Supporting Information

Diastereoselective Synthesis of [1]Rotaxane via Active Metal Template Strategy.

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I. Chemistry Section

I.1. General experimental methods

Synthesis: All reactions were performed under an argon atmosphere. Unless otherwise stated, solvents used were of HPLC quality. For oxygen sensitive reactions like copper catalysed reaction, solvents were deoxygenated by purging with argon. Chemicals were of analytical grade from commercial sources and were used without further purification. Reaction were monitored using precoated silica gel TLC plates MACHEREY-NAGEL ALUGRAM® SIL G/UV254. (0.2 mm silica gel 60). Spots were visualized under 254 nm UV light and/or by dipping the TLC plate into a solution of phosphomolybdic acid (3 g) in ethanol (100 mL) followed by heating with a heat gun. Automatic flash chromatography was performed on Combi Flash 210i (Teledyne-Isco) with pre-packed column purchased from Interchim, Silicycle or Buchi. Particles size (from 50 μm to 15 μm) and column size (4 g to 280 g) were adapted according the difficulty of the purification and the quantity of crude product.

Analysis: $^1$H, $^{13}$C and $^{19}$F NMR spectra were respectively recorded at 400 MHz, 100MHz and 376 MHz, on a Bruker 400 Avance III instrument, equipped with an ultrashielded plus magnet and a BBFO 5 mm broadband probe or at 500 MHz, 126 MHz, and 470 MHz on a Bruker 500 Avance NEO instrument, equipped with an ultrashielded magnet and a Prodigy cryoprobe. $^1$H and $^{13}$C NMR spectra of compound (S)-3 were respectively recorded at 500 and 126 MHz on a BRUKER TXI-1H-13C-15N cryoprobe based on Rennes analytical platform PRISM. Chemical shifts (δ) are reported in parts per million (ppm) from low to high field and referenced to residual solvent peaks or using C$_6$F$_6$ as external reference for $^{19}$F. Coupling constants (J) are reported in hertz (Hz). Standard abbreviations indicating multiplicity are used as follows: b = broad, s = singlet, d = doublet, t = triplet, q = quartet, qi = quintet, m = multiplet, dd = doublet of doublets. High-resolution mass spectra (HRMS) were performed on a Bruker maXis mass spectrometer by the "Fédération de Recherche" ICOA/CBM (FR2708) platform and by the mass spectrometry service or Poitiers (Platina) on a LC-QToF MaXis Impact, Bruker. Circular dichroism (CD) spectra were recorded on a Jasco (model J-815) spectropolarimeter equipped with a Peltier thermostated cell holder and Xe laser. Data were recorded in distilled methylene chloride at 20 °C using a 1 mm*1 cm cell. The obtained signals were processed by subtracting solvent and cell contribution.
**HPLC method:** Reaction follow-up and compound purity were performed on DIONEX Ultimate 3000 with UV light set to 254 nm with MACHELY-NAGEL Nucleoshell® (150/4.6, RP18, 5 μm) column in a thermostatically controlled oven at 30 °C. Spectra analysis was carried out with the software Chromeleon. Eluents were A (H₂O + 0.2 % TFA), B (MeCN) and solvent flow: 1.25 mL.min⁻¹. Method: linear gradient beginning with A/B 80:20 reaching A/B 0:100 within 8 minutes, then isocratic A/B 0:100 for 5 minutes and linear gradient toward A/B 80:20 within 2 minutes.

The following compounds were synthesized according to literature procedures:

![Chemical structures](image)

**Scheme S1. References of literature procedures:** compound 11,¹ compound 15,² compound 2a,³ compound 16,⁴ compound 27.⁵

**I.2. Synthetic schemes towards compounds 5a, 5b, (S)-1/(R)-1, 4, (S)-3/(R)-3, 2b, 29, (S)-7, (S)-32, (S)-9.**

Compound 5a was prepared according to the following strategy:

![Chemical structures](image)

**Scheme S2. Reagents and conditions:** (a) DMF, MeCN, CO(Cl)₂, (R)-Mosher’s acid, Et₃N, 0 °C to RT, 22 h, 36%; (b) DIBAL-H, THF, -78 °C, 1 h, 93%; (c) 4-nitrophenyl chloroformate, pyridine, DCM, 0 °C to RT, 5 h, 83%; (d) i) HOBt, DMF [0.08M], 33 °C, 8 h; ii) DMF [0.001M], 33 °C, 48 h, 36%.
Compound 5b was prepared according to the following strategy:

Scheme S3. Reagents and conditions: (a) allyl chloroformate, pyridine, DCM, 0 °C to RT, 3 h, 94%; (b) APTS.H₂O, THF, H₂O, 0 °C to RT, 24 h, not purified; (c) 4-nitrophenyl chloroformate, pyridine, DCM, 0 °C to RT, 3 h, 68% (two steps); (d) HOBt, DMF [0.08M], RT, 8 h; ii) DMF [0.001M], RT, 96 h, 42%.

Compound (S)-1 and (R)-1 were prepared according to the following strategy:

Scheme S4. Reagents and conditions: (a) (R)- or (S)-Fmoc-Phe-OH, ethyl chloroformate, Et₃N, DMF/DCM, RT, 18 h, quantitative.; (b) APTS.H₂O, THF, H₂O, 0 °C to RT, 5 h, not purified; (c) 4-nitrophenyl chloroformate, pyridine, THF, 0 °C to RT, 5 h, 80% (over two steps); (d) HOBt.H₂O, DMF [0.08M], 33 °C, 8 h; ii) DMF [0.001M], 33 °C, 4 days, not purified; (e) piperidine, DMF, RT, 1 h, 36% (over two steps); (f) 6-heptynoic acid 25, DMAP, EDC.HCl, DMF, RT, 24 h, 86%.
Compounds (S)-4 and (R)-4 were prepared according to the following strategy:

**Scheme S5.** *Reagents and conditions:* (a) [Cu(MeCN)₄]PF₆, DCM, RT, 18 h, 49%; (b) (R)- or (S)-24, DMAP, EDC.HCl, DMF, RT, 24 h, 84%.

Compounds (S)-3 and (R)-3 were prepared according to the following strategy:

**Scheme S6.** *Reagents and conditions:* (a) [Cu(MeCN)₄]PF₆, 5a or 5b, DCM, 60 °C, 24 h, 45%. *Mechanical planar chirality drawn as (Rᵐᵖ) for visual purposes, not experimentally determined.*

Compound 2b was prepared according to the following strategy:

**Scheme S7.** *Reagents and conditions:* (a) DMAP, EDC.HCl, DCM, RT, 3 h, 95%.
Compound (S)-29 was prepared according to the following strategy:

\[
\text{Scheme S8. Reagents and conditions: (a) [Cu(MeCN)]PF}_6, \text{ DCM, RT, 20 h, 60%; (b) (S)-24, DMAP, EDC.HCl, DMF, 35 °C, 24 h, 45%}.\]

Compound (S)-7 was prepared according to the following strategy:

\[
\text{Scheme S9. Reagents and conditions: [Cu(MeCN)]PF}_6, \text{ 5a, DCM, 60 °C, 24 h, 26%}.\]

*Mechanical planar chirality drawn as (R) for visual purposes, not experimentally determined.*
Compound (S)-32 was prepared according to the following strategy:

Scheme S10. Reagents and conditions: (a) triphenylphosphine, THF/NH$_2$OH, 65 °C, 5 h, 97%; (b) 27, DMAP, EDC.HCl, DMF, RT, 12 h, 66%; (c) 25, [Cu(MeCN)$_4$]PF$_6$, DCM, RT, 18 h, 74%; (d) (S)-24, DMAP, EDC.HCl, DMF, RT, 48 h, 85%.

Compound (S)-9 was prepared according to the following strategy:

Scheme S11. Reagents and conditions: (a) DIPEA, DCM, 40 °C, 48 h, 54%. Mechanical planar chiralities drawn as (R)$_{mp}$ for visual purposes, not experimentally determined.
I.3. Synthetic procedures and characterization details with $^1$H NMR and $^{13}$C NMR plots

**Preparation of compound 12**

Oxalyl chloride (1.7 mL, 19.4 mmol, 1 equiv.) was added to a cooled solution at 0 °C of dry DMF (2.14 mL, 27.6 mmol, 1.4 equiv.) in MeCN (60 mL). A solution of (R)-(+)-$\alpha$-methoxy-$\alpha$-trifluoromethylphenylacetic acid ((R)-Mosher’s acid) (5.0 g, 21.4 mmol, 1.1 equiv.) in MeCN (15 mL) was then added. After 30 minutes stirring, a solution of aniline 11 (3.79 g, 19.4 mmol, 1 equiv.) in MeCN (25 mL) was added followed by addition of a solution of dry Et$_3$N (3.0 mL, 19.4 mmol, 1 equiv.) in MeCN (100 mL). The reaction mixture was allowed to room temperature and stirring was pursued for 22 hours. Solvents were removed *in vacuo* and the crude was diluted with DCM (100 mL). The organic layer was washed with saturated NaHCO$_3$(aq) (3 x 100 mL), dried over MgSO$_4$, filtered and concentrated *in vacuo*. Chromatography (petrol/AcOEt, gradient elution 90:10 to 70:30, $R_f$ = 0.4 (70:30)) gave 12 as a colorless wax (2.87 g, 6.98 mmol, 36%).

$^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 10.23 (bs, 1H, H$_{\text{NH-amide}}$), 8.32 (d, $J$ = 8.6, 1H, H$_1$), 7.98 (dd, $J$ = 8.6, 2.0, 1H, H$_4$), 7.81 (d, $J$ = 2.0, 1H, H$_4$), 7.62 (m, 2H, H$_2$), 7.43 – 7.40 (m, 3H, H$_1$, H$_3$), 4.74 (dd, $J$ = 12.6, 4.2, 1H, H$_G'$), 4.66 (dd, $J$ = 12.6, 3.9, 1H, H$_G'$), 4.33 (q, $J$ = 7.1, 2H, H$_5$), 3.53 (s, 3H, H$_4$), 2.45 (bs, 1H, H$_{\text{OH}}$), 1.37 (t, $J$ = 7.1, 3H, H$_6$).

$^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$ 166.1 (C$_{\text{CO-ester}}$), 165.3 (C$_{\text{CO-amide}}$), 141.0-132.4 (C$_{\text{quat. arom.}}$), 130.9 (C$_1$), 130.1 (C$_H$), 129.8 (C$_3$), 129.0 (C$_{\text{quat. arom.}}$), 128.8 (C$_1$), [128.2-125.3-122.4-119.5] (q, $J$ = 290, C$_{\text{CF3}}$), 127.7 (C$_2$), 126.3 (C$_{\text{quat. arom.}}$), 121.2 (C$_1$), [8.0-84.7-84.5-84.2] (q, $J$ = 27, C$_{\text{quat.}}$), 64.4 (C$_G'$), 61.2 (C$_3$), 55.5 (C$_4$), 14.4 (C$_6$).

HRMS (ESI$^+$) $m/z$ = 434.1187 [M+Na]$^+$ (calc. for C$_{20}$H$_{20}$F$_3$NO$_5$Na: 434.1191 [M+Na]$^+$).
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1H NMR spectrum of 12, 400 MHz, 298 K, CDCl3

13C NMR spectrum of 12, 100 MHz, 298 K, CDCl3
Preparation of compound 13

A solution of 12 (314 mg, 0.76 mmol, 1 equiv.) in anhydrous THF (8.4 mL) was cooled to -78 °C and a 1 M solution of DIBAL-H in DCM (3.05 mL, 3.05 mmol, 4 equiv.) was added dropwise. The reaction mixture was stirred for 7 hours at −78 °C and then poured in 20 mL of a saturated aqueous solution of Rochelle salt. The mixture was stirred for 1 hour and subsequently extracted with diethyl ether (3 x 10 mL) and AcOEt (3 x 10 mL). The organic layers were dried over MgSO₄, filtered and concentrated in vacuo. Chromatography (petrol/AcOEt, gradient elution 60:40 to 40:60, \( R_f = 0.4 \) (40:60)) gave 13 as a colorless wax (260 mg, 0.704 mmol, 93%).

\(^1\text{H NMR}\) (500 MHz, CDCl₃) δ 9.82 (s, 1H, H_{NH-amide}), 8.08 (d, \( J = 8.3 \), 1H, H₁), 7.63 (dd, \( J = 2.6 \), 6.5, 2H, H₂), 7.43-7.42 (m, 3H, H₂, H₃), 7.30 (dd, \( J = 8.3 \), 1.9, 1H, H₁), 7.20 (d, \( J = 1.8 \), 1H, H₄), 4.68 (d, \( J = 12.3 \), 1H, H₁), 4.63 (s, 2H, H₂), 4.59 (d, \( J = 12.4 \), 1H, H₂), 3.54 (s, 3H, H₄), 2.25 (bs, 1H, H_{OH}), 1.86 (bs, 1H, H_{OH}).

\(^{13}\text{C NMR}\) (126 MHz, CDCl₃) δ 165.2 (C_{CO-amide}), 137.7-135.8-132.6-130.3 (C_{quat. arom.}), 129.8 (C₂), 128.8 (C₃), 127.8 (C₁, C₅), 127.7 (C₄), [127.3-125.0-122.7-120.4] (q, \( J = 290 \), C_{CF₃}), 122.5 (C₇), [84.8-84.6-84.4-84.2] (q, \( J = 26 \), C_{quat.}), 64.8 (C₆), 64.3 (C₅), 55.5 (C₄).

\(^{19}\text{F NMR}\) (376 MHz, CDCl₃) δ -68.75 (s, CF₃)

**HRMS (ESI⁺)** m/z = 392.1086 [M+Na]⁺ (calc. for C₁₈H₁₈F₃NO₄Na: 392.1085 [M+Na]⁺).
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$^{1}H$ NMR spectrum of 13, 500 MHz, 298 K, CDCl$_3$

$^{13}C$ NMR spectrum of 13, 126 MHz, 298 K, CDCl$_3$
$^{19}$F NMR spectrum of 13, 470 MHz, 298 K, CDCl$_3$
Preparation of compound 14

To a stirred solution of dialcohol 13 (627 mg, 1.7 mmol, 1 equiv.) and 4-nitrophenoxychloroformate (1.37 g, 6.8 mmol, 4 equiv.) in anhydrous DCM (32 mL) cooled at 0 °C, was added pyridine (96 µL, 1.18 mmol, 4 equiv.) dropwise. The reaction mixture was stirred for 20 minutes at 0°C and warmed up to room temperature for 5 hours. The reaction was hydrolyzed with saturated NaHCO$_3$(aq) and the aqueous phase was extracted with DCM (3x). The combined organic layers were dried over MgSO$_4$, filtered and concentrated in vacuo. Chromatography (petrol/AcOEt, gradient elution 90:10 to 70:30, $R_f = 0.4$ (60:40)) gave 14 as a colorless wax (984 mg, 1.41 mmol, 83%).

$^1$H NMR (400 MHz, CDCl$_3$) δ 9.41 (s, 1H, H$_{NH}$-amide), 8.29 – 8.26 (m, 4H, H$_a$, H$_{a'}$), 8.01 (d, $J = 8.2$, 1H, H$_1$), 7.63 – 7.60 (m, 2H, H$_1$), 7.54 – 7.51 (m, 2H, H$_b$, H$_{b'}$), 7.44 (m, 3H, H$_2$, H$_3$), 7.39 – 7.34 (m, 4H, H$_b$, H$_{b'}$), 5.32 (d, $J = 12.6$, 1H, H$_G'$), 5.29 (s, 2H, H$_G$), 5.24 (d, $J = 12.6$, 1H, H$_G'$), 3.50 (s, 3H, H$_4$).

$^{13}$C NMR (126 MHz, CDCl$_3$) δ 165.3 (C$_{CO}$-amide), 155.5-155.3 (C$_{CO}$-carbonate), 152.6-152.5-145.7-145.8-136.5-132.0-131.9 (C$_{quat.}$ arom.), 131.6 (C$_n$), 131.1 (C$_i$), 130.0 (C$_2$), 129.0 (C$_3$), 127.8 (C$_1$), [127.3-125.0-122.7-120.4] (q, $J = 290$, C$_{CF3}$), 126.0 (C$_{quat.}$ arom.), 125.5 (C$_w$, C$_{a'}$), 124.3 (C$_i$), 121.9-121.8 (C$_b$, C$_{b'}$), 84.5 (q, $J = 26.6$, C$_{quat.}$)70.1 (C$_G$), 67.8 (C$_{G'}$), 55.5 (C$_4$).

$^{19}$F NMR (376 MHz, CDCl$_3$) δ -68.72 (s, CF$_3$)

HRMS (ESI$^+$) $m/z = 722.1203$ [M+Na]$^+$ (calc. for C$_{32}$H$_{24}$F$_3$N$_3$O$_{12}$Na: 722.1204 [M+Na]$^+$).
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H NMR spectrum of 14, 400 MHz, 298 K, CDCl₃

C NMR spectrum of 14, 126 MHz, 298 K, CDCl₃
$^{19}$F NMR spectrum of 14, 376 MHz, 298 K, CDCl$_3$
Preparation of compound 5a

To a solution of carbonate 14 (300 mg, 0.43 mmol, 1 equiv.) and di-aniline 15 (345 mg, 0.98 mmol, 2.3 equiv.) in DMF (5.4 mL), was added HOBt (58 mg, 0.43 mmol, 1 equiv.) and the solution was stirred for 8 hours at 33 °C. The solution was diluted with DMF (430 mL) and stirred for 48 hours at 33 °C. The solvent was removed in vacuo and the crude material was diluted with DCM (100 mL) and washed with saturated NaHCO₃(aq) (3 x 50 mL). The organic layer was dried over MgSO₄, filtered and concentrated in vacuo. Chromatography (DCM/MeOH, gradient elution 100:0 to 95:5, \(R_f = 0.5\) (95:5)) gave 5a as a white solid (119 mg, 0.155 mmol, 36%).

\(^1\)H NMR (500 MHz, CD₂Cl₂) δ 9.67 (bs, 1H, H\(_{\text{NH-amide}}\)), 7.82 (d, \(J = 8.2\), 1H, H\(_4\)), 7.71 (t, \(J = 7.7\), 1H, H\(_A\)), 7.66 (m, 2H, H\(_J\)), 7.46 (m, 5H, H\(_{\text{quat. arom.}}\), H\(_3\), H\(_2\)), 7.38 (d, \(J = 8.3\), 1H, H\(_I\)), 7.31 (2d, \(J = 7.4\), 2H, H\(_B\), H\(_{B'}\)), 7.19 – 7.105 (m, 9H, H\(_E\), H\(_{E'}\)), 4.94 (d, \(J = 12.8\), 1H, H\(_G\)), 4.47 (2s, 4H, H\(_C\), H\(_C'\)), 4.40-4.35 (2s, 4H, H\(_D\), H\(_D'\)), 3.57 (s, 3H, H\(_4\)).

\(^{13}\)C NMR (126 MHz, CD₂Cl₂) δ 165.6 (C\(_{\text{CO-amide}}\)), 158.1-157.9 (C\(_{\text{quat. arom.}}\)), 153.8-153.6 (C\(_{\text{CO-carbamate}}\)), 138.2 (C\(_{\text{quat. arom.}}\)), 137.7 (C\(_A\)), 135.7-135.0-133.1-132.8 (C\(_{\text{quat. arom.}}\)), 131.7 (C\(_H\)), 130.2 (C\(_J\)), 129.8 (C\(_3\)), 129.7-129.7 (C\(_E\), C\(_C'\)), 129.4 (C\(_2\)), 129.2 (C\(_{\text{quat. arom.}}\)), 128.2 (C\(_1\)), [127.9-125.6-123.3-121.7] (q, \(J = 126\), C\(_{CF3}\)), 124.5 (C\(_I\)), 121.2 (C\(_B\)), 118.7 (C\(_F\), C\(_F'\)), 85.0 (q, \(J = 26\), C\(_{\text{quat.}}\)), 72.3-72.1 (C\(_D\), C\(_{D'}\)), 71.8-71.3 (C\(_C\), C\(_C'\)), 66.3 (C\(_G\)), 63.2 (C\(_G'\)), 55.9 (C\(_4\)).

\(^{19}\)F NMR (376 MHz, CD₂Cl₂) δ -69.25 (s, CF₃).

HRMS (ESI⁺) \(m/z = 793.2457\) [M+Na]⁺ (calc. for C₄₁H₃₇F₃N₄O₈Na: 793.2456 [M+Na]⁺)

HPLC rt: 5.45 minutes
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N
O
O
NH
NH
O
O
O
O
N
H
OCH₃
CF₃

A
B
C
D
E
F
G
H
I
J
B'
C'
D'
E'
F'
G'
1
2
3
4
5a

-0.5
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
6.5
7.0
7.5
8.0
8.5
9.0
9.5
10.0

f1 (ppm)

3.3
4.1
4.3
1.1
1.1
2.1
8.7
2.4
1.3
5.5
2.3
1.3
1.0
0.8

3.57
4.35
4.40
4.47
4.48
4.93
4.95
5.04
5.07
5.10
7.05
7.12
7.30
7.31
7.33
7.37
7.39
7.45
7.46
7.46
7.65
7.66
7.66
7.69
7.71
7.72
7.81
7.82

9.67

1H NMR spectrum of 5a, 500 MHz, 298 K, CD₂Cl₂

55.9
63.2
66.3
71.3
71.8
72.1
72.3
84.6
84.8
85.0
85.2
118.7
121.2
121.7
123.3
124.5
125.6
127.9
128.2
129.2
129.4
129.7
129.8
130.2
131.7
132.7
132.8
133.1
135.0
135.7
137.7
138.2
153.6
153.8
157.9
158.1
165.6

13C NMR spectrum of 5a, 126 MHz, 298 K, CD₂Cl₂
$^{19}$F NMR spectrum of 5a, 376 MHz, 298 K, CDCl$_3$
Preparation of compound 17

To a stirred solution of aniline 16 (1.95 g, 5.12 mmol, 1 equiv.) in anhydrous DCM (49 mL) cooled at 0 °C, was added pyridine (0.83 mL, 10.24 mmol, 2 equiv.) and allyl chloroformate (0.57 mL, 5.38 mmol, 1.05 equiv.). The reaction mixture was stirred for 20 minutes at 0 °C and warmed up to room temperature for 3 hours. The reaction was hydrolyzed with saturated NH₄Cl(aq) (2x). The organic layer was dried over MgSO₄, filtered and concentrated in vacuo. Chromatography (petrol/AcOEt, gradient elution 100:0 to 95:5, Rf = 0.6 (90:10)) gave 17 as a light brown oil (2.25 g, 4.83 mmol, 94%).

**¹H NMR** (500 MHz, CDCl₃) δ: 8.35 (bs, 1H, H_NH), 7.99 (bs, 1H, H_I), 7.22 (dd, J = 8.4, 1.7, 1H, H_I), 7.05 (d, J = 1.2, 1H, H_H), 5.97 (ddt, J = 17.2, 10.7, 5.5 Hz, 1H, H_J), 5.35 (dq, J = 17.2, 1.6 Hz, 1H, H_J-trans), 5.23 (dq, J = 10.5, 1.4 Hz, 1H, H_J-cis), 4.72 (s, 2H, H_G'), 4.67 – 4.66 (m, 4H, H_G, H_1), 0.92-0.90 (2s, 18H, H_a, H_a'), 0.09-0.08 (2s, 12H, H_b, H_b').

**¹³C NMR** (125 MHz, CDCl₃) δ 153.6 (CO), 137.0-135.9 (C_quat. arom.), 132.9 (C_2), 128.1 (C_quat. arom.), 126.7 (C_1), 126.0 (C_1'), 119.8 (C_3), 117.6 (C_3), 65.6 (C_1), 65.5 (C_1'), 64.7 (C_0), 26.1-25.9 (C_a, C_a'), 18.6-18.2 (C_quat. t-bu), -5.1 (C_b), -5.3 (C_b').

**HRMS (ESI⁺)** m/z = 488.2625 [M+Na]⁺ (calc. for C₂₄H₄₃NO₄Si₂Na: 488.2623 [M+Na]⁺)
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$-0.5 \quad 0.0 \quad 0.5 \quad 1.0 \quad 1.5 \quad 2.0 \quad 2.5 \quad 3.0 \quad 3.5 \quad 4.0 \quad 4.5 \quad 5.0 \quad 5.5 \quad 6.0 \quad 6.5 \quad 7.0 \quad 7.5 \quad 8.0 \quad 8.5$ $f_1 (ppm)$

$N$ $H$ $O$ $O$ $O$ $Si$ $Si$ $H$ $I$ $J$ $G$ $G'$ $a$ $b$ $a'$ $b'$ $1$ $2$ $3$

$^{1}H$ NMR spectrum of 17, 500 MHz, 298 K, CDCl$_3$

$N$ $H$ $O$ $O$ $O$ $17$ $Si$ $Si$ $H$ $I$ $J$ $G$ $G'$ $a$ $b$ $a'$ $b'$ $1$ $2$ $3$

$^{13}C$ NMR spectrum of 17, 126 MHz, 298 K, CDCl$_3$
Preparation of compound 18

To a stirred solution of compound 17 (1.33 g, 2.85 mmol, 1 equiv.) in THF (26 mL) cooled at 0 °C, was added dropwise a solution of APTS.H₂O (326 mg, 1.71 mmol, 0.6 equiv.) in water (3 mL). The reaction mixture was stirred at room temperature for 24 hours. The reaction was hydrolyzed with water and the solution was extracted with Et₂O (2x). The aqueous layer was saturated with NaCl and extracted with Et₂O (2x). The combined organic layers were dried over MgSO₄, filtered and concentrated in vacuo to give 18 without further purification as a white solid (1.1 g).

¹H NMR (400 MHz, CDCl₃) δ: 7.94 (bs, 1H, HNH), 7.89 (d, J = 7.4, 1H, H₁), 7.29 (s, 1H, Hᵢ), 7.16 (s, 1H, Hᵢ), 5.97 (ddt, J = 17.2, 10.7, 5.5 Hz, 1H, H₂), 5.35 (dd, J = 17.2, 1.4, 1H, H₃-trans), 5.23 (dd, J = 10.5, 1.4, 1H, H₃-cis), 4.6 (2s, 4H, H₁G', H₁), 4.60 (s, 2H, H₂G).

HRMS (ESI⁺) m/z = 260.0893[M+Na]⁺ (calc. for C₁₂H₁₅NO₄Na: 260.0893[M+Na]⁺)

¹H NMR spectrum of 18, 400 MHz, 298 K, CDCl₃
Preparation of compound 19

To a stirred solution of crude dialcohol 18 (1.1 g, 4.6 mmol, 1 equiv.) and 4-nitrophenyl chloroformate (3.7 g, 18.4 mmol, 4 equiv.) in anhydrous DCM (80 mL) cooled at 0 °C, was added pyridine (1.5 mL, 18.4 mmol, 4 equiv.) dropwise. The reaction mixture was stirred for 20 minutes at 0 °C and warmed up to room temperature for 3 hours. The reaction was hydrolyzed with saturated NaHCO$_3$(aq) and the aqueous phase was extracted with DCM (3x). The combined organic layers were dried over MgSO$_4$, filtered and concentrated in vacuo. Chromatography (petrol/AcOEt, gradient elution 80:20 to 40:60, $R_f = 0.3$ (70:30)) gave 19 as a white solid (1.1 g, 1.94 mmol, 68% over two steps).

$^1$H NMR (500 MHz, CD$_2$Cl$_2$) $\delta$ 8.25 (2d, $J = 9.3$, 4H, H$_a$, H$_{a'}$), 7.91 (d, $J = 7.9$, 1H, H$_i$), 7.54 (d, $J = 1.9$, 1H, H$_h$), 7.51 (m, 2H, H$_{NH}$, H$_j$), 7.39 (2d, $J = 9.2$, 4H, H$_b$, H$_{b'}$), 5.99 (ddt, $J = 16.2$, 10.5, 5.7, 1H, H$_2$), 5.44 – 5.16 (m, 6H, H$_3$, H$_G$, H$_{G'}$), 4.66 (dt, $J = 5.7$, 1.3, 2H, H$_3$).

$^{13}$C NMR (126 MHz, CD$_2$Cl$_2$) $\delta$ 156.0-155.8-154.0-153.3-152.9-146.0-145.9-138.2 (C$_{CD}$-carbonate, C$_{CD}$-carbamate, C$_{quat. arom.}$), 133.0 (C$_2$), 132.2 (C$_{ii}$), 131.3 (C$_i$), 131.0 (C$_{quat. arom.}$), 125.8-125.7 (C$_{ar}$, C$_{ar'}$), 123.4 (C$_{j}$), 122.3 (C$_b$, C$_{b'}$), 118.5 (C$_3$), 70.6 (C$_G$), 68.2 (C$_{G'}$), 66.6 (C$_i$).

HRMS (ESI$^+$) $m/z = 590.1011$ [M+Na]$^+$ (calc. for C$_{26}$H$_{21}$N$_3$O$_{12}$Na: 590.1017 [M+Na]$^+$).
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$^1$H NMR spectrum of 19, 500 MHz, 298 K, CD$_2$Cl$_2$

$^{13}$C NMR spectrum of 19, 126 MHz, 298 K, CD$_2$Cl$_2$
Preparation of compound 5b

To a solution of carbonate 19 (283 mg, 0.5 mmol, 1 equiv.) and di-aniline 15 (402 mg, 1.15 mmol, 2.3 equiv.) in DMF (6.85 mL), was added HOBt.H₂O (68 mg, 0.5 mmol, 1 equiv.) and the solution was stirred for 8 hours at room temperature. The solution was diluted with DMF (500 mL) and stirred for 96 hours at room temperature. The solvent was removed in vacuo, the crude material was diluted with DCM (100 mL) and washed with saturated NaHCO₃(aq) (3 x 20 mL). The organic layer was dried over MgSO₄, filtered and concentrated in vacuo. Chromatography (DCM/MeOH, gradient elution 100:0 to 97:3, Rf = 0.4 (95:5)) gave 5b as a white solid (133 mg, 0.21 mmol, 42%).

**1H NMR** (400 MHz, CD₂Cl₂) δ 7.74 (bs, 1H, H_1), 7.68 (t, J = 7.7, 1H, H_A), 7.48 (d, J = 1.9, 1H, H_3), 7.35 (dd, J = 8.4, 1.9, 1H, H_I), 7.29 (d, J = 7.7, 2H, H_B, H_B'), 7.21 – 7.14 (m, 8H, H_E, H_G, H_H, H_F), 7.14 (bs, 1H, H_NH-carbamate), 6.01 (ddt, J = 17.1, 10.0, 5.7, 1H, H_2), 5.38 (dd, J_\text{trans} = 17.2, 1.5, H_3), 5.27 (dd, J_\text{cis} = 10.4, 1.3, 1H, H_3), 5.12 – 5.14 (2s, 4H, H_G, H_G'), 4.66 (dt, J = 5.7, 1.3, 2H, H_1), 4.50-4.49 (2s, 4H, H_C, H_C'), 4.39 (m, 4H, H_D, H_D').

**13C NMR** (100 MHz, CD₂Cl₂) δ 158.2-154.3-153.6 138.1 (C_D, C_quat. arom.), 137.6 (C_A), 133.5-133.4 (C_quat. arom.), 133.3 (C_4), 131.9 (C_H), 130.6 (C_I), 129.8-129.7 (C_E, C_E'), 123.3 (C_I), 121.2 (C_B, C_B'), 119.1 (C_F, C_F'), 118.4 (C_3), 72.2-72.1 (C_C, C_C', C_D, C_D'), 66.6-66.5 (C_G, C_J), 64.0 (C_G').

**HRMS (ESI*)** m/z = 639.2461 [M+H]+ (calc. for C_{35}H_{35}N_{4}O_{8}: 639.2449 [M+H]+)

**HPLC rt:** 4.45 minutes
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$^1$H NMR spectrum of 5b, 400 MHz, 298 K, CD$_2$Cl$_2$

$^{13}$C NMR spectrum of 5b, 100 MHz, 298 K, CD$_2$Cl$_2$
Preparation of compound (S)-20 (same procedure for (R)-20)

To a solution of N-(9-Fluorenlymethoxycarbonyl)-L-phenylalanine for (S)-20 (or N-(9-Fluorenlymethoxycarbonyl)-D-phenylalanine for (R)-20) (3.42 g, 8.65 mmol, 1.1 equiv.) in dry mixture of 9:1 DMF/DCM (35 mL) were successively added Et₃N (1.20 mL, 8.65 mmol, 1.1 equiv.), ethyl chloroformate (853 µL, 8.65 mmol, 1.1 equiv.) and a solution of aniline 16 (2.98 g, 7.81 mmol, 1 equiv.) in dry mixture of 9:1 DMF/DCM (35 mL). The solution was stirred for 18 hours at room temperature and solvents were removed under reduced pressure. The crude was diluted with AcOEt (400 mL) and washed with saturated NH₄Cl(aq) (2 x 200 mL) and saturated NaCl(aq) (300 mL). The organic layer was dried over MgSO₄, filtered and concentrated in vacuo. Chromatography (petrol/AcOEt, gradient elution 100:0 to 85:15, Rf = 0.3 (85:15)) gave (S)-20 as a white solid wax (5.86 g, 7.80 mmol, quantitative).

¹H NMR (400 MHz, CDCl₃) δ 8.89 (bs, 1H, HNH-amide), 8.07 (d, J = 8.3, 1H, Hj), 7.78 (d, J = 7.5, 2H, Hq), 7.58 (2d, J = 8.4, 2H, Hn), 7.41 (t, J = 7.3, 2H, Hr), 7.32 – 7.21 (m, 8H, HI, HK, HL, HM, Hl), 7.07 (s, 1H, Hg), 5.53 (d, 1H, J = 7.2, HNH-carbamate), 4.69 (s, 2H, Hc), 4.50 (m, 3H, HG(1H), H1, H2(1H)), 4.39 – 4.30 (m, 2H, HG(1H), H2(1H)), 4.21 (t, J = 7.0, 1H, Hs), 3.19 (m, 2H, H1'), 0.95 (s, 9H, Ha), 0.86 (s, 9H, Ha'), 0.1 (s, 6H, Hb), 0.03-0.01 (2s, 6H, Hb').

¹³C NMR (100 MHz, CDCl₃), δ 168.9 (C CO-amide), 155.8 (C CO-carbamate), 143.9-141.4-137.5-136.2-135.7-129.7 (C arom,quat.), 129.5-128.9-127.8-127.3-127.2-126.4 (C1, Ck, Cu, Cm, Co, Cb), 125.9 (C1l), 125.3-125.2 (Cn), 122.0 (Cl), 120.1 (Cq), 67.2 (C2), 65.2 (Cg'), 64.6 (C6), 57.4 (C1), 47.3 (C3), 39.5 (C1'), 26.1-25.9 (Ca, Cg'), 18.5-18.3 (C quat. t-Bu'), -5.1 (Cb, Cb').

HRMS (ESI⁺) m/z = 773.3786 [M+Na]⁺ (calc. for C₄₄H₅₈N₂O₅Si₂Na 773.3776 [M+Na]⁺).
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$\text{H NMR spectrum of } (S)-20, 400 \text{ MHz, 298 K, CDCl}_3$

$\text{C NMR spectrum of } (S)-20, 100 \text{ MHz, 298 K, CDCl}_3$
Preparation of compound (S)-21 (same procedure for (R)-21)

To a stirred solution of compound (S)-20 (4.07 g, 5.41 mmol, 1 equiv.) in THF (54 mL) cooled at 0 °C, was added a solution of APTS.H₂O (309 mg, 1.6 mmol, 0.3 equiv.) in water (6 mL) dropwise. The reaction mixture was stirred at room temperature for 5 hours. The solvents were removed in vacuo and the crude residue was triturated with Et₂O. The solid was filtrated and dried in vacuo to give (S)-21 without further purification as a white solid (2.87 g, 5.49 mmol, quantitative). Rᵣ = 0.3 (DCM/MeOH : 95:5).

$^1$H NMR (400 MHz, (CD$_3$)$_2$CO) δ 9.51 (bs, 1H, H$_{NH}$-amide), 7.95 (d, J = 7.9, 1H, H$_I$), 7.85 (d, J = 7.5, 2H, H$_Q$), 7.64 (t, J = 8.7, 2H, H$_J$), 7.41 – 7.20 (m, 11H, H$_H$, H$_K$, H$_L$, H$_M$, H$_N$, H$_O$, H$_P$), 7.00 (d, J = 8.0, 1H, H$_{NH}$-carbamate), 4.61 – 4.53 (m, 6H, H$_G$, H$_G'$, H$_I$, H$_{OH}$), 4.28 (m, 2H, H$_2$), 4.9 (m, 1H, H$_3$), 4.14 (t, J = 5.8, 1H, H$_{OH}$), 3.36 (dd, J = 13.8, 5.2, 1H, H$_{1'}$), 3.09 (dd, J = 13.8, 9.3, 1H, H$_{1'}$).

$^{13}$C NMR (100 MHz, (CD$_3$)$_2$CO), δ: 170.6 (C$_{CO}$-amide), 157.1 (C$_{CO}$-carbamate), 145.1-145.0-142.1-139.2-138.9-136.8-132.5 (C$_{quat. arom.}$), 130.2-129.3-128.5-128.0-127.5-127.4-126.9 (C$_H$, C$_i$, C$_K$, C$_M$, C$_N$, C$_O$, C$_P$), 126.2 (C$_i$), 122.9 (C$_j$), 120.8 (C$_Q$), 67.4 (C$_2$), 64.4-63.7 (C$_G$, C$_G'$), 58.6 (C$_3$), 48.0 (C$_3$), 38.4 (C$_{1'}$).

HRMS (ESI$^+$) m/z = 545.2064 [M+Na]$^+$ (calc. for C$_{32}$H$_{30}$N$_2$O$_5$Na 545.2047 [M+Na]$^+$).
Diastereoselective Synthesis of [1]Rotaxanes via Active Metal Template Strategy

**Figure 1:**

- **1H NMR spectrum of (S)-21, 400 MHz, 298 K, (CD$_3$)$_2$CO**

- **13C NMR spectrum of (S)-21, 100 MHz, 298 K, (CD$_3$)$_2$CO**
Preparation of compound (S)-22 (same procedure for (R)-22)

To a stirred solution of 4-nitrophenyl chloroformate (4.12 g, 21.9 mmol, 4 equiv.) in anhydrous THF (130 mL) cooled at 0 °C, was added pyridine (1.75 mL, 21.9 mmol, 4 equiv.) dropwise. After five minutes the crude dialcohol (S)-21 (2.87 g, 5.49 mmol, 1 equiv.) was added portionwise and the reaction mixture was stirred at room temperature for 5 hours. The solvent was removed in vacuo and the crude residue was diluted with DCM and washed with saturated NaHCO$_3$(aq) (3x). Organic layer was dried over MgSO$_4$, filtered and concentrated in vacuo. The crude solid was dissolved with a minimum of DCM and precipitated with a large volume of petrol. After filtration, compound (S)-22 as obtained as a white solid (3.7 g, 4.4 mmol, 80% over two steps. $R_f$ = 0.3 (DCM/AcOEt : 95:5).

$^1$H NMR (400 MHz, CDCl$_3$) δ 8.57 (s, 1H, H$_{NH}$-amide), 8.27 (d, $J = 8.6$, 2H, H$_a$), 8.12 (d, $J = 8.3$, 2H, H$_b$), 7.92 (d, $J = 7.3$, 1H, H$_i$), 7.74 (d, $J = 6.5$, 2H, H$_Q$), 7.51 (d, $J = 7.2$, 1H; H$_I$), 7.47 – 7.20 (m, 16H, H$_b$, H$_b'$, H$_H$, H$_K$, H$_L$, H$_M$, H$_N$, H$_O$, H$_P$), 5.35 (bs, 1H, H$_{NH}$-carbamate), 5.27 (s, 2H, H$_G$), 5.08 (d, $J = 15$, 1H, H$_G'$), 4.85 (d, $J = 13.7$, 1H, H$_G'$), 4.58 (bs, 1H, H$_1$), 4.41 – 4.30 (m, 2H, H$_2$), 4.13 (t, $J = 6.8$, 1H, H$_3$), 3.21 (m, 2H, H$_1'$).

$^{13}$C NMR (100 MHz, CDCl$_3$), δ 169.9 (C$_{CO}$-amide), 155.5-155.2-152.9-152.5-145.6-143.6-141.4-136.9-136.3 (C$_{quat. arom.}$, C$_{CO}$-carbonate, C$_{CO}$-carbamate), 131.9 (C$_{arom.}$), 131.7 (C$_{quat. arom.}$), 131.0 (C$_i$), 129.5-129.1-128.0-127.5-127.2 (C$_{arom.}$), 125.9 (C$_{quat. arom.}$), 125.5-125.4 (C$_a$, C$_a'$), 125.0 (C$_{arom.}$), 124.7 (C$_i$), 121.9-121.7 (C$_b$, C$_b'$), 120.2 (C$_Q$), 70.1 (C$_O$), 67.6 (C$_G$, C$_2$), 57.3 (C$_1$), 47.1 (C$_3$), 38.1 (C$_1'$).

HRMS (ESI$^+$) $m/z = 875.2186$ [M+Na]$^+$ (calc. for C$_{46}$H$_{36}$N$_4$O$_{13}$Na 875.2171 [M+Na]$^+$).
Diastereoselective Synthesis of [1]Rotaxanes via Active Metal Template Strategy

-0.5 0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5 6.0 6.5 7.0 7.5 8.0 8.5 9.0

\( f_1 \) (ppm)

2.3 1.1 2.4 1.1 1.1 1.1 2.2 1.1 4.2 12.1 1.2 2.1 1.0 2.2 2.1 1.0

\( \text{\(^1H NMR spectrum of (S)-22, 400 MHz, 298 K, CDCl\textsubscript{3}\)} \)

180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10

\( \text{\(^{13}C NMR spectrum of (S)-22, 100 MHz, 298 K, CDCl\textsubscript{3}\)} \)
To a solution of bis-carbonate \((S)-22\) (426 mg, 0.5 mmol, 1 equiv.) and di-aniline \(15\) (402 mg, 1.15 mmol, 2.3 equiv.) in DMF (6.25 mL), was added HOBt.H\(_2\)O (68 mg, 0.5 mmol, 1 equiv.) and the solution was stirred for 8 hours at 33°C. The solution was diluted with DMF (500 mL) and stirred for four days at 33°C. The solvent was removed \textit{in vacuo} and the crude material was diluted with DCM (100 mL) and washed with saturated NaHCO\(_3\) (aq) (3 x 50 mL). The organic layer was dried over MgSO\(_4\), filtered and concentrated \textit{in vacuo} to give a brown oil. This crude macrocycle \((S)-23\) was engaged in the next step without further purification. To a solution of the crude fmoc derivative macrocycle \((S)-23\) in DMF (5 mL) was added piperidine (0.5 mL) and the reaction mixture was stirred at room temperature for 1 hour. The solvent was removed \textit{in vacuo} and chromatography (DCM/MeOH, gradient elution 100:0 to 95:5, \(R_f = 0.3\) (95:5)) gave \((S)-24\) as a solid wax (125 mg, 0.18 mmol, 36% over two steps).

\(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 9.81 (bs, 1H, \(H_{NH\text{-amide}}\)), 7.94 (d, \(J = 8.3, 1\ H, H_i\)), 7.86 (t, \(J = 7.7, 1H, H_A\)), 7.49 (s, 1H, \(H_{NH\text{-carbamate}}\)), 7.34 – 7.14 (m, 16 H, \(H_B, H_B', H_E, H_E', H_F, H_F', H_I, H_K, H_L, H_M\)), 7.00 (bs, 1H, \(H_{NH\text{-carbamate}}\)), 6.88 (bs, \(H_{NH\text{-carbamate}}\)), 5.13 (s, 2H, \(H_G\)), 5.02 (m, 2H, \(H_{G'}\)), 4.52-4.50 (2s, 4H, \(H_C, H_C'\)), 4.45-4.43 (2s, 4H, \(H_D, H_D'\)), 3.79 (dd, \(J = 8.7, 4.2, 1H, H_1\)), 3.31 (dd, \(J = 13.7, 4.3, 1H, H_1'\)), 2.87 (dd, \(J = 13.7, 8.9, 1H, H_1'\)).

\(^{13}\)C NMR (100 MHz, CDCl\(_3\)) \(\delta\) 173.1 \((C_{CO\text{-amide}})\), 157.7-153.4 \((C_{CO\text{-carbamate}})\), 137.7, 137.5 \((C_{quat. arom.})\), 137.2 \((C_A)\), 136.2-133.3-132.8 \((C_{quat. arom.})\), 130.6 \((C_H)\), 129.9 \((C_i)\), 129.5-129.4-128.9-127.1 \((C_{arom.})\), 123.3 \((C_j)\), 120.8-118.9 \((C_{arom.})\), 71.9-71.7 \((C_C, C_C', C_D, C_D')\), 66.3 \((C_G)\), 63.2 \((C_{G'})\), 57.2 \((C_I)\), 41.1 \((C_{I'})\).

HRMS (ESI\(^{+}\)) \(m/z = 702.2941\) [M+H]\(^{+}\) (calc. for \(C_{40}H_{40}N_5O_7\): 702.2922 [M+H]\(^{+}\))
Diastereoselective Synthesis of [1]Rotaxanes via Active Metal Template Strategy

$^{1}\text{H NMR}$ spectrum of (S)-24, 400 MHz, 298 K, CDCl$_3$

$^{13}\text{C NMR}$ spectrum of (S)-24, 100 MHz, 298 K, CDCl$_3$
Preparation of compound (S)-1 (same procedure for (R)-1)

To a solution of macrocycle (S)-24 (105 mg, 0.15 mmol, 1 equiv.) and 6-heptynoic acid 25 (38 mg, 0.30 mmol, 2 equiv.) in DMF (3 mL) was added DMAP (37 mg, 0.30 mmol, 2 equiv.) and EDC.HCl (58 mg, 0.30 mmol, 2 equiv.). The solution was stirred at room temperature for 24 hours. The solvent was removed in vacuo and chromatography (DCM/MeOH, gradient elution 100:0 to 95:5, \( R_f = 0.5 \) (95:5)) gave (S)-1 as a beige solid (105 mg, 0.13 mmol, 86%).

\[ ^1H \text{NMR} (400 \text{ MHz}, \text{DMSO-}d_6) \delta 9.75-9.66 \text{ (2bs, 3H, H}_{\text{NH}} \text{-amide, H}_{\text{NH}} \text{-carbamate), 8.28 (d, } J = 8.0, 1H, H_{\text{NH-amide}}), 7.80 \text{ (t, } J = 7.7, 1H, H_A), 7.44 \text{ (s, 1H, H}_{\text{H}}), 7.37 - 7.15 \text{ (m, 17H, H}_{\text{B}}, H_{\text{B'}}, H_{\text{E}}, H_{\text{E'}}, H_{\text{F}}, H_{\text{F'}}, H_i, H_j, H_{\text{K}}), 5.13 \text{ (s, 2H, H}_{G}), 5.04 \text{ (AB syst., } J = 14.4, 2H, H_{G'}), 4.72 \text{ (m, 1H, H}_1), 4.48-4.45-4.44-4.42 \text{ (4s, 8H, H}_{C}, H_{C'}, H_{D}, H_{D'}), 3.11 \text{ (dd, } J = 13.6, 5.4, 1H, H_{I}), 2.90 \text{ (dd, } J = 13.4, 9.5, 1H, H_{I'}), 2.73 \text{ (t, } J = 2.6, 1H, H_6), 2.08 \text{ (m, 4H, H}_{2}, H_{5}), 1.49 \text{ (m, 2H, H}_{3}), 1.28 \text{ (m, 2H, H}_{4}). \]

\[ ^13C \text{NMR} (100 \text{ MHz, DMSO-d}_6) \delta 172.2-170.6 \text{ (C}_{\text{CO-amide}, \text{CO-carbamate, C}_{\text{quat. arom.}}), 157.2-153.3-138.4-138.3-137.7 \text{ (C}_{\text{quat. alkyne}}), 137.3 \text{ (C}_{\text{Ar}}), 134.4-134.3-131.9 \text{ (C}_{\text{quat. arom.}}), 130.8 \text{ (C}_{\text{H}}), 129.3-128.9-128.8-128.2 \text{ (C}_{\text{arom.}}), 126.8 \text{ (C}_{\text{N}}), 126.4-125.3-121.5-121.4-118.5-118.2 \text{ (C}_{\text{arom.}}), 84.3 \text{ (C}_{\text{quat. alkyne}}), 71.4 \text{ (C}_{6}), 71.3 - 70.5 \text{ (C}_{C}, C_{C'}, C_{D}, C_{D'}), 69.4 \text{ (C}_{6}), 64.9 \text{ (C}_{G}), 61.4 \text{ (C}_{G'}), 54.5 \text{ (C}_{1}), 37.6 \text{ (C}_{1'}), 34.5 \text{ (C}_{2}), 27.3 \text{ (C}_{4}), 24.3 \text{ (C}_{3}), 17.4 \text{ (C}_{5}). \]

HRMS (ESI\(^+\)) \( m/z = 810.3488 \text{ [M+H]}^+ \) (calc. for C\(_{48}H_{46}N_5O_8\): 810.3497 [M+H]\(^+\))

HPLC rt: 4.95 minutes
Diastereoselective Synthesis of [1]Rotaxanes via Active Metal Template Strategy

$\text{^1H NMR spectrum of (S)-1, 400 MHz, 298 K, DMSO-d$_6$}$

$\text{^{13}C NMR spectrum of (S)-1, 100 MHz, 298 K, DMSO-d$_6$}$
Preparation of compound 26

To a solution of azide 2a (209.4 mg, 0.35 mmol, 1 equiv.) and 6-heptynoic acid 25 (44.8 mg, 0.35 mmol, 1 equiv.) in degassed DCM (7 mL) was added [Cu(MeCN)₄]PF₆ (136.0 mg, 0.35 mmol, 1 equiv.). The solution was stirred at room temperature for 18 hours. The reaction was hydrolyzed with saturated EDTA.2Na(aq) (10 mL) for one hour and the aqueous phase was extracted with DCM (3x). The combined organic layers were dried over MgSO₄, filtered and concentrated in vacuo. Chromatography (DCM/MeOH, gradient elution 100:0 to 95:5, Rᵣ = 0.3 (95:5)) gave 26 as a white solid (125.3 mg, 0.17 mmol, 49%).

**¹H NMR** (400 MHz, CDCl₃) δ 7.30 (s, 1H, H₆), 7.23 (d, J = 8.1, 6H, Hₘ), 7.07 (m, 8H, Hₐ, Hₙ), 6.74 (d, J = 8.4, 2H, Hₖ), 4.53 (t, J = 6.3, 2H, Hₜ), 3.93 (m, 2H, H₃), 2.74 (m, 2H, Hₕ), 2.37 (m, 4H, H₂, H₉), 1.71 (m, 4H, H₃, H₄), 1.30 (s, 27H, Hₐ).

**¹³C NMR** (100 MHz, CDCl₃) δ 178.2 (Cₐ₉), 156.5-148.5-144.2-140.3 (C quat. arom.), 132.5-130.9 (Cₐ, Cₖ), 124.2 (C₈), 121.4 (C₇), 113.1 (Cₗ), 64.1 (Cₗ), 47.2 (Cₙ), 34.4 (C quat. t-but), 33.7 (C₂ or C₈), 31.5 (C₈), 30.2 (C₂ or C₈), 28.8 (C₃ or C₄), 25.3 (Cₗ), 24.4 (C₃ or C₄).

**HRMS (ESI⁺)** m/z = 714.4636 [M+H]⁺ (calc. for C₄₇H₆₀N₃O₃: 714.4629 [M+H]⁺)
Diastereoselective Synthesis of [1]Rotaxanes via Active Metal Template Strategy

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\[ \text{N} \quad \text{N} \quad \text{N} \quad \text{O} \]

\[ a \quad b \quad c \quad d \quad e \]

\[ f \quad g \quad h \]

3 4 5 6 26

HO

2

1

\[ 1^\text{H} \text{NMR spectrum of 26, 400 MHz, 298 K, CDCl}_3 \]

\[ \text{N} \quad \text{N} \quad \text{N} \quad \text{O} \]

\[ a \quad b \quad c \quad d \quad e \]

\[ f \quad g \quad h \]

3 4 5 6 26

HO

2

1

\[ ^{13}\text{C} \text{NMR spectrum of 26, 100 MHz, 298 K, CDCl}_3 \]
Preparation of compound (S)-4

To a solution of macrocycle (S)-24 (30.2 mg, 0.04 mmol, 1 equiv.) and acid 26 (33.7 mg, 0.047 mmol, 1.2 equiv.) in DMF (0.5 mL) was added DMAP (6.6 mg, 0.054 mmol, 1.4 equiv.) and EDC.HCl (9.7 mg, 0.049 mmol, 1.2 equiv.). The solution was stirred at room temperature for 24 hours. The solvent was removed in vacuo and chromatography (DCM/MeOH, gradient elution 98:2 to 95:5, R_f = 0.5 (95:5)) gave (S)-4 as a white solid (46.3 mg, 0.033 mmol, 84%).

1H NMR (500 MHz, CDCl_2) δ 9.02 (bs, 1H, H_NH-amide arom.), 8.38 (bs, 1H, H_NH-carbamate), 7.87 (d, 1H, J = 8.1, H_j), 7.66 (t, 1H, J = 7.7, H_a), 7.42 (s, 1H, H_h), 7.29 (m, 1H, H_i), 7.29 – 7.13 (m, 32H, H_j, H_b, H_b', H_c, H_c', H_d, H_d'), H_NH-carbamate), 6.76 (bs, 1H, H_NH-amide), 6.76 (d, 2H, J = 8.9, H_e), 5.10 (m, 3H, H_g, H'2(1H), H_1), 4.93 – 4.88 (m, 2H, H_2, H C or H_C'), 4.49 (s, 2H, H_C or H_C'), 4.47 (t, 2H, J = 7.0, H_h), 4.35 (2s, 4H, H_D, H_D'), 3.92 (t, 2H, J = 6.4, H_g), 2.25 (t, 2H, J = 6.6, H_2), 1.55 (m, 4H, H_3, H_4), 1.30 (s, 27H, H_a).

13C NMR (126 MHz, CDCl_2) δ 174.9-169.9 (C_CO-amides), 158.1-156.9-153.1-148.9-147.8-145.0-140.6-138.1 (C_quat. arom., CO-carbamate), 137.5 (C_A), 137.4 – 132.4 (C_arom.), 131.4 (C_H), 130.8 – 124.8 (C_arom.), 123.0 (C_J), 121.8 – 118.6 (C_arom.), 113.7 (C_E), 72.2 (C_C, C_C'), 72.0 (C_D, C_D'), 66.5 (C_G), 64.7 (C_I), 64.1 (C_G'), 63.6 (C_quat.), 55.8 (C_I), 47.5 (C_H), 36.9 (C_I'), 36.4 (C_2), 34.7 (C_quat. t-But), 31.6 (C_a), 30.6 (C_g), 28.8 (C_4), 25.3 (C_5, C_3).

HRMS (ESI+) m/z = 714.4636 [M+H]^+ (calc. for C_{47}H_{60}N_{3}O_{3}: 714.4629 [M+H]^+)

HPLC rt: 9.19 minutes
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$^1$H NMR spectrum of (S)-4, 500 MHz, 298 K, CD$_2$Cl$_2$

$^{13}$C NMR spectrum of (S)-4, 126 MHz, 298 K, CD$_2$Cl$_2$
Preparation of compound (S)-3 (same procedure for (R)-3)

Mechanical planar chirality drawn as (R_mp) for visual purposes, not experimentally determined.

Macrocycle (S)-1 (30.0 mg, 0.037 mmol, 1 equiv.) and [Cu(MeCN)_4]PF_6 (13.8 mg, 0.037 mmol, 1 equiv.) were placed in a 100 mL two-neck round-bottom flask equipped with a condenser. The system is purged with argon. Degassed DCM (18 mL) was added and the solution was stirred at 60°C for 30 minutes. Stopper 2a (109 mg, 0.185 mmol, 5 equiv.) and additive 5a or 5b (0.0185 mmol, 0.5 equiv.) were placed in a 50 mL two-neck round-bottom flask and purged with argon. Degassed DCM (19 mL) was added to obtain a clear solution. This solution was carefully added under argon to the solution of (S)-1 and Cu(I) catalyst. The crude yellow solution was stirred at 60 °C for 24 hours. The solvent was removed in vacuo and the residue was dissolved with a solution of DCM/MeOH 1:1 (4 mL). The resulting yellow dark solution was stirred with KCN (12 mg, 0.185 mmol, 5 equiv.) for one hour until it turned white and solvent were removed by air bubbling. The crude material was dissolved in DCM and washed with water (5x). The organic layer was dried over MgSO_4, filtered and concentrated in vacuo. Chromatography (DCM/MeOH, gradient elution 100:0 to 95:5, Rf = 0.4 (95:5)) gave (S)-3 as a solid colorless wax (23 mg, 0.016 mmol, 45%).

^1H NMR (500 MHz, CD_2Cl_2) δ 9.1 (s, 1H, H_{NH-amide arom.}), 8.37 (bs, 1H, H_{NH-carbamate}), 7.95 (d, 1H, J = 8.1, H_j), 7.40 – 6.91 (m, 33H, H_A, H_B, H_B', H_E, H_F, H_F', H_K, H_L, H_M, H_H, H_i, H_b, H_c, H_d, H_{NH-carbamate}), 6.87 (bs, 1H, H_{NH-carbamate}), 6.76 (d, 2H, J = 8.9, H_E), 5.99 (s, 1H, H_B), 5.41 (d, J = 11.5, 1H, H_G), 5.20 (bs, 1H, H_C), 4.94 (dd, 2H, J = 8.1, 7.9, H_1, H_C), 4.77 (d, J = 12.6, 1H, H_G), 4.67 (d, J = 12.5, 1H, H_C or H_C'), 4.55 (d, J = 11.6, 1H, H_C or H_C'), 4.41 (d, J = 12.7, 1H, H_C or H_C'), 4.38 (d,
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$J = 12.1, 1H, H_C$ or $H_C'$, 4.31 (d, $J = 13.1, 1H, H_D$ or $H_D'$), 4.27 (d, $J = 12.6, 1H, H_D$ or $H_D'$), 4.18 (d, $J = 12.6, 2H, H_D$ or $H_D'$), 3.34 (dd, $J = 14.2, 7.4, 1H, H_1'$), 3.30 (t, $J = 8.2, 2H, H_1$), 3.09 (dd, 1H, $J = 14.1, 7.9, H_1'$), 2.96 (bs, 2H, $H_1$), 2.38 (m, 3H, $H_2(1H)_a, H_3$), 2.19 (m, 1H, $H_2$), 1.49 (m, 3H, $H_3, H_4(1H)_a$), 1.32 (s, 28H, $H_4(1H)_a, H_a$), 1.02 (m, 2H, $H_3$).

$^{13}$C NMR (126 MHz, CD$_2$Cl$_2$) $\delta$ 175.4-169.3 (C$_{CO}$), 157.9, 157.8, 156.7, 153.3, 152.8, 148.6, 146.2, 145.2, 139.8, 138.0, 137.8, 137.4, 133.4, 132.8, 132.4, 131.8 (C$_d$), 131.3-131.2 (C$_{H, i}$), 130.7, 129.6, 129.4, 129.0, 127.2, 126.9, 124.9, 122.3 (C$_i$), 120.2 (C$_6$), 119.8, 119.5, 118.7, 118.5, 113.6 (C$_e$), 76.4 (C$_{quat. triazole}$), 72.5-72.1 (C$_C, C_C'$), 70.9-70.7 (C$_D, C_P$), 66.1 (C$_F$), 64.6 (C$_I$), 64.1 (C$_G$), 63.5, 55.6 (C$_J$), 47.0 (C$_h$), 36.7 (C$_2$), 35.6 (C$_1$), 34.5 (C$_{quat. r-but.}$), 31.5 (C$_a$), 28.7 (C$_g$), 28.1 (C$_d$), 24.9 (C$_3$), 24.9 (C$_5$).

HRMS (ESI+) $m/z = 1419.7231$ [M+Na]$^+$ (calc. for $C_{87}H_{96}N_{8}O_{9}Na$: 1419.7192 [M+H]$^+$)

HPLC rt: 9.35 minutes
Diastereoselective Synthesis of [1]Rotaxanes via Active Metal Template Strategy

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$^{1}H$ NMR spectrum of (S)-3, 500 MHz, 298 K, CD$_2$Cl$_2$

$^{13}C$ NMR spectrum of (S)-3, 126 MHz, 298 K, CD$_2$Cl$_2$
Preparation of compound 2b

To a solution of 5-azidopentanoic acid 27 (1 g, 7.0 mmol, 1.4 equiv.) in dry DCM (25 mL) were added EDC.HCl (1.34 g, 7.0 mmol, 1.4 equiv.) and DMAP (855 mg, 7.0 mmol, 1.4 equiv.). Solution was stirred 5 min before 2,6-diphenyl-4-nitrophenol 10 (1.46 g, 5.0 mmol, 1 equiv.) was added and stirred for 3 hours at room temperature. DCM was removed in vacuo before EtOAc and water were added. Layers were separated and organic layers was washed with saturated NaHCO$_3$(aq), brine, dried over MgSO$_4$ and concentrated in vacuo. Chromatography (petrol/AcOEt 95:5, $R_f = 0.7$ (70:30)) afforded product 2b as a pale-yellow oil (1.98 g, 4.7 mmol, 95 %).

$^1$H NMR (500 MHz, CD$_2$Cl$_2$) $\delta$ 8.28 (s, 2H, H$_a$), 7.49 – 7.43 (m, 10H, H$_b$, H$_c$, H$_d$), 3.05 (t, $J = 6.8$, 2H, H$_h$), 2.12 (t, $J = 7.1$, 2H, H$_e$), 1.35 – 1.29 (m, 2H, H$_f$), 1.16 – 1.10 (m, 2H, H$_g$).

$^{13}$C NMR (126 MHz, CD$_2$Cl$_2$) $\delta$ 170.8 (C$_{CO}$), 150.7-146.2-138.0-136.3 (C$_{quat.\ arom.}$), 129.4-129.1-129.1 (C$_b$, C$_c$, C$_d$), 125.4 (C$_a$), 51.3 (C$_h$), 33.6 (C$_e$), 28.1 (C$_g$), 21.8 (C$_f$).

HRMS (ESI$^+$) $m/z = 417.1556$ [M+H]$^+$ (calc. for C$_{23}$H$_{26}$N$_4$O$_4$ 417.1557 [M+H]$^+$).
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$1^1$H NMR spectrum of 2b, 500 MHz, 298 K, CD$_2$Cl$_2$

$1^3$C NMR spectrum of 2b, 126 MHz, 298 K, CD$_2$Cl$_2$
Preparation of compound 28

To a solution of azide \(2b\) (57 mg, 0.14 mmol, 1 equiv.) and 6-heptynoic acid \(25\) (17.3 mg, 0.14 mmol, 1 equiv.) in degassed DCM (6 mL) was added \([\text{Cu(MeCN)}_4]\)PF\(_6\) (51 mg, 0.14 mmol, 1 equiv.). The solution was stirred at room temperature for 20 hours. The reaction was hydrolyzed with saturated EDTA.2Na\(_{\text{aq}}\) (5 mL) for one hour and the aqueous phase was extracted with DCM (3x). The combined organic layers were dried over MgSO\(_4\), filtered and concentrated \textit{in vacuo}. Chromatography (DCM/MeOH, gradient elution 100:0 to 95:5, \(R_f = 0.3\) (95:5)) gave 28 as a colorless oil (45 mg, 0.083 mmol, 60%).

\(^1\text{H NMR}\) (500 MHz, CD\(_2\)Cl\(_2\)) \(\delta\) 8.19 (s, 2H, H\(_a\)), 7.37 – 7.29 (m, 10H, H\(_b\), H\(_c\), H\(_d\)), 7.10 (s, 1H, H\(_6\)), 3.97 (t, \(J = 7.0\), 2H, H\(_h\)), 2.63 (t, \(J = 7.1\), 2H, H\(_2\)), 2.29 (t, \(J = 6.9\), 2H, H\(_5\)), 2.04 (t, \(J = 7.0\), 2H, H\(_e\)), 1.61 (m, 4H, H\(_3\), H\(_4\)), 1.28 (m, 2H, H\(_g\)), 1.17 (m, 2H, H\(_f\)).

\(^{13}\text{C NMR}\) (120 MHz, CD\(_2\)Cl\(_2\)) \(\delta\) 178.2-170.7 (C\(_{\text{Co}}\)), 150.6-148.0-146.2-138.0-136.3 (C\(_{\text{quat. arom.}}\), C\(_{\text{quat. triazol}}\)), 129.4-129.1 129.0 (C\(_b\), C\(_c\), C\(_d\)), 125.3 (C\(_a\)), 121.2 (C\(_6\)), 50.0 (C\(_h\)), 34.2 (C\(_5\)), 34.3 (C\(_e\)), 29.3 (C\(_3\) or C\(_4\), C\(_6\)), 25.5 (C\(_2\)), 24.8 (C\(_3\) or C\(_4\)), 21.5 (C\(_f\)).

HRMS (ESI\(^+\)) \(m/z = 543.2237\) [M+H]\(^+\) (calc. for C\(_{30}\)H\(_{31}\)N\(_4\)O\(_5\) 543.2238 [M+H]\(^+\)).
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$^{1}$H NMR spectrum of 28, 500 MHz, 298 K, CD$_2$Cl$_2$

$^{13}$C NMR spectrum of 28, 126 MHz, 298 K, CD$_2$Cl$_2$
Preparation of compound (S)-29

To a solution of macrocycle (S)-24 (58 mg, 0.08 mmol, 1 equiv.) and acid 28 (45 mg, 0.08 mmol, 1 equiv.) in DMF (2 mL) was added EDC.HCl (15.5 mg, 1 equiv.). The solution was stirred at 35 °C for 24 hours and the solvent was removed in vacuo. Chromatography (DCM/MeOH, gradient elution 100:0 to 95:5, \( R_f = 0.4 \) (95:5)) gave (S)-29 as a pale yellow wax (45 mg, 0.036 mmol, 45%).

\[^1\text{H} \text{NMR} \text{ (500 MHz, CD}_{2}\text{Cl}_2) \delta 8.99 (bs, 1H, H_NH), 8.32 (bs, 1H, H_NH), 8.27 (s, 2H, H_a), 7.87 (d, J = 8.2, 1H, H_j), 7.66 (t, J = 7.7, 1H, H_A), 7.47 – 7.41 (m, 9H, H_NH, H_arom.), 7.38 (m, 2H, H_arom.), 7.28 – 7.21(m, 13H, H_arom., H_e), 7.18 – 7.07 (m, 5H, H_arom.), 6.89 (bs, 1H, H_NH) 5.08 (m, 3H, H_G, H_{G'(1H)}), 4.90 (m, 2H, H_J, H_{G'(1H)}), 4.51-4.48 (2s, 4H, H_C, H_{C'}), 4.36 (m, 4H, H_D, H_{D'}), 4.02 (t, J = 7.0, 2H, H_h), 3.30 (m, 1H, H_1'), 3.12 (dd, J = 14.1, 8.2, 1H, H_1'), 2.59 (m, 2H, H_3), 2.25 (t, J = 6.7, 2H, H_2), 2.11 (t, J = 7.0, 2H, H_e), 1.57 (m, 4H, H_a, H_3), 1.37 – 1.34 (m, 2H, H_g), 1.24 – 1.21 (m, 2H, H_l).

\[^{13}\text{C} \text{NMR} \text{ (126 MHz, CD}_{2}\text{Cl}_2) \delta 174.7-170.7-169.9-158.1-153.7-150.5-147.1-146.2-138.0 (C_{CO}, C_{quat. arom.}), 137.5 (C_A), 137.1-136.3-135.8-130.3-129.8-129.6-129.4-129.1-127.8-127.4 (C_{arom.}), 125.3 (C_a), 123.2 (C_j), 121.3-121.1-121.0-118.9 (C_{arom.}), 72.2-72.0 (C_C, C_{C'}, C_D, C_{D'}), 66.5 (C_G), 64.1 (C_{G'}), 55.8 (C_1), 49.9 (C_h), 37.0 (C_{1'}), 36.4 (C_2), 33.4 (C_6), 29.3 (C_{g'}), 28.9 (C_3 or C_4), 25.3 (C_5, C_3 or C_4), 21.5 (C_l).

\(^{1}\text{H} \text{NMR} \text{ (500 MHz, CD}_{2}\text{Cl}_2) \delta 8.99 (bs, 1H, H_NH), 8.32 (bs, 1H, H_NH), 8.27 (s, 2H, H_a), 7.87 (d, J = 8.2, 1H, H_j), 7.66 (t, J = 7.7, 1H, H_A), 7.47 – 7.41 (m, 9H, H_NH, H_arom.), 7.38 (m, 2H, H_arom.), 7.28 – 7.21(m, 13H, H_arom., H_e), 7.18 – 7.07 (m, 5H, H_arom.), 6.89 (bs, 1H, H_NH) 5.08 (m, 3H, H_G, H_{G'(1H)}), 4.90 (m, 2H, H_J, H_{G'(1H)}), 4.51-4.48 (2s, 4H, H_C, H_{C'}), 4.36 (m, 4H, H_D, H_{D'}), 4.02 (t, J = 7.0, 2H, H_h), 3.30 (m, 1H, H_1'), 3.12 (dd, J = 14.1, 8.2, 1H, H_1'), 2.59 (m, 2H, H_3), 2.25 (t, J = 6.7, 2H, H_2), 2.11 (t, J = 7.0, 2H, H_e), 1.57 (m, 4H, H_a, H_3), 1.37 – 1.34 (m, 2H, H_g), 1.24 – 1.21 (m, 2H, H_l).

\[^{13}\text{C} \text{NMR} \text{ (126 MHz, CD}_{2}\text{Cl}_2) \delta 174.7-170.7-169.9-158.1-153.7-150.5-147.9147.1-146.2-138.0 (C_{CO}, C_{quat. arom.}), 137.5 (C_A), 137.1-136.3-135.8-130.3-129.8-129.6-129.4-129.1-127.8-127.4 (C_{arom.}), 125.3 (C_a), 123.2 (C_j), 121.3-121.1-121.0-118.9 (C_{arom.}), 72.2-72.0 (C_C, C_{C'}, C_D, C_{D'}), 66.5 (C_G), 64.1 (C_{G'}), 55.8 (C_1), 49.9 (C_h), 37.0 (C_{1'}), 36.4 (C_2), 33.4 (C_6), 29.3 (C_{g'}), 28.9 (C_3 or C_4), 25.3 (C_5, C_3 or C_4), 21.5 (C_l).

HRMS (ESI\(^{+}\)) \( m/z = 1226.4982 \ [M+H]^+ \) (calc. for C\(_{70}H_{68}N_{9}O_{12} 1226.4981 \ [M+H]^+\)).

HPLC rt: 6.51 minutes
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$\text{H NMR spectrum of } (S)-29, 500 \text{ MHz, } 298 \text{ K, } \text{CD}_2\text{Cl}_2$

$\text{C NMR spectrum of } (S)-29, 126 \text{ MHz, } 298 \text{ K, } \text{CD}_2\text{Cl}_2$
**Preparation of compound (S)-7**

Mechanical planar chirality drawn as \((R_{mp})\) for visual purposes, not experimentally determined.

Macrocycle (S)-1 (30.0 mg, 0.037 mmol, 1 equiv.) and \([\text{Cu(MeCN)}_4]\)PF\(_6\) (13.8 mg, 0.037 mmol, 1 equiv.) were placed in a 100 mL two-neck round-bottom flask equipped with a condenser. The system is purged with argon. Degassed DCM (18 mL) was added and the solution was stirred at 60 °C for 30 minutes. Stopper 2b (77 mg, 0.185 mmol, 5 equiv.) and additive 5a (14.3 mg, 0.0185 mmol, 0.5 equiv.) were placed in a 50 mL two-neck round-bottom flask and purged with argon. Degassed DCM (19 mL) was added to obtain a clear solution. This solution was carefully added under argon to the solution of (S)-1 and Cu(I) catalyst. The crude yellow solution was stirred at 60 °C for 24 hours. The solvent was removed in vacuo and the residue was dissolved in DCM (5 mL) and the resulting solution was stirred with saturated \(\text{EDTA}.2\text{Na}\) \((4 \times 5 \text{ mL})\) for 24 hours. The organic layer was dried over MgSO\(_4\), filtered and concentrated in vacuo. Chromatography (DCM/MeOH, gradient elution 100:0 to 95:5, \(R_f = 0.5 \text{ (95:5)}\)) gave (S)-7 as a solid colorless wax (12 mg, 0.0097 mmol, 26%).

\(^1\text{H NMR} (500 \text{ MHz, CD}_2\text{Cl}_2)\) \(\delta\) 9.06 (s, 1H, H\(_{\text{NH-amide}}\)), 8.79 (bs, 1H, H\(_{\text{NH-carbamate}}\)), 8.3 (s, 2H, H\(_a\)), 7.98 (d, \(J = 8.4\), 1H, H\(_j\)), 7.59 – 7.12 (m 20 H, H\(_b\) – H\(_d\), H\(_A\) – H\(_F\), H\(_B\) – H\(_B'\), H\(_H\) – H\(_L\)), 7.12 (d, \(J = 8.3\), 2H, H\(_F\) or H\(_F'\)), 7.03 (d, \(J = 8.3\), 2H, H\(_E\) or H\(_E'\)), 6.92 (m, 4H, H\(_E\) – H\(_E'\)), 6.75 (s, 1H, H\(_{\text{NH-carbamate}}\)), 6.47 (d, \(J = 7.9\), 1H, H\(_{\text{NH-amide}}\)), 5.62 (s, 1H, H\(_6\)), 5.58 (d, \(J = 12.7\), H\(_G\)), 4.91 (dd, \(J = 7.8, 15.7\), 1H, H\(_1\)), 4.81 (d, \(J = 12.6\), 1H, H\(_{g'}\)), 4.69 (d, \(J = 12.3\), 1H, H\(_G\)), 4.56 (d, \(J = 11.9\), 1H, H\(_C\) or H\(_{g'}\)), 4.38 (d, \(J = 12.7\), 1H, H\(_G\)), 4.35 (d, \(J = 12.4\), 1H, H\(_C\) or H\(_{g'}\)), 4.22 (2d, \(J = 13.1\), 2H, H\(_C\) or H\(_D\)), 4.10 (2d, \(J = 13.0\), 2H, H\(_C\) or H\(_D\)), 3.35 (dd, \(J = 14.2, 7.2\), 1H, H\(_{1'}\)), 3.02 (dd, \(J = 14.2, 8.0\), 1H,
$^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 7.47 (d, $J$ = 8.8, 2H, H$_5$), 7.35 – 7.29 (m, 2H, H$_6$), 7.29 – 7.23 (m, 1H, H$_7$), 7.19 – 7.11 (m, 1H, H$_8$), 7.07 (t, $J$ = 8.2, 2H, H$_9$), 6.96 (t, $J$ = 8.4, 2H, H$_{10}$), 6.88 (d, $J$ = 8.4, 2H, H$_{11}$), 6.85 (d, $J$ = 8.8, 2H, H$_{12}$), 6.70 (d, $J$ = 8.4, 2H, H$_{13}$), 6.51 (d, $J$ = 8.4, 2H, H$_{14}$), 6.38 (d, $J$ = 8.8, 2H, H$_{15}$), 6.30 (d, $J$ = 8.4, 2H, H$_{16}$), 6.18 (d, $J$ = 8.4, 2H, H$_{17}$), 6.09 (d, $J$ = 8.8, 2H, H$_{18}$), 5.92 (d, $J$ = 8.4, 2H, H$_{19}$), 5.84 (d, $J$ = 8.8, 2H, H$_{20}$), 4.40 (s, 1H, H$_{21}$), 4.25 (s, 1H, H$_{22}$), 3.58 – 3.42 (m, 1H, H$_{23}$), 3.42 – 3.28 (m, 1H, H$_{24}$), 2.64 (d, $J$ = 13.2, 2H, H$_{25}$), 2.56 (d, $J$ = 13.2, 2H, H$_{26}$), 2.52 (d, $J$ = 13.2, 2H, H$_{27}$), 2.49 (d, $J$ = 13.2, 2H, H$_{28}$), 2.38 (d, $J$ = 13.2, 2H, H$_{29}$), 2.24 (d, $J$ = 13.2, 2H, H$_{30}$), 1.88 (s, 3H, H$_{31}$), 1.70 (s, 3H, H$_{32}$), 1.59 (s, 3H, H$_{33}$), 1.39 (s, 3H, H$_{34}$), 1.18 (s, 3H, H$_{35}$), 1.03 (s, 3H, H$_{36}$), 0.96 (s, 3H, H$_{37}$), 0.88 (s, 3H, H$_{38}$), 0.85 (s, 3H, H$_{39}$), 0.80 (s, 3H, H$_{40}$), 0.77 (s, 3H, H$_{41}$), 0.74 (s, 3H, H$_{42}$), 0.72 (s, 3H, H$_{43}$), 0.69 (s, 3H, H$_{44}$), 0.66 (s, 3H, H$_{45}$), 0.63 (s, 3H, H$_{46}$), 0.60 (s, 3H, H$_{47}$), 0.58 (s, 3H, H$_{48}$), 0.56 (s, 3H, H$_{49}$), 0.53 (s, 3H, H$_{50}$), 0.51 (s, 3H, H$_{51}$), 0.49 (s, 3H, H$_{52}$), 0.47 (s, 3H, H$_{53}$), 0.45 (s, 3H, H$_{54}$), 0.43 (s, 3H, H$_{55}$), 0.41 (s, 3H, H$_{56}$), 0.39 (s, 3H, H$_{57}$), 0.37 (s, 3H, H$_{58}$), 0.35 (s, 3H, H$_{59}$), 0.33 (s, 3H, H$_{60}$), 0.31 (s, 3H, H$_{61}$), 0.29 (s, 3H, H$_{62}$), 0.27 (s, 3H, H$_{63}$), 0.25 (s, 3H, H$_{64}$), 0.23 (s, 3H, H$_{65}$), 0.21 (s, 3H, H$_{66}$), 0.19 (s, 3H, H$_{67}$), 0.17 (s, 3H, H$_{68}$), 0.15 (s, 3H, H$_{69}$), 0.13 (s, 3H, H$_{70}$), 0.11 (s, 3H, H$_{71}$), 0.09 (s, 3H, H$_{72}$), 0.07 (s, 3H, H$_{73}$), 0.05 (s, 3H, H$_{74}$), 0.03 (s, 3H, H$_{75}$), 0.01 (s, 3H, H$_{76}$).

$^{13}$C NMR (126 MHz, CD$_2$Cl$_2$) $\delta$ 175.7, 171.23, 169.6, 168.9, 158.1, 152.9, 150.9, 146.2, 146.1, 138.6, 138.2, 138.2, 137.5, 137.4, 136.7, 133.2, 131.4, 130.8, 130.0, 129.8, 129.7, 129.5, 129.4, 129.4, 127.4, 126.8, 125.5 (C$_a$), 122.3 (C$_l$), 119.9, 119.6 (C$_g$), 118.8, 72.7-72.6-71.3 (C$_G$, C$_C$, C$_C$, C$_D$, C$_D'$) 64.7 (C$_{G'}$), 55.7, 54.5 (C$_l$), 54.3, 54.0, 53.7, 53.5, 48.8, 37.3, 35.4 (C$_{l'}$), 33.1, 28.6, 28.1, 25.7, 25.3, 21.7 (C$_l$).

HRMS (ESI$^+$) $m/z$ = 1226.4985 [M+H]$^+$ (calc. for C$_{70}$H$_{68}$N$_9$O$_{12}$ 1226.4982 [M+H]$^+$).

HPLC rt: 7.97 minutes
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\[^1\text{H}\] NMR spectrum of (S)-7, 400 MHz, 298 K, \text{CD}_2\text{Cl}_2

\[^{13}\text{C}\] NMR spectrum of (S)-7, 100 MHz, 298 K, \text{CD}_2\text{Cl}_2
**Preparation of compound 8**

A solution of azide 2a (377 mg, 0.57 mmol, 1 equiv.) and polymer-bound triphenylphosphine (3 mmol/g loading, 573 mg, 1.72 mmol, 3 equiv.) in a mixture of THF/NH₄OH 9:1 (20 mL) was stirred at 65 °C for 5 hours. The solution was filtrated through a pad of celite and solvents were removed *in vacuo* to give 8 as a yellow powder without further purification (310 mg, 97%, $R_f = 0.04$ (DCM/MeOH 95:5)).

$^1$H NMR (400 MHz, CDCl₃) $\delta$ 7.23 (d, $J = 8.6$, 6H, Hₐ), 7.08 (d, $J = 8.6$, 8H, Hₖ, Hₙ), 6.76 (d, $J = 8.9$, 2H, Hₜ), 4.02 (t, $J = 6.1$, 2H, Hₖ), 2.90 (t, $J = 6.8$, 2H, Hₙ), 1.91 (m, 2H, Hₜ), 1.30 (s, 27H, Hₐ).

$^{13}$C NMR (100 MHz, CDCl₃) $\delta$ 156.9-148.4-144.3-139.7 (C quat. arom.), 132.5 (Cₖ), 130.9 (Cₗ), 124.2 (Cₜ), 113.0 (Cₗ), 65.8 (Cₙ), 63.2 (C quat.), 39.5 (Cₖ), 34.4 (C quat.), 33.3 (Cₖ), 31.5 (Cₗ).

HRMS (ESI⁺) $m/z = 562.4049$ [M+H]$^+$ (calc. for C₄₀H₅₂NO 562.4043 [M+H]$^+$).

HPLC rt: 8.76 minutes
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1H NMR spectrum of 8, 400 MHz, 298 K, CDCl₃

13C NMR spectrum of 8, 100 MHz, 298 K, CDCl₃
**Preparation of compound 30**

To a solution of 5-azidopentanoic acid 27 (25.5 mg, 0.18 mmol, 1 equiv.) in DMF (3 mL) was added DMAP (22 mg, 0.18 mmol, 1 equiv.) and EDC.HCl (34.5 mg, 0.18 mmol, 1 equiv.). The solution was stirred at room temperature for 15 minutes before amine 8 (100 mg, 0.18 mmol, 1 equiv.) was added and stirred for 12 hours at room temperature. The solvent was removed *in vacuo* and chromatography (DCM/MeOH, gradient elution 100:0 to 95:5, $R_f = 0.6$ (95:5)) gave 30 as a white wax (80 mg, 0.12 mmol, 66%).

$^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 7.30 (d, $J = 8.7$, 6H, $H_b$), 7.16 (m, 8H, $H_c$, $H_d$), 6.81 (d, $J = 8.9$, 2H, $H_e$), 6.10 (t, $J = 4.8$, 1H, $H_{NH}$), 4.08 (t, $J = 5.7$, 2H, $H_f$), 3.52 (q, $J = 6.2$, 2H, $H_g$), 3.34 (t, $J = 6.7$, 2H, $H_h$), 2.25 (t, $J = 7.3$, 2H, $H_i$), 2.08 – 2.02 (m, 2H, $H_j$), 1.85 – 1.74 (m, 2H, $H_k$), 1.72 – 1.61 (m, 2H, $H_l$), 1.37 (s, 27H, $H_a$).

$^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$ 172.4 (C$_{CO}$), 156.4-148.4-144.2-140.1 (C$_{quat.\ arom.}$), 132.4 (C$_d$), 130.8 (C$_c$), 124.2 (C$_b$), 113.0 (C$_a$), 66.3 (C$_f$), 63.1 (C$_{quat.}$), 51.2 (C$_i$), 37.6 (C$_g$), 36.1 (C$_l$), 34.4 (C$_{quat.\ t\text{-but}}$), 31.5 (C$_h$), 29.0 (C$_j$), 28.4 (C$_k$), 22.9 (C$_n$).

HRMS (ESI$^+$) $m/z = 687.4644$ [M+H]$^+$ (calc. for C$_{45}$H$_{59}$N$_4$O$_2$ 687.4632 [M+H]$^+$).
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$-0.5 \quad 0.0 \quad 0.5 \quad 1.0 \quad 1.5 \quad 2.0 \quad 2.5 \quad 3.0 \quad 3.5 \quad 4.0 \quad 4.5 \quad 5.0 \quad 5.5 \quad 6.0 \quad 6.5 \quad 7.0 \quad 7.5$

$f_1$ (ppm)

$26.9 \quad 2.1 \quad 2.0 \quad 2.1 \quad 2.0 \quad 2.0 \quad 2.0 \quad 2.0 \quad 0.9 \quad 2.0 \quad 1.37 \quad 1.67 \quad 1.68 \quad 1.70 \quad 1.72 \quad 1.75 \quad 1.77 \quad 1.79 \quad 1.80 \quad 2.02 \quad 2.03 \quad 2.05 \quad 2.06 \quad 2.08 \quad 2.24 \quad 2.26 \quad 2.27 \quad 3.32 \quad 3.34 \quad 3.36 \quad 3.50 \quad 3.51 \quad 3.53 \quad 3.54 \quad 4.07 \quad 4.08 \quad 4.09 \quad 6.09 \quad 6.10 \quad 6.11 \quad 6.80 \quad 6.82 \quad 7.15 \quad 7.17 \quad 7.19 \quad 7.29 \quad 7.31$

$O$

$HN$

$O$

$N$

$3$

$a$

$b$

$c$

$d$

$e$

$f$

$g$

$h$

$i$

$j$

$k$

$l$

$30$

$1$ $H NMR spectrum of 30, 400 MHz, 298 K, CDCl$_3$

$180 \quad 170 \quad 160 \quad 150 \quad 140 \quad 130 \quad 120 \quad 110 \quad 100 \quad 90 \quad 80 \quad 70 \quad 60 \quad 50 \quad 40 \quad 30 \quad 20 \quad 10 \quad 0 \quad -10$

$\delta$ (ppm)

$13C$ NMR spectrum of 30, 100 MHz, 298 K, CDCl$_3$
Preparation of compound 31

To a solution of azide 30 (80 mg, 0.12 mmol, 1 equiv.) and and 6-heptynoic acid 25 (15 mg, 0.12 mmol, 1 equiv.) in degassed DCM (4 mL) was added [Cu(MeCN)]PF$_6$ (45 mg, 0.12 mmol, 1 equiv.). The solution was stirred at room temperature for 18 hours. The reaction was hydrolyzed with saturated EDTA$_{aq}$ (5 mL) for one hour and the aqueous phase was extracted with DCM (3x). The combined organic layers were dried over MgSO$_4$, filtered and concentrated in vacuo. Chromatography (DCM/MeOH, gradient elution 100:0 to 95:5, $R_f = 0.2$ (95:5)) gave 31 as a white wax (72 mg, 0.088 mmol, 74%).

$^1$H NMR (400 MHz, CD$_2$Cl$_2$) $\delta$ 7.72 (bs, 1H, H$_6$), 7.27 (d, $J = 8.7$, 6H, H$_b$), 7.17 (d, $J = 8.7$, 8H, H$_c$, H$_d$), 6.76 (d, $J = 8.9$, 2H, H$_a$), 6.26 (bs, 1H, H$_{NH}$), 4.30 (t, $J = 6.4$, 2H, H$_l$), 3.99 (t, $J = 5.8$, 2H, H$_f$), 3.39 (q, $J = 6.3$, 2H, H$_h$), 2.71 (m, 2H, H$_5$), 2.38 (m, 2H, H$_i$), 2.18 (t, $J = 7.2$, 2H, H$_2$), 1.95 (m, 4H, H$_g$, H$_j$), 1.69 – 1.59 (m, 6H, H$_3$, H$_4$, H$_j$), 1.31 (s, 27H, H$_a$).

$^{13}$C NMR (100 MHz, CD$_2$Cl$_2$) $\delta$ 173.3 (C$_{CO}$), 157.1-149.0-145.0-140.5 (C$_{quat.~arom.}$), 132.5 (C$_d$), 131.0 (C$_c$), 124.9 (C$_b$, C$_e$), 113.7 (C$_e$), 66.6 (C$_l$), 63.7 (C$_{quat.}$), 50.4 (C$_i$), 37.8 (C$_h$), 36.1 (C$_2$), 34.8 (C$_{quat.~t\text{-but}}$), 31.7 (C$_a$), 30.1-29.6 (C$_{g}$, C$_k$), 29.2-25.6-23.1 (C$_3$, C$_4$, C$_j$).

HRMS (ESI$^+$) $m/z = 813.5314$ [M+H]$^+$ (calc. for C$_{52}$H$_{69}$N$_4$O$_8$ 813.5313 [M+H]$^+$).
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$^1$H NMR spectrum of 31, 400 MHz, 298 K, CD$_2$Cl$_2$

$^{13}$C NMR spectrum of 31, 100 MHz, 298 K, CD$_2$Cl$_2$
Preparation of compound (S)-32

To a solution of acid 31 (18 mg, 0.02 mmol, 1 equiv.) in DMF (1 mL) was added DMAP (3 mg, 0.02 mmol, 1 equiv.) and EDC.HCl (5 mg, 0.02 mmol, 1 equiv.). The solution was stirred at room temperature for 15 minutes before macrocycle (S)-24 (15 mg, 0.02 mmol, 1 equiv.) was added and stirred for 48 hours at room temperature. The solvent was removed in vacuo and chromatography (DCM/MeOH, gradient elution 100:0 to 95:5, \( R_f = 0.3 \) (95:5)) gave (S)-32 as a colorless wax (28 mg, 0.018 mmol, 85%).

**\(^1\)H NMR** (500 MHz, DMSO-\( d_6 \)) \( \delta \) 9.77-9.69 (2s, 3H, H\(_{NH-carbamate}\), H\(_{NH-amide}\)), 8.31 (d, \( J = 7.9 \), 1H, H\(_{NH-amide}\)), 7.90 (t, \( J = 5.5 \), 1H, H\(_{NH-amide}\)), 7.80 (t, \( J = 7.7 \), 1H, H\(_A\)), 7.74 (s, 1H), 7.46 (s, 1H), 7.37 - 7.02 (m, 31H), 6.82 (d, \( J = 9 \), 2H, H\(_b\)), 5.14 (s, 2H, H\(_C\)), 5.04 (m, 2H, H\(_C'\)), 4.74 (m, 1H, H\(_1\)), 4.48-4.46-4.44-4.43 (4s, 8H, H\(_C\), H\(_C'\), H\(_D\), H\(_D'\)), 4.26 (t, \( J = 7.0 \), 2H, H\(_l\)), 3.91 (t, \( J = 6.0 \), 2H, H\(_h\)), 3.18 (m, 2H, H\(_i\)), 3.11 (dd, \( J = 13.6 \), 5.4, 1H, H\(_1\)), 2.91 (dd, \( J = 13.5 \), 9.4, 1H, H\(_1\)), 2.5 (2H masked by DMSO-\( d_6 \)), 2.14 – 2.06 (m, 4H), 1.84 – 1.70 (m, 4H, H\(_g\), H\(_k\)), 1.43 (m, 6H), 1.25 (s, 27H, H\(_a\)).

**\(^{13}\)C NMR** (126 MHz, DMSO-\( d_6 \)) \( \delta \) 172.3, 171.7, 170.672, 157.2, 156.2, 153.3, 147.7, 146.6, 144.0, 138.9, 138.4, 138.2, 137.6, 137.3, 134.4, 131.4, 130.0, 129.2, 128.8, 128.7, 128.1, 127.8, 126.3, 125.7, 125.1, 124.3, 121.5, 121.4, 113.3, 71.0, 70.9, 70.5, 70.4, 64.9, 62.6, 54.5, 48.8, 37.6, 35.4, 34.8, 34.6, 34.0, 31.1, 29.3, 28.9, 28.4, 24.7, 22.2.

**HRMS (ESI\(^+\))** \( m/z = 1496.8044 \) [M+H\(^+\)] (calc. for C\(_{92}\)H\(_{106}\)N\(_9\)O\(_{10}\) 1496.8057 [M+H\(^+\)]).

**HPLC rt:** 9.04 minutes
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$\text{H NMR spectrum of (S)-32, 500 MHz, 298 K, DMSO-d}_6$

$\text{C NMR spectrum of (S)-32, 126 MHz, 298 K, DMSO-d}_6$
**Preparation of compound (S)-9**

![Chemical structure of (S,R)-9](image)

Mechanical planar chirality drawn as (R,mp) for visual purposes, not experimentally determined.

To a solution of [1]rotaxane (S)-7 (20 mg, 0.016 mmol, 1 equiv.) in DCM (2 mL) was added amine 8 (46 mg, 0.081 mmol, 5 equiv.) and DIPEA (0.014 mL, 0.081 mmol, 5 equiv.). The reaction mixture was stirred at 40 °C for 48 hours. The solvent was removed in vacuo and chromatography (DCM/MeOH, gradient elution 100:0 to 95:5, Rf = 0.3 (95:5)) gave (S)-9 as a colorless wax (13 mg, 0.009 mmol, 54%).

**1H NMR** (500 MHz, DMSO-<d6>) δ 9.51-9.47 (2s, 3H, H NH-carbamate H NH-amide), 8.59 (d, J = 7.6, 1H, H NH-amide), 7.57 (t, J = 7.8, 1H, H<sub>A</sub>), 7.49 (d, J = 8.7, 1H, H<sub>I</sub>), 7.35 – 6.94 (m, 31H, H<sub>B</sub>, H<sub>B'</sub>, H<sub>E</sub>, H<sub>E'</sub>, H<sub>F</sub>, H<sub>F'</sub>, H<sub>g</sub>, H<sub>h</sub>, H<sub>i</sub>, H<sub>j</sub>, H<sub>m</sub>, H<sub>b</sub>, H<sub>c</sub>, H<sub> NH-amide</sub>, H<sub>h'</sub>), 6.82 (d, J = 8.8, 2H, H<sub>d</sub>), 6.48 (d, J = 8.9, 2H, H<sub>e</sub>), 5.15 – 5.04 (m, 3H, H<sub>g</sub>, H<sub>G'</sub>), 4.95 (bs, 1H, H<sub>G</sub>), 4.72 (m, 1H, H<sub>1</sub>), 4.46 – 4.37 (m, 4H, H<sub>C</sub>, H<sub>C'</sub>, or H<sub>D</sub>, H<sub>D'</sub>), 4.20 – 4.06 (m, 4H, H<sub>C</sub>, H<sub>C'</sub>, or H<sub>D</sub>, H<sub>D'</sub>), 3.41 (m, 4H), 3.09 (dd, J = 13.8, 5.6, 1H, H<sub>1</sub>), 2.94 (m, 3H, H<sub>f</sub>), 2.25 (m, 1H), 2.11 (m, 1H), 1.59 (m, 4H), 1.45 (m, 4H), 1.25 (29H), 0.84 (m, 4H).

**13C NMR** (126 MHz, DMSO-<d6>) δ 173.5, 171.6, 170.33, 157.2, 157.0, 156.1, 153.2, 152.9, 147.6, 146.3, 144.3, 138.4, 137.9, 137.1, 136.0, 133.2, 130.0, 129.0, 128.2, 126.5, 124.3, 123.9, 120.5, 119.7, 119.6, 117.6, 113.2, 71.6, 71.4, 70.2, 69.7, 65.2, 64.9, 64.7, 62.6, 55.0, 48.5, 39.8, 39.7, 39.5, 39.3, 39.2, 36.2, 35.4, 34.9, 34.2, 34.1, 31.2, 29.0, 28.8, 27.6, 24.5, 24.4, 21.5.

**HRMS (ESI)<sup>+</sup>** m/z = 1496.8040 [M+H]<sup>+</sup> (calc. for C<sub>92</sub>H<sub>106</sub>N<sub>9</sub>O<sub>10</sub> 1496.8057 [M+H]<sup>+</sup>).

**HPLC rt**: 9.28 minutes
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$^{1}H$ NMR spectrum of (S)-9, 500 MHz, 298 K, DMSO-$d_6$

$^{13}C$ NMR spectrum of (S)-9, 126 MHz, 298 K, DMSO-$d_6$
I.4. Stacked spectra

**Figure S1.** $^1$H NMR full stacked spectra of crude (S)-3, isolated (S)-3, (S)-4, (S)-1 and 5a.

**Figure S2.** $^1$H NMR partial stacked spectra of crude (S)-3, isolated (S)-3, (S)-4, (S)-1 and 5a.
Figure S3. $^1$H NMR partial stacked spectra of crude (S)-3, isolated (S)-3, (S)-4, (S)-1 and 5a.

I.5. CD and absorbance spectra of (S)-4

Figure S4. CD spectrum of (S)-4 (red). Absorbance spectrum of (S)-4 (black). Measured in CH$_2$Cl$_2$ (c = 10$^{-3}$ M) at 20 °C.
I.6. Method of mechanical stereodescriptor determination of MPC [1]rotaxane

In order to assign the mechanical stereodescriptor of a [1]rotaxane bearing a dissymmetric macrocycle, we propose the following procedure which is derived from the already known strategy for the MPC [2]rotaxanes. For this purpose, the [1]rotaxane has to be visualized as a “virtual” [2]rotaxane using the following rules (scheme S12):

**Step 1:** Break the covalent bond between the macrocycle and the exocyclic chain in order to form the corresponding pseudo[2]rotaxane.

**Step 2:** Unfold linearly the axle.

**Step 3:** Extend each new non-covalently linked unit of the pseudo[2]rotaxane by the missing part with which it is linked within the [1]rotaxane. Thus, the interlocked axle is extended by a new macrocycle, playing the role of the second stopper in the newly formed [2]rotaxane (see highlighted grey box no.1, scheme S12) while the macrocycle is extended by the axle bearing the terminal stopper (see highlighted grey box no.2, scheme S12).

Each newly formed element (highlighted with grey boxes) in the resulting [2]rotaxane is then considered as “virtual” with the following properties:

i. None of the newly added atoms can be selected when determining the priority atoms, both into the axle and the macrocycle (e.g. scheme S12, for the determination of axle atoms of highest priority, the amide moieties have priority against “virtual” endocyclic carbamates).

ii. However, the addition of these “virtual” fragments can then allow to define the order of priority between two identical functional groups within the pre-existing [1]rotaxane (see the two amide functions of the axle or the two carbamate functions of the macrocycle).

**Step 4:** Determine the mechanical stereodescriptor of the MPC [2]rotaxane with the new rules previously described in step 3:

i. Determine the atom of highest priority in the axle with the Cahn-Ingold-Prelog (CIP) methodology and attribute the label “A” to it. If the atom of highest priority is out of the axle line, the all functional group connected to the axle, which bears this atom of highest priority, is considered as “A”.

ii. From “A”, determine the highest priority atom with the CIP methodology and give it the label “B”. The directionality of the axle is then directed by the vector A→B.
iii. Execute the same process for the macrocycle with the atom/functional group of highest priority labelled “C” and attribute the label “D” to the atom of highest priority when looking from “C”. The orientation of the macrocycle is then directed by the vector C→D.

iv. Look at the [2]rotaxane along the direction of vector A→B and observe the orientation of the vector C→D. If the vector C→D shows a clockwise orientation, the mechanical stereodescriptor is considered (R_{mp}), otherwise, if the vector C→D shows an anticlockwise orientation then the mechanical stereodescriptor is considered as (S_{mp}).
Scheme S12. Representation of the methodology for the mechanical stereodescriptor determination of MPC [1]rotaxane 3.
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