Experimental protocol (S1):

Hexakis(6-deoxy-6-iodo)cyclomaltohexaose:

I$_2$ (12.27 g, 48.36 mmol, 15.7 eq.) was added by few portions to a stirring solution of PPh$_3$ (12.12 g, 46.2 mmol, 15 eq.) in dry DMF (50 mL). After 15 min, α-cyclodextrin (3 g, 3.08 mmol) was added in portions and the reaction was heated at 70 °C for 19 h concentrated under reduced pressure. Then the medium was allowed to reach room temperature and concentrated by two thirds under reduced pressure (1/3 vol.). A 3M solution of MeONa (20 mL) was injected dropwise at 0 °C and the mixture was stirred for 30 min. The solution was then poured into MeOH (50 mL). The precipitate was filtered off and washed with MeOH. The product was recovered as a brown powder (4 g, 80 %).

$^{13}$C-NMR (CDCl$_3$, 100 MHz): 101.8 (C1), 84.6 (C4), 72.4 (C3), 71.5 (C2), 70.5 (C5), 34.7 (C6).

Hexakis(6-deoxy-6-azido)cyclomaltohexaose:

NaN$_3$ (1.593 g, 24.5 mmol, 10 eq.) was added to a stirring solution of 6-per-iodo-6-deoxy-α-cyclodextrin (4 g, 2.45 mmol) in dry DMF (60 mL). The reaction was performed at 60 °C under an inert atmosphere of argon for 20 h. The medium was then allowed to reach room temperature and the solvent concentrated under reduced pressure. The product was precipitated by addition of water. The yellow brown powder was dried under high vacuum over P$_2$O$_5$ for 48 h (2.28 g, 83 %). $^{13}$C-NMR (CDCl$_3$, 100 MHz): 101.7 (C-1), 83.4 (C-4), 72.8 (C-5), 71.6 (C-3), 70.4 (C-2), 51.4 (C-6).

Hexakis(6-deoxy-6-amino)cyclomaltohexaose: (NH$_2$-α-CD):

PPh$_3$ (10.15 g, 38.7 mmol, 15.8 eq.) was added to a solution of 6-per-azido-6-deoxy-α-cyclodextrin (2.75 g, 2.45 mmol) in DMF (47 mL). The reaction was stirred at RT for 150min allowing the iminophosphorane intermediate to be formed. Hydrolysis was then achieved by addition of NH$_4$OH 28 %. The resultant suspension was stirred for a further 18h. The mixture was concentrated under
reduced pressure (65 °C) and the product was precipitated by addition of EtOH. The pure compound was recovered in quantitative yield as a yellow solid (2.35 g). The compound was submitted to acidification and lyophilized before characterization. \[^1\text{H}-\text{NMR}\] (D\textsubscript{2}O, 250 MHz): 5.20 (d, 6H, \(J = 2.8\) MHz), 4.27-4.32 (m, 6H), 4.02 (m, 6H), 3.60-3.72 (m, 12H), 3.47-3.53 (m, 6H), 3.27-3.36 (m, 6H). MS (ES+), found for C\textsubscript{36}H\textsubscript{66}N\textsubscript{6}O\textsubscript{24} (Mw = 966): m/z = 484.5 uma \([\text{M} + 2\text{H}^+]^{2+}\), 502.5 uma \([\text{M} + \text{H}^+ + \text{K}^+]^{2+}\).

**DOSY NMR experiments**

Self-diffusion is defined as translational motion reflecting the random motions of a molecule in the absence of a concentration gradient. The coefficient of this motion is related to the size, shape, charge of the molecules as well as their surrounding environment, such as solution, temperature and aggregation state, according to Debye-Einstein equation (1). It is indicative of hydrodynamic properties of the diffusion molecules. The signal of each component decreases with different diffusion rates as the gradient strength increases, inducing a two dimensional data set of the mixture: one dimension corresponds to a proton spectrum and the second one to the diffusion coefficients. The self-diffusion coefficients were then calculated with the standard form of the Stejskal-Tanner equation (2): \(I = I_0 \exp[-D\gamma^2g^2\delta^2(\Delta-\delta/3)]\), where \(I\) and \(I_0\) are respectively the observed intensity and the reference intensity (unattenuated signal intensity), \(D\) is the diffusion coefficient, \(\gamma\) represents the gyromagnetic ratio of proton, \(g\) is the gradient strength, and \(\delta\) denotes the duration of the magnetic field gradient pulses separated by a time interval \(\Delta\) (diffusion time). The measurement of the self-diffusion coefficients being very temperature-sensitive (3, 4), all the DOSY experiments were performed at the same temperature (25.2 °C), corresponding to the standard temperature for CDplexes preparation.

A typical \(\ln I\) versus \(\gamma^2g^2\delta^2(\Delta-\delta/3)\) plot gave a linear relationship and the diffusion coefficient was determined from the slope; an example was given for the equimolar mixture of α-CD and L-histidine (Figure S12). This mathematical treatment was used for each sample.
References


Figure S2: Images projection of the phantom with increasing gradient strength (only images obtained with 5% to 50% of the maximum gradient strength are shown; a residual signal is observed due to water in the inside screw thread for ease of phantom handling)
Figure S3: $^1$H NMR of Hexakis(6-deoxy-6-histidinyl)cyclomaltohexaose (His-$\alpha$-CD)
Figure S4: $^1$H NMR of Hexakis(6-deoxy-6-lysyl)cyclomaltohexaose (Lys-α-CD)
Figure S5: $^{13}$C NMR of Hexakis(6-deoxy-6-histidinyl)cyclomaltohexaose (His-α-CD)
Figure S6: $^{13}$C NMR of Hexakis(6-deoxy-6-lysiny) cyclomaltohexaose (Lys-α-CD)
Figure S7: MS (MALDI-TOF/TOF) spectrum of Hexakis(6-deoxy-6-histidinyl)cyclomaltohexaose (His-α-CD)
Figure S8: MS (MALDI-TOF/TOF) spectrum of Hexakis(6-deoxy-6-lysiny]cyclomaltohexaose (Lys-α-CD).
Figure S9: HSQC experiment of His-α-CD in D$_2$O (experiment with water suppression, which explains the reason why the D$_2$O and anomeric proton signals did not appear).
Figure S10: COSY experiment of Lys-α-CD in D₂O at 25.2 °C; [Lys-α-CD]=9.3×10⁻³ mol/L
Figure S11: $^1$H spectrum of a mixture (1/1) of $\alpha$CD and L-histidine in D$_2$O at 25.2°C; $[\alpha$CD]$=[L$\text{-histidine}] = 2.18 \times 10^{-3}$ mol/L.
Figure S12: lnI versus $\gamma^2 g^2 \delta^2 (\Delta - \delta/3)$ plot considering the anomeric proton at 4.97 ppm; $[\alpha$-CD]= [L-histidine] = 21.6x10$^{-3}$ mol/L in D$_2$O; 25.2°C.

Figure S13: lnI versus $\gamma^2 g^2 \delta^2 (\Delta - \delta/3)$ plot considering the peaks resonated between 4.3 and 2.8 ppm. [His-$\alpha$-CD] = 9.0x10$^{-3}$ mol/L in D$_2$O; 25.2°C; $\Delta$=200 ms; $\delta$=4.5 ms
Figure S14: lnI versus $\gamma^2 g^2 \delta^2(\Delta-\delta/3)$ plot considering the peaks resonated between 4.2 and 3.1 ppm; [Lys-$\alpha$-CD] = 9.3×10^{-3} mol/L in D$_2$O; 25.2°C