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Supporting Information

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Highly Enantioselective Catalytic Thiolysis of Prochiral Cyclic Dicarboxylic Anhydrides Utilizing a Bifunctional Chiral Sulfonamide

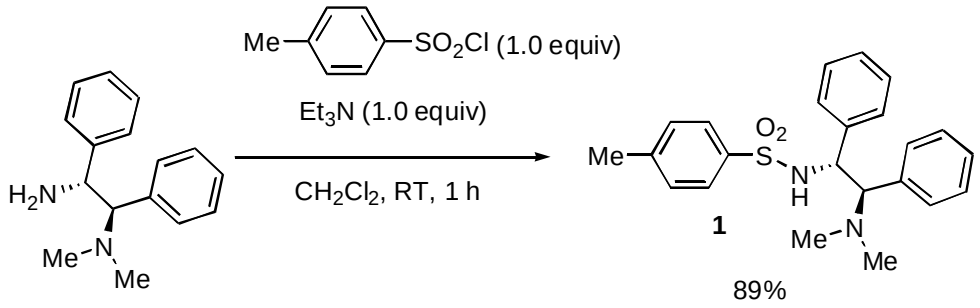
*Takashi Honjo, Shigeki Sano, Motoo Shiro, and Yoshimitsu Nagao**

General

All melting points were determined on a Yanagimoto micro melting point apparatus and uncorrected. IR spectra were recorded on a JASCO FT/IR-420 Infrared Fourier Transform Spectrometer. ^{1}H-NMR spectra were recorded on a JEOL-GSX400 (400 MHz) spectrometer. Chemical shifts are given in δ values (ppm) using tetramethylsilane (TMS) as an internal standard. EI-MS were recorded on a JEOL JMS SX-120A spectrometer. Elementary combustion analyses were determined by a Yanaco CHN CORDER MT-5. All reactions were monitored by TLC employing 0.25 mm silicagel plates (E. Merck 5715, 60F-254). Column chromatography was carried out on silica gel [Kanto Chemical 60N (63-210 mesh)]. Optical rotations were measured on a JASCO DIP-370 polarimeter. HPLC analyses were performed by using a JASCO (PU-980, UV-970, 807-IT) instrument. All reagents were used as purchased.

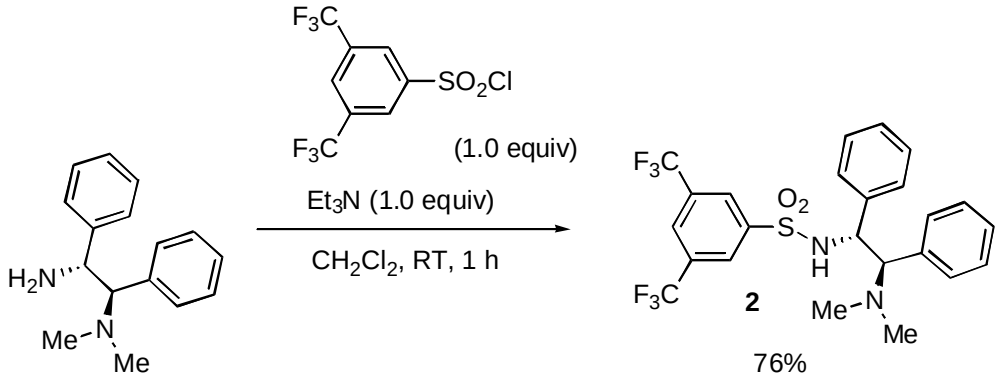
(*1R,2R*)-*N,N*-Dimethyl-*N'*-*p*-toluenesulfonyl-1,2-diphenyl-1,2-ethanediamine (1):

To a solution of (*1R,2R*)-*N,N*-dimethyl-1,2-diphenyl-1,2-ethanediamine[1] (72 mg, 0.30 mmol) and *p*-toluenesulfonyl chloride (57 mg, 0.30 mmol) in CH_2Cl_2 (5 mL) was added Et_3N (42 μL, 0.30 mmol) at room temperature. The mixture was stirred at room temperature under Ar for 1 h. After addition of some water, the mixture was extracted with $CHCl_3$. The extract was dried over $MgSO_4$, filtrated, and then the filtrate was evaporated *in vacuo*. The residue was chromatographed on a silica gel column with $CHCl_3$-MeOH (25 : 1) to afford compound **2** (105 mg, 89% yield) as a white solid. mp 109-110 °C; $[\alpha]_D^{19}$ 53.0° (*c* 0.50, $CHCl_3$); ^{1}H NMR (400 MHz, DMSO-d_6) δ 7.54-7.42 (3H, m), 7.25-6.86 (12H, m), 4.67-4.57 (1H, m), 3.77 (1H, d, *J* = 11.0 Hz), 2.31 (3H, s), 1.89 (6H, s); IR (KBr) 3087, 2967, 2938, 2865, 2832, 2786, 1596, 1497, 1454, 1369, 1311, 1149 cm^{-1}; HREI-MS calcd for $C_{23}H_{26}N_2O_2S$ MW 394.1715, found *m/z* 394.1735 $(M)^+$; Anal. Calcd for $C_{23}H_{26}N_2O_2S$: C, 70.02; H, 6.64; N, 7.10. Found: C, 69.74; H, 6.66; N, 7.02.



(*1R,2R*)-*N,N*-Dimethyl-*N'*-3,5-bis(trifluoromethyl)benzenesulfonyl-1,2-diphenyl-1,2-ethanediamine (2):

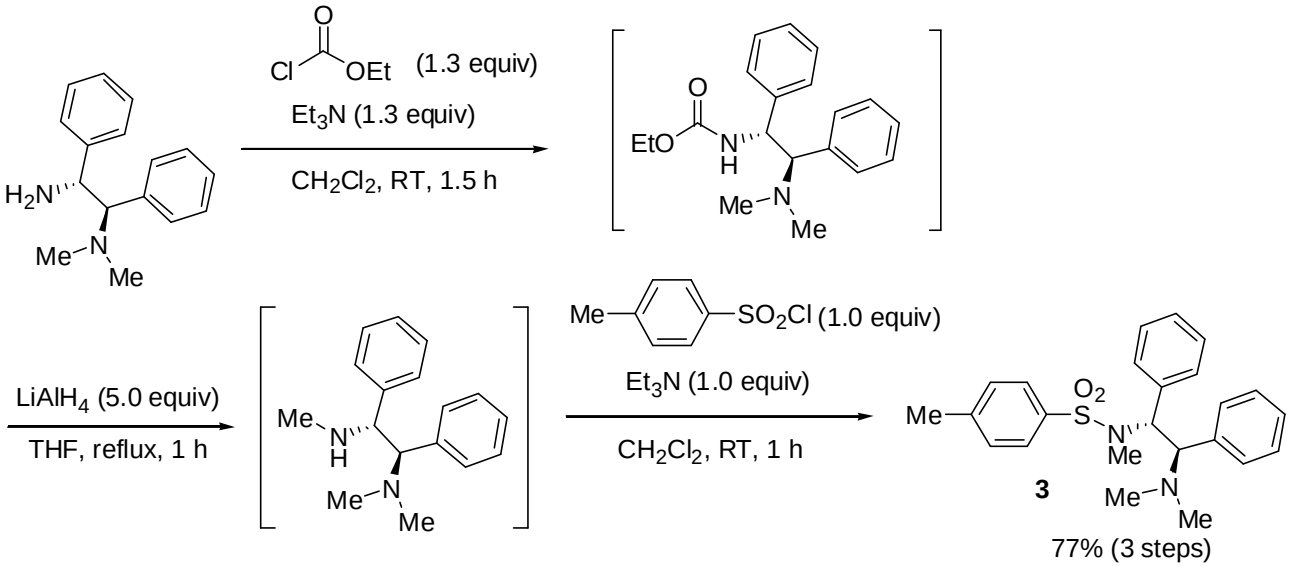
To a solution of (*1R,2R*)-*N,N*-dimethyl-1,2-diphenyl-1,2-ethanediamine (752 mg, 3.13 mmol) and 3,5-bis(trifluoromethyl)benzenesulfonyl chloride (978 mg, 3.13 mmol) in CH_2Cl_2 (30 mL) was added Et_3N (436 μL, 3.13 mmol) at room temperature. The mixture was stirred at room temperature under Ar for 1 h. After addition of some water, the mixture was extracted with $CHCl_3$. The extract was dried over $MgSO_4$, filtrated, and then the filtrate was evaporated *in vacuo*. The residue was chromatographed on a silica gel column with $CHCl_3$-MeOH (25 : 1) to afford compound **2** (1.23 g, 76% yield) as colorless needles ($CHCl_3$-*n*-hexane). mp 168-169 °C; $[\alpha]_D^{18}$ 131.5° (*c* 1.21, $CHCl_3$); ^{1}H NMR (400 MHz, DMSO-d_6) δ 8.61 (1H, bs), 8.20 (1H, s), 8.05 (2H, s), 7.15-6.93 (7H, m), 6.84-6.73 (3H, m), 4.95 (1H, d, *J* = 11.2 Hz), 3.86 (1H, d, *J* = 11.2 Hz), 1.96 (6H, s); IR (KBr) 3301, 2975, 2942, 2869, 2836, 2794, 1454, 1365, 1280, 1180, 1157, 1133 cm^{-1}; HREI-MS calcd for $C_{24}H_{22}F_6N_2O_2S$ MW 516.1306, found *m/z* 516.1331 $(M)^+$; Anal. Calcd for $C_{24}H_{22}F_6N_2O_2S$: C, 55.81; H, 4.29; N, 5.42. Found: C, 55.61; H, 4.35; N, 5.37.



(*1R,2R*)-*N,N,N'*-Timethyl-*N'*-*p*-toluenesulfonyl-1,2-diphenyl-1,2-ethanediamine (3):

To a solution of (*1R,2R*)-*N,N*-dimethyl-1,2-diphenyl-1,2-ethanediamine (201 mg, 0.837 mmol) and ethyl chlorocarbonate (103 μL, 1.09 mmol) in CH_2Cl_2 (15 mL) was added Et_3N (152 μL, 1.09 mmol) at room temperature. The mixture was stirred at room temperature under Ar for 1.5 h. After addition of some water, the mixture was extracted with $CHCl_3$. The extract was dried over $MgSO_4$, filtrated, and then the filtrate was evaporated *in vacuo*. The residue was dissolved in THF (10 mL), and $LiAlH_4$ (159 mg, 4.19 mmol) was added at room temperature, and then refluxed for 1 h. After addition of some water, the mixture was extracted with $CHCl_3$. The $CHCl_3$ extract was dried over

$MgSO_4$, filtrated, and then the filtrate was evaporated *in vacuo*. The residue was dissolved in in CH_2Cl_2 (15 mL). To the solution were added *p*-toluenesulfonyl chloride (160 mg, 0.837 mmol) and Et_3N (117 μL, 0.837 mmol) at room temperature. The mixture was stirred at room temperature under Ar for 1 h and then treated with some water followed by extraction with $CHCl_3$. The $CHCl_3$ extract was dried over $MgSO_4$ and filtrated. The filtrate was evaporated *in vacuo* to give an oily residue. The residue was chromatographed on a silica gel column with AcOEt-*n*-hexane (1 : 2) to afford compound **3** (263 mg, 77% yield) as a colorless amorphous powder. $[\alpha]_D^{21}$ -30.2° (*c* 1.24 $CHCl_3$); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.64-7.57 (2H, m), 7.22-7.00 (12H, m), 5.85 (1H, d, *J* = 12.0 Hz), 4.16 (1H, d, *J* = 12.0 Hz), 2.79 (3H, s), 2.34 (3H, s), 2.19 (6H, s); ^{13}C NMR (100 MHz, $CDCl_3$) δ 142.3, 137.5, 136.8, 132.6, 129.4, 128.89, 128.8, 127.9, 127.5, 127.3, 127.2, 127.0, 67.1, 59.3, 40.9, 28.8, 21.4; IR (KBr) 3031, 2931, 2830, 2784, 2596, 1596, 1450, 1319, 1211, 1157 cm^{-1}; HREI-MS calcd for $C_{24}H_{28}N_2O_2S$ MW 408.1872, found *m/z* 408.1857 $(M)^+$; Anal. Calcd for $C_{24}H_{28}N_2O_2S$.



A typical procedure for the enantioselective catalytic thiolysis (Table 2, Entry 1):

To a solution of 3-phenylglutaric anhydride **6** (190 mg, 1.0 mmol) and chiral sulfonamide **2** (25.8 mg, 0.05 mmol) in Et_2O (10 mL) was added benzyl mercaptan (141 μL, 1.2 mmol) at room temperature. The mixture was stirred at room temperature under Ar for 20 h and then treated with 10% HCl followed by extraction with $CHCl_3$. The $CHCl_3$ extract was dried over $MgSO_4$ and filtrated. After evaporation of the filtrate *in vacuo*, the residue was dissolved in benzene-MeOH (7 : 2) (9 mL). To the solution was added an ethereal solution of $TMSCHN_2$ (2.0 M in Et_2O, 1 mL, 2.0 mmol). The mixture was stirred at room temperature for 15 min and then evaporated *in vacuo* to give an oily residue. Chromatographic purification of the residue on a silica gel column with AcOEt-*n*-hexane (1 : 4) afforded compound **8** (312 mg, 95% yield, 91% ee) as a white solid.

Methyl (*S*)-5-(Benzylthio)-5-oxo-3-phenylpentanoate (8) (Table 2, Entry 1):

white solid; 95% yield; mp 34.5-35 °C; 91% ee; $[\alpha]_D^{20}$ 43.7° (*c* 1.10, $CHCl_3$); ^1H NMR (400 MHz, $CDCl_3$) δ 7.34-7.07 (10H, m), 4.05 (2H, s), 3.77-3.67 (1H, m), 3.57 (3H, s), 2.96 (1H, dd, *J* = 15.1 and 7.1 Hz), 2.91 (1H, dd, *J* = 15.1 and 7.8 Hz), 2.73 (1H, dd, *J* = 15.6 and 6.8 Hz), 2.65 (1H, dd, *J* = 15.6 and 8.1 Hz); IR (KBr) 3054, 2946, 1735, 1685, 1492, 1423, 1365, 1257, 1203, 1160 cm^{-1}; HREI-MS calcd for $C_{19}H_{20}O_3S$ MW 328.1133, found *m/z* 328.1130 $(M)^+$; Anal. Calcd for $C_{19}H_{20}O_3S$: C, 69.48; H, 6.14. Found: C, 69.22; H, 6.12.

The ee of **8** was determined on a Daicel chiral OD-H column with *n*-hexane : isopropanol = 19 : 1, flow = 1 mL/min. The absolute configuration of **8** was determined by its chemical conversion to known ketoester **19**.[2]

Chemical conversion of 8 to ketoester 19:

To a solution of **8** (91% ee, 100 mg, 0.30 mmol) and $Fe(acac)_3$ (21.5 mg, 0.061 mmol) in THF (5 mL) was added EtMgBr (0.98 M in THF, 747 μL, 0.73 mmol) at –78 °C. The mixture was stirred at –78 °C under Ar for 4 h. 10% HCl was added to the reaction mixture, followed by extraction with $CHCl_3$, dried over $MgSO_4$, and filtrated. The filtrate was evaporated *in vacuo*. The residue was chromatographed on a silica gel column with AcOEt-*n*-hexane (1 : 4) to afford compound **19** (59 mg, 83% yield, 91% ee) as a white solid.

Methyl (*R*)-5-Oxo-3-phenylheptanoate (19):

white solid; 83% yield from **8**; mp 36-36.5°C; 91% ee; $[\alpha]_D^{18}$ 31.5° (*c* 0.75, C_6H_6) (*R* enantiomer: lit.[2] $[\alpha]_D^{24}$ 35.3° (*c* 2-3, C_6H_6)); ^1H NMR (400 MHz, $CDCl_3$) δ 7.32-7.16 (5H, m), 3.72-3.65 (1H, m), 3.58 (3H, s), 2.82 (1H, dd, *J* = 16.6 and 7.1 Hz), 2.77 (1H, dd, *J* = 16.6 and 7.3 Hz), 2.69 (1H, dd, *J* = 15.3 and 7.2 Hz), 2.61 (1H, dd, *J* = 15.3 and 7.7 Hz), 2.41-2.23 (2H, m), 0.96 (3H, t, *J* = 7.3 Hz); IR (KBr) 3039, 2985, 2946, 2892, 1951, 1889, 1720, 1604, 1496, 1442, 1365 cm^{-1}; HREI-MS calcd for $C_{14}H_{18}O_3$ MW 234.1256, found *m/z* 234.1247 $(M)^+$; Anal. Calcd for $C_{14}H_{18}O_3$: C, 71.77; H, 7.74. Found: C, 71.49; H, 7.72.

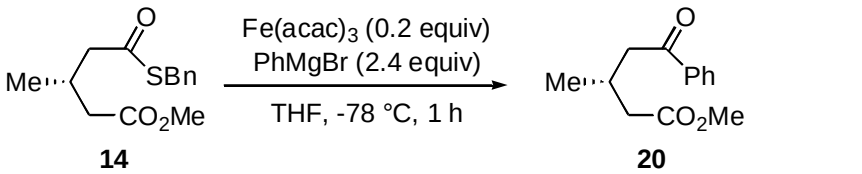
The ee of **19** was determined on a Daicel chiral OD-H column with *n*-hexane : isopropanol = 19 : 1, flow = 1 mL/min.

Methyl (*S*)-5-(Benzylthio)-3-methyl-5-oxopentanoate (14) (Table 2, Entry 2):

colorless oil; 87% yield; 91% ee; $[\alpha]_D^{20}$ 5.4° (*c* 1.24, $CHCl_3$); ^1H NMR (400 MHz, $CDCl_3$) δ 7.34-7.19 (5H, m), 4.12 (2H, s), 3.66 (3H, s), 2.69-2.45 (3H, m), 2.39 (1H, dd, *J* = 15.4 and 5.9 Hz), 2.23 (1H, dd, *J* = 15.4 and 7.3 Hz), 1.01 (3H, d, *J* = 6.3 Hz); IR (neat) 2958, 2360, 1735, 1689, 1500, 1450, 1365 cm^{-1}; HREI-MS calcd for $C_{14}H_{18}O_3S$ MW 266.0977, found *m/z* 266.1000 $(M)^+$; Anal. Calcd for $C_{14}H_{18}O_3S$: C, 63.13; H, 6.81. Found: C, 63.05; H, 6.85.

The ee of **14** was determined on a Daicel chiral OB-H column with *n*-hexane : isopropanol = 15 : 1,

flow = 0.7 mL/min. The absolute configuration of **14** was determined by its chemical conversion to known ketoester **20**.[3]



14 **20**

51% (33% recovery of **14**)

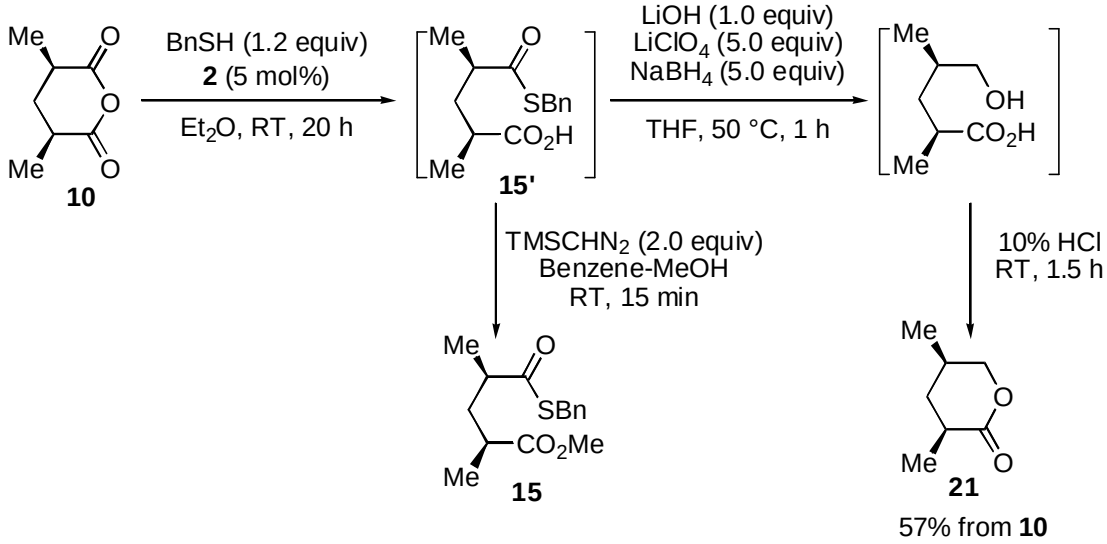
Methyl (*R*)-3-Methyl-5-oxophenylpentanoate (20):

colorless oil; 51% yield from **14**; $[\alpha]_D^{18}$ 3.14° (*c* 1.05, C_6H_6) (*S* enantiomer: lit.[3] $[\alpha]_D^{25}$ -5.65° (*c* 1.24, C_6H_6)); ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.01-7.91 (2H, m), 7.61-7.52 (1H, m), 7.51-7.41 (2H, m), 3.68 (3H, s), 3.11 (1H, dd, *J* = 16.4 and 5.9 Hz), 2.85 (1H, dd, *J* = 16.4 and 7.6 Hz), 2.73-2.61 (1H, m), 2.45 (1H, dd, *J* = 15.1 and 6.6 Hz), 2.33 (1H, dd, *J* = 15.1 and 7.1 Hz), 1.05 (3H, d, *J* = 6.8 Hz).

Methyl (*2S,4R*)-5-(Benzylthio)-2,4-dimethyl-5-oxopentanoate (15) (Table 2, Entry 3):

colorless oil; 100% yield; 90% ee; $[\alpha]_D^{20}$ -17.2° (*c* 1.05, $CHCl_3$); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.33-7.20 (5H, m), 4.11 (2H, s), 3.66 (3H, s), 2.76-2.65 (1H, m), 2.56-2.45 (1H, m), 2.20-2.11 (1H, m), 1.54-1.44 (1H, m), 1.20 (3H, d, *J* = 7.1 Hz), 1.17 (3H, d, *J* = 7.1 Hz); IR (neat) 3023, 2969, 1735, 1689, 1604, 1450, 1373, 1319, 1187 cm^{-1}; HREI-MS calcd for $C_{15}H_{20}O_3S$ MW 280.1133, found *m/z* 280.1118 $(M)^+$; Anal. Calcd for $C_{15}H_{20}O_3S$: C, 64.26; H, 7.19. Found: C, 64.09; H, 7.15.

The ee of **15** was determined on a Daicel chiral OB-H column with *n*-hexane : isopropanol = 15 : 1, flow = 1.0 mL/min. The absolute configuration of **15** was determined by chemical conversion of monocarboxylic acid **15'** to known lactone **21**.[4]



Chemical conversion of 10 to known lactone 21 via monocarboxylic acid 15':

To a solution of anhydride **10** (55 mg, 0.387 mmol) and **2** (10 mg, 0.0193 mmol) in Et_2O (3.9 mL) was added benzyl mercaptan (55 μL, 0.464 mmol) at room temperature. The mixture was stirred at room temperature under Ar for 20 h. *Sat*. $NaHCO_3$ *aq*. was added to the reaction mixture and washed with Et_2O. The aqueous portion was acidified with 10% HCl, and extracted with $CHCl_3$. The extract was dried over $MgSO_4$, filtrated, and then the filtrate was evaporated *in vacuo*. The residue was dissolved in THF (12 mL), and LiOH (9.2 mg, 0.387 mmol) was added. After being stirred at 50 °C for 15 min, $LiClO_4$ (205 mg, 1.935 mmol) and $NaBH_4$ (73 mg, 1.935 mmol) were added. The mixture was stirred at 50 °C for 1 h. The reaction mixture was concentrated *in vacuo*. The residue was treated with 10% HCl (15 mL), and stirred at room temperature for 1.5 h followed by extraction with $CHCl_3$. The extract was dried over $MgSO_4$, filtrated, and the filtrate was evaporated *in vacuo*. The residue was chromatographed on a silica gel column with AcOEt-*n*-hexane (1 : 1) to afford compound **21** (28.4 mg, 57% yield from **10**).

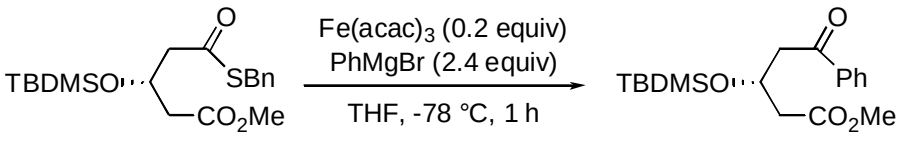
(*2S,4R*)-*cis*-2,4-Dimethyl-d**-valerolactone (21):**

white solid; 57% yield ; mp 33-36°C; $[\alpha]_D^{19}$ 41.2° (*c* 0.95, $CHCl_3$) (*2R,4S* enantiomer: lit.[4] $[\alpha]_D^{25}$ -41.1° (*c* 5-10, $CHCl_3$)); ^{1}H NMR (400 MHz, $CDCl_3$) δ 4.36-4.29 (1H, m), 3.93-3.86 (1H, m), 2.59-2.48 (1H, m), 2.20-2.03 (2H, m), 1.32-1.19 (1H, m), 1.27 (3H, d, *J* = 6.6 Hz), 0.99 (3H, d, *J* = 6.6 Hz).

Methyl (*S*)-5-(Benzylthio)-3-(*tert*-butyldimethylsilyloxy)-5-oxopentanoate (16) (Table 2, Entry 4):

colorless oil; 88% yield; 93% ee; $[\alpha]_D^{20}$ 16.6° (*c* 1.38, $CHCl_3$); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.32-7.21 (5H, m), 4.62-4.53 (1H, m), 4.14 (1H, d, *J* = 13.7 Hz), 4.09 (1H, d, *J* = 13.7 Hz), 3.66 (3H, s), 2.83 (1H, dd, *J* = 14.9 and 6.6 Hz), 2.77 (1H, dd, *J* = 14.9 and 5.7 Hz), 2.56 (1H, dd, *J* = 15.1 and 5.9 Hz), 2.51 (1H, dd, *J* = 15.1 and 6.6 Hz), 0.83 (9H, s), 0.05 (3H, s), 0.04 (3H, s); IR (neat) 2946, 2857, 1739, 1689, 1442, 1369, 1319, 1253 cm^{-1}; HREI-MS calcd for $C_{19}H_{30}O_4SSi$ MW 382.1634, found *m/z* 382.1642 $(M)^+$; Anal. Calcd for $C_{19}H_{30}O_4SSi$: C, 59.65; H, 7.90. Found: C, 59.39; H, 7.85.

The ee of **16** was determined on a Daicel chiral OD-H column with *n*-hexane : isopropanol = 19 : 1, flow = 0.5 mL/min. The absolute configuration of **16** was determined by its chemical conversion to known ketoester **22**.[5]



16 **22**

40% (40% recovery of **16**)

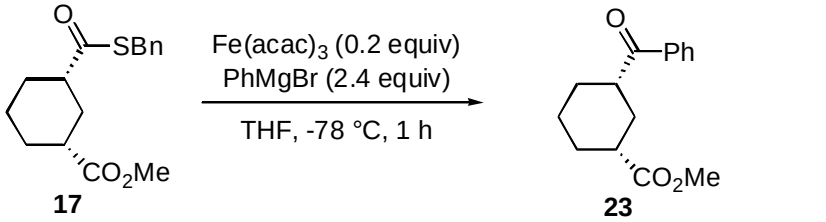
Methyl (*R*)-3-(*tert*-Butyldimethylsilyloxy)-5-oxo-5-phenylpentanoate (22):

colorless oil; 40% yield from **16**; $[\alpha]_D^{19}$ 10.4° (*c* 1.50, $CHCl_3$) (*S* enantiomer: lit.[5] $[\alpha]_D^{25}$ -7.7° (*c* 0.99, $CHCl_3$)); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.99-7.93 (2H, m), 7.60-7.54 (1H, m), 7.50-7.42 (2H, m), 4.80-4.72 (1H, m), 3.69 (3H, s), 3.29 (1H, dd, *J* = 16.2 and 6.6 Hz), 3.17 (1H, dd, *J* = 16.2 and 6.0 Hz), 2.66 (1H, dd, *J* = 14.7 and 5.7 Hz), 2.56 (1H, dd, *J* = 14.7 and 6.3 Hz), 0.80 (9H, s), 0.07 (3H, s), -0.02 (3H, s).

Methyl (*1R,3S*)-3-(Benzylthiocarbonyl)cyclohexanecarboxylate (17) (Table 2, Entry 5):

colorless oil; 90% yield; 98% ee; $[\alpha]_D^{20}$ -22.6° (*c* 1.42, $CHCl_3$); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.35-7.20 (5H, m), 4.11 (2H, s), 3.66 (3H, s), 2.58-2.48 (1H, m), 2.38-2.28 (1H, m), 2.26-2.18 (1H, m), 2.03-1.85 (3H, m), 1.68-1.56 (1H, m), 1.49-1.24 (3H, m); IR (neat) 3023, 2938, 2861, 1735, 1681, 1604, 1496, 1450, 1373, 1303, 1249, 1203 cm^{-1}; HREI-MS calcd for $C_{16}H_{20}O_3S$ MW 292.1133, found *m/z* 292.1118 $(M)^+$; Anal. Calcd for $C_{16}H_{20}O_3S$: C, 65.72; H, 6.89. Found: C, 65.42; H, 6.90.

The ee of **17** was determined on a Daicel chiral AD-H column with *n*-hexane : isopropanol = 19 : 1, flow = 0.5 mL/min. The absolute configuration of **17** was determined by its chemical conversion to known ketoester **23**.[5]



58% (20% recovery of **17**)

Methyl (*1R,3S*)-3-Benzoylcyclohexanecarboxylate (23):

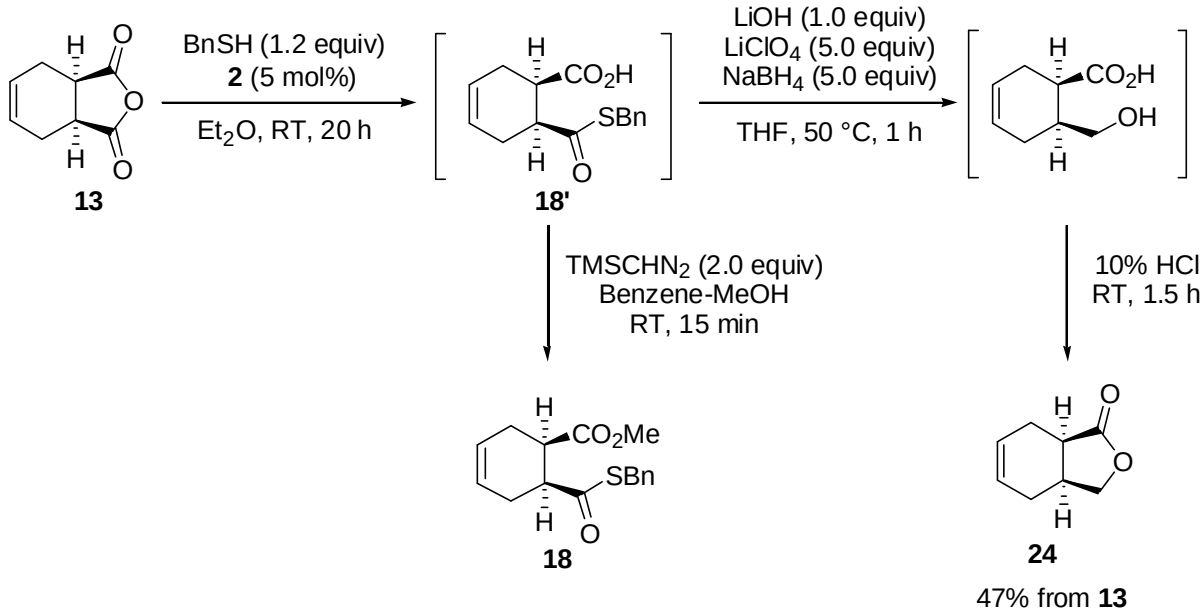
colorless oil; 58% yield from **17**; $[\alpha]_D^{18}$ –26.3° (*c* 1.60, $CHCl_3$) (*1S,3R* enantiomer: lit.[5] $[\alpha]_D^{25}$ 22.4° (*c* 1.13, $CHCl_3$)); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.98-7.84 (2H, m), 7.60-7.38 (3H, m), 3.67 (3H, s), 3.36-3.23 (1H, m), 2.54-2.39 (1H, m), 2.21-1.84 (4H, m), 1.74-1.57 (1H, m), 1.53-1.34 (3H, m).

Methyl (*1R,6S*)-6-(Benzylthiocarbonyl)cyclohex-3-enecarboxylate (18) (Table 2, Entry 6):

colorless oil; 90% yield; 83% ee; $[\alpha]_D^{20}$ -15.6° (*c* 1.17, $CHCl_3$); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.32-7.19 (5H, m), 5.74-5.64 (2H, m), 4.16 (1H, d, *J* = 13.7 Hz), 4.10 (1H, d, *J* = 13.7 Hz), 3.65 (3H, s), 3.22-3.15 (1H, m), 3.10-3.03 (1H, m), 2.66-2.31 (4H, m); IR (neat) 3031, 2923, 2846, 1735, 1681, 1604, 1496, 1442, 1342, 1288, 1203 cm^{-1}; HREI-MS calcd for $C_{16}H_{18}O_3S$ MW 290.0977, found *m/z* 290.0968 $(M)^+$; Anal. Calcd for $C_{16}H_{18}O_3S$: C, 66.18; H, 6.25. Found: C, 65.94; H, 6.29.

The ee of **18** was determined on a Daicel chiral OD-H column with *n*-hexane : isopropanol = 19 :

1, flow = 1.0 mL/min. The absolute configuration of **18** was determined by chemical conversion of **13** to known lactone **24**[6] via monocarboxylic acid **18'**.



(*1S,6R*)-8-Oxabicyclo[4.3.1]non-3-en-7-one (24):

colorless oil; 47% yield from **13**; $[\alpha]_D^{19}$ 41.8° (*c* 1.40, $CHCl_3$) (*1R,6S* enantiomer: lit.[6] $[\alpha]_D^{25}$ –67.1° (*c* 1.00, $CHCl_3$)); ^{1}H NMR (400 MHz, $CDCl_3$) δ 5.84-5.66 (2H, m), 4.33 (1H, dd, *J* = 8.8 and 5.1 Hz), 4.04 (1H, dd, *J* = 8.8 and 1.7 Hz), 2.87-2.19 (5H, m), 1.98-1.80 (1H, m).

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