Supplementary Information for:

Effects of crystallinity and dispersity on the self-assembly behavior of block co-oligomers in water

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Table of Contents

1. Materials and Experimental methods

Most reagents were purchased from Aldrich and used as received. The monodisperse ethylene glycol MeO-EO_{11}-OH and MeO-EO_{11}-OH and MeO-EO_{17}-OH were purchased from Polypure, and MeO-EO_{48}-OH was purchased from Quanta BioDesign. All ethylene glycol oligomers were dried in the vacuo oven at 40°C over phosphorus pentoxide overnight before use. All solvents were purchased from Biosolve and dry solvents were obtained using MBraun solvent purification system (MB SPS-800). Deuterated compounds were obtained from Cambridge Isotopes Laboratories. Reactions were followed by thin-layer chromatography (TLC) using 60-F254 silica gel plates from Merck and visualized by cerium molybdate (CeMo) stain.

Automated column chromatography was performed on a Grace Reveleris X2 using Reveleris Silica Flash Cartridges.

^{1}H NMR and **^{13}C NMR** spectra were recorded on a Varian Mercury Vx 400 MHz (400 MHz for ^{1}H-NMR and 100 MHz for ^{13}C-NMR). Proton chemical shifts are reported in ppm (δ) downfield from trimethylsilane (TMS) using the resonance frequency of the deuterated solvent as the internal standard. Peak multiplicity abbreviated as s: singlet; d: doublet, q: quartet; p: pentet; m: multiplet; dd: double doublet; dt: double triplet; dq: double quartet; Carbon chemical shifts are reported in ppm (δ) downfield from TMS using the resonance frequency of the deuterated solvent as the internal standard.

Matrix assisted laser absorption/ionization mass time of flight (MALDI-TOF) measurements were performed with an Autoflex Speed instrument (Bruker, Bremen, Germany) equipped with a 355 nm Nd:YAG smartbeam laser with maximum repetition rate of 1000 Hz, capable of executing both linear and reflector modes. The accelerating voltage was held at 19 kV and the delay time at 130 ns for all experiments. Mass spectra were acquired in the reflector positive ion mode in the m/z range of 200-3000 by summing spectra from 500 random laser shots at an acquisition rate of 100 Hz. The MS spectra were calibrated with CsI clusters of known masses. α-cyano-4-hydroxycinnamic acid (CHCA) and trans-2-[3-(4-tert-butylphenyl)-2-methyl-2-propenylidene]malononitrile (DCBT) were used as matrix. Matrix solutions were freshly prepared in THF at a concentration of approximately 20 mg/mL for CHCA and 40 mg/mL for DCTB. All the sample solutions were also freshly prepared by dissolving 1 mg of the compound into 1 mL of tetrahydrofuran.

Differential scanning calorimetry (DSC) data was collected on a DSC Q2000 TA Instruments, calibrated with indium as a standard. The samples were heated to 150 °C (40 °C/min), cooled to -85 °C (10 °C/min), heated to 150 °C (10 °C/min). The last cooling and heating cycle were repeated to check for degradation. The peak maximum of the melting transition was used as melting point (T_m). The peak minimum of the crystallization transition was used as crystallization temperature (T_c). The peak minimum of the glass transition temperatures (T_g) were taken at the mid-point of the transition.

Bulk small angle X-ray scattering (SAXS) was performed on an instrument from Ganesha Lab. The flight tube and sample holder were all under vacuum in a single housing, with a GeniX-Cu ultra-low divergence X-ray generator. The source produces X-rays with a wavelength (λ) of 0.154 nm and a flux of 1 x 10^8 ph s^{-1}. Scattered X-rays were captured on a 2-dimensional Pilatus 300K detector with 487 x 619 pixel resolution. Samples were prepared in a glass capillary with a diameter of 1 mm, glass thickness 0.01 mm and length of 80 mm. All samples were heated to 110 °C in vacuo, cooling down to RT occurred overnight as the oven cooled down to RT. The sample-to-detector distance was 0.084 m (WAXS mode) or 0.431 m (MAXS mode). The instrument was calibrated with diffraction patterns from silver behenate.

Micro-DSC: The measurements were taken in TA multi-cell micro differential scanning calorimeter (micro-DSC). 1.0 mL polymer solutions (c = 2.5 - 5.0 mg /mL in 1:9 THF : water) were prepared following the above procedure and transferred to the designed DSC pan for the machine, with a sealed cap. For the reference pan, 1 mL 1:9 THF:water was used. The samples were initially cooled to 5 °C and then subjected to one heating / cooling cycle from 5 °C to 70 °C and back with a rate of 0.1 °C min^{-1}. The data presented, represents the first heating and second cooling runs.

Dynamic Light Scattering (DLS) measurements were performed using a Malvern μV Zetasizer equipped with an 830 nm laser and a scattering angle of 90° at a temperature of 25 °C. Samples were prepared at 1 mg/mL and held in Sarstedt UV-transparent disposable cuvettes with a pathlength of 10 x 2 mm. Measurements were analyzed using Zetasizer software provided by Malvern Instruments to derive the correlation functions and the distributions of the hydrodynamic diameter.

Dynamic Light Scattering (DLS) and Static Light Scattering (SLS) measurements were performed on an ALV ALVCGS-3 Compact Goniometer equipped with ALV5000 digital correlator and a a HeNe laser operating at 532 nm. Scattering intensity was detected over the angular range of 30 to 150 degrees with steps of 10 degrees, with 3 runs of 30 seconds per angle. Samples were prepared at 2.0 or 0.25 mg/mL, held in Wilmad-Labglass high throughput nuclear magnetic resonance (NMR) sample tubes with an outer diameter of 5 mm, and measured at 25 °C. For MA-DLS After ALV software provided by Dullware Inc. was used to derive the hydrodynamic diameter. For SLS, scattering intensity was averaged for each angle over 3 runs of 30 seconds per angle.

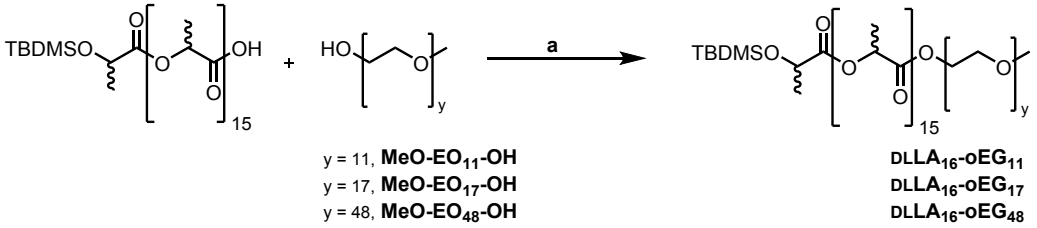
Fluorescence spectroscopy was performed on a Safire II multi-mode plate reader using an excitation wavelength of 550 nm and an emission range of 595 – 675 nm in steps of 5 nm. A black flat bottom 96-wells plate was used to prepare a dilution series of previously assembled samples. 100 μL of each sample was placed in the first well, after which a dilution series was made with MilliQ. To all wells 2 μL Nile Red from a 50 μM stock solution in MeOH was added and the samples were equilibrated for one hour.

TIRF microscopy: Total internal reflection fluorescence (TIRF) spectroscopy was performed using previously assembled samples with a concentration of 0.5-1 mg/mL. Then, 36 μL of previously assembled samples was placed in a 1.5 mL LCMS vial and 0.5-1 μL Nile Red from a 1 mM stock solution in MeoH was added to achieve 5 mol% of Nile Red present in the sample. The samples were equilibrated overnight. TIRF images were acquired with a Nikon N-STORM system. Nile Red was excited using a 561 nm laser. Fluorescence was collected by means of a Nikon ×100, 1.4NA oil immersion objective and passed through a quad-band pass dichroic filter (97335 Nikon). Images were recorded with an EMCCD camera (ixon3, Andor, pixel size 0.17 μm).

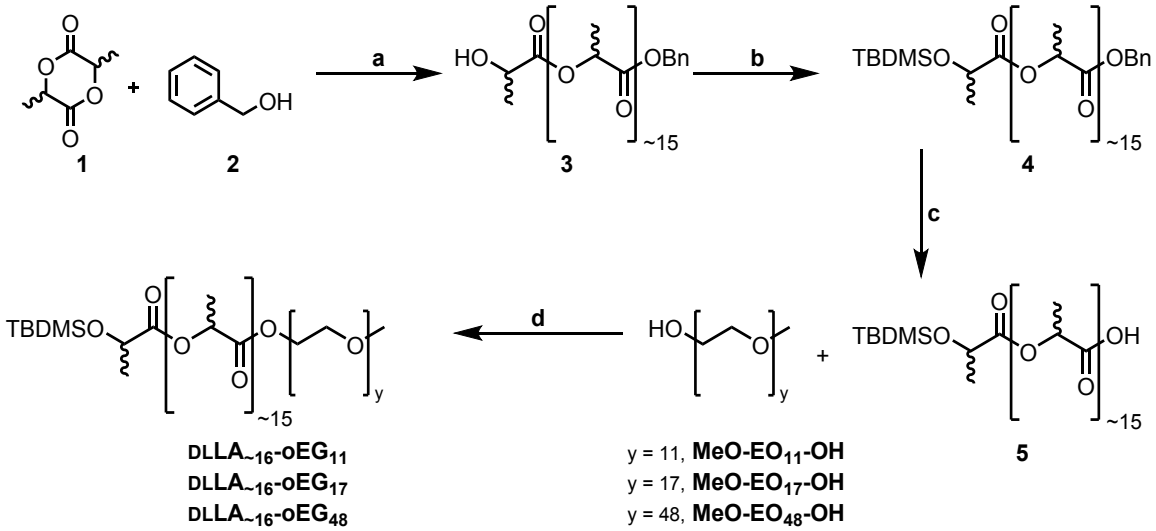
Small-angle neutron scattering (SANS) experiments were performed at the Larmor instrument of ISIS at the STFC Rutherford Appleton Laboratory. The observed q-range was 0.004 $Å^{-1} < q < 0.7$ $Å^{-1}$, where q is the magnitude of the scattering vector $q = \frac{4 * \pi *}{\lambda} * \sin\left(\frac{\theta}{2}\right)$, with λ being the neutron wavelength and θ the scattering angle. The 2D images were radially averaged to obtain the intensity *I(q)* vs q profiles. Standard data reduction procedures, i.e. subtraction of the empty capillary and solvent contribution, were applied by making use of the MantidPlot software.

2. Synthetic procedures

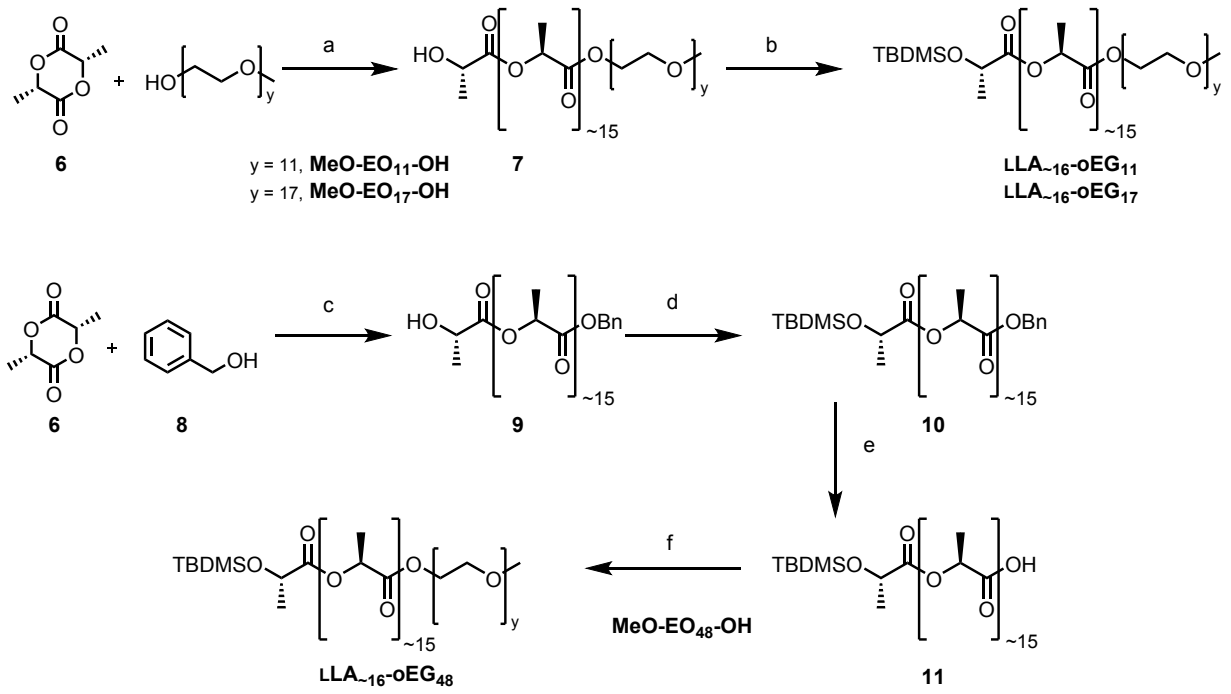
TBDMS-DLLA$_{16}$-COOH[1], LLA$_{16}$-EG$_{11,}$ LLA$_{16}$-EG$_{17}$ and LLA$_{16}$-EG$_{48}$[2] were synthesized according to literature procedures.



Scheme S1 Coupling of discrete DLLA to oligo ethylene glycols forming discrete amorphous DLLA-EG$_y$ BCOs. Reagents and conditions: (a) EDC·HCl, DPTS, DCM, RT, argon, O/N, 25-41%. EDC·HCl = *N*-(3-dimethylaminopropyl)-*N*'-ethylcarbodiimide hydrochloride, DPTS = 4-(dimethylamino) pyridinium 4-toluenesulfonate.



Scheme S2 Synthetic route towards disperse amorphous DLLA$_{\sim 16}$-EG$_y$ BCOs. Reaction conditions: (a) Benzyl alcohol, DBU, DCM, RT, 2 h, 91%. (b) TBDMS-Cl, imidazole, DMF, RT, argon, 24 h, 17%. (c) Pd/C, H_2, EtOAc, RT, O/N, 76%. (e) EDC·HCl, DPTS, DCM, RT, argon, O/N, 19-37%. DBU = 1,8-diazabicyclo[5.4.0]undec-7-ene, TBDMS-Cl = *tert*-butyldimethylsilyl chloride. EDC·HCl = *N*-(3-dimethylaminopropyl)-*N*'-ethylcarbodiimide hydrochloride, DPTS = 4-(dimethylamino)pyridinium 4-toluenesulfonate.



Scheme S3 Synthetic route towards disperse cyrstalline LLA$_{\sim 16}$-*EG*$_y$ BCOs. Reaction conditions: (a) DBU, DCM, RT, 2 h, 51% (b) TBDMS-Cl, imidazole, DMF, RT, argon, 24 h, 51%. (c) Benzyl alcohol, DBU, DCM, RT, 2 h. (d) TBDMS-Cl, imidazole, DMF, RT, argon, 24 h, 14%. (e) Pd/C, H_2, EtOAc, RT, O/N, 69%. (f) EDC·HCl, DPTS, DCM, RT, argon, O/N, 14%. DBU = 1,8-diazabicyclo[5.4.0]undec-7-ene, TBDMS-Cl = *tert*-butyldimethylsilyl chloride. EDC·HCl = *N*-(3-dimethylaminopropyl)-*N*'-ethylcarbodiimide hydrochloride, DPTS = 4-(dimethylamino)pyridinium 4-toluenesulfonate.

DLLA$_{16}$-EG$_{11}$

TBDMS-DLLA$_{16}$-COOH (98.9 mg, 0.077 mmol, 1 eq) was dissolved in dry DCM (0.5 mL, 0.15 M) in a 10 mL round bottom flask under an argon atmosphere. The solution was cooled to 0 ˚C in ice water and 4-(dimethylamino)pyridinium 4-toluenesulfonate (DPTS, 12 mg, 0.042 mmol, 0.5 eq) and *N*-(3-dimethylaminopropyl)-*N*'-ethylcarbodiimide hydrochloride (EDC·HCl, 33.6 mg, 0.175 mmol, 2.3 eq) were added. The mixture was stirred for 10 minutes until the solids were dissolved and the solution turned transparent, followed by the addition of the 11mer of poly(ethylene glycol) (*MeO-EO$_{11}$-OH*), 44 mg, 0.085 mmol, 1.1 eq). EG$_{11}$ was first dried overnight under vacuum over P_2O_5. The resulting solution was stirred overnight at room temperature under N_2 atmosphere. The conversion was checked by TLC analysis (DCM/MeOH 90:10; CeMo stain; $R_{f,product}$ = 0.79). The reaction mixture was diluted with DCM (2 mL) and washed with saturated $NaHCO_3$ solution (4 x 3 mL) and brine (1 x 3 mL). The organic layer was dried with $MgSO_4$ and concentrated in vacuo, giving the crude product. The crude product was purified using automated column chromatography by using DCM/1,2-dimethoxyethane (100/0 to 80/20) as eluent, giving product **DLLA$_{16}$-EG$_{11}$** as a colorless oil (34.3 mg, 0.0192 mmol, 25 %).

^{1}H NMR (400 MHz, $CDCl_3$) δ: 5.27 – 5.10 (m, 15H, O-C$\underline{H}$(CH_3)-CO), 4.40 (q, *J* = 6.7 Hz, 1H, TBDMS-C$\underline{H}$(CH_3)-CO), 4.35 – 4.21 (m, 2H, CO-O-C$\underline{H}_2$-CH_2-,), 3.73 – 3.59 (m, 40H, -(($C\underline{H}_2$)$_2$-O)$_{10}$-CH_3), 3.59 – 3.52 (m, 2H, -CH_2-C$\underline{H}_2$-O-CH_3), 3.38 (s, 3H, TBDMS-CH(C$\underline{H}_3$)-CO), 1.62 – 1.49 (m, 45H, O-CH(C$\underline{H}_3$)-CO), 1.45 (d, *J* = 6.7 Hz, 3H, TBDMS-CH(C$\underline{H}_3$)-CO),), 0.90 (s, 9H, ($C\underline{H}_3$)$_3$C-Si(CH_3)$_2$), 0.11 (s, 3H, (CH_3)$_3$C-Si(C$\underline{H}_3$)$_2$), 0.08 (s, 3H, (CH_3)$_3$C-Si(C$\underline{H}_3$)$_2$). ^{13}C NMR (100 MHz, $CDCl_3$) δ: 173.54, 173.35, 170.06, 170.03, 169.94, 169.80, 169.76, 169.62, 169.59, 169.53, 169.41, 169.35, 169.31, 169.27, 169.15, 169.13, 106.02, 77.24, 72.57, 71.93, 70.95, 70.60, 70.56, 70.51, 69.23, 69.18, 69.15, 69.06, 69.03, 68.99, 68.86, 68.80, 68.53, 67.97, 66.55, 64.43, 59.39, 59.03, 56.44, 25.70, 21.27, 21.21,

18.29, 16.88, 16.79, 16.77, 16.74, 16.66, 16.62, 16.60, -0.00, -4.91, -5.30. HRMS (MALDI-ToF): *m/z* calcd $C_{77}H_{126}O_{44}Si+Na^+$: 1805.72 $[M + Na]^+$, found 1805.79; *m/z* calcd $C_{77}H_{126}O_{44}Si+K^+$: 1821.70 $[M + K]^+$, found 1822.77.

DLLA$_{16}$-EG$_{17}$

TBDMS-DLLA$_{16}$-COOH (261.9 mg, 0.21 mmol, 1 eq) was dissolved in dry DCM (2 mL, 0.11 M) in a 10 mL round bottom flask under an argon atmosphere. The solution was cooled to 0 ˚C in icewater and 4-(dimethylamino)pyridinium 4-toluenesulfonate (DPTS, 11.4 mg, 0.041 mmol, 0.2 eq) and *N*-(3-dimethylaminopropyl)-*N*'-ethylcarbodiimide hydrochloride (EDC·HCl, 54.8 mg, 0.27 mmol, 1.3 eq) were added. The mixture was stirred for 10 minutes until the solids were dissolved and the solution turned transparent, followed by the addition of the 17mer of poly(ethylene glycol) (*MeO-EO$_{17}$-OH*), 164 mg, 0.21 mmol, 1 eq). EG$_{17}$ was first dried overnight under vacuum over P_2O_5. The resulting solution was stirred overnight at room temperature. The conversion was checked by TLC analysis (DCM/MeOH 90:10; CeMo stain; $R_{f,product}$ = 0.73). The reaction mixture was diluted with DCM (2 mL) and washed with saturated $NaHCO_3$ solution (4 x 3 mL) and brine (1 x 3 mL). The organic layer was dried with $MgSO_4$ and concentrated in vacuo, giving the crude product. The crude product was purified using automated column chromatography by using DCM/1,2-dimethoxyethane (100/0 to 80/20) as eluent, giving product **DLLA$_{16}$-EG$_{17}$** as a colorless oil (173 mg, 0.084 mmol, 40%).

^{1}H NMR (400 MHz, $CDCl_3$) δ: 5.27 – 5.09 (m, 15H, O-C<u>H</u>(CH_3)-CO), 4.40 (q, *J* = 6.7 Hz, 1H, TBDMS-C<u>H</u>(CH_3)-CO), 4.34 – 4.20 (m, 2H, CO-O-C<u>H$_2$</u>-CH_2), 3.89 – 3.58 (m, 64H, -((CH_2)$_2$-O)$_{16}$-CH_3), 3.58 – 3.53 (m, 2H, -CH_2-C<u>H$_2$</u>-O-CH_3), 3.38 (s, 3H, TBDMS-CH(C<u>H$_3$</u>)-CO), 1.64 – 1.49 (m, 45H, O-CH(C<u>H$_3$</u>)-CO), 1.45 (d, *J* = 6.8 Hz, 3H, TBDMS-CH(C<u>H$_3$</u>)-CO), 0.90 (s, 9H, (C<u>H$_3$</u>)$_3$C-Si(CH_3)$_2$), 0.11 (s, 3H, (CH_3)$_3$C-Si(C<u>H$_3$</u>)$_2$), 0.08 (s, 3H, (CH_3)$_3$C-Si(C<u>H$_3$</u>)$_2$). ^{13}C NMR (100 MHz, $CDCl_3$) δ: 173.54, 173.35, 170.05, 169.76, 169.61, 169.53, 169.41, 169.35, 169.31, 169.26, 169.15, 169.13, 77.25, 74.32, 71.93, 70.61, 70.56, 70.51, 70.42, 69.22, 69.18, 69.15, 69.06, 69.03, 68.99, 68.86, 68.80, 68.53, 67.97, 64.42, 64.11, 63.71, 59.38, 59.28, 59.03, 55.30, 53.44, 29.69, 25.70, 21.27, 21.21, 18.28, 16.88, 16.77, 16.74, 16.67, 16.62, 16.60, -0.00, -4.91, -5.30. HRMS (MALDI-ToF): *m/z* calcd $C_{89}H_{150}O_{50}Si+Na^+$: 2069.88 $[M + Na]^+$, found 2070.96; *m/z* calcd $C_{89}H_{150}O_{50}Si+K^+$: 2085.9 $[M + K]^+$, found 2086.9.

DLLA$_{16}$-EG$_{48}$

TBDMS-DLLA$_{16}$-COOH (63.6 mg mg, 0.0495 mmol, 1.06 eq) was dissolved in dry DCM (1 mL, 0.05 M) in a 10 mL round bottom flask under an argon atmosphere. The solution was cooled to 0 ˚C in icewater and 4-(dimethylamino)pyridinium 4-toluenesulfonate (DPTS, 8.3 mg, 0.03 mmol, 0.6 eq) and *N*-(3-dimethylaminopropyl)-*N*'-ethylcarbodiimide hydrochloride (EDC·HCl, 21.4 mg, 0.112 mmol, 2.4 eq) were added. The mixture was stirred for 15 minutes until the solids were dissolved and the solution turned transparent, followed by the addition of the 48mer of poly(ethylene glycol) (*MeO-EO$_{48}$-OH*), 100 mg, 0.0467 mmol, 1 eq). EG$_{48}$ was first dried overnight under vacuum over P_2O_5. The resulting solution was stirred overnight at room temperature. The conversion was checked by TLC analysis (DCM/MeOH 90:10; CeMo stain; $R_{f,product}$ = 0.6). The reaction mixture was diluted with DCM (2 mL) and washed with saturated $NaHCO_3$ solution (4 x 3 mL) and brine (1 x 3 mL). The organic layer was dried with $MgSO_4$ and concentrated in vacuo, giving the crude product. The crude product was purified using automated column chromatography by using DCM/MeOH (100/0 to 85/15) as eluent, giving product **DLLA$_{16}$-EG$_{48}$** as a white solid (66.2 mg, 0.019 mmol, 41%).

^{1}H NMR (400 MHz, $CDCl_3$) δ: 5.27 – 5.09 (m, 15H, O-C<u>H</u>(CH_3)-CO), 4.40 (q, *J* = 6.8 Hz, 1H, TBDMS-C<u>H</u>(CH_3)-CO), 4.35 – 4.20 (m, 2H, CO-O-C<u>H$_2$</u>-CH_2), 3.78 – 3.52 (m, 188H, -((CH_2)$_2$-O)$_{47}$-CH_3), 3.50 – 3.44 (m, 2H, CO-O-CH_2-C<u>H$_2$</u>-), 3.38 (s, 3H, TBDMS-CH(C<u>H$_3$</u>)-CO), 1.64 – 1.49 (m, 45H, O-CH(C<u>H$_3$</u>)-CO), 1.45 (d, *J* = 6.8 Hz, 3H, TBDMS-CH(C<u>H$_3$</u>)-CO), 0.90 (s, 9H, (C<u>H$_3$</u>)$_3$C-Si(CH_3)$_2$), 0.11 (s, 3H, (CH_3)$_3$C-Si(C<u>H$_3$</u>)$_2$), 0.08 (s, 3H, (CH_3)$_3$C-Si(C<u>H$_3$</u>)$_2$). ^{13}C NMR (100 MHz, $CDCl_3$) δ: 173.35, 170.05, 169.59, 169.35, 169.27, 169.13, 77.24, 71.93, 70.61, 70.56, 70.51, 69.18, 68.99, 68.86, 68.80,

68.53, 67.97, 64.42, 59.04, 29.69, 25.70, 21.27, 18.29, 16.88, 16.75, 16.67, -0.00, -4.90, -5.30. HRMS (MALDI-ToF): *m/z* calcd $C_{151}H_{274}O_{81}Si+Na^+$: 3434.69 $[M + Na]_+$, found 3435.68; *m/z* calcd $C_{89}H_{150}O_{50}Si+K^+$: 3450.68 $[M + K]_+$, found 3452.71.

HO-DLLA$_{\sim 16}$-OBn (3)

Benzyl alcohol (**2**) (0.94 g, 8.7 mmol, 1 eq) and DL-lactide (**1**) (10.04 g, 70 mmol, 8eq) were dissolved at room temperature in 10 mL DCM and DBU (11 µL, 73 mmol, 8 eq) was added. The reaction mixture was stirred at rt under argon atmosphere until full conversion (1 h). The reaction mixture was diluted with more DCM and washed twice with 1 M $KHSO_4$ and brine. After drying over Na_2SO_4 **7** was precipitated using cold diethyl ether yielded 9.98 g (91%) of crude **3** which was used as such in the next step.

^{1}H NMR (400 MHz, $CDCl_3$) δ: 7.41 - 7.28 (m, 5H), 5.30 (s, 7H), 5.19 (m, J = 14.5, 11.5, 6.6 Hz, 17H), 4.35 (q, J = 7.2, 6.7 Hz, 1H), 1.63 - 1.40 (m, 47H))

TBDMS-DLLA$_{\sim 16}$-OBn (4)

HO-DLLA$_{\sim 16}$-Bn **(3)** (13.6 g, 10.78 mmol) was dissolved in dry DMF (82 mL) in a 250 mL round bottom flask under argon atmosphere. Imidazole (1.88 g, 27.61 mmol, 2.6 eq) and *tert*-butyldimethylsilyl chloride (TBDMS-Cl, 2 g, 13.27 mmol, 1.2 eq) were added as solids and the resulting colorless solution was stirred overnight at room temperature. Full conversion of the alcohol was confirmed by TLC analysis (hept/EtOAc 50:50; CeMo stain; $R_{f,product}$ = 0.56). The mixture was poured into sat. $NaHCO_3$ (200 mL) and extracted with pentane (4 x 100 mL). A precipitate (possibly consisting out of the longer oLA chains) formed during the extraction with pentane. The combined organic layers were dried with $MgSO_4$ and the solvent was removed in *vacuo*, giving the crude product **4a** as a colorless oil (1.84 g). Due to the low product outcome, the precipitate was checked for presence of the product, TLC analysis confirmed the presence of the product (hept/EtOAc 50:50, CeMo stain). In order to remove the product, the precipitate was poured into DCM and stirred for 15 minutes, after which the resulting suspension was filtered. The solvent of the filtrate was removed in *vacuo*, giving the crude product **4b** as a colorless oil (11.8 g). ^{1}H-NMR showed that crude product **4a** has a DP of around 4, crude product **4b** has a DP of around 17. Crude product **4b** was purified by automated column chromatography by using heptane/EtOAc (gradient 90/10 to 40/60) as eluent. Pure material **4**, with a DP of 18, was obtained as a colorless oil (2.7 g, 17%).

^{1}H-NMR (400 MHz, $CDCl_3$) δ: 7.45 – 7.30 (m, 5H, Ar-H), 5.28 – 5.09 (m, 19H, O-C$\underline{H}$(CH_3)-CO and Ar-C$\underline{H_2}$-O), 4.41 (q, J = 6.5 Hz, 1H, TBDMS-C$\underline{H}$(CH_3)-CO), 1.67 – 1.49 (m, 52H, O-CH(C$\underline{H_3}$)-CO), 1.46 (d, 3H, TBDMS-CH(C$\underline{H_3}$)-CO), 0.92 (s, 9H, ($C\underline{H_3}$)$_3$C-Si(CH_3)$_2$), 0.11 (dd, J = 9.2, 4.3 Hz, 6H, (CH_3)$_3$C-Si(C$\underline{H_3}$)$_2$)

TBDMS-DLLA$_{\sim 16}$-OH (5)

TBDMS-DLLA$_{\sim 16}$-Bn **(4)** (2.7 g, 1.8 mmol) was dissolved in EtOAc (7 mL, 2.6 M) in a 25 mL round bottom flask. The solution was purged with nitrogen and palladium (10% on carbon, 0.08 eq) was added. The mixture was stirred overnight under hydrogen atmosphere, using a balloon, at room temperature. Full conversion of the benzyl ester was confirmed by TLC analysis (hept/EtOAc 50:50; CeMo stain; $R_{f,product}$ = 0-0.25 (tailing)). The black suspension was filtered through a 4 cm thick layer of celite and the filter cake was washed with EtOAc (4 x 30 mL). The filtrate was concentrated in *vacuo*, giving the product **(5)** as a colorless oil (2.16 g, 76%).

^{1}H NMR (400 MHz, $CDCl_3$) δ: 5.29 – 5.09 (m, 19H, O-C$\underline{H}$(CH_3), 4.40 (q, *J* = 6.8, 2.1 Hz, 1H, TBDMS-C$\underline{H}$(CH_3)-CO), 1.67 – 1.49 (m, 57H, O-CH(C$\underline{H_3}$)-CO), 1.48 – 1.37 (m, 3H, TBDMS-CH(C$\underline{H_3}$)-CO), 0.90 (s, 9H, ($C\underline{H_3}$)$_3$C-Si(CH_3)$_{237}$), 0.09 (dd, *J* = 9.0, 4.4 Hz, 6H, (CH_3)$_3$C-Si(C$\underline{H_3}$)$_2$). ^{13}C NMR (100 MHz, $CDCl_3$) δ: 173.53, 173.31, 171.31, 169.62, 169.52, 169.45, 169.41, 169.37, 169.30, 129.02, 128.21, 77.24, 69.42, 69.31, 69.18, 69.10, 69.01, 68.81, 68.55, 68.41, 68.15, 68.00, 67.98, 60.46, 25.69,

21.29, 21.26, 21.20, 21.04, 18.27, 16.87, 16.84, 16.74, 16.70, 16.65, 16.62, 16.59, 16.55, 14.19, -0.01, -4.92, -4.94, -5.30, -5.39. HRMS (MALDI-ToF): *m/z* calcd $C_{69}H_{100}O_{43}Si+K^+$: 1683.50 $[M + K]^+$, found 1683.50 as one of the most abundant peaks in the DCTB matrix. The dispersity of the block can be seen from the lower intensity peaks of 72.02 m/z more or less, corresponding to one lactic acid repeating unit.

DLLA$_{\sim 16}$-EG$_{11}$

TBDMS-DLLA$_{\sim 16}$-COOH **(5)** (491.8 mg, 0.312 mmol, 1 eq) was dissolved in dry DCM (2 mL, 0.15 M) in a 10 mL round bottom flask under an argon atmosphere. The solution was cooled to 0 °C in ice water and 4-(dimethylamino)pyridinium 4-toluenesulfonate (DPTS, 17.8 mg, 0.0064 mmol, 0.2 eq) and *N*-(3-dimethylaminopropyl)-*N*'-ethylcarbodiimide hydrochloride (EDC·HCl, 77 mg, 0.04 mmol, 1.3 eq) were added. The mixture was stirred for 10 minutes until the solids were dissolved and the solution turned transparent, followed by the addition of the 11mer of poly(ethylene glycol) (*MeO-EO$_{11}$-OH*, 161 mg, 0.312 mmol, 1 eq). EG$_{11}$ was first dried overnight under vacuum over P_2O_5. The resulting solution was stirred overnight at room temperature. The conversion was checked by TLC analysis (DCM/MeOH 90:10; CeMo stain; $R_{f,product}$ = 0.72). The reaction mixture was diluted with DCM (2 mL) and washed with saturated $NaHCO_3$ solution (4 x 3 mL) and brine (1 x 3 mL). The organic layer was dried with $MgSO_4$ and concentrated in vacuo, giving the crude product. The crude product was purified using automated column chromatography by using DCM/1,2-dimethoxyethane (100/0 to 80/20) as eluent, giving product **DLLA$_{\sim 16}$-EG$_{11}$** as a colorless oil (25.3 mg, 0.012 mmol, 4%).

^{1}H NMR (400 MHz, $CDCl_3$) δ: 5.27 – 5.11 (m, 17H, O-C<u>H</u>(CH_3)-CO), 4.40 (q, *J* = 6.7, 2.0 Hz, 1H, TBDMS-C<u>H</u>(CH_3)-CO), 4.35 – 4.21 (m, 2H, CO-O-C<u>H$_2$</u>-CH_2-), 3.87 – 3.59 (m, 40H, -(($C\underline{H_2}$)$_2$-O)$_{10}$-CH_3), 3.59 – 3.51 (m, 2H, -CH_2-C<u>H$_2$</u>-O-CH_3), 3.38 (s, 3H, TBDMS-CH(C<u>H$_3$</u>)-CO),), 1.64 – 1.47 (m, 51H, O-CH(C<u>H$_3$</u>)-CO), 1.47 – 1.40 (m, 3H, TBDMS-CH(C<u>H$_3$</u>)-CO), 0.90 (s, 9H, (C<u>H$_3$</u>)$_3$C-Si(CH_3)$_2$), 0.09 (dd, *J* = 9.1, 4.3 Hz, 6H, (CH_3)$_3$C-Si(C<u>H$_3$</u>)$_2$). ^{13}C NMR (100 MHz, $CDCl_3$) δ: 173.48, 170.04, 169.80, 169.59, 169.40, 169.34, 169.27, 106.02, 98.90, 77.25, 72.56, 71.93, 71.80, 70.97, 70.60, 70.57, 70.51, 69.40, 69.31, 69.17, 68.99, 68.79, 68.52, 68.38, 68.14, 67.98, 66.56, 64.46, 64.43, 59.38, 59.06, 59.02, 56.43, 53.44, 29.69, 25.69, 21.26, 21.21, 18.27, 16.79, 16.74, 16.71, 16.66, 16.64, -0.01, -4.92, -5.30, -5.39. HRMS (MALDI-ToF) *m/z* calcd $C_{77}H_{126}O_{44}Si+Na^+$: 1805.72 $[M + Na]^+$, found 1805.74 as one of the most abundant peaks in the DCTB matrix. The dispersity of the block can be seen from the lower intensity peaks of 72.02 m/z more or less, corresponding to one lactic acid repeating unit.

DLLA$_{\sim 16}$-EG$_{17}$

TBDMS-DLLA$_{\sim 16}$-COOH **(5)** (396.9 mg, 0.25 mmol, 1 eq) was dissolved in dry DCM (2 mL, 0.13 M) in a 10 mL round bottom flask under an argon atmosphere. The solution was cooled to 0 ˚C in icewater and 4-(dimethylamino)pyridinium 4-toluenesulfonate (DPTS, 14.4 mg, 0.05 mmol, 0.2 eq) and *N*-(3-dimethylaminopropyl)-*N*'-ethylcarbodiimide hydrochloride (EDC·HCl, 63.1 mg, 0.32 mmol, 1.3 eq) were added. The mixture was stirred for 10 minutes until the solids were dissolved and the solution turned transparent, followed by the addition of the 17mer of poly(ethylene glycol) (*MeO-EO$_{17}$-OH,* 195 mg, 0.25 mmol, 1 eq). EG$_{17}$ was first dried overnight under vacuum over P_2O_5. The resulting solution was stirred overnight at room temperature. The conversion was checked by TLC analysis (DCM/MeOH 90:10; CeMo stain; $R_{f,product}$ = 0.73). The reaction mixture was diluted with DCM (2 mL) and washed with saturated $NaHCO_3$ solution (4 x 3 mL) and brine (1 x 3 mL). The organic layer was dried with $MgSO_4$ and concentrated in vacuo, giving the crude product. The crude product was purified using automated column chromatography by using DCM/1,2-dimethoxyethane (100/0 to 80/20) as eluent, giving product **DLLA$_{\sim 16}$-EG$_{17}$** as a colorless oil (189.2 mg, 0.092 mmol, 37%).

^{1}H NMR (400 MHz, $CDCl_3$) δ: 5.26 – 5.10 (m, 17H, O-C<u>H</u>(CH_3)-CO), 4.40 (q, *J* = 6.7, 2.0 Hz, 1H, TBDMS-C<u>H</u>(CH_3)-CO), 4.35 – 4.21 (m, 2H, CO-O-C<u>H$_2$</u>-CH_2), 3.85 – 3.60 (m, 64H, -(($C\underline{H_2}$)$_2$-O)$_{16}$-CH_3), 3.59 – 3.50 (m, 2H, -CH_2-C<u>H$_2$</u>-O-CH_3), 3.38 (s, 3H, TBDMS-CH(C<u>H$_3$</u>)-CO), 1.63 – 1.48 (m, 51H, O-CH(C<u>H$_3$</u>)-CO), 1.47 – 1.39 (m, 3H, TBDMS-CH(C<u>H$_3$</u>)-CO), 0.90 (s, 9H, (C<u>H$_3$</u>)$_3$C-Si(CH_3)$_2$), 0.09

(dd, J = 9.1, 4.4 Hz, 6H, $(CH_3)_3C$-Si($C\underline{H}_3)_2$). ^{13}C NMR (100 MHz, $CDCl_3$) δ: 173.46, 170.04, 169.59, 169.39, 169.35, 77.24, 71.94, 70.61, 70.57, 70.52, 69.41, 69.31, 69.17, 68.99, 68.80, 68.14, 67.99, 64.43, 59.03, 53.44, 25.69, 21.27, 21.21, 18.27, 16.79, 16.75, 16.71, 16.65, -0.00, -4.91, -4.93, -5.30, -5.39. HRMS (MALDI-ToF): *m/z* calcd $C_{89}H_{150}O_{50}Si+Na^+$: 2069.88 $[M + Na]_+$, found 2070.91 as one of the most abundant peaks in the DCTB matrix. The dispersity of the block can be seen from the lower intensity peaks of 72.02 m/z more or less, corresponding to one lactic acid repeating unit.

DLLA$_{\sim16}$-EG$_{48}$

TBDMS-DLLA$_{\sim16}$-COOH **(5)** (80.4 mg, 0.05 mmol, 1.1 eq) was dissolved in dry DCM (1 mL, 0.04 M) in a 10 mL round bottom flask under an argon atmosphere. The solution was cooled to 0 ˚C in icewater and 4-(dimethylamino)pyridinium 4-toluenesulfonate (DPTS, 8.2 mg, 0.03 mmol, 0.6 eq) and *N*-(3-dimethylaminopropyl)-*N*'-ethylcarbodiimide hydrochloride (EDC·HCl, 21.6 mg, 0.11 mmol, 2.4 eq) were added. The mixture was stirred for 10 minutes until the solids were dissolved and the solution turned transparent, followed by the addition of the 48mer of poly(ethylene glycol) (*MeO-EO$_{48}$-OH,* 102 mg, 0.047 mmol, 1 eq). EG$_{48}$ was first dried overnight under vacuum over P_2O_5. The resulting solution was stirred overnight at room temperature. The conversion was checked by TLC analysis (DCM/MeOH 90:10; CeMo stain; $R_{f,product}$ = 0.55). The reaction mixture was diluted with DCM (2 mL) and washed with saturated $NaHCO_3$ solution (4 x 3 mL) and brine (1 x 3 mL). The resulting water layer was washed with DCM (2 x 4 mL). The organic layer was dried with $MgSO_4$ and concentrated in vacuo, giving the crude product. The crude product was purified using automated column chromatography by using DCM/MeOH (100/0 to 85/15) as eluent, giving product **DLLA$_{\sim16}$-EG$_{48}$** as a white solid (31.1 mg, 0.00911 mmol, 19%).

^1H NMR (400 MHz, $CDCl_3$) δ: 5.27 – 5.09 (m, 16H, O-C$\underline{H}$(CH_3)-CO), 4.40 (q, J = 7.1, 6.6 Hz, 1H, TBDMS-C$\underline{H}$(CH_3)-CO), 4.35 – 4.22 (m, 2H, m, 2H, CO-O-C$\underline{H}_2$-CH_2), 3.84 – 3.58 (m, 188H, -(($CH_2)_2$-$O)_{47}$-CH_3), 3.57 – 3.53 (m, 2H, CO-O-CH_2-C$\underline{H}_2$-), 3.38 (s, 3H, TBDMS-CH(C$\underline{H}_3$)-CO), 1.64 – 1.49 (m, 48H, m, 45H, O-CH(C$\underline{H}_3$)-CO), 1.47 – 1.41 (m, 3H, TBDMS-CH(C$\underline{H}_3$)-CO), 0.90 (s, 9H, ($C\underline{H}_3)_3$C-Si($CH_3)_2$), 0.09 (dd, J = 9.1, 4.4 Hz, 6H, $(CH_3)_3$C-Si($C\underline{H}_3)_2$). ^{13}C NMR (100 MHz, $CDCl_3$) δ: 173.42, 170.01, 169.57, 169.32, 77.29, 71.92, 71.28, 70.55, 69.39, 69.30, 69.15, 68.98, 68.78, 68.50, 68.13, 67.97, 64.41, 59.01, 53.45, 30.31, 29.66, 25.68, 21.25, 21.19, 18.25, 16.73, 16.63, -0.01, -4.92, -5.31, -5.39. HRMS (MALDI-ToF): *m/z* calcd $C_{151}H_{274}O_{81}Si+Na^+$: 3434.69 $[M + Na]_+$, found 3437.71 as one of the most abundant peaks in the DCTB matrix; *m/z* calcd $C_{151}H_{274}O_{81}Si+K^+$: 3450.67 $[M + K]_+$, found 3452.67 as one of the most abundant peaks in the DCTB matrix. The dispersity of the block can be seen from the lower intensity peaks of 72.02 m/z more or less, corresponding to one lactic acid repeating unit.

HO-LLA$_{\sim16}$-EG$_{11}$ ($\mathbf{7}_{y=11}$)

MeO-EO$_{11}$-OH (0.45 g, 0.8 mmol, 1 eq) and L-lactide (**6**) (1 g, 6.9 mmol, 8eq) were dissolved at rt in 7 mL DCM and DBU (65 µL, 0.4 mmol, 0.5 eq) was added. The reaction mixture was stirred at room temperature under argon atmosphere until full conversion (1 h). The reaction mixture was diluted with more DCM and washed twice with 1 M $KHSO_4$ and brine. After drying over Na_2SO_4 $\mathbf{7}_{y=11}$ was precipitated using cold diethyl ether yield 0.5 g (34%) of crude $\mathbf{7}_{y=11}$ which was used as such in the next step.

HO-LLA$_{\sim16}$-EG$_{17}$ ($\mathbf{7}_{y=17}$)

MeO-EO$_{17}$-OH (0.677 g, 0.8 mmol, 1 eq) and L-lactide (**6**) (1 g, 6.9 mmol, 8eq) were dissolved at rt in 7 mL DCM and DBU (65 µL, 0.4 mmol, 0.5 eq) was added. The reaction mixture was stirred at rt under argon atmosphere until full conversion (1 h). The reaction mixture was diluted with more DCM and washed twice with 1 M $KHSO_4$ and brine. After drying over Na_2SO_4 **7** was precipitated using cold diethyl ether yielding 0.86 g (51%) of crude **7** which was used as such in the next step.

LLA$_{\sim16}$-EG$_{11}$

7$_{y = 11}$ (0.5g, 0.29 mmol, 1eq) was dissolved in dry DMF and TBDMS-Cl (17 mg, 0.11 mmol, 1.2 eq) and imidazole (16 mg, 0.23 mmmol, 2.5 eq) were added. The reaction mixture was left to stir overnight at room temperature. Subsequently DMF was evaporated and the crude was redissolved in DCM and purified using automated column chromatography (eluent: DCM/MeOH; gradient 100:00 to 80:20 over 20 CV). The molar mass dispersity *Đ* of several tubes was determined using ^{1}H-NMR and only tubes containing the correct *Đ* were combined yielding pure product **LLA$_{\sim 16}$-EG$_{11}$** (160 mg, 0.09 mmol, 11%).

^{1}H NMR (399 MHz, Chloroform-*d*) δ 5.16 (q, *J* = 7.0 Hz, 16H), 4.39 (q, *J* = 6.7 Hz, 1H), 4.28 (dt, *J* = 13.0, 4.8 Hz, 2H), 3.71 – 3.60 (m, 40H), 3.58 – 3.51 (m, 2H), 3.37 (s, 3H), 1.62 – 1.47 (m, 48H), 1.47 – 1.40 (m, 3H), 0.90 (s, 9H), 0.09 (d, *J* = 9.4 Hz, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 173.67, 170.18, 170.13, 169.87, 169.74, 169.67, 125.65, 100.13, 77.48, 77.36, 77.16, 76.84, 72.08, 70.76, 70.72, 70.67, 69.37, 69.15, 68.95, 68.68, 68.14, 64.58, 59.18, 36.62, 30.47, 25.84, 21.36, 18.42, 16.94, 16.89, 16.82, 16.79, -4.77, -5.16. HRMS (MALDI-ToF) *m/z* calcd $C_{77}H_{126}O_{44}Si+Na^+$: 1805.72 [M + Na]$^+$, found 1805.74 as one of the abundant peaks in the DCTB matrix. The dispersity of the block can be seen from the lower intensity peaks of 144.04 m/z more or less, corresponding to two lactic acid repeating units.

LLA$_{\sim 16}$-EG$_{17}$

7$_{y = 17}$ (0.86 g, 0.44 mmol, 1 eq) was dissolved in dry DMF (0.6 mL) and TBDMS-Cl (80 mg, 0.55 mmol, 1.2 eq) and imidazole (76 mg, 1.11 mmol, 2.5 eq) were added. The reaction mixture was left to stir overnight at room temperature. Subsequently DMF was evaporated and the crude was redissolved in DCM and purified using automated column chromatography (eluent: DCM/MeOH; gradient 100:00 to 80:20 over 20 CV). The molar mass dispersity *Đ* of several tubes was determined using ^{1}H-NMR and only tubes containing the correct *Đ* were combined yielding pure product **LLA$_{\sim 16}$-EG$_{17}$** (492 mg, 0.23 mmol, 52%).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 5.23 – 5.08 (m, 15H), 4.39 (q, *J* = 6.7 Hz, 1H), 4.34 – 4.21 (m, 2H), 3.78 – 3.60 (m, 64H), 3.59 – 3.51 (m, 2H), 3.38 (s, 3H), 1.62 – 1.48 (m, 46H), 1.48 – 1.40 (m, 7H), 0.90 (s, 10H), 0.09 (d, *J* = 9.3 Hz, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 173.52, 170.02, 169.98, 169.71, 169.63, 169.59, 169.51, 77.25, 71.93, 70.61, 70.56, 70.51, 69.22, 69.04, 68.99, 68.95, 68.80, 68.53, 67.99, 64.43, 59.03, 25.69, 21.21, 18.27, 16.79, 16.74, 16.67, 16.64, -0.00, -4.91, -5.30.HRMS (MALDI-ToF) *m/z* calcd $C_{77}H_{126}O_{44}Si+Na^+$: 2069.88 [M + Na]+, found 2070.9 as one of the abundant peaks in the DCTB matrix. The dispersity of the block can be seen from the lower intensity peaks of 144.04 m/z more or less, corresponding to two lactic acid repeating units.

HO-LLA$_{\sim 16}$-OBn (9)

Benzyl alcohol (0.93 g, 8.7 mmol, 1 eq) and L-lactide (**1**) (10 g, 69 mmol, 8eq) were dissolved at rt in 10 mL DCM and DBU (10 µL, 73 mmol, 8 eq) was added. The reaction mixture was stirred at rt under argon atmosphere until full conversion (1 h). The reaction mixture was diluted with DCM and washed twice with 1 M $KHSO_4$ and brine. After drying over Na_2SO_4 **9** was obtained (10.533 g, 96%).

^{1}H NMR (400 MHz, $CDCl_3$) δ: 7.34 (q, J = 8.3, 7.8 Hz, 5H), 5.30 (s, 4H), 5.16 (q, J = 7.2 Hz, 18H), 4.35 (q, J = 6.9 Hz, 1H), 1.58 (d, J = 7.1 Hz, 41H), 1.55 - 1.42 (m, 11H))

TBDMS-LLA$_{\sim 16}$-OBn (10)

Disperse OH-LLA16-Bn (**9**) (10.38 g, 8.23 mmol, 1 eq) was dissolved in dry *N,N*-dimethylformamide (DMF) (90 mL) under argon atmosphere in a 250 mL 2-necked round-bottom flask (dried overnight in the oven at 140°C). *tert*-Butyldimethylsilyl chloride (TBDMS-Cl) (1.49 g, 9.877 mmol, 1.2 eq) and imidazole (1.40 g, 20.5 mmol, 2.5 eq) were added and the resulting solution was stirred overnight at ambient temperature. The reaction was followed by TLC analysis (eluent: heptane/ethyl acetate – 50:50; CeMo stain, R_f, product = smear between 0.38-0.83). The mixture was poured into saturated $NaHCO_3$ (200 mL) and extracted with dichloromethane (DCM) (3 x 100 mL). The organic layers were dried over

MgSO4 and concentrated in vacuo, giving the crude product as a light yellow solid (7.47 g). The crude product was purified by column chromatography (eluent: heptane/ethyl acetate; gradient 90:10 to 30:70 over 10 CV). From column chromatography only 660 mg pure product was obtained (white solid), since the product crystallized in the column. The remainder was tried to be purified by precipitation over cold pentane. The longer chains precipitated, giving 743 mg of pure product **(10)** as a white solid. The shorter chains were purified by automated column chromatography (eluent: heptane/ethyl acetate; gradient 90:10 to 40:60 over 20 CV), giving 252 mg of pure product as a yellow oil. (Combined, 1.6063 g, 1.168 mmol, 14%)

^{1}H-NMR (400 MHz, CDCl3) δ: 7.39 – 7.28 (m, 5H, Ar-H), 5.25 – 5.08 (m, 19H, O-CH(CH_3)-CO and Ar-CH_2-O), 4.40 (q, J = 6.8 Hz, 1H, TBDMS-CH(CH_3)-CO), 1.63 – 1.46 (m, 52H, O-CH(CH_3)-CO), 1.45 (d, J = 6.8 Hz, 3H, TBDMS-CH(CH_3)-CO), 0.90 (s, 9H, (CH_3)$_3$C-Si(CH_3)$_2$), 0.14 – 0.04 (dd, 6H, (CH_3)$_3$C-Si(CH_3)$_2$). ^{13}C-NMR (101 MHz, $CDCl_3$) δ: 173.53, 169.99, 169.89, 169.72, 169.59, 169.52, 135.06, 128.62, 128.53, 128.24, 77.32, 77.21, 77.01, 76.69, 69.28, 69.00, 68.81, 68.53, 68.00, 67.22, 54.33, 53.42, 53.24, 25.70, 21.22, 18.28, 16.75, 16.65, 16.57, 1.13, -0.00, -4.91, -5.30. HRMS (MALDI-TOF): m/z calcd for $C_{61}H_{86}O_{33}Si+Na^+$: 1397.47 $[M+Na]^+$, found 1397.50 as one of the most abundant peaks in the DCTB matrix. The dispersity of the block can be seen from the lower intensity peaks of approximately 72.03 m/z, corresponding to one lactic acid repeating unit.

TBDMS-LLA$_{\sim 16}$-OH (11)

Disperse *TBDMS-LLA$_{\sim 16}$-Bn* (**10**) (271 mg, 0.197 mmol, 1 eq) was dissolved in ethyl acetate (1.25 mL) in a 50 mL round-bottom flask. The solution was purged with nitrogen for 10 minutes. Palladium on carbon 10 wt. % (4.4 mg, 0.041 mmol, 0.2 eq) was added and the black solution was stirred overnight under hydrogen atmosphere at ambient temperature. The reaction was followed by TLC analysis (eluent: heptane/ethyl acetate – 50:50; CeMo stain, R_f, product = smear between 0.0 – 0.25). The solution was filtered over celite and the filter cake was washed with ethyl acetate (100 mL). The transparent solution was concentrated in vacuo and product **(11)** was obtained as a white solid (174 mg, 0.136 mmol, 69%).

^{1}H-NMR (400 MHz, $CDCl_3$) δ: 5.16 (m, J = 8.8, 7.9, 5.8 Hz, 19H, O-CH(CH3), 4.40 (q, J = 6.7 Hz, 1H, TBDMS-CH(CH_3)-CO), 1.58 (m, J = 7.2 Hz, 57H, O-CH(CH_3)-CO), 1.45 (d, J = 6.8 Hz, 3H, TBDMS-CH(CH_3)-CO), 0.90 (s, 9H, (CH_3)$_3$C-Si(CH_3)$_2$), 0.10 (d, J = 9.3 Hz, 6H). ^{13}C-NMR (101 MHz, $CDCl_3$) δ: 169.67, 169.62, 77.33, 77.22, 77.02, 76.70, 69.02, 68.83, 68.55, 68.01, 60.43, 53.43, 25.70, 21.22, 21.06, 18.29, 16.75, 16.68, 16.65, 16.59, 14.20, 0.00, -4.91, -5.30. HRMS (MALDI-TOF): m/z calcd for $C_{54}H_{80}O_{33}Si+Na^+$: 1307.43 $[M+Na]^+$, found 1307.45 as one of the most abundant peaks in the DCTB matrix; m/z calcd $C^{54}H^{80}O^{33}Si+K^+$: 1323.54 $[M + K]^+$, found 1323.44 as one of the most abundant peaks in the DCTB matrix. The dispersity of the block can be seen from the lower intensity peaks of approximately 72.02 m/z, corresponding to one lactic acid repeating unit.

LLA$_{\sim 16}$-EG$_{48}$

MeO-EG_{48}-OH and DPTS were dried overnight in the vacuum oven, over P_2O_5, at 40°C. TBDMS-LLA$_{\sim 16}$-OH (**11**) (73.8 mg, 0.057 mmol, 1.06 eq) was dissolved in dry DCM (250 µL, 0.15 M) at 0°C in ice water, under argon atmosphere in a 1 mL flask (dried overnight in the oven at 140°C). DPTS (7.9 mg, 0.027 mmol, 0.5 eq) and EDC·HCl (20.8 mg, 0.108 mmol, 2 eq) were added. After 30 minutes (when fully dissolved), *MeO-EG$_{48}$-OH* (116.3 mg, 0.054 mmol, 1 eq) dissolved in dry DCM (100 µL) was added. The solution was taken out of the ice water and stirred overnight at ambient temperature with a balloon filled with N_2 gas on the reaction, to prevent evaporation of the solvent. The reaction was followed by TLC analysis (eluent: DCM/methanol – 90:10; CeMo stain, R_f, product = 0.6). The solution was diluted with DCM (4 mL) and washed with saturated $NaHCO_3$ (3 x 3 mL), followed by brine (3 mL). The organic layer was dried over $MgSO_4$ and concentrated in vacuo, giving the crude as a white solid. The crude product was purified by column chromatography (eluent: DCM/methanol; gradient 100:00 to 85:15 over 25 CV), obtaining pure product **LLA$_{\sim 16}$-EG$_{48}$** (25.5 mg, 0.007 mmol, 14%).

^{1}H-NMR (400 MHz, $CDCl_3$) δ: 5.17 (q, J = 7.0 Hz, 13H, O-C<u>H</u>(CH_3)-CO), 4.40 (q, J = 6.8 Hz, 1H, TBDMS-C<u>H</u>(CH_3)-CO), 4.36 – 4.21 (m, 2H, CO-O-C<u>H_2</u>-CH_2), 3.64 (s, 155H, -((CH_2)$_2$-O)$_{47}$-CH_3), 3.58 – 3.50 (m, 2H, CO-O-CH_2-C<u>H_2</u>-), 3.38 (s, 2H, TBDMS-CH(C<u>H_3</u>)-CO), 1.62 – 1.48 (m, 41H, O-CH(C<u>H_3</u>)-CO), 1.45 (d, J = 6.7 Hz, 3H, TBDMS-CH(C<u>H_3</u>)-CO), 0.90 (s, 9H, (C<u>H_3</u>)$_3$C-Si(CH_3)$_2$), 0.11 – 0.06 (m, 6H, (CH_3)$_3$C-Si(C<u>H_3</u>)$_2$). ^{13}C-NMR (101 MHz, $CDCl_3$) δ: 173.54, 169.74, 169.61, 77.35, 77.23, 77.03, 76.71, 71.95, 70.62, 70.58, 70.53, 69.23, 69.01, 68.81, 68.54, 68.00, 64.44, 59.05, 29.70, 25.70, 21.22, 18.28, 16.80, 16.75, 16.65, 1.02, 0.00, -4.91, -5.30. HRMS (MALDI-TOF): m/z calcd for $C_{151}H_{274}O_{81}Si+Na^+$: 3436.85 $[M+Na]^+$, found 3435.72.45 as one of the most abundant peaks in the DCTB matrix; The dispersity of the block can be seen from the lower intensity peaks of approximately 72.01 m/z, corresponding to one lactic acid repeating unit.

3 Supporting characterization Figures

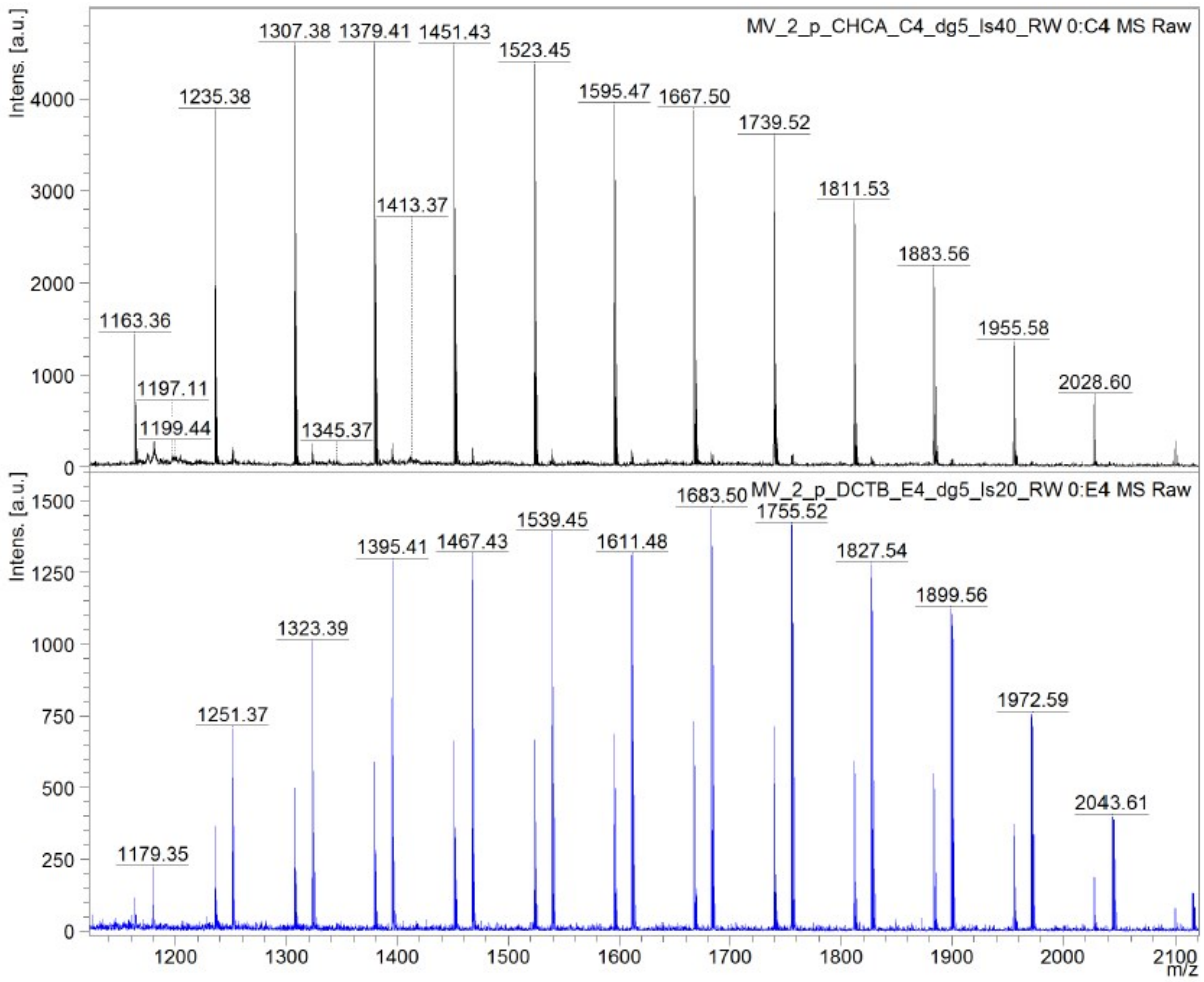


Figure S1 MALDI-ToF MS of TBDMS-DLLA$_{\sim 16}$-OH (5)

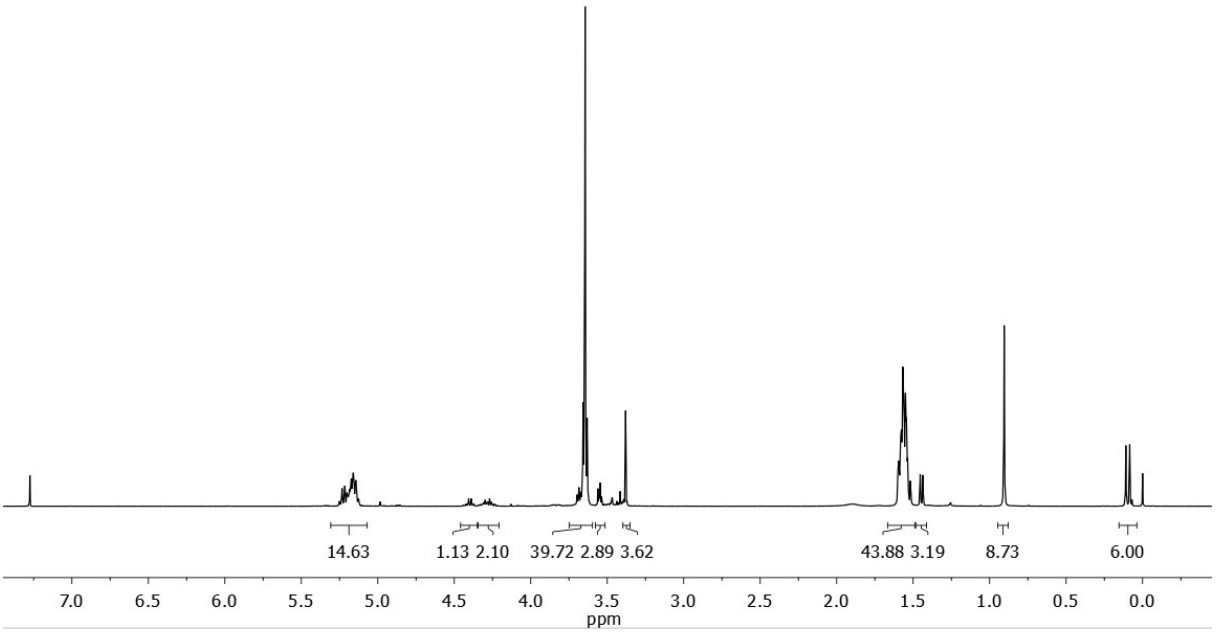


Figure S2 ^{1}H NMR spectrum for **DL**$\mathbf{LA_{16}EG_{11}}$.

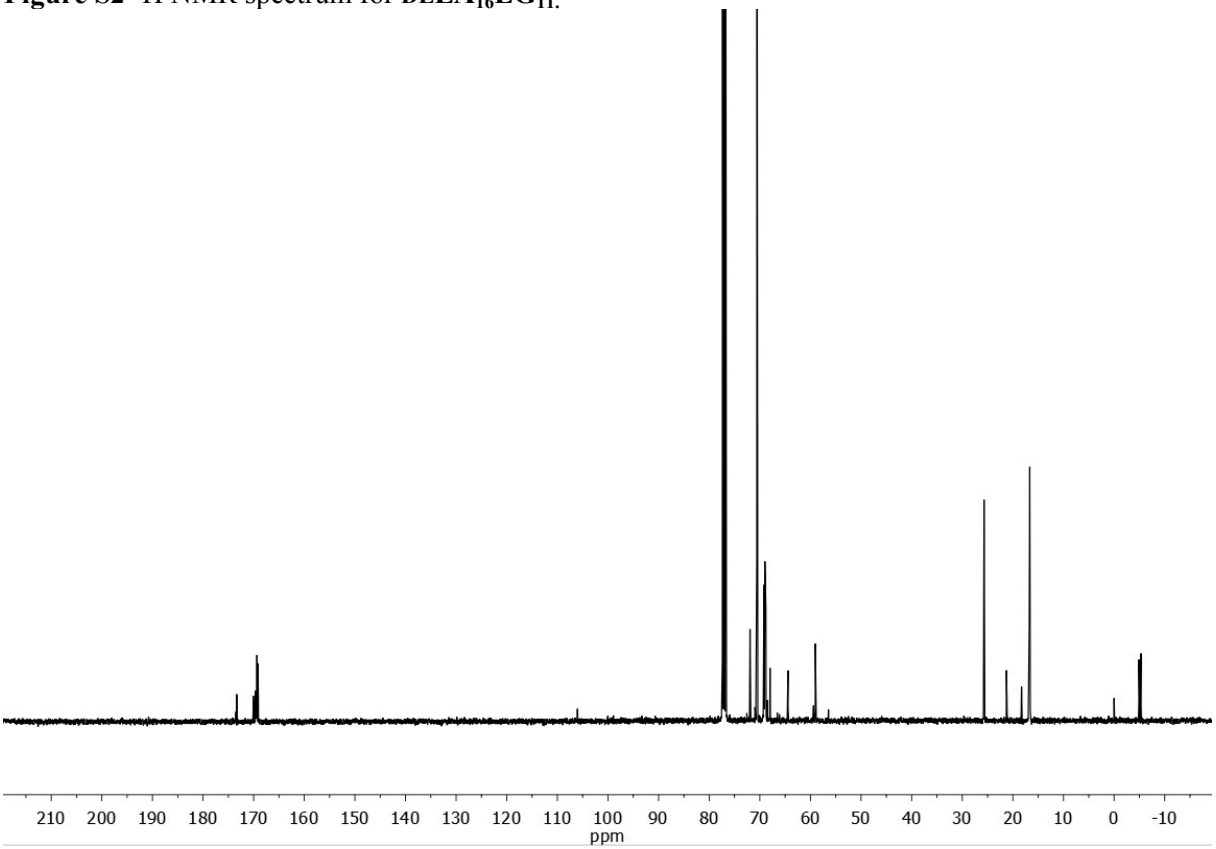


Figure S3 ^{13}C NMR spectrum for **DL**$\mathbf{LA_{16}EG_{11}}$.

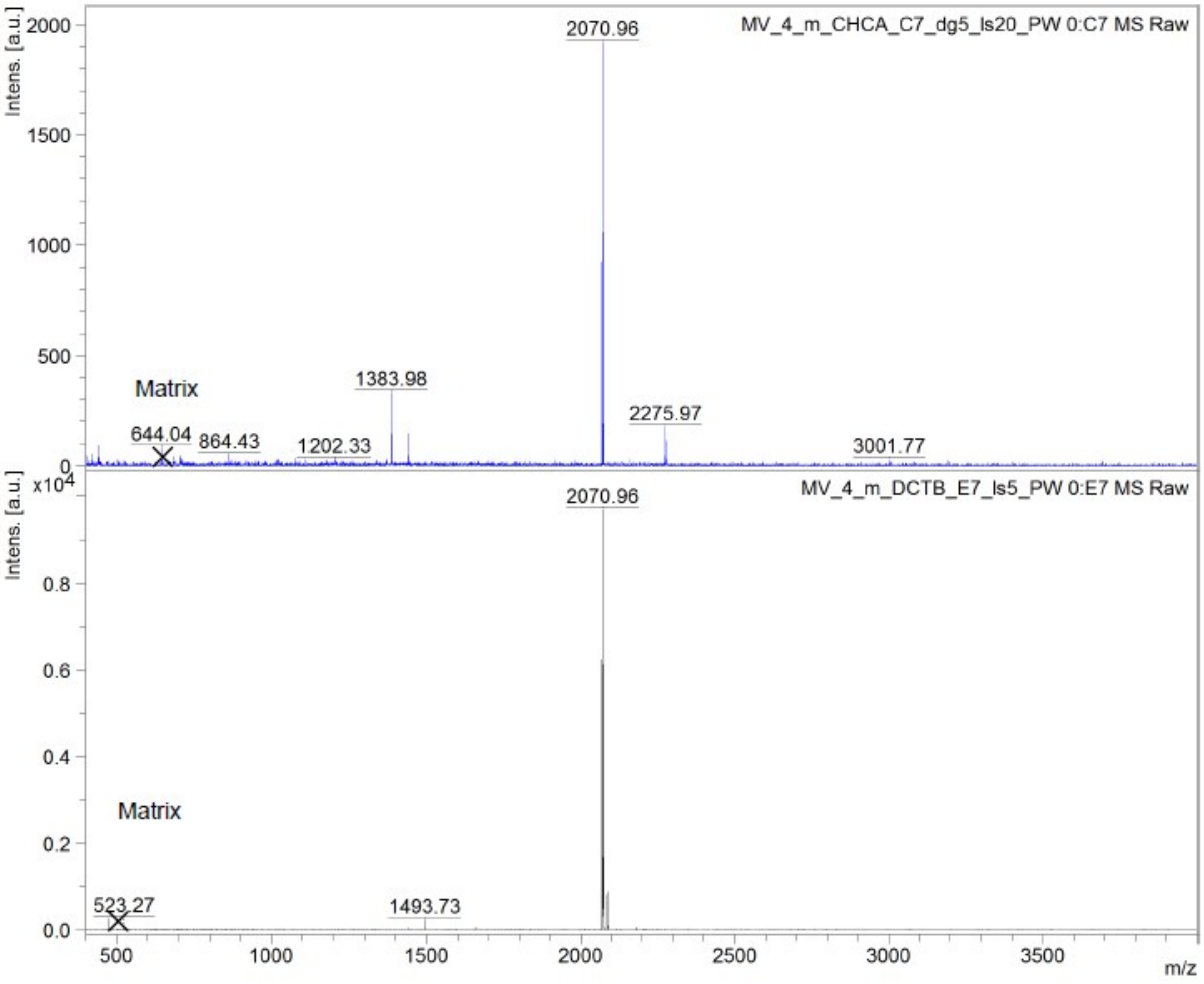


Figure S4 MALDI-ToF MS of **DLLA$_{16}$EG$_{17}$**.

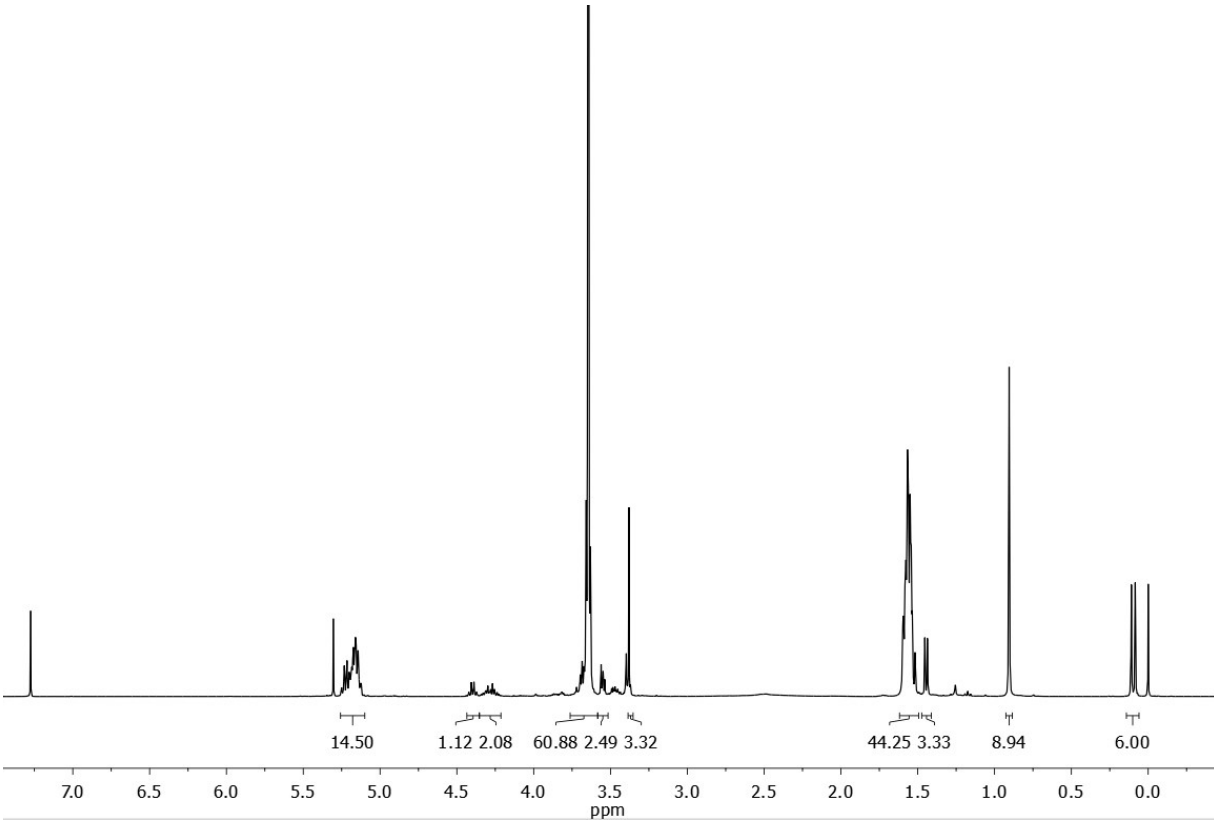


Figure S5 ^{1}H NMR spectrum for **DL$LA_{16}EG_{17}$**.

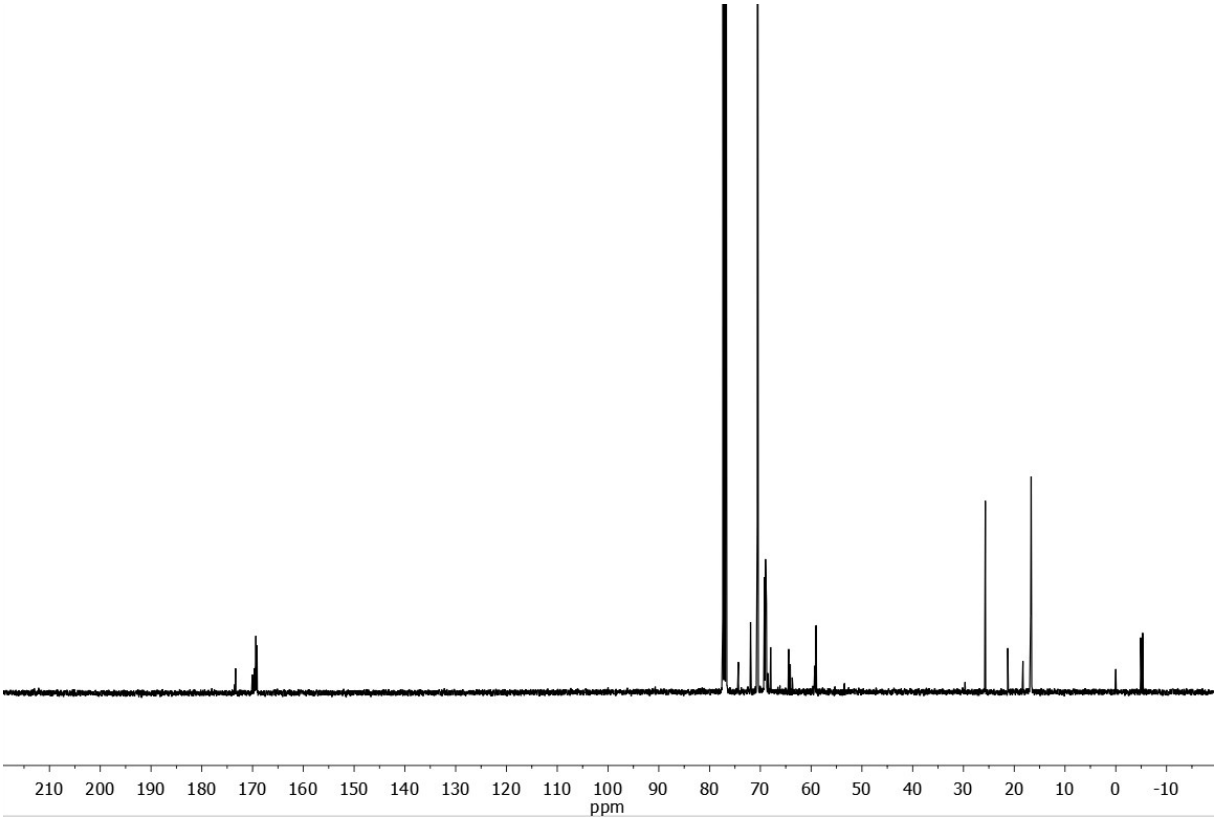


Figure S6 ^{13}C NMR spectrum for **DL$LA_{16}EG_{17}$**.

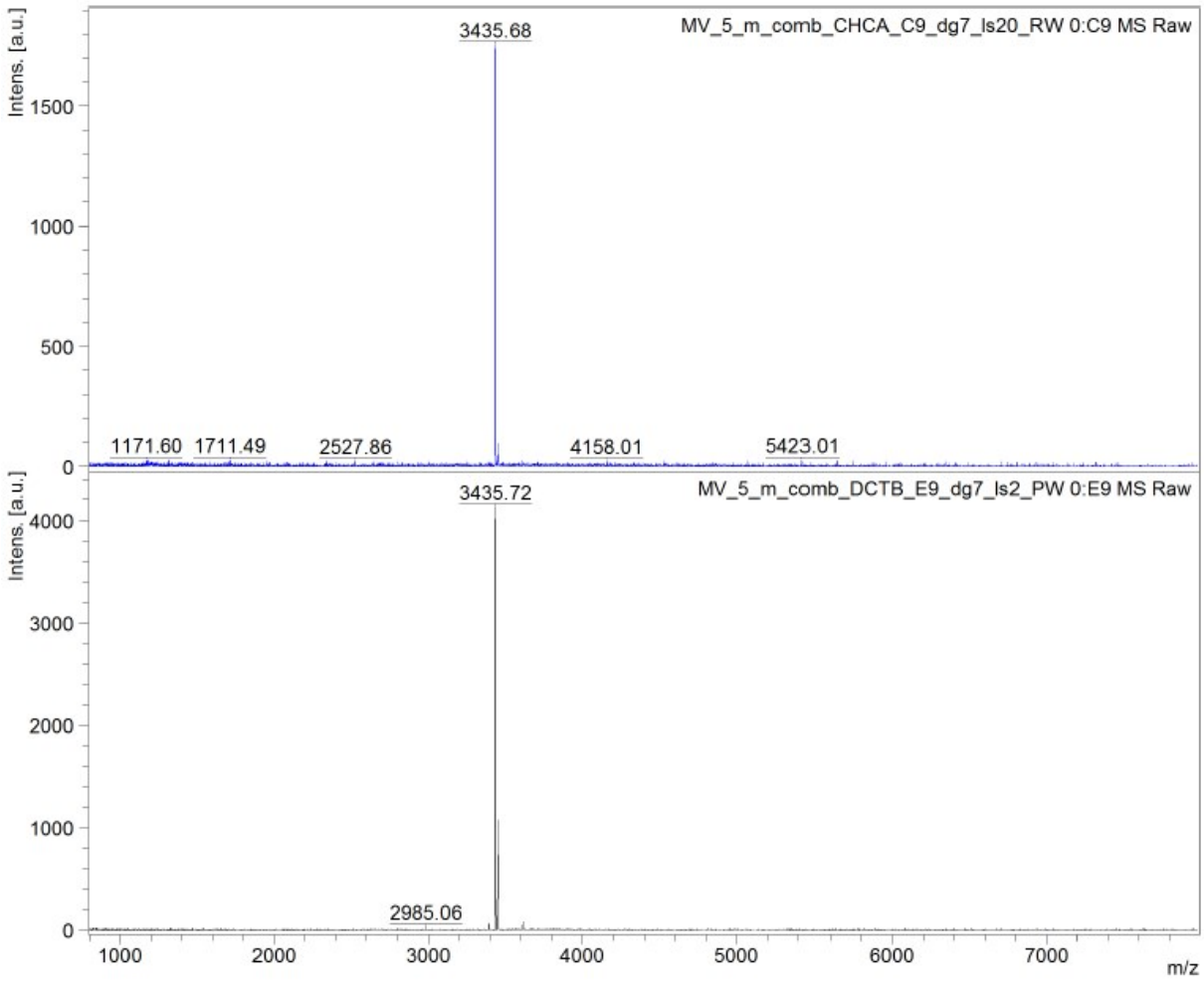


Figure S7 MALDI-ToF MS of **DLLA$_{16}$EG$_{48}$**.

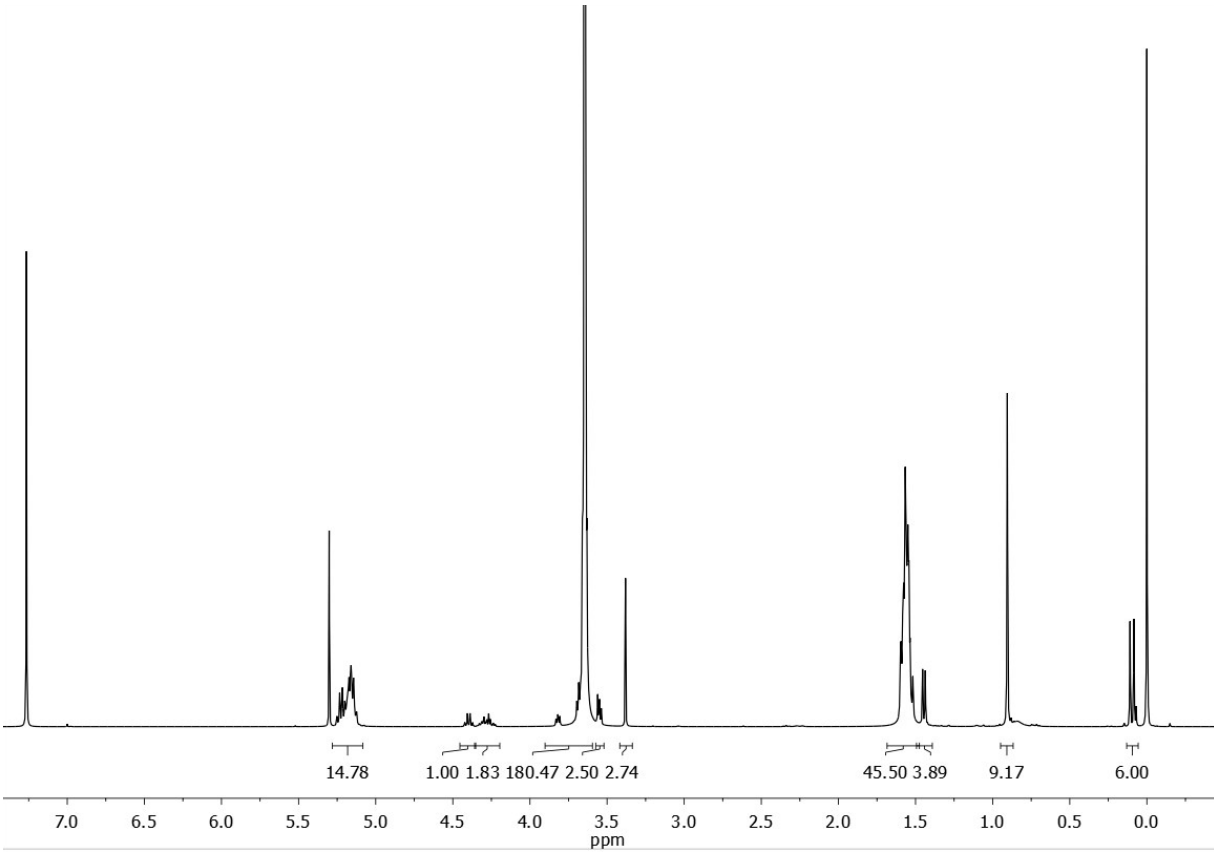


Figure S8 ^{1}H NMR spectrum for **DL**$\mathbf{LA_{16}EG_{48}}$.

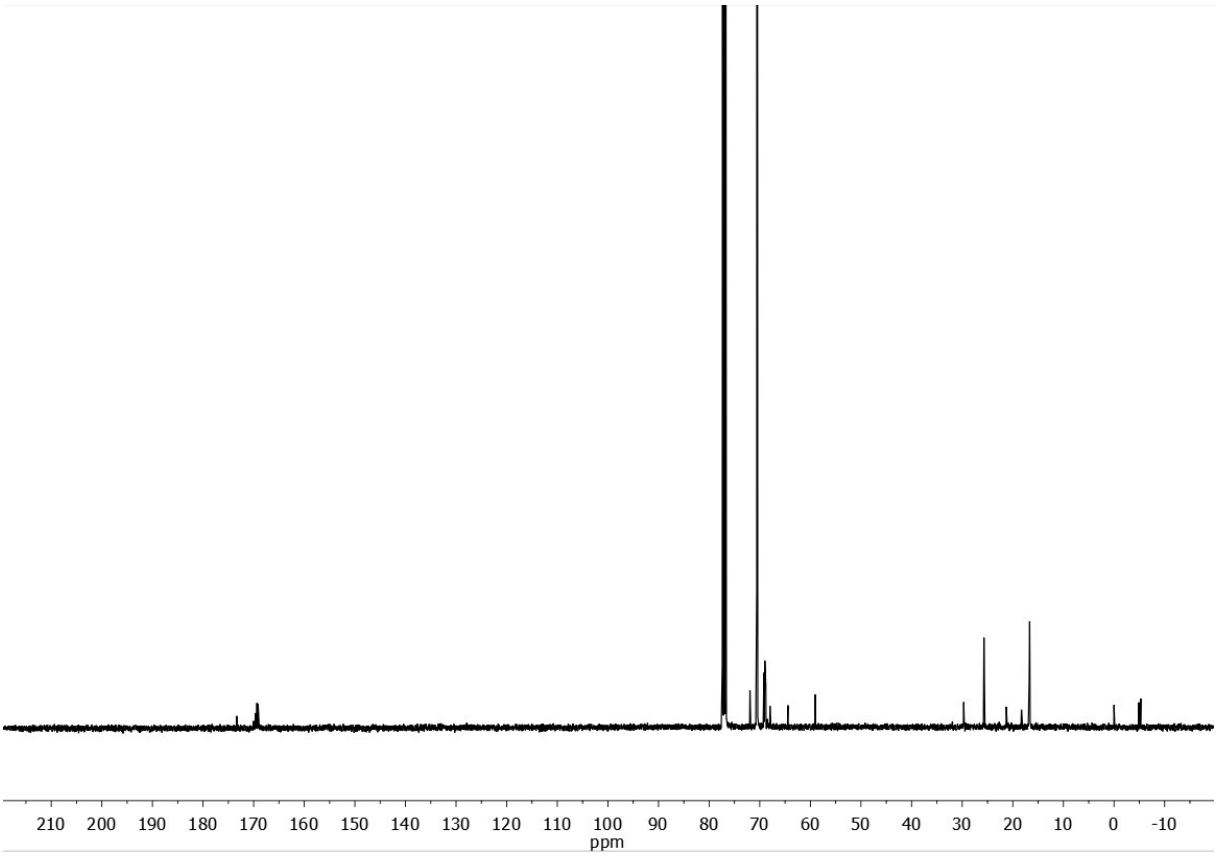


Figure S9 ^{13}C NMR spectrum for **DL**$\mathbf{LA_{16}EG_{48}}$.

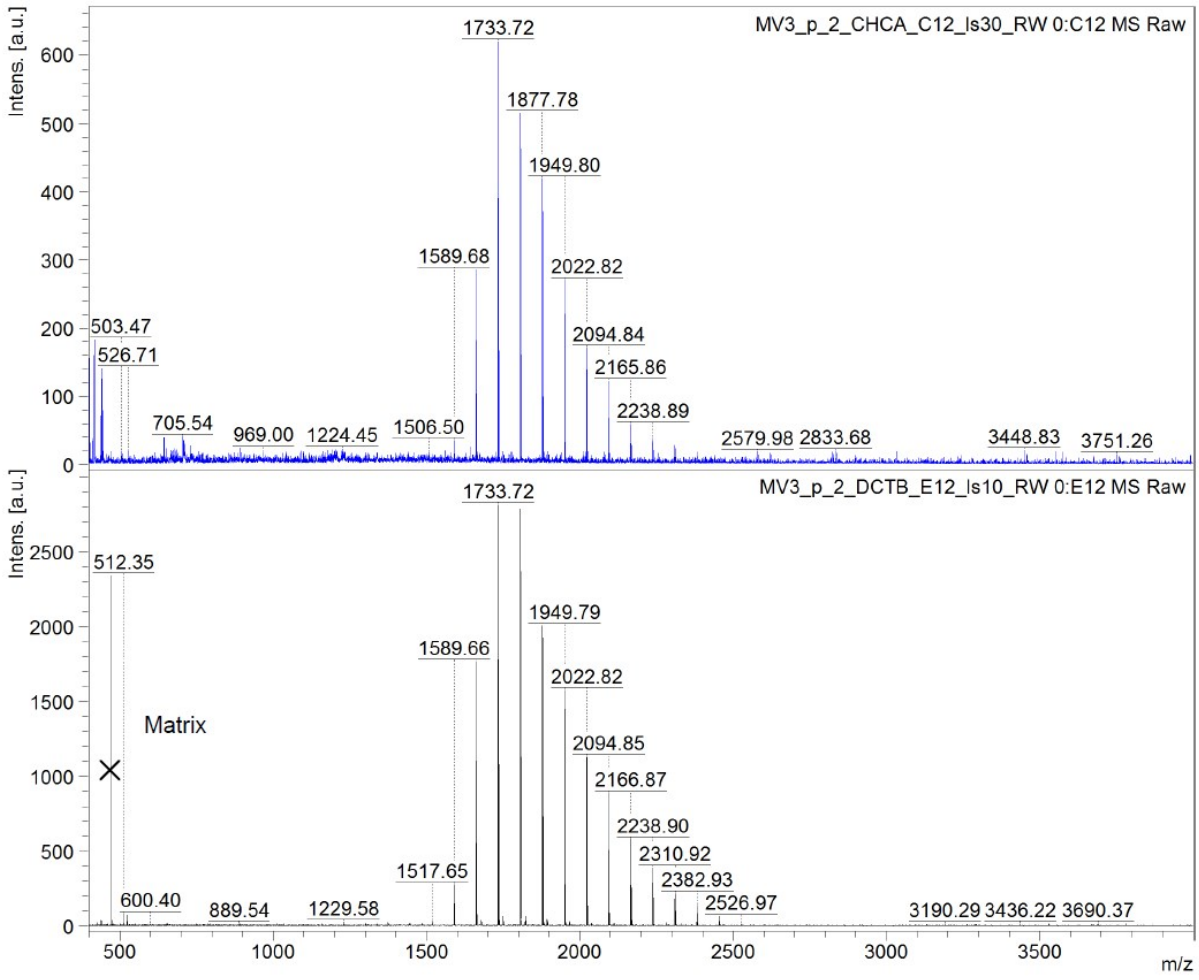


Figure S10 MALDI-ToF MS of **DLLA$_{\sim 16}$EG$_{11}$**.

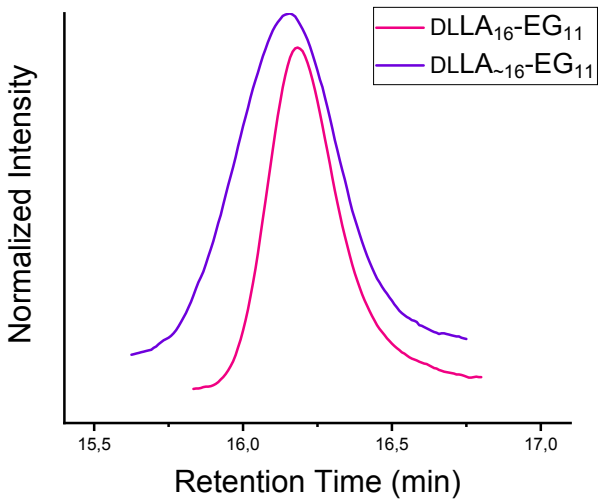


Figure S11 SEC traces (RI) of **DLLA$_{16}$EG$_{11}$** and **DLLA$_{\sim 16}$EG$_{11}$**. Data is shifted vertically for clarity.

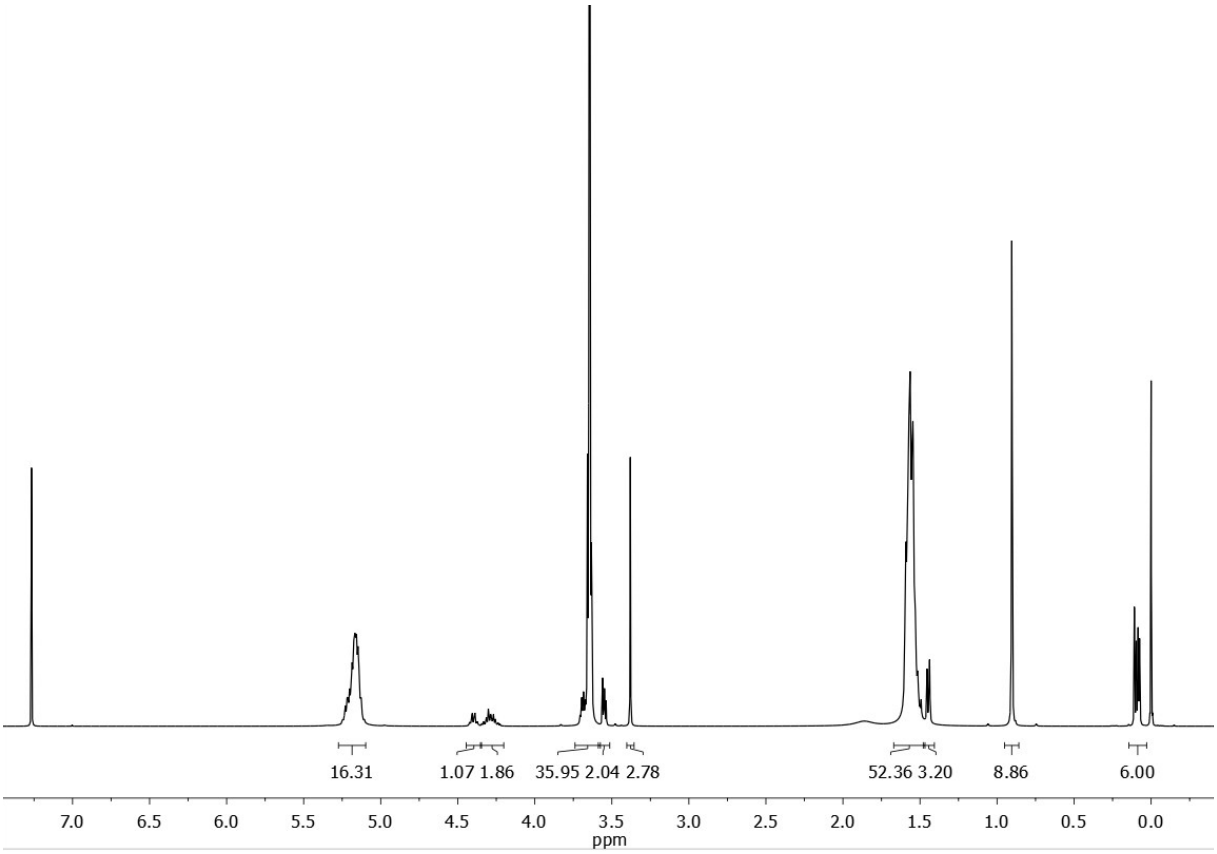


Figure S12 ^{1}H NMR spectrum for **DL**$\mathbf{LA_{\sim 16}EG_{11}}$.

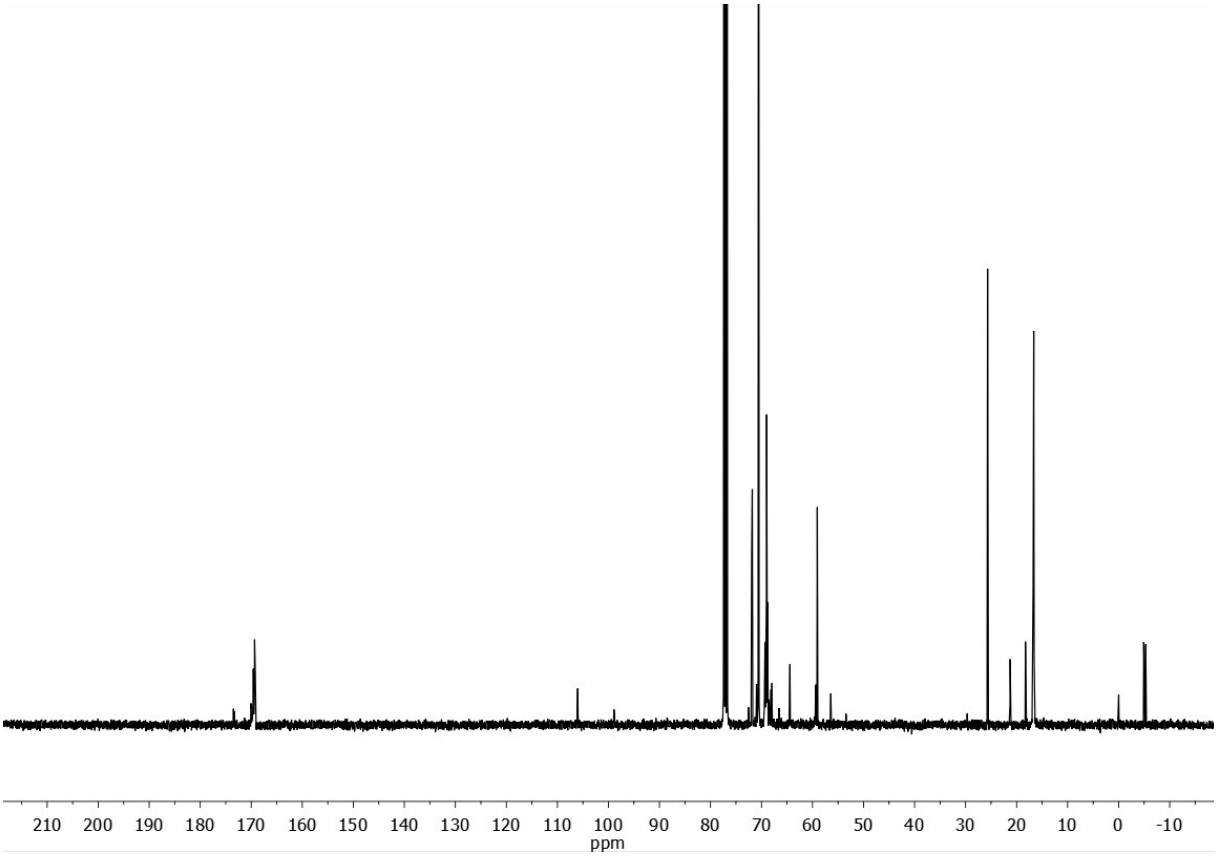


Figure S13 ^{13}C NMR spectrum for **DL**$\mathbf{LA_{\sim 16}EG_{11}}$.

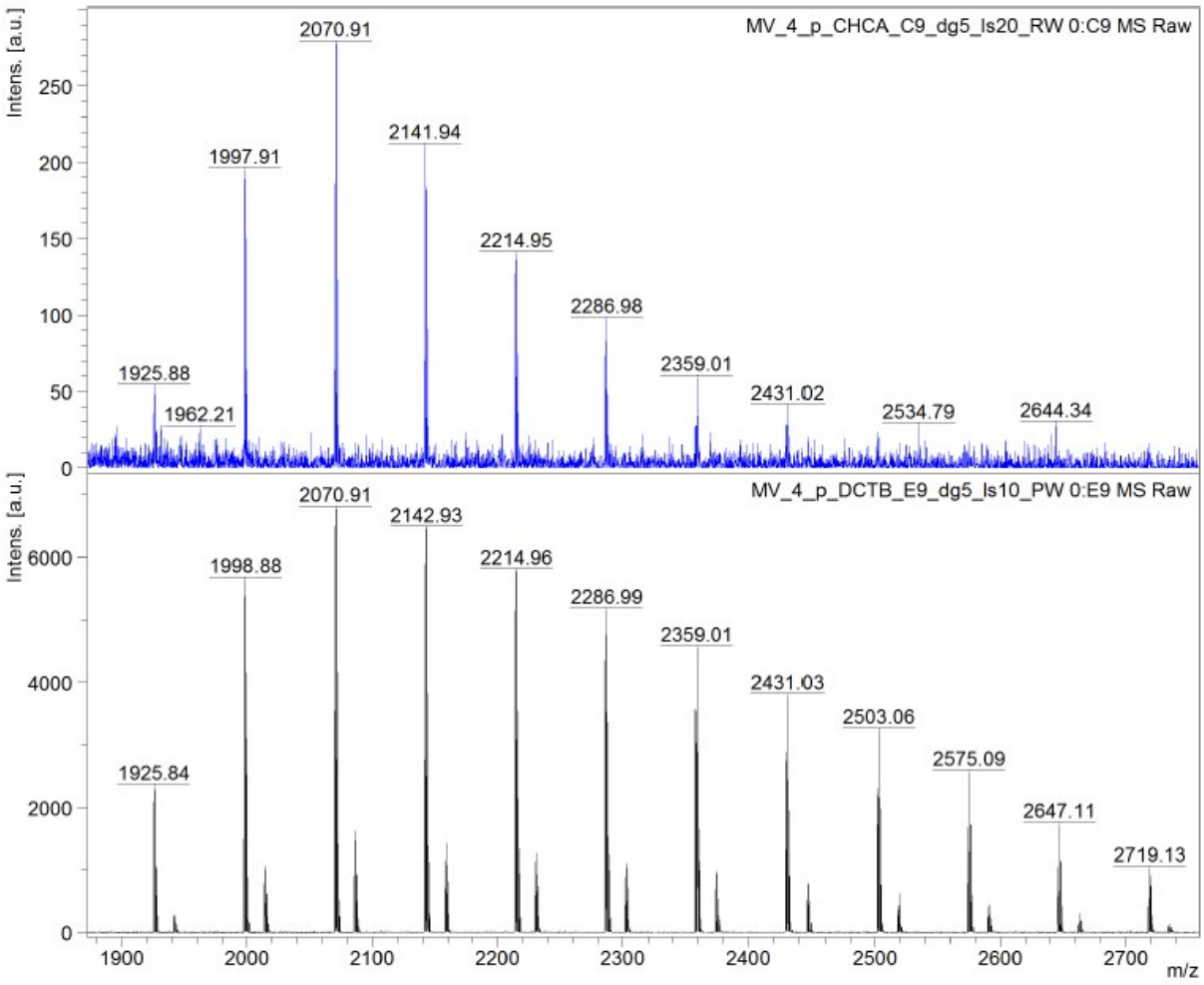


Figure S14 MALDI-ToF MS of **DLLA**$_{\sim 16}$**EG**$_{17}$.

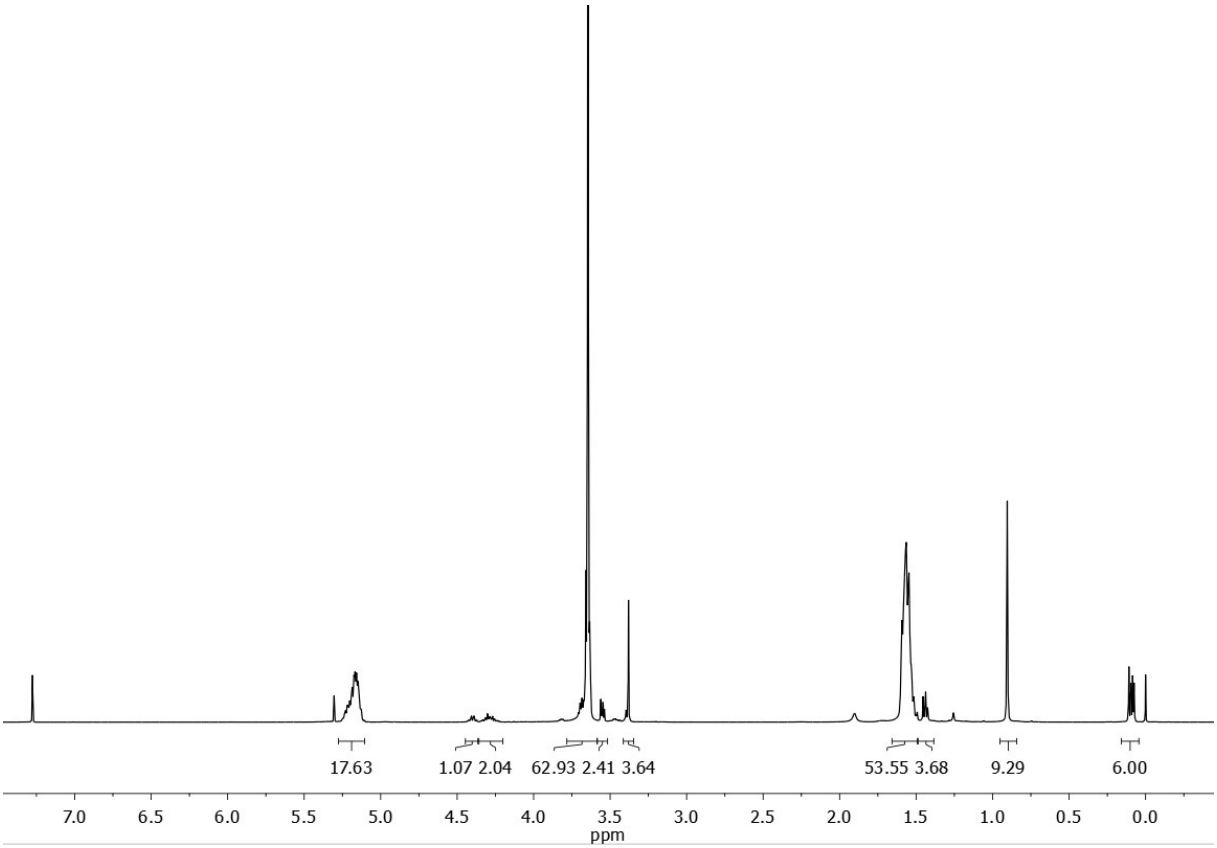


Figure S15 ^{1}H NMR spectrum for **DL**$\mathbf{LA_{\sim 16}EG_{17}}$.

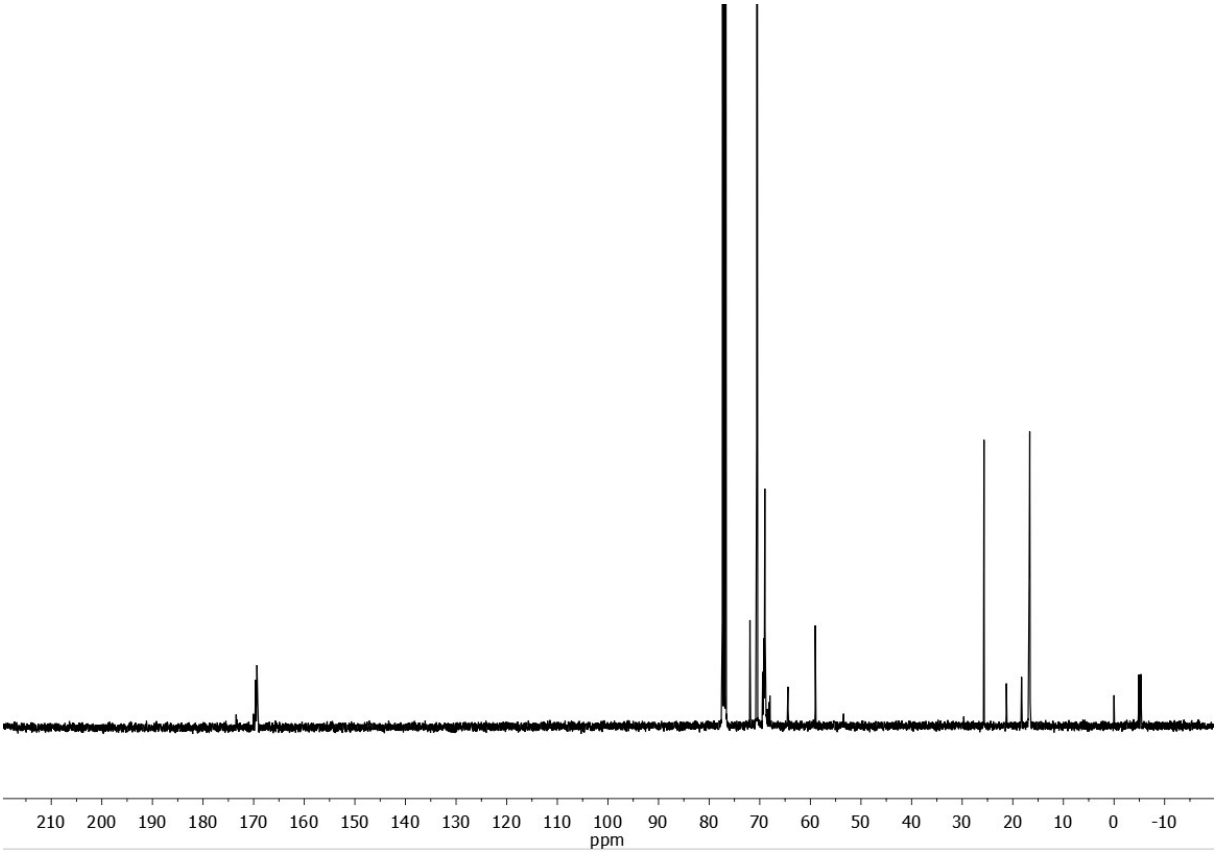


Figure S16 ^{13}C NMR spectrum for **DL**$\mathbf{LA_{\sim 16}EG_{17}}$.

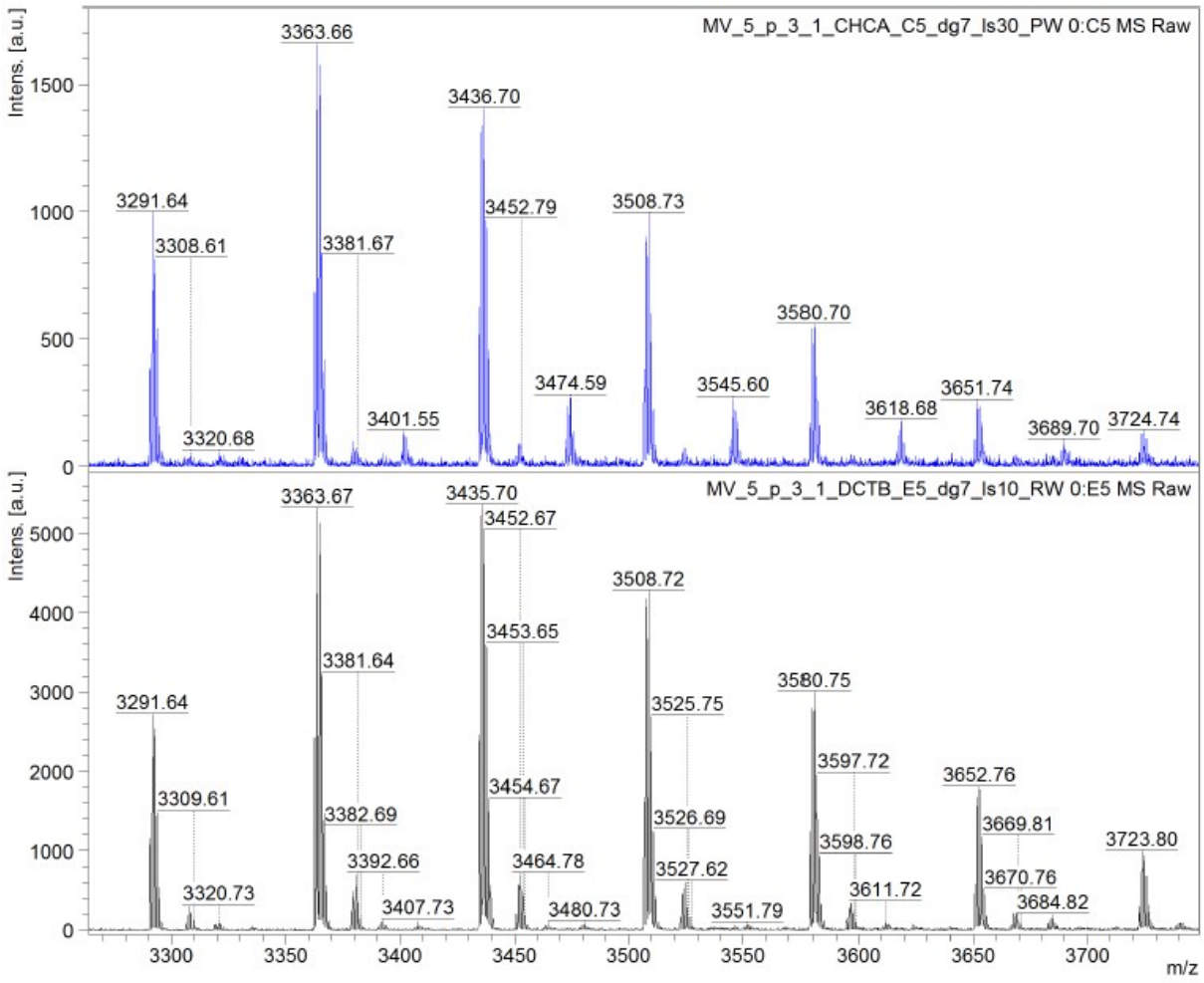


Figure S17 MALDI-ToF MS of **DLLA**$_{\sim 16}$**EG**$_{48}$.

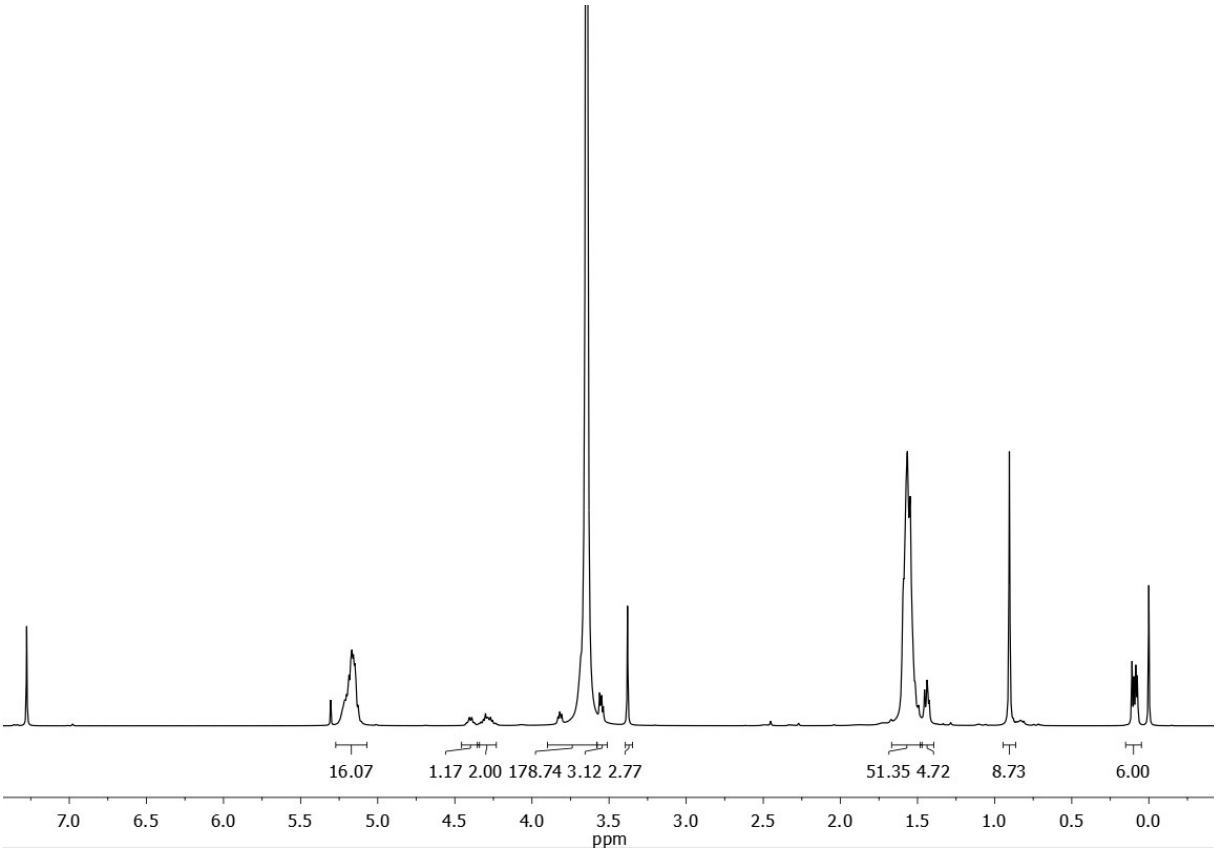


Figure S18 ^{1}H NMR spectrum for **DL**$\mathbf{LA_{\sim 16}EG_{48}}$.

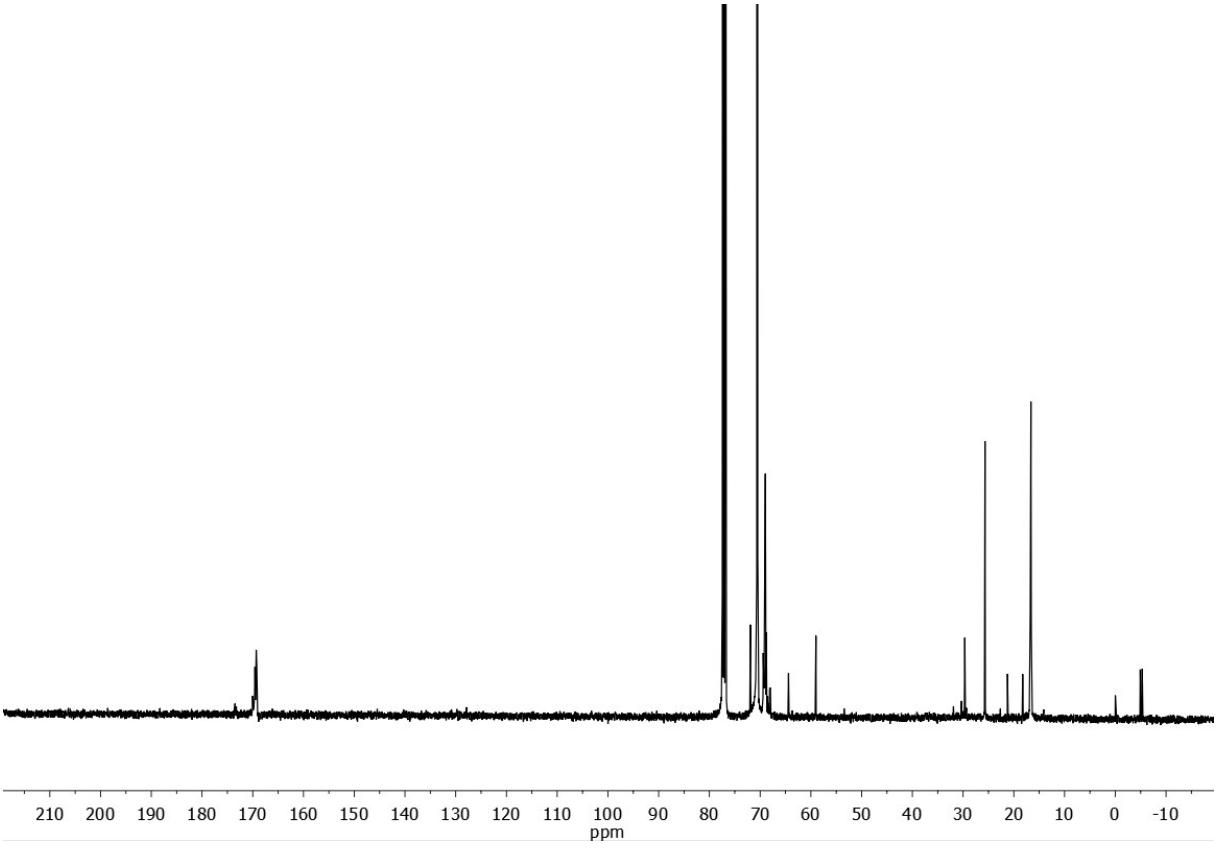


Figure S19 ^{13}C NMR spectrum for **DL**$\mathbf{LA_{\sim 16}EG_{48}}$.

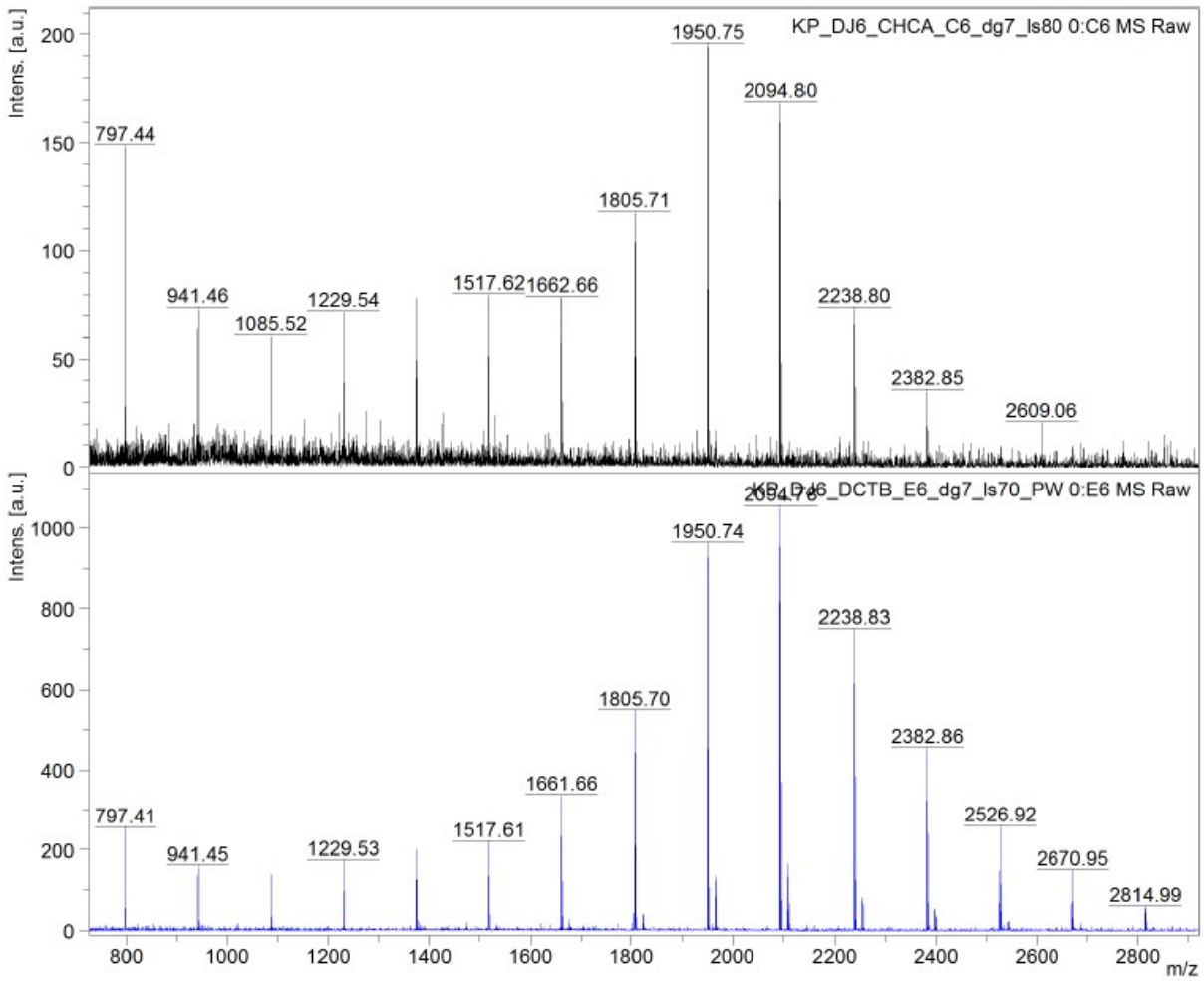


Figure S20 MALDI-ToF MS of **LLA$_{\sim 16}$EG$_{11}$**.

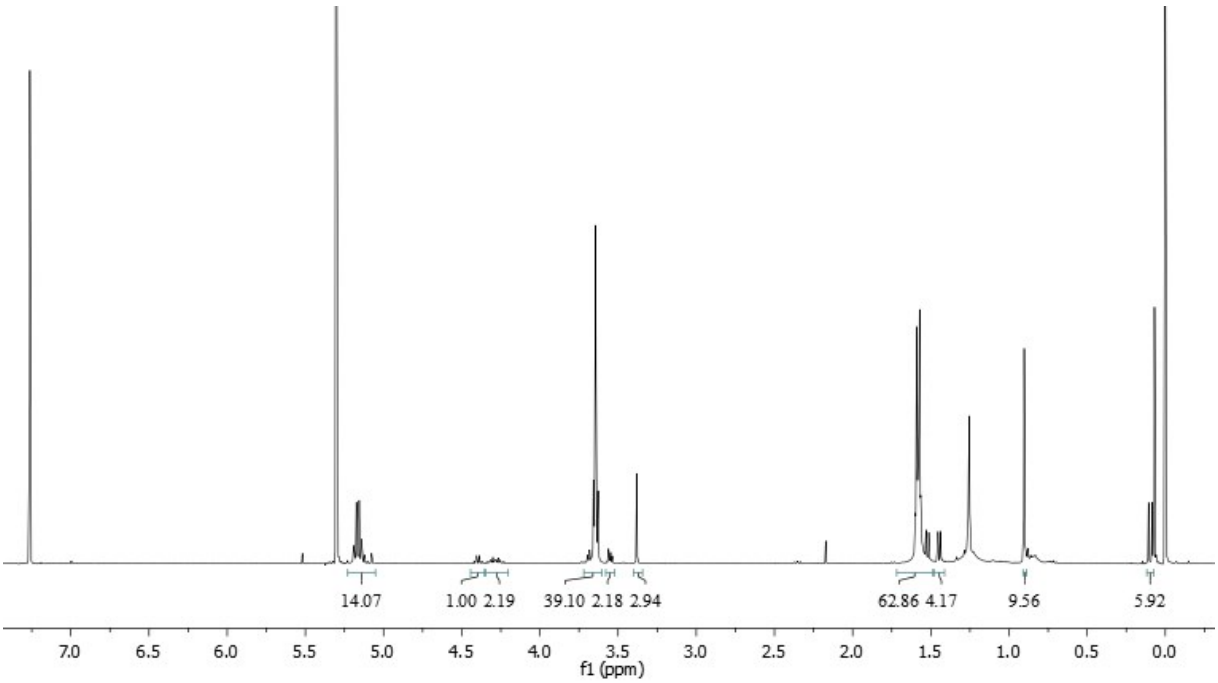


Figure S21 ^{1}H NMR spectrum for **LLA$_{\sim 16}$EG$_{11}$.**

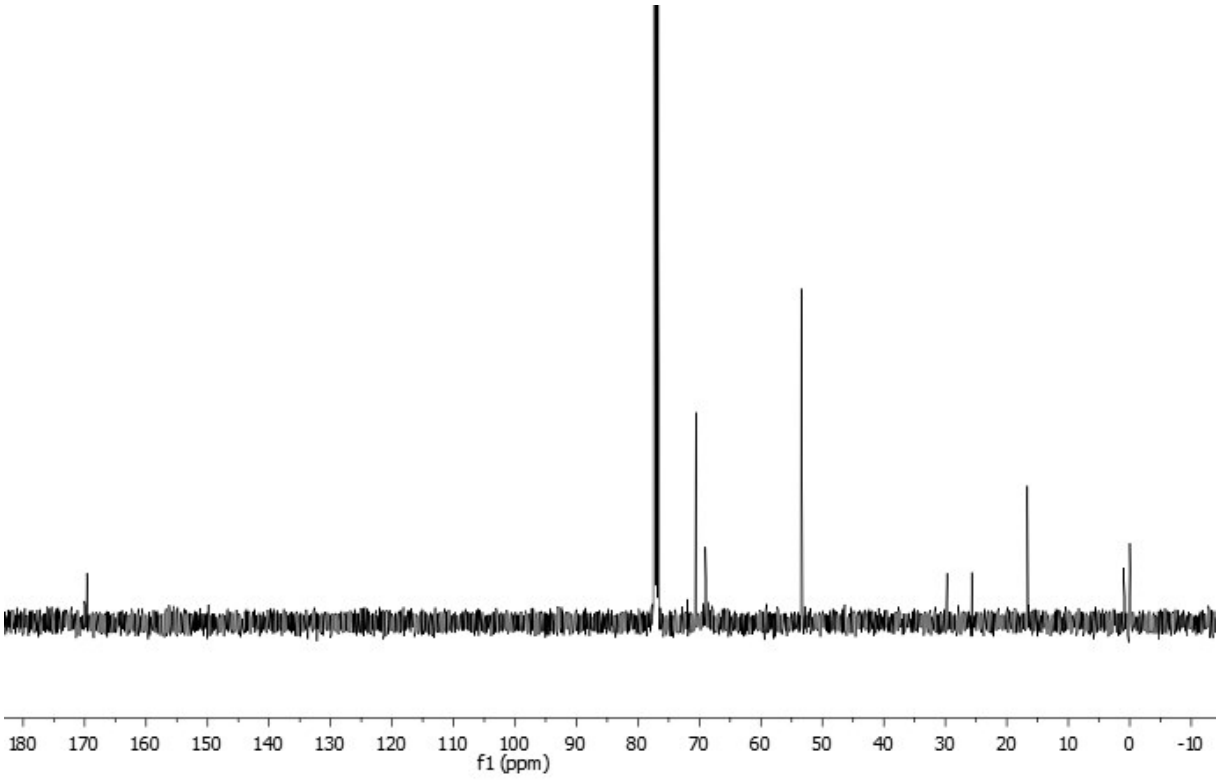


Figure S22 ^{13}C NMR spectrum for **LLA$_{\sim 16}$EG$_{11}$.**

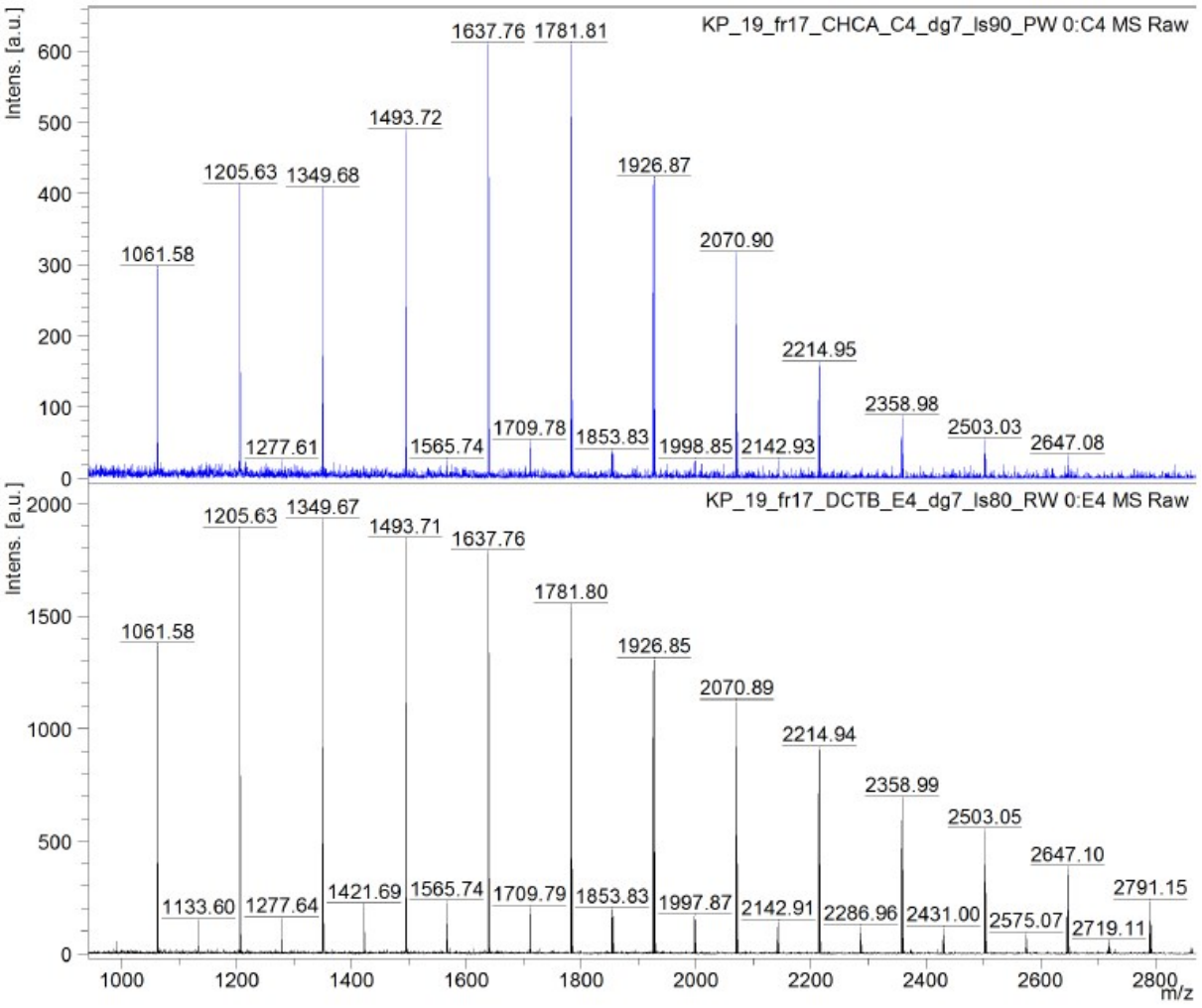


Figure S23 MALDI-ToF MS of **LLA$_{\sim 16}$EG$_{17}$**.

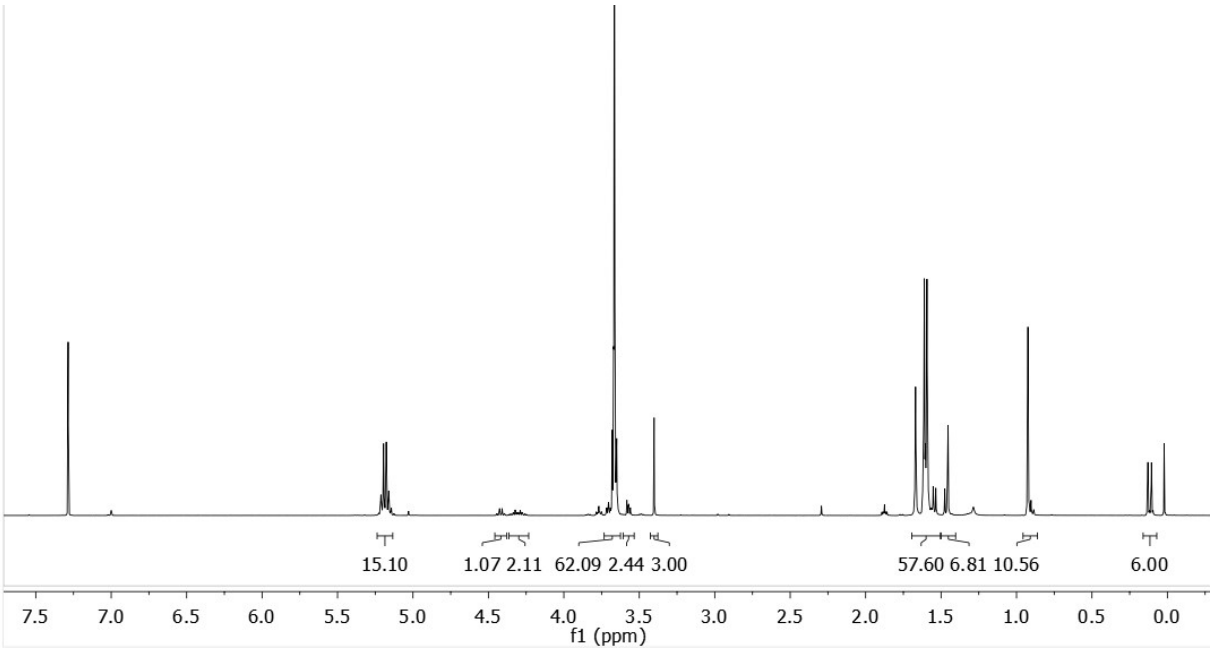


Figure S24 ^{1}H NMR spectrum for **LLA$_{\sim 16}$EG$_{17}$**.

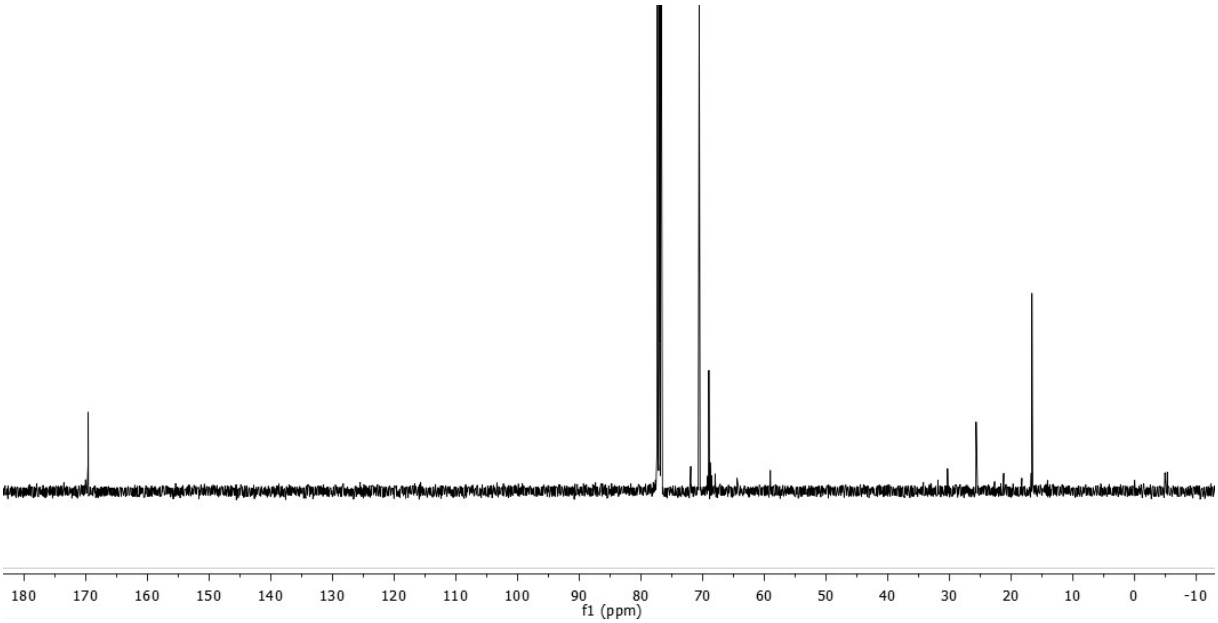


Figure S25 ^{13}C NMR spectrum for **LLA$_{\sim 16}$EG$_{17}$.**

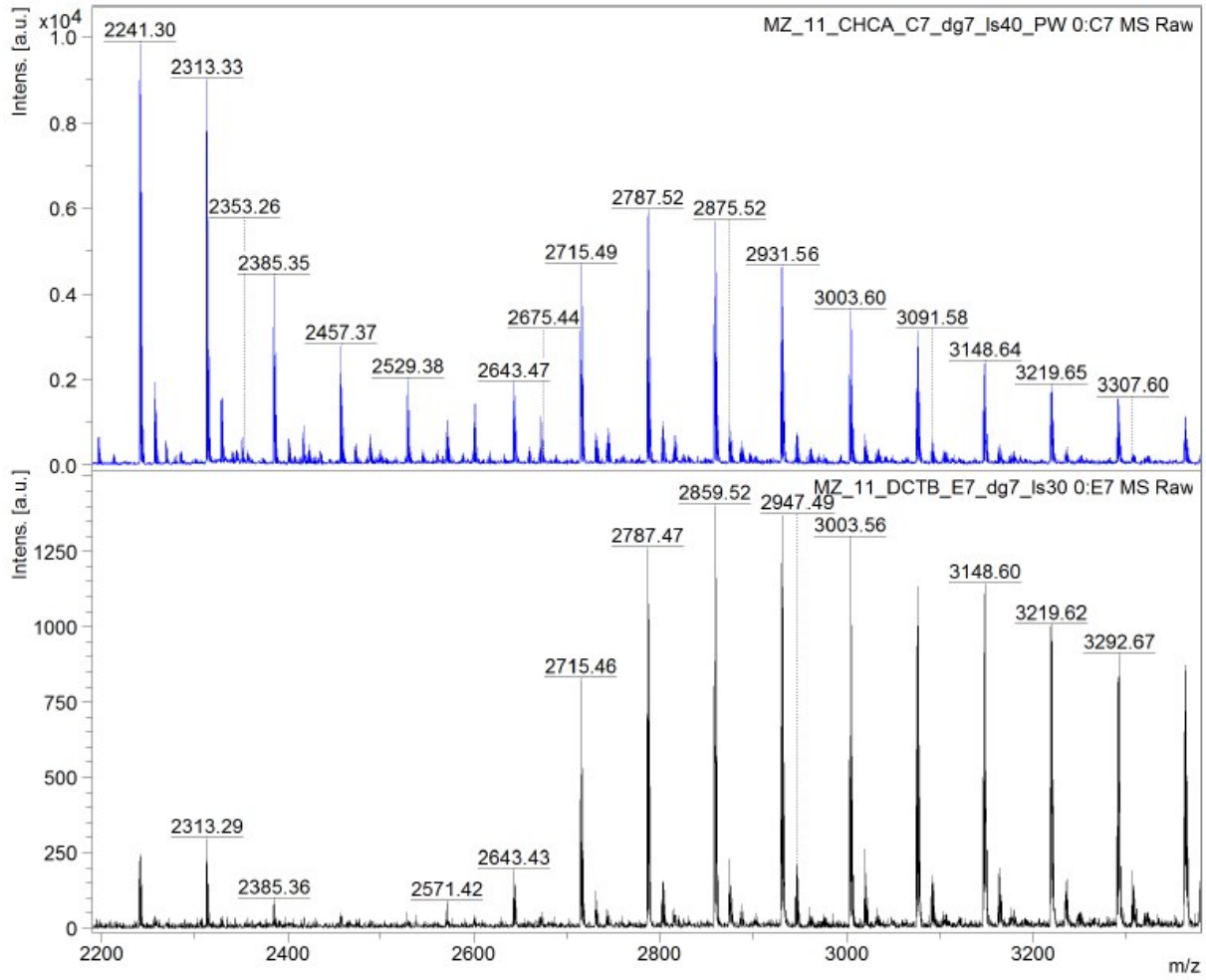


Figure S26 MALDI-ToF MS of **LLA$_{\sim 16}$EG$_{48}$.**

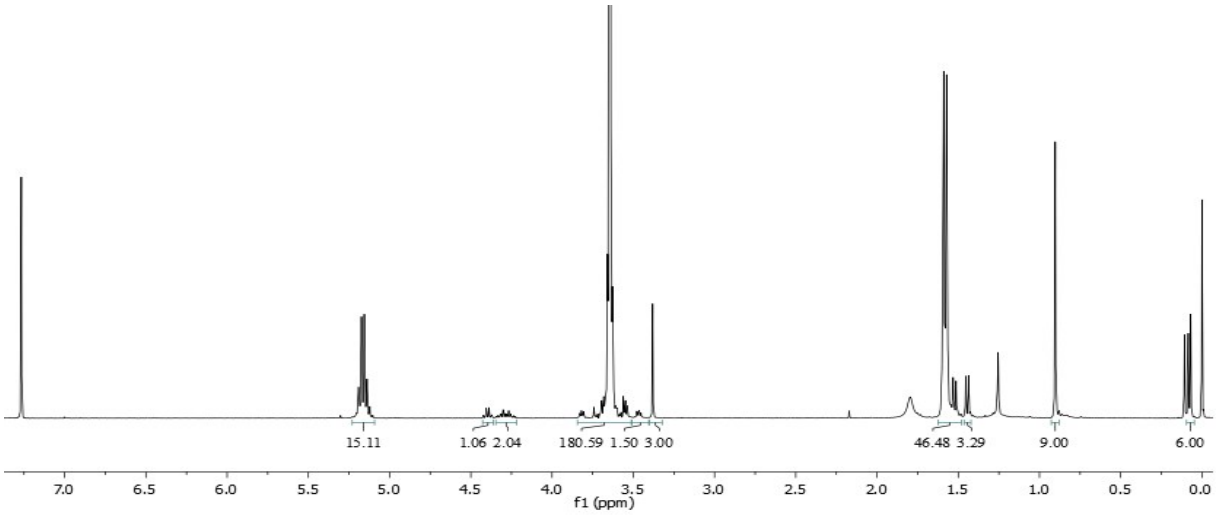


Figure S27 ^{1}H NMR spectrum for **LLA$_{\sim 16}$EG$_{48}$.**

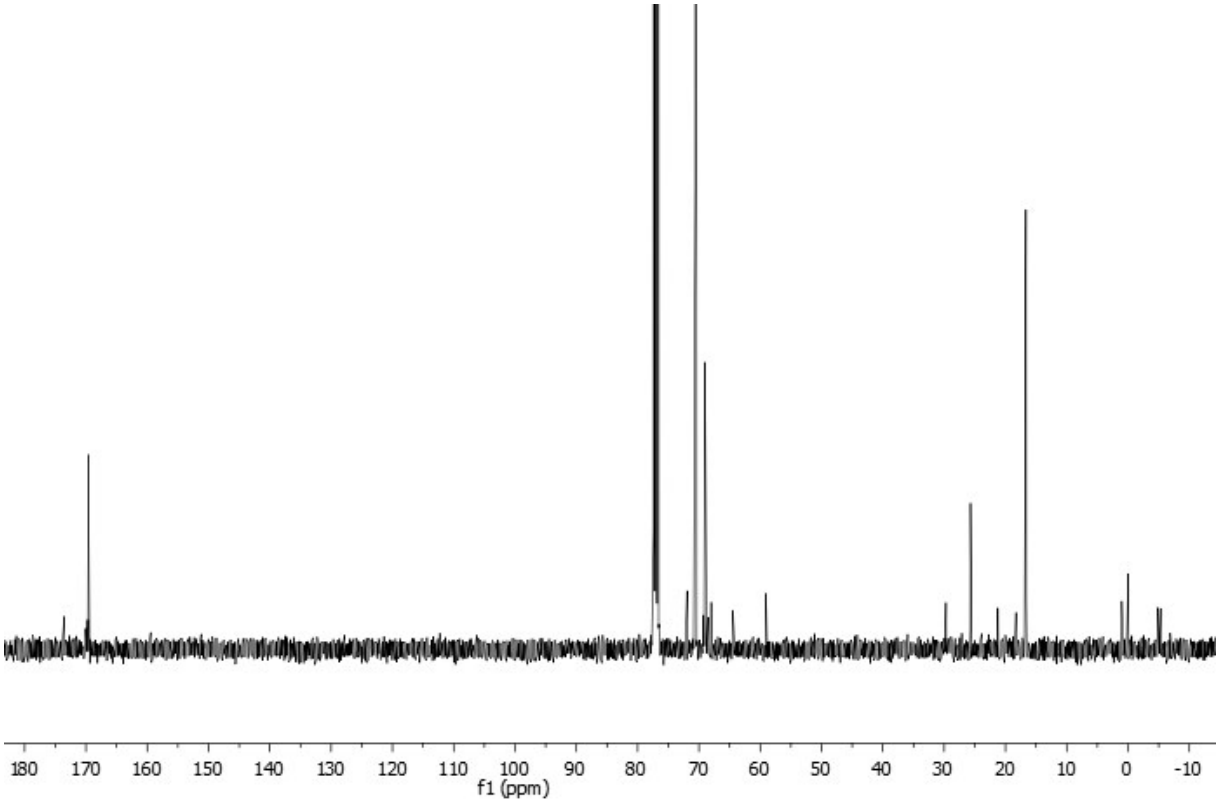


Figure S28 ^{13}C NMR spectrum for **LLA$_{\sim 16}$EG$_{48}$.**

4. Bulk properties of BCOs

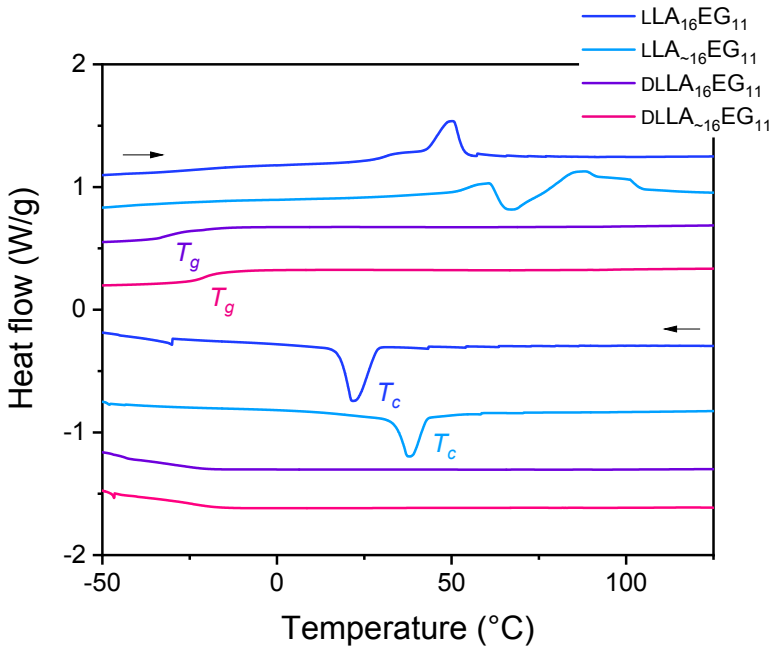


Figure S29 DSC traces (second cycle) for BCOs. Endothermic heat flows have a positive value. The data are shifted vertically for clarity.

5. Self-assembly in solution

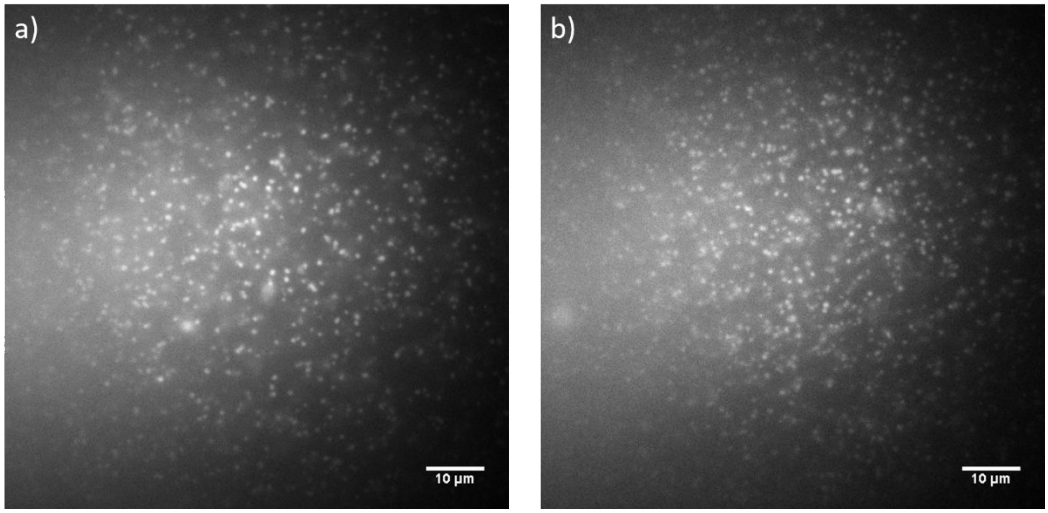


Figure S30 TIRF images of a) DLLA$_{16}$EG$_{11}$ and b) DLLA$_{\sim 16}$EG$_{11}$, showing spherical non-interacting particles.

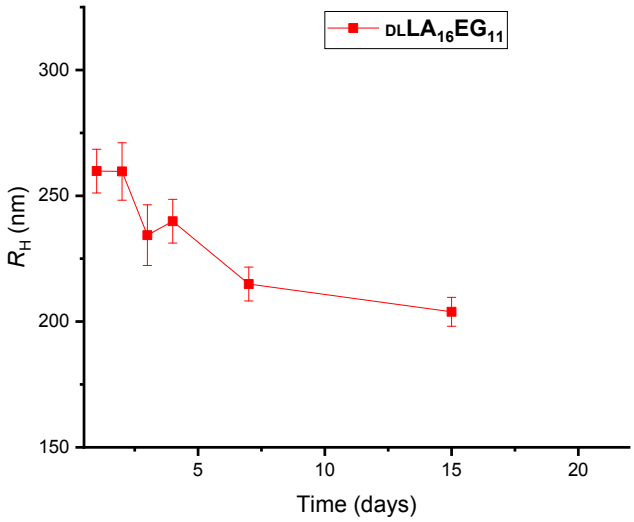


Figure S31 Sizes of particles of DL$LA_{16}EG_{11}$ over time, showing evaporation of organic solvent and corresponding size decrease.

6. Sample preparation procedures

6.1 Sample preparation $LA_{16}EG_{11}$

To remove all sample history and crystalline domains within the solid material, the BCOs were rigorously dissolved and the dissolution was carefully followed overtime. The BCOs were first dried overnight over P2O5 and 40 °C under high vacuum. Afterwards they were dissolved in DCM overnight and filtered with a 0.45 µm filter to remove dust and aggregates and the DCM was evaporated slowly overnight. Consecutively, the samples were dried in the vacuum oven for 4 h over P_2O_5 at 40 °C after they were weighed out and THF was added to obtain the THF stock solutions at 20 mg/mL. The final THF stock solutions were used after standing overnight at room temperature to ensure solubilization of the BCOs.

60 µL of the THF stock solution was placed in a clean LCMS vial. To ensure the formation of the thermodynamically stable bilayered structures, 540 µL MilliQ water was added slowly using a Nexus 3000 Syringe pump (0.05 mL/min) under stirring at 250 rpm overnight with the vial open, but covered with aluminum foil to prevent dust or particles in the sample.

6.2 Sample preparation $LA_{16}EG_{17}$

To remove all sample history and crystalline domains within the solid material, the BCOs were rigorously dissolved and the dissolution was carefully followed overtime. The BCOs were first dried overnight over P_2O_5 and 40 °C under high vacuum. Afterwards they were dissolved in DCM overnight and filtered with a 0.45 µm filter to remove dust and aggregates and the DCM was evaporated slowly overnight. Consecutively, the samples were dried in the vacuum oven for 4 h over P_2O_5 at 40 °C after they were weighed out and THF was added to obtain the THF stock solutions at 20 mg/mL. The final THF stock solutions were used after standing overnight at room temperature to ensure solubilization of the BCOs.

60 µL of the THF stock solution was placed in a clean LCMS vial. To ensure the formation of the thermodynamically stable cylinder structures, 540 µL MilliQ water was added slowly using a Nexus 3000 Syringe pump (0.05 mL/min) under stirring at 250 rpm overnight with the vial open, but covered with aluminum foil to prevent dust or particles in the sample.

6.3 Sample preparation $LA_{16}EG_{48}$

To remove all sample history and crystalline domains within the solid material, the BCOs were rigorously dissolved and the dissolution was carefully followed overtime. The BCOs were first dried overnight over P_2O_5 and 40 °C under high vacuum. Afterwards they were dissolved in DCM overnight and filtered with a 0.45 µm filter to remove dust and aggregates and the DCM was evaporated slowly overnight. Consecutively, the samples were dried in the vacuum oven for 4 h over P_2O_5 at 40 °C after they were weighed out and THF was added to obtain the THF stock solutions at 20 mg/mL. The final THF stock solutions were used after standing overnight at room temperature to ensure solubilization of the BCOs.

600 µL of MilliQ water was placed in an SLS vial. To ensure the formation of spherical micelles, 37.5 µL of the stock solution was quickly injected during vortexing (15 seconds) to obtain samples with a concentration of 1.2 mg/mL. The sample is closed and after an hour the sample was filtered with an Anatop 0.1µL filter.

7. SANS data analysis

The overall scattering curve intensities, $I(q)$, from the PLA – PEO are defined by the product of the form factor, $P(q)$, and the structure factor $S(q)$ plus incoherent scattering contributions (background):

$$I(q) = N(\Delta\rho)^2 * P(q)S(q) + background$$

Where N is the number density of scattering objects, and $\Delta\rho$ is the contrast term of the electronic density between the objects and the solvent. At low concentrations, the scattering profile is mainly determined by $P(q)$, except the case of $LA_{16}EO_{17}$ series which presents concentration – dependent scattering curves (Figure S32). Fittings were performed using SasView ® software. The scattering length density of D_2O was fixed to 6 *10^{-6} Å^{-2}, the scattering length density of the LA tail was fixed to 1.73 *10^{-6} Å^{-2} and the scattering length density of the EG shell fixed to 4.9 *10^{-6} Å^{-2}, assuming a total dry state and 75% hydration for the LA tail and EG shell, respectively.[3,4]

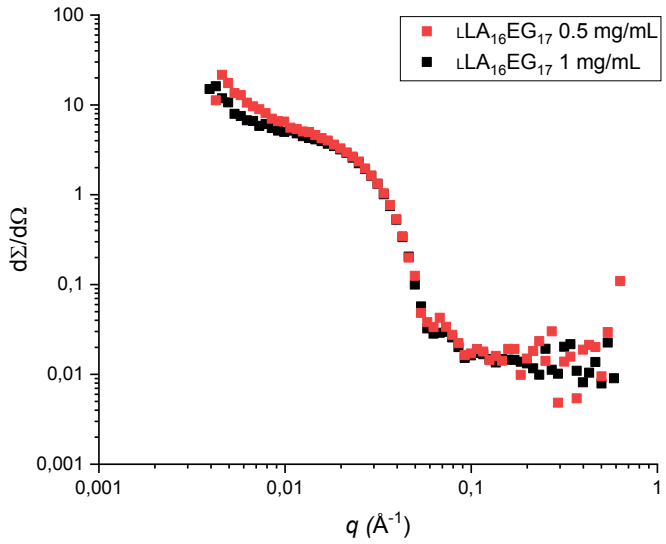


Figure S32 Concentration dependent scattering curves of $LLA_{16}EG_{17}$.

$LA_{16}EG_{11}$ curves were fitted to a lamellar phase with head and tail groups with a random distribution (Eq 1), with a fixed head group length of 31 Å. The length for the EG_{11} chains of 31 Å was based on the PEO unit length of 2.8 Å in water.[5]

$$I(q) = 2\pi \frac{scale}{2(\delta_H + \delta_T)} \frac{4}{q^2} \{\Delta\rho_H (\sin\left(q(\delta_H + \delta_T)\right) - \sin\left(q\delta_T\right)) + \Delta\rho_T \sin\left(q\delta_T\right)\}^2 \frac{1}{q^2} \quad (1)$$

Where δ_T is the tail length, δ_H is head length, $\Delta\rho_H$ is head contrast (scattering length density head – scattering length density solvent), and $\Delta\rho_T$ is tail contrast (scattering length density tail – scattering length density solvent). The total thickness of the lamellar sheet is $\delta_H + \delta_T + \delta_T + \delta_H$. The model fits well at low and high q values but deviates at mid q for crystalline BCOs. To account for different lengths of the LA tails present in these assemblies, polydispersity in the tail length is introduced by averaging the form factor over a Gaussian distribution.

Scattering patterns of $LA_{16}EG_{17}$ structures were fitted to a form factor of a core-shell cylinder (Eq. 2). The model fits well at high and mid q, however it deviates at low q due to interparticle interactions. To account for this effect we included a hard – sphere structure factor with an effective radius of *c.a.* 10 nm. The thickness of the shell was set to 4 nm with a dispersity index of 0.15.

$$I(q) = \frac{scale}{\pi(R+T)^2(L+2T)} \left[(\rho_c - \rho_s) V_c \frac{\sin(q(\frac{1}{2}L\cos\alpha)}{q\frac{1}{2}L\cos\alpha} \frac{2J_1(qR\sin\alpha)}{qR\sin\alpha} + (\rho_s - \rho_{sol} \right. \quad (2)$$

Where α is the angle between the axis of the cylinder and $\vec{q}$, V_s the total volume, V_c the volume of the core, L core length, R core radius, T the thickness of the shell, ρ_c is the scattering length density of the core, ρ_s is the scattering length density of the shell, ρ_{solv} is the scattering length density of the solvent. The outer radius of the shell is given by R+T. J_1 is the first order Bessel function.

8. References

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