Lipophilic iminosugars : synthesis and evaluation as inhibitors of glucosylceramide metabolism

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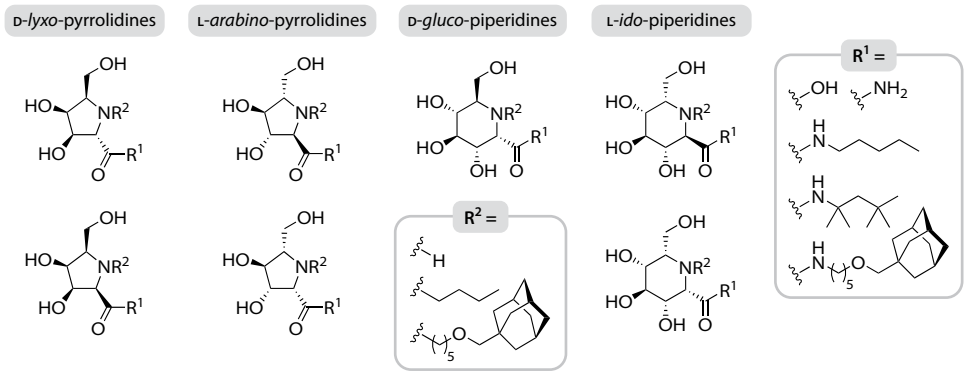
7 Combinatorial Synthesis of Lipophilic Iminosugars

via a Tandem Staudinger/aza-Wittig/ Ugi Three-component Reaction

Abstract

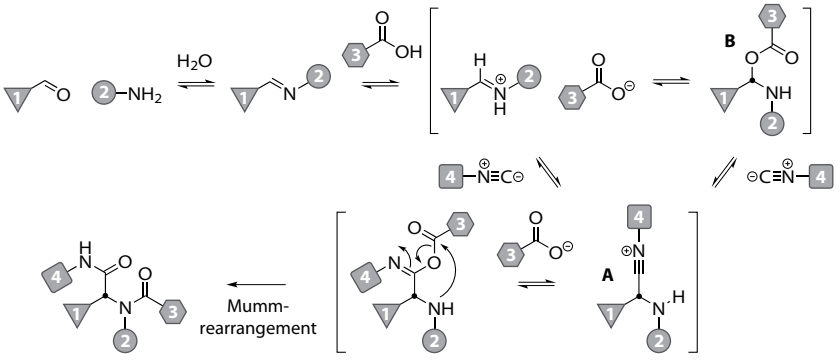
This chapter reports the use of the tandem Staudinger/aza-Wittig/Ugi three-component reaction to synthesize four libraries of lipophilic iminosugars in a combinatorial fashion. Four azido-aldehyde derivatives of D-lyxose, L-arabinose, D-glucose and L-idose were exposed to trimethylphosphine to provide the intermediate cyclic imines that were subsequently exposed to pent-4-enoic acid and four different isocyanides to provide 16 library precursors. Deprotection of the pent-4-enamide moiety and subsequent deprotection or *N*-alkylation and deprotection provided the final 73 library entries. Evaluation of the four libraries in an enzyme assay for inhibition of glucocerebrosidase, β-glucosidase 2 and glucosylceramide synthase produced several hits in the μM range.



Introduction

Multicomponent reactions (MCRs) are frequently used as a powerful method to generate large families of structurally related molecules.[1-6] MCRs are generally defined as processes in which three or more starting materials react in one-pot to form a product that incorporates essentially all of the atoms of the reactants.[6] Among MCRs, the Ugi reaction is one of the most explored to date and is widely used in organic and medicinal chemistry research because of its versatility in the creation of densely functionalized α-acylamino amides.[7]

Figure 1. Overview of the Ugi four-component reaction mechanism.

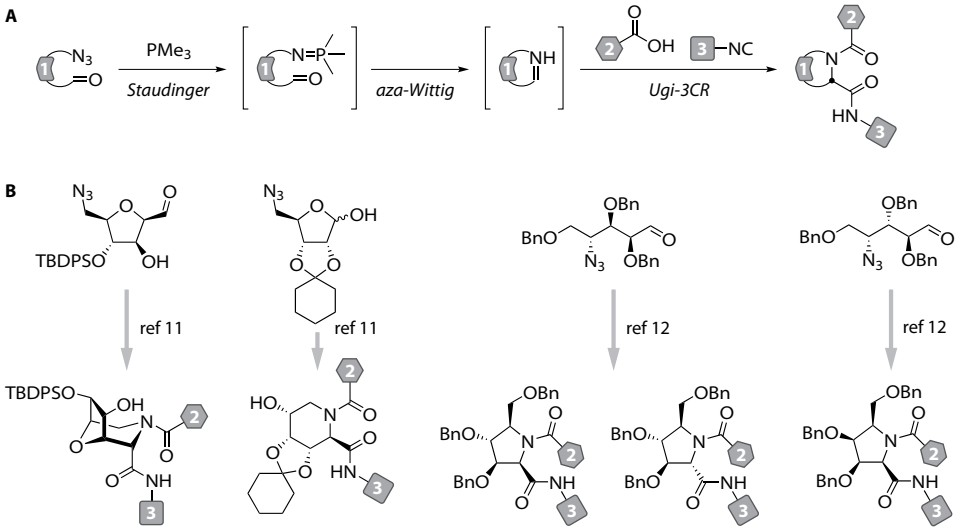


In the classic Ugi four-component reaction (Ugi-4CR), reported in 1959,[8] an aldehyde, an amine, a carboxylic acid and an isocyanide, all of which may possess a variety of different functionalities, are combined to form α-acylamino amides.[9,10] The first step in this process is the condensation of the aldehyde and amine entities to an intermediate imine (Figure 1). The imine is protonated by the carboxylic acid after which two pathways are possible. In the first pathway, the isocyanide attacks the α-carbon atom of the activated imine to form an intermediate nitrilium ion species (**A**). The second proposed pathway involves attack of the carboxylate on the protonated imine to generate an intermediate acyloxy intermediate (**B**).[5,9] The isocyanide can displace the acyl moiety in an S_N2 attack that generates nitrilium ion **A**. Intermediate **A** is attacked by the carboxylate and the subsequent product undergoes a Mumm-rearrangement to yield the Ugi product. The imine can also be preformed and subsequently mixed with a carboxylic acid and isocyanide. This variant is called the Ugi three-component reaction (Ugi-3CR).

Timmer *et al.* recently reported a variation of the Ugi-3CR, which was termed the tandem Staudinger/aza-Wittig/Ugi-3C reaction (SAWU-3CR).[11] In this process an azido-aldehyde is reacted with a trialkylphosphine (Staudinger reaction) to give an intermediate phosphazene that undergoes an intramolecular aza-Wittig reaction with the aldehyde moiety to provide a cyclic imine. Addition at this stage of a carboxylic acid and an isocyanide provides an α-acylamino amide product in an Ugi-3CR sequence of events (Figure 2A). The versatility of the SAWU-3CR has since been demonstrated by

its application on a variety of carbohydrate derived azido-aldehydes to produce small libraries of bridged morpholine derivatives, pipecolic acid derivatives and pyrrolidine iminosugars (Figure 2B).[11-13]

Figure 2. Overview of the tandem SAWU-3CR sequence of events (**A**) and its reported applications (**B**).

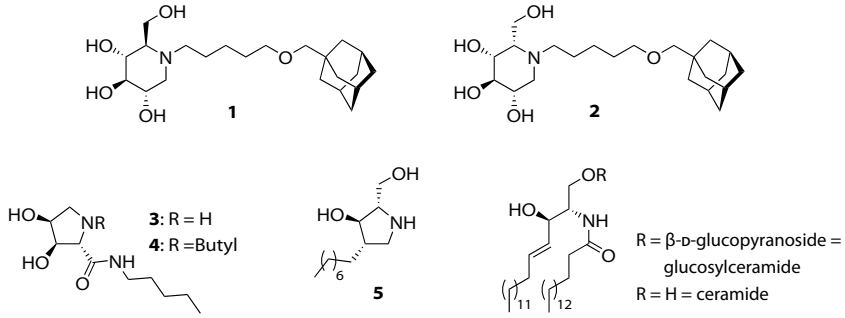


The overall goal of the research presented in this thesis is the development of selective and potent inhibitors of the enzymes involved in the metabolism of glucosylceramide (Figure 3). These targeted enzymes are glucosylceramide synthase (GCS), glucocerebrosidase (GBA1) and β-glucosidase 2 (GBA2). The structure of the developed compounds is based on lead compound **1** (Figure 3) that has been identified as a potent inhibitor of all three enzymes and its L-*ido* derivative **2** – a more selective inhibitor of GCS than **1**.

The chapters leading up to here have mostly discussed the development of new lipophilic iminosugars based on **1** and **2** via traditional linear multistep syntheses that often require separate routes for each target. In an alternative approach the preparation and use of the appropriate azido-aldehydes in the SAWU-3CR with a selection of carboxylic acids and isocyanides would in a combinatorial fashion generate a wide variety of lipophilic iminosugars in a few steps. Davis and co-workers have already applied this approach and developed a large library of lipophilic pyrrolidines via the Ugi-3CR and evaluated them as inhibitors of GCS among others.[14] In that study the cyclic imine was generated by elimination of a precursor *N*-chloropyrrolidine. However, none of the Ugi-3CR products were active against GCS. This can be explained by the fact that all studies on GCS inhibitors up to now have shown that GCS inhibitors require a basic nitrogen function. Indeed Davis and co-workers were able to identify two GCS inhibitors from the library, **3** and **4**, upon reduction or cleavage of the amide function on the endocylic nitrogen (Figure 3). In general, inhibitors of glucosylceramide metabolism based on pyrrolidine iminosugars have not been extensively investigated yet. A recent study by

Baltas and co-workers identified another distinct pyrrolidine iminosugar inhibitor of GCS. They modelled their target compounds on the structure of ceramide and found that compound **5** was a potent inhibitor of GCS (Figure 3).[15]

Figure 3. Structures of piperidine and pyrrolidine GCS inhibitors; structures of glucosylceramide and ceramide.



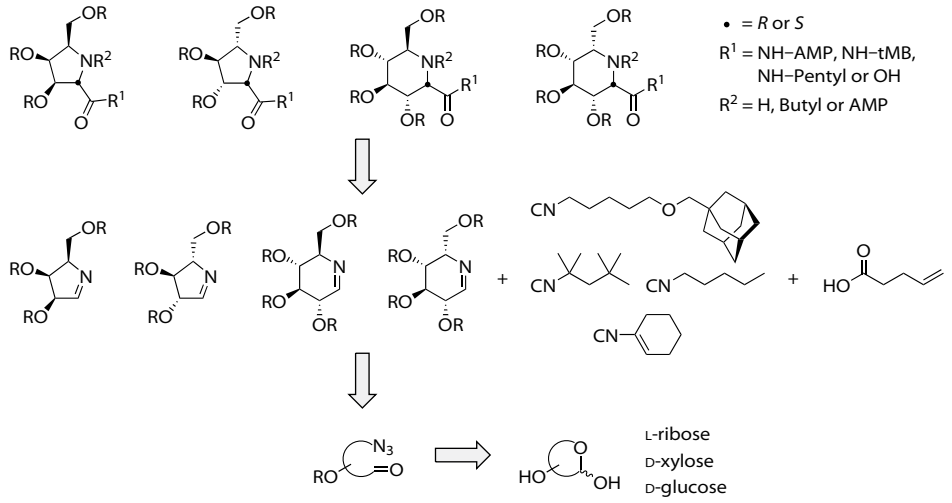
The research described in this chapter addresses the topics discussed above. It will discuss the use of the SAWU-3CR in a combinatorial approach towards the development of pyrrolidine and piperidine based lipophilic iminosugars. Simultaneously this will also further explore the scope of the SAWU-3CR and advance the structure–activity relationship knowledge on pyrrolidine-based inhibitors of GCS, GBA1 and GBA2.

The SAWU-3CR was applied on a previously studied[12,13] azido-aldehyde, synthesized from L-ribose, to create a library of lipophilic pyrrolidines with D-*lyxo* stereochemistry that among others generated derivatives of the above discussed compounds **3** and **4** of Davis and co-workers. A second azido-aldehyde, synthesized from D-xylose, was incorporated in the SAWU-3CR and generated a library of pyrrolidines with L-*arabino* stereochemistry – similar to the substitution pattern of **5**.

Finally, D-glucose was used as a starting material to prepare two azido-aldehydes that produced two libraries of lipophilic iminosugars. One based on lead compound **1** with D-*gluco* stereochemistry and another with L-*ido* stereochemistry based on **2**. For the isocyanides that were used in conjunction with the four azido-aldehyes, 5-(adamantane-1yl-methoxy)-pentyl- (AMP), 1,1,3,3-tetramethylbutyl- (tMB), pentyl- and cyclohexenyl-isocyanide were selected. The first isocyanide was selected for structural mimicry of **1** and **2**. The second and third were chosen as a way of introducing either a bulky or linear alternate hydrophobic moiety. The fourth isocyanide produces a cyclohexenamidoacyl function in the Ugi-3CR product that is known to be able to isomerize and hydrolyze when exposed to aqueous acidic conditions to generate a carboxylic acid.

The choice of suitable carboxylic acids for incorporation in the SAWU-3CR was restricted. Previous inhibition studies with amide derivatives of **1** and the earlier discussed results as obtained by Davis and co-workers have shown that amides of the iminosugar endocyclic nitrogen do not produce inhibitors of GCS, GBA1 or GBA1. Post-Ugi reduction of this amide results in low yields and difficultly separable mixtures of starting compound, the reduced amide and the free secondary amide.[16]

Figure 4. Retro-synthetic analysis of the four libraries of lipophilic iminosugars.



Therefore it was decided to incorporate pent-4-enoic acid in all the here presented SAWU-3C reactions. This produces the pent-4-enamide of the endocyclic nitrogen that can be cleaved to the secondary amine under mild conditions. The secondary nitrogen was then functionalized via reductive amination with butyraldehyde or 5-(adamantane-1yl-methoxy)-pentanal. All the prepared library entries were evaluated in an *in vitro* enzyme assay for inhibition of GBA1 and a selection of entries were also evaluated as inhibitors of GBA2 (*in vitro*) and GCS (*in vivo*).

Results and Discussion

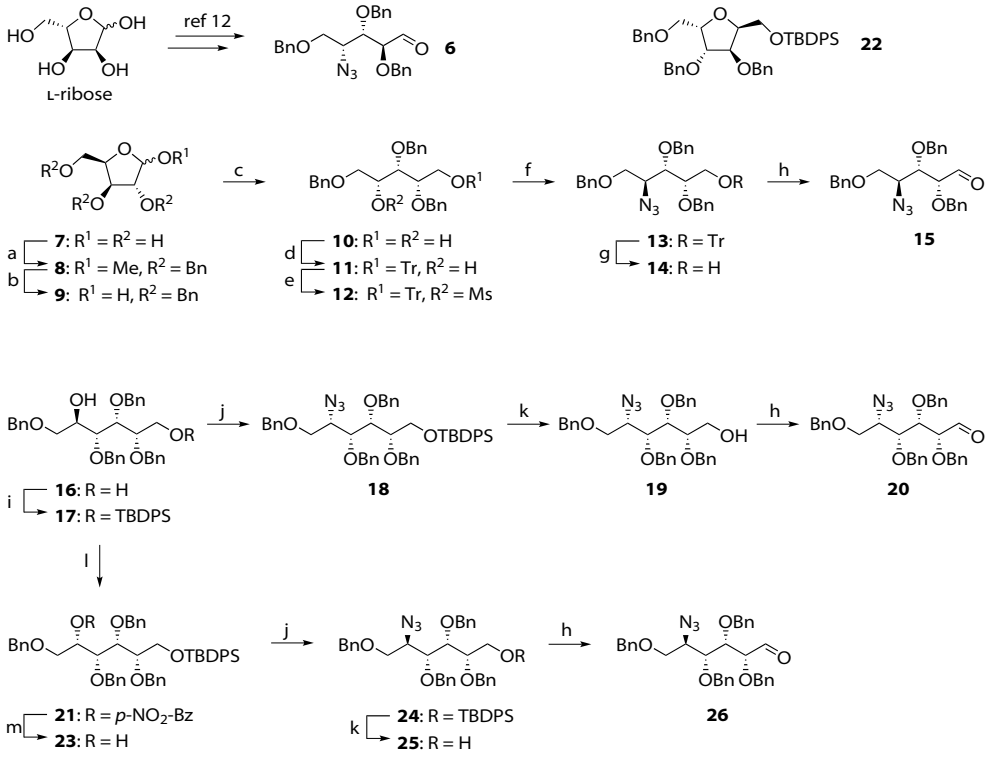
Synthesis of the Azido-aldehydes and Isocyanides.

Azido-aldehyde **6** was synthesized from L-ribose as previously reported.[12] Azido-alcohol **14** was synthesized starting from D-xylose in seven steps and 40% overall yield via the same route as reported for **6** (Scheme 1 on the next page). Dess-Martin periodinane mediated oxidation of **14** provided the azido-aldehyde **15**. The synthesis of azido-aldehydes **20** and **26** started from the common building block **17** that was prepared by silylation of the previously described glucitol derivate **16**. Azido-aldehyde **20** was prepared from **17** by introduction of an azide function at C-5 with inversion (**18**) via a Mitsunobu reaction with diphenylphosphoryl azide (DPPA) und subsequent desilylation to **19** and oxidation to **20**.

The synthesis of azido-aldehyde **26** with D-*gluco*-stereochemistry required a double inversion of the C-5 position. Inversion of the C-5 position with a Mitsunobu reaction with *p*-nitrobenzoic acid produced **21**, but was accompanied by the formation of byproduct **22** in 40–50%. Intramolecular cyclization of D-glucitol derivatives by nucleophilic attack of a C-2 benzylether upon activation of C-5 as a sulfon-ester has been

described in literature.[17] It has also been reported for a PPh_3-mediated C-5 iodination reaction.[18,19] Using different acids (AcOH, trichloroacetic acid and benzoic acid) in the Mitsunobu reaction and variation of other reaction conditions did not diminish the formation of byproduct **22**. Product **21** and **22** were difficult to separate and therefore the crude concentrated Mitsunobu reaction mixture was exposed to alkaline ester hydrolysis conditions that produced **23** in 38% yield over two steps, which could now be easily separated from **22**. Intermediate **23** could now be transformed into azido-aldehyde **26** by successive C-5 azide insertion (**24**), desilylation at C-1 (**25**) and oxidation.

Scheme 1. Synthesis of azido-aldehyes **6**, **15**, **20** and **26**.

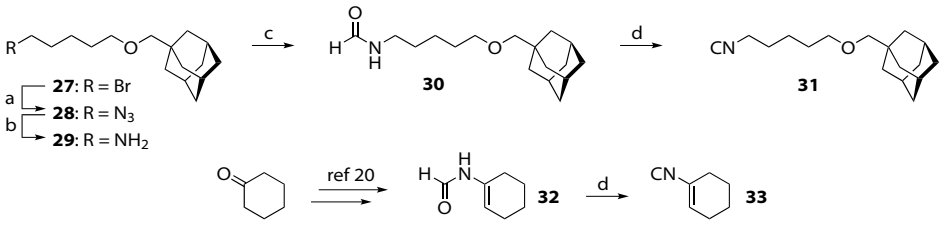


Reagents and conditions: [**a**] i: HCl, MeOH, rt, 20h; ii: BnBr, NaH, TBAI, DMF, 0 °C » rt, 48h, 93% 2 steps. [**b**] aq HCl, dioxane, reflux, 5h, 70%. [**c**] $NaBH_4$, MeOH, 0 °C, 3h, 87%. [**d**] TrCl, pyridine, 40 °C, 20h, 94%. [**e**] MsCl, Et_3N, DCM, 85%. [**f**] NaN_3, 15-crown-5, DMF, 90 °C, 48h, 88%. [**g**] $BF_3{\cdot}OEt_2$, MeOH, toluene, 3h, 98%. [**h**] Dess-Martin periodinane, DCM, 0 °C » rt, 1.5h, **15**: 76%, **20**: 89%, **26**: 96%. [**i**] TBDPSCl, imidazole, DMF, 20h, 99%. [**j**] DPPA, DIAD, PPh_3, THF, 0 °C » rt, 20h, **18**: 66%, **24**: 63%. [**k**] TBAF, THF, 20h, **19**: 71%, **25**: 74%. [**l**] *p*-NO_2-benzoic acid, DIAD, PPh_3, 0 °C » rt, 20h, used crude. [m] LiOH, H_2O/THF/EtOH, 2h, 38%, **22**: 46% from previous reaction.

Of the four isocyanides that were needed for the preparation of the libraries, 1,1,3,3-tetramethylbutylisocyanide and pentylisocyanide are commercially available. The synthesis of isocyanide **31** started with substitution of the bromide in the previously reported **27** with sodium azide to provide **28** (Scheme 2). Staudinger reduction of the azide to amine

29 and subsequent treatment with acetic formic anhydride produced formamide **30**. Phosphorylchloride mediated dehydration of **30** produced isocyanide **31** that showed two indicative triplets in ^{13}C-NMR due to ^{14}N–^{13}C coupling. Known isocyanide **33** could be prepared by dehydration of formamide **32**, which in turn was prepared via a known procedure from cyclohexanone.[20,21]

Scheme 2. Synthesis of isocyanides **31** and **33**.



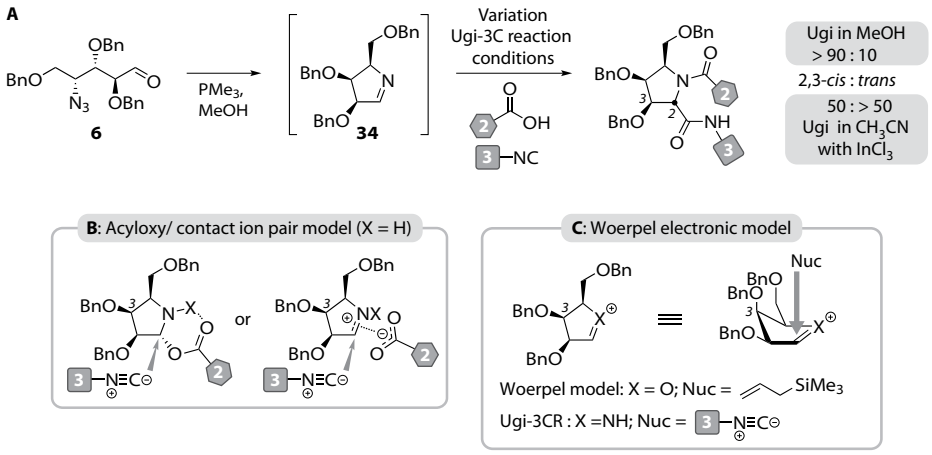
Reagents and conditions: [**a**] NaN_3, DMSO, rt, 20h, 95%. [**b**] PMe_3, H_2O, THF, 0 °C, 3h, 84%. [**c**] acetic formic anhydride, DCM, 0 °C » rt, 20h, 82%. [**d**] $POCl_3$, Et_3N, DCM, 30 °C, 1h, **31**: 81%, **33**: 65%.

Evaluation of Azido-aldehydes **6, 15, 20** and **26** in the SAWU-3C Reaction.

With the azido-aldehydes **6**, **15**, **20**, **26** and isocyanides **31**, **33** in hand attention was focused on the SAWU-3CR. Application of the SAWU-3CR on azido-aldehyde **6** has already been investigated extensively.[12,13] An initial study revealed that it almost exclusively (> 90%) produces pyrrolidines with a counter-intuitive 2,3-*cis* relationship during the final Ugi-3CR step with the intermediate cyclic imine,[14,22-25] regardless of the used carboxylic acid or isocyanide component (see Figure 5A on the next page).[12] There are numerous examples in the literature about the effect of Lewis acids on the reaction rate, yields and diastereoselectivity of the Ugi-reaction.[26-32] Consequently, a second study reported the effect of Lewis acids in the Ugi-3CR with cyclic imine **34**. This study established that carrying out the Ugi-3CR part of the SAWU-3CR process with **34** in acetonitrile in the presence of a stoichiometric amount of indium(III)chloride was able to promote the formation of the 2,3-*trans* product.[13] The hereby obtained ratios were dependant on the used carboxylic acid and isocyanide and varied from 1:1–1:9 (2,3-*cis*:*trans*) in yields ranging from 20–72% (Figure 5A).

A possible explanation for the diastereoselective formation of 2,3-*cis* pyrrolidines in the Ugi-3C reaction with **34** in the absence of Lewis acids may be found in the involvement of the previously mentioned acyloxy intermediate in the course of the reaction (Figure 5B). This intermediate was already postulated by Ugi in 1967 and its involvement in the Ugi reaction has subsequently been proposed by others.[5,9,23,33] Attack of the carboxylate from the less hindered side and subsequent inversion after S_N2 attack of the isocyanide on this acyloxy intermediate would lead to the 2,3-*cis* pyrrolidine. The carboxylate may also form a non-covalent contact ion pair with the protonated cylic imine and thereby shield the less hindered face of the imine from isocyanide attack.

Figure 5. The effect of Lewis acids on the stereochemistry in the Ugi-3CR with cyclic imine **34** (**A**). Two possible models (**B**/**C**) for the observed 2,3-*cis* diastereoselectivity of the Ugi-3CR in the absence of Lewis acids.



Another plausible explanation for the 2,3-*cis* pyrrolidine formation in the absence of Lewis acids involves the influence of electronic effects on the conformation of the activated cyclic imine. Woerpel and co-workers proposed a model for nucleophilic additions to five-membered ring oxocarbenium ion electrophiles (Figure 5C; X = O) that may also be applied to protonated cyclic imines (X = NH).[34,35] In this model, a pseudoaxial position of the benzyloxy substituent at C-3 of the protonated cyclic imine ion produces the lowest energy conformer that is preferentially attacked by the isocyanide from the concave side of the envelope conformation – giving the 2,3-*cis* pyrrolidine.

At present there is no conclusive evidence to discount or confirm either of the above discussed models. However, if the acyloxy intermediate is incorporated in the electronic Woerpel model, in the absence of Lewis acids, it would predict 1,3-*cis* attack of the carboxylate resulting in 2,3-*trans* pyrrolidines – making the two models mutually exclusive. An explanation for the role of the Lewis acid in promoting 2,3-*trans* pyrrolidine formation is challenging because of the multitude of instances where Lewis acids could have an effect in the complex interplay of equilibria between intermediates in the Ugi-3CR (Figure 1). A Lewis acid can coordinate to the endocylic nitrogen of the imine and activate it (X = LA in Figure 5B and X = N–LA in 5C).[36] In the acyloxy model the Lewis acid activated imine might favor direct attack of the isocyanide from the less hindered side. In the electronic model coordination and activation of cyclic imine by a Lewis acid via the nitrogen might disturb the electronic effects of the C-3 position. Additionally, coordination of the Lewis acid with the benzyloxy ether substituents might disfavour an axial orientation of C-3 or shield the *cis*-face of activated imine.

The three novel azido-aldehydes (**15**, **20** and **26**) were also subjected to the SAWU-3CR process. Treatment of **15**, **20** and **26** with trimethylphosphine and subsequent concentration of the reaction mixture produced the intermediate cyclic imines. The

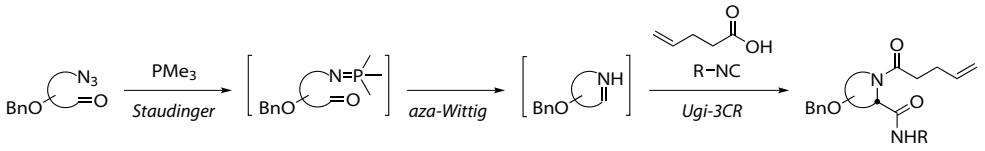
cyclic imines derived from **15** and **26** proved more stable than the cyclic imine from **20**, which already showed minor degradation during concentration. The cyclic imines were exposed to pent-4-enoic acid and pentylisocyanide at 0 °C in either methanol or in the presence of $InCl_3$ in acetonitrile. The cyclic imine from **15** produced a ~1:2 mixture of diastereoisomers in methanol, and the ratio changed to ~1:1 in the $InCl_3$ mediated Ugi-3CR. This result conforms to the Woerpel electronic model (Figure 5C), because epimerization of the C-3 benzyloxy in this cyclic imine disfavors its axial orientation and subsequent preferential isocyanide attack from one side. Azido-aldehyde **26** produced a single product in the SAWU-3CR. Addition of a Lewis acid only resulted in multiple minor byproducts and an overall lowered yield. None of the byproducts could be identified as the other diastereoisomer. Azido-aldehyde **20** produced a ~1:1.6 mixture of diastereoisomers in methanol. Addition of a Lewis acid resulted in a similar ratio and lowered yields. The stereochemistry of the introduced chiral centers at C-2 of these products could not be elucidated at this stage due to rotamers of the pent-4-enamide during NMR-analysis.

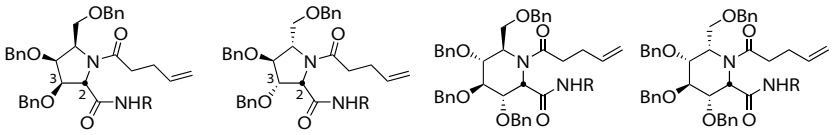
First Step in Library Synthesis: The SAWU-3C Reactions.

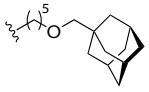
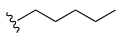
Synthesis of the four libraries started with sixteen SAWU-3C reactions of azido-aldehydes **6**, **15**, **20** and **26** with the four isocyanides and pent-4-enoic acid. The Ugi-3CR part of the four SAWU-3C reactions with **6** was also carried out in the presence of $InCl_3$ in acetonitrile to generate the 2,3-*trans* D-*lyxo*-pyrrolidines. Due to the lack of influence on stereochemistry by the Lewis acid in the SAWU-3CR with **15**, **20** and **26** the synthesis of the three libraries from them was solely carried out in the absence of $InCl_3$. The results of the SAWU-3C reactions are summarized in Table 1 on the next page.

Notably, from this point on in the chapter each library intermediate and final entry is identified by a three part code (*e.g.* **F1-V**): the type of iminosugar core and stereochemistry at C-2 is denoted by the letters **A**–**G**; the subsequent number relates to the state of the endocyclic nitrogen (pent-4-enamide, free or *N*-alkylated) and iminosugar hydroxyls (protected or deprotected); the final roman numeral (**I**–**VI**) specifies the moiety appended at C-1 (the coding system is explained with structures in Figure 7 on page 223).

Table 1. Yields and 2,3-*cis* : 2,3-*trans* ratios for products of SAWU-3CR with azido-aldehydes **6**, **15**, **20** and **26**.





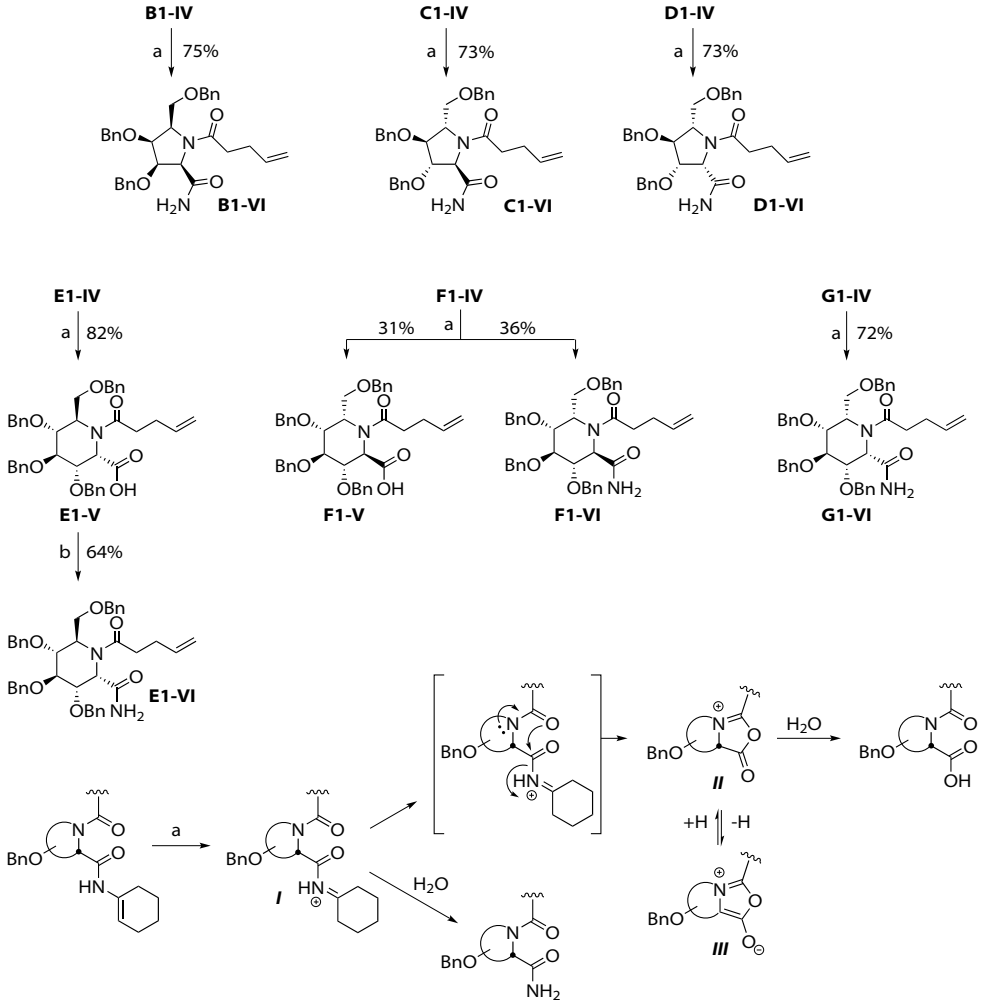
	D-*lyxo*-pyrrolidines			L-*arabino*-pyrrolidines			D-*gluco*-piperidines	L-*ido*-piperidines		
	2,3-*trans* **A1**	:	2,3-*cis* **B1**	2,3- *trans* **C1**	:	2,3-*cis* **D1**	2,3-*cis* **E1**	2,3-*trans* **F1**	:	2,3-*cis* **G1**
R = **I** 	47% (+$InCl_3$) 1.7 : 1			41% 1 : 1.9			73%	55% 1 : 1.25		
	62% 1 : 20									
R = **II** 	63% (+$InCl_3$) 5.3 : 1			54% 1 : 1.1			81%	61% 1 : 0.94		
	72% 1 : 15									
R = **III** 	34% (+$InCl_3$) 5.4 : 1			43% 1 : 2.1			77%	57% 1 : 1.6		
	94% 1 : 21									
R = **IV** 	23% (+$InCl_3$) 1 : 4.2			45% 1 : 2.4			80%	41% 1 : 1.5		
	54% 1 : 11									

Second Step: Isomerization & Hydrolysis of Cyclohexenylamide Library Intermediates.

The next step in the library synthesis involved the isomerization and hydrolysis of the cyclohexenyl containing SAWU-3CR products. The reaction of **6** with cyclohexenylisocyanide in the presence of $InCl_3$ produced very low yields and only minor amounts of the 2,3-*trans* pyrrolidine **A1-IV**. Therefore **A1-IV** was not incorporated in this step of the library synthesis. First the pyrrolidine SAWU-3CR products were exposed to aqueous hydrochloric acid in THF (Scheme 3). Instead of resulting in the C-1 carboxylic acid all three reactions produced the primary amide (**B1-VI**, **C1-VI** and **D1-VI**) in good yields. The first step in the reaction is the protonation and isomerization of the double bond to produce an acyliminium ion ***I*** (bottom of Scheme 3).[21] To obtain the carboxylic acid, intermediate ***I*** needs to cyclize into intermediate ***II*** with expulsion of cyclohexanimine. For the pyrrolidines this would result in two fused strained five-

membered rings. Therefore intermediate ***I*** is instead hydrolyzed by water to produce the primary amide.

Scheme 3. The isomerization and hydrolysis of cyclohexene containing SAWU-3CR products.



Reagents and conditions: [**a**] aq HCl, THF, 20h. [**b**] i: ClC(O)OEt, Et_3N, THF, 0 °C; ii: addition 25% aq NH_3, 0 °C, 1h.

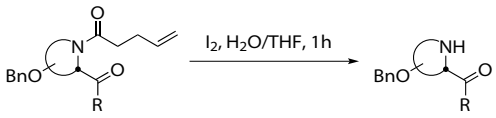
Treatment of D-*gluco* **E1-IV** did result in carboxylic acid **E1-V**. Armstrong and co-workers have proposed that the mechanism for cyclohexenyl cleavage to the carboxylic acid also involves Münchnone intermediate ***III*** that is formed upon proton abstraction of cyclized intermediate ***II***.[21] A Münchnone is a 1,3-dipole and Armstrong and co-workers indeed observed cycloaddition products upon exposing the reaction mixtures to 1,3-dipolarophiles.[21] This could also lead to racemization of the new chiral center created during the Ugi-reaction. However, product **E1-V** was not racemized and the C-2

chiral center was also not epimerized. Carboxylic acid **E1-V** was also transformed into its primary amide **E1-VI** (Scheme 3). Treatment of the two L-*ido* SAWU-3CR products resulted in the formation of a mixture of the carboxylic acid **F1-V** and primary amide **F1-VI** from **F1-IV** and the sole formation of primary amide **G1-VI** from **G1-IV**.

Third Step: Removal of the Pent-4-enamide and Assignment of C-2 Stereochemistry.

The penultimate step in the library synthesis consisted of the removal of the pent-4-enamides in the SAWU-3CR products and the products from the cyclohexenyl cleavage. This was carried out by exposing them to molecular iodine in THF in the presence of water.[37] All reactions successfully produced the free secondary amines of which the yields are summarized in Table 2. Several depent-4-enoylation reactions produced the secondary amine in a low to moderate yield. Upon investigation of the major byproduct observed in these reactions it turned out to be the hydrolyzed product of the iodonium ion intermediate (*e.g.* for **E1-V** to **E2-V**: 37% yield of the byproduct; found HRMS: 794.2189 = $C_{40}H_{44}INO_8$).

Table 2. Yields (%) for deprotection of pent-4-enamides.



	Product	A2	B2	C2	D2	E2	F2	G2
	I = NH–AMP	75	97	55	62	99	50	65
	II = NH–tMB	69	92	95	75	90	40	55
R =	**III** = NH–Pentyl	80	77	95	83	95	59	77
	V = OH	-	-	-	-	35	63	-
	VI = NH_2	-	52	26	55	79	66	72

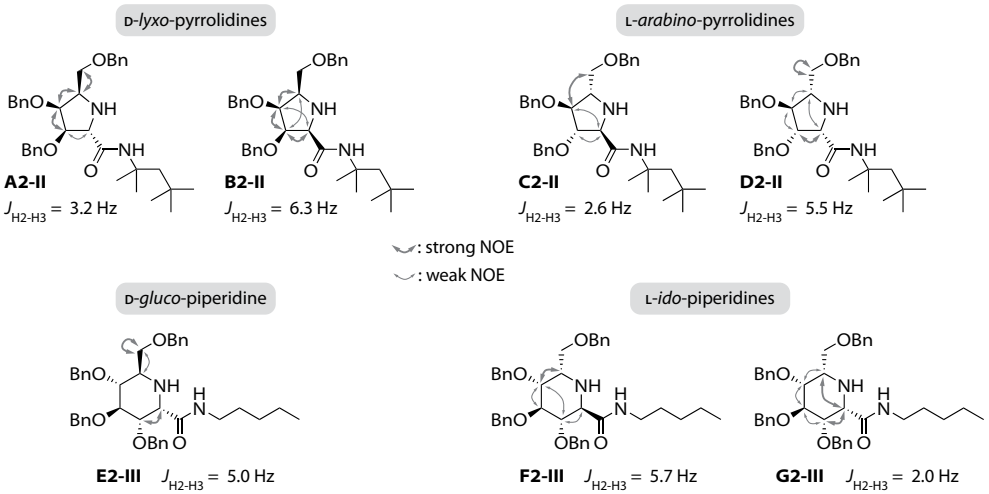
AMP = 5-(adamantan-1yl-methoxy)-pentyl; tMB = 1,1,3,3-tetramethylbutyl.

Elucidation of the stereochemistry of the newly formed chiral center at C-2 by NMR-analysis was now possible due to the removal of the pent-4-enamide and its associated rotamers. Determination of the coupling constants for the pyrrolidine and piperidine ring protons in combination with NOESY spectra resulted in the C-2 stereochemistry assignments as summarized in Figure 6.

Final Step: Alkylation of Endocyclic Nitrogen and Deprotection.

The final step in the library synthesis consisted of either straight deprotection of the benzyl ethers of the compounds listed in Table 2 or prior *N*-alkylation of the free secondary amine. The deprotection reactions were carried out via two methods. All penultimate library entries that did not contain an adamantane-1yl-methoxy ether function were

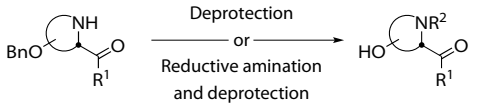
Figure 6. Overview of the assignment of C-2 stereochemistry based on ^{1}H- and NOESY-NMR analysis.



treated with boron trichloride in dichloromethane at 0 °C to deprotect the benzyl ethers. The adamantane-1yl-methoxy ether is labile under these conditions so all library entries containing this moiety were exposed to a palladium catalyzed hydrogenation at atmospheric or 4 bar hydrogen pressure to effect benzyl ether deprotection. The results for these straight deprotections are listed in Table 3 (on the next page) under the **A3** to **G3** entries.

As mentioned, the secondary amines of the library intermediates listed in Table 2 were also subjected to a reductive amination with either butyraldehyde or 5-(adamantane-1yl-methoxy)-pentanal. The *N*-alkylated intermediates were isolated via extraction and employed crude in the deprotection reaction via one of the two methods described above. The reductive amination worked for all entries except the 2,3-*cis*-L-*ido*-piperidines (**G2-I** to **G2-VI**). These did not produce any or only trace amounts of *N*-alkylated intermediates. For these library entries the reductive amination was repeated, but now with the deproteced free secondary amines of **G3-I**, **G3-II** and **G3-III**. This time the reductive amination with butyraldehyde proceeded in all instances. The reductive amination with 5-(adamantane-1yl-methoxy)-pentanal only resulted in *N*-alkylated products in combination with **G3-II** and **G3-III**. The yields for all the deprotection reactions, reductive aminations and final compositions of the libraries are summarized in Table 3.

Table 3. Yields (%) for reductive amination and/or deprotection of lipophilic iminosugars.



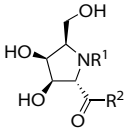
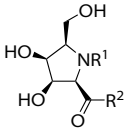
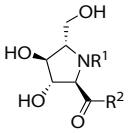
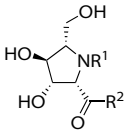
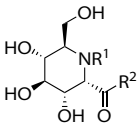
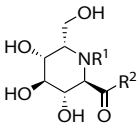
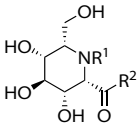
Product		R^1 = **I** = NH–AMP	**II** = NH–tMB	**III** = NH–Pentyl	**V** = OH	**VI** = NH_2
2,3-*trans*-D-*lyxo*-pyrrolidines	**A3** R^2 = H	82	93	89	-	-
	A4 R^2 = Butyl	67	85	44	-	-
	A5 R^2 = AMP	72	72	73	-	-
2,3-*cis*-D-*lyxo*-pyrrolidines	**B3** R^2 = H	37	53	66	-	-
	B4 R^2 = Butyl	48	87	86	-	78
	B5 R^2 = AMP	59	74	69	-	57
2,3-*trans*-L-*arabino*-pyrrolidines	**C3** R^2 = H	85	58	51	-	-
	C4 R^2 = Butyl	75	53	31	-	-
	C5 R^2 = AMP	65	42	22	-	92
2,3-*cis*-D-*arabino*-pyrrolidines	**D3** R^2 = H	55	78	78	-	-
	D4 R^2 = Butyl	74	55	49	-	92
	D5 R^2 = AMP	79	86	52	-	97
2,3-*cis*-D-*gluco*-piperidines	**E3** R^2 = H	36	67	77	-	-
	E4 R^1 = Butyl	92	82	71	69	30
	E5 R^2 = AMP	60	54	71	-	39
2,3-*trans*-L-*ido*-piperidines	**F3** R^2 = H	41	88	92	-	-
	F4 R^2 = Butyl	83	59	64	95	88
	F5 R^2 = AMP	79	69	51	80	-
2,3-*cis*-L-*ido*-piperidines	**G3** R^2 = H	71	81	79	-	-
	G4 R^2 = Butyl	41	49	33	-	-
	G5 R^2 = AMP	-	21	24	-	-

Deprotections: Method A = BCl_3, DCM, 0 °C, 20h or Method B = Pd/C, H_2 (atm/4 bar), HCl, EtOH, 20h; *Reductive aminations*: Method A = Butyraldehyde or 5-(adamantan-1yl-methoxy)-pentanal, $NaCNBH_3$, Na_2SO_4, AcOH/EtOH (1/20) or Method B: **G3-I/II/III**, aldehyde, $NaCNBH_3$, AcOH/MeOH (1/100); AMP = 5-(adamantan-1yl-methoxy)-pentyl; tMB = 1,1,3,3-tetramethylbutyl.

Biological evaluation

All the 73 entries in the four libraries were evaluated in an *in vitro* enzyme assay for inhibition of glucocerebrosidase (GBA1). GBA1 degrades glucosylceramide in the lysosomes and constitutes the primary catabolic pathway. Inhibitors of GBA1 are currently being scrutinized in many studies as potential pharmacoligical chaperones for improving the lysosomal activity of GBA1 in Gaucher disease. In Gaucher disease the gene encoding GBA1 is mutated and produces a deficient enzyme (see sections 1.3.4 and 1.3.3 in Chapter 1). The results of the inhibition assay of GBA1 are summarized in Table 4.

Table 4. Enzyme inhibition assay results for GBA1 and GBA2 (right *italic* value): apparent IC_{50} values in μM.

Compound[a]		**I**: R^2 = NH–AMP	**II**: R^2 = NH–tMB	**III**: R^2 = NH–Pentyl	**V**: R^2 = OH	**VI**: R^2 = NH_2
	**A3**: R^1 = H	3.75; *55*	400	350; > *1000*	-	-
	A4: R^1 = Bu	20	150	650; > *1000*	-	-
	A5: R^1 = AMP	15	50	50	-	-
	**B3**: R^1 = H	80; *30*	> 1000	> 1000	-	-
	B4: R^1 = Bu	200	> 1000	> 1000	-	> 1000
	B5: R^1 = AMP	100	800	140	-	140; *90*
	**C3**: R^1 = H	45; *30*	> 1000	> 1000	-	-
	C4: R^1 = Bu	50	100	1000	-	-
	C5: R^1 = AMP	25	100	40	-	140; *100*
	**D3**: R^1 = H	3.5; *125*	100	450	-	-
	D4: R^1 = Bu	40	500	> 1000	-	> 1000
	D5: R^1 = AMP	20	300	500	-	350; *1000*
	**E3**: R^1 = H	7; *2.25*	400	> 1000	-	-
	E4: R^1 = Bu	45	1000	> 1000	> 1000	-
	E5: R^1 = AMP	30	40	100	5; *0.1*	200; *7*
	**F3**: R^1 = H	30; *40*	> 1000	> 1000	-	-
	F4: R^1 = Bu	40	> 1000	> 1000	> 1000	> 1000
	F5: R^1 = AMP	50	250	70	-	80; *4*
	**G3**: R^1 = H	150; *85*	> 1000	> 1000	-	-
	G4: R^1 = Bu	20	> 1000	> 1000	-	-
	G5: R^1 = AMP	-	250	130	-	-

[a]Bu = butyl; tMB = 1,1-3,3-tetramethylbutyl; AMP = 5-(adamantan-1-yl-methoxy)-pentyl.

A general trend observed in the assay results for GBA1 inhibition is that iminosugars functionalized with a single 5-(adamantan-1-yl-methoxy)-pentyl (AMP) moiety on either the endocyclic nitrogen or the C-1 amide produce the most potent GBA1 inhibitors. The iminosugars with a pentyl or 1,1,3,3-tetramethylbutyl (tMB) moiety on the C-1 amide only yield sub 100 μM inhibitors when the endocylic nitrogen is functionalized with a AMP as a second hydrophobic moiety. Pyrrolidines **A3-I** and **D3-I** represent the most potent GBA1 inhibitors with an IC_{50} of 3.75 and 3.5 μM. D-*Gluco* library entries **E3-I** and **E5-V** are the other two potent entries with an IC_{50} for GBA1 of 7 and 5 μM. From

all four libraries, lipophilic iminosugars **E5-V** and **E5-VI** most closely resemble lead compound **1**. Interestingly, they show a 40-fold difference in their IC_{50} for GBA1 and the main difference between them is that the carboxylic acid in **E5-V** probably forms an intramolecular salt with the tertiary nitrogen atom.

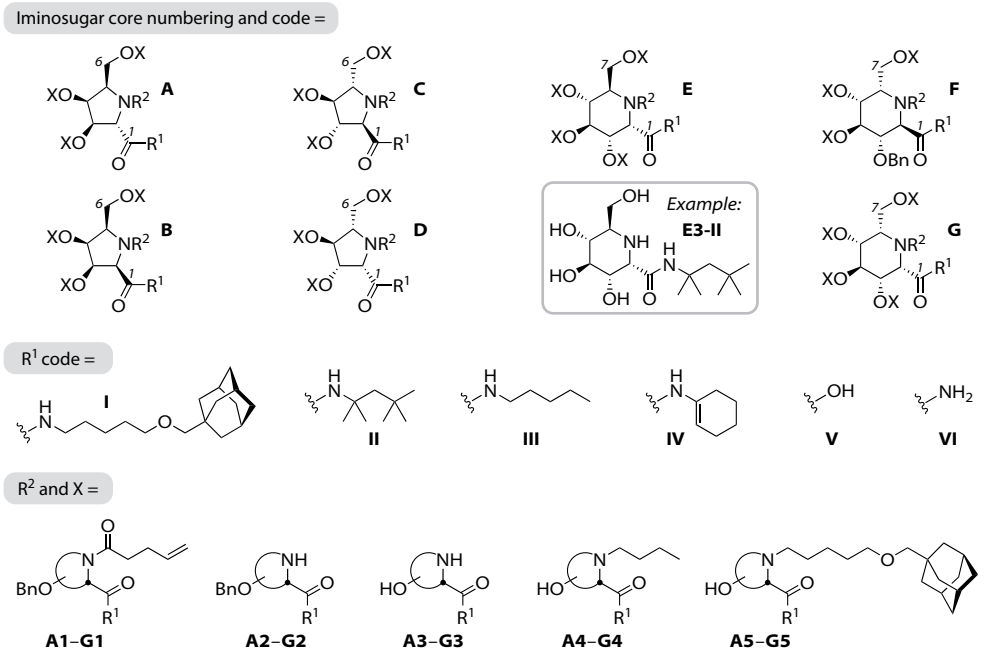
A selection of 15 entries from the four libraries was also evaluated for inhibition of GBA2 (*in vitro*) and GCS (*in vivo*). The selection consisted of all library entries containing a single AMP moiety. Additionally, **A3-III** and **A4-III** were evaluated because they constitute C-5 hydroxymethyl analogues of known GCS inhibitors **3** and **4** (see Figure 3). In the GBA2 assay the selected pyrroldine entries proved poor GBA2 inhibitors. From the selection of piperidines, **E3-I**, **E5-V**, **E5-VI** and **F5-V** inhibited GBA2 with **E5-V** being the most potent with an IC_{50} of 0.1 μM (right *italic* values in Table 4). With the exeption of **E5-V** none of the selected entries significantly inhibited GCS at 20 μM. Entry **E5-V** inhibited GCS activity with an IC_{50} of 20 μM.

Conclusion

This chapter describes the use of the tandem SAWU-3CR to synthesize four libraries of lipophilic iminosugars. Azido-aldehydes **6**, **15**, **20**, **26** were prepared from carbohydrates and subjected to a Staudinger reaction. The resulting cyclic imines were exposed to pent-4-enoic acid and a panel of four isocyanides (**31**, **33**, pentyl- and 1,1,3,3-tetramethylbutyl-isocyanide) that reacted together in an Ugi-3CR to produce 16 library precursors. The use of pent-4-enoic acid together with cyclohexenylisocyanide (**33**) in the Ugi-3CR introduced two post SAWU-3CR cleavable groups. This allowed for the production of lipophilic iminosugars with two or a single hydrophobic tail. Straight deprotection of penultimates or prior *N*-alkylation created two libraries of lipophilic D-*lyxo* and L-*arabino* pyrrolidines; and two libraries of lipophilic D-*gluco* and L-*ido* piperdines with a total of 73 entries. All compounds were evaluated for inhibition of GBA1, which identified pyrrolidines **A3-I**, **D3-I** and piperdines **E3-I**, **E5-V** as low μM inhibitors of GBA1. A selection of entries was also evaluated for inhibition of GBA2 and GCS. Entry **E5-V** proved to be the most potent GBA2 and GCS inhibitor in this selection.

Experimental section

Figure 7. Compound coding system for library intermediates and final entries used throughout this chapter.



General methods: All solvents and reagents were obtained commercially and used as received unless stated otherwise. Reactions were executed at ambient temperatures unless stated otherwise. All moisture sensitive reactions were performed under an argon atmosphere. Residual water was removed from starting compounds by repeated coevaporation with dioxane, toluene or dichloroethane. All solvents were removed by evaporation under reduced pressure. Reaction grade acetonitrile, *n*-propanol and methanol were stored on 3Å molecular sieves. Other reaction grade solvents were stored on 4Å molecular sieves. Methanol used in the SAWU-3C-reaction was distilled from magnesium (5 g/L)/molecular iodine (0.5 g/L) and stored on activated 3Å molecular sieves under argon. Ethanol was purged of acetaldehyde contamination by distillation from zinc/KOH. DCM was distilled prior to use from P_2O_5. R_F values were determined from TLC analysis using DC-fertigfolien (Schleicher & Schuell, F1500, LS254) with detection by spraying with a solution of $(NH_4)_6Mo_7O_{24}\times4H_2O$ (25 g/L) and $(NH_4)_4Ce(SO_4)_4\times2H_2O$ (10 g/L) in 10% sulfuric acid or a solution of phosphomolybdic acid hydrate (7.5 wt% in ethanol) followed by charring at ~150 °C. Visualization of all deprotected iminosugar compounds during TLC analysis was accomplished by exposure to iodine vapour. Column chromatography was performed on silica gel (40–63 µm). ^{1}H and ^{13}C-APT NMR spectra were recorded on a Bruker DMX 600 (600/150 MHz), Bruker DMX 500 (500/125 MHz), or Bruker AV 400 (400/100 MHz) spectrometer in $CDCl_3$ or MeOD. Chemical shifts are given in ppm (δ) relative to tetramethylsilane as internal standard (^{1}H NMR in $CDCl_3$) or the signal of the deuterated solvent. Coupling constants (*J*) are given in Hz. Where indicated, NMR peak assignments were made using COSY and HSQC experiments. All presented ^{13}C-APT spectra are proton decoupled. High resolution mass spectra were recorded by direct injection (2 µL of a 2 µM solution in water/acetonitrile; 50/50; v/v and 0.1% formic acid) 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 250 °C) with resolution R = 60000 at m/z 400 (mass range m/z = 150–2000) and dioctylpthalate (m/z = 391.28428) as a "lock mass". The high resolution

mass spectrometer was calibrated prior to measurements with a calibration mixture (Thermo Finnigan). Optical rotations were measured on a Propol automatic polarimeter (Sodium D-line, λ = 589 nm). ATR-IR spectra were recorded on a Shimadzu FTIR-8300 fitted with a single bounce Durasample IR diamond crystal ATR-element and are reported in cm^{-1}.

Enzyme Assays: The enzyme assays used for determining the inhibition of activity of glucosylceramide synthase (GCS), glucocerebrosidase (GBA1) are described in the experimental section of Chapter 3. All compounds were strored (−20 °C) and tested as their hydrochloric acid salt .

*General Procedure A – Dess-Martin periodinane mediated oxidation of azido-alcohols **15**, **20** and **26***: Dess-Martin periodinane (1.5 eq; synthesis described in Chapter 6) was added to a dry and cooled (0 °C) solution of the azido- alcohol (1 eq) in DCM (0.2M). The reaction mixture was stirred for 30 min at 0 °C and a further hour at rt. The reaction mixture was quenched by the addition of sat aq $NaHCO_3$ (5 mL/mmol) and 1M aq $Na_2S_2O_3$ (5 mL/mmol). The resulting two-phase mixture was rapidly stirred/mixed for 15 min. The mixture was diluted with additional DCM and washed successively with sat $NaHCO_3$ and brine. The organic phase was dried (Na_2SO_4) and concentrated. The residue was purified by silica gel column chromatography (5% » 25% EtOAc in PE) to provide the aldehyde that should preferably be used immediately but can be stored for 20 h at −20 °C under argon.

*General procedure B – The tandem Staudinger/ aza-Wittig/ Ugi three-component reaction of azido-aldehydes **6**, **15**, **20** and **26***: The synthesis of azido-aldehyde **6** is described in reference 12. Trimethylphosphine (2 eq, 1M in toluene) was added to a dry and cooled (0 °C) solution of the appropriate azido-aldehyde (1 eq) in anhydrous MeOH (0.2M). The reaction mixture was stirred for 3 hours at 0 °C until TLC analysis indicated complete consumption of the azido-aldehyde and the appearance of the intermediate phosphazene (R_F = 0 in 1:2; EtOAc:toluene). The reaction mixture was concentrated and coevaporated with toluene (3×), concomitant TLC analysis showed complete disappearance of the baseline phosphazene intermediate and emergence of the cyclic imine (R_F of imine from **6** = 0.34 (1:4; EtOAc:toluene); imine from **15** = 0.38 (1:1; EtOAc:PE), imine from **20** = 0.15 (1:4; EtOAc:toluene), imine from **26** = 0.33 (1:3; EtOAc:toluene)). The crude cyclic imine was dissolved in anhydrous MeOH (0.3M) or CH_3CN (0.3M for reactions with $InCl_3$), divided in the appropriate amount of portions and cooled to 0 °C. Where appropriate, $InCl_3$ (1.1 eq) was added to the CH_3CN solutions of cyclic imine. Next, the appropriate carboxylic acid (1.1 eq) and isocyanide (1.3 eq) were successively added and the reaction mixture was stirred for 20 hours at 0–5 °C. Saturated aq $NaHCO_3$ was added to the mixture and it was allowed to warm to room temperature whilst stirring. Ethyl acetate was added to the mixture and the organic phase was washed with aq. sat. $NaHCO_3$. The organic phase was dried (Na_2SO_4), concentrated and the product was isolated by silica gel column chromatography (5% » 50% EtOAc in toluene) to afford the SAWU-3CR product as a light yellow oil.

General procedure C – Acid mediated isomerization and hydrolysis of 1-cyclohexene-amides: The 1-cyclohexene-amide containing iminosugar was dissolved in THF (0.05M) containing 1.6% aq HCl (from 36% aq HCl). The reaction mixture was stirred 20 h during which it turned brown. Sodium carbonate was added to quench the reation mixture and subsequently removed by filtration. The filtrate was concentrated and the resulting residue was purified by silica gel column chromatography (0% » 100% EtOAc in toluene; 5% AcOH was added to the eluent if the hydrolysis produced a carboxylic acid) to provide the product as a colorless oil.

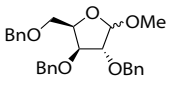
General procedure D – Iodine mediated deprotection of pent-4-enamides: Molecular iodine (3 eq) was added to a solution of the pent-4-enamide (1 eq) in THF/H_2O (0.05M; 3/1, v/v). The reaction mixture was stirred for 30–60 min until TLC analysis indicated complete conversion into a lower running product. Aqueous 1M $Na_2S_2O_3$ was added and the mixture was vigorously stirred for 30 min. The suspension was poured into a mixture of 1M aq

$Na_2S_2O_3$/sat aq NaCl (1/1, v/v) and extracted with EtOAc (3×). The combined organic layers were dried (Na_2SO_4) and concentrated. The residue was purified by silica gel column chromatography (1: 25% EtOAc in toluene until (*R*/*S*)-γ-iodomethyl-gamma-butyrolactone has eluted; 2: 25% » 100% EtOAc in toluene; 3: optional isocratic 10% MeOH in EtOA + 2% NH_4OH for low running products) to yield the deprotected secondary amine as a colorless oil. R_F (*R*/*S*)-γ-Iodomethyl-gamma-butyrolactone = 0.70 (2:1; EtOAc:toluene).

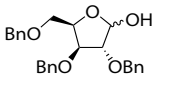
General method E – N-alkylation of benzyl protected iminosugars by reductive amination: Sodium sulphate (10 eq) was added to a dry solution of the iminosugar (1 eq) and either butyraldehyde (5 eq) or 5-(adamantane-1-yl-methoxy)-1-pentanal **(**3 eq; synthesis described in Chapter 2**)** in a mixture of 'acetaldehyde free' EtOH and AcOH (0.05M, 20/1, v/v). Subsequently, $NaBH_3CN$ (4 eq) was added to the mixture. The reaction mixture was stirred for 20 h and subsequently Et_20 (2-fold reaction volume) and sat aq $NaHCO_3$ (2-fold reaction volume) were added and vigorously mixed with the reaction mixture. The organic phase was isolated and the aqueous phase was extracted with Et_2O (2×). The combined organic layers were dried (Na_2SO_4) and concentrated. The crude *N*-alkylated compound was used in the ensuing benzyl-ether deprotection reaction.

General procedure F – Deprotection of benzyl-ethers: All 5-(adamantane-1-yl-methoxy)-1-pentyl moiety containing iminosugars were deprotected by Pd/C catalyzed hydrogenation. *Hydrogenolysis at atmospheric H_2 pressure*: A solution of compound (~50–250 µmol) in 'acetaldehyde free' EtOH (4 mL) was acidified to pH ~2 with 1M aq HCl. Argon was passed through the solution for 5 minutes, after which a catalytic amount of Pd/C (~50 mg, 10 wt % on act. carbon) was added. Hydrogen was passed through the reaction mixture for 15 minutes and the reaction was stirred for 20 h under atmospheric hydrogen pressure. Pd/C was removed by filtration over a glass microfibre filter, followed by thorough rinsing of the filter cake with MeOH. The filtrate was concentrated with coevaporation of toluene. In the case of incomplete reduction hydrogenolysis was repeated after workup and coevaporation (3×) with 'acetaldehyde free' EtOH), at atmospheric pressure in the presence of Pd/C (~50 mg) and Pd black (~5 mg) or at higher H_2 pressure in a Parr-apparatus. *Hydrogenolysis in Parr-apparatus*: A solution of compound (~50–250 µmol) in 'acetaldehyde free' EtOH (50 mL) was acidified to pH ~2 with 1M aq HCl. Argon was passed through the solution for 5 minutes, after which a catalytic amount of Pd/C (50 mg, 10 wt % on act. carbon) was added. The reaction vessel was placed under vacuum and subsequently ventilated with hydrogen gas. This cycle was repeated one more time after which the vessel was placed under 4 bar of hydrogen gas and mechanically shaken for 20 h. Work-up was the same as described before. The obtained residue was purified by silica gel column chromatography (5% » 20% MeOH in DCM + 2% NH_4OH) to yield the deprotected iminosugar as a colorless oil.
All iminosugars that do not contain a 5-(adamantane-1-yl-methoxy)-1-pentyl moiety were deprotected by a BCl_3 mediated debenzylatyion. *Boron trichloride mediated debenzylation*: Boron trichloride (10 eq, 1M in DCM) was added to a cooled (0 °C) solution of the benzylated iminosugar (1 eq) in DCM (0.05M). The reaction mixture was stirred for 20 hours at 0–5 °C after which MeOH (0.5 mL) was carefully added. The reaction mixture was concentrated and coevaporated with toluene (3×). The obtained residue was purified by silica gel column chromatography (5% » 20% MeOH in DCM + 2% NH_4OH) to yield the deprotected iminosugar as a colorless oil.

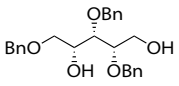
General method G – N-alkylation of deprotected iminsugars by reductive amination: Sodium cyanoborohydride (5 eq) was added to a dry solution of the iminosugar (1 eq) and either butyraldehyde (5 eq) or 5-(adamantane-1-yl-methoxy)-1-pentanal **(**3 eq; synthesis described in Chapter 2**)** in a mixture of anhydrous MeOH and AcOH (0.05M, 100/1, v/v). The reaction mixture was stirred for 20 h and subsequently 4M HCl (0.5 mL; in dioxane/H_2O) was added. The mixture was stirred for 3h and subsequently concentrated and coevaporated with toluene (3×). The obtained residue was purified by silica gel column chromatography (5% » 20% MeOH in DCM + 2% NH_4OH) to yield the deprotected iminosugar as a colorless oil.



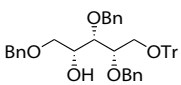
Mixture of 2,3,5-tri-*O*-benzyl-1-*O*-methyl-α/β-D-xylofuranoside (8). A dry solution of HCl (prepared by careful addition of 2 mL AcCl) in MeOH (100 mL) was added to a dry solution of D-xylose (**7**: 20.07 g, 133.7 mmol) in MeOH (340 mL). The reaction mixture was stirred for 20 h at rt. The reaction was quenched by adjusting the pH of the reaction mixture to ~7 by addition of 3M aq NaOH. The mixture was concentrated and coevaporated with toluene (4×100 mL). The crude residue was dissolved in DMF (500 mL) and cooled to 0°C. Subsequently, NaH (30.04 g, 751 mmol; 60% in mineral oil), tetrabutylammonium iodide (32.312 g, 88 mmol) and benzyl bromide (52 mL, 437 mmol) were added. After stirring the reaction mixture for 48 h at rt, methanol (10 mL) was added and the mixture was concentrated. The residue was dissolved in ethyl acetate (100 mL) and washed successively with H_2O (4×50 mL) and sat aq NaCl (50 mL). The organic layer was dried ($MgSO_4$) concentrated. The resulting residue was purified by silica gel column chromatography (5% » 20% EtOAc in toluene) to provide **8** (53.9 g, 124.1 mmol) in 93% yield as a colourless oil. R_F β-anomer = 0.58; α-anomer = 0.42 (5:1 EtOAc:PE). ^{1}H NMR ($CDCl_3$, 200 MHz) δ β-anomer: 7.28 – 7.26 (m, 15H, H_{Ar} Bn), 4.91 (d, 1H, *J* = 1.8, H-1), 4.56 – 4.40 (m, 7H), 4.04 (dd, 1H, *J* = 2.5, 2.6), 3.97 (m, 1H), 3.77 – 3.71 (m, 2H), 3.37 (s, 3H, OMe); α-anomer: 7.29 – 7.25 (m, 15H, H_{Ar} Bn), 4.80 (d, 1H, *J* = 4.0, H-1), 4.67 – 4.46 (m, 6H, 3×CH_2 Bn), 4.43 – 4.26 (m, 2H, H-3, H-4), 4.03 – 4.01 (m, 1H, H-2), 3.74 – 3.53 (m, 2H, CH_2-5), 3.39 (s, 3H, OMe). ^{13}C-NMR ($CDCl_3$, 50 MHz) δ β-anomer: 139.1, 138.6, 138.1 (3×C_q Bn), 129.0, 128.6, 128.4, 127.7, 127.5 (CH_{Ar} Bn), 108.1 (C-1), 87.0, 82.0, 80.0 (C-2, C-3, C-4), 73.3, 72.1, 71.8 (3×CH_2 Bn), 69.9 (C-5), 55.9 (OMe); α-anomer: 138.4, 138.2, 137.9 (3×C_q Bn), 127.9, 127.5, 127.4 (CH_{Ar} Bn), 100.5 (C-1), 84.0, 81.5, 76.0 (C-2, C-3, C-4), 73.2, 72.3 (3×CH_2 Bn), 69.3 (C-5), 54.9 (OMe).



Mixture of 2,3,5-tri-*O*-benzyl-α/β-D-xylose (9). The comined α/β-anomers of **8** (25.11 g, 57.8 mmol) in dioxane (200 mL) and 4M aq HCl (200 mL) were refluxed for 5 h until TLC analysis indicated complete conversion of the starting material. The reaction mixture was cooled to rt, diluted with Et_2O (200 mL) and washed successively with sat aq $NaHCO_3$ (100 mL), H_2O (3×50 mL) and sat aq NaCl (50 mL). The organic phase was dried ($MgSO_4$) and concentrated. The residue was purified by silica gel column chromatography (5% » 20% EtOAc in toluene) to provide **9** (16.9 g, 40.2 mmol) in 70% yield as a colourless oil. R_F = 0.38 (1:1; EtOAc:toluene). ^{1}H NMR ($CDCl_3$, 200 MHz) δ 7.34 – 7.17 (m, 15H, H_{Ar} Bn), 5.46 (d, 1H, *J* = 4.4, H-1α), 5.23 (s, 1H, H-1β), 4.65 – 4.46 (m, 6H, 3×CH_2 Bn), 4.42 – 4.33 (m, 1H), 4.10 – 3.90 (m, 2H), 3.79 – 3.60 (m, 2H), 2.34 (s, 1H, OH); ^{13}C NMR ($CDCl_3$, 50 MHz) δ 137.3, 136.8, 136.6, 136.1 (3×C_q Bn α/β), 128.2, 127.6, 127.3, 127.1, 127.0, 126.9, 126.5, 126.0 (CH_{Ar} Bn α/β), 100.8 (C-1 β), 95.1 (C-1 α), 85.8, 80.6, 80.4, 80.2, 78.9, 72.7, 72.5, 71.9, 71.6, 71.4, 71.9, 67.9, 67.6, 64.0.

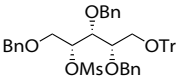


2,3,5-Tri-*O*-benzyl-D-xylitol (10). Sodium borohydride (10.78 g, 285 mmol) was added to a cooled solution (0 °C) of **9** (20 g, 48.0 mmol) in MeOH (240 mL). The reaction mixture was stirred for 3 h at rt after which the pH was adjusted to 5 by addition of acetic acid. The mixture was concentrated, dissolved in Et_2O (500 mL), and washed successively with water (200 mL), 1M aq. HCl (300 mL), 10% aq. $NaHCO_3$ (300 mL), and sat aq NaCl (200 mL). The organic phase was dried ($MgSO_4$), concentrated, and the residue was purified by silica gel column chromatography (20% » 60% EtOAc in PE) to give **10** (17.6 g, 41.6 mmol) in 87% yield as a colorless oil. R_F = 0.45 (1:1; EtOAc:PE). ^{1}H NMR ($CDCl_3$, 200 MHz) δ 7.26 – 7.19 (m, 15H, H_{Ar} Bn), 4.94 – 4.37 (m, 6H, 3×CH_2 Bn), 4.15 – 4.01 (m, 1H), 3.77 – 3.70 (m, 4H), 3.63 – 3.36 (m, 2H), 2.94 (br s, 2H, OH-1, OH-4); ^{13}C NMR ($CDCl_3$, 50 MHz) δ 137.9, 137.8, 137.7 (3×C_q Bn), 128.1, 127.6, 127.5, 127.4 (CH_{Ar} Bn), 78.7, 77.3 (C-2, C-3), 73.9, 72.9, 72.0 (3×CH_2 Bn), 70.9 (C-5), 68.4 (C-4), 60.2 (C-1).

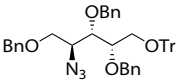


2,3,5-Tri-*O*-benzyl-1-*O*-trityl-D-xylitol (11). Triphenylmethyl chloride (14.1 g, 50.6 mmol) was added to a solution of **10** (17.6 g, 40.5 mmol) in pyridine (210 mL). The reaction mixture was stirred 20 h at 40 °C. Excess triphenylmethyl chloride was quenched by addition of H_2O

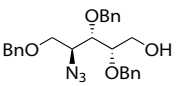
(5 mL) and the mixture was concentrated. The residue was redissolved in Et_2O (100 mL) and washed successively with 0.1M aq HCl (2×100 mL), sat aq $NaHCO_3$ (100 mL) and sat aq NaCl (50 mL). The organic phase was dried ($MgSO_4$) and concentrated. The residue was purified by silica gel column chromatography (0% » 20% EtOAc in toluene) to give **11** (25.3 g, 38.1 mmol) in 94% yield as a colourless oil. R_F = 0.45 (1:4; EtOAc:PE). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.48 – 7.43 (m, 6H, H_{Ar} Tr), 7.35 – 7.13 (m, 24H, H_{Ar} Bn/Tr), 4.73 – 4.65 (m, 2H, 2×C*H*H Bn), 4.55 – 4.48 (m, 2H, 2×CH*H* Bn), 4.42 (s, 2H, CH_2 Bn), 3.91 (dd, *J* = 3.1, 5.6, 1H, H-3), 3.85 – 3.79 (m, 2H, H-2, H-4), 3.44 (dd, *J* = 4.2, 10.2, 1H, H-1a), 3.38 (d, *J* = 6.0, 2H, CH_2-5), 3.32 (dd, *J* = 5.0, 10.2, 1H, H-1b), 2.45 (d, *J* = 6.3, 1H, OH-4). ^{13}C NMR (100 MHz, $CDCl_3$) δ 144.1 (C_q-Ph Tr), 138.5, 138.4, 138.3 (3×C_q Bn), 128.9, 128.5, 128.5, 128.4, 128.4, 128.2, 128.0, 127.9, 127.8, 127.8, 127.2 (CH_{Ar} Bn/Tr), 87.0 (C_q Tr), 79.6 (C-2), 78.3 (C-3), 75.0, 73.3, 73.0 (3×CH_2 Bn), 71.2 (C-5), 70.0 (C-4), 63.0 (C-1). IR ν_{max}(thin film)/ cm^{-1}: 3031, 2956, 1726, 1491, 1452, 1285, 1069, 747, 700. $[\alpha]^{20}_D$: −3.3 (*c* 2.2, $CHCl_3$). HRMS: found 687.3080 $[M+Na]^+$, calculated for $[C_{45}H_{44}O_5+Na]^+$ 687.3080.



2,3,5-Tri-*O*-benzyl-4-methanesulfonyl-1-*O*-trityl-D-xylitol (12). Methanesulfonylchloride (6.7 mL, 86 mmol) was added to a dry solution of **11** (14.4 g, 21.7 mmol) and Et_3N (10.9 mL, 78.0 mmol) in DCM (110 mL). The reaction mixture and stirred for 20 hours, after which it was quenched by addition of H_2O (5 mL). The reaction mixture was washed successively with 0.1M aq HCl (50 mL), sat aq $NaHCO_3$ (50 mL) and sat aq NaCl (50 mL). The organic phase was dried ($MgSO_4$), concentrated and the residue was purified by silica gel column chromatography (5% » 25% EtOAc in PE) to produce **12** (13.7 g, 18.5 mmol) in 85% yield as a colorless oil. R_F = 0.60 (1:9; EtOAc:toluene). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.44 – 7.38 (m, 6H, H_{Ar} Tr), 7.34 – 7.08 (m, 26H, H_{Ar} Bn/Tr), 4.79 (ddd, *J* = 2.8, 5.3, 6.9, 1H, H-4), 4.62 – 4.55 (m, 2H, 2×C*H*H Bn), 4.52 (d, *J* = 11.2, 1H, CH*H* Bn), 4.47 (d, *J* = 11.9, 1H, C*H*H Bn), 4.32 – 4.27 (m, 2H, 2×CH*H* Bn), 4.11 (dd, *J* = 3.4, 6.8, 1H, H-3), 3.73 (ddd, *J* = 3.5, 5.1, 6.1, 1H, H-2), 3.62 (dd, *J* = 2.8, 11.5, 1H, H-6a), 3.47 (dd, *J* = 5.1, 9.8, 1H, H-1a), 3.39 (dd, *J* = 5.3, 11.5, 1H, H-6b), 3.35 (dd, *J* = 6.2, 9.8, 1H, H-1b), 2.81 (s, 3H, CH_3 Ms). ^{13}C NMR (100 MHz, $CDCl_3$) δ 143.9 (C_q-Ph Tr), 137.9, 137.8, 137.7 (3×C_q Bn), 128.8, 128.7, 128.6, 128.5, 128.5, 128.5, 128.1, 128.0, 127.3 (CH_{Ar} Bn/Tr), 87.3 (C_q Tr), 82.1 (C-4), 77.3 (C-3), 76.9 (C-2), 75.3, 73.4, 72.6 (3×CH_2 Bn), 69.3 (C-5), 62.1 (C-1), 38.3 (CH_3 Ms). IR ν_{max}(thin film)/ cm^{-1}: 3032, 1492, 1452, 1358, 1213, 1175, 1073, 918, 748, 701. $[\alpha]^{20}_D$: 23.5 (*c* 1.6, $CHCl_3$). HRMS: found 765.2860 $[M+Na]^+$, calculated for $[C_{46}H_{46}O_7S+Na]^+$ 765.2862.

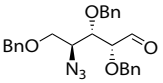


4-Azido-2,3,5-tri-*O*-benzyl-4-deoxy-1-*O*-trityl-L-arabinitol (13). Sodium azide (7.80 g, 120 mmol) and 15-crown-5 (0.25 mL, 1.25 mmol) were added to a dry solution of **12** (9.21, 12.4 mmol) in DMF (60 mL). The resulting suspension was stirred at 90 °C for 48h. The reaction mixture was concentrated. The residue was dissolved in Et_2O (100 mL) and washed successively with water (100 mL) and sat aq NaCl (100 mL). The organic layer was dried ($MgSO_4$), concentrated and the resulting residue was purified by silica gel column chromatography (5% » 20% EtOAc in PE) to produce **13** (7.5g, 10.9 mmol) in 88% yield as a colorless oil. R_F = 0.80 (1:9; EtOAc:toluene). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.46 – 7.39 (m, 6H, H_{Ar} Tr), 7.33 – 7.02 (m, 24H, H_{Ar} Bn/Tr), 4.63 (d, *J* = 11.6, 1H, C*H*H Bn), 4.49 (d, *J* = 11.6, 1H, CH*H* Bn), 4.46 – 4.38 (m, 4H, 2×CH_2 Bn), 3.86 (dd, *J* = 3.3, 7.4, 1H, H-3), 3.82 – 3.78 (m, 1H, H-2), 3.77 – 3.71 (m, 2H, H-4, H-5a), 3.63 (dd, *J* = 6.5, 10.2, 1H, H-5b), 3.45 (dd, *J* = 5.3, 9.8, 1H, H-1a), 3.30 (dd, *J* = 6.5, 9.8, 1H, H-1b). ^{13}C NMR (100 MHz, $CDCl_3$) δ 144.1 (C1-Ph Tr), 138.5, 138.1, 138.1 (3×C_q Bn), 128.9, 128.7, 128.6, 128.5, 128.2, 128.0, 128.0, 127.8, 127.4 (CH_{Ar} Bn/Tr), 87.4 (C_q Tr), 78.3 (C-3), 78.2 (C-2), 75.0, 73.5, 73.4 (3×CH_2 Bn), 70.0 (C-5), 62.9 (C-1), 61.3 (C-4). IR ν_{max}(thin film)/ cm^{-1}: 3032, 2870, 2096, 1492, 1452, 1073, 747, 699. $[\alpha]^{20}_D$: 11.2 (*c* 1.2, $CHCl_3$). HRMS: found 712.3147 $[M+Na]^+$, calculated for $[C_{45}H_{43}N_3O_4+Na]^+$ 712.3151.

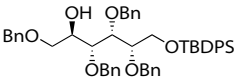


4-Azido-2,3,5-tri-*O*-benzyl-4-deoxy-L-arabinitol (14). Boron trifluoride diethyletherate (4.8 mL, 38.0 mmol) was added to a solution of **13** (7.3 g, 10.5 mmol) in a mixture of toluene/MeOH (265 mL, 16/1, v/v). The reaction mixture was stirred for 3 h, after which the reaction

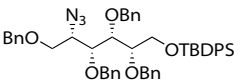
was successively washed with sat aq $NaHCO_3$ (100 mL) and sat aq NaCl (100 mL). The organic phase was dried ($MgSO_4$) and concentrated. The residue was dissolved in EtOAc, cooled to 0 °C and the triphenylmethoxymethane that precipitated was removed by filtration. Subsequent concentration and purification of the residue by silica gel column chromatography (5% » 50% EtOAc in toluene) afforded **14** (4.6 g, 10.3 mmol) in 98% yield as a colorless oil. R_F = 0.15 (1:19; EtOAc:toluene). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.39 – 7.15 (m, 15H, H_{Ar} Bn), 4.62 – 4.51 (m, 4H, 2×CH_2 Bn), 4.49 (s, 2H, CH_2 Bn), 3.82 – 3.61 (m, 7H, CH_2-1, H-2, H-3, H-4, CH_2-5), 2.27 (s, 1H, OH-1). ^{13}C NMR (100 MHz, $CDCl_3$) δ 138.1, 137.7, 137.7 (3×C_q Bn), 128.5, 128.4, 128.2, 128.1, 128.0, 127.9, 127.8, 127.7, 126.9 (CH_{Ar} Bn), 79.1, 78.0 (C-2, C-3), 74.4, 73.4, 73.1 (3×CH_2 Bn), 69.6 (C-5), 61.3 (C-4), 61.3 (C-1). IR ν_{max}(thin film)/ cm^{-1}: 3465, 3033, 2868, 2096, 1496, 1454, 1267, 1211, 1093, 1027, 735, 698. $[\alpha]^{20}_D$: 18.5 (*c* 7.0, $CHCl_3$). HRMS: found 470.2046 $[M+Na]^+$, calculated for $[C_{26}H_{29}N_3O_4+Na]^+$ 470.2056.



4-Azido-2,3,5,-tri-*O*-benzyl-4-deoxy-L-arabinose (15). Azido-alcohol **14** (2.00 g, 4.47 mmol) was subjected to a Dess-Martin mediated oxidation (General Procedure A) to produce **15** (1.51 g, 3.39 mmol) in 76% yield as a colourless oil. R_F = 0.60 (1:9; EtOAc:toluene). ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.66 (d, *J* = 1.1, 1H, C(O)H-1), 7.37 – 7.14 (m, 15H, H_{Ar} Bn), 4.75 (d, *J* = 11.7, 1H, C*H*H Bn), 4.60 (d, *J* = 11.7, 1H, CH*H* Bn), 4.53 (s, 2H, CH_2 Bn), 4.44 (s, 2H, CH_2 Bn), 4.03 (dd, *J* = 1.2, 3.0, 1H, H-2), 3.96 (dd, *J* = 3.0, 8.1, 1H, H-3), 3.85 (dt, *J* = 2.7, 5.7, 1H, H-4), 3.81 (dd, *J* = 2.7, 9.9, 1H, H-5a), 3.70 (dd, *J* = 5.6, 9.9, 1H, H-5b). ^{13}C NMR (100 MHz, $CDCl_3$) δ 203.2 (C(O)H-1), 137.7, 137.1, 136.9 (3×C_q Bn), 128.8, 128.7, 128.7, 128.6, 128.6, 128.3, 128.3, 128.1, 128.0 (CH_{Ar} Bn), 83.4 (C-2), 78.0 (C-3), 74.5, 73.9, 73.6 (3×CH_2 Bn), 69.3 (C-5), 60.9 (C-4). IR ν_{max}(thin film)/ cm^{-1}: 2867, 2097, 1728, 1496, 1454, 1315, 1266, 1210, 1093, 1026, 912, 734, 695. $[\alpha]^{20}_D$: 12.6 (*c* 1.8, $CHCl_3$). HRMS: found 468.1891 $[M+Na]^+$, calculated for $[C_{26}H_{27}N_3O_4+Na]^+$ 468.1899.

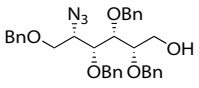


2,3,4,6-Tetra-*O*-benzyl-1-*O*-*tert*-butyldiphenylsilyl-D-glucitol (17). *tert*-Butyldiphenylsilylchloride (21 mL, 80.7 mmol) was added over a 2 min period to a dry solution of 2,3,4,6-tetra-*O*-benzyl-D-glucitol (**16**: 39.0 g, 71.9 mmol; synthesis described in Chapter 2) and imidazole (10.8 g, 158.6 mmol) in DMF (75 mL). The reaction mixture was stirred for 20 hours and subsequently concentrated. The residue was purified by silica gel column chromatography (20% » 25% EtOAc in PE) to provide **17** (55.7 g, 71.4 mmol) as a colourless oil in 99% yield. R_F = 0.85 (1:1; EtOAc:toluene). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.66 – 7.61 (m, 4H, H_{Ar} TBDPS), 7.42 – 7.07 (m, 26H, H_{Ar} TBDPS/Bn), 4.64 (s, 2H, CH_2 Bn), 4.63 (d, *J* = 11.6, 1H, C*H*H Bn), 4.54 – 4.45 (m, 5H, CH*H* Bn, 2×CH_2 Bn), 3.97 (dd, *J* = 4.5, 1H, H-3), 3.96 – 3.92 (m, 1H, H-5), 3.88 (dd, *J* = 4.9, 10.6, 1H, H-1a), 3.83 (dd, *J* = 4.9, 9.9, 1H, H-2), 3.78 (dd, *J* = 3.9, 6.5, 1H, H-4), 3.76 (dd, *J* = 4.9, 10.1, 1H, H-1b), 3.60 (dd, *J* = 2.5, 8.9, 1H, H-6b), 3.58 (dd, *J* = 4.2, 8.9, 1H, H-6b), 2.91 (d, *J* = 4.8, 1H, OH-5), 1.04 (s, 9H, *t*-butyl-Si). ^{13}C NMR (150 MHz, $CDCl_3$) δ 138.6, 138.4, 138.3, 138.3 (4×C_q Bn), 135.8 (CH_{Ar} TBDPS), 133.5 (C_q Si-Ph), 129.9, 129.9, 128.6, 128.6, 128.5, 128.5, 128.4, 128.1, 128.0, 127.9, 127.8, 127.7(CH_{Ar} Bn/TBDPS), 79.8 (C-2), 78.1 (C-3), 77.6 (C-4), 74.4, 73.6, 73.5, 73.2 (4×CH_2 Bn), 71.4 (C-6), 71.2 (C-5), 63.3 (C-1), 27.1 (CH_3 *t*-butyl), 19.4 (C_q *t*-butyl). IR ν_{max}(thin film)/ cm^{-1}: 3030, 2929, 2862, 1490, 1454, 1358, 1208, 1080, 1027, 823, 735, 698. $[\alpha]^{20}_D$: 16.2 (*c* 2.1, $CHCl_3$). HRMS: found 803.3739 $[M+Na]^+$; calculated for $[C_{50}H_{56}O_6Si+Na]^+$ 803.3744.

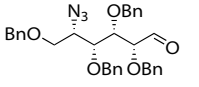


5-Azido-2,3,4,6-tetra-*O*-benzyl-*tert*-1-*O*-butyldiphenylsilyl-L-iditol (18). Diisopropyl azodicarboxylate (2.52 mL, 12.8 mmol) and diphenylphosphoryl azide (2.76 mL, 12.8 mmol) were successively added over 2 min periods to a dry and cooled (0 °C) solution of **17** (5.00 g, 6.4 mmol) and triphenylphosphine (3.36 g, 12.8 mmol) in THF (48 mL). The reaction mixture was stirred for 20 h and allowed to warm to rt. The mixture was concentrated and the resulting residue was purified by silica gel column chromatography (0% » 10% EtOAc in PE) to afford **18** (3.70 g, 4.2 mmol) in 66% yield as a colourless oil. R_F = 0.60 (1:6; EtOAc:PE). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.67 (dd, *J* = 6.7, 19.6, 4H, H_{Ar} TBDPS),

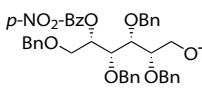
7.43 – 7.13 (m, 26H, H_{Ar} TBDPS/Bn), 4.78 – 4.71 (m, 2H, C*H*H Bn, C*H*H Bn), 4.64 (d, *J* = 11.3, 1H, CH*H* Bn), 4.59 (d, *J* = 12.0, 1H, C*H*H Bn), 4.52 (d, *J* = 11.5, 1H, CH*H* Bn), 4.39 – 4.32 (m, 2H, CH_2 Bn), 4.29 (d, *J* = 12.0, 1H, CH*H* Bn), 4.04 (dd, *J* = 2.7, 7.6, 1H, H-3), 3.93 (dd, *J* = 6.3, 10.5, 1H, H-1a), 3.87 (dd, *J* = 5.6, 10.5, 1H, H-1b), 3.82 (dd, *J* = 3.0, 7.7, 1H, H-4), 3.61 – 3.56 (m, 1H, H-2), 3.53 (dd, *J* = 8.1, 9.2, 1H, H-6a), 3.34 (dd, *J* = 4.8, 9.5, 1H, H-6b), 3.30 – 3.23 (m, 1H, H-5), 1.08 (s, 9H, *t*-butyl-Si). ^{13}C NMR (100 MHz, $CDCl_3$) δ 138.9, 138.8, 138.6, 138.4 (4×C_q Bn), 136.3, 136.2 (CH_{Ar} TBDPS), 133.9 (C_q Si-Ph), 130.5, 130.4, 129.0, 128.9, 128.6, 128.5, 128.4, 128.3, 128.2 (CH_{Ar} Bn/TBDPS), 79.6, 79.0, 78.6 (C-2, C-2, C-4), 75.8, 75.5, 73.8, 73.0 (4×CH_2 Bn), 70.4 (C-6), 63.0 (C-1), 61.9 (C-5), 27.5 (CH_3 *t*-butyl), 19.8 (C_q *t*-butyl). IR ν_{max}(thin film)/ cm^{-1}: 3030, 2928, 2857, 2955, 2097, 1494, 1454, 1428, 1358, 1208, 1080, 1027, 734, 699. $[\alpha]^{20}_D$: 21.3 (*c* 8.2, $CHCl_3$). HRMS: found 828.3807 $[M+Na]^+$; calculated for $[C_{50}H_{55}N_3O_5Si+Na]^+$ 828.3809.



5-Azido-2,3,4,6-tetra-*O*-benzyl-L-iditol (19). Tetrabutylammoniumflouride (12 mL, 12 mmol; 1M in THF) was added to a dry solution of **18** (7.25 g, 9.0 mmol) in THF (150 mL) and the resulting reaction mixture was stirred for 20 h. The mixture was concentrated, redissolved in Et_2O (100 mL) and washed with sat aq NaCl (100 mL). The organic phase was dried (Na_2SO_4) and concentrated. The resulting residue was purified by silica gel column chromatography (9% » 25% EtOAc in PE) to produce **19** (3.62 g, 6.38 mmol) in 71% yield as a colourless oil. R_F = 0.20 (1:4; EtOAc:PE). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.38 – 7.17 (m, 20H, H_{Ar} Bn), 4.75 (d, *J* = 11.5, 1H, C*H*H Bn), 4.67 (d, *J* = 11.1, 1H, C*H*H Bn), 4.65 – 4.60 (m, 2H, C*H*H Bn, CH*H* Bn), 4.55 – 4.52 (m, 2H, C*H*H Bn, C*H*H Bn), 4.38 (d, *J* = 11.8, 1H, C*H*H Bn), 4.35 (d, *J* = 11.8, 1H, CH*H* Bn), 3.91 (dd, *J* = 4.0, 7.3, 1H, H-3), 3.87 (dd, *J* = 2.8, 7.4, 1H, H-4), 3.78 (dd, *J* = 5.0, 11.5, 1H, H-1a), 3.71 (dd, *J* = 5.0, 11.6, 1H, H-1b), 3.60 (dd, *J* = 4.9, 9.2, 1H, H-2), 3.59 – 3.52 (m, 2H, H-5, H-6a), 3.46 (dd, *J* = 4.5, 8.9, 1H, H-6b), 3.24 – 2.79 (m, 1H, OH-1).^{13}C NMR (150 MHz, $CDCl_3$) δ 137.8, 137.7, 137.5 (4×C_q Bn), 128.2, 128.1, 128.1, 128.1, 127.9, 127.7, 127.6, 127.5, 127.5, 127.4, 127.4, 127.3 (CH_{Ar} Bn), 78.9 (C-3), 78.1 (C-2), 78.0 (C-4), 74.6, 74.5, 72.9, 72.1 (4×CH_2 Bn), 69.3(C-6), 61.0 (C-1), 60.8 (C-5). IR ν_{max}(thin film)/ cm^{-1}: 3469, 3032, 2866, 2097, 1496, 1454, 1353, 1263, 1210, 1061, 1027, 734, 698. $[\alpha]^{20}_D$: 17.8 (*c* 13.2, $CHCl_3$). HRMS: found 590.2620 $[M+Na]^+$; calculated for $[C_{34}H_{37}N_3O_5+Na]^+$ 590.2631.

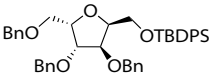


5-Azido-2,3,4,6-tetra-*O*-benzyl-L-idose (20). Azido-alcohol **19** (2.22 g, 3.9 mmol) was subjected to a Dess-Martin mediated oxidation (General Procedure A) to produce **20** (1.97 g, 3.5 mmol) in 89% yield as a colourless oil. R_F = 0.55 (1:4; EtOAc:PE). ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.66 (s, 1H, H-1), 7.36 – 7.21 (m, 18H, H_{Ar} Bn), 7.21 – 7.13 (m, 2H, H_{Ar} Bn), 4.81 (d, *J* = 11.9, 1H, C*H*H Bn), 4.63 (d, *J* = 11.1, 1H, C*H*H Bn), 4.56 – 4.50 (m, 3H, CH*H* Bn, CH_2 Bn), 4.47 (d, *J* = 11.9, 1H, CH*H* Bn), 4.41 (d, *J* = 12.2, 1H, C*H*H Bn), 4.38 (d, *J* = 12.2, 1H, CH*H* Bn), 3.96 (dd, *J* = 4.8, 4.8, 1H, H-3), 3.92 (d, *J* = 4.6, 1H, H-2), 3.86 (dd, *J* = 5.0, 5.0, 1H, H-4), 3.58 – 3.51 (m, 1H, H-5), 3.51 – 3.43 (m, 2H, CH_2-6). ^{13}C NMR (100 MHz, $CDCl_3$) δ 200.8 (CH-1), 137.8, 137.6, 137.2, 137.0 (4×C_q Bn), 128.7, 128.6, 128.5, 128.5, 128.4, 128.4, 128.3, 128.2, 127.9, 127.9, 127.8 (CH_{Ar} Bn), 80.9 (C-2), 79.3 (C-3), 77.4 (C-4), 74.5, 74.1, 73.3, 73.2 (4×CH_2 Bn), 69.5 (C-6), 61.6 (C-1). IR ν_{max}(thin film)/ cm^{-1}: 3032, 2864, 2097, 1729, 1496, 1454, 1352,1264, 1210, 1092, 1027, 734, 697. $[\alpha]^{20}_D$: 23.7 (*c* 10.7, $CHCl_3$). HRMS: found 588.2468 $[M+Na]^+$; calculated for $[C_{34}H_{35}N_3O_5+Na]^+$ 588.2474.

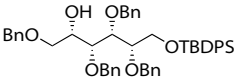


2,3,4,6-Tetra-*O*-benzyl-1-*O*-*tert*-butyldiphenylsilyl-5-*O*-*para*-nitrobenzoyl-L-iditol (21). Diisopropyl azodicarboxylate (7.54 mL, 38.4 mmol) was added over a 2 min period to a dry and cooled (0 °C) solution of **17** (15.02 g, 19.2 mmol), *p*-nitrobenzoic acid (6.42 g, 38.4 mmol) and triphenylphosphine (10.07 g, 38.4 mmol) in THF (77 mL). The reaction mixture was stirred for 20h and allowed to warm to rt. The reaction mixture was diluted with EtOAc (200 mL) and successively washed with sat aq $NaHCO_3$ (3×100 mL) and sat aq NaCl (100 mL). The organic phase was dried (Na_2SO_4) and concentrated. The residue was used crude in the next reaction. A portion of the residue was purified for characterization by silica gel column chromatography (2% » 5% EtOAc in PE) to provide **21** as

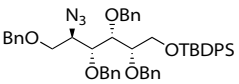
a colourless oil. R_F = 0.60 (1:6; EtOAc:PE). ^{1}H NMR (200 MHz, $CDCl_3$) δ 7.64 – 7.55 (m, 6H, H_{Ar} TBDPS/*p*-NO_2Bz), 7.45 – 7.07 (m, 28H, H_{Ar} Bn/TBDPS/*p*-NO_2Bz), 5.49 (dd, *J* = 5.3, 9.5, 1H, H-5), 4.84 – 4.27 (m, 8H, 4×CH_2 Bn), 4.19 – 3.48 (m, 7H, CH_2-1, H-2, H-3, H-4, CH_2-6), 0.90 (s, 9H, *t*-butyl-Si). ESI-MS: found 930.4 $[M+H]^+$; calculated for $[C_{57}H_{59}NO_9Si+H]^+$ 930.4.



2,5-Anhydro-1-*O*-*tert*-butyldiphenylsilyl-3,4,6-tri-*O*-benzyl-L-iditol (22). Side product **22** could be separated from **23** by silica gel column chromatography (5% » 15% EtOAc in PE) to provide **22** (5.94 g, 8.83 mmol) as a colourless oil in 46% yield. R_F = 0.65 (1:6; EtOAc:PE). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.70 – 7.63 (m, 4H, H_{Ar} TBDPS), 7.42 – 7.16 (m, 21H, H_{Ar} TBDPS/Bn), 4.59 (d, *J* = 12.0, 1H, C*H*H Bn), 4.56 – 4.44 (m, 5H, CH*H* Bn, 2×CH_2 Bn), 4.37 – 4.30 (m, 2H, H-2, H-5), 4.09 (dd, *J* = 1.5, 4.0, 1H, H-3), 4.04 (dd, *J* = 1.4, 4.0, 1H, H-4), 3.98 (dd, *J* = 7.9, 9.9, 1H, H-1a), 3.87 (dd, *J* = 5.2, 10.0, 1H, H-1b), 3.71 (dd, *J* = 5.8, 9.9, 1H, H-6a), 3.66 (dd, *J* = 6.5, 9.8, 1H, H-6b), 1.06 (s, 9H, *t*-butyl-Si). ^{13}C NMR (100 MHz, $CDCl_3$) δ 138.4, 138.2, 138.1 (3×C_q Bn), 135.7, 135.7 (CH_{Ar} TBDPS), 133.7, 133.5 (2×C_q Si-Ph), 129.7, 129.7, 128.5, 128.5, 128.4, 127.9, 127.9, 127.8, 127.7, 127.7, 127.6 (CH_{Ar} Bn/TBDPS), 81.9 (C-4), 81.3 (C-3), 80.5 (C-2), 79.2 (C-5), 73.5, 72.6, 72.4 (3×CH_2 Bn), 68.8 (C-6), 61.7 (C-1), 27.0 (CH_3 *t*-butyl), 19.3(C_q *t*-butyl). IR ν_{max}(thin film)/ cm^{-1}: 3032, 2931, 2858, 1494, 1454, 1428, 1358, 1208, 1080, 1027, 823, 735, 699, 611, 504. $[\alpha]^{20}_D$: 9.4 (*c* 10.6, $CHCl_3$). HRMS: found 695.3161 $[M+Na]^+$; calculated for $[C_{43}H_{48}O_5Si+Na]^+$ 695.3169.

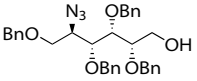


2,3,4,6-Tetra-*O*-benzyl-1-*O*-*tert*-butyldiphenylsilyl-L-iditol (23). The crude **21**- and **22**-containing residue from the previous reaction was dissolved in a mixture of H_2O/EtOH/THF (100 mL, 1/2/2, v/v/v). Lithiumhydroxide (2.85 g, 119 mmol) was added to the solution and the resulting yellow coloured reaction mixture was stirred for 2h, after which TLC analysis showed complete consumption of the starting material. The pH of reaction mixture was adjusted to pH ~7 with 1M aq HCl. The mixture was concentrated to ~¼ of its initial volume, diluted with Et_2O (100 mL) and washed successively with sat aq $NaHCO_3$ (3×100 mL) and sat aq NaCl (100 mL). The organic phase was dried (Na_2SO_4) and concentrated. The resulting residue was purified by silica gel column chromatography (5% » 15% EtOAc in PE) to provide **23** (5.68 g, 7.28 mmol) in 38% yield over the two steps as a colourless oil. R_F = 0.35 (1:6; EtOAc:PE). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.67 – 7.63 (m, 4H, H_{Ar} TBDPS), 7.47 – 7.16 (m, 26H, H_{Ar} TBDPS/Bn), 4.77 – 4.70 (m, 2H, C*H*H Bn, C*H*H Bn), 4.67 – 4.58 (m, 2H, C*H*H Bn, CH*H* Bn), 4.49 (d, *J* = 11.2, 1H, CH*H* Bn), 4.43 (d, *J* = 11.9, 1H, C*H*H Bn), 4.41 (d, *J* = 8.9, 1H, CH*H* Bn), 4.38 (d, *J* = 11.9, 1H, CH*H* Bn), 4.02 (dd, *J* = 3.1, 7.7, 1H, H-3), 3.87 (dd, *J* = 4.5, 9.1, 1H, H-1a), 3.85 (dd, *J* = 4.5, 9.1, 1H, H-1b), 3.80 (dd, *J* = 2.3, 7.7, 1H, H-4), 3.75 – 3.69 (m, 2H, H-2, H-5), 3.42 (dd, *J* = 6.8, 9.2, 1H, H-6a), 3.26 (dd, *J* = 5.7, 9.2, 1H, H-6b), 2.51 (d, *J* = 6.5, 1H, OH-5), 1.04 (s, 9H, *t*-butyl-Si). ^{13}C NMR (150 MHz, $CDCl_3$) δ 138.5, 138.5, 138.4, 138.3 (4×C_q Bn), 135.9, 135.8 (CH_{Ar} TBDPS), 133.5 (C_q Si-Ph), 130.0, 129.9, 128.6, 128.5, 128.4, 128.0, 127.9, 127.9, 127.9, 127.8 (CH_{Ar} Bn/TBDPS), 79.0 (C-3), 78.9 (C-2), 78.7 (C-4), 75.1, 75.0, 73.4, 73.1 (4×CH_2 Bn), 71.6 (C-6), 69.9 (C-5), 63.2 (C-1), 27.1 (CH_3 *t*-butyl), 19.3 (C_q *t*-butyl). IR ν_{max}(thin film)/ cm^{-1}: 3031, 2929, 2861, 1495, 1454, 1358, 1208, 1080, 1027, 823, 734, 699. $[\alpha]^{20}_D$: 13.0 (*c* 0.3, $CHCl_3$). HRMS: found 803.3736 $[M+Na]^+$; calculated for $[C_{50}H_{56}O_6Si+Na]^+$ 803.3744.

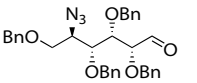


5-Azido-2,3,4,6-tetra-*O*-benzyl-1-*O*-*tert*-butyldiphenylsilyl-D-glucitol (24). Diiso-propyl azodicarboxylate (2.87 mL, 14.6 mmol) and diphenylphosphoryl azide (3.15 mL, 14.6 mmol) were successively added over 2 min periods to a dry and cooled (0 °C) solution of **23** (5.68, 7.3 mmol) and triphenylphosphine (3.83 g, 14.6 mmol) in THF (55 mL). The reaction mixture was stirred for 20 h and allowed to warm to rt. The mixture was concentrated and the resulting residue was purified by silica gel column chromatography (0% » 10% EtOAc in PE) to afford **24** (3.70 g, 4.60 mmol) in 63% yield as a colourless oil. R_F = 0.6 (1:6; EtOAc:PE). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.68 – 7.63 (m, 4H, H_{Ar}

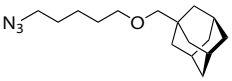
TBDPS), 7.42 – 7.11 (m, 26H, H_{Ar} TBDPS/Bn), 4.69 – 4.64 (m, 3H, C*H*H Bn, CH_2 Bn), 4.58 (d, *J* = 11.2, 1H, C*H*H Bn), 4.54 (d, *J* = 11.2, 1H, CH*H* Bn), 4.48 – 4.43 (m, 3H, CH*H* Bn, CH_2 Bn), 3.93 – 3.61 (m, 8H, CH_2-1, H-2, H-3, H-4, H-5, CH_2-6), 1.06 (s, 9H, *t*-butyl-Si). ^{13}C NMR (100 MHz, $CDCl_3$) δ 138.4, 138.3, 138.2, 138.0 (4×C_q Bn), 135.8 (CH_{Ar} TBDPS), 133.4 (C_q Si-Ph), 129.9, 129.9, 128.6, 128.5, 128.4, 128.2, 128.0, 127.9, 127.9, 127.8, 127.8, 127.7 (CH_{Ar} Bn/TBDPS), 79.5, 78.9, 78.7 (C-2, C-2, C-4), 75.1, 74.5, 73.4, 72.9 (4×CH_2 Bn), 69.8 (C-6), 63.1 (C-1), 61.9 (C-5), 27.0 (CH_3 *t*-butyl), 19.3 (C_q *t*-butyl). IR ν_{max}(thin film)/ cm^{-1}: 3031, 2926, 2864, 2097, 1495, 1454, 1354, 1209, 1076, 1027, 734, 699. $[\alpha]^{20}_D$: −4.1 (*c* 0.7, $CHCl_3$).HRMS: found 828.3805 [M+Na]$^+$; calculated for $[C_{50}H_{55}N_3O_5Si+Na]^+$ 828.3809.



5-Azido-2,3,4,6-tetra-*O*-benzyl-D-glucitol (25). Tetrabutylammoniumflouride (4.2 mL, 4.2 mmol; 1M in THF) was added to a dry solution of **24** (2.26 g, 2.8 mmol) in THF (47 mL) and the resulting reaction mixture was stirred for 20 h. The mixture was concentrated, redissolved in Et_2O (100 mL) and washed with sat aq NaCl (100 mL). The organic phase was dried (Na_2SO_4) and concentrated. The resulting residue was purified by silica gel column chromatography (9% » 25% EtOAc in PE) to produce **25** (1.17 g, 2.07 mmol) in 74% yield as a colourless oil. R_F = 0.20 (1:4; EtOAc:PE). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.42 – 7.15 (m, 20H, H_{Ar} Bn), 4.70 (d, *J* = 11.2, 1H, C*H*H Bn), 4.68 – 4.61 (m, 3H, CH*H* Bn, C*H*H Bn), 4.58 (d, *J* = 11.8, 1H, CH*H* Bn), 4.47 (s, 2H, CH_2 Bn), 3.86 – 3.83 (m, 1H, H-4), 3.82 – 3.78 (m, 3H, H-1a, H-3, H-5), 3.76 – 3.66 (m, 3H, H-1b, H-2, H-6a), 3.59 (dd, *J* = 4.9, 11.7, 1H, H-6b), 3.09 – 2.72 (m, 1H, OH-1). ^{13}C NMR (150 MHz, $CDCl_3$) δ 138.0, 138.0, 137.8, 137.6 (4×C_q Bn), 128.3, 128.3, 128.2, 128.2, 128.2, 127.9, 127.8, 127.7, 127.6, 127.5 (CH_{Ar} Bn), 79.1 (C-4), 78.8 (C-3), 78.3 (C-2), 74.8, 74.0, 73.1, 72.6 (4×CH_2 Bn), 69.4 (C-6), 61.4 (C-5), 61.3 (C-1). IR ν_{max}(thin film)/ cm^{-1}: 3031,2865, 2095, 1495, 1454, 1353, 1353, 1264, 1209, 1094, 1027, 734, 697. $[\alpha]^{20}_D$: −3.1 (*c* 11.5, $CHCl_3$). HRMS: found 590.2621 [M+Na]$^+$; calculated for $[C_{34}H_{37}N_3O_5+Na]^+$ 590.2631.

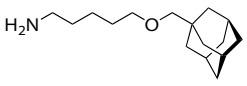


5-Azido-2,3,4,6-tetra-*O*-benzyl-D-glucose (26). Azido-alcohol **25** (1.80 g, 3.2 mmol) was subjected to a Dess-Martin mediated oxidation (General Procedure A) to produce **26** (1.71 g, 3.0 mmol) in 96% yield as a colourless oil. R_F = 0.60 (1:4; EtOAc:PE). ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.75 (s, 1H, H-1), 7.40 – 7.20 (m, 18H, H_{Ar} Bn), 7.20 – 7.14 (m, 2H, H_{Ar} Bn), 4.85 (d, *J* = 12.0, 1H, C*H*H Bn), 4.64 (d, *J* = 11.5, 1H, C*H*H Bn), 4.59 (d, *J* = 11.5, 1H, CH*H* Bn), 4.56 – 4.47 (m, 4H, CH_2 Bn, CH*H* Bn, C*H*H Bn), 4.37 (d, *J* = 10.9, 1H, CH*H* Bn), 4.02 (dd, *J* = 2.9, 5.8, 1H, H-3), 3.89 (d, *J* = 5.9, 1H, H-2), 3.86 – 3.78 (m, 2H, H-4, H-6a), 3.75 – 3.67 (m, 2H, H-5, H-6b). ^{13}C NMR (100 MHz, $CDCl_3$) δ 200.2 (CH-1), 137.7, 137.5, 137.4, 137.3 (4×C_q Bn), 128.8, 128.7, 128.7, 128.6, 128.5, 128.4, 128.3, 128.3, 128.0, 128.0, 127.9 (CH_{Ar} Bn), 80.0 (C-2), 79.9 (C-3), 76.7 (C-4), 74.3, 74.0, 73.6, 73.3 (4×CH_2 Bn), 69.5 (C-6), 60.8 (C-5). IR ν_{max}(thin film)/ cm^{-1}: 3064, 3032, 2865, 2096, 1727, 1496, 1454, 1328, 1265, 1211, 1072, 1027, 734, 697. $[\alpha]^{20}_D$: 3.8 (*c* 10.2, $CHCl_3$). HRMS: found 588.2466 [M+Na]$^+$; calculated for $[C_{34}H_{35}N_3O_5+Na]^+$ 588.2474.

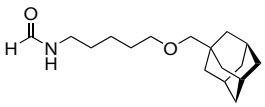


5-(Adamantan-1-yl-methoxy)-pentan-1-azide (28). Sodium azide (1.56 g, 240 mmol) was added to a dry solution of 5-(adamantan-1-yl-methoxy)-1-bromo-pentane **(27**: 6.0 g, 191 mmol; synthesis described in Chapter 5) in DMSO (20 mL). The reaction mixture was stirred for 20h. The mixture was diluted with Et_2O (500 mL) and washed successively with H_2O (2×500 mL) and sat aq NaCl (200 mL). The organic phase was dried (Na_2SO_4) and concentrated. The residue was purified by silica gel column chromatography (10% » 70% toluene in PE) to give **28** (5.14 g, 185 mmol mol) in 95% yield as a colourless oil. R_F **27** = 0.60 (4% EtOAc in PE); **28** = 0.70 (1:4; EtOAc:PE). ^{1}H NMR (400 MHz, $CDCl_3$) δ 3.38 (t, *J* = 6.3, 2H, CH_2-5 pentyl), 3.27 (t, *J* = 7.0, 2H, CH_2-1 pentyl), 2.95 (s, 2H, OCH_2-Ada), 1.95 (s, 3H, 3×CH Ada), 1.77 – 1.54 (m, 12H, 3×CH_2 Ada, CH_2-2, CH_2-4 pentyl), 1.53 (d, *J* = 2.7, 6H, 3×CH_2 Ada), 1.49 – 1.39 (m, 2H, CH_2-3 pentyl). ^{13}C NMR (100 MHz, $CDCl_3$) δ 82.2 (OCH_2-Ada), 71.4 (CH_2-5 pentyl), 51.6 (CH_2-1 pentyl), 39.9 (CH_2 Ada), 37.4 (CH_2 Ada), 34.3 (C_q Ada), 29.3 (CH_2-4 pentyl), 28.9 (CH_2-2 pentyl), 28.5 (CH Ada), 23.7 (CH_2-3 pentyl).

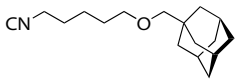
IR ν_{max}(thin film)/ cm^{-1}: 2902, 2848, 2093, 1727, 1453, 1358, 1259, 1158, 1112. HRMS: found 278.2228 $[M+H]^+$; calculated for $[C_{16}H_{27}N_3O+H]^+$ 278.2227.



5-(Adamantan-1-yl-methoxy)-pentan-1-amine (29). Trimethylphosphine (33 mL, 33 mmol, 1M solution in THF) was added over a 2 min period to a cooled (0 °C) solution of **28** (4.57 g, 16.5 mmol) in THF (83 mL) and H_2O (7 mL). The reaction mixture stirred for 3 h at 0 °C after which it was concentrated and coevaporated three times with toluene. The residue was purified by silica gel column chromatography (10% » 70% MeOH in EtOAc + 5% NH_4OH). Purified **29** contained some dissolved silica gel that could be removed by redissolving **29** in DCM and passing it over a glassfibre filter to provide **29** (3.48 g, 13.86 mmol) after concentration in 84% yield as a colourless oil. R_F = 0.10 (25% MeOH in EtOAc). ^{1}H NMR (200 MHz, $CDCl_3$) δ 3.38 (t, *J* = 6.4, 1H, CH_2-5 pentyl), 2.95 (s, 2H, OCH_2-Ada), 2.70 (t, *J* = 6.7, 1H, CH_2-1 pentyl), 1.94 (s, 3H, 3×CH Ada), 1.73 – 1.44 (m, 18H, 6×CH_2 Ada, 3×CH_2 pentyl).^{13}C NMR (50 MHz, $CDCl_3$) δ 81.8 (OCH_2-Ada), 71.3 (CH_2-5 pentyl), 41.9 (CH_2-1 pentyl), 39.6 (CH_2 Ada), 37.2 (CH_2 Ada), 34.0 (C_q Ada), 29.4, 29.3 (2×CH_2 pentyl), 28.2 (CH Ada), 23.4 (CH_2-3 pentyl). IR ν_{max}(thin film)/ cm^{-1}: 3358, 2899, 2847, 1575, 1453, 1297, 1156, 1111, 945, 860, 745. HRMS: found 252.2321 $[M+H]^+$; calculated for $[C_{16}H_{29}NO+H]^+$ 252.2322.

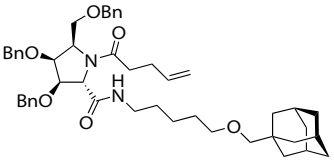


***N*-[5-(Adamantan-1-yl-methoxy)-pentan]formamide (30).** Acetic formic anhydride was prepared by heating a mixture of acetic anhydride (1.51 mL, 16.0 mmol) and formic acid (0.66 mL, 17.6 mmol) at 55 °C for 2 h. The prepared acetic formic anhydride (16.0 mmol) was cooled to 0 °C and added to a cooled (0 °C) solution of **29** (2.01 g, 8.0 mmol) in DCM (22 mL). The reaction mixture was stirred at rt for 20 h, after which it was concentrated. The residue was purified by silica gel column chromatography (30% » 90% EtOAc in PE) to afford **30** (1.84 g, 6.6 mmol) in 82% yield as a colourless oil. R_F = 0.39 (EtOAc); $KMnO_4$ staining. ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.17 (s, 1H, HC(O)N), 5.56 – 5.41 (m, 1H, C(O)NH), 3.38 (t, *J* = 6.3, 2H, CH_2-5 pentyl), 3.32 (dd, *J* = 6.7, 13.4, 1H, C*H*H-1 pentyl), 3.25 (dd, *J* = 7.0, 13.0, 1H, CH*H*-1 pentyl), 2.95 (s, 2H, OCH_2-Ada), 1.96 (s, 3H, 3×CH Ada), 1.68 (dd, *J* = 12.0, 34.5, 6H, 3×CH_2 Ada), 1.62 – 1.53 (m, 4H, CH_2-2, CH_2-4 pentyl), 1.52 (d, *J* = 2.3, 6H, 3×CH_2 Ada), 1.45 – 1.32 (m, 2H, CH_2-3pentyl). ^{13}C NMR (50 MHz, $CDCl_3$) δ 161.5 (C=O), 81.9 (OCH_2-Ada), 71.3 (CH_2-5 pentyl), 39.7 (CH_2 Ada), 38.1 (CH_2-1 pentyl), 37.2 (CH_2 Ada), 34.0 (C_q Ada), 29.1, 29.1 (2×CH_2 pentyl), 28.2 (CH Ada), 23.5 (CH_2-3 pentyl). IR ν_{max}(thin film)/ cm^{-1}: 3288, 2899, 2847, 1666, 1540, 1452, 1382, 1232, 1157, 110, 753. HRMS: found 280.2272 $[M+H]^+$; calculated for $[C_{17}H_{29}NO_2+H]^+$ 280.2271.

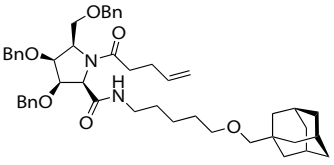


***N*-[5-(Adamantan-1-yl-methoxy)-pentan]isocyanide (31).** Phosphorylchloride (0.51 mL, 5.49 mmol) was added dropwise to a dry and cooled (−30 °C) solution of **30** (1.02 g, 3.66 mmol) and Et_3N (2.54 mL, 18.3 mmol) in DCM (19 mL). The reaction mixture was stirred for 1 h at −30 °C, after which TLC analysis indicated complete consumption of **30**. The dark brown reaction mixture was quenched by addition of sat aq $NaHCO_3$ (5 mL).The reaction mixture was diluted with Et_2O (100 mL) and washed successively with sat aq $NaHCO_3$ (2×100 mL) and brine (50 mL). The organic phase was dried (Na_2SO_4) and concentrated. The resulting residue was purified by silica gel column chromatography (20% » 100% DCM in hexane) to afford **31** (773 mg, 2.96 mmol) in 81% yield as a colourless oil. Isocyanide **31** was preferably used immediately but was stable when stored at −20 °C under argon. R_F = 0.90 (EtOAc); 0.40 (1:9; EtOAc:PE); $KMnO_4$ staining. ^{1}H NMR (400 MHz, $CDCl_3$) δ 3.43 – 3.34 (m, 4H, CH_2-1 pentyl, CH_2-5 pentyl), 2.95 (s, 2H, OCH_2-Ada), 1.95 (s, 3H, 3×CH Ada), 1.76 – 1.45 (m, 18H, 6×CH_2 Ada, 3×CH_2 pentyl). ^{13}C NMR (100 MHz, $CDCl_3$) δ 155.9 (t, J_{CN} = 5.5, NC), 81.9 (OCH_2-Ada), 71.0 (CH_2-5 pentyl), 41.5(t, $J_{N\text{-}C1}$ = 6.4, CH_2-1), 39.7 (CH_2 Ada), 37.2 (CH_2 Ada), 34.0 (C_q Ada), 28.9, 28.6, 28.3 (CH Ada), 23.2 (CH_2-3 pentyl). IR ν_{max}(thin film)/ cm^{-1}: 2900, 2847, 2146, 1453, 1358, 1157, 1102,, 2929, 1652, 1460, 1058.

***N*-(1-Cyclohexene)isocyanide (33).** Phorphorylchloride (1.15 mL, 12.35 mmol) was added dropwise to a dry and cooled (−30 °C) solution of known[20,21] *N*-(1-cyclohexene)formamide (**32**: 1.03 g, 8.23 mmol) and Et_3N (5.70 mL, 41.1 mmol) in DCM (41 mL). The reaction mixture was stirred for 1 h at −30 °C, after which TLC analysis indicated complete consumption of **32**. The dark brown reaction mixture was quenched by addition of sat aq $NaHCO_3$ (5 mL).The reaction mixture was diluted with Et_2O (100 mL) and washed successively with sat aq $NaHCO_3$ (2×100 mL) and brine (50 mL). The organic phase was dried (Na_2SO_4) and concentrated. The resulting residue was purified by silica gel column chromatography (20% » 100% DCM in hexane) to afford **33** (574 mg, 5.35 mmol) in 65% yield as a colourless oil. Isocyanide **3** was preferably used immediately, but was stable when stored at −20 °C under argon. R_F **33** = 0.85 (1:1; EtOAc:PE); **32** = 0.40 (1:1; EtOAc:PE); $KMnO_4$ staining. ^{1}H NMR (400 MHz, $CDCl_3$) δ 6.17 – 5.88 (m, 1H, =CH-2), 2.26 – 2.19 (m, 2H, CH_2 3 or 6), 2.15 – 2.07 (m, 2H, CH_2 3 or 6), 1.73 – 1.65 (m, 2H, CH_2 4 or 5), 1.61 – 1.52 (m, 2H, CH_2 4 or 5). ^{13}C NMR (100 MHz, $CDCl_3$) δ 160.1 (t, J_{CN} = 5.7, NC), 129.1 (=CH-2), 124.9 (t, J_{CN} = 11.7, N-C1), 28.6, 24.3 (t, J = 1.6), 21.9, 21.0.

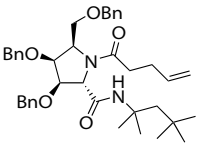


5-(Adamantan-1yl-methoxy)-pentyl 3,4,6-tri-*O*-benzyl-2,5-dideoxy-2,5-(pent-4-enimido)-D-*talo*-hexonamide (A1-I). Subjecting azido-aldehyde **6** (750 µmol) to the tandem SAWU-3CR (General procedure B in the presence of $InCl_3$ in CH_3CN) produced a separable 1.7:1 mixture of **A1-I** (170 mg, 223 µmol) and **B1-I** (100 mg, 131 µmol) in a combined yield of 47%. R_F = 0.49 (2:3; EtOAc:toluene). ^{1}H NMR (600 MHz, $CDCl_3$) 10:1 mixture of rotamers; major rotamer: δ 7.36 – 7.23 (m, 15H, H_{Ar} Bn), 6.63 (t, J = 5.6, 1H, C(O)NH), 5.76 (ddt, J = 6.5, 10.2, 16.8, 1H, =CH pentenyl), 5.00 – 4.91 (m, 2H, =CH_2 pentenyl), 4.67 (d, J = 12.0, 1H, C*H*H Bn), 4.61 (d, J = 11.6, 1H, C*H*H Bn), 4.59 – 4.55 (m, 2H, 2×CH*H* Bn), 4.48 (d, J = 11.9, 1H, C*H*H Bn), 4.46 (dd, J = 4.3, 7.8, 1H, H-4), 4.42 (d, J = 11.9, 1H, CH*H* Bn), 4.39 (s, 1H, H-2), 4.38 – 4.35 (m, 1H, H-5), 4.13 (dd, J = 3.5, 10.6, 1H, H-6a), 4.06 (d, J = 4.3, 1H, H-3), 3.70 (dd, J = 6.1, 10.6, 1H, H-6b), 3.35 (t, J = 6.6, 2H, CH_2-5 pentyl), 3.20 (dt, J = 7.1, 13.5, 1H, NC*H*H-1 pentyl), 3.07 (dt, J = 7.1, 12.7, 1H, NCH*H*-1 pentyl), 2.94 (s, 2H, OCH_2-Ada), 2.75 (ddd, J = 6.3, 8.8, 15.4, 1H, NC*H*H pentenyl), 2.53 (ddd, J = 6.4, 8.9, 15.6, 1H, NCH*H* pentenyl), 2.40 – 2.25 (m, 2H, CH_2 pentenyl), 1.95 (s, 3H, 3×CH Ada), 1.67 (dd, J = 12.1, 36.2, 6H, 3×CH_2 Ada), 1.59 – 1.49 (m, 8H, 3×CH_2 Ada, CH_2-4 pentyl), 1.49 – 1.42 (m, 2H, CH_2-2 pentyl), 1.36 – 1.29 (m, 2H, CH_2-3 pentyl). ^{13}C NMR (150 MHz, $CDCl_3$) major rotamer: δ 174.3 (NC=O pentenyl), 169.6 (NHC(O)-1), 138.2, 137.9, 137.9 (3×C_q Bn), 137.6 (=CH pentenyl), 128.6, 128.5, 128.0, 128.0, 127.9, 127.8, 127.7 (CH_{Ar} Bn), 115.2 (=CH_2 pentenyl), 82.1 (OCH_2-Ada), 78.9 (C-4), 78.4 (C-3), 73.5, 72.7 (3×CH_2 Bn), 71.7 (C-6), 71.6 (CH_2-5 pentyl), 65.4 (C-2), 59.3 (C-5), 39.9 (CH_2 Ada), 39.8 (NCH_2-1 pentyl), 37.4 (CH_2 Ada), 34.2 (C_q Ada), 33.8 (NCH_2 pentenyl), 29.4, 29.3, 29.3 (CH_2 pentenyl, CH_2-2, CH_2-4 pentyl), 28.4 (CH Ada), 23.7 (CH_2-3 pentyl). IR ν_{max}(thin film)/ cm^{-1}: 3308, 2901, 2848, 1651, 1622, 1545, 1452, 1360, 1146, 1097, 1054, 1027, 911, 734, 696. $[\alpha]^{20}_D$: 25.5 (*c* 2.4, $CHCl_3$). HRMS: found 763.4684 $[M+H]^+$, calculated for $[C_{48}H_{62}O_6N_2+H]^+$ 763.4681.

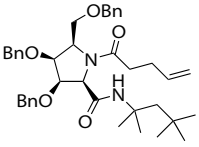


5-(Adamantan-1yl-methoxy)-pentyl 3,4,6-tri-*O*-benzyl-2,5-dideoxy-2,5-(pent-4-enimido)-D-*galacto*-hexonamide (B1-I). Subjecting azido-aldehyde **6** (200 µmol) to the tandem SAWU-3CR (General procedure B in MeOH) produced a separable 1:20 mixture of **A1-I** (4 mg, 5 µmol) and **B1-I** (91 mg, 119 µmol) in a combined yield of 62%. R_F = 0.15 (2:3; EtOAc:toluene). ^{1}H NMR (600 MHz, $CDCl_3$) 2:1 mixture of rotamers; major rotamer: δ 7.41 – 7.12 (m, 15H, H_{Ar} Bn), 6.22 (t, J = 5.7, 1H, C(O)NH), 5.84 – 5.72 (m, 1H, =CH pentenyl), 5.06 – 4.89 (m, 2H), 4.85 – 4.66 (m, 2H, =CH_2 pentenyl), 4.85 – 4.66 (m, 2H), 4.64 (d, J = 6.0, 1H, H-2), 4.60 – 4.46 (m, 3H), 4.44 – 4.40 (m, 1H, H-4), 4.39 – 4.33 (m, 1H, H-5), 4.14 (t, J = 10.1, 1H, H-6a), 3.88 (dd, J = 5.0, 6.7, 1H, H-3), 3.82 (dd, J = 3.3, 10.1, 1H, H-6b), 3.29 – 3.20 (m, 2H, CH_2-5 pentyl), 3.18 – 2.97 (m, 1H, NCH_2-1 pentyl), 2.90 (s, 2H, OCH_2-Ada), 2.87 – 2.72 (m, 2H, NCH_2 pentenyl),

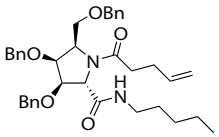
2.45 – 2.27 (m, 2H, CH_2 pentenyl), 1.95 (s, 3H, 3×CH Ada), 1.67 (dd, *J* = 12.7, 38.4, 6H, 3×CH_2 Ada), 1.59 – 0.97 (m, 12H, 3×CH_2 Ada, 3×CH_2 pentyl). ^{13}C NMR (150 MHz, $CDCl_3$) major rotamer: δ 173.7 (NC=O pentenyl), 167.7 (NHC(O)-1), 138.3, 137.7, 137.4 (3×C_q Bn), 137.2 (=CH pentenyl), 128.6 – 127.5 (CH_{Ar} Bn), 115.2 (=CH_2 pentenyl), 81.8 (OCH_2-Ada), 78.8 (C-3), 76.7 (C-4), 74.8, 73.5, 72.4 (3×CH_2 Bn), 71.3(CH_2-5 pentyl), 69.3 (C-6), 64.3 (C-2), 58.5 (C-5), 39.7 (CH_2 Ada), 39.4 (NCH_2-1 pentyl), 37.3 (CH_2 Ada), 34.0 (C_q Ada), 33.4 (NCH_2 pentenyl), 29.3, 29.2, 28.9 (CH_2 pentenyl, CH_2-2, CH_2-4 pentyl), 28.3 (CH Ada), 23.4 (CH_2-3 pentyl). IR ν_{max}(thin film)/ cm^{-1}: 3316, 2901, 2848, 1653, 1532, 1453, 1407, 1359, 1212, 1097, 911, 733, 696. [α]$^{20}_D$: 6.3 (*c* 9.0, $CHCl_3$). HRMS: found 763.4683 [M+H]$^+$, calculated for [$C_{48}H_{62}O_6N_2$+H]$^+$ 763.4681.



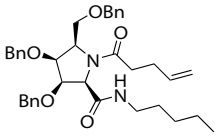
1,1,3,3-Tetramethylbutyl 3,4,6-tri-*O*-benzyl-2,5-dideoxy-2,5-(pent-4-enimido)-D-*talo*-hexonamide (A1-II). Subjecting azido-aldehyde **6** (600 µmol) to the tandem SAWU-3CR (General procedure B in the presence of $InCl_3$ in CH_3CN) produced a separable 5.3:1 mixture of **A1-II** (204 mg, 318 µmol) and **B1-II** (38 mg, 60 µmol) in a combined yield of 63%. R_F = 0.72 (2:3; EtOAc:toluene). ^{1}H NMR (400 MHz, $CDCl_3$) 6:1 mixture of rotamers; major rotamer: δ 7.33 – 7.22 (m, 15H, H_{Ar}), 6.28 (s, 1H, C(O)NH), 5.81 – 5.74 (m, 1H, =CH pentenyl), 4.97 (ddd, *J* = 1.2, 16.8, 37.2, 2H, =CH_2 pentenyl), 4.65 (d, *J* = 12.0, 1H, C*H*H Bn), 4.63 (d, *J* = 12.0, 1H, C*H*H Bn), 5.58 (d, *J* = 12.0, 1H, CH*H* Bn), 4.55 (d, *J* = 12.0, 1H, CH*H* Bn), 4.47 (d, *J* = 12.0, 1H, C*H*H Bn), 4.44 (dd, *J* = 4.2, 7.8 Hz, 1H, H-4), 4.41 (d, *J* = 12.0, 1H, CH*H* Bn), 4.34 – 4.32 (m, 2H, H-2, H-5), 4.16 (dd, *J* = 3.6, 10.8, 1H, H-6a), 4.08 (d, *J* = 4.2, 1H, H-3), 3.69 (dd, *J* = 5.4, 10.8, 1H, H-6b), 2.76 – 2.71 (m, 1H, NC*H*H pentenyl), 2.56 – 2.51 (m, 1H, NCH*H* pentenyl), 2.41 – 2.31 (m, 2H, CH_2 pentenyl), 1.71 (d, *J* = 15.0, 1H, C*H*H-2 tMB), 1.60 (d, *J* = 15.0, 1H, CH*H*-2 tMB), 1.32 (d, *J* = 14.4, 6H, 2×CH_3 tMB), 0.95 (s, 9H, 2×CH_3, CH_3-4 tMB). ^{13}C NMR (100 MHz, $CDCl_3$) major rotamer: δ 174.1 (NC=O pentenyl), 168.1 (NHC(O)-1), 137.8, 137.7, 137.6 (3×C_q Bn), 137.3 (=CH pentenyl), 128.4, 128.3, 128.2, 128.0, 127.6, 127.5, 127.4 (CH_{Ar} Bn), 114.9 (=CH_2 pentenyl), 78.7 (C-4), 77.9 (C-3), 73.2, 72.4 (3×CH_2 Bn), 71.5 (C-6), 65.8 (C-2), 59.1 (C-5), 55.2 (NHC_q-1 tMB), 51.4 (CH_2-2 tMB), 33.6 (NCH_2 pentenyl), 31.4 (C_q-3 tMB), 31.3 (CH_3-4, 2×CH_3 tMB), 29.0 (CH_2 pentenyl), 28.8, 28.6 (2×CH_3 tMB). IR ν_{max}(thin film)/ cm^{-1}: 3329, 2950, 1679, 1624, 1544, 1422, 1096, 733, 696. [α]$^{20}_D$: 22.3 (*c* 6.1, $CHCl_3$). HRMS: found 641.3949 [M+H]$^+$, calculated for [$C_{40}H_{52}O_5N_2$+H]$^+$ 641.3949.



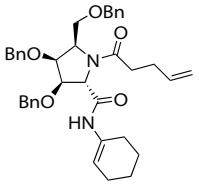
1,1,3,3-Tetramethylbutyl 3,4,6-tri-*O*-benzyl-2,5-dideoxy-2,5-(pent-4-enimido)-D-*galacto*-hexonamide (B1-II). Subjecting azido-aldehyde **6** (500 µmol) to the tandem SAWU-3CR (General procedure B in MeOH) produced a separable 1:15 mixture of **A1-II** (15 mg, 23 µmol) and **B1-II** (216 mg, 338 µmol) in a combined yield of 72%. R_F = 0.24 (2:3; EtOAc:toluene). ^{1}H NMR (400 MHz, $CDCl_3$) 2:1 mixture of rotamers; major rotamer: δ 7.32 – 7.25 (m, 15H, H_{Ar} Bn), 6.02 (s, 1H, C(O)NH), 5.85 – 5.73 (m, 1H, =CH pentenyl), 5.06 – 4.91 (m, 2H, =CH_2 pentenyl), 4.75 (d, *J* = 11.5, 1H, C*H*H Bn), 4.69 (d, *J* = 11.6, 1H, CH*H* Bn), 4.58 (d, *J* = 11.6, 1H, C*H*H Bn), 4.53 – 4.47 (m, 3H, H-2, C*H*H Bn, CH*H* Bn), 4.44 – 4.36 (m, 2H, H-4, CH*H* Bn), 4.34 – 4.27 (m, 1H, H-5), 4.11 (dd, *J* = 10.2, 1H, H-6a), 3.87 (d, *J* = 9.9, 1H, H-6b), 3.83 (dd. *J* = 4.8, 1H, H-3), 2.89 – 2.84 (m, 1H, NC*H*H pentenyl), 2.46 – 2.31 (m, 3H, NCH*H* pentenyl, CH_2 pentenyl), 1.61 (d, *J* = 14.8, 1H, C*H*H-2 tMB), 1.46 (d, *J* = 15.2, 1H, CH*H*-2 tMB), 1.00 (d, *J* = 5.6, 6H, 2×CH_3 tMB), 0.87 (s, 9H, 2×CH_3, CH_3-4 tMB). ^{13}C NMR (100 MHz, $CDCl_3$) major rotamer: δ 173.8 (NC=O pentenyl), 166.3 (NHC(O)-1), 138.0, 137.5 (2×C_q Bn), 137.1 (=CH pentenyl), 137.0 (C_q Bn), 128.3 – 127.1 (CH_{Ar} Bn), 114.9 (=CH_2 pentenyl), 78.7 (C-4), 76.6 (C-3), 74.6, 73.3, 72.0 (3×CH_2 Bn), 69.8 (C-6), 64.7 (C-2), 59.0 (C-5), 55.6 (NHC_q-1 tMB), 53.3 (CH_2-2 tMB), 33.3 (CH_2 pentenyl), 31.4 (C_q-3 tMB), 31.3, 31.2 (2×CH_3-2 tMB), 31.1 (3×CH_3 tMB), 28.6 (CH_2 pentenyl). IR ν_{max}(thin film)/ cm^{-1}: 3323, 2951, 1666, 1521, 1400, 1098, 734, 697. [α]$^{20}_D$: 11.4 (*c* 9.0, $CHCl_3$). HRMS: found 641.3949 [M+H]$^+$, calculated for [$C_{40}H_{52}O_5N_2$+H]$^+$ 641.3949.



Pentyl 3,4,6-tri-*O*-benzyl-2,5-dideoxy-2,5-(pent-4-enimido)-D-*talo*-hexonamide (A1-III). Subjecting azido-aldehyde **6** (750 µmol) to the tandem SAWU-3CR (General procedure B in the presence of $InCl_3$ in CH_3CN) produced a separable 5.4:1 mixture of **A1-III** (128 mg, 215 µmol) and **B1-III** (24 mg, 40 µmol) in a combined yield of 34%. R_F = 0.72 (2:3; EtOAc:toluene). ^{1}H NMR (600 MHz, $CDCl_3$) 5.5:1 mixture of rotamers; major rotamer: δ 7.35 – 7.24 (m, 15H, H_{Ar} Bn), 6.76 (t, *J* = 5.6, 1H, C(O)NH), 5.76 (ddt, *J* = 6.5, 10.2, 16.8, 1H, =CH pentenyl), 4.99 – 4.89 (m, 2H, =CH_2 pentenyl), 4.67 – 4.52 (m, 4H, 2×CH_2 Bn), 4.50 – 4.45 (m, 2H, H-4, C*H*H Bn), 4.43 (s, *J* = 12.2, CH*H* Bn), 4.42 (s, 1H, H2), 4.40 – 4.36 (m, 1H, H-5), 4.13 (dd, *J* = 3.5, 10.6, 1H, H-6a), 4.04 (d, *J* = 4.3, 1H, H-3), 3.70 (dd, *J* = 6.2, 10.6, 1H, H-6b), 3.20 (dt, *J* = 7.1, 13.5, 1H, NC*H*H-1 pentyl), 3.04 (dt, *J* = 7.2, 12.7, 1H, NCH*H*-1 pentyl), 2.75 (ddd, *J* = 6.2, 8.9, 15.5, 1H, NC*H*H pentenyl), 2.54 (ddd, *J* = 6.3, 9.0, 15.6, 1H, NCH*H* pentenyl), 2.44 – 2.26 (m, 2H, CH_2 pentenyl), 1.46 – 1.39 (m, 2H, CH_2-2 pentyl), 1.33 – 1.21 (m, 4H, CH_2-3, CH_2-4 pentyl), 0.88 (t, *J* = 7.2, 3H, CH_3-5 pentyl). ^{13}C NMR (150 MHz, $CDCl_3$) major rotamer: δ 174.3 (NC=O pentenyl), 169.6 (NHC(O)-1), 138.2, 137.9, 137.8 (3×C_q Bn), 137.6 (=CH pentenyl), 129.0, 128.6, 128.6, 128.5, 128.4, 128.3, 128.0, 128.0, 127.9, 127.8, 127.7, 127.6 (CH_{Ar} Bn), 115.2 (=CH_2 pentenyl), 78.8 (C-4), 78.4 (C-3), 73.4, 72.6, 72.5 (3×CH_2 Bn), 71.7 (C-6), 65.4 (C-2), 59.2 (C-5), 39.7 (NCH_2-1 pentyl), 33.8 (NCH_2 pentenyl), 29.3 (CH_2 pentenyl), 29.2, 29.1, 22.5 (3×CH_2 pentyl), 14.2. IR ν_{max}(thin film)/ cm^{-1}: 3312, 2956, 2929, 2869, 1652, 1622, 1557, 1453, 1434, 1361, 1143, 1097, 1027, 1000, 911, 734, 697. $[\alpha]^{20}_D$: 26.6 (*c* 2.5, $CHCl_3$). HRMS: found 599.3478 $[M+H]^+$, calculated for $[C_{37}H_{46}O_5N_2+H]^+$ 599.3479.

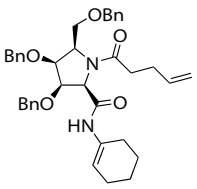


Pentyl 3,4,6-tri-*O*-benzyl-2,5-dideoxy-2,5-(pent-4-enimido)-D-*galacto*-hexonamide (B1-III). Subjecting azido-aldehyde **6** (194 µmol) to the tandem SAWU-3CR (General procedure B in MeOH) produced a separable 1:21 mixture of **A1-III** (5 mg, 8 µmol) and **B1-III** (104 mg, 174 µmol) in a combined yield of 94%. R_F = 0.40 (2:1; EtOAc:toluene). ^{1}H NMR (600 MHz, $CDCl_3$) 2:1 mixture of rotamers; major rotamer: δ 7.38 – 7.20 (m, 15H, H_{Ar} Bn), 6.19 (t, *J* = 5.5, 1H, C(O)NH), 5.84 – 5.74 (m, 1H, =CH pentenyl), 5.07 – 4.91 (m, 2H, =CH_2 pentenyl), 4.86 – 4.46 (m, 7H, H-2, 3×CH_2 Bn), 4.44 – 4.41 (m, 1H, H-4), 4.39 – 3.34 (m, 1H, H-5), 4.14 (dd, *J* = 10.2, 1H, H-6a), 3.88 (dd, *J* = 5.0, 6.7, 1H, H-3), 3.83 (dd, *J* = 3.6, 10.3, 1H, H-6b), 3.19 – 2.97 (m, 2H, NCH_2-1 pentyl), 2.97 – 2.69 (m, 2H, NCH_2 pentenyl), 2.46 – 2.29 (m, 2H, CH_2 pentenyl), 1.35 – 0.94 (m, 6H, 3×CH_2 pentyl), 0.80 – 0.73 (m, 6H, CH_3-5 pentyl). ^{13}C NMR (150 MHz, $CDCl_3$) major rotamer: δ 173.8 (NC=O pentenyl), 167.7 (NHC(O)-1), 138.4, 137.8, 137.5 (3×C_q Bn), 137.2 (=CH pentenyl), 128.7 – 127.5 (CH_{Ar} Bn), 115.2 (=CH_2 pentenyl), 78.8 (C-4), 76.8 (C-3), 74.9, 73.6, 72.4 (3×CH_2 Bn), 69.4 (C-6), 64.4 (C-2), 58.6 (C-5), 39.4 (NCH_2-1 pentyl), 33.5 (NCH_2 pentenyl), 29.0, 22.3, 14.1 (CH_3-5 pentyl). IR ν_{max}(thin film)/ cm^{-1}: 3320, 2939, 2868, 1652, 1532, 1454, 1406, 1212, 1142, 1096, 1025, 911, 734, 696. $[\alpha]^{20}_D$: 8.9 (*c* 4.2, $CHCl_3$). HRMS: found 599.3478 $[M+H]^+$, calculated for $[C_{37}H_{46}O_5N_2+H]^+$ 599.3479.

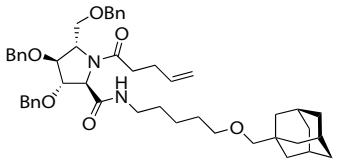


1-Cyclohexenyl 3,4,6-tri-*O*-benzyl-2,5-dideoxy-2,5-(pent-4-enimido)-D-*talo*-hexonamide (A1-IV). Subjecting azido-aldehyde **6** (750 µmol) to the tandem SAWU-3CR (General procedure B in the presence of $InCl_3$ in CH_3CN) produced a separable 1:4.2 mixture of **A1-IV** (20 mg, 33 µmol) and **B1-IV** (84 mg, 139 µmol) in a combined yield of 23%. R_F = 0.72 (2:3; EtOAc:toluene). ^{1}H NMR (600 MHz, $CDCl_3$) 8.7:1 mixture of rotamers; major rotamer: δ 7.74 (s, 1H, C(O)NH), 7.47 – 6.94 (m, 15H, H_{Ar} Bn), 6.11 – 6.03 (m, 1H, =CH-2 cyclohexenyl), 5.84 – 5.68 (m, 1H, =CH pentenyl), 5.04 – 4.88 (m, 2H, =CH_2 pentenyl), 4.73 – 4.40 (m, 10H, 3×CH_2 Bn, H-2, H-4), 4.37 – 4.32 (m, 1H, H-5), 4.23 – 4.09 (m, 2H, H-3, H-6a), 3.68 (dd, *J* = 5.9, 10.6, 1H, H-6b), 2.77 – 2.70 (m, 1H, NC*H*H pentenyl), 2.58 – 2.50 (m, 1H, NCH*H* pentenyl), 2.41 – 2.27 (m, 2H, CH_2 pentenyl), 2.12 – 1.93 (m, 4H, CH_2-2, CH_2-3 cyclohexenyl), 1.77 – 1.45 (m, 4H, CH_2-2, CH_2-3 cyclohexenyl). ^{13}C NMR (151 MHz, CDCl3) major rotamer: δ 174.6 (NC=O pentenyl), 167.8 (NHC(O)-1), 138.2, 138.0, 137.9 (3×C_q Bn), 137.5 (=CH pentenyl), 132.8 (C_q-1 cyclohexenyl), 128.6, 128.6, 128.5, 128.1, 128.0, 127.9, 127.8, 127.7 (CH_{Ar} Bn), 115.3 (=CH_2 pentenyl),

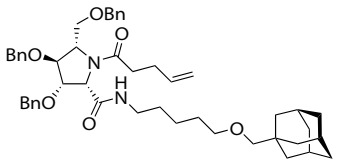
112.9 (=CH-2 cyclohexenyl), 79.0 (C-4), 78.3 (C-3), 73.5, 72.8, 72.7 (3×CH_2 Bn), 71.8 (C-6), 65.9 (C-2), 59.4 (C-5), 33.9 (NCH_2 pentenyl), 29.3 (CH_2 pentenyl), 28.0 (CH_2-3 cyclohexenyl), 24.2 (CH_2-4 cyclohexenyl), 22.6, 22.1 (2×CH_2 cyclohexenyl). IR ν_{max}(thin film)/ cm^{-1}: 3310, 2929, 2860, 1683, 1622, 1558, 1453, 1362, 1210, 1096, 1027, 914, 35, 698. $[\alpha]^{20}_D$: 3.2 (*c* 0.5, $CHCl_3$). HRMS: found 609.3323 $[M+H]^+$, calculated for $[C_{38}H_{44}O_5N_2+H]^+$ 609.3323.



1-Cyclohexenyl 3,4,6-tri-*O*-benzyl-2,5-dideoxy-2,5-(pent-4-enimido)-D-*galacto*-hexonamide (B1-IV). Subjecting azido-aldehyde **6** (750 µmol) to the tandem SAWU-3CR (General procedure B in MeOH) produced a separable 1:11 mixture of **A1-IV** (21 mg, 34 µmol) and **B1-IV** (228 mg, 371 µmol) in a combined yield of 54%. R_F = 0.40 (2:1; EtOAc:toluene). ^{1}H NMR (600 MHz, $CDCl_3$) 2:1 mixture of rotamers; major rotamer: δ 8.23 (s, 1H, C(O)NH), 7.56 – 7.17 (m, 15H, H_{Ar} Bn), 6.01 (s, 1H, =CH-2 cyclohexenyl), 5.90 – 5.72 (m, 1H, =CH pentenyl), 5.14 – 4.94 (m, 2H, =CH_2 pentenyl), 4.89 – 4.52 (m, 7H, 3×CH_2 Bn, H-2), 4.49 – 4.46 (m, 1H, H-4), 4.45 – 4.39 (m, 1H, H-5), 4.22 – 4.14 (m, 1H, H-6a), 4.00 – 3.89 (m, 1H, H-3), 3.89 – 3.84 (m, 1H, H-6b), 2.99 – 2.81 (m, 1H, NC*H*H pentenyl), 2.51 – 2.34 (m, 3H, NCH_H, CH_2 pentenyl), 2.14 – 1.43 (m, 8H, 4×CH_2 cyclohexenyl). ^{13}C NMR (150 MHz, $CDCl_3$) major rotamer: δ 173.9 (NC=O pentenyl), 165.9 (NHC(O)-1), 138.3, 137.8, 137.4 (3×C_q Bn), 137.3 (=CH pentenyl), 132.2 (C_q-1 cyclohexenyl), 128.6 –127.5 (CH_{Ar} Bn), 115.2 (=CH_2 pentenyl), 113.3 (CH-2 cyclohexenyl), 78.8 (C-3), 76.9 (C-4), 74.8, 73.7, 72.4 (3×CH_2 Bn), 69.4 (C-6), 64.9 (C-2), 58.7 (C-5), 33.4 (NCH_2 pentenyl), 28.9 (CH_2 pentenyl), 27.8, 24.0, 22.5, 22.0 (4×CH_2 cyclohexenyl). IR ν_{max}(thin film)/ cm^{-1}: 3314, 3032, 2930, 2860, 1653, 1529, 1453, 1407, 1359, 1305, 1214, 1142, 1100, 1056, 913, 735, 697. $[\alpha]^{20}_D$: 17.2 (*c* 5.0, $CHCl_3$). HRMS: found 609.3323 $[M+H]^+$, calculated for $[C_{38}H_{44}O_5N_2+H]^+$ 609.3323.

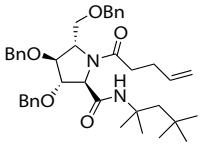


5-(Adamantan-1yl-methoxy)-pentyl 3,4,6-tri-*O*-benzyl-2,5-dideoxy-2,5-(pent-4-enimido)-L-*gulo*-hexonamide (C1-I). Subjecting azido-aldehyde **15** (1.04 mmol) to the tandem SAWU-3CR (General procedure B in MeOH) produced a separable 1:1.9 mixture of **C1-I** (114 mg, 0.15 mmol) and **D1-I** (213 mg, 0.28 mmol) in a combined yield of 41%. R_F = 0.63 (1:1; EtOAc:PE). ^{1}H NMR (400 MHz, $CDCl_3$) 2:1 mixture of rotamers; major rotamer δ 7.37 – 7.20 (m, 15H, H_{Ar} Bn), 6.17 (t, *J* = 5.8, 1H, C(O)NH), 5.84 – 5.71 (m, 1H, =CH pentenyl), 5.10 – 4.92 (m, 2H, =CH_2 pentenyl), 4.70 – 4.41 (m, 7H, 3×CH_2 Bn, H-5), 4.38 (s, 1H, H-2), 4.22 (s, 1H, H-3), 4.18 (s, 1H, H-4), 3.98 (dd, *J* = 4.4, 8.8, 1H), 3.49 (dd, *J* = 8.8, 10.5, 1H, H-6b), 3.27 (t, *J* = 6.5, 2H, CH_2-5 pentyl), 3.17 – 2.92 (m, 2H, NCH_2-1 pentyl), 2.91 (s, 2H, OCH_2-Ada), 2.47 – 2.19 (m, 4H, 2×CH_2 pentenyl), 1.95 (s, 3H, 3×CH Ada), 1.68 (dd, *J* = 12.0, 27.2, 6H, 3×CH_2 Ada), 1.51 (d, *J* = 2.6, 6H, 3×CH_2 Ada), 1.48 – 1.35 (m, 2H, CH_2-2 pentyl), 1.35 – 1.04 (m, 4H, 2×CH_2 pentyl). ^{13}C NMR (100 MHz, $CDCl_3$) major rotamer δ 173.0 (NC=O pentenyl), 169.9 (NHC(O)-1), 138.5, 137.1 (3×C_q Bn), 137.0 (=CH pentenyl), 128.8 – 127.8 (CH_{Ar} Bn), 115.8 (=CH_2 pentenyl), 85.9 (C-4), 82.1 (OCH_2-Ada), 80.9 (C-3), 73.3, 71.9 (2×CH_2 Bn), 71.5 (CH_2-5 pentyl), 71.4 (CH_2 Bn), 69.1 (C-2), 66.8 (C-6), 64.1 (C-5), 39.9 (CH_2 Ada), 39.8 (NCH_2-1 pentyl), 37.5 (CH_2 Ada), 34.3 (C_q Ada), 34.1 (CH_2 pentenyl), 29.3, 29.1, 29.0 (CH_2 pentenyl, 2×CH_2 pentyl), 28.5 (CH Ada), 23.7 (CH_2-3 pentyl). IR ν_{max}(thin film)/ cm^{-1}: 3338, 2901, 2848, 1654, 1648, 1454, 1407, 1206, 1096, 734, 698. $[\alpha]^{20}_D$: 12.8 (*c* 2.2, $CHCl_3$). HRMS: found 763.4683 $[M+H]^+$, calculated for $[C_{48}H_{62}O_6N_2+H]^+$ 763.4681.

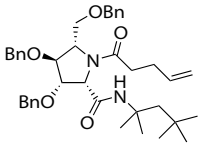


5-(Adamantan-1yl-methoxy)-pentyl 3,4,6-tri-*O*-benzyl-2,5-dideoxy-2,5-(pent-4-enimido)-L-*ido*-hexonamide (D1-I). R_F = 0.50 (1:1; EtOAc:PE). ^{1}H NMR (400 MHz, $CDCl_3$) 6:1 mixture of rotamers; major rotamer δ 7.65 (t, *J* = 5.9, 1H, C(O)NH), 7.45 – 7.19 (m, 15H, H_{Ar} Bn), 5.87 – 5.71 (m, 1H, =CH pentenyl), 5.09 – 4.92 (m, 2H, =CH_2 pentenyl), 4.78 (d, *J* = 11.8, 1H, C*H*H Bn), 4.67 – 4.36 (m, 6H, H-2, H-6a, CH*H* Bn, C*H*H Bn, CH_2 Bn), 4.26 – 4.20 (m, 3H, CH*H* Bn, H-3, H-4),

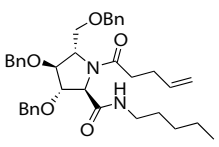
3.84 – 3.79 (m, 1H, H-5), 3.48 (dd, *J* = 1.3, 9.6, 1H, H-6b), 3.26 (t, *J* = 6.6, 2H, CH_2-5 pentyl), 2.92 (s, 2H, OCH_2-Ada), 2.68 – 2.56 (m, 2H, NCH_2-1 pentyl), 2.41 – 2.31 (m, 4H, 2×CH_2 pentenyl), 1.96 (s, 3H, 3×CH Ada), 1.68 (dd, *J* = 11.8, 27.1, 6H, 3×CH_2 Ada), 1.53 (d, *J* = 2.6, 6H, 3×CH_2 Ada), 1.46 – 1.33 (m, 2H, CH_2-2 pentyl), 1.13 – 1.01 (m, 4H, 2×CH_2 pentyl). ^{13}C NMR (100 MHz, $CDCl_3$) major rotamer δ 173.3 (NC=O pentenyl), 168.8 (NHC(O)-1), 138.2, 137.7, 137.0 (3×C_q Bn), 137.1 (=CH pentenyl), 128.8, 128.7, 128.6, 128.5, 128.4, 128.3, 128.1, 128.1, 128.0, 127.9 (CH_{Ar} Bn), 115.7 (=CH_2 pentenyl), 82.1 (OCH_2-Ada), 82.1, 79.0 (C-3, C-4), 73.8, 73.4, 73.0 (3×CH_2 Bn), 71.7 (CH_2-5 pentyl), 66.6 (C-6), 63.4 (C-2), 60.2 (C-5), 40.0 (CH_2 Ada), 39.2 (NCH_2-1 pentyl), 37.5 (CH_2 Ada), 34.3 (C_q Ada), 33.5 (CH_2 pentenyl), 29.8, 29.5, 29.3, 28.8 (CH_2 pentenyl, 2×CH_2 pentyl), 28.5 (CH Ada), 23.6 (CH_2-3 pentyl). IR ν_{max}(thin film)/ cm^{-1}: 3322, 2902, 2848, 1664, 1560, 1454, 1406, 1095, 1028, 737, 698. $[\alpha]^{20}_D$: 16.8 (*c* 4.0, $CHCl_3$).HRMS: found 763.4684 $[M+H]^+$, calculated for $[C_{48}H_{62}O_6N_2+H]^+$ 763.4681.



1,1,3,3-Tetramethylbutyl 3,4,6-tri-*O*-benzyl-2,5-dideoxy-2,5-(pent-4-enimido)-L-*gulo*-hexonamide (C1-II). Subjecting azido-aldehyde **15** (1.59 mmol) to the tandem SAWU-3CR (General procedure B in MeOH) produced a separable 1:1.1 mixture of **C1-II** (269 mg, 0.42 mmol) and **D1-II** (282 mg, 0.44 mmol) in a combined yield of 54%. R_F = 0.75 (1:1; EtOAc:PE). ^{1}H NMR (400 MHz, $CDCl_3$) 4:1 mixture of rotamers; major rotamer δ 7.40 – 7.18 (m, 15H, H_{Ar} Bn), 6.13 (s, 1H, C(O)NH), 5.88 – 5.73 (m, 1H, =CH pentenyl), 5.08 – 4.93 (m, 2H, =CH_2 pentenyl), 4.70 – 4.39 (m, 7H, H-5, 3×CH_2 Bn), 4.24 (s, 1H, H-2), 4.21 (s, 1H, H-3), 4.16 (s, 1H, H-4), 3.99 (dd, *J* = 4.3, 8.8, 1H, H-6a), 3.45 (dd, *J* = 8.8, 10.9, 1H, H-6b), 2.43 – 2.24 (m, 4H, 2×CH_2 pentenyl), 1.48 – 1.32 (m, 2H, CH_2-2 tMB), 1.23 (s, 3H, CH_3 tMB), 1.18 (s, 3H, CH_3 tMB), 0.85 (s, 9H, CH_3-4, 2×CH_3 tMB). ^{13}C NMR (100 MHz, $CDCl_3$) major rotamer δ 172.9 (NC=O pentenyl), 168.7 (NHC(O)-1), 138.5, 137.2, 136.9 (3×C_q Bn), 137.1 (=CH pentenyl), 128.7, 128.7, 128.5, 128.4, 128.3, 128.1, 128.0, 127.8, 127.8 (CH_{Ar} Bn), 115.8 (=CH_2 pentenyl), 85.9 (C-4), 81.3 (C-3), 73.3, 71.8 (3×CH_2 Bn), 70.0 (C-2), 66.7 (C-6), 64.0 (C-5), 55.8 (NHC_q-1 tMB), 53.4 (CH_2-2 tMB), 34.2 (NCH_2 pentenyl), 31.6 (CH_3-4, 2×CH_3 tMB, C_q-3 tMB), 28.9 (CH_2 pentenyl), 28.3, 27.3 (2×CH_3 tMB). IR ν_{max}(thin film)/ cm^{-1}: 2952, 1654, 1560, 1458, 1096, 736, 698, 668. $[\alpha]^{20}_D$: 11.2 (*c* 2.0, $CHCl_3$). HRMS: found 641.3949 $[M+H]^+$, calculated for $[C_{40}H_{52}O_5N_2+H]^+$ 641.3949.

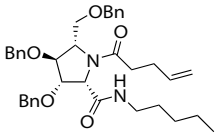


1,1,3,3-Tetramethylbutyl 3,4,6-tri-*O*-benzyl-2,5-dideoxy-2,5-(pent-4-enimido)-L-*ido*-hexonamide (D1-II). R_F = 0.65 (1:1; EtOAc:PE). ^{1}H NMR (400 MHz, $CDCl_3$) 5:1 mixture of rotamers; major rotamer δ 7.41 – 7.14 (m, 15H, H_{Ar} Bn), 6.99 (s, 1H, C(O)NH), 5.83 (ddd, *J* = 6.3, 12.3, 16.8, 1H, =CH pentenyl), 5.09 – 4.90 (m, 2H, =CH_2 pentenyl, C*H*H Bn), 4.65 (d, *J* = 11.7, 1H, C*H*H Bn), 4.59 – 4.41 (m, 5H, H-2, CH_2 Bn, 2×CH*H* Bn), 4.26 – 4.20 (m, 2H, H-3, H-4), 4.17 (dd, *J* = 4.3, 9.7, 1H, H-6a), 3.95 – 3.89 (m, 1H, H-5), 3.50 (dd, *J* = 2.3, 9.7, 1H, H-6b), 2.45 – 2.29 (m, 4H, 2×CH_2 pentenyl), 1.92 (d, *J* = 14.8, 1H, C*H*H-2 tMB), 1.59 (d, *J* = 14.5, 1H, CH*H*-2 tMB), 1.32 (d, *J* = 9.6, 6H, 2×CH_3 tMB), 0.93 (s, 9H, CH_3-4, 2×CH_3 tMB). ^{13}C NMR (100 MHz, $CDCl_3$) major rotamer δ 173.8 (NC=O pentenyl), 167.9 (NHC(O)-1), 138.0, 137.7, 137.6 (3×C_q Bn), 137.1 (=CH pentenyl), 128.7, 128.5, 128.2, 128.2, 128.0, 127.8 (CH_{Ar} Bn), 115.7 (=CH_2 pentenyl), 82.7, 79.3 (C-3, C-4), 73.4, 73.0, 72.8 (3×CH_2 Bn), 66.1 (C-6), 64.5 (C-2), 60.7 (C-5), 55.7 (NHC_q-1 tMB), 51.5 (CH_2-2 tMB), 33.7 (NCH_2 pentenyl), 31.7 (CH_3-4, 2×CH_3 tMB), 31.6 (C_q-3 tMB), 29.4, 28.8 (2×CH_3 tMB), 28.8 (CH_2 pentenyl). IR ν_{max}(thin film)/ cm^{-1}: 2952, 2361, 2343, 1668, 1540, 1455, 1398, 1365, 1206, 1096, 1028, 736, 698, 668. $[\alpha]^{20}_D$: 12.1 (*c* 2.1, $CHCl_3$). HRMS: found 641.3949 $[M+H]^+$, calculated for $[C_{40}H_{52}O_5N_2+H]^+$ 641.3949.

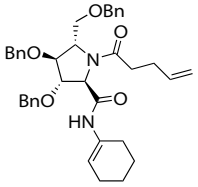


Pentyl 3,4,6-tri-*O*-benzyl-2,5-dideoxy-2,5-(pent-4-enimido)-L-*gulo*-hexonamide (C1-III). Subjecting azido-aldehyde **15** (3.39 mmol) to the tandem SAWU-3CR (General procedure B in MeOH) produced a separable 1:2.1 mixture of **C1-III** (285 mg, 0.48 mmol) and **D1-III** (585 mg, 0.98 mmol) in a combined yield of 43%. R_F = 0.65 (1:1; EtOAc:PE). ^{1}H NMR (600 MHz, $CDCl_3$) 3.5:1 mixture of rotamers; major rotamer δ 7.39

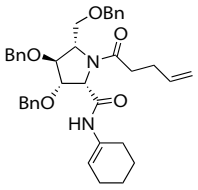
– 7.20 (m, 15H, H_{Ar} Bn), 6.16 (t, *J* = 5.6, 1H, C(O)NH), 5.83 – 5.72 (m, 1H, =CH pentenyl), 5.07 – 4.93 (m, 2H, $=CH_2$ pentenyl), 4.68 – 4.39 (m, 7H, H-5, 3×CH_2 Bn), 4.38 (s, 1H, H-2), 4.22 (s, 1H, H-3), 4.18 (s, 1H, H-4), 3.98 (dd, *J* = 4.4, 8.8, 1H, H-6a), 3.49 (dd, *J* = 9.7, 1H, H-6b), 3.13 – 3.05 (m, 1H, NC*H*H-1 pentyl), 2.97 – 2.86 (m, 1H, NCH*H*-1 pentyl), 2.48 – 2.24 (m, 4H, 2×CH_2 pentenyl), 1.28 – 1.06 (m, 6H, 3×CH_2 pentyl), 0.81 (t, *J* = 7.2, 3H, CH_3-5 pentyl). ^{13}C NMR (150 MHz, $CDCl_3$) major rotamer δ 173.0 (NC=O pentenyl), 169.9 (NHC(O)-1), 138.5, 137.7, 137.1 (3×C_q Bn), 137.0 (=CH pentenyl), 128.7, 128.7, 128.6, 128.3, 128.2, 127.9, 127.9, 127.8 (CH_{Ar} Bn), 115.8 ($=CH_2$ pentenyl), 85.9 (C-4), 80.9 (C-3), 73.3, 71.9, 71.5 (3×CH_2 Bn), 69.1 (C-2), 66.8 (C-6), 64.1 (C-2), 39.8 (NCH_2-1 pentyl), 34.1 (NCH_2 pentenyl), 29.2, 28.9, 22.4 (CH_2 pentyl/pentenyl), 14.1 (CH_3-5 pentyl). IR ν_{max}(thin film)/ cm^{-1}: 3325, 2930, 1652, 1540, 1455, 1366, 1097, 737, 699. $[\alpha]^{20}_D$: 17.3 (*c* 0.3, $CHCl_3$). HRMS: found 599.3478 $[M+H]^+$, calculated for $[C_{37}H_{46}O_5N_2+H]^+$ 599.3479.



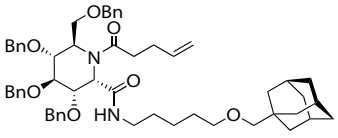
Pentyl 3,4,6-tri-*O*-benzyl-2,5-dideoxy-2,5-(pent-4-enimido)-L-*ido*-hexonamide (D1-III). R_F = 0.55 (1:1; EtOAc:PE). ^{1}H NMR (600 MHz, $CDCl_3$) 9:1 mixture of rotamers; major rotamer δ 7.65 (t, *J* = 5.8, 1H, C(O)NH), 7.43 – 7.15 (m, 15H, H_{Ar} Bn), 5.83 – 5.76 (m, 1H, =CH pentenyl), 5.05 – 4.97 (m, 3H, $=CH_2$ pentenyl, C*H*H Bn), 4.78 (d, *J* = 11.8, 1H, C*H*H Bn), 4.60 – 4.55 (m, 2H, H-2 (d, *J* = 6.9), CH*H* Bn), 4.53 (d, *J* = 11.2, 1H, CH*H* Bn), 4.45 – 4.39 (m, 2H, H-6a, C*H*H Bn), 4.25 – 4.21 (m, 3H, H-3, H-4, CH*H* Bn), 3.81 (d, *J* = 4.4, 1H, H-5), 3.48 (d, *J* = 10.6, 1H, H-6b), 2.69 (dt, *J* = 6.4, 13.4, 1H, NC*H*H-1 pentyl), 2.60 (dt, *J* = 6.1, 13.4, 1H, NCH*H*-1 pentyl), 2.41 – 2.32 (m, 3H, NC*H*H pentenyl, CH_2 pentenyl), 2.23 – 2.15 (m, 1H, NC*H*H pentenyl), 1.22 – 1.12 (m, 2H, CH_2-2 pentyl), 1.11 – 0.98 (m, 4H, 2×CH_2 pentyl), 0.81 (t, *J* = 7.4, 3H, CH_3-5 pentyl). ^{13}C NMR (150 MHz, $CDCl_3$) major rotamer δ 173.4 (NC=O pentenyl), 168.8 (NHC(O)-1), 138.2, 137.7, 137.1 (3×C_q Bn), 137.0 (=CH pentenyl), 128.8, 128.8, 128.6, 128.6, 128.6, 128.6, 128.5, 128.2, 128.1 (CH_{Ar} Bn), 115.7 ($=CH_2$ pentenyl), 82.1, 79.0 (C-3, C-4), 73.8, 73.4, 73.1 (3×CH_2 Bn), 66.5 (C-6), 63.4 (C-2), 60.2 (C-5), 39.2 (NCH_2-1 pentyl), 33.5 (CH_2 pentenyl), 29.6, 29.1, 28.8, 22.6 (CH_2 pentyl/pentenyl), 14.2 (CH_3-5 pentyl). IR ν_{max}(thin film)/ cm^{-1}: 3330, 2940, 1667, 1538, 1365, 1096, 737, 700. $[\alpha]^{20}_D$: 23.3 (*c* 0.3, $CHCl_3$). HRMS: found 599.3477 $[M+H]^+$, calculated for $[C_{37}H_{46}O_5N_2+H]^+$ 599.3479.



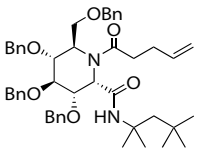
1-Cyclohexenyl 3,4,6-tri-*O*-benzyl-2,5-dideoxy-2,5-(pent-4-enimido)-L-*gulo*-hexonamide (C1-IV). Subjecting azido-aldehyde **15** (0.60 mmol) to the tandem SAWU-3CR (General procedure B in MeOH) produced a separable 1:2.4 mixture of **C1-IV** (49 mg, 0.08 mmol) and **D1-IV** (116 mg, 0.19 mmol) in a combined yield of 45%. R_F = 0.67 (1:1; EtOAc:PE). ^{1}H NMR (400 MHz, $CDCl_3$) 2.5:1 mixture of rotamers; major rotamer δ 7.40 – 7.20 (m, 15H, H_{Ar} Bn), 7.07 (s, 1H, C(O)NH), 5.88 – 5.68 (m, 2H, =CH pentenyl, =CH-1 cyclohexenyl), 5.08 – 4.92 (m, 2H, $=CH_2$ pentenyl), 4.71 – 4.41 (m, 7H, H-5, 3×CH_2 Bn), 4.36 (s, 1H, H-2), 4.24 (s, 1H, H-3), 4.21 (s, 1H, H-4), 3.96 (dd, *J* = 4.4, 8.8, 1H, H-6a), 3.50 (dd, *J* = 9.1, 10.4, 1H, H-6b), 2.55 – 2.17 (m, 4H, 2×CH_2 pentenyl), 2.05 – 1.34 (m, 8H, 4×CH_2 cyclohexenyl). ^{13}C NMR (100 MHz, $CDCl_3$) major rotamer δ 173.1 (NC=O pentenyl), 168.0 (NHC(O)-1), 138.5, 137.1, 137.0 (3×C_q Bn), 136.7 (=CH pentenyl), 132.2 ($=C_q$-1 cyclohexenyl), 128.7, 128.7, 128.6, 128.4, 128.2, 128.2, 128.1, 127.9, 127.8, 127.8 (CH_{Ar} Bn), 115.8 ($=CH_2$ pentenyl), 114.1 (=CH-2 cyclohexenyl), 85.9 (C-4), 81.0 (C-3), 73.3, 72.0, 71.9 (3×CH_2 Bn), 69.9 (C-2), 66.7 (C-6), 64.1 (C-5), 34.1 (NCH_2 pentenyl), 28.9 (CH_2 pentenyl), 27.4, 24.1, 22.5, 22.0 (4×CH_2 cyclohexenyl). IR ν_{max}(thin film)/ cm^{-1}: 2928, 1652, 1539, 1455, 1099, 737, 698, 668. $[\alpha]^{20}_D$: 2.0 (*c* 1.0, $CHCl_3$). HRMS: found 609.3322 $[M+H]^+$, calculated for $[C_{38}H_{44}O_5N_2+H]^+$ 609.3323.



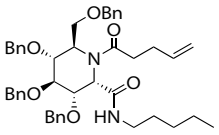
1-Cyclohexenyl 3,4,6-tri-*O*-benzyl-2,5-dideoxy-2,5-(pent-4-enimido)-L-*ido*-hexonamide (D1-IV). R_F = 0.54 (1:1; EtOAc:PE). ^{1}H NMR (500 MHz, $CDCl_3$) 5:1 mixture of rotamers; major rotamer δ 8.35 (s, 1H), 7.43 – 7.16 (m, 15H, H_{Ar} Bn), 5.89 – 5.72 (m, 2H, =CH pentenyl, =CH-1 cyclohexenyl), 5.09 – 4.93 (m, 3H, =CH_2 pentenyl, C*H*H Bn), 4.69 (d, *J* = 11.5, 1H, C*H*H Bn), 4.59 (d, *J* = 7.7, 1H, H-2), 4.58 – 4.35 (m, 4H, CH*H* Bn, CH_2 Bn), 4.30 (dd, *J* = 3.6, 9.8, 1H, H-6a), 4.23 (d, *J* = 7.5, 1H, H-3), 4.23 (d, *J* = 3.4, 1H, H-4), 3.89 – 3.86 (m, 1H, H-5), 3.50 (dd, *J* = 1.7, 9.6, 1H, H-6b), 2.43 – 2.22 (m, 4H, 2×CH_2 pentenyl), 2.12 – 1.92 (m, 4H, 2×CH_2 cyclohexenyl), 1.63 – 1.46 (m, 4H, 2×CH_2 cyclohexenyl). ^{13}C NMR (125 MHz, $CDCl_3$) major rotamer δ 173.6 (NC=O pentenyl), 167.3 (NHC(O)-1), 138.0, 137.6, 137.3, 137.1, 132.7 (=C_q-1 cyclohexenyl), 128.7, 128.6, 128.5, 128.5, 128.5, 128.1, 128.0, 128.0, 127.9, 127.9, 127.7, 127.7 (CH_{Ar} Bn), 115.7 (=CH_2 pentenyl), 115.4 (=CH-2 cyclohexenyl), 82.2, 79.8 (C-3, C-4), 73.4, 73.4, 73.1 (3×CH_2 Bn), 66.1 (C-6), 64.1 (C-2), 60.5 (C-5), 33.6 (NCH_2 pentenyl), 28.8 (CH_2 pentenyl), 27.9, 24.2, 22.7, 21.9 (4×CH_2 cyclohexenyl). IR ν_{max}(thin film)/ cm^{-1}: 2928, 1668, 1540, 1455, 1102, 736, 697, 668. [α]$^{20}_D$: 7.3 (*c* 2.3, $CHCl_3$). HRMS: found 609.3322 [M+H]$^+$, calculated for [$C_{38}H_{44}O_5N_2$+H]$^+$ 609.3323.



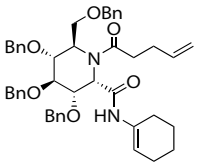
5-(Adamantan-1yl-methoxy)-pentyl 3,4,5,7-tetra-*O*-benzyl-2,6-dideoxy-2,6-(pent-4-enimido)-D-*glycero*-D-*ido*-heptonamide (E1-I). Subjecting azido-aldehyde **26** (1.01 mmol) to the tandem SAWU-3CR (General procedure B in MeOH) produced **E1-I** (655 mg, 0.74 mmol) in a yield of 73%. R_F = 0.50 (1:2; EtOAc:toluene). ^{1}H NMR (500 MHz, $CDCl_3$) collapsed iminosugar signals δ 7.44 – 7.16 (m, 21H, H_{Ar} Bn, C(O)NH), 5.85 – 5.74 (m, 1H, =CH pentenyl), 4.97 (dd, *J* = 13.5, 34.2, 2H, =CH_2 pentenyl), 4.86 – 3.43 (m, 15H, 4×CH_2 Bn, H-2, H-3, H-4, H-5, H-6, CH_2-7), 3.25 (t, *J* = 6.6, 2H, CH_2-5 pentyl), 3.02 – 2.87 (m, 4H, NCH_2-1 pentyl, OCH_2-Ada), 2.50 – 2.21 (m, 4H, 2×CH_2 pentenyl), 1.95 (s, 3H, 3×CH Ada), 1.67 (dd, *J* = 11.9, 32.0, 6H, 3×CH_2 Ada), 1.52 (d, *J* = 1.9, 6H, 3×CH_2 Ada), 1.43 – 1.34 (m, 2H, CH_2 pentyl), 1.20 – 1.07 (m, 4H, 2×CH_2 pentyl). ^{13}C NMR (125 MHz, $CDCl_3$) collapsed iminosugar signals δ 174.5 (NC=O pentenyl), 168.2 (NHC(O)-1), 138.3, 137.8, 137.6, 137.2 (4×C_q Bn), 137.4 (=CH pentenyl), 128.5, 128.5, 128.5, 128.4, 128.3, 128.0, 127.9, 127.8, 127.7 (CH_{Ar} Bn), 115.3 (=CH_2 pentenyl), 82.0 (OCH_2-Ada), 73.4, 73.2, 72.0, 71.5 (CH_2-5 pentyl), 70.9, 68.8 (C-7), 39.8 (CH_2 Ada), 39.4 (NCH_2-1 pentyl), 37.4 (CH_2 Ada), 34.2 (C_q Ada), 33.2, 29.2, 29.2, 29.1 (2×CH_2 pentenyl, 2×CH_2 pentyl), 28.4 (CH Ada), 23.5 (CH_2-3 pentyl). IR ν_{max}(thin film)/ cm^{-1}: 3352, 2902, 2849, 1667, 1541, 1454, 1365, 1209, 1090, 909, 731, 697. [α]$^{20}_D$: 11.1 (*c* 3.8, $CHCl_3$). HRMS: found 883.5263 [M+H]$^+$; calculated for [$C_{56}H_{70}N_2O_7$+H]$^+$ 883.5256.



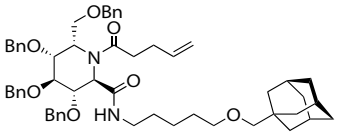
1,1,3,3-Tetramethylbutyl 3,4,5,7-tetra-*O*-benzyl-2,6-dideoxy-2,6-(pent-4-enimido)-D-*glycero*-D-*ido*-heptonamide (E1-II). Subjecting azido-aldehyde **26** (1.01 mmol) to the tandem SAWU-3CR (General procedure B in MeOH) produced **E1-II** (625 mg, 0.82 mmol) in a yield of 81%. R_F = 0.48 (1:3; EtOAc:toluene). ^{1}H NMR (400 MHz, $CDCl_3$) collapsed iminosugar signals δ 7.44 – 7.22 (m, 20H, H_{Ar} Bn), 7.08 (s, 1H, C(O)NH), 5.95 – 5.80 (m, 1H, =CH pentenyl), 5.04 (dd, *J* = 13.1, 25.0, 2H, =CH_2 pentenyl), 4.86 – 3.53 (m, 15H, 4×CH_2 Bn, H-2, H-3, H-4, H-5, H-6, CH_2-7), 2.50 – 2.26 (m, 4H, 2×CH_2 pentenyl), 1.88 – 1.52 (m, 2H, CH_2-2 tMB), 1.23 (s, 6H, 2×CH_3 tMB), 0.92 (s, 9H, 2×CH_3, CH_3-4 tMB). ^{13}C NMR (100 MHz, $CDCl_3$) collapsed iminosugar signals δ 174.7 (NC=O pentenyl), 167.0 (NHC(O)-1), 138.4, 137.7, 137.6, 137.4 (4×C_q Bn), 137.4 (=CH pentenyl), 128.5, 128.4, 128.4, 128.3, 128.1, 128.0, 127.9 (CH_{Ar} Bn), 115.2 (=CH_2 pentenyl), 75.1, 73.7, 73.2, 71.5, 70.6, 68.8, 65.2, 55.3 (NHC_q-1 tMB), 51.3 (CH_2-2 tMB), 33.3 (CH_2 pentenyl), 31.5 (CH_3-4, 2×CH_3 tMB), 29.2 (CH_2 pentenyl), 29.4, 28.5 (2×CH_3 tMB). IR ν_{max}(thin film)/ cm^{-1}: 3363, 2950, 1667, 1531, 1454, 1366, 1208, 1073, 1027, 911, 734, 697. [α]$^{20}_D$: 6.6 (*c* 2.8, $CHCl_3$). HRMS: found 461.4529 [M+H]$^+$; calculated for [$C_{48}H_{60}N_2O_6$+H]$^+$ 761.4524.



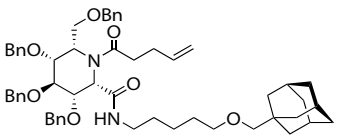
Pentyl 3,4,5,7-tetra-*O*-benzyl-2,6-dideoxy-2,6-(pent-4-enimido)-D-*glycero*-D-*ido*-heptonamide (E1-III). Subjecting azido-aldehyde **26** (1.01 mmol) to the tandem SAWU-3CR (General procedure B in MeOH) produced **E1-III** (556 mg, 0.77 mmol) in a yield of 77%. R_F = 0.45 (1:2; EtOAc:toluene). ^{1}H NMR (400 MHz, $CDCl_3$) collapsed iminosugar signals δ 7.45 – 7.16 (m, 21H, H_{Ar} Bn, C(O)NH), 5.90 – 5.71 (m, 1H, =CH pentenyl), 4.97 (dd, *J* = 13.6, 28.1, 2H, =CH_2 pentenyl), 4.87 – 3.29 (m, 15H, 4×CH_2 Bn, H-2, H-3, H-4, H-5, H-6, CH_2-7), 3.08 – 2.87 (m, 2H, NCH_2-1 pentyl), 2.56 – 2.20 (m, 4H, 2×CH_2 pentenyl), 1.24 – 0.97 (m, 6H, 3×CH_2 pentyl), 0.79 (t, *J* = 7.1, 3H, CH_3 pentyl). ^{13}C NMR (100 MHz, $CDCl_3$) collapsed iminosugar signals δ 174.5 (NC=O pentenyl), 168.2 (NHC(O)-1), 138.3, 137.7, 137.6, 137.1 (4×C_q Bn), 137.4 (=CH pentenyl), 128.5, 128.4, 128.4, 128.2, 128.0, 128.0, 127.9, 127.7, 127.6 (CH_{Ar} Bn), 115.3 (=CH_2 pentenyl), 77.7, 76.0, 73.4, 73.2, 71.9, 70.9, 68.8 (C-7), 39.4 (NCH_2-1 pentyl), 33.1 (NC(O)*C*H_2 pentenyl), 29.1, 29.0, 28.9, 22.3 (CH_2 pentenyl, 3×CH_2 pentyl), 14.1 (CH_3 pentyl). IR ν_{max}(thin film)/ cm^{-1}: 3351, 2929, 1667, 1540, 1454, 1367, 1208, 1071, 1027, 910, 732, 696. [α]$^{20}_D$: 16.0 (*c* 3.5, $CHCl_3$). HRMS: found 719.4060 [M+H]$^+$; calculated for [$C_{45}H_{54}N_2O_6$+H]$^+$ 719.4055.



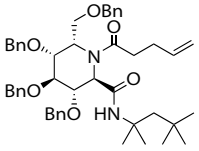
1-Cyclohexenyl 3,4,5,7-tetra-*O*-benzyl-2,6-dideoxy-2,6-(pent-4-enimido)-D-*glycero*-D-*ido*-heptonamide (E1-IV). Subjecting azido-aldehyde **26** (0.89 mmol) to the tandem SAWU-3CR (General procedure B in MeOH) produced **E1-IV** (520 mg, 0.71 mmol) in a yield of 80%. R_F = 0.50 (1:3; EtOAc:toluene). ^{1}H NMR (400 MHz, $CDCl_3$) collapsed iminosugar signals δ 8.20 (s, 1H, C(O)NH), 7.43 – 7.10 (m, 20H, H_{Ar} Bn), 5.94 – 5.72 (m, 2H, =CH-2 cyclohexenyl, =CH pentenyl), 5.13 – 4.89 (m, 2H, =CH_2 pentenyl), 4.87 – 3.30 (m, 15H, 4×CH_2 Bn, H-2, H-3, H-4, H-5, H-6, CH_2-7), 2.52 – 2.21 (m, 4H, 2×CH_2 pentenyl), 2.09 – 1.42 (m, 8H, 4×CH_2 cyclohexenyl). ^{13}C NMR (100 MHz, $CDCl_3$) collapsed iminosugar signals δ 176.4, 174.6 (2×C=O), 138.2, 137.7, 137.3, 137.1 (4×C_q Bn), 137.4 (=CH pentenyl), 132.3 (C_q-1 cyclohexenyl), 128.7, 128.5, 128.4, 128.4, 128.2, 128.0, 127.9, 127.8, 127.6 (CH_{Ar} Bn), 115.3 (=CH_2 pentenyl), 113.3 (=CH-2 cyclohexenyl), 77.7, 75.6, 73.5, 73.2, 71.9, 70.9, 68.7 (C-7), 33.3, 33.1, 29.1, 28.8, 27.6, 24.0, 22.5, 21.9. IR ν_{max}(thin film)/ cm^{-1}: 3330, 2927, 1653, 1543, 1497, 1453, 1368, 1209, 1072, 911, 732, 696. [α]$^{20}_D$: 25.4 (*c* 4.4, $CHCl_3$). HRMS: found 729.3902 [M+H]$^+$; calculated for [$C_{46}H_{52}N_2O_6$+H]$^+$ 729.3898.



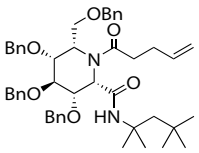
5-(Adamantan-1yl-methoxy)-pentyl 3,4,5,7-tetra-*O*-benzyl-2,6-dideoxy-2,6-(pent-4-enimido)-L-*glycero*-D-*gulo*-heptonamide (F1-I). Subjecting azido-aldehyde **20** (1.16 mmol) to the tandem SAWU-3CR (General procedure B in MeOH) produced a separable 1.25:1 mixture of **G1-I** (314 mg, 0.36 mmol) and **F1-I** (248 mg, 0.28 mmol) in a combined yield of 55%. R_F = 0.27 (1:3; EtOAc:toluene). ^{1}H NMR (500 MHz, $CDCl_3$) 2.5:1 mixture of rotamers; major rotamer/ collapsed iminosugar signals δ 7.37 – 7.16 (m, 20H, H_{Ar} Bn), 6.18 (s, 1H, C(O)NH), 5.83 – 5.74 (m, 1H, =CH pentenyl), 5.03 – 4.91 (m, 2H, =CH_2 pentenyl), 4.81 – 3.60 (m, 15H, 4×CH_2 Bn, H-2, H-3, H-4, H-5, H-6, CH_2-7), 3.30 (t, *J* = 6.6, 2H, CH_2-5 pentyl), 3.27 – 3.09 (m, 2H, NCH_2-1 pentyl), 2.92 (s, 2H, OCH_2-Ada), 2.71 – 2.40 (m, 2H, CH_2 pentenyl), 2.40 – 2.23 (m, 2H, CH_2 pentenyl), 1.95 (s, 3H, 3×CH Ada), 1.67 (dd, *J* = 11.8, 30.7, 6H, 3×CH_2 Ada), 1.56 – 1.13 (m, 12H, 3×CH_2 Ada, 3×CH_2 pentyl). ^{13}C NMR (125 MHz, $CDCl_3$) major rotamer/ collapsed iminosugar signals δ 174.1 (NC(O) pentenyl), 169.0 (NHC(O)-1), 138.3, 138.0, 138.0, 137.8, 137.6 (C_q Bn, =CH pentenyl), 128.6 – 127.7 (CH_{Ar} Bn), 115.0 (=CH_2 pentenyl), 82.0 (OCH_2-Ada), 78.1, 73.4, 71.9, 71.5 (CH_2-5 pentyl), 59.0, 54.8 (C-2, C-6), 39.9 (NCH_2-1 pentyl), 39.8 (CH_2 Ada), 37.3 (CH_2 Ada), 34.2 (C_q Ada), 29.4, 29.3, 29.0, 28.4 (CH Ada), 23.6 (CH_2-3 pentyl). IR ν_{max}(thin film)/ cm^{-1}: 3328, 2902, 2849, 1635, 1543, 1453, 1361, 1092, 910, 732, 696. [α]$^{20}_D$: −11.7 (*c* 4.7, $CHCl_3$). HRMS: found 883.5265 [M+H]$^+$; calculated for [$C_{56}H_{70}N_2O_7$+H]$^+$ 883.5256.



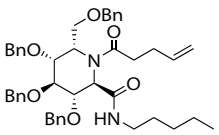
5-(Adamantan-1yl-methoxy)-pentyl 3,4,5,7-tetra-*O*-benzyl-2,6-dideoxy-2,6-(pent-4-enimido)-L-*glycero*-D-*ido*-heptonamide (G1-I). R_F = 0.46 (1:3; EtOAc:toluene). ^{1}H NMR (500 MHz, $CDCl_3$) 3.5:1 mixture of rotamers; major rotamer δ 7.41 – 7.18 (m, 20H, H_{Ar} Bn), 6.69 (t, *J* = 5.7, 1H, C(O)NH), 5.80 – 5.68 (m, 1H, =CH pentenyl), 5.13 (d, *J* = 6.7, 1H, H-2), 5.00 – 4.91 (m, 2H, =CH_2 pentenyl), 4.89 – 4.59 (m, 7H, 3×CH_2 Bn, H-4), 4.45 (d, *J* = 11.9, 1H, C*H*H Bn), 4.38 (d, *J* = 11.9, 1H, CH*H* Bn), 4.26 – 4.19 (m, 1H, H-6), 4.07 (dd, *J* = 10.1, 1H, H-7a), 3.81 (dd, *J* = 4.3, 9.9, 1H, H-7b), 3.54 (dd, *J* = 6.5, 9.4, 1H, H-5), 3.48 (dd, *J* = 6.7, 9.3, 1H, H-3), 3.28 (t, *J* = 6.6, 2H, CH_2-5 pentyl), 3.26 – 3.13 (m, 1H, NC*H*H-1 pentyl), 2.97 – 2.84 (m, 3H, OCH_2-Ada, NCH*H*-1 pentyl), 2.66 – 2.17 (m, 4H, 2×CH_2 pentenyl), 1.94 (s, 3H, 3×CH Ada), 1.67 (dd, *J* = 11.7, 32.0, 6H, 3×CH_2 Ada), 1.51 (d, *J* = 2.4, 6H, 3×CH_2 Ada), 1.48 – 1.15 (m, 6H, 3×CH_2 pentyl). ^{13}C NMR (125 MHz, $CDCl_3$) major rotamer δ 175.1 (NC(O) pentenyl), 169.1 (NHC(O)-1), 139.0, 138.5, 138.3, 138.1 (4×C_q Bn), 137.4 (=CH pentenyl), 128.8, 128.7, 128.5, 128.4, 128.4, 128.3, 128.1, 128.0, 127.8, 127.7, 127.6, 127.1 (CH_{Ar} Bn), 115.4 (=CH_2 pentenyl), 82.1 (OCH_2-Ada), 79.3 (C-5), 78.8 (C-4), 78.5 (C-3), 75.7, 74.0, 74.0, 73.1 (4×CH_2 Bn), 71.5 (CH_2-5 pentyl), 67.0 (C-7), 55.8 (C-6), 53.4 (C-2), 39.9 (CH_2 Ada), 39.5 (NCH_2-1 pentyl), 37.4 (CH_2 Ada), 34.2 (C_q Ada), 33.0 (CH_2 pentenyl), 29.4, 29.4, 29.3 (CH_2 pentenyl, 2×CH_2 pentyl), 28.5 (CH Ada), 23.7 (CH_2-3 pentyl). IR ν_{max}(thin film)/ cm^{-1}: 3361, 2902, 2849, 1727, 1681, 1638, 1530, 1497, 1453, 1364, 1092, 1027, 911, 733, 697. $[\alpha]^{20}_D$: −45.4 (*c* 1.7, $CHCl_3$). HRMS: found 883.5265 $[M+H]^+$; calculated for $[C_{56}H_{70}N_2O_7+H]^+$ 883.5256.



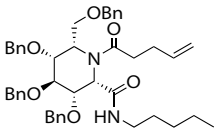
1,1,3,3-Tetramethylbutyl 3,4,5,7-tetra-*O*-benzyl-2,6-dideoxy-2,6-(pent-4-enimido)-L-*glycero*-D-*gulo*-heptonamide (F1-II). Subjecting azido-aldehyde **20** (1.16 mmol) to the tandem SAWU-3CR (General procedure B in MeOH) produced a separable 0.94:1 mixture of **G1-II** (260 mg, 0.34 mmol) and **F1-II** (278 mg, 0.37 mmol) in a combined yield of 61%. R_F = 0.59 (1:3; EtOAc:toluene). ^{1}H NMR (500 MHz, $CDCl_3$) complex mixture of rotamers; major signals δ 7.38 – 7.17 (m, 20H, H_{Ar} Bn), 5.89 – 5.75 (m, 1H, =CH pentenyl), 5.67 (s, 1H, C(O)NH), 5.12 – 3.65 (m, 17H, =CH_2 pentenyl, 4×CH_2 Bn, H-2, H-3, H-4, H-5, H-6, CH_2-7), 2.76 – 2.30 (m, 4H, 2×CH_2 pentenyl), 1.66 – 1.10 (m, 8H, CH_2-2 tMB, 2×CH_3 tMB), 0.94 – 0.82 (m, 9H, CH_3-4, 2×CH_3 tMB). ^{13}C NMR (125 MHz, $CDCl_3$) major signals δ 174.3 (NC(O) pentenyl), 168.1 (NHC(O)-1), 138.2, 137.7 (C_q Bn), 136.7 (=CH pentenyl), 128.7 – 127.1 (CH_{Ar} Bn), 115.7 (=CH_2 pentenyl), 71.8, 65.4, 53.0, 33.4, 31.7 (CH_3-4, 2×CH_3 tMB), 29.3 (CH_2 pentenyl), 28.6, 28.3 (2×CH_3 tMB). IR ν_{max}(thin film)/ cm^{-1}: 3347, 2953, 2869, 1725, 1682, 1636, 1537, 1454, 1365, 1276, 1209, 1073, 1027, 911, 734, 696. $[\alpha]^{20}_D$: −16.8 (*c* 3.2, $CHCl_3$). HRMS: found 461.4531 $[M+H]^+$; calculated for $[C_{48}H_{60}N_2O_6+H]^+$ 761.4524.



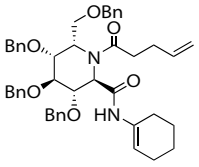
1,1,3,3-Tetramethylbutyl 3,4,5,7-tetra-*O*-benzyl-2,6-dideoxy-2,6-(pent-4-enimido)-L-*glycero*-D-*ido*-heptonamide (G2-II). R_F = 0.67 (1:3; EtOAc:toluene). ^{1}H NMR (500 MHz, $CDCl_3$) 3.5:1 mixture of rotamers; major rotamer δ 7.35 – 7.22 (m, 20H, H_{Ar} Bn), 6.66 (s, 1H, C(O)NH), 5.86 – 5.70 (m, 1H, =CH pentenyl), 5.19 (d, *J* = 6.8, 1H, H-2), 5.01 – 4.35 (m, 11H, =CH_2 pentenyl, 4×CH_2 Bn, H-4), 4.23 – 4.16 (m, 1H, H-6), 4.05 (dd, *J* = 9.8, 1H, H-7a), 3.85 (dd, *J* = 3.7, 9.9, 1H, H-7b), 3.49 (dd, *J* = 6.5, 9.7, 1H, H-5), 3.44 (dd, *J* = 6.7, 9.6, 1H, H-3), 2.46 – 2.18 (m, 4H, 2×CH_2 pentenyl), 1.73 (d, *J* = 14.8, 1H, C*H*H-2 tMB), 1.49 (d, *J* = 14.8, 1H, CH*H*-2 tMB), 1.37 (s, 3H, CH_3 tMB), 1.27 (s, 3H, CH_3 tMB), 0.93 (s, 9H, CH_3-4, 2×CH_3 tMB). ^{13}C NMR (125 MHz, $CDCl_3$) δ 174.7 (NC(O) pentenyl), 167.9 (NHC(O)-1), 139.0, 138.6, 138.3, 138.1 (4×C_q Bn), 137.4 (=CH pentenyl), 128.7, 128.6, 128.5, 128.4, 128.2, 128.1, 127.9, 127.7, 127.6, 127.4 (CH_{Ar} Bn), 115.3 (=CH_2 pentenyl), 79.4 (C-5), 78.8, 78.7 (C-3, C-4), 75.8, 74.1, 73.9, 73.0 (4×CH_2 Bn), 67.1 (C-7), 56.6 (C-6), 55.2 (NHC_q-1 tMB), 54.0 (C-2), 52.7 (CH_2-2 tMB), 33.3 (C_q-3 tMB), 32.8 (CH_2 pentenyl), 31.6 (CH_3-4, 2×CH_3 tMB), 29.3 (CH_2 pentenyl), 28.8, 28.5 (2×CH_3 tMB). IR ν_{max}(thin film)/ cm^{-1}: 2952, 1726, 1683, 1638, 1532, 1454, 1365, 1227, 1091, 1027, 911, 734, 696. $[\alpha]^{20}_D$: −51.0 (*c* 3.0, $CHCl_3$). HRMS: found 461.4531 $[M+H]^+$; calculated for $[C_{48}H_{60}N_2O_6+H]^+$ 761.4524.



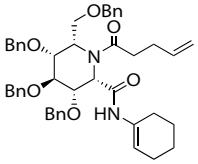
Pentyl 3,4,5,7-tetra-*O*-benzyl-2,6-dideoxy-2,6-(pent-4-enimido)-L-*glycero*-D-*gulo*-heptonamide (F1-III). Subjecting azido-aldehyde **20** (1.16 mmol) to the tandem SAWU-3CR (General procedure B in MeOH) produced a separable 1.6:1 mixture of **G1-III** (297 mg, 0.41 mmol) and **F1-III** (182 mg, 0.25 mmol) in a combined yield of 57%. R_F = 0.27 (1:3; EtOAc:toluene). ^{1}H NMR (500 MHz, $CDCl_3$) complex mixture of rotamers; major signals δ 7.38 – 7.19 (m, 20H, H_{Ar} Bn), 5.82 – 5.74 (m, 1H, =CH pentenyl), 5.02 – 4.92 (m, 2H, =CH_2 pentenyl), 4.81 – 3.61 (m, 15H, 4×CH_2 Bn, H-2, H-3, H-4, H-5, H-6, CH_2-7), 3.23 – 3.12 (m, 2H, NCH_2-1 pentyl), 2.68 – 2.22 (m, 4H, 2×CH_2 pentenyl), 1.73 – 0.97 (m, 6H, 3×CH_2 pentyl), 0.85 (t, *J* = 7.0, 3H, CH_3-5 pentyl). ^{13}C NMR (125 MHz, $CDCl_3$) major signals δ 174.2 (NC(O) pentenyl), 169.1 (NHC(O)-1), 138.4, 138.2, 138.2, 137.8 (4×C_q Bn), 138.0 (=CH pentenyl), 128.8 – 127.7 (CH_{Ar} Bn), 115.0 (=CH_2 pentenyl), 80.8, 78.7, 78.2, 73.6, 72.0, 70.1, 69.1, 64.5, 59.1, 54.9, 40.1 (NCH_2-1 pentyl), 33.3 (CH_2 pentenyl), 29.3, 29.2, 22.5 (CH_2 pentyl/pentenyl), 14.2 (CH_3-5 pentyl). IR ν_{max}(thin film)/ cm^{-1}: 3325, 2929, 2862, 1726, 1636, 1543, 1454, 1417, 1363, 1279, 1072, 1027, 911, 724, 967. $[\alpha]^{20}_D$: −12.4 (*c* 0.9, $CHCl_3$). HRMS: found 719.4058 $[M+H]^+$; calculated for $[C_{45}H_{54}N_2O_6+H]^+$ 719.4055.



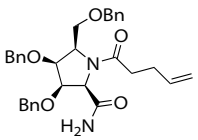
Pentyl 3,4,5,7-tetra-*O*-benzyl-2,6-dideoxy-2,6-(pent-4-enimido)-L-*glycero*-D-*ido*-heptonamide (G1-III). R_F = 0.45 (1:3; EtOAc:toluene). ^{1}H NMR (500 MHz, $CDCl_3$) major rotamer; 3.5:1 mixture of rotamers δ 7.39 – 7.14 (m, 20H, H_{Ar} Bn), 6.67 (t, *J* = 5.7, 1H, C(O)NH), 5.79 – 5.68 (m, 1H, =CH pentenyl), 5.13 (d, *J* = 6.7, 1H, H-2), 5.03 – 4.50 (m, 9H, =CH_2 pentenyl, 3×CH_2 Bn, H-4), 4.45 (d, *J* = 11.8, 1H, C*H*H Bn), 4.38 (d, *J* = 11.8, 1H, CH*H* Bn), 4.27 – 4.19 (m, 1H, H-6), 4.07 (dd, *J* = 10.1, 1H, H-7a), 3.82 (dd, *J* = 4.3, 9.9, 1H, H-7b), 3.54 (dd, *J* = 6.5, 9.5, 1H, H-5), 3.48 (dd, *J* = 6.7, 9.4, 1H, H-3), 3.26 – 3.16 (m, 1H, NC*H*H-1), 2.97 – 2.85 (m, 1H, NCH*H*-1), 2.67 – 2.21 (m, 4H, 2×CH_2 pentenyl), 1.40 – 1.27 (m, 2H, CH_2 pentyl), 1.27 – 1.12 (m, 4H, 2×CH_2 pentyl), 0.82 (t, *J* = 7.1, 3H, CH_3-5 pentyl). ^{13}C NMR (125 MHz, $CDCl_3$) major rotamer δ 175.0 (NC(O) pentenyl), 169.1 (NHC(O)-1), 139.0, 138.5, 138.3, 138.1 (4×C_q Bn), 137.4 (=CH pentenyl), 128.7, 128.6, 128.4, 128.3, 128.3, 127.9, 127.9, 127.8, 127.4, 127.1 (CH_{Ar} Bn), 115.3 (=CH_2 pentenyl), 79.3 (C-4), 78.8 (C-5), 78.5 (C-3), 75.7, 74.0, 74.0, 73.0 (4×CH_2 Bn), 67.0 (C-7), 55.8 (C-6), 53.4 (C-2), 39.5 (NCH_2-1 pentyl), 33.0 (CH_2 pentenyl), 29.2, 29.2, 29.2, 22.4 (CH_2 pentenyl, 3×CH_2 pentyl), 14.1 (CH_3-5 pentyl). IR ν_{max}(thin film)/ cm^{-1}: 3364, 2930, 2862, 1681, 1531, 1454, 1365, 1208, 1091, 1027, 911, 733, 696. $[\alpha]^{20}_D$: −58.1 (*c* 2.0, $CHCl_3$). HRMS: found 719.4059 $[M+H]^+$; calculated for $[C_{45}H_{54}N_2O_6+H]^+$ 719.4055.



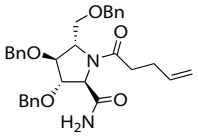
1-Cyclohexenyl 3,4,5,7-tetra-*O*-benzyl-2,6-dideoxy-2,6-(pent-4-enimido)-L-*glycero*-D-*gulo*-heptonamide (F-IV). Subjecting azido-aldehyde **20** (0.93 mmol) to the tandem SAWU-3CR (General procedure B in MeOH) produced a separable 1.5:1 mixture of **G-IV** (210 mg, 0.29 mmol) and **F-IV** (140 mg, 0.19 mmol) in a combined yield of 41%. R_F = 0.52 (1:3; EtOAc:toluene). ^{1}H NMR (400 MHz, CDCl3) complex mixture of rotamers; major signals δ 7.40 – 7.12 (m, 20H, H_{Ar} Bn), 6.90 – 6.82 (m, 1H, C(O)NH), 6.18 – 6.06 (m, 1H, =CH-2 cyclohexenyl), 5.89 – 5.71 (m, 1H, =CH pentenyl), 5.02 – 4.90 (m, 2H, =CH_2 pentenyl), 4.83 – 3.62 (m, 15H, 4×CH_2 Bn, H-2, H-3, H-4, H-5, H-6, CH_2-7), 2.71 – 2.24 (m, 4H, 2×CH_2 pentenyl), 2.16 – 1.23 (m, 8H, 4×CH_2 cyclohexenyl). ^{13}C NMR (100 MHz, $CDCl_3$) major signals δ 138.1, 137.8 (Cq Bn, =CH pentenyl), 128.6 – 127.8 (CH_{Ar} Bn), 115.2 (=CH_2 pentenyl), 112.7 (=CH-2 cyclohexenyl), 80.9 (C-4), 79.4 (C-5), 78.2 (C-3), 73.8, 73.6, 73.4 (CH_2 Bn), 68.7 (C-7), 59.8 (C-6), 55.6 (C-2), 33.5, 29.4 (2×CH_2 pentenyl), 28.0, 24.2, 22.8, 22.2 (4×CH_2 cyclohexenyl). IR ν_{max}(thin film)/ cm^{-1}: 3312, 2928, 2860, 1730, 1695, 1622, 1556, 1453, 1367, 1208, 1072, 1027, 912, 734, 696. $[\alpha]^{20}_D$: −16.0 (*c* 2.7, $CHCl_3$). HRMS: found 751.3716 $[M+H]^+$; calculated for $[C_{46}H_{52}N_2O_6+Na]^+$ 751.3723.



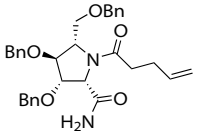
1-Cyclohexenyl 3,4,5,7-tetra-*O*-benzyl-2,6-dideoxy-2,6-(pent-4-enimido)-L-*glycero*-D-*ido*-heptonamide (G-IV). R_F = 0.63 (1:3; EtOAc:toluene). ^{1}H NMR (400 MHz, $CDCl_3$) 3.5:1 mixture of rotamers; major rotamer δ 7.70 (s, 1H, C(O)NH), 7.42 – 7.14 (m, 20H, H_{Ar} Bn), 6.16 (s, 1H, =CH-2 cyclohexenyl), 5.90 – 5.61 (m, 1H, =CH pentenyl), 5.14 (d, *J* = 6.6, 1H, H-2), 5.04 – 4.58 (m, 9H, =CH_2 pentenyl, 3×CH_2 Bn, H-4), 4.44 (d, *J* = 11.8, 1H, C*H*H Bn), 4.35 (d, *J* = 11.8, 1H, CH*H* Bn), 4.26 – 4.16 (m, 1H, H-6), 4.01 (dd, *J* = 10.3, 1H, H-7a), 3.81 (dd, *J* = 4.3, 9.9, 1H, H-7b), 3.54 (dd, *J* = 6.4, 9.5, 1H, H-5), 3.46 (dd, *J* = 6.6, 9.5, 1H, H-3), 2.69 – 2.12 (m, 4H, 2×CH_2 pentenyl), 2.09 – 1.20 (m, 8H, 4×CH_2 cyclohexenyl). ^{13}C NMR (100 MHz, $CDCl_3$) major rotamer δ 175.4 (NC(O) pentenyl), 167.3 (NHC(O)-1), 138.9, 138.5, 138.2, 138.1 (4×C_q Bn), 137.3 (=CH pentenyl), 132.6 (=C_q-1 cyclohexenyl), 128.6, 128.5, 128.4, 128.2, 128.2, 128.0, 127.9, 127.7, 127.6, 127.4, 127.0 (CH_{Ar} Bn), 115.3 (=CH_2 pentenyl), 112.0 (=CH-2 cyclohexenyl), 79.2 (C-4), 78.8 (C-4), 78.5 (C-3), 75.8, 74.0, 73.9, 73.0 (4×CH_2 Bn), 66.7 (C-7), 55.8 (C-6), 53.8 (C-2), 32.9, 29.2 (2×CH_2 pentenyl), 28.0, 24.0, 22.4, 22.0 (4×CH_2 cyclohexenyl). IR ν_{max}(thin film)/ cm^{-1}: 3321, 3032, 2929, 1695, 1635, 1542, 1497, 1454, 1366, 1273, 1235, 1208, 1091, 1027, 913, 734, 697. $[\alpha]^{20}_D$: −61.2 (*c* 4.2, $CHCl_3$). HRMS: found 729.3904 $[M+H]^+$; calculated for $[C_{46}H_{52}N_2O_6+H]^+$ 729.3898.



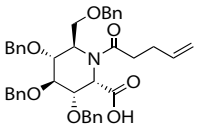
3,4,6-Tri-*O*-benzyl-2,5-dideoxy-2,5-(pent-4-enimido)-D-*galacto*-hexonamide (B1-VI). Compound **B1-VI** (81 mg, 0.15 mmol) was synthesized in 75% yield from **B1-IV** (0.20 mmol) by isomerization and hydrolysis of the 1-cyclohexene-amide moiety (general procedure C). R_F = 0.20 (4:1; EtOAc:toluene). ^{1}H NMR (600 MHz, $CDCl_3$) 2:1 mixture of rotamers; major rotamer: δ 7.39 – 7.20 (m, 15H, H_{Ar} Bn), 5.91 (s, 1H, NH_2), 5.84 – 5.73 (m, 1H, =CH pentenyl), 5.06 – 4.90 (m, 2H, =CH-2 cyclohexenyl), 4.75 – 4.38 (m, 7H, 3×CH_2 Bn, H-2, H-4), 4.37 – 4.32 (m, 1H, H-5), 4.12 (dd, *J* = 10.1, 1H, H-6a), 3.89 (dd, *J* = 5.1, 6.4, 1H, H-3), 3.81 (dd, *J* = 3.4, 10.3, 1H, H-6b), 2.86 – 2.78 (m, 1H, NC*H*H pentenyl), 2.45 – 2.30 (m, 3H, NCH*H*, CH_2 pentenyl).^{13}C NMR (150 MHz, $CDCl_3$) major rotamer: δ 174.1 (NC=O pentenyl), 170.7 (NHC(O)-1), 138.3, 137.7 (3×C_q Bn), 137.6 (=CH pentenyl), 137.3 (C_q Bn), 128.8 – 127.7 (CH_{Ar} Bn), 115.4 (=CH_2 pentenyl), 79.0 (C-3), 76.7 (C-4), 75.0, 73.6, 72.6 (3×CH_2 Bn), 69.0 (C-6), 64.2 (C-2), 58.7 (C-5), 33.6 (NCH_2 pentenyl), 29.0 (CH_2 pentenyl). IR ν_{max}(thin film)/ cm^{-1}: 3320, 3030, 2868, 1683, 1652, 1638, 1495, 1454, 1406, 1360, 1212, 1109, 1055, 1026, 913, 735, 698. $[\alpha]^{20}_D$: 21.2 (*c* 1.5, $CHCl_3$).HRMS: found 529.2693 $[M+H]^+$, calculated for $[C_{32}H_{36}O_5N_2+H]^+$ 529.2693.



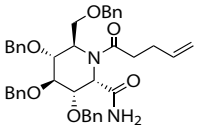
3,4,6-Tri-*O*-benzyl-2,5-dideoxy-2,5-(pent-4-enimido)-L-*gulo*-hexonamide (C1-VI). Compound **C1-VI** (27 mg, 51 μmol) was synthesized in 73% yield from **C1-IV** (70 μmol) by isomerization and hydrolysis of the 1-cyclohexene-amide moiety (general procedure C). R_F = 0.50 (3:1; EtOAc:PE). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.44 – 7.09 (m, 15H, H_{Ar} Bn), 5.88 – 5.70 (m, 1H, =CH pentenyl), 5.12 – 4.84 (m, 2H, =CH_2 pentenyl), 4.74 – 3.39 (m, 12H, H-2, H-3, H-4, H-5, CH_2-6, 3×CH_2 Bn), 2.55 – 208 (m, 4H, 2×CH_2 pentenyl). IR ν_{max}(thin film)/ cm^{-1}: 2924, 2855, 1638, 1454, 1409, 1206, 1095, 911, 736, 698. $[\alpha]^{20}_D$: 10.8 (*c* 0.5, $CHCl_3$). HRMS: found 529.2694 $[M+H]^+$, calculated for $[C_{32}H_{36}O_5N_2+H]^+$ 529.2697.



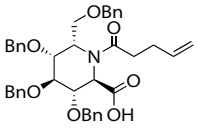
3,4,6-Tri-*O*-benzyl-2,5-dideoxy-2,5-(pent-4-enimido)-L-*ido*-hexonamide (D1-VI). Compound **D1-VI** (62 mg, 117 μmol) was synthesized in 73% yield from **D1-IV** (160 μmol) by isomerization and hydrolysis of the 1-cyclohexene-amide moiety (general procedure C). R_F = 0.57 (3:1; EtOAc:PE). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.78 – 7.01 (m, 15H, H_{Ar} Bn), 5.94 – 5.67 (m, 1H, =CH pentenyl), 5.28 – 3.39 (m, 14H, =CH_2 pentenyl, H-2, H-3, H-4, H-5, CH_2-6, 3×CH_2 Bn), 2.73 – 1.91 (m, 4H, 2×CH_2 pentenyl). IR ν_{max}(thin film)/ cm^{-1}: 2924, 1651, 1454, 1402, 1363, 1208, 1094, 1026, 912, 736, 698. $[\alpha]^{20}_D$: 25.3 (*c* 1.2, $CHCl_3$). HRMS: found 529.2693 $[M+H]^+$, calculated for $[C_{32}H_{36}O_5N_2+H]^+$ 529.2693.



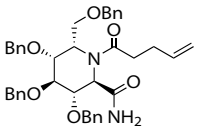
3,4,5,7-Tetra-*O*-benzyl-2,6-dideoxy-2,6-(pent-4-enimido)-D-*glycero*-D-*ido*-heptonic acid (E1-V). Compound **E1-V** (245 mg, 0.38 mmol) was synthesized in 82% yield from **E1-IV** (0.46 mmol) by isomerization and hydrolysis of the 1-cyclohexene-amide moiety (general procedure C). R_F = 0.36 (1:1; EtOAc:toluene+5% AcOH). ^{1}H NMR (400 MHz, $CDCl_3$) collapsed iminosugar signals δ 9.83 – 8.15 (m, 1H, COOH), 7.43 – 7.13 (m, 20H, H_{Ar} Bn), 5.79 (ddd, *J* = 6.2, 10.3, 16.7, 1H, =CH pentenyl), 4.97 (dd, *J* = 13.7, 23.2, 2H, =CH_2 pentenyl), 4.89 – 3.16 (m, 15H, 4×CH_2 Bn, H-2, H-3, H-4, H-5, H-6, CH_2-7), 2.50 – 2.30 (m, 4H, 2×CH_2 pentenyl). ^{13}C NMR (100 MHz, $CDCl_3$) collapsed iminosugar signals δ 174.2 (NC=O pentenyl), 169.5 (NHC(O)-1), 137.6, 136.5 (C_q Bn), 137.1 (=CH pentenyl), 128.6, 128.6, 128.5, 128.3, 128.2, 128.0, 127.9, 127.7 (CH_{Ar} Bn), 115.5 (=CH_2 pentenyl), 73.2, 56.1, 32.6 (C(O)NCH_2 pentenyl), 29.0 (CH_2 pentenyl). IR ν_{max}(thin film)/ cm^{-1}: 3031, 2868, 1739, 1652, 1496, 1454, 1367, 1203, 1074, 1027, 912, 736, 698. $[\alpha]^{20}_D$: 11.6 (*c* 2.8, $CHCl_3$). HRMS: found 650.3114 $[M+H]^+$; calculated for $[C_{40}H_{43}NO_7+H]^+$ 650.3112.



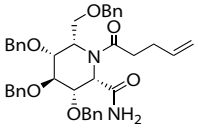
3,4,5,7-Tetra-*O*-benzyl-2,6-dideoxy-2,6-(pent-4-enimido)-D-*glycero*-D-*ido*-heptonamide (E1-VI). Ethyl chloroformate (25 µL, 0.25 mmol) was added to a cooled (0 °C) solution of **E1-IV** (100 mg, 0,15 mmol) and Et_3N (36 µL, 0.26 mmol) in THF (1.5 mL). After stirring for 1h at 0 °C, aqueous ammonia (0.2mL, 25%) was added and the reaction was stirred for an additional hour at 0 °C. The mixture was diluted with H_2O (20 mL) and extracted with Et_2O (3×30 mL). The combined organic layers were dried and concentrated. The residue was purified with silica gel column chromatography (0% » 50% EtOAc in toluene) to afford **E1-VI** (64 mg, 0.10 mmol) in 64% yield as a colorless oil. R_F = 0.52 (1:1; EtOAc:toluene+5% AcOH). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.38 – 7.18 (m, 20H, H_{Ar} Bn), 6.86 (s, 1H, C(O)NH), 5.80 (ddt, *J* = 6.5, 10.2, 16.8, 1H, =CH pentenyl), 5.06 – 4.93 (m, 3H, =CH_2 pentenyl, H-2), 4.87 – 4.39 (m, 8H, 4×CH_2 Bn), 4.36 (dd, *J* = 7.5, 9.8, 1H, H-3), 4.22 (t, *J* = 7.5, 1H, H-6), 3.67 (dd, *J* = 6.8, 9.8, 1H, H-4), 3.64 – 3.54 (m, 2H, H-5, C*H*H-7), 3.46 (dd, *J* = 6.7, 9.7, 1H, CH*H*-7), 2.59 – 2.51 (m, 2H, C(O)NCH_2 pentenyl), 2.42 – 2.33 (m, 2H, CH_2 pentenyl). ^{13}C NMR (100 MHz, $CDCl_3$) δ 174.2 (NC=O pentenyl), 172.4 (NHC(O)-1), 138.4, 138.4, 137.8, 137.8 (4×C_q Bn), 137.3 (=CH pentenyl), 128.7, 128.6, 128.5, 128.5, 128.1, 128.1, 128.0, 127.8 (CH_{Ar} Bn), 115.5 (=CH_2 pentenyl), 81.9 (C-4), 80.3 (C-5), 75.5 (C-3), 74.8, 74.5, 73.4, 72.4 (4×CH_2 Bn), 70.1 (C-7), 59.5 (C-6), 58.3 (C-2), 32.7 (C(O)NCH_2 pentenyl), 29.2 (CH_2 pentenyl). IR ν_{max}(thin film)/ cm^{-1}: 3033, 2867, 1695, 1639, 1496, 1454, 1365, 1070, 1028, 914, 735, 698. $[\alpha]^{20}_D$: 47.0 (*c* 1.3, $CHCl_3$). HRMS: found 649.3272 $[M+H]^+$; calculated for $[C_{40}H_{44}N_2O_6+H]^+$ 649.3272.



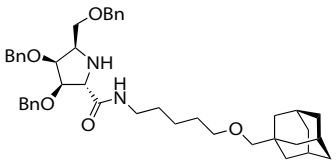
3,4,5,7-Tetra-*O*-benzyl-2,6-dideoxy-2,6-(pent-4-enimido)-L-*glycero*-D-*gulo*-heptonic acid (F1-V). Compound **F1-V** (35 mg, 54 µmol) was produced in 31% yield together with **F1-VI** (40 mg, 62 µmol) in 36% yield from **F1-IV** (0.17 mmol) by isomerization and hydrolysis of the 1-cyclohexene-amide moiety (general procedure C). R_F = 0.13 (1:1; EtOAc:toluene). ^{1}H NMR (400 MHz, $CDCl_3$) 4:1 mixture of rotamers; major rotamer δ 7.43 – 7.19 (m, 20H, H_{Ar} Bn), 5.84 – 5.67 (m, 1H, =CH pentenyl), 4.95 (dd, *J* = 13.7, 18.1, 2H, =CH_2 pentenyl), 4.66 (d, *J* = 5.0, 1H, H-2), 4.65 – 4.38 (m, 8H, 4×CH_2 Bn), 4.35 – 4.30 (m, 1H, H-6), 4.09 (dd, *J* = 2.6, 5.0, 1H, H-3), 4.04 (dd, *J* = 6.1, 7.5, 1H, H-5), 3.82 (dd, *J* = 3.8, 10.0, 1H, H-7a), 3.79 – 3.69 (m, 2H, H-4, H-7b), 2.80 – 2.18 (m, 4H, 2×CH_2 pentenyl). ^{13}C NMR (100 MHz, $CDCl_3$) major rotamer δ 175.5 (NC(O) pentenyl), 172.5 (C(O)-1), 138.2, 138.0, 138.0, 137.6 (4×C_q Bn), 137.7 (=CH pentenyl), 128.6, 128.6, 128.3, 128.2, 128.1, 128.0, 127.9, 127.8, 127.7 (CH_{Ar} Bn), 115.2 (=CH_2 pentenyl), 80.3 (C-4), 77.8 (C-5), 77.5 (C-3), 73.5, 73.2, 72.7, 72.6 (4×CH_2 Bn), 69.2 (C-7), 56.4 (C-2), 55.1 (C-6), 32.9, 29.1 (2×CH_2 pentenyl). IR ν_{max}(thin film)/ cm^{-1}: 3333, 2926, 1684, 1636, 1495, 1454, 1417, 1278, 1208, 1073, 1027, 911, 735, 698. $[\alpha]^{20}_D$: −22.9 (*c* 0.7, $CHCl_3$). HRMS: found 650.3114 $[M+H]^+$; calculated for $[C_{40}H_{43}NO_7+H]^+$ 650.3112.



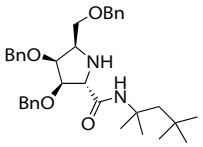
3,4,5,7-Tetra-*O*-benzyl-2,6-dideoxy-2,6-(pent-4-enimido)-L-*glycero*-D-*gulo*-heptonamide (F1-VI). Compound **F1-VI** (40 mg, 62 µmol) was produced in 36% yield together with **F1-V** (35 mg, 54 µmol) in 31% yield from **F1-IV** (0.17 mmol) by isomerization and hydrolysis of the 1-cyclohexene-amide moiety (general procedure C). R_F = 0.07 (1:1; EtOAc:toluene). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.75 – 7.66 (m, 1H, C(O)N*H*H), 7.56 – 7.49 (m, 1H, C(O)NH*H*), 7.43 – 7.14 (m, 20H, H_{Ar} Bn), 5.89 – 5.68 (m, 1H, =CH pentenyl), 5.03 – 4.87 (m, 2H, =CH_2 pentenyl), 4.79 – 4.32 (m, 8H, 4×CH_2 Bn), 4.32 – 4.22 (m, 2H, H-2, H-6), 4.09 – 4.02 (m, 1H, H-3), 4.03 – 3.96 (m, 1H, H-5), 3.87 – 3.76 (m, 1H, H-7a), 3.75 – 3.69 (m, 2H, H-4, H-7b), 2.70 – 2.22 (m, 4H, 2×CH_2 pentenyl). ^{13}C NMR (100 MHz, $CDCl_3$) δ 175.7 (NC(O) pentenyl), 172.3 (NH_2C(O)-1), 138.3, 138.1, 138.0, 137.7 (4×C_q Bn), 137.8 (=CH pentenyl), 129.0, 128.6, 128.6, 128.3, 128.2, 128.1, 128.0, 127.9, 127.8 (CH_{Ar} Bn), 115.3 (=CH_2 pentenyl), 80.6 (C-4), 78.9 (C-5), 78.0 (C-3), 73.6, 73.5, 73.5, 73.4 (4×CH_2 Bn), 68.6 (C-7), 58.4, 55.5 (C-2, C-6), 33.3, 29.2 (2×CH_2 pentenyl). IR ν_{max}(thin film)/ cm^{-1}: 3032, 2860, 1739, 1652, 1454, 1365, 1205, 1092, 1027, 913, 736, 698. $[\alpha]^{20}_D$: −18.8 (*c* 0.8, $CHCl_3$). HRMS: found 649.3271 $[M+H]^+$; calculated for $[C_{40}H_{44}N_2O_6+H]^+$ 649.3272.



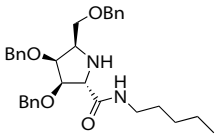
3,4,5,7-Tetra-*O*-benzyl-2,6-dideoxy-2,6-(pent-4-enimido)-L-*glycero*-D-*ido*-heptonamide (G1-VI). Compound **G1-VI** (122 mg, 0.19 mmol) was synthesized in 72% yield from **G1-IV** (0.26 mmol) by isomerization and hydrolysis of the 1-cyclohexene-amide moiety (general procedure C). R_F = 0.52 (1:1; EtOAc:toluene). ^{1}H NMR (400 MHz, $CDCl_3$) 3:1 mixture of rotamers; major rotamer δ 7.37 – 7.17 (m, 20H, H_{Ar} Bn), 6.70 (d, *J* = 2.2, 1H, C(O)N*H*H), 5.87 – 5.62 (m, 1H, =CH pentenyl), 5.49 (d, *J* = 2.8, 1H, C(O)NH*H*), 5.25 (d, *J* = 6.6, 1H, H-2), 4.99 – 4.58 (m, 8H, =CH_2 pentenyl, 3×CH_2 Bn), 4.51 (dd, *J* = 9.3, 1H, H-4), 4.48 – 4.36 (m, 2H, CH_2 Bn), 4.28 – 4.19 (m, 1H, H-6), 4.00 (dd, *J* = 10.0, 1H, H-7a), 3.81 (dd, *J* = 4.2, 9.9, 1H, H-7b), 3.63 – 3.48 (m, 2H, H-3, H-5), 2.67 – 2.19 (m, 4H, 2×CH_2 pentenyl). ^{13}C NMR (100 MHz, $CDCl_3$) major rotamer δ 174.8 (NC(O) pentenyl), 171.5 (NH_2C(O)-1), 138.8, 138.4, 138.0, 138.0 (4×C_q Bn), 137.4 (=CH pentenyl), 128.6, 128.6, 128.5, 128.4, 128.2, 128.1, 127.9, 127.9, 127.6, 127.5 (CH_{Ar} Bn), 115.3 (=CH_2 pentenyl), 79.3 (C-5), 78.6 (C-4), 78.2 (C-3), 75.5, 74.1, 73.9, 73.0 (4×CH_2 Bn), 66.9 (C-7), 55.7 (C-6), 52.6 (C-2), 32.9, 29.2 (2×CH_2 pentenyl). IR ν_{max}(thin film)/ cm^{-1}: 3428, 3032, 2869, 1695, 1650, 1495, 1454, 1366, 1274, 1209, 1092, 1027, 912, 736, 698. $[\alpha]^{20}_D$: −76.4 (*c* 2.4, $CHCl_3$). HRMS: found 649.3273 $[M+H]^+$; calculated for $[C_{40}H_{44}N_2O_6+H]^+$ 649.3272.



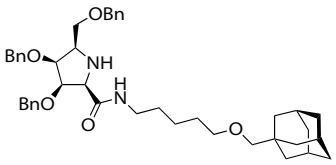
5-(Adamantan-1yl-methoxy)-pentyl 3,4,6-tri-*O*-benzyl-2,5-dideoxy-2,5-imino-D-*talo*-hexonamide (A2-I). Compound **A2-I** (75 mg, 0.11 mmol) was synthesized in 75% yield from **A1-I** (0.15 mmol) by deprotection of the pent-4-enamide (general procedure D). R_F = 0.46 (1:1; EtOAc:toluene). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.41 (t, *J* = 5.8, 1H, C(O)NH), 7.38 – 7.24 (m, 15H, H_{Ar} Bn), 4.73 (d, *J* = 12.2, 1H, C*H*H Bn), 4.65 (d, *J* = 12.2, 1H, CH*H* Bn), 4.63 (d, *J* = 11.8, 1H, C*H*H Bn), 4.53 (d, *J* = 11.9, 1H, C*H*H Bn), 4.50 (d, *J* = 11.9, 1H, CH*H* Bn), 4.45 (d, *J* = 11.8, 1H, CH*H* Bn), 4.10 (dd, *J* = 4.0, 1H, H-3), 3.95 (dd, *J* = 5.1, 1H, H-4), 3.79 (d, *J* = 3.4, 1H, H-2), 3.77 (dd, *J* = 9.2, 1H, H-6a), 3.72 (dd, *J* = 5.0, 9.5, 1H, H-6b), 3.55 – 3.48 (m, 1H, H-5), 3.35 (t, *J* = 6.5, 2H, CH_2-5 pentyl), 3.27 – 3.21 (m, 1H, NC*H*H-1 pentyl), 3.21 – 3.09 (m, 1H, NCH*H*-1 pentyl), 2.94 (s, 2H, OCH_2-Ada), 1.95 (s, 3H, 3×CH Ada), 1.67 (dd, *J* = 12.1, 37.4, 6H, 3×CH_2 Ada), 1.58 – 1.49 (m, 8H, 3×CH_2 Ada, CH_2-4 pentyl), 1.49 – 1.41 (m, 2H, CH_2-2 pentyl), 1.38 – 1.29 (m, 2H, CH_2-3 pentyl). ^{13}C NMR (150 MHz, $CDCl_3$) δ 172.5 (C(O)-1), 138.4, 138.3, 138.2 (3×C_q Bn), 128.7, 128.6, 128.5, 128.2, 128.1, 128.1, 128.0, 127.9, 127.9, 127.8 (CH_{Ar} Bn), 82.1 (OCH_2-Ada), 81.7 (C-3), 78.9 (C-4), 73.5, 72.9, 72.0 (3×CH_2 Bn), 71.5 (CH_2-5 pentyl), 70.6 (C-6), 64.3 (C-2), 59.2 (C-5), 39.9 (CH_2 Ada), 39.3 (NCH_2-1 pentyl), 37.4 (CH_2 Ada), 34.3 (C_q Ada), 29.6 (CH_2-2 pentyl), 29.4 (CH_2-4 pentyl), 28.5 (CH Ada), 23.8 (CH_2-3 pentyl). IR ν_{max}(thin film)/ cm^{-1}: 3328, 2900, 2848, 1667, 1653, 1519, 1453, 1360, 1096, 1058, 1027, 734, 697. $[\alpha]^{20}_D$: −4.2 (*c* 0.6, $CHCl_3$). HRMS: found 681.4261 $[M+H]^+$, calculated for $[C_{43}H_{56}O_5N_2+H]^+$ 681.4262.



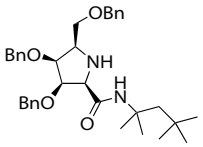
1,1,3,3-Tetramethylbutyl 3,4,6-tri-*O*-benzyl-2,5-dideoxy-2,5-imino-D-*talo*-hexonamide (A2-II). Compound **A2-II** (212 mg, 0.38 mmol) was synthesized in 69% yield from **A1-II** (0.55 mmol) by deprotection of the pent-4-enamide (general procedure D). R_F = 0.59 (1:2; EtOAc:toluene). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.40 (s, 1H, C(O)NH), 7.39 – 7.21 (m, 15H, H_{Ar} Bn), 4.73 (d, *J* = 12.0, 1H, C*H*H Bn), 4.65 – 4.59 (m, 2H, CH*H* Bn, C*H*H Bn), 4.52 (d, *J* = 11.8, 1H, CH*H* Bn), 4.48 (d, *J* = 11.8, 1H, CH*H* Bn), 4.42 (d, *J* = 11.8, 1H, CH*H* Bn), 4.08 (dd, *J* = 3.2, 4.7, 1H, H-3), 3.91 (dd, *J* = 4.7, 6.0, 1H, H-4), 3.78 (dd, *J* = 9.3, 1H, H-6a), 3.72 (dd, *J* = 4.8, 9.6, 1H, H-6b), 3.67 (d, *J* = 3.2, 1H, H-2), 3.52 (ddd, *J* = 4.8, 5.9, 8.9, 1H, H-5), 2.55 (s, 1H, NH), 1.72 (d, *J* = 14.8, 1H, C*H*H-2 tMB), 1.63 (d, *J* = 14.8, 1H, CH*H*-2 tMB), 1.36 (d, *J* = 17.3, 6H, 2×CH_3 tMB), 0.94 (s, 9H, 2×CH_3, CH_3-4 tMB). ^{13}C NMR (150 MHz, $CDCl_3$) δ 171.0 (C(O)-1), 138.1, 138.0, 137.8 (3×C_q Bn), 128.3, 128.2, 127.8, 127.7, 127.6, 127.4 (CH_{Ar} Bn), 81.1 (C-3), 78.2 (C-4), 73.2, 73.4, 71.5 (3×CH_2 Bn), 70.3 (C-6), 64.6 (C-2), 58.8 (C-5), 54.2 (NHC_q-1 tMB), 51.7 (CH_2-2 tMB), 31.5 (C_q-3 tMB), 31.3 (2×CH_3, CH_3-4 tMB), 29.1, 28.6 (2×CH_3 tMB). IR ν_{max}(thin film)/ cm^{-1}: 3317, 2950, 1668, 1515, 1093, 734, 696. $[\alpha]^{20}_D$: –14.6 (*c* 3.7, $CHCl_3$). HRMS: found 559.3528 $[M+H]^+$, calculated for $[C_{35}H_{46}O_4N_2+H]^+$ 559.3530.



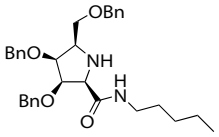
Pentyl 3,4,6-tri-*O*-benzyl-2,5-dideoxy-2,5-imino-D-*talo*-hexonamide (A2-III). Compound **A2-III** (81 mg, 0.16 mmol) was synthesized in 80% yield from **A1-III** (0.20 mmol) by deprotection of the pent-4-enamide (general procedure D). R_F = 0.85 (1:1; EtOAc:toluene). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.43 – 7.21 (m, 16H, C(O)NH, H_{Ar} Bn), 4.73 (d, *J* = 12.0, 1H, C*H*H Bn), 4.65 (d, *J* = 12.0, 1H, CH*H* Bn), 4.63 (d, *J* = 11.8, 1H, C*H*H Bn), 4.53 (d, *J* = 11.7, 1H, C*H*H Bn), 4.50 (d, *J* = 11.7, 1H, CH*H* Bn), 4.45 (d, *J* = 11.8, 1H, CH*H* Bn), 4.10 (dd, *J* = 3.6, 4.5, 1H, H-3), 3.95 (dd, *J* = 4.9, 5.5, 1H, H-4), 3.79 (d, *J* = 3.6, 1H, H-2), 3.77 – 3.71 (m, 2H, CH_2-6), 3.52 (dt, *J* = 5.3, 8.8, 1H, H-5), 3.26 – 3.11 (m, 2H, NCH_2-1 pentyl), 1.48 – 1.41 (m, 2H, CH_2-2 pentyl), 1.34 – 1.28 (m, 2H, CH_2 pentyl), 1.28 – 1.21 (m, 2H, CH_2 pentyl), 0.88 (t, *J* = 7.2, 3H, CH_3-5 pentyl). ^{13}C NMR (150 MHz, $CDCl_3$) δ 172.5 (C(O)-1), 138.4, 138.3, 138.2 (3×C_q Bn), 128.6, 128.5, 128.2, 128.0, 127.9, 127.9, 127.8 (CH_{Ar} Bn), 81.7 (C-3), 78.9 (C-4), 73.6, 72.9, 72.0 (3×CH_2 Bn), 70.6 (C-6), 64.3 (C-2), 59.2 (C-5), 39.2 (NCH_2-1 pentyl), 29.5 (CH_2-2 pentyl), 29.2, 22.5 (2×CH_2 pentyl), 14.2 (CH_3-5 pentyl). IR ν_{max}(thin film)/ cm^{-1}: 3325, 2929, 2867, 1667, 1521, 1454, 1360, 1209, 1096, 1027, 735, 698. $[\alpha]^{20}_D$: –4.0 (*c* 0.8, $CHCl_3$). HRMS: found 517.3059 $[M+H]^+$, calculated for $[C_{32}H_{40}O_4N_2+H]^+$ 517.3061.



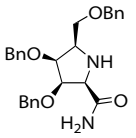
5-(Adamantan-1yl-methoxy)-pentyl 3,4,6-tri-*O*-benzyl-2,5-dideoxy-2,5-imino-D-*galacto*-hexonamide (B2-I). Compound **B2-I** (385 mg, 0.57 mmol) was synthesized in 97% yield from **B1-I** (0.58 mmol) by deprotection of the pent-4-enamide (general procedure C). R_F = 0.25 (2:1; EtOAc:toluene). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.68 (t, *J* = 5.5, 1H, C(O)NH), 7.38 – 7.18 (m, 15H, H_{Ar} Bn), 5.91 – 5.73 (s, NH), 4.95 (dd, *J* = 4.1, 5.8, 1H, H-3), 4.84 (d, *J* = 6.0, 1H, H-2), 4.74 (d, *J* = 11.3, 1H, C*H*H Bn), 4.70 (d, *J* = 11.3, 1H, CH*H* Bn), 4.62 – 4.46 (m, 4H, 2×CH_2 Bn), 4.35 (dd, *J* = 3.8, 6.4, 1H, H-4), 4.16 (dt, *J* = 5.4, 10.8, 1H, H-5), 3.96 (dd, *J* = 10.4, 1H, H-6a), 3.70 (dd, *J* = 4.6, 10.4, 1H, H-6b), 3.37 (t, *J* = 6.4, 2H, CH_2-5 pentyl), 3.32 – 3.16 (m, 2H, CH_2-1 pentyl), 2.91 (s, 2H, OCH_2-Ada), 1.95 (s, 3H, 3×CH Ada), 1.67 (dd, *J* = 12.4, 40.4, 6H, 3×CH Ada), 1.61 – 1.54 (m, 2H, CH_2-4 pentyl), 1.52 (d, *J* = 6.6, 6H, 3×CH Ada), 1.47 – 1.36 (m, 3H, CH_2-2, C*H*H-3 pentyl), 1.31 – 1.23 (m, 1H, CH*H*-3 pentyl). ^{13}C NMR (150 MHz, $CDCl_3$) δ 164.8 (C(O)-1), 137.3, 137.1, 136.9 (3×C_q Bn), 128.7, 128.7, 128.6, 128.3, 128.1, 128.1, 127.7, 127.7 (CH_{Ar} Bn), 82.1 (C-3), 82.0 (C-4), 78.7, 78.4, 74.7, 73.7, 73.7, 71.4, 71.4 (3×CH_2 Bn), 66.1 (C-6), 59.9 (C-2), 58.5 (C-5), 40.5 (CH_2-1 pentyl), 39.9 (CH_2 Ada), 37.4 (CH_2 Ada), 34.2 (C_q Ada), 29.3 (CH_2 pentyl), 29.2, 29.0 (CH_2 pentyl), 28.4 (CH Ada), 23.7, 23.7 (CH_2-3 pentyl). IR ν_{max}(thin film)/ cm^{-1}: 3242, 2900, 2847, 1686, 1544, 1453, 1359, 1153, 1097, 1026, 734, 697. $[\alpha]^{20}_D$: 13.5 (*c* 1.8, $CHCl_3$). HRMS: found 681.4262 $[M+H]^+$, calculated for $[C_{43}H_{56}O_5N_2+H]^+$ 681.4262.



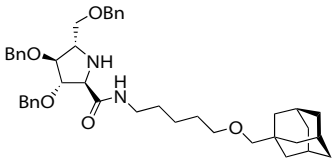
1,1,3,3-Tetramethylbutyl 3,4,6-tri-*O*-benzyl-2,5-dideoxy-2,5-imino-D-*galacto*-hexonamide (B2-II). Compound **B2-II** (301 mg, 0.54 mmol) was synthesized in 92% yield from **B1-II** (0.58 mmol) by deprotection of the pent-4-enamide (general procedure D). R_F = 0.40 (1:2; EtOAc:toluene). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.46 (s, 1H, C(O)NH), 7.37 – 7.25 (m, 15H, H_{Ar} Bn), 5.56 – 5.19 (s, 1H, NH), 4.76 (d, *J* = 11.4, 1H, C*H*H Bn), 4.73 (d, *J* = 11.4, 1H, CH*H* Bn), 4.64 (d, *J* = 11.7, 1H, C*H*H Bn), 4.61 (dd, *J* = 3.8, 6.1, 1H, H-3), 4.57 (d, *J* = 11.7, 1H, C*H*H Bn), 4.55 – 4.49 (m, 2H, 2×CH*H* Bn), 4.28 (d, *J* = 6.3, 1H, H-2), 4.18 (dd, *J* = 3.8, 6.2, 1H, H-4), 3.89 – 3.84 (m, 1H, H-5), 3.81 (dd, *J* = 9.2, 1H, H-6a), 3.76 (dd, *J* = 4.6, 9.7, 1H, H-6b), 1.66 – 1.57 (m, 2H, CH_2-2 tMB), 1.33 (d *J* = 29.4, 6H, 2×CH_3 tMB), 0.95 (s, 9H, 2×CH_3, CH_3-4 tMB). ^{13}C NMR (150 MHz, $CDCl_3$) δ 167.1 (C(O)-1), 137.8, 137.7, 137.5 (3×C_q Bn), 128.3, 128.1, 127.9, 127.7, 127.6, 127.5, 127.4 (CH_{Ar} Bn), 79.2 (C-3), 78.7 (C-4), 73.7, 73.2, 73.0 (3×CH_2 Bn), 69.2 (C-6), 60.9 (C-2), 57.9 (C-5), 55.2 (NHC_q-1 tMB), 52.4 (CH_2-2 tMB), 31.6 (C_q-3 tMB), 31.4 (2×CH_3, CH_3-4 tMB), 28.4 (2×CH_3 tMB). IR ν_{max}(thin film)/ cm^{-1}: 3274, 2951, 1681, 1668, 1530, 1093, 732, 696. $[\alpha]^{20}_D$: 4.2 (*c* 6.0, $CHCl_3$). HRMS: found 559.3529 $[M+H]^+$, calculated for $[C_{35}H_{46}O_4N_2+H]^+$ 559.3530.



Pentyl 3,4,6-tri-*O*-benzyl-2,5-dideoxy-2,5-imino-D-*galacto*-hexonamide (B2-III). Compound **B2-III** (341 mg, 0.66 mmol) was synthesized in 77% yield from **B1-III** (0.86 mmol) by deprotection of the pent-4-enamide (general procedure D). R_F = 0.15 (1:1; EtOAc:toluene). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.70 (s, 1H, C(O)NH), 7.38 – 7.19 (m, 15H, H_{Ar} Bn), 6.34 – 6.11 (s, 1H, NH), 4.74 – 4.48 (m, 7H, H-3, 3×CH_2 Bn), 4.47 (d, *J* = 5.6, 1H, H-2), 4.20 (dd, *J* = 3.9, 6.2, 1H, H-4), 3.92 – 3.86 (m, 1H, H-5), 3.83 (dd, *J* = 9.6, 1H, H-6a), 3.74 – 3.67 (m, 1H, H-6b), 3.16 – 3.10 (m, 2H, NCH_2-1 pentyl), 1.39 – 1.32 (m, 2H, CH_3-2 pentyl), 1.23 – 1.13 (m, 4H, 2×CH_2 pentyl), 0.80 (t, *J* = 7.0, 3H, CH_3-5 pentyl). ^{13}C NMR (150 MHz, $CDCl_3$) δ 167.7 (C(O)-1), 137.8, 137.6, 137.4 (3×C_q Bn), 128.8, 128.4, 128.4, 128.3, 128.3, 128.0, 127.9, 127.9, 127.8, 127.7, 127.6, 127.6, 127.5, 127.5, 127.2 (CH_{Ar} Bn), 79.1 (C-3), 78.8 (C-4), 74.0, 73.4, 73.2 (3×CH_2 Bn), 68.3 (C-6), 60.6 (C-2), 58.0 (C-5), 39.9 (NCH_2-1 pentyl), 29.0 (CH_2-2 pentyl), 28.8, 22.2 (2×CH_2 pentyl), 14.0 (CH_3-5 pentyl). IR ν_{max}(thin film)/ cm^{-1}: 3231, 2929, 2862, 1682, 1652, 1543, 1454, 1358, 1257, 1210, 1092, 1026, 734, 696. $[\alpha]^{20}_D$: 14.4 (*c* 5.5, $CHCl_3$). HRMS: found 517.3059 $[M+H]^+$, calculated for $[C_{32}H_{40}O_4N_2+H]^+$ 517.3061.

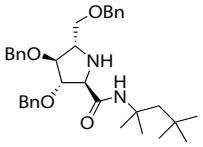


3,4,6-Tri-*O*-benzyl-2,5-dideoxy-2,5-imino-D-*galacto*-hexonamide (B2-VI). Compound **B2-VI** (40 mg, 90 µmol) was synthesized in 52% yield from **B1-VI** (173 µmol) by deprotection of the pent-4-enamide (general procedure D). R_F = 0.36 (1:9; MeOH:EtOAc). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.35 – 7.25 (m, 15H, H_{Ar} Bn), 5.38 (s, 1H, NH_2), 4.75 (d, *J* = 11.8, 1H, C*H*H Bn), 4.69 (d, *J* = 11.8, 1H, C*H*H Bn), 4.66 (d, *J* = 11.8, 1H, CH*H* Bn), 4.55 – 4.51 (m, 2H, CH*H* Bn, C*H*H Bn), 4.48 (d, *J* = 11.9, 1H, CH*H* Bn), 4.29 (dd, *J* = 3.9, 6.7, 1H, H-3), 3.99 (dd, *J* = 4.0, 5.9, 1H, H-4), 3.94 (d, *J* = 6.7, 1H, H-2), 3.76 (dd, *J* = 4.6, 9.4, 1H, H-6a), 3.66 (dd, *J* = 8.7, 1H, H-6b), 3.58 – 3.53 (m, 1H, H-5), 2.30 – 2.07 (m, 2H, NH). ^{13}C NMR (150 MHz, $CDCl_3$) δ 174.9 (C(O)-1), 138.5, 138.5, 138.3 (3×C_q Bn), 128.6, 128.6, 128.5, 128.1, 127.9, 127.9, 127.7, 127.7, 127.7 (CH_{Ar} Bn), 80.1 (C-3), 79.5 (C-4), 73.8, 73.6, 73.1 (3×CH_2 Bn), 71.5 (C-6), 62.0 (C-2), 58.3 (C-5). IR ν_{max}(thin film)/ cm^{-1}: 3319, 2928, 2870, 1726, 1682, 1495, 1454, 1363, 1277, 1209, 1126, 1074, 1026, 735, 698. $[\alpha]^{20}_D$: 9.2 (*c* 0.2, $CHCl_3$). HRMS: found 447.2276 $[M+H]^+$, calculated for $[C_{27}H_{30}O_5N_2+H]^+$ 447.2278.

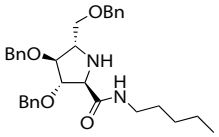


5-(Adamantan-1yl-methoxy)-pentyl 3,4,6-tri-*O*-benzyl-2,5-dideoxy-2,5-imino-L-*gulo*-hexonamide (C2-I). Compound **C2-I** (54 mg, 79 µmol) was synthesized in 55% yield from **C1-I** (144 µmol) by deprotection of the pent-4-enamide (general procedure D). R_F = 0.38 (1:1; EtOAc:PE). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.68 (t, *J* = 5.9, 1H, C(O)NH), 7.39 – 7.18 (m, 15H,

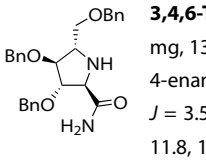
H_{Ar} Bn), 4.77 (d, *J* = 11.8, 1H, C*H*H Bn), 4.62 (d, *J* = 11.8, 1H, CH*H* Bn), 4.55 – 4.45 (m, 3H, C*H*H Bn, CH_2 Bn), 4.41 (d, *J* = 11.6, 1H, CH*H* Bn), 4.36 (dd, *J* = 2.9, 1H, H-3), 3.88 (dd, *J* = 3.2, 5.7, 1H, H-4), 3.74 (d, *J* = 2.3, 1H, H-2), 3.58 (dd, *J* = 4.0, 9.6, 1H, H-6a), 3.53 (dd, *J* = 5.6, 9.6, 1H, H-6b), 3.34 (t, *J* = 6.5, 2H, CH_2-5 pentyl), 3.29 – 3.15 (m, 3H, H-5, NCH_2-1 pentyl), 2.93 (s, 2H, OCH_2-Ada), 2.66 (s, 1H, NH), 1.95 (s, 3H, 3×CH Ada), 1.67 (dd, *J* = 11.6, 36.7, 6H, 3×CH_2 Ada), 1.58 – 1.43 (m, 10H, 3×CH_2 Ada), 1.39 – 1.30 (m, 2H, CH_2-3 pentyl). ^{13}C NMR (150 MHz, $CDCl_3$) δ 171.9 (NHC(O)-1), 138.1, 137.9, 137.9 (3×C_q Bn), 128.5, 128.4, 128.3, 128.0, 127.9, 127.8, 127.8, 127.7, 127.6 (CH_{Ar} Bn), 87.2 (C-3), 84.9 (C-4), 81.9 (OCH_2-Ada), 73.2, 71.8, 71.6 (3×CH_2 Bn), 71.4 (CH_2-5 pentyl), 68.8 (C-6), 65.7 (C-2), 62.4 (C-5), 39.7 (CH_2 Ada), 39.1 (NCH_2-1 pentyl), 37.3 (CH_2 Ada), 34.1 (C_q Ada), 29.5, 29.2 (2×CH_2 pentyl), 28.3 (CH Ada), 23.6 (CH_2-3 pentyl). IR ν_{max}(thin film)/ cm^{-1}: 2901, 1669, 1513, 1455, 1097, 735, 697. $[\alpha]^{20}_D$: –0.5 (*c* 0.8, $CHCl_3$). HRMS: found 681.4259 $[M+H]^+$, calculated for $[C_{43}H_{56}O_5N_2+H]^+$ 681.4262.



1,1,3,3-Tetramethylbutyl 3,4,6-tri-*O*-benzyl-2,5-dideoxy-2,5-imino-L-*gulo*-hexonamide (C2-II). Compound **C2-II** (175 mg, 313 µmol) was synthesized in 95% yield from **C1-II** (330 µmol) by deprotection of the pent-4-enamide (general procedure D). R_F = 0.69 (1:1; EtOAc:PE). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.72 (s, 1H, C(O)NH)), 7.39 – 7.20 (m, 15H, H_{Ar} Bn), 4.78 (d, *J* = 11.8, 1H, C*H*H Bn), 4.62 (d, *J* = 11.8, 1H, CH*H* Bn), 4.59 – 4.41 (m, 4H, 2×CH_2 Bn), 4.34 (dd, *J* = 2.8, 3.3, 1H, H-3), 3.90 (dd, *J* = 3.4, 6.0, 1H, H-4), 3.61 (d, *J* = 2.6, 1H, H-2), 3.59 – 3.51 (m, 2H, CH_2-6), 3.20 – 3.13 (m, 1H, H-5), 2.74 – 2.61 (m, 1H, NH), 1.76 (d, *J* = 14.9, 1H, C*H*H-2 tMB), 1.60 (d, *J* = 13.7, 1H, CH*H*-2 tMB), 1.39 (d, *J* = 12.9, 6H, 2×CH_3 tMB), 0.98 (s, 9H, CH_3-4, 2×CH_3 tMB). ^{13}C NMR (150 MHz, $CDCl_3$) δ 171.0 (NHC(O)-1), 138.5, 138.2, 138.1 (3×C_q Bn), 128.6, 128.5, 128.5, 128.1, 128.1, 128.0, 128.0, 127.8, 127.7 (CH_{Ar} Bn), 87.7 (C-3), 85.2 (C-4), 73.4, 72.1, 71.9 (3×CH_2 Bn), 68.8 (C-6), 66.3 (C-2), 62.3 (C-5), 54.5 (NHC_q-1 tMB), 52.8 (CH_2-2 tMB), 31.8 (C_q-3 tMB), 31.7 (CH_3-4, 2×CH_3 tMB), 29.3, 28.6 (2×CH_3 tMB). IR ν_{max}(thin film)/ cm^{-1}: 3322, 2948, 1670, 1516, 1092, 738, 698. $[\alpha]^{20}_D$: –1.5 (*c* 2.0, $CHCl_3$). HRMS: found 559.3525 $[M+H]^+$, calculated for $[C_{35}H_{46}O_4N_2+H]^+$ 559.3530.

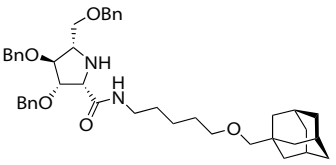


Pentyl 3,4,6-tri-*O*-benzyl-2,5-dideoxy-2,5-imino-L-*gulo*-hexonamide (C2-III). Compound **C2-III** (220 mg, 0.43 mmol) was synthesized in 95% yield from **C1-III** (0.45 mmol) by deprotection of the pent-4-enamide (general procedure D). R_F = 0.57 (1:1; EtOAc:PE). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.62 (t, *J* = 5.6, 1H, C(O)NH), 7.40 – 7.19 (m, 15H, H_{Ar} Bn), 4.77 (d, *J* = 11.8, 1H, C*H*H Bn), 4.62 (d, *J* = 11.8, 1H), CH*H* Bn, 4.54 – 4.39 (m, 4H, 2×CH_2 Bn), 4.36 (dd, *J* = 2.9, 1H, H-3), 3.89 (dd, *J* = 3.3, 5.6, 1H, H-4), 3.78 (d, *J* = 2.3, 1H, H-2), 3.58 (dd, *J* = 4.1, 9.6, 1H, H-6a), 3.55 (dd, *J* = 5.7, 9.6, 1H, H-6b), 3.28 – 3.15 (m, 3H, H-5, NCH_2-1 pentyl), 1.51 – 1.42 (m, 2H, CH_2-2 pentyl), 1.32 – 1.24 (m, 4H, 2×CH_2 pentyl), 0.87 (t, *J* = 7.0, 3H, CH_3-5 pentyl). ^{13}C NMR (150 MHz, $CDCl_3$) δ 171.8 (NHC(O)-1), 138.3, 138.1, 138.0 (3×C_q Bn), 128.7, 128.6, 128.5, 128.2, 128.2, 128.2, 128.1, 128.0, 128.0, 127.9 (CH_{Ar} Bn), 87.3 (C-3), 85.0 (C-4), 73.4, 72.1, 71.9 (3×CH_2 Bn), 68.9 (C-6), 65.8 (C-2), 62.7 (C-5), 39.3 (NCH_2-1 pentyl), 29.5, 29.3, 22.6 (3×CH_2 pentyl), 14.2 (CH_3-5 pentyl). IR ν_{max}(thin film)/ cm^{-1}: 3325, 2930, 2860, 1668, 1526, 1455, 1096, 736, 698. $[\alpha]^{20}_D$: –1.6 (*c* 4.4, $CHCl_3$). HRMS: found 517.3055 $[M+H]^+$, calculated for $[C_{32}H_{40}O_4N_2+H]^+$ 517.3061.

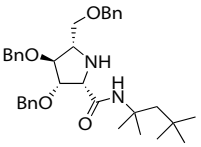


3,4,6-Tri-*O*-benzyl-2,5-dideoxy-2,5-imino-L-*gulo*-hexonamide (C2-VI). Compound **C2-VI** (6 mg, 13 µmol) was synthesized in 26% yield from **C1-VI** (50 µmol) by deprotection of the pent-4-enamide (general procedure D). R_F = 0.23 (100% EtOAc). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.48 (d, *J* = 3.5, 1H, C(O)N*H*H), 7.38 – 7.17 (m, 15H, H_{Ar} Bn), 5.51 (d, *J* = 3.9, 1H, C(O)NH*H*), 4.73 (d, *J* = 11.8, 1H, C*H*H Bn), 4.64 – 4.40 (m, 5H, CH*H* Bn, 2×CH_2 Bn), 4.38 (dd, *J* = 2.8, 1H, H-3), 3.90 (dd, *J* = 3.1, 5.4, 1H, H-4), 3.77 (d, *J* = 2.5, 1H, H-2), 3.62 – 3.50 (m, 2H, H-6a, H-5), 3.29 (dd, *J* = 5.4, 10.0, 1H, H-6b). ^{13}C NMR (101 MHz, CDCl3) δ 175.5 (NHC(O)-1), 138.2, 138.1, 138.1 (3×C_q Bn), 128.9, 128.8, 128.7, 128.7, 128.6, 128.6, 128.2, 128.1, 128.1, 128.0, 128.0, 127.9 (CH_{Ar} Bn), 87.3 (C-3), 85.1 (C-4), 73.4, 72.1, 71.9 (3×CH_2 Bn), 69.1 (C-6), 65.8

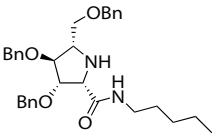
(C-2), 62.8 (C-5). IR ν_{max}(thin film)/ cm^{-1}: 3427, 295, 2856, 1682, 1454, 1364, 1093, 1027, 735, 698. $[\alpha]^{20}_D$: –2.0 (*c* 0.2, $CHCl_3$). HRMS: found 447.2275 $[M+H]^+$, calculated for $[C_{27}H_{30}O_5N_2+H]^+$ 447.2278.



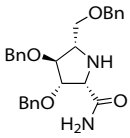
5-(Adamantan-1yl-methoxy)-pentyl 3,4,6-tri-*O*-benzyl-2,5-dideoxy-2,5-imino-L-*ido*-hexonamide (D2-I). Compound **D2-I** (111 mg, 163 µmol) was synthesized in 62% yield from **D1-I** (262 µmol) by deprotection of the pent-4-enamide (general procedure D). R_F = 0.16 (1:1; EtOAc:PE). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.39 (t, *J* = 5.6, 1H, C(O)NH), 7.37 – 7.19 (m, 15H, H_{Ar} Bn), 4.59 (d, *J* = 11.7, 1H, C*H*H Bn), 4.53 – 4.39 (m, 5H, CH*H* Bn, 2×CH_2 Bn), 4.29 (dd, *J* = 1.7, 5.6, 1H, H-3), 4.16 (d, *J* = 5.6, 1H, H-2), 3.85 (dd, *J* = 2.1, 1H, H-4), 3.56 – 3.47 (m, 3H, H-5, CH_2-6), 3.30 (t, *J* = 6.6, 2H, CH_2-5 pentyl), 3.23 – 3.18 (m, 2H, NCH_2-1 pentyl), 2.92 (s, 2H, OCH_2-Ada), 2.55 – 2.14 (m, 1H, NH), 1.95 (s, 3H, 3×CH Ada), 1.67 (dd, *J* = 11.6, 38.8, 6H, 3×CH_2 Ada), 1.54 – 1.37 (m, 10H, 3×CH_2 Ada, 2×CH_2 pentyl), 1.34 – 1.26 (m, 2H, CH_2-3 pentyl). ^{13}C NMR (150 MHz, $CDCl_3$) δ 170.5 (NHC(O)-1), 138.2, 138.0, 137.8 (3×C_q Bn), 128.7, 128.4, 128.4, 128.3, 128.0, 127.8, 127.8, 127.7, 127.7, 127.7, 127.6 (CH_{Ar} Bn), 83.2 (C-4), 83.0 (C-3), 81.9 (OCH_2-Ada), 73.2, 72.9 (2×CH_2 Bn), 72.0 (C-6), 71.5 (CH_2 Bn), 71.4 (CH_2-5 pentyl), 64.5 (C-2), 62.3 (C-5), 39.8 (CH_2 Ada), 39.1 (NCH_2-1 pentyl), 37.3 (CH_2 Ada), 34.1 (C_q Ada), 29.5, 29.2 (2×CH_2 pentyl), 28.3 (CH Ada), 23.6 (CH_2-3 pentyl). IR ν_{max}(thin film)/ cm^{-1}: 3030, 2903, 1668, 1512, 1454, 1096, 735, 699. $[\alpha]^{20}_D$: –4.6 (*c* 2.2, $CHCl_3$). HRMS: found 681.4259 $[M+H]^+$, calculated for $[C_{43}H_{56}O_5N_2+H]^+$ 681.4262.



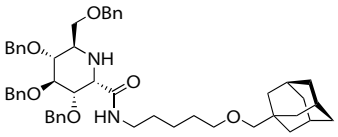
1,1,3,3-Tetramethylbutyl 3,4,6-tri-*O*-benzyl-2,5-dideoxy-2,5-imino-L-*ido*-hexonamide (D2-II). Compound **D2-II** (151 mg, 270 µmol) was synthesized in 75% yield from **D1-II** (360 µmol) by deprotection of the pent-4-enamide (general procedure D). R_F = 0.47 (1:1; EtOAc:PE). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.40 – 7.22 (m, 16H, C(O)NH), H_{Ar} Bn), 4.62 (d, *J* = 11.7, 1H, C*H*H Bn), 4.56 (d, *J* = 12.0, 1H, C*H*H Bn), 4.53 – 4.45 (m, 3H, CH*H* Bn, CH*H* Bn, C*H*H Bn), 4.43 (d, *J* = 11.9, 1H, CH*H* Bn), 4.26 (dd, *J* = 1.4, 5.5, 1H, H-3), 4.02 (d, *J* = 5.5, 1H, H-2), 3.88 (dd, *J* = 1.7, 1H, H-4), 3.57 (dd, *J* = 5.5, 7.0, 1H, H-6a), 3.53 – 3.47 (m, 2H, H-5, H-6b), 2.33 (s, 1H, NH), 1.81 (d, *J* = 14.9, 1H, C*H*H-2 tMB), 1.51 (d, *J* = 14.9, 1H, CH*H*-2 tMB), 1.40 (d, *J* = 29.5, 6H, 2×CH_3 tMB), 0.98 (s, 9H, CH_3-4, 2×CH_3 tMB). ^{13}C NMR (150 MHz, $CDCl_3$) δ 169.5 (NHC(O)-1), 138.3, 138.1, 137.9 (3×C_q Bn), 128.4, 128.4, 128.2, 128.1, 127.9, 127.8, 127.7, 127.7, 127.7, 127.7, 127.5 (CH_{Ar} Bn), 83.5 (C-4), 83.1 (C-3), 73.2, 72.9 (2×CH_2 Bn), 72.6 (C-6), 71.4 (CH_2 Bn), 65.4 (C-2), 62.5 (C-5), 54.4 (NHC_q-1 tMB), 53.0 (CH_2-2 tMB), 31.6 (C_q-3 tMB), 31.5 (CH_3-4, 2×CH_3 tMB), 28.9, 28.2 (2×CH_3 tMB). IR ν_{max}(thin film)/ cm^{-1}: 3320, 2950, 1669, 1522, 1096, 738, 698. $[\alpha]^{20}_D$: –6.1 (*c* 2.1, $CHCl_3$). HRMS: found 559.3525 $[M+H]^+$, calculated for $[C_{35}H_{46}O_4N_2+H]^+$ 559.3530.



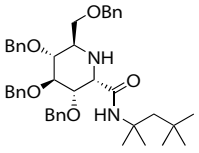
Pentyl 3,4,6-tri-*O*-benzyl-2,5-dideoxy-2,5-imino-L-*ido*-hexonamide (D2-III). Compound **D2-III** (410 mg, 0.79 mmol) was synthesized in 83% yield from **D1-III** (0.95 mmol) by deprotection of the pent-4-enamide (general procedure D). R_F = 0.35 (1:1; EtOAc:PE). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.40 (t, *J* = 5.7, 1H, C(O)NH), 7.35 – 7.21 (m, 15H, H_{Ar} Bn), 4.60 (d, *J* = 11.7, 1H, C*H*H Bn), 4.52 – 4.40 (m, 5H, CH*H* Bn, 2×CH_2 Bn), 4.30 (dd, *J* = 1.5, 5.6, 1H, H-3), 4.17 (d, *J* = 5.7, 1H, H-2), 3.85 (s, 1H, H-4), 3.56 – 3.47 (m, 3H, H-5, CH_2-6), 3.26 – 3.12 (m, 2H, NCH_2-1 pentyl), 2.44 (s, 1H, NH), 1.46 – 1.38 (m, 2H, CH_2-2 pentyl), 1.29 – 1.19 (m, 4H, 2×CH_2 pentyl), 0.84 (t, *J* = 7.0, 3H, CH_3-5 pentyl). ^{13}C NMR (150 MHz, $CDCl_3$) δ 170.7 (NHC(O)-1), 138.3, 138.2, 137.9 (3×C_q Bn), 128.8, 128.6, 128.6, 128.5, 128.0, 128.0, 127.9, 127.9, 127.9, 127.8 (CH_{Ar} Bn), 83.4 (C-4), 83.2 (C-3), 73.4, 73.1 (2×CH_2 Bn), 72.1 (C-6), 71.7 (CH_2 Bn), 64.6 (C-2), 62.6 (C-5), 39.3 (NCH_2-1 pentyl), 29.5, 29.3, 22.5 (3×CH_2 pentyl), 14.2 (CH_3-5 pentyl). IR ν_{max}(thin film)/ cm^{-1}: 3325, 3032, 2929, 2861, 1668, 1532, 1497, 1455, 1363, 1208, 1093, 1028, 735, 698. $[\alpha]^{20}_D$: –5.8 (*c* 8.2, $CHCl_3$). HRMS: found 517.3056 $[M+H]^+$, calculated for $[C_{32}H_{40}O_4N_2+H]^+$ 517.3061.



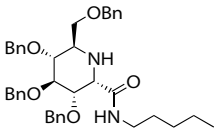
3,4,6-Tri-*O*-benzyl-2,5-dideoxy-2,5-imino-L-*ido*-hexonamide (D2-VI). Compound **D2-VI** (29 mg, 63 µmol) was synthesized in 55% yield from **D1-VI** (115 µmol) by deprotection of the pent-4-enamide (general procedure D). R_F = 0.11 (100% EtOAc). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.39 – 7.19 (m, 16H, H_{Ar} Bn, C(O)N*H*H), 5.50 (s, 1H, C(O)NH*H*), 4.62 (d, *J* = 11.7, 1H, C*H*H Bn), 4.55 – 4.39 (m, 5H, CH*H* Bn, 2×CH_2 Bn), 4.26 (dd, *J* = 2.1, 5.8, 1H, H-3), 4.11 (d, *J* = 5.8, 1H, H-2), 3.89 (dd, *J* = 2.3, 1H, H-4), 3.59 – 3.43 (m, 3H, H-5, CH_2-6), 2.30 (s, 1H, NH). ^{13}C NMR (100 MHz, $CDCl_3$) δ 174.4 (NHC(O)-1), 138.4, 138.1, 138.0 (3×C_q Bn), 128.6, 128.6, 128.5, 128.0, 128.0, 127.9, 127.9 (CH_{Ar} Bn), 83.5, 83.3 (C-3, C-4), 73.4, 73.1 (2×CH_2 Bn), 72.4 (C-6), 71.8 (CH_2 Bn), 64.6 (C-2), 62.6 (C-5). IR ν_{max}(thin film)/ cm^{-1}: 3431, 2860, 1682, 1453, 1363, 1092, 1070, 1027, 735, 697. $[\alpha]^{20}_D$: –34.2 (*c* 0.4, $CHCl_3$). HRMS: found 447.2275 $[M+H]^+$, calculated for $[C_{27}H_{30}O_5N_2+H]^+$ 447.2278.



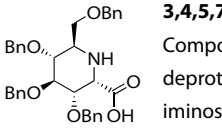
5-(Adamantan-1yl-methoxy)-pentyl 3,4,5,7-tetra-*O*-benzyl-2,6-dideoxy-2,6-imino-D-*glycero*-D-*ido*-heptonamide (E2-I). Compound **E2-I** (585 mg, 0.73 mmol) was synthesized in 99% yield from **E1-I** (0.74 mmol) by deprotection of the pent-4-enamide (general procedure D). R_F = 0.22 (1:2; EtOAc:toluene). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.88 (t, *J* = 5.0, 1H, C(O)NH), 7.55 (s, 1H, NH), 7.41 – 7.00 (m, 20H, H_{Ar} Bn), 4.94 (d, *J* = 10.9, 1H, C*H*H Bn), 4.90 (d, *J* = 11.2, 1H, C*H*H Bn), 4.80 (d, *J* = 10.9, 1H, CH*H* Bn), 4.76 – 4.67 (m, 3H, H-2, CH*H* Bn, C*H*H Bn), 4.58 – 4.43 (m, 3H, H-3, CH_2 Bn), 4.36 (d, *J* = 11.0, 1H, CH*H* Bn), 3.80 – 3.64 (m, 4H,), 3.59 – 3.48 (m, 1H, H-6), 3.28 (t, *J* = 6.5, 2H, CH_2-5 pentyl), 3.20 (dt, *J* = 6.8, 20.8, 2H, NCH_2-1 pentyl), 2.91 (s, 2H, OCH_2-Ada), 1.93 (s, 3H, 3×CH Ada), 1.65 (dd, *J* = 12.0, 27.5, 6H, 3×CH_2 Ada), 1.53 – 1.39 (m, 11H, 3×CH_2 Ada, 2×CH_2 pentyl), 1.31 – 1.22 (m, 2H, CH_2-3 pentyl). ^{13}C NMR (100 MHz, $CDCl_3$) δ 166.7 (C(O)-1), 137.7, 137.2, 136.8, 136.6 (4×C_q Bn), 128.6, 128.4, 128.4, 128.4, 128.3, 128.1, 128.1, 127.9, 127.9, 127.8, 127.8 (CH_{Ar} Bn), 81.8 (OCH_2-Ada), 80.9, 76.9, 76.7 (C-3, C-4, C-5), 75.1, 74.6, 73.1 (CH_2 Bn), 71.2 (CH_2-5 pentyl), 66.6 (C-7), 55.8 (C-6), 54.5 (C-2), 39.8 (NCH_2-1 pentyl), 39.6 (CH_2 Ada), 37.1 (CH_2 Ada), 34.0 (C_q Ada), 29.1, 28.8, 28.2 (CH Ada), 23.5 (CH_2-3 pentyl). IR ν_{max}(thin film)/ cm^{-1}: 2901, 2848, 1679, 1545, 1497, 1453, 1362, 1210, 1155, 1067, 1027, 909, 730, 697. $[\alpha]^{20}_D$: 28.1 (*c* 9.1, $CHCl_3$). HRMS: found 801.4839 $[M+H]^+$; calculated for $[C_{51}H_{64}N_2O_6+H]^+$ 801.4837.



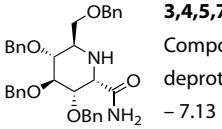
1,1,3,3-Tetramethylbutyl 3,4,5,7-tetra-*O*-benzyl-2,6-dideoxy-2,6-imino-D-*glycero*-D-*ido*-heptonamide (E2-II). Compound **E2-II** (468 mg, 0.69 mmol) was synthesized in 90% yield from **E1-II** (0.77 mmol) by deprotection of the pent-4-enamide (general procedure D). R_F = 0.34 (1:3; EtOAc:toluene). ^{1}H NMR (400 MHz, CDCl3) δ 7.60 (s, 1H, C(O) NH), 7.43 – 7.01 (m, 20H, H_{Ar} Bn), 4.96 – 4.89 (m, 2H, 2×C*H*H Bn), 4.86 (d, *J* = 10.5, 1H, CH*H* Bn), 4.80 (d, *J* = 11.3, 1H, CH*H* Bn), 4.76 (d, *J* = 10.8, 1H, C*H*H Bn), 4.58 (d, *J* = 12.4, 1H, C*H*H Bn), 4.53 (d, *J* = 12.4, 1H, CH*H* Bn), 4.47 – 4.38 (m, 3H, CH*H* Bn, H-2, H-3), 3.75 – 3.70 (m, 3H, H-5, CH_2-7), 3.63 (dd, *J* = 8.8, 1H, H-4), 3.38 (dt, *J* = 5.5, 10.8, 1H, H-6), 1.70 (d, *J* = 14.9, 1H, C*H*H-2 tMB), 1.47 (d, *J* = 14.9, 1H, CH*H*-2 tMB), 1.27 (d, *J* = 10.0, 6H, 2×CH_3 tMB), 0.87 (s, 9H, 2×CH_3, CH_3-4 tMB). ^{13}C NMR (100 MHz, $CDCl_3$) δ 165.8 (NHC(O)-1), 137.9, 137.2, 136.9, 136.6 (4×C_q Bn), 128.8, 128.7, 128.5, 128.5, 128.4, 128.4, 128.3, 128.2, 128.1, 128.0, 127.9, 127.8 (4×C_q Bn), 81.9 (C-4), 77.7 (C-3), 77.5 (C-5), 75.5, 75.4, 75.2, 73.3 (4×CH_2 Bn), 67.2 (C-7), 56.1 (C-6), 56.0 (NHC_q-1 tMB), 55.1 (C-2), 51.8 (CH_2-2 tMB), 31.5 (CH_3-4, 2×CH_3 tMB), 29.4, 28.5 (2×CH_3 tMB). IR ν_{max}(thin film)/ cm^{-1}: 3327, 3032, 2951, 1680, 1637, 1543, 1454, 1366, 1223, 1153, 1067, 1027, 910, 731, 697. $[\alpha]^{20}_D$: 33.7 (*c* 4.3, $CHCl_3$). HRMS: found 679.4105 $[M+H]^+$; calculated for $[C_{43}H_{54}N_2O_5+H]^+$ 679.4105.



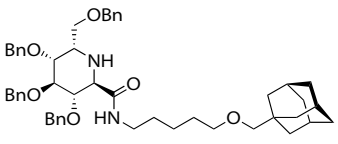
Pentyl 3,4,5,7-tetra-*O*-benzyl-2,6-dideoxy-2,6-2,6-imino-D-*glycero*-D-*ido*-heptonamide (E2-III). Compound **E2-III** (459 mg, 0.72 mmol) was synthesized in 95% yield from **E1-III** (0.76 mmol) by deprotection of the pent-4-enamide (general procedure D). R_F = 0.22 (1:2; EtOAc:toluene). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.56 (t, *J* = 5.5, 1H, C(O)NH), 7.33 – 7.12 (m, 20H, H_{Ar} Bn), 4.84 (d, *J* = 11.1, 1H, C*H*H Bn), 4.77 – 4.72 (m, 3H, 2×C*H*H Bn, CH*H* Bn), 4.68 (d, *J* = 11.3, 1H, CH*H* Bn), 4.58 (d, *J* = 12.1, 1H, C*H*H Bn), 4.47 – 4.41(m, 2H, CH*H* Bn, CH*H* Bn), 4.02 (dd, *J* = 5.0, 8.8, 1H, H-3), 3.70 (dd, *J* = 7.6, 8.9, 1H, H-4), 3.66 (d, *J* = 5.0, 1H, H-2), 3.62 (dd, *J* = 2.7, 9.7, 1H, H-7a), 3.51 (dd, *J* = 6.1, 9.7, 1H, H-7b), 3.41 (dd, *J* = 7.7, 9.7, 1H, H-5), 3.33 – 3.12 (m, 2H, CH_2-1 pentyl), 3.06 – 2.98 (m, 1H, H-6), 2.85 (s, 1H, NH), 1.47 – 1.38 (m, 2H, CH_2-2 pentyl), 1.32 – 1.17 (m, 4H, 2×CH_2 pentyl), 0.85 (t, *J* = 7.0, 3H, CH_3-5 pentyl). ^{13}C NMR (100 MHz, $CDCl_3$) δ 170.8 (NHC(O)-1), 138.4, 138.3, 138.1, 137.4 (4×C_q Bn), 128.6, 128.4, 128.3, 128.3, 128.1, 128.0, 128.0, 127.9, 127.8, 127.7, 127.6, 127.6 (4×CH_2 Bn), 82.8 (C-4), 79.7 (C-3), 79.6 (C-5), 74.9, 74.5, 74.0, 72.9 (4×CH_2 Bn), 69.9 (C-7), 56.2 (C-2), 55.0 (C-6), 39.2 (CH_2-1 pentyl), 29.2 (CH_2-2 pentyl), 29.1, 22.3 (2×CH_2 pentyl), 14.0 (CH_3-5 pentyl). IR ν_{max}(thin film)/ cm^{-1}: 3344, 2929, 2861, 1667, 1532, 1497, 1454, 1362, 1209, 1066, 1027, 909, 733, 696. $[\alpha]^{20}_D$: 35.4 (*c* 4.9, $CHCl_3$). HRMS: found 637.3632 $[M+H]^+$; calculated for $[C_{40}H_{48}N_2O_5+H]^+$ 637.3636.



3,4,5,7-Tetra-*O*-benzyl-2,6-dideoxy-2,6-imino-D-*glycero*-D-*ido*-heptonic acid (E2-V). Compound **E2-V** (58 mg, 73 μmol) was synthesized in 35% yield from **E1-V** (0.21 mmol) by deprotection of the pent-4-enamide (general procedure D). ^{1}H NMR (400 MHz, $CDCl_3$) collapsed iminosugar signals δ 7.56 – 6.91 (m, 20H, H_{Ar} Bn), 4.82 – 3.48 (m, 15H, 4×CH_2 Bn, H-2, H-3, H-4, H-5, H-6, CH_2-7). ^{13}C NMR (100 MHz, $CDCl_3$) collapsed iminosugar signals δ 138.0, 137.9, 137.8, 137.5 (4×C_q Bn), 128.7, 128.6, 128.6, 128.5, 128.2, 128.1, 128.0, 127.9 (CH_{Ar} Bn), 73.8, 73.3 (CH_2 Bn), 55.9 (C-2), 54.1 (C-6). IR ν_{max}(thin film)/ cm^{-1}: 3031, 2864, 1635, 1453, 1360, 1323, 1091, 1072, 1026, 910, 733, 697. $[\alpha]^{20}_D$: 26.0 (*c* 0.9, $CHCl_3$). HRMS: found 568.2690 $[M+H]^+$; calculated for $[C_{35}H_{37}NO_6+H]^+$ 568.2694.

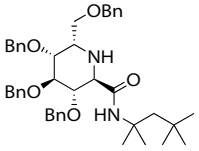


3,4,5,7-Tetra-*O*-benzyl-2,6-dideoxy-2,6-imino-D-*glycero*-D-*ido*-heptonamide (E2-VI). Compound **E2-VI** (45 mg, 79 μmol) was synthesized in 79% yield from **E1-V1** (100 μmol) by deprotection of the pent-4-enamide (general procedure D). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.36 – 7.13 (m, 20H, H_{Ar} Bn), 6.12 (d, *J* = 1.6, 1H, C(O)N*H*H), 5.78 (d, *J* = 1.9, 1H, C(O)NH*H*), 4.89 (s, 2H, CH_2 Bn), 4.86 (d, *J* = 10.6, 1H, C*H*H Bn), 4.81 (d, *J* = 10.9, 1H, C*H*H Bn), 4.63 (d, *J* = 10.6, 1H, CH*H* Bn), 4.55 – 4.47 (m, 2H, C*H*H Bn, CH*H* Bn), 4.43 (d, *J* = 11.9, 1H, CH*H* Bn), 3.64 (dd, *J* = 2.6, 9.0, 1H, H-7a), 3.62 – 3.54 (m, 3H, H-3, H-4, H-7b), 3.50 – 3.44 (m, 1H, H-5), 3.20 (d, *J* = 9.1, 1H, H-2), 2.77 (ddd, *J* = 2.6, 5.2, 9.6, 1H, H-6), 2.27 (s, 1H, NH). ^{13}C NMR (100 MHz, $CDCl_3$) δ 173.1 (NHC(O)-1), 138.5, 138.2, 137.9, 137.8 (4×C_q Bn), 129.1, 128.7, 128.5, 128.5, 128.4, 128.3, 128.1, 128.0, 128.0, 127.9, 127.8, 127.7 (CH_{Ar} Bn), 87.6, 82.2 (C-3, C-4), 80.0 (C-5), 75.7, 75.3, 75.2, 73.4 (4×CH_2 Bn), 69.5 (C-7), 61.9 (C-2), 58.3 (C-6). IR ν_{max}(thin film)/ cm^{-1}: 3398, 3031, 2909, 2864, 1668, 1453, 1359, 1149, 1087, 1054, 1027, 735, 696. $[\alpha]^{20}_D$: 29.1 (*c* 0.9, $CHCl_3$). HRMS: found 567.2850 $[M+H]^+$; calculated for $[C_{35}H_{38}N_2O_5+H]^+$ 567.2853.

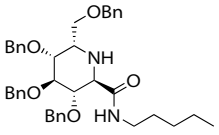


5-(Adamantan-1yl-methoxy)-pentyl 3,4,5,7-tetra-*O*-benzyl-2,6-dideoxy-2,6-imino-L-*glycero*-D-*gulo*-heptonamide (F2-I). Compound **F2-I** (108 mg, 0.14 mmol) was synthesized in 50% yield from **F1-I** (0.27 mmol) by deprotection of the pent-4-enamide (general procedure D). R_F = 0.17 (1:2; EtOAc:toluene). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.34 – 7.20 (m, 20H, H_{Ar} Bn), 6.86 (t, *J* = 5.7, 1H, C(O)NH), 4.72 – 4.45 (m, 8H, 4×CH_2 Bn), 4.01 (dd, *J* = 5.7, 1H, H-3), 3.77 (dd, *J* = 6.1, 1H, H-4), 3.63 – 3.52 (m, 3H, CH_2-7, H-5), 3.50 (d, *J* = 5.6, 1H, H-2), 3.39 (dt, *J* = 4.2, 8.3, 1H, H-6), 3.30 (t, *J* = 6.5,

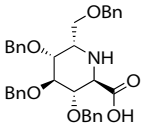
2H, CH_2-5 pentyl), 3.29 – 3.20 (m, 1H, NC*H*H-1 pentyl), 3.19 – 3.08 (m, 1H, NCH*H*-1 pentyl), 2.91 (s, 2H, OCH_2-Ada), 2.47 (s, 1H, NH), 1.94 (s, 3H, 3×CH Ada), 1.67 (dd, *J* = 12.1, 24.3, 6H, 3×CH_2 Ada), 1.55 – 1.36 (m, 10H, 3×CH_2 Ada, 2×CH_2 pentyl), 1.36 – 1.24 (m, 2H, CH_2-3 pentyl). ^{13}C NMR (100 MHz, CDCl3) δ 170.6 (C(O)-1), 138.5, 138.4, 138.3, 138.3 (4×C_q Bn), 128.6, 128.5, 128.4, 128.1, 128.1, 128.0, 128.0, 127.9, 127.8, 127.8, 127.8, 127.7, 127.6 (CH_{Ar} Bn), 82.0 (OCH_2-Ada), 77.3 (C-4), 76.9 (C-5), 76.7 (C-3), 73.7, 73.6, 73.5, 72.3 (4×CH_2 Bn), 71.5 (CH_2-5 pentyl), 68.9 (C-7), 58.1 (C-2), 52.2 (C-6), 39.9 (CH_2 Ada), 39.5 (NCH_2-1 pentyl), 37.4 (CH_2 Ada), 34.2 (C_q Ada), 29.5, 29.4 (2×CH_2 pentyl), 28.4 (CH Ada), 23.7 (CH_2-3 pentyl). IR ν_{max}(thin film)/ cm^{-1}: 3313, 2901, 2849, 1667, 1524, 1497, 1453, 1363, 1207, 1092, 1027, 908, 730, 696. $[\alpha]^{20}_D$: −8.4 (*c* 2.1, $CHCl_3$). HRMS: found 801.4840 $[M+H]^+$; calculated for $[C_{51}H_{64}N_2O_6+H]^+$ 801.4837.



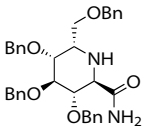
1,1,3,3-Tetramethylbutyl 3,4,5,7-tetra-*O*-benzyl-2,6-dideoxy-2,6-imino-L-*glycero*-D-*gulo*-heptonamide (F2-II). Compound **F2-II** (94 mg, 0.14 mmol) was synthesized in 40% yield from **F1-II** (0.35 mmol) by deprotection of the pent-4-enamide (general procedure D). R_F = 0.37 (1:3; EtOAc:toluene). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.37 – 7.19 (m, 20H, H_{Ar} Bn), 6.99 (s, 1H, C(O)NH), 4.71 – 4.43 (m, 8H, 4×CH_2 Bn), 4.11 (dd, *J* = 4.9, 1H, H-3), 3.78 (dd, *J* = 5.4, 1H, H-4), 3.61 – 3.48 (m, 3H, H-5, CH_2-7), 3.44 (d, *J* = 4.7, 1H, H-2), 3.41 – 3.33 (m, 1H, H-6), 2.38 (s, 1H, NH), 1.76 (d, *J* = 14.8, 1H, C*H*H-2 tMB), 1.61 (d, *J* = 14.8, 1H, CH*H*-2 tMB), 1.32 (d, *J* = 11.7, 6H, 2×CH_3 tMB), 0.94 (s, 9H, CH_3-4, 2×CH_3 tMB). ^{13}C NMR (100 MHz, $CDCl_3$) δ 169.2 (C(O)-1), 138.4, 138.4, 138.3, 138.3 (4×C_q Bn), 128.4, 128.4, 128.3, 128.3, 128.0, 127.9, 127.8, 127.7, 127.7, 127.6, 127.6, 127.6 (CH_{Ar} Bn), 75.9, 75.8 (C-4, C-5), 75.2 (C-3), 73.4, 73.1, 73.0, 72.0 (4×CH_2 Bn), 69.4 (C-7), 58.7 (C-2), 54.6 (NHC_q-1 tMB), 52.0 (CH_2-2 tMB), 51.6 (C-6), 31.6 (C_q-3 tMB), 31.5 (CH_3-4, 2×CH_3 tMB), 28.8, 28.7 (2×CH_3 tMB). IR ν_{max}(thin film)/ cm^{-1}: 3329, 2867, 1671, 1517, 1454, 1366, 1208, 1093, 1027, 734, 697. $[\alpha]^{20}_D$: −4.6 (*c* 1.0, $CHCl_3$). HRMS: found 679.4102 $[M+H]^+$; calculated for $[C_{43}H_{54}N_2O_5+H]^+$ 679.4105.



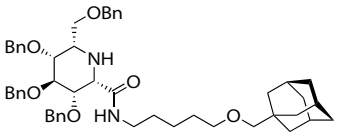
Pentyl 3,4,5,7-tetra-*O*-benzyl-2,6-dideoxy-2,6-imino-L-*glycero*-D-*gulo*-heptonamide (F2-III). Compound **F2-III** (98 mg, 0.15 mmol) was synthesized in 59% yield from **F1-III** (0.26 mmol) by deprotection of the pent-4-enamide (general procedure D). R_F = 0.17 (1:2; EtOAc:toluene). ^{1}H NMR (400 MHz, CDCl3) δ 7.36 – 7.18 (m, 20H, H_{Ar} Bn), 6.84 (t, *J* = 5.6, 1H, C(O)NH), 4.73 – 4.45 (m, 8H, 4×CH_2 Bn), 4.02 (dd, *J* = 5.7, 1H, H-3), 3.78 (dd, *J* = 6.1, 1H, H-4), 3.60 (dd, *J* = 8.4, 9.6, 1H, H-7a) 3.57 – 3.52 (m, 2H, H-5, H-7b), 3.50 (d, *J* = 5.7, 1H, H-2), 3.40 (dt, *J* = 4.2, 8.4, 1H, H-6), 3.32 – 3.21 (m, 1H, NC*H*H-1 pentyl), 3.20 – 3.06 (m, 1H, NCH*H*-1 pentyl), 2.35 (s, 1H, NH), 1.48 – 1.32 (m, 2H, CH_2-2 pentyl), 1.32 – 1.13 (m, 4H, 2×CH_2 pentyl), 0.84 (t, *J* = 6.9, 3H, CH_3-5 pentyl). ^{13}C NMR (100 MHz, $CDCl_3$) δ 170.6 (C(O)-1), 138.5, 138.5, 138.4, 138.3 (4×C_q Bn), 128.5, 128.5, 128.4, 128.1, 128.1, 128.0, 128.0, 127.9, 127.8, 127.8, 127.8, 127.7, 127.6 (CH_{Ar} Bn), 77.3 (C-4), 76.9 (C-5), 76.7 (C-3), 73.6, 73.6, 73.5, 72.3 (4×CH_2 Bn), 68.9 (C-7), 58.1 (C-2), 52.2 (C-3), 39.5 (NCH_2-1 penty), 29.3, 29.2, 22.5 (3×CH_2 pentyl), 14.1 (CH_3-5 pentyl). IR ν_{max}(thin film)/ cm^{-1}: 3306, 2928, 2861, 1725, 1653, 1527, 1497, 1454, 1365, 1208, 1069, 1027, 908, 733, 696. $[\alpha]^{20}_D$: −9.9 (*c* 1.5, $CHCl_3$). HRMS: found 637.3633 $[M+H]^+$; calculated for $[C_{40}H_{48}N_2O_5+H]^+$ 637.3636.



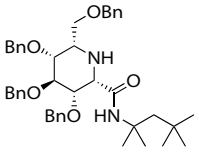
3,4,5,7-Tetra-*O*-benzyl-2,6-dideoxy-2,6-imino-L-*glycero*-D-*gulo*-heptonic acid (F2-V). Compound **F2-V** (19 mg, 34 µmol) was synthesized in 63% yield from **F1-V** (54 µmol) by deprotection of the pent-4-enamide (general procedure D). ^{1}H NMR (400 MHz, $CDCl_3$) collapsed iminosugar signals δ 7.38 – 6.97 (m, 20H, H_{Ar} Bn), 4.88 – 3.45 (m, 15H, 4×CH_2 Bn, H-2, H-3, H-4, H-5, H-6, CH_2-7). ^{13}C NMR (100 MHz, $CDCl_3$) collapsed iminosugar signals δ 137.9, 137.4, 137.2, 137.1 (4×C_q Bn), 128.6, 128.6, 128.5, 128.2, 128.0 (CH_{Ar} Bn), 73.8, 73.8, 72.3 (CH_2 Bn). IR ν_{max}(thin film)/ cm^{-1}: 2866, 1636, 1454, 1395, 1208, 1073, 910, 734, 698. $[\alpha]^{20}_D$: −5.3 (*c* 0.4, $CHCl_3$). HRMS: found 568.2691 $[M+H]^+$; calculated for $[C_{35}H_{37}NO_6+H]^+$ 568.2694.



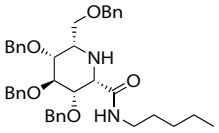
3,4,5,7-Tetra-*O*-benzyl-2,6-dideoxy-2,6-imino-L-*glycero*-D-*gulo*-heptonamide (F2-VI). Compound **F2-VI** (23 mg, 41 µmol) was synthesized in 66% yield from **F1-VI** (62 µmol) by deprotection of the pent-4-enamide (general procedure D). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.37 – 7.20 (m, 20H, H_{Ar} Bn), 6.75 (d, *J* = 2.7, 1H, C(O)N*H*H), 5.53 (d, *J* = 1.8, 1H, C(O)NH*H*), 4.75 – 4.46 (m, 8H, 4×CH_2 Bn), 3.97 (dd, *J* = 5.9, 1H, H-3), 3.79 (dd, *J* = 6.2, 1H, H-4), 3.64 – 3.52 (m, 4H, H-2 (d, *J* = 4.6), H-5, CH_2-7), 3.48 – 3.42 (m, 1H, H-6), 2.30 (s, 2H, NH). ^{13}C NMR (100 MHz, $CDCl_3$) δ 173.5 (C(O)-1), 138.5, 138.4, 138.3, 138.2 (4×C_q Bn), 128.6, 128.6, 128.5, 128.1, 128.1, 128.0, 128.0, 127.9, 127.9, 127.9, 127.8 (CH_{Ar} Bn), 77.7 (C-4), 76.9 (C-5), 76.8 (C-3), 73.9, 73.8, 73.6, 72.5 (4×CH_2 Bn), 68.6 (C-7), 57.8 (C-2), 52.3 (C-6).IR ν_{max}(thin film)/ cm^{-1}: 2923, 1682, 1495, 1454, 1365, 1069, 1027, 734, 697. $[\alpha]^{20}_D$: −9.6 (*c* 0.5, $CHCl_3$). HRMS: found 567.2850 $[M+H]^+$; calculated for $[C_{35}H_{38}N_2O_5+H]^+$ 567.2853.



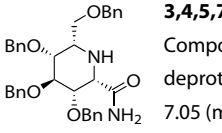
5-(Adamantan-1yl-methoxy)-pentyl 3,4,5,7-tetra-*O*-benzyl-2,6-dideoxy-2,6-imino-L-*glycero*-D-*ido*-heptonamide (G2-I). Compound **G2-I** (130 mg, 0.16 mmol) was synthesized in 65% yield from **G1-I** (0.25 mmol) by deprotection of the pent-4-enamide (general procedure D). R_F = 0.20 (1:3; EtOAc:toluene). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.37 – 7.12 (m, 20H, H_{Ar} Bn), 7.05 (t, *J* = 5.9, 1H, C(O)NH), 4.62 (d, *J* = 11.7, 1H, C*H*H Bn), 4.55 – 4.25 (m, 7H, CH*H* Bn, 3×CH_2 Bn), 4.18 – 4.13 (m, 1H, H-3), 3.67 (dd, *J* = 2.6, 1H, H-4), 3.60 (d, *J* = 1.9, 1H, H-2), 3.53 (dd, *J* = 6.7, 9.2, 1H, H-7a), 3.45 (dd, *J* = 7.5, 9.2, 1H, H-7b), 3.43 – 3.40 (m, 1H, H-5), 3.33 (t, *J* = 6.5, 2H, CH_2-5 pentyl), 3.30 – 3.23 (m, 2H, NCH_2-1 pentyl), 3.20 (dt, *J* = 2.3, 7.2, 1H, H-6), 2.93 (s, 2H, OCH_2-Ada), 1.95 (s, 3H, 3×CH Ada), 1.90 (s, 1H, NH), 1.67 (dd, *J* = 12.2, 24.6, 6H, 3×CH_2 Ada), 1.58 – 1.46 (m, 10H, 3×CH_2 Ada, 2×CH_2 pentyl), 1.40 – 1.28 (m, 2H, CH_2-3 pentyl). ^{13}C NMR (100 MHz, $CDCl_3$) δ 171.3 (C(O)-1), 138.8, 138.4, 138.4, 138.0 (4×C_q Bn), 128.6, 128.5, 128.4, 128.4, 128.3, 128.2, 128.0, 127.9, 127.9, 127.8, 127.7 (CH_{Ar} Bn), 82.1 (OCH_2-Ada), 73.7, 73.4 (2×CH_2 Bn), 73.3 (C-3), 73.1 (C-5), 72.3, 72.2 (2×CH_2 Bn), 71.7 (C-4), 71.5 (CH_2-5 pentyl), 70.6 (C-7), 60.1 (C-2), 56.0 (C-6), 39.9 (CH_2 Ada), 39.3 (NCH_2-1 pentyl), 37.4 (CH_2 Ada), 34.3 (C_q Ada), 29.7, 29.4 (2×CH_2 pentyl), 28.5 (CH Ada), 23.8 (CH_2-3 pentyl). IR ν_{max}(thin film)/ cm^{-1}: 2902, 2849, 1726, 1670, 1454, 1363, 1288, 1208, 1093, 1028, 909, 735, 698. $[\alpha]^{20}_D$: 0.4 (*c* 0.9, $CHCl_3$). HRMS: found 801.4839 $[M+H]^+$; calculated for $[C_{51}H_{64}N_2O_6+H]^+$ 801.4837.



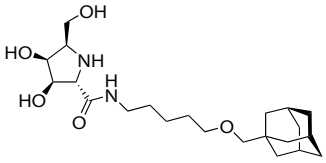
1,1,3,3-Tetramethylbutyl 3,4,5,7-tetra-*O*-benzyl-2,6-dideoxy-2,6-imino-L-*glycero*-D-*ido*-heptonamide (G2-II). Compound **G2-II** (120 mg, 0.18 mmol) was synthesized in 55% yield from **G1-II** (0.32 mmol) by deprotection of the pent-4-enamide (general procedure D). R_F = 0.59 (1:3; EtOAc:toluene). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.35 – 7.13 (m, 20H, H_{Ar} Bn), 7.05 (s, 1H, C(O)NH), 4.62 (d, *J* = 11.5, 1H, C*H*H Bn), 4.56 – 4.28 (m, 7H, CH*H* Bn, 3×CH_2 Bn), 4.20 – 4.17 (m, 1H, H-3), 3.68 (dd, *J* = 2.7, 1H, H-4), 3.54 – 3.48 (m, 2H, CH_2-7), 3.47 (d, *J* = 2.0, 1H. H-2), 3.44 (s, 1H, H-5), 3.19 (dt, *J* = 2.1, 7.3, 1H, H-6), 1.90 (s, 1H, NH), 1.79 (d, *J* = 14.8, 1H, C*H*H-2 tMB), 1.65 (d, *J* = 14.8, 1H, CH*H*-2 tMB), 1.40 (d, *J* = 11.9, 6H, 2×CH_3 tMB), 0.96 (s, 9H, CH_3-4, 2×CH_3 tMB).^{13}C NMR (100 MHz, $CDCl_3$) δ 170.1 (C(O)-1), 138.9, 138.6, 138.5, 138.1 (4×C_q Bn), 128.6, 128.6, 128.4, 128.4, 128.3, 128.2, 128.0, 127.9, 127.9, 127.8, 127.8, 127.6 (CH_{Ar} Bn), 73.6, 73.4 (2×CH_2 Bn), 73.1, 73.0 (C-3, C-5), 72.3, 72.2 (2×CH_2 Bn), 71.9 (C-4), 70.5 (C-7), 60.5 (C-2), 56.2 (C-6), 54.7 (NHC_q-1 tMB), 52.3 (CH_2-2 tMB), 31.8 (C_q-3 tMB), 31.7 (CH_3-4, 2×CH_3 tMB), 29.1, 29.0 (2×CH_3 tMB). IR ν_{max}(thin film)/ cm^{-1}: 3371, 2868, 1678, 1518, 1454, 1365, 1208, 1071, 1028, 911, 724, 698. $[\alpha]^{20}_D$: 4.7 (*c* 0.4, $CHCl_3$). HRMS: found 679.4102 $[M+H]^+$; calculated for $[C_{43}H_{54}N_2O_5+H]^+$ 679.4105.



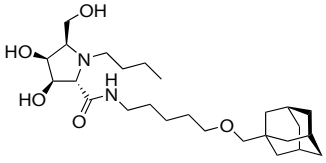
Pentyl 3,4,5,7-tetra-*O*-benzyl-2,6-dideoxy-2,6-imino-L-*glycero*-D-*ido*-heptonamide (G2-III). Compound **G2-III** (181 mg, 0.28 mmol) was synthesized in 77% yield from **G1-III** (0.37 mmol) by deprotection of the pent-4-enamide (general procedure D). R_F = 0.20 (1:3; EtOAc:toluene). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.37 – 7.12 (m, 20H, H_{Ar} Bn), 7.04 (t, *J* = 5.9, 1H, C(O)NH), 4.62 (d, *J* = 11.7, 1H, C*H*H Bn), 4.54 – 4.27 (m, 7H, CH*H* Bn, 3×CH_2 Bn), 4.18 – 4.16 (m, 1H, H-3), 3.67 (dd, *J* = 2.7, 1H, H-4), 3.60 (d, *J* = 2.0, 1H, H-2), 3.53 (dd, *J* = 6.7, 9.3, 1H, H-7a), 3.45 (dd, *J* = 7.2, 9.3, 1H, H-7b), 3.43 – 3.40 (m, 1H, H-5), 3.31 – 3.17 (m, 3H, NCH_2-1 pentyl, H-6), 2.01 (s, 1H, NH), 1.53 – 1.44 (m, 2H, CH_2-2 pentyl), 1.35 – 1.22 (m, 4H, 2×CH_2 pentyl), 0.87 (t, *J* = 7.0, 3H, CH_3-5 pentyl). ^{13}C NMR (100 MHz, $CDCl_3$) δ 171.3 (C(O)-1), 138.8, 138.4, 138.4, 138.0 (4×C_q Bn), 128.6, 128.5, 128.4, 128.4, 128.2, 128.0, 127.9, 127.8, 127.7 (CH_{Ar} Bn), 73.7, 73.4 (2×CH_2 Bn), 73.3 (C-3), 73.1 (C-5), 72.3, 72.2 (2×CH_2 Bn), 71.7 (C-4), 70.6 (C-7), 60.2 (C-2), 56.0 (C-6), 39.3 (NCH_2-1 penty), 29.6, 29.3, 22.6 (3×CH_2 pentyl), 14.2 (CH_3-5 pentyl). IR ν_{max}(thin film)/ cm^{-1}: 3387, 2927, 2862, 1725, 1668, 1521, 1497, 1454, 1364, 1288, 1208, 1070, 908, 735, 698. $[\alpha]^{20}_D$: 2.1 (*c* 0.6, $CHCl_3$). HRMS: found 637.3633 $[M+H]^+$; calculated for $[C_{40}H_{48}N_2O_5+H]^+$ 637.3636.



3,4,5,7-Tetra-*O*-benzyl-2,6-dideoxy-2,6-imino-L-*glycero*-D-*ido*-heptonamide (G2-VI). Compound **G2-VI** (77 mg, 136 µmol) was synthesized in 72% yield from **G1-VI** (188 µmol) by deprotection of the pent-4-enamide (general procedure D). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.38 – 7.05 (m, 21H, H_{Ar} Bn, C(O)N*H*H), 5.83 (s, 1H, C(O)NH*H*), 4.60 (d, *J* = 11.6, 1H, C*H*H Bn), 4.52 – 4.43 (m, 5H, CH_2 Bn, 2×C*H*H Bn, CH*H* Bn), 4.36 (d, *J* = 12.2, 1H, CH*H* Bn), 4.26 (d, *J* = 11.7, 1H, CH*H* Bn), 4.24 – 4.21 (m, 1H, H-3), 3.79 (d, *J* = 1.5, 1H, H-2), 3.70 (dd, *J* = 2.6, 1H, H-4), 3.60 (dd, *J* = 6.7, 9.4, 1H, H-7a), 3.48 (dd, *J* = 7.4, 9.6, 1H, H-7b), 3.46 – 3.43 (m, 1H, H-5), 3.33 (dt, *J* = 1.7, 6.7, 1H, H-6). ^{13}C NMR (100 MHz, $CDCl_3$) δ 173.3 (C(O)-1), 138.2, 138.2, 138.0, 137.8 (4×C_q Bn), 128.6, 128.5, 128.4, 128.4, 128.2, 128.1, 128.0, 127.9, 127.9, 127.8 (CH_{Ar} Bn), 73.6, 73.4 (2×CH_2 Bn), 73.2 (C-3), 72.6 (C-5), 72.5, 72.2 (2×CH_2 Bn), 70.9 (C-4), 69.8 (C-7), 59.8 (C-2), 55.5 (C-6). IR ν_{max}(thin film)/ cm^{-1}: 3031, 2865, 1682, 1495, 1454, 1366, 1208, 1071, 1027, 909, 734, 698. $[\alpha]^{20}_D$: −4.6 (*c* 1.5, $CHCl_3$). HRMS: found 567.2850 $[M+H]^+$; calculated for $[C_{35}H_{38}N_2O_5+H]^+$ 567.2853.

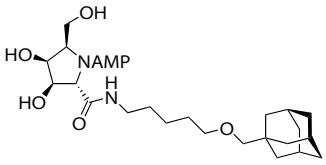


5-(Adamantan-1yl-methoxy)-pentyl 2,5-dideoxy-2,5-imino-D-*talo*-hexonamide (A3-I). Compound **A3-I** (11 mg, 27 µmol) was synthesized in 82% yield from **A2-I** (33 µmol) by deprotection of the benzyl-ethers (appropriate method in general procedure F). R_F = 0.16 (1:9; MeOH:DCM+2% NH_4OH). ^{1}H NMR (600 MHz, MeOD) δ 4.07 (t, *J* = 4.1, 1H, H-4), 4.02 (dd, *J* = 4.3, 7.1, 1H, H-3), 3.77 (dd, *J* = 5.9, 10.9, 1H, H-6a), 3.65 (dd, *J* = 6.3, 10.9, 1H, H-6b), 3.52 (d, *J* = 7.1, 1H, H-2), 3.38 (t, *J* = 6.3, 2H, CH_2-5 pentyl), 3.30 – 3.27 (m, 1H, H-5), 3.23 (t, *J* = 7.0, 2H, NCH_2-1 pentyl), 2.96 (s, 2H, OCH_2-Ada), 1.95 (s, 3H, 3×CH Ada), 1.72 (dd, *J* = 11.9, 45.9, 6H, 3×CH_2 Ada), 1.61 – 1.51 (m, 10H, 3×CH_2 Ada, 2×CH_2 pentyl), 1.44 – 1.36 (m, 2H, CH_2-3 pentyl). ^{13}C NMR (150 MHz, MeOD) δ 175.5 (C(O)-1), 83.2 (OCH_2-Ada), 78.6 (C-3), 74.3 (C-4), 72.6 (CH_2-5 pentyl), 65.9 (C-2), 62.7 (C-5), 62.5 (C-6), 41.0 (CH_2 Ada), 40.5 (NCH_2-1 pentyl), 38.5 (CH_2 Ada), 35.3 (C_q Ada), 30.5, 30.5 (2×CH_2 pentyl), 29.9 (CH Ada), 24.8 (CH_2-3 pentyl). IR ν_{max}(thin film)/ cm^{-1}: 3319, 2902, 2849, 1652, 1543, 1454, 1112. $[\alpha]^{20}_D$: −1.0 (*c* 0.2, MeOH). HRMS: found 411.2851 $[M+H]^+$, calculated for $[C_{22}H_{38}O_5N_2+H]^+$ 411.2853.

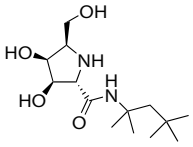


5-(Adamantan-1yl-methoxy)-pentyl 2,5-butylimino-2,5-dideoxy-D-*talo*-hexonamide (A4-I). Compound **A4-I** (11 mg, 24 µmol) was synthesized in 67% yield over two steps from **A2-I** (36 µmol) via a reductive amination with the appropriate aldehyde (general procedure E) and a subsequent benzyl-ether deprotection (appropriate method in general

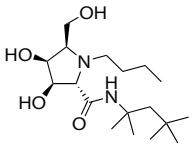
procedure F). R_F = 0.30 (1:9; MeOH:DCM+2% NH_4OH); R_F *N*-alkylated penultimate = 0.85 (1:1; EtOAc:toluene+2% Et_3N). ^1H NMR (600 MHz, MeOD) δ 4.31 (dd, *J* = 5.7, 6.5, 1H, H-4), 3.87 (dd, *J* = 1.0, 5.7, 1H, H-3), 3.80 (d, *J* = 8.2, 1H, H-6a), 3.70 (dd, *J* = 1.4, 11.6, 1H, H-6b), 3.39 – 3.37 (m, 3H, H-2, CH_2-5 pentyl), 3.35 – 3.32 (m, 1H, H-5), 3.28 – 3.20 (m, 1H, NC*H*H-1 pentyl), 3.20 – 3.11 (m, 1H, NCH*H*-1 pentyl), 2.96 (s, 2H, OCH_2-Ada), 2.93 – 2.85 (m, 1H, NC*H*H butyl), 2.60 – 2.47 (m, 1H, NCH*H* butyl), 1.95 (s, 3H, 3×CH Ada), 1.72 (dd, *J* = 12.1, 46.3, 8H, 3×CH_2 Ada), 1.62 – 1.27 (m, 16H, 3×CH_2 Ada, 5×CH_2 pentyl/butyl), 0.94 (t, *J* = 7.4, 3H, CH_3 butyl). ^{13}C NMR (150 MHz, MeOD) δ 175.8 (C(O)-1), 83.2 (OCH_2-Ada), 76.2 (C-3), 76.2 (C-2), 72.7 (C-4), 72.6 (CH_2-5 pentyl), 64.9 (C-5), 58.3 (C-6), 50.7 (NCH_2 butyl), 41.0 (CH_2 Ada), 40.0 (NCH_2-1 pentyl), 38.5 (CH_2 Ada), 35.3 (C_q Ada), 32.2, 30.6, 30.5 (3×CH_2 pentyl/butyl), 29.9 (CH Ada), 25.0 (CH_2-3 pentyl), 21.9 (CH_2 butyl), 14.6 (CH_3 butyl). IR ν_{max}(thin film)/ cm^{-1}: 3328, 2903, 2850, 1652, 1456, 1097, 1016. $[\alpha]^{20}_D$: −29.7 (*c* 0.2, MeOH). HRMS: found 467.3475 $[M+H]^+$, calculated for $[C_{26}H_{46}O_5N_2+H]^+$ 467.3479.



5-(Adamantan-1yl-methoxy)-pentyl 2,5-[5-(adamantan-1yl-methoxy)-pentyl]imino-2,5-dideoxy-D-*talo*-hexonamide (A5-I). Compound **A5-I** (17 mg, 26 μmol) was synthesized in 72% yield over two steps from **A2-I** (36 μmol) via a reductive amination with the appropriate aldehyde (general procedure E) and a subsequent benzyl-ether deprotection (appropriate method in general procedure F). R_F = 0.37 (1:9; MeOH:DCM+2% NH_4OH); R_F *N*-alkylated penultimate = 0.88 (1:1; EtOAc:toluene+2% Et_3N). ^1H NMR (600 MHz, MeOD) δ 4.31 (dd, *J* = 6.0, 7.1, 1H, H-4), 3.88 (dd, *J* = 1.5, 5.8, 1H, H-3), 3.81 (dd, *J* = 3.5, 11.7, 1H, H-6a), 3.71 (dd, *J* = 1.9, 11.7, 1H, H-6b), 3.41 – 3.36 (m, 5H, H-2, 2×CH_2-5 pentyl), 3.35 – 3.32 (m, 1H, H-5), 3.26 (dt, *J* = 7.0, 13.8, 1H, C(O)NC*H*H-1 pentyl), 3.16 (dt, *J* = 6.9, 13.5, 1H, C(O)NCH*H*-1 pentyl), 2.98 – 2.95 (m, 4H, 2×OCH_2-Ada), 2.94 – 2.87 (m, 1H, NC*H*H pentyl), 2.53 (ddd, *J* = 7.1, 9.3, 12.3, 1H, NCH*H* pentyl), 1.95 (s, 6H, 6×CH Ada), 1.72 (dd, *J* = 11.9, 46.7, 12H, 6×CH_2 Ada), 1.63 – 1.47 (m, 20H, 6×CH_2 Ada, 4×CH_2 pentyl), 1.47 – 1.31 (m, 4H, 2×CH_2-3 pentyl). ^{13}C NMR (150 MHz, MeOD) δ 175.8 (C(O)-1), 83.3, 83.2 (2×OCH_2-Ada), 76.3 (C-3), 76.2 (C-2), 72.7 (C-4), 72.6, 72.5 (2×CH_2-5 pentyl), 64.8 (C-5), 58.3 (C-6), 50.9 (NCH_2-1 pentyl), 41.0, 41.0 (2×CH_2 Ada), 40.1 (C(O)NCH_2-1 pentyl), 38.5 (2×CH_2 Ada), 35.3, 35.3 (2×C_q Ada), 29.9 (2×CH Ada), 30.8, 30.6, 30.5, 29.8 (4×CH_2 pentyl), 25.4, 25.0 (2×CH_2-3 pentyl). IR ν_{max}(thin film)/ cm^{-1}: 3332, 2902, 2848, 1652, 1454, 1361, 1158, 1112. $[\alpha]^{20}_D$: −14.6 (*c* 0.3, MeOH). HRMS: found 645.4834 $[M+H]^+$, calculated for $[C_{38}H_{64}O_6N_2+H]^+$ 645.4837.

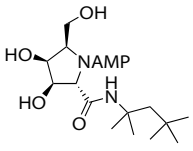


1,1,3,3-Tetramethylbutyl 2,5-dideoxy-2,5-imino-D-*talo*-hexonamide (A3-II). Compound **A3-II** (15 mg, 52 μmol) was synthesized in 93% yield from **A2-II** (56 μmol) by deprotection of the benzyl-ethers (appropriate method in general procedure F). R_F = 0.16 (1:9; MeOH:DCM+2% NH_4OH). ^1H NMR (600 MHz, MeOD) δ 4.06 (dd, *J* = 4.1, 1H, H-4), 4.02 (dd, *J* = 4.2, 6.8, 1H, H-4), 3.76 (dd, *J* = 5.9, 10.9, 1H, H-6a), 3.65 (dd, *J* = 6.1, 10.9, 1H, H-6b), 3.45 (d, *J* = 6.8, 1H, H-2), 3.24 (dd, *J* = 5.8, 10.1, 1H, H-5), 1.83 (d, *J* = 14.8, 1H, C*H*H-2 tMB), 1.75 (d, *J* = 14.9, 1H, CH*H*-2 tMB), 1.40 (d, *J* = 8.2, 6H, 2×CH_3 tMB), 1.02 (s, 9H, CH_3-4, 2×CH_3 tMB). ^{13}C NMR (150 MHz, MeOD) δ 174.4 (C(O)-1), 78.2 (C-3), 74.4 (C-4), 66.3 (C-2), 62.6 (C-5), 62.4 (C-6), 55.9 (NHC_q-1 tMB), 52.4 (CH_2-2 tMB), 32.7 (C_q-3 tMB), 32.1 (CH_3-4, 2×CH_3 tMB), 29.8, 29.7 (2×CH_3 tMB). IR ν_{max}(thin film)/ cm^{-1}: 3309, 2970, 2904, 1652, 1529, 1391, 1366, 1227, 1050. $[\alpha]^{20}_D$: −7.1 (*c* 0.3, MeOH). HRMS: found 289.2123 $[M+H]^+$, calculated for $[C_{14}H_{28}O_4N_2+H]^+$ 289.2122.

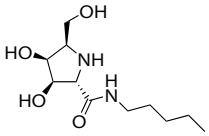


1,1,3,3-Tetramethylbutyl 2,5-butylimino-2,5-dideoxy-D-*talo*-hexonamide (A4-II). Compound **A4-II** (23 mg, 67 μmol) was synthesized in 85% yield over two steps from **A2-II** (79 μmol) via a reductive amination with the appropriate aldehyde (general procedure E) and a subsequent benzyl-ether deprotection (appropriate method in general procedure F). R_F = 0.29 (1:9; MeOH:DCM+2% NH_4OH); R_F *N*-alkylated penultimate = 0.93

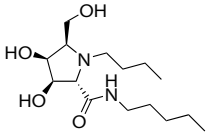
(1.5:1; EtOAc:toluene+2% Et_3N). ^1H NMR (600 MHz, MeOD) δ 4.23 (dd, *J* = 5.8, 6.8, 1H, H-4), 3.92 (d, *J* = 5.3, 1H, H-3), 3.83 (dd, *J* = 3.5, 11.9, 1H, H-6a), 3.75 (d, *J* = 10.9, 1H, H-6b), 3.41 (s, 1H, H-5), 3.31 (s, 1H, H-1), 3.03 – 2.95 (m, 1H, NC*H*H butyl), 2.61 – 2.51 (m, 1H, NCH*H* butyl), 1.83 (d, *J* = 14.9, 1H, C*H*H-2 tMB), 1.73 (d, *J* = 14.9, 1H, CH*H*-2 tMB), 1.61 – 1.27 (m, 10H, 2×CH_2 butyl, 2×CH_3 tMB), 1.02 (s, 9H, 2×CH_3, CH_3-4 tMB), 0.96 (t, *J* = 7.4, 3H, CH_3 butyl). ^{13}C NMR (150 MHz, MeOD) collapsed iminosugar signals δ 76.7 (C-2), 75.9 (C-3), 72.7 (C-4), 65.1 (C-5), 57.9 (C-6), 56.0 (NHC_q-1 tMB), 52.8 (CH_2-2 tMB), 50.9 (NCH_2 butyl), 32.6 (C_q-3 tMB), 32.1 (CH_3-4, 2×CH_3 tMB), 30.9 (CH_2 butyl), 29.9, 29.1 (2×CH_3 tMB), 22.0 (CH_2 butyl), 14.6 (CH_3 butyl). IR ν_{max}(thin film)/ cm^{-1}: 3328, 2957, 2929, 1652, 1432, 1366, 1227, 1166, 1046. $[\alpha]^{20}_D$: −33.6 (*c* 0.5, MeOH). HRMS: found 345.2748 $[M+H]^+$, calculated for $[C_{18}H_{36}O_4N_2+H]^+$ 345.2748.



1,1,3,3-Tetramethylbutyl 2,5-[5-(adamantan-1yl-methoxy)-pentyl]imino-2,5-dideoxy-D-*talo*-hexonamide (A5-II). Compound **A5-II** (34 mg, 65 µmol) was synthesized in 72% yield over two steps from **A2-II** (90 µmol) via a reductive amination with the appropriate aldehyde (general procedure E) and a subsequent benzyl-ether deprotection (appropriate method in general procedure F). R_F = 0.32 (1:9; MeOH:DCM+2% NH_4OH); R_F *N*-alkylated penultimate = 0.89 (1:2; EtOAc:toluene+2% Et_3N). ^1H NMR (600 MHz, MeOD) δ 4.22 (dd, *J* = 5.9, 7.2, 1H, H-4), 3.89 (dd, *J* = 1.6, 5.8, 1H, H-4), 3.83 (dd, *J* = 3.4, 11.8, 1H, H-6a), 3.72 (dd, *J* = 2.1, 11.8, 1H, H-6b), 3.39 (t, *J* = 6.2, 2H, CH_2-5 pentyl), 3.37 – 3.33 (m, 1H, H-5), 3.25 (d, *J* = 1.6, 1H, H-2), 3.00 – 2.94 (m, 3H, OCH_2-Ada, NC*H*H-1 pentyl), 2.49 (dt, *J* = 8.2, 12.5, 1H, NCH*H*-1 pentyl), 1.95 (s, 3H, 3×CH Ada), 1.86 (d, *J* = 14.9, 1H, C*H*H-2 tMB), 1.79 – 1.66 (m, 7H, 3×CH_2 Ada, CH*H*-2 tMB), 1.64 – 1.45 (m, 11H, 3×CH_2 Ada, 2×CH_2 pentyl, C*H*H-3 pentyl), 1.44 – 1.37 (m, 7H, CH*H*-3pentyl, 2×CH_3 tMB), 1.03 (s, 9H, 2×CH_3, CH_3-4 tMB). ^{13}C NMR (150 MHz, MeOD) δ 174.3 (C(O)-1), 83.2 (OCH_2-Ada), 77.2 (C-2), 75.9 (C-3), 72.7 (C-4), 72.4 (CH_2-5 pentyl), 64.3 (C-5), 57.9 (C-6), 56.0 (NHC_q-1 tMB), 52.8 (CH_2-2 tMB), 50.9 (NCH_2-1 pentyl), 41.1 (CH_2 Ada), 38.5 (CH_2 Ada), 35.3 (C_q Ada), 32.7 (C_q-3 tMB), 32.1 (CH_3-4, 2×CH_3 tMB), 30.8, 30.0 (2×CH_2 pentyl), 29.9 (CH Ada), 30.1, 29.2 (2×CH_3 tMB), 25.7 (CH_2-3 pentyl). IR ν_{max}(thin film)/ cm^{-1}: 3328, 2903, 2849, 1652, 1429, 1366, 1228, 1159, 1109. $[\alpha]^{20}_D$: −34.2 (*c* 0.5, MeOH). HRMS: found 523.4100 $[M+H]^+$, calculated for $[C_{30}H_{54}O_5N_2+H]^+$ 523.4105.

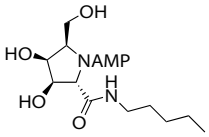


Pentyl 2,5-dideoxy-2,5-imino-D-*talo*-hexonamide (A3-III). Compound **A3-III** (10 mg, 41 µmol) was synthesized in 89% yield from **A2-III** (46 µmol) by deprotection of the benzyl-ethers (appropriate method in general procedure F). R_F = 0.09 (1:9; MeOH:DCM+2% NH_4OH). ^1H NMR (600 MHz, MeOD) δ 4.10 (dd, *J* = 4.0, 1H, H-4), 4.05 (dd, *J* = 4.2, 7.2, 1H, H-3), 3.79 (dd, *J* = 5.8, 11.0, 1H, H-6a), 3.69 (dd, *J* = 6.4, 11.0, 1H, H-6b), 3.58 (d, *J* = 7.2, 1H, H-2), 3.39 – 3.33 (m, 1H, H-5), 3.22 (t, *J* = 7.1, 2H, NCH_2-1 pentyl), 1.57 – 1.49 (m, 2H, CH_2-2 pentyl), 1.41 – 1.28 (m, 4H, 2×CH_2 pentyl), 0.92 (t, *J* = 6.9, 3H, CH_3-5 pentyl). ^{13}C NMR (150 MHz, MeOD) δ 174.7 (C(O)-1), 78.4 (C-3), 74.1 (C-4), 65.5 (C-2), 63.0 (C-5), 62.1 (C-6), 40.6 (NCH_2-1 pentyl), 30.3, 23.6 (3×CH_2 pentyl), 14.5 (CH_3-5 pentyl). IR ν_{max}(thin film)/ cm^{-1}: 3350, 2930, 2857, 1652, 1544, 1464, 1317, 1127. $[\alpha]^{20}_D$: −2.0 (*c* 0.2, MeOH). HRMS: found 247.1654 $[M+H]^+$, calculated for $[C_{11}H_{22}O_4N_2+H]^+$ 247.1652.

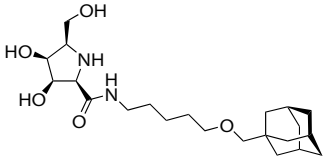


Pentyl 2,5-butylimino-2,5-dideoxy-D-*talo*-hexonamide (A4-III). Compound **A4-III** (7 mg, 23 µmol) was synthesized in 44% yield over two steps from **A2-III** (52 µmol) via a reductive amination with the appropriate aldehyde (general procedure E) and a subsequent benzyl-ether deprotection (appropriate method in general procedure F). R_F = 0.23 (1:9; MeOH:DCM+2% NH_4OH); R_F *N*-alkylated penultimate = 0.83 (1:1; EtOAc:toluene+2% Et_3N). ^1H NMR (600 MHz, MeOD) δ 4.32 (dd, *J* = 5.8, 7.2, 1H, H-4), 3.87 (dd, *J* = 1.7, 5.8, 1H, H-3), 3.80 (dd, *J* = 3.6, 11.6, 1H, H-6a), 3.71 (dd, *J* = 2.1, 11.6, 1H, H-6b), 3.39 (d, *J* = 1.4, 1H, H-2), 3.35 – 3.32 (m, 1H, H-5),

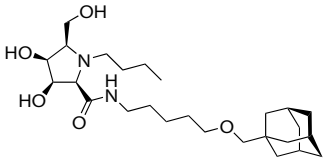
3.26 – 3.19 (m, 1H, NC*H*H-1 pentyl), 3.19 – 3.11 (m, 1H, NCH*H*-1 pentyl), 2.88 (ddd, *J* = 4.8, 9.5, 12.6, 1H, NC*H*H butyl), 2.54 (ddd, *J* = 6.8, 9.8, 12.5, 1H, NCH*H* butyl), 1.56 – 1.26 (m, 10H, 5×CH_2 pentyl/butyl), 0.96 – 0.90 (m, 6H, 2×CH_3 pentyl/butyl). ^{13}C NMR (150 MHz, MeOD) δ 175.8 (C(O)-1), 76.2 (C-3), 76.0 (C-2), 72.7 (C-4), 65.0 (C-5), 58.4 (C-6), 50.7 (NCH_2 butyl), 40.1 (NCH_2-1 pentyl), 32.2, 30.5, 30.4, 23.6, 21.9 (5×CH_2 pentyl/butyl), 14.6, 14.5 (2×CH_3 pentyl/butyl).IR ν_{max}(thin film)/ cm^{-1}: 3312, 2927, 2856, 1652, 1528, 1461, 1167. [α]$^{20}_D$: −32.3 (*c* 0.1, MeOH). HRMS: found 303.2279 [M+H]$^+$, calculated for [$C_{15}H_{30}O_4N_2$+H]$^+$ 303.2278.



Pentyl 2,5-[5-(adamantan-1yl-methoxy)-pentyl]imino-2,5-dideoxy-D-*talo*-hexonamide (A5-III). Compound **A5-III** (17 mg, 35 µmol) was synthesized in 73% yield over two steps from **A2-III** (48 µmol) via a reductive amination with the appropriate aldehyde (general procedure E) and a subsequent benzyl-ether deprotection (appropriate method in general procedure F). R_F = 0.29 (1:9; MeOH:DCM+2% NH_4OH); R_F *N*-alkylated penultimate = 0.87 (1:1; EtOAc:toluene+2% Et_3N). ^{1}H NMR (600 MHz, MeOD) δ 4.31 (dd, *J* = 5.8, 7.4, 1H, H-4), 3.87 (dd, *J* = 1.6, 5.8, 1H, H-3), 3.81 (dd, *J* = 3.4, 11.5, 1H, H-6a), 3.70 (d, *J* = 11.5, 1H, H-6b), 3.39 – 3.37 (m, 3H, H-2, CH_2-5 pentyl AMP), 3.36 – 3.32 (m, 1H, H-5), 3.27 – 3.20 (m, 1H, NC*H*H-1 pentyl AMP), 3.19 – 3.11 (m, 1H, NCH*H*-1 pentyl AMP), 2.96 (s, 2H, OCH_2-Ada), 2.94 – 2.85 (m, 1H, NC*H*H pentyl), 2.58 – 2.50 (m, 1H, NCH*H* pentyl), 1.95 (s, 3H, 3×CH Ada), 1.72 (dd, *J* = 12.1, 48.4, 6H, 3×CH_2 Ada), 1.60 – 1.27 (m, 18H, 3×CH_2 Ada, 6×CH_2 pentyl/pentyl AMP), 0.93 (t, *J* = 7.1, 3H, CH_3-5 pentyl). ^{13}C NMR (150 MHz, MeOD) δ 175.8 (C(O)-1), 83.2 (OCH_2-Ada), 76.3 (C-3), 76.2 (C-2), 72.7 (C-4), 72.6 (CH_2-5 pentyl AMP), 64.9 (C-5), 58.3 (C-6), 50.9 (NCH_2 pentyl), 41.0 (CH_2 Ada), 40.1 (NCH_2 pentyl AMP), 38.5 (CH_2 Ada), 35.3 (C_q Ada), 29.9 (CH Ada), 30.7, 30.5, 30.4, 29.7, 25.4, 23.6 (6×CH_2 pentyl/pentyl AMP), 14.6 (CH_3-5 pentyl). IR ν_{max}(thin film)/ cm^{-1}: 3319, 2902, 2849, 1652, 1458, 1112. [α]$^{20}_D$: −17.3 (*c* 0.3, MeOH). HRMS: found 481.3631 [M+H]$^+$, calculated for [$C_{27}H_{48}O_5N_2$+H]$^+$ 481.3636.

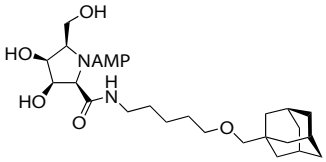


5-(Adamantan-1yl-methoxy)-pentyl 2,5-dideoxy-2,5-imino-D-*galacto*-hexonamide (B3-I). Compound **B3-I** (20 mg, 49 µmol) was synthesized in 37% yield from **B2-I** (131 µmol) by deprotection of the benzyl-ethers (appropriate method in general procedure F). R_F = 0.14 (1:9; MeOH:DCM+2% NH_4OH). ^{1}H NMR (500 MHz, MeOD) δ 4.27 – 4.21 (m, 2H, H-3, H-4), 3.75 (d, *J* = 5.3, 1H, H-2), 3.69 (dd, *J* = 5.1, 11.1, 1H, H-6a), 3.63 (dd, *J* = 4.3, 11.1, 1H, H-6b), 3.42 – 3.35 (m, 4H, H-5, CH_2-5 pentyl), 3.24 (dt, *J* = 1.4, 7.0, 2H, NCH_2-1 pentyl), 2.97 (s, 2H, OCH_2-Ada), 1.94 (s, 3H, 3×CH Ada), 1.72 (dd, *J* = 11.7, 38.7, 6H, 3×CH_2 Ada), 1.62 – 1.51 (m, 10H, 3×CH_2 Ada, 2×CH_2 pentyl), 1.45 – 1.37 (m, 2H, CH_2-3 pentyl). ^{13}C NMR (125 MHz, MeOD) δ 174.6 (C(O)-1), 83.2 (OCH_2-Ada), 74.4 (C-3), 74.2 (C-4), 72.7 (CH_2-5 pentyl), 63.8 (C-2), 62.7 (C-6), 61.5 (C-5), 41.0 (CH_2 Ada), 40.2 (NCH_2-1 pentyl), 38.5 (CH_2 Ada), 35.3 (C_q Ada), 30.5, 30.5 (2×CH_2 pentyl), 29.9 (CH Ada), 24.8 (CH_2-3 pentyl). IR ν_{max}(thin film)/ cm^{-1}: 3320, 2902, 2848, 1637, 1543, 1456, 1114. [α]$^{20}_D$: 27.1 (*c* 0.3, MeOH). HRMS: found 411.2851 [M+H]$^+$, calculated for [$C_{22}H_{38}O_5N_2$+H]$^+$ 411.2853.

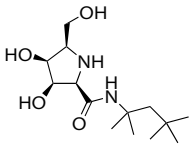


5-(Adamantan-1yl-methoxy)-pentyl 2,5-butylimino-2,5-dideoxy-D-*galacto*-hexonamide (B4-I). Compound **B4-I** (36 mg, 77 µmol) was synthesized in 48% yield over two steps from **B2-I** (161 µmol) via a reductive amination with the appropriate aldehyde (general procedure E) and a subsequent benzyl-ether deprotection (appropriate method in general procedure F). R_F = 0.31 (1:9; MeOH:DCM+2% NH_4OH); R_F *N*-alkylated penultimate = 0.61 (1:1; EtOAc:toluene+2% Et_3N). ^{1}H NMR (600 MHz, MeOD) δ 4.30 (dd, *J* = 4.5, 7.9, 1H, H-4), 4.18 (dd, *J* = 4.9, 1H, H-3), 3.72 (dd, *J* = 2.8, 11.2, 1H, H-6a), 3.62 (dd, *J* = 4.3, 11.2, 1H, H-6b), 3.41 – 3.31 (m, 4H, H-2, CH_2-5, NC*H*H-1 pentyl), 3.22 – 3.15 (m, 1H, NCH*H*-1 pentyl), 3.04 – 2.99 (m, 1H, H-5), 2.96 (s, 1H, OCH_2-Ada), 2.68 – 2.61 (m, 1H, NC*H*H butyl), 2.57

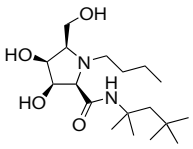
– 2.49 (m, 1H, NCH*H* butyl), 1.95 (s, 3H, 3×CH Ada), 1.72 (dd, *J* = 11.6, 46.0, 6H, 3×CH_2 Ada), 1.62 – 1.26 (m, 16H, 3×CH_2 Ada, 5×CH_2 pentyl/butyl), 0.94 (t, *J* = 7.4, 3H, CH_3 butyl). ^{13}C NMR (150 MHz, MeOD) δ 174.4 (C(O)-1), 83.2 (OCH_2-Ada), 74.2 (C-3), 73.2 (C-4), 72.7 (CH_2-5 pentyl), 72.3 (C-2), 67.8 (C-5), 61.7 (C-6), 57.4 (NCH_2 butyl), 41.0 (CH_2 Ada), 40.1 (NCH_2-1 pentyl), 38.5 (CH_2 Ada), 35.3 (C_q Ada), 29.9 (CH Ada), 32.0, 30.6, 30.5, 24.9, 21.7 (5×CH_2 pentyl/butyl), 14.6 (CH_3 butyl). IR ν_{max}(thin film)/ cm^{-1}: 3319, 2902, 2849, 1651, 1637, 1458, 1113. $[\alpha]^{20}_D$: 34.7 (*c* 0.7, MeOH). HRMS: found 467.3475 $[M+H]^+$, calculated for $[C_{26}H_{46}O_5N_2+H]^+$ 467.3479.



5-(Adamantan-1yl-methoxy)-pentyl 2,5-[5-(adamantan-1yl-methoxy)-pentyl]imino-2,5-dideoxy-D-*galacto*-hexonamide (B5-I). Compound **B5-I** (56 mg, 87 µmol) was synthesized in 59% yield over two steps from **B2-I** (148 µmol) via a reductive amination with the appropriate aldehyde (general procedure E) and a subsequent benzyl-ether deprotection (appropriate method in general procedure F). R_F = 0.37 (1:9; MeOH:DCM+2% NH_4OH); R_F *N*-alkylated penultimate = 0.69 (1:1; EtOAc:toluene+2% Et_3N). ^{1}H NMR (500 MHz, MeOD) δ 4.29 (dd, *J* = 4.5, 7.9, 1H, H-4), 4.18 (dd, *J* = 4.5, 5.5, 1H, H-3), 3.72 (dd, *J* = 3.0, 11.2, 1H, H-6a), 3.64 (dd, *J* = 4.5, 11.2, 1H, H-6b), 3.41 – 3.36 (m, 2H, 2×CH_2-5 pentyl), 3.37 – 3.34 (m, 1H, C(O)NC*H*H-1 pentyl), 3.33 (d, *J* = 5.5, 1H, H-2), 3.18 (dt, *J* = 6.8, 13.5, 1H, C(O)NCH*H*-1 pentyl), 3.02 (ddd, *J* = 3.0, 4.5, 7.6, 1H, H-5), 2.97 (s, 4H, 2×OCH_2-Ada), 2.70 – 2.62 (m, 1H, NC*H*H-1 pentyl), 2.54 (ddd, *J* = 6.3, 9.3, 12.5, 1H, NCH*H*-1 pentyl), 1.95 (s, 6H, 3×CH_2 Ada), 1.72 (dd, *J* = 11.8, 39.2, 12H, 6×CH_2 Ada), 1.63 – 1.30 (m, 24H, 6×CH_2 Ada, 6×CH_2 pentyl). ^{13}C NMR (125 MHz, MeOD) δ 174.4 (C(O)-1), 83.2 (2×OCH_2-Ada), 74.2 (C-3), 73.3 (C-4), 72.7, 72.6 (2×CH_2-5 pentyl), 72.3 (C-2), 67.9 (C-5), 61.8 (C-6), 57.6 (NCH_2-1 pentyl), 41.0, 41.0 (2×CH_2 Ada), 40.1 (C(O)NCH_2-1 pentyl), 38.5 (2×CH_2 Ada), 35.3, 35.3 (2×C_q Ada), 30.8, 30.6, 30.6, 29.7 (4×CH_2 pentyl), 29.9 (2×CH Ada), 25.3, 24.9 (2×CH_2-3 pentyl). IR ν_{max}(thin film)/ cm^{-1}: 3319, 2902, 2848, 1651, 1455, 1361, 1113. $[\alpha]^{20}_D$: 24.3 (*c* 0.7, MeOH). HRMS: found 645.4834 $[M+H]^+$, calculated for $[C_{38}H_{64}O_6N_2+H]^+$ 645.4837.

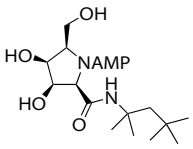


1,1,3,3-Tetramethylbutyl 2,5-dideoxy-2,5-imino-D-*galacto*-hexonamide (B3-II). Compound **B3-II** (14 mg, 47 µmol) was synthesized in 53% yield from **B2-II** (90 µmol) by deprotection of the benzyl-ethers (appropriate method in general procedure F). R_F = 0.15 (1:9; MeOH:DCM+2% NH_4OH). ^{1}H NMR (600 MHz, MeOD) δ 4.25 – 4.18 (m, 2H, H-3, H-4), 3.71 – 3.61 (m, 2H, CH_2-6), 3.59 (d, *J* = 5.9, 1H, H-2), 3.37 – 3.32 (m, 1H, H-5), 1.87 (d, *J* = 14.8, 1H, C*H*H-2 tMB), 1.65 (d, *J* = 14.8, 1H, CH*H*-2 tMB), 1.41 (d, *J* = 20.5, 6H, 2×CH_3 tMB), 1.03 (s, 9H, 2×CH_3, CH_3-4 tMB). ^{13}C NMR (150 MHz, MeOD) δ 173.8 (C(O)-1), 74.6, 74.2 (C-3, C-4), 63.9 (C-2), 62.8 (C-6), 61.3 (C-5), 55.9 (NHC_q-1 tMB), 53.1 (CH_2-2 tMB), 32.6 (C_q-3 tMB), 32.1 (CH_3-4, 2×CH_3 tMB), 29.7, 29.4 (2×CH_3 tMB). IR ν_{max}(thin film)/ cm^{-1}: 3325, 2952, 1651, 1537, 1452, 1390, 1366, 1227, 1120, 1034. $[\alpha]^{20}_D$: 33.1 (*c* 0.3, MeOH). HRMS: found 289.2123 $[M+H]^+$, calculated for $[C_{14}H_{28}O_4N_2+H]^+$ 289.2122.

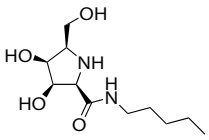


1,1,3,3-Tetramethylbutyl 2,5-butylimino-2,5-dideoxy-D-*galacto*-hexonamide (B4-II). Compound **B4-II** (27 mg, 78 µmol) was synthesized in 87% yield over two steps from **B2-II** (90 µmol) via a reductive amination with the appropriate aldehyde (general procedure E) and a subsequent benzyl-ether deprotection (appropriate method in general procedure F). R_F = 0.31 (1:9; MeOH:DCM+2% NH_4OH); R_F *N*-alkylated penultimate = 0.82 (1.5:1; EtOAc:toluene+2% Et_3N). ^{1}H NMR (600 MHz, MeOD) δ 4.27 (dd, *J* = 4.5, 7.7, 1H, H-4), 4.20 – 4.12 (m, 1H, H-3), 3.71 (dd, *J* = 2.6, 10.8, 1H, H-6a), 3.63 (dd, *J* = 4.8, 10.8, 1H, H-6b), 3.18 (d, *J* = 5.7, 1H, H-2), 3.03 – 2.99 (m, 1H, H-5), 2.66 – 2.59 (m, 1H, NC*H*H butyl), 2.57 – 2.49 (m, 1H, NCH*H* butyl), 1.93 (d, *J* = 14.8, 1H, C*H*H-2 tMB), 1.63 (d, *J* = 14.9, 1H, CH*H*-2 tMB), 1.55 – 1.26 (m, 10H, 2×CH_2 butyl, 2×CH_3 tMB), 1.04 (s, 9H, 2×CH_3, CH_3-4 tMB), 0.94 (t,

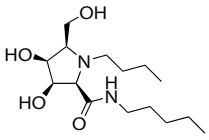
J = 7.4, 3H, CH_3 butyl). ^{13}C NMR (150 MHz, MeOD) δ 173.5 (C(O)-1), 74.4 (C-3), 73.3 (C-4), 72.5 (C-2), 67.5 (C-5), 61.9 (C-6), 57.4 (NCH_2 butyl), 56.2 (NHC_q-1 tMB), 53.6 (CH_2-2 tMB), 32.6 (C_q-3 tMB), 32.3 (CH_2 butyl), 32.2 (CH_3-4, 2×CH_3 tMB), 29.4, 29.3 (2×CH_3 tMB), 21.8 (CH_2 butyl), 14.6 (CH_3 butyl). IR ν_{max}(thin film)/ cm^{-1}: 3292, 2957, 2928, 1639, 1461, 1440, 1366, 1229, 1149, 1128, 1034. $[\alpha]^{20}_D$: 37.8 (*c* 0.5, MeOH). HRMS: found 345.2748 $[M+H]^+$, calculated for $[C_{18}H_{36}O_4N_2+H]^+$ 345.2748.



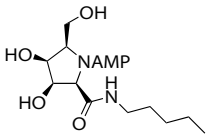
1,1,3,3-Tetramethylbutyl 2,5-[5-(adamantan-1yl-methoxy)-pentyl]imino-2,5-dideoxy-D-*galacto*-hexonamide (B5-II). Compound **B5-II** (35 mg, 67 μmol) was synthesized in 74% yield over two steps from **B2-II** (90 μmol) via a reductive amination with the appropriate aldehyde (general procedure E) and a subsequent benzyl-ether deprotection (appropriate method in general procedure F). R_F = 0.35 (1:9; MeOH:DCM+2% NH_4OH); R_F *N*-alkylated penultimate = 0.84 (1.5:1; EtOAc:toluene+2% Et_3N). ^1H NMR (600 MHz, MeOD) δ 4.28 (dd, *J* = 4.5, 7.7, 1H, H-4), 4.17 (t, *J* = 5.0, 1H, H-3), 3.72 (dd, *J* = 1.6, 10.5, 1H, H-6a), 3.64 (dd, *J* = 4.5, 10.5, 1H, H-6b), 3.39 (t, *J* = 6.3, 2H, CH_2-5 pentyl), 3.20 (d, *J* = 3.4, 1H, H-2), 3.07 – 3.01 (m, 1H, H-5), 2.96 (s, 2H, OCH_2-Ada), 2.70 – 2.61 (m, 1H, NC*H*H-1 pentyl), 2.60 – 2.48 (m, 1H, NCH*H*-1 pentyl), 1.98 – 1.91 (m, 4H, 3×CH Ada, C*H*H-2 tMB), 1.80 – 1.65 (m, 7H, 3×CH_2 Ada, CH*H* tMB), 1.65 – 1.31 (m, 18H, 3×CH_2 Ada, 3×CH_2 pentyl, 2×CH_3 tMB), 1.04 (s, 9H, 2×CH_3, CH_3-4 tMB). ^{13}C NMR (150 MHz, MeOD) δ 173.3 (C(O)-1), 83.2 (OCH_2-Ada), 74.3 (C-3), 73.3 (C-4), 72.5 (C-2), 72.5 (CH_2-5 pentyl), 67.5 (C-5), 61.9 (C-6), 57.7 (NCH_2-1), 56.2 (NHC_q-1 tMB), 53.6 (CH_2-2 tMB), 41.0 (CH_2 Ada), 38.5 (CH_2 Ada), 35.3 (C_q Ada), 32.6 (C_q-3 tMB), 32.3 (CH_3-4, 2×CH_3 tMB), 30.8 (CH_2 pentyl), 29.9 (CH Ada), 29.5, 29.4 (2×CH_3 tMB, CH_2 pentyl), 25.4 (CH_2-1 pentyl). IR ν_{max}(thin film)/ cm^{-1}: 3325, 2903, 2850, 1651, 1454, 1366, 1228, 1110, 1055. $[\alpha]^{20}_D$: 28.4 (*c* 0.7, MeOH). HRMS: found 523.4101 $[M+H]^+$, calculated for $[C_{30}H_{54}O_5N_2+H]^+$ 523.4105.



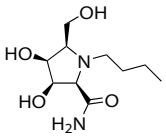
Pentyl 2,5-dideoxy-2,5-imino-D-*galacto*-hexonamide (B3-III). Compound **B3-III** (22 mg, 89 μmol) was synthesized in 66% yield from **B2-III** (135 μmol) by deprotection of the benzyl-ethers (appropriate method in general procedure F). R_F = 0.08 (1:9; MeOH:DCM+2% NH_4OH). ^1H NMR (500 MHz, MeOD) δ 4.28 – 4.21 (m, 2H, H-3, H-4), 3.76 (d, *J* = 5.4, 1H, H-2), 3.69 (dd, *J* = 5.2, 11.1, 1H, H-6a), 3.63 (dd, *J* = 4.4, 11.1, 1H, H-6b), 3.37 (dd, *J* = 5.1, 11.6, 1H, H-5), 3.28 – 3.17 (m, 2H, NCH_2-1 pentyl), 1.58 – 1.50 (m, 2H, CH_2-2 pentyl), 1.39 – 1.30 (m, 4H, 2×CH_2 pentyl), 0.92 (t, *J* = 7.0, 3H, CH_3-5 pentyl). ^{13}C NMR (151 MHz, MeOD) δ 174.4 (C(O)-1), 74.3 (C-3), 74.1 (C-4), 63.8 (C-2), 62.6 (C-6), 61.5 (C-5), 40.3 (NCH_2-1 pentyl), 30.3, 23.6 (3×CH_2 pentyl), 14.5 (CH_3-5 pentyl). IR ν_{max}(thin film)/ cm^{-1}: 3325, 2959, 2930, 1636, 1543, 1456, 1408, 1251, 1118, 1048. $[\alpha]^{20}_D$: 53.6 (*c* 0.3, MeOH). HRMS: found 247.1654 $[M+H]^+$, calculated for $[C_{11}H_{22}O_4N_2+H]^+$ 247.1652.



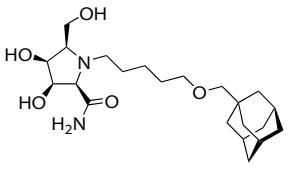
Pentyl 2,5-butylimino-2,5-dideoxy-D-*galacto*-hexonamide (B4-III). Compound **B4-III** (55 mg, 182 μmol) was synthesized in 86% yield over two steps from **B2-III** (212 μmol) via a reductive amination with the appropriate aldehyde (general procedure E) and a subsequent benzyl-ether deprotection (appropriate method in general procedure F). R_F = 0.24 (1:9; MeOH:DCM+2% NH_4OH); R_F *N*-alkylated penultimate = 0.56 (1:1; EtOAc:toluene+2% Et_3N). ^1H NMR (600 MHz, MeOD) δ 4.32 (dd, *J* = 4.6, 8.0, 1H, H-4), 4.20 (dd, *J* = 4.6, 5.4, 1H, H-3), 3.75 (dd, *J* = 2.9, 11.2, 1H, H-6a), 3.64 (dd, *J* = 4.4, 11.2, 1H, H-6b), 3.37 – 3.30 (m, 2H, H-2, NC*H*H-1 pentyl), 3.25 – 3.16 (m, 1H, NCH*H*-1 pentyl), 3.06 – 3.00 (m, 1H, H-5), 2.72 – 2.62 (m, 1H, NC*H*H butyl), 2.59 – 2.50 (m, 1H, NCH*H* butyl), 1.60 – 1.29 (m, 10H, 5×CH_2 pentyl/butyl), 0.99 – 0.90 (m, 6H, 2×CH_3 pentyl/butyl). ^{13}C NMR (150 MHz, MeOD) δ 174.4 (C(O)-1), 74.2 (C-3), 73.2 (C-4), 72.4 (C-2), 67.8 (C-5), 61.7 (C-6), 57.4 (NCH_2 butyl), 40.1 (NCH_2-1 pentyl), 32.0, 30.4, 30.4, 23.6, 21.7 (5×CH_2 pentyl/butyl), 14.6, 14.5(2×CH_3 pentyl/butyl). IR ν_{max}(thin film)/ cm^{-1}: 3327, 2957, 2930, 2862, 1650, 1636, 1539, 1463, 1141, 1030, 1011. $[\alpha]^{20}_D$: 60.6 (*c* 0.9, MeOH). HRMS: found 303.2279 $[M+H]^+$, calculated for $[C_{15}H_{30}O_4N_2+H]^+$ 303.2278.



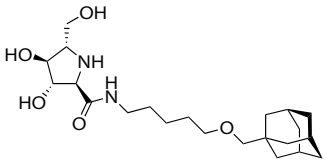
Pentyl 2,5-[5-(adamantan-1yl-methoxy)-pentyl]imino-2,5-dideoxy-D-*galacto*-hexonamide (B5-III). Compound **B5-III** (71 mg, 148 µmol) was synthesized in 69% yield over two steps from **B2-III** (213 µmol) via a reductive amination with the appropriate aldehyde (general procedure E) and a subsequent benzyl-ether deprotection (appropriate method in general procedure F). R_F = 0.26 (1:9; MeOH:DCM+2% NH_4OH); R_F *N*-alkylated penultimate = 0.62 (1:1; EtOAc:toluene+2% Et_3N). ^1H NMR (600 MHz, MeOD) collapsed iminosugar signals δ 4.50 – 4.03 (m, 2H), 4.03 – 3.55 (m, 2H), 3.38 (t, *J* = 6.3, 2H, CH_2-5 pentyl AMP), 3.27 – 3.00 (m, 2H), 2.96 (s, 2H, OCH_2-Ada), 2.84 – 2.48 (m, 1H), 1.95 (s, 3H, 3×CH Ada), 1.72 (dd, *J* = 12.1, 48.0, 6H, 3×CH_2 Ada), 1.63 – 1.32 (m, 18H, 3×CH_2 Ada, 6×CH_2 pentyl/pentyl AMP), 0.93 (t, *J* = 7.0, 3H, CH_3-5 pentyl). ^{13}C NMR (150 MHz, MeOD) collapsed iminosugar signals δ 83.2 (OCH_2-Ada), 72.4 (CH_2-5 pentyl AMP), 41.0 (CH_2 Ada), 38.5 (CH_2 Ada), 35.3 (C_q Ada), 29.9 (CH Ada), 30.6, 30.5, 30.4, 30.3, 25.3, 23.6 (6×CH_2 pentyl/pentyl AMP), 14.6 (CH_3-5 pentyl). IR ν_{max}(thin film)/ cm^{-1}: 3280, 1638, 1471, 1360, 1114, 1010. $[\alpha]^{20}_D$: 22.2 (*c* 0.2, MeOH). HRMS: found 481.3631 $[M+H]^+$, calculated for $[C_{27}H_{48}O_5N_2+H]^+$ 481.3636.



2,5-Butylimino-2,5-dideoxy-D-*galacto*-hexonamide (B4-VI). Compound **B4-VI** (11 mg, 47 µmol) was synthesized in 78% yield over two steps from **B2-VI** (60 µmol) via a reductive amination with the appropriate aldehyde (general procedure E) and a subsequent benzyl-ether deprotection (appropriate method in general procedure F). R_F = 0.29 (1:4; MeOH:DCM+2% NH_4OH); R_F *N*-alkylated penultimate = 0.51 (1.5:1; EtOAc:toluene). ^1H NMR (400 MHz, MeOD) δ 4.30 (dd, *J* = 4.5, 7.9, 1H, H-4), 4.18 (dd, *J* = 4.5, 5.3, 1H, H-3), 3.72 (dd, *J* = 2.9, 11.3, 1H, H-6a), 3.62 (dd, *J* = 4.4, 11.3, 1H, H-6b), 3.30 – 3.29 (m, 1H, H-2), 3.02 (ddd, *J* = 3.0, 4.3, 7.6, 1H, H-5), 2.71 – 2.50 (m, 2H, NCH_2-1 butyl), 1.53 – 1.43 (m, 2H, CH_2-2 butyl), 1.40 – 1.26 (m, 2H, CH_2-3 butyl), 0.93 (t, *J* = 7.3, 3H, CH_3-4 butyl). ^{13}C NMR (100 MHz, MeOD) δ 178.0 (C(O)-1), 74.2 (C-3), 73.3 (C-4), 72.3 (C-2), 67.9 (C-5), 61.7 (C-6), 57.2 (NCH_2-1 butyl), 31.8 (CH_2-2 butyl), 21.7 (CH_2-3 butyl), 14.5 (CH_3-4 butyl). IR ν_{max}(thin film)/ cm^{-1}: 3288, 2930, 1667, 1460, 1127. $[\alpha]^{20}_D$: 4.6 (*c* 0.3, MeOH). HRMS: found 233.1499 $[M+H]^+$, calculated for $[C_{10}H_2O_4N_2+H]^+$ 233.1496.

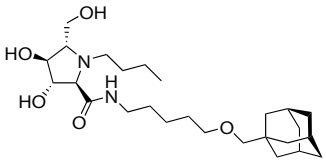


2,5-[5-(Adamantan-1yl-methoxy)-pentyl]imino-2,5-dideoxy-D-*galacto*-hexonamide (B5-VI). Compound **B5_VI** (14 mg, 34 µmol) was synthesized in 57% yield over two steps from **B2-VI** (60 µmol) via a reductive amination with the appropriate aldehyde (general procedure E) and a subsequent benzyl-ether deprotection (appropriate method in general procedure F). R_F = 0.46 (1:4; MeOH:DCM+2% NH_4OH); R_F *N*-alkylated penultimate = 0.59 (1.5:1; EtOAc:toluene). ^1H NMR (400 MHz, MeOD) δ 4.33 (dd, *J* = 4.4, 7.9, 1H, H-4), 4.20 (dd, *J* = 4.4, 8.8, 1H, H-3), 3.75 (dd, *J* = 2.9, 11.3, 1H, H-6a), 3.65 (dd, *J* = 4.4, 11.3, 1H, H-6b), 3.40 (t, *J* = 6.4, 2H, CH_2-5 pentyl), 3.37 – 3.34 (m, 1H, H-2), 3.09 – 3.03 (m, 1H, H-5), 2.99 (s, 2H, OCH_2-Ada), 2.74 – 2.56 (m, 2H, NCH_2-1 pentyl), 1.97 (s, 3H, 3×CH Ada), 1.75 (dd, *J* = 11.6, 32.2, 6H, 3×CH_2 Ada), 1.65 – 1.47 (m, 11H, 3×CH_2 Ada, 2×CH_2 pentyl), 1.44 – 1.35 (m, 2H, CH_2-3 pentyl). ^{13}C NMR (100 MHz, MeOD) δ 176.2 (C(O)-1), 81.7 (OCH_2-Ada), 72.6 (C-3), 71.7 (C-4), 71.1 (CH_2-5 pentyl), 70.7 (C-2), 66.3 (C-5), 60.1 (C-6), 55.9 (NCH_2-1 pentyl), 39.4 (CH_2 Ada), 36.9 (CH_2 Ada), 33.8 (C_q Ada), 29.1 (CH_2 pentyl), 28.4 (CH Ada), 27.7 (CH_2 pentyl), 23.7 (CH_2-3 pentyl). IR ν_{max}(thin film)/ cm^{-1}: 3290, 2902, 2849, 1668, 1453, 1114. $[\alpha]^{20}_D$: 15.0 (*c* 0.2, MeOH). HRMS: found 411.2852 $[M+H]^+$, calculated for $[C_{22}H_{38}O_5N_2+H]^+$ 411.2853.

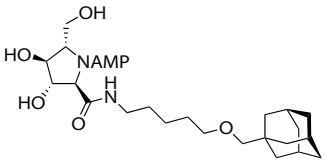


5-(Adamantan-1yl-methoxy)-pentyl 2,5-dideoxy-2,5-imino-L-*gulo*-hexonamide (C3-I). Compound **C3-I** (7 mg, 17 µmol) was synthesized in 85% yield from **C2-I** (20 µmol) by deprotection of the benzyl-ethers (appropriate method in general procedure F). R_F = 0.29 (1:9; MeOH:DCM+2% NH_4OH). ^1H NMR (400 MHz, MeOD) δ 4.02 (dd, *J* = 5.2, 1H,

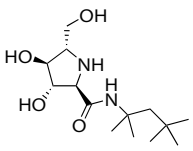
H-3), 3.79 (dd, *J* = 5.7, 1H, H-4), 3.70 (dd, *J* = 4.1, 11.1, 1H, H-6a), 3.60 (dd, *J* = 5.8, 11.1, 1H, H-6b), 3.49 (d, *J* = 5.3, 1H, H-2), 3.38 (t, *J* = 6.4, 2H, CH_2-5 pentyl), 3.22 (t, *J* = 7.0, 2H, NCH_2-1 pentyl), 3.08 (dd, *J* = 5.8, 10.2, 1H, H-5), 2.97 (s, 2H, OCH_2-Ada), 1.94 (s, 3H, 3×CH Ada), 1.72 (dd, *J* = 11.9, 31.5, 6H, 3×CH_2 Ada), 1.63 – 1.49 (m, 10H, 3×CH_2 Ada, 2×CH_2 pentyl), 1.46 – 1.35 (m, 2H, CH_2-3 pentyl). ^{13}C NMR (100 MHz, MeOD) δ 175.0 (C(O)-1), 83.2 (OCH_2-Ada), 82.6 (C-3), 80.0 (C-4), 72.7 (CH_2-5 pentyl), 67.0 (C-2), 66.0 (C-5), 63.3 (C-6), 41.0 (CH_2 Ada), 40.4 (NCH_2-1 pentyl), 38.5 (CH_2 Ada), 35.3 (C_q Ada), 30.5, 30.4 (2×CH_2 pentyl), 29.9 (CH Ada), 24.8 (CH_2-3 pentyl). IR ν_{max}(thin film)/ cm^{-1}: 3313, 2902, 2849, 1652, 1452, 1109. $[\alpha]^{20}_D$: 1.5 (*c* 0.1, MeOH). HRMS: found 411.2851 $[M+H]^+$, calculated for $[C_{22}H_{38}O_5N_2+H]^+$ 411.2853.



5-(Adamantan-1yl-methoxy)-pentyl 2,5-butylimino-2,5-dideoxy-L-*gulo*-hexonamide (C4-I). Compound **C4-I** (7 mg, 15 μmol) was synthesized in 75% yield over two steps from **C2-I** (20 μmol) via a reductive amination with the appropriate aldehyde (general procedure E) and a subsequent benzyl-ether deprotection (appropriate method in general procedure F). R_F = 0.76 (1:4; MeOH:DCM+2% NH_4OH); R_F *N*-alkylated penultimate = 0.80 (1:1; EtOAc:PE). ^{1}H NMR (400 MHz, MeOD) δ 3.96 (dd, *J* = 1.7, 1H, H-4), 3.89 (dd, *J* = 1.8, 1H, H-3), 3.79 (dd, *J* = 5.0, 11.4, 1H, H-6a), 3.69 (dd, *J* = 3.2, 11.4, 1H, H-6b), 3.40 (s, 1H, H-2), 3.38 (t, *J* = 5.6, 2H, CH_2-5 pentyl), 3.28 – 3.11 (m, 3H, H-5, C(O)NCH_2-1 pentyl), 2.97 (s, 2H, OCH_2-Ada), 2.88 – 2.79 (m, 1H, NC*H*H-1 pentyl), 2.65 – 2.55 (m, 1H, NCH*H*-1 pentyl), 1.95 (s, 3H, 3×CH Ada), 1.72 (dd, *J* = 11.7, 31.6, 6H, 3×CH_2 Ada), 1.64 – 1.23 (m, 16H, 3×CH_2 Ada, 3×CH_2 pentyl, 2×CH_2 butyl), 0.94 (t, *J* = 7.3, 3H, CH_3 butyl). ^{13}C NMR (100 MHz, MeOD) δ 83.3 (OCH_2-Ada), 82.3 (C-3), 81.5 (C-4), 76.3 (CH_2-5 pentyl), 72.7 (C-2), 70.9 (C-5), 61.0 (C-6), 49.8 (NCH_2-1 pentyl), 41.0 (CH_2 Ada), 40.2 (C(O)NCH_2-1 pentyl), 38.5 (CH_2 Ada), 35.3 (C_q Ada), 29.9 (CH Ada), 32.1, 30.5, 30.5, 24.9, 21.8 (3×CH_2 pentyl, 2×CH_2 butyl), 14.6 (CH_3 butyl). IR ν_{max}(thin film)/ cm^{-1}: 3324, 2904, 2851, 1651, 1457, 1057. $[\alpha]^{20}_D$: 14.3 (*c* 0.1, MeOH). HRMS: found 467.3476 $[M+H]^+$, calculated for $[C_{26}H_{46}O_5N_2+H]^+$ 467.3479.

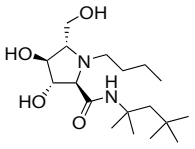


5-(Adamantan-1yl-methoxy)-pentyl 2,5-[5-(adamantan-1yl-methoxy)-pentyl]imino-2,5-dideoxy-L-*gulo*-hexonamide (C5-I). Compound **C5-I** (8 mg, 13 μmol) was synthesized in 65% yield over two steps from **C2-I** (20 μmol) via a reductive amination with the appropriate aldehyde (general procedure E) and a subsequent benzyl-ether deprotection (appropriate method in general procedure F). R_F = 0.80 (1:4; MeOH:DCM+2% NH_4OH); R_F *N*-alkylated penultimate = 0.82 (1:1; EtOAc:PE). ^{1}H NMR (400 MHz, MeOD) δ 3.96 (dd, *J* = 1.6, 1H, H-4), 3.89 (dd, *J* = 1.7, 1H, H-3), 3.80 (dd, *J* = 5.0, 11.4, 1H, H-6a), 3.69 (dd, *J* = 3.2, 11.4, 1H, H-6b), 3.42 – 3.35 (m, 5H, H-2, 2×CH_2-5 pentyl), 3.27 – 3.16 (m, 3H, H-5, C(O)NCH_2-1 pentyl), 2.97 (s, 4H, 2×OCH_2-Ada), 2.88 – 2.79 (m, 1H, NC*H*H-1 pentyl), 2.65 – 2.53 (m, 1H, NCH*H*-1 pentyl), 1.95 (s, 6H, 6×CH Ada), 1.72 (dd, *J* = 12.1, 31.4, 12H, 6×CH_2 Ada), 1.63 – 1.52 (m, 20H, 6×CH_2 Ada, 4×CH_2 pentyl), 1.49 – 1.34 (m, 4H, 2×CH_2-3 pentyl). ^{13}C NMR (100 MHz, MeOD) δ 83.3, 83.3 (2×OCH_2-Ada), 82.4 (C-3), 81.6 (C-4), 76.5 (C-2), 72.7, 72.7 (2×CH_2-5 pentyl), 70.8 (C-5), 61.0 (C-6), 50.0 (NCH_2-1 pentyl), 41.0 (CH_2 Ada), 40.2 (C(O)NCH_2-1 pentyl), 38.5 (CH_2 Ada), 35.4, 35.3 (2×C_q Ada), 29.9 (CH Ada), 30.8, 30.5, 30.5, 29.7, 25.4 (CH_2 pentyl), 24.9 (CH_2-3 pentyl). IR ν_{max}(thin film)/ cm^{-1}: 3328, 2902, 2849, 1651, 1454, 1157, 1111. $[\alpha]^{20}_D$: 13.8 (*c* 0.2, MeOH). HRMS: found 645.4834 $[M+H]^+$, calculated for $[C_{38}H_{64}O_6N_2+H]^+$ 645.4837.

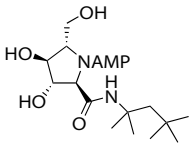


1,1,3,3-Tetramethylbutyl 2,5-dideoxy-2,5-imino-L-*gulo*-hexonamide (C3-II). Compound **C3-II** (10 mg, 35 μmol) was synthesized in 58% yield from **C2-II** (60 μmol) by deprotection of the benzyl-ethers (appropriate method in general procedure F). R_F = 0.43 (1:4; MeOH:DCM+2% NH_4OH). ^{1}H NMR (400 MHz, MeOD) δ 4.02 (dd, *J* = 5.2, 1H, H-3), 3.78 (dd, *J* = 5.4, 6.1, 1H, H-4), 3.69 (dd, *J* = 4.1, 11.2, 1H, H-6a), 3.60 (dd, *J* = 5.7, 11.2, 1H,

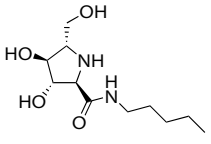
H-6b), 3.39 (d, *J* = 5.2, 1H, H-2), 3.02 (dt, *J* = 4.1, 6.0, 1H, H-5), 1.81 (d, *J* = 14.9, 1H, C*H*H-2 tMB), 1.74 (d, *J* = 14.8, 1H, CH*H*-2 tMB), 1.41 (s, 6H, 2×CH_3 tMB), 1.02 (s, 9H, 2×CH_3, CH_3-4 tMB). ^{13}C NMR (100 MHz, MeOD) δ 174.1 (C(O)-1), 82.4 (C-3), 80.0 (C-4), 67.4 (C-2), 65.9 (C-5), 63.2 (C-6), 55.8 (NHC_q-1 tMB), 52.9 (CH_2-2 tMB), 32.6 (C_q-3 tMB), 32.1 (2×CH_3, CH_3-4 tMB), 29.6, 29.4 (2×CH_3 tMB). IR ν_{max}(thin film)/ cm^{-1}: 3304, 2954, 1652, 1453, 1366, 1227, 1055. $[\alpha]^{20}_D$: 8.0 (*c* 0.2, MeOH). HRMS: found 289.2123 $[M+H]^+$, calculated for $[C_{14}H_{28}O_4N_2+H]^+$ 289.2122.



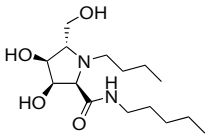
1,1,3,3-Tetramethylbutyl 2,5-butylimino-2,5-dideoxy-L-*gulo*-hexonamide (C4-II). Compound **C4-II** (11 mg, 32 µmol) was synthesized in 53% yield over two steps from **C2-II** (60 µmol) via a reductive amination with the appropriate aldehyde (general procedure E) and a subsequent benzyl-ether deprotection (appropriate method in general procedure F). R_F = 0.85 (1:4; MeOH:DCM+2% NH_4OH); R_F *N*-alkylated penultimate = 0.95 (1:1; EtOAc:PE). ^{1}H NMR (400 MHz, MeOD) δ 3.97 (s, 1H, H-4), 3.89 (s, 1H, H-3), 3.81 (dd, *J* = 5.1, 11.5, 1H, H-6a), 3.69 (dd, *J* = 3.0, 11.5, 1H, H-6b), 3.29 (s, 2H, H-2, H-5), 2.94 – 2.82 (m, 1H, NC*H*H butyl), 2.67 – 2.51 (m, 1H, NCH*H* butyl), 1.88 (d, *J* = 14.8, 1H, C*H*H-2 tMB), 1.73 (d, *J* = 14.8, 1H, CH*H*-2 tMB), 1.63 – 1.25 (m, 10H, 2×CH_3 tMB, 2×CH_2 butyl), 1.02 (s, 9H, 2×CH_3, CH_3-4 tMB), 0.95 (t, *J* = 7.3, 3H, CH_3 butyl). ^{13}C NMR (100 MHz, MeOD) δ 82.1 (C-3), 81.5 (C-4), 77.5, 70.5 (C-2, C-5), 60.8 (C-6), 52.8 (CH_2-2 tMB), 49.9 (NCH_2 butyl), 32.6 (C_q-3 tMB), 32.2 (2×CH_3, CH_3-4 tMB), 29.6, 29.4 (2×CH_3 tMB), 21.9 (CH_2 butyl), 14.6 (CH_3 butyl). IR ν_{max}(thin film)/ cm^{-1}: 3312, 2957, 1651, 1439, 1366, 1226, 1155, 1066. $[\alpha]^{20}_D$: 20.9 (*c* 0.2, MeOH). HRMS: found 345.2748 $[M+H]^+$, calculated for $[C_{18}H_{36}O_4N_2+H]^+$ 345.2748.



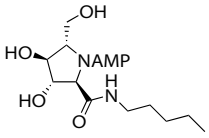
1,1,3,3-Tetramethylbutyl 2,5-[5-(adamantan-1yl-methoxy)-pentyl]imino-2,5-dideoxy-L-*gulo*-hexonamide (C5-II). Compound **C5-II** (13 mg, 25 µmol) was synthesized in 42% yield over two steps from **C2-II** (60 µmol) via a reductive amination with the appropriate aldehyde (general procedure E) and a subsequent benzyl-ether deprotection (appropriate method in general procedure F). R_F = 0.85 (1:4; MeOH:DCM+2% NH_4OH); R_F *N*-alkylated penultimate = 0.83 (1:1; EtOAc:PE). ^{1}H NMR (400 MHz, MeOD) δ 3.97 (s, 1H, H-4), 3.89 (s, 1H, H-3), 3.81 (dd, *J* = 5.1, 11.5, 1H, H-6a), 3.68 (dd, *J* = 3.1, 11.5, 1H, H-6b), 3.39 (t, *J* = 6.3, 2H, CH_2-5 pentyl), 3.30 – 3.23 (m, 2H, H-2, H-5), 2.97 (s, 2H, OCH_2-Ada), 2.93 – 2.84 (m, 1H, NC*H*H pentyl), 2.61 – 2.53 (m, 1H, NCH*H* pentyl), 1.95 (s, 3H, 3×CH Ada), 1.89 (d, *J* = 14.8, 1H, C*H*H-2 tMB), 1.81 – 1.65 (m, 7H, CH*H*-2 tMB, 3×CH_2 Ada), 1.64 – 1.37 (m, 18H, 3×CH_2 Ada, 2×CH_3 tMB, 3×CH_2 pentyl), 1.03 (s, 9, 2×CH_3, CH_3-4 tMBH). ^{13}C NMR (100 MHz, MeOD) δ 83.2 (OCH_2-Ada), 82.1 (C-3), 81.6 (C-4), 77.7 (C-2), 72.6 (CH_2-5 pentyl), 70.4 (C-5), 60.9 (C-6), 56.1 (NHC_q-1 tMB), 52.8 (CH_2-2 tMB), 50.1 (NCH_2-1 pentyl), 41.0 (CH_2 Ada), 38.5 (CH_2 Ada), 35.3 (C_q Ada), 32.6 (C_q-3 tMB), 32.2 (2×CH_3, CH_3-4 tMB), 30.9 (CH_2 pentyl), 29.9 (CH Ada), 29.7, 29.4 (2×CH_3 tMB), 25.5 (CH_2-3 pentyl). IR ν_{max}(thin film)/ cm^{-1}: 3342, 2903, 2850, 1651, 1440, 1227, 1064. $[\alpha]^{20}_D$: 24.6 (*c* 0.3, MeOH). HRMS: found 523.4101 $[M+H]^+$, calculated for $[C_{30}H_{54}O_5N_2+H]^+$ 523.4105.



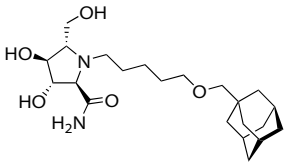
Pentyl 2,5-dideoxy-2,5-imino-L-*gulo*-hexonamide (C3-III). Compound **C3-III** (19 mg, 77 µmol) was synthesized in 51% yield from **C2-III** (150 µmol) by deprotection of the benzyl-ethers (appropriate method in general procedure F). R_F = 0.24 (1:5; MeOH:DCM+2% NH_4OH). ^{1}H NMR (400 MHz, MeOD) δ 4.24 – 4.11 (m, 1H, H-3), 4.06 – 3.94 (m, 1H, H-4), 3.91 – 3.81 (m, 1H, H-6a), 3.81 – 3.71 (m, 2H, H-2, H-6b), 3.43 – 3.36 (m, 3H, H-5, NCH_2-1 pentyl), 1.68 – 1.55 (m, 2H, CH_2-2 pentyl), 1.51 – 1.33 (m, 4H, 2×CH_2 pentyl), 1.07 – 0.91 (m, 3H, CH_3-5 pentyl). ^{13}C NMR (100 MHz, MeOD) δ 172.3 (C(O)-1), 81.7 (C-3), 78.8 (C-4), 66.2, 66.1 (C-2, C-5), 61.9 (C-6), 40.7 (NCH_2-1 pentyl), 30.3, 30.2, 23.5 (3×CH_2 pentyl), 14.5 (CH_3-5 pentyl). IR ν_{max}(thin film)/ cm^{-1}: 3290, 2930, 1652, 1544, 1377, 1055. $[\alpha]^{20}_D$: 1.1 (*c* 0.4, MeOH). HRMS: found 247.1653 $[M+H]^+$, calculated for $[C_{11}H_{22}O_4N_2+H]^+$ 247.1652.



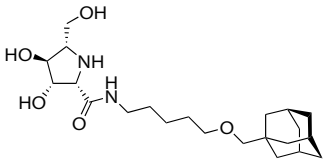
Pentyl 2,5-butylimino-2,5-dideoxy-L-*gulo*-hexonamide (C4-III). Compound **C4-III** (13 mg, 43 µmol) was synthesized in 31% yield over two steps from **C2-III** (140 µmol) via a reductive amination with the appropriate aldehyde (general procedure E) and a subsequent benzyl-ether deprotection (appropriate method in general procedure F). R_F = 0.69 (1:4; MeOH:DCM+2% NH_4OH); R_F *N*-alkylated penultimate = 0.77 (1:1; EtOAc:PE). ^{1}H NMR (400 MHz, MeOD) δ 4.01 (s, 1H, H-4), 3.94 (s, 1H, H-3), 3.85 (dd, *J* = 4.5, 11.8, 1H, H-6a), 3.75 (dd, *J* = 3.1, 11.8, 1H, H-6b), 3.61 – 3.51 (m, 1H, H-2), 3.41 – 3.33 (m, 1H, H-5), 3.23 (t, *J* = 7.0, 2H, NCH_2-1 pentyl), 3.04 – 2.90 (m, 1H, NC*H*H-1 butyl), 2.83 – 2.67 (m, 1H, NCH*H*-1 butyl), 1.59 – 1.48 (m, 4H, 2×CH_2-2 pentyl/butyl), 1.43 – 1.28 (m, 6H, 3×CH_2 pentyl/butyl), 0.98 – 0.90 (m, 6H, 2×CH_3 butyl/pentyl). ^{13}C NMR (100 MHz, MeOD) δ 81.9 (C-3), 80.7 (C-4), 75.5 (C-2), 71.3 (C-5), 60.3 (C-6), 50.4 (NCH_2 butyl), 40.4 (NCH_2-1 pentyl), 31.4, 30.3, 30.3, 23.5, 21.7 (5×CH_2 pentyl/butyl), 14.5, 14.4 (2×CH_3 pentyl/butyl). IR ν_{max}(thin film)/ cm^{-1}: 3294, 2959, 2930, 2871, 1652, 1461, 1378, 1066. $[\alpha]^{20}_D$: 27.7 (*c* 0.3, MeOH). HRMS: found 303.2279 $[M+H]^+$, calculated for $[C_{15}H_{30}O_4N_2+H]^+$ 303.2278.



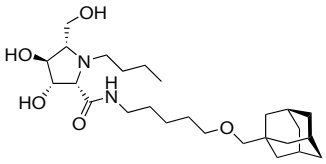
Pentyl 2,5-[5-(adamantan-1yl-methoxy)-pentyl]imino-2,5-dideoxy-L-*gulo*-hexonamide (C5-III). Compound **C5-III** (15 mg, 31 µmol) was synthesized in 22% yield over two steps from **C2-III** (140 µmol) via a reductive amination with the appropriate aldehyde (general procedure E) and a subsequent benzyl-ether deprotection (appropriate method in general procedure F). R_F = 0.37 (1:9; MeOH:DCM+2% NH_4OH); R_F *N*-alkylated penultimate = 0.80 (1:1; EtOAc:PE). ^{1}H NMR (400 MHz, MeOD) δ 3.96 (dd, *J* = 1.7, 1H, H-4), 3.89 (dd, *J* = 1.8, 1H, H-3), 3.80 (dd, *J* = 5.0, 11.4, 1H, H-6a), 3.69 (dd, *J* = 3.2, 11.4, 1H, H-6b), 3.40 (s, 1H, H-2), 3.38 (t, *J* = 4.9, 2H, CH_2-5 pentyl), 3.28 – 3.12 (m, 3H, H-5, C(O)NCH_2-1 pentyl), 2.97 (s, 2H, OCH_2-Ada), 2.90 – 2.78 (m, 1H, NC*H*H-1 pentyl), 2.66 – 2.52 (m, 1H, NCH*H*-1 pentyl), 1.95 (s, 3H, 3×CH Ada), 1.72 (dd, *J* = 12.1, 32.1, 6H, 3×CH_2 Ada), 1.64 – 1.26 (m, 18H, 3×CH Ada, 6×CH_2 pentyl), 0.93 (t, *J* = 6.9, 3H, CH_3-5 pentyl). ^{13}C NMR (100 MHz, MeOD) δ 175.9 (C(O)-1), 83.2 (OCH_2-Ada), 82.4 (C-3), 81.6 (C-4), 76.4 (C-2), 72.7 (CH_2-5 pentyl), 70.8 (C-5), 61.0 (C-6), 50.0 (NCH_2-1 pentyl), 41.0 (CH_2 Ada), 40.2 (C(O)NCH_2-1 pentyl), 38.5 (CH_2 Ada), 35.3 (C_q Ada), 29.9 (CH Ada), 30.8, 30.4, 30.4, 29.7, 25.4, 23.6 (6×CH_2 pentyl), 14.5 (CH_3 pentyl). IR ν_{max}(thin film)/ cm^{-1}: 3297, 2902, 2849, 1651, 1456, 1361, 1157, 1111. $[\alpha]^{20}_D$: 11.4 (*c* 0.3, MeOH). HRMS: found 481.3632 $[M+H]^+$, calculated for $[C_{27}H_{48}O_5N_2+H]^+$ 481.3636.



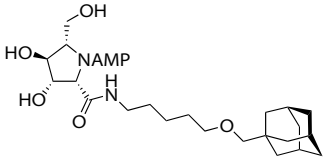
2,5-[5-(Adamantan-1yl-methoxy)-pentyl]imino-2,5-dideoxy-L-*gulo*-hexonamide (C5-VI). Compound **C5-VI** (5 mg, 12 µmol) was synthesized in 92% yield over two steps from **C2-VI** (13 µmol) via a reductive amination with the appropriate aldehyde (general procedure E) and a subsequent benzyl-ether deprotection (appropriate method in general procedure F). R_F = 0.45 (14% MeOH in DCM+2% NH_4OH); R_F *N*-alkylated penultimate = 0.74 (1% MeOH in EtOAc+2% NH_4OH). ^{1}H NMR (400 MHz, MeOD) δ 3.98 – 3.96 (m, 1H, H-4), 3.95 – 3.93 (m, 1H, H-3), 3.80 (dd, *J* = 5.0, 11.4, 1H, H-6a), 3.68 (dd, *J* = 3.2, 11.4, 1H, H-6b), 3.40 (s, 1H, H-2), 3.38 (t, *J* = 4.8, 2H, CH_2-5 pentyl), 3.23 (s, 1H, H-5), 2.97 (s, 2H, OCH_2-Ada), 2.89 – 2.80 (m, 1H, NC*H*H pentyl), 2.66 – 2.58 (m, 1H, NCH*H* pentyl), 1.95 (s, 3H, 3×CH Ada), 1.72 (dd, *J* = 11.7, 31.3, 6H, 3×CH_2 Ada), 1.64 – 1.31 (m, 12H, 3×CH_2 Ada, 3×CH_2 pentyl). ^{13}C NMR (100 MHz, MeOD) δ 83.2 (OCH_2-Ada), 82.6 (C-3), 81.7 (C-4), 76.1 (C-2), 72.7 (CH_2-5 pentyl), 70.8 (C-5), 61.0 (C-6), 49.9 (NCH_2-1 pentyl), 41.0 (CH_2 Ada), 38.5 (CH_2 Ada), 35.3 (C_q Ada), 30.7 (CH_2 pentyl), 29.9 (CH Ada), 29.6 (CH_2 pentyl), 25.3 (CH_2-3 pentyl). IR ν_{max}(thin film)/ cm^{-1}: 3312, 2903, 1669, 1410, 1056. $[\alpha]^{20}_D$: 23.4 (*c* 0.1, MeOH). HRMS: found 411.2852 $[M+H]^+$, calculated for $[C_{22}H_{38}O_5N_2+H]^+$ 411.2853.



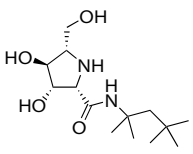
5-(Adamantan-1yl-methoxy)-pentyl 2,5-dideoxy-2,5-imino-L-*ido*-hexonamide (D3-I). Compound **D3-I** (12 mg, 29 µmol) was synthesized in 55% yield from **D2-I** (53 µmol) by deprotection of the benzyl-ethers (appropriate method in general procedure F). R_F = 0.10 (1:9; MeOH:DCM+2% NH_4OH). ^{1}H NMR (400 MHz, MeOD) δ 4.17 (dd, *J* = 2.1, 5.1, 1H, H-3), 4.04 (d, *J* = 5.1, 1H, H-2), 3.92 (dd, *J* = 2.4, 1H, H-4), 3.71 – 3.68 (m, 2H, CH_2-6), 3.38 (t, *J* = 6.4, 2H, CH_2-5 pentyl), 3.27 – 3.22 (m, 3H, H-5, NCH_2-1 pentyl), 2.97 (s, 2H, OCH_2-Ada), 1.95 (s, 3H, 3×CH Ada), 1.72 (dd, *J* = 12.1, 31.7, 7H, 3×CH_2 Ada), 1.62 – 1.52 (m, 10H, 3×CH_2 Ada, 2×CH_2 pentyl), 1.46 – 1.37 (m, 2H, CH_2-3 pentyl). ^{13}C NMR (100 MHz, MeOD) δ 175.0 (C(O)-1), 83.2 (OCH_2-Ada), 79.8 (C-4), 79.0 (C-3), 72.7 (CH_2-5 pentyl), 67.9 (C-5), 65.8 (C-2), 63.5 (C-6), 41.0 (CH_2 Ada), 40.4 (NCH_2-1 pentyl), 38.5 (CH_2 Ada), 35.3 (C_q Ada), 30.5, 30.4 (2×CH_2 pentyl), 29.9 (CH Ada), 24.8 (CH_2-3 pentyl). IR ν_{max}(thin film)/ cm^{-1}: 3326, 2902, 2849, 1652, 1454, 1050. $[\alpha]^{20}_D$: −22.4 (*c* 0.1, MeOH). HRMS: found 411.2851 $[M+H]^+$, calculated for $[C_{22}H_{38}O_5N_2+H]^+$ 411.2853.



5-(Adamantan-1yl-methoxy)-pentyl 2,5-butylimino-2,5-dideoxy-L-*ido*-hexonamide (D4-I). Compound **D4-I** (18 mg, 39 µmol) was synthesized in 74% yield over two steps from **D2-I** (53 µmol) via a reductive amination with the appropriate aldehyde (general procedure E) and a subsequent benzyl-ether deprotection (appropriate method in general procedure F). R_F = 0.54 (1:4; MeOH:DCM+2% NH_4OH); R_F *N*-alkylated penultimate = 0.85 (1:1; EtOAc:PE). ^{1}H NMR (400 MHz, MeOD) collapsed iminosugar signals δ 4.19 – 3.49 (m, 5H), 3.38 (t, *J* = 6.4, 2H, CH_2-5 pentyl), 3.22 (s, 1H), 2.97 (s, 2H, OCH_2-Ada), 2.91 – 2.55 (m, 3H), 1.95 (s, 3H, 3×CH Ada), 1.72 (dd, *J* = 12.1, 32.0, 6H, 3×CH_2 Ada), 1.64 – 1.25 (m, 16H, 3×CH_2 Ada, 3×CH_2 pentyl, 2×CH_2 butyl), 0.94 (t, *J* = 7.3, 3H, CH_3 butyl). ^{13}C NMR (100 MHz, MeOD) collapsed iminosugar signals δ 83.3 (OCH_2-Ada), 79.3 (CH), 78.4 (CH), 72.7 (CH_2-5 pentyl), 41.0 (CH_2 Ada), 40.3 (NCH_2-1 pentyl), 38.5 (CH_2 Ada), 35.3 (C_q Ada), 30.5 (CH_2), 29.9 (CH Ada), 24.9 (CH_2), 21.8 (CH_2), 14.5 (CH_3 butyl). IR ν_{max}(thin film)/ cm^{-1}: 3295, 2902, 2849, 1637, 1456, 1360, 1110, 756. $[\alpha]^{20}_D$: −16.7 (*c* 0.4, MeOH). HRMS: found 467.3476 $[M+H]^+$, calculated for $[C_{26}H_{46}O_5N_2+H]^+$ 467.3479.

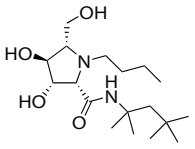


5-(Adamantan-1yl-methoxy)-pentyl 2,5-[5-(adamantan-1yl-methoxy)-pentyl]imino-2,5-dideoxy-L-*ido*-hexonamide (D5-I). Compound **D5-I** (27 mg, 42 µmol) was synthesized in 79% yield over two steps from **D2-I** (53 µmol) via a reductive amination with the appropriate aldehyde (general procedure E) and a subsequent benzyl-ether deprotection (appropriate method in general procedure F). R_F = 0.56 (1:9; MeOH:DCM+2% NH_4OH); R_F *N*-alkylated penultimate = 0.72 (1:1; EtOAc:PE). ^{1}H NMR (400 MHz, MeOD) collapsed iminosugar signals δ 4.47 – 3.50 (m, 5H), 3.39 (t, *J* = 6.4, 4H, 2×CH_2-5 pentyl), 3.27 – 3.16 (m, 1H), 2.97 (s, 4H, 2×OCH_2-Ada), 2.94 – 2.49 (m, 2H), 1.95 (s, 6H, 6×CH Ada), 1.72 (dd, *J* = 12.0, 32.1, 12H, 6×CH_2 Ada), 1.65 – 1.48 (m, 20H, 6×CH_2 Ada, 4×CH_2 pentyl), 1.48 – 1.32 (m, 4H, 2×CH_2-3 pentyl). ^{13}C NMR (100 MHz, MeOD) collapsed iminosugar signals δ 83.3 (OCH_2-Ada), 78.4 (CH), 72.7 (CH_2-5 pentyl), 41.0 (CH_2 Ada), 40.3 (NCH_2-1 pentyl), 38.5 (CH_2 Ada), 35.3, 35.3 (2×C_q Ada), 30.7, 30.5, 30.5 (CH_2), 29.9 (CH Ada), 25.2, 24.9 (2×CH_2-3 pentyl). IR ν_{max}(thin film)/ cm^{-1}: 3295, 2900, 2848, 1652, 1453, 1361, 1157, 1109, 755. $[\alpha]^{20}_D$: −18.1 (*c* 0.5, MeOH). HRMS: found 645.4835 $[M+H]^+$, calculated for $[C_{38}H_{64}O_6N_2+H]^+$ 645.4837.

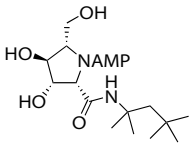


1,1,3,3-Tetramethylbutyl 2,5-dideoxy-2,5-imino-L-*ido*-hexonamide (D3-II). Compound **D3-II** (14 mg, 49 µmol) was synthesized in 78% yield from **D2-II** (63 µmol) by deprotection of the benzyl-ethers (appropriate method in general procedure F). R_F = 0.38 (1:4; MeOH:DCM+2% NH_4OH). ^{1}H NMR (400 MHz, MeOD) δ 4.11 (dd, *J* = 2.4, 5.4, 1H, H-3), 3.90 (dd, *J* = 2.7, 1H, H-4), 3.81 (d, *J* = 5.4, 1H, H-2), 3.66 (dd, *J* = 4.1, 10.1, 1H, H-6a),

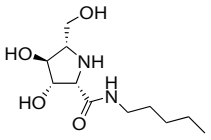
3.62 (dd, *J* = 4.3, 10.1, 1H, H-6b), 3.14 (dt, *J* = 2.9, 4.9, 1H, H-5), 1.83 (d, *J* = 14.8, 1H, C*H*H-2 tMB), 1.69 (d, *J* = 14.8, 1H, CH*H*-2 tMB), 1.41 (d, *J* = 6.0, 6H, 2×CH_3 tMB), 1.03 (s, 9H, 2×CH_3, CH_3-4 tMB). ^{13}C NMR (100 MHz, MeOD) δ 172.9 (C(O)-1), 80.3 (C-4), 79.4 (C-3), 67.3 (C-5), 66.2 (C-2), 64.6 (C-6), 56.0 (NHC_q-1 tMB), 53.2 (CH_2-2 tMB), 32.6 (C_q-3 tMB), 32.1 (2×CH_3, CH_3-4 tMB), 29.6 (2×CH_3 tMB). IR ν_{max}(thin film)/ cm^{-1}: 3328, 2955, 2481, 1667, 1559, 1454, 1367, 1226, 1042. $[\alpha]^{20}_D$: −44.1 (*c* 0.3, MeOH). HRMS: found 289.2123 $[M+H]^+$, calculated for $[C_{14}H_{28}O_4N_2+H]^+$ 289.2122.



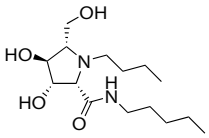
1,1,3,3-Tetramethylbutyl 2,5-butylimino-2,5-dideoxy-L-*ido*-hexonamide (D4-II). Compound **D4-II** (12 mg, 35 µmol) was synthesized in 55% yield over two steps from **D2-II** (63 µmol) via a reductive amination with the appropriate aldehyde (general procedure E) and a subsequent benzyl-ether deprotection (appropriate method in general procedure F). R_F = 0.66 (1:4; MeOH:DCM+2% NH_4OH); R_F *N*-alkylated penultimate = 0.88 (1:1; EtOAc:PE). ^{1}H NMR (400 MHz, MeOD) collapsed iminosugar signals δ 4.15 – 4.07 (m, 1H, H-3), 4.02 (dd, *J* = 2.6, 1H, H-4), 3.68 (s, 2H, CH_2-6), 3.41 (s, 1H, H-2), 2.88 – 2.57 (m, 3H, H-5, NCH_2 butyl), 1.87 (d, *J* = 14.7, 1H, C*H*H-2 tMB), 1.70 (d, *J* = 14.2, 1H, CH*H*-2 tMB), 1.65 – 1.21 (m, 10H, 2×CH_2 butyl, 2×CH_3 tMB), 1.06 (s, 9H, 2×CH_3, CH_3-4 tMB), 0.97 (t, *J* = 7.3, 3H, CH_3 butyl). ^{13}C NMR (100 MHz, MeOD) collapsed iminosugar signals δ 79.7 (C-4), 78.7 (C-3), 74.2 (C-2), 73.4 (C-5), 63.7 (C-6), 57.5 (NCH_2 butyl), 56.2 (C_q-3 tMB), 53.9 (CH_2-2 tMB), 32.6 (C_q-3 tMB), 32.3 (CH_2 butyl), 32.2 (2×CH_3, CH_3-4 tMB), 29.7, 29.1 (2×CH_3 tMB), 21.9 (CH_2 butyl), 14.4 (CH_3 butyl). IR ν_{max}(thin film)/ cm^{-1}: 3290, 2957, 2420, 1651, 1458, 1366, 1227, 1072, 756. $[\alpha]^{20}_D$: −30.7 (*c* 0.3, MeOH). HRMS: found 345.2748 $[M+H]^+$, calculated for $[C_{18}H_{36}O_4N_2+H]^+$ 345.2748.



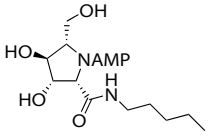
1,1,3,3-Tetramethylbutyl 2,5-[5-(adamantan-1yl-methoxy)-pentyl]imino-2,5-dideoxy-L-*ido*-hexonamide (D5-II). Compound **D5-II** (28 mg, 54 µmol) was synthesized in 86% yield over two steps from **D2-II** (63 µmol) via a reductive amination with the appropriate aldehyde (general procedure E) and a subsequent benzyl-ether deprotection (appropriate method in general procedure F). R_F = 0.25 (1:9; MeOH:DCM+2% NH_4OH); R_F *N*-alkylated penultimate = 0.83 (1:1; EtOAc:PE). ^{1}H NMR (400 MHz, MeOD) collapsed iminosugar signals δ 4.72 – 3.44 (m, 6H), 3.39 (t, *J* = 6.2, 2H, CH_2-5 pentyl), 3.26 – 3.02 (m, 1H), 2.97 (s, 2H, OCH_2-Ada), 2.94 – 2.47 (m, 1H), 2.20 – 1.31 (m, 23H, CH_2-2 tMB, 3×CH Ada, 6×CH_2 Ada, 3×CH_2 pentyl), 1.04 (s, 9H, 2×CH_3, CH_3-4 tMB). ^{13}C NMR (101 MHz, MeOD) collapsed iminosugar signals δ 83.2 (OCH_2-Ada), 78.4 (CH), 72.3 (CH_2-5 pentyl), 41.0 (CH_2 Ada), 38.5 (CH_2 Ada), 35.3 (C_q Ada), 32.6 (C_q-3 tMB), 32.2 (2×CH_3, CH_3-4 tMB), 30.7 (CH_2 pentyl), 29.9 (CH Ada), 29.6 (2×CH_3 tMB). IR ν_{max}(thin film)/ cm^{-1}: 3291, 2902, 2849, 2409, 1668, 1452, 1366, 1225, 1156, 1110, 755. $[\alpha]^{20}_D$: −21.4 (*c* 0.6, MeOH). HRMS: found 523.4101 $[M+H]^+$, calculated for $[C_{30}H_{54}O_5N_2+H]^+$ 523.4105.



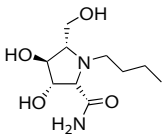
Pentyl 2,5-dideoxy-2,5-imino-L-*ido*-hexonamide (D3-III). Compound **D3-III** (52 mg, 211 µmol) was synthesized in 78% yield from **D2-III** (270 µmol) by deprotection of the benzyl-ethers (appropriate method in general procedure F). R_F = 0.15 (1:4; MeOH:DCM+2% NH_4OH). ^{1}H NMR (400 MHz, MeOD) δ 4.29 (dd, *J* = 2.1, 4.9, 1H, H-3), 4.25 (d, *J* = 4.9, 1H, H-2), 3.99 (dd, *J* = 2.4, 1H, H-4), 3.79 (d, *J* = 6.0, 2H, CH_2-6), 3.41 (dt, *J* = 2.7, 6.0, 1H, H-5), 3.25 (t, *J* = 7.1, 2H, NCH_2-1 pentyl), 1.61 – 1.49 (m, 2H, CH_2-2 pentyl), 1.40 – 1.31 (m, 4H, 2×CH_2 pentyl), 0.92 (t, *J* = 6.9, 3H, CH_3-5 pentyl). ^{13}C NMR (100 MHz, MeOD) δ 169.5 (C(O)-1), 79.0 (C-4), 78.4 (C-3), 68.5 (C-5), 65.3 (C-2), 62.0 (C-6), 40.7 (NCH_2-1 pentyl), 30.3, 30.2, 23.5 (3×CH_2 pentyl), 14.5 (CH_3-5 pentyl). IR ν_{max}(thin film)/ cm^{-1}: 3287, 2957, 2931, 2871, 1666, 1638, 1652, 1560, 1470, 1377, 1310, 1066, 1034. $[\alpha]^{20}_D$: −54.5 (*c* 1.0, MeOH). HRMS: found 247.1654 $[M+H]^+$, calculated for $[C_{11}H_{22}O_4N_2+H]^+$ 247.1652.



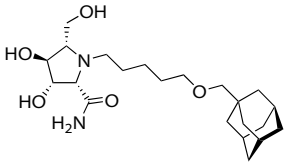
Pentyl 2,5-butylimino-2,5-dideoxy-L-*ido*-hexonamide (D4-III). Compound **D4-III** (24 mg, 79 µmol) was synthesized in 49% yield over two steps from **D2-III** (160 µmol) via a reductive amination with the appropriate aldehyde (general procedure E) and a subsequent benzyl-ether deprotection (appropriate method in general procedure F). R_F = 0.58 (1:4; MeOH:DCM+2% NH_4OH); R_F *N*-alkylated penultimate = 0.75 (1:1; EtOAc:PE). ^{1}H NMR (400 MHz, MeOD) δ 4.08 (dd, *J* = 3.2, 6.1, 1H, H-3), 3.96 (dd, *J* = 3.2, 1H, H-4), 3.67 (d, *J* = 4.0, 2H, CH_2-6), 3.51 (d, *J* = 6.2, 1H, H-2), 3.35 – 3.25 (m, 1H, NC*H*H-1 pentyl), 3.17 (dt, *J* = 6.9, 13.5, 1H, NCH*H*-1 pentyl), 2.80 (dd, *J* = 3.7, 7.2, 1H, H-5), 2.70 (ddd, *J* = 5.9, 9.3, 12.5, 1H, NC*H*H-1 butyl), 2.59 (ddd, *J* = 6.4, 9.3, 12.5, 1H, NCH*H*-1 butyl), 1.59 – 1.26 (m, 10H, 5×CH_2 pentyl/butyl), 0.96 – 0.89 (m, 6H, 2×CH_3 butyl/pentyl). ^{13}C NMR (100 MHz, MeOD) δ 174.6 (C(O)-1), 79.3 (C-4), 78.4 (C-3), 73.3, 73.2 (C-2, C-5), 63.0 (C-6), 57.1 (NCH_2-1 butyl), 40.1 (NCH_2-1 pentyl), 31.9, 30.4, 23.6, 21.8 (5×CH_2 pentyl/butyl), 14.5 (2×CH_3 butyl/pentyl). IR ν_{max}(thin film)/ cm^{-1}: 3274, 2959, 2931, 2871, 1637, 1464, 1376, 1118, 1069, 754. $[\alpha]^{20}_D$: −39.3 (*c* 0.3, MeOH). HRMS: found 303.2279 $[M+H]^+$, calculated for $[C_{15}H_{30}O_4N_2+H]^+$ 303.2278.



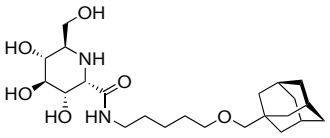
Pentyl 2,5-[5-(adamantan-1yl-methoxy)-pentyl]imino-2,5-dideoxy-L-*ido*-hexonamide (D5-III). Compound **D5-III** (40 mg, 83 µmol) was synthesized in 52% yield over two steps from **D2-III** (160 µmol) via a reductive amination with the appropriate aldehyde (general procedure E) and a subsequent benzyl-ether deprotection (appropriate method in general procedure F). R_F = 0.69 (1:4; MeOH:DCM+2% NH_4OH); R_F *N*-alkylated penultimate = 0.80 (1:1; EtOAc:PE). ^{1}H NMR (400 MHz, MeOD) δ 4.08 (dd, *J* = 3.2, 6.1, 1H, H-3), 3.97 (dd, *J* = 3.1, 1H, H-4), 3.69 – 3.66 (m, 2H, CH_2-6), 3.51 (d, *J* = 6.1, 1H, H-2), 3.38 (t, *J* = 6.3, 2H, CH_2-5 pentyl), 3.35 – 3.26 (m, 1H, C(O)NC*H*H-1 pentyl), 3.17 (dt, *J* = 6.9, 13.5, 1H, C(O)NCH*H*-1 pentyl), 2.96 (s, 2H, OCH_2-Ada), 2.80 (dd, *J* = 3.6, 7.1, 1H, H-5), 2.70 (ddd, *J* = 5.8, 9.1, 12.5, 1H, NC*H*H-1 pentyl), 2.59 (ddd, *J* = 6.5, 9.1, 12.5, 1H, NCH*H*-1 pentyl), 1.95 (s, 3H, 3×CH Ada), 1.72 (dd, *J* = 11.9, 32.3, 6H, 3×CH_2 Ada), 1.60 – 1.29 (m, 18H, 3×CH_2 Ada, 6×CH_2 pentyl), 0.92 (t, *J* = 6.9, 3H, CH_3 pentyl). ^{13}C NMR (100 MHz, MeOD) δ 174.6 (C(O)-1), 83.2 (OCH_2-Ada), 79.4 (C-4), 78.4 (C-3), 73.4 (C-2), 73.2 (C-5), 72.6 (CH_2-5 pentyl), 63.1 (C-6), 57.4 (NCH_2-1 pentyl), 41.0 (CH_2 Ada), 40.1 (C(O)NCH_2-1 pentyl), 38.5 (CH_2 Ada), 35.3 (C_q Ada), 29.9 (CH Ada), 30.7, 30.4, 30.4, 29.5, 25.3, 23.6 (6×CH_2 pentyl), 14.6 (CH_3 pentyl). IR ν_{max}(thin film)/ cm^{-1}: 3343, 2903, 2850, 1637, 1457, 1374, 1157, 1072. $[\alpha]^{20}_D$: −32.1 (*c* 0.7, MeOH). HRMS: found 481.3632 $[M+H]^+$, calculated for $[C_{27}H_{48}O_5N_2+H]^+$ 481.3636.



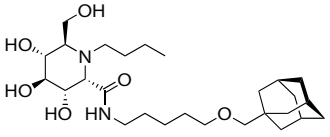
2,5-Butylimino-2,5-dideoxy-L-*ido*-hexonamide (D4-VI). Compound **D4-VI** (6 mg, 25 µmol) was synthesized in 92% yield over two steps from **D2-VI** (30 µmol) via a reductive amination with the appropriate aldehyde (general procedure E) and a subsequent benzyl-ether deprotection (appropriate method in general procedure F). R_F = 0.21 (14% MeOH in DCM+2% NH_4OH); R_F *N*-alkylated penultimate = 0.62 (1% MeOH in EtOAc+2% NH_4OH). ^{1}H NMR (400 MHz, MeOD) δ 4.08 (dd, *J* = 3.1, 6.0, 1H, H-3), 3.99 (dd, *J* = 3.1, 1H, H-4), 3.70 – 3.63 (m, 2H, CH_2-6), 3.50 (d, *J* = 6.0, 1H, H-2), 2.83 – 2.77 (m, 1H, H-5), 2.76 – 2.55 (m, 2H, NCH_2-1 butyl), 1.55 – 1.42 (m, 2H, CH_2-2 butyl), 1.41 – 1.27 (m, 2H, CH_2-3 butyl), 0.93 (t, *J* = 7.3, 3H, CH_3-4 butyl). ^{13}C NMR (100 MHz, MeOD) δ 79.4 (C-4), 78.4 (C-3), 73.4, 73.3 (C-2, C-5), 63.2 (C-6), 57.0 (NCH_2-1 butyl), 31.6 (CH_2-2 butyl), 21.7 (CH_2-3 butyl), 14.5 (CH_3-4 butyl). IR ν_{max}(thin film)/ cm^{-1}: 3314, 2972, 2931, 1652, 1380, 1086, 1048, 881. $[\alpha]^{20}_D$: −33.3 (*c* 0.1, MeOH). HRMS: found 233.1499 $[M+H]^+$, calculated for $[C_{10}H_2O_4N_2+H]^+$ 233.1496.



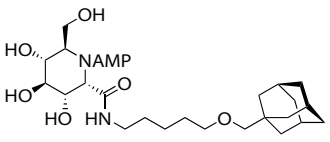
2,5-[5-(Adamantan-1yl-methoxy)-pentyl]imino-2,5-dideoxy-L-*ido*-hexonamide (D5-VI). Compound **D5-VI** (12 mg, 29 µmol) was synthesized in 97% yield over two steps from **D2-VI** (30 µmol) via a reductive amination with the appropriate aldehyde (general procedure E) and a subsequent benzyl-ether deprotection (appropriate method in general procedure F). R_F = 0.40 (14% MeOH in DCM+2% NH_4OH); R_F *N*-alkylated penultimate = 0.67 (1% MeOH in EtOAc+2% NH_4OH). ^{1}H NMR (400 MHz, MeOD) δ 4.09 (dd, *J* = 3.0, 6.0, 1H, H-3), 3.99 (dd, *J* = 2.8, 1H, H-4), 3.73 – 3.62 (m, 2H, CH_2-6), 3.52 (d, *J* = 6.0, 1H, H-2), 3.38 (t, *J* = 6.3, 2H, CH_2-5 pentyl), 2.96 (s, 2H, OCH_2-Ada), 2.84 – 2.79 (m, 1H, H-5), 2.76 – 2.57 (m, 2H, NCH_2-1 pentyl), 1.94 (s, 3H, 3×CH Ada), 1.72 (dd, *J* = 12.0, 31.6, 6H, 3×CH_2 Ada), 1.62 – 1.46 (m, 12H, 3×CH_2 Ada, 3×CH_2 pentyl), 1.43 – 1.34 (m, 2H, CH_2-3 pentyl). ^{13}C NMR (100 MHz, MeOD) δ 83.2 (OCH_2-Ada), 79.4 (C-4), 78.5 (C-3), 73.3 (C-2, C-5), 72.6 (CH_2-5 pentyl), 63.2 (C-6), 57.2 (NCH_2-1 pentyl), 41.0 (CH_2 Ada), 38.5 (CH_2 Ada), 35.3 (C_q Ada), 30.7 (CH_2 pentyl), 29.9 (CH Ada), 29.1 (CH_2 pentyl), 25.2 (CH_2-3 pentyl). IR ν_{max}(thin film)/ cm^{-1}: 3340, 2902, 2849, 1666, 1452, 1158, 1111, 1056. $[\alpha]^{20}_D$: −17.2 (*c* 0.2, MeOH). HRMS: found 411.2850 $[M+H]^+$, calculated for $[C_{22}H_{38}O_5N_2+H]^+$ 411.2853.



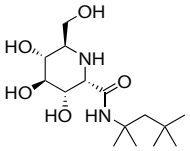
5-(Adamantan-1yl-methoxy)-pentyl 2,6-dideoxy-2,6-imino-D-*glycero*-D-*ido*-heptonamide (E3-I). Compound **E3-I** (23 mg, 52 µmol) was synthesized in 36% yield from **E1-I** (144 µmol) by deprotection of the benzyl-ethers (appropriate method in general procedure F). R_F = 0.14 (1:6.6; MeOH:DCM+2% NH_4OH). ^{1}H NMR (400 MHz, MeOD) δ 8.06 – 8.03 (m, 1H, (C(O)N)), 3.86 (dd, *J* = 3.1, 11.2, 1H, H-7a), 3.79 (d, *J* = 5.7, 1H, H-2), 3.72 (dd, *J* = 5.7, 9.5, 1H, H-3), 3.63 (dd, *J* = 6.4, 11.2, 1H, H-7b), 3.51 (dd, *J* = 8.7, 9.5, 1H, H-4), 3.39 (t, *J* = 6.4, 2H, CH_2-5 pentyl), 3.29 – 3.19 (m, 3H, H-5, NCH_2-1 pentyl), 2.97 (s, 2H, OCH_2-Ada), 2.92 (ddd, *J* = 3.1, 6.4, 9.6, 1H, H-6), 1.94 (s, 3H, 3×CH Ada), 1.72 (dd, *J* = 11.8, 31.8, 6H, 3×CH_2 Ada), 1.63 – 1.51 (m, 10H, 3×CH_2 Ada, 2×CH_2 pentyl), 1.46 – 1.36 (m, 2H, CH_2-3 pentyl). ^{13}C NMR (100 MHz, MeOD) δ 172.4 (C(O)-1), 83.2 (OCH_2-Ada), 76.2 (C-4), 73.0 (C-3), 72.6 (CH_2-5 pentyl), 72.6 (C-5), 62.3 (C-7), 59.3 (C-6), 58.3 (C-2), 41.0 (CH_2 Ada), 40.3 (NCH_2-1 pentyl), 38.5 (CH_2 Ada), 35.3 (C_q Ada), 30.4, 30.4 (2×CH_2 pentyl), 29.9 (CH Ada), 24.9 (CH_2-3 pentyl). IR ν_{max}(thin film)/ cm^{-1}: 3304, 2902, 2848, 1643, 1454, 1052. $[\alpha]^{20}_D$: 18.7 (*c* 0.5, MeOH). HRMS: found 441.2956 $[M+H]^+$; calculated for $[C_{23}H_{40}N_2O_6+H]^+$ 441.2959.



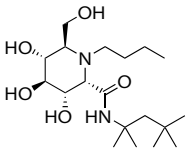
5-(Adamantan-1yl-methoxy)-pentyl 2,6-butylimino-2,6-dideoxy-D-*glycero*-D-*ido*-heptonamide (E4-I). Compound **E4-I** (66 mg, 133 µmol) was synthesized in 92% yield over two steps from **E2-I** (144 µmol) via a reductive amination with the appropriate aldehyde (general procedure E) and a subsequent benzyl-ether deprotection (appropriate method in general procedure F). R_F *N*-alkylated penultimate = 0.64 (1:2; EtOAc:toluene). ^{1}H NMR (400 MHz, MeOD) collapsed iminosugar signals δ 4.18 – 2.92 (m, 15H, H-2, H-3, H-4, H-5, H-6, CH_2-7, 2×NCH_2, OCH_2-Ada, CH_2-5 pentyl), 1.95 (s, 3H, 3×CH Ada), 1.82 – 1.51 (m, 18H, 6×CH_2 Ada, 3×CH_2 pentyl/butyl), 1.51 – 1.25 (m, 4H, 2×CH_2 pentyl/butyl), 1.06 – 0.93 (m, 3H, CH_3 butyl). ^{13}C NMR (100 MHz, MeOD) collapsed iminosugar signals δ 83.2 (OCH_2-Ada), 74.8, 74.8, 72.7 (CH_2-5 pentyl), 70.1, 70.0, 64.1, 41.0 (CH_2 Ada), 40.6 (NCH_2-1 pentyl), 38.5 (CH_2 Ada), 35.3 (C_q Ada), 29.9 (CH Ada), 30.4, 30.2, 24.9, 21.3 (CH_2 pentyl/butyl), 14.2 (CH_3 butyl). $[\alpha]^{20}_D$: 8.6 (*c* 0.7, MeOH). IR ν_{max}(thin film)/ cm^{-1}: 3344, 2901, 2848, 1668, 1652, 1456, 1360, 1093, 1027. HRMS: found 497.3581 $[M+H]^+$; calculated for $[C_{27}H_{48}N_2O_6+H]^+$ 497.3585.



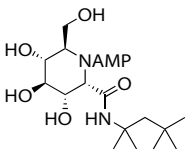
5-(Adamantan-1yl-methoxy)-pentyl 2,6-[5-(adamantan-1yl-methoxy)-pentyl]imino-2,6-dideoxy-D-*glycero*-D-*ido*-heptonamide (E5-I). Compound **E5-I** (59 mg, 87 µmol) was synthesized in 60% yield over two steps from **E2-I** (145 µmol) via a reductive amination with the appropriate aldehyde (general procedure E) and a subsequent benzyl-ether deprotection (appropriate method in general procedure F). R_F *N*-alkylated penultimate = 0.69 (1:2; EtOAc:toluene). ^{1}H NMR (400 MHz, MeOD) collapsed iminosugar signals δ 3.94 – 3.33 (m, 11H, H-2, H-3, H-4, H-5, H-6, CH_2-7, 2×CH_2-5 pentyl), 3.29 – 3.08 (m, 2H, C(O)NCH_2-1 penty), 2.98 – 2.91 (s, 5H, 2×OCH_2-Ada, NC*H*H-1 pentyl), 2.88 – 2.78 (m, 1H, NCH*H*-1 pentyl), 1.94 (s, 6H, 6×CH Ada), 1.81 – 1.47 (m, 20H, 6×CH_2 Ada, 4×CH_2 pentyl), 1.46 – 1.31 (m, 4H, 2× CH_2-3 pentyl). ^{13}C NMR (100 MHz, MeOD) collapsed iminosugar signals δ 83.2, 83.2 (2×OCH_2-Ada), 76.0 (C-4), 72.7, 72.6 (2×CH_2-5 pentyl), 71.4 (C-3), 71.1 (C-5), 64.5 (C-2), 63.9 (C-6), 59.1 (C-7), 50.9 (NCH_2-1 pentyl), 41.0 (2×CH_2 Ada), 40.3 (C(O)NCH_2-1 pentyl), 38.5 (2×CH_2 Ada), 35.3 (2×C_q Ada), 30.7, 30.5, 30.4 (CH_2), 29.9 (2×CH Ada), 28.3 (CH_2), 25.1, 24.9 (2×CH_2-3 pentyl). IR ν_{max}(thin film)/ cm^{-1}: 3367, 2901, 2848, 1638, 1455, 1109. $[\alpha]^{20}_D$: 12.8 (*c* 0.5, MeOH). HRMS: found 675.4942 $[M+H]^+$; calculated for $[C_{39}H_{66}N_2O_7+H]^+$ 675.4943.



1,1,3,3-Tetramethylbutyl 2,6-dideoxy-2,6-imino-D-*glycero*-D-*ido*-heptonamide (E3-II). Compound **E3-II** (20 mg, 63 µmol) was synthesized in 67% yield from **E2-II** (94 µmol) by deprotection of the benzyl-ethers (appropriate method in general procedure F). R_F = 0.21 (1:6.6; MeOH:DCM+2% NH_4OH). ^{1}H NMR (400 MHz, MeOD) δ 3.88 (dd, *J* = 3.2, 11.3, 1H, H-7a), 3.79 (dd, *J* = 5.7, 9.4, 1H, H-3), 3.75 (d, *J* = 5.7, 1H, H-2), 3.67 (dd, *J* = 6.4, 11.3, 1H, H-7b), 3.47 (dd, *J* = 8.7, 9.4, 1H, H-4), 3.27 (d, *J* = 8.7, 1H, H-5), 2.94 – 2.86 (m, 1H, H-6), 1.86 (d, *J* = 14.9, 1H, C*H*H-2 tMB), 1.70 (d, *J* = 14.9, 1H, CH*H*-2 tMB), 1.43 (d, *J* = 11.8, 6H, 2×CH_3 tMB), 1.03 (s, 9H, CH_3-4, 2×CH_3 tMB). ^{13}C NMR (100 MHz, MeOD) δ 169.9 (C(O)-1), 76.1 (C-4), 72.3 (C-3), 72.0 (C-5), 61.7 (C-7), 59.4 (C-6), 58.5 (C-1), 56.6 (NHC_q-1 tMB), 53.0 (CH_2-2 tMB), 32.6 (C_q-3 tMB), 32.1 (CH_3-4, 2×CH_3 tMB), 29.6, 29.5 (2×CH_3 tMB). IR ν_{max}(thin film)/ cm^{-1}: 3304, 2955, 2362, 1726, 1651, 1559, 1419, 1366, 1272, 1227, 1119, 1073, 1040. $[\alpha]^{20}_D$: 47.7 (*c* 0.3, MeOH). HRMS: found 319.2229 $[M+H]^+$; calculated for $[C_{15}H_{30}N_2O_5+H]^+$ 319.2222.

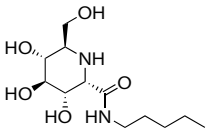


1,1,3,3-Tetramethylbutyl 2,6-butylimino-2,6-dideoxy-D-*glycero*-D-*ido*-heptonamide (E4-II). Compound **E4-II** (30 mg, 80 µmol) was synthesized in 82% yield over two steps from **E2-II** (97 µmol) via a reductive amination with the appropriate aldehyde (general procedure E) and a subsequent benzyl-ether deprotection (appropriate method in general procedure F). R_F *N*-alkylated penultimate = 0.70 (1:3; EtOAc:toluene). ^{1}H NMR (400 MHz, MeOD) collapsed iminosugar signals δ 4.01 – 3.39 (m, 7H, H-2, H-3, H-4, H-5, H-6, CH_2-7), 3.06 – 3.02 (s, 2H, NCH_2 butyl), 1.84 – 1.73 (m, 2H, CH_2-2 tMB), 1.71 – 1.24 (m, 8H, 2×CH_3 tMB, 2×CH_2 butyl), 1.03 (s, 9H, CH_3-4, 2×CH_3 tMB), 0.98 (t, *J* = 7.4, 3H, CH_3 butyl). ^{13}C NMR (101 MHz, MeOD) collapsed iminosugar signals δ 70.4, 64.8, 63.2, 56.9 (NHC_q-1 tMB), 54.0, 53.7, 52.9 (CH_2-2 tMB), 33.7 (CH_2 butyl), 32.5 (C_q-3 tMB), 32.1 (CH_3-4, 2×CH_3 tMB), 29.4, 29.3 (2×CH_3 tMB), 21.4 (CH_2 butyl), 14.3 (CH_3 butyl). IR ν_{max}(thin film)/ cm^{-1}: 3327, 2959, 1668, 1652, 1458, 1366, 1227, 1051. $[\alpha]^{20}_D$: 22.2 (*c* 0.4, MeOH). HRMS: found 375.2854 $[M+H]^+$; calculated for $[C_{19}H_{38}N_2O_5+H]^+$ 375.2853.

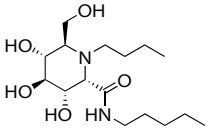


1,1,3,3-Tetramethylbutyl 2,6-[5-(adamantan-1yl-methoxy)-pentyl]imino-2,6-dideoxy-D-*glycero*-D-*ido*-heptonamide (E5-II). Compound **E5-II** (33 mg, 60 µmol) was synthesized in 54% yield over two steps from **E2-II** (111 µmol) via a reductive amination with the appropriate aldehyde (general procedure E) and a subsequent benzyl-ether deprotection (appropriate method in general procedure F). R_F *N*-alkylated penultimate = 0.74 (1:3; EtOAc:toluene). ^{1}H NMR (400 MHz, MeOD) δ 3.89 (dd, *J* = 3.5, 11.8, 1H, H-7a), 3.78 (dd, *J* = 6.4, 11.8,

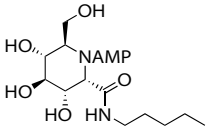
1H, H-7b), 3.68 (dd, *J* = 6.0, 9.6, 1H, H-3), 3.62 (d, *J* = 5.9, 1H, H-2), 3.58 – 3.51 (m, 1H, H-4), 3.39 (t, *J* = 6.3, 2H, CH_2-5 pentyl), 3.37 – 3.32 (m, 1H, H-5), 3.06 – 2.98 (m, 1H, H-6), 2.97 (s, 2H, OCH_2-Ada), 2.91 – 2.81 (m, 1H, NC*H*H-1 pentyl), 2.76 – 2.65 (m, 1H, NCH*H*-1 pentyl), 1.95 (s, 3H, 3×CH Ada), 1.85 (d, *J* = 14.8, 1H, C*H*H-2 tMB), 1.80 – 1.64 (m, 7H, 3×CH_2 Ada, CH*H*-2 tMB), 1.64 – 1.51 (m, 10H, 3×CH_2 Ada, 2×CH_2 pentyl), 1.47 – 1.34 (m, 8H, CH_2-3 pentyl, 2×CH_3 tMB), 1.03 (s, 9H, CH_3-4, 2×CH_3 tMB). ^{13}C NMR (101 MHz, MeOD) δ 83.3 (OCH_2-Ada), 77.7 (C-4), 72.7 (CH_2-5 pentyl), 71.6, 71.4 (C-3, C-5), 63.6 (C-6), 63.1 (C-2), 60.0 (C-7), 56.3 (NHC_q-1 tMB), 53.0 (CH_2-2 tMB), 48.9 (NCH_2-1 pentyl), 41.0 (CH_2 Ada), 38.5 (CH_2 Ada), 35.3 (C_q Ada), 33.6 (C_q-3 tMB), 32.6 (CH_2 pentyl), 32.2 (CH_3-4, 2×CH_3 tMB), 30.8 (CH_2 pentyl), 29.9 (CH Ada), 29.5, 29.2 (2×CH_3 tMB), 25.2 (CH_2-3 pentyl). IR ν_{max}(thin film)/ cm^{-1}: 3377, 2902, 2849, 1651, 1424, 1366, 1227, 1157, 1098. $[\alpha]^{20}_D$: 24.8 (*c* 0.4, MeOH). HRMS: found 553.4208 $[M+H]^+$; calculated for $[C_{31}H_{56}N_2O_6+H]^+$ 553.4211.



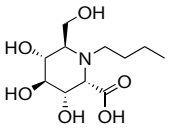
Pentyl 2,6-dideoxy-2,6-imino-D-*glycero*-D-*ido*-heptonamide (E3-III). Compound **E3-III** (20 mg, 72 μmol) was synthesized in 77% yield from **E2-III** (93 μmol) by deprotection of the benzyl-ethers (appropriate method in general procedure F). R_F = 0.13 (1:6.6; MeOH:DCM+2% NH_4OH). ^{1}H NMR (400 MHz, MeOD) δ 3.90 (d, *J* = 5.7, 1H, H-2), 3.87 (dd, *J* = 3.2, 11.4, 1H, H-7a), 3.78 (dd, *J* = 5.7, 9.4, 1H, H-3), 3.74 – 3.70 (dd, *J* = 6.1, 11.4, 1H, H-7b), 3.52 (dd, *J* = 8.5, 9.4, 1H, H-4), 3.35 – 3.30 (m, 1H, H-5), 3.30 – 3.17 (m, 2H, NCH_2-1 pentyl), 3.09 (ddd, *J* = 3.2, 6.1, 9.6, 1H, H-6), 1.59 – 1.50 (m, 2H, CH_2-2 pentyl), 1.40 – 1.27 (m, 4H, 2×CH_2 pentyl), 0.92 (t, *J* = 7.0, 3H, CH_3-5 pentyl). ^{13}C NMR (100 MHz, MeOD) δ 169.4 (C(O)-1), 74.3 (C-4), 70.6 (C-3), 70.2 (C-5), 59.9 (C-7), 57.9 (C-6), 56.5 (C-2), 38.9 (NCH_2-1 pentyl), 28.8, 28.7, 22.0 (3×CH_2 pentyl), 12.9 (CH_3-5 pentyl). IR ν_{max}(thin film)/ cm^{-1}: 3289, 2957, 2929, 1729, 1651, 1558, 1454, 1274, 1074, 1037. $[\alpha]^{20}_D$: 35.9 (*c* 0.4, MeOH). HRMS: found 277.1759 $[M+H]^+$; calculated for $[C_{12}H_{24}N_2O_5+H]^+$ 277.1758.



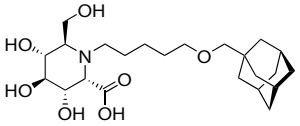
Pentyl 2,6-butylimino-2,6-dideoxy-D-*glycero*-D-*ido*-heptonamide (E4-III). Compound **E4-III** (23 mg, 69 μmol) was synthesized in 71% yield over two steps from **E2-III** (97 μmol) via a reductive amination with the appropriate aldehyde (general procedure E) and a subsequent benzyl-ether deprotection (appropriate method in general procedure F). R_F *N*-alkylated penultimate = 0.64 (1:2; EtOAc:toluene). ^{1}H NMR (400 MHz, MeOD) collapsed iminosugar signals δ 4.18 – 3.44 (m, 7H, H-2, H-3, H-4, H-5, H-6, CH_2-7), 3.30 – 2.87 (m, 4H, 2×NCH_2 pentyl/butyl), 1.84 – 1.28 (m, 10H, 5×CH_2 pentyl/butyl), 0.98 (t, *J* = 7.4, 3H, CH_3 butyl), 0.92 (t, *J* = 6.2, 3H, CH_3-5 pentyl). ^{13}C NMR (100 MHz, MeOD) collapsed iminosugar signals δ 73.3, 68.6, 63.7, 62.6, 39.1, 39.0, 28.8, 28.5, 22.0, 19.8, 12.9 (CH_3-5 pentyl), 12.7 (CH_3 butyl). IR ν_{max}(thin film)/ cm^{-1}: 3323, 2960, 1652, 1460, 1030. $[\alpha]^{20}_D$: 13.0 (*c* 0.2, MeOH). HRMS: found 333.2385 $[M+H]^+$; calculated for $[C_{16}H_{32}N_2O_5+H]^+$ 333.2384.



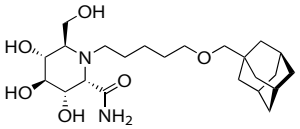
Pentyl 2,6-[5-(adamantan-1yl-methoxy)-pentyl]imino-2,6-dideoxy-D-*glycero*-D-*ido*-heptonamide (E5-III). Compound **E5-III** (40 mg, 78 μmol) was synthesized in 71% yield over two steps from **E2-III** (110 μmol) via a reductive amination with the appropriate aldehyde (general procedure E) and a subsequent benzyl-ether deprotection (appropriate method in general procedure F). R_F *N*-alkylated penultimate = 0.69 (1:2; EtOAc:toluene). ^{1}H NMR (400 MHz, MeOD) collapsed iminosugar signals δ 4.31 – 2.99 (m, 13H, H-2, H-3, H-4, H-5, H-6, CH_2-7, CH_2-5 pentyl, 2×NCH_2), 2.97 (s, 2H, OCH_2 Ada), 1.94 (s, 3H, 3×CH Ada), 1.87 – 1.28 (m, 18H, 3×CH_2 Ada, 6×CH_2 pentyl), 0.97 – 0.85 (m, 3H, CH_3-5 pentyl). ^{13}C NMR (100 MHz, MeOD) collapsed iminosugar signals δ 83.2 (OCH_2 Ada), 74.7, 72.2 (CH_2-5 pentyl), 69.9, 65.5, 64.0, 41.0 (CH_2 Ada), 40.6 (C(O)NCH_2-1 pentyl), 38.5 (CH_2 Ada), 35.3 (C_q Ada), 29.9 (CH Ada), 30.4, 30.4, 30.1, 26.6, 24.8, 23.6 (6×CH_2 pentyl), 14.5 (CH_3-5 pentyl). IR ν_{max}(thin film)/ cm^{-1}: 3328, 2903, 2849, 1668, 1652, 1455, 1093, 1028. $[\alpha]^{20}_D$: 6.8 (*c* 0.8, MeOH). HRMS: found 511.3738 $[M+H]^+$; calculated for $[C_{28}H_{50}N_2O_6+H]^+$ 511.3742.



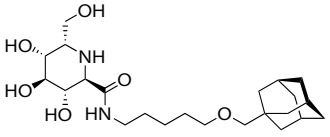
2,6-Butylimino-2,6-dideoxy-D-*glycero*-D-*ido*-heptonic acid (E4-V). Compound **E4-V** (19 mg, 72 µmol) was synthesized in 69% yield over two steps from **E2-V** (104 µmol) via a reductive amination with the appropriate aldehyde (general procedure E) and a subsequent benzyl-ether deprotection (appropriate method in general procedure F). R_F = 0.04 (1:3; MeOH:DCM). ^{1}H NMR (400 MHz, MeOD) δ 4.10 (d, *J* = 5.5, 1H, H-2), 4.00 (d, *J* = 4.0, 2H, CH_2-7), 3.90 – 3.80 (m, 2H, H-3, H-6), 3.66 (dd, *J* = 8.4, 1H, H-4), 3.59 (dd, *J* = 8.0, 10.0, 1H, H-5), 3.53 – 3.32 (m, 2H, NCH_2 butyl), 1.81 – 1.65 (m, 2H, CH_2-2 butyl), 1.54 – 1.37 (m, 4H, 2×CH_2 butyl), 0.99 (t, *J* = 7.3, 3H, CH_3 butyl). ^{13}C NMR (100 MHz, MeOD) δ 75.8 (C-4), 70.0 (C-3), 69.5 (C-5), 65.1 (C-6), 63.4 (C-2), 56.8 (C-7), 51.7 (NCH_2 butyl), 28.5, 21.1 (2×CH_2 butyl), 14.1 (CH_3 butyl). IR ν_{max}(thin film)/ cm^{-1}: 3265, 2962, 1622, 1380, 1100, 1025. $[\alpha]^{20}_D$: 9.3 (*c* 0.2, MeOH). HRMS: found 264.1444 $[M+H]^+$; calculated for $[C_{11}H_{21}NO_6+H]^+$ 264.1442.



2,6-[5-(Adamantan-1yl-methoxy)-pentyl]imino-2,6-dideoxy-2,6-imino-D-*glycero*-D-*ido*-heptonic acid (E5-V). Compound **E5-V** (6 mg, 14 µmol) was synthesized in 30% yield over two steps from **E5-V** (45 µmol) via a reductive amination with the appropriate aldehyde (general procedure E) and a subsequent benzyl-ether deprotection (appropriate method in general procedure F). R_F = 0.10 (1:3; MeOH:DCM). ^{1}H NMR (400 MHz, MeOD) collapsed iminosugar signals δ 4.12 – 3.32 (m, 11H, H-2, H-3, H-4, H-5, H-6, CH_2-7, CH_2-5 pentyl, NCH_2), 2.97 (s, 2H, OCH_2-Ada), 1.95 (s, 3H), 1.82 – 1.36 (m, 18H, 6×CH_2 Ada, 3×CH_2 pentyl). ^{13}C NMR (100 MHz, MeOD) collapsed iminosugar signals δ 83.3 (OCH_2-Ada), 72.3 (CH_2-5 pentyl), 70.1, 69.6, 41.0 (CH_2 Ada), 38.5 (CH_2 Ada), 35.3 (C_q Ada), 30.3, 29.9 (CH Ada), 24.7 (CH_2-3 pentyl). IR ν_{max}(thin film)/ cm^{-1}: 3311, 2902, 2848, 1651, 1456, 1398, 1053. $[\alpha]^{20}_D$: 2.3 (*c* 0.1, MeOH). HRMS: found 442.2801 $[M+H]^+$; calculated for $[C_{23}H_{39}NO_7+H]^+$ 442.2799.

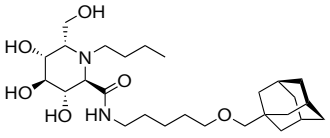


2,6-[5-(Adamantan-1yl-methoxy)-pentyl]imino-2,6-dideoxy-2,6-imino-D-*glycero*-D-*ido*-heptonamide (E5-VI). Compound **E5-VI** (12 mg, 27 µmol) was synthesized in 39% yield over two steps from **E2-VI** (70 µmol) via a reductive amination with the appropriate aldehyde (general procedure E) and a subsequent benzyl-ether deprotection (appropriate method in general procedure F). R_F = 0.31 (1:6.5; MeOH:DCM+2% NH_4OH). ^{1}H NMR (400 MHz, MeOD) δ 3.88 (dd, *J* = 3.4, 11.8, 1H, H-7a), 3.79 (dd, *J* = 5.2, 11.8, 1H, H-7b), 3.73 (d, *J* = 5.7, 1H, H-2), 3.71 – 3.60 (m, 2H, H-3, H-4), 3.39 (t, *J* = 6.4, 2H, CH_2-5 pentyl), 3.35 – 3.31 (m, 1H, H-5), 3.15 – 3.08 (m, 1H, H-6), 2.97 (s, 2H, OCH_2-Ada), 2.79 – 2.74 (m, 2H, NCH_2-1 pentyl), 1.95 (s, 3H, 3×CH Ada), 1.72 (dd, *J* = 11.6, 31.4, 6H, 3×CH_2 Ada), 1.64 – 1.52 (m, 10H, 3×CH_2 Ada, 2×CH_2 pentyl), 1.44 – 1.33 (m, 2H, CH_2-3 pentyl). ^{13}C NMR (100 MHz, MeOD) δ 178.1 (C(O)-1), 83.2 (OCH_2-Ada), 76.8 (C-4), 72.7 (CH_2-5 pentyl), 72.2 (C-5), 71.6 (C-3), 63.8 (C-2), 63.1 (C-6), 60.6 (C-7), 49.9 (NCH_2-1 pentyl), 41.0 (CH_2 Ada), 38.5 (CH_2 Ada), 35.3 (C_q Ada), 30.7 (CH_2 pentyl), 29.9 (CH Ada), 29.4 (CH_2 pentyl), 25.2 (CH_2-3 pentyl). IR ν_{max}(thin film)/ cm^{-1}: 3326, 2902, 2848, 1650, 1451, 1158, 1096. $[\alpha]^{20}_D$: 17.5 (*c* 0.2, MeOH).HRMS: found 441.2956 $[M+H]^+$; calculated for $[C_{23}H_{40}N_2O_6+H]^+$ 441.2959.

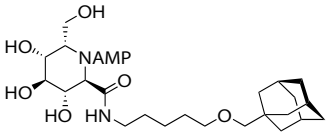


5-(Adamantan-1yl-methoxy)-pentyl 2,6-dideoxy-2,6-imino-L-*glycero*-D-*gulo*-heptonamide (F3-I). Compound **F3-I** (7 mg, 16 µmol) was synthesized in 41% yield from **F2-I** (39 µmol) by deprotection of the benzyl-ethers (appropriate method in general procedure F). ^{1}H NMR (400 MHz, MeOD) collapsed iminosugar signals δ 4.01 – 3.35 (m, 9H, H-2, H-3, H-4, H-5, H-6, CH_2-7, CH_2-5 pentyl), 3.28 – 3.22 (m, 2H, NCH_2-1 pentyl), 2.96 (s, 2H, OCH_2-Ada), 1.95 (s, 3H, 3×CH Ada), 1.72 (d, *J* = 21.1, 6H, 3×CH_2 Ada, 1.63 – 1.49 (m, 10H, 3×CH_2 Ada, 2×CH_2 pentyl), 1.49 – 1.35 (m, 2H, CH_2-5

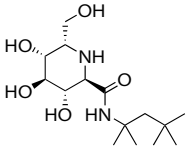
pentyl). ^{13}C NMR (100 MHz, MeOD) δ 171.8 (C(O)-1), 83.2 (OCH_2-Ada), 74.3, 73.3, 71.9 (C-3, C-4, C-5), 72.6 (CH_2-3 pentyl), 59.2 (C-7), 59.1, 57.7 (C-2, C-6), 41.0 (CH_2 Ada), 40.7 (NCH_2-1 pentyl), 38.5 (CH_2 Ada), 35.3 (C_q Ada), 30.5, 30.3 (2×CH_2 pentyl), 29.9 (CH Ada), 24.8 (CH_2-3 pentyl). $[\alpha]^{20}_D$: −3.0 (*c* 1.0, MeOH). IR ν_{max}(thin film)/ cm^{-1}: 3312, 2901, 2848, 1652, 1455, 1099. HRMS: found 441.2957 $[M+H]^+$; calculated for $[C_{23}H_{40}N_2O_6+H]^+$ 441.2959.



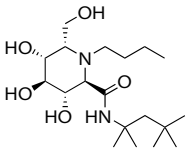
5-(Adamantan-1yl-methoxy)-pentyl 2,6-butylimino-2,6-dideoxy-L-*glycero*-D-*gulo*-heptonamide (F4-I). Compound **F4-I** (17 mg, 34 μmol) was synthesized in 83% yield over two steps from **F2-I** (41 μmol) via a reductive amination with the appropriate aldehyde (general procedure E) and a subsequent benzyl-ether deprotection (appropriate method in general procedure F). R_F = 0.36 (1:4; MeOH:DCM+2% NH_4OH); R_F *N*-alkylated penultimate = 0.62 (1:2; EtOAc:toluene). ^{1}H NMR (400 MHz, MeOD) collapsed iminosugar signals δ 4.16 – 3.47 (m, 6H, H-2, H-3, H-4, H-5, CH_2-7), 3.39 (t, *J* = 6.4, 3H, H-6, CH_2-5 pentyl), 3.30 – 3.17 (m, 2H, NCH_2-1 pentyl), 3.10 – 2.86 (m, 3H, OCH_2-Ada, NC*H*H butyl), 2.81 – 2.57 (m, 1H, NCH*H* butyl), 1.95 (s, 3H, 3×CH Ada), 1.80 – 1.26 (m, 22H, 6×CH_2 Ada, 3×CH_2 pentyl, 2×CH_2 butyl), 0.94 (t, *J* = 7.3, 3H, CH_3 butyl). ^{13}C NMR (100 MHz, MeOD) δ 83.3 (OCH_2-Ada), 75.3, 73.1 (C-3, C-4, C-5), 72.6 (CH_2-5 pentyl), 68.1, 62.9 (C-2, C-5), 56.2 (C-7), 52.2 (NCH_2 butyl), 41.0 (CH_2 Ada), 40.7 (NCH_2-1 pentyl), 38.5 (CH_2 Ada), 35.3 (C_q Ada), 30.5, 30.2 (CH_2 pentyl/butyl), 29.9 (CH Ada), 24.9 (CH_2-3 pentyl), 21.4 (CH_2 butyl), 14.3 (CH_3 butyl). IR ν_{max}(thin film)/ cm^{-1}: 3316, 2903, 2849, 1652, 1458, 1074. $[\alpha]^{20}_D$: −1.0 (*c* 0.2, MeOH). HRMS: found 497.3581 $[M+H]^+$; calculated for $[C_{27}H_{48}N_2O_6+H]^+$ 497.3585.



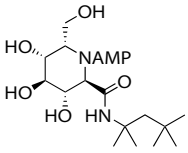
5-(Adamantan-1yl-methoxy)-pentyl 2,6-[5-(adamantan-1yl-methoxy)-pentyl]imino-2,6-dideoxy-L-*glycero*-D-*gulo*-heptonamide (F5-I). Compound **F5-I** (22 mg, 33 μmol) was synthesized in 79% yield over two steps from **F2-I** (42 μmol) via a reductive amination with the appropriate aldehyde (general procedure E) and a subsequent benzyl-ether deprotection (appropriate method in general procedure F). R_F *N*-alkylated penultimate = 0.66 (1:2; EtOAc:toluene). ^{1}H NMR (400 MHz, MeOD) δ 3.96 – 3.82 (m, 2H, CH_2-7), 3.77 – 3.69 (m, 1H, H-5), 3.67 – 3.53 (m, 1H, H-3), 3.53 – 3.43 (m, 1H, H-4), 3.43 – 3.34 (m, 5H, 2×CH_2-5 pentyl, H-2), 3.33 – 3.12 (m, 3H, H-5, C(O)NCH_2-1 pentyl), 3.00 – 2.95 (m, 3H, 2×OCH_2-Ada), 2.86 – 2.73 (m, 1H, NC*H*H pentyl), 2.61 – 2.49 (m, 1H, NCH*H* pentyl), 1.95 (s, 6H, 6×CH Ada), 1.82 – 1.26 (m, 24H, 6×CH_2 Ada, 6×CH_2 pentyl). ^{13}C NMR (100 MHz, MeOD) δ 83.3, 83.2 (2×OCH_2-Ada), 75.9 (C-4), 73.6 (C-3), 72.7, 72.6 (2×CH_2-5 pentyl), 71.8(C-5), 68.0 (C-2), 62.5 (C-6), 56.9 (C-7), 51.7 (NCH_2-1 pentyl), 41.0 (CH_2 Ada), 40.6 (C(O)NCH_2-1 pentyl), 38.5 (CH_2 Ada), 35.3 (C_q Ada), 30.7, 30.6, 30.3 (CH_2 pentyl), 29.9 (CH Ada), 25.1, 25.0 (2×CH_2-3 pentyl). IR ν_{max}(thin film)/ cm^{-1}: 3366, 2901, 2848, 1652, 1455, 130, 1157, 1110. $[\alpha]^{20}_D$: −2.3 (*c* 0.4, MeOH). HRMS: found 675.4941 $[M+H]^+$; calculated for $[C_{39}H_{66}N_2O_7+H]^+$ 675.4943.



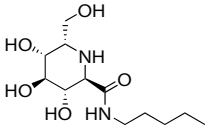
1,1,3,3-Tetramethylbutyl 2,6-dideoxy-2,6-imino-L-*glycero*-D-*gulo*-heptonamide (F3-II). Compound **F3-II** (17 mg, 53 μmol) was synthesized in 88% yield from **F2-II** (60 μmol) by deprotection of the benzyl-ethers (appropriate method in general procedure F). R_F = 0.30 (1:4; MeOH:DCM+2% NH_4OH). ^{1}H NMR (400 MHz, MeOD) δ 3.95 – 3.55 (m, 7H, H-2, H-3, H-4, H-5, H-6, CH_2-7), 1.88 (s, 1H, C*H*-2 tMB), 1.72 (s, 1H, CH*H*-2 tMB), 1.41 (s, 6H, 2×CH_3 tMB), 1.02 (s, 9H, 2×CH_3, CH_3-4 tMB). ^{13}C NMR (100 MHz, MeOD) δ 166.5 (C(O)-1), 72.2, 70.9, 69.0 (C-3, C-4, C-5), 57.3 (C-2), 57.0 (C-7), 56.0 (C-6), 55.3 (NHC_q-1 tMB), 51.2 (CH_2-2 tMB), 31.0 (C_q-3 tMB), 30.5 (2×CH_3, CH_3-4 tMB), 28.0, 27.7 (2×CH_3 tMB). IR ν_{max}(thin film)/ cm^{-1}: 3319,2953, 2438, 1667, 1444, 1366, 1226, 1062. $[\alpha]^{20}_D$: −13.6 (*c* 0.8, MeOH). HRMS: found 319.2229 $[M+H]^+$; calculated for $[C_{15}H_{30}N_2O_5+H]^+$ 319.2222.



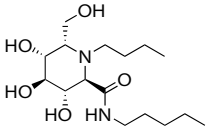
1,1,3,3-Tetramethylbutyl 2,6-butylimino-2,6-dideoxy-L-*glycero*-D-*gulo*-heptonamide (F4-II). Compound **F4-II** (11 mg, 29 µmol) was synthesized in 59% yield over two steps from **F2-II** (49 µmol) via a reductive amination with the appropriate aldehyde (general procedure E) and a subsequent benzyl-ether deprotection (appropriate method in general procedure F). R_F = 0.47 (1:4; MeOH:DCM+2% NH_4OH); R_F *N*-alkylated penultimate = 0.74 (1:3; EtOAc:toluene). ^{1}H NMR (400 MHz, MeOD) δ 3.87 (dd, *J* = 4.1, 11.8, 1H, H-7a), 3.79 (dd, *J* = 6.8, 11.7, 1H, H-7b), 3.70 (dd, *J* = 5.6, 9.7, 1H, H-5), 3.59 (dd, *J* = 9.2, 1H, H-3), 3.40 (dd, *J* = 9.1, 1H, H-4), 3.23 – 3.17 (m, 1H, H-6), 3.16 (d, *J* = 9.5, 1H, H-2), 2.71 (ddd, *J* = 5.5, 9.6, 12.6, 1H, NC*H*H-1 pentyl), 2.54 (ddd, *J* = 5.6, 9.7, 12.6, 1H, NCH*H*-1 pentyl), 1.92 (d, *J* = 14.8, 1H, C*H*H-2 tMB), 1.68 (d, *J* = 14.8, 1H, CH*H*-2 tMB), 1.61 – 1.38 (m, 8H, 2×CH_3 tMB, CH_2 butyl), 1.36 – 1.24 (m, 2H, CH_2 butyl), 1.03 (s, 9H, 2×CH_3, CH_3-4 tMB), 0.92 (t, *J* = 7.3, 3H). ^{13}C NMR (100 MHz, MeOD) δ 173.1 (C(O)-1), 76.1 (C-4), 73.6 (C-3), 71.8 (C-5), 67.8 (C-2), 62.2 (C-6), 57.4 (C-7), 56.5 (NHC_q-1 tMB), 52.9 (CH_2-2 tMB), 51.1 (NCH_2 butyl), 32.6 (C_q-3 tMB), 32.2 (2×CH_3, CH_3-4 tMB), 32.0 (CH_2 butyl), 29.6, 29.2 (2×CH_3 tMB), 21.6 (CH_2 butyl), 14.6 (CH_3 butyl). IR ν_{max}(thin film)/ cm^{-1}: 3374, 2957, 2497, 1728, 1652, 1434, 1366, 1276, 1228, 1122, 1072. $[\alpha]^{20}_D$: −7.8 (*c* 0.2, MeOH). HRMS: found 375.2854 $[M+H]^+$; calculated for $[C_{19}H_{38}N_2O_5+H]^+$ 375.2853.



1,1,3,3-Tetramethylbutyl 2,6-[5-(adamantan-1yl-methoxy)-pentyl]imino- 2,6-dideoxy-L-*glycero*-D-*gulo*-heptonamide (F5-II). Compound **F5-II** (20 mg, 36 µmol) was synthesized in 69% yield over two steps from **F2-II** (52 µmol) via a reductive amination with the appropriate aldehyde (general procedure E) and a subsequent benzyl-ether deprotection (appropriate method in general procedure F). R_F *N*-alkylated penultimate = 0.77 (1:3; EtOAc:toluene). ^{1}H NMR (400 MHz, MeOD) δ 3.98 – 3.80 (m, 2H, CH_2-7), 3.80 – 3.65 (m, 1H, H-4), 3.65 – 3.50 (m, 1H, H-3), 3.50 – 3.21 (m, 5H, CH_2-5 pentyl, H-2, H-4, H-6), 3.03 – 2.91 (m, 2H, OCH_2-Ada), 2.89 – 2.74 (m, 1H, NC*H*H-1 pentyl), 2.73 – 2.53 (m, 1H, NCH*H*-1 pentyl), 2.03 – 1.17 (m, 27H, 3×CH Ada, CH_2-2 tMB, 6×CH_2 Ada, 3×CH_2 pentyl, 2×CH_3 tMB), 1.03 (s, 9H, 2×CH_3, CH_3-4 tMB). ^{13}C NMR (100 MHz, MeOD) δ 81.6 (OCH_2-Ada), 74.3 (C-4), 71.9 (C-3), 71.0 (CH_2-5 pentyl), 70.0 (C-5), 66.5 (C-2), 60.8 (C-6), 55.5 (NHC_q-1 tMB), 55.1 (C-7), 51.4 (CH_2-2 tMB), 50.1 (NCH_2-1 pentyl), 39.5 (CH_2 Ada), 36.9 (CH_2 Ada), 33.7 (C_q Ada), 31.0, 30.7, 29.2, 28.4 (CH Ada), 28.0, 27.7 (2×CH_3 tMB), 23.6 (CH_2-3 pentyl). IR ν_{max}(thin film)/ cm^{-1}: 3342, 2902, 2849, 1652, 1449, 1366, 1227, 1157, 1111. $[\alpha]^{20}_D$: −3.1 (*c* 0.4, MeOH). HRMS: found 553.4208 $[M+H]^+$; calculated for $[C_{31}H_{56}N_2O_6+H]^+$ 553.4211.

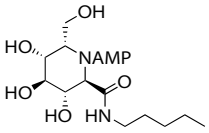


Pentyl 2,6-dideoxy-2,6-imino-L-*glycero*-D-*gulo*-heptonamide (F3-III). Compound **F3-III** (13 mg, 46 µmol) was synthesized in 92% yield from **F2-III** (50 µmol) by deprotection of the benzyl-ethers (appropriate method in general procedure F). R_F = 0.85 (1:4; MeOH:DCM+2% NH_4OH). ^{1}H NMR (400 MHz, MeOD) δ 3.89 (dd, *J* = 4.5, 11.7, 1H, H-7a), 3.86 – 3.75 (m, 3H, H-2, H-5, H-7b), 3.73 (t, *J* = 7.3, 1H, CH), 3.67 (t, *J* = 7.3, 1H, CH), 3.57 (dt, *J* = 4.7, 9.0, 1H, H-6), 3.24 (dt, *J* = 2.7, 7.0, 2H, NCH_2-1 pentyl), 1.61 – 1.47 (m, 2H, CH_2-2 pentyl), 1.46 – 1.23 (m, 4H, 2×CH_2 pentyl), 0.92 (t, *J* = 6.8, 3H, CH_3-5 pentyl). ^{13}C NMR (100 MHz, MeOD) δ 170.0 (C(O)-1), 73.7, 72.7, 70.9 (C-3, C-4, C-5), 58.9 (C-2), 58.8 (C-7), 57.7 (C-6), 40.9 (NCH_2-1 pentyl), 30.3, 30.1, 23.6 (3×CH_2 pentyl), 14.5 (CH_3 pentyl). IR ν_{max}(thin film)/ cm^{-1}: 3312, 2931, 1652, 1460, 1062. $[\alpha]^{20}_D$: −7.5 (*c* 0.8, MeOH). HRMS: found 277.1759 $[M+H]^+$; calculated for $[C_{12}H_{24}N_2O_5+H]^+$ 277.1758.

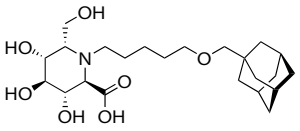


Pentyl 2,6-butylimino-2,6-dideoxy-L-*glycero*-D-*gulo*-heptonamide (F4-III). Compound **F4-III** (10 mg, 30 µmol) was synthesized in 64% yield over two steps from **F2-III** (47 µmol) via a reductive amination with the appropriate aldehyde (general procedure E) and a subsequent benzyl-ether deprotection (appropriate method in general procedure F). R_F = 0.37 (1:4; MeOH:DCM+2% NH_4OH); R_F *N*-alkylated

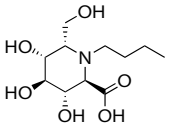
penultimate = 0.59 (1:2; EtOAc:toluene). ^{1}H NMR (400 MHz, MeOD) δ 3.88 (dd, *J* = 4.2, 11.8, 1H, H-7a), 3.82 (dd, *J* = 6.4, 11.8, 1H, H-7b), 3.76 – 3.69 (m, 1H, H-5), 3.63 – 3.57 (m, 1H, H-3), 3.41 (dd, *J* = 8.9, 9.9, 1H, H-4), 3.29 – 3.14 (m, 4H, H-2, H-6, NCH_2-1 pentyl), 2.70 (ddd, *J* = 5.4, 9.6, 12.5, 1H, NC*H*H butyl), 2.47 (ddd, *J* = 5.7, 9.7, 12.5, 1H, NCH*H* butyl), 1.62 – 1.23 (m, 10H, 3×CH_2 pentyl, 2×CH_2 butyl), 0.96 – 0.88 (m, 6H, 2×CH_3 pentyl/butyl). ^{13}C NMR (100 MHz, MeOD) δ 174.2 (C(O)-1), 76.1 (C-4), 73.8 (C-3), 72.1 (C-5), 67.9 (C-2), 62.3 (C-6), 57.1 (C-7), 51.1 (NCH_2 butyl), 40.6 (NCH_2-1 pentyl), 31.6, 30.5, 30.2, 23.6, 21.6 (3×CH_2 pentyl, 2×CH_2 butyl), 14.5, 14.5 (2×CH_3 butyl/pentyl). IR ν_{max}(thin film)/ cm^{-1}: 3329, 2958, 2931, 2871, 1730, 1637, 1462, 1378, 1278, 1122, 1073. $[\alpha]^{20}_D$: −7.8 (*c* 0.2, MeOH). HRMS: found 333.2385 $[M+H]^+$; calculated for $[C_{16}H_{32}N_2O_5+H]^+$ 333.2384.



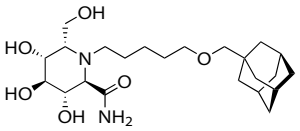
Pentyl 2,6-[5-(adamantan-1yl-methoxy)-pentyl]imino-2,6-dideoxy-L-*glycero*-D-*gulo*-heptonamide (F5-III). Compound **F5-III** (13 mg, 25 μmol) was synthesized in 51% yield over two steps from **F2-III** (49 μmol) via a reductive amination with the appropriate aldehyde (general procedure E) and a subsequent benzyl-ether deprotection (appropriate method in general procedure F). R_F *N*-alkylated penultimate = 0.62 (1:2; EtOAc:toluene). ^{1}H NMR (400 MHz, MeOD) δ 3.89 (dd, *J* = 2.8, 11.6, 1H, H-7a), 3.84 (dd, *J* = 6.1, 11.7, 1H, H-7b), 3.72 (dd, *J* = 5.6, 9.8, 1H, H-5), 3.60 (dd, *J* = 9.2, 1H, H-3), 3.46 – 3.39 (m, 1H, H-4), 3.36 (t, *J* = 6.4, 2H, CH_2-5 pentyl), 3.30 – 3.09 (m, 4H, H-2, H-6, C(O)NCH_2-1 pentyl), 2.96 (s, 2H, OCH_2-Ada), 2.83 – 2.68 (m, 1H, NC*H*H pentyl), 2.56 – 2.43 (m, 1H, NCH*H* pentyl), 1.94 (s, 3H, 3×CH Ada), 1.72 (dd, *J* = 12.2, 33.0, 6H, 3×CH_2 Ada), 1.64 – 1.26 (m, 18H, 3×CH_2 Ada, 6×CH_2 pentyl), 0.92 (t, *J* = 6.2, 3H, CH_3-5 pentyl). ^{13}C NMR (100 MHz, MeOD) δ 81.7 (OCH_2-Ada), 74.5 (C-4), 72.2 (C-3), 71.1 (CH_2-5 pentyl), 70.4 (C-5), 66.4 (C-2), 60.9 (C-6), 55.5 (C-7), 49.9 (NCH_2-1 pentyl), 39.5 (CH_2 Ada), 39.1 (C(O)NCH_2-1 pentyl), 36.9 (CH_2 Ada), 33.8 (C_q Ada), 28.4 (CH Ada), 29.2, 28.9, 28.7, 27.5, 23.5, 22.1 (6×CH_2 pentyl), 13.0 (CH_3 pentyl). IR ν_{max}(thin film)/ cm^{-1}: 3342, 2903, 2849, 1651, 1458, 1157, 1051. $[\alpha]^{20}_D$: −1.1 (*c* 0.2, MeOH). HRMS: found 511.3738 $[M+H]^+$; calculated for $[C_{28}H_{50}N_2O_6+H]^+$ 511.3742.



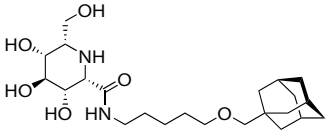
2,6-Butylimino-2,6-dideoxy-L-*glycero*-D-*gulo*-heptonic acid (F4-V). Compound **F4-V** (8 mg, 30 μmol) was synthesized in 88% yield over two steps from **F2-V** (34 μmol) via a reductive amination with the appropriate aldehyde (general procedure E) and a subsequent benzyl-ether deprotection (appropriate method in general procedure F). R_F = 0.04 (1:3; MeOH:DCM). ^{1}H NMR (400 MHz, MeOD) δ 4.19 – 3.70 (m, 7H, H-2, H-3, H-4, H-5, H-6, CH_2-7), 3.48 – 3.38 (m, 2H, NCH_2 butyl), 1.74 (s, 2H, CH_2 butyl), 1.49 – 1.39 (m, 2H, CH_2 butyl), 0.98 (t, *J* = 7.3, 3H, CH_3 butyl). ^{13}C NMR (100 MHz, MeOD) δ 72.4, 71.8, 69.8, 68.6 (C-2, C-3, C-4, C-5), 61.7 (C-6), 57.3 (C-7), 52.7 (NCH_2 butyl), 28.8 (CH_2 butyl), 20.9 (CH_2 butyl), 14.1. IR ν_{max}(thin film)/ cm^{-1}: 3224, 2927, 1622, 1404, 1067. $[\alpha]^{20}_D$: −0.6 (*c* 0.4, MeOH). HRMS: found 264.1444 $[M+H]^+$; calculated for $[C_{11}H_{21}NO_6+H]^+$ 264.1442.



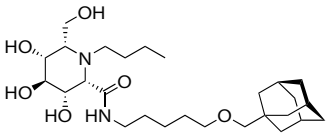
2,6-Butylimino-2,6-dideoxy-L-*glycero*-D-*gulo*-heptonamide (F4-VI). Compound **F4-VI** (5 mg, 19 μmol) was synthesized in 95% yield over two steps from **F2-VI** (20 μmol) via a reductive amination with the appropriate aldehyde (general procedure E) and a subsequent benzyl-ether deprotection (appropriate method in general procedure F). R_F = 0.21 (1:3; MeOH:DCM). ^{1}H NMR (400 MHz, MeOD) δ 3.95 – 3.80 (m, 2H, CH_2-7), 3.73 (dd, *J* = 5.5, 9.8, 1H, H-5), 3.60 (dd, *J* = 9.3, 1H, H-3), 3.45 (dd, *J* = 9.4, 1H, H-4), 3.37 – 3.20 (m, 2H, H-2, H-6), 2.82 – 2.71 (m, 1H, NC*H*H butyl), 2.62 – 2.46 (m, 1H, NCH*H* butyl), 1.70 – 1.22 (m, 4H, 2×CH_2 butyl), 1.01 – 0.87 (m, 3H, CH_3 butyl). ^{13}C NMR (100 MHz, MeOD) δ 76.0, 73.7, 71.9, 67.5, 62.3 (C-2, C-3, C-4, C-5, C-6), 57.1 (C-7), 51.2 (NCH_2 butyl), 38.3 (CH_2 butyl), 21.5 (CH_2 butyl), 14.5 (CH_3 butyl). IR ν_{max}(thin film)/ cm^{-1}: 3262, 2960, 1641, 1460, 1072. $[\alpha]^{20}_D$: 0.5 (*c* 0.1, MeOH). HRMS: found 263.1603 $[M+H]^+$; calculated for $[C_{11}H_{22}N_2O_5+H]^+$ 263.1601.



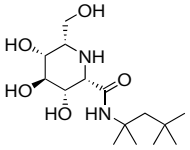
2,6-[5-(Adamantan-1yl-methoxy)-pentyl]imino-2,6-dideoxy-L-*glycero*-D-*gulo*-heptonamide (F5-VI). Compound **F5-VI** (7 mg, 16 µmol) was synthesized in 80% yield over two steps from **F2-VI** (20 µmol) via a reductive amination with the appropriate aldehyde (general procedure E) and a subsequent benzyl-ether deprotection (appropriate method in general procedure F). R_F = 0.43 (1:3; MeOH:DCM). ^{1}H NMR (400 MHz, MeOD) δ 3.89 (dd, *J* = 4.1, 11.9, 1H, H-7a), 3.83 (dd, *J* = 6.3, 11.6, 1H, H-7b), 3.73 (dd, *J* = 5.7, 9.6, 1H, H-5), 3.59 (dd, *J* = 9.2, 1H, H-3), 3.49 – 3.28 (m, 4H, H-2, H-4, CH_2-5 pentyl), 3.23 (dd, *J* = 5.5, 10.4, 1H, H-6), 2.98 – 2.95 (m, 2H, OCH_2-Ada), 2.81 – 2.71 (m, 1H, NC*H*H-1 pentyl), 2.60 – 2.50 (m, 1H, NCH*H*-1 pentyl), 1.94 (s, 3H, 3×CH Ada), 1.72 (dd, *J* = 11.8, 33.6, 6H, 3×CH_2 Ada), 1.65 – 1.46 (m, 10H, 3×CH_2 Ada, 2×CH_2 pentyl), 1.40 – 1.28 (m, 2H, CH_2-3 pentyl). ^{13}C NMR (100 MHz, MeOD) δ 83.2 (OCH_2-Ada), 76.1 (C-4), 73.8 (C-3), 72.8 (CH_2-5 pentyl), 72.0 (C-5), 67.6 (C-2), 62.3 (C-6), 57.2 (C-7), 51.3 (NCH_2-1 pentyl), 41.0 (CH_2 Ada), 38.5(CH_2 Ada), 36.0 (C_q Ada), 30.7 (CH_2 pentyl), 29.9 (CH Ada), 29.2 (CH_2 pentyl), 25.0 (CH_2-3 pentyl). IR ν_{max}(thin film)/ cm^{-1}: 3327, 2903, 2849, 1641, 1452, 1158, 1112. $[\alpha]^{20}_D$: 4.6 (*c* 0.1, MeOH). HRMS: found 441.2957 $[M+H]^+$; calculated for $[C_{23}H_{40}N_2O_6+H]^+$ 441.2959.



5-(Adamantan-1yl-methoxy)-pentyl 2,6-dideoxy-2,6-imino-L-*glycero*-D-*ido*-heptonamide (G3-I). Compound **G3-I** (14 mg, 32 µmol) was synthesized in 71% yield from **G2-I** (45 µmol) by deprotection of the benzyl-ethers (appropriate method in general procedure F). ^{1}H NMR (400 MHz, MeOD) δ 4.10 (s, 1H, H-3), 3.97 (dd, *J* = 3.1, 1H, H-4), 3.90 (s, 1H, H-2), 3.86 – 3.73 (m, 3H, H-5, CH_2-7), 3.39 (t, *J* = 6.4, 2, CH_2-5 pentyl), 3.34 – 3.23 (m, 3H, H-6, NCH_2-1 pentyl), 2.97 (s, 2H, OCH_2-Ada), 1.95 (s, 3H, 3×CH Ada), 1.72 (dd, *J* = 11.7, 32.5, 6H, 3×CH_2 Ada), 1.63 – 1.52 (m, 10H, 3×CH_2 Ada, 2×CH_2 pentyl), 1.47 – 1.37 (m, 2H, CH_2-3 pentyl). ^{13}C NMR (100 MHz, MeOD) δ 171.3 (C(O)-1), 83.2 (OCH_2-Ada), 72.6 (CH_2-5 pentyl), 71.3 (C-3), 69.7, 69.7 (C-4, C-5), 62.2 (C-7), 59.9 (C-2), 57.6 (C-6), 41.0 (CH_2 Ada), 40.6 (NCH_2-1 pentyl), 38.5 (CH_2 Ada), 35.3 (C_q Ada), 30.5, 30.3 (2×CH_2 pentyl), 29.9 (CH Ada), 24.8 (CH_2-3 pentyl). IR ν_{max}(thin film)/ cm^{-1}: 3304, 2902, 2848, 1652, 1453, 1056. $[\alpha]^{20}_D$: −11.3 (*c* 0.3, MeOH). HRMS: found 441.2957 $[M+H]^+$; calculated for $[C_{23}H_{40}N_2O_6+H]^+$ 441.2959.

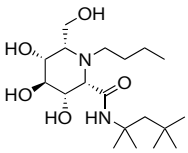


5-(Adamantan-1yl-methoxy)-pentyl 2,6-butylimino-2,6-dideoxy-L-*glycero*-D-*ido*-heptonamide (G4-I). Compound **G4-I** (6 mg, 12 µmol) was synthesized in 41% yield from **G2-I** (29 µmol) via a reductive amination with the appropriate aldehyde (general procedure G). ^{1}H NMR (400 MHz, MeOD) collapsed iminosugar signals δ 3.99 – 3.60 (m, 6H, H-3, H-4, H-5, H-6, CH_2-7), 3.53 (d, *J* = 3.4, 1H, H-2), 3.39 (t, *J* = 6.4, 2H, CH_2-5 pentyl), 3.34 – 3.15 (m, 4H, H-5, NCH_2-1 pentyl), 2.97 (s, 2H, OCH_2-Ada), 2.84 – 2.64 (m, 2H, NCH_2 butyl), 1.95 (s, 3H, 3×CH Ada), 1.72 (dd, *J* = 12.0, 31.0, 6H, 3×CH_2 Ada), 1.62 – 1.23 (m, 16H, 3×CH_2 Ada, 3×CH_2 pentyl, 2×CH_2 butyl), 0.94 (t, *J* = 7.3, 3H, CH_3 butyl). ^{13}C NMR (100 MHz, MeOD) δ 81.7 (OCH_2-Ada), 71.8, 71.7, 70.0 (C-3, C-4, C-5), 71.1 (CH_2-5 pentyl), 63.8 (C-2), 60.3 (C-7), 59.5 (C-6), 52.7 (NCH_2 butyl), 39.5 (CH_2 Ada), 38.8 (NCH_2-1 pentyl), 36.9 (CH_2 Ada), 35.3 (C_q Ada), 28.4 (CH Ada), 29.0, 28.7, 23.5, 20.1 (3×CH_2 pentyl, 2×CH_2 butyl), 12.9 (CH_3 butyl).IR ν_{max}(thin film)/ cm^{-1}: 3315, 2904, 2850, 1651, 1590, 1456, 1065. $[\alpha]^{20}_D$: −6.7 (*c* 0.1, MeOH). HRMS: found 497.3580 $[M+H]^+$; calculated for $[C_{27}H_{48}N_2O_6+H]^+$ 497.3585.

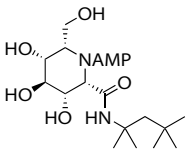


1,1,3,3-Tetramethylbutyl 2,6-dideoxy-2,6-imino-L-*glycero*-D-*ido*-heptonamide (G3-II). Compound **G3-II** (12 mg, 37 µmol) was synthesized in 81% yield from **G2-II** (46 µmol) by deprotection of the benzyl-ethers (appropriate method in general procedure F). R_F = 0.41 (1:4; MeOH:DCM+2% NH_4OH). ^{1}H NMR (400 MHz, MeOD) δ 4.13 (s, 1H, CH), 3.97 (s, 1H, CH), 3.87 (s, 1H, CH), 3.82 (s, 3H, CH_2-7, CH), 3.33 (s, 1H, H-6), 1.81 (s, 2H, CH_2-2 tMB), 1.42 (s, 6H, 2×CH_3 tMB), 1.02 (d, *J* = 4.6, 9H, 2×CH_3, CH_3-4 tMB). ^{13}C NMR (100 MHz, MeOD) δ 71.1, 69.6, 69.5 (C-3,

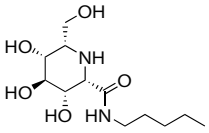
C-4, C-5), 61.8 (C-7), 60.1 (C-2), 57.7 (C-5), 56.7 (NHC_q-1 tMB), 52.4 (CH_2-2 tMB), 32.6 (C_q-3 tMB), 32.0 (2×CH_3, CH_3-4 tMB), 29.8, 29.5 (2×CH_3 tMB). IR ν_{max}(thin film)/ cm^{-1}: 3311, 2955, 2409, 1667, 1752, 1453, 1391, 1366, 1225, 1056. $[\alpha]^{20}_D$: −4.5 (*c* 0.6, MeOH). HRMS: found 319.2229 $[M+H]^+$; calculated for $[C_{15}H_{30}N_2O_5+H]^+$ 319.2222.



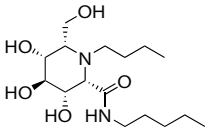
1,1,3,3-Tetramethylbutyl 2,6-butylimino-2,6-dideoxy-L-*glycero*-D-*ido*-heptonamide (G4-II). Compound **G4-II** (7 mg, 19 µmol) was synthesized in 49% yield from **G2-II** (39 µmol) via a reductive amination with the appropriate aldehyde (general procedure G). ^{1}H NMR (400 MHz, MeOD) δ 3.88 – 3.78 (m, 2H, H-7a, CH), 3.77 – 3.70 (m, 2H, 2×CH), 3.66 (dd, *J* = 6.6, 11.3, 1H, H-7b), 3.40 (d, *J* = 3.3, 1H, H-2), 2.97 (dd, *J* = 5.9, 9.8, 1H, H-6), 2.88 – 2.65 (m, 2H, NCH_2-1 butyl), 1.86 (d, *J* = 14.8, 1H, C*H*H-2 tMB), 1.72 (d, *J* = 14.8, 1H, CH*H*-2 tMB), 1.59 – 1.46 (m, 2H, CH_2 butyl), 1.42 (d, *J* = 1.7, 6H, 2×CH_3 tMB), 1.37 – 1.26 (m, 2H, CH_2 butyl), 1.03 (s, 9H, 2×CH_3, CH_3-4 tMB), 0.94 (t, *J* = 7.4, 3H, CH_3 butyl). ^{13}C NMR (100 MHz, MeOD) δ 73.2, 73.1, 71.8 (C-3, C-4, C-5), 65.0 (C-2), 61.9 (C-6), 61.4 (C-7), 56.4 (NHC_q-1 tMB), 54.9 (NCH_2 butyl), 53.0 (CH_2-2 tMB), 32.6 (C_q-3 tMB), 32.1 (2×CH_3, CH_3-4 tMB), 29.3 (CH_2 butyl), 29.1, 29.1 (CH_2-2 tMB), 21.6 (CH_2 butyl), 14.5 (CH_3 butyl). IR ν_{max}(thin film)/ cm^{-1}: 3339, 2955, 1638, 1434, 1366, 1227, 1048. $[\alpha]^{20}_D$: −1.4 (*c* 0.1, MeOH). HRMS: found 375.2856 $[M+H]^+$; calculated for $[C_{19}H_{38}N_2O_5+H]^+$ 375.2853.



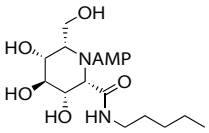
1,1,3,3-Tetramethylbutyl 2,6-[5-(adamantan-1yl-methoxy)-pentyl]imino-2,6-dideoxy-L-*glycero*-D-*ido*-heptonamide (G5-II). Compound **G5-II** (5 mg, 9 µmol) was synthesized in 21% yield from **G2-II** (43 µmol) via a reductive amination with the appropriate aldehyde (general procedure G). ^{1}H NMR (400 MHz, MeOD) δ 3.85 (dd, *J* = 5.7, 11.4, 1H, H-7a), 3.82 – 3.79 (m, 1H, H-5), 3.77 – 3.71 (m, 2H, H-3, H-4), 3.68 (dd, *J* = 6.4, 11.4, 1H, H-7b), 3.42 (d, *J* = 3.3, 1H, H-2), 3.39 (t, *J* = 6.4, 2H, CH_2-5 pentyl), 3.02 – 2.95 (m, 3H, H-6, OCH_2-Ada), 2.90 – 2.64 (m, 2H, NCH_2-1 pentyl), 1.95 (s, 3H, 3×CH Ada), 1.87 (d, *J* = 14.8, 1H, C*H*H-2 tMB), 1.81 – 1.64 (m, 7H, 3×CH_2 Ada, CH*H*-2 tMB), 1.63 – 1.50 (m, 10H, 3×CH_2 Ada, 2×CH_2 pentyl), 1.42 (d, *J* = 1.9, 6H, 2×CH_3 tMB), 1.39 – 1.25 (m, 2H, CH_2-3 pentyl), 1.03 (s, 9H, 2×CH_3, CH_3-4 tMB). ^{13}C NMR (100 MHz, MeOD) δ 81.7 (OCH_2-Ada), 71.1 (CH_2-5 pentyl), 71.5, 71.5, 70.1 (C-3, C-4, C-5), 63.5 (C-2), 60.3 (C-6), 60.0 (C-7), 54.9 (NHC_q-1 tMB), 53.5 (NCH_2-1 pentyl), 51.4 (CH_2-2 tMB), 39.5 (CH_2 Ada), 36.9 (CH_2 Ada), 33.8 (CH Ada), 31.0 (C_q-3 tMB), 30.6 (2×CH_3, CH_3-4 tMB), 29.2 (CH_2 pentyl), 28.4 (CH Ada), 27.8, 27.6 (2×CH_3 tMB), 25.1 (CH_2 pentyl), 23.6 (CH_2 pentyl). IR ν_{max}(thin film)/ cm^{-1}: 3367, 2903, 2849, 1638, 1451, 1227, 1056. $[\alpha]^{20}_D$: −2.0 (*c* 0.1, MeOH). HRMS: found 553.4207 $[M+H]^+$; calculated for $[C_{31}H_{56}N_2O_6+H]^+$ 553.4211.



Pentyl 2,6-dideoxy-2,6-imino-L-*glycero*-D-*ido*-heptonamide (G3-III). Compound **G3-III** (13 mg, 46 µmol) was synthesized in 79% yield from **G2-III** (58 µmol) by deprotection of the benzyl-ethers (appropriate method in general procedure F). R_F = 0.29 (1:4; MeOH:DCM+2% NH_4OH). ^{1}H NMR (400 MHz, MeOD) δ 4.13 – 4.10 (m, 1H, H-3), 3.98 (dd, *J* = 3.4, 1H, H-4), 3.92 (d, *J* = 2.1, 1H, H-2), 3.86 – 3.80 (m, 1H, H-7a), 3.80 – 3.75 (m, 2H, H-7b, H-5), 3.36 – 3.32 (m, 1H, H-6), 3.24 (dt, *J* = 0.9, 7.0, 2H, $NHCH_2$-1 pentyl), 1.60 – 1.50 (m, 2H, CH_2-2 pentyl), 1.39 – 1.29 (m, 4H, 2×CH_2 pentyl), 0.92 (t, *J* = 7.0, 3H, CH_3-5 pentyl). ^{13}C NMR (100 MHz, MeOD) δ 169.1 (C(O)-1), 69.8 (C-3), 68.1, 67.9 (C-4, C-5), 60.4 (C-7), 58.3 (C-2), 56.2 (C-6), 39.1 (NCH_2-1 pentyl), 28.8, 28.7, 22.0 (3×CH_2 pentyl), 12.9 (CH_3 pentyl). IR ν_{max}(thin film)/ cm^{-1}: 3259, 2929, 1652, 1460, 1058. $[\alpha]^{20}_D$: −9.8 (*c* 0.8, MeOH). HRMS: found 277.1758 $[M+H]^+$; calculated for $[C_{12}H_{24}N_2O_5+H]^+$ 277.1758.



Pentyl 2,6-butylimino-2,6-dideoxy-L-*glycero*-D-*ido*-heptonamide (G4-III). Compound **G4-III** (5 mg, 15 µmol) was synthesized in 33% yield from **G2-III** (45 µmol) via a reductive amination with the appropriate aldehyde (general procedure G). ^{1}H NMR (400 MHz, MeOD) δ 3.98 (dd, *J* = 3.9, 8.0, 1H, H-7a), 3.91 – 3.52 (m, 5H, H-2, H-3, H-4, H-5, H-7b), 3.29 – 3.10 (m, 2H, NCH_2-1 pentyl), 3.10 – 2.94 (m, 1H, H-6), 2.94 – 2.64 (m, 2H, NCH_2 butyl), 1.76 – 1.25 (m, 10H, 3×CH_2 pentyl, 2×CH_2 butyl), 0.97 – 0.88 (m, 6H, 2×CH_3 pentyl/butyl). ^{13}C NMR (100 MHz, MeOD) δ 71.7, 71.6, 71.1 (C-3, C-4, C-5), 63.7 (C-2), 60.2 (C-7), 59.8 (C-6), 52.6 (NCH_2 butyl), 38.8 (NCH_2-1 pentyl), 36.4 (CH_2 butyl), 28.9, 28.7 (2×CH_2 pentyl), 22.0 (CH_2 pentyl), 20.0 (CH_2 butyl), 12.9, 12.7 (2×CH_3 pentyl/butyl). IR ν_{max}(thin film)/ cm^{-1}: 3344, 2959, 2931, 2872, 1638, 1461, 1061. $[\alpha]^{20}_D$: −2.0 (*c* 0.1, MeOH). HRMS: found 333.2385 $[M+H]^+$; calculated for $[C_{16}H_{32}N_2O_5+H]^+$ 333.2384.



Pentyl 2,6-[5-(adamantan-1yl-methoxy)-pentyl]imino-2,6-dideoxy-L-*glycero*-D-*ido*-heptonamide (G5-III). Compound **G5-III** (6 mg, 12 µmol) was synthesized in 24% yield from **G2-III** (50 µmol) via a reductive amination with the appropriate aldehyde (general procedure G). ^{1}H NMR (400 MHz, MeOD) δ 3.90 – 3.81 (m, 2H, H-5, H-7a), 3.80 – 3.68 (m, 3H, H-3, H-4, H-7b), 3.53 (d, *J* = 3.5, 1H, H-2), 3.38 (t, *J* = 6.4, 2H, CH_2-5 pentyl), 3.30 – 3.12 (m, 2H, C(O)NCH_2-1 pentyl), 3.00 – 2.93 (m, 3H, H-6, OCH_2-Ada), 2.85 – 2.63 (m, 2H, NCH_2-1 pentyl), 1.95 (s, 3H, 3×CH Ada), 1.72 (dd, *J* = 11.8, 31.6, 6H, 3×CH_2 Ada), 1.65 – 1.49 (m, 10H, 3×CH_2 Ada, 2×CH_2 pentyl/butyl), 1.42 – 1.26 (m, 6H, 3×CH_2 pentyl/butyl), 0.93 (t, *J* = 7.0, 3H, CH_3-5 pentyl). ^{13}C NMR (100 MHz, MeOD) δ 83.2 (OCH_2-Ada), 72.7 (CH_2-5 pentyl), 73.3, 73.3, 71.5 (C-3, C-4, C-5), 65.4 (C-2), 61.9 (C-7), 61.1 (C-6), 54.5 (NCH_2-1 pentyl), 41.0 (CH_2 Ada), 40.4 (C(O)NCH_2-1 pentyl), 38.5 (CH_2 Ada), 35.3 (C_q Ada), 29.9 (CH Ada), 30.7, 30.5, 30.2, 25.9, 25.2, 23.6 (6×CH_2 pentyl), 14.5 (CH_3 pentyl). IR ν_{max}(thin film)/ cm^{-1}: 3327, 2903, 2850, 1649, 1638, 1455, 1362, 1157, 1096, 1057. $[\alpha]^{20}_D$: −1.7 (*c* 0.1, MeOH). HRMS: found 511.3737 $[M+H]^+$; calculated for $[C_{28}H_{50}N_2O_6+H]^+$ 511.3742.

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