Supplementary Material (ESI) for Chemical Communications

Supplementary Information for

Highly regioselective ring-opening of trisubstituted aziridines by sulfur-stabilised carbanions

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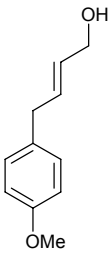
General experimental

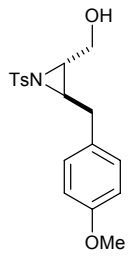
Melting points were determined using a Stuart Scientific SMP1 melting point apparatus and are uncorrected. Infrared spectra were recorded on a Mattson 5000 FTIR spectrometer and on a Perkin-Elmer Spectrum RX FT-IR System. Proton magnetic resonance (^{1}H NMR) and carbon magnetic resonance (^{13}C NMR) spectra were recorded in $CDCl_3$ unless otherwise stated on a Jeol GSX-270, a Bruker DRX-300, a Bruker AV-400 or a Bruker AV-500 spectrometer. Chemical shifts are in part per million (ppm) and are referenced relative to the residual proton-containing solvent (^{1}H NMR: 7.26 ppm for $CDCl_3$; ^{13}C NMR: 77.0 ppm for $CDCl_3$). The following abbreviations are used to indicate the multiplicities: s, singlet, bs, broad signal; d, doublet; t, triplet; m multiplet. Mass spectra (CI) were recorded using Micromass AutoSpec-Q, Micromass Platform II or Micromass AutoSpec Premier instruments. Elemental analyses were performed at the microanalytical laboratory of the London Metropolitan University. Analytical thin layer chromatography (TLC) was performed on pre-coated aluminium-backed Merck Kiesegel 60 F_{254} plates. Visualisation was effected with ultraviolet light, potassium permanganate or vanillin as appropriate. Flash chromatography was performed using BDH (40-63 μm) silica gel unless otherwise stated. DMSO and CH_2Cl_2 were distilled under nitrogen from CaH_2 prior to use. All other solvents were reagent-grade. Petrol refers to the fraction with bp_{760} 40–60 °C. All liquid reagents except HCl and Me_2S were distilled prior to use. KOAc was oven-dried at 120 °C for several days prior to use. All other reagents were purchased from Aldrich, Fluka, Acros, Alfa Aesar Lancaster and used as such unless otherwise stated. Microwave reactions were performed using a Biotage Initiator instrument.

(*E*)-4-(4-Methoxyphenyl)but-2-en-1-ol 1



To a solution of butadiene monoxide (5.00 g, 71.4 mmol, 1.0 equiv.) and CuCN (639 mg, 7.14 mmol, 0.1 equiv.) in THF (130 mL) at –78 °C was added dropwise a freshly prepared solution of (4-methoxyphenyl)magnesium bromide (17 mL of a *ca.* 0.5 M solution in THF, 8.40 mmol, 0.1 equiv.). After 15 min the solution was warmed to –20 °C then re-cooled to –78 °C for 20 min and a further amount of (4-methoxyphenyl)magnesium bromide (153 mL of a *ca.* 0.5 M solution in THF, 76.6 mmol, 1.1 equiv.) was added. After 45 min, the resulting solution was warmed to rt. After 1 h sat. $NH_4Cl_{(aq.)}$ (13 mL) and NH_3 (10 mL of a 17% aqueous solution) were added. After 15 min the solution was diluted with sat. $NH_4Cl_{(aq.)}$ (53 mL), H_2O (36 mL) and the aqueous phase was extracted with EtOAc (3 × 100 mL). The combined organic layers were washed with brine (2 × 100 mL) and dried (Na_2SO_4). Concentration under reduced pressure and column chromatography (20% EtOAc–petrol) gave *(*E*)-4-(4-methoxyphenyl)but-2-en-1-ol* **1** (11.6 g, 91%) as a colourless oil; R_f 0.30 (20% EtOAc–petrol); ν_{max} (film) 3357, 3029, 3002, 2952, 1670, 1610, 1583, 1463, 1463, 1440, 1299, 1176, 1108, 1089, 1035, 998, 971, 817 cm^{-1}; δ_H (270 MHz) 7.08 (2H, d, *J* 8.0 Hz, *meta* ArOMe), 6.28 (2H, d, *J* 8.0 Hz, *ortho* ArOMe), 5.85-5.68 (2H, m, CH=CH), 4.10 (2H, d, *J* 5.0 Hz, C*H*$_2$OH), 3.79 (3H, s, OMe), 3.35 (2H, d, *J* 6.0 Hz, C*H*$_2$Ar); δ_C (67.5 MHz) [158.1, 132.2 (q Ar)], [132.1, 130.0 (*ortho* & *meta* ArOMe)], [114.0, 113.9 (CH=CH)], 63.6 (OMe), 55.4 (CH_2OH), 37.8 (*C*H$_2$ArOMe); *m/z* (CI) 196 $[M+NH_4]^+$, 179 $[M+H]^+$, 161 (Found: $[M+NH_4]^+$, 196.1335. $C_{11}H_{14}O_2$ requires $[M+NH_4]^+$, 196.1337).

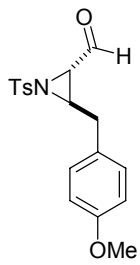
[(2*S,3*R**)-3-(4-Methoxybenzyl)-1-tosylaziridin-2-yl]methanol 9**



To a solution of allylic alcohol **1** (8.20 g, 46.1 mmol, 1.0 equiv.) and Chloramine-T® (14.3 g, 50.7 mmol, 1.1 equiv.) in MeCN (250 mL) was added phenyltrimethylammonium tribromide (1.70 g, 4.61 mmol, 0.1 equiv.) rt. After 24 h the reaction mixture was concentrated to *ca.* 20 mL and filtered though a short pad of silica gel with Et_2O. Concentration under reduced pressure and column chromatography (40:30:30 CH_2Cl_2:Et_2O:petrol) gave *[(2*S**,3*R**)-3-(4-methoxybenzyl)-1-tosylaziridin-2-yl]methanol* **9** (12.3 g, 77%) as colourless crystalline solids; mp 72–74 °C (CH_2Cl_2–EtOAc); R_f 0.52 (90% CH_2Cl_2–EtOAc); ν_{max} (film) 3512, 2935, 1612, 1514, 1443, 1304, 1248, 1157, 1088, 1034, 976, 943, 816, 710 cm^{-1}; δ_H (300 MHz) 7.65 (2H, d, *J* 8.0 Hz, *ortho* Ts), 7.24 (2H, d, *J* 8.0 Hz, *meta* Ts), 6.92 (2H, d, *J* 8.0 Hz, *meta* ArOMe), 6.69 (2H, d, *J* 8.0 Hz, *ortho* ArOMe), 4.15-3.86 (2H, m, C*H*$_2$OH), 3.78 (3H, s, Me of

ArOMe), 3.19-3.14 (1H, m, C*H*CH_2OH), 3.07-2.88 (3H, m, C*H*CH_2ArOMe, OH & C*H*HArOMe), 2.65 (1H, dd, *J* 14.0, 7.0 Hz, CH*H*ArOMe), 2.44 (3H, s, Me of Ts); δ_C (75 MHz) 158.4, 144.1, 136.9, 129.6, 129.2, 127.4, 126.4, 114.0, 60.7, 55.2, 51.3, 48.9, 36.5, 21.6; *m/z* (CI) 365 $[M+NH_4]^+$, 348 $[M+H]^+$, 189 (Found: $[M+H]^+$, 348.1279. $C_{18}H_{21}NO_4S$ requires $[M+H]^+$, 348.1270) (Found: C, 62.40; H, 6.24; N, 4.15. $C_{18}H_{21}NO_4S$ requires C, 62.23; H, 6.09; N, 4.03).

(2*S,3*R**)-3-(4-Methoxybenzyl)-1-tosylaziridine-2-carbaldehyde**



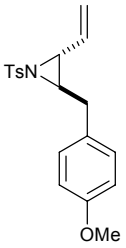
Dess–Martin periodinane (257 mg, 0.610 mmol, 2.1 equiv.) was added to a solution of [(2*S**,3*R**)-3-(4-methoxybenzyl)-1-tosylaziridin-2-yl]methanol (100 mg, 0.290 mmol, 1.0 equiv.) in water saturated CH_2Cl_2 (2 mL) at rt with vigorous stirring. After 2 h the reaction was diluted with Et_2O (10 mL), washed with sat. $Na_2S_2O_{3(aq.)}$ (10 mL) and the combined organic extracts dried (Na_2SO_4). Concentration under reduced pressure and column chromatography (50% Et_2O–petrol) gave *(2*S**,3*R**)-3-(4-methoxybenzyl)-1-tosylaziridine-2-carbaldehyde* (60.1 mg, 60%) as a pale yellow oil; R_f 0.35 (50% Et_2O–petrol); ν_{max} (film) 1714, 1612, 1512, 1327, 1248, 1159, 1090, 1034, 887, 814 cm^{-1}; δ_H (300 MHz) 9.50 (1H, d, *J* 7.0 Hz, CHO), 7.69 (2H, d, *J* 7.0 Hz, *ortho* TS), 7.28 (2H, d, *J* 7.0 Hz, *meta* Ts), 6.94 (2H, d, *J* 7.0 Hz, *meta* ArOMe), 6.72 (2H, d, *J* 7.0 Hz, *ortho* ArOMe), 3.80 (3H, s, OMe), 3.61-3.60 (1H, m, C*H*CHO), 3.19-3.18 (1H, m, C*H*CH_2), 3.03 (1H, dd, *J* 14.0, 4.0 Hz, C*H*HAr), 2.75 (1H, dd, *J* 14.0, 7.0 Hz, CH*H*Ar), 2.47 (3H, s, Me of Ts); δ_C (75 MHz) 194.0, 158.7, 144.9, 135.5, 129.8, 128.3, 128.1, 127.7, 114.1, 55.3, 52.3, 47.7, 35.5, 21.7; *m/z* (CI) 363 $[M+NH_4]^+$, 346 $[M+H]^+$, 243, 226, 189, 72 (Found: C, 62.36; H, 5.29; N, 3.88. $C_{18}H_{19}O_4NS$ requires C, 62.59; H, 5.54; N, 4.06%).

IBX preparation

To a solution of [(2*S**,3*R**)-3-(4-methoxybenzyl)-1-tosylaziridin-2-yl]methanol (1.00 g, 2.88 mmol, 1.0 equiv.) in DMSO (28.8 mL) at rt was added IBX (846 mg, 2.88 mmol, 1.0 equiv.) with rapid stirring. After 12 h the mixture was diluted with Et_2O (100 mL) and washed with sat. $NaHCO_{3(aq.)}$ (100 mL), water (100 mL), brine (50 mL) and dried (Na_2SO_4).

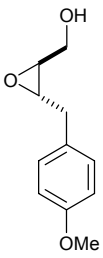
Concentration under reduced pressure gave *(2*S**,3*R**)-3-(4-methoxybenzyl)-1-tosylaziridine-2-carbaldehyde* (910 mg, 92%) as a pale yellow oil that required no further purification. Data were videntical to that reported for the Dess–Martin method above.

(2*R,3*R**)-2-(4-Methoxybenzyl)-1-tosyl-3-vinylaziridine 2**



To a suspension of Ph_3PCH_3Br (50.0 mg, 0.190 mmol, 1.2 equiv.) in THF (1 mL) at –25°C was added KHMDS (380 μL of a 0.5 M solution in THF, 0.190 mmol, 1.2 equiv.). After 15 min the mixture was warmed to rt for 30 min then re-cooled to –20°C and (2*S**,3*R**)-3-(4-methoxybenzyl)-1-tosylaziridine-2-carbaldehyde (55.1 mg, 1.60 mmol, 1.0 equiv.) in THF (1 mL) added. After 35 min the reaction was warmed to rt. After 10 min the mixture was poured into brine (5 mL), extracted with Et_2O (2 x 10 mL) and the combined organic extracts dried (Na_2SO_4). Concentration under reduced pressure and column chromatography (40% Et_2O–petrol) gave *(2*R**,3*R**)-2-(4-methoxybenzyl)-1-tosyl-3-vinylaziridine* **22** (35.2 mg, 71%) as a colourless oil; R_f 0.81 (30% EtOAc–petrol); ν_{max} (film) 3061, 3030, 2996, 2955, 2837, 1611, 1598, 1585, 1512, 1462, 1440, 1398, 1323, 1302, 1247, 1177, 1157, 1088, 1085, 989, 928, 906, 814, 750, 711, 687, 671 cm^{-1}; δ_H (300 MHz) 7.65 (2H, d, *J* 8.0 Hz, *ortho* Ts), 7.20 (2H, d, *J* 8.0 Hz, *meta* Ts), 6.92 (2H, d, *J* 8.5 Hz, *meta* ArOMe), 6.68 (2H, d, *J* 8.5 Hz, *ortho* ArOMe), 6.07 (1H, m, C*H*=CH_2), 5.52 (1H, d, *J* 17.0 Hz, *trans* CH=C*H*$_2$), 5.37 (1H, d, *J* 10.0 Hz, *cis* CH=C*H*$_2$), 3.77 (3H, s, OMe), 3.27-3.14 (2H, m, CHNCH), 2.93 (1H, dd, *J* 14.5, 5.0 Hz, C*H*HArOMe), 2.69 (1H, dd, *J* 14.5, 6.5 Hz, CH*H*ArOMe), 2.42 (3H, s, Me of Ts); δ_C (67.5 MHz) [158.4, 143.9, 137.1 (q Ar)], 131.8 (C*H*=CH_2), [129.7, 129.5 (ArH)], 129.2 (q Ar), 127.5 (ArH), 122.0 (CH=*C*H_2), 113.9 (ArH), 55.3 (OMe of ArOMe), [51.6, 49.6 (*C*HCH_2Ar and *C*HC=CH_2)], 36.1 (*C*H_2ArOMe), 21.7 (Me of Ts); *m/z* (CI) 344 $[M+NH_4]^+$, 173, 121, 70 (Found: $[M+NH_4]^+$, 344.1319. $C_{19}H_{22}NO_3S$ requires $[M+NH_4]^+$, 344.1320) (Found: C, 66.35; H, 6.24; N, 3.93. $C_{19}H_{22}NO_3S$ requires C, 66.45; H, 6.16; N, 4.08%).

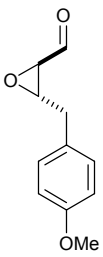
[(2*R,3*R**)-3-(4-Methoxybenzyl)oxiran-2-yl]methanol**



To a solution of (*E*)-4-(4-methoxyphenyl)but-2-en-1-ol **1** (21.0 g, 118 mmol, 1.0 equiv.) in CH_2Cl_2 (170 mL) at –20 ºC was added m-CPBA (26.5 g, 153.4 mmol, 1.3 equiv.). The suspension was warmed to rt over 2 h. After 1 h, it was re-cooled to –20 ºC. 10% $Na_2SO_{3(aq.)}$ (10 mL) was added, then warmed to rt and a further amount of 10% $Na_2SO_{3(aq.)}$ (290 mL) was added. After 1 h, it was diluted with H_2O

(200 mL) and the mixture extracted with EtOAc (4 × 100 mL). The combined organic layers were washed with 10% $Na_2CO_{3(aq.)}$ (2 × 100 mL), sat. $NaHCO_{3(aq.)}$ (3 × 100 mL), brine (3 × 150 mL) and dried (Na_2SO_4). Concentration under reduced pressure and column chromatography (20→45% EtOAc–petrol) gave *[(2*R**,3*R**)-3-(4-methoxybenzyl)oxiran-2-yl]methanol* as a brown oil (22.0 g, 96%); R_f 0.24 (50% EtOAc–petrol); ν_{max} (film) 3415, 2993, 2931, 2836, 1612, 1583, 1513, 1463, 1442, 1301, 1247, 1180, 1081, 1033 cm^{-1}; δ_H (400 MHz) 7.16 (2H, d, *J* 8.5 Hz, *meta* ArOMe), 6.87 (2H, d, *J* 8.5 Hz, *ortho* ArOMe), 3.93 (1H, dd, *J* 12.5, 2.5 Hz, C*H*HOH), 3.80 (3H, s, OMe), 3.65 (1H, dd, *J* 12.5, 4.5 Hz, CH*H*OH), 3.20 (1H, ddd, *J* 8.5, 5.5, 3.0 Hz, C*H*CH_2OH), 3.00 (1H, ddd, *J* 4.5, 4.5, 3.0 Hz, ArCH_2C*H*), 2.86 (1H, dd, *J* 12.0, 6.5 Hz, ArC*H*HCH), 2.84 (1H, dd, *J* 12.0, 6.5 Hz, ArCH*H*CH); δ_C (125 MHz) 158.4 (q ArOMe), 130.0 (ArH), 128.9 (q ArOMe), 114.3 (ArH), 61.6 (OMe), 58.4 (CH_2OH), 56.2 (*C*HCH_2OH), 55.3 (ArCH_2*C*H), 36.9 (*C*H_2Ar); *m/z* (CI) 212 $[M+NH_4]^+$, 195 $[M+H]^+$, 177, 163, 151, 147, 121 (Found: $[M+NH_4]^+$, 195.1018. $C_{11}H_{14}O_3$ requires $[M+NH_4]^+$, 195.1021).

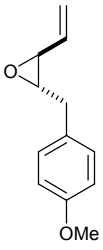
(2*S,3*R**)-3-(4-Methoxybenzyl)oxirane-2-carbaldehyde**



To a solution of $(COCl)_2$ (1.05 mL, 12.1 mmol, 1.20 equiv.) in CH_2Cl_2 (15 mL) at –78 ºC was added DMSO (1.72 mL, 24.2 mmol, 2.4 equiv.) in CH_2Cl_2 (7 mL) dropwise. After 5 min, a solution of [(2*R**,3*R**)-3-(4-methoxybenzyl)oxiran-2-yl]methanol (1.96 g, 10.1 mmol, 1.0 equiv.) in CH_2Cl_2 (23 mL) was added. After 25 min, Et_3N (7.0 mL, 50.5 mmol, 5.0 equiv.) in CH_2Cl_2 (7 mL) was added slowly. After 10 min it was warmed to rt over 15 min and sat. $NaHCO_{3(aq.)}$ (15 mL) was added. The aqueous phase was extracted with Et_2O (3 × 50 mL). The combined organic layers were washed with H_2O (2 × 50 mL), brine (2 × 50 mL) and dried (Na_2SO_4). Concentration under reduce pressure and column chromatography (20→40% EtOAc–petrol) gave *(2*S**,3*R**)-3-(4-methoxybenzyl)oxirane-2-carbaldehyde* (1.74 g, 85%); R_f 0.35 (40% EtOAc–petrol); ν_{max} (film) 3000, 2956, 2913, 1836, 2738, 1725, 1612, 1514, 1464, 1440, 1301, 1249, 1180, 1143, 1112, 1033 cm^{-1}; δ_H (270 MHz) 8.90 (1H, d, *J* 6.5 Hz, CHO), 7.13 (2H, d, *J* 8.5 Hz, *meta* ArOMe), 6.84 (2H, d, *J* 8.5 Hz, *ortho* ArOMe), 3.77 (3H, s, OMe), 3.42 (1H, dt, *J* 5.0, 1.5 Hz, C*H*CH_2Ar), 3.14 (1H, dd, *J* 6.5, 1.5 Hz, C*H*CHO), 2.96 (1H, dd, *J* 15.5, 5.0 Hz, C*H*HAr), 2.88 (1H, dd, *J* 15.0, 5.5 Hz, CH*H*Ar); δ_C (67.5 MHz) 198.3 (CHO), 158.8 (q ArOMe), 130.2 (ArH), 127.5 (q ArOMe), 114.2 (ArH), [58.4, 57.0 (*C*H*C*H)], 55.3 (O*Me*), 36.4 (*C*H_2Ar); *m/z*

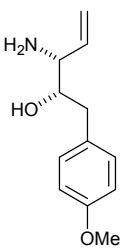
(CI) 210 $[M+NH_4]^+$, 193 $[M+H]^+$, 175, 163, 147, 138, 121, 71, 52 (Found: $[M+H]^+$, 193.0862. $C_{11}H_{12}O_3$ requires $[M+H]^+$, 193.0865).

(2*R,3*R**)-2-(4-Methoxybenzyl)-3-vinyloxirane 3**



To a mixture of Ph_3PCH_3Br (43.6 g, 121.9 mmol, 2.0 equiv.) and THF (140 mL) at –20 ºC was added KHMDS (243.8 mL of a 0.5 M solution in toluene, 121.9 mmol, 2.0 equiv.). After 30 min, the reaction mixture was warmed to rt for 30 min, then re-cooled to –20 ºC. A solution of (2*S**,3*R**)-3-(4-methoxybenzyl)oxirane-2-carbaldehyde (11.7 g, 60.9 mmol, 1.0 equiv.) in THF (30 mL) was added slowly. After 1 h, brine (400 mL) was added and the mixture extracted with Et_2O (3 × 200 mL). The combined organic layers were washed with H_2O (3 × 150 mL), brine (4 × 150 mL) and dried (Na_2SO_4). Following concentration under reduced pressure, the residual brown liquid was cooled and filtered. Column chromatography of the filtrate (20% Et_2O–petrol) gave *(2*R**,3*R**)-2-(4-methoxybenzyl)-3-vinyloxirane* **3** (11.1 g, 96%); R_f 0.55 (10% EtOAc–petrol); ν_{max} (film) 2992, 2949, 2913, 2844, 1611, 1583, 1512, 1461, 1445, 1246, 1034, 923, 806 cm^{-1}; δ_H (400 MHz) 7.18 (2H, d, *J* 8.5 Hz, *meta* ArOMe), 6.88 (2H, d, *J* 8.5 Hz, *ortho* ArOMe), 5.58 (1H, ddd, *J* 17.0, 10.0, 7.5 Hz, C*H*=CH_2), 5.47 (1H, dd, *J* 17.0, 1.5 Hz, *trans* CH=C*H*H), 5.25 (1H, dd, *J* 10.0, 1.5 Hz, *cis* CH=CH*H*), 3.82 (3H, s, OMe), 3.18 (1H, dd, *J* 7.5, 2.0 Hz, C*H*CH=CH_2), 3.06 (1H, ddd, 5.5, 5.5, 2.0 Hz, $ArCH_2CH$), 2.89 (1H, dd, 10.0, 5.5 Hz, ArC*H*H), 2.87 (1H, dd, *J* 10.0, 5.5 Hz, ArCH*H*); δ_C (125 MHz) 158.4 (q ArOMe), 135.5 (q ArOMe), 130.0 (ArH), 128.9 (*C*H=CH_2), 119.3 (CH=*C*H_2), 114.3 (ArH), 60.6 (OMe), [58.4, 55.3 (*C*HO*C*H)], 37.4 (CH_2Ar); *m/z* (CI) 208 $[M+NH_4]^+$, 192, 173, 161, 147, 134, 121, 107 (Found: $[M+NH_4]^+$. 208.1333. $C_{12}H_{14}O_2$ requires $[M+NH_4]^+$, 208.1338).

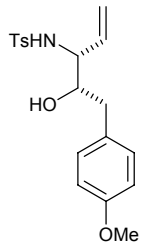
(2*R,3*S**)-3-Amino-1-(4-methoxyphenyl)pent-4-en-2-ol**



A mixture of (2*R**,3*R**)-2-(4-methoxybenzyl)-3-vinyloxirane (2 g, 10.4 mmol, 1.0 equiv.) and NH_4OH (17 mL of 28% NH_3 in H_2O, 251 mmol, 24.1 equiv.) was irradiated under microwave conditions at 110 ºC for 35 min. H_2O (20 mL) was added to the resulting mixture and the aqueous phase was extracted with Et_2O (3 × 20 mL). The combined organic layers were washed with brine (3 × 10 mL) and dried (Na_2SO_4). Concentration under reduced pressure gave (2*R**,3*S**)-3-amino-1-(4-methoxyphenyl)pent-4-en-2-ol (1.8 g, 84%); ν_{max} (film) 3355, 3289, 3099, 3031, 2935, 1612, 1582, 1511, 1463, 1442, 1423, 1299, 1246, 1178, 1108, 1035 cm^{-1}; δ_H (400 MHz) 7.16 (2H, d, *J* 8.5 Hz, *meta* ArOMe), 6.87 (2H, d, *J* 8.5 Hz, *ortho* ArOMe), 6.03-5.94 (1H, m,

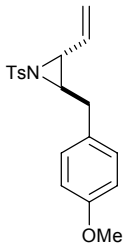
C*H*=CH_2), 6.29-5.25 (2H, m, CH=CH_2), 3.83-3.78 (4H, m, O*Me* & C*H*OH), 3.45 (1H, dd, *J* 7.0, 3.0 Hz, C*H*NH_2), 2.74 (1H, dd, *J* 14.0, 4.5 Hz, C*H*HAr), 2.65 (1H, dd, *J* 14.0, 8.5 Hz, CH*H*Ar), 1.77 [2H, s (br), NH_2]; δ_C (125 MHz) [158.2, 138.2 (q ArOMe)], 130.6 (*C*H=CH_2), 130.4 (ArH), 116.7 (CH=*C*H_2), 114.0 (ArH), 75.3 (*C*HOH), 58.0 (*C*HNH_2), 38.4 (*C*H_2Ar); *m/z* (CI) 208 $[M+H]^+$, 189, 168, 150, 135, 123, 121, 109 (Found: $[M+H]^+$, 208.1337. $C_{12}H_{17}NO_2$ requires $[M+H]^+$, 208.1338).

_N_-[(3*S,4*R**)-4-Hydroxy-5-(4-methoxyphenyl)pent-1-en-3-yl]-4-methylbenzenesulfonamide**



To a solution of crude (2*R**,3*S**)-3-amino-1-(4-methoxyphenyl)pent-4-en-2-ol (7.1 g, 34.3 mmol, 1.0 equiv.), DMAP (503 mg, 4.1 mmol, 0.12 equiv.) and TsCl (13.0 g, 68.2 mmol, 2.0 equiv.) in CH_2Cl_2 (61 mL) at 0 ºC was added Et_3N (15 mL, 108.2 mmol, 3.2). After 3 h CH_2Cl_2 (200 mL) and 10% $NaHCO_{3(aq.)}$ (130 mL) were added. The aqueous phase was extracted with CH_2Cl_2 (2 × 50 mL). The combined organic layers were washed with brine (3 × 30 mL) and dried (Mg_2SO_4). Concentration under reduced pressure and column chromatography (35→60% EtOAc-petrol) gave *N-[(3*S**,4*R**)-4-hydroxy-5-(4-methoxyphenyl)pent-1-en-3-yl]-4-methylbenzenesulfonamide* (10.1 g, 81%); R_f 0.3 (30% EtOAc–petrol); ν_{max} (film) 3447, 3356, 3291, 1511, 1322, 1288, 1153, 1077, 1025, 813, 675 cm^{-1}; δ_H (400 MHz) 7.70 (2H, d, *J* 8.0 Hz, *ortho* Ts), 7.28 (2H, d, *J* 8.0 Hz, *meta* Ts), 7.05 (2H, d, *J* 8.5 Hz, *meta* ArOMe), 6.85 (2H, d, *J* 8.5 Hz, *ortho* ArOMe), 6.74 (1H, ddd, *J* 17.5, 10.5, 7.5 Hz, C*H*=CH_2), 6.19-5.08 (2H, m, CH=CH_2), 3.86-3.79 (5H, m, O*Me*, C*H*NHTs & C*H*OH), 2.67 (1H, dd, *J* 14.0, 4.5 Hz, ArC*H*H), 2.58 (1H, dd, *J* 14.0, 9.0 Hz, CH*H*Ar), 2.65 (1H, dd, *J* 14.0, 8.5 Hz, CH*H*Ar), 2.44 (3H, s, Me of Ts), 1.88 (1H, d, *J* 4.5 Hz, N*H*Ts); δ_C (100 MHz) [158.2, 143.4, 137.7 (q Ar)], 132.5 (*C*H=CH_2), [130.2, 129.6, (ArH)], 129.1 (q ArOMe), 127.2 (ArH), 119.4 (CH=*C*H_2), 114.2 (ArH), 74.7 (*C*HOH), 59.9 (*C*HNH_2), 55.3 (OMe), 39.0 (*C*H_2Ar), 21.6 (Me of Ts); *m/z* (CI) 379 $[M+NH_4]^+$, 362 $[M+H]^+$, 344, 300, 251, 228, 227, 207, 189, 150, 148, 140, 134, 122, 120, 109 (Found: $[M+H]^+$, 362.1438. $C_{19}H_{23}NO_4S$ requires $[M+H]^+$, 362.1426).

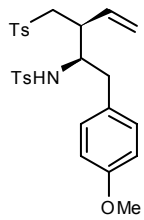
(2*R,3*R**)-2-(4-Methoxybenzyl)-1-tosyl-3-vinylaziridine 2**



To a solution of *N*-[(3*S**,4*R**)-4-hydroxy-5-(4-methoxyphenyl)pent-1-en-3-yl]-4-methylbenzenesulfonamide (7.20 g, 19.9 mmol, 1.0 equiv.) and PPh_3 (13.6 g,

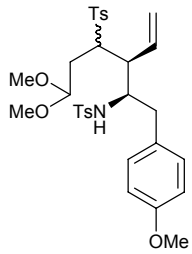
51.9 mmol, 2.6 equiv.) in THF (200 mL) at –15 ºC was added DIAD (8.10 g, 39.9 mmol, 2.0 equiv.) dropwise. The solution was warmed to –5 ºC. After 14 h the solvent was removed under reduced pressure. The residual liquid was cooled to 0 ºC and the resulting mixture filtered. The filtrate was concentrated under reduced pressure and the residue purified by column chromatography (25% EtOAc–petrol) to give *(2*R**,3*R**)-2-(4-methoxybenzyl)-1-tosyl-3-vinylaziridine* **2** (6.4 g, 94%); data were identical to those listed above.

(2*R*,3*S*)-*N*-[1-(4-Methoxy-benzyl)-2-(toluene-4-sulfonylmethyl)-but-3-enyl]-4-methyl-benzenesulfonamide 5a



To a solution of TsMe (88.0 mg, 0.52 mmol, 2.0 equiv.) in THF (1 mL) at –50˚C was added *n*BuLi (0.24 mL of a 2.15 M solution in hexanes, 0.52 mmol, 2.0 equiv.), After 25 min, the reaction temperature reached –20 ˚C. A solution of (2*R*,3*R*)-2-(4-methoxybenzyl)-1-tosyl-3-vinylaziridine (87.0 mg, 0.254 mmol, 1.0 equiv.) in THF (1.1 mL) was added. The reaction was then gradually warmed to rt. After 12 h, it was quenched with sat. $NH_4Cl_{(aq.)}$ (5 mL) and the aqueous phase extracted with EtOAc (3 × 30 mL). The combined organic layers were washed with brine, and dried (Na_2SO_4). Concentration under reduced pressure and column chromatography (30% EtOAc–petrol) gave (*2*R*,3*S*)-N-*[1-(4-methoxy-benzyl)-2-(toluene-4-sulfonylmethyl)-but-3-enyl]-4-methyl-benzenesulfonamide* **5a** (96.0 mg, 74%) as a colourless oil; R_f 0.29 (40% EtOAc–petrol); ν_{max} (film) 3268, 2923, 1736, 1612, 1596, 1511, 1442, 1317, 1301, 1288, 1247, 1159, 1086, 1036, 932, 816, 663 cm^{-1}; δ_H (270 MHz) 7.62 (2H, d, *J* 8.5 Hz, *ortho* Ts), 7.56 (2H, d, *J* 8.5 Hz, *ortho* Ts), 7.20 (4H, m, *meta* Ts), 6.72 (2H, d, *J* 8.5 Hz, ArH), 6.63 (2H, d, *J* 8.5 Hz, ArH), 5.62 (1H, ddd, *J* 17.0, 10.5, 9.0 Hz, C*H*=CH_2), 5.18 (1H, d, *J* 10.5 Hz, CH=C*H*H), 5.01 (1H, d, *J* 17.0 Hz, CH=CH*H*), 4.92 (1H, d, *J* 9.5 Hz, N*H*), 3.75 (3H, s, O*Me*), 3.74 (1H, m, C*H*NH), 3.58 (1H, dd, *J* 14.5, 7.0 Hz, CH_2Ts), 3.01 (1H, dd, *J* 14.5, 5.0 Hz, CH_2Ts), 2.69 (1H, m, C*H*$CHCH_2$), [2.50 and 2.20 (2H, m, CH_2Ar)], {2.39 and 2.37 [2 × Me, s, Me(Ts)]}; δ_c (67.5 MHz) [158.4, 144.5, 143.6, 137.1 and 136.7 (q Ar)], [133.8, 130.1 and 129.8 (*meta* or *ortho* Ar & *C*HCH_2)], 128.6 (4°), [128.2 and 127.3 (*meta* or *ortho* Ar)], 120.3 ($CHCH_2$), 114.0 (*meta* or *ortho* Ar), [57.4 and 57.1 (*C*HNH and *C*$HCHCH_2$)], 55.2 (OMe), [40.2 and 38.6 (CH_2Ts and CH_2Ar)], {21.7 and 21.6 [2 Me(Ts)]}; *m/z* (CI) 531 $[M+NH_4]^+$, 514 $[M+H]^+$, 467, 450, 409, 377, 360, 349, 327, 324, 308, 304, 296, 294, 288, 279, 271, 253, 236, 227, 197, 189, 176, 174, 161, 150, 139, 123, 106, 82 (Found: $[M+H]^+$ 514.1724. $C_{27}H_{31}NO_5S_2$ requires $[M+H]^+$ 514.1722).

_N_-[(2_R_,3_S_,4_R_)-6,6-Dimethoxy-1-(4-methoxyphenyl)-4-tosyl-3-vinylhexan-2-yl]-4-methylbenzenesulfonamide and _N_-[(2_R_,3_S_,4_S_)-6,6-dimethoxy-1-(4-methoxyphenyl)-4-tosyl-3-vinylhexan-2-yl]-4-methylbenzenesulfonamide 5b



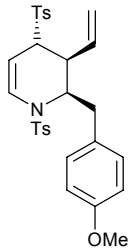
To a solution of 1-(3,3-dimethoxypropylsulfonyl)-4-methylbenzene **4b** (1.84 g, 7.12 mmol, 1.50 equiv.) in THF (20 mL) at –30 ºC was added *n*BuLi (2.97 mL of a 2.4 M solution in hexanes, 7.12 mmol, 1.50 equiv.). After 20 min, to the resulting yellow solution was added (2*R*,3*R*)-2-(4-methoxybenzyl)-1-tosyl-3-vinylaziridine (1.63 g, 4.75 mmol, 1.0 equiv.) in THF (15 mL). The reaction was then gradually warmed to rt. After 16 h it was quenched with sat. $NaHCO_{3(aq.)}$ (30 mL). The aqueous phase was extracted with CH_2Cl_2 (3 × 30 mL). The combined organic layers were washed with brine (2 × 20 mL) and dried (Na_2SO_4). Concentration under reduced pressure and column chromatography (30% EtOAc–petrol) gave a 3:1 mixture of the (2*R*,3*S*,4*R*)- and (2*R*,3*S*,4*S*)-diastereoisomers of **5b** (2.58 g, 90%) which could be separated by further careful chromatography.

N-*[(2*R*,3*S*,4*S*)-6,6-Dimethoxy-1-(4-methoxyphenyl)-4-tosyl-3-vinylhexan-2-yl]-4-methylbenzene-sulfonamide*: R_f 0.29 (10% EtOAc–CH_2Cl_2); ν_{max} (film) 3268, 2923, 2850, 2836, 1612, 1596, 1494, 1444, 1322, 1301, 1247, 1180, 1083 cm^{-1}; δ_H (270 MHz) 7.70 (2H, d, *J* 8.5 Hz, *ortho* Ts), 7.46 (2H, d, *J* 8.5 Hz, *ortho* Ts), 7.25 (4H, m, *meta* Ts), 7.00 (2H, d, *J* 8.5 Hz, *meta* ArOMe), 6.73 (2H, d, *J* 8.5 Hz, *ortho* ArOMe), 5.74 (1H, dt, *J* 17.0, 10.0 Hz, C*H*=CH_2), 5.20 (1H, dd, *J* 10.0, 1.5 Hz, CH=C*H*H), 5.00 (1H, dd, *J* 17.0, 1.5 Hz, CH=CH*H*), 4.98 (1H, d, *J* 8.0 Hz, NH), 4.14 [2H, m, *J* 5.5 Hz, C*H*$(OMe)_2$ & C*H*NH)], 3.77 (3H, s, OMe), 3.42 (1H, m, C*H*Ts), [3.31, 3.03 (2 × 3H, 2 × s, CH(O*Me*)$_2$], 2.82 (1H, dd, *J* 14.0, 4.5 Hz, C*H*HAr), 2.69 (1H, dd, *J* 14.0, 8.0 Hz, CH*H*Ar), 2.61 (1H, ddd, *J* 10.0, 8.0, 3.0 Hz, C*H*$CHCH_2$), 2.40 (2 × 3H, 2 × s, 2 × Me of Ts), 1.94 [2H, t, *J* 6.0 Hz, C$H_2$$CH(OMe)_2$]; δ_C (67.5 MHz) [158.4, 144.7, 143.3, 137.8, 136.0 (q Ar)], 133.2 (*C*H=CH_2), [130.8, 129.8, 129.7 (ArH)], 129.2 (q Ar), [128.7, 127.4 (ArH)], 121.4 (CH=*C*H_2), 113.9 (ArH), 102.2 [*C*$H(OMe)_2$)], [61.9, 56.0 (*C*HTs, *C*HNTs)], [55.3, 54.4, 52.8 (3 × OMe)], 47.6 (*C*$HCHCH_2$), 38.9 (*C*H_2Ar), 30.8 [*C*$H_2CH(OMe)_2$], [21.7, 21.6 (2 × Me of Ts)]; *m/z* (CI) 619 $[M+NH_4]^+$, 537, 570, 476, 416, 384, 212, 189, 173 (Found: $[M+NH_4]^+$, 619.2517. $C_{31}H_{39}NO_7S_2$ requires $[M+NH_4]^+$, 619.2512).

*N-[(2*R*,3*S*,4*R*)-6,6-Dimethoxy-1-(4-methoxyphenyl)-4-tosyl-3-vinylhexan-2-yl]-4-methylbenzene-sulfonamide*: R_f 0.25 (10% EtOAc–CH_2Cl_2); ν_{max} (film) 2915, 2868, 1612,

1596, 1511, 1442, 1324, 1299, 1288, 1247, 1178, 1145, 1088, 1035 cm^{-1}; δ_H (270 MHz) 7.70 (2H, d, *J* 8.0 Hz, *ortho* Ts), 7.45 (2H, d, *J* 8.5 Hz, *ortho* Ts), 7.22 (2H, d, *J* 8.0 Hz, *meta* Ts), 7.18 (2H, d, *J* 8.5 Hz, *meta* Ts), 6.78 (2H, d, *J* 8.5 Hz, *meta* ArOMe), 6.65 (2H, d, *J* 8.5 Hz, *ortho* ArOMe), 5.60 (1H, dt, *J* 17.0, 10.0 Hz, C*H*CH_2), 5.25 (1H, dd, *J* 10.0, 1.5 Hz, CH=C*H*H), 5.16 (1H, d, *J* 8.0 Hz, NH), 4.88 (1H, dd, *J* 17.0, 1.5 Hz, CH=CH*H*), 4.25 [1H, t, *J* 5.5 Hz, C*H*$(OMe)_2$], 3.90 (1H, m, C*H*NH), 3.72 (3H, s, OMe), 3.64 (1H, m, C*H*Ts), [3.26, 3.23 (2 × 3H, 2 × s, CH(O*Me*)$_2$], 2.70 (1H, ddd, *J* 10.0, 6.5, 3.0 Hz, C*H*CHCH_2), 2.39 (2H, m, CH_2Ar), 2.37 (2 × 3H, 2 × s, 2 × Me of Ts), 1.99 [1H, dt, *J* 15.0, 6.0 Hz, C*H*HCH$(OMe)_2$], 1.78 [1H, dt, *J* 15.0, 6.0 Hz, CH*H*CH$(OMe)_2$]; δ_C (67.5 MHz) [158.3, 144.5, 143.5, 137.0, 134.2 (q *Ar*)], 132.5 (*C*H=CH_2), [130.3, 129.7, 129.6, 129.1 (ArH)], 128.7 (q Ar), 127.4 (ArH), 122.4 (CH=*C*H_2), 113.8 (ArH), 103.5 [*C*H$(OMe)_2$)], [59.1, 57.7 (*C*HTs, *C*HNTs)], [55.2, 54.7, 53.8 (3 × OMe)], 45.0 (*C*HCHCH_2), 38.8 (*C*H_2Ar), 30.8 [*C*H_2CH$(OMe)_2$], [21.7, 21.6 (2 × Me of Ts)]; *m/z* (CI) 619 $[M+NH_4]^+$, 588, 570, 555, 449, 416, 414, 384, 230, 189, 174 (Found: $[M+NH_4]^+$, 619.2498. $C_{31}H_{39}NO_7S_2$ requires $[M+NH_4]^+$, 619.2512).

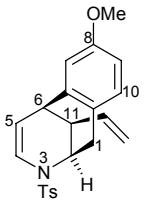
(2*R*,3*S*,4*S*)-2-(4-Methoxybenzyl)-1,4-ditosyl-3-vinyl-1,2,3,4-tetrahydropyridine



To a solution of *N*-[(2*R*,3*S*,4*S*)-6,6-dimethoxy-1-(4-methoxyphenyl)-4-tosyl-3-vinylhexan-2-yl]-4-methylbenzenesulfonamide **5b** (40.0 mg, 0.067 mmol, 1.0 equiv.) in CH_2Cl_2 (1.3 mL) at –78 °C was added $BF_3{\cdot}Et_2O$ (0.13 mL, 1.0 mmol, 15.0 equiv.). The solution was warmed to –50 °C over 2.5 h. The mixture was quenched with sat. $NaHCO_{3(aq.)}$ (2 mL) and warmed to rt. After stirring for 15 min the mixture was extracted with CH_2Cl_2 (2 × 20 mL). The combined organic layers were washed with brine and dried (Na_2SO_4). Concentration under reduced pressure and column chromatography (1% EtOAc–CH_2Cl_2) gave *(2*R*,3*S*,4*S*)-2-(4-methoxybenzyl)-1,4-ditosyl-3-vinyl-1,2,3,4-tetrahydropyridine* (29.0 mg, 83%); R_f 0.25 (2% EtOAc–CH_2Cl_2); ν_{max} (film) 3066, 2925, 2854, 1637, 1596, 1513, 1456, 1398, 1365, 1342, 1303, 1247, 1170, 1137, 1087, 1035 cm^{-1}; δ_H (270 MHz) 7.50 (2H, d, *J* 8.5 Hz, *ortho* Ts), 7.35 (2H, d, *J* 8.5 Hz, *ortho* Ts), 7.23 (2H, d, *J* 8.5 Hz, *meta* Ts), 7.07 (2H, d, *J* 8.5 Hz, *meta* Ts), 6.95 (2H, d, *J* 8.0 Hz, *meta* ArOMe), 6.79 (1H, m, NC*H*=CH), 6.77 (2H, d, *J* 8.0 Hz, *ortho* ArOMe), 5.71 (1H, ddd, *J* 17.0, 10.0, 8.5 Hz, C*H*=CH_2), 5.33 (1H, dd, *J* 8.0, 2.0 Hz, NCH=C*H*), 5.09 (1H, d, *J* 10.0 Hz, *trans* CH=CH*H*), 4.69 (1H, d, *J* 17.0 Hz, *cis* CH=C*H*H), 3.85 (1H, dt, *J* 9.0, 4.0 Hz, CH_2C*H*NTs), 3.77 (3H, s, OMe), 3.72 (1H, dt, *J* 10.5, 2.0 Hz, C*H*Ts), 2.68 (1H, dd, *J* 14.0, 4.5 Hz, C*H*HAr), 2.55 (1H, m, CH*H*Ar), [2.47, 2.39 (2 × 3H, 2 × s, 2 × Me of Ts)], 1.76 (1H,

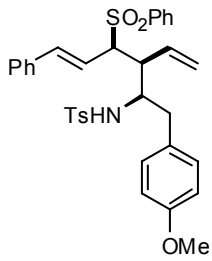
m, C*H*CH=CH_2); δ_C (67.5 MHz) [158.5, 144.8, 143.7 (q Ar)], 136.7 (*C*H=CH_2), [135.3, 133.4 (q Ar)], [130.6, 129.6, 129.5, 129.4 (*meta* & *ortho* Ar)], 128.9 (q Ar), 126.9 (*meta* or *ortho* Ar), 118.2 (CH=*C*H_2), 113.8 (*meta* or *ortho* Ar), [62.1, 61.0 (*C*HNTs & *C*HTs)], 52.2 (OMe), 40.9, 32.6 (*C*H_2Ar), [21.9, 21.7 (2 × Me of Ts)]; *m/z* (CI) 555 $[M+NH_4]^+$, 538 $[M+H]^+$, 417, 398, 382, 320, 303, 279, 266, 260, 244 189, 174, 121, 106 (Found: $[M+ NH_4]^+$, 555.1981. $C_{29}H_{31}NO_5S_2$ requires $[M+ NH_4]^+$, 555.1987).

(2*R*,6*R*,11*R*)-8-Methoxy-3-tosyl-11-vinyl-1,2,3,6-tetrahydro-2,6-methanobenzo[*d*]azocine 6



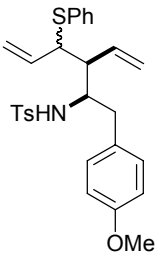
To a solution of (2*R*,3*S*,4*S*)-2-(4-methoxybenzyl)-1,4-ditosyl-3-vinyl-1,2,3,4-tetrahydropyridine and (2*R*,3*S*,4*R*)-2-(4-methoxybenzyl)-1,4-ditosyl-3-vinyl-1,2,3,4-tetrahydropyridine (approx. 1:1, 99.0 mg, 0.18 mmol, 1.0 equiv.) in CH_2Cl_2 (0.9 mL) at –78 ˚C was added $SnCl_4$ (0.45 mL of a 1.0 M solution in CH_2Cl_2, 0.45 mmol, 2.5 equiv.) and the solution allowed to warm to 0 ˚C during 5 h. Sat. $NaHCO_{3(aq.)}$ (3 mL) was added and the reaction mixture diluted and extracted with CH_2Cl_2 (2 × 30 ml). The combined organic layers were washed with brine (2 × 10 mL) and dried (Na_2SO_4). Concentration under reduced pressure and column chromatography (20% EtOAc–petrol) gave *8-methoxy-3-tosyl-11-vinyl-1,2,3,6-tetrahydro-2,6-methano-benzo[*d*]azocine* **6** (37.0 mg, 53%); R_f 0.35 (20% EtOAc–petrol); $[\alpha]_D^{23}$ –526 ($CDCl_3$, *c* 1.6); ν_{max} (film) 3066, 3000, 2923, 2852, 2836, 1643, 1610, 1502, 1463, 1427, 1394, 1363, 1342, 1303, 1267, 1249, 1166, 1120, 1093, 1051, 985, 919, 885, 856, 813, 777, 732, 711, 680, 611, 595, 580, 549 cm^{-1}; δ_H (270 MHz) 7.70 (2H, d, *J* 8.5 Hz, *ortho* Ts), 7.30 (2H, d, *J* 8.5 Hz, *meta* Ts), 6.96 (1H, d, *J* 8.5 Hz, H-10), 6.38 (2H, m, H-4 and H-9), 6.56 (1H, d, *J* 2.5 Hz, H-7), 5.50 (1H, ddd, *J* 17.0, 10.5, 7.5 Hz, C*H*CH_2), 5.27 (1H, dd, *J* 8.0, 7.0 Hz, H-5), 4.94 (1H, dt, *J* 10.5, 1.0 Hz, CHC*H*$_2$), 4.90 (1H, dt, *J* 17.0, 1.5 Hz, CHC*H*$_2$), 4.30 (1H, m, H-2), 3.74 (3H, s, OMe), 3.20 (1H, dd, J 18.5, 6.0 Hz, C*H*$_2$Ar), 3.08 [1H, d (br), J 7.0 Hz, H-6], 2.94 (1H, d, *J* 18.5 Hz, C*H*$_2$Ar), 2.43 [3H, s, Me(Ts)], 2.09 (1H, m, H-3); δ_H (67.5 MHz) [157.8, 143.8 and 139.4 (q Ar)], 136.7 (*C*H=CH_2), 136.4 (q Ar), [130.2, 129.9 and 126.9 (3°)], 124.6 (q Ar), 123.1 (3°), 117.4 (CH=*C*H_2), [113.3, 113.0 and 111.9 (3°)], 55.3 (OMe), 52.8 (C-2), 39.5 and 37.1 (C-6 and C-11), 33.8 (*C*H_2Ar), 21.7 [Me(Ts)]; *m/z* (CI) 382 $[M+H]^+$, 228, 189, 174, 139, 108, 106, 91, 84, 77, 69, 52, 44 (Found: $[M+H]^+$ 382.1479. $C_{22}H_{23}NO_3S$ requires $[M+H]^+$ 382.1477).

***N*-[(2*R**,3*S**,4*R**,*E*)-1-(4-Methoxyphenyl)-6-phenyl-4-(phenylsulfonyl)-3-vinylhex-5-en-2-yl]-4-methylbenzenesulfonamide 5c**



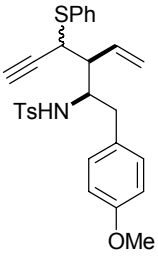
To a mixture of cinnamylsulfonylbenzene **4c** (1.58 g, 6.12 mmol, 1.4 equiv.) in THF (5.0 mL)–TMEDA (1.7 mL) at –20 °C was added *n*BuLi (570 μL of a 11.5 M solution in hexanes, 6.56 mmol, 1.5 equiv.). The resulting red solution was warmed to 0 °C during 15 min, and then to rt. After 15 min the reaction was re-cooled to 0 °C and a solution of aziridine **2** (1.51 g, 4.39 mmol, 1.0 equiv.) in THF (0.9 mL) added slowly. After 16 h, the reaction was quenched with sat. $NH_4Cl_{(aq.)}$ (10 mL) then diluted with H_2O (10 mL). The aqueous phase was extracted with EtOAc (3 × 10 mL). The combined organic layers were washed with brine (3 × 5 mL) and dried (Na_2SO_4). Concentration under reduced pressure and column chromatography gave **5c** (1.20 g, 45%) as a 10:1 mixture of diastereoisomers. Upon recrystallisation the major diastereomer was obtained; data for *N-[(2*R**,3*S**,4*R**,*E*)-1-(4-methoxyphenyl)-6-phenyl-4-(phenylsulfonyl)-3-vinylhex-5-en-2-yl]-4-methylbenzenesulfonamide*: mp 120–122 °C (EtOAc–petrol); R_f 0.46 (30% EtOAc–petrol); ν_{max} (film) 3260, 2954, 2952, 1611, 1512, 1446, 1302, 1247, 1147, 1032, 926, 735 cm^{-1}; δ_H (400 MHz) 7.85 (2H, d, *J* 7.5 Hz, *ortho* $PhSO_2$), 7.76 (2H, d, *J* 8.5 Hz, *ortho* Ts), 7.58 (1H, t, *J* 7.5 Hz, *para* $PhSO_2$), 7.46 (2H, t, *J* 7.5 Hz, *meta* $PhSO_2$), 7.27-7.15 (5H, m, *Ph*CH=CH), 6.88 (2H, d, *J* 8.5 Hz, *meta* ArOMe), 6.71 (2H, d, *J* 8.5 Hz, *ortho* ArOMe), 6.0 (1H, d, *J* 15.8 Hz, PhC*H*=CH), 6.75 (1H, dd, *J* 16.0, 10.5 Hz, PhCH=C*H*), 5.51 (1H, ddd, *J* 17.0, 10.5, 7.0 Hz, C*H*=CH_2), 5.29 (1H, dd, *J* 10.5, 1.5 Hz, *trans* CH=C*H*H), 5.16 (1H, dd, *J* 17.0, 1.5 Hz, *cis* CH=CH*H*), 4.63-4.58 (2H, m, C*H*SO_2Ph & TsNHC*H*), 4.32 (1H, d, *J* 9.5 Hz, NH), 3.81 (3H, s, OMe), 3.11 (1H, ddd, *J* 10.5, 10.0, 1.5 Hz, C*H*CH=CH_2), 2.60 (1H, dd, *J* 14.0, 8.5 Hz, ArOMeC*H*H), 2.45 (3H, s, Me of Ts), 2.33 (1H, dd, *J* 14.0, 6.5 Hz, ArOMeCH*H*); δ_C (125 MHz) 158.4, 143.6, 137.6, 136.7, 135.9, 133.5, 132.6, 130.2, 129.8, 129.3, 128.7, 128.6, 128.2, 128.1, 127.3, 126.5, 121.3, 113.9, 67.4, 56.4, 55.2, 44.5, 39.4, 21.6; *m/z* (ESI) 624.1842 $[M+Na]^+$, 602.2050 $[M+H]^+$, 539.1342, 304.1051 (Found: $[M+H]^+$, 602.2050. $C_{34}H_{35}NO_5S_2$ requires $[M+H]^+$, 602.2035) (Found: C, 67.84; H, 6.00; N, 2.44. $C_{34}H_{35}NO_5S_2$ requires C, 67.86; H, 5.86; N, 2.33%).

***N*-[(2*R**,3*S**)-1-(4-Methoxyphenyl)-4-(phenylthio)-3-vinylhex-5-en-2-yl]-4-methylbenzene-sulfonamide 5d**



To a solution of allyl(phenyl)sulfide **4d** (241 mg, 1.60 mmol, 1.1 equiv.) in THF (1.0 mL) at –78 °C was added *n*BuLi (988 μL of a 1.62 M solution in hexanes, 1.60 mmol, 1.1 equiv.). After 25 min the reaction vessel was placed in a 0 °C ice–water bath for 5 min and then re-cooled to –78 °C. To the resulting solution was added a solution of aziridine **2** (500 mg, 1.46 mmol, 1.0 equiv.) in THF (0.8 mL) at –78 °C. After 20 min, the reaction was quenched with a solution of AcOH (96 mg) in THF (865 mg) dropwise then warmed to rt. This solution was further diluted with H_2O (10 mL) and the aqueous phase extracted with EtOAc (3 × 15 mL). The combined organic layers were washed with brine (2 × 10 mL) and dried (Na_2SO_4). Concentration under reduced pressure and column chromatography (15% EtOAc–petrol) gave **5d** (547 mg, 76%) as a 5:1 mixture of diastereoisomers; data for major diastereoisomer: R_f 0.33 (15% EtOAc–petrol); ν_{max} (film) 3280, 1612, 1513, 1440, 1325, 1247, 1158, 1093, 1035, 923 cm^{-1}; δ_H (500 MHz) 7.73 (2H, d, *J* 8.5 Hz, *ortho* Ts), 7.33–7.19 (7H, m, *meta* Ts and PhS), 6.88 (2H, d, *J* 8.5 Hz, *meta* ArOMe), 6.77 (2H, d, *J* 8.5 Hz, *ortho* ArOMe), 5.74 (1H, ddd, *J* 15.5, 10.0, 8.5 Hz, CH_2=C*H*CHCHN), 5.40 (1H, dd, *J* 10.0, 1.5 Hz, *trans* C*H*H=CHCHCHN), 5.29-5.17 (2H, m, CH_2=C*H*CHS & *cis* CH*H*=CHCHCHN), 4.89 (1H, dd, *J* 10.0, 1.0 Hz, *trans* C*H*H=CHCHS), 4.65 (1H, dd, *J* 17.0, 1.0 Hz, *cis* CH*H*=CHCHS), 4.34 (1H, m, NH), 3.83-3.76 (5H, m, OMe & NCH & CHS), 2.62-2.49 (2H, m, CH_2CHN), 2.44 (3H, s, Me of Ts), 2.22–2.17 (1H, m, C*H*CHN); δ_C (125 MHz) [158.3, 143.5 137.7, 136.7 (q Ar)], [134.4, 134.2 (*C*H=CH_2 & *C*H=CH_2)], [133.1, 130.2, 129.7 (*meta* & *ortho* Ar)], [128.9, 128.8 (q Ar)], [128.6, 127.1 (*meta* & *ortho* Ar)], [120.9, 117.9 (CH=*C*H_2 & CH=*C*H_2)], 113.9 (*meta* or *ortho* Ar), 56.0, 55.2, 53.0, 48.6, 39.1, 21.6; *m/z* (ESI) 532, 516 $[M+Na]^+$, 494 $[M+H]^+$, 384, 304 (Found: $[M+Na]^+$, 516.1646. $C_{28}H_{31}NO_3S_2$ requires $[M+Na]^+$, 516.1643).

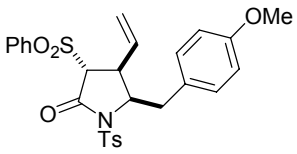
_N_-[(2_R_*,3_S_*,4_S_*)-1-(4-Methoxyphenyl)-4-(phenylthio)-3-vinylhex-5-yn-2-yl]-4-methylbenzenesulfonamide and _N_-[(2_R_*,3_S_*,4_R_*)-1-(4-methoxyphenyl)-4-(phenylthio)-3-vinylhex-5-yn-2-yl]-4-methylbenzenesulfonamide 5e



To a solution of phenyl(propargyl)sulfide **4e** (1.25 g, 8.4 mmol, 1.2 equiv.) in THF (9 mL) at –78 °C was added *n*BuLi (6.72 mL of a 2.5 M solution in hexanes, 16.8 mmol, 2.4 equiv.) dropwise. The mixture was warmed to –30 °C during 1.5 h, then re-cooled to –78 °C and a solution of aziridine **2** (2.3 g, 6.7 mmol, 1.0 equiv.) in THF (5.0 mL) added *via* cannula. The resulting red solution was warmed to 5 °C during 3 h then to rt. After 30 min, it was cooled to 0 °C,

quenched with sat. $NH_4Cl_{(aq.)}$ (19 mL) then diluted with H_2O (10 mL). The aqueous phase was extracted with EtOAc (3 × 10 mL). The combined organic layers were washed with brine (3 × 5 mL) and dried (Na_2SO_4). Concentration under reduced pressure and column chromatography (15→20% EtOAc-petrol) gave **5e** (2.5 g, 76%) as a 2:1 mixture of diastereoisomers; R_f 0.42 (25% EtOAc–petrol); ν_{max} (film) 3285, 2925, 1731, 1612, 1512, 1439, 1326, 1303, 1248, 1158, 1081, 1034, 927, 815, 742, 691, 663 cm^{-1}; δ_H (400 MHz) 7.78 (2H, d, *J* 8.0 Hz, *ortho* Ts, minor diast.), 7.63 (2H, d, *J* 8.0 Hz, *ortho* Ts, major diast.), 7.36-7.21 (2 × 7H, m, SPh & *meta* Ts, 2 × diast.), 6.98 (2H, d, *J* 8.5 Hz, *meta* ArOMe, minor diast.), 6.89 (2H, d, *J* 8.5 Hz, *meta* ArOMe, major diast.), 6.78-6.72 (2 × 2H, m, *ortho* ArOMe, 2 × diast.), 5.73-5.61 (2 × 1H, m, C*H*=CH_2, 2 × diast.), 5.44-5.38 (2 × 1H, m, *trans* CH=C*H*H, 2 × diast.), 5.15 (1H, dd, *J* 17.0, 1.0 Hz, *cis* CH=CH*H*, major diast.), 5.13 (1H, dd, *J* 17.0, 1.0 Hz, *cis* CH=CH*H*, minor diast.), 4.69-4.59 (2 × 1H, m, NH, 2 × diast.), 4.14-3.91 (2 × 2H, m, NCH & CHSPh, 2 × diast.), 3.82 (3H, s, Me of ArOMe, minor diast.), 3.79 (3H, s, Me of ArOMe, major diast.), 2.79-2.52 (2 × 3H, m, C*H*CH=CH_2 & C*H*$_2$ArOMe, 2 × diast.), 2.44 (3H, s, Me of Ts, minor diast.), 2.41 (3H, s, Me of Ts, major diast.), 2.37 (1H, d, *J* 2.0 Hz, *H*CCCHSPh, major diast.), 2.32 (1H, d, *J* 2.5 Hz, *H*CCCHSPh, minor diast.); δ_C (125 MHz) [158.5, 158.3, 143.6, 143.4 (q Ar, 2 × diast.)], 137.5, 134.2, 133.6, 133.3, 133.2, 132.9, 132.2, 130.1, 130.4, 130.1, 129.7, 129.6, 129.5, 128.9, 128.7, 128.2, 127.4, 127.3, 126.9, [121.6, 121.4 (CH=*C*H_2, 2 × diast.)], 114.1, 113.9, 89.6, 82.8, 74.6, 73.6, 56.8, 56.4, 55.8, 55.2, 51.6, 49.6, 40.4, 39.8, 39.7, 39.6, 21.9, 21.6; *m/z* (ESI) 514.1473 $[M+Na]^+$, 492.1661 $[M+H]^+$; (Found: $[M+H]^+$, 492.1661, $C_{28}H_{29}NO_3S_2$ requires $[M+H]^+$, 492.1667).

(3*R,4*S**,5*R**)-5-(4-Methoxybenzyl)-3-(phenylsulfonyl)-1-tosyl-4-vinylpyrrolidin-2-one**

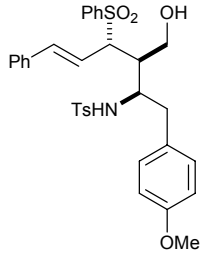


8

Benzenesulfonyl acetic acid methyl ester **4f** (0.531 mL, 3.15 mmol, 1.0 equiv.) in DMF (10 mL) was added dropwise to KH (440 mg of a 30% wt. dispersion in mineral oil, 3.30 mmol, 1.1 equiv, washed with hexanes) at 0 ºC. After 30 min aziridine **2** (1.03 g, 3.00 mmol, 1.0 equiv.) in DMF (5 mL) was added dropwise, the reaction brought to rt and then heated to 60 ºC. After 12 h the reaction was quenched with MeOH (20 mL) and extracted with CH_2Cl_2 (3 × 30 mL). The combined organic layers were then washed with H_2O (2 × 10 mL), brine (20 mL) and dried (Na_2SO_4). Concentration under reduced pressure and column chromatography (30% EtOAc–petrol) gave *(3*R**,4*S**,5*R**)-5-(4-methoxybenzyl)-3-(phenylsulfonyl)-1-tosyl-4-vinylpyrrolidin-2-one* **8** as a colourless solid (1.40 g, 89%); mp 123–124 ºC (EtOAc); R_f 0.34 (30% EtOAc–petrol); ν_{max} (film) 1740,

1671, 1612, 1513, 1448, 1362, 1326, 1310, 1172, 1083, 1033, 815 cm^{-1}; δ_H (600 MHz) 7.93 (2H, d, *J* 8.0 Hz, *ortho* Ts), 7.61 (1H, t, *J* 8.0 Hz, *para* $PhSO_2$), 7.59 (2H, d, *J* 8.0 Hz, *ortho* $PhSO_2$), 7.42 (2H, d, *J* 8.0 Hz, *meta* $PhSO_2$), 7.37 (2H, d, *J* 8.0 Hz, *meta* Ts), 7.15 (2H, d, *J* 9.0 Hz, *meta* ArOMe), 6.82 (2H, d, *J* 9.0 Hz, *ortho* ArOMe), 5.87 (1H, m, C*H*=CH_2), 5.33 (1H, d, *J* 10.0 Hz, *trans* CH=C*H*$_2$), 5.25 (1H, d, *J* 17.0 Hz, *cis* CH=C*H*$_2$), 4.76 (1H, dt, *J* 8.0, 3.0 Hz, C*H*NTs), 3.80 (3H, s, OMe), 3.52 (1H, q, *J* 8.5 Hz, C*H*CH=CH_2), 3.38 (1H, d, *J* 9.0 Hz, C*H*SO_2Ph), 3.24 (1H, dd, *J* 15.0, 3.0 Hz, C*H*HArOMe), 3.10 (1H, dd, *J* 15.0, 7.0 Hz, CHHArOMe), 2.51 (3H, s, Me of Ts;); δ_C (150 MHz) 164.0 (C=O), 158.8 (*para* $PhSO_2$), 145.6 (*para* Ts), 136.8 (*ipso* $PhSO_2$), 135.0 (*ipso* Ts), 134.2 (*para* $PhSO_2$), 132.4 (*C*H=CH_2), 131.3 (*ortho* ArOMe), 129.6 (*meta* Ts), 129.4 (*ortho* $PhSO_2$), 128.9 (*meta* $PhSO_2$), 128.8 (*ortho* Ts), 127.1 (*ipso* ArOMe), 120.8 (CH=*C*H_2), 114.2 (*meta* ArOMe), 69.0 (*C*H_2ArOMe), 62.5 (*C*HNTs), 55.2 (OMe), 43.0 (*C*HCH=CH_2), 35.7 (*C*H_2ArOMe), 21.8 (Me of Ts); *m/z* (CI) 543 $[M+NH_4]^+$, 526 $[M+H]^+$, 403, 389, 232, 174, 160, 139 (Found: $[M+NH_4]^+$, 543.1601. $C_{27}H_{27}NO_6S_2$ requires $[M+NH_4]^+$, 543.1624) (Found: C, 61.68; H, 4.99; N, 2.66. $C_{27}H_{27}NO_6S_2$ requires C, 61.69; H, 5.18; N, 2.59%).

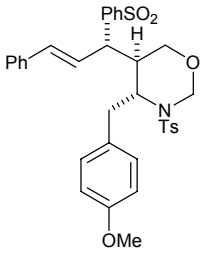
***N*-[(2*R**,3*R**,4*S**,*E*)-3-(Hydroxymethyl)-1-(4-methoxyphenyl)-6-phenyl-4-(phenylsulfonyl)hex-5-en-2-yl]-4-methylbenzenesulfonamide 14**



Preparation of solution 1: To a solution of cinnamylsulfonylbenzene **4c** (484 mg, 1.87 mmol, 1.3 equiv.) in THF (3.5 mL) at –20 °C was added *n*BuLi (821 μL of a 2.3 M solution in hexanes, 1.87 mmol, 1.3 equiv.). After 5 min the mixture was warmed to 0 °C for 30 min then re-cooled to –20 °C.

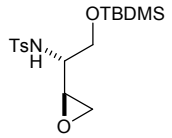
Preparation of solution 2: To a solution of [(2*S**,3*R**)-3-(4-methoxybenzyl)-1-tosylaziridin-2-yl]methanol **9** (500 mg, 1.44 mmol, 1.0 equiv.) in THF (2 mL) at –78 °C was added *n*BuLi (632 μL of a 2.3 M solution in hexanes, 1.44 mmol, 1.0 equiv.). After 10 min, solution 1 was added *via* cannula. The resulting solution was warmed to 8 °C during 2.5 h and then to 25 °C. After 1 h, the reaction was quenched with sat. $NH_4Cl_{(aq.)}$ (4 mL), then diluted with H_2O (15 mL). The aqueous phase was extracted with EtOAc (3 × 8 mL). The combined organic layers were washed with brine (2 × 8 mL) and dried (Na_2SO_4). Concentration under reduced pressure and column chromatography (10% EtOAc–petrol) gave **14** (453 mg, 52%) as a colourless gum, as a 10:1 mixture of diastereoisomers; data for N-*[(2*R**,3*R**,4*S**,E)-3-(hydroxymethyl)-1-(4-methoxyphenyl)-6-phenyl-4-(phenylsulfonyl)hex-5-en-2-yl]-4-methylbenzenesulfonamide* (major diastereomer) only; R_f 0.19 (43% EtOAc–petrol); ν_{max} (film) 3582, 3298, 2954, 2932, 1513, 1447, 1318, 1301, 1247, 1154, 1035, 735, 690 cm^{-1}; δ_H (400 MHz) 7.72 (2H, d, *J* 8.0 Hz, *ortho* Ts), 7.71 (2H, d, *J* 6.5 Hz, *ortho* $PhSO_2$), 7.58 (1H, t, *J* 7.0 Hz, *para* $PhSO_2$), 7.44 (2H, dd, *J* 7.0, 6.5 Hz, *meta* $PhSO_2$), 7.29-7.28 (3H, m, *ortho & para* Ph), 7.21 (2H, d, *J* 8.0 Hz, *meta* Ts), 6.93-6.91 (2H, m, *meta* $PhSO_2$), 6.89 (2H, d, *J* 8.6 Hz, *meta* ArOMe), 6.76 (2H, d, *J* 8.6 Hz, *ortho* ArOMe), 5.71 (1H, d, *J* 16.0 Hz, PhC*H*=CH), 5.18 (1H, dd, *J* 16.0, 9.5 Hz, PhCH=C*H*), 4.57-4.54 (1H, m, NH), 4.29-4.24 (1H, m, TsNHC*H*), 3.98 (1H, t, *J* 9.5 Hz, $PhSO_2CH$), 3.81 (3H, s, OMe), 3.72-3.59 (2H, m, CH_2OH), 2.87 (1H, dd, *J* 14.0, 4.5 Hz, C*H*HArOMe), 2.73 (1H, dd, *J* 14.0, 11.0 Hz, CH*H*ArOMe), 2.45-2.40 (1H, m, C*H*CH_2OH), 2.37 (3H, s, Me of Ts); δ_C (125 MHz) 171.2, 158.4, 143.0, 139.7, 138.8, 137.8, 135.5, 133.9, 129.9, 129.7, 129.6, 129.1, 128.9, 128.8, 128.5, 126.9, 126.7, 126.5, 120.1, 114.2, 113.9, 67.4, 58.9, 56.9, 55.2, 53.5, 40.3, 39.4, 21.5; *m/z* (ESI) 628.1789 $[M+Na]^+$, 606.1971 $[M+H]^+$, 464.1922, 304.1042, 241.1812, 196.0183 (Found: $[M+H]^+$, 606.1971, $C_{33}H_{35}NO_6S_2$ requires $[M+H]^+$, 606.1984) (Found: C, 65.48; H, 5.87; N, 2.39. $C_{33}H_{35}NO_6S_2$ requires C, 65.43; H, 5.82; N, 2.31%).

(4*R,5*R**)-4-(4-Methoxybenzyl)-5-[(*S**,*E*)-3-phenyl-1-(phenylsulfonyl)allyl]-3-tosyl-1,3-oxazinane 15**



A suspension of hydroxytosamide **14** (496 mg, 0.82 mmol, 1.0 equiv.), paraformaldehyde (32 mg, 1.06 mmol, 1.3 equiv.) and *p*-TsOH·H_2O (10.0 mg, 0.05 mmol, 0.064 equiv.) in benzene (2 mL) was heated under reflux for 16 h. The dark-coloured mixture was filtered through a short pad of cotton wool, and the filtrate extracted with EtOAc (5 mL). The organic layers were washed with brine (3 × 3 mL) and dried (Na_2SO_4). Concentration under reduced pressure and column chromatography (15→25% EtOAc–petrol) gave **15** (316 mg, 62%). Upon recrystallisation, *(4*R**,5*R**)-4-(4-methoxybenzyl)-5-[(*S**,E*)-3-phenyl-1-(phenylsulfonyl)allyl]-3-tosyl-1,3-oxazinane* (major diastereomer) was obtained as a colourless solid; mp 136–138 °C (CH_2Cl_2–MeOH); R_f 0.31 (40% EtOAc–petrol); ν_{max} (film) 2928, 1621, 1513, 1447, 1341, 1304, 1248, 1178, 1146, 1084, 1034, 970, 816, 734, 693 cm^{-1}; δ_H (400 MHz) 7.65 (2H, d, *J* 7.5 Hz, *ortho* $PhSO_2$), 7.59 (2H, d, *J* 8.0 Hz, *ortho* Ts), 7.53 (1H, dd, *J* 7.5, 7.5 Hz, *para* $PhSO_2$), 7.39 (2H, dd, *J* 7.5, 7.5 Hz, *meta* $PhSO_2$), 7.29-7.27 (3H, m, *ortho & para* PhCH=CH), 7.21 (2H, d, *J* 8.5 Hz, *meta* Ts), 6.95 (2H, d, *J* 8.5 Hz, *meta* ArOMe), 6.91-6.89 (2H, m, *meta* PhCH=CH), 6.78 (2H, d, *J* 8.5 Hz, *ortho* ArOMe), 5.62 (1H, d, *J* 16.0 Hz, PhC*H*=CH), 5.49 (1H, d, *J* 10.5 Hz, NTsC*H*HO), 5.14-5.05 (2H, m, PhCH=C*H* & CHC*H*$HOCH_2$), 4.76 (1H, d, *J* 10.5 Hz, NTsCH*H*O), 4.13-4.05 (2H, m, CHCH*H*OCH_2 & C*H*NTs), 3.96 (1H, dd, *J* 10.5, 10.0 Hz, C*H*SO_2Ph), 3.82 (3H, s, OMe), 3.06 (1H, dd, *J* 13.5, 11.0 Hz, C*H*HArOMe), 2.82 (1H, dd, *J* 13.5, 4.5 Hz, CH*H*ArOMe), 2.39 (3H, s, CH_3 of Ts), 2.20-2.18 (1H, m, C*H*CH_2O); δ_C (125 MHz) 158.6, 143.6, 139.6, 138.6, 137.8, 135.6, 133.4, 130.2, 129.7, 129.1, 128.8, 128.7, 128.6, 128.5, 127.3, 126.5, 120.68, 114.3, 74.1, 66.9, 64.3, 55.4, 55.3, 36.2, 34.6, 21.5; *m/z* (ESI) 640.1835 $[M+Na]^+$, 618.1989 $[M+H]^+$, 476.1903, 182.9854, 154.9901 (Found: $[M+Na]^+$, 640.1835, $C_{34}H_{35}NO_6S_2$ requires $[M+Na]^+$, 640.1804) (Found: C, 66.00; H, 5.68; N, 2.28. $C_{34}H_{35}NO_6S_2$ requires C, 66.10; H, 5.71; N, 2.27%).

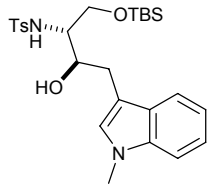
N-{(*R)-2-(*tert*-Butyldimethylsilyloxy)-1-[(*S**)-oxiran-2-yl]ethyl}-4-methylbenzenesulfonamide 11**



To a suspension of NaH (7.30 g of a 60% wt. disp. in mineral oil, 183 mmol, 4.0 equiv.) in THF (360 mL) at 0 °C was added a solution of aziridine **10** (17.0 g, 45.7 mmol, 1 equiv.) in THF (140 mL) dropwise. The reaction mixture was stirred for 3 hours at 0°C after which it was cooled to –78 °C and sat.

$NH_4Cl_{(aq.)}$ was added dropwise. After warming to rt, the aqueous layer was extracted with Et_2O (3 × 200 mL), the combined organic layers were dried (Na_2SO_4). Concentration under reduced pressure gave *N-{(*R**)-2-(*tert*-butyldimethylsilyloxy)-1-[(*S**)-oxiran-2-yl]ethyl}-4-methylbenzenesulfonamide* **11** as a colourless oil (17.0 g, 100%); R_f = 0.75 (1:1 EtOAc–petrol); ν_{max} (film) 2952, 2856, 1445, 1254, 1163, 1093, 837, 814, 669 cm^{-1}; δ_H (400 MHz, $CDCl_3$): 7.75 (2H, d, *J* 8.5 Hz, *ortho* Ts), 7.30 (2H, d, *J* 8.0 Hz, *meta* Ts), 4.73 (1H, d, *J* 8.0 Hz, NHTs), 3.50 (3H, m, CH_2OTBS & CHNTs), 3.15 (1H, m, C*H*OCH_2), 2.67 (1H, dd, *J* 4.5 Hz, CHOC*H*$_2$), 2.55 (1H, dd, *J* 4.5 Hz, CHOC*H*$_2$), 2.42 (3H, s, ArCH_3), 0.84 [9H, s, $(CH_3)_3$C], 0.00 [6H, s, $(CH_3)_2$Si]; δ_C (100 MHz, $CDCl_3$), 143.6 (Ar*C*CH_3), 137.9 (ArCSO_2), 129.7 (*ortho* Ts), 126.9 (*meta* Ts), 63.2 (CH_2OTBDMS), 53.7 (CHNHTs), 51.2 (CH_2O*C*H), 43.9 (*C*H_2OCH), 25.8 [(*C*H_3)$_3$C], 21.5 (ArCH_3), 18.2 [$(CH_3)_3$*C*], -5.6 [$(CH_3)_2$Si]; *m/z* (CI): 389 $[M+NH_4]^+$, 372, 314, 218, 174, 116, 108, 91 (Found $[M+Na]^+$ 394.1489, $[M+H]^+$ 372.1667)

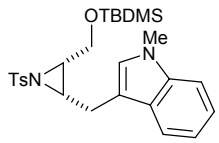
N-[(2*R,3*R**)-1-(*tert*-Butyldimethylsilyloxy)-3-hydroxy-4-(1-methyl-1H-indol-3-yl)butan-2-yl]-4-methylbenzenesulfonamide 13**



To a suspension of epoxide **11** (38.0 g, 102 mmol, 1.0 equiv.), *N*-methylindole (26.0 mL, 204 mmol, 2.0 equiv.) and anhydrous $NaHCO_3$ (34.3 g, 408 mmol, 4.0 equiv.) in CH_2Cl_2 (280 mL) at –70 °C was added $BF_3{\cdot}Et_2O$ (12.9 mL, 102 mmol, 1.0 equiv.) dropwise. The reaction mixture was stirred at –70 °C until TLC observation revealed total consumption of epoxide. The reaction mixture was quenched with H_2O (60 mL) and the aqueous phase was extracted with Et_2O (3 × 200 mL). The combined organic layers were dried (Na_2SO_4). Concentration under reduced pressure and column chromatography (20% EtOAc–petrol) gave *N-[(2*R**,3*R**)-1-(tert-butyldimethylsilyloxy)-3-hydroxy-4-(1-methyl-1H-indol-3-yl)butan-2-yl]-4-methylbenzenesulfonamide* **13** as a pale yellow oil (40.0 g, 85%); R_f 0.33 (33% EtOAc–petrol); ν_{max} (film) 3507, 3379, 3288, 3055, 2951, 2929, 2857, 1615, 1598, 1554, 1471, 1328, 1254, 1159, 1094, 1077, 838 cm^{-1}; δ_H (400 MHz, $CDCl_3$) 7.81 (2H, d, *J* 8.0 Hz, Ts), 7.49 (1H, d, *J* 8.0 Hz, Ar), 7.31 (3H, d, *J* 8.5 Hz, Ts & Ar), 7.22 (1H, t, *J* 7.5 Hz, Ar), 7.09 (1H, t, *J* 7.5 Hz, Ar), 6.65 (1H, s, CHNMe), 5.27 (1H, d, *J* 9.0 Hz, NH), 4.22 (1H, t, *J* 6.5 Hz, CHOH), 3.72 (3H, s, NCH_3), 3.69 (1H, dd, *J* 7.0, 3.0 Hz, C*H*HOTBS), 3.60 (1H, dd, *J* 7.0, 2.0 Hz, CH*H*OTBS), 3.41-3.34 (1H, m, CHN), 2.91 (1H, d, *J* 1.5 Hz, OH), 2.75 (2H, d, *J* 6.0 Hz, CH_2C), 2.43 (3H, s, Me of Ts) 0.89-0.79 [9H, m, C$(CH_3)_3$], 0.03-0.04 [6H, m, Si$(CH_3)_2$]; δ_C (100 MHz, $CDCl_3$) 143.6 (q Ts), 138.7 (q Ts), 137.2 (q Ar), 129.9 (2 × TsCH), 128.0

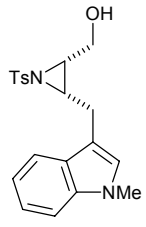
(*C*HNMe), 127.7 (q Ar), 127.3 (2 × TsH), 121.8 (ArH), 119.0 (ArH), 119.0 (ArH), 110.0 (*C*CH_2), 109.4 (ArH), 72.4 (CHOH), 66.0 (CH_2OTBS), 55.6 (CHN), 32.8 (NCH_3), 29.6 (*C*H_2C), 26.0 [C(*C*H_3)$_3$], 21.7 (Me of Ts), 18.3 (SiC), –5.9 ($SiCH_3$), –5.9 ($SiCH_3$); *m/z* (CI) 503 $(M+H)^+$, 429, 349, 174, 146, 132, 52 (Found: $[M+H]^+$, 503.2388. $C_{26}H_{39}N_2O_4SSi$ requires $[M+H]^+$, 503.2400) (Found: C, 61.97; H, 7.52; N, 5.41. $C_{26}H_{38}N_2O_4SSi$ requires C, 62.11; H, 7.62; N, 5.57%).

3-{{(2*S,3*S**)-3-[(*tert*-Butyldimethylsilyloxy)methyl]-1-tosylaziridin-2-yl}methyl}-1-methyl-1*H*-indole**



To a solution of hydroxysulfonamide **13** (0.80 g, 1.60 mmol, 1.0 equiv.) and PPh_3 (0.50 g, 1.92 mmol, 1.2 equiv.) in THF (10 mL) at rt was added DIAD (0.14 mL, 0.14 g, 0.71 mmol, 1.5 equiv.) dropwise over 10 min. After 1 h, concentration under reduced pressure and column chromatography gave *3-{{(2*S**,3*S**)-3-[(tert-butyldimethylsilyloxy)methyl]-1-tosylaziridin-2-yl}methyl}-1-methyl-1*H-*indole* (0.75 g, 97%) as a colourless oil (gradient elution 15%→25%→33%→50% petrol–Et_2O); R_f 0.54 (Et_2O); ν_{max} (film) 2953, 2929, 2884, 1725, 1598, 1472, 1326, 1160, 1122, 838 cm^{-1}; δ_H (400 MHz, $CDCl_3$) 7.64 (2H, d, *J* 8.0 Hz, Ts), 7.48 (1H, d, *J* 8.0 Hz, Ar), 7.27-7.20 (2H, m, Ar), 7.12 (2H, d, *J* 8.0 Hz, Ts), 7.12-7.06 (1H, m, Ar), 6.85 (1H, s, CHNMe), 3.90 (1H, dd, *J* 11.0, 5.5 Hz, C*H*HOTBS), 3.78 (1H, dd, *J* 11.0, 6.5 Hz, CH*H*OTBS), 3.68 (3H, s, NCH_3), 3.34 (3H, s, OCH_3), 3.18 (1H, app quartet, *J* 6.5 Hz, C*H*CH_2OTBS), 3.11 (1H, app quartet, *J* 6.5 Hz, C*H*CH_2C), 2.99 (1H, dd, *J* 15.5, 5.5 Hz, C*H*HC), 2.89 (1H, dd, *J* 15.5, 7.5 Hz, CH*H*C), 2.40 (3H, s, $TsCH_3$), 0.88 [9H, s, C(CH_3)$_3$], 0.04 [6H, s, Si(CH_3)$_2$]; δ_C (100 MHz, $CDCl_3$) 144.1 (q Ts), 136.6 (q Ar), 129.4 (2 × TsH), 128.1 (2 × TsH), 127.7 (q Ar), 127.0 (CHNMe), 121.8 (ArH), 119.1 (ArH), 118.8 (ArH), 109.9 (CCH_2), 109.2 (ArH), 60.4 (CH_2OTBS), 44.9 (*C*H CH_2OTBS), 44.8 (*C*HCH_2C), 32.7 (NCH_3), 26.0 [C(*C*H_3)$_3$], 22.9 (*C*H_2C), 21.6 (Me of Ts), –5.2 ($SiCH_3$), –5.3 ($SiCH_3$); (TsC and SiC not discernable from the baseline); *m/z* (CI) 485 $[M+H]^+$, 331, 222, 185, 174, 158, 144, 132. (Found: $[M+H]^+$, 485.2309. $C_{26}H_{37}N_2O_3SSi$ requires $[M+H]^+$, 485.2294.) (Found: C, 64.56; H, 7.59; N, 5.77. $C_{26}H_{36}N_2O_3SSi$ requires C, 64.42; H, 7.49; N, 5.78%).

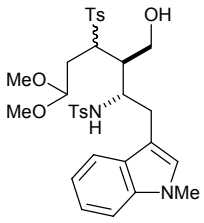
{(2*S,3*S**)-3-[(1-Methyl-1*H*-indol-3-yl)methyl]-1-tosylaziridin-2-yl}methanol 12**



To a solution of 3-{{(2*S**,3*S**)-3-[(*tert*-butyldimethylsilyloxy)methyl]-1-tosylaziridin-2-yl}methyl}-1-methyl-1*H*-indole (1.53 g, 3.20 mmol, 1.0 equiv.)

in THF (3.2 mL) at 0 °C was added TBAF (3.2 mL of a 1 M solution in THF, 3.20 mmol, 1.0 equiv.). After 10 min, sat. $NH_4Cl_{(aq.)}$ (10 mL) was added and the aqueous layer was extracted with CH_2Cl_2 (3 × 20 mL). The combined organic layers were dried (Na_2SO_4). Concentration under reduced pressure and column chromatography (gradient elution: 50% Et_2O–petrol→95% Et_2O–petrol→100% Et_2O→10% acetone–Et_2O) gave *{(2*S**,3*S**)-3-[(1-methyl-1*H*-indol-3-yl)methyl]-1-tosylaziridin-2-yl}methanol* **12** (1.08 g, 91%) as a colourless oil; R_f 0.31 (2 elutions with Et_2O); ν_{max} (film) 3508, 3364, 2932, 1808, 1783, 1598, 1325, 1184, 1091, 739 cm^{-1}; δ_H (400 MHz, $CDCl_3$) 7.63 (2H, d, *J* 8.0 Hz, Ts), 7.47 (1H, d, *J* 8.0 Hz, Ar), 7.27-7.21 (2H, m, Ar), 7.13 (2H, d, *J* 8.0 Hz, Ts), 7.08 (1H, t, *J* 7.5 Hz, Ar), 6.78 (1H, s, CHNMe), 3.91 (1H, ddd, *J* 12.0, 7.5, 5.0 Hz, C*H*HOH), 3.82 (1H, app quartet, *J* 6.0 Hz, CH*H*OH), 3.68 (3H, s, NCH_3), 3.23 (1H, app quartet, *J* 7.0 Hz, C*H*CH_2C), 3.16 (1H, app quartet, *J* 6.5 Hz, C*H*CH_2OH), 2.99 (1H, dd, *J* 15.5, 6.0 Hz, CH_AH_BC), 2.94 (1H, dd, *J* 15.5, 7.5 Hz, CH*H*C), 2.41 (3H, s, TsCH_3), 1.59 (1H, s, OH); δ_C (100 MHz, $CDCl_3$) 144.4 (q Ts), 137.0 (q Ts), 134.7 (q Ar), 129.5 (2 × TsH), 128.1 (2 × TsH), 127.5 (q Ar), 126.8 (CHNMe), 122.0 (ArH), 119.3 (ArH), 118.7 (ArH), 110.2 (CCH_2), 109.3 (ArH), 59.6 (CH_2OH), 45.6 (*C*HCH_2C), 44.6 (*C*HCH_2OH), 32.8 (NCH_3), 23.1 (*C*H_2C), 21.9 (Me of Ts); *m/z* (CI) 371 $[M+H]^+$, 257, 200, 189, 146, 132, 101 (Found: $[M+H]^+$, 371.1414. $C_{20}H_{23}N_2O_3S$ requires $[M+H]^+$, 371.1429) (Found: C, 64.69; H, 5.88; N, 7.39. $C_{20}H_{22}N_2O_3S$ requires C, 64.84; H, 5.99; N, 7.56%).

N-[(2S*,3R*)-3-(Hydroxymethyl)-6,6-dimethoxy-1-(1-methyl-1H-indol-3-yl)-4-tosylhexan-2-yl]-4-methylbenzenesulfonamide 16



To a solution of sulfone **4b** (0.49g, 1.88 mmol, 1.5 equiv.) in THF (3 mL) at –78 °C was added *n*BuLi (1.32 mL of a 2.05M solution in hexanes, 2.71 mmol, 2.2 equiv.) dropwise. After 30 min, a solution of aziridine **12** (0.46 g, 1.23 mmol, 1 equiv.) in THF (3 mL) was added *via* cannula at –78 °C and the reaction mixture was allowed to warm to rt overnight. The reaction was quenched with H_2O (10 mL) and the aqueous phase was extracted with CH_2Cl_2 (3 × 20 mL). The combined organic layers were dried (Na_2SO_4). Concentration under reduced pressure and column chromatography (eluent: 1:1 to 1:5 petrol-Et_2O to Et_2O to 10:1 Et_2O-acetone) gave a 3:1 mixture of diastereoisomers **16** (0.64 g, 83%) as a colourless oil; R_f 0.14 (Et_2O × 2); ν_{max} (film) 3508, 3301, 2938, 1597, 1326, 1287, 1154, 1080, 739 cm^{-1}; δ_H (400 MHz, $CDCl_3$) 7.81 (2H, d, *J* 8.0 Hz, Ts), 7.58 (2H, d, *J* 8.0 Hz, Ts), 7.37 (2H, d, *J* 8.0 Hz, Ts), 7.27-7.22 (1H, m, Ar), 7.19 (2H, d, *J* 4.0 Hz, Ar), 7.10 (2H, d, *J* 8.0 Hz, Ts), 7.06-7.02

(1H, m, Ar), 6.79 (1H, s, CHNMe), 5.90 (1H, d, *J* 9.0 Hz, NH), 4.13-4.08 (1H, m, C*H*NH), 3.96 (2H, t, *J* 7.0 Hz, CH_2OH), 3.82 [1H, t, *J* 5.5 Hz, $CH(OMe)_2$], 3.75-3.71 (1H, m, CHTs), 3.65 (3H, s, NCH_3), 3.43 (1H, t, *J* 7.5 Hz, OH), 3.08 (3H, s, OCH_3), 3.02 (1H, dd, *J* 15.0, 7.0 Hz, CH_AH_BC), 2.96 (3H, s, OCH_3), 2.84 (1H, dd, *J* 15.0, 6.5 Hz, CH*H*C), 2.60-2.55 (1H, m, C*H*CHN), 2.46 (3H, s, $TsCH_3$), 2.38 (3H, s, $TsCH_3$), 2.20-2.13 (1H, m, C*H*HCHTs), 2.01 (1H, dt, *J* 15.5, 4.5 Hz, CH*H*CHTs); δ_C (100 MHz, $CDCl_3$) 145.4 (q Ts), 143.0 (q Ts), 138.0 (q Ts), 137.0 (q Ar), 135.4 (q Ts), 130.2 (2 × TsH), 129.4 (2 × TsH), 129.0 (2 × TsH), 128.0 (q Ar), 127.8 (CHNMe), 126.9 (2 × TsH), 121.8 (ArH), 119.3 (ArH), 118.7 (ArH), 109.3 (ArH), 109.0 (q Ar), 102.5 [$CH(OMe)_2$], 60.1 (CH_2OH), 59.6 (CHTs), 54.8 (OCH_3), 53.2 (CHN), 52.0 (OCH_3), 46.3 (*C*HCHN), 32.7 (NCH_3), 31.7 (*C*H_2CHTs), 30.0 (*C*H_2C), 21.9 (Me of Ts), 21.8 (Me of Ts); *m/z* (FAB) 628 ($[M]^+$), 565, 264, 144, 75, 55 (Found: $[M]^+$, 628.2297. $C_{32}H_{40}N_2O_7S_2$ requires $[M+NH_4]^+$, 629.2277).

Supporting Information — X-Ray Crystallography

Manuscript: Highly regioselective ring-opening of trisubstituted aziridines by sulfur-stabilised carbanions B815971H REVISED

Authors: Santiago Carballares, Donald Craig, Christopher J.T. Hyland, Pengfei Lu, Tanya Mathie and Andrew J.P. White

The C(1)=C(2) double bond moiety in the structure of **5c** was found to be disordered. Two partial occupancy orientations were identified of *ca.* 79 and 21% occupancy, with only the non-hydrogen atoms of the major occupancy orientation being refined anisotropically. Distance and angle restraints were applied to this unit, and the equivalent isotropic thermal parameters of the "duplicate" atoms were restrained to be the same. A spherical thermal parameter restraint was applied to the major occupancy orientation of the terminal carbon atom C(1). The N(32)–H proton was located from a ΔF map and refined subject to an N–H distance constraint of 0.90 Å.

The crystals of **7** proved to be exceptionally weak scatterers, and so the experiment had to be trimmed to a resolution of 1.0 Å and set to collect just orthorhombic data (so much less redundancy than for **5c** or **15**). Despite this, the data collection time was still *ca.* 5 days, making it clear that it would not have been either practicable or worthwhile to collect any higher resolution data.

The crystals of **17** suffered from desolvation and proved to be weak and diffuse scatterers, and so the experiment was trimmed to a target resolution of 0.93 Å. The C(17) tolyl unit in **17** was found to be disordered. Two partial occupancy orientations were identified of *ca.* 74 and 26% occupancy, with only the non-hydrogen atoms of the major occupancy orientation being refined anisotropically. The C_6 rings of both orientations were refined as optimised rigid bodies. and the equivalent isotropic thermal parameters of the "duplicate" atoms were restrained to be the same. The N(13)–H proton was located from a ΔF map and refined subject to an N–H distance constraint of 0.90 Å.

The structure of **17** was found to contain a significant amount of empty space; PLATON suggests a solvent accessible volume of *ca.* 463 $Å^3$ per unit cell (which has a volume of 6323 $Å^3$). This ties in with observation of desolvation noted above, and so it is reasonable to assume that these voids held the solvent that is being lost. In fact some partial occupancy disordered solvent may still be present, but not of sufficient electron density to be visible in difference electron density maps.

Fig. S1 The molecular structure of **5c** (50% probability ellipsoids).

Fig. S2 The molecular structure of **7** (50% probability ellipsoids).

Fig. S3 The molecular structure of **15** (50% probability ellipsoids).

Fig. S4 The molecular structure of **17** (50% probability ellipsoids).

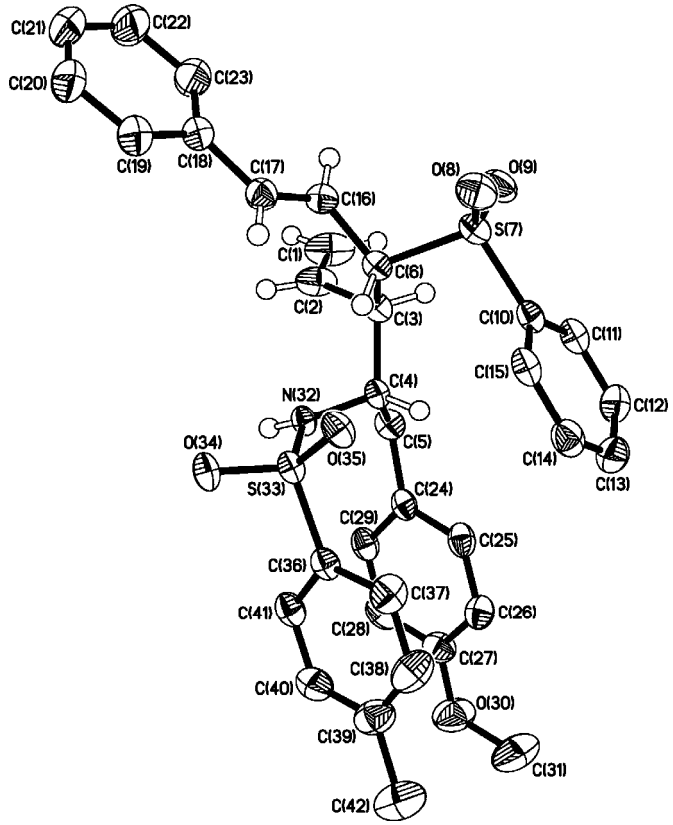
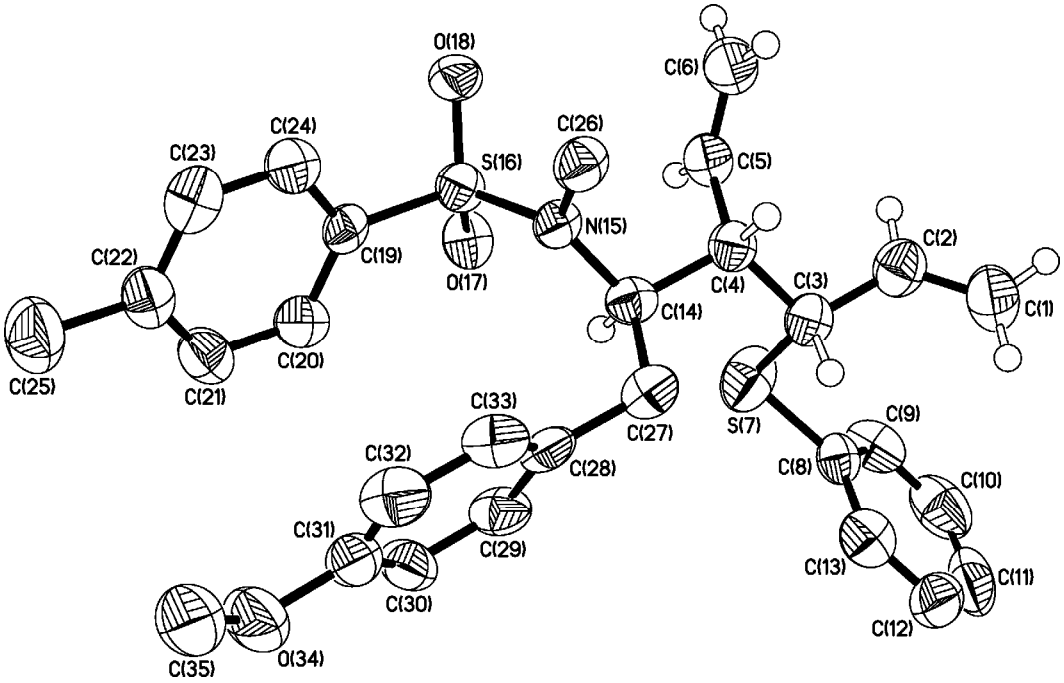


Fig. S1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O(34)

Fig. S2

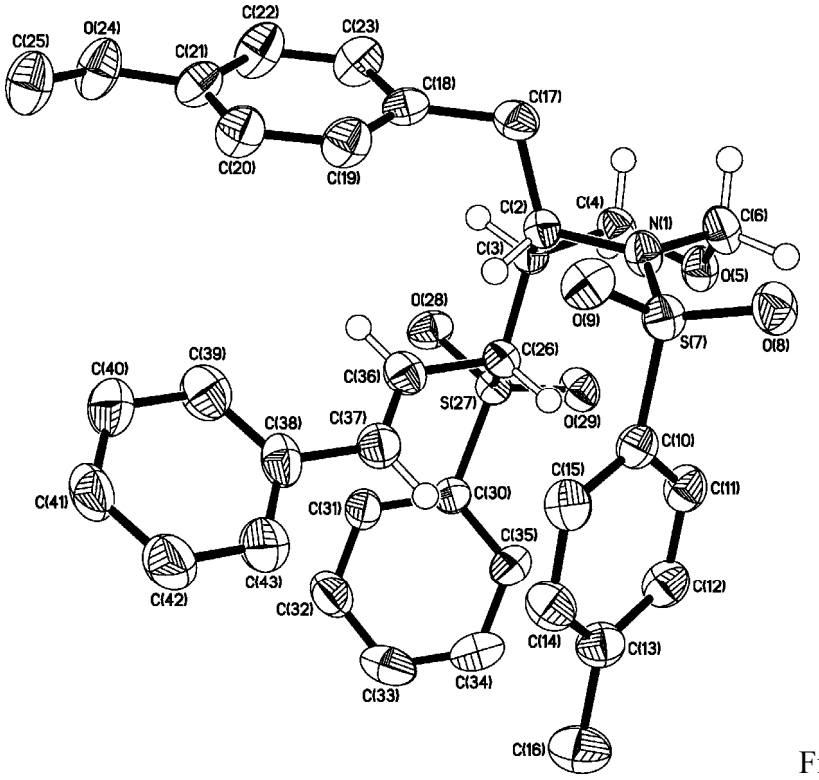
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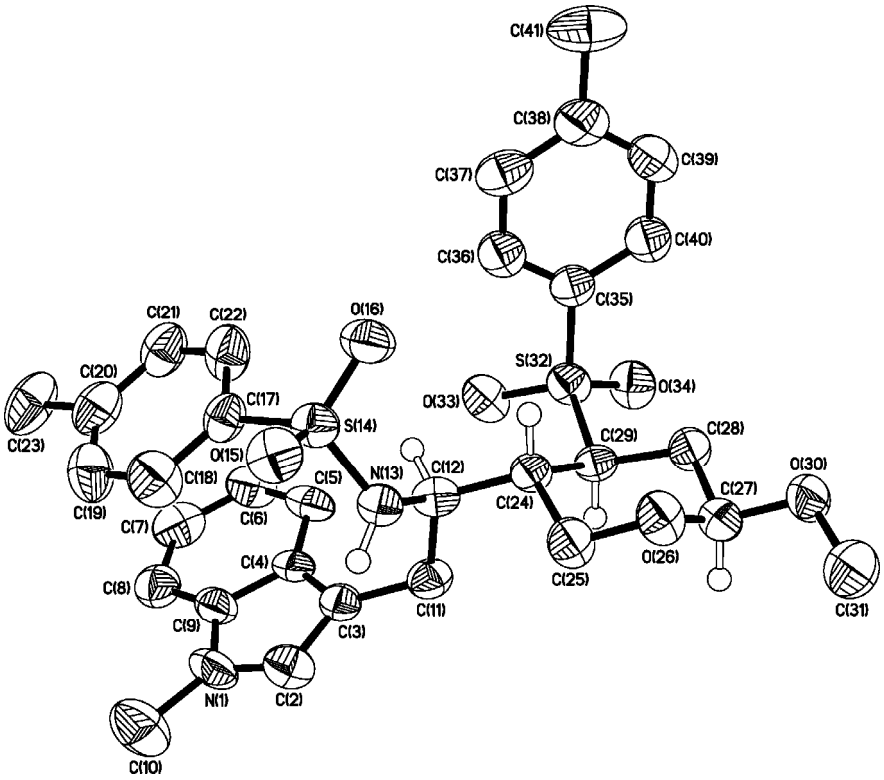
Fig. S3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C(10)

Fig. S4