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Search for α-glucosidase inhibitors: New N-substituted valienamine and conduramine F-1 derivatives

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Dedicated to Professor Bernd Giese on the occasion of his 66th birthday.

Abstract—A solid-phase synthesis of new N-substituted valienamines has been developed and new synthesis of (±)-conduramine F-1, (−)-conduramine F-1, and (+)-*ent*-conduramine F-1 is presented, together with the preparation of N-benzylated conduramines F-1. N-Benzylation of both valienamine and (+)-*ent*-conduramine F-1 improves their inhibitory activity toward α-glucosidases significantly. The additional hydroxymethyl group makes valienamine derivatives more active than their (+)-*ent*-conduramine F-1 analogues.

1. Introduction

Glycosidases are involved in a wide range of anabolic and catabolic processes such as digestion, lysosomal catabolism of glycoconjugates, and the biosynthesis of glycoproteins. Glycosidase inhibitors arouse great interest as potential therapeutic agents such as antidiabetics,[1] antiobesities,[1] antiviral,[2] anti-cancer agents,[3] and therapeutic agents for some genetic disorders.[4] Inhibitors of α-D-glucosidase such as Miglitol (**1**): *N*-(2-hydroxyethyl-1-deoxynojirimycin: Glyset®, Diastabol®) have found application in type II (non-insulino-dependent mellitus) diabetes[5] and Miglustat (**2**: *N*-butyl-1-deoxynojirimycin: Zavesca®) in Gaucher's disease.[6] Acarbose (**3**: Glucor®, Precose®, Glucobay®) is a mimic of the non-reductive tetrasaccharide end of amylase[7] that contains valienamine **4** (Fig. 1).[8] It has shown long-term efficacy and tolerability in patients with type II diabetes[9] and has been approved in medications as adjunct therapy for weight loss in patients with obesity.[10] Chemists at Takeda have converted valienamine (**4**) to N-alkylated analogues **5** using either alkylation or reductive amination as part of their work which resulted in the antidiabetic voglibose. This has generated a collection of selective and potent α-glucosidase inhibitors.[8c,11] Inhibitors of α-D-glucosidases and α-L-fucosidases have manifested moderate in vitro anti-HIV activities.[12] Selective inhibitors of influenza neuraminidase have been developed into effective drugs against influenza.[13] Zanamivir (**6**: Relenza®, GG167)[14] (from GlaxoSmithKline and Biota) and Oseltamivir Phosphate (**7**: GS4104, Tamiflu®, Ro 64-0796/002)[15] (from Hoffman La Roche and Gilead Sciences), a prodrug of the corresponding acid **8** (GS-4071, Ro 64-0802),[16] play dominant roles in this fight. Tamiflu® is forseen to be used in the event of an influenza pandemic.[17]

As we have found that the glycosidase inhibitory activities of 2-(aminomethyl)pyrrolidine-3,4-diols can be increased significantly by N-benzylation[18] and that *N*-benzyl derivatives of conduramines B-1 can generate potent inhibitors of β-glucosidases[19] or/and of α-mannosidases,[20] we have extended Takeda's library of N-substituted valienamines **5**[11] to further N-benzylated

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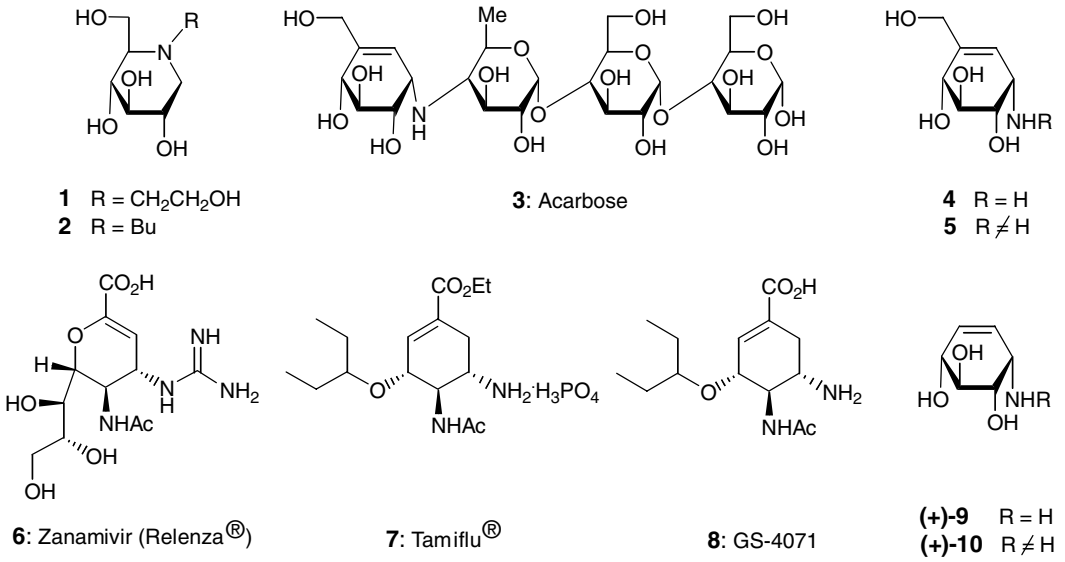


Figure 1. Examples of useful glycosidase inhibitors in medicine.

derivatives and have found new, potent inhibitors of α-glucosidases. Although initially prepared in the fruitless attempt of finding potent trehalase inhibitors, they were tested as potentially new inhibitors of HIV replication.[12] As none of these compounds showed anti-HIV activity, we explored less polar analogues that should penetrate into lymphocytes more readily. For that we envisioned the *ent*-conduramine F-1 ((+)-**9**) which can be seen as a norvalienamine, with one hydroxymethyl group less than valienamine. New syntheses of (±)-**9**, (+)-**9** and (−)-**9** will be presented. A small library of N-benzylated derivatives **10** has been prepared. These compounds were evaluated for their inhibitory activities toward commercially available glycosidases. As for valienamine, N-benzylation of *ent*-conduramine F and 1 (+)-**9** gave derivatives (+)-**10c**, **10g**, **10j**, **10k**, **10o**, **10p** that were more selective α-glucosidase inhibitors than (+)-**9**. Unfortunately, none showed anti-HIV activity.

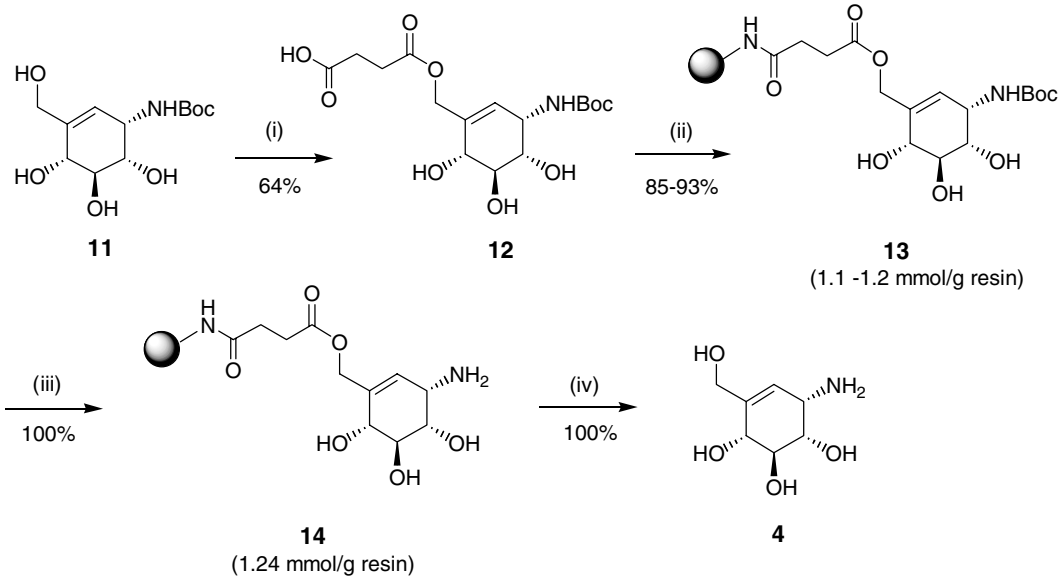
2. Synthesis of valienamine derivatives on solid phase

Although solid-phase carbohydrate synthesis has become an established and important procedure,[21] only Bols and co-workers have reported a solid-phase synthesis of a library of aminosugars.[22] They attached azafagomine to a resin-bound peptide chain and cleaved the adduct from the resin. In our case, we have attached the Fmoc-protected valienamine to the resin via an ester linkage using the primary alcoholic function of valienamine (Scheme 3). Reliable methods allowed its coupling to densely functionalized resins in high yield. Similarly, treatment with a volatile amine allowed the high yield cleavage of the aminopseudosugar from the resin. Because such high loading was used, samples of more than 5 mg amounts of products were formed in 1 ml deep well plate format.

Valienamine **4** was obtained by degradation of validoxylamine with *N*-bromosuccinimide[23] and converted to its Boc derivative **11** (Scheme 1). In order to selectively acylate the primary hydroxy group, we initially went through a series of protection/deprotection steps before finally using a simple selective acylation with collidine as catalyst,[24] which provided the desired 7-O-acylated compound **12** in 64% yield with only 6% of the 3,7-diacylated compound as byproduct. Acid **12** was then linked to an aminomethylated polystyrene resin by a standard procedure. Although a capping procedure could be used, a five-fold excess of **12** guarantees the highest possible loading of the resin. The *tert*-butyloxycarbonyl group was removed quantitatively by 4 M HCl in dioxane. When CF_3CO_2H in CH_2Cl_2 was used for this purpose ca. 10% trifluoroacetamide was formed as byproduct after cleavage from the resin. Cleavage from the resin was performed using *n*-$PrNH_2$ to avoid the small buildup of pressure in the apparatus when ammonia was used.

Once the linked valienamine **14** was shown to be cleaved quantitatively and tracelessly from the resin under mild conditions, the derivatization step was optimized. However, although reductive amination has been shown repeatedly to work well for solid-state derivatization, the derivatization of **14** was not straightforward. The seven aldehydes and acetone (Fig. 2) were used to represent substrates of various reactivity, and many combinations of solvent, dehydrating agent, and reductant were tried. Although one-pot procedures[25] were more effective than two-step[26] condensation reduction sequences, conversions were poor and dialkylation accompanied the desired product.

We suspected that the 2-hydroxy group interfered with the reaction by forming an oxazolidine (Scheme 2). Indeed simply on dissolving equimolar amounts of valienamine **4** and *n*-$BuNH_2$, doublets at δ 94.0 and 91.6 ppm in CD_3OD or δ 92.3 and 90.2 ppm in DMSO-d_6 showed that epimeric oxazolidines **15** were formed, and no ^{13}C signals of their tautomeric imines **16**[11a] were observed. The reduction step is consequently slow.



Scheme 1. Method of development: Reagents and conditions: (i) 2,4,6-collidine, succinic anhydride; (ii) HOBt, DIC, DMF, 0.2 equiv aminomethylated polystyrene resin; (iii) CH_2Cl_2/TFA/H_2O (10:10:1) (90%) or 4 M HCl in dioxane/CH_2Cl_2 (1:1), (100%); (iv) THF/MeOH/*n*-$PrNH_2$ (3:1:0.5), 12 h.

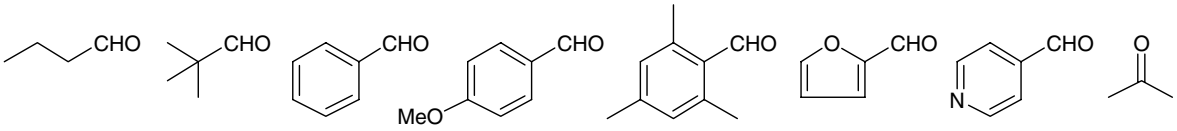
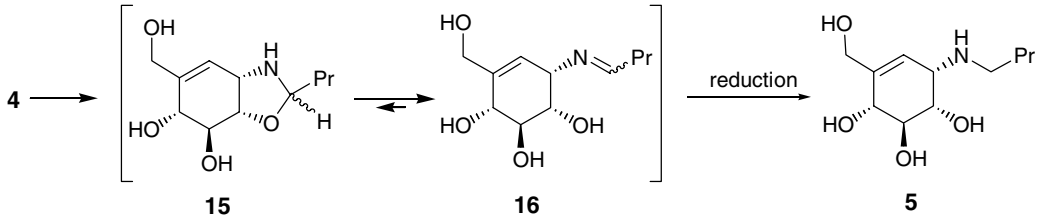


Figure 2. Representative aldehydes and ketones used for library construction.



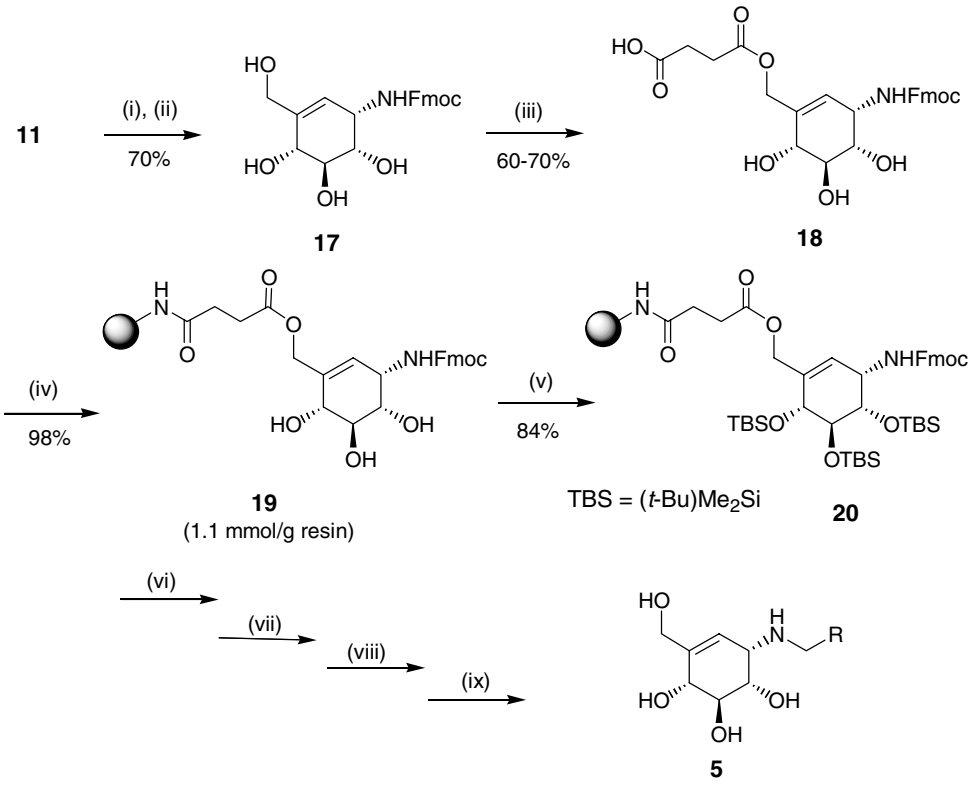
Scheme 2. Competitive oxazolidine formation.

Fortunately, protecting the hydroxy groups as silyl ethers much improved the reductive alkylation. For this purpose Fmoc was used to protect the primary amino group of **4**. The Et_3Si group was found to be too labile to the reductive amination conditions but the *t*-$BuMe_2Si$ group was stable and was attached in 84% yield (according to weight gain). As the reductive amination of 4,6-dimethoxysalicylaldehyde failed completely when the hydroxy groups were unprotected, it was used to test these new conditions. Aqueous HF in MeCN was used to remove the silyl groups, as Bu_4NF caused some cleavage of the aminosugar from the resin (Scheme 3). Encouraged by this success we moved to the productive phase using Flexchem® reaction blocks. Although small amounts of starting valienamine were present, TLC and MS control of the product showed reasonable purity in most cases. The 91 pure N-alkylated valienamines **5** presented in Table 2 were obtained by column chromatography on silica gel (CH_2Cl_2/MeOH/$MeNH_2$ eluant).

Apart from **5a** and **5c** (R = benzyl and *para*-hydroxybenzyl) reported by Kameda and co-workers,[11] all our derivatives **5** are new α-glucosidase inhibitors, most of them are more potent than valienamine (**4**).

3. Synthesis of racemic and enantiomerically pure conduramine F-1 and derivatives

The first examples of optically pure conduramines (aminocoduritols)[27] were obtained by Paulsen and co-workers.[28] Starting from quebrachitol (2-*O*-methyl-L-*chiro*-inositol) they prepared (+)-conduramine F-1 ((+)-**9**).[28a] Kresze and Dittel[29] developed a four-step route to racemic conduramine F-1 tetraacetate via a hetero-Diels–Alder addition of 1-chloro-1-nitrosocyclohexane to *trans*-1,3-cyclohexadiene-5,6-diyl diacetate. Muchowski and co-workers[30] obtained (±)-**9** starting from the Diels–Alder adduct of tosylacetylene and *N*-*tert*-butoxy-



Scheme 3. Solid-phase parallel synthesis of a library of valienamine derivatives **5**. Reagents and conditions: (i) TFA/CH_2Cl_2 (1:1) then ion exchange; (ii) *N*-(9-fluorenylmethoxycarbonyloxy)succinimide, $NaHCO_3$, aq acetone; (iii) 2,4,6-collidine, succinic anhydride; (iv) AM resin, 1 equiv DIC, 1 equiv HOBt, DMF, CH_2Cl_2, rt; (v) TBSOTf, DMF, py; (vi) piperidine (10%), DMF; (vii) 1.3 equiv aldehyde, THF/AcOH/H_2O (18:1:1), 3 h, then $NaBH_3CN$, 3 h, THF; (viii) 20% HF aq in CH_3CN (73%); (ix) THF/MeOH/*n*-$PrNH_2$ (6:2:1), 24 h.

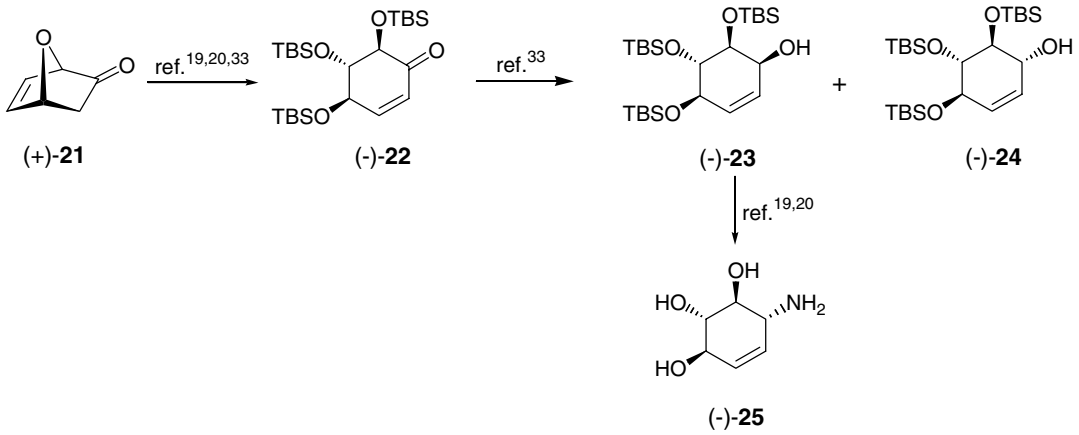
carbonylpyrrole.[31] Enantiomerically pure (+)-**9** was prepared by Knapp and co-workers starting from D-glucose.[32] Recently, we described the synthesis of (−)-conduramine B-1 ((−)-**25**) starting with (+)-7-oxabicyclo[2.2.1]-hept-5-en-2-one ((+)-**21**) via enone (−)-**22** which was reduced under Luche's conditions into a 2.5:1 mixture of allylic alcohols (−)-**23** and (−)-**24**. Mitsunobu displacement of (−)-**23** with phthalimide and subsequent deprotection provided (−)-conduramine B-1 ((−)-**25**) (Scheme 4).[19,20] Le Drian et al.[33] had found that the reduction of enone (−)-**22** with (*i*-Bu)$_2$AlH in THF at −78 °C gives a 1:5.1 mixture of (−)-**23** and (−)-**24** (Scheme 4).

Starting from (±)-**21**,[34] racemic enone (±)-**22** was obtained and reduced with (*i*-Bu)$_2$AlH into 1:5.1 mixture of (±)-**23** and (±)-**24** in 98% yield. Treatment of this mixture with phthalimide, DEAD, and Ph_3P in dry toluene[35] (0 °C, 6 h) gave a 1:2.5 mixture of N-substituted phthalimides (±)-**26** and (±)-**27** in 53% yield. After separation by column chromatography on silica gel, pure (±)-**27** was reacted with 5 equiv of $N_2H_4{\cdot}H_2O$ in MeOH (65 °C, 5 h) giving amine (±)-**28** in 56% yield. Desilylation of (±)-**28** with $Bu_4NF{\cdot}3H_2O$ gave impure (±)-**9**. In contrast, desilylation of (±)-**27** with acidic MeOH, followed by aminolysis with 40% aqueous $MeNH_2$, provided pure (±)-**9** in 85% overall yield (Scheme 5). The relative configuration of (±)-**9** was confirmed by its 2D-COSY-45 and NOESY ^{1}H NMR spectra and by transforming (±)-**9** to its peracetate (Ac_2O/pyridine), the characteristics of which were identical to those reported for this product.[30b]

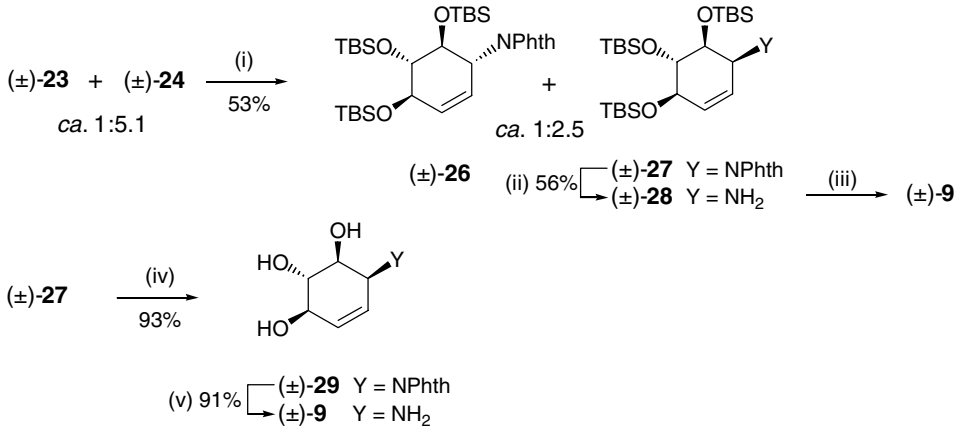
As observed for valienamine **4**, treatment of (±)-**9** with aromatic aldehydes (PhCHO, 4-PhC_6H_4CHO, 4-PhOC_6H_4CHO) and $NaBH_4$, $NaBH_3CN$, or $NaBH(OAc)_3$ under various conditions (THF, MeOH, AcOH, 0–65 °C) led to low yields of the expected N-benzylated products (±)-**10a**, **10d**, **10e** because of concomitant formation of isoxazolidines. We thus explored the reductive amination of various aromatic aldehydes with the silyl triether (±)-**28**. For instance, the reaction of (±)-**28** and *p*-phenoxybenzaldehyde with $NaBH(OAc)_3$ (1.4 equiv) in dry 1,2-dichloroethane gave the expected amine (±)-**30e** in 80% yield (Scheme 6).

Unexpectedly, all our attempts to obtain pure unprotected **10e** (R = *p*-Ph$OC_6H_4CH_2$) by desilylation of (±)-**30e** failed. Treatment of (±)-**30e** with Bu_4NF (20 °C, 1 h), with *p*-TsOH/MeOH (65 °C, 5 h), with DOWEX-50W-X8/MeOH/H_2O (20 °C, 26 h), with 40% HF/H_2O in CH_3CN (20 °C, 24 h), or with Montmorillonite K-10 in EtOH/H_2O (100 °C, 36 h) produced the free amine that could not be purified by standard techniques (Scheme 6).

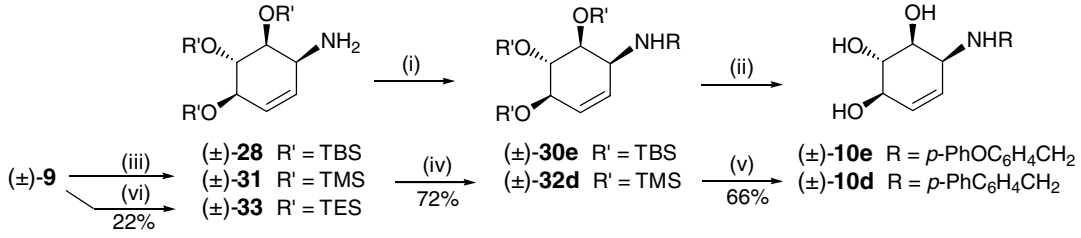
Thus, we decided to exchange the TBS-protected groups of (±)-**28** for TMS groups. Treatment of pure (±)-**9** with Me_3SiCl/imidazole in dry DMF gave the expected trimethylsilyl triether (±)-**31** (58–65%). Reaction of (±)-**31** with *p*-phenylbenzaldehyde and $NaBH(OAc)_3$ in dry 1,2-dichloroethane gave (±)-**32d** in 72% yield. Unfortunately, this compound contained about 10–15% of the



Scheme 4. Synthesis of (−)-conduramine B-1.



Scheme 5. Synthesis of (±)-conduramine F-1 via the phthalimides. Reagents and conditions: (i) PPh_3, phthalimide, DEAD, PhMe, 0 °C, 6 h; (ii) 5 equiv $N_2H_4{\cdot}H_2O$/MeOH, 65 °C, 5 h; (iii) $Bu_4NF{\cdot}H_2O$, THF, 20 °C; (iv) 1% *p*-TsOH/MeOH, 65 °C, 45 min; (v) 40% $MeNH_2/H_2O$, 20 °C, 45 min, purification by DOWEX-50 W, 2 M NH_4OH.

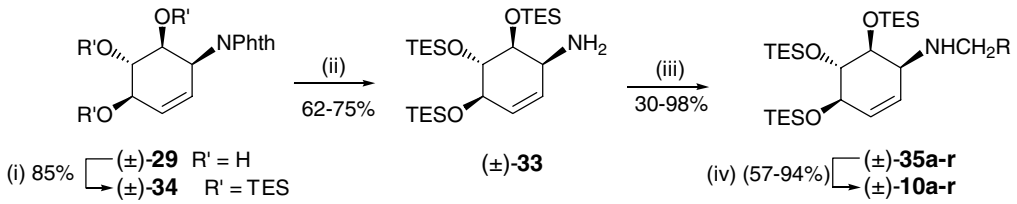


Scheme 6. Attempts to generate N-benzylated conduramines F-1. Reagents and conditions: (i) *p*-$PhOC_6H_4CHO$, $NaBH(OAc)_3$, $ClCH_2CH_2Cl$, rt, 2.5 h; (ii) several conditions, see text, led to impure (±)-**10e**; (iii) Me_3SiCl/imidazole/DMF, 0–20 °C, 3 h; (iv) *p*-PhC_6H_4CHO, $NaBH(OAc)_3$, $ClCH_2CH_2Cl$, rt, 3 h; (v) AcOH/H_2O (1:9), 20 °C, 15 min; (vi) Et_3SiCl/imidazole/DMF, 20 °C, 4 h.

mixtures of the corresponding diastereomeric oxazolidines, thus requiring a tedious chromatographic purification (by ^1H NMR). Treatment of (±)-**32d** so-obtained with AcOH/H_2O (1:9) provided impure (±)-**10d** (R = *p*-Ph–$C_6H_4CH_2$) in 66% yield (Scheme 6). In order to avoid the formation of oxazolidines, we searched for a more suitable protection of the triol moiety of (±)-**9**.

We finally found that triethylsilyl triether (±)-**33** is a good precursor for the synthesis of pure N-benzylated (±)-conduramine F-1. Direct silylation of (±)-**9** with Et_3SiCl and imidazole in dry DMF led to low yields of (±)-**33** (22% at the best). Thus, we derived (±)-**33** in two steps from the phthalimide (±)-**29** (Scheme 7). Treatment of (±)-**29** with Et_3SiCl under standard conditions furnished (±)-**34** in 85% yield. Aminolysis of (±)-**35** with aqueous $MeNH_2$ provided (±)-**33** in 62–75% yield. The reductive benzylation of (±)-**33** and subsequent desilylation produced pure secondary amines (±)-**10a**–**r** (Scheme 7).

Starting from the enantiomerically pure (+)-7-oxanorbornenone ((+)-**21**: a 'naked sugar' of the first generation[36]), enantiomerically pure (+)-*ent*-conduramine F-1 ((+)-**9**) was obtained via synthetic intermediates



Scheme 7. Synthesis of a library of N-benzylated (±)-conduramines F-1. Reagents and conditions: (i) Et_3SiCl/imidazole/DMF, 20 °C, 15 h; (ii) 40% $MeNH_2/H_2O/CH_2Cl_2$, 20 °C, 15 h; (iii) ArCHO, $NaBH(OAc)_3$ (1.4 equiv), dry $ClCH_2CH_2Cl$, 20 °C, 2–5 h; (iv) AcOH/THF/H_2O (6:1:3), 20 °C, 5–10 h, purification by flash chromatography on silica gel (light petroleum ether/EtOAc → → 25% NH_3 aq in CH_3CN).

(−)-**22** → (−)-**24** → (−)-**27** → (+)-**29** → (+)-**9**. Six N-substituted derivatives of *ent*-conduramine F-1 (+)-**10c**, **10g**, **10j**, **10k**, **10o**, **10p** derived from aldehydes **c**, **g**, **j**, **k**, **o**, and **p** (see Table 1) were then prepared following the method described in Scheme 7, via (+)-**29** → (−)-**35** → (−)-**33** → (+)-**10c**, **10g**, **10j**, **10k**, **10o**, **10p**. Similarly, (−)-conduramine F-1 ((−)-**9**) was obtained starting from enantiomerically pure (−)-7-oxanorbornenone ((−)-**21**), via enone (+)-**22** following the route (+)-**22** → (+)-**24** → (+)-**27** → (−)-**29** → (−)-**9**. Six N-substituted derivatives (−)-**10c**, **10g**, **10j**, **10k**, **10o**, **10p** derived from aldehydes **c**, **g**, **j**, **k**, **o** and **p** were prepared also following the route (−)-**29** → (+)-**35** → (+)-**33** → (−)-**10c**, **10g**, **10j**, **10k**, **10o**, **10p**.

4. Glucosidase inhibitory activities of valienamine derivatives

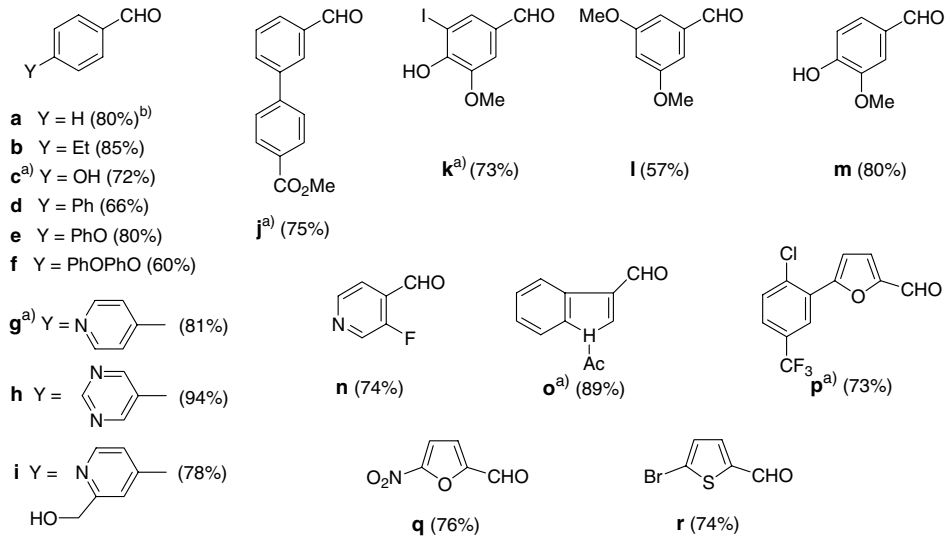
The valienamine derivatives **5** that could be purified have been assayed for their inhibitory activities toward five α-glucosidases: maltase from yeast (My), maltase from rice (Mr), isomaltase from yeast (IMy), amyloglucosidase from *Aspergillus niger* (AMan), and amyloglucosidase from *Rhizopus* mold (AMrm).

In all our studies, the substrate was *p*-nitrophenyl α-D-glucopyranoside and the enzymes were assayed under optimal pH conditions.[37] The results are shown in Table 2. For the most potent inhibitors IC_{50} values and K_i values (Lineweaver–Burk plots) were measured. Maltase (α-glucosidase) and isomaltase (α-glucosidase) from yeast recognize the valienamine derivatives much better than maltase from rice and amyloglucosidase from *A. niger* and *Rhizopus* mold. The best inhibitors of maltase from yeast (My) reported by Kameda and co-workers[8] are derivatives **5** with R = $PhCH_2$ (IC_{50} = 9.2 μM), R = *p*-hydroxybenzyl (IC_{50} = 5 μM), R = $(CH_2)_4Ph$ (IC_{50} = 0.98 μM), R = $(CH_2)_5Ph$ (IC_{50} = 0.75 μM), R = CH_2CHPh_2 (IC_{50} = 0.038 μM), and CH_2–*c*-C_6H_{11} (IC_{50} = 0.38 μM) (substrate *p*-nitrophenyl α-D-glucopyranoside). For **5a** (R = Bn) and **5c** (R = *p*-hydroxybenzyl) we found IC_{50} = 0.70 μM and 0.94 for the same enzyme and substrate. As it can be seen (Table 2) isomaltase from yeast (IMy) responds about ten times better to the same inhibitors than maltase from yeast (My).

In both enzymes our best inhibitors are **5c** (IC_{50} = 51 nM, K_i = 16 nM IMy) and **5ba** (IC_{50} = 91 nM, K_i = 13 nM IMy), both being competitive inhibitors.

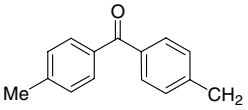
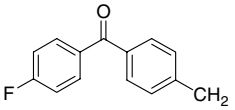
Thirty-five compounds (**5a**, **5c**, **5d**, **5l**, **5s**, **5t**, **5u**, **5x**, **5y**, **5z**, **5aa**, **5ah**, **5aj**, **5ak**, **5al**, **5am**, **5ao**, **5ar**, **5as**, **5av**, **5aw**, **5ax**, **5ay**, **5az**, **5ba**, **5bb**, **5bc**, **5bd**, **5bf**, **5bg**, **5bx**, **5by**, **5cf**, **5cj**, and **5cg**) have $IC_{50} \leqslant 1.5$ μM for the inhibition of maltase from yeast. Except for **5cf** (R = $Me(CH_2)_2$

Table 1. Aldehydes used to prepare the library of (±)-**10a**–**r** and yield in isolated (±)-**10a**–**r**



[a] Aldehydes used to prepare enantiomerically pure derivatives (+)-**10c**, **10g**, **10j**, **10k**, **10o**, **10p** and (−)-**10c**, **10g**, **10j**, **10k**, **10o**, **10p**.
[b] Yield after deprotection of (±)-**35a**–**r**.

Table 2. Inhibitory activities of valienamine derivatives **5** toward α-glucosidases

Inhibitor Concn:	My 0.06 mM	Mr 0.6 mM	IMy 0.12 mM	AMan 3 mM	AMrm 3 mM	EC_{50}[a] (μg/mL)	CC_{50}[a] (μg/mL)	R in **5**
4	*170* μM	ni	*120* μM	30%	*350* μM	nm	nm	
5a[b,d]	83%, *0.7* μM	26%	98%, *0.12* μM, **73 nM (C)**	91%	89%	>121	121	$PhCH_2$
5b[d]	83%, *2.6* μM	29%	87%, *0.22* μM, **34 nM (C)**	92%	84%	>2	2	$4\text{-}EtC_6H_4CH_2$
5c[d]	97%, *0.94* μM	16%	99%, *0.051* μM, **16 nM (C)**	94%	87%	>70	70	$4\text{-}HOC_6H_4CH_2$
5d[d]	93%, *0.68* μM	18%	86%	96%	90%	>52	52	$4\text{-}PhC_6H_4CH_2$
5l[d]	97%[c]	14%	97%	77%	92%	>9	9	$3,4\text{-}(MeO)_2C_6H_3CH_2$
5m[d]	71%, *3.3* μM	7%	87%, *0.28* μM	87%	82%	>54	54	$4\text{-}OH,3\text{-}MeOC_6H_3CH_2$
5s	71%, *1.4* μM	26%	79%, *0.21* μM, **222 nM (C)**	95%	91%	>115	>115	$4\text{-}MeC_6H_4CH_2$
5t	78%, *1.2* μM	26%	89%, *0.16* μM, **250 nM (C)**	91%	91%	>75	>75	$4\text{-}MeOC_6H_4CH_2$
5u	83%, *0.70* μM	39%	90%, *0.18* μM, **58 nM (C)**	92%	86%	>12	12	$4\text{-}FC_6H_4CH_2$
5v	67%, *1.6* μM	37%	79%, *0.14* μM, **620 nM (C)**	36%	55%	>86	86	$2\text{-}NCC_6H_4CH_2$
5w	34%	34%	85%	85%	83%	>85	85	$4\text{-}ClC_6H_4CH_2$
5x	96%[c]	35%	94%	97%	91%	>30	30	$4\text{-}MeSC_6H_4CH_2$
5y	97%[c]	38%	94%	97%	90%	>46	46	$4\text{-}(Me_2CHCH_2)C_6H_4CH_2$
5z	97%[c]	28%	90%	83%	81%	>58	58	$4\text{-}(CF_2HCF_2O)C_6H_4CH_2$
5aa	86%, 1 μM	33%	88%	94%	87%	>58	58	$4\text{-}Et_2NC_6H_4CH_2$
5ab	63%	ni	87%	94%	89%	>125	125	$4\text{-}CF_3OC_6H_4CH_2$
5ac	82%	18%	80%	91%	88%	>125	125	$4\text{-}(MeO_2C)C_6H_4CH_2$
5ad	ni	33%	63%	85%	70%	>125	125	$4\text{-}(HO_2C)C_6H_4CH_2$
5ae	58%	9%	46%	89%	94%	>125	>125	$4\text{-}PhOC_6H_4CH_2$
5af	57%	10%	ni	46%	38%	>87	87	
5ag	46%	24%	ni	37%	26%	>82	82	
5ah	67%, *1.2* μM	37%	85%, *0.2* μM, **280 nM (C)**	96%	92%	>20	20	$4\text{-}(4\text{-}CF_3C_6H_4O)C_6H_4CH_2$
5ai	49%	33%	88%	70%	75%	>67	67	$4\text{-}BrC_6H_4CH_2$
5aj	95%, *0.6* μM	26%	97%, *0.095* μM, **71 nM**	80%	78%	>125	>125	$2\text{-}MeC_6H_4CH_2$
5ak	93%, *0.42* μM	46%	91%, *0.15* μM, **38 nM (C)**	86%	72%	>75	75	$2\text{-}ClC_6H_4CH_2$
5al	97%[c]	10%	87%	65%	59%	>74	74	$2\text{-}MeOC_6H_4CH_2$
5am	99%[c]	10%	90%	65%	62%	>66	66	$2\text{-}i\text{-}PrSC_6H_4CH_2$
5an	43%	34%	78%	85%	85%	>125	125	$2\text{-}O_2NC_6H_4CH_2$
5ao	97%[c]	10%	63%	12%	41%	>58	58	$2\text{-}BnSC_6H_4CH_2$
5ap	18%	14%	ni	24%	15%	>125	125	$2\text{-}(HO_2CCH_2O)C_6H_4CH_2$
5aq	ni	12%	ni	ni	ni	>51	51	$2\text{-}HO_3SC_6H_4CH_2$
5ar	94%, *0.5* μM	14%	88%, *0.25* μM, **35 nM (C)**	95%	87%	>55	55	$3\text{-}PhOC_6H_4CH_2$
5as	82%, *1.5* μM	18%	87%, *0.19* μM, **40 nM (C)**	92%	90%	>112	>112	$3\text{-}ClC_6H_4CH_2$
5au	90%	13%	93%	88%	85%	>90	90	$3\text{-}(t\text{-}BuO)C_6H_4CH_2$
5av	95%[c]	13%	90%	93%	90%	>125	125	$3\text{-}MeC_6H_4CH_2$
5aw	78%, *1* μM	36%	89%	98%	90%	>51	51	$4\text{-}CF_3OC_6H_4CH_2$
5ax	88%, *0.95* μM	49%	88%	98%	91%	>50	50	$3\text{-}(4\text{-}MeC_6H_4O)C_6H_4CH_2$
5ay	96%[c]	36%	85%	93%	90%	>125	125	$3\text{-}MeOC_6H_4CH_2$
5az	93%[c], *1.2* μM	13%	33%	96%	92%	>40	40	$3\text{-}(4\text{-}FC_6H_4O)C_6H_4CH_2$
5ba	94%, *0.42* μM	28%	96%, *91 nM*, **13 nM (C)**	91%	82%	>14	14	$2\text{-}Cl,4\text{-}Me_2NC_6H_3CH_2$
5bb	88%, *0.7* μM	14%	97%, *76 nM*, **52 nM (C)**	94%	86%	>67	67	$3\text{-}Cl,4\text{-}(OH)C_6H_3CH_2$
5bc	82%, *0.75* μM	17%	96%, *100 nM*, **235 nM (C)**	94%	85%	>79	79	$3\text{-}MeO,4\text{-}(AcO)C_6H_3CH_2$
5bd	75%, *1* μM	37%	79%, *230 nM*, **650 nM (C)**	93%	89%	>125	125	$2,4\text{-}(F_2)C_6H_3CH_2$
5be	70%	14%	97%	85%	89%	>82	82	$3,4\text{-}(F_2)C_6H_3CH_2$
5bf	97%[c]	14%	97%	77%	82%	>9	9	$3,5\text{-}(MeO)_2C_6H_3CH_2$
5bg	81%	8%	95%	67%	52%	>29	29	$2,4\text{-}(Cl)_2C_6H_3CH_2$
5bh	67%	41%	95%	97%	85%	>109	109	$3,4\text{-}(OCH_2O)C_6H_3CH_2$
5bi	79%	14%	93%	91%	82%	>29	29	$2\text{-}F,4\text{-}(CF_3)C_6H_3CH_2$
5bj	ni	31%	89%	96%	77%	>107	107	$3\text{-}(NO_2),4\text{-}ClC_6H_3CH_2$
5bk	45%	25%	87%	83%	77%	>125	>125	$2,5\text{-}(F)_2C_6H_3CH_2$
5bl	78%	38%	86%	66%	33%	>68	68	$2,3\text{-}(MeO)_2C_6H_3CH_2$
5bm	44%	39%	86%	84%	76%	>125	>125	$3,4\text{-}(MeO)_2C_6H_3CH_2$

(*continued on next page*)

Table 2 (*continued*)

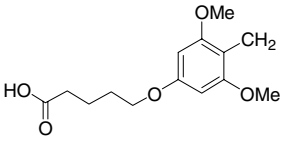
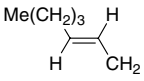
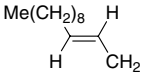
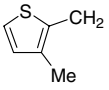
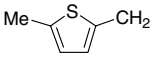
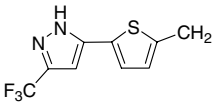
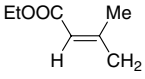
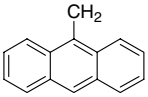
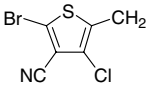
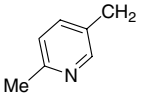
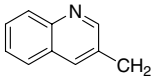
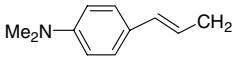
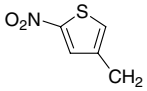
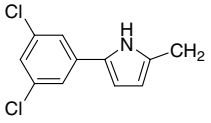
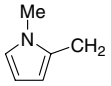
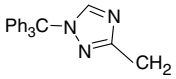
Inhibitor Concn:	My 0.06 mM	Mr 0.6 mM	IMy 0.12 mM	AMan 3 mM	AMrm 3 mM	EC_{50}[a] (μg/mL)	CC_{50}[a] (μg/mL)	R in **5**
5bn	ni	43%	85%	91%	76%	>45	45	2-(HO),4-(MeO)$C_6H_3CH_2$
5bo	84%, *1* μM	16%	79%, *280 nM*	89%	83%	>17	17	2-Cl,4-F$C_6H_3CH_2$
5bp	26%	69%	77%	99%	85%	>11	11	3,4-(BnO)$_2C_6H_3CH_2$
5bq	94%[c]	ni	77%	81%	75%	>55	55	2,3-(Cl)$_2C_6H_3CH_2$
5br	76%	29%	76%	37%	44%	>28	28	2,6-(MeO)$_2C_6H_3CH_2$
5bs	87%	12%	76%	94%	90%	>95	95	3-F,4-Me$C_6H_3CH_2$
5bt	86%	23%	73%	77%	76%	>73	73	2,3-(OCF_2O)$C_6H_3CH_2$
5bu	55%, *1.9* μM	7%	52%, *1.7* μM	94%	87%	>39	39	2-(HO_2C)$C_6H_3CH_2$
5bv	31%	ni	39%	41%	22%	>125	>125	2-(HO),3-(MeO_2CC)$C_6H_3CH_2$
5bw	37%	21%	ni	86%	82%	>125	>125	3,4-(EtO)$_2C_6H_3CH_2$
5bx	93%[c]	43%	98%	53%	72%	>125	>125	2,4,6-(Me)$_3C_6H_2CH_2$
5by	97%[c]	16%	98%	94%	86%	>86	86	2,3-(Me)$_2$,4-Me$OC_6H_2CH_2$
5bz	75%	14%	97%	92%	82%	>53	53	3,5-(Cl)$_2$,4-(HO)$C_6H_2CH_2$
5ca	68%	16%	95%	49%	40%	>36	36	3,4-(OCH_2CH_2O)$C_6H_3CH_2$
5cb	94%	28%	94%	83%	82%	>12	12	4-(OH),3-I,5-Me$OC_6H_2CH_2$
5cc	38%	ni[e]	21%	ni	12%	>125	>125	
5cd	15%	15%	ni	25%	16%	>125	>125	4-(HO),3-(HO_2C), 5-Me$OC_6H_2CH_2$
5ce	87%	16%	97%	87%	76%	>125	>125	Me_2CHCH_2
5cf	93%[c]	15%	98%	80%	69%	>125	>125	$Me(CH_2)_2CH(Me)CH_2$
5cg	90%	16%	96%	80%	82%	>125	>125	$Me_2C{=}CHCH_2$
5ch	90%	30%	95%	93%	84%	>74	74	
5ci	82%	38%	90%	95%	87%	>11	11	$HO(CH_2)_5$
5cj	83%, *0.86* μM	15%	70%	96%	90%	>67	67	Ph–C≡C–CH_2
5ck	ni	ni	61%	15%	ni	>57	57	
5cl	82%	15%	93%	58%	64%	>125	>125	
5cm	89%	20%	91%	59%	64%	>125	>125	Ph_2CHCH_2
5cn	82%	ni	87%	83%	78%	>125	>125	
5co	79%	29%	83%	92%	85%	>17	17	
5cp	ni	9%	75%	34%	32%	>125	>125	
5cq	91%, *0.6* μM	18%	71%	81%	78%	>7	7	
5cr	81%	24%	71%	72%	61%	>54	54	
5cs	76%	20%	27%	78%	81%	>125	>125	

Table 2 (*continued*)

Inhibitor Concn:	My 0.06 mM	Mr 0.6 mM	IMy 0.12 mM	AMan 3 mM	AMrm 3 mM	EC_{50}[a] (μg/mL)	CC_{50}[a] (μg/mL)	R in **5**
5ct	57%	10%	55%	93%	86%	>125	>125	
5cu	24%	ni	20%	86%	80%	>125	>125	
5cv	48%	17%	ni	90%	84%	>63	63	
5cx	57%	ni	ni	ni	ni	>125	>125	
5cy	15%	14%	ni	28%	43%	>54	54	
5cz	16%	34%	ni	10%	12%	>125	>125	

My, maltase from yeast; Mr, maltase from rice; IMy, isomaltase from yeast; AMan, amyloglucosidase from *A. niger*; AMrm, amyloglucosidase from *Rhizopus* mold; substrate, α-D-(Glc*p*-O–C_6H_4–4-NO_2); nm, not measured.

Percentage of inhibition for given concentrations, IC_{50} (in italics), K_i (bold), when measured (C, competitive).

EC_{50}: effective concentration 50 to inhibit 50% HIV-induced cell death.

CC_{50}: cytotoxic concentration 50 or needed concentration to induce 50% death of non-infected cells.

[a] Evaluated with the MTT method in MT4 cells (Ref. 38).

[b] Inhibitor numbering uses **a**–**r** (aldehydes of Table 1), then **s** to **cw** for the other derivatives.

[c] We expect theses derivatives to have IC_{50} values <1.5 μM by analogy with those for which IC_{50} have been measured.

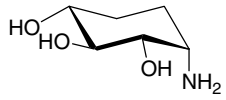
[d] See the corresponding conduramine F-1 derivatives **10a**–**r** (Table 3).

[e] ni, no inhibition.

$CH(Me)CH_2$), all these inhibitors are *N*-benzyl derivatives. The monosubstituted aryl derivatives are better inhibitors than polysubstituted aryl derivatives, except for **5ba** (R = 2-Cl,4-$Me_2NC_6H_3CH_2$) and **5bb** (R = 3-Cl,4-$(OH)C_6H_3CH_2$) which showed IC_{50} = 0.42 and 0.7 μM toward My, and IC_{50} = 91 (K_i = 13 nM) and 76 nM (K_i = 52 nM) toward isomaltase from yeast. Substitution of the *para* carbon atom of the benzyl group by substituents such as Me, Et, MeO, and Cl leads to slight decreases of the inhibitory activities toward My and IMy. The effect is more significant for *p*-chloro substituent than for the other substituents. In contrast, *para*-substitution with phenyl (**5d**), MeS (**5x**), Me_2CHCH_2 (**5y**), and CF_2HCF_2O (**5z**) generates the most potent α-glucosidase inhibitors. Interestingly, *ortho*- and *meta*-substitution of **5a** leads to increase of the inhibitory activities (compare e.g., **5w**) (R = 4-ClC_6H_4: 34% of inhibition of My at 0.06 mM concentration) with **5ak** (R = 2-ClC_6H_4: 93%) and **5as** (R = 3-ClC_6H_4: 82%). *para*-Substitution by a dimethylamino group does not improve the inhibitory activities as seen by the comparison of data for **5a** (IC_{50} = 0.7 μM (My), IC_{50} = 0.12 μM (IMy)), **5aa** (IC_{50} = 1 μM (My)) and for **5ak** (IC_{50} = 0.42 μM (My), IC_{50} = 0.15 μM (IMy)) and **5ba** (IC_{50} = 0.42 μM (My), IC_{50} = 0.091 μM (IMy)). *ortho*-Substitution by groups such as MeO (**5al**), *i*-PrS (**5am**), and BnS (**5ao**) generates the most potent inhibitors of maltase from yeast.

In contrast, *ortho*-substitution by electron-withdrawing groups such as nitro (**5an**) and HO_3S (**5aq**) is detrimental to the α-glucosidase inhibitory activity. Interestingly, while *para*-fluoro substitution maintains the inhibitory activity (compare **5a** with **5u**), disubstitution by two fluoro groups decreases the activity (compare **5a** with **5bd** (2,4-$(F_2)C_6H_3CH_2$) and **5be** (3,4-$(F_2)C_6H_3CH_2$)). Replacement of benzyl moieties by heterocyclic analogues (see **5cl**, **5cn**, **5co**, **5cr**, **5cs**, **5ct**, **5cv**, **5cw**, **5cx**, **5cy**, **5cz**) generates less potent inhibitors.

All compounds tested in Table 2 were assayed for their ability to inhibit HIV replication as measured by the inhibition of HIV-induced cytopathic effect in lymphoid cells. Unfortunately, none of them showed any activity. Some of the inhibitors are cytotoxic. If one considers the inhibitors with IC_{50} < 1.5 μM toward maltase from yeast one finds that **5ah**, **5bo**, **5u**, **5cq**, and **5ba** have relatively high cytotoxicities (<20 μg/mL). The groups of compounds **5v**, **5t**, **5c**, **5ak**, **5cj**, **5aq**, and **5d** have modest cytotoxicities (50–90 μg/mL). The cases of **5b** (R = 4-$EtC_6H_4CH_2$; IC_{50} = 2.6 μM (My); CC_{50} = 2 μg/mL), **5s** (R = 4-$MeC_6H_4CH_2$; IC_{50} = 1.4 μM (My); CC_{50} > 115 μg/mL), and **5aj** (R = 2-$MeC_6H_4CH_2$; IC_{50} = 0.6 μM (My); CC_{50} > 125 μg/mL) are surprising as the ethyl substituent seems to induce a much higher cytotoxicity than methyl substituents. From our data (Table 2) it appears that the cytotoxicity of our inhibitors increas-



(±)-**36**

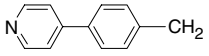
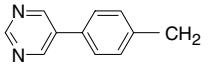
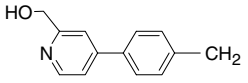
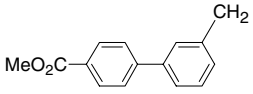
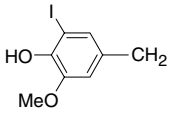
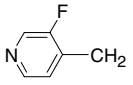
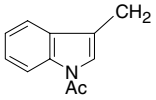
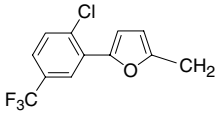
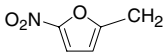
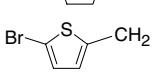
Figure 3. (±)-Dihydroconduramine F-1.

es with the electron-releasing ability of the benzyl group substituents, as seen with **5l** (R = 3,4-$(MeO)_2C_6H_3CH_2$), **5ba** (R = 2-Cl,4-$Me_2NC_6H_3CH_2$), **5bp** (R = 3,4-$(BnO)_2C_6H_3CH_2$), **5br** (R = 2,6-$(MeO)_2C_6H_3CH_2$), and **5cb** (R = 4-(OH),3-I,5-$MeC_6H_2CH_2$). The 9-anthrylmethyl derivative **5cq** (IC_{50} = 0.6 μM (My)) is also one of the most cytotoxic compound of our library.

5. Glycosidase inhibitory activities of conduramine F-1 and derivatives

Enantiomerically pure (+)-*ent*-conduramine F-1 (norvalienamine) ((+)-**9**) is a highly selective but moderate inhibitor of maltase (α-glucosidase) from yeast

Table 3. Inhibitory activities of (±)-conduramine F-1 ((±)-**9**) and *N*-benzyl derivatives (±)-**10a**–**r**

Inhibitor	Gb	My	Mr	Aman	Amrm	R in **10**
(±)-**9**	70%	45%, *550* μM	ni	ni	40%	
(+)-**9**	ni	96%, *250* μM, **42 μM (C)**	ni	ni	40%	
(−)-**9**	ni	ni	ni	ni	ni	
(±)-**10a**	ni	84%, *130* μM	ni	33%	49%	$PhCH_2$
(±)-**10b**	ni	86%, *90* μM	ni	41%	52%	4-$EtC_6H_4CH_2$
(±)-**10c**	70%	98%, *6.4* μM, **1.7 μM (C)**	ni	28%	39%	4-$HOC_6H_4CH_2$
(+)-**10c**	ni	97%, *3.5* μM, **0.9 μM (C)**	ni	71%	nm	
(−)-**10c**	ni	54%	ni	37%	nm	
(±)-**10d**	64%	89%, *27* μM	ni	60%, *300* μM	64%, *410* μM	4-$PhC_6H_4CH_2$
(±)-**10e**	70%	93%, *45* μM, **3.5 μM (C)**	ni	ni	37%	4-$PhOC_6H_4CH_2$
(±)-**10f**	52%	ni	ni	53%	63%, *98* μM	4-(4-PhO)$PhOC_6H_4CH_2$
(±)-**10g**	53%	97%, *8.0* μM, **0.44 μM (C)**	ni	54%	77%, *240* μM	
(+)-**10g**	73%	98%, *6.0* μM, **0.54 μM (C)**	ni	ni	72%, *470* μM	
(−)-**10g**	nm	nm	nm	nm	nm	
(±)-**10h**	42%	83%, *160* μM	ni	20%	34%	
(±)-**10i**	ni	88%, *56*μM	ni	42%	48%	
(±)-**10j**	66%	92%, *41*μM	ni	20%	50%	
(+)-**10j**	84%	96%, *30* μM, **15 μM (C)**	ni	51%	86%, *156* μM	
(−)-**10j**	71%	88%, *46* μM, **14 μM (C)**	ni	ni	nm	
(±)-**10k**	ni	94%, *30* μM	ni	29%	33%	
(+)-**10k**	ni	98%, *12* μM, **1.8 μM (C)**	ni	ni	26%	
(−)-**10k**	ni	23%	ni	ni	nm	
(±)-**10l**	26%	90%, *62* μM	ni	ni	ni	3,5-$(MeO)_2C_6H_3CH_2$
(±)-**10m**	ni	93%	ni	28%	41%	4-(HO),3-$(MeO)C_6H_3CH_2$
(±)-**10n**	ni	90%, *68* μM, **4.5 μM (C)**	ni	ni	ni	
(±)-**10o**	20%	95%, *21* μM, **1.3 μM (C)**	ni	ni	ni	
(+)-**10o**	26%	98%, *9* μM, **0.8 μM (C)**	ni	ni	20%	
(−)-**10o**	nm	nm	nm	nm	nm	
(±)-**10p**	55%	78%, *41* μM, **2.3 μM (C)**	ni	ni	ni	
(+)-**10p**	65%	80%, *150* μM	ni	ni	ni	
(−)-**10p**	nm	nm	nm	nm	nm	
(±)-**10q**	51%	72%, *130* μM	ni	ni	ni	
(±)-**10r**	56%	97%, *7.5* μM, **0.45 μM (C)**	ni	30%	62%	

See Table 1 for derivatives of **a**–**r** and of selected enantiomerically pure compounds toward β-galactosidase from bovine liver (Gb), α-glucosidases (maltase from yeast), My; maltase from rice, Mr; amyloglucosidase from *A. niger*, AMan; and from *Rhizopus* mold, AMrm.

Percentage of inhibition at 1 mM concentration of the inhibitor (see Ref. 37), IC_{50} in italics and K_i bold, when measured (C, competitive).

ni, no inhibition detected at 1 mM concentration; nm, not measured.

(IC_{50} = 250 μM, K_i = 42 μM, competitive). At 1 mM concentration it did not inhibit α-fucosidase from bovine kidney, β-galactosidase from *Escherichia coli*, from bovine liver or from *Aspergillus orizae*, maltase from rice, amyloglucosidase from *A. niger* or from *Rhizopus* mold, β-glucosidase from almonds, α-mannosidase from jack bean, β-xylosidase from *A. niger* and β-*N*-acetylglucosoaminidase from jack bean or from bovine kidney. Racemic conduramine F-1 ((±)-**9**) was less selective. It inhibited also β-galactosidase from bovine liver (70% at 1 mM), amyloglucosidase from *Rhizopus* mold (40% at 1 mM), and α-mannosidase from jack bean (45%) and from almonds (31% at 1 mM). (−)-Conduramine F-1 ((−)-**9**) did not inhibit any of our enzymes, except for a weak inhibitory activity toward α-mannosidase from jack bean (34% at 1 mM), and β-*N*-acetylglucosoaminidase from jack bean (23% at 1 mM).

Racemic dihydroconduramine F-1 ((±)-**36**) (Fig. 3) obtained by hydrogenation (H_2, Pd/C, MeOH) of (±)-**9** (98% yield) was inactive at 1 mM toward all 17 glycosidases assayed. This demonstrates the importance of the greater flatness and flexibility of the cyclohexene moiety of conduramine F-1 compared with the cyclohexane derivative (±)-**36** for the aminotriol array to be recognized by α-glucosidases. The failure of (±)-**9** to recognize other α-glucosidases than maltase from yeast might be associated to the different mechanism of the hydrolysis catalyzed by the α-glucosidases in this study.

Unexpected is the finding that (+)-*ent*-conduramine F-1 is more selective toward α-glucosidases than valienamine. Whereas (+)-**9** inhibits maltase from yeast only (IC_{50} = 250 μM, K_i = 42 μM, competitive), valienamine (**4**) is recognized by both maltose (IC_{50} = 170 μM) and isomaltase from yeast, and by amyloglucosidase from both *A. niger* and *Rhizopus* mold (Table 2). Note that (+)-**9** and our conduramine F-1 derivatives have not been assayed toward isomaltase from yeast. The racemic phthalimido derivative (±)-**29**, like (±)-**36**, did not inhibit any of the 17 glycosidases tested at 1 mM concentration. Table 3 collects our inhibition results for racemic (±)-**9** and its *N*-benzyl derivatives (±)-**10a**–(±)-**10r** and for selected enantiomerically pure (+)-**10c**, **10g**, **10j**, **10k**, **10o**, **10p** and (−)-**10c**, **10g**, **10j**, **10k**, **10o**, **10p** derivatives. None of these compounds inhibited the following enzymes at 1 mM concentration: α-L-fucosidase from bovine kidney, α-galactosidase from coffee beans and from *E. coli*, β-galactosidase from *E. coli* and from *A. orizae*, β-glucosidase from almond, α-mannosidase from jack bean and almond (except for (±)-**9** which inhibited these two latter enzymes by 45% and 31% at 1 mM concentration), β-mannosidase from *Helix pomatia*, β-xylosidase from *A. niger* (except for (±)-**9**, 23% at 1 mM) and β-*N*-acetylglucosoaminidase from jack bean and from bovine kidney.

Apart from (−)-**10j**, which is an inhibitor of maltase from yeast almost as potent as its enantiomer (+)-**10j**, derivatives of (−)-conduramine F-1 (−)-**10c**, and **10k** are not recognized by any of the enzymes assayed as is the case for (−)-**9** itself.

Our best α-glucosidase inhibitors in the conduramine F-1 series are (+)-**10c** (R = *para*-hydroxybenzyl: IC_{50} = 3.5 μM, K_i = 0.9 μM), (+)-**10g** (R = 4-(4-pyridinyl)phenylmethyl: IC_{50} = 6 μM, K_i = 0.54 μM), and (±)-**10r** (R = 5-bromothien-2-yl, IC_{50} = 7.5 μM, K_i = 0.45 μM), which are all competitive inhibitors of maltase from yeast. They are about one order of magnitude less active than the best valienamine derivatives **5a** (R = $PhCH_2$; IC_{50} = 0.7 μM), **5c** (R = 4-$HOC_6H_4CH_2$; IC_{50} = 0.94 μM), **5d** (R = 4-$PhC_6H_4CH_2$; IC_{50} = 0.68 μM), **5aj** (R = 2-$MeC_6H_4CH_2$; IC_{50} = 0.6 μM), **5ak** (R = 2-$ClC_6H_4CH_2$; IC_{50} = 0.42 μM), **5ar** (R = 3-$PhOC_6H_4CH_2$; IC_{50} = 0.5 μM), and **5ba** (R = 2-Cl,4-$Me_2NC_6H_3CH_2$; IC_{50} = 0.42 μM). Comparison of the IC_{50} values (maltase from yeast) found for valienamine derivatives **5a**, **5b**, **5c**, **5d**, **5l**, and **5m** with those measured for the corresponding conduramine F-1 derivatives **10a**, **10b**, **10c**, **10d**, **10l**, and **10m** demonstrates that the hydroxymethyl group of valienamine improves significantly the inhibitory activity toward α-glucosidases. None of the compounds (±)-**10a**–**e**, **g**–**r** showed any anti-HIV activity at concentration ⩽25 μg/mL. Interestingly, except for (±)-**10f** (R = 4-(4-PhO)-$PhOC_6H_4CH_2$), which showed a cytotoxicity of 7 μg/mL, the other derivatives (±)-**10a**–**e**, **10g**–**r** showed no cytotoxicity at concentration ⩽25 μg/mL. This was not the case for several valienamine derivatives (see e.g., **5b**, **5l**).

6. Conclusion

As for valienamine, N-substitution of (+)-*ent*-conduramine F-1, especially N-benzylation, increases significantly its inhibitory activity toward amylase from yeast. As expected, (−)-conduramine F-1 derivatives are recognized neither by α-glucosidases, nor by other glycosidases. The hydroxymethyl group of valienamine makes its derivatives more active than conduramine F-1 analogues. Unfortunately, none of the new α-glucosidase inhibitors showed any anti-HIV activity. Some of these inhibitors are cytotoxic. The cytotoxicity does not correlate with the α-glucosidase inhibitory activity. A new approach to the synthesis of (±)-conduramines F-1, (−)-conduramine F-1 and (+)-*ent*-conduramine F-1 has been developed. It uses the 'naked sugar' methodology.

7. Experimental

(a) *General*. All commercially available reagents (Fluka, Aldrich, Acros Organics) were used without further purification. Solvents were dried by standard methods. Light petroleum ether used refers to the fraction boiling between 40 and 60 °C. Solvents after reactions and extractions were evaporated in a rotatory evaporator under reduced pressure. Liquid/solid flash chromatography (FC): silica gel 60 (Merck No. 9385, 240–400 mesh) or neutral alumina. TLC (reaction monitoring): Merck silica gel $60F_{254}$ plates; detection by UV light, Pancaldi reagent ($(NH_4)_6MoO_4$, $Ce(SO_4)_2$, H_2SO_4, H_2O), 1% $KMnO_4$ in H_2O or 1% ninhydrin in MeOH. IR Spectra: Per-

kin-Elmer 1420 spectrometer; in cm^{-1}. Optical rotations: at 25 °C: Jasco P-1020 polarimeter; $[\alpha]_D$ in 10^{-1} deg cm^2 g^{-1}. ^1H NMR spectra: Bruker ARX-400 spectrometer (400 MHz); δ(H) in parts per million relative to the solvent's residual ^1H signal ($CDCl_3$, δ(H) 7.27; CD_3OD, δ(H) 3.31) as internal reference; all ^1H assignments were confirmed by 2D-COSY-45 and 2D-NOESY experiments. ^{13}C NMR spectra: same instrument as for ^1H (100.6 MHz); δ(C) in ppm rel. to the solvent's C-signal ($CDCl_3$, δ(C) 77.0; CD_3OD, δ(C) 49.0) as internal reference; all ^{13}C assignments were confirmed by 2D-HMQC; coupling constants J in hertz. MS: Nermag R 10-10C, chemical-ionization (NH_3) mode; *m/z* (% rel to the base peak (=100%)). Elemental analyses: Ilse Beetz, D-96301 Kronach, Germany. Melting points: BÜCHI SMP-20 apparatus and are uncorrected. HPLC–MS was performed on a Waters 2790 HT with a Micromass 2MD2000 MS machine. The column was a YMC 50 × 4.6 mm filled with S-5 μm Combiscreen ODS-AQ reversed-phase material. A gradient of 6 min from 20% MeCN in H_2O to 100% MeCN was run. Detection was by both MS and UV (diode array). Aminomethylated polystyrene resin (AM resin), 2% DVB, with 2.39 mmol/g substitution was purchased from Calbiochem-Novabiochem. Flexchem® Teflon reaction blocks with 1 mL vessels in 96-well plate format were purchased from Robbins Scientific (now SciGene). The rotary shaker was a Mini-Shaker purchased from Alfred Kühner AG, Birsfelden, Switzerland. When using a flask or the Flexchem® well plates the rotational shaking speed was adjusted so that the resin was just mobile, to avoid mechanical damage to the resin. We call this process swirling.

(b) Glycosidase inhibition assays, see Ref. 37

(c) Anti-HIV evaluation and cytotoxicity assays, see Ref. 38

(d) Optical rotations for enantiomerically pure derivatives **35c**, **35g**, **35j**, **35k**, **35o**, **35p** in both forms were not measured.

7.1. Solid-phase preparation of the valienamine derivatives

7.1.1. *N*-Butyl-valienamine (5). Resin-bound valienamine **14** (0.107 g, 0.66 mmol/g, 0.071 mmol) was swirled in $THF/HC(OMe)_3$ (4 mL, 1:1). Butyraldehyde (0.100 mL, 1.11 mmol) was added and the mixture was swirled for 2 h at rt. The resin was filtered off, washed twice with $THF/HC(OMe)_3$ (1:1), resuspended in $THF/HC(OMe)_3$ (1:1), again butyraldehyde (0.100 mL, 1.11 mmol) was added, and the swirling and washing procedure were repeated. The resin-bound intermediate imine was washed with THF (2×) and DMF (3×), suspended in DMF (4 mL), $NaBH(OAc)_3$ (0.076 g, 0.36 mmol) was added, the mixture was swirled overnight at rt, and the resin was filtered and washed with DMF (2×), EtOH (1×), and THF (2×). This *N*-butyl-valienamine-bound resin was suspended in EtOH/THF (6 mL, 1:1), NH_3 (25% aq, 1.5 mL) was added, and swirled overnight at rt. The product solution was removed, the resin washed with MeOH (3×), and the solvent was evaporated to yield crude valienamine 0.129 g (79%), which contained valienamine and *N*,*N*-dibutyl-valienamine according to ^1H NMR, TLC, and MS. A sample was chromatographed on silica with $CHCl_3$/MeOH/AcOH/H_2O (60:30:3:5) to yield pure *N*-butyl-valienamine acetate, which was free-based by adsorbtion onto an ion exchange resin and elution with NH_3 (2.5% aq). Evaporation gave *N*-butyl-valienamine as a transparent glass. ^1H NMR (500 MHz, CD_3OD): 5.82 (d, J(C,H) = 3.0, H–C(6)); 4.19 (d, J(7,7) = 14.2, H–C(7)); 4.15 (d, J(7,7) = 14.2, H–C(7)); 3.96 (d, J(3,4) = 5.7, H–C(4)); 3.76 (dd, J(2,3) = 8.5, J(3,4) = 5.7, H–C(3)); 3.71 (dd, J(1,2) = 4.6, J(2,3) = 8.7, H–C(2)); 3.38 (app br s, H–C(1)); 2.78 (m, CH_2N); 2.67 (m, CH_2N); 1.40, 1.54 (2m, CH_2CH_2); 0.96 (t, J = 7.3, CH_3). ^{13}C NMR (125 MHz, CD_3OD): 142.9 (C(5)); 121.6 (C(6)); 74.2, 72.5, 70.3 (C(2), C(3), C(4)); 63.4 (C(7)); 56.9 (C(1)); 49.3 (C(1′)); 32.4 (C(2′)); 21.4 (C(3′)); 14.4 (C4′). MS: ES+ve 232 $[M+H]^+$.

7.1.2. Succinic acid *N*-Boc-valienamine ester (12). Succinic anhydride (22.5 g, 225 mmol) was added to a suspension of *N*-Boc-valienamine (**11**)[39] (51.5 g, 187 mmol) in 2,4,6-collidine with stirring at 0 °C. After 30 min at 0 °C, the cooling bath was removed and the reaction mixture was allowed to warm to rt. After 3 h the solid had completely dissolved and TLC (10% H_2O in MeCN) indicated almost complete reaction. Water (1 L) was added and the aqueous phase washed with toluene (2× 400 mL), ether (400 mL), and hexane (400 mL) then evaporated. The crude product was chromatographed (MeCN/AcOH/H_2O 100:1:3) to yield 43.2 g (115 mmol, 61%) of the product. ^1H NMR (300 MHz, CD_3OD): 1.43 (s, *t*-Bu); 2.61 (br s, succinyl); 3.67 (br s, H–C(2), H–C(3)); 3.92 (br s, H–C(4)); 4.36 (br s, H–C(1)); 4.58 (d, J(C,H) = 13, H–C(7)); 4.77 (d, J(C,H) = 13, H–C(7)); 5.67 (d, J(C,H) = 4, H–C(6)). MS: ES−ve 749 $(M-H^+)$, 749 $(2M-H^+)$.

Fractions containing the 3,7-diacylated byproduct were evaporated and the crude was dissolved in MeOH (250 mL) and treated with NH_3 (concn 25 mL) overnight. Evaporation and chromatography gave recovered **11** (9.8 g, 35.6 mmol, 19%).

7.1.3. Resin-bound *N*-Boc-valienamine (13). Diisopropylcarbodiimide (21 mL, 136.6 mmol) and *N*-hydroxy-benzotriazole (containing 12% water, 20.3 g, 134 mmol) were added sequentially to a solution of **12** (50.3 g, 134 mmol) in DMF (200 mL) and CH_2Cl_2 (50 mL) at rt with stirring. After stirring for 30 min, during which the mixture warmed slightly, aminomethylated polystyrene resin (2.39 mmol/g, 12.3 g, 29.4 mmol amino groups, 0.22 equiv) was added and the mixture was swirled overnight. The resin was filtered off, and the mother liquors were reused for another batch as described below. The resin was washed with DMF (3×), MeOH (3×), toluene (3×), CH_2Cl_2 (3×), MeOH (again 3×), and dried under vacuum overnight to yield 20.46 g of resin. The weight increase of 8.16 g is equivalent to 22.84 mmol (78% conversion and 1.12 mmol/g).

The mother liquors were added to a further 12.3 g aminomethylated polystyrene resin and the reaction and washing procedure described above repeated to yield

this time 22.15 g of functionalized resin. The weight increase of 9.85 g corresponds to 27.54 mmol (94% conversion and 1.24 mmol/g). The two batches of resin were mixed thoroughly to give material with ca. 1.18 mmol/g. A similar small variation in loading of the resin was observed from batch to batch.

7.1.4. Cleavage of *N*-Boc-valienamine 11 from the resin 13. NH_3 (1 mL, 24% aq) was added to a suspension of **13** (0.094 g, 0.111 mmol) which had been swollen in THF (3 mL) and MeOH (1 mL), and the mixture was swirled for 3 h at rt. TLC ($CHCl_3$/MeOH/AcOH/H_2O (60:30:3:5)) showed only **11** ($R_f = 0.7$).

7.1.5. Resin-bound valienamine (14). The resin **13** (10 g, 1.10 mmol/g, 11.0 mmol) was swelled in CH_2Cl_2 (60 mL), cooled to 0 °C, and under swirling HCl (4 M in dioxane, 60 mL) was added slowly causing an exothermic reaction and evolution of gas. Swirling was continued for 2 h under nitrogen and then the resin was filtered off and washed with dioxane (3×), H_2O (3×), dioxane (3×), CH_2Cl_2 (3×), CH_2Cl_2/Et_3N (9:1) (5×, leaving the resin each time for 5 min in the solution), CH_2Cl_2 (3×), toluene (3×), and MeOH (3×). The resin was then dried overnight under vacuum to yield 9.11 g. The weight loss of 890 mg corresponds to 8.9 mmol (81%). The amount and integrity of loaded valienamine was also assessed by cleavage from a sample of resin.

7.1.6. Cleavage of valienamine 4 from the resin 14. NH_3 (1 mL, 24% aq) was added to a suspension of **14** (0.092 g), which had been swollen in THF (3 mL) and MeOH (1 mL), and the mixture was swirled overnight at rt. The resin was filtered off, washed with MeOH, the solvent evaporated and the product dried under vacuum to yield valienamine **4** (0.0196 g, 0.112 mmol), which was identical by ^{1}H NMR and TLC to authentic material. Thus, 1.22 mmol valienamine can be cleaved from 1 g of resin.

7.1.7. *N*-Fmoc-valienamine (17). *N*-Boc-valienamine ester **11** (4.49 g, 16.3 mmol) was dissolved in a mixture of CF_3CO_2H and CH_2Cl_2 (1:1), stirred at rt for 1 h, and then H_2O (100 mL) was added. The mixture was poured on a DOWEX-50W-X8 column. The column was washed first with H_2O (500 mL) then with NH_3 (1.6 M aq, 1.1 L). Evaporation of aqueous alkaline phase gave 3.5 g of crude valienamine **4**. A solution of valienamine **4** (2.01 g, 9.37 mmol) in water (23 mL) was stirred at 0 °C, then $NaHCO_3$ (0.79 g, 9.40 mmol) and a solution of *N*-(9-fluorenylmethoxycarbonyloxy)succinimide (3.1 g, 9.19 mmol) in acetone (25 mL) were added. The ice bath was removed and the mixture stirred at rt for 2 h. The solvents were evaporated under vacuum and recrystallization of the residue from MeOH gave *N*-Fmoc-valienamine **17** (2.6 g, 6.5 mmol) in 70% yield. ^{1}H NMR (300 MHz, DMSO-d_6): 7.90 (m, 2 arom H); 7.75 (m, 2 arom H); 7.3–7.40 (m, 4 arom H); 7.15 (d, *J*(NH,1) = 7.5, NH); 5.45 (s, H–C(6)); 4.42 (s, OH); 4.72 (m, 4 OH); 4.25 (m, 3 Fmoc, H–C(1)); 3.95 (m, 2 H–C(7)); 3.7–3.5 (m, H–C(2); H–C(3); H–C(4)). MS: ES−442 ($M+HCO_2^-$); 839 ($2M + HCO_2^-$).

7.1.8. Succinic acid *N*-Fmoc-valienamine ester (18). Succinic anhydride (0.8 g, 8 mmol) was added to a solution of *N*-Fmoc-valienamine **17** (3.060 g, 7.7 mmol) in 2,4,6-collidine (50 mL) at 0 °C. The reaction mixture was stirred at 0 °C, allowed to warm to rt, and stirred at rt over the weekend. The solvent was evaporated and NaCl (aq half saturated) was added. The pH of the solution was adjusted to 1 by addition of HCl (1 M aq) then extracted with EtOAc (3× 100 mL). The solvent was evaporated from the combined organic phases under reduced pressure. The succinic acid *N*-Fmoc-valienamine ester could be obtained after recrystallization from EtOH or was purified by silica gel chromatography with a mixture of CH_2Cl_2/EtOH/AcOH (30:2:1) to yield 2.27 g of **18** (59%). ^{1}H NMR (300 MHz, DMSO-d_6): 12.25 (br s, COOH); 7.95 (m, 2 arom H); 7.75 (m, 2 arom H); 7.45–7.30 (m, 4 arom H); 7.15 (d, *J*(NH,1) = 7.5, NH); 5.7 (s, H–C(6)); 5.05–4.85 (m, 3 OH); 4.58 (m, 2 H–C(7)); 4.30–4.20 (m, 4H); 3.8 (m, 1H); 3.65 (m, 1H); 3.55 (m, 1H); 2.55 (4H, 2× CH_2). MS ES: 496 ($M-H^+$); 993 ($2M-H^+$).

7.1.9. Solid-phase synthesis, general procedure. Succinic acid *N*-Fmoc-valienamine ester **18** (1.602 g, 1.9 mmol) was dissolved in a mixture of DMF and CH_2Cl_2 (4:1) then *N*,*N*′-diisopropylcarbodiimide (DIC, 0.24 g, 1.9 mmol), *N*-hydroxybenzotriazole (BtOH, 0.289 g, 1.9 mmol), and aminomethylated resin (0.237 g, 2 mmol/g) were added at rt and the mixture was swirled overnight at rt. The excess reagents and solvents were removed by filtration. The resin **19** was washed with DMF, CH_2Cl_2, MeOH, and CH_2Cl_2 (3× 20 mL each). The weight gain of resin obtained was 0.456 g (98% yield).

This Fmoc-valienamine bound resin **19** (6.41 g, 7.3 mmol, 1.14 mmol/g) was swollen in DMF (60 mL) then pyridine (6.5 mL, 80.4 mmol) and *tert*-butyldimethylsilyl triflate (TBSOTf, 16.8 mL, 73.1 mmol) were added. The mixture was swirled at rt overnight. The excess of reagents was removed by suction before washing thoroughly with DMF (3×), water (3×), DMF (3×), CH_2Cl_2 (3×), MeOH (3×), and CH_2Cl_2 (3×). The weight gain of the resin indicated that reaction was incomplete, so the reaction was repeated once again under the same conditions. The weight gain of resin **20** obtained was 2.02 g (84% yield).

This resin **20** (8.433 g, 11.8 mmol, 1.14 mmol/g) was added to a 10% solution of piperidine in DMF (70 mL). The mixture was swirled overnight at rt. The excess reagents and solvents were removed by filtration. The resin was washed with DMF (3×), CH_2Cl_2 (3×), MeOH (3×), CH_2Cl_2 (3×), THF (3×), and CH_2Cl_2 (3×). The weight loss of resin obtained was 1.53 g (72% yield).

This resin (0.06 g, 0.07 mmol, 1.14 mmol/g) was swollen in a solution of THF, AcOH, and H_2O (0.8 mL, 11.5:1:1) in each of 91 wells of a reaction block by swirling for 3 h at rt. The 91 aldehydes (0.17 mL of a 0.5 M solution in THF, 0.085 mmol) were added. Then $NaBH(OAc)_3$ (0.073 mL, 0.073 mmol, 1 M in THF) was added. The mixture was swirled for 3 h at rt. The resin was

washed with DMF, CH_2Cl_2, THF, and CH_2Cl_2. The silyl groups were removed by treatment with a solution of HF/H_2O/MeCN (15:5:80), followed by washing with DMF, CH_2Cl_2, MeOH, CH_2Cl_2, THF, and CH_2Cl_2. The finished products were cleaved from the resin using a mixture of THF/MeOH/*n*-PrNH_2 (6:2:1). The mixture was swirled for 24 h at rt. The product solutions were removed by filtration. The resin was washed with a solution of MeOH/CH_2Cl_2 (2:3) (2× 0.5 mL). Evaporation of the solvent gave the *N*-alkyl valienamines **5**. A second reaction block with 42 aldehydes was treated in the same fashion. Valienamine has weak UV absorbance, and occasionally the molecular ion was not detected in the MS, so it was not possible to quantify the purity of the compounds by UV or MS, so TLC in two systems (eluant EtOH/CH_2Cl_2/AcOH/H_2O (5:11:1:1) and NH_3/H_2O/EtOH (1:3:16)) was used to examine purity qualitatively. There was always a small spot of starting valienamine **4** present. The products which showed a major spot or an almost pure product on TLC were examined by HPLC–UV–MS (Table 4). The biological results shown in Table 2 were obtained by purifying these 91 compounds further by column chromatography on silica gel (CH_2Cl_2/MeOH/$MeNH_2$).

7.2. Preparation of conduramine F-1 derivatives

7.2.1. (±)-(1*SR*,2*SR*,3*RS*,6*SR*)-6-Aminocyclohex-4-ene-1,2,3-triol, (±)-conduramine F-1 ((±)-9). A 40% aq $MeNH_2$ solution (15 mL) was added to (±)-**29** (1.1 g, 3.99 mmol). Stirring at 20 °C was continued for ca. 1 h (TLC monitoring). After evaporation, the residue was purified by ion exchange (Dowex-50 W (H^+ form), 2 N NH_4OH): pure (±)-**9** (0.54 g; 91%). FC (silica gel, Light petroleum ether/AcOEt (1:1) → AcOEt → 25% aq NH_3 soln/MeCN (1:4)). Very hygroscopic crystals. UV (MeOH): 213 (1280). IR (KBr): 3280, 2889, 1582, 1560, 1439, 1393, 1110, 1073, 1029, 985, 770. ^{1}H NMR (400 MHz, CD_3OD): 5.79 (ddd, J(5,4) = 10.1, J(5,6) = 4.5, J(5,3) = 1.9, H–C(5)); 5.72 (dd, J(4,5) = 10.2, J(4,3) = 1.8, H–C(4)); 3.97 (m, H–C(3)); 3.60–3.45 (m, H–C(6), H–C(2), H–C(1)). ^{13}C NMR (100.6 MHz, CD_3OD): 133.1 (d, J(C,H) = 161, C(4)); 128.4 (d, J(C,H) = 161, C(5)); 73.6, 73.5 (2d, J(C,H) ≈ 140, C(3), C(2)); 71.5 (d, J(C,H) = 143, C(1)); 51.5 (d, J(C,H) = 139, C(6)). CI-MS (NH_3): (3, $[M + H]^+$), 132 (24), 119 (3), 117 (44), 104 (36), 98 (25), 85 (100), 77 (12), 76 (19). HR-MALDI-TOF-MS: 146.0837 ($C_6H_{12}NO_3^+$, $[M+H]^+$; calcd 146.0817). Anal. Calcd for $C_6H_{11}NO_3$ (145.156): C, 49.65; H, 7.64. Found: C, 49.93; H, 7.40.

7.2.2. (+)-(1*S*,2*S*,3*R*,6*S*)-6-Aminocyclohex-4-ene-1,2,3-triol, (+)-*ent*-conduramine F-1 ((+)-9). Compound (+)-**9** was obtained according to the above procedure using (+)-**29** (91%). $[\alpha]_{589}^{25}$ +52, $[\alpha]_{577}^{25}$ +57, $[\alpha]_{435}^{25}$ +126, $[\alpha]_{405}^{25}$ +144 (*c* 0.11, MeOH). HR-MALDI-TOF-MS: 146.0810 ($C_6H_{12}NO_3^+$, $[M+H]^+$; calcd 146.0817).

7.2.3. (−)-(1*R*,2*R*,3*S*,6*R*)-6-Aminocyclohex-4-ene-1,2,3-triol, (−)-conduramine F-1 ((−)-9). Compound (−)-**9** was obtained according to the above procedure using (−)-**29** (95%). $[\alpha]_{589}^{25}$ −50, $[\alpha]_{577}^{25}$ −60, $[\alpha]_{435}^{25}$ −125, $[\alpha]_{405}^{25}$ −148 (*c* 0.11, MeOH). HR-MALDI-TOF-MS: 146.0837 ($C_6H_{12}NO_3^+$, $[M+H]^+$; calcd 146.0817).

7.2.4. Hydrolysis of triethylsilyl groups, general procedure. A 5–10% solution of protected *N*-benzyl derivatives of conduramine F-1 (±)-**35a**–**r**, *ent*-**35c**, **35g**, **35j**, **35k**, **35o**, **35p** or **35c**, **35g**, **35j**, **35k**, **35o**, **35p**, in AcOH/THF/H_2O (6:1:3) was stirred at 20 °C for 5–10 h. After solvent evaporation in vacuo, the residue was purified by FC on silica gel or alumina (light petroleum ether/AcOEt (1:1) → AcOEt → MeCN → 25% aq NH_3 soln/MeCN (1:9 → 1:4)).

The following compounds were obtained in this manner.

7.2.5. (±)-(1*SR*,2*SR*,3*RS*,6*SR*)-6-[(Benzyl)amino]cyclohex-4-ene-1,2,3-triol ((±)-10a). Conventional deprotection of (±)-**35a** gave (±)-**10a** (80%). TLC (MeOH/AcOEt (3:7)). Oil. UV (MeOH): 260 (420), 214 (3681). IR (KBr): 3381, 1559, 1419, 1212, 1080, 1051, 956. ^{1}H NMR (400 MHz, CD_3OD): 7.53–7.39 (m, 5 arom H); 5.98 (dd, J(4,5) = 10.2, J(4,3) = 1.7, H–C(4)); 5.81 (ddd, J(5,4) = 10.2, J(5,6) = 3.8, J(5,3) = 1.6, H–C(5)); 4.21 (d, J = 13.1, 1 ArCH_2N); 4.16 (d, J = 13.1, 1 ArCH_2N); 4.01–3.98 (m, H–C(3)); 3.84 (dd, J(1,2) = 9.2, J(1,6) = 5.4, H–C(1)); 3.76–3.73 (m, H–C(6)); 3.71 (d, J(2,1) = 9.2, J(2,3) = 6.5, H–C(2)). ^{13}C NMR (100.6 MHz, CD_3OD): 136.3 (d, J(C,H) = 163, C(4)); 135.2 (s, arom C); 130.6 (d, J(C,H) = 161, 2 arom C); 130.1 (d, J(C,H) = 161, 2 arom C); 129.9 (d, J(C,H) = 159, arom C); 122.8 (d, J(C,H) = 164, C(5)); 73.7 (d, J(C,H) = 145, C(2)); 72.1 (d, J(C,H) = 143, C(3)); 69.1 (d, J(C,H) = 146, C(1)); 56.5 (d, J(C,H) = 144, C(6)); 51.0 (t, J(C,H) = 141, ArCH_2N). CI-MS (NH_3): 236 (10, $[M+H]^+$), 175 (24), 149 (4), 117 (3), 106 (9), 104 (8), 91 (100), 84 (94), 77 (18), 71 (5). HR-MALDI-TOF-MS: 258.1109 ($C_{13}H_{17}NNaO_3^+$, $[M+Na]^+$; calcd 258.1106).

7.2.6. (±)-(1*SR*,2*SR*,3*RS*,6*SR*)-6-[(4-Ethylbenzyl)amino]cyclohex-4-ene-1,2,3-triol ((±)-10b). Conventional deprotection of (±)-**35b** gave (±)-**10b** (85%). TLC (MeOH/AcOEt (3:7)). Oil. UV (MeOH): 263 (810), 220 (7206). IR (KBr): 3388, 1636, 1419, 1081, 954, 828. ^{1}H NMR (400 MHz, CD_3OD): 7.36 (d, J = 7.9 Hz, 2 arom H); 7.25 (d, J = 7.9 Hz, 2 arom H); 5.89 (dd, J(4,5) = 10.3, J(4,3) = 1.9, H–C(4)); 5.81 (ddd, J(5,4) = 10.3, J(5,6) = 3.7, J(5,3) = 1.3, H–C(5)); 4.06 (d, J = 13.0, 1 ArCH_2N); 3.99 (d, J = 13.0, 1 ArCH_2N); 3.99–3.97 (m, H–C(3)); 3.73 (dd, J(1,2) = 9.4, J(1,6) = 5.4, H–C(1)); 3.65 (dd, J(2,1) = 9.4, J(2,3) = 6.5, H–C(2)); 3.60–3.57 (m, H–C(6)); 2.67 (q, J(1′,2′) = 7.6, H–C(1′)); 1.24 (t, J(2′,1′) = 7.6, H–C(2′)). ^{13}C NMR (100.6 MHz, CD_3OD): 145.8 (s, arom C); 134.9 (d, J(C,H) = 162, C(4)); 134.4 (s, arom C); 130.3 (d, J(C,H) = 158, 2 arom C); 129.4 (d, J(C,H) = 157, 2 arom C); 124.6 (d, J(C,H) = 163, C(5)); 74.1 (d, J(C,H) = 145, C(2)); 72.5 (d, J(C,H) = 143, C(3)); 69.9 (d, J(C,H) = 145, C(1)); 56.4 (d, J(C,H) = 142, C(6)); 51.4 (t, J(C,H) = 139, ArCH_2N); 29.5 (t, J(C,H) = 126, CH_3CH_2); 16.1 (q,

Table 4. HPLC–MS–UV characterization of the compounds **5**

Publ. no.	Amount (mg)	Formula	M (calcd)	t_R[a]	% area MS	% area UV
5a	15.2	$C_{14}H_{19}NO_4$	265.1	0.48	25	80
5b	13.8	$C_{16}H_{23}NO_4$	293.2	0.48;0.9	41	60
5c	16.1	$C_{14}H_{19}NO_5$	281.1	0.5	33	89
5d	14.9	$C_{20}H_{23}NO_4$	341.2	0.43;1.4	100	100
5l	17.1	$C_{16}H_{23}NO_6$	325.2	0.5; 0.6	33	92
5m	18.7	$C_{15}H_{21}NO_6$	311.1	0.43	40	90
5s	13.4	$C_{15}H_{21}NO_4$	279.1	0.46	45	0
5t	17	$C_{15}H_{21}NO_5$	295.1	0.47	36	83
5u	13.7	$C_{14}H_{18}FNO_4$	283.1	0.48	31	89
5v	25.5	$C_{15}H_{18}N_2O_4$	290.1	Not found		
5w	11.9	$C_{14}H_{18}ClNO_4$	299.1	0.4	14	54
5x	16.9	$C_{15}H_{21}NO_4S$	311.1	0.47; 0.8	46	92
5y	16.1	$C_{18}H_{27}NO_4$	321.2	1.5	92	26
5z	15.7	$C_{16}H_{19}F_4NO_5$	381.1	1.2	59	38
5aa	21.3	$C_{18}H_{28}N_2O_4$	336.2	Not found		
5ab	10	$C_{15}H_{18}F_3NO_5$	349.1	4.1	100	14
5ac	13.5	$C_{16}H_{21}NO_6$	323.1	0.47	58	88
5ad	23.9	$C_{15}H_{19}NO_6$	309.1	0.5	39	0
5ae	6.8	$C_{20}H_{23}NO_5$	357.2	4.5	76	19
5af		$C_{22}H_{27}NO_4$	369.2	Not found		
5ag		$C_{20}H_{21}F_2NO_4$	377.1	Not found		
5ah	24.6	$C_{21}H_{22}F_3NO_5$	425.1	1.8	44	93
5ai	13	$C_{14}H_{18}BrNO_4$	343	0.8	20	0
5aj	21.6	$C_{15}H_{21}NO_4$	279.1	0.47	43	79
5ak	13.3	$C_{14}H_{18}ClNO_4$	299.1	0.47	34	0
5al	15.2	$C_{15}H_{21}NO_5$	295.1	0.47	55	90
5am	15.8	$C_{17}H_{25}NO_4S$	339.2	0.47; 1.1	100	100
5an	10.4	$C_{14}H_{18}N_2O_6$	310.1	0.47	38	84
5ao	15.9	$C_{21}H_{25}NO_4S$	387.2	1.4	42	100
5ap	5	$C_{16}H_{21}NO_7$	339.1	3.6	94	47
5aq	24	$C_{14}H_{19}NO_7S$	345.1	2.7	3	3
5ar	14.5	$C_{20}H_{23}NO_5$	357.2	1.4	90	0
5as	11.3	$C_{14}H_{18}ClNO_4$	299.1	0.47	36	61
5au	13.8	$C_{18}H_{27}NO_5$	337.2	Not found		
5av	11.5	$C_{15}H_{21}NO_4$	279.1	0.48	24	78
5av	14.5	$C_{15}H_{21}NO_4$	279.1	3.6	100	23
5aw	14.5	$C_{15}H_{18}F_3NO_5$	349.1	0.50; 0.6; 1.1	78	60
5ax	20.3	$C_{21}H_{25}NO_5$	371.2	1.59	100	0
5ay	14.6	$C_{15}H_{21}NO_5$	295.1	0.48	34	91
5az	19.8	$C_{20}H_{22}FNO_5$	375.1	1.4	46	0
5ba	16.8	$C_{16}H_{23}ClN_2O_4$	342.1	0.5	11	63
5bb	16.3	$C_{14}H_{18}ClNO_5$	315.1	0.47	37	83
5bc	16.4	$C_{17}H_{23}NO_7$	353.1	Not found		
5bd	12.8	$C_{14}H_{17}F_2NO_4$	301.1	0.47	40	80
5be	12.3	$C_{14}H_{17}F_2NO_4$	301.1	0.5	33	74
5bg	14.8	$C_{14}H_{17}Cl_2NO_4$	333.1	0.47; 0.8	67	73
5bh	17.9	$C_{15}H_{19}NO_6$	309.1	0.5	61	88
5bi	12.4	$C_{15}H_{17}F_4NO_4$	351.1	0.9	30	30
5bj	13.4	$C_{14}H_{17}ClN_2O_6$	344.1	Not found		
5bk	13.2	$C_{14}H_{17}F_2NO_4$	301.1	0.48	52	85
5bl	29.8	$C_{16}H_{23}NO_6$	325.2	0.47	66	78
5bm	17.1	$C_{16}H_{23}NO_6$	325.2	0.47	60	0
5bn	23.9	$C_{15}H_{21}NO_6$	311.1	0.5	31	25
5bo	15.1	$C_{14}H_{17}ClFNO_4$	317.1	0.5	26	67
5bp	20.8	$C_{28}H_{31}NO_6$	477.2	2	45	94
5bq	14	$C_{14}H_{17}Cl_2NO_4$	333.1	0.47; 0.8	38	69
5br	16.1	$C_{16}H_{23}NO_6$	325.2	0.5; 0.7	43	0
5bs	13.3	$C_{15}H_{20}FNO_4$	297.1	0.48; 0.7	56	69
5bt	15.9	$C_{15}H_{17}F_2NO_6$	345.1	0.47; 0.8	49	0
5bu	13.7	$C_{15}H_{19}NO_6$	309.1	0.47	100	100
5bv	12.7	$C_{16}H_{21}NO_7$	339.1	3.7	16	2
5bw	15.9	$C_{18}H_{27}NO_6$	353.2	0.5; 0.8	40	67
5bx	14.2	$C_{17}H_{25}NO_4$	307.2	0.47; 1.0	86	78
5by	14.8	$C_{17}H_{25}NO_5$	323.2	0.48; 0.9	72	73
5bz	14.8	$C_{14}H_{17}Cl_2NO_5$	349	0.5	35	80

(*continued on next page*)

Table 4 (*continued*)

Publ. no.	Amount (mg)	Formula	M (calcd)	t_R[a]	% area MS	% area UV
5ca	17.4	$C_{16}H_{21}NO_6$	323.1	0.47	46	0
5cb	21.6	$C_{15}H_{20}INO_6$	437	0.49;0.7	48	91
5cc	11.4	$C_{21}H_{31}NO_9$	441.2	4.1	31	69
5cd	12.5	$C_{16}H_{21}NO_8$	355.1	1.7;3.0	54	77
5ce	4.4	$C_{11}H_{21}NO_4$	231.1	1.3	89	0
5cf	8.2	$C_{13}H_{25}NO_4$	259.2	3.5	82	0
5cg	8.8	$C_{12}H_{21}NO_4$	243.1	1.8	24	44
5ch	8.8	$C_{14}H_{25}NO_4$	271.2	3.99	23	0
5ci	10.2			Not found		
5cj	18.4	$C_{16}H_{19}NO_4$	289.1	0.48; 0.7	26	62
5ck	19.8	$C_{19}H_{35}NO_4$	341.3	Not found		
5cl	8.1	$C_{13}H_{19}NO_4S$	285.1	1.8; 2.6;3.2	90	39
5 cm	19.8	$C_{21}H_{25}NO_4$	355.2	4.5	38	6
5cn	12.5	$C_{13}H_{19}NO_4S$	285.1	1.8; 3.2	77	50
5co	14.6	$C_{17}H_{20}F_3N_3O_4S$	419.1	1.4	31	95
5cp	21.8	$C_{14}H_{23}NO_6$	301.2	1.7;2.8	12	28
5cq	17.5	$C_{22}H_{23}NO_4$	365.2	1.4	96	0
5cr	16	$C_{13}H_{14}BrClN_2O_4S$	408	0.51;0.8	69	100
5cs	8.8	$C_{14}H_{20}N_2O_4$	280.1	1.7;1.9	97	14
5ct	5.1	$C_{17}H_{20}N_2O_4$	316.1	2.2;3.4	79	71
5cu	17.5	$C_{18}H_{26}N_2O_4$	334.2	Not found		
5cv	16.7	$C_{12}H_{16}N_2O_6S$	316.1	0.5	50	100
5cw	6.9	$C_{12}H_{16}N_2O_6S$	316.1	1.7;2.3	5	40
5cx	10.7	$C_{18}H_{20}Cl_2N_2O_4$	398.1	4.6	15	8
5cy	13.2	$C_{13}H_{20}N_2O_4$	268.1	Not found		
5cz	24.5	$C_{29}H_{30}N_4O_4$	498.2	Not found		

[a] t_R, retention time.

J(C,H) = 126, CH_3CH_2). HR-MALDI-TOF-MS: 264.1607 ($C_{15}H_{22}NO_3^+$, $[M+H]^+$; calcd 264.1600).

7.2.7. (±)-(1*SR*,2*SR*,3*RS*,6*SR*)-6-[(4-Hydroxybenzyl)-amino]cyclohex-4-ene-1,2,3-triol ((±)-10c). Conventional deprotection of (±)-**35c** gave (±)-**10c** (72%). TLC (MeOH/AcOEt (2:3)). Colorless crystals. Mp 173–175 °C (MeOH). UV (MeOH): 276 (1114), 231 (4192). IR (KBr): 3382, 1616, 1517, 1419, 1260, 1081, 1049, 835. ^{1}H NMR (400 MHz, CD_3OD): 7.34 (d, J = 8.4, 2 arom H); 6.85 (d, J = 8.4, 2 arom H); 6.00 (dd, J(4,5) = 10.2, J(4,3) = 1.3, H–C(4)); 5.78 (ddd, J(5,4) = 10.1, J(5,6) = 3.6, J(5,3) = 1.4, H–C(5)); 4.15 (d, J = 13.1, 1 ArCH_2N); 4.09 (d, J = 13.1, 1 ArCH_2N); 4.01–3.98 (m, H–C(3)); 3.86 (dd, J(1,2) = 9.1, J(1,6) = 5.5, H–C(1)); 3.79–3.76 (m, H–C(6)); 3.69 (dd, J(2,1) = 9.1, J(2,3) = 6.5, H–C(2)). ^{13}C NMR (100.6 MHz, CD_3OD): 159.5 (s, arom C); 136.7 (d, J(C,H) = 160, C(4)); 132.3 (d, J(C,H) = 157, 2 arom C); 124.6 (s, arom C); 122.1 (d, J(C,H) = 163, C(5)); 116.8 (d, J(C,H) = 159, 2 arom C); 73.6 (d, J(C,H) = 146, C(2)); 71.9 (d, J(C,H) = 143, C(3)); 68.8 (d, J(C,H) = 146, C(1)); 56.1 (d, J(C,H) = 145, C(6)); 50.5 (t, J(C,H) = 142, ArCH$_2$N). HR-MALDI-TOF-MS: 252.1226 ($C_{13}H_{18}NO_4^+$, $[M+H]^+$; calcd 252.1236). Anal. Calcd for $C_{13}H_{17}NO_4$ (251.278): C, 62.14; H, 6.82; N, 5.57. Found: C, 62.04; H, 6.70; N, 5.49.

7.2.8. (+)-(1*S*,2*S*,3*R*,6*S*)-6-[(4-Hydroxybenzyl)amino]cyclohex-4-ene-1,2,3-triol ((+)-10c). Compound (+)-**10c** was obtained according to the general procedures using (−)-**33** and *p*-hydroxybenzaldehyde (66% in two steps). $[\alpha]_{589}^{25}$ +47, $[\alpha]_{577}^{25}$ +48, $[\alpha]_{435}^{25}$ +75, $[\alpha]_{405}^{25}$ +98 (*c* 0.125, MeOH). HR-MALDI-TOF-MS: 274.1059 ($C_{13}H_{17}NNaO_4^+$, $[M+Na]^+$; calcd 274.1055).

7.2.9. (−)-(1*R*,2*R*,3*S*,6*R*)-6-[(4-Hydroxybenzyl)amino]cyclohex-4-ene-1,2,3-triol ((−)-10c). Compound (−)-**10c** was obtained according to the general procedures using (+)-**33** and *p*-hydroxybenzaldehyde (61% in two steps). $[\alpha]_{589}^{25}$ −62, $[\alpha]_{577}^{25}$ −66, $[\alpha]_{435}^{25}$ −134, $[\alpha]_{405}^{25}$ −169 (*c* 0.16, MeOH). HR-MALDI-TOF-MS: 274.1046 ($C_{13}H_{17}NNaO_4^+$, $[M+Na]^+$; calcd 274.1055).

7.2.10. (±)-(1*SR*,2*SR*,3*RS*,6*SR*)-6-[(1,1′-Biphenyl-4-ylmethyl)amino]cyclohex-4-ene-1,2,3-triol ((±)-10d). Conventional deprotection of (±)-**35d** gave (±)-**10d** (66%). TLC (MeOH/AcOEt (3:7)). White crystals. Mp 136–138 °C (MeOH/Et_2O). UV (MeOH): 262 (8660), 253 (9881), 215 (6600), 200 (1051). IR (KBr): 3428, 1636, 1560, 1413, 1089, 1050, 697. ^{1}H NMR (400 MHz, CD_3OD): 7.73 (d, J = 8.2, 2 arom H); 7.65 (d, J = 7.3, 2 arom H); 7.61 (d, J = 8.2, 2 arom H); 7.47 (t, J = 7.4, 2 arom H); 7.41–7.35 (m, arom H); 6.07 (dd, J(4,5) = 10.2, J(4,3) = 1.7, H–C(4)); 5.85 (ddd, J(5,4) = 10.2, J(5,6) = 3.6, J(5,3) = 1.5, H–C(5)); 4.33 (d, J = 13.2, 1 ArCH_2N); 4.27 (d, J = 13.2, 1 ArCH_2N); 4.04–4.00 (m, H–C(3)); 3.91 (dd, J(1,2) = 8.8, J(1,6) = 5.5, H–C(1)); 3.88–3.84 (m, H–C(6)); 3.73 (dd, J(2,1) = 8.8, J(2,3) = 6.4, H–C(2)). ^{13}C NMR (100.6 MHz, CD_3OD): 143.5 (s, arom C); 141.4 (s, arom C); 137.3 (d, J(C,H) = 162, C(4)); 132.6 (s, arom C); 131.4 (d, J(C,H) = 159, 2 arom C); 130.0 (d, J(C,H) = 161, 2 arom C); 128.8 (d, J(C,H) = 161, arom C); 128.7 (d, J(C,H) = 160, 2 arom C); 128.0 (d, J(C,H) = 159, 2 arom C); 121.5 (d, J(C,H) = 162,

C(5)); 73.5 (d, J(C,H) = 141, C(2)); 71.8 (d, J(C,H) = 143, C(3)); 68.6 (d, J(C,H) = 143, C(1)); 56.3 (d, J(C,H) = 142, C(6)); 50.2 (t, J(C,H) = 143, ArCH_2N). CI-MS (NH_3): 251 (14), 182 (7), 168 (23), 167 (100), 165 (24), 152 (18), 128 (3), 98 (2), 84 (50), 76 (2). HR-MALDI-TOF-MS: 334.1419 ($C_{19}H_{21}NNaO_3^+$, $[M+Na]^+$; calcd 334.1419).

7.2.11. (±)-(1*SR*,2*SR*,3*RS*,6*SR*)-6-[(4-Phenoxybenzyl)amino]cyclohex-4-ene-1,2,3-triol ((±)-10e). Conventional deprotection of (±)-**35e** gave (±)-**10e** (80%). TLC (MeOH/AcOEt (1:4)). White solid. UV (MeOH): 271 (1805), 235 (9264), 203 (1212). IR (KBr): 3377, 1589, 1508, 1489, 1242, 1074, 871, 692. ^{1}H NMR (400 MHz, CD_3OD): 7.48 (d, J = 8.4, 2 arom H); 7.38 (t, J = 8.1, 2 arom H); 7.16 (t, J = 7.2, arom H); 7.04–7.00 (m, 4 arom H); 5.97 (dd, J(4,5) = 10.2, J(4,3) = 2.0, H–C(4)); 5.83 (ddd, J(5,4) = 10.2, J(5,6) = 3.7, J(5,3) = 1.4, H–C(5)); 4.17 (d, J = 13.1, 1 ArCH_2N); 4.11 (d, J = 13.1, 1 ArCH_2N); 4.01–3.99 (m, H–C(3)); 3.82 (dd, J(1,2) = 9.3, J(1,6) = 5.4, H–C(1)); 3.74–3.71 (m, H–C(6)); 3.70 (dd, J(2,1) = 9.3, J(2,3) = 6.7, H–C(2)). ^{13}C NMR (100.6 MHz, CD_3OD): 159.4 (s, arom C); 158.1 (s, arom C); 136.0 (d, J(C,H) = 163, C(5)); 132.3 (d, J(C,H) = 159, 2 arom C); 131.0 (d, J(C,H) = 159, 2 arom C); 130.2 (s, arom C); 124.9 (d, J(C,H) = 158, arom C); 123.2 (d, J(C,H) = 163, C(6)); 120.3 (d, J(C,H) = 161, 2 arom C); 119.8 (d, J(C,H) = 162, 2 arom C); 73.8 (d, J(C,H) = 145, C(2)); 72.2, (d, J(C,H) = 143, C(3)); 69.3 (d, J(C,H) = 146, C(1)); 56.4 (d, J(C,H) = 143, C(6)); 50.6 (t, J(C,H) = 141, ArCH_2N). CI-MS (NH_3): 267 (12), 198 (6), 184 (19), 183 (100), 107 (10), 94 (8), 86 (31), 77 (61), 70 (5). HR-MALDI-TOF-MS: 328.1533 ($C_{19}H_{22}NO_4^+$, $[M+H]^+$; calcd 328.1549).

7.2.12. (±)-(1*SR*,2*SR*,3*RS*,6*SR*)-6-{[4-(4-Phenoxyphenoxy)benzyl]amino}cyclohex-4-ene-1,2,3-triol ((±)-10f). Conventional deprotection of (±)-**35f** gave (±)-**10f** (60%). TLC (MeOH/AcOEt (1:4)). Colorless crystals. Mp 133–135 °C (MeOH/Et_2O). UV (MeOH): 271 (2750), 260 (3060), 241 (10268). IR (KBr): 3368, 1587, 1498, 1487, 1234, 1191, 1083, 841. ^{1}H NMR (400 MHz, CD_3OD): 7.50 (d, J = 8.5, 2 arom H); 7.39 (t, J = 8.2, 2 arom H); 7.12 (t, J = 7.4, arom H); 7.07–6.98 (m, 8 arom H); 6.03 (dd, J(4,5) = 10.1, J(4,3) = 2.0, H–C(4)); 5.82 (ddd, J(5,4) = 10.2, J(5,6) = 3.8, J(5,3) = 1.6, H–C(5)); 4.23 (d, J = 13.1, 1 ArCH_2N); 4.17 (d, J = 13.1, 1 ArCH_2N); 4.02–3.99 (m, H–C(3)); 3.86 (dd, J(1,2) = 9.1, J(1,6) = 5.5, H–C(1)); 3.82–3.78 (m, H–C(6)); 3.69 (dd, J(2,1) = 9.1, J(2,3) = 6.4, H–C(2)). ^{13}C NMR (100.6 MHz, CD_3OD): 160.3 (s, arom C); 159.1 (s, arom C); 154.9 (s, arom C); 153.4 (s, arom C); 137.0 (d, J(C,H) = 163, C(4)); 132.6 (d, J(C,H) = 159, 2 arom C); 130.9 (d, J(C,H) = 159, 2 arom C); 128.0 (s, arom C); 124.3 (d, J(C,H) = 160, arom C); 122.1 (d, J(C,H) = 162, 2 arom C); 121.9 (d, J(C,H) = 162, C(5)); 121.5 (d, J(C,H) = 163, 2 arom C); 119.5 (d, J(C,H) = 160, 2 arom C); 119.3 (d, J(C,H) = 162, 2 arom C); 73.6 (d, J(C,H) = 143, C(2)); 71.9, (d, J(C,H) = 143, C(3)); 68.8 (d, J(C,H) = 145, C(1)); 56.4 (d, J(C,H) = 146, C(6)); 50.2 (t, J(C,H) = 141, ArCH_2N). CI-MS (NH_3): 359 (2), 275 (100), 186 (3), 181 (4), 141 (9), 121 (9), 110 (11), 94 (69), 84 (37), 77 (87), 71 (11). HR-MALDI-TOF-MS: 442.1609 ($C_{25}H_{25}NNaO_5^+$, $[M+Na]^+$; calcd 442.1630).

7.2.13. (±)-(1*SR*,2*SR*,3*RS*,6*SR*)-6-[(4-Pyridin-4-ylbenzyl)amino]cyclohex-4-ene-1,2,3-triol ((±)-10g). Conventional deprotection of (±)-**35 g** gave (±)-**10 g** (81%). TLC (MeOH/AcOEt (2:3)). White solid. UV (MeOH): 274 (8746), 262 (8169), 255 (9277), 219 (6221), 208 (4049). IR (KBr): 3394, 2922, 1602, 1407, 1225, 1081, 1001, 810. ^{1}H NMR (400 MHz, CD_3OD): 8.61 (br s, 2 arom H); 7.84 (d, J = 8.1, 2 arom H); 7.75 (d, J = 5.4, 2 arom H); 7.66 (d, J = 8.1, 2 arom H); 5.97 (dd, J(4,5) = 10.2, J(4,3) = 2.2, H–C(4)); 5.86 (ddd, J(5,4) = 10.2, J(5,6) = 3.8, J(5,3) = 1.5, H–C(5)); 4.26 (d, J = 13.3, 1 ArCH_2N); 4.19 (d, J = 13.3, 1 ArCH_2N); 4.02–4.00 (m, H–C(3)); 3.82 (dd, J(1,2) = 9.4, J(1,6) = 5.4, H–C(1)); 3.73–3.71 (m, H–C(6)); 3.70 (dd, J(2,1) = 9.4, J(2,3) = 6.7, H–C(2)). ^{13}C NMR (100.6 MHz, CD_3OD): 150.7 (d, J(C,H) = 181, 2 arom C); 149.8 (s, arom C); 139.5 (s, arom C); 136.5 (d, J(C,H) = 164, C(4)); 136.0 (s, arom C); 131.6 (d, J(C,H) = 161, 2 arom C); 128.7 (d, J(C,H) = 162, 2 arom C); 123.1 (d, J(C,H) = 163, 2 arom C); 122.4 (d, J(C,H) = 164, C(5)); 73.7 (d, J(C,H) = 147, C(2)); 72.0 (d, J(C,H) = 144, C(3)); 69.1 (d, J(C,H) = 144, C(1)); 56.6 (d, J(C,H) = 144, C(6)); 50.5 (t, J(C,H) = 139, ArCH_2N). HR-MALDI-TOF-MS: 313.1549 ($C_{18}H_{21}N_2O_3^+$, $[M+H]^+$; calcd 313.1552).

7.2.14. (+)-(1*S*,2*S*,3*R*,6*S*)-6-[(4-Pyridin-4-ylbenzyl)amino]cyclohex-4-ene-1,2,3-triol ((+)-10g). Compound (+)-**10g** was obtained according to the general procedures using (−)-**33** and 4-(4-formylphenyl)pyridine (67% in two steps). $[\alpha]_{589}^{25}$ +58, $[\alpha]_{577}^{25}$ +61, $[\alpha]_{435}^{25}$ +126, $[\alpha]_{405}^{25}$ +161 (*c* 0.12, MeOH). HR-MALDI-TOF-MS: 335.1390 ($C_{18}H_{20}N_2NaO_3^+$, $[M+Na]^+$; calcd 335.1372).

7.2.15. (−)-(1*R*,2*R*,3*S*,6*R*)-6-[(4-Pyridin-4-ylbenzyl)amino]cyclohex-4-ene-1,2,3-triol ((−)-10g). Compound (−)-**10g** was obtained according to the general procedures described (+)-**33** and 4-(4-formylphenyl)pyridine (92% in two steps). $[\alpha]_{589}^{25}$ −77, $[\alpha]_{577}^{25}$ −80, $[\alpha]_{435}^{25}$ −163, $[\alpha]_{405}^{25}$ −190 (*c* 0.15, MeOH). HR-MALDI-TOF-MS: 335.1385 ($C_{18}H_{20}N_2NaO_3^+$, $[M+Na]^+$; calcd 335.1372).

7.2.16. (±)-(1*SR*,2*SR*,3*RS*,6*SR*)-6-[(4-Pyrimidin-5-ylbenzyl)amino]cyclohex-4-ene-1,2,3-triol ((±)-10h). Conventional deprotection of (±)-**35h** gave (±)-**10h** (94%). TLC (MeOH/AcOEt (3:7)). Colorless crystals. Mp 174–177 °C (MeOH/Et_2O). UV (MeOH): 268 (14887), 263 (14604), 255 (16445), 199 (2496). IR (KBr): 3359, 3150, 1576, 1419, 1080, 719. ^{1}H NMR (400 MHz, CD_3OD): 9.18 (br s, arom H); 9.12 (br s, 2 arom H); 7.85 (d, J = 8.2, 2 arom H); 7.72 (d, J = 8.2, 2 arom H); 6.05 (dd, J(4,5) = 10.2, J(4,3) = 1.6, H–C(4)); 5.86 (ddd, J(5,4) = 10.2, J(5,6) = 3.7, J(5,3) = 1.6, H–C(5)); 4.34 (d, J = 13.3, 1 ArCH_2N); 4.29 (d, J = 13.2, 1 ArCH_2N); 4.04–4.00 (m, H–C(3)); 3.89 (dd, J(1,2) = 9.0, J(1,6) = 5.5, H–C(1)); 3.86–3.82 (m, H–C(6)); 3.73 (dd, J(2,1) = 9.0, J(2,3) = 6.4, H–C(2)). ^{13}C NMR (100.6 MHz, CD_3OD): 158.3 (d, J(C,H) = 206, arom C); 156.2 (d, J(C,H) = 183, 2 arom C); 137.4 (d,

J(C,H) = 161, C(4)); 136.2 (s, arom C); 135.2 (s, arom C); 134.9 (s, arom C); 132.0 (d, *J*(C,H) = 161, 2 arom C); 128.9 (d, *J*(C,H) = 161, 2 arom C); 121.5 (d, *J*(C,H) = 164, C(5)); 73.5 (d, *J*(C,H) = 144, C(2)); 71.8 (d, *J*(C,H) = 142, C(3)); 68.7 (d, *J*(C,H) = 145, C(1)); 56.6 (d, *J*(C,H) = 145, C(6)); 50.2 (t, *J*(C,H) = 141, Ar*C*H_2N). CI-MS (NH_3): 268 (2), 253 (38), 170 (57), 140 (5), 129 (4), 115 (64), 106 (9), 94 (14), 84 (100), 76 (20). HR-MALDI-TOF-MS: 314.1520 ($C_{17}H_{20}N_3O_3^+$, $[M+H]^+$; calcd 314.1505).

7.2.17. (±)-(1*SR*,2*SR*,3*RS*,6*SR*)-6-({4-[2-(Hydroxymethyl)pyridin-4-yl]benzyl}amino)cyclohex-4-ene-1,2,3-triol ((±)-10i). Conventional deprotection of (±)-**35i** gave (±)-**10i** (78%). TLC (MeOH/AcOEt (1:1)). White solid. UV (MeOH): 282 (12278), 249 (12055), 213 (10094), 202 (3079). IR (KBr): 3372, 1576, 1456, 1080, 1048, 795. ^{1}H NMR (400 MHz, CD_3OD): 8.09 (d, *J* = 8.1, 2 arom H); 7.92 (t, *J* = 7.8, arom H); 7.77 (d, *J* = 7.8, arom H); 7.62 (d, *J* = 8.1, 2 arom H); 7.52 (d, *J* = 7.7, arom H); 5.99 (dd, *J*(4,5) = 10.3, *J*(4,3) = 2.3, H–C(4)); 5.85 (ddd, *J*(5,4) = 10.2, *J*(5,6) = 3.9, *J*(5,3) = 1.5, H–C(5)); 4.79 (br s, CH_2OH); 4.27 (d, *J* = 13.2, 1 ArCH_2N); 4.22 (d, *J* = 13.2, 1 ArCH_2N); 4.02–4.00 (m, H–C(3)); 3.85 (dd, *J*(1,2) = 9.2, *J*(1,6) = 5.4, H–C(1)); 3.78–3.76 (m, H–C(6)); 3.71 (dd, *J*(2,1) =9.2, *J*(2,3) = 6.5, H–C(2)). ^{13}C NMR (100.6 MHz, CD_3OD): 162.5 (s, arom C); 157.2 (s, arom C); 141.1 (s, arom C); 139.2 (d, *J*(C,H) = 164, arom C); 136.3 (d, *J*(C,H) = 164, C(4)); 136.1 (s, arom C); 130.9 (d, *J*(C,H) = 159, 2 arom C); 128.7 (d, *J*(C,H) = 161, 2 arom C); 122.9 (d, *J*(C,H) = 164, C(5)); 120.5 (d, *J*(C,H) = 164, 2 arom C); 73.8 (d, *J*(C,H) = 145, C(2)); 72.1 (d, *J*(C,H) = 143, C(3)); 69.3 (d, *J*(C,H) = 145, C(1)); 65.9 (t, *J*(C,H) = 141, *C*H_2OH); 56.6 (d, *J*(C,H) = 143, C(6)); 50.8 (t, *J*(C,H) = 143, Ar*C*H_2N). HR-MALDI-TOF-MS: 343.1634 ($C_{19}H_{23}N_2O_4^+$, $[M+H]^+$; calcd 343.1658). Anal. Calcd for $C_{19}H_{22}N_2O_4$ (342.389): C, 66.65; H, 6.48; N, 8.18. Found: C, 66.45; H, 6.58; N, 7.90.

7.2.18. (±) Methyl 3′-({[(1*SR*,4*RS*,5*SR*,5*SR*)-4,5,6-trihydroxycyclohex-2-en-1-yl]amino}methyl)biphenyl-4-carboxylate ((±)-10j). Conventional deprotection of (±)-**35j** gave (±)-**10j** (75%). TLC (MeOH/AcOEt (1.5:8.5)). Colorless crystals. Mp 150–152 °C (MeOH). UV (MeOH): 284 (7835), 262 (7123), 260 (7848), 223 (5928). IR (KBr): 3382, 1713, 1610, 1563, 1435, 1287, 1196, 1109, 961, 769. ^{1}H NMR (400 MHz, CD_3OD): 8.10 (d, *J* = 8.3, 2 arom H); 7.82 (s, arom H); 7.78 (d, *J* = 8.3, 2 arom H); 7.71–7.68 (m, arom H); 7.56–7.51 (m, 2 arom H); 5.95 (dd, *J*(3,2) = 10.3, *J*(3,4) = 2.0, H–C(3)); 5.86 (ddd, *J*(2,3) = 10.3, *J*(2,1) = 3.8, *J*(2,4) = 1.5, H–C(2)); 4.24 (d, *J* = 13.2, 1 ArCH_2N); 4.17 (d, *J* = 13.2, 1 ArCH_2N); 4.01–3.97 (m, H–C(4)); 3.93 (br s, *Me*CO); 3.82 (dd, *J*(6,5) = 9.3, *J*(6,1) = 5.4, H–C(6)); 3.74–3.68 (m, H–C(5), H–C(1)). ^{13}C NMR (100.6 MHz, CD_3OD): 168.3 (s, Me*C*O); 146.4 (s, arom C); 141.7 (s, arom C); 137.1 (s, arom C); 135.6 (d, *J*(C,H) = 162, C(3)); 131.1 (d, *J*(C,H) = 163, 2 arom C); 130.7 (d, *J*(C,H) = 162, arom C); 130.33 (s, arom C); 130.3 (d, *J*(C,H) = 160, arom C); 129.3 (d, *J*(C,H) = 158, arom C); 128.4 (d, *J*(C,H) = 159, arom C); 128.2 (d, *J*(C,H) = 160, 2 arom C); 123.7 (d, *J*(C,H) = 163, C(2)); 73.9 (d, *J*(C,H) = 145, C(5)); 72.3 (d, *J*(C,H) = 143, C(4)); 69.5 (d, *J*(C,H) = 146, C(6)); 56.6 (d, *J*(C,H) = 142, C(1)); 52.7 (q, *J*(C,H) = 147, *Me*CO); 51.2 (t, *J*(C,H) = 140, Ar*C*H_2N). HR-MALDI-TOF-MS: 370.1642 ($C_{21}H_{24}NO_5^+$, $[M+H]^+$; calcd 370.1654). Anal. Calcd for $C_{21}H_{23}NO_5$ (369.411): C, 68.28; H, 6.28; N, 3.79. Found: C, 68.40; H, 6.30; N, 4.01.

7.2.19. (+)-Methyl 3′-({[(1*S*,4*R*,5*S*,6*S*)-4,5,6-trihydroxycyclohex-2-en-1-yl]amino}methyl)biphenyl-4-carboxylate ((+)-10j). Compound (+)-**10j** was obtained according to the general procedures using (−)-**33** and methyl 4-(3-formylphenyl)benzoate (75% in two steps). $[\alpha]_{589}^{25}$ +49, $[\alpha]_{577}^{25}$ +50, $[\alpha]_{435}^{25}$ +90, $[\alpha]_{405}^{25}$ +127 (*c* 0.175, MeOH). HR-MALDI-TOF-MS: 370.1671 ($C_{21}H_{24}NO_5^+$, $[M+H]^+$; calcd 370.1654).

7.2.20. (−)-Methyl 3′-({[(1*R*,4*S*,5*R*,6*R*)-4,5,6-trihydroxycyclohex-2-en-1-yl]amino}methyl)biphenyl-4-carboxylate ((−)-10j). Compound (−)-**10j** was obtained according to the general procedures using (+)-**33** and methyl 4-(3-formylphenyl)benzoate (58% in two steps). $[\alpha]_{589}^{25}$ −42, $[\alpha]_{577}^{25}$ −47, $[\alpha]_{435}^{25}$ −101, $[\alpha]_{405}^{25}$ −128 (*c* 0.12, MeOH). HR-MALDI-TOF-MS: 370.1699 ($C_{21}H_{24}NO_5^+$, $[M+H]^+$; calcd 370.1654).

7.2.21. (±)-(1*SR*,2*SR*,3*RS*,6*SR*)-6-[(4-Hydroxy-3-iodo-5-methoxybenzyl)amino]cyclohex-4-ene-1,2,3-triol ((±)-10k). Conventional deprotection of (±)-**35k** gave (±)-**10k** (73%). TLC (MeOH/AcOEt (1.5:8.5)). White solid. UV (MeOH): 290 (2421), 227 (8190). IR (KBr): 3382, 1576, 1559, 1423, 1285, 1187, 1042. ^{1}H NMR (400 MHz, CD_3OD): 7.43 (br m, arom H); 7.13 (br m, arom H); 6.01 (dd, *J*(4,5) = 10.2, *J*(4,3) = 1.6, H–C(4)); 5.81 (ddd, *J*(5,4) = 10.2, *J*(5,6) = 3.8, *J*(5,3) = 1.6, H–C(5)); 4.13 (d, *J* = 13.1, 1 ArCH_2N); 4.06 (d, *J* = 13.1, 1 ArCH_2N); 4.01–3.98 (m, H–C(3)); 3.91 (s, *Me*O); 3.86 (dd, *J*(1,2) = 9.0, *J*(1,6) = 5.0, H–C(1)); 3.78–3.75 (m, H–C(6)); 3.69 (dd, *J*(2,1) = 9.1, *J*(2,3) = 6.5, H–C(2)). ^{13}C NMR (100.6 MHz, CD_3OD): 149.0 (s, arom C); 148.6 (s, arom C); 137.2 (d, *J*(C,H) = 161, C(4)); 133.2 (d, *J*(C,H) = 165, arom C); 126.0 (s, arom C); 121.4 (d, *J*(C,H) = 162, C(5)); 113.9 (d, *J*(C,H) = 159, arom C); 83.6 (s, arom C); 73.4 (d, *J*(C,H) = 141, C(2)); 71.8 (d, *J*(C,H) = 142, C(3)); 68.5 (d, *J*(C,H) = 143, C(1)); 56.8 (q, *J*(C,H) = 145, *Me*O); 56.3 (d, *J*(C,H) = 146, C(6)); 49.8 (t, *J*(C,H) = 143, Ar*C*H_2N). HR-MALDI-TOF-MS: 408.0308 ($C_{14}H_{19}INO_5^+$, $[M+H]^+$; calcd 408.0308). Anal. Calcd for $C_{14}H_{18}INO_5$ (407.201): C, 41.29; H, 4.46; N, 3.44. Found: C, 40.95; H, 4.27; N, 3.50.

7.2.22. (+)-(1*S*,2*S*,3*R*,6*S*)-6-[(4-Hydroxy-3-iodo-5-methoxybenzyl)amino]cyclohex-4-ene-1,2,3-triol ((+)-10k). Compound (+)-**10k** was obtained according to the general procedures using (−)-**33** and 5-iodovanillin (68% in two steps). $[\alpha]_{589}^{25}$ +38, $[\alpha]_{577}^{25}$ +39, $[\alpha]_{435}^{25}$ +79, $[\alpha]_{405}^{25}$ +103 (*c* 0.19, MeOH). HR-MALDI-TOF-MS: 430.0779. ($C_{14}H_{18}INNaO_5^+$, $[M+Na]^+$; calcd 430.0127).

7.2.23. (−)-(1*R*,2*R*,3*S*,6*R*)-6-[(4-Hydroxy-3-iodo-5-methoxybenzyl)amino]cyclohex-4-ene-1,2,3-triol ((−)-10k). Compound (−)-**10k** was obtained according to the gen-

eral procedures using (+)-**33** and 5-iodovanillin (55% in two steps). $[\alpha]^{25}_{589}$ −47, $[\alpha]^{25}_{577}$ −66, $[\alpha]^{25}_{435}$ −136, $[\alpha]^{25}_{405}$ −180 (*c* 0.22, MeOH). HR-MALDI-TOF-MS: 407.0214. ($C_{14}H_{18}INO_5^+$, $[M]^+$; calcd 407.0230).

7.2.24. (±)-(1*SR*,2*SR*,3*RS*,6*SR*)-6-[(3,5-Dimethoxybenzyl)amino]cyclohex-4-ene-1,2,3-triol ((±)-10l). Conventional deprotection of (±)-**35l** gave (±)-**10l** (57%). TLC (MeOH/AcOEt (3:7)). Solid foam. UV (MeOH): 280 (1496), 214 (6481). IR (KBr): 3386, 1599, 1458, 1430, 1206, 1155, 1072, 840. ^{1}H NMR (400 MHz, CD_3OD): 6.72 (br d, *J* = 2.1, 2 arom H); 6.55 (t, *J* = 2.1, arom H); 6.06 (dd, *J*(4,5) = 10.2, *J*(4,3) = 1.6, H–C(4)); 5.81 (ddd, *J*(5,4) = 10.2, *J*(5,6) = 3.8, *J*(5,3) = 1.6, H–C(5)); 4.23 (d, *J* = 13.2, 1 ArCH_2N); 4.17 (d, *J* = 13.2, 1 ArCH_2N); 4.04–4.00 (m, H–C(3)); 3.89 (dd, *J*(1,2) = 9.1, *J*(1,6) = 5.5, H–C(1)); 3.82 (s, 2 *Me*O); 3.79–3.78 (m, H–C(6)); 3.71 (dd, *J*(2,1) = 9.1, *J*(2,3) = 6.4, H–C(2)). ^{13}C NMR (100.6 MHz, CD_3OD): 162.9 (s, 2 arom C); 137.5 (d, *J*(C,H) = 161, C(4)); 135.3 (s, arom C); 121.3 (d, *J*(C,H) = 162, C(5)); 108.6 (d, *J*(C,H) = 161, 2 arom C); 101.9 (d, *J*(C,H) = 160, arom C); 73.5 (d, *J*(C,H) = 141, C(2)); 71.8 (d, *J*(C,H) = 144, C(3)); 68.5 (d, *J*(C,H) = 142, C(1)); 56.3 (d, *J*(C,H) = 144, C(6)); 56.0 (q, *J*(C,H) = 144, 2 *Me*O); 50.5 (t, *J*(C,H) = 143, Ar*C*H_2N). HR-MALDI-TOF-MS: 296.1507 ($C_{15}H_{22}NO_5^+$, $[M+H]^+$; calcd 296.1498).

7.2.25. (±)-(1*SR*,2*SR*,3*RS*,6*SR*)-6-[(4-Hydroxy-3-methoxybenzyl)amino]cyclohex-4-ene-1,2,3-triol ((±)-10m). Conventional deprotection of (±)-**35m** gave (±)-**10m** (80%). TLC (MeOH/AcOEt (1:4)). Solid foam. UV (MeOH): 281 (3064), 232 (6353), 211 (7675). IR (KBr): 3385, 1609, 1521, 1405, 1283, 1162, 1086, 1032, 798. ^{1}H NMR (400 MHz, CD_3OD): 7.12 (br s, arom H); 6.95 (d, *J* = 8.0, arom H); 6.85 (d, *J* = 8.0, arom H); 6.02 (dd, *J*(4,5) = 10.2, *J*(4,3) = 1.5, H–C(4)); 5.79 (ddd, *J*(5,4) = 10.2, *J*(5,6) = 3.8, *J*(5,3) = 1.6, H–C(5)); 4.17 (d, *J* = 13.1, 1 ArCH_2N); 4.11 (d, *J* = 13.1, 1 ArCH_2N); 4.02–3.98 (m, H–C(3)); 3.91 (s, *Me*O); 3.86 (dd, *J*(1,2) = 9.1, *J*(1,6) = 5.5, H–C(1)); 3.80–3.77 (m, H–C(6)); 3.68 (dd, *J*(2,1) = 9.1, *J*(2,3) = 6.5, H–C(2)). ^{13}C NMR (100.6 MHz, CD_3OD): 149.5 (s, arom C); 148.7 (s, arom C); 136.9 (d, *J*(C,H) = 160, C(4)); 125.0 (s, arom C); 124.0 (d, *J*(C,H) = 160, arom C); 121.9 (d, *J*(C,H) = 162, C(5)); 116.6 (d, *J*(C,H) = 159, arom C); 114.2 (d, *J*(C,H) = 158, arom C); 73.6 (d, *J*(C,H) = 142, C(2)); 71.9 (d, *J*(C,H) = 142, C(3)); 68.8 (d, *J*(C,H) = 143, C(1)); 56.5 (q, *J*(C,H) = 144, *Me*O); 56.0 (d, *J*(C,H) = 145, C(6)); 50.7 (t, *J*(C,H) = 141, Ar*C*H_2N). HR-MALDI-TOF-MS: 282.1331 ($C_{14}H_{20}NO_5^+$, $[M+H]^+$; calcd 282.1341). Anal. Calcd for $C_{14}H_{19}NO_5$ (281.304): C, 59.78; H, 6.81; N, 4.98. Found: C, 59.95; H, 6.84; N, 4.70.

7.2.26. (±)-(1*SR*,2*SR*,3*RS*,6*SR*)-6-{[(3-Fluoropyridin-4-yl)methyl]amino}cyclohex-4-ene-1,2,3-triol ((±)-10n). Conventional deprotection of (±)-**35n** gave (±)-**10n** (74%). TLC (MeOH/AcOEt (1:4)). Colorless crystals. Mp 141–143 °C (MeOH). UV (MeOH): 261 (2479), 210 (2603). IR (KBr): 3393, 3166, 1612, 1419, 1244, 1201, 1085, 1057, 997, 848. ^{1}H NMR (400 MHz, CD_3OD): 8.49 (br s, arom H); 8.43 (br s, arom H); 7.67 (*t*, *J* = 5.5, arom H); 5.87–5.84 (m, H–C(5), H–C(4)); 4.23 (d, *J* = 14.3, 1 ArCH_2N); 4.19 (d, *J* = 14.3, 1 ArCH_2N); 3.98 (d, *J*(3,2) = 6.5, H–C(3)); 3.76 (dd, *J*(1,2) = 9.6, *J*(1,6) = 5.2, H–C(1)); 3.70 (dd, *J*(2,1) = 9.6, *J*(2,3) = 6.5, H–C(2)); 3.63–3.61 (m, H–C(6)). ^{13}C NMR (100.6 MHz, CD_3OD): 159.7 (d, *J*(C,F) = 255, arom C); 146.8 (d, *J*(C,H) = 183, arom C); 138.5 (d, *J*(C,H) = 183, arom C); 135.1 (*s*, arom C); 135.0 (d, *J*(C,H) = 162, C(4)); 126.6 (*d*, *J*(C,H) = 167, arom C); 124.8 (d, *J*(C,H) = 163, C(5)); 74.1 (d, *J*(C,H) = 144, C(2)); 72.7 (d, *J*(C,H) = 138, C(3)); 70.3 (d, *J*(C,H) = 144, C(1)); 57.4 (d, *J*(C,H) = 138, C(6)); 44.1 (*t*, *J*(C,H) = 141, Ar*C*H_2N). HR-MALDI-TOF-MS: 255.1132 ($C_{12}FH_{16}N_2O_3^+$, $[M+H]^+$; calcd 255.1145). Anal. Calcd for $C_{12}FH_{15}N_2O_3$ (254.258): C, 56.69; H, 5.95; N, 11.02. Found: C, 56.20; H, 5.71; N, 10.80.

7.2.27. (±)-(1*SR*,2*SR*,3*RS*,6*SR*)-6{[(1-Acetyl-1*H*-indol-3-yl)]methyl}amino}cyclohex-4-ene-1,2,3-triol ((±)-10o). Conventional deprotection of (±)-**35o** gave (±)-**10o** (89%). TLC (MeOH/AcOEt (3:7)). Colorless crystals. Mp 188–190 °C (MeOH/Et_2O). UV (MeOH): 298 (4406), 289 (4366), 242 (7697). IR (KBr): 3403, 1700, 1689, 1453, 1388, 1331, 1254, 1217, 1075, 1019, 745. ^{1}H NMR (400 MHz, CD_3OD): 8.40 (d, *J* = 7.6, arom H); 7.93 (s, arom H); 7.77 (d, *J* = 7.3, arom H); 7.41–7.32 (m, 2 arom H); 6.01 (dd, *J*(4,5) = 10.2, *J*(4,3) = 2.2, H–C(4)); 5.91 (ddd, *J*(5,4) = 10.2, *J*(5,6) = 3.6, *J*(5,3) = 1.6, H–C(5)); 4.40 (d, *J* = 13.9, 1 ArCH_2N); 4.36 (d, *J* = 13.9, 1 ArCH_2N); 4.02 (br d, *J*(3,2) = 6.8, H–C(3)); 3.89–3.84 (m, H–C(6), H–C(1)); 3.74–3.68 (m, H–C(2)); 2.68 (s, *Me*CO). ^{13}C NMR (100.6 MHz, CD_3OD): 170.9 (s, *C*OMe); 137.2 (s, arom C); 136.5 (d, *J*(C,H) = 164, C(4)); 130.6 (s, arom C); 128.1 (d, *J*(C,H) = 189, arom C); 126.6 (d, *J*(C,H) = 160, arom C); 124.9 (d, *J*(C,H) = 160, arom C); 122.8 (d, *J*(C,H) = 164, C(5)); 119.9 (d, *J*(C,H) = 160, arom C); 117.6 (d, *J*(C,H) = 168, arom C); 115.9 (s, arom C); 73.9 (d, *J*(C,H) = 146, C(2)); 72.2 (d, *J*(C,H) = 143, C(3)); 69.2 (d, *J*(C,H) = 147, C(1)); 56.8 (d, *J*(C,H) = 144, C(6)); 41.8 (*t*, *J*(C,H) = 142, Ar*C*H_2N), 23.9 (q, *J*(C,H) = 130, CO*Me*). CI-MS (NH_3): 260 (2), 245 (12), 172 (15), 130 (100), 117 (57), 110 (14), 102 (13), 89 (55), 81 (19), 77 (21), 70 (9). HR-MALDI-TOF-MS: 339.1358 ($C_{17}H_{20}N_2NaO_4^+$, $[M+Na]^+$; calcd 339.1321).

7.2.28. (+)-(1*S*,2*S*,3*R*,6*S*)-6{[(1-Acetyl-1*H*-indol-3-yl)]methyl}amino}cyclohex-4-ene-1,2,3-triol ((+)-10o). Compound (+)-**10o** was obtained according to the general procedures using (−)-**33** and 1-acetyl-3-indolecarboxaldehyde (70% in two steps). $[\alpha]^{25}_{589}$ +103, $[\alpha]^{25}_{577}$ +104, $[\alpha]^{25}_{435}$ +214, $[\alpha]^{25}_{405}$ +266 (*c* 0.165, MeOH). HR-MALDI-TOF-MS: 339.1337 ($C_{17}H_{20}N_2NaO_4^+$, $[M+Na]^+$; calcd 339.1321).

7.2.29. (−)-(1*R*,2*R*,3*S*,6*R*)-6{[(1-Acetyl-1*H*-indol-3-yl)]-methyl}amino}cyclohex-4-ene-1,2,3-triol ((−)-10o). Compound (−)-**10o** was obtained according to the general procedures using (+)-**33** and 1-acetyl-3-indolecarboxaldehyde (89% in two steps). $[\alpha]^{25}_{589}$ −88, $[\alpha]^{25}_{577}$ −94, $[\alpha]^{25}_{435}$ −187, $[\alpha]^{25}_{405}$ −228 (*c* 0.15, MeOH). HR-MALDI-TOF-MS: 339.1311 ($C_{17}H_{20}N_2NaO_4^+$, $[M+Na]^+$; calcd 339.1321).

7.2.30. (±)-(1*SR*,2*SR*,3*RS*,6*SR*)-6-[({5-[2-Chloro-5′-(trifluoromethyl)phenyl]-2-furyl}methyl)amino]cyclohex-4-ene-1,2,3-triol ((±)-10p). Conventional deprotection of (±)-**35p** gave (±)-**10p** (73%). TLC (MeOH/AcOEt (1:9)). Colorless crystals. Mp 153–156 °C (MeOH). UV (MeOH): 290 (13315), 288 (13314), 230 (8545), 219 (9155), 205 (5025). IR (KBr): 3385, 2920, 1394, 1329, 1176, 1115, 1076, 1034. ^{1}H NMR (400 MHz, CD_3OD): 8.23 (br s, arom H); 7.71 (d, J = 8.3, arom H); 7.58 (d, J = 8.2, arom H); 7.28 (d, J = 3.3, arom H); 6.69 (d, J = 3.3, arom H); 5.89 (dd, J(4,5) = 10.1, J(4,3) = 2.0, H–C(4)); 5.82 (ddd, J(5,4) = 10.1, J(5,6) = 3.6, J(5,3) = 1.5, H–C(5)); 4.21 (br s, 2 ArCH_2N); 3.98 (d, J(3,2) = 5.8, H–C(3)); 3.75 (dd, J(1,2) = 9.4, J(1,6) = 5.3, H–C(1)); 3.67 (dd, J(2,1) =9.4, J(2,3) = 6.7, H–C(2)); 3.66–3.61 (m, H–C(6)). ^{13}C NMR (100.6 MHz, CD_3OD): 152.3 (s, arom C); 150.3 (s, arom C); 135.1 (d, J(C,H) = 162, C(4)); 134.7 (s, arom C); 132.9 (d, J(C,H) = 170, 2 arom C); 130.8 (s, arom C); 130.5 (s, arom C); 125.8 (d, J(C,F) = 166, CF_3); 125.6 (d, J(C,H) = 162, arom C); 124.6 (d, J(C,H) = 162, C(5)); 114.5 (d, J(C,H) = 179, arom C); 113.2 (d, J(C,H) = 176, arom C); 74.1 (d, J(C,H) = 145, C(2)); 72.7 (d, J(C,H) = 143, C(3)); 70.1 (d, J(C,H) = 146, C(1)); 56.7 (d, J(C,H) = 140, C(6)); 44.1 (*t*, J(C,H) = 141, ArCH_2N). CI-MS (NH_3): 343 (8), 274 (9), 259 (66), 162 (3), 121 (4), 108 (6), 84 (100), 81 (10), 73 (8). HR-MALDI-TOF-MS: 404.0870 ($C_{18}ClF_3H_{18}NO_4^+$, $[M+H]^+$; calcd 404.0876).

7.2.31. (+)-(1*S*,2*S*,3*R*,6*S*)-6-[({5-[2-Chloro-5′-(trifluoromethyl)phenyl]-2-furyl}methyl)amino]cyclohex-4-ene-1,2,3-triol ((+)-10p). Compound (+)-**10p** was obtained according to the general procedures using (−)-**33** and 5-(2-chloro-5-(trifluoromethyl)phenyl)furfural (75% in two steps). $[\alpha]_{589}^{25}$ +77, $[\alpha]_{577}^{25}$ +71, $[\alpha]_{435}^{25}$ +156, $[\alpha]_{405}^{25}$ +197 (*c* 0.13, MeOH). HR-MALDI-TOF-MS: 404.1470 ($C_{18}H_{18}ClF_3NO_4^+$, $[M+H]^+$; calcd 404.0876).

7.2.32. (−)-(1*R*,2*R*,3*S*,6*R*)-6-[({5-[2-Chloro-5′-(trifluoromethyl)phenyl]-2-furyl}methyl) amino]cyclohex-4-ene-1,2,3-triol ((−)-10p). Compound (−)-**10p** was obtained according to the general procedures using (+)-**33** and 5-(2-chloro-5-(trifluoromethyl)phenyl)furfural (85% in two steps). $[\alpha]_{589}^{25}$ −50, $[\alpha]_{577}^{25}$ −56, $[\alpha]_{435}^{25}$ −107, $[\alpha]_{405}^{25}$ −140 (*c* 0.1, MeOH). HR-MALDI-TOF-MS: 426.0689 ($C_{18}H_{17}ClF_3NNaO_4^+$, $[M+Na]^+$; calcd 426.0696).

7.2.33. (±)-(1*SR*,2*SR*,3*RS*,6*SR*)-6-{[(5-Nitro-2-furyl)-methyl]amino}cyclohex-4-ene-1,2,3-triol ((±)-10q). Conventional deprotection of (±)-**35q** gave (±)-**10q** (76%). TLC (MeOH/AcOEt (1:9)). Brown oil. UV (MeOH): 316 (7850), 209 (5960). IR (KBr): 3410, 1653, 1586, 1490, 1357, 1240, 1077, 1023. ^{1}H NMR (400 MHz, CD_3OD): 7.45 (d, J = 3.6, arom H); 6.76 (d, J = 3.6, arom H); 5.86–5.79 (m, H–C(5), H–C(4)); 4.12 (br s, 2 ArCH_2N); 3.97 (d, J(3,2) = 4.7, H–C(3)); 3.68–3.61 (m, H–C(2), H–C(1)); 3.50–3.46 (m, H–C(6)). ^{13}C NMR (100.6 MHz, CD_3OD): 157.5 (s, arom C); 153.4 (s, arom C); 134.1 (d, J(C,H) = 162, C(4)); 125.9 (d, J(C,H) = 162, C(5)); 113.5 (d, J(C,H) = 186, arom C); 113.1 (d, J(C,H) = 181, arom C); 74.2 (d, J(C,H) = 145, C(2)); 73.0 (d, J(C,H) = 144, C(3)); 70.9 (d, J(C,H) = 145, C(1)); 57.0 (q, ^1J(C,H) = 139, C(6)); 44.7 (*t*, J(C,H) = 140, ArCH_2N). HR-MALDI-TOF-MS: 271.0938 ($C_{11}H_{15}N_2O_6^+$, $[M+H]^+$; calcd 271.0930).

7.2.34. (±)-(1*SR*,2*SR*,3*RS*,6*SR*)-6-{[(5-Bromo-2-thienyl)methyl]amino}cyclohex-4-ene-1,2,3-triol ((±)-10r). Conventional deprotection of (±)-**35r** gave (±)-**10r** (74%). TLC (MeOH/AcOEt (1.5:8.5)). Oil. UV (MeOH): 244 (7902), 209 (3705). IR (KBr): 3031, 2361, 1558, 1407, 1082, 971, 802, 656. ^{1}H NMR (400 MHz, CD_3OD): 7.00 (d, J = 3.7, arom H); 6.91 (d, J = 3.6, arom H); 5.85–5.78 (m, H–C(5), H–C(4)); 4.18 (d, J = 14.4, 1 ArCH_2N); 4.12 (d, J = 14.4, 1 ArCH_2N); 3.96 (d, J(3,2) = 6.2, H–C(3)); 3.65 (dd, J(1,2) = 9.7, J(1,6) = 5.0, H–C(1)); 3.61 (dd, J(2,1) = 9.7, J(2,3) = 6.5, H–C(2)); 3.51–3.49 (m, H–C(6)). ^{13}C NMR (100.6 MHz, CD_3OD): 144.4 (s, arom C); 133.9 (d, J(C,H) = 162, C(4)); 131.0 (d, J(C,H) = 173, arom C); 128.6 (d, J(C,H) = 169, arom C); 126.0 (d, J(C,H) = 162, C(5)); 112.9 (s, arom C); 74.4 (d, J(C,H) = 145, C(2)); 72.9 (d, J(C,H) = 145, C(3)); 70.6 (d, J(C,H) = 145, C(1)); 56.2 (q, J(C,H) = 142, C(6)); 46.7 (*t*, J(C,H) = 139, ArCH_2N). HR-MALDI-TOF-MS: 319.9959 ($BrC_{11}H_{15}NO_3S^+$, $[M+H]^+$; calcd 319.9956). Anal. Calcd for $BrC_{11}H_{14}NO_3S$ (320.202): C, 41.26; H, 4.41; N, 4.37. Found: C, 41.00; H, 4.56; N, 4.17.

7.2.35. (±)-2-(1*RS*,4*RS*,5*SR*,6*SR*)-4,5,6-Tris-({[*tert*-butyl(dimethyl)silyl]oxy}cyclohex-2-en-1-yl)-1*H*-isoindole-1,3(2*H*)-dione ((±)-26) and (±)-2-(1*SR*,4*RS*,5*SR*,6*SR*)-4,5,6-tris-({[*tert*-butyl(dimethyl)silyl]oxy}cyclohex-2-en-1-yl)-1*H*-isoindole-1,3(2*H*)-dione ((±)-27). A solution of diethyl azodicarboxylate (DEAD; 2.26 mL, 14.57 mmol, 1.25 equiv) in dry toluene (15 mL) was added dropwise to (±)-**23**/(±)-**24** (ca. 1:5.1) (5.70 g, 11.66 mmol), phthalimide (2.14 g, 14.57 mmol, 1.25 equiv), and PPh_3 (3.82 g, 14.57 mmol, 1.25 equiv) in dry toluene (85 mL) at 0 °C, and the mixture was stirred at 0 °C for 6 h (TLC monitoring). After 6 h, the suspension was filtered off and H_2O was added. The mixture was extracted with Et_2O (3×), the combined organic extracts were washed with brine, dried ($MgSO_4$), evaporated, and the residue was subjected to FC (silica gel, AcOEt/light petroleum ether (3:97)). The obtained yellowish oil (3.8 g, 53%) (1:2.5 mixture of (±)-**26**/(±)-**27**, (ratio of isomers was taken from the ^{1}H NMR spectra of the crude product)) was resubjected to CC (AcOEt/hexane (0.5:99.5 → 5:95)): (±)-**26** (∼1.0 g) and (±)-**27** (∼2.4 g). All analytical data for compounds (±)-**26** and (±)-**27** are identical to those reported previously.[20]

Data of (±)-**27**. White solid after storage in the refrigerator. UV (MeCN): 293 (2150), 260 (995), 235 (7188). IR (KBr): 2930, 2858, 1778, 1719, 1742, 1391, 1325, 1257, 1189, 1079, 1006, 867, 835, 774, 719. ^{1}H NMR (400 MHz, $CDCl_3$): 7.85–7.82 (*m*, 2 arom H); 7.74–7.69 (m, 2 arom H); 6.01 (br d, J(3,2) = 10.0, H–C(3)); 5.81 (br d, J(2,3) = 10.0, H–C(2)); 5.09 (br m, H–C(1)); 4.04–3.94 (2 br m, H–C(6), H–C(5), H–C(4)); 0.97, 0.94, 0.76 (3s, 3 ^{t}BuSi); 0.22, 0.16, 0.14, 0.13, −0.02, −0.4 (6s, 6 *Me*Si). ^{13}C NMR (100.6 MHz, $CDCl_3$): 168.3 (s, 2 arom C); 133.8 (d, J(C,H) = 164, 2 arom

C); 132.1 (*s*, 2 arom C); 127.0 (d, *J*(C,H) = 160, C(3)); 123.0 (*d*, *J*(C,H) ≈ 160, C(2)); 122.9 (d, *J*(C,H) = 165, 2 arom C); 74.5 (d, *J*(C,H) = 148, C(5)); 70.5, 69.1 (2d, *J*(C,H) ≈ 144, C(6), C(4)); 49.8 (d, *J*(C,H) = 139, C(1)); 26.2, 25.8, 25.7 (3q, *J*(C,H) = 125, 3 *Me*$_3$C); 18.5, 17.9, 17.8 (3*s*, 3 Me$_3$*C*); −4.3, −4.35, −4.4, −4.5, −4.6, −5.4 (6q, *J*(C,H) = 119, 6 *Me*Si). HR-MALDI-TOF-MS: 640.3143 ($C_{32}H_{55}NNaO_5Si_3^+$, [M+Na]$^+$; calcd 640.3286). Anal. Calcd for $C_{32}H_{55}NO_5Si_3$ (618.039): C, 62.19; H, 8.97; N, 2.27. Found: C, 62.03; H, 9.05; N, 2.10.

7.2.36. (−)-2-(1*S*,4*R*,5*S*,6*S*)-4,5,6-Tris-({[*tert*-butyl(dimethyl)silyl]oxy}cyclohex-2-en-1-yl)-1*H*-isoindole-1,3(2*H*)-dione ((−)-27). Compound (−)-**27** was obtained according to the procedure described above (major isomer) starting from (−)-**24**. $[\alpha]_{589}^{25}$ −50, $[\alpha]_{577}^{25}$ −51, $[\alpha]_{435}^{25}$ −99, $[\alpha]_{405}^{25}$ −128 (*c* 0.44, $CHCl_3$). HR-MALDI-TOF-MS: 640.3283 ($C_{32}H_{55}NNaO_5Si_3^+$, [M+Na]$^+$; calcd 640.3286).

7.2.37. (+)-2-(1*R*,4*S*,5*R*,6*R*)-4,5,6-Tris-({[*tert*-butyl(dimethyl)silyl]oxy}cyclohex-2-en-1-yl)-1*H*-isoindole-1,3(2*H*)-dione ((+)-27). Compound (+)-**27** was obtained according to the procedure described above (major isomer) starting with (+)-**24**. $[\alpha]_{589}^{25}$ +49, $[\alpha]_{577}^{25}$ +50, $[\alpha]_{435}^{25}$ +99, $[\alpha]_{405}^{25}$ +114 (*c* 0.29, $CHCl_3$). HR-MALDI-TOF-MS: 640.3263 ($C_{32}H_{55}$ $NNaO_5Si_3^+$, [M+Na]$^+$; calcd 640.3286).

7.2.38. (±)-(1*SR*,4*RS*,5*SR*,6*SR*)-4,5,6-Tris-{[(*tert*-butyl)-dimethylsilyl]oxy}cyclohex-2-en-1-amine (±)-28. *Procedure 1*. To a solution of (±)-**27** (0.292 g, 0.47 mmol) in MeOH (6 mL) was added $N_2H_4{\cdot}H_2O$ (0.115 mL, 2.36 mmol, 5.0 equiv). The reaction mixture was stirred under reflux for 5 h, treated with aqueous 1 N HCl (15 mL), and made alkaline with 2 N NaOH solution. The mixture was extracted with AcOEt (3×). The combined organic extracts were washed with brine, dried (Na_2SO_4), filtered, and evaporated under reduced pressure. The crude product was purified by FC (5–15% AcOEt/hexane): 0.13 g of (±)-**28** as a yellowish oil (56%).

Procedure 2. Conduramine F-1 ((±)-**9**) (0.51 g, 3.51 mmol, 1.0 equiv) was dissolved in anhyd DMF (10 mL) at 0 °C and imidazole (1.22 g, 17.9 mmol, 5.1 equiv) followed by TBSCl (2.22 g, 14.76 mmol, 4.2 equiv) were added. After stirring for 1 day at rt, a brine was added. The mixture was extracted with *t*-BME (3×). The combined organic layers were washed with H_2O, dried ($MgSO_4$), and evaporated, and the residue was submitted to FC (10–25% AcOEt/light petroleum ether): 1.1 g (65%) of (±)-**28**. IR (KBr): 3286, 2950, 2857, 1471, 1389, 1361, 1256, 1078, 1006, 775. ^{1}H NMR (400 MHz, $CDCl_3$): 5.62–5.52 (br *m*, H–C(3), H–C(2)), 3.98 (br s, H–C(4)); 3.84 (br m, H–C(5)); 3.69–3.65 (br m, H–C(6)); 3.48 (br s, H–C(1)); 0.93, 0.92, 0.90 (3s, 3 ^{t}BuSi); 0.132, 0.126, 0.121, 0.112, 0.098 (5s, 6 *Me*Si). ^{13}C NMR (100.6 MHz, $CDCl_3$): 130.2, 128.3 (2d, *J*(C,H) ≈ 162, C(3), C(2)); 74.4 (d, *J*(C,H) = 147, C(5)); 72.3 (d, *J*(C,H) = 144, C(6)); 71.6 (d, *J*(C,H) = 142, C(4)); 48.0 (d, *J*(C,H) = 136, C(1)), 26.2, 26.1, 25.9 (3q, *J*(C,H) = 125, 3 *Me*$_3$C); 18.32, 18.28, 17.9 (*s*, 3 Me$_3$*C*); −3.7, −4.25, −4.31, −4.35, −4.7 (5q, ^{1}*J*(C,H) = 118, 6 *Me*Si). CI-MS (NH_3): 442 (42), 430 (38), 340 (4), 488 (1), 444 (9), 340 (4), 277 (3), 199 (100), 149 (7), 147 (13), 73 (79). HR-MALDI-TOF-MS: 488.3437 ($C_{24}H_{54}NO_3Si_3^+$, [M+H]$^+$; calcd 488.3412).

7.2.39. (±)-2-[(1*SR*,4*RS*,5*SR*,6*SR*)-4,5,6-{[Trihydroxy]-cyclohex-2-en-1-yl}-1*H*-isoindole-1,3(2*H*)-dione ((±)-29). Compound (±)-**27** (5.0 g, 8.08 mmol) was dissolved in 40 mL of 1% *p*-TsOH in MeOH and stirred under reflux for 45 min (TLC control). The solvent was evaporated, and the residue was subjected to FC (AcOEt/Hexane (4:1) → AcOEt → MeOH/AcOEt (5:95)): 2.1 g of (±)-**29** (95%). White crystals. Mp 185–187 °C (from MeOH/AcOEt). UV (MeOH): 283 (1319), 237 (4626), 196 (637). IR (KBr): 3449, 1768, 1703, 1396, 1331, 1105, 1079, 1040, 893, 766, 716. ^{1}H NMR (400 MHz, CD_3OD): 7.88–7.80 (m, 4 arom H); 5.94 (dt, *J*(3,2) = 10.1, *J*(3,4) = *J*(3,1) = 2.0, H–C(3)); 5.67 (ddd, *J*(2,3) = 10.1, *J*(2,1) = 4.1, *J*(2,4) = 1.8, H–C(2)); 5.14 (ddd, *J*(1,6) = 6.5, *J*(1,2) = 4.2, *J*(1,3) = 2.1, H–C(1)); 4.13–4.06 (m, H–C(5), H–C(4)); 3.58 (dd, *J*(6,5) = 9.2, *J*(6,1) = 6.5, H–C(6)). ^{13}C NMR (100.6 MHz, CD_3OD): 170.2 (s, 2 *C*O); 135.2 (d, *J*(C,H) = 164, 2 arom C); 134.1 (d, *J*(C,H) = 162, C(3)); 133.3 (s, 2 arom C); 124.0 (2d, *J*(C,H) = 165, 2 arom C); 123.8 (d, *J*(C,H) = 162, C(2)); 75.0 (d, *J*(C,H) = 148, C(5)); 73.2 (d, *J*(C,H) = 143, C(4)); 71.1 (d, *J*(C,H) = 140, C(6)); 50.7 (d, *J*(C,H) = 141, C(1)). CI-MS (NH_3): 258 (4), 241 (11), 229 (31), 216 (12), 186 (13), 160 (15), 148 (17), 131 (17), 130 (100), 110 (80), 104 (63), 99 (11), 81 (56). HR-MALDI-TOF-MS: 298.0621 ($C_{14}H_{13}NNaO_5^+$, [M+Na]$^+$; calcd 298.0691).

7.2.40. (+)-2-[(1*S*,4*R*,5*S*,6*S*)-4,5,6-{[Trihydroxy]cyclohex-2-en-1-yl}-1*H*-isoindole-1,3(2*H*)-dione ((+)-29). Compound (+)-**29** was obtained according to the above procedure using (−)-**27** (90%). $[\alpha]_{589}^{25}$ +161, $[\alpha]_{577}^{25}$ +161, $[\alpha]_{435}^{25}$ +350, $[\alpha]_{405}^{25}$ +444 (*c* 0.23, MeOH). HR-MALDI-TOF-MS: 298.0688 ($C_{14}H_{13}NNaO_5^+$, [M+Na]$^+$; calcd 298.0691).

7.2.41. (−)-2-[(1*R*,4*S*,5*R*,6*R*)-4,5,6-{[Trihydroxy]cyclohex-2-en-1-yl}-1*H*-isoindole-1,3(2*H*)-dione ((−)-29). Compound (−)-**29** was obtained according to the above procedure using (+)-**27** (91%). $[\alpha]_{589}^{25}$ −161, $[\alpha]_{577}^{25}$ −172, $[\alpha]_{435}^{25}$ −376, $[\alpha]_{405}^{25}$ −476 (*c* 0.23, MeOH). HR-MALDI-TOF-MS: 298.0610 ($C_{14}H_{13}NNaO_5^+$, [M+Na]$^+$; calcd 298.0691).

7.2.42. Reductive amination, general procedure. $NaBH(OAc)_3$ (1.4 equiv) was added portionwise to a stirred amino derivative (±)-**28**, (±)-**31**, (±)-**33**, *ent*-(+)-**33** or (−)-**33** (0.4 mmol) and an appropriate aromatic aldehyde (0.4 mmol) in abs $ClCH_2CH_2Cl$ (2 mL) at 20 °C. After complete disappearance of (±)-**28**, (±)-**31**, (±)-**33**, *ent*-(+)-**33** or (−)-**33** (TLC control), the solution was poured into brine. The organic phase was collected and the aqueous phase extracted with *t*-BME (10 mL mmol^{-1}). The combined organic extracts were dried (Na_2SO_4). Solvent evaporation in vacuo and FC on silica gel gave pure amines (±)-**30e**, (±)-**32d**, (±)-**35a**–**r**, *ent*-**35c**, **35g**, **35j**, **35k**, **35o**, **35p** or **35c**, **35g**, **35j**, **35k**, **35o**, **35p**, all as oils (light petroleum ether → AcOEt/light petroleum ether (0.5:99.5 up to 3:7)).

7.2.43. (±)-(1*SR*,4*RS*,5*SR*,6*SR*)-*N*-(4-Phenoxybenzyl)-4,5,6-tris-{[(*tert*-butyl)dimethylsilyl] oxy}cyclohex-2-ene-1-amine ((±)-30e). Compound (±)-**30e** was obtained according to the procedure described above using (±)-**28** and 4-phenoxybenzaldehyde (80%). Yellowish oil. IR (film): 3380, 2953, 2931, 1702, 1587, 1490, 1244, 1080, 835, 776. ^{1}H NMR (400 MHz, $CDCl_3$): 7.37–7.28 (m, 4 arom H); 7.10 (*t*, *J* = 7.1, 1 arom H); 7.01 (d, *J* = 8.4, 2 arom H); 6.98 (d, *J* = 8.5, 2 arom H); 5.69 (br d, *J*(2,3) = 10.5, H–C(2)); 5.63 (br d, *J*(3,2) = 10.5, H–C(3)); 3.96–3.78 (m, H–C(6), H–C(5), H–C(4), 2 ArCH_2N); 3.32 (br m, H–C(1)); 0.93, 0.91, 0.86 (3s, 3 ^{t}BuSi); 0.155, 0.151, 0.122, 0.103, 0.096 (5s, 6 *Me*Si). ^{13}C NMR (100.6 MHz, $CDCl_3$): 157.6 (s, arom C); 155.8 (s, arom C); 135.7 (s, arom C); 129.6 (d, *J*(C,H) = 159, 2 arom C); 129.3 (d, *J*(C,H) = 158, 2 arom C); 128.4 (*d*, *J*(C,H) = 159, C(3)); 127.9 (d, *J*(C,H) = 159, C(2)); 122.9 (d, *J*(C,H) = 158, arom C); 118.9 (d, *J*(C,H) = 160, 2 arom C); 118.5 (d, *J*(C,H) = 160, 2 arom C); 74.7, 71.6 (2d, *J*(C,H) ≈ 144, C(5), C(4)); 69.0 (d, *J*(C,H) = 145, C(6)); 52.0 (d, *J*(C,H) = 135, C(1)); 49.9 (*t*, *J*(C,H) = 134, Ar*C*H_2N); 26.1, 26.0, 25.8 (3q, *J*(C,H) = 125, 3 *Me*$_3$C); 18.4, 18.2, 17.8 (*s*, 3 *Me*$_3$C); −3.6, −4.3, −4.4, −4.5, −4.7 (5q, *J*(C,H) = 118, 6 *Me*Si). HR-MALDI-TOF-MS: 692.3989 ($C_{37}H_{63}NNaO_4Si_3^+$, $[M+Na]^+$; calcd 692.3963).

7.2.44. (±)-(1*SR*,4*RS*,5*SR*,6*SR*)-4,5,6-Tris-{[trimethylsilyl]oxy}cyclohex-2-en-1-amine ((±)-31). Compound (±)-**31** was obtained according to the Procedure 1 described for (±)-**28**. Yellowish oil. ^{1}H NMR (400 MHz, $CDCl_3$): 5.62–5.52 (br m, H–C(3), H–C(2)), 3.99 (m, H–C(4)), 3.54 (dd, *J*(5,6) = 9.9, *J*(5,4) = 6.0, H–C(5)); 3.49 (dd, *J*(6,5) = 9.9, *J*(6,1) = 4.6, H–C(6)); 3.31 (br m, H–C(1)), 0.17, 0.15, 0.12 (3s, 9 *Me*Si). HR-MALDI-TOF-MS: 384.1849 ($C_{15}H_{35}NNaO_3Si_3^+$, $[M+Na]^+$; calcd 384.1822).

7.2.45. (±)-(1*SR*,4*RS*,5*SR*,6*SR*)-*N*-(1,1′-Biphenyl-4-ylmethyl)-4,5,6-tris[(trimethylsilyl)oxy]cyclohex-2-ene-1-amine ((±)-32d). Compound (±)-**32d** was obtained according to the procedure described earlier using (±)-**31** and 4-biphenylcarboxaldehyde (72%). Yellowish oil. ^{1}H NMR (400 MHz, $CDCl_3$): 7.61 (d, *J* = 7.9, 2 arom H); 7.58 (d, *J* = 7.9, 2 arom H); 7.47–7.39 (m, 4 arom H); 7.36 (*t*, *J* = 7.6, 1 arom H); 5.81 (dd, *J*(2,3) = 10.2, *J*(2,4) = 4.4, H–C(2)); 5.65 (br d, *J*(3,2) = 10.2, H–C(3)); 4.04–3.93 (m, H–C(5), H–C(4), 1 ArCH_2N); 3.80 (*d*, *J* = 13.5, 1 ArCH_2N); 3.61 (dd, *J*(6,5) = 9.1, *J*(6,1) = 4.7, H–C(6)); 3.27 (br m, H–C(1)); 0.18, 0.16, 0.11 (3s, 9 *Me*Si). HR-MALDI-TOF-MS: 550.2598 ($C_{28}H_{45}NNaO_3Si_3^+$, $[M+Na]^+$; calcd 550.2605).

7.2.46. (±)-(1*SR*,4*RS*,5*SR*,6*SR*)-4,5,6-Tris-{[triethylsilyl]oxy}cyclohex-2-en-1-amine ((±)-33). *Procedure 1*. Conduramine F-1 ((±)-**9**) (0.20 g, 1.38 mmol, 1.0 equiv) was dissolved in anhyd DMF (5 mL) at 0 °C and imidazole (0.45 g, 6.62 mmol, 4.8 equiv) followed by triethylchlorosilane (0.83 mL, 4.96 mmol, 3.6 equiv) were added. After stirring for 4 h at rt, the solution was dissolved in *t*-BME and washed with brine. The organic phase was collected and the aqueous phase extracted with *t*-BME (3×). The combined organic extracts were dried (Na_2SO_4), evaporated, and the residue submitted to FC (10–30% AcOEt/light petroleum ether): 0.15 g (22%) of (±)-**33**.

Procedure 2. Fully protected conduramine F-1 derivative ((±)-**34**) (2.0 g, 3.24 mmol) was dissolved in 1:1 mixture of CH_2Cl_2/40% aq $MeNH_2$ (30 mL) and stirred overnight at rt (TLC control). Subsequently, the mixture was poured into brine (50 mL) and extracted with *t*-BME (3×). The combined organic extracts were dried (Na_2SO_4), evaporated and the residue submitted to FC (10–30% AcOEt/light petroleum ether): 1.15 g (73%) of (±)-**33**. Yellowish oil. UV ($CHCl_3$): 261 (410). IR (KBr): 3370, 2953, 2876, 1463, 1415, 1239, 1125, 1079, 1006, 735. ^{1}H NMR (400 MHz, $CDCl_3$): 5.71 (ddd, *J*(2,3) = 10.1, *J*(2,1) = 4.1, *J*(2.3) = 1.5, H–C(2)); 5.66 (br d, *J*(3,2) = 10.1, H–C(3)); 4.00 (m, H–C(4)), 3.68 (dd, *J*(5,6) = 8.6, *J*(5,4) = 6.0, H–C(5)); 3.58 (dd, *J*(6,5) = 8.6, *J*(6,1) = 4.3, H–C(6)); 3.38 (m, H–C(1)), 1.03–0.96 (m, 9 CH_3CH$_2$Si); 0.72–0.63 (m, 9 CH$_3$CH_2Si). ^{13}C NMR (100.6 MHz, $CDCl_3$): 130.8 (d, *J*(C,H) = 161, C(3)); 128.1 (d, *J*(C,H) = 161, C(2)); 73.8 (d, *J*(C,H) = 142, C(4)); 73.4 (d, *J*(C,H) = 143, C(5)); 72.8 (d, *J*(C,H) = 142, C(6)); 51.2 (d, *J*(C,H) = 139, C(1)); 7.1, 7.0, 6.9 (3q, *J*(C,H) = 124, 9 *C*H$_3$CH$_2$Si); 5.3, 5.14, 5.08 (3*t*, *J*(C,H) = 116, 9 CH$_3$*C*H_2Si). CI-MS (NH_3): 459 (2), 199 (100), 160 (4), 133 (5), 115 (31), 104 (4), 103 (27), 87 (90), 75 (38). HR-MALDI-TOF-MS: 488.3498 ($C_{24}H_{54}NO_3Si_3^+$, $[M+H]^+$; calcd 488.3412).

7.2.47. (−)-(1*S*,4*R*,5*S*,6*S*)-4,5,6-Tris-{[triethylsilyl]oxy}-cyclohex-2-en-1-amine ((−)-33). Compound (−)-**33** was obtained according to the above procedure using (−)-**34** (75%). $[\alpha]_{589}^{25}$ −30, $[\alpha]_{577}^{25}$ −34, $[\alpha]_{435}^{25}$ −56, $[\alpha]_{405}^{25}$ −66 (*c* 0.24, $CHCl_3$). $[\alpha]_{589}^{25}$ −18, $[\alpha]_{577}^{25}$ −21, $[\alpha]_{435}^{25}$ −41, $[\alpha]_{405}^{25}$ −55 (*c* 0.245, MeOH). HR-MALDI-TOF-MS: 488.3424 ($C_{24}H_{54}NO_3Si_3^+$, $[M+H]^+$; calcd 488.3412).

7.2.48. (+)-(1*R*,4*S*,5*R*,6*R*)-4,5,6-Tris-{[triethylsilyl]oxy}-cyclohex-2-en-1-amine ((+)-33). Compound (+)-**33** was obtained according to the above procedure using (+)-**34** (70%). $[\alpha]_{589}^{25}$ +17, $[\alpha]_{577}^{25}$ +24, $[\alpha]_{435}^{25}$ +44, $[\alpha]_{405}^{25}$ +54 (*c* 0.2, $CHCl_3$). HR-MALDI-TOF-MS: 488.3470 ($C_{24}H_{54}NO_3Si_3^+$, $[M+H]^+$; calcd 488.3412).

7.2.49. (±)-2-(1*SR*,4*RS*,5*SR*,6*SR*)-4,5,6-Tris-({[triethylsilyl]oxy}cyclohex-2-en-1-yl)-1*H*-isoindole-1,3(2*H*)-dione ((±)-34). Triol (±)-**29** (1.1 g, 3.99 mmol, 1.0 equiv) was dissolved in anhyd DMF (12 mL) at 0 °C and imidazole (1.47 g, 21.55 mmol, 5.4 equiv) followed by Et_3Cl (3.0 mL, 17.98 mmol, 4.5 equiv) were added. After stirring overnight at room temperature, the solution was dissolved in *t*-BME (40 mL) and washed with brine (40 mL). The organic phase was collected and the aqueous phase extracted with *t*-BME (3×). The combined organic extracts were dried (Na_2SO_4) and concentrated. FC on silica gel (light petroleum ether/AcOEt (97:3)) provided derivative (±)-**34** as a yellowish oil; 2.1 g (85%). UV ($CHCl_3$): 294 (2255), 244 (6486). IR (KBr): 2951, 2876, 1775, 1716, 1467, 1385, 1239, 1169, 1132, 1085, 1006, 718. ^{1}H NMR (400 MHz, $CDCl_3$): 7.84–

7.81 (m, 2 arom H); 7.72–7.68 (m, 2 arom H); 5.82 (dt, $J(3,2) = 10.4$, $J(3,4) = J(3,1) = 2.4$, H–C(3)); 5.75 (br d, $J(2,3) = 10.4$, H–C(2)); 5.07 (m, H–C(1)), 4.15 (dd, $J(5,6) = 6.6$, $J(5,4) = 4.1$, H–C(5)); 4.03 (m, H–C(4)), 3.92 (dd, $J(6,5) = 6.4$, $J(6,1) = 5.1$, H–C(6)); 1.06–0.63 (m, 9 *Et*Si). ^{13}C NMR (100.6 MHz, $CDCl_3$): 168.4 (s, 2 arom C); 133.8 (d, J(C,H) = 163, 2 arom C); 132.0 (s, 2 arom C); 130.3 (d, J(C,H) = 160, C(3)); 122.9 (d, J(C,H) = 165, 2 arom C); 122.8 (d, J(C,H) ≈ 160, C(2)); 74.2 (d, J(C,H) = 146, C(5)); 71.7 (d, J(C,H) = 141, C(4)); 70.4 (d, J(C,H) = 140, C(6)); 50.4 (d, J(C,H) = 140, C(1)); 7.0, 6.9, 6.8 (3q, J(C,H) = 124, 9 CH_3CH_2Si); 5.1, 4.7 (2*t*, J(C,H) = 116, 9 CH_3CH_2Si). CI-MS (NH_3): 588 (8), 457 (4), 355 (8), 329 (77), 288 (20), 161 (3), 115 (35), 103 (14), 87 (100), 75 (22). HR-MALDI-TOF-MS: 640.3280 ($C_{32}H_{55}NNaO_5Si_3^+$, $[M+Na]^+$; calcd 640.3286). Anal. Calcd for $C_{32}H_{55}NO_5Si_3$ (618.039): C, 62.19; H, 8.97; N, 2.27. Found: C, 62.00; H, 9.10; N, 2.15.

7.2.50. (−)-2-(1*S*,4*R*,5*S*,6*S*)-4,5,6-Tris-({[triethylsilyl]oxy}cyclohex-2-en-1-yl)-1*H*-isoindole-1,3(2*H*)-dione ((−)-34). Compound (−)-**34** was obtained according to the above procedure using (+)-**29** (85%). $[\alpha]_{589}^{25}$ −7, $[\alpha]_{577}^{25}$ −9, $[\alpha]_{435}^{25}$ −12, $[\alpha]_{405}^{25}$ −18 (*c* 0.18, MeOH). HR-MALDI-TOF-MS: 640.3297 ($C_{32}H_{55}NNaO_5Si_3^+$, $[M+Na]^+$; calcd 640.3286).

7.2.51. (+)-2-(1*R*,4*S*,5*R*,6*R*)-4,5,6-Tris-({[triethylsilyl]oxy}cyclohex-2-en-1-yl)-1*H*-isoindole-1,3(2*H*)-dione ((+)-34). Compound (+)-**34** was obtained according to the above procedure using (−)-**29** (78%). $[\alpha]_{589}^{25}$ +5, $[\alpha]_{577}^{25}$ +3, $[\alpha]_{435}^{25}$ +12, $[\alpha]_{405}^{25}$ +14 (*c* 0.18, MeOH). HR-MALDI-TOF-MS: 640.3270 ($C_{32}H_{55}NNaO_5Si_3^+$, $[M+Na]^+$; calcd 640.3286).

7.2.52. (±)-(1*SR*,4*RS*,5*SR*,6*SR*)-*N*-Benzyl-4,5,6-tris[(triethylsilyl)oxy]cyclohex-2-ene-1-amine ((±)-35a). Compound (±)-**35a** was obtained according to the procedure described earlier using (±)-**33** and benzaldehyde (75%). TLC (light petroleum ether/AcOEt (9.5:0.5)). Yellowish oil. ^{1}H NMR (400 MHz, $CDCl_3$): 7.38–7.24 (m, 5 arom H); 5.76 (dd, $J(2,3) = 10.2$, $J(2,4) = 3.0$, H–C(2)); 5.64 (br *d*, $J(3,2) = 10.2$, H–C(3)); 4.01–3.95 (m, H–C(5), H–C(4)); 3.91 (d, $J = 13.4$, 1 ArCH_2N); 3.83 (d, $J = 13.4$, 1 ArCH_2N); 3.80–3.74 (m, H–C(6)); 3.31 (br m, H–C(1)); 1.02–0.95 (m, 9 CH_3CH_2Si); 0.70–0.61 (m, 9 CH_3CH_2Si). ^{13}C NMR (100.6 MHz, $CDCl_3$): 140.7 (s, arom C); 129.9 (d, J(C,H) = 161, C(3)); 128.2 (d, J(C,H) = 159, 2 arom C); 128.0 (d, J(C,H) = 162, 2 arom C); 127.7 (*d*, J(C,H) = 160, C(2)); 126.7 (d, J(C,H) = 160, arom C); 74.1, 73.2 (2d, J(C,H) ≈ 143, C(5), C(4)); 71.1 (d, J(C,H) = 142, C(6)); 54.7 (d, J(C,H) = 134, C(1)); 51.1 (*t*, J(C,H) = 133, ArCH_2N); 7.02, 6.99, 6.95 (3q, J(C,H) = 125, 9 CH_3CH_2Si); 5.15, 5.13, 5.08 (3*t*, J(C,H) = 117, 9 CH_3CH_2Si).

7.2.53. (±)-(1*SR*,4*RS*,5S*R*,6*SR*)-*N*-(4-Ethylbenzyl)-4,5,6-tris[(triethylsilyl)oxy]cyclohex-2-ene-1-amine ((±)-35b). Compound (±)-**35b** was obtained according to the procedure described earlier using (±)-**33** and 4-ethylbenzaldehyde (81%). TLC (light petroleum ether/AcOEt (9.5:0.5)). Yellowish oil. ^{1}H NMR (400 MHz, $CDCl_3$): 7.27 (d, $J = 7.8$ Hz, 2 arom H); 7.17 (d, $J = 7.9$ Hz, 2 arom H); 5.75 (dd, $J(2,3) = 10.2$, $J(2,4) = 2.9$, H–C(2)); 5.63 (br d, $J(3,2) = 10.2$, H–C(3)); 4.01–3.98 (m, H–C(5), H–C(4)); 3.88 (d, $J = 13.3$, 1 ArCH_2N); 3.78 (d, $J = 13.3$, 1 ArCH_2N); 3.77–3.74 (m, H–C(6)); 3.29 (br m, H–C(1)); 2.65 (q, $J(1',2') = 7.6$, H–C(1′)); 1.25 (*t*, $J(2',1') = 7.6$, H–C(2′)); 1.03–0.96 (m, 9 CH_3CH_2Si); 0.70–0.60 (m, 9 CH_3CH_2Si). ^{13}C NMR (100.6 MHz, $CDCl_3$): 142.6 (s, arom C); 138.0 (s, arom C); 129.9 (d, J(C,H) = 160, C(3)); 128.0 (d, J(C,H) = 157, 2 arom C); 127.7 (d, J(C,H) = 160, C(2)); 127.6 (d, J(C,H) = 157, 2 arom C); 74.1, 73.3 (2d, J(C,H) ≈ 143, C(5), C(4)); 71.1 (d, J(C,H) = 140, C(6)); 54.6 (d, J(C,H) = 136, C(1)); 50.8 (*t*, J(C,H) = 133, ArCH_2N); 28.5 (*t*, J(C,H) = 126, CH_3CH_2); 15.7 (q, J(C,H) = 126, CH_3CH_2); 7.02, 6.99, 6.94 (3q, J(C,H) = 126, 9 CH_3CH_2Si); 5.15, 5.13, 5.07 (3*t*, J(C,H) = 116, 9 CH_3CH_2Si).

7.2.54. (±)-4-[({(1*SR*,4*RS*,5*SR*,6*SR*)-4,5,6-Tris[(triethylsilyl)oxy]cyclohex-2-en-1-yl}amino)methyl]phenol ((±)-35c). Compound (±)-**35c** was obtained according to the procedure described earlier using (±)-**33** and 4-hydroxybenzaldehyde (94%). TLC (light petroleum ether/AcOEt (4:1)). Yellowish oil. ^{1}H NMR (400 MHz, $CDCl_3$): 7.11 (d, $J = 8.3$, 2 arom H); 6.64 (d, $J = 8.3$, 2 arom H); 5.74 (dd, $J(2,3) = 10.3$, $J(2,4) = 2.6$, H–C(2)); 5.64 (br d, $J(3,2) = 10.3$, H–C(3)); 4.98–3.96 (m, H–C(5), H–C(4)); 3.81–3.78 (m, H–C(6)); 3.77 (d, $J = 12.7$, 1 ArCH_2N); 3.72 (d, $J = 12.7$, 1 ArCH_2N); 3.36 (br m, H–C(1)); 1.01–0.95 (m, 9 CH_3CH_2Si); 0.68–0.62 (m, 9 CH_3CH_2Si). ^{13}C NMR (100.6 MHz, $CDCl_3$): 155.3 (s, arom C); 131.7 (s, arom C); 130.1 (d, J(C,H) = 160, C(3)); 129.5 (d, J(C,H) = 157, 2 arom C); 127.3 (d, J(C,H) = 159, C(2)); 115.6 (d, J(C,H) = 158, 2 arom C); 74.1, 73.0 (2d, J(C,H) ≈ 144, C(5), C(4)); 70.6 (d, J(C,H) = 140, C(6)); 54.8 (d, J(C,H) = 133, C(1)); 50.6 (*t*, J(C,H) = 134, ArCH_2N); 7.05, 6.97, 6.93 (3q, J(C,H) = 126, 9 CH_3CH_2Si); 5.14, 5.11 (2*t*, J(C,H) = 117, 9 CH_3CH_2Si).

7.2.55. (±)-(1*SR*,4*RS*,5*SR*,6*SR*)-*N*-(1,1′-Biphenyl-4-ylmethyl)-4,5,6-tris[(triethylsilyl)oxy]cyclohex-2-ene-1-amine ((±)-35d). Compound (±)-**35d** was obtained according to the procedure described earlier using (±)-**33** and 4-biphenylcarboxaldehyde (75%). TLC (light petroleum ether/AcOEt (9.5:0.5)). Yellowish oil. ^{1}H NMR (400 MHz, $CDCl_3$): 7.62 (d, $J = 7.4$, 2 arom H); 7.57 (d, $J = 8.1$, 2 arom H); 7.48–7.42 (m, 4 arom H); 7.36 (*t*, $J = 7.3$, arom H); 5.78 (dd, $J(2,3) = 10.1$, $J(2,4) = 2.7$, H–C(2)); 5.65 (br d, $J(3,2) = 10.1$, H–C(3)); 4.03–3.98 (m, H–C(5), H–C(4)); 3.96 (d, $J = 13.5$, 1 ArCH_2N); 3.87 (d, $J = 13.5$, 1 ArCH_2N); 3.80–3.75 (m, H–C(6)); 3.33 (br m, H–C(1)); 1.03–0.96 (m, 9 CH_3CH_2Si); 0.70–0.62 (m, 9 CH_3CH_2Si). ^{13}C NMR (100.6 MHz, $CDCl_3$): 141.1 (s, arom C); 139.9 (s, arom C); 139.7 (s, arom C); 130.0 (d, J(C,H) = 160, C(3)); 128.7 (d, J(C,H) = 161, 2 arom C); 128.4 (d, J(C,H) = 158, 2 arom C); 127.7 (d, J(C,H) = 160, C(2)); 127.07 (d, J(C,H) = 159, arom C); 127.04 (d, J(C,H) = 158, 2 arom C); 126.99 (d, J(C,H) = 158, 2 arom C); 74.1, 73.2 (2d, J(C,H) ≈ 143, C(5), C(4));

71.1 (d, J(C,H) = 139, C(6)); 54.6 (d, J(C,H) = 134, C(1)); 50.8 (*t*, J(C,H) = 133, Ar*C*H$_2$N); 7.06, 7.00, 6.97 (3q, J(C,H) = 126, 9 *C*H$_3$CH$_2$Si); 5.17, 5.14, 5.10 (3*t*, J(C,H) = 116, 9 CH$_3$*C*H$_2$Si).

7.2.56. (±)-(1*SR*,4*RS*,5*SR*,6*SR*)-*N*-(4-Phenoxybenzyl)-4,5,6-tris[(triethylsilyl)oxy]cyclohex-2-ene-1-amine ((±)-35e). Compound (±)-**35e** was obtained according to the procedure described earlier using (±)-**33** and 4-phenoxybenzaldehyde (85%). TLC (light petroleum ether/AcOEt (9.5:0.5)). Yellowish oil. ^{1}H NMR (400 MHz, CDCl$_3$): 7.36–7.28 (m, 4 arom H); 7.10 (*t*, J = 8.1, arom H); 7.01 (d, J = 8.6, 2 arom H); 6.98 (d, J = 8.4, 2 arom H); 5.74 (dd, J(2,3) = 10.3, J(2,4) = 2.3, H–C(2)); 5.64 (br d, J(3,2) = 10.3, H–C(3)); 4.01–3.96 (m, H–C(5), H–C(4)); 3.88 (d, J = 13.3, 1 ArC*H*$_2$N); 3.80 (d, J = 13.3, 1 ArC*H*$_2$N); 3.79–3.74 (m, H–C(6)); 3.29 (br m, H–C(1)); 1.01–0.95 (m, 9 C*H*$_3$CH$_2$Si); 0.67–0.63 (m, 9 CH$_3$C*H*$_2$Si). ^{13}C NMR (100.6 MHz, CDCl$_3$): 157.6 (s, arom C); 155.8 (s, arom C); 130.1 (s, arom C); 129.9 (d, J(C,H) = 160, C(3)); 129.6 (d, J(C,H) = 159, 2 arom C); 129.3 (d, J(C,H) = 158, 2 arom C); 127.7 (d, J(C,H) = 160, C(2)); 122.9 (d, J(C,H) = 159, arom C); 118.9 (d, J(C,H) = 160, 2 arom C); 118.6 (d, J(C,H) = 161, 2 arom C); 74.1, 73.1 (2d, J(C,H) ≈ 142, C(5), C(4)); 71.1 (d, J(C,H) = 142, C(6)); 54.5 (d, J(C,H) = 134, C(1)); 50.5 (*t*, J(C,H) = 134, Ar*C*H$_2$N); 7.03, 6.99, 6.94 (3q, J(C,H) = 126, 9 *C*H$_3$CH$_2$Si); 5.16, 5.14, 5.11 (3*t*, J(C,H) = 116, 9 CH$_3$*C*H$_2$Si).

7.2.57. (±)-(1*SR*,4*RS*,5*SR*,6*SR*)-*N*-(4-(4-Phenoxyphenoxy)benzyl)-4,5,6-tris[(triethylsilyl)oxy]cyclohex-2-ene-1-amine ((±)-35f). Compound (±)-**35f** was obtained according to the procedure described earlier using (±)-**33** and 4-(4-phenoxyphenoxy)benzaldehyde (72%). TLC (light petroleum ether/AcOEt (9.5:0.5)). Yellowish oil. ^{1}H NMR (400 MHz, CDCl$_3$): 7.37–7.28 (m, 4 arom H); 7.11 (*t*, J = 7.4, arom H); 7.05–6.96 (m, 8 arom H); 5.74 (dd, J(2,3) = 10.5, J(2,4) = 2.7, H–C(2)); 5.64 (br d, J(3,2) = 10.5, H–C(3)); 3.99–3.97 (m, H–C(5), H–C(4)); 3.88 (d, J = 13.3, 1 ArC*H*$_2$N); 3.80 (d, J = 13.3, 1 ArC*H*$_2$N); 3.79–3.75 (m, H–C(6)); 3.30 (br m, H–C(1)); 1.02–0.96 (m, 9 C*H*$_3$CH$_2$Si); 0.69–0.61 (m, 9 CH$_3$C*H*$_2$Si). ^{13}C NMR (100.6 MHz, CDCl$_3$): 156.4 (s, 2 arom C); 153.1 (s, arom C); 152.4 (s, arom C); 135.6 (s, arom C); 129.9 (d, J(C,H) = 160, C(3)); 129.7 (d, J(C,H) = 158, 2 arom C); 129.4 (d, J(C,H) = 161, 2 arom C); 127.7 (d, J(C,H) = 160, C(2)); 122.9 (d, J(C,H) = 160, 2 arom C); 120.5 (d, J(C,H) = 162, 2 arom C); 120.1 (d, J(C,H) = 163, 2 arom C); 118.3 (d, J(C,H) = 160, 2 arom C); 118.2 (d, J(C,H) = 160, 2 arom C); 74.2, 73.1 (2d, J(C,H) ≈ 144, C(5), C(4)); 71.0 (d, J(C,H) = 139, C(6)); 54.5 (d, J(C,H) = 135, C(1)); 50.4 (*t*, J(C,H) = 134, Ar*C*H$_2$N); 7.05, 7.00, 6.96 (3q, J(C,H) = 126, 9 *C*H$_3$CH$_2$Si); 5.15 (*t*, J(C,H) = 116, 9 CH$_3$*C*H$_2$Si).

7.2.58. (±)-(1*SR*,4*RS*,5*SR*,6*SR*)-*N*-(4-Pyridin-4-ylbenzyl)-4,5,6-tris[(triethylsilyl)oxy]cyclohex-2-ene-1-amine ((±)-35g). Compound (±)-**35g** was obtained according to the procedure described earlier using (±)-**33** and 4-(4-formylphenyl)pyridine (74%). TLC (light petroleum ether/AcOEt (7:3)). Yellowish oil. ^{1}H NMR (400 MHz, CDCl$_3$): 8.65 (br s, 2 arom H); 7.61 (d, J = 8.1, 2 arom H); 7.53 (d, J = 5.5, 2 arom H); 7.48 (d, J = 8.1, 2 arom H); 5.75 (dd, J(2,3) = 10.1, J(2,4) = 2.2, H–C(2)); 5.64 (br d, J(3,2) = 10.1, H–C(3)); 4.00–3.97 (m, H–C(5), H–C(4)); 3.96 (d, J = 13.7, 1 ArC*H*$_2$N); 3.89 (d, J = 13.7, 1 ArC*H*$_2$N); 3.80–3.77 (m, H–C(6)); 3.31 (br m, H–C(1)); 1.01–0.90 (m, 9 C*H*$_3$CH$_2$Si); 0.70–0.62 (m, 9 CH$_3$C*H*$_2$Si). ^{13}C NMR (100.6 MHz, CDCl$_3$): 150.0 (d, J(C,H) = 179, 2 arom C); 148.3 (s, arom C); 142.1 (s, arom C); 136.4 (s, arom C); 129.9 (d, J(C,H) = 159, C(3)); 128.7 (d, J(C,H) = 159, 2 arom C); 127.5 (d, J(C,H) = 158, arom C); 126.8 (d, J(C,H) = 159, 2 arom C); 121.5 (d, J(C,H) = 162, C(2)); 74.1, 73.0 (2d, J(C,H) ≈ 144, C(5), C(4)); 71.0 (d, J(C,H) = 140, C(6)); 54.6 (d, J(C,H) = 140, C(1)); 50.6 (*t*, J(C,H) = 133, Ar*C*H$_2$N); 7.0, 6.95, 6.92 (3q, J(C,H) = 125, 9 *C*H$_3$CH$_2$Si); 5.10, 5.08, 5.07 (3*t*, J(C,H) = 117, 9 CH$_3$*C*H$_2$Si).

7.2.59. (±)-(1*SR*,4*RS*,5*SR*,6*SR*)-*N*-(4-Pyrimidin-5-ylbenzyl)-4,5,6-tris[(triethylsilyl)oxy]cyclohex-2-ene-1-amine ((±)-35h). Compound (±)-**35h** was obtained according to the procedure described earlier using (±)-**33** and 5-(4-formylphenyl)pyrimidine (82%). TLC (light petroleum ether/AcOEt (7:3)). Yellowish oil. ^{1}H NMR (400 MHz, CDCl$_3$): 9.20 (br s, arom H); 8.96 (br s, 2 arom H); 7.56–7.51 (m, 4 arom H); 5.74 (dd, J(2,3) = 10.3, J(2,4) = 1.6, H–C(2)); 5.64 (br d, J(3,2) = 10.3, H–C(3)); 4.01–3.96 (m, H–C(5), H–C(4)); 3.95 (d, J = 13.8, 1 ArC*H*$_2$N); 3.90 (d, J = 13.8, 1 ArC*H*$_2$N); 3.79–3.77 (m, H–C(6)); 3.30 (br m, H–C(1)); 1.01–0.94 (m, 9 C*H*$_3$CH$_2$Si); 0.68–0.60 (m, 9 CH$_3$C*H*$_2$Si). ^{13}C NMR (100.6 MHz, CDCl$_3$): 157.3 (d, J(C,H) = 205, arom C); 154.8 (d, J(C,H) = 181, 2 arom C); 142.2 (s, arom C); 134.2 (s, arom C); 132.6 (s, arom C); 129.9 (d, J(C,H) = 161, C(3)); 129.0 (d, J(C,H) = 159, 2 arom C); 127.6 (d, J(C,H) = 161, C(2)); 126.8 (d, J(C,H) = 158, 2 arom C); 74.1, 72.9 (2d, J(C,H) ≈ 143, C(5), C(4)); 71.0 (d, J(C,H) = 140, C(6)); 54.6 (d, J(C,H) = 136, C(1)); 50.7 (*t*, J(C,H) = 133, Ar*C*H$_2$N); 7.0, 6.95, 6.9 (3q, J(C,H) = 125, 9 *C*H$_3$CH$_2$Si); 5.11, 5.09 (2*t*, J(C,H) = 117, 9 CH$_3$*C*H$_2$Si).

7.2.60. (±)-(4-{4-[{(1*SR*,4*RS*,5*SR*,6*SR*)-4,5,6-Tris[(triethylsilyl)oxy]cyclohex-2-en-1-yl}amino)methyl]phenyl}pyridin-2-yl-methanol ((±)-35i). Compound (±)-**35i** was obtained according to the procedure described earlier using (±)-**33** and 2-(4-formylphenyl)-6-(hydroxymethyl)pyridine (84%). TLC (light petroleum ether/AcOEt (7:3)). Yellowish oil. ^{1}H NMR (400 MHz, CDCl$_3$): 7.99 (d, J = 8.1, 2 arom H); 7.75 (*t*, J = 7.7, arom H); 7.65 (d, J = 7.8, arom H); 7.48 (d, J = 8.1, 2 arom H); 7.15 (d, J = 7.6, arom H); 5.76 (dd, J(2,3) = 10.3, J(2,4) = 2.7, H–C(2)); 5.64 (br d, J(3,2) = 10.3, H–C(3)); 4.83 (br s, C*H*$_2$OH); 4.01–3.97 (m, H–C(5), H–C(4)); 3.96 (d, J = 13.6, 1 ArC*H*$_2$N); 3.89 (*d*, J = 13.6, 1 ArC*H*$_2$N); 3.79–3.77 (*m*, H–C(6)); 3.33 (br m, H–C(1)); 1.02–0.95 (m, 9 C*H*$_3$CH$_2$Si); 0.69–0.61 (m, 9 CH$_3$C*H*$_2$Si). ^{13}C NMR (100.6 MHz, CDCl$_3$): 158.3 (s, arom C); 156.0 (s, arom C); 142.1 (s, arom C); 137.4 (d, J(C,H) = 164, arom C); 137.3 (s, arom C); 129.9 (d, J(C,H) = 161, C(3)); 128.4 (d, J(C,H) = 159, 2 arom C); 127.7 (d, J(C,H) = 161, C(2)); 126.7 (d, J(C,H) = 161, 2

arom C); 118.8 (d, J(C,H) = 161, arom C); 118.5 (d, J(C,H) = 162, arom C); 74.1, 73.1 (2d, J(C,H) ≈ 143, C(5), C(4)); 71.1 (d, J(C,H) = 140, C(6)); 63.8 (*t*, J(C,H) = 141, *C*H_2OH); 54.4 (d, J(C,H) = 138, C(1)); 50.8 (*t*, J(C,H) = 133, Ar*C*H_2N); 7.04, 6.99, 6.95 (3q, J(C,H) = 125, 9 *C*H_3CH$_2$Si); 5.14, 5.12, 5.09 (3*t*, J(C,H) = 117, 9 CH$_3$*C*H_2Si).

7.2.61. (±) Methyl 3′-[({(1*SR*,4*RS*,5*SR*,6*SR*)-4,5,6-tris[(triethylsilyl)oxy]cyclohex-2-en-1-yl}amino)methyl]biphenyl-4-carboxylate ((±)-35j). Compound (±)-**35j** was obtained according to the procedure described earlier using (±)-**33** and methyl 4-(3-formylphenyl)benzoate (98%). TLC (light petroleum ether/AcOEt (9.5:0.5)). Yellowish oil. ^{1}H NMR (400 MHz, $CDCl_3$): 8.12 (d, J = 8.4, 2 arom H); 7.68 (d, J = 8.4, 2 arom H); 7.66 (br s, arom H); 7.52 (d, J = 7.3, arom H); 7.44–7.37 (m, 2 arom H); 5.78 (dd, J(2,3) = 10.4, J(2,4) = 2.3, H–C(2)); 5.65 (br d, J(3,2) = 10.4, H–C(3)); 4.00–3.96 (m, H–C(5), H–C(4), 1 ArCH_2N); 3.90 (*d*, J = 13.5, 1 ArCH_2N); 3.79 (dd, J(6,5) = 6.2, J(6,1) = 4.1, H–C(6)); 3.33 (br m, H–C(1)); 1.01–0.92 (m, 9 CH_3CH$_2$Si); 0.69–0.62 (m, 9 CH$_3$CH_2Si). ^{13}C NMR (100.6 MHz, $CDCl_3$): 167.1 (s, Me*C*O); 145.7 (*s*, arom C); 141.5 (s, arom C); 139.9 (s, arom C); 130.0 (d, J(C,H) = 163, 3 arom C); 128.8 (d, J(C,H) = 160, C(3)); 128.7 (s, arom C); 127.9 (d, J(C,H) = 160, C(2)); 127.5 (d, J(C,H) = 159, arom C); 127.0 (d, J(C,H) = 160, 2 arom C); 126.9 (d, J(C,H) = 160, arom C); 125.5 (d, J(C,H) = 159, arom C); 74.1, 73.0 (2d, J(C,H) ≈ 143, C(5), C(4)); 71.1 (d, J(C,H) = 138, C(6)); 54.6 (d, J(C,H) = 134, C(1)); 52.1 (q, J(C,H) = 147, *Me*CO); 51.0 (*t*, J(C,H) = 134, Ar*C*H_2N); 7.03, 6.97, 6.94 (3q, J(C,H) = 126, 9 *C*H_3CH$_2$Si); 5.13, 5.11 (2*t*, J(C,H) = 117, 9 CH$_3$*C*H_2Si).

7.2.62. (±)-2-Iodo-6-methoxy-4-[({(1*SR*,4*RS*,5*SR*,6*SR*)-4,5,6-tris[(triethylsilyl)oxy]cyclohex-2-en-1-yl}amino)methyl]phenol ((±)-35k). Compound (±)-**35k** was obtained according to the procedure described earlier using (±)-**33** and 5-iodovanillin (91%). TLC (light petroleum ether/AcOEt (9:1)). Yellowish oil. ^{1}H NMR (400 MHz, $CDCl_3$): 7.25 (br s, arom H); 6.93 (br s, arom H); 5.70 (dd, J(2,3) = 10.3, J(2,4) = 2.7, H–C(2)); 5.62 (br d, J(3,2) = 10.3, H–C(3)); 3.98–3.96 (m, H–C(5), H–C(4)); 3.88 (s, *Me*O); 3.78–3.76 (*m*, H–C(6)); 3.78 (d, J = 13.2, 1 ArCH_2N); 3.71 (d, J = 13.2, 1 ArCH_2N); 3.28 (br m, H–C(1)); 1.01–0.93 (m, 9 CH_3CH$_2$Si); 0.68–0.60 (m, 9 CH$_3$CH_2Si). ^{13}C NMR (100.6 MHz, $CDCl_3$): 146.0 (s, arom C); 144.5 (s, arom C); 134.5 (s, arom C); 129.9 (d, J(C,H) = 159, C(3)); 129.7 (d, J(C,H) = 164, arom C); 127.5 (d, J(C,H) = 159, C(2)); 110.7 (d, J(C,H) = 160, arom C); 80.9 (s, arom C); 74.0, 72.9 (2*d*, J(C,H) ≈ 143, C(5), C(4)); 70.9 (d, J(C,H) = 141, C(6)); 56.1 (q, J(C,H) = 145, *Me*O); 54.5 (d, J(C,H) = 133, C(1)); 50.2 (*t*, J(C,H) = 134, Ar*C*H_2N); 7.05, 6.99, 6.94 (3*q*, J(C,H) = 126, 9 *C*H_3CH$_2$Si); 5.15, 5.13, 5.12 (3*t*, J(C,H) = 117, 9 CH$_3$*C*H_2Si).

7.2.63. (±)-(1*SR*,4*RS*,5*SR*,6*SR*)-*N*-(3,5-Dimethoxybenzyl)-4,5,6-tris[(triethylsilyl)oxy]cyclohex-2-ene-1-amine ((±)-35l). Compound (±)-**35l** was obtained according to the procedure described earlier using (±)-**33** and 3,5-dimethoxybenzaldehyde (63%). TLC (light petroleum ether/AcOEt (9:1)). Yellowish oil. ^{1}H NMR (400 MHz, $CDCl_3$): 6.55 (br d, J = 2.0, 2 arom H); 6.36 (*t*, J = 2.1, arom H); 5.73 (dd, J(2,3) = 10.5, J(2,4) = 2.5, H–C(2)); 5.63 (br d, J(3,2) = 10.5, H–C(3)); 4.00–3.98 (m, H–C(5), H–C(4)); 3.87–3.75 (m, H–C(6), 2 ArCH_2N); 3.80 (s, 2 *Me*O); 3.29 (br m, H–C(1)); 1.01–0.95 (m, 9 CH_3CH$_2$Si); 0.69–0.61 (m, 9 CH$_3$CH_2Si). ^{13}C NMR (100.6 MHz, $CDCl_3$): 160.7 (s, 2 arom C); 143.4 (s, arom C); 129.9 (d, J(C,H) = 159, C(3)); 127.7 (d, J(C,H) = 159, C(2)); 105.7 (d, J(C,H) = 158, 2 arom C); 99.1 (d, J(C,H) = 157, arom C); 74.1, 73.2 (2d, J(C,H) ≈ 142, C(5), C(4)); 71.2 (d, J(C,H) = 140, C(6)); 55.2 (q, J(C,H) = 144, *Me*O); 54.8 (d, J(C,H) = 135, C(1)); 51.3 (*t*, J(C,H) = 134, Ar*C*H_2N); 7.03, 6.98, 6.94 (3*q*, J(C,H) = 126, 9 *C*H_3CH$_2$Si); 5.16, 5.14, 5.11 (*t*, J(C,H) = 117, 9 CH$_3$*C*H_2Si).

7.2.64. (±)-2-Methoxy-4-[({(1*SR*,4*RS*,5*SR*,6*SR*)-4,5,6-tris[(triethylsilyl)oxy]cyclohex-2-en-1-yl}amino)methyl]phenol ((±)-35m). Compound (±)-**35m** was obtained according to the procedure described earlier using (±)-**33** and vanillin (61%). TLC (light petroleum ether/AcOEt (9:1)). Yellowish oil. ^{1}H NMR (400 MHz, $CDCl_3$): 6.97 (br s, arom H); 6.84 (d, J = 8.0, arom H); 6.78 (d, J = 8.0, arom H); 5.72 (dd, J(2,3) = 10.5, J(2,4) = 2.8, H–C(2)); 5.62 (br d, J(3,2) = 10.5, H–C(3)); 3.97–3.95 (m, H–C(5), H–C(4)); 3.89 (s, *Me*O); 3.80 (d, J = 12.9, 1 ArCH_2N); 3.74 (d, J = 12.9, 1 ArCH_2N); 3.80–3.77 (m, H–C(6)); 3.31 (br m, H–C(1)); 1.00–0.90 (m, 9 CH_3CH$_2$Si); 0.67–0.61 (m, 9 CH$_3$CH_2Si). ^{13}C NMR (100.6 MHz, $CDCl_3$): 146.5 (s, arom C); 144.5 (s, arom C); 132.4 (s, arom C); 129.8 (d, J(C,H) = 158, C(3)); 127.6 (d, J(C,H) = 160, C(2)); 120.9 (d, J(C,H) = 159, arom C); 113.9 (d, J(C,H) = 159, arom C); 110.8 (d, J(C,H) = 159, arom C); 74.1, 72.9 (2d, J(C,H) ≈ 142, C(5), C(4)); 70.7 (d, J(C,H) = 142, C(6)); 55.8 (q, J(C,H) = 145, *Me*O); 54.5 (d, J(C,H) = 135, C(1)); 40.9 (*t*, J(C,H) = 135, Ar*C*H_2N); 7.02, 6.97, 6.93 (3q, J(C,H) = 126, 9 *C*H_3CH$_2$Si); 5.11 (*t*, J(C,H) = 117, 9 CH$_3$*C*H_2Si).

7.2.65. (±)-(1*SR*,4*RS*,5*SR*,6*SR*)-*N*-[(3-Fluoropyridin-4-yl)methyl]-4,5,6-tris[(triethylsilyl)oxy]cyclohex-2-ene-1-amine ((±)-35n). Compound (±)-**35n** was obtained according to the procedure described earlier using (±)-**33** and 3-fluoroisonicotinaldehyde (67%). TLC (light petroleum ether/AcOEt (9:1)). Yellowish oil. ^{1}H NMR (400 MHz, $CDCl_3$): 8.37–8.35 (m, 2 arom H); 7.46 (*t*, J = 5.7, arom H); 5.70 (dd, J(2,3) = 10.5, J(2,4) = 3.1, H–C(2)); 5.63 (br d, J(3,2) = 10.5, H–C(3)); 3.98–3.92 (m, H–C(5), H–C(4), 2 ArCH_2N); 3.75 (dd, J(6,5) = 7.2, J(6,1) = 3.9, H–C(6)); 3.25–3.23 (m, H–C(1)); 1.00–0.92 (m, 9 CH_3CH$_2$Si); 0.67–0.58 (m, 9 CH$_3$CH_2Si). ^{13}C NMR (100.6 MHz, $CDCl_3$): 158.0 (d, J(C,F) = 251, arom C); 145.7 (d, J(C,H) = 180, arom C); 137.5 (dd, J(C,F) = 182, J(C,C,F) = 24, arom C); 136.7 (s, arom C); 130.5 (d, J(C,H) = 160, C(3)); 127.0 (d, J(C,H) = 159, C(2)); 123.8 (d, J(C,H) = 164, arom C); 74.0, 73.0 (2d, J(C,H) ≈ 143, C(5), C(4)); 71.1 (d, J(C,H) = 142, C(6)); 55.0 (d, J(C,H) = 134, C(1)); 43.0 (*t*, J(C,H) = 135, Ar*C*H_2N); 6.95 (q, J(C,H) = 126,

9 CH_3CH_2Si); 5.12, 5.06 (2*t*, *J*(C,H) = 116, 9 CH_3 CH_2Si).

7.2.66. (±)-(1*SR*,4*RS*,5*SR*,6*SR*)-*N*-[((1-Acetyl-1*H*-indol-3-yl)methyl)-4,5,6-tris[(triethylsilyl)oxy]cyclohex-2-ene-1-amine ((±)-35o). Compound (±)-**35o** was obtained according to the procedure described earlier using (±)-**33** and 1-acetyl-3-indolecarboxaldehyde (80%). TLC (light petroleum ether/AcOEt (4:1)). Yellowish oil. ^{1}H NMR (400 MHz, $CDCl_3$): 8.45 (br s, arom H); 7.62 (d, *J* = 7.7, arom H); 7.39–7.26 (m, 3 arom H); 5.79 (dd, *J*(2,3) = 10.3, *J*(2,4) = 3.4, H–C(2)); 5.67 (br *d*, *J*(3,2) = 10.3, H–C(3)); 4.05–3.93 (m, H–C(5), H–C(4), 2 ArCH_2N); 3.78 (dd, *J*(6,5) = 6.4, *J*(6,1) = 4.3, H–C(6)); 3.38 (br m, H–C(1)); 2.61 (s, *Me*CO); 1.01–0.94 (m, 9 CH_3CH_2Si); 0.68–0.61 (m, 9 CH_3CH_2Si). ^{13}C NMR (100.6 MHz, $CDCl_3$): 168.5 (s, *C*OMe); 136.1 (*s*, arom C); 130.3 (d, *J*(C,H) = 163, C(3)); 130.1 (*s*, arom C); 127.2 (d, *J*(C,H) = 160, C(2)); 125.3 (*d*, *J*(C,H) = 160, arom C); 123.4 (d, *J*(C,H) = 160, arom C); 122.4 (d, *J*(C,H) = 186, arom C); 122.3 (s, arom C); 119.3 (d, *J*(C,H) = 160, arom C); 116.6 (d, *J*(C,H) = 166, arom C); 74.1, 73.1 (2d, *J*(C,H) ≈ 143, C(5), C(4)); 71.3 (d, *J*(C,H) = 142, C(6)); 55.3 (d, *J*(C,H) = 132, C(1)); 42.3 (*t*, *J*(C,H) = 133, Ar*C*H_2N); 23.9 (q, *J*(C,H) = 129, CO*Me*); 6.98, 6.94, 6.92 (3q, *J*(C,H) = 127, 9 *C*H_3CH_2Si); 5.12, 5.09, 5.07 (3*t*, *J*(C,H) = 117, 9 CH_3CH_2Si).

7.2.67. (±)-(1*SR*,4*RS*,5*SR*,6*SR*)-*N*-({5-[2-Chloro-5′-(trifluoromethyl)phenyl]-2-furyl}methyl)-4,5,6-tris[(triethylsilyl)oxy]cyclohex-2-ene-1-amine ((±)-35p). Compound (±)-**35p** was obtained according to the procedure described earlier using (±)-**33** and 5-(2-chloro-5-(trifluoromethyl)phenyl)furfural (75%). TLC (light petroleum ether/AcOEt (9.5:0.5)). Yellowish oil. ^{1}H NMR (400 MHz, CD_3OD): 8.13 (br s, arom H); 7.55 (d, *J* = 8.3, arom H); 7.42 (d, *J* = 8.3, arom H); 7.19 (d, *J* = 3.3, arom H); 6.37 (d, *J* = 3.3, arom H); 5.75 (dd, *J*(2,3) = 10.3, *J*(2,4) = 3.1, H–C(2)); 5.67 (br d, *J*(3,2) = 10.3, H–C(3)); 4.01–3.97 (m, H–C(5), H–C(4), 1 ArCH_2N); 4.89 (d, *J* = 14.7, 1 ArCH_2N); 3.73 (dd, *J*(6,5) = 7.3, *J*(6,1) = 4.2, H–C(6)); 3.33 (br m, H–C(1)); 1.05–0.92 (m, 9 CH_3CH_2Si); 0.72–0.58 (m, 9 CH_3CH_2Si). ^{13}C NMR (100.6 MHz, $CDCl_3$): 155.2 (s, arom C); 147.8 (s, arom C); 133.0 (s, arom C); 131.2 (d, *J*(C,H) = 169, arom C); 130.9 (d, *J*(C,H) = 162, C(3)); 129.9 (d, *J*(C,H) = 160, arom C); 129.6 (s, arom C); 129.3 (s, arom C); 126.7 (d, *J*(C,H) = 159, C(2)); 124.4 (d, *J*(C,H) = 165, arom C); 123.8 (d, *J*(C,F) = 220, CF_3); 113.1 (d, *J*(C,H) = 178, arom C); 109.3 (d, *J*(C,H) = 175, arom C); 74.0, 73.6 (2d, *J*(C,H) ≈ 143, C(5), C(4)); 71.3 (d, *J*(C,H) = 142, C(6)); 54.7 (d, *J*(C,H) = 136, C(1)); 43.6 (*t*, *J*(C,H) = 136, Ar*C*H_2N); 7.00, 6.95, 6.89 (3q, *J*(C,H) = 126, 9 *C*H_3CH_2Si); 5.23, 5.17, 5.03 (3*t*, *J*(C,H) = 116, 9 CH_3CH_2Si).

7.2.68. (±)-(1*SR*,4*RS*,5*SR*,6*SR*)-*N*-[(5-Nitro-2-furyl)-methyl]-4,5,6-tris[(triethylsilyl)oxy]cyclohex-2-ene-1-amine ((±)-35q). Compound (±)-**35q** was obtained according to the procedure described earlier using (±)-**33** and 5-nitro-2-furaldehyde (57%). TLC (light petroleum ether/AcOEt (9:1)). Yellowish oil. ^{1}H NMR (400 MHz, $CDCl_3$): 7.27 (d, *J* = 4.0, arom H); 6.47 (d, *J* = 3.6, arom H); 5.65 (br s, H–C(3), H–C(2)); 3.97–3.90 (m, H–C(5), H–C(4)), (2ArCH_2N); 3.71 (dd, *J*(6,5) = 6.9, *J*(6,1) = 4.1, H–C(6)); 3.29 (br d, *J*(1,6) = 4.1, H–C(1)); 1.00–0.93 (m, 9 CH_3CH_2Si); 0.68–0.58 (m, 9 CH_3CH_2Si). ^{13}C NMR (100.6 MHz, $CDCl_3$): 159.1 (s, arom C); 149.7 (s, arom C); 131.0, 126.4 (2 d, *J*(C,H) = 159, C(3), C(2)); 112.6 (d, *J*(C,H) = 185, arom C); 110.1 (d, *J*(C,H) = 181, arom C); 73.9, 73.1 (2d, *J*(C,H) ≈ 142, C(5), C(4)); 71.0 (d, *J*(C,H) = 141, C(6)); 54.9 (d, *J*(C,H) = 135, C(1)); 43.9 (*t*, *J*(C,H) = 136, Ar*C*H_2N); 7.0, (q, *J*(C,H) = 126, 9 *C*H_3CH_2Si); 5.20, 5.15, 5.11 (3*t*, *J*(C,H) = 116, 9 CH_3CH_2Si).

7.2.69. (±)-(1*SR*,4*RS*,5*SR*,6*SR*)-*N*-[(5-Bromo-2-thienyl)methyl]-4,5,6-tris[(triethylsilyl)oxy]cyclohex-2-ene-1-amine ((±)-35r). Compound (±)-**35r** was obtained according to the procedure described earlier using (±)-**33** and 5-bromothiophene-2-carboxaldehyde (30%). TLC (light petroleum ether/AcOEt (9.5:0.5)). Yellowish oil. ^{1}H NMR (400 MHz, $CDCl_3$): 6.88 (d, *J* = 3.6, arom H); 6.67 (d, *J* = 3.6, arom H); 5.68 (dd, *J*(2,3) = 10.2, *J*(2,4) = 2.2, H–C(2)); 5.63 (br d, *J*(3,2) = 10.2, H–C(3)); 4.00–3.91 (m, H–C(5), H–C(4), 2 ArCH_2N); 3.75 (dd, *J*(6,5) = 6.0, *J*(6,1) = 4.2, H–C(6)); 3.33 (br m, H–C(1)); 1.02–0.92 (m, 9 CH_3CH_2Si); 0.68–0.60 (m, 9 CH_3CH_2Si). ^{13}C NMR (100.6 MHz, $CDCl_3$): 147.3 (s, arom C); 129.7 (d, *J*(C,H) = 160, C(3)); 129.2 (d, *J*(C,H) = 174, arom C); 127.3 (d, *J*(C,H) = 159, C(2)); 124.3 (d, *J*(C,H) = 170, arom C); 110.7 (s, arom C); 74.0, 72.6 (2d, *J*(C,H) ≈ 143, C(5), C(4)); 70.8 (d, *J*(C,H) = 141, C(6)); 53.9 (d, *J*(C,H) = 137, C(1)); 46.2 (*t*, *J*(C,H) = 136, Ar*C*H_2N); 7.03, 6.95, (2q, *J*(C,H) = 126, 9 *C*H_3CH_2Si); 5.08 (*t*, *J*(C,H) = 117, 9 CH_3CH_2Si).

7.2.70. (±)-(1*RS*,2*SR*,3*SR*,4*SR*)-4-Amino-1,2,3-cyclohexanetriol, (±)-dihydroconduramine F-1 ((±)-36). Compound (±)-**9** (0.046 g, 0.32 mmol) was dissolved in MeOH (5 mL) and stirred under H_2 for 2 h in the presence of 10% Pd/C (0.01 g). The solution was passed through Celite and evaporated under reduced pressure: (0.045 g), (98%) of (±)-**37**. White solid. Mp 120–122 °C ($MeOH/Et_2O$). IR (KBr): 3312, 1576, 1473, 1356, 1107, 1052, 950. ^{1}H NMR (400 MHz, CD_3OD): 3.61–3.46 (m, H–C(3), H–C(2), H–C(1)); 3.20 (m, H–C(4)); 1.84–1.76, 1.71–1.55 (2 m, H–C(6), H–C(5)). ^{13}C NMR (100.6 MHz, CD_3OD): 74.8, 74.7, 73.2 (d, *J*(C,H) ≈ 147, C(3), C(2), C(1)); 51.6 (d, *J*(C,H) = 140, C(4)); 27.6, 25.6 (2*t*, *J*(C,H) ≈ 128, C(6), C(5)). HR-MALDI-TOF-MS: 170.0730 ($C_6H_{13}NNaO_3^+$, $[M+Na]^+$; calcd 170.0793). Anal. Calcd for $C_6H_{13}NO_3$ (147.172): C, 48.97; H, 8.90; N, 9.52. Found: C, 49.30; H, 8.70; N, 9.63.

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