Experiment section

Reagents and general methods

All reagents were purchased from commercial suppliers and were dried and purified when necessary, and **4a**, **4c**, **4e-f, 5a, 5c, 5e-h**, **5k, 5l, 5o-p**, **6a, 6c, 6e-h**, **6k, 6l, 6o-p**, **7a, 7c, 7e-h**, **7k, 7l** and **7o-p** were prepared as previously described by our group.

ESI-MS spectra were obtained from VG ZAB-HS spectrometer. ^{1}H NMR and ^{13}C NMR spectra were recorded on a AVANCE III 400MHz spectrometer at 400 MHz and 100 MHz and a Varian INOVA 500NB spectrometer at 500 MHz and 125 MHz, respectively, using TMS as internal standard and $CDCl_3$ or DMSO-d_6 as solvent and chemical shifts (d) were expressed in ppm. HRMS were obtained from ESI-Q-TOF maxis 4G spectrometer. Silica gel F254 were used in analytical thin-layer chromatography (TLC) and silica gel were used in column chromatography respectively.

General procedure for the preparation of 1-substituted-1,2,3,4-tetrahydro-β-carboline-3-carboxylic acid (2)

A mixture of L-tryptophan (40.8g, 200mmol), acetic acid (300ml) and the appropriate aldehydes (210mmol) was refluxed for 3 h, then cooled and adjusted pH to 5 with concentrated ammonium hydroxide, the precipitated product was collected by filtration and washed well with water and dried to provide the intermediates **2**. Further purification was not necessary and used directly for the next steps.

General procedure for the preparation of ethyl 1-substituted-1,2,3,4-tetrahydro-β-carboline-3-carboxylate (3)

1-substituted 1,2,3,4-tetrahydro-β-carboline-3-carboxylic acid **2** (100mmol), anhydrous

ethanol (300ml) and $SOCl_2$ (20ml) was heated at reflux for 4 h, and then evaporated in reduced pressure. The resulting mixture was poured into H_2O (200ml) and neutralized with sodium hydrogen carbonate. The solution was extracted with ethyl acetate (3×150 ml). The organic phase was washed with water and brine, then dried over anhydrous sodium sulfate, filtered and evaporated to give intermediates **3**. Further purification was not necessary and used directly for the next steps.

General procedure for the preparation of ethyl 1-substituted-β-carboline-3-carboxylate (**4**)

Ethyl 1-substituted-1,2,3,4-tetrahydro-β-carboline-3-carboxylate **3** (100mmol) and sulfur (9.6g, 300mmol) in xylene (200ml) was heated at reflux for 8 h. Completion of the reaction as indicated by TLC. The solution was cooled and stored at 4 ℃ for 3 h, and then filtered and washed generously with petroleum ether, the solid was purified by column chromatography with ethyl acetate and petroleum ether (1:1), ethyl acetate as the eluent to successfully afford the intermediates **4**.

Ethyl 1-isopropyl-β-carboline-3-carboxylate（4b）

Starting from ethyl 1-isopropyl-1,2,3,4-tetrahydro-β-carboline-3-carboxylate **3b** (28.6g, 100mmol) and sulfur (9.6g, 300mmol), white solid was obtained (12.0g, 42%). ^{1}H NMR (400 MHz, $CDCl_3$): δ 9.55 (s, 1H), 8.76 (s, 1H), 8.16 (d, J = 8.0 Hz, 1H), 7.51-7.59 (m, 2H), 7.29-7.33 (m, 1H), 4.49 (q, J = 7.2 Hz, 2H), 3.43- 3.53 (m, 1H), 1.44 (t, J = 7.2 Hz, 3H), 1.32 (d, J = 6.8 Hz, 6H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 166.8, 150.7, 140.5, 137.2, 135.0, 128.5, 122.1, 121.6, 120.6, 116.2, 112.2, 61.4, 32.8, 21.0, 14.5.

Ethyl 1-(4-chlorophenyl)-β-carboline-3-carboxylate（4d）

Starting from ethyl 1-(4-chlorophenyl)-1,2,3,4-tetrahydro-β-carboline-3-carboxylate **3e**

(35.4g, 100mmol) and sulfur (9.6g, 300mmol), yellow solid was obtained (18.5g, 53%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.30 (d, J = 7.6 Hz, 1H), 7.61(d, J = 8.0 Hz, 1H), 7.55 (d, J = 6.0 Hz, 1H), 7.48 (dd, J = 8.0, 1.2 Hz, 1H), 7.27-7.31 (m, 2H), 7.18-7.24 (m, 3H), 7.03-7.07 (m, 1H), 4.21 (q, J = 7.1 Hz, 2H), 1.29 (t, J = 7.1 Hz, 4H).

General procedure for the preparation of ethyl 1,9-disubstituted-β-carboline-3-carboxylate (5)

Ethyl 1-substituted-β-carboline-3-carboxylate **4** (10mmol) and anhydrous DMF (50ml) was stirred at RT until clear, and then 60% NaH (0.6g, 15mmol) and halogenated alkane (20-40mmol) were added. The mixture was stirred at RT for 0.5-2 h. After completion of the reaction as indicated by TLC, the solution was poured into H_2O (150ml), and extracted with ethyl acetate. The organic phase was washed with water and brine, then dried over anhydrous sodium sulfate, filtered and evaporated. The resulting oil was crystallized from ethyl ether or ethyl ether-petroleum ether to provide compounds **5**.

Ethyl 9-isopropyl-1-methyl-β-carboline-3-carboxylate (5b)

Starting from ethyl 1-methyl-β-carboline-3-carboxylate **4a** (2.54g, 10mmol) and 2-bromopropane (30mmol), white solid was obtained (2.1 g, 71%). ESI-MS m/z: 297 (100) $[M+H]^+$. ^{1}H NMR (300 MHz, $CDCl_3$): δ 8.72 (1H, s, ArH), 8.18 (1H, d, J =7.8Hz), 7.73 (1H, d, J =8.4Hz),7.51-7.57(1H, m, ArH), 7.29-7.33 (1H, m, ArH),5.57-5.67 (1H, m, C***H***$[CH_3]_2$), 4.51 (2H, q, J =7.2Hz, OC***H***$_2CH_3$), 3.13 (3H, s, C***H***$_3$), 1.77 (6H, d, J =6.9Hz, CH[C***H***$_3]_2$), 1.49 (3H, t, J =7.2Hz, OCH_2C***H***$_3$). ^{13}C NMR (75 MHz, $CDCl_3$): δ 166.3, 141.3, 140.3, 137.3, 136.8, 128.9, 128.0, 123.1, 122.0, 120.4, 116.2, 113.8, 61.8, 48.9, 25.8, 21.8(2C), 14.9.

Ethyl 9-isobutyl-1-methyl-β-carboline-3-carboxylate (5d)

Starting from ethyl 1-methyl-β-carboline-3-carboxylate **4a** (2.54g, 10mmol) and 1-bromo-2-methyl-propane (30mmol), white solid was obtained (2.4 g, 77%). ESI-MS m/z: 311 (100) $[M+H]^+$. ^1H NMR (300 MHz, $CDCl_3$): δ 8.75 (1H, s, ArH), 8.18 (1H, d, J =7.8Hz), 7.57-7.62 (1H, m, ArH), 7.49-7.51 (1H, m, ArH), 7.30-7.35 (1H, m, ArH), 4.52 (2H, q, J =7.2Hz, $OC\boldsymbol{H}_2CH_3$), 4.21 (2H, d, J =7.5Hz, $C\boldsymbol{H}_2CH[CH_3]_2$), 3.12 (3H, s, $C\boldsymbol{H}_3$), 2.21-2.34 (1H, m, $CH_2C\boldsymbol{H}[CH_3]_2$), 1.50 (3H, t, J =7.2Hz, $OCH_2C\boldsymbol{H}_3$), 0.94 (6H, d, J =6.6Hz, $CH_2CH[C\boldsymbol{H}_3]_2$).

Ethyl 9-butyl-1-isopropyl-β-carboline-3-carboxylate (5i)

Starting from ethyl 1-isopropyl-β-carboline-3-carboxylate **4b** (2.82g, 10mmol) and 1-bromobutane (30mmol), yellow oil was obtained (1.93g, 57%). ESI-MS m/z: 339 (100) $[M+H]^+$. ^1H NMR (400 MHz, $CDCl_3$): δ 8.72 (s, 1H), 8.13 (d, J = 7.6 Hz, 1H), 7.54 (d, J = 7.2 Hz, 1H), 7.44 (d, J = 8.0 Hz, 1H), 7.25-7.28 (m, 1H), 4.46-4.52 (m, 4H), 3.69-3.79 (m, 1H), 1.74-1.84 (m, 2H), 1.54 (d, J = 7.2 Hz, 6H), 1.48 (t, J = 7.2 Hz, 3H), 1.36-1.44 (m, 2H), 0.95 (t, J = 7.2 Hz, 3H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 166.4, 150.1, 142.0, 137.1, 135.0, 129.5, 128.3, 121.8, 121.4, 120.4, 115.5, 110.1, 61.1, 45.2, 32.5, 31.9, 22.4, 20.2, 14.5, 13.8.

Ethyl 9-benzyl-1-isopropyl-β-carboline-3-carboxylate (5j)

Starting from ethyl 1-isopropyl-β-carboline-3-carboxylate **4b** (2.82g, 10mmol) and benzyl bromide (15mmol), white solid was obtained (1.6g, 43%). ESI-MS m/z: 373 (100) $[M+H]^+$. Mp 135.7 -136.2℃; ^1H NMR (400 MHz, $CDCl_3$): δ 8.77 (s, 1H), 8.24 (d, J = 7.6 Hz, 1H), 7.57 (t, J = 7.6 Hz, 1H), 7.42 (d, J = 8.4 Hz, 1H), 7.36 (t, J = 7.2 Hz, 1H), 7.20-7.32 (m, 3H), 6.98 (d, J = 6.0 Hz, 2H), 5.83 (s, 2H), 4.50 (q, J = 7.2 Hz, 2H), 3.57-3.67 (m, 1H), 1.49 (t, J = 7.2 Hz, 3H), 1.37 (d, J = 6.8 Hz, 6H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 166.3, 150.6, 142.5, 137.6, 137.3, 135.6, 129.7, 129.0, 128.7, 127.7, 125.4, 121.9, 121.5, 120.8, 115.6, 110.2, 61.2, 48.9, 31.6, 22.5, 14.5.

Ethyl 9-butyl-1-(4-chlorophenyl)-β-carboline-3-carboxylate (5m)

Starting from ethyl 1-(4-chlorophenyl)-β-carboline-3-carboxylate **4d** (3.51g, 10mmol) and 1-bromobutane (30mmol), white solid was obtained (1.87g, 46%). ESI-MS m/z: 408 (100) $[M+H]^+$. ^1H NMR (400 MHz, $CDCl_3$): δ 8.89 (s, 1H), 8.26 (d, J = 7.6 Hz, 1H), 7.59-7.66 (m, 3H), 7.47 – 7.51 (m, 3H), 7.36 – 7.40 (m, 1H), 4.52 (q, J = 7.2 Hz, 2H), 3.99 (t, J = 8.0 Hz, 2H), 1.47 (t, J = 7.2 Hz, 3H), 1.32-1.40 (m, 2H), 0.84-0.93 (m, 2H), 0.67 (t, J = 7.2 Hz, 3H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 166.0, 142.7, 142.5, 137.9, 137.3, 135.6, 134.9, 131.1, 130.6, 128.9, 128.4, 121.8, 121.7, 120.9, 116.8, 110.6, 61.6, 44.6, 31.1, 19.8, 14.5, 13.5.

Ethyl 9-benzyl-1-isopropyl-β-carboline-3-carboxylate (5n)

Starting from ethyl 1-(4-chlorophneyl)-β-carboline-3-carboxylate **4d** (3.51g, 10mmol) and benzyl bromide (15mmol), yellow solid was obtained (1.68g, 38%). ESI-MS m/z: 442 (100) $[M+H]^+$. ^1H NMR (400 MHz, $CDCl_3$): δ 8.93 (s, 1H), 8.30 (d, J = 8.0 Hz, 1H), 7.59 (t, J = 8.0 Hz, 1H), 7.37-7.42 (m, 2H), 7.32 (dd, J = 8.4, 2.0 Hz, 2H), 7.23 (dd, J = 8.4, 2.0 Hz, 2H), 7.11-7.17 (m, 3H), 6.55 (d, J = 7.2 Hz, 2H), 5.25 (s, 2H), 4.51 (q, J = 7.2 Hz, 2H), 1.46 (t, J = 7.2 Hz, 3H). ^{13}C NMR (101 MHz, $CDCl_3$): δ 136.0, 135.6, 131.2, 130.8, 130.5, 130.0, 128.8, 128.7, 128.5, 128.3, 127.7, 127.5, 125.4, 125.3, 122.4, 122.1, 121.7, 121.2, 117.2, 111.1, 62.1, 29.7, 14.5.

Ethyl 9-hexyl-1-(4-methoxyphenyl)-β-carboline-3-carboxylate (5q)

Starting from ethyl 1-(4-methoxyphenyl)-β-carboline-3-carboxylate **4e** (3.46g, 10mmol) and 1-bromohexane (30mmol), white solid was obtained (1.89g, 44%). ESI-MS m/z: 431 (100) $[M+H]^+$. ^1H NMR (400 MHz, $CDCl_3$): δ 8.86 (s, 1H), 8.24 (d, J = 7.2 Hz, 1H), 7.59-7.63 (m, 1H), 7.56 (d, J = 8.8 Hz, 2H), 7.47 (d, J = 8.4 Hz, 1H), 7.33 – 7.37 (m, 1H), 7.03 (d, J = 8.8 Hz, 2H), 4.51 (q, J = 7.2 Hz, 2H), 4.00 (t, J = 8.0 Hz, 2H), 3.89 (s, 3H), 1.47 (t, J = 7.2 Hz, 3H), 1.33-1.41

(m, 2H), 1.08 – 1.15 (m, 2H), 0.98 –1.03 (m, 2H), 0.82-0.89 (m, 2H), 0.78 (t, J = 7.2 Hz, 3H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 166.3, 160.1, 144.0, 142.4, 137.2, 135.9, 132.0, 130.9, 130.2, 128.6, 121.8, 121.7, 120.6, 116.4, 113.7, 110.6, 61.5, 55.5, 44.7, 31.2, 29.0, 26.2, 22.4, 14.5, 13.9.

General procedure for the preparation of 1,9-disubstituted-3-hydroxymethyl-β-carboline (6).

A fine suspension of compounds **6** (10mmol) in dry THF (100ml) was treated with $LiBH_4$ (30mmol), and the mixture was stirred at room temperature for 6 h. The reaction was cooled, treated with 10% aq. HCl (20ml), and stirred for 4 h. The reaction mixture was neutralized with 10% aq. NaOH solution and extracted with ethyl acetate. The organic phase was washed with water and brine, then dried over anhydrous sodium sulfate, filtered and evaporated. The residue obtained was purified by silica column chromatography with ethyl acetate as the eluent. Upon recrystallization, white crystals were obtained.

9-Isopropyl-3-hydroxymethyl-1-methyl-β-carboline (6b)

Starting from ethyl 9-isopropyl-1-methyl-β-carboline-3-carboxylate **5b** (2.96g, 10mmol), white solid was obtained (1.6 g, 63%). ESI-MS m/z: 255 (100) $[M+H]^+$. ^{1}H NMR (300 MHz, $CDCl_3$): δ 8.09 (1H, d, J= 7.8MHz, ArH), 7.78 (1H, s, ArH), 7.53-7.61 (2H, m, ArH), 7.24-7.29 (2H, m, ArH), 4.99-5.08 (1H, m, C***H***$[CH_3]_2$), 4.94 (2H, s, C***H***$_2$OH), 1.75 (2H, d, J =6.9Hz, CH[C***H***$_3]_2$). ^{13}C NMR (75 MHz, $CDCl_3$): δ 147.6, 140.5,140.2, 135.2, 130.2, 127.7, 122.8, 121.9, 119.5, 113.4, 109.9, 65.0, 48.5, 24.9, 21.7.

9-Isobutyl-3-hydroxymethyl-1-methyl-β-carboline (6d)

Starting from ethyl 9-isobutyl-1-methyl-β-carboline-3-carboxylate **5d** (3.10g, 10mmol), white solid was obtained (2.0g, 75%). ESI-MS m/z: 269 (100) $[M+H]^+$. ^{1}H NMR (300 MHz, $CDCl_3$): δ 8.08 (1H, d, J=7.8Hz, ArH), 7.78 (1H, s, ArH), 7.53-7.58 (1H, m, ArH), 7.44 (1H, d,

J=8.4Hz, ArH), 7.22-7.27 (1H, m, ArH), 4.89 (2H, s, C***H***$_2$OH), 4.32 (2H, d, *J*=7.5Hz, C***H***$_2$CH[CH$_3$]$_2$), 3.02 (3H, s, CH$_3$), 2.18-2.32 (1H, m, CH$_2$C***H***[CH$_3$]$_2$), 0.93 (6H, d, *J* =6.6Hz, CH$_2$CH[C***H***$_3$]$_2$). ^{13}C NMR (75 MHz, CDCl$_3$): δ 147.4, 142.7,140.5, 134.9, 130.3, 128.2, 121.6, 119.7, 112.3, 110.7, 109.9, 65.0, 52.1, 31.0, 23.8, 20.5.

9-Butyl-3-hydroxymethyl-1-isopropyl-β-carboline (6i)

Starting from ethyl 9-butyl-1-isopropyl-β-carboline-3-carboxylate **5i** (3.4g, 10mmol), white solid was obtained (2.5g, 86%). ESI-MS m/z: 297 (100) [M+H]$^+$. ^{1}H NMR (400 MHz, CDCl$_3$): δ 8.11 (1H, d, *J* = 8.0 Hz), 7.70 (1H, s), 7.55-7.59 (1H, m), 7.46 (1H, d, *J* = 8.0 Hz), 7.23-7.27 (1H, m), 4.90 (2H, s), 4.48 (2H, t, *J* = 8.0 Hz), 3.74-3.77 (1H, m), 1.78-1.86 (2H, m), 1.43-1.50 (9H, m), 0.88 (3H, t, *J* = 7.2 Hz).

9-Benzyl-3-hydroxymethyl-1-isopropyl-β-carboline (6j)

Starting from ethyl 9-benzyl-1-isopropyl-β-carboline-3-carboxylate **5j** (3.7g, 10mmol), white solid was obtained (2.7g, 83%). ESI-MS m/z: 331 (100) [M+H]$^+$. ^{1}H NMR (400 MHz, CDCl$_3$): δ 8.14 (1H, d, *J* = 8.0 Hz), 7.75 (1H, s), 7.52-7.56 (1H, m), 7.37 (1H, d, *J* = 8.0 Hz), 7.22-7.30 (4H, m), 7.01 (1H, d, *J* = 7.6 Hz), 6.99-7.01 (2H, d, *J* = 8.0 Hz), 5.76 (2H, s), 4.91 (2H, s), 3.58-3.62 (1H, m), 1.29 (6H, d, *J* = 6.8 Hz).

9-Butyl-3-hydroxymethyl-1-(4-chlorophenyl)-β-carboline (6m)

Starting from ethyl 9-butyl-1-(4-chlorophenyl)-β-carboline-3-carboxylate **5m** (4.1g, 10mmol), white solid was obtained (2.9g, 79%). ESI-MS m/z: 365 (100) [M+H]$^+$. ^{1}H NMR (400 MHz, CDCl$_3$): δ 8.17 (1H, d, *J* = 8.0 Hz), 7.95 (1H, s), 7.55–7.62 (3H, m), 7.49-7.52 (2H, m), 7.44 (1H, d, *J* = 8.4 Hz), 7.28-7.32 (1H, m), 4.95 (2H, s), 3.97 (2H, t, *J* = 8.0 Hz), 1.28-1.36 (2H, m), 0.85 – 0.91 (2H, m), 0.66 (3H, t, *J* = 7.2 Hz).

9-Benzyl-3-hydroxymethyl-1-(4-chlorophenyl)-β-carboline (6n)

Starting from ethyl 9-benzyl-1-(4-chlorophenyl)-β-carboline-3-carboxylate **5n** (4.4g, 10mmol), white solid was obtained (2.86g, 72%). ESI-MS m/z: 399 (100) $[M+H]^+$. ^1H NMR (400 MHz, $CDCl_3$): δ 8.21 (1H, d, J = 8.0 Hz), 7.99 (1H, s), 7.52-7.57 (1H, m), 7.23-7.34 (6H, m), 7.09 -7.16 (3H, m), 6.57 (2H, d, J = 8.0 Hz), 5.21 (2H, s), 4.94 (2H, s).

9-Hexyl-3-hydroxymethyl-1-(4-methoxyphenyl)-β-carboline (6q)

Starting from ethyl 9-hexyl-1-(4-methoxylphenyl)-β-carboline-3-carboxylate **5q** (4.3g, 10mmol), white solid was obtained (2.91g, 75%). EI-MS m/z: 389 $[M+H]^+$. ^1H NMR (400 MHz, $CDCl_3$): δ 8.17 (1H, d, J = 8.0 Hz), 7.93 (1H, s), 7.55-7.62 (3H, m), 7.44 (1H, d, J = 8.4 Hz), 7.28-7.32 (1H, m), 7.04-7.07 (2H, m), 4.97 (2H, s), 3.98 (2H, t, J = 8.0 Hz), 3.90 (3H, s), 1.32-1.36 (2H, m), 1.08-1.12 (2H, m), 0.96-1.01 (2H, m), 0.84-0.87 (2H, m), 0.77 (3H, t, J = 7.2 Hz).

General procedure for the preparation of 1,9-disubstituted-β-carboline-3-carbaldehyde (7).

To a solution of compounds **6** (10mmol) in CH_3CN (120 ml) was added activated MnO_2 (50 mmol). The suspension was refluxed for 2 h and then cooled and filtered through Celite. The filtrate was passed through silica gel and washed with dichloromethane, and the solvent was removed under reduced pressure. The residue was crystallized from acetone or acetone-petroleum ether to afford white crystals **7**.

9-Isopropyl-1-methyl-β-carboline-3-carbaldehyde (7b)

Starting from 9-isopropyl-3-hydroxymethyl-1-methyl-β-carboline **6b** (2.54g, 10mmol), white solid was obtained (1.7g, 67%). EI-MS m/z: 253 $[M+H]^+$. ^1H NMR (300 MHz, $CDCl_3$): δ 10.15 (1H, s, C***H***O), 8.58 (1H, s, ArH), 8.19 (1H, d, J= 7.8Hz, ArH), 7.76 (1H, d, J=8.4Hz, ArH), 7.55-7.60 (1H, m, ArH), 7.31-7.36 (1H, m, ArH), 5.58-5.72 (1H, m, C***H***$[CH_3]_2$), 3.14 (3H, s, C***H***$_3$),

1.80 (2H, d, J =6.9Hz, CH[C$\boldsymbol{H}_3$]$_2$). ^{13}C NMR (75 MHz, $CDCl_3$): δ 193.0, 142.9, 141.5, 140.2, 138.0, 128.8, 128.3, 123.2, 122.0, 120.8, 113.9, 113.5,49.0, 25.6, 21.8.

9-Isobutyl-1-methyl-β-carboline-3-carbaldehyde (7d)

Starting from 9-isobutyl-3-hydroxymethyl-1-methyl-β-carboline **6d** (2.68g, 10mmol), white solid was obtained (1.8g, 68%). EI-MS m/z: 267 $[M+H]^+$. ^{1}H NMR (300 MHz, $CDCl_3$): δ 10.17 (1H, s, C$\boldsymbol{H}$O), 8.60 (1H, s, ArH), 8.17 (1H, d, J=7.8Hz, ArH), 7.59-7.65 (1H, m, ArH), 7.51 (1H, d, J=8.4Hz, ArH)，7.32-7.38 (1H, m, ArH), 4.43 (2H, d, J =6.9Hz, C$\boldsymbol{H}_2$CH[CH_3]$_2$), 3.12 (3H, s, C$\boldsymbol{H}_3$), 2.23-2.37 (1H, m, CH_2C$\boldsymbol{H}$[CH_3]$_2$), 0.97 (2H, d, J=6.9Hz, CH_2CH[C$\boldsymbol{H}_3$]$_2$). ^{13}C NMR (75 MHz, $CDCl_3$): δ 193.0, 143.2, 142.4, 141.7, 137.7, 129.0, 128.8, 121.7, 121.0, 113.5, 111.2, 52.1, 31.0, 24.3, 20.5.

9-Butyl-1-isopropyl-β-carboline-3-carbaldehyde (7i)

Starting from 9-butyl-3-hydroxymethyl-1-isopropyl-β-carboline **6i** (2.98g, 10mmol), white solid was obtained (2.1g, 74%). EI-MS m/z: 295 $[M+H]^+$. ^{1}H NMR (400 MHz, $CDCl_3$): δ 10.22 (1H, s), 8.58 (1H, s), 8.18 (1H, d, J = 8.0 Hz), 7.61-7.65 (1H, m), 7.51 (1H, d, J = 8.0 Hz), 7.33-7.37 (1H, m), 4.45 (2H, t, J = 8.0 Hz), 3.74-3.81 (1H, m), 1.83– 1.91 (2H, m), 1.43-1.54 (8H, m), 1. 01 (3H, t, J = 7.2 Hz).

9-Benzyl-1-isopropyl-β-carboline-3-carbaldehyde (7j)

Starting from 9-benzyl-3-hydroxymethyl-1-isopropyl-β-carboline **6j** (3.30g, 10mmol), white solid was obtained (2.8g, 86%). EI-MS m/z: 329 $[M+H]^+$. ^{1}H NMR (400 MHz, $CDCl_3$): δ 10.24 (1H, s), 8.64 (1H, s), 8.23 (1H, d, J = 8.0 Hz), 7.56-7.60 (1H, m), 7.36-7.43 (2H, m), 7.27-7.32 (3H, m), 7.01 (2H, d, J = 8.0 Hz), 5.83 (2H, s), 3.63-3.66 (1H, m), 1.36 (6H, d, J = 6.4 Hz).

9-Butyl-1-(4-chlorophenyl)-β-carboline-3-carbaldehyde (7m)

Starting from 9-butyl-3-hydroxymethyl-1-(4-chlorophenyl)-β-carboline **6m** (3.64g, 10mmol), white solid was obtained (3.22g, 89%). EI-MS m/z: 363 $[M+H]^+$. ^1H NMR (400 MHz, $CDCl_3$): δ 10.33 (1H, s), 8.79 (1H, s), 8.26 (1H, d, J = 8.0 Hz), 7.66-7.70 (1H, m), 7.50-7.63 (5H, m), 7.40-7.44 (1H, m), 4.04 (2H, t, J = 8.0 Hz), 1.37-1.43 (2H, m), 0.90-0.96 (2H, m), 0.70 (3H, t, J = 7.2 Hz).

9-Benzyl-1-(4-chlorophenyl)-β-carboline-3-carbaldehyde (7n)

Starting from 9-benzyl-3-hydroxymethyl-1-(4-chlorophenyl)-β-carboline **6n** (3.98g, 10mmol), white solid was obtained (2.85g, 72%). EI-MS m/z: 397 $[M+H]^+$. ^1H NMR (400 MHz, $CDCl_3$): δ 10.24 (1H, s), 8.80 (1H, s), 8.30 (1H, d, J = 8.0 Hz), 7.58-7.62 (1H, m), 7.38-7.45 (2H, m), 7.27 – 7.33 (4H, m), 7.12-7.18 (3H, m), 6.58 (2H, d, J = 8.0 Hz), 5.28 (2H, s).

9-Hexyl-1-(4-methoxyphenyl)-β-carboline-3-carbaldehyde (7q)

Starting from 9-hexyl-3-hydroxymethyl-1-(4-methoxyphenyl)-β-carboline **6q** (3.88g, 10mmol), white solid was obtained (2.75g, 71%). EI-MS m/z: 387 $[M+H]^+$. ^1H NMR (400 MHz, $CDCl_3$): δ 10.30 (1H, s), 8.75 (1H, s), 8.26 (1H, d, J = 8.0 Hz), 7.63-7.67 (1H, m), 7.56-7.59 (2H, m), 7.51 (1H, d, J = 8.4 Hz), 7.40 (1H, t, J = 7.6Hz), 7.08 (2H, d, J = 8.0 Hz), 4.03 (2H, t, J = 8.0 Hz), 3.92 (3H, s), 1.40-1.44 (2H, m), 1.12-1.17 (2H, m), 0.98-1.06 (2H, m), 0.87-0.91 (2H, m), 0.80 (3H, t, J = 7.2 Hz).

General procedure for the preparation of bivalent β-carbolines 8a-ae.

A mixture of β-carboline-3-carboxaldehydes **7** (2.2 mmol), anhydrous methanol (30mL) and anhydrous CH_2Cl_2 (10 mL) was stirred at room temperature for 10 min, and the corresponding diamine (1.0 mmol) was added. The mixture was refluxed for 2 hrs, and the solvent was evaporated under vacuum to give the crude schiff base, which was used directly in the next step

without further purification.

$NaBH_3CN$ (5 mmol) was added to a solution of the above-mentioned crude schiff base in anhydrous CH_3OH (30 mL) at 0 ^oC. The mixture was stirred at room temperature for 4-6 h. After completion of the reaction as indicated by TLC, the reaction mixture was concentrated under vacuum. The residue was dissolved in CH_2Cl_2 (150 mL) and washed with aqueous Na_2CO_3 (pH 10, 50 mL). The organic layer was separated, dried over anhydrous Na_2SO_4, filtered, and concentrated under vacuum. The residue was purified by flash chromatography on silica gel (CH_2Cl_2/CH_3OH/NH_4OH, 100:1:0.8) e to provide target products.

N,N-Bis[(1,9-dimethyl-β-carboline-3-yl)methyl]butane-1,4-diamine (8a).

Starting from 1,9-dimethyl-β-carboline-3-carboxaldehyde and 1,4-diamino-butane, compound **8a** was obtained as white solid (0.75 g, 68%). EI-MS m/z: 505.1 $[M+H]^+$. ^1H NMR (300 MHz, $CDCl_3$): δ 8.04 (2H, d, J =7.8Hz), 7.75(2H, s), 7.52-7.58(2H, m), 7.35(2H, d, J =7.8Hz), 7.20-7.23(2H, m), 4.02(4H, s), 3.96(6H, s), 2.99(6H, s), 2.81(4H, t, J =6.3Hz), 1.71-1.75(4H, m). ^{13}C NMR (75 MHz, $CDCl_3$): δ 147.4, 142.4, 141.1, 134.9, 129.4, 128.1, 121.6, 121.2, 119.5, 111.2, 109.4, 55.5, 49.8, 32.3,28.4, 23.8. HRMS calcd for $C_{32}H_{36}N_6$ $[M+H]^+$ 505.3074, found 505.3077.

N,N-Bis[(1,9-dimethyl-β-carboline-3-yl)methyl]hexane-1,6-diamine (8b).

Starting from 1,9-dimethyl-β-carboline-3-carboxaldehyde and 1,4-diaminohexane, compound **8b** was obtained as white solid (0.70 g, 60%). EI-MS m/z: 533.1 $[M+H]^+$. ^1H NMR (300 MHz, $CDCl_3$): δ 8.07 (2H, d, J =7.5Hz), 7.80(2H, s), 7.53-7.58(2H, m), 7.40(2H, d, J =8.1Hz), 7.21-7.23(2H, m), 4.11 (4H, s), 4.02(6H, s), 3.06(6H, s), 2.71(4H, t, J =7.2Hz), 1.55-1.64(4H, m), 1.37-1.41(4H, m). ^{13}C NMR (75 MHz, $CDCl_3$) : δ 148.1, 142.6, 141.2, 135.1, 129.6,

128.1, 121.6, 121.4, 119.6, 111.3, 109.5, 55.9, 50.0, 32.5, 30.6, 27.8, 24.0. HRMS calcd for $C_{34}H_{40}N_6$ $[M+H]^+$ 533.3387, found 533.3393.

N,N-Bis[(9-isopropyl-1-methyl-β-carboline-3-yl)methyl]butane-1,4-diamine (8c).

Starting from 9-isopropyl-1-methyl-β-carboline-3-carboxaldehyde and 1,4-diaminohexane, compound **8c** was obtained as yellow oil (0.39 g, 70%). EI-MS m/z: 561.1 $[M+H]^+$. ^{1}H NMR (300 MHz, $CDCl_3$): δ 8.09 (2H, d, J =7.8Hz), 7.80 (2H, s), 7.66 (2H, d, J =8.7Hz), 7.43-7.51 (2H, m), 7.18-7.24 (2H, m), 4.46-5.55 (2H, m), 4.02 (4H, s), 3.02 (4H, s), 2.76 (4H, t, J =6.0Hz), 1.74 (6H, s), 1.72 (6H, s), 1.65-1.70 (4H, m). ^{13}C NMR (75 MHz, $CDCl_3$) : δ 147.3, 140.7, 140.3, 135.0, 129.8, 127.5, 122.9, 121.9, 119.4, 113.3, 111.3, 55.5, 49.8, 48.5, 28.4, 25.3, 21.8. HRMS calcd for $C_{36}H_{44}N_6$ $[M+H]^+$ 561.3700, found 561.3709.

N,N-Bis[(9-butyl-1-methyl-β-carboline-3-yl)methyl]butane-1,4-diamine (8d).

Starting from 9-butyl-1-methyl-β-carboline-3-carboxaldehyde and 1,4-diaminohexane, compound **8d** was obtained as white solid (0.32 g, 25%). EI-MS m/z: 589.2 $[M+H]^+$. ^{1}H NMR (300 MHz, $CDCl_3$): δ 8.07 (2H, d, J =7.8Hz), 7.80(2H, s), 7.51-7.56 (2H, m), 7.41(2H, d, J =7.8Hz), 7.19-7.22 (2H, m), 4.47(4H, t, J =6.6Hz), 4.02 (4H, s), 3.01(6H, s), 2.76 (4H, t, J =6.3Hz), 1.75-1.85(4H, m), 1.65-1.70 (4H, m), 1.37-1.49(4H, m), 0.97(6H, t, J =7.2Hz). ^{13}C NMR (75 MHz, $CDCl_3$) : δ 147.8, 141.9, 140.7, 134.2, 129.8, 128.0, 121.6, 121.5, 119.5, 111.2, 109.8, 55.8, 49.9, 44.8, 33.1, 28.4, 23.8, 20.5, 14.2. HRMS calcd for $C_{38}H_{48}N_6$ $[M+H]^+$ 589.4013, found 589.4018.

N,N-Bis[(9-isobutyl-1-methyl-β-carboline-3-yl)methyl]propane-1,3-diamine (8e).

Starting from 9-isobutyl-1-methyl-β-carboline-3-carboxaldehyde and 1,3-diaminopropane, compound **8e** was obtained as yellow oil (0.57 g, 45%). EI-MS m/z: 575.2 $[M+H]^+$. ^{1}H NMR (300

MHz, $CDCl_3$): δ 7.93 (2H, d, J =7.8Hz), 7.83(2H, s), 7.46-7.51 (2H, m), 7.35(2H, d, J =7.8Hz), 7.09-7.14 (2H, m), 4.13(4H, s), 4.09 (4H, d, J =7.5Hz), 3.11(4H, t, J =5.4Hz), 2.82 (6H, s), 2.03-2.17(4H, m), 0.85(6H, s), 0.83(6H, s). ^{13}C NMR (75 MHz, $CDCl_3$) : δ 143.5, 142.3, 141.1, 134.7, 129.8, 128.1, 121.6, 121.0, 119.7, 112.3, 110.6, 53.7, 51.8, 49.2, 31.0, 25.6, 23.9, 20.5. HRMS calcd for $C_{37}H_{46}N_6$ $[M+H]^+$ 575.3857, found 575.3877.

N,N-Bis[(9-isobutyl-1-methyl-β-carboline-3-yl)methyl]butane-1,4-diamine (8f).

Starting from 9-isobutyl-1-methyl-β-carboline-3-carboxaldehyde and 1,4-diaminobutane, compound **8f** was obtained as yellow oil (0.52 g, 40%). EI-MS m/z: 589.2 $[M+H]^+$. ^{1}H NMR (300 MHz, $CDCl_3$): δ 8.06 (2H, d, J =7.8Hz), 7.82(2H, s), 7.48-7.53 (2H, m), 7.40 (2H, d, J =7.8Hz), 7.18-7.23 (2H, m), 4.28 (4H, d, J =7.5Hz), 4.02(4H, s), 2.99 (6H, s), 2.77(4H, t, J =6.0Hz), 2.19-2.28(2H, m), 1.65-1.70 (2H, m), 0.92 (6H, s), 0.90 (6H, s). ^{13}C NMR (75 MHz, $CDCl_3$) : δ 147.9, 142.4, 140.8, 134.5, 129.9, 127.9, 121.6, 121.3, 119.4, 111.3, 110.5, 55.8, 51.9, 50.0, 30.9, 28.4, 24.1, 20.5. HRMS calcd for $C_{38}H_{48}N_6$ $[M+H]^+$ 589.4013, found 589.4020.

N,N-Bis[(9-benzyl-1-methyl-β-carboline-3-yl)methyl]propane-1,3-diamine (8g).

Starting from 9-benzyl-1-methyl-β-carboline-3-carboxaldehyde and 1,3-diaminopropane, compound **8g** was obtained as yellow oil (0.37 g, 58%). EI-MS m/z: 643.4 $[M+H]^+$. ^{1}H NMR (300 MHz, $CDCl_3$): δ 8.08 (2H, d, J =7.8Hz), 7.87 (2H, s), 7.46-7.51 (2H, m), 7.31 (2H, d, J =8.4Hz), 7.20-7.24 (8H, m), 6.94-6.98 (4H, m), 5.71(4H, s), 4.05(4H, s), 2.88 (4H, t, J =6.9Hz), 2.82 (6H, s), 1.85-1.94 (2H, m). ^{13}C NMR (75 MHz, $CDCl_3$) : δ 148.1, 142.4, 141.2, 138.2, 134.7, 130.0, 129.1, 128.5, 127.6, 125.6, 121.8, 121.6, 120.1, 111.6, 110.0, 55.8, 48.6, 48.4, 30.5, 23.5. HRMS calcd for $C_{43}H_{42}N_6$ $[M+H]^+$ 643.3544, found 643.3550.

N,N-Bis[(9-benzyl-1-methyl-β-carboline-3-yl)methyl]butane-1,4-diamine (8h).

Starting from 9-benzyl-1-methyl-β-carboline-3-carboxaldehyde and 1,4-diaminobutane, compound **8h** was obtained as yellow oil (0.36 g, 60%). EI-MS m/z: 657.4 $[M+H]^+$. ^1H NMR (300 MHz, $CDCl_3$): δ 8.12 (2H, d, J =7.8Hz), 7.86 (2H, s), 7.48-7.53 (2H, m), 7.31 (2H, d, J =8.4Hz), 7.22-7.26 (8H, m), 6.94-6.97 (4H, m), 5.71(4H, s), 4.04(4H, s), 2.82 (6H, s), 2.77 (4H, t, J =6.0Hz), 1.68-1.72 (4H, m). ^{13}C NMR (75 MHz, $CDCl_3$) : δ 148.0, 142.4, 141.2, 138.2, 134.8, 130.0, 129.2, 128.5, 127.7, 125.6, 121.8, 121.6, 120.1, 111.6, 110.0, 55.6, 49.9, 48.4, 28.4, 23.5. HRMS calcd for $C_{44}H_{44}N_6$ $[M+H]^+$ 657.3700, found 657.3700.

N,N-Bis[(9-(3-chlorobenzyl)-1-methyl-β-carboline-3-yl)methyl]propane-1,3-diamine (8i).

Starting from 9-(3-chlorobenzyl)-1-methyl-β-carboline-3-carboxaldehyde and 1,3-diaminopropane, compound **8i** was obtained as white solid (0.91 g, 58%). EI-MS m/z: 711.0 $[M+H]^+$. ^1H NMR (300 MHz, $CDCl_3$): δ 8.07 (2H, d, J =7.8Hz), 7.87 (2H, s), 7.46-7.51 (2H, m), 7.13-7.26 (8H, m), 7.00 (2H, s), 6.76 (2H, d, J =7.5Hz), 5.63(4H, s), 4.06 (4H, s), 2.89 (4H, t, J =6.9Hz), 2.79 (6H, s), 1.85-1.92 (2H, m). ^{13}C NMR (75 MHz, $CDCl_3$) : δ 148.5, 142.2, 141.0, 140.4, 135.1, 134.6, 130.5, 130.1, 128.6, 128.0, 125.8, 123.8, 121.8, 121.7, 120.3, 111.5, 109.8, 55.7, 48.6, 47.9, 30.5, 23.5. HRMS calcd for $C_{43}H_{40}Cl_2N_6$ $[M+H]^+$ 711.2764, found 711.2761.

N,N-Bis[(9-(3-propylphenyl)-1-methyl-β-carboline-3-yl)methyl]propane-1,3-diamine (8j).

Starting from 9-(3-propylphenyl)-1-methyl-β-carboline-3-carboxaldehyde and 1,3-diaminopropane, compound **8j** was obtained as yellow oil (0.58 g, 38%). EI-MS m/z: 698.8 $[M+H]^+$. ^1H NMR (300 MHz, $CDCl_3$): δ 8.02 (2H, d, J =7.5Hz), 7.80 (2H, s), 7.46-7.52 (2H, m), 7.15-7.31 (14H, m), 4.46(4H, t, J=8.1Hz), 4.03(4H, s), 2.86 (6H, s), 2.85(4H, t, J =6.6Hz), 2.73 (4H, t, J =7.5 Hz), 2.07-2.15 (4H, m), 1.83-1.89 (2H, m). ^{13}C NMR (75 MHz, $CDCl_3$) : δ 147.7, 141.9, 140.8, 134.2, 129.9, 128.8, 128.6, 128.2, 126.5, 121.7, 121.6, 119.7, 111.5, 109.8, 55.7,

48.5, 44.4, 33.4, 32.3, 30.5, 23.6. HRMS calcd for $C_{47}H_{50}N_6$ $[M+H]^+$ 699.4170 found 399.4171.

N,N-Bis[1-isopropyl-β-carboline-3-yl)methyl]pentane-1,5-diamine (8k).

Starting from 1-isopropyl-β-carboline-3-carboxaldehyde and 1,5-diaminopentane, compound **8k** was obtained as yellow solid (0.32 g, 27%). ESI-MS m/z: 547 $[M+1]^+$. ^{1}H NMR (400 MHz, DMSO): δ 8.16 (2H, d, J = 8.0 Hz), 8.03 (2H, s), 7.61 (2H, d, J = 8.0 Hz), 7.52 –7.56 (2H, m), 7.22 –7.26 (2H, m), 4.24 (4H, s), 3.64-3.68 (2H, m), 2.90 (4H, t, J = 6.0 Hz), 1.64-1.68 (4H, m), 1.37-1.39 (14H, m). ^{13}C NMR (100 MHz, DMSO): δ 149.8, 140.6, 132.4, 127.97, 127.93, 121.3, 120.7, 119.2, 111.9, 111.8, 51.7, 46.8, 30.8, 26.0, 23.4, 21.3. HRMS calcd for $C_{35}H_{42}N_6$ $[M+H]^+$ 547.3549，found 547.3553.

N,N-Bis[(9-butyl-1-isopropyl-β-carboline-3-yl)methyl]butane-1,4-diamine (8l).

Starting from 9-butyl-1-isopropyl-β-carboline-3-carboxaldehyde and 1,4-diaminobutane, compound **8l** was obtained as yellow solid (0.37 g, 26%). ESI-MS m/z: 645$[M+1]^+$. ^{1}H NMR (400 MHz, $CDCl_3$): δ 9.21 (2H, s), 8.10 (2H, d, J =8.0Hz), 7.95 (2H, s), 7.55 (2H, d, J = 8.4 Hz), 7.43 (2H, d, J = 7.4 Hz), 5.08 (4H, s), 4.48 (4H, t, J = 6.4Hz), 3.72 - 3.76 (2H, m), 2.95-2.98 (4H, t, J = 7.6 Hz), 1.98-2.02 (4H, m), 1.79-1.83 (4H, m), 1.41-1.46 (16H, m), 0.96-0.99 (6H, t, J = 7.6Hz). ^{13}C NMR (100 MHz, $CDCl_3$)：δ 150.1, 142.2, 139.0, 133.1, 130.7, 128.3, 121.6, 121.1, 119.7, 112.4, 109.6, 51.6, 46.9, 45.1, 32.4, 31.4, 28.7, 26.7, 24.2, 22.7, 20.2, 13.8.

N,N-Bis[(9-butyl-1-isopropyl-β-carboline-3-yl)methyl]pentane-1,5-diamine (8m).

Starting from 9-butyl-1-isopropyl-β-carboline-3-carboxaldehyde and 1,5-diaminopentane, compound **8m** was obtained as yellow solid (0.46 g, 32%). ESI-MS m/z: 659 $[M+1]^+$. ^{1}H NMR (400 MHz, $CDCl_3$): δ 9.19 (2H, s), 8.41 (2H, d, J = 8.0 Hz), 7.78 (2H, t, J = 7.6 Hz), 7.56 (2H, d, J = 8.4 Hz), 7.42 (2H, t, J = 7.4 Hz), 5.11 (4H, s), 4.54 (4H, t, J = 6.4Hz), 3.99-4.06 (2H, m), 3.41

(4H, s), 2.12-2.15 (4H, m), 1.85-1.90 (16H, m), 1.47-1.55 (4H, m), 1.02 (6H, t, J = 7.2 Hz). ^{13}C NMR (100 MHz, $CDCl_3$)：δ 147.6, 145.3, 135.3, 133.6, 132.6, 131.9, 124.1, 122.6, 120.0, 119.8, 110.3, 47.1, 46.7, 46.2, 32.5, 29.9, 22.7, 21.9, 20.1, 13.7. HRMS calcd for $C_{43}H_{58}N_6$ $[M+H]^+$ 659.4801，found 659.4793.

N,N-Bis[(9-benzyl-1-isopropyl-β-carboline-3-yl)methyl]propane-1,3-diamine (8n).

Starting from 9-benzyl-1-isopropyl-β-carboline-3-carboxaldehyde and 1,3-diaminopropane, compound **8n** was obtained as white solid (0.49 g, 32%). ESI-MS m/z: 699.4 $[M+1]^+$. ^{1}H NMR (400 MHz, DMSO)：δ 8.50 (2H, s), 8.32 (2H, d, J = 7.6 Hz), 7.80 (2H, d, J = 8.0 Hz), 7.68 (2H, t, J = 7.2 Hz), 7.40 (2H, t, J = 7.2 Hz), 7.21-7.31 (6H, m), 6.93 (4H, d, J = 6.8 Hz), 5.96 (4H, s), 4.54 (4H, s), 3.71-3.76 (2H, m), 3.19-3.22 (4H, t, J = 7.6 Hz), 2.25-2.29 (2H, m), 1.24 (12H, d, J = 6.8 Hz). ^{13}C NMR (100 MHz, DMSO)：δ 149.4, 143.2, 138.5, 137.7, 132.3, 128.7, 127.2, 125.2, 121.8, 120.8, 119.9, 110.8, 48.0, 43.8, 30.1, 30.0, 22.2, 22.0. HRMS calcd for $C_{47}H_{50}N_6$ $[M+H]^+$ 699.4175，found 699.4168.

N,N-Bis[(9-benzyl-1-isopropyl-β-carboline-3-yl)methyl]hexane-1,6-diamine (8o).

Starting from 9-benzyl-1-isopropyl-β-carboline-3-carboxaldehyde and 1,3-diaminohexane, compound **8o** was obtained as white solid (0.70 g, 43%). ESI-MS m/z: 741 $[M+1]^+$. ^{1}H NMR (400 MHz, $CDCl_3$)：δ 9.19 (2H, s), 8.45 (2H, d, J = 7.6 Hz), 7.79 (2H, d, J = 8.0 Hz), 7.56 (2H, t, J = 7.2 Hz), 7.48(2H, t, J = 7.2 Hz), 7.31-7.35 (6H, m), 7.01 (4H, d, J = 6.8 Hz), 5.84 (4H, s), 5.01 (4H, s), 3.89 (2H, m), 3.31-3.35 (4H, m), 2.58 (4H, m), 1.96-1.98 (4H, m), 1.59 (12H, d, J = 6.8 Hz). ^{13}C NMR (100 MHz, DMSO)：δ 148.9, 143.7, 137.9, 136.2, 132.6, 127.9, 127.1, 125.8, 122.1, 120.4, 119.3, 111.3, 55.4, 48.3, 42.7, 33.4, 31.2, 28.1, 22.7. HRMS calcd for $C_{50}H_{56}N_6$ $[M+H]^+$ 741.4645，found 741.4639.

N,N-Bis[(9-methyl-1-phenyl-β-carboline-3-yl)methyl]butane-1,4-diamine (8p).

Starting from 9-methyl-1-phenyl-β-carboline-3-carboxaldehyde and 1,4-diaminobutane, compound **8p** was obtained as yellow solid (0.58 g, 42%). ESI-MS m/z: 629 $[M+1]^+$. ^{1}H NMR (400 MHz, D_2O): δ 8.85 (2H, s), 8.60 (2H, d, J = 8.0 Hz), 7.85 -8.11 (14H, m), 7.74 (2H, t, J = 7.6 Hz), 5.02 (4H, s), 3.64 (6H, s), 3.54 (4H, t, J = 6.0 Hz), 2.20-2.24 (4H, m). ^{13}C NMR (100 MHz, D_2O)：δ 146.3, 142.0, 134.8, 134.7, 133.6, 132.9, 132.6, 132.1, 130.9, 129.9, 123.6, 122.9, 120.4, 118.1, 112.0, 49.4, 47.8, 33.4, 23.7. HRMS calcd for $C_{42}H_{40}N_6$ $[M+H]^+$ 629.3393，found 629.3389.

N,N-Bis[(9-methyl-1-phenyl-β-carboline-3-yl)methyl]hexane-1,6-diamine (8q).

Starting from 9-methyl-1-phenyl-β-carboline-3-carboxaldehyde and 1,6-diaminohexane, compound **8q** was obtained as yellow solid (0.39 g, 27%). ESI-MS m/z: 657 $[M+1]^+$. ^{1}H NMR (400 MHz, DMSO): δ 8.74 (2H, s), 8.37 (2H, d, J = 8.0 Hz), 7.75-7.81 (8H, m), 7.60-7.66 (6H, m), 7.43 (2H, t, J = 7.6 Hz), 4.55 (4H, s), 3.50 (6H, s), 3.02 (4H, t, J = 6.0 Hz), 1.71-1.75 (4H, m), 1.33-1.38 (4H, m). ^{13}C NMR (100 MHz, D_2O)：δ 148.1, 142.3, 138.4, 134.2, 133.6, 132.2, 130.5, 129.3, 126.8, 123.9, 122.4, 121.7, 119.2, 117.8, 111.0, 51.4, 49.2, 33.8, 26.1, 24.4. HRMS calcd for $C_{44}H_{44}N_6$ $[M+H]^+$ 657.3706，found 657.3705.

N,N-Bis[(9-benzyl-1-phenyl-β-carboline-3-yl)methyl]propane-1,3-diamine (8r).

Starting from 9-benzyl-1-phenyl-β-carboline-3-carboxaldehyde and 1,3-diaminopropane, compound **8r** was obtained as yellow solid (0.54 g, 32%). ESI-MS m/z: 767 $[M+1]^+$. ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.19 (2H, s), 8.11 (2H, d, J = 8.0 Hz), 7.47-7.51 (2H, m), 7.29-7.33 (2H, m), 7.07-7.25 (18H, m), 6.54 (4H, d, J = 8.0Hz), 5.05 (4H, s), 4.19 (4H, s), 3.08 (4H, t, J = 6.0 Hz), 2.25-2.28(2H, m). ^{13}C NMR (100 MHz, $CDCl_3$): δ 143.9, 143.2, 142.9, 139.2, 136.8, 133.9, 131.3,

129.1, 128.8, 128.4, 128.0, 127.0, 125.6, 121.8, 121.2, 120.4, 113.4, 110.5, 52.7, 48.9, 47.9, 24.1. HRMS calcd for $C_{53}H_{46}N_6$ $[M+H]^+$ 767.3862，found 767.3861.

N,N-Bis[(9-benzyl-1-phenyl-β-carboline-3-yl)methyl]hexane-1,6-diamine (8s).

Starting from 9-benzyl-1-phenyl-β-carboline-3-carboxaldehyde and 1,6-diaminohexane, compound **8s** was obtained as yellow solid (0.52 g, 29%). ESI-MS m/z: 809 $[M+1]^+$. ^{1}H NMR (400 MHz, DMSO) δ 8.92 (2H, s), 8.43 (2H, d, J = 8.0 Hz), 7.74-7.76 (4H, m), 7.56-7.60 (6H, m), 7.44-7.49 (6H, m), 7.06–7.12(6H, m), 6.47 (4H, d, J = 8.0Hz), 5.37 (4H, s), 4.58 (4H, s), 3.02-3.05 (4H, t, J = 6.0 Hz), 1.71-1.74 (4H, m), 1.36 –1.42 (4H, m), 1.05 (2H, t, J = 7.0 Hz). ^{13}C NMR (100 MHz, $CDCl_3$) δ 145.0, 135.5, 134.9, 134.4, 133.3, 133.1, 132.9, 132.7, 132.6, 129.9, 128.3, 127.5, 124.4, 122.7, 120.7, 120.1, 110.5, 47.1, 46.8, 44.7, 31.3, 24.4, 19.9, 13.3. HRMS calcd for $C_{56}H_{52}N_6$ $[M+H]^+$ 809.4332，found 809.4324.

N,N-Bis[(1-(4-chlorophenyl)-9-butyl-β-carboline-3-yl)methyl]propane-1,3-diamine (8t).

Starting from 1-(4-chlorophenyl)-9-butyl-β-carboline-3-carboxaldehyde and 1,3-diaminopropane, compound **8t** was obtained as yellow solid (0.71 g, 42%). ESI-MS m/z: 767.5 $[M+1]^+$. ^{1}H NMR (400 MHz, DMSO): δ 8.61 (2H, d, J = 7.6 Hz), 8.32 (2H, s), 7.66 –7.79 (12H, m), 7.37-7.40 (2H, t, J = 7.2 Hz), 4.49(4H, s), 4.05 (4H, t, J = 8.0Hz), 3.16 (4H, t, J = 6.0 Hz), 2.23-2.26 (2H, m), 1.21-1.25 (4H, m), 0.81-0.83 (4H, m), 0.57 (6H, t, J = 7.2 Hz). ^{13}C NMR (100 MHz, DMSO): δ 142.7, 140.9, 138.4, 133.9, 132.8, 131.5, 131.3, 129.6, 128.1, 121.8, 120.6, 119.9, 115.3, 111.2, 49.7, 43.9, 43.7, 30.3, 22.0, 19.0, 13.1. HRMS calcd for $C_{47}H_{48}Cl_2N_6$ $[M+H]^+$ 767.3396，found 767.3390.

N,N-Bis[(1-(4-chlorophenyl)-9-butyl-β-carboline-3-yl)methyl]butane-1,4-diamine (8u).

Starting from 1-(4-chlorophenyl)-9-butyl-β-carboline-3-carboxaldehyde and 1,4-

diaminobutane, compound **8u** was obtained as yellow solid (0.31 g, 18%). ESI-MS m/z: 781 $[M+1]^+$. ^1H NMR (400 MHz, $CDCl_3$): δ 8.13 (2H, d, J = 7.6 Hz), 7.99 (2H, s), 7.39-7.59 (12H, m), 7.25-7.28 (2H, t, J = 7.2Hz), 4.08 (4H, s), 3.87 (4H, t, J = 8.0Hz), 2.76 (4H, t, J =6.0Hz), 1.67-1.69 (4H, m), 1.27-1.31 (4H, m), 0.83 -0.89 (4H, m), 0.63 (6H, t, J = 7.2 Hz). ^{13}C NMR (100 MHz, $CDCl_3$)：δ 142.5, 142.0, 138.6, 134.4, 133.2, 131.4, 130.7, 128.3, 121.7, 121.3，119.8, 112.4, 110.1, 65.8, 54.9, 49.3, 44.3, 30.8, 28.0, 19.8, 13.5. HRMS calcd for $C_{48}H_{50}Cl_2N_6$ $[M+H]^+$ 781.3552，found 781.3547.

N,N-Bis[(1-(4-chlorophenyl)-9-benzyl-β-carboline-3-yl)methyl]pentane-1,5-diamine (8v).

Starting from 1-(4-chlorophenyl)-9-benzyl-β-carboline-3-carboxaldehyde and 1,5-diaminopentane, compound **8v** was obtained as yellow solid (0.45 g, 24%). ESI-MS m/z: 863 $[M+1]^+$. ^1H NMR (400 MHz, DMSO): δ 8.62 (2H, s), 8.37 (2H, d, J = 7.6 Hz), 7.74 (2H, d, J = 8.4 Hz), 7.67 (2H, t, J = 7.7 Hz), 7.33-7.59 (12H, m), 7.01-7.16 (8H, m), 6.45 (4H, d, J = 6.6 Hz), 4.47 (4H, s), 2.97 (4H, t, J = 6.0 Hz), 1.68-1.72 (4H, m), 1.36-1.40 (2H, m). ^{13}C NMR (100 MHz, DMSO)：δ 143.1, 141.2, 139.4, 136.7, 133.7, 133.1, 131.5, 131.3, 129.7, 128.2, 127.8, 127.0, 125.2, 121.8, 120.9, 120.2, 115.0, 111.3, 47.3, 46.4, 33.9, 24.6, 22.9. HRMS calcd for $C_{55}H_{48}Cl_2N_6$ $[M+H]^+$ 863.3396，found 863.3384.

N,N-Bis[(1-(4-chlorophenyl)-9-benzyl-β-carboline-3-yl)methyl]hexane-1,6-diamine (8w).

Starting from 1-(4-chlorophenyl)-9-benzyl-β-carboline-3-carboxaldehyde and 1,6-diaminohexane, compound **8w** was obtained as yellow solid (0.44 g, 23%). ESI-MS m/z: 877.4 $[M+1]^+$. ^1H NMR (400 MHz, DMSO): δ 8.56 (2H, s), 8.41 (2H, d, J = 7.6 Hz), 7.62 (2H, d, J = 8.4 Hz), 7.57 (2H, t, J = 7.7 Hz), 7.36-7.51 (10H, m), 6.92-7.13 (10H, m), 6.36 (4H, d, J = 6.4 Hz), 4.22 (4H, s), 2.68 (4H, t, J = 6.0 Hz), 1.45-1.53 (4H, m), 1.12-1.21 (4H, m). ^{13}C NMR (100 MHz,

DMSO)： δ 145.4, 141.9, 140.1, 136.7, 135.6, 133.8, 133.2, 131.2, 129.7, 128.3, 127.9, 125.6, 123.3, 122.7, 121.1, 119.1, 115.3, 111.2, 52.4, 51.5, 47.4, 26.1, 22.4. HRMS calcd for $C_{56}H_{50}Cl_2N_6$ $[M+H]^+$ 877.3552，found 877.3545.

N,N-Bis[1-(4-methoxyphenyl-β-carboline-3-yl)methyl]butane-1,4-diamine (8x).

Starting from 1-(4-methoxyphenyl)-β-carboline-3-carboxaldehyde and 1,4-diaminobutane, compound **8x** was obtained as yellow solid (0.64 g, 44%). ESI-MS m/z: 661 $[M+1]^+$. ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.44 (2H, s), 7.98 (2H, d, J = 8.0 Hz), 7.76 (4H, d, J = 8.4 Hz), 7.66 (2H, s), 7.40-7.51 (4H, m), 7.43 (2H, d, J = 8.1 Hz), 7.20-7.25 (2H, m), 6.99 (4H, t, J = 8.8 Hz), 4.02 (4H, s), 3.83 (6H, s), 2.82 (4H, t, J = 6.0 Hz), 1.73-1.76 (4H, m). ^{13}C NMR (100 MHz, $CDCl_3$): δ 160.0, 141.7, 140.6, 132.3, 130.9, 130.3, 129.3, 128.2, 121.8, 120.0, 114.4, 111.6, 111.3, 111.1, 55.3, 54.3, 49.0, 27.9. HRMS calcd for $C_{42}H_{40}N_6O_2$ $[M+H]^+$ 661.3291，found 661.3286.

N,N-Bis[(1-(4-methoxyphenyl)-9-methyl-β-carboline-3-yl)methyl]-butane-1,4-diamine (8y).

Starting from 1-(4-methoxyphenyl)-9-methyl-β-carboline-3-carbox-aldehyde and 1,4-diaminobutane, compound **8y** was obtained as yellow solid (0.44 g, 30%). ESI-MS m/z: 689 $[M+1]^+$. ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.07 (2H,d, J = 7.6 Hz), 7.84 (2H, s), 7.48-7.58 (2H, m), 7.34-7.37 (6H, m), 7.24-7.28 (2H, m), 6.94 (4H, d, J = 8.4 Hz), 4.08 (4H, s), 3.84 (6H, s), 3.31 (6H, s), 2.86-2.88 (4H, m), 1.76-1.78 (4H, m). ^{13}C NMR (100 MHz, $CDCl_3$): δ 159.7, 147.1, 143.2, 134.2, 132.3, 130.7, 128.3, 121.6, 121.1, 119.6, 113.5, 111.8, 109.6, 65.8, 55.1, 53.4, 49.2, 32.7, 28.0, 15.2. HRMS calcd for $C_{44}H_{44}N_6O_2$ $[M+H]^+$ 689.3604，found 689.3608.

N,N-Bis[(1-(4-methoxyphenyl)-9-methyl-β-carboline-3-yl)methyl]-pentane-1,5-diamine (8z).

Starting from 1-(4-methoxyphenyl)-9-methyl-β-carboline-3-carbox-aldehyde and 1, 5-diaminopentane, compound **8z** was obtained as yellow solid (0.43 g, 28%). ESI-

MS m/z: 703 $[M+1]^+$. ^1H NMR (400 MHz, $CDCl_3$): δ 8.12 (2H, d, J = 7.6Hz); 8.01 (2H, s), 7.49-7.58 (2H, m), 7.47-7.51（4H, m）,7.35（2H，d，J = 8.4Hz）, 7.24-7.28（2H，m）, 6.98（4H, d, J = 8.4 Hz）, 4.20 (4H, s), 3.86 (6H, s), 3.40 (6H, s), 2.84 (4H, t, J = 6.8Hz), 1.68-1.74 (4H, m), 1.44-1.45(2H, m). ^{13}C NMR (100 MHz, $CDCl_3$): δ 159.8, 143.3, 134.5, 131.8, 130.9, 130.9, 121.8, 121.0, 119.9, 113.6, 112.7, 109.7, 32.8, 31.9, 29.7, 26.9, 23.8, 22.7. HRMS calcd for $C_{45}H_{46}N_6O_2$ $[M+H]^+$ 703.3760，found 703.3760.

N,N-Bis[(9-hexyl-1-(4-methoxyphenyl)-β-carboline-3-yl)methyl]-hexane-1,6-diamine (8aa).

Starting from 9-hexyl-1-(4-methoxyphenyl)-β-carboline-3-carbox-aldehyde and 1, 6-diaminohexane, compound **8aa** was obtained as yellow solid (0.62 g, 33%). ESI-MS m/z: 857 $[M+1]^+$. ^1H NMR (400 MHz, $CDCl_3$): δ 8.14 (2H, d, J = 7.6 Hz), 7.99 (2H, s), 7.47-7.57 (6H, m), 7.47-7.51 (4H, m), 7.38-7.41(2H, d, J = 8.4Hz), 7.24-7.28 (2H, m), 7.00-7.03 (4H, d, J = 8.4 Hz), 4.12 (4H, s), 3.90 (4H, t, J = 8.0 Hz), 3.87 (6H, s), 2.72 (4H, t, J = 7.2 Hz), 1.58-1.61 (4H, m), 1.25 -1.36 (8H, m), 1.09 –1.14 (4H, m), 0.94 -1.02 (4H, m), 0.82 –0.88 (4H, m), 0.75 (6H, t, J = 7.2 Hz). ^{13}C NMR (100 MHz, $CDCl_3$)：δ 159.8, 146.1, 143.4, 142.5, 133.5, 132.4, 131.1, 130.5, 128.2, 121.5, 121.3, 119.6, 113.6, 112.1, 110.1, 55.4, 54.7, 49.2, 44.4, 31.1, 26.2, 22.4. HRMS calcd for $C_{56}H_{68}N_6O_2$ $[M+H]^+$ 857.5482，found 857.5467.

N,N-Bis[(9-benzyl-1-(4-methoxyphenyl)-β-carboline-3-yl)methyl]-pentane-1,5-diamine (8ab).

Starting from 9-butyl-1-(4-methoxyphenyl)-β-carboline-3-carboxaldehyde and 1,5-diaminopentane, compound **8ab** was obtained as white solid (0.53 g, 31%). ESI-MS m/z: 856 $[M+1]^+$. ^1H NMR (400 MHz, $CDCl_3$): δ 9.24 (2H, s), 8.43 (2H, d, J = 8.0Hz), 7.69 (2H, t, J = 7.6 Hz), 7.38-7.51 (8H, m), 7.12-7.21 (6H, m), 6.85 (4H, d, J = 8.4 Hz), 6.58 (4H, d, J = 6.8 Hz), 5.26 (4H, s), 4.97 (4H, s), 3.78 (6H, s), 3.27-2.30 (4H, m), 1.91-1.94 (4H, m), 1.67-1.70 (2H, m). ^{13}C

NMR (100 MHz, $CDCl_3$): δ 161.9, 145.5, 140.0, 135.3, 135.1, 134.0, 133.4, 132.4 , 131.7, 128.8, 127.8, 125.3, 124.0, 122.8, 120.4, 119.8, 114.1, 111.2, 55.5, 48.5, 47.3, 46.9, 29.7, 24.1. HRMS calcd for $C_{57}H_{54}N_6O_2$ $[M+H]^+$ 855.4387，found 855.4381.

N,N-Bis[(9-benzyl-1-(4-methoxyphenyl)-β-carboline-3-yl)methyl]-hexane-1,6-diamine (8ac).

Starting from 9-benzyl-1-(4-methoxyphenyl)-β-carboline-3-carboxaldehyde and 1,6-diaminohexane, compound **8ac** was obtained as yellow solid (0.71 g, 37%). ESI-MS m/z: 869 $[M+1]^+$. ^1H NMR (400 MHz, DMSO): δ 8.79 (2H, s), 8.40 (2H, d, J = 8.0 Hz), 7.69-7.78 (4H, m), 7.53 (4H, d, J = 8.4 Hz), 7.45 (2H, t, J = 7.2 Hz), 7.06 – 7.12 (6H, m), 7.02 (4H, d, J = 8.4 Hz), 6.51 (4H, d, J = 6.8 Hz), 5.42 (4H, s), 4.55 (4H, s), 3.84 (6H, s), 2.88-3.02 (4H, m), 1.73-1.76 (4H, m), 1.33-1.36 (4H, m). ^{13}C NMR (100 MHz, DMSO): δ 160.2, 143.7, 136.6, 133.0, 131.2, 130.4, 128.2, 127.1, 125.4, 122.2, 121.3, 120.0, 113.4, 111.6, 55.3, 47.3, 46.6, 33.9, 25.4, 25.0. HRMS calcd for $C_{57}H_{54}N_6O_2$ $[M+H]^+$ 869.4543，found 869.4538.

N,N-Bis[1-(3,4,5-trimethoxy)-9-ethyl-β-carboline-3-yl)methyl]propane-1,3-diamine (8ad).

Starting from 1-(3,4,5-trimethoxy)-9-ethyl-β-carboline-3-carboxaldehyde and 1,3-diaminopropane, compound **8ad** was obtained as yellow oil (0.20 g, 21%). EI-MS m/z: 823 $[M+H]^+$. ^1H NMR (300 MHz, $CDCl_3$): δ 8.10 (2H, d, J =7.5Hz), 8.01 (2H, s), 7.53-7.59 (2H, m), 7.40(2H, d, J=8.4Hz), 7.20-7.24(2H, m), 6.78(4H, s), 4.11(4H, s), 3.99(4H, q, J=7.2Hz), 3.90 (6H, s), 3.86 (12H, s), 2.90 (4H, t, J =6.9Hz),1.85-1.94 (2H, m), 1.03(6H, t, J =6.9Hz). ^{13}C NMR (75 MHz, $CDCl_3$) : δ 153.2, 147.5, 143.4, 142.2, 138.2, 135.8, 133.1, 131.3, 128.6, 121.9, 121.6, 119.6, 112.6, 110.2, 106.5, 61.2, 56.5, 55.7, 48.7, 39.4, 30.2, 14.7. HRMS calcd for $C_{49}H_{54}N_6O_6$ $[M+H]^+$ 823.4178，found 823.4176.

N,N-Bis[1-(3,4,5-trimethoxy)-9-(3-propylphenyl)-β-carboline-3-yl)methyl]-propane-1,3-di-

amine (8ae).

Starting from 1-(3,4,5-trimethoxy)-9-(3-propylphenyl)-β-carboline-3-carboxaldehyde and 1,3-diaminopropane, compound **8ae** was obtained as yellow oil (0.20 g, 76%). EI-MS m/z:1045.3 $[M+H]^+$. ^1H NMR (300 MHz, $CDCl_3$): δ 8.15 (2H, d, J =7.8Hz), 8.04 (2H, s), 7.51-7.56 (2H, m), 7.30 (2H, d, J=8.7Hz), 7.12-7.26(8H, m), 6.96(4H, d, J=6.9Hz), 6.81(4H, s), 4.13 (4H, s), 3.97(4H, t, J=7.8Hz), 3.94 (6H, s), 3.86 (12H, s), 2.77 (4H, t, J =7.2Hz), 2.23 (4H, t, J =7.8Hz), 1.70-1.81 (4H, m), 1.58-1.63 (4H, m), 1.33-1.41 (4H, m). ^{13}C NMR (75 MHz, $CDCl_3$) : δ 153.3, 147.1, 143.4, 142.5, 140.8, 138.4, 135.7, 133.4, 131.4, 128.6, 128.1, 126.2, 122.0, 121.6, 120.1, 112.8, 110.2, 106.9, 61.3, 56.6, 55.4, 49.8, 44.6, 33.3, 31.2, 30.0, 27.6. HRMS calcd for $C_{66}H_{72}N_6O_6$ $[M+H]^+$ 1045.5586，found 1045.5589.