Stereoselective Synthesis of Bromopiperidinones and their Conversion to Annulated Heterocycles

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Dedicated to Professor Hubert Schmidbaur on the occasion of his 75th birthday

N-Galactopyranosyl- and *N*-glucopyranosyl imines of aliphatic, aromatic and heteroaromatic aldehydes react with 1-methoxy-3-trimethylsilyloxy-1,3-butadiene in a domino Mannich-Michael reaction cascade to give 2-substituted 5,6-dehydro-piperidin-4-ones with high diastereoselectivity. Treatment of these cyclic enaminones with *N*-bromo-succinimide yields the corresponding 2-substituted 5-bromo-5,6-dehydropiperidinones which react with L-Selectride® or methylcuprate to afford the saturated bromo-piperidinones with high diastereoselectivity. Condensation reactions of these products with thioamides afford thiazolopiperidines.

Key words: Glycosylamines, Stereoselective Mannich Reactions, Bromopiperidinones, Stereoselective Michael Addition, Thiazolopiperidinones

Introduction

Substituted piperidines constitute interesting pharmacophoric motifs contained in numerous natural products, *e. g.* alkaloids and drugs. Therefore, efficient stereoselective syntheses of functionalized piperidine derivatives are of interest in medicinal chemistry. This also holds for aryl-substituted piperidines. The 4-imidazolyl derivative thioperamide [1] was shown to act as a histamine H_3 and H_4 antagonist, while the heteroaryl-condensed piperidine ticlopidine [2] has the effect of an $P2Y_{12}$ adenosine diphosphate receptor antagonist and impairs the ADP-mediated activation of integrin IIb/IIIa.

Recently we reported the stereoselective synthesis of 2-substituted *N*-arabinopyranosyl-dehydropiperidinones and their further conversion to 2,3-, 2,5- and 2,6-substituted piperidinones [3]. In the present article, we describe the stereoselective synthesis of piperidinones with opposite configuration at position 2 and their conversion to the 5-bromo-piperidines. These α-bromoketones can then be transformed into condensed piperidines.

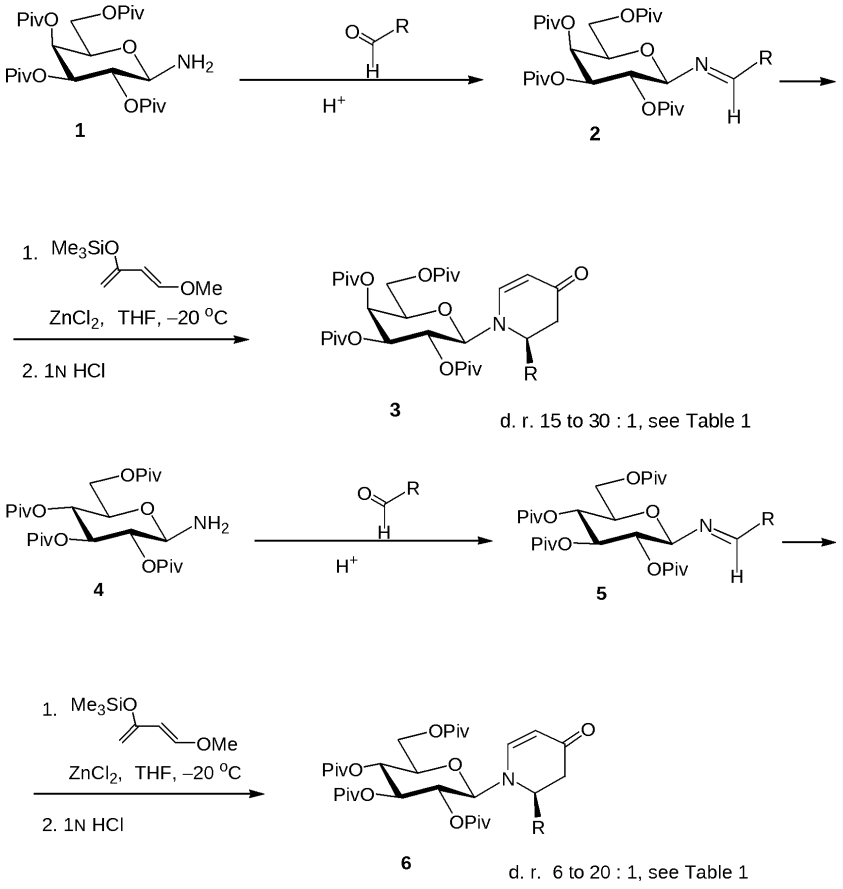
Results and Discussion

2,3,4,6-Tetra-*O*-pivaloyl-β-D-galactopyranosylamine (**1**) reacts with aliphatic, aromatic and heteroaromatic aldehydes to afford the corresponding aldimines **2** (Scheme 1). Lewis acid-catalyzed reactions of these aldimines **2** with 1-methoxy-3-trimethylsilyloxy-butadiene (Danishefsky-diene [4]) afford 2-substituted dehydropiperidinones **3** in a Mannich-Michael-condensation reaction sequence in high yield and high diastereoselectivity [5, 6]. The configuration at C-2 of the major diastereomer **3** of the piperidine derivative is opposite to those of piperidinones formed by analogous reactions of *N*-D-arabinopyranosylimines [3], as has been confirmed by X-ray crystal structure analysis [6].

Aldimines **5** formed analogously from 2,3,4,6-tetra-*O*-pivaloyl-β-D-glucopyranosylamine (**4**) undergo the Mannich-Michael condensation sequence with the Danishefsky diene under identical conditions to give *N*-glucosyl-dehydropiperidinones **6** (Scheme 2). Comparison of these reactions of the glucosylimines with those of the corresponding galactosyl imines displayed in Table 1 shows that the yields are similar to those obtained with the *N*-galactosylimines **2**. However, the diastereoselectivity is slightly lower in case of the *N*-glucosyl derivatives **6**.

Due to the higher diastereoselectivity achieved in their formation, *N*-galactosyl-dehydropiperidones **3** were mostly used for further conversions.

Reactions with *N*-bromosuccinimide (NBS) cannot be performed with *N*-galactosyl piperidinones **3** having C=C double bonds (**3e**) or electron-rich aro-



Scheme 1. d. r. = ratio of diastereomers.

Scheme 2.

Table 1. Domino Mannich-Michael condensation of *N*-glucopyranosyl imine **4** with the Danishefsky diene to give *N*-glucosyl-dehydropiperidinones **6** and comparison with analogous reactions to give the corresponding *N*-galactosyl derivatives **3**.

	N-Glucosyl piperidinones **6**			*N*-Galactosyl piperidinones (**3**)			
	R	Yield (%)	d. r.		Yield (%)	d. r.	ref.
6a	Isopropyl	57	> 12:1[a]	**3a**	58	> 30:1[a]	[6]
6b	3,4-Dimethoxy-phenyl	71	> 9:1[b]	**3b**	72	15:1[b]	[7]
6c	3-Furyl	72	> 20:1[a]	**3c**	72	> 20:1[b]	[8]
6d	4-Cyanophenyl	79	> 20:1[a]	**3d**	71	> 20:1[b]	[6]
6e	Hex-5-enyl	64	> 6:1[a]	**3e**	68	> 40:1[a]	[9]

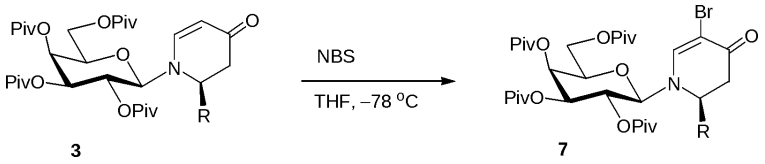
[a] Analytical HPLC of crude product; [b] ^{1}H NMR after chromatography.

matic groups in the side chain. Therefore, in addition to the 2-isopropyl-piperidinone **3a**, the known 2-propyl- (**3f**) [5] and the 2-(4-chlorophenyl)-dehydropiperidinone (**3g**) [5] were also used for bromination reactions. In addition, the 2-phenyl- (**3h**, from benzylaldehyde, yield 88 %, d. r. 26 : 1), 2-(4-bromophenyl)- (**3i**, from 4-bromobenzaldehyde, yield 91 %, d. r. 30 : 1) and 2-ethyl-dehydropiperidinone (**3j**, from propionaldehyde, yield 88 %, d. r. 28 : 1) were synthesized according to Scheme 1.

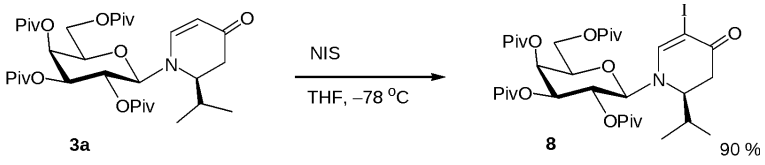
The reactions of *N*-galactosyl-dehydropiperidinones **3** with NBS were performed in tetrahydrofuran at −78 °C (Scheme 3). In case of piperidinones with aliphatic side chains (**3a**, **3f**, **3j**), NBS can be applied in large excess. Piperidones with aromatic side chains (**3c, 3h**) can form by-products containing more than one bromine atom, if NBS was applied in large excess. Provided these limitations are considered, the 5-bromo-dehydropiperidinones **7** were obtained in high yield and in enantiomerically pure form (Scheme 3, Table 2).

The electrophilic substitution reaction can also be carried out with *N*-iodosuccinimide (NIS) under identical conditions, as was shown for the conversion of **3a** to give the 5-iodo-piperidinone **8** (Scheme 4).

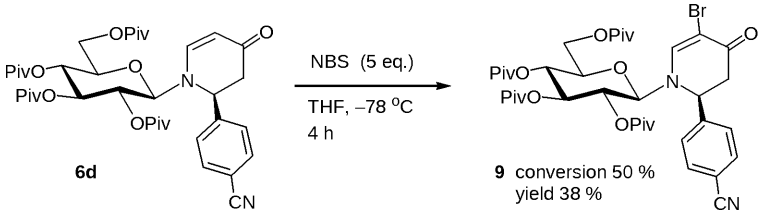
The yield was high and comparable to those achieved with the corresponding *N*-arabinosyl



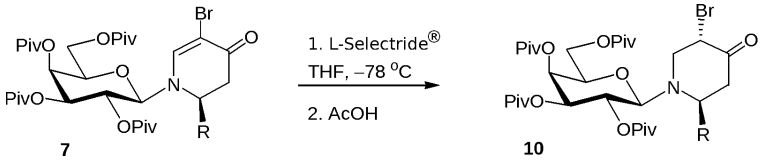
3 **7** Scheme 3.



3a **8** Scheme 4.



6d Scheme 5.



7 **10** Scheme 6.

Table 2. Bromination of *N*-galactosyl-dehydropiperidinones **3** to form compounds **7** (see Scheme 3).

Educt **3**	R	NBS equiv.	Reaction time (h)	Product **7**	Yield[a] (%)
3a	*i*Pr	2	14	**7a**	95
3c	3-Furyl	10[a]	12	**7b**	36
		1.5[b]			62
3f	*n*Pr [5]	5	24	**7c**	48[b]
3g	Ph	2	14	**7d**	89
3h	4-Cl-Ph [5]	1.5	4	**7e**	86
3i	4-Br-Ph	2	2	**7f**	87
3j	Et	5	2	**7g**	87

[a] After chromatography; [b] Reaction time was extended to 12 h at room temperature. This resulted in a decrease of yield.

piperidines of opposite configuration [10]. *N*-Glucosyl-dehydropiperidinones **6** react more slowly with NBS, as is shown for the conversion of **6d** in Scheme 5.

Because the use of 5-halo-dehydropiperidinones in the Knochel transmetallation and C–C bond forming reactions [11] has already been described for *N*-D-arabinosyl derivatives [10], the conversion of compounds **7** to saturated α-bromoketones (piperidinones) was investigated. The conjugate addition of hydride to the enaminine structure [5, 10] of these compounds was achieved with lithium tri-(*sec*-butyl)borohydride (L-Selectride®) in tetrahydrofuran at −78 °C (Scheme 6). The 2,5-*trans*-disubstituted piperidinones **10** were formed in high diastereoselectivity (Table 3).

Table 3. Bromopiperidinones **10** according to Scheme 6.

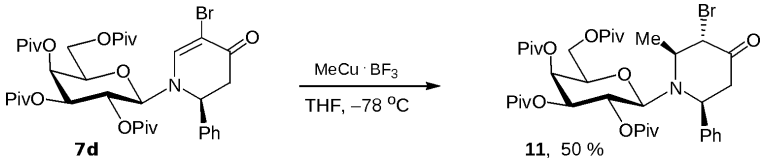
10	R	L-Selectride® equiv.	Reaction time (h)	Yield[a] (%)	d. r.[a]
10a	*i*Pr	1.25	2.5	94	94 : 6 : 0 : 0
10b	*n*Pr	1.25	1	82	91 : 9 : 0 : 0
10c	Et	1.25	2	91	92 : 8 : 0 : 0
10d	Ph	1.25	3	72[b]	83 : 17 : 0 : 0
10e	4-Cl-Ph	1.75	4	71	91 : 9 : 0 : 0
10f	4-Br-Ph	1.75	3	21[c]	88 : 12 : 0 : 0

[a] Analytical HPLC of crude product **10**; [b] 13 % of educt **3g** were recovered; [c] isolated by prep. HPLC.

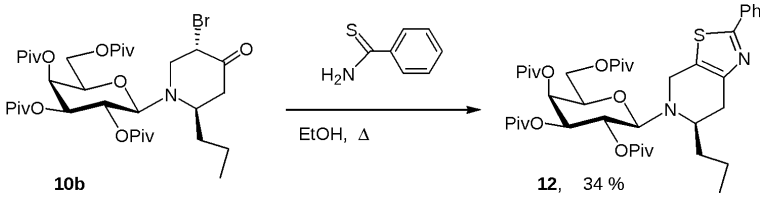
The formation of the *trans*-2,5-disubstituted compounds **10** was confirmed by ^{1}H NMR spectroscopy ($J_{5ax,6ax}$ = 11.7 Hz) and by X-ray crystal structure analysis of the 4-chloro-phenyl-piperidinone **10e** (Fig. 1) [20].

Additional evidence is given by positive NOE contacts between axial 3-H and 5-H in the NMR spectrum of compound **10e**.

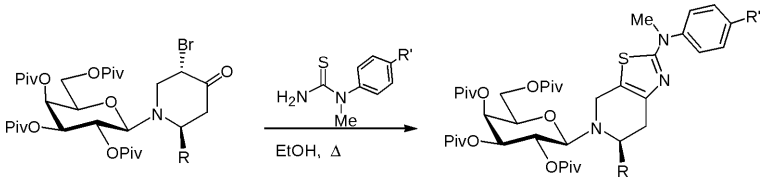
As an alternative to the hydride transfer, conjugate addition of organocopper complexes to the enaminone structure [3, 6] of **7** was investigated, as is shown for **7d** in Scheme 7.



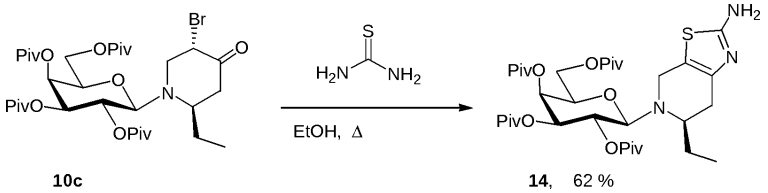
Scheme 7.



Scheme 8.



Scheme 9.



Scheme 10.

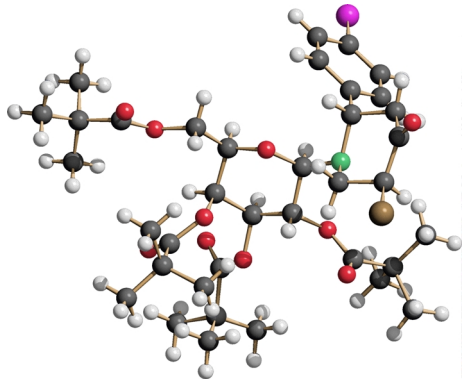


Fig. 1. Molecular structure of *N*-galactosyl-bromo-piperidinone **10e** as determined by single-crystal X-ray diffraction [20].

The 2,5,6-trisubstituted piperidinone **11** was formed slowly (70 % conversion after 14 h), but with high diastereoselectivity to give the 2,6-*cis*-2,5-*trans* major diastereomer. Kinetic protonation of the intermediate enolate should produce the all-*cis* diastereomer [8]. However, the bromo-substituted CH group adjacent to the carbonyl group obviously is too CH-acidic. Therefore, the thermodynamically preferred 5,6-*trans* isomer **11** is obtained with high selectivity.

Efforts to further convert the *N*-glycosyl-bromo-piperidinones to condensed heterocycles according to Hantzsch syntheses [12] were of moderate success. Reaction of **10b** with thiobenzamide in boiling ethanol afforded thiazolo-piperidine **12** in moderate yield (Scheme 8).

Electron-donating groups in the thioamide reagents, *e. g.* in 1-methyl-1-aryl-thiourea (Scheme 9), did not improve the yield of the desired thiazolo-piperidines **13**.

Instead, a number of by-products were formed in these reactions which hardly could be separated. The isolation of the thiazolo-piperidinones **13** was only achieved by preparative HPLC and resulted in low yield of pure compounds.

In contrast, the reaction of bromo-piperidinone **10c** with unsubstituted thiourea in boiling THF in the

presence of DBU as a strong base [13] gave the 2-amino-thiazolo-piperidine **14** (Scheme 10) in satisfactory yield.

Epimerization at C-2 of the piperidine portion was not observed in these reactions. The outcome of these Hantzsch-type reactions [14] suggests that the nucleophilic attack of the thionucleophile is sterically hindered in these *N*-glycosyl-bromo-piperidinones. Considerable amounts of re-isolated starting material **10** after these conversions support this conclusion. Therefore, more promising results might be achieved if the *N*-glycosyl group is removed and substituted by a small *N*-protecting group prior to the Hantzsch reaction. However, the chiral bromo-piperidinones are efficiently accessible with high stereoselectivity by the strategy outlined above. These α-bromoketones are valuable components for further preparative use.

Experimental Section

General procedures

Reagents and solvents were distilled before use: Tetrahydrofuran, dioxane, and Et_2O were distilled from potassium/benzophenone ketyl. CH_2Cl_2 was distilled from CaH_2. Light petroleum refers to b. p. 60 – 80 °C. All reactions and distillations were carried out in flame-dried glassware under argon atmosphere.

Analytical HPLC was carried out using a Knauer system (Knauer MaxiStar K1000 pump and DAD 2062 for diode array detection), flow rate: 1 $cm^3\,min^{-1}$. Preparative HPLC was performed using two Knauer Ministar K500 pumps. Columns: A: Eurospher 100, C8, 5 μ, 250 × 4 mm, Knauer, B: Kromasil C18, 5 μ, 250 × 4 mm, Knauer; flow rate: 1 $cm^3\,min^{-1}$. Thin layer chromatography (TLC) was performed on Merck silica gel 60_{F254}, column chromatography on silica gel 60 (0.6 – 0.2 mm, Baker), flash-chromatography on silica (0.032 – 0.063 mm, ICN Biomedicals, Eschwege, Germany). FAB mass spectra were measured on a Finnigan MAT 95 spectrometer, ESI mass spectra on a Thermoquest Navigator instrument. Melting points were taken on a Büchi Dr. Tottoli apparatus and are uncorrected. ^1H and ^{13}C NMR spectra were recorded on Bruker WT 200, Bruker AC 300 and Bruker AM 400 instruments. Optical rotation values were measured with a Perkin-Elmer 241 polarimeter.

*2,3,4,6-Tetra-O-pivaloyl-β-D-galactopyranosylamine (**1**) [15]*

Compound **1** was prepared in analogy to *O*-pivaloyl-protected L-fucosylamine and D-arabinosylamine [16] from penta-*O*-acetyl-galactopyranose by conversion to the tetra-*O*-acetyl-β-D-galactopyranosyl azide [17] [yield: 97 %, m. p. 97 °C; $[\alpha]_D^{23} = -16.9$ (c = 1, $CHCl_3$)], which was deacetylated using NaOMe in methanol to give β-D-galactopyranosylazide (quant., m. p. 149 °C). *O*-Pivaloylation with pivaloyl chloride in pyridine gave tetra-*O*-pivaloyl-β-D-galactopyranosylazide (91 %, m. p. 90 – 91 °C), which was hydrogenated in methanol over neutral-washed Raney-nickel to give **1** [(90 %, m. p. 66 – 67 °C), $[\alpha]_D^{23} = +8.0$ (c = 1, $CHCl_3$)].

*2,3,4,6-Tetra-O-pivaloyl-β-D-glucopyranosylamine (**4**) [18]*

Compound **4** was prepared in analogy to the synthesis of **1** from penta-*O*-acetyl-glucopyranose *via* 2,3,4,6-tetra-*O*-acetyl-glucopyranosylazide [19], β-glucopyranosyl azide and its *O*-pivaloylation.

*N-(Tetra-O-pivaloyl-β-D-galactopyranosyl)-aldimines **2** and N-(tetra-O-pivaloyl-β-D-glucopyranosyl)-aldimines **5***

Compounds **2** and **3** were obtained according to the general procedures given in ref. [15b] for aliphatic and aromatic aldehydes.

*N-Galactopyranosyl-dehydropiperidinones **3** and N-Glucopyranosyl-dehydropiperidinones **6***

These compounds were synthesized from aldimines **2** or **5** according to the general procedure described in ref. [6]. The procedure was slightly modified: To the solution of the aldimine **2** or **5** (10 mmol) in tetrahydrofuran (50 mL) at −78 °C, 11 mL of a solution of 1 M $ZnCl_2$ in tetrahydrofuran was added. After 15 min stirring at −78 °C, 1-methoxy-3-trimethylsilyloxy-1,3-butadiene (Danishefsky diene, 2.5 mL, 12.5 mmol) was added through a syringe. The mixture was stirred at −78 °C for 30 min, then at −20 °C for 24 – 48 h (TLC monitoring). Work-up was performed as described in [6].

*N-Galactopyranosyl-dehydropiperidinones **3***

Compounds **3a** – **3h** were prepared according to published procedures: **3a** – **3e** [6 – 9], **3f**, **g** [5], and **3h** [15b]; see also Table 1.

*(S)-N-(2,3,4,6-Tetra-O-pivaloyl-β-D-galactopyranosyl-2-(4-bromophenyl)-5,6-dehydropiperidin-4-one (**3i**)*

Purification was carried out by flash-chromatography in light petroleum/ethyl acetate 4 : 1. Yield: 91 %, colorless amorphous solid; $[\alpha]_D^{22} = +16.8$ (c = 1.0, $CHCl_3$). $R_f = 0.18$ (light petroleum/ethyl acetate 3 : 1). Analytical RP-HPLC of the crude product on column LUNA C18 in MeCN-H_2O = 80 : 20 to 100 : 0 within 40 min: R_f = 14.5 min (major diastereomer), ratio of diastereomers (d. r.) = 98 : 2. –

$C_{37}H_{52}BrNO_{10}$ (750.71): calcd. C 59.20, H 6.98, N 1.87; found C 59.07, H 6.90, N 1.84. – MS ((+)-ESI): *m/z* = 772.5 [M(^{79}Br)+Na]$^+$, 774.5 [M(^{81}Br)+Na]$^+$. – ^{1}H NMR (200 MHz, $CDCl_3$): δ = ^{1}H NMR (200 MHz, $CDCl_3$): δ = 7.45 (d, 2H, ^3J = 8.3 Hz, aryl), 7.24 (d, 1H, ^3J = 7.8 Hz, NC*H*=CH), 7.17 (d, 2H, ^3J = 8.3 Hz, aryl), 5.56 (t, 1H, ^3J = 9.8 Hz, H-2), 5.31 (d, 1H, ^3J = 3.4 Hz, H-4), 5.20 (d, 1H, ^3J = 7.8 Hz, NCH=C*H*), 5.01 (dd, 1H, ^3J = 3.4 Hz, ^3J = 9.8 Hz, H-3), 4.79 (dd, 1H, ^3J = 6.3 Hz, ^3J = 8.3 Hz, CHN), 4.35 (d, 1H, ^3J = 9.8 Hz, H-1), 3.93 – 3.70 (m, 3H, H-5, H-6a, H-6b), 2.77 (dd, 1H, ^3J = 5.9 Hz, ^2J = 16.6 Hz, CH_2C=O), 2.61 (dd, 1H, ^3J = 8.5 Hz, ^2J = 16.4 Hz, CH_2C=O), 1.23, 1.15, 1.14, 1.08 (4s, 36H, PivCH_3). – ^{13}C NMR (50.3 MHz, $CDCl_3$): δ = 212.56 (C=O), 177.70, 177.07, 176.44 (PivC=O), 149.71 (N*C*H=CH), 137.82 (*ipso*-aryl), 132.05, 128.77 (aryl), 122.45 (*ipso*-CBr), 103.26 (NCH=*C*H), 88.73 (C-1), 72.74, 71.37, 66.63, 65.24 (C-2, C-3, C-4, C-5), 61.00 (C-6), 59.07 (CHN), 43.52 (*C*H_2C=O), 39.05, 38.93, 38.78, 38.69 (Piv*C*Me_3), 27.18, 27.05 (PivCH_3).

*(2R)-N-(2,3,4,6-Tetra-O-pivaloyl-β-*D*-galactopyranosyl)-2-ethyl-5,6-dehydropiperidin-4-one (**3j**)*

The compound was purified by flash chromatography in light petroleum/ethyl acetate 3 : 1. Yield: 88 %; colorless amorphous solid; $[\alpha]_D^{22}$ = −77.3 (*c* = 1.0, $CHCl_3$). R_f = 0.14 (light petroleum/cyclohexane 3 : 1); d. r.: 97 : 3 (analytical HPLC of crude product, Eurospher C-18, 80 % → 100 % CH_3CN, 20 min, λ = 220 nm, R_t = 8.42 min (minor diastereomer), 9.30 min (major diastereomer). – $C_{33}H_{53}NO_{10}$ (623.77): calcd. C 63.54, H 8.56, N 2.25; found C 63.48, H 8.52, N 2.24. – MS ((+)-ESI): *m/z* = 624.4 [M+H]$^+$, 646.4 [M+Na]$^+$. – ^{1}H NMR ($CDCl_3$, 400 MHz): δ = 6.90 (d, 1H, ^3J = 7.8 Hz, NC*H*=CH), 5.53 (t, 1H, ^3J = 9.6 Hz, H-2), 5.41 (d, 1H, ^3J = 2.8 Hz, H-4), 5.15 (dd, 1H, ^3J = 3.1 Hz, ^3J = 10.2 Hz, H-3), 4.95 (d, 1H, ^3J = 7.8 Hz, NCH=C*H*), 4.55 (d, 1H, ^3J = 9.0 Hz, H-1), 4.15 (dd, 1H, ^3J = 6.4 Hz, ^2J = 10.7 Hz, H-6a), 4.01 (t, 1H, ^3J = 7.0 Hz, H-5), 3.94 (dd, 1H, ^3J = 7.0 Hz, ^2J = 10.6 Hz, H-6b), 3.63 – 3.59 (m, 1H, CHN), 2.58 (dd, 1H, ^3J = 6.1 Hz, ^2J = 16.6 Hz, CH_2C=O), 2.37 (dd, 1H, ^3J = 1.0 Hz, ^2J = 16.6 Hz, CH_2C=O), 1.91 – 1.81 (m, 1H, CH_2), 1.72 – 1.65 (m, 1H, CH_2), 1.27, 1.15, 1.10, 1.09 (4s, 36H, PivCH_3), 0.86 (t, 3H, ^3J = 7.4 Hz, CH_3). – ^{3}C NMR ($CDCl_3$, 100.6 MHz): δ = 192.18 (C=O), 177.81, 177.17, 177.06, 176.52 (PivC=O), 149.78 (N*C*H=CH), 100.10 (NCH=*C*H), 91.47 (C-1), 72.80, 71.31, 66.48, 65.70 (C-2, C-3, C-4, C-5), 60.83 (C-6), 55.25 (CHN), 39.09, 38.90, 38.78, 38.72 (Piv*C*Me_3), 38.62 (*C*H_2C=O), 27.18, 27.12, 27.03 (PivCH_3), 23.77 (CH_2), 10.26 (CH_3).

*N-(2′,3′,4′,6′-Tetra-O-pivaloyl-β-*D*-glucopyranosyl)-2-isopropyl-5,6-dehydropiperidin-4-one (**6a**)*

Purification was carried out by column chromatography with light petroleum/ethyl acetate 3 : 1. Yield: 3.7 g (58 %, based on glucosylamine **4**); colorless, amorphous solid, $[\alpha]_D^{22}$= −73.1 (*c* = 1.1, $CHCl_3$). R_f = 0.11 (light petroleum/ethyl acetate 3 : 1). HPLC (crude product): Eurospher C-18; methanol, 20 % water; UV detection at 309.5 nm; R_t = 8.03 (minor diastereomer), 9.10 min (major diastereomer); d. r.: 10 : 1 (HPLC). – $C_{34}H_{55}NO_{10}$ (637.81): calcd. C 64.03, H 8.69, N 2.20; found C 63.13, H 8.99, N 2.15. – ^{1}H NMR (400 MHz, $CDCl_3$): δ = 0.87 (2d, 6H, *J* = 6.9 Hz, CH_3), 1.08, 1.11 and 1.17 (4s, each 9H, Piv-CH_3), 2.19 (m, 1H, C*H*(CH_3)$_2$), 2.37 (dd, 1H, J_{vic} = 2.5 Hz, J_{gem} = 16.9 Hz, CH_2C=O), 2.55 (dd, 1H, J_{vic} = 7.4 Hz, J_{gem} = 16.9 Hz, CH_2C=O), 3.48 (m, 1H, isoproylCHN), 3.76 (ddd, 1H, $J_{5',6b'}$ = 1.8 Hz, $J_{5,6a'}$ = 5.0b Hz, $J_{5,4}$ = 10.2 Hz, H-5′), 4.03 (dd, 1H, $J_{6a',5'}$ = 5.0 Hz, $J_{6a',6b'}$ = 12.4 Hz, H-6a′), 4.14 (dd, 1H, $J_{6b',5'}$ = 1.8 Hz, $J_{6b',6a'}$ = 12.4 Hz, H-6b′), 4.57 (d, 1H, $J_{1',2'}$ = 8.9 Hz, H-1′), 4.92 (d, 1H, *J* = 7.7 Hz, olefin), 5.10 (dd, 1H, $J_{4,5}$ = 9.9 Hz, $J_{4',3'}$ = 9.5 Hz, H-4′), 5.30 (dd, 1H, $J_{2',3'}$ = 9.2 Hz, $J_{2',1'}$ = 8.8 Hz, H-2′), 5.36 (dd, 1H, $J_{3',2'}$ = 9.1 Hz, $J_{3',4'}$ = 9.3 Hz, H-3′), 6.96 (d, 1H, *J* = 7.8 Hz, alkene). – ^{13}C NMR (100.6 MHz, $CDCl_3$): δ = 17.85 and 19.73 (isopropyl-CH_3), 27.01 und 27.11 (Piv-CH_3), 31.39 (*C*H(CH_3)$_2$), 35.89 (*C*H_2C=O), 38.74, 38.81 and 38.89 (Piv-C_{quart}), 58.87 (isopropyl*C*HN), 61.56 (C-6′), 67.50, 68.33, 72.78 and 74.43 (C-2′, C-3′, C-4′, C-5′), 90.59 (C-1′), 100.96 and 149.43 (alkene), 176.26, 176.83, 176.99 and 177.78 (PivC=O), 192.51 (C=O).

*N-(2′,3′,4′,6′-Tetra-O-pivaloyl-β-*D*-glucopyranosyl)-2-(3″,4″-dimethoxy-phenyl)-5,6-dehydropiperidin-4-one (**6b**)*

Purification was carried out by column chromatography with light petroleum/ethyl acetate 2 : 1. Yield: 5.17 g (71 %, based on glucosylamine **4**), colorless, amorphous solid; $[\alpha]_D^{22}$= −5.0 (*c* = 1.0, $CHCl_3$). R_f = 0.08 (light petroleum/ethyl acetate 3 : 1); d. r.: > 9 : 1. – $C_{39}H_{57}NO_{12}$ (731.87): calcd. C 64.00, H 7.85, N 1.91; found C 63.96, H 7.68, N 2.04. – ^{1}H NMR (200 MHz, $CDCl_3$): δ = 1.08, 1.08, 1.15 and 1.20 (4s, each 9H, Piv-CH_3), 2.60 (dd, 1H, J_{vic} = 5.2 Hz, J_{gem} = 16.5 Hz, CH_2C=O), 2.76 (m, 1H, CH_2C=O), 3.35 (ddd, 1H, $J_{5,4}$ = 9.6 Hz, $J_{5',6a'}$ = 4.6 Hz, $J_{5',6b'}$ = 1.6 Hz, H-5′), 3.85 (s, 3H, OCH_3), 3.90 (m, 1H, H-6a′), 3.91 (s, 3H, OCH_3), 4.09 (dd, 1H, $J_{6b',5'}$ = 1.8 Hz, $J_{6b',6a'}$ = 12.6 Hz, H-6b′), 4.25 (d, 1H, $J_{1',2'}$ = 9.6 Hz, H-1′), 4.72 (dd, 1H, J_{vic} = 5.0 Hz, $J_{vic'}$ = 12.1 Hz, arylCHN), 5.04 (t, 1H, *J* = 9.4 Hz, H-4′), 5.13 (d, 1H, *J* = 8.5 Hz, alkene), 5.20 (m, 1H, H-3′), 5.35 (dd, 1H, $J_{2',3'}$ = 9.0 Hz, $J_{2',1'}$ = 9.3 Hz, H-2′), 6.82 (m, 3H, aryl), 7.29 (d, 1H, *J* = 8.2 Hz, alkene). – ^{13}C NMR (100.6 MHz, $CDCl_3$): δ = 26.94 and 27.07 (Piv-CH_3), 38.67, 38.74 and 38.79 (Piv-C_{quart}), 44.02 (*C*H_2C=O), 55.90 and 56.06 (OCH_3), 61.14 (aryl*C*HN), 61.60 (C-6′), 67.47, 67.56, 72.80 and 74.02 (C-2′, C-3′, C-4′, C-5′), 86.47 (C-1′), 104.05 (alkene), 110.70, 111.50, 120.52 and 129.78 (aryl), 148.94 (alkene), 149.55 and 149.62 (aryl), 176.18, 176.56, 176.91 and 177.76 (PivC=O), 192.06 (C=O).

*N-(2′,3′,4′,6′-Tetra-O-pivaloyl-β-D-glucopyranosyl)-2-(3″-furyl)-5,6-dehydropiperidin-4-one (**6c**)*

Purification was achieved by recrystallization from CH_2Cl_2 and light petroleum. Yield: 4.76 g (72 %); colorless cryst. solid, m. p. 98 °C, $[\alpha]_D^{22}$= −25.5 (c = 1.0, $CHCl_3$). R_f = 0.13 (light petroleum/ethyl acetate 3 : 1); HPLC (crude product): Lichrospher C18; methanol, 25 % water; UV detection at 308.5 nm; R_t = 14.77 (minor diastereomer), 17.00 min (major diastereomer); d. r.: 21.2 : 1 (HPLC). – $C_{35}H_{51}NO_{11}$ (661.79): calcd. C 62.85, H 7.91, N 2.16; found C 62.81, H 7.84, N 2.13. – ^{1}H NMR (200 MHz, $CDCl_3$): δ = 1.06, 1.08 and 1.16 (3s, 36H, Piv-CH_3), 2.61 (m, 2H, CH_2C=O), 3.63 (ddd, 1H, $J_{5',6b'}$ = 1.7 Hz, $J_{5',6a'}$ = 4.7 Hz, $J_{5,4}$ = 10.4 Hz, H-5′), 3.99 (dd, 1H, $J_{6a',5'}$ = 4.8 Hz, $J_{6a',6b'}$ = 12.5 Hz, H-6a′), 4.12 (dd, 1H, $J_{6b',5'}$ = 1.8 Hz, $J_{6b',6a'}$ = 12.5 Hz, H-6b′), 4.48 (d, 1H, $J_{1',2'}$ = 8.8 Hz, H-1′), 4.77 (dd, 1H, J_{vic} = 5.8 Hz, J_{vic} = 7.1 Hz, furylC*H*N), 5.11 (dd, 1H, $J_{4',3'}$ = 7.9 Hz, H-4′), 5.30 (m, 3H, H-3′, H-2′, alkene), 6.37 (s, 1H, aryl), 7.03 (d, 1H, J = 7.9 Hz, alkene), 7.34 (m, 2H, aryl). – ^{13}C NMR (50.3 MHz, $CDCl_3$): δ = 26.93 and 27.03 (Piv-CH_3), 38.67 and 38.78 (Piv-C_{quart}), 42.10 (CH_2C=O), 50.56 (furyl *C*HN), 61.54 (C-6′), 67.28, 68.07, 72.46 and 74.23 (C-2′, C-3′, C-4′, C-5′), 88.31 (C-1′), 102.59 (alkene), 109.59 and 122.68 (furyl), 148.78 (alkene), 176.21, 176.77, 176.91 and 177.79 (PivC=O), 191.86 (C=O).

*N-(2′,3′,4′,6′-Tetra-O-pivaloyl-β-D-glucopyranosyl)-2-(4″-cyano-phenyl)-5,6-dehydropiperidin-4-one (**6d**)*

Purification was carried out by column chromatography in light petroleum/ethyl acetate 3 : 1. Yield: 5.5 g (79 %); colorless, crystalline solid, m. p. 121 °C, $[\alpha]_D^{22}$ = 22.2 (c = 1.0, $CHCl_3$). R_f = 0.44 (light petroleum/ethyl acetate 1 : 1); HPLC (crude product): Lichrospher C18; methanol, 15 % water; UV detection at 309.0 nm; R_t = 2.95 (major diastereomer), 3.31 min (minor diastereomer); d. r.: 22.4:1 (HPLC). – $C_{38}H_{52}N_2O_{10}$ (696.84): calcd. C 65.50, H 7.52, N 4.02; found C 65.47, H 7.50, N 3.97. – ^{1}H NMR (200 MHz, $CDCl_3$): δ = 1.07 (m, 36H, Piv-CH_3), 2.50 (dd, 1H, J_{vic} = 4.6 Hz, J_{gem} = 16.5 Hz, CH_2C=O), 2.90 (dd, 1H, J_{vic} = 7.0 Hz, J_{gem} = 16.5 Hz, CH_2C=O), 3.57 (ddd, 1H, $J_{5',6a'}$ = 1.7 Hz, $J_{5',6b'}$ = 4.2 Hz, $J_{5,4}$ = 10.2 Hz, H-5′), 3.85 (m, 2H, H-6a′, H-6b′), 4.52 (d, 1H, $J_{1',2'}$ = 8.6 Hz, H-1′), 4.97 (m, 2H, H-4′, arylCHN), 5.08 (d, 1H, J = 7.9 Hz, alkene), 5.31 (m, 2H, H-2′, H-3′), 7.17 (d, 1H, J = 7.9 Hz, alkene), 7.37 (d, 2H, J = 8.3 Hz, aryl), 7.54 (d, 2H, J = 8.3 Hz, aryl). – ^{13}C NMR (50.3 MHz, $CDCl_3$): δ = 26.91, 27.06 and 27.13 (Piv-CH_3), 38.67 and 38.90 (Piv-C_{quart}), 42.66 (*C*H_2C=O), 56.77 (aryl*C*HN), 61.13 (C-6′), 66.89, 68.12, 72.04 and 74.41 (C-2′, C-3′, C-4′, C-5′), 90.13 (C-1′), 102.42 (alkene), 111.78, 118.25, 127.86 and 132.30 (aryl), 144.47 (CN), 149.88 (alkene), 176.15, 176.84, 177.06 and 177.45 (PivC=O), 190.04 (C=O).

*N-(2′,3′,4′,6′-Tetra-O-pivaloyl-β-D-glucopyranosyl)-2-(4″-pentenyl)-5,6-dehydropiperidin-4-on (**6e**)*

Purification was carried out by column chromatography in light petroleum/ethyl acetate 4 : 1. Yield: 4.25 g (64 %, related on glucosylamine **4**), colorless, amorphous solid, $[\alpha]_D^{22}$ = −84.9 (c = 1.0, $CHCl_3$). R_f = 0.57 (light petroleum/ethyl acetate 1 : 1). HPLC (crude product): Eurospher C18; methanol, 20 % water; UV detection at 309.0 nm; R_t = 9.65 (minor diastereomer), 11.52 min (major diastereomer); d. r.: 6.2 : 1 (HPLC). – $C_{36}H_{57}NO_{10}$ (663.84): calcd. C 65.14, H 8.65, N 2.11; found C 64.89, H 8.60, N 2.07. – ^{1}H NMR (400 MHz, $CDCl_3$): δ = 1.05, 1.06, 1.10 and 1.16 (4s, each 9H, Piv-CH_3), 1.25, 1.38, 1.59 and 1.83 (4m, each 1H, CH_2), 1.96 (m, 2H, CH_2), 2.29 (d, 1H, J = 16.6 Hz, CH_2C=O), 2.55 (dd, 1H, J_{vic} = 6.4 Hz, J_{gem} = 16.8 Hz, CH_2C=O), 3.67 (m, 1H, alkylC*H*N), 3.75 (dd, 1H, $J_{5,4}$ = 10.1 Hz, $J_{5',6a'}$ = 3.8 Hz, H-5′), 4.00 (m, 2H, H-6a′, H-6b′), 4.51 (d, 1H, $J_{1',2'}$ = 9.1 Hz, H-1′), 4.91 (m, 3H, alkene, alkene-CH_2), 5.11 (dd, 1H, $J_{4,5}$ = 9.8 Hz, $J_{4',3'}$ = 9.6 Hz, H-4′), 5.26 (t, 1H, J = 9.3 Hz, H-3′), 5.34 (t, 1H, J = 9.4 Hz, H-2′), 5.68 (dd, 1H, J_1 = 10.3 Hz, J_2 = 17.0 Hz, alkene′-CH), 6.84.(d, 1H, J = 7.7 Hz, olefin). – ^{13}C NMR (100.6 MHz, $CDCl_3$): δ = 24.85 (CH_2), 26.95, 27.00 and 27.07 (Piv-CH_3), 30.18 and 33.43 (CH_2), 38.66, 38.67, 38.82 and 38.96 (Piv-C_{quart}), 53.33 (alkyl*C*HN), 61.42 (C-6′), 67.24, 68.38, 72.42 and 74.48 (C-2′, C-3′, C-4′, C-5′), 91.25 (C-1′), 100.08 (alkene), 114.93 and 137.88 (alkene-C_{quart}, alkene-C_{tert}), 149.49 (alkene), 176.16, 176.83, 176.90 and 177.66 (PivC=O), 191.90 (C=O).

*Bromination of N-Galactosyl-dehydropiperidinones **3** – General procedure*

To a solution of dehydropiperidinone **3** (see, Table 2, 1 mmol) in tetrahydrofuran (20 mL) at −78 °C, *N*-bromosuccinimide (NBS, equivalents are given for the corresponding compound) was added. The solution was stirred at this temperature for the indicated time. Then, the solution was warmed up to r. t. Diethyl ether (100 mL) was added, and the solution was washed three times with 20 mL of 10 % aqueous $Na_2S_2O_3$. The combined aqueous solutions were extracted with diethyl ether (50 mL). The combined ether solutions were washed with brine (50 mL). After drying with $MgSO_4$, the solvent was evaporated, and the crude product was purified by chromatography.

*(2S)-N-(2,3,4,6-Tetra-O-pivaloyl-β-D-galactopyranosyl)-5-bromo-2-isopropyl-5,6-dehydro-piperidin-4-one (**7a**)*

From **3a**: reaction time: 14 h (2 eq. NBS). Purification by flash-chromatography in cyclohexane/ethyl acetate 5 : 1. Yield: 0.71 g (> 95 %); colorless amorphous solid; R_f = 0.33 (cyclohexane/ethyl acetate 3 : 1); $[\alpha]_D^{22}$ = −104.2

(c = 1.0, $CHCl_3$). $C_{34}H_{54}BrNO_{10}$ (716.70): calcd. C 56.98, H 7.59, N 1.95; found C 56.82, H 7.66, N 1.92. – MS ((+)-ESI): m/z = 716.5 $[M(^{79}Br)+H]^+$, 718.5 $[M(^{81}Br)+H]^+$, 738.4 $[M(^{79}Br)+Na]^+$, 740.4 $[M(^{81}Br)+Na]^+$. – ^{1}H NMR (200 MHz, $CDCl_3$): δ = 7.32 (s, 1H, CH=CBr), 5.49 (t, 1H, ^3J = 10.1 Hz, H-2), 5.41 (d, 1H, ^3J = 2.9 Hz, H-4), 5.14 (dd, 1H, ^3J = 3.2 Hz, ^3J = 10.1 Hz, H-3), 4.62 (d, 1H, ^3J = 8.8 Hz, H-1), 4.18 – 3.90 (m, 3H, H-5, H-6a, H-6b), 3.59 – 3.52 (m, 1H, CHN), 2.75 (dd, 1H, ^3J = 6.8 Hz, ^2J = 17.1 Hz, CH_2C=O), 2.63 (dd, 1H, ^3J = 2.9 Hz, ^2J = 17.1 Hz, CH_2C=O), 2.27 – 2.14 (m, 1H, C*H*$(CH_3)_2$), 1.25, 1.14, 1.10, 1.09 (4s, 36H, PivCH_3), 0.91, 0.86 (2d, 6H, ^3J = 7.1 Hz, CH_3). – ^{13}C NMR (50.3 MHz, $CDCl_3$): δ = 184.90 (C=O), 177.78, 177.14, 176.49 (PivC=O), 149.95 (*C*H=CBr), 92.10 (CH=*C*Br), 90.94 (C-1), 73.13, 71.37, 66.50, 66.01 (C-2, C-3, C-4, C-5), 61.00 (C-6); 59.00 (CHN), 39.10, 39.02, 38.79, 38.31 (Piv*C*Me_3), 35.94 (*C*H_2C=O), 31.63 (*C*H$(CH_3)_2$), 27.20, 27.15 (PivCH_3), 19.79, 17.86 (CH_3).

*N-(2′,3′,4′6′-Tetra-O-pivaloyl-β-*D*-galactopyranosyl)-2-(3″-furyl)-5-b romo-5,6-dehydropiperidin-4-one (**7b**)*

From **3c**: reaction time: 12 h (1.5 eq. NBS). Purification by column chromatography with light petroleum/ethyl acetate 3 : 1. Yield: 0.46 g (62 %); colorless amorphous solid; R_f = 0.37 (light petroleum/ethyl acetate 3 : 1). – $C_{35}H_{50}NO_{11}Br$ (740.68): calcd. C 56.76, H 6.80, N 1.89; found C 56.68, H 6.96, N 1.86. – ^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.35 – 7.39 (m, 3H, alkene, furyl), 6.35 (d, 1H, J = 0.7 Hz, furyl), 5.50 (dd, 1H, $J_{2',1'}$ = 9.4 Hz, $J_{2',3'}$ = 9.8 Hz, H-2′), 5.40 (d, 1H, $J_{4',3'}$ = 3.0 Hz, H-4′), 5.11 (dd, 1H, $J_{3',4'}$ = 3.1 Hz, $J_{3',2'}$ = 10.1 Hz, H-3′), 4.82 (t, 1H, J = 5.8 Hz, furylC*H*N), 4.55 (d, 1H, $J_{1',2'}$ = 9.2 Hz, H-1′), 3.96 – 4.07 (m, 3H, H-5′, H-6a′, H-6b′), 2.92 (dd, 1H, J_{vic} = 7.7 Hz, J_{gem} = 16.6 Hz, CH_2C=O), 2.78 (dd, 1H, J_{vic} = 6.2 Hz, J_{gem} = 16.7 Hz, CH_2C=O), 1.08, 1.11, 1.14 and 1.25 (4s, each 9H, Piv-CH_3). – ^{13}C NMR (100.6 MHz, $CDCl_3$): δ = 184.35 (C=O), 41.64 (*C*H_2C=O), 177.73, 177.09, 177.04 and 176.453 (PivC=O), 149.11 (CH=), 122.47 and 109.57 (furyl), 73.23, 71.21, 66.62 and 66.00, (C-2′, C-3′, C-4′, C-5′), 89.04 (C-1′), 94.05 (CBr), 61.17 (C-6′), 50.44 (furyl*C*HN), 39.09, 38.95, 38.77 and 38.71 (Piv-C_{quart}), 27.21, 27.11 and 27.03 (Piv-CH_3).

*(2R)-N-(2,3,4,6-Tetra-O-pivaloyl-β-*D*-galactopyranosyl)-5-bromo-2-n-propyl-5,6-dehydro-piperidin-4-one (**7c**)*

From **3f**: reaction time: 24 h (5 eq. NBS). Purification by flash-chromatography in light petroleum/ethyl acetate 8 : 1. Yield: 0.34 g (48 %); colorless amorphous solid; $[\alpha]_D^{22}$ = −87.0 (c = 1.0, $CHCl_3$). R_f = 0.44 (light petroleum/ethyl acetate 3 : 1). – $C_{34}H_{54}BrNO_{10}$ (716.70): calcd. C 56.98, H 7.59, N 1.95; found C 56.89, H 7.61, N 1.95. – MS ((+)-ESI): m/z = 716.4 $[M(^{79}Br)+H]^+$, 718.4 $[M(^{81}Br)+H]^+$, 738.5 $[M(^{79}Br)+Na]^+$, 740.5 $[M(^{81}Br)+Na]^+$. – ^{1}H NMR (200 MHz, $CDCl_3$): δ = 7.25 (s, 1H, CH=CBr), 5.52 – 5.42 (m, 2H, H-2, H-4), 5.15 (dd, 1H, ^3J = 3.2 Hz, ^3J = 10.0 Hz, H-3), 4.56 (d, 1H, ^3J = 8.8 Hz, H-1), 4.21-3.90 (m, 3H, H-5, H-6a, H-6b), 3.84-3.73 (m, 1H, CHN), 2.74 (dd, 1H, ^3J = 5.9 Hz, ^2J = 16.6 Hz, CH_2C=O), 2.57 (dd, 1H, ^3J = 1.9 Hz, ^2J = 16.6 Hz, CH_2C=O), 1.65 – 1.59 (m, 1H, CH_2), 1.85 – 1.78 (m, 1H, CH_2), 1.36 – 1.10 (m, 38H, PivCH_3, CH_2), 0.88 (t, 3H, ^3J = 7.3 Hz, CH_3). – ^{13}C NMR (50.3 MHz, $CDCl_3$): δ = 184.53 (C=O), 177.77, 177.16, 177.11, 176.49 (PivC=O), 149.68 (*C*H=CBr), 91.36 (CH=*C*Br), 91.30 (C-1), 73.66, 71.08, 66.46, 66.06 (C-2, C-3, C-4, C-5), 60.87 (C-6), 53.43 (CHN), 39.10 (*C*H_2C=O), 38.99, 38.96, 38.80, 38.75 (Piv*C*Me_3), 32.93 (CH_2), 27.20, 27.13, 27.05 (PivCH_3), 18.87 (CH_2), 13.70 (CH_3).

*(2S)-N-(2,3,4,6-Tetra-O-pivaloyl-β-*D*-galactopyranosyl)-5-bromo-2-phenyl-5,6-dehydro-piperidin-4-one (**7d**)*

From **3g**: reaction time: 14 h (2 eq. NBS). Purification by flash-chromatography with light petroleum/ethyl acetate 8 : 1. Yield: 0.67 g (89 %); colorless amorphous solid, $[\alpha]_D^{22}$ = 7.1 (c = 1.0, $CHCl_3$). R_f = 0.27 (light petroleum/ethyl acetate 5 : 1). – $C_{37}H_{52}BrNO_{10}$ (750.71): calcd. C 59.20, H 6.98, N 1.87; found C 58.97, H 7.12, N 1.81. – MS ((+)-ESI): m/z = 772.3 $[M(^{79}Br)+Na]^+$, 774.3 $[M(^{81}Br)+Na]^+$. – ^{1}H NMR (200 MHz, $CDCl_3$): δ = 7.65 (s, 1H, NCH=CBr), 7.36 – 7.23 (m, 5H, aryl), 5.53 (t, 1H, ^3J = 9.8 Hz, H-2), 5.31 (d, 1H, ^3J = 2.9 Hz, H-4), 4.99 (dd, 1H, ^3J = 2.9 Hz, ^3J = 9.8 Hz, H-3), 4.86 (dd, 1H, ^3J = 6.3 Hz, ^3J = 9.3 Hz, CHN), 4.32 (d, 1H, ^3J = 9.3 Hz, H-1), 3.96 – 3.68 (m, 3H, H-5, H-6a, H-6b), 2.93 – 2.87 (m, 2H, CH_2C=O), 1.26, 1.16, 1.15, 1.08 (4s, 36H, PivCH_3). – ^{13}C NMR (50.3 MHz, $CDCl_3$): δ = 184.26 (C=O), 177.70, 177.08, 177.03, 176.51 (PivC=O), 150.14 (*C*H=CBr), 137.44 (*ipso*-aryl), 129.09, 128.98, 127.13 (aryl), 95.37 (CH=*C*Br), 88.00 (C-1), 72.82, 71.31, 66.60, 65.39 (C-2, C-3, C-4, C-5), 61.08 (C-6), 60.39 (CHN), 43.30 (*C*H_2C=O), 38.96, 38.78, 38.69 (Piv*C*Me_3), 27.21, 27.18, 27.07, 27.04 (PivCH_3).

*(2S)-N-(2,3,4,6-Tetra-O-pivaloyl-β-*D*-galactopyranosyl)-5-bromo-2-(4-chlorphenyl)-5,6-dehydro-piperidin-4-one (**7e**)*

From **3h**: reaction time: 4 h + 4 h (1.5 eq. + 1.5 eq. NBS). Since after 4 h considerable amounts of starting material **3h** were detectable, additional 1.5 eq. of NBS were added, and stirring was continued for additional 4 h. Purification by flash-chromatography with cyclohexane/ethyl acetate 5 : 1. Yield: 0.68 g (86 %); colorless amorphous solid, $[\alpha]_D^{22}$ = 7.3 (c = 1.0, $CHCl_3$). R_f = 0.37 (cyclohexane/ethyl acetate 3 : 1). – $C_{37}H_{51}BrClNO_{10}$ (785.16): calcd. C 56.60, H 6.55, N 1.78; found C 56.65, H 6.56, N 1.70. – MS ((+)-ESI): m/z = 784.2 $[M(^{79}Br)+H]^+$,

786.2 [M(^{81}Br)+H]$^+$, 806.3 [M(^{79}Br)+Na]$^+$, 808.3 [M(^{81}Br)+Na]$^+$, 847.3 [M(^{79}Br)+CH_3CN+Na]$^+$, 849.3 [M(^{81}Br)+CH_3CN+Na]$^+$. – ^{1}H NMR (200 MHz, $CDCl_3$): δ = 7.59 (s, 1H, CH=CBr), 7.30 (d, 2H, ^3J = 8.3 Hz, aryl), 7.19 (d, 2H, ^3J = 8.8 Hz, aryl), 5.52 (t, 1H, ^3J = 9.8 Hz, H-2), 5.33 (d, 1H, ^3J = 3.4 Hz, H-4), 5.05 (dd, 1H, ^3J = 2.9 Hz, ^3J = 10.2 Hz, H-3), 4.86 (t, 1H, ^3J = 6.8 Hz, CHN), 4.42 (d, 1H, ^3J = 9.3 Hz, H-1), 3.89 – 3.78 (m, 3H, H-5, H-6a, H-6b), 2.99 (dd, 1H, ^3J = 5.9 Hz, ^2J = 16.6 Hz, CH_2C=O), 2.79 (dd, 1H, ^3J = 7.6 Hz, ^2J = 16.3 Hz, CH_2C=O), 1.24, 1.16, 1.13, 1.09 (4s, 36H, PivCH_3). – ^{13}C NMR (50.3 MHz, $CDCl_3$): δ = 183.72 (C=O), 177.70, 177.16, 177.05, 176.43 (PivC=O), 150.10 (*C*H=CBr), 136.50, 134.60 (*ipso*-aryl), 129.21, 128.22 (aryl), 94.72 (CH=*C*Br), 88.99 (C-1), 72.97, 71.12, 66.50, 65.58 (C-2, C-3, C-4, C-5), 60.97 (C-6), 58.62 (CHN), 43.03 (*C*H_2C=O), 39.01, 38.78, 38.69 (Piv*C*Me_3), 27.20, 27.04 (PivCH_3).

*(2S)-N-(2,3,4,6-Tetra-O-pivaloyl-β-*D*-galactopyranosyl)-5-bromo-2-(4-bromophenyl)-5,6-dehydropiperidin-4-one (**7f**)*

From **3i**; reaction time: 2 h (2 eq. NBS). Purification by flash-chromatography with light petroleum/ethyl acetate 8 : 1. Yield: 0.72 g (87 %); colorless amorphous solid; $[\alpha]_D^{22}$ = 11.0 (*c* = 1.0, $CHCl_3$). R_f = 0.41 (cyclohexane/ethyl acetate 3 : 1). – $C_{37}H_{51}Br_2NO_{10}$ (829.61): calcd. C 53.57, H 6.20, N 1.69; found C 53.48, H 6.19, N 1.66. – MS ((+)-ESI): *m/z* = 828.4 [M(2 ^{79}Br)+H]$^+$, 830.4 [M(^{79}Br + ^{81}Br)+H]$^+$, 832.4 [M(2 ^{81}Br)+H]$^+$, 850.4 [M(2 ^{79}Br)+Na]$^+$, 852.4 [M(^{79}Br + ^{81}Br)+Na]$^+$, 854.3 [M(2 ^{81}Br)+Na]$^+$. – ^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.59 (s, 1H, CH=CBr), 7.44 (d, 2H, ^3J = 8.2 Hz, aryl), 7.13 (d, 2H, ^3J = 8.6 Hz, aryl), 5.51 (t, 1H, ^3J = 9.6 Hz, H-2), 5.33 (d, 1H, ^3J = 3.1 Hz, H-4), 5.05 (dd, 1H, ^3J = 3.1 Hz, ^3J = 10.2 Hz, H-3), 4.84 (t, 1H, ^3J = 6.8 Hz, CHN), 4.42 (d, 1H, ^3J = 9.4 Hz, H-1), 3.90 – 3.78 (m, 3H, H-5, H-6a, H-6b), 2.98 (dd, 1H, ^3J = 6.2 Hz, ^2J = 16.4 Hz, CH_2C=O), 2.79 (dd, 1H, ^3J = 7.8 Hz, ^2J = 16.4 Hz, CH_2C=O), 1.24, 1.15, 1.13, 1.08 (4s, 36H, PivCH_3). – ^{13}C NMR (50.3 MHz, $CDCl_3$): δ = 183.67 (C=O), 177.69, 177.16, 177.03, 176.41 (PivC=O), 150.06 (*C*H=CBr), 137.02 (*ipso*-aryl), 132.16, 128.50 (aryl), 122.69 (*ipso*-CBr), 94.72 (CH=*C*Br), 89.01 (C-1), 72.98, 71.12, 66.50, 65.59 (C-2, C-3, C-4, C-5), 60.97 (C-6), 58.64 (CHN), 42.96 (*C*H_2C=O), 39.07, 38.99, 38.78, 38.69 (Piv*C*Me_3), 27.20, 27.04 (PivCH_3).

*(2R)-N-(2,3,4,6-Tetra-O-pivaloyl-β-*D*-galactopyranosyl)-5-bromo-2-ethyl-5,6-dehydropiperidin-4-one (**7g**)*

From **3j**: reaction time: 2 h (5 eq. NBS). Purification by flash-chromatography with light petroleum/ethyl acetate 8 : 1. Yield: 0.61 g (87 %); colorless amorphous solid, $[\alpha]_D^{22}$ = −108.4 (*c* = 1.0, $CHCl_3$). R_f = 0.34 (cyclohexane/ethyl acetate 3 : 1). – $C_{33}H_{52}BrNO_{10}$ (702.67): calcd. C 56.41, H 7.46, N 1.99; found C 56.32, H 7.47, N 1.98. – MS ((+)-ESI): *m/z* = 702.5 [M(^{79}Br)+H]$^+$, 704.5 [M(^{81}Br)+H]$^+$, 724.4 [M(^{79}Br)+Na]$^+$, 726.4 [M(^{81}Br)+Na]$^+$, 765.4 [M(^{79}Br)+CH_3CN+Na]$^+$, 767.4 [M(^{81}Br)+CH_3CN+Na]$^+$. – ^{1}H NMR (200 MHz, $CDCl_3$): δ = 7.26 (s, 1H, CH=CBr), 5.48 (t, 1H, ^3J = 10.0 Hz, H-2), 5.42 (d, 1H, ^3J = 3.4 Hz, H-4), 5.15 (dd, 1H, ^3J = 2.9 Hz, ^3J = 10.3 Hz, H-3), 4.57 (d, 1H, ^3J = 8.8 Hz, H-1), 4.15 (dd, 1H, ^3J = 5.9 Hz, ^2J = 9.3 Hz, H-6a), 4.02 (dd, 1H, ^3J = 5.9 Hz, ^2J = 11.7 Hz, H-6b), 3.93 (t, 1H, ^3J = 6.4 Hz, H-5), 3.63 – 3.58 (m, 1H, CHN), 2.73 (dd, 1H, ^3J = 6.1 Hz, ^2J = 16.8 Hz, CH_2C=O), 2.60 (dd, 1H, ^3J = 2.4 Hz, ^2J = 16.6 Hz, CH_2C=O), 1.92 – 1.61 (m, 2H, CH_2), 1.26, 1.15, 1.10, 1.09 (4s, 36H, PivCH_3), 0.86 (t, 3H, ^3J = 7.3 Hz, CH_3). – ^{13}C NMR (50.3 MHz, $CDCl_3$): δ = 184.47 (C=O), 177.78, 177.14, 177.10, 176.44 (PivC=O), 149.71 (*C*H=CBr), 91.37 (CH=*C*Br), 91.21 (C-1), 73.09, 71.10, 66.44, 65.99 (C-2, C-3, C-4, C-5), 60.87 (C-6), 55.40 (CHN), 39.10 (*C*H_2C=O), 38.97, 38.78, 38.74, 38.50 (Piv*C*Me_3), 27.20, 27.12, 27.04 (PivCH_3), 24.09 (CH_2), 10.23 (CH_3).

*(2S)-N-(2,3,4,6-Tetra-O-pivaloyl-β-*D*-galactopyranosyl)-5-iodo-2-isopropyl-5,6-dehydropiperidin-4-one (**8**)*

Compound **8** was synthesized from *N*-galactosyl-2-isoproyl-dehydropiperidinone **3a** (2.13 g, 3.33 mmol) according to the general procedure for the bromination reaction, but using *N*-iodosuccinimide (NIS, 2 eq.) instead of NBS. Reaction time: 2.5 h. Purification was carried out by flash-chromatography with cyclohexane/ethyl acetate 11 : 1. Yield: 2.84 g (90 %); colorless amorphous solid, $[\alpha]_D^{22}$ = −123.9 (*c* = 1.0, $CHCl_3$). R_f = 0.47 (cyclohexane/ethyl acetate 2 : 1). – $C_{34}H_{54}INO_{10}$ (763.70): calcd. C 53.47, H 7.13, N 1.83; found C 53.19, H 7.18, N 1.75. – ESI-MS (ES^+): *m/z* = 764.3 [M+H]$^+$, 786.3 [M+Na]$^+$, 827.4 [M+CH_3CN+Na]$^+$. – ^{1}H NMR (200 MHz, $CDCl_3$): δ = 7.44 (s, 1H, NCH=CI), 5.50 (t, 1H, ^3J = 9.5 Hz, H-2), 5.41 (d, 1H, ^3J = 2.9 Hz, H-4), 5.14 (dd, 1H, ^3J = 2.9 Hz, ^3J = 9.8 Hz, H-3), 4.62 (d, 1H, ^3J = 9.3 Hz, H-1), 4.15 (dd, 1H, ^3J = 5.4 Hz, ^2J = 8.8 Hz, H-6a), 4.07 – 3.90 (m, 2H, H-5, H-6b), 3.65 – 3.57 (m, 1H, CHN), 2.74 (d, 2H, ^3J = 4.9 Hz, CH_2C=O), 2.30 – 2.15 (m, 1H, C*H*(CH_3)$_2$), 1.26, 1.15, 1.11, 1.10 (4s, 36H, PivCH_3), 0.90, 0.86 (2d, 6H, ^3J = 4.6 Hz, CH_3). – ^{13}C NMR (50.3 MHz, $CDCl_3$): δ = 186.16 (C=O), 177.78, 177.14, 176.49 (PivC=O), 154.48 (N*C*H=), 90.90 (C-1), 73.13, 71.37, 66.49, 66.02 (C-2, C-3, C-4, C-5), 64.68 (=*C*I), 61.00 (C-6), 58.94 (CHN), 39.10, 39.05, 38.80, 38.74 (Piv*C*Me_3), 35.08 (*C*H_2C=O), 31.90 (*C*H(CH_3)$_2$), 27.20, 27.04, 26.91 (PivCH_3), 19.78 (CH_3), 17.83 (CH_3).

*N-(2′,3′,4′6′-Tetra-O-pivaloyl-β-*D*-glucopyranosyl)-2-(4″-cyanophenyl)-5-bromo-5,6-dehydropiperidin-4-one (**9**)*

Compound **9** was obtained from *N*-glucopyranosyl-dehydropiperidinone **6d** according to the general procedure for

the bromination of the *N*-galactosyl derivatives using 5 eq. of NBS. Reaction time 4 h. Purification was carried out by column chromatography with light petroleum/ethyl acetate 3 : 1. Yield: 0.295 g (38 %); conversion 50 %; colorless amorphous solid, $[\alpha]_D^{22} = -43.9$ (c = 1.0, $CHCl_3$). R_f = 0.30 (light petroleum/ethyl acetate 3 : 1). – $C_{38}H_{51}N_2O_{10}Br$ (775.73): calcd. C 58.84, H 6.63, N 3.61; found C 58.59, H 6.72, N 3.76. – ^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.57 (d, 2H, J = 8.4 Hz, aryl), 7.54 (s, 1H, alkene), 7.36 (d, J = 8.3 Hz, aryl), 5.33 (dd, 1H, $J_{2',3'}$ = 2.5 Hz, $J_{2',1'}$ = 6.8 Hz, H-2′), 5.30 (dd, 1H, $J_{3',2'}$ = 2.5 Hz, $J_{3',4'}$ = 6.7 Hz, H-3′), 5.01 (m, 2H, H-1′, H-4′), 4.58 (dd, 1H, J_{vic} = 2.3 Hz, $J_{vic'}$ = 6.4 Hz, arylCHN), 3.92 (dd, 1H, $J_{6b',5'}$ = 1.6 Hz, $J_{6b',6a'}$ = 12.6 Hz, H-6b′), 3.82 (dd, 1H, $J_{6a',5'}$ = 4.6 Hz, $J_{6a',6b'}$ = 12.6 Hz, H-6a′), 3.63 (ddd, 1H, $J_{5',6b'}$ = 1.5 Hz, $J_{5',6a'}$ = 4.5 Hz, $J_{5',4'}$ = 10.1 Hz, H-5′), 3.09 (dd, 1H, J_{vic} = 6.8 Hz, J_{gem} = 16.7 Hz, CH_2C=O), 2.77 (dd, 1H, J_{vic} = 4.4 Hz, J_{gem} = 16.7 Hz, CH_2C=O), 1.12, 1.08, 1.07 and 1.06 (4s, je 9H, Piv-CH_3). – ^{13}C NMR (100.6 MHz, $CDCl_3$): δ = 182.77 (C=O), 177.40, 177.14, 176.79, 176.14 (PivC=O), 149.58 (NCH=), 143.55 (CN), 132.50, 127.22, 118.04 and 112.27 (aryl), 94.00 (=CBr), 89.93 (C-1′), 74.71, 71.92, 68.45 and 66.88 (C-2′, C-3′, C-4′, C-5′), 61.11 (C-6′), 56.80 (aryl*C*HN), 42.24 (CH_2C=O), 38.96 and 38.69 (Piv-C_{quart}), 27.13, 27.06, 26.94 (Piv-CH_3).

*N-Galactosyl bromopiperidinones (**10**) – General procedure*

To a solution of 5-bromo-5,6-dehydropiperidinone **7** (2 mmol) in 25 mL of dry tetrahydrofuran at −78 °C, 1.25 eq. (or 1.75 eq., see Table 3) of a 1 M solution of L-Selectride® in tetrahydrofuran was added dropwise. After stirring for the reaction time given in Table 3 the solution was warmed up to r. t. and stirred for 15 min. Then, the mixture was cooled to −78 °C, and 1 mL glacial acetic acid was added. At r. t., the solvent was evaporated *in vacuo*. The remainder was dissolved in diethyl ether (50 mL), and the solution was washed with brine (20 mL). After drying the organic solution with $MgSO_4$ the solvent was evaporated *in vacuo* to give the crude 5-bromo-piperidinones **10**.

*(2S,5S)-N-(2,3,4,6-Tetra-O-pivaloyl-β-D-galactopyr-anosyl)-5-bromo-2-isopropyl-piperidin-4-one (**10a**)*

From **3a**. Reaction time: 2.5 h. Purification by flash-chromatography with cyclohexane/ethyl acetate 6 : 1. Yield: 1.35 g (94 %); yellow amorphous solid; $[\alpha]_D^{22} = -1.2$ (c = 1.0, $CHCl_3$). R_f = 0.44 (cyclohexane/ethyl acetate 3 : 1); d. r.: 94 : 6 : 0 : 0 (analytical HPLC of the crude product, Luna C-18, 80 % → 100 % CH_3CN, 40 min, λ = 240 nm, R_t = 27.62 (minor diastereomer), 31.47 min (major diastereomer)). – MS ((+)-ESI): m/z = 718.4 [M(^{79}Br)+H]$^+$, 720.4 [M(^{81}Br)+H]$^+$, 740.3 [M(^{79}Br)+Na]$^+$, 742.3 [M(^{81}Br)+Na]$^+$. – ^{1}H NMR (400 MHz, $CDCl_3$): δ = 5.52 – 5.46 (m, 1H, H-2), 5.37 (d, 1H, ^3J = 2.3 Hz, H-4), 5.14 (dd, 1H, ^3J = 2.9 Hz, ^3J = 10.0 Hz, H-3), 4.87 (dd, 1H, ^3J = 6.7 Hz, ^3J = 11.2 Hz, CHBr), 4.42 (d, 1H, ^3J = 9.4 Hz, H-1), 4.02 – 3.86 (m, 4H, H-5, H-6a, H-6b, NCH_2), 3.10 (dd, 1H, ^3J = 11.1 Hz, ^2J = 15.1 Hz, NCH_2), 2.99 (dd, 1H, ^3J = 5.7 Hz, ^2J = 12.7 Hz, CH_2CO), 2.89 – 2.82 (m, 2H, CHN, CH_2CO), 1.64 – 1.55 (m, 1H, C*H*(CH_3)$_2$), 1.27, 1.14, 1.12, 1.11 (4s, 36H, PivCH_3), 0.88, 0.82 (2d, 6H, ^3J = 6.7 Hz, CH_3). – ^{13}C NMR (50.3 MHz, $CDCl_3$): δ = 200.51 (C=O), 177.83, 177.35, 177.14, 176.76 (PivC=O), 95.39 (C-1), 72.20, 72.03, 67.30, 66.47 (C-2, C-3, C-4, C-5), 65.74 (CHN), 62.08 (C-6), 53.51 (CHBr), 49.79 (NCH_2), 44.37 (*C*H_2C=O), 38.70, 38.80 (Piv*C*Me_3), 29.77 (*C*H(CH_3)$_2$), 27.28, 27.23, 27.10, 27.07 (PivCH_3), 20.19, 19.71 (CH_3).

*(2R,5S)-N-(2,3,4,6-Tetra-O-pivaloyl-β-D-galactopyr-anosyl)-5-bromo-2-n-propyl-piperidin-4-one (**10b**)*

From **3f**. Reaction time: 1 h. Purification by flash-chromatography with cyclohexane/ethyl acetate 8 : 1. Yield: 1.18 g (82 %); colorless amorphous solid, $[\alpha]_D^{22}$ = 1.2 (c = 1.0, $CHCl_3$). R_f = 0.41 (light petroleum/ethyl acetate 3 : 1); d. r.: 91 : 9 : 0 : 0 (analytical HPLC of the crude product, Luna C-18, 80 % → 100 % CH_3CN, 40 min, λ = 215 nm, R_t = 27.60 (minor diastereomer), 30.32 min (major diastereomer)). – $C_{34}H_{56}BrNO_{10}$ (718.71): calcd. C 56.82, H 7.85, N 1.95; found C 56.89, H 7.81, N 1.95. – MS ((+)-ESI): m/z = 718.4 [M(^{79}Br)+H]$^+$, 720.4 [M(^{81}Br)+H]$^+$, 740.3 [M(^{79}Br)+Na]$^+$, 742.3 [M(^{81}Br)+Na]$^+$. – ^{1}H NMR ($CDCl_3$, 400 MHz): δ = 5.47 (t, 1H, ^3J = 9.6 Hz, H-2), 5.38 (d, 1H, ^3J = 2.7 Hz, H-4), 5.14 (dd, 1H, ^3J = 2.9 Hz, ^3J = 9.9 Hz, H-3), 4.89 (dd, 1H, ^3J = 6.8 Hz, ^3J = 11.1 Hz, CHBr), 4.43 (d, 1H, ^3J = 9.4 Hz, H-1), 4.05 – 3.90 (m, 3H, H-5, H-6a, H-6b), 3.86 (dd, 1H, ^3J = 6.1 Hz, ^2J = 15.1 Hz, NCH_2), 3.35 – 3.29 (m, 1H, CHN), 3.14 (dd, 1H, ^3J = 11.3 Hz, ^2J = 14.5 Hz, NCH_2), 3.02 (dd, 1H, ^3J = 6.3 Hz, ^2J = 13.3 Hz, CH_2C=O), 2.52 (dd, 1H, ^3J = 1.4 Hz, ^2J = 13.1 Hz, CH_2C=O), 1.42 – 1.30 (m, 4H, CH_2), 1.27, 1.14, 1.13, 1.10 (4s, 36H, PivCH_3), 0.84 (t, 3H, ^3J = 7.2 Hz, CH_3). – ^{13}C NMR (50.3 MHz, $CDCl_3$): δ = 200.05 (C=O), 177.29, 177.10, 176.92, 176.75 (PivC=O), 95.42 (C-1), 72.31, 71.93, 67.06, 65.56 (C-2, C-3, C-4, C-5), 63.04 (CHN), 62.05 (C-6), 54.23 (CHBr), 49.68 (NCH_2), 47.35 (*C*H_2C=O), 39.13, 38.78, 38.74, 38.70 (Piv*C*Me_3), 35.14 (CH_2), 27.18, 27.26 (Piv-CH_3), 19.62 (CH_2), 13.65 (CH_3).

*(2R,5S)-N-(2,3,4,6-Tetra-O-pivaloyl-β-D-galactopyr-anosyl)-5-bromo-2-ethyl-piperidin-4-one (**10c**)*

From **3h**. Reaction time: 2 h. Purification by flash-chromatography with cyclohexane/ethyl acetate 8 : 1. Yield: 1.28 g (91 %); colorless amorphous solid, $[\alpha]_D^{22}$ = 3.3 (c = 1.0, $CHCl_3$). R_f = 0.38 (cyclohexane/ethyl acetate 3 : 1); d. r.: 92 : 8 : 0 : 0 (analytical HPLC of the crude

product, Luna C-18, 80 % → 100 % CH_3CN, 40 min, λ = 228 nm, R_t = 24.37 (minor diastereomer), 27.58 min (major diastereomer)). – $C_{33}H_{54}BrNO_{10}$ (704.69): calcd. C 56.25, H 7.72, N 1.99; found C 56.50, H 7.81, N 1.94. – MS ((+)-ESI): *m/z* = 602.3 $[M(^{79}Br)–PivOH+H]^+$, 604.3 $[M(^{81}Br)–PivOH+H]^+$, 704.7 $[M(^{79}Br)+H]^+$, 706.5 $[M(^{81}Br)+H]^+$, 726.3 $[M(^{79}Br)+Na]^+$, 728.4 $[M(^{81}Br)+Na]^+$, 767.3 $[M(^{79}Br)+CH_3CN+Na]^+$, 769.4 $[M(^{81}Br)+CH_3CN+Na]^+$. – ^{1}H NMR (400 MHz, $CDCl_3$): δ = 5.47 (t, 1H, ^3J = 9.8 Hz, H-2), 5.37 (d, 1H, ^3J = 2.8 Hz, H-4), 5.13 (dd, 1H, ^3J = 3.1 Hz, ^3J = 9.8 Hz, H-3), 4.87 (dd, 1H, ^3J = 6.8 Hz, ^3J = 11.2 Hz, CHBr), 4.42 (d, 1H, ^3J = 9.0 Hz, H-1), 4.06 – 3.89 (m, 3H, H-5, H-6a, H-6b), 3.84 (dd, 1H, ^3J = 6.6 Hz, ^2J = 14.9 Hz, NCH_2), 3.24 – 3.18 (m, 1H, CHN), 3.13 (dd, 1H, ^3J = 11.3 Hz, ^3J = 14.9 Hz, NCH_2), 3.00 (dd, 1H, ^3J = 6.3 Hz, ^2J = 13.3 Hz, CH_2C=O), 2.55 (dd, 1H, ^3J = 2.0 Hz, ^2J = 13.3 Hz, CH_2C=O), 1.47 – 1.34 (m, 2H, CH_2), 1.26, 1.13, 1.12, 1.09 (4s, 36H, PivCH_3), 0.81 (t, 3H, ^3J = 7.4 Hz, CH_3). – ^{13}C NMR (100.6 MHz, $CDCl_3$): δ = 200.04 (C=O), 177.79, 177.25, 176.88, 176.70 (PivC=O), 95.26 (C-1), 72.22, 71.87, 66.98, 65.46 (C-2, C-3, C-4, C-5), 64.73 (CHN), 62.00 (C-6), 54.05 (CHBr), 49.57 (NCH_2), 46.91 (CH_2C=O), 39.07, 38.72, 38.68, 38.65 (Piv$C$Me$_3$), 27.20, 27.15, 27.01 (PivCH_3), 26.01 (CH_2), 11.01 (CH_3).

*(2S,5S)-N-(2,3,4,6-Tetra-O-pivaloyl-β-*D*-galactopyranosyl)-5-bromo-2-phenyl-piperidin-4-one (**10d**)*

From **3g**. Reaction time: 3 h. Purification by flash-chromatography with light petroleum/ethyl acetate 5 : 1. Yield: 1.08 g (72 %, conversion 87 %); yellow amorphous solid, $[\alpha]_D^{22}$ = −41.5 (*c* = 1.0, $CHCl_3$). R_f = 0.47 (light petroleum/ethyl acetate 3:1); d. r.: 83 : 17 : 0 : 0 (analytical HPLC of the crude product, Luna C-18, 80 % → 100 % CH_3CN, 40 min, λ = 207 nm, R_t = 27.25 (minor diastereomer), 29.02 min (major diastereomer)). – MS ((+)-ESI): *m/z* = 752.2 $[M(^{79}Br)+H]^+$, 754.2 $[M(^{81}Br)+H]^+$, 774.2 $[M(^{79}Br)+Na]^+$, 776.2 $[M(^{81}Br)+Na]^+$, 815.4 $[M(^{79}Br)+CH_3CN+Na]^+$, 817.4 $[M(^{81}Br)+CH_3CN+Na]^+$. – ^{1}H NMR (200 MHz, $CDCl_3$): δ = 7.37 – 7.26 (m, 5H, aryl), 5.36 (t, 1H, ^3J = 9.3 Hz, H-2), 5.23 (d, 1H, ^3J = 2.9 Hz, H-4), 4.86 (dd, 1H, ^3J = 3.2 Hz, ^3J = 9.9 Hz, H-3), 4.58 (dd, 1H, ^3J = 5.9 Hz, ^3J = 11.7 Hz, CHBr), 4.23 – 3.82 (m, 4H, CHN, H-5, H-6a, H-6b), 3.77 (d, 1H, ^3J = 9.8 Hz, H-1), 3.51 – 3.41 (m, 2H, NCH_2), 2.82 (dd, 1H, ^3J = 4.2 Hz, ^2J = 14.9 Hz, CH_2C=O), 2.66 (dd, 1H, ^3J = 11.7 Hz, ^2J = 15.1 Hz, CH_2C=O), 1.24, 1.21, 1.18, 1.07 (4s, 36H, PivCH_3). – ^{13}C NMR (50.3 MHz, $CDCl_3$): δ = 200.24 (C=O), 178.10, 178.06, 177.89, 177.68 (PivC=O), 141.21 (*ipso*-aryl), 129.52, 129.40, 129.12 (aryl), 92.16 (C-1), 71.90, 71.73, 66.74, 65.65 (C-2, C-3, C-4, C-5), 62.41 (C-6), 60.89 (CHN), 53.82 (CHBr), 49.71 (NCH_2), 44.75 (CH_2C=O), 39.06, 38.69, 38.66, 38.57 (Piv$C$Me$_3$), 27.41, 27.37, 27.06, 26.89 (PivCH_3).

*(2S,5S)-N-(2,3,4,6-Tetra-O-pivaloyl-β-*D*-galactopyranosyl)-5-bromo-2-(4-chlorphenyl)-piperidin-4-one (**10e**)*

From **3h**. Reaction time: 4 h. 1.75 eq. L-Selectride®. Purification by flash-chromatography with cyclohexane/ethyl acetate 6 : 1. Yield: 1.12 g (71 %); colorless amorphous solid, $[\alpha]_D^{22}$ = −25.9 (*c* = 1.0, $CHCl_3$). R_f = 0.41 (cyclohexane/ethyl acetate 3 : 1); d. r.: 91 : 9 : 0 : 0 (analytical HPLC of the crude product, Luna C-18, 80 % → 100 % CH_3CN, 40 min, λ = 219 nm, R_t = 29.71 (minor diastereomer), 30.18 min (major diastereomer)). – $C_{37}H_{53}BrClNO_{10}$ (787.17): calcd. C 56.45, H 6.79, N 1.78; found C 56.28, H 6.85, N 1.74. – MS ((+)-ESI): *m/z* = 786.5 $[M(^{79}Br)+H]^+$, 788.5 $[M(^{81}Br)+H]^+$, 808.3 $[M(^{79}Br)+Na]^+$, 810.3 $[M(^{81}Br)+Na]^+$. – ^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.35 (d, 2H, ^3J = 8.2 Hz, aryl), 7.17 (d, 2H, ^3J = 8.6 Hz, aryl), 5.37 (t, 1H, ^3J = 9.6 Hz, H-2), 5.25 (d, 1H, ^3J = 2.7 Hz, H-4), 4.90 (dd, 1H, ^3J = 3.1 Hz, ^3J = 9.8 Hz, H-3), 4.55 (dd, 1H, ^3J = 6.2 Hz, ^3J = 11.7 Hz, CHBr), 4.14 (dd, 1H, ^3J = 3.9 Hz, ^3J = 11.0 Hz, CHN), 4.05 – 3.98 (m, 2H, H-6a, NCH_2), 3.90 (dd, 1H, ^3J = 6.4 Hz, ^2J = 11.2 Hz, H-6b), 3.76 (d, 1H, ^3J = 9.4 Hz, H-1), 3.48 (t, 1H, ^3J = 6.4 Hz, H-5), 3.10 (t, 1H, ^3J = 11.9 Hz, NCH_2), 2.80 (dd, 1H, ^3J = 3.5 Hz, ^2J = 14.5 Hz, CH_2C=O), 2.63 (dd, 1H, ^3J = 11.2 Hz, ^2J = 14.3 Hz, CH_2C=O), 1.24, 1.20, 1.18, 1.07 (4s, 36H, PivCH_3). – ^{13}C NMR (50.3 MHz, $CDCl_3$): δ = 198.31 (C=O), 177.78, 177.46, 177.03, 176.65 (PivC=O), 137.20, 134.87 (*ipso*-aryl), 129.48, 129.21 (aryl), 86.98 (C-1), 72.03, 71.34, 67.01, 65.31 (C-2, C-3, C-4, C-5), 63.39 (CHN), 61.67 (C-6), 53.13 (NCH_2), 51.74 (CHBr), 48.04 (CH_2C=O), 39.07, 38.88, 38.72 (Piv$C$Me$_3$), 27.44, 27.21, 27.13, 27.04 (PivCH_3). Single crystals suitable for X-ray diffraction analysis [20] were obtained after recrystallization from isopropanol.

*(2S,5S)-N-(2,3,4,6-Tetra-O-pivaloyl-β-*D*-galactopyranosyl)-5-bromo-2-(4-bromphenyl)-piperidin-4-one (**10f**)*

From **3i**. Reaction time: 3 h. 1.75 eq. L-Selectride®. Purification by flash-chromatography with cyclohexane/ethyl acetate 7 : 1 and subsequent preparative HPLC (Luna C-18, 80 % → 100 % CH_3CN, 80 min, λ = 207 nm, R_t = 66.03 min). Yield: 0.35 g (21 %); colorless amorphous solid, $[\alpha]_D^{22}$ = −58.6 (*c* = 1.0, $CHCl_3$). R_f = 0.56 (cyclohexane/ethyl acetate 2 : 1); d. r.: 88 : 12 : 0 : 0 (analytical HPLC of the crude product, Luna C-18, 80 % → 100 % CH_3CN, 40 min, λ = 212 nm, R_t = 30.45 (minor diastereomer), 32.67 min (major diastereomer)). – $C_{37}H_{53}Br_2NO_{10}$ (831.63): calcd. C 53.44, H 6.42, N 1.68; found C 53.54, H 6.43, N 1.63. – MS ((+)-ESI): *m/z* = 830.5.4 $[M(2\ ^{79}Br)+H]^+$, 832.5 $[M(^{79}Br + ^{81}Br)+H]^+$, 834.5 $[M(2\ ^{81}Br)+H]^+$, 852.4 [M(2

^{79}Br)+Na]$^+$, 854.4 [M(^{79}Br + ^{81}Br)+Na]$^+$, 856.3 [M(2 ^{81}Br)+Na]$^+$. – ^{1}H NMR (300 MHz, $CDCl_3$): δ = 7.47 (d, 2H, ^3J = 8.1 Hz, aryl), 7.19 (d, 2H, ^3J = 8.5 Hz, aryl), 5.51 (t, 1H, ^3J = 9.6 Hz, H-2), 5.29 (d, 1H, ^3J = 2.9 Hz, H-4), 4.96 (dd, 1H, ^3J = 3.1 Hz, ^3J = 9.7 Hz, H-3), 4.57 – 4.54 (m, 1H, CHBr), 4.25 (dd, 1H, ^3J = 4.4 Hz, ^3J = 9.2 Hz, CHN), 4.21 (d, 1H, ^3J = 9.6 Hz, H-1), 4.03 (dd, 1H, ^3J = 7.2 Hz, ^2J = 11.2 Hz, H-6a), 3.92 (dd, 1H, ^3J = 6.1 Hz, ^2J = 11.2 Hz, H-6b), 3.66 (t, 1H, ^3J = 6.4 Hz, H-5), 3.54 (dd, 1H, ^3J = 3.9 Hz, ^2J = 14.5 Hz, NCH_2), 3.43 (dd, 1H, ^3J = 5.5 Hz, ^2J = 14.7 Hz, NCH_2), 3.36 (dd, 1H, ^3J = 9.0 Hz, ^2J = 14.5 Hz, CHCH_2C=O), 2.65 (ddd, 1H, ^4J = 1.2 Hz, ^3J = 4.4 Hz, ^2J = 14.3 Hz, CHCH_2C=O), 1.24, 1.19, 1.17, 1.08 (4s, 36H, PivCH_3). – ^{13}C NMR (75.5 MHz, $CDCl_3$): δ = 199.99 (C=O), 177.81, 177.21, 176.60, 176.51 (PivC=O), 138.58 (*ipso*-aryl), 132.16, 129.21 (aryl), 122.47 (*ipso*-CBr), 90.00 (C-1), 72.16, 72.09, 67.04, 64.46 (C-2, C-3, C-4, C-5), 63.96 (CHN), 61.78 (C-6), 49.94 (CHBr), 49.56 (NCH_2), 44.29 (CHCH_2C=O), 39.08, 38.70 (Piv$C$Me$_3$), 27.31, 27.22, 27.11, 27.05 (PivCH_3).

*2S,5R,6S-N-(Tetra-O-pivaloyl-β-*D*-galactopyranosyl)-5-bromo-6-methyl-2-phenyl-piperidin-4-one (**11**)*

To a stirred mixture of CuI (0.38 g, 2 mmol) in dry tetrahydrofuran under argon atmosphere at −78 °C was added dropwise a 3 M solution of MeMgBr in diethyl ether (0.67 mL, 2 mmol). After 1 h $BF_3 \cdot OEt_2$ (0.25 mL, 2 mmol) was added. The mixture was stirred for 15 min. A solution of the *N*-glycosyl-5-bromo-dehydropiperidinone **7d** (0.33 g, 0.44 mmol) in tetrahydrofuran (20 mL) was added *via* a syringe. The mixture was stirred at −40 °C for 15 h. By addition of NH_4OH/sat. NH_4Cl (1 : 1, 20 mL) the reaction was terminated. Diethyl ether (50 mL) was added. The diethyl ether layer was washed twice with NH_4OH/sat. NH_4Cl solution (2 × 29 mL) and brine (30 mL). The combined aqueous solutions were extracted with diethyl ether (25 mL). The combined diethyl ether solutions were dried with $MgSO_4$. The solvent was evaporated *in vacuo*. The crude product was purified by flash-chromatography with light petroleum/ethyl acetate 10 : 1. Yield: 0.174 g (50 %), conversion 70 %; colorless amorphous solid, $[\alpha]_D^{25}$ = −48.2 (*c* = 1.0, $CHCl_3$). R_f = 0.68 (light petroleum/ethyl acetate 5 : 1); d. r.: 8 : 1 : 0 : 0 (analytical HPLC). – ^{1}H NMR (400 MHz, $CDCl_3$): δ = 1.05, 1.16, 1.21, 1.22 (4s, 36H, Piv-CH_3), 1.43 (d, 3H, *J* = 7.0 Hz, CH_3), 2.36 (dd, 1H, J_1 = 2.3 Hz, J_2 = 14.9 Hz, CH_2C=O), 2.62 – 2.75 (m, 1H, CH_2C=O), 3.25 – 3.29 (m, 1H, alkylCHN), 3.49 – 3.55 (m, 1H, arylCHN), 3.81 – 3.86 (m, 1H, H-6a), 3.97 (d, 1H, *J* = 6.6 Hz, CHBr), 3.99 – 4.08 (m, 2H, H-5, H-6b), 4.49 (d, 1H, $J_{1,2}$ = 9.8 Hz, H-1), 4.79 (dd, 1H, $J_{3,4}$ = 2.9 Hz, $J_{3,2}$ = 9.6 Hz, H-3), 5.19 (d, 1H, $J_{4,3}$ = 3.1 Hz, H-4), 5.51 (t, 1H, $J_{2,1}$ = $J_{2,3}$ = 9.4 Hz, H-2), 7.34 – 7.39 (m, 5H, Ar). – ^{13}C NMR (100.6 MHz, $CDCl_3$): δ = 16.79 (CH_3), 27.01, 27.18, 27.32 (Piv-CH_3), 38.69, 38.72, 38.96 (Piv-C_{quart}), 43.59 (*C*H_2C=O), 55.42 (alkylCHN), 58.10 (arylCHN), 61.62 (C-6), 64.34, 65.52, 66.99, 71.31, 72.94 (C-2, C-3, C-4, C-5, CHBr), 88.15 (C-1), 127.99, 128.65, 129.03 (aryl), 139.95 (aryl$_{quart}$), 176.47, 176.59, 177.37, 177.87 (PivC=O), 201.75 (C=O). – Minor diasteromer: ^{1}H NMR (400 MHz, $CDCl_3$): δ = 1.05, 1.16, 1.21, 1.22 (4s, 36H, Piv-CH_3), 1.39 (d, 3H, *J* = 7.0 Hz, CH_3), 2.36 (dd, 1H, J_1 2.3 Hz, J_2 = 14.9 Hz, CH_2C=O), 2.62 – 2.75 (m, 1H, CH_2C=O), 3.25 – 3.29 (m, 1H, alkylCHN), 3.49 – 3.55 (m, 1H, ArCHN), 3.81 – 3.86 (m, 1H, H-6a), 3.97 (d, 1H, *J* = 6.6 Hz, CHBr), 3.99 – 4.08 (m, 2H, H-5, H-6b), 4.48 (d, 1H, $J_{1,2}$ = 9.8 Hz, H-1), 4.83 (dd, 1H, $J_{3,4}$ = 2.9 Hz, $J_{3,2}$ = 9.6 Hz, H-3), 5.20 (d, 1H, $J_{4,3}$ = 3.1 Hz, H-4), 5.42 (t, 1H, $J_{2,1}$ = $J_{2,3}$ = 9.4 Hz, H-2), 7.34 – 7.39 (m, 5H, Ar). – ^{13}C NMR (100.6 MHz, $CDCl_3$): δ = 24.92 (CH_3), 27.01, 27.07, 27.18, 27.32 (Piv-CH_3), 38.69, 38.72, 38.96 (Piv-C_{quart}), 43.59 (*C*H_2C=O), 55.42 (alkylCHN), 57.56 (ArCHN), 61.62 (C-6), 64.34, 65.52, 66.99, 71.63, 71.84 (C-2, C-3, C-4, C-5, CHBr), 87.86 (C-1), 128.21, 128.65, 129.15 (Ar), 139.95 (Ar$_{quart}$), 176.47, 176.59, 177.37, 177.87 (PivC=O), 201.75 (C=O).

*(6R)-N^5-(2,3,4,6-Tetra-O-pivaloyl-β-*D*-galactopyranosyl)-2-phenyl-6-n-propyl-4,5,6,7-tetrahydrothiazolo[5,4-c]pyridine (**12**)*

A solution of 5-bromo-2-propyl-piperidinone **7d** (0.29 g, 0.40 mmol) and thiobenzamide (82 mg, 0.60 mmol) in ethanol (5 mL) was stirred and heated under reflux for 20 h. After evaporation of the solvent and purification of the remaining residue by flash-chromatography with light petroleum/ethyl acetate 15 : 1, product **12** was obtained. Yield: 0.103 g (34 %); pale yellow amorphous solid, $[\alpha]_D^{22}$ = −17.7 (*c* = 1.0, $CHCl_3$). R_f = 0.59 (light petroleum/ethyl acetate 3 : 1). – $C_{41}H_{60}N_2O_9S$ (756.99): calcd. C 65.05, H 7.99, N 3.70; found C 65.17, H 8.04, N 3.71. – MS ((+)-ESI): *m/z* = 655.4 [M–PivOH+H]$^+$, 757.3 [M+H]$^+$, 779.4 [M+Na]$^+$. – ^{1}H NMR (200 MHz, $CDCl_3$): δ = 7.88 – 7.83 (m, 2H, aryl), 7.40 – 7.35 (m, 3H, aryl), 5.45 (t, 1H, ^3J = 9.5 Hz, H-2), 5.34 (d, 1H, ^3J = 2.9 Hz, H-4), 5.13 (dd, 1H, ^3J = 3.2 Hz, ^3J = 9.9 Hz, H-3), 4.33 (d, 1H, ^3J = 9.3 Hz, H-1), 4.10 (br s, 2H, NCH_2), 3.92 – 3.78 (m, 3H, H-5, H-6a, H-6b), 3.34 – 3.20 (m, 1H, CHN), 2.98 (dd, 1H, ^3J = 5.1 Hz, ^2J = 15.9 Hz, CH_2C=O), 2.69 (d, 1H, ^3J = 15.6 Hz, CH_2C=O), 1.63 – 1.55 (m, 1H, CH_2), 1.41 – 1.32 (m, 3H, CH_2), 1.24, 1.13, 1.10, 1.09 (4s, 36H, PivCH_3), 0.87 (t, 3H, ^3J = 6.8 Hz, CH_3). – ^{13}C NMR (50.3 MHz, $CDCl_3$): δ = 177.90, 177.29, 177.19, 176.75 (PivC=O), 164.89, 149.50, 137.58 (*ipso*-aryl), 129.57, 128.84 (aryl), 126.30 (*ipso*-aryl), 126.25 (aryl), 93.54 (C-1), 71.93, 71.75, 67.25, 65.79 (C-2, C-3, C-4, C-5), 61.67 (C-6), 56.90 (CHN), 40.73 (NCH_2), 39.07, 38.75, 38.72, 38.67 (Piv$C$Me$_3$), 34.30 (CH_2), 31.57 (CHCH_2), 27.23, 27.13, 27.09 (PivCH_3), 20.19 (CH_2), 14.17 (CH_3).

*Reaction of N-galactosyl-bromo-piperidinones **10** with N-methyl-N-aryl-thioureas to give thiazolo-tetrahydropyridines **13** – General procedure*

5-Bromo-piperidinone **10** (0.20 mmol) and *N*-methyl-*N*-aryl-thiourea (0.23 mmol) were dissolved in dry ethanol (10 mL). The solution was heated under reflux for 1 – 6 d. After cooling to r. t. the solvent was evaporated *in vacuo*. The remaining residue was dissolved in diethyl ether (10 mL), and the solution was washed with 10 mL of sat. $NaHCO_3$ solution and 10 mL of brine. The organic solution was dried with $MgSO_4$. After removal of the solvent, the product was purified by chromatography.

*(6S)-N^5-(2,3,4,6-Tetra-O-pivaloyl-β-D-galactopyranosyl)-6-isopropyl-2-(N-methyl-N-phenylamino)-4,5,6,7-tetrahydrothiazolo[5,4-c]pyridine (**13a**)*

From **10a**. Reaction time: 5 d. Purification by flash-chromatography with cyclohexane/ethyl acetate 13 : 1 and subsequent preparative HPLC (Luna C-18, 90 % → 100 % CH_3CN, 80 min, λ = 283 nm, R_t = 93.14 min). Yield: 20 mg (13 %); yellow amorphous solid; R_f = 0.32 (cyclohexane/ethyl acetate 3 : 1). – MS ((+)-ESI): *m/z* = 786.7 $[M+H]^+$. – ^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.37 – 7.24 (m, 4H, aryl), 7.21 – 7.16 (m, 1H, aryl), 5.42 (t, 1H, ^3J = 9.6 Hz, H-2), 5.31 (d, 1H, ^3J = 3.1 Hz, H-4), 5.11 (dd, 1H, ^3J = 3.1 Hz, ^3J = 9.8 Hz, H-3), 4.32 (d, 1H, ^3J = 9.2 Hz, H-1), 3.93 – 3.72 (m, 5H, H-5, H-6a, H-6b, NCH_2), 3.47 (s, 3H, NCH_3), 2.75 – 2.64 (m, 3H, C*H*CH_2, CHC*H*$_2$), 1.88 – 1.76 (m, 1H, C*H*$(CH_3)_2$), 1.20, 1.15, 1.10, 1.05 (4s, 36H, PivCH_3), 0.91, 0.88 (2d, 6H, ^3J = 6.7 Hz, CH(C*H*$_3$)$_2$).

*(6S)-N^5-(2,3,4,6-Tetra-O-pivaloyl-β-D-galactopyranosyl)-6-(4-chlorophenyl)-2-(N-methyl-N-phenylamino)-4,5,6,7-tetrahydrothiazolo[5,4-c]pyridine (**13b**)*

From **10e**. Reaction time: 1 d. Purification by flash-chromatography with cyclohexane/ethyl acetate 16 : 1 and subsequent preparative HPLC (Luna C-18, 90 % → 100 %, 100 min, λ = 254 nm, R_t = 92.83 min). Yield: 20 mg (12 %); yellow, amorphous solid; R_f = 0.28 (cyclohexane/ethyl acetate 3 : 1). – MS ((+)-ESI): *m/z* = 854.6 $[M+H]^+$, 876.5 $[M+Na]^+$. – ^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.42 – 7.24 (m, 9H, aryl), 5.41 (t, 1H, ^3J = 9.6 Hz, H-2), 5.24 (d, 1H, ^3J = 2.7 Hz, H-4), 4.87 (dd, 1H, ^3J = 3.1 Hz, ^3J = 9.8 Hz, H-3), 4.15 (dd, 1H, ^3J = 4.3 Hz, ^3J = 9.0 Hz, CHN), 3.99 (s, 2H, NCH_2), 3.98 – 3.88 (m, 2H, H-1, H-6a), 3.86 (dd, 1H, ^3J = 7.0 Hz, ^2J = 11.1 Hz, H-6b), 3.50 (s, 3H, NCH_3), 3.46 (t, 1H, ^3J = 6.7 Hz, H-5), 2.93 (dd, 1H, ^3J = 9.0 Hz, ^2J = 16.1 Hz, CHC*H*$_2$), 2.83 (dd, 1H, ^3J = 4.3 Hz, ^2J = 16.1 Hz, CHC*H*$_2$), 1.20, 1.17, 1.12, 1.05 (4s, 36H, PivCH_3). – ^{13}C NMR (50.3 MHz, $CDCl_3$): δ = 177.94, 177.16, 177.11, 176.62 (PivC=O), 168.67, 145.96, 141.88, 138.96, 133.87 (*ipso*-aryl), 129.96, 129.67, 128.97, 127.07, 125.07 (aryl), 88.94 (C-1), 71.99, 71.56, 67.27, 65.13 (C-2, C-3, C-4, C-5), 61.76 (C-6), 60.65 (CHN), 40.65 (NCH_2), 40.47 (NCH_3), 39.05, 38.78, 38.72 (Piv*C*Me_3), 34.28 (CH*C*H_2), 27.23, 27.15, 27.05 (PivCH_3).

*(6S)-N^5-(2,3,4,6-Tetra-O-pivaloyl-β-D-galactopyranosyl)-6-(4-chlorophenyl)-2-(N-methyl-N-(4-methoxyphenyl-amino)-4,5,6,7-tetrahydrothiazolo[5,4-c]pyridine (**13c**)*

From **10e**. Reaction time: 3.5 d. Purification by column-chromatography with cyclohexane/ethyl acetate 14 : 1 and subsequent preparative HPLC (Luna C-18, 90 % → 100 %, 100 min, λ = 214 nm, R_t = 91.97 min). Yield: 22 mg (12 %); yellow, amorphous solid; R_f = 0.43 (cyclohexane/ethyl acetate 3:1). – MS ((+)-ESI): *m/z* = 884.4 $[M+H]^+$. – ^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.34 – 7.22 (m, 6H, aryl), 6.96 – 6.94 (m, 2H, aryl), 5.38 (t, 1H, ^3J = 9.8 Hz, H-2), 5.24 (d, 1H, ^3J = 2.7 Hz, H-4), 4.87 (dd, 1H, ^3J = 3.1 Hz, ^3J = 9.8 Hz, H-3), 4.12 (dd, 1H, ^3J = 4,3 Hz, ^3J = 9.0 Hz, CHN), 3.95 (s, 2H, NCH_2), 3.94 – 3.84 (m, 3H, H-1, H-6a, H-6b), 3.82 (s, 3H, OCH_3), 3.52 (s, 3H, NCH_3), 3.47 (t, 1H, ^3J = 6.7 Hz, H-5), 2.96 (dd, 1H, ^3J = 9.0 Hz, ^2J = 16.4 Hz, CHC*H*$_2$), 2.87 (dd, 1H, ^3J = 4.3 Hz, ^2J = 16.4 Hz, CHC*H*$_2$), 1.20, 1.17, 1.12, 1.05 (4s, 36H, PivCH_3).

*(6R)-N^5-(2,3,4,6-Tetra-O-pivaloyl-β-D-galactopyranosyl)-2-amino-6-ethyl-4,5,6,7-tetrahydrothiazolo[5,4-c]pyridine (**14**)*

A solution of 5-bromo-2-ethyl-piperidinone (**10c**) (0.21 g, 0.30 mmol), thiourea (0.05 g, 0.60 mmol) and diazabicycloundecene (DBU, 0.07 g, 0.45 mmol) in dry tetrahydrofuran (5 mL) was heated under reflux for 19 h. The solvent was evaporated *in vacuo*, and the crude product was purified by flash-chromatography in cyclohexane/ethyl acetate 2 : 1. Subsequent preparative HPLC (Luna C-18, 80 % → 100 % CH_3CN, 80 min, λ = 250 nm, R_t = 42.02 min) afforded the pure thiazolopyridine derivative **14**. Yield: 0.13 g (62 %); yellow amorphous solid; $[\alpha]_D^{22}$ = −12.5 (*c* = 1.0, $CHCl_3$). R_f = 0.08 (cyclohexane/ethyl acetate 2 : 1). – MS ((+)-ESI): *m/z* = 580.1 $[M–PivOH+H]^+$, 682.1 $[M+H]^+$. HRMS ((+)-ESI): *m/z* = 682.3758 (calcd. 682.3737 for $C_{34}H_{56}N_3O_9S$, $[M+H]^+$). – ^{1}H NMR (300 MHz, $CDCl_3$): δ = 5.42 (t, 1H, ^3J = 9.9 Hz, H-2), 5.34 (d, 1H, ^3J = 2.9 Hz, H-4), 5.12 (dd, 1H, ^3J = 3.3 Hz, ^3J = 9.9 Hz, H-3), 4.29 (d, 1H, ^3J = 9.2 Hz, H-1), 3.96 – 3.76 (m, 5H, H-5, H-6a, H-6b, NCH_2), 3.09 – 3.07 (m, 1H, CHN), 2.69 (dd, 1H, ^3J = 5.2 Hz, ^2J = 15.8 Hz, CHC*H*$_2$), 2.39 (d, 1H, ^2J = 15.8 Hz, CHC*H*$_2$), 1.72 – 1.57 (m, 1H, C*H*$_2$CH$_3$), 1.44 – 1.35 (m, 1H, C*H*$_2$CH$_3$), 1.24, 1.15, 1.09, 1.08 (4s, 36H, PivCH_3), 0.88 (t, 3H, ^3J = 7.4 Hz, CH_3). – ^{13}C NMR (75.5 MHz, $CDCl_3$): δ = 177.91, 177.23, 177.12, 176.67 (PivC=O), 166.11 (NCSN), 140.31, 114.53 (*ipso*-aryl), 93.16 (C-1), 71.88, 71.73, 67.18, 65.66 (C-2, C-3, C-4, C-5), 61.62 (C-6), 58.20 (CHN), 40.16 (NCH_2), 39.05, 38.72, 38.67 (Piv*C*Me_3), 29.97 (CH*C*H_2), 27.22, 27.05, 24.78 (PivCH_3), 24.78 (CH_2), 11.39 (CH_3).

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[20] Crystal structure data of **10e**: mol weight = 787.16 g mol^{-1}, crystal size: $0.10 \times 0.30 \times 0.30$ mm^3, orthorhombic space group $P2_12_12_1$, lattice parameters: a = 50.241 (13), b = 14.959 (2), c = 11.0402 (15) Å, V = 8298 (3) Å^3, Z = 8, $F(000)$ = 3312 e, T = −80 °C, $D_{\text{calcd.}}$ = 1.26 g cm^{-3}, $\mu(\text{Mo}K_\alpha)$ = 2.4 mm^{-1}. Enraf-Nonius Turbo-CAD4 diffractometer, MoK_α radiation, graphite monochromator, number of reflections: measured: 11586, independent: 11538, observed: 8204 with $|F| \geq 4.0\sigma(F)$, discrepancy factors: $wR2$ = 0.1881 ($R1$ = 0.064 for all observed reflections, 0.1043 for all reflections), x(Flack) = 0.02, $\Delta\rho_{\text{fin}}$ (max/min) = 1.03 / −0.60 e Å^{-3}.

CCDC 745336 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.