF (80 mL) gave the crude product. Purification by FSPE gave alkylated oxindole 13 (3.78 g, 5.20 mmol, 68%) as a yellow oil. \(^1\)H NMR (400 MHz, CDCl\(_3\)): \(\delta\) 7.37-7.30 (m, 2H; 2 × Ar-CH), 7.12 (dt, \(J = 7.6, 1.0\) Hz, 1H; Ar-CH), 6.87 (d, \(J = 7.8\) Hz, 1H; Ar-CH), 5.65-5.59 (m, 1H; =CH), 5.23-5.31 (m, 1H; =CH), 4.05 (ddd, \(J = 11.8, 8.3, 1.3\) Hz, 1H; =CH\(_2\)CH\(_3\)), 3.97 (dd, \(J = 11.8, 7.3\) Hz, 1H; =CH\(_2\)CH\(_3\)), 3.62-3.74 (m, 2H; CH\(_2\)N), 2.97 (ddd, \(J = 14.1, 8.8, 1.3\) Hz, 1H; =CH\(_2\)CH\(_3\)), 2.80 (ddd, \(J = 14.1, 7.1, 1.3\) Hz, 1H; =CH\(_2\)CH\(_3\)), 2.22-2.11 (m, 2H; CH\(_2\)C\(_6\)F\(_{17}\)), 1.68 (sextet, \(J = 7.4\) Hz, 2H; CH\(_2\)CH\(_3\)), 0.96 (t, \(J = 7.4\) Hz, 3H; CH\(_3\)); \(^{13}\)C NMR (100 MHz, CDCl\(_3\)): \(\delta\) 175.6 (C=O), 142.7 (Ar-C), 129.7 (=CH), 129.5 (Ar-CH), 128.3 (Ar-C), 126.3 (=CH), 124.2 (Ar-CH), 123.0 (Ar-CH), 108.8 (Ar-CH), 53.8 (C-C=O), 41.9 (NCH\(_2\)), 38.9 (=CHCH\(_2\)Cl), 33.4 (=CHCH\(_2\)C), 31.6 (t, \(J = 22.0\) Hz; CH\(_2\)C\(_6\)F\(_{17}\)), 20.8 (CH\(_2\)CH\(_3\)), 19.8 (t, \(J = 3.7\) Hz; CH\(_2\)-S), 11.3 (CH\(_3\)); IR (film): \(\nu_{\text{max}}\) 3060, 2971, 2939, 2878, 1712 (C=O), 1612, 1487, 1468, 1444, 1360, 1249, 1114, 1025, 953, 872, 751 cm\(^{-1}\); MS (EI\(^{+}\)): \(m/z\) (%): 764 (100, \([M + Na]^+\)); HRMS (EI\(^{+}\)): \(m/z\): calcld for C\(_{28}\)H\(_{21}\)NOClF\(_{17}\)S: 764.0655 \([M + Na]^+\); found: 764.0659.

3-(4-Chlorobut-2-enyl)-3-(3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,10-heptadecafluorodecylsulfanyl)-6-methoxy-1-propyl-1,3-dihydroindol-2-one 14
Using general procedure G, oxindole **S12** (606 mg, 0.89 mmol), *cis*-1,4-dichlorobut-2-ene (112 µL, 1.06 mmol) and K₂CO₃ (490 mg, 3.55 mmol) in DMF (10 mL) gave the crude product. Purification by **FSPE** gave alkylated oxindole **14** (600 mg, 0.78 mmol, 88%) as a yellow oil, ¹H NMR (500 MHz, CDCl₃): δ 7.24 (d, J = 8.2 Hz, 1H; Ar-CH), 6.61 (dd, J = 8.2, 2.2 Hz, 1H; Ar-CH), 6.43 (d, J = 2.2 Hz, 1H, Ar-CH), 5.65-5.60 (m, 1H; CH), 5.31-5.25 (m, 1H; CH=CH), 3.97 (dd, J = 12.0, 7.3 Hz, 1H; CH₃CH₂Cl), 3.67 (dt, J = 14.2, 7.2 Hz, 1H; NCH₃CH₂CH₂), 3.62 (dt, J = 14.2, 7.2 Hz, 1H; NCH₃CH₂CH₂), 2.94 (ddd, J = 14.0, 8.5, 0.6 Hz, 1H; =CHCH₂H₂B), 2.77 (dd, J = 14.0, 7.0, 1H; =CHCH₂H₂B), 2.69 (dt, J = 13.4, 7.4 Hz, 1H; CH₃CH₂S), 2.62 (dt, J = 13.4, 7.8, 1H; CH₃H₂S), 2.42-2.13 (m, 2H; CH₂C₆F₁₇), 1.68 (sextet, J = 7.2 Hz, 2H; CH₂CH₃), 0.96 (t, J = 7.2 Hz, 3H; CH₃); ¹³C NMR (125 MHz, CDCl₃): δ 176.5 (C=O), 161.1 (Ar-C), 143.9 (Ar-C), 129.5 (CH=CH₂Cl), 126.5 (CH=CH₂C), 125.0 (Ar-CH), 119.9 (Ar-C), 106.6 (Ar-CH), 96.8 (Ar-CH), 55.5 (OCH₃), 53.5 (C-C=O), 41.8 (CH₂N), 39.0 (CH₂Cl), 33.4 (=CHCH₂C), 31.6 (t, J = 21.7 Hz; CH₂C₆F₁₇), 20.8 (CH₂CH₃), 19.7 (t, J = 3.6 Hz; CH₂S), 11.3 (CH₃); IR (film): νmax 2966, 2941, 1716 (C=O), 1624, 1602, 1504, 1463, 1370, 1241, 1209, 1148, 1109, 1034 cm⁻¹; MS (ES⁺): m/z (%): 794 (100, [M + Na⁺]), 533 (20), 151 (20); HRMS (EI⁺): m/z: calcd for C₂₉H₂₃NO₂ClF₁₅S: 794.0759 [M + Na⁺]; found: 794.0775.

### 6-Methoxy-3-(4-chlorobut-2-enyl)-3-(3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10-heptadecafluorodecysulfanyl)-1-p-methoxybenzyl-1,3-dihydropyridol-2-one 15

![Structural diagram](image-url)
Using general procedure G, oxindole S13 (0.29 g, 0.40 mmol), cis-1,4-dichlorobut-2-ene (0.60 mL, 0.60 mmol) and K$_2$CO$_3$ (0.26 g, 1.90 mmol) in DMF (5 mL) gave the crude product. Purification by FSPE gave alkylated oxindole 15 (0.24 g, 0.29 mmol, 77%) as a yellow oil, $^1$H NMR (400 MHz, CDCl$_3$): δ 7.17-7.11 (m, 3H; 3 × Ar-CH$_2$), 6.83 (d, J = 8.8 Hz, 2H; Ar-CH$_2$), 6.58 (dd, J = 8.2, 2.3 Hz, 1H; Ar-CH$_2$), 6.37 (d, J = 2.3 Hz, 1H; Ar-CH$_2$), 5.66-5.59 (m, 1H; =CH), 5.24-5.30 (m, 1H; =CH), 4.88 (d, J = 15.4 Hz, 1H; Ar-CH$_2$), 4.74 (d, J = 15.4 Hz, 1H; =CH), 4.07 (ddd, J = 11.8, 8.1, 1.3 Hz, 1H; =CHCH$_2$Cl), 3.97 (dd, J = 11.8, 7.3 Hz, 1H; =CHCH$_2$Cl), 3.77 (s, 3H; OCH$_3$), 3.76 (s, 3H; OCH$_3$), 3.00 (ddd, J = 14.1, 8.6, 1.5 Hz, 1H; =CHCH$_2$Cl), 2.79 (ddd, J = 14.1, 6.8, 1.8 Hz, 1H; =CHCH$_2$Cl), 2.73-2.62 (m, 2H; CH$_2$S), 2.25-2.11 (m, 2H, CH$_2$C$_8$F$_{17}$); $^{13}$C NMR (100 MHz, CDCl$_3$): δ 176.6 (C=O), 160.9 (Ar-C), 159.2 (Ar-C), 143.6 (Ar-C), 130.9 (Ar-CH), 129.3 (=CH), 128.8 (Ar-CH), 127.4 (Ar-C), 126.5 (=CH), 124.9 (Ar-CH), 119.7 (Ar-C), 114.2 (2 × Ar-CH), 106.9 (Ar-CH), 97.5 (Ar-C), 55.4 (OCH$_3$), 55.2 (OCH$_3$), 53.5 (C-C=O), 43.7 (NCH$_2$), 39.0 (=CHCH$_2$Cl), 33.5 (=CHCH$_2$C), 31.5 (t, J=22.2 Hz; CH$_2$C$_8$F$_{17}$), 19.7 (t, J=2.9 Hz; CH$_2$S); IR (film): ν=3006, 2942, 2841, 2364, 1714 (C=O), 1622, 1515, 1470, 1374, 1239, 1152, 1036 cm$^{-1}$; MS (EI+): m/z (%): 872 (100, [M + Na]$^+$); HRMS (EI+): m/z: calcd for C$_{31}$H$_{25}$NO$_3$ClF$_{17}$S: 872.0870 [M + Na]$^+$; found: 872.0870.

3-(4-Chlorobut-2-enyl)-3-(3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,10-heptadecafluorodecylsulfanyl)-1-benzyl-1,3-dihydroindol-2-one 16

Using general procedure G, oxindole S14 (1.36 g, 1.86 mmol), cis-1,4-dichlorobut-2-ene (0.23 mL, 2.23 mmol) and K$_2$CO$_3$ (1.03 mg, 7.94 mmol) in DMF (16 mL) gave the crude product. Purification by FSPE gave alkylated oxindole 16 (1.23g, 2.78 mmol, 80%) as a yellow oil, $^1$H NMR (500 MHz, CDCl$_3$): δ 7.33-7.24 (m, 6H; 6 ×
Ar-CH), 6.59 (dd, J = 8.2, 2.0 Hz, 1H; Ar-CH), 6.34 (d, J = 2.0 Hz, 1H, Ar-CH),
5.66-5.61 (m, 1H; CH=CHCl), 5.33-5.27 (m, 1H; CH=CH2), 4.95 (d, J = 15.6 Hz,
1H; NCH3H8Ph), 4.81 (d, J = 15.6 Hz, 1H; NCH3H8Ph), 4.07 (dd, J = 12.0, 8.9 Hz,
1H; CH3CH8Cl), 3.97 (dd, J = 12.0, 7.3 Hz, 1H; CH3CH8Cl), 3.75 (s, 3H; OCH3),
3.02 (dd, J = 14.0, 8.8 Hz, 1H; NCH3CH8Cl=C-O), 2.82 (dd, J = 14.0, 7.0 Hz, 1H;
NCH3CH8C-C=O), 2.76-2.65 (m, 2H; CH2S), 2.25-2.15 (m, 2H; CH2C8F17); 13C
NMR (100 MHz, CDCl3): δ 176.7 (C=O), 161.0 (Ar-C), 143.6 (Ar-C), 135.3 (Ar-C),
129.7 (CH=CH2Cl), 128.8 (Ar-CH), 127.9 (Ar-CH), 127.3 (Ar-CH), 126.5
(CH=CH2Cl), 124.9 (Ar-CH), 119.7 (Ar-C), 107.0 (Ar-CH), 97.5 (Ar-CH), 55.4
(OCH3), 53.5 (C-C=O), 44.0 (NCH3Ph), 39.0 (CH2Cl), 33.4 (=CHCH2C), 31.5 (t, J =
27.5 Hz; CH2C8F17), 19.7 (t, J = 4.6 Hz; CH2S); IR (film): ν 2958, 2945, 1713 (C=O),
1624, 1501, 1375, 1236, 1200, 1145, 1114, 1081, 1033 cm⁻¹; MS (ES+): m/z
(%): 844 (30, [37ClM + Na]⁺), 842 (100, [35ClM + Na]⁺); HRMS (ES+): m/z: calcd for
C26H23NO2ClF17S: 842.0759 [M + Na⁺]; found: 794.0748.
rac-(1S,2S)-5'-bromo-1'-propyl-2-vinylspiro[cyclopropane-1,3'-indolin]-2'-one 17

A solution of oxindole 11 (452 mg, 0.55 mmol) in THF (17 mL) was deoxygenated by bubbling through nitrogen gas for 45 min. Then, SmI$_2$ (11.0 mL of a 0.1M solution in THF, 1.10 mmol) was added dropwise over 1 h (using a syringe pump) at rt under nitrogen. On completion of the addition, a saturated aqueous solution of NaHCO$_3$ (20 mL) and EtOAc (20 mL) were added, and the layers were separated. The aqueous layer was extracted with EtOAc (2 × 10 mL), and the combined organic layers were dried (MgSO$_4$) and evaporated under reduced pressure to give the crude product.

Purification by flash column chromatography on silica gel eluting with 10% EtOAc in petroleum ether gave vinylcyclopropane 17 (90 mg, 0.29 mmol, 53%) as a pale yellow oil, $^1$H NMR (400 MHz, CDCl$_3$): $\delta$ 7.35 (dd, $J = 8.3$, 2.0 Hz, 1H; Ar-CH), 6.95 (d, $J = 2.0$ Hz, 1H; Ar-CH), 6.76 (d, $J = 8.3$ Hz, 1H; Ar-CH), 6.21 (dd, $J = 17.1$, 10.3, 9.4 Hz, 1H; CH=CH$_2$), 5.27 (dd, $J = 17.1$, 1.5, 0.5 Hz, 1H; CH=CH$_2$H$_8$), 5.14 (dd, $J = 10.3$, 2.0 Hz, 1H; CH=CH$_2$H$_8$), 3.73-3.69 (m, 2H; NCH$_2$), 2.53-2.46 (m, 1H; CH$_2$CHN), 2.00 (dd, $J = 8.1$, 4.8 Hz, 1H; CH$_2$H$_8$CHN), 1.94 (dd, $J = 8.8$, 4.8 Hz, 1H; CH$_2$H$_8$CHN), 1.75-1.65 (m, 2H; CH$_2$CH$_3$), 0.95 (t, $J = 7.3$ Hz, 3H; CH$_3$); $^{13}$C NMR (100 MHz, CDCl$_3$): $\delta$ 174.1 (C=O), 141.8 (Ar-C), 133.6 (CH=CH$_2$), 132.8 (Ar-C), 129.4 (Ar-CH), 121.4 (Ar-CH), 117.2 (CH=CH$_2$), 114.4 (Ar-C), 109.5 (Ar-CH), 42.0 (NCH$_2$), 37.7 (CH-CH=CH$_2$), 33.6 (C-C=O), 25.0 (CH$_2$CH), 21.0 (CH$_2$CH$_3$), 11.4 (CH$_3$); IR (film): $\nu_{max}$ 3417, 2080, 2965, 2359, 1716 (C=O), 1607, 1485, 1367, 1204, 1141 cm$^{-1}$; MS (ES+): $m/z$ (%): 308 (100, $[^{81}$BrM + H]$^+$), 306 (100, $[^{79}$BrM + H]$^+$); HRMS (ES+): $m/z$: calcd for C$_{15}$H$_{16}$NO$^{79}$Br: 306.0488 [M + H]$^+$; found: 306.0501.
rac-(2'S,5'S,3'S)-1'Allyl-5-bromo-2'-phenyl-1-propyl-5'-vinyl-1H-spiro[indole-3,3'-pyrrolidin]-2-one 19

Using general procedure I, oxindole 14 (101 mg, 0.12 mmol) and SmI$_2$ (2.5 mL of a 0.1 M solution in THF, 0.25 mmol) in THF (4 mL), and a solution of imine (36 mg, 0.25 mmol) in THF (1 mL) gave the crude product as a 3:1 mixture of diastereoisomers (by $^1$H NMR spectroscopy). Purification by flash column chromatography on silica gel eluting with 10% Et$_2$O in petroleum ether gave 19a (30 mg, 0.07 mmol, 54%, major diastereoisomer) as an off-white solid, m.p. (Et$_2$O) 104–107 °C; $^1$H NMR (400 MHz, CDCl$_3$): δ 7.46 (d, J = 2.0 Hz, 1H; Ar-CH), 7.15 (dd, J = 8.3, 2.0 Hz, 1H; Ar-CH), 7.10-6.95 (m, 5H; 5 × Ar-CH), 6.38 (d, J = 8.3 Hz, 1H; Ar-CH), 5.96 (ddd, J = 17.1, 10.1, 8.3 Hz, 1H; CHCH=CH$_2$), 5.88 (ddt, J = 17.2, 10.4, 6.9 Hz, 1H; CH$_2$CH=CH$_2$), 5.33 (ddd, J = 17.2, 1.6, 0.8 Hz, 1H; CHCH=CH$_2$H$_B$), 5.26 (dd, J = 10.1, 1.6 Hz, 1H; CHCH=CH$_2$H$_B$), 5.13-5.10 (m, 1H; CH$_2$CH=CH$_2$H$_B$), 4.96 (ddt, J = 17.1, 2.0, 1.3 Hz, 1H; CH$_2$CH=CH$_2$H$_B$), 4.26 (s, 1H; CHPh), 3.79-3.73 (m, 1H; CH$_2$CHN), 3.66 (ddd, J = 14.1, 8.3, 6.3 Hz, 1H; NCH$_2$H$_B$CH$_2$), 3.42-3.32 (m, 2H; NCH$_2$H$_B$CH$_2$ and CH$_2$H$_B$CH=CH$_2$), 3.22 (dd, J = 14.9, 6.9 Hz, 1H; CH$_2$H$_B$CH=CH$_2$), 2.67 (dd, J = 13.4, 9.1 Hz, 1H; CH$_2$H$_B$CHN), 1.88 (dd, J = 13.4, 7.0 Hz, 1H; CH$_2$H$_B$CHN), 1.56-1.45 (m, 2H; CH$_2$CH$_3$), 0.82 (t, J = 7.3 Hz, 3H; CH$_3$); $^{13}$C NMR (100 MHz, CDCl$_3$): δ 178.2 (C=O), 141.3 (Ar-C), 140.1 (CH$_2$CH=CH$_2$), 136.1 (Ar-C), 134.7 (Ar-C), 132.2 (CHCH=CH$_2$), 130.0 (Ar-CH), 128.8 (Ar-CH), 128.1 (Ar-CH), 127.47 (Ar-CH), 127.42 (Ar-CH), 118.9 (CH$_2$CH=CH$_2$), 117.1 (CHCH=CH$_2$), 114.2 (Ar-C), 108.9 (Ar-CH), 74.8 (CHPh), 63.8 (CH$_2$CHN), 57.9 (C-C=O), 51.2 (CH$_2$CH=CH$_2$), 41.7 (NCH$_2$CH$_2$), 40.9 (CH$_2$CHN), 20.7 (CH$_2$CH$_3$), 11.4 (CH$_3$); IR (film): $v_{\text{max}}$ 2966, 2932, 1710 (C=O), 1606, 1480, 1456, 1426, 1349, 1336, 1142, 1114, 923, 806, 747, 703 cm$^{-1}$; MS (ES+): m/z (%): 475 (90, $^{81}$BrM + Na$^+$), 473 (100, $^{79}$BrM + Na$^+$); HRMS (ES+): m/z: calcd for C$_{25}$H$_{27}$N$_2$O$_{81}$Br: 453.1365 [M + H$^+$]; found: 453.1372; and 19b (13 mg, 0.03 mmol, 23%, minor diastereoisomer) as a yellow oil, which crystallized from aqueous
ethanol as an off-white solid, m.p. 132–134 °C; \(^1\)H NMR (400 MHz, CDCl\(_3\)): \(\delta\) 7.48 (d, \(J = 2.0\) Hz, 1H; Ar-CH), 7.34 (dd, \(J = 8.3, 2.0\) Hz, 1H; Ar-CH), 7.19-7.00 (m, 5H; 5 × Ar-CH), 6.49 (d, \(J = 8.3\) Hz, 1H; Ar-CH), 6.08 (ddd, \(J = 17.2, 9.9, 8.3\) Hz, 1H; CH\(_2\)CH=CH\(_2\)), 5.84 (ddt, \(J = 17.2, 10.1, 7.0\) Hz, 1H; CH\(_2\)CH=CH\(_2\)), 5.31 (ddd, \(J = 17.2, 1.8, 0.5\) Hz, 1H; CHCH=CH\(_2\)), 5.22 (dd, \(J = 10.1, 1.8\) Hz, 1H; CHCH=CH\(_2\)), 5.12 (br dd, \(J = 10.1, 1.3\) Hz, 1H; CH\(_2\)CH=CH\(_2\)), 4.93 (ddt, \(J = 17.2, 2.0, 1.3\) Hz, 1H; CH\(_2\)CH=CH\(_2\)), 4.01 (s, 1H; C\(_6\)H\(_5\)N), 3.63 (q, \(J = 8.3\) Hz, 1H; CH\(_2\)C=O), 3.45 (ddd, \(J = 14.5, 8.6, 6.0\) Hz, 1H; NCH\(_2\)), 3.36 (br dd, \(J = 14.7, 7.0\) Hz, 1H; CH\(_2\)H\(_5\)CH=CH\(_2\)), 3.14 (dd, \(J = 14.7, 7.0\) Hz, 1H; CH\(_2\)H\(_5\)CH=CH\(_2\)), 2.95 (ddd, \(J = 14.5, 8.3, 6.6\) Hz, 1H; NCH\(_2\)), 2.24 (dd, \(J = 13.2, 8.3\) Hz, 1H; CH\(_2\)H\(_5\)CH=CH\(_2\)), 2.00 (t, \(J = 7.3\) Hz, 3H; CH\(_3\)); \(^{13}\)C NMR (100 MHz, CDCl\(_3\)): \(\delta\) 177.1 (C=O), 142.5 (Ar-C), 140.2 (CH=CH\(_2\)), 135.7 (Ar-C), 135.3 (Ar-C), 131.6 (CHCH=CH\(_2\)), 130.7 (Ar-CH), 128.0 (Ar-CH), 127.8 (Ar-CH), 127.7 (Ar-CH), 126.0 (Ar-CH), 119.1 (CH\(_2\)CH=CH\(_2\)), 117.1 (CHCH=CH\(_2\)), 114.4 (Ar-C), 109.1 (Ar-CH), 77.4 (CHPh), 65.5 (CH\(_2\)CH=CH\(_2\)), 57.4 (C-C=O), 50.6 (CH\(_2\)CH=CH\(_2\)), 41.3 (NCH\(_2\)CH\(_3\)), 40.6 (CH\(_2\)CH=CH\(_2\)), 20.3 (CH\(_2\)CH\(_3\)), 11.1 (CH\(_3\)); IR (film): \(\nu_{\text{max}}\) 2967, 2932, 1716 (C=O), 1605, 1486, 1455, 1423, 1348, 1208, 1189, 1137, 1114, 1098, 996, 923, 806, 748, 700 cm\(^{-1}\); MS (ES\(^+\)): \(m/z\) (%): 475 (100, \([^{81}\text{Br}M + \text{Na}]^+\)), 473 (85, \([^{79}\text{Br}M + \text{Na}]^+\)); HRMS (ES\(^+\)): \(m/z\): calcd (%) for C\(_{25}\)H\(_{27}\)N\(_2\)O\(_8\)Br: 473.1199 \([M + \text{Na}]^+\); found: 473.1206.

\textbf{rac-(2'S,5'S,3'S)-1'-Allyl-5-bromo-2'-4-bromophenyl)-1-propyl-5'-vinyl-1H-spiro[indole-3,3'-pyrrolidin]-2-one 20}

Using general procedure I, oxindole 11 (67 mg, 0.08 mmol) and SmI\(_2\) (1.6 mL of a 0.1 M solution in THF, 0.16 mmol) in THF (2 mL), and a solution of imine (37 mg,
0.16 mmol) in THF (1 mL) gave the crude product as a 3:1 mixture of diastereoisomers (by $^1$H NMR spectroscopy). Purification by flash column chromatography on silica gel eluting with 10% EtOAc in petroleum ether gave 20 (30 mg, 0.06 mmol, 69%) as a 3:1 mixture of diastereoisomers (by $^1$H NMR spectroscopy), as a yellow oil. Further purification by flash chromatography on silica gel eluting with 20% Et$_2$O in petroleum ether gave the minor diastereoisomer as a pale yellow oil, $^1$H NMR (400 MHz, CDCl$_3$): $\delta$ 7.47 (d, $J = 2.0$ Hz, 1H; Ar-CH), 7.35 (dd, $J = 8.3, 2.0$ Hz, 1H; Ar-CH), 7.31-7.24 (m, 4H; 4 × Ar-CH), 6.52 (d, $J = 8.3$ Hz, 1H; Ar-CH), 6.05 (dd, $J = 17.2, 10.1, 8.3$ Hz, 1H; CHCH=CH$_2$), 5.82 (ddt, $J = 17.2, 10.1, 6.8$ Hz, 1H; CH$_2$CH=CH$_2$), 5.31 (dd, $J = 17.2, 1.8$ Hz, 1H; CHCH=CH$_A$H$_B$), 5.23 (dd, $J = 10.1, 1.8$ Hz, 1H; CHCH=CH$_A$H$_B$), 5.13 (dd, $J = 10.1, 2.0$ Hz, 1H; CH$_2$CH=CH$_A$H$_B$), 4.92 (br dd, $J = 17.2, 2.0$ Hz, 1H; CHCH=CH$_A$H$_B$), 3.96 (s, 1H; CHAr), 3.63 (q, $J = 8.3$ Hz, 1H; CH$_2$CHN), 3.48 (dd, $J = 13.8, 8.3, 6.3$ Hz, 1H; NCH$_A$H$_B$), 3.34 (dd, $J = 14.9, 6.6$ Hz, 1H; CH$_A$H$_B$CH=CH$_2$), 3.10 (dd, $J = 14.9, 7.3$ Hz, 1H; CH$_A$H$_B$CH=CH$_2$), 3.00 (ddd, $J = 13.8, 8.1, 6.6$ Hz, 1H; NCH$_A$H$_B$), 2.31 (dd, $J = 13.2, 8.3$ Hz, 1H; CH$_A$H$_B$CHN), 2.25 (dd, $J = 13.2, 8.3$ Hz, 1H; CH$_A$H$_B$CHN), 1.60-1.00 (m, 2H; CH$_2$CH$_2$), 0.56 (t, $J = 7.6$ Hz, 3H; CH$_3$); $^{13}$C NMR (100 MHz, CDCl$_3$): $\delta$ 177.0 (C=O), 142.5 (Ar-C), 140.0 (CH=CH$_2$), 135.0 (2 × Ar-C), 131.4 (CHCH=CH$_2$), 130.94 (Ar-CH), 130.89 (Ar-CH), 129.81 (Ar-CH), 126.1 (Ar-CH), 121.8 (Ar-C), 119.4 (CH$_2$CH=CH$_2$), 117.4 (CHCH=CH$_2$), 114.6 (Ar-C), 109.3 (Ar-CH), 76.7 (CHAr), 65.6 (CH$_2$CHN), 57.4 (C-C=O), 50.7 (CH$_2$CH=CH$_2$), 41.4 (CH$_2$N), 40.7 (CH$_2$CHN), 20.5 (CH$_2$CH$_3$), 11.1 (CH$_3$); IR (film): $\nu_{\text{max}}$ 2964, 2930, 1715 (C=O), 1606, 1483, 1348, 1206, 1189, 1110, 1069, 1007, 923, 806 and 736 cm$^{-1}$; MS (ES+): $m/z$ (%): 555 (50, [${}^{81}$Br$^{81}$BrM + Na$^+$]), 553 (100, [${}^{81}$Br$^{79}$BrM + Na$^+$]), 551 (50, [${}^{79}$Br$^{79}$BrM + Na$^+$]); HRMS (ES+): $m/z$: calcd (%) for C$_{23}$H$_{26}$N$_2$O$^{79}$Br$_2$: 551.0304 [M + Na$^+$]; found: 551.0298; and the major diastereoisomer as an off-white solid, m.p. 110–112 °C; $^1$H NMR (400 MHz, CDCl$_3$): $\delta$ 7.46 (d, $J = 2.2$ Hz, 1H; Ar-CH), 7.21-7.18 (m, 3H; 3 × Ar-CH), 6.93 (d, $J = 8.1$ Hz, 2H; 2 × Ar-CH), 6.42 (d, $J = 8.3$ Hz, 1H; Ar-CH), 5.95 (ddd, $J = 17.1, 10.1, 8.3$ Hz, 1H; CHCH=CH$_2$), 5.84 (ddt, $J = 17.2, 10.1, 6.8$ Hz, 1H; CH$_2$CH=CH$_2$), 5.32 (br d, $J = 17.1$ Hz, 1H; CHCH=CH$_A$H$_B$), 5.25 (dd, $J = 10.1, 2.0$ Hz, 1H; CHCH=CH$_A$H$_B$), 5.12 (dd, $J = 10.1, 2.0$ Hz, 1H; CH$_2$CH=CH$_A$H$_B$), 4.94 (dd, $J = 17.2, 2.0$ Hz, 1H; CH$_2$CH=CH$_A$H$_B$), 4.21 (s, 1H; CHAr), 3.78-3.72 (m, 1H; CH$_2$CHN), 3.65 (ddd, $J = 14.1, 8.1, 6.6$ Hz, 1H; NCH$_A$H$_B$).
3.42-3.34 (m, 2H; NCH$_3$), 3.16 (dd, $J = 14.9$, 6.8 Hz, 1H; CH$_2$H$_2$CH=CH$_2$), 2.68 (dd, $J = 13.4$, 9.3 Hz, 1H; CH$_2$H$_2$CHN), 1.88 (dd, $J = 13.4$, 6.8 Hz, 1H; CH$_2$H$_2$CHN), 1.57-1.45 (m, 2H; CH$_2$CH$_3$), 0.83 (t, $J = 7.6$ Hz, 3H; CH$_3$); $^{13}$C NMR (100 MHz, CDCl$_3$): $\delta = 177.9$ (C=O), 141.3 (Ar-C), 139.8 (CH$_2$CH$_2$), 135.2 (Ar-C), 134.4 (Ar-C), 131.8 (CH$_2$CH$_2$), 130.6 (Ar-CH), 130.4 (Ar-CH), 129.7 (Ar-CH), 128.6 (Ar-CH), 121.3 (Ar-C), 119.2 (CH$_2$CH$_2$), 117.3 (CHCH=CH$_2$), 114.3 (Ar-C), 109.1 (Ar-CH), 74.1 (CHAr), 63.7 (CH$_2$CHN), 57.8 (C-C=O), 51.1 (CH$_2$CH$_2$CH=N), 41.7 (CH$_2$N), 40.8 (CH$_2$CHN), 20.7 (CH$_2$CH$_3$), 11.3 (CH$_3$); IR (film): $\nu_{\text{max}}$ 2964, 2930, 1712 (C=O), 1606, 1483, 1427, 1348, 1141, 1069, 1010, 923 and 805 cm$^{-1}$; MS (ES+): $m/z$ (%): 555 (50, $[^{81}\text{Br}^{81}\text{Br}]M + \text{Na}^+$), 553 (100, $[^{81}\text{Br}^{79}\text{Br}]M + \text{Na}^+$), 551 (50, $[^{79}\text{Br}^{79}\text{Br}]M + \text{Na}^+$); HRMS (ES+): $m/z$: calcd for C$_{25}$H$_{26}$N$_2$O$_7^{[81}\text{Br}^{81}\text{Br}]$: 529.0490 $[^{81}\text{Br}^{81}\text{Br}]M + \text{H}^+$; found: 529.0490.

**rac-(2'R,5'S,3S)-1'-Allyl-1-propyl-2'-(triisopropylsilyl)ethynyl)-5'-vinylspiro[indoline-3,3'-pyrrolidin]-2-one 21**

![Image of rac-(2'R,5'S,3S)-1'-Allyl-1-propyl-2'-(triisopropylsilyl)ethynyl)-5'-vinylspiro[indoline-3,3'-pyrrolidin]-2-one 21]

Using general procedure I, oxindole 13 (0.23 g, 0.32 mmol) and SmI$_2$ (6.5 mL of a 0.1 M solution in THF, 0.65 mmol) in THF (2 mL), and a solution of imine (0.16 g, 0.65 mmol) in THF (1 mL) gave the crude product as a 11:1 mixture of diastereoisomers (by $^1$H NMR spectroscopy). Purification by flash column chromatography on silica gel eluting with 20% Et$_2$O in petroleum ether gave 21 (0.11 g, 0.23 mmol 75%) as a 11:1 mixture of diastereoisomers (by $^1$H NMR spectroscopy) as a yellow oil. $^1$H NMR (400 MHz, CDCl$_3$): $\delta = 7.53$ (dd, $J = 7.6$, 1.4 Hz, 1H; Ar-CH), 7.20 (td, $J = 7.6$, 1.4 Hz, 1H; Ar-CH), 7.02 (td, $J = 7.6$, 1.0 Hz, 1H; Ar-CH), 6.78 (br d, $J = 7.6$ Hz, 1H; Ar-CH), 6.04-5.93 (m, 1H; CH$_2$CH=CH$_2$), 5.80 (ddd, $J = 17.1$, 10.2, 8.3 Hz, 1H; CH$_2$CH=CH$_2$), 5.29-5.15 (m, 4H; CHCH=CH$_2$ and CH$_2$CH=CH$_2$), 3.87 (s, 1H; CH-
C≡C, 3.77-3.68 (m, 1H; NCH₃H₂CH₂), 3.64-3.53 (m, 2H; CH₃H₂CH=CH₂ and NCH₃H₂CH₂), 3.51-3.43 (m, 2H; CH₃H₂CH=CH₂ and CH₂CHN), 2.51 (dd, J = 13.2, 8.7 Hz, 1H; CH₃H₂CHN), 1.84 (dd, J = 13.2, 7.8 Hz, 1H; CH₃H₂CHN), 1.72-1.64 (m, 2H; CH₂CH₃), 0.95 (t, J = 7.3 Hz, 3H; CH₂CH₃), 0.87-0.75 (m, 21H; Si(CH₂CH₃)₂); ¹³C NMR (100 MHz, CDCl₃): δ 178.3 (C=O), 142.5 (Ar-C), 139.5 (CHCH=CH₂), 134.0 (Ar-C), 131.6 (CH₂CH=CH₂), 127.6 (Ar-CH), 125.1 (Ar-CH), 122.4 (Ar-CH), 119.6 (CH₂CH=CH₂), 117.5 (CHCH=CH₂), 107.9 (Ar-CH), 102.9 (CHC≡CSi), 87.3 (CHC≡CSi), 63.6 (CH₂CHN), 62.6 (CH-C≡CSi), 55.4 (C-C=O), 50.8 (CH₂CH₂CH₂), 41.9 (CH₂CHN), 41.7 (NCH₂CH₂), 20.8 (CH₂CH₃), 11.5 (CH₂CH₃), 11.1 (3 x CH(CH₃)₂), 10.9 (3 x CH(CH₃)₂); IR (film): ν max 2944, 2866, 2167 (C≡C), 1643 (C=O), 1463, 1383, 1337, 1266, 1242, 1203, 1148, 1099, 996, 920, 883 cm⁻¹; MS (ES+): m/z (%): 477 (100, [M + H]⁺); HRMS (ES+): m/z: calcd for C₃₀H₄₄N₂O₅Si: 477.3281 [M + H⁺]; found: 477.3296.

**rac-(2'R,5'S,3S)-1'-Benzyl-5-bromo-2'-furan-2-yl-1-propyl-5'-vinyl-1H-spiro[indole-3,3'-pyrrolidin]-2-one 22**

![Structure of 22](image)

Using general procedure I, oxindole 11 (102 mg, 0.12 mmol) and SmI₂ (2.5 mL of a 0.1 M solution in THF, 0.25 mmol) in THF (4 mL), and a solution of imine (46 mg, 0.25 mmol) in THF (1 mL) gave the crude product as a 7:1 mixture of diastereoisomers (by ¹H NMR spectroscopy). Purification by flash column chromatography on silica gel eluting with 5% EtOAc in petroleum ether gave 22 (38 mg, 0.08 mmol, 65%) as a 7:1 mixture of diastereoisomers (by ¹H NMR spectroscopy) as a pale yellow oil. Further purification by flash column chromatography on silica gel eluting with 3% acetone in pentane gave the minor diastereoisomer as a pale yellow oil, and the major diastereoisomer as a white solid, m.p. (Et₂O) 115–117 °C; ¹H NMR (400 MHz, CDCl₃): δ 7.51 (d, J = 1.7 Hz, 1H; Ar-CH), 7.27-7.19 (m, 5H; 5 × Ar-CH), 7.12 (dd, J = 8.2, 1.7 Hz, 1H; Ar-CH), 7.09 (br...
Using general procedure I, oxindole 11 (99 mg, 0.12 mmol) and SmI$_2$ (2.4 mL of a 0.1 M solution in THF, 0.25 mmol) in THF (4 mL), and a solution of imine (52 mg, 0.25 mmol) in THF (1 mL) gave the crude product as a 4:1:0.8 mixture of diastereoisomers (by $^1$H NMR spectroscopy). Purification by flash column chromatography on silica gel eluting with 10% EtOAc in petroleum ether gave 23 (47 mg, 0.09 mmol, 74%) as a 4:1 mixture of diastereoisomers (by $^1$H NMR spectroscopy) as a pale yellow oil. Further purification by recrystallisation from
ethanol gave the major diastereoisomer as a white solid, m.p. (EtOH) 115–117 °C; $^1$H NMR (400 MHz, CDCl$_3$): $\delta$ 7.31 (dd, $J$ = 8.3, 2.0 Hz, 1H; Ar-CH), 7.23 (dd, $J$ = 5.0, 1.0 Hz, 1H; thienyl-CH), 6.95 (dd, $J$ = 5.0, 3.5 Hz, 1H; thienyl-CH), 6.81 (d, $J$ = 9.2 Hz, 2H; 2 × Ar-CH), 6.75 (d, $J$ = 9.2 Hz, 2H; 2 × Ar-CH), 6.65 (d, $J$ = 8.3 Hz, 1H; Ar-CH), 6.58 (br d, $J$ = 3.5 Hz, 1H; thienyl-CH), 6.22 (d, $J$ = 2.0 Hz, 1H; Ar-CH), 6.09 (ddd, $J$ = 17.2, 10.1, 7.5 Hz, 1H; CH$_2$-[CH=CH$_2$]), 5.47 (d, $J$ = 17.2 Hz, 1H; CH=C=C$_2$H$_4$), 5.30 (d, $J$ = 10.1, 1.0 Hz, 1H; CH=CH$_2$H$_4$), 4.91 (s, 1H; C$_7$H$_7$thienyl), 4.80 (q, $J$ = 7.5 Hz, 1H; CH$_2$CN), 3.72 (s, 3H; OCH$_3$), 3.65-3.60 (m, 2H; NC$_2$H$_4$CH$_2$), 2.44 (d, $J$ = 7.5 Hz, 2H; CH$_2$CHN), 1.68 (sextet, $J$ = 7.3 Hz, 2H; CH$_2$CH$_3$), 0.93 (t, $J$ = 7.3 Hz, 3H; CH$_3$); $^{13}$C NMR (100 MHz, CDCl$_3$): $\delta$ 178.4 (C=O), 153.0 (thienyl-C), 146.9 (Ar-C), 141.9 (Ar-C), 141.8 (Ar-C), 140.0 (CH=CH$_2$), 130.9 (Ar-C), 129.9 (Ar-C), 128.6 (Ar-CH), 127.0 (thienyl-CH), 124.8 (thienyl-CH), 124.7 (thienyl-CH), 116.8 (CH=CH$_2$), 116.6 (Ar-CH), 114.4 (Ar-C), 114.2 (Ar-CH), 109.2 (Ar-CH), 69.4 (CH$_2$H$_4$thienyl), 61.8 (CH$_2$CHN), 57.3 (OCH$_3$), 55.6 (C-C=O), 41.5 (NCH$_2$CH$_2$), 41.3 (CH$_2$CHN), 20.6 (CH$_2$CH$_3$), 11.3 (CH$_3$); IR (film): $\nu_{\text{max}}$ 2964, 2924, 2874, 1712 (C=O), 1603, 1510, 1480, 1424, 1351, 1337, 1239, 1178, 1110, 1038, 993, 811, 730, 697 cm$^{-1}$; MS (ES+): $m/z$ (%): 547 (70, [$^{81}$BrM + Na$^+$]), 545 (70, [$^{79}$BrM + Na$^+$]), 525 (90), 523 (90), 521 (70), 519 (50), 144 (35), 130 (100); HRMS (ES+): $m/z$: calcd for C$_{27}$H$_{27}$N$_2$O$_2$$_{79}$BrS: 523.1049 [M + H$^+$]; found: 523.1036.

**rac-(2'R,5'S,3S)-1'-Allyl-6-methoxy-1-(4-methoxybenzyl)-2'-
((triisopropylsilyl)ethynyl)-5'-vinylspiro[indoline-3,3'-pyrrolidin]-2-one 24**

Using general procedure I, oxindole 15 (0.10 g, 0.11 mmol) and SmI$_2$ (2.3 mL of a 0.1 M solution in THF, 0.23 mmol) in THF (2 mL), and a solution of imine (0.06 g, 0.23 mmol) in THF (1 mL) gave the crude product as a 8:1 mixture of diastereoisomers (by $^1$H NMR spectroscopy). Purification by flash column chromatography on silica gel
eluting with 10% Et₂O in petroleum ether gave 24 (40 mg, 0.07 mmol, 63%) as a 8:1 mixture of diastereoisomers (by ¹H NMR spectroscopy) as a yellow oil, ¹H NMR (400 MHz, CDCl₃): δ 7.41 (d, J = 8.2 Hz, 1H; Ar-CH), 7.22 (d, J = 8.8 Hz, 2H; Ar-CH), 6.82 (d, J = 8.8 Hz, 2H; Ar-CH), 6.50 (dd, J = 8.2, 2.3 Hz, 1H; Ar-CH), 6.29 (d, J = 2.3 Hz, 1H; Ar-CH), 6.05-5.93 (m, 1H; CH₂=CH-CH₂), 5.80 (ddd, J = 17.2, 10.1, 8.3 Hz, 1H; CHC≡CH₂), 5.30-5.16 (m, 4H; 2H CH₂CH=CH₂ and CH₂CH₂), 4.83 (d, J = 15.4 Hz, 1H; NCH₂H₂CH₂OH), 4.77 (1 H, d, J = 15.4 Hz, 1H; NCH₂H₂OH), 3.90 (s, 1H; C≡CSi), 3.77 (s, 3H; OCH₃), 3.72 (s, 3H; OCH₃), 3.57 (dd, J = 14.9, 7.3 Hz, 1H; CH₂CHN), 2.55 (dd, J = 13.1, 8.3 Hz, 1H; CH₂H₂CHN), 1.85 (1 H, dd, J = 13.1, 8.1 Hz, 1H; CH₂H₂CHN), 0.84-0.80 (m, 21 H, Si(CH₃)₂Si); ¹³C NMR (100 MHz, CDCl₃): δ 179.2 (C=O), 159.8 (Ar-C), 158.9 (Ar-C), 143.4 (Ar-C), 139.4 (CHCH=CH₂), 131.6 (CH₂CH=CH₂), 128.6 (Ar-CH), 127.9 (Ar-C), 126.0 (Ar-C), 125.5 (Ar-CH), 119.6 (CH₂CH=CH₂), 117.5 (CHCH=CH₂), 114.1 (Ar-CH), 106.2 (Ar-CH), 103.0 (CHC≡CSi), 96.9 (Ar-CH), 87.4 (CH≡CSi), 63.6 (CH₂CHN), 62.6 (HC≡CSi), 55.4 (C-C=O), 55.2 (OCH₃), 55.0 (OCH₃), 50.9 (NCH₂CH=CH₂), 43.4 (NCH₂CH₂), 42.2 (CH₂CHN), 18.3 (3 × CH(CH₃)₂), 10.9 (3 × CH(CH₃)₂); IR (film): νmax 2941, 2863, 2172 (C≡C), 1716 (C=O), 1626, 1514, 1463, 1379, 1248, 1158, 1037, 995, 922 cm⁻¹; MS (ES+): m/z (%): 585 (100, [M + H]+); HRMS (ES+): m/z: calcd for C₃₆H₄₈N₂O₃Si: 585.3489 [M + H⁺]; found: 585.3507.

**rac-(2'S,5'S,3S)-1'-Benzy1-6-methoxy-2'-phenyl-1-propyl-5'-vinyl-1H-spiro[indole-3,3'-pyrrolidin]-2-one 25**

Using general procedure I, oxindole 14 (105 mg, 0.14 mmol) and SmI₂ (2.7 mL of a 0.1 M solution in THF, 0.3 mmol) in THF (4 mL), and a solution of imine (53 mg, 0.27 mmol) in THF (1 mL) gave the crude product as a 4:1 mixture of diastereoisomers (by ¹H NMR spectroscopy). Purification by FSPE eluting with
MeOH (100 mL) gave the non-fluorous crude product, then eluting with THF (100 mL) gave fluorous disulfide\(^9\) (45 mg, 0.05 mmol, 69%) as a white solid. Further purification of the non-fluorous crude product by flash column chromatography on silica gel eluting with 10% EtOAc in hexane gave 25 (43 mg, 0.10 mmol, 70%) as a 4:1 mixture of diastereoisomers (by \(^1\)H NMR spectroscopy) as a pale yellow oil. Recrystallisation from Et\(_2\)O-hexane (1:1) gave the major diastereoisomer as a white solid, m.p. (1:1 Et\(_2\)O-hexane) 117–120 °C; \(^1\)H NMR (400 MHz, CDCl\(_3\)): \(\delta\) 7.36 (d, \(J = 8.3\) Hz, 1H; Ar-CH), 7.27-7.19 (m, 3H; 3 × Ar-CH), 7.13-7.04 (m, 7H; 7 × Ar-CH), 6.45 (dd, \(J = 8.3, 2.3\) Hz, 1H; Ar-CH), 6.09 (d, \(J = 2.3\) Hz, 1H; Ar-CH), 5.94 (ddd, \(J = 17.1, 10.1, 8.3\) Hz, 1H; CH=CH\(_2\)), 5.25 (br d, \(J = 17.1\) Hz, 1H; CH=CH\(_2\)), 5.09 (ddd, \(J = 10.1, 1.2\) Hz, 1H; CH=CH\(_2\)), 4.11 (s, 1H; CH=CH\(_2\)), 3.94 (d, \(J = 14.2\) Hz, 1H; NCH\(_2\)H\(_2\)Ph), 3.74 (s, 3H; OCH\(_3\)), 3.70 (d, \(J = 14.2\) Hz, 1H; NCH\(_2\)H\(_2\)Ph), 3.66-3.60 (m, 2H; NCH\(_2\)H\(_2\)CH\(_2\) and CH\(_2\)CHN), 3.31 (ddd, \(J = 14.6, 8.1, 6.8\) Hz, 1H; NCH\(_2\)H\(_2\)CH\(_2\)), 2.61 (dd, \(J = 13.2, 9.6\) Hz, 1H; CH\(_3\)H\(_2\)CN), 1.85 (dd, \(J = 13.2, 6.8\) Hz, 1H; CH\(_3\)H\(_2\)CN), 1.56-1.42 (m, 2H; CH\(_2\)CH\(_3\)), 0.80 (t, \(J = 7.3\) Hz, 3H; CH\(_3\)); \(^{13}\)C NMR (100 MHz, CDCl\(_3\)): \(\delta\) 179.1 (C=O), 159.4 (Ar-C), 143.5 (Ar-C), 140.6 (CH=CH\(_2\)), 136.5 (Ar-C), 136.1 (Ar-C), 130.1 (Ar-CH), 128.4 (Ar-CH), 127.8 (Ar-CH), 127.4 (Ar-CH), 127.1 (Ar-CH), 126.9 (Ar-CH), 126.2 (Ar-CH), 124.9 (Ar-C), 116.2 (CH=CH\(_2\)), 105.1 (Ar-CH), 95.6 (Ar-CH), 75.3 (CHPh), 64.2 (CH\(_2\)CHN), 57.3 (C-C=O), 55.3 (OCH\(_3\)), 53.3 (NCH\(_2\)Ph), 41.6 (NCH\(_2\)CH\(_2\)), 41.2 (CH\(_2\)CHN), 20.7 (CH\(_2\)CH\(_3\)), 11.4 (CH\(_3\)); IR (film): \(\nu\) max 2966, 2930, 1711 (C=O), 1624, 1597, 1501, 1455, 1379, 1210, 1106 cm\(^{-1}\); MS (ES+): \(m/z\) (%): 475 (100, [M + Na]\(^+\)), 453 (70, [M + H]\(^+\)); HRMS (ES+): \(m/z\): calcld (%) for C\(_{30}\)H\(_{32}\)N\(_2\)O\(_2\): 453.2537 [M + H\(^+\)]; found: 453.2547.

\(\text{rac-}(2'R,5'S,3S)-1'\text{-Benzyl-2'-furan-2-yl-1-(4-methoxybenzyl)-5'-vinyl-1H-spiro[indole-3,3'-pyrrolidin]-2-one 26}\)
Using general procedure I, oxindole 12 (138 mg, 0.17 mmol) and SmI$_2$ (3.4 mL of a 0.1 M solution in THF, 0.34 mmol) in THF (4 mL), and a solution of imine (62 mg, 0.25 mmol) in THF (1 mL) gave the crude product as a 5:1 mixture of diastereoisomers (by $^1$H NMR spectroscopy). Purification by flash column chromatography on silica gel eluting with 20% Et$_2$O in petroleum ether gave 26 (56 mg, 0.11 mmol, 68%) as a 5:1 mixture of diastereoisomers (by $^1$H NMR spectroscopy) as a pale yellow oil. Further purification by slow crystallisation from ethanol gave the major diastereoisomer as a white solid, m.p. (EtOH) 138−140 °C; $^1$H NMR (500 MHz, CDCl$_3$): $\delta$7.46 (dd, $J = 7.7, 0.8$ Hz, 1H; Ar-CH), 7.28-7.25 (m, 2H; 2 × Ar-CH), 7.22-7.20 (m, 1H; Ar-CH), 7.17-7.15 (m, 2H; 2 × Ar-CH), 7.07-7.01 (m, 4H; 3 × Ar-CH and furyl-CH), 6.96 (td, $J = 7.7, 0.8$ Hz, 1H; Ar-CH), 6.78 (d, $J = 8.8$ Hz, 2H; 2 × Ar-CH), 6.52 (d, $J = 7.7$ Hz, 1H; Ar-CH), 6.04 (dd, $J = 3.2, 1.9$ Hz, 1H; furyl-CH), 5.91 (ddd, $J = 17.3, 10.1, 8.2$ Hz, 1H; CH=CH$_2$), 5.90 (d, $J = 3.2$ Hz, 1H; furyl-CH), 5.30 (dd, $J = 17.3, 1.0$ Hz, 1H; CH=CH$_A$H$_B$), 5.14 (dd, $J = 10.1, 1.6$ Hz, 1H; CH=CH$_A$H$_B$), 5.01 (d, $J = 15.6$ Hz, 1H; NCH$_A$H$_B$C$_6$H$_4$OCH$_3$), 4.58 (d, $J = 15.6$ Hz, 1H; NCH$_A$H$_B$C$_6$H$_4$OMe), 4.32 (s, 1H; CH$_2$C$_H$N), 3.94 (d, $J = 14.2$ Hz, 1H; NCH$_A$H$_B$Ph), 3.82 (d, $J = 14.2$ Hz, 1H; NCH$_A$H$_B$Ph), 3.77 (s, 3H; OCH$_3$), 3.68-3.63 (m, 1H; CH$_2$CHN), 2.59 (dd, $J = 13.3, 8.9$ Hz, 1H; CH$_A$H$_B$CHN), 1.99 (dd, $J = 13.3, 7.6$ Hz, 1H; CH$_A$H$_B$CHN); $^{13}$C NMR (125 MHz, CDCl$_3$): $\delta$ 178.7 (C=O), 158.8 (Ar-C), 151.3 (Ar-C), 142.1 (Ar-C), 141.4 (furyl-CH), 140.1 (CH=CH$_2$), 136.5 (Ar-C), 132.6 (Ar-C), 129.8 (Ar-CH), 128.2 (Ar-CH), 127.8 (Ar-CH), 127.7 (Ar-C), 127.6 (Ar-CH), 126.8 (Ar-CH), 125.2 (Ar-CH), 122.1 (Ar-CH), 117.0 (CH=CH$_2$), 113.9 (Ar-CH), 109.9 (furyl-CH), 108.8 (furyl-CH), 108.5 (Ar-CH), 69.3 (CH$_2$C$_H$N), 64.8 (CH$_2$CHN), 56.3 (C-C=O), 55.2 (OCH$_3$), 54.1 (NCH$_2$C$_6$H$_4$OMe), 41.8 (CH$_2$CHN); IR (film): $\nu_{\text{max}}$ 2924, 2835, 1712 (C=O), 1611, 1513, 1485, 1466, 1359, 1245, 1178, 1155, 1029, 1010, 920, 814, 736, 694 cm$^{-1}$; MS (ES+): $m/z$ (%): 513 (100, [M + Na]$^+$); HRMS (ES+): $m/z$: calcld for C$_{32}$H$_{30}$N$_2$O$_3$: 513.2149 [M + Na]$^+$; found: 513.2164.
rac-(1'S,3'S,8a'S)-1-Benzyl-6-methoxy-3'-vinyl-3',5',6',7',8',8a'-hexahydro-2'H-spiro[indoline-3,1'-indolizin]-2-one 27

Using general procedure I, oxindole 16 (134 mg, 0.16 mmol) and SmI₂ (3.3 mL of a 0.1 M solution in THF, 0.33 mmol) in THF (3 mL), and a solution of imine (41 mg, 0.33 mmol) in THF (0.5 mL) gave the crude product as a 5:1 mixture of diastereoisomers (by ¹H NMR spectroscopy). Purification by FSPE eluting with MeOH (100 mL) gave the non-fluorous crude product, then eluting with THF (100 mL) gave fluorous disulfide (52 mg, 0.05 mmol, 66%) as a white solid. Further purification of the non-fluorous crude product by flash column chromatography on silica gel eluting with 10% EtOAc in petroleum ether gave 27 (37 mg, 0.10 mmol, 58%) as a 5:1 mixture of diastereoisomers (by ¹H NMR spectroscopy) as a pale yellow oil. Further purification by flash column chromatography on silica gel eluting with 10% EtOAc in petroleum ether gave the major diastereoisomer as a pale yellow oil, ¹H NMR (400 MHz, CDCl₃): δ 7.35-7.23 (m, 6H; 6 × Ar-CH), 6.53 (dd, J = 8.3, 2.3 Hz, 1H; Ar-CH), 6.29 (d, J = 2.3 Hz, 1H; Ar-CH), 5.81 (ddd, J = 17.1, 9.9, 8.2 Hz, 1H; CH=CH₂), 5.25 (dd, J = 17.1, 1.8 Hz, 1H; CH=CH₂H₅B), 5.17 (ddd, J = 9.9, 1.8 Hz, 1H; CH=CH₂H₅B), 5.03 (d, J = 15.6 Hz, 1H; NCH₂H₅BPh), 4.75 (d, J = 15.6 Hz, 1H; NCH₂H₅BPh), 3.73 (s, 3H; OCH₃), 3.20-3.14 (m, 1H; NCH₂H₅CH₂), 3.04 (q, J = 8.2 Hz, 1H; NCHCH=CH₂), 2.63-2.57 (m, 2H; NCHCH₂H₅C and NCHCH₂CH₂), 1.92 (td, J = 12.1, 2.5 Hz, 1H; NCH₃H₅CH₂), 1.76 (dd, J = 13.4, 7.8 Hz, 1H; NCH₃H₅B), 1.66-1.57 (m, 2H; 2 × CH), 1.46-1.35 (m, 1H; CH), 1.26-1.10 (m, 2H; 2 × CH), 0.97-0.87 (m, 1H; CH); ¹³C NMR (100 MHz, CDCl₃): δ 180.2 (C=O), 159.5 (Ar-C), 143.4 (Ar-C), 139.7 (CH=CH₂), 136.0 (Ar-C), 128.8 (Ar-CH), 127.6 (Ar-CH), 127.2 (Ar-CH), 125.7 (Ar-C), 125.4 (Ar-CH), 117.1 (CH=CH₂), 105.9 (Ar-CH), 96.9 (Ar-CH), 72.2 (NCHCH₂CH₂), 68.6 (CHCH=CH₂), 55.4 (C-C=O and OCH₃), 51.9 (NCH₂CH₂), 43.9 (NCH₂Ph), 42.4 (CH₂C=C=O), 26.6 (CH₂), 25.0 (CH₂), 23.7 (CH₂); IR (film): v max 2937, 2852, 2790, 1707 (C=O), 1624, 1598, 1499, 1455, 1378, 1341, 1263, 1210, 1164, 1147, 1119, 1036, 922, 825, 732; MS (ES+): m/z
rans-(2'S,3S,5'S)-1'-Benzy1-5-bromo-2'-isopropyl-1-propyl-5'-vinylspiro[indoline-3,3'-pyrrolidin]-2-one 28

Using general procedure I, oxindole 11 (109 mg, 0.13 mmol) and SmI$_2$ (2.7 mL of a 0.1 M solution in THF, 0.27 mmol) in THF (2 mL), and a solution of imine (43 mg, 0.27 mmol) in THF (0.5 mL) gave the crude product as a 3:1:1 mixture of diastereoisomers (by $^1$H NMR spectroscopy). Purification by FSPE eluting with MeOH (100 mL) gave the non-fluorous crude product, then eluting with THF (100 mL) gave fluorous disulfide (38 mg, 0.04 mmol, 60%) as a white solid. Further purification of the non-fluorous crude product by flash column chromatography on silica gel eluting with 20% Et$_2$O in petroleum ether gave 28 (37 mg, 0.08 mmol, 60%, 3:1:1 mixture of diastereoisomers) as a yellow solid. Recrystallisation from Et$_2$O gave the major diastereoisomer, m.p. 128-130 °C; $^1$H NMR (400 MHz, CDCl$_3$): $\delta$ 7.72 (d, J = 2.0 Hz, 1H; Ar-CH), 7.38-7.30 (m, 5H; 5 × Ar-CH), 7.28-7.21 (m, 1H; Ar-CH), 6.71 (d, J = 8.3 Hz, 1H; Ar-CH), 5.76 (ddd, J = 17.2, 10.1, 7.8 Hz, 1H; CH=CH$_2$), 5.06 (br dd, J = 17.2, 1.5 Hz, 1H; CH=CH$_2$A$_BH$B), 4.93 (br dd, J = 10.1, 1.5 Hz, 1H; CH=CH$_2$A$_BH$B), 3.94 (d, J = 14.4 Hz, 1H; NCH$_2$A$_BH$BPh), 3.82 (d, J = 14.4 Hz, 1H; NCH$_2$A$_BH$BPh), 3.71 (dt, J = 14.1, 6.8 Hz, 1H, NCH$_2$A$_BH$BCH$_2$), 3.57 (dt, J = 14.1, 7.1 Hz, 1H, NCH$_2$A$_BH$BCH$_2$), 3.54-3.48 (m, 1H; CH$_2$CHN), 3.14 (d, J = 5.0 Hz, 1H; NCH$_2$CH(CH$_3$)$_2$), 2.44 (dd, J = 13.1, 9.3 Hz, 1H; CH$_2$A$_BH$BCHN), 2.05-1.96 (m, 1H; CH(CH$_3$)$_2$), 1.75-1.63 (m, 3H; CH$_2$A$_BH$BCHN and CH$_2$CH$_3$), 0.96 (t, J = 7.3 Hz, 3H; CH$_2$CH$_3$), 0.77 (d, J = 6.8 Hz, 3H; CH(CH$_3$)$_2$A$_BH$B), 0.48 (d, J = 7.0 Hz, 3H; CH(CH$_3$)$_2$A$_BH$B); $^{13}$C NMR (100 MHz, CDCl$_3$): $\delta$ 179.4 (C=O), 141.6 (Ar-C), 140.9 (CH=CH$_2$), 139.1 (Ar-C), 135.9 (Ar-C), 130.2 (Ar-CH), 129.9 (Ar-CH), 129.2 (Ar-
CH), 128.0 (Ar-CH), 126.7 (Ar-CH), 115.8 (CH=CH₂), 114.4 (Ar-C), 109.4 (Ar-CH), 76.4 (NCHCH(CH₃)₂), 66.6 (CH₂CHN), 56.4 (CH₂Ph), 55.5 (C-C=O), 43.9 (CH₂CHN), 41.8 (NCH₂CH₂CH₃), 29.1 (CHCH(CH₃)₂), 20.5 (CH₂CH₃), 19.5 (CH(CH₃)₂), 18.8 (CH(CH₃)₂), 11.4 (CH₂CH₃); IR (film): νₘₐₓ 2965, 2929, 1698 (C=O), 1601, 1606, 1478, 1424, 1346, 1217, 1199, 1176, 1107, 917, 826, 704 cm⁻¹; MS (ES+): m/z (%): 491 (80, [⁸¹BrM + Na]+), 489 (100, [⁷⁹BrM + Na]+); HRMS (ES+): m/z: calcd for C₂₈H₃₁N₂O⁷⁹Br: 489.1512 [M + Na⁺]; found: 489.1510.

**rac-(2'S,5'S,3'S)-1'Benzyl-6-methoxy-2'-phenyl-5'-vinyl-1H-spiro[indole-3,3'-pyrrolidin]-2-one 29**

Using general procedure I, oxindole 10 (252 mg, 0.35 mmol) and SmI₂ (6.9 mL of a 0.1 M solution in THF, 0.69 mmol) in THF (6 mL), and a solution of imine (135 mg, 0.69 mmol) in THF (1 mL) gave the crude product as a 4:1 mixture of diastereoisomers (by ¹H NMR spectroscopy). Purification by flash column chromatography on silica gel eluting with 30% EtOAc in petroleum ether gave 29 (109 mg, 0.27 mmol, 76%) as a 4:1 mixture of diastereoisomers (by ¹H NMR spectroscopy) as a pale yellow oil. Recrystallisation from EtOAc-hexane (1:1) gave the major diastereoisomer as an off-white solid, m.p. (Et₂O) 137-140 °C; ¹H NMR (400 MHz, CDCl₃): δ 7.31 (d, J = 8.3 Hz, 1H; Ar-CH), 7.25-7.20 (m, 3H; Ar-CH), 7.19-7.12 (m, 3H; 3 × Ar-CH), 7.10-7.05 (m, 5H; 4 × Ar-CH and NH), 6.46 (dd, J = 8.3, 2.3 Hz, 1H; Ar-CH), 6.13 (d, J = 2.3 Hz, 1H; Ar-CH), 5.93 (ddd, J = 17.3, 10.2, 8.2 Hz, 1H; CH=CH₂), 5.26 (dd, J = 17.3, 1.0 Hz, 1H; CH=CH₃), 5.11 (dd, J = 10.2, 1.0 Hz, 1H; CH=CH₂), 4.10 (s, 1H; CHPh), 3.94 (d, J = 14.3 Hz, 1H; NCH₃), 3.705 (s, 3H; OCH₃), 3.702 (d, J = 14.3 Hz, 1H; NCH₃), 3.66-3.59 (m, 1H; CHCH=CH₂), 2.61 (dd, J = 13.4, 9.3 Hz, 1H; CH₃), 1.189 (dd, J = 13.4, 7.1 Hz, 1H; CH₃); ¹³C NMR (100 MHz, CDCl₃): δ 181.4 (C=O), 159.4 (Ar-C), 140.6 (Ar-C), 140.5 (CH=CH₂), 136.6 (Ar-C), 136.0 (Ar-C), 130.1 (2 ×
Ar-CH), 128.4 (2 × Ar-CH), 127.8 (2 × Ar-CH), 127.5 (2 × Ar-CH), 127.2 (Ar-CH), 126.9 (Ar-CH), 126.6 (Ar-CH), 125.0 (Ar-C), 116.4 (CH=CH), 106.7 (Ar-CH), 96.1 (Ar-CH), 75.2 (CHPh), 64.2 (CHCH=CH2), 57.8 (C-C=O), 55.3 (OCH3), 53.3 (NCH2Ph), 41.5 (CH2CHN); IR (film): νmax 3220 (NH), 2923, 2835, 1705 (C=O), 1639, 1617, 1584, 1501, 1453, 1335, 1305, 1277, 1191, 1152, 1119, 1108, 1024, 920, 823, 749, 698; MS (ES-): m/z (%): 409 (100, [M – H]+); HRMS (ES-): m/z: calcd for C27H25N2O2: 409.1921 [M – H]+; found: 409.1916.

rac-(2'S,3S,5'S)-1'-Benzyl-6-methoxy-2'-(pyridin-3-yl)-5'-vinylspiro[indoline-3,3'-pyrrolidin]-2-one 30

Using general procedure I, oxindole 10 (87 mg, 0.12 mmol) and SmI2 (2.4 mL of a 0.1 M solution in THF, 0.24 mmol) in THF (2 mL), and a solution of imine (47 mg, 0.24 mmol) in THF (0.5 mL) gave the crude product as a 5:1 mixture of diastereoisomers (by 1H NMR spectroscopy). Purification by FSPE eluting with MeOH (100 mL) gave the non-fluorous crude product, then eluting with THF (100 mL) gave fluorous disulfide (41 mg, 0.04 mmol, 72%) as a white solid. Further purification of the non-fluorous crude product by flash column chromatography on silica gel eluting with EtOAc gave 30 (34 mg, 0.08 mmol, 69%) as a 5:1 mixture of diastereoisomers (by 1H NMR spectroscopy) as a yellow oil. Further purification by flash column chromatography on silica gel eluting with EtOAc gave the major diastereoisomer as a yellow oil. 1H NMR (400 MHz, CDCl3): δ 8.36-8.29 (m, 3H; 2 × pyridyl-CH and NH), 7.41 (d, J = 5.0 Hz, 1H; pyridyl-CH), 7.24-7.18 (m, 4H; 4 × Ar-CH), 7.03-7.01 (m, 2H; 2 × Ar-CH), 6.97 (dd, J = 7.6, 5.0 Hz, 1H; pyridyl-CH), 6.44 (dd, J = 8.3, 2.3 Hz, 1H; Ar-CH), 6.15 (d, J = 2.3 Hz, 1H; Ar-CH), 5.96 (ddd, J = 17.3, 10.1, 8.0 Hz, 1H; CH=CH2), 5.31 (dd, J = 17.3, 0.9 Hz, 1H; CH=CH2), 5.17 (dd, J = 10.1, 0.9 Hz, 1H; CH=CH2), 4.12 (s, 1H; CH-pyridyl), 3.86 (d, J = 14.2 Hz, 1H; NCH3), 3.73 (d, J = 14.2 Hz, 1H; NCH3), 3.69 (s, 3H; OCH3), 3.71-3.65 (m, 1H; NCH=CH2), 2.63 (dd, J = 13.4, 9.1 Hz, 1H; CH2NHCH3), 1.93
(dd, J = 13.4, 7.0 Hz, 1H; CH₃H₂CHN); ¹³C NMR (100 MHz, CDCl₃): δ 181.0 (C=O), 159.6 (Ar-C), 149.5 (pyridyl-CH), 148.5 (pyridyl-CH), 140.9 (Ar-C), 140.0 (CH=CH₂), 136.0 (pyridyl-CH), 135.7 (Ar-C), 132.7 (Ar-C), 129.9 (Ar-CH), 128.0 (Ar-CH), 127.1 (Ar-CH), 126.3 (Ar-CH), 124.1 (Ar-C), 122.5 (pyridyl-CH), 117.0 (CH=CH₂), 106.7 (Ar-CH), 96.5 (Ar-CH), 73.1 (CH-pyridyl), 64.6 (NCH₂CH=CH₂), 57.8 (C-C=O), 55.3 (OCH₃), 53.6 (NCH₂Ph), 41.1 (CH₂CHN); IR (film): ν max 3204 (NH), 2924, 2834, 1697 (C=O), 1632, 1594, 1502, 1345, 1315, 1262, 1150, 1122, 1074, 1023, 923; MS (ES+): m/z (%): 434 (100, [M + Na]⁺); HRMS (ES+): m/z: calcd for C₃₀H₂₅N₃O₂: 434.1839 [M + H]⁺; found: 434.1834.

**Benzylidene-[4-(3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,10-heptadecafluorodecyl)-benzyl]-amine**

Benzaldehyde (0.09 mL, 0.90 mmol, 1.0 eq) and MgSO₄ (excess) were added to a solution of 4-(3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,10-heptadecafluorodecyl)-benzylamine (500 mg, 0.90 mmol, 1.0 eq) in CH₂Cl₂ (5.00 mL). The resulting mixture was stirred for 18 h, then filtered through Celite. Evaporation of the filtrate gave benzylidene-[4-(3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,10-heptadecafluorodecyl)-benzyl]-amine (296 mg, 0.46 mmol, 51%) as a white powder, m.p. 95-97 °C (MeOH); ¹H NMR (400 MHz, CDCl₃): 8.41 (s, 1H; CH=N), 7.31-7.82 (m, 2H; 2 × Ar-CH), 7.40-7.47 (m, 3H; 3 × Ar-CH), 7.31 (d, J = 8.1 Hz, 2H; 2 × Ar-CH), 7.21 (d, J = 8.1 Hz, 2H; 2 × Ar-CH), 4.82 (s, 2H; NCH₂), 2.88-2.95 (m, 2H; CH₂CH₂C₈F₁₇), 2.28-2.45 (m, 2H; CH₂C₈F₁₇); ¹³C NMR (400 MHz, CDCl₃): δ 162.0 (CH=N), 137.8 (2 × Ar-C), 136.1 (Ar-C), 130.8 (Ar-CH), 128.6 (Ar-CH), 128.45 (Ar-CH), 128.43 (Ar-CH), 128.3 (Ar-CH), 64.7 (NCH₂), 33.0 (t, J = 21.2 Hz; CH₂C₈F₁₇), 26.1 (t, J = 4.2 Hz; CH₂CH₂C₈F₁₇); IR (film): ν 2917, 2848, 1640 (C=O), 1371, 1332, 1198, 1144, 1114, 1085, 955, 825, 703, 655; MS (ES+): m/z (%): 642 (100, [M + H]⁺); HRMS (ES+): m/z: calcd for C₂₂H₁₇NF₁₇: 642.1084 [M + H]⁺; found: 642.1079.
rac-(2'S,3S,5'S)-1'-(4-(3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10-Heptafluorodecyl)benzyl-6-methoxy-2'-phenyl-5'-vinylspiro[indoline-3,3'-pyrrolidin]-2-one 41

Using general procedure I, oxindole 10 (109 mg, 0.15 mmol) and SmI₂ (3.0 mL of a 0.1 M solution in THF, 0.30 mmol) in THF (4 mL), and imine (115 mg, 0.18 mmol) gave the crude product as a 4:1 mixture of diastereoisomers (by ¹H NMR spectroscopy). Purification by FSPE eluting with 60% aqueous MeCN gave the non-fluorous reaction components, then elution with MeOH (100 mL) gave spirooxindole 41 (87 mg, 0.10 mmol, 68%) as a 4:1 mixture of diastereoisomers (by ¹H NMR spectroscopy) as a pale yellow solid, then eluting with THF (100 mL) gave fluorous disulfide (60 mg, 0.06 mmol, 84%) as an off-white solid. Further purification of the fluorous fraction by flash column chromatography on silica gel eluting with 3% acetone in CHCl₃ allowed separation of the diastereoisomers. 41 (major diastereoisomer): m.p. (Et₂O) 131-134 °C; ¹H NMR (400 MHz, CDCl₃): δ 7.81 (s, 1H; NH), 7.30 (d, J = 8.3 Hz, 1H; Ar-CH), 7.40-7.00 (m, 7H; Ar-CH), 6.99 (d, J = 8.0 Hz, 2H; 2 × Ar-CH), 6.46 (dd, J = 8.3, 2.4 Hz, 1H; Ar-CH), 6.16 (d, J = 2.4 Hz, 1H; Ar-CH), 5.95 (ddd, J = 17.2, 10.1, 8.3 Hz, 1H; CH=CH₂), 5.29 (dd, J = 17.2, 1.1 Hz, 1H; CH=CH₂), 5.15 (dd, J = 10.1, 1.1 Hz, 1H; CH=CH₂), 4.08 (s, 1H; CHPh), 3.91 (d, J = 14.1 Hz, 1H; NCH₃H₅Ar), 3.72 (d, J = 14.1 Hz, 1H; NCH₃H₅Ar), 3.70 (s, 3H; OCH₃), 3.65-3.59 (m, 1H; CHCH=CH₂), 2.90-2.86 (m, 2H; CH₂S), 2.60 (dd, J = 13.4, 9.6 Hz, 1H; CH₃H₅CHN), 2.40-2.30 (m, 2H; CH₂C₈F₁₇), 1.89 (dd, J = 13.4, 7.0 Hz, 1H; CH₃H₅CHN); ¹³C NMR (100 MHz, CDCl₃): δ 181.5 (C=O), 159.4 (Ar-C), 140.6 (CH=CH₂), 140.4 (Ar-C), 137.7 (Ar-C), 136.5 (Ar-C), 134.1 (Ar-C), 130.6 (Ar-C), 128.4 (Ar-CH), 127.8 (Ar-CH), 127.5 (Ar-CH), 127.2 (Ar-CH), 126.6 (Ar-CH), 124.9 (Ar-C), 116.6 (CH=CH₂), 106.7 (Ar-CH), 96.2 (Ar-CH), 74.9 (CHPh), 63.8 (CHCH=CH₂), 57.9 (C-C=O), 55.3 (OCH₃), 52.5 (NCH₃Ar), 41.3 (CH₂CHN), 33.0 (t, J = 22.2 Hz; CH₂C₈F₁₇), 26.0 (t, J = 3.7 Hz; CH₂S); IR (film): vₘₐₓ 3200 (NH), 3016, 2959, 2937, 1714 (C=O), 1624, 1505, 1455, 1237, 1199, 1146, 12113, 984.
835, 802, 701; MS (ES+): m/z (%): 879 (100, [M + Na]+), 857 (20, [M + H]+); HRMS (ES+): m/z: calcd for C_{37}H_{29}N_{2}O_{2}: 857.2031 [M + Na]+; found: 857.2031.
Reduction of fluorous disulfide to fluorous thiol:

In all tag-removal cyclisation reactions to form spirooxindoles, FSPE can be used to isolate fluorous disulfide for recycling.

\[
\text{C}_8\text{F}_{17} \text{S-S-C}_8\text{F}_{17} \xrightarrow{n-\text{Bu}_3\text{P}, \text{H}_2\text{O}, \text{THF}} \text{C}_8\text{F}_{17} \text{-SH}
\]

A solution of water (0.57 mL of a 1.0 M solution in THF, 0.57 mmol) and \(n-\text{Bu}_3\text{P}\) (141 \(\mu\)L, 0.57 mmol) were added sequentially to a stirred solution of disulfide\(^9\) (500 mg, 0.52 mmol) in THF (15 mL) at room temperature under nitrogen. The resulting solution was stirred at room temperature for 9 h, then evaporated under reduced pressure to give the crude product. Purification by Kugelrohr distillation (bp 60-70 °C, 10 mm Hg) gave fluorous thiol\(^9\) (349 mg, 0.73 mmol, 70%) as a colorless oil.

Use of recycled fluorous thiol in a Pummerer reaction:

\[
\begin{align*}
\text{MeO-} & \text{N-} \text{O-} \text{OH} \\
\text{i)} \text{Swern oxidation} & \rightarrow \text{SR}^\text{F} \\
\text{ii)} \text{R}^\text{F}-\text{SH (recycled)} & \text{then TFAA} \\
\end{align*}
\]

Using general procedure D, hydroxyamide \(\text{S7}\) (289 mg, 1.29 mmol) was oxidized to the corresponding glyoxamide. Using general procedure F, the crude glyoxamide, recycled fluorous thiol (621 mg, 1.29 mmol) and TFAA (360 \(\mu\)L, 2.59 mmol) in \(\text{CH}_2\text{Cl}_2\) (10 mL) gave the crude product. Purification by FSPE eluting with 60% MeCN in water gave the non-fluorous components of the mixture, then elution with MeCN gave oxindoles \(\text{17}\) (688 mg, 1.01 mmol, 78%) as a 5:1 mixture of regioisomers (by \(^1\)H NMR spectroscopy) as a pale brown oil.
rac-(2’S,5’S,35)-1’-Benzy1-6-methoxy-2-oxo-2’-phenyl-1-propyl-1,2-
dihydropirido[ndole-3,3’-pyrrolidine]-5’-carbaldehyde 31

Using general procedure J, OsO₄ (207 µL of a 2.5% w/v solution in tert-butanol, 20.3 µmol), NMO (71 mg, 0.6 mmol) and spirooxindole 25 (92 mg, 0.20 mmol) in acetone (12 mL) and water (1.5 mL), then NaIO₄ (61 mg, 0.29 mmol) in THF (10 mL) and water (2 mL) gave the crude product. Purification by flash column chromatography on silica gel eluting with 20% EtOAc in petroleum ether gave aldehyde 31 (80 mg, 0.18 mmol, 87% over two steps) as a white solid, m.p. (Et₂O) 148-151 °C; ^1H NMR (400 MHz, CDCl₃): δ 9.22 (d, J = 1.8 Hz, 1H; CHO), 7.30-7.17 (m, 7H; 7 × Ar-CH), 7.13 (d, J = 8.3 Hz, 1H; Ar-CH), 7.08-7.03 (m, 3H; 3 × Ar-CH), 6.38 (dd, J = 8.3, 2.2 Hz, 1H; Ar-CH), 6.06 (d, J = 2.2 Hz, 1H; Ar-CH), 4.27 (s, 1H; CHPh), 4.02 (d, J = 12.7 Hz, 1H; NCH₂H₂Ph), 3.67 (OCH₃), 3.63-3.56 (m, 2H; CH₂CHN and NCH₂H₂Ph), 3.31 (d, J = 12.7 Hz, 1H; NCH₂H₂Ph), 3.32-3.25 (m, 1H; NCH₂H₂Ph), 2.71 (dd, J = 13.8, 11.4 Hz, 1H; CH₂H₂CHN), 1.97 (dd, J = 13.8, 5.6 Hz, 1H; CH₂H₂CHN), 1.51-1.38 (m, 2H; CH₂CH₃), 0.74 (t, J = 7.3 Hz, 3H; CH₃); ^13C NMR (100 MHz, CDCl₃): δ 201.7 (C=O), 177.8 (C=O), 159.8 (Ar-C), 143.6 (Ar-C), 137.0 (Ar-C), 135.9 (Ar-C), 130.0 (Ar-CH), 128.6 (Ar-CH), 128.0 (Ar-CH), 127.9 (Ar-CH), 127.74 (Ar-CH), 127.71 (Ar-CH), 125.8 (Ar-CH), 123.0 (Ar-C), 105.4 (Ar-CH), 96.1 (Ar-CH), 76.8 (CH₂Ph), 70.3 (CH₂CHN), 57.8 (NCH₂Ph), 57.3 (C-C=O), 55.4 (OCH₃), 41.7 (NCH₂CH₃), 36.3 (CH₂CHN), 20.7 (CH₂CH₃), 11.4 (CH₃); IR (film): νₘₐₓ 2961, 2934, 1726 (C=O), 1713 (C=O), 1624, 1600, 1503, 1455, 1379, 1210, 1107 cm⁻¹; MS (ES+): m/z (%): 477 (100, [M + Na]⁺); HRMS (ES+): m/z: calcd (%) for C₂₉H₃₀N₂O₃: 477.2149 [M + Na⁺]; found: 477.2161.
rac-(2'S,5'S,3S)-1'-Benzy1-6-methoxy-2-oxo-2'-phenyl-1,2-dihydrospiro[indole-3,3'pyrrolidine]-5'-carbaldehyde 32

OsO₄ (0.27 mL of a 2.5% w/v solution in tert-butanol, 0.03 mmol) and NMO (95 mg, 0.81 mmol) were added to a stirred suspension of spirooxindole 29 (110 mg, 0.27 mmol) in acetone (9 mL) and water (1.5 mL) at room temperature under nitrogen. The resulting suspension was stirred at room temperature for 48 h, then a saturated aqueous solution of Na₂S₂O₃ (10 mL) and CH₂Cl₂ (10 mL) were added. The layers were separated, and the aqueous layer was extracted with CH₂Cl₂ (2 × 15 mL). The combined organic layers were dried (Na₂SO₄) and evaporated under reduced pressure to give the crude diol product. The crude product was dissolved in EtOAc (6.8 mL), Pb(OAc)₄ (180 mg, 0.41 mmol) was added and the resulting suspension was stirred at room temperature for 15 min. The resulting mixture was filtered through a short silica plug, washing with EtOAc. The filtrate was evaporated under reduced pressure to give aldehyde 32 (100 mg, 0.24 mmol, 94% over two steps) as a white foam; ¹H NMR (500 MHz, CDCl₃): δ 9.29 (d, J = 3.5 Hz, 1H; CHO), 7.64 (s, 1H; NH), 7.38-7.28 (m, 7H; 7 × ArCH), 7.19-7.11 (m, 4H; 4 × ArCH), 6.46 (dd, J = 8.2, 2.3 Hz, 1H; ArCH), 6.20 (d, J = 2.3 Hz, 1H; ArCH), 4.34 (s, 1H; CHPh), 4.10 (d, J = 12.7 Hz, 1H; CH₃H₅Ph), 3.71 (s, 3H; OCH₃), 3.66 (ddd, J = 10.9, 5.4, 3.5 Hz, 1H; CHCHO), 3.40 (d, J = 12.7 Hz, 1H; CH₃H₅Ph), 2.78 (dd, J = 13.7, 10.9 Hz, 1H; CH₃H₅CHN), 2.10 (dd, J = 13.7, 5.4 Hz, 1H; CH₃H₅CHN); ¹³C NMR (100 MHz, CDCl₃): δ 201.5 (C=O), 179.9 (C=O), 159.8 (Ar-C), 140.7 (Ar-C), 136.8 (Ar-C), 136.0 (Ar-C), 130.0 (2 × Ar-CH), 128.6 (3 × Ar-CH), 128.1 (Ar-CH), 128.0 (Ar-CH), 127.9 (2 × Ar-CH), 127.8 (Ar-CH), 126.2 (Ar-CH), 123.1 (Ar-C), 106.9 (Ar-CH), 96.7 (Ar-CH), 76.6 (CHPh), 70.3 (CHCHO), 57.9 (C=C=O), 57.8 (PhCH₂), 55.3 (OCH₃), 36.4 (CH₂CHN); IR (film): νmax 3238 (NH), 2928, 2825, 1722 (2 × C=O), 1629, 1596, 1501, 1453, 1342, 1307, 1272, 1191, 1154, 1122, 1027, 825, 753, 698; MS (ES−): m/z (%): 411 (100, [M − H]+); HRMS (ES+): m/z: calcd for C₂₆H₂₅N₂O₃: 413.1860 [M + H⁺]; found: 413.1877.
Using general procedure K, oxidant solution (1.60 mL), aldehyde 31 (77 mg, 0.17 mmol) in tert-butanol (4 mL), MeCN (4 mL) and 2-methyl-2-butene (2 mL) then trimethylsilyldiazomethane (1.50 mL of a 2.0 M solution in hexanes, 3.00 mmol) in anhydrous MeOH (8 mL) gave the crude product. Purification by flash column chromatography on silica gel eluting with 20% EtOAc in petroleum ether gave methyl ester 33 (66 mg, 0.14 mmol, 80%) as a white solid, m.p. (Et2O) 116-118 °C; 1H NMR (500 MHz, CDCl3): δ 7.77 (d, J = 8.3 Hz, 1H; Ar-CH), 7.32-7.22 (m, 7H; 7 × Ar-CH), 7.10-7.08 (m, 3H; 3 × Ar-CH), 6.51 (dd, J = 2.5, 8.3 Hz, 1H; Ar-CH), 6.09 (d, J = 2.5 Hz, 1H; Ar-CH), 4.19 (s, 1H; CHPh), 4.04 (d, J = 13.6 Hz, 1H; NCH₂H₂Ph), 3.77 (dd, J = 11.1, 5.6 Hz, 1H; NCH₂CO₂CH₃), 3.75 (s, 3H; OCH₃), 3.64 (ddd, J = 14.5, 8.5, 6.3 Hz, 1H; NCH₂H₂CH₂), 3.51 (d, J = 13.6 Hz, 1H; NCH₂H₂Ph), 3.45 (s, 3H; OCH₃), 3.31 (ddd, J = 14.5, 8.2, 6.6 Hz, 1H; NCH₂H₂CH₂), 2.80 (dd, J = 13.5, 11.1 Hz, 1H; CH₂H₂CHN), 2.13 (dd, J = 13.5, 5.6 Hz, 1H; CH₂H₂CHN), 1.54-1.44 (m, 2H; CH₂CH₃), 0.79 (t, J = 7.3 Hz, 3H; CH₃); 13C NMR (125 MHz, CDCl₃): δ 178.1 (C=O), 174.1 (C=O), 159.7 (Ar-C), 143.4 (Ar-C), 136.1 (Ar-C), 135.8 (Ar-C), 130.0 (Ar-CH), 128.3 (Ar-CH), 128.0 (Ar-CH), 127.5 (Ar-CH), 127.3 (Ar-CH), 127.2 (Ar-CH), 123.5 (Ar-C), 105.4 (Ar-CH), 95.7 (Ar-CH), 76.3 (CHPh), 63.3 (NCH₂CO₂Me), 57.4 (C-C=O), 56.2 (NCH₂Ph), 55.3 (OCH₃), 51.6 (OCH₃), 41.7 (NCH₂CH₂), 38.2 (CH₂CHN), 20.7 (CH₂CH₃), 11.4 (CH₃); IR (film): v_max 2951, 2930, 1747 (C=O), 1711 (C=O), 1624, 1504, 1435, 1382, 1367, 1209, 1173, 1106 cm⁻¹; MS (ES+): m/z (%): 507 (100, [M + Na]+); HRMS (ES+): m/z: calcd for C₃₀H₃₂N₂O₄: 507.2254 [M + Na⁺]; found: 507.2262.
rac-(2'S,5'S,3S)-1'-Benzy1-6-methoxy-2-oxo-2'-phenyl-1,2-dihydrospiro[indole-3,3'-pyrrolidine]-5'-carboxylic acid methyl ester 34

Using general procedure K, oxidant solution (2.4 mL), aldehyde 32 (100 mg, 0.24 mmol) in tert-butanol (10.4 mL), MeCN (10.4 mL) and 2-methyl-2-butene (5.2 mL) then trimethylsilyldiazomethane (2.1 mL of a 2.0 M solution in hexanes, 4.20 mmol) in anhydrous MeOH (14.9 mL) gave the crude product. Purification by flash column chromatography on silica gel eluting with 40% EtOAc in petroleum ether gave methyl ester 34 (85 mg, 0.13 mmol, 80%) as a white solid, m.p. (EtOAc/hexane) 172-175 °C; ¹H NMR (500 MHz, CDCl₃): δ 7.79 (s, 1H; NH), 7.72 (d, J = 8.5 Hz, 1H; ArCH), 7.33-7.22 (m, 7H; 7 × ArCH), 7.13-7.10 (m, 3H; 3 × ArCH), 6.52 (dd, J = 8.5, 2.4 Hz, 1H; ArCH), 6.16 (d, J = 2.4 Hz, 1H; ArCH), 4.19 (s, 1H; CHPh), 4.04 (d, J = 13.6 Hz, 1H; NCH₆H₂Ph), 3.77-3.74 (m, 1H; CHCO₂CH₃), 3.71 (s, 3H; OCH₃), 3.51 (d, J = 13.6 Hz, 1H; NCH₆H₂Ph), 3.46 (s, 3H; OCH₃), 2.80 (dd, J = 13.4, 10.9 Hz, 1H; CH₂H₆CHN), 2.18 (dd, J = 13.4, 6.2 Hz, 1H; CH₃H₆CHN); ¹³C NMR (100 MHz, CDCl₃): δ 180.3 (C=O), 174.0 (C=O), 159.6 (Ar-C), 140.5 (Ar-C), 136.8 (Ar-C), 135.9 (Ar-C), 130.0 (Ar-CH), 129.5 (Ar-CH), 128.5 (Ar-CH), 128.3 (Ar-CH), 128.2 (Ar-CH), 128.0 (2 × Ar-CH), 127.7 (Ar-CH), 127.65 (Ar-CH), 127.63 (Ar-CH), 127.3 (Ar-CH), 123.6 (Ar-C), 106.9 (Ar-CH), 96.2 (Ar-CH), 76.1 (CHPh), 63.2 (CHCO₂CH₃), 57.9 (C-C=O), 56.1 (NCH₂Ph), 55.4 (OCH₃), 51.7 (OCH₃), 38.4 (CH₂CHN); IR (film): ν 3243 (NH), 3030, 2941, 2830, 1708 (C=O), 1624 (C=O), 1596, 1453, 1342, 1240, 1200, 1149, 1024, 1110, 1027, 827, 751, 700, 668; MS (ES+): m/z (%): 465 (100, [M + Na]⁺); HRMS (ES+): m/z: calcd for C₂₅H₂₆N₂O₄: 465.1785 [M + Na]⁺; found: 465.1779.

rac-(2'S,5'S,3S)-6-Methoxy-2-oxo-2'-phenyl-1-propyl-1,2-dihydrospiro[indole-3,3'-pyrrolidine]-5'-carboxylic acid methyl ester 35

S 51
Using general procedure L, N-benzyl amine 33 (38 mg, 0.08 mmol) and Pd(OH)$_2$ (8 mg, 20% wt.) in a 0.05 M solution of HCl in MeOH (8 mL) gave amine 35 (30 mg, 0.08 mmol, 97%) as a white solid, m.p. (Et$_2$O) 66-69 °C; $^1$H NMR (400 MHz, CDCl$_3$): $\delta$ 7.17 (d, $J = 8.3$ Hz, 1H; Ar-CH), 7.12-7.06 (m, 5H; 5 × Ar-CH), 6.41 (dd, $J =$ 8.3, 2.3 Hz, 1H; Ar-CH), 6.15 (d, $J = 2.3$ Hz, 1H; Ar-CH), 4.68 (s, 1H; CHPh), 4.43 (dd, $J =$ 10.6, 5.8 Hz, 1H; NCHCO$_2$CH$_3$), 3.85 (s, 3H; OCH$_3$), 3.72 (s, 3H; OCH$_3$), 3.68 (ddd, $J =$ 14.5, 8.3, 6.3 Hz, 1H; NCH$_A$H$_B$CH$_2$), 3.41 (ddd, $J =$ 14.5, 8.1, 6.8 Hz, 1H; NCH$_A$H$_B$CH$_2$), 2.31 (br s, 1H; NH), 2.95 (dd, $J =$ 13.5, 10.6 Hz, 1H; CH$_A$H$_B$CH), 2.33 (dd, $J =$ 13.5, 5.8 Hz, 1H; CH$_A$H$_B$CHN), 1.62-1.48 (m, 2H; CH$_2$CH$_3$), 0.85 (t, $J =$ 7.3 Hz, 3H; CH$_3$); $^{13}$C NMR (100 MHz, CDCl$_3$): $\delta$ 178.0 (C=O), 173.9 (C=O), 159.7 (Ar-C), 143.5 (Ar-C), 136.1 (Ar-C), 127.6 (Ar-CH), 126.6 (Ar-CH), 125.7 (Ar-CH), 122.8 (Ar-C), 105.5 (Ar-CH), 96.1 (Ar-CH), 71.2 (CHPh), 58.0 (C=C=O), 57.4 (NCHCO$_2$CH$_3$), 55.3 (OCH$_3$), 52.5 (OCH$_3$), 41.8 (CH$_2$N), 40.2 (CH$_2$CHN), 20.7 (CH$_2$CH$_3$), 11.4 (CH$_3$); IR (neat): $\nu_{max}$ 3337 (NH), 2956, 2933, 1739 (C=O), 1701 (C=O), 1625, 1599, 1500, 1380, 1204, 1175, 1097, 1013 cm$^{-1}$; MS (ES+): m/z (%): 395 (100, [M + H]$^+$); HRMS (ES+): m/z: calcd for C$_{23}$H$_{26}$N$_2$O$_4$: 395.1965 [M + Na$^+$]; found: 395.1978.

$rac$-(2'S,5'S,3S)-6-Methoxy-2-oxo-2'-phenyl-1,2-dihydro-spiro[indole-3,3'-pyrrololine]-5'-carboxylic acid methyl ester 36
Using general procedure L, N-benzyl amine 34 (70 mg, 0.16 mmol) and Pd(OH)$_2$ (14 mg, 20% wt.) in a 0.05 M solution of HCl in MeOH (4.6 mL) gave amine 36 (41 mg, 0.25 mmol, 74%) as a white foam; $^1$H NMR (400 MHz, CDCl$_3$): $\delta$ 7.85 (s, 1H; NH), 7.18-7.07 (m, 6H; 6 $\times$ Ar-CH), 6.41 (dd, $J$ = 8.3, 2.4 Hz, 1H; Ar-CH), 6.19 (d, $J$ = 2.4 Hz, 1H; Ar-CH), 4.64 (s, 1H; CHPh), 4.35 (dd, $J$ = 10.3, 6.1 Hz, 1H; NCHCO$_2$Me), 3.84 (s, 3H; OCH$_3$), 3.70 (s, 3H; OCH$_3$), 2.93 (dd, $J$ = 13.5, 10.3 Hz, 1H; CH$_A$H$_B$CHN), 2.87 (br s, 1H; NHCHCO$_2$Me), 2.36 (dd, $J$ = 13.5, 6.1 Hz, 1H; CH$_A$H$_B$CHN); $^{13}$C NMR (100 MHz, CDCl$_3$): $\delta$ 180.5 (C=O), 174.1 (C=O), 159.6 (Ar-C), 140.6 (Ar-C), 136.9 (Ar-C), 127.7 (2 $\times$ Ar-CH), 127.5 (Ar-CH), 126.7 (Ar-CH and Ar-C), 126.1 (Ar-CH), 123.4 (Ar-CH), 106.9 (Ar-CH), 96.5 (Ar-CH), 71.3 (CHPh), 58.5 (CHCO$_2$CH$_3$), 57.6 (C-C=O), 55.3 (OCH$_3$), 52.3 (OCH$_3$), 40.5 (CH$_2$CHN); IR (film): $\nu_{\text{max}}$ 3202 (NH), 2951, 2921, 2849, 1718 (broad; C=O), 1628, 1598, 1506, 1457, 1340, 1311, 1276, 1193, 1154, 1125, 1031, 833, 754, 699; MS (ES+): $m/z$ (%) : 353 (100, $[M + H]^+$); HRMS (ES+): $m/z$: calcd for C$_{20}$H$_{21}$N$_2$O$_4$: 353.1496 [$M + H]^+$; found: 353.1498.

(2'S,5'S,3'S)-6-Methoxy-2-oxo-2'-phenyl-1-propyl-1'-[1-(3,3,3-trichloroethoxy carbonyl)-pyrrolidine-2S-carbonyl]-1,2-dihydrospiro[indole-3,3'-pyrrolidine]-5'-carboxylic acid methyl ester 37b and

(2'R,5'R,3'R)-6-Methoxy-2-oxo-2'-phenyl-1-propyl-1'-[1-(3,3,3-trichloroethoxy carbonyl)-pyrrolidine-2S-carbonyl]-1,2-dihydrospiro[indole-3,3'-pyrrolidine]-5'-carboxylic acid methyl ester 37a

Using general procedure M, a solution of N-Troc (S)-prolinyl chloride (136 mg, 0.44 mmol) in CH$_2$Cl$_2$ (3 mL), amine 35 (58 mg, 0.15 mmol) and Et$_3$N (123 µL, 0.88
mmol) in CH$_2$Cl$_2$ (12 mL) gave the crude product. Purification by flash column chromatography on silica gel eluting with 50% EtOAc in hexane gave amide 37b (49 mg, 0.07 mmol, 50%) as a white solid, m.p. (Et$_2$O) 158-160 °C; [$\alpha$]$_D^{21}$ = +38.4 (c 0.75, CHCl$_3$); $^1$H NMR (500 MHz; CDCl$_3$, 3:1 mixture of rotamers; data given for major rotamer only): $\delta$ 8.32 (d, $J$ = 7.6 Hz, 1H; Ar-CH), 7.53 (t, $J$ = 7.6 Hz, 1H; Ar-CH), 7.33 (t, $J$ = 7.6 Hz, 1H; Ar-CH), 7.15 (t, $J$ = 7.6 Hz, 1H; Ar-CH), 6.48 (d, $J$ = 7.6 Hz, 1H; Ar-CH), 6.35 (d, $J$ = 2.3 Hz, 1H; Ar-CH), 6.08 (dd, $J$ = 8.5, 2.3 Hz, 1H; Ar-CH), 5.46 (d, $J$ = 8.5 Hz, 1H; Ar-CH), 5.44 (s, 1H; CHPh), 5.36 (d, $J$ = 12.0 Hz, 1H; CH$_2$H$_2$CCl$_3$), 5.18 (dd, $J$ = 11.3, 6.8 Hz, 1H; NCCH$_2$CO$_2$CH$_3$), 4.59 (d, $J$ = 12.0 Hz, 1H; CH$_2$H$_2$CCl$_3$), 4.34 (dd, $J$ = 8.5, 3.8 Hz, 1H; NCCH$_2$CO$_2$CH$_3$), 3.85 (s, 3H; OCH$_3$), 3.80-3.72 (m, 1H; CHN), 3.73 (s, 3H; OCH$_3$), 3.66-3.60 (m, 1H; CHN), 3.50-3.44 (m, 2H; 2×CH$_2$), 2.43 (dd, $J$ = 13.3, 6.8 Hz, 1H; CH$_2$H$_2$CHCO$_2$CH$_3$), 2.34 (dd, $J$ = 13.3, 11.3 Hz, 1H; CH$_2$H$_2$CHCO$_2$CH$_3$), 1.77-1.61 (m, 4H; 2×CH$_2$), 1.46-1.38 (m, 1H; CH), 0.98 (t, $J$ = 7.3 Hz, 3H; CH$_3$); $^{13}$C NMR (125 MHz, CDCl$_3$, 3:1 mixture of rotamers; data given for major rotamer only): $\delta$ 178.1 (C=O), 173.3 (C=O), 172.7 (C=O), 160.5 (C=O), 151.7 (Ar-C), 144.2 (Ar-C), 139.6 (Ar-C), 129.0 (Ar-CH), 128.7 (Ar-CH), 128.4 (Ar-CH), 128.1 (Ar-CH), 127.6 (Ar-CH), 126.2 (Ar-CH), 117.2 (Ar-CH), 105.5 (Ar-CH), 97.1 (CCl$_3$), 96.2 (Ar-CH), 73.5 (OCH$_2$CCl$_3$), 66.1 (CHPh), 58.0 (NCHCO$_2$CH$_3$), 57.3 (C-C=O), 56.7 (NCHC(O)N), 55.4 (OCH$_3$), 52.4 (OCH$_3$), 47.6 (NCH$_2$CH$_2$CO$_2$CH$_3$), 41.6 (NCH$_2$CH$_2$CO$_2$CH$_3$), 36.5 (CH$_2$CHN), 30.5 (CH$_2$), 23.3 (CH$_2$), 20.7 (CH$_2$CH$_3$), 11.4 (CH$_3$); IR (neat): $\nu_{max}$ 2951, 2931, 1732 (C=O), 1717 (C=O), 1703 (C=O), 1656 (C=O), 1623, 1408, 1348, 1310, 1211, 1170, 1112, 1173 cm$^{-1}$; MS (ES+): $m$/z (%): 690 (85, [Cl$_2$Cl$_3$M + Na$^+$]); 688 (100, [Cl$_3$M + Na$^+$]); HRMS (ES+): $m$/z: calcd for C$_{31}$H$_{34}$N$_3$O$_7$Cl$_3$: 688.1365 [M + Na$^+$]; found: 688.1355; and amide 37a (47 mg, 0.07 mmol, 48%) as an amorphous white solid, [$\alpha$]$_D^{21}$ = +43.2 (c 0.84, CHCl$_3$); $^1$H NMR (500 MHz; D$_6$-DMSO, complex mixture of rotamers; data given for the two major rotamers only): $\delta$ 8.55-8.23 (br m, 2H; Ar-CH, both rotamers), 7.57-7.36 (br m, 2H; Ar-CH, both rotamers), 7.34 (t, $J$ = 7.3 Hz, 1H; Ar-CH, one rotamer), 7.30 (t, $J$ = 7.3 Hz, 1H; Ar-CH, one rotamer), 7.22-7.08 (br m, 2H; Ar-CH, both rotamers), 6.88-6.72 (br m, 2H; Ar-CH, both rotamers), 6.66 (d, $J$ = 2.2 Hz, 1H; Ar-CH, one rotamer), 6.64 (d, $J$ = 2.2 Hz, 1H; Ar-CH, one rotamer), 6.14 (dd, $J$ = 8.2, 2.2 Hz, 1H; Ar-CH, one rotamer), 6.10 (d, $J$ = 8.2, 2.2 Hz, 1H; Ar-CH, one rotamer), 5.32 (d, $J$ = 8.2 Hz, 1H; Ar-CH, one rotamer), 5.27 (d, $J$ =
8.2 Hz, 1H; Ar-CH, one rotamer), 4.98 (s, 2H; CHPh, both rotamers), 4.83 (d, $J = 12.3$ Hz, 1H; $CH_AH_BCCl_3$, one rotamer), 4.79-4.75 (m, 1H; C(O)NCH, one rotamer), 4.76 (d, $J = 12.3$ Hz, 1H; $CH_AH_BCCl_3$, one rotamer), 4.72 (dd, $J = 11.4, 7.3$ Hz, 1H; C(O)NCH, one rotamer), 4.64 (d, $J = 12.3$ Hz, 1H; $CH_AH_BCCl_3$, one rotamer), 4.21 (d, $J = 8.8, 2.5$ Hz, 1H; C(O)NCH, one rotamer), 4.16 (dd, $J = 12.3$ Hz, 1H; CH$_A$H$_B$CCl$_3$, one rotamer), 4.16 (d, $J = 12.3$ Hz, 1H; CH$_A$H$_B$CCl$_3$, both rotamers), 4.03 (dd, $J = 9.2, 2.2$ Hz, 1H; C(O)NCH, one rotamer), 3.74 (s, 3H; OCH$_3$, one rotamer), 3.72 (s, 3H; OCH$_3$, one rotamer), 3.72-3.61 (m, 4H; NC$_2$CH$_2$CH$_3$, both rotamers), 3.69 (s, 3H; OCH$_3$, one rotamer), 3.68 (s, 3H; OCH$_3$, one rotamer), 3.66-3.51-3.34 (m, 4H; NC$_2$CH$_2$CH$_3$, both rotamers), 2.37-2.30 (m, 4H; 2 × CH, both rotamers), 1.94-1.79 (m, 4H; 2 × CH, both rotamers), 1.71-1.57 (m, 4H; CH$_2$C$_6$H$_5$, both rotamers), 0.898 (t, $J = 7.3$ Hz, 3H; CH$_3$, one rotamer), 0.895 (t, $J = 7.3$ Hz, 3H; CH$_3$, one rotamer); $^{13}$C NMR (125 MHz, D$_6$-DMSO, complex mixture of rotamers; data given for the two major rotamers only): $\delta$ 178.4 (C=O, one rotamer), 178.3 (C=O, one rotamer), 172.0 (C=O, one rotamer), 171.8 (C=O, one rotamer), 171.3 (C=O, one rotamer), 171.2 (C=O, one rotamer), 160.2 (C=O, both rotamers), 152.0 (Ar-C, one rotamer), 151.5 (Ar-C, one rotamer), 144.2 (Ar-C, both rotamers), 138.3 (Ar-C, one rotamer), 138.2 (Ar-C, one rotamer), 128.2-127.5 (3 × Ar-CH, both rotamers), 125.6 (Ar-CH, one rotamer), 125.4 (Ar-CH, one rotamer), 116.8 (Ar-C, one rotamer), 116.7 (Ar-C, one rotamer), 106.0 (Ar-CH, both rotamers), 96.1 (Ar-CH, one rotamer), 95.9 (Ar-CH, one rotamer), 95.4 (CCl$_3$, both rotamers), 74.0 (OCH$_2$CCl$_3$, one rotamer), 73.7 (OCH$_2$CCl$_3$, one rotamer), 65.0 (CHPh, both rotamers), 58.4 (NCHC(O), both rotamers), 58.2 (NCHC(O), both rotamers), 56.4 (C-C=O, both rotamers), 55.4 (OCH$_3$, both rotamers), 52.1 (OCH$_3$, one rotamer), 52.0 (OCH$_3$, one rotamer), 47.6 (NCH$_2$CH$_2$CH$_2$, one rotamer), 46.7 (NCH$_2$CH$_2$CH$_2$, one rotamer), 40.7 (NCH$_2$CH$_2$CH$_3$, both rotamers), 35.5 (CH$_2$, one rotamer), 35.1 (CH$_2$, one rotamer), 29.3 (CH$_2$, one rotamer), 28.5 (CH$_2$, one rotamer), 23.2 (CH$_2$, one rotamer), 22.2 (CH$_2$, one rotamer), 20.3 (CH$_2$CH$_3$, both rotamers), 11.1 (CH$_3$, both rotamers); IR (film): $\nu$ 2955, 2930, 1704 (broad; C=O), 1668 (C=O), 1622, 1407, 1356, 1206, 1170, 1124, 1110 cm$^{-1}$; MS (ES+): $m/z$ (%): 690 (80, [Cl$_{35}$Cl$_{37}$M + Na]$^+$); 688 (100, [Cl$_{35}$M + Na]$^+$); HRMS (ES+): $m/z$: calcd for C$_{31}$H$_{34}$N$_3$O$_7$Cl$_3$: 666.1535 [$M + H^+$]; found: 666.1537.
(2'S,5'S,3S)-6-Methoxy-2-oxo-2'-phenyl-1'-(1-(3,3,3-trichloroethoxycarbonyl)-pyrrolidine-2S-carbonyl]-1,2-dihydrospiro[indole-3,3'-pyrrolidine]-5'-carboxylic acid methyl ester 38b and

(2'R,5'R,3R)-6-Methoxy-2-oxo-2'-phenyl-1'-(1-(3,3,3-trichloroethoxycarbonyl)-pyrrolidine-2S-carbonyl]-1,2-dihydrospiro[indole-3,3'-pyrrolidine]-5'-carboxylic acid methyl ester 38a

Using general procedure M, a solution of N-Troc-(S)-prolinyl chloride (14.0 mg, 0.05 mmol) in CH₂Cl₂ (5.60 mL), amine 36 (16 mg, 0.05 mmol) and Et₃N (6.60 μL, 0.05 mmol) gave the crude product. Purification by flash column chromatography on silica gel eluting with 50% EtOAc in hexane gave amide 38b (14 mg, 0.02 mmol, 50%) as a white solid, m.p. (Et₂O) 110-113 °C; [α]D²⁶ = +1.65 (c 2.5, CHCl₃); ¹H NMR (400 MHz, CDCl₃, 1:5:1 mixture of rotamers): δ 8.29-8.37 (m, 2H; 2 × ArCH, both rotamers), 7.91 (s, 1H; NH, one rotamer), 7.61 (s, 1H; NH; one rotamer), 7.57-7.50 (m, 2H; 2 × ArCH, both rotamers), 7.37-7.30 (m, 2H; 2 × ArCH, both rotamers), 7.19-7.12 (m, 2H; 2 × ArCH, both rotamers), 6.63 (d, J = 7.1 Hz, 1H; ArCH, one rotamer), 6.53 (d, J = 7.8 Hz, 1H; ArCH, one rotamer), 6.43 (d, J = 2.3 Hz, 1H; ArCH, one rotamer), 6.41 (d, J = 2.3 Hz, 1H; ArCH, one rotamer), 6.12-6.07 (m, 2H; ArCH, both rotamers), 5.48-5.46 (m, 3H; ArCH both rotamers and CHPh, one rotamer), 5.45 (s, 1H; CHPh, one rotamer), 5.36 (d, J = 12.2 Hz, 1H; CH₃H₃CCl₃; one rotamer), 5.15-5.24 (m, 2H; CHCO₂CH₃, both rotamers), 4.95 (d, J = 12.2 Hz, 1H; CH₃H₃CCl₃; one rotamer), 4.51 (d, J = 12.2 Hz, 1H; CH₃H₃CCl₃; one rotamer), 4.17 (dd, J = 8.4, 4.2 Hz, 1H; NCHCH₂CH₂, one rotamer), 4.32 (dd, J = 8.4, 4.2 Hz, 1H; NCHCH₂CH₂, one rotamer), 3.87 (s, 3H; OCH₃, one rotamer), 3.86 (s, 3H; OCH₃, one rotamer), 3.73-3.71 (m, 6H; OCH₃, both rotamers), 3.69-3.60 (m, 2H; NCHCH₂CH₂CH₃H₃B, both rotamers), 3.55-3.45 (m, 2H; NCHCH₂CH₂CH₃H₃B, both rotamers), 2.47-2.40 (m, 4H; 2 × NCHCH₂C, both rotamers), 2.13-2.01 (m, 2H; NCHCH₂CH₃H₃B, both rotamers), 0.56-0.48 (m, 3H; 3 × OH, both rotamers).
1.78-1.63 (m, 4H; NCH₂CH₃H₄ and NCHCH₂H₅CH₂, both rotamers), 1.47-1.29 ppm (m, 2H; NCH₂CH₃H₄CH₂); ¹³C NMR (100 MHz, CDCl₃, 1.5:1 mixture of rotamers): δ 180.6 (C=O, one rotamer), 180.3 (C=O, one rotamer), 171.1 (C=O, one rotamer), 173.3 (2 × C=O, both rotamers), 172.9 (C=O, one rotamer), 172.8 (C=O, one rotamer), 172.6 (C=O, one rotamer), 160.45 (ArC, one rotamer), 160.47 (ArC, one rotamer), 152.9 (ArC, one rotamer), 151.8 (ArC, one rotamer), 142.1 (ArC, one rotamer), 141.7 (ArC, one rotamer), 139.5 (ArC, one rotamer), 139.3 (ArC, one rotamer), 129.0 (Ar-CH, one rotamer), 128.8 (Ar-CH, one rotamer), 128.6 (2 × Ar-CH, both rotamers), 128.4 (Ar-CH, one rotamer), 128.3 (Ar-CH, one rotamer), 127.73 (Ar-CH, one rotamer), 127.68 (Ar-CH, one rotamer), 126.70 (Ar-CH, one rotamer), 126.66 (Ar-CH, one rotamer), 126.4 (Ar-CH, one rotamer), 126.3 (Ar-CH, one rotamer), 117.7 (CCl₃, one rotamer), 117.6 (CCl₃, one rotamer), 107.0 (Ar-CH, one rotamer), 106.8 (Ar-CH, one rotamer), 96.7 (Ar-CH, one rotamer), 96.2 (Ar-CH, one rotamer), 75.1 (CH₂CCl₃, one rotamer), 73.7 (CH₂CCl₃, one rotamer), 66.5 (CHPh, one rotamer), 66.3 (CHPh, one rotamer), 58.6 (C-C=O, one rotamer), 58.5 (C-C=O, one rotamer), 58.1 (2 × CHCO₂CH₃, both rotamers), 57.6 (NCHCH₂C, one rotamer), 57.4 (NCHCH₂C, one rotamer), 52.5 (OCH₃, one rotamer), 52.5 (OCH₃, one rotamer), 47.8 (NCHCH₂CH₂CH₂, one rotamer), 47.1 (NCHCH₂CH₂CH₂, one rotamer), 36.2 (2 × CHCH₂C, both rotamers), 29.8 (NCHCH₂, one rotamer), 29.7 (NCHCH₂, one rotamer), 24.4 (NCHCH₂CH₂, one rotamer), 23.1 (NCHCH₂CH₂, one rotamer); IR (film): ν 3238 (NH), 2955, 2918, 2844, 1719 (C=O), 1659 (C=O), 1655 (C=O), 1634 (C=O), 1599, 1504, 1453, 1432, 1413, 1339, 1307, 1284, 1256, 1205, 1193, 1159, 1124, 1031, 811, 753, 702; MS (ES+): m/z (%): 646 (100, [M + Na]+); HRMS (ES+): m/z: calcd for C₂₈H₂₈N₃O₇Cl₃Na: 646.0885 [M + Na⁺]; found:646.0894; and amide 38a (12.5 mg, 0.02 mmol, 45%) as a white solid, m.p. (Et₂O) 155-157°C; [α]D 26 = +29.45 (c 2.2, CHCl₃); ¹H NMR (400 MHz, CDCl₃, complex mixture of rotamers; data given for the two major rotamer only): δ 8.64 - 8.42 (m, 2 H; 2 × ArCH, both rotamers), 7.85-7.79 (m, 2 H; NH, both rotamers), 7.67-7.44 (m, 2 H; 2 × ArCH, both rotamers), 7.37-7.09 (m, 2 H; 2 × ArCH, both rotamers), 6.66-6.48 (m, 2 H; 2 × ArCH, both rotamers), 6.43 (d, J = 2.4 Hz, 1 H; ArCH, one rotamer), 6.42 (d, J = 2.4 Hz, 1 H; ArCH, one rotamer), 6.15 (dd, J = 8.5, 2.4 Hz, 1 H; ArCH, one rotamer), 6.11 (dd, J = 8.5, 2.4 Hz, 1 H; ArCH, one rotamer), 5.45 (d, J = 8.4 Hz, 1 H; ArCH, one rotamer), 5.34 (d, J = 8.4 Hz, 1 H; ArCH, one rotamer),
rotamer), 5.05-4.99 (m, 2 H; CHPh, one rotamer), 4.97 (s, H; CHPh, one rotamer), 4.86 (d, J = 11.9 Hz, 1 H; CH$_2$H$_2$CCl$_3$, one rotamer), 4.74 (d, J = 11.9 Hz, 1 H; CH$_2$H$_2$CCl$_3$, one rotamer), 4.52 (d, J = 11.9 Hz, 1 H; CH$_2$H$_2$CCl$_3$, one rotamer), 4.33 (t, J = 6.1 Hz, 1 H; CH$_2$H$_2$CCl$_3$, one rotamer), 4.21 (d, J = 11.9 Hz, 1 H; CH$_2$H$_2$CCl$_3$, one rotamer), 3.86 (s, 6 H; OCH$_3$, both rotamers), 3.75 (s, 3 H; OCH$_3$, one rotamer), 3.73 (s, 3 H; OCH$_3$, one rotamer), 3.68 - 3.72 (m, 2 H; NCHCH$_2$CH$_2$CCl$_3$, both rotamers), 3.41 - 3.52 (m, 2 H; NCHCH$_2$CH$_2$CCl$_3$, both rotamers), 2.37 - 2.50 (m, 4 H; 2 × CHCH$_2$C, both rotamers), 2.22 - 2.30 (m, 2 H, NCHCH$_2$; both rotamers), 2.11 - 2.15 (m, 4 H, NCHCH$_2$ and NCHCH$_2$CH$_2$; both rotamers), 1.94 – 1.85 ppm (m, 2 H, NCHCH$_2$CH$_2$; both rotamers); $^{13}$C NMR (100 MHz, CDCl$_3$, complex mixture of rotamers, data given only for the major rotamers): $\delta$ 180.9 (C=O), 180.6 (C=O), 174.1 (C=O), 173.3 (C=O), 172.5 (C=O), 172.2 (C=O), 171.8 (C=O), 171.7 (C=O), 160.53 (Ar-C, one rotamer), 160.51 (Ar-C, one rotamer), 152.6 (Ar-C, one rotamer), 152.3 (Ar-C, one rotamer), 141.6 (2 × Ar-C, both rotamers), 137.8 (Ar-C, one rotamer), 137.3 (Ar-C, one rotamer), 129.68 (Ar-CH, one rotamer), 128.7 (Ar-CH, one rotamer), 128.6 (Ar-CH, one rotamer), 126.9 (2 × Ar-CH, both rotamers), 126.5 (2 × Ar-CH, both rotamers), 117.6 (CCl$_3$, one rotamer), 117.4 (CCl$_3$, one rotamer), 106.98 (Ar-CH, one rotamer), 106.93 (Ar-CH, one rotamer), 100 (2 × Ar-CH, both rotamers), 96.91 (Ar-CH, one rotamer), 96.87 (Ar-CH, one rotamer), 96.64 (Ar-CH, one rotamer), 96.62 (Ar-CH, one rotamer), 75.1 (CH$_2$CCl$_3$, one rotamer), 74.5 (CH$_2$CCl$_3$, one rotamer), 65.9 (CHPh, one rotamer), 65.8 (CHPh, one rotamer), 58.8 (CHCO$_2$CH$_3$, one rotamer), 58.6 (CHCO$_2$CH$_3$, one rotamer), 58.51 (NCHCH$_2$, one rotamer), 58.47 (NCHCH$_2$, one rotamer), 57.63 (C-C=O, one rotamer), 57.59 (C-C=O, one rotamer), 52.53 (OCH$_3$), 52.50 (OCH$_3$), 47.7 (NCHCH$_2$CH$_2$CH$_2$, one rotamer), 46.9 (NCHCH$_2$CH$_2$CH$_2$, one rotamer), 36.1 (CHCH$_2$C, one rotamer), 35.8 (CHCH$_2$C, one rotamer), 30.0 (NCHCH$_2$, one rotamer), 29.7 (NCHCH$_2$, one rotamer), 23.7 (NCHCH$_2$CH$_2$, one rotamer), 22.6 (NCHCH$_2$CH$_2$, one rotamer); IR (film): $\nu$ 3238 (NH), 2955, 2918, 2844, 1719 (C=O), 1659 (C=O), 1655 (C=O), 1634 (C=O), 1599, 1504, 1453, 1432, 1413, 1339, 1307, 1284, 1256, 1205, 1193, 1159, 1124, 1031, 811, 753, 702; MS (ES+): m/z (%): 646 (100, [M + Na]$^+$); HRMS (ES+): m/z: calcd for C$_{28}$H$_{28}$N$_3$O$_7$Cl$_3$Na: 646.0885 [M + Na$^+$]; found:646.0894.
(2S,3S,5aS,10aS)-6'-Methoxy-3-phenyl-1'-propyl-5a,6,7,8-tetrahydro-1H-spiro[dipyrrrolo[1,2-a:1'2'-d]pyrazine-2,3'-indoline]-2',5,10(3H,10aH)-trione 39b

Using general procedure N, Zn dust (480 mg, 7.34 mmol), N-Troc amide 37b (49 mg, 0.07 mmol) in THF (4 mL), MeOH (4 mL) and a saturated solution of NH₄Cl (4 mL) gave the crude product. Purification by flash column chromatography on silica gel eluting with 3% MeOH in CH₂Cl₂ gave diketopiperazine 39b (32 mg, 0.07 mmol, 95%) as a white solid, m.p. (Et₂O) 129-132°C; [α]_D²₀ = +141.0 (c 0.52, CHCl₃); ¹H NMR (500 MHz, CDCl₃): δ 7.42-7.30 (br m, 1H; Ar-CH), 7.26 (t, J = 7.3 Hz, 1H; Ar-CH), 7.20-7.07 (br m, 1H; Ar-CH), 7.04-6.91 (br m, 1H; Ar-CH), 6.70-6.54 (br m, 1H; Ar-CH), 6.37 (d, J = 2.2 Hz, 1H; Ar-CH), 5.43 (d, J = 8.3 Hz, 1H; Ar-CH), 5.24 (dd, J = 10.8, 6.9 Hz, 1H; CCH₂N), 5.08 (s, 1H; CPh), 4.38 (t, J = 7.9 Hz, 1H; CH₂CH₂CH₃N), 3.79-3.69 (m, 2H; NC₃H₃A₃H₃BCH₂CH₂CN), 3.73 (s, 3H; OCH₃), 3.65-3.60 (m, 2H; NC₃H₃A₃H₃BCH₂CH₂CN), 2.73 (dd, J = 13.6, 10.8 Hz, 1H; CCH₃A₃H₃BCH₂CN), 2.35-2.29 (m, 1H; NCH₃A₃H₃BCH₂CH₂CN), 2.32 (dd, J = 13.6, 6.9 Hz, 1H; CCH₃A₃H₃BCH₂CN), 2.27-2.19 (m, 1H; NCH₃A₃H₃BCH₂CH₂CN), 2.05-1.94 (m, 2H; CH₃CH₂CH₂CN), 1.75 (sextet, J = 7.3 Hz, 2H; CH₂CH₃), 0.99 (t, J = 7.3 Hz, 3H; CH₃); ¹³C NMR (125 MHz, CDCl₃): δ 179.3 (C=O), 167.1 (C=O), 166.9 (C=O), 160.5 (Ar-C), 144.2 (Ar-C), 138.0 (Ar-C), 128.1 (3 × Ar-CH), 126.2 (Ar-CH), 117.5 (Ar-C), 105.6 (Ar-CH), 96.3 (Ar-CH), 65.2 (CH₂CH₂NCH), 61.0 (CH₂CH₂NCH), 58.8 (CCH₃NCH), 55.7 (C-C=O), 55.4 (OCH₃), 45.3 and 41.4 (2 × CH₂N), 34.0 (CCH₃CHN), 27.4 (CH₃CH₂N), 23.7 (CH₃CH₂CH₂CN), 20.7 (CH₂CH₃), 11.3 (CH₃); IR (neat): ν_max 2964, 2933, 2876, 1716 (C=O), 1662 (C=O), 1624, 1422, 1379, 1277, 1208, 1107 cm⁻¹; MS (ES+): m/z (%): 482 (100, [M + Na]⁺); HRMS (ES+): m/z: calcd for C₂₇H₂₉N₃O₄: 460.2231 [M + H⁺]; found: 460.2224.
Using general procedure N, Zn dust (461 mg, 7.05 mmol), N-Troc amide 37a (47 mg, 0.07 mmol) in THF (4 mL), MeOH (4 mL) and a saturated solution of NH₄Cl (4 mL) gave the crude product. Purification by flash column chromatography on silica gel eluting with 3% MeOH in CH₂Cl₂ gave diketopiperazine 39a (30 mg, 0.07 mmol, 93%) as an amorphous white solid; [α]D²⁸ = +69.3 (c 0.56, CHCl₃); ¹H NMR (400 MHz, CDCl₃): δ 7.43-6.55 (br m, 5H; 5 × Ar-CH), 6.35 (d, J = 2.2 Hz, 1H; Ar-CH), 6.07 (dd, J = 8.6, 2.2 Hz, 1H; Ar-CH), 5.56 (d, J = 8.6 Hz, 1H; Ar-CH), 5.38 (ddd, J = 11.3, 6.0, 1.5 Hz, 1H; CCH₂C), 5.21 (s, 1H; CPh), 4.17 (ddd, J = 12.1, 9.3, 6.3 Hz, 1H; NCH₂H₂CH₂CH₂), 4.11 (ddd, J = 12.1, 5.8, 1.8 Hz, 1H; CH₂CH₂C), 3.72 (s, 3H; OCH₃), 3.70-3.66 (m, 2H; NCH₂CH₂CH₃), 3.30 (ddd, J = 12.1, 9.8, 4.8 Hz, 1H; NCH₂H₂CH₂CH₂), 2.54 (dd, J = 12.8, 6.0 Hz, 1H; NCH₂CH₂H₂C), 2.48 (dd, J = 12.8, 11.3 Hz, 1H; NCH₂CH₂H₂C), 2.40-2.30 (m, 1H; CH), 2.13-1.79 (m, 3H; 3 × CH), 1.78-1.69 (m, 2H; CH₂CH₃), 0.98 (t, J = 7.6 Hz, 3H; CH₃); ¹³C NMR (100 MHz, CDCl₃): δ 179.4 (C=O), 166.4 (C=O), 164.5 (C=O), 160.3 (Ar-C), 144.0 (Ar-C), 137.8 (Ar-C), 128.4 (2 × Ar-CH), 128.0 (Ar-CH), 126.0 (Ar-CH), 118.0 (Ar-C), 105.7 (Ar-CH), 96.3 (Ar-CH), 66.5 (CPh), 63.2 (CH₂CH₂CH₃), 57.8 (CCH₂CH₂N), 55.4 (OCH₃), 54.6 (C-C=O), 44.4 (NCH₂CH₂CH₂), 41.4 (NCH₂CH₂CH₂), 36.7 (CCH₂CH₂N), 28.2 (CH₂), 22.4 (CH₂), 20.7 (CH₂CH₃), 11.3 (CH₃); IR (neat): νmax 2964, 2934, 2876, 1702 (C=O), 1661 (C=O), 1622, 1427, 1378, 1305, 1209, 1177, 1106 cm⁻¹; MS (ES+): m/z (%): 482 (100, [M + Na⁺]); HRMS (ES+): m/z: calcd for C₂₇H₂₆N₃O₄: 460.2231 [M + H⁺]; found: 460.2233.

(2R,3R,5aS,10aR)-6'-Methoxy-3-phenyl-1'-propyl-5a,6,7,8-tetrahydro-1Η-spiro[dipyrrolo[1,2-a:1'2'-d]pyrazine-2,3'-indoline]-2',5,10(3Η,10aΗ)-trione 39a
(2S,3S,5aS,10aS)-6'-Methoxy-3-phenyl-5a,6,7,8-tetrahydro-1H-spiro[dipyrrolo[1,2-a:1'2'-d]pyrazine-2,3'-indoline]-2',5,10(3H,10aH)-trione 40b

Using general procedure N, Zn dust (187 mg, 2.88 mmol), N-Troc amide 38b (18 mg, 0.03 mmol) in THF (1 mL), MeOH (1 mL) and a saturated solution of NH₄Cl (1 mL) gave the crude product. Purification by flash column chromatography on silica gel eluting with 10% MeOH in EtOAc gave diketopiperazine 40b (11.5 mg, 0.03 mmol, 96%) as a white solid, m.p. (EtOAc) 290-292 °C; [α]D²⁴ = −74.7 (c 1.50, CHCl₃); ¹H NMR (CDCl₃, 400 MHz) δ 7.88 (s, 1H; NH), 7.42-7.31 (m, 1H; ArCH), 7.27 (t, J = 7.3 Hz, 1H; Ar-CH), 7.19-7.08 (m, 1H; ArCH), 7.04-6.91 (m, 1H; ArCH), 6.71-6.60 (m, 1H; ArCH), 6.40 (d, J = 2.4 Hz, 1H; ArCH), 6.09 (dd, J = 8.4, 2.4 Hz, 1H; ArCH), 5.40 (d, J = 8.3 Hz, 1H; ArCH), 5.20 (dd, J = 11.0, 6.8 Hz, 1H; NCHCH₂C), 5.16 (s, 1H; CHPh), 4.41 (t, J = 7.8 Hz, 1H; NCHCH₂CH₂), 3.81-3.73 (m, 1H; NCH₂H₂B), 3.71 (s, 3H; OCH₃), 3.67-3.60 (m, 1H; NCH₂H₂B), 2.73 (dd, J = 13.6, 11.0 Hz, 1H; NCHCH₂H₂B), 2.40 (dd, J = 13.6, 6.8 Hz, 1H; NCHCH₂H₂B), 2.36-2.28 (m, 1H; NCHCH₂H₂B), 2.28-2.19 (m, 1H; NCHCH₂H₂B), 2.05-1.96 (m, 2H; NCHCH₂CH₂); ¹³C NMR (CDCl₃, 100 MHz) δ 180.9 (C=O), 167.00 (C=O), 166.99 (C=O), 160.3 (ArC), 141.5 (ArC), 137.7 (ArC), 128.2 (ArC), 126.5 (ArC), 117.8 (ArC), 117.8 (ArC), 106.7 (ArC), 96.8 (ArC), 64.9 (CHPh), 61.1 (NCHCH₂CH₂), 58.7 (NCHCH₂C), 56.1 (C=C=O), 55.3 (OCH₃), 45.3 (NCHCH₂CH₂CH₂), 33.9 (NCHCH₂C), 27.4 (NCHCH₂), 23.7 (NCHCH₂CH₂); IR (film): v max 3206 (NH), 2918, 2858, 1712 (C=O), 1661 (C=O), 1594, 1501, 1453, 1425, 1337, 1307, 1281, 1189, 1156, 1124, 1108, 1031, 834, 749, 698; MS (ES+): m/z (%): 418 (100, [M + H]+); HRMS (ES+): m/z: calcd for C₂₄H₂₄N₄O₃: 418.1770 [M + H]⁺; found: 418.1761.
Using general procedure N, Zn dust (156 mg, 2.40 mmol), N-Troc amide 38a (15 mg, 0.02 mmol) in THF (1 mL), MeOH (1 mL) and a saturated solution of NH₄Cl (1 mL) gave the crude product. Purification by flash column chromatography on silica gel eluting with 10% MeOH in EtOAc gave diketopiperazine 40a (8 mg, 0.02 mmol, 80%) as a white solid, m.p. (Et₂O) 239-241 °C; [α]D²⁵ +10.8 (c 0.75, CHCl₃); ¹H NMR (CDCl₃, 400 MHz) δ 7.80 (s, 1H; NH), 7.33-7.17 (m, 5H; 5 × ArCH), 6.39 (d, J = 2.5 Hz, 1H; ArCH), 6.08 (dd, J = 8.5, 2.5 Hz, 1H; ArCH), 5.52 (d, J = 8.5 Hz, 1H; ArCH), 5.34 (dd, J = 11.5, 6.1 Hz, 1H; NCH₂C), 5.29 (s, 1H; CHPh), 4.20-4.10 (m, 2H; NCH₂CH₂ and NCH₃H₃), 3.70 (s, 3H; OCH₃), 3.32 (m, 1H; NCH₃H₂), 2.50-2.00 (m, 2H; NCH₂CH₂ and NCH₃H₃), 1.92-1.82 (m, 1H; NCH₂CH₃), 1.92-1.82 (m, 1H; NCH₂CH₃), 181.1 (C=O), 166.2 (C=O), 157.6 (C=O), 128.5 (Ar-CH), 128.1 (Ar-CH), 126.3 (Ar-CH), 107.0 (Ar-CH), 96.7 (Ar-CH), 66.2 (CH₂), 63.2 (NCH₂CH₂), 57.7 (NCH₂CH₂), 55.4 (C=C=O), 55.0 (OCH₃), 44.5 (NCH₂CH₂), 36.7 (NCH₂CH₂), 28.2 (NCH₂), 22.4 (NCH₂CH₂); IR (film): νmax 3206 (NH), 2918, 2858, 1712 (C=O), 1661 (C=O), 1631 (C=O), 1594, 1501, 1453, 1425, 1337, 1307, 1281, 1189, 1156, 1124, 1108, 1031, 834, 749, 698; MS (ES+): m/z (%): 418 (100, [M + H]+); HRMS (ES+): m/z: calcd for C₂₄H₂₄N₄O₃: 418.1770 [M + H]+; found: 418.1761.
rac-(2’S,3S,5’S)-Methyl 1’-(4-(3,3,4,4,5,6,6,7,7,8,8,9,9,10,10-
heptafluorodecyl)benzyl-6-methoxy-2-oxo-2’-phenylspiro[indoline-3,3’-
pyrrolidine]-5’-carboxylate 42

OsO₄ (82 µL of a 2.5% w/v solution in tert-butanol, 8.06 µmol) and NMO (28 mg,
0.24 mmol) were added to a stirred suspension of spirooxindole 41 (69 mg, 0.08
mmol) in acetone (5 mL) and water (1 mL) at room temperature under nitrogen. The
resulting suspension was stirred at room temperature for 84 h, then a saturated
aqueous solution of Na₂S₂O₃ (5 mL) and CH₂Cl₂ (5 mL) were added. The layers were
separated, and the aqueous layer was extracted with CH₂Cl₂ (2 × 5 mL). The
combined organic layers were dried (Na₂SO₄) and evaporated under reduced
pressure to give the crude diol product. The crude product was dissolved in EtOAc (5 mL),
then Pb(OAc)₃H₃OCH₃ (54 mg, 0.12 mmol) was added and the resulting suspension was
stirred at room temperature for 15 min. The resulting mixture was filtered through a
short silica plug, washing with EtOAc. The filtrate was evaporated under reduced
pressure to give the crude aldehyde product. Using general procedure K, oxidant
solution (1.0 mL) and the crude aldehyde in tert-butanol (2 mL), MeCN (2 mL) and
2-methyl-2-butene (1 mL), then trimethylsilyldiazomethane (1.0 mL of a 2.0 M
solution in hexanes, 2.0 mmol) in anhydrous MeOH (5 mL) gave the crude product.
Purification by FSPE eluting with 60% aqueous MeCN gave the non-fluorous
reaction components, then elution with MeOH (100 mL) gave methyl ester 42 (57 mg,
0.06 mmol, 80%) as a pale yellow solid, m.p. 69-71 °C (Et₂O); ¹H NMR (400 MHz,
CDCl₃): δ 7.79 (s, 1H; NH), 7.69 (d, J = 8.3 Hz, 1H; Ar-CH), 7.29-7.11 (m, 9H; 9
Ar), 3.52 (s, 3H; OCH₃), 3.55 (d, J = 13.9 Hz, 1H; NCH₃H₂Ar), 3.77 (dd, J = 10.8, 6.0 Hz,
1H; NCHCO₂CH₃), 3.71 (s, 3H; OCH₃), 2.92-2.88 (m, 2H; CH₂S), 2.79 (dd, J = 13.4, 10.8 Hz,
1H; CH₂H₂CHN), 2.44-2.30 (m, 2H; CH₂C₆F₁₇), 2.18 (dd, J = 13.4, 6.0 Hz, 1H; CH₂H₂CHN); ¹³C NMR
(100 MHz, CDCl₃): δ 180.3 (C=O), 174.3 (C=O), 159.6 (Ar-C), 140.5 (Ar-C), 138.1
(Ar-C), 135.6 (Ar-C), 134.1 (Ar-C), 130.5 (Ar-CH), 128.3 (Ar-CH), 127.9 (Ar-CH),
127.7 (Ar-CH), 127.6 (Ar-CH), 127.5 (Ar-CH), 123.6 (Ar-C), 106.8 (Ar-CH), 96.2
(Ar-CH), 75.7 (CHPh), 62.7 (NCHCO₂CH₃), 57.9 (C-C=O), 55.3 (OCH₃), 55.1
(NCH₂Ar), 51.7 (OCH₃), 38.3 (CH₂), 32.9 (t, J = 22.1 Hz; CH₂C₈F₁₇), 26.1 (CH₂S);
IR (film): νₘₐₓ 3210 (NH), 2948, 2922, 2849, 1714 (2 × C=O), 1631, 1506, 1456,
1341, 1236, 1198, 1145, 1113, 1087, 1026, 806, 702; MS (ES+): m/z (%): 887 (100,
[M - H]+); HRMS (ES-): m/z: calcd for C₃₇H₂₉F₁₇N₂O₄: 887.1783 [M – H]⁺; found:
887.1776.
$^1$H NMR (400 MHz, CDCl$_3$)

$^{13}$C NMR (100 MHz, CDCl$_3$)
$^1$H NMR (400 MHz, CDCl$_3$)

$^{13}$C NMR (100 MHz, CDCl$_3$)
$\text{H NMR (400 MHz, CDCl}_3\text{)}$

$\text{C NMR (100 MHz, CDCl}_3\text{)}$
$^1$H NMR (300 MHz, CDCl$_3$)

$^{13}$C NMR (75 MHz, CDCl$_3$)
$^{1}H$ NMR (400 MHz, CDCl$_3$)

$^{13}C$ NMR (100 MHz, CDCl$_3$)
$^{1}$H NMR (400 MHz, CDCl$_3$)

$^{13}$C NMR (100 MHz, CDCl$_3$)
\[ \text{NMR (500 MHz, CDCl}_3 \text{)} \]

\[ \text{C NMR (125 MHz, CDCl}_3 \text{)} \]

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

$^{13}C$ NMR (100 MHz, CDCl$_3$)
$^1$H NMR (400 MHz, CDCl$_3$)

$^{13}$C NMR (100 MHz, CDCl$_3$)
\[ \text{S10} \]

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

$^{13}$C NMR (100 MHz, CDCl$_3$)
$^1$H NMR (400 MHz, CDCl$_3$)

$^{13}$C NMR (100 MHz, CDCl$_3$)
$^1$H NMR (400 MHz, CDCl$_3$)

$^{13}$C NMR (100 MHz, CDCl$_3$)
\(^1\)H NMR (500 MHz, CDCl\(_3\))

\(^{13}\)C NMR (100 MHz, CDCl\(_3\))
$^{1}H$ NMR (400 MHz, CDCl$_3$)

$^{13}C$ NMR (100 MHz, CDCl$_3$)
$^1$H NMR (400 MHz, CDCl$_3$)

$^{13}$C NMR (100 MHz, CDCl$_3$)
$^1$H NMR (400 MHz, CDCl$_3$)

$^{13}$C NMR (100MHz, CDCl$_3$)
$^1$H NMR (400 MHz, CDCl$_3$)

$^{13}$C NMR (100 MHz, CDCl$_3$)
$^1$H NMR (400 MHz, CDCl$_3$)

$^{13}$C NMR (125 MHz, CDCl$_3$)
$^{1}$H NMR (400 MHz, CDCl$_3$)

$^{13}$C NMR (100 MHz, CDCl$_3$)
$\text{C}_{17}\text{F}_{37} \quad \text{S} \quad \text{Cl}$

$\text{H NMR (400 MHz, CDCl}_3\text{)}$

$\text{13C NMR (100 MHz, CDCl}_3\text{)}$
$^1$H NMR (500 MHz, CDCl$_3$)

$^{13}$C NMR (125 MHz, CDCl$_3$)
$^1$H NMR (400 MHz, CDCl$_3$)

$^{13}$C NMR (100 MHz, CDCl$_3$)
$^{1}$H NMR (400 MHz, CDCl$_3$)

$^{13}$C NMR (100 MHz, CDCl$_3$)
$^1$H NMR (400 MHz, CDCl$_3$)

$^{13}$C NMR (100 MHz, CDCl$_3$)
$^1$H NMR (400 MHz, CDCl$_3$)

$^{13}$C NMR (100 MHz, CDCl$_3$)
$^{1}$H NMR (400 MHz, CDCl$_3$)

$^{13}$C NMR (100 MHz, CDCl$_3$)
$^1$H NMR (400 MHz, CDCl$_3$)

$^{13}$C NMR (100 MHz, CDCl$_3$)
$^1$H NMR (400 MHz, CDCl$_3$)

$^{13}$C NMR (100 MHz, CDCl$_3$)
$^1$H NMR (400 MHz, CDCl$_3$)

$^{13}$C NMR (100 MHz, CDCl$_3$)
$^1$H NMR (400 MHz, CDCl$_3$)

$^{13}$C NMR (100 MHz, CDCl$_3$)
$^{1}H$ NMR (400 MHz, CDCl$_3$)

$^{13}C$ NMR (100 MHz, CDCl$_3$)
$^1$H NMR (500 MHz, CDCl$_3$)

$^{13}$C NMR (125 MHz, CDCl$_3$)

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

$^{13}$C NMR (100 MHz, CDCl$_3$)
\[ \text{H NMR (400 MHz, CDCl}_3\text{)} \]

\[ \text{C NMR (100 MHz, CDCl}_3\text{)} \]
$^1$H NMR (500 MHz, CDCl$_3$)

$^{13}$C NMR (125 MHz, CDCl$_3$)
$^1$H NMR (400 MHz, CDCl$_3$)

$^{13}$C NMR (100 MHz, CDCl$_3$)
$^1$H NMR (400 MHz, CDCl$_3$)

$^{13}$C NMR (100 MHz, CDCl$_3$)
$^1$H NMR (500 MHz, CDCl$_3$)

$^{13}$C NMR (125 MHz, CDCl$_3$)
$^{1}H$ NMR (400 MHz, CDCl$_3$)

$^{13}$C NMR (125 MHz, CDCl$_3$)
\[ ^1H \text{ NMR} \ (400 \text{ MHz}, \text{CDCl}_3) \]

\[ ^13C \text{ NMR} \ (100 \text{ MHz}, \text{CDCl}_3) \]
$^{1}H$ NMR (400 MHz, CDCl$_3$)

$^{13}C$ NMR (100 MHz, CDCl$_3$)
$^{1}$H NMR (400 MHz, CDCl$_3$)

$^{13}$C NMR (100 MHz, CDCl$_3$)
$^1$H NMR (400 MHz, CDCl$_3$)

$^{13}$C NMR (100 MHz, CDCl$_3$)
$^1$H NMR (400 MHz, CDCl$_3$)

$^{13}$C NMR (100 MHz, CDCl$_3$)
$^1$H NMR (500 MHz, CDCl$_3$)

$^{13}$C NMR (125 MHz, CDCl$_3$)
$^1$H NMR (400 MHz, CDCl$_3$)

$^{13}$C NMR (100 MHz, CDCl$_3$)
$^1$H NMR (500 MHz, CDCl$_3$)

$^{13}$C NMR (125 MHz, CDCl$_3$)
$^{1}{H}$ NMR (400 MHz, CDCl$_3$)

$^{13}$C NMR (100 MHz, CDCl$_3$)
$^1$H NMR (400 MHz, CDCl$_3$)

$^{13}$C NMR (100 MHz, CDCl$_3$)
$^1$H NMR (400 MHz, CDCl$_3$)

$^{13}$C NMR (100 MHz, CDCl$_3$)
$^1$H NMR (500 MHz, CDCl$_3$)

$^{13}$C NMR (100 MHz, CDCl$_3$)
$^1$H NMR (400 MHz, CDCl$_3$)

$^{13}$C NMR (400 MHz, CDCl$_3$)
$^1$H NMR (400 MHz, CDCl$_3$)

$^{13}$C NMR (400 MHz, CDCl$_3$)
X-ray crystal structure of 19a (CCDC 780379):

![Structure of 19a](image)

X-ray crystal structure of 19b (CCDC 780380):

![Structure of 19b](image)
X-ray crystal structure of 23 (CCDC 780381):

X-ray crystal structure of 35 (CCDC 780382):
X-ray crystal structure of 40b (CCDC 791298):

![X-ray structure of 40b](image1)

NOE study of diketopiperazines 39a and 39b:

![NOE study of 39a and 39b](image2)
References for the Supporting Information: