Supporting information for Fenniri *et al.* (March 12, 2002) *Proc. Natl. Acad. Sci. USA*, 10.1073/pnas.032527099.

Spectroscopic Investigations and Molecular Models of the Nanotubular Assemblies

NMR. All NMR experiments were carried out on a Varian Inova 600-MHz spectrometer equipped with the latest generation triple–resonance z–gradient probe. Experiments performed were one-dimensional (1D) jump–return (1), fb–NOESY (2), and ROESY (3) with TOCSY peak suppression (4) and excitation sculpting for water signal elimination (5). 1D experiments between 2°C and 42°C indicated broadening at all but the lowest temperatures. ROESY and NOESY experiments with mixing times of 75 ms and 100 ms were performed at 27°C and 2°C, respectively. Comparison of the two type of dipolar correlation experiments clearly shows that an exchange process is taking place, which affects all imino proton resonances. A major and a minor population of imino protons coexist with a ratio of 3:1 (Figs. 7 and 8), which is independent of concentration (0.001 to 0.025 M) and temperature (2–42°C). We then carried out fb–TOCSY, NOESY, and ROESY experiments on the same solution to gain further information about the nature of these species.

fb–TOCSY experiments did not show any cross–peaks between the imino protons, except an exchange NOE between the minor and major ^{A}H resonances. fb–NOESY experiments showed the expected cross–peaks between, respectively, the major and minor ^{B}H and ^{C}H resonances, which were confirmed by fb–ROESY as nonchemical exchange NOEs. Because ^{B}H and ^{C}H are too far apart to display any intramodular NOEs, the observation of an NOE between them confirms the existence of intermodular H–bonds as highlighted in Fig. 8. The fb–NOESY revealed also the expected cross–peak between the minor ^{A}H and ^{B}H resonances but not between the major ^{A}H and ^{B}H resonances, thereby suggesting that the major $CH_3{}^{A}$H protons are in a nonhydrogen–bonded conformation (Fig. 9). Such conformation would apparently place $CH_3{}^{A}$H away from ^{B}H. To rationalize these results, we suggest that within the NMR time scale, three of four of the peripheral hydrogen bonds involving ^{A}H are disconnected (Fig. 8). A reasonable justification for this may stem from (*i*) steric compression caused by the crown ethers, or (*ii*) an increased H–bonding strength for the inner imino protons (^{B}H, ^{C}H), which would as a result constrain a population of ^{A}H protons (three of four) to sustain an open, nonhydrogen–bonded state.

There are, of course, other possible explanations involving fewer hydrogen bonds to rationalize the NMR data without necessarily invoking the formation of a rosette assembly. However, the present rational is in agreement with the SAXS and TEM data, with our early report on the rosette nanotubes (6), as well as with other ongoing investigations of similar systems in our laboratories. Furthermore, electrospray inonization MS (ESI–MS) of dilute aqueous solutions of **1** or **2** displayed all the peaks corresponding to the noncovalent intermediate species (1–mer to 6–mer) of the parent rosette, although the hexamer peak was somewhat weaker (2%), reflecting the instability of the assembly in the gas phase and reinforcing the major role played by the hydrophobic effects (data not shown).

UV-Visible Spectroscopy. Absorption spectra of **1**, **2**, and 4-aminobenzo-18-crown-6-ether (18C6) (40×10^{-6} M in H_2O) were recorded in the presence and absence of Na^+ or K^+ (1–10

equivalents) on a Beckman DU–7500 between 25°C and 95°C. Representative data and spectra are shown in Table 2 and Fig. 10, respectively.

DLS Measurements. These experiments were carried out on a Protein–Solutions MSTC200 instrument. The concentrations and temperatures investigated are listed in Fig. 2. The parameter settings used are listed below.

Optics block:

1. Laser wavelength = 826.7 nm.
2. scattering angle $\theta = 90°$.
3. Clean water count = 5,000.

Solvent:

1. Name = Mes aqueous buffer.
2. Buffer's refractive index = 1.333.
3. Viscosity = 1.019 at 20°C, 0.7977 at 30°C, and 0.6532 at 40°C.
4. Temperature model = aqueous.

Standard curve:

1. Name = dextran.
2. R_h factor = 1.283.
3. Power = 1.915.

Volume shape hydration:

1. Name = lipase.
2. Specific volume = 0.714.
3. Friction ratio = 1.19.

Correlator = Flex–30.
Max acquisition time = 5 s.
Number of acquisitions = 30.
Average counts = 1.8×10^6 counts/s.

SAXS Measurements. These experiments were carried out on a custom–built instrument at Argonne National Laboratories equipped with a 2D Gabriel gas detector and a Cu–K(α) x–ray source (λ = 1.54 Å) operating at 50 kV and 94 mA. The samples were dissolved in distilled water at room temperature in the absence or presence of NaCl or KCl (see Table 1). An acquisition time of 60–120 min was sufficient to obtain significant scattering against a background of water or water and salt (NaCl, KCl, or Mes buffer, depending on the experiment). The data recorded were processed and analyzed by using a modified Guinier method for a rod–shaped model with infinite length (7, 8). Representative SAXS data and corresponding Guinier plots are shown in Fig. 11.

Electron Microscopy. Formvar- and carbon-coated grids were floated on droplets of 1–2 mg/ml solutions of **1** or **2** in distilled water for ~30 s, transferred to droplets of 2% aqueous uranyl acetate for ~30 s, blotted, and viewed in a Philips EM–400 transmission electron microscope at 80 kV. Images of the 8.75-nm lattice spacing of catalase crystals, taken at the same magnification, were used for calibration. Negatives were digitized at 600 dpi resolution, and the dimensions of the nanotubes were determined by using the National Institutes of Health image analysis program Image. The measured outer diameters are an average of 100 measurements

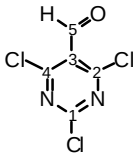
made on randomly selected nanotubes. In agreement with the SAXS data and computer models, the diameter revolves around 4 nm.

Molecular Models. The molecular models were generated using by the program Macromodel 7.2. First, the side-chain amino nitrogen of **2** was assigned +1 charge (through protonation). The energy of this compound was then minimized in water by using Merck Molecular Force Fields (9, 10). The structure rapidly evolved toward the formation of an ionic hydrogen bond between the ammonium and the closest carbonyl oxygen of the base. Six molecules of **2** were then arranged to form a 6–fold symmetry rosette maintained by 18 H–bonds, then the energy was minimized in water as above to result in the rosette structure of Fig. 1. Two, four, six, and eight rosettes were then arranged in a tubular fashion with a starting interplane distance of 0.45 nm and a rotation angle per plateau along the tube's main axis of 30°. This arrangement was based on Whitesides' studies of the isocyanurate–melamine system (11) and was anticipated to minimize the steric hindrance between peripheral side chains, maximize the stacking interactions and hydrophobic effect, and maintain a high level of symmetry. Energy minimization of the resulting 12–fold symmetry tubular architecture resulted in the model depicted in Fig. 1. The tubular structure is thus held exclusively through inter–rosette stacking interactions. With an inter–plane distance of 0.34 nm (as is the case in DNA), the overall strain energy increases dramatically for the four–rosette stack, which results in severe distortion of the rosette plane for higher-order stacks.

Synthesis of 1 and 2 (Fig. 6)

Abbreviations. Boc, *tert*–butyloxycarbonyl; br, broaden; CI-MS, chemical impact MS; dH_2O, deionized NanoPure water; EA, ethylacetate; EI-MS, electron impact MS; ESI-MS, electrospray ionization MS; Et_2O, diethylether; Et_3N, triethylamine; mp, melting point; R_f, retention factor; rt, room temperature; THF, tetrahydrofuran.

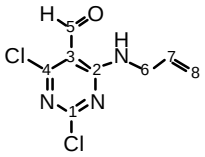
General. Melting points (mps) were recorded on a Thomas Hoover capillary mp apparatus (Unimelt). ^1H and ^{13}C–NMR spectra were recorded on Varian NMR spectrometers (Gemini 200, Inova 300, Unity 500, or Unity Plus 600 MHz) with the solvent as internal reference. The NMR data are presented as follows: chemical shift, peak assignment, multiplicity, coupling constant, integration. The mass spectra were performed at the Mass Spectrometry Center of Purdue University. Compound **5** (12) was prepared according to previously reported procedures. All the reagents and solvents are commercially available from Aldrich, Novabiochem, Fisher Scientific, or Advanced ChemTech. Reagent grade solvents were distilled under inert atmosphere (N_2) before use: CH_2Cl_2 was distilled over CaH_2, tetrahydrofuran (THF) over Na/benzophenone and CH_3OH over Mg. All the reactions were performed under N_2 atmosphere. For column chromatography, commercial solvents were used without purification. Chromatographic supports were silica flash Merck 60 (0.040–0.063 mm) or silica gel Merck 60 (0.063–0.2 mm) for gravity chromatography. Silica–coated TLC plates (Merck F 60_{254}) were used for monitoring reaction progress and visualizations were made under UV light or by chemical staining [$KMnO_4$/deionized NanoPure water (dH_2O), phosphomolybdic acid/EtOH, or ninhydrin/*n*–BuOH/acetic acid].



Synthesis of compound **5** (10).

Barbituric acid **4** (10 g, 78.1 mMol) was added to a stirred solution of $POCl_3$ (47 ml, 77.3 g, 504 mMol) and dimethylformamide (6 ml, 5.66 g, 77.5 mMol) at room temperature (rt) under N_2 atmosphere. The mixture was refluxed for 15 h then allowed to cool down to rt. Excess $POCl_3$ was removed under reduced pressure (high vacuum rotavap), and the resulting viscous material was carefully poured over crushed ice (250 g) while it was vigorously stirred. The resulting pale brown precipitate was then filtered and dried under high vacuum. The desired compound **5** ($C_5HCl_3N_2O$, 10.7 g, 65%) was obtained as yellow crystalline solid upon sublimation (120°C, 0.05 mm Hg). Retention factor (R_f) = 0.43 [10% ethylacetate (EA)/Hex]. mp = 130°C.

^{1}H–NMR (300 MHz, $CDCl_3$) δ (ppm): 10.45 (C_5H, s,1H).
^{13}C–NMR (50 MHz, $CDCl_3$) δ (ppm): 185.06 (C_5), 164.50 (C_1), 123.44 (C_2, C_4).



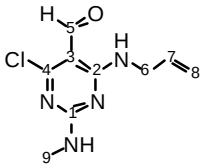
Synthesis of compound **6**.

To a stirred solution of **5** (6.0 g, 28.4 mmol) in CH_2Cl_2 (50 ml), allylamine (3.34 g, 4.26 ml, 56.8 mmol) was slowly added at –78°C under N_2 atmosphere. The resulting mixture was stirred at –78°C for 2 h then allowed to warm to –20°C over a period of 7 h. The reaction was then quenched with dH_2O (10 ml) and extracted with CH_2Cl_2 (100 ml). The organic layer was washed with dH_2O (2 × 50 ml) and brine (50 ml), then dried over anhydrous Na_2SO_4. After filtration and evaporation of the solvent (rotavap) the crude product was purified by gravity silica gel chromatography (0-2% EA/Hex). The desired compound **6** was obtained as a colorless liquid ($C_8H_7Cl_2N_3O$, 5.29 g, 79%). R_f = 0.33 (10% EA/Hex).

^{1}H–NMR (200 MHz, $CDCl_3$) δ (ppm): 10.25 (C_5H, s, 1H), 9.32 [NHC_6, broaden (br), s, 1H], 5.94–5.79 (C_7H, m, 1H), 5.25–5.12 (C_8H, m, 2H), 4.20–4.13 (C_6H, m, 2H).

^{13}C–NMR (50 MHz, $CDCl_3$) δ (ppm): 190.91 (C_5), 166.46, 163.14 (C_1, C_2), 162.00 (C_4), 132.73 (C_7), 117.99 (C_8), 107.15 (C_3), 44.01(C_6).

Positive electrospray ionization-MS (ESI–MS): Expected mass for $(M + H^+)/z$, 232.00. Observed, 232.1 [$(M + H^+)/z$, 93%].



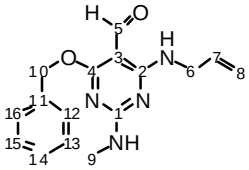
Synthesis of compound **7**.

To a stirred solution of **6** (9.1 g, 39.2 mmol) in THF (100 ml), methylamine (2 M solution in THF, 39.2 ml, 78.4 mMol,) was added at 0°C under N_2 atmosphere. The reaction mixture was stirred at 0°C for 1 h then at rt for 6 h. The reaction was quenched with saturated aqueous NH_4Cl (10 ml) and the solvent was removed under reduced pressure (rotovap). The desired product **7** ($C_9H_{11}ClN_4O$, 7.36 g, 83%) was obtained as a crystalline white solid after gravity silica gel chromatography. R_f = 0.22 (SiO_2, 10% EA/Hex). mp = 156°C.

^{1}H–NMR (200 MHz, $CDCl_3$) δ (ppm): 10.03 (C_5H, s, 1H), 9.37 (NHC_6, br, s, 1H), 6.92 (NHC_9, br, s, 1H), 5.95–5.86 (C_7H, m, 1H), 5.28–5.14 (C_8H, m, 2H), 4.18 (C_6H, t, ^3J = 5.4 Hz, 2H), 3.01 (C_9H, d, ^3J = 4.76 Hz, 3H).

^{13}C–NMR (50 MHz, $CDCl_3$) δ (ppm): 188.83 (C_5), 165.77, 162.65 (C_1, C_2), 161.94 (C_4), 134.12 (C_7), 116.97 (C_8), 102.04 (C_3), 43.44(C_6), 28.71(C_9).

Electron impact MS (EI–MS): Expected mass for $(M^+)/z$, 226.06. Observed, 226 [$(M^+)/z$, 67%], 211 [$(M^+)/z$ – CH_3, 100%].
High-resolution EI–MS: Expected mass for $(M^+)/z$, 226.0621. Observed, 226.0624.



Synthesis of compound **8**.

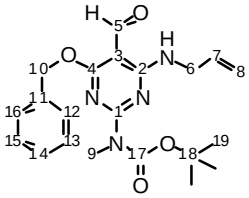
Benzyl alcohol (6.68 g, 6.39 ml, 61.8 mmol) was added to a stirred suspension of 95% NaH (1.79 g, 70.8 mmol) in THF (10 ml) at rt under N_2 atmosphere. After 15 min, the solution was cooled to 0°C then a solution of compound **7** (7.0 g, 30.9 mmol) in THF (40 ml) was added. The mixture was allowed to warm to rt then it was refluxed for 22 h. The mixture was then cooled to 0°C and carefully quenched with saturated NH_4Cl (5 ml). The solvent was removed under reduced pressure (rotovap), and the residual solid was dissolved in diethylether (Et_2O), washed with dH_2O (100 ml) and brine (50 ml) and dried over anhydrous Na_2SO_4. Filtration, evaporation of the solvent under reduced pressure (rotavap) followed by gravity silica gel chromatography (0 to 5% EA/Hex) yielded **8** as a white solid ($C_{16}H_{18}N_4O_2$, 7.0 g, 75%). R_f = 0.51 (30% EA/Hex). mp = 56°C.

^{1}H–NMR (200 MHz, $CDCl_3$) δ (ppm): 10.32 (C_5H, s, 1H), 9.42 (NHC_6, br, s, 1H, major isomer), (because of the possible hydrogen bond between C_5O and C_6NH, this compound displays two

sets of peaks for certain protons). 9.25 (NHC_6, br, s, 1H, minor isomer), 7.49–7.37 ($C_{12}H$–$C_{16}H$, m, 5H), 6.03–5.84 (C_7H, br, m, 1H), 5.46–5.10 (C_8H, $C_{10}H$, m, 4H), 4.19 (C_6H, br, s, 2H, major isomer), 4.06 (C_6H, br, s, 2H, minor isomer), 2.98 (C_9H, d, ^3J = 8.5 Hz, 3H).

^{13}C–NMR (50 MHz, $CDCl_3$) δ (ppm): 186.42 (C_5), 171.87 (C_4), 163.86, 163.37 (C_1, C_2), 137.09 (C_{11}), 134.79 (C_7), 129.03, 128.93, 127.43 (C_{12}–C_{16}), 116.43 (C_8), 93.92 (C_3), 68.06 (C_{10}), 43.32 (C_6), 28.68 (C_9).

EI–MS: Expected mass for $(M^+)/z$, 298.14. Observed, 298 [$(M^+)/z$, 15%], 283 [$(M^+)/z - CH_3$, 2.1%], 207 [$(M^+)/z - C_7H_7$, 27%], 91 [$(C_7H_7)^+$, 100%].
High-resolution EI–MS: Expected mass for $(M^+)/z$, 298.1430. Observed, 298.1424.



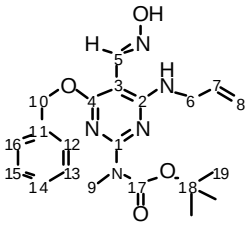
Synthesis of compound **9**.

To a stirred solution of compound **8** (5.0 g, 16.8 mmol), 4–*N*,*N*–dimethylaminopyridine (1.0 g, 8.35 mmol) and THF (50 ml), triethylamine (Et_3N) (5.1 g, 7.0 ml, 50.3 mmol) was added at rt under N_2 atmosphere. After stirring for 5 min, Boc_2O (4.39 g, 20.1 mmol) was added, and the mixture was stirred at rt for 18 h. The reaction was quenched with dH_2O (10 ml) followed by removal of the solvent under reduced pressure (rotovap). The residual solid was dissolved in EA (300 ml) and washed with 10% aqueous citric acid (50 ml), dH_2O (2 × 50 ml), 5% aqueous $NaHCO_3$ (50 ml), and brine (50 ml). After drying the organic layer over anhydrous Na_2SO_4, filtration and removal of the solvent under reduced pressure (rotavap), the residue was purified by gravity silica gel chromatography (0-5% EA/Hex). The desired compound **9** ($C_{21}H_{26}N_4O_4$**,** 5.86 g, 88%) was obtained as a white crystalline solid. R_f = 0.38 (10% EA/Hex). mp = 54°C.

^{1}H–NMR (300 MHz, $CDCl_3$) δ (ppm): 10.18 (C_5H, s, 1H), 9.26 (NHC_6, br, t, J = 5.7 Hz, 1H), 7.49–7.36 ($C_{12}H$–$C_{16}H$, br, m, 5H), 6.01–5.90 (C_7H, m, 1H), 5.53 ($C_{10}H$, s, 2H), 5.31–5.14 (C_8H, br, m, 2H), 4.23 (C_6H, t, J = 4.8 Hz, 2H), 3.43 (C_9H, s, 3H), 1.59 ($C_{19}H$, s, 9H).

^{13}C–NMR (50 MHz, $CDCl_3$) δ (ppm): 188.09 (C_5), 171.89 (C_4), 163.16, 162.30 (C_1, C_2), 154.25 (C_{17}), 136.79 (C_{11}), 134.57 (C_7), 129.03, 128.68, 128.54 (C_{12}–C_{16}), 116.70 (C_8), 94.75 (C_3), 82.39 (C_{18}), 68.74 (C_{10}), 43.48 (C_6), 35.15 (C_9), 28.69 (C_{19}).

Chemical impact–MS (CI-MS): Expected mass for $(M + H^+)/z$, 399.20. Observed, 399 [$(M + H^+)/z$, 100%], 299 [$(M + H^+)/z$ – *tert*–butyloxycarbonyl (Boc) 7.1%].
High-resolution EI–MS: Expected for $(M^+)/z$, 398.1954. Observed, 398.1943.



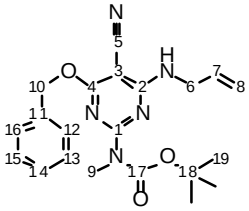
Synthesis of compound **10**.

To a stirred solution of **9** (4.2 g, 10.6 mmol) in anhydrous methanol (100 ml) $KHCO_3$ (4.23 g, 42.2 mmol) and hydroxylamine hydrochloride (1.47 g, 21.1 mmol) were added at rt under N_2 atmosphere. The resulting slurry was refluxed for 3 h then cooled to rt and quenched with dH_2O (10 ml). The solvent was removed (rotovap) and the residual solid was dissolved in EA (200 ml), washed with dH_2O (50 ml) and brine (25 ml). The organic layer was dried over anhydrous Na_2SO_4, filtered, and evaporated to dryness (rotavap) to yield compound **10** ($C_{21}H_{27}NO_4$, 4 g, 92%). This material was used in the next step without further purification. R_f = 0.50 (30% EA/Hex).

^{1}H–NMR (200 MHz, $CDCl_3$) δ (ppm): 8.58 (C_5H, s, 1H), 8.05 (NHC_6, t, ^3J = 6.5 Hz, 1H), 7.60 (NOH, br, s, 1H), 7.46–7.34 (C_{12}H–C_{16}H, m, 5H), 6.06–5.80 (C_7H, m, 1H), 5.44 (C_{10}H, s, 2H), 5.28–5.10 (C_8H, m, 2H), 4.25–4.18 (C_6H, m, 2H), 3.41 (C_9H, s, 3H), 1.89 (C_{19}H, s, 9H).

^{13}C–NMR (50 MHz, $CDCl_3$) δ (ppm): 167.63 (C_4), 161.16, 159.53 (C_1, C_2), 155.03 (C_{17}), 146.42 (C_5), 137.25 (C_{11}), 135.30 (C_7), 128.95, 128.74 (C_{12}–C_{16}), 116.07 (C_8), 88.54 (C_3), 81.96 (C_{18}), 68.63 (C_{10}), 43.85 (C_6), 35.34 (C_9), 28.84 (C_{19}).

CI–MS: Expected mass for $(M + H^+)/z$, 414.20. Observed, 414 [$(M + H^+)/z$, 100%], 396 [$(M + H^+)/z - H_2O$, 18.3%], 314 [$(M + H^+)/z$ – Boc, 18.3%].
High-resolution EI–MS: Expected for $(M^+)/z$, 413.2063. Observed, 413.2050.



Synthesis of compound **11**.

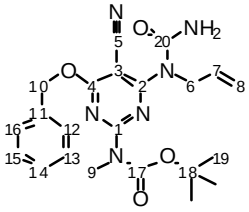
Compound **10** (4.0 g, 9.66 mmol), Et_3N (4.03 ml, 2.93 g, 29.0 mmol), and THF (50 ml) were cooled to 0°C then trifluoroacetic anhydride (2.0 ml, 3.04 g, 14.5 mmol) was slowly added. After stirring for 15 min, the mixture was allowed to warm to rt then it was refluxed for 5 h. After cooling down to rt the reaction was quenched with dH_2O (10 ml) and the solvent was removed under reduced pressure (rotovap). The residual solid was dissolved in EA (300 ml), washed with dH_2O (2 × 50 ml), 10% aqueous citric acid (25 ml), dH_2O (50 ml), 5% aqueous $NaHCO_3$ (50 ml), and brine (50 ml). The organic layer was dried over anhydrous Na_2SO_4, filtered, and

evaporated to dryness under reduced pressure (rotavap). Compound **11** was obtained as a white solid ($C_{21}H_{25}N_5O_3$, 3.3 g, 79% from **9**) after gravity silica gel chromatography (3% EA/Hex). R_f = 0.64 (30% EA/Hex). mp = 68°C.

^{1}H–NMR (300 MHz, $CDCl_3$) δ (ppm): 7.49–7.35 (C_{12}H–C_{16}H, m, 5H), 5.91–5.83 (C_7H, m, 1H), 5.78 (NHC_6, t, ^3J = 5.6 Hz, 1H), 5.51 (C_{10}H, s, 2H), 5.27 (C_8H, d, ^3J = 17.1 Hz, 1H), 5.19 (C_8H, d, ^3J = 10.1 Hz, 1H), 4.18 (C_6H, t, ^3J = 5.7 Hz, 2H), 3.40 (C_9H, s, 3H), 1.58 (C_{19}H, s, 9H).

^{13}C–NMR (75 MHz, $CDCl_3$) δ (ppm): 170.62 (C_4), 164.31, 161.05 (C_1, C_2), 153.80 (C_{17}), 136.26 (C_{11}), 134.14 (C_7), 128.76, 128.44, 128.25 (C_{12}–C_{16}), 117.20 (C_8), 115.05 (C_5), 82.27 (C_{18}), 69.06 (C_3), 68.83 (C_{10}), 43.90 (C_6), 34.94(C_9), 28.47 (C_{19}).

CI–MS: Expected mass for $(M + H^+)/z$, 396.20. Observed, 396 [$(M + H^+)/z$, 100%], 296 [$(M + H^+)/z$ – Boc, 32%].
High-resolution EI–MS: Expected for $(M^+)/z$, 395.1957. Observed, 395.1961.



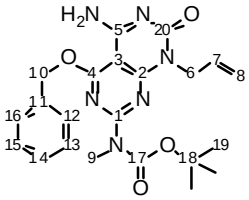
Synthesis of compound **12**.

To a solution of compound **11** (15.2 g, 38.4 mmol) in CH_2Cl_2 (300 ml), *N*–chlorocarbonylisocyanate (13) (8.09 g, 6.2 ml, 76.7 mmol) was added dropwise at 0°C over a period of 15 min under N_2 atmosphere. After stirring for 2 h at 0°C, the mixture was allowed to warm to rt and was stirred for an additional 3 h. The reaction mixture was cooled to 0°C and carefully quenched with dH_2O (10 ml, exothermic reaction) followed by 5% aqueous $NaHCO_3$ (10 ml). The product was extracted with chloroform (1,500 ml) and the resulting organic layer was washed with dH_2O (2 × 100 ml) and brine (100 ml) and dried over anhydrous Na_2SO_4. Filtration and evaporation of the organic solvents under reduced pressure (rotavap) yielded **12** ($C_{22}H_{26}N_6O_4$, 16.4 g, 97%) as a viscous liquid, which was used in the next step without further purification. A small sample of this compound was purified by gravity silica gel chromatography (30% EA/Hex) to yield **12** as an analytically pure white solid. R_f = 0.16 (30% EA/Hex). mp = 98°C.

^{1}H–NMR (200 MHz, $CDCl_3$) δ (ppm): 7.46 (C_{12}H–C_{16}H, br, m, 5H), 5.94–5.75 (C_7H, m, 1H), 5.51 (C_{10}H, s, 2H), 5.18 (C_8H, t, ^3J = 21.2 Hz, 2H), 4.92 (C_6H, d, ^3J = 5.4 Hz, 2H), 3.41 (C_9H, s, 3H), 1.54 (C_{19}H, s, 9H).

^{13}C–NMR (50 MHz, $CDCl_3$) δ (ppm): 172.54 (C_4), 163.51 (C_1), 159.08 (C_2), 155.86 (C_{17}), 152.95 (C_{20}), 135.70 (C_{11}), 133.82 (C_7), 129.14, 128.93, 128.21 (C_{12}–C_{16}), 117.34 (C_8), 114.44 (C_5), 86.50 (C_3), 83.90 (C_{18}), 70.18 (C_{10}), 48.51 (C_6), 34.99 (C_9), 28.51 (C_{19}).

CI–MS: Expected mass for $(M + H^+)/z$, 439.20. Observed, 439 [$(M + H^+)/z$, 2.8%], 396 [$(M + H^+)/z - CONH_2$, 100%], 296 [$(M + H^+)/z - (Boc + CONH_2)$, 39%].
High-resolution EI–MS: Expected mass for $(M^+)/z$, 438.2016. Observed, 438.2027.



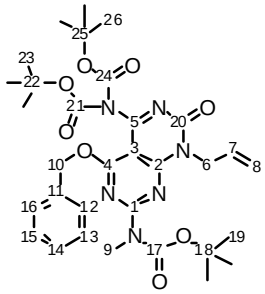
Synthesis of compound **13**.

Compound **12** (1.63 g, 3.72 mmol) was stirred in 7 M NH_3 in CH_3OH (55 ml) under N_2 atmosphere at rt for 3 h. Excess CH_3OH was removed under reduced pressure (rotovap) and the desired compound **13** was obtained as a white solid ($C_{22}H_{26}N_6O_4$, 9.94 g, 85% from **11**) after gravity silica gel chromatography (30-100% Hex/EA). R_f = 0.26 (EA). mp = 192°C.

^{1}H–NMR (300 MHz, $CDCl_3$) δ (ppm): 8.00 (NHC_5, br, s, 1H), 7.51–7.41 ($C_{12}H$–$C_{16}H$, m, 5H), 7.15 (NHC_5, s, 1H), 6.02–5.91 (C_7H, br, m, 1H), 5.66 ($C_{10}H$, s, 2H), 5.27 (C_8H, d, ^3J = 17.2 Hz, 1H), 5.18 (C_8H, d, ^3J = 10.2 Hz, 1H), 4.87 (C_6H, d, ^3J = 5.6 Hz, 2H), 3.47 (C_9H, s, 3H), 1.61 ($C_{19}H$, s, 9H).

^{13}C–NMR (50 MHz, $CDCl_3$) δ (ppm): 167.04 (C_4), 161.72, 161.09 (C_1, C_2), 160.83 (C_5), 156.37 (C_{17}), 153.53 (C_{20}), 135.58 (C_{11}), 132.99 (C_7), 129.27, 129.07 (C_{12}–C_{16}), 117.80 (C_8), 86.65 (C_3), 82.97 (C_{18}), 70.31 (C_{10}), 45.01 (C_6), 35.26 (C_9), 28.64 (C_{19}).

CI–MS: Expected mass for $(M + H^+)/z$, 439.20. Observed, 439 [$(M + H^+)/z$, 100%], 339 [$(M + H^+)/z$ – Boc, 29%].
Positive high-resolution CI–MS: Expected mass for $(M + H^+)/z$, 439.2094. Observed, 439.2096.



Synthesis of compound **14**.

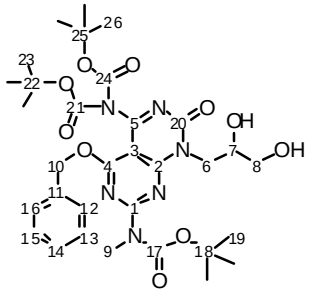
To a solution of compound **13** (2.5 g, 5.69 mmol), 4–*N*,*N*–dimethylaminopyridine (0.7 g, 5.69 mmol) and Et_3N (4.8 ml, 3.5 g, 34.2 mmol) in THF (50 ml), Boc_2O (3.72 g, 17.1 mmol) was

added under N_2 atmosphere. After stirring at rt for 22 h, the reaction was quenched with dH_2O (10 ml) and the solvent was removed under reduced pressure (rotovap). The residual solid was dissolved in EA (300 ml), washed with dH_2O (100 ml), 10% aqueous citric acid (50 ml), dH_2O (2×50 ml), 5% aqueous $NaHCO_3$ (50 ml), and brine (50 ml), then dried over anhydrous Na_2SO_4. After filtration and removal of the solvent under reduced pressure (rotavap) the residual solid was purified by gravity silica gel chromatography (5-20% EA/Hex) to yield compound **14** ($C_{32}H_{42}N_6O_8$, 3.25 g, 89%) as a white foam. R_f = 0.66 (50% EA/Hex). mp = 78°C.

^{1}H–NMR (200 MHz, $CDCl_3$) δ (ppm): 7.48–7.44 (C_{12}H–C_{16}H, m, 5H), 6.07–5.87 (C_7H, m, 1H), 5.58 (C_{10}H, s, 2H), 5.24 (C_8H, t, ^3J = 12.4 Hz, 2H), 4.94 (C_6H, d, ^3J = 9.2 Hz, 2H), 3.46 (C_9H s, 3H), 1.59 (C_{19}H, s, 9H), 1.35 (C_{23}H and C_{26}H, s, 18H).

^{13}C–NMR (50 MHz, $CDCl_3$) δ (ppm): 165.96 (C_4), 161.37, 161.06 (C_1, C_2), 160.67 (C_5), 155.60 (C_{17}), 152.88 (C_{20}), 149.41 (C_{21}, C_{24}), 135.19 (C_{11}), 131.48 (C_7), 128.85, 128.72 (C_{12}–C_{16}), 118.26 (C_8), 93.08 (C_3), 83.83 (C_{22}, C_{25}), 83.23 (C_{18}), 70.35 (C_{10}), 45.49 (C_6) 35.16 (C_9), 28.35 (C_{19}), 28.05 (C_{23}, C_{26}).

EI–MS: Expected mass for $(M + H^+)/z$, 638.31. Observed 639.8 ($(M + H^+)/z$, 89%).
High-resolution EI–MS: Expected for $(M^+)/z$, 638.3064. Observed, 638.3057.



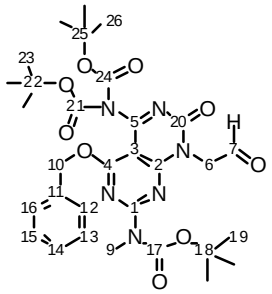
Synthesis of compound **15**.

To a stirred solution of compound **14** (3.2 g, 5.01 mmol) in acetone/dH_2O (8:1, 90 ml) was added 50% aqueous *N*–methylmorpholine *N*–oxide (1.17 g, 2.4 ml, 10.0 mmol) at rt. After stirring for 5 min, OsO_4 (0.1 M solution in *t*–BuOH, 2.5 ml, 0.25 mmol) was added dropwise over a period of 5 min. The resulting brown solution was stirred at rt for 23 h then quenched with aqueous sodium sulfite until all the excess OsO_4 was destroyed (brown solution turns colorless). Diol **15** was extracted in $CHCl_3$ (250 ml) and washed with dH_2O (2×10 ml) and brine (25 ml). The organic layer was dried over anhydrous Na_2SO_4, filtered, and evaporated to dryness under reduced pressure (rotavap). Crystallization from EA yielded compound **15** as a white solid ($C_{32}H_{44}N_6O_{10}$, 3.31 g, 98%). R_f = 0.15 (50% EA/Hex). mp = 136°C.

^{1}H–NMR (300 MHz, $CDCl_3$) δ (ppm): 7.46 (C_{12}H–C_{16}H, br, m, 5H), 5.61 (C_{10}H, s, 2H), 4.63 (C_6H, d, ^3J = 4.5 Hz, 2H), 4.18 (C_7H, m, 1H), 4.09 (C_7OH, d, ^3J = 5.6 Hz, 1H), 3.60 (C_8H, m, 2H), 3.51 (C_9H, s, 3H), 3.28 (C_8OH, t, ^3J = 7.2 Hz, 1H), 1.62 (C_{19}H, s, 9H,), 1.39 (C_{23}H, C_{26}H, s, 18H).

^{13}C–NMR (50 MHz, $CDCl_3$) δ (ppm): 166.33 (C_4), 162.24, 161.25, 160.00 (C_1, C_2, C_5), 157.36 (C_{17}), 152.81 (C_{20}), 149.71, 149.63 (C_{21}, C_{24}), 135.15 (C_{11}), 129.14, 128.51 (C_{12}–C_{16}), 93.76 (C_3), 84.46 (C_{22}, C_{25}), 84.34 (C_{18}), 71.18 (C_7), 70.77 (C_{10}), 63.79 (C_8), 45.90 (C_6), 35.21 (C_9), 28.52 (C_{19}), 28.29 (C_{26}, C_{23}).

CI–MS: Expected mass for $(M + H^+)/z$, 673.31. Observed 673.8 [$(M + H^+)/z$, 100%], 573.8 [$M + H^+)/z$ – Boc, 23%].
EI–MS: Expected mass for $(M^+)/z$, 672.31. Observed 711 [$(M + K^+)/z$, 11%], 672.2 [$(M^+)/z$, 33%], 373 [$(M + H^+)/z$ – 3Boc, 93%].
High-resolution EI–MS: Expected mass for $(M^+)/z$, 672.3119. Observed, 672.3131.



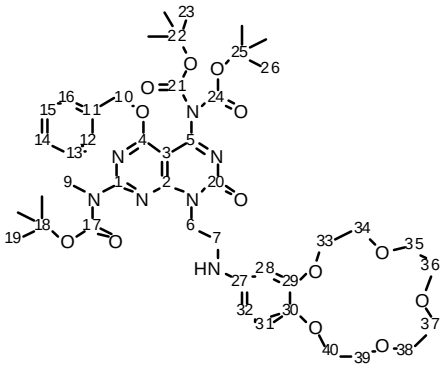
Synthesis of compound **16**.

A solution of compound **15** (12.0 g, 17.8 mmol) in CH_2Cl_2/dH_2O (4:1, 250 ml) and sodium periodate (7.63 g, 35.7 mmol) was stirred at rt for 36 h. The mixture was then filtered through a pad of celite and washed with CH_2Cl_2 (2 × 200 ml). Separation and evaporation of the organic layer under reduced pressure (rotavap) followed by gravity silica gel chromatography (5-30% EA/Hex) yielded compound **16** ($C_{31}H_{40}N_6O_9$, 9.82 g, 86%) as a white foam. R_f = 0.48 (30% EA/Hex). mp = 152°C.

^{1}H–NMR (300 MHz, $CDCl_3$) δ (ppm): 9.58 (C_7H, s, 1H), 7.39–7.29 (C_{12}H–C_{16}H, br, m, 5H), 5.53 (C_{10}H, s, 2H), 5.09 (C_6H, s, 2H), 3.34 (C_9H, s, 3H), 1.49 (C_{19}H, s, 9H), 1.27 (C_{23}H, C_{26}H, s, 18H).

^{13}C–NMR (75 MHz, $CDCl_3$) δ (ppm): 193.96 (C_7), 165.82 (C_4), 161.24, 161.16, 160.88 (C_1, C_2, C_5), 155.57 (C_{17}), 152.51 (C_{20}), 149.18 (C_{21}, C_{24}), 134.93 (C_{11}), 128.83, 128.79, 128.62 (C_{12}–C_{16}), 92.99 (C_3), 84.04 (C_{22}, C_{25}), 83.39 (C_{18}), 70.42 (C_{10}), 52.20 (C_6), 35.05 (C_9), 28.23 (C_{19}), 27.94 (C_{26}, C_{23}).

Plasma desorption MS (PD–MS): Expected mass for $(M + H^+)/z$, 641.29. Observed, 678.7 [$(M + H^+)/z + K^+$], 641.7 [$(M + H^+)/z$], 613.0 [$(M + H^+)/z$ – CO].
High-resolution CI–MS: Expected for $(M + H^+)/z$, 641.2935. Observed, 641.2945.



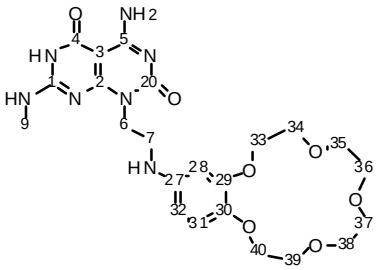
Synthesis of compound **17**.

A solution of compound **16** (0.68 g, 1.1 mmol), 4–aminobenzo–15–crown–5–ether (0.30 g, 1.1 mmol), and diisopropylethylamine (0.1 ml) in 1,2–dichloroethane (30 ml) was stirred for 10 min at rt. $Na(AcO)_3BH$ (14) (0.34 g, 1.62 mmol) was then added and the mixture was stirred at rt under N_2 atmosphere for 48 h. The reaction was quenched with dH_2O (20 ml). The aqueous layer was extracted with $CHCl_3$ (2×40 ml) and the combined organic layers were washed successively with 5% aqueous citric acid (30 ml), dH_2O (2×30 ml), and brine (40 ml), then dried over anhydrous Na_2SO_4. Filtration and evaporation of the solvent under reduced pressure (rotavap) followed by silica gel flash chromatography (30-50% EA/Hex) yielded compound **17** as an orange foam ($C_{45}H_{61}N_7O_{13}$, 0.78 g, 81%). R_f = 0.16 (5% MeOH/CH_2Cl_2). mp = 62°C.

^{1}H–NMR (300 MHz, $CDCl_3$): δ (ppm) 7.44–7.30 (C_{12}H–C_{16}H, m, 5H), 6.69 ($C_{\mathbf{31}}$H, d, ^3J = 8.4 Hz, 1H), 6.23 (C_{28}H, d, ^4J = 2.4 Hz, 1H), 6.09 ($C_{\mathbf{32}}$H, dd, ^3J = 8.4 Hz, ^4J = 2.4 Hz, 1H), 5.56 (C_{10}H, s, 2H), 4.58 (C_6H, t, ^3J = 5.7 Hz, 2H), 4.44 (NH, br, 1 H), 4.06 (C_{33}H, t, ^3J = 4.6 Hz, 2H), 4.01 (C_{40}H, t, ^3J = 4.6 Hz, 2H), 3.86–3.81 (C_{34}H, C_{39}H, m, 4H), 3.70 (C_{35}H–C_{38}H, s, 8H), 3.46 (C_7H, t, ^3J = 5.7 Hz, 2H), 3.43 (C_9H, s, 3H), 1.56 (C_{19}H, s, 9H), 1.28 (C_{23}H, C_{26}H, s, 18H).

^{13}C–NMR (75 MHz, $CDCl_3$): δ (ppm) 165.74 (C_4), 161.30, 160.90, 160.49 (C_1, C_2, C_5), 156.03 (C_{17}), 152.38 (C_{20}), 150.62 (C_{29}), 149.27 (C_{21}, C_{24}), 144.06 (C_{27}), 140.81 (C_{30}), 134.79 (C_{11}), 128.55 (C_{13}–C_{15}), 128.16 (C_{12}, C_{16}), 117.73 (C_{31}), 104.05 (C_{32}), 100.11 (C_{28}), 93.03 (C_3), 83.78 (C_{22}, C_{25}), 83.10 (C_{18}), 70.42 (C_{10}), 70.97, 70.85, 70.77, 70.07, 69.95, 69.60, 68.60 (C_{33}–C_{40}), 42.94 (C_6), 42.70 (C_7), 34.78 (C_9), 28.06 (C_{19}), 27.73 (C_{23}, C_{26}).

Positive ESI–MS: Expected mass for $(M + Na^+)/z$, 930.44. Observed, 930.0 [$(M + Na^+)/z$, 100%].
Positive high-resolution ESI–MS: Expected mass for $(M + H^+)/z$, 908.4406. Observed, 908.4440.
Positive high-resolution ESI–MS: Expected mass for $(M + Na^+)/z$, 930.4225. Observed, 930.4259.



Synthesis of module **1**.

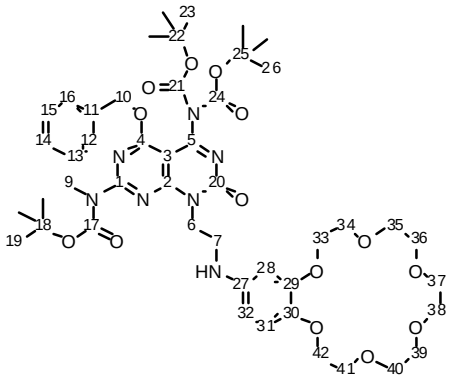
A 94% solution of trifluoroacetic acid/thioanisole (7.5 ml) was added to **17** (0.73 g, 0.81 mmol) at rt under N_2 atmosphere. After stirring for 70 h at rt, Et_2O (100 ml) was added. The precipitate formed was filtered, washed with Et_2O, and dried under vacuum. Module **1** was obtained as a white solid ($C_{23}H_{31}N_7O_7$–$(CF_3CO_2H)_2$–H_2O, 0.59 g, 95.5%). mp = 186°C (decomposed).

^{1}H–NMR (300 MHz, CD_3OD) δ (ppm): 6.77 (C_{31}H, d, ^3J = 8.4 Hz, 1H), 6.53 (C_{28}H, s, 1H), 6.36 (C_{32}H, d, ^3J = 8.4 Hz), 4.44 (C_6H, t, ^3J = 5.7 Hz, 2H), 4.08–3.71 (C_{33}H–C_{40}H, m, 16H), 3.61 (C_7H, t, ^3J = 5.7 Hz, 2H), 2.95 (C_9H, s, 3H).

^{1}H–NMR (600 MHz, 90% H_2O/D_2O, 20 mg/mL, 27°C) δ (ppm): 9.14 (^{C}H, s, 1H × 75%), 9.11 (^{C}H, s, 1H × 25%), 8.43 (^{A}H, q, ^3J = 4.8 Hz, 1H × 25%), 8.35 (^{B}H, s, 2H × 75%), 8.32 (^{B}H, s, 2H × 25%), 7.62 (^{A}H, q, ^3J = 4.8 Hz, 1H × 75%), 6.93 (C_{31}H, d, ^3J = 8.4 Hz, 1H), 6.85 (C_{28}H, s, ^4J = 2.4 Hz, 1H), 6.82 (C_{32}H, dd, ^3J = 8.4 Hz, ^4J = 2.4 Hz, 1H), 4.06 (C_6H, br, t, ^3J = 6.0 Hz, 2H), 3.85 (C_{33}H, C_{40}H, m, 4H), 3.81 (C_7H, t, ^3J = 5.4 Hz, 2H), 3.72–3.62 (C_{34}H–C_{39}H, m, 12H), 2.96 (C_9H, d, ^3J = 4.8 Hz, 3H × 25%), 2.90 (C_9H, d, ^3J = 4.8 Hz, 3H × 75%). C_7NH was suppressed with the solvent peak.

^{13}C–NMR (125 MHz, DMSO–d_6) δ (ppm): 161.52 (C_4). 160.06 (C_5), 160.00 (CF_3COOH), 156.37 (C_1), 155.74 (C_{20}), 149.83 (C_2), 148.33 (C_{29}), 143.74 (C_{27}), 137.48 (C_{30}), 116.29 (CF_3COOH), 115.93 (C_{31}), 108.55 (C_{32}), 103.45 (C_{28}), 82.29 (C_3), 70.35, 69.99, 69.74, 69.08, 68.79, 68.40 (C_{33}–C_{40}), 43.55 (C_6, C_7), 27.63 (C_9).

Positive high-resolution ESI–MS: Expected mass for $(M + H^+)/z$, 518.2363. Observed 518.2357. Elemental analysis: calculated for [$C_{23}H_{31}N_7O_7$–$(CF_3CO_2H)_2$–H_2O]: C 42.47, H 4.62, N 12.84, F 14.93. Found: C 42.37, H 4.47, N 12.77, F 14.88.



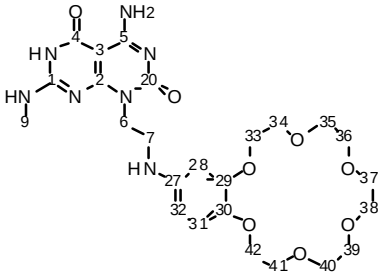
Synthesis of compound **18**.

A solution of compound **16** (0.51 g, 0.80 mmol), 4–aminobenzo–18–crown–6–ether sesquihydrate hydrochloride (0.31 g, 0.80 mmol), and diisopropylethylamine (0.28 ml, 1.6 mmol) in 1,2–dichloroethane (30 ml) was stirred for 30 min at rt. $Na(AcO)_3BH$[15] (0.41 g, 1.93 mmol) was then added and the mixture was stirred at rt under N_2 atmosphere for 60 h. The reaction was quenched with dH_2O (10 ml). The aqueous layer was extracted with CH_2Cl_2 (3×15 ml) and the combined organic layers were washed successively with 10% aqueous citric acid (15 ml), dH_2O (2×30 ml), and brine (20 ml), then dried over anhydrous Na_2SO_4. Filtration and evaporation of the solvent under reduced pressure (rotavap) followed by silica gel flash chromatography (30-50% EA/Hex) yielded compound **18** as a orange foam ($C_{47}H_{65}N_7O_{14}$, 0.52 g, 68%). R_f = 0.11 (5% MeOH/CH_2Cl_2). mp = 51°C.

^{1}H–NMR (300 MHz, $CDCl_3$): δ (ppm) 7.44–7.32 (C_{12}H–C_{16}H, m, 5H), 6.73 (C_{31}H, d, ^3J = 8.4 Hz, 1H), 6.26 (C_{28}H, d, ^4J = 2.4 Hz, 1H), 6.12 (C_{32}H, dd, ^3J = 8.4 Hz, ^4J = 2.4 Hz, 1H), 5.56 (C_{10}H, s, 2H), 4.61 (C_6H, t, ^3J = 5.7 Hz, 2H), 4.44 (NH, br, 1H), 4.11 (C_{33}H, t, ^3J = 4.6 Hz, 2H), 4.05 (C_{42}H, t, ^3J = 4.6 Hz, 2H), 3.91 (C_{34}H, t, ^3J = 4.6 Hz, 2H), 3.85 (C_{41}H, t, ^3J = 4.6 Hz, 2H), 3.74–3.37 (m, C_{35}H–C_{40}H, m, 12H), 3.49 (C_7H, t, ^3J = 5.7 Hz, 2H), 3.46 (s, C_9H, 3H), 1.59 (C_{19}H, s, 9H), 1.31 (C_{23}H, C_{26}H, s, 18H).

^{13}C–NMR (125 MHz, $CDCl_3$): δ (ppm) 165.56 (C_4), 161.14, 160.73, 160.30 (C_1, C2, C5), 155.82 (C_{17}), 152.19 (C_{20}), 150.31 (C_{29}), 149.07 (C_{21}, C_{24}), 143.93 (C_{27}), 140.51 (C_{30}), 134.61 (C_{11}), 128.38 (C_{13}–C_{15}), 127.99 (C_{12}, C_{16}), 117.69 (C_{31}), 103.95 (C_{32}), 100.27 (C_{28}), 92.82 (C_3), 83.58 (C_{22}, C_{25}), 82.92 (C_{18}), 70.41 (C_{10}), 70.59, 70.46, 69.91, 69.82, 69.55, 68.66 (C_{33}–C_{42}), 42.72 (C_6), 42.50 (C_7), 34.62 (C_9), 27.88 (C_{19}), 27.55 (C_{23}, C_{26}).

Positive ESI–MS: Expected mass for $(M + H^+)/z$, 952.47. Observed, 974.3 [$(M + Na^+)/z$, 22%], 952.0 [$(M + H^+)/z$, 75%], 852.2 [$(M + H^+)/z$ – Boc, 64%], 752.3 [$(M + H^+)/z$ – 2Boc, 100%]. Positive high-resolution ESI–MS: Expected mass for $(M + H^+)/z$, 952.4668. Observed, 952.4666.



Synthesis of module **2**.

A 94% solution of TFA/thioanisole (15 ml) was added to **18** (0.54 g, 0.57 mmol) at rt under N_2 atmosphere. After stirring for 70 h at rt, Et_2O (50 ml) was added. The precipitate formed was filtered, washed with Et_2O, and dried under vacuum. Module **2** was obtained as a white solid [$C_{25}H_{35}N_7O_8$–$(CF_3CO_2H)_2$–H_2O, 0.42 g, 91%]. mp = 164°C (decomposed).

^{1}H–NMR (300 MHz, CD_3OD) δ (ppm): 6.66 (C_{32}H, dd, ^3J = 8.4 Hz, ^4J = 2.1 Hz, 1H), 6.47 (C_{28}H, s, ^4J = 2.1 Hz, 1H), 6.18 (C_{31}H, d, ^3J = 8.4 Hz), 4.43 (C_6H, t, ^3J = 5.7 Hz, 2H), 4.14–3.65 (C_{33}H–C_{42}H, m, 20 H), 3.59 (C_7H, t, ^3J = 5.7 Hz, 2H), 2.99 (C_9H, s, 3H).

^{1}H–NMR (600 MHz, 90% H_2O/D_2O, 20 mg/ml, 2°C) δ (ppm): 9.17 (^{C}H, s, 1H × 75%), 9.14 (^{C}H, s, 1H × 25%), 8.61 (^{A}H, q, ^3J = 4.8 Hz, 1H × 25%), 8.45 (^{B}H, s, 2H × 75%), 8.42 (^{B}H, s, 2H × 25%), 7.72 (^{A}H, q, ^3J = 4.8 Hz, 1H × 75%), 6.93 (C_{31}H, d, ^3J = 8.4 Hz, 1H), 6.85 (C_{28}H, s, ^4J = 2.4 Hz, 1H), 6.82 (C_{32}H, dd, ^3J = 8.4 Hz, ^4J = 2.4 Hz, 1H), 4.12 (C_6H, br, t, 2H), 3.90–3.83 (C_7H, C_{33}H, C_{40}H, m, 6H), 3.73–3.64 (C_{34}H–C_{39}H, m, 16H), 2.98 (C_9H, d, ^3J = 4.8 Hz, 3H × 25%), 2.94 (C_9H, d, ^3J = 4.8 Hz, 3H × 75%). C_7NH was suppressed with the solvent peak.

^{13}C–NMR (125 MHz, CD_3OD) δ (ppm): 162.82 (C_4). 161.97 (C_5), 157.40 (C_1), 150.96 (C_{20}), 149.93 (C_2), 130.00 (C_{29}), 129.74 (C_{27}), 127.76 (C_{30}), 115.44 (C_{31}), 110.85 (C_{32}), 104.54 (C_{28}), 83.81 (C_3), 71.76, 71.61, 71.30, 71.22, 70.83, 70.32, 69.58 (C_{33}–C_{42}), 45.71 (C_6) , 41.83 (C_7), 28.72 (C_9).

Positive high-resolution ESI–MS: Expected mass for $(M + H^+)/z$, 562.2625. Observed 562.2631. Elemental analysis: Calculated for [$C_{25}H_{35}N_7O_8$–$(CF_3CO_2H)_2$–H_2O]: C 43.13, H 4.87, N 12.14, F 14.11. Found: C 43.21, H 4.56, N 11.95, F 13.97.

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