Highly Diastereo- and Enantioselective Synthesis of \textit{syn}-\beta-Substituted Tryptophans via the Reaction of a Chiral Equivalent of Nucleophilic Glycine and Sulfonylindoles

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(A) General Methods

The reagents (chemicals) were purchased from commercial sources, and used without further purification. Analytical thin layer chromatography (TLC) was HSGF 254 (0.15-0.2 mm thickness). All products were characterized by their NMR and MS spectra. $^1$H and $^{13}$C NMR spectra were recorded in deuterochloroform (CDCl$_3$) on a 300 MHz or 400 MHz instrument. Chemical shifts were reported in parts per million (ppm, δ) downfield from tetramethylsilane. Proton coupling patterns are described as singlet (s), doublet (d), triplet (t), quartet (q), multiplet (m), and broad (br). Low- and high-resolution mass spectra (LRMS and HRMS) were measured on spectrometer. Optical rotations were reported as follows: $\alpha$$_D$ (c: g/100 mL, in solvent).
(B) General Procedure for the Asymmetric Reactions

General Procedure for the Synthesis of (S)(2S,3R)-3a. The nickel(II) complex of glycine (S)-1 (100 mg, 0.201 mmol) was dissolved in dichloromethane (10 mL). Sulfonylindole derived from benzaldehyde 2a (76 mg, 0.211 mmol) and DBU (37 µL, 0.241 mmol) were added at ambient temperature. The reaction mixture was stirred for 1 h. The reaction was quenched by pouring the crude reaction mixture over 30 mL of aq. sat. NH₄Cl. The suspension was extracted with ethyl acetate (3 times). The combined organic layers were dried with MgSO₄, concentrated, and purified by column chromatography on silica gel (petroleum ether/ethyl acetate = 1/1) to give (S)(2S,3R)-3a as a red solid.

Procedure for the Synthesis of (2S,3R)-4a: The crystallized complex (S)(2S,3R)-3a (1 g, 1.42 mmol) was decomposed by refluxing a suspension in a mixture of aqueous 6 N HCl (1 mL) and MeOH (15 mL) for 30 min, until the red color of the solution disappeared, as described previously. The reaction was cooled to room temperature and then evaporated to dryness. Water (20 mL) was added to the residue to form a clear solution, and this solution was then separated by column chromatography on C₁₈-reversed phase (230-400 mesh) silica gel. Pure water as an eluent was employed to remove the green NiCl₂ and excess HCl; water was then used to obtain optically pure product (2S,3R)-4a (398 mg, 96%). The ligand BPB that decomposed from
(S)(2S,3R)-3a was recovered by MeOH eluent (608 mg, 96%), and the column chromatography was washed with 100 mL of MeOH for further use.

**Procedure for the synthesis of (S)-1.**

(S)-BPB (1 g, 2.60 mmol), Gly (976 mg, 13.0 mmol), Ni(NO$_3$)$_2$·6H$_2$O (1.52 g, 5.21 mmol), MeOH (50 mL) was added as solvent. And NaH (55-65% in oil, 1.04 g, 26 mmol), KOH (437 mg, 7.81 mmol) were added successively. The resulting mixture was refluxed for 2 h and then the reaction was terminated and cooled. The solution was neutralized with acetic acid. After 12 h the separated crystalline solid was filtered and washed with 100 mL of ethanol, followed by stirring in methane/water (v/v) 1:2, 200 mL), then filtered to form a red crystal (1.27 g, yield 98%). The complex was sufficiently pure for further use without additional purification.
(C) Analytical Characterization Data of Products

Nickel(II)-(S)-BPB/(2S,3R)-2-Amino-3-(1H-indol-3-yl)-3-phenyl-propanoic Acid Schiff Base Complex 3a.

Obtained as a red solid by flash column chromatography (petroleum ether/ethyl acetate = 1/1), yield 82%. Mp 183-185 ºC; [α] D 24 = +1792 (c = 0.25 g/100 mL, CHCl3). 1H NMR (CDCl3, 300 MHz) δ 8.34 (d, J = 8.4 Hz, 1H), 8.03 (d, J = 8.1 Hz, 2H), 7.45-7.29 (m, 6H), 7.26-7.19 (m, 4H), 7.15-7.02 (m, 2H), 6.99-6.92 (m, 1H), 6.87-6.80 (m, 2H), 6.71-6.64 (m, 2H), 4.76 (d, J = 2.7 Hz, 1H), 4.44 (d, J = 2.7 Hz, 1H), 4.25 (d, J = 12.6 Hz, 1H), 3.49-3.40 (m, 2H), 2.80-2.76 (m, 1H), 2.40-2.31 (m, 2H), 2.01-1.87 (m, 2H) ppm. 13C NMR (CDCl3, 100 MHz) δ 180.6, 171.6, 143.0, 140.8, 135.5, 134.2, 133.8, 133.3, 132.5, 131.6, 130.4, 129.3, 128.9, 128.8, 128.7, 127.8, 127.4, 126.7, 126.5, 126.1, 123.8, 123.1, 121.4, 120.5, 118.6, 115.2, 110.7, 96.6, 74.7, 70.6, 63.7, 57.5, 49.8, 30.9, 23.2 ppm. LRMS (ESI) [M+H]+ found m/z 703. HRMS (ESI) [M+Na]+ found m/z 725.2045, calcd for C42H36N4NiO3Na 725.2039. HPLC (Chiralpak IA, n-hexane/i-propanol = 60/40, flow rate 1.0 mL/min, λ= 220 nm), tmajor = 13.6 min, de > 99%.

Nickel(II)-(S)-BPB/(2S,3R)-2-Amino-3-(1H-indol-3-yl)-3-0-tolyl-propanoic Acid Schiff Base Complex 3b.

Obtained as a red solid by flash column chromatography (petroleum ether/ethyl acetate = 1/1), yield 82%. Mp 183-185 ºC; [α] D 24 = +1792 (c = 0.25 g/100 mL, CHCl3). 1H NMR (CDCl3, 300 MHz) δ 8.34 (d, J = 8.4 Hz, 1H), 8.03 (d, J = 8.1 Hz, 2H), 7.45-7.29 (m, 6H), 7.26-7.19 (m, 4H), 7.15-7.02 (m, 2H), 6.99-6.92 (m, 1H), 6.87-6.80 (m, 2H), 6.71-6.64 (m, 2H), 4.76 (d, J = 2.7 Hz, 1H), 4.44 (d, J = 2.7 Hz, 1H), 4.25 (d, J = 12.6 Hz, 1H), 3.49-3.40 (m, 2H), 2.80-2.76 (m, 1H), 2.40-2.31 (m, 2H), 2.01-1.87 (m, 2H) ppm. 13C NMR (CDCl3, 100 MHz) δ 180.6, 171.6, 143.0, 140.8, 135.5, 134.2, 133.8, 133.3, 132.5, 131.6, 130.4, 129.3, 128.9, 128.8, 128.7, 127.8, 127.4, 126.7, 126.5, 126.1, 123.8, 123.1, 121.4, 120.5, 118.6, 115.2, 110.7, 96.6, 74.7, 70.6, 63.7, 57.5, 49.8, 30.9, 23.2 ppm. LRMS (ESI) [M+H]+ found m/z 703. HRMS (ESI) [M+Na]+ found m/z 725.2045, calcd for C42H36N4NiO3Na 725.2039. HPLC (Chiralpak IA, n-hexane/i-propanol = 60/40, flow rate 1.0 mL/min, λ= 220 nm), tmajor = 13.6 min, de > 99%.
acetate = 1/1), yield 88%. Mp 174-176 ºC; \([\alpha]^{21}_D = +1017\) (c = 0.18 g/100 mL, CHCl₃). ¹H NMR (CDCl₃, 300 MHz) \(\delta\) 8.34 (d, \(J = 8.7\) Hz, 1H), 8.03 (d, \(J = 7.5\) Hz, 2H), 7.90 (s, 1H), 7.65 (s, 1H), 7.54-7.52 (m, 2H), 7.45-7.31 (m, 5H), 7.19-7.07 (m, 5H), 6.97-6.95 (m, 1H), 6.81-6.66 (m, 5H), 4.76 (d, \(J = 2.1\) Hz, 1H), 4.41 (d, \(J = 1.8\) Hz, 1H), 4.25 (d, \(J = 12.3\) Hz, 1H), 3.44-3.29 (m, 2H), 2.82-2.73 (m, 1H), 2.38-2.24 (m, 5H), 2.04-1.98 (m, 1H) ppm. ¹³C NMR (CDCl₃, 100 MHz) \(\delta\) 180.5, 180.4, 170.3, 141.9, 133.4, 133.3, 132.0, 131.5, 129.7, 128.9, 127.4, 127.1, 126.4, 123.8, 120.8, 70.2, 66.5, 63.0, 57.2, 30.7, 24.1, 21.8 ppm. LRMS (ESI) [M+H]⁺ found m/z 717. HRMS (ESI) [M+Na]⁺ found m/z 739.2179, calcd for C₄₃H₃₈N₄NiO₃Na 739.2195.

HPLC (Chiralpak IA, \(n\)-hexane/\(i\)-propanol = 60/40, flow rate 1.0 mL/min, \(\lambda = 220\) nm), t_major = 11.5 min, de > 99%.

**Nickel(II)-(S)-BPB/(2S,3R)-2-Amino-3-(1H-indol-3-yl)-3-m-tolyl-propanoic Acid Schiff Base Complex 3c.**

Obtained as a red solid by flash column chromatography (petroleum ether/ethyl acetate = 1/1), yield 89%. Mp 177-179ºC; \([\alpha]^{20}_D = +1979\) (c = 0.14 g/100 mL, CHCl₃). ¹H NMR (CDCl₃, 300 MHz) \(\delta\) 8.46 (s, 1H), 8.28 (d, \(J = 8.8\) Hz, 1H), 8.03 (d, \(J = 7.2\) Hz, 2H), 7.35-7.29 (m, 1H), 7.24-7.20 (m, 2H), 7.15-7.01 (m, 2H), 7.15-7.01 (m, 1H), 6.66-6.57 (m, 3H), 4.90 (d, \(J = 1.2\) Hz, 1H), 4.79 (d, \(J = 3.6\) Hz, 1H), 4.22-4.09 (m, 2H), 3.49 (s, 3H), 3.38-3.34 (m, 1H), 3.26-3.20 (m, 1H), 2.76-2.71 (m, 1H), 2.04 (s, 2H), 1.89-1.84 (m, 3H) ppm. ¹³C NMR (CDCl₃, 100 MHz) \(\delta\) 181.4, 177.3, 171.6, 142.5, 134.6, 133.3, 133.2, 132.2, 131.7, 129.7, 129.6, 129.3, 129.1,
128.9, 126.2, 125.6, 125.2, 124.2, 120.8, 69.9, 63.1, 61.3, 57.5, 30.7, 23.7 ppm.

LRMS (ESI) [M+H]$^+$ found m/z 717. HRMS (ESI) [M+Na]$^+$ found m/z 739.2192, calcd for C$_{43}$H$_{38}$N$_4$NiO$_3$Na 739.2195. HPLC (Chiralpak IA, $n$-hexane/$i$-propanol = 60/40, flow rate 1.0 mL/min, $\lambda$= 220 nm), $t_{\text{major}}$ = 12.2 min, de > 99%.

**Nickel(II)-(S)-BPB/(2S,3R)-2-Amino-3-(1H-indol-3-yl)-3-p-tolyl-propanoic Acid Schiff Base Complex 3d.**

Obtained as a red solid by flash column chromatography (petroleum ether/ethyl acetate = 1/1), yield 87%. Mp 171-173 ºC; $[\alpha]^{20}_D = +1467$ (c = 0.12 g/100 mL, CHCl$_3$). $^1$H NMR (CDCl$_3$, 400 MHz) $\delta$ 8.63 (s, 1H), 8.28 (d, $J$ = 8.8 Hz, 1H), 8.03 (d, $J$ = 7.2 Hz, 2H), 7.35-7.29 (m, 2H), 7.24-7.20 (m, 5H), 7.15-7.01 (m, 8H), 6.84 (d, $J$ = 7.1 Hz, 1H), 6.66-6.57 (m, 2H), 6.15 (d, $J$ = 7.6 Hz, 1H), 5.53 (d, $J$ = 8.8 Hz, 1H), 4.70 (d, $J$ = 4.4 Hz, 1H), 4.27 (d, $J$ = 12.8 Hz, 1H), 3.40 (d, $J$ = 12.4 Hz, 1H), 3.31-3.27 (m, 1H), 2.92-2.86 (m, 1H), 2.67 (s, 3H), 2.32-2.25 (m, 3H), 2.21-2.10 (m, 1H), 2.07-2.05 (m, 2H) ppm. $^{13}$C NMR (CDCl$_3$, 100 MHz) $\delta$ 181.3, 177.3, 171.6, 142.4, 134.6, 133.3, 133.2, 132.2, 131.7, 129.7, 129.6, 129.3, 129.1, 128.9, 126.2, 125.6, 125.2, 124.2, 120.8, 69.9, 63.1, 61.2, 57.4, 30.7, 23.7 ppm. LRMS (ESI) [M+H]$^+$ found m/z 717. HRMS (ESI) [M+Na]$^+$ found m/z 739.2188, calcd for C$_{43}$H$_{38}$N$_4$NiO$_3$Na 739.2195. HPLC (Chiralpak IA, $n$-hexane/$i$-propanol = 60/40, flow rate 1.0 mL/min, $\lambda$= 220 nm), $t_{\text{major}}$ = 12.2 min, de > 99%.

**Nickel(II)-(S)-BPB/(2S,3R)-2-Amino-3-(1H-indol-3-yl)-3-(4-methoxy-phenyl)-pro
panoic Acid Schiff Base Complex 3e.

Obtained as a red solid by flash column chromatography (petroleum ether/ethyl acetate = 1/1), yield 90%. Mp 180-182 °C; [α]20D = +1590 (c = 0.20 g/100 mL, CHCl3). 1H NMR (CDCl3, 300 MHz) δ 8.31-8.29 (m, 1H), 8.04 (d, J = 5.7 Hz, 2H), 7.55 (s, 1H), 7.43-7.35 (m, 3H), 7.30-7.29 (m, 2H), 7.24-7.14 (m, 5H), 7.07-7.00 (m, 2H), 6.98-6.91 (m, 3H), 6.83-6.81 (m, 2H), 6.67-6.65 (m, 2H), 4.72 (d, J = 2.1 Hz, 1H), 4.39 (d, J = 2.1 Hz, 1H), 4.23 (d, J = 9.3 Hz, 1H), 3.78 (s, 3H), 3.42-3.29 (m, 3H), 2.87-2.81 (m, 1H), 2.44-2.34 (m, 2H), 2.05-2.02 (m, 2H) ppm. 13C NMR (CDCl3, 100 MHz) δ 180.6, 177.9, 171.6, 159.1, 142.9, 135.6, 134.1, 133.8, 133.4, 132.4, 132.1, 131.5, 131.3, 129.3, 129.0, 128.8, 128.7, 127.8, 126.7, 126.5, 126.1, 123.7, 123.1, 121.3, 120.5, 118.7, 118.6, 115.2, 114.1, 110.7, 74.7, 70.7, 63.8, 57.6, 55.2, 50.7, 48.9, 30.8, 23.0 ppm. LRMS (ESI) [M+H]+ found m/z 733. HRMS (ESI) [M+Na]+ found m/z 755.2141, calcd for C43H38N4NiO4Na 755.2144. HPLC (Chiralpak IA, n-hexane/i-propanol = 60/40, flow rate 1.0 mL/min, λ = 220 nm), tmajor = 11.6 min, de > 99%.

Nickel(II)-(S)-BPB/(2S,3R)-2-Amino-3-(1H-indol-3-yl)-3-(4-nitro-phenyl)-propanoic Acid Schiff Base Complex 3f.

Obtained as a red solid by flash column chromatography (petroleum ether/ethyl acetate = 1/1), yield 67%. Mp 184-186 °C; [α]20D = +1815 (c = 0.13 g/100 mL, CHCl3). 1H NMR (CDCl3, 400 MHz) δ 8.34 (d, J = 8.4 Hz, 1H), 8.03 (d, J = 7.6 Hz, 2H), 7.97 (s, 1H), 7.63 (d, J = 2.0 Hz, 1H), 7.51-7.49 (m, 2H), 7.36-7.30 (m, 5H), 7.23-7.10 (m, 4H), 7.05-7.04 (m, 2H), 6.92-6.85 (m, 3H), 6.70-6.67 (m, 2H),

s8
4.74-4.73 (m, 1H), 4.41-4.40 (m, 1H), 4.29-4.26 (m, 1H), 3.65 (s, 1H), 3.49-3.33 (m, 4H), 2.87-2.83 (m, 1H), 2.45-2.41 (m, 2H), 2.03-2.01 (m, 1H) ppm. $^{13}$C NMR (CDCl$_3$, 100 MHz) $\delta$ 180.2, 178.3, 170.9, 143.1, 142.8, 133.8, 133.2, 131.5, 129.3, 128.8, 128.7, 128.6, 128.5, 128.0, 127.7, 127.1, 126.1, 121.8, 114.0, 109.6, 75.7, 70.6, 63.3, 57.2, 50.1, 30.7, 29.7, 23.4, 21.1 ppm. LRMS (ESI) [M+H]$^+$ found m/z 748. HRMS (ESI) [M+Na]$^+$ found m/z 770.1892, calcd for C$_{42}$H$_{35}$N$_5$NiO$_5$Na 770.1889. HPLC (Chiralpak IA, n-hexane/i-propanol = 60/40, flow rate 1.0 mL/min, $\lambda$ = 220 nm), $t_{\text{minor}}$ = 5.5 min, $t_{\text{major}}$ = 11.4 min, de = 80%.

**Nickel(II)-(S)-BPB/(2S,3R)-2-Amino-3-(1H-indol-3-yl)-3-(4-chloro-phenyl)-propionic Acid Schiff Base Complex 3g.**

Obtained as a red solid by flash column chromatography (petroleum ether/ethyl acetate = 1/1), yield 91%. Mp 175-177 ºC; [a]$_{D}^{20}$ = +2400 (c = 0.11 g/100 mL, CHCl$_3$). $^1$H NMR (CDCl$_3$, 400 MHz) $\delta$ 8.34 (d, $J$ = 8.8 Hz, 1H), 8.19 (s, 1H), 8.03 (d, $J$ = 7.6 Hz, 2H), 7.64-7.62 (m, 2H), 7.53-7.29 (m, 6H), 7.15-7.05 (m, 5H), 6.97-6.95 (m, 1H), 6.80-6.74 (m, 2H), 6.68-6.66 (m, 3H), 4.77-4.74 (m, 1H), 4.43-4.41 (m, 1H), 4.31-4.23 (m, 1H), 4.15-4.09 (m, 1H), 3.47-3.26 (m, 4H), 2.79-2.75 (m, 2H), 1.89-1.84 (m, 2H) ppm. $^{13}$C NMR (CDCl$_3$, 100 MHz) $\delta$ 180.2, 178.1, 171.4, 143.0, 139.8, 136.0, 134.0, 133.8, 133.3, 132.5, 132.2, 131.5, 129.9, 129.4, 128.9, 128.7, 128.1, 127.8, 127.2, 126.0, 124.5, 123.1, 122.5, 120.5, 120.2, 119.0, 113.7, 111.3, 74.5, 70.4, 63.5, 60.4, 57.2, 48.7, 30.3, 23.0, 21.0, 14.2 ppm. LRMS (ESI) [M+H]$^+$ found m/z 737. HRMS (ESI) [M+Na]$^+$ found m/z 759.1633, calcd for C$_{42}$H$_{35}$N$_4$NiO$_3$ClNa
759.1649. HPLC (Chiralpak IA, n-hexane/i-propanol = 60/40, flow rate 1.0 mL/min, 
λ= 220 nm), t_{major} = 11.4 min, de > 99%.

Nickel(II)-(S)-BPB/(2S,3R)-2-Amino-3-(1H-indol-3-yl)-3-(4-bromo-phenyl)-propanoic Acid Schiff Base Complex 3h.

Obtained as a red solid by flash column chromatography (petroleum ether/ethyl acetate = 1/1), yield 90%. Mp 186-188°C; [α]^{20}_D = +1856 (c = 0.16 g/100 mL, CHCl₃). $^1$H NMR (CDCl₃, 400 MHz) δ 8.27 (d, J = 8.4 Hz, 1H), 8.03 (d, J = 7.2 Hz, 2H), 7.53 (d, J = 8.0 Hz, 1H), 7.41-7.37 (m, 2H), 7.30-7.28 (m, 2H), 7.26-7.21 (m, 5H), 7.19-7.05 (m, 7H), 6.67-6.62 (m, 3H), 4.90 (d, J = 3.6 Hz, 1H), 4.78 (d, J = 3.6 Hz, 1H), 4.18 (d, J = 12.4 Hz, 1H), 3.35 (d, J = 12.4 Hz, 1H), 3.25-3.21 (m, 1H), 2.75-2.72 (m, 1H), 2.15-2.08 (m, 1H), 1.92-4384 (m, 4H) ppm. $^{13}$C NMR (CDCl₃, 100 MHz) δ 180.2, 178.1, 171.4, 160.5, 143.0, 140.3, 136.1, 133.9, 133.8, 133.3, 132.5, 131.5, 131.1, 130.3, 129.4, 128.9, 128.7, 128.1, 127.8, 127.2, 126.1, 124.6, 123.1, 122.5, 120.5, 120.4, 120.1, 119.0, 113.5, 111.4, 96.6, 74.5, 70.4, 63.5, 57.2, 48.8, 30.3, 23.0 ppm. LRMS (ESI) [M+H]^+ found m/z 781. HRMS (ESI) [M+Na]^+ found m/z 803.1147, calcd for C₄₂H₃₅N₄NiO₃BrNa 803.1144. HPLC (Chiralpak IA, 
n-hexane/i-propanol = 60/40, flow rate 1.0 mL/min, λ= 220 nm), t_{minor} = 7.2 min, t_{major} = 12.8 min, de = 70%.

Nickel(II)-(S)-BPB/(2S,3R)-2-Amino-3-(1H-indol-3-yl)-3-furan-2-yl-propanoic Acid Schiff Base Complex 3i.
Obtained as a red solid by flash column chromatography (petroleum ether/ethyl acetate = 1/1), yield 61%. Mp 183-185ºC; \([\alpha]^{24}_D = +2100 \) (c = 0.12 g/100 mL, CHCl₃). \(^1\)H NMR (CDCl₃, 300 MHz) \(\delta\) 8.34 (d, \(J = 8.7\) Hz, 1H), 8.03 (d, \(J = 7.5\) Hz, 2H), 7.57 (m, 1H), 7.34-7.28 (m, 6H), 7.23-7.11 (m, 4H), 7.02-6.98 (m, 2H), 6.90-6.82 (m, 4H), 6.68-6.63 (m, 2H), 4.74 (s, 1H), 4.43 (s, 1H), 4.26-4.21 (m, 1H), 3.48-3.29 (m, 2H), 2.29-2.18 (m, 6H), 2.03-1.91 (m, 1H) ppm. \(^{13}\)C NMR (CDCl₃, 100 MHz) \(\delta\) 180.2, 176.7, 172.8, 162.5, 148.9, 143.5, 143.1, 133.8, 133.7, 132.9, 132.8, 131.5, 130.3, 129.4, 129.3, 128.8, 128.7, 127.9, 126.5, 125.7, 123.3, 120.6, 111.3, 109.7, 74.4, 70.3, 70.1, 63.5, 56.9, 39.7, 36.4, 31.4, 30.5, 22.9 ppm. LRMS (ESI) \([M+H]^+\) found m/z 693. HRMS (ESI) \([M+Na]^+\) found m/z 715.1812, calcd for C₄₀H₃₄N₄NiO₄Na 715.1831. HPLC (Chiralpak IA, \(n\)-hexane/\(i\)-propanol = 60/40, flow rate 1.0 mL/min, \(\lambda = 220\) nm), \(t_{\text{minor}} = 7.9\) min, \(t_{\text{major}} = 11.3\) min, de > 97%.

**Nickel(II)-(S)-BPB/(2S,3R)-2-Amino-3-(1H-indol-3-yl)-3-cyclohexyl-propanoic Acid Schiff Base Complex 3j.**

Obtained as a red solid by flash column chromatography (petroleum ether/ethyl acetate = 1/1), yield 53%. Mp 180-182 ºC; \([\alpha]^{20}_D = +1580 \) (c = 0.15 g/100 mL, CHCl₃). \(^1\)H NMR (CDCl₃, 300 MHz) \(\delta\) 8.51 (s, 1H), 8.33-8.16 (m, 1H), 7.95-7.89 (m, 3H), 7.59-7.49 (m, 5H), 7.36-7.34 (m, 2H), 7.21-7.08 (m, 4H), 7.00-6.90 (m, 1H), 6.69-6.67 (m, 2H), 4.69 (s, 1H), 4.51 (s, 1H), 4.12 (d, \(J = 12.6\) Hz, 1H), 3.38-3.30 (m, 2H), 3.01-2.93 (m, 1H), 2.75-2.69 (m, 2H), 2.49-2.41 (m, 2H), 2.12-2.06 (m, 2H), 1.82-1.64 (m, 3H), 1.51-1.38 (m, 5H) ppm. \(^{13}\)C NMR (CDCl₃, 100 MHz) \(\delta\) 179.8,
Nickel(II)-(S)-BPB/(2S,3R)-2-Amino-3-(2-methyl-1H-indol-3-yl)-3-phenyl-propionic Acid Schiff Base Complex 3k.

Obtained as a red solid by flash column chromatography (petroleum ether/ethyl acetate = 1/1), yield 64%. Mp 181-183 °C; [α]<sup>20</sup><sub>D</sub> = +2500 (c = 0.12 g/100 mL, CHCl<sub>3</sub>). ¹H NMR (CDCl<sub>3</sub>, 400 MHz) δ 8.36 (d, J = 8.8 Hz, 1H), 8.04-7.98 (m, 3H), 7.55-7.53 (m, 3H), 7.43-7.28 (m, 5H), 7.26-7.03 (m, 6H), 6.84-6.82 (m, 2H), 6.69-6.65 (m, 3H), 4.73 (d, J = 2.8 Hz, 1H), 4.51 (d, J = 2.8 Hz, 1H), 4.27 (d, J = 12.8 Hz, 1H), 3.44-3.33 (m, 2H), 2.83-2.78 (m, 1H), 2.46-2.43 (m, 1H), 2.36-2.32 (m, 1H), 2.25 (s, 3H), 2.00-1.98 (m, 2H), 1.53-1.48 (m, 1H) ppm. ¹³C NMR (CDCl<sub>3</sub>, 100 MHz) δ 180.5, 177.7, 171.5, 143.0, 140.1, 133.8, 132.4, 131.6, 130.2, 129.2, 128.8, 128.7, 128.6, 127.9, 127.3, 126.7, 123.1, 122.9, 120.4, 110.3, 70.5, 63.6, 57.4, 49.8, 30.9, 23.3, 21.4 ppm. LRMS (ESI) [M+H]<sup>+</sup> found m/z 717. HRMS (ESI) [M+Na]<sup>+</sup> found m/z 739.2186, calced for C<sub>43</sub>H<sub>38</sub>N<sub>4</sub>NiO<sub>3</sub>Na 739.2195. HPLC (Chiralpak IA, n-hexane/i-propanol = 60/40, flow rate 1.0 mL/min, λ= 220 nm), t<sub>major</sub> = 11.4 min, de > 99%.
Nickel(II)-(S)-BPB/(2S,3R)-2-Amino-3-(4-methyl-1H-indol-3-yl)-3-phenyl-propionic Acid Schiff Base Complex 3l.

Obtained as a red solid by flash column chromatography (petroleum ether/ethyl acetate = 1/1), yield 76%. Mp 178-180 °C; [α]$_D^{20}$ = +2570 (c = 0.10 g/100 mL, CHCl$_3$). $^1$H NMR (CDCl$_3$, 300 MHz) δ 8.78 (s, 1H), 8.30 (d, $J$ = 8.7 Hz, 1H), 8.03 (d, $J$ = 7.5 Hz, 2H), 7.31-7.29 (m, 2H), 7.26-7.01 (m, 13H), 6.85-6.82 (m, 1H), 6.64-6.64 (m, 2H), 6.18-6.16 (m, 1H), 4.72-4.71 (m, 1H), 4.26 (d, $J$ = 12.6 Hz, 1H), 3.42-3.28 (m, 2H), 2.92-2.84 (m, 1H), 2.67 (s, 3H), 2.34-2.21 (m, 1H), 2.08-2.01 (m, 1H), 1.91-1.86 (m, 1H) ppm. $^{13}$C NMR (CDCl$_3$, 100 MHz) δ 180.3, 178.4, 170.9, 143.1, 142.8, 136.1, 133.8, 133.2, 132.4, 131.5, 129.9, 129.3, 128.9, 128.7, 128.6, 128.5, 128.0, 127.7, 127.1, 126.1, 126.0, 125.8, 125.3, 123.0, 121.9, 121.7, 120.5, 113.9, 109.6, 75.7, 70.6, 63.3, 57.2, 50.1, 30.7, 29.7, 23.3, 21.1 ppm. LRMS (ESI) [M+H]$^+$ found m/z 717. HRMS (ESI) [M+Na]$^+$ found m/z 739.2215, calcd for C$_{43}$H$_{38}$N$_4$NiO$_3$Na 739.2195. HPLC (Chiralpak IA, $n$-hexane/i-propanol = 60/40, flow rate 1.0 mL/min, $\lambda$= 220 nm), $t_{\text{minor}}$ = 9.1 min, $t_{\text{major}}$ = 17.5 min, de = 96%.

Nickel(II)-(S)-BPB/(2S,3R)-2-Amino-3-(5-methyl-1H-indol-3-yl)-3-phenyl-propionic Acid Schiff Base Complex 3m.

Obtained as a red solid by flash column chromatography (petroleum ether/ethyl acetate = 1/1), yield 88%. Mp 180-182°C; [α]$_D^{21}$ = +1400 (c = 0.15 g/100 mL, CHCl$_3$).
(CHCl₃). ¹H NMR (CDCl₃, 300 MHz) δ 8.38 (d, J = 8.7 Hz, 1H), 8.10-8.02 (m, 3H), 7.68-7.65 (m, 1H), 7.54-7.31 (m, 7H), 7.26-7.00 (m, 7H), 6.84-6.81 (m, 2H), 6.69-6.65 (m, 2H), 4.73-4.72 (m, 1H), 4.52-4.45 (m, 1H), 4.26 (d, J = 12.0 Hz, 1H), 4.13-4.09 (m, 1H), 3.45-3.30 (m, 2H), 2.84-2.75 (m, 1H), 2.39-2.25 (m, 5H), 3.05-1.99 (m, 3H) ppm. ¹³C NMR (CDCl₃, 100 MHz) δ 180.5, 177.8, 171.5, 143.0, 140.1, 134.1, 133.8, 133.7, 133.3, 132.4, 131.5, 130.2, 129.2, 128.8, 128.7, 128.6, 127.9, 127.8, 127.3, 126.8, 126.7, 126.1, 124.0, 123.0, 122.9, 120.4, 118.2, 114.5, 110.4, 74.9, 70.6, 63.6, 57.4, 49.8, 30.8, 23.2, 21.4 ppm. LRMS (ESI) [M+H]+ found m/z 717. HRMS (ESI) [M+Na]+ found m/z 739.2200, calcd for C₄₃H₃₈N₄NiO₃Na 739.2195. HPLC (Chiralpak IA, n-hexane/i-propanol = 60/40, flow rate 1.0 mL/min, λ = 220 nm), tₘₐᵢₗₐᵢᵦ = 7.8 min, tₘᵢₐᵢᵦᵦᵦ = 13.0 min, de = 97%.

Nickel(II)-(S)-BPB/(2S,3R)-2-Amino-3-(5-chloro-1H-indol-3-yl)-3-phenyl-propionic Acid Schiff Base Complex 3n.

Obtained as a red solid by flash column chromatography (petroleum ether/ethyl acetate = 1/1), yield 84%. Mp 179-181°C; [α] D²₀ = +1302 (c = 0.30 g/100 mL, CHCl₃). ¹H NMR (CDCl₃, 400 MHz) δ 8.33 (d, J = 9.2 Hz, 1H), 8.02 (d, J = 7.6 Hz, 3H), 7.78 (d, J = 2.4 Hz, 1H), 7.56-7.29 (m, 5H), 7.20-7.10 (m, 8H), 7.00-6.95 (m, 1H), 6.75-6.65 (m, 4H), 4.72 (d, J = 2.4 Hz, 1H), 4.30-4.24 (m, 2H), 3.64 (s, 1H), 3.49-3.42 (m, 2H), 3.33-3.28 (m, 1H), 2.79-2.75 (m, 1H), 2.40-2.32 (m, 3H), 2.01-1.98 (m, 1H) ppm. ¹³C NMR (CDCl₃, 100 MHz) δ 180.2, 176.7, 172.4, 143.1, 143.5, 133.7, 133.6, 133.1, 132.8, 131.4, 130.2, 129.4, 128.9, 128.7, 128.6, 127.7,
126.6, 125.5, 123.1, 120.6, 71.4, 70.3, 63.6, 60.3, 57.2, 46.3, 30.5, 22.9, 21.0, 14.1 ppm. LRMS (ESI) [M+H]+ found m/z 737. HRMS (ESI) [M+Na]+ found m/z 759.1655, calcd for C$_{42}$H$_{35}$N$_4$NiO$_3$ClNa 759.1649. HPLC (Chiralpak IA, n-hexane/i-propanol = 60/40, flow rate 1.0 mL/min, $\lambda$ = 220 nm), t$_{major}$ = 13.5 min, de > 99%.

Nickel(II)-(S)-BPB/(2S,3R)-2-Amino-3-(7-methyl-1H-indol-3-yl)-3-phenyl-propionic Acid Schiff Base Complex 3o.

Obtained as a red solid by flash column chromatography (petroleum ether/ethyl acetate = 1/1), yield 86%. Mp 184-186 °C; [a]$_{21}^{21}$ = +1420 (c = 0.20 g/100 mL, CHCl$_3$). $^1$H NMR (CDCl$_3$, 400 MHz) $\delta$ 8.32 (d, $J$ = 8.4 Hz, 1H), 8.32 (d, $J$ = 7.2 Hz, 2H), 7.59 (s, 1H), 7.45-7.28 (m, 8H), 7.17-7.14 (m, 4H), 7.06-6.99 (m, 2H), 6.93-6.91 (m, 1H), 6.86-6.68 (m, 2H) 6.68-6.64 (m, 2H), 4.76 (d, $J$ = 2.4 Hz, 1H), 4.39 (d, $J$ = 2.4 Hz, 1H), 4.24 (d, $J$ = 12.8 Hz, 1H), 4.14-4.09 (m, 2H), 3.43-3.34 (m, 2H), 3.86-3.81 (m, 1H), 2.42-2.35 (m, 2H), 2.06-2.01 (m, 4H) ppm. $^{13}$C NMR (CDCl$_3$, 100 MHz) $\delta$ 180.5, 177.7, 171.6, 143.1, 140.2, 135.1, 134.2, 133.8, 133.3, 132.4 131.6, 130.4, 129.3, 129.0, 128.9, 128.8, 128.7, 128.6, 127.8, 127.4, 126.7, 126.1, 123.5, 123.1, 121.9, 120.4, 119.8, 119.0, 116.3, 115.5, 96.6, 74.7, 70.6, 63.7, 57.5, 49.9, 30.8, 23.2, 16.5 ppm. LRMS (ESI) [M+H]+ found m/z 717. HRMS (ESI) [M+Na]+ found m/z 739.2220, calcd for C$_{43}$H$_{38}$N$_4$NiO$_3$Na 739.2195. HPLC (Chiralpak IA, n-hexane/i-propanol = 60/40, flow rate 1.0 mL/min, $\lambda$ = 220 nm), t$_{major}$ = 14.7 min, de >99%.
(2S,3R)-2-amino-3-(1H-indol-3-yl)-3-phenylpropanoic acid 4a.

Obtained as a pink solid by column chromatography on C₁₈-reversed phase (230-400 mesh) silica gel (methanol / water = 1/1), yield 96%. Mp 147-179 ºC; [α]D²⁰ = +23.7 (c = 0.38 g/100 mL, 6 N HCl). ¹H NMR (DMSO, 300 MHz): δ 11.02 (s, 1H), 8.26 (d, J = 8.4 Hz, 1H), 7.75-7.48 (m, 5H), 7.45-7.09 (m, 5H), 3.73 (d, J = 12.9 Hz, 1H), 3.52 (d, J = 13.2 Hz, 1H) ppm. ¹³C NMR (DMSO, 100 MHz): δ 173.2, 138.2, 137.9, 137.6, 133.0, 132.9, 131.6, 129.8, 128.9, 128.6, 127.9, 126.9, 126.2, 122.8, 121.4, 53.5, 30.2 ppm. LRMS (ESI) [M-H]⁺ found m/z 279. HRMS (ESI) [M-H]⁺ found m/z 279.1134, calcd. for C₁₇H₁₅N₂O₂ 279.1134.

Analytical high performance liquid chromatography was carried out using the Model 410 automated sampler, using the Chiralpak IA column. The loading loop was 20 μL. The eluting employed was an isocratic mixture of n-hexane and i-propanol (60:40 respectively) at a flow of 1 mL/min unless stated. Retention times are reported in minutes. The enantiomeric excess was calculated from the integration of the absorption peaks at 220 nm.
HPLC (Chiralpak IA, n-hexane/i-propanol = 60/40, flow rate 1.0 mL/min, λ= 220 nm),
t\(_{\text{major}} = 13.6\) min, de > 99%.

3b

HPLC (Chiralpak IA, n-hexane/i-propanol = 60/40, flow rate 1.0 mL/min, λ= 220 nm),
t\(_{\text{major}} = 11.5\) min, de > 99%.

3c

HPLC (Chiralpak IA, n-hexane/i-propanol = 60/40, flow rate 1.0 mL/min, λ= 220 nm),
t\(_{\text{major}} = 12.2\) min, de > 99%.

3d
t_{major} = 12.2 \text{ min}, \ de > 99\%.

3e

HPLC (Chiralpak IA, \(n\)-hexane/\(i\)-propanol = 60/40, flow rate 1.0 mL/min, \(\lambda\) = 220 nm), \(t_{major} = 11.6 \text{ min}, \ de > 99\%.

3f

HPLC (Chiralpak IA, \(n\)-hexane/\(i\)-propanol = 60/40, flow rate 1.0 mL/min, \(\lambda\) = 220 nm), \(t_{minor} = 5.5 \text{ min}, \ t_{major} = 11.4 \text{ min}, \ de = 80\%.

3g

HPLC (Chiralpak IA, \(n\)-hexane/\(i\)-propanol = 60/40, flow rate 1.0 mL/min, \(\lambda\) = 220 nm), \(t_{major} = 11.4 \text{ min}, \ de > 99\%.

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HPLC (Chiralpak IA, $n$-hexane/i-propanol = 60/40, flow rate 1.0 mL/min, $\lambda$ = 220 nm), $t_{\text{minor}} = 7.2$ min, $t_{\text{major}} = 12.8$ min, de = 70%.

HPLC (Chiralpak IA, $n$-hexane/i-propanol = 60/40, flow rate 1.0 mL/min, $\lambda$ = 220 nm), $t_{\text{minor}} = 7.9$ min, $t_{\text{major}} = 11.3$ min, de > 97%.

HPLC (Chiralpak IA, $n$-hexane/i-propanol = 60/40, flow rate 1.0 mL/min, $\lambda$ = 220 nm), $t_{\text{major}} = 12.8$ min, de > 99%.
HPLC (Chiralpak IA, \(n\)-hexane/\(i\)-propanol = 60/40, flow rate 1.0 mL/min, \(\lambda = 220\) nm), \(t_{\text{major}} = 11.4\) min, \(d.e > 99\%\).

HPLC (Chiralpak IA, \(n\)-hexane/\(i\)-propanol = 60/40, flow rate 1.0 mL/min, \(\lambda = 220\) nm), \(t_{\text{minor}} = 9.1\) min, \(t_{\text{major}} = 17.5\) min, \(d.e = 96\%\).

HPLC (Chiralpak IA, \(n\)-hexane/\(i\)-propanol = 60/40, flow rate 1.0 mL/min, \(\lambda = 220\) nm), \(t_{\text{minor}} = 7.8\) min, \(t_{\text{major}} = 13.0\) min, \(d.e = 97\%\).
HPLC (Chiralpak IA, $n$-hexane/$i$-propanol = 60/40, flow rate 1.0 mL/min, $\lambda = 220$ nm), $t_{\text{major}} = 13.5$ min, de > 99%.

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HPLC (Chiralpak IA, $n$-hexane/$i$-propanol = 60/40, flow rate 1.0 mL/min, $\lambda = 220$ nm), $t_{\text{major}} = 14.7$ min, de > 99%.
(D) The Absolute Configuration of 3a and Quantum Chemical Calculation

X-ray Single Crystal Stucture Analysis of (S)(2S,3R)-3a:

X-ray crystallographic data of (S)(2S,3R)-3a were solutions at T = 293(2) K: C_{42}H_{36}N_{4}NiO_{3}, M_r = 702.21, monoclinic. Space group P2_1 (1), a = 9.5816 (5) Å, b = 12.4509 (7) Å, c = 16.5961 (9) Å, α = 90°, β = 104.6403 (7)°, γ = 90°, V = 1915.62 (18) Å^3, Z = 2.

FIGURE S1. The crystal structure of (S)(2S,3R)-3a by X-ray analysis.

These data can be obtained free of charge from the Cambridge Crystallographic Data Centre via www.ccdc.cam.ac.uk/data_request/cif, the CCDC number is 796799.
(E) Copies of $^1$H NMR and $^{13}$C NMR Spectra for the Products
Nickel(II)-(S)-BPB/(2S,3R)-2-Amino-3-(1H-indol-3-yl)-3-phenyl-propanoic Acid Schiff Base Complex 3a.
Nickel(II)-(S)-BPB/(2S,3R)-2-Amino-3-(1H-indol-3-yl)-3-\textit{o}-tolyl-propanoic Acid Schiff Base Complex 3b.
Nickel(II)-(S)-BPB/(2S,3R)-2-Amino-3-(1H-indol-3-yl)-3-m-tolyl-propanoic Acid Schiff Base Complex 3c.
Nickel(II)-(S)-BPB/(2S,3R)-2-Amino-3-(1H-indol-3-yl)-3-p-tolyl-propanoic Acid Schiff Base Complex 3d.
Nickel(II)-(S)-BPB/(2S,3R)-2-Amino-3-(1H-indol-3-yl)-3-(4-methoxy-phenyl)-propanoic Acid Schiff Base Complex 3e.
Nickel(II)-(S)-BPB/(2S,3R)-2-Amino-3-(1H-indol-3-yl)-3-(4-nitro-phenyl)-propanoic Acid Schiff Base Complex 3f.
Nickel(II)-(S)-BPB/(2S,3R)-2-Amino-3-(1H-indol-3-yl)-3-(4-chloro-phenyl)-propanoic Acid Schiff Base Complex 3g.
Nickel(II)-(S)-BPB/(2S,3R)-2-Amino-3-(1H-indol-3-yl)-3-(4-bromo-phenyl)-propanoic Acid Schiff Base Complex 3h.
Nickel(II)-(S)-BPB/(2S,3R)-2-Amino-3-(1H-indol-3-yl)-3-furan-2-yl-propanoic Acid Schiff Base Complex 3i.
Nickel(II)-(S)-BPB/(2S,3R)-2-Amino-3-(1H-indol-3-yl)-3-cyclohexyl-propanoic Acid Schiff Base Complex 3j.
Nickel(II)-(S)-BPB/(2S,3R)-2-Amino-3-(2-methyl-1H-indol-3-yl)-3-phenyl-propanoic Acid Schiff Base Complex 3k.
Nickel(II)-(S)-BPB/(2S,3R)-2-Amino-3-(4-methyl-1H-indol-3-yl)-3-phenyl-propanoic Acid Schiff Base Complex 3l.
Nickel(II)-(S)-BPB/(2S,3R)-2-Amino-3-(5-methyl-1H-indol-3-yl)-3-phenyl-propanoic Acid Schiff Base Complex 3m.
Nickel(II)-(S)-BPB/(2S,3R)-2-Amino-3-(5-chloro-1H-indol-3-yl)-3-phenyl-propanoic Acid Schiff Base Complex 3n.
Nickel(II)-(S)-BPB/(2S,3R)-2-Amino-3-(7-methyl-1H-indol-3-yl)-3-phenyl-propanoic Acid Schiff Base Complex 3o.
(2S,3R)-2-amino-3-(1H-indol-3-yl)-3-phenylpropanoic acid 4a.
(F) Reference
