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Application of L-Erythrose-Derived Nitrones in the Synthesis of Polyhydroxylated Compounds via 3,6-Dihydro-2*H*-1,2-oxazine Derivatives

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Enantiopure 3,6-dihydro-2*H*-1,2-oxazines were prepared by [3+3] cyclisations starting from lithiated methoxyallene and the L-erythrose-derived nitrones **1′** and **3**. The role of the side-chain protective group, which steers the highly selective formation of either *anti*- or *syn*-configured products, was demonstrated. A hydroboration/oxidation protocol smoothly converted 1,2-oxazine derivative *syn*-**5** into secondary alcohol **6**. After deprotection, polyhydroxylated tetrahydro-2*H*-1,2-oxazine **11**, which can be regarded as an azasugar, was isolated. Analogous treatment of 1,2-oxazine *anti*-**5** with the borane not only provided the expected secondary alcohol **7**, but it also induced reduction of the C=C bond and ring opening. Treatment of *syn*-**5** and *anti*-**2** with hydrochloric acid in methanol induced deprotections and cyclisations leading to bicyclic tetrahydro-2*H*-1,2-oxazine derivatives. The second ring can be either a furan or a pyran ring. In the *syn* series, furan derivative **12** was formed exclusively, and its hydrogenolysis led to enantiopure aminofuran derivative **14**. Acid-promoted rearrangement of unprotected *anti*-**2** led to a mixture of bicyclic compounds with furan or pyran rings fused to the 1,2-oxazine core. However, when TBDPS-protected compound **20** was used it cleanly led to 1,2-oxazine **21** with a fused furan ring and then to aminofuran **22**. Alternatively, the N–O bond in unprotected *anti*-**2** was chemoselectively reduced with samarium diiodide, efficiently generating highly functionalized allylic alcohol **23**. Acid-promoted cyclisation and deprotection furnished furan derivative **24**. Mechanistic suggestions to explain the different outcomes of the acid-induced transformations are provided. Overall, it is demonstrated that the stereodivergent addition of lithiated alkoxyallenes to L-erythrose-derived nitrones allow flexible access to a series of enantiopure amino polyols, including aminofuran derivatives.

Introduction

The remarkably high synthetic potential of 3,6-dihydro-2*H*-1,2-oxazine derivatives for the preparation of various polyfunctionalized compounds has been presented in a series of recent papers.[1] Syntheses of, for instance, enantiopure amino-substituted carbohydrates and sugar mimetics,[2] polycyclic compounds[3] and nitrogen heterocycles[4] such as pyrrolidines and azetidines have been described. These extremely versatile building blocks are easily accessible through formal [3+3] cyclisations between lithiated alkoxyallenes and carbohydrate-derived nitrones as shown in Scheme 1.[5] Depending on the reaction conditions, preferential formation either of *syn*-configured products (in the absence of additives) or of *anti*-configured compounds (in the presence of suitable Lewis acids) is observed.

In this report we turned our attention to L-erythrose-derived *N*-benzylhydroxylamine **1** (Scheme 2) as a promising candidate for the preparation of 1,2-oxazines with new substitution patterns. A series of *N*-glycosylhydroxylamines of this type, which are known to exist in equilibrium with the corresponding open-chain nitrones, have been used successfully as reaction partners with nucleophilic reagents such as organyllithium or Grignard reagents.[6] As expected, treatment of **1**/**1′** with lithiated methoxyallene proceeded smoothly and led to the corresponding *anti*-configured 1,2-oxazine with a free hydroxy group, whereas in the case of an *O*-silylated nitrone derived from **1′** a perfect switch of stereoselectivity to a *syn*-configured product was observed. Further transformations of these new 1,2-oxazine derivatives exploiting the enol ether functionality – namely, hydroboration and acid-induced cyclisations to afford highly substituted polyhydroxylated compounds – are also presented.

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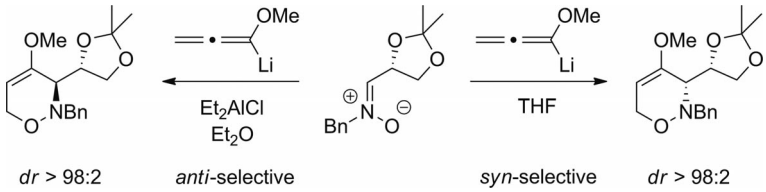
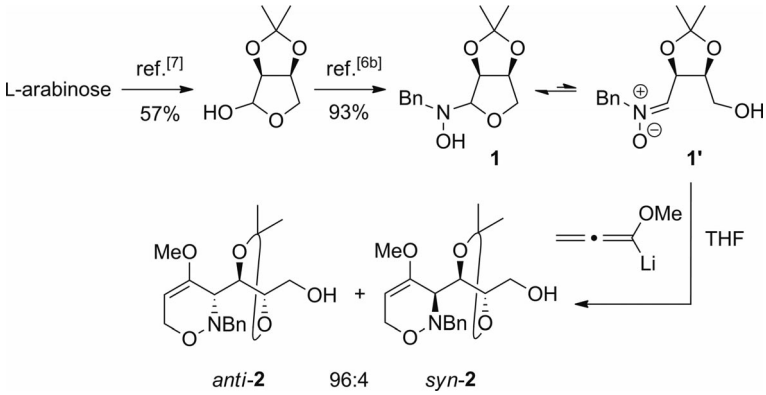


Scheme 1. Stereodivergent reactions between lithiated methoxyallene and a D-glyceraldehyde-derived nitrone leading to 3,6-dihydro-2*H*-1,2-oxazines.



Scheme 2. Synthesis of *N*-benzylglycosylhydroxylamine **1** and reaction of its tautomer **1′** with lithiated methoxyallene to form 1,2-oxazines **2**.

Results and Discussion

As shown in Scheme 2, the starting masked nitrone **1** was readily available through heating of an excess of *N*-benzylhydroxylamine with 2,3-*O*-isopropylidene-L-erythrose under solvent-free conditions.[6b] The latter starting material was prepared in a one-pot fashion from L-arabinose as described.[7] The first experiment with compound **1** was conducted in accordance with the general protocol with use of lithiated methoxyallene (3.0 equiv.) at –78 °C and delivered the expected 1,2-oxazine derivative **2** in 33% yield after 2 h, accompanied by unconsumed hydroxylamine **1**. Increasing the amount of lithiated methoxyallene to 6.0 equiv. did not improve the yield significantly (Table 1, Entries 1 and 2). The reaction time was then extended to 6.5 h at the same temperature, and the desired product **2** was isolated in 52% yield (Entry 3). However, starting material could still be detected in the crude mixture. These results clearly suggest that addition of lithiated methoxyallene is limited by slow formation of nitrone **1′**, and so the reaction was repeated at slightly elevated temperature (–41 °C). After 8 h, the desired product **2** was isolated in high yield (Entry 4). In all cases, excellent *anti* stereoselectivity (*anti*/*syn* ≈ 96:4) was observed. In all reactions the first equivalent of lithiated methoxyallene is consumed by deprotonation of the hydroxy group of **1**, and hence nitrone **1′** is also formed and reacts as the lithium alkoxide.

Table 1. Optimisation of reactions between **1**/**1′** and lithiated methoxyallene.

Entry	Methoxyallene [equiv.]	*T* [°C]	Time [h]	Yield [%] **1**	**2**
1	3.0	–78	2.0	55	33
2	6.0	–78	2.0	55	37
3	6.0	–78	6.5	43	52
4	6.0	–41	8.0	–	91

The role of the lithium alkoxide moiety in the formation of the *anti*-configured 1,2-oxazine **2** is illustrated in Figure 1. We assume that the lithium cation intramolecularly coordinates to the nitrone oxygen atom to form an eight-membered ring (model **A**). Subsequent attack of the nucleophile at the less hindered back side and subsequent cyclisation then yields *anti*-**2**.[6c] In contrast, an *O*-protected derivative of **1′** should lead to a *syn*-configured product as depicted (model **B**). This alternative approach is governed by the Felkin–Anh model, as observed for the reaction of related glyceraldehyde-derived nitrones.[5] To test this hypothesis, TBS-protected nitrone **3** was prepared and also treated with lithiated methoxyallene (Scheme 3).

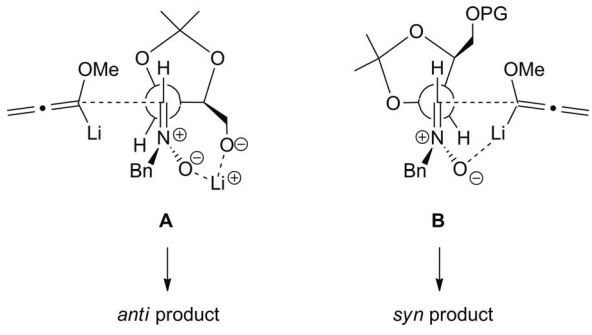
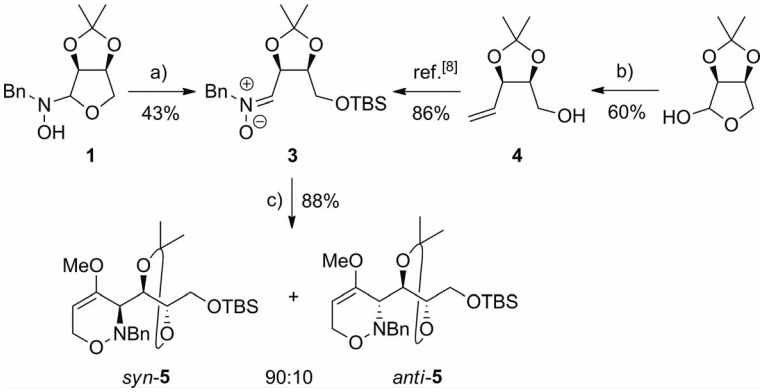


Figure 1. Pathways **A** and **B** explaining the formation of *anti*- or *syn*-configured 1,2-oxazines.

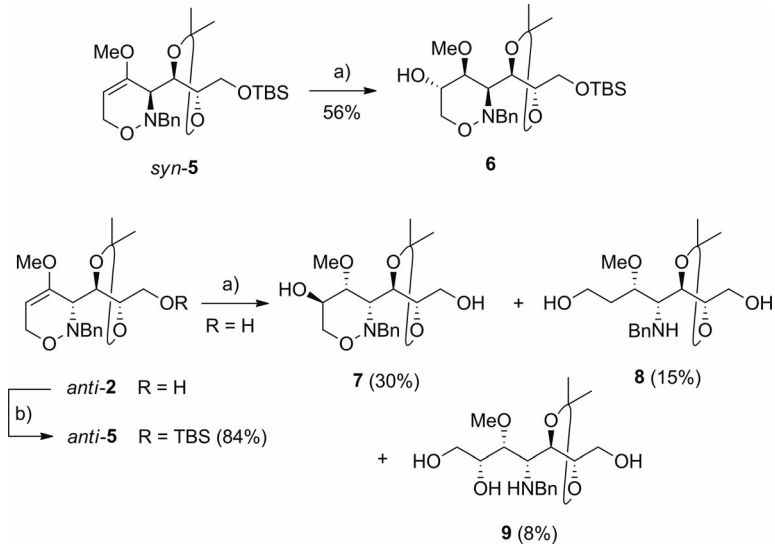


Scheme 3. Synthesis of *O*-silylated nitrone **3** and its transformation into 1,2-oxazines **5**. (a) TBSCl (2.2 equiv.), imidazole (2.4 equiv.), DMAP (0.05 equiv.), CH_2Cl_2, room temp., 3 d. (b) Ph_3PCH_3Br (2.3 equiv.), KO*t*Bu (2.1 equiv.), THF, –78 °C to room temp., 3 h. (c) Lithiated methoxyallene (6.0 equiv.), THF, –78 °C, 1 h.

According to the literature, the required compound **3** should be available from 2,3-*O*-isopropylidene-L-erythrose in a five-step sequence (by Wittig reaction, TBS protection, C=C dihydroxylation followed by diol cleavage, and subsequent condensation with *N*-benzylhydroxylamine) in an overall yield of 77%.[8] In our hands, similarly to other reports,[9] the crucial Wittig reaction delivered the expected olefin **4** only in 60% yield. We were therefore very pleased to find that the direct silylation of hydroxylamine **1** with TBSCl led to a mixture in which the desired **3** was the major component. It could be isolated by simple column chromatography in pure form and an acceptable yield of 43%. This direct approach to nitrones such as **3** should have general importance, because it strongly facilitates access to carbohydrate-derived nitrones. As anticipated, treatment of **3** with lithiated methoxyallene at –78 °C smoothly yielded an inseparable mixture of the diastereomeric 1,2-oxazines **5** with very good *syn* preference. This experiment demonstrates that a stereodivergent approach to highly functionalized 3,6-dihydro-1,2-oxazine derivatives is also possible in the erythrose series, with *syn*/*anti* ratios being strongly dependant on the terminal hydroxy-protecting group.

The presence of the electron-rich double bond in the 3,6-dihydro-2*H*-1,2-oxazine system opens several possibilities for further stereoselective transformations. Results on cyclopropanations,[10] brominations[11] and the more extensively studied hydroborations[4a,4c,12] have recently been published.

Because of the great interest of polyhydroxylated compounds as glycosidase inhibitors,[13] the hydroboration should be of particular importance. In general, treatment of *syn*-configured 1,2-oxazines with BH_3·THF yields, after oxidative workup, the corresponding hydroxylated compounds as single diastereomers. This excellent stereocontrol could be partially influenced in the presence of alkoxyborane species generated in situ.[12] The introduction of a hydroxy group at C-5 in 1,2-oxazines *anti*-**2** and *syn*-**5** was achieved under standard conditions and yielded the corre-

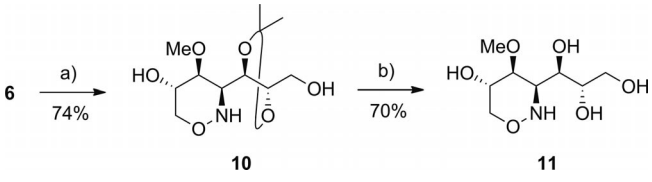


Scheme 4. Transformations of 1,2-oxazines *syn*-**5** and *anti*-**2** in a hydroboration/oxidation sequence. (a) BH_3·THF (4.0 equiv.), THF, –30 °C to room temp., 3 h, then NaOH (2 M), H_2O_2, –10 °C to room temp., overnight. (b) TBSCl (1.3 equiv.), imidazole (1.4 equiv.), DMAP (5 mol-%), room temp., 16 h.

sponding alcohols **6** and **7**, respectively (Scheme 4). Whereas *syn*-**5** (*dr* = 90:10) delivered the expected product exclusively (with respect to the major diastereomer), in the case of *anti*-**2** a complex mixture was obtained. The more polar compounds **8** and **9** were isolated by standard column chromatography. From the less polar fraction, containing mainly target compound **7**, this desired product was obtained after purification by HPLC in 30% yield.

The structures of the isolated byproducts **8** and **9** clearly show that reduction of C=C and N–O bonds take place under the applied conditions. In order to examine whether the free OH group might influence the chemoselectivity through the formation of the corresponding alkoxyboranes,[12] we prepared the TBS-protected derivative of *anti*-**2** under typical conditions. The resulting *O*-silylated *anti*-**5** was treated with borane, followed by oxidative workup. The formation of a complex mixture of products related to **7**–**9** was observed. Only a 26% yield of the expected alcohol was isolated; after treatment of this with TBAF under standard conditions, **7** was obtained in 89% yield. The relative configurations of 3,6-dihydro-2*H*-1,2-oxazine derivatives at C-3 therefore seem to be a decisive factor for the observed decreasing chemoselectivity. This observation is in full agreement with the behaviour of other *anti*-configured 1,2-oxazines.[4a]

With the new hydroxylated compound **6** in hand, we could prepare polyhydroxylated azasugar **11** by stepwise deprotection as shown in Scheme 5. Firstly, alcohol **6** was subjected to hydrogen in the presence of palladium on charcoal as catalyst to give the *N*-debenzylated product after a short reaction time (45 min). Notably, this primarily formed compound slowly underwent cleavage of the TBS group, either during storage at room temperature in the presence of methanol or on treatment with silica gel, yielding the corresponding diol **10** in 74% yield. Complete deprotection by



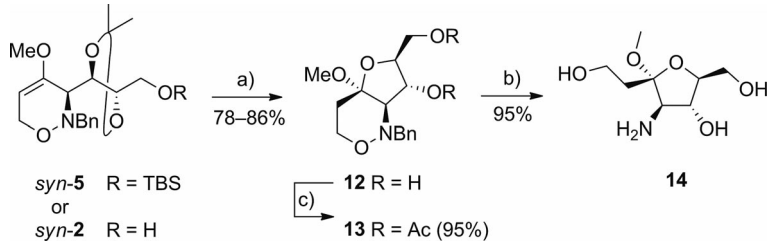
Scheme 5. Deprotection of 1,2-oxazine **6** leading to polyhydroxylated azasugar **11**. (a) (i) H_2, Pd/C, MeOH, room temp., 45 min; (ii) MeOH, room temp., 24 h. (b) DOWEX-50, EtOH, 50 °C, 24 h.

removal of the acetonide function was achieved with ion exchange resin DOWEX-50 at enhanced temperature, furnishing the azasugar **11** in good overall yield. A diastereomer of this compound should similarly be accessible by starting with compound **7**.

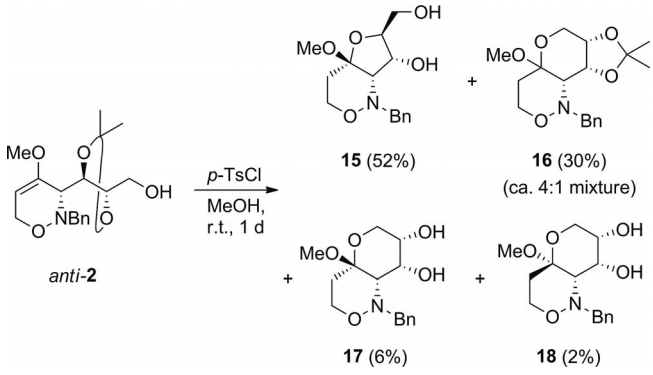
Because of the presence of the acetonide moieties in their side chains, 1,2-oxazines such as *syn*-**5** or *anti*-**2** should be ideal candidates for Brønsted-acid-mediated transformations. This stereoselective approach to aminosugar derivatives had been explored earlier by our group.[2b,14] By the general protocol, with *p*-toluenesulfonyl chloride in methanol as a source of hydrogen chloride, transformation of *syn*-**5** (*dr* = 90:10) furnished bicyclic compound **12** as the only isolated product in an excellent 86% yield (Scheme 6). As expected, this compound was also formed by acid-induced transformation of *syn*-**2**. Column chromatography afforded pure **12** in 78% yield. The furanoid structure of **12** was confirmed by the ^{1}H NMR spectroscopic data of the acetylated derivative **13**, in which significant low-field shifts for the signals assigned to protons adjacent to OAc groups could be observed. The desired aminosugar derivative **14** was prepared in excellent yield by exhaustive hydrogenolysis of **12** under standard conditions.

We then examined *anti*-**2** under similar conditions. After 24 h, a complex mixture was found as crude product. Careful purification by chromatography allowed the isolation of products **15**–**18** as depicted in Scheme 7. In contrast with the previously described cyclisation of a D-arabinose-derived *anti*-1,2-oxazine exclusively producing bicyclic pyranoid ketals (81% yield),[2b] in the case of *anti*-**2** we observed a preference for the formation of the bicyclic furan derivative **15** (52%). Additionally, the corresponding pyrans were isolated in both anomeric forms (**16**–**18**, 38%). The structure of *cis*-fused **15** was unambiguously confirmed by a single-crystal X-ray analysis (Figure 2).

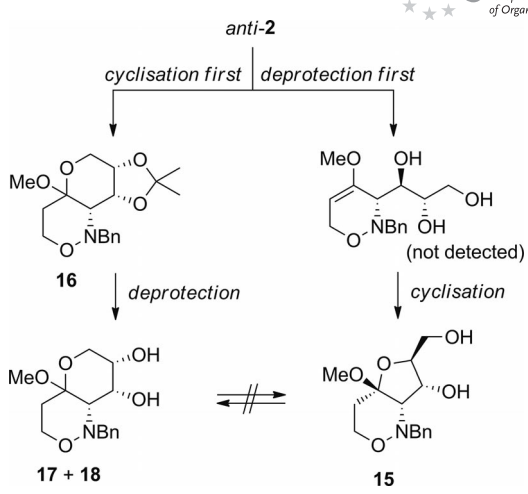
In order to gain more detailed information about the transformation, we resubjected ketal **16** to the tested conditions. The formation of two more polar products was clearly observed (TLC monitoring), and after the mixture had been stirred for 3 d, complete conversion, exclusively yielding fused pyran derivatives **17** and **18**, was observed. In an additional experiment, furan derivative **15** was treated with HCl generated in situ; after 3 d at room temperature, this had induced no changes in the examined sample. These observations led to the conclusion that bicyclic furan **15** and pyran derivatives **17** and **18** are irreversibly formed un-



Scheme 6. Two-step synthesis of aminofuran derivative **14** via the bicyclic 1,2-oxazine derivative **12**. (a) *p*TsCl (0.5 equiv.), MeOH, room temp., 1 d. (b) H_2, Pd/C, MeOH, 22 h. (c) Ac_2O (4.2 equiv.), Et_3N (12 equiv.), DMAP (10 mol-%), CH_2Cl_2, room temp., 16 h.



Scheme 7. Acid-mediated cyclisation of *anti*-**2** leading to a mixture of bicyclic products **15**–**18**.



Scheme 8. Cyclisation versus deprotection: a plausible explanation for the observed formation of furan **15** and pyran derivatives **16**–**18**.

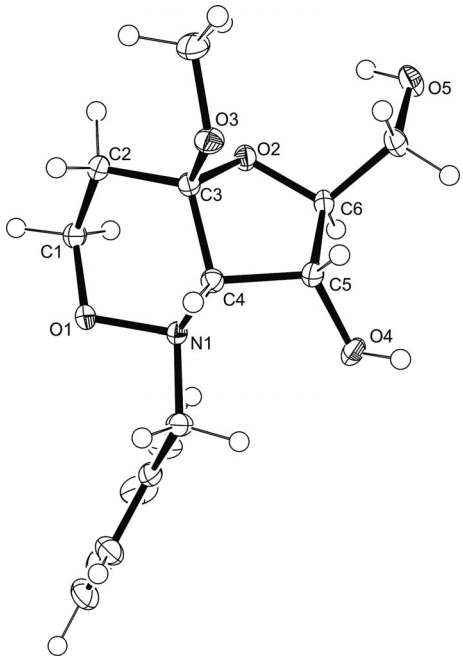


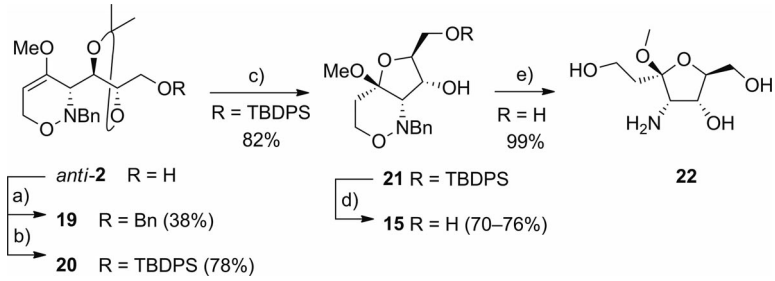
Figure 2. X-ray crystal structure of compound **15** (ellipsoids are drawn at a 50% probability level).

der the applied conditions as a result of competitive cyclisation versus acetal cleavage as shown in Scheme 8.

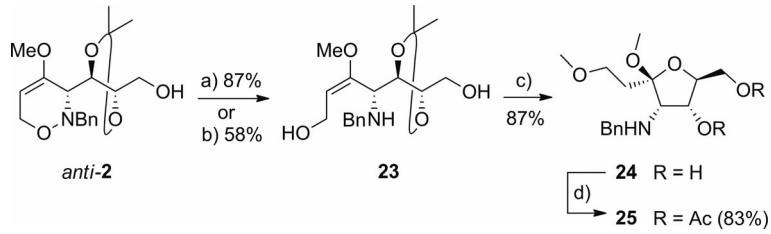
In search of a more efficient synthesis of compound **15** a series of *O*-protected analogues of *anti*-**2** was studied. In the case of *anti*-**5** complete cleavage of the TBS moiety was observed, and a mixture of compounds **15**, **16** and **17** was isolated in combined 71% yield (48, 22 and 1% yields, respectively). A furan/pyran ratio slightly larger than that seen in the cyclisation reaction of unprotected *anti*-**2** was observed (ca. 3:2 and 2:1). An attempted benzylation of the free hydroxy group of *anti*-**2** under standard conditions was not successful; treatment of this 1,2-oxazine with sodium hydride in dry DMF and subsequent addition of benzyl bromide resulted in the formation of a complex mixture. The ^{1}H NMR spectrum of the crude material showed no signals attributable to an acetonide group.

The desired compound **19** (Scheme 9) was finally prepared by a known method with use of Ag_2O as promoter[15] in a low 38% yield. Finally, the TBDPS-protected compound **20** was prepared, and under analogous conditions it delivered the expected bicyclic furan derivative **21** in high yield (82%), accompanied by a small amount of desilylated compound **15** (13%). Attempted removal of the TBDPS group by treatment with TBAF gave unsatisfactory results, so $Et_3N{\cdot}3HF$ was applied as a mildly acidic source of fluoride to give the desired product **15** in 70% yield. A similar result was observed when **21** was resubjected to anhydrous HCl in methanol. Subsequent deprotection and simultaneous opening of the 1,2-oxazine ring by hydrogenolysis furnished the desired aminofuran derivative **22** (Scheme 9).

The synthesis of aminosugar derivatives through transformations of 1,2-oxazine derivatives is also possible in the opposite order (first reduction, then cyclisation).[14] We therefore examined *anti*-**2** in this sequence. The reductive N–O bond cleavage of 1,2-oxazine derivatives has recently been studied in a series of publications[2,4a,4c,16] in which samarium diiodide was employed as a highly chemoselective reducing agent. Compound *anti*-**2** was treated with an excess of SmI_2 (ca. 0.1 M solution in THF) according to the general procedure. After 3 h at room temperature, the starting material had been fully consumed (TLC). The corresponding (*E*)-configured allylic alcohol **23** (Scheme 10) was formed in high yield with >95% purity, and – after filtration through a short silica gel pad – the spectroscopically pure product was isolated in 87% yield. Compound **23** could also be prepared by applying zinc dust in the presence of hydrochloric acid, which is an alternative method for N–O bond cleavage of 1,2-oxazines.[17] Because of the formation of several side products, careful purification was necessary, and the product was isolated only in moderate yield (58%). In line with a more recent report on the synthesis of vinyl-substituted aminofuran derivatives,[14] in which an allylic alcohol of type **23** was proposed as key intermediate, compound **23** was subjected to acidic condi-



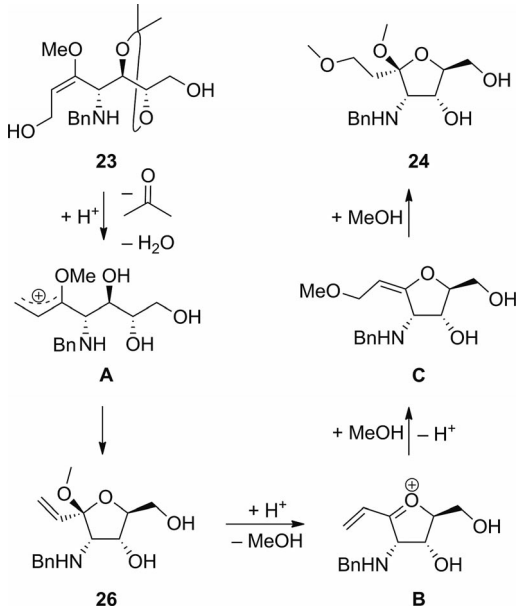
Scheme 9. Synthesis of aminofuran **22** via bicyclic 1,2-oxazine derivative **21**. (a) Ag_2O (3.0 equiv.), BnBr (1.3 equiv.), toluene, reflux, 2 d. (b) TBDPSCl (1.4 equiv.), imidazole (1.5 equiv.), DMAP (0.05 equiv.), CH_2Cl_2, room temp., 36 h. (c) *p*TsCl (0.5 equiv.), MeOH, room temp., 18 h. (d) $Et_3N{\cdot}3HF$ (10 equiv.), THF, room temp., 36 h (70%); or *p*TsCl (1.1 equiv.), MeOH, room temp., 5 d (76%). (e) H_2, Pd/C, MeOH, 20 h.



Scheme 10. Transformation of *anti*-**2** into amino furan derivative **24** by reduction/cyclisation sequences. (a) SmI_2 (3.0 equiv.), THF, room temp., 4 h. (b) Zn (5.0 equiv.), HCl (4.9 equiv.), MeOH, room temp., 16 h. (c) HCl (3 N), MeOH, room temp., 5 d. (d) Ac_2O (4.3 equiv.), Et_3N (10 equiv.), DMAP (0.1 equiv.), CH_2Cl_2, room temp., overnight.

tions (3 N HCl in methanol). After 5 d at room temperature, a single product had been formed (TLC monitoring) and was isolated in 87% yield. This compound was also prepared in slightly higher yield (92%) when **23** was treated for 6 h with a boiling HCl/methanol solution. Surprisingly, no characteristic vinyl signals were found in the ^1H NMR spectrum, but two singlets at δ = 3.25 and 3.18 ppm (2× 3 H) attributable to two methoxy groups were observed. From the NMR spectroscopic data and other analytical data, including HRMS showing a peak at *m*/*z* = 311, the newly formed product is proposed to be furan derivative **24** (Scheme 10). A particular preference for the formation of the furan ring was observed again. The furan-derived structure was confirmed by acylation of both free hydroxy groups present in **24**. As expected, in the ^1H NMR spectrum of **25** three sets of signals attributable to 3-H and the exocyclic CH_2 moiety were low-field-shifted (by ca. 0.9 and 0.7 ppm, respectively).

A possible pathway for the formation of **24** involving addition of methanol is shown in Scheme 11. After acid-promoted cleavage of the acetonide moiety and subsequent elimination of water, the well-stabilized allylic carbenium ion **A** should be generated. Intramolecular nucleophilic attack of the free hydroxy group could form vinylfuran derivative **26**. Protonation followed by elimination of methanol could generate vinyl-substituted oxocarbenium ion **B**. This intermediate could accept methanol to form *exo*-ethylidene derivative **C**, and subsequent acid-induced addition of methanol could finally yield product **24**. This compound is unquestionably generated under thermodynamic control, and only one diastereomer was formed. The relative configuration of furan **24** at C-5 was confirmed by NOESY experiments in which a correlation peak between 2-H and the methoxy group of the 5-(methoxyethyl) substituent was observed.



Scheme 11. Proposed mechanism for the transformation of allylic alcohol **23** into aminofuran derivative **24**.

Finally, the described acid-catalysed transformation of **23** was repeated under milder conditions with use of *p*-toluenesulfonic acid in methanol. The reaction was performed at 0 °C, and – after 9 h – almost complete acetonide cleav-

age was observed, but no cyclisation products could be detected at this temperature. The formation of vinylfuran **26** was observed at 25 °C, but a subsequent conversion of this primary product into **24** occurred. From the ^{1}H NMR spectra, the maximum concentration of **26** was observed after 3 d, accompanied by the acetonide-cleaved derivative of **23** and product **24** in ca. 2:1:1 ratio. Attempted syntheses of **26** with the aid either of a less nucleophilic solvent (trifluoroethanol in the presence of *p*TsCl) or of another proton source (trifluoroacetic acid in dichloromethane) gave no satisfactory results.

Compounds **11**, **14**, **22** and **24** prepared in this study were examined for their glycosidase inhibitory properties towards eleven commercially available enzymes. Unfortunately, none of the compounds, tested as 1 mM solutions,[18] showed promising inhibition.

Conclusions

The reactions between lithiated methoxyallene and either nitrone **1′** or its *O*-protected analogue **3** could be carried out on gram scales to yield 1,2-oxazines in an *anti*- or *syn*-selective fashion. As observed earlier, the hydroboration proceeded smoothly only for the *syn*-configured 1,2-oxazine *syn*-**5**, which after subsequent deprotections led to azasugar **11**. Acid-induced reactions of *syn*-**2** and *anti*-**5** depend strongly on the protective groups present and allow the synthesis of a range of aminofuran derivatives. Alternatively, chemoselective N–O bond cleavage by samarium diiodide was examined and – after subsequent deprotections – also provided an aminofuran derivative. These experiments again demonstrate the great potential of 1,2-oxazine intermediates for the synthesis of cyclic or acyclic enantiopure amino polyols. Because the starting arabinose is readily available in both the L- and the D-series, it is clear that the products presented in this report are also available with opposite absolute configurations.

Experimental Section

General Methods: Reactions were generally performed under argon in flame-dried flasks. Solvents and reagents were added by syringe. Solvents were purified with an MB SPS-800-dry solvent system. Other reagents were purchased and used as received without further purification unless stated otherwise. Products were purified by flash chromatography on silica gel (230–400 mesh, Merck or Fluka). Unless stated otherwise, yields refer to analytically pure samples. NMR spectra were recorded with Bruker (AC 250, AC 500, AVIII 700) and JOEL (ECX 400, Eclipse 500) instruments. Chemical shifts are reported relative to TMS or solvent residual peaks [^{1}H: δ = 0.00 ppm (TMS), δ = 7.26 ppm ($CDCl_3$); ^{13}C: δ = 77.0 ppm ($CDCl_3$)]. Integrals are consistent with assignments, and coupling constants are given in Hz. All ^{13}C NMR spectra are proton-decoupled. For detailed peak assignments 2D spectra were measured (COSY, HMQC, HMBC). IR spectra were measured with a Nexus FT-IR spectrometer fitted with a Nicolet Smart Dura Sample IR ATR. MS and HRMS analyses were performed with a Varian Ionspec QFT-7 (ESI-FT ICRMS) instrument. Elemental analyses were carried out with a Vario EL or a Vario EL III (Elementar Analysensysteme GmbH) instrument. Melting points were measured with a Reichert apparatus (Thermovar) and are uncorrected. Optical rotations were determined with a Perkin–Elmer 241 polarimeter at the temperatures given. Single-crystal X-ray data were collected with a Bruker SMART CCD diffractometer (Mo-K_α radiation, λ = 0.71073 Å, graphite monochromator); the structure solution and refinement were achieved by use of SHELXS-97[19] and SHELXL-97[19] in the WINGX system.[20] CCDC-854944 contains the supplementary crystallographic data for this paper. These data can be obtained free of charge from The Cambridge Crystallographic Data Centre via www.ccdc.cam.ac.uk/data_request/cif.

Reaction between Lithiated Methoxyallene and 1-(*N*-Benzylhydroxylamino)-2,3-*O*-isopropylidene-1-deoxy-β-L-erythrose (1): Lithiated methoxyallene was generated under dry argon by treatment of a solution of methoxyallene (1.19 g, 1.45 mL, 17.0 mmol) in dry tetrahydrofuran (35 mL) with *n*BuLi (2.5 M in hexane, 6.7 mL, 16.8 mmol) at –40 °C. After 5 min, a solution of *N*-benzylhydroxylamine derivative **1** (0.711 g, 2.68 mmol) in tetrahydrofuran (30 mL) was added slowly at the same temperature. The mixture was stirred at –40 °C for 8 h and was then quenched with water. Warming up to room temp. was followed by extraction with diethyl ether (3 × 45 mL) and drying of the combined extracts with $MgSO_4$. Removal of the solvents in vacuo yielded crude 1,2-oxazines **2** as an orange oil (*anti*-**2**/*syn*-**2** = 96:4), which was purified by column chromatography (silica gel, hexane/ethyl acetate = 1:1). The major product *anti*-**2** (0.818 g, 91%, >98% purity) was isolated as a light yellow oil and the minor isomer *syn*-**2** (18 mg, 2%) as a colourless oil. An analytically pure sample of *anti*-**2** was obtained after a second chromatographic purification (silica gel, hexane/ethyl acetate = 3:1) as a colourless liquid.

(3*S*,4′*R*,5′*S*)-2-Benzyl-3-(5′-hydroxymethyl-2′,2′-dimethyl-1′,3′-dioxolan-4′-yl)-4-methoxy-3,6-dihydro-2*H*-[1,2]oxazine (*anti*-2): $[\alpha]_D^{22}$ = +100.3 (*c* = 1.34, $CHCl_3$). ^{1}H NMR ($CDCl_3$, 500 MHz): δ = 1.33, 1.45 (2 s, 2 × 3 H, 2 Me), 3.34 (ddd, *J* = 4.5, 8.5, 12.0 Hz, 1 H, 5′-C*H*$_2$OH), 3.40 (d, *J* = 8.6 Hz, 1 H, 3-H), 3.62 (s, 3 H, OMe), 3.66 (ddd, *J* = 4.9, 9.5, 12.0 Hz, 1 H, 5′-C*H*$_2$OH), 4.08, 4.12 (2 d, *J* = 12.7 Hz, 1 H each, C*H*$_2$Ph), 4.28–4.33 (m, 3 H, 5′-H, 6-H, OH), 4.45 (br. dd, *J* ≈ 1.2, 15.1 Hz, 1 H, 6-H), 4.67 (dd, *J* = 5.5, 8.6 Hz, 1 H, 4′-H), 4.83 (t, *J* ≈ 2.8 Hz, 1 H, 5-H), 7.28–7.37 (m, 5 H, Ph) ppm. ^{13}C NMR ($CDCl_3$, 126 MHz): δ = 25.6, 27.3 (2 q, 2 Me), 54.1 (q, OMe), 57.4 (t, *C*H$_2$Ph), 59.3 (d, C-3), 59.7 (t, CH$_2$OH), 61.4 (t, C-6), 77.47 (d, C-5′), 77.55 (d, C-4′), 90.6 (d, C-5), 108.6 (s, C-2′), 127.9, 128.5, 129.5, 135.2 (3 d, s, Ph), 150.4 (s, C-4) ppm. IR (ATR): $\tilde{\nu}$ = 3390 (O–H), 3060–2830 (=C–H, C–H), 1675 (C=C), 1215, 1075, 1055 (C–O) cm^{-1}. HRMS (ESI-TOF): calcd. for $C_{18}H_{25}NNaO_5$ [M + Na]$^+$ 358.1625; found 358.1605. $C_{18}H_{25}NO_5$ (335.4): calcd. C 64.46, H 7.51, N 4.18; found C 64.38, H 7.48, N 4.07.

(3*R*,4′*R*,5′*S*)-2-Benzyl-3-(5′-hydroxymethyl-2′,2′-dimethyl-1′,3′-dioxolan-4′-yl)-4-methoxy-3,6-dihydro-2*H*-[1,2]oxazine (*syn*-2): $[\alpha]_D^{22}$ = –65.0 (*c* = 1.07, $CHCl_3$). ^{1}H NMR ($CDCl_3$, 500 MHz): δ = 1.41, 1.53 (2 s, 2 × 3 H, 2 Me), 2.62 (dd, *J* = 2.1, 9.8 Hz, 1 H, OH), 3.32 (d, *J* = 8.2 Hz, 1 H, 3-H), 3.47 (ddd, *J* = 2.1, 8.1, 11.2 Hz, 1 H, 5′-C*H*$_2$OH), 3.57 (s, 3 H, OMe), 3.80 (ddd, *J* = 3.8, 9.8, 11.2 Hz, 1 H, 5′-C*H*$_2$OH), 4.11 (ddd, *J* = 3.8, 5.3, 8.1 Hz, 1 H, 5′-H), 4.13 (d, *J* = 13.8 Hz, 1 H, C*H*$_2$Ph), 4.24 (dd, *J* = 3.2, 14.8 Hz, 1 H, 6-H), 4.27 (d, *J* = 13.8 Hz, 1 H, C*H*$_2$Ph), 4.39 (dt, *J* = 2.1, 14.8 Hz, 1 H, 6-H), 4.53 (dd, *J* = 5.4, 8.2 Hz, 1 H, 4′-H), 4.84 (t, *J* ≈ 2.9 Hz, 1 H, 5-H), 7.24–7.28, 7.30–7.34, 7.40–7.43 (3 m, 5 H, Ph) ppm. ^{13}C NMR ($CDCl_3$, 126 MHz): δ = 25.9, 28.2 (2 q, 2 Me), 54.3 (q, OMe), 58.8 (t, *C*H$_2$Ph), 59.0 (d, C-3), 61.6 (t, CH$_2$OH), 63.3 (t, C-6), 76.9 (d, C-4′), 78.2 (d, C-5′), 93.0 (d, C-5), 108.1 (s, C-2′), 127.2,

128.2, 128.8, 137.4 (3 d, s, Ph), 151.0 (s, C-4) ppm. IR (ATR): $\tilde{\nu}$ = 3470 (O–H), 3090–2835 (=C–H, C–H), 1675 (C=C), 1215, 1055 (C–O) cm^{-1}. HRMS (ESI-TOF): calcd. for $C_{18}H_{25}NNaO_5$ $[M + Na]^+$ 358.1625; found 358.1640. $C_{18}H_{25}NO_5$ (335.4): calcd. C 64.46, H 7.51, N 4.18; found C 64.44, H 7.58, N 4.08.

Synthesis of Nitrone 3: Imidazole (116 mg, 1.70 mmol), DMAP (4.0 mg) and TBSCl (240 mg, 1.59 mmol) in dichloromethane (10 mL) were added dropwise at 0 °C to a solution of *N*-benzylhydroxylamine derivative **1** (192 mg, 0.72 mmol) in dry dichloromethane (10 mL). The mixture was allowed to reach room temp. and stirred for 3 d. Dichloromethane (ca. 20 mL) was then added, followed by H_2O (40 mL), and the layers were separated. The aqueous layer was extracted with dichloromethane (3× 20 mL), the combined organic layers were dried (Na_2SO_4) and filtered, and the solvents were removed in vacuo. Purification by column chromatography (silica gel, hexane/ethyl acetate = 4:3) furnished nitrone **3** (118 mg, 43%) as a colourless oil. $[\alpha]_D^{22}$ = –138.2 (*c* = 1.29, $CHCl_3$) {ref.[8] $[\alpha]_D$ = –106.8 (*c* = 1.96, $CHCl_3$)}. ^1H NMR ($CDCl_3$, 500 MHz): δ = 0.01, 0.02, 0.87 (3 s, 9 H, 2× 3 H, TBS), 1.34, 1.46 (2 s, 2× 3 H, 2 Me), 3.50 (dd, *J* = 4.0, 11.4 Hz, 1 H, C*H*$_2$OTBS), 3.65 (dd, *J* = 3.2, 11.4 Hz, 1 H, C*H*$_2$OTBS), 4.49 (dt, *J* = 3.6, 7.2 Hz, 1 H, C*H*–O), 4.83, 4.87 (2 d, *J* = 13.5 Hz, 1 H each, C*H*$_2$Ph), 5.34 (dd, *J* = 5.5, 7.2 Hz, 1 H, N=CH–C*H*–O), 6.92 (d, *J* = 5.5 Hz, 1 H, C*H*=N), 7.36–7.43 (m, 5 H, Ph) ppm. ^{13}C NMR ($CDCl_3$, 126 MHz): δ = –5.4, –5.3, 18.2, 25.9 (2 q, s, q, TBS), 24.5, 26.7 (2 q, 2 Me), 62.3 (t, *C*H$_2$OTBS), 69.0 (t, *C*H$_2$Ph), 77.5 (d, N=CH–*C*H–O), 78.8 (d, CH–O), 109.2 [s, O–*C*(Me$_2$)–O], 128.9, 129.1, 129.3, 132.4 (3 d, s, Ph), 138.0 (d, N=CH) ppm. IR (ATR): $\tilde{\nu}$ = 3090–2855 (=C–H, C–H), 1600 (C=N), 1255, 1150, 1080 (C–O) cm^{-1}. HRMS (ESI-TOF): calcd. for $C_{20}H_{33}NNaO_4Si$ $[M + Na]^+$ 402.2071; found 402.2067.

Reaction between Lithiated Methoxyallene and Nitrone 3: Lithiated methoxyallene was generated under dry argon by treatment of a solution of methoxyallene (1.79 g, 2.15 mL, 25.5 mmol) in tetrahydrofuran (65 mL) with *n*BuLi (2.5 M in hexane, 9.2 mL, 23.0 mmol) at –40 °C. After 5 min, it was cooled to –78 °C, and a solution of nitrone **3** (2.90 g, 7.64 mmol) in dry tetrahydrofuran (30 mL) was added slowly. The mixture was stirred at this temperature for 1 h and was then quenched with water (10 mL). Warming up to room temp. was followed by extraction with diethyl ether (3× 60 mL) and drying of the combined extracts with $MgSO_4$. Removal of the solvent in vacuo yielded crude product (*syn*-**5**/*anti*-**5** = 90:10), which was purified by column chromatography (silica gel, hexane/ethyl acetate = 6:1) to give a 9:1 mixture of *syn*-**5**/*anti*-**5** as a pale yellow oil (3.02 g, 88%).

(3*R*,4′*R*,5′*S*)-2-Benzyl-3-[5′-(*tert*-butyldimethylsiloxymethyl)-2′,2′-dimethyl-1′,3′-dioxolan-4′-yl]-4-methoxy-3,6-dihydro-2*H*-[1,2]oxazine (*syn*-5): $[\alpha]_D^{22}$ = –38.7 (*c* = 1.09, $CHCl_3$, *dr* = 9:1). ^1H NMR ($CDCl_3$, 500 MHz): δ = 0.05, 0.06, 0.89 (3 s, 2× 3 H, 9 H, TBS), 1.39, 1.53 (2 s, 2× 3 H, 2 Me), 3.54 (d, *J* = 8.0 Hz, 1 H, 3-H), 3.56 (s, 3 H, OMe), 3.75 (dd, *J* = 6.5, 10.5 Hz, 1 H, 5′-C*H*$_2$–), 3.92 (dd, *J* = 3.8, 10.5 Hz, 1 H, 5′-C*H*$_2$–), 4.04 (d, *J* = 14.3 Hz, 1 H, C*H*$_2$Ph), 4.15 (td, *J* = 3.8, 6.2 Hz, 1 H, 5′-H), 4.24 (br. dd, *J* ≈ 3.0, 14.6 Hz, 1 H, 6-H), 4.31 (ddd, *J* = 1.9, 2.6, 14.6 Hz, 1 H, 6-H), 4.37 (d, *J* = 14.3 Hz, 1 H, C*H*$_2$Ph), 4.46 (dd, *J* = 5.8, 8.0 Hz, 1 H, 4′-H), 4.82 (t, *J* ≈ 2.9 Hz, 1 H, 5-H), 7.23–7.45 (m, 5 H, Ph) ppm. ^{13}C NMR ($CDCl_3$, 126 MHz): δ = –5.27, –5.29, 18.4, 26.0 (2 q, s, q, TBS), 25.9, 27.8 (2 q, 2 Me), 54.3 (q, OMe), 59.3 (t, *C*H$_2$Ph), 60.2 (d, C-3), 63.0 (t, 5′-*C*H$_2$-), 63.3 (t, C-6), 77.1 (d, C-4′), 79.0 (d, C-5′), 92.7 (d, C-5), 108.2 (s, C-2′), 126.9, 128.1, 128.7, 138.4 (3 d, s, Ph), 152.1 (s, C-4) ppm. IR (ATR): $\tilde{\nu}$ = 3085–2840 (=C–H, C–H), 1675 (C=C), 1255, 1220, 1070 (C–O) cm^{-1}. HRMS (ESI-TOF): calcd. for $C_{24}H_{39}NNaO_5Si$ $[M + Na]^+$ 472.2490; found 472.2483.

For the analytical data for *anti*-**5**, see the next experiment.

(3*S*,4′*R*,5′*S*)-2-Benzyl-3-[5′-(*tert*-butyldimethylsiloxymethyl)-2′,2′-dimethyl-1′,3′-dioxolan-4′-yl]-4-methoxy-3,6-dihydro-2*H*-[1,2]oxazine (*anti*-5): Imidazole (241 mg, 3.54 mmol), DMAP (13 mg, 0.11 mmol) and TBSCl (520 mg, 3.45 mmol) in dichloromethane (5 mL) were added dropwise at 0 °C to a solution of 1,2-oxazine *anti*-**2** (850 mg, 2.53 mmol) in dry dichloromethane (10 mL). The reaction mixture was allowed to reach room temp. and stirred overnight. Dichloromethane (15 mL) was then added, followed by water (15 mL), and the layers were separated. The aqueous layer was extracted with three portions of dichloromethane (7 mL each), the combined organic layers were washed with brine, dried (Na_2SO_4) and filtered, and the solvents were removed. Purification by column chromatography (silica gel, hexane/ethyl acetate = 6:1) yielded *anti*-**5** (958 mg, 84%) as a colourless oil. $[\alpha]_D^{22}$ = +55.7 (*c* = 1.00, $CHCl_3$). ^1H NMR ($CDCl_3$, 500 MHz): δ = 0.03, 0.05, 0.88 (3 s, 2× 3 H, 9 H, TBS), 1.35, 1.45 (2 s, 2× 3 H, 2 Me), 3.48 (d, *J* = 7.2 Hz, 1 H, 3-H), 3.62 (s, 3 H, OMe), 3.61 (dd, *J* = 7.1, 11.2 Hz, 1 H, 5′-C*H*$_2$–), 3.99 (dd, *J* = 3.8, 11.2 Hz, 1 H, 5′-C*H*$_2$–), 3.97, 4.03 (2 d, *J* = 13.8 Hz, 2 H, C*H*$_2$Ph), 4.22 (dd, *J* = 2.9, 15.0 Hz, 1 H, 6-H), 4.25 (ddd, *J* = 3.8, 6.2, 7.1 Hz, 1 H, 5′-H), 4.37 (br. ddd, *J* = 1.6, 2.1, 15.0 Hz, 1 H, 6-H), 4.61 (dd, *J* = 6.2, 7.2 Hz, 1 H, 4′-H), 4.78 (t, *J* ≈ 2.7 Hz, 1 H, 5-H), 7.24–7.39 (m, 5 H, Ph) ppm. ^{13}C NMR ($CDCl_3$, 126 MHz): δ = –5.2, –5.1, 18.4, 26.0 (2 q, s, q, TBS), 25.3, 27.5 (2 q, 2 Me), 54.0 (q, OMe), 57.0 (t, *C*H$_2$Ph), 60.3 (d, C-3), 61.6 (t, C-6), 62.8 (t, 5′-*C*H$_2$–), 77.0 (d, C-4′), 79.0 (d, C-5′), 90.8 (d, C-5), 108.1 (s, C-2′), 127.3, 128.3, 128.8, 137.1 (3 d, s, Ph), 151.2 (s, C-4) ppm. IR (ATR): $\tilde{\nu}$ = 3090–2835 (=C–H, C–H), 1680 (C=C), 1245, 1215, 1070 (C–O) cm^{-1}. HRMS (ESI-TOF): calcd. for $C_{24}H_{39}NNaO_5Si$ $[M + Na]^+$ 472.2490; found 472.2513. $C_{24}H_{39}NO_5Si$ (449.7): calcd. C 64.11, H 8.74, N 3.11; found C 63.69, H 8.63, N 3.20.

Typical Procedure for the Hydroboration of 2*H*-1,2-Oxazines: BH_3·THF (1 M in THF, 4.4 mL, 4.4 mmol) was added at –30 °C to a solution of *syn*-**5** (490 mg, 1.09 mmol) in tetrahydrofuran (25 mL). The solution was allowed to reach room temp. and stirred for 3 h and was then cooled to –10 °C, and an NaOH solution (2 M, 9.0 mL) and H_2O_2 (30%; 3.0 mL) were added. After the mixture had been stirred at room temp. overnight, an $Na_2S_2O_3$ solution (satd.; 20 mL) was added, the layers were separated, and the aqueous layer was extracted with diethyl ether (3× 35 mL). The combined organic phases were dried ($MgSO_4$) and filtered, and the solvents were removed under reduced pressure. The crude product was purified by column chromatography (silica gel, hexane/AcOEt = 2:1) to give **6** as a colourless oil (288 mg, 56%).

(3*R*,4*S*,5*R*,4′*R*,5′*S*)-2-Benzyl-3-[5′-(*tert*-butyldimethylsiloxymethyl)-2′,2′-dimethyl-1′,3′-dioxolan-4′-yl]-4-methoxy-3,4,5,6-tetrahydro-2*H*-[1,2]oxazinan-5-ol (6): $[\alpha]_D^{22}$ = –66.4 (*c* = 1.15, $CHCl_3$). ^1H NMR ($CDCl_3$, 500 MHz): δ = 0.10, 0.11, 0.92 (3 s, 2× 3 H, 9 H, TBS), 1.33, 1.44 (2 s, 2× 3 H, 2 Me), 2.22 (d, *J* = 8.1 Hz, 1 H, OH), 3.42 (dd, *J* = 2.6, 9.2 Hz, 1 H, 3-H), 3.46 (s, 3 H, OMe), 3.59 (dd, *J* = 3.8, 10.9 Hz, 1 H, 5′-C*H*$_2$–), 3.67 (ddd, *J* = 0.8, 3.0, 12.0 Hz, 1 H, 6-H), 3.74 (m$_c$, 1 H, 5-H), 3.79 (d, *J* = 15.0 Hz, 1 H, C*H*$_2$Ph), 3.84 (br. t, *J* ≈ 3.7 Hz, 1 H, 4-H), 3.85 (dd, *J* = 6.3, 10.9 Hz, 1 H, 5′-C*H*$_2$-), 4.16 (dt, *J* ≈ 4.1, 6.3 Hz, 1 H, 5′-H), 4.21 (dd, *J* = 2.1, 12.0 Hz, 1 H, 6-H), 4.49 (dd, *J* = 4.5, 9.2 Hz, 1 H, 4′-H), 4.65 (d, *J* = 15.0 Hz, 1 H, C*H*$_2$Ph), 7.21–7.43 (m, 5 H, Ph) ppm. ^{13}C NMR ($CDCl_3$, 126 MHz): δ = –5.44, –5.40, 18.3, 26.0 (2 q, s, q, TBS), 25.7, 28.3 (2 q, 2 Me), 58.3 (q, OMe), 60.8 (t, *C*H$_2$Ph), 61.5 (d, C-6), 63.5 (t, 5′-*C*H$_2$–), 63.9 (d, C-4), 70.3 (t, C-3), 76.5 (d, C-4′), 78.2 (d, C-5), 78.7 (d, C-5′), 107.6 (s, C-2′), 126.6, 127.9, 128.6, 138.8 (3 d, s, Ph) ppm. IR (ATR): $\tilde{\nu}$ = 3460 (O–H), 3085–

2825 (=C–H, C–H), 1095 (C–O) cm^{-1}. HRMS (ESI-TOF): calcd. for $C_{24}H_{41}NNaO_6Si$ $[M + Na]^+$ 490.2601; found 490.2600. $C_{24}H_{41}NO_6Si$ (467.7): calcd. C 61.64, H 8.84, N 2.99; found C 61.57, H 8.87, N 2.96.

According to the typical procedure for the hydroboration of *syn*-**5**, compound *anti*-**2** (247 mg, 0.74 mmol) in dry tetrahydrofuran (10 mL) was treated with BH_3·THF (1 M in THF, 3.0 mL, 3.0 mmol), and – after oxidative workup – a colourless oil was obtained and purified by column chromatography (silica gel, ethyl acetate) to give a fraction containing impure **7** (107 mg), and two other fractions containing pure **8** (40 mg, 15%) and pure **9** (22 mg, 8%) as viscous colourless oils. A pure sample of **7** (78 mg, 30%) was obtained by a second chromatographic separation (silica gel, dichloromethane/methanol = 30:1) and subsequent purification by HPLC (Nucleosil 50-5, Macherey–Nagel, 4 × 250 mm, hexane/propan-2-ol = 9:1, flow 2 mL min^{-1}, 129 bar).

(3*S*,4*R*,5*S*,4′*R*,5′*S*)-2-Benzyl-3-(5′-hydroxymethyl-2′,2′-dimethyl-1′,3′-dioxolan-4′-yl)-4-methoxy-3,4,5,6-tetrahydro-2*H*-[1,2]oxazin-an-5-ol (7): $[\alpha]_D^{22}$ = –40.6 (*c* = 1.23, $CHCl_3$). ^1H NMR ([D$_8$]toluene, 80 °C, 500 MHz): δ = 1.24, 1.32 (2 s, 2 × 3 H, 2 Me), 3.13–3.19 (m, 1 H, 6-H), 3.18 (s, 3 H, OMe), 3.45 (m_c, 1 H, 4-H), 3.48 (m_c, 1 H, 5-H), 3.62 (dd, *J* = 4.7, 11.6 Hz, 1 H, 5′-CH_2–), 3.68 (d, *J* = 14.7 Hz, 1 H, CH_2Ph), 3.81–3.85 (m, 1 H, 3-H), 3.89 (dd, *J* = 7.5, 11.6 Hz, 1 H, 5′-CH_2–), 4.08 (br. dd, *J* ≈ 0.9, 12.7 Hz, 1 H, 6-H), 4.13 (dt, *J* ≈ 5.2, 7.5 Hz, 1 H, 5′-H), 4.27 (dd, *J* = 5.7, 8.2 Hz, 1 H, 4′-H), 4.36 (d, *J* = 14.7 Hz, 1 H, CH_2Ph), 7.02–7.07, 7.10–7.16, 7.28–7.33 (3 m, 5 H, Ph) ppm. ^{13}C NMR ([D$_8$]toluene, 80 °C, 126 MHz): δ = 25.6, 28.3 (2 q, 2 Me), 56.3 (t, *C*H$_2$Ph), 58.5 (q, OMe), 60.6 (d, C-3), 62.4 (t, 5′-*C*H$_2$–), 64.7 (t, C-6), 65.0 (d, C-5), 75.4 (d, C-4′), 78.0 (d, C-4), 79.3 (d, C-5′), 107.7 (s, C-2′), 127.5, 128.6, 129.1, 138.2 (3 d, s, Ph) ppm. IR (ATR): $\tilde{\nu}$ = 3400 (O–H), 3060–2830 (=C–H, C–H), 1095, 1070, 1040 (C–O) cm^{-1}. HRMS (ESI-TOF): calcd. for $C_{18}H_{27}NNaO_6$ $[M + Na]^+$ 376.1731; found 376.1736.

(3*R*,4*R*,4′*R*,5′*S*)-4-Benzylamino-4-(5′-hydroxymethyl-2′,2′-dimethyl-1′,3′-dioxolan-4′-yl)-3-methoxybutanol (8): $[\alpha]_D^{22}$ = +16.9 (*c* = 1.21, $CHCl_3$). ^1H NMR ($CDCl_3$, 500 MHz): δ = 1.32, 1.44 (2 s, 2 × 3 H, 2 Me), 1.79 (ddt, *J* ≈ 4.2, 6.5, 14.0 Hz, 1 H, 2-H), 1.90 (dddd, *J* = 4.3, 7.6, 8.9, 14.0 Hz, 1 H, 2-H), 3.35 (dd, *J* = 2.3, 10.0 Hz, 1 H, 4-H), 3.47 (s, 3 H, OMe), 3.70–3.77 (m, 2 H, 5′-CH_2–), 3.75 (d, *J* = 11.8 Hz, 1 H, CH_2Ph), 3.80 (ddd, *J* = 4.3, 6.5, 10.8 Hz, 1 H, 1-H), 3.86–3.92 (m, 2 H, 1-H, 3-H), 3.95 (dd, *J* = 5.7, 10.0 Hz, 1 H, 4′-H), 4.22 (d, *J* = 11.8 Hz, 1 H, CH_2Ph), 4.36 (dt, *J* ≈ 5.3, 9.0 Hz, 1 H, 5′-H), 7.25–7.35 (m, 5 H, Ph) ppm. ^{13}C NMR ($CDCl_3$, 126 MHz): δ = 25.3, 28.0 (2 q, 2 Me), 31.2 (t, C-2), 52.2 (t, *C*H$_2$Ph), 55.7 (d, C-4), 57.5 (q, OMe), 60.4 (t, 5′-*C*H$_2$–), 60.7 (t, C-1), 77.1 (d, C-4′), 77.9 (d, C-5′), 81.9 (d, C-3), 108.4 (s, C-2′), 127.6, 128.6, 128.7, 138.7 (3 d, s, Ph) ppm. IR (ATR): $\tilde{\nu}$ = 3390 (O–H), 3290 (N–H), 3060–2810 (=C–H, C–H), 1050 (C–O) cm^{-1}. HRMS (ESI-TOF): calcd. for $C_{18}H_{30}NO_5$ $[M + H]^+$ 340.2124; found 340.2127. $C_{18}H_{29}NO_5$ (339.4): calcd. C 63.69, H 8.61, N 4.13; found C 63.69, H 8.60, N 4.03.

(2*R*,3*R*,4*R*,4′*R*,5′*S*)-4-Benzylamino-4-(5′-hydroxymethyl-2′,2′-dimethyl-1′,3′-dioxolan-4′-yl)-3-methoxybutane-1,2-diol (9): $[\alpha]_D^{22}$ = +21.0 (*c* = 1.10, $CHCl_3$). ^1H NMR ($CDCl_3$, 500 MHz): δ = 1.33, 1.43 (2 s, 2 × 3 H, 2 Me), 3.32 (dd, *J* = 2.8, 10.3 Hz, 1 H, 4-H), 3.56 (s, 3 H, OMe), 3.68–3.75 (m, 3 H, 1-H, 3-H, 5′-CH_2–), 3.71 (d, *J* = 11.6 Hz, 1 H, CH_2Ph), 3.78 (dd, *J* = 4.8, 11.4 Hz, 1 H, 5′-CH_2–), 3.80 (dd, *J* = 5.9, 11.2 Hz, 1 H, 1-H), 4.05 (ddd, *J* = 2.5, 4.4, 5.9 Hz, 1 H, 2-H), 4.14 (dd, *J* = 5.7, 10.3 Hz, 1 H, 4′-H), 4.29 (d, *J* = 11.6 Hz, 1 H, CH_2Ph), 4.41 (dt, *J* ≈ 5.2, 9.5 Hz, 1 H, 5′-H), 7.24–7.34 (m, 5 H, Ph) ppm. ^{13}C NMR ($CDCl_3$, 126 MHz): δ = 25.4, 28.0 (2 q, 2 Me), 52.9 (t, *C*H$_2$Ph), 56.4 (d, C-4), 59.0 (q, OMe), 60.2 (t, 5′-*C*H$_2$–), 65.3 (t, C-1), 71.4 (d, C-2), 77.2 (d, C-4′), 77.8 (d, C-5′), 82.0 (d, C-3), 108.6 (s, C-2′), 127.6, 128.6, 128.8, 139.0 (3 d, s, Ph) ppm. IR (ATR): $\tilde{\nu}$ = 3385 (OH), 3315 (N–H), 3030–2825 (=C–H, C–H), 1070 (C–O) cm^{-1}. HRMS (ESI-TOF): calcd. for $C_{18}H_{30}NO_6$ $[M + H]^+$ 356.2073; found 356.2081. $C_{18}H_{29}NO_6$ (355.4): calcd. C 60.83, H 8.22, N 3.94; found C 60.93, H 8.32, N 3.89.

(3*R*,4*S*,5*S*,1′*R*,2′*S*)-5-Hydroxy-4-methoxy-3-(1′,2′,3′-trihydroxypropyl)-3,4,5,6-tetrahydro-2*H*-1,2-oxazine (11): Hydrogen was bubbled through a stirred suspension of Pd/C (10% Pd, 86 mg) in dry methanol (10 mL) for 1 h. A solution of **6** (210 mg, 0.45 mmol) in methanol (2 mL) was added, and the mixture was stirred at room temp. at normal pressure (hydrogen balloon). After 45 min, the solution was filtered through a short pad of Celite, and the solvent was removed to provide a colourless oil. This primarily formed debenzylated product was kept in methanol (2 mL) for 24 h, the solvent was removed, and the resulting oil was purified by column chromatography (silica gel, dichloromethane/methanol = 10:1) to give **10** (87 mg, 74%) as a colourless semisolid product. $[\alpha]_D^{22}$ = –34.4 (*c* = 1.19, $CHCl_3$). ^1H NMR ($CDCl_3$, 700 MHz): δ = 1.31, 1.44 (2 s, 2 × 3 H, 2 Me), 3.36 (m_c, 1 H, 4-H), 3.47 (s, 3 H, OMe), 3.65 (dd, *J* = 4.9, 11.8 Hz, 1 H, CH_2OH), 3.68 (dd, *J* = 1.8, 6.8 Hz, 1 H, 3-H), 3.72 (dd, *J* = 5.2, 11.8 Hz, 1 H, CH_2OH), 3.78 (dd, *J* = 1.9, 12.2 Hz, 1 H, 6-H), 3.80 (m_c, 1 H, 5-H), 4.10 (dd, *J* = 0.9, 12.2 Hz, 1 H, 6-H), 4.17 (dd, *J* ≈ 5.2, 10.7 Hz, 1 H, 5′-H), 4.28 (t, *J* ≈ 6.4 Hz, 1 H, 4′-H) ppm. ^{13}C NMR ($CDCl_3$, 126 MHz): δ = 25.3, 27.6 (2 q, 2 Me), 54.9 (d, C-3), 58.9 (q, OMe), 61.3 (t, 5′-*C*H$_2$OH), 64.4 (d, C-5), 71.0 (t, C-6), 75.1 (d, C-4′), 76.6 (d, C-4), 77.4 (d, C-5′), 108.4 (s, C-2′) ppm. IR (ATR): $\tilde{\nu}$ = 3395 (O–H), 3295 (N–H), 2990–2830 (C–H), 1095, 1045 (C–O) cm^{-1}. HRMS (ESI-TOF): calcd. for $C_{11}H_{21}NNaO_6$ $[M + Na]^+$ 286.1267; found 286.1274.

Acidic ion-exchange resin (DOWEX-50, 390 mg, washed several times with ethanol before use) was added to a solution of **10** (80 mg, 0.30 mmol) in ethanol (4.0 mL). The suspension was vigorously stirred at 50 °C for 24 h and then decanted, the resin was washed with three portions of ammonia in methanol solution (7 N, ca. 3.0 mL each), and the organic layers were combined. After evaporation of the solvents, compound **11** (48 mg, 70%) was isolated as a colourless solid. M.p. 182–184 °C. $[\alpha]_D^{22}$ = –6.6 (*c* = 1.01, H_2O). ^1H NMR (CD_3OD, 400 MHz): δ = 3.36 (m_c, 1 H, 4-H), 3.48 (s, 3 H, OMe), 3.61 (dd, *J* = 5.9, 10.4 Hz, 1 H, 3′-H), 3.65 (m_c, 1 H, 3-H), 3.68–3.77 (m, 4 H, 6-H, 1′-H, 2′-H, 3′-H), 3.85 (m_c, 1 H, 5-H), 4.05 (dd, *J* = 2.0, 12.4 Hz, 1 H, 6-H) ppm. ^{13}C NMR (D_2O/CD_3OD = 9:1, 126 MHz, 295K): δ = 56.3 (d, C-3), 57.2 (q, OMe), 62.2 (t, C-3′), 62.7 (d, C-5), 70.5 (t, C-6), 71.2* (t, d, C-1′, C-2′), 76.6 (d, C-4) ppm; * higher intensity. IR (ATR): $\tilde{\nu}$ = 3470–3230 (O–H, N–H), 2965–2830 (C–H), 1090 (C–O) cm^{-1}. HRMS (ESI-TOF): calcd. for $C_8H_{17}NNaO_6$ $[M + Na]^+$ 246.0954; found 246.0942. $C_8H_{17}NO_6$ (223.2): calcd. C 43.04, H 7.68, N 6.27; found C 43.00, H 7.48, N 6.30.

(4a*R*,6*S*,7*R*,7a*R*)-1-Benzyl-7-hydroxy-6-hydroxymethyl-4a-methoxy-hexahydro-1*H*-furano[3,2-*c*][1,2]oxazine (12): A solution of *syn*-**5** (1.21 g, 2.69 mmol) in methanol (20 mL) was added to a stirred solution of *p*TsCl (260 mg, 1.36 mmol) in dry methanol (20 mL), and the mixture was stirred at room temp. for 1 d, quenched with saturated aq. $NaHCO_3$ solution (5 mL) and extracted with dichloromethane (3 × 25 mL). The combined organic layers were dried with $MgSO_4$ and filtered, and the solvents were removed under reduced pressure. The crude products were purified by column chromatography (silica gel, dichloromethane/methanol = 20:1) to

give **12** (686 mg, 86%) as a pale yellow oil. $[\alpha]_D^{22}$ = –71.1 (*c* = 1.05, $CHCl_3$). ^1H NMR ($CDCl_3$, 400 MHz): δ = 1.87 (td, *J* = 6.3, 12.8 Hz, 1 H, 4-H), 2.15, 2.18 (2 m_c, 1 H, 4-H), 3.08 (s, 1 H, 7a-H), 3.25 (br. s, 1 H, 7-OH), 3.36 (s, 3 H, OMe), 3.76 (d, *J* = 14.4 Hz, 1 H, CH_2Ph), 3.80 (br. td, *J* ≈ 2.7, 12.2 Hz, 1 H, 3-H), 3.82 (dd, *J* = 2.7, 11.8 Hz, 1 H, 6-CH_2-), 4.24 (br. dd, *J* ≈ 0.9, 12.2 Hz, 1 H, 3-H), 3.90 (dd, *J* = 2.1, 11.8 Hz, 1 H, 6-CH_2–), 4.13 (br. s, 1 H, 7-H), 4.23 (dd, *J* ≈ 2.3, 4.3 Hz, 1 H, 6-H), 4.24 (d, *J* = 14.4 Hz, 1 H, CH_2Ph), 7.25–7.34 (m, 5 H, Ph) ppm. ^{13}C NMR ($CDCl_3$, 126 MHz): δ = 30.1 (t, C-4), 48.0 (q, OMe), 59.4 (t, *C*H_2Ph), 62.5 (t, 6-*C*H_2–), 65.9 (t, C-3), 75.7 (d, C-7a), 75.8 (d, C-7), 88.4 (d, C-6), 105.5 (s, C-4a), 127.4, 128.2, 129.1, 135.8 (3 d, s, Ph) ppm. IR (ATR): $\tilde{\nu}$ = 3415 (O–H), 3085–2830 (=C–H, C–H), 1060 (C–O) cm^{-1}. HRMS (ESI-TOF): calcd. for $C_{15}H_{21}NNaO_5$ $[M + Na]^+$ 318.1317; found 318.1319.

(4a*R*,6*S*,7*R*,7a*R*)-7-Acetoxy-6-acetoxymethyl-1-benzyl-4a-methoxy-hexahydro-1*H*-furano[3,2-*c*][1,2]oxazine (13): A solution of Ac_2O (0.12 mL, 1.30 mmol) in dichloromethane (6 mL) was added dropwise at 0 °C to a solution of **12** (93 mg, 0.31 mmol), Et_3N (0.35 mL, 3.7 mmol) and DMAP (3.8 mg) in dry dichloromethane (6 mL). The resulting mixture was stirred at room temp. overnight and quenched with water, the organic layer was separated, and the aqueous layer was extracted with three portions of dichloromethane (5 mL each). The combined organic layers were dried with Na_2SO_4 and filtered, and the solvent was removed under reduced pressure. Purification by column chromatography (silica gel, hexane/ethyl acetate = 2:1) yielded product **13** (114 mg, 95%) as a colourless solid. M.p. 73–74 °C. $[\alpha]_D^{22}$ = –93.6 (*c* = 1.15, $CHCl_3$). ^1H NMR ($CDCl_3$, 500 MHz): δ = 1.86 (td, *J* ≈ 6.5, 13.2 Hz, 1 H, 4-H), 2.07, 2.12 (2 s, 2 × 3 H, 2 Ac), 2.16 (br. dd, *J* ≈ 2.1, 13.2 Hz, 1 H, 4-H), 3.11 (s, 1 H, 7a-H), 3.32 (s, 3 H, OMe), 3.67 (d, *J* = 15.3 Hz, 1 H, CH_2Ph), 3.77 (td, *J* ≈ 2.9, 12.0 Hz, 1 H, 3-H), 3.86 (br. dd, *J* ≈ 5.8, 12.0 Hz, 1 H, 3-H), 4.18 (dt, *J* ≈ 4.1, 6.3 Hz, 1 H, 6-H), 4.28 (dd, *J* = 6.3, 11.5 Hz, 1 H, CH_2OAc), 4.40 (d, *J* = 15.3 Hz, 1 H, CH_2Ph), 4.49 (dd, *J* = 4.4, 11.5 Hz, 1 H, CH_2OAc), 4.83 (br. d, *J* ≈ 3.3 Hz, 1 H, 7-H), 7.23–7.26, 7.29–7.35 (2 m, 5 H, Ph) ppm. ^{13}C NMR ($CDCl_3$, 126 MHz): δ = 20.8, 21.0 (2 × q, 2 × Ac), 30.6 (d, C-4), 47.8 (q, OMe), 59.4 (t, *C*H_2Ph), 64.1 (t, *C*H_2OAc), 65.6 (t, C-3), 75.1 (d, C-7a), 77.0 (d, C-7), 80.6 (d, C-6), 105.0 (s, C-4a), 127.0, 128.1, 128.2, 137.7 (3 d, s, Ph), 170.5, 170.8 (2 s, C=O) ppm. IR (ATR): $\tilde{\nu}$ = 3035–2825 (=C–H, C–H), 1735 (C=O), 1235, 1055, 1035 (C–O) cm^{-1}. HRMS (ESI-TOF): calcd. for $C_{19}H_{25}NNaO_7$ $[M + Na]^+$ 402.1529; found 402.1535. $C_{19}H_{25}NO_7$ (379.4): calcd. C 60.15, H 6.64, N 3.69; found C 60.07, H 6.49, N 3.69.

(2*S*,3*R*,4*R*,5*R*)-4-Amino-5-(2-hydroxyethyl)-2-hydroxymethyl-5-methoxy-tetrahydrofuran-3-ol (14): Hydrogen was bubbled through a stirred suspension of Pd/C (10% Pd, 273 mg) in dry methanol (25 mL) for 1 h. A solution of **12** (197 mg, 0.67 mmol) in methanol (5 mL) was added, and the mixture was stirred at room temp. at normal pressure (hydrogen balloon). After 22 h, the solution was filtered through a short pad of Celite, and the solvent was removed to give spectroscopically pure product **14** (131 mg, 95%) as a light yellow oil. $[\alpha]_D^{22}$ = –66.8 (*c* = 1.20, MeOH). ^1H NMR (CD_3OD, 500 MHz): δ = 1.94 (dt, *J* = 7.3, 15.5 Hz, 1 H, 5-CH_2–), 2.11 (dt, *J* = 4.3, 15.5 Hz, 1 H, 5-CH_2–), 3.21 (br. s, 1 H, 4-H), 3.23 (s, 3 H, OMe), 3.82 (dd, *J* = 4.2, 11.8 Hz, 1 H, 2-CH_2OH), 3.64–3.68 (m, 2 H, 5-CH$_2$–CH_2OH), 3.77 (dd, *J* = 2.7, 11.8 Hz, 1 H, 2-CH_2OH), 3.82 (ddd, *J* = 2.7, 4.2, 4.8 Hz, 1 H, 2-H), 3.87 (dd, *J* = 2.2, 4.8 Hz, 1 H, 3-H) ppm. ^{13}C NMR (CD_3OD, 126 MHz): δ = 32.6 (t, 5-*C*H$_2$–), 48.1 (q, OMe), 58.0 (t, 5-CH$_2$–*C*H$_2$OH), 62.3 (t, 2-*C*H$_2$OH), 66.0 (d, C-4), 79.6 (d, C-3), 86.1 (d, C-2), 111.0 (s, C-5) ppm. IR (ATR): $\tilde{\nu}$ = 3450–3220 (O–H, N–H), 2965–2835 (C–H), 1065 (C–O) cm^{-1}. HRMS (ESI-TOF): calcd. for $C_8H_{18}NO_5$ $[M + H]^+$ 208.1185; found 208.1195.

Acid-Mediated Cyclisation of *anti*-2: In a procedure similar to that used for the reaction of *syn*-**5**, a solution of *anti*-**2** (473 mg, 1.41 mmol) in methanol (12 mL) was added to a solution of *p*TsCl (134 mg, 0.70 mmol) in methanol (12 mL), and the mixture was stirred for 1 d to yield a yellow oil. The crude products were purified by column chromatography (silica gel, hexane/ethyl acetate = 3:1 gradient to 1:1) to give **16** as the first eluted fraction (142 mg, 30%, ca. 4:1 mixture of diastereomers), **17** as second fraction (27 mg, 6%), and a mixture of **15** and **18** (243 mg) as the last fraction. The last fraction was purified by a second column chromatography (silica gel, dichloromethane/methanol = 25:1) to afford **18** (8 mg, 2%, >95% purity) and **15** (218 mg, 52%). An additional purification of **16** by column chromatography (silica gel, dichloromethane/methanol = 98:2) gave **16** (117 mg, *dr* = 10:1, 25%) as a colourless oil.

(4a*S*,6*S*,7*R*,7a*S*)-1-Benzyl-6-hydroxymethyl-4a-methoxy-hexahydro-1*H*-furano[3,2-*c*][1,2]oxazinan-7-ol (15): Colourless crystals. M.p. 140–141 °C. Crystals suitable for X-ray analysis were obtained by slow evaporation of the solvent from an ethyl acetate solution. $[\alpha]_D^{22}$ = +71.5 (*c* = 1.61, $CHCl_3$). ^1H NMR ($CDCl_3$, 500 MHz): δ = 1.93 (ddd, *J* = 6.5, 9.7, 13.4 Hz, 1 H, 4-H), 2.03 (dt, *J* ≈ 3.6, 13.4 Hz, 1 H, 4-H), 2.36 (br. s, 1 H, CH$_2$–O*H*), 2.90 (d, *J* = 6.7 Hz, 1 H, 7-O*H*), 3.16 (d, *J* = 4.9 Hz, 1 H, 7a-H), 3.30 (s, 3 H, OMe), 3.72 (br. d, *J* ≈ 11.7 Hz, 1 H, CH_2–OH), 3.76 (d, *J* = 14.9 Hz, 1 H, CH_2Ph), 3.81 (br. dd, *J* ≈ 3.7, 11.7 Hz, 1 H, CH_2–OH), 3.86 (ddd, *J* = 3.4, 6.5, 11.5 Hz, 1 H, 3-H), 3.90 (ddd, *J* = 3.8, 9.7, 11.5 Hz, 1 H, 3-H), 4.30 (dt, *J* ≈ 4.2, 6.4 Hz, 1 H, 6-H), 4.54 (d, *J* = 14.9 Hz, 1 H, CH_2Ph), 4.62 (dt, *J* ≈ 5.2, 6.4 Hz, 1 H, 7-H), 7.23–7.27, 7.30–7.33, 7.32–7.40 (3 m, 5 H, Ph) ppm. ^{13}C NMR ($CDCl_3$, 126 MHz): δ = 30.8 (t, C-4), 48.4 (q, OMe), 61.4 (t, *C*H$_2$Ph), 63.5 (t, –*C*H$_2$OH), 65.2 (t, C-3), 70.5 (d, C-7a), 73.4 (d, C-7), 84.1 (d, C-6), 105.3 (s, C-4a), 126.9, 128.2, 128.3, 138.1 (3 d, s, Ph) ppm. IR (ATR): $\tilde{\nu}$ = 3410 (O–H), 3090–2830 (=C–H, C–H), 1125, 1100, 1065, 1030 (C–O) cm^{-1}. HRMS (ESI-TOF): calcd. for $C_{15}H_{22}NO_5$ $[M + H]^+$ 296.1492; found 296.1518. $C_{15}H_{21}NO_5$ (295.3): calcd. C 61.00, H 7.17, N 4.74; found C 61.06, H 7.24, N 4.74.

(4a*S*,7*S*,8*R*,8a*S*)-1-Benzyl-4a-methoxy-7,8-*O*-isopropylidene-hexahydro-1*H*,3*H*-pyrano[3,2-*c*][1,2]oxazine-7,8-diol (16): $[\alpha]_D^{22}$ = +26.4 (*c* = 0.25, $CHCl_3$, *dr* = 10:1). ^1H NMR ($CDCl_3$, 500 MHz): δ = 1.37, 1.56 (2 s, 2 × 3 H, 2 Me), 2.08–2.16 (m, 1 H, 4-H), 2.26 (ddd, *J* = 7.0, 11.7, 14.0 Hz, 1 H, 4-H), 2.83 (d, *J* = 2.5 Hz, 1 H, 8a-H), 3.28 (s, 3 H, OMe), 3.58 (d, *J* = 13.1 Hz, 1 H, 6-H), 3.69 (dd, *J* = 2.0, 13.1 Hz, 1 H, 6-H), 2.26 (ddd, *J* = 1.8, 7.0, 11.2 Hz, 1 H, 3-H), 3.90 (ddd, *J* = 3.6, 11.2, 11.7 Hz, 1 H, 3-H), 3.94 (d, *J* = 13.7 Hz, 1 H, CH_2Ph), 4.23 (dd, *J* = 2.0, 7.8 Hz, 1 H, 7-H), 4.29 (d, *J* = 13.7 Hz, 1 H, CH_2Ph), 4.68 (dd, *J* = 2.5, 7.8 Hz, 1 H, 8-H), 7.23–7.27, 7.29–7.33, 7.40–7.44 (3 m, 5 H, Ph) ppm. ^{13}C NMR ($CDCl_3$, 126 MHz): δ = 24.6, 26.2 (2 q, 2 Me), 29.3 (t, C-4), 47.8 (q, OMe), 58.4 (t, *C*H$_2$Ph), 61.6 (t, C-6), 63.7 (d, C-8a), 64.3 (t, C-3), 70.6 (d, C-8), 74.6 (d, C-7), 96.6 (s, C-4a), 110.1 [s, O–*C*(CH$_3$)$_2$–O], 127.1, 128.2, 128.8, 137.4 (3 d, s, Ph) ppm. IR (ATR): $\tilde{\nu}$ = 3095–2825 (=C–H, C–H), 1120, 1100, 1055, 1025, 1005 (C–O) cm^{-1}. HRMS (ESI-TOF): calcd. for $C_{18}H_{25}NNaO_5$ $[M + Na]^+$ 358.1625; found 358.1686.

(4a*S*,7*S*,8*R*,8a*S*)-1-Benzyl-4a-methoxy-hexahydro-1*H*,3*H*-pyrano-[3,2-*c*][1,2]oxazine-7,8-diol (17): Colourless crystals. M.p. 144–149 °C. $[\alpha]_D^{22}$ = +78.2 (*c* = 1.45, $CHCl_3$). ^1H NMR ($CDCl_3$, 500 MHz): δ = 1.72 (td, *J* ≈ 5.6, 12.6 Hz, 1 H, 4-H), 2.02 (dt, *J* ≈ 1.9, 12.6 Hz, 1 H, 4-H), 2.41 (br. s, 1 H, 8-OH), 3.16 (br. d, *J* ≈ 3.3 Hz, 1 H, 8a-H), 3.25 (s, 3 H, OMe), 3.70 (d, *J* = 14.7 Hz, 1 H,

CH_2Ph), 3.74 (m_c, 1 H, 7-H), 3.80 (dd, J = 1.7, 11.9 Hz, 1 H, 6-H), 3.85 (ddd, J = 1.5, 5.6, 12.0 Hz, 1 H, 3-H), 3.87 (dd, J = 2.0, 11.9 Hz, 1 H, 6-H), 3.96 (td, $J \approx$ 2.4, 12.0 Hz, 1 H, 3-H), 4.55 (br. s, 1 H, 7-OH), 4.58 (m_c, 1 H, 8-H), 5.07 (d, J = 14.7 Hz, 1 H, CH_2Ph), 7.22–7.25, 7.28–7.36 (2 m, 5 H, Ph) ppm. ^{13}C NMR ($CDCl_3$, 126 MHz): δ = 34.2 (t, C-4), 47.9 (q, OMe), 61.6 (t, CH_2Ph), 66.3 (t, C-3), 66.4 (t, C-6), 68.5 (d, C-8), 69.8 (d, C-8a), 70.5 (d, C-7), 97.8 (s, C-4a), 126.9, 128.2, 128.7, 138.0 (3 d, s, Ph) ppm. IR (ATR): $\tilde{\nu}$ = 3370 (O–H), 3060–2830 (=C–H, C–H), 1130, 1080, 1065, 1055 (C–O) cm^{-1}. HRMS (ESI-TOF): calcd. for $C_{15}H_{21}NNaO_5$ [M + Na]$^+$ 318.1312; found 318.1371.

(4a*R*,7*S*,8*R*,8a*S*)-1-Benzyl-4a-methoxy-hexahydro-1*H*,3*H*-pyrano-[3,2-*c*][1,2]oxazine-7,8-diol (18): Colourless crystals. M.p. 194–198 °C (decomp.). $[\alpha]_D^{22}$ = +55.2 (c = 1.00, $CHCl_3$). ^{1}H NMR ($CDCl_3$, 500 MHz): δ = 1.58 (ddd, J = 5.3, 12.7, 14.1 Hz, 1 H, 4-H), 2.00 (dt, $J \approx$ 1.6, 14.1 Hz, 1 H, 4-H), 2.64 (d, J = 2.8 Hz, 1 H, 8a-H), 2.65 (br. d, $J \approx$ 10.7 Hz, 1 H, 7-OH), 3.31 (s, 3 H, OMe), 3.46 (t, $J \approx$ 10.9 Hz, 1 H, 6-H), 3.63–3.70 (m, 1 H, 7-H), 3.71 (d, J = 14.2 Hz, 1 H, CH_2Ph), 3.73 (dd, J = 5.9, 10.9 Hz, 1 H, 6-H), 3.86 (ddd, J = 1.3, 5.3, 11.7 Hz, 1 H, 3-H), 3.95 (br. td, $J \approx$ 2.2, 11.7 Hz, 1 H, 3-H), 4.18 (d, J = 9.9 Hz, 1 H, 8-OH), 4.23 (dt, $J \approx$ 2.8, 9.9 Hz, 1 H, 8-H), 4.43 (d, J = 14.2 Hz, 1 H, CH_2Ph), 7.24–7.34, 7.40–7.43 (2 m, 5 H, Ph) ppm. ^{13}C NMR ($CDCl_3$, 126 MHz): δ = 31.3 (t, C-4), 47.7 (q, OMe), 57.4 (t, CH_2Ph), 59.9 (t, C-6), 65.7 (t, C-3), 66.5 (d, C-7), 67.3 (d, C-8), 67.9 (d, C-8a), 98.1 (s, C-4a), 127.1, 128.1, 129.1, 136.9 (3 d, s, Ph) ppm. IR (ATR): $\tilde{\nu}$ = 3460 (O–H), 3060–2830 (=C–H, C–H), 1140, 1060, 1045, 1030 (C–O) cm^{-1}. HRMS (ESI-TOF): calcd. for $C_{15}H_{21}NNaO_5$ [M + Na]$^+$ 318.1312; found 318.1331.

(3*S*,4′*R*,5′*S*)-2-Benzyl-3-(5′-benzyloxymethyl-2′,2′-dimethyl-1′,3′-dioxolan-4′-yl)-4-methoxy-3,6-dihydro-2*H*-[1,2]oxazine (19): Ag_2O (217 mg, 0.93 mmol) was added at room temp. to a solution of *anti*-**2** (103 mg, 0.31 mmol) in dry toluene (2 mL), and the mixture was stirred for 1 h. Benzyl bromide (145 mg, 0.10 mL, 0.80 mmol) was added in two portions (0.05 mL each, the second batch was added after 24 h), and the mixture was heated at reflux for 2 d (TLC monitoring). The mixture was filtered through a short Celite pad and washed with dichloromethane, and the solvents were removed. The resulting complex mixture was purified twice by column chromatography on silica gel (first: hexane/ethyl acetate = 3:1; second: dichloromethane/methanol = 19:1) to give pure **19** (50 mg, 38%) as a colourless oil. $[\alpha]_D^{22}$ = +59.2 (c = 2.50, $CHCl_3$). ^{1}H NMR ($CDCl_3$, 500 MHz): δ = 1.37, 1.48 (2 s, 2× 3 H, 2 Me), 3.24 (d, J = 8.2 Hz, 1 H, 3-H), 3.31 (dd, J = 8.4, 10.4 Hz, 1 H, 5′-CH_2–), 3.60 (s, 3 H, OMe), 3.78 (dd, J = 2.8, 10.4 Hz, 1 H, 5′-CH_2–), 3.86, 4.01 (2 d, J = 13.4 Hz, 1 H each, NCH_2Ph), 4.19 (dd, J = 3.0, 15.0 Hz, 1 H, 6-H), 4.38 (br. dt, $J \approx$ 1.7, 15.0 Hz, 1 H, 6-H), 4.41 (d, J = 12.4 Hz, 1 H, OCH_2Ph), 4.43 (ddd, J = 2.8, 5.9, 8.4 Hz, 1 H, 5′-H), 4.53 (d, J = 12.4 Hz, 1 H, OCH_2Ph), 4.57 (dd, J = 5.9, 8.2 Hz, 1 H, 4′-H), 4.76 (t, $J \approx$ 2.7 Hz, 1 H, 5-H), 7.24–7.33 (m, 10 H, 2 Ph) ppm. ^{13}C NMR ($CDCl_3$, 126 MHz): δ = 25.6, 27.5 (2 q, 2 Me), 53.9 (q, OMe), 56.7 (t, NCH_2Ph), 59.8 (d, C-3), 60.8 (t, C-6), 69.0 (t, 5′-CH_2), 73.2 (t, OCH_2Ph), 77.3* (d, C-4′, C-5′), 90.6 (d, C-5), 108.6 (s, C-2′), 127.4, 127.5, 127.7, 128.28, 128.32, 129.1, 136.6, 138.2 (6 d, 2 s, 2 Ph), 150.9 (s, C-4) ppm; * higher intensity. IR (ATR): $\tilde{\nu}$ = 3085–2830 (=C–H, C–H), 1675 (C=C), 1365, 1215, 1075 (C–O) cm^{-1}. HRMS (ESI-TOF): calcd. for $C_{25}H_{31}NNaO_5$ [M + Na]$^+$ 448.2094; found 448.2116. $C_{25}H_{31}NO_5$ (425.5): calcd. C 70.57, H 7.34, N 3.29; found C 70.54, H 7.34, N 3.37.

(3*S*,4′*R*,5′*S*)-2-Benzyl-3-(5′-*tert*-butyldiphenylsiloxymethyl-2′,2′-dimethyl-1′,3′-dioxolan-4′-yl)-4-methoxy-3,6-dihydro-2*H*-[1,2]oxazine (20): Imidazole (180 mg, 2.65 mmol), DMAP (12 mg, 0.10 mmol) and *tert*-butylchlorodiphenylsilane (683 mg, 2.49 mmol) in dichloromethane (60 mL) were added dropwise at 0 °C to a solution of *anti*-**2** (588 mg, 1.75 mmol) in dry dichloromethane (80 mL). The mixture was allowed to reach room temp. and stirred for 36 h. Dichloromethane (40 mL) was added followed by H_2O (80 mL), and the layers were separated. The aqueous layer was extracted with dichloromethane (3× 30 mL), the combined organic layers were washed with brine (30 mL), dried (Na_2SO_4) and filtered, and the solvents were removed in vacuo. Purification by column chromatography (silica gel, hexane/ethyl acetate = 6:1) yielded **20** (0.782 g, 78%) as a colourless solid. M.p. 82–83 °C. $[\alpha]_D^{22}$ = +37.3 (c = 1.37, $CHCl_3$). ^{1}H NMR ($CDCl_3$, 500 MHz): δ = 1.08 (s, 9 H, TBS), 1.39, 1.48 (2 s, 2× 3 H, 2 Me), 3.45 (br. s, 1 H, 3-H), 3.58 (s, 3 H, OMe), 3.76 (dd, J = 7.2, 11.1 Hz, 1 H, 5′-CH_2–), 3.77, 3.93 (2 br. d, J = 13.7 Hz, 1 H each, CH_2Ph), 4.08 (br. dd, $J \approx$ 1.7, 15.0 Hz, 1 H, 6-H), 4.14 (dd, J = 3.3, 11.1 Hz, 1 H, 5′-CH_2–), 4.27 (br. d, $J \approx$ 15.0 Hz, 1 H, 6-H), 4.37 (ddd, J = 3.3, 6.3, 7.2 Hz, 1 H, 5′-H), 4.61 (br. t, $J \approx$ 6.8 Hz, 1 H, 4′-H), 4.71 (t, $J \approx$ 2.7 Hz, 1 H, 5-H), 7.15–7.21, 7.33–7.44, 7.71–7.75 (3 m, 15 H, Ph) ppm. ^{13}C NMR ($CDCl_3$, 126 MHz): δ = 19.2, 26.8 (s, q, TBS), 25.4, 27.5 (2 q, 2 Me), 54.0 (q, OMe), 56.8 (t, CH_2Ph), 60.6 (d, C-3), 61.2 (t, C-6), 63.5 (t, 5′-CH_2–), 77.0 (d, C-5′), 78.9 (d, C-4′), 90.7 (d, C-5), 108.2 (s, C-2′), 127.1, 127.52, 127.54, 128.1, 128.4, 129.5*, 133.4, 133.7, 135.6, 135.7, 136.9 (6 d, 2 s, 2 d, s, Ph), 151.2 (s, C-4) ppm; * higher intensity. IR (ATR): $\tilde{\nu}$ = 3070–2850 (=C–H, C–H), 1675 (C=C), 1220, 1110, 1070 (C–O) cm^{-1}. HRMS (ESI-TOF): calcd. for $C_{34}H_{43}NNaO_5Si$ [M + Na]$^+$ 596.2803; found 596.2818. $C_{34}H_{43}NO_5Si$ (573.8): calcd. C 71.17, H 7.55, N 2.44; found C 71.22, H 7.59, N 2.60.

(4a*S*,6*S*,7*R*,7a*S*)-1-Benzyl-6-(*tert*-butyldiphenylsiloxymethyl)-4a-methoxy-hexahydro-1*H*-furano[3,2-*c*][1,2]oxazinan-7-ol (21): According to the procedure described for the reaction of *syn*-**5**, compound **20** (1.89 g, 3.29 mmol) in methanol (12 mL) was added to a solution of *p*TsCl (310 mg, 1.63 mmol) in methanol (12 mL), and the mixture was stirred for 18 h to give – after purification by column chromatography (silica gel, hexane/ethyl acetate = 5:1, then 1:1) – compounds **21** (1.45 g, 82%) and **15** (121 mg, 13%) as colourless oils.

Analytical Data for 21: $[\alpha]_D^{22}$ = +43.9 (c = 1.15, $CHCl_3$). ^{1}H NMR ($CDCl_3$, 500 MHz): δ = 1.09 (s, 9 H, TBS), 1.88 (ddd, J = 6.9, 9.0, 13.3 Hz, 1 H, 4-H), 2.05 (dt, $J \approx$ 3.6, 13.3 Hz, 1 H, 4-H), 2.42 (br. d, $J \approx$ 4.5 Hz, 1 H, OH), 3.20 (d, J = 4.9 Hz, 1 H, 7a-H), 3.22 (s, 3 H, OMe), 3.80 (d, J = 14.8 Hz, 1 H, CH_2Ph), 3.81 (dd, J = 6.3, 10.5 Hz, 1 H, 6-CH_2–), 3.87–3.91 [m, 3 H, 3-H (2 H), 6-CH_2– (1 H)], 4.30 (td, $J \approx$ 4.8, 6.3 Hz, 1 H, 6-H), 4.63 (d, J = 14.8 Hz, 1 H, CH_2Ph), 4.72 (dt, $J \approx$ 4.9, 6.4 Hz, 1 H, 7-H), 7.26–7.48, 7.70–7.73 (2 m, 15 H, 3 Ph) ppm. ^{13}C NMR ($CDCl_3$, 126 MHz): δ = 19.2, 26.8 (s, q, TBS), 31.5 (t, C-4), 48.2 (q, OMe), 61.2 (t, CH_2Ph), 65.2 (t, 6-CH_2–), 65.4 (t, C-3), 69.7 (d, C-7a), 74.8 (d, C-7), 83.0 (d, C-6), 104.8 (s, C-4a), 126.8, 127.7, 127.8, 128.1, 128.3, 129.8, 129.9, 132.9, 133.0, 135.5, 135.6, 138.3 (7 d, 2 s, 2 d, s, Ph) ppm. IR (ATR): $\tilde{\nu}$ = 3445 (O–H), 3075–2825 (=C–H, C–H), 1115, 1065 (C–O) cm^{-1}. HRMS (ESI-TOF): calcd. for $C_{31}H_{39}NNaO_5Si$ [M + Na]$^+$ 556.2495; found 556.2513.

(2*S*,3*R*,4*S*,5*S*)-4-Amino-5-(2-hydroxyethyl)-2-hydroxymethyl-5-methoxy-tetrahydrofuran-3-ol (22): According to a procedure similar to that used for **12**, hydrogenolysis of **15** (230 mg, 0.69 mmol) in the presence of Pd/C (10% Pd, 317 mg) for 24 h yielded **22** (140 mg, 99%, 97% purity) as a colourless oil. $[\alpha]_D^{22}$ = +31.3 (c = 1.51, CH_3OH). ^{1}H NMR (CD_3OD, 500 MHz): δ = 1.98 (dt, J = 7.5, 15.2 Hz, 1 H, 5-CH_2–), 2.13 (dt, J = 4.7, 15.2 Hz, 1 H, 5-CH_2–), 3.21 (s, 3 H, OMe), 3.24 (br. d, $J \approx$ 5.3 Hz, 1 H, 4-H), 3.55 (dd, J

= 7.5, 11.6 Hz, 1 H, 2-CH_2–), 3.62 (dd, J = 4.7, 7.5 Hz, 2 H, 5-CH_2–CH_2OH), 3.71 (dd, J = 3.4, 11.6 Hz, 1 H, 2-CH_2–), 3.94 (td, J = 3.4, 7.5 Hz, 1 H, 2-H), 4.29 (br. t, $J \approx$ 6.3 Hz, 1 H, 3-H) ppm. ^{13}C NMR (CD_3OD, 126 MHz): δ = 33.2 (t, 5-CH_2–), 48.3 (q, OMe), 58.3 (t, 5-CH_2–CH_2OH), 60.6 (d, C-4), 65.4 (t, 2-CH_2–), 73.1 (d, C-3), 84.5 (d, C-2), 111.2 (s, C-5) ppm. IR (ATR): $\tilde{\nu}$ = 3480–3195 (O–H, N–H), 2960–2850 (C–H), 1095, 1035 (C–O) cm^{-1}. HRMS (ESI-TOF): calcd. for $C_8H_{18}NO_5$ [M + H]$^+$ 208.1185; found 208.1184.

(*E*)-(4*S*,4′*R*,5′*S*)-4-Benzylamino-4-(5′-hydroxymethyl-2′,2′-dimethyl-1′,3′-dioxolan-4′-yl)-3-methoxybut-2-en-1-ol (23): A solution of *anti*-**2** (316 mg, 0.94 mmol) in degassed tetrahydrofuran (30 mL) was added dropwise at room temp. to a solution of samarium diiodide (ca. 0.1 M in tetrahydrofuran, 29 mL, ca. 2.9 mmol). The mixture was stirred for 4 h and was then quenched with satd. aqueous sodium potassium tartrate solution (35 mL) and extracted with three portions of diethyl ether (40 mL each). The combined organic layers were dried ($MgSO_4$) and filtered, and the solvents were removed under reduced pressure to give spectroscopically pure **23** as a yellow oil in quantitative yield. Filtration through a short silica gel pad (hexane/ethyl acetate = 1:1) yielded **23** (275 mg, 87%) as a colourless oil. $[\alpha]_D^{22}$ = +18.6 (c = 1.18, $CHCl_3$). ^{1}H NMR ($CDCl_3$, 500 MHz): δ = 1.30, 1.38 (2 s, 2× 3 H, 2 Me), 3.55 (d, J = 12.0 Hz, 1 H, CH_2Ph), 3.61 (dd, J = 3.6, 11.6 Hz, 1 H, 5′-CH_2–), 3.66 (d, J = 12.0 Hz, 1 H, CH_2Ph), 3.66 (s, 3 H, OMe), 3.74 (dd, J = 9.8, 11.6 Hz, 1 H, 5′-CH_2–), 3.88 (d, J = 10.0 Hz, 1 H, 4-H), 4.01 (dd, J = 7.7, 12.1 Hz, 1 H, 1-H), 4.13 (dd, J = 8.6, 12.1 Hz, 1 H, 1-H), 4.22 (dd, J = 6.3, 10.0 Hz, 1 H, 4′-H), 4.42 (ddd, J = 3.6, 6.3, 9.8 Hz, 1 H, 5′-H), 5.25 (br. t, $J \approx$ 8.2 Hz, 1 H, 2-H), 7.24–7.35 (m, 5 H, Ph) ppm. ^{13}C NMR ($CDCl_3$, 126 MHz): δ = 24.5, 27.2 (2 q, 2 Me), 50.9 (t, CH_2Ph), 54.9 (q, OMe), 55.5 (d, C-4), 56.9 (t, C-1), 60.7 (t, 5′-CH_2–), 76.4 (d, C-4′), 77.9 (d, C-5′), 101.7 (d, C-2), 108.1 (s, C-2′), 127.7, 128.7*, 137.8 (2 d, s, Ph), 155.9 (s, C-3) ppm; * higher intensity. IR (ATR): $\tilde{\nu}$ = 3455–3250 (O–H, N–H), 3065–2830 (=C–H, C–H), 1660 (C=C), 1210, 1045 (C–O) cm^{-1}. HRMS (ESI-TOF): calcd. for $C_{18}H_{27}NNaO_5$ [M + Na]$^+$ 360.1781; found 360.1799.

(2*S*,3*R*,4*S*,5*S*)-4-Benzylamino-2-hydroxymethyl-5-methoxy-5-(2-methoxyethyl)-tetrahydrofuran-3-ol (24): A solution of **23** (118 mg, 0.35 mmol) in methanol (3 mL) was treated with HCl in methanol (3 N, 5 mL) and stirred at room temp. for 5 d. After quenching with satd. $NaHCO_3$ (8 mL), it was extracted with three portions of dichloromethane (5 mL each). The combined organic layers were dried ($MgSO_4$) and filtered, and the solvents were removed under reduced pressure. The crude product was purified on a short pad of silica gel (dichloromethane/methanol = 25:1) to give **24** (95 mg, 87%) as a colourless oil. $[\alpha]_D^{22}$ = +10.2 (c = 1.05, $CHCl_3$). ^{1}H NMR ($CDCl_3$, 500 MHz): δ = 1.88 (dt, $J \approx$ 4.7, 14.7 Hz, 1 H, 5-CH_2–), 2.19 (ddd, J = 5.6, 8.8, 14.7 Hz, 1 H, 5-CH_2–), 2.89 (br. s, 3 H, 2 OH, NH), 3.14 (d, J = 5.9 Hz, 1 H, 4-H), 3.18 (s, 3 H, CH_2OMe), 3.25 (s, 3 H, 2-OMe), 3.28–3.38 (m, 2 H, CH_2OMe), 3.62 (dd, J = 2.5, 12.0 Hz, 1 H, 2-CH_2–), 3.73 (d, J = 12.8 Hz, 1 H, CH_2Ph), 3.75 (dd, J = 2.8, 12.0 Hz, 1 H, 2-CH_2–), 3.94 (d, J = 12.8 Hz, 1 H, CH_2Ph), 4.04 (m_c, 1 H, 2-H), 4.06 (dd, J = 2.3, 5.9 Hz, 1 H, 3-H), 7.23–7.27, 7.30–7.38 (2 m, 5 H, Ph) ppm. ^{13}C NMR ($CDCl_3$, 126 MHz): δ = 30.9 (t, 5-CH_2–), 47.7 (q, 5-OMe), 52.0 (t, CH_2Ph), 58.4 (q, CH_2OMe), 63.0 (t, 2-CH_2–), 63.5 (d, C-4), 68.2 (t, –CH_2OMe), 70.7 (d, C-3), 86.8 (d, C-2), 107.3 (s, C-5), 127.1, 128.3, 128.5, 139.9 (3 d, s, Ph) ppm. IR (ATR): $\tilde{\nu}$ = 3500–3295 (O–H, N–H), 3060–2810 (=C–H, C–H), 1105, 1050, 1025 (C–O) cm^{-1}. HRMS (ESI-TOF): calcd. for $C_{16}H_{26}NO_5$ [M + H]$^+$ 312.1811; found 312.1797. $C_{16}H_{25}NO_5$ (311.4): calcd. C 61.72, H 8.09, N 4.50; found C 61.66, H 8.16, N 4.45.

(2*S*,3*R*,4*S*,5*S*)-3-Acetoxy-2-acetoxymethyl-4-benzylamino-5-methoxy-5-(2-methoxyethyl)-tetrahydrofuran (25): In a procedure similar to that used for **12**, treatment of **24** (115 mg, 0.37 mmol) with Et_3N (0.35 mL, 3.7 mmol), DMAP (4.5 mg, 0.037 mmol) in dry dichloromethane (8 mL) and a solution of Ac_2O (0.15 mL, 1.58 mmol) in dichloromethane (10 mL) yielded – after purification by column chromatography (silica gel, hexane/ethyl acetate = 1:1) – compound **25** (122 mg, 83%) as a colourless oil. $[\alpha]_D^{22}$ = +14.4 (c = 1.15, $CHCl_3$). ^{1}H NMR ($CDCl_3$, 500 MHz): δ = 1.98 (ddd, J = 5.5, 8.0, 14.3 Hz, 1 H, 5-CH_2–), 1.98, 2.10 (2 s, 2× 3 H, 2 Ac), 2.13 (ddd, J = 6.7, 8.3, 14.3 Hz, 1 H, 5-CH_2–), 3.14 (d, J = 7.0 Hz, 1 H, 4-H), 3.22, 3.24 (2 s, 2× 3 H, 2 OMe), 3.44 (ddd, J = 6.7, 8.0, 9.6 Hz, 1 H, –CH_2–OMe), 3.44 (ddd, J = 5.5, 8.3, 9.6 Hz, 1 H, –CH_2–OMe), 3.66, 3.82 (2 d, J = 12.9 Hz, 1 H each, CH_2Ph), 4.01 (br. dd, $J \approx$ 3.4, 6.3 Hz, 1 H, 2-H), 4.17 (dd, J = 4.0, 11.7 Hz, 1 H, 2-CH_2–), 4.33 (dd, J = 3.3, 11.7 Hz, 1 H, 2-CH_2–), 4.99 (dd, J = 2.5, 7.0 Hz, 1 H, 3-H), 7.22–7.34 (m, 5 H, Ph) ppm. ^{13}C NMR ($CDCl_3$, 126 MHz): δ = 20.7, 21.0 (2 q, Ac), 31.5 (t, 5-CH_2–), 47.8 (q, 5-OMe), 51.9 (t, CH_2Ph), 58.3 (q, CH_2OMe), 63.3 (d, C-4), 64.1 (t, 2-CH_2–), 68.1 (t, CH_2OMe), 71.6 (d, C-3), 81.0 (d, C-2), 105.9 (s, C-5), 127.1, 128.3*, 139.9 (2 d, s, Ph), 170.5, 170.8 (2 s, C=O) ppm; * higher intensity. IR (ATR): $\tilde{\nu}$ = 3360 (N–H), 3085–2805 (=C–H, C–H), 1740 (C=O), 1225, 1065, 1035 (C–O) cm^{-1}. HRMS (ESI-TOF): calcd. for $C_{20}H_{30}NO_7$ [M + H]$^+$ 396.2022; found 396.2023. $C_{20}H_{29}NO_7$ (395.4): calcd. C 60.74, H 7.39, N 3.54; found C 60.73, H 7.39, N 3.65.

Supporting Information (see footnote on the first page of this article): Copies of the ^{1}H and ^{13}C NMR spectra of all synthesized compounds.

Acknowledgments

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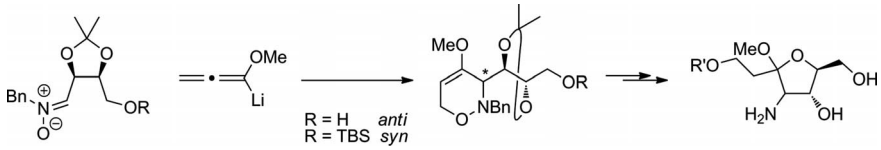

Depending on the protection of the starting L-erythrose-derived nitrone, the addition of lithiated methoxyallene leads to the formation either of *anti*- or of *syn*-configured 1,2-oxazine derivatives. Subsequent hydroboration also proceeds with excellent stereoselectivity. The high synthetic value is demonstrated by conversion of the resulting intermediates into amino polyols.

Keywords: 1,2-Oxazines / *N*-Glycosyl hydroxylamines / Amino alcohols / Hydroboration / Azasugars / Furans / Lithiation / Allenes

