Synthesis of {242}- and {323}-*p*-Octiphenyls

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The introduction of rigid-rod molecules as privileged scaffolds has opened routes to otherwise problematic supramolecular architecture like artificial β-barrels and functional supramolecules covering pores, hosts, sensors, and catalysts. The usefulness of *p*-oligophenyls for the construction of functional barrel-stave architecture has, however, been limited by uniform substitution along the rigid-rod scaffold. The objective of this report is to overcome this obstacle for the synthesis of *p*-octiphenyls with orthogonally protected carboxylic acid groups along the rigid-rod scaffold. In the reported {242}-*p*-octiphenyl **1**, the two peripheral arene moieties carry carboxylic acid groups protected as benzyl esters, whereas the four central carboxylic acid groups are protected orthogonally as *tert*-butyl esters (*Scheme 2*). The complementary orthogonal protection of the three peripheral and the two central arenes is achieved in the {323}-*p*-octiphenyl **2** (*Scheme 3*). The realized {242}- and {323}-*p*-octiphenyls **1** and **2**, respectively, provide a complete set for the general access to refined rigid-rod barrel-stave architecture with maximized functional plasticity. The need for resolution-enhanced (aliased) HMBC 2D-NMR spectroscopy to characterize these refined oligomers is described in the following publication in this issue of *Helv. Chim. Acta.*

Introduction. – In this report, we describe the synthesis of {242}-*p*-octiphenyl **1** and {323}-*p*-octiphenyl **2** (*Scheme 1*). The carboxylic acid groups lining the scaffold of both rigid-rod molecules carry orthogonal protecting groups. Benzyl esters, cleaved by hydrogenolysis and resistant to CF_3COOH, and the solubilizing [1] *tert*-butyl esters, removed by CF_3COOH and untouched by hydrogenolysis, were selected for orthogonal protection in this study [2]. The design of refined rigid-rod oligomers **1** and **2** focused on maximal complementarity. The conventional $1^3,2^3,3^2,4^3,5^2,6^3,7^2,8^3$ 1) (= $3,3',2'',3''',2'''',3''''',2'''''',3'''''''$) motif [3–6] of {242}-*p*-octiphenyl **1** was complemented by the new $1^2,2^2,3^3,4^2,5^3,6^2,7^3,8^2$ 1) (= $2,2',3'',2''',2'''',3''''',2''''''$) sequence in {323}-*p*-octiphenyl **2**. {242}-*p*-Octiphenyl **1** comprises compressed terminal $1^3,2^3$ and $7^2,8^3$ domains separated by an expanded central $3^2,4^3,5^2,6^3$ domain, whereas {323}-*p*-octiphenyl **2** features a compressed central $4^2,5^3$ domain flanked by expanded $1^2,2^2,3^3$ and $6^2,7^3,8^2$ domains. Finally, the sequence of the same orthogonal protecting groups was inverted from central *tert*-butyl esters and terminal benzyl esters in **1** to terminal *tert*-butyl esters and central benzyl esters in **2**.

With complementary {242}-rod **1** and {323}-rod **2** in hand, a comprehensive set of general precursors for refined rigid-rod barrel-stave architecture is available. For example, central and peripheral peptide strands of different sequences can be selectively introduced in conjugates **3** and **4** to produce {242}- and {323}-rigid-rod β-barrel pores [3], sensors [4] [5], and catalysts [6] with central and peripheral domains of different dimensions.

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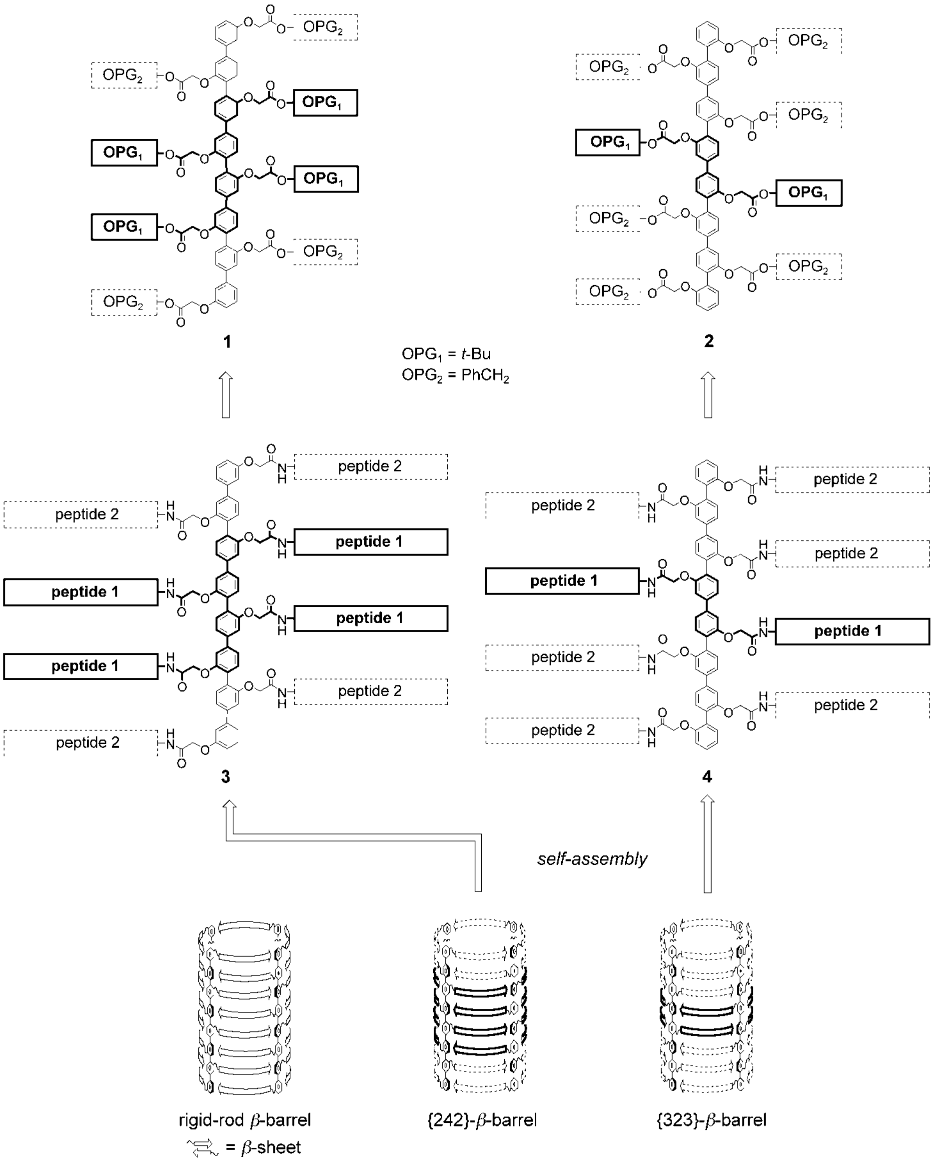
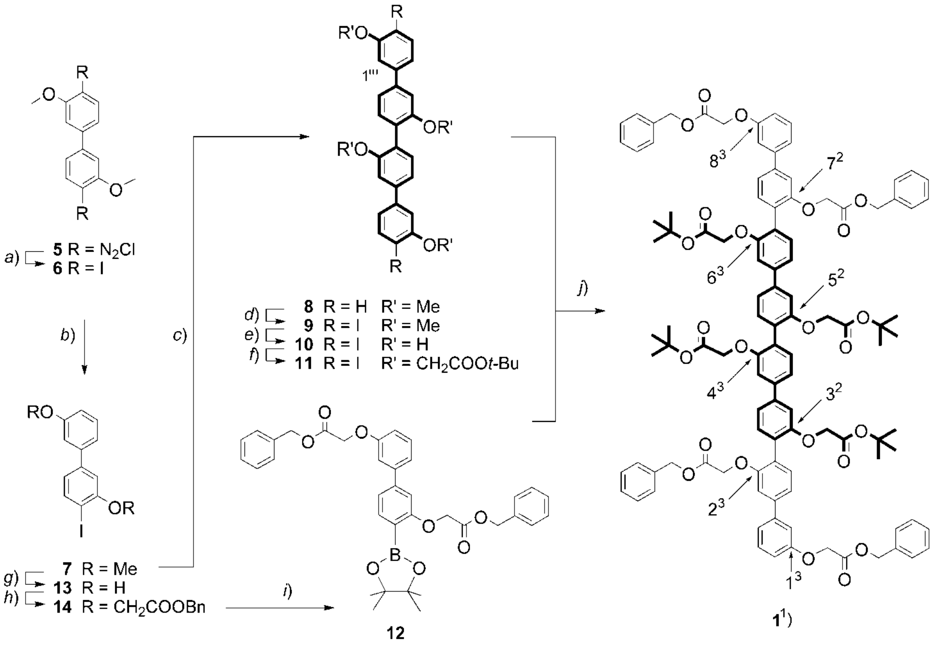
1) Arbitrary numbering; for systematic names, see *Exper. Part.*

Scheme 1. *{242}-*p*-Octiphenyl* **1** *and {323}-*p*-Octiphenyl* **2** *with Carboxylic Acid Groups Carrying the Orthogonal Protecting Groups OPG_1 and OPG_2 along Their Scaffold Enable,* e.g., *the Introduction of Chemically Distinct Peptide Strands for Self-Assembly of {242}- and {323}-β-Barrels with Partially or Fully Contracted Active Sites*



Results and Discussion. – Many strategies for the synthesis of more-complex *p*-oligophenyls and related rigid-rod scaffolds have been reported in the literature [7–44]. {242}-*p*-Octiphenyl **1** was prepared in ten steps from commercial biphenyl **5**

Scheme 2



a) KI, 70% [43]. *b*) 1. BuLi; 2. MeOH; 67% [42]. *c*) 1. BuLi, 2. $CuCl_2$; 64% [42]. *d*) 1. *t*-BuLi, toluene; 2. I_2; 46% [42]. *e*) BBr_3; 85%. *f*) *tert*-Butyl bromoacetate, Cs_2CO_3; 89%. *g*) BBr_3; 90%. *h*) Benzyl bromoacetate, Cs_2CO_3; 87%. *i*) 4,4,5,5-Tetramethyl-1,3,2-dioxaborolane, [$PdCl_2$(dppf)], Et_3N. *j*) [$Pd(PPh_3)_4$], K_2CO_3, DMSO; 51% form **14**.

(*Scheme 2*). The first four steps of the synthesis of the central *p*-quaterphenyl subunit were accomplished according to [42][43]. Specifically, diazonium salt **5** was iodinated with KI. One I-substituent in biphenyl **6** was removed non-selectively with BuLi. After quenching with MeOH, the desired iodobiphenyl **7** could be isolated from a roughly statistical mixture of biphenyls with either no or one (**7**) terminal I-substituent. Oxidative coupling of iodobiphenyl **7** gave *p*-quaterphenyl **8**. The same product was prepared in similar yields by conversion of iodo compound **7** to the corresponding boronic acid and subsequent *Suzuki* coupling (not shown). *p*-Quaterphenyl **8** was regioselectively iodinated with *t*-BuLi and molecular I_2. The *p*-quaterphenyl product **9** is the last compound of this sequence that was previously reported [42]. Multiple alkyl ether cleavage in *p*-quaterphenyl **9** with BBr_3 gave tetrol **10**, which was treated with *tert*-butyl bromoacetate to give the desired *p*-quaterphenyl subunit **11**. This key intermediate carries four lateral carboxylate handles protected as *tert*-butyl esters and two terminal I-substituents for *Suzuki* coupling with the peripheral biphenyl subunits **12**.

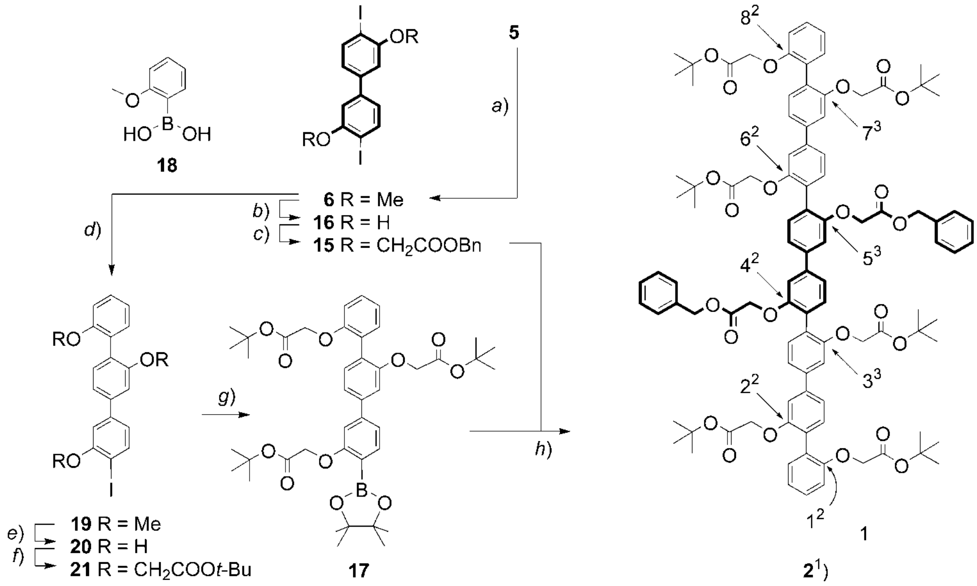
The peripheral boronate **12** was accessible from diether **7** in three steps. Ether exchange *via* diol **13** to dibenzyl ester **14** was as unproblematic as expected. The homologous bis(4-nitrobenzyl) and di(*tert*-butyl) esters were prepared analogously for controls (not shown). Several conditions were tested to optimize the preparation of boronate **12**. Best substrate conversion was observed by reacting dibenzyl ester **14** with pinacolborane (=4,4,5,5-tetramethyl-1,3,2-dioxalorolane), Et_3N, and $[PdCl_2(dppf)]$ in MeCN at 85° for 3 h (dppf = 1,1′-bis(diphenylphosphino)ferrocene). Less-satisfactory results were obtained, in our hands, with bis(4-nitrobenzyl) instead of dibenzyl ester **14** as the starting material. Less-satisfactory results were further obtained with bis(pinacolato)diboron [41–43] instead of pinacolborane [45], KOAc instead of Et_3N as base, and DMSO or dioxane instead of MeCN as solvents. Boronate **12** was used as the crude product for the next reaction to avoid unnessesary losses due to product decomposition during purification on silica gel and, less pronounced, on alox.

Suzuki coupling [46–52] of the central *p*-quaterphenyl subunit **11** carrying lateral *tert*-butyl esters and the peripheral biphenyl subunits **12** carrying orthogonal benzyl esters gave the desired {242}-*p*-octiphenyl **1** in 51% yield. This reaction was complicated by the need for aprotic solvents to avoid ester hydrolysis or transesterification. For instance, the use of aqueous Cs_2CO_3 as the base of choice in many examples [46][47] resulted in partial loss of the benzyl esters. The presence of MeOH as in some of *McClure*'s fluorine-mediated couplings resulted in transesterification [48]. Good yields of up to 44% were achieved with *Fu*'s fluorine-mediated *Suzuki* coupling in THF [49]. A maximal yield, *i.e.*, 51%, was obtained with a procedure based on $[Pd(PPh_3)_4]$ and K_2CO_3 in DMSO, adapting insights from several reports [48–51] to the excellent conditions published last year by *Yoburn* and *Van Vranken* [52].

The synthesis of {323}-*p*-octiphenyl **2** in eight steps from commercial biphenyl **5** has been communicated previously and is summarized here only briefly for comparison and completion (*Scheme 3*) [7]. The central biphenyl subunit **15** was readily accessible from diiodo compound **6** by transetherification *via* diol **16**. The synthesis of the peripheral *p*-terphenyl subunit **17** from biphenyl **6** was more demanding. Slow addition of boronic acid **18** to an excess of biphenyl **6** was the key for controlled *Suzuki* coupling to afford *p*-terphenyl **19** as the main product; routine conditions afforded overreacted *p*-quaterphenyl and unreacted biphenyl **6** together with traces of terphenyl **19**. Side-chain introduction by ether exchange *via* triol **20** was straightforward. Conversion of the tri(*tert*-butyl) ester **21** to boronate **17** worked best under the conditions used in the synthesis of **1**, *i.e.*, pinacolborane, $[PdCl_2(dppf)]$, and Et_3N in MeCN. The instability of benzyl esters in basic protic solvents prevented the application of many routine conditions for the final *Suzuki* coupling of central and terminal *p*-oligophenyls **15** and **17**, respectively. In agreement with the results for rod **1**, the modified conditions of *Yoburn* and *Van Vranken* [52] proved best in our hands, providing access to pure {323}-*p*-octiphenyl **2** in 48% yield. The synthesis of the homologous {323}-*p*-octiphenyl with 4-methoxybenzyl (4-MeOBn) rather than benzyl protection has been reported [7]. Because preliminary results from selective deprotection confirmed the orthogonality of Bn/*t*-Bu pairs as superior to 4-MeOBn/*t*-Bu pairs, we focused our attention on Bn/*t*-Bu-{323}-rod **2**.

The purities and structures of the final {242}-*p*-octiphenyl **1** and {323}-*p*-octiphenyl **2** were confirmed by conventional spectroscopic and analytical methods as described in the *Exper. Part*. The characterization of refined oligomers by NMR spectroscopy, however, is notoriously problematic. The similar chemical shifts of several nearly identical ring moieties result in signal clusters that are challenging to separate and to

Scheme 3



a) KI; 70%. *b*) BBr_3, 100%. *c*) Benzyl bromoacetate, Cs_2CO_3; 84%. *d*) $[Pd(PPh_3)_4]$, K_2CO_3, acetone/H_2O 5 : 1; 37%. *e*) BBr_3; 92%. *f*) *tert*-Butyl bromoacetate, Cs_2CO_3; 90%. *g*) Pinacolborane, $[PdCl_2(dppf)]$, Et_3N, MeCN. *h*) $[Pd(PPh_3)_4]$, K_2CO_3, DMSO; 48% from **21** [7].

assign. At worst, these signal clusters are detected as the broad, unresolved signals known from the corresponding polymers. Satisfactory interpretation of the ^1H- as well as the ^{13}C-NMR spectra of {242}-rod **1** and {323}-rod **2** was not possible by conventional NMR techniques including DEPT, COSY, HMBC, and HSQC. High-resolution (aliased) HSQC and HMBC NMR spectroscopy, however, were confirmed as user-friendly methods for complete characterization of complex oligomers. The application of this somewhat underappreciated method for full interpretation of both ^1H- as well as the ^{13}C-NMR spectra of {242}-rod **1** and {323}-rod **2** is described in the following publication [53].

Preliminary studies confirmed orthogonal deprotection of {242}-*p*-octiphenyl **1** and {323}-*p*-octiphenyl **2** in practice. Namely, the benzyl esters could be cleaved selectively by hydrogenolysis without cleavage of the *tert*-butyl esters, whereas the *tert*-butyl esters could be cleaved selectively with CF_3COOH without cleavage of the benzyl esters. Efforts to synthesize refined peptide–*p*-octiphenyl conjugates **3** and **4** and to study their self-assembly into multifunctional {242}- and {323}-β-barrel pores are ongoing and will be reported in due course.

We thank *A. Pinto* and *J.-P. Saulnier* for NMR measurements, *P. Perrottet* and the group of *F. Gülaçar* for MS measurements, *H. Eder* for elemental analyses, and the *Swiss National Science Foundation* for financial support (200020-101486 and *National Research Program* Supramolecular Functional Materials 4047-057496).

Experimental Part

General. Reagents for synthesis were purchased either from *Aldrich*, *Fluka*, or *Acros*. Solvents were distilled and dried before use. All reactions were performed under Ar. Column chromatography (CC): silica gel *60* (*Fluka*; 40–63 μm). Anal. and prep. TLC: silica gel *60* (*Fluka*; 0.2 mm) and silica gel *GF* (*Analtech*; 1000 μm), resp. IR Spectra: *Perkin-Elmer-Spectrum-One*-FT-IR spectrometer; solid samples; $\tilde{\nu}$ cm^{-1}. ^{1}H- and ^{13}C-NMR Spectra[1]): *Bruker-300*, *-400*, or *-500* spectrometer; chemical shifts δ in ppm relative to $SiMe_4$ (=0 ppm), coupling constants J in Hz; assignments with the aid of additional information from 2D NMR spectra (^{1}H,^{1}H-COSY, HSQC, HMBC) [53]; ESI-MS and Atmospheric-pressure chemical-ionization (APCI) MS: *Finnigan-MAT-SSQ-7000* instrument; in *m*/*z* (rel. %). HR-MS: *VG* analytical *7070E*.

1^4,4^4-Diiodo-1^3,2^3,3^2,4^3-tetramethoxy-p-*quaterphenyl* (=4,4‴-Diiodo-3,3′,2″,3‴-tetramethoxy-1,1′:4″,1‴-quaterphenyl; **9**). Intermediate **9** was prepared from biphenyl **5** in overall four steps as described in [42] (Supporting Information).

1^4,4^4-Diiodo-tetrol-p-*quaterphenyl-1^3,2^3,3^2,4^3* (=4,4‴-Diiodo[1,1″:4″-,1‴-quaterphenyl]-2″,3,3′,3‴-tetrol; **10**). To a soln. of **9** (130 mg, 0.19 mmol) in dry CH_2Cl_2 (10 ml), 1M BBr_3 in CH_2Cl_2 (1.5 ml) was added at −78°. This soln. was allowed to warm to r.t. over 14 h. Then, H_2O was added at −78°. After warming to 5°, the soln. was washed with brine, dried (Na_2SO_4), and evaporated, and the crude product purified by CC (CH_2Cl_2/MeOH 15:1): pure **10** (100 mg, 85%). Colorless solid. TLC (CH_2Cl_2/MeOH 15:1): R_f 0.22. M.p. >230°. IR: 3370*s*, 2972*m*, 2931*m*, 1697*m*, 1584*m*, 1545*m*, 1489*w*, 1469*m*, 1399*s*, 1175*s*, 1130*s*. ^{1}H-NMR (500 MHz, CD_3OD): 7.68 (*d*, ^3J=8.2, H–C(1^5), H–C(4^5)); 7.28 (*d*, ^3J=7.9, H–C(2^5), H–C(3^6)); 7.16 (*d*, ^4J=1.7, H–C(2^2), H–C(3^3)); 7.1 (*dd*, ^3J=7.90, ^4J=1.7, H–C(2^6), H–C(3^5)); 7.1 (*d*, ^4J=2.0, H–C(1^2), H–C(4^2)); 6.9 (*dd*, ^3J=8.2, ^4J=2.0, H–C(1^6), H–C(4^6)). ^{13}C-NMR (125 MHz, CD_3OD): 158.2 (*s*, C(1^3), C(4^3)); 155.3 (*s*, C(2^3), C(3^2)); 143.5 (*s*, C(1^1), C(4^1)); 141.9 (*s*, C(2^1), C(3^4)); 140.6 (*d*, C(1^5)); 133.1 (*d*, C(2^5)); 126.6 (*s*, C(2^4), C(3^1)); 120.8 (*d*, C(1^6), C(4^6)); 119.9 (*d*, C(2^6), C(3^5)); 115.4 (*d*, C(2^2), C(3^3)); 113.9 (*d*, C(1^2), C(4^2)); 83.5 (*s*, C(1^4), C(4^4)). HR-MS: 621.9173 (M^+, $C_{24}H_{16}O_4I_2^+$; calc. 621.9138).

2,2′,2″,2‴-[(1^4,4^4-Diiodo-p-*quaterphenyl-1^3,2^3,3^2,4^3-tetrayl)tetrakis(oxy)]tetrakis[acetic Acid] Tetra(*tert-*butyl Ester] (=2,2′,2″,2‴-[(4,4‴-Diiodo[1,1′:4′,1″:4″,1‴-quaterphenyl]-2″,3,3′,3‴-tetrayl)tetrakis(oxy)]tetrakis-[acetic Acid] Tetra(*tert-*butyl Ester)*; **11**). To a soln. of **10** (100 mg, 0.16 mmol) in dry acetone (25 ml) was added Cs_2CO_3 (420 mg, 1.3 mmol). The resulting suspension was stirred at r.t. for 30 min. Then, *tert*-butyl bromoacetate (190 μl, 1.3 mmol) was added, and the mixture was stirred for an additional 3 h. The mixture was then evaporated, the residue dissolved in AcOEt, washed with brine, dried ($MgSO_4$), and evaporated, and the crude product purified by CC (CH_2Cl_2/petroleum ether 4:1, then CH_2Cl_2/AcOEt 120:1): anal. pure **11** (165 mg, 96%). Colorless solid. TLC (CH_2Cl_2/AcOEt 120:1): R_f 0.44. M.p. 48–49°; IR: 2979*m*, 2918*m*, 1752*s*, 1737*s*, 1606*w*, 1473*m*, 1393*m*, 1241*s*, 1156*s*, 631*s*, 539*s*. ^{1}H-NMR (500 MHz, CD_2Cl_2): 7.87 (*d*, ^3J=8.0, H–C(1^5), H–C(4^5)); 7.45 (*d*, ^3J=7.8, H–C(2^5), H–C(3^6)); 7.25 (*dd*, ^3J=7.8, ^4J=1.7, H–C(2^6), H–C(3^5)); 7.02 (*d*, ^4J=1.7, H–C(2^2), H–C(3^3)); 7.02 (*dd*, ^3J=8.0, ^4J=1.9, H–C(1^6), H–C(4^6)); 6.96 (*d*, ^4J=1.9, H–C(1^2), H–C(4^2)); 4.66 (*s*, CH_2O–C(1^3), CH_2O–C(4^3)); 4.57 (*s*, CH_2O–C(2^3), CH_2O–C(3^2)); 1.51 (*s*, 2 *t*-Bu (rings 1 and 4)); 1.46 (*s*, 2 *t*-Bu (rings 2 and 3)). ^{13}C-NMR (125 MHz, CD_2Cl_2): 168.1 (*s*, *C*OCH_2O–C(2^3), *C*OCH_2O–C(3^2)); 167.5 (*s*, *C*OCH_2O–C(1^3), *C*OCH_2O–C(3^2)); 157.5 (*s*, C(1^3), C(4^3)); 156.2 (*s*, C(2^3), C(3^2)); 143.0 (*s*, C(1^1), C(4^1)); 141.2 (*s*, C(2^1), C(3^4)); 140.3 (*d*, C(1^5), C(4^5)); 132.6 (*d*, C(2^5), C(3^6)); 127.2 (*s*, C(2^4), C(3^1)); 122.4 (*d*, C(1^6), C(4^6)); 120.2 (*d*, C(2^6), C(3^5)); 111.4 (*d*, C(1^2), C(4^2)); 111.1 (*d*, C(2^2), C(3^3)); 85.4 (*s*, C(1^4), C(4^4)); 82.8 (*s*, 2 Me_3*C* (rings 1 and 4)); 82.4 (*s*, 2 Me_3*C* (rings 2 and 3)); 67.0 (*t*, *C*H_2O–C(1^3), *C*H_2O–C(4^3)); 66.6 (*t*, *C*H_2O–C(2^3), *C*H_2O–C(3^2)); 28.2 (*q*, 2 Me_3C (rings 1 and 4)); 28.1 (*q*, 2 Me_2C (rings 2 and 3)). APCI-MS (acetone/$N(CH_2CH_2OH)_3$; neg.): 1113 (100, $[M+Cl]^-$). APCI-MS (acetone/$N(CH_2CH_2OH)_3$; pos.): 1228 (100, $[M+N(CH_2CH_2OH)_3]^+$).

4-Iodo-3,3′-dimethoxy-1,1′-biphenyl (**7**). Intermediate **7** was prepared from biphenyl **5** in overall two steps as described in [42] (Supporting Information).

4-Iodo[1,1′-biphenyl]-3,3′-diol (**13**). To a soln. of **7** (60 mg, 0.18 mmol) in dry CH_2Cl_2 (10 ml) was added 1M BBr_3 in CH_2Cl_2 (0.72 ml) at −78°. This soln. was allowed to warm to r.t. over 14 h. Then, H_2O was added at −78° to quench the reaction. After warming to 5°, the soln. was washed with brine (3×), dried (Na_2SO_4), and evaporated and the crude product purified by CC (CH_2Cl_2/MeOH 20:1): anal. pure **13** (49 mg, 90%). Colorless solid. TLC (CH_2Cl_2/MeOH 12:1): R_f 0.50. M.p. 134–135°. IR: 3338*m*, 2921*m*, 1613*w*, 1589*m*, 1567*s*, 1481*m*, 1339*s*, 1309*s*, 1184*s*, 1172*s*, 939*s*. ^{1}H-NMR (500 MHz, CD_3OD): 7.68 (*d*, ^3J=8.2, H–C(1^5)); 7.2 (*t*, ^3J=7.8, H–C(2^5)); 7.0 (*d*, ^4J=2.1, H–C(1^2)); 7.01 (*ddd*, ^3J=7.9, ^4J=2.2, ^4J=1.0, H–C(2^4)); 6.98 (*dd*, ^4J=2.2, 2.4, H–C(2^2)); 6.80 (*dd*, ^3J=8.2, ^4J=2.1, H–C(1^6)); 6.77 (*ddd*, ^3J=7.9, ^4J=1.0, 2.4, H–C(2^6)). ^{13}C-NMR (125 MHz, CD_3OD): 158.8 (*s*, C(2^3)); 158.2 (*s*, C(1^3)); 144.2 (*s*, C(1^1)); 142.9 (*s*, C(2^1)); 140.5 (*d*, C(1^5)); 130.9

(*d*, C(2^5)); 120.9 (*d*, C(1^6)); 119.0 (*d*, C(2^4)); 115.6 (*d*, C(2^6)); 114.5 (*d*, C(2^2)); 114.1 (*d*, C(1^2)); 83.3 (*s*, C(1^4)). APCI-MS (acetone): 347 (22, $[M+\mathrm{Cl}]^-$), 311 (50, $[M-\mathrm{H}]^-$). HR-MS: 311.9656 (M^+, $C_{12}H_9O_2I^+$; calc. 311.9647).

2,2′-[(4-Iodo[1,1′-biphenyl]-3,3′-diyl)bis(oxy)]bis[acetic Acid] Dibenzyl Ester (**14**). To a soln. of **13** (120 mg, 0.39 mmol) in dry acetone (25 ml) was added Cs_2CO_3 (757 mg, 2.34 mmol). The resulting suspension was stirred at r.t. for 10 min. Then benzyl bromoacetate (182 µl, 1.17 mmol) was added, and the suspension was stirred for an additional hour. The mixture was evaporated, the residue dissolved in AcOEt, the soln. washed with brine, dried ($MgSO_4$), and evaporated and the crude product purified by CC (CH_2Cl_2/petroleum ether 4 : 1, then CH_2Cl_2): anal. pure **14** (206 mg, 87%). Colorless solid. TLC (CH_2Cl_2): R_f 0.53. M.p. 89–90°. IR: 3035*w*, 2914*w*, 1716*s*, 1593*m*, 1561*m*, 1474*m*, 1455*m*, 1395*m*, 1233*s*, 1071*s*, 968*m*. ^{1}H-NMR (300 MHz, CD_2Cl_2): 7.86 (*d*, $^3J = 8.1$, H–C(1^5)); 7.42–7.30 (*m*, 2 *Ph*CH$_2$, H–C(2^5)); 7.13 (*ddd*, $^3J = 7.7$, $^4J = 1.5$, 1.5, H–C(2^6)); 7.07 (*dd*, $^4J = 1.9$, 1.5, H–C(2^2)); 6.96 (*dd*, $^3J = 8.1$, $^4J = 1.9$, H–C(1^6)); 6.91 (*d*, $^4J = 1.9$, H–C(1^2)); 6.90 (*ddd*, $^3J = 7.7$, $^4J = 1.5$, 1.5, H–C(2^4)); 5.25 (*s*, PhC*H*$_2$ (ring 1)); 5.24 (*s*, PhC*H*$_2$ (ring 2)); 4.81 (*s*, CH$_2$O–C(1^3)); 4.74 (*s*, CH$_2$O–C(2^3)). ^{13}C-NMR (75 MHz, CD_2Cl_2): 168.9 (*s*, *C*OCH$_2$O–C(2^3)); 168.4 (*s*, *C*OCH$_2$O–C(1^3)); 158.6 (*d*, C(2^3)); 157.3 (*d*, C(1^3)); 142.9 (*s*, C(1^1)); 142.0 (*s*, C(2^1)); 140.4 (*d*, C(1^5)); 135.8 (*s*, 2 C_{ipso} (Bn)); 130.4 (*d*, C(2^5)); 129.0–128.6 (6*d*, 4 C_o, 4 C_m, 2 C_p (all Bn)); 122.7 (*d*, C(1^6)); 120.8 (*d*, C(2^6)); 114.0 (*d*, C(2^2)); 114.0 (*d*, C(2^4)); 111.6 (*d*, C(1^2)); 85.5 (*s*, C(1^4)); 67.4 (*t*, 2 Ph*C*H$_2$); 66.7 (*t*, *C*H$_2$O–C(1^3)); 65.8 (*t*, *C*H$_2$O–C(2^3)). APCI-MS (acetone; neg.): 643 (5, $[M+\mathrm{Cl}]^-$), 517 (24, $[M-\mathrm{I}+\mathrm{Cl}]^-$), 459 (100, $[M-2\,\mathrm{Bn}+\mathrm{Cl}]^-$). APCI-MS (acetone; pos.): 608 (12, $[M]^+$), 482 (100, $[M-\mathrm{I}]^+$), 391 (47, $[M-\mathrm{Bn}-\mathrm{I}]^+$). HR-MS: 608.0739 ($M^+$, $C_{30}H_{25}O_6I^+$; calc. 608.0696).

{424}-p-*Octiphenyl* **1** (*=2,2′,2″,2‴,2⁗,2′′′′′,2′′′′′′,2′′′′′′′-[[1,1′:4′,1″:4″,1‴:4‴,1⁗:4⁗,1′′′′′.4′′′′′,1′′′′′′:4′′′′′′,1′′′′′′′-Octiphenyl-2″,2⁗,2′′′′′′,3,3′,3‴,3′′′′′,3′′′′′′′-octayloctakis(oxy)]octakis[acetic Acid] 0*^{1}*,0*$^{1'}$*,0*$^{1''''''}$*,0*$^{1'''''''}$*-Tetrabenzyl 0*$^{1''}$*,0*$^{1'''}$*,0*$^{1''''}$*,0*$^{1'''''}$*-Tetra(*tert-*butyl) Ester*). To a soln. of **14** (300 mg, 0.49 mmol) in degassed MeCN (9 ml) were added [PdCl$_2$(dppf)] (3 mol-%), Et$_3$N (412 µl, 3.0 mmol) and 4,4,5,5-tetramethyl-1,3,2-dioxaborolane (= pinacolborane) (430 µl, 3.0 mmol). The soln. was heated at 80° for 3 h. Benzene (8 ml) was then added and the soln. washed with brine, dried ($MgSO_4$), and evaporated: intermediate **12**.

a) Crude **12** (68 mg, 0.11 mmol) was then added to a soln. of **11** (20 mg, 0.019 mmol), [Pd(PPh$_3$)$_4$] (6 mol-%) and K_2CO_3 (15 mg, 0.11 mmol) in degassed DMSO (3 ml). The soln. was heated at 90° for 14 h. After cooling to r.t., CHCl$_3$ (40 ml) was added, the mixture washed with H_2O, dried ($MgSO_4$), and evaporated, and the crude product purified by prep. TLC (CH_2Cl_2/AcOEt 120 : 1, double elution): anal. pure **1** (17 mg, 51%). Colorless solid.

b) Crude **12** (68 mg, 0.11 mmol) was added to a soln. of **11** (20 mg, 0.019 mmol), [Pd(PPh$_3$)$_4$] (6 mol-%), and CsF (17 mg, 0.11 mmol) in degassed THF (3 ml). The soln. was heated to reflux for 14 h. Workup and purification as in *a*) gave anal. pure **1** (13.5 mg, 44%). Colorless solid. TLC (CH_2Cl_2/AcOEt 120 : 1): R_f 0.27. ^{1}H-NMR (500 MHz, CD_2Cl_2): 7.52 (*d*, $^3J = 7.9$, H–C(4^5), H–C(5^6)); 7.47 (*d*, $^3J = 7.7$, H–C(2^5), H–C(7^6)); 7.46 (*d*, $^3J = 7.1$, H–C(3^6), H–C(6^5)); 7.38 (*m*, H–C(1^5), H–C(8^5)); 7.36 (*m*, 4 H_o (Bn, rings 1 and 8), 4 H_m (Bn, rings 1 and 8)); 7.35 (*m*, 2 H_p (Bn, rings 1 and (8));7.34 (*m*, H–C(4^6), H–C(5^5)); 7.33 (*m*, H–C(3^5), H–C(6^6)); 7.31 (*m*, 4 H_o (Bn, rings 2 and 7)); 7.30 (*m*, 2 H_p (Bn, rings 2 and 7), 4 H_m (Bn, rings 2 and 7)); 7.29 (*dd*, $^3J = 7.7$, $^4J = 1.6$, H–C(2^6), H–C(7^6)); 7.23 (*ddd*, $^3J = 7.7$, $^4J = 1.7$, 0.8, H–C(1^6), H–C(8^6)); 7.16 (*dd*, $^4J = 2.5$, 1.7, H–C(1^2), H–C(8^2)); 7.14 (*d*, $^4J = 1.6$, H–C(4^2), H–C(5^3)); 7.09 (*d*, $^4J = 1.7$, H–C(3^3), H–C(6^2)); 7.09 (*d*, $^4J =$ 1.6, H–C(2^2), H–C(7^3)); 6.91 (*ddd*, $^3J = 8.2$, $^4J = 2.5$, 0.8, H–C(1^4), H–C(8^4)); 5.25 (*s*, 2 PhC*H*$_2$ (rings 1 and 8)); 5.20 (*s*, 2 PhC*H*$_2$ (rings 2 and 7)); 4.77 (*s*, CH$_2$O–C(2^3), CH$_2$O–C(7^2)); 4.76 (*s*, CH$_2$O–C(1^3), CH$_2$O–C(8^2); 4.62 (*s*, CH$_2$O–C(4^3), CH$_2$O–C(5^2)); 4.56 (*s*, CH$_2$O–C(3^2), CH$_2$O–C(6^3)); 1.49 (*s*, 2 ^{t}Bu (rings 4 and 5)); 1.47 (*s*, 2 ^{t}Bu (rings 3 and 6)). ^{13}C-NMR (125 MHz, CD_3OD): 169.2 (*s*, *C*OCH$_2$–C(2^3), *C*OCH$_2$–C(7^2)); 169.0 (*s*, *C*OCH$_2$–C(1^3), *C*OCH$_2$–C(8^3)); 168.2 (*s*, *C*OCH$_2$–C(4^3), *C*OCH$_2$–C(8^3)); 168.2 (*s*, *C*OCH$_2$–C(3^2), *C*OCH$_2$–C(6^3)); 158.7 (*s*, C(1^3), C(8^3); 156.3 (*s*, C(4^3), C(5^2)); 156.2 (*s*, C(3^2), C(6^3)); 156.2 (*s*, C(2^3), C(7^2)); 142.9 (*s*, C(1^1), C(8^1)); 142.1 (*s*, C(3^4), C(6^1)); 142.0 (*s*, C(4^1), C(5^4)); 141.9 (*s*, C(2^1), C(7^4)); 135.9 (*s*, 4 C_{ipso} (Bn, rings 1, 2, 7 and 8)); 132.7 (*d*, C(2^5), C(7^6)); 132.6 (*d*, C(4^5), C(5^6)); 132.5 (*d*, C(3^6), C(6^5)); 130.4 (*d*, C(1^5), C(8^5)); 129.0 (*d*, 4 C_m (Bn, rings 1 and 8)); 129.0 (*d*, 4 C_m (Bn, rings 2 and 7)); 128.9 (*d*, 2 C_p (Bn, rings 1 and 8)); 128.8 (*d*, 2 C_p (Bn, rings 2 and 7)); 128.7 (*d*, 4 C_o (Bn, rings 1 and 8)); 128.7 (*d*, 4 C_o (Bn, rings 2 and 7)); 127.3 (*s*, C(2^4), C(7^1)); 127.1 (*s*, C(4^4), C(5^1)); 126.9 (*s*, C(3^1), C(6^4)); 121.0 (*d*, C(1^6), C(8^6)); 120.7 (*d*, C(2^6), C(7^5)); 120.4 (*d*, C(4^6), C(5^5)); 120.4 (*d*, C(3^5), C(6^6)); 114.0 (*d*, C(1^2), C(8^2)); 113.8 (*d*, C(1^4), C(8^4)); 111.6 (*d*, C(2^2), C(7^3)); 111.4 (*d*, C(4^2), C(5^3)); 111.3 (*d*, C(3^3), C(5^2)); 82.4 (*s*, 4 Me$_3$*C* (rings 3–5)); 67.3 (*t*, 2 PhC*H*$_2$ (rings 1 and 8)); 67.2 (*t*, 2 Ph*C*H$_2$ (rings 2 and 6)); 66.7 (*t*, *C*H$_2$O–C(4^3), *C*H$_2$O–C(5^2)); 66.6 (*t*, *C*H$_2$O–C(3^2), *C*H$_2$O–C(6^3)); 66.5 (*t*, *C*H$_2$O–C(2^3), *C*H$_2$O–C(7^2)); 65.9 (*t*, *C*H$_2$O–C(1^3), *C*H$_2$O–C(8^3));

28.3 (*q*, 2 *Me*$_3$C (rings 4 and 5)); 28.2 (*q*, 2 *Me*$_3$C (rings 3 and 6)). ESI-MS (CH_2Cl_2/MeOH 9:1): 1811 (100, $[M+Na]^+$), 917 (81, $[M+2 Na]^{2+}$).

{323}-p-*Octiphenyl* **2** (*=2,2',2'',2''',2'''',2''''',2'''''',2'''''''-[[1,1':4',1'':4'',1''':4''',1'''':4'''',1'''''.4''''',1'''''':4'''''',1'''''''-Octiphenyl-2'',2'''',2'''''',3,3',3''',3''''',3'''''''-octayloctakis(oxy)]octakis[acetic Acid]* $0^{1'''}$,$0^{1'''''}$*-Dibenzyl* 0^{1},$0^{1'}$,$0^{1''}$, $0^{1''''}$, $0^{1''''''}$, $0^{1'''''''}$*-Hexa(*tert*-butyl) Ester*). Compound **2** was prepared from biphenyl **5** in overall eight steps as described in [7] (Supporting Information).

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