Some Key Experimental Features of a Modular Synthesis of Heparin-Like Oligosaccharides

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The key features of a modular *n*+2 strategy for a completely stereoselective synthesis of oligosaccharides containing the GlcN–IdoA repeating unit of the major sequence of heparin are presented and discussed in detail. These key features include the regio- and stereoselective synthesis of disaccharide building blocks and the reactivity of building blocks in the modular assembly process. The synthetic strategy, the effectiveness of which has previously been demonstrated by the total synthesis of four hexasaccharides and two octasaccharides, allows the size and the charge distribution of the target oligosaccharide fragments to be controlled.

Introduction

In the framework of a program on the activation of fibroblast growth factors (FGFs) by glycosaminoglycans (GAGs), we have previously synthesized hexasaccharides **1**−**4** and octasaccharides **5** and **6** (Figure 1).[1] FGFs[2] are the most thoroughly studied heparin-binding proteins,[3] with the single exception of antithrombin III (AT III).[4] However, the molecular basis of FGF activation is still a matter of debate, as a consequence of the diversity and the complexity of the FGF system.[2] The availability of homogeneous oligosaccharides with precisely defined molecular structures, such as **1**−**6**, would most probably represent a major contribution in the elucidation of the molecular mechanism of the FGF activation process.[2] Compounds **1**−**6** are composed of variously sulfated D-glucosamine and L-iduronate units, as the major sequences in heparin.[5] In terms of overall conformation, compounds **1**−**6**, like heparin itself,[6] have well defined three-dimensional helical structures.[1,7,8] This conformation, which can be assessed by NMR and computational modeling,[8] determines the spatial orientation of the negative charges. Since biological interactions between GAGs and proteins are primarily electrostatic in nature,[3] it is generally accepted that the charge distribution, the charge orientation, and the size of the oligosaccharide chain are major factors in determining the activity and defining the specificity of GAG-FGF interactions.[2,3] Indeed, the results obtained so far with compounds **1**−**6** and FGF-1, the first member of the FGF family to be discovered,[2] have shown the importance of these factors in the regulation of FGF-induced mitogenesis signaling.[1a,7]

The syntheses of **1**−**6** were performed by a convergent *n*+2 modular strategy (Scheme 1).[1] As could be anticipated, the already well established glycosylation methodologies[9] and the plethora of existing protecting groups[10] allowed these molecules to be designed and constructed by the successive assembly of disaccharide building blocks. This strategy, which allows the length of the final product and the charge distribution along the oligosaccharide sequence to be controlled, has proven to be effective and versatile. However, the elucidation of the molecular basis of FGF activation requires the synthesis and purification of sufficient quantities of a variety of such oligosaccharides specifically designed to provide information on the recognition, binding, and signaling processes. Therefore, for these synthetic molecules to serve as a significant tool in these studies, further simplification, optimization, and possibly automation of the synthetic process are much needed. The chemistry underlying these syntheses therefore has to be optimized and successfully translated into solid-phase methodologies in order to be effective enough for subsequent parallel syntheses and combinatorial developments.

A recent publication[11] on a related modular approach to the synthesis of heparin oligosaccharides has prompted us to present here a detailed report on ours, including new unpublished data and relevant results in this context. These findings provided the basis for our syntheses of **1**−**6** but were not explicitly discussed in our previous reports.[1] The wide scope of those papers,[1] dealing with structural and biological studies as well, did not allow proper attention to be devoted to these practical details that now, having been further developed and elaborated, may contribute valuable knowledge to the wealth of existing data.[11,12]

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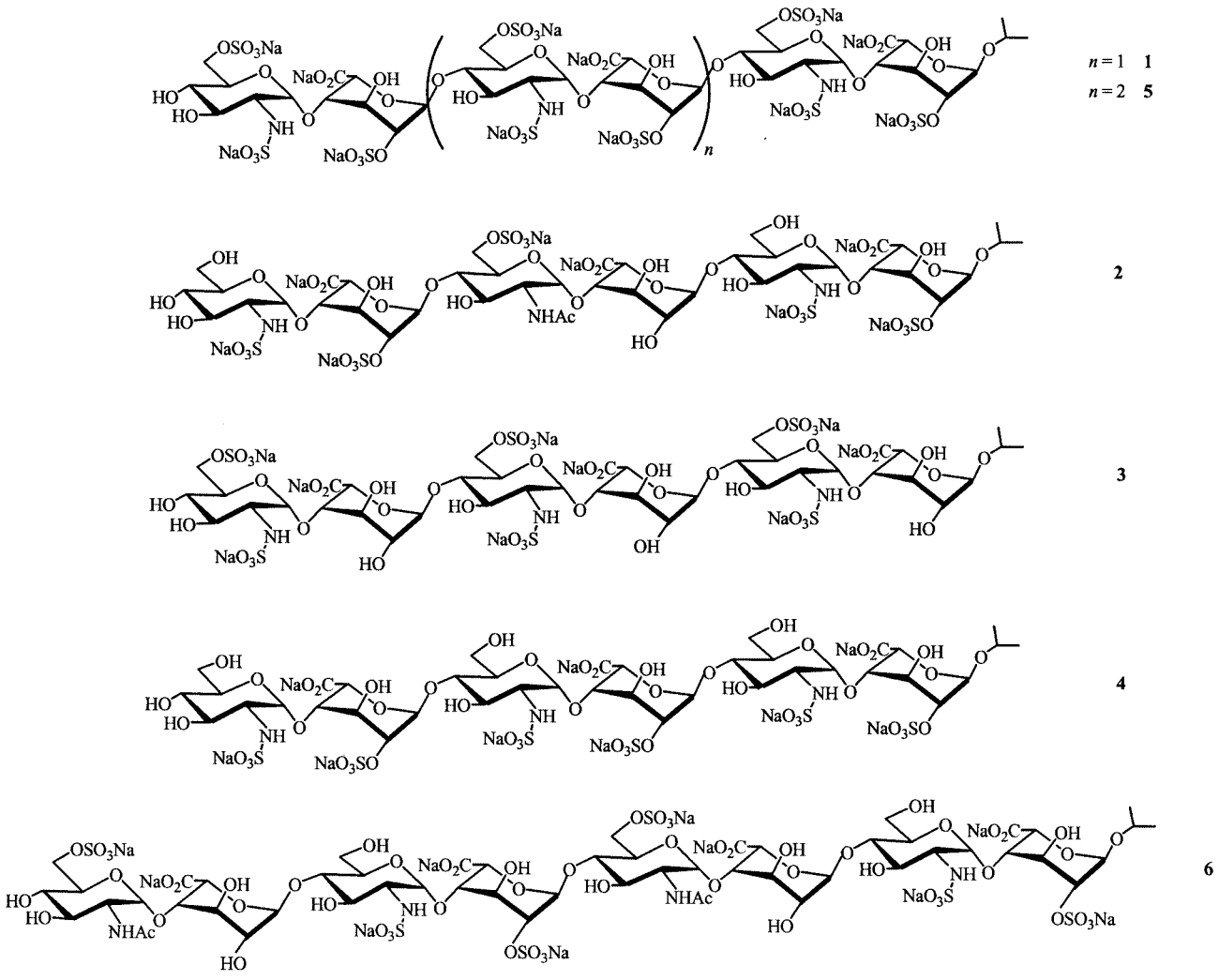
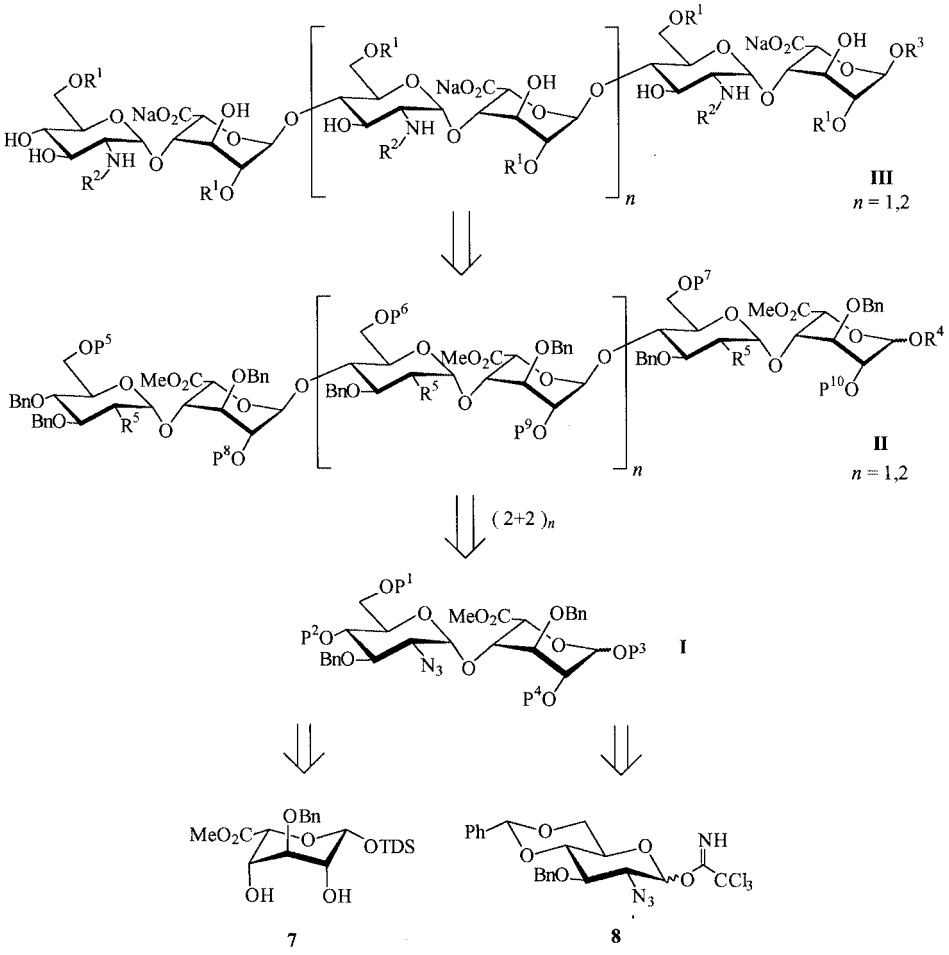


Figure 1. Six synthetic oligosaccharides, differing in length and/or sulfation pattern

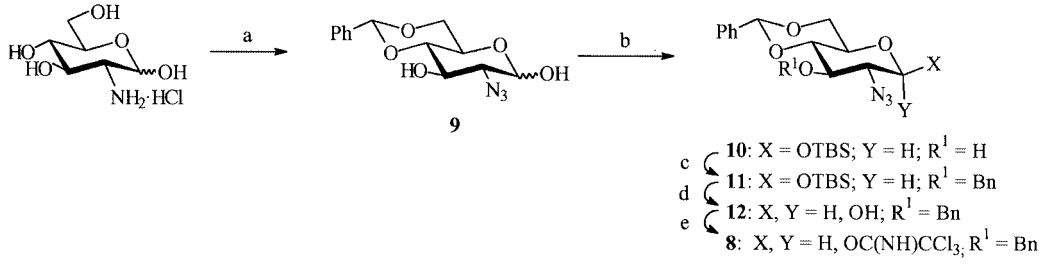
Results and Discussion

Synthesis Strategy and Monosaccharide Building Blocks

The synthesis of GAG oligosaccharides is already well developed.[12] The major achievement in the field has been the work performed around the pentasaccharide constituting the minimum heparin sequence for recognition and binding to AT III.[4,13] Many of the strategies currently used in the synthesis of GAG oligosaccharides are somehow inspired by these pioneering studies. This is indeed the case for our synthesis of oligosaccharides **1**–**6**,[1] based on the retrosynthetic analysis shown in Scheme 1.[1] The key building blocks are disaccharide structures such as **I**, which are effectively synthesized from the monosaccharide derivatives **7** and **8**. Building block **7** is most conveniently prepared as reported by Bonnaffé et al.[14] This method has a number of advantages over other literature procedures previously used in our laboratory to produce L-iduronic acid derivatives.[15] Those advantages include reproducibility, simplicity, and ready scale-up potential. By this procedure, diol **7** is currently being synthesized in tens of grams in ordinary laboratory equipment. Building block **8** is obtained from D-glucosamine hydrochloride through a diazo transfer reaction[16] followed by benzylidenation and activation of the anomeric position as a trichloroacetimidate (Scheme 2). The direct installation of the azide function from commercially available amino sugars was first reported by us for the preparation of 2-azido-2-deoxy-D-*gluco*, D-*manno*, D-*galacto*, and D-*allo* derivatives[16a] and was later revisited and modified in an attempt to improve yield and reproducibility.[16b,16c] Both the original[16a] and the modified[16b] procedures have been extensively used in our laboratory over the years. For the reliable ten gram scale synthesis of **8** with excellent reproducibility we currently use the original method[16a] under carefully controlled experimental conditions, followed by direct benzylidenation to obtain **9**[17] in 65–70% overall yield from D-glucosamine hydrochloride (Scheme 2). Stereoselective silylation (→ **10**),[18] benzylation (→ **11**),[18a] desilylation (→ **12**),[19] and anomeric activation[20] finally yield **8**.[19,21] Compound **11** has been used as starting material for the preparation of other glycosyl donors such as **18**, **19**, and **20** (Table 2), which are also used



Scheme 1. General retrosynthetic analysis; R^1 = H, SO_3Na; R^2 = Ac, SO_3Na; R^5 = N_3, NHAc; R^3, R^4, P^1–P^{10} = protecting groups; TDS = dimethylthexylsilyl



Scheme 2. Synthesis of donor **8**; reagents and conditions: a) MeONa, MeOH; TfN_3, DMAP; $PhCH(OMe)_2$, *p*TsOH, DMF, 40 °C 71%; b) TBSCl, imidazole, CH_2Cl_2, −10 °C 70%; c) BnBr, NaH, CH_2Cl_2, TBAI, 85%; d) TBAF, AcOH, THF, −40 °C quantitative; e) Cl_3CCN, DBU, CH_2Cl_2, 95%; DMAP = 4-dimethylaminopyridine, TBS = *tert*-butyldimethylsilyl, TBAF = tetrabutylammonium fluoride, DBU = 1,8-diazabicyclo[5.4.0]undec-7-ene

as monosaccharide building blocks for specific purposes in our reported synthesis of compounds **1**–**6**.

Disaccharide Building Blocks

A key step in our syntheses of compounds **1**–**6** is the regio- and stereoselective condensation of diol **7** with trichloroacetimidate **8**.[1] This and other related glycosylations of diol **7** are in routine use in our laboratory for the preparation of structures **I**.[1] The usefulness of this regio- and stereoselective glycosylation, which is key for the simplification of the synthetic scheme, has recently been questioned with regard to the regioselectivity of the process, and a multi-step route to obtain 2-OH protected L-iduronate glycosyl acceptors from **7** has been proposed as a preferred alternative.[11] A considerable volume of data from our laboratory, however, indicates that the direct glycosylation of **7** followed by installation of the needed protecting group at position 2 of the resulting disaccharide is a convenient procedure for the preparation of the key building blocks **I**. We have already reported that the $^1C_4$ conformation of **7**, which is stabilized by two cooperative intramolecular hydrogen bonds (4-OH → 2-OH → 1OR),[1,15b,22] results in

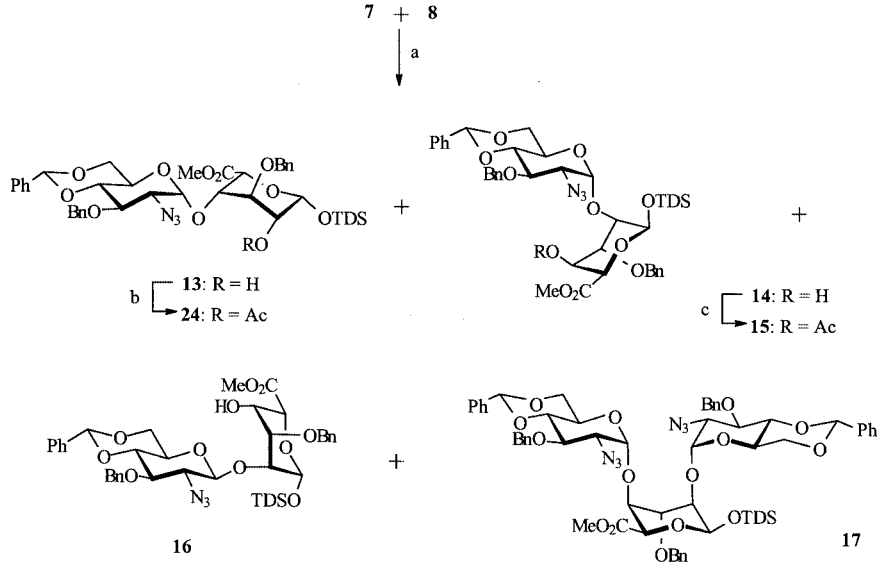
Table 1. Reaction conditions for the glycosylation between diol **7** and trichloroacetimidate **8**

Entry	Ratio **8**/**7** (equiv.)	Catalyst	Solvent	Inverse procedure	*T* (°C)	Yield (%)
1	1.5:1	TMSOTf	Et_2O	No	0	38[a]
2	1.5:1	TMSOTf	Et_2O	Yes	−20	35[a]
3	1.5:1	TMSOTf	Et_2O	Yes	0	33[a]
4	0.6:1	TMSOTf	Et_2O	Yes	0	46[b]
5	1:1	TMSOTf	CH_2Cl_2	Yes	0	45[a]
6	0.6:1	TMSOTf	CH_2Cl_2	Yes	0	62[b]

[a] Yield calculated with respect to acceptor equivalents. [b] Yield calculated with respect to donor equivalents.

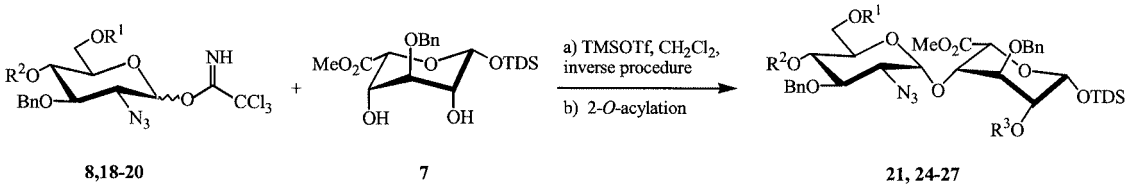
decreased nucleophilicity of OH-2, which, on the other hand, is sterically hindered by the bulky dimethylthexylsilyl neighboring group. The successful use of these reactions in the reported syntheses of **1**−**6**[1] supports this. The reaction conditions have been carefully investigated, and the results of this study are summarized in Table 1. When the condensation of **7** with **8** was carried out in dichloromethane as solvent with a 0.6:1 donor/acceptor ratio by the inverse procedure,[23] the desired disaccharide **13** was obtained in 62% yield. The reaction mixture also contained acceptor **7** (35%) and small amounts of the α(1→2) disaccharide (**14**, characterized as acetate **15**), the β(1→2) disaccharide (**16**), and trisaccharide **17** (Scheme 3). No β(1→4) disaccharide was observed, which constitutes a further indication of the difficulty of explaining the steric course of this glycosylation. As would be expected, an excess of donor resulted in an increase of the proportion of **17**. No significant changes in yield, regioselectivity, or stereoselectivity of this reaction were observed for other 2-azido-2-deoxy glycosyl donors with different substitution patterns, such as in compounds **18**,[1a] **19**,[1b] and **20**[1c] (Table 2). Thus, a similar result was obtained in the glycosylation of **7** with **18**, from which subsequent benzoylation of the reaction mixture allowed the isolation of the α(1→4) disaccharide (**21**, 51%) and small amounts of the α(1→2) disaccharide (**22**) and trisaccharide **23** (Scheme 4). The isolation of the major compound from these reaction mixtures is most conveniently carried out after treatment with the corresponding acylating agent to give the 2-*O*-substituted disaccharide building block with the required protecting group pattern. In all cases the yield of the two-step process was around 50%. The obtained results are summarized in Table 2.

In order to evaluate the advantages and disadvantages of constructing the key building blocks **I** by the above direct regioselective glycosylations of diol **7**, we also investigated some alternative routes involving glycosylation of conveniently 2-*O*-substituted derivatives of **7**. For these alternative routes to compete effectively with the direct glycosylations of diol **7**, the glycosyl acceptors have to be directly and effectively prepared, lengthy multi-step processes being avoided. Thus, regioselective monosubstitution of diol **7** was attempted both through selective cleavage of 2,4-benzylidene acetal derivatives[24] and by 2,4-stannylidene acetal- or tributyltin ether-mediated selective acylation[25] (Scheme 5). With regard to the first approach, the 2,4-benzylidene acetal derivative of **7** could not be satisfactorily prepared, most probably due to insufficient reactivity of benzaldehyde dimethyl acetal under the conventional acetalation conditions. However, the *p*-methoxybenzylidene acetal **28** was prepared in high yield (82%) from **7** and then



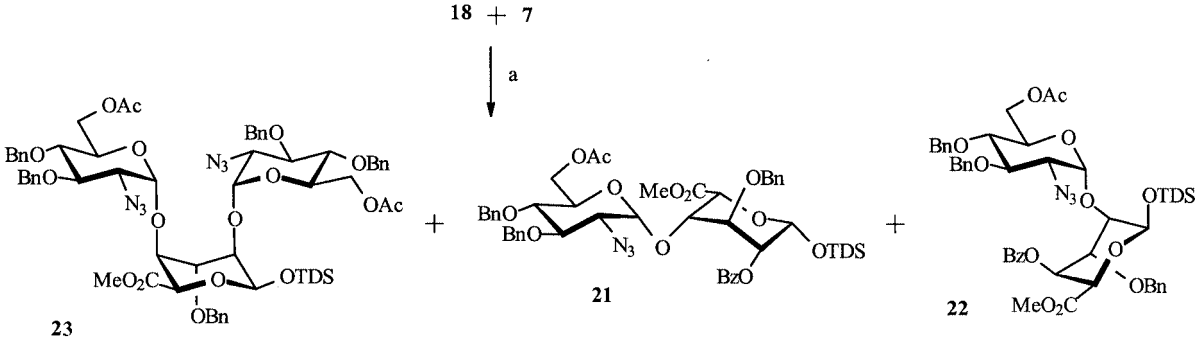
Scheme 3. Synthesis of disaccharide **13**; reagents and conditions: a) TMSOTf, CH_2Cl_2, 0 °C 62% (**13**) +35% of recovered **7**; b) Ac_2O, Py, 93%; c) Ac_2O, Py, quantitative. TMSOTf = trimethylsilyl trifluoromethanesulfonate

Table 2. Regio- and stereoselective glycosylations between acceptor **7** and different donors



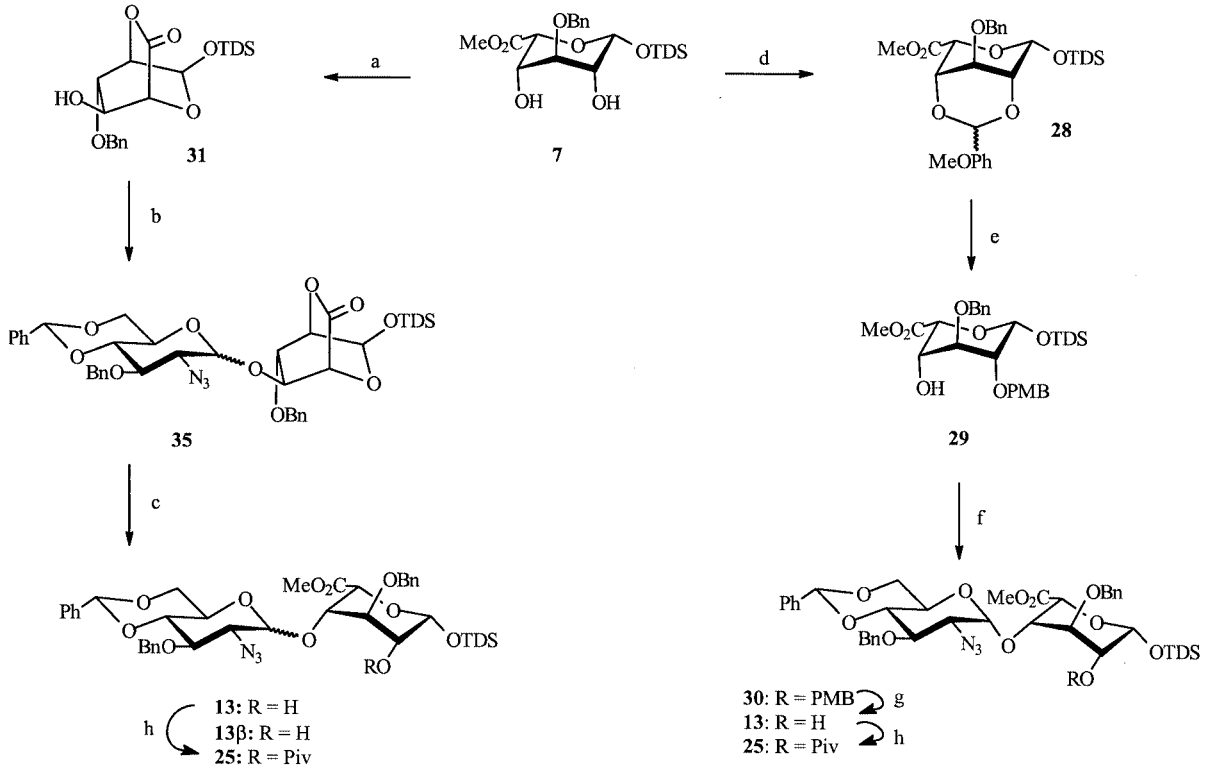
8,18-20 **7** **21, 24-27**

Donor	R^1	R^2	R^3	Yield (%)	Disaccharide
8	Ph-CH-		Ac	57	**24**
8	Ph-CH-		Piv	56	**25**
18	Ac	Bn	Bz	51	**21**
19	Bz	Bn	Ac	43	**26**
20	PMB	Bn	Bz	51	**27**

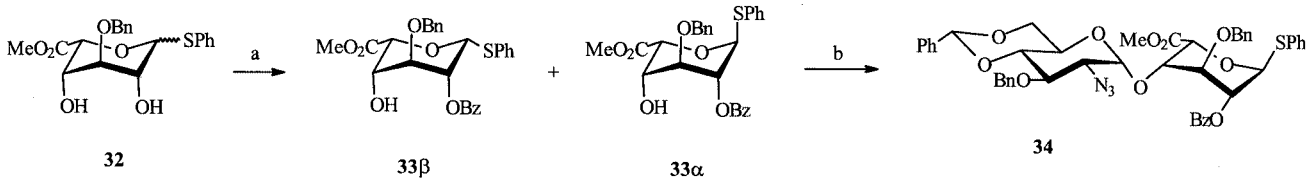


Scheme 4. Synthesis of disaccharide **21**; reagents and conditions: a) TMSOTf, CH_2Cl_2, 0 °C; BzCl, Py, 51% (**21**)

subjected to regioselective reductive opening to give the 2-*O* substituted L-iduronate derivative **29** (85%) and a small amount of the corresponding regioisomer, which could not be purified from the reaction mixture. The observed selectivity in the cleavage of acetal **28** opens a convenient route to the preparation of L-iduronate building blocks for the modular synthesis of heparin-like oligosaccharides. In our case this reaction permitted the preparation of building blocks such as **25**, a key intermediate in the synthesis of **1** and **5**, by glycosylation of **29** with **8** (→ **30**, 85%), subsequent removal of the *p*-methoxybenzyl group in **30** (→ **13**, 90%), and pivaloylation of **13** (→ **25**, 95%) (Scheme 5). After these transformations **25** could be obtained in 51% overall yield from **7** in five high-yielding steps. This yield is similar to that obtained by direct regioselective glycosylation of **7** and in situ pivaloylation of the resulting disaccharide mixture (56%, Table 2). As for the second alternative, attempted selective activation of diol **7** with dibutyltin oxide in toluene followed by treatment with benzoyl chloride resulted in a mixture of lactone **31** and partially benzoylated derivatives in low yield. The presence of the β-oriented dimethylthexylsilyl group in **7** seemed to prevent effective formation of the intermediate 2,4-dibutylstannylidene acetal. Treatment of **7** with bis(tributyltin) oxide afforded **31** in 77% yield (Scheme 5). Therefore, for the selective activation to proceed, an L-iduronate building block with a less sterically demanding protecting group at the anomeric position and also easily accessible from currently available intermediates had to be used. Phenylthioglycoside **32** was chosen. (Scheme 6). Dibutylstannylidene-mediated benzoylation of **32** gave the 2-*O*-benzoyl derivatives **33**α and **33**β (80% overall). The α anomer was subjected to glycosylation with building block **8** to give **34** (65%, Scheme 6). In this case the overall yield of the disaccharide module (**34**) reached 52% in two steps, which was similar to the yield obtained for a similar building block by direct glycosylation of diol **7**. Interestingly enough, glycosylation of lactone **31** with **8** gave an 8:1 anomeric mixture of glycosides **35** in 88% yield. Treatment of this mixture with dibutyltin oxide[26] in methanol gave a mixture of **13** and the β anomer **13**β, from which **13** was isolated in 75% yield. (Scheme 5). It may be concluded that even for acceptors **29** and **33**, which can be prepared in good yield after two-step processes and successfully glycosylated with **8**, these multistep approaches do not seem to be remarkably superior in practical terms to direct regioselective glycosylation of the L-iduronate diol **7**. It is also interesting to note that the glycosylation of **31** does not occur with complete stereo-



Scheme 5. Reagents and conditions: a) $(Bu_3Sn)_2O$, toluene, reflux, 77%; b) **8**, TMSOTf, CH_2Cl_2, −5 °C, 88%, α/β = 8:1; c) Bu_2SnO (1 equiv.), MeOH, reflux, 24 h, 75% (α anomer **13**); d) *p*MeOPhCH(OMe)$_2$, *p*TsOH, DMF, 25 mbar, 82%; e) $NaBH_3CN$, TMSCl, CH_3CN, MS 3 Å, −45 °C, 85%; f) **8**, TMSOTf, CH_2Cl_2, −10 °C, 85%; g) DDQ, CH_2Cl_2/H_2O 10:1, 0 °C, 90%; h) PivCl, Py, DMAP, 95%[1a]



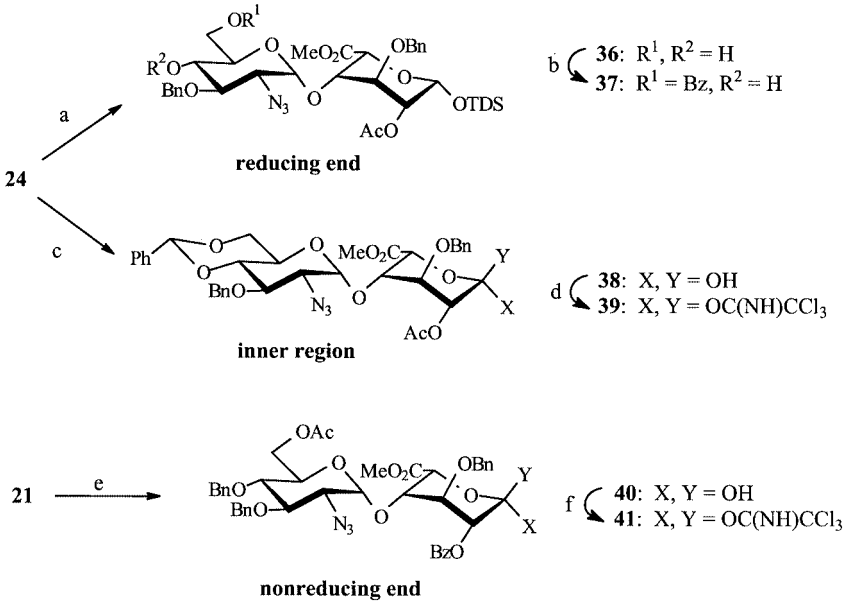
Scheme 6. Synthesis of disaccharide **34**; reagents and conditions: a) Bu_2SnO, MeOH, reflux 1 h; dioxane, BzCl, Et_3N, 0 °C, 80%; b) **8**, TMSOTf, CH_2Cl_2, 0 °C, 65%

selectivity, in contrast to the results obtained in the glycosylation of **7**, **29**, **33** and other L-iduronate derivatives. The conformation of **31** is tightly locked, so the recent report that conformational constraint of the glycosyl acceptor results in complete α stereoselectivity of the glycosylation[11,27] does not seem to hold for equatorially oriented hydroxy groups.

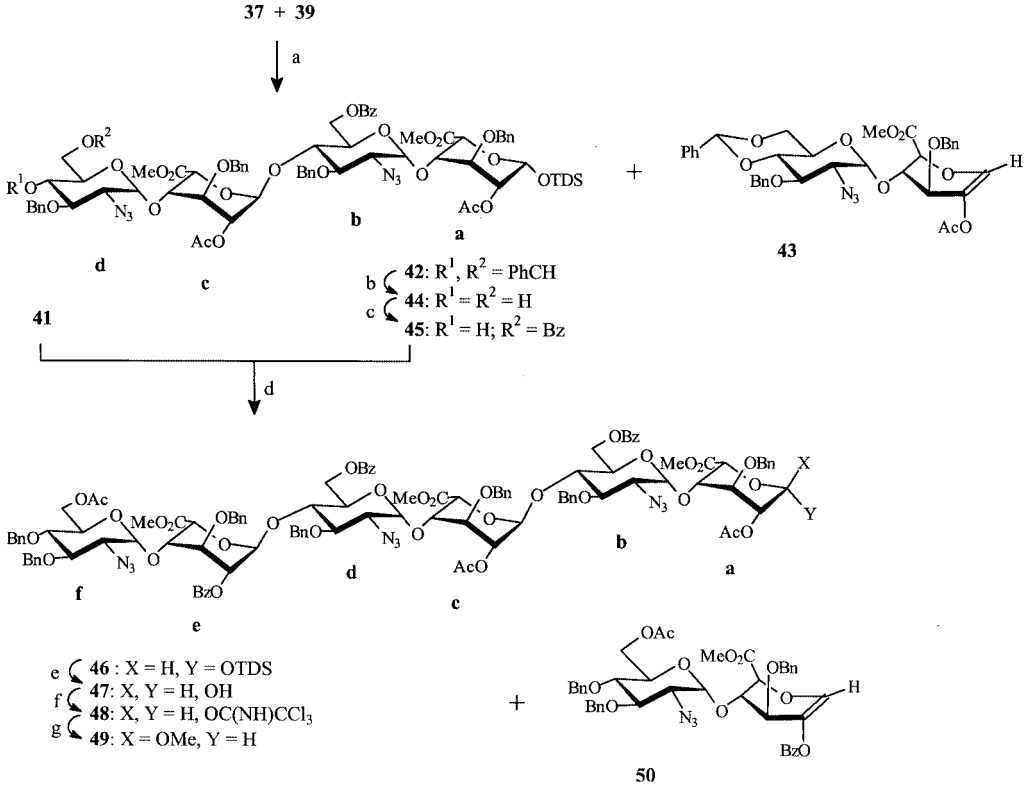
Assembly of Building Blocks

The assembly of these building blocks for the construction of the oligosaccharide sequences has to be carefully planned. The structure of the final product would determine the synthetic strategy and the protecting group pattern in the different building blocks. Obviously, the latter would strongly influence their reactivity and therefore their performance as glycosyl donors or glycosyl acceptors. To match donor-acceptor reactivity is essential for a reasonable outcome of the process. Our studies on the syntheses of **1**−**6** provided a series of useful data in this regard, discussed below.

The protecting group strategy for the synthesis of these oligosaccharide fragments is dictated by the desired sulfation pattern and the configurations of the glycosidic linkages. In addition, depending on the studies to be performed with the target molecule, the necessary installation of an appropriate chemical functionality at a specific position also has to be considered when planning the synthesis. The importance of choosing the appropriate set of protecting groups and of designing the most convenient strategy to achieve the final target can be illustrated by comparison of a successful synthesis[1a] and an unsuccessful approach to the synthesis of oligosaccharides with the structure of the regular region of heparin (**1** and **5**). In our reported synthesis of **1**−**6** we decided to install an α-isopropyl group at the reducing end.[1] These oligosaccharides were primarily synthesized for conformational studies, sedimentation equi-



Scheme 7. Synthesis of disaccharide building blocks; reagents and conditions: a) EtSH, *p*TsOH (cat.), CH_2Cl_2, 89%; b) BzCN, Et_3N (cat.), MeCN, −40 °C, 91%; c) $(HF)_x$·Py, THF, −15 °C→0 °C, 94%; d) Cl_3CCN, K_2CO_3, 87%; e) $(HF)_x$·Py, THF, −10 °C → 0 °C, 88%; g) Cl_3CCN, K_2CO_3, 95%



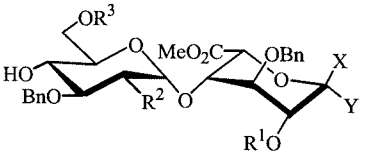
Scheme 8. Assembly of hexasaccharide **46**; reagents and conditions: a) TMSOTf, CH_2Cl_2, 0 °C, 50% + 44% of recovered **37**; b) EtSH, *p*TsOH (cat.), 84%; c) BzCN, Et_3N (cat.), MeCN, −40 °C, 95%; d) TMSOTf, CH_2Cl_2, 0 °C, 60% + 37% of recovered **45**; e) $(HF)_x$·Py, THF, 0 °C, 90%; f) Cl_3CCN, K_2CO_3, 85%; g) MeOH, TMSOTf, CH_2Cl_2, 0 °C, 31%

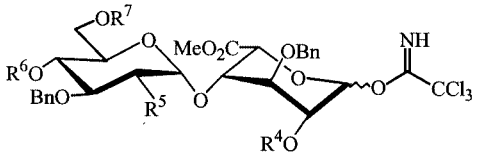
librium analysis experiments, and stimulation of FGF mitogenic activity assays. The planned syntheses of **1** and **5** were successful when the α-isopropyl group was directly introduced in the reducing end building block.[1] Different strategies aiming to prepare a common, fully protected oligosaccharide intermediate that would permit the synthesis of a variety of molecules differently substituted at the reducing end for different purposes rendered the synthesis impracticable. The use of pivaloyl or benzoyl groups as participating protecting groups instead of acetyl at position 2 of

the L-iduronate also greatly facilitates the assembly process. Thus, for the synthesis of **1**[1a] we first decided to proceed through the fully protected hexasaccharide derivative **46**. As indicated above, a successful synthesis of **46** would allow different groupings to be installed at the reducing end for structural and biological investigation or handles for binding studies after desilylation and anomeric activation, giving rise to a variety of derivatives. Following our general retrosynthesis analysis (Scheme 1), the required disaccharide building blocks were prepared from **21** and **24** (Scheme 7). The reducing end building block **37** was prepared from **24** by removal of the benzylidene group[28] (→ **36**), followed by regioselective benzoylation[29] (→ **37**). The inner region building block **39** was prepared from **24** by desilylation[30] (→ **38**) and anomeric activation[20,31] (→ **39**). The nonreducing end building block **41** was prepared from **21** by a similar sequence (→ **40** → **41**). The assembly of these building blocks was carried out as shown in Scheme 8. Glycosylation of **37** with **39** at 0 °C with TMSOTf as promoter gave tetrasaccharide **42** in 50% yield. A substantial amount of **37** (44%), as well as glycal **43**,[15a] could be isolated from the reaction mixture. Removal of the benzylidene acetal[28] in **42** and selective benzoylation[29] of the resulting diol **44** afforded acceptor **45**. Glycosylation of **45** with donor **41** at room temperature gave hexasaccharide **46** in 60% yield. A considerable amount of unchanged **45** and glycal **50** were also isolated from the reaction mixture. The feasibility of obtaining further derivatization at the anomeric position was then investigated. Desilylation[30] (→ **47**) and anomeric activation[20] afforded trichloroacetimidate **48**. In contrast with our reported synthetic approach to **1** and **5**,[1a] which yielded these compounds in an effective manner, this synthetic route finally had to be abandoned, as attempted glycosylation with **48** resulted in low yields and selectivity.

The total syntheses of **1**−**6** involved the successful assembly of building blocks with different reactivities as glycosyl donors and as glycosyl acceptors. To achieve a reasonable assembly process that would finally allow the isolation of the four hexasaccharides (**1**−**4**) and the two octasaccharides (**5**, **6**) for structural and biological investigation,[1] the coupling strategy and the experimental conditions had to be carefully established. Since the process was designed to allow further developments towards further simplification, a limited number of well established effective protecting groups, a unique robust and versatile glycosylation method, and standard experimental conditions seemed advisable. The assembly was therefore always carried out with building blocks with benzyl groups as permanent protecting groups, benzoyl, pivaloyl, and − to a far lesser extent − acetyl as temporary protecting groups, and benzylidene and *p*-methoxybenzylidene acetals as versatile groups for manipulation of hydroxy protection. All glycosylations were performed by the trichloroacetimidate procedure in di-

Table 3. Summary of glycosylation reactions for the synthesis of precursors of heparin-like oligosaccharides· O-D = *O*-Disaccharide; O-T = *O*-Tetrasaccharide





R^1	R^2	R^3	$X^{[a]}$	Y	R^4	R^5	R^6	R^7	Yield (%)	Reference
Ac	N_3	Bz	H	OTDS	Ac	N_3		Ph-CH-	50	
Piv	N_3	Bz	O^{i}Pr	H	Piv	N_3		Ph-CH-	79	[1a]
Piv	N_3	Ac	O^{i}Pr	H	Ac	NHAc		Ph-CH-	33	[1b]
Piv	N_3	Bn	O^{i}Pr	H	Ac	NHAc		Ph-CH-	50	[1b]
Bz	N_3	PMB	O^{i}Pr	H	Bz	N_3		*p*MeO-Ph-CH-	85	[1c]
Ac	N_3	Bz	O-D	H	Bz	N_3	Bn	Ac	60	
Piv	N_3	Bz	O-D	H	Bz	N_3	Bn	Ac	58	[1a]
Bn	NHAc	Bz	O-D	H	Piv	N_3		Ph-CH-	65	[1b]
Piv	N_3	Bz	O-D	H	Piv	N_3		Ph-CH-	52	[1a]
Bz	N_3	PMB	O-D	H	Bz	N_3	Bn	PMB	79	[1c]
Piv	N_3	Bz	O-T	H	Bz	N_3	Bn	Ac	60	[1a]
Piv	N_3	Bn	O-T	H	Ac	NHAc	Bn	Bz	40	[1b]
acceptor isopropyl alcohol					Piv	N_3		Ph-CH-	70	[1a]
acceptor isopropyl alcohol					Bz	N_3		Ph-CH-	70	[1c]

chloromethane with trimethylsilyl triflate as promoter at temperatures ranging from −20° to 20 °C. A summary of the results is shown in Table 3. The stereoselectivity of the glycosylations was complete in all cases and the yields of isolated product ranged from 85% to 33%. The protecting group patterns of donors and acceptors were the best compatible in the synthesis of **3** and **4**, in which the sulfation pattern allowed the synthesis to be based on benzoyl, *p*-methoxybenzylidene, and *p*-methoxybenzyl groups. The most difficult situation arose when acetamido groups rather than azido groups had to be installed in either donor or acceptor.[20] On the whole, the process is effective and in the essential aspects can be translated into solid-phase synthesis. The synthesis of structures containing the structural features of the heparin major sequence has thus already been completed and will be reported elsewhere.

Conclusion

In conclusion, we have developed an effective, basically modular strategy for the preparation of oligosaccharides with the structure of the major sequence in heparin, permitting the size and the charge distribution along the oligosaccharide chain to be controlled. This basic strategy, discussed in this paper, has already allowed the practical synthesis of four different series of hexa- and octasaccharides,[1] which have been used for structural and biological investigation.[1,7] Key points of these syntheses are the direct preparation of disaccharide building blocks by regio- and stereoselective glycosylation of an L-iduronic ester diol with a 2-azido-2-deoxy-D-glucopyranosyl trichloroacetimidate, the use of a limited number of well established protecting groups and a unique glycosylation procedure. With these elements, a reasonable assembly of building blocks can be achieved matching donor and acceptor reactivities, affording the desired oligosaccharide sequences in acceptable yield.

Experimental Section

General Procedures: Thin layer chromatography (TLC) analyses were performed on silica gel 60 F_{254} precoated aluminium plates (Merck) and the compounds were detected by staining with sulfuric acid/ethanol (1:9) or with anisaldehyde solution (anisaldehyde (25 mL) with sulfuric acid (25 mL), ethanol (450 mL), and acetic acid (1 mL)], followed by heating at over 200 °C. Column chromatography was carried out on silica gel 60 (0.2−0.5 mm, 0.2−0.063 mm or 0.040−0.015 mm; Merck). Optical rotations were determined with a Perkin−Elmer 341 polarimeter. ^1H and ^{13}C NMR spectra were acquired with Bruker DPX 300, DRX 400, and DRX 500 spectrometers, and chemical shifts are given in ppm (δ) relative to tetramethylsilane as an internal reference or relative to D_2O. Elemental analyses were performed with a Leco CHNS-932 apparatus, after drying of analytical samples over phosphorous pentoxide for 24 h. Mass spectra (fast atom bombardment, FAB MS) were carried out by the Mass Spectrometry Service, Facultad Química, Seville, with a Kratos MS-80 RFA spectrometer.

***O*-(2-Azido-3-*O*-benzyl-4,6-*O*-benzylidene-2-deoxy-α,β-D-glucopyranosyl) Trichloroacetimidate (8):**[19,21] Trichloroacetonitrile (0.5 mL, 5.1 mmol) and catalytic DBU were added to a solution of **12** (130 mg, 0.34 mmol) in dry CH_2Cl_2 (2 mL). After 3 h stirring, the reaction mixture was concentrated in vacuo and the residue was purified by chromatography over a short silica gel column (hexane/EtOAc, 4:1 + 1% Et_3N) to furnish **8** (170 mg, 95%) as an α/β mixture. The physical data were in good agreement with published values.[19,21]

2-Azido-4,6-*O*-benzylidene-2-deoxy-α,β-D-glucopyranose (9):[17] NaN_3 (62.2 g, 0.96 mol) was dissolved at room temperature in H_2O (156 mL) in a 1-L three-necked round-bottomed flask, fitted with a dropping funnel, a septum, and an argon balloon. CH_2Cl_2 (194 mL) was added to the vigorously stirred solution at 0 °C. Tf_2O (32 mL, 0.19 mol) was added over 1 h. The mixture was stirred for 2 h at 0 °C, the organic layer was separated, and the aqueous layer was extracted with CH_2Cl_2 (2 × 78 mL). The combined organic layers were washed with saturated aqueous $NaHCO_3$ solution (156 mL) and H_2O (156 mL), dried with $MgSO_4$, and filtered, to yield a 0.4 M solution of TfN_3 (350 mL) (***WARNING: TfN_3 has been reported to be explosive when not in solvent and should always be used as a solution***). A suspension of D-glucosamine hydrochloride (5 g, 23 mmol) in MeOH (100 mL) was treated with a solution of NaOMe in MeOH (0.5 M, 55 mL, 28 mmol) and stirred at room temperature for 10 min. Dilution with MeOH (245 mL) and treatment with DMAP (3 g, 25 mmol) afforded a clear, colorless solution, to which the TfN_3 solution (0.4 M, 175 mL, 70 mmol) was added at room temperature over 2 h. After the mixture had been stirred at room temperature for 48 h, the solvent was evaporated at 30 °C. The oily, white suspension of the residue was dissolved in MeOH (50 mL), treated with methanolic acetic acid solution until neutral pH, and concentrated to dryness. The residue was dissolved in DMF (30 mL) and treated with benzaldehyde dimethyl acetal (5.2 mL, 35 mmol) and *p*TsOH (50 mg). After stirring at 40 °C for 48 h, the mixture was neutralized with solid $NaHCO_3$ and concentrated in vacuo. The residue was purified by flash column chromatography (8:1 → 4:1 toluene/acetone) to yield **9** (4.83 g, 71%). The physical data were in good agreement with published values.[17]

***tert*-Butyldimethylsilyl 2-Azido-4,6-*O*-benzylidene-2-deoxy-β-D-glucopyranoside (10):**[18] *tert*-Butyldimethylsilyl chloride (148 mg, 0.98 mmol) was added under argon to a cooled (−10 °C) solution of **9** (261 mg, 0.89 mmol) and imidazole (151 mg, 2.23 mmol) in CH_2Cl_2 (1.3 mL). After the mixture had been stirred for 2 h, H_2O (1 mL) was added and the mixture was diluted with CH_2Cl_2 (50 mL) and washed with H_2O (50 mL). The aqueous layer was extracted with CH_2Cl_2 (2 × 25 mL), and the combined organic layers were dried with $MgSO_4$ and concentrated to dryness. The residue was purified by flash column chromatography (hexane/EtOAc, 9:1) to afford **10** (254 mg, 70%). The physical data were in good agreement with published values.[18]

***tert*-Butyldimethylsilyl 2-Azido-3-*O*-benzyl-4,6-*O*-benzylidene-2-deoxy-β-D-glucopyranoside (11):**[18a] NaH (60% dispersion in mineral oil, 1.76 g, 43.9 mmol) was added to a cooled (0 °C) solution of **10** (11.93 g, 29.3 mmol) in dry CH_2Cl_2 (120 mL). After the mixture had been stirred for 1 h, benzyl bromide (6.27 mL, 52.7 mmol) and catalytic TBAI (200 mg) were added. After the mixture had then been stirred at room temperature for 24 h, MeOH (10 mL) was added, and the mixture was diluted with CH_2Cl_2 (400 mL) and washed with saturated NH_4Cl solution (100 mL) and H_2O (200 mL). The aqueous layers were extracted with CH_2Cl_2 (2 × 100 mL), and the combined organic layers were dried with $MgSO_4$ and concentrated in vacuo. The residue was purified by flash col-

umn chromatography (hexane/EtOAc, 25:1) to furnish **11** (12.35 g, 85%). The physical data were in good agreement with published values.[18a]

2-Azido-3-*O*-benzyl-4,6-*O*-benzylidene-2-deoxy-α,β-D-glucopyranose (12):[19] Acetic acid (755 μL, 13.2 mmol) and TBAF (13.2 mL of a 1 M solution in THF) were added to a cooled (−40 °C) solution of **11** (5.97 g, 12.0 mmol) in dry THF (60 mL). After 3 h, H_2O (5 mL) was added and the mixture was diluted with Et_2O (250 mL) and washed with H_2O (150 mL). The aqueous layer was extracted with Et_2O (2 × 50 mL), and the combined organic layers were dried ($MgSO_4$) and concentrated to dryness. The residue was purified by flash chromatography (10:1 toluene/acetone) to yield **12** (4.60 g, 100%). The physical data were in good agreement with published values.[19]

Methyl [Dimethylthexylsilyl 4-*O*-(2-Azido-3-*O*-benzyl-4,6-*O*-benzylidene-2-deoxy-α-D-glucopyranosyl)-3-*O*-benzyl-β-L-idopyranoside]-uronate (13): TMSOTf (50 μL of a 0.26 M solution in dry CH_2Cl_2) was added under argon to a cooled (0 °C) solution of **7** (114 mg, 0.26 mmol) in dry CH_2Cl_2 (4 mL). While the reaction was stirred, a solution of **8** (82 mg, 0.16 mmol) in dry CH_2Cl_2 (1.5 mL) was added dropwise. After 30 min, the mixture was neutralized with saturated aqueous $NaHCO_3$ solution, and CH_2Cl_2 (50 mL) was then added at room temperature. The suspension was washed with H_2O (50 mL). The organic layer was dried ($MgSO_4$) and concentrated in vacuo, and the residue was purified by flash column chromatography (30:1 toluene/EtOAc) to yield **13** (78 mg, 62%) and unchanged acceptor **7** (40 mg, 35% of initial acceptor). Di- and trisaccharides **14**, **16**, and **17** were also isolated from the reaction mixture (**14** was acetylated to afford **15** and ensure the NMR assignment).

Compound 13: $[\alpha]_D^{20} = -4.3$ ($c = 1$, $CHCl_3$). TLC (hexane/EtOAc, 4:1). $R_f = 0.30$, (toluene/EtOAc, 15:1). $R_f = 0.32$. ^{1}H NMR (500 MHz, $CDCl_3$): δ = 7.43−7.24 (m, 15 H, Ph), 5.51 (s, 1 H, PhC*H*O), 5.02 (br. s, 1 H, H-1), 4.90 (d, $J_{1',2'}$ = 3.8 Hz, 1 H, H-1′), 4.87−4.73 (2d, J_{gem} = 10.7 Hz, 2 H, CH_2Ph), 4.64−4.61 (2d, J_{gem} = 11.8 Hz, 2 H, CH_2Ph), 4.55 (br. s, 1 H, H-5), 4.25 (dd, $J_{5',6'a}$ = 2.5, $J_{6'a,6'b}$ = 8.9 Hz, 1 H, H-6′a), 4.06 (br. s, 1 H, H-4), 3.97−3.92 (m, 2 H, H-3 and H-3′), 3.79 (s, 3 H, COOCH_3), 3.69−3.62 (m, 4 H, H-2, H-4′, H-5′ and H-6′b), 3.53 (dd, $J_{2',3'}$ = 9.8 Hz, 1 H, H-2′), 3.03 (d, $J_{2,OH}$ = 9.9 Hz, 1 H, O*H*), 1.66 [m, 1 H, C*H*(CH_3)$_2$], 0.90−0.88 [4s, 12 H, C(CH_3)$_2$ and CH(CH_3)$_2$], 0.24−0.19 [2s, 6 H, Si(CH_3)$_2$] ppm. ^{13}C NMR (125 MHz, $CDCl_3$): δ = 169.0, 137.7, 126.0, 101.6, 95.9, 94.9, 82.1, 77.2, 75.2, 73.7, 72.7, 71.5, 68.5, 63.2, 63.1, 52.5, 34.0, 25.1, 20.4, 18.5, −1.9 and −3.2 ppm. FAB-MS: *m*/*z* = 828 [MNa^+]. $C_{42}H_{55}N_3O_{11}Si$ (806.0): calcd. C 62.59, H 6.88, N 5.21; found C 62.61, H 6.74, N 5.36.

Methyl [Dimethylthexylsilyl 2-*O*-(2-Azido-3-*O*-benzyl-4,6-*O*-benzylidene-2-deoxy-α-D-glucopyranosyl)-3-*O*-benzyl-β-L-idopyranoside]-uronate (14): TLC (toluene/EtOAc, 15:1). $R_f = 0.39$. ^{1}H NMR (500 MHz, $CDCl_3$): δ = 7.48−7.24 (m, 15 H, Ph), 5.53 (s, 1 H, PhC*H*O), 5.50 (d, $J_{1',2'}$ = 3.8 Hz, 1 H, H-1′), 5.05 (br. s, 1 H, H-1), 4.88−4.76 (2d, J_{gem} = 10.8 Hz, 2 H, CH_2Ph), 4.73−4.56 (2d, J_{gem} = 12.0 Hz, 2 H, CH_2Ph), 4.50 (br. s, 1 H, H-5), 4.06 (dd, $J_{5',6'a}$ = 4.2, $J_{6'a,6'b}$ = 9.8 Hz, 1 H, H-6′a), 3.99 (br. d, $J_{4,OH}$ = 12.6 Hz, 1 H, H-4), 3.93 (dd, $J_{2',3'}$ = $J_{3',4'}$ = 9.4 Hz, 1 H, H-3′), 3.82 (m, 1 H, H-3), 3.79 (s, 3 H, COOCH_3), 3.76−3.63 (m, 4 H, H-2, H-4′, H-5′ and H-6′b), 3.48 (d, $J_{14,OH}$ = 12.6 Hz, 1 H, O*H*), 3.37 (dd, 1 H, H-2′), 1.64 [m, 1 H, C*H*(CH_3)$_2$], 0.90−0.83 [4s, 12 H, C(CH_3)$_2$ and CH(CH_3)$_2$], 0.20−0.17 [2s, 6 H, Si(CH_3)$_2$] ppm. FAB-MS: *m*/*z* = 828 [MNa^+].

Methyl [Dimethylthexylsilyl 4-*O*-Acetyl-2-*O*-(2-azido-3-*O*-benzyl-4,6-*O*-benzylidene-2-deoxy-α-D-glucopyranosyl)-3-*O*-benzyl-β-L-idopyranoside]uronate (15): $[\alpha]_D^{20} = +75.0$ ($c = 1$, $CHCl_3$). TLC (hexane/EtOAc, 4:1). $R_f = 0.48$. ^{1}H NMR (500 MHz, $CDCl_3$): δ = 7.46−7.24 (m, 15 H, Ph), 5.50 (s, 1 H, PhC*H*O), 5.21 (d, $J_{1',2'}$ = 3.7 Hz, 1 H, H-1′), 5.17 (br. s, 1 H, H-4), 5.02 (br. s, 1 H, H-1), 4.88−4.74 (2d, J_{gem} = 11.2 Hz, 2 H, CH_2Ph), 4.78−4.62 (2d, J_{gem} = 12.0 Hz, 2 H, CH_2Ph), 4.55 (d, $J_{4,5}$ = 2.0 Hz, 1 H, H-5), 3.90 (dd, $J_{2',3'}$ = $J_{3',4'}$ = 9.5 Hz, 1 H, H-3′), 3.83 (m, 1 H, H-6′a), 3.78 (m, 1 H, H-3), 3.73 (s, 3 H, COOCH_3), 3.66−3.52 (m, 4 H, H-2, H-4′, H-5′ and H-6′b), 3.14 (dd, 1 H, H-2′), 1.94 (s, 3 H, OCOCH_3), 1.65 [m, 1 H, C*H*(CH_3)$_2$], 0.88−0.86 [4s, 12 H, C(CH_3)$_2$ and CH(CH_3)$_2$], 0.30−0.18 [2s, 6 H, Si(CH_3)$_2$] ppm. FAB-MS: *m*/*z* = 870 [MNa^+]. $C_{44}H_{57}N_3O_{12}Si$ (848.0): calcd. C 62.32, H 6.78, N 4.96; found C 62.39, H 7.15, N 4.70.

Methyl [Dimethylthexylsilyl 2-*O*-(2-azido-3-*O*-benzyl-4,6-*O*-benzylidene-2-deoxy-β-D-glucopyranosyl)-3-*O*-benzyl-β-L-idopyranoside]-uronate (16): $[\alpha]_D^{20} = -19.5$ ($c = 1$, $CHCl_3$). TLC (toluene/EtOAc, 15:1). $R_f = 0.13$. ^{1}H NMR (500 MHz, $CDCl_3$): δ = 7.49−7.12 (m, 15 H, Ph), 5.56 (s, 1 H, PhC*H*O), 5.13 (br. s, 1 H, H-1), 4.91−4.78 (2d, J_{gem} = 11.0 Hz, 2 H, CH_2Ph), 4.76−4.60 (2d, J_{gem} = 11.5 Hz, 2 H, CH_2Ph), 4.46 (d, $J_{4,5}$ = 2.0 Hz, 1 H, H-5), 4.32 (br. d, 1 H, H-1′), 4.26 (dd, $J_{5',6'a}$ = 5.1, $J_{6'a,6'b}$ = 10.6 Hz, 1 H, H-6′a), 4.05 (br. d, $J_{4,OH}$ = 12.2 Hz, 1 H, H-4), 3.91 (m, 1 H, H-3), 3.79 (s, 3 H, COOCH_3), 3.72−3.61 (m, 3 H, H-2, H-4′ and H-6′b), 3.59 (t, $J_{2',3'}$ = $J_{3',4'}$ = 9.2 Hz, 1 H, H-3′), 3.43 (t, $J_{1',2'}$ = 8.7 Hz, 1 H, H-2′), 3.25 (dt, $J_{4',5'}$ = $J_{5',6'b}$ = 9.5 Hz, 1 H, H-5′), 1.62 [m, 1 H, C*H*(CH_3)$_2$], 0.88−0.86 [4s, 12 H, C(CH_3)$_2$ and CH(CH_3)$_2$], 0.22−0.17 [2s, 6 H, Si(CH_3)$_2$] ppm. FAB-MS: *m*/*z* = 828 [MNa^+]. $C_{42}H_{55}N_3O_{11}Si$ (806.0): calcd. C 62.59, H 6.88, N 5.21; found C 62.55, H 7.33, N 4.75.

Methyl [Dimethylthexylsilyl 2-*O*-(2-Azido-3-*O*-benzyl-4,6-*O*-benzylidene-2-deoxy-α-D-glucopyranosyl)-4-*O*-(2-azido-3-*O*-benzyl-4,6-*O*-benzylidene-2-deoxy-α-D-glucopyranosyl)-3-*O*-benzyl-β-L-idopyranoside]uronate (17): TLC (toluene/EtOAc, 15:1). $R_f = 0.39$. ^{1}H NMR (500 MHz, $CDCl_3$): δ = 7.41−7.04 (m, 25 H, Ph), 5.49−5.47 (2s, 2 H, PhC*H*O), 5.42 (d, $J_{1'',2''}$ = 3.9 Hz, 1 H, H-1′′), 5.01 (br. s, 1 H, H-1), 4.88 (d, $J_{1',2'}$ = 3.6 Hz, 1 H, H-1′), 4, 1 H.81−4.60 (m, 6 H, CH_2Ph), 4.43 (br. s, 1 H, H-5), 4.33 (dd, $J_{5',6'a}$ = 5.0, $J_{6'a,6'b}$ = 10.0 Hz, H-6′a), 4.26−3.97 (m, 6 H, H-3, H-4, H-3′, H-3′′, H-6′′a, H-5′ or H-5′′), 3.88 (dt, $J_{5,6a}$ = 5.1, $J_{4,5}$ = $J_{5,6b}$ = 10.1 Hz, 1 H, H-5′ or H-5′′), 3.79 (br. s, 1 H, H-2), 3.75 (s, 3 H, COOCH_3), 3.68−3.58 (m, 4 H, H-4′, H-4′′, H-6′b and H-6′′b), 3.36 (dd, $J_{2',3'}$ = 9.9 Hz, 1 H, H-2′), 3.28 (dd, $J_{2'',3''}$ = 9.8 Hz, 1 H, H-2′′), 1.67 [m, 1 H, C*H*(CH_3)$_2$], 0.89−0.87 [4s, 12 H, C(CH_3)$_2$ and CH(CH_3)$_2$], 0.32−0.20 [2s, 6 H, Si(CH_3)$_2$] ppm. FAB-MS: *m*/*z* = 1194 [MNa^+]. $C_{62}H_{74}N_6O_{15}Si$ (1171.4): calcd. C 63.57, H 6.37, N 7.17; found C 63.21, H 6.07, N 7.00.

Methyl [Dimethylthexylsilyl 4-*O*-(6-*O*-Acetyl-2-azido-3,4-di-*O*-benzyl-2-deoxy-α-D-glucopyranosyl)-2-*O*-benzoyl-3-*O*-benzyl-β-L-idopyranoside]uronate (21): TMSOTf (39 μL, 0.22 mmol) was added under argon to a cooled (0 °C) solution of **7** (1.90 g, 4.32 mmol) in dry CH_2Cl_2 (100 mL). While the reaction mixture was stirred, a solution of **18** (2.48 g, 4.32 mmol) in dry CH_2Cl_2 (25 mL) was added dropwise. After 30 min, the mixture was neutralized with saturated aqueous $NaHCO_3$ solution, and CH_2Cl_2 (400 mL) was then added. The suspension was washed with H_2O (250 mL). The organic layer was dried ($MgSO_4$) and concentrated in vacuo, and the residue was separated by flash column chromatography (toluene/EtOAc, 12:1) to obtain unchanged acceptor **7** (363 mg, 19%) and fractions containing the desired disaccharide; these were combined, concentrated, and dissolved in Py (15 mL). Benzoyl chloride (4.1 mL, 35 mmol) was added and the solution was stirred at room temperature. After 24 h, the mixture was diluted with CH_2Cl_2

(400 mL), washed with H_2O (300 mL), dried ($MgSO_4$), and concentrated in vacuo. The residue was purified by flash column chromatography (toluene/EtOAc, 12:1) to yield **21** (2.12 g, 51%). Disaccharide **22** and trisaccharide **23** were also isolated from the reaction mixture.

Compound 21: $[\alpha]_D^{20} = +18.0$ ($c = 1$, $CHCl_3$). TLC (toluene/EtOAc, 12:1). $R_f = 0.26$. ^1H NMR (500 MHz, $CDCl_3$): δ = 8.11−7.22 (m, 20 H, Ph), 5.17 (br. s, 1 H, H-1), 5.07 (br. s, 1 H, H-2), 4.84−4.74 (2d, $J_{gem} = 11.7$ Hz, 2 H, CH_2Ph), 4.72 (d, $J_{1',2'} = 3.4$ Hz, 1 H, H-1′), 4.67−4.49 (2d, $J_{gem} = 10.7$ Hz, 2 H, CH_2Ph), 4.48 (br. s, 1 H, H-5), 4.38 (dd, $J_{5',6'a} = 1.8$, $J_{6'a,6'b} = 12.4$ Hz, 1 H, H-6′a), 4.30 (dd, $J_{5',6'b} = 2.3$ Hz, 1 H, H-6′b), 4.23 (m, 1 H, H-3), 4.07 (m, 1 H, H-5′), 4.01 (br. s, 1 H, H-4), 3.96−3.87 (2d, $J_{gem} = 10.7$ Hz, 2 H, CH_2Ph), 3.75 (s, 3 H, COOCH_3), 3.53−3.43 (m, 2 H, H-3′and H-4′), 3.12 (dd, $J_{2',3'} = 10.1$ Hz, 1 H, H-2′), 1.99 (s, 3 H, OCOCH_3), 1.56 [m, 1 H, CH(CH$_3$)$_2$], 0.79−0.75 [4s, 12 H, C(CH_3)$_2$ and CH(CH_3)$_2$], 0.25−0.13 [2s, 6 H, Si(CH_3)$_2$] ppm. ^{13}C NMR (125 MHz, $CDCl_3$): δ = 170.6, 168.6, 166.6, 137.9, 127.7, 99.7, 94.0, 79.9, 77.3, 75.6, 75.0, 74.9, 74.6, 73.4, 73.0, 70.1, 68.7, 63.7, 62.3, 52.2, 34.0, 24.8, 20.9, 20.2, 18.4, −2.0, −3.4 ppm. FAB-MS: m/z = 976 [MNa$^+$]. $C_{51}H_{63}N_3O_{13}Si$ (954.2): calcd. C 64.20, H 6.66, N 4.40; found C 64.47, H 6.64, N 4.24.

Methyl [Dimethylthexylsilyl 2-*O*-(6-*O*-Acetyl-2-azido-3,4-di-*O*-benzyl-2-deoxy-α-D-glucopyranosyl)-4-*O*-benzoyl-3-*O*-benzyl-β-L-idopyranoside]uronate (22): $[\alpha]_D^{20} = +70.4$ ($c = 0.98$, $CHCl_3$). TLC (toluene/EtOAc, 12:1). $R_f = 0.39$. ^1H NMR (500 MHz, $CDCl_3$): δ = 8.06−7.11 (m, 20 H, Ph), 5.20 (br. s, 1 H, H-4), 5.15 (d, $J_{1',2'} = 3.5$ Hz, 1 H, H-1′), 5.08 (br. s, 1 H, H-1), 4.86−4.73 (2d, $J_{gem} = 11.8$ Hz, 2 H, CH_2Ph), 4.70 (d, $J_{4,5} = 1.8$ Hz, 1 H, H-5), 4.51−4.32 (2d, $J_{gem} = 11.1$ Hz, 2 H, CH_2Ph), 4.23 (dd, $J_{2,3} = J_{3,4} = 2.6$ Hz, 1 H, H-3), 4.06−4.02 (m, 2 H, H-6′a and CH_2Ph), 3.83 (dd, $J_{5',6'b} = 1.6$, $J_{6'a,6'b} = 12.1$ Hz, 1 H, H-6′b), 3.78 (d, $J_{gem} = 10.6$ Hz, 1 H, CH_2Ph), 3.71 (s, 4 H, H-2 and COOCH_3), 3.46 (m, 1 H, H-5′), 3.26 (t, $J_{3',4'} = J_{4',5'} = 9.3$ Hz, 1 H, H-4′), 3.17 (dd, 1 H, H-3′), 2.94 (dd, $J_{2',3'} = 10.4$ Hz, 1 H, H-2′), 1.95 (s, 3 H, OCOCH_3), 1.65 [m, 1 H, CH(CH$_3$)$_2$], 0.89−0.87 [4s, 12 H, C(CH_3)$_2$ and CH(CH_3)$_2$], 0.33−0.21 [2s, 6 H, Si(CH_3)$_2$] ppm. FAB-MS: m/z = 976 [MNa$^+$]. MS-HRFAB: calcd. for $C_{51}H_{63}N_3O_{13}SiNa$: 976.4028, found 976.4069. $C_{51}H_{63}N_3O_{13}Si$ (954.2): calcd. C 64.20, H 6.66, N 4.40; found C 63.75, H 6.86, N 4.48.

Methyl [Dimethylthexylsilyl 2-*O*-(6-*O*-Acetyl-2-azido-3,4-di-*O*-benzyl-2-deoxy-α-D-glucopyranosyl)-4-*O*-(6-*O*-acetyl-2-azido-3,4-di-*O*-benzyl-2-deoxy-α-D-glucopyranosyl)-3-*O*-benzyl-β-L-idopyranoside]uronate (23): $[\alpha]_D^{20} = +89.5$ ($c = 1.33$, $CHCl_3$). TLC (toluene/EtOAc, 12:1). $R_f = 0.14$. ^1H NMR (500 MHz, $CDCl_3$): δ = 7.47−7.14 (m, 25 H, Ph), 5.36 (d, $J_{1'',2''} = 3.9$ Hz, 1 H, H-1′′), 4.98 (m, 2 H, H-1 and H-1′), 4.93 (d, $J_{gem} = 10.4$ Hz, 1 H, CH_2Ph), 4.86−4.80 (2d, $J_{gem} = 10.5$ Hz, 2 H, CH_2Ph), 4.76−4.73 (m, 3 H, CH_2Ph), 4.70−4.64 (2d, $J_{gem} = 11.9$ Hz, 2 H, CH_2Ph), 4.56 (d, $J_{gem} = 11.4$ Hz, 1 H, CH_2Ph), 4.51 (d, $J_{gem} = 11.3$ Hz, 1 H, CH_2Ph), 4.43 (d, $J_{4,5} = 1.6$ Hz, 1 H, H-5), 4.33 (dd, $J_{5',6'a} = 1.7$, $J_{6'a,\ 6'b} = 12.3$ Hz, 1 H, H-6′a), 4.20−3.95 (m, 8 H, H-3, H-4, H-3′, H-3′′, H-6′′a, H-6′b, H-6′′b, H-5′ or H-5′′), 3.84 (m, 1 H, H-5′ or H-5′′), 3.77 (br. s, 1 H, H-2), 3.73 (s, 3 H, COOCH_3), 3.56−3.51 (2t, $J_{3,4} = J_{4,5} = 9.4$ Hz, 2 H, H-4′ and H-4′′), 3.28 (dd, $J_{1',2'} = 3.6$, $J_{2',3'} = 9.9$ Hz, 1 H, H-2′), 3.26 (dd, $J_{2'',3''} = 10.0$ Hz, 1 H, H-2′′), 1.94−1.93 (2s, 6 H, OCOCH_3), 1.67 [m, 1 H, CH(CH$_3$)$_2$], 0.89−0.87 [4s, 12 H, C(CH_3)$_2$ and CH(CH_3)$_2$], 0.31−0.20 [2s, 6 H, Si(CH_3)$_2$] ppm. FAB-MS: m/z = 1282 [MNa$^+$]. $C_{66}H_{83}N_6O_{17}Si$ (1260.5): calcd. C 62.89, H 6.64, N 6.67; found C 62.61, H 6.73, N 6.23.

Methyl [Dimethylthexylsilyl 2-*O*-Acetyl-4-*O*-(2-azido-3-*O*-benzyl-4,6-*O*-benzylidene-2-deoxy-α-D-glucopyranosyl)-3-*O*-benzyl-β-L-idopyranoside]uronate (24): Compound **13** (204 mg, 0.25 mmol) was dissolved in Py (2 mL) at 0 °C. Acetic anhydride (1 mL) was added, and the mixture was stirred at 0 °C for 24 h and at room temperature for 48 h. The solution was diluted with CH_2Cl_2 (50 mL), washed with H_2O, dried ($MgSO_4$), and concentrated in vacuo. The residue was coevaporated twice with toluene (20 mL) and then purified by column chromatography (hexane/EtOAc, 6:1) to afford **24** (200 mg, 93%): $[\alpha]_D^{20} = +29.5$ ($c = 1$, $CHCl_3$). TLC (hexane/EtOAc, 4:1). $R_f = 0.38$. ^1H NMR (500 MHz, $CDCl_3$): δ = 7.45−7.24 (m, 15 H, Ph), 5.51 (s, 1 H, PhCHO), 5.07 (br. s, 1 H, H-1), 4.97 (br. s, 1 H, H-2), 4.76 (d, $J_{1',2'} = 3.5$ Hz, 1 H, H-1′), 4.88−4.70 (2d, $J_{gem} = 11.1$ Hz, 2 H, CH_2Ph), 4.74−4.66 (2d, $J_{gem} = 11.8$ Hz, 2 H, CH_2Ph), 4.47 (br. s, 1 H, H-5), 4.30 (dd, $J_{5',6'a} = 4.9$, $J_{6'a,6'b} = 10.1$ Hz, 1 H, H-6′a), 4.04−3.95 (m, 4 H, H-3, H-4, H-3′ and H-5′), 3.75 (s, 3 H, COOCH_3), 3.64−3.59 (m, 2 H, H-4′ and H-6′b), 3.28 (dd, $J_{2',3'} = 9.9$ Hz, 1 H, H-2′), 2.03 (s, 3 H, OCOCH_3), 1.61 [m, 1 H, CH(CH$_3$)$_2$], 0.86−0.83 [4s, 12 H, C(CH_3)$_2$ and CH(CH_3)$_2$], 0.24−0.14 (2s, 6 H, Si(CH_3)$_2$] ppm. ^{13}C NMR (125 MHz, $CDCl_3$): δ = 170.7, 168.8, 137.8, 126.1, 101.6, 98.4, 93.7, 82.6, 76.0, 74.8, 74.3, 73.6, 73.4, 72.9, 68.5, 67.7, 63.2, 63.1, 52.1, 34.1, 24.8, 21.0, 20.2, 18.4, −2.0, −3.6 ppm. FAB-MS: m/z = 870 [MNa$^+$]. $C_{44}H_{57}N_3O_{12}Si$ (848.0): calcd. C 62.32, H 6.78, N 4.96; found C 62.37, H 6.98, N 4.89.

Methyl (Dimethylthexylsilyl 3-*O*-Benzyl-2,4-*O*-*p*-methoxybenzylidene-β-L-idopyranoside)uronate (28): A catalytic amount of *p*TsOH was added to a solution of diol **7** (1.84 g, 4.17 mmol) and *p*-methoxybenzaldehyde dimethylacetal (1.43 mL, 8.34 mmol) in DMF (10 mL). The reaction was carried out under reduced pressure (20−30 mbar) by use of a rotary evaporator at 45 °C for 3.5 h. The major part of the solvent was then removed by reduced pressure, and the residue was taken up in ethyl acetate (100 mL), washed with saturated $NaHCO_3$ solution and brine, dried with $MgSO_4$, filtered, and concentrated in vacuo. Column chromatography (hexane/EtOAc, 20:1 → 10:1) afforded **28** (1.91 g, 82%) as a colorless oil. $[\alpha]_D^{20} = +30.1$ ($c = 1.03$, $CHCl_3$). TLC (hexane/EtOAc, 3:1). $R_f = 0.65$. ^1H NMR (500 MHz, $CDCl_3$): δ = 7.38−7.34 (m, 9 H, Ph), 7.02 (s, 1 H, CH$_3$OPhCHO), 5.44 (s, 1 H, H-1), 4.87 (d, 1 H, H-5), 4.72 (d, $J_{gem} = 11.9$ Hz, 1 H, CH_2Ph), 4.67 (d, 1 H, CH_2Ph), 4.32−4.30 (m, 1 H, H-4), 4.25−4.22 (m, 1 H, H-3), 3.91 (d, $J_{2,3} = 4.1$ Hz, 1 H, H-2), 3.78 (s, 6 H, COOCH_3, CH_3OPhCHO), 1.70−1.66 [m, 1 H, CH(CH$_3$)$_2$], 0.91−0.88 [4s, 12 H, C(CH_3)$_2$ and CH(CH_3)$_2$], 0.28−0.18 [2s, 6 H, Si(CH_3)$_2$] ppm. ^{13}C NMR (125 MHz, $CDCl_3$): δ = 169.9, 160.5, 137.7, 131.6, 129.1, 128.7, 128.1, 128.0, 114.0, 96.7, 93.5, 77.9, 77.0, 74.1, 72.5, 72.1, 70.7, 69.8, 55.7, 52.7, 34.6, 25.0, 20.7, 20.4, 19.1, 18.9, −1.7, −2.7 ppm. FAB-MS: m/z = 581 [MNa$^+$].

Methyl (Dimethylthexylsilyl 3-*O*-Benzyl-2-*O*-*p*-methoxybenzyl-β-L-idopyranoside)uronate (29): Acetal **28** (1.42 g, 2.7 mmol) and powdered molecular sieves (3 Å) in CH_3CN (50 mL) were stirred at room temperature for 30 min, then cooled to −45 °C and treated with $NaBH_3CN$ (1 M solution in THF, 8.2 mL). After the mixture had been stirred for 5 min, a solution of TMSCl (0.88 mL in 16 mL of CH_3CN) was added dropwise to the reaction mixture. After 1 h, TLC analysis indicated the complete conversion of the starting material. The solution was diluted with CH_2Cl_2 (50 mL) and filtered through Celite, and the filtrate was washed with saturated $NaHCO_3$ solution. The aqueous layer was further extracted with CH_2Cl_2 (2 × 100 mL), and the organic layers were combined, dried with $MgSO_4$, and concentrated in vacuo. Purification over silica gel (hexane/EtOAc, 10:1 → 4:1) gave **29** (1.21 g, 85%) as a colorless

oil. $[\alpha]_D^{20}$ = +71.6 (*c* = 1.16 $CHCl_3$). TLC (hexane/EtOAc, 3:1). R_f = 0.36. ^{1}H NMR (500 MHz, $CDCl_3$): δ = 7.33−6.82 (m, 9 H, Ph), 5.03 (s, 1 H, H-1), 4.80 (d, J_{gem} = 11.8 Hz, 1 H, CH_2Ph), 4.53 (d, J_{gem} = 12.0 Hz, 1 H, CH_2PhOMe), 4.52 (d, 1 H, CH_2Ph), 4.45 (m, 2 H, CH_2PhOMe, H-5), 3.93 (m, 1 H, H-4), 3.86 (d, $J_{4,OH}$ = 11.9 Hz, O*H*), 3.79−3.76 (2s, 6 H, COOCH_3, CH_3OPhCH$_2$), 3.73 (t, $J_{2,3}$ = $J_{3,4}$ = 3.1 Hz, 1 H, H-3), 3.46 (d, 1 H, H-2), 1.67−1.63 [m, 1 H, C*H*(CH$_3$)$_2$], 0.89−0.88 [4s, 12 H, C(CH_3)$_2$ and CH(CH_3)$_2$], 0.25−0.17 [2s, 6 H, Si(CH_3)$_2$] ppm. ^{13}C NMR (125 MHz, $CDCl_3$): δ = 169.4, 159.4, 137.4, 129.8, 129.6, 128.6, 128.1, 127.6, 113.8, 94.8, 77.3, 77.2, 75.8, 75.0, 74.7, 74.0, 72.2, 67.8, 55.3, 52.1, 34.0, 24.9, 20.2, 18.6, 10.3, −1.7, −3.5 ppm.

Methyl (Dimethylthexylsilyl 4-*O*-(2-Azido-3-*O*-benzyl-4,6-*O*-benzylidene-2-deoxy-α-D-glucopyranosyl)-3-*O*-benzyl-2-*O*-*p*-methoxybenzyl-β-L-idopyranoside)uronate (30): Alcohol **29** (199 mg, 0.38 mmol) and glycosyl donor **8** (239 mg, 0.45 mmol) were dried together overnight under high vacuum, taken up in CH_2Cl_2 (2 mL) under argon, cooled to −10 °C, and treated with a freshly prepared TMSOTf solution (0.15 M, 100 μL, 0.015 mmol, 0.04 equiv.). TLC analysis indicated completion of the reaction after 20 min. The reaction mixture was quenched with saturated $NaHCO_3$ solution (1 mL), diluted with CH_2Cl_2 (10 mL), and extracted twice with CH_2Cl_2/H_2O. The collected organic fractions were washed with brine and dried with $MgSO_4$, and the solvent was removed under reduced pressure. Chromatographic purification (toluene/EtOAc, 40:1) yielded disaccharide **30** (298 mg, 85%) as a colorless gum. $[\alpha]_D^{20}$ = +21.6 (*c* = 0.33, $CHCl_3$). TLC (toluene/EtOAc, 12:1). R_f = 0.47. ^{1}H NMR (500 MHz, $CDCl_3$): δ = 7.52−6.61 (m, 19 H, Ph), 5.49 (s, 1 H, PhC*H*O), 5.04 (d, $J_{1,2}$ = 1.4 Hz, 1 H, H-1), 4.84 (d, $J_{1',2'}$ = 3.5 Hz, 1 H, H-1′), 4.75 (d, J_{gem} = 11.2 Hz, 1 H, CH_2Ph), 4.64 (d, J_{gem} = 11.6 Hz, 1 H, CH_2Ph), 4.60 (d, 1 H, CH_2Ph), 4.49 (d, 1 H, CH_2Ph), 4.45 (d, J_{gem} = 11.2 Hz, 1 H, CH_2Ph), 4.40 (s, 1 H, H-4), 4.35 (dd, $J_{5',6'a}$ = 5.0, $J_{6'a,6'b}$ = 9.9 Hz, 1 H, H-6′a), 4.20−4.16 (m, 1 H, H-5′), 4.13 (d, 1 H, CH_2Ph), 3.73−3.71 (m, 4 H, COOCH_3, H-3′), 3.54 (dd, $J_{5',6'b}$ = 3.5 Hz, 1 H, H-6′b), 3.54 (t, $J_{3',4'}$ = $J_{4',5'}$ = 10.2 Hz, 1 H, H-4′), 3.43−3.41 (m, 4 H, CH_3OPhCH$_2$, H-2), 3.11 (dd, $J_{2',3'}$ = 10.0 Hz, 1 H, H-2′), 1.69−1.65 [m, 1 H, C*H*(CH$_3$)$_2$], 0.90−0.88 [4s, 12 H, C(CH_3)$_2$ and CH(CH_3)$_2$], 0.31−0.19 [2s, 6 H, Si(CH_3)$_2$] ppm. ^{13}C NMR (125 MHz, $CDCl_3$): δ = 169.1, 158.8, 138.3, 137.9, 131.0, 129.1, 128.9, 128.6, 128.2, 128.1, 127.9, 127.8, 127.5, 126.4, 126.3, 113.7, 113.6, 101.4, 99.0, 96.2, 82.8, 76.1, 75.8, 75.3, 74.7, 74.3, 73.9, 73.3, 72.9, 68.5, 63.1, 54.8, 51.9, 34.1, 29.7, 24.9, 22.7, 20.2, 18.6, 14.1 ppm. FAB-MS: *m*/*z* = 949 [MNa^+].

Hydrolysis of the *p*-Methoxybenzyl Ether of 30: Disaccharide **30** (103 mg, 0.13 mmol) was dissolved in a mixture of CH_2Cl_2/H_2O (10:1, 3 mL), and DDQ (0.13 mmol, 44 mg) was added slowly whilst stirring at room temperature. After 40 min, TLC analysis indicated the complete hydrolysis of the starting material. The reaction mixture was diluted with CH_2Cl_2 (10 mL) and quenched by addition of H_2O (2 mL). After extraction with CH_2Cl_2/saturated $NaHCO_3$ solution, followed by the washing of the organic fraction with brine, drying over $MgSO_4$, and removal of the solvent under reduced pressure, the crude residue was subjected to column chromatography (hexane/EtOAc, 4:1) to afford disaccharide **13** (97 mg, 90%) as a colorless gum. The spectroscopic data of the compound were in agreement with the data reported above.

Dimethylthexylsilyl (3-*O*-Benzyl-β-L-idopyranuroside)-6,2-lactone (31): Diol **7** (1.91 g, 4.33 mmol) and $(Bu_3Sn)_2O$ (1.11 mL, 2.17 mmol) were dissolved in toluene (60 mL) and heated at reflux for 4 h with use of a Dean−Stark device for the continuous removal of reaction water. After the mixture had cooled to room temperature, the stannylene complex was hydrolyzed by addition of saturated $NaHCO_3$ solution and the mixture was extracted with EtOAc (2 × 150 mL). The joined organic extracts were washed with brine and dried with $MgSO_4$. Purification by column chromatography afforded the lactone **31** (1.36 g, 77%) as a colorless oil. $[\alpha]_D^{20}$ = +41.0 (*c* = 8.58, $CHCl_3$). TLC (hexane/EtOAc, 2:1). R_f = 0.69. ^{1}H NMR (300 MHz, $CDCl_3$): δ = 7.38−7.33 (m, 5 H, Ph), 5.48 (s, 1 H, H-1), 4.73 (d, J_{1gem} = 12 Hz, 1 H, CH_2Ph), 4.59 (d, 1 H, CH_2Ph), 4.53 (d, $J_{2,3}$ = 4.1 Hz, 1 H, H-2), 4.26 (d, $J_{15,4}$ = 4 Hz, 1 H, H-5), 4.13 (br. s, 1 H, H-4), 3.83−3.81 (m, 1 H, H-3), 2.90 (br. s, 1 H, O*H*), 1.64−1.55 [m, 1 H, C*H*(CH$_3$)$_2$], 0.87−85 [4s, 12 H, C(CH_3)$_2$ and CH(CH_3)$_2$], 0.22−0.09 [2s, 6 H, Si(CH_3)$_2$] ppm. ^{13}C NMR (75 MHz, $CDCl_3$): δ = 170.4, 137.4, 129.1, 128.7, 128.5, 88.9, 79.0, 78.0, 72.7, 72.5, 71.4, 34.5, 25.1, 20.6, 20.4, 19.0, 18.8, −1.6, −2.7 ppm. FAB-MS: *m*/*z* = 431 [MNa^+].

Methyl (Phenyl 3-*O*-Benzyl-1-thio-α,β-L-idopyranoside)uronate (32): Methyl (acetyl 2,4-di-*O*-acetyl-3-*O*-benzyl-α,β-L-idopyranoside)uronate[15a] (1.44 g, 3.40 mmol) in CH_2Cl_2 (30 mL) was cooled to 0 °C and treated first with BF_3·Et_2O (2.15 mL, 17 mmol) and then with thiophenol (0.38 mL, 3.7 mmol). The reaction mixture was stirred at room temperature overnight and neutralized by addition of saturated $NaHCO_3$ solution (50 mL). The organic layer was separated, washed with brine, dried with $MgSO_4$, and concentrated in vacuo. The crude material was purified by column chromatography (hexane/EtOAc, 4:1) to obtain the thioglycoside as a mixture of anomers. The thioglycoside (1.28 g, 2.7 mmol) was dissolved in methanol, cooled to 0 °C, and treated with a catalytic amount (20 mg) of sodium. The cooling bath was removed after complete solution of the sodium, and the reaction mixture was stirred at room temperature until TLC analysis indicated complete conversion of the starting material. After neutralization with acidic resin (Amberlite IR-120) and filtration, the solvent was removed under reduced pressure and the crude material (780 mg, 73% over two steps) was used as such for the next step. **Data for the β Anomer:** $[\alpha]_D^{20}$ = −86.3 (*c* = 0.93, $CHCl_3$). TLC (hexane/EtOAc, 1:1). R_f = 0.4. ^{1}H NMR (500 MHz, $CDCl_3$): δ = 7.50−7.22 (m, 10 H, Ph), 5.55 (s, 1 H, H-1), 5.21 (d, $J_{4,5}$ = 1.4 Hz, 1 H, H-5), 4.77 (d, J_{gem} = 11.8 Hz, 1 H, CH_2Ph), 4.61 (d, 1 H, CH_2Ph), 4.16 (m, 1 H, H-4), 4.12−4.11 (m, 1 H, H-2), 3.81−3.80 (m, 4 H, COOCH_3, H-3) ppm. ^{13}C NMR (75 MHz, $CDCl_3$): δ = 171.1, 137.7, 136.7, 131.4, 129.4, 129.0, 128.9, 128.6, 128.4, 128.1, 128.0, 127.7, 89.9, 74.7, 72.7, 69.3, 69.1, 68.8, 53.0 ppm.

Methyl (Phenyl 2-*O*-Benzoyl-3-*O*-benzyl-1-thio-α,β-L-idopyranoside)uronate (33): A mixture of **32** (800 mg, 2.06 mmol) and Bu_2SnO (565 mg, 2.27 mmol) in methanol was heated at reflux under an inert gas for 1 h until the turbid solution became clear. The solvent was removed in vacuo, and the resulting foam was dried under high vacuum for one hour. The stannylene acetal was then dissolved in dioxane (30 mL), cooled to 0 °C, and treated with excess BzCl (2.39 mL, 20.6 mmol) and Et_3N (2.9 mL, 21 mmol). Upon addition of the base, rapid formation of an insoluble salt was observed. TLC analysis indicated complete consumption of the starting material after 30 min. After neutralization with acidic resin (Amberlite IR-120) and filtration by suction through a pad of Celite, the solvent was removed by evaporation under reduced pressure, coevaporating three times with toluene. The crude residue was then subjected to column chromatography (hexane/EtOAc, 4:1 → 1:1) to afford the pure 2-*O*-benzoyl derivative **33** as a mixture of anomers (814 mg, 80%). $[\alpha]_D^{20}$ = −11.8 (*c* = 0.17, $CHCl_3$). TLC (hexane/EtOAc, 2:1). R_f = 0.37. ^{1}H NMR (500 MHz, $CDCl_3$): δ = 8.08−7.26 (m, 30 H, Ph), 5.73 (s, 1 H, H-1α), 5.51−5.49 (m, 1 H, H-2α), 5.41 (m, 2 H, H-5α, H-2β), 5.31 (d, $J_{1,2}$ = 1.5 Hz, 1 H, H-

1β), 4.90 (d, J_{gem} = 12 Hz, 1 H, CH_2Ph), 4.78 (d, J_{gem} = 11.7 Hz, 1 H, CH_2Ph), 4.71 (d, 1 H, CH_2Ph), 4.69 (d, 1 H, CH_2Ph), 4.62 (s, 1 H, H-5β), 4.15 (m, 1 H, H-4α), 4.03 (m, 2 H, H-3β, H-4β), 3.94 (m, 1 H, H-3α), 3.83 (2s, 6 H, COOCH_3), 2.83 (d, $J_{4,OH}$ = 12 Hz, 1 H, O*H*) ppm. FAB-MS: *m*/*z* = 494 [MNa^+].

Methyl (Phenyl 4-*O*-(2-Azido-3-*O*-benzyl-4,6-*O*-benzylidene-α-D-glucopyranosyl)-2-*O*-benzoyl-3-*O*-benzyl-1-thio-α-L-idopyranoside)-uronate (34): Acceptor **33α** (160 mg, 0.32 mmol) and donor **7** (222 mg, 0.42 mmol) were dried under high vacuum, dissolved in CH_2Cl_2 (4 mL), cooled to 0 °C, and treated with a freshly prepared TMSOTf solution in CH_2Cl_2 (0.17 M, 100 μL, 0.017 mmol, 4%). After stirring for 1 h, the reaction mixture was quenched with saturated $NaHCO_3$ solution (1.5 mL), the mixture was extracted with CH_2Cl_2/H_2O, the organic fraction was dried with $MgSO_4$, and the solvent was removed under reduced pressure. Column chromatography of the crude residue afforded the disaccharide **34** (183 mg, 65%). $[\alpha]_D^{20}$ = −97.8 (*c* = 0.72, $CHCl_3$). TLC (toluene/EtOAc, 5:1). R_f = 0.61. ^{1}H NMR (500 MHz, $CDCl_3$): δ = 8.13−7.21 (m, 25 H, Ph), 5.80 (s, 1 H, H-1), 5.48 (s, 1 H, PhC*H*O), 5.41 (s, 1 H, H-2), 5.38 (d, $J_{4,5}$ = 1.6 Hz, 1 H, H-5), 4.98 (d, J_{gem} = 11.7 Hz, 1 H, CH_2Ph), 4.77 (d, 1 H, CH_2Ph), 4.70 (d, $J_{1',2'}$ = 3.6 Hz, 1 H, H-1′), 4.35−3.96 (m, 2 H, CH_2Ph, H-6′a), 4.21 (br. s, 1 H, H-3), 4.10 (br. s, 1 H, H-4), 4.01 (m, 1 H, H-4′), 3.82 (d, J_{gem} = 10.7 Hz, 1 H, CH_2Ph), 3.78 (s, 3 H, COO*C*H_3), 3.61 (t, $J_{5',6'a}$ = $J_{6'a,6'b}$ = 10.2 Hz, 1 H, H-5′), 3.54−3.49 (m, 2 H, H-3′, H-6′b), 3.23−3.20 (m, 1 H, H-2′) ppm. ^{13}C NMR (125 MHz, $CDCl_3$): δ = 169.2, 165.5, 137.8, 137.5, 137.1, 135.5, 133.3, 131.4, 130.0, 129.6, 129.1, 129.0, 128.8, 128.5, 128.3, 128.1, 127.9, 127.7, 127.6, 126.1, 101.3, 100.4, 87.1, 82.3, 76.9, 76.8, 76.7, 74.7, 72.8, 72.3, 69.2, 68.5, 68.3, 63.5, 63.3, 52.3, 2937 ppm. FAB-MS: *m*/*z* = 882 [MNa^+].

Dimethylthexylsilyl 4-*O*-(2-Azido-3-*O*-benzyl-4,6-*O*-benzylidene-2-deoxy-α,β-D-glucopyranosyl)-3-*O*-benzyl-β-L-idopyranoside)-6,2-lactone (35): Alcohol **31** (186 mg, 0.46 mmol) and glycosyl donor **8** (316 mg, 0.60 mmol) were dissolved in CH_2Cl_2 (1 mL), and the solvents were evaporated under reduced pressure to afford a stable foam, which was dried under high vacuum for several h. The mixture was dissolved in CH_2Cl_2 (3 mL) under an inert gas, cooled to −5 °C, and activated by addition of TMSOTf solution (100 μL of a 0.03 M solution in CH_2Cl_2, 0.04 equiv.). After 30 min, the cooling bath was removed and the reaction mixture was warmed to room temperature. After 2.5 h no further evolution was observed, and the reaction was quenched by the addition of saturated $NaHCO_3$ solution (5 mL). After dilution with CH_2Cl_2 (10 mL), the phases were separated and the aqueous layer was further extracted with CH_2Cl_2 (2 × 10 mL). The combined organic extracts were dried with $MgSO_4$ and concentrated in vacuo. Purification by silica gel (hexane/EtOAc, 10:1 → 4:1) afforded the disaccharide **35** (312 mg, 88%) as a mixture of anomers (α/β: 8:1), $[\alpha]_D^{20}$ = +32.0 (*c* = 1.5, $CHCl_3$). TLC (toluene/EtOAc, 9:1). R_f = 0.55. ^{1}H NMR (500 MHz,$CDCl_3$, data for the α anomer): δ = 7.48−7.27 (m, 15 H, Ph), 5.53 (s, 1 H, PhC*H*O), 5.49 (s, 1 H, H-1), 4.93 (d, J_{gem} = 10.9 Hz, 1 H, CH_2Ph), 4.90 (d, $J_{1',2'}$ = 3.9 Hz, 1 H, H-1′), 4.75 (d, 1 H, CH_2Ph), 4.74 (d, J_{gem} = 11.9 Hz, 1 H, CH_2Ph), 4.62 (d, 1 H, CH_2Ph), 4.51 (d, $J_{2,3}$ = 4.1 Hz, 1 H, H-2), 4.44 (d, $J_{4,5}$ = 4.0 Hz, 1 H, H-5), 4.42 (m, 1 H, H-6′a), 3.99 (m, 1 H, H-4), 3.97 (m, 2 H, H-3, H-3′), 3.85 (m, 1 H, H-5′), 3.67 (m, 2 H, H-4′, H-6′b), 3.87 (dd, $J_{2',3'}$ = 10.1 Hz, 1 H, H-2′), 1.59 [m, 1 H, C*H*$(CH_3)_2$], 0.86−0.83 [4s, 12 H, C(CH_3)$_2$ and CH(CH_3)$_2$], 0.14−15 [2s, 6 H, Si(CH_3)$_2$] ppm. ^{13}C NMR (125 MHz, $CDCl_3$): δ = 167.5, 137.7, 137.2, 136.7, 128.9, 128.7, 128.4, 128.2, 128.0, 127.9, 126.1, 101.4, 100.2, 88.7, 82.3, 80.8, 76.8, 76.1, 75.8, 75.1, 72.5, 70.7, 68.4, 63.7, 62.8, 34.1, 24.8, 20.1, 20.0, 18.5, 18.4, −2.1, −3.1 ppm. FAB-MS: *m*/*z* = 796 [MNa^+].

Methanolysis of Lactone 35: Disaccharide **35** (84 mg, 0.11 mmol) and Bu_2SnO (54 mg, 0.22 mmol) were suspended in MeOH (4 mL) and heated at reflux for 5 h, after which TLC analysis indicated the complete methanolysis of the lactone. The Bu_2SnO complex was hydrolyzed by addition of saturated $NaHCO_3$ solution (2 mL), and the desired ester was extracted with CH_2Cl_2 (20 mL). After drying over $MgSO_4$ and evaporation of the solvent under reduced pressure, the obtained residue was subjected to column chromatography to afford disaccharide **13** (80 mg, 0.1 mmol, 75%) as a colorless foam. The β anomer **13β** was also isolated from the reaction mixture. Spectroscopic data for the α anomer were found to be identical with those for compound **13** described above. Physical data for β anomer **13β**: TLC (toluene/EtOAc, 4:1). R_f = 0.59. $[\alpha]_D^{20}$ = −47.3 (*c* = 0.64, $CHCl_3$). ^{1}H NMR (500 MHz, $CDCl_3$): δ = 7.46−7.25 (m, 15 H, Ph), 5.50 (s, 1 H, PhC*H*O), 5.01 (d, $J_{1,2}$ = 1.0 Hz, 1 H, H-1), 4.87 (d, J_{gem} = 11.2 Hz, 1 H, CH_2Ph), 4.76 (d, 1 H, CH_2Ph), 4.62 (d, J_{gem} = 12.3 Hz, 1 H, CH_2Ph), 4.56 (d, 1 H, CH_2Ph), 4.50 (d, $J_{4,5}$ = 1.9 Hz, 1 H, H-5), 4.21 (d, $J_{1',2'}$ = 8.1 Hz, 1 H, H-1′), 4.09 (dd, $J_{6'a,6'b}$ = 10.5, $J_{5',6'a}$ = 5.0 Hz, 1 H, H-6′a), 4.01 (m, 1 H, H-4), 3.95 (m, 1 H, H-3), 3.81 (s, 3 H, COO*C*H_3), 3.69−3.58 (m, 3 H, H-6′b, H-4′, H-2), 3.53 (t, $J_{2',3'}$ = $J_{3',4'}$ = 9.3 Hz, 1 H, H-3′), 3.34−3.31 (m, 1 H, H-2′), 3.27−3.22 (ddd, 1 H, H-5′), 2.56 (d, $J_{2,OH}$ = 8.9 Hz, 1 H, OH), 1.66−1.62 [m, 1 H, C*H*$(CH_3)_2$], 0.87−0.86 [4s, 12 H, C(CH_3)$_2$ and CH(CH_3)$_2$], 0.23−0.17 [2s, 6 H, Si(CH_3)$_2$] ppm. ^{13}C NMR (125 MHz, $CDCl_3$): δ = 168.9, 137.7, 137.5, 137.0, 129.1, 128.6, 128.4, 128.3, 128.1, 127.9, 127.8, 127.7, 126.0, 103.9, 101.3, 94.6, 81.2, 79.4, 77.2, 76.3, 76.1, 74.9, 73.9, 72.3, 68.5, 68.4, 66.2, 66.0, 52.2, 34.1, 25.0, 20.3, 20.1, 18.6, 18.4, 1.0, −1.9, −3.2 ppm. FAB-MS: *m*/*z* = 828 [MNa^+].

Methyl [Dimethylthexylsilyl 2-*O*-Acetyl-4-*O*-(2-azido-3-*O*-benzyl-2-deoxy-α-D-glucopyranosyl)-3-*O*-benzyl-β-L-idopyranoside]uronate (36): EtSH (87 μL, 1.2 mmol) and catalytic *p*TsOH were added to a solution of **24** (100 mg, 0.12 mmol) in dry CH_2Cl_2 (1.5 mL). After stirring for 3 h under argon, the mixture was neutralized with solid $NaHCO_3$, diluted with CH_2Cl_2 (25 mL), washed with H_2O (25 mL), dried ($MgSO_4$), and concentrated to dryness. The purification of the residue was carried out by flash chromatography (hexane/EtOAc, 3:2) to yield **36** (80 mg, 89%). $[\alpha]_D^{20}$ = +52.0 (*c* = 1, $CHCl_3$). TLC (hexane/EtOAc, 3:2). R_f = 0.18. ^{1}H NMR (500 MHz, $CDCl_3$): δ = 7.38−7.27 (m, 10 H, Ph), 5.05 (br. s, 1 H, H-1), 4.96 (br. s, 1 H, H-2), 4.78 (d, $J_{1',2'}$ = 3.3 Hz, 1 H, H-1′), 4.85−4.75 (2d, J_{gem} = 11.2 Hz, 2 H, CH_2Ph), 4.73−4.66 (2d, J_{gem} = 11.7 Hz, 2 H, CH_2Ph), 4.47 (br. s, 1 H, H-5), 4.00 (m, 1 H, H-4), 3.98 (m, 1 H, H-3), 3.82−3.57 (m, 5 H, H-3′, H-4′, H-5′, H-6′a and H-6′b), 3.75 (s, 3 H, COO*C*H_3), 3.17 (dd, $J_{2',3'}$ = 10.2 Hz, 1 H, H-2′), 2.09 (s, 3 H, OCOCH_3), 1.60 [m, 1 H, C*H*$(CH_3)_2$], 0.87−0.82 [4s, 12 H, C(CH_3)$_2$ and CH(CH_3)$_2$], 0.20−0.13 [2s, 6 H, Si(CH_3)$_2$] ppm. ^{13}C NMR (125 MHz, $CDCl_3$): δ = 170.7, 169.0, 138.0, 128.0, 97.8, 93.6, 79.6, 74.9, 73.9, 73.4, 73.2, 72.9, 72.2, 71.1, 67.6, 63.0, 62.2, 52.3, 34.1, 24.9, 20.9, 20.2, 18.4, −2.1, −3.6 ppm. FAB-MS: *m*/*z* = 782 [MNa^+]. $C_{37}H_{53}N_3O_{12}Si$ (759.9): calcd. C 58.48, H 7.03, N 5.53; found C 58.80, H 7.32, N 5.17.

Methyl [Dimethylthexylsilyl 2-*O*-Acetyl-4-*O*-(2-azido-6-*O*-benzoyl-3-*O*-benzyl-2-deoxy-α-D-glucopyranosyl)-3-*O*-benzyl-β-L-idopyranoside]uronate (37): BzCN (72 μL of a 0.9 M solution in dry CH_3CN) and catalytic Et_3N were added to a cooled (−40 °C) solution of **36** (47 mg, 62 μmol) in dry CH_3CN (1 mL). After 4 h, additional BzCN was added (18 μL of a 0.9 M solution in dry CH_3CN) until starting material had disappeared. After 7 h, MeOH was added and the mixture was allowed to reach room temperature. The solvent was evaporated, and the residue was dissolved in MeOH and concentrated to dryness. The purification was carried out by flash

chromatography (hexane/EtOAc, 4:1) to afford **37** (48 mg, 91%). $[\alpha]_D^{20}$ = +72.7 (*c* = 1, $CHCl_3$). TLC (hexane/EtOAc, 4:1). R_f = 0.17. ^{1}H NMR (500 MHz, $CDCl_3$): δ = 8.02−7.24 (m, 15 H, Ph), 5.06 (d, $J_{1,2}$ = 1.4 Hz, 1 H, H-1), 4.99 (m, 1 H, H-2), 4.88 (d, $J_{1',2'}$ = 3.5 Hz, 1 H, H-1′), 4.87−4.81 (2d, J_{gem} = 10.9 Hz, 2 H, CH_2Ph), 4.71−4.65 (2d, J_{gem} = 11.7 Hz, 2 H, CH_2Ph), 4.62 (dd, $J_{6'a,6'b}$ = 12.5, $J_{5',6'a}$ = 2.4 Hz, 1 H, H-6′a), 4.48 (br. s, 1 H, H-5), 4.39 (dd, $J_{5',6'b}$ = 2.0 Hz, 1 H, H-6′b), 4.10−4.08 (m, 2 H, H-4 and H-5′), 3.98 (m, 1 H, H-3), 3.79 (m, 1 H, H-3′), 3.78 (s, 3 H, COOCH_3), 3.51 (m, 1 H, H-4′), 3.16 (dd, $J_{2',3'}$ = 10.2 Hz, 1 H, H-2′), 3.08 (d, $J_{4',OH}$ = 3.3 Hz, 1 H, O*H*), 2.11 (s, 3 H, OCOCH_3), 1.60 [m, 1 H, C*H*$(CH_3)_2$], 0.88−0.83 [4s, 12 H, C$(CH_3)_2$ and CH$(CH_3)_2$], 0.22−0.13 [2s, 6 H, Si$(CH_3)_2$] ppm. ^{13}C NMR (125 MHz, $CDCl_3$): δ = 170.6, 169.0, 167.6, 137.9, 127.9, 97.7, 93.7, 78.8, 75.2, 74.3, 73.3, 72.94, 72.87, 71.2, 70.5, 67.6, 63.0, 62.9, 52.2, 34.1, 24.8, 21.0, 20.2, 18.4, −2.0, −3.5 ppm. FAB-MS: *m*/*z* = 886 [MNa^+]. $C_{44}H_{57}N_3O_{13}Si{\cdot}H_2O$ (882.1): calcd. C 59.91, H 6.74, N 4.76; found C 60.15, H 6.76, N 4.65.

Methyl 2-*O*-Acetyl-4-*O*-(2-azido-3-*O*-benzyl-4,6-*O*-benzylidene-2-deoxy-α-D-glucopyranosyl)-3-*O*-benzyl-α,β-L-idopyranosuronate (38): An excess of $(HF)_n$·Py complex (3 mL) was added to a cooled (−15 °C) solution of **24** (1.17 g, 1.37 mmol) in dry THF (30 mL). The reaction mixture was then warmed up to 0 °C and stirred under argon. After 24 h, CH_2Cl_2 (200 mL) was added and the mixture was washed with H_2O (2 × 50 mL) and saturated $NaHCO_3$ solution (100 mL) until neutral pH. The organic layer was dried ($MgSO_4$) and concentrated in vacuo. The residue was purified by flash column chromatography (hexane/EtOAc, 2:1) to yield **38** (893 mg, 94%) as an α/β mixture: TLC (hexane/EtOAc, 2:1). R_f = 0.17. ^{1}H NMR (500 MHz, $CDCl_3$): δ = 7.45−7.24 (m, 15 H, Ph), 5.52−5.51 (2s, 1 H, PhC*H*O α and β), 5.31 (br. d, $J_{1\alpha,OH}$ = 8.4 Hz, 0.5 H, H-1α), 5.10 (br. d, $J_{1\beta,OH}$ = 10.7 Hz, 0.5 H, H-1β), 4.90−4.66 (m, 6 H, H-2, H-5α, H-1′α, CH_2Ph), 4.63 (d, $J_{1',2'}$ = 3.4 Hz, 0.5 H, H-1′β), 4.58 (d, $J_{4,5}$ = 1.9 Hz, 0.5 H, H-5β), 4.27 (dd, $J_{5',6'a}$ = 4.7, $J_{6'a,6'b}$ = 10.1 Hz, 1 H, H-6′a), 4.12−3.75 (m, 4 H, H-3, H-4, H-3′, H-5′), 3.67−3.61 (m, 2 H, H-4′, H-6′b), 3.79−3.77 (2s, 3 H, COOCH_3 α and β), 3.38 (dd, $J_{2',3'}$ = 9.9 Hz, 0.5 H, H-2′β), 3.34 (dd, $J_{1',2'}$ = 3.6, $J_{2',3'}$ = 9.9 Hz, 0.5 H, H-2′α), 2.09−2.05 (2s, 3 H, OCOCH_3 α and β) ppm. FAB-MS: *m*/*z* = 728 [MNa^+]. $C_{36}H_{39}N_3O_{12}{\cdot}2H_2O$ (741.8): calcd. C 58.29, H 5.84, N 5.67; found C 58.29, H 6.03, N 5.67.

***O*-(Methyl 2-*O*-Acetyl-4-*O*-(2-azido-3-*O*-benzyl-4,6-*O*-benzylidene-2-deoxy-α-D-glucopyranosyl)-3-*O*-benzyl-α,β-L-idopyranosyluronate) Trichloroacetimidate (39):** Cl_3CCN (3.8 mL, 39 mmol) and K_2CO_3 (187 mg, 1.35 mmol) were added to a solution of **38** (893 mg, 1.29 mmol) in dry CH_2Cl_2 (10 mL). After stirring at room temperature for 3 h, the mixture was then filtered off and concentrated in vacuo, and the residue was purified by chromatography over a short silica gel column (hexane/EtOAc, 3:1) to yield **39** (935 mg, 87%) as an α/β mixture. **39β:** TLC (hexane/EtOAc, 2:1). R_f = 0.61. ^{1}H NMR (500 MHz, $CDCl_3$): δ = 8.67 (s, 1 H, N*H*), 7.44−7.22 (m, 15 H, Ph), 6.40 (br. s, 1 H, H-1), 5.53 (s, 1 H, PhC*H*O), 5.13 (br. s, 1 H, H-2), 4.98 (d, $J_{4,5}$ = 1.7 Hz, 1 H, H-5), 4.91−4.71 (2d, J_{gem} = 11.0 Hz, 2 H, CH_2Ph), 4.82−4.65 (2d, J_{gem} = 11.6 Hz, 2 H, CH_2Ph), 4.80 (d, $J_{1',2'}$ = 3.7 Hz, 1 H, H-1′), 4.29 (dd, $J_{5',6'a}$ = 4.9, $J_{6'a,6'b}$ = 10.1 Hz, 1 H, H-6′a), 4.15 (m, 1 H, H-4), 3.97−3.92 (m, 2 H, H-3 and H-3′), 3.78 (s, 3 H, COOCH_3), 3.78 (m, 1 H, H-5′), 3.67−3.63 (m, 2 H, H-4′ and H-6′b), 3.36 (dd, $J_{12',3'}$ = 10.0 Hz, 1 H, H-2′), 2.09 (s, 3 H, OCOCH_3) ppm. FAB-MS: *m*/*z* = 871 [MNa^+]. **39α:** TLC (hexane/EtOAc, 2:1). R_f = 0.50. ^{1}H NMR (500 MHz, $CDCl_3$): δ = 8.66 (s, 1 H, N*H*), 7.42−7.24 (m, 15 H, Ph), 6.20 (d, $J_{1,2}$ = 1.4 Hz, 1 H, H-1), 5.50 (s, 1 H, PhC*H*O), 5.27 (br. s, 1 H, H-2), 4.89−4.70 (2d, J_{gem} = 11.0 Hz, 2 H, CH_2Ph), 4.78−4.70 (2d, J_{gem} = 11.6 Hz, 2 H, CH_2Ph), 4.74 (d, $J_{1',2'}$ = 3.6 Hz, 1 H, H-1′), 4.68 (m, 1 H, H-5), 4.26 (dd, $J_{5',6'a}$ = 4.8, $J_{6'a,6'b}$ = 10.1 Hz, 1 H, H-6′a), 4.11 (m, 1 H, H-3), 4.05 (m, 1 H, H-4), 3.97 (dd, 1 H, H-3′), 3.88 (ddd, 1 H, H-5′), 3.78 (s, 3 H, COOCH_3), 3.65−3.61 (m, 2 H, H-4′ and H-6′b), 3.38 (dd, $J_{12',3'}$ = 9.9 Hz, 1 H, H-2′), 2.05 (s, 3 H, OCOCH_3) ppm. FAB-MS: *m*/*z* = 871 [MNa^+].

Methyl 4-*O*-(6-*O*-Acetyl-2-azido-3,4-di-*O*-benzyl-2-deoxy-α-D-glucopyranosyl)-2-*O*-benzoyl-3-*O*-benzyl-α,β-L-idopyranosuronate (40): An excess of $(HF)_n$·Py complex (3.1 mL) was added to a cooled (−10 °C) solution of **21** (1.067 g, 1.12 mmol) in dry THF (30 mL). The reaction mixture was then warmed up to 0 °C and stirred under argon. After 24 h, CH_2Cl_2 (200 mL) was added and the mixture was washed with H_2O (2 × 100 mL) and saturated $NaHCO_3$ solution (50 mL) until neutral pH. The organic layer was dried ($MgSO_4$) and concentrated in vacuo. The residue was purified by flash column chromatography (hexane/EtOAc, 2:1) to afford **40** (800 mg, 88%) as an α/β mixture. TLC (hexane/EtOAc, 2:1). R_f = 0.25. ^{1}H NMR (500 MHz, $CDCl_3$): δ = 8.14−7.06 (m, 20 H, Ph), 5.45 (br. d, $J_{1\alpha,OH}$ = 8.4 Hz, 0.5 H, H-1α), 5.21 (br. d, $J_{1\beta,OH}$ = 9.0 Hz, 0.5 H, H-1β), 5.06 (br. s, 1 H, H-2 α and β), 4.91 (br. s, 0.5 H, H-5α), 4.91−4.85 (m, 1 H, CH_2Ph), 4.80−4.74 (2d, J_{gem} = 11.5, J_{gem} = 11.7 Hz, 1 H, CH_2Ph), 4.66−4.62 (m, 2 H, H-1′, CH_2Ph), 4.59 (br. s, 0.5 H, H-5β), 4.47 (m, 1 H, CH_2Ph), 4.37 (m, 1 H, H-6′a), 4.31 (m, 1 H, H-3), 4.25−4.19 (m, 1.5 H, H-6′b, O*H*α), 4.01−3.82 (m, 4 H, H-5′, H-4, CH_2Ph), 3.64 (m, 0.5 H, OHβ), 3.79 (s, 3 H, COOCH_3 α and β), 3.41 (m, 2 H, H-3′ and H-4′), 3.19 (dd, $J_{1',2'}$ = 3.7, $J_{2',3'}$ = 9.2 Hz, 1 H, H-2′), 2.00 (s, 3 H, OCOCH_3 α and β) ppm. FAB-MS: *m*/*z* = 834 [MNa^+]. $C_{43}H_{45}N_3O_{13}$ (811.9): calcd. C 63.62, H 5.59, N 5.18; found C 63.22, H 5.95, N 4.94.

***O*-(Methyl 4-*O*-(6-*O*-Acetyl-2-azido-3,4-di-*O*-benzyl-2-deoxy-α-D-glucopyranosyl)-2-*O*-benzoyl-3-*O*-benzyl-α,β-L-idopyranosyluronate) Trichloroacetimidate (41):** Cl_3CCN (593 μL, 5.9 mmol) and K_2CO_3 (55 mg, 0.39 mmol) were added to a solution of **40** (320 mg, 0.39 mmol) in dry CH_2Cl_2 (4 mL). After stirring at room temperature for 4 h, the mixture was then filtered and concentrated in vacuo, and the residue was purified by chromatography over a short silica gel column (hexane/EtOAc, 2:1) to yield **41** (357 mg, 95%) as an α/β mixture. TLC (hexane/EtOAc, 2:1). R_f = 0.53 and 0.38 (β and α). ^{1}H NMR (500 MHz, $CDCl_3$): δ = 8.67 (s, 0.6 H, N*H*β), 8.64 (s, 0.4 H, N*H*α), 8.13−7.10 (m, 20 H, Ph), 6.55 (br. s, 0.6 H, H-1β), 6.29 (d, $J_{1,2}$ = 1.8 Hz, 0.4 H, H-1α), 5.43 (m, 0.4 H, H-2α), 5.33 (br. s, 0.6 H, H-2β), 5.00 (br. s, 0.4 H, H-5α), 4.93−4.88 (m, 1 H, CH_2Ph), 4.79−4.65 (m, 3.6 H, H-5β, H-1′, CH_2Ph), 4.52−4.46 (m, 1 H, CH_2Ph), 4.38−4.35 (m, 1.4 H, H-6′a, H-3α), 4.25−4.23 (m, 1.6 H, H-6′b, H-3β), 4.15 (br. s, 0.4 H, H-4α), 4.03−3.88 (m, 3.6 H, H-5′, H-4β, CH_2Ph), 3.79−3.78 (2s, 3 H, COOCH_3 α and β), 3.51−3.41 (m, 2 H, H-3′ and H-4′), 3.23−3.19 (m, 1 H, H-2′), 1.99 (s, 3 H, OCOCH_3 α and β) ppm. $C_{45}H_{45}Cl_3N_4O_{13}$ (956.2): calcd. C 56.52, H 4.74, N 5.86; found C 56.17, H 4.98, N 5.79.

Methyl [Dimethylthexylsilyl *O*-(2-Azido-3-*O*-benzyl-4,6-*O*-benzylidene-2-deoxy-α-D-glucopyranosyl)-(1→4)-*O*-(methyl 2-*O*-acetyl-3-*O*-benzyl-α-L-idopyranosyluronate)-(1→4)-*O*-(2-azido-6-*O*-benzoyl-3-*O*-benzyl-2-deoxy-α-D-glucopyranosyl)-(1→4)-2-*O*-acetyl-3-*O*-benzylβ-L-idopyranoside]uronate (42): TMSOTf (100 μL of a 0.18 M solution in dry CH_2Cl_2) was added under argon to a cooled (0 °C) solution of **37** (394 mg, 0.46 mmol) and **39** (573 mg, 0.68 mmol) in dry CH_2Cl_2 (5 mL). After 1.5 h, saturated $NaHCO_3$ solution (10 mL) and CH_2Cl_2 (250 mL) were added, and the mixture was washed with H_2O (200 mL). The organic layer was dried ($MgSO_4$)

and concentrated in vacuo, and the residue was purified by flash column chromatography (toluene/EtOAc, 12:1 and hexane/EtOAc, 4:1) to yield **42** (352 mg, 50%) and unchanged acceptor (175 mg, 44%). Glycal **43** was also isolated from the reaction mixture. **42:** $[\alpha]_D^{20}$ = +39.4 (*c* = 0.58, $CHCl_3$). TLC (hexane/EtOAc, 4:1). R_f = 0.19. ^{1}H NMR (500 MHz, $CDCl_3$): δ = 8.08−7.24 (m, 30 H, Ph), 5.51 (s, 1 H, PhC*H*O), 5.39 (d, $J_{1,2}$ = 4.2 Hz, 1 H, H-1c), 5.06 (d, $J_{11,2}$ = 1.4 Hz, 1 H, H-1a), 4.96 (br. s, 1 H, H-2a), 4.92 (dd, 1 H, H-2c), 4.89 (d, $J_{1,2}$ = 3.7 Hz, 1 H, H-1d), 4.79 (d, $J_{1,2}$ = 3.5 Hz, 1 H, H-1 b), 4.88−4.80 (m, 3 H, H-6b and CH_2Ph), 4.74−4.62 (m, 7 H, H-5c and CH_2Ph), 4.49 (d, $J_{114,5}$ = 1.6 Hz, 1 H, H-5a), 4.34 (dd, $J_{5,6'}$ = 2.3, $J_{6,6'}$ = 12.5 Hz, 1 H, H-6′b), 4.19 (dd, $J_{115,6}$ = 4.8, $J_{6,6'}$ = 10.1 Hz, 1 H, H-6d), 4.08−4.03 (m, 3 H, H-4b, H-5b, H-4a), 3.98−3.96 (m, 2 H, H-3a, H-4c), 3.91 (dd, $J_{112,3}$ = $J_{3,4}$ = 5.4 Hz, 1 H, H-3c), 3.83−3.76 (m, 3 H, H-5d, H-3b, H-3d), 3.67−3.60 (m, 2 H, H-4d, H-6′d), 3.73 and 3.37 (2s, 6 H, COOCH_3 a and c), 3.29 (dd, $J_{112,3}$ = 10.3 Hz, 1 H, H-2b), 3.25 (dd, $J_{112,3}$ = 10.0 Hz, 1 H, H-2d), 2.10 and 2.06 (2s, 6 H, OCOCH_3 a and c), 1.60 [m, 1 H, C*H*(CH_3)$_2$], 0.89−0.84 (4s, 12 H, C(CH_3)$_2$ and CH(CH_3)$_2$], 0.23−0.15 (2s, 6 H, Si(CH_3)$_2$] ppm. ^{13}C NMR (125 MHz, $CDCl_3$): δ = 170.7, 169.7, 169.0, 168.9, 166.1, 137.8, 126.0, 101.5, 98.8, 98.0, 97.1, 93.5, 82.5, 78.3, 75.6, 75.1, 75.0, 74.9, 74.8, 73.9, 73.8, 73.7, 73.5, 72.9, 72.7, 70.0, 69.9, 68.5, 67.7, 63.4, 63.2, 62.8, 62.2, 52.3, 51.8, 34.1, 24.9, 20.9, 20.7, 20.2, 18.4, −1.9, −3.5 ppm. FAB-MS: *m*/*z* = 1573 [MNa^+]. $C_{80}H_{94}N_6O_{24}Si$ (1551.8): calcd. C 61.92, H 6.11, N 5.42; found C 61.59, H 6.41, N 5.25.

Methyl 2-*O*-Acetyl-1,5-anhydro-4-*O*-(2-azido-3-*O*-benzyl-4,6-*O*-benzylidene-2-deoxy-α-D-glucopyranosyl)-3-*O*-benzyl-L-*xylo*-hex-1-enitoluronate (43): $[\alpha]_D^{20}$ = −2.8 (*c* = 1, $CHCl_3$). TLC (hexane/EtOAc, 4:1). R_f = 0.12; (toluene/EtOAc, 8:1). R_f = 0.20. ^{1}H NMR (500 MHz, $CDCl_3$): δ = 7.46−7.24 (m, 15 H, Ph), 6.80 (s, 1 H, H-1), 5.53 (s, 1 H, PhC*H*O), 4.91−4.89 (m, 2 H, H-1′ and CH_2Ph), 4.73 (d, J_{gem} = 10.9 Hz, 1 H, CH_2Ph), 4.69−4.61 (2d, J_{11gem} = 12.1 Hz, 2 H, CH_2Ph), 4.57 (br. s, 1 H, H-5), 4.36 (t, $J_{113,4}$ = $J_{4,5}$ = 1.6 Hz, 1 H, H-4), 4.28 (dd, $J_{5',6'a}$ = 3.9, $J_{6'a,6'b}$ = 9.3 Hz, 1 H, H-6′a), 4.10 (d, 1 H, H-3), 4.00 (dd, $J_{113',4'}$ = 9.5 Hz, 1 H, H-3′), 3.83 (s, 3 H, COOCH_3), 3.74−3.62 (m, 3 H, H-4′, H-5′ and H-6′b), 3.26 (dd, $J_{111',2'}$ = 3.6, $J_{2',3'}$ = 10.1 Hz, 1 H, H-2′), 2.06 (s, 3 H, OCOCH_3) ppm. FAB-MS: *m*/*z* = 710 [MNa^+]. $C_{36}H_{37}N_3O_{11}$ (687.7): calcd. C 62.87, H 5.42, N 6.11; found C 62.52, H 5.31, N 6.14.

Methyl [Dimethylthexylsilyl *O*-(2-azido-3-*O*-benzyl-2-deoxy-α-D-glucopyranosyl)-(1→4)-*O*-(methyl 2-*O*-acetyl-3-*O*-benzyl-α-L-idopyranosyluronate)-(1→4)-*O*-(2-azido-6-*O*-benzoyl-3-*O*-benzyl-2-deoxy-α-D-glucopyranosyl)-(1→4)-2-*O*-acetyl-3-*O*-benzyl-β-L-idopyranoside]uronate (44): EtSH (13 μL, 0.17 mmol) and catalytic *p*TsOH were added to a solution of **42** (54 mg, 35 μmol) in dry CH_2Cl_2 (1.5 mL). After stirring for 3 h under argon, the mixture was neutralized with saturated $NaHCO_3$ solution, diluted with CH_2Cl_2 (25 mL), washed with H_2O (25 mL), dried ($MgSO_4$), and concentrated to dryness. The purification of the residue was carried out by flash column chromatography (hexane/EtOAc, 1:1) to yield **44** (43 mg, 84%). $[\alpha]_D^{20}$ = +49.7 (*c* = 0.75, $CHCl_3$). TLC (hexane/EtOAc, 1:1). R_f = 0.29. ^{1}H NMR (500 MHz, $CDCl_3$): δ = 8.08−7.24 (m, 25 H, Ph), 5.38 (d, $J_{111,2}$ = 4.3 Hz, 1 H, H-1c), 5.06 (d, $J_{111,2}$ = 1.2 Hz, 1 H, H-1a), 4.95−4.91 (m, 3 H, H-1d, H-2a, H-2c), 4.86 (d, J_{gem} = 10.2 Hz, 1 H, CH_2Ph), 4.83−4.78 (m, 3 H, H-1b, H-6b, CH_2Ph), 4.72−4.62 (m, 7 H, H-5c, CH_2Ph), 4.49 (d, $J_{14,5}$ = 1.4 Hz, 1 H, H-5 a), 4.35 (dd, $J_{5,6'}$ = 2.3, $J_{6,6'}$ = 12.3 Hz, 1 H, H-6′b), 4.11−3.99 (m, 4 H, H-4a, H-4c, H-4b, H-5b), 3.96 (t, $J_{12,3}$ = $J_{3,4}$ = 2.6 Hz, 1 H, H-3a), 3.93 (t, $J_{12,3}$ = $J_{3,4}$ = 5.4 Hz, 1 H, H-3c), 3.79 (t, $J_{12,3}$ = $J_{3,4}$ = 10.1 Hz, 1 H, H-3b), 3.69−3.54 (m, 5 H, H-3d, H-4d, H-5d, H-6d, H-6′d), 3.73 and 3.37 (2s, 6 H, COOCH_3 a and c), 3.29 (dd, $J_{11,2}$ = 3.4 Hz, 1 H, H-2b), 3.12 (dd, $J_{12,3}$ = 9.7, $J_{1,2}$ = 3.5 Hz, 1 H, H-2d), 2.38 (d, 1 H, O*H*-4), 1.91 (m, 1 H, O*H*-6), 2.10 and 2.01 (2s, 6 H, OCOCH_3 a and c), 1.59 [m, 1 H, C*H*(CH_3)$_2$], 0.88−0.83 [4s, 12 H, C(CH_3)$_2$ and CH(CH_3)$_2$], 0.22−0.14 [2s, 6 H, Si(CH_3)$_2$] ppm. ^{13}C NMR (125 MHz, $CDCl_3$): δ = 170.7, 169.7, 169.3, 169.0, 166.2, 137.8, 127.7, 98.1, 97.9, 97.1, 93.5, 79.3, 78.2, 75.14, 75.06, 74.85, 74.76, 73.7, 73.6, 73.5, 73.2, 72.9, 72.6, 72.1, 71.0, 70.1, 70.0, 69.9, 67.7, 63.3, 62.8, 62.3, 62.1, 52.3, 51.8, 34.1, 24.9, 20.9, 20.8, 20.2, 18.4, −1.9, −3.5 ppm. FAB-MS: *m*/*z* = 1485 [MNa^+]. $C_{73}H_{90}N_6O_{24}Si$ (1463.7): calcd. C 59.90, H 6.20, N 5.74; found C 59.85, H 6.35, N 5.40.

Methyl [Dimethylthexylsilyl *O*-(2-Azido-6-*O*-benzoyl-3-*O*-benzyl-2-deoxy-α-D-glucopyranosyl)-(1→4)-*O*-(methyl 2-*O*-acetyl-3-*O*-benzyl-α-L-idopyranosyluronate)-(1→4)-*O*-(2-azido-6-*O*-benzoyl-3-*O*-benzyl-2-deoxy-α-D-glucopyranosyl)-(1→4)-2-*O*-acetyl-3-*O*-benzyl-β-L-idopyranoside]uronate (45): BzCN (21 mg, 0.16 mmol) and catalytic Et_3N were added to a cooled (−35 °C) solution of **44** (215 mg, 0.15 mmol) in dry CH_3CN (3 mL). After 1 h, MeOH was added and the mixture was warmed up to room temperature and stirred for 15 min. The solvent was then removed in vacuo, and the residue was dissolved in MeOH and concentrated twice more. The purification was carried out by flash column chromatography (hexane/EtOAc, 3:1) to afford **45** (219 mg, 95%). $[\alpha]_D^{20}$ = +53.2 (*c* = 1, $CHCl_3$). TLC (hexane/EtOAc, 2:1). R_f = 0.26. ^{1}H NMR (500 MHz, $CDCl_3$): δ = 8.10−7.24 (m, 30 H, Ph), 5.36 (d, $J_{11,2}$ = 4.0 Hz, 1 H, H-1c), 5.06 (d, $J_{11,2}$ = 1.5 Hz, 1 H, H-1a), 4.96−4.91 (m, 3 H, H-2a and c, and H-1d), 4.86 (d, J_{gem} = 10.4 Hz, 1 H, CH_2Ph), 4.80−4.74 (m, 4 H, H-1b, H-6d, CH_2Ph), 4.70−4.62 (m, 7 H, H-6b, H-5c, CH_2Ph), 4.49 (d, $J_{14,5}$ = 1.7 Hz, 1 H, H-5a), 4.36 (dd, $J_{5,6'}$ = 2.4, $J_{6,6'}$ = 12.5 Hz, 1 H, H-6′d), 4.27 (dd, $J_{5,6'}$ = 2.0, $J_{6,6'}$ = 12.5 Hz, 1 H, H-6′b), 4.07−4.02 (m, 4 H, H-4a, H-4c, H-4b, H-5b), 3.97 (dd, 1 H, H-3a), 3.92 (dd, 1 H, H-3c), 3.80 (m, 2 H, H-3b and H-5d), 3.73 and 3.42 (2s, 6 H, COOCH_3 a and c), 3.62 (dd, 1 H, H-3d), 3.48 (ddd, 1 H, H-4d), 3.29 (dd, $J_{11,2}$ = 3.5, $J_{2,3}$ = 10.3 Hz, 1 H, H-2b), 3.13 (dd, $J_{11,2}$ = 3.5, $J_{2,3}$ = 10.2 Hz, 1 H, H-2d), 2.99 (d, $J_{14,OH}$ = 3.5 Hz, 1 H, O*H*), 2.10 and 2.02 (2s, 6 H, OCOCH_3 a and c), 1.62 [m, 1 H, C*H*(CH_3)$_2$], 0.88−0.84 [4s, 12 H, C(CH_3)$_2$ and CH(CH_3)$_2$], 0.23−0.14 [2s, 6 H, Si(CH_3)$_2$] ppm. ^{13}C NMR (125 MHz, $CDCl_3$): δ = 170.7, 169.7, 169.1, 168.9, 167.4, 166.1, 137.8, 127.7, 98.1, 98.0, 97.1, 93.5, 78.7, 78.3, 75.14, 75.10, 74.9, 74.5, 73.7, 73.6, 73.5, 73.3, 72.9, 72.6, 71.2, 70.5, 69.9, 69.79, 69.76, 67.7, 63.4, 62.4, 52.3, 51.8, 34.1, 24.9, 20.9, 20.8, 20.2, 18.4, −1.9, −3.5 ppm. $C_{80}H_{94}N_6O_{25}Si$ (1567.8): calcd. C 61.29, H 6.04, N 5.36; found C 61.41, H 6.32, N 5.06.

Methyl [Dimethylthexylsilyl *O*-(6-*O*-Acetyl-2-azido-3,4-di-*O*-benzyl-2-deoxy-α-D-glucopyranosyl)-(1→4)-*O*-(methyl 2-*O*-benzoyl-3-*O*-benzyl-α-L-idopyranosyluronate)-(1→4)-*O*-(2-azido-6-*O*-benzoyl-3-*O*-benzyl-2-deoxy-α-D-glucopyranosyl)-(1→4)-*O*-(methyl 2-*O*-acetyl 3-*O*-benzyl-α-L-idopyranosyluronate)-(1→4)-*O*-(2-azido-6-*O*-benzoyl-3-*O*-benzyl-2-deoxy-α-D-glucopyranosyl)-(1→4)-2-*O*-acetyl-3-*O*-benzyl-β-L-idopyranoside]uronate (46): TMSOTf (50 μL of a 0.14 M solution in dry CH_2Cl_2) was added at room temperature, under argon, to a solution of **45** (147 mg, 94 μmol) and **41** (134 mg, 0.14 mmol) in dry CH_2Cl_2 (2 mL). After 30 min, saturated $NaHCO_3$ solution and CH_2Cl_2 (100 mL) were added, and the mixture was washed with H_2O (75 mL). The organic layer was dried ($MgSO_4$) and concentrated in vacuo, and the residue was purified by flash column chromatography (toluene/acetone, 16:1 and hexane/EtOAc, 3:1) to yield **46** (133 mg, 60%) and unchanged acceptor (55 mg, 37%). Glycal **50** was also isolated from the reaction mixture.

Compound 46: $[\alpha]_D^{20}$ = +41.8 (*c* = 1, $CHCl_3$). TLC (toluene/acetone, 14:1). R_f = 0.32. ^1H NMR (500 MHz, $CDCl_3$): δ = 8.07−7.15 (m, 50 H, Ph), 5.53 (d, $J_{1,2}$ = 4.2 Hz, 1 H, H-1e), 5.36 (d, $J_{1,2}$ = 4.2 Hz, 1 H, H-1c), 5.14 (dd, 1 H, H-2e), 5.05 (br. s, 1 H, H-1a), 4.95 (br. s, 1 H, H-2a), 4.89−4.78 (m, 4 H, H-1d, H-1f, C*H*$_2$Ph and H-2c), 4.81−4.48 (m, 17 H, C*H*$_2$Ph, H-5a, H-5c, H-5e, H-6b, H-6′b, H-6d, H-1b), 4.38−4.30 (m, 3 H, C*H*$_2$Ph and H-6′d), 4.23 (m, 2 H, H-6f and C*H*$_2$Ph), 4.17−4.13 (m, 2 H, H-6′f and H-3e), 4.03−3.93 (m, 7 H, H-4b, H-4d, H-5b or d, H-4a, H-4c, H-4e, H-3a), 3.86 (m, 2 H, H-5f, H-3c), 3.78 (m, 2 H, H-5b or d, H-3b), 3.64 (t, $J_{12,3}$ = $J_{3,4}$ = 9.6 Hz, 1 H, H-3d), 3.54 (t, $J_{12,3}$ = $J_{3,4}$ = 9.9 Hz, 1 H, H-3f), 3.45 (t, $J_{14,5}$ = 9.4 Hz, 1 H, H-4f), 3.72−3.23 (3s, 9 H, COOC*H*$_3$ a, c and e), 3.28−3.18 (m, 3 H, H-2 b, d and f), 2.09−1.95 (3s, 9 H, OCOC*H*$_3$ a, c and f), 1.58 [m, 1 H, C*H*(CH$_3$)$_2$], 0.87−0.83 [4s, 12 H, C(C*H*$_3$)$_2$ and CH(C*H*$_3$)$_2$], 0.22−0.13 [2s, 6 H, Si(C*H*$_3$)$_2$] ppm. ^{13}C NMR (125 MHz, $CDCl_3$): δ = 170.7, 170.5, 169.7, 169.1, 169.0, 168.9, 166.05, 165.98, 165.2, 137.7, 127.7, 99.0, 98.3, 97.9, 97.4, 97.0, 93.5, 80.0, 78.1, 75.4, 75.3, 75.0, 74.9, 74.8, 74.1, 73.8, 73.7, 73.6, 73.5, 73.0, 72.9, 72.6, 70.5, 70.1, 70.02, 69.95, 69.9, 69.8, 67.7, 63.5, 62.1, 52.3, 51.9, 51.6, 34.1, 24.9, 20.9, 20.8, 20.7, 20.2, 18.4, −1.9, −3.5 ppm. MS-HRFAB: calcd. for $C_{123}H_{137}N_9O_{37}SiNa$ 2382.88; found 2382.82 [MNa^+].

Methyl *O*-(6-*O*-Acetyl-2-azido-3,4-di-*O*-benzyl-2-deoxy-α-D-glucopyranosyl)-(1→4)-*O*-(methyl 2-*O*-benzoyl-3-*O*-benzyl-α-L-idopyranosyluronate)-(1→4)-*O*-(2-azido-6-*O*-benzoyl-3-*O*-benzyl-2-deoxy-α-D-glucopyranosyl)-(1→4)-*O*-(methyl 2-*O*-acetyl 3-*O*-benzyl-α-L-idopyranosyluronate)-(1→4)-*O*-(2-azido-6-*O*-benzoyl-3-*O*-benzyl-2-deoxy-α-D-glucopyranosyl)-(1→4)-2-*O*-acetyl-3-*O*-benzyl-α,β-L-idopyranosuronate (47): An excess of $(HF)_n$·Py complex (0.2 mL) was added to a cooled (−15 °C) solution of **46** (210 mg, 89 μmol) in dry THF (5 mL). The reaction mixture was warmed to 0 °C and stirred for 24 h under argon. The mixture was diluted with CH_2Cl_2 (50 mL) and washed with H_2O (2 × 25 mL) and saturated $NaHCO_3$ solution (25 mL) until neutral pH. The aqueous layer was extracted with CH_2Cl_2 (2 × 25 mL), and the organic layers were dried ($MgSO_4$) and concentrated to dryness. The residue was purified by flash column chromatography (hexane/EtOAc, 3:2) to afford **47** (178 mg, 90%) as an α/β mixture. TLC (hexane/EtOAc, 3:2). R_f = 0.13. ^1H NMR (500 MHz, $CDCl_3$) (0.6:0.4 α/β): δ = 8.08−7.15 (m, 50 H, Ph), 5.54 (d, $J_{1,2}$ = 4.4 Hz, 1 H, H-1e), 5.38 (d, $J_{1,2}$ = 4.6 Hz, 1 H, H-1c), 5.30 (br. d, $J_{11,OH}$ = 8.8 Hz, 0.6 H, H-1aα), 5.15 (t, $J_{12,3}$ = 4.6 Hz, 1 H, H-2e), 5.10 (dd, $J_{11,OH}$ = 11.4, $J_{1,2}$ = 2.4 Hz, 0.4 H, H-1aβ), 4.93−4.49 (m, 22 H, C*H*$_2$Ph, H-5a, H-5c, H-5e, H-6b, H-6′b, H-6d, H-1b, H-1d, H-1f, H-2 a, H-2c), 4.38−4.31 (m, 3 H, C*H*$_2$Ph and H-6′d), 4.26−4.22 (m, 2 H, H-6f and C*H*$_2$Ph), 4.17−3.63 (m, 17 H, H-6′f, H-4b, H-4d, H-5b, H-5d, H-5f, H-4a, H-4c, H-4e, H-3a, H-3c, H-3e, H-3b, H-3d, COOC*H*$_3$), 3.55 (t, $J_{12,3}$ = $J_{3,4}$ = 10.1 Hz, 1 H, H-3f), 3.42 (m, 4 H, H-4f, COOC*H*$_3$), 3.30−3.24 (m, 5 H, H-2b, d and COOC*H*$_3$), 3.18 (dd, $J_{11,2}$ = 3.5 Hz, 1 H, H-2f), 2.16−1.95 (3s, 9 H, OCOC*H*$_3$ a, c and f) ppm.

***O*-(Methyl *O*-(6-*O*-acetyl-2-azido-3,4-di-*O*-benzyl-2-deoxy-α-D-glucopyranosyl)-(1→4)-*O*-(methyl 2-*O*-benzoyl-3-*O*-benzyl-α-L-idopyranosyluronate)-(1→4)-*O*-(2-azido-6-*O*-benzoyl-3-*O*-benzyl-2-deoxy-α-D-glucopyranosyl)-(1→4)-*O*-(methyl 2-*O*-acetyl 3-*O*-benzyl-α-L-idopyranosyluronate)-(1→4)-*O*-(2-azido-6-*O*-benzoyl-3-*O*-benzyl-2-deoxy-α-D-glucopyranosyl)-(1→4)-2-*O*-acetyl-3-*O*-benzyl-α,β-L-idopyranosuronate) trichloroacetimidate (48):** Cl_3CCN (75 μL, 0.74 mmol) and K_2CO_3 (4 mg, 30 μmol) were added to a solution of **47** (55 mg, 25 μmol) in dry CH_2Cl_2 (2 mL). After stirring overnight at room temperature, the mixture was then filtered off and concentrated in vacuo, and the residue was purified by chromatography over a short silica gel column (hexane/EtOAc, 3:2) to yield **48** (50 mg, 85%) as an α/β mixture. TLC (hexane/EtOAc, 3:2). R_f = 0.39 and 0.33 (β and α). ^1H NMR (500 MHz, $CDCl_3$) (0.5:0.5 α/β): δ = 8.67−8.65 (2s, 1 H, N*H* α and β), 8.07−7.17 (m, 50 H, Ph), 6.40 (br. s, 0.5 H, H-1aβ), 6.20 (d, $J_{1,2}$ = 1.8 Hz, 0.5 H, H-1aα), 5.54 (2d, $J_{1,2}$ = 3.7 Hz, 1 H, H-1e α and β), 5.40−5.35 (2d, $J_{1,2}$ = 4.5 Hz, 1 H, H-1c α and β), 5.15 (2dd, 1 H, H-2e α and β), 4.98−4.49 (m, 22 H, C*H*$_2$Ph, H-5a, H-5c, H-5e, H-6b, H-6′b, H-6d, H-1b, H-1d, H-1f, H-2a, H-2c), 4.38−4.31 (m, 3 H, C*H*$_2$Ph and H-6′d), 4.26−4.23 (m, 2 H, H-6f and C*H*$_2$Ph), 4.17−3.73 (m, 16 H, H-6′f, H-4b, H-4d, H-5b, H-5d, H-5f, H-4a, H-4c, H-4e, H-3a, H-3c, H-3e, H-3b, COOC*H*$_3$), 3.65 (t, $J_{12,3}$ = $J_{3,4}$ = 9.5 Hz, 1 H, H-3d), 3.55 (t, $J_{12,3}$ = $J_{3,4}$ = 10.0 Hz, 1 H, H-3f), 3.47−3.44 (m, 4 H, H-4f, COOC*H*$_3$), 3.36−3.24 (m, 5 H, H-2b, d and COOC*H*$_3$), 3.18 (dd, $J_{11,2}$ = 3.4 Hz, 1 H, H-2f), 2.12−1.95 (5s, 9 H, OCOC*H*$_3$ a, c and f) ppm. MS-HRFAB: Calcd. for $C_{117}H_{119}Cl_3N_{10}O_{37}Na$ 2383.667; found 2383.509 [MNa^+].

Methyl [Methyl *O*-(6-*O*-Acetyl-2-azido-3,4-di-*O*-benzyl-2-deoxy-α-D-glucopyranosyl)-(1→4)-*O*-(methyl 2-*O*-benzoyl-3-*O*-benzyl-α-L-idopyranosyluronate)-(1→4)-*O*-(2-azido-6-*O*-benzoyl-3-*O*-benzyl-2-deoxy-α-D-glucopyranosyl)-(1→4)-*O*-(methyl 2-*O*-acetyl 3-*O*-benzyl-α-L-idopyranosyluronate)-(1→4)-*O*-(2-azido-6-*O*-benzoyl-3-*O*-benzyl-2-deoxy-α-D-glucopyranosyl)-(1→4)-2-*O*-acetyl-3-*O*-benzyl-α-L-idopyranoside]uronate (49): TMSOTf (50 μL of a 0.04 M solution in dry CH_2Cl_2) and MeOH (24 μL, 0.76 mmol) were added under argon to a cooled (0 °C) solution of **48** (90 mg, 38 μmol) in dry CH_2Cl_2 (0.5 mL). After 1 h, saturated $NaHCO_3$ solution and CH_2Cl_2 (50 mL) were added and the mixture was washed with H_2O (30 mL). The organic layer was dried ($MgSO_4$) and concentrated in vacuo, and the residue was purified by flash column chromatography (hexane/EtOAc, 2:1) to yield **49** (26 mg, 31%) and **47** (25 mg, 29%). TLC (hexane/EtOAc, 2:1). R_f = 0.12. ^1H NMR (500 MHz, $CDCl_3$): δ = 8.08−7.17 (m, 50 H, Ph), 5.54 (d, $J_{1,2}$ = 4.3 Hz, 1 H, H-1e), 5.37 (d, $J_{1,2}$ = 4.6 Hz, 1 H, H-1c), 5.15 (t, $J_{12,3}$ = $J_{1,2}$ = 4.6 Hz, 1 H, H-2e), 4.91−4.87 (m, 6 H, H-1d, H-1f, H-1a, H-2a, H-2c, CH$_2$Ph), 4.83−4.49 (m, 17 H, C*H*$_2$Ph, H-5a, H-5c, H-5e, H-6b, H-6′b, H-6d, H-1b), 4.36−4.31 (m, 3 H, C*H*$_2$Ph and H-6′d), 4.26−4.23 (m, 2 H, H-6f and C*H*$_2$Ph), 4.16−4.10 (m, 2 H, H-3e, H-6′f), 4.05−3.84 (m, 10 H, H-4b, H-4d, H-5b, H-5d, H-5f, H-4a, H-4c, H-4e, H-3a, H-3c), 3.76 (m, 4 H, H-3b, COOC*H*$_3$), 3.66 (t, $J_{12,3}$ = $J_{3,4}$ = 9.5 Hz, 1 H, H-3d), 3.55 (t, $J_{12,3}$ = $J_{3,4}$ = 9.4 Hz, 1 H, H-3f), 3.45 (m, 7 H, H-4f, OC*H*$_3$, COOC*H*$_3$), 3.28−3.25 (m, 5 H, H-2b, d and COOC*H*$_3$), 3.21 (dd, $J_{11,2}$ = 3.5 Hz, 1 H, H-2f), 2.06, 2.01, 1.95 (3s, 9 H, OCOC*H*$_3$) ppm.

Methyl 4-*O*-(6-*O*-Acetyl-2-azido-3,4-di-*O*-benzyl-2-deoxy-α-D-glucopyranosyl)-1,5-anhydro-2-*O*-benzoyl-3-*O*-benzyl-L-*xylo*-hex-1-enitoluronate (50): $[\alpha]_D^{20}$ = +12.0 (*c* = 1, $CHCl_3$). TLC (hexane/EtOAc, 3:1). R_f = 0.19. ^1H NMR (500 MHz, $CDCl_3$): δ = 8.02−7.14 (m, 20 H, Ph), 6.91 (s, 1 H, H-1), 4.99 (d, $J_{11',2'}$ = 3.5 Hz, 1 H, H-1′), 4.88 (d, J_{gem} = 10.7 Hz, 1 H, C*H*$_2$Ph), 4.84−4.81 (m, 2 H, C*H*$_2$Ph), 4.68 (d, J_{gem} = 12.1 Hz, 1 H, C*H*$_2$Ph), 4.64−4.61 (m, 2 H, H-5 and C*H*$_2$Ph), 4.56 (d, J_{gem} = 11.0 Hz, 1 H, C*H*$_2$Ph), 4.39 (m, 1 H, H-4), 4.33 (dd, $J_{5',6'a}$ = 2.0, $J_{6'a,6'b}$ = 12.3 Hz, 1 H, H-6′a), 4.28 (d, $J_{13,4}$ = 1.7 Hz, 1 H, H-3), 4.20 (dd, $J_{5',6'b}$ = 3.5, $J_{6'a,6'b}$ = 12.3 Hz, 1 H, H-6′b), 3.97 (dd, $J_{13',4'}$ = 9.0 Hz, 1 H, H-3′), 3.83 (s, 3 H, COOC*H*$_3$), 3.79 (m, 1 H, H-5′), 3.54 (dd, $J_{14',5'}$ = 9.5 Hz, 1 H, H-4′), 3.28 (dd, $J_{12',3'}$ = 10.4 Hz, 1 H, H-2′), 2.02 (s, 3 H, OCOC*H*$_3$) ppm. FAB-MS: *m*/*z* = 816 [MNa^+]. MS-HRFAB: calcd. for $C_{43}H_{43}N_3O_{12}Na$ 816.2744; found 816.2716 [MNa^+]. $C_{43}H_{43}N_3O_{12}$ (793.8): calcd. C 65.06, H 5.46, N 5.29; found C 64.78, H 5.47, N 5.21.

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