The Intramolecular Asymmetric Allylation of Aldehydes via Organo-SOMO Catalysis. A Novel Approach to Ring Construction

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General Information. Commercial reagents were purified prior to use following the guidelines of Perrin and Armarego.[1] Organic solutions were concentrated under reduced pressure on a Büchi rotary evaporator. Chromatographic purification of products was accomplished using forced-flow chromatography on SiliCycle F60 40-63 μm silica gel according to the method of Still.[2] Thin-layer chromatography (TLC) was performed on Silicycle 250 μm with fluorescence indicator silica gel plates. Visualization of the developed chromatogram was performed by fluorescence quenching, *p*-anisaldehyde, ceric ammonium molybdate or potassium permanganate stain. ^{1}H and ^{13}C NMR spectra were recorded on a Varian Mercury 300, Varian Inova 400, and Bruker 500 Spectrometers and are internally referenced to residual solvent signals. Data for ^{1}H NMR are reported as follows: chemical shift (δ ppm), multiplicity (s = singlet, d = doublet, t = triplet, q = quartet, quin = quintet, m = multiplet), integration, coupling constant (Hz) and assignment. Data for ^{13}C NMR are reported in terms of chemical shift. IR spectra were recorded on a Perkin Elmer Spectrum 100 FR-IR Spectrometer and are reported in terms

[1] Perrin, D. D. and Armarego, W. L. F. *Purification of Laboratory Chemicals*; 3rd ed., Pergamon Press, Oxford, 1988.

[2] Still, W. C.; Kahn, M.; Mitra, A. J. *J. Org. Chem.* **1978**, *43*, 2923.

of frequency of absorption (cm^{-1}). High resolution mass spectra were obtained at Princeton University and Caltech mass spectrometry facilities: ESI method on Agilent Time-of-Flight LC/MS (Princeton), EI method on Kratos MS50RF Spectrometer (Princeton) and JEOL JMS-60 double focusing high resolution magnetic mass spectrometer (Caltech). Gas liquid chromatography (GLC) was performed on Hewlett-Packard 6850 and 6890 Series gas chromatographs equipped with a split- mode capillary injection system and flame ionization detectors using a Bodman Chiraldex Γ-TA (30 m × 0.25 mm) as noted. Supercritical Fluid Chromatography (SFC) was performed on a Berger Minigram equipped with a variable-wavelength UV detector using a Chiralpak®ASH column (25 cm) as noted (4.0 mL/min.). Optical rotations were recorded on a Jasco P-1010 Polarimeter.

Benzoylation and Deprotection General Procedure

Benzoylation: To a solution of alcohol (1.0 equiv) in CH_2Cl_2 (0.2 M), cooled to 0 °C, was added N,N-dimethylaminopyridine (DMAP; 1.1 equiv), triethylamine (2.0 equiv), then benzoyl chloride (1.2 to 1.3 equiv). The resulting suspension was warmed to 23 °C and stirred until the reaction was judged to be complete by TLC. The reaction mixture was quenched with HCl 1N solution (2.2 equiv). The aqueous layer was extracted with diethyl ether (2×) and the combined organic layers were dried over $MgSO_4$, filtered and concentrated *in vacuo*. The residue was purified by flash chromatography (solvents noted) to afford the title compound.

Deprotection: To a solution of benzoate ester (1.0 equiv) in methanol (0.05 M), cooled to 0 °C, was added sodium hydroxide (3 equiv). The resulting solution was warmed to 23 °C and stirred until the reaction was judged to be complete by TLC (2 to 3

hours). After removing methanol the residue was quenched with water followed by extraction with diethyl ether (2×) and the combined organic layers were dried over $MgSO_4$, filtered and concentrated *in vacuo*. The residue was purified by flash chromatography (solvents noted) to afford the title compound.

TBS Protection and Deprotection General Procedure

TBS Protection: To a solution of alcohol (1 equiv) in THF (0.4 M) was added imidazole (2.5 equiv) and *tert*-butyldimethylsilyl chloride (1.25 equiv). The resulting white suspension was stirred for 48 h at room temperature. The reaction mixture was filtered through a plug of layered Celite and silica. The resulting colorless filtrate was concentrated in vacuo, and the residue was dissolved in pentane. The organic solution was washed with H_2O, then with brine, dried over $MgSO_4$, separated and concentrated *in vacuo* to afford the title compound.

Deprotection: To a solution of silane ether (1.0 equiv) in THF (0.1 M), cooled to 0 °C under argon, was added the solution of tetrabutylammonium fluoride (1M in THF, 5 equiv). The resulting solution was warmed to 23 °C and stirred until the reaction was judged to be complete by TLC (2 hours). The reaction was diluted with ether and water. The aqueous layer was extracted twice more with ether and the ether layers were combined and washed twice with brine. After being dried ($MgSO_4$), filtered and concentrated *in vacuo*, the residue was purified by flash chromatography (solvents noted) to afford the title compound.

Cross Metathesis General Procedure:

A 25 mL round bottomed flask equipped with a magnetic stir bar was charged with starting materials of type I (1.0 equiv) and type III (3.0 equiv) olefins in CH_2Cl_2 (0.2 M).

Grubbs 2nd generation catalyst (0.05 equiv) was added and the reaction mixture heated to 50 °C for 8 to 12 hours. Upon completion the reaction mixture was diluted with Et_2O and flushed through a pad of silica, eluting with Et_2O, and then concentrated *in vacuo*. The product was purified by silica gel chromatography (solvents noted) to yield the title compound.

Wittig Reaction General Procedure:

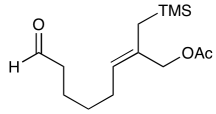
Wittig reagent (1.5 equiv) was suspended in dry THF (0.25 M) under an atmosphere of argon and cooled to –78 °C. *n*-butyllithium (1.5 equiv; 2.5 M solution in hexane) was added and, after 10 min at –78 °C, the solution stirred for a further 40 min at room temperature. Aldehyde (1 equiv) in THF (0.1 M) was added and the reaction mixture stirred for 1 – 3 h. After dilution with pentane, the solution was poured onto a pre-packed column of Florisil and eluted with hexane. The organic layer was concentrated *in vacuo* and the residue was purified by flash chromatography (solvents noted) to afford the title compound.

Dess-Martin Oxidation General Procedure:

To a solution of alcohol (1.0 equiv) in CH_2Cl_2 (0.1 M), cooled to 0 °C, was added Dess-Martin periodinane (1.1 to 1.2 equiv). The resulting suspension was warmed up to 23 °C and stirred until the reaction was judged to be complete by TLC. The reaction mixture was poured into saturated aqueous $NaHCO_3$ containing $Na_2S_2O_3$ (7 equiv). This mixture was stirred vigorously until both layers became clear. The aqueous layer was extracted with CH_2Cl_2 (2×) and the combined organic layers were dried over $MgSO_4$, filtered and concentrated *in vacuo*. The residue was purified by flash chromatography (solvents noted) to afford the title compound.

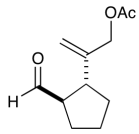
SOMO Intramolecular Cyclization General Procedure:

A 10 mL round bottomed flask equipped with a large magnetic stir bar was charged with starting aldehyde (1.0 equiv) and water (2.0 equiv) in solvent (0.0625 M). The reaction mixture was cooled to –60 °C and the solvent degassed via an evacuation/argon flush. Base (2.2 to 3.0 equiv) was added followed by catalyst **1** (0.2 equiv). Ceric ammonium nitrate was added (2.2 to 3.0 equiv) and the flask evacuated and flushed for a fourth and final time. The heterogeneous reaction mixture was stirred at –10 to –30 ^{o}C for 24 hours, ensuring constant agitation throughout the time period. Upon completion the reaction mixture was diluted with Et_2O to precipitate the catalyst, flushed through a small pad of florisil, eluting with Et_2O, and then concentrated *in vacuo*. The product was purified by Davisil silica gel chromatography (solvents noted) to yield the title compound.



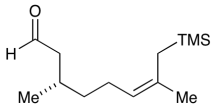
7-(1'-Methyl acetate)-8-(trimethylsilyl)oct-6-enal was prepared according to the cross metathesis general procedure from *cis*-6-nonenal (320 μL, 1.9 mmol) and 2-((trimethylsilyl)methyl)allyl acetate (1.2 mL, 5.7 mmol). A crude product was obtained which, upon concentration and flash column chromatography on silica gel (10% Et_2O/pentane), produced the desired product as a clear oil (97 mg, 19% yield). The compound was isolated as an inseparable mixture of *E*- and *Z*- alkenes. IR (film) 2950, 2862, 1738, 1725, 1245, 1045, 843 cm^{-1}; ^{1}H NMR (400 MHz, $(CD_3)_2CO$) Diastereomer x δ 9.68 (m, 1H, C**H**O), 5.22 (t, 1H, *J* = 7.6 Hz, C**H**=C), 4.36 (s, 2H, C**H$_2$**OAc), 2.41 (dt, 2H, *J* = 1.6, 7.2 Hz, C**H$_2$**CHO), 2.05 – 1.95 (m, 2H, C**H$_2$**CH=C), 1.97 (s, 3H, C**H$_3$**CO),

1.54 - 1.62 (m, 4H, C**H**$_2$CH$_2$CHO and C**H**$_2$Si(CH$_3$)$_3$), 1.31 – 1.40 (m, 2H, C**H**$_2$CH$_2$CH$_2$CHO), –0.01 (s, 9H, Si(C**H**$_3$)$_3$). Diastereomer y δ 9.69 (t, 1H, *J* = 1.6 Hz, C**H**O), 5.30 (t, 1H, *J* = 7.2 Hz, C**H**=C), 4.49 (s, 2H, C**H**$_2$OAc), 2.42 (dt, 2H, *J* = 1.6, 7.2 Hz, C**H**$_2$CHO), 2.14 – 2.05 (m, 2H, C**H**$_2$CH=C), 1.98 (s, 3H, C**H**$_3$CO), 1.54 – 1.62 (m, 4H, C**H**$_2$CH$_2$CHO and C**H**$_2$Si(CH$_3$)$_3$), 1.31 - 1.40 (m, 2H, C**H**$_2$CH$_2$CH$_2$CHO), 0.02 (s, 9H, Si(C**H**$_3$)$_3$); ^{13}C NMR (125 MHz, (CD$_3$)$_2$CO) δ 203.4 (203.3), 171.6 (171.4), 134.1 (133.6), 129.5(127.0), 70.6 (64.0), 44.8 (44.7), 29.3 (28.8), 26.2, 23.1 (22.9), 21.5, 20.1, 0.0 (–0.6); HRMS (CI) exact mass calculated for [M]$^+$ (C$_{14}$H$_{26}$O$_3$Si) required *m/z* 270.1651, found 270.1657.

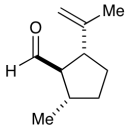


(1*R*,2*R*)-2-(2'-allyl acetate)cyclopentanecarbaldehyde was prepared according to the SOMO cyclization general procedure from 7-(1'-methyl acetate)-8-(trimethylsilyl)oct-6-enal (35.0 mg, 0.13 mmol). A crude product was obtained which, upon concentration and flash column chromatography on silica gel (30% Et$_2$O/pentane), produced the desired product as a clear oil (20.5 mg, 80% yield, 16.5:1 dr, 90% ee). IR (film) 2956, 2868, 1741, 1723, 1373, 1232, 1026 cm^{-1}; ^{1}H NMR (300 MHz, (CD$_3$)$_2$CO) δ 9.60 (d, 1H, *J* = 3.0 Hz, C**H**O), 5.08 (m, 1H, CH=C**H**$_2$), 5.06 (m, 1H, CH=C**H**$_2$), 4.56 (s, 2H, C**H**$_2$OAc), 2.90 – 2.82 (m, 1H, C**H**CH=CH$_2$), 2.81 – 2.74 (m, 1H, C**H**CHO), 2.03 (s, 3H, C**H**$_3$CO), 1.54 – 2.00 (m, 6H, C**H**$_2$C**H**$_2$C**H**$_2$); ^{13}C NMR (75 MHz, (CD$_3$)$_2$CO) δ 202.4, 169.7, 145.9, 111.2, 65.6, 55.9, 43.9, 32.1, 26.0, 24.4, 19.9; HRMS (CI) exact mass calculated for [M]$^+$ (C$_{11}$H$_{17}$O$_3$) requires *m/z* 197.1178, found *m/z* 197.1137; [α]$_D$ = –26.6º (c = 1.0, CHCl$_3$); The enantiomeric ratio was determined by GLC using a Γ-TA column (100 ºC isotherm

for 120 minutes, 1 mL/min); major enantiomer t_r = 89.61 min and minor enantiomer t_r = 81.30 min. The diastereomeric ratio was also determined by GLC using a Γ-TA column (100 ºC isotherm for 20 minutes followed by a ramp to 150ºC at a rate of 1 ºC/min, 1 mL/min); major diastereomer, major enantiomer t_r = 47.41 min and major diastereomer, minor enantiomer t_r = 46.22 min, minor diastereomer, major enantiomer t_r= 56.42 min and minor diastereomer, minor enantiomer t_r = 55.42 min.



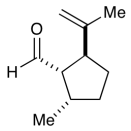
(*S*,*Z*)-3,7-dimethyl-8-(trimethylsilyl)oct-6-enal was prepared according to the literature precedent[3]



(1*R*,2*S*,5*R*)-2-methyl-5-(prop-1-en-2-yl)cyclopentanecarbaldehyde was prepared according to the SOMO cyclization general procedure from (*S*,*Z*)-3,7-dimethyl-8-(trimethylsilyl)oct-6-enal (95.9 mg, 0.42 mmol), CAN (511.9 mg, 0.93 mmol), $NaHCO_3$ (71.5 mg, 0.85 mmol), (2*S*,5*S*)-5-benzyl-2-*tert*-butyl-3-methylimidazolidin-4-one•TFA (29.2 mg, 0.08(5) mmol) and H_2O (15.2 μL, 0.84 mmol) in dimethoxyethane (6.7 mL). The mixture was stirred at –20 °C for 24 h. A crude product was obtained which, upon concentration and flash column chromatography on Davisil silica gel (5% Et_2O/petroleum ether), produced the desired product as a clear oil (47.0 mg, 73% yield, 21:6:1:<1 dr). IR (film) 2954, 2871, 1719, 1644, 1455, 1377, 1292, 887, 851, 838 cm^{-1};

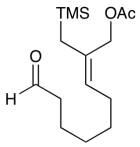
[3] Schlosser, M.; Franzini, L.; Bauer, C.; Leroux, F. *Chem. Eur. J.* **2001**, *7*, 1909.

^{1}H NMR (500 MHz, ($CDCl_3$) δ 9.55 (d, 1H, *J* = 3.3 Hz, C**H**O), 4.76 (d, 2H, *J* = 10.2 Hz, =C**H**$_2$), 2.86 (q, 1H, *J* = 8.7 Hz, C**H**C=), 2.28 – 2.25 (m, 1H, *J* = 6.5 Hz, C**H**CH_3), 2.25 – 2.23 (m, 1H, *J* = 3.6 Hz, C**H**CHO), 1.97 – 1.93 (m, 1H, *J* = 7.7 Hz, C**H**$_2$CHC=; m, 1H, *J* = 3.0 Hz, C**H**$_2CHCH_3$), 1.74 (s, 3H, C**H**$_3$C=), 1.70 – 1.67 (m, 1H, *J* = 6.5, 2.7 Hz, C**H**-$_2$CHC=), 1.37 - 1.43 (m, 1H, C**H**$_2CHCH_3$), 1.09 (d, 3H, *J* = 5.9 Hz, C**H**$_3$CH); ^{13}C NMR (125 MHz, $CDCl_3$) δ 203.9, 145.7, 110.3, 63.5, 48.9, 36.0, 33.3, 30.1, 21.4, 20.3; HRMS (ESI) exact mass calculated for $[M]^+$ ($C_{10}H_{16}O$) required *m/z* 152.12012, found *m/z* 152.11962; $[\alpha]_D$ = –14.5º (c = 0.4, CH_2Cl_2). The diastereomeric ratio was determined by ^{1}H NMR and GLC using a BTBDAC column (85 ºC isotherm for 80 minutes, 1 mL/min); diastereomers observed: t_r = 50.53 min, 52.08 min, 53.79 min, 62.59 min.



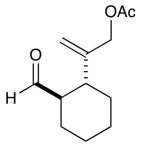
(1*S*,2*S*,5*S*)-2-methyl-5-(prop-1-en-2-yl)cyclopentanecarbaldehyde was prepared according to the SOMO cyclization general procedure from (*S*,*Z*)-3,7-dimethyl-8-(trimethylsilyl)oct-6-enal (86.5 mg, 0.38 mmol), CAN (470.2 mg, 0.86 mmol), $NaHCO_3$ (64.6 mg, 0.77 mmol), (2*R*,5*R*)-5-benzyl-2-*tert*-butyl-3-methylimidazolidin-4-one•TFA (26.5 mg, 0.07(7) mmol) and H_2O (13.8 μL, 0.77 mmol) in dimethoxyethane (6.1 mL). The mixture was stirred at –20 ^{o}C for 21 h. A crude product was obtained which, upon concentration and flash column chromatography on Davisil silica gel (5 – 10% Et_2O/petroleum ether), produced the desired product as a clear oil (39.8 mg, 69% yield, 11:2:1:<1 dr). IR (film) 2954, 2871, 1719, 1644, 1455, 1377, 1292, 887, 851,838 cm^{-1}; ^{1}H NMR (400 MHz, ($CDCl_3$) δ 9.76 (d, 1H, *J* = 3.6 Hz, C**H**O), 4.73 (d, 2H, *J* = 0.8 Hz, =C**H**$_2$), 2.93 (dd, 1H, *J* = 8.7, 8.6 Hz, C**H**C=), 2.58 (td, 1H, *J* = 5.4, 3.5 Hz, C**H**CHO),

2.44 – 2.36 (m, 1H, *J* = 7.3, 1.4 Hz, C**H**CH_3), 1.92 – 1.86 (m, 1H, C**H**$_2$CHC=), 1.85 – 1.79 (m, 1H, *J* = 3.0 Hz, C**H**$_2$$CHCH_3$), 1.58 (s, 3H, C**H**$_3$C=), 1.47 – 1.42 (m, 1H, C**H**-$_2$CHC=), 1.27 – 1.22 (m, 1H, C**H**$_2$$CHCH_3$), 0.93 (d, 3H, *J* = 5.9 Hz, C**H**$_3$CH); ^{13}C NMR (125 MHz, $CDCl_3$) δ 205.1, 146.3, 109.9, 58.4, 45.8, 37.2, 34.5, 31.1, 21.0, 17.5; HRMS (ESI) exact mass calculated for $[M]^+$ ($C_{10}H_{16}O$) required *m/z* 152.12012, found *m/z* 152.11962; $[\alpha]_D$ = 17.0 º (c = 0.7, CH_2Cl_2). The diastereomeric ratio was determined by ^{1}H NMR and GLC using a BTBDAC column (85 ºC isotherm for 80 minutes, 1 mL/min); diastereomers observed: t_r = 50.58 min, 53.23 min, 62.39 min, 65.87 min.

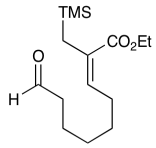


8-(1'-Methyl acetate)-9-(trimethylsilyl)non-7-enal was prepared according to the cross metathesis general procedure from *cis*-7-decenal (0.5 mL, 2.8 mmol) and 2-((trimethylsilyl)methyl)allyl acetate (1.7 mL, 8.4 mmol). A crude product was obtained which, upon concentration and flash column chromatography on silica gel (30% Et_2O/pentane), produced the desired product as a clear (105 mg, 13% yield). The compound was isolated as an inseparable mixture of *E*- and *Z*- alkenes. IR (film) 2933, 2858, 1740, 1722, 1245, 1026, 844 cm^{-1}; 1H NMR (400 MHz, $(CD_3)_2CO$) Diastereomer x δ 9.75 – 9.70 (m, 1H, C**H**O), 5.26 (t, 1H, *J* = 7.2 Hz, -C**H**=C), 4.52 (s, 2H, C**H**$_2$OAc), 2.44 – 2.38 (m, 2H, C**H**$_2$CHO), 2.00 (s, 3H, C**H**$_3$CO), 1.93 – 1.86 (m, 2H, C**H**$_2$CH=C), 1.55 – 1.65 (m, 4H, C**H**$_2$$CH_2$CHO and C**H**$_2$$Si(CH_3)_3$), 1.29 – 1.41 (m, 4H, C**H**$_2$C**H**$_2$$CH_2CH_2$CHO), 0.03 (s, 9H, $Si(C\mathbf{H}_3)_3$). Diastereomer y δ 9.72 (m, 1H, C**H**O), 5.34 (dt, 1H, *J* = 7.2, 0.8 Hz, C**H**=C), 4.40 (s, 2H, C**H**$_2$$Si(CH_3)_3$), 2.43 (m, 2H, C**H**$_2$CHO), 2.06 (m, 2H, C**H**$_2$CH=C), 2.01 (s, 3H, C**H**$_3$CO), 1.55 – 1.65 (m, 4H,

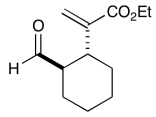
C**H**$_2$CH$_2$CHO and C**H**$_2$Si(CH$_3$)$_3$), 1.29 – 1.41 (m, 4H, C**H**$_2$C**H**$_2$CH$_2$CH$_2$CHO), 0.06 (s, 9H, Si(C**H**$_3$)$_3$); ^{13}C NMR (125 MHz, (CD$_3$)$_2$CO) δ 203.4, 171.6 (171.4), 133.9 (133.4), 129.8 (127.3), 70.6 (64.1), 44.9 (44.8), 31.3, 29.3 (28.9), 26.2, 23.3 (23.2), 21.5, 20.1, 0.0 (–0.6); HRMS (CI) exact mass calculated for [M]$^+$ (C$_{15}$H$_{28}$O$_3$Si) required *m/z* 284.18077, found 284.18010.



(1*R*,2*R*)-2-(2'-allyl acetate)cyclohexanecarbaldehyde was prepared according to the general procedure from 8-(1'-methyl acetate)-9-(trimethylsilyl)non-7-enal (72.0 mg, 0.25 mmol). A crude product was obtained which, upon concentration and flash column chromatography on Davisil silica gel (30% Et$_2$O/pentane), produced the desired product as a clear oil (36.0 mg, 65% yield, >20:1 dr, 94% ee,). IR (film) 2933, 2856, 1740, 1739, 1449, 1372, 1232, 1045 cm^{-1}; ^{1}H NMR (300 MHz, (CD$_3$)$_2$CO) δ 9.51 (d, 1H, *J* = 3.2 Hz, C**H**O), 5.09 – 5.04 (m, 1H, CH=C**H**$_2$), 5.03 – 4.98 (m, 1H, CH=C**H**$_2$), 4.60 – 4.51 (m, 2H, C**H**$_2$OAc), 2.48 (qd, 1H, *J* = 3.2, 3.2, 11.6, 11.6 Hz, C**H**CHO), 2.32 – 2.23 (m, 1H, C**H**CH=CH$_2$), 2.03 (s, 3H, C**H**$_3$CO), 1.20 – 1.35 (m, 4H, C**H**$_2$CH$_2$CH$_2$C**H**$_2$); ^{13}C NMR (75 MHz, (CD$_3$)$_2$CO) δ 203.7, 169.9, 147.7, 112.4, 65.5, 53.5, 42.1, 32.7, 26.6, 26.0, 24.9, 20.1; HRMS (ESI) exact mass calculated for [M]$^+$ (C$_{12}$H$_{18}$O$_3$) required *m/z* 210.1256, found 210.1258; $[\alpha]_D$ = –29.4 º (c = 0.3, CHCl$_3$); The enantiomeric excess was determined by GLC using a Γ-TA column (110 ºC isotherm for 120 minutes, 1 mL/min); major enantiomer t_r = 75.82 min and minor enantiomer t_r = 70.88 min. The diastereomeric ratio was determined by the same assay; minor diastereomer, major enantiomer t_r = 45.85 min and minor diastereomer, minor enantiomer t_r = 43.21 min.

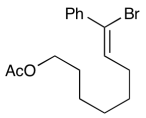


8-(Ethyl formate)-9-(trimethylsilyl)non-7-enal was prepared according to the cross methathesis general procedure from *cis*-7-decenal (2.0 mL, 10.0 mmol) and ethyl 2-((trimethylsilyl)methyl)acrylate (0.6 mL, 3.3 mmol). A crude product was obtained which, upon concentration and flash column chromatography on silica gel (10% Et_2O/pentane), produced the desired product as a clear oil (94 mg, 10% yield). The compound was isolated as a single isomer though the exact configuration was not determined. IR (film) 2950, 2862, 1725, 1710, 1249, 1179, 849 cm^{-1}; ^1H NMR (400 MHz, $(CD_3)_2CO$) δ 9.72 (t, 1H, *J* = 1.6 Hz, C**H**O), 6.58 (t, 1H, *J* = 7.2 Hz, C**H**=C), 4.13 (q, 2H, *J* = 7.2 Hz, OC**H₂**CH_3), 2.45 (dt, 2H, *J* = 7.2, 1.6 Hz, C**H₂**CHO), 2.15 (q, 2H, *J* = 7.2 Hz, C**H₂**CH=C), 1.84 (s, 2H, C**H₂**$Si(CH_3)_3$), 1.63 (q, 2H, *J* = 7.2 Hz, C**H₂**CH_2CHO), 1.53 – 1.42 (m, 2H, C**H₂**$(CH_2)_3$CHO), 1.41 – 1.32 (m, 2H, C**H₂**CH_2CH_2CHO), 1.25 (t, 3H, *J* = 7.2 Hz, OCH_2C**H₃**), 0.07 (s, 9H, Si(C**H₃**)₃); ^{13}C NMR (125 MHz, $(CD_3)_2CO$) δ 202.6, 168.3, 138.4, 131.1, 60.7, 44.1, 29.6, 29.4, 29.3, 22.4, 17.5, 14.5, –1.0; HRMS (CI) exact mass calculated for $[M]^+$ ($C_{15}H_{28}O_3Si$) required *m/z* 284.18077, found 284.18011.



(1*R*,2*R*)-2-(2'-ethyl acrylate)cyclohexanecarbaldehyde was prepared according to the general procedure from 8-(Ethyl formate)-9-(trimethylsilyl)non-7-enal (32.0mg, 0.11 mmol). A crude product was obtained which, upon concentration and flash column chromatography on Davisil silica gel (30% Et_2O/pentane), produced the desired product

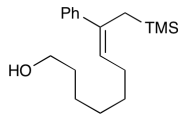
as a clear oil (16.3 mg, 70% yield, 92% ee, >20:1 dr). IR (film) 2932, 2857, 1722, 1712, 1149 cm^{-1}; ^1H NMR (300 MHz, $(CD_3)_2CO$) δ 9.45 (d, 1H, J = 3.3 Hz, C**H**O), 6.22 - 6.12 (m, 1H, CH=C**H**$_2$), 5.65 (m, 1H, CH=C**H**$_2$), 4.18 (q, 2H, J = 6.9 Hz, OC**H$_2$**CH$_3$), 2.84 – 2.75 (m, 1H, C**H**CH=CH$_2$), 2.59 – 2.48 (m, 1H, C**H**CHO), 1.70 – 1.90 (m, 4H, CH$_2$C**H$_2$**C**H$_2$**CH$_2$), 1.27 (t, 3H, J = 6.9 Hz, OCH$_2$C**H$_3$**), 1.20 – 1.40 (m, 4H, C**H**$_2$CH$_2$CH$_2$C**H$_2$**); ^{13}C NMR (75 MHz, $(CD_3)_2CO$) δ 203.0, 151.8, 144.0, 123.8, 60.3, 53.8, 39.2, 32.6, 26.3, 25.7, 24.6, 13.5; HRMS (CI) exact mass calculated for $[M]^+$ ($C_{12}H_{19}O_3$) requires *m/z* 211.1334, found *m/z* 211.1293; $[\alpha]_D$ = –24.1° (c = 0.77, $CHCl_3$); The enantiomeric ratio was determined by GLC using a Γ-TA column (90 ºC isotherm for 250 minutes, 1 mL/min); major enantiomer t_r = 210.62 min and minor enantiomer t_r = 185.20 min. The diastereomeric ratio was determined by the same assay; minor diastereomer, major enantiomer t_r = 121.94 min and minor diastereomer, minor enantiomer t_r = 112.04 min.



(*Z*)-8-bromo-8-phenyloct-7-enyl acetate was prepared according to the general procedure[4] from 8-(*tert*-butyldimethylsilyloxy)-1-phenyloctan-1-one (150.7 mg, 0.44 mmol), acetyl bromide (0.54 mL, 7.04 mmol) and Zinc bromide on silica gel (350.5 mg, 0.45 mmol) in 1,2-dichloroethane. A crude product was obtained which, upon concentration and flash column chromatography on silica gel (5 – 10% Et_2O/pentane), produced the desired product as a clear oil (122.2 mg, 85% yield). IR (film) 2933, 2857,

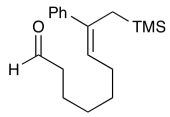
[4] Kodomari, M.; Nagaoka, T.; Furusawa, Y. *Tetrahedron Lett.* **2001**, *42*, 3105.

1738, 1491, 1445, 1365, 1240, 1036 cm^{-1}; ^1H NMR (400 MHz, ($CDCl_3$) δ 7.53 (dt, 2H, *J* = 6.8, 2.0, 2Ar**H**), 7.35 – 7.28 (m, 3H, 3Ar**H**), 6.20 (t, 1H, *J* = 7.0 Hz, =C**H**), 4.07 (t, 2H, *J* = 6.8 Hz, C$\mathbf{H_2}$O), 2.38 (q, 1H, *J* = 7.2 Hz, C$\mathbf{H_2}$CH=), 2.05 (s, 3H, C$\mathbf{H_3}$CO), 1.69 – 1.62 (m, 2H, *J* = 7.0 Hz, HOCCH$_2$C$\mathbf{H_2}$), 1.57 – 1.49 (m, 2H, *J* = 7.0 Hz, CH$_2$C$\mathbf{H_2}$CH$_2$), 1.47 – 1.38 (m, 4H, *J* = 3.6 Hz, CH$_2$C$\mathbf{H_2}$C$\mathbf{H_2}$CH$_2$); ^{13}C NMR (125 MHz, $CDCl_3$) δ 171.2, 140.0, 131.6, 128.2, 127.5, 125.4, 64.5, 32.4, 28.9, 28.5, 28.3, 25.8, 21.0; HRMS (ESI) exact mass calculated for $[M]^+$ ($C_{16}H_{21}BrO_2$) required *m/z* 324.07249, found 324.07207.

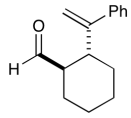


(*Z*)-8-phenyl-9-(trimethylsilyl)non-7-en-1-ol was prepared according to the general procedure[5] from (*Z*)-8-bromo-8-phenyloct-7-enyl acetate (1.24 g, 3.8 mmol), *bis*(tri-*tert*-butylphosphine) palladium(0) (96.8 mg, 0.19 mmol) in THF (38 mL), and ((trimethylsilyl)methyl)magnesium chloride (38 mL, 1.0 M in diethyl ether). A crude product was obtained which, upon concentration and flash column chromatography on silica gel (30 – 50% Et_2O/pentane), produced the desired product as a clear oil to provide the title compound (892.9 mg, 81% yield). IR (film) 3328, 2928, 2855, 1492, 1443, 1415, 1247, 1157, 1055, 852, 836, 773, 753, 695 cm^{-1}; ^1H NMR (400 MHz, ($CDCl_3$) δ 7.33 – 7.17 (m, 5H, 5Ar**H**), 5.49 (t, 1H, *J* = 6.8 Hz, =C**H**), 3.66 (t, 2H, *J* = 6.4 Hz, C$\mathbf{H_2}$O), 2.12 (q, 2H, *J* = 7.2 Hz, C$\mathbf{H_2}$CH=), 1.59 (bt, 2H, *J* = 7.6 Hz, C$\mathbf{H_2}$CH$_2$CHO), 1.47 – 1.37 (m, 6H, 3C$\mathbf{H_2}$), –0.14 (s, 9H, Si(C$\mathbf{H_3}$)$_3$); ^{13}C NMR (125 MHz, $CDCl_3$) δ 145.9, 138.8, 128.7, 127.5, 127.3, 127.0, 64.0, 33.7, 30.7, 33.2, 33.1, 26.6, 21.8, 0.1; HRMS (ESI) exact mass calculated for $[M]^+$ ($C_{18}H_{30}OSi$) required *m/z* 290.20609, found 290.20636.

[5] Ji-cheng Shi, Ei-ichi Negishi, *Journal of Organometallic Chemistry* **2003**, *687,* 518.

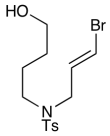


(*Z*)-8-phenyl-9-(trimethylsilyl)non-7-enal was prepared according to the general procedure from (*Z*)-8-phenyl-9-(trimethylsilyl)non-7-en-1-ol (890.0 mg, 3.0 mmol), Dess-Martin periodinane (2.0 g, 4.6 mmol) in CH_2Cl_2 (30 mL). A crude product was obtained which, upon concentration and flash column chromatography on silica gel (5 – 10% Et_2O/pentane), produced the desired product as a clear oil (523.2 mg, 61% yield). IR (film) 2930, 2856, 1726, 1492, 1443, 1414, 1275, 1259, 1248, 1157, 855, 839, 751, 698 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 9.73 (t, 1H, *J* = 1.6 Hz, -C**H**O), 7.26 –7.15 (m, 5H, 5Ar**H**), 5.43 (t, 1H, *J* = 7.2 Hz, =C**H**), 2.40 (ddd, 2H, *J* = 7.6, 2.0, 1.6 Hz, C**H₂**CHO), 2.08 (q, 2H, *J* = 6.8 Hz, C**H₂**CH=), 1.93 (s, 2H, C**H₂**Si**(**$CH_3)_3$), 1.62 (quin, 2H, *J* = 7.2 Hz, $OHCCH_2C\mathbf{H_2}$), 1.44 - 1.33 (m, 4H, 2C**H₂**), –0.19 (s, 9H, $CH_2Si(C\mathbf{H_3})_3$); ^{13}C NMR (125 MHz, $CDCl_3$) δ 203.8, 145.8, 139.0, 128.9, 127.5, 127.4, 126.6, 44.8, 30.4, 29.9, 23.0, 21.9, 0.0; HRMS (ESI) exact mass calculated for $[M]^+$ ($C_{18}H_{28}OSi$) required *m/z* 288.19094, found 288.19021.



(1*R*,2*R*)-2-(1-phenylvinyl)cyclohexanecarbaldehyde was prepared according to the general procedure of SOMO cyclization from (*Z*)-8-phenyl-9-(trimethylsilyl)non-7-enal (57.1 mg, 0.20 mmol), CAN (254.7 mg, 0.43 mmol), $NaHCO_3$ (37.2 mg, 0.44 mmol), (2*S*,5*S*)-5-methyl-2-*tert*-butyl-3-methylimidazolidin-4-one•TFA (11.5 mg, 0.04 mmol) and H_2O (7.1 μL, 0.39 mmol) in dimethoxyethane (3.2 mL). The mixture was stirred at –20 °C for 24 h. A crude product was obtained which, upon concentration and flash

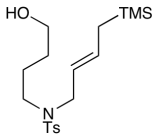
column chromatography on Davisil silica gel (5 – 25% Et_2O/petroleum ether), produced the desired product as a clear oil (35.2 mg, 83% yield, 4:1 dr, 90% ee). IR (film) 3057, 2929, 2854, 1720, 1626, 1493, 1445, 1292, 1121, 1064, 1027, 899, 777, 702 cm^{-1}; ^1H NMR (300 MHz, $CDCl_3$) δ 9.59 (d, 1H, *J* = 3.6 Hz, C**H**O), 7.36 – 7.27 (m, 5H, 5Ar**H**), 5.24 (d, 1H, *J* = 0.6 Hz, =C**H**$_2$), 5.07 (d, 1H, *J* = 0.6 Hz, =C**H**$_2$), 2.72 (td, 1H, *J* = 11.1, 3.6 Hz, C**H**C=), 2.51 – 2.56 (m, 1H, *J* = 3.6 Hz, C**H**CHO), 1.99 – 1.95 (m, 1H, *J* = 2.1 Hz, C**H**$_2$CHC=), 1.94 – 1.90 (m, 1H, *J* = 3.0 Hz, C**H**$_2$CHCO), 1.88 – 1.83 (m, 1H, *J* = 9.9 Hz, C**H**$_2$CH$_2$CHC=), 1.80 – 1.74 (m, 1H, C**H**$_2$CH$_2$CHCHO), 1.45 – 1.19 (m, 4H, 4C**H**$_2$); ^{13}C NMR (125 MHz, $CDCl_3$) δ 206.0, 153.1, 143.2, 129.2, 128.6, 127.7, 114.0, 55.1, 44.1, 33.9, 28.7, 27.8, 25.9; HRMS (ESI) exact mass calculated for $[M]^+$ ($C_{15}H_{18}O$) required *m/z* 214.13577, found 214.13527. $[\alpha]_D$ = –5.5º (c = 0.97, CH_2Cl_2).The enantiomeric and diastereomeric ratio were determined by GLC using a Dex-CB column (135 ºC isotherm for 50 minutes, 1 mL/min); major diastereomer, major enantiomer t_r= 41.22 min and major diastereomer, minor enantiomer t_r= 39.99 min, minor diastereomer, major enantiomer t_r= 44.79 min and minor diastereomer, minor enantiomer t_r= 46.01 min.



(*E*)-*N*-(3-bromoallyl)-*N*-(4-hydroxybutyl)-4-methylbenzenesulfonamide was prepared from *N*-(4-hydroxybutyl)-4-methylbenzenesulfonamide and (*E*)-1,3-dibromoprop-1-ene according to the N-alkylation process.[6] A crude product was obtained which, upon concentration and flash column chromatography on silica gel (30 – 50% AcOEt/hexane), produced the desired product as a light yellow oil (81% yield). IR (neat)

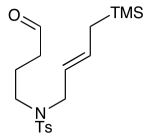
[6] William, J. T.; Bahia, P. S.; Snaith, J. S. *Org. Lett.* **2002**, *4*, 3727.

3426, 2934, 2871, 1733, 1620, 1448, 1332, 1241, 1153, 1088, 1031, 941, 908, 813, 710, 692 cm^{-1}; ^1H NMR (500 MHz, CD_3Cl_3) δ 7.68 (dd, 2H, *J* = 8.2, 1.6 Hz, 2Ar**H**), 7.32 (d, 2H, *J* = 7.9 Hz, 2Ar**H**), 6.26 (d, 1H, *J* = 13.7 Hz, BrC**H**=CH), 6.05 – 6.95 (m, 1H, BrCH=C**H**–CH_2N), 3.78 (d, 2H, *J* = 6.9 Hz, =CH-C**H₂**NTs), 3.66 (dd, 2H, *J* = 5.7, 4.2 Hz, C**H₂**OH), 3.16 (t, 2H, *J* = 6.7, 7.4 Hz, CH_2C**H₂**$NTsCH_2$), 2.44 (s, 3H, C**H₃**Ar), 1.66 – 1.54 (m, 4H, C**H₂**C**H₂**), 1.39 (t, 1H, *J* = 5.2 Hz, O**H**); ^{13}C NMR (125 MHz, CD_3Cl_3) δ 143.6, 136.6, 132.5, 129.8, 127.2, 109.5, 62.3, 49.2, 47.3, 29.4, 24.7, 21.6; HRMS (ESI) exact mass calculated for $[M]^+$ ($C_{14}H_{20}BrNO_3S$) required *m/z* 361.03473, found 361.03439.

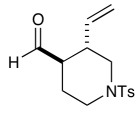


(*E*)-*N*-(4-hydroxybutyl)-4-methyl-*N*-(4-(trimethylsilyl)but-2-enyl)benzenesulfonamide was prepared from (*E*)-*N*-(3-bromoallyl)-*N*-(4-hydroxybutyl)-4-methylbenzenesulfonamide and ((trimethylsilyl)methyl)magnesium chloride by applying the known procedure (2 h).[5] A crude product was obtained which, upon concentration and flash column chromatography on silica gel (30 – 50% AcOEt/hexane), produced the desired product (94% yield). IR (neat) 3502, 2951, 2872, 1738, 1656, 1598, 1449, 1335, 1247, 1152, 1089, 1037, 969, 841, 813, 750 cm^{-1}; ^1H NMR (500 MHz, CD_3Cl_3) δ 7.69 (d, 2H, *J* = 8.1 Hz, 2Ar**H**), 7.30 (d, 2H, *J* = 8.0 Hz, 2Ar**H**), 5.55 (dt, 1H, *J* = 15.1, 8.2 Hz, $TMSCH_2C$**H**=CH), 5.03 (dt, 1H, *J* = 15.1, 6.9 Hz, CH=C**H**CH_2NTs), 3.79 (d, 2H, *J* = 6.9 Hz, =CH-C**H₂**NTs), 3.70 (t, 2H, *J* = 6.3 Hz, C**H₂**OH), 3.19 (t, 2H, *J* = 6.7, 7.3 Hz, CH_2C**H₂**NTs), 2.48 (s, 3H, C**H₃**Ar), 1.70 – 1.52 (m, 4H, C**H₂**C**H₂**), 1.46 (d, 2H, *J* = 8.1 Hz, $TMSC$**H₂**CH=), 1.40 (b, 1H, O**H**), –0.05 (s, 9H, (C**H₃**)$_3$Si); ^{13}C NMR (125

MHz, CD_3Cl_3) δ 145.0, 139.2, 134.5, 131.6, 129.1, 124.4, 54.5, 51.9, 48.1, 31.5, 26.5, 24.7, 23.5, 0.0; HRMS (ESI) exact mass calculated for $[M]^+$ ($C_{18}H_{31}NO_3SSi$) required *m/z* 369.17939, found 369.17885.



(*E*)-4-methyl-*N*-(4-oxobutyl)-*N*-(4-(trimethylsilyl)but-2-enyl)benzenesulfonamide was prepared according to the general procedure of Dess-Martin oxidation from (*E*)-*N*-(4-hydroxybutyl)-4-methyl-*N*-(4-(trimethylsilyl)but-2-enyl)benzenesulfonamide. A crude product was obtained which, upon concentration and flash column chromatography on silica gel (15 – 40% Et_2O/petroleum ether), produced the desired product as a clear oil (79% yield). IR (neat) 2953, 2895, 1722, 1656, 1598, 1449, 1336, 1247, 1154, 1089, 968, 841, 814, 723 cm^{-1}; ^1H NMR (500 MHz, CD_3Cl_3) δ 9.79 (b, 1H, C**H**O), 7.68 (d, 2H, *J* = 8.1 Hz, 2Ar**H**), 7.30 (d, 2H, *J* = 8.0 Hz, 2Ar**H**), 5.56 (dt, 1H, *J* = 15.1, 8.1 Hz, $TMSCH_2C\mathbf{H}$=CH), 5.01 (dt, 1H, *J* = 15.1, 7.0 Hz, CH=C**H**CH_2NTs), 3.73 (d, 2H, *J* = 7.0 Hz, =CHC$\mathbf{H_2}$NTs), 3.13 (t, 2H, *J* = 6.8 Hz, $CH_2C\mathbf{H_2}NTsCH_2$), 2.57 (t, 2H, *J* = 7.2, 7.0 Hz, C$\mathbf{H_2}$CHO), 2.43 (s, 3H, C$\mathbf{H_3}$Ar), 1.88 – 1.80 (m, 2H, *J* = 7.0, 6.9 Hz, C$\mathbf{H_2}CH_2CHO$), 1.40 (d, 2H, *J* = 8.2 Hz, TMSC$\mathbf{H_2}$CH=), –0.05 (s, 9H, $(C\mathbf{H_3})_3Si$); ^{13}C NMR (125 MHz, CD_3Cl_3) δ 203.7, 145.2, 138.9, 135.0, 131.7, 129.1, 124.1, 52.3, 47.5, 42.6, 24.8, 23.5, 22.5, 0.0; HRMS (ESI) exact mass calculated for $[M]^+$ ($C_{18}H_{29}NO_3SSi$) required *m/z* 367.16374, found 367.16305.

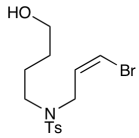


(3*S*,4*R*)-1-tosyl-3-vinylpiperidine-4-carbaldehyde was prepared according to the

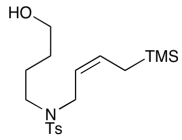
general procedure of SOMO cyclization from (*E*)-4-methyl-*N*-(4-oxobutyl)-*N*-(4-(trimethylsilyl)but-2-enyl)benzenesulfonamide (88.5 mg, 0.24 mmol), CAN (309.4 mg, 0.53 mmol), $NaHCO_3$ (44.7 mg, 0.53 mmol), (2*S*,3*S*)-5-methyl-2-*tert*-butyl-3-benzylimidazolidin-4-one•TFA (16.6 mg, 0.04(8) mmol) and H_2O (8.6 μL, 0.48 mmol) in DME (3.8 mL). The mixture was stirred at –30 °C for 26 h. A crude product was obtained which, upon concentration and flash column chromatography on Davisil silica gel (40 – 60% Et_2O/petroleum ether), produced the desired product as white crystals (60.8 mg, 86% yield, 20:1 dr, 89% ee). IR (neat) 3057, 2926, 2848, 1724, 1598, 1465, 1352, 1338, 1265, 1163, 1091, 1036, 963, 925, 816, 731, 702 cm^{-1}; ^1H NMR (500 MHz, CD_3Cl_3) δ 9.58 (d, 1H, *J* = 2.3 Hz, C**H**O), 7.65 (d, 2H, *J* = 8.1 Hz, 2Ar**H**), 7.35 (d, 2H, *J* = 8.0 Hz, 2Ar**H**), 5.65 (dd, 1H, *J* = 8.2, 2.3 Hz, CHC**H**=CH_2), 5.13 (ds, 2H, *J* = 8.2, 10.0 Hz, CH=C**H$_2$**), 3.77 (d, 1H, *J* = 10.9 Hz, CH_2C**H$_2$**NTs), 3.71 (dd, 1H, *J* = 11.6, 10.9, 3.9 Hz, CHC**H$_2$**NTs), 2.70 – 2.63 (m, 1H, *J* = 11.3, 3.2 Hz, C**H**CH_2NTs), 2.45 (s, 3H, C**H$_3$**Ar), 2.35 (tt, 1H, *J* = 11.5, 2.6 Hz, CH_2C**H$_2$**NTs), 2.19 (t, 1H, *J* = 10.8, 10.3 Hz, CHC**H$_2$**NTs). 2.15 – 2.08 (m, 1H, *J* = 10.6, 2.7 Hz, C**H**CHO), 1.92 (dd, 1H, *J* = 10.2, 3.5 Hz, C**H$_2$**CH_2NTs), 1.77 (dd, 1H, *J* = 7.2, 4.4 Hz, C**H$_2$**CH_2NTs); ^{13}C NMR (125 MHz, CD_3Cl_3) δ 203.6, 144.8, 136.9, 133.8, 130.8, 128.6, 119.7, 52.4, 50.7, 45.9, 41.3, 25.3, 22.6; HRMS (ESI) exact mass calculated for $[M]^+$ ($C_{15}H_{19}NO_3S$) required *m/z* 293.10856, found 293.10806. $[\alpha]_D$ = –108.9º (c = 0.47, CH_2Cl_2).

The diastereomeric ratio was determined by 1H NMR analysis (major diastereomer: 9.57 ppm; minor diastereomer: 9.55 ppm). The enantiomeric excess was determined by SFC analysis using an ASH column (gradient MeCN 5 – 10%, 4 mL/min): minor diastereomer, minor enantiomer t_r= 1.48 min and minor diastereomer, major enantiomer

t_r= 1.59 min, major diastereomer, minor enantiomer t_r= 2.41 min and major diastereomer, major enantiomer t_r= 2.86 min.



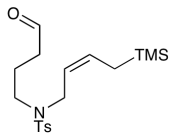
(*Z*)-*N*-(3-bromoallyl)-*N*-(4-hydroxybutyl)-4-methylbenzenesulfonamide was prepared from *N*-(3-hydroxypropyl)-4-methylbenzenesulfonamide and (*E*)-1,3-dibromoprop-1-ene according to the N-alkylation process.[7] A crude product was obtained which, upon concentration and flash column chromatography on silica gel (30 - 60% AcOEt/hexane), produced the desired product as a light yellow oil (86% yield). IR (neat) 3431, 2938, 2870, 1735, 1620, 1597, 1448, 1334, 1290, 1241, 1154, 1089, 1038, 906, 814, 766, 663 cm^{-1}; ^1H NMR (500 MHz, CD_3Cl_3) δ 7.70 (d, 2H, *J* = 8.3 Hz, 2Ar**H**), 7.32 (d, 2H, *J* = 8.5 Hz, 2Ar**H**), 6.28 (dt, 1H, *J* = 1.6, 7.2 Hz, BrC**H**=CH), 6.05 (dd, 1H, *J* = 6.4, 7.1 Hz, BrCH=C**H**–CH_2N), 3.95 (dd, 2H, *J* = 1.6, 6.4 Hz, =CHC**H_2**NTs), 3.66 (q, 2H, *J* = 5.7, 6.2 Hz, C**H_2**OH), 3.16 (t, 2H, *J* = 7.0, 7.3 Hz, CH_2C**H_2**NTsCH_2), 2.44 (s, 3H, C**H_3**Ar), 1.70 – 1.62 (m, 2H, C**H_2**CH_2), 1.62 – 1.53 (m, 2H, C**H_2**CH_2), 1.34 (t, 1H, *J* = 3.4, 1.5 Hz, O**H**); ^{13}C NMR (125 MHz, CD_3Cl_3) δ 143.5, 136.5, 130.5, 129.9, 127.2, 110.7, 62.4, 48.0, 47.1, 29.5, 24.7, 21.5; HRMS (ESI) exact mass calculated for $[M]^+$ ($C_{14}H_{20}BrNO_3S$) required *m/z* 361.03473, found 361.03449.



***(Z)*-*N*-(4-hydroxybutyl)-4-methyl-*N*-(4-(trimethylsilyl)but-2-enyl)benzenesulfonamide** was prepared from (*Z*)-*N*-(3-bromoallyl)-*N*-(4-hydroxybutyl)-

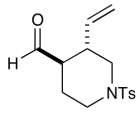
[7] William, J. T.; Bahia, P. S.; Snaith, J. S. *Org. Lett.* **2002**, *4*, 3727.

4-methylbenzenesulfonamide and ((trimethylsilyl)methyl)magnesium chloride by applying the known procedure (2 h).[5] A crude product was obtained which, upon concentration and flash column chromatography on silica gel (30 – 50% AcOEt/hexane), produced the desired product (75% yield). IR (neat) 3424, 2951, 2871, 1450, 1339, 1247, 1155, 1090, 1031, 854, 764 cm^{-1}; ^1H NMR (500 MHz, CD_3Cl_3) δ 7.70 (d, 2H, *J* = 8.3 Hz, 2Ar**H**), 7.30 (d, 2H, *J* = 7.9 Hz, 2Ar**H**), 5.55 (qt, 1H, *J* = 10.8, 1.5 Hz, $TMSCH_2C\mathbf{H}$=CH), 5.07 (dt, 1H, *J* = 10.9, 1.3 Hz, CH=C**H**CH_2NTs), 3.82 (dd, 2H, *J* = 6.8, 1.1 Hz, =CHC$\mathbf{H_2}$NTs), 3.66 (q, 2H, *J* = 6.1, 5.6 Hz, C$\mathbf{H_2}$OH), 3.14 (t, 2H, *J* = 7.3, 6.8 Hz, $CH_2C\mathbf{H_2}$NTs), 2.43 (s, 3H, C$\mathbf{H_3}$Ar), 1.67 - 1.56 (m, 4H, C$\mathbf{H_2}C\mathbf{H_2}$), 1.46 (d, 2H, *J* = 8.9 Hz, TMSC$\mathbf{H_2}$CH=), 1.39 (t, 1H, *J* = 5.4 Hz, O**H**), –0.01 (s, 9H, $(C\mathbf{H_3})_3Si$); ^{13}C NMR (125 MHz, CD_3Cl_3) δ 144.9, 139.0, 132.4, 131.4, 129.0, 123.2, 64.3, 48.6, 45.9, 31.4, 26.7, 23.4, 20.7, 0.0; HRMS (ESI) exact mass calculated for $[M]^+$ ($C_{18}H_{31}NO_3SSi$) required *m/z* 369.17939, found 369.17889.



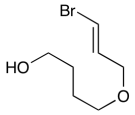
(*Z*)-4-methyl-*N*-(4-oxobutyl)-*N*-(4-(trimethylsilyl)but-2-enyl)benzenesulfonamide was prepared according to the general procedure of Dess-Martin oxidation from (*Z*)-*N*-(4-hydroxybutyl)-4-methyl-*N*-(4-(trimethylsilyl)but-2-enyl)benzenesulfonamide. A crude product was obtained which, upon concentration and flash column chromatography on silica gel (40% Et_2O/petroleum ether), produced the desired product as a clear oil (90% yield). IR (neat) 2948, 2864, 1716, 1597, 1450, 1412, 1337, 1245, 1157, 1112, 1088, 1027, 854, 840, 811, 730 cm^{-1}; ^1H NMR (500 MHz,

CD_3Cl_3) δ 9.80 (d, 1H, *J* = 0.8 Hz, C**H**O), 7.68 (d, 2H, *J* = 8.2 Hz, 2Ar**H**), 7.29 (d, 2H, *J* = 8.0 Hz, 2Ar**H**), 5.55 (qt, 1H, *J* = 10.8, 1.6 Hz, TMSCH$_2$C**H**=CH), 5.04 (dt, 1H, *J* = 10.9, 1.4 Hz, CH=C**H**–CH$_2$NTs), 3.79 (d, 2H, *J* = 6.9 Hz, =CH-C**H$_2$**NTs), 3.12 (t, 2H, *J* = 6.8 Hz, CH$_2$C**H$_2$**NTsCH$_2$), 2.58 (tt, 2H, *J* = 7.1, 0.9 Hz, C**H$_2$**CHO), 2.43 (s, 3H, C**H$_3$**Ar), 1.90 – 1.82 (m, 2H, *J* = 7.0, 6.0 Hz, C**H**$_2$CH$_2$CHO), 1.47 (d, 2H, *J* = 9.0 Hz, TMSC**H**$_2$CH=), –0.01 (s, 9H, (C**H$_3$**)$_3$Si); ^{13}C NMR (125 MHz, CD_3Cl_3) δ 203.6, 145.0, 138.7, 132.8, 131.5, 129.0, 122.8, 48.0, 46.2, 42.6, 23.4, 22.7, 20.7, 0.0; HRMS (ESI) exact mass calculated for $[M]^+$ ($C_{18}H_{29}NO_3SSi$) required *m/z* 367.16374, found 367.16305.

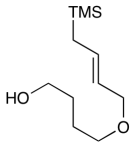


(3*S*,4*R*)-1-tosyl-3-vinylpiperidine-4-carbaldehyde was prepared according to the general procedure of SOMO cyclization from (*Z*)-4-methyl-*N*-(4-oxobutyl)-*N*-(4-(trimethylsilyl)but-2-enyl)benzenesulfonamide (152.5 mg, 0.41 mmol), CAN (544.1 mg, 0.93 mmol), $NaHCO_3$ (19.5 mg, 0.23 mmol), (2*S*,3*S*)-5-methyl-2-*tert*-butyl-3-benzylimidazolidin-4-one•TFA (29.1 mg, 0.08 mmol) and H_2O (15 μL, 0.83 mmol) in DME (6.6 mL). The mixture was stirred at –30 °C for 24 h. A crude product was obtained which, upon concentration and flash column chromatography on Davisil silica gel (30 - 50% Et_2O/petroleum ether) then with iatro bead silica gel (50 – 70% Et_2O/petroleum ether), produced the desired product (94.1 mg, 78% yield, 11:1 dr, 91% ee). $[\alpha]_D$ = – 106.8º (c = 0.49, CH_2Cl_2).

Data is consistent with the above.

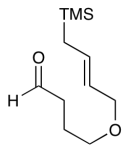


(*E*)-4-(3-bromoallyloxy)butan-1-ol: 1,4-Butanediol (107.1 mg, 1.2 mmol) was slowly added to the mixture of sodium hydride (59.9 mg, 1.5 mmol) in DMF (5 ml) at 0 ^{o}C. Then, the mixture was let to warm up to room temperature and stirred for one more hour before (*E*)-1,3-dibromoprop-1-ene (289.0 mg, 1.4 mmol) was added. The reaction was quenched with water followed by extracting by diethyl ether, washed with brine and dried over magnesium sulfate. A crude product was obtained which, upon concentration and flash column chromatography on silica gel (50 – 80% Et_2O/pentane), produced the desired product (125.1 mg, 50% yield). IR (film) 3369, 2938, 2862, 1620, 1476, 1446, 1356, 1275, 1100, 1055, 926, 764, 749 cm^{-1}; ^{1}H NMR (300 MHz, CD_3Cl_3) δ 6.34 (d, 1H, *J* = 0.6 Hz, BrC**H**=CH), 6.38 – 6.26 (m, 1H, BrCH=C**H**CH_2O), 3.95 (d, 2H, *J* = 5.4 Hz, =CHC**H$_2$**O), 3.66 (db, 2H, *J* = 3.6 Hz, C**H$_2$**OH), 3.48 (ddd, 2H, *J* = 5.1, 0.9 Hz, CH_2C**H$_2$**O), 1.68 (b, 4H, C**H**$_2$C**H$_2$**); ^{13}C NMR (125 MHz, CD_3Cl_3) δ 134.0, 108.6, 70.4 ($2CH_2$), 58.1, 29.9, 26.5; HRMS (ESI) exact mass calculated for $[M]^+$ ($C_7H_{13}BrO_2$) required *m/z* 208.00989, found 208.00916.



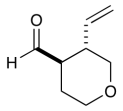
(*E*)-4-(4-(trimethylsilyl)but-2-enyloxy)butan-1-ol: To the dry-ice cooled mixture of (*E*)-4-(3-bromoallyloxy)butan-1-ol (113.2 mg, 0.5 mmol) and *bis*(tri-*tert*-butylphosphine) palladium(0) (14.2 mg, 0.02 mmol) in THF (5.4 mL) was slowly added ((trimethylsilyl)methyl)magnesium chloride (1.6 mL, 1.0 M in diethyl ether). The mixture was stirred overnight at room temperature then diluted by diethyl ether,

quenched with saturated ammonium chloride solution followed by water, washed with brine and dried over magnesium sulfate. A crude product was obtained which, upon concentration and flash column chromatography on silica gel (50 – 80% Et_2O/pentane), produced the desired product (84.0 mg, 72% yield). IR (film) 3386, 2950, 2855, 1659, 1447, 1406, 1360, 1275, 1259, 1247, 1152, 1103, 1056, 967, 837, 764, 749 cm^{-1}; ^1H NMR (400 MHz, CD_3Cl_3) δ 5.73 – 5.64 (m, 1H, *J* = 15.6 Hz, $TMSCH_2CH=C\mathbf{H}$), 5.45 – 5.36 (m, 1H, *J* = 15.2 Hz, $TMSCH_2C\mathbf{H}=CH$), 3.93 (d, 2H, *J* = 6.0 Hz, $=CHC\mathbf{H_2}O$), 3.65 (q, 2H, *J* = 5.6, $C\mathbf{H_2}OH$), 3.44 (t, 2H, *J* = 6.0, $CH_2C\mathbf{H_2}OCH_2$), 2.52 (b, 1H, $CH_2O\mathbf{H}$), 1.72 – 1.65 (m, 4H, $C\mathbf{H}_2C\mathbf{H_2}$), 1.50 (d, 2H, *J* = 8.8 Hz, $=CHC\mathbf{H_2}TMS$), 0.00 (s, 9H, $(C\mathbf{H_3})_3Si$); ^{13}C NMR (125 MHz, CD_3Cl_3) δ 134.0, 126.2, 73.9, 71.5, 64.7, 32.5, 29.0, 24.8, 0.0; HRMS (ESI) exact mass calculated for $[M]^+$ ($C_{11}H_{24}O_2Si$) required *m/z* 216.15456, found 216.15394.



(*E*)-4-(4-(trimethylsilyl)but-2-enyloxy)butanal was prepared according to the general procedure of Dess-Martin oxidation from (*E*)-4-(4-(trimethylsilyl)but-2-enyloxy)butan-1-ol (527.6 mg, 2.4 mmol) and Dess-Martin periodinane (1.55 g, 3.6 mmol) in CH_2Cl_2 (24 mL). A crude product was obtained which, upon concentration and flash column chromatography on silica gel (15 - 30% Et_2O/petroleum ether), produced the desired product as a clear oil (406.7 mg, 79% yield). IR (film) 2953, 2856, 1726, 1658, 1410, 1359, 1248, 1152, 1108, 1032, 969, 849 cm^{-1}; ^1H NMR (300 MHz, CD_3Cl_3) δ 9.78 (t, 1H, *J* = 1.8 Hz, $C\mathbf{H}O$), 5.73 – 5.61 (m, 1H, *J* = 15.0, 0.9 Hz,

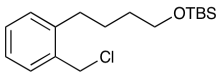
TMSCH$_2$CH=C**H**), 5.44 – 5.32 (m, 1H, *J* = 15.3, 1.2 Hz, TMSCH$_2$C**H**=CH), 3.89 (dt, 2H, *J* = 5.7, 0.9 Hz, =CHC**H$_2$**O), 3.42 (t, 2H, *J* = 6.3 Hz, CH$_2$C**H$_2$**OCH$_2$), 2.53 (ddd, 2H, *J* = 7.2, 1.5 Hz, C**H$_2$**CHO), 1.96 – 1.86 (m, 2H, CH$_2$C**H$_2$**CH$_2$), 1.50 (tt, 2H, *J* = 8.1, 0.6 Hz, =CHC**H$_2$**TMS), 0.00 (s, 9H, (C**H$_3$**)$_3$Si); ^{13}C NMR (125 MHz, CD_3Cl_3) δ 204.4, 133.7, 126.5, 73.8, 70.2, 42.9, 24.8, 24.5, 0.0; HRMS (ESI) exact mass calculated for $[M]^+$ ($C_{11}H_{22}O_2Si$) required *m/z* 214.13891, found 214.13791.



(3*S*,4*R*)-3-vinyltetrahydro-2*H*-pyran-4-carbaldehyde was prepared according to the general procedure of SOMO cyclization from (*E*)-4-(4-(trimethylsilyl)but-2-enyloxy)butanal (74.1 mg, 0.34 mmol), CAN (437.7 mg, 0.80 mmol), $NaHCO_3$ (14.4 mg, 0.17 mmol), (2*S*,3*S*)-5-methyl-2-*tert*-butyl-3-benzylimidazolidin-4-one•TFA (23.2 mg, 0.07 mmol) and H_2O (12.2 μL, 0.68 mmol) in acetone (5.4 mL). The mixture was stirred at –20 °C for 25 h. A crude product was obtained which, upon concentration and flash column chromatography on Davisil silica gel (10 – 40% Et_2O/petroleum ether), produced the desired product (35.3 mg, 74% yield, >20:1 dr (65:1), 91% ee). IR (film) 2955, 2842, 1721, 1640, 1466, 1439, 1421, 1385, 1348, 1267, 1240, 1129, 1086, 994, 922, 887 cm^{-1}; ^{1}H NMR (300 MHz, CD_3Cl_3) δ 9.63 (d, 1H, *J* = 2.4, C**H**O), 5.65 (ddd, 1H, *J* = 17.7, 10.2, 7.8 Hz , C**H**=CH$_2$), 5.21 – 5.16 (m, 2H, *J* = 0.9, 4.8, 1.2, 16.2, 11.4, 0.9 Hz, CH=C**H$_2$**), 4.06 – 4.0 (dd dd, 1H, *J* = 11.4, 4.5, 2.4 Hz, CH$_2$C**H$_2$**O), 3.93 – 3.87 (dd, 1H, *J* = 11.4, 4.5 Hz, CHC**H$_2$**O), 3.47 – 3.38 (m, 1H, *J* = 11.4, 3.0 Hz, CH$_2$C**H$_2$**O), 3.24 – 3.17(dd, 1H, *J* = 11.7, 10.2 Hz, CHC**H$_2$**O), 2.62 – 2.51 (m, 1H, *J* = 12.6, 4.8, 2.4 Hz, C**H**CH=), 2.45 – 2.36 (m, 1H, *J* = 10.8, 4.8, 2.4 Hz, C**H**CHO), 1.81 – 1.67 (m, 2H, C**H$_2$**CH$_2$O); ^{13}C NMR

(125 MHz, CD_3Cl_3) δ 203.1, 135.6, 118.4, 70.9, 66.6, 51.4, 40.9, 25.0; HRMS (ESI) exact mass calculated for $[M]^+$ ($C_8H_{12}O_2$) required *m/z* 140.08373, found 140.08271. $[\alpha]_D$ = –48.6º (c = 0.91, CH_2Cl_2).

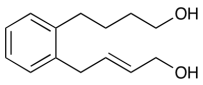
The enantiomeric and diastereomeric ratio were determined by GLC using a BTBDAC column (100 ºC isotherm for 75 minutes, 1 mL/min); major diastereomer, major enantiomer t_r= 51.27 min and major diastereomer, minor enantiomer t_r= 54.83 min, minor diastereomer, major enantiomer t_r= 58.72 min and minor diastereomer, minor enantiomer t_r= 61.27 min.



***tert*-Butyl(4-(2-(chloromethyl)phenyl)butoxy)dimethylsilane**

Methanesulfonyl chloride (0.42 mL, 5.4 mmol) was added dropwise to a cold (0 ^oC) solution of (2-(4-(*tert*-butyldimethylsilyloxy)butyl)phenyl)methanol (533.8 mg, 1.8 mmol), 2,6–lutidine (0.85 mL, 7.2 mmol) and LiCl (321.1 mg, 7.5 mmol) in DMF (8 mL) while stirring. The reaction is then let to warm up to room-temperature for 3 h before being diluted with 50 mL of diethyl ether. The organic phase was then washed with H_2O (4x16 mL), saturate solution of $CuSO_4$ (3x8 mL), NH_4Cl (8 mL), water (16 mL), and brine (5 mL) before being dried over $MgSO_4$. A crude product was obtained which, upon concentration and flash column chromatography on silica gel (3% Et_2O/petroleum ether), produced the desired product (484.9 mg, 86% yield). IR (film) 2962, 2885, 2857, 1471, 1462, 1387, 1275, 1259, 1097, 834, 764, 750 cm^{-1}; ^1H NMR (400 MHz, CD_3Cl_3) δ 7.33 (d, 1H, *J* = 7.6 Hz, Ar**H**), 7.27 (t, 1H *J* =7.3 Hz, Ar**H**), 7.21 (dd, 2H, *J* =7.6, 7.3 Hz, 2Ar**H**), 4.65 (s, 2H, ArC**H₂**Cl), 3.65 (t, 2H *J* =6.3, 6.1 Hz, C**H₂**OTBS), 2.71 (dd, *J* = 8.0, 7.6 Hz, ArC**H₂**CH_2), 1.74 – 1.67 (m, 2H, TBSOCH_2C**H₂**), 1.67 – 1.60 (m, 2H,

ArCH$_2$C**H$_2$**), 0.90 (s, 9H, (C**H$_3$**)$_3$CSi), 0.06 (s, 6H, (C**H$_3$**)$_2$Si); ^{13}C NMR (125 MHz, CD_3Cl_3) δ 141.5, 135.1, 130.3, 129.6, 128.9, 126.3, 62.8, 44.2, 32.7, 32.0, 27.5, 25.9, 18.3, –5.2; HRMS (ESI) exact mass calculated for $[M]^+$ ($C_{17}H_{29}ClOSi$) required *m/z* 312.16762, found 312.16722.



(*E*)-4-(2-(4-hydroxybutyl)phenyl)but-2-en-1-ol

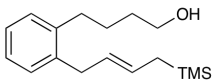
1. *tert*-Butyl(4-(2-(4-(*tert*-butyldimethylsilyloxy)but-2-ynyl)phenyl)butoxy)dimethyl silane was prepared from *tert*-Butyl(4-(2-(chloromethyl)phenyl)butoxy)dimethylsilane and *tert*-butyldimethyl(prop-2-ynyloxy)silane by utilizing the procedure from[8] using acetonitrile as a solvent (0.2 M) and heating at 90 ^{o}C for 35 hours. The crude product (73% yield) was directly used for the next step. ^{1}H NMR (500 MHz, CD_3Cl_3) δ 7.18 – 7.13 (m, 4H, 4Ar**H**), 4.34 (t, 2H, *J* = 2.1 Hz, ≡CC**H$_2$**OTBS), 3.64 (t, 2H, *J* = 6.2, 5.8 Hz, CH$_2$C**H$_2$**OTBS), 3.60 – 3.56 (b, 2H, ArC**H$_2$**C≡), 2.64 (dd, *J* = 8.0, 7.0 Hz, ArC**H$_2$**CH$_2$), 1.65 – 1.55 (m, 4H, TBSOCH$_2$C**H$_2$**C**H$_2$**), 0.90 (s, 9H, (C**H$_3$**)$_3$CSi), 0.89 (s, 9H, (C**H$_3$**)$_3$CSi), 0.10 (s, 6H, (C**H$_3$**)$_2$Si), 0.04 (s, 6H, (C**H$_3$**)$_2$Si); ^{13}C NMR (125 MHz, CD_3Cl_3) δ 140.2, 134.4, 129.0, 128.8, 126.9, 126.1, 82.8, 81.0, 63.0, 52.1, 32.5, 32.4, 26.7, 26.0, 25.9, 22.7, 18.36, 18.35, –5.1, –5.3.

2. 4-(2-(4-Hydroxybutyl)phenyl)but-2-yn-1-ol was prepared by hydrolyzing *tert*-butyl(4-(2-(4-(*tert*-butyldimethylsilyloxy)but-2-ynyl)phenyl)butoxy)dimethylsilane with 5% HCl/4MeOH-1THF solution for 0.5 h to afford quantitative yield. The crude mixture was concentrated, then diluted with ethyl acetate, washed with H_2O (2 times), saturate $NaHCO_3$, H_2O, brine, followed by drying over $MgSO_4$. The crude product was then

[8] Catharine, L. H.; Kevin, A. W.; Rachel, T. E.; Stephen, B. L. *Synlett* **2006**, 2941.

directly used for the next reduction step. ^{1}H NMR (400 MHz, CD_3Cl_3) δ 7.34 (d, 1H, *J* = 7.3 Hz, Ar**H**), 7.25 - 7.15 (m, 3H, 3Ar**H**), 4.27 (ddd, 2H, *J* = 2.1, 0.8 Hz, ≡CC**H$_2$**OH), 3.71 (t, 2H, *J* = 6.1 Hz, CH_2C**H$_2$**OH), 3.60 (t, 2H, *J* = 2.1 Hz, ArC**H$_2$**C≡), 2.69 (dd, *J* = 8.1, 7.3 Hz, ArC**H$_2$**CH_2), 1.80 – 1.68 (m, 2H, $HOCH_2C$**H$_2$**CH_2), 1.68 - 1.60 (m, 2H, $HOCH_2CH_2C$**H$_2$**).

3. (*E*)-4-(2-(4-hydroxybutyl)phenyl)but-2-en-1-ol was prepared by the reduction of 4-(2-(4-hydroxybutyl)phenyl)but-2-yn-1-ol following the procedure in reference[9] (the reaction was let to warm up to room temperature overnight in order to get full conversion). A crude product was obtained which, upon concentration and flash column chromatography on silica gel (85% AcOEt/petroleum ether), produced the desired product (95% yield). IR (neat) 3334, 3008, 2932, 2863, 1450, 1275, 1260, 1066, 972, 764, 750 cm^{-1}; ^{1}H NMR (500 MHz, CD_3Cl_3) δ 7.17 (d, 2H, *J* = 2.9 Hz, 2Ar**H**), 7.15 (d, 2H, *J* =3.9 Hz, 2Ar**H**), 5.84 (tt, 1H, *J* = 15.4, 6.3 Hz, =C**H**), 5.63 (tt, 1H, *J* = 15.3, 6.0 Hz, =C**H**), 4.13 (d, 2H, *J* = 5.4 Hz, =CHC**H$_2$**OH), 3.69 (t, 2H, *J* = 6.0, 5.6 Hz, CH_2C**H$_2$**OH), 3.42 (d, *J* = 6.1 Hz, ArC**H$_2$**CH=), 2.65 (dd, *J* = 7.7, 7.3 Hz, ArC**H$_2$**CH_2), 1.72 – 1.58 (m, 4H, $ArCH_2C$**H$_2$C H$_2$**); ^{13}C NMR (125 MHz, CD_3Cl_3) δ 140.6, 137.5, 131.7, 130.1, 129.8, 129.4, 126.5, 126.1, 63.6, 62.7, 35.8, 32.5, 32.4, 27.3; HRMS (ESI) exact mass calculated for $[M]^+$ ($C_{14}H_{20}O_2$) required *m/z* 220.14633, found 220.14570.



(*E*)-4-(2-(4-(trimethylsilyl)but-2-enyl)phenyl)butan-1-ol

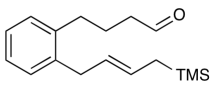
1. (*E*)-4-(2-(4-(2,2,2-trifluoroacetoxy)but-2-enyl)phenyl)butyl 2,2,2-trifluoroacetate was prepared from (*E*)-4-(2-(4-hydroxybutyl)phenyl)but-2-en-1-ol and trifluoroacetic

[9] Fleming, I.; Kühne, H.; Takaki, K. *J. Chem. Soc., Perkin Trans. 1* **1986**, 725.

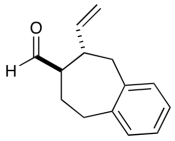
anhydride following the same general procedure for benzoylation using THF as a solvent to afford a quantitative conversion to the desired product. The crude product was directly used for the next step. ^{1}H NMR (500 MHz, CD_3Cl_3) δ 7.25 – 7.10 (m, 4H, *4*Ar**H**), 6.07 (tt, 1H, *J* = 15.3, 6.3 Hz, =C**H**), 5.56 (tt, 1H, *J* = 15.3, 6.5 Hz, =C**H**), 4.80 (d, 2H, *J* = 6.6 Hz, =CHC**H$_2$**OH), 4.38 (t, 2H, *J* = 6.5 Hz, CH_2C**H$_2$**OH), 3.43 (d, *J* = 6.1 Hz, ArC**H$_2$**CH=), 2.67 (dd, *J* = 7.8, 7.7 Hz, ArC**H$_2$**CH_2), 1.83 (m, 2H, $ArCH_2CH_2$C**H$_2$**), 1.69 (m, 2H, $ArCH_2$C**H$_2$**CH_2); ^{19}F NMR (376 MHz, CD_3Cl_3) δ –75.51(s), –75.53(s).

2. (*E*)-4-(2-(4-(trimethylsilyl)but-2-enyl)phenyl)butan-1-ol was prepared from (*E*)-4-(2-(4-(2,2,2-trifluoroacetoxy)but-2-enyl)phenyl)butyl 2,2,2-trifluoroacetate and hexamethydisilane following the described procedure.[10] The crude product was hydrolyzed following the general procedure for deprotection of ester using K_2CO_3 as the base. A crude product was obtained which, upon concentration and flash column chromatography on silica gel (50% Et_2O/petroleum ether), produced the desired product (61% yield after 2 steps). IR (neat) 3323, 3017, 2951, 2866, 1489, 1450, 1247, 1155, 1056, 965, 848, 750 cm^{-1}; ^{1}H NMR (500 MHz, CD_3Cl_3) δ 7.20 – 7.12 (m, 4H, 4Ar**H)**, 5.44 – 5.38 (m, 2H, C**H**=C**H**), 3.74 – 3.65 (b, 2H, CHC**H$_2$**OH), 3.34 (d, *J* = 3.8 Hz, ArC**H$_2$**CH=), 2.70 – 2.60 (b, 2H, ArC**H$_2$**CH_2), 1.72 – 1.62 (m, 4H, $ArCH_2$C**H$_2$**C**H$_2$**), 1.43 (d, *J* = 4.0 Hz, TMSC**H$_2$**CH=), –0.01 (s, 9H, CH_2Si(C**H$_3$**)$_3$); ^{13}C NMR (125 MHz, CD_3Cl_3) δ 142.1, 140.8, 131.3, 131.0, 129.6, 129.0, 127.93, 127.90, 64.8, 37.9, 34.7, 34.3, 28.9, 24.6, 0.0; HRMS (ESI) exact mass calculated for $[M]^+$ ($C_{17}H_{28}OSi$) required *m/z* 276.19094, found 276.19000.

[10] Fernández-Rivas, C.; Méndez, M. Nieto-Oberhuber, C.; M. Echavarren, A. *J. Org. Chem.* **2002**, *67*, 5197.



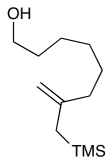
(*E*)-4-(2-(4-(trimethylsilyl)but-2-enyl)phenyl)butanal was prepared according to the general procedure of Dess-Martin oxidation from (*E*)-4-(2-(4-(trimethylsilyl)but-2-enyl)phenyl)butan-1-ol (70.4 mg, 0.25 mmol) and Dess-Martin periodinane (164.4 mg, 0.38 mmol) in CH_2Cl_2 (2.5 mL). A crude product was obtained which, upon concentration and flash column chromatography on silica gel (10% Et_2O/petroleum ether), produced the desired product as a clear oil (59.8 mg, 87% yield. IR (neat) 3017, 2952, 2894, 1724, 1489, 1450, 1246, 1154, 1054, 965, 837, 750 cm^{-1}; ^1H NMR (400 MHz, CD_3Cl_3) δ 9.79 (t, 1H, *J* = 1.6 Hz, CH_2CHO), 7.16 (dd, *J* = 3.5, 3.1 Hz, 4H, 4Ar**H)**, 5.40 (dd, *J* = 5.9, 1.8 Hz, 2H, C**H**=C**H**), 3.35 (d, *J* = 4.7 Hz, ArC$\mathbf{H_2}$CH=), 2.67 (dd, 2H, *J* = 8.1, 6.3 Hz, ArC$\mathbf{H_2}CH_2$), 2.51 (tt, 2H, *J* = 7.3, 1.6 Hz, $CH_2C\mathbf{H_2}$CHO), 1.98 – 1.89 (m, 2H, *J* = 7.5 Hz, C$\mathbf{H_2}CH_2$CHO), 1.44 (d, *J* = 6.5 Hz, TMSC$\mathbf{H_2}$CH=), –0.01 (s, 9H, $CH_2Si(C\mathbf{H_3})_3$); ^{13}C NMR (125 MHz, CD_3Cl_3) δ 204.2, 141.0, 140.9, 131.5, 131.7, 129.8, 128.8, 128.2, 128.0, 45.4, 37.8, 33.8, 25.0, 24.6, 0.0; HRMS (ESI) exact mass calculated for $[M]^+$ ($C_{17}H_{26}OSi$) required *m/z* 274.17529, found 274.17460.



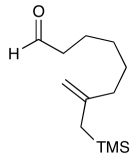
(6*S*,7*R*)-6-vinyl-6,7,8,9-tetrahydro-5*H*-benzo[7]annulene-7-carbaldehyde was prepared according to the general procedure of SOMO cyclization from (*E*)-4-(2-(4-(trimethylsilyl)but-2-enyl)phenyl)butanal (55.7 mg, 0.20 mmol), CAN (333.9 mg, 0.61 mmol), 2,6–di-*t*–butylpyridine (0.139 mL, 0.60 mmol), (2*S*,3*S*)-5-methyl-2-*tert*-butyl-3-benzylimidazolidin-4-one•TFA (14.0 mg, 0.04(0) mmol) and H_2O (7.3 μL, 0.40 mmol)

in 5% of acetonitrile/dimethoxyethane (1.6 mL). The mixture was stirred at –20 °C for 25 h. A crude product was obtained which, upon concentration and flash column chromatography on Davisil silica gel (5 – 15% Et_2O/petroleum ether), produced the desired product as a clear oil (220.3 mg, 73% yield, 14:1 dr, 95% ee). IR (film) 2933, 1724, 1637, 1493, 1453, 1247, 999, 920, 853, 755 cm^{-1}; ^1H NMR (400 MHz, CD_3Cl_3) δ 9.57 (d, 1H, *J* = 2.7 Hz, CHC**H**O), 7.38 – 7.20 (m, 4H, 4Ar**H)**, 5.76 (dddd, *J* = 8.6, 1.7 Hz, 1H, CHC**H**=CH_2), 5.09 (dd, *J* = 1.1, 17.4, 10.7, 2H, CH=C**H$_2$**), 2.94 (dd, 1H, *J* = 9.5, 9.3 Hz, ArC**H$_2$**CH), 2.90 – 2.86 (m, 2H, ArC**H$_2$**CH_2), 2.84 – 2.81 (dd, 1H, *J* = 12.2, 2.0 Hz, ArC**H$_2$**CH), 2.67 (q, 1H, *J* = 9.3 Hz, C**H**CH=), 2.57 – 2.49 (m, 1H, *J* = 5.6, 2.9 Hz, C**H**CHO), 2.06 – 1.98 (m, *J* = 3.7, 1.0 Hz, 1H, C**H$_2$**CHCHO), 1.78 – 1.67 (m, *J* = 9.3, 2.8 Hz, 1H, C**H$_2$**CHCHO); ^{13}C NMR (125 MHz, CD_3Cl_3) δ 204.3, 141.8, 140.8, 139.4, 129.8, 128.8, 126.8, 126.5, 115.3, 58.2, 42.3, 40.3, 33.2, 26.3; HRMS (ESI) exact mass calculated for $[M]^+$ ($C_{14}H_{16}O$) required *m/z* 200.12012, found 200.11939; $[\alpha]_D$ = –7.5º (c = 0.98, CH_2Cl_2).

The diastereomeric ratio was determined by ^1H NMR analysis (major diastereomer: 9.57 ppm; minor diastereomer: 9.66 ppm). The enantiomeric excess was determined by GLC using a Dex–CB column (60 ºC isotherm for 15 minutes, 1 mL/min, then ramps to 110 °C at a rate of 20 °C/min, holds for 90 min); major diastereomer, minor enantiomer t_r= 92.83 min and major diastereomer, major enantiomer t_r= 94.52 min, minor diastereomer, minor enantiomer t_r= 98.46 min and major diastereomer, minor enantiomer t_r= 101.18 min.



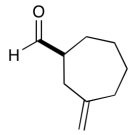
7-((Trimethylsilyl)methyl)oct-7-en-1-ol was prepared according to the general procedure[11] from oxocan-2-one (307.1 mg, 2.4 mmol), Cerium(III) chloride (2.97 g, 12.0 mmol), and 1M (trimethylsilyl)methylmagnisium chloride (12 mL, 12.0 mmol in THF (29 mL). A crude product was obtained which, upon concentration and flash column chromatography on silica gel (20 – 35% Et_2O/pentane), produced the desired product as a clear oil (226.2 mg, 44% yield). IR (film) 3327, 2930, 2857, 1632, 1417, 1247, 1055, 836 cm^{-1}; ^1H NMR (400 MHz, ($CDCl_3$) δ 4.58 (ddd, 1H, J = 1.6, 1.2, 0.8 Hz, =C**H**$_2$), 4.50 (s, 1H, =C**H**$_2$), 3.66 (ddd, 2H, J = 6.8, 5.6, 5.2, 1.2 Hz C**H**$_2$O), 1.96 (t, 2H, J = 7.2 Hz, C**H**$_2$C=), 1.53 (s, 2H, -C**H**$_2$-TMS), 1.45 – 1.35 (m, 6H, C**H**$_2$C**H**$_2$C**H**$_2$), 0.02 (s, 9H, Si(C**H**$_3$)$_3$); ^{13}C NMR (125 MHz, $CDCl_3$) δ 149.1, 110.9, 67.1, 39.4, 34.1, 30.5, 29.8, 28.1, 26.9, 0.07; HRMS (ESI) exact mass calculated for $[M]^+$ ($C_{12}H_{26}OSi$) required *m/z* 214.17529, found 214.17456.



7-((Trimethylsilyl)methyl)oct-7-enal was prepared according to the general procedure of Dess-Martin oxidation from 7-((trimethylsilyl)methyl)oct-7-en-1-ol (1.81 g, 8.5 mmol), Dess-Martin periodinane (4.86 g, 11.3 mmol) in CH_2Cl_2 (85 mL). A crude product was obtained which, upon concentration and flash column chromatography on silica gel (2 – 4% Et_2O/petroleum ether), produced the desired product as a clear oil (609.6 mg, 34% yield). IR (film) 3074, 2934, 2859, 1726, 1632, 1415, 1247, 1155, 836 cm^{-1}; ^1H NMR (400 MHz, ($CDCl_3$) δ 9.77 (t, 1H, J = 1.6 Hz, C**H**O), 4.57 (ddd, 1H, J = 1.6, 1.2, 0.8 Hz, =C**H**$_2$), 4.51 (d, 1H, J = 1.2 Hz, =C**H**$_2$), 2.44 (td, 2H, J = 7.6, 6.8, 2.0,

[11] Narayanan B.A. and Bunnelle W.H. *Tetrahedron Lett.* **1987**, *28*, 6241.

1.6 Hz, C**H**$_2$CHO), 1.96 (t, 2H, *J* = 7.2 Hz, C**H**$_2$C=CH$_2$), 1.67 – 1.60 (m, 2H, *J* = 7.6 Hz, C**H**$_2$), 1.52 (s, 2H, C**H**$_2$TMS), 1.46 - 1.40 (m, 2H, *J* = 7.6 Hz, C**H**$_2$), 1.35 – 1.28 (m, 2H, *J* = 7.6 Hz, C**H**$_2$), 0.02 (s, 9H, Si(C**H**$_3$)$_3$); ^{13}C NMR (125 MHz, $CDCl_3$) δ 204.1, 148.7, 108.2, 45.2, 39.2, 30.1, 28.8, 26.0, 23.1, 0.00; HRMS (ESI) exact mass calculated for $[M]^+$ ($C_{12}H_{26}OSi$) required *m/z* 212.15964, found 212.15865.



(*S*)-3-methylenecycloheptanecarbaldehyde was prepared according to the general procedure of SOMO cyclization from 7-((trimethylsilyl)methyl)oct-7-enal (48.1 mg, 0.23 mmol), CAN (285.7 mg, 0.52 mmol), $NaHCO_3$ (38.3 mg, 0.45 mmol), (2*S*,3*S*)-2-benzyl-5-*tert*-butyl-3-methylimidazolidin-4-one•TFA (12.1 mg, 0.04(5) mmol) and H_2O (8.2 μL, 0.45 mmol) in dimethoxyethane (3.6 mL). The mixture was stirred at –20 °C for 21 h. A crude product was obtained which, upon concentration and flash column chromatography on Davisil silica gel (2 – 4% Et_2O/petroleum ether), produced the desired product as a clear oil (21.1 mg, 73% yield, 60% ee). IR (film) 3006, 2988, 2926, 2856, 1724, 1639, 1445, 1275, 1260, 887, 764 cm^{-1}; ^{1}H NMR (500 MHz, ($CDCl_3$) δ 9.68 (d, 1H, *J* = 1.0 Hz, C**H**O), 4.80 (d, 2H, *J* = 1.5 Hz, =C**H**$_2$), 2.62 (dd, 1H, *J* = 9.9, 4.0 Hz, C**H**$_2$C=), 2.40 – 2.35 (m, 1H, C**H**CHO), 2.34 – 2.31 (b, 1H), 2.30 – 2.26 (dd, 1H, *J* = 9.8, 4.5 Hz, C**H**$_2$C=), 2.22 – 2.17 (m, 1H), 1.81 - 1.68 (m, 2H), 1.51 – 1.36 (m, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 203.8, 148.2, 112.7, 51.8, 36.1, 34.8, 28.4, 28.2, 27.1; HRMS (ESI) exact mass calculated for $[M]^+$ ($C_9H_{14}O$) required *m/z* 138.10447, found 138.10361; $[\alpha]_D$ = 3.0º (c = 0.95, CH_2Cl_2).

The enantiomeric excess was determined by first reducing the product with $NaBH_4$

in MeOH, then esterification the obtained alcohol with 4-nitrobenzoyl chloride. The enantiomeric excess of the ester was found by HPLC Chiracel OJ column (1% IPA/hexane, 45 min), major enantiomer t_r= 30.39 min and minor enantiomer t_r = 28.15 min.