47. Glycosylidene Carbenes

Part 6

Synthesis of Alkyl and Fluoroalkyl Glycosides

by **Karin Briner** and **Andrea Vasella***

Organisch-chemisches Institut der Universität Zürich, Winterthurerstrasse 190, CH–8057 Zürich

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The syntheses of glycosides from the diazirine **1** and a range of alcohols under thermal and/or photolytic conditions are described. Yields and diastereoselectivities depend upon the pK_{HA} values of the alcohols, the solvent, and the reaction temperature. The glycosidation of weakly acidic alcohols (MeOH, EtOH, i-PrOH, and *t*-BuOH, 1 equiv. each) in CH_2Cl_2 at room temperature leads to the glycosides **2–5** in yields between 60 and 34% (*Scheme 1* and *Table 1*). At –70 to –60°, yields are markedly higher. In CH_2Cl_2, diastereoselectivities are very low. In THF, at –70 to –60°, however, glycosidation of i-PrOH leads to α-D-/β-D-**4** in a ratio of 8:92. More strongly acidic alcohols, such as CF_3CH_2OH, $(CF_3)_2CHOH$, and $(CF_3)_2C(Me)OH$, and the highly fluorinated long-chain alcohols $CF_3(CF_2)_5(CH_2)_2OH$ (**11**) and $CHF_2(CF_2)_9CH_2OH$ (**13**) react (CH_2Cl_2, r.t.) in yields between 73 and 85% and lead mainly to the β-D-glucosides β-D-**6** to β-D-**8**, β-D-**12**, and β-D-**14** (d.e. 14–68%). Yields and diastereoselectivities are markedly improved, when toluene, dioxane, 1,2-dimetoxyethane, or THF are used, as examined for the glycosidation of $(CF_3)_2C(Me)OH$, yielding (1,2-dimethoxyethane, 25°) 80% of α-D-/β-D-**8** in a ratio of 2:98 (d.e. 96%; *Table 4*). In EtCN, $(CF_3)_2C(Me)OH$ yields up to 55% of the imidate **10**. Glycosidation of di-*O*-isopropylidene-glucose **15** leads to **16** (CH_2Cl_2, r.t.; 65%, α-D/β-D = 33:67). That glycosidation occurs by initial protonation of the intermediate glycosylidene carbene is evidenced, for strongly acidic alcohols, by the formation of **10**, derived from the attack of $(CF_3)_2MeCO^-$ on an intermediate nitrilium ion (*Scheme 4*), and, for weakly acidic alcohols, by the formation of α-D-**9** and β-D-**9**, derived by attack of i-PrO^- on intermediate tetrahydrofuranylium ions. A working hypothesis is presented (*Scheme 3*). The diastereoselectivities are rationalized on the basis of a protonation in the σ plane of the intermediate carbene, the stabilization of the thereby generated ion pair by interaction with the BnO–C(2) group, with the solvent, and/or with the alcohol, and the final nucleophilic attack by RO^- in the π plane of the (solvated) oxonium ion.

Introduction. – We described a new glycosidation method, based on the generation of a glycosylidene carbene and its insertion into the O–H bond of phenols and alcohols [1–3]. The generation of glycosylidene carbenes by thermolysis or photolysis of diazirines[1]) does not require a promoter. This simplification of the reaction conditions should facilitate a systematic analysis of the glycosidation. In so far as the glycosyl acceptor reacts by protonating the glycosylidene carbene to form an ion pair, one expects an effect of the degree of acidity of the OH groups of a glycosyl acceptor on the course of the reaction, since both the protonation of the carbene and the reactivity of the ensuing ion pair are affected. This effect[2]) could be useful in solving the problem of regioselective glycosidation.

[1]) Photolysis of an *O*-acetylated glycosylidene diazide [4] gave a glycosylidene carbene – probably *via* an azidonitrene – of which the cycloaddition products to acrylonitrile were described [5]. For the preparation of *N*-tosylglyconolactone hydrazones as carbene precursors, see [6].

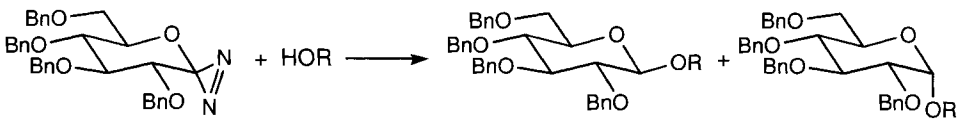
[2]) Depending upon the structure of a glycosylidene carbene, its basic (nucleophilic) or electrophilic properties may be more pronounced. The basic properties of the carbene derived from **1** appear to dominate its interaction with hydroxy compounds. Electrophilic properties may become important in the interaction of glycosylidene carbenes possessing strong acceptor substituents with weakly acidic and hence more nucleophilic alcohols. For leading references on the insertion of carbenes into the O–H bond of alcohols, see [7][8].

Glycosidation of phenols by glycosylidene-derived diazirines indeed proceeds well [2] [3]. It leads mainly to 1,2-*trans*-glycosides and appears to be hardly affected by steric hindrance of the phenolic OH group. The non-chelated OH group of methyl orsellinate is selectively glycosylated, evidencing the influence of (kinetic) acidity on the regioselectivity. Finally, the intermediacy of ion pairs is clearly indicated by the formation of *C*-aryl glycosides as by-products, resulting from a *Friedel-Crafts* alkylation of electron-rich phenols.

In the following, we report on the glycosidation of some model alcohols with the benzyl-protected D-*gluco*-diazirine **1**. We chose a range of alcohols which differ in their pK_{HA} values and the steric hindrance of their OH groups. In each case, the alcohol and **1** were used in equimolar or nearly equimolar amounts.

Results. – 1. *Glycosidation of MeOH, EtOH, i-PrOH, and* t-*BuOH with the Diazirine* **1** (see *Scheme 1* and *Table 1*). The thermal reactions of the diazirine **1** with MeOH, EtOH, i-PrOH, and *t*-BuOH in CH_2Cl_2 yielded 1:1 mixtures of the glucopyranosides α-D- and β-D-

Scheme 1



1 *b*-D *a*-D

2	R = Me	**7**	R = $(CF_3)_2CH$
3	R = Et	**8**	R = $(CF_3)_2C(Me)$
4	R = i-Pr	**9**	R = i-PrO$CH_2CH_2CH_2CH_2$
5	R = *t*-Bu	**12**	R = $CF_3(CF_2)_5CH_2CH_2$
6	R = CF_3CH_2	**14**	R = $CHF_2(CF_2)_9CH_2$

Table 1. *Glycosidation of Some Model Alcohols with the Diazirine* **1**

ROH	pK_{HA}	Conditions	Glycosides	Yield[a]) [%]	Ratio β-D/*a*-D (anal. method[b]))
MeOH	15.21 [9]	CH_2Cl_2, 25°	**2**	60	1:1 (HPLC)
EtOH	15.85 [9]	CH_2Cl_2, 25°	**3**	55	1:1 (HPLC)
i-PrOH	16.48 [9]	CH_2Cl_2, 25°	**4**	39	1:1 (^{1}H-NMR)
		CH_2Cl_2, –70 to –60°, *hν*	**4**	71	1:1 (^{1}H-NMR)
		THF, –70 to –60°, *hν*	**4**	60	92: 8 (^{1}H-NMR)
			+**9**	9	78:22 (^{1}H-NMR)
t-BuOH	16.54 [9]	CH_2Cl_2, 30°	**5**	34	1:1 (^{1}H-NMR)
		CH_2Cl_2, –70 to –60°, *hν*	**5**	55	1:1 (^{1}H-NMR)
CF_3CH_2OH	12.4 [18]	CH_2Cl_2, 25°	**6**	73	70:30 (HPLC)
$(CF_3)_2CHOH$	9.3 [18]	CH_2Cl_2, 25°	**7**	77	78:22 (HPLC)
$(CF_3)_2C(Me)OH$	9.6 [18]	CH_2Cl_2, 25°	**8**	74	84:16 (HPLC)

[a]) Total yield after FC. [b]) See *Exper. Part.*

2 [10] (60%), α-D- [11] and β-D-**3** [12] (55%), α-D- and β-D-**4** [13] [1] (39%), α-D- [14] and β-D-**5** [14] (34%), respectively. The by-products in the glycosidation of *t*-BuOH are mainly (lactone) azines and the tetrabenzylated 2-hydroxyglucal [15]. These decomposition products of **1** will be described separately [16]. Only traces of the glycosides α-D- and β-D-**5** were formed in 1,4-dioxane[3]).

Much better yields were obtained, when the carbene was generated at a lower temperature by photolysis. In CH_2Cl_2 at –70 to –60°, 71% of a 1:1 mixture of α-D- and β-D-**4** and 55% of a 1:1 mixture of α-D- and β-D-**5** were obtained, whereas photolysis at 25° gave the same results as the thermal reactions. Photolysis of **1** in the presence of i-PrOH in THF at –70° gave 60% of a 92:8 mixture of β-D- and α-D-**4** and 9% of a 78:22 mixture of β-D- and α-D-**9**.

The CI-MS of β-D-**9** shows $[M + NH_4]^+$ at *m/z* 672.7 as base peak. In the ^{1}H-NMR spectrum, H–C(1) resonates at 4.72 ppm with J = 7.8 Hz. The aglycon H-atoms H_A–C(1') and H_B–C(1') appear at 3.99 (*dt*) and 3.60–3.55 (*m*) ppm, CH_2(2') and CH_2(3') at 1.71–1.62 ppm, and the 2 geminal H–C(4') at 3.43 ppm as *t*. The i-Pr moiety gives rise to a *sept.* at 3.54 ppm and a *d* for the 2 equivalent Me groups at 1.15 ppm. C(1) resonates at 103.6 ppm. The side-chain C-atoms occur at 71.3 (Me_2CH), 69.7 (C(1')), 67.7 (C(4')), 22.8 and 22.6 (C(2') and C(3')), and 22.1 ppm (2 Me). The ^{1}H-NMR of α-D-**9** shows a *d* with J = 3.6 for H–C(1). The side-chain H-atoms H_A–C(1') and H_B–C(1') appear as *dt*'s at 3.66 and 3.44 ppm, CH_2(2') and CH_2(3') at 1.71–1.62 ppm, and the 2 geminal H–C(4') as a *t* at 3.43 ppm. The *sept.* of $CHMe_2$ occurs at 3.53 ppm and the 2 equivalent Me groups give rise to a *d* at 1.14 ppm.

2. *Glycosidation of CF_3CH_2OH, $(CF_3)_2CHOH$, and $(CF_3)_2C(Me)OH$ with the Diazirine* **1** (see *Scheme 1* and *Table 1*). The reaction of **1** with CF_3CH_2OH in CH_2Cl_2[4]) at 25° gave 73% of a 70:30 mixture of the glucopyranosides β-D- and α-D-**6**. Similarly, the diazirine **1** reacted with $(CF_3)_2CHOH$ in CH_2Cl_2 at 25° to yield 77% of a 78:22 mixture of β-D-**7** and α-D-**7**. Finally, glycosidation of $(CF_3)_2C(Me)OH$ with the diazirine **1** in CH_2Cl_2 at 25° afforded 74% of a 84:16 mixture of β-D- and α-D-**8**. The anomeric mixtures β-D-/α-D-**6** and β-D-/α-D-**7** were completely separated by chromatography, while β-D-/α-D-**8** could only be partially separated by MPLC. Selected ^{1}H- and ^{13}C-NMR data of the carbohydrate moieties of **6–8** are given in *Table 2*. In each case, the α-D-anomers of the fluoroalkyl glucopyranosides are more dextrarotatory than the β-D-glucopyranosides.

Table 2. *Selected ^{1}H-NMR* (400 MHz, $CDCl_3$) *and ^{13}C-NMR* (50 or 100 MHz, $CDCl_3$) *Data of* **6–8**, **12**, *and* **14** (chemical shifts δ [ppm] and coupling constants J [Hz])

	H–C(1)	*J*(1,2)	*H*–C(3)	*H*–C(5)	C(1)	C(2)	C(3)	C(5)
β-D-**6**	4.51	7.7	3.66–3.59	3.46	103.5	81.6	84.2	74.9
α-D-**6**	4.83	3.6	3.99	3.77	97.8	79.6	81.5	70.9
β-D-**7**	4.67	7.6	3.68–3.58	3.49	103.4	81.5	84.2	75.5
α-D-**7**	5.15	3.9	3.97	3.88	99.4	79.0	81.2	72.0
β-D-**8**	4.75	7.6	3.65	3.44	99.0	81.5	84.7	75.0
α-D-**8**	5.35	3.7	3.98	3.92	94.1	79.2	81.3	71.2
β-D-**12**	4.41	7.8	3.66–3.58	3.50–3.43	103.6	82.2	84.6	74.9
α-D-**12**	4.71	3.6	3.95	3.74	97.5	79.9	81.8	70.6
β-D-**14**	4.50	7.7	3.68–3.60	3.47	103.8	81.8	84.4	75.1
α-D-**14**	4.82	3.6	3.97	3.76	98.1	79.8	81.5	71.0

[3]) 1,4-Dioxane will be referred to as dioxane further on.

[4]) CH_2Cl_2 had been dried over CaH_2 in all cases. A 65:35 β-D/α-D mixture was obtained, when this reaction was run in CH_2Cl_2 which had been dried over P_2O_5.

The CF_3CH_2 group of β-D-**6**[5]) gives rise to 2 *dq*'s at 4.22 and 3.97 ppm for H_A–C(1') and H_B–C(1'), respectively. The 2 geminal H–C(1') of α-D-**6** are nearly chemically equivalent and appear in a system of higher order at 3.90 ppm. In the ^{13}C-NMR spectrum of β-D-**6**, C(1') appears as a *tq* at 65.83 ppm with ^2J(C,F) = 34.8 Hz. C(1') of α-D-**6** occurs as *tq* at 64.61 ppm with ^2J(C,F) = 34.9 Hz. In the spectra of both anomers, the *q*'s of CF_3 have a very low intensity (β-D-**6**: 123.7 ppm, ^1J(C,F) = 278 Hz; α-D-**6**: 123.8 ppm, ^1J(C,F) = 279 Hz).

In the ^{1}H-NMR spectrum of β-D- and α-D-**7**, the *m*'s of H–C(1') appear at 4.63–4.53 and 4.52–4.43 ppm, respectively. The ^{13}C-NMR spectrum of β-D-**7** shows a *dsept.* for C(1') at 72.32 ppm with ^2J(C,F) = 33.0 Hz. Again, the broad *q*'s of CF_3 at 121.7 and 120.8 ppm are weak (^1J(C,F) ≈ 285 Hz). In the ^{13}C-NMR spectrum of α-D-**7**, the *m* of C(1') at 72.87 ppm with ^2J(C,F) = 32.7 Hz is partially hidden by other signals. The broad *q*'s of the CF_3 groups at *ca.* 122 and 121 ppm with ^{1}J(C,F) *ca.* 285 Hz are hardly visible. In the ^{19}F-NMR spectrum of β-D-**7**, the 2 CF_3 groups give rise to 2 *m*'s at –73.19 and –73.39 ppm. In the corresponding ^{1}H-decoupled spectrum, both signals are simplified to *q*'s with ^4J(F,F) = 9.1 Hz. The ^{19}F-NMR spectrum of α-D-**7** shows 1 *m* from –72.71 to –72.80 ppm for the 2 CF_3 groups.

In the ^{1}H-NMR spectra of β-D- and α-D-**8**, the *s* of the Me group appears at 1.76 and 1.70 ppm, respectively. The ^{13}C-NMR spectrum of β-D-**8** shows a *q* at 12.14 ppm for Me. Part of the weak *sept.* of the quarternary C-atom of the $(CF_3)_2C$(Me) group is at 78.7 ppm with ^2J(C,F) ≈ 30 Hz, and the weak *q*'s of the CF_3 are at 123.1 and 122.3 ppm with ^1J(C,F) = 285 Hz. In the ^{19}F-NMR spectra, the *q*'s of the CF_3 groups appear at –78.60 and –77.68 ppm for β-D-**8** and at –76.84 and –77.34 ppm for α-D-**8** with ^4J(F,F) = 9.7 Hz.

3. *Influence of the Solvent on the Glycosidation of the Fluorinated Alcohols with the Diazirine* **1** (see *Tables 3* and *4*). *Koenigs-Knorr*-type glycosidations of the acidic (for pK_{HA} values [18], see *Table 1*) and thus less nucleophilic fluorinated alcohols are difficult [19] (see also [20]). In this respect, glycosidations by carbene precursors, such as **1**, are complementary to the *Koenigs-Knorr*-type glycosidations. Therefore, we studied the solvent dependence of the glycosidation of fluorinated short-chain alcohols (particularly of $(CF_3)_2C$(Me)OH) and of highly fluorinated long-chain alcohols.

Table 3. *Glycosidation of Some Fluorinated Alcohols with the Diazirine* **1** *in Dioxane at 25°*

ROH	Glycosides	Yield[a])[%]	Ratio β-D/α-D[b])
CF_3CH_2OH	**6**	74	77:23
$(CF_3)_2CHOH$	**7**	70	92: 8
$(CF_3)_2C$(Me)OH	**8**	74	95: 5
$CF_3(CF_2)_5CH_2CH_2OH$ (**11**)	**12**	68	76:24
$CHF_2(CF_2)_9CH_2OH$ (**13**)	**14**	79	78:22

[a]) Total yield after FC. [b]) Determined by HPLC.

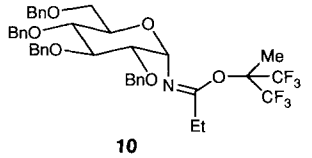
Table 4. *Solvent Dependence of the Glycosidation of* $(CF_3)_2C$*(Me)OH with the Diazirine* **1**

	CH_2Cl_2, 25°	Toluene, 25°	Dioxane, 25°	THF, 25°	DME[a]), 25°	EtCN, 25°	EtCN, *hν*, –60°
Yield of **8**[b]) [%]	75	74	76	73	80	54[c])	25[d])
Ratio β-D/α-D	84:16	91:9	95:5	96:4	98:2	90:10	87:13

[a]) 1,2-Dimethoxyethane. [b]) Total yield after FC. [c]) + 16% of imidate **10**. [d]) + 55% of imidate **10**.

[5]) 2',2',2'-Trifluoroethyl β-D-glucopyranoside and its tetraacetate were described in [17].

We examined the glycosidation of fluorinated alcohols with **1** in CH_2Cl_2 (*Table 1*) and in dioxane at 25° (*Table 3*). The glycosidation of $(CF_3)_2C(Me)OH$ was studied in several solvents (*Table 4*). Dioxane and toluene gave the best diastereoselectivities in the glycosidation of phenols [2]. Dioxane led to better diastereoselectivities also in the glycosidation of the fluorinated alcohols, favoring the β-D-anomers to an extent ranging from β-D/α-D 76:24 for alcohol **11** to 95:5 for $(CF_3)_2C(Me)OH$ (*Table 3*). Yields remained more or less the same as those obtained by using CH_2Cl_2. The best β-D-selectivities in the glycosidation of $(CF_3)_2C(Me)OH$ were obtained using the ethers 1,2-dimethoxyehane (DME), dioxane, and THF (*Table 4*). With EtCN as solvent, glycosidation at 25° yielded 16% of the *N*-(α-D-glucosyl)imidate **10** besides 54% of a 90:10 mixture of the glycosides β-D- and α-D-**8**. A similar result was obtained, when the carbene was photolytically generated at the same temperature (25°), while photolysis at –60° gave **10** as the main product in 55% yield, besides 25% of a 87:13 mixture of β-D- and α-D-**8**.



10

$CF_3(CF_2)_5CH_2CH_2OH$

11

$CHF_2(CF_2)_9CH_2OH$

13

The IR spectrum of the imidate **10** shows the absorption of the C=N stretching vibration at 1695 cm^{-1}. In the ^{1}H-NMR spectrum, H–C(1) gives a *d* at 5.12 ppm with $J(1,2) = 4.3$ Hz. H–C(3) resonates at 3.90 and H–C(5) at 3.92 ppm. The *s* of the $(CF_3)_2C(Me)$ group appears at 1.99 ppm. In the ^{13}C-NMR spectrum, the *s* of C=N is at 163.29 and the *d* of C(1) at 83.20 ppm. The Et residue gives rise to a *t* at 23.14 and to a *q* at 10.26 ppm. The *q* of CH_3–$C(CF_3)_2$ lies at 13.94 ppm. The ^{19}F-NMR spectrum shows a *q* for each CF_3 group at – 74.82 and at – 75.83 ppm, with $^4J(F,F) = 10.2$ Hz.

Glycosides of polyfluorinated long-chain alcohols (see *Scheme 1*) are of interest as surfactants in fluorocarbon emulsions serving as blood substitutes (see [19] and ref. cit. therein). The *Koenigs-Knorr* glycosidation of 3,3,4,4,5,5,6,6,7,7,8,8,8-tridecafluorooctan-1-ol (**11**) by tetra-*O*-acetylated glycopyranosyl bromides gave the corresponding orthoesters, which could be rearranged only to mixtures of the corresponding anomeric glycosides (α-D/β-D ratio in the range of 6:4 to 7:3) [19]. These results reflect the low nucleophilicity of highly fluorinated alcohols. The concomitant high acidity of these alcohols, particularly of **13**, where the OH group is separated from the polyfluoroalkyl moiety by only one CH_2 group, should be favorable for a glycosidation by the diazirine **1**. A correlation of the ^{1}H-NMR chemical-shift differences (*cf.* [18a]) of the OH protons of **11** and **13** in (D_6)DMSO and (D_6)benzene with those of CF_3CH_2OH, $(CF_3)_2CHOH$, and $(CF_3)_2C(Me)OH$ shows that the pK_{HA} value of **13** is similar to the one of CF_3CH_2OH[6]) and that **11** is less acidic than **13** by *ca.* 1–2 p*K* units.

Thus, glycosidation of **11**[7]) by **1** in dioxane at 25° afforded 68% of a 76:24 mixture of the glucosides β-D- and α-D-**12**, which were separated by FC (see *Scheme 1* and *Table 3*). Higher yields (85%), but a lower diastereoselectivity (57:43) were obtained in CH_2Cl_2. The glycosidation of **13** in dioxane at 25° led to 79% of a 78:22 mixture of β-D- and α-D-**14**, which were separated by MPLC.

[6]) $CHF_2CF_2CH_2OH$ has a pK_{HA} value of 12.74 [21].

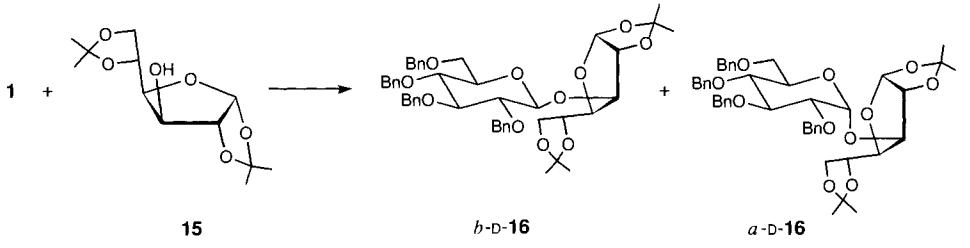
[7]) We thank *Hoechst AG*, Burgkirchen, Germany, for a generous gift of this alcohol.

Some characteristic NMR data of the pyranosyl ring of **12** and **14** are listed in *Table 2*. The fluoroalkyl chain of β-D-**12** gives rise to 2 *dt* at 4.19 and 3.85 ppm with $^4J(H,F) = 6.7$ and 7.1, respectively, due to the geminal H-atoms at C(1') and a *m* at 2.53–2.41 ppm due to CH_2(2'). The CH_2(1')-atoms of α-D-**12** resonate at 3.93 and 3.77–3.66 ppm, and the *m* of the CH_2(2')-atoms appears between 2.54 and 2.41 ppm. The ^{13}C-NMR of β-D-**12** shows a broad *t* at 61.51 ppm with $^3J(C,F) \approx 3.9$ Hz for C(1') and a *tt* at 31.67 ppm for C(2') with $^2J(C,F) \approx 21.6$ Hz. C(1') of α-D-**12** resonates at 59.94 ppm, for C(2') a *tt* is found at 31.26 ppm with $^2J(C,F) = 21.7$ Hz.

The signals of H–C(11') of β-D- and α-D-**14** are identical, appearing as *tt* at 6.06 ppm with $J(H,F) = 51.9$ and 5.1 Hz. The CH_2(1')-atoms of β-D-**14** occur as broad *q*'s at 4.38 and 4.04 ppm. In α-D-**14**, the CH_2(1')-atoms appear as 1 *m* at 4.09–3.89 ppm. C(1') of β-D-**14** is at 65.3 (*tt*, $J(C,F) = 25$ Hz) and C(1') of α-D-**14** at 64.3 ppm (*tt*, $J(C,F) = 25$ Hz). The ^{19}F-NMR spectra of β-D- and α-D-**14** show signals of 10 CF_2 groups between –120 and –138 ppm. The geminal F-atoms at C(11') occur as a broad *d* at –137.36 ppm in both anomers; the $^2J(H,F)$ values of 51.9 Hz confirm the values found in the corresponding ^{1}H-NMR spectra. A *quint.* with $J = 13$ Hz is found at –120.20 ppm for β-D-**14** and at –119.96 ppm for α-D-**14**; it is simplified to a *t* upon ^{1}H-decoupling. The F-substituted C-atoms are not detected in the ^{13}C-NMR spectra of β-D- and α-D-**12** and β-D- and α-D-**14**.

4. *Glycosidation of 1,2:5,6-Di-*O*-isopropylidene-α-*D*-glucofuranose* (**15**, *see Scheme 2*). The strong dependence of the glycosidation by **1** on the acidity of the glycosyl acceptor prompted us to examine the glycosidation of di-*O*-isopropylideneglucose **15**, which was used to probe various glycosidation procedures of the *Koenigs-Knorr* type [23–25]. The acidity of **15** is expected [22] to be between the one of the weakly and of the strongly acidic alcohols investigated above. Glycosidation of **15** by **1** in CH_2Cl_2 at 25° gave 65% of a 67:33 mixture of β-D- [23] and α-D-**16** [23] [24]. Under photolytic conditions at –80°, we obtained β-D- and α-D-**16** in 64% as a 60:40 mixture when CH_2Cl_2 was the solvent, while 73% of a 67:33 mixture were obtained, when toluene was used. The reaction in dioxane at 25° gave low yields and a vanishing diastereoselectivity. Similar observations were made for MeCN. Low yields were also reported for the glycosidation of **15** in MeCN with pent-4-enyl tetra-*O*-benzyl-D-glucopyranoside [25] and with the trichloroacetimidate of tetra-*O*-benzyl-α-D-glucopyranose [26].

Scheme 2



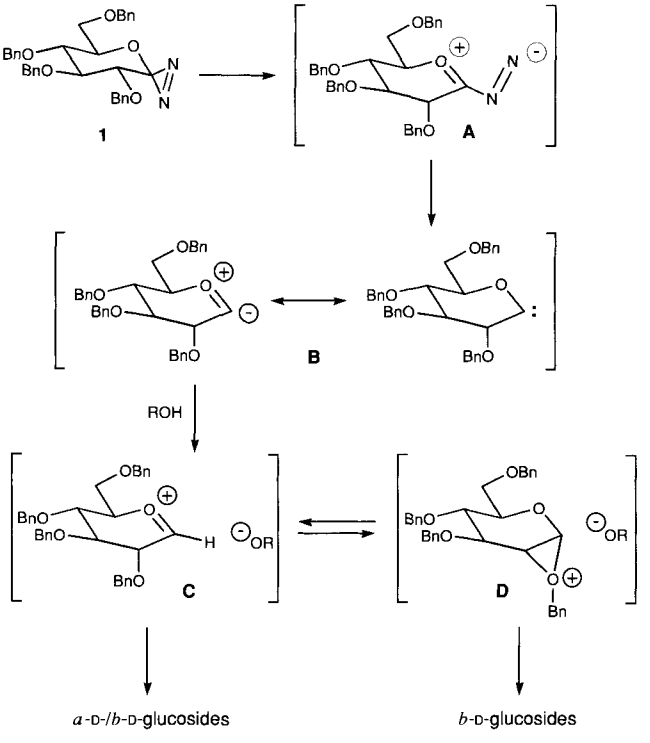
15 *b*-D-**16** *a*-D-**16**

Discussion. – The glycosidations of highly acidic and of relatively non-acidic alcohols by the diazirine **1** differ strongly with regard to their dependence on the reaction temperature, yields[8]), diastereoselectivity, and effect of the solvent. The glycosidation of strongly acidic

[8]) Note that the reaction of methoxyphenyldiazirine at 25° in CH_2=C(Me)CMe_2OH gave 42% of the corresponding acetal, whereas the reaction with CH_2=C(Me)CMe_2OOH (in much lower concentration) gave 80% of the corresponding O–H-insertion product [27] (*cf.* pK_{HA} value of *t*-BuOOH,12.8 [28]).

alcohols proceeds in good yields and gives predominantly β-D-anomers between –80 and +30°. These alcohols behave very similarly to phenols [2] and are apparently glycosylated by the same mechanism. The glycosidations of the weakly acidic alcohols show a strong dependence on the temperature. Poor yields are observed at r.t. At lower temperatures, yields are much higher, and the influence of the solvent on the diastereoselectivity is striking. In both cases, the results are consistent with the intermediate formation of a carbene. A working hypothesis is formulated in *Scheme* 3.

Scheme 3

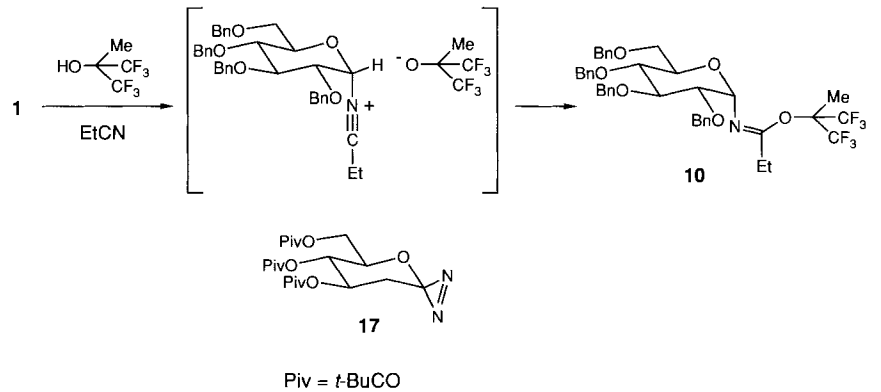


Thermolysis of the diazirine may occur stepwise and lead to a zwitterionic intermediate **A**, which loses N_2 to generate a carbene **B**. Rearrangements of diazirines to diazo compounds were described [29]. It is not clear, to which extent – if at all – a diazo-ether intervenes in the glycosidation. In any case, acid does not enhance the thermal decomposition of the diazirine **1**. Solutions of **1** in CH_2Cl_2 containing either no further reagent or $(CF_3)_2CHOH$ (1 equiv.) or $MeSO_3H$ (2 equiv.) did not show any decomposition after 3 h at –45°. In these experiments, only very little decomposition was detected after 12 h at –25°. After 3.5 h at 25°, **1** had decomposed in all cases. In some instances, the reaction mixtures were deeply yellow at the beginning of the reaction, but progressively lost their color. THF and dioxane solutions of **1** containing hydroperoxides gave rise to this color, which was, however, also observed sometimes in CH_2Cl_2.

The carbene **B** is protonated both by strongly and weakly acidic alcohols[9]). Reaction with the strongly acidic alcohols is much faster [32]. This explains that strongly acidic alcohols react with **1** under thermal conditions to give glycosides even in highly diluted solutions, where weakly acidic alcohols are no longer glycosylated.

Protonation leads to a series of intimate ion pairs (**C**) which differ from each other by the nature of RO^-. The ion pair **C** may be stabilized by intramolecular coordination of the oxonium ion with the C(2)-benzyloxy group (→ **D**), or – intermolecularly – by solvation. Intramolecular coordination leads to 1,2-*trans*-configurated glycosides, as is observed for fluorinated alcohols and for phenols [2]. Solvation by nucleophilic solvents in the glycosidation of acidic alcohols is evidenced by the formation of the imidate **10**. It is formed *via* an intermediate axial nitrilium ion (see *Scheme 4*), which is generated by the interaction of EtCN with the intermediate oxonium ion, and not by interaction with the carbene, as no ylide could be detected during laser flash photolysis of **1** in MeCN [32]. The imidate **10** is stable under the reaction conditions at r.t.; the higher yields in which it is formed at –60° reflects the increased selectivity at low temperatures for addition *vs.* substitution of the weakly nucleophilic alcoholate $(CF_3)_2C(Me)O^-$ (for similar observations, *cf.* [33][34]). The intramolecular interception of an axial nitrilium ion by a Zn alcoholate was postulated to account for the formation of a 5*H*-pyrano[2,3-*d*]oxazole from an 1,2-anhydropyranose [35]. Axial nitrilium ions were suggested as intermediates in *Koenigs-Knorr*-type glycosidations to rationalize the high β-D-selectivities which are often observed, in MeCN or EtCN, with glycosyl donors which do not possess a participating neighboring group [36] [26]. A similar interaction of dioxane, DME, or THF with the intermediate ion pair **C** would also explain the high β-D-selectivity which we observed for the glycosidation of the acidic alcohols in these solvents[10]). Strong and stereoselective interactions with these solvents, however, are

Scheme 4



[9]) For evidences for a protonation mechanism in O–H insertions of carbenes, see also [8] [30] [31].

[10]) There is evidence that secondary and tertiary fluorinated alcohols form stable (distillable or recrystallizable) 1:1 complexes with suitable H-bond acceptors such as THF [18a]. Such complexes may well be the reactive species in the glycosidation of fluorinated alcohols in these solvents, which would make the participation of the solvent entropically more favorable.

in contradiction to the results of the glycosidations by the 2-deoxy-3,4,6-tri-*O*-pivaloyl-D-glucopyranosylidene-derived diazirine **17**, where almost no diastereoselectivity was observed at 18°, when dioxane and toluene were the solvents [3][11]).

In the glycosidation of weakly acidic alcohols, protonation of the carbene is evidenced by the formation of α-D-/β-D-**9**, which are derived from intermediate tetrahydrofuranylium cations (*cf.* also [31]; for other THF ring-opening products in *Koenigs-Knorr*-type glycosidations see [38]). To rationalize the selectivity observed with i-PrOH in THF at low temperatures (→ **4** + **9**; see *Table 1*), we assume that oligomeric and hence more acidic alcohol protonates the carbene [32] [30], although it may be present in small concentrations only (*cf.* [39]). Protonation occurs in the σ plane of the carbene, while the ensuing attack of the alkoxide takes place in the π plane. Thus, it is not the protonating molecule which attacks, but one of the originally H-bonded neighboring molecules that *a priori* could be above or below the σ plane of the carbene. The newly generated oxonium ion can also be solvated by the nucleophilic solvent, of which the axial attack should be stereoelectronically favored. The thereby generated α-D-tetrahydrofuranylium ion is expected – based on the reverse anomeric effect [40] – to be more reactive than its anomer, which is also generated, as evidenced by the formation of β-D-**9**. The α-D-anomer is thus preferentially attacked by the alkoxide ion, leading to the β-D-glucoside (*e.g.* β-D-**4**). The 2-benzyloxy group cannot compete with the more nucleophilic solvent. In CH_2Cl_2, the oxonium ion is preferentially solvated by the weakly acidic and hence nucleophilic alcohol, competing with the 2-benzyloxy group.

We thank Mr. *M. Vöhler* and Mr. *D. Nanz* for their help with the NMR experiments and the *Swiss National Science Foundation* and *F. Hoffmann-La Roche AG*, Basel, for generous support.

Experimental Part

1. *General.* Evaporation of the solvent was performed under reduced pressure at or below 40°. Qual. TLC: 0.25-mm precoated silica-gel plates (*Merck*, silica gel *60* F_{254}) with the solvent systems indicated; detection by spraying the plates with 0.02M I_2 and 0.30M KI in 10% aq. H_2SO_4 soln. followed by heating at *ca.* 200°, or – for specific detection of the diazirines – with 2% 4-(4-nitrobenzyl)pyridine soln. in acetone and heating at 100° [41]. Flash chromatography (FC): silica gel *Merck 60* (0.040–0.063 mm). Medium-pressure liquid chromatography (MPLC): silica gel *Merck 60* (0.015–0.040 mm). High-performance liquid chromatography (HPLC): anal. *Merck-LiChrosorb-Si60* 250 × 4.0-mm cartridge (for the compounds **6–8**, **10**, **12**, and **14**) or *Zorbax-Sil* 250 × 4.6-mm column (for **2**, **3**, and **16**); prep. *Zorbax-Sil* 250 × 20-mm column. M.p.'s uncorrected. Optical rotations: 1-dm cell at 25° and 365, 436, 546, 578, and 589 nm; values at 589 nm were determined from a regression curve. IR spectra: 3% $CHCl_3$ soln. NMR spectra: chemical shifts in ppm rel. to TMS as internal standard for ^1H and ^{13}C and relative to $CFCl_3$ as external standard for ^{19}F[12]); in ambiguous cases, ^1H-NMR attributions by selective homonuclear decoupling experiments; ^{13}C-NMR attributions by ^1H,^{13}C-HMQC (^1H 400 MHz) of β-D- and α-D-**6** and **10** [43]. Mass spectra: chemical ionization (CI) (NH_3) at 70 eV.

[11]) α-D/β-D mixtures of 57:43 and of 60:40 were obtained with $(CF_3)_2CHOH$ in dioxane and in toluene, respectively [37]. A 2-(benzyloxy)oxonium ion is, however, less stable than the corresponding 2-deoxy-oxonium ion. Solvent interactions might thus be more important for the oxonium ion in **C** (*Scheme 3*) than for the oxonium ion that derives from the diazirine **17**, in spite of the different nature of the protecting groups.

[12]) At the measuring frequency of 565 MHz, $CFCl_3$ gives rise to 4 signals due to the two Cl-isotopes, of which the 3 most intense signals are observed [42]. The chemical shifts are referred to the central line.

2. *General Glycosidation Procedures.* 2.1. *Solvents and Reagents.* CH_2Cl_2 was distilled over CaH_2, 1,4-dioxane and THF over Na and benzophenone, 1,2-dimethoxyethane (DME) over CaH_2, toluene over NaH, and propiononitrile (EtCN) over P_2O_5 and K_2CO_3. MeOH, EtOH, and i-PrOH were distilled over Mg, and *t*-BuOH, CF_3CH_2OH, and $(CF_3)_2CHOH$ over Na. $(CF_3)_2C(Me)OH$ and $CF_3(CF_2)_5CH_2CH_2OH$ (**11**) were distilled (2×) and $CHF_2(CF_2)_9CH_2OH$ (**13**) was recrystallized from H_2O/MeOH and dried over blue silica gel under reduced pressure.

Glycosidations under Thermal Conditions. Under Ar, solid diazirine **1** was added to a soln. of the pre-dried alcohol (1.0–1.1 equiv.) in the indicated pre-dried solvent. The mixture was stirred at the indicated temp. After all **1** had disappeared, the mixture was processed as described below for each case.

Glycosidations under Photolytic Conditions. Under Ar, the pre-dried alcohol and the pre-dried solvent were added to the solid diazirine **1**. Under stirring, the mixture was then irradiated (*HPK-125-Philips* high-pressure Hg lamp, *Solidex* or *Jena* glass filter) at the temp. indicated. After disappearance of all **1**, the mixture was processed as described below for each case.

3. *Glycosidation of MeOH.* Reaction of **1** (300 mg, 0.54 mmol) with MeOH (25 µl, 0.62 mmol) in CH_2Cl_2 (5.5 ml) at 25° for 3 h gave, after FC (hexane /AcOEt 4:1), α-D-/β-D-**2** (182 mg, 60%; 1:1 by HPLC), which were separated by FC (hexane/AcOEt 6:1; identical anomer ratio before and after FC).

*Methyl 2,3,4,6-Tetra-*O*-benzyl-*α*-D-glucopyranoside* (α-D-**2**; see [10]). Anal. HPLC (hexane/AcOEt 4:1, 1.5 ml/min): t_R 5.3 min. R_f (hexane/AcOEt 2:1) 0.49. ^{1}H-NMR (400 MHz, $CDCl_3$): 7.37–7.26 (*m*, 18 arom. H); 7.15–7.11 (*m*, 2 arom. H); 4.98 (*d*, *J* = 10.8, 1 H, PhC*H*$_2$); 4.83 (*d*, *J* = 10.5, 1 H, PhC*H*$_2$); 4.82 (*d*, *J* = 10.8, 1 H, PhC*H*$_2$); 4.80 (*d*, *J* = 12.1, 1 H, PhC*H*$_2$); 4.67 (*d*, *J* =12.1, 1 H, PhC*H*$_2$); 4.63 (*d*, *J* = 3.6, H–C(1)); 4.61 (*d*, *J* = 12.1, 1 H, PhC*H*$_2$); 4.48 (*d*, *J* = 12.1, 1 H, PhC*H*$_2$); 4.46 (*d*, *J* = 10.7, 1 H, PhC*H*$_2$); 3.98 (*dd* ('*t*'), *J* = 9.3, H–C(3)); 3.74 (*m*, H–C(5)); 3.72 (*dd*, *J* = 3.6, 11.7, H_A–C(6)); 3.66–3.61 (*m*, H_B–C(6), H–C(4)); 3.56 (*dd*, *J* = 3.6, 9.6, H–C(2)); 3.38 (*s*, MeO).

*Methyl 2,3,4,6-Tetra-*O*-benzyl-*β*-D-glucopyranoside* (β-D-**2**; see [10]). Anal. HPLC (hexane/AcOEt 4:1, 1.5 ml/min): t_R 4.2 min. R_f (hexane/AcOEt 2:1) 0.54. ^{1}H-NMR (400 MHz, $CDCl_3$): 7.35–7.26 (*m*, 18 arom. H); 7.18–7.14 (*m*, 2 arom. H); 4.93 (*d*, *J* = 10.8, 1 H, PhC*H*$_2$); 4.92 (*d*, *J* = 10.7, 1 H, PhC*H*$_2$); 4.82 (*d*, *J* = 11.0, 1 H, PhC*H*$_2$); 4.79 (*d*, *J* = 11.1, 1 H, PhC*H*$_2$); 4.71 (*d*, *J* = 11.1, 1 H, PhC*H*$_2$); 4.63 (*d*, *J* = 12.2, 1 H, PhC*H*$_2$); 4.56 (*d*, *J* = 12.2, 1 H, PhC*H*$_2$); 4.53 (*d*, *J* = 10.7, 1 H, PhC*H*$_2$); 4.32 (*d*, *J* = 7.8, H–C(1)); 3.76 (*dd*, *J* = 1.9, 10.8, H_A–C(6)); 3.69 (*dd*, *J* = 4.7, 10.8, H_B–C(6)); 3.65 (*dd* ('*t*'), *J* = 8.7, H–C(3)); 3.60 (*dd* ('*t*'), *J* = 8.8, 9.3, H–C(4)); 3.59 (*s*, MeO); 3.47 (*ddd*, *J* = 1.9, 4.7, 9.3, H–C(5)); 3.44 (*dd* ('*t*'), *J* = 8.3, H–C(2)).

4. *Glycosidation of EtOH.* Reaction of **1** (100 mg, 0.18 mmol) with EtOH (11 µl, 0.19 mmol) in CH_2Cl_2 (1.5 ml) for 3 h at 25° gave, after FC (hexane/AcOEt 8:1), α-D-/β-D-**3** (7 mg, 55%; 1:1 by HPLC; identical anomer ratio before and after FC).

*Ethyl 2,3,4,6-Tetra-*O*-benzyl-*α*-D-glucopyranoside* (α-D-**3**; see [12]). Anal. HPLC (hexane/AcOEt 6:1, 1.5 ml/min): t_R 6.6 min. R_f (hexane/AcOEt 4:1) 0.25. ^{1}H-NMR (300 MHz, $CDCl_3$): 7.38–7.26 (*m*, 18 arom. H); 7.15–7.11 (*m*, 2 arom. H); 5.00 (*d*, *J* = 10.8, 1 H, PhC*H*$_2$); 4.83 (*d*, *J* = 10.7, 1 H, PhC*H*$_2$); 4.82 (*d*, *J* = 10.8, 1 H, PhC*H*$_2$); 4.80 (*d*, *J* = 12.2, 1 H, PhC*H*$_2$); 4.76 (*d*, *J* = 3.6, H–C(1)); 4.60–4.51 (*m*, 2 H, 2 PhC*H*$_2$); 4.47 (*d*, *J* = 12.3, 1 H, PhC*H*$_2$); 4.46 (*d*, *J* = 10.2, 1 H, PhC*H*$_2$); 4.01 (*dd* ('*t*'), *J* = 9.3, H–C(3)); 3.79 (*ddd*, *J* = 1.9, 3.3, 10.0, H–C(5)); 3.75–3.60 (*m*, 2 H–C(6), H_A–C(1'), H–C(4)); 3.56 (*dd*, *J* = 3.6, 9.6, H–C(2)); 3.52 (*dq*, *J* = 10.0, 7.0, H_B–C(1')); 1.25 (*t*, *J* = 7.0, Me).

*Ethyl 2,3,4,6-Tetra-*O*-benzyl-*β*-D-glucopyranoside* (β-D-**3**; see [12]). Anal. HPLC (hexane/AcOEt 6:1, 1.5 ml/min): t_R 5.5 min. R_f (hexane/AcOEt 4:1) 0.33. ^{1}H-NMR (300 MHz, $CDCl_3$): 7.38–7.26 (*m*, 18 arom. H); 7.18–7.14 (*m*, 2 arom. H); 4.97 (*d*, *J* = 10.9, 1 H, PhC*H*$_2$); 4.94 (*d*, *J* = 10.9, 1 H, PhC*H*$_2$); 4.84–4.77 (*m*, 2 H, 2 PhC*H*$_2$); 4.73 (*d*, *J* = 11.0, 1 H, PhC*H*$_2$); 4.62 (*d*, *J* = 12.2, 1 H, PhC*H*$_2$); 4.56 (*d*, *J* = 12.2, 1 H, PhC*H*$_2$); 4.52 (*d*, *J* = 10.7, 1 H, PhC*H*$_2$); 4.41 (*d*, *J* = 7.8, H–C(1)); 4.02 (*dq*, *J* = 9.5, 7.0, H_A–C(1')); 3.75 (*dd*, *J* = 2.0, 10.7, H_A–C(6)); 3.68 (*dd*, *J* = 4.6, 10.7, H_B–C(6)); 3.69–3.58 (*m*, H_B–C(1')); 3.65 (*t*, *J* = 8.8, H–C(3)); 3.58 (*t*, *J* = 8.8, H–C(4)); 3.50–3.44 (*m*, H–C(5)); 3.46 (*dd*, *J* = 7.8, 8.7, H–C(2)); 1.30 (*t*, *J* = 7.0, Me).

5. *Glycosidations of i-PrOH.* 5.1. *Thermal Conditions.* Reaction of **1** (100 mg, 0.18 mmol) with i-PrOH (15 µl, 0.19 mmol) in CH_2Cl_2 (1.5 ml) for 3 h at 25° yielded, after FC (hexane/AcOEt 10:1), α-D-/β-D-**4** (41.5 mg, 39%; 1:1 by ^{1}H-NMR (*d*'s of Me_2CH)). The anomeric mixture was separated by FC (CCl_4/CH_2Cl_2 1:1).

5.2 *Photolytic Conditions.* 5.2.1. Irradiation (*Solidex* filter) at –65° under Ar of a soln. of **1** (48 mg, 0.087 mmol) and i-PrOH (10 µl, 0.13 mmol) in CH_2Cl_2 (0.75 ml) for 20 min gave, after FC (hexane/AcOEt 10:1), α-D-/β-D-**4** 1:1 (36.3 mg, 71%).

5.2.2. Irradiation (*Solidex* filter) at –70° under Ar of a soln. of **1** (50 mg, 0.09 mmol) and i-PrOH (10 µl, 0.13 mmol) in THF (0.75 ml) for 1 h gave after FC (hexane/AcOEt 10:1), α-D-/β-D-**4** 8:92 (31.7 mg, 60%) and α-D-/β-D-**9** 22:78 (^{1}H-NMR (*d*'s of Me_2CH); 5.3 mg, 9%).

*Isopropyl 2,3,4,6-Tetra-*O*-benzyl-α and β-*D*-glucopyranoside* (α-D- and β-D-**4**) see [1][13].

*4'-(1''-Methylethoxy)butyl 2,3,4,6-Tetra-*O*-benzyl-β-*D*-glucopyranoside* (β-D-**9**). R_f (hexane/AcOEt 4:1) 0.29. $[\alpha]_D^{25}$ = +10.5 (*c* = 0.84, $CHCl_3$). IR: 3100*w*, 3070*w*, 3000*w*, 2970*m*, 2930*m*, 2880*m*, 1495*w*, 1455*m*, 1360*m*, 1335*w*, 1260*m*, 1150*m* (sh), 1120*s* (sh), 1090*s* (sh), 1070*s*, 1030*s*, 1010*m* (sh) 915*w*. ^{1}H-NMR (400 MHz, $CDCl_3$): 7.37–7.25 (*m*, 18 arom. H); 7.18–7.15 (*m*, 2 arom. H); 4.96 (*d*, *J* = 10.8, 1 H, PhCH_2); 4.93 (*d*, *J* = 10.9, 1 H, PhCH_2); 4.82 (*d*, *J* = 10.8, 1 H, PhCH_2); 4.79 (*d*, *J* = 10.9, 1 H, PhCH_2); 4.72 (*d*, *J* = 10.8, 1 H, PhCH_2); 4.62 (*d*, *J* = 12.2, 1 H, PhCH_2); 4.56 (*d*, *J* = 12.2, 1 H, PhCH_2); 4.54 (*d*, *J* = 10.8, 1 H, PhCH_2); 4.40 (*d*, *J* = 7.8, H–C(1)); 3.99 (*dt*, *J* = 9.6, 6.4, H_A–C(1')); 3.75 (*dd*, *J* = 2.0, 10.8, H_A–C(6)); 3.68 (*dd*, *J* = 4.8, 10.8, H_B–C(6)); 3.65 (*t*, *J* = 8.8, H–C(3)); 3.58 (*dd* ('*t*'), *J* = 8.8, 9.4, H–C(4)); 3.60–3.55 (*m*, H_B–C(1')); 3.54 (*sept.*, *J* = 6.2, Me_2CH); 3.46 (*ddd*, *J* = 3.7, 10.5, H–C(5)); 3.45 (*dd*, *J* = 7.8, 8.8, H–C(2)); 3.43 (*t*, *J* = 6.3, H_2C(4')); 1.71–1.62 (*m*, CH_2(2'), CH_2(3')); 1.15 (*d*, *J* = 6.2, 2 Me). ^{13}C-NMR (HMQC, ^{13}C 100 MHz, $CDCl_3$): 103.6 (C(1)); 84.8 (C(3)); 82.3 (C(2)); 78.0 (C(4)); 75.5 (PhCH_2); 74.9 (C(5), PhCH_2); 74.8 (PhCH_2); 73.4 (PhCH_2); 71.3 (Me_2CH); 69.7 (C(1')); 69.1 (C(6)); 67.7 (C(4')); 26.8, 26.6 (C(2'), C(3')); 22.1 (2 Me). MS: 672.7 (100, $[M + NH_4]^+$). Anal. calc. for $C_{41}H_{50}O_7$ (654.84): C 75.20, H 7.70; found: C 75.05, H 7.88.

*4'-(1''-Methylethoxy)butyl 2,3,4,6-Tetra-*O*-benzyl-α-*D*-glucopyranoside* (α-D-**9**). R_f (hexane/AcOEt 4:1) 0.28. ^{1}H-NMR (400 MHz, $CDCl_3$): 7.52–7.25 (*m*, 18 arom. H); 7.15–7.12 (*m*, 2 arom. H); 4.98 (*d*, *J* = 10.9, 1 H, PhCH_2); 4.83 (*d*, *J* = 10.8, 1 H, PhCH_2); 4.81 (*d*, *J* = 10.9, 1 H, PhCH_2); 4.77 (*d*, *J* = 12.0, 1 H, PhCH_2); 4.76 (*d*, *J* = 3.6, H–C(1)); 4.65 (*d*, *J* = 12.0, 1 H, PhCH_2); 4.60 (*d*, *J* = 12.1, 1 H, PhCH_2); 4.48 (*d*, *J* = 10.8, 1 H, PhCH_2); 4.47 (*d*, *J* = 12.1, 1 H, PhCH_2); 3.98 (*dd* ('*t*'), *J* = 9.2, H–C(3)); 3.77 (*ddd*, *J* = 2.0, 3.7, 10.0, H–C(5)); 3.72 (*dd*, *J* = 3.7, 10.5, H_A–C(6)); 3.66 (*dt*, *J* = 9.8, 6.6, H_A–C(1')); 3.63 (*dd* ('*t*'), *J* = 8.6, 10.0, H–C(4)); 3.62 (*dd*, *J* = 2.2, 10.5, H_B–C(6)); 3.55 (*dd*, *J* = 3.6, 9.6, H–C(2)); 3.53 (*sept.*, *J* = 6.0, Me_2CH); 3.44 (*dt*, *J* = 9.8, 6.4, H_B–C(1')); 3.41 (*t*, *J* = 6.2, CH_2(4')); 1.72–1.59 (*m*, CH_2(2'), CH_2(3')); 1.14 (*d*, *J* = 6.0, 2 Me).

6. *Glycosidations of* t-*BuOH* 6.1. *Thermal Conditions.* Reaction of **1** (100 mg, 0.18 mmol) with *t*-BuOH (18 µl, 0.19 mmol) in CH_2Cl_2 (1.5 ml) for 3 h at 25° yielded, after FC (hexane/AcOEt 10:1), α-D-/β-D-**5** 1:1 (37 mg, 34%; 1:1 by ^{1}H-NMR (*s* of *t*-Bu; H–C(5); H–C(3) of α-D, H–C(5) of β-D)); identical ratio before and after FC. The anomeric mixture was separated by FC (CCl_4/CH_2Cl_2 1:1).

6.2 *Photolytic Conditions.* Irradiation (*Solidex* filter) at –65° under Ar of a soln. of **1** (50 mg, 0.09 mmol) and *t*-BuOH (10 µl, 0.11 mmol) in CH_2Cl_2 (0.75 ml) for 20 min gave, after FC (hexane/AcOEt 10:1), α-D-/β-D-**5** 1:1 (29.8 mg, 55%).

tert-*Butyl 2,3,4,6-Tetra-*O*-benzyl-α-*D*-glucopyranoside* (α-D-**5**; see [14]). R_f (CCl_4/CH_2Cl_2 1:2) 0.23. ^{1}H-NMR (400 MHz, $CDCl_3$): 7.37–7.25 (*m*, 18 arom. H); 7.16–7.13 (*m*, 2 arom. H); 5.15 (*d*, *J* = 3.7, H–C(1)); 4.99 (*d*, *J* = 10.9, 1 H, PhCH_2); 4.84 (*d*, *J* = 10.6, 1 H, PhCH_2); 4.82 (*d*, *J* = 10.9, 1 H, PhCH_2); 4.73 (*d*, *J* = 11.7, 1 H, PhCH_2); 4.67 (*d*, *J* = 11.9, 1 H, PhCH_2); 4.64 (*d*, *J* = 12.2, 1 H, PhCH_2); 4.48 (*d*, *J* = 10.7, 1 H, PhCH_2); 4.46 (*d*, *J* = 12.2, 1 H, PhCH_2); 4.01 (*dd* ('*t*'), *J* = 9.2, H–C(3)); 3.98 (*ddd*, *J* = 2.1, 3.2, 10.0, H–C(5)); 3.77 (*dd*, *J* = 3.4, 10.5, H_A–C(6)); 3.67 (*dd*, *J* = 9.0, 10.0, H–C(4)); 3.60 (*dd*, *J* = 2.1, 10.5, H_B–C(6)); 3.54 (*dd*, *J* = 3.7, 9.6, H–C(2)); 1.27 (*s*, *t*-Bu).

tert-*Butyl 2,3,4,6-Tetra-*O*-benzyl-β-*D*-glucopyranoside* (β-D-**5**; see [14]). R_f (CCl_4/CH_2Cl_2 1:2) 0.15. ^{1}H-NMR (400 MHz, $CDCl_3$): 7.36–7.26 (*m*, 18 arom. H); 7.20–7.17 (*m*, 2 arom. H); 4.98 (*d*, *J* = 10.9, 1 H, PhCH_2); 4.92 (*d*, *J* = 10.9, 1 H, PhCH_2); 4.82 (*d*, *J* = 10.9, 1 H, PhCH_2); 4.78 (*d*, *J* = 10.9, 1 H, PhCH_2); 4.72 (*d*, *J* = 10.9, 1 H, PhCH_2); 4.58 (*d*, *J* = 7.7, H–C(1)); 4.62–4.52 (*m*, 3 H, 3 PhCH_2); 3.72 (*dd*, *J* = 1.9, 10.7, H_A–C(6)); 3.68–3.61 (*m*, H_B–C(6), H–C(3)); 3.53 (*t*, *J* = 9.7, H-C(4)); 3.46 (*ddd*, *J* = 1.9, 5.2, 9.8, H–C(5)); 3.43 (*dd*, *J* = 7.9, 9.1, H–C(2)); 1.33 (*s*, *t*-Bu).

7. *Glycosidations of* CF_3CH_2OH. Reaction of **1** (307 mg, 0.56 mmol) with CF_3CH_2OH (55.8 mg, 0.56 mmol) in CH_2Cl_2 (4.5 ml) for 3 h at 25° gave, after evaporation and FC (hexane/CH_2Cl_2 2:3) of the residue, β-D-/α-D-**6** (254.3 mg, 73%; 70:30 by HPLC). The anomeric mixture was separated by MPLC (hexane/CH_2Cl_2 2:3).

Analogous reaction of **1** (312 mg, 0.57 mmol) with CF_3CH_2OH (56.8 mg, 0.57 mmol) in dioxane (4.5 ml) at 25° afforded β-D-/α-D-**6** 77:23 (216 mg, 74%).

*2',2',2'-Trifluoroethyl 2,3,4,6-Tetra-*O*-benzyl-β-*D*-glucopyranoside* (β-D-**6**). Anal. HPLC (hexane/CH_2Cl_2 1:10, 1.5 ml/min): t_R 3.7 min. R_f (hexane/CH_2Cl_2 1:4) 0.23. M.p. 94–95°. $[\alpha]_D^{25}$ = +6.1 (*c* = 0.4, $CHCl_3$). IR: 3090*w*, 3060*w*, 3000*w*, 2950*w*, 2910*w*, 2870*m*, 1950*w*, 1875*w*, 1810*w*, 1600*w*, 1495*w*, 1450*w*, 1370*w*, 1305*m*, 1275*m*, 1160*s*, 1120*s* (sh), 1095*s* (sh), 1080*s* (sh), 1070*s*, 1030*m*, 965*w*, 910*w*, 690*w*, 660*w*. ^{1}H-NMR (400 MHz, $CDCl_3$):

7.37–7.25 (*m*, 18 arom. H); 7.17–7.14 (*m*, 2 arom. H); 4.94 (*d*, *J* = 11.0, 1 H, PhC*H*$_2$); 4.93 (*d*, *J* = 10.7, 1 H, PhC*H*$_2$); 4.82 (*d*, *J* = 11.0, 1 H, PhC*H*$_2$); 4.79 (*d*, *J* = 11.1, 1 H, PhC*H*$_2$); 4.69 (*d*, *J* =10.7, 1 H, PhC*H*$_2$); 4.61 (*d*, *J* = 12.2, 1 H, PhC*H*$_2$); 4.54 (*d*, *J* = 12.2, 1 H, PhC*H*$_2$); 4.52 (*d*, *J* = 11.0, 1 H, PhC*H*$_2$); 4.51 (*d*, *J* = 7.7, H–C(1)); 4.22 (*dq*, *J* = 12.3, 8.8, H$_A$–C(1')); 3.97 (*dq*, *J* = 12.3, 8.5, H$_B$–C(1')); 3.73 (*dd*, *J* = 2.2, 10.9, H$_A$–C(6)); 3.68 (*dd*, *J* = 4.4, 10.9, H$_B$–C(6)); 3.66–3.59 (*m*, H–C(3), H–C(4)); 3.51 (*dd*, *J* = 7.7, 9.0, H–C(2)); 3.46 (*ddd*, *J* = 2.2, 4.4, 9.5, H–C(5)). ^{13}C-NMR (50 MHz, $CDCl_3$): 138.41 (*s*, arom. C); 137.93 (*s*, 3 arom. C); 128.44–127.27 (*m*, arom. C); 123.67 (*q*, ^1J(C,F) = 278.3, CF_3); 103.51 (*d*, C(1)); 84.24 (*d*, C(3)); 81.61 (*d*, C(2)); 77.33 (*d*, C(4)); 75.54 (*t*, PhCH_2); 74.94 (*d*, C(5)); 74.88 (*t*, PhCH_2); 74.75 (*t*, PhCH_2); 73.36 (*t*, PhCH_2); 68.52 (*t*, C(6)); 65.83 (*tq*, ^2J(C,F) = 34.8, C(1')). Anal. calc. for $C_{36}H_{37}F_3O_6$ (622.68): C 69.44, H 5.99, F 9.15; found: C 69.51, H 5.81, F 9.09.

*2',2',2'-Trifluoroethyl 2,3,4,6-Tetra-O-benzyl-α-*D*-glucopyranoside* (α-D-**6**). Anal. HPLC (hexane/CH_2Cl_2 1:10, 1.5 ml/min): t_R 2.5 min. R_f (hexane/CH_2Cl_2 1:4) 0.28. $[\alpha]_D^{25}$ = +31.9 (*c* = 1.0, $CHCl_3$). IR: 3090*w*, 3070*w*, 3040*w*, 3000*m*, 2960*m*, 2920*m*, 2870*m*, 1955*w*, 1880*w*, 1815*w*, 1600*w*, 1495*w*, 1450*m*, 1360*m*, 1280*s*, 1260*s*, 1140*s*, 1080*s* , 1045*s*, 1030*s*, 970*m*, 920*w*, 860*m*, 695*m* , 665*m*. ^{1}H-NMR (400 MHz, $CDCl_3$): 7.38–7.26 (*m*, 18 arom. H); 7.16–7.13 (*m*, 2 arom. H); 4.99 (*d*, *J* = 10.9, 1 H, PhC*H*$_2$); 4.85 (*d*, *J* = 10.7, 1 H, PhC*H*$_2$); 4.83 (*d*, *J* = 3.6, H–C(1)); 4.82 (*d*, *J* = 11.0, 1 H, PhC*H*$_2$); 4.81–4.78 (*d*, 1 H, PhC*H*$_2$); 4.65 (*d*, *J* =12.0, 1 H, PhC*H*$_2$); 4.60 (*d*, *J* = 12.1, 1 H, PhC*H*$_2$); 4.49 (*d*, *J* = 10.7, 1 H, PhC*H*$_2$); 4.48 (*d*, *J* = 12.1, 1 H, PhC*H*$_2$); 3.99 (*dd* ('*t*'), J = 9.3, H–C(3)); 3.93–3.88 (*m*, CH_2(1')); 3.77 (*ddd*, *J* = 1.8, 3.5, 10.0, H–C(5)); 3.73 (*dd*, *J* = 3.6, 10.5, H$_A$–C(6)); 3.66 (*m*, H–C(4)); 3.65–3.61 (*m*, H$_B$–C(6)); 3.60 (*dd*, *J* = 3.6, 9.6, H–C(2)). ^{13}C-NMR (50 MHz, $CDCl_3$): 138.66 (*s*, arom. C); 138.01 (*s*, 2 arom. C); 137.70 (*s*, arom. C); 128.43–127.57 (*m*, arom. C); 123.8 (*q*, ^1J(C,F) = 279, CF_3); 97.75 (*d*, C(1)); 81.52 (*d*, C(3)); 79.63 (*d*, C(2)); 77.18 (*d*, C(4)); 75.72 (*t*, PhCH_2); 75.11 (*t*, PhCH_2); 73.46 (*t*, PhCH_2); 73.27 (*t*, PhCH_2); 70.88 (*d*, C(5)); 68.11 (*t*, C(6)); 64.61 (*tq*, ^2J(C,F) = 34.9, C(1')).

8. *Glycosidations of 1,1,1,3,3,3-Hexafluoropropan-2-ol.* Reaction of **1** (50 mg, 0.09 mmol) with $(CF_3)_2CHOH$ (18 mg, 0.11 mmol) in CH_2Cl_2 (0.8 ml) for 3h at 25° gave, after evaporation and FC (hexane/AcOEt 10:1) of the residue, β-D-/α-D-**7** (48 mg, 76.5%; 78:22 by HPLC). The anomeric mixture was completely separated by FC (CCl_4/CH_2Cl_2 3:2).

Analogously, reaction of **1** (100 mg, 0.18 mmol) with $(CF_3)_2CHOH$ (31 mg, 0.18 mmol) in dioxane (1.5 ml) at 25° for 3 h gave, after FC, β-D-/α-D-**7** 92:8 (87.8 mg, 70%).

*2',2',2'-Trifluoro-1'-(trifluoromethyl)ethyl 2,3,4,6-Tetra-O-benzyl-β-*D*-glucopyranoside* (β-D-**7**). Anal. HPLC (hexane/AcOEt 12:1, 1.5 ml/min.): t_R 8.7 min. R_f (CCl_4/CH_2Cl_2 1:1) 0.10. $[\alpha]_D^{25}$ = +4.2 (*c* = 0.4, $CHCl_3$). IR: 3090*w*, 3070*w*, 3040*w*, 3010*w*, 2910*m*, 2870*m*, 1955*w*, 1880*w*, 1810*w*, 1600*w*, 1495*w*, 1455*w*, 1400*w* (sh), 1365*s*, 1290*s*, 1265*m*, 1190*m*, 1150*s* (sh), 1100*s*, 1030*m*, 900*m*, 875*w*, 680*w* (br.). ^{1}H-NMR (400 MHz, $CDCl_3$): 7.40–7.27 (*m*, 18 arom. H); 7.22–7.17 (*m*, 2 arom. H); 4.92 (*d*, *J* = 11.0, 1 H, PhC*H*$_2$); 4.91 (*d*, *J* = 10.6, 1 H, PhC*H*$_2$); 4.82 (*d*, *J* = 11.1, 1 H, PhC*H*$_2$); 4.79 (*d*, *J* = 11.2, 1 H, PhC*H*$_2$); 4.68 (*d*, *J* =10.6, 1 H, PhC*H*$_2$); 4.67 (*d*, *J* = 7.6, H–C(1)); 4.63–4.53 (*m*, 4 H, H–C(1'), 3 PhC*H*$_2$); 3.73 (*dd*, *J* = 2.0, 11.0, H$_A$–C(6)); 3.67 (*dd*, *J* = 4.8, 11.0, H$_B$–C(6)); 3.68–3.58 (*m*, H–C(3), H–C(4)); 3.54 (*dd*, *J* = 7.6, 8.7, H–C(2)); 3.49 (*ddd*, *J* = 2.0, 4.8, 9.5, H–C(5)). ^{13}C-NMR (50 MHz, $CDCl_3$): 138.40 (*s*, arom. C); 138.07 (*s*, arom. C); 137.85 (*s*, arom. C); 137.67 (*s*, arom. C); 128.40–127.46 (*m*, arom. C); 121.70 (br. *q*, ^1J(C,F) ≈ 285, CF_3); 120.80 (br. *q*, ^1J(C,F) ≈ 285, CF_3); 103.40 (*d*, C(1)); 84.18 (*d*, C(3)); 81.49 (*d*, C(2)); 77.19 (*d*, C(4)); 75.69 (*t*, PhCH_2); 75.46 (*d*, C(5)); 75.05 (*t*, 2 PhCH_2); 73.42 (*t*, PhCH_2); 72.32 (*dsept.*, ^2J(C,F) = 33.0, C(1')); 68.53 (*t*, C(6)). ^{19}F-NMR (564.6 MHz, $CDCl_3$): –73.19 (*m*, CF_3); –73.39 (*m*, CF_3); ^{19}F-NMR (^{1}H-decoupled): –73.19 (*q*, ^4J(F,F) = 9.1, CF_3); –73.39 (*q*, ^4J(F,F) = 9.1, CF_3). Anal. calc. for $C_{37}H_{36}F_6O_6$ (690.68): C 64.34, H 5.25, F 16.50; found: C 64.51, H 5.36, F 16.38.

*2',2',2'-Trifluoro-1'-(trifluoromethyl)ethyl 2,3,4,6-Tetra-O-benzyl-α-*D*-glucopyranoside* (α-D-**7**). Anal. HPLC (hexane/AcOEt 12:1, 1.5 ml/min): t_R 10.0 min. R_f (CCl_4/CH_2Cl_2 1:1) 0.18. $[\alpha]_D^{25}$ = +35.6 (*c* = 0.4, $CHCl_3$). IR: 3090*w*, 3070*w*, 3010*w*, 2930*m*, 2870*m*, 1955*w*, 1880*w*, 1815*w*, 1605*w*, 1590*w*, 1495*w*, 1455*m*, 1395*w* (sh), 1370*s*, 1330*w*, 1290*s*, 1265*m*, 1190*m*, 1160*s*, 1140*m*, 1105*s*, 1070*s*, 1040*s*, 1030*s*, 1005*m*, 940*w*, 900*m*, 870*w*, 690*m*, 630*w*. ^{1}H-NMR (400 MHz, $CDCl_3$): 7.35–7.27 (*m*, 18 arom. H); 7.16–7.13 (*m*, 2 arom. H); 5.15 (*d*, *J* = 3.9, H–C(1)); 4.97 (*d*, *J* = 10.8, 1 H, PhC*H*$_2$); 4.84 (*d*, *J* = 10.7, 1 H, PhC*H*$_2$); 4.83 (*d*, *J* = 10.8, 1 H, PhC*H*$_2$); 4.71 (*s*, 2 H, PhC*H*$_2$); 4.61 (*d*, *J* =12.1, 1 H, PhC*H*$_2$); 4.50 (*d*, *J* = 10.7, 1 H, PhC*H*$_2$); 4.46 (*d*, *J* = 12.1, 1 H, PhC*H*$_2$); 4.52–4.43 (*m*, H–C(1')); 3.97 (*dd* ('*t*'), *J* = 9.4, H–C(3)); 3.88 (*m*, *J* ≈ 2.5, 10.0, H–C(5)); 3.77 (*dd*, *J* = 3.1, 10.8, H$_A$–C(6)); 3.71 (*t*, *J* = 9.8, H–C(4)); 3.65 (*dd*, *J* = 3.9, 9.9, H–C(2)); 3.61 (*dd*, *J* = 2.1, 10.8, H$_B$–C(6)); ^{13}C-NMR (100 MHz, $CDCl_3$): 138.63 (*s*, arom. C); 138.04 (*s*, arom. C); 137.72 (*s*, arom. C); 137.65 (*s*, arom. C); 128.42–127.61 (*m*, arom. C); *ca.* 122 (br. *q*, very low intensity, ^1J(C,F) ≈ 285, CF_3); 121 (br. *q*, very low intensity, ^1J(C,F) ≈ 285, CF_3); 99.44 (*d*, C(1)); 81.20 (*d*, C(3)); 79.00 (*d*, C(2)); 77.00 (*d*, C(4)); 75.73 (*t*, PhCH_2); 75.24 (*t*, PhCH_2); 73.56 (*t*, PhCH_2); 73.36 (*t*, PhCH_2); 72.87 (*dsept.*, partially observed, ^2J(C,F) = 32.7, C(1')); 71.97 (*d*, C(5)); 67.92 (*t*, C(6)). ^{19}F-NMR (564.6 MHz, $CDCl_3$): –72.71 to –72.80 (*m*, 2 CF_3).

9. *Glycosidation of 1,1,1,3,3,3-Hexafluoro-2-methylpropan-2-ol in CH_2Cl_2 and Dioxane.* Reaction of **1** (30 mg, 0.05 mmol) with $(CF_3)_2C(Me)OH$ (11 mg, 0.06 mmol) in CH_2Cl_2 (0.45 ml) for 3 h at 25° gave, after evaporation and FC (hexane/CH_2Cl_2 1:1) of the residue, β-D-/α-D-**8** (28.4 mg, 74%; 84:16 by HPLC). The anomeric mixture could only partially be separated by MPLC (hexane/CH_2Cl_2 1:1).

Analogous reaction of **1** (30 mg, 0.054 mmol) and $(CF_3)_2C(Me)OH$ (12 mg, 0.066 mmol) in dioxane (0.45 ml) at 25° for 3 h gave, after FC, 76% of β-D-/α-D-**8** 95:5.

*2',2',2'-Trifluoro-1'-methyl-1'-(trifluoromethyl)ethyl 2,3,4,6-Tetra-*O*-benzyl-β-D-glucopyranoside* (β-D-**8**). Anal. HPLC (hexane/CH_2Cl_2 1:2, 1.5 ml/min): t_R 3.9 min. R_f (hexane/CH_2Cl_2 1:5) 0.52. M.p. 83°. $[\alpha]_D^{25}$ = +18.5 (c = 0.15, $CHCl_3$). IR: 3090*w*, 3060*w*, 3040*w*, 3000*w*, 2900*m*, 2860*m*, 1950*w*, 1810*w*, 1495*w*, 1450*w*, 1380*w* (sh), 1355*m*, 1300*m*, 1140*s* (sh), 1125*s* (sh), 1075*s*, 1030*m*, 1000*m*, 950*w*, 905*w*, 870*w*. ^{1}H-NMR (400 MHz, $CDCl_3$): 7.36–7.25 (*m*, 18 arom. H); 7.20–7.17 (*m*, 2 arom. H); 4.91 (*d*, J = 11.1, 1 H, PhCH_2); 4.90 (*d*, J = 10.6, 1 H, PhCH_2); 4.81 (*d*, J = 10.9, 1 H, PhCH_2); 4.78 (*d*, J = 11.1, 1 H, PhCH_2); 4.75 (*d*, J = 7.6, H-C(1)); 4.67 (*d*, J = 10.6, 1 H, PhCH_2); 4.58 (*d*, J = 12.3, 1 H, PhCH_2); 4.56 (*d*, J = 10.9, 1 H, PhCH_2); 4.53 (*d*, J = 12.3, 1 H, PhCH_2); 3.66 (*dd*, J = 2.1, 10.8, H_A–C(6)); 3.65 (*t*, J = 8.8, H–C(3)); 3.61 (*m*, H_B–C(6)); 3.57 (*dd* ('*t*'), J = 9.2, 9.5, H–C(4)); 3.54 (*dd*, J = 7.6, 9.1, H–C(2)); 3.44 (*ddd*, J = 2.1, 5.3, 9.6, H–C(5)); 1.76 (*s*, Me). ^{13}C-NMR (50 MHz, $CDCl_3$): 138.42 (*s*, arom. C); 138.09 (*s*, arom. C); 137.90 (*s*, arom. C); 137.82 (*s*, arom. C); 128.33–127.29 (*m*, arom. C); 99.00 (*d*, C(1)); 84.67 (*d*, C(3)); 81.55 (*d*, C(2)); 77.42 (*d*, C(4)); 75.69 (*t*, PhCH_2); 75.13 (*t*, PhCH_2); 75.01 (*d*, C(5)); 74.94 (*t*, PhCH_2); 73.33 (*t*, PhCH_2); 68.67 (*t*, C(6)); 12.14 (*q*, Me); additional signals in the amplified spectrum: 123.1 (*q*, J = 285, CF_3); 122.3 (*q*, J = 285, CF_3); 78.7 (*m*, J = 30, $(CF_3)_2$CMe). ^{19}F-NMR (564.6 MHz, $CDCl_3$): –76.80 (*q*, ^4J(F,F) = 9.7, CF_3); –77.68 (*q*, ^4J(F,F) = 9.7, CF_3). Anal. calc. for $C_{38}H_{38}F_6O_6$ (704.705): C 64.77, H 5.43, F 16.18; found: C 65.00, H 5.50, F 16.05.

*2',2',2'-Trifluoro-1'-methyl-1'-(trifluoromethyl)ethyl 2,3,4,6-Tetra-*O*-benzyl-α-D-glucopyranoside* (α-D-**8**). Anal. HPLC (hexane/CH_2Cl_2 1:2, 1.5 ml/min): t_R 3.5 min. R_f (hexane/CH_2Cl_2 1:5) 0.57. $[\alpha]_D^{25}$ = +38.1 (c = 0.5, $CHCl_3$). IR: 3090*w*, 3070*w*, 3040*w*, 3010*w*, 2960*m*, 2930*m*, 2870*m*, 1955*w*, 1810*w*, 1730*w*, 1495*w*, 1455*w*, 1395*w* (sh), 1365*w*, 1325*m*, 1305*m*, 1260*m*, 1165*s* (sh), 1140*s* (sh), 1125*s* (sh), 1105*s*, 1045*s*, 1085*s*, 1030*s*, 1010*s*, 910*w*, 870*w*, 690*w*. ^{1}H-NMR (400 MHz, $CDCl_3$): 7.38–7.23 (*m*, 18 arom. H); 7.15–7.12 (*m*, 2 arom. H); 5.35 (*d*, J = 3.7, H–C(1)); 4.95 (*d*, J = 10.8, 1 H, PhCH_2); 4.83 (*d*, J = 10.7, 1 H, PhCH_2); 4.81 (*d*, J = 10.8, 1 H, PhCH_2); 4.69 (*s*, 2 H, PhCH_2); 4.61 (*d*, J = 12.1, 1 H, PhCH_2); 4.48 (*d*, J = 10.7, 1 H, PhCH_2); 4.44 (*d*, J = 12.1, 1 H, PhCH_2); 3.98 (*dd* ('*t*'), J = 9.4, H–C(3)); 3.92 (*m*, H–C(5)); 3.75 (*dd*, J = 3.5, 10.7, H_A–C(6)); 3.64 (*dd* ('*t*'), J = 9.8, 9.4, H–C(4)); 3.59 (*dd*, J = 3.7, 9.8, H–C(2)); 3.61–3.56 (*m*, H_B–C(6)); 1.70 (*s*, Me). ^{13}C-NMR (50 MHz, $CDCl_3$): 138.62 (*s*, arom. C); 138.04 (*s*, arom. C); 137.84 (*s*, arom. C); 137.74 (*s*, arom. C); 128.37–127.51 (*m*, arom. C); 94.14 (*d*, C(1)); 81.34 (*d*, C(3)); 79.21 (*d*, C(2)); 77.22 (*d*, C(4)); 75.65 (*t*, PhCH_2); 75.19 (*t*, PhCH_2); 73.45 (*t*, PhCH_2); 73.39 (*t*, PhCH_2); 71.16 (*d*, C(5)); 68.07 (*t*, C(6)); 12.45 (*q*, Me). ^{19}F-NMR (564.6 MHz, $CDCl_3$): – 76.84 (*q*, ^4J(F,F) = 9.7, CF_3); –77.34 (*q*, ^4J(F,F) = 9.7, CF_3).

10. *Glycosidations of 1,1,1,3,3,3-Hexafluoro-2-methylpropan-2-ol in Propiononitrile.* 10.1. Reaction of **1** (60 mg, 0.11 mmol) with $(CF_3)_2C(Me)OH$ (20 mg, 0.11 mmol) in EtCN (0.9 ml) at 25° gave β-D-/α-D-**8** 90:10 (41.5 mg, 54%) and the α-D-imidate **10** (13 mg, 16%).

10.2. Irradiation (*Solidex* or *Jena* glass filter) of a mixture of **1** (300 mg, 0.54 mmol) and $(CF_3)_2C(Me)OH$ (100 mg, 0.55 mmol) in EtCN under Ar at –60° for 30 min gave, after FC (hexane/CH_2Cl_2 1:1), the α-D-imidate **10** (228 mg, 55%) and β-D-/α-D-**8** 87:13 (96 mg, 25%).

N-*(2,3,4,6-Tetra-*O*-benzyl-α-D-glucopyranosyl)-*O*-[2',2',2'-trifluoro-1'-methyl-1'-(trifluoromethyl)ethyl]-propanimidate* (**10**). Anal. HPLC (hexane/CH_2Cl_2 1:2, 1.5 ml/min): t_R 5.3 min. R_f (hexane/CH_2Cl_2 1:5) 0.46. $[\alpha]_D^{25}$ = +61.1 (c = 0.5, $CHCl_3$). IR: 3090*w*, 3070*w*, 3000*w*, 2930*w*, 2870*w*, 1955*w*, 1875*w*, 1810*w*, 1695*m*, 1500*w*, 1455*m*, 1385*w* (sh), 1360*m*, 1305*s*, 1295*m* (sh), 1280*m* (sh), 1145*s*, 1120*s*, 1090*s*, 1070*s* (sh), 1030*m*, 1000*m*, 960*w*, 910*w*, 880*w*, 865*w*, 695*m*, 665*w*. ^{1}H-NMR (400 MHz, $CDCl_3$): 7.33–7.25 (*m*, 18 arom. H); 7.19–7.16 (*m*, 2 arom. H); 5.12 (*d*, J = 4.3, H–C(1)); 4.86 (*d*, J = 10.9, 1 H, PhCH_2); 4.85 (*d*, J = 11.1, 1 H, PhCH_2); 4.81 (*d*, J = 10.9, 1 H, PhCH_2); 4.79 (*d*, J = 11.9, 1 H, PhCH_2); 4.62 (*d*, J = 11.2, 1 H, PhCH_2); 4.59 (*d*, J = 12.0, 1 H, PhCH_2); 4.52 (*d*, J = 11.1, 1 H, PhCH_2); 4.45 (*d*, J = 12.1, 1 H, PhCH_2); 3.92 (*ddd*, J = 2.0, 3.5, 10.0, H–C(5)); 3.90 (*t*, J = 9.3, H–C(3)); 3.72–3.66 (*m*, H–C(2), H–C(4), H_A–C(6)); 3.58 (*dd*, J = 2.0, 10.7, H_B–C(6)); 2.31–2.14 (*m*, CH_3CH_2); 1.99 (*s*, $(CF_3)_2$CMe); 1.05 (*t*, J = 7.5, CH_3CH_2). ^{13}C-NMR (50 MHz, $CDCl_3$): 163.29 (*s*, C=N); 138.58 (*s*, arom. C); 138.47 (*s*, arom. C); 138.30 (*s*, arom. C); 137.94 (*s*, arom. C); 128.28–127.49 (*m*, arom. C); 83.20 (*d*, C(1)); 82.47 (*d*, C(3)); 80.64 (*d*, C(2)); 78.11 (*d*, C(4)); 75.40 (*t*, PhCH_2); 74.80 (*t*, PhCH_2); 73.64 (*t*, PhCH_2); 73.36 (*t*, PhCH_2); 71.82 (*d*, C(5)); 68.72 (*t*, C(6)); 23.14 (*t*, CH_3CH_2); 13.94 (*q*, $(CF_3)_2$CMe); 10.26 (*q*, CH_3CH_2). ^{19}F-NMR (564.6 MHz, $CDCl_3$): –74.32 (*q*, ^4J(F,F) = 10.2, CF_3); –75.33 (*q*, ^4J(F,F) = 10.2, CF_3). Anal. calc. for $C_{41}H_{43}F_6NO_6$ (759.78): C 64.81, H 5.70, F 15.00, N 1.84; found: C 64.98, H 5.90, F 14.85, N 1.74.

11. *Glycosidation of 3,3,4,4,5,5,6,6,7,7,8,8,8-Tridecafluorooctan-1-ol* (**11**). Reaction of **1** (464 mg, 0.84 mmol) with $CF_3(CF_2)_5CH_2CH_2OH$ (**11**; 324 mg, 0.88 mmol) in CH_2Cl_2 (7.5 ml) at 35° for 2 h gave, after FC (hexane/CH_2Cl_2 1:1), β-D-/α-D-**12** 5(641 mg, 85%; 57:43 by HPLC).

Analogous reaction of **1** (530 mg, 0.96 mmol) and **11** (340 mg, 0.92 mmol) in dioxane (8 ml) at 25° for 4 h gave, after FC (hexane/CH_2Cl_2 1:1), β-D-/α-D-**12** 75:25 (554 mg, 68%) which was separated by FC (hexane/CH_2Cl_2 3:1).

3',3',4',4',5',5',6',6',7',7',8',8',8'-Tridecafluorooctyl 2,3,4,6-Tetra-O-benzyl-β-D-glucopyranoside (β-D-**12**). Anal. HPLC (hexane/CH_2Cl_2 1:2, 1.5 ml/min): t_R 7.7 min. R_f (hexane/CH_2Cl_2 1:2) 0.22. M.p. 73–74°. IR: 3090*w*, 3070*w*, 3000*w*, 2950*w* (sh), 2910*w*, 2870*m*, 1950*w*, 1810*w*, 1600*w*, 1495*w*, 1450*w*, 1355*m*, 1305*w*, 1140*s*, 1120*s*, 1090*s* (sh), 1065*s*, 1030*s*, 1010*s* (sh), 950*w*, 910*w*, 860*w*, 690*w*, 660*w*. ^{1}H-NMR (400 MHz, $CDCl_3$): 7.34–7.21 (*m*, 18 arom. H); 7.18–7.14 (*m*, 2 arom. H); 4.93 (*d*, *J* = 11.0, 1 H, PhC*H*$_2$); 4.87 (*d*, *J* = 11.1, 1 H, PhC*H*$_2$); 4.82 (*d*, *J* = 10.8, 1 H, PhC*H*$_2$); 4.80 (*d*, *J* = 10.9, 1 H, PhC*H*$_2$); 4.72 (*d*, *J* = 11.1, 1 H, PhC*H*$_2$); 4.61 (*d*, *J* = 12.2, 1 H, PhC*H*$_2$); 4.54 (*d*, *J* = 12.2, 1 H, PhC*H*$_2$); 4.53 (*d*, *J* = 10.7, 1 H, PhC*H*$_2$); 4.41 (*d*, *J* = 7.8, H–C(1)); 4.20 (*dt*, *J* = 10.2, 6.7, H_A–C(1')); 3.86 (*dt*, *J* = 10.2, 7.1, H_B–C(1')); 3.73 (*dd*, *J* = 2.0, 10.7, H_A–C(6)); 3.68 (*dd*, *J* = 4.6, 10.7, H_B–C(6)); 3.66–3.58 (*m*, H–C(3), H–C(4)); 3.50–3.43 (*m*, H–C(5), H–C(2)); 2.53–2.40 (*m*, CH_2(2')). ^{13}C-NMR (50 MHz, $CDCl_3$): 138.54 (*s*, arom. C); 138.38 (*s*, arom. C); 138.07 (*s*, arom. C); 138.02 (*s*, arom. C); 128.36–127.49 (*m*, arom. C); 103.60 (*d*, C(1)); 84.60 (*d*, C(3)); 82.16 (*d*, C(2)); 77.68 (*d*, C(4)); 75.61 (*t*, PhC*H*$_2$); 74.91 (*d* and *t*, C(5), PhC*H*$_2$); 74.80 (*t*, PhC*H*$_2$); 73.41 (*t*, PhC*H*$_2$); 68.71 (*t*, C(6)); 61.51 (br. *t*, ^3J(C,F) ≈ 3.9, C(1')); 31.67 (*tt*, ^2J(C,F) ≈ 21.6, C(2')).

3',3',4',4',5',5',6',6',7',7',8',8',8'-Tridecafluorooctyl 2,3,4,6-Tetra-O-benzyl-α-D-glucopyranoside (α-D-**12**). Anal. HPLC (hexane/CH_2Cl_2 1:2, 1.5 ml/min): t_R 5.3 min. R_f (hexane/CH_2Cl_2 1:2) 0.25. IR: 3090*w*, 3060*w*, 3030*w*, 3000*m*, 2920*m*, 2870*m*, 1955*w*, 1875*w*, 1815*w*, 1750*w*, 1605*w*, 1590*w*, 1495*w*, 1450*m*, 1360*s*, 1315*m*, 1240*s* (sh), 1160*s* (sh), 1145*s*, 1120*s*, 1090*s* (sh), 1070*s*, 1050*s*, 1025*s*, 1005*s*, 950*w*, 910*m*, 840*w*, 690*m*. ^{1}H-NMR (400 MHz, $CDCl_3$): 7.37–7.26 (*m*, 18 arom. H); 7.15–7.12 (*m*, 2 arom. H); 4.97 (*d*, *J* = 10.9, 1 H, PhC*H*$_2$); 4.83 (*d*, *J* = 10.7, 1 H, PhC*H*$_2$); 4.82 (*d*, *J* = 10.9, 1 H, PhC*H*$_2$); 4.81 (*d*, *J* = 12.0, 1 H, PhC*H*$_2$); 4.71 (*d*, *J* = 3.6, H–C(1)); 4.62 (*d*, *J* = 12.0, 1 H, PhC*H*$_2$); 4.60 (*d*, *J* = 12.1, 1 H, PhC*H*$_2$); 4.48 (*d*, *J* = 10.7, 1 H, PhC*H*$_2$); 4.47 (*d*, *J* = 12.1, 1 H, PhC*H*$_2$); 3.95 (*dd* ('*t*'), *J* = 9.4, H–C(3)); 3.93 (*dt*, *J* = 10.2, 7.2, H_A–C(1')); 3.74 (*m*, *J* = 1.7, 3.7, 9.9, H–C(5)); 3.73–3.66 (*m*, H_A–C(6), H_B–C(1')); 3.66–3.60 (*m*, H–C(4), H_B–C(6)); 3.57 (*dd*, *J* = 3.6, 9.6, H–C(2)); 2.54–2.41 (*m*, CH_2(2')). ^{13}C-NMR (50 MHz, $CDCl_3$): 138.71 (*s*, arom. C); 138.12 (*s*, arom. C); 138.08 (*s*, arom. C); 137.77 (*s*, arom. C); 132.8–108.0 (several *m* of low intensity, CF_3 and several CF_2); 128.44–127.57 (*m*, arom. C); 97.50 (*d*, C(1)); 81.84 (*d*, C(3)); 79.93 (*d*, C(2)); 77.51 (*d*, C(4)); 75.71 (*t*, PhC*H*$_2$); 75.09 (*t*, PhC*H*$_2$); 73.53 (*t*, PhC*H*$_2$); 73.45 (*t*, PhC*H*$_2$); 70.56 (*d*, C(5)); 68.29 (*t*, C(6)); 59.94 (*tt*, ^3J(C,F) ≈ 3.8, C(1')); 31.26 (*tt*, ^2J(C,F) ≈ 21.7, C(2')).

12. *Glycosidation of 2,2,3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,11,11-Icosafluoroundecan-1-ol* (**13**). Reaction of **1** (509 mg, 0.92 mmol) and $CHF_2(CF_2)_9CH_2OH$ (**13**, 491 mg, 0.92 mmol) in dioxane (7.5 ml) at 25° for 3 h yielded, after FC (hexane/CH_2Cl_2 1:1), β-D-/α-D-**14** (775 mg, 79%; 78:22 by HPLC) which was separated by MPLC (hexane/CH_2Cl_2 1:1).

2,2,3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,11,11-Icosafluoroundecyl 2,3,4,6-Tetra-O-benzyl-β-D-glucopyranoside (β-D-**14**). Anal. HPLC (hexane/CH_2Cl_2 1:1, 1.5 ml/min): t_R 7.8 min. R_f (hexane/CH_2Cl_2 1:2) 0.27. $[\alpha]_D^{25}$ = +2.4 (*c* = 1.0, $CHCl_3$). IR ($CHCl_3$): 3090*w*, 3070*w*, 3010*w*, 2970*w*, 2910*w*, 2870*m*, 1955*w*, 1875*w*, 1815*w*, 1600*w*, 1495*w*, 1455*m*, 1400*w*, 1360*m*, 1305*w*, 1260*s*, 1170*m*, 1070*s*, 910*w*, 860*w*, 695*m*. ^{1}H-NMR (400 MHz, $CDCl_3$): 7.35–7.26 (*m*, 18 arom. H); 7.17–7.14 (*m*, 2 arom. H); 6.06 (*tt*, ^2J(H,F) = 51.9, ^3J(H,F) = 5.1, CHF_2(11')), 4.94 (*d*, *J* = 11.0, 1 H, PhC*H*$_2$); 4.91 (*d*, *J* = 10.7, 1 H, PhC*H*$_2$); 4.82 (*d*, *J* = 10.9, 1 H, PhC*H*$_2$); 4.79 (*d*, *J* = 11.0, 1 H, PhC*H*$_2$); 4.69 (*d*, *J* = 10.7, 1 H, PhC*H*$_2$); 4.61 (*d*, *J* = 12.3, 1 H, PhC*H*$_2$); 4.55 (*d*, *J* = 12.3, 1 H, PhC*H*$_2$); 4.54 (*d*, *J* = 10.8, 1 H, PhC*H*$_2$); 4.50 (*d*, *J* = 7.7, H–C(1)); 4.38 (br. *q*, *J* ≈ 13.5, H_A–C(1')); 4.04 (br. *q*, *J* ≈ 13.5, H_B–C(1')); 3.73 (*dd*, *J* = 2.2, 10.8, H_A–C(6)); 3.69 (*dd*, *J* = 4.5, 10.8, H_B–C(6)); 3.68–3.60 (*m*, H–C(3), H–C(4)); 3.51 (*dd* ('*t*'), *J* = 7.7, 8.9, H–C(2)); 3.47 (*ddd*, *J* = 2.2, 4.5, 9.3, H–C(5)). ^{13}C-NMR (50 MHz, $CDCl_3$): 138.47 (*s*, arom. C); 137.96 (*s*, 3 arom. C); 128.37–127.47 (*m*, arom. C); 103.76 (*d*, C(1)); 84.35 (*d*, C(3)); 81.75 (*d*, C(2)); 77.43 (*d*, C(4)); 75.72 (*t*, PhC*H*$_2$); 75.10 (*d*, C(5)); 75.06 (*t*, PhC*H*$_2$); 74.90 (*t*, PhC*H*$_2$); 73.48 (*t*, PhC*H*$_2$); 68.58 (*t*, C(6)); 65.31 (*tt*, *J*(C,F) = 25, CH_2(1')). ^{19}F-NMR (564.6 MHz, $CDCl_3$): –120.2 (*quint.*, *J* = 13.0, CF_2); –122.1 (*s*, 3 CF_2); –122.3 (br. *s*, 2 CF_2); –123.5 (*s*, CF_2); –123.7 (*s*, CF_2); –129.6 (br. *s*, CF_2); –137.4 (*d*, *J* = 51.8, CHF_2). ^{19}F-NMR (^{1}H-decoupled): –120.2 (*t*, *J* = 13.0, CF_2); –137.4 (*s*, *J* = 51.8, CHF_2).

2,2,3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,11,11-Icosafluoroundecyl 2,3,4,6-Tetra-O-benzyl-α-D-glucopyranoside (α-D-**14**). Anal. HPLC (hexane/CH_2Cl_2 1:1, 1.5 ml/min): t_R 5.6 min. R_f (hexane/CH_2Cl_2 1:2) 0.32. $[\alpha]_D^{25}$ = +26.1 (*c* = 0.8, $CHCl_3$). IR: 3100*w*, 3070*w*, 3040*w*, 3010*w*, 2930*m*, 2870*m*, 1955*w*, 1870*w*, 1810*w*, 1730*w*, 1495*w*,

1455*m*, 1400*w*, 1360*m*, 1225*s* (sh), 1150*s*, 1085*s* (sh), 1070*s*, 1050*s*, 1030*s*, 930*m*, 910*m* (sh), 850*m*, 800–700*s* (br.), 660*s*. ^{1}H-NMR (400 MHz, $CDCl_3$): 7.36–7.25 (*m*, 18 arom. H); 7.16–7.13 (*m*, 2 arom. H); 6.06 (*tt*, ^2J(H,F) = 51.9, ^3J(H,F) = 5.1, CHF_2(11')); 4.97 (*d*, *J* = 10.9, 1 H, PhC*H*$_2$); 4.84 (*d*, *J* = 11.0, 1 H, PhC*H*$_2$); 4.82 (*d*, *J* = 3.6, H–C(1)); 4.81 (*d*, *J* = 10.9, 1 H, PhC*H*$_2$); 4.77 (*d*, *J* = 12.0, 1 H, PhC*H*$_2$); 4.63(*d*, *J* = 12.0, 1 H, PhC*H*$_2$); 4.59 (*d*, *J* = 12.1, 1 H, PhC*H*$_2$); 4.49 (*d*, *J* = 10.8, 1 H, PhC*H*$_2$); 4.47 (*d*, *J* = 12.1, 1 H, PhC*H*$_2$); 4.09–3.89 (*m*, CH_2(1')); 3.97 (*dd* ('*t*'), *J* = 9.3, H–C(3)); 3.76 (*ddd*, *J* = 2.0, 3.7, 10.1, H–C(5)); 3.72 (*dd*, *J* = 3.7, 10.5, H_A–C(6)); 3.76–3.61 (*m*, H–C(4), H_B–C(6)); 3.60 (*dd*, *J* = 3.6, 9.6, H–C(2)). ^{13}C-NMR (50 MHz, $CDCl_3$): 138.69 (*s*, arom. C); 138.13 (*s*, arom. C); 138.08 (*s*, arom. C); 137.7 (*s*, arom. C); 128.37–127.59 (*m*, arom. C); 98.14 (*d*, C(1)); 81.47 (*d*, C(3)); 79.83 (*d*, C(2)); 77.20 (*d*, C(4)); 75.72 (*t*, PhCH_2); 75.13 (*t*, PhCH_2); 73.49 (*t*, PhCH_2); 73.24 (*t*, PhCH_2); 71.02 (*d*, C(5)); 68.58 (*t*, C(6)); 64.3 (*tt*, *J*(C,F) = 25, H_2C(1')). ^{19}F-NMR (564.6 MHz, $CDCl_3$): –120.0 (*quint.*, *J* = 13.0, CF_2); –122.1 (*s*, 3 CF_2); –122.2 (*s* , CF_2); –122.3 (*s* , CF_2); –123.5 (*s*, CF_2); –123.7 (*s*, CF_2); –129.6 (br. *s*, CF_2); –137.4 (*d*, *J* = 51.8, CHF_2); ^{19}F-NMR (^{1}H-decoupled): –120.0 (*t*, *J* = 13.0, CF_2); –137.4 (*s*, *J* = 51.8, CHF_2).

13. *Glycosidations of 1,2:5,6-Di-*O*-isopropylidene-*α*-*D*-glucofuranoside* (**15**). 13.1. Reaction of **1** (190 mg, 0.345 mmol) and **15** (90 mg, 0.346 mmol) in CH_2Cl_2 (dried over P_2O_5, 4 ml) at 25° for 2.5 h gave, after evaporation of the solvent and FC (hexane/AcOEt 8:1), *β*-D-/*α*-D-**16** 66:34 (HPLC). The anomers were separated by prep. HPLC (hexane/AcOEt 3:1, 16 ml/min).

13.2. Irradiation (*Jena* glass filter) of a mixture of **1** (300 mg, 0.5 mmol) and **15** (14 mg, 0.55 mmol) in CH_2Cl_2 under Ar at –80° for 30 min yielded, after FC, *β*-D-/*α*-D-**16** 60:40 (27.5 mg, 64%).

*1,2:5,6-Di-*O*-isopropylidene-3-*O*-(2,3,4,6-tetra-*O*-benzyl-β-D-glucopyranosyl)-α-D-glucofuranoside* (*β*-D-**16** [23]). Anal. HPLC (hexane/AcOEt 2:1, 1.5 ml/min): t_R 3.4 min. ^{1}H-NMR (400 MHz, $CDCl_3$): 7.35–7.25 (*m*, 18 arom. H); 7.21–7.16 (*m*, 2 arom. H); 5.77 (*d*, *J* = 3.8, H–C(1)); 4.91 (*d*, *J* = 11.0, 1 H, PhC*H*$_2$); 4.83 (*d*, *J* = 11.0, 1 H, PhC*H*$_2$); 4.82 (*d*, *J* = 11.0, 1 H, PhC*H*$_2$); 4.74 (*s*, PhC*H*$_2$); 4.62 (*d*, *J* = 12.1, 1 H, PhC*H*$_2$); 4.59 (*d*, *J* = 10.4, 1 H, PhC*H*$_2$); 4.56 (*d*, *J* = 12.1, 1 H, PhC*H*$_2$); 4.50 (*d*, *J* = 3.8, H–C(2)); 4.47 (*d*, *J* = 7.9, H–C(1')); 4.44 (*dt*, *J* = 4.7, 6.3, H–C(5)); 4.39 (*dd*, *J* = 3.1, 4.6, H–C(4)); 4.36 (*d*, *J* = 3.2, H–C(3)); 4.08 (*d*, *J* = 6.3, CH_2(6)); 3.72 (*d*, *J* = 3.1, CH_2(6')); 3.68–3.61 (*m*, H–C(3'), H–C(4')); 3.44 (*m*, H–C(5')); 3.39 (*dd*, *J* = 7.8, 9.1, H–C(2')); 1.49, 1.43, 1.32, 1.25 (4 *s*, 4 Me).

*1,2:5,6-Di-*O*-isopropylidene-3-*O*-(2,3,4,6-tetra-*O*-benzyl-α-D-glucopyranosyl)-α-D-glucofuranoside* (*α*-D-**16**, [23] [24]). Anal. HPLC (hexane/AcOEt 2:1, 1.5 ml/min): t_R 3.3 min. ^{1}H-NMR (400 MHz, $CDCl_3$): 7.36–7.26 (*m*, 18 arom. H); 7.15–7.12 (*m*, 2 arom. H); 5.88 (*d*, *J* = 3.6, H–C(1)); 5.25 (*d*, *J* = 3.6, H–C(1')); 4.97 (*d*, *J* = 10.9, 1 H, PhC*H*$_2$); 4.84 (*d*, *J* = 11.8, 1 H, PhC*H*$_2$); 4.81 (*d*, *J* = 11.0, 1 H, PhC*H*$_2$); 4.76 (*d*, *J* = 11.8, 1 H, PhC*H*$_2$); 4.70 (*d*, *J* = 11.8, 1 H, PhC*H*$_2$); 4.68 (*d*, *J* = 3.6, H–C(2)); 4.62 (*d*, *J* = 12.1, 1 H, PhC*H*$_2$); 4.50 (*d*, *J* = 12.1, 1 H, PhC*H*$_2$); 4.51–4.45 (*m*, H–C(5)); 4.47 (*d*, *J* = 10.9, 1 H, PhC*H*$_2$); 4.24 (*d*, *J* = 2.8, H–C(3)); 4.19 (*dd*, *J* = 2.8, 8.0, H–C(4)); 4.06 (*d*, *J* = 5.5, CH_2(6)); 3.95 (*dd* ('*t*'), *J* = 9.3, H–C(3')); 3.81 (br. *dt*, *J* = 10.0, 3.0, H–C(5')); 3.73–3.70 (*m*, CH_2(6')); 3.62 (*dd*, *J* = 9.1, 9.8, H–C(4')); 3.57 (*dd*, *J* = 3.6, 9.8, H–C(2')); 1.49, 1.42, 1.26, 1.24 (4 *s*, 4 Me).

REFERENCES

[1] K. Briner, A. Vasella, *Helv. Chim. Acta* **1989**, *72*, 1371.
[2] K. Briner, A. Vasella, *Helv. Chim. Acta* **1990**, *73*, 1764.
[3] A. Vasella, *Pure Appl. Chem.* **1991**, *63*, 507.
[4] J.-P. Praly, Z. El Kharraf, G. Descotes, *J. Chem. Soc., Chem. Commun.* **1990**, 431.
[5] J.-P. Praly, Z. El Kharraf, G. Descotes, *Tetrahedron Lett.* **1990**, *31*, 4441.
[6] S. E. Mangholz, A. Vasella, *Helv. Chim. Acta* **1991**, *74*, 2100.
[7] X.-M. Du, H. Fan, J. L. Goodman, M. A. Kesselmayer, K. Krogh-Jespersen, A. LaVilla, R. A. Moss, S. Shen, R. S. Sheridan, *J. Am. Chem. Soc.* **1990**, *112*, 1920.
[8] W. Kirmse, G. Hömberger, *J. Am. Chem. Soc.* **1991**, *113*, 3925; W. Kirmse, J. Kilian, S. Steenken, *ibid.* **1990**, *112*, 6399; W. Kirmse, K. Kund, *J. Org. Chem.* **1990**, *55*, 2325; M. T. H. Liu, R. Subramanian, *J. Chem. Soc., Perkin Trans. 2* **1988**, 15; R. A. Moss, S. Shen, M. Wlostowski, *Tetrahedron Lett.* **1988**, *29*, 6417; H. Tomioka, N. Hayashi, T. Sugiura, Y. Izawa, *J. Chem. Soc., Chem. Commun.* **1986**, 1364; S. Oikawa, M. Tsuda, *J. Am. Chem. Soc.* **1985**, *107*, 1940; J. J. Zupancic, P. B. Grasse, S. C. Lapin, G. B. Schuster, *Tetrahedron* **1985**, *41*, 1471; M. T. H. Liu, R. Subramanian, *J. Chem. Soc., Chem. Commun.* **1984**, 1062; P. M. Warner, I.-S. Chu, *J. Am. Chem. Soc.* **1984**, *106*, 5366; W. Kirmse, P. Van Chiem, P. G. Henning, *ibid.* **1983**, *105*, 1695; H. Tomioka, S. Suzuki, Y. Izawa, *ibid.* **1982**, *104*, 1047; D. Bethell, R. D. Howard, *J. Chem. Soc. (B)* **1969**, 745; W. Kirmse, *Liebigs Ann. Chem.* **1963**, *666*, 9.
[9] W. Reeve, C. M. Erikson, P. F. Aluotto, *Can. J. Chem.* **1979**, *57*, 2747.
[10] T. Iwashige, H. Saeki, *Chem. Pharm. Bull.* **1967**, *15*, 1803; S. N. Dhawan, T. L. Chick, W. J. Goux, *Carbohydr. Res.* **1988**, *172*, 297.
[11] R. R. Schmidt, J. Michel, *J. Org. Chem.* **1981**, *46*, 4787.
[12] F. Weygand, H. Ziemann, *Liebigs Ann. Chem.* **1962**, *657*, 179.
[13] Y. Ito, T. Ogawa, *Tetrahedron Lett.* **1987**, *28*, 4701.
[14] D. Qui, Y. Wang, M. Cai, *Synth. Commun.* **1989**, *19*, 3453.
[15] R. Betz, Ph. D. Thesis, University of Konstanz, 1984; R. R. Schmidt, R. Preuss, R. Betz, *Tetrahedron Lett.* **1987**, *28*, 6591.
[16] K. Briner, A. Vasella, in preparation.
[17] R. D. Poretz, I. J. Goldstein, *Biochemistry* **1970**, *9*, 2890.
[18] a) W. J. Middleton, R. V. Lindsey, Jr., *J. Am. Chem. Soc.* **1962**, *86*, 4948; b) R. Filler, R. M. Schure, *J. Org. Chem.* **1967**, *32*, 1217.
[19] J. Greiner, A. Manfredi, J. G. Riess, *Nouv. J. Chim.* **1989**, *13*, 247; J. Greiner, A. Milius, J. G. Riess, *Tetrahedron Lett.* **1988**, *29*, 2193.
[20] P. J. Garegg, P. Konradsson, I. Kvarnström, T. Norberg, S. C. T. Svensson, B. Wigilius, *Acta Chem. Scand., Ser. B* **1985**, *39*, 569.
[21] P. Ballinger, F. A. Long, *J. Am. Chem. Soc.* **1960**, *82*, 795.
[22] D. D. Perrin, B. Dempsey, E. P. Serjeant, in 'pK_a Prediction for Organic Acids and Bases', Chapman & Hall, 1981, pp. 60-63.
[23] J.-R. Pougny, J.-C. Jacquinet, M. Nassr, D. Duchet, M.-L. Milat, P. Sinaÿ, *J. Am. Chem. Soc.* **1977**, *99*, 6762; J.-R. Pougny, M. A. M. Nassr, N. Naulet, P. Sinaÿ, *Nouv. J. Chim.* **1978**, *2*, 389; P. J. Garegg, C. Ortega, B. Samuelsson, *Acta Chem. Scand., Ser. B* **1981**, *35*, 631.
[24] R. U. Lemieux, K. B. Hendriks, R. V. Stick, K. James, *J. Am. Chem. Soc.* **1975**, *97*, 4056; J. Leroux, A. S. Perlin, *Carbohydr. Res.* **1978**, *67*, 163; H. B. Mereyala, G. V. Reddy, *Tetrahedron* **1991**, *47*, 6435.
[25] B. Fraser-Reid, P. Konradsson, D. R. Mootoo, U. Udodong, *J. Chem. Soc., Chem. Commun.* **1988**, 823.
[26] R. R. Schmidt, M. Behrendt, A. Toepfer, *Synlett* **1990**, 694.
[27] R. A. Moss, J. Wlostowska, *Tetrahedron Lett.* **1988**, *29*, 2559.
[28] A. J. Everett, G. J. Minkoff, *Trans. Faraday Soc.* **1953**, *49*, 410; J. Koller, M. Hodoscek, B. Plesnicar, *J. Am. Chem. Soc.* **1990**, *112*, 2124.
[29] R. S. Sheridan, R. A. Moss, B. K. Wilk, S. Shen, M. Wlostowski, M. A. Kesselmayer, R. Subramanian, G. Kmiecik-Lawrynowicz, K. Krogh-Jespersen, *J. Am. Chem. Soc.* **1988**, *110*, 7563; M. T. H. Liu, G. E. Palmer, N. H. Chishti, *J. Chem. Soc., Perkin Trans. 2* **1981**, 53; H. Gstach, H. Kisch, *Chem. Ber.* **1982**, *115*, 2586; J. Brunner, H. Senn, F. M. Richards, *J. Biol. Chem.* **1980**, *255*, 3313; M. T. H. Liu, K. Ramakrishnan, *Tetrahedron Lett.* **1977**, 3139; M. T. H. Liu, B. M. Jennings, *Can. J. Chem.* **1977**, *55*, 3596; G. F. Bradley, W. B. L. Evans, I. D. R. Steven, *J. Chem. Soc., Perkin Trans. 2* **1977**, 1214; R. A. G. Smith, J. R. Knowles, *ibid.* **1975**, 686; C. G. Overberger, J. P. Anselme, *Tetrahedron Lett.* **1963**, 1405.

[30] D. Griller, M. T. H. Liu, J. C. Scaiano, *J. Am. Chem. Soc.* **1982**, *104*, 5549.
[31] J. E. Chateauneuf, *J. Chem. Soc., Chem. Commun.* **1991**, 1437.
[32] A. Vasella, K. Briner, M. Soundararajan, M. S. Platz, *J. Org. Chem.* **1991**, *56*, 4741.
[33] A. J. Ratcliffe, B. Fraser-Reid, *J.Chem.Soc., Perkin Trans. 1* **1990**, 747; J.-R. Pougny, P. Sinaÿ, *Tetrahedron Lett.* **1976**, 4073.
[34] A. J. Ratcliffe, B. Fraser-Reid, *J.Chem.Soc., Perkin Trans. 1* **1989**, 1805; R. U. Lemieux, R. M. Ratcliffe, *Can. J. Chem.* **1979**, *57*, 1244; A. A. Pavia, S. N. Ung-Chhun, J.-L. Durand, *J. Org. Chem.* **1981**, *46*, 3158.
[35] D. M. Gordon, S. J. Danishefsky, *J. Org. Chem.* **1991**, *56*, 3713.
[36] A. Marra, J.-M. Mallet, C. Amatore, P. Sinaÿ, *Synlett* **1990**, 572; A. Marra, P. Sinaÿ, *Carbohydr. Res.* **1990**, *195*, 303; A. Marra, F. Gauffeny, P. Sinaÿ, *Tetrahedron* **1991**, *47*, 5149; A. Hasegawa, T. Nagahama, H. Ohki, K. Hotta, H. Ishida, M. Kiso, *J. Carbohydr. Chem.* **1991**, *10*, 493; Y. Ito, T. Ogawa, *Tetrahedron Lett.* **1987**, 4701.
[37] Y. Takahashi, A. Vasella, in preparation.
[38] B. Helferich, J. Zirner, *Chem. Ber.* **1959**, *92*, 3053; G. Wulff, W. Schmidt, *Carbohydr. Res.* **1977**, *53*, 33; J. Tamura, S. Horito, J. Yoshimura, H. Hashimoto, *ibid.* **1990**, *207*, 153.
[39] F. Hibbert, J. Emsley, *Adv. Phys. Org. Chem.* **1990**, *26*, 255; F. Hibbert, *Acc. Chem. Res.* **1984**, *17*, 115.
[40] R. U. Lemieux, A. R. Morgan, *Can. J. Chem.* **1965**, *43*, 2205; A. C. West, C. Schuerch, *J. Am. Chem. Soc.* **1973**, *95*, 1333; F. J. Kronzer, C. Schuerch, *Carbohydr. Res.* **1974**, *33*, 273; R. Eby, C. Schuerch, *ibid.* **1975**, *39*, 33.
[41] G. W. Fischer, *Anal. Chim. Acta* **1977**, *92*, 149.
[42] M. Vöhler, W. von Philipsborn, unpublished results.
[43] A. Bax, M. Ikura, L. E. Kay, D. A. Torchia, R. Tschudin, *J. Magn. Reson.* **1990**, *86*, 304; A. Bax, R. H. Griffey, B. L. Hawkins, *ibid.* **1983**, *55*, 301.