Supporting information for:

Palladium Catalyzed Enantioselective C-3 Allylation of 3-Substituted-1*H*-indoles

using Trialkylboranes

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EXPERIMENTAL

General.

All solvents were dried by passing through an alumina column before use. Flash chromatography was performed with EM Science silica gel (0.040-0.063 μm grade). Analytical thin-layer chromatography was performed with 0.2 mm coated commercial silica gel plates (E.Merck, DC-Plasrikfolien, kieselgel 60 F254). Melting points were obtained on a Thomas-Hoover apparatus in open capillary tubes and are uncorrected. Infrared spectra were recorded on a Perkin-Elmer-Paragon 500 FTIR apparatus with automatic background subtraction. ^1H NMR and spectra were recorded on Varian Inova 500 (500 MHz) and Mercury 400 (400 MHz) spectrometers. All spectra are referenced to the residual solvent peak (7.26 ppm for CDCl_3). Chemical shifts (δ) are quoted in parts per million (ppm) and coupling constants (J) are recorded in Hertz (Hz). ^{13}C NMR and spectra were recorded on Varian Inova 500 (125 MHz) and Mercury 400 (100 MHz) spectrometers. All spectra are referenced to the residual solvent peak (77.0 ppm for CDCl_3). Chemical shifts (δ) are quoted in parts per million (ppm). Low and high resolution mass spectra were recorded by the mass spectroscopy facility, school of pharmacy, University of California San Francisco. Chiral HPLC analyses were performed on a Thermo Separation Products Spectra Series P-100 or 200 and UV100 (254 nm) using Chiralcel® columns (OD, OJ, AD, OC) eluting with heptane / *iso*-propanol mixtures as indicated. Optical rotations were measured on a Jasco DIP-1000 digital polarimeter using

5 cm cells and the sodium D line (589 nm) at ambient temperature in the solvent and concentration indicated. Substrates **3b-c**,^{S1} **3e**,^{S2} **9a**,^{S3} **9b**,^{S4} **11b**,^{S5} **15**,^{S6} were synthesized according to literature procedures.

5-Methoxy-3-methyl-1H-indole 1.

To a well stirred mixture of *N*-benzylanisidine (7.04 g, 33 mmol) and NEt₃ (16.7 mL, 120 mmol) at 80 °C was added chloroacetone (8.36 mL, 105 mmol) dropwise over 1 h 30. The mixture was then cooled to 0 °C and diluted with EtOH (20 mL). Flame dried zinc chloride (28.95 g, 212 mmol) was then added and the mixture was stirred at 110 °C for 4 h and cooled down to rt. The mixture was quenched with ice-water (50 mL) and CH₂Cl₂ (100 mL) was added. The organic layer was separated and filtered on a pad of silica gel. The solvent was concentrated under reduced pressure and the residue was purified by flash chromatography on silica gel (PE/EtOAc, 95:5) to give the *N*-benzylindole (5.54 g, 68 %) as a white solid.

In THF (40 mL) was condensed NH₃ (105 mL) at -78 °C followed by addition of Na (1.67 g, 72.6 mmol). A solution of the *N*-benzylindole (3g, 12.1 mmol) in THF (40 mL) was then added dropwise and the mixture was stirred at -33 °C for 1 h 30. Isoprene was then added at -78 °C until decoloration of the mixture followed by NH₄Cl (4g). The solvent was evaporated under reduced pressure, H₂O (80 mL) was added and the mixture was extracted with Et₂O (3 x 60 mL). The combined organic layers were dried (MgSO₄),

filtered and concentrated. The residue was purified by flash chromatography on silica gel (PE/EtOAc, 93:7) to give **1** (1.61 g, 83 %) as an orange solid identical to previously described material.^{S7} Mp = 66-67 °C

4-(5-methoxy-1H-Indol-3-yl)-butan-2-one **3d**.

To a solution of 5-methoxyindole (736 mg, 5 mmol) in CH_3CN (10 mL) was added successively methylvinylketone (410 μL , 5 mmol) and $\text{Bi}(\text{OTf})_3$ (98 mg, 0.15 mmol) and the resulting mixture was stirred 3 h at rt. The catalyst was filtered and the filtrate was concentrated under reduced pressure. **3d** was obtained in 72 % yield after purification by flash chromatography on silica gel (gradient elution 9:1 to 75:25, PE/EtOAc). Analysis didn't match the reported values.^{S8} Mp = 107-108°C. R_f (PE/EtOAc, 7:3) = 0.27. ^1H NMR (CDCl_3 , 400 MHz) δ = 7.86 (bs, 1H), 7.24 (dd, J = 0.6, 8.8 Hz, 1H), 7.02 (d, J = 2.4 Hz, 1H), 6.98-6.95 (m, 1H), 6.86 (dd, J = 2.4, 8.8 Hz, 1H), 3.87 (s, 3H), 3.04-2.99 (m, 2H), 2.87-2.82 (m, 2H), 2.16 (s, 3H). ^{13}C NMR(CDCl_3 , 125 MHz) δ = 208.8, 153.9, 131.4, 127.5, 122.2, 114.9, 112.2, 111.8, 100.5, 55.9, 43.9, 30.1, 19.3. IR (thin film, cm^{-1}) 3366, 2884, 1763, 1487, 1452, 1316, 1276, 1212, 1174, 1082, 1040, 1022, 914, 821, 819, 777, 744. HRMS (EI+) m/z calculated for $\text{C}_{13}\text{H}_{15}\text{NO}_2$ [M^+]: 217.1103, 217.1104.

General procedure A for conjugate addition of methylvinylketone to indoles : synthesis of 3a and 3h-j. The synthesis of 4-(5-nitro-1H-Indol-3-yl)-butan-2-one 3a is representative.^{S9}

To a solution of 5-nitroindole (1.62 mg, 10 mmol) in CH₂Cl₂ (20 mL) was added successively methylvinylketone (820 µL, 10 mmol) and InCl₃ (221 mg, 1 mmol) and the resulting mixture was stirred 4 h at rt. The mixture was diluted in H₂O (10 mL) and the aqueous layer was extracted with CH₂Cl₂ (3 x 5 mL). The combined organic layers were dried (MgSO₄), filtered and concentrated under reduced pressure. The residue was purified by flash chromatography on silica gel (gradient elution 9:1 to 7:3, PE/EtOAc) to give **3a** (1.43 g, 71%) as a yellow solid. Mp = 123-124 °C. R_f (PE/EtOAc, 7:3) = 0.15. ¹H NMR (CDCl₃, 400 MHz) δ = 8.57 (q, *J* = 0.8 Hz, 1H), 8.47 (bs, 1H), 8.10 (dd, *J* = 2.0, 9.0 Hz, 1H), 7.38 (dd, *J* = 0.8, 9.0 Hz, 1H), 7.17-7.15 (m, 1H), 3.12-3.04 (m, 2H), 2.87 (t, *J* = 7.2 Hz, 2H), 2.17 (s, 3H). ¹³C NMR (CDCl₃, 100 MHz) δ = 208.0, 141.5, 139.2, 126.7, 124.7, 117.9, 116.1, 111.1, 43.7, 30.1, 18.8. IR (thin film, cm⁻¹) 3296, 2901, 2856, 1694, 1648, 1624, 1582, 1474, 1459, 1408, 1374, 1325, 1238, 1169, 1127, 1106, 1061, 1023, 878, 836, 820, 804, 791, 756, 741. HRMS (EI⁺) *m/z* calculated for C₁₂H₁₂N₂O₃ [M⁺]: 232.0848, found: 232.0854.

4-(4-methoxy-1H-Indol-3-yl)-butan-2-one 3h.

Following general procedure A, **3h** was obtained in 59 % yield from 4-methoxyindole^{S10} after purification by flash chromatography on silica gel (gradient elution 9:1 to 75:25, PE/EtOAc) as a white solid. Mp = 114-115 °C. R_f (PE/EtOAc, 7:3) = 0.27. ¹H NMR (CDCl₃, 400 MHz) δ = 7.92 (bs, 1H), 7.09 (t, *J* = 8.0 Hz, 1H), 6.95 (dd, *J* = 0.7, 8.0 Hz, 1H), 6.86-6.84 (m, 1H), 6.51 (d, *J* = 7.6 Hz, 1H), 3.92 (s, 3H), 3.16-3.11 (m, 2H), 2.85 (t, *J* = 7.5 Hz, 2H), 2.14 (s, 3H). ¹³C NMR(CDCl₃, 100 MHz) δ = 209.6, 154.6, 138.1, 122.8, 120.3, 117.1, 115.7, 104.4, 99.3, 55.1, 45.8, 30.0, 21.4. IR (thin film, cm⁻¹) 3316, 2993, 2914, 2835, 1706, 1615, 1585, 1549, 1510, 1463, 1434, 1360, 1337, 1264, 1242, 1165, 1093, 1057, 1036, 972, 776, 744, 690. HRMS (EI+) *m/z* calculated for C₁₃H₁₅NO₂ [M⁺]: 217.1103, found: 217.1112.

4-(6-methoxy-1H-Indol-3-yl)-butan-2-one 3i.

Following general procedure A, **3i** was obtained in 43 % yield from 6-methoxyindole^{S10} after purification by flash chromatography on silica gel (gradient elution 9:1 to 75:25, PE/EtOAc) as a white solid. Mp = 84-85 °C. R_f (PE/EtOAc, 7:3) = 0.27. ¹H NMR

(CDCl₃, 500 MHz) δ = 7.84 (bs, 1H), 7.45 (d, J = 8.3 Hz, 1H), 6.88-6.86 (m, 1H), 6.84 (d, J = 2.4 Hz, 1H), 6.80 (dd, J = 2.4, 8.3 Hz, 1H), 3.84 (s, 3H), 3.03-2.99 (m, 2H), 2.86-2.81 (m, 2H), 2.14 (s, 3H). ¹³C NMR(CDCl₃, 125 MHz) δ = 208.8, 156.5, 137.0, 121.6, 120.1, 119.2, 115.1, 109.2, 94.6, 55.7, 40.1, 30.1, 19.4. IR (thin film, cm⁻¹) 3316, 2958, 2906, 2886, 2844, 1698, 1627, 1556, 1505, 1443, 1359, 1306, 1258, 1192, 1160, 1026, 844, 790, 778, 750, 630. HRMS (EI+) m/z calculated for C₁₃H₁₅NO₂ [M⁺]: 217.1103, found: 217.1098.

4-(7-methoxy-1H-Indol-3-yl)-butan-2-one **3j**.

Following general procedure A, **3j** was obtained in 62 % yield from 7-methoxyindole^{S10} after purification by flash chromatography on silica gel (gradient elution 9:1 to 75:25, PE/EtOAc) as a white solid. Mp = 84-85 °C. R_f (PE/EtOAc, 7:3) = 0.27. ¹H NMR (CDCl₃, 500 MHz) δ = 8.16 (bs, 1H), 7.20 (dd, J = 1, 7.3 Hz, 1H), 7.04 (t, J = 7.8 Hz, 1H), 6.98-6.96 (m, 1H), 6.65 (t, J = 7.8 Hz, 1H), 3.95 (s, 3H), 3.06-3.01 (m, 2H), 2.86-2.82 (m, 2H), 2.14 (s, 3H). ¹³C NMR(CDCl₃, 125 MHz) δ = 208.8, 146.2, 128.4, 126.7, 121.0, 119.7, 115.6, 111.4, 101.8, 55.3, 44.2, 30.1, 19.5. IR (thin film, cm⁻¹) 3422, 2892, 2847, 1711, 1622, 1581, 1557, 1503, 1445, 1372, 1356, 1336, 1259, 1222, 1161, 1089, 1072, 1024, 808, 783, 741. HRMS (EI+) m/z calculated for C₁₃H₁₅NO₂ [M⁺]: 217.1103, found: 217.1101.

4-(5-hydroxy-1H-Indol-3-yl)-butan-2-one **3f**.

A mixture of **3e** (370 mg, 1.26 mmol), 5 % Pd/C (126 mg) in EtOAc (12.5 mL) was stirred under H₂ overnight. The mixture was filtered on a celite pad and the filtrate was concentrated under reduced pressure. The crude product was purified by flash chromatography on silica gel (6:4, PE/EtOAc) to give **3f** (240 mg, 94 %) as a white solid. Mp = 88-90°C. R_f (PE/EtOAc, 1:1) = 0.53. ¹H NMR (CDCl₃, 500 MHz) δ = 7.86 (bs, 1H), 7.21 (d, *J* = 9.0 Hz, 1H), 6.97 (dd, *J* = 2.4, 6.4 Hz, 2H), 6.77 (dd, *J* = 2.4, 9.0 Hz, 1H), 4.82 (bs, 1H), 3.06-2.96 (m, 2H), 2.85-2.80 (m, 2H), 2.15 (s, 3H). ¹³C NMR(CDCl₃, 125 MHz) δ = 209.1, 149.3, 131.5, 127.9, 122.6, 114.6, 111.8, 103.2, 43.9, 30.1, 19.3. IR (thin film, cm⁻¹) 3406, 3060, 3027, 2916, 1709, 1626, 1603, 1583, 1552, 1493, 1452, 1359, 1296, 1203 1162, 1071, 1028, 960, 788, 733, 698. HRMS (EI+) *m/z* calculated for C₁₂H₁₃NO₂ [M+]: 203.0946, found: 203.0940.

4-(5-dibenzylamino-1H-Indol-3-yl)-butan-2-one **3g**.

A mixture of **3a** (929 mg, 4 mmol), 10 % Pd/C (400 mg) in EtOAc (20 mL) was stirred under H₂ overnight. The mixture was filtered on a celite pad and the filtrate was

concentrated under reduced pressure. The crude amine was dissolved in CH₃CN (20 mL) and Et₃N (1.22 mL, 8.8 mmol) and BnBr (1.43 mL, 12 mmol) were added and the mixture was relaxed under N₂ for 12 h. The mixture was then diluted in EtOAc (100 mL), washed with sat. aq. NaHCO₃ (3 x 30 mL), brine (30 mL), dried (MgSO₄), filtered and concentrated. The crude product was purified by flash chromatography on silica gel (gradient elution 9:1 to 7:3, PE/EtOAc) to give **3g** (765 mg, 50 %) as a white solid. Mp = 114-115 °C. R_f (PE/EtOAc, 7:3) = 0.36. ¹H NMR (CDCl₃, 500 MHz) δ = 7.69 (bs, 1H), 7.35-7.21 (m, 10H), 7.19-7.16 (m, 1H), 6.88 (d, *J* = 2.4 Hz, 1H), 6.86-6.82 (m, 2H), 4.62 (s, 4H), 2.88 (t, *J* = 7.3 Hz, 2H), 2.65 (t, *J* = 7.3 Hz, 2H), 2.05 (s, 3H). ¹³C NMR (CDCl₃, 125 MHz) δ = 209.2, 143.9, 139.7, 130.6, 128.7, 128.1, 127.5, 127.0, 122.2, 114.6, 112.6, 111.9, 103.1, 56.1, 44.0, 30.3, 19.6. IR (thin film, cm⁻¹) 3406, 3060, 3027, 2916, 1709, 1626, 1603, 1583, 1552, 1493, 1452, 1359, 1296, 1203 1162, 1071, 1028, 960, 788, 733, 698. HRMS (EI⁺) *m/z* calculated for C₂₆H₂₆N₂O [M⁺]: 382.2045, found: 382.2057.

2-(5-Methoxy-1H-indol-3-ylmethyl)-phenylamine **5**.

Following Zhu's procedure:^{S10} A mixture of 5-methoxyindole (441.5 mg, 3 mmol), Zn(OTf)₃ (1.09 g, 3 mmol), tetrabutylammonium iodide (923 mg, 2.5 mmol) and diisopropylethylamine (958 μL, 5.5 mmol) in toluene (9 mL) was stirred at rt for 15 min. Then, 1-Bromo-3-methyl-but-2-ene (291 μL, 2.5 mmol) was added *via* syringe pump over 1h30. The reaction mixture was stirred further for 4h at rt. Sat. NH₄Cl (3 mL) was then added and the mixture was extracted with Et₂O (3 x 5 mL). The combined organic

layers were washed with brine (5 mL), dried (MgSO₄), filtered and concentrated. The crude product was purified by flash chromatography on silica gel (97:3, PE/EtOAc) to give a 97:3 mixture of **5** and its γ,γ -isomer (280 mg, 52 %) as a yellow oil. R_f (PE/EtOAc, 9:1) = 0.59. Major isomer: ¹H NMR (CDCl₃, 500 MHz) δ = 7.80 (bs, 1H), 7.24 (d, *J* = 8.3 Hz, 1H), 7.03 (d, *J* = 2.0 Hz, 1H), 6.95-6.93 (m, 1H), 6.95 (dd, *J* = 2.4, 8.8 Hz, 1H), 5.46-5.41 (m, 1H), 3.87 (s, 3H), 3.42 (d, *J* = 7.3 Hz, 2H), 1.78 (s, 3H), 1.76 (s, 3H). ¹³C NMR (CDCl₃, 125 MHz) δ = 153.7, 131.9, 131.6, 127.7, 122.9, 122.0, 115.8, 112.0, 111.7, 100.8, 55.9, 25.7, 24.1, 17.8. IR (neat, cm⁻¹) 3416, 2966, 2912, 2830, 1673, 1625, 1584, 1485, 1454, 1440, 1376, 1348, 1322, 1297, 1278, 1254, 1213, 1173, 1126, 1092, 1056, 1033, 927, 829, 794, 697, 606. HRMS (EI⁺) *m/z* calculated for C₁₄H₁₇NO [M⁺]: 215.1310, found: 215.1306.

3-Benzyl-5-methoxy-1H-indole **7**.

LiAlH₄ (76 mg, 2 mmol) was added portionwise to a suspension of 3-Benzoyl-5-methoxy-1H-indole^{S11} in Et₂O (15 mL) and the mixture was refluxed for 4h. After cooling down to rt, 40 % KOH (3 mL) followed by H₂O (5 mL) were then added slowly and the mixture was stirred at rt for 15 min. The mixture was then diluted with H₂O (20 mL) and extracted with Et₂O (3 x 20 mL). The combined organic layers were washed with brine (20 mL), dried (MgSO₄), filtered and concentrated. The crude product was purified by flash chromatography on silica gel (9:1, PE/EtOAc) to give **7** (147 mg, 77 %) as a white solid which was identical to the previously described material.^{S12}

2-(5-Methoxy-1H-indol-3-ylmethyl)-phenol **13**.

Following Decodts's procedure:^{S13} A mixture of 5-methoxyindole (441.5 mg, 3 mmol) and 2-hydroxybenzylalcohol (186 mg, 1.5 mmol) was heated in a sealed tube at 170°C for 4h. After cooling down, the residue was taken up in CH₂Cl₂ (20 mL), dried over Na₂SO₄, filtered and concentrated. The crude product was purified by flash chromatography on silica gel (gradient elution, 9:1 to 85:15, PE/EtOAc) to give **13** (252 mg, 66 %) as a pale yellow solid. Mp = 77-78°C. R_f (PE/EtOAc, 7:3) = 0.36. ¹H NMR (CDCl₃, 400 MHz) δ = 7.93 (bs, 1H), 7.28-7.23 (m, 2H), 7.16 (dt, *J* = 1.5, 7.7 Hz, 1H), 6.98-6.81 (m, 5H), 5.05 (bs, 1H), 4.09 (s, 2H), 3.80 (s, 3H). ¹³C NMR (CDCl₃, 100 MHz) δ = 154.3, 154.0, 131.8, 130.5, 127.8, 127.5, 126.2, 123.1, 120.8, 116.0, 113.0, 112.7, 111.9, 100.9, 55.8, 26.9. IR (neat, cm⁻¹) 3416, 1584, 1486, 1453, 1352, 1212, 1169, 1092, 1052, 1022, 924, 800, 755. HRMS (EI+) *m/z* calculated for C₁₆H₁₆N₂O [M⁺]: 253.1103, found: 253.1095.

2-[2-(5-Methoxy-1H-indol-3-yl)-ethyl]-malonic acid dimethyl ester **19**.

To a solution of 5-methoxytryptophol **11b** (478 mg, 2.5 mmol) in benzene (40 mL) were successively added imidazole (206.5 mg, 3 mmol), PPh₃ (720 mg, 2.75 mmol) and iodine

(698 mg, 2.75 mmol). After stirring at rt for 4h, the reaction mixture was quenched with a 1:1 solution of sat. aq. $\text{Na}_2\text{S}_2\text{O}_3$ and sat. aq. NaHCO_3 (50 mL). The organic layer was separated and the aqueous layer was extracted with Et_2O (3 x 20 mL). The combined organic layers were washed with brine (30 mL), dried (MgSO_4), filtered and concentrated. The crude product was purified by flash chromatography on silica gel (95:5, PE/EtOAc) to give (670 mg, 89 %) the iodine derivative as a white solid.

To a suspension of NaH (164 mg, 4.14 mmol) in THF (10 mL) at 0°C was added dropwise dimethylmalonate (493 μL , 4.32 mmol). After 15 min stirring, a solution of the iodide (650 mg, 2.16 mmol) in THF (12 mL) was added and the mixture was refluxed for 24h. After cooling to room temperature, an ice-cold solution of brine (15 mL) was added and the mixture was extracted with Et_2O (3 x 20 mL). The combined organic layers were dried (MgSO_4), filtered and concentrated. The crude product was purified by flash chromatography on silica gel (8:2, PE/EtOAc) to give **17** (530 mg, 80 %) as a pale yellow oil. R_f (PE/EtOAc, 7:3) = 0.27. ^1H NMR (CDCl_3 , 500 MHz) δ = 7.89 (bs, 1H), 7.24 (d, J = 8.8 Hz, 1H), 7.04 (d, J = 2.4, 1H), 6.98 (d, J = 2.4, 1H), 6.85 (dd, J = 2.4, 8.8 Hz, 1H), 3.87 (s, 3H), 3.73 (s, 6H), 3.47 (t, J = 7.5 Hz, 1H), 2.78 (t, J = 7.5 Hz, 2H), 2.78 (q, J = 7.5 Hz, 2H). ^{13}C NMR (CDCl_3 , 125 MHz) δ = 169.9, 153.9, 131.4, 127.6, 122.5, 114.3, 112.2, 111.8, 100.5, 55.9, 52.5, 51.1, 29.0, 22.8. IR (neat, cm^{-1}) 3412, 2999, 2953, 2833, 1732, 1624, 1585, 1486, 1439, 1293, 1216, 1165, 1066, 1037, 924, 831, 799, 627. HRMS (EI+) m/z calculated for $\text{C}_{16}\text{H}_{19}\text{NO}_5$ [M^+]: 305.1263, found: 305.1251.

2-[3-(5-Methoxy-1H-indol-3-yl)-propyl]-malonic acid dimethyl ester **19.**

To a solution of alcohol **15** (924 mg, 4.5 mmol) in benzene (70 mL) were successively added imidazole (372 mg, 5.4 mmol), PPh₃ (1.3 g, 4.95 mmol) and iodine (1.26 g, 4.95 mmol). After stirring at rt for 4h, the reaction mixture was quenched with a 1:1 solution of sat. aq. Na₂S₂O₃ and sat. aq. NaHCO₃ (100 mL). The organic layer was separated and the aqueous layer was extracted with EtOAc (3 x 20 mL). The combined organic layers were washed with brine (30 mL), dried (MgSO₄), filtered and concentrated. The crude product was purified by flash chromatography on silica gel (9:1, PE/EtOAc) to give the iodide (1.2 g, 85 %) as a yellow oil.

To a suspension of NaH (114 mg, 2.85 mmol) in THF (10 mL) at 0°C was added dropwise dimethylmalonate (343 µL, 3 mmol). After 15 min stirring, a solution of the iodide (473 mg, 1.5 mmol) in THF (10 mL) was added and the mixture was refluxed for 16h. After cooling to room temperature, an ice-cold solution of brine (15 mL) was added and the mixture was extracted with EtOAc (2 x 30 mL). The combined organic layers were dried (MgSO₄), filtered and concentrated. The crude product was purified by flash chromatography on silica gel (8:2, PE/EtOAc) to give **19** (410 mg, 86 %) as a white solid. Mp = 49-51°C. R_f (PE/EtOAc, 7:3) = 0.33. ¹H NMR (CDCl₃, 400 MHz) δ = 7.84 (bs, 1H), 7.24 (dd, *J* = 0.5, 8.8 Hz, 1H), 7.01 (d, *J* = 2.4, 1H), 6.98-6.96 (m, 1H), 6.85 (ddd, *J* = 0.5, 2.4, 8.8 Hz, 1H), 3.87 (s, 3H), 3.72 (s, 6H), 3.42 (t, *J* = 7.6 Hz, 1H), 2.76 (dt, *J* = 6.7, 7.5 Hz, 2H), 2.06 (m, 2H), 1.78 (m, 2H). ¹³C NMR(CDCl₃, 125 MHz) δ = 169.9, 153.8, 131.5, 127.7, 122.1, 115.6, 112.1, 111.7, 100.7, 55.9, 52.5, 51.6, 28.7, 27.5, 24.7. IR (neat, cm⁻¹) 3412, 2999, 2952, 2846, 1732, 1623, 1585, 1486, 1455, 1437, 1346,

1293, 1270, 1215, 1174, 1154, 1071, 1028, 924, 832, 797, 609. HRMS (EI+) m/z calculated for $C_{17}H_{21}NO_5$ $[M+]$: 319.1420, found: 319.1405.

2-(5-Methoxy-1H-indol-3-ylmethyl)-phenylamine **21**.

A mixture of 5-methoxyindole (736 mg, 5 mmol) and 2-aminobenzylalcohol (308 mg, 2.5 mmol) was heated in a sealed tube at 170°C for 8h. After cooling down, the residue was taken up in CH_2Cl_2 (40 mL), dried over Na_2SO_4 , filtered and concentrated. The crude product was purified by flash chromatography on silica gel (gradient elution, 9:1 to 1:1, CH_2Cl_2 /EtOAc) to give the aniline (372 mg, 59 %) as a white solid.

To a solution of the aniline (208 mg, 0.82 mmol) in dioxane (8.2 mL) was added 0.5 N NaOH (4.1 mL) followed by Boc_2O (313 mg, 1.43 mmol) and the mixture was vigorously stirred overnight. The mixture was diluted in EtOAc (40 mL), washed with H_2O (15 mL), brine (15 mL), dried ($MgSO_4$), filtered and concentrated. The crude product was purified by flash chromatography on silica gel (gradient elution, 9:1 to 7:3, PE/EtOAc) to give **21** (274 mg, 94 %) as a white solid. Mp = 156-158 °C. R_f (PE/EtOAc, 8:2) = 0.33. 1H NMR ($CDCl_3$, 500 MHz) δ = 7.97 (bs, 1H), 7.81 (d, J = 7.3 Hz, 1H), 7.29-7.23 (m, 3H), 7.06 (dt, J = 1.0, 7.3 Hz, 1H), 6.96 (d, J = 2.4 Hz, 1H), 6.88 (dd, J = 2.4, 8.8 Hz, 1H), 6.79-6.76 (m, 1H), 6.50 (bs, 1H), 4.02 (s, 2H), 3.82 (s, 3H), 1.45 (s, 9H). ^{13}C NMR($CDCl_3$, 125 MHz) δ = 154.0, 153.2, 136.4, 131.6, 130.2, 130.1, 127.4, 127.2, 123.8, 123.0, 121.9, 113.1, 112.5, 111.9, 100.6, 80.2, 55.8, 28.4, 28.4. IR (neat, cm^{-1}) 3436, 3088, 3064, 3031, 2975, 2930, 2856, 1732, 1497, 1454, 1418, 1374, 1234,

1163, 1102, 1026, 890, 853, 816, 735, 698. HRMS (EI+) m/z calculated for $C_{21}H_{24}N_2O_3$ [M⁺]: 352.1787, found: 352.1797.

General procedure B : asymmetric allylation : (3*S*)-3-Allyl-5-methoxy-3-methyl-3*H*-indole 2 is representative.

Borane generation : A 5 mL rb flask was charged with 9-BBN (25.6 mg, 0.105 mmol) and the flask was flushed with nitrogen. THF (420 μ L) was added, followed by 1-hexene (31 μ L, 0.25 mmol, distilled from sodium) and the mixture was stirred at rt for 4 h.

A flask was charged with $[Pd_2(dba)_3 \cdot CHCl_3]$ (5.16 mg, 0.005 mmol), (*S,S*)-**A** (12.2 mg, 0.015 mmol) and indole **1** (32.2 mg, 0.2 mmol) and was flushed with nitrogen. Dry CH_2Cl_2 (2 mL, degassed by freeze-pump-thaw) was added and the mixture was stirred for 15 min. Then, the borane solution was added and the suspension stirred further for 5 min and cooled to 0 $^{\circ}C$. Allyl alcohol (41 μ L, 0.6 mmol) was then added dropwise and the resulting solution was stirred for 20h at 4 $^{\circ}C$.

Workup A : the reaction mixture was diluted with EtOAc (5 mL). 2N NaOH (2 mL) was added and the heterogeneous mixture was vigorously stirred for 2 h. The organic layer was separated and washed with sat. aq. Na_2CO_3 (2 mL), brine (2 mL), dried ($MgSO_4$), filtered and concentrated under reduced pressure.

Workup B: the mixture was concentrated under reduced pressure and taken up in 2 mL THF. Ethanolamine (18 μ L, 3 mmol) was added and the mixture stirred for 2h. The mixture was filtered and the solids were washed with EtOAc (15 mL). The filtrate was

washed with sat. aq. Na₂CO₃ (3 x 5 mL), brine (5 mL), dried (MgSO₄), filtered and concentrated under reduced pressure.

The residue was purified by flash chromatography on silica gel (gradient elution 9:1 to 7:3, PE/EtOAc) to give **2** (36.2 mg, 92%) as a yellow oil. *R*_f (PE/EtOAc, 7:3) = 0.27. $[\alpha_D]^{22.9}$ (c 1.07, CH₂Cl₂) = -136.7°. ¹H NMR (CDCl₃, 500 MHz) δ = 7.90 (s, 1H), 7.52 (dd, *J* = 5.4, 3.7 Hz, 1H), 6.86-6.83 (m, 2H), 5.52 (dddd, *J* = 17.1, 10.1, 7.5, 7.1, 1H), 5.05-4.97 (m, 2H), 3.84 (s, 3H), 2.51-2.41 (m, 2H), 1.33 (s, 3H). ¹³C NMR (CDCl₃, 125 MHz) δ = 176.8, 158.5, 148.6, 145.0, 132.7, 121.4, 118.6, 112.2, 108.4, 57.1, 55.7, 40.4, 19.8. IR (thin film, cm⁻¹) 3074, 2962, 2932, 2833, 1639, 1610, 1592, 1555, 1484, 1434, 1385, 1327, 1279, 1213, 1179, 1040, 996, 918, 867, 807, 744, 700. HRMS (EI+) *m/z* calculated for C₁₃H₁₅NO [M⁺]: 201.1154, found: 201.1150.

Enantiomeric excess was determined after reduction of a small quantity of material : a few mg of **2** were dissolved in a few drops of MeOH. NaBH₃CN (a small scoop) was added and the mixture was stirred at rt for 20 min. The mixture was diluted in Et₂O (3 mL) and sat. aq. NaHCO₃ (1 mL) was added. The organic layer was separated, dried (MgSO₄), filtered on a pad of silica gel and concentrated under reduced pressure. The ee was determined to be 85 % ee by chiral HPLC (Chiralpak AD, 99:1 heptane:*i*PrOH, 1.0 mL/min, 19.25 min minor, 22.18 min major).

(3S)-4-(3-Allyl-5-bromo-3H-indol-3-yl)-butan-2-one 4b. JQV43.

Following general procedure B for asymmetric allylation of **3b** and workup A, the crude product was purified by flash chromatography on silica gel (gradient elution 8:2 to 6:4, PE/EtOAc) to give **4b** (89 %) as a yellow oil. Enantiomeric excess was determined to be 60 % by chiral HPLC (Chiralpak OD, 98:2 heptane:*i*PrOH, 0.8 mL/min, 29.01 min minor, 30.33 min major). R_f (PE/EtOAc, 1:1) = 0.35. $[\alpha_D]^{23.7}$ (c 0.18, CH₂Cl₂) = -17.9°. ¹H NMR (CDCl₃, 500 MHz) δ = 7.94 (s, 1H), 7.50 (d, J = 1.0 Hz, 2H), 7.39-7.37 (m, 1H), 5.43 (ddt, J = 7.3, 10.3, 17.1 Hz, 1H), 5.05-4.97 (m, 2H), 2.58-2.46 (m, 2H), 2.33 (ddd, J = 5.9, 9.3, 15.1 Hz, 1H), 2.11 (ddd, J = 5.9, 9.3, 15.1 Hz, 1H), 1.93 (s, 3H), 1.93-1.78 (m, 2H). ¹³C NMR(CDCl₃, 125 MHz) δ = 207.3, 178.2, 154.6, 142.9, 131.5, 131.3, 122.6, 125.5, 120.4, 119.4, 61.4, 39.6, 37.7, 30.0, 27.2. IR (neat, cm⁻¹) 3408, 3076, 3009, 2971, 2921, 2848, 1716, 1640, 1579, 1552, 1445, 1415, 1367, 1168, 1063, 920, 823. HRMS (EI+) m/z calculated for C₁₅H₁₆BrNO [M⁺]: 305.0415, found: 305.0429.

(3S)-4-(3-Allyl-3H-indol-3-yl)-butan-2-one 4c.

Following general procedure B for asymmetric allylation of **3c** and workup A, the crude product was purified by flash chromatography on silica gel (gradient elution 8:2 to 6:4, PE/EtOAc) to give **4c** (92 %) as a yellow oil. Enantiomeric excess was determined to be 74 % by chiral HPLC (Chiralpak AD, 97:3 heptane:*i*PrOH, 1 mL/min, 22.65 min major, 25.75 min minor). R_f (PE/EtOAc, 7:3) = 0.16. $[\alpha_D]^{24.3}$ (c 1, CH₂Cl₂) = -23.4°. ¹H NMR (CDCl₃, 500 MHz) δ = 7.97 (s, 1H), 7.63 (d, J = 7.8 Hz, 1H), 7.36 (dt, J = 1.5, 7.8 Hz,

1H), 7.29-7.23 (m, 2 H), 5.45 (ddt, $J = 7.3, 10.3, 17.0$ Hz, 1H), 5.03-4.94 (m, 2H), 2.59-2.48 (m, 2H), 2.31 (ddd, $J = 5.8, 9.5, 15.1$ Hz, 1H), 2.17 (ddd, $J = 5.8, 9.5, 15.1$ Hz, 1H), 1.90 (ddd, $J = 5.8, 9.5, 15.1$ Hz, 1H), 1.88 (s, 3H), 1.77 (ddd, $J = 5.8, 9.5, 15.1$ Hz, 1H). ^{13}C NMR(CDCl_3 , 125 MHz) $\delta = 207.7, 177.9, 155.6, 140.5, 132.1, 128.1, 126.3, 122.1, 121.2, 118.9, 60.9, 39.7, 37.7, 30.0, 27.3$ IR (neat, cm^{-1}) 3413, 3076, 3007, 2924, 2860, 1715, 1640, 1609, 1592, 1556, 1455, 1415, 1368, 1282, 1212, 1168, 1167, 1014, 923, 920, 891, 845, 761, 715, 666. HRMS (EI+) m/z calculated for $\text{C}_{15}\text{H}_{17}\text{NO}$ $[\text{M}^+]$: 227.1310, found: 227.1306.

(3S)-4-(3-Allyl-5-methoxy-3H-indol-3-yl)-butan-2-one 4d.

Following general procedure B for asymmetric allylation of **3d** and workup A, the crude product was purified by flash chromatography on silica gel (gradient elution 8:2 to 6:4, PE/EtOAc) to give **4d** (95 %) as a yellow oil. Enantiomeric excess was determined to be 84 % by chiral HPLC (Chiralpak OD, 97:3 heptane:*i*PrOH, 0.8 mL/min, 27.55 min minor, 29.33 min major). R_f (PE/EtOAc, 7:3) = 0.24. $[\alpha_D]^{22.3}$ (c 0.47, CH_2Cl_2) = -23.7° . ^1H NMR (CDCl_3 , 500 MHz) $\delta = 7.83$ (s, 1H), 7.52 (d, $J = 8.5$ Hz, 1H), 6.87 (dd, $J = 2.5, 8.5$ Hz, 1H), 6.78 (d, $J = 2.5$ Hz, 1H), 5.44 (tdd, $J = 6.3, 10.1, 17.0$ Hz, 1H), 5.01 (ddd, $J = 1.3, 3.0, 17.0$ Hz, 1H), 4.98-4.94 (m, 1H), 3.83 (s, 3H), 2.50 (dq, $J = 7.3, 13.8$ Hz, 2H), 2.29 (ddd, $J = 5.5, 9.7, 14.1$ Hz, 1H), 2.10 (ddd, $J = 5.5, 9.7, 14.1$ Hz, 1H), 1.91 (ddd, $J = 5.5, 9.7, 18.2$ Hz, 1H), 1.90 (s, 3H), 1.78 (ddd, $J = 5.5, 9.7, 18.2$ Hz, 1H). ^{13}C

NMR(CDCl₃, 125 MHz) δ = 207.8, 175.6, 158.7, 149.3, 142.3, 132.1, 121.5, 118.8, 112.7, 108.6, 60.9, 55.7, 39.9, 37.8, 30.0, 27.5. IR (neat, cm⁻¹) 3412, 3077, 3003, 2923, 2836, 1715, 1640, 1610, 1592, 1554, 1471, 1437, 1368, 1336, 1277, 1252, 1230, 1210, 1177, 112, 1053, 1027, 993, 920, 873, 820. HRMS (EI+) *m/z* calculated for C₁₆H₁₉NO₂ [M⁺]: 257.1416, found: 257.1407.

(3S)-4-(3-Allyl-5-benzyloxy-3H-indol-3-yl)-butan-2-one 4e.

Following general procedure B for asymmetric allylation of **3e** and workup A, the crude product was purified by flash chromatography on silica gel (gradient elution 8:2 to 6:4, PE/EtOAc) to give **4e** (87 %) as a yellow oil. Enantiomeric excess was determined to be 83 % by chiral HPLC (Chiralpak OD, 90:10 heptane:*i*PrOH, 0.8 mL/min, 17.55 min minor, 19.16 min major). *R_f* (PE/EtOAc, 1:1) = 0.26. [α_D]^{22.3} (c 0.86, CH₂Cl₂) = - 16.0°. ¹H NMR (CDCl₃, 500 MHz) δ = 7.84 (s, 1H), 7.53 (d, *J* = 8.4 Hz, 1H), 7.46-7.43 (m, 2H), 7.42-7.37 (m, 2H), 7.36-7.31 (m, 1H), 6.97 (dd, *J* = 2.5, 8.5 Hz, 1H), 6.86 (d, *J* = 2.5 Hz, 1H), 5.44 (tdd, *J* = 7.3, 10.1, 17.1 Hz, 1H), 5.08 (ABq, *J* = 2.5 Hz, $\Delta\nu$ = 0 Hz, 2H), 5.02-4.94 (m, 2H), 2.50 (ddd, *J* = 7.3, 12.7, 13.7 Hz, 2H), 2.32-2.25 (m, 1H), 2.09 (ddd, *J* = 5.4, 9.8, 14.4 Hz, 1H), 1.91 (s, 3H), 1.91 (ddd, *J* = 5.7, 9.9, 17.9 Hz, 1H), 1.78 (ddd, *J* = 5.7, 9.9, 17.9 Hz, 1H). ¹³C NMR(CDCl₃, 125 MHz) δ = 207.7, 175.8, 157.9, 149.5, 142.3, 136.7, 132.1, 128.6, 128.1, 127.6, 121.6, 118.9, 113.9, 109.6, 70.5, 60.9, 39.9, 37.8, 30.0, 27.5. IR (neat, cm⁻¹) 3409, 3072, 3032, 2922, 1715, 1609, 1590, 1553,

1497, 1462, 1370, 1334, 1277, 1226, 1180, 1021, 920, 874, 814, 740, 698. HRMS (EI+) m/z calculated for $C_{22}H_{23}NO_2$ $[M+]$: 333.1729, found: 333.1730.

(3S)-4-(3-Allyl-5-hydroxy-3H-indol-3-yl)-butan-2-one 4f.

Following general procedure B for asymmetric allylation of **3f** and workup A, the crude product was purified by flash chromatography on silica gel (gradient elution 8:2 to 5:5, PE/EtOAc) to give **4f** (88%) as a yellow oil. Enantiomeric excess was determined to be 86 % by chiral HPLC (Chiralpak AD, 90:10 heptane:*i*PrOH, 1 mL/min, 14.47 min major, 19.59 min minor). R_f (PE/EtOAc, 1:1) = 0.18. $[\alpha_D]^{25.2}$ (c 1.43, CH_2Cl_2) = -37.3° . 1H NMR ($CDCl_3$, 500 MHz) δ = 7.98 (bs, 1H), 7.86 (s, 1H), 7.46 (d, J = 8.3 Hz, 1H), 6.83 (dd, J = 2.5, 8.3 Hz, 1H), 6.78 (d, J = 2.5 Hz, 1H), 5.45 (tdd, J = 7.3, 10.1, 17.1 Hz, 1H), 5.05-4.95 (m, 2H), 2.52 (ddd, J = 7.3, 13.8, 15.5 Hz, 2H), 2.30 (ddd, J = 5.6, 9.6, 14.2 Hz, 1H), 2.15-2.08 (m, 1H), 1.95 (ddd, J = 5.6, 9.6, 18.2 Hz, 1H), 1.92 (s, 3H), 1.84 (ddd, J = 5.6, 9.6, 18.2 Hz, 1H). ^{13}C NMR($CDCl_3$, 125 MHz) δ = 208.1, 175.5, 155.7, 148.2, 132.0, 121.6, 119.0, 114.8, 110.1, 60.9, 39.9, 37.8, 30.0, 27.6. IR (neat, cm^{-1}) 3124, 3077, 2981, 2925, 2856, 2713, 2650, 2507, 1714, 1640, 1594, 1557, 1462, 1415, 1369, 1265, 1222, 1182, 1111, 1048, 993, 922, 868, 822, 736, 704, 622. HRMS (EI+) m/z calculated for $C_{15}H_{17}NO_2$ $[M+]$: 243.1259, found: 243.1255.

(3S)-4-(3-Allyl-5-dibenzylamino-3H-indol-3-yl)-butan-2-one 4g.

Following general procedure B for asymmetric allylation of **3g** and workup A, the crude product was purified by flash chromatography on silica gel (gradient elution 8:2 to 6:4, PE/EtOAc) to give **4e** (94 %) as a yellow oil. Enantiomeric excess was determined to be 90 % by chiral HPLC (Chiralpak AD, 90:10 heptane:*i*PrOH, 1 mL/min, 23.20 min minor, 41.60 min major). R_f (PE/EtOAc, 1:1) = 0.38. $[\alpha_D]^{25.6}$ (c 0.99, CH₂Cl₂) = 33.1°. ¹H NMR (CDCl₃, 500 MHz) δ = 7.69 (s, 1H), 7.41 (d, J = 8.3 Hz, 1H), 7.36-7.30 (m, 4H), 7.28-7.22 (m, 6H), 6.72 (dd, J = 2.4, 8.3 Hz, 1H), 6.54 (d, J = 2.9 Hz, 1H), 5.35 (ddt, J = 7.3, 10.2, 17.6 Hz, 1H), 4.91-4.85 (m, 2H), 4.68 (ABq, J = 17.1 Hz, $\Delta\nu$ = 25.3 Hz, 4H), 2.36 (dq, J = 7.3, 13.6 Hz, 2H), 2.16 (ddd, J = 5.3, 9.8, 15.1 Hz, 1H), 1.98-1.91 (m, 1H), 1.89 (s, 3H), 1.89-1.82 (m, 1H), 1.72 (ddd, J = 5.3, 9.8, 15.1 Hz, 1H). ¹³C NMR (CDCl₃, 125 MHz) δ = 208.0, 173.4, 148.1, 146.4, 141.9, 138.3, 132.3, 128.6, 127.0, 126.7, 121.4, 118.5, 112.0, 107.2, 106.4, 55.0, 39.9, 37.8, 30.0, 27.6. IR (neat, cm⁻¹) 3408, 3062, 3028, 2919, 2857, 1715, 1615, 1582, 1548, 1488, 1452, 1361, 1298, 1233, 1203, 1165, 1113, 1075, 1028, 992, 958, 919, 847, 807, 735, 698. HRMS (EI+) m/z calculated for C₂₉H₃₀N₂O [M⁺]: 422.2358, found: 422.2359.

(3S)-4-(3-Allyl-4-methoxy-3H-indol-3-yl)-butan-2-one 4h.

Following general procedure B for asymmetric allylation of **3h** and workup A, the crude product was purified by flash chromatography on silica gel (gradient elution 8:2 to 6:4, PE/EtOAc) to give **4h** (92%) as a yellow oil. Enantiomeric excess was determined to be 83 % by chiral HPLC (Chiralpak AD, 90:10 heptane:*i*PrOH, 1.0 mL/min, 9.86 min major, 10.96 min minor). R_f (PE/EtOAc, 1:1) = 0.32. $[\alpha_D]^{22.0}$ (c 0.82, CH₂Cl₂) = -36.4°. ¹H NMR (CDCl₃, 500 MHz) δ = 7.91 (s, 1H), 7.33 (dd, J = 7.7, 8.1 Hz, 1H), 7.25 (dd, J = 0.7, 7.7 Hz, 1H), 6.77 (d, J = 8.1 Hz, 1H), 5.31 (tdd, J = 7.3, 10.1, 17.1 Hz, 1H), 4.96 (tdd, J = 1.1, 1.9, 17.1 Hz, 1H), 4.83 (tdd, J = 1.1, 1.9, 10.1 Hz, 1H), 3.85 (s, 3H), 2.75 (td, J = 1.0, 7.3 Hz, 2H), 2.45 (ddd, J = 6.7, 8.8, 13.9 Hz, 1H), 2.28 (ddd, J = 6.7, 8.8, 13.9 Hz, 1H), 1.89 (s, 3H), 1.84 (ddd, J = 3.3, 6.5, 8.7 Hz, 2H). ¹³C NMR (CDCl₃, 125 MHz) δ = 208.0, 178.7, 157.0, 155.8, 132.7, 129.6, 126.3, 117.8, 114.0, 108.7, 62.3, 55.4, 38.2, 37.7, 30.0, 25.7. IR (neat, cm⁻¹) 3413, 3075, 3005, 2936, 2838, 1715, 1640, 1598, 1559, 1483, 1450, 1368, 1263, 1166, 1074, 992, 918, 793, 744. HRMS (EI+) m/z calculated for C₁₆H₁₉NO₂ [M⁺]: 257.1416, found: 257.1415.

(3S)-4-(3-Allyl-4-methoxy-3H-indol-3-yl)-butan-2-one 4i.

Following general procedure B for asymmetric allylation of **3i** and workup A, the crude product was purified by flash chromatography on silica gel (gradient elution 8:2 to 6:4, PE/EtOAc) to give **34i** (89%) as a yellow oil. Enantiomeric excess was determined to be 78 % by chiral HPLC (Chiralpak OD, 95:5 heptane:*i*PrOH, 0.8 mL/min, 17.27 min minor, 18.80 min major). R_f (PE/EtOAc, 1:1) = 0.32. $[\alpha_D]^{22.0}$ (c 0.82, CH₂Cl₂) = -36.4°. ¹H NMR (CDCl₃, 500 MHz) δ = 7.96 (s, 1H), 7.20 (d, J = 2.4 Hz, 1H), 7.11 (d, J = 8.3 Hz, 1H), 6.82 (dd, J = 2.4, 8.3 Hz, 1H), 5.45 (ddt, J = 7.3, 10.3, 17.1 Hz, 1H), 5.03-4.94 (m, 2H), 3.85 (s, 3H), 2.55-2.46 (m, 2H), 2.27 (ddd, J = 5.9, 9.5, 15.1 Hz, 1H), 2.13 (ddd, J = 5.9, 9.5, 15.1 Hz, 1H), 1.90 (ddd, J = 5.9, 9.5, 15.1 Hz, 1H), 1.89 (s, 3H), 1.79 (ddd, J = 5.9, 9.5, 15.1 Hz, 1H). ¹³C NMR(CDCl₃, 125 MHz) δ = 207.8, 179.2, 160.1, 157.0, 132.3, 122.4, 118.7, 112.3, 106.8, 60.4, 55.5, 39.8, 37.8, 30.0, 27.4. IR (neat, cm⁻¹) 3412, 3076, 3004, 2920, 2837, 1715, 1624, 1591, 1556, 1481, 1442, 1362, 1276, 1240, 1164, 1139, 1110, 1061, 1024, 993, 926, 887, 848, 819, 783, 762, 738, 706. HRMS (EI+) m/z calculated for C₁₆H₁₉NO₂ [M⁺]: 257.1416, found: 257.1413.

(3R)-3-Allyl-5-methoxy-3-(3-methyl-but-2-enyl)-3H-indole 6.

Following general procedure B for asymmetric allylation of **5** and workup B, the crude product was purified by flash chromatography on silica gel (gradient elution 9:1 to 8:2, PE/EtOAc) to give **6** (85 %) as a yellow oil (one isomer only). Enantiomeric excess was

determined to be 84 % by chiral HPLC (Chiralpak AD, 94:6 heptane:*i*PrOH, 1 mL/min, 8.25 min major, 9.41 min minor). R_f (PE/EtOAc, 7:3) = 0.56. $[\alpha_D]^{22.9}$ (c 0.95, CH₂Cl₂) = 56.3°. ¹H NMR (CDCl₃, 500 MHz) δ = 7.89 (s, 1H), 7.50 (dt, J = 1.5, 9.0 Hz, 1H), 6.86-6.83 (m, 2H), 5.46-5.36 (m, 1H), 5.02-4.97 (m, 1H), 4.95-4.92 (m, 1H), 4.88-4.82 (m, 1H), 3.83 (s, 3H), 2.58-2.46 (m, 3H), 2.37 (dd, J = 6.8, 14.1 Hz, 1H), 1.60 (s, 3H), 1.54 (s, 3H). ¹³C NMR (CDCl₃, 125 MHz) δ = 176.1, 158.3, 149.2, 143.5, 135.0, 132.6, 121.7, 118.4, 118.1, 122.2, 108.8, 61.6, 55.6, 38.5, 33.0, 25.8, 17.9. IR (neat, cm⁻¹) 3417, 3077, 2976, 2914, 2835, 1672, 1640, 1611, 1591, 1554, 1470, 1437, 1377, 1265, 1228, 1202, 1176, 1151, 1109, 1031, 992, 917, 870, 846, 820, 795, 782, 746, 704. HRMS (EI+) m/z calculated for C₁₇H₂₁NO [M⁺]: 255.1623, found: 255.1619.

(3R)-3-Allyl-5-methoxy-3-(3-methyl-but-2-enyl)-3H-indole 8.

Following general procedure B for asymmetric allylation of **7** and workup B, the crude product was purified by flash chromatography on silica gel (gradient elution 9:1 to 8:2, PE/EtOAc) to give **8** (89 %) as a yellow oil. Enantiomeric excess was determined to be 85 % by chiral HPLC (Chiralpak OJ, 90:10 heptane:*i*PrOH, 1 mL/min, 10.15 min minor, 12.69 min major). R_f (PE/EtOAc, 7:3) = 0.46. $[\alpha_D]^{22.5}$ (c 0.8, CH₂Cl₂) = 165.6°. ¹H NMR (CDCl₃, 500 MHz) δ = 7.94 (s, 1H), 7.42 (d, J = 8.3 Hz, 1H), 7.20-7.15 (m, 3H), 7.00-6.96 (m, 2H), 6.33 (dd, J = 2.4, 8.3 Hz, 1H), 6.78 (d, J = 2.4 Hz, 1H), 5.38 (ddt, J = 7.3, 9.8, 17.1 Hz, 1H), 5.02-4.96 (m, 1H), 4.95-4.92 (m, 1H), 3.82 (s, 3H), 3.03 (ABq, J =

13.7, $\Delta\nu = 30.1$, 2H), 2.64-2.52 (m, 2H). ^{13}C NMR (CDCl_3 , 125 MHz) $\delta = 175.3, 158.3, 149.3, 142.8, 136.1, 132.3, 129.9, 127.9, 126.7, 121.4, 118.7, 112.5, 109.1, 61.8, 55.7, 41.2, 38.7$. IR (neat, cm^{-1}) 3062, 3022, 3004, 2916, 2835, 1640, 1610, 1592, 1554, 1496, 1470, 1455, 1437, 1337, 1279, 1260, 1231, 1177, 1153, 1107, 1081, 1030, 992, 919, 870, 813, 759, 744, 702, 662. HRMS (EI+) m/z calculated for $\text{C}_{19}\text{H}_{19}\text{NO}$ $[\text{M}^+]$: 277.1467, found: 277.1463.

(2R,3R)-3a-Allyl-3,3a,8,8a-tetrahydro-2H-pyrrolo[2,3-b]indole-1-carboxylic acid tert-butyl ester 10a.

Following general procedure B for asymmetric allylation of **9a** and workup B, the crude product was purified by flash chromatography on silica gel (gradient elution 97:3 to 9:1, PE/EtOAc) to give **10a** (87%) as a pale yellow oil. Enantiomeric excess was determined to be 72 % by chiral HPLC (Chiralpak OD, 90:10 heptane:*i*PrOH, 0.8 mL/min, 5.62 min major, 6.99 min minor). R_f (PE/EtOAc, 8:2) = 0.64. $\text{Mp} = 89\text{-}90^\circ\text{C}$ $[\alpha_D]^{24.4}$ (c 0.41, CH_2Cl_2) = +337.5°. ^1H NMR (CDCl_3 , 500 MHz) $\delta = 7.09\text{-}7.04$ (m, 2H), 6.78-6.72 (m, 1H), 6.61 (d, $J = 7.3$ Hz, 1H), 5.83-5.73 (m, 1H), 5.15-5.04 + 4.64 (m + s, Boc *cis/trans* isomerization, 4H), 3.73-3.55 (m, 1H), 3.08 (m, 1H), 2.53-2.42 (m, 2H), 2.21-2.07 (m, 2H), 1.55 + 1.40 (2s, Boc *cis/trans* isomerization, 9H). ^{13}C NMR(CDCl_3 , 125 MHz) $\delta = 154.5, 153.5, 149.4, 149.0, 133.8, 131.8, 131.7, 128.3, 128.2, 123.3, 123.2, 119.0, 118.5, 118.3, 118.2, 109.2, 109.2, 80.1, 79.8, 79.7, 57.3, 56.3, 45.7, 45.3, 42.4, 34.9, 34.7, 28.6, 28.4$. IR (neat, cm^{-1}) 3365, 3076, 3053, 2976, 2930, 2882, 1682, 1641, 1610, 1484, 1467,

1403, 1366, 1328, 1313, 1255, 1206, 1165, 1140, 1056, 996, 915, 881, 773, 744, 716.

HRMS (EI+) m/z calculated for $C_{18}H_{24}N_2O_2$ [M+]: 300.1838, found : 300.1840.

(2R,3R)-3a-Allyl-5-methoxy-3,3a,8,8a-tetrahydro-2H-pyrrolo[2,3-b]indole-1-carboxylic acid tert-butyl ester **10b.**

Following general procedure B for asymmetric allylation of **9b** and workup B, the crude product was purified by flash chromatography on silica gel (gradient elution: 95:5 to 9:1, PE/EtOAc) to give **10b** (91%) as a pale yellow oil. Enantiomeric excess was determined to be 82 % by chiral HPLC (Chiralpak AD, 90:10 heptane:*i*PrOH, 1 mL/min, 13.25 min minor, 26.49 min major). R_f (PE/EtOAc, 9:1) = 0.38. $[\alpha_D]^{23.3}$ (c 0.53, CH_2Cl_2) = +264.3°.

1H NMR ($CDCl_3$, 500 MHz) δ = 6.67 (d, J = 2.5 Hz, 1H), 6.64 (dd, J = 2.5, 8.3 Hz, 1H), 6.54 (dd, J = 2.4, 8.3 Hz, 1H), 5.80-5.70 (m, 1H), 5.12-5.00 (m, 3H), 4.84+4.82 (2bs, Boc *cis/trans* isomerization, 1H), 3.75 (s, 3H), 3.71-3.52 (m, 1H), 3.05-2.97 (m, 1H), 2.50-2.38 (m, 2H), 2.15-2.02 (m, 2H), 1.51+1.44 (2s, Boc *cis/trans* isomerization, 9H).

^{13}C NMR($CDCl_3$, 125 MHz) δ = 154.5, 153.6, 153.5, 153.3, 143.3, 142.9, 133.7, 133.5, 133.3, 118.4, 118.3, 112.9, 112.8, 110.4, 110.4, 109.8, 109.7, 80.5, 80.1, 79.7, 57.7, 56.7, 55.9, 45.7, 45.3, 42.2, 42.0, 34.8, 34.7, 28.6, 28.4. IR (neat, cm^{-1}) 3384, 3076, 2976, 2937, 2832, 1698, 1662, 1641, 1598, 1494, 1455, 1434, 1393, 1366, 1327, 1279, 1251, 1204, 1164, 1117, 1041, 997, 916, 880, 807, 774, 735, 698. HRMS (EI+) m/z calculated for $C_{19}H_{26}N_2O_3$ [M+]: 330.1943, found: 330.1933.

(2*R*,3*R*)-3a-Allyl-3,3a,8,8a-tetrahydro-2H-furo[2,3-b]indole 12a.

Following general procedure B for asymmetric allylation of **11a** and workup B, the crude product was purified by flash chromatography on silica gel (gradient elution 95:5 to 85:15, PE/EtOAc) to give **12a** (90%) as a pale yellow oil. Enantiomeric excess was determined to be 81 % by chiral HPLC (Chiralpak AD, 90:10 heptane:*i*PrOH, 1 mL/min, 8.47 min major, 12.26 min minor). R_f (PE/EtOAc, 8:2) = 0.42. $[\alpha_D]^{22.7}$ (c 1.51, CH₂Cl₂) = +102.4°. ¹H NMR (CDCl₃, 500 MHz) δ = 7.07 (ddd, J = 1.2, 7.4, 15.2 Hz, 2H), 6.75 (td, J = 1.2, 7.4 Hz, 1H), 6.59 (d, J = 7.4 Hz, 1H), 5.70 (dddd, J = 6.4, 8.1, 14.5, 16.6 Hz, 1H), 5.37 (s, 1H), 5.12-5.04 (m, 2H), 4.57 (bs, 1H), 3.96 (ddd, J = 1.8, 6.9, 8.6 Hz, 1H), 3.56 (ddd, J = 5.5, 8.6, 11.0 Hz, 1H), 2.62 (tdd, J = 1.4, 6.4, 13.9 Hz, 1H), 2.52-2.46 (m, 1H), 2.19-2.09 (m, 2H). ¹³C NMR (CDCl₃, 125 MHz) δ = 149.5, 134.2, 132.1, 128.1, 123.5, 118.7, 118.0, 108.2, 97.4, 67.1, 57.5, 42.4, 39.6. IR (neat, cm⁻¹) 3354, 3075, 3054, 2974, 2943, 2869, 1640, 1610, 1486, 1489, 1445, 1415, 1360, 1334, 1310, 1256, 1231, 1172, 1152, 1118, 1017, 960, 917, 744, 715, 658. HRMS (EI+) m/z calculated for C₁₃H₁₅NO [M⁺]: 201.1154, found : 201.1153.

(2*R*,3*R*)-3a-Allyl-5-methoxy-3,3a,8,8a-tetrahydro-2H-furo[2,3-b]indole 12b.

Following general procedure B for asymmetric allylation of **11b** and workup B, the crude product was purified by flash chromatography on silica gel (gradient elution: 95:5 to 85:15, PE/EtOAc) to give **12b** (91%) as a pale yellow oil. Enantiomeric excess was determined to be 86 % by chiral HPLC (Chiralpak OD, 90:10 heptane:*i*PrOH, 0.8 mL/min, 11.04 min major, 13.06 min minor). R_f (PE/EtOAc, 9:1) = 0.19. $[\alpha_D]^{22.2}$ (c 0.61, CH₂Cl₂) = +92.8°. ¹H NMR (CDCl₃, 500 MHz) δ = 6.70 (d, J = 2.5 Hz, 1H), 6.64 (dd, J = 2.5, 8.5 Hz, 1H), 6.53 (d, J = 8.5 Hz, 1H), 5.70 (dddd, J = 6.3, 8.3, 10.3, 17.1 Hz, 1H), 5.35 (d, J = 2.0 Hz, 1H), 5.12-5.04 (m, 2H), 4.35 (bs, 1H), 3.95 (ddd, J = 2.0, 7.0, 8.8 Hz, 1H), 3.75 (s, 3H), 3.36 (ddd, J = 5.3, 8.3, 10.2 Hz, 1H), 2.63-2.58 (m, 1H), 2.50-2.44 (m, 1H), 2.17-2.08 (m, 2H). ¹³C NMR (CDCl₃, 125 MHz) δ = 153.6, 143.5, 134.1, 133.9, 118.1, 112.8, 110.5, 109.1, 98.2, 67.1, 58.0, 55.9, 42.3, 39.5. IR (neat, cm⁻¹) 3362, 3074, 2942, 2870, 2832, 1640, 1598, 1493, 1437, 1360, 1334, 1302, 1283, 1249, 1211, 1182, 1035, 960, 918, 807, 748, 651. HRMS (EI+) m/z calculated for C₁₄H₁₇NO₂ [M+]: 213.1259, found: 231.1251.

(2R,3R)-4b-Allyl-3-methoxy-4b,5,10a,11-tetrahydro-10-oxa-11-aza-benzo[b]fluorene
14.

Following general procedure B for asymmetric allylation of **13** and workup B, the crude product was purified by flash chromatography on silica gel (95:5, PE/EtOAc) to give **14** (84%) as a colorless oil. Enantiomeric excess was determined to be 90 % by chiral HPLC (Chiralpak AD, 90:10 heptane:*i*PrOH, 1 mL/min, 15.22 min major, 20.73 min minor). R_f

(PE/EtOAc, 7:3) = 0.67. $[\alpha_D]^{24.8}$ (c 1.08, CH₂Cl₂) = +175.9°. ¹H NMR (CDCl₃, 500 MHz) δ = 7.05-7.00 (m, 1H), 6.98-6.94 (m, 1H), 6.93-6.78 (m, 2H), 6.59 (d, J = 2.5 Hz, 1H), 6.50 (dd, J = 2.5, 8.4 Hz, 1H), 6.44 (d, J = 8.4 Hz, 1H), 5.72 (tdd, J = 7.3, 10.2, 17.5 Hz, 1H), 5.49 (s, 1H), 5.16-5.11 (m, 2H), 4.42 (bs, 1H), 3.70 (s, 3H), 2.98 (q, J = 14.8 Hz, 2H), 2.51 (dt, J = 1.0, 7.3 Hz, 2H). ¹³C NMR(CDCl₃, 125 MHz) δ = 154.2, 153.5, 142.4, 133.6, 133.1, 128.3, 127.2, 126.0, 121.8, 118.8, 117.2, 112.2, 110.1, 108.6, 95.5, 55.8, 51.8, 44.5, 33.4. IR (neat, cm⁻¹) 3384, 3074, 2940, 2833, 1732, 1639, 1590, 1494, 1457, 1436, 1372, 1286, 1249, 1228, 1209, 1183, 1112, 1044, 957, 921, 806, 759. HRMS (EI+) m/z calculated for C₁₉H₁₉NO₂ [M⁺]: 293.1416, found: 293.1430.

(2R,3S)-4a-Allyl-6-methoxy-2,3,4,4a,9,9a-hexahydro-pyrano[2,3-b]indole 16.

Following general procedure B for asymmetric allylation of **15** and workup B, the crude product was purified by flash chromatography on silica gel (9:1, PE/EtOAc) to give **16** (93%) as a yellow oil. Enantiomeric excess was determined to be 88 % by chiral HPLC (Chiralpak AD, 90:10 heptane:*i*PrOH, 1 mL/min, 15.22 min major, 20.73 min minor). R_f (PE/EtOAc, 7:3) = 0.45. $[\alpha_D]^{24.8}$ (c 1.39, CH₂Cl₂) = +108.2°. ¹H NMR (CDCl₃, 500 MHz) δ = 6.68-6.59 (m, 3H), 5.72 (ddd, J = 7.46, 10.0, 14.7 Hz, 1H), 5.07-4.97 (m, 2H), 4.76 (s, 1H), 3.76 (s, 3H), 3.75-3.69 (m, 1H), 4.15 (bs, 1H), 3.40 (ddd, J = 3.5, 10.0, 11.3 Hz, 1H), 2.23 (ddd, J = 7.5, 13.5, 52.9 Hz, 2H), 2.17-2.08 (m, 1H), 1.74 (ddd, J = 5.11, 12.0, 14.0 Hz, 1H), 1.56-1.40 (m, 2H). ¹³C NMR(CDCl₃, 125 MHz) δ = 153.6, 142.8, 134.2,

133.8, 118.0, 111.8, 110.7, 110.1, 94.2, 62.5, 55.9, 47.3, 43.5, 28.0, 21.7. IR (neat, cm^{-1}) 3332, 2938, 2832, 1638, 1600, 1489, 1436, 1270, 1202, 1181, 1150, 1122, 1073, 1033, 1016, 916, 868, 8065. HRMS (EI+) m/z calculated for $\text{C}_{15}\text{H}_{19}\text{NO}_2$ [M^+]: 245.1416, found: 245.1410.

(2R,3S)-8b-Allyl-7-methoxy-1,3a,4,8b-tetrahydro-2H-cyclopenta[b]indole-3,3-dicarboxylic acid dimethyl ester **18.**

Following general procedure B for asymmetric allylation of **17** and workup B (with 2.5 eq ethanolamine), the crude product was purified by flash chromatography on silica gel (9:1, PE/EtOAc) to give **18** (89%) as a yellow oil. Enantiomeric excess was determined to be 84 % by chiral HPLC (Chiralpak AD, 90:10 heptane:*i*PrOH, 1 mL/min, 11.69 min minor, 12.88 min major). R_f (PE/EtOAc, 7:3) = 0.51. $[\alpha_D]^{22.4}$ (c 0.82, CH_2Cl_2) = +76.0°. ^1H NMR (CDCl_3 , 500 MHz) δ = 6.62 (d, J = 2.5 Hz, 1H), 6.58 (dd, J = 2.5, 8.4 Hz, 1H), 6.45 (d, J = 8.4 Hz, 1H), 5.55 (dddd, J = 5.6, 8.9, 10.1, 17.1 Hz, 1H), 5.14-5.08 (m, 1H), 5.01-4.97 (m, 1H), 4.65 (d, J = 1.6 Hz, 1H), 3.75 (s, 3H), 3.75-3.70 (m, 6H), 3.73 (bs, 1H) 2.64 (tdd, J = 1.5, 5.6, 13.7 Hz, 1H), 2.48 (dd, J = 8.8, 13.7 Hz, 1H), 2.23 (dt, J = 6.6, 13.0 Hz, 1H), 2.13 (tdd, J = 1.3, 6.0, 13.0 Hz, 1H), 2.00 (ddd, J = 1.2, 6.5, 13.0 Hz, 1H), 1.74 (dt, J = 6.1, 13.0 Hz, 1H). ^{13}C NMR(CDCl_3 , 125 MHz) δ = 171.6, 169.7, 153.8, 144.4, 136.2, 135.2, 117.7, 112.8, 110.1, 109.8, 70.8, 67.9, 58.6, 55.9, 52.6, 52.3, 44.5, 38.2, 31.5. IR (neat, cm^{-1}) 3373, 3074, 2953, 2835, 1732, 1640, 1599, 1495, 1435,

1374, 1329, 1301, 1275, 1258, 1028, 1208, 1147, 1120, 1096, 1038, 995, 918, 871, 800, 656. HRMS (EI+) m/z calculated for $C_{19}H_{23}NO_5$ $[M+]$: 345.1576, found: 345.1578.

(2R,3S)-4a-Allyl-6-methoxy-2,3,4,4a,9,9a-hexahydro-pyrano[2,3-b]indole 22.

Following general procedure B for asymmetric allylation of **19** and workup B (after addition of 2.5 eq ethanolamine, the mixture was stirred at rt for 24h to obtain complete cyclization to the imine), the crude product was purified by flash chromatography on silica gel (gradient elution 95:5 to 9:1, PE/EtOAc) to give **20** (85%) as a yellow oil. Enantiomeric excess was determined to be 81 % by chiral HPLC (Chiralpak AD, 90:10 heptane:*i*PrOH, 1 mL/min, 12.05 min major, 13.80 min minor). R_f (PE/EtOAc, 7:3) = 0.59. $[\alpha_D]^{25.1}$ (c 0.82, CH_2Cl_2) = +22.3°. 1H NMR ($CDCl_3$, 500 MHz) δ = 6.62-6.54 (m, 3H), 5.74-5.66 (m, 1H), 5.09-5.00 (m, 2H), 4.46 (d, J = 1.0 Hz, 1H), 4.16 (bs, 1H), 3.75 (s, 3H), 3.74 (s, 6H), 2.47-2.37 (m, 2H), 2.37-2.31 (m, 1H), 1.97-1.89 (m, 1H), 1.68-1.47 (m, 4H). ^{13}C NMR($CDCl_3$, 125 MHz) δ = 171.2, 171.0, 153.6, 142.7, 137.6, 134.6, 117.7, 112.0, 110.4, 109.4, 63.5, 57.3, 55.8, 52.8, 52.7, 48.2, 41.4, 33.4, 24.7, 17.4. IR (neat, cm^{-1}) 3380, 3074, 2951, 2834, 1732, 1639, 1600, 1495, 1435, 1372, 1327, 1252, 1221, 1179, 1151, 1108, 1066, 1037, 1000, 914, 864, 644, 810, 764, 734, 708, 649, 607. HRMS (EI+) m/z calculated for $C_{20}H_{25}NO_5$ $[M+]$: 359.1733, found: 359.1716.

(2*R*,3*R*)-4a-Allyl-6-methoxy-2,3-dimethyl-4,4a,9,9a-tetrahydro-pyrido[2,3-*b*]indole-1-carboxylic acid tert-butyl ester **22.**

Following general procedure B for asymmetric allylation of **21** and workup B, the crude product was purified by flash chromatography on silica gel (gradient elution 95:5 to 9:1, PE/EtOAc) to give **22** (91%) as a yellow oil. Enantiomeric excess was determined to be 85 % by chiral HPLC (Chiralpak AD, 92:8 heptane:*i*PrOH, 1 mL/min, 9.61 min minor, 44.47 min major). R_f (PE/EtOAc, 8:2) = 0.47. $[\alpha_D]^{23.2}$ (c 1.05, CH₂Cl₂) = +277.23°. ¹H NMR (CDCl₃, 500 MHz) δ = 7.27 (s, 1H), 7.04 (dt, J = 1.5, 8.3 Hz, 1H), 6.94 (dd, J = 1, 7.3 Hz, 1H), 6.87 (dt, J = 1.5, 7.3 Hz, 1H), 6.50 (d, J = 2.4 Hz, 1H), 6.42 (dd, J = 2.4, 8.3 Hz, 1H), 6.31 (d, J = 6.8 Hz, 1H), 5.89 (s, 1H), 5.74 (ddt, J = 7.8, 10.0, 17.3 Hz, 1H), 5.21-5.12 (m, 2H), 4.19 (bs, 1H), 3.67 (s, 3H), 2.88 (ABq, J = 14.2, $\Delta\nu$ = 9.7 Hz, 2H), 2.60-2.50 (m, 2H), 1.53 (s, 9H). ¹³C NMR(CDCl₃, 125 MHz) δ = 153.9, 153.1, 143.2, 137.5, 133.3, 131.3, 127.9, 126.1, 124.5, 118.8, 112.1, 110.0, 108.6, 81.2, 55.8, 54.9, 45.7, 36.2, 28.4. IR (neat, cm⁻¹) 3393m 3074, 2976, 2934, 2832, 1694, 1640, 1598, 1494, 1454, 1417, 1392, 1365, 1349, 1328, 1274, 1251, 1219, 1173, 1144, 1082, 1031, 957, 917, 862, 782, 740, 657. HRMS (EI+) m/z calculated for C₂₀H₂₈N₂O₃ [M⁺]: 392.2100, found: 392.2102.

(3S)-3-Allyl-5-methoxy-3-methyl-1,3-dihydro-indol-2-one 25.

To a solution of **2** (402 mg, 2 mmol) in CH₃CN (30 mL) at 0°C was added acetic acid (110 µL, 2 mmol) followed by NBU₄HSO₅ (2.655 g, 4.4 mmol). The mixture was stirred at rt for 20h and the volume was reduced to 5 mL under reduced pressure. Et₂O (80 mL) was added and the mixture was washed with sat. aq. NaHCO₃ (3 x 20 mL), brine (20 mL), dried (MgSO₄) and concentrated. The crude product was purified by flash chromatography on silica gel (85:15, PE/EtOAc) to give **23** (339 mg, 78%) as a white solid. Recrystallization from hexanes/EtOAc provided **23** with 99 % ee as determined by chiral HPLC (Chiralpak OD, 90:10 heptane:iPrOH, 0.8 mL/min, 8.01 min minor, 8.96 min major). *R_f* (PE/EtOAc, 8:2) = 0.16. [α _D]^{22.3} (c 0.79, CH₂Cl₂) = -43.5°. ¹H NMR (CDCl₃, 500 MHz) δ = 8.28 (bs, 1H), 6.82-6.78 (m, 2H), 6.73 (dd, *J* = 2.6, 8.4 Hz, 1H), 5.51 (dddd, *J* = 6.9, 7.8, 10.1, 17.1 Hz, 1H) 5.05-4.94 (m, 2H), 3.79 (s, 3H), 2.58-2.46 (m, 2H), 1.39 (s, 3H). ¹³C NMR(CDCl₃, 125 MHz) δ = 182.2, 155.7, 135.5, 133.5, 132.4, 118.8, 111.9, 110.7, 119.8, 55.8, 49.2, 42.4, 22.8. IR (neat, cm⁻¹) 3224., 3078, 2987, 2928, 2835, 1707, 1641, 1603, 1492, 1439, 1373, 1306, 1271, 1204, 1177, 1047, 1031, 996, 920, 852, 807, 662, 627, 591. HRMS (EI+) *m/z* calculated for C₁₃H₁₅NO₂ [M⁺]: 217.1103, found: 217.1109.

(3S)-(5-Methoxy-1,3-dimethyl-2-oxo-2,3-dihydro-1H-indol-3-yl)-acetaldehyde 24.

To a suspension of NaH (20 mg, 0.496 mmol) in THF (2 mL) was added a solution of **23** (90 mg, 0.414 mmol) in THF (2 mL) at 0°C. After 15 min stirring at 0°C, MeI (31 µL,

0.496 mmol) was added and the mixture was stirred at rt overnight. The mixture was quenched with H₂O (5 mL) and extracted with Et₂O (3 x 5 mL). The combined organic layers were washed with brine (3 x 5 mL), dried (MgSO₄), filtered and concentrated. The crude product was purified by flash chromatography on silica gel (85:15, PE/EtOAc) to give the methylated oxindole (93 mg, 97%) as a white solid. $[\alpha_D]^{22.1}$ (c 1.23, CH₂Cl₂) = -40.0°.

To a solution of the methylated oxindole (81 mg, 0.35 mmol) on CH₂Cl₂ (2 mL) was added NMO (117 mg, 0.99 mmol) followed by 4% OsO₄ in H₂O (115 µL) and the mixture was stirred vigorously for 45 min. Sat. aq. Na₂SO₃ (5 mL) was added and the mixture was extracted with CH₂Cl₂ (3 x 5 mL). The combined organic layers were dried (MgSO₄), filtered and concentrated to give a white solid. The crude diol was taken up in acetone/water (3:1, 1.7 L), NaIO₄ (155 mg, 0.7 mmol) was added and the mixture was stirred at rt for 3h. The mixture was diluted in water (10 mL), extracted with CH₂Cl₂ (3 x 10 mL). The combined organic layers were dried (MgSO₄), filtered and concentrated. The crude product was purified by flash chromatography on silica gel (1:1, PE/EtOAc) to give **24** (71 mg, 87%) as a white solid. Analyses were identical to previously described material.¹⁴ $[\alpha_D]^{22.8}$ (c 0.83, C₆H₆) = +49.5°, litt. $[\alpha_D]^{25}$ (c 0.67, C₆H₆) = +49 °.^{S14}

(-)-Esermethole 25.

Following Overman's procedure:^{S14} a mixture of **24** (56 mg, 0.24 mmol), NEt₃ (334 μ L, 2.4 mmol), MeNH₂.HCl (162 mg, 2.4 mmol) and MgSO₄ (170 mg) in THF (6 mL) was stirred overnight at rt. Then, LaH (92 mg, 2.4 mmol) was added portionwise and the mixture was refluxed for 1h30 and cooled down to rt. EtOAc (15 mL) was added, the organic layer was separated and the aqueous layer was extracted with EtOAc (2 x 15 mL). The combined organic layers were washed with brine (15 mL), dried (MgSO₄), filtered and concentrated. The crude product was purified by flash chromatography on silica gel (gradient elution 1 % to 5 % MeOH in CH₂Cl₂) to give **25** (48 mg, 86%) as a slightly yellow solid. Analyses were identical to previously described material.^{S14} $[\alpha_D]^{26.1}$ (c 0.55, C₆H₆) = -136.9°, litt. $[\alpha_D]^{25}$ (c 0.36, C₆H₆) = -141°.^{S14}

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