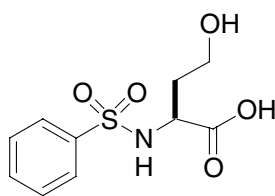


Experimental Section : THF was distilled over LiAlH₄ before use, and was transferred by syringe. Jones reagent was prepared freshly from CrO₃-H₂SO₄-H₂O. All the Grignard reagents were either prepared freshly or bought from Aldrich Company. ¹H NMR spectra were recorded on a Varian U400 (400 MHz) and U500 (500 MHz) and are reported in ppm (δ units). All melting points are uncorrected.

N-(Phenyl sulfonyl)-L-Homoserine 2 :



2

L-Homoserine (1.19 g, 10 mmol) was dissolved in 20 mL of 1N NaOH at 0°C, and benzene sulfonyl chloride (1.776g, 10 mmol) was added dropwise. The mixture was stirred at room temperature for 7 hours and the alkaline solution was poured into chilled hydrochloric acid solution. The precipitate was filtered and dried under vacuum to provide 2.42g (89%) of the product as a white solid.

Yield : 2.42g (89%).

M. p. : 138°C.

IR (neat) : 3273, 1730.

¹H NMR (DMSO-d₆) δ 1.59 (m, 1H), 1.65 (m, 1H), 3.3 (m, 3H), 3.81 (m, 1H), 4.42 (m, 1H), 7.58(m, 3H), 7.82(m, 2H).

¹³C NMR (DMSO-d₆) δ 35.9, 53.4, 57.5, 127.1, 129.6, 133.0, 142.0, 173.7.

Mass calculated for (M+1) C₁₀H₁₄NO₅S 260.0593, found (HRMS-FAB) 260.0592.

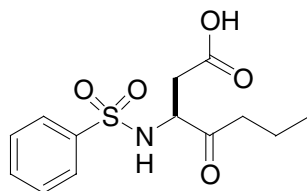
General Procedure for the preparation of 4-oxo-3-[(phenyl sulfonyl)amino] carboxylic acid.

Ni(dppe)Cl₂ (0.026g 0.05 mmol) was added to a solution of carboxylic acid (0.259g 1mmol) in 10 mL dry THF. After stirring under N₂ for a few minutes at room temperature the Grignard reagent (6 mmol) was added dropwise through syringe. After an

initial exothermic reaction the resultant black mixture was allowed to stir for 48 hrs. at room temperature. The reaction was then quenched by pouring the mixture into dil. HCl (1N) and extracted with ethyl acetate (3x10 mL). The organic layer was washed with 10 mL saturated NaHCO₃ solution followed by 10 mL of water. The resulting organic layer was dried over anhydrous Na₂SO₄. On concentration under reduced pressure a brown-colored residue was obtained, which was then column chromatographed (SiO₂) using 50% hexane-ethyl acetate as eluent to furnish a mixture of ketone and a small amount of secondary alcohol.

The above crude mixture was then dissolved in 10 mL acetone at 0°C. 5 equivalents of Jones reagent (freshly prepared) was added dropwise. The reaction mixture was stirred for 1 hr. at 0°C. After completion of reaction as monitored by TLC (EtOAc-Hexane, 2:1), 10 mL of water was added, followed by the addition of 10 mL of diethyl ether. The organic layer was separated, whereas the aqueous layer was further extracted with 3x10 mL portions of diethyl ether. The combined ether layer was then treated with 50 mL of saturated NaHCO₃ solution. The aqueous layer was further extracted with 2x10 mL portions of diethyl ether. The aqueous layer was then neutralized with conc. HCl and extracted with 10x4 mL portions of dichloromethane. The combined organic layer was dried over anhydrous Na₂SO₄, filtered and concentrated under reduced pressure to furnish 4-oxo-3-[(phenyl sulfonyl)amino] heptanoic acid as white solid.

(3*S*)-4-oxo-3-[(phenyl sulfonyl)amino] heptanoic acid 4a :



4a

crude yield of Grignard mixture : 67%

yield of (3*S*)- 4-oxo-3-[(phenyl sulfonyl)amino] heptanoic acid : 62%

M. p. : 76°C.

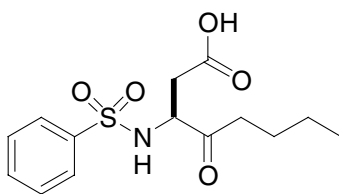
IR (neat) 3271,

^1H NMR (CDCl_3) δ 0.75 (t, 3H, $J=7\text{Hz}$), 1.42 (m, 2H), 2.40 (m, 2H), 2.65 (dd, 1H $J=17$ Hz, $J=5$ Hz), 2.90 (dd, 1H $J=17$ Hz, $J=5$ Hz), 4.00 (m, 2H), 6.28 (m, 1H), 7.59 (m, 3H), 7.82 (m, 2H).

^{13}C NMR (CDCl_3) δ 13.6, 17.0, 36.3, 41.0, 58.0, 127.2, 129.7, 133.5, 139.94, 175.9, 207.0.

Mass calculated for (M+1) $\text{C}_{13}\text{H}_{18}\text{NO}_5\text{S}$ 300.0906, found (HRMS-EI) 300.0898.

(3S)-4-oxo-3-[(phenyl sulfonyl)amino] octanoic acid 4b :



4b

Crude yield of Grignard mixture : 50%

Yield of (3S)-4-oxo-3-[(phenyl sulfonyl)amino] octanoic acid : 52%

M.p. : 95°C.

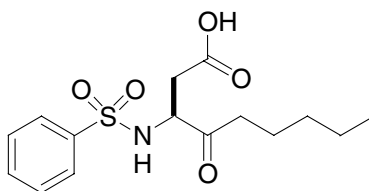
IR (neat) : 3257, 1716.34.

^1H NMR (CDCl_3) δ 0.80 (t, 3H, $J=7$ Hz), 1.16 (m, 2H), 1.40 (m, 2H), 2.40 (m, 2H), 2.66 (dd, 1H $J=17$ Hz, $J=5$ Hz), 2.99 (dd, 1H $J=17$ Hz, $J=5$ Hz), 4.00 (m, 1H), 6.38 (d, 1H, $J=9$ Hz), 7.58 (m, 3H), 7.82 (m, 2H).

^{13}C NMR (CDCl_3) δ 13.9, 22.2, 25.5, 36.3, 38.8, 57.9, 127.2, 129.6, 133.4, 140.0, 175.8, 207.1.

Mass calculated for (M+1) $\text{C}_{14}\text{H}_{20}\text{NO}_5\text{S}$ 314.1062, found (HRMS-EI) 314.1060.

(3S)-4-oxo-3-[(phenyl sulfonyl)amino] nonanoic acid 4c :



4c

Crude yield of Grignard mixture : 56%.

Yield of (3S)-4-oxo-3-[(phenyl sulfonyl)amino] nonanoic acid : 53%.

M. p. 83°C.

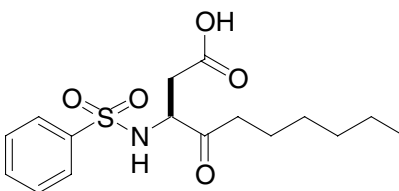
IR (neat) : 3271, 1718.

¹H NMR (CDCl₃) δ 0.80 (t, 3H), 1.10 (m, 2H), 1.1 (m, 2H), 1.40 (m, 2H), 2.40 (m, 2H), 2.65 (dd, 1H *J*=17 Hz, *J*=5 Hz), 2.92 (dd, 1H *J*=17 Hz, *J*=5 Hz), 4.00 (m, 1H), 6.35 (d, 1H, *J*=9 Hz), 7.56 (m, 3H), 7.82 (m, 2H).

¹³C NMR (CDCl₃) δ 14.0, 22.5, 23.1, 31.2, 36.3, 39.1, 57.9, 127.2, 129.6, 133.4, 140.0, 175.8, 207.1.

Mass calculated for (M+1) C₁₅H₂₂NO₅S 328.1219, found (HRMS-EI) 328.1214.

(3S)-4-oxo-3-[(phenyl sulfonyl)amino] decanoic acid 4d :



4d

Crude yield of Grignard mixture : 46%.

Yield of (3S)-4-oxo-3-[(phenyl sulfonyl)amino] decanoic acid : 52%

M.P. : 78°C.

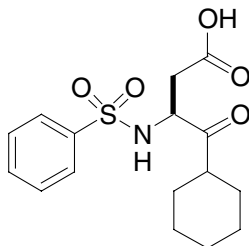
IR (neat) : 3261, 1723.16.

¹H NMR (CDCl₃) δ 0.81 (t, 3H, *J*=7 Hz), 1.2 (m, 6H), 1.42 (m, 2H), 2.40 (m, 2H), 2.62 (dd, 1H *J*=17 Hz, *J*=5 Hz), 2.90 (dd, 1H *J*=17 Hz, *J*=5 Hz), 4.00 (m, 1H), 6.35 (d, 1H, *J*=9 Hz), 7.59 (m, 3H), 7.82 (m, 2H).

^{13}C NMR (CDCl_3) δ 14.2, 22.6, 23.4, 28.7, 31.6, 36.3, 39.1, 57.9, 127.2, 129.6, 133.4, 140.0, 175.8, 207.2.

Mass calculated for (M+1) $\text{C}_{16}\text{H}_{24}\text{NO}_5\text{S}$ 342.1375, found (HRMS-EI) 342.1375.

(3S)-4-cyclohexyl-4-oxo-3-[(phenyl sulfonyl)amino] butanoic acid 4e :



4e

Crude yield of Grignard mixture : 62%.

Yield of (3S)-4-cyclohexyl-4-oxo-3-[(phenyl sulfonyl)amino] butanoic acid : 64%

M.p. : 128°C.

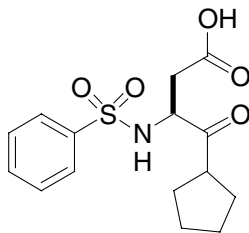
IR (neat) : 3271, 1714.

^1H NMR (CDCl_3) δ 1.16 (m, 5H), 1.62 (m, 5H), 2.56 (m, 1H), 2.69 (dd, 1H $J=17$ Hz, $J=5$ Hz), 2.84 (dd, 1H $J=17$ Hz, $J=5$ Hz), 4.2 (m, 1H), 6.18 (d, 1H, $J=8$ Hz), 7.58 (m, 3H), 7.82 (m, 2H).

^{13}C NMR (CDCl_3) δ 25.4, 25.6, 25.7, 28.3, 28.9, 36.2, 46.3, 56.3, 127.3, 129.6, 133.4, 139.9, 175.4, 209.2.

Mass calculated for (M+1) $\text{C}_{16}\text{H}_{22}\text{NO}_5\text{S}$ 340.1211, found (HRMS-EI) 340.1219.

(3S)-4-cyclopentyl-4-oxo-3-[(phenyl sulfonyl)amino] butanoic acid 4f :



4f

Crude yield of Grignard mixture : 36%

Yield of (3S)-4-cyclopentyl-4-oxo-3-[(phenyl sulfonyl)amino] butanoic acid : 68%

M.p. 106°C.

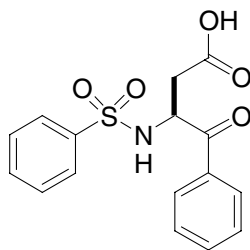
IR (neat) : 3273, 1714.

^1H NMR (CDCl_3) δ 1.35-1.85 (m, 8H), 2.62 (dd, 1H $J=17$ Hz, $J=5$ Hz), 2.82 (dd, 1H $J=17$ Hz, $J=5$ Hz), 3.08 (m, 1H), 4.18 (m, 1H), 6.19 (d, 1H, $J=9$ Hz), 7.54 (m, 3H), 7.86 (m, 2H).

^{13}C NMR (CDCl_3) δ 26.2, 26.2, 29.5, 30.2, 36.0, 47.2, 57.5, 127.3, 129.6, 133.4, 140.0, 175.8, 209.3.

Mass calculated for (M+1) $\text{C}_{15}\text{H}_{20}\text{NO}_5\text{S}$ 326.1062, found (HRMS-EI) 326.1067.

(3S)-4-oxo-4-phenyl-3-[(phenyl sulfonyl)amino] butanoic acid 4g :



4g

Crude yield of Grignard mixture : 47%

Yield of (3S)-4-oxo-4-phenyl-3-[(phenyl sulfonyl)amino] butanoic acid : 70%.

M. p. : 115°C.

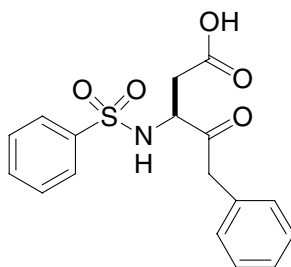
IR (neat) : 3282, 1720, 1689, 1596.

^1H NMR (CDCl_3) δ 2.70 (dd, 1H $J=17$ Hz, $J=6$ Hz), 2.85 (dd, 1H $J=17$ Hz, $J=6$ Hz), 5.20 (m, 1H), 6.15 (d, 1H, $J=9$ Hz), 7.30-7.65 (m, 6H), 7.82 (m, 4H).

^{13}C NMR (CDCl_3) δ 37.9, 54.2, 127.4, 128.9, 129.2, 129.5, 133.3, 133.7, 134.4, 139.9, 175.2, 195.9.

Mass calculated for (M+1) $\text{C}_{16}\text{H}_{16}\text{NO}_5\text{S}$ 334.0749, found (HRMS-EI) 334.0746.

(3S)-4-oxo-4-phenyl-3-[(phenyl sulfonyl)amino] pentanoic acid 4h:



4h

Crude yield of Grignard mixture : 51%

Yield of (3S)-4-oxo-4-phenyl-3-[(phenyl sulfonyl)amino] pentanoic acid : 50%.

M.p. : 126°C.

IR (neat) : 3525, 1720.

¹H NMR (CDCl₃) δ 2.62 (dd, 1H *J*=17 Hz, *J*=6 Hz), 2.88 (dd, 1H *J*=17 Hz, *J*=6 Hz), 3.80 (m, 2H), 4.16 (m, 1H), 6.22 (d, 1H, *J*=9 Hz), 7.00 (m, 2H), 7.1-7.9 (m, 8H).

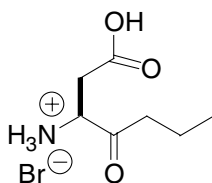
¹³C NMR (CDCl₃) δ 35.23, 45.07, 57.04, 126.47, 126.54, 128.00, 129.25, 132.57, 133.14, 137.82, 172.30, 203.99.

Mass calculated for (M+1) C₁₇H₁₈NO₅S 348.0906, found (HRMS-EI) 348.913.

General procedure for the preparation of β-aminoγ-keto carboxylic acid hydrobromide :

A mixture of carboxylic acid (1 mmol), phenol (3 mmol) and 48% HBr solution (3.5 mL) was refluxed for 1.5 hrs. After completion of reaction, the switch of the oil-bath was turned off and stirring was continued until the reaction mixture was cooled down to room temperature. 5 mL of ethyl acetate was added and the aqueous layer was separated. The aqueous layer was further extracted with 3x5mL portions of ethyl acetate. The aqueous layer was then concentrated under reduced pressure to furnish brown solid residue of β-aminoγ-keto carboxylic acid hydrobromide.

(3S)-3-Amino-4-oxo-heptanoic acid hydrobromide 5a :



5a

Yield: 52%.

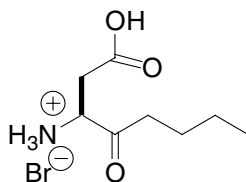
$^1\text{H NMR}$ (D_2O) δ 0.68 (t, 3H, $J=7$ Hz), 1.39 (m, 2H), 2.46 (m, 2H), 3.04 (d, 2H, $J=5$ Hz), 4.29 (t, 1H, $J=5$ Hz).

$^{13}\text{C NMR}$ (DMSO-d_6) δ 14.0, 16.9, 34.4, 40.2, 55.3, 171.7, 205.4.

Mass calculated for (M-80) $\text{C}_7\text{H}_{14}\text{NO}_3$ 160.0974, found (HRMS-FAB) 160.0973.

$[\alpha] = -4.90$ in MeOH at 0.45g/dL

(3S)-3-Amino-4-oxo-octanoic acid hydrobromide 5b :



5b

Yield: 63%.

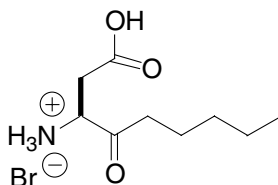
$^1\text{H NMR}$ (D_2O) δ 0.73 (t, 3H, $J=7$ Hz), 1.17 (m, 1H), 1.42 (m, 2H), 2.52 (m, 2H), 3.09 (d, 2H, $J=5$ Hz), 4.32 (m, 1H).

$^{13}\text{C NMR}$ (DMSO-d_6) δ 14.4, 22.1, 25.3, 34.4, 38.0, 55.2, 171.7, 205.5.

Mass calculated for (M-80) $\text{C}_8\text{H}_{16}\text{NO}_3$ 174.1130, found (HRMS-FAB) 174.1135.

$[\alpha] = -9.08$ in MeOH at 1.00 g/dL

(3S)-3-Amino-4-oxo-nonanoic acid hydrobromide 5c :



5c

Yield : 60%.

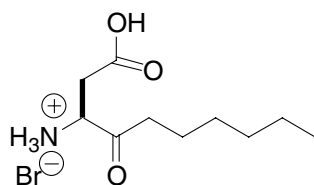
^1H NMR (D_2O) δ 0.7 (t, 3H, $J=7$ Hz), 1.12 (m, 4H), 1.42 (m, 2H), 2.5 (m, 2H), 3.04 (m, 1H), 4.30 (m, 1H).

^{13}C NMR (DMSO-d_6) δ 13.27, 27.99, 22.46, 30.42, 33.40, 38.13, 55.46, 172.83, 207.00.

Mass calculated for (M-80) $\text{C}_9\text{H}_{18}\text{NO}_3$ 188.1287, found (HRMS-FAB) 188.1286.

$[\alpha] = -10.08$ in MeOH at 0.83 g/dL

(3S)-3-Amino-4-oxo-decanoic acid hydrobromide 5d :



5d

Yield : 51%

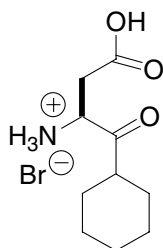
^1H NMR (D_2O) δ 0.68 (t, 3H, $J=7$ Hz), 1.12 (m, 5H), 1.42 (m, 2H), 2.50 (m, 2H), 3.05 (m, 2H), 4.30 (m, 1H).

^{13}C NMR (DMSO-d_6) δ 14.6, 22.6, 23.3, 28.6, 31.6, 34.5, 38.3, 55.3, 171.7, 205.5.

Mass calculated for (M-80) $\text{C}_{10}\text{H}_{20}\text{NO}_3$ 202.1443, found (HRMS-FAB) 202.1444.

$[\alpha] = -11.60$ in MeOH at 0.65 g/dL

(3S)-3-Amino-4-cyclohexyl-4-oxo-5-butyric acid hydrobromide 5e :



5e

Yield : 62%.

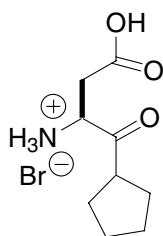
^1H NMR (D_2O) δ 0.90-1.90 (m, 10H), 2.62 (m, 1H), 3.09 (m, 2H), 4.2 (m, 1H).

^{13}C NMR (DMSO-d_6) δ 25.1, 25.8, 25.9, 27.8, 29.7, 34.3, 45.7, 53.8, 171.7, 208.3.

Mass calculated for (M-80) $\text{C}_{10}\text{H}_{18}\text{NO}_3$ 200.1287, found (HRMS-FAB) 200.1313.

$[\alpha] = -3.56$ in MeOH at 0.60 g/dL

(3S)-3-Amino-4-cyclopentyl-4-oxo-5-butyric acid hydrobromide 5f :



5f

Yield : 58%.

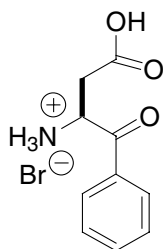
^1H NMR (D_2O) δ 1.30-1.90 (m, 8H), 3.08 (m, 3H), 4.2 (m, 1H).

^{13}C NMR (DMSO-d_6) δ 26.2, 26.3, 28.8, 30.8, 34.2, 46.8, 54.7, 171.6, 208.1.

Mass calculated for (M-80) $\text{C}_9\text{H}_{16}\text{NO}_3$ 186.1130, found (HRMS-FAB) 186.1131.

$[\alpha] = -6.92$ in MeOH at 0.45 g/dL

(3S)-3-Amino-4-oxo-4-phenyl-butyric acid hydrobromide 5g :



5g

Yield : 60%.

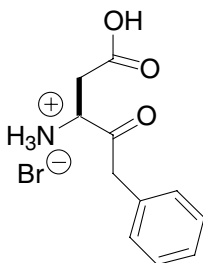
^1H NMR (D_2O) δ 2.65 (dd, 1H), 2.8 (dd, 1H), 5.09 (m, 1H), 7.19 (m, 2H), 7.34 (m, 1H), 7.58 (m, 2H).

^{13}C NMR (DMSO-d_6) δ 35.9, 52.1, 129.4, 129.8, 133.9, 135.1, 171.1, 195.6.

Mass calculated for (M-80+1) $\text{C}_{10}\text{H}_{11}\text{NO}_3$ 195.0895, found (HRMS-FAB) 195.0983.

$[\alpha] = -13.75$ in MeOH at 0.87 g/dL

(3S)-3-Amino-4-oxo-5-phenyl-pentanoic acid hydrobromide 5h :



5h

Yield : 48%.

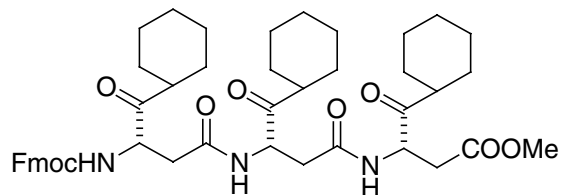
^1H NMR (D_2O) δ 3.12 (m, 2H), 3.88 (m, 2H), 4.45 (m, 1H), 7.1 (m, 2H), 7.25 (m, 3H).

^{13}C NMR (DMSO-d_6) δ 34.5, 45.0, 55.3, 127.5, 129.0, 130.5, 134.3, 171.7, 203.2.

Mass calculated for (M-80) $\text{C}_{11}\text{H}_{14}\text{NO}_3$ 208.0974, found (HRMS-FAB) 208.0974.

$[\alpha] = -8.36$ in MeOH at 0.83 g/dL

Preparation of Compound 9 :



9

Amino acid hydrobromide **5e** (1 mmol) was dissolved in 10% solution of Na_2CO_3 in water (5.3 mL, 5 mmol); dioxane (3 mL) was added and the mixture was stirred in a ice-water bath. 9-Fluorenyl methyl chlorocarbonate (0.26g 1 mmol) was added in small portions and stirring was continued at ice-water bath temperature for 4 hours, then at room temperature for 8 hours. The reaction mixture was poured into water (60 mL) and extracted with 2x20 mL portions of ether. The aqueous layer was cooled in an ice-water bath and acidified with 10% HCl solution. The aqueous layer was then extracted with 3x20 mL portions of dichloromethane. The combined organic layer was then dried with anhydrous Na_2SO_4 , and concentrated with the rotary evaporator to furnish the residue of Fmoc-amino acids **6** in 56% yield. The amino acid hydrobromide methyl ester was prepared by dissolving 1 mmol of amino acid hydrobromide **5e** in 2 mL of dry methanol, followed by the addition of one drop of concentrated H_2SO_4 ; the reaction mixture was then refluxed for 2 hrs. After cooling the solution at room temperature, methanol was removed using the rotary evaporator to furnish residue of amino acid hydrobromide methyl ester **7** in 88% yield.

The coupling of compound **6** and **7** was accomplished by dissolving compound **7** (0.2 mmol), compound **6** (0.22 mmol), and PyBOP (0.22 mmol) in CHCl_3 (5 mL). Diisopropyl ethyl amine (DIEA, 0.5 mmol) was added and the mixture stirred for 30 min. After completion of the reaction the solvent was removed under reduced pressure and the residue was purified using column purification (SiO_2) to furnish peptide **8** in 54% yield. The Fmoc- functionality of compound **8** was removed as follows. 2 mL of diethyl amine was added, and the mixture was stirred for 0.5 hours to furnish the amine in quantitative yield. The crude amine was again coupled with compound **6** using the above procedure to

provide trimer **9**. The protected peptide **9** was finally purified by column chromatography (SiO₂) using 60% EtOAc-hexane as eluent to furnish compound **9** in 51% yield.

¹H NMR (CDCl₃) δ 1.00-2.00 (m, 30H), 2.4-3.00 (m, 8H), 3.62 (s, 3H), 4.00-5.00 (m, 6H), 7.39 (m, 4H), 7.6 (m, 2H), 7.79 (m, 2H).

Mass calculated for C₄₆H₅₉N₃O₉ 797.4251, found (HRMS-FAB) 797.4299.