Highly Diastereoselective Aldol Additions of a Chiral Ethyl Ketone Enolate Under Lewis Base Catalysis

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SUPPORTING INFORMATION

General Experimental

All reactions were performed in oven and/or flame dried glassware under an atmosphere of dry nitrogen. Dichloromethane (CH_2Cl_2) was distilled from P_2O_5, silicon tetrachloride was distilled immediately before use. Analytical thin-layer chromatography was performed on Merck silica gel plates with QF-254 indicator. Analytical supercritical fluid chromatography (SFC) was performed on a Berger Instruments[1] packed-column SFC with a built-in photometric detector (λ = 220 nm) using a Daicel Chiralpak AD and AS column, as indicated. Kugelrohr (bulb-to-bulb) distillations were performed on a Büchi GKR-50 Kugelrohr; boiling points (bp) correspond to uncorrected air-bath temperatures (ABT). All temperatures correspond to internal reaction temperatures measured by Teflon-coated thermocouples unless otherwise noted.

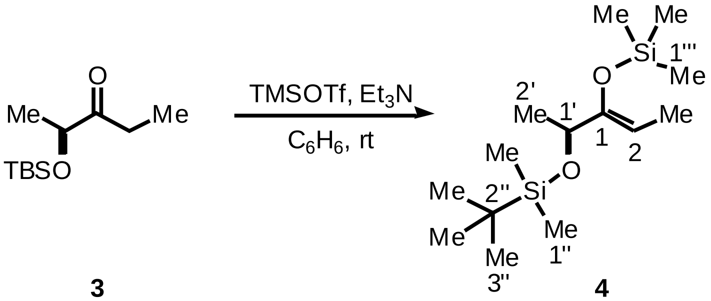
^{1}H NMR spectra and ^{13}C NMR spectra were recorded on a Varian Unity Inova 500 (500 MHz) spectrometer and a Varian Unity 500 (125 MHz) spectrometer, respectively. Spectra are referenced to residual chloroform (δ 7.26, ^{1}H; δ 77.0, ^{13}C). Chemical shifts are reported in ppm (δ); multiplicities are indicated by s (singlet), d (doublet), t (triplet), q (quartet), quint (quintet), sext (sextet), m (multiplet) and br (broad). Coupling constants, *J*, are reported in Hertz. Mass spectrometry was performed by the University of Illinois Mass Spectrometry Center. Data are reported in the form of *m*/*z* (intensity relative to base peak = 100). Infrared spectra (IR) were recorded on a Mattson Galaxy 5020 spectrophotometer. Peaks are reported in cm^{-1} with the indicated relative intensities: br (broad); s (strong, 67-100%); m (medium, 34-66%); w (weak, 0-33%). Optical rotations were obtained on a Jasco DIP-360 digital polarimeter and are reported as follows: $[\alpha]_D^T$ temperature (T), concentration (c = g/100 mL) and solvent. Elemental analyses were performed by the University of Illinois Microanalytical Service Laboratory.

Literature Preparations

(*S*)-2-Hydroxy-*N*-methoxy-*N*-methylpropionamide (**6**)[2] was prepared according to a modified procedure of Luke and Morris.[3] (*S*)-2-Hydroxy-3-pentanone (**7**)[4] was prepared according the method of Paterson.[2] 3-Phenyl propynal was prepared from DMF according to the method of Journet and Cai.[5] Achiral phosphoramides **1** and chiral phosphoramides **2** were prepared according to the literature and used as analytically pure samples.[6]

Experimental Procedures

(–)-(*S*)-(*Z*)-Trimethyl[(1-((1-((dimethyl)-(1,1-dimethylethyl)silyl)oxy)ethyl)propenyl)oxy] silane (4)



3 **4**

Trimethylsilyl trifluoromethanesulfonate (TMSOTf) (240 μL, 1.32 mmol, 1.2.0 equiv) was dissolved in benzene (2 mL) at room temperature. Triethylamine (210 μL, 1.65 mmol, 1.5 equiv) was carefully added via syringe and the entire solution was cooled in an ice bath. Silyloxy ketone **3** (232 mg, 1.1 mmol) was then added dropwise via syringe. The reaction was allowed to warm to room temperature and monitored by TLC. After 3 h, the biphasic mixture was quickly poured in to cold water (10 mL, 0 °C) with rapid stirring. The layers were separated and the aqueous phase was extracted with pentane (3 × 5 mL). The combined organic extracts were then washed with brine (5 mL), dried over Na_2SO_4, filtered and concentrated to give a crude oil. The residue was distilled under reduced pressure to afford 288 mg (96%) of **4** as a clear, colorless oil, suitable for use in subsequent reactions. To obtain an analytically pure sample, **4** was sacrificially purified by chromatography (SiO_2, pentane/CH_2Cl_2, 6/1). The residue was again distilled under reduced pressure to afford 159 mg (53%) of analytically pure **4**.

Analytical data for **4**:

bp: 110 °C (0.1 mmHg, ABT)

^{1}H NMR: ($CDCl_3$, 500 MHz)

4.84 (qd, *J* = 6.6, 0.6, 1 H, HC(2)); 4.08 (q, *J* = 6.2, 1 H, HC(1')); 1.54 (dd, *J* = 6.6, 0.9, 3 H, H_3C(3)); 1.25 (d, *J* = 6.2, 3 H, H_3C(2')); 0.92 (s, 9 H, H_3C(3")); 0.23 (s, 9 H, H_3C(1"')); 0.08, (d, *J* = 4.1, 6 H, H_3C(1"))

^{13}C NMR: ($CDCl_3$, 125 MHz)

153.51 (C(1)); 101.54 (C(2)); 70.54 (C(1')); 25.92 (C(3")); 22.15 (C(2')); 18.29 (C(2")); 10.52 (C(3)); 0.67 (C(1"')); –4.70 (C(1")); –4.98 (C(1"))

MS: (FI)

289 (M^++1, 27), 288 (M^+, 100), 231 (4), 120 (2)

IR: (neat)

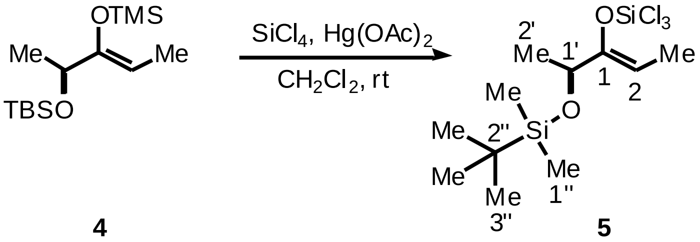
2958 (s), 2931 (s), 2858 (m), 1257 (s), 1119 (m), 1078 (m), 1049 (m), 837 (s), 777 (m)

Optical Rotation: $[\alpha]_D^{23}$ –4.1° (*c* = 2.00, $CHCl_3$)

Analysis: $C_{14}H_{32}O_2Si_2$ (288.58)

Calculated:	C, 58.27;	H, 11.18%
Found:	C, 58.11;	H, 11.31%

(*S*)-(*Z*)-Trichloro[(1-((1-((dimethyl)-(1,1-dimethylethyl)silyl)oxy)ethyl)propenyl)oxy]silane (5)



Mercuric acetate (32 mg, 0.1 mmol, 0.01 equiv) was suspended in CH_2Cl_2 (10 mL) at room temperature. Silicon tetrachloride (2.3 mL, 20 mmol, 2.0 equiv) was then carefully added via syringe and the cloudy mixture was allowed to stir for several minutes. TMS enol ether **4** (2.7 g, 10 mmol) was then added dropwise via syringe. The reaction was allowed to stir at room temperature and could be monitored by careful removal of 10 μL aliquots for ^{1}H NMR analysis. After 18 h, the mercury salts were allowed to settle and the supernatant was carefully transferred to a dry 35 mL round bottom flask via cannula. The volatile components were removed at 100 mmHg and the residual oil was purified by distillation to afford 2.3 g (65%) of **5** as a 15/1 mixture of *Z*/*E* isomers by ^{1}H NMR.

<u>Analytical data for **5**</u>:

<u>bp</u>: 150 °C (0.1 mmHg, ABT)

^{1}<u>H NMR</u>: ($CDCl_3$, 500 MHz)

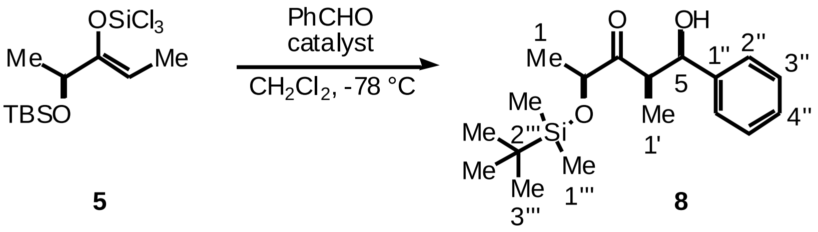
5.04 (q, *J* = 7.0 1 H, HC(2), *Z*); 4.95 (q, *J* = 7.0, 1 H, HC(2), *E*); 4.21 (q, *J* = 6.8, 1 H, HC(1'), *Z*); 4.18 (q, *J* = 6.8, 1 H, HC(1'), *E*); 1.60 (d, *J* = 7.0, 3 H, $H_3C(3)$); 1.31 (d, *J* = 6.8, 3 H, $H_3C(2')$); 0.93 (s, 9 H, $H_3C(3'')$); 0.07, (d, *J* = 4.1, 6 H, $H_3C(1'')$)

^{13}<u>C NMR</u>: ($CDCl_3$, 125 MHz)

150.92 (C(1)); 108.30 (C(2)); 69.50 (C(1')); 25.75 (C(3'')); 22.15 (C(2')); 18.56 (C(2'')); 10.45 (C(3)); 0.65 (C(1''')); –4.71 (C(1'')); –5.01 (C(1''))

Catalyzed Aldol Additions: General Procedure I

(+)-(2*S*,4*R*,5*S*)-5-Hydroxy-4-methyl-5-phenyl-2-[((dimethyl)-(1,1-dimethylethyl)silyl)oxy]-3-pentanone (8a)[7] [Table 1, entry 1]



To a solution of 55 mg (0.15 mmol, 0.15 equiv) of (*R*,*R*)-**2a** in CH_2Cl_2 (2.0 mL) was added quickly trichlorosilyl enolate **5** (350 mg, 1.0 mmol) and the solution was cooled to –78 °C. Benzaldehyde (102 μL, 1.0 mmol) was then added dropwise via syringe and the reaction mixture was allowed to stir at –78 °C for 2 h. The reaction mixture was then poured into a rapidly stirring sat. aq. $NaHCO_3$ solution at 0 °C (30 mL) and was allowed to stir at room temperature for up to 6 h. The heterogeneous mixture was then filtered through Celite, the organic phase was separated and the aqueous phase was extracted with CH_2Cl_2 (3 × 15 mL). The organic extracts were combined, dried over Na_2SO_4, filtered and concentrated to give a crude oil. Purification of the residue by silica gel chromatography (SiO_2, pentane/Et_2O, 6/1) afforded 284 mg (88%) of **8a** as a clear, colorless oil. The diastereomeric ratio was determined to have a relative dr of 16/1 and an internal dr of >50/1 by SFC analysis.

Analytical data for **8a**:

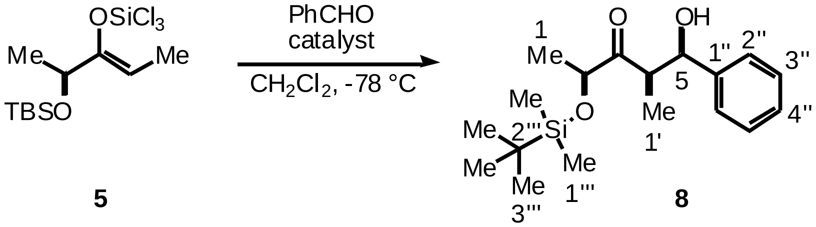
^{1}H NMR: ($CDCl_3$, 500 MHz)

7.38-7.20 (m, 5 H, 2 × H(C2''), 2 × HC(3''), HC(4'')); 5.06 (dd, *J* = 5.0, 2.8, 1 H, HC(5), *syn*,*syn*); 5.01 (dd, *J* = 5.0, 2.8, 1 H, HC(5), *anti*,*syn*); 4.77 (dd, *J* = 8.5, 4.2, 1 H, HC(5), *anti*-relative); 4.73 (dd, *J* = 8.5, 4.2, 1 H, HC(5), *anti*-relative); 4.19 (q, *J* = 6.9, 1 H, HC(2)); 3.37 (dq, *J* = 7.2, 5.0, 1 H, HC(4)); 3.25, (d, *J* = 2.8, 1 H, OH); 1.27 (d, *J* = 6.9, 3 H, $H_3C(1)$); 1.05 (d, *J* = 7.2, 3 H, $H_3C(1')$); 0.90 (s, 9 H, $H_3C(3''')$); 0.08 (s, 3 H, $H_3C(1''')$); 0.06 (s, 3 H, $H_3C(1''')$)

TLC: R_f 0.15 (pentane/Et_2O, 6/1, anisaldehyde)

SFC: t_R (2*S*,4*R*,5*S*)-**8a**, 5.1 min (Daicel Chiralpak AD, 5% MeOH in CO_2, 150 bar, 40 °C, 3.0 mL min^{-1})

(+)-(2*S*,4*R*,5*S*)-5-Hydroxy-4-methyl-5-phenyl-2-[((dimethyl)-(1,1-dimethylethyl)silyl)oxy]-3-pentanone (8a)[7] [Table 1, entry 2]



Following General Procedure I: from trichlorosilyl enolate **5** (350 mg, 1.0 mmol), (S,*S*)-**2a** (55 mg, 0.15 mmol, 0.15 equiv) in CH_2Cl_2 (2.0 mL) and benzaldehyde (102 μL, 1.0 mmol) was obtained after chromatography, 258 mg (80%) of **8a** as a clear, colorless oil. The diastereomeric ratio was determined to have a relative dr of 15/1 and an internal dr of 30/1 by SFC analysis.

Analytical data for **8a**:

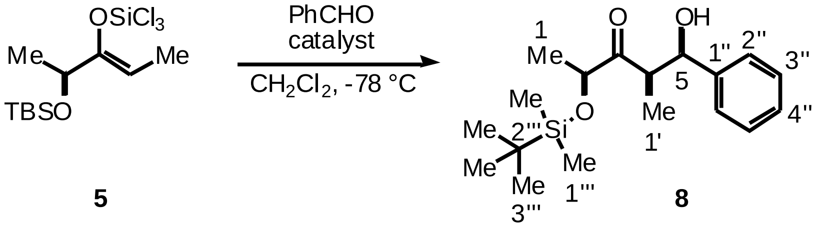
^{1}H NMR: ($CDCl_3$, 500 MHz)

7.38-7.20 (m, 5 H, 2 × H(C2''), 2 × HC(3''), HC(4'')); 5.06 (dd, *J* = 5.0, 2.8, 1 H, HC(5), *syn,syn*); 5.01 (dd, *J* = 5.0, 2.8, 1 H, HC(5), *anti,syn*); 4.77 (dd, *J* = 8.5, 4.2, 1 H, HC(5), *anti*-relative); 4.73 (dd, *J* = 8.5, 4.2, 1 H, HC(5), *anti*-relative); 4.19 (q, *J* = 6.9, 1 H, HC(2)); 3.37 (dq, *J* = 7.2, 5.0, 1 H, HC(4)); 3.25, (d, *J* = 2.8, 1 H, OH); 1.27 (d, *J* = 6.9, 3 H, $H_3C(1)$); 1.05 (d, *J* = 7.2, 3 H, $H_3C(1')$); 0.90 (s, 9 H, $H_3C(3''')$); 0.08 (s, 3 H, $H_3C(1''')$); 0.06 (s, 3 H, $H_3C(1''')$)

TLC: R_f 0.15 (pentane/Et_2O, 6/1, anisaldehyde)

SFC: t_R (2*S*,4*R*,5*S*)-**8a**, 5.1 min (Daicel Chiralpak AD, 5% MeOH in CO_2, 150 bar, 40 °C, 3.0 mL min^{-1})

(+)-(2*S*,4*R*,5*S*)-5-Hydroxy-4-methyl-5-phenyl-2-[((dimethyl)-(1,1-dimethylethyl)silyl)oxy]-3-pentanone (8a)[7] [Table 1, entry 3]



Following General Procedure I: from trichlorosilyl enolate **5** (350 mg, 1.0 mmol), (*R*,*R*)-**2b** (74 mg, 0.15 mmol, 0.15 equiv) in CH_2Cl_2 (2.0 mL) and benzaldehyde (102 μL, 1.0 mmol) was obtained after chromatography, 210 mg (65%) of **8a** as a clear, colorless oil. The diastereomeric ratio was determined to have a relative dr of 15/1 and an internal dr of 3/1 by SFC analysis.

Analytical data for **8a**:

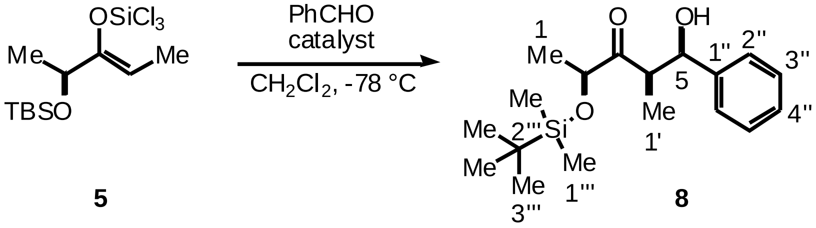
^{1}H NMR: ($CDCl_3$, 500 MHz)

7.38-7.20 (m, 5 H, 2 × H(C2''), 2 × HC(3''), HC(4'')); 5.06 (dd, *J* = 5.0, 2.8, 1 H, HC(5), *syn*,*syn*); 5.01 (dd, *J* = 5.0, 2.8, 1 H, HC(5), *anti*,*syn*); 4.77 (dd, *J* = 8.5, 4.2, 1 H, HC(5), *anti*-relative); 4.73 (dd, *J* = 8.5, 4.2, 1 H, HC(5), *anti*-relative); 4.19 (q, *J* = 6.9, 1 H, HC(2)); 3.37 (dq, *J* = 7.2, 5.0, 1 H, HC(4)); 3.25, (d, *J* = 2.8, 1 H, OH); 1.27 (d, *J* = 6.9, 3 H, $H_3C(1)$); 1.05 (d, *J* = 7.2, 3 H, $H_3C(1')$); 0.90 (s, 9 H, $H_3C(3''')$); 0.08 (s, 3 H, $H_3C(1''')$); 0.06 (s, 3 H, $H_3C(1''')$)

TLC: R_f 0.15 (pentane/Et_2O, 6/1, anisaldehyde)

SFC: t_R (2*S*,4*R*,5*S*)-**8a**, 5.1 min (Daicel Chiralpak AD, 5% MeOH in CO_2, 150 bar, 40 °C, 3.0 mL min^{-1})

(+)-(2*S*,4*R*,5*S*)-5-Hydroxy-4-methyl-5-phenyl-2-[((dimethyl)-(1,1-dimethylethyl)silyl)oxy]-3-pentanone (8a)[7] [Table 1, entry 4]



Following General Procedure I: from trichlorosilyl enolate **5** (350 mg, 1.0 mmol), **1a** (27 mg, 0.15 mmol, 0.15 equiv) in CH_2Cl_2 (2.0 mL) and benzaldehyde (102 µL, 1.0 mmol) was obtained after chromatography, 245 mg (76%) of **8a** as a clear, colorless oil. The diastereomeric ratio was determined to have a relative dr of 15/1 and an internal dr of 34/1 by SFC analysis.

Analytical data for **8a**:

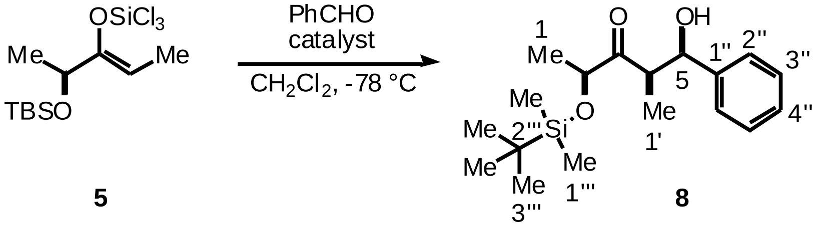
^{1}H NMR: ($CDCl_3$, 500 MHz)

7.38-7.20 (m, 5 H, 2 × H(C2''), 2 × HC(3''), HC(4'')); 5.06 (dd, *J* = 5.0, 2.8, 1 H, HC(5), *syn*,*syn*); 5.01 (dd, *J* = 5.0, 2.8, 1 H, HC(5), *anti*,*syn*); 4.77 (dd, *J* = 8.5, 4.2, 1 H, HC(5), *anti*-relative); 4.73 (dd, *J* = 8.5, 4.2, 1 H, HC(5), *anti*-relative); 4.19 (q, *J* = 6.9, 1 H, HC(2)); 3.37 (dq, *J* = 7.2, 5.0, 1 H, HC(4)); 3.25, (d, *J* = 2.8, 1 H, OH); 1.27 (d, *J* = 6.9, 3 H, $H_3C(1)$); 1.05 (d, *J* = 7.2, 3 H, $H_3C(1')$); 0.90 (s, 9 H, $H_3C(3''')$); 0.08 (s, 3 H, $H_3C(1''')$); 0.06 (s, 3 H, $H_3C(1''')$)

TLC: R_f 0.15 (pentane/Et_2O, 6/1, anisaldehyde)

SFC: t_R (2*S*,4*R*,5*S*)-**8a**, 5.1 min (Daicel Chiralpak AD, 5% MeOH in CO_2, 150 bar, 40 °C, 3.0 mL min^{-1})

(+)-(2*S*,4*R*,5*S*)-5-Hydroxy-4-methyl-5-phenyl-2-[((dimethyl)-(1,1-dimethylethyl)silyl)oxy]-3-pentanone (8a)[7] [Table 1, entry 5]



5 **8**

Following General Procedure I: from trichlorosilyl enolate **5** (350 mg, 1.0 mmol), **1b** (33 mg, 0.15 mmol, 0.15 equiv) in CH_2Cl_2 (2.0 mL) and benzaldehyde (102 μL, 1.0 mmol) was obtained after chromatography, 245 mg (76%) of **8a** as a clear, colorless oil. The diastereomeric ratio was determined to have a relative dr of 15/1 and an internal dr of 37/1 by SFC analysis.

Analytical data for **8a**:

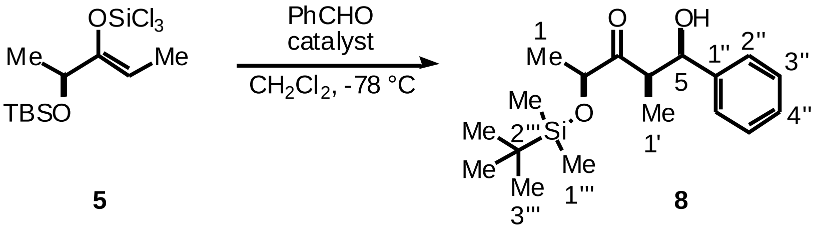
^{1}H NMR: ($CDCl_3$, 500 MHz)

7.38-7.20 (m, 5 H, 2 × H(C2''), 2 × HC(3''), HC(4'')); 5.06 (dd, *J* = 5.0, 2.8, 1 H, HC(5), *syn,syn*); 5.01 (dd, *J* = 5.0, 2.8, 1 H, HC(5), *anti,syn*); 4.77 (dd, *J* = 8.5, 4.2, 1 H, HC(5), *anti*-relative); 4.73 (dd, *J* = 8.5, 4.2, 1 H, HC(5), *anti*-relative); 4.19 (q, *J* = 6.9, 1 H, HC(2)); 3.37 (dq, *J* = 7.2, 5.0, 1 H, HC(4)); 3.25, (d, *J* = 2.8, 1 H, OH); 1.27 (d, *J* = 6.9, 3 H, $H_3C(1)$); 1.05 (d, *J* = 7.2, 3 H, $H_3C(1')$); 0.90 (s, 9 H, $H_3C(3''')$); 0.08 (s, 3 H, $H_3C(1''')$); 0.06 (s, 3 H, $H_3C(1''')$)

TLC: R_f 0.15 (pentane/Et_2O, 6/1, anisaldehyde)

SFC: t_R (2*S*,4*R*,5*S*)-**8a**, 5.1 min (Daicel Chiralpak AD, 5% MeOH in CO_2, 150 bar, 40 °C, 3.0 mL min^{-1})

(+)-(2*S*,4*R*,5*S*)-5-Hydroxy-4-methyl-5-phenyl-2-[((dimethyl)-(1,1-dimethylethyl)silyl)oxy]-3-pentanone (8a)[7] [Table 1, entry 6]



Following General Procedure I: from trichlorosilyl enolate **5** (350 mg, 1.0 mmol), **1c** (51 mg, 0.15 mmol, 0.15 equiv) in CH_2Cl_2 (2.0 mL) and benzaldehyde (102 μL, 1.0 mmol) was obtained after chromatography, 216 mg (67%) of **8a** as a clear, colorless oil. The diastereomeric ratio was determined to have a relative dr of 15/1 and an internal dr of 3/1 by SFC analysis.

Analytical data for **8a**:

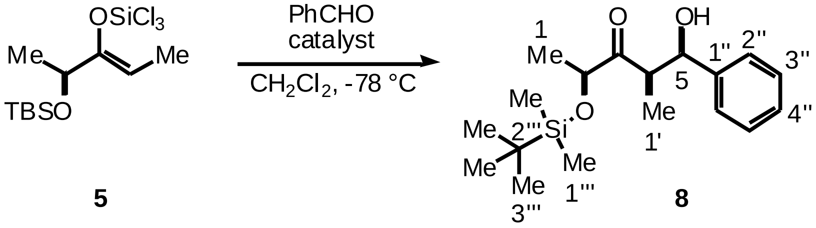
^{1}H NMR: ($CDCl_3$, 500 MHz)

7.38-7.20 (m, 5 H, 2 × H(C2''), 2 × HC(3''), HC(4'')); 5.06 (dd, *J* = 5.0, 2.8, 1 H, HC(5), *syn*,*syn*); 5.01 (dd, *J* = 5.0, 2.8, 1 H, HC(5), *anti*,*syn*); 4.77 (dd, *J* = 8.5, 4.2, 1 H, HC(5), *anti*-relative); 4.73 (dd, *J* = 8.5, 4.2, 1 H, HC(5), *anti*-relative); 4.19 (q, *J* = 6.9, 1 H, HC(2)); 3.37 (dq, *J* = 7.2, 5.0, 1 H, HC(4)); 3.25, (d, *J* = 2.8, 1 H, OH); 1.27 (d, *J* = 6.9, 3 H, $H_3C(1)$); 1.05 (d, *J* = 7.2, 3 H, $H_3C(1')$); 0.90 (s, 9 H, $H_3C(3''')$); 0.08 (s, 3 H, $H_3C(1''')$); 0.06 (s, 3 H, $H_3C(1''')$)

TLC: R_f 0.15 (pentane/Et_2O, 6/1, anisaldehyde)

SFC: t_R (2*S*,4*R*,5*S*)-**8a**, 5.1 min (Daicel Chiralpak AD, 5% MeOH in CO_2, 150 bar, 40 °C, 3.0 mL min^{-1})

(+)-(2*S*,4*R*,5*S*)-5-Hydroxy-4-methyl-5-phenyl-2-[((dimethyl)-(1,1-dimethylethyl)silyl)oxy]-3-pentanone (8a)[7] [Table 1, entry 7]



Following General Procedure I: from trichlorosilyl enolate **5** (350 mg, 1.0 mmol), HMPA (26 μL, 0.15 mmol, 0.15 equiv) in CH_2Cl_2 (2.0 mL) and benzaldehyde (102 μL, 1.0 mmol) was obtained after chromatography, 255 mg (79%) of **8a** as a clear, colorless oil. The diastereomeric ratio was determined to have a relative dr of 15/1 and an internal dr of 30/1 by SFC analysis.

Analytical data for **8a**:

^{1}H NMR: ($CDCl_3$, 500 MHz)

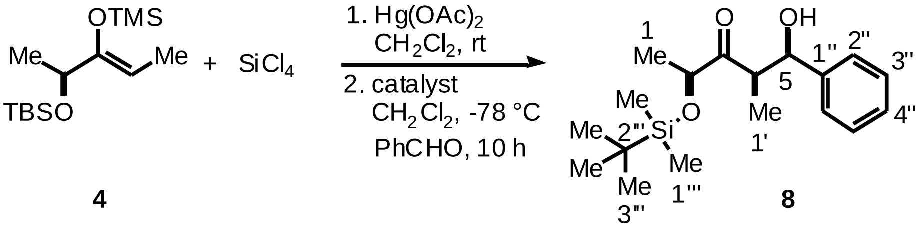
7.38-7.20 (m, 5 H, 2 × H(C2''), 2 × HC(3''), HC(4'')); 5.06 (dd, *J* = 5.0, 2.8, 1 H, HC(5), *syn,syn*); 5.01 (dd, *J* = 5.0, 2.8, 1 H, HC(5), *anti,syn*); 4.77 (dd, *J* = 8.5, 4.2, 1 H, HC(5), *anti*-relative); 4.73 (dd, *J* = 8.5, 4.2, 1 H, HC(5), *anti*-relative); 4.19 (q, *J* = 6.9, 1 H, HC(2)); 3.37 (dq, *J* = 7.2, 5.0, 1 H, HC(4)); 3.25, (d, *J* = 2.8, 1 H, OH); 1.27 (d, *J* = 6.9, 3 H, $H_3C(1)$); 1.05 (d, *J* = 7.2, 3 H, $H_3C(1')$); 0.90 (s, 9 H, $H_3C(3''')$); 0.08 (s, 3 H, $H_3C(1''')$); 0.06 (s, 3 H, $H_3C(1''')$)

TLC: R_f 0.15 (pentane/Et_2O, 6/1, anisaldehyde)

SFC: t_R (2*S*,4*R*,5*S*)-**8a**, 5.1 min (Daicel Chiralpak AD, 5% MeOH in CO_2, 150 bar, 40 °C, 3.0 mL min^{-1})

Catalyzed Aldol Additions: General Procedure II

(+)-(2*S*,4*R*,5*S*)-5-Hydroxy-4-methyl-5-phenyl-2-[((dimethyl)-(1,1-dimethylethyl)silyl)oxy]-3-pentanone (8a)[7] [Table 3, entry 1]



4 **8**

Silyl enol ether **4** (273 mg, 1.0 mmol) was added quickly to a stirred suspension of silicon tetrachloride (230 μL, 2.0 mmol, 2.0 equiv) and mercuric acetate (3.2 mg, 0.01 mmol, 0.01 equiv) in CH_2Cl_2 (1.0 mL) at room temperature. After addition, the mixture was stirred at room temperature for 18 h, then the volatile components were removed under reduced pressure (0.1 mmHg) to give a cloudy oil. A solution of (*R*,*R*)-**2a** (18 mg, 0.05 mmol, 0.05 equiv) in CH_2Cl_2 (2.0 mL) was then added via cannula and the mixture was cooled to –78 °C. Benzaldehyde (102 μL, 1.0 mmol) was then added dropwise via syringe and the reaction mixture was allowed to stir at –78 °C for 10 h. The reaction mixture was then poured into a rapidly stirring sat. aq. $NaHCO_3$ solution (30 mL) submerged in an ice bath and was allowed to stir at room temperature for 6 h. The heterogeneous mixture was then filtered through Celite, the organic phase was separated and the aqueous phase was extracted with CH_2Cl_2 (3 × 15 mL). The organic extracts were combined, dried over Na_2SO_4, filtered and concentrated to give a crude oil. Purification by silica gel chromatography (SiO_2, pentane/Et_2O, 6/1) afforded 284 mg (88%) of **8a** as a clear, colorless oil. The diastereomeric ratio was determined to be (*syn*,*syn*)-**8a**/minor isomers, 95/5 by SFC analysis.

Analytical data for **8a**:

^{1}H NMR: ($CDCl_3$, 500 MHz)

7.38-7.20 (m, 5 H, 2 × H(C2"), 2 × HC(3"), HC(4")); 5.06 (dd, J = 5.0, 2.8, 1 H, HC(5), *syn,syn*); 5.01 (dd, J = 5.0, 2.8, 1 H, HC(5), *anti,syn*); 4.77 (dd, J = 8.5, 4.2, 1 H, HC(5), *anti*-relative); 4.73 (dd, J = 8.5, 4.2, 1 H, HC(5), *anti*-relative); 4.19 (q, J = 6.9, 1 H, HC(2)); 3.37 (dq, J = 7.2, 5.0, 1 H, HC(4)); 3.25, (d, J = 2.8, 1 H, OH); 1.27 (d, J = 6.9, 3 H, $H_3C(1)$); 1.05 (d, J = 7.2, 3 H, $H_3C(1')$); 0.90 (s, 9 H, $H_3C(3''')$); 0.08 (s, 3 H, $H_3C(1''')$); 0.06 (s, 3 H, $H_3C(1''')$)

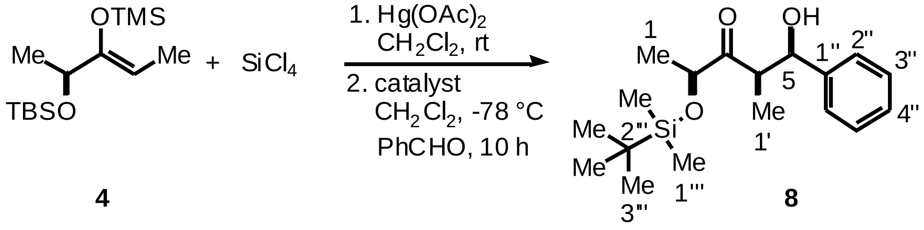
^{13}C NMR: ($CDCl_3$, 125 MHz)

218.73 (C(3)); 141.72 (C(1")); 128.21 (C(3")); 127.21 (C(4")); 125.95 (C(2")); 74.61 (C(2)); 72.80 (C(5)); 46.91 (C(4)); 25.70 (C(3"')); 21.05 (C(1)); 18.03 (C(8)); 10.40 (C(1')); –4.74 (C(1"')); –5.01 (C(1"'))

TLC: Rf 0.15 (pentane/Et2O, 6/1, anisaldehyde)

SFC: t_R (2*S*,4*R*,5*S*)-**8a**, 5.1 min (Daicel Chiralpak AD, 5% MeOH in CO_2, 150 bar, 40 °C, 3.0 mL min^{-1})

(+)-(2*S*,4*R*,5*S*)-5-Hydroxy-4-methyl-5-phenyl-2-[((dimethyl)-(1,1-dimethylethyl)silyl)oxy]-3-pentanone (8a)[7] [Table 3, entry 2]



4 **8**

Following General Procedure II: from silyl enol ether **4** (273 mg, 1.0 mmol), silicon tetrachloride (230 μL, 2.0 mmol, 2.0 equiv) and mercuric acetate (3.2 mg, 0.01 mmol, 0.01 equiv) in CH_2Cl_2 (1.0 mL) followed by HMPA (26 μL, 0.15 mmol, 0.15 equiv) in CH_2Cl_2 (2.0 mL) and benzaldehyde (102 μL, 1.0 mmol) was obtained after chromatography, 281 mg (87%)

of **8a** as a clear, colorless oil. The diastereomeric ratio was determined to be (*syn*,*syn*)-**8a**/minor isomers, 94/2/2/2 by SFC analysis.

Analytical data for **8b**:

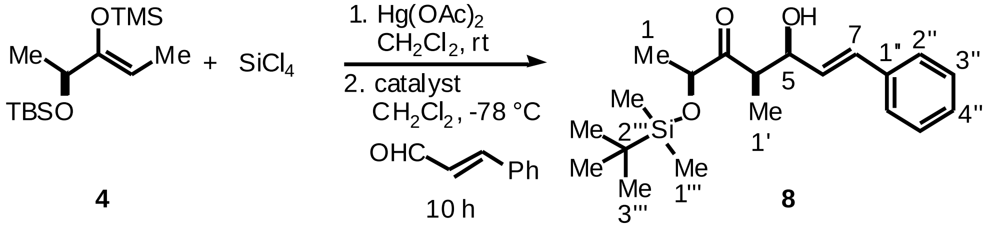
^{1}H NMR: (CDCl$_3$, 500 MHz)

7.38-7.20 (m, 5 H, 2 × H(C2"), 2 × HC(3"), HC(4")); 5.06 (dd, *J* = 5.0, 2.8, 1 H, HC(5), *syn*,*syn*); 5.01 (dd, *J* = 5.0, 2.8, 1 H, HC(5), *anti*,*syn*); 4.77 (dd, *J* = 8.5, 4.2, 1 H, HC(5), *anti*-relative); 4.73 (dd, *J* = 8.5, 4.2, 1 H, HC(5), *anti*-relative); 4.19 (q, *J* = 6.9, 1 H, HC(2)); 3.37 (dq, *J* = 7.2, 5.0, 1 H, HC(4)); 3.25, (d, *J* = 2.8, 1 H, OH); 1.27 (d, *J* = 6.9, 3 H, $H_3C(1)$); 1.05 (d, *J* = 7.2, 3 H, $H_3C(1')$); 0.90 (s, 9 H, $H_3C(3''')$); 0.08 (s, 3 H, $H_3C(1''')$); 0.06 (s, 3 H, $H_3C(1''')$)

TLC: R_f 0.15 (pentane/Et$_2$O, 6/1, anisaldehyde)

SFC: t_R (2*S*,4*R*,5*S*)-**8a**, 5.1 min (Daicel Chiralpak AD, 5% MeOH in CO$_2$, 150 bar, 40 °C, 3.0 mL min^{-1})

(–)-(2*S*,4*R*,5*S*)-(*E*)-5-Hydroxy-4-methyl-7-phenyl-2-[((dimethyl)-(1,1-dimethylethyl)silyl) oxy]-6-hepten-3-one (8b) [Table 3, entry 3]



Following General Procedure II: from silyl enol ether **4** (273 mg, 1.0 mmol), silicon tetrachloride (230 μL, 2.0 mmol, 2.0 equiv) and mercuric acetate (3.2 mg, 0.01 mmol, 0.01 equiv) in CH$_2$Cl$_2$ (1.0 mL) followed by (*R*,*R*)-**2a** (18 mg, 0.05 mmol, 0.05 equiv) in CH$_2$Cl$_2$ (2.0 mL) and (*E*)-cinnamaldehyde (130 μL, 1.0 mmol) was obtained after chromatography, 283 mg (81%) of **8b** as a clear, colorless oil. The diastereomeric ratio was determined to be (*syn*,*syn*)-**8b**/minor isomers, 93/5/2 by SFC analysis.

^{1}H NMR: ($CDCl_3$, 500 MHz)

7.40-7.22 (m, 5 H, 2 × H(C2"), 2 × HC(3"), HC(4")); 6.66 (dd, *J* = 15.9, 1.5, 1 H, HC(7)); 6.14 (dd, *J* = 16.1, 5.9, 1 H, HC(6)); 4.61 (m, 1 H, HC(5)); 4.25 (q, *J* = 6.9, 1 H, HC(2)); 3.31 (dq, *J* = 7.1, 3.4, 1 H, HC(4)); 3.02, (d, *J* = 2.8, 1 H, OH); 1.35 (d, *J* = 6.9, 3 H, H$_3$C(1)); 1.19 (d, *J* = 7.1, 3 H, H$_3$C(1')); 0.93 (s, 9 H, H$_3$C(3'")); 0.10 (d, *J* = 1.5, 6 H, H$_3$C(1'"))

^{13}C NMR: ($CDCl_3$, 125 MHz)

218.23 (C(3)); 136.72 (C(1")); 131.01 (C(3")); 129.01 (C(4")); 128.55 (C(6)); 127.61 (C(7)); 126.47 (C(4")); 74.61 (C(2)); 71.90 (C(5)); 45.11 (C(4)); 25.70 (C(3'")); 21.15 (C(1)); 18.03 (C(8)); 10.80 (C(1')); –4.64 (C(1'")); –5.01 (C(1'"))

MS: (FI)

348 (M^+, 100), 291 (12), 244 (5), 216 (6), 159 (13), 132 (19)

IR: (neat)

3467 (br), 2931 (s), 2858 (m), 1712 (m), 1462 (m), 1365 (m), 1255 (m), 1124 (m), 835 (s), 779 (s)

TLC: R_f 0.13 (pentane/Et_2O, 6/1, anisaldehyde)

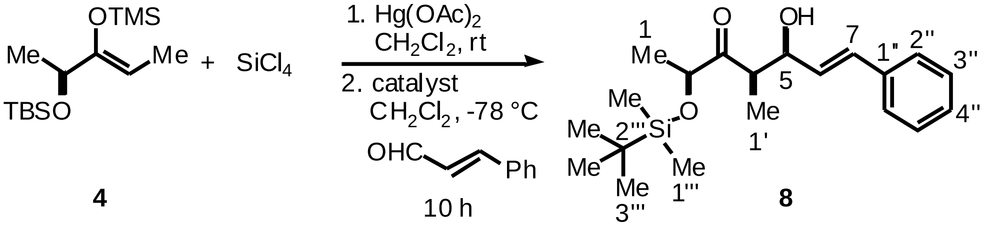
Optical Rotation: $[\alpha]_D^{23}$ –17.8° (*c* = 1.00, $CHCl_3$)

SFC: t_R (2*S*,4*R*,5*S*)-**8b**, 5.7 min (Daicel Chiralpak AD, 1% MeOH in CO_2, 150 bar, 40 °C, 3.0 mL min^{-1})

Analysis: $C_{20}H_{32}O_3Si$ (348.56)

Calculated:	C, 68.92;	H, 9.25%
Found:	C, 68.75;	H, 9.20%

(–)-(2*S*,4*R*,5*S*)-(*E*)-5-Hydroxy-4-methyl-7-phenyl-2-[((dimethyl)-(1,1-dimethylethyl)silyl) oxy]-6-hepten-3-one (8b) [Table 3, entry 4]



Following General Procedure II: from silyl enol ether **4** (273 mg, 1.0 mmol), silicon tetrachloride (230 µL, 2.0 mmol, 2.0 equiv) and mercuric acetate (3.2 mg, 0.01 mmol, 0.01 equiv) in CH_2Cl_2 (1.0 mL) followed by HMPA (26 µg, 0.15 mmol, 0.15 equiv) in CH_2Cl_2 (2.0 mL) and (*E*)-cinnamaldehyde (130 µL, 1.0 mmol) was obtained after chromatography, 279 mg (79%) of **8b** as a clear, colorless oil. The diastereomeric ratio was determined to be (*syn*,*syn*)-**8b**/minor isomers, 91/6/3 by SFC analysis.

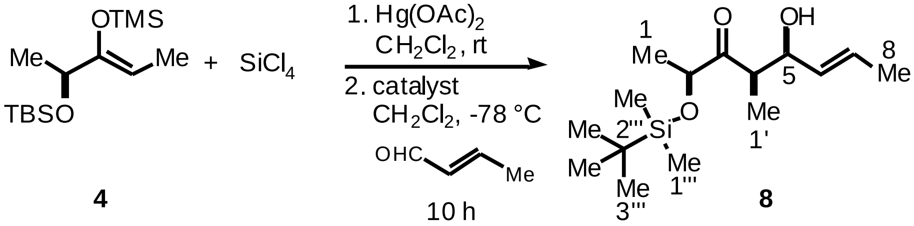
^{1}H NMR: ($CDCl_3$, 500 MHz)

7.40-7.22 (m, 5 H, 2 × H(C2"), 2 × HC(3"), HC(4")); 6.66 (dd, *J* = 15.9, 1.5, 1 H, HC(7)); 6.14 (dd, *J* = 16.1, 5.9, 1 H, HC(6)); 4.61 (m, 1 H, HC(5)); 4.25 (q, *J* = 6.9, 1 H, HC(2)); 3.31 (dq, *J* = 7.1, 3.4, 1 H, HC(4)); 3.02, (d, *J* = 2.8, 1 H, OH); 1.35 (d, *J* = 6.9, 3 H, $H_3C(1)$); 1.19 (d, *J* = 7.1, 3 H, $H_3C(1')$); 0.93 (s, 9 H, $H_3C(3''')$); 0.10 (d, *J* = 1.5, 6 H, $H_3C(1''')$)

TLC: R_f 0.13 (pentane/Et_2O, 6/1, anisaldehyde)

SFC: t_R (2*S*,4*R*,5*S*)-**8b**, 5.7 min (Daicel Chiralpak AD, 1% MeOH in CO_2, 150 bar, 40 °C, 3.0 mL min^{-1})

(–)-(2*S*,4*R*,5*S*)-(*E*)-5-Hydroxy-4-methyl-2-[((dimethyl)-(1,1-dimethylethyl)silyl)oxy]-6-octen-3-one (8c) [Table 3, entry 5]



Following General Procedure II: from silyl enol ether **4** (273 mg, 1.0 mmol), silicon tetrachloride (230 μL, 2.0 mmol, 2.0 equiv) and mercuric acetate (3.2 mg, 0.01 mmol, 0.01 equiv) in CH_2Cl_2 (1.0 mL) followed by (*R*,*R*)-**2a** (18 mg, 0.05 mmol, 0.05 equiv) in CH_2Cl_2 (2.0 mL) and (*E*)-crotanaldehyde (83 μL, 1.0 mmol) was obtained after chromatography, 244 mg (85%) of **8c** as a clear, colorless oil. The diastereomeric ratio was determined to be (*syn*,*syn*)-**8c**/minor isomers, 93/4/3 by SFC analysis.

Analytical data for **8c**:

^{1}H NMR: ($CDCl_3$, 500 MHz)

5.71 (dq, *J* = 15.2, 6.4, 1 H, HC(7)); 5.44 (ddd, *J* = 15.4, 6.4, 1.7, 1 H, HC(6)); 4.33 (br s, 1 H, HC(5)); 4.22 (q, *J* = 7.1, 1 H, HC(2)); 3.19 (dq, *J* = 7.1, 3.9, 1 H, HC(4)); 2.73, (d, *J* = 2.8, 1 H, OH); 1.71 (d, J = 6.4, 3 H, $H_3C(8)$); 1.33 (d, *J* = 6.9, 3 H, $H_3C(1)$); 1.14 (d, *J* = 7.1, 3 H, $H_3C(1')$); 0.92 (s, 9 H, $H_3C(3''')$); 0.09 (s, 6 H, $H_3C(1''')$)

^{13}C NMR: ($CDCl_3$, 125 MHz)

218.04 (C(3)); 130.58 (C(6)); 127.78 (C(7)); 74.58 (C(2)); 72.19 (C(5)); 45.11 (C(4)); 25.69 (C(3''')); 21.03 (C(1)); 18.01 (C(8)); 17.75 (C(2''')); 11.01 (C(1')); –4.67 (C(1''')); –5.03 (C(1'''))

MS: (FI)

286 (M^+, 11), 229 (100), 159 (4), 110 (2)

IR: (neat)

3460 (br), 2956 (m), 2933 (m), 2858 (m), 1712 (m), 1461 (m), 1255 (m), 1120 (m), 966 (m), 935 (m), 835 (s), 777 (m)

TLC: R_f 0.13 (pentane/Et_2O, 6/1, anisaldehyde)

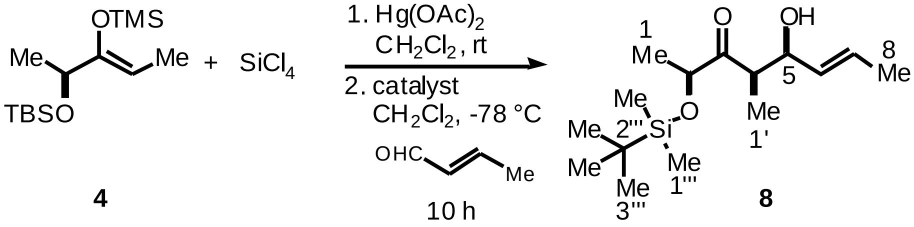
Optical Rotation: $[\alpha]_D^{23}$ –3.7° (*c* = 2.00, $CHCl_3$)

SFC: t_R (2*S*,4*R*,5*S*)-**8c**, 2.0 min (Daicel Chiralpak AD, 5% MeOH in CO_2, 150 bar, 40 °C, 2.0 mL min^{-1})

Analysis: $C_{15}H_{30}O_3Si$ (286.49)

Calculated:	C, 62.89;	H, 10.56%
Found:	C, 62.64;	H, 10.71%

(–)-(2*S*,4*R*,5*S*)-(*E*)-5-Hydroxy-4-methyl-2-[((dimethyl)-(1,1-dimethylethyl)silyl)oxy]-6-octen-3-one (8c) [Table 3, entry 6]



Following General Procedure II: from silyl enol ether **4** (273 mg, 1.0 mmol), silicon tetrachloride (230 μL, 2.0 mmol, 2.0 equiv) and mercuric acetate (3.2 mg, 0.01 mmol, 0.01 equiv) in CH_2Cl_2 (1.0 mL) followed by HMPA (26 μL, 0.15 mmol, 0.15 equiv) in CH_2Cl_2 (2.0 mL) and (*E*)-crotanaldehyde (83 μL, 1.0 mmol) was obtained after chromatography, 238 mg (83%) of **8c** as a clear, colorless oil. The diastereomeric ratio was determined to be (*syn,syn*)-**8c**/minor isomers, 84/15/1 by SFC analysis.

Analytical data for **8c**:

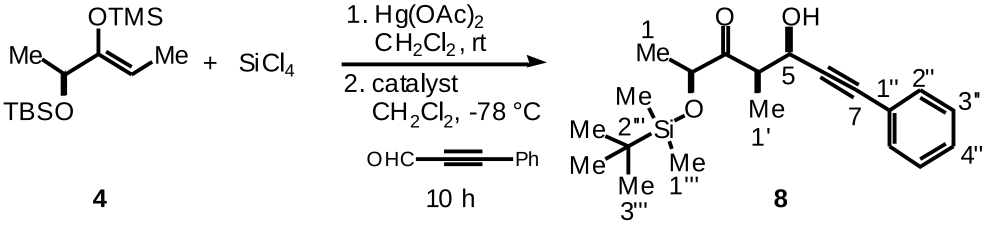
^{1}H NMR: ($CDCl_3$, 500 MHz)

5.71 (dq, *J* = 15.2, 6.4, 1 H, HC(7)); 5.44 (ddd, *J* = 15.4, 6.4, 1.7, 1 H, HC(6)); 4.33 (br s, 1 H, HC(5)); 4.22 (q, *J* = 7.1, 1 H, HC(2)); 3.19 (dq, *J* = 7.1, 3.9, 1 H, HC(4)); 2.73, (d, *J* = 2.8, 1 H, OH); 1.71 (d, J = 6.4, 3 H, $H_3C(8)$); 1.33 (d, *J* = 6.9, 3 H, $H_3C(1)$); 1.14 (d, *J* = 7.1, 3 H, $H_3C(1')$); 0.92 (s, 9 H, $H_3C(3''')$); 0.09 (s, 6 H, $H_3C(1''')$)

TLC: R_f 0.13 (pentane/Et_2O, 6/1, anisaldehyde)

SFC: t_R (2*S*,4*R*,5*S*)-**8c**, 2.0 min (Daicel Chiralpak AD, 5% MeOH in CO_2, 150 bar, 40 °C, 2.0 mL min^{-1})

(–)-(2*S*,4*R*,5*R*)-5-Hydroxy-4-methyl-7-phenyl-2-[((dimethyl)-(1,1-dimethylethyl)silyl)oxy]-6-heptyn-3-one (8d) [Table 3, entry 7]



Following General Procedure II: from silyl enol ether **4** (273 mg, 1.0 mmol), silicon tetrachloride (230 μL, 2.0 mmol, 2.0 equiv) and mercuric acetate (3.2 mg, 0.01 mmol, 0.01 equiv) in CH_2Cl_2 (1.0 mL) followed by (*R*,*R*)-**2a** (18 mg, 0.05 mmol, 0.05 equiv) in CH_2Cl_2 (2.0 mL) and 3-phenyl propynal[5] (122 μL, 1.0 mmol) was obtained after chromatography, 274 mg (79%) of **8d** as a clear, colorless oil. The diastereomeric ratio was determined to be (*syn*,*syn*)-**8d**/minor isomers, 95/3/2 by SFC analysis.

Analytical data for **8d**:

^{1}H NMR: ($CDCl_3$, 500 MHz)

7.46-7.26 (m, 5 H, 2 × H(C2''), 2 × HC(3''), HC(4'')); 4.92 (t, *J* = 4.5, 1 H, HC(5)); 4.31 (q, *J* = 6.9, 1 H, HC(2)); 3.41 (dq, *J* = 6.9, 4.1, 1 H, HC(4)); 3.01, (d, *J* = 4.7, 1 H, OH); 1.41 (d, *J* = 6.6, 3 H, $H_3C(1)$); 1.41 (d, *J* = 6.9, 3 H, $H_3C(1')$); 0.96 (s, 9 H, $H_3C(3''')$); 0.14 (s, 3 H, $H_3C(1''')$); 0.13 (s, 3 H, $H_3C(1''')$)

^{13}C NMR: ($CDCl_3$, 125 MHz)

216.42 (C(3)); 131.77 (CAr); 128.46 (CAr); 128.24 (CAr); 122.47 (C(1'')); 87.79 (C(6)); 85.27 (C(7)); 74.50 (C(2)); 63.54 (C(5)); 46.80 (C(4)); 25.69 (C(3''')); 21.17 (C(1)); 18.02 (C(8)); 18.02 (C(2''')); 11.60 (C(1')); –4.64 (C(1''')); –5.05 (C(1'''))

MS: (FI)

346 (M^+, 1), 289 (100), 216 (1), 187 (2), 159 (7), 145 (5), 130 (2)

IR: (neat)

3440 (br), 2954 (s), 2931 (s), 2858 (m), 1714 (m), 1462 (m), 1365 (m), 1255 (m), 1126 (m), 935 (m), 835 (s), 779 (s), 758 (s), 692 (m)

TLC: R_f 0.24 (pentane/Et_2O, 4/1, anisaldehyde)

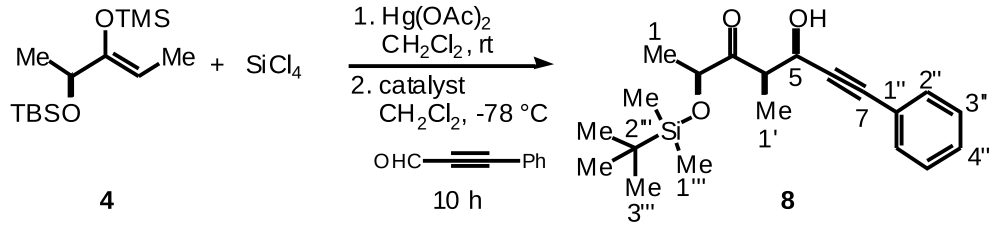
Optical Rotation: $[\alpha]_D^{23}$ –1.2° (*c* = 2.00, $CHCl_3$)

SFC: t_R (2*S*,4*R*,5*S*)-**8d**, 5.7 min (Daicel Chiralpak AD, 2% MeOH in CO_2, 150 bar, 40 °C, 3.0 mL min^{-1})

Analysis: $C_{20}H_{30}O_3Si$ (346.54)

Calculated:	C, 69.32;	H, 8.73%
Found:	C, 69.17;	H, 8.96%

(–)-(2*S*,4*R*,5*R*)-5-Hydroxy-4-methyl-7-phenyl-2-[((dimethyl)-(1,1-dimethylethyl)silyl)oxy]-6-heptyn-3-one (8d) [Table 3, entry 8]



Following General Procedure II: from silyl enol ether **4** (273 mg, 1.0 mmol), silicon tetrachloride (230 μL, 2.0 mmol, 2.0 equiv) and mercuric acetate (3.2 mg, 0.01 mmol, 0.01 equiv) in CH_2Cl_2 (1.0 mL) followed by HMPA (26 μL, 0.15 mmol, 0.15 equiv) in CH_2Cl_2 (2.0 mL) and 3-phenyl propynal (122 μL, 1.0 mmol) was obtained after chromatography, 284 mg (82%) of **8d** as a clear, colorless oil. The diastereomeric ratio was determined to be (*syn*,*syn*)-**8d**/minor isomers, 89/5/4/3 by SFC analysis.

Analytical data for **8d**:

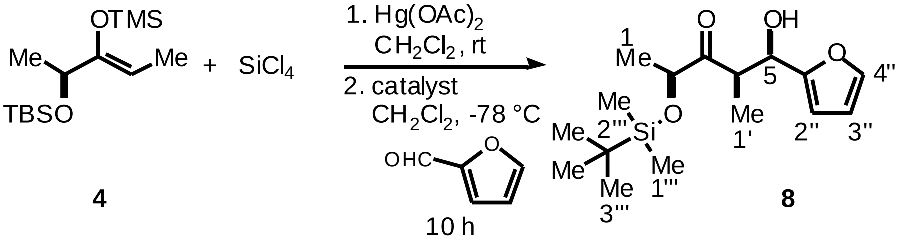
^{1}H NMR: ($CDCl_3$, 500 MHz)

7.46-7.26 (m, 5 H, 2 × H(C2''), 2 × HC(3''), HC(4'')); 4.92 (t, *J* = 4.5, 1 H, HC(5)); 4.31 (q, *J* = 6.9, 1 H, HC(2)); 3.41 (dq, *J* = 6.9, 4.1, 1 H, HC(4)); 3.01, (d, *J* = 4.7, 1 H, OH); 1.41 (d, *J* = 6.6, 3 H, $H_3C(1)$); 1.41 (d, *J* = 6.9, 3 H, $H_3C(1')$); 0.96 (s, 9 H, $H_3C(3''')$); 0.14 (s, 3 H, $H_3C(1''')$); 0.13 (s, 3 H, $H_3C(1''')$)

TLC: R_f 0.24 (pentane/Et_2O, 4/1, anisaldehyde)

SFC: t_R (2*S*,4*R*,5*S*)-**8d**, 5.7 min (Daicel Chiralpak AD, 2% MeOH in CO_2, 150 bar, 40 °C, 3.0 mL min^{-1})

(–)-(2*S*,4*R*,5*R*)-5-Hydroxy-4-methyl-5-(1-furyl)-2-[((dimethyl)-(1,1-dimethylethyl)silyl)oxy]-3-pentanone (8e) [Table 3, entry 9]



Following General Procedure II: from silyl enol ether **4** (273 mg, 1.0 mmol), silicon tetrachloride (230 μL, 2.0 mmol, 2.0 equiv) and mercuric acetate (3.2 mg, 0.01 mmol, 0.01 equiv) in CH_2Cl_2 (1.0 mL) followed by (*R*,*R*)-**2a** (18 mg, 0.05 mmol, 0.05 equiv) in CH_2Cl_2 (2.0 mL) and 2-furaldehyde (83 μL, 1.0 mmol) was obtained after chromatography, 257 mg (82%) of **8e** as a clear, colorless oil. The diastereomeric ratio was determined to be (*syn,syn*)-**8e**/minor isomers, 94/6 by SFC analysis.

Analytical data for **8e**:

^{1}H NMR: (CDCl$_3$, 500 MHz)

7.34 (d, *J* = 1.7, 1 H, HC(4")); 6.33 (dd, *J* = 3.2, 1.7, 1 H, HC(3")); 6.27 (d, J = 3.2, 1 H, HC(2"); 5.03 (t, J = 4.1, 1 H, HC(5)); 4.20 (q, *J* = 7.1, 1 H, HC(2)); 3.58 (dq, *J* = 7.1, 4.1, 1 H, HC(4)); 2.95, (d, *J* = 3.6, 1 H, OH); 1.31 (d, *J* = 6.6, 3 H, H$_3$C(1)); 1.18 (d, *J* = 7.2, 3 H, H$_3$C(1')); 0.95 (s, 9 H, H$_3$C(3''')); 0.12 (s, 3 H, H$_3$C(1''')); 0.11 (s, 3 H, H$_3$C(1'''))

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

217.59 (C(3)); 154.38 (C(1")); 141.65 (C(4")); 110.25 (C(3")); 106.62 (C(2")); 74.36 (C(2)); 68.27 (C(5)); 44.74 (C(4)); 25.66 (C(3''')); 21.02 (C(1)); 18.00 (C(2''')); 11.34 (C(1')); –4.70 (C(1''')); –5.11 (C(1'''))

MS: (FI)

312.2 (M$^+$, 44), 255.1 (100), 208.6 (8), 159.1 (16), 96.0 (6)

IR: (neat)

3467 (br), 2956 (m), 2933 (m), 2858 (m), 1714 (m), 1255 (m), 1126 (m), 1006 (m), 931 (m), 835 (s), 779 (m)

TLC: R_f 0.13 (pentane/Et$_2$O, 6/1, anisaldehyde)

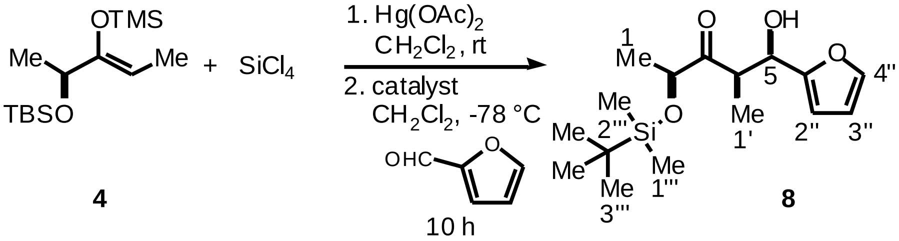
Optical Rotation: $[\alpha]_D^{23}$ –1.2° (*c* = 2.00, CHCl$_3$)

SFC: t_R (2*S*,4*R*,5*R*)-**8e**, 4.0 min (Daicel Chiralpak AD, 1.5% MeOH in CO$_2$, 150 bar, 40 °C, 2.5 mL min^{-1})

Analysis: C$_{16}$H$_{28}$O$_3$Si (312.48)

Calculated:	C, 61.50;	H, 9.03%
Found:	C, 61.30;	H, 9.04%

(–)-(2*S*,4*R*,5*R*)-5-Hydroxy-4-methyl-5-(1-furyl)-2-[((dimethyl)-(1,1-dimethylethyl)silyl)oxy]-3-pentanone (8e) [Table 3, entry 10]



Following the General Procedure II: from silyl enol ether **4** (273 mg, 1.0 mmol), silicon tetrachloride (230 µL, 2.0 mmol, 2.0 equiv) and mercuric acetate (3.2 mg, 0.01 mmol, 0.01 equiv) in CH_2Cl_2 (1.0 mL) followed by HMPA (26 µL, 0.15 mmol, 0.15 equiv) in CH_2Cl_2 (2.0 mL) and 2-furaldehyde (83 µL, 1.0 mmol) was obtained after chromatography, 225 mg (72%) of **8e** as a clear, colorless oil. The diastereomeric ratio was determined to be (*syn*,*syn*)-**8e**/minor isomers, 93/5/1 by SFC analysis.

Analytical data for **8e**:

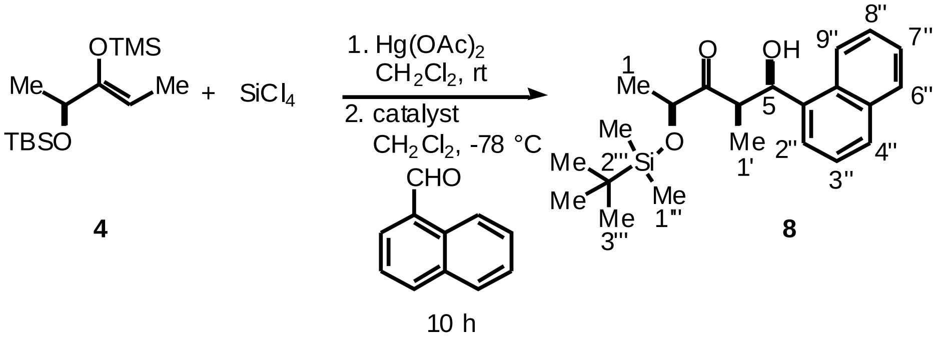
^{1}H NMR: ($CDCl_3$, 500 MHz)

7.34 (d, *J* = 1.7, 1 H, HC(4")); 6.33 (dd, *J* = 3.2, 1.7, 1 H, HC(3")); 6.27 (d, J = 3.2, 1 H, HC(2"); 5.03 (t, J = 4.1, 1 H, HC(5)); 4.20 (q, *J* = 7.1, 1 H, HC(2)); 3.58 (dq, *J* = 7.1, 4.1, 1 H, HC(4)); 2.95, (d, *J* = 3.6, 1 H, OH); 1.31 (d, *J* = 6.6, 3 H, $H_3C(1)$); 1.18 (d, *J* = 7.2, 3 H, $H_3C(1')$); 0.95 (s, 9 H, $H_3C(3''')$); 0.12 (s, 3 H, $H_3C(1''')$); 0.11 (s, 3 H, $H_3C(1''')$)

TLC: R_f 0.13 (pentane/Et_2O, 6/1, anisaldehyde)

SFC: t_R (2*S*,4*R*,5*R*)-**8e**, 4.0 min (Daicel Chiralpak AD, 1.5% MeOH in CO_2, 150 bar, 40 °C, 2.5 mL min^{-1})

(+)-(2*S*,4*R*,5*R*)-5-Hydroxy-4-methyl-5-(1-naphthyl)-2-[((dimethyl)-(1,1-dimethylethyl) silyl)oxy]-3-pentanone (8f) [Table 3, entry 11]



Following General Procedure II: from silyl enol ether **4** (273 mg, 1.0 mmol), silicon tetrachloride (230 μL, 2.0 mmol, 2.0 equiv) and mercuric acetate (3.2 mg, 0.01 mmol, 0.01 equiv) in CH_2Cl_2 (1.0 mL) followed by (*R*,*R*)-**2a** (18 mg, 0.05 mmol, 0.05 equiv) in CH_2Cl_2 (2.0 mL) and 1-naphthaldehyde (135 μL, 1.0 mmol) was obtained after chromatography, 270 mg (72%) of **8f** as a clear, colorless oil. The diastereomeric ratio was determined to be (*syn*,*syn*)-**8f**/ minor isomers, 98/1/1 by SFC analysis.

Analytical data for **8f**:

^{1}H NMR: ($CDCl_3$, 500 MHz)

7.90-7.44 (m, 7 H, HC(2"), HC(3"), HC(4"), HC(6"), HC(7"), HC(8"), HC(9")); 5.88 (br s, 1 H, HC(5)); 4.27 (q, *J* = 6.9, 1 H, HC(2)); 3.70 (d, *J* = 1.9, 1 H, OH); 3.59, (dq, *J* = 7.3, 2.8, 1 H, HC(4)); 1.35 (d, *J* = 6.9, 3 H, $H_3C(1)$); 1.05 (d, *J* = 7.3, 3 H, $H_3C(1')$); 0.86 (s, 9 H, $H_3C(3''')$); 0.10 (d, *J* = 1.9, 6 H, $H_3C(1''')$)

^{13}C NMR: ($CDCl_3$, 125 MHz)

219.51 (C(3)); 136.45 (C(1")); 133.72 (C(5")); 129.70 (C(10")); 129.08 (CAr); 127.71 (CAr); 125.96 (CAr); 125.36 (CAr); 125.29 (CAr); 124.43 (CAr); 122.61 (CAr); 74.77 (C(2)); 69.38 (C(5)); 45.16 (C(4)); 25.70 (C(3"')); 21.35 (C(1)); 18.06 (C(2"')); 10.19 (C(1')); –4.75 (C(1"')); –4.97 (C(1"'))

MS: (FI)

372.3 (M^+, 100), 315.2 (6), 266.7 (12), 216.2 (5), 156.1 (16)

IR: (neat)

3502 (br), 2931 (m), 2958 (m), 1699 (m), 1255 (m), 1128 (m), 837 (s), 777 (s)

TLC: R_f 0.19 (pentane/Et_2O, 6/1, anisaldehyde)

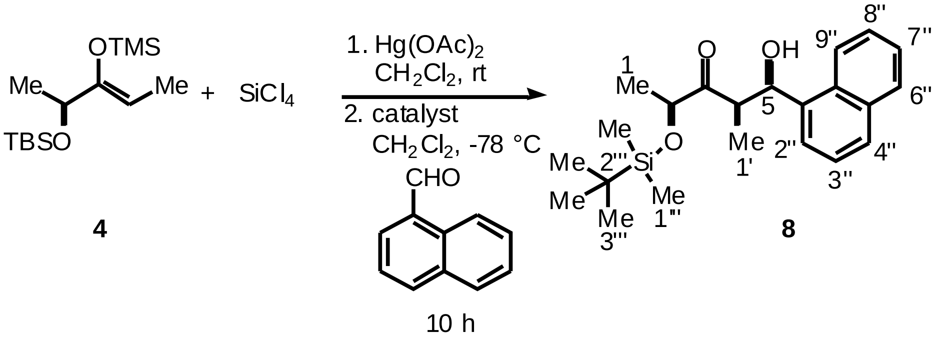
Optical Rotation: $[\alpha]_D^{23}$ +53.1° (*c* = 1.00, $CHCl_3$)

SFC: t_R (2*S*,4*R*,5*R*)-**8f**, 2.8 min (Daicel Chiralpak AS, 4% MeOH in CO_2, 150 bar, 40 °C, 3.0 mL min^{-1})

Analysis: $C_{22}H_{32}O_3Si$ (372.58)

Calculated:	C, 70.92;	H, 8.66%
Found:	C, 70.78;	H, 8.42%

(+)-(2*S*,4*R*,5*R*)-5-Hydroxy-4-methyl-5-(1-naphthyl)-2-[((dimethyl)-(1,1-dimethylethyl) silyl)oxy]-3-pentanone (8f) [Table 3, entry 12]



Following General Procedure II: from silyl enol ether **4** (273 mg, 1.0 mmol), silicon tetrachloride (230 μL, 2.0 mmol, 2.0 equiv) and mercuric acetate (3.2 mg, 0.01 mmol, 0.01 equiv) in CH_2Cl_2 (1.0 mL) followed by HMPA (26 μL, 0.15 mmol, 0.15 equiv) in CH_2Cl_2 (2.0 mL) and 1-naphthaldehyde (135 μL, 1.0 mmol) was obtained after chromatography, 231 mg (62%) of **8f** as a clear, colorless oil. The diastereomeric ratio was determined to be (*syn*,*syn*)-**8f**/ minor isomers, 83/12/3/1 by SFC analysis.

Analytical data for **8f**:

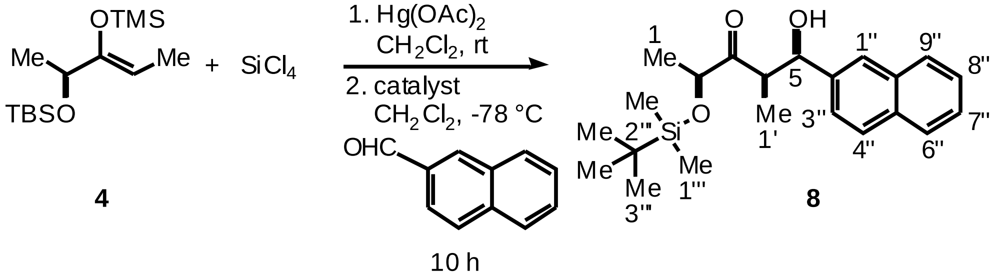
^{1}H NMR: ($CDCl_3$, 500 MHz)

7.90-7.44 (m, 7 H, HC(2''), HC(3''), HC(4''), HC(6''), HC(7''), HC(8''), HC(9'')); 5.88 (br s, 1 H, HC(5)); 4.27 (q, *J* = 6.9, 1 H, HC(2)); 3.70 (d, *J* = 1.9, 1 H, OH); 3.59, (dq, *J* = 7.3, 2.8, 1 H, HC(4)); 1.35 (d, *J* = 6.9, 3 H, $H_3C(1)$); 1.05 (d, *J* = 7.3, 3 H, $H_3C(1')$); 0.86 (s, 9 H, $H_3C(3''')$); 0.10 (d, *J* = 1.9, 6 H, $H_3C(1''')$)

TLC: R_f 0.19 (pentane/Et_2O, 6/1, anisaldehyde)

SFC: t_R (2*S*,4*R*,5*R*)-**8f**, 2.8 min (Daicel Chiralpak AS, 4% MeOH in CO_2, 150 bar, 40 °C, 3.0 mL min^{-1})

(–)-(2*S*,4*R*,5*R*)-5-Hydroxy-4-methyl-5-(2-naphthyl)-2-[((dimethyl)-(1,1-dimethylethyl) silyl)oxy]-3-pentanone (8g) [Table 3, entry 13]



Following General Procedure II: from silyl enol ether **4** (273 mg, 1.0 mmol), silicon tetrachloride (230 μL, 2.0 mmol, 2.0 equiv) and mercuric acetate (3.2 mg, 0.01 mmol, 0.01 equiv) in CH_2Cl_2 (1.0 mL) followed by (*R*,*R*)-**2a** (18 mg, 0.05 mmol, 0.05 equiv) in CH_2Cl_2 (2.0 mL) and 2-naphthaldehyde (156 mg, 1.0 mmol) was obtained after chromatography, 265 mg (71%) of **8g** as a clear, colorless oil. The diastereomeric ratio was determined to be (*syn*,*syn*)-**8g**/ minor isomers, 94/3/3 by SFC analysis.

Analytical data for **8g**:

^{1}H NMR: (CDCl$_3$, 500 MHz)

7.86-7.36 (m, 7 H, HC(1"), HC(3"), HC(4"), HC(6"), HC(7"), HC(8"), HC(9")); 5.23 (br s, 1 H, HC(5)); 4.21 (q, *J* = 6.9, 1 H, HC(2)); 3.51 (dq, *J* = 7.1, 3.2, 1 H, HC(4)); 3.46, (d, *J* = 1.9, 1 H, OH); 1.32 (d, *J* = 6.9, 3 H, H$_3$C(1)); 1.09 (d, *J* = 7.1, 3 H, H$_3$C(1')); 0.93 (s, 9 H, H$_3$C(3''')); 0.11 (s, 3 H, H$_3$C(1''')); 0.09 (s, 3 H, H$_3$C(1'''))

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

219.11 (C(3)); 139.04 (C(2")); 133.23 (C(10")); 132.73 (C(5")); 128.05 (CAr); 127.92 (CAr); 127.60 (CAr); 126.08 (CAr); 125.75 (CAr); 124.87 (CAr); 123.91 (CAr); 74.63 (C(2)); 72.77 (C(5)); 46.58 (C(4)); 25.68 (C(3''')); 21.15 (C(1)); 18.01 (C(2''')); 10.21 (C(1')); –4.70 (C(1''')); –5.01 (C(1'''))

MS: (FI)

372.2 (M$^+$, 100), 315.2 (8), 266.9 (15), 216.2 (4), 156.1 (10)

IR: (neat)

3487 (br), 2954 (m), 2931 (m), 2858 (m), 1711 (m), 1462 (m), 1363 (m), 1255 (m), 1124 (m), 935 (m), 835 (s), 779 (m), 735 (m)

TLC: R_f 0.26 (pentane/Et$_2$O, 4/1, anisaldehyde)

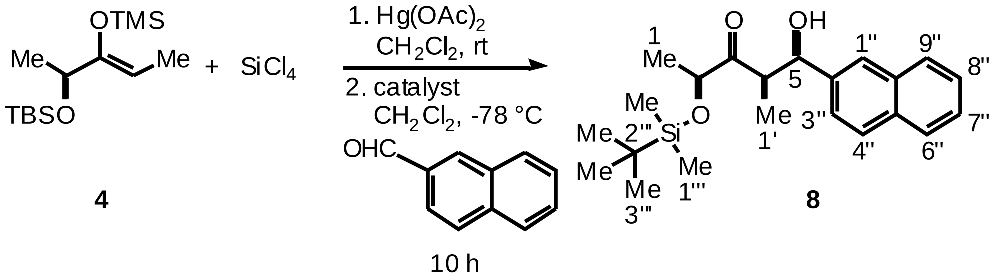
Optical Rotation: $[\alpha]_D^{23}$ –1.7° (c = 2.00, CHCl$_3$)

SFC: t_R (2*S*,4*R*,5*R*)-**8g**, 2.5 min (Daicel Chiralpak AS, 4% MeOH in CO$_2$, 150 bar, 40 °C, 3.0 mL min^{-1})

Analysis: C$_{22}$H$_{32}$O$_3$Si (372.58)

Calculated:	C, 70.92;	H, 8.66%
Found:	C, 70.62;	H, 8.78%

(–)-(2*S*,4*R*,5*R*)-5-Hydroxy-4-methyl-5-(2-naphthyl)-2-[((dimethyl)-(1,1-dimethylethyl) silyl)oxy]-3-pentanone (8g) [Table 3, entry 14]



Following General Procedure II: from silyl enol ether **4** (273 mg, 1.0 mmol), silicon tetrachloride (230 μL, 2.0 mmol, 2.0 equiv) and mercuric acetate (3.2 mg, 0.01 mmol, 0.01 equiv) in CH_2Cl_2 (1.0 mL) followed by HMPA (26 μL, 0.15 mmol, 0.15 equiv) in CH_2Cl_2 (2.0 mL) and 2-naphthaldehyde (156 mg, 1.0 mmol) was obtained after chromatography, 220 mg (59%) of **8g** as a clear, colorless oil. The diastereomeric ratio was determined to be (*syn*,*syn*)-**8g**/ minor isomers, 89/6/4/1 by SFC analysis.

Analytical data for **8g**:

^{1}H NMR: ($CDCl_3$, 500 MHz)

7.86-7.36 (m, 7 H, HC(1''), HC(3''), HC(4''), HC(6''), HC(7''), HC(8''), HC(9'')); 5.23 (br s, 1 H, HC(5)); 4.21 (q, *J* = 6.9, 1 H, HC(2)); 3.51 (dq, *J* = 7.1, 3.2, 1 H, HC(4)); 3.46, (d, *J* = 1.9, 1 H, OH); 1.32 (d, *J* = 6.9, 3 H, $H_3C(1)$); 1.09 (d, *J* = 7.1, 3 H, $H_3C(1')$); 0.93 (s, 9 H, $H_3C(3''')$); 0.11 (s, 3 H, $H_3C(1''')$); 0.09 (s, 3 H, $H_3C(1''')$)

TLC: R_f 0.26 (pentane/Et_2O, 4/1, anisaldehyde)

SFC: t_R (2*S*,4*R*,5*R*)-**8g**, 2.5 min (Daicel Chiralpak AS, 4% MeOH in CO_2, 150 bar, 40 °C, 3.0 mL min^{-1})

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