

Supporting Information

General. Unless otherwise stated, all reactions were carried out under strictly anhydrous, air-free conditions. Formation of ligand-metal complex **2** was done in a glove box under N₂. All solvents were dried and distilled by standard procedures. The ¹H and ¹³C NMR spectra were acquired on a Varian Unity 400 MHz Spectrometer. The ¹H (400 MHz) and ¹³C chemical shifts (101 MHz) are given in parts per million (δ) with respect to internal TMS standards or residual solvent peaks. FTIR spectra were recorded on a Bruker IFS-55 spectrometer and optical rotations were recorded on a Perkin Elmer 120 polarimeter at room temperature. When possible, enantiomeric ratios were obtained using a Chiralcel OD chiral HPLC column. The ethyl glyoxylate was synthesized and purified by a known procedure.¹ The Cu(I)ClO₄•(CH₃CN)₄ was made according to the Kubas procedure.² Trimethylsilylethanesulfonamide³ and 4-Methoxy-2,6-dimethylbenzenesulfonamide,⁴ and nucleophiles **4a**, **4c**, and **4d**⁵ were prepared according to published procedures. All other starting materials were purchased from Aldrich Chemical Company, except for (*R*)-Tol-BINAP which were purchased from Strem Chemical. N, O-acetals **1g** and **1h**,⁶ and products **5a** and **5b**⁷ are known so characterization data is excluded.

General Synthesis of N,O Acetals 1a-h. The requisite amide or sulfonamide (5.0 g, 29.2 mmol) was mixed with ethyl glyoxylate (3.0 g, 29.2 mmol) in CHCl₃ and refluxed for several hours depending on the amide or sulfonamide. The reactions were monitored by ¹H NMR assays and glyoxylate was added when necessary to drive the reaction to completion. The reactions were worked up by removal of the solvent and any excess glyoxylate *in vacuo*. The crystalline residue was recrystallized from EtOAc/Hexanes, Et₂O/Hexanes or chromatographed on Florisil to yield analytically pure material.

***N-p*-Toluenesulfonylhydroxyglycine ethyl ester (1a).** White crystalline solid recrystallized from EtOAc/Hexanes; mp = 178-180 °C, Yield = 87%. ¹H NMR (CDCl₃) δ 7.78 (d, 2H), 7.28 (d, 2H), 5.92 (d, 1H), 5.28 (d, 1H), 4.20 (m, 2H), 3.78 (bs, 1H), 2.41 (s, 3H), 1.23 (t, 3H) ppm; ¹³C NMR (CDCl₃) δ 168.8, 143.9, 137.7, 129.6, 127.0, 75.4, 62.9, 21.5, 13.8 ppm; IR (CH₂Cl₂): 3459, 3278, 2955, 1736, 1338, 1161, 1096; Anal. Calcd for C₁₁H₁₅NO₅S: C, 48.34; H, 5.54; N, 5.13. Found C, 48.24; H, 5.55; N, 5.16.

(1) Kelly, T. R.; Schmidt, T. E.; Haggerty, J. G. *Synthesis* **1972**, 544-545.

(2) Kubas, G. J. *Inorg. Synth.*, Vol. XIX, Shriver, D. F., Ed.; Plenum, p 90-91, **1979**.

(3) Weinreb, S. M.; Demko, D. M.; Lessen, T. A. *Tetrahedron Lett.* **1986**, 42, 2099-2102.

(4) Wakimasu, M.; Kitada, C.; Fujino, M. *Chem. Pharm. Bull.* **1981**, 29, 2592-2597.

(5) (a) Colvin, E. W. *Silicon Reagents in Organic Synthesis*, Academic: New York, **1988**; Chapter 15.1. (b) Narayanan, B. A.; Bunnelle, W. H. *Tetrahedron Lett.* **1987**, 28, 6261-6264.

(6) Schmitt, M.; Bourguignon, J.-J.; Barlin, G. B.; Davies, L. P. *Aust. J. Chem.* **1997**, 50, 719-725.

(7) (a) Ferraris, D.; Young, B.; Dudding, T.; Lectka, T. *J. Am. Chem. Soc.* **1998**, 120, 4548-4549. (b) Drury, W. J. III, Ferraris, D.; Cox, C.; Young, B.; Lectka, T. *J. Am. Chem. Soc.* **1998**, 120, 11006-11007.

N-2,6 Dimethyl-4-methoxybenzenesulfonylhydroxyglycine ethyl ester (1b). White crystalline solid recrystallized from Et₂O; mp = 98-100 °C, Yield = 85%. ¹H NMR (CDCl₃) δ 6.60 (s, 2H), 5.68 (d, 1H), 5.18 (d, 1H), 4.19 (m, 2H), 3.80 (s, 3H), 3.50 (d, 1H), 2.64 (s, 6H), 1.25 (t, 3H) ppm; ¹³C NMR (CDCl₃) δ 161.4, 141.7, 129.0, 116.1, 94.3, 75.2, 62.8, 55.3, 23.3, 13.8 ppm; IR (CH₂Cl₂): 3267, 2921, 1736, 1596, 1461, 1309, 1212, 1153, 1088; Anal. Calcd for C₁₃H₁₉NO₆S: C, 49.20; H, 6.04; N, 4.42. Found C, 48.29; H, 6.08; N, 4.42.

N-2,6 Dimethyl-4-methoxybenzenesulfonylethoxyglycine ethyl ester (1c). The general procedure was followed except that the reaction was carried out in EtOAc and heated for several days to get the ether **1c** (45% yield) as the major product upon workup and column chromatography on silica gel (EtOAc/Hexanes). White crystalline solid mp = 89-91 °C; ¹H NMR (CDCl₃) δ 6.60 (s, 2H), 5.82 (d, 1H), 4.97 (d, 1H), 4.11 (q, 2H), 3.78 (s, 3H), 3.42 (m, 2H), 2.60 (s, 6H), 1.19 (t, 3H), 0.98 (t, 3H) ppm; ¹³C NMR (CDCl₃) δ 161.2, 141.3, 129.6, 116.0, 94.3, 81.1, 63.6, 62.3, 55.2, 23.3, 14.5, 13.8 ppm; IR (CH₂Cl₂): 3288, 2996, 2932, 1736, 1590, 1477, 1440, 1336, 1309, 1153, 1088; Anal. Calcd for C₁₅H₂₃NO₆S: C, 52.16; H, 6.72; N, 4.06. Found C, 52.27; H, 6.63; N, 3.97.

N-Methanesulfonylhydroxyglycine ethyl ester (1d). White crystalline solid recrystallized from Et₂O/hexane, mp = 76-78 °C, yield = 83%; ¹H NMR (CDCl₃) δ 6.21 (d, 1H), 5.28 (d, 1H), 4.22 (q, 2H), 3.70 (bs, 1H), 3.08 (s, 3H), 1.28 (t, 3H) ppm; ¹³C NMR (CDCl₃) δ 169.2, 75.5, 63.0, 43.2, 13.9 ppm; IR (CH₂Cl₂): 3285, 2927, 1744, 1334, 1159, 1094; Anal. Calcd for C₅H₁₁NO₅S: C, 30.45; H, 5.63; N, 7.11. Found C, 30.54; H, 5.59; N, 7.14.

N-p-Nitrobenzenesulfonylethoxyglycine ethyl ester (1e). The general procedure was followed except that the reaction was carried out in EtOAc and heated for several days to get the ether **1e** (35% yield) upon workup and column chromatography on silica gel (EtOAc/Hexanes). Yellow crystalline solid mp = 94-96 °C, ¹H NMR (CDCl₃) δ 8.31 (d, 2H), 8.04 (d, 2H), 6.26 (d, 1H), 5.14 (d, 1H), 4.18 (q, 2H), 3.54 (m, 2H), 1.25 (t, 3H), 1.04 (t, 3H) ppm; ¹³C NMR (CDCl₃) δ 166.9, 150.0, 146.7, 128.2, 124.1, 81.3, 64.1, 62.7, 14.5, 13.9 ppm; IR (CH₂Cl₂): 3279, 2983, 1746, 1533, 1351, 1172; Anal. Calcd for C₁₂H₁₆N₂O₇S: C, 43.36; H, 4.86; N, 8.43. Found C, 43.56; H, 4.79; N, 8.46.

N-(Trimethylsilyl)ethanesulfonylhydroxyglycine ethyl ester (1f). Colorless oil, yield = 93%; ¹H NMR (CDCl₃) δ 5.92 (d, 1H), 5.27 (d, 1H), 4.25 (q, 2H), 3.65 (bs, 1H), 3.04 (m, 2H), 1.30 (t, 3H), 1.03 (m, 2H) 0.02 (s, 9H) ppm; ¹³C NMR (CDCl₃) δ 169.3, 75.4, 62.9, 51.6, 13.9, 10.2, -2.05 ppm; IR (CH₂Cl₂): 3273, 2956, 1743, 1266, 1147; Anal. Calcd for C₉H₂₁NO₅SSi: C, 38.15; H, 7.48; N, 4.95. Found C, 38.26; H, 7.49; N, 4.97.

Synthesis of Trimethyl(2-phenyl-2-propenyl)silane (4b). This material was generated by a modification of a known route to the corresponding stannane.^[8] A flask was loaded with potassium *tert*-butoxide (4.52 g, 40.27 mmol) and α-methyl styrene (4.73 g, 40.00 mmol). The reagents were dissolved in THF (120 mL) and the resultant pale yellow solution cooled to -78 °C. To this solution was added a 1.29 M solution of butyllithium in hexanes (31 mL, 40.00 mmol) over 5 min causing color change to dark red. The solution was

(8) Desponds, O.; Schlosser, M. J. *Organomet. Chem.* **1991**, *409*, 93-101.

warmed and allowed to stir for 5 h at $-50\text{ }^{\circ}\text{C}$. This solution was then added to rapidly stirring $-78\text{ }^{\circ}\text{C}$ solution of chlorotrimethylsilane (11 mL, 86.67 mmol) in THF (30 mL). During the addition, the solution of silane becomes very thick and cloudy. The solution is then allowed to warm and stir at rt overnight. The THF was removed and the residue taken up in *n*-pentane. The solution was filtered through celite, the solvent removed and the residue purified by column chromatography on florisil (5x13cm Pet Ether to 1% Et₂O/Pet Ether) to give 79% yield of a clear colorless oil (6.06g 31.77 mmol) identical to that reported previously in the literature.^{5b}

Representative Alkylation Procedure. The catalyst **2** was made by dissolving (*R*)Tol-BINAP (15 mg, 0.022 mmol) and CuClO₄•(CH₃CN)₂ (7 mg, 0.021 mmol) in CH₂Cl₂. To the tosyl acetal **1a** (100 mg, 0.37 mmol), in CH₂Cl₂ (2 mL) was added the solution of catalyst **2**. This reaction mixture was cooled to $0\text{ }^{\circ}\text{C}$ and the enol silane **4a** (142 mg, 0.74 mmol) was added to the reaction mixture over a period of 30 minutes. The reaction was stirred at room temperature or heated to reflux until completion as shown by TLC (30% EtOAc/Hexanes). The reaction was partitioned with water (3 mL) and CH₂Cl₂ (3 mL). The organic layer was dried with MgSO₄ and the solvent removed *in vacuo*. The crude residue (200 mg) was subject to column chromatography on silica gel to yield 128 mg of the final product (93% yield, 95% ee).

(*S*)-Ethyl-3-(phenylcarboxy)-2-(tosylamino)propanoate (5c). White crystalline solid. mp = $88\text{--}90\text{ }^{\circ}\text{C}$; $[\alpha]_{\text{D}} = +16.6$ ($c = 0.03$, CH₂Cl₂); ¹H NMR (CDCl₃) δ 7.78 (d, 2H), 7.30 (m, 5H), 7.00 (d, 2H), 5.61 (d, 1H), 4.22 (m, 1H), 4.03 (m, 2H), 3.16 (m, 2H), 2.40 (s, 3H), 1.07 (t, 3H); ¹³C NMR (CDCl₃) δ 169.6, 168.8, 150.1, 143.8, 136.5, 129.7, 129.4, 127.2, 126.1, 121.3, 62.4, 52.2, 38.2, 21.5, 13.8; IR (CH₂Cl₂): 3283, 2926, 1743, 1493, 1342, 1267, 1164; HPLC (10% *i*PrOH/Hexane, 0.7 mL/min) (*R*) = 42.5, (*S*) = 48.2 min. Anal. Calcd for C₁₉H₂₁NO₆S: C, 58.3; H, 5.41; N, 3.58. Found C, 58.50; H, 5.44; N, 3.62.

(*S*)-Ethyl-3-Benzoyl-2-(4-methoxy-2,6-dimethylbenzenesulfonylamino)-propanoate (5d). Colorless oil; $[\alpha]_{\text{D}} = +35.6$ ($c = 0.042$, CH₂Cl₂); ¹H NMR (CDCl₃) δ 7.81 (d, 2H), 7.57 (t, 1H), 7.42 (t, 2H), 6.58 (s, 2H), 4.20 (m, 1H), 4.09 (m, 2H), 3.78 (s, 3H), 3.59 (d, 2H), 2.62 (s, 6H), 1.12 (t, 3H) ppm; ¹³C NMR (CDCl₃) δ 196.8, 170.6, 161.1, 141.6, 135.8, 133.7, 128.8, 128.6, 128.0, 116.0, 62.0, 55.1, 51.5, 41.5, 23.3, 13.8 ppm; IR (CH₂Cl₂): 3300, 2978, 2936, 1738, 1682, 1594, 1449, 1312, 1155, 1088; HPLC (12% EtOH/Hexane, 1.4 mL/min) (*R*) = 17.62, (*S*) = 20.95 min. Anal. Calcd for C₂₁H₂₅NO₆S: C, 60.12; H, 6.01; N, 3.34. Found C, 60.34; H, 6.07; N, 3.37.

(*S*)-Ethyl-3-Benzoyl-2-(4-nitrobenzenesulfonylamino)propanoate (5e). White crystalline solid mp = $152\text{--}154\text{ }^{\circ}\text{C}$; $[\alpha]_{\text{D}} = +46.2$ ($c = 0.19$, CH₂Cl₂); ¹H NMR (CDCl₃) δ 8.29 (d, 2H), 8.04 (d, 2H), 7.82 (d, 2H), 7.57 (t, 1H), 7.41 (t, 2H), 6.05 (d, 1H), 4.35 (m, 1H), 4.03 (q, 2H), 3.74 (m, 1H), 3.58 (m, 1H), 1.08 (t, 3H) ppm; ¹³C NMR (CDCl₃) δ 196.8, 169.8, 146.0, 135.5, 134.0, 128.7, 128.4, 128.0, 124.1, 62.2, 52.0, 41.9, 13.8 ppm; IR (CH₂Cl₂): 3305, 3054, 1742, 1533, 1422, 1350, 1265, 1167; HPLC (12% EtOH/Hexane, 1.0 mL/min) (*R*) = 25.8, (*S*) = 30.9 min. Anal. Calcd for C₁₈H₁₈N₂O₇S: C, 53.19; H, 4.47; N, 6.90. Found C, 53.34; H, 4.54; N, 6.67.

(*S*)-Ethyl-3-Benzoyl-2-(methanesulfonylamino)propanoate (5f). Colorless oil; $[\alpha]_{\text{D}} = +16.4$ ($c = 0.02$, CH₂Cl₂); ¹H NMR (CDCl₃) δ 7.90 (d, 2H), 7.61 (t, 1H), 7.47 (t, 2H), 5.58 (d, 1H), 4.47 (m, 1H), 4.21 (m, 2H), 3.80 (m, 1H), 3.57 (m, 1H), 3.07 (s, 3H), 1.20 (t, 3H) ppm; ¹³C NMR (CDCl₃) δ 171.1, 135.6, 133.9, 128.8, 128.1, 62.2, 52.2, 42.4, 41.5, 14.0 ppm; IR (CH₂Cl₂): 3056, 2975, 2936, 1736, 1681, 1338,

1261, 1152, 906; HPLC (10% EtOH/Hexane, 1.0 mL/min) (*R*) = 42.44, (*S*) = 50.54 min. Anal. Calcd for C₁₃H₁₇NO₅S: C, 52.16; H, 5.73; N, 4.68. Found C, 51.98; H, 5.79; N, 4.72.

(*S*)-Ethyl-3-Benzoyl-2-((trimethylsilyl)ethanesulfonylamino)-propanoate (5g). Colorless oil; [α]_D = +17.3 (*c* = 0.026, CH₂Cl₂); ¹H NMR (CDCl₃) δ 7.91 (d, 2H), 7.58 (t, 1H), 7.45 (t, 2H), 5.44 (d, 1H), 4.44 (m, 1H), 4.20 (m, 2H), 3.78 (m, 1H), 3.56 (m, 1H), 3.03 (m, 2H), 1.23 (t, 3H), 1.03 (m, 2H) ppm; ¹³C NMR (CDCl₃) δ 197.3, 171.0, 135.7, 133.9, 128.7, 128.1, 62.0, 52.2, 50.0, 42.6, 14.0, 10.3, -2.02 ppm; IR (CH₂Cl₂): 3206, 2912, 1740, 1676, 1325, 1220, 1152, 1116, 1029; HPLC (10% EtOH/Hexane, 1.0 mL/min) (*R*) = 42.44, (*S*) = 50.54 min. Anal. Calcd for C₁₇H₂₇NO₅SSi: C, 52.97; H, 7.07; N, 3.64. Found C, 52.72; H, 7.18; N, 3.71.

(2*S*)-4-Phenyl-2-(toluene-4-(trimethylsilyl)ethanesulfonyl)-pent-4-enoic acid ethyl ester (5h). Colorless oil; [α]_D = +5.3 (*c* = 0.004); ¹H NMR (CDCl₃) δ 7.33 (m, 5H), 5.38 (s, 1H), 5.18 (s, 1H), 4.77 (d, 1H), 4.12 (m, 1H), 4.00 (m, 2H), 3.01 (m, 1H), 2.92 (m, 1H), 2.76 (m, 2H), 1.20 (t, 3H), 0.90 (m, 2H), -0.03 (s, 9H) ppm; ¹³C NMR (CDCl₃) δ 171.8, 142.9, 139.2, 128.5, 128.0, 126.3, 117.1, 61.7, 54.7, 49.9, 39.4, 14.0, 10.1, -2.07 ppm; IR (CH₂Cl₂): 3209, 1736, 1339, 1145, 910; HPLC (10% iPrOH/Hexane, 1.0 mL/min) (*R*) = 8.25, (*S*) = 9.15 min. Anal. Calcd for C₁₈H₂₉NO₄SSi: C, 56.37; H, 7.63; N, 3.65. Found C, 56.57; H, 7.60; N, 3.55.

(*S*)-Ethyl-3-(phenylcarboxy)-2-(trimethylsilylethanesulfonylamino)-propanoate (5i). Colorless oil; [α]_D = + 5.7 (*c* = 0.012, CH₂Cl₂); ¹H NMR (CDCl₃) δ 7.37 (t, 2H), 7.22 (t, 1H), 7.05 (d, 2H), 5.38 (d, 1H), 4.42 (m, 1H), 4.22 (m, 2H), 3.24 (m, 1H), 3.10 (m, 1H), 3.00 (m, 2H), 1.26 (t, 3H), 1.08 (m, 2H), 0.02 (s, 9H) ppm; ¹³C NMR (CDCl₃) δ 170.3, 169.3, 150.1, 129.5, 126.2, 121.2, 62.4, 52.6, 50.1, 38.4, 14.1, 10.3, -2.05 ppm; IR (CH₂Cl₂): 3296, 2955, 1751, 1593, 1332, 1251, 1194, 1145; Anal. Calcd for C₁₇H₂₇NO₆SSi: C, 50.86; H, 6.78; N, 3.49. Found C, 50.67; H, 6.85; N, 3.52.⁹

(*S*)-Ethyl-3-(benzoyl)-2-(acetamino)propanoate (5j). Colorless oil; [α]_D = +31.3 (*c* = 0.064, CH₂Cl₂); ¹H NMR (CDCl₃) δ 7.89 (d, 2H), 7.56 (t, 1H), 7.41 (t, 2H), 6.72 (d, 1H), 4.93 (m, 1H), 4.19 (q, 2H), 3.73 (m, 1H), 3.57 (m, 1H), 2.00 (s, 3H), 1.22 (t, 3H) ppm; ¹³C NMR (CDCl₃) δ 197.8, 171.1, 169.9, 135.8, 133.7, 128.7, 128.0, 61.7, 48.2, 40.4, 23.0, 13.9 ppm; IR (CH₂Cl₂): 3437, 3055, 1741, 1680, 1503, 1265, 1219; HPLC (10% iPrOH/Hexane, 0.4 mL/min) (*R*) = 41.1, (*S*) = 43.4 min. Anal. Calcd for C₁₄H₁₇NO₄: C, 63.85; H, 6.51; N, 5.32. Found C, 63.74; H, 6.45; N, 5.26.

(*S*)-Ethyl-3-(phenylcarboxy)-2-(amino)propanoate hydrochloride (6a).¹⁰ Potassium carbonate (45 mg, 0.33 mmol) was added to a solution of optically pure (*S*)-**5e** (40 mg, 0.10 mmol) and thiophenol (13 mg, 0.11 mmol) in acetonitrile (3 mL). The reaction mixture was stirred at room temperature overnight. The volatiles were removed *in vacuo* and the residue was taken up in Et₂O and extracted with 1 N HCl. The acid layer was basified with solid potassium carbonate and extracted with EtOAc (3 mL) to afford 28 mg of the crude amine. The

(9) The optical purity of compound **13** was obtained by the use of chiral shift reagent preseodymium tris[3-(heptafluoropropylhydroxymethylene)-(+)-camphorate see: Parker, D. *Chem. Rev.* **1991**, 1441-1457.

(10) Bowman, W. R.; Coghlan, D. R. *Tetrahedron* **1997**, *53*, 15787-15798.

crude compound was dissolved in Et₂O and gaseous HCl was bubbled through the solution to precipitate the hydrochloride salt **6a** (22 mg, 88% yield): [α]_D = + 5.5 (c = 0.010, D₂O); ¹H NMR (D₂O) δ 8.00 (d, 2H), 7.72 (t, 1H), 7.58 (t, 2H), 4.58 (m, 1H), 4.28 (m, 2H), 3.94 (q, 2H), 1.22 (t, 3H) ppm; ¹³C NMR (D₂O, dioxane reference) δ 199.7, 170.3, 135.5, 135.4, 129.6, 128.9, 64.3, 49.5, 38.7, 13.7 ppm; IR (NaCl): 3305, 3054, 1740, 1350, 1265, 1167; HPLC (amine) (20% EtOH/Hexane, 1.4 mL/min) (*R*) = 8.15, (*S*) = 9.54 min. Anal. Calcd for C₁₂H₁₆ClNO₃: C, 65.13; H, 6.84; N, 6.33. Found C, 65.33; H, 6.85; N, 6.26. Acidic hydrolysis of **6** in 6 M HCl yielded (L)-benzoylalanine hydrochloride (96%) which was identical in all respects ([α], ¹H NMR, ¹³C NMR and IR) to the literature compound.¹¹

Deprotection of 5d.⁴ Compound **5d** (50 mg, 0.12 mmol) was taken up into a solution of (trifluoroacetic acid:thioanisole; 9:1; 1 mL) followed by the addition of methylsulfonic acid (0.2 mL). The mixture was stirred for 12 h at rt and the volatiles removed under high vacuum. The resulting oil was diluted with 1 N HCl (2 mL) and washed repeatedly with Et₂O, the aqueous layer was basified with K₂CO₃, and extraction with EtOAc. The EtOAc layer was dried over MgSO₄, filtered and concentrated *in vacuo* affording a yellow oil. The crude compound was dissolved in Et₂O and gaseous HCl was bubbled through the solution to precipitate the hydrochloride salt **6** (24 mg, 77% yield). Acidification of amine **6** as stated above produced (L)-benzoylalanine in similar yield and minimal racemization.

Deprotection of 5g.¹² A solution of compound **5g** (65 mg, 0.17 mmol) and Cesium fluoride (82 mg, 0.54 mmol) were heated together in DMF (1 mL) for 24 h. The reaction mixture was concentrated and the resulting crude residue was partitioned between Et₂O and 1 M HCl. Basification of the acid layer followed by extraction with EtOAc (3 mL) afforded the crude amine which was transformed to the hydrochloride salt as above (36 mg, 90% yield). The amine was refluxed for 4 h in 6M HCl and concentrated to afford 34 mg (87% overall yield) of (L)-benzoylalanine hydrochloride.

One pot Synthesis of 5a. A solution of toluenesulfonamide (150 mg, 0.88 mmol) and freshly distilled ethyl glyoxylate (90 mg, 0.88 mmol) were mixed together in CH₂Cl₂ (3 mL). After 1 h, a solution of catalyst **2** was added and the reaction mixture was stirred at rt for 24 h. The enol silane **4a** was then added to the mixture at 0 °C over a 30 min period. After 2 h, the reaction was quenched with H₂O (3 mL) and extracted with CH₂Cl₂ (3 mL). The aqueous layer was reextracted with CH₂Cl₂ and the combined organics were dried with MgSO₄ and concentrated. The crude reaction mixture was triturated with hexanes and the resulting crystals were recrystallized from Et₂O to yield 294 mg (89%) of compound **5a**. Chiral HPLC analysis revealed that the product was 95% enantiomerically enriched.

Synthesis of [L]-*m*-Nitrobenzoylalanine. To solution of N, O acetal **1d** (2.18 g, 6.5 mmol) in THF (20 mL) was added 1-(*m*-Nitrophenyl)-1-(trimethylsilyloxy)ethylene¹³ (1.7 g, 7.0 mmol) and a solution of catalyst **2** (100 mg, 0.1 mmol) at rt. The reaction was refluxed for 24 hours and quenched with water (15 mL). The product was extracted from the THF:H₂O mixture with CH₂Cl₂ (2 x 20 mL). The combined organics were dried,

(11) Gulobev, A. S.; Sewald, N.; Burger, K. *Tetrahedron* **1996**, *52*, 14757-14776.

(12) Garigipati, R. S.; Tschaen, D. M.; Weinreb, S. M. *J. Am. Chem. Soc.* **1990**, *112*, 3475-3482.

(13) Schumacher, R.; Reißig, H.-U. *Liebigs Ann./Recueil* **1997**, 521-525.

concentrated and chromatographed on silica gel (1:5:5 EtOAc:Hexanes:CH₂Cl₂) to afford 2.45 g (85% yield, 94 %ee) of a yellow crystalline solid. Recrystallization of **5k** from EtOAc/Hexanes provided 1.8 g of 99% enantiomerically enriched material. mp = 130-131°C [α]_D = +21.9 (c = 0.05, EtOAc); ¹H NMR (CDCl₃) δ 8.68 (s, 1H), 8.43 (d, 2H), 8.33 (d, 2H), 8.22 (d, 1H), 8.04 (d, 2H), 7.68 (t, 1H), 6.00 (d, 1H), 4.37 (m, 1H), 4.03 (m, 2H), 3.79 (m, 1H), 3.66 (m, 1H), 1.04 (t, 3H) ppm; ¹³C NMR (CDCl₃) δ 194.9, 169.5, 150.1, 148.4, 145.6, 136.7, 133.5, 130.2, 128.5, 128.2, 124.2, 123.0, 62.6, 51.8, 42.5, 13.9 ppm; IR (CH₂Cl₂): 3355, 3075, 2942, 1742, 1692, 1613, 1535, 1352, 1313, 1221, 1169; HPLC (15% EtOH/Hexane, 1.0 mL/min) (*R*) = 41.1, (*S*) = 43.1 min. Anal. Calcd for C₁₈H₁₇N₃O₉S: C, 47.89; H, 3.80; N, 9.31. Found C, 47.75; H, 3.84; N, 9.28. Deprotection of the nitrosulfonyl group was done analogously to compound (*S*)-**5e** stated above. The ethyl ester was cleaved by heating in 6M HCl (10 mL) to yield 0.703 g (77% overall) of the enantiomerically pure [L]-*m*-Nitrobenzoylalanine.¹⁴

O-Silylation NMR Experiment: The following 0.5 mL CD₂Cl₂ solutions were made up A) *N*-*p*-Toluenesulfonylhydroxyglycine ethyl ester **1a** (25 mg, 0.091 mmol) B) Cu(I)ClO₄•(CH₃CN)₄ (30 mg, 0.091 mmol) and (*R*)-Tol-BINAP (62 mg, 0.091 mmol) C) 1-phenyl-1-(trimethylsilyloxy)ethylene **4a** [35 mg, 0.181 mmol, ¹H NMR: δ 7.65 (d, 2H), 7.38 (m, 3H), 5.00 (s, 1H), 4.51 (s, 1H), 0.38 (s, 9H) ppm]. Solutions A and B were mixed together. No detectable peak shifts were observed. A solution of C (0.125 mL) is added to the solution of A/B. The spectra contained peaks corresponding to both the enol silane (see above) and acetophenone [¹H NMR: δ 8.01 (d, 2H), 7.58 (t, 1H), 7.50 (t, 2H), 2.62 (s, 3H) ppm]. The amide peak of **1a** (δ 5.95 ppm) maintained its relative integration. The alcohol proton of **1a**, however, (δ 3.78 ppm) decreased its relative integration and the presence of a new silyl group (δ 0.18 ppm). Another 0.130 mL of C is added to A/B and the spectra taken at 5 min and 1 hr after the addition. After 1 hr all new peaks can be attributed to the product **5a**. The rest of C is added to A/B and the proton spectra collected at 5 min, 1 hr, 2 hr, 4 hr and 18 hr. During this period the smooth conversion to product is observed. As indicated in the text: 1) peaks corresponding to the silylated product **7** are not observed during the reaction. 2) peaks corresponding to the imine **3** are not observed.

In a separate experiment, *N*-*p*-Toluenesulfonylhydroxyglycine ethyl ester **1a** (25 mg, 0.091 mmol) and 1-phenyl-1-(trimethylsilyloxy)ethylene **4a** (70 mg, 0.364 mmol) were dissolved in CD₂Cl₂ (0.75 mL) and a ¹H spectra was obtained. There is no evidence for any product formation under these conditions even after 18 hr.

(14) Pellicciari, R.; Natalini, B.; Constantino, G. *J. Med. Chem.* **1994**, *37*, 647-655.