Synthesis and NMR analysis of ^{13}C and ^{15}N-labeled long-chain polyamines (LCPAs)

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Supporting Information

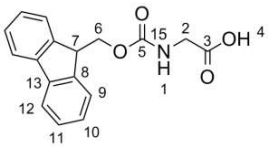
Contents

1. General Information

Reactions with substrates and reagents sensitive to oxygen or moisture were performed under an atmosphere of argon in flame-dried glassware. Unless otherwise noted, reagents were purchased commercially from Aldrich, Alfa Aesar, Acros or TCI and used without further purification. All chemicals and solvents used for the synthesis of peptide building blocks or peptide synthesis were purchased from commercial sources and were not purified further. Peptide grade DMF and all amino acids were purchased from Iris Biotech. The syntheses of the isotope-labeled glycine were monitored by analytical thin layer chromatography (TLC) using analytical TLC plates coated with silica gel from Merck (60F254). A Finnigan LTQ-FT (Fisher Thermo Scientific) was used to obtain the HRMS spectra. The analytical HPLC spectra were recorded with a Thermo Scientific Dionex UltiMate 3000 system, including a LPG-3400SD pump, a WPS-3000SL autosampler, a TCC-3000SD column compartment and a DAD-3000 detector. An ACE UltraCore 2.5 SuperC18 column (150 × 2.1 mm) was used as stationary phase. Purification by RP-HPLC was performed with a Thermo Scientific Dionex UltiMate 3000 semi-preparative system, including a HPG-3200BX pump, an ERC Series-300 solvent degasser, a MWD-3000 detector and a AFC-3000 fraction collector.A Macherey-Nagel VP Nucleodur C18 Gravity column (5 µm, 125 × 21 mm) was used. Eluents in both systems: A: H2O + 0.1% TFA, B: MeCN + 0.085% TFA. Afterwards, the peptides were lyophilized with a Christ Alpha 2 – 4 LDplus. The NMR spectroscopy (^{1}H, TOCSY, HSQC, ^{13}C) was performed with a Bruker AV-300 or AV-500/HD-500 spectrometer. Chemical shifts are reported in ppm and are referenced to the residual solvent peak (DMSO-d_6). Multiplicities are indicated by s (singlet), d (doublet), t (triplet), bs (broad singlet) and m (multiplet). Coupling constants (J) are reported in Hertz [Hz]. High-resolution ESI(+) mass spectra were recorded in the positive mode with a Finnigan LTQ-FT from Fisher Thermo Scientific.

2. Synthesis of isotope labeled Fmoc protected glycine derivatives

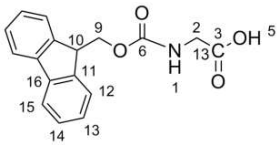
***N*-(9-Fluorenylmethoxycarbonyl)-glycine-^{15}N**



Gly-^{15}N-OH (0.41 g, 5.33 mmol, 1.0 equiv) was dissolved in water (20.0 mL) and $NaHCO_3$ (0.45 g, 5.33 mmol, 1.0 equiv), acetone (20.0 mL) and Fmoc-OSu (1.80 g, 5.33 mmol, 1.0 equiv) added. The solution was stirred at ambient temperature until it became clear. Saturated aqueous $KHSO_4$ (35.0 mL) solution was added and the resulting solid was filtered, washed with water and dried. The solid was dissolved in EtOAc, the inorganic salt filtered off and the organic phase was concentrated under reduced pressure. *N*-(9-Fluorenylmethoxycarbonyl)-glycine-^{15}N was obtained with 88% yield (1.41 g, 4.69 mmol) as a colorless solid. In the ^{15}N-NMR spectra nitromethane (CH_3NO_2) was used as external standard. The reference substance used nitromethane.

^{1}H-NMR (500 MHz, 300 K, DMSO-d_6) δ = 7.88 (d, 2H, $^3J_{H;\,H}$ = 7.5 Hz, 12-C*H*), 7.70 (d, 2H, $^3J_{H;\,H}$ = 7.2 Hz, 9-C*H*), 7.52 (dt, 1H, $^1J_{H;\,N}$ = 92 Hz, $^3J_{H;\,H}$ = 6.2 Hz, 1-^{15}N*H*), 7.42 (t, 2H, $^3J_{H;\,H}$ = 7.5 Hz, 11-C*H*), 7.33 (d, 2H, $^3J_{H;\,H}$ = 7.5 Hz, 10-C*H*), 4.30 - 4.21 (m, 3H, 7-C*H*, 6-CH_2), 3.61 (d, 2H, $^3J_{H;\,H}$ = 6.3 Hz, 2-CH_2) ppm. **^{13}C-NMR** (125 MHz, 300 K, DMSO-d_6) δ = 171.5 (3-*C*OOH), 156.6 (5-*C*), 143.8 ($C_{arom.}$), 140.7 ($C_{arom.}$), 127.6 (11-*C*H$_{arom.}$), 127.1 (10-*C*H$_{arom.}$), 125.2 (9-*C*H$_{arom.}$), 120.1 (12-*C*H$_{arom.}$), 65.7 (6-*C*H$_2$), 46.6 (7-*C*H), 42.0 (d, $^1J_{N;\,C}$ = 15.0 Hz, 2-*C*H$_2$) ppm. **^{15}N-NMR** (50 MHz, 300 K, DMSO-d_6) δ = 77.27 (1-^{15}*N*H) ppm. **HRMS (ESI+)** $C_{17}H_{15}{}^{15}N_1O_4Na^+$ [M+Na$^+$]; calculated: 321.0864, found: 321.0861.

***N*-(9-Fluorenylmethoxycarbonyl)-glycine-1-^{13}C**

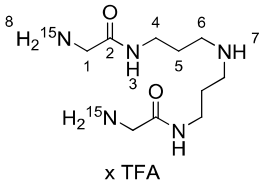


Gly-1-^{13}C-OH (0.41 g, 5.33 mmol, 1.0 equiv) was dissolved in water (20.0 mL) and $NaHCO_3$ (0.45 g, 5.33 mmol, 1.0 equiv), acetone (20.0 mL) and Fmoc-OSu (1.80 g, 5.33 mmol, 1.0 equiv) added. The solution was stirred at ambient temperature until it became clear. Saturated aqueous $KHSO_4$ (35.0 mL) solution was added and the resulting solid was filtered, washed with water and dried. The solid was dissolved in EtOAc, the inorganic salt filtered off and the organic phase was concentrated under reduced pressure. *N*-(9-Fluorenylmethoxycarbonyl)-glycine-1-^{13}C was obtained with 93% yield (1.47 g, 4.93 mmol) as a colorless solid. **^{1}H-NMR** (300 MHz, 300 K, DMSO-d_6) δ = 7.88 (d, 2H, $^3J_{H;\,H}$ = 7.4 Hz, 12-C*H*), 7.70 (d, 2H, $^3J_{H;\,H}$ = 7.4 Hz, 9-C*H*), 7.63 (t, 1H, $^3J_{H;\,H}$ = 6.2 Hz, 1-N*H*), 7.42 (t, 2H, $^3J_{H;\,H}$ = 7.6 Hz, 11-C*H*), 7.33 (dt, 2H, $^3J_{H;\,H}$ = 7.4 Hz, $^1J_{H;\,H}$ = 1.1 Hz, 10-C*H*), 4.31 - 4.22 (m, 3H, 7-C*H*, 6-CH_2), 3.66 (t, 2H, $^3J_{H;\,H}$ = 5.7 Hz, 2-CH_2) ppm. **^{13}C-NMR** (75 MHz, 300 K, DMSO-d_6) δ = 171.6 (3-^{13}*C*OOH), 156.5 (5-*C*), 143.9 ($C_{arom.}$), 140.8 ($C_{arom.}$), 127.7 (11-*C*H$_{arom.}$), 127.1 (10-*C*H$_{arom.}$), 125.2 (9-*C*H$_{arom.}$), 120.2 (12-*C*H$_{arom.}$), 65.7 (6-*C*H$_2$), 46.6 (7-*C*H), 41.7 (d, $^1J_{C;\,C}$ = 59.0 Hz, 2-*C*H$_2$) ppm. **HRMS (ESI+)** $C_{16}{}^{13}C_1H_{15}N_1O_4Na^+$ [M+Na$^+$]; calculated: 321.0927, found: 321.0926.

3. Analytical Data

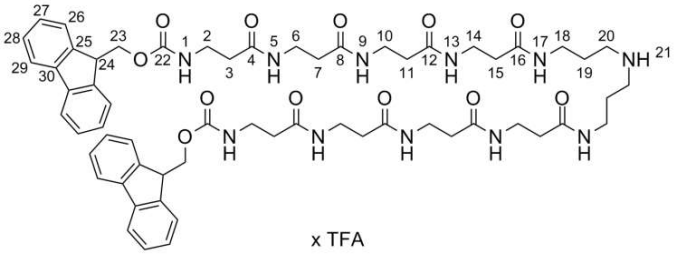
3.1. Analytical Data of Oligoamide precursors

Oligoamide precursor 3b



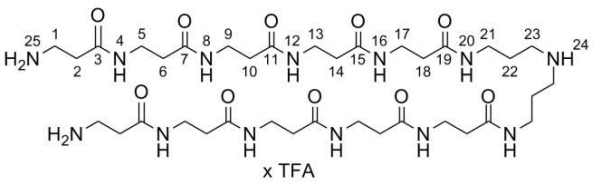
^{1}H-NMR (300 MHz, 300 K, DMSO-d_6) δ = 8.26 (bs, 3H, 3-, 7-N*H*), 8.06 - 7.82 (d, 2H, $^{1}J_{N;\,H}$ = 74.4 Hz, 8-N*H*), 3.54 – 3.51 (m, 4H, 1-CH_2), 3.22 – 3.18 (m, 4H, 4-CH_2), 2.89 (m, 4H, 6-CH_2), 1.74 (m, 4H, 5-CH_2) ppm. **^{13}C-NMR** (125 MHz, 300 K, DMSO-d_6) δ = 170.7 (2-C_q), 46.2 (1-CH$_2$), 43.6 (6-CH$_2$), 37.4 (4-CH$_2$), 26.8 (5-CH$_2$) ppm. **HRMS (ESI+)** $C_{10}H_{23}N_3{}^{15}N_2O_2H^+$ [M+H$^+$]; calculated: 247.3129, found: 247.3127.

Oligoamide precursor 2b



^{1}H-NMR (500 MHz, 300 K, DMSO-d_6) δ = 8.28 (bs, 2H, 21-N*H*), 8.03 (t, 2H, $^{3}J_{H;\,H}$ = 5.6 Hz, 17-N*H*), 7.97 (m, 8H, 1-, 5-, 9-, 13-N*H*), 7.84 (d, 4H, $^{3}J_{H;\,H}$ = 7.6 Hz, C*H* $_{arom.}$), 7.65 (d, 4H, $^{3}J_{H;\,H}$ = 7.5 Hz, C*H* $_{arom.}$), 7.38 (t, 4H, $^{3}J_{H;\,H}$ = 7.4 Hz, C*H* $_{arom.}$), 7.29 (t, 4H, $^{3}J_{H;\,H}$ = 7.4 Hz, C*H* $_{arom.}$), 4.27 (d, 4H, $^{3}J_{H;\,H}$ = 7.0 Hz, 23-CH_2), 4.19 (t, 2H, $^{3}J_{H;\,H}$ = 6.5 Hz, 24-C*H*), 3.30 - 3.16 (m, 16H, 2-, 6-, 10-, 14-CH_2), 3.11 (dt, 4H, $^{3}J_{H;\,H}$ = 6.4 Hz, $^{3}J_{H;\,H}$ = 6.2 Hz, 18-CH_2), 2.91 - 2.82 (m, 4H, 20-CH_2), 2.29 - 2.17 (m, 16H, 3-, 7-, 11-, 15-CH_2), 1.70 (qi, 4H, $^{3}J_{H;\,H}$ = 7.1 Hz, 19-CH_2) ppm. **^{13}C-NMR** (125 MHz, 300 K, DMSO-d_6) δ = 171.6 (C_q), 170.98 (C_q), 170.96 (C_q), 170.8 (C_q), 156.5 (22-C_q), 144.3 ($C_{q,\,arom.}$), 141.2 ($C_{q,\,arom.}$), 127.9 (CH$_{arom}$), 127.4 (CH$_{arom}$), 125.5 (CH$_{arom}$), 120.4 (CH$_{arom}$), 65.7 (23-CH$_2$), 47.2 (24-CH), 45.2 (20-CH$_2$), 36.0 (18-CH$_2$), 35.8, 26.5 (19-CH$_2$) ppm. **HRMS (ESI+)** $C_{60}H_{77}N_{11}O_{12}H^+$ [M+H$^+$]; calculated: 1144.5826, found: 1144.5823.

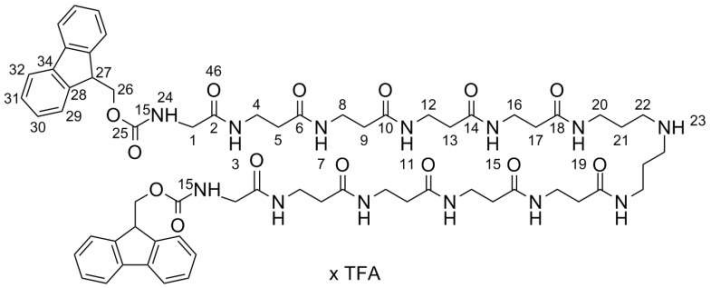
Oligoamide precursor 5b



^{1}H-NMR (500 MHz, 300 K, DMSO-d_6) δ = 8.32 (bs, 2H, 24-NH_2^+), 8.07 (t, 2H, $^{3}J_{H;\,H}$ = 5.6 Hz, 4-N*H*), 8.04 (t, 2H, $^{3}J_{H;\,H}$ = 5.7 Hz, 20-N*H*), 8.00 - 7.86 (m, 6H, 8-N*H*, 12-N*H*, 16-N*H*), 7.67 (bs, 6H, 25-NH_3^+), 3.31 - 3.19 (m, 16H, 5-, 9-, 13-, 17-CH_2), 3.12 (dt, 4H, $^{3}J_{H;\,H}$ = 6.5 Hz, $^{3}J_{H;\,H}$ = 6.2 Hz, 21-CH_2), 3.01 - 2.94 (m, 4H, 1-CH_2), 2.91 - 2.82 (m, 4H, 23-CH_2), 2.41 (t, 4H, $^{3}J_{H;\,H}$ = 6.8 Hz, 2-CH_2), 2.25 (t, 4H, $^{3}J_{H;\,H}$ = 6.9 Hz, 6-CH_2), 2.22 (dt, 12H, $^{3}J_{H;\,H}$ = 6.9 Hz, $^{3}J_{H;\,H}$ = 6.9 Hz, 10-, 14-, 18-CH_2), 1.71 (qi, 4H, $^{3}J_{H;\,H}$ = 7.2 Hz, 12-CH_2) ppm. **^{13}C-NMR** (125 MHz, 300 K, DMSO-d_6) δ = 45.0 (23-CH$_2$), 35.6 (1-, 5-, 6-, 9-, 10-, 13-, 14-, 17-, 18-, 21-CH$_2$), 32.2 (2-CH$_2$), 26.3 (22-CH$_2$) ppm. **HRMS (ESI+)** $C_{36}H_{67}N_{13}N_{13}O_{10}H^+$ [M+H$^+$],

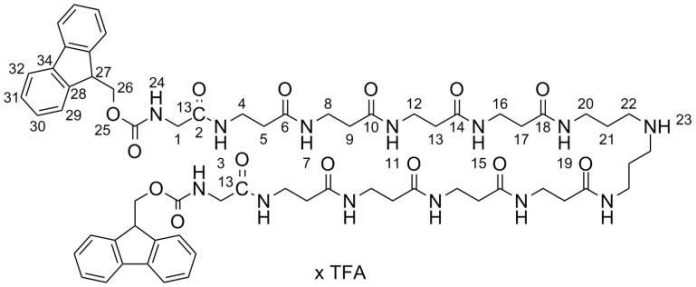
calculated: 842.5207, found: 842.5216. **HPLC** [r.t.; 25-90% CH_3CN in 0.05% TFA/H_2O, in 5 min (gradient)]: t_R = 4.76 min.

Oligoamide precursor 7b



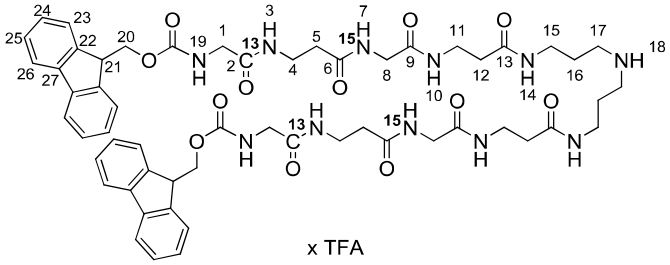
^{1}H-NMR (500 MHz, 300 K, DMSO-d_6) δ = 8.28 (bs, 2H, 23-N*H*), 8.02 (t, 2H, $^3J_{H;\,H}$ = 5.2 Hz, 19-N*H*), 7.97 - 7.79 (m, 12H, 3-, 7-, 11-, 15-N*H*, C*H* $_{arom.}$), 7.72 - 7.63 (m, 4H, C*H* $_{arom.}$), 7.62 - 7.46 (m, 2H, 24-^{15}N*H*), 7.44 - 7.35 (m, 4H, C*H* $_{arom.}$), 7.35 - 7.29 (m, 4H, C*H* $_{arom.}$), 4.31 - 4.24 (m, 4H, 26-CH_2), 4.24 - 4.17 (27-C*H*), 3.61 - 3.53 (m, 4H, 1-CH_2), 3.33 - 3.17 (m, 16H, 4-, 8-, 12-, 16-CH_2), 3.11 (dt, 4H, $^3J_{H;\,H}$ = 6.4 Hz, $^3J_{H;\,H}$ = 6.3 Hz, 20-CH_2), 2.93 - 2.80 (m, 4H, 22-CH_2), 2.30 - 2.13 (m, 16H, 5-, 9-, 13-, 17-CH_2), 1.70 (qi, 4H, $^3J_{H;\,H}$ = 7.1 Hz, 21-CH_2) ppm. **^{13}C-NMR** (125 MHz, 300 K, DMSO-d_6) δ = 127.8 (*C*H$_{arom}$), 127.3 (*C*H$_{arom}$), 125.3 (*C*H$_{arom}$), 120.3 (*C*H$_{arom}$), 65.4 (26-*C*H$_2$), 46.6 (27-*C*H), 44.9 (22-*C*H$_2$), 43.5 (1-*C*H$_2$), 35.4 (4-, 5-, 8-, 9-, 12-, 13-, 16-, 17-, 20-*C*H$_2$), 26.3 (21-*C*H$_2$) ppm. **HRMS (ESI+)** $C_{64}H_{83}N_{11}{}^{15}N_2O_{14}H^+$ [M+H$^+$], calculated: 1261.6228, found: 1261.6332. **HPLC** [r.t.; 25-90% CH_3CN in 0.05% TFA/H_2O, in 5 min (gradient)]: t_R = 4.48 min.

Oligoamide precursor 9b



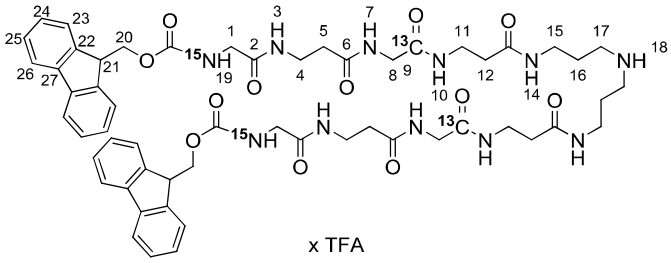
^{1}H-NMR (500 MHz, 300 K, DMSO-d_6) δ = 8.29 (bs, 2H, 23-N*H*), 8.04 (t, 2H, $^3J_{H;\,H}$ = 5.2 Hz, 19-N*H*), 7.99 - 7.88 (m, 8H, 3-, 7-, 11-, 15-N*H*), 7.86 (d, 4H, $^3J_{H;\,H}$ = 7.5 Hz, C*H* $_{arom.}$), 7.70 (d, 4H, $^3J_{H;\,H}$ = 7.4 Hz, C*H* $_{arom.}$), 7.56 - 7.44 (m, 2H, 24-N*H*), 7.39 (t, 4H, $^3J_{H;\,H}$ = 7.4 Hz, C*H* $_{arom.}$), 7.31 (t, 4H, $^3J_{H;\,H}$ = 7.4 Hz, C*H* $_{arom.}$), 4.28 (d, 4H, $^3J_{H;\,H}$ = 7.0 Hz, 26-CH_2), 4.21 (t, 2H, $^3J_{H;\,H}$ = 6.9 Hz, 27-CH_2), 3.65 - 3.49 (m, 4H, 1-CH_2), 3.33 - 3.18 (m, 16H, 4-, 8-, 12-, 16-CH_2), 3.15 - 3.05 (m, 4H, 20-CH_2), 2.92 - 2.81 (m, 4H, 22-CH_2), 2.31 - 2.13 (m, 16H, 5-, 9-, 13-, 17-CH_2), 1.76 - 1.64 (m, 4H, 21-CH_2) ppm. **^{13}C-NMR** (125 MHz, 300 K, DMSO-d_6) δ = 127.6 (*C*H$_{arom}$), 127.2 (*C*H$_{arom}$), 125.2 (*C*H$_{arom}$), 120.1 (*C*H$_{arom}$), 65.7 (26-*C*H$_2$), 46.7 (27-*C*H), 44.8 (22-*C*H$_2$), 43.5 (1-*C*H$_2$), 35.3 (4-, 5-, 8-, 9-, 12-, 13-, 16-, 17-, 20-*C*H$_2$), 26.2 (21-*C*H$_2$) ppm. **HRMS (ESI+)** $C_{62}{}^{13}C2H_{83}N_{13}O_{14}H^+$ [M+H$^+$]; calculated: 1260.6322, found: 1260.6301. **HPLC** [r.t.; 25-90% CH_3CN in 0.05% TFA/H_2O, in 5 min (gradient)]: t_R = 4.48 min.

Oligoamide precursor 11b



^{1}H-NMR (500 MHz, 300 K, DMSO-d_6) δ = 8.25 (bs, 2H, 18-N*H*), 8.09 (d, 2H, $^{1}J_{H;\,H}$ = 102.0 Hz, 7-^{15}N*H*), 8.01 - 7.95 (m, 2H, 14-N*H*), 7.84 - 7.75 (m, 8H, 3-, 10-N*H*, C*H*$_{arom.}$), 7.67 - 7.60 (m, 4H, C*H*$_{arom.}$), 7.36 - 7.29 (m, 4H, C*H*$_{arom.}$), 4.29 (d, 4H, $^{3}J_{H;\,H}$ = 6.8 Hz, 20-CH_2), 4.20 (t, 2H, $^{3}J_{H;\,H}$ = 6.2 Hz, 21-CH_2), 3.64 (s, 4H, 8-CH_2), 3.58 (s, 4H, 1-CH_2), 3.29 (bs, 8H, 4-, 11-CH_2), 3.12 - 2.99 (m, 4H, 15-CH_2), 2.86 (bs, 4H, 17-CH_2), 2.3 (t, 4H, $^{3}J_{H;\,H}$ = 6.9 Hz, 5-CH_2), 2.26 (t, 4H, $^{3}J_{H;\,H}$ = 6.9 Hz, 12-CH_2), 1.70 (qi, 4H, $^{3}J_{H;\,H}$ = 6.9 Hz, 16-CH_2) ppm. **^{13}C-NMR** (125 MHz, 300 K, DMSO-d_6) δ = 169.9 (9-^{13}*C*), 127.8 (*C*H$_{arom}$), 127.4 (*C*H$_{arom}$), 125.5 (*C*H$_{arom}$), 120.4 (*C*H$_{arom}$), 66.1 (20-*C*H$_2$), 47.1 (21-*C*H), 45.1 (17-*C*H$_2$), 43.9 (1-*C*H$_2$), 42.35 (8-*C*H$_2$), 35.9 (15-*C*H$_2$), 36.7 (4-, 5-, 11-, 12-*C*H$_2$), 26.5 (16-*C*H$_2$) ppm. **HRMS (ESI+)** $C_{54}{}^{13}C_2H_{69}N_9{}^{15}N_2O_{12}H^+$ [M+H$^+$]; calculated: 1092.525, found: 1092.521.

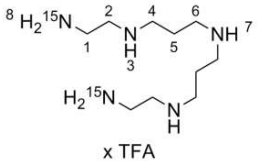
Oligoamide precursor 13b



^{1}H-NMR (500 MHz, 300 K, DMSO-d_6) δ = 8.23 (bs, 2H, 18-N*H*), 8.10 (bs, 2H, 7-N*H*), 8.00 (t, 2H, $^{3}J_{H;\,H}$ = 5.8 Hz, 14-N*H*), 7.84 (bs, 2H, 3-N*H*), 7.82 - 7.80 (m, 2H, 10-N*H*), 7.76 (d, 4H, $^{3}J_{H;\,H}$ = 7.6 Hz, C*H*$_{arom.}$), 7.62 (d, 4H, $^{3}J_{H;\,H}$ = 7.6 Hz, C*H*$_{arom.}$), 7.32 (t, 4H, $^{3}J_{H;\,H}$ = 7.4 Hz, C*H*$_{arom.}$), 7.24 (t, 4H, $^{3}J_{H;\,H}$ = 7.5 Hz, C*H*$_{arom.}$), 4.28 (d, 4H, $^{3}J_{H;\,H}$ = 7.0 Hz, 20-CH_2), 4.21 (t, 2H, $^{3}J_{H;\,H}$ = 6.9 Hz, 21-CH_2), 3.63 (s, 4H, 8-CH_2), 3.58 (s, 4H, 1-CH_2), 3.40 - 3.29 (m, 8H, 4-, 11-CH_2), 3.18 - 3.07 (m, 4H, 15-CH_2), 2.83 (bs, 4H, 17-CH_2), 2.30 (t, 4H, $^{3}J_{H;\,H}$ = 6.9 Hz, 5-CH_2), 2.25 (t, 4H, $^{3}J_{H;\,H}$ = 6.9 Hz, 12-CH_2), 1.69 (qi, 4H, $^{3}J_{H;\,H}$ = 6.8 Hz, 16-CH_2) ppm. **^{13}C-NMR** (125 MHz, 300 K, DMSO-d_6) δ = 170.6 (9-^{13}*C*), 128.7 (*C*H$_{arom}$), 128.1 (*C*H$_{arom}$), 126.3 (*C*H$_{arom}$), 121.0 (*C*H$_{arom}$), 66.8 (20-*C*H$_2$), 47.9 (21-*C*H), 45.8 (17-*C*H$_2$), 44.7 (1-*C*H$_2$), 43.2 (8-*C*H$_2$), 36.6 (15-*C*H$_2$), 36.4 (4-, 5-, 11-, 12-*C*H$_2$), 26.9 (16-*C*H$_2$) ppm. **HRMS (ESI+)** $C_{54}{}^{13}C_2H_{69}N_9{}^{15}N_2O_{12}Na^+$ [M+Na$^+$]; calculated: 1114.503, found: 1114.507.

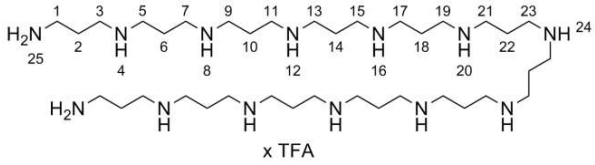
3.2. Analytical Data of LCPAs

LCPA 4



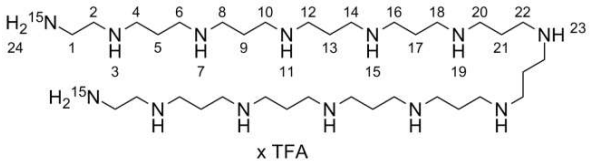
^{1}H-NMR (500 MHz, 300 K, DMSO-d_6) δ = 9.13 – 8.65 (m, 6H, 3-. 7-N*H*, 8-^{15}NH_3^+), 8.12 - 7.92 (m, 1H, 8-^{15}NH_3^+), 3.28 - 3.09 (m, 4H, 1-CH_2), 3.09 - 2.92 (m, 8H, 4-CH_2, 6-CH_2), 2.67 - 2.61 (m, 4H, 2-CH_2), 2.01 - 1.89 (m, 4H, 5-CH_2) ppm. **^{13}C-NMR** (125 MHz, 300 K, DMSO-d_6) δ = 44.1 (1-, 4-, 6-*C*H$_2$), 42.6, 32.7 (2-CH_2), 22.7 (5-CH_2) ppm.

LCPA 6



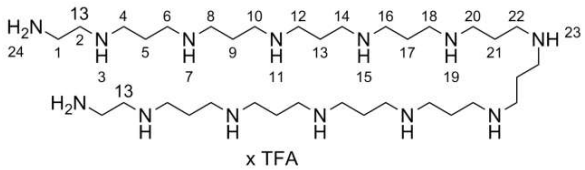
^{1}H-NMR (500 MHz, 300 K, DMSO-d_6) δ = 9.12 - 8.62 (m, 15H, 4-, 8-, 12-, 16-, 20-, 24-N*H*, 25-^{15}NH_3^+), 3.52 - 3.38 (m, 4H, 21-CH_2), 3.27 - 3.04 (m, 12H, 1-, 2-, 19-CH_2), 3.04 - 2.80 (m, 32H, 3-, 5-, 7-, 9-, 11-, 13-, 15-, 17-CH_2), 2.14 - 1.84 (m, 16H, 6-, 10-, 14-, 18-CH_2), 1.84 - 1.53 (m, 4H, 23-CH_2), 1.53 - 1.39 (m, 4H, 22-CH_2) ppm. **^{13}C-NMR** (125 MHz, 300 K, DMSO-d_6) δ = 60.4 (21-*C*H$_2$), 52.1 (1-, 2-, 19-*C*H$_2$), 44.7 (3-, 5-, 7-, 9-, 11-, 13-, 15-, 17-*C*H$_2$), 29.6 (22-*C*H$_2$), 23.1 (6-, 10-, 14-, 18-*C*H$_2$), 20.3 (23-*C*H$_2$) ppm.

LCPA 8



^{1}H-NMR (500 MHz, 300 K, DMSO-d_6) δ = 9.11 - 8.45 (m, 15H, 3-, 7-, 11-, 15-, 19-, 23-N*H*, 24-^{15}NH_3^+), 3.58 - 3.39 (m, 4H, 20-CH_2), 3.35 - 3.04 (m, 8H, 1-CH_2, 2-CH_2), 3.04 - 2.85 (m, 32H, 4-, 6-, 8-, 10-, 12-, 14-, 16-, 18-CH_2), 2.11 - 1.87 (m, 16H, 5-, 9-, 13-, 17-CH_2), 1.83 - 1.58 (m, 4H, 22-CH_2), 1.54 - 1.39 (m, 4H, 21-CH_2) ppm. **^{13}C-NMR** (125 MHz, 300 K, DMSO-d_6) δ = 60.5 (20-*C*H$_2$), 52.6 (1-*C*H$_2$), 50.1 (2-*C*H$_2$), 44.8 (4-, 6-, 8-, 10-, 12-, 14-, 16-, 18-*C*H$_2$), 29.6 (21-*C*H$_2$), 23.3 (5-, 9-, 13-, 17-*C*H$_2$), 21.0 (22-*C*H$_2$) ppm.

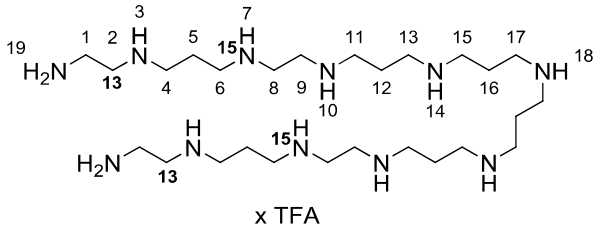
LCPA 10



^{1}H-NMR (500 MHz, 300 K, DMSO-d_6) δ = 9.14 - 8.44 (m, 13H, 3-, 7-, 11-, 15-, 19-, 23-N*H*, 24-^{15}NH_3^+), 3.54 - 3.38 (m, 4H, 20-CH_2), 3.30 - 3.05 (m, 8H, 1-CH_2, 2-^{13}CH_2), 3.05 - 2.80 (m, 32H, 4-, 6-, 8-, 10-, 12-, 14-, 16-, 18-CH_2), 2.15 - 1.85 (m, 16H, 5-, 9-, 13-, 17-CH_2), 1.76 - 1.59 (m,

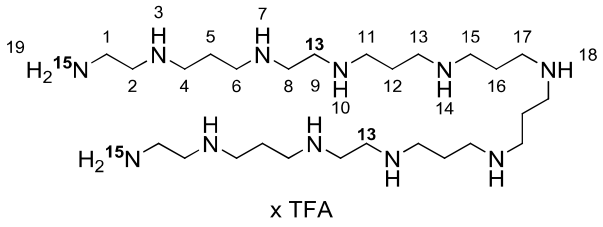
4H, 22-CH_2), 1.51 - 1.38 (m, 4H, 21-CH_2) ppm. **^{13}C-NMR** (125 MHz, 300 K, DMSO-d_6) δ = 60.0 (20-CH$_2$), 51.8 (1-CH$_2$), 44.2 (4-, 6-, 8-, 10-, 12-, 14-, 16-, 18-CH$_2$), 42.7 (2-CH$_2$), 29.1 (21-CH$_2$), 22.5 (5-, 9-, 13-, 17-CH$_2$), 19.9 (22-CH$_2$) ppm.

LCPA 12



^{1}H-NMR (500 MHz, 300 K, DMSO-d_6) δ = 9.09 - 8.52 (m, 13H, 3-, 7-, 10-, 14- 18- 19- NH), 3.52 (bs, 4H, 1-CH_2), 3.42 - 3.36 (m, 12H, 2-, 8-, 9-CH_2), 3.29 - 3.09 (m, 4H, 15-CH_2), 3.03 - 2.79 (m, 16H, 4-, 6-, 11-, 13-CH_2), 2.61 - 2.34 (m, 8H, 5-, 12-CH_2), 2.24 - 1.89 (m, 4H, 17-CH_2), 1.79 - 1.59 (m, 4H, 16-CH_2) ppm. **^{13}C-NMR** (125 MHz, 300 K, DMSO-d_6) δ = 60.2 (15-CH_2), 52.2 (1-CH_2), 34.7 (4-, 6-, 8-, 9-11-, 13-CH_2), 42.4 (2-CH_2), 29.5 (16-CH_2), 22.7 (5-, 12-CH_2), 20.1 (17-CH_2) ppm.

LCPA 14



^{1}H-NMR (500 MHz, 300 K, DMSO-d_6) δ = 9.13 - 8.42 (m, 13H, 3-, 7-, 10-, 14- 18- 19- NH), 3.53 (bs, 4H, 1-CH_2), 3.44 - 3.36 (m, 12H, 2-, 8-, 9-CH_2), 3.34 - 3.12 (m, 4H, 15-CH_2), 3.02 - 2.76 (m, 16H, 4-, 6-, 11-, 13-CH_2), 2.58 - 2.31 (m, 8H, 5-, 12-CH_2), 2.22 - 1.89 (m, 4H, 17-CH_2), 1.82 - 1.64 (m, 4H, 16-CH_2) ppm. **^{13}C-NMR** (125 MHz, 300 K, DMSO-d_6) δ = 60.3 (15-CH_2), 52.1 (1-CH_2), 34.8 (4-, 6-, 8-, 9-11-, 13-CH_2), 42.9 (2-CH_2), 29.2 (16-CH_2), 22.9 (5-, 12-CH_2), 20.5 (17-CH_2) ppm.

4. ^{1}H and ^{13}C-NMR spectra of selected compounds

***N*-(9-Fluorenylmethoxycarbonyl)-glycine-^{15}N**

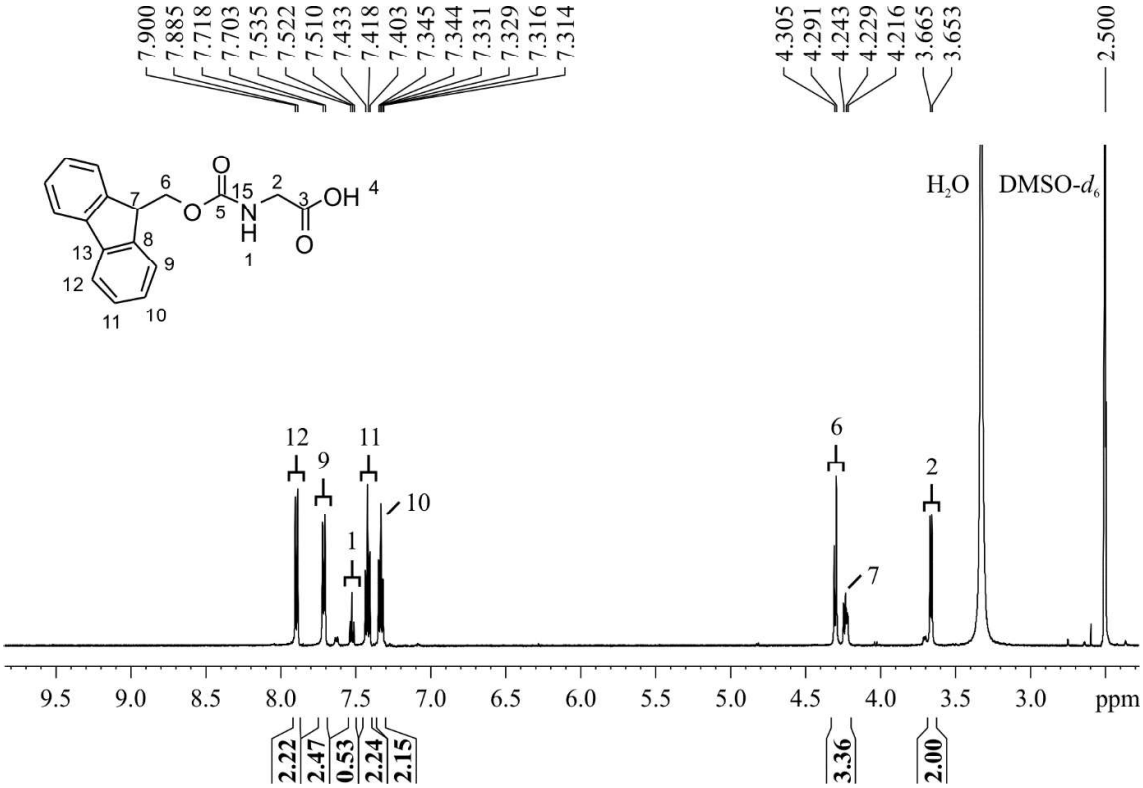


Figure 1: ^{1}H-NMR spectra (500 MHz, 300 K) of N-(9-Fluorenylmethoxycarbonyl)-glycine-^{15}N in DMSO-d_6.

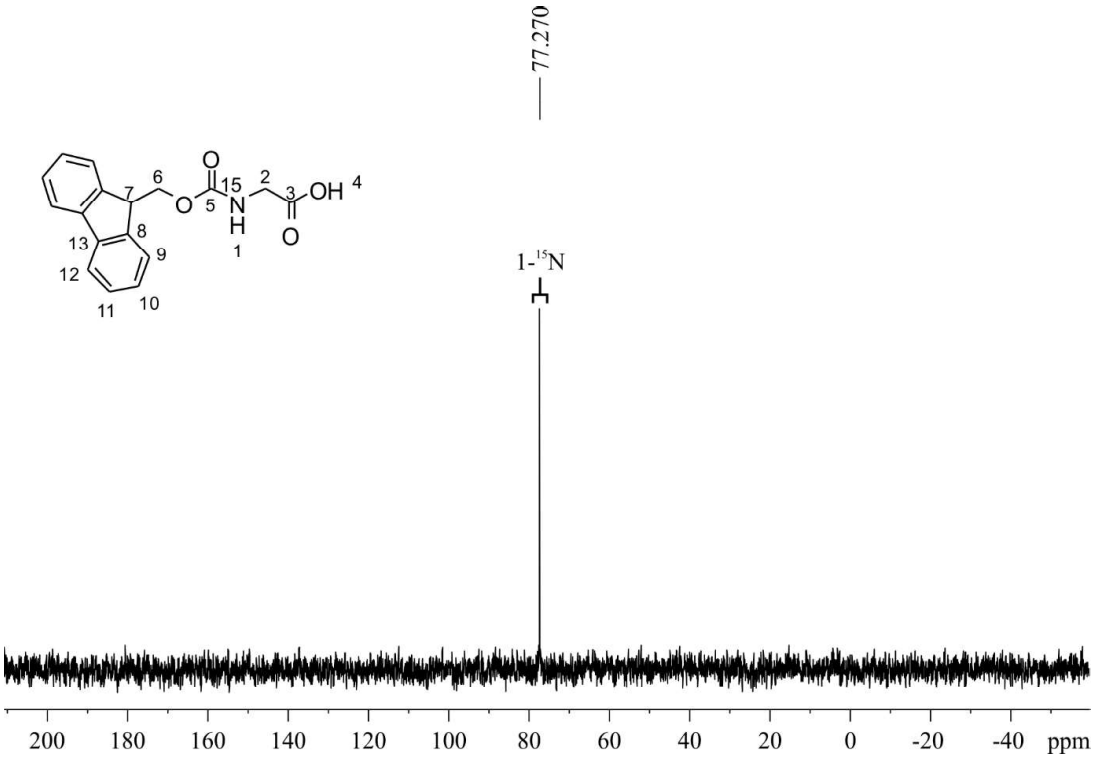


Figure 2: ^{15}N-NMR spectra (50 MHz, 300 K) of N-(9-Fluorenylmethoxycarbonyl)-glycine-^{15}N in DMSO-d_6.

***N*-(9-Fluorenylmethoxycarbonyl)-glycine-1-^{13}C**

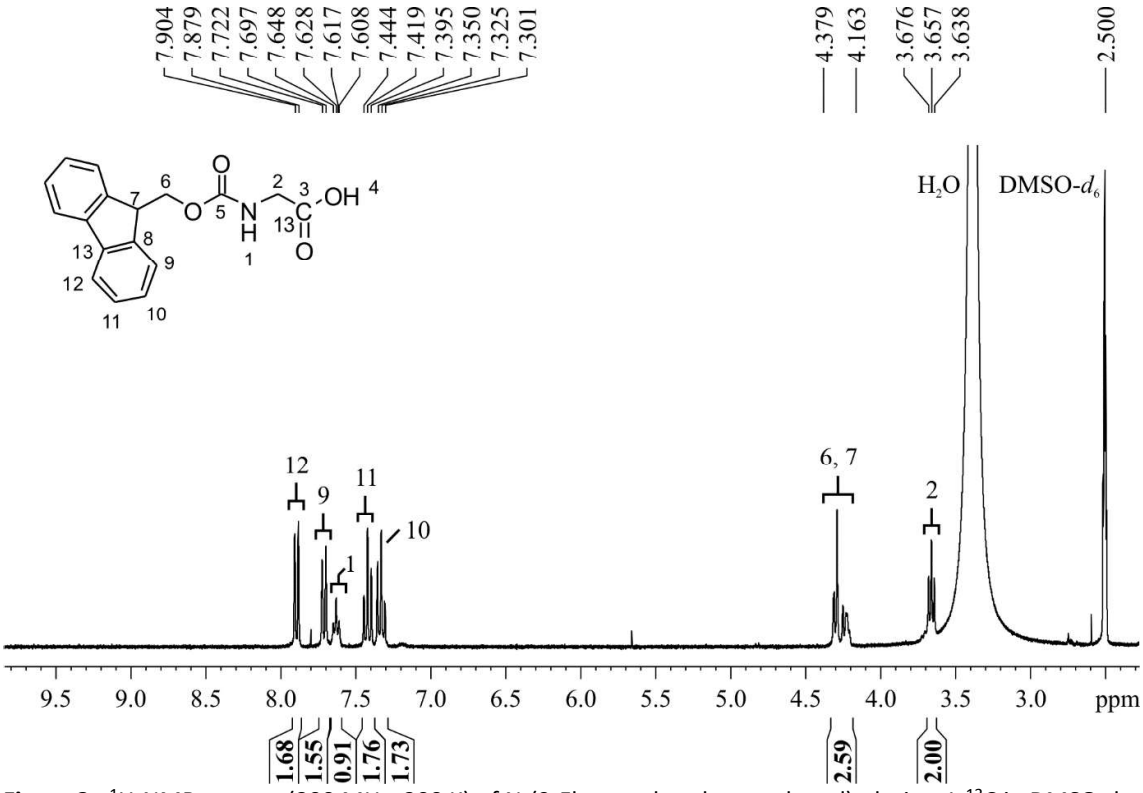


Figure 3: ^{1}H-NMR spectra (300 MHz, 300 K) of N-(9-Fluorenylmethoxycarbonyl)-glycine-1-^{13}C in DMSO-d_6.

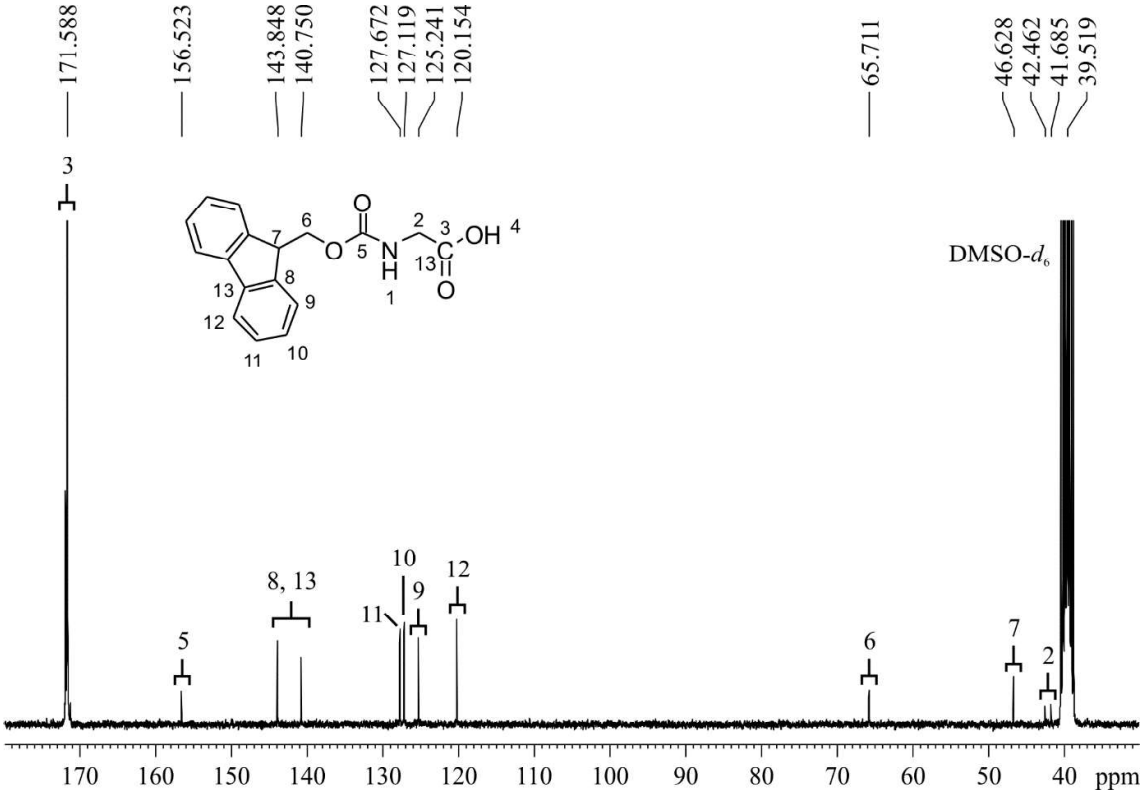


Figure 4: ^{13}C-NMR spectra (75 MHz, 300 K) of N-(9-Fluorenylmethoxycarbonyl)-glycine-1-^{13}C in DMSO-d_6.

Oligoamide precursor 2b

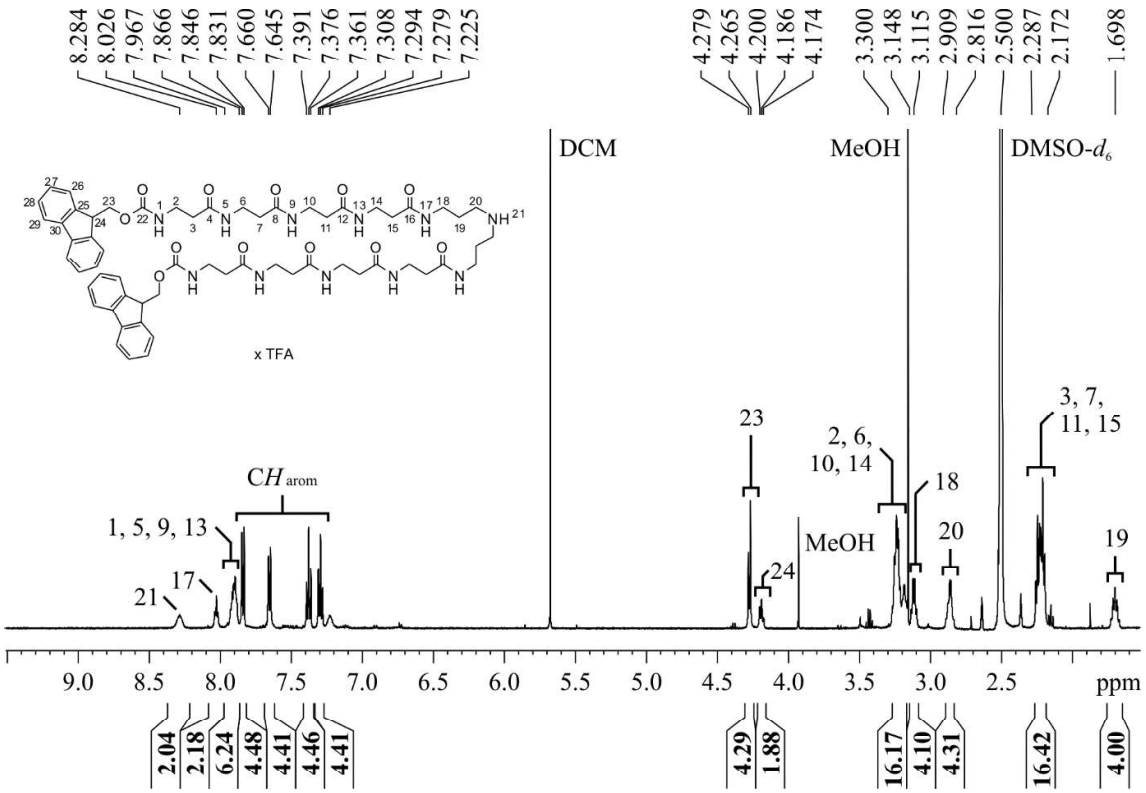


Figure 5: ^{1}H-NMR spectra (500 MHz, 300 K) of the Oligoamide precursor **2b** in DMSO-d_6 (test cleavage).

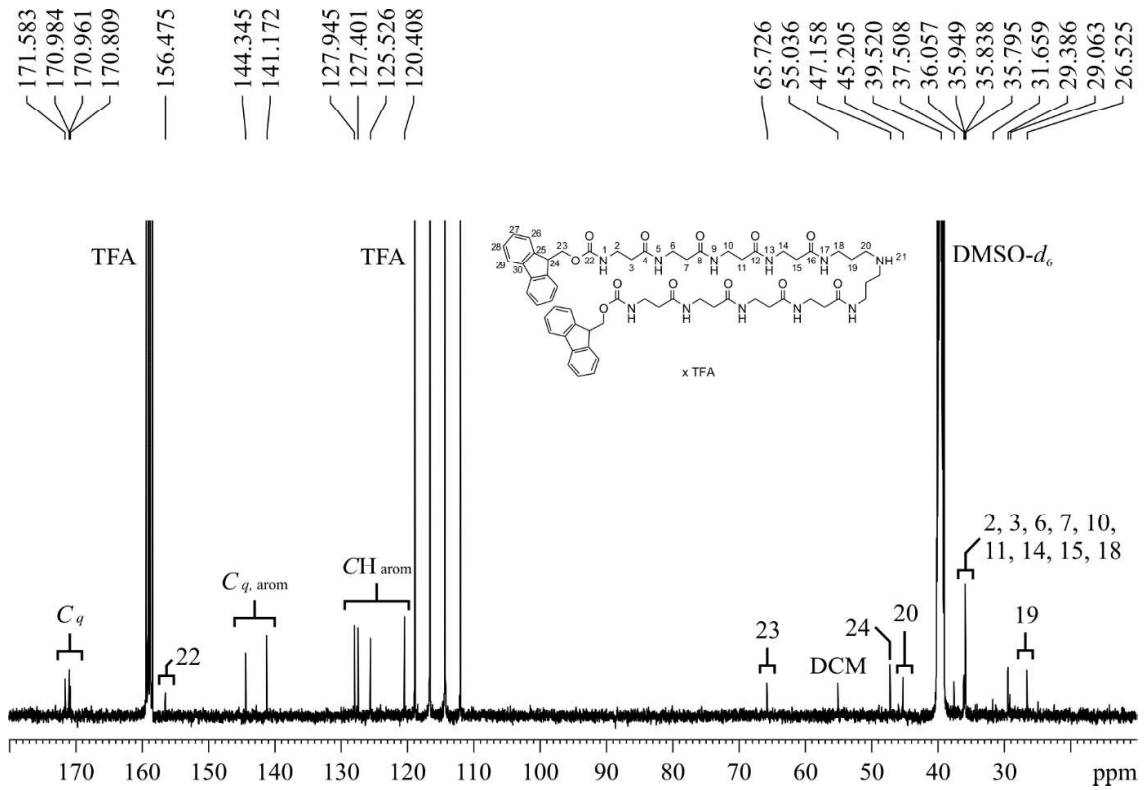


Figure 6: ^{13}C-NMR spectra (125 MHz, 300 K) of the Oligoamide precursor **2b** in DMSO-d_6 (test cleavage).

LCPA 8

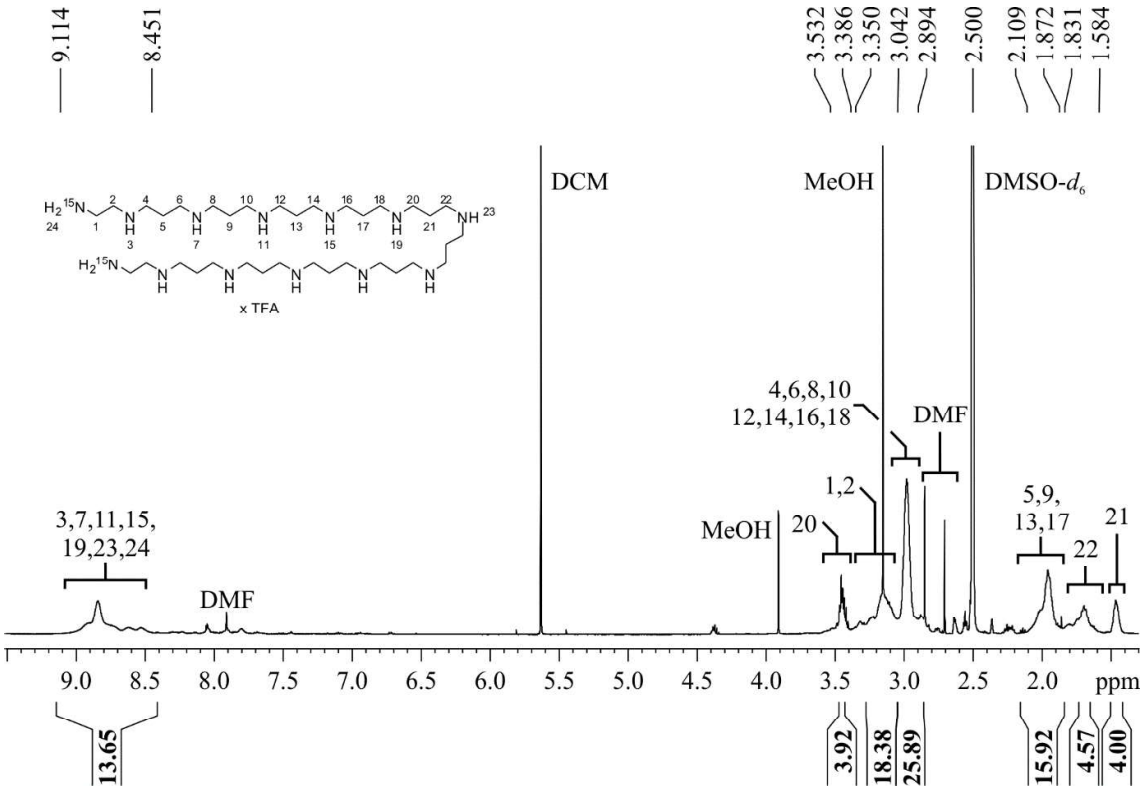


Figure 7: ^{1}H-NMR spectra (500 MHz, 300 K) of the LCPA **8** in DMSO-d_6 (NMR test cleavage).

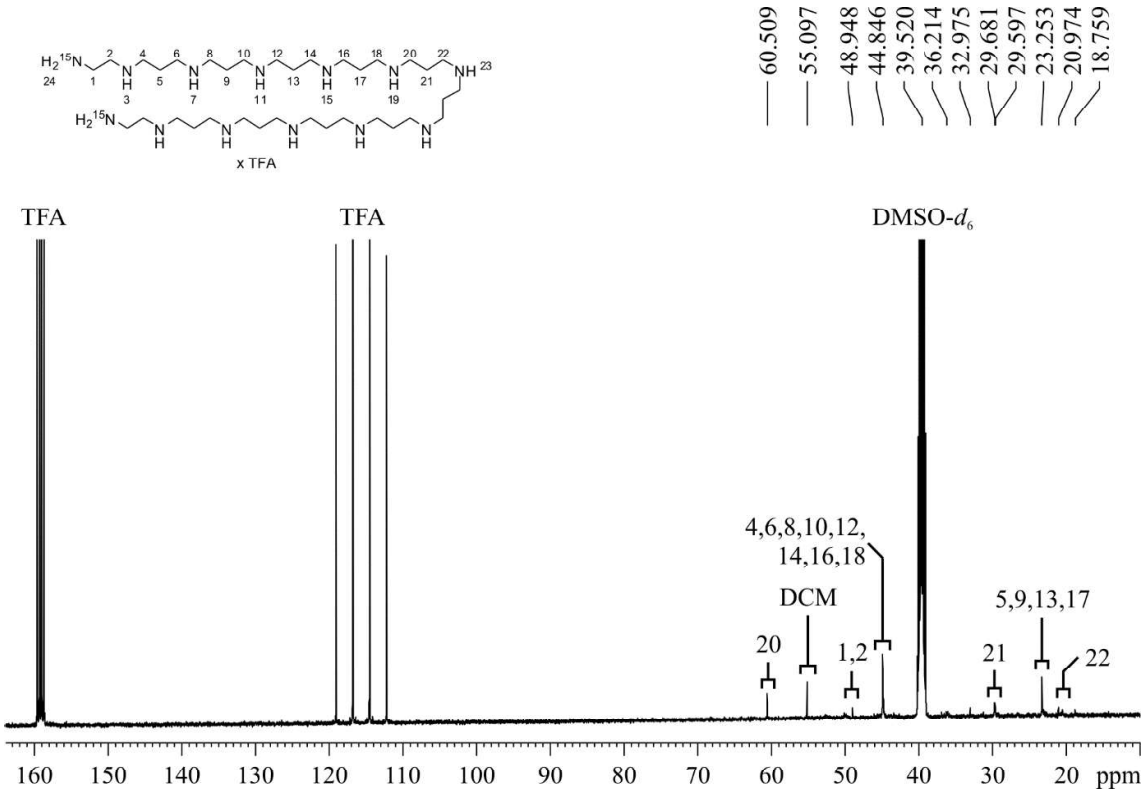


Figure 8: ^{13}C-NMR spectra (125 MHz, 300 K) of the LCPA **8** in DMSO-d_6 (NMR test cleavage).

LCPA 10

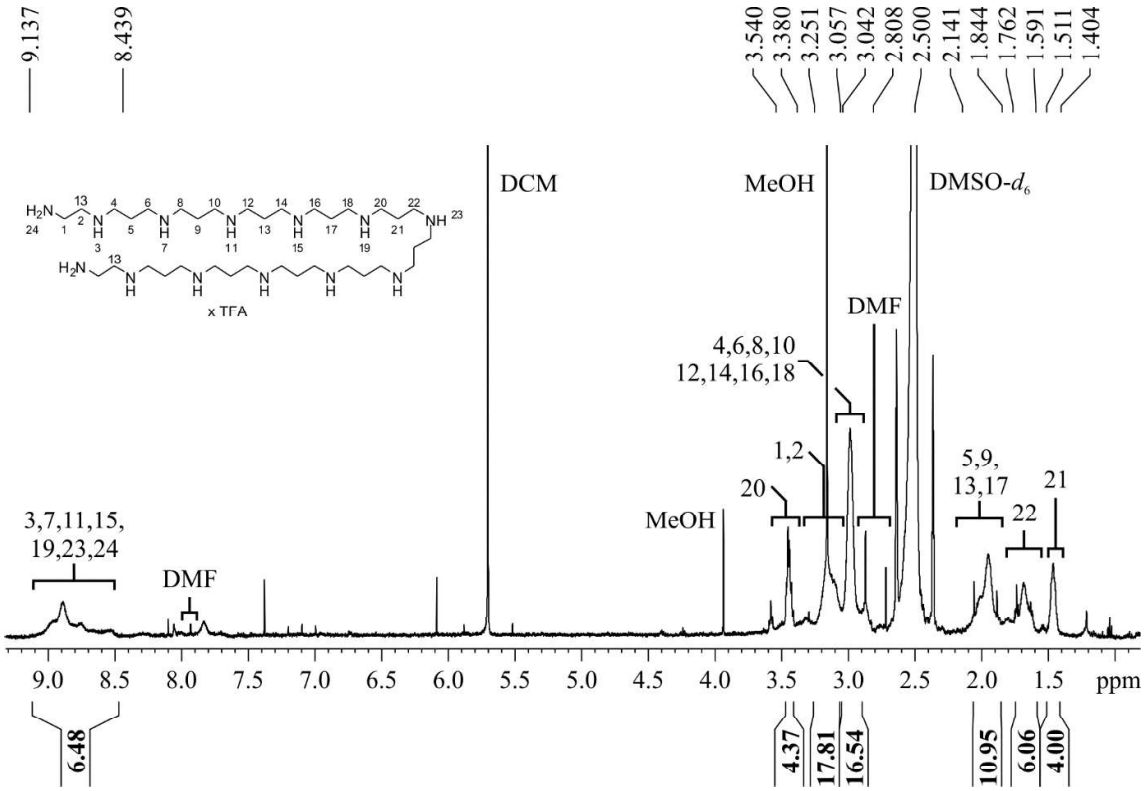


Figure 9: ^{1}H-NMR spectra (500 MHz, 300 K) of the LCPA **10** in DMSO-d_6 (NMR test cleavage).