Synthetic methods to glycerol teichoic acids

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Chapter 4

Fluorous Linker Assisted TA Synthesis

Introduction

Chapter two and **chapter three** describe the generation of teichoic acids (TAs) *via* solution phase and automated solid phase approaches, both of which have advantages and disadvantages. The solution phase protocol is relatively labor and time consuming due to the intermediate isolation and purification steps. However, the approach bears some important advantages: It can be executed on both small and large scale and it can be performed employing a stoichiometric amount or small excess of reagents.[1] The automated solid phase synthesis strategy is time and labor efficient by postponing product purification to the final stage of the synthesis, which makes it suitable for the generation of a small library of structures. The main disadvantages are that this protocol requires a relatively large excess of expensive building blocks (6-8 eq) and can only be executed on a relatively small scale (~15 μmol).[2]

Alternative synthetic strategies have recently emerged that are based on the use of soluble supports. In an ideal situation, these strategies combine the "best of both worlds": the soluble support allows the application of (a relatively small) excess of reagents to drive the reactions to completion; it also enables the rapid isolation and purification of intermediates and is readily adapted to different reaction scales. Several supports have been recommended over the years, including polyethylene glycol polymers (PEG)[3], lipophilic tails[4] and ionic tags.[5] With the advent of fluorous solid phase extraction (F-SPE) methodologies, a technique known as light fluorous synthesis[6-11] has become popular for the construction of biopolymers, especially in the area of carbohydrate chemistry.[10,12-16] Applications in the assembly of oligopeptides[10] have also been reported, but the use of fluorous chemistry in oligonucleotide synthesis has been restricted to tagging techniques, in which a fluorous building block is employed at the end of a solid phase oligonucleotide synthesis to discriminate the target full length oligomers from unwanted, capped deletion sequences.[17-19]

This chapter discusses the light fluorous approach to (aminoglucosylated) TAs. With use of perfluorooctylpropylsulfonyl ethyl (F-Pse) as the fluorous phosphate protection a dodecamer glycerol TA (**19**) is built up using phosphoramidite chemistry. After each elongation cycle, which comprises 3 steps (coupling, oxidation, detritylation), an F-SPE purification is performed. Using this technique a set of aminoglucosylated TA fragments is obtained (molecules **32a**, **32b** and **43**).[20] The

antigenicity of these fragments is determined using an opsonophagocytic inhibition assay (OPIA) which measures their binding to rabbit antibodies raised against enterococcal LTA.

Results and Discussion

The first objective was the selection of a suitable light fluorous phosphate protecting group. To date only one such protecting group has been reported, which has been applied in the synthesis of a disaccharide.[21] In 2003 De Visser *et al.* and, more recently, Ali *et al.* reported on the use of fluorous sulfonylethyl based groups to protect both amino and hydroxyl functions, in the form of a carbamate and carbonate respectively (See Figure 1).[22,23] This group seemed suitable to protect phosphate functions since it can be removed at the end of the synthesis by base catalyzed β-elimination. The effective use of the 2-(methylsulfonyl) ethyl (MSc) group in solid phase oligonucleotide synthesis bodes well for this approach. Whereas the use of the fluorous version of the MSc group, the [1*H*,1*H*,2*H*,2*H*]-perfluorodecylsulfonyl-ethoxycarbonyl (F-Msc, **1**), functioned well as a nitrogen protecting group, it proved to be too base labile for use as a hydroxyl protecting group (as in **2**). Thus, for the fluorous version of the Msc carbonate, an extra methylene moiety between the fluorous part and the sulfonyl group was incorporated to provide extra insulation for the C_8F_{17} tail, giving the perfluorooctylpropylsulfonylethoxycarbonyl (F-Psc, **3**) group.[23] Based on these considerations F-Pse group **4** was chosen as a fluorous linker and phosphate protecting group. With this linker, synthesized as reported previously, the first goal was to establish the scope and limitations of fluorous teichoic acid synthesis.

As depicted in Scheme 1, F-Pse alcohol **5** was elongated in a step-wise manner with glycerol phosphoramidite **6**.[1] Each elongation cycle consisted of four steps: 1) reaction of the alcohol with phosphoramidite **6** under the agency of dicyanoimidazole (DCI); 2) oxidation of the intermediate phosphite with I_2; 3) removal of the DMT protecting group using dichloroacetic acid (DCA) in the presence of triethylsilane (TES); and 4) F-SPE purification. The work-up procedure includes an extraction with aqueous MeCN and hexane to remove most of the 4,4'-dimethoxytriphenylmethane and excess TES, since it was found that these could not be separated from the target compounds by F-SPE when present in relatively large amounts. Using this protocol, protected oligoglycerol phosphates up to the dodecamer level were rapidly generated. Although the relative fluorous content in compounds **7**-**18** significantly decreases with increasing oligomer length (ranging from 37% fluorine in compound **7** to 8% fluorine in dodecamer **18**), this had little or no effect on

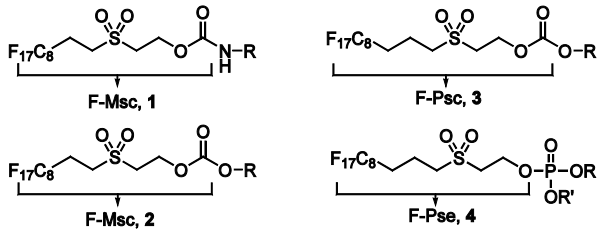
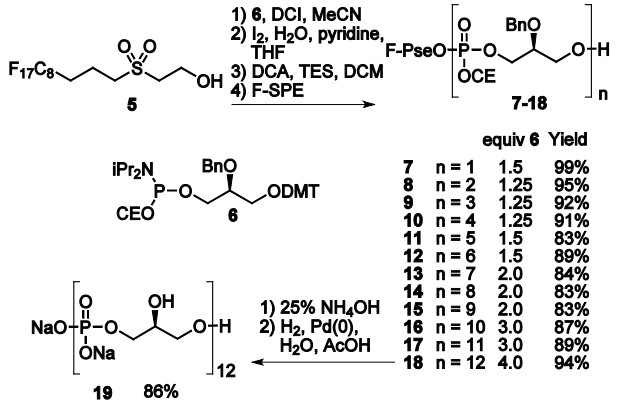


Figure 1. Fluorous versions of the MSc type protecting group.

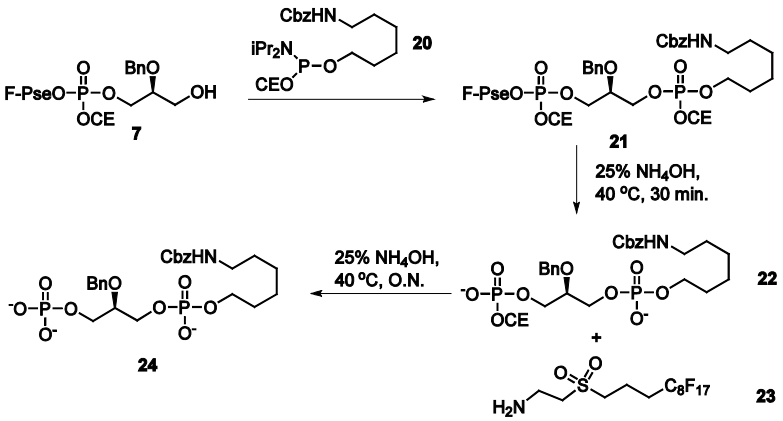
Scheme 1. Light fluorous synthesis of dodecamer **19**.



the purification efficiency and a single fluorous silica column (2 or 4g) was sufficient to purify all oligomers (0.1-0.25 mmol). However, a larger excess of **6** was required to push the coupling reactions to completion with increasing length of the oligomer. Up to four equivalents of the phosphoramidite were required in the final coupling step to the dodecamer (see scheme 1). Because at this stage an automated solid phase approach becomes competitive, further elongation was abandoned.

Deprotection of the fully protected dodecamer (**18**) started with removal of the F-Pse and cyanoethyl groups using 25% aqueous ammonia solution. In a model deprotection experiment (Scheme 2) compound **21** was subjected to the above mentioned deprotection conditions at slightly elevated temperatures (40 °C) and it was observed that the F-Pse group at the terminal phosphotriester was selectively cleaved with respect to the cyanoethyl group (compound **22**, see Scheme 2 and Figure 2). Elimination of the remaining cyanoethyl group on the obtained phosphodiester required prolonged reaction times (typically overnight) to ensure complete unmasking of the target phosphomonoester (**24**). Applying this protocol to dodecamer **18** (scheme 1) led, after ensuing hydrogenolysis of the partially protected oligomer and gel filtration, to 30 mg of fully deprotected dodecamer **19** (86%).

Scheme 2. Monitoring of the deprotection of model compound **21** with 25% NH_4OH.



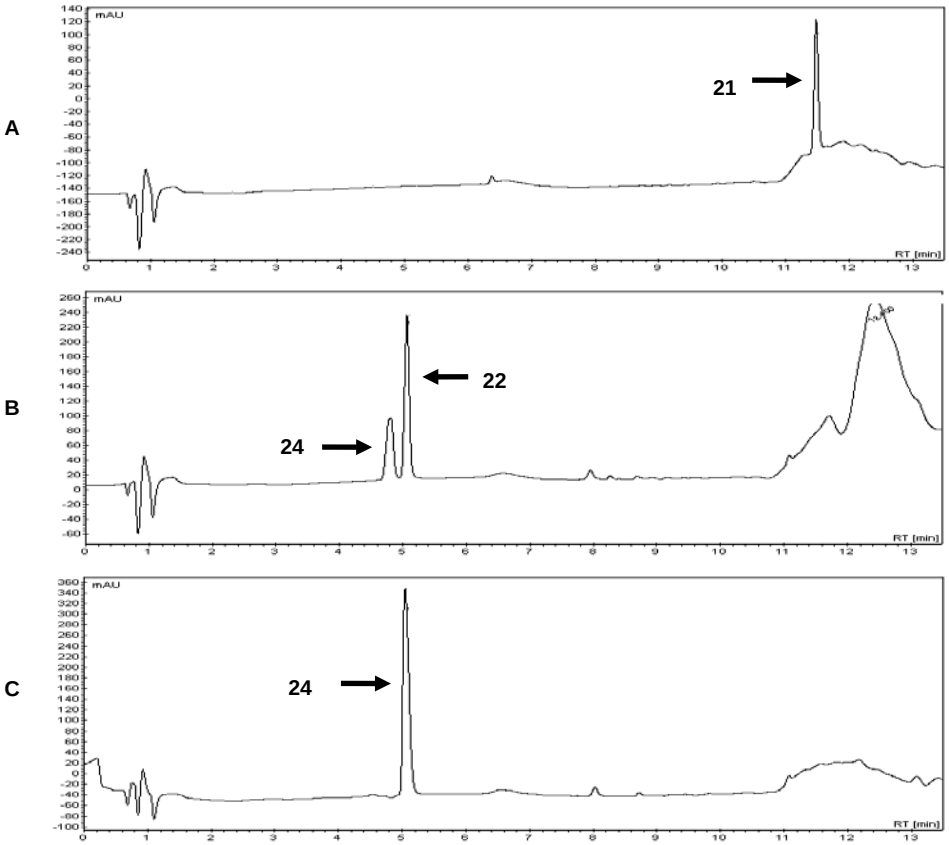
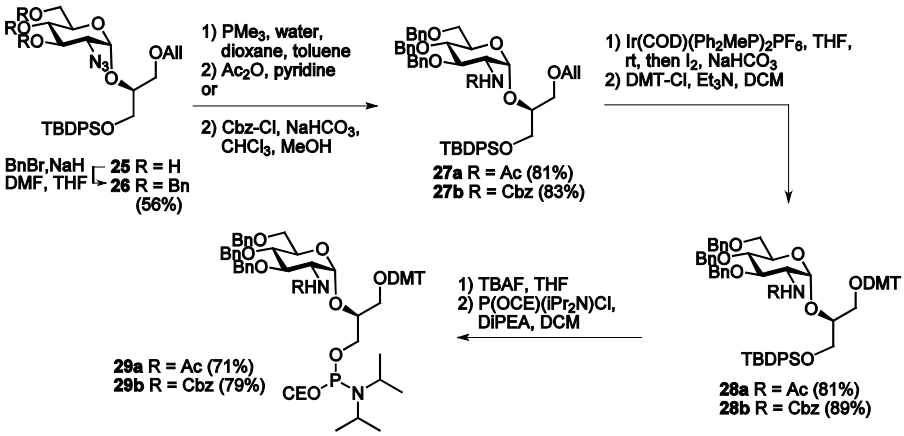


Figure 2. LC-MS (C-18, gradient (13.5 min) 10% → 90% MeCN, 15mM NH_4OAc) analysis of the base catalyzed deprotection (25% NH_4OH at 40 °C) of compound **21**. A) before the reaction. B) after 30 minutes. C) after overnight reaction.

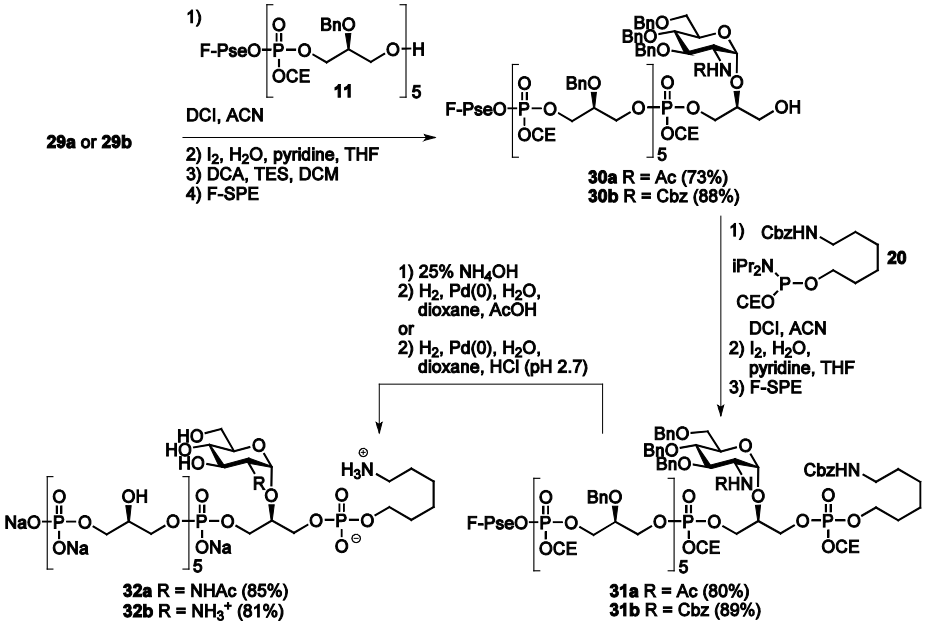
Having established that F-Pse alcohol **5** can be used for the efficient assembly of glycerol phosphate teichoic acids, the next goal was to investigate the incorporation of glycosyl substituents in the TA chains through the assembly of two teichoic acid hexamers. TA **32a** (Scheme 4) carries a GlcNAc residue, as present in TA chains of *Staphylococcus aureus*,[24] whereas a positively charged glucosamine is grafted on hexamer **32b**, a structural element found in several *Streptomyces* species.[25,26] The required glucosaminyl glycerol phosphoramidites were obtained as depicted in Scheme 3. Triol **25** was benzylated to give intermediate **26**[27] from which both building blocks **29a** and **29b** were assembled. Reduction of the azide functionality in **26** and subsequent acetylation gave *N*-acetyl glucosamine derivative **27a**, while protection with a benzyloxycarboxyl group led to **27b**. Both glucosaminyl glycerol building blocks were then transformed into the required phosphoramidites **29a** and **29b** following a well-established sequence of reactions, involving deallylation, dimethoxytritylation desilylation and phosphitylation (see Scheme 3).[1,2,20]

Scheme 3. Synthesis of glucosamineglycerol phosphoramidites **29a** and **29b**.



With building blocks **29a/b** the target hexamers **32a/b** were assembled starting from fluorous pentamer **11** (Scheme 4). Thus, condensation of **11** and **29a/b** and subsequent oxidation and removal of the DMT-group gave crude **30a/b**. Also in this case F-SPE purification proceeded uneventfully and hexamers **30a/b** were obtained in 73% and 88% respectively. The hexamers were then equipped with a hexylamino spacer using phosphoramidite **20** to give fully protected TA structures **31a/b** in pure form after F-SPE. Global deprotection using the deprotection protocol described above led to both target hexamers **32a/b**, the successful assembly of which indicates that the

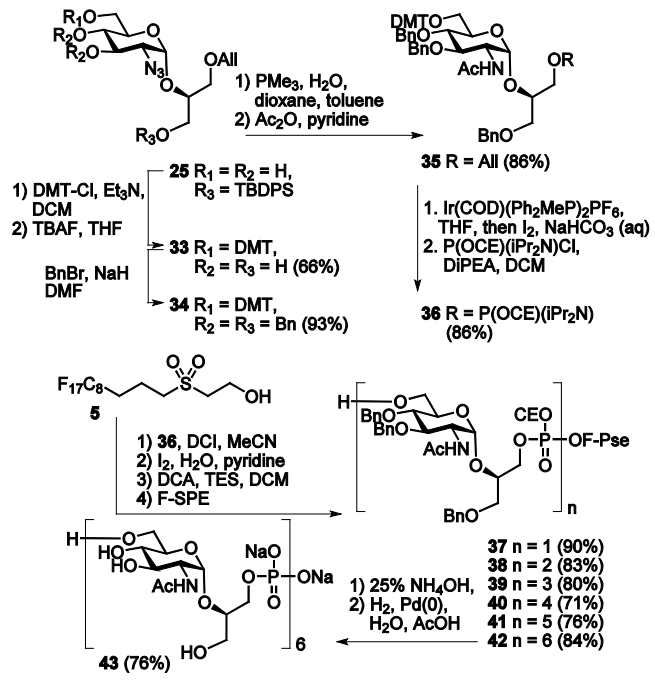
Scheme 4. Light fluorous synthesis of glucosamine containing GTA hexamer **32a** and **32b**.



fluorous synthesis strategy can also be applied to substituted oligoglycerolphosphates.

Finally, the assembly of more complex structures was explored, as exemplified by the synthesis of teichoic acid fragment **43**, which is characterized by the [→6)-glucosamine-(α-1→2)-sn-glycerol-1-phosphate-] repeating unit and is found in *Spirilliplanes Yamanashiensis* (scheme 5).[28] The synthesis of the required GlcNHAc-glycerol phosphoramidite building block **36** commenced with dimethoxytritylation of the primary alcohol in **25**. Subsequent desilylation and benzylation of the resulting triol gave the fully protected GlcNHAc-glycerol **34**, which was transformed into required phosphoramidite **36** through azide reduction and acetylation followed by a deallylation-phosphitylation reaction sequence. For the assembly of hexamer **43**, F-Pse linker **5** was elongated in a step-wise manner with **36** using the chemistry described above. As can be seen in Scheme 5 all elongation steps proceeded efficiently. Although **36** is a more lipophilic building block than the above described glycerol phosphates, this did not pose any problems in the purification of the oligomers. Notably, the single C_8F_{17}-tail sufficed for the easy purification of fully protected hexamer **42**, having a molecular mass of 4.7 kDa (relative fluorine content: 7%). Finally, deprotection of **42** was accomplished by β-elimination of the F-Pse linker and cyanoethyl groups and global debenzylation to give target compound **43** in 76% yield.

Scheme 5. Synthesis of complex hexamer **43**.



TA fragments **19**, **32a** and **32b** were evaluated in an OPIA, where the binding of the molecules to antibodies raised in rabbits against enterococcal LTA was measured. The three TAs all partially inhibited the killing of *E. faecalis* by the opsonic antibodies when added in a concentration of 100 μg/ml (see Figure 3). However, when compared to the glucosylated hexamers described in **chapter three** the inhibition of killing by these molecules was

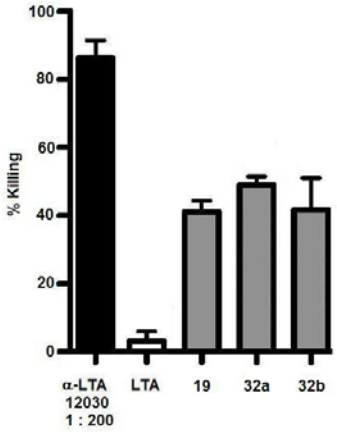


Figure 3. Results OPIA of compounds **19**, **32a/b** at 100 μg/ml. The left bar represents killing by the serum without addition of inhibitor. The second bar from the left (LTA) represents the positive control where native LTA is added as the inhibitor.

considerably less. This indicates that the presence of either the (*N*-acetyl)aminoglucosyl or the terminal phosphate moiety (or both) might have a negative effect on the potency of the antigen.

Conclusion

In conclusion, an efficient fluorous synthesis strategy for the assembly of teichoic acid fragments, was developed, based on the application of perfluorooctylpropylsulfonylethanol as a new fluorous phosphate protecting group. The strategy is especially useful for the assembly of multi-milligram quantities of medium sized TA fragments, featuring 6-12 repeating units. As displayed by the assembly of teichoic acid fragment **43**, complex glycerol phosphate building blocks can also be used, indicating that this strategy might be a valuable asset for the construction of various classes of phosphate ester containing biomolecules.

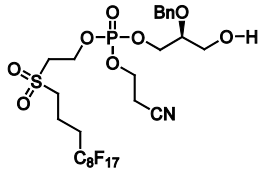
Experimental section

General Procedures and Material: All chemicals (Acros, Fluka, Merck, Schleicher & Schuell, Sigma-Aldrich, Genscript, Fluorous Technologies) were used as received and reactions were carried out dry, under an argon atmosphere, at ambient temperature, unless stated otherwise. Column chromatography was performed on Screening Devices silica gel 60 (0.040-0.063 mm). TLC analysis was conducted on HPTLC aluminium sheets (Merck, silica gel 60, F245). Compounds were visualized by UV absorption (245 nm), by spraying with 20% H_2SO_4 in ethanol or with a solution of $(NH_4)_6Mo_7O_{24}$•4 H_2O 25 g/l and $(NH_4)_4Ce(SO_4)_4$•2 H_2O 10 g/l, in 10% aqueous H_2SO_4 followed by charring at +/- 140 °C. Some unsaturated compounds were visualized by spraying with a solution of $KMnO_4$ (2%) and K_2CO_3 (1%) in water. Optical rotation measurements ($[\alpha]_D^{20}$) were performed on a Propol automated polarimeter (Sodium D-line, λ = 589 nm) with a concentration of 10 mg/ml (c = 1), unless stated otherwise. Infrared spectra were recorded on a Shimadzu FT-IR 8300. ^{31}P, ^{1}H, and ^{13}C NMR spectra were recorded with a Bruker AV 400 (161.7, 400 and 125 MHz respectively) or a Bruker DMX 600 (600 and 150 MHz respectively). NMR spectra were recorded in $CDCl_3$ with chemical shift (δ) relative to tetramethylsilane, unless stated otherwise. When D_2O was used, ^{1}H-NMR spectra were recorded with chemical shift relative (δ) to HDO (4.755 ppm), ^{31}P spectra were measured with chemical shift relative to 85% H_3PO_4 (external standard) and ^{13}C-NMR spectra were recorded with chemical shift relative to TMS (external standard). High resolution mass spectra (HRMS) were recorded by direct injection (2 μl of a 2 μM solution in water/acetonitrile; 50/50; v/v and either 0.1% formic acid or 10mM ammonium formate for the oligomers) on a mass spectrometer (Thermo Finnigan LTQ Orbitrap) equipped with an electrospray ion source in positive mode (source voltage 3.5 kV, sheath gas flow 10, capillary temperature 275 °C) with resolution R = 60000 at m/z 400 (mass range m/z = 150-2000) and dioctylphthalate (m/z = 391.28428) as a

lock mass. The high resolution mass spectrometer was calibrated prior to measurements with a calibration mixture (Thermo Finnigan).

General procedure for phosphoramidite coupling, oxidation, detritylation and F-SPE on a typical scale (0.1-0.25 mmol): Starting alcohol was dissolved in MeCN (0.1M). DCI (0.25M solution in MeCN, 2 eq with respect to phosphoramidite) was added, together with freshly activated MS3Å and the mixture was stirred under argon for 15 minutes. Phosphoramidite (0.1-0.2 M solution in MeCN, 1.3 - 4.0 eq with respect to starting material) was added and the reaction was stirred until TLC analysis revealed full conversion of the starting material into a higher running spot (~1 hr). Added were H_2O (~1 ml) and I_2 (0.2 M in THF/pyr 4/1, 1.5 eq with respect to phosphoramidite) and the mixture was stirred for an additional 5 min. The mixture was diluted with EtOAc (~50 ml) and washed with sat. aq. $Na_2S_2O_3$ (~20 ml), 0.5 M $KHSO_4$ (~20 ml) and a 1/1 mixture of sat. aq. $NaHCO_3$ and brine (~20 ml), respectively. The organic layer was dried over Na_2SO_4 (s) and concentrated under reduced pressure. The residue was coevaporated once with toluene (10 ml) before it was redissolved in DCM (50 mM). Triethylsilane and dichloroacetic acid (20 eq with respect to starting material) were added and the mixture was stirred until the bright orange color fully dissapeared (~30 min). DCM (~40 ml) was added and the organic layer was washed with a 1/1 mixture of sat. aq. $NaHCO_3$ and brine (~20 ml, check if pH >7), before it was dried over Na_2SO_4 and concentrated *in vacuo*. The residue was taken up in 4/1 MeCN/H_2O (10 ml) and washed with hexane (50 ml). The hexane layer was extracted twice with 4/1 MeCN/H_2O (2 x 10 ml) and the combined MeCN/H_2O layers were concentrated under reduced pressure in a 100 ml pear shaped flask. The residue was taken up in 0.5 ml MeCN and applied to a small column containing fluoroflash™ fluorous silica (2 or 4g) which was preeluted with 1/1 MeCN/H_2O. The column was eluted with 1/1 MeCN/H_2O until all the non-fluorous byproducts (DMT-H, phosphates, DCI) were removed. Subsequently the fluorous product was eluted from the column with CH_3CN and acetone.

Global deprotection and purification of oligomers: The fully protected oligomer was treated with a 9/1 mixture of 28% NH_4OH (aq)/1,4-dioxane at a concentration of 5 mg/ml at 40 - 45 °C overnight in a sealed flask or tube. After cooling down to RT the mixture was washed with Et_2O (equal volume) and the ether layer was extracted twice with H_2O (~5.0 ml). The aqueous layer was concentrated under reduced pressure after which NMR and HRMS analysis confirmed full conversion to the semiprotected intermediate. The intermediate was then treated with Pd (0)/H_2 (using ~5 mg palladium black per ml reaction medium) in a slightly acidic (pH ~2.7) mixture of dioxane/water (1/4, containing ~1% AcOH, or, in the case of hexamer **27b**, containing aqueous HCl, pH 2.7) at a concentration of ~5 mg of starting material per ml. After stirring for three days the mixture was filtered and concentrated *in vacuo*. The residue was purified by size exclusion chromatography (Sephadex HW40, eluent: 0.15 M NH_4OAc). After repeated lyophilisation, the purified product was eluted through a small column containing Dowex Na^+ cation-exchange resin (type: 50WX4-200, stored on 0.5 M NaOH in H_2O, flushed with H_2O and MeOH before use). Lyophilization gave the fully deprotected oligomer of which the integrity and purity was confirmed by HRMS and NMR (^1H, ^{13}C, ^{31}P) analysis.

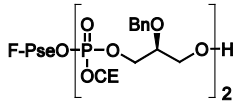


1-[(Perfluorooctylpropysulfonylethyl)-(2-cyanoethyl)-phosphate]-2-*O*-benzyl-*sn*-glycerol (7)

Perfluorooctylpropylsulfonyl ethanol **5** (145 mg, 254 μmol) was coupled to glycerol phosphoramidite **6** (0.175 M in MeCN, 2.18 ml, 381 μmol, 1.5 eq), oxidized, detritylated and purified (F-SPE) using the general procedure as described above. Monomer **7** (218 mg, 251 μmol, 99 %) was obtained as a colorless oil. ^{31}P NMR (161.7

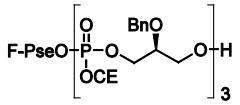
MHz): δ = -1.5, -1.5 (1P); ^{1}H NMR (400 MHz): δ = 2.12 - 2.36 (m, 4H, $F_{17}C_8CH_2CH_2CH_2CH_2SO_2$-, $F_{17}C_8CH_2CH_2CH_2CH_2SO_2$-), 2.52 (bs, 1H, CH_2OH), 2.66 - 2.72 (m, 2H, CH_2 cyanoethyl), 3.08 - 3.15 (m, 2H, $F_{17}C_8CH_2CH_2CH_2CH_2SO_2$-), 3.29 - 3.35 (m, 2H, -$OCH_2CH_2CH_2SO_2$-), 3.68 - 3.77 (m, 3H, CH glycerol, CH_2 glycerol), 4.19 - 4.27 (m, 3H, CH*H* glycerol, CH_2 cyanoethyl), 4.31 - 4.38 (m, 1H, CH*H* glycerol), 4.47 - 4.52 (m, 2H, -$OCH_2CH_2CH_2SO_2$-,), 4.62 - 4.68 (m, 2H, CH_2 Bn), 7.30 - 7.37 (m, 5H, H_{arom}); ^{13}C NMR (100 MHz): δ = 13.4 ($F_{17}C_8CH_2CH_2CH_2CH_2SO_2$-), 19.5 - 19.6 ($CH_2$ cyanoethyl), 29.3 (t, *J* = 22 Hz, $F_{17}C_8CH_2CH_2CH_2CH_2SO_2$-), 53.1 - 53.3 ($F_{17}C_8CH_2CH_2CH_2CH_2SO_2$-, -$OCH_2CH_2CH_2SO_2$-), 60.5 ($CH_2$ glycerol), 61.3 - 61.4 (-$OCH_2CH_2CH_2SO_2$-), 62.3 - 62.4 (CH_2 cyanoethyl), 66.8 - 66.9 (CH_2 glycerol), 72.0 (CH_2 Bn), 77.4 (CH glycerol), 116.6 (C_q cyanoethyl), 127.9 - 128.5 (CH_{arom}), 137.5 (C_q Bn); HRMS: $C_{26}H_{27}F_{17}NO_8PS$ + H^+ requires 868.0996, found 868.0996.

2-*O*-Benzyl-glycerol phosphate dimer (8)



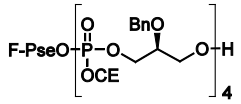
Alcohol **7** (217 mg, 250 μmol) was coupled to glycerol phosphoramidite **6** (0.175 M in MeCN, 1.86 ml, 325 μmol, 1.3 eq), oxidized, detritylated and purified (F-SPE) using the general procedure as described above. dimer **8** (277 mg, 238 μmol, 95 %) was obtained as a colorless oil. ^{31}P NMR (161.7 MHz): δ = -1.9, -1.9, -1.8, -1.8 (1P), -0.8, -0.8, -0.8, -0.8 (1P); ^{1}H NMR (400 MHz): δ = 2.11 - 2.35 (m, 4H, $F_{17}C_8CH_2CH_2CH_2CH_2SO_2$-, $F_{17}C_8CH_2CH_2CH_2CH_2SO_2$-), 2.56 - 2.70 (m, 5H, 2 x CH_2 cyanoethyl, CH_2OH), 3.07 - 3.14 (m, 2H, $F_{17}C_8CH_2CH_2CH_2CH_2SO_2$-), 3.26 - 3.34 (m, 2H, -$OCH_2CH_2CH_2SO_2$-), 3.65 - 3.78 (m, 3H, CH glycerol, CH_2 glycerol), 3.82 - 3.86 (m, 1H, CH glycerol), 4.15 - 4.36 (m, 10H, 3 x CH_2 glycerol, 2 x CH_2 cyanoethyl), 4.45 - 4.51 (m, 2H, -$OCH_2CH_2CH_2SO_2$-,), 4.59 - 4.67 (m, 4H, 2 x CH_2 Bn), 7.28 - 7.37 (m, 10H, H_{arom}); ^{13}C NMR (100 MHz): δ = 13.3 ($F_{17}C_8CH_2CH_2CH_2CH_2SO_2$-), 19.4 - 19.5 (2 x CH_2 cyanoethyl), 29.3 (t, *J* = 22 Hz, $F_{17}C_8CH_2CH_2CH_2CH_2SO_2$-), 53.0 - 53.2 ($F_{17}C_8CH_2CH_2CH_2CH_2SO_2$-, -$OCH_2CH_2CH_2SO_2$-), 60.4 - 60.5 ($CH_2$ glycerol), 61.3 - 61.4 (-$OCH_2CH_2CH_2SO_2$-), 62.1 (CH_2 cyanoethyl), 62.4 (CH_2 cyanoethyl), 65.3 (CH_2 glycerol), 66.0 (CH_2 glycerol), 66.5 - 66.6 (CH_2 glycerol), 66.8 - 66.9 (CH_2 glycerol), 72.0 (CH_2 Bn), 72.2 (CH_2 Bn), 75.1 - 75.2 (CH glycerol), 77.4 - 77.5 (CH glycerol), 116.6 (2 x C_q cyanoethyl), 127.8 - 128.5 (CH_{arom}), 137.0 (C_q Bn), 137.6 (C_q Bn); HRMS: $C_{39}H_{43}F_{17}N_2O_{13}P_2S$ + H^+ requires 1165.1762, found 1165.1756.

2-*O*-Benzyl-glycerol phosphate trimer (9)



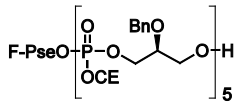
Glycerol phosphate dimer **8** (275 mg, 236 μmol) was coupled to glycerol phosphoramidite **6** (0.175 M in MeCN, 2.02 ml, 354 μmol, 1.5 eq), oxidized, detritylated and purified (F-SPE) using the general procedure as described above. trimer **9** (318 mg, 217 μmol, 92 %) was obtained as a colorless oil. ^{31}P NMR (161.7 MHz): δ = -1.9, -1.9, -1.8, (1P), -1.3, -1.3, -1.2, -1.1 (1P), -0.8, -0.8, -0.8, -0.8 (1P); ^{1}H NMR (400 MHz): δ = 2.10 - 2.36 (m, 4H, $F_{17}C_8CH_2CH_2CH_2CH_2SO_2$-, $F_{17}C_8CH_2CH_2CH_2CH_2SO_2$-), 2.56 - 2.73 (m, 7H, 3 x CH_2 cyanoethyl, CH_2OH), 3.06 - 3.13 (m, 2H, $F_{17}C_8CH_2CH_2CH_2CH_2SO_2$-), 3.26 - 3.34 (m, 2H, -$OCH_2CH_2CH_2SO_2$-), 3.64 - 3.73 (m, 3H, CH glycerol, CH_2 glycerol), 3.81 - 3.86 (m, 2H, 2 x CH glycerol), 4.11 - 4.35 (m, 16H, 5 x CH_2 glycerol, 3 x CH_2 cyanoethyl), 4.44 - 4.50 (m, 2H, -$OCH_2CH_2CH_2SO_2$-,), 4.58 - 4.67 (m, 6H, 3 x CH_2 Bn), 7.27 - 7.37 (m, 15H, H_{arom}); ^{13}C NMR (100 MHz): δ = 13.3 ($F_{17}C_8CH_2CH_2CH_2CH_2SO_2$-), 19.3 - 19.4 (3 x CH_2 cyanoethyl), 29.2 (t, *J* = 22 Hz, $F_{17}C_8CH_2CH_2CH_2CH_2SO_2$-), 53.0 - 53.2 ($F_{17}C_8CH_2CH_2CH_2CH_2SO_2$-, -$OCH_2CH_2CH_2SO_2$-), 60.3 - 60.4 ($CH_2$ glycerol), 61.3 (-$OCH_2CH_2CH_2SO_2$-), 62.0 - 62.4 (3 x CH_2 cyanoethyl), 65.4 - 66.6 (5 x CH_2 glycerol), 71.9 (CH_2 Bn), 72.1 (2 x CH_2 Bn), 75.2 - 75.3 (2 x CH glycerol), 77.4 - 77.5 (CH glycerol), 116.7 (3 x C_q cyanoethyl), 127.5 - 128.5 (CH_{arom}), 137.1 (2 x C_q Bn), 137.7 (C_q Bn); HRMS: $C_{52}H_{59}F_{17}N_3O_{18}P_3S$ + Na^+ requires 1484.2348, found 1484.2363.

2-*O*-Benzyl-glycerol phosphate tetramer (10)



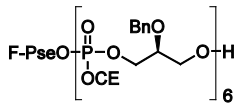
Glycerol phosphate trimer **9** (311 mg, 213 μmol) was coupled to glycerol phosphoramidite **6** (0.175 M in MeCN, 1.83 ml, 320 μmol, 1.5 eq), oxidized, detritylated and purified (F-SPE) using the general procedure as described above. tetramer **10** (339 mg, 192 μmol, 91 %) was obtained as a colorless oil. ^{31}P NMR (161.7 MHz): δ = -1.9, -1.9 (1P), -1.4, -1.3 (1P), -1.2, -1.2, -1.1 (1P), -0.9, -0.9, -0.8, -0.8 (1P); ^{1}H NMR (400 MHz): δ = 2.10 - 2.36 (m, 4H, $F_{17}C_8CH_2C\mathit{H}_2CH_2CH_2SO_2$-, $F_{17}C_8C\mathit{H}_2CH_2CH_2CH_2SO_2$-), 2.54 - 2.76 (m, 9H, 4 x CH_2 cyanoethyl, $CH_2O\mathit{H}$), 3.06 - 3.13 (m, 2H, $F_{17}C_8CH_2CH_2C\mathit{H}_2SO_2$-), 3.25 - 3.34 (m, 2H, -$OCH_2C\mathit{H}_2SO_2$-), 3.64 - 3.72 (m, 3H, CH glycerol, CH_2 glycerol), 3.79 - 3.85 (m, 3H, 3 x CH glycerol), 4.10 - 4.35 (m, 22H, 7 x CH_2 glycerol, 4 x CH_2 cyanoethyl), 4.44 - 4.50 (m, 2H, -$OC\mathit{H}_2CH_2SO_2$-,), 4.58 - 4.67 (m, 8H, 4 x CH_2 Bn), 7.27 - 7.36 (m, 20H, H_{arom}); ^{13}C NMR (100 MHz): δ = 13.3 ($F_{17}C_8CH_2\mathit{C}H_2CH_2SO_2$-), 19.3 - 19.4 (4 x CH_2 cyanoethyl), 29.2 (t, *J* = 22 Hz, $F_{17}C_8\mathit{C}H_2CH_2CH_2SO_2$-), 52.9 - 53.1 ($F_{17}C_8CH_2CH_2\mathit{C}H_2SO_2$-, -$OCH_2\mathit{C}H_2SO_2$-), 60.3 - 60.4 ($CH_2$ glycerol), 61.3 (-$O\mathit{C}H_2CH_2SO_2$-), 62.0 - 62.4 (4 x CH_2 cyanoethyl), 65.4 - 66.6 (7 x CH_2 glycerol), 71.9 (CH_2 Bn), 72.1 (3 x CH_2 Bn), 75.1 - 75.4 (3 x CH glycerol), 77.4 - 77.5 (CH glycerol), 116.6 - 116.7 (4 x C_q cyanoethyl), 127.7 - 128.5 (CH_{arom}), 137.1 - 137.2 (3 x C_q Bn), 137.7 (C_q Bn); HRMS: $C_{65}H_{75}F_{17}N_4O_{23}P_4S$ + Na^+ requires 1781.3114, found 1781.3106.

2-*O*-Benzyl-glycerol phosphate pentamer (11)



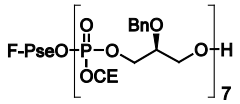
Glycerol phosphate tetramer **10** (538 mg, 306 μmol) was coupled to glycerol phosphoramidite **6** (0.175 M in MeCN, 2.62 ml, 459 μmol, 1.5 eq), oxidized, detritylated and purified (F-SPE) using the general procedure as described above. Pentamer **11** (524 mg, 255 μmol, 83 %) was obtained as a colorless oil. ^{31}P NMR (161.7 MHz): δ = -1.9, -1.9 (1P), -1.4 - -1.1 (3P), -0.9, -0.9, -0.9 (1P); ^{1}H NMR (400 MHz): δ = 2.11 - 2.34 (m, 4H, $F_{17}C_8CH_2C\mathit{H}_2CH_2CH_2SO_2$-, $F_{17}C_8C\mathit{H}_2CH_2CH_2CH_2SO_2$-), 2.53 - 2.70 (m, 11H, 5 x CH_2 cyanoethyl, $CH_2O\mathit{H}$), 3.06 - 3.13 (m, 2H, $F_{17}C_8CH_2CH_2C\mathit{H}_2SO_2$-), 3.25 - 3.34 (m, 2H, -$OCH_2C\mathit{H}_2SO_2$-), 3.63 - 3.72 (m, 3H, CH glycerol, CH_2 glycerol), 3.79 - 3.85 (m, 4H, 4 x CH glycerol), 4.09 - 4.34 (m, 28H, 9 x CH_2 glycerol, 5 x CH_2 cyanoethyl), 4.43 - 4.50 (m, 2H, -$OC\mathit{H}_2CH_2SO_2$-,), 4.58 - 4.66 (m, 10H, 5 x CH_2 Bn), 7.26 - 7.36 (m, 25H, H_{arom}); ^{13}C NMR (100 MHz): δ = 13.3 ($F_{17}C_8CH_2\mathit{C}H_2CH_2CH_2SO_2$-), 19.2 - 19.4 (5 x CH_2 cyanoethyl), 29.2 (t, *J* = 21 Hz, $F_{17}C_8\mathit{C}H_2CH_2CH_2SO_2$-), 52.9 - 53.1 ($F_{17}C_8CH_2CH_2\mathit{C}H_2SO_2$-, -$OCH_2\mathit{C}H_2SO_2$-), 60.3 - 60.4 ($CH_2$ glycerol), 61.3 (-$O\mathit{C}H_2CH_2SO_2$-), 62.0 - 62.4 (5 x CH_2 cyanoethyl), 65.4 - 66.6 (9 x CH_2 glycerol), 71.8 (CH_2 Bn), 72.1 (4 x CH_2 Bn), 75.1 - 75.3 (4 x CH glycerol), 77.4 - 77.5 (CH glycerol), 116.6 - 116.7 (5 x C_q cyanoethyl), 127.7 - 128.5 (CH_{arom}), 137.1 - 137.2 (4 x C_q Bn), 137.7 (C_q Bn); HRMS: $[C_{78}H_{91}F_{17}N_5O_{28}P_5S + 2NH_4]^{2+}$ requires 1045.7332, found 1045.7344.

2-*O*-Benzyl-glycerol phosphate hexamer (12)



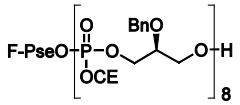
Glycerol phosphate pentamer **11** (237 mg, 115 μmol) was coupled to glycerol phosphoramidite **6** (0.175 M in MeCN, 0.99 ml, 173 μmol, 1.5 eq), oxidized, detritylated and purified (F-SPE) using the general procedure as described above. Hexamer **12** (240 mg, 102 μmol, 89 %) was obtained as a colorless oil. ^{31}P NMR (161.7 MHz): δ = -1.9, -1.9 (1P), -1.4 - -1.1 (4P), -0.9, -0.9, -0.9 (1P); ^{1}H NMR (400 MHz): δ = 2.09 - 2.36 (m, 4H, $F_{17}C_8CH_2C\mathit{H}_2CH_2CH_2SO_2$-, $F_{17}C_8C\mathit{H}_2CH_2CH_2CH_2SO_2$-), 2.46 - 2.69 (m, 13H, 6 x CH_2 cyanoethyl, $CH_2O\mathit{H}$), 3.06 - 3.13 (m, 2H, $F_{17}C_8CH_2CH_2C\mathit{H}_2SO_2$-), 3.25 - 3.34 (m, 2H, -$OCH_2C\mathit{H}_2SO_2$-), 3.63 - 3.72 (m, 3H, CH glycerol, CH_2 glycerol), 3.79 - 3.86 (m, 5H, 5 x CH glycerol), 4.08 - 4.33 (m, 34H, 11 x CH_2 glycerol, 6 x CH_2 cyanoethyl), 4.43 - 4.50 (m, 2H, -$OC\mathit{H}_2CH_2SO_2$-,), 4.58 - 4.66 (m, 12H, 6 x CH_2 Bn), 7.26 - 7.36 (m, 30H, H_{arom}); ^{13}C NMR (100 MHz): δ = 13.3 ($F_{17}C_8CH_2\mathit{C}H_2CH_2CH_2SO_2$-), 19.2 - 19.4 (6 x CH_2 cyanoethyl), 29.3 ($F_{17}C_8\mathit{C}H_2CH_2CH_2SO_2$-), 53.0 - 53.1 ($F_{17}C_8CH_2CH_2CH_2\mathit{C}H_2SO_2$-, -$OCH_2\mathit{C}H_2SO_2$-), 60.4

- 60.5 (CH_2 glycerol), 61.3 (-O*C*$H_2CH_2SO_2$-), 62.0 - 62.4 (6 x CH_2 cyanoethyl), 65.4 - 66.6 (11 x CH_2 glycerol), 71.9 (CH_2 Bn), 72.1 (5 x CH_2 Bn), 75.1 - 75.4 (5 x CH glycerol), 77.5 - 77.6 (CH glycerol), 116.7 - 116.8 (6 x C_q cyanoethyl), 127.8 - 128.5 (CH_{arom}), 137.1 - 137.3 (5 x C_q Bn), 137.7 (C_q Bn); HRMS: $[C_{91}H_{107}F_{17}N_6O_{33}P_6S + 2H]^{2+}$ requires 1177.2450, found 1177.2466.



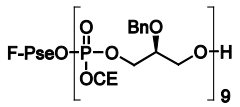
2-*O*-Benzyl-glycerol phosphate heptamer (13)

Glycerol phosphate hexamer **12** (238 mg, 101 μmol) was coupled to glycerol phosphoramidite **6** (0.175 M in MeCN, 1.15 ml, 202 μmol, 2 eq), oxidized, detritylated and purified (F-SPE) using the general procedure as described above. Heptamer **13** (225 mg, 84.7 μmol, 84 %) was obtained as a colorless oil. ^{31}P NMR (161.7 MHz): δ = -1.9, -1.9 (1P), -1.4 - -1.1 (5P), -0.9, -0.9 (1P); ^{1}H NMR (400 MHz): δ = 2.10 - 2.36 (m, 5H, $F_{17}C_8CH_2CH_2CH_2SO_2$-, $F_{17}C_8CH_2CH_2CH_2SO_2$-, CH_2OH), 2.52 - 2.69 (m, 14H, 7 x CH_2 cyanoethyl), 3.06 - 3.13 (m, 2H, $F_{17}C_8CH_2CH_2CH_2SO_2$-), 3.25 - 3.34 (m, 2H, -$OCH_2CH_2SO_2$-), 3.64 - 3.71 (m, 3H, CH glycerol, CH_2 glycerol), 3.78 - 3.85 (m, 6H, 6 x CH glycerol), 4.07 - 4.34 (m, 40H, 13 x CH_2 glycerol, 7 x CH_2 cyanoethyl), 4.43 - 4.50 (m, 2H, -$OCH_2CH_2SO_2$-,), 4.58 - 4.67 (m, 14H, 7 x CH_2 Bn), 7.26 - 7.36 (m, 35H, H_{arom}); ^{13}C NMR (100 MHz): δ = 13.4 ($F_{17}C_8CH_2CH_2CH_2SO_2$-), 19.3 - 19.5 (7 x CH_2 cyanoethyl), 29.3 (t, *J* = 22 Hz, $F_{17}C_8CH_2CH_2CH_2SO_2$-), 53.0 - 53.2 ($F_{17}C_8CH_2CH_2CH_2SO_2$-, -$OCH_2CH_2SO_2$-), 60.4 - 60.5 ($CH_2$ glycerol), 61.3 (-O*C*$H_2CH_2SO_2$-), 62.0 - 62.4 (7 x CH_2 cyanoethyl), 65.4 - 66.6 (13 x CH_2 glycerol), 71.9 (CH_2 Bn), 72.1 (6 x CH_2 Bn), 75.2 - 75.5 (6 x CH glycerol), 77.5 - 77.6 (CH glycerol), 116.6 - 116.8 (7 x C_q cyanoethyl), 127.8 - 128.5 (CH_{arom}), 137.1 - 137.3 (6 x C_q Bn), 137.7 (C_q Bn); HRMS: $[C_{104}H_{123}F_{17}N_7O_{38}P_7S + 2Na]^{2+}$ requires 1348.2669, found 1348.2666.



2-*O*-Benzyl-glycerol phosphate octamer (14)

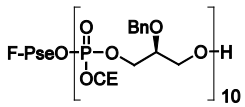
Glycerol phosphate heptamer **13** (222 mg, 83.7 μmol) was coupled to glycerol phosphoramidite **6** (0.175 M in MeCN, 0.96 ml, 167 μmol, 2 eq), oxidized, detritylated and purified (F-SPE) using the general procedure as described above. Octamer **14** (206 mg, 69.7 μmol, 83 %) was obtained as a colorless oil. ^{31}P NMR (161.7 MHz): δ = -1.9, -1.8 (1P), -1.4 - -1.1 (6P), -0.9 (1P); ^{1}H NMR (400 MHz): δ = 2.10 - 2.36 (m, 5H, $F_{17}C_8CH_2CH_2CH_2SO_2$-, $F_{17}C_8CH_2CH_2CH_2SO_2$-, CH_2OH), 2.51 - 2.68 (m, 16H, 8 x CH_2 cyanoethyl), 3.06 - 3.13 (m, 2H, $F_{17}C_8CH_2CH_2CH_2SO_2$-), 3.25 - 3.33 (m, 2H, -$OCH_2CH_2SO_2$-), 3.64 - 3.72 (m, 3H, CH glycerol, CH_2 glycerol), 3.78 - 3.85 (m, 7H, 7 x CH glycerol), 4.07 - 4.33 (m, 46H, 15 x CH_2 glycerol, 8 x CH_2 cyanoethyl), 4.43 - 4.50 (m, 2H, -$OCH_2CH_2SO_2$-,), 4.57 - 4.66 (m, 16H, 8 x CH_2 Bn), 7.26 - 7.37 (m, 40H, H_{arom}); ^{13}C NMR (100 MHz): δ = 13.3 ($F_{17}C_8CH_2CH_2CH_2SO_2$-), 19.3 - 19.4 (8 x CH_2 cyanoethyl), 29.3 ($F_{17}C_8CH_2CH_2CH_2SO_2$-), 53.0 - 53.2 ($F_{17}C_8CH_2CH_2CH_2SO_2$-, -$OCH_2CH_2SO_2$-), 60.4 - 60.5 ($CH_2$ glycerol), 61.3 (-O*C*$H_2CH_2SO_2$-), 62.0 - 62.4 (8 x CH_2 cyanoethyl), 65.4 - 66.6 (15 x CH_2 glycerol), 71.9 (CH_2 Bn), 72.1 (7 x CH_2 Bn), 75.2 - 75.5 (7 x CH glycerol), 77.5 - 77.6 (CH glycerol), 116.6 - 116.7 (8 x C_q cyanoethyl), 127.8 - 128.5 (CH_{arom}), 137.2 - 137.3 (7 x C_q Bn), 137.8 (C_q Bn); HRMS: $[C_{117}H_{139}F_{17}N_8O_{43}P_8S + 2Na]^{2+}$ requires 1496.8052, found 1496.8054.



2-*O*-Benzyl-glycerol phosphate nonamer (15)

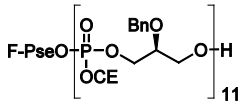
Glycerol phosphate octamer **14** (200 mg, 68.0 μmol) was coupled to glycerol phosphoramidite **6** (0.175 M in MeCN, 0.78 ml, 136 μmol, 2 eq), oxidized, detritylated and purified (F-SPE) using the general procedure as described above. Nonamer **15** (182 mg, 56.1 μmol, 83 %) was obtained as a colorless oil. ^{31}P NMR (161.7 MHz): δ = -1.9, -1.9 (1P), -1.3 - -1.1 (7P), -0.9 (1P); ^{1}H NMR (400 MHz): δ = 2.11 - 2.41 (m, 5H, $F_{17}C_8CH_2CH_2CH_2SO_2$-, $F_{17}C_8CH_2CH_2CH_2SO_2$-, CH_2OH), 2.51 - 2.70 (m, 18H, 9 x CH_2 cyanoethyl), 3.06 - 3.14 (m, 2H, $F_{17}C_8CH_2CH_2CH_2SO_2$-), 3.25

- 3.34 (m, 2H, -OCH$_2$C*H*$_2$SO$_2$-), 3.64 - 3.71 (m, 3H, CH glycerol, CH$_2$ glycerol), 3.78 - 3.85 (m, 8H, 8 x CH glycerol), 4.07 - 4.33 (m, 52H, 17 x CH$_2$ glycerol, 9 x CH$_2$ cyanoethyl), 4.43 - 4.50 (m, 2H, -OC*H*$_2$CH$_2$SO$_2$-,), 4.58 - 4.66 (m, 18H, 9 x CH$_2$ Bn), 7.26 - 7.37 (m, 45H, H$_{arom}$); ^{13}C NMR (100 MHz): δ = 13.3 (F$_{17}$C$_8$CH$_2$*C*H$_2$CH$_2$SO$_2$-), 19.3 - 19.4 (9 x CH$_2$ cyanoethyl), 29.3 (t, *J* = 21 Hz, F$_{17}$C$_8$*C*H$_2$CH$_2$CH$_2$SO$_2$-), 53.0 - 53.2 (F$_{17}$C$_8$CH$_2$CH$_2$*C*H$_2$SO$_2$-, -OCH$_2$*C*H$_2$SO$_2$-), 60.4 - 60.5 (CH$_2$ glycerol), 61.3 - 61.4 (-O*C*H$_2$CH$_2$SO$_2$-), 62.0 - 62.4 (9 x CH$_2$ cyanoethyl), 65.4 - 66.6 (17 x CH$_2$ glycerol), 71.9 (CH$_2$ Bn), 72.1 (8 x CH$_2$ Bn), 75.2 - 75.5 (8 x CH glycerol), 77.5 - 77.6 (CH glycerol), 116.6 - 116.8 (9 x C$_q$ cyanoethyl), 127.8 - 128.5 (CH$_{arom}$), 137.2 - 137.3 (8 x C$_q$ Bn), 137.8 (C$_q$ Bn); HRMS: [C$_{130}$H$_{155}$F$_{17}$N$_9$O$_{48}$P$_9$S + 2Na]$^{2+}$ requires 1645.3435, found 1645.3433.



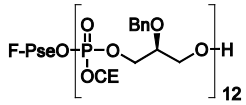
2-*O*-Benzyl-glycerol phosphate decamer (16)

Glycerol phosphate nonamer **15** (175 mg, 54.0 μmol) was coupled to glycerol phosphoramidite **6** (0.175 M in MeCN, 0.93 ml, 162 μmol, 3 eq), oxidized, detritylated and purified (F-SPE) using the general procedure as described above. Decamer **16** (166 mg, 46.9 μmol, 87 %) was obtained as a colorless oil. ^{31}P NMR (161.7 MHz): δ = -1.9, -1.9 (1P), -1.4 - -1.1 (8P), -0.9 (1P); ^{1}H NMR (400 MHz): δ = 2.10 - 2.40 (m, 5H, F$_{17}$C$_8$CH$_2$C*H*$_2$CH$_2$SO$_2$-, F$_{17}$C$_8$C*H*$_2$CH$_2$CH$_2$SO$_2$-, CH$_2$O*H*), 2.51 - 2.69 (m, 20H, 10 x CH$_2$ cyanoethyl), 3.06 - 3.14 (m, 2H, F$_{17}$C$_8$CH$_2$CH$_2$C*H*$_2$SO$_2$-), 3.25 - 3.34 (m, 2H, -OCH$_2$C*H*$_2$SO$_2$-), 3.64 - 3.71 (m, 3H, CH glycerol, CH$_2$ glycerol), 3.78 - 3.86 (m, 9H, 9 x CH glycerol), 4.06 - 4.34 (m, 58H, 19 x CH$_2$ glycerol, 10 x CH$_2$ cyanoethyl), 4.43 - 4.49 (m, 2H, -OC*H*$_2$CH$_2$SO$_2$-,), 4.57 - 4.65 (m, 20H, 10 x CH$_2$ Bn), 7.25 - 7.37 (m, 50H, H$_{arom}$); ^{13}C NMR (100 MHz): δ = 13.4 (F$_{17}$C$_8$CH$_2$*C*H$_2$CH$_2$SO$_2$-), 19.3 - 19.5 (10 x CH$_2$ cyanoethyl), 29.3 (t, *J* = 21 Hz, F$_{17}$C$_8$*C*H$_2$CH$_2$CH$_2$SO$_2$-), 53.0 - 53.2 (F$_{17}$C$_8$CH$_2$CH$_2$*C*H$_2$SO$_2$-, -OCH$_2$*C*H$_2$SO$_2$-), 60.4 - 60.5 (CH$_2$ glycerol), 61.3 - 61.4 (-O*C*H$_2$CH$_2$SO$_2$-), 62.0 - 62.4 (10 x CH$_2$ cyanoethyl), 65.4 - 66.6 (19 x CH$_2$ glycerol), 71.9 (CH$_2$ Bn), 72.1 (9 x CH$_2$ Bn), 75.2 - 75.5 (9 x CH glycerol), 77.5 - 77.6 (CH glycerol), 116.7 - 116.8 (10 x C$_q$ cyanoethyl), 127.8 - 128.5 (CH$_{arom}$), 137.2 - 137.3 (9 x C$_q$ Bn), 137.7 (C$_q$ Bn); HRMS: [C$_{143}$H$_{171}$F$_{17}$N$_{10}$O$_{53}$P$_{10}$S + 2Na]$^{2+}$ requires 1793.8818, found 1793.8812.



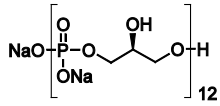
2-*O*-Benzyl-glycerol phosphate undecamer (17)

Glycerol phosphate decamer **16** (165 mg, 46.6 μmol) was coupled to glycerol phosphoramidite **6** (0.175 M in MeCN, 0.80 ml, 140 μmol, 3 eq), oxidized, detritylated and purified (F-SPE) using the general procedure as described above. Undecamer **17** (159 mg, 41.5 μmol, 89 %) was obtained as a colorless oil. ^{31}P NMR (161.7 MHz): δ = -1.9, -1.9 (1P), -1.4 - -1.1 (9P), -0.9, -0.9 (1P); ^{1}H NMR (400 MHz): δ = 2.10 - 2.37 (m, 4H, F$_{17}$C$_8$CH$_2$C*H*$_2$CH$_2$SO$_2$-, F$_{17}$C$_8$C*H*$_2$CH$_2$CH$_2$SO$_2$-), 2.46 - 2.68 (m, 23H, 11 x CH$_2$ cyanoethyl, CH$_2$O*H*), 3.06 - 3.13 (m, 2H, F$_{17}$C$_8$CH$_2$CH$_2$C*H*$_2$SO$_2$-), 3.25 - 3.34 (m, 2H, -OCH$_2$C*H*$_2$SO$_2$-), 3.64 - 3.70 (m, 3H, CH glycerol, CH$_2$ glycerol), 3.77 - 3.85 (m, 10H, 10 x CH glycerol), 4.06 - 4.31 (m, 64H, 21 x CH$_2$ glycerol, 11 x CH$_2$ cyanoethyl), 4.43 - 4.50 (m, 2H, -OC*H*$_2$CH$_2$SO$_2$-,), 4.57 - 4.66 (m, 22H, 11 x CH$_2$ Bn), 7.26 - 7.36 (m, 55H, H$_{arom}$); ^{13}C NMR (100 MHz): δ = 13.3 (F$_{17}$C$_8$CH$_2$*C*H$_2$CH$_2$SO$_2$-), 19.2 - 19.4 (11 x CH$_2$ cyanoethyl), 29.3 (F$_{17}$C$_8$*C*H$_2$CH$_2$CH$_2$SO$_2$-), 53.0 - 53.1 (F$_{17}$C$_8$CH$_2$CH$_2$*C*H$_2$SO$_2$-, -OCH$_2$*C*H$_2$SO$_2$-), 60.3 - 60.4 (CH$_2$ glycerol), 61.3 (-O*C*H$_2$CH$_2$SO$_2$-), 62.0 - 62.4 (11 x CH$_2$ cyanoethyl), 65.4 - 66.6 (21 x CH$_2$ glycerol), 71.9 (CH$_2$ Bn), 72.1 (10 x CH$_2$ Bn), 75.2 - 75.5 (10 x CH glycerol), 77.5 - 77.6 (CH glycerol), 116.6 - 116.8 (11 x C$_q$ cyanoethyl), 127.8 - 128.5 (CH$_{arom}$), 137.2 - 137.3 (10 x C$_q$ Bn), 137.7 (C$_q$ Bn); HRMS: [C$_{156}$H$_{187}$F$_{17}$N$_{11}$O$_{58}$P$_{11}$S + 2H]$^{2+}$ requires 1920.4382, found 1920.4386.



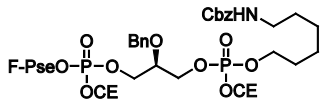
2-*O*-Benzyl-glycerol phosphate dodecamer (18)

Glycerol phosphate undecamer **17** (159 mg, 41.4 μmol) was coupled to glycerol phosphoramidite **6** (0.175 M in MeCN, 0.95 ml, 166 μmol, 4 eq), oxidized, detritylated and purified (F-SPE) using the general procedure as described above. Dodecamer **18** (161 mg, 38.8 μmol, 94 %) was obtained as a colorless oil. ^{31}P NMR (161.7 MHz): δ = -1.9, -1.9 (1P), -1.4 - -1.1 (10P), -0.9, -0.9, -0.9 (1P); ^{1}H NMR (400 MHz): δ = 2.11 - 2.40 (m, 5H, $F_{17}C_8CH_2CH_2CH_2CH_2SO_2$-, $F_{17}C_8CH_2CH_2CH_2CH_2SO_2$-, CH_2OH), 2.52 - 2.69 (m, 24H, 12 x CH_2 cyanoethyl), 3.06 - 3.13 (m, 2H, $F_{17}C_8CH_2CH_2CH_2CH_2SO_2$-), 3.25 - 3.34 (m, 2H, -$OCH_2CH_2SO_2$-), 3.64 - 3.71 (m, 3H, CH glycerol, CH_2 glycerol), 3.78 - 3.85 (m, 11H, 11 x CH glycerol), 4.06 - 4.32 (m, 70H, 23 x CH_2 glycerol, 12 x CH_2 cyanoethyl), 4.43 - 4.50 (m, 2H, -$OCH_2CH_2SO_2$-,), 4.57 - 4.65 (m, 24H, 12 x CH_2 Bn), 7.26 - 7.37 (m, 60H, H_{arom}); ^{13}C NMR (100 MHz): δ = 13.3 ($F_{17}C_8CH_2CH_2CH_2CH_2SO_2$-), 19.2 - 19.5 (12 x CH_2 cyanoethyl), 29.3 (t, *J* = 21 Hz, $F_{17}C_8CH_2CH_2CH_2CH_2SO_2$-), 53.0 - 53.2 ($F_{17}C_8CH_2CH_2CH_2CH_2SO_2$-, -$OCH_2CH_2SO_2$-), 60.4 - 60.5 ($CH_2$ glycerol), 61.3 (-$OCH_2CH_2SO_2$-), 62.0 - 62.4 (12 x CH_2 cyanoethyl), 65.4 - 66.6 (23 x CH_2 glycerol), 71.9 (CH_2 Bn), 72.1 (11 x CH_2 Bn), 75.2 - 75.5 (11 x CH glycerol), 77.5 - 77.6 (CH glycerol), 116.6 - 116.8 (12 x C_q cyanoethyl), 127.8 - 128.5 (CH_{arom}), 137.1 - 137.3 (11 x C_q Bn), 137.7 (C_q Bn); HRMS: $[C_{169}H_{203}F_{17}N_{12}O_{63}P_{12}S + 3Na]^{3+}$ requires 1401.6354, found 1401.6361.



Glycerol phosphate dodecamer (19)

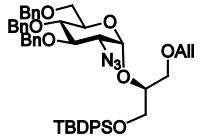
Protected dodecamer **18** (72.4 mg, 17.5 μmol) was treated with aqueous ammonia as described above. The compound was eluted (H_2O, ~5 ml) through a small column containing Dowex Na^+ cation-exchange resin (type: 50WX4-200, stored on 0.5 M NaOH in H_2O, flushed with MeOH and H_2O until pH neutral before use) and, subsequently, lyophilized, yielding the intermediate dodecamer (56.5 mg, 17.5 μmol, 100 %) as an amorphous white solid. Analytical data intermediate: ^{31}P NMR (161.7 MHz, D_2O): δ = 1.0 - 1.2 (11P), 2.5 (1P, phosphomonoester); ^{1}H NMR (400 MHz, D_2O): δ = 3.46 - 3.71 (m, 14H, 12 x CH glycerol, CH_2 glycerol), 3.72 - 4.01 (m, 46H, 23 x CH_2 glycerol), 4.26 - 4.58 (m, 24H, 12 x CH_2 Bn), 6.93 - 7.33 (m, 60H, H_{arom}); ^{13}C NMR (100 MHz, D_2O): δ = 60.2 (CH_2 glycerol), 63.2 (CH_2 glycerol), 64.3 - 64.6 (22 x CH_2 glycerol), 71.6 (CH_2 Bn), 71.8 - 72.0 (11 x CH_2 Bn), 76.9 - 77.1 (11 x CH glycerol), 78.1 (CH glycerol), 127.9 - 128.6 (CH_{arom}), 137.4 - 137.6 (12 x C_q Bn); HRMS: $[C_{120}H_{158}O_{61}P_{12} + 2NH_4]^{2+}$ requires 1491.8411, found 1491.8423. A portion of the intermediate (53.0 mg, 16.4 μmol) was deprotected with Pd (0)/H_2 using the standard procedure. Dodecaglycerolphosphate **19** (30.3 mg, 14.1 μmol, 86 %) was obtained as an amorphous white solid. ^{31}P NMR (161.7 MHz, D_2O): δ = 1.2 - 1.3 (11P), 2.8 (1P, phosphomonoester); ^{1}H NMR (600 MHz, D_2O): δ = 3.59 (dd, 1H, *J* = 6.1 Hz, 11.8 Hz, CH*H* glycerol), 3.67 (dd, 1H, *J* = 4.3 Hz, 11.8 Hz, CH*H* glycerol), 3.81 - 3.97 (m, 48H, 2 x CH glycerol, 23 x CH_2 glycerol), 3.99 - 4.06 (m, 10H, 10 x CH glycerol); ^{13}C NMR (150 MHz, D_2O): δ = 63.1 (CH_2 glycerol), 66.3 (d, *J* = 4.9 Hz, CH_2 glycerol), 67.1 (d, *J* = 5.5 Hz, CH_2 glycerol), 67.2 (d, *J* = 5.4 Hz, 19 x CH_2 glycerol), 67.4 (d, *J* = 5.8 Hz, CH_2 glycerol), 67.4 (d, *J* = 5.7 Hz, CH_2 glycerol), 70.5 (t, *J* = 8.0 Hz, 10 x CH glycerol), 70.9 (t, *J* = 7.7 Hz, CH glycerol), 71.7 (d, *J* = 7.8 Hz, CH glycerol); HRMS: $C_{36}H_{86}O_{61}P_{12} + NH_4^+$ requires 1884.0817, found 1884.0826.



1-[(Perfluorooctylpropysulfonylethyl)-(2-cyanoethyl)-phosphate]-2-*O*-benzyl-3-*O*-[(6-Cbz-aminohexyl)-(2-cyanoethyl) phosphate]-*sn*-glycerol (21)

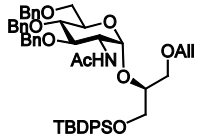
Monomeric glycerol phosphate alcohol **7** (182 mg, 209 μmol) was coupled to spacer phosphoramidite **20** (0.2 M in MeCN, 2.61 ml, 523 μmol, 2.5 eq), oxidized and purified (F-SPE) as described in the general procedure. Construct **21** (243 mg, 197 μmol, 94 %) was obtained as a colorless oil. ^{31}P NMR (161.7 MHz): δ

= -1.8, -1.8 (1P), -1.1, -1.0 (1P); ^{1}H NMR (400 MHz): δ = 1.31 - 1.42 (m, 4H, 2 x CH_2 hexylspacer), 1.46 - 1.55 (m, 2H, CH_2 hexylspacer), 1.64 - 1.72 (m, 2H, CH_2 hexylspacer), 2.12 - 2.37 (m, 4H, $F_{17}C_8CH_2CH_2CH_2SO_2$-, $F_{17}C_8CH_2CH_2CH_2SO_2$-), 2.63 - 2.72 (m, 4H, 2 x CH_2 cyanoethyl), 3.07 - 3.21 (m, 4H, $F_{17}C_8CH_2CH_2CH_2SO_2$-, CH_2-N hexylspacer), 3.25 - 3.36 (m, 2H, -$OCH_2CH_2SO_2$-), 3.85 - 3.91 (m, 1H, CH glycerol), 4.05 - 4.10 (m, 2H, CH_2-O hexylspacer), 4.14 - 4.29 (m, 7H, CH_2 glycerol, CH*H* glycerol, 2 x CH_2 cyanoethyl), 4.32 - 4.39 (m, 1H, CH*H* glycerol), 4.46 - 4.52 (m, 2H, -$OCH_2CH_2SO_2$-,), 4.67 (s, 2H, CH_2 Bn), 4.95 (bs, 1H, NH CBz), 5.09 (s, 2H, CH_2 CBz), 7.29 - 7.38 (m, 10H, H_{arom}); ^{13}C NMR (100 MHz): δ = 13.3 ($F_{17}C_8CH_2CH_2CH_2SO_2$-), 19.4 - 19.5 (2 x CH_2 cyanoethyl), 24.8, 25.9 (2 x CH_2 hexylspacer), 29.2 (t, *J* = 23 Hz, $F_{17}C_8CH_2CH_2CH_2SO_2$-), 29.6 ($CH_2$ hexylspacer), 29.8 (d, *J* = 6.6 Hz, CH_2 hexylspacer), 40.7 (CH_2-N hexylspacer), 53.0 - 53.2 ($F_{17}C_8CH_2CH_2CH_2SO_2$-, -$OCH_2CH_2SO_2$-), 61.3 (-$OCH_2CH_2SO_2$-), 61.8 - 61.9 ($CH_2$ cyanoethyl), 62.3 - 62.4 (CH_2 cyanoethyl), 65.2 - 65.3 (CH_2 glycerol), 66.1 - 66.2 (CH_2 glycerol), 66.4 (CH_2 CBz), 68.3 - 68.5 (CH_2-O hexylspacer), 72.2 (CH_2 Bn), 75.3 (t, *J* = 6.8 Hz, CH glycerol), 116.6 (2 x C_q cyanoethyl), 127.8 - 128.5 (CH_{arom}), 136.6, 137.1 (C_q Bn, C_q CBz), 156.3 (C=O CBz); HRMS: $C_{43}H_{50}F_{17}N_3O_{13}P_2S$ + H^+ requires 1234.2341, found 1234.2342.



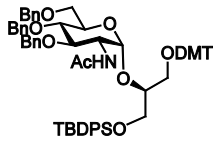
1-*O*-*tert*-Butyldiphenylsilyl-2-*O*-(2-azido-3,4,6-tri-*O*-benzyl-2-deoxy-α-D-glucopyranosyl)-3-*O*-allyl-*sn*-glycerol (26).

To a cooled (0 °C) solution of triol **25** (5.09 g, 9.13 mmol) and benzyl bromide (10.2 ml, 85.0 mmol) in a 3/2 mixture of DMF/THF (110 ml) was added NaH (60 % dispersion in mineral oil, 2.90 g, 72.5 mmol). After stirring for 30 h at RT, MeOH (10 ml) was added and the mixture was allowed to stir for another 30 min. The volatiles were removed under reduced pressure and the residue was taken up in Et_2O (500 ml) and washed with H_2O (100 ml) and brine (300 ml). The organic layer was dried (Na_2SO_4) and concentrated *in vacuo*, after which purification of the residue by column chromatography (EtOAc/PE) yielded fully protected **26** (4.24 g, 5.12 mmol, 56%) as a colorless oil. Analytical data were in accordance to literature data.[27]



1-*O*-*tert*-Butyldiphenylsilyl-2-*O*-(2-acetamido-3,4,6-tri-*O*-benzyl-2-deoxy-α-D-glucopyranosyl)-3-*O*-allyl-*sn*-glycerol (27a).

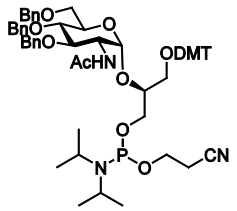
To a solution of compound **26** (3.38 g, 4.09 mmol) in a 5/1 mixture of 1,4-dioxane/H_2O (24 ml) was added PMe_3 (1M in toluene, 8.2 ml, 8.2 mmol). After stirring for 4 h, the volatiles were removed under reduced pressure and, subsequently, the residue was coevaporated with toluene (3 x 20 ml). The residue was taken up in pyridine (20 ml) and, after the addition of Ac_2O (0.80 ml, 8.5 mmol), stirred overnight. The mixture was diluted with Et_2O (200 ml) and and washed with H_2O (70 ml), sat. aq. $NaHCO_3$ (70 ml) and brine (70 ml). The organic layer was dried (Na_2SO_4) and concentrated *in vacuo* after which purification of the residue by column chromatography (EtOAc/PE) gave title compound **27a** (2.80 g, 3.32 mmol, 81%) as a colourless oil. Analytical data were in accordance to literature data.[27]



1-*O*-*tert*-Butyldiphenylsilyl-2-*O*-(2-acetamido-3,4,6-tri-*O*-benzyl-2-deoxy-α-D-glucopyranosyl)-3-*O*-(4,4'-dimethoxytrityl)-*sn*-glycerol (28a).

To a solution of allyl ether **27a** (1.92 g, 2.11 mmol) in THF (29 ml) was added $Ir(COD)(PPh_2Me)_2PF_6$ (89 mg, 0.11 mmol). The solution was shortly purged with H_2 (g) (~10s) and stirred for 45 min under argon atmosphere. The mixture was diluted with sat. aq. $NaHCO_3$ (10 ml) and I_2 (1.45 g, 5.71 mmol) was added. After stirring for 30 m in the mixture was diluted with EtOAc (250 ml) and washed

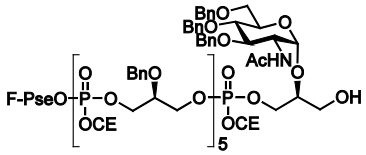
with sat. aq. $Na_2S_2O_3$ (50 ml) and brine (100 ml), respectively. The organic layer was dried (Na_2SO_4) and the volatiles removed under reduced pressure after which purification of the residue by column chromatography (EtOAc/PE) gave the intermediate **1-*O*-*tert*-Butyldiphenylsilyl-2-*O*-(2-acetamido-3,4,6-tri-*O*-benzyl-2-deoxy-α-D-glucopyranosyl)-*sn*-glycerol** as a slightly yellow oil. Analytical data were in accordance to literature data.[27] To a cooled (0 °C) solution of 1-*O*-*tert*-butyldiphenylsilyl-2-*O*-(2-acetamido-3,4,6-tri-*O*-benzyl-2-deoxy-α-D-glucopyranosyl)-*sn*-glycerol (2.17 g, 2.70 mmol) and Et_3N (0.60 ml, 4.33 mmol) in DCM (14 ml) was added DMT-Cl (1.17 g, 3.46 mmol). The mixture was stirred for 2 hrs before MeOH (5.0 ml) was added. After stirring for an additional 15 minutes the reaction mixture was diluted with DCM (40 ml) and washed with a 1/1 mixture of sat. aq. $NaHCO_3$ and brine (30 ml). The aqueous layer was extracted with DCM (2 x 10 ml) and the combined organic layers were dried (Na_2SO_4) and concentrated under reduced pressure. The residual oil was purified by silica gel column chromatography (EtOAc/PE, containing ~0.5% Et_3N) yielding DMT ether **28a** (2.57 g, 2.32 mmol, 86%) as an off white oil. $[\alpha]_D^{20}$ ($CHCl_3$): +41.0; IR (neat): 1028, 1248, 1508, 1684, 2906, 2930; ^1H NMR (400 MHz): δ = 0.95 (s, 9H, *t*-Bu TBDPS), 1.53 (s, 3H, NHAc), 3.20 (dd, 1H, *J* = 6.4 Hz, 10.1 Hz, CH*H* glycerol), 3.36 (d, 1H, *J* = 10.2 Hz, H-6), 3.40 (dd, 1H, *J* = 3.5 Hz, 10.2 Hz, CH*H* glycerol), 3.59 (dd, 1H, *J* = 2.5 Hz, 10.7 Hz, H-6'), 3.63 - 3.67 (m, 2H, H-3, CH*H* glycerol), 3.72 - 3.82 (m, 9H, H-4, H-5, CH*H* glycerol, 2 x OMe), 3.89 - 3.94 (m, 1H, CH glycerol), 4.29 - 4.39 (m, 2H, H-2, CH*H* Bn), 4.47 (d, 1H, *J* = 10.9 Hz, CH*H* Bn), 4.56 (d, 1H, *J* = 12.2 Hz, CH*H* Bn), 4.61 (d, 1H, *J* = 11.5 Hz, CH*H* Bn), 4.77 (d, 1H, *J* = 10.8 Hz, CH*H* Bn), 4.79 (d, 1H, *J* = 11.4 Hz, CH*H* Bn), 4.96 (d, 1H, *J* = 3.7 Hz, H-1), 5.49 (d, 1H, *J* = 9.7 Hz, NH), 6.78 - 6.82 (m, 4H, H_{arom}), 7.12 - 7.40 (m, 30H, H_{arom}), 7.54 - 7.57 (m, 4H, H_{arom}); ^{13}C NMR (100 MHz): δ = 19.1 (C_q *t*-Bu), 23.3 (CH_3 NHAc), 26.7 (3 x CH_3 TBDPS), 52.4 (C-2), 55.2 (2 x OMe), 63.0 (CH_2 glycerol), 63.6 (CH_2 glycerol), 68.1 (C-6), 71.1 (C-5), 73.3 (CH_2 Bn), 74.8 (CH_2 Bn), 74.9 (CH_2 Bn), 77.5 (CH glycerol), 78.0 (C-4), 81.0 (C-3), 86.2 (C_q DMTr), 97.6 (C-1), 113.1 (CH_{arom}), 126.8 - 130.0 (CH_{arom}), 133.1, 133.1 (2 x C_q phenyl), 135.4 (CH_{arom}), 135.8, 135.9, 138.0, 138.2, 138.4 (2 x C_q DMTr, 3 x C_q Bn), 144.8 (C_q DMTr), 158.5 (C_q DMTr), 169.7 (C=O NHAc); HRMS: $C_{69}H_{75}NO_{10}Si + Na^+$ requires 1128.5052, found 1128.5062.



1-([*N,N,*-Diisopropylamino]-2-cyanoethylphosphite)-2-*O*-(2-acetamido-3,4,6-tri-*O*-benzyl-2-deoxy-α-D-glucopyranosyl)-3-*O*-(4,4'-dimethoxytrityl)-*sn*-glycerol (29a)

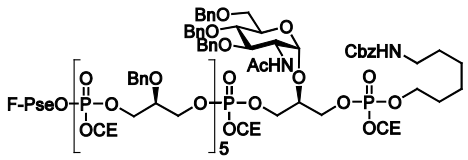
Compound **28a** (2.36 g, 2.13 mmol) was dissolved in THF (21 ml) and after addition of TBAF (1.00 M in THF, 3.20 ml, 3.20 mmol) stirred overnight. After evaporation of the solvents under reduced pressure the resulting oil was purified by column chromatography (EtOAc/PE, containing ~0.5% Et_3N) giving the intermediate alcohol (1.74 g, 2.00 mmol, 94%) as a colourless oil. Analytical data **2-*O*-(2-acetamido-3,4,6-tri-*O*-benzyl-2-deoxy-α-D-glucopyranosyl)-3-*O*-(4,4'-dimethoxytrityl)-*sn*-glycerol:** $[\alpha]_D^{20}$ ($CHCl_3$): +45.5; IR (neat): 906, 1373, 1541, 1663, 2900; ^1H NMR (400 MHz): δ = 1.59 (s, 3H, NHAc), 3.18 (dd, 1H, *J* = 3.7 Hz, 10.2 Hz, CH*H* glycerol), 3.29 (dd, 1H, *J* = 6.7 Hz, 10.1 Hz, CH*H* glycerol), 3.54 - 3.59 (m, 3H, H-4, H-6, CH*H* glycerol), 3.67 - 3.78 (m, 10H, H-3, H-6', CH glycerol, CH*H* glycerol, 2 x OMe), 4.03 - 4.07 (m, 1H, H-5), 4.33 (td, 1H, *J* = 3.8 Hz, 10.0 Hz, 10.0 Hz, H-2), 4.47 - 4.57 (m, 3H, 3 x CH*H* Bn), 4.65 (d, 1H, *J* = 11.4 Hz, CH*H* Bn), 4.80 (d, 1H, *J* = 10.9 Hz, CH*H* Bn), 4.83 (d, 1H, *J* = 11.4 Hz, CH*H* Bn), 4.90 (d, 1H, *J* = 3.8 Hz, H-1), 5.53 (d, 1H, *J* = 9.5 Hz, NH), 6.80 - 6.83 (m, 4H, H_{arom}), 7.15 - 7.41 (m, 24H, H_{arom}) ; ^{13}C NMR (100 MHz): δ = 23.2 (CH_3 NHAc), 52.5 (C-2), 55.1 (2 x OMe), 63.4 (CH_2 glycerol), 63.6 (CH_2 glycerol), 68.7 (C-6), 71.4 (C-5), 73.4 (CH_2 Bn), 75.0 (CH_2 Bn), 75.1 (CH_2 Bn), 78.4 (C-4), 81.0, 81.4 (C-3, CH glycerol), 86.3 (C_q DMTr), 98.2 (C-1), 113.1 (CH_{arom}), 126.9 - 129.9 (CH_{arom}), 135.7, 137.5, 137.7, 138.2 (2 x C_q DMTr, 3 x C_q Bn), 144.6 (C_q DMTr), 158.5 (C_q DMTr), 169.8 (C=O NHAc); HRMS: $C_{53}H_{57}NO_{10} + Na^+$ requires 890.3875, found

890.3882. To a cooled (0 °C) solution of the intermediate alcohol (828 mg, 0.950 mmol) and Et_3N (200 µl, 1.44 mmol) in freshly distilled DCM (10 ml) was added 2-cyanoethyl-*N*,*N*-diisopropylchlorophosphoramidite (250 µl, 1.12 mmol). After stirring overnight, the reaction was quenched by the addition of H_2O (2.0 ml), diluted with DCM (40 ml) and washed with H_2O (20 ml) and brine (20 ml), respectively. The organic layer was dried over Na_2SO_4 and concentrated *in vacuo*. Purification of the residue by column chromatography (EtOAc/PE, containing ~0.5% Et_3N) gave phosphoramidite **29a** (760 mg, 0.710 mmol, 75%, mixture of diastereomers) as a white foam. IR (neat): 1248, 1508, 1607, 1676, 2870, 2928, 3279; ^{31}P NMR (161.7 MHz, CD3CN): δ = 148.9, 149.2 (diastereoisomers); ^{1}H NMR (400 MHz, CD_3CN): δ = 1.09 - 1.16 (m, 12H, 4 x CH_3 isopropylamino), 1.67, 1.68 (2s, 3H, NHAc, diastereoisomers), 2.48 - 2.54 (m, 2H, CH_2 cyanoethyl), 3.14 - 3.24 (m, 1H, CH*H* glycerol), 3.30 - 3.36 (m, 1H, CH*H* glycerol), 3.50 - 3.90 (m, 16H, H-3, H-4, H-6, H-6', CH_2 glycerol, 2 x OMe, CH_2 cyanoethyl, 2 x CH isopropylamino), 3.92 - 4.00 (m, 1H, CH glycerol), 4.02 - 4.16 (m, 2H, H-2, H-5), 4.52 - 4.61 (m, 3H, 3 x CH*H* Bn), 4.69 (d, 1H, *J* = 11.2 Hz, CH*H* Bn), 4.79 - 4.82 (m, 2H, 2 x CH*H* Bn), 4.91, 4.93 (2d, 1H, *J* = 3.5 Hz, H-1, diastereoisomers), 6.33, 6.36 (2d, 1H, *J* = 9.7 Hz, NH), 6.87 (d, 4H, *J* = 8.8 Hz, H_{arom}), 7.21 - 7.47 (m, 24H, H_{arom}); ^{13}C NMR (100 MHz, CD_3CN): δ = 20.9, 20.9 (CH_2 cyanoethyl), 23.4 (CH_3 NHAc) 24.9 - 25.2 (4 x CH_3 isopropylamino), 43.7, 43.8 (2 x CH isopropylamino), 53.7 (C-2), 55.9 (2 x OMe), 59.3, 59.5 (CH_2 cyanoethyl), 63.4 (CH_2 glycerol), 64.4 - 64.6 (CH_2 glycerol), 69.9, 69.9 (C-6), 71.9, 72.0 (C-5), 73.8, 73.9 (CH_2 Bn), 75.4, 75.5 (CH_2 Bn), 75.7 (CH_2 Bn), 76.7, 77.1 (2d, *J* = 8 Hz, CH glycerol, diastereoisomers), 79.5, 79.6 (C-4), 81.6 (C-3), 87.0 (C_q DMTr), 97.7, 98.0 (C-1), 114.1 (CH_{arom}), 118.2 (C_q cyanoethyl), 127.7 - 130.9 (CH_{arom}), 136.9, 139.5 - 139.9 (2 x C_q DMTr, 3 x C_q Bn), 146.2 (C_q DMTr), 159.6 (C_q DMTr), 170.4 (C=O NHAc); HRMS: $C_{62}H_{74}N_3O_{11}P$ + Na^+ requires 1090.4953, found 1090.4953.



GlcNAc-2-*O*-benzylglycerol phosphate hexamer (30a)

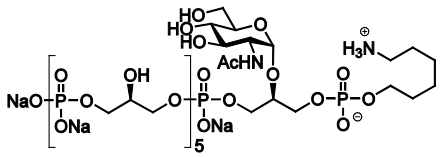
Glycerol phosphate pentamer **11** (74.1 mg, 36.0 µmol) and *N*-acetylglucosamineglycerol phosphoramidite **29a** (77.0 mg, 72.1 µmol, 2 eq) were dissolved in CH_3CN (1.0 ml) together with freshly activated MS3Å and stirred for 15 min under argon. Subsequently, DCI (0.25M solution in CH_3CN, 0.72 ml, 0.18 mmol) was added and the mixture stirred for 1 hr before water (0.50 ml) was added. The oxidation, detritylation and F-SPE steps were performed according to the general procedure. Hexamer **30a** (71.6 mg, 26.2 µmol, 73 %) was obtained as a colorless oil. ^{31}P NMR (161.7 MHz): δ = -1.9, -1.8 (1P), -1.6 - -1.0 (5P); ^{1}H NMR (400 MHz): δ = 1.87 - 1.92 (bs, 3H, NHAc), 2.10 - 2.34 (m, 5H, CH_2OH, $F_{17}C_8CH_2CH_2CH_2SO_2$-, $F_{17}C_8CH_2CH_2CH_2SO_2$-), 2.42 - 2.70 (m, 12H, 6 x CH_2 cyanoethyl), 3.06 - 3.13 (m, 2H, $F_{17}C_8CH_2CH_2CH_2SO_2$-), 3.24 - 3.33 (m, 2H, -$OCH_2CH_2SO_2$-), 3.54 - 3.98 (m, 13H, H-3, H-4, H-5, H-6, H-6', 6 x CH glycerol, CH_2 glycerol), 4.03 - 4.34 (m, 35H, H-2, 11 x CH_2 glycerol, 6 x CH_2 cyanoethyl), 4.43 - 4.51 (m, 2H, -$OCH_2CH_2SO_2$-), 4.56 - 4.69 (m, 14H, 7 x CH_2 Bn), 4.75 - 4.80 (m, 2H, CH_2 Bn), 4.96 (m, 1H, H-1), 6.55 - 6.76 (m, 1H, NHAc), 7.11 - 7.17 (m, 2H, H_{arom}), 7.22 - 7.36 (m, 38H, H_{arom}); HRMS: $[C_{113}H_{132}F_{17}N_7O_{38}P_6S + 2NH_4]^{2+}$ requires 1386.3598, found 1386.3608.



GlcNAc-2-*O*-benzylglycerol phosphate hexamer-aminohexyl spacer (31a)

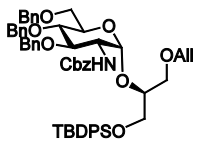
Hexamer **30a** (68.9 mg, 25.2 µmol) was coupled to phosphoramidite **20** (0.2 M in MeCN, 0.50 ml, 101 µmol, 4 eq), oxidized and purified (F-SPE) using the general procedure as described above. Oligomer **31a** (62.5 mg, 20.1 µmol, 80 %) was obtained as a colorless oil. ^{31}P NMR (161.7 MHz): δ = -1.9, -1.8 (1P), -1.4 - -0.9

(5P), -0.8, -0.7 (1P); ^{1}H NMR (400 MHz): δ = 1.15 - 1.54 (m, 6H, 3 x CH_2 hexylspacer), 1.63 - 1.69 (m, 2H, CH_2 hexylspacer), 1.96 - 2.00 (bs, 3H, NHAc), 2.06 - 2.36 (m, 4H, $F_{17}C_8CH_2CH_2CH_2CH_2SO_2$-, $F_{17}C_8CH_2CH_2CH_2SO_2$-), 2.42 - 2.73 (m, 14H, 7 x CH_2 cyanoethyl), 3.05 - 3.20 (m, 4H, $F_{17}C_8CH_2CH_2CH_2SO_2$-, CH_2-N hexylspacer), 3.23 - 3.34 (m, 2H, -$OCH_2CH_2SO_2$-), 3.64 - 3.97 (m, 11H, H-3, H-4, H-5, H-6, H-6', 6 x CH glycerol), 4.03 - 4.38 (m, 41H, H-2, 12 x CH_2 glycerol, 7 x CH_2 cyanoethyl, CH_2-O hexylspacer), 4.42 - 4.51 (m, 4H, -$OCH_2CH_2SO_2$-, CH_2 Bn), 4.56 - 4.65 (m, 11H, 5 x CH_2 Bn, CH Bn), 4.68 - 4.80 (m, 3H, CH_2 Bn, CH Bn), 4.90 - 4.93 (m, 1H, H-1), 5.00 - 5.15 (m, 3H, NH CBz, CH_2 CBz), 7.09 - 7.20 (m, 3H, NHAc, H_{arom}), 7.22 - 7.38 (m, 43H, H_{arom}); HRMS: $[C_{130}H_{155}F_{17}N_9O_{43}P_7S + 2NH_4]^{2+}$ requires 1569.4271, found 1569.4276.



GlcNAc glycerol phosphate hexamer-aminohexyl spacer (32a)

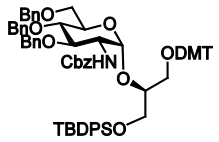
Protected hexamer **31a** (59.7 mg, 19.2 μmol) was treated with aqueous ammonia as described above. The compound was eluted through a small column containing Dowex Na^+ cation-exchange resin (type: 50WX4-200, stored on 0.5 M NaOH in H_2O, flushed with H_2O and MeOH before use) and, subsequently, lyophilized, yielding the intermediate semi-protected hexamer (43.6 mg, 18.6 μmol, 97 %) as an amorphous white solid. Analytical data intermediate: ^{31}P NMR (161.7 MHz, D_2O): δ = 1.0 - 1.3 (6P), 2.5 (1P, phosphomonoester); ^{1}H NMR (400 MHz, D_2O): δ = 0.90 - 1.30 (m, 6H, 3 x CH_2 hexylspacer), 1.39 - 1.52 (m, 2H, CH_2 hexylspacer), 1.96 (bs, 3H, NHAc), 2.82 - 2.93 (m, 2H, CH_2-N hexylspacer), 3.43 - 4.17 (m, 40H, H-2, H-3, H-4, H-5, H-6, H-6', 12 x CH_2 glycerol, 6 x CH glycerol, CH_2-O hexylspacer, 2 x CH Bn), 4.28 - 4.55 (m, 14H, 6 x CH_2 Bn, 2 x CH Bn), 4.78 - 4.85 (m, 3H, NH CBz, CH_2 CBz), 4.96 - 4.98 (m, 1H, H-1), 6.76 - 6.82 (m, 3H, NHAc, H_{arom}), 6.96 - 7.29 (m, 43H, H_{arom}); HRMS: $[C_{96}H_{125}N_2O_{41}P_7 + 2H]^{2+}$ requires 1090.3033, found 1090.3043. A portion of the intermediate (43.0 mg, 18.4 μmol) was deprotected with Pd (0)/H_2 using the standard procedure. monoGlcNAc hexamer **32a** (23.6 mg, 16.1 μmol, 88 %) was obtained as an amorphous white solid. ^{31}P NMR (161.7 MHz, D_2O): δ = 1.0 (1P), 1.1 (1P), 1.3 (3P), 1.4 (1P), 3.2 (1P, phosphomonoester); ^{1}H NMR (600 MHz, D_2O): δ = 1.33 - 1.37 (m, 4H, 2 x CH_2 hexylspacer), 1.55 - 1.62 (m, 4H, 2 x CH_2 hexylspacer), 1.99 (s, 3H, NHAc), 2.92 (t, 2H, *J* = 7.5 Hz, CH_2-N hexylspacer), 3.39 (at, 1H, *J* = 9.6 Hz, H-3), 3.69 - 3.99 (m, 37H, H-2, H-4, H-5, H-6, H-6', 6 x CH glycerol, 12 x CH_2 glycerol, CH_2-O hexylspacer), 5.00 (d, 1H, *J* = 3.5 Hz, H-1); ^{13}C NMR (150 MHz, D_2O): δ = 23.0 (CH_3 NHAc), 25.4, 26.1, 27.5 (3 x CH_2 hexylspacer), 30.4 (d, *J* = 6.9 Hz, CH_2 hexylspacer), 40.3 (CH_2-N hexylspacer), 54.6 (C-2), 61.4 (C-6), 65.2 (d, *J* = 5.1 Hz, CH_2 glycerol), 66.0 - 66.1 (CH_2 glycerol, CH_2-O hexylspacer), 67.0 - 67.4 (10 x CH_2 glycerol), 70.4 (t, *J* = 7.9 Hz, 4 x CH glycerol), 70.9 - 71.0 (C-3, CH glycerol), 71.9 (C-4), 73.0 (C-5), 76.7 (t, *J* = 7.8 Hz, CH glycerol), 97.7 (C-1), 175.5 (C=O NHAc); HRMS: $C_{32}H_{71}N_2O_{39}P_7 + H^+$ requires 1325.1870, found 1325.1873.



1-*O*-*tert*-Butyldiphenylsilyl-2-*O*-(2-benzylcarbamate-3,4,6-tri-*O*-benzyl-2-deoxy-α-D-glucopyranosyl)-3-*O*-allyl-*sn*-glycerol (27b)

To a solution of compound **26** (787 mg, 0.950 mmol) in dioxane/water (5/1, 6.0 ml) was added PMe_3 (1.00 M in toluene, 2.00 ml, 2.00 mmol). This mixture was allowed to stir at rt for 4h after which the volatiles were removed *in vacuo*. The crude intermediate was, after coevaporation with toluene, redissolved in MeOH (7.0 ml) and $CHCl_3$ (14 ml). To this mixture were added $NaHCO_3$ (500 mg, 5.95 mmol) and benzylchloroformate (0.160 ml, 1.14 mmol). After stirring for 1.5 h, the solvents were removed under reduced pressure and the residue was taken up in EtOAc, filtrated and concentrated *in vacuo*. Purification by silica gel column chromatography

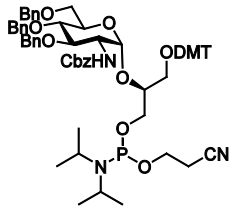
(EtOAc/PE) afforded carbamate **27b** (738 mg, 0.788 mmol, 83%) as a colorless oil. $[\alpha]_D^{20}$ ($CHCl_3$): +46.0; IR (neat): 908, 1024, 1045, 1508, 1719, 2858, 3030; ^{1}H NMR (400 MHz): δ = 1.03 (s, 9H, *t*-Bu TBDPS), 3.38 (ad, 1H, *J* = 10.7 Hz, H-6), 3.49 (m, 1H, CH*H* glycerol), 3.56 - 3.81 (m, 7H, H-4, H-5, H-6', CH glycerol, CH*H* glycerol, CH_2 glycerol), 3.86 - 4.04 (m, 4H, H-2, H-3, CH_2 allyl), 4.37 (d, 1H, *J* = 12.2 Hz, CH*H* Bn), 4.46 (d, 1H, *J* = 10.9 Hz, CH*H* Bn), 4.55 (d, 1H, *J* = 12.2 Hz, CH*H* Bn), 4.64 (d, 1H, *J* = 11.2 Hz, CH*H* Bn), 4.74 (d, 1H, *J* = 11.2 Hz, CH*H* Bn), 4.77 (d, 1H, *J* = 10.9 Hz, CH*H* Bn), 4.99 (d, 1H, *J* = 3.5 Hz, H-1), 5.02 - 5.08 (m, 2H, CH*H* Cbz, CH*H* allyl), 5.14 - 5.19 (m, 2H, CH*H* Cbz, CH*H* allyl), 5.31 (d, 1H, *J* = 9.7 Hz, NH), 5.79 (ddd, 1H, *J* = 5.6 Hz, 10.8 Hz, 16.2 Hz, CH allyl), 7.11 - 7.13 (m, 2H, H_{arom}), 7.22 - 7.40 (m, 24H, H_{arom}), 7.61 - 7.63 (m, 4H, H_{arom}); ^{13}C NMR (100 MHz): δ = 19.2 (C_q *t*-Bu), 26.8 (3 x CH_3 TBDPS), 55.0 (C-2), 63.6 (CH_2 glycerol), 66.7 (CH_2 Cbz), 68.1 (C-6), 69.5 (CH_2 glycerol), 71.2 (C-5), 72.2 (CH_2 allyl), 73.3 (CH_2 Bn), 74.7 (CH_2 Bn), 75.2 (CH_2 Bn), 77.8 (C-3, CH glycerol), 81.3 (C-4), 98.4 (C-1), 117.2 (CH_2 allyl), 127.4 - 128.4 (CH_{arom}), 129.7 (CH_{arom}), 133.1, (C_q phenyl), 134.4 (CH allyl), 135.5 (CH_{arom}), 136.5, 138.0, 138.3, 138.4 (4 x C_q Bn), 156.0 (C=O, Cbz); HRMS: $C_{57}H_{65}NO_9Si$ + Na^+ requires 958.4324, found 958.4321.



1-*O*-*tert*-Butyldiphenylsilyl-2-*O*-(2-benzylcarbamate-3,4,6-tri-*O*-benzyl-2-deoxy-α-D-glucopyranosyl)-3-*O*-(4,4'-dimethoxytrityl)-*sn*-glycerol (28b)

A solution of glycoside **27b** (1.08 g, 1.15 mmol) in freshly distilled THF (10 ml) was stirred under argon for 30 min. After the addition of $Ir(COD)(Ph_2MeP)_2PF_6$ (48 mg, 0.060 mmol) the solution was purged with H_2 (g) for ~15s. After stirring under argon for 1.5 hrs, the mixture was diluted with THF (10 ml) and sat. aq. $NaHCO_3$ (10 ml). Upon addition of I_2 (0.58 g, 2.3 mmol), the mixture was allowed to stir for 30 mins at room temperature. The mixture was then diluted with EtOAc (100 ml) and washed with sat. aq. $Na_2S_2O_3$ (30 ml) and brine (40 ml), respectively. The organic layer was dried over Na_2SO_4 and concentrated *in vacuo*. Column chromatography (EtOAc/PE) afforded the intermediate alcohol (963 mg, 1.09 mmol, 95%) as a pale yellow oil. Analytical data **1-*O*-*tert*-butyldiphenylsilyl-2-*O*-(2-benzylcarbamate-3,4,6-tri-*O*-benzyl-2-deoxy-α-D-glucopyranosyl)-*sn*-glycerol:** $[\alpha]_D^{20}$ ($CHCl_3$): +57.0; IR (neat): 816, 1036, 1452, 1549, 1670, 1697, 2924, 3065, 3306; ^{1}H NMR (400 MHz):δ = 1.03 (s, 9H, *t*-Bu TBDPS), 2.27 (bs, 1H, OH), 3.37 (ad, 1H, *J* = 10.2 Hz, H-6), 3.56 (ad, 1H, *J* = 10.0 Hz, H-6'), 3.64 - 3.84 (m, 8H, H-3, H-4, H-5, CH glycerol, 2 x CH_2 glycerol), 3.94 - 4.00 (m, 1H, H-2), 4.38 (d, 1H, *J* = 12.2 Hz, CH*H* Bn), 4.46 (d, 1H, *J* = 10.8 Hz, CH*H* Bn), 4.53 (d, 1H, *J* = 12.2 Hz, CH*H* Bn), 4.62 (d, 1H, *J* = 10.9 Hz, CH*H* Bn), 4.73 - 4.78 (m, 2H, 2 x CH*H* Bn), 4.99 - 5.05 (m, 2H, H-1, CH*H* Cbz), 5.14 (d, 1H, *J* = 12.2 Hz, CH*H* Cbz), 5.21 (d, 1H, *J* = 8.0 Hz, NH), 7.06 - 7.41 (m, 26H, H_{arom}), 7.61 - 7.65 (m, 4H, H_{arom}); ^{13}C NMR (100 MHz): δ = 19.1 (C_q *t*-Bu), 26.8 (3 x CH_3 TBDPS), 55.0 (C-2), 62.2 (CH_2 glycerol), 64.2 (CH_2 glycerol), 66.8 (CH_2 Cbz), 68.1 (C-6), 71.1 (C-5), 73.3 (CH_2 Bn), 74.7 (CH_2 Bn), 75.1 (CH_2 Bn), 77.9, 78.1, (C-3, CH glycerol), 80.7 (C-4), 97.4 (C-1), 127.6 - 128.4 (CH_{arom}), 129.8 (CH_{arom}), 132.8 (C_q phenyl), 135.5 (CH_{arom}), 136.4, 137.8, 138.2 (4 x C_q Bn), 156.1 (C=O, Cbz); HRMS: $C_{54}H_{61}NO_9Si$ + Na^+ requires 918.4009, found 918.4008. To a cooled (0 °C) solution of the intermediate alcohol (755 mg, 0.858 mmol) and Et_3N (0.19 ml, 1.3 mmol) in DCM (4.3 ml) was added DMTr-Cl (349 mg, 1.02 mmol). The mixture was stirred for 2 hrs before MeOH (1.0 ml) was added. After stirring for an additional 15 minutes the reaction mixture was diluted with DCM (40 ml) and washed with a 1/1 mixture of sat. aq. $NaHCO_3$ and brine (30 ml). The aqueous layer was extracted with DCM (2 x 10 ml) and the combined organic layers were dried (Na_2SO_4) and concentrated under reduced pressure. The residual oil was purified by silica gel column chromatography (EtOAc/PE, containing ~0.5% Et_3N) yielding DMTr-ether **28b** (962 mg, 0.803 mmol, 94%) as an off white oil. $[\alpha]_D^{20}$ ($CHCl_3$): +52.0; IR (neat): 1028, 1248, 2951, 1508, 1726, 2857, 2901, 2930; ^{1}H NMR (400 MHz): δ = 0.93 (s, 9H, *t*-Bu TBDPS), 3.10 (dd, 1H, *J* = 7.0 Hz, 10.3

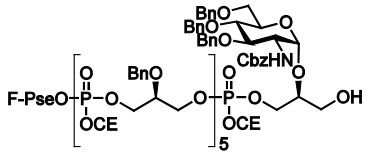
Hz, CH*H* glycerol), 3.37 (ad, 1H, *J* = 10.6 Hz, H-6), 3.44 (dd, 1H, *J* = 2.1 Hz, 9.8 Hz, CH*H* glycerol), 3.55 - 3.63 (m, 3H, H-3, H-6', CH*H* glycerol), 3.71 - 3.78 (m, 9H, H-4, H-5, CH*H* glycerol, 2 x OMe), 3.96 - 4.01 (m, 1H, CH glycerol), 4.05 - 4.11 (m, 1H, H-2), 4.39 (d, 1H, *J* = 12.2 Hz, CH*H* Bn), 4.45 (d, 1H, *J* = 10.9 Hz, CH*H* Bn), 4.57 (d, 1H, *J* = 12.2 Hz, CH*H* Bn), 4.60 (d, 1H, *J* = 11.9 Hz, CH*H* Bn), 4.63 (d, 1H, *J* = 12.5 Hz, CH*H* Cbz), 4.72 (d, 1H, *J* = 11.2 Hz, CH*H* Bn), 4.76 (d, 1H, *J* = 10.9 Hz, CH*H* Bn), 4.93 (d, 1H, *J* = 9.9 Hz, NH), 5.09 (d, 1H, *J* = 12.0 Hz, CH*H* Cbz), 5.15 (d, 1H, *J* = 3.3 Hz, H-1), 6.70 - 6.83 (m, 4H, H_{arom}), 7.11 - 7.41 (m, 35H, H_{arom}), 7.51 - 7.56 (m, 4H, H_{arom}); ^{13}C NMR (100 MHz): δ = 19.1 (C_q *t*-Bu), 26.7 (3 x CH_3 TBDPS), 54.8 (C-2), 55.1 (2 x OMe), 63.6 (CH_2 glycerol), 63.8 (CH_2 glycerol), 66.7 (CH_2 Cbz), 68.1 (C-6), 71.1 (C-5), 73.3 (CH_2 Bn), 74.8 (CH_2 Bn), 75.2 (CH_2 Bn), 77.4 (CH glycerol), 77.8 (C-4), 81.4 (C-3), 86.2 (C_q DMTr), 98.1 (C-1), 113.1 (CH_{arom}), 126.6 - 130.0 (CH_{arom}), 133.0, 133.1 (2 x C_q phenyl), 135.4 (CH_{arom}), 135.6, 136.0, 136.3, 137.9, 138.2, 138.3 (2 x C_q DMTr, 4 x C_q Bn), 144.9 (C_q DMTr), 155.8 (C=O, Cbz), 158.3 (C_q DMTr); HRMS: $C_{75}H_{79}NO_{11}Si$ + Na^+ requires 1220.5320, found 1220.5315.



1-([*N*,*N*,-Diisopropylamino]-2-cyanoethylphosphite)-2-*O*-(2-benzylcarbamate-3,4,6-tri-*O*-benzyl-2-deoxy-α-D-glucopyranosyl)-3-*O*-(4,4'-dimethoxytrityl)-*sn*-glycerol (29b)

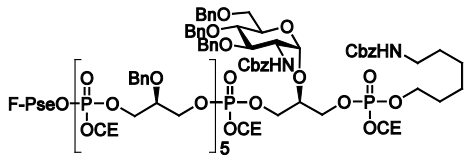
Compound **28b** (900 mg, 0.751 mmol) was dissolved in THF (7.50 ml) and after addition of TBAF (1.00 M in THF, 1.20 ml, 1.20 mmol) stirred overnight. After evaporation of the solvents under reduced pressure the resulting oil was purified by column chromatography (EtOAc/PE, containing ~0.5% Et_3N), giving the intermediate alcohol (711 mg, 0.741 mmol, 99%) as a colourless oil. Analytical data **2-*O*-(2-Benzylcarbamate-3,4,6-tri-*O*-benzyl-2-deoxy-α-D-glucopyranosyl)-3-*O*-(4,4'-dimethoxytrityl)-*sn*-glycerol**: $[\alpha]_D^{20}$ ($CHCl_3$): +59.4; IR (neat): 906, 1209, 1714, 2249; ^{1}H NMR (400 MHz): δ = 2.79 (bs, 1H, OH), 3.20 - 3.23 (m, 2H, CH_2 glycerol), 3.51 - 3.60 (m, 3H, H-4, H-6, CH*H* glycerol), 3.65 - 3.78 (m, 10H, H-3, H-6', CH glycerol, CH*H* glycerol, 2 x OMe), 4.00 - 4.11 (m, 2H, H-2, H-5), 4.47 (d, 1H, *J* = 10.9 Hz, CH*H* Bn), 4.51 (d, 1H, *J* = 12.3 Hz, CH*H* Bn), 4.57 (d, 1H, *J* = 12.3 Hz, CH*H* Bn), 4.65 (d, 1H, *J* = 11.1 Hz, CH*H* Bn), 4.75 - 4.81 (m, 3H, 2 x CH*H* Bn, CH*H* Cbz), 4.96 (d, 1H, *J* = 9.9 Hz, NH), 5.01 (d, 1H, *J* = 3.5 Hz, H-1), 5.12 (d, 1H, *J* = 12.2 Hz), CH*H* Cbz), 6.75 - 6.78 (m, 4H, H_{arom}), 7.12 - 7.41 (m, 29H, H_{arom}); ^{13}C NMR (100 MHz): δ = 54.9 (C-2), 55.1 (2 x OMe), 63.5 (2 x CH_2 glycerol), 66.8 (CH_2 Cbz), 68.7 (C-6), 71.4 (C-5), 73.4 (CH_2 Bn), 75.0 (CH_2 Bn), 75.4 (CH_2 Bn), 78.3 (C-4), 81.1 (CH glycerol), 81.5 (C-3), 86.3 (C_q DMTr), 98.5 (C-1), 113.1 (CH_{arom}), 126.7 - 130.0 (CH_{arom}), 135.7, 135.8, 136.3, 137.5, 137.8, 138.1 (2 x C_q DMTr, 4 x C_q Bn), 144.7 (C_q DMTr), 155.9 (C=O, Cbz), 158.4 (C_q DMTr); HRMS: $C_{59}H_{61}NO_{11}$ + Na^+ requires 982.4137, found 982.4142. To a cooled (0 °C) solution of the intermediate alcohol (969 mg, 1.01 mmol) and Et_3N (220 µl, 1.52 mmol) in freshly distilled DCM (10 ml) was added 2-cyanoethyl-*N*,*N*-diisopropylchlorophosphoramidite (267 µl, 1.20 mmol). After stirring overnight, the reaction was quenched by the addition of H_2O (2.0 ml), diluted with DCM (40 ml) and washed with, respectively, H_2O (20 ml) and brine (20 ml). The organic layer was dried over Na_2SO_4 and concentrated *in vacuo*. Purification of the residue by column chromatography (EtOAc/PE, containing ~0.5% Et_3N) gave phosphoramidite **29b** (939 mg, 0.810 mmol, 80%) as a white foam. IR (neat): 1248, 1508, 1606, 1724, 2837, 2870, 2930, 2965, 3063; ^{31}P NMR (161.7 MHz, CD_3CN): δ = 149.1, 149.2 (diastereoisomers); ^{1}H NMR (400 MHz, CD_3CN): δ = 1.03 - 1.12 (m, 12H, 4 x CH_3 isopropylamino), 2.40 - 2.47 (m, 2H, CH_2 cyanoethyl), 3.07 - 3.18 (m, 1H, CH*H* glycerol), 3.27 - 3.33 (m, 1H, CH*H* glycerol), 3.44 - 4.04 (m, 19H, H-2, H-3, H-4, H-5, H-6, H-6', CH glycerol, CH_2 glycerol, 2 x OMe, CH_2 cyanoethyl, 2 x CH isopropylamino), 4.50 - 4.80 (m, 7H, 3 x CH_2 Bn, CH*H* Cbz), 4.99 - 5.07 (m, 2H, H-1, CH*H* Cbz), 5.43 - 5.49 (m, 1H, NH), 6.77 - 6.82 (m, 4H, H_{arom}), 7.16 - 7.45 (m, 29H, H_{arom}); ^{13}C NMR (100 MHz, CD_3CN): δ = 20.9, 20.9 (CH_2 cyanoethyl), 24.8 - 25.1 (4 x CH_3 isopropylamino), 43.7, 43.8 (2 x CH isopropylamino), 55.9 (2 x OMe), 56.2 (C-2), 59.3, 59.5 (CH_2 cyanoethyl), 64.0 - 64.4 (2 x

CH_2 glycerol), 67.1 (CH_2 Cbz), 69.8, 69.9 (C-6), 72.0 (C-5), 73.8, 73.9 (CH_2 Bn), 75.4, 75.4 (CH_2 Bn), 76.0 (CH_2 Bn), 77.3 - 77.5 (CH glycerol), 79.4 (C-4), 82.1 (C-3), 87.1 (C_q DMTr), 98.6, 98.7 (C-1), 114.0 (CH_{arom}), 118.3 (C_q cyanoethyl), 127.7 - 131.0 (CH_{arom}), 136.8, 137.0, 137.9, 139.5 - 139.7 (2 x C_q DMTr, 4 x C_q Bn), 146.2 (C_q DMTr), 156.9 (C=O, Cbz), 159.5 (C_q DMTr); HRMS: $C_{68}H_{78}N_3O_{12}P + H^+$ requires 1160.5396, found 1160.5392.



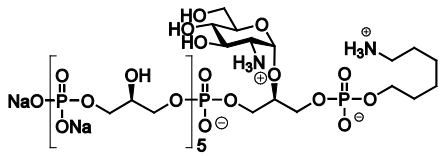
Cbz-glucosamine-2-*O*-benzylglycerol phosphate hexamer (30b)

Glycerol phosphate pentamer **11** (76.3 mg, 37.1 μmol) and *N*-CBz-glucosamineglycerol phosphoramidite **29b** (86.1 mg, 74.2 μmol) were dissolved in CH_3CN (1.0 ml) together with freshly activated MS3Å and stirred for 15 min under argon. Subsequently, DCI (0.25M solution in CH_3CN, 0.4 ml, 0.19 mmol) was added and the mixture stirred for 1 hr before water (0.50 ml) was added. The oxidation, detritylation and F-SPE steps were performed according to the general procedure. Hexamer **30b** (91.4 mg, 32.5 μmol, 88 %) was obtained as a colorless oil. ^{31}P NMR (161.7 MHz): δ = -1.9, -1.9 (1P), -1.4 - -1.0 (5P); ^{1}H NMR (400 MHz): δ = 2.09 - 2.69 (m, 17H, CH_2O*H*, $F_{17}C_8CH_2C$*H*$_2CH_2SO_2$-, $F_{17}C_8C$*H*$_2CH_2CH_2SO_2$-, 6 x CH_2 cyanoethyl), 3.05 - 3.13 (m, 2H, $F_{17}C_8CH_2CH_2C$*H*$_2SO_2$-), 3.24 - 3.33 (m, 2H, -OCH_2C*H*$_2SO_2$-), 3.54 - 4.34 (m, 48H, H-2, H-3, H-4, H-5, H-6, H-6', 6 x CH glycerol, 12 x CH_2 glycerol, 6 x CH_2 cyanoethyl), 4.40 - 4.81 (m, 18H, -OC*H*$_2CH_2SO_2$-, 8 x CH_2 Bn), 4.95 - 5.04 (m, 2H, H-1, CH*H* CBz), 5.12 - 5.19 (m, 1H, CH*H* CBz), 5.78 - 5.98 (m, 1H, NH CBz), 7.10 - 7.15 (m, 2H, H_{arom}), 7.22 - 7.38 (m, 43H, H_{arom}); HRMS: $[C_{119}H_{136}F_{17}N_7O_{39}P_6S + 2Na]^{2+}$ requires 1437.3283, found 1437.3288.



Cbz-glucosamine-2-*O*-benzylglycerol phosphate hexamer aminohexyl spacer (31b)

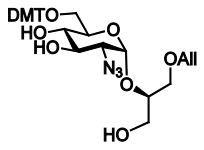
Hexamer **30b** (88.6 mg, 31.5 μmol) was coupled to spacer phosphoramidite **20** (0.2M in MeCN, 0.63 ml, 126 μmol, 4 eq), oxidized and purified (F-SPE) using the general procedure as described above. Hexamer **31b** (89.3 mg, 28.1 μmol, 89 %) was obtained as a colorless oil. ^{31}P NMR (161.7 MHz): δ = -1.9, -1.8 (1P), -1.4 - -0.8 (6P); ^{1}H NMR (400 MHz): δ = 1.23 - 1.68 (m, 8H, 4 x CH_2 hexylspacer), 2.06 - 2.71 (m, 18H, $F_{17}C_8CH_2C$*H*$_2CH_2SO_2$-, $F_{17}C_8C$*H*$_2CH_2CH_2SO_2$-, 7 x CH_2 cyanoethyl), 3.05 - 3.18 (m, 4H, $F_{17}C_8CH_2CH_2C$*H*$_2SO_2$-, CH_2-N hexylspacer), 3.23 - 3.34 (m, 2H, -OCH_2C*H*$_2SO_2$-), 3.67 - 3.88 (m, 11H, H-3, H-4, H-5, H-6, H-6', 6 x CH glycerol), 3.94 - 4.34 (m, 41H, H-2, 12 x CH_2 glycerol, 7 x CH_2 cyanoethyl, CH_2-O hexylspacer), 4.42 - 4.51 (m, 4H, -OC*H*$_2CH_2SO_2$-, CH_2 Bn), 4.55 - 4.66 (m, 11H, 5 x CH_2 Bn, CH*H* Bn), 4.69 - 4.79 (m, 3H, CH_2 Bn, CH*H* Bn), 4.96 - 5.16 (m, 6H, H-1, NH CBz, 2 x CH_2 CBz), 5.93 - 6.23 (m, 1H, NH CBz), 7.09 - 7.13 (m, 2H, H_{arom}), 7.24 - 7.37 (m, 48H, H_{arom}); HRMS: $[C_{136}H_{159}F_{17}N_9O_{44}P_7S + 2Na]^{2+}$ requires 1620.3956, found 1620.3957.



Glucosamine glycerol phosphate hexamer-aminohexyl spacer (32b)

Protected hexamer **31b** (87.3 mg, 27.5 μmol) was treated with aqueous ammonia as described above. The compound was eluted through a small column containing Dowex Na^+ cation-exchange resin (type: 50WX4-200, stored on 0.5 M NaOH in

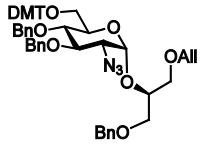
H_2O, flushed with H_2O and MeOH before use) and, subsequently, lyophilized, yielding the intermediate hexamer (66.3 mg, 27.5 µmol, 100 %) as an amorphous white solid. Analytical data intermediate: ^{31}P NMR (161.7 MHz, D_2O): δ = 0.9 - 1.4 (6P), 3.4 (1P, phosphomonoester); ^{1}H NMR (400 MHz, D_2O): δ = 0.86 - 1.49 (m, 8H, 4 x CH_2 hexylspacer), 2.72 - 2.88 (m, 2H, CH_2-N hexylspacer), 3.34 - 4.07 (m, 40H, H-2, H-3, H-4, H-5, H-6, H-6', 12 x CH_2 glycerol, 6 x CH glycerol, CH_2-O hexylspacer, 2 x CH*H* Bn), 4.15 - 4.55 (m, 14H, 6 x CH_2 Bn, 2 x CH*H* Bn), 4.80 - 5.17 (m, 5H, H-1, 2 x CH_2 CBz), 6.64 - 6.69 (m, 2H, H_{arom}), 6.75 - 7.29 (m, 48H, H_{arom}); HRMS: $[C_{102}H_{129}N_2O_{42}P_7 + 2NH_4]^{2+}$ requires 1153.8447, found 1153.8455. A portion of the intermediate (24.7 mg, 10.2 µmol) was deprotected with Pd (0)/H_2 using the standard procedure. Glucosaminylated hexamer **32b** (11.7 mg, 8.33 µmol, 81 %) was obtained as an amorphous white solid. ^{31}P NMR (161.7 MHz, D_2O): δ = 0.9 (1P), 1.2 (1P), 1.3 (2P), 1.4 (1P), 1.5 (1P), 2.6 (1P, phosphomonoester); ^{1}H NMR (600 MHz, D_2O): δ = 1.39 - 1.42 (m, 4H, 2 x CH_2 hexylspacer), 1.61 - 1.69 (m, 4H, 2 x CH_2 hexylspacer), 2.98 (t, 2H, *J* = 7.5 Hz, CH_2-N hexylspacer), 3.32 (dd, 1H, *J* = 3.5 Hz, 10.6 Hz, H-2), 3.47 (at, 1H, *J* = 9.6 Hz, H-4), 3.75 - 4.08 (m, 35H, H-3, H-5, H-6, H-6', 5 x CH glycerol, 12 x CH_2 glycerol, CH_2-O hexylspacer), 4.14 - 4.17 (m, 1H, CH glycerol), 5.40 (d, 1H, *J* = 3.5 Hz, H-1); ^{13}C NMR (150 MHz, D_2O): δ = 25.5, 26.1, 27.6 (3 x CH_2 hexylspacer), 30.4 (d, *J* = 6.7 Hz, CH_2 hexylspacer), 40.4 (CH_2-N hexylspacer), 55.0 (C-2), 61.2 (C-6), 65.5 (d, *J* = 5.5 Hz, CH_2 glycerol), 65.9 (d, *J* = 5.3 Hz, CH_2 glycerol), 66.3 (d, *J* = 4.9 Hz, CH_2-O hexylspacer), 67.1 - 67.5 (10 x CH_2 glycerol), 70.5 - 70.9 (C-4, C-5, 5 x CH glycerol), 73.3 (C-3), 76.5 (t, *J* = 7.7 Hz, CH glycerol), 95.7 (C-1); HRMS: $C_{30}H_{69}N_2O_{38}P_7 + H^+$ requires 1283.1764, found 1283.1769.



3-*O*-Allyl-2-*O*-(2-azido-2-deoxy-6-*O*-[4,4'-dimethoxytrityl]-α-D-glucopyranosyl)-*sn*-glycerol (33)

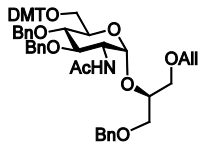
To a solution of glycoside **25** (1.26 g, 2.26 mmol) in DCM/1,4-dioxane (1/1, 60 ml) were added Et_3N (0.490 ml, 3.39 mmol) and DMTr-Cl (0.920 g, 2.72 mmol), respectively. After stirring for 24h MeOH (10 ml) was added and the mixture stirred for 30 minutes after which the solution was further diluted with DCM (50 ml) and washed with water (10 ml) and brine (20 ml). The combined waterlayers were extracted with DCM (20 ml) and the organic layer was washed with brine. The combined organic layers were dried (Na_2SO_4) and concentrated *in vacuo*, after which purification with column chromatography (EtOAc/PE, containing ~0.5% Et_3N) gave the intermediate diol as a pale yellow oil (1.51 g, 1.76 mmol, 78 **%).** Analytical data **3-*O*-allyl-2-*O*-(2-azido-2-deoxy-6-*O*-[4,4'-dimethoxytrityl]-α-D-glucopyranosyl)-1-*O*-*tert*-butyldiphenylsilyl-*sn*-glycerol:** $[\alpha]_D^{20}$ ($CHCl_3$): +30.6; IR (neat): 1028, 1248, 1508, 1607, 2106, 2932; ^{1}H NMR (400 MHz): δ = 1.01 (s, 9H, *t*-Bu TBDPS), 3.16 (dd, 1H, *J* = 3.6 Hz, 10.4 Hz, H-2), 3.18 - 3.24 (m, 2H, H-6, H-6'), 3.59 - 3.65 (m, 2H, H-4, CH*H* glycerol), 3.69 - 3.84 (m, 10H, H-5, CH_2 glycerol, C*H*H glycerol, 2 x OMe), 3.95 - 4.02 (m, 4H, H-3, CH glycerol, CH_2 allyl), 5.18 (dd, 1H, *J* = 1.6 Hz, 10.4 Hz, C*H*H allyl), 5.25 - 5.30 (m, 2H, H-1, CH*H* allyl), 5.90 (ddd, 1H, *J* = 5.6 Hz, 10.6 Hz, 17.1 Hz, CH allyl), 6.78 - 6.81 (m, 4H, H_{arom}), 7.17 - 7.40 (m, 15H, H_{arom}), 7.60 - 7.65 (m, 4H, H_{arom}); ^{13}C NMR (100 Mhz): δ = 19.2 (C_q *t*-Bu), 26.8 (3 x CH_3 TBDPS), 55.2 (2 x OMe), 62.5 (C-2), 63.2 (C-6), 63.9 (CH_2 glycerol), 69.8 (C-5), 70.0 (CH_2 glycerol), 71.0 (C-3), 72.4 (CH_2 allyl), 72.6 (C-4), 77.3 (CH glycerol), 86.4 (C_q DMTr), 97.2 (C-1), 113.2 (CH_{arom}), 117.0 (CH_2 allyl), 126.9 - 129.9 (CH_{arom}), 133.1, 133.2 (2 x C_q TBDPS), 134.6 (CH allyl), 135.6 (CH_{arom}), 135.6, 144.4, 158.5 (5 x C_q DMTr); HRMS: $C_{49}H_{57}N_3O_9Si+Na^+$ requires 882.3756, found 882.3764. To a solution of the intermediate diol (840 mg, 0.977 mmol) in THF (10 ml) was added TBAF (1.00 M in THF, 1.50 ml). This mixture was stirred overnight and concentrated *in vacuo*. Purification with column chromatography (EtOAc/PE, containing ~0.5% Et_3N) furnished triol **33** (508 mg, 0.817 mmol, 84 %) as a colourless oil. $[\alpha]_D^{20}$ ($CHCl_3$): +38.0; IR (neat): 1038, 1074, 1105, 1497, 2104, 2857, 2901, 2928, 3067; ^{1}H NMR (400 MHz): δ = 3.12 (dd, 1H, *J* = 3.6 Hz, 10.4 Hz, H-2), 3.31 (dd, 1H, *J* = 5.1 Hz, 10.1 Hz, H-6), 3.38 (dd, 1H, *J* = 3.5 Hz, 10.1 Hz, H-6'), 3.49 - 3.78 (m, 11H,

H-4, 2 x OMe, 2 x CH_2 glycerol), 3.90 - 4.01 (m, 5H, H-3, H-5, CH_2 allyl, CH glycerol), 5.16 - 5.20 (m, 2H, H-1, C*H*H allyl), 5.27 (dd, 1H, *J* = 1.6 Hz, 17.2 Hz, CH*H* allyl), 5.89 (ddd, 1H, *J* = 5.6 Hz, 11.0 Hz, 17.3 Hz, CH allyl), 6.82 (d, 4H, *J* = 8.9 Hz, H_{arom}), 7.15 - 7.33 (m, 7H, H_{arom}), 7.43 (d, 2H, *J* = 7.4 Hz, H_{arom}); ^{13}C NMR (100 MHz): δ = 55.2 (2 x OMe), 62.7 (C-2), 63.4 (C-6), 63.6 (CH_2 glycerol), 69.8 (CH_2 glycerol), 70.6 (C-5), 71.1 (C-4), 72.3 (C-3), 72.4 (CH_2 allyl), 78.1 (CH glycerol), 86.5 (C_q DMTr), 97.5 (C-1), 113.1 (CH_{arom}), 117.3 (CH_2 allyl), 126.9 - 130.0 (CH_{arom}), 134.2 (CH allyl), 135.7, 135.8, 144.5, 158.5, 158.5 (5 x C_q DMTr); HRMS: $C_{33}H_{39}N_3O_9$+Na^+ requires 644.2580, found 644.2579.



3-*O*-Allyl-2-*O*-(2-azido-3,4-di-*O*-benzyl-2-deoxy-6-*O*-[4,4'-dimethoxytrityl]-α-D-glucopyranosyl)-1-*O*-benzyl-*sn*-glycerol (34)

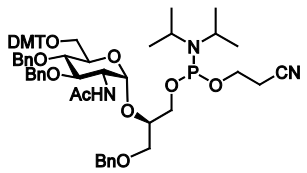
To a cooled (0° C) solution of triol **33** (4.08 g, 6.56 mmol) in DMF (35 ml) were added sodium hydride (60% in mineral oil, 944 mg, 23.7 mmol) and benzyl bromide (2.83 ml, 23.7 mmol). This reaction mixture was allowed to stir overnight at rt before MeOH was added (10 ml). After strring for 30 min the reaction mixture was diluted with Et_2O (250 ml) and washed with water (2 x 50 ml) and brine (100 ml). The organic layer was dried (Na_2SO_4) and concentrated *in vacuo*, after which the residue was purified by column chromatography (EtOAc/PE, containing ~0.5% Et_3N) yielding fully protected construct **34** (5.45 g, 6.11 mmol, 93%) as a colourless oil. $[\alpha]_D^{20}$ ($CHCl_3$): +48.6; IR (neat): 1034, 1250, 1508, 1607, 2106, 2851, 2922; ^{1}H NMR (400 MHz): δ = 3.10 (dd, 1H, *J* = 3.4 Hz, 10.3 Hz, H-6), 3.40 (dd, 1H, *J* = 1.4 Hz, 10.3 Hz, H-6'), 3.45 (dd, 1H, *J* = 3.6 Hz, 10.3 Hz, H-2), 3.56 - 3.68 (m, 4H, 2 x CH_2 glycerol), 3.73 - 3.75 (m, 6H, 2 x OMe), 3.83 (at, 1H, *J* = 9.5 Hz, H-4), 3.98 (at, 1H, *J* = 10.0 Hz, H-3), 4.02 - 4.09 (m, 3H, H-5, CH_2 allyl), 4.10 - 4.16 (m, 1H, CH glycerol), 4.29 (d, 1H, *J* = 10.4 Hz, CH*H* Bn), 4.43 (s, 2H, CH_2 Bn), 4.65 (d, 1H, *J* = 10.4 Hz, CH*H* Bn), 4.86 (s, 2H, CH_2 Bn), 5.21 (dd, 1H, *J* = 1.3 Hz, 10.4 Hz, C*H*H allyl), 5.29 - 5.34 (m, 2H, H-1, CH*H* allyl), 5.94 (ddd, 1H, *J* = 5.6 Hz, 10.7 Hz, 17.4 Hz, CH allyl), 6.74 - 6.78 (m, 4H, H_{arom}), 6.82 - 6.86 (m, 2H, H_{arom}), 7.14 - 7.47 (m, 22H, H_{arom}); ^{13}C NMR (100 MHz): δ = 55.1 (2 x OMe), 61.5 (C-6), 63.6 (C-2), 70.3, 70.4 (2 x CH_2 glycerol), 70.8 (C-5), 72.4 (CH_2 allyl), 73.1, 74.8 (2 x CH_2 Bn), 75.3 (CH glycerol), 75.6 (CH_2 Bn), 78.6 (C-4), 80.1 (C-3), 85.6 (C_q DMTr), 97.4 (C-1), 113.0 (CH_{arom}), 117.1 (CH_2 allyl), 126.6 - 129.1 (CH_{arom}), 130.1, 130.2 (CH_{arom}), 134.6 (CH allyl), 135.7, 136.2, 137.8, 138.0, 144.9, (3 x C_q Bn, 5 x C_q DMTr), 158.3, 158.4 (2 x C_q DMTr); HRMS: $C_{54}H_{57}N_3O_9$+Na^+ requires 914.3987, found 914.3995.



3-*O*-Allyl-2-*O*-(2-acetamido-3,4-di-*O*-benzyl-2-deoxy-6-*O*-[4,4'-dimethoxytrityl]-α-D-glucopyranosyl)-1-*O*-benzyl-*sn*-glycerol (35)

To a solution of compound **34** (5.45 g, 6.11 mmol) in a mixture of 1,4-dioxane/water (36 ml, 5:1) was added PMe_3 (1.0 M in toluene, 12.2 ml, 12.2 mmol). After stirring for 4 h the mixture was concentrated *in vacuo* and coevaporated with toluene (3 x 50 ml). The crude intermediate was taken up in pyridine (30 ml) and Ac_2O (1.13 ml, 12.0 mmol) was added. After stirring overnight, the mixture was diluted with EtOAc (300 ml) and washed with water (50 ml), saturated aqueous $NaHCO_3$ solution (50 ml) and brine (50 ml). The organic layer was dried (Na_2SO_4) and concentrated *in vacuo*, after which purification by column chromatography (EtOAc/PE, containing ~0.5% Et_3N) yielded acetamide **35** (4.77 g, 5.25 mmol, 86%) as a slightly yellow oil. $[\alpha]_D^{20}$ ($CHCl_3$): +30.0; IR (neat): 1090, 1250, 1454, 1508, 2853, 2924, 3063; ^{1}H NMR (400 MHz): δ = 1.87 (s, 3H, HNAc). 3.17 - 3.23 (m, 1H, H-6), 3.41 - 3.65 (m, 12H, H-3, H-6', 2 x CH_2 glycerol, 2 x OMe), 3.71 - 3.78 (m, 1H, H-4), 3.86 - 4.09 (m, 4H, H-5, CH glycerol, CH_2 allyl), 4.30 - 4.46 (m, 4H, H-2, CH_2Bn, CH*H* Bn), 4.65 - 4.72 (m, 2H, 2 x CH*H* Bn), 4.85 (d, 1H, *J* = 11.5 Hz, CH*H* Bn), 5.08 - 5.25 (m, 3H, H-1, CH_2 allyl), 5.82 (ddd, 1H, *J* = 5.4 Hz, 10.5 Hz, 16.1 Hz, CH allyl), 6.09 (d, 1H, *J* = 9.0 Hz, *H*NAc), 6.73 - 6.77 (m, 4H, H_{arom}), 6.86 - 6.89 (m, 2H, H_{arom}), 7.09 - 7.40 (m, 20H, H_{arom}),

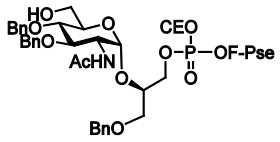
7.52 (d, 2H, *J* = 7.5 Hz, H_{arom}); ^{13}C NMR (100 MHz): δ = 22.8 (HNAc), 52.6 (C-2), 54.4 (2 x OMe), 61.3 (C-6), 69.6, 69.7 (2 x CH_2 glycerol), 70.8 (C-5), 71.6 (CH_2 allyl), 72.5, 74.2, 74.5 (3 x CH_2 Bn), 76.0 (CH glycerol), 78.0 (C-4), 80.3 (C-3), 85.1 (C_q DMTr), 97.8 (C-1), 112.5 (CH_{arom}), 116.6 (CH_2 allyl), 126.0 - 127.8 (CH_{arom}), 129.6, 129.7 (CH_{arom}) 133.8 (CH allyl), 135.2, 135.6, 137.3, 137.4, 138.1, 144.6, 157.8 (3 x C_q Bn, 5 x C_q DMTr), 169.3 (C=O NHAc); HRMS: $C_{56}H_{61}NO_{10}$+Na^+ requires 930.4188, found 930.4195.



3-([*N,N*,Diisopropylamino]-2-cyanoethylphosphite)-2-*O*-(2-acetamido-3,4-di-*O*-benzyl-2-deoxy-6-*O*-[4,4'-dimethoxytrityl]-α-D-glucopyranosyl)-1-*O*-benzyl-*sn*-glycerol (36)

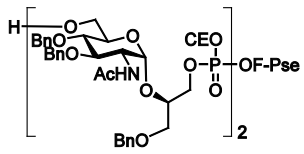
A solution of compound **35** (6.36 g, 7.00 mmol) in THF (100 ml) was stirred under argon for 30 min after which $Ir(COD)(PPhMe)_2PF_6$ (177 mg, 0.209 mmol) was added. The solution was purged with H_2 (g) (20s) before it was stirred under argon for 1 h. After the addition of, respectively, saturated aqueous $NaHCO_3$ solution (25 ml) and I_2 (4.80 g, 18.9 mmol) the mixture was stirred for 30 min before it was diluted with EtOAc (400 ml) and washed with saturated $Na_2S_2O_3$ solution (100 ml) and brine (200 ml). The organic layer was dried (Na_2SO_4) and concentrated *in vacuo*, after which purification by column chromatography (EtOAc/PE, containing ~0.5% Et_3N) yielded the intermediate alcohol (5.63 g, 6.49 mmol, 93%) as a yellow foam. Analytical data **1-*O*-benzyl-2-*O*-(2-acetamido-3,4-di-*O*-benzyl-2-deoxy-6-*O*-[4,4'-dimethoxytrityl]-α-D-glucopyranosyl)-*sn*-glycerol:** $[\alpha]_D^{20}$ ($CHCl_3$): +49.8; IR (neat): 1028, 1091, 1246, 1660, 2945; ^1H NMR (400 MHz): δ = 1.86 (s, 3H, HNAc), 2.70 (bs, 1H, OH), 3.19 (dd, 1H, *J* = 4.0, 10.2 Hz, H-6), 3.42 (dd, 1H, *J* = 1.3, 10.0 Hz, H-6'), 3.59 (dd, 1H, *J* = 5.3 Hz, 10.0 Hz, C*H*H glycerol), 3.64 - 3.79 (m, 10H, H-3, CH_2 glycerol, CH*H* glycerol, 2 x OMe), 3.79 - 3.90 (m, 2H, H-4, CH glycerol), 3.95 (dd, 1H, *J* = 2.2 Hz, 9.9 Hz, H-5), 4.26 - 4.33 (m, 2H, H-2, C*H*H Bn), 4.43 (s, 2H, CH_2 Bn), 4.61 - 4.67 (m, 2H, CH_2 Bn), 4.84 (d, 1H, *J* = 11.6 Hz, C*H*H Bn), 5.09 (d, 1H, *J* = 3.6 Hz, H-1), 6.16 (d, 1H, *J* = 8.8 Hz, *H*NAc), 6.76 - 6.81 (m, 4H, H_{arom}), 6.84 - 6.88 (m, 2H, H_{arom}), 7.15 - 7.37 (m, 20H, H_{arom}), 7.46 - 7.49 (m, 2H, H_{arom}); ^{13}C NMR (100 MHz): δ = 23.2 (NHAc), 53.1 (C-2), 55.1 (2 x OMe), 61.9 (C-6), 62.6, 70.5 (2 x CH_2 glycerol), 71.4 (C-5), 73.4, 74.9, 75.0 (3 x CH_2 Bn), 77.2 (CH glycerol), 78.4 (C-4), 80.3 (C-3), 85.7 (C_q DMTr), 97.5 (C-1), 113.0 (CH_{arom}), 126.6 - 130.2 (CH_{arom}), 135.8, 136.1, 137.5, 137.7, 138.4, 144.9, 158.4 (3 x C_q Bn, 5 x C_q DMTr), 170.5 (C=O); HRMS: $C_{53}H_{57}NO_{10}$+Na^+ requires 890.3875, found 890.3880. To a solution of the intermediate alcohol (694 mg, 0.800 mmol) and Et_3N (166 µl, 1.20 mmol) in DCM (8.0 ml) was added (*N,N*-diisopropylamino)-2-cyanoethyl-chlorophosphoramidite (214 µl, 0.959 mmol). This mixture was allowed to stir for 2 h, after which H_2O (2.0 ml) was added. The mixture was diluted with DCM (20 ml) and washed was washed with brine (15 ml). The organic layer was dried (Na_2SO_4) and concentrated *in vacuo*, after which the residue was purified by column chromatography (EtOAc/PE, containing ~0.5% Et_3N) yielding phosphoramidite **36** (786 mg, 0.736 mmol, 92%, mixture of diastereoisomers) as a white foam. IR (neat): 1248, 1454, 1508, 1653, 2837, 2870, 2928, 2965, 3021, 3055, 3221; ^{31}P NMR (162 MHz): δ = 147.3, 147.8 (diastereoisomers); ^1H NMR (400 MHz): δ = 1.21 - 1.24 (m, 12 H, 4 x CH_3 isopropylamino), 1.95 - 1.97 (m, 3H, *J* = 1.6 Hz, HNAc), 2.64 - 2.68 (m, 2H, CH_2 cyanoethyl), 3.07 (dd, 1H, *J* = 4.7, 10.1 Hz, H-6), 3.38 (ad, 1H, *J* = 9.9 Hz, H-6'), 3.61 - 3.90 (m, 16H, H-3, H-4, 2 x CH isopropylamino, 2 x CH_2 glycerol, CH_2 cyanoethyl, 2 x OMe), 4.09 - 4.15 (m, 2H, H-5, CH glycerol), 4.17 - 4.26 (m, 1H, H-2), 4.30 (d, 1H, *J* = 10.7 Hz, C*H*H Bn), 4.47 - 4.54 (m, 2H, CH_2 Bn), 4.66 - 4.73 (m, 2H, CH_2 Bn), 4.79 - 4.84 (m, 1H, C*H*H Bn), 5.10 (d, 0.5H, *J* = 3.6 Hz, H-1 diastereoisomer 1), 5.12 (d, 0.5H, *J* = 3.6 Hz, H-1 diastereoisomer 2), 6.47 (d, 0.5H, *J* = 9.5 Hz, *H*NAc diastereoisomer 1), 6.53 (d, 0.5H, *J* = 9.6 Hz, *H*NAc diastereoisomer 2), 6.82 - 6.87 (m, 4H, H_{arom}), 6.92 - 6.96 (m, 2H, H_{arom}), 7.20 - 7.38 (m, 20H, H_{arom}), 7.52 (d, 2H, *J* = 7.5 Hz, H_{arom}); ^{13}C NMR (100 MHz): δ = 21.0, 21.1 (CH_2 cyanoethyl), 23.5 (HNAc), 24.9 - 25.1 (4 x CH_3

isopropylamino), 43.8, 43.9 (2 x CH isopropylamino), 53.9, 53.9 (C-2), 55.8 (2 x OMe), 59.3 - 59.6 (CH_2 cyanoethyl), 63.3 (C-6), 63.8, 63.9 (CH_2 glycerol) 71.1 (CH_2 glycerol), 71.9 (C-5), 73.6, 75.2, 75.8 (3 x CH_2 Bn), 76.7 - 76.9 (CH glycerol), 79.6 (C-4), 81.7, 81.8 (C-3), 86.5 (C_q DMTr), 98.0, 98.2 (C-1), 114.0 (CH_{arom}), 118.3 (C_q cyanoethyl), 127.6 - 129.2 (CH_{arom}), 131.0, 131.1 (CH_{arom}), 136.8, 137.1, 139.2, 139.5, 139.9, 146.3, 159.5 (3 x C_q Bn, 5 x C_q DMTr), 170.5 (C=O NHAc); HRMS: $C_{62}H_{74}N_3O_{11}P+H^+$ requires 1068.5134, found 1068.5146.



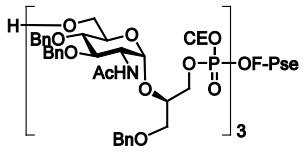
GlcNAc-glycerol phosphate monomer (37)

Fluorous alcohol **5** (254 mg, 445 µmol) was coupled to phosphoramidite **36** (0.2 M in MeCN, 3.34 ml, 668 µmol, 1.5 eq), oxidized, detritylated and purified (F-SPE) using the general procedure as described above. Monomer **37** (501 mg, 400 µmol, 90 %) was obtained as a white foam. ^{31}P NMR (161.7 MHz): δ = -1.8, -1.6 (1P); ^{1}H NMR (400 MHz): δ = 1.95 (s, 3H, NHAc), 2.00 - 2.39 (m, 5H, $F_{17}C_8CH_2CH_2CH_2SO_2$-, $F_{17}C_8CH_2CH_2CH_2SO_2$-, CH_2OH), 2.58 - 2.76 (m, 2H, cyanoethyl), 3.00 (t, 1H, *J* = 7.4 Hz, $F_{17}C_8CH_2CH_2CHHSO_2$-), 3.14 (t, 1H, *J* = 7.4 Hz, $F_{17}C_8CH_2CH_2CHHSO_2$-), 3.25 - 3.40 (m, 2H, -$OCH_2CH_2SO_2$-), 3.52 - 3.79 (m, 7H, H-3, H-4, H-5, H-6, H-6', CH_2 glycerol), 3.88 - 3.92 (m, 1H, CH glycerol), 4.13 - 4.37 (m, 5H, H-2, CH_2 cyanoethyl, CH_2 glycerol), 4.43 - 4.52 (m, 4H, CH_2 Bn, -$OCH_2CH_2SO_2$-), 4.63 (d, 1H, *J* = 10.8 Hz, CHH Bn), 4.71 (d, 1H, *J* = 11.4 Hz, CHH Bn), 4.79 - 4.86 (m, 2H, 2 x CHH Bn), 4.91 (m, 1H, H-1), 6.87 (d, 0.5 H, *J* = 9.6 Hz, NHAc), 6.91 (d, 0.5 H, *J* = 9.5 Hz, NHAc), 7.24 - 7.37 (m, 15H, H_{arom}); ^{13}C NMR (100 MHz): δ = 13.4 ($F_{17}C_8CH_2CH_2CH_2SO_2$-), 19.4 - 19.6 ($CH_2$ cyanoethyl), 23.0 (NHAc), 29.1 - 29.6 ($F_{17}C_8CH_2CH_2CH_2SO_2$-), 52.7 (C-2), 52.9 - 53.4 ($F_{17}C_8CH_2CH_2CH_2SO_2$-, -$OCH_2CH_2SO_2$-), 61.1 (-$OCH_2CH_2SO_2$-), 61.6 (C-6), 62.4 - 62.6 (CH_2 cyanoethyl), 68.3 - 68.7 (2 x CH_2 glycerol), 72.1 (C-5), 73.5 (CH_2 Bn), 74.8 - 75.1 (2 x CH_2 Bn), 76.8 (CH glycerol), 77.7, 77.8 (C-4), 80.3 (C-3), 99.6 (C-1), 116.5 (C_q cyanoethyl), 127.6 - 128.5 (CH_{arom}), 137.4, 137.9, 138.4 (3 x C_q Bn), 170.7 (C_q acetyl); HRMS: $C_{48}H_{52}F_{17}N_2O_{13}PS+H^+$ requires 1252.2763, found 1252.2764.



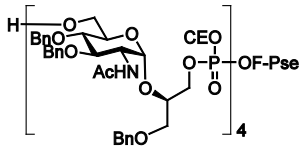
GlcNAc-glycerol phosphate dimer (38)

Monomer **37** (250 mg, 200 µmol) was coupled to phosphoramidite building-block **36** (0.2M in MeCN, 1.50 ml, 300 µmol, 1.5 eq), oxidized, detritylated and purified (F-SPE) using the general procedure as described above. Dimer **38** (321 mg, 166 µmol, 83 %) was obtained as a white foam. ^{31}P NMR (161.7 MHz): δ = -1.9, -1.9 (0.5P), -1.7, -1.7 (0.5P), -1.1, -1.1 (0.5P), -0.9, -0.9 (0.5P); ^{1}H NMR (400 MHz): δ = 1.94 - 1.99 (m, 6H, 2 x NHAc), 2.03 - 2.37 (m, 5H, CH_2OH, $F_{17}C_8CH_2CH_2CH_2SO_2$-, $F_{17}C_8CH_2CH_2CH_2SO_2$-), 2.54 - 2.76 (m, 4H, 2 x CH_2 cyanoethyl), 2.93 (t, 0.5H, *J* = 7.5 Hz, $F_{17}C_8CH_2CH_2CHHSO_2$-), 3.02 (t, 0.5H, *J* = 7.4 Hz, $F_{17}C_8CH_2CH_2CHHSO_2$-), 3.13 (t, 1H, *J* = 7.1 Hz, $F_{17}C_8CH_2CH_2CHHSO_2$-), 3.23 - 3.41 (m, 2H, -$OCH_2CH_2SO_2$-), 3.46 - 3.85 (m, 12H, 2 x H-3, 2 x H-4, 2 x H-5, H-6, H-6', 2 x CH_2 glycerol), 3.89 - 3.96 (m, 2H, 2 x CH glycerol), 4.00 - 4.33 (m, 12H, 2 x H-2, H-6, H-6', 2 x CH_2 glycerol, 2 x CH_2 cyanoethyl), 4.39 - 4.52 (m, 6H, -$OCH_2CH_2SO_2$-, 2 x CH_2 Bn), 4.58 - 4.93 (m, 10H, 2 x H-1, 4 x CH_2 Bn), 6.81 - 7.15 (m, 2H, 2 x NH), 7.22 - 7.37 (m, 30H, H_{arom}); ^{13}C NMR (100 MHz): δ = 13.2 - 13.4 ($F_{17}C_8CH_2CH_2CH_2SO_2$-), 19.2 - 19.5 (2 x CH_2 cyanoethyl), 22.9 (2 x NHAc), 28.9 - 29.4 ($F_{17}C_8CH_2CH_2CH_2SO_2$-), 52.5, 52.6 (2 x C-2), 52.9 - 53.2 ($F_{17}C_8CH_2CH_2CH_2SO_2$-, -$OCH_2CH_2SO_2$-), 61.0 - 61.1 (-$OCH_2CH_2SO_2$-), 61.4 - 62.5 (C-6, 2 x CH_2 cyanoethyl), 66.3 - 66.6 (C-6), 67.9 - 68.6 (4 x CH_2 glycerol), 70.2 (CH glycerol), 72.1, 72.5 (2 x C-5), 73.3 (2 x CH_2 Bn), 74.9 - 75.1 (4 x CH_2 Bn), 76.3 - 76.6 (CH glycerol), 77.6, 78.3 (2 x C-4), 80.1 - 80.5 (2 x C-3), 99.0 - 99.7 (2 x C-1), 116.5 (2 x C_q cyanoethyl), 127.4 - 128.4 (CH_{arom}), 137.3 - 138.3 (6 x C_q Bn), 170.7 - 170.8 (2 x C_q acetyl); HRMS $C_{83}H_{93}F_{17}N_4O_{23}P_2S+H^+$, requires 1931.5228, found 1931.5237.



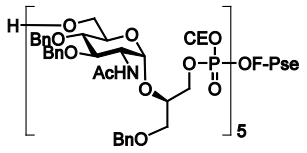
GlcNAc-glycerol phosphate trimer (39)

Dimer **38** (312 mg, 162 μmol) was coupled to phosphoramidite building-block **36** (0.2 M in MeCN, 1.22 ml, 243 μmol, 1.5 eq), oxidized, detritylated and purified (F-SPE) using the general procedure as described above. Trimer **39** (336 mg, 129 μmol, 80 %) was obtained as a white foam. ^{31}P NMR (161.7 MHz): δ = -1.9, -1.9 (0.5P), -1.7, -1.7 (0.5P), -1.3, -1.2, -1.2, -1.1 (1P), -0.9, -0.9 (1P); ^{1}H NMR (400 MHz): δ = 1.93 - 2.02 (m, 9H, 3 x NHAc), 2.06 - 2.33 (m, 4H, $F_{17}C_8CH_2CH_2CH_2SO_2$-, $F_{17}C_8CH_2CH_2CH_2SO_2$-), 2.47 - 2.73 (m, 7H, 3 x CH_2 cyanoethyl, CH_2OH), 2.94 - 3.05 (m, 1H, $F_{17}C_8CH_2CH_2CHHSO_2$-), 3.12 (t, 1H, 7.0 Hz, $F_{17}C_8CH_2CH_2CHHSO_2$-), 3.21 - 3.38 (m, 2H, -$OCH_2CH_2SO_2$-), 3.45 - 3.86 (m, 17H, 3 x H-3, 3 x H-4, 3 x H-5, H-6, H-6', 3 x CH_2 glycerol), 3.88 - 3.99 (m, 3H, 3 x CH glycerol), 4.00 - 4.35 (m, 19H, 3 x H-2, 2 x H-6, 2 x H-6', 3 x CH_2 glycerol, 3 x CH_2 cyanoethyl), 4.38 - 4.51 (m, 8H, -$OCH_2CH_2SO_2$-, 3 x CH_2 Bn), 4.55 - 4.93 (m, 15H, 3 x H-1, 6 x CH_2 Bn), 6.95 - 7.60 (m, 48H, 3 x NHAc, H_{arom}); ^{13}C NMR (100 MHz); δ = 13.2 - 13.4 ($F_{17}C_8CH_2CH_2CH_2SO_2$-), 19.2 - 19.6 (3 x CH_2 cyanoethyl), 22.9 (NHAc), 29.2 ($F_{17}C_8CH_2CH_2CH_2SO_2$-), 52.5 - 52.6 (3 x C-2), 53.0 - 53.2 ($F_{17}C_8CH_2CH_2CH_2SO_2$-, -$OCH_2CH_2SO_2$-), 61.0 - 61.1 (-$OCH_2CH_2SO_2$-), 61.4 - 62.5 (C-6, 3 x CH_2 cyanoethyl), 66.3 - 66.9 (2 x C-6), 67.9 - 68.6 (6 x CH_2 glycerol), 70.1 - 70.2 (2 x CH glycerol) , 72.0 - 72.5 (3 x C-5), 73.2 - 73.4 (3 x CH_2 Bn), 74.8 - 75.2 (6 x CH_2 Bn), 76.9 (CH glycerol), 77.1, 77.6, 78.5 (3 x C-4), 80.3 - 80.6 (3 x C-3), 99.1 - 99.8 (3 x C-1), 116.4 - 116.5 (3 x C_q cyanoethyl), 127.4 - 128.5 (CH_{arom}), 137.3 - 138.4 (9 x C_q Bn), 170.7 - 170.8 (3 x C_q acetyl); HRMS: $[C_{118}H_{134}F_{17}N_6O_{33}P_3S+2NH_4]^{2+}$ requires 1323.9182, found 1323.9186.



GlcNAc-glycerol phosphate tetramer (40)

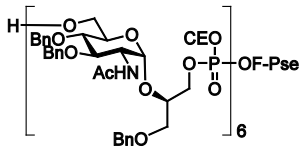
Trimer **39** (252 mg, 96.4 μmol) was coupled to phosphoramidite building-block **36** (0.2 M in MeCN, 0.72 ml, 144 μmol, 1.5 eq), oxidized, detritylated and purified (F-SPE) using the general procedure as described above. Tetramer **40** (225 mg, 68.2 μmol, 71 %) was obtained as a white foam. ^{31}P NMR (161.7 MHz): δ = -1.9, -1.9 (0.5P), -1.7, -1.7 (0.5P), -1.3 - -1.1 (1.5P), -0.9 - -0.9 (1.5 P); ^{1}H NMR (400 MHz): δ = 1.93 - 2.01 (m, 12H, 4 x NHAc), 2.08 - 2.37 (m, 5H, CH_2OH, $F_{17}C_8CH_2CH_2CH_2SO_2$-, $F_{17}C_8CH_2CH_2CH_2SO_2$-), 2.52 - 2.74 (m, 8H, 4 x CH_2 cyanoethyl), 2.94 - 3.15 (m, 2H, $F_{17}C_8CH_2CH_2CH_2SO_2$), 3.23 - 3.38 (m, 2H, -$OCH_2CH_2SO_2$-), 3.45 - 3.89 (m, 22H, 4 x H-3, 4 x H-4, 4 x H-5, H-6, H-6', 4 x CH_2 glycerol), 3.90 - 3.98 (m, 4H, 4 x CH glycerol), 3.99 - 4.35 (m, 26H, 4 x H-2, 3 x H-6, 3 x H-6', 4 x CH_2 glycerol, 4 x CH_2 cyanoethyl), 4.37 - 4.51 (m, 10H, -$OCH_2CH_2SO_2$-, 4 x CH_2 Bn), 4.55 - 4.93 (m, 20H, 4 x H-1, 8 x CH_2 Bn), 6.94 - 7.62 (m, 64H, 4 x NHAc, H_{arom}); HRMS: $[C_{153}H_{175}F_{17}N_8O_{43}P_4S+2H]^{2+}$ requires 1647.0166, found 1647.0176.



GlcNAc-glycerol phosphate pentamer (41)

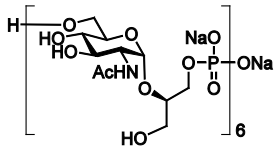
Tetramer **40** (218 mg, 66.1 μmol) was coupled to phosphoramidite building-block **36** (0.2 M in MeCN, 0.59 ml, 119 μmol, 1.8 eq), oxidized, detritylated and purified (F-SPE) using the general procedure as described above. Pentamer **41** (199 mg, 50.0 μmol, 76 %) was obtained as a white foam. ^{31}P NMR (161.7 MHz): δ = -1.9, -1.9 (0.5P), -1.7, -1.7 (0.5P), -1.2 - -1.1 (2P), -1.0 - -0.9 (2P); ^{1}H NMR (400 MHz): δ = 1.94 - 2.02 (m, 15H, 5 x NHAc), 2.08 - 2.36 (m, 5H, CH_2OH, $F_{17}C_8CH_2CH_2CH_2SO_2$-, $F_{17}C_8CH_2CH_2CH_2SO_2$-), 2.49 - 2.74 (m, 10H, 5 x CH_2 cyanoethyl), 2.94 - 3.15 (m, 2H, $F_{17}C_8CH_2CH_2CH_2SO_2$), 3.23 - 3.38 (m, 2H, -$OCH_2CH_2SO_2$-), 3.44 - 3.87 (m, 27H, 5 x H-3, 5 x H-4, 5 x H-5, H-6, H-6', 5 x CH_2 glycerol), 3.88 - 3.98 (m, 5H, 5 x CH glycerol), 3.99 - 4.36 (m, 33H, 5 x H-2, 4 x H-6, 4 x H-6', 5 x CH_2 glycerol, 5 x CH_2 cyanoethyl), 4.37 - 4.52 (m, 12H, -$OCH_2CH_2SO_2$-, 5 x

CH_2 Bn), 4.55 - 4.93 (m, 25H, 5 x H-1, 10 x CH_2 Bn), 6.95 - 7.65 (m, 80H, 5 x N*H*Ac, H_{arom}); HRMS: $[C_{188}H_{216}F_{17}N_{10}O_{53}P_5S+2H]^{2+}$ requires 1987.6432, found 1987.6437.



GlcNAc-glycerol phosphate hexamer (42)

Pentamer **41** (186 mg, 46.9 μmol) was coupled to phosphoramidite building-block **36** (0.2 M in MeCN, 0.47 ml, 93.8 μmol, 2.0 eq), oxidized, detritylated and purified (F-SPE) using the general procedure as described above. Hexamer **42** (183 mg, 39.3 μmol, 84 %) was obtained as a white foam. ^{31}P NMR (161.7 MHz): δ = -1.9, -1.9, (0.5P), -1.7, -1.7 (0.5P), -1.3 - -1.1 (2.5P), -1.0 - -0.9 (2.5P); ^{1}H NMR (400 MHz): δ = 1.93 - 2.02 (m, 18H, 6 x NHAc), 2.09 - 2.37 (m, 5H, CH_2OH, $F_{17}C_8CH_2CH_2CH_2SO_2$-, $F_{17}C_8CH_2CH_2CH_2CH_2SO_2$-), 2.49 - 2.74 (m, 12H, 6 x CH_2 cyanoethyl), 2.94 - 3.16 (m, 2H, $F_{17}C_8CH_2CH_2CH_2CH_2SO_2$), 3.22 - 3.38 (m, 2H, -$OCH_2CH_2SO_2$-), 3.44 - 3.87 (m, 32H, 6 x H-3, 6 x H-4, 6 x H-5, H-6, H-6', 6 x CH_2 glycerol), 3.89 - 3.98 (m, 6H, 6 x CH glycerol), 3.98 - 4.35 (m, 40H, 6 x H-2, 5 x H-6, 5 x H-6', 6 x CH_2 glycerol, 6 x CH_2 cyanoethyl), 4.37 - 4.52 (m, 14H, -$OCH_2CH_2SO_2$-, 6 x CH_2 Bn), 4.54 - 4.93 (m, 30H, 6 x H-1, 12 x CH_2 Bn), 6.90 - 7.61 (m, 96H, 6 x N*H*Ac, H_{arom}); HRMS: $[C_{223}H_{257}F_{17}N_{12}O_{63}P_6S+2H]^{2+}$ requires 2327.7681, found 2327.7673.



GlcNAc-glycerol phosphate hexamer (43)

Protected hexamer **42** (85.7 mg, 18.4 μmol) was treated with aqueous ammonia as described above affording the intermediate hexamer (71.6 mg, 18.3 μmol, 100%). Analytical data intermediate: ^{31}P NMR (161.7 MHz): δ = 0.5 - 0.9 (6P); ^{1}H NMR (400 MHz): δ = 1.72 - 1.98 (m, 18H, 6 x NHAc), 2.89, 3.35 (2 x t, 2 x 12H, *J* = 6.8 Hz, 6 x NH_4), 3.35 - 4.65 (m, 102H, 6 x H-2, 6 x H-3, 6 x H-4, 6 x H-5, 6 x H-6, 6 x H-6', 6 x CH glycerol, 12 x CH_2 glycerol, 18 x CH_2 Bn), 4.86 - 5.02 (m, 6H, 6 x H-1), 6.67 - 7.22 (m, 90H, H_{arom}); HRMS: $[C_{192}H_{230}N_6O_{61}P_6+H+NH_4]^{2+}$ requires 1901.1991, found 1901.2015. A portion of the semiprotected hexamer (69.6 mg, 17.8 μmol) was deprotected with Pd (0)/H_2 using the standard procedure. Hexamer **43** (31.5 mg, 13.6 μmol, 76%) was obtained as an amorphous white solid. ^{31}P NMR (161.7 MHz): δ = 1.2 - 1.3 (5P), 3.0 (1P, phosphomonoester); ^{1}H NMR (600 MHz): δ = 2.06 - 2.08 (m, 18H, 6 x NHAc), 3.48 (t, 1H, *J* = 9.4 Hz, H-3), 3.53 - 3.57 (m, 5H, 5 x H-3), 3.72 - 3.80 (m, 19H, 6 x H-4, H-6, 6 x CH_2 glycerol), 3.82 - 3.91 (m, 10H, H-5, H-6', 6 x CH glycerol, CH_2 glycerol), 3.92 - 4.03 (m, 21H, 6 x H-2, 6 x H-5, 5 x H-6, 5 x H-6'), 4.06 - 4.10 (m, 10H, 5 x CH_2 glycerol), 5.03 (d, 1H, *J* = 3.8 Hz, H-1), 5.04 (d, 4H, *J* = 3.6 Hz, H-1), 5.07 (d, 1H, *J* = 3.7 Hz, H-1); ^{13}C NMR (150 MHz): δ = 23.0 - 23.1 (6 x NHAc), 54.5 (6 x C-2), 61.4 (C-6), 62.1 - 62.2 (6 x CH_2 glycerol), 63.9 (CH_2 glycerol), 65.1 - 65.4 (5 x C-6, 5 x CH_2 glycerol), 70.5 (5 x C-3), 70.9 (C-3), 71.9 - 72.1 (6 x C-4, 5 x C-5), 73.1 (C-5), 78.3 (d, *J* = 7.4 Hz, CH glycerol), 78.9 - 79.1 (4 x CH glycerol), 79.3 (d, *J* = 7.4 Hz, CH glycerol), 97.9 (C-1), 98.2 - 98.4 (5 x C-1), 175.4 (5 x C_q acetyl), 175.6 (C_q acetyl); HRMS: $C_{66}H_{122}N_6O_{61}P_6+NH_4^+$ requires 2178.5393, found 2178.5405.

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