Second-Generation Trifluoromethyl-Substituted Chiral Dendrimers Containing Triply Branched Building Blocks: CF_3 as Sensitive NMR Probe for 'Remote' Diastereotopicity[1])

by **Guy Greiveldinger**[2]) and **Dieter Seebach***

Laboratorium für Organische Chemie der Eidgenössischen Technischen Hochschule, ETH-Zentrum, Universitätstrasse 16, CH-8092 Zürich

(*S*)-4,4,4-Trifluoro-3-hydroxybutanoic acid was used as a starting material for the synthesis of dendritic branches (**16**–**21**, **30**–**32**) which were attached to a chiral triol (**6** or *ent*-**6**), derived from (*R*)-3-hydroxybutanoic acid, to give CF_3-substituted dendrimers (**33**–**36**, **38**–**40**) and dendritic compounds (**37**) of 1st and 2nd generation. The key steps in these syntheses are diastereoselective aldol additions of dioxanone enolates (building blocks and intermediates **6**–**15**, **22**, **23**, and **25**–**28**) and *Williamson* etherifications of benzylic-branch bromides with triols (intermediates and products **16**–**21**, **28**, and **30**–**40**). The surfaces of the dendrimers are covered with MeO (**33**–**35**, **38**–**40**) or allyloxy groups (**36** and **37**). The new dendrimers are characterized by NMR and mass spectroscopy. ^{19}F-NMR Signals of the CF_3 groups reveal constitutional heterotopicities caused by substituents which are separated from the F-nuclei by up to 15 bonds (through a 1,1′-biphenyl-4,4′-diyl spacer!) (*Fig. 6*).

1. Introduction. – There exist four fundamentally different ways for the construction of chiral dendrimers [2][3]. The first one consists of attaching branches to a chiral core; in a second one chiral building blocks are used as spacers or branching units, with an achiral core; in a third mode, the surface of a dendrimer from achiral building blocks is functionalized with chiral units; a fourth possibility is the attachment of achiral branches of different generations to a nonplanar core. The synthesis of chiral dendrimers, their properties as well as first applications have been reviewed in detail [3][4].

Triggered by our interest in chiral structures and enantioselective catalysis, we developed synthetic methods to build chiral dendrimers from non-racemic derivatives of 'tris(hydroxymethyl)methane' [5–7]. During these investigations, we discovered an unprecedented case of diastereoselectivity [8], and we have been able to synthesize dendrimers up to the fourth generation with doubly branching chiral building blocks [9]. Besides the primarily synthetic work accomplished so far, we have obtained first promising results from applications of our chiral dendritic systems [10][11].

With the main goal to gather additional structural information, we have now extended our work to an investigation of F-containing chiral dendrimers[3]). Our group has been engaged for many years in studies on chiral, CF_3-substituted compounds, because of their surprising reactivity, and with the aim to better understand the inter- and in-

[1]) Partially published in a preliminary communication [1].

[2]) Part of the Dissertation (No. 12488) of *G.G.*, ETH-Zürich, 1997. Present address: Department of Chemistry, University of California Berkeley, Berkeley, CA 94720-1460, USA.

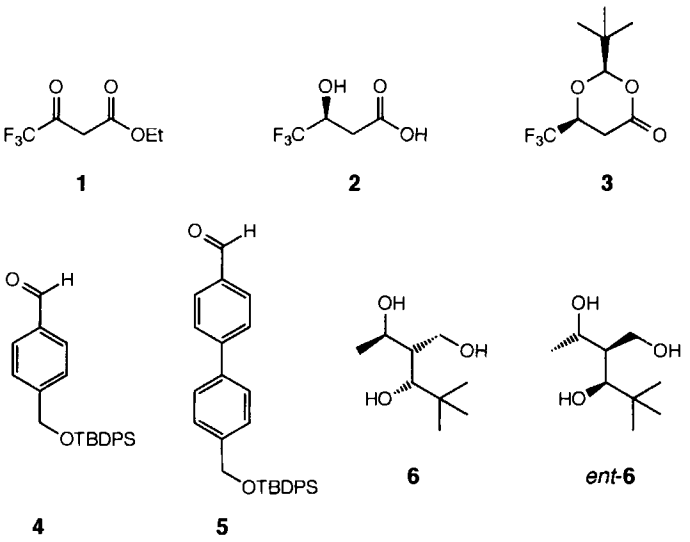
[3]) For reviews on biologically active fluoro-organics, for applications in medicinal chemistry, as agrochemicals, and for fluorinated polymers which are important as thermoplastics, elastomers, membranes, and coatings, see [12–15].

tramolecular interactions of fluoro substituents in organic compounds [16][17]. The use of ^{19}F as NMR probe was highly attractive as a tool for obtaining structural information about our chiral dendrimers.

To date, only few publications dealing with the synthesis of F-containing dendritic compounds have appeared. *Percec et al.* synthesized F-containing monodendra which were functionalized with crown ethers, and they observed the formation of nanotubes through self-organization due to the fluorophobic effect [18][19]. Surface functionalization of poly(propylenimine) dendrimers with perfluorinated alkanes by *Meijer et al.* led to so-called unimolecular inverse micelles [20]. From REDOR experiments on fluorinated ^{13}C-labelled poly(benzyl ether) dendrimers, *Wooley et al.* concluded that the peripheral groups undergo an inward-folding, depending on the dendrimer size [21][22]. Molecular-modelling studies could then be performed on the basis of the measured ^{13}C, ^{19}F distances in these dendrimers.

Here, we report on the first synthesis of CF_3-containing *chiral* dendrimers and the investigations of their properties.

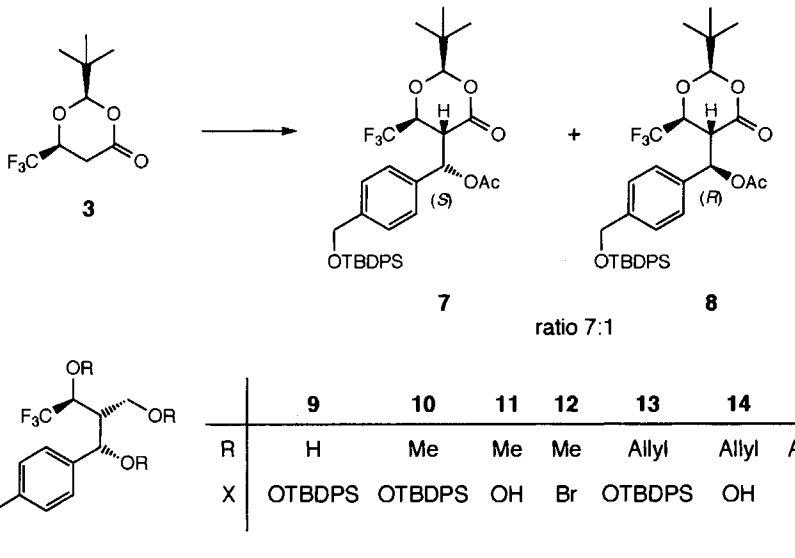
2. Synthesis of the Chiral Building Blocks and Branches. – The starting materials for the center pieces and branches of the new dendrimers are the carbonyl compounds **1**–**5** and the triol **6** [5][8]. The source of the CF_3-substituted components was the commercially available 4,4,4-trifluoro-3-oxobutanoate (**1**) which was treated with $NaBH_4$ and NaOH using known literature procedures [23][24]. Resolution of the resulting acid with 1-phenylethylamine afforded the enantiomerically pure (*S*)-4,4,4-trifluoro-3-hydroxybutanoic acid (**2**) [25], which was acetalized with pivalaldehyde to afford, after recrystallization from pentane, the pure *cis*-dioxanone **3** [26]. The Li-enolate of **3** was generated by deprotonation with *t*-BuLi as a base [16][27]. We first added this enolate to the benzaldehyde derivative **4**: to our surprise, and in contrast to the nonselective (1.2:1) [8] reaction with the non-fluorinated analogue [5][28], we isolated two diastereoisomers **7** and **8** in



1 **2** **3**

4 **5** **6** ***ent*-6**

Scheme 1



	9	10	11	12	13	14	15
R	H	Me	Me	Me	Allyl	Allyl	Allyl
X	OTBDPS	OTBDPS	OH	Br	OTBDPS	OH	Br

a 7:1 ratio (*Scheme 1*). The configuration of the major product **7** (2*R*,5*R*,6*R*,1′*S*) was determined by X-ray crystal-structure analysis (*Fig. 1*). This proves that the product has been formed by a (*Re*,*Si*) or *unlike* combination of the trigonal centers in the aldol addition[4]).

The primary Li-aldolate adduct may be depicted as shown in *Fig. 2*, *a* and *b*. We assume that the preference for the *unlike* combination of the trigonal centers results from a π-stacking interaction between the benzaldehyde and the enolate π-systems; this interaction appears to be stronger in the presence of a CF_3 group as compared to a CH_3 group in the 6-position of the Li-enolate. The relative topicity of the addition of the Li-enolate from **3** to aliphatic aldehydes is *like* (*Fig. 2*, *c*), *i.e.*, opposite to that of the reaction with an aromatic aldehyde. It is interesting to note that, in the case of aliphatic aldehydes, the diastereoselectivities are identical for the CF_3- and CH_3-substitued dioxanones [5][16].

To prevent an observed *retro*-aldol reaction during the purification of the aldol product by flash chromatography, we used AcCl and pyridine instead of NH_4Cl for quenching of the aldol reaction at −78°. The resulting acetylated derivative **7** could be easily separated from the crude product mixture by precipitation with Et_2O. The reduction of **7** was performed with $NaBH_4$ in THF/MeOH 20:1 and furnished the triol **9** as a viscous oil in analytically pure form (after flash chromatography and rigorous removal of traces of solvent). Etherification with MeI and $CH_2{=}CHCH_2Br$ afforded the peripheral building blocks **10** and **13**, respectively, and subsequent treatment with Bu_4NF (TBAF) gave the benzyl alcohols **11** and **14**, respectively, in almost quantitative yields.

[4]) A control experiment with unsubstituted benzaldehyde afforded a major product (6:1) with the same relative configuration (established by X-ray crystal-structure analysis) as that of **7**.

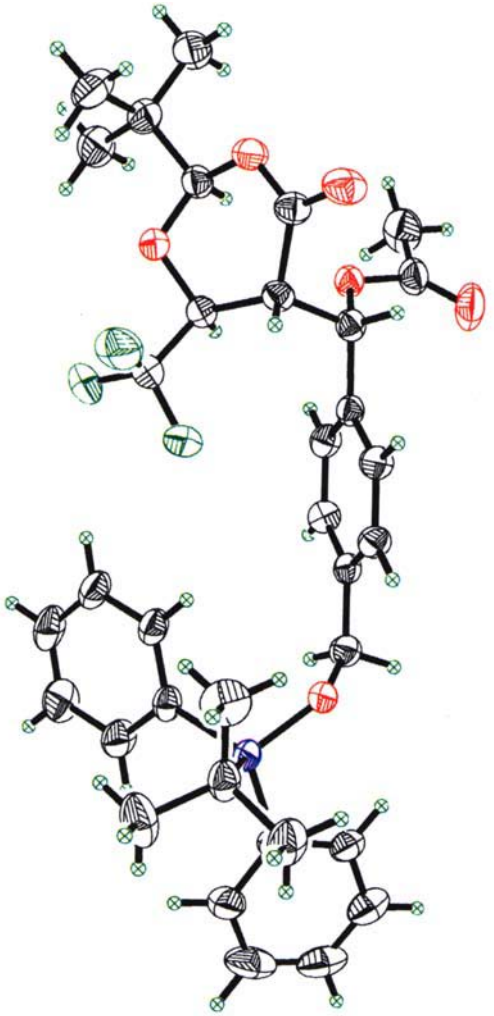


Fig. 1. *ORTEP Representation of dioxanone* **7** ((2*R*,5*R*,6*S*,1′*S*)-configuration). The thermal elipsoids are drawn to the 30% probability level. The X-ray structure was determined by *Rheiner*.

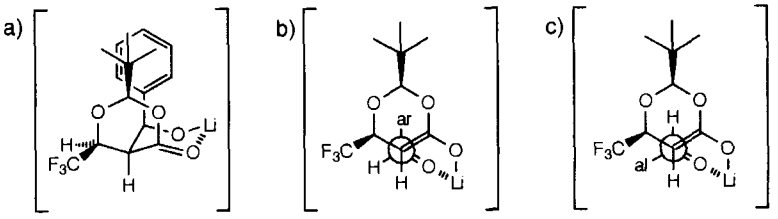
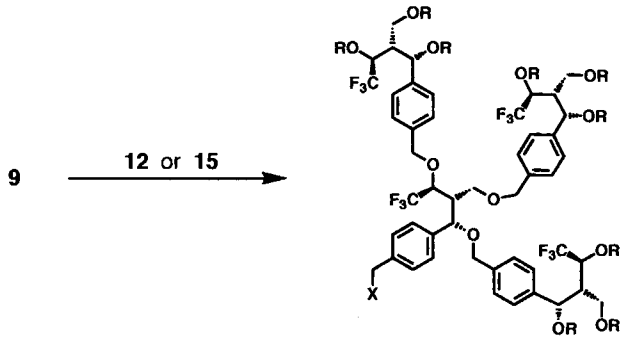


Fig. 2. *Mechanism for the aldol addition of the enolate of* **3** *to different aldehydes. a) Zimmermann-Traxler* model and *b*) corresponding *Newman* projection for the addition to aromatic (ar) aldehydes, and *c*) to aliphatic (al) aldehydes.

Treatment with Ph_3P/Br_4C produced the corresponding 1st-generation benzyl bromides **12** and **15** in *ca.* 95% yield (*Scheme 1*).

The benzyl bromides **12** and **15** were then used for the etherification of the OH groups of the triol **9** under *Williamson* conditions (NaH, THF, reflux). After flash chromatography (Et_2O/pentane/CH_2Cl_2), the 2nd-generation products **16** and **19** were isolated in analytically pure form in *ca.* 60% yield (*Scheme 2*). Removal of the (*t*-Bu)Ph_2Si (TBDPS) protecting group (→ **17**, **20**) and treatment with Ph_3P/Br_4C yielded the 2nd-generation benzyl bromides **18** and **21**, respectively.

Scheme 2



	16	17	18	19	20	21
R	Me	Me	Me	Allyl	Allyl	Allyl
X	OTBDPS	OH	Br	OTBDPS	OH	Br

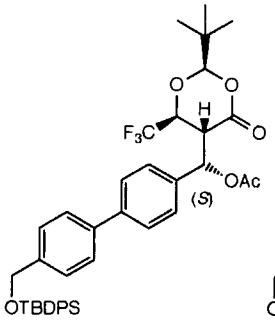
The strategy described above has also been applied for the construction of branches containing 1,1′-biphenyl-4,4′-diyl spacers[5]). Aldol addition of **3** to the TBDPS-protected biphenyl-carbaldehyde **5** afforded the diastereoisomeric dioxanones **22** and **23** (6:1). These isomers had to be separated by flash chromatography, during which partial β-elimination occurred (→ **24**), probably due to the acidity of the used silica-gel material[6])[7]). The resulting mixture **22**/**24** was treated with $NaBH_4$ in THF/MeOH 20:1 and furnished the triol **25** and the diol **29**, which, fortunately, could be readily separated by flash chromatography. Etherification of the OH groups of the biphenyl derivative **25** (→ **26**), deprotection with TBAF (→ **27**), and bromination under the above mentioned conditions afforded the 1st-generation bromide **28**. Coupling of the triol **25** with **28** gave

---

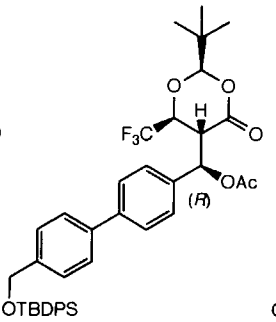
[5]) The aldehyde **5** was prepared by *Suzuki* coupling of the 4-formylphenylboronic acid [29] with TBDPS-protected 4-bromobenzyl alcohol [8].

[6]) Treatment of the silica gel with Et_3N prior to chromatography resulted in *complete* β-elimination.

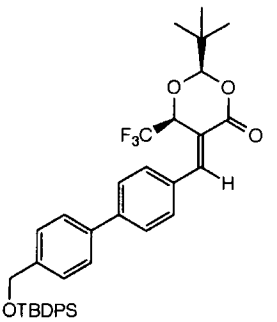
[7]) With the non-fluorinated hydroxybenzylated dioxanones, we have never encountered such problems [5][28].



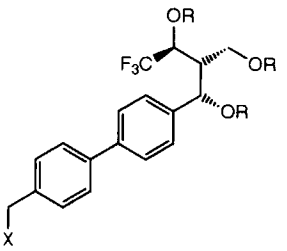
22

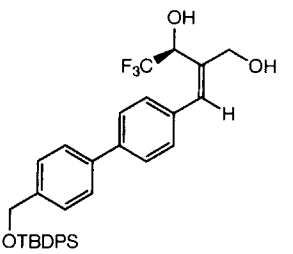


23



24





29

	25	**26**	**27**	**28**
R	H	Me	Me	Me
X	OTBDPS	OTBDPS	OH	Br

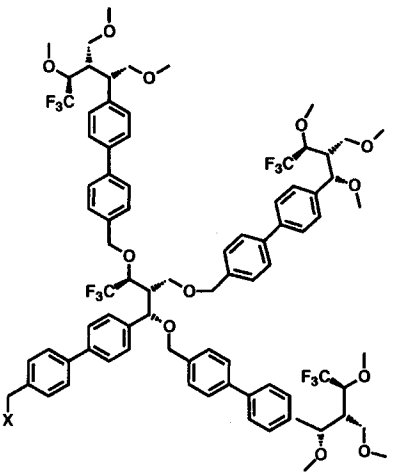
the TBDPS-protected branch **30**, which, in turn, gave the 2nd-generation branch bromide **32** (60% overall yield) after treatment with TBAF (→ **31**) and Ph_3P/Br_4C.

All of the above described building blocks and dendritic branches were fully characterized (^{1}H-, ^{13}C-, and ^{19}F-NMR, IR, MS (EI, FAB, MALDI-TOF) spectra as well as elemental analysis) and were shown to be very pure.

3. Preparation and Characterization of the CF_3-Substituted Chiral Dendrimers 33–36 and 38–40. – The center pieces in our dendrimer synthesis are the enantiomeric triols **6** and *ent*-**6**, the coupling of which with the benzyl bromides was achieved by treating the triol with excess NaH (9 equiv.) in refluxing THF and adding an excess of the corresponding branched benzyl bromide (3.3–4 equiv.).

The coupling of **6** and *ent*-**6** with the benzyl bromide **12** gave, after flash chromatography, the 1st-generation chiral dendrimers **33** and **34** (*Fig. 3*), respectively, in *ca.* 70% yield. While no significant differences are observed in the ^{1}H-NMR spectra of the diastereoisomeric compounds **33** and **34**, ^{19}F-NMR spectroscopy seems to be an ideal

	X
30	OTBDPS
31	OH
32	Br



means for detecting CF_3-group diastereotopicity. In the spectrum of **33**, the three CF_3 groups are isochronous and give rise to a *doublet*; in compound **34**, however, with the core from **6** exchanged by its enantiomeric counterpart from *ent*-**6**, the CF_3 groups 'perceive' the difference, and three of the possible six signals are seen.

The analysis of the ^{19}F-NMR spectrum of the 2nd-generation dendrimer **35** (*Fig. 4*), containing twelve CF_3 groups or 36 F-atoms, and having a molecular weight of 3702 Da, exhibits a clear-cut difference between the inner CF_3 groups and those located at the periphery (*Fig. 4*). Moreover, the three inner CF_3 groups of **35** give rise to four of the six possible signals, while eight signals can be recognized from the nine constitutionally heterotopic outer CF_3 groups[8]).

During the synthesis of the dendrimers containing allyl groups at the periphery, we did not encounter any problems with the 1st-generation chiral dendrimer **36** (*Fig. 5*), except that the yield of the *Williamson*-coupling reaction was lower (40% compared to the 72% obtained with bromide **12**). However, the triol **6** reacted only twice with the 2nd-generation branched benzyl bromide **21** to afford the dendritic compound **37**. Thus, the replacement of peripheral CH_3 by allyl groups prevents the 'acceptance' of a third branch[9]). This case of incomplete coupling probably results from steric hindrance of the 'third' OH groups (*cf.* the diastereoisomeric differentiation described in our previous paper [8]). This is especially remarkable, because we are not dealing with 'real' dendrimers of spherical shape and with steric congestion at the periphery. The periphery of compounds **36** and **37** is ready for chemical modifications, for instance, by hydroboration or hydrosilylation of the allyl groups.

---

[8]) Similar observations of differences between analogous nuclei in various *layers* of dendrimers have been made in the ^{1}H-NMR spectra of the non-fluorinated dendrimers, where the signals of the peripheral, interior, and central Me groups give rise to distinct sets of signals [8].

[9]) As in the non-fluorinated 'doubly coupled' derivatives of this type (see Fig. 2 and Fig. 4 in [8]), there is a distinct upfield shift of the central C*H* resonance in the ^{1}H-NMR spectrum of **37**, as compared to the 'fully coupled' dendrimers.

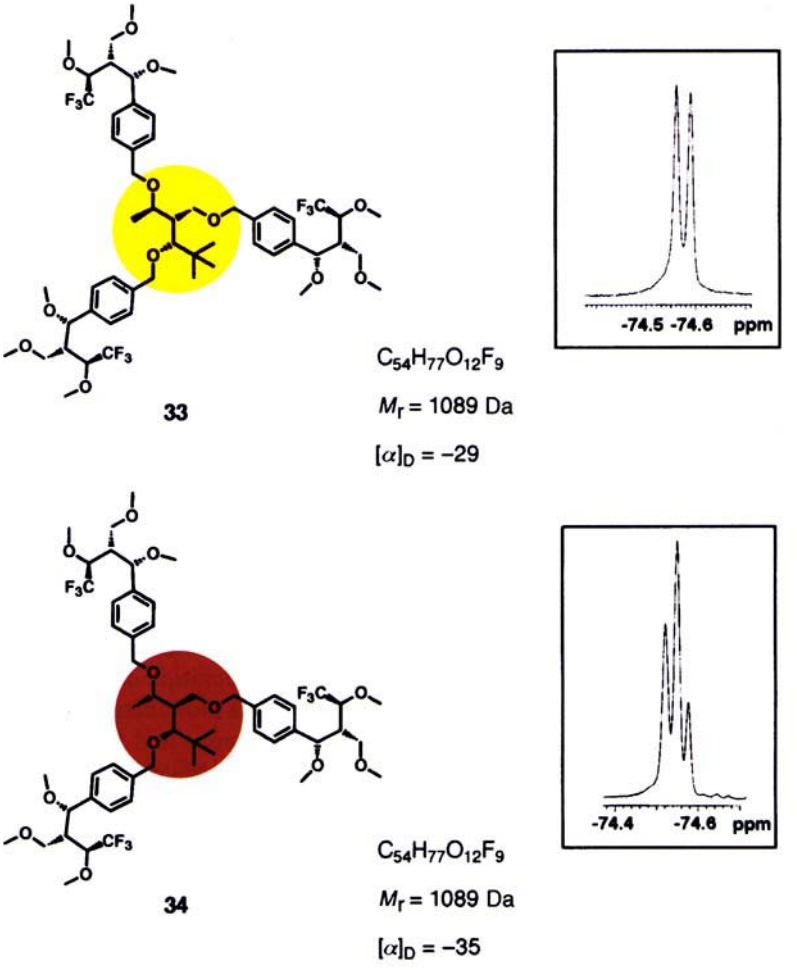


Fig. 3. *Formulae and* ^{19}*F-NMR spectra of 1st-generation dendrimers* **33** *and* **34** ($CDCl_3$). Note that the two dendrimers differ only by having enantiomeric center piece units.

To reduce steric hindrance, we synthesized the dendrimers **38**–**40** containing biphenyl moieties. The 1,1′-biphenyl-4,4′-diyl system appeared to be the most suitable 'spacer'. By coupling the branch bromide **28** with the center pieces **6** and *ent*-**6**, we obtained the 1st-generation dendrimers **38** and **39**, respectively. We now also succeeded in preparing the 2nd-generation dendrimer **40** (M_r 4614 Da) (*Fig. 6*). Inspite of the greatly increased distances between the CF_3 groups and the heterotopicity-generating constitutional differences in these 'elongated' dendrimers, three signals from the inner and four signals from the outer CF_3 group can be recognized in the ^{19}F-NMR spectrum (282-MHz spectrometer)[10]).

[10]) ^{19}F-NMR Measurements with **40** at different temperatures (–35° to 25°) did not reveal the existence of preferred axially chiral biphenyl conformations in this type of structure.

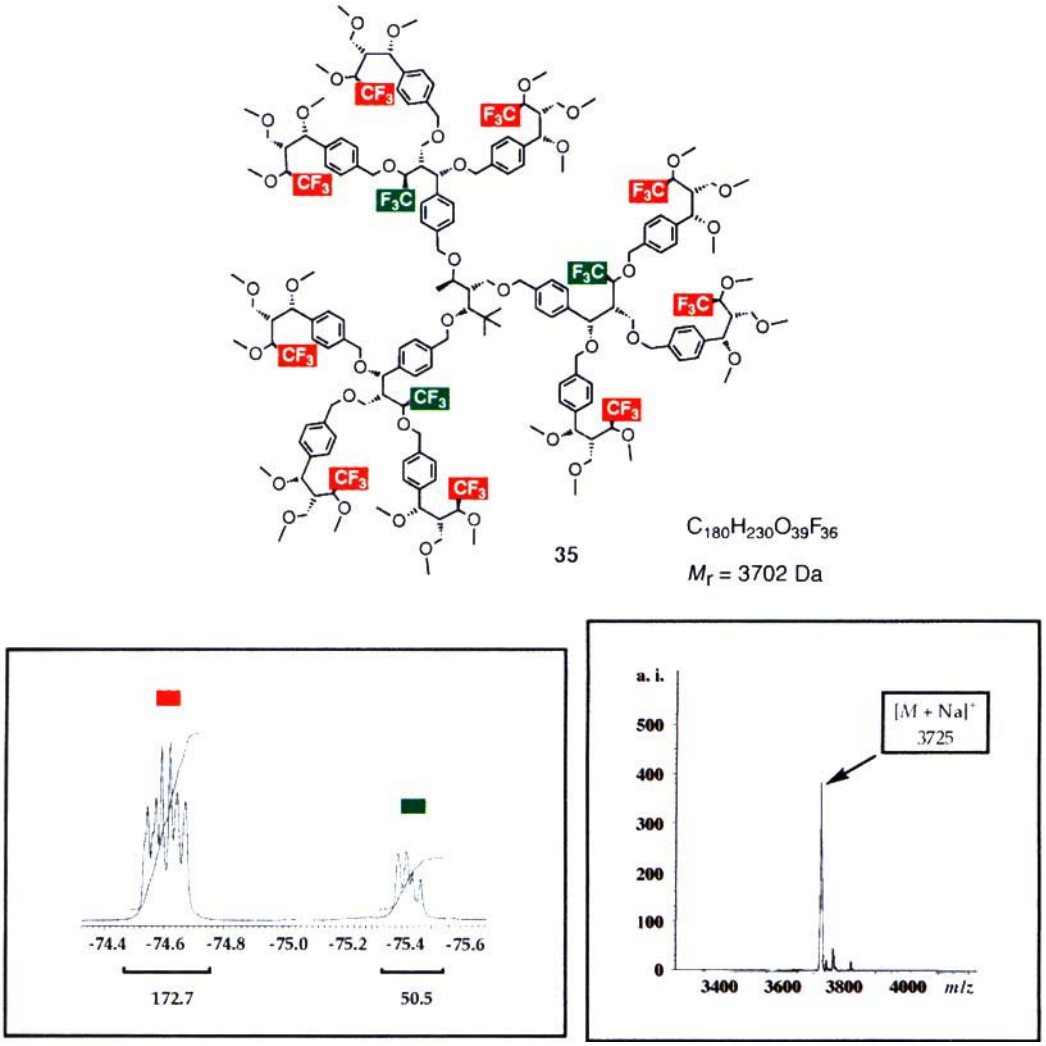


Fig. 4. *Formula, ^{19}F-NMR* ($CDCl_3$), *and MALDI-TOF mass* (α-cyano-4-hydroxycinnamic-acid (CCA) matrix) *spectra of 2nd-generation dendrimer* **35**

The dendrimers **33**–**36** and **38**–**40** as well as the dendritic compound **37** are very viscous oils or glassy solids, well soluble in solvents of varying polarity (toluene, Et_2O, CH_2Cl_2). They have been characterized by ^{1}H-, ^{13}C-, and ^{19}F-NMR, and IR spectroscopy, and elemental analysis. Since the accuracy of these methods is not sufficient (due to the oligomeric nature of the dendritic macromolecules) to detect subtle structural differences, *i.e.*, structural defects, the purity of the compounds was demonstrated by MALDI-TOF mass spectrometry (see *Figs. 4–6*).

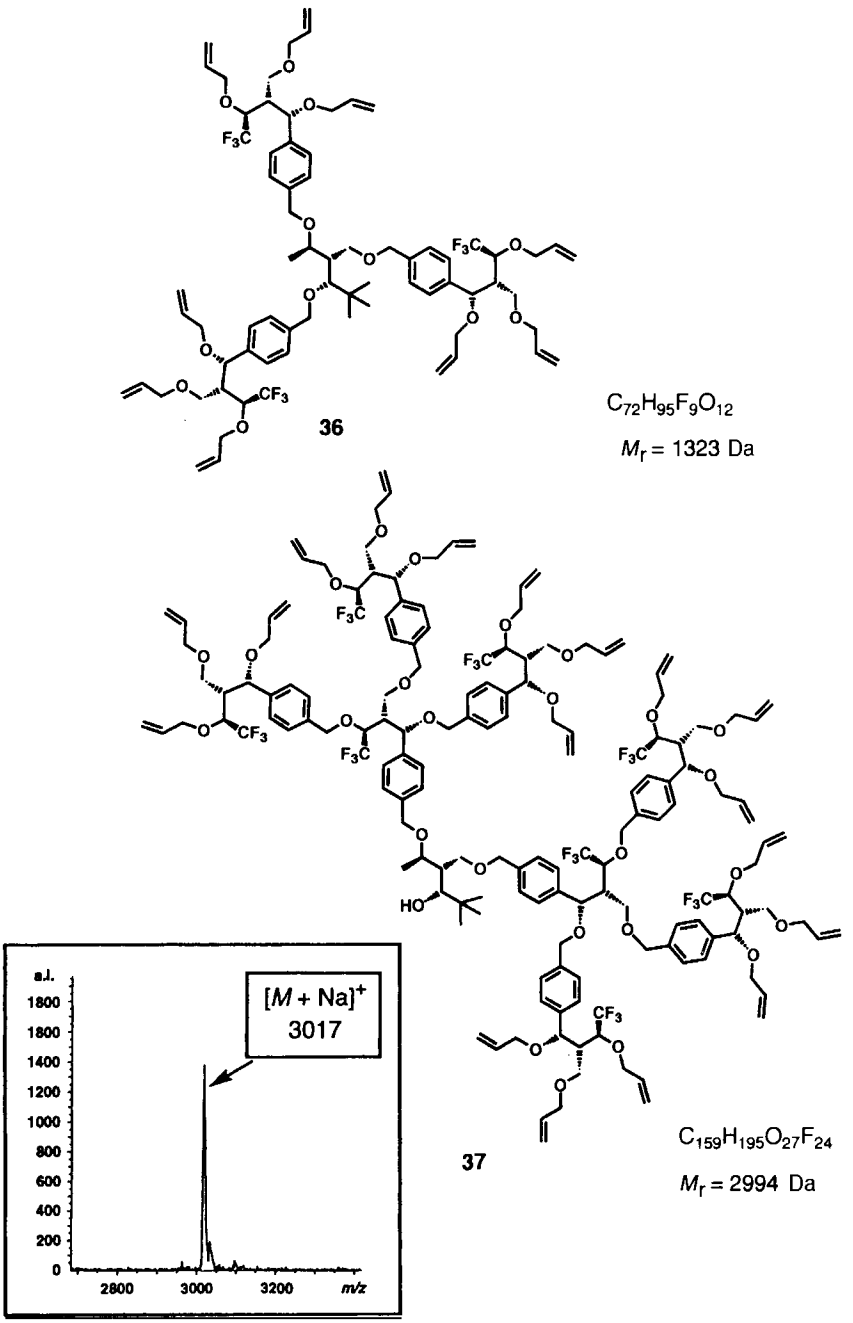
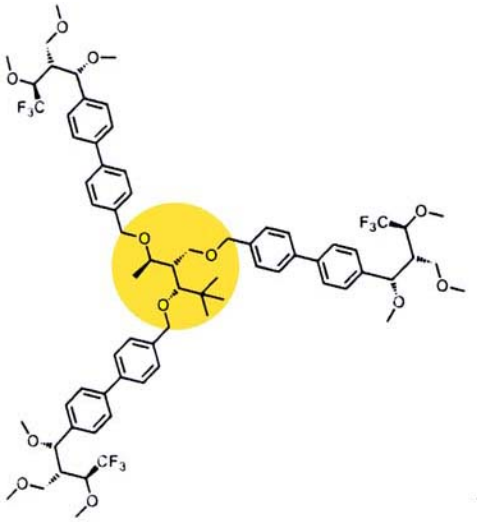
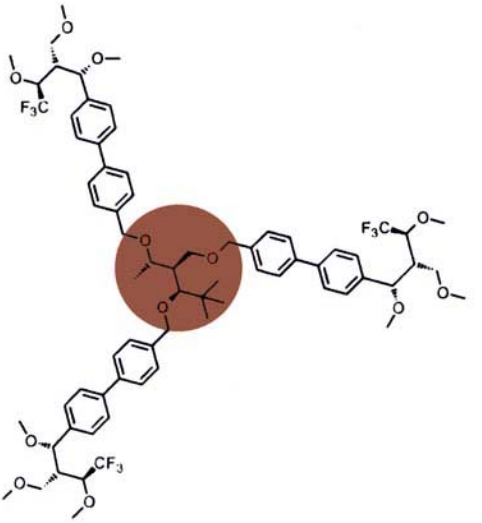


Fig. 5. *Formulae of the 1st- and 2nd-generation dendrimers* **36** *and* **37** *with peripheral allyl groups, and MALDI-TOF mass spectrum of compound* **37** (α-cyano-4-hydroxycinnamic-acid (CCA) matrix)



38



39

We gratefully acknowledge the financial support of the *Swiss National Science Foundation* (project No. 2100-040659.94/1). We thank *P.B. Rheiner* for determining the X-ray structure of **7**. Continuing support of our research by *Novartis AG*, Basel, is greatly appreciated.

Experimental Part

1. *General.* All reactions were carried out under Ar. Reagent-grade chemicals were purchased from *Fluka* or *Aldrich*, and used without further purification unless otherwise stated. Crude solvents for chromatography and for workup were distilled from *Sikkon* (Et_2O from $KOH/FeSO_4$), THF was freshly distilled from sodium benzophenone ketyl radical. The compounds **1**–**6** and *ent*-**6** were prepared according to literature procedures [8][16][25][29]. TLC: glass-plated TLC silica gel *60* F_{254} (*Merck*). Flash chromatography (FC): silica gel *60* (*Merck*) 40–63 mm. M.p. *Büchi 510*, uncorrected. Optical rotations: *Perkin-Elmer-241* polarimeter, 10-cm cells; in $CHCl_3$. IR: *Perkin-Elmer-1600-FTIR*, in cm^{-1}. ^1H-, ^{13}C-, and ^{19}F-NMR: *Bruker AMX-II-500*, *AMX-400*, *AMX-300*, *Varian-Gemini-200*, and *-300* spectrometers at r.t.; in $CDCl_3$; chemical shifts, δ, in ppm downfield from internal TMS, coupling constants, *J*, in Hz. MS (*m/z* (%)): *Hitachi-Perkin-Elmer RMU-6M* for EI; *VG-ZAB2-SEQ* for FAB in a 3-nitrobenzyl-alcohol matrix (3-NOBA). Matrix-assisted laser desorption ionization time-of-flight (MALDI-TOF) on a *Bruker-Reflex*™ instrument with a N_2 laser system (337 nm), positive-ion mode, α-cyano-4-hydroxycinnamic acid (CCA); spectra were processed and printed using the *X-MASS* program on a *SUN* workstation. Elemental analyses were performed by the Mikroanalytisches Laboratorium der ETH-Zürich. *Abbreviations*: TBDPS-Cl ((*t*-Bu)Ph_2SiCl), LAH ($LiAlH_4$), TBAF ($Bu_4NF \cdot 3\ H_2O$), r.e. (rotary evaporator).

2. *Nomenclature.* The nomenclature used for identification of the dendrimers, dendritic compounds, and dendritic branches is based on the convention proposed by *Seebach* and coworkers (see Fig. 8 in [8]).

*(2R,5R,6S)-2-(*tert*-Butyl)-5-[(S)-(4-{[(*tert*-butyl)diphenylsilyloxy]methyl}phenyl)acetoxymethyl]-6-(trifluoromethyl)-1,3-dioxan-4-one* (**7**). A soln. of 6.0 g (26.5 mmol) of **3** in THF (45 ml) was cooled to −78°, and 19.5 ml (29.2 mmol) of *t*-BuLi were added at such a rate that the inner temp. never exceeded −70°, and the mixture was subsequently kept at −78° for 20 min. Compound **4** (11.9 g, 31.8 mmol) in THF (45 ml) was slowly added, the mixture kept at −78° for 6 h, then quenched with 3.8 ml (53 mmol) of AcCl and 10.7 ml (132.5 mmol) of pyridine. After stirring at r.t. for 16 h, the mixture was extracted with 10% HCl, H_2O, and sat. NaCl (70 ml each), the combined org. extracts were dried ($MgSO_4$) and concentrated *in vacuo*. ^{19}F-NMR of the crude product showed a ratio **7**/**8** of 7:1. The main isomer **7** was precipitated with Et_2O (11.1 g, 65%). Upon slow recrystallization from

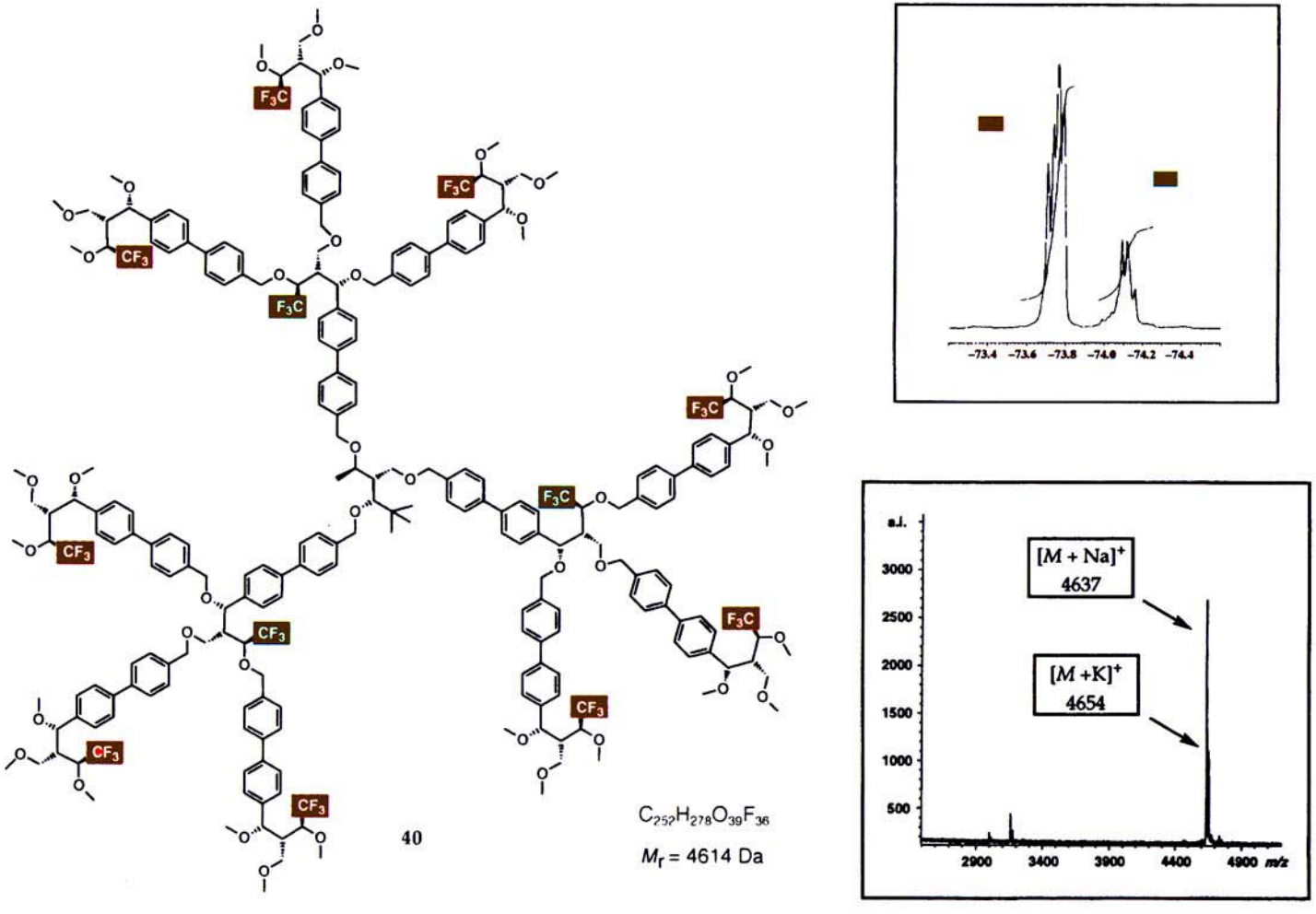


Fig. 6. *Formula, ^{19}F-NMR* ($CDCl_3$), *and MALDI-TOF mass* (anthracene-1,8,9-triol matrix) *spectra of 2nd-generation dendrimer* **40**

Et_2O, crystals of **7**, suitable for X-ray analysis were isolated. M.p. 168–169°. $[\alpha]_D^{r.t.} = -24.9$ ($c = 1.6$). IR: 2963*m*, 2932*m*, 2859*m*, 1758*s*, 1428*m*, 1371*m*, 1278*m*, 1150*s*, 1110*s*, 1010*m*. ^{1}H-NMR (400 MHz): 0.96 (*s*, *t*-Bu–C(2)); 1.09 (*s*, *t*-BuSi); 2.18 (*s*, AcO); 3.43 (*dd*, $J = 5.6, 4.7$, H–C(5)); 4.43–4.49 (*m*, H–C(6)); 4.74 (*s*, H–C(2)); 4.76 (*s*, CH_2OSi); 6.22 (*d*, $J = 4.7$, H–C(1′)); 7.26–7.68 (*m*, 14 arom. H). ^{13}C-NMR (100 MHz): 19.31; 20.93; 23.54; 26.82; 34.94; 45.72; 65.00; 72.04; 74.68; 105.26; 122.71; 126.09; 126.54; 127.77; 129.79; 133.31; 133.85; 135.53; 142.44; 165.45; 168.73. ^{19}F-NMR (282 MHz): −79.56 (*d*, $J = 6.0$). EI-MS: 585 (18, $[M - 57]^+$), 439 (43), 395 (17), 360 (53), 317 (29), 221 (33), 201 (62), 199 (100), 197 (75), 177 (51), 119 (34), 91 (84), 57 (60), 43 (56), 41 (37). Anal. calc. for $C_{35}H_{41}F_3O_6Si$ (642.50): C 65.40, H 6.43; found: C 65.60, H 6.51.

*(1S,2R,3S)-1-(4-{[(*tert*-Butyl)diphenylsilyloxy]methyl}phenyl)-2-(hydroxymethyl)-4,4,4-trifluorobutane-1,3-diol* (**9**). To $NaBH_4$ (0.59 g, 15.6 mmol) in THF (30 ml)/MeOH (3 ml) at 0°, **7** (2 g, 3.1 mmol) in THF (30 ml) was added. The mixture was stirred at r.t. for 7 h, then diluted with H_2O (30 ml) and saturated with NaCl. The mixture was extracted with Et_2O (3 × 70 ml), the combined org. extracts were dried ($MgSO_4$) and concentrated *in vacuo*. The crude product was purified by FC (pentane/Et_2O 1:1): 1.4 g (87%) of **9**. Colorless, very viscous oil. $[\alpha]_D^{r.t.} = -16.0$ ($c = 1.9$). IR: 3386*m*, 2931*m*, 2859*m*, 1601*w*, 1472*m*, 1428*s*, 1274*s*, 1169*s*, 1113*s*, 1074*s*, 1017*m*. ^{1}H-NMR (400 MHz): 1.10 (*s*, *t*-Bu); 2.08–2.11 (*m*, H–C(2)); 2.14 (br. *s*, OH); 2.65 (*d*, $J = 3.1$, OH); 3.60–3.63 (*m*, 1 H, CH_2OH); 4.11–4.14 (*m*, 1 H, CH_2OH); 4.24 (*d*, $J = 7.1$, OH); 4.57–4.61 (*m*, H–C(3)); 4.78 (*s*, CH_2OSi); 5.22–5.24 (*m*, H–C(1)); 7.35–7.70 (*m*, 14 arom. H). ^{13}C-NMR (100 MHz): 19.34; 26.87; 45.23; 61.48; 65.23; 70.22; 72.84; 125.15; 126.21; 126.44; 127.75; 129.77; 133.42; 135.58; 140.25; 141.31. ^{19}F-NMR (282 MHz): −76.89 (*d*, $J = 8.0$). EI-MS: 461 (9, $[M - 57]^+$), 365 (10), 317 (10), 245 (7), 231 (12), 211 (7), 199 (70), 197 (11), 195 (13), 183 (16), 129 (15), 91 (100), 77 (18), 57 (16). Anal. calc. for $C_{28}H_{33}F_3O_4Si$ (518.64): C 64.84, H 6.41; found: C 64.88, H 6.51.

*1-{[(*tert*-Butyl)diphenylsilyloxy]methyl}-4-[(1S,2R,3S)-4,4,4-trifluoro-1,3-dimethoxy-2-(methoxymethyl)-butyl]benzene* (**10**). To NaH (0.48 g, 20 mmol) in THF (10 ml) at 0°, a soln. of **9** (1.15 g, 2.2 mmol) in THF (20 ml) was added, and the mixture was stirred at r.t. for 30 min, prior to the addition of MeI (1.25 ml, 20 mmol). The mixture was heated to reflux for 3 h, then quenched with H_2O (40 ml). The mixture was extracted with Et_2O (3 × 40 ml), and the combined org. extracts were dried ($MgSO_4$) and concentrated *in vacuo*. The crude product was purified by FC (pentane/Et_2O 9:1): 1.13 g (91%) of pure **10**. Colorless, viscous oil. $[\alpha]_D^{r.t.} = -17.5$ ($c = 1.8$). IR: 2932*m*, 2859*m*, 1463*w*, 1428*w*, 1382*w*, 1279*m*, 1170*s*, 1112*s*, 1018*w*. ^{1}H-NMR (300 MHz): 1.10 (*s*, *t*-Bu); 2.14–2.20 (*m*, H–C(2)); 3.12 (*s*, MeO); 3.23 (*s*, MeO); 3.23–3.35 (*m*, CH_2OMe); 3.82 (*s*, MeO); 4.12 (*qd*, $J = 8.0, 2.3$, H–C(3)); 4.37 (*d*, $J = 8.3$, H–C(1)); 4.79 (*s*, CH_2OSi); 7.25–7.72 (*m*, 14 arom. H). ^{13}C-NMR (75 MHz): 19.33; 26.87; 46.02; 56.78; 58.64; 61.31; 65.36; 68.27; 77.04; 80.88; 126.07; 127.25; 127.70; 127.83; 129.71; 133.53; 135.60; 138.22; 140.85. ^{19}F-NMR (282 MHz): −74.52 (*d*, $J = 7.8$). EI-MS: 503 (4, $[M - 57]^+$), 389 (7), 352 (27), 351 (100), 241 (59), 231 (22), 213 (15), 209 (48), 201 (19), 199 (13), 166 (43), 134 (32), 129 (35), 91 (42), 57 (2). Anal. calc. for $C_{31}H_{39}F_3O_4Si$ (564.70): C 66.40, H 7.01; found: C 66.46, H 6.70.

4-[(1S,2R,3S)-4,4,4-Trifluoro-1,3-dimethoxy-2-(methoxymethyl)butyl]benzenemethanol (**11**). The compound **10** (1.08 g, 1.94 mmol) in THF (25 ml) was treated with TBAF (1.22 g, 3.88 mmol) for 12 h at r.t., then H_2O (15 ml) was added. The combined org. extracts were dried ($MgSO_4$) and concentrated *in vacuo*. The residue was purified by FC (pentane/Et_2O 1:1): 0.55 g (89%) of pure **11**. Colorless, viscous oil. $[\alpha]_D^{r.t.} = -35.3$ ($c = 1.6$). IR: 3460*w*, 3008*m*, 2932*s*, 2823*w*, 1608*w*, 1499*w*, 1453*w*, 1383*m*, 1272*s*, 1170*s*, 1120*s*, 1021*s*. ^{1}H-NMR (300 MHz): 1.81 (br. *s*, OH); 2.13–2.19 (*m*, H–C(2)); 3.11 (*s*, MeO); 3.22 (*s*, MeO); 3.21–3.45 (*m*, CH_2OMe); 3.61 (*s*, MeO); 4.10 (*qd*, $J = 8.0, 2.3$, H–C(3)); 4.38 (*d*, $J = 8.2$, H–C(1)); 4.72 (*d*, $J = 5.0$, CH_2OH); 7.31–7.40 (*m*, 4 arom. H). ^{13}C-NMR (75 MHz): 45.97; 56.81; 58.66; 61.33; 65.10; 68.22; 77.22; 80.80; 125.02; 127.09; 127.61; 139.16; 140.59. ^{19}F-NMR (282 MHz): −74.57 (*d*, $J = 7.8$). EI-MS: 322 (1, M^+), 307 (1), 259 (13), 229 (2), 215 (1), 177 (5), 152 (23), 151 (100), 147 (4), 44 (7). Anal. calc. for $C_{15}H_{21}F_3O_4$ (322.32): C 55.90, H 6.57; found: C 55.86, H 6.79.

1-(Bromomethyl)-4-[(1S,2R,3S)-4,4,4-trifluoro-1,3-dimethoxy-2-(methoxymethyl)butyl]benzene (**12**). To a soln. of **11** (1.45 g, 4.52 mmol) in THF (60 ml) at 0°, Ph_3P (2.37 g, 9.03 mmol) and Br_4C (3.0 g, 9.03 mmol) were added. After stirring at r.t. for 16 h, H_2O (60 ml) was added. The mixture was extracted with CH_2Cl_2 (3 × 100 ml), dried ($MgSO_4$), and evaporated. The crude product was purified by FC (pentane/Et_2O 6:1): giving 1.39 g (80%) of pure **12**. Colorless, viscous oil. $[\alpha]_D^{r.t.} = -26.5$ ($c = 2.2$). IR: 3005*m*, 2933*m*, 2825*w*, 1512*w*, 1448*w*, 1384*w*, 1279*m*, 1170*s*, 1145*s*, 1103*s*. ^{1}H-NMR (300 MHz): 2.10–2.17 (*m*, H–C(2)); 3.11 (*s*, MeO); 3.21–3.46 (*m*, CH_2OMe); 3.23 (*s*, MeO); 3.61 (*s*, MeO); 4.08 (*qd*, $J = 8.0, 2.3$, H–C(3)); 4.38 (*d*, $J = 8.2$, H–C(1)); 4.51 (*s*, CH_2Br); 7.29–7.42 (*m*, 4 arom. H). ^{13}C-NMR (75 MHz): 33.18; 45.99; 56.93; 58.62; 61.34; 68.17; 77.14; 80.75; 127.80; 127.90; 129.16; 137.45; 140.20. ^{19}F-NMR (282 MHz): −74.56 (*d*, $J = 8.2$). EI-MS: 384 (< 1, M^+), 305 (7), 273 (33), 215 (91), 214 (11), 213 (100), 135 (15), 134 (41), 119 (13), 91 (19), 45 (15). Anal. calc. for $C_{15}H_{20}BrF_3O_3$ (385.22): C 46.77, H 5.23; found: C 46.95, H 5.23.

*1-{[(*tert*-Butyl)diphenylsilyloxy]methyl}-4-[(1S,2R,3S)-1,3-diallyloxy-2-(allyloxymethyl)-4,4,4-trifluorobutyl]benzene* (**13**). As described for **10**, with **9** (1.0 g, 1.93 mmol), NaH (0.42 g, 17.36 mmol), and CH_2=$CHCH_2Br$ (1.47 ml, 17.36 mmol), reaction time 4 h. FC (pentane/Et_2O 17:1): **13** (0.98 g, 80%). Slightly-yellow, viscous oil. $[\alpha]_D^{r.t.} = -17.6$ ($c = 1.4$). IR: 3073*w*, 3005*w*, 2931*m*, 2859*m*, 1472*w*, 1428*m*, 1278*m*, 1171*s*, 1113*s*, 998*m*, 932*m*, 826*m*. ^{1}H-NMR (300 MHz): 1.10 (*s*, *t*-Bu); 2.26–2.32 (*m*, H–C(2)); 3.41 ('*dd*', *ABX*, $J = 10.1$, 6.0, 1 H, CH_2OAllyl); 3.53 ('*dd*', *ABX*, $J = 10.1$, 4.2, 1 H, CH_2OAllyl); 3.69–4.33 (*m*, 3 CH_2=$CHCH_2$, H–C(3)); 4.55 (*d*, $J = 7.3$, H–C(1)); 4.78 (*s*, CH_2OSi); 5.04–5.37 (*m*, 3 CH_2=$CHCH_2$); 5.67–6.01 (*m*, 3 CH_2=$CHCH_2$); 7.25–7.72 (*m*, 14 arom. H). ^{13}C-NMR (75 MHz): 19.32; 26.87; 46.10; 65.36; 65.95; 69.92; 71.77; 73.90; 74.71; 78.96; 116.41; 116.74; 117.47; 126.05; 127.20; 127.66; 127.70; 129.71; 133.53; 134.22; 134.63; 134.79; 135.60; 138.45; 140.74. ^{19}F-NMR (282 MHz): −74.98 (*d*, $J = 8.2$). FAB-MS: 638 (2, M^+), 637 (4), 581 (8), 255 (31), 199 (51), 197 (51), 135 (5), 119 (65), 91 (100), 71 (47). Anal. calc. for $C_{37}H_{45}F_3O_4Si$ (638.84): C 69.56, H 7.10; found: C 69.78, H 7.16.

4-[(1S,2R,3S)-1,3-Diallyloxy-2-(allyloxymethyl)-4,4,4-trifluorobutyl]benzenemethanol (**14**). As described for **11**, with **13** (0.88 g, 1.38 mmol) and TBAF (0.87 g, 2.76 mmol), reaction time 3.5 h. FC (pentane/Et_2O 2:1): **14** (0.48 g, 87%). Slightly-yellow, viscous oil. $[\alpha]_D^{r.t.} = -30.6$ ($c = 1.9$). IR: 3609*m*, 3443*w* (br.), 3083*w*, 3005*m*, 2925*m*, 2876*m*, 1647*w*, 1512*w*, 1459*m*, 1422*m*, 1278*s*, 1171*s*, 1095*s*, 990*s*, 930*s*. ^{1}H-NMR (300 MHz): 1.70 (*t*, $J = 5.7$, OH); 2.34–2.31 (*m*, H–C(2)); 3.38–3.51 (*m*, CH_2OAllyl); 3.71–4.29 (*m*, 3 CH_2=$CHCH_2$, H–C(3)); 4.57 (*d*, $J = 7.2$, H–C(1)); 4.71 (*d*, $J = 5.7$, CH_2OH); 5.05–5.36 (*m*, 3 CH_2=$CHCH_2$); 5.69–6.01 (*m*, 3 CH_2=$CHCH_2$); 7.31–7.38 (*m*, 4 arom. H). ^{13}C-NMR (75 MHz): 46.11; 65.15; 65.96; 70.01; 71.80; 73.93; 74.68; 78.89; 116.41; 116.89; 117.54; 127.12; 127.52; 127.57; 134.21; 134.63; 134.81; 139.48; 140.49. ^{19}F-NMR (282 MHz): −75.07 (*d*, $J = 7.9$). EI-MS: 399 (3, M^+), 359 (14), 344 (18), 343 (88), 327 (26), 255 (35), 177 (100), 161 (25), 135 (22), 119 (17). Anal. calc. for $C_{21}H_{27}F_3O_4$ (400.44): C 62.99, H 6.80; found: C 62.70, H 6.99.

1-(Bromomethyl)-4-[(1S,2R,3S)-1,3-diallyloxy-2-(allyloxymethyl)-4,4,4-trifluorobutyl]benzene (**15**). As described for **12**, with **14** (0.43 g, 1.08 mmol), Ph_3P (0.42 g, 17.36 mmol), and Br_4C (0.53 g, 1.62 mmol), reaction time 16 h. FC (pentane/Et_2O 18:1): **15** (0.45 g, 90%). Slightly-yellow, viscous oil. $[\alpha]_D^{r.t.} = -22.0$ ($c = 1.6$). IR: 3082*w*, 3006*w*, 2868*m*, 1647*w*, 1422*m*, 1351*m*, 1279*m*, 1171*s*, 1092*s*, 996*m*, 933*s*. ^{1}H-NMR (400 MHz): 2.24–2.29 (*m*, H–C(2)); 3.39 ('*dd*', *ABX*, $J = 10.2$, 6.2, 1 H, CH_2OAllyl); 3.51 ('*dd*', *ABX*, $J = 10.2$, 3.9, 1 H, CH_2OAllyl); 3.68–4.31 (*m*, 3 CH_2=$CHCH_2$, H–C(3)); 4.50 (*s*, CH_2Br); 4.56 (*d*, $J = 7.4$, H–C(1)); 5.05–5.35 (*m*, 3 CH_2=$CHCH_2$); 5.66–5.98 (*m*, 3 CH_2=$CHCH_2$); 7.29–7.52 (*m*, 4 arom. H). ^{13}C-NMR (100 MHz): 33.17; 46.04; 65.83; 70.02; 71.75; 73.91; 74.63; 78.83; 116.50; 116.95; 117.57; 126.64; 127.75; 129.12; 134.10; 134.39; 134.66; 137.35; 140.41. ^{19}F-NMR (282 MHz): −75.00 (*d*, $J = 10.9$). EI-MS: 463 (4, M^+), 422 (19), 407 (100), 327 (19), 255 (10), 241 (35), 239 (36), 229 (12). Anal. calc. for $C_{21}H_{26}BrF_3O_3$ (463.33): C 54.44, H 5.66; found: C 54.47, H 5.75.

(MeO)$_9$-[(S)G$_2$(F$_{12}$)]^3-OTBDPS (**16**). To NaH (0.40 g, 16.74 mmol) in THF (20 ml) at 0°, a soln of **9** (0.96 g, 1.86 mmol) in THF (10 ml) was added, and the mixture was stirred at r.t. for 30 min. The bromide **12** (2.86 g, 7.44 mmol) in THF (20 ml) was added at 0°, and the mixture was stirred under reflux for 19 h. The reaction was quenched with H_2O (50 ml), and the mixture was extracted with Et_2O (3 × 100 ml). The combined org. extracts were dried ($MgSO_4$) and concentrated *in vacuo*. The crude product was purified by FC (CH_2Cl_2/pentane/Et_2O 6:3:0.5): 1.63 g (62%) of pure **16**. Slightly-yellow, viscous oil. $[\alpha]_D^{r.t.} = -40.6$ ($c = 1.4$). IR: 3005*w*, 2931*m*, 1463*w*, 1428*w*, 1384*w*, 1279*m*, 1170*s*, 1141*s*, 1104*s*, 1019*w*. ^{1}H-NMR (400 MHz): 1.11 (*s*, *t*-Bu); 2.13–2.15 (*m*, 3 H–C(2)(G$_2$)); 2.42–2.44 (*m*, H–C(2)(G$_1$)); 3.08–3.11 (3*s*, 3 MeO(P)); 3.19–3.21 (3*s*, 3 MeO(P)); 3.22–3.36 (*m*, 3 CH_2OMe(P)); 3.59–3.60 (2*s*, 3 MeO(P)); 3.57–3.69 (*m*, OCH_2–C(2)(G$_1$)); 4.05–4.13 (*m*, 3 H–C(3)(G$_2$)); 4.21–4.76 (*m*, H–C(3)(G$_1$), 3 OCH_2Ph, 3 H–C(1)(G$_2$), H–C(1)(G$_1$)); 4.80 (*s*, CH_2OSi); 7.18–7.71 (*m*, 26 arom. H). ^{13}C-NMR (100 MHz): 19.35; 26.88*s*, 46.04; 46.33; 56.75; 56.83; 58.62; 61.30; 65.33; 66.49; 68.21; 70.90; 72.72; 74.74; 77.06; 79.55; 80.81; 124.39; 126.20; 127.21; 127.29; 127.35; 127.39; 127.51; 127.70; 127.74; 127.86; 129.75; 133.47; 135.60; 137.48; 137.90; 138.15; 138.26; 138.86; 139.29; 139.40; 141.00. ^{19}F-NMR (282 MHz): −74.52 to −74.63 (*m*, 3 $CF_3(G_2)$); −75.19 (*d*, $J = 7.9$, $CF_3(G_1)$). FAB-MS: 1431 (1, M^+), 1259 (1), 305 (8), 274 (16), 273 (100), 241 (12), 229 (51), 197 (24). Anal. calc. for $C_{73}H_{90}F_{12}O_{13}Si$ (1431.55): C 61.25, H 6.34; found: C 61.09, H 6.46.

(MeO)$_9$-[(S)G$_2$(F$_{12}$)]^3-OH (**17**). As described for **11**, with **16** (1.63 g, 1.15 mmol) and TBAF (0.72 g, 2.28 mmol), reaction time 16 h. FC (pentane/Et_2O 1:1): **17** (1.1 g, 81%). Slightly-yellow, viscous oil. $[\alpha]_D^{r.t.} = -50.1$ ($c = 1.8$). IR: 3450*w*, 3005*w*, 2933*m*, 2882*m*, 2820*m*, 1513*w*, 1461*w*, 1420*w*, 1385*m*, 1277*s*, 1169*s*, 1138*s*, 1102*s*. ^{1}H-NMR (400 MHz): 1.76 (*t*, $J = 5.9$, OH); 2.14–2.16 (*m*, 3 H–C(2)(G$_2$)); 2.43–2.45 (*m*, H–C(2)(G$_1$)); 3.08–3.10 (2*s*, 3 MeO(P)); 3.19–3.22 (3*s*, 3 MeO(P)); 3.23–3.33 (*m*, 3 CH_2OMe(P)); 3.56 ('*dd*', *ABX*, $J = 10.3$, 3.8, 1 H, OCH_2–C(2)(G$_1$)); 3.60–3.61 (3*s*, 3 MeO(P)); 3.66 ('*dd*', *ABX*, $J = 10.3$, 6.2, 1 H, OCH_2–C(2)(G$_1$)); 4.04–4.12 (*m*, 3 H–C(3)(G$_2$)); 4.19–4.77 (*m*, H–C(3)(G$_1$), 3 OCH_2Ph, 3 H–C(1)(G$_2$),

H–C(1)(G_1)); 4.72 (*d*, J = 5.8, CH_2OH); 7.15–7.52 (*m*, 16 arom. H). ^{13}C-NMR (100 MHz): 46.04; 46.28; 56.77; 56.85; 58.63; 61.31; 65.02; 66.39; 68.21; 70.86; 72.62; 74.75; 77.20; 79.63; 80.80; 127.19; 127.25; 127.37; 127.41; 127.61; 127.72; 127.86; 137.39; 137.75; 138.08; 138.82; 139.15; 139.36; 139.47; 140.79. ^{19}F-NMR (282 MHz): −74.51 to −74.63 (*m*, 3 $CF_3(G_2)$); −75.02 (*d*, J = 8.1, $CF_3(G_1)$). FAB-MS: 1192 (4, M^+), 1160 (8), 1021 (16), 643 (17), 503 (8), 305 (35), 273 (100), 229 (55), 134 (38). Anal. calc. for $C_{57}H_{72}F_{12}O_{13}$ (1193.17): C 57.38, H 6.08; found: C 57.31, H 6.07.

(MeO)$_9$-[(S)G$_2$(F$_{12}$)]^3-Br (**18**). As described for **12**, with **17** (0.83 g, 0.83 mmol), Ph_3P (0.32 g, 1.24 mmol), and Br_4C (0.41 g, 1.24 mmol). After stirring at r.t. for 16 h, another 1.5 equiv. Ph_3P/Br_4C was added and the mixture was stirred at r.t. for 24 h. After workup, FC (pentane/Et_2O 2:1) gave **18** (0.90 g, 86%) as a colorless oil. $[\alpha]_D^{r.t.} = -45.2$ (c = 1.4). IR: 3005*w*, 2933*m*, 2882*w*, 2820*w*, 1461*w*, 1385*w*, 1277*s*, 1169*s*, 1138*s*, 1103*s*. ^{1}H-NMR (400 MHz): 2.14–2.16 (*m*, 3 H–C(2)(G_2)); 2.43–2.45 (*m*, H–C(2)(G_1)); 3.08–3.11 (3*s*, 3 MeO(P)); 3.19–3.21 (3*s*, 3 MeO(P)); 3.24–3.33 (*m*, 3 CH_2OMe(P)); 3.55 ('*dd*', *ABX*, J = 10.2, 6.4, 1 H, OCH_2–C(2)(G_1)); 3.59–3.61 (3*s*, 3 MeO(P)); 3.65 ('*dd*', *ABX*, J = 10.2, 4.0, 1 H, OCH_2–C(2)(G_1)); 4.03–4.19 (*m*, 3 H–C(3)(G_2)); 4.22–4.76 (*m*, H–C(3)(G_1), 3 OCH_2Ph, 3 H–C(1)(G_2), H–C(1)(G_1)); 4.51 (*s*, CH_2Br); 7.14–7.52 (*m*, 16 arom. H). ^{13}C-NMR (100 MHz): 33.05; 46.03; 56.85; 58.63; 61.31; 68.22; 71.00; 72.70; 74.75; 77.20; 79.51; 80.79; 127.29; 127.37; 127.42; 127.47; 127.71; 127.81; 127.86; 129.29; 137.34; 137.61; 137.99; 138.90; 139.42; 140.20. ^{19}F-NMR (282 MHz): **−74.53 to −74.64 (*m*, 3 $CF_3(G_2)$); −75.11 (*d*, J = 7.8, $CF_3(G_1)$). FAB-MS: 1256 (8, M^+), 1224 (7),** 1086 (15), 1085 (30), 1084 (12), 1083 (28), 305 (36), 273 (100), 230 (15), 229 (72), 198 (22), 160 (32). Anal. calc. for $C_{57}H_{71}BrF_{12}O_{12}$ (1256.07): C 54.51, H 5.70; found: C 54.49, H 5.75.

(Allyl)$_9$-[(S)G$_2$(F$_{12}$)]^3-OTBDPS (**19**). As described for **16**, with **9** (1.12 g, 2.16 mmol), NaH (0.47 g, 19.44 mmol), and **15** (3.5 g, 7.56 mmol), reaction time 19 h. FC (pentane/Et_2O 10:1): **19** (1.48 g, 40%). Slightly-yellow, viscous oil. $[\alpha]_D^{r.t.} = -38.5$ (c = 1.4). IR: 3008*m*, 2930*m*, 2860*m*, 1646*w*, 1512*w*, 1458*w*, 1427*m*, 1351*w*, 1262*s*, 1171*s*, 1139*s*, 1094*s*, 1019*m*. ^{1}H-NMR (400 MHz): 1.11 (*s*, *t*-Bu); 2.23–2.28 (*m*, 3 H–C(2)(G_2)); 2.43–2.44 (*m*, H–C(2)(G_1)); 3.36–4.78 (*m*, 3 CH_2OAllyl, OCH_2–C(2)(G_1), 3 H–C(3)(G_2), 9 CH_2=CHCH_2, H–C(3)(G_1), 3 OCH_2Ph, 3 H–C(1)(G_2), H–C(1)(G_1)); 4.80 (*s*, CH_2OSi); 5.02–5.36 (*m*, 9 CH_2=$CHCH_2$); 5.67–5.98 (*m*, 9 CH_2=C*H*CH_2); 7.16–7.71 (*m*, 26 arom. H). ^{13}C-NMR (100 MHz): 19.35; 26.89; 46.12; 46.35; 65.34; 65.91; 66.51; 69.91; 69.99; 70.86; 71.74; 71.76; 71.77; 72.09; 72.70; 73.90; 74.23; 74.52; 74.83; 77.22; 78.87; 79.69; 116.38*s*, 116.40; 116.44; 116.77; 116.83; 117.47; 117.51; 124.22; 127.23; 127.27; 127.33; 127.43; 127.49; 127.71; 127.74; 127.78; 127.90; 127.75; 133.48; 134.17; 134.19; 134.48; 134.55; 134.74; 134.78; 135.60; 137.40; 137.82; 137.86; 138.05; 138.27; 139.08; 139.46; 139.51; 139.66; 141.02. ^{19}F-NMR (282 MHz): −74.25 to −74.40 (*m*, 4 CF_3). MALDI-TOF-MS: 1688 ($[M + 23]^+$). Anal. calc. for $C_{91}H_{108}F_{12}O_{13}Si$ (1665.91): C 65.61, H 6.53; found: C 65.38, H 6.30.

(Allyl)$_9$-[(S)G$_2$(F$_{12}$)]^3-OH (**20**). As described for **11**, with **19** (1.38 g, 0.83 mmol) and TBAF (0.52 g, 1.66 mmol), reaction time 16 h. FC (pentane/Et_2O 6:4): **20** (0.95 g, 81%). Slightly-yellow, viscous oil. $[\alpha]_D^{r.t.} = -51.3$ (c = 1.4). IR: 3684*w*, 3619*m*, 3008*s*, 2976*s*, 2888*s*, 1646*w*, 1514*w*, 1477*w*, 1422*m*, 1351*w*, 1262*s*, 1171*s*, 1140*s*, 1094*s*, 1046*s*. ^{1}H-NMR (400 MHz): 1.74 (*t*, J = 5.9, OH); 2.23–2.29 (*m*, 3 H–C(2)(G_2)); 2.43–2.44 (*m*, H–C(2)(G_1)); 3.37–4.77 (*m*, 3 CH_2OAllyl, OCH_2–C(2)(G_1), 3 H–C(3)(G_2), 9 CH_2=CHCH_2, H–C(3)(G_1), 3 OCH_2Ph, 3 H–C(1)(G_2), H–C(1)(G_1)); 4.71 (*d*, J = 5.8, CH_2OH); 5.03–5.36 (*m*, 9 CH_2=$CHCH_2$); 5.67–5.99 (*m*, 9 CH_2=C*H*CH_2); 7.10–7.37 (*m*, 16 arom. H). ^{13}C-NMR (100 MHz): 46.09; 46.13; 46.31; 65.01; 65.92; 66.40; 69.93; 70.00; 70.84; 71.76; 71.78; 72.60; 73.91; 74.46; 74.65; 74.85; 75.32; 75.60; 78.85; 78.87; 79.80; 116.42; 116.45; 116.82; 116.85; 117.52; 124.22; 127.04; 127.18; 127.34; 127.36; 127.67; 127.74; 127.80; 134.17; 134.20; 134.47; 134.56; 134.75; 134.77; 137.32; 137.68; 137.97; 139.05; 139.15; 139.58; 139.74; 140.82. ^{19}F-NMR (282 MHz): −74.15 to −74.40 (*m*, 4 CF_3). MALDI-TOF-MS: 1450 ($[M + 23]^+$). Anal. calc. for $C_{75}H_{90}F_{12}O_{13}$ (1427.51): C 63.10, H 6.35; found: C 63.25, H 6.32.

(Allyl)$_9$-[(S)G$_2$(F$_{12}$)]^3-Br (**21**). As described for **12**, with **20** (0.86 g, 0.61 mmol), Ph_3P (0.24 g, 0.91 mmol), and Br_4C (0.30 g, 0.91 mmol). After stirring at r.t. for 16 h, another 1.5 equiv. of Ph_3P/Br_4C was added and the mixture was stirred at r.t. for 24 h. After workup, FC (pentane/Et_2O 8.5:1.5) gave **21** (0.82 g, 90%). Colorless oil. $[\alpha]_D^{r.t.} = -37.8$ (c = 1.6). IR: 3008*s*, 2872*m*, 1646*w*, 1513*w*, 1458*w*, 1422*m*, 1351*w*, 1278*s*, 1171*s*, 1140*s*, 1094*s*, 1019*m*. ^{1}H-NMR (400 MHz): 2.23–2.30 (*m*, 3 H–C(2)(G_2)); 2.41–2.42 (*m*, H–C(2)(G_1)); 3.38–4.76 (*m*, 3 CH_2OAllyl, OCH_2–C(2)(G_1), 3 H–C(3)(G_2), 9 CH_2=C*H*CH_2, H–C(3)(G_1), 3 OCH_2Ph, 3 H–C(1)(G_2), H–C(1)(G_1)); 4.51 (*s*, CH_2Br); 5.03–5.36 (*m*, 9 CH_2=$CHCH_2$); 5.67–5.98 (*m*, 9 CH_2=C*H*CH_2); 7.10–7.42 (*m*, 16 arom. H). ^{13}C-NMR (100 MHz): 33.02; 46.10; 46.27; 65.90; 66.32; 69.94; 69.99; 70.93; 71.74; 72.65; 73.88; 74.46; 74.63; 74.76; 75.32; 75.60; 78.82; 79.67; 116.38; 116.42; 116.78; 116.82; 117.46; 117.50; 124.22; 127.02; 127.18; 127.32; 127.33; 127.41; 127.71; 127.76; 127.86; 129.25; 129.85; 134.14; 134.19; 134.44; 134.54; 134.72; 134.77; 137.24; 137.52; 137.61; 137.84; 139.10; 139.62; 139.74; 140.17. ^{19}F-NMR (282 MHz): −74.23 to −74.42 (*m*, 4 CF_3). MALDI-TOF-MS: 1513 ($[M + 23]^+$). Anal. calc. for $C_{75}H_{89}BrF_{12}O_{13}$ (1490.41): C 60.44, H 6.02; found: C 60.21, H 5.97.

*(2R,5R,6S)-2-(*tert*-Butyl)-5-(4'-{[(*tert*-Butyl)diphenylsilyloxy]methyl}-1,1'-biphenyl-4-yl)(acetoxy)methyl)-6-(trifluoromethyl)-1,3-dioxan-4-one* (**22**). As described for **7**, with 0.84 g (3.7 mmol) of **3**, 2.7 ml (4.7 mmol) of *t*-BuLi, 2 g (4.44 mmol) of **5**, 0.53 ml (7.4 mmol) of AcCl, and 1.5 ml (18.5 mmol) of pyridine (**22**/**23** ratio 5:1). FC (pentane/Et_2O 1:3) afforded 1.18 g (44%) of **22** with *ca.* 6% traces of **24** (according to ^{19}F-NMR). M.p. 62–65°. $[\alpha]_D^{r.t.} = -29.3$ (*c* = 1.6). IR: 2964*m*, 2923*m*, 2861*m*, 1759*s*, 1600*w*, 1425*m*, 1369*m*, 1276*m*, 1148*s*, 1112*s*, 1087*m*. ^{1}H-NMR (400 MHz): 0.96 (*s*, *t*-Bu–C(2)); 1.11 (*s*, *t*-BuSi); 2.21 (*s*, AcO); 3.47 (*dd*, *J* = 5.6, 4.9, H–C(5)); 4.47–4.51 (*m*, H–C(6)); 4.75 (*s*, H–C(2)); 4.81 (*s*, CH_2OSi); 6.25 (*d*, *J* = 4.8, H–C(1')); 7.36–7.72 (*m*, 18 arom. H). ^{13}C-NMR (100 MHz): 19.33; 20.93; 23.52; 26.85; 34.95; 45.70; 65.23; 72.11; 74.57; 105.30; 122.67; 126.51; 126.65; 126.93; 127.62; 127.74; 129.73; 133.45; 134.07; 135.57; 140.78; 142.12; 165.37; 168.79. ^{19}F-NMR (282 MHz): –78.78 (*d*, *J* = 7.0). FAB-MS: 717 (20, M^+), 661 (46), 575 (7), 529 (25), 463 (100), 273 (25), 197 (7), 135 (12). Anal. calc. for $C_{41}H_{45}F_3O_6Si$ (718.90): C 68.50, H 6.31; found: C 68.65, H 6.38.

*(1S,2R,3S)-1-(4'-{[(*tert*-Butyl)diphenylsilyloxy]methyl}-1,1'-biphenyl-4-yl)-2-(hydroxymethyl)-4,4,4-trifluorobutane-1,3-diol* (**25**). As described for **9**, with **22** (1.29 g, 1.79 mmol) and $NaBH_4$ (0.34 g, 8.95 mmol). FC (pentane/Et_2O 1:1): **25**. Slightly-yellow, viscous oil. $[\alpha]_D^{r.t.} = -15.6$ (*c* = 1.6). IR: 3415*w*, 2933*m*, 2851*m*, 15941*w*, 1497*m*, 1430*s*, 1272*s*, 1169*s*, 1138*s*, 1113*s*, 1077*s*. ^{1}H-NMR (400 MHz): 1.11 (*s*, *t*-Bu), 2.11–2.20 (*m*, H–C(2), OH); 2.70 (br. *s*, OH); 3.66–3.75 (*m*, 1 H, CH_2OH); 4.15–4.18 (*m*, 1 H, CH_2OH); 4.25 (*d*, *J* = 6.9, OH); 4.55–4.70 (*m*, H–C(3)); 4.82 (*s*, CH_2OSi); 5.30 (*d*, *J* = 7.7, H–C(1)); 7.36–7.73 (*m*, 18 arom. H). ^{13}C-NMR (100 MHz): 19.36; 26.87; 45.19; 61.51; 65.29; 70.26; 72.72; 125.55; 126.51; 126.79; 126.91; 127.43; 127.76; 129.74; 133.48; 135.60; 139.06; 140.50; 141.12. ^{19}F-NMR (282 MHz): –76.13 (*d*, *J* = 8.7). FAB-MS: 593 (18, $[M - H]^+$), 577 (23), 537 (85), 339 (100), 291 (17), 196 (12), 135 (12). Anal. calc. for $C_{34}H_{37}F_3O_4Si$ (594.74): C 68.66, H 6.27; found: C 68.37, H 6.24.

*4-{[(*tert*-Butyl)diphenylsilyloxy]methyl}-4'-[(1S,2R,3S)-4,4,4-trifluoro-1,3-dimethoxy-2-(methoxymethyl)-butyl]-1,1'-biphenyl* (**26**). As described for **10**, with **25** (1.65 g, 2.78 mmol), NaH (0.6 g, 25 mmol), and MeI (1.6 ml, 25 mmol), reaction time 4 h. FC (pentane/Et_2O 8:1): **26** (1.73 g, 98%). Slightly-yellow, viscous oil. $[\alpha]_D^{r.t.} = -13.1$ (*c* = 1.6). IR: 2994*w*, 2933*m*, 2861*m*, 1600*w*, 1497*w*, 1472*w*, 1428*w*, 1385*w*, 1277*m*, 1164*s*, 1107*s*, 1005*w*. ^{1}H-NMR (400 MHz): 1.11 (*s*, *t*-Bu); 2.19–2.23 (*m*, H–C(2)); 3.13 (*s*, MeO); 3.27 (*s*, MeO); 3.25–3.44 (*m*, CH_2OMe); 3.63 (*s*, MeO); 4.10 (*qd*, *J* = 8.0, 2.2, H–C(3)); 4.41 (*d*, *J* = 8.3, H–C(1)); 4.82 (*s*, CH_2OSi); 7.36–7.73 (*m*, 18 arom. H). ^{13}C-NMR (100 MHz): 19.34; 26.54; 26.85; 46.00; 56.85; 58.66; 61.36; 65.30; 68.25; 77.04; 80.80; 125.82; 126.45; 126.85; 127.01; 127.72; 127.82; 129.64; 129.71; 133.50; 134.79; 135.58; 138.56; 139.28; 140.29; 140.63. ^{19}F-NMR (282 MHz): –73.70 (*d*, *J* = 8.7). FAB-MS: 635 (23, $[M - H]^+$), 605 (10), 579 (81), 465 (34), 381 (100), 305 (68), 210 (33), 195 (22), 135 (15). Anal. calc. for $C_{37}H_{43}F_3O_4Si$ (636.83): C 69.78, H 6.81; found: C 69.79, H 6.63.

4'-[(1S,2R,3S)-4,4,4-Trifluoro-1,3-dimethoxy-2-(methoxymethyl)butyl]-1,1'-biphenyl-4-methanol (**27**). As described for **11**, with **26** (1.42 g, 2.23 mmol) and TBAF (1.41 g, 4.46 mmol), reaction time 12 h. FC (pentane/Et_2O 1:1): **27** (0.83 g, 94%). Slightly-yellow, viscous oil. $[\alpha]_D^{r.t.} = -24.0$ (*c* = 1.8). IR: 3459*w*, 3005*m*, 2931*m*, 2824*w*, 1602*w*, 1497*w*, 1462*w*, 1383*m*, 1278*s*, 1170*s*, 1120*s*, 1020*s*. ^{1}H-NMR (400 MHz): 1.80 (br. *s*, OH); 2.18–2.23 (*m*, H–C(2)); 3.13 (*s*, MeO); 3.26 (*s*, MeO); 3.27–3.44 (*m*, CH_2OMe); 3.63 (*s*, MeO); 4.14 (*qd*, *J* = 8.0, 2.3, H–C(3)); 4.41 (*d*, *J* = 8.3, H–C(1)); 4.74 (*s*, CH_2OH); 7.38–7.63 (*m*, 8 arom. H). ^{13}C-NMR (100 MHz): 46.01; 56.88; 58.68; 61.37; 65.07; 68.27; 77.24; 80.81; 124.98; 127.07; 127.22; 127.49; 127.87; 130.08; 138.82; 140.04; 140.11; 140.39. ^{19}F-NMR (282 MHz): –73.72 (*d*, *J* = 7.0). FAB-MS: 398 (14, M^+), 381 (44), 367 (25), 305 (43), 291 (20), 227 (100), 210 (14), 154 (15), 136 (16). Anal. calc. for $C_{21}H_{25}F_3O_4$ (398.42): C 63.31, H 6.32; found: C 63.35, H 6.32.

4-(Bromomethyl)-4'-[(1S,2R,3S)-4,4,4-trifluoro-1,3-dimethoxy-2-(methoxymethyl)butyl]-1,1'-biphenyl (**28**). As described for **12**, with **27** (0.72 g, 1.79 mmol), Ph_3P (0.71 g, 2.69 mmol), and Br_4C (0.90 g, 2.69 mmol), reaction time 16 h. FC (pentane/Et_2O 9:1): **28** (0.75 g, 90%). White solid. M.p. 77–78°. $[\alpha]_D^{r.t.} = -21.4$ (*c* = 1.7). IR: 3007*m*, 2933*m*, 2825*w*, 1609*w*, 1497*m*, 1462*w*, 1384*w*, 1279*m*, 1170*s*, 1141*s*, 1103*s*, 1066*m*, 1034*w*. ^{1}H-NMR (400 MHz): 2.17–2.22 (*m*, H–C(2)); 3.12 (*s*, MeO); 3.26 (*s*, MeO); 3.27–3.43 (*m*, CH_2OMe); 3.62 (*s*, MeO); 4.13 (*qd*, *J* = 8.0, 2.3, H–C(3)); 4.41 (*d*, *J* = 8.3, H–C(1)); 4.55 (*s*, CH_2Br); 7.39–7.60 (*m*, 8 arom. H). ^{13}C-NMR (100 MHz): 33.34; 46.03; 56.90; 58.68; 61.38; 68.26; 77.34; 80.80; 125.32; 127.45; 127.91; 129.55; 130.07; 136.90; 139.15; 139.98; 140.88. ^{19}F-NMR (282 MHz): –73.73 (*d*, *J* = 8.7). FAB-MS: 460 (14, $[M - H]^+$), 429 (32), 381 (82), 305 (96), 289 (100), 210 (51), 195 (44), 165 (21), 154 (55), 136 (43). Anal. calc. for $C_{21}H_{24}BrF_3O_3$ (461.32): C 54.68, H 5.24; found: C 54.73, H 5.37.

(MeO)$_9$-[(S)G$_2$(F$_{12}$)(Biph.)]^3-OTBDPS (**30**). As described for **16**, with **25** (1.24 g, 2.08 mmol), NaH (0.45 g, 18.75 mmol), and **28** (3.36 g, 7.29 mmol), reaction time 19 h. FC (CH_2Cl_2/pentane/Et_2O 6:3:0.5): **30** (2.93 g, 81%). Slightly-yellow, viscous oil. $[\alpha]_D^{r.t.} = -62.3$ (*c* = 1.9). IR: 3008*s*, 2975*s*, 2894*s*, 1520*s*, 1475*m*, 1426*m*, 1391*m*, 1248*s*, 1170*s*, 1141*s*, 1103*s*, 1046*s*. ^{1}H-NMR (400 MHz): 1.14 (*s*, *t*-Bu); 2.18–2.22 (*m*, 3 H–C(2)(G_2));

2.49–2.51 (*m*, H–C(2)(G_1)); 3.12–3.14 (3*s*, 3 MeO(P)); 3.26–3.28 (3*s*, 3 MeO(P)); 3.30–3.38 (*m*, 3 CH_2OMe(P)); 3.64–3.65 (3*s*, 3 MeO(P)); 3.62–3.76 (*m*, OCH_2–C(2)(G_1)); 4.13–4.83 (*m*, 3 H–C(3)(G_2), H–C(3)(G_1), 3 OCH_2Ph, 3 H–C(1)(G_2), H–C(1)(G_1)); 4.85 (*s*, CH_2OSi); 7.22–7.75 (*m*, 42 arom. H). ^{13}C-NMR (100 MHz): 19.37; 26.89; 46.05; 46.38; 56.84; 56.87; 56.88; 58.65; 61.35; 65.34; 66.41; 68.26; 70.61; 71.91; 72.69; 74.55; 75.16; 77.20; 77.23; 79.11; 80.82; 126.51; 126.85; 126.97; 127.00; 127.04; 127.05; 127.12; 127.18; 127.76; 127.82; 127.86; 127.96; 127.99; 128.32; 128.36; 128.62; 129.24; 129.75; 133.51; 135.60; 136.77; 137.18; 137.43; 137.55; 138.64; 138.69; 138.81; 138.92; 139.26; 139.74; 140.15; 140.24; 140.26; 140.29; 140.34; 140.41; 140.47; 140.77. ^{19}F-NMR (282 MHz): −73.69 to −73.77 (*m*, 3 CF_3(G_2)); −73.99 (*d*, *J* = 7.0, CF_3(G_1)). FAB-MS: 1734 (25, [*M* − H]$^+$), 1564 (27), 1353 (6), 1251 (5), 957 (4), 381 (100), 305 (53), 195 (48), 135 (19). Anal. calc. for $C_{97}H_{106}F_{12}O_{13}Si$ (1735.96): C 67.11, H 6.15; found: C 66.92, H 6.24.

(MeO)$_9$-[(S)G_2(F_{12})(Biph.)]^3-OH (**31**). As described for **11**, with **30** (2.4 g, 1.39 mmol) and TBAF (0.87 g, 2.77 mmol), reaction time 16 h. FC (pentane/Et_2O 6:4): **31** (1.82 g, 89%). Colorless, viscous oil. $[\alpha]_D^{r.t.} = -74.1$ (*c* = 1.5). IR: 3682*w*, 3619*s*, 3464*w*, 3009*s*, 2975*s*, 2932*m*, 2895*m*, 1520*w*, 1476*w*, 1423*w*, 1248*s*, 1140*m*, 1103*s*, 1046*s*. ^{1}H-NMR (400 MHz): 1.82 (*t*, *J* = 5.9, OH); 2.17–2.22 (*m*, 3 H–C(2)(G_2)); 2.47–2.50 (*m*, H–C(2)(G_1)); 3.11–3.12 (3*s*, 3 MeO(P)); 3.26–3.27 (3*s*, 3 MeO(P)); 3.28–3.36 (*m*, 3 CH_2OMe(P)); 3.58 ('*dd*', *ABX*, *J* = 10.1, 6.1, 1 H, OCH_2–C(2)(G_1)); 3.62–3.63 (2*s*, 3 MeO(P)); 3.72 ('*dd*', *ABX*, *J* = 10.1, 3.6, 1 H, OCH_2–C(2)(G_1)); 4.10–4.82 (*m*, 3 H–C(3)(G_2), H–C(3)(G_1), 3 OCH_2Ph, 3 H–C(1)(G_2), H–C(1)(G_1)); 4.75 (*d*, *J* = 5.5, CH_2OH); 7.16–7.63 (*m*, 32 arom. H). ^{13}C-NMR (100 MHz): 46.05; 46.38; 56.86; 56.87; 56.89; 58.65; 61.35; 65.05; 66.32; 68.27; 70.55; 72.61; 74.46; 75.18; 76.94; 79.15; 80.82; 80.85; 125.83; 126.98; 126.99; 127.03; 127.05; 127.07; 127.20; 127.24; 127.49; 127.80; 127.86; 127.90; 128.04; 128.35; 138.61; 136.75; 137.14; 137.48; 138.66; 138.87; 138.94; 139.68; 140.02; 140.18; 140.26; 140.28; 140.30; 140.32; 140.46; 140.52. ^{19}F-NMR (282 MHz): −73.69 to −73.86 (*m*, 4 CF_3). FAB-MS: 1519 (7, [*M* + 13]$^+$), 719 (20), 381 (100), 305 (44), 210 (22), 195 (17). Anal. calc. for $C_{81}H_{88}F_{12}O_{13}$ (1497.56): C 64.97, H 5.92; found: C 64.92, H 5.88.

(MeO)$_9$-[(S)G_2(F_{12})(Biph.)]^3-Br (**32**). As described for **12**, with **31** (1.43 g, 0.96 mmol), Ph_3P (0.38 g, 1.44 mmol), and Br_4C (0.48 g, 1.44 mmol). After stirring at r.t. for 16 h, another 1.5 equiv. of Ph_3P/Br_4C was added, and the mixture was stirred at r.t. for 24 h. After workup, FC (pentane/Et_2O 2:1) gave **32** (1.2 g, 80%). Slightly-yellow, viscous oil. $[\alpha]_D^{r.t.} = -60.4$ (*c* = 1.4). IR: 3008*s*, 2975*s*, 2894*w*, 2434*m*, 1520*s*, 1476*m*, 1423*s*, 1103*s*, 1046*s*. ^{1}H-NMR (400 MHz): 2.19–2.22 (*m*, 3 H–C(2)(G_2)); 2.48–2.52 (*m*, H–C(2)(G_1)); 3.11–3.12 (3*s*, 3 MeO(P)); 3.25–3.27 (3*s*, 3 MeO(P)); 3.28–3.37 (*m*, 3 CH_2OMe(P)); 3.58 ('*dd*', *ABX*, *J* = 10.0, 6.3, 1 H, OCH_2–C(2)(G_1)); 3.62–3.63 (2*s*, 3 MeO(P)); 3.73 ('*dd*', *ABX*, *J* = 10.1, 3.6, 1 H, OCH_2–C(2)(G_1)); 4.10–4.82 (*m*, 3 H–C(3)(G_2), H–C(3)(G_1), 3 OCH_2Ph, 3 H–C(1)(G_2), H–C(1)(G_1)); 4.55 (*s*, CH_2Br); 7.16–7.62 (*m*, 32 arom. H). ^{13}C-NMR (100 MHz): 33.27; 46.05; 46.37; 56.88; 58.67; 61.36; 66.34; 68.27; 70.59; 72.64; 74.56; 75.10; 79.14; 80.82; 125.30; 126.81; 126.98; 127.04; 127.05; 127.07; 127.24; 127.49; 127.83; 127.87; 127.92; 128.06; 128.36; 128.61; 129.23; 129.58; 136.72; 137.00; 137.11; 137.47; 138.72; 138.75; 139.21; 139.71; 140.12; 140.27; 140.31; 140.42; 140.82. ^{19}F-NMR (282 MHz): −73.72 to −73.79 (*m*, 3 CF_3(G_2)); −73.91 (*d*, *J* = 8.8, CF_3(G_1)). FAB-MS: 1573 (12, [*M* + 13]$^+$), 1390, (10), 1251 (7), 781 (15), 381 (100), 305 (32), 210 (24), 195 (22), 139 (10). Anal. calc. for $C_{81}H_{87}BrF_{12}O_{12}$ (1560.46): C 62.35, H 5.62; found: C 62.23, H 5.42.

(MeO)$_9$-{[(S)G_1(F_9)]^3}$_3$-[C] (**33**). To NaH (50 mg, 2.1 mmol) in THF (7 ml), **6** (40 mg, 0.23 mmol) in THF (6 ml) was added, and the mixture was stirred under reflux for 30 min. The bromide **12** (335 mg, 0.92 mmol) in THF (7 ml) was then added at 0°, and the mixture was stirred under reflux for 4 h. The reaction was quenched by the addition of H_2O (20 ml), and the mixture was extracted with Et_2O (3 × 40 ml). The combined org. extracts were dried ($MgSO_4$) and concentrated *in vacuo*. The crude product was purified by FC (pentane/Et_2O 4:1 → 1:1): **33** (180 mg, 74%). Colorless, glassy oil. $[\alpha]_D^{r.t.} = -29.1$ (*c* = 1.6). IR: 2936*m*, 1704*w*, 1464*w*, 1383*m*, 1279*m*, 1170*s*, 1140*s*, 1103*s*, 1020*m*. ^{1}H-NMR (400 MHz): 0.94 (*s*, *t*-Bu); 1.31 (*d*, *J* = 6.4, Me); 2.05–2.15 (*m*, 3 H–C(2)(G_1)); 2.31–2.34 (*m*, H–C(3)(C)); 3.09–3.11 (3*s*, 3 MeO(P)); 3.20–3.22 (3*s*, 3 MeO(P)); 3.22–3.33 (*m*, 3 CH_2OMe(P), H–C(4)(C)); 3.59–3.62 (*m*, 1 H, CH_2(C), 3 MeO(P)); 3.74–3.83 (*m*, 1 H, CH_2(C), H–C(2)(C)); 4.05–4.14 (*m*, 3 H–C(3)(G_1)); 4.34–4.37 (*m*, 3 H–C(1)(G_1)); 4.38–4.68 (*m*, 3 OCH_2Ph); 7.24–7.38 (*m*, 12 arom. H). ^{13}C-NMR (75 MHz): 16.67; 26.34; 37.42; 44.93; 46.03; 56.66; 56.79; 58.64; 61.32; 68.26; 70.70; 72.83; 73.64; 77.46; 80.85; 86.40; 125.70; 126.93; 127.15; 127.34; 127.51; 127.67; 127.83; 127.95; 138.39; 138.68; 138.80; 139.39. ^{19}F-NMR (282 MHz): −74.58 (br. *s*, 3 CF_3). FAB-MS: 1087 (5, *M*$^+$), 1056 (2), 917 (6), 457 (9), 425 (12), 305 (57), 273 (100), 229 (43), 198 (13), 134 (36), 91 (10). Anal. calc. for $C_{54}H_{77}F_9O_{12}$ (1089.17): C 59.55, H 7.13; found: C 59.57, H 7.19.

(MeO)$_9$-{[(S)G_1(F_9)]^3}$_3$-[$C_{enant.}$] (**34**). As described for **33**, with *ent*-**6** (40 mg, 0.23 mmol), NaH (50 mg, 2.1 mmol), and **12** (335 mg, 0.92 mmol), reaction time 4 h. FC (pentane/Et_2O 4:1 → 1:1): **34** (175 mg, 70%). $[\alpha]_D^{r.t.} = -35.0$ (*c* = 1.8). IR: 3005*w*, 2933*m*, 2831*w*, 1461*w*, 1385*w*, 1277*m*, 1169*s*, 1138*s*, 1103*s*. ^{1}H-NMR (400 MHz): 0.94 (*s*, *t*-Bu); 1.31 (*d*, *J* = 6.4, Me); 2.09–2.16 (*m*, 3 H–C(2)(G_1)); 2.31–2.33 (*m*, H–C(3)(C));

3.09–3.11 (3*s*, 3 MeO(P)); 3.21–3.22 (3*s*, 3 MeO(P)); 3.22–3.32 (*m*, 3 CH_2OMe(P), H–C(4)(C)); 3.59–3.63 (*m*, 1 H, CH_2(C), 3 MeO(P)); 3.73–3.83 (*m*, 1 H, CH_2(C), H–C(2)(C)); 4.06–4.12 (*m*, 3 H–C(3)(G_1)); 4.33–4.37 (*m*, 3 H–C(1)(G_1)); 4.41–4.68 (*m*, 3 OCH_2Ph); 7.24–7.38 (*m*, 12 arom. H). ^{13}C-NMR (100 MHz): 16.62; 26.33; 37.40; 44.90; 46.02; 56.78; 58.62; 61.31; 68.24; 68.35; 70.63; 72.81; 73.63; 76.49; 76.90; 80.84; 86.34; 126.95; 127.14; 127.33; 127.63; 127.77; 138.41; 138.68; 138.79; 138.86; 139.35. ^{19}F-NMR (282 MHz): −74.52 to −74.58 (*m*, CF_3). FAB-MS: 1089 (10, M^+), 1087 (42), 918 (12), 917 (24), 306 (10), 305 (46), 273 (100), 229 (49), 160 (19), 135 (31), 134 (45). Anal. calc. for $C_{84}H_{77}F_9O_{12}$ (1089.18): C 59.55, H 7.13; found: C 59.56, H 7.09.

(MeO)$_{27}$-{[(S)G$_2$(F$_{36}$)]^3}$_3$-[C] (**35**). As described for **33**, with **6** (33 mg, 0.19 mmol), NaH (41 mg, 1.71 mmol), and **18** (830 mg, 0.67 mmol), reaction time 24 h. FC (pentane/Et_2O 1:1): **35** (397 mg, 58%). $[\alpha]_D^{r.t.} = -47.3$ (*c* = 1.6). IR: 3301*m*, 2934*m*, 1710*w*, 1513*w*, 1463*w*, 1383*m*, 1279*m*, 1170*s*, 1141*s*, 1103*s*, 1019*m*. ^{1}H-NMR (400 MHz): 0.96 (*s*, *t*-Bu); 1.36 (*d*, *J* = 6.4, Me); 2.12–2.17 (*m*, 9 H–C(2)(G_2)); 2.40–2.43 (*m*, 3 H–C(2)(G_1), H–C(3)(C)); 3.07–3.11 (4*s*, 9 MeO(P)); 3.17–3.21 (7*s*, 9 MeO(P)); 3.22–3.32 (*m*, 9 CH_2OMe(P), H–C(4)(C)); 3.59–3.69 (3*s*, 9 MeO(P), 3 OCH_2–C(2)(G_1), 1 H, CH_2(C)); 3.85–3.87 (*m*, H–C(2)(C)); 3.90–3.92 (*m*, 1 H, CH_2(C)); 4.04–4.13 (*m*, 9 H–C(3)(G_2)); 4.23–4.78 (*m*, 3 H–C(3)(G_1), 9 H–C(1)(G_2), 3 H–C(1)(G_1), 12 OCH_2Ph); 7.20–7.47 (*m*, 48 arom. H). ^{13}C-NMR (100 MHz): 16.30; 26.43; 37.56; 44.52; 45.53; 46.06; 46.20; 46.37; 56.77; 56.82; 56.83; 58.59; 58.61; 61.29; 66.47; 68.21; 68.90; 70.64; 71.04; 72.74; 72.85; 73.66; 74.70; 74.85; 75.08; 75.31; 75.55; 76.16; 79.38; 79.41; 80.78; 80.81; 80.84; 85.74; 124.68; 126.74; 126.91; 126.94; 127.06; 127.19; 127.21; 127.30; 127.33; 127.40; 127.50; 127.67; 127.87; 128.03; 137.43; 137.79; 137.84; 138.13; 138.59; 138.75; 138.86; 138.91; 138.92; 138.96; 139.37; 139.39. ^{19}F-NMR (282 MHz): −74.52 to −74.58 (*m*, 3 CF_3(G_2)); −75.39 to −75.50 (*m*, CF_3(G_1)). MALDI-TOF: 3724 ($[M + Na]^+$). Anal. calc. for $C_{180}H_{230}F_{36}O_{39}$ (3701.72): C 58.40, H 6.26; found: C 58.15, H 6.09.

(Allyl)$_9$-{[(S)G$_1$(F$_9$)]^3}$_3$-[C] (**36**). As described for **33**, with **6** (257 mg, 1.46 mmol), NaH (315 mg, 13.12 mmol), and **15** (2.7 g, 5.83 mmol), reaction time 4 h. FC (pentane/Et_2O 8:1): **36** (0.75 g, 40%). $[\alpha]_D^{r.t.} = -20.7$ (*c* = 2.0). IR: 2869*w*, 1423*w*, 1352*w*, 1278*m*, 1170*s*, 1140*s*, 1095*s*, 1018*m*. ^{1}H-NMR (400 MHz): 0.94 (*s*, *t*-Bu); 1.30 (*d*, *J* = 6.4, Me); 2.25–2.29 (*m*, 3 H–C(2)(G_1)); 2.30–2.34 (*m*, H–C(3)(C)); 3.22 (*d*, *J* = 1.9, H–C(4)(C)); 3.34–4.69 (*m*, 3 CH_2OAllyl, CH_2(C), 9 CH_2=CHCH_2, 3 H–C(3)(G_1), H–C(2)(C), 3 OCH_2Ph, 3 H–C(1)(G_1)); 5.02–5.39 (*m*, 9 CH_2=CHCH_2); 5.67–5.99 (*m*, 9 CH_2=C*H*CH_2); 7.20–7.35 (*m*, 12 arom. H). ^{13}C-NMR (100 MHz): 16.56; 26.30; 26.47; 37.40; 44.82; 46.09; 65.90; 68.39; 69.93; 70.66; 71.72; 71.75; 72.80; 73.58; 73.88; 74.55; 76.48; 78.82; 78.85; 78.93; 86.18; 116.39; 116.72; 116.77; 117.45; 124.19; 126.86; 127.21; 127,58; 127,73; 129.85; 134.18; 134.53; 134.55; 134.57; 134.77; 138.56; 138.59; 138.66; 139.01; 139.07; 139.23. ^{19}F-NMR (282 MHz): −74.28 to −74.37 (*m*, 3 CF_3). MALDI-TOF: 1362 ($[M + K]^+$), 1346 ($[M + Na]^+$). Anal. calc. for $C_{72}H_{95}F_9O_{12}$ (1323.52): C 65.34, H 7.23; found: C 65.29, H 6.98.

(Allyl)$_{18}$-{[(S)G$_2$(F$_{24}$)]^3}$_2$-[C]-OH (**37**). As described for **33**, with **6** (27 mg, 0.16 mmol), NaH (33 mg, 1.36 mmol), and **21** (790 mg, 0.53 mmol), reaction time 24 h. FC (pentane/Et_2O 8:1): **37** (278 mg, 58%). $[\alpha]_D^{r.t.} = -45.3$ (*c* = 1.4). IR: 3683*m*, 3620*s*, 3449*w*, 3008*s*, 2975*s*, 2892*s*, 2433*m*, 1521*s*, 1476*m*, 1422*s*, 1248*s*, 1140*s*, 1047*s*. ^{1}H-NMR (500 MHz): 0.92 (*s*, *t*-Bu); 1.35 (*d*, *J* = 6.3, Me); 2.02–2.03 (*m*, H–C(3)(C)); 2.25–2.29 (*m*, 6 H–C(2)(G_2)); 2.41–2.43 (*m*, 2 H–C(2)(G_1)); 2.98 (*d*, *J* = 5.2, H–C(4)(C)); 3.35–4.75 (*m*, 6 CH_2OAllyl, 2 OCH_2–C(2)(G_1), CH_2(C), 6 H–C(3)(G_2), 18 CH_2=CHCH_2, 2 H–C(3)(G_1), H–C(2)(C), 8 OCH_2Ph, 6 H–C(1)(G_2), 2 H–C(1)(G_1)); 5.05–5.35 (*m*, 18 CH_2=CHCH_2); 5.63–5.97 (*m*, 18 CH_2=C*H*CH_2); 7.17–7.37 (*m*, 32 arom. H). ^{13}C-NMR (125 MHz): 14.52; 16.96; 26.49; 35.76; 44.98; 46.12; 46.33; 65.90; 66.46; 68.04; 69.94; 69.99; 70.77; 70.98; 71.75; 72.71; 73.12; 73.89; 74.24; 74.72; 75.21; 75.45; 78.82; 78.85; 79.52; 80.08; 116.40; 116.44; 116.80; 116.84; 117.49; 117.52; 126.05; 126.75; 127.21; 127.30; 127.33; 127.38; 127.41; 127.47; 127.69; 127.78; 127.80; 127.87; 129.02; 134.14; 134.16; 134.18; 134.45; 134.48; 134.54; 134.73; 134.77; 137.35; 137.69; 138.00; 138.05; 138.50; 139.10; 139.19; 139.25; 139.57; 139.66. ^{19}F-NMR (282 MHz): −74.30 to −74.51 (*m*, 8 CF_3) MALDI-TOF: 3017 ($[M + Na]^+$).

(MeO)$_9$-{[(S)G$_1$(F$_9$)(Biph.)]^3}$_3$-[C] (**38**). As described for **33**, with **6** (50 mg, 0.28 mmol), NaH (62 mg, 2.55 mmol), and **28** (524 mg, 1.14 mmol), reaction time 4 h. FC (pentane/Et_2O 5:1 → 2:1): **38** (138 mg, 50%). ^{1}H-NMR (200 MHz): 1.00 (*s*, *t*-Bu); 1.37 (*d*, *J* = 6.2, Me); 2.19–2.24 (*m*, 3 H–C(2)(G_1)); 2.36–2.38 (*m*, H–C(3)(C)); 3.13 (2*s*, 3 MeO(P)); 3.27 (3*s*, 3 MeO(P)); 3.28–3.38 (*m*, 3 CH_2OMe(P), H–C(4)(C)); 3.60–3.70 (*m*, 1 H, CH_2(C), 3 MeO(P)); 3.81–3.90 (*m*, 1 H, CH_2(C), H–C(2)(C)); 4.10–4.19 (*m*, 3 H–C(3)(G_1)); 4.32–4.74 (*m*, 3 H–C(1)(G_1), 3 OCH_2Ph); 7.26–7.68 (*m*, 24 arom. H). ^{19}F-NMR (282 MHz): −73.69 to −73.71 (br. *t*, 3 CF_3).

(MeO)$_9$-{[(S)G$_1$(F$_9$)(Biph.)]^3}$_3$-[C$_{enant.}$] (**39**). As described for **33**, with *ent*-**6** (50 mg, 0.28 mmol), NaH (62 mg, 2.55 mmol), and **28** (524 mg, 1.14 mmol), reaction time 4 h. FC (pentane/Et_2O 4:1 → 1:1): **39** (150 mg, 53%). $[\alpha]_D^{r.t.} = -38.0$ (*c* = 1.4). IR: 3005*w*, 2934*m*, 1497*w*, 1463*w*, 1383*w*, 1278*m*, 1169*s*, 1139*s*, 1102*s*. ^{1}H-NMR (200 MHz): 1.02 (*s*, *t*-Bu); 1.28 (*d*, *J* = 6.2, Me); 2.15–2.25 (*m*, 3 H–C(2)(G_1)); 2.27–2.42 (*m*, H–C(3)(C)); 3.15

(*s*, 3 MeO(P)); 3.29 (*s*, 3 MeO(P)); 3.32–3.38 (*m*, 3 CH_2OMe(P), H–C(4)(C)); 3.60–3.70 (*m*, 1 H, CH_2(C), 3 MeO(P)); 3.80–3.90 (*m*, 1 H, CH_2(C), H–C(2)(C)); 4.10–4.22 (*m*, 3 H–C(3)(G_1)); 4.40–4.80 (*m*, 3 H–C(1)(G_1), 3 OCH_2Ph); 7.25–7.65 (*m*, 24 arom. H). ^{13}C-NMR (75 MHz): 16.58; 25.96; 37.41; 45.61; 46.02; 56.44; 58.25; 67.31; 68.24; 68.35; 70.63; 72.86; 73.63; 76.43; 76.90; 80.74; 86.34; 126.85; 127.14; 127.33; 127.63; 138.09; 138.18; 138.36; 138.75; 139.30. ^{19}F-NMR (282 MHz): −73.74 to −73.79 (br. *t*, 3 CF_3). FAB-MS: 1316 (5, $[M-1]^+$), 1146 (13), 761 (7), 381 (100), 305 (37), 210 (61), 195 (43), 139 (12).

(MeO)$_{27}$-{[(S)G$_2$(F$_{36}$)(Biph.)]^3}$_3$-[C] (**40**). As described for **33**, with **6** (33 mg, 0.18 mmol), NaH (41 mg, 1.71 mmol), and **32** (1.0 g, 0.67 mmol), reaction time 4 h. FC (pentane/Et_2O 1:1): **40** (200 mg, 25%). $[\alpha]_D^{r.t.} = -45.8$ ($c = 1.0$). IR: 2985*w*, 2933*m*, 1492*w*, 1461*w*, 1390*m*, 1277*m*, 1174*s*, 1138*s*, 1097*s*, 1010*w*. ^{1}H-NMR (500 MHz): 1.01 (*s*, *t*-Bu); 1.38 (*d*, $J = 6.3$, Me); 2.18–2.19 (*m*, 9 H–C(2)(G_2)); 2.42–2.49 (*m*, H–C(3)(C), 3 H–C(2)(G_1)); 3.09–3.11 (3*s*, 9 MeO(P)); 3.24–3.26 (4*s*, 9 MeO(P)); 3.29–3.36 (*m*, 9 CH_2OMe(P), H–C(4)(C)); 3.61–3.69 (3*s*, 9 MeO(P), 3 OCH_2–C(2)(G_1), 1 H, CH_2(C)); 3.82–3.87 (*m*, H–C(2)(C)); 3.90–3.93 (*m*, 1 H, CH_2(C)); 4.09–4.16 (*m*, 9 H–C(3)(G_2)); 4.23–4.79 (*m*, 3 H–C(3)(G_1), 9 H–C(1)(G_2), 3 H–C(1)(G_1), 12 OCH_2Ph); 7.20–7.47 (*m*, 96 arom. H). ^{13}C-NMR (125 MHz): 16.60; 26.44; 26.57; 29.71; 37.55; 46.05; 46.39; 56.87; 56.88; 58.65; 61.29; 66.47; 68.21; 68.90; 70.64; 71.04; 72.74; 72.85; 73.66; 74.75; 74.99; 75.08; 75.31; 75.45; 76.76; 80.00; 80.81; 86.08; 124.64; 126.74; 126.91; 126.94; 127.00; 127.03; 127.04; 127.06; 127.15; 127.22; 127.42; 127.81; 127.86; 127.97; 128.00; 128.21; 128.32; 128.64; 129.23; 136.76; 137.14; 137.54; 138.23; 138.34; 138.71; 138.75; 138.79; 138.83; 138.92; 139.45; 139.75; 139.79; 140.26; 140.32; 140.45; 140.62; 140.66; 140.69. ^{19}F-NMR (282 MHz): −73.70 to −73.79 (*m*, 3 CF_3(G_2)); −74.09 to −74.16 (*m*, CF_3(G_1)). MALDI-TOF: 4637 ($[M + Na]^+$).

X-Ray Crystal-Structure Analysis of Compound **7** ($C_{35}H_{41}O_6F_3Si$). Determination of the cell parameters and collection of the reflection intensities were performed on an *Enraf-Nonius-CAD4* four-circle diffractometer (graphite monochromatized MoK_α radiation, $\lambda = 0.7107$ Å). Colorless prism, $0.4 \times 0.6 \times 0.8$ mm, monoclinic, space group $P2_1$, $a = 10.960(3)$ Å, $b = 8.980(5)$ Å, $c = 18.396(4)$ Å, $\beta = 103.48(2)$, $V = 1067(7)$ Å^3, $Z = 2$, $\rho_{calc.} = 1.212$ gcm^{-3}, $\mu = 0.124$ mm^{-1}, $F(000) = 680$. Number of reflections measured 3294 ($\omega/2\theta$ scan, $2 < 2\theta < 40°$, $T = 295$ K); 3294 unique reflections, which were used for the determination (direct methods, SHELXS-86). SHELXS-93 was used for structure refinement (full-matrix least squares). The non-H-atoms were refined anisotropically, the H-atoms were added to the molecule with constant isotropic temp. factors on idealized positions and refined according to the riding model (afix 3). The refinement converged at $R = 0.041$ ($wR^2 = 0.099$), min. and max. rest electron density −0.19, 0.15 eÅ^{-3}, number of variables 406.

REFERENCES

[1] G. Greiveldinger, D. Seebach, *Polym. Mat. Sci. Eng.* **1997**, *77*, 134.
[2] D. Seebach, J.-M. Lapierre, K. Skobridis, G. Greiveldinger, *Angew. Chem.* **1994**, *106*, 457.
[3] D. Seebach, P. B. Rheiner, G. Greiveldinger, T. Butz, H. Sellner, *Topics Curr. Chem.* **1998**, in press.
[4] H. W. I. Peerlings, E. W. Meijer, *Chem. Eur. J.* **1997**, *3*, 1563.
[5] D. Seebach, J.-M. Lapierre, W. Jaworek, P. Seiler, *Helv. Chim. Acta* **1993**, *76*, 459.
[6] J.-M. Lapierre, D. Seebach, K. Skobridis, *Helv. Chim. Acta* **1993**, *76*, 2419.
[7] D. Seebach, J.-M. Lapierre, G. Greiveldinger, K. Skobridis, *Helv. Chim. Acta* **1994**, *77*, 1673.
[8] P. K. Murer, J.-M. Lapierre, G. Greiveldinger, D. Seebach, *Helv. Chim. Acta* **1997**, *80*, 1648.
[9] P. Murer, D. Seebach, *Helv. Chim. Acta* **1998**, *81*, 603.
[10] P. B. Rheiner, H. Sellner, D. Seebach, *Helv. Chim. Acta* **1997**, *80*, 2027.
[11] T. Butz, P. Murer, D. Seebach, *Polym. Mat. Sci. Eng.* **1997**, *77*, 132.
[12] R. Filler, Y. Kobayashi, L. M. Yagupolskii, 'Organofluorine Compounds in Medicinal Chemistry and Biomedical Applications', Elsevier, Amsterdam-London-New York-Tokyo, 1993, p. 2.
[13] I. Ojima, J. R. McCarthy, J. T. W. (Eds.), *ACS Symposium Series 639*, 1996.
[14] J. G. Dingwall, 'Fluorine in Agriculture', Manchester UK, 1995.
[15] R. E. Banks, B. E. Smart, J. C. T. (Eds.), 'Organofluorine Chemistry', Plenum Press, New York-London, 1994.
[16] M. Gautschi, W. B. Schweizer, D. Seebach, *Chem. Ber.* **1994**, *127*, 565.
[17] D. Seebach, *Angew. Chem.* **1990**, *102*, 1363.
[18] V. Percec, G. Johansson, G. Ungar, J. Zhou, *J. Am. Chem. Soc.* **1996**, *118*, 9855.
[19] S. D. Hudson, H.-T. Jung, V. Percec, W.-D. Cho, G. Johansson, G. Ungar, V. S. K. Balagurusamy, *Science* **1997**, *278*, 449.

[20] M. W. P. L. Baars, E. W. Meijer, *Polym. Mat. Sci. Eng.* **1997**, *77*, 149.
[21] K. L. Wooley, C. A. Klug, K. Tasaki, J. Schaefer, *J. Am. Chem. Soc.* **1997**, *119*, 53.
[22] C. Klug, T. Kowalewski, J. Schaefer, T. Straw, K. Tasaki, K. Wooley, *Polym. Mat. Sci. Eng.* **1997**, *77*, 99.
[23] G. F. Grillot, S. Aftergut, S. Marmor, F. Carrock, *J. Org. Chem.* **1958**, *23*, 386.
[24] E. T. McBee, O. R. Pierce, D. D. Smith, *J. Am. Chem. Soc.* **1954**, *76*, 3722.
[25] M. Acs, C. von dem Bussche, D. Seebach, *Chimia* **1990**, *44*, 90.
[26] A. K. Beck, M. Gautschi, D. Seebach, *Chimia* **1990**, *44*, 291.
[27] M. Gautschi, D. Seebach, *Angew. Chem.* **1992**, *104*, 1061.
[28] W. Amberg, D. Seebach, *Chem. Ber.* **1990**, *123*, 2429.
[29] H. Feulner, G. Linti, H. Nöth, *Chem. Ber.* **1990**, *123*, 1841.

Received March 30, 1998