Total Asymmetric Syntheses of 1,5-Dideoxy-1,5-iminooctitols and 1,2,6,7,8-Pentahydroxyindolizidines[1]

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(1*R*,4*R*,5*S*,6*S*,7*S*)-4-*exo*-[(1'*S*,2'*R*)-1'-Hydroxy-2',3'-(isopropylidenedioxy)propyl]-6-*exo*,7-*exo*-(isopropylidenedioxy)-2,8-dioxabicyclo[3.2.1]octan-3-one ((+)-**5**) and its diastereomer (1*S*,4*S*,5*R*,6*R*,7*R*)-(1'*R*,2'*R*)-(−)-**30** derived from (*R*)-2,3-*O*-isopropylideneglyceraldehyde and (±)-5-*exo*,6-*exo*-(isopropylidenedioxy)-7-oxabicyclo[2.2.1]hept-2-one were alcoholyzed with benzyl alcohol in CCl_4 (CsF as base) into the corresponding 5-*C*-(benzyloxycarbonyl)-5-deoxyoctofuranoses (+)-**9** and (−)-**31** which were converted via Curtius rearrangements into (−)-1,5-dideoxy-1,5-imino-D-*erythro*-D-*talo*-octitol ((−)-**20**) and its D-*threo*-L-*talo* isomer (+)-**36**, respectively. Alcoholyses of (+)-**5** and (−)-**30** with benzyl alcohol in DMSO in the presence of CsF or K_2CO_3 led to the epimerized benzyl esters (−)-**10** and (−)-**38**, respectively, which were converted into (−)-1,5-dideoxy-1,5-imino-D-*erythro*-L-*allo*-octitol ((−)-**27**) and its D-*threo*-D-*allo* isomer (+)-**42**. The 1,5-dideoxy-1,5-iminooctitols were converted into the corresponding 1,2,6,7,8-pentahydroxyindolizidines in a single step.

Introduction

Polyhydroxypiperidines and polyhydroxypyrrolidines (azasugars) can be powerful and specific glycosidase inhibitors,[2] the chemotherapeutic potential of which as bactericidal[3] or as antidiabetes[4] agents has been recognized. Because some derivatives have exhibited activity against human immunodeficiency virus (HIV),[5] there has been much effort expended in the search for new azasugars.[6] Swainsonine ((−)-**1**)[7] is an inhibitor of α-D-mannosidases involved in the biosynthesis of glycoproteins.[8] It has immunostimulatory properties and may find possible use in cancer chemotherapy.[9] Castanospermine ((+)-**2**)[7,10] is a drug candidate for the treatment of cancer and viral infections.[10,11] These polyhydroxyindolizidines have thus attracted considerable attention, and several syntheses of these natural alkaloids[7] and analogues[10,12,13] have been proposed in recent years. It has been shown that stereochemical modifications to any of the five chiral centers of (+)-**2** remarkably change the inhibitory selectivities of the polyhydroxyindolizidines toward glycosidases.[13,15,16] We report here the total synthesis of the 1,2,6,7,8-

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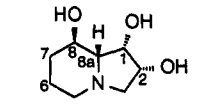
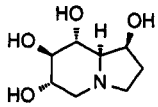
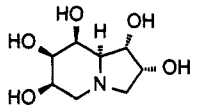
pentahydroxyindolizidines (−)-3, (+)-4, and their respective 8a epimers.



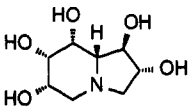
(−)-1



(+)-2



(−)-3



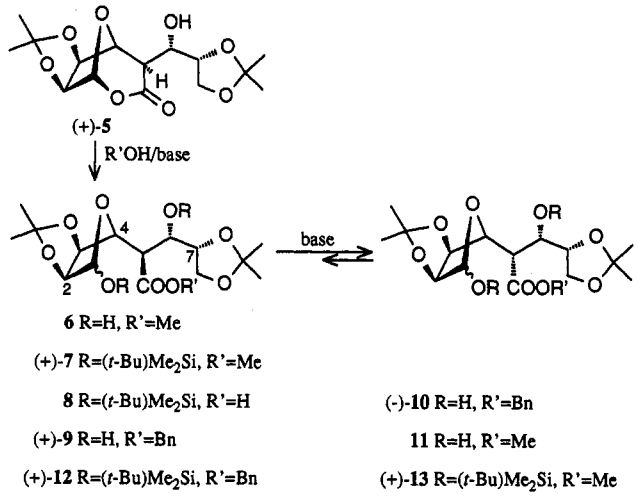
(+)-4

Results and Discussion

A first plan for the introduction of an amino moiety at C(5) of the octitol system (−)-3 was to transform the known uronolactone (+)-5[17] into the corresponding carboxamide followed by Hofmann degradation. When treated with NH_3 in THF, no carboxamide was formed; with NH_3 in MeOH, branched furanose 6 was obtained, the treatment of which with $(t\text{-Bu})Me_2SiOSO_2CF_3$ in the presence of 2,6-lutidine afforded the corresponding furanoside (+)-7 (Scheme 1). Attempts to saponify the methyl ester of (+)-7 with LiOH/THF/H_2O, LiOOH/THF/H_2O, NaSMe/DMF, and Me_3SiCl/NaI failed to give the expected carboxylic acid 8. We thus attempted to exchange the methyl ester with a benzyl ester treating (+)-7 with benzyl alcohol in the presence of $Ti(O\text{-}i\text{-}Pr)_4$ (100 °C), 4-(dimethylamino)pyridine (100 °C), or with BnOLi/THF. This was not met with success. Direct alcoholysis of uronolactone (+)-5 with BnOH in the presence of various bases such as K_2CO_3 and CsF led to mixtures of the expected benzyl ester (+)-9 and its epimer (−)-10, the ratio (+)-9/(−)-10 being close to 1:1 for pure BnOH and 0.2 equiv of K_2CO_3 (20 °C, 24 h) and for (+)-5 with one equiv of BnOH in CCl_4 (20 °C, 30 min) in the presence of 3 equiv of CsF. However, when (+)-5 was treated with 30 equiv of CsF and 60 equiv of BnOH in CCl_4 (BnOH/CCl_4 1:6) at 0 °C for 17 min, a 12:1 mixture of (+)-9 and (−)-10 was obtained and (+)-9 could be isolated in 81% yield. Ester (+)-9 was shown to be the product of kinetic control as it was equilibrated with (−)-10 when standing under the above conditions for longer times. In DMSO and in the presence of K_2CO_3 or CsF, the alcoholysis of (+)-5 with BnOH (6 equiv, 20 °C) was much faster than in CCl_4 and led to mixtures in which the epimerized ester (−)-10 was the major compound. For instance a product ratio 1:11 was obtained for (+)-9/(−)-10 after 10 min at 20 °C on treatment of (+)-5 with 3 equiv of CsF and 6 equiv of BnOH. This ratio was 1:13.5 after 17 h at 20 °C with 3 equiv of K_2CO_3. We thus could define conditions under which the epimerized ester (−)-10 was isolated in 76% yield.

Methanolysis also showed epimerization depending on the reaction conditions. For instance, the treatment of (+)-5 in pure MeOH with 0.1 equiv of K_2CO_3 led to a 6:1 ratio of methyl esters 6 and 11 after 15 min at 20 °C. After 24 h at 20 °C, this ratio was reduced to 2.3:1. The same results were obtained using CsF as a base. When using DMSO as solvent, methanolyses of (+)-5 in the presence of 3 equiv of CsF gave a 1:8.5 mixture of 6/11 after 10 min at 20 °C. These observations demonstrate that the nonepimerized and the epimerized esters have similar stabilities in alcoholic media whereas in DMSO the epimerized derivatives (−)-10 and 11 are more stable than (+)-9 and 6, respectively. These results can be interpreted in terms of a possible chelation in (−)-10 and 11 for the zigzag conformers; this chelation is more important in

Scheme 1.



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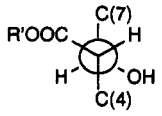
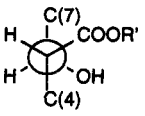
DMSO than in alcoholic media since it does not have to compete with ester–solvent interactions (intermolecular hydrogen bonding).



(+)-9, 6

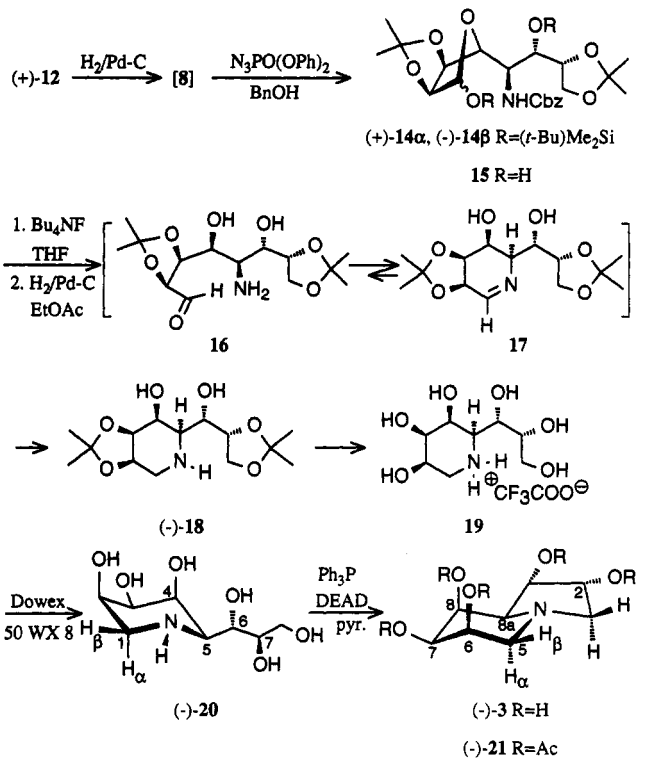


(-)-10, 11

To confirm the relative configurations of benzyl ester (+)-9 and (-)-10, (+)-9 was silylated with (*t*-Bu)Me_2-$SiOSO_2CF_3$/2,6-lutidine giving (+)-12. Debenzylation (H_2/Pd-C) followed by esterification with CH_2N_2 provided the methyl ester (+)-7 which was the major isomer derived from the K_2CO_3-catalyzed methanolysis of (+)-5 followed by silylation. This procedure was shown to lead to only 5–10% epimerization.[17] Likewise, (-)-10 was converted into (+)-13, the furanoside obtained by silylation of 11 resulting from the base-catalyzed epimerization of 6. The structures of (+)-9 and (-)-10 were further confirmed by their mode of transformations given below.

Silylation of the two hydroxyl groups of (+)-9 with (*t*-Bu)$Me_2SiOSO_2CF_3$ gave (+)-12 (ca. 100%) as a 4:1 mixture of the α- and β-anomers that could not be separated by chromatographic techniques. Catalytic hydrogenolysis of (+)-12 (10% Pd/C) provided the corresponding carboxylic acid 8 (100%) which was treated without purification with $N_3PO(OPh)_2$[18] and then with BnOH to provide the benzyl carbamate (+)-14 (72%). In this case the two α- and β-anomers could be separated and characterized. Desilylation with Bu_4NF/THF, followed by catalytic hydrogenolysis (10% Pd/C) in EtOAc furnished (-)-18 (62%) probably via 15 → 16 → 17. The partially protected 1,5-dideoxy-1,5-iminooctitol (-)-18 was treated with 8:1 CF_3COOH/H_2O yielding the trifluoroacetate 19 which on treatment with Dowex 50 WX8 (H^+ form) gave (-)-20 nearly quantitatively. The ^{1}H-NMR spectrum (e.g. $^3J(H_\beta C(1),HC(2)) = {}^3J(H_\alpha C(1),HC(2)) \cong {}^3J((4),(5)) \cong 0$ Hz) of (-)-20 was consistent with the conformer shown in Scheme 2. Applying the method of Bernotas and Cube[19] to the synthesis of azacycles, treatment of the unprotected iminooctitol (-)-20 with the Mitsunobu reagents (Ph_3P/EtOOCN=NCOOEt)[20] in pyridine at 0 °C for 2 h led to smooth cyclization and provided the pentahydroxyindolizidine (-)-3 which was converted to the pentaacetate (-)-21 with Ac_2O/pyridine/DMAP in 85% yield. Pure (-)-3 was obtained by ammonolysis in MeOH (overall yield based on (+)-5: 30.4%). The spectral data of (-)-3 were consistent with the conformer shown in Scheme 2 (see Experimental Section) in which the piperidine ring adopts a chair conformation and the substituents at N(4), C(7), and C(8a) are in equatorial positions. The relatively small coupling constant $^3J(H_\beta C(5),HC(6)) = 3$ Hz and the existence of a W-coupling constant $^4J(HC(6),HC(8)) = 1.5$ Hz both support this assignment. The coupling constants $^3J(HC(1),HC(8a)) = 7.5$ Hz, $^3J(HC(8),HC(8a)) = 1.5$ Hz confirm the *cis* relationship between protons HC(8) and HC(8a). Furthermore, strong NOE's between HC(7) and HC(8a), between $H_\alpha C(5)$ and HC(8a), and between $H_\alpha C(5)$ and HC(7) were also in agreement with our proposal. The ^{1}H NMR data of (-)-21 indicated that this compound also adopts the average conformation shown in Scheme 2.

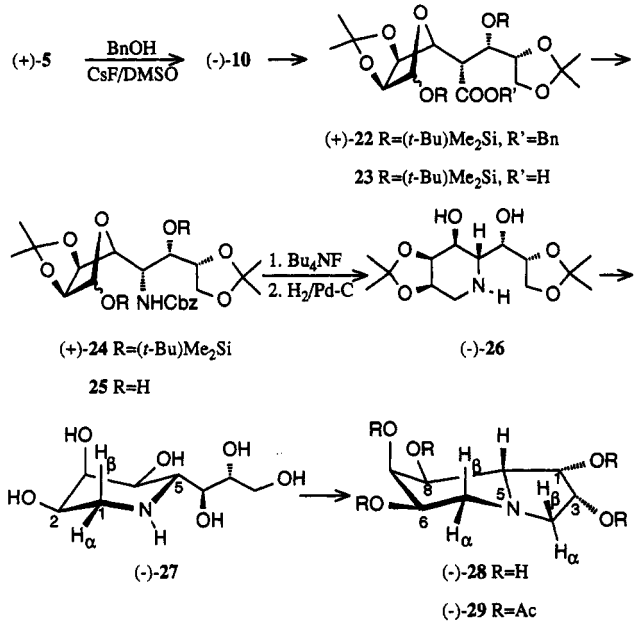
Scheme 2



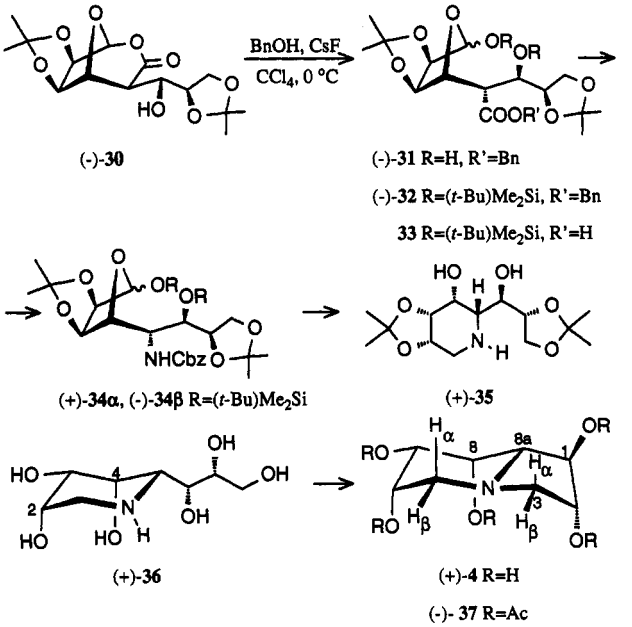
In similar fashion, the epimeric benzyl uronic ester (-)-10 was converted to the iminooctitol (-)-27 and the pentahydroxyindolizidine (-)-28. Silylation of (-)-10 gave a 10:1 mixture of the α- and β-silyl furanosides (+)-22 ($^3J(HC(1),HC(2)) = 0$ Hz for the α-anomer, $^3J(HC(1),HC(2)) = 4$ Hz for the β-anomer) in 99% yield. Catalytic hydrogenolysis of (+)-22 gave 23 which was treated with $N_3PO(OPh)_2/Et_3N$ and then with BnOH to give (+)-24 (92%). Treatment of (+)-24 with Bu_4NF/THF, gave 25, the hydrogenolysis of which with H_2 (1 atm) on 10% Pd/C (EtOAc) furnished (-)-26 (83%). Acidic hydrolysis with 8:1 CF_3COOH/H_2O followed by purification with Dowex 50 WX8 (H^+ form) provided (-)-27 (100%; overall yield based on (+)-5: 57%), the ^{1}H-NMR data (e.g. vicinal coupling constants between axial protons $^3J(H_\beta C(1),HC(2)) = {}^3J(HC(4),HC(5)) = 10.5$ Hz) of which were consistent with the conformation shown in Scheme 3. The cyclization of (-)-27 into the pentahydroxyindolizidine (-)-28 was carried out with a yield of 83% (overall yield based on (+)-5: 47%) by treatment with 2 equiv of Ph_3P, 1 equiv of CCl_4 (which generates Ph_3PCCl_2 + Ph_3PCl_2)[21] in pyridine, followed by addition of Et_3N.[22] The reaction proceeds probably via the selective formation of a 8-chloro-8-deoxyiminooctitol intermediate which undergoes HCl elimination between the chloride and the imino moieties. The ^{1}H-NMR spectrum of (-)-28 was consistent with the conformation shown in Scheme 3 (large coupling constants $^3J(H_\beta C(5),HC(6)) = {}^3J(HC(8),HC(8a)) = 10$ Hz, strong NOE's between pairs of protons $H_\beta C(5)$/HC(8a), HC(2)/HC(8a), and HC(8)/HC(6)). Acetylation of (-)-28 with Ac_2O/pyridine/DMAP provided the pentaacetate (-)-29

(18) Ninomiya, K.; Shioiri, T.; Yamada, S. *Tetrahedron* **1974**, *30*, 2151.
(19) Bernotas, R. C.; Cube, R. V. *Tetrahedron Lett.* **1991**, *32*, 161.
(20) Mitsunobu, O. *Synthesis* **1981**, 1.
(21) Ramirez, F.; Desai, N. B.; McKelvie, N. *J. Am. Chem. Soc.* **1962**, *84*, 1745.
(22) Anisuzzaman, A. K. M.; Whistler, R. L. *Carbohydr. Res.* **1978**, *61*, 511.

Scheme 3



Scheme 4

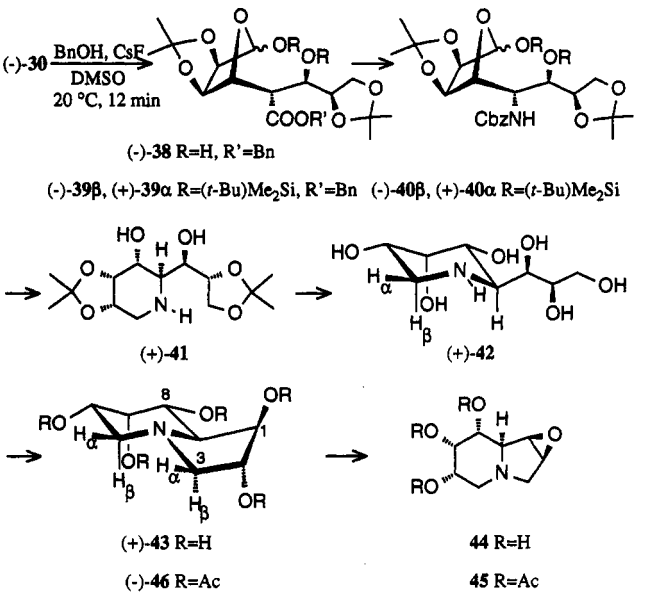


which adopts a conformation similar to that of (−)-**28** (Scheme 3).

Starting with the known uronolactone (−)-**30**,[17] the two iminooctitols (+)-**36** and (+)-**42** and the two pentahydroxyindolizidines (+)-**4** and (+)-**43** were obtained readily. Alcoholysis of (−)-**30** with 60 equiv of BnOH in CCl_4 in the presence of 30 equiv of CsF (0 °C, 20 min) gave (−)-**31** (91%) the silylation of which afforded (−)-**32** (97%). Catalytic hydrogenolysis of (−)-**32** (10% Pd–C) followed by treatment of the carboxylic acid **33** with $N_3PO(OPh)_2$ and BnOH furnished the carbamates **34** (92%) composed of the corresponding α- and β-anomers (+)-**34α** and (−)-**34β** that could be separated by column chromatography and fully characterized. Desilylation (Bu_4NF, 20 °C) followed by hydrogenolysis provided (+)-**35** (78%) which was deprotected with CF_3COOH/H_2O to give iminooctitol (+)-**36** (96%). Its ^{1}H-NMR data were consistent with the chair conformation shown in Scheme 4 (e.g. ^3J(HC(1),HC(2)) = 2.0 Hz, ^3J(H′C(1),HC(2)) = 1 Hz). Treatment of (+)-**36** with 1.2 equiv of Ph_3P and EtOOCN=NCOOEt in pyridine at 0 °C afforded (+)-**4** which was converted into its pentaacetate (−)-**37** in 90% yield. Pure (+)-**4** was obtained by ammonolysis in MeOH (overall yield based on (−)-**30**: 54%), the ^{1}H-NMR spectrum of which (^3J(H_βC(5),HC(6)) = 3.0 Hz, ^3J(HC(8),HC(8a)) = 0.5 Hz, ^4J(HC(6),HC(8)) = 1.0 Hz; strong NOE's between pairs of protons HC(7)/HC(8a) and HC(2)/HC(8a)) suggested the preferred conformation shown in Scheme 4.

When the alcoholysis of (−)-**30** with BnOH (6 equiv) was done in DMSO instead of CCl_4 in the presence of 3 equiv of CsF (20 °C, 12 min), the epimerized benzyl uronate (−)-**38** was obtained in 85% yield. Silylation of (−)-**38** gave (−)-**39β** and (+)-**39α** (93%) which led to **40** (92%) applying the method described above (Scheme 5). The silyl α- and β-furanosides could be separated at this stage. They were converted into (+)-**41** (68%) as above. Deprotection afforded (+)-**42** quantitatively, the ^{1}H-NMR data of which were consistent with the chair conformation shown in Scheme 5 (^3J(H_βC(1),HC(2)) = 11.5 Hz, ^3J(HC(4),HC(5)) = 10 Hz). Reaction of (+)-**42** with Ph_3P/CCl_4 led to a complex mixture containing (+)-**43** and epoxide **44**. The latter compound was characterized as the triacetate **45**.

Scheme 5



However, when (+)-**42** was kept at 0 °C with 1.2 equiv of Ph_3P/EtOOCN=NCOOEt in pyridine, cyclization into (+)-**43** occurred in 1 h. The crude pentahydroxyindolizidine was treated with Ac_2O/pyridine/DMAP and gave (−)-**46** (81%), the treatment of which with NH_3/MeOH (20 °C, 8 h) and elution through Dowex 50 WX8 (H^+ form) provided pure (+)-**43** (overall yield based on (−)-**30**: 40%). The ^{1}H-NMR spectra of (−)-**43** and (−)-**46** (coupling constants, NOE's) were in agreement with the average conformation shown in Scheme 5.

Conclusion

Four 1,5-dideoxy-1,5-iminooctitols ((−)-**20**, (−)-**27**, (+)-**36**, (+)-**42**) and the corresponding 1,2,6,7,8-pentahydroxyindolizidines (−)-**3**, (−)-**28**, (+)-**4**, and (+)-**43** have been derived readily from 2,3-*O*-isopropylidene-D-glyceraldehyde and 5-*exo*,6-*exo*-(isopropylidenedioxy)-7-oxabicyclo[2.2.1]heptan-2-one via the uronolactones (+)-**5** and (−)-**30**[17] in a highly stereoselective manner. In principle, the

same approach can be applied to other pentahydroxyindolizidine stereomers and to derivatives in which the hydroxy groups are replaced by other moieties since all kinds of polysubstituted 7-oxabicyclo[2.2.1]heptan-2-one derivatives can be obtained readily in both enantiomeric forms.[23,24]

Experimental Section

General remarks, see ref 25. *J* values are given in hertz. None of the procedures has been optimized.

(−)-(1*S*,2*R*,6*R*,7*R*,8*S*,8a*R*)-1,2,6,7,8-Pentahydroxyindolizidine ((−)-3). A mixture of (−)-**21** (63 mg, 0.15 mmol) and 2 mL of saturated NH_3/MeOH solution was kept at 20 °C for 24 h. The solvent was evaporated and the residue was deposited on a column of Dowex 50 WX8 (H^+ form, 200–400 mesh, 5 g). The column was washed with MeOH, with H_2O, and finally with 2 NH_3/H_2O to give 30.5 mg (100%) of pure (−)-**3**; colorless solid; mp 128 °C dec; ^{1}H NMR (360 MHz, pyridine-d_5) δ 4.82 (t, ^3J = 7.5, HC(1)), 4.66 (ddd, ^3J = 3.0, 1.5, ^4J = 1.5, HC(8)), 4.57 (ddd, ^3J = 7.5, 6.5, 5.5 HC(2)), 4.24 (dddd, ^3J = 3.0, 3.0, 1.5, ^4J = 1.5, HC(6)), 3.79 (t, ^3J = 3.0, HC(7)), 3.66 (dd, ^2J = 9.0, ^3J = 6.5, H_βC(3)), 3.35 (dd, ^2J = 11.5, ^3J = 3.0, H_βC(5)), 2.62 (dd, ^2J = 9.0, ^3J = 5.5, H_αC(3)), 2.61 (dd, ^3J = 7.5, 1.5, HC(8a)), 2.38 (dd, ^2J = 11.5, ^3J = 1.5, H_αC(5)); ^{13}C NMR (62.9 MHz, D_2O, CH_3CN as internal standard) δ 69.8, 69.3, 69.1, 68.8, 68.0 (5 d, ^1J(C,H) = 145–150, 6 C, C(1), C(2), C(6), C(7), C(8), C(8a)), 60.0, 56.4 (2 t, ^1J(C,H) = 140, C(3), C(5)); $[\alpha]^{25}_D$ = −59.4° (*c* = 9.7 g/dm^3, H_2O).

(+)-(1*R*,2*R*,6*S*,7*S*,8*R*,8a*S*)-1,2,6,7,8-Pentahydroxyindolizidine ((+)-4). A mixture of (−)-**37** (81 mg, 0.19 mmol) and 3 mL of saturated NH_3 solution in MeOH was kept at 20 °C for 24 h. The solvent was evaporated and the residue was deposited on a column of Dowex 50 WX 8 (H^+ form, 200–400 mesh, 10 g). The column was washed with MeOH, with H_2O, and finally with 4 N $NH_3 \cdot H_2O$ to give 39.8 mg (99%) colorless solid: mp 145 °C dec; ^{1}H NMR (360 MHz, pyridine-d_5) δ 5.14 (dd, ^3J = 8.0, 3.0, HC(1)), 4.74 (ddd, ^3J = 7.0, 3.0, 1.0, HC(2)), 4.60 (ddd, ^3J = 2.5, 1.5, ^4J = 1.5, HC(8)), 4.26 (dddd, ^3J = 3.0, 3.0, 1.5, ^4J = 1.5, HC(6)), 3.80 (t, ^3J = 3.0, HC(7)), 3.36 (dd, ^2J = 10.0, ^3J = 1.5, H_βC(3)), 3.35 (dd, ^2J = 10.5, ^3J = 3.0, H_βC(5)), 2.90 (dd, ^2J = 10.0, ^3J = 7.0, H_αC(3)), 2.56 (dd, ^3J = 7.5, 1.5, HC(8a)), 2.33 (dd, ^2J = 10.5, ^3J = 1.5, H_αC(5)); ^{13}C NMR (62.9 MHz, D_2O, CH_3CN as internal standard) δ 77.4, 76.7, 71.3, 69.9, 69.4, 68.4 (6 d, ^1J(C,H) = 140–150, C(1), C(2), C(6), C(7), C(8), C(8a)), 59.8, 56.3 (2 t, ^1J(C,H) = 140, C(3), C(5)); $[\alpha]^{25}_D$ = +28.2° (*c* = 11.0 g/dm^3, H_2O). Anal. Calcd for $C_8H_{15}NO_5$ (205.21): C, 46.82; H, 7.37; N, 6.83. Found: C, 46.77; H, 7.26; N, 6.88.

(+)-*tert*-Butyldimethylsilyl 6-*O*-(*tert*-Butyldimethylsilyl)-5-*C*-(methoxycarbonyl)-5-deoxy-2,3:7,8-di-*O*-isopropylidene-α-D-*erythro*-D-*talo*-octofuranoside ((+)-7). A mixture of (+)-**12** (36 mg, 0.054 mmol) and 10% Pd on charcoal (18 mg) in EtOAc (2 mL) was stirred under H_2 atmosphere for 2 h at 20 °C. After filtration (Celite), the solvent was evaporated and the residue taken up with $CHCl_3$ (1 mL). An excess of CH_2N_2 in Et_2O was added. After 10 min at 20 °C, the solvent was evaporated to give 32 mg (97%) of pure (+)-7: ^{1}H NMR (250 MHz, $CDCl_3$) δ 5.34 (s, (HC(1)), 4.80 (dd, ^3J = 6.0, 1.5, HC(3)), 4.64 (dd, ^3J = 11.5, 1.5, HC(4)), 4.50 (d, ^3J = 6.0, HC(2)), 4.80 (ddd, ^3J = 5.0, 6.5, 6.5, HC(7)), 4.03 (t, ^3J = 5.0, HC(6)), 4.0 (dd, ^2J = 8.0, ^3J = 6.5, H'C(8)), 3.76 (dd, ^2J = 8.0, ^3J = 6.5, HC(8)), 3.68 (s, OMe), 3.10 (dd, ^3J = 11.5, 5.0, HC(5)), 1.45, 1.42, 1.32, 1.30 (4 s, 2 C(CH_3)$_2$), 0.90, 0.88 (2 s, SiC(CH_3)$_3$), 0.15, 0.12, 0.10, 0.08 (4 s, 2 Si(CH_3)$_2$); $[\alpha]^{25}_D$ = 35° (*c* = 7.9 g/dm^3, $CHCl_3$).

***tert*-Butyldimethylsilyl 6-*O*-(*tert*-Butyldimethylsilyl)-5-*C*-carboxy-5-deoxy-2,3:7,8-di-*O*-isopropylidene-α-D-*erythro*-D-*talo*-octofuranoside (8).** A solution of (+)-**12** (1.44 g, 2.2 mmol) and 10% Pd–C (140 mg) in EtOAc (15 mL) was stirred under H_2 atmosphere at 20 °C for 5 h. After filtration (Celite) the solvent was evaporated, giving a colorless oil, mostly α-anomer: ^{1}H NMR (250 MHz, $CDCl_3$) δ 5.43 (s, HC(1)), 4.95 (dd, ^3J = 6.0, 1.5, HC(3)), 4.65 (dd, ^3J = 11.0, 1.5, HC(4)), 4.53 (d, ^3J = 6.0, HC(2)), 4.28 (dd, ^3J = 6.5, 3.5, HC(6)), 4.22 (dt, ^3J = 6.0, 6.5, HC(7)), 4.07 (dd, ^2J = 8.0, ^3J = 6.0, HC(8)), 3.80 (dd, ^2J = 8.0, ^3J = 6.0, H'C(8)), 3.05 (dd, ^3J = 11.0, 3.5, HC(5)), 1.47, 1.42, 1.35, 1.32 (4 s, 2 C(CH_3)$_2$), 0.90, 0.89 (2 s, 2 SiC(CH_3)$_3$), 0.12 (s, 2 Si(CH_3)$_2$).

(+)-5-*C*-(Benzyloxycarbonyl)-5-deoxy-2,3:7,8-di-*O*-isopropylidene-α-D-*erythro*-D-*talo*-octofuranose ((+)-9). A mixture of $PhCH_2OH$ (12.5 mL, 0.12 mol, 60 equiv), CsF (9.2 g, 60.3 mmol, 30 equiv), and 77 mL CCl_4 (anhydrous) was stirred at 20 °C for 40 min. It was then cooled to 0 °C and (+)-**5** (665 mg, 2.01 mmol)[17] was added. After stirring at 0 °C for 17 min (TLC: light petroleum/Et_2O/CH_2Cl_2 2:3:2), ice–H_2O (60 mL) was added and the organic phase was separated. The aqueous phase was extracted with EtOAc (20 mL, five times), the combined organic extracts were dried ($MgSO_4$), and the solvent was evaporated. $PhCH_2OH$ was distilled off under vacuum. The residue was separated by flash chromatography (FC) (silica gel 80 g, petroleum ether/Et_2O/CH_2Cl_2 2:3:2) to give 717 mg (81%) of (+)-**9**, colorless oil, and 60 mg (6.8%) of (−)-**10**. (+)-**9** was composed mostly of the α-anomer (α/β 4.6:1): ^{1}H NMR (250 MHz, $CDCl_3$) of the α-*furanose* δ 7.38 (m, HC arom), 5.37 (d, ^3J = 8.0, HC(1)), 5.27, 5.13 (2 d, ^2J = 12, CH_2Ph), 4.86 (dd, ^3J = 6.0, 1.0, HC(3)), 4.64 (d, ^3J = 6.0, HC(2)), 4.65 (dd, ^3J = 6.0, 1.0, HC(4)), 4.21 (d, ^3J = 8.0, HOC(1)), 4.04 (m, 4 H, HC(7), HC(8), H'C(8), HC(6)), 3.23 (d, ^3J = 6.0, HOC(6)), 3.07 (dd, ^3J = 6.0, 5.9, HC(5)), 1.49, 1.38, 1.31, 1.30 (4 s, 2 C(CH_3)$_2$); $[\alpha]^{25}_D$ = +16° (*c* = 7.4 g/dm^3, $CHCl_3$).

(−)-5-*C*-(Benzyloxycarbonyl)-5-deoxy-2,3:7,8-di-*O*-isopropylidene-α-D-*erythro*-L-*allo*-octofuranose ((−)-10). A mixture of $PhCH_2OH$ (0.99 mL, 9.6 mmol, 6 equiv) and CsF (730 mg, 4.8 mmol, 3 equiv) in 5 mL anhydrous DMSO was stirred at 20 °C for 40 min. (+)-**5** (526 mg, 1.59 mmol) was added and the solution stirred at 20 °C for another 25 min. Ice–H_2O was added, the solution extracted with EtOAc (20 mL, 5 times) and dried ($MgSO_4$), and the solvent evaporated. The ^{1}H NMR spectrum of the crude showed a 1:10.9 mixture of (+)-**7**/(−)-**10**. It was separated by FC (petroleum ether/Et_2O/CH_2Cl_2 = 2:3:2) to yield 43 mg (13%) of starting material (+)-**5**, 42 mg (6%) of(+)-**7**, and 484 mg (69.3%, 76% based on the reacted starting material) of (−)-**10** composed mostly of the α-furanose (α/β 12:1 by ^{1}H NMR): mp 100–101 °C, colorless solid; ^{1}H NMR (250 MHz, $CDCl_3$) δ 7.37 (m, HC arom), 5.47 (d, ^3J = 3.5, HC(1)), 5.28, 5.30 (2 d, ^2J = 12.5, CH_2Ph), 4.73 (dd, ^3J = 6, 1, HC(3)), 4.62 (d, ^3J = 6, HC(2)), 4.63 (dd, ^3J = 11, 1, HC(4)), 4.10–3.90 (m, 4 H, HC(6), HC(7), H_2C(8)), 3.19 (dd, ^3J = 11, 2, HC(5)), 3.14 (d, ^3J = 3.5, HOC(1)), 3.04 (br s, HOC(6)), 1.49, 1.37, 1.30, 1.28 (4 s, 2 C(CH_3)$_2$); $[\alpha]^{25}_D$ = −12.3° (*c* = 9.1 g/dm^3, $CHCl_3$).

(+)-*tert*-Butyldimethylsilyl 5-*C*-(Benzyloxycarbonyl)-6-*O*-(*tert*-butyldimethylsilyl)-5-deoxy-2,3:7,8-di-*O*-isopropylidene-α-D-*erythro*-D-*talo*-octofuranoside ((+)-12). A mixture of (+)-**9** (920 mg, 2.10 mmol), 2,6-lutidine (1.46 mL, 12.6 mmol, 3 equiv), and CH_2Cl_2 (anhydrous, 15 mL) was cooled to 0 °C and (*tert*-butyl)dimethylsilyltrifluoromethanesulfonate (1.45 mL, 6.3 mmol, 1.5 equiv) was added. After stirring at 20 °C for 5 h, the mixture was poured into brine (30 mL) and extracted with CH_2Cl_2 (20 mL, four times). The organic extracts were dried ($MgSO_4$) and evaporated. The residue was purified by FC (silica gel 80 g, petroleum ether/EtOAc 6:1) to give 1.39 g (100%): colorless oil, which contains mostly the α-isomer (α/β 4:1); ^{1}H NMR (250 MHz, $CDCl_3$) of the α-isomer of (+)-**12** δ 7.35 (m, HC arom), 5.34 (s, HC(1)), 5.20, 5.10 (2 d, ^2J = 12.5, CH_2Ph), 4.81 (dd, ^3J = 6.0, 1.8, HC(3)), 4.64 (dd, ^3J = 11.0, 1.8, HC(4)), 4.49 (d, ^3J = 6.0, HC(2)), 4.75 (m, 1 H, HC(7)), 4.05 (t, ^3J = 4.5, HC(6)), 3.94 (dd, ^2J = 8.0, ^3J = 6.5, HC(8)), 3.73 (dd, ^2J = 8.0, ^3J = 6.5, H'C(8)), 3.10 (dd, ^3J = 11.0, 4.5, HC(5)); 1.48, 1.40, 1.31, 1.30 (4 s, 2 C(CH_3)$_2$), 0.86, 0.85 (2 s, 2 SiC(CH_3)$_3$), 0.1, 0.9, 0.8, 0.6 (4 s, 2 Si(CH_3)$_2$); $[\alpha]^{25}_D$ = +23° (*c* = 0.78 g/dm^3, $CHCl_3$).

(23) Vogel, P.; Fattori, D.; Gasparini, F.; Le Drian, C. *Synlett* **1990**, 173; Vogel, P. *Bull. Soc. Chim. Belg.* **1990**, *99*, 395; Allemann, S.; Vogel, P. *Synthesis* **1991**, 923; Allemann, S.; Vogel, P. *Synlett* **1993**, 801.

(24) Preliminary studies have shown that (−)-**28**, which possesses the same configurations at C-2, C-3, C-8, and C-8a as swainsonine (−)-**1**, is, like the natural alkaloid, a potent inhibitor of α-mannosidases from jack beans and almonds, but unlike (−)-**1**, it does not inhibit acidic β-galactosidases: Picasso, S.; Chen, Y.; Vogel, P. Manuscript in preparation.

(25) Gasparini, F.; Vogel, P. *J. Org. Chem.* **1990**, *55*, 2451. Wagner, J.; Vieira, E.; Vogel, P. *Helv. Chim. Acta* **1988**, *71*, 624.

(+)-*tert*-Butyldimethylsilyl 6-*O*-*tert*-(Butyldimethylsilyl)-5-deoxy-5-*C*-(methoxycarbonyl)-2,3:7,8-di-*O*-isopropylidene-α-D-*erythro*-L-*allo*-octofuranoside ((+)-13). A mixture of (+)-**22** (12 mg, 0.018 mmol) and 6 mg of Pd–C (10% Pd) in EtOAc (2 mL) was stirred under H_2 atmosphere for 2 h. The mixture was filtered through Celite, and the solvent was evaporated. The residue was dissolved in $CHCl_3$ (1 mL) and an excess of CH_2N_2 (in ether) was added and kept at 20 °C for 10 min. The solvent was evaporated yielding 10.1 mg (95%) of the pure (+)-**13**: colorless oil; ^{1}H NMR (250 MHz, $CDCl_3$) δ 5.40 (s, HC(1)), 4.52 (d, ^3J = 11.0, HC(4)), 4.51, 4.48 (2 d, ^3J = 6.0, HC(2), HC(3)), 4.42 (dd, ^3J = 3.5, 1.8, HC(6)), 4.14 (dt, ^3J = 8.0, 8.0, 3.5, HC(7)), 3.95 (t, ^2J = 8.0, ^3J = 8.0, HC(8)), 3.74 (t, ^2J = ^3J = 8.0, HC(8)), 3.72 (s, OCH_3), 2.80 (dd, ^3J = 11.0, 1.8, HC(5)), 1.50, 1.42, 1.32, 1.30 (4 s, 2 $C(CH_3)_2$), 0.90, 0.92 (2 s, 2 $SiC(CH_3)_3$), 0.08, 0.09, 0.10, 0.12 (4 s, 2 $Si(CH_3)_2$); $[\alpha]^{25}_D$ = +21.3° (*c* = 6.0 g/dm^3, $CHCl_3$).

(+)-*tert*-Butyldimethylsilyl 5-[*N*-(Benzyloxycarbonyl)-amino]-6-*O*-(*tert*-butyldimethylsilyl)-5-deoxy-2,3:7,8-di-*O*-isopropylidene-α-D-*erythro*-D-*talo*-octofuranoside ((+)-14α) and (−)-*tert*-Butyldimethylsilyl 5-[*N*-(Benzyloxycarbonyl)-amino]-6-*O*-(*tert*-butyldimethylsilyl)-5-deoxy-2,3:7,8-di-*O*-isopropylidene-β-D-*erythro*-D-*talo*-octofuranoside ((−)-14β). The free acid **8** (2.2 mmol) was dissolved in toluene (20 mL). Et_3N (1.5 mL, 10.8 mmol, 5 equiv) and $N_3PO(OPh)_2$ (0.56 mL, 2.59 mmol, 1.2 equiv) were added and the mixture was stirred at 20 °C under Ar atmosphere for 2 h. $PhCH_2OH$ (2.2 mL, 21.6 mmol, 10 equiv) was added and the mixture heated to 100 °C overnight. After the reaction was ended (control by TLC, petroleum ether/EtOAc 6:1), the solvent was evaporated and the residue was purified by FC (silica gel 160 g, petroleum ether/EtOAc 6:1) to give 894 mg of the α-isomer (+)-14α and 163 mg of the β-isomer (−)-14β. Total yield: 72%.

Data of (+)-14α: mp 104–106 °C; ^{1}H NMR (250 MHz, $CDCl_3$) δ 7.30 (m, HC arom), 6.32 (br d, ^3J = 10.0, NH), 5.39 (s, 1 H, HC(1)), 5.05, 5.15 (2 d, ^2J = 12, CH_2Ph), 4.68 (dd, ^3J = 2.0, 1.5, HC(4)), 4.52 (dd, ^3J = 6.0, 1.5, HC(3)), 4.38 (d, ^3J = 6.0, HC(2)), 4.15 (ddd, ^3J = 9.0, 6.0, 2.5, HC(7)), 4.0 (dd, ^2J = 7.0, ^3J = 6.0, HC(8)), 3.92 (dd, ^3J = 10.0, 2.5, HC(6)), 3.88 (dd, ^2J = 7.0, ^3J = 9.0, H′C(8)), 3.54 (td, ^3J = 10.0, 2.0, HC(5)), 1.45, 1.43, 1.39, 1.35 (4 s, 2 $C(CH_3)_2$), 0.92, 0.90 (2 s, 2 $SiC(CH_3)_3$), 0.15, 0.13, 0.12 (3 s, 12 H, 2 $Si(CH_3)_2$); $[\alpha]^{25}_D$ = +30° (*c* = 7.1 g/dm^3, $CHCl_3$).

Data of (−)-14β: mp 84–86 °C; ^{1}H NMR (250 MHz, $CDCl_3$) δ 7.35 (m, HC arom), 5.25 (d, ^3J = 4.0, HC(1)), 5.14, 5.08 (2 d, ^2J = 12.0, CH_2Ph), 4.95 (d, ^3J = 9.0, NH), 4.49 (dd, ^3J = 7.0, 3.0, HC(3)), 4.47 (dd, ^3J = 7.0, 4.0, HC(2)), 4.45 (dd, ^3J = 3.0, 3.0, HC(4)), 4.41 (dd, ^2J = 7.0, ^3J = 4.0, HC(8)), 3.86–4.02 (m, 3 H, HC(5), HC(6), HC(7)), 3.83 (t, ^2J = ^3J = 7.0, H′C(8)), 1.53, 1.43, 1.32, 1.29 (4 s, 2 $C(CH_3)_2$), 0.92, 0.91, 0.89 (3 s, 18 H, 2 $Si(CH_3)_3$), 0.12, 0.10 (2 s, 2 $Si(CH_3)_2$); $[\alpha]^{25}_D$ = −4.0° (*c* = 7.8 g/dm^3, $CHCl_3$).

(−)-1,5-Dideoxy-1,5-imino-2,3:7,8-di-*O*-isopropylidene-D-*erythro*-D-*talo*-octitol ((−)-18). A solution of (+)-14α and (−)-14β (702 mg, 1.03 mmol) in THF (8 mL) was cooled to 0 °C. After Bu_4NF (1 M solution in THF, 4.1 mL, 2 equiv) was added at 0 °C and stirred at 20 °C for 7 h, the solvent was evaporated and the residue was filtered through a short column (silica gel 20 g, petroleum ether/EtOAc 1:2) to give the octofuranose **15** as a colorless oil which was taken in EtOAc (8 mL). After the addition of 10% Pd–C (450 mg), the mixture was stirred at 20 °C under H_2 atmosphere for 19 h. The mixture was filtered through Celite (rinsing with EtOAc); the solvent was evaporated and the residue purified by FC (silica gel, 40 g, first EtOAc, then CH_2Cl_2/MeOH 8:1) to give (−)-18 as a colorless solid, which was recrystallized from EtOAc/petroleum ether to give 193 mg (62%) of pure product: colorless crystals; mp 186–187 °C; ^{1}H NMR (250 MHz, $CDCl_3$) δ 4.23–3.96 (m, 6 H, HC(2), HC(3), HC(6), HC(7), H_2C(8)), 3.78 (dd, ^3J = 7.0, 5.0, HC(4)), 3.48 (d, ^2J = 15.0, HC(1)), 3.20 (br s, OH), 3.04 (dd, ^2J = 15.0, ^3J = 3.5, HC(1)), 2.95 (br s, OH), 2.53 (dd, ^3J = 5.0, 1.0, HC(5)), 1.58, 1.42, 1.36 (3 s, 12 H, 2 $C(CH_3)_2$); $[\alpha]^{25}_D$ = −42.4° (*c* = 12.1 g/dm^3, $CHCl_3$).

Trifluoroacetic Acid Salt of 1,5-Dideoxy-1,5-imino-D-*erythro*-D-*talo*-octitol (19). (−)-18 (188 mg, 0.62 mmol) was dissolved in 5 mL of CF_3COOH/H_2O (8:1) and kept at 20 °C for 2 days. The solvent was evaporated to give 209 mg (100%) of pure **19**, as a colorless foam: ^{1}H NMR (250 MHz, D_2O, CH_3CN as internal standard) δ 4.48 (dd, ^3J = 1.5, 1.4, HC(4)), 4.26 (dd, ^3J = 2.5, 1.0, HC(2)), 3.83 (dd, ^3J = 8.5, 7.0, HC(6)), 3.86–3.70 (m, 4 H, HC(7), H_2C(8), HC(3)), 3.56 (dd, ^2J = 14.0, ^3J = 2.5, HC(1)), 3.50 (dd, ^3J = 7.0, 1.4, HC(5)), 3.35 (dd, ^2J = 14.0, ^3J = 1.0, H′C(1)).

(−)-1,5-Dideoxy-1,5-imino-D-*erythro*-D-*talo*-octitol ((−)-20). **19** (208 mg, 0.62 mmol) was deposited on Dowex 50 WX8 (H^+ form, 10 g, 200–400 mesh) and washed first with H_2O, with MeOH, and finally with 5 N $NH_3 \cdot H_2O$ to provide the solution of (−)-**20**. The solvent was evaporated and lyophilized to give a slightly yellow foam, which was decolorized by active charcoal (H_2O) to give 136 mg (99%) of pure (−)-**20**: colorless foam; mp 150 °C dec; ^{1}H NMR (360 MHz, D_2O, CH_3CN as internal standard) δ 4.23 (s, HC(4)), 3.99 (s, HC(2)), 3.80 (m, 3 H, HC(3), HC(6), HC(7)), 3.70 (m, 2 H, H_2C(8)), 3.20 (d, ^2J = 14.0, HC(1)), 2.88 (d, ^2J = 14.0, H′C(1)); 2.86 (d, ^3J = 7.0, HC(5)); ^{13}C NMR (62.9 MHz, D_2O, CH_3CN as internal standard) δ 73.5, 70.5, 69.4, 69.3, 69.1 (5 d, ^1J(C,H) = 145–150, C(2), C(3), C(4), C(6), C(7)), 62.8 (t, ^1J(C,H) = 145, C(8)), 59.2 (d, ^1J(C,H) = 140, C(5)), 49.6 (t, ^1J(C,H) = 140, C(1)); $[\alpha]^{25}_D$ = −12.8 (*c* = 4.9 g/dm^3, H_2O).

(−)-(1*S*,2*R*,6*R*,7*R*,8*S*,8a*R*)-1,2,6,7,8-Pentaacetoxyindolizidine ((−)-21). Diethyl azodicarboxylate (DEAD, 50 μL, 0.32 mmol, 1.2 equiv) was added dropwise to a stirred mixture of (−)-**20** (60 mg, 0.27 mmol), Ph_3P (83 mg, 0.32 mmol, 1.2 equiv), and pyridine (anhydrous, 1.5 mL) at 0 °C under Ar atmosphere. The mixture was stirred at 0 °C for 3 h (controlled by ^{1}H NMR) and quenched with ice–H_2O (5 mL). The aqueous layer was extracted with CH_2Cl_2 (5 mL, 4 times). The aqueous phase was evaporated and coevaporated with pyridine and toluene to obtain crude (−)-**3**, a slightly yellow foam. It was dissolved in pyridine (anhydrous, 2 mL) and Ac_2O (1 mL). A catalytic amount of DMAP was added and the mixture was kept at 20 °C for 20 h. Most of the solvent was evaporated and ice–H_2O (4 mL) was added. The mixture was extracted with CH_2Cl_2 (4 mL, twice). The aqueous phase was alkalized with K_2CO_3 to pH = 12 and extracted again with CH_2Cl_2 (3 mL, four times). Combined organic phases were dried ($MgSO_4$) and evaporated. The residue was purified by FC (silica gel 10 g, petroleum ether/EtOAc 1:1 first and then EtOAc) to obtain 95 mg (85%) of pure (−)-**21**: colorless foam; mp 181 °C dec; ^{1}H NMR (360 MHz, $CDCl_3$) δ 5.42 (ddd, ^3J = 4.0, 2.0, ^4J = 1.0, HC(8)), 5.3 (m, 2 H, HC(2), HC(6)), 5.10 (dd, ^3J = 9.0, 7.0, HC(1)), 4.96 (t, ^3J = 4.0, HC(7)), 3.69 (dd, ^2J = 10.0, ^3J = 7.0, H_βC(3)), 3.25 (dd, ^2J = 13.0, ^3J = 2.5, H_βC(5)), 2.67 (dd, ^3J = 9.0, 2.0, HC(8a)), 2.56 (dd, ^2J = 13.0, ^3J = 2.0, H_αC(5)), 2.34 (dd, ^2J = 10.0, ^3J = 5.0, H_αC(3)), 2.18, 2.16, 2.06, 2.03, 2.01 (5 s, 5 AcO); ^{13}C NMR (62.9 MHz, $CDCl_3$) δ 170.6, 170.4, 169.9, 169.6 (4 s, 5 CO), 69.1, 69.0, 68.5, 66.5, 65.1, 64.8, (6 d, ^1J(C,H) = 135–160, C(1), C(2), C(6), C(7), C(8), C(8a)), 58.4, 54.1 (2 t, ^1J(C,H) = 140, C(5), C(3)), 21.2, 20.8, 20.6, 20.4 (4 q, ^1J(C,H) = 130, 5 C, 5 OAc); $[\alpha]^{25}_D$ = −25.5° (*c* = 6.4 g/dm^3, $CHCl_3$).

(+)-*tert*-Butyldimethylsilyl 5-*C*-(Benzyloxycarbonyl)-6-*O*-(*tert*-butyldimethylsilyl)-5-deoxy-2,3:7,8-di-*O*-isopropylidene-α-D-*erythro*-D-*allo*-octofuranoside ((+)-22). A mixture of (−)-**10** (445 mg, 1.03 mmol), 2,6-lutidine (0.707 mL, 6.09 mmol, 3 equiv), and 10 mL of anhydrous CH_2Cl_2 was cooled to 0 °C, and then *tert*-butyldimethylsilyl trifluoromethanesulfonate (0.7 mL, 3.0 mmol, 1.5 equiv) was added. After stirring at 0 °C for 1.5 h, the solution was then poured into brine (20 mL) and extracted with CH_2Cl_2 (20 mL, four times). The combined organic extracts were dried ($MgSO_4$) and evaporated, and the residue was purified by FC (silica gel 40 g, petroleum ether/EtOAc 6:1) to obtain 672 mg (99.3%), colorless oil, of a 10:1 mixture of α-furanoside/β-furanoside: ^{1}H NMR (250 MHz, $CDCl_3$) δ 7.38 (m, HC arom), 5.40 (s, HC(1)), 5.22, 5.12 (2 d, ^2J = 12.0, CH_2Ph), 4.57 (dd, ^3J = 10.5, 1.5, HC(4)), 4.50 (dd, ^3J = 6.0, 1.5, HC(3)), 4.47 (d, ^3J = 6.0, HC((2), 4.40 (dd, ^3J = 4.0, 1.8, HC(6)), 4.12 (ddd, ^3J = 8.0, 6.5, 4.0, HC(7)), 3.9 (dd, ^2J = 8.0, ^3J = 6.5, HC(8)), 3.62 (t, ^2J = ^3J = 8.0, H′C(8)), 2.84 (dd, ^3J = 10.5, 1.8, HC(5)), 1.49, 1.39, 1.30, 1.26 (4 s, 2 $C(CH_3)_2$), 0.89, 0.85 (2 s, 2 $SiC(CH_3)_2$), 0.15, 0.14, 0.13, 0.08 (4 s, 2 $Si(CH_3)_2$), $[\alpha]^{25}_D$ = +27.2° (*c* = 10.7 g/dm^3, $CHCl_3$).

***tert*-Butyldimethylsilyl 6-*O*-(*tert*-Butyldimethylsilyl)-5-*C*-carboxy-5-deoxy-2,3:7,8-*O*-isopropylidene-α-D-*erythro*-L-*allo*-octofuranoside (23).** A solution of (+)-**22** (663 mg, 1.0 mmol) and 10% Pd–C (66 mg) in EtOAc (8 mL) was stirred under H_2 atmosphere at 20 °C for 5 h. The solution was filtered through Celite (rinsing with EtOAc). The acid **23** was obtained after solvent evaporation: ^{1}H NMR (250 MHz, $CDCl_3$) δ 5.48 (s,

HC(1)), 4.83 (d, ^3J = 5.5, HC(2)), 4.52 (d, ^3J = 5.5, HC(3)), 4.44 (dd, ^3J = 3.5, 1.5, HC(6)), 4.37 (d, ^3J = 11.5, HC(4)), 4.17 (ddd, ^3J = 7.0, 6.5, 3.0, HC(7)), 4.0 (dd, ^2J = 7.5, ^3J = 6.0, HC(8)), 3.70 (t, ^3J = ^2J = 7.5, H'C(8)), 2.70 (dd, ^3J = 11.5, 1.5, HC(5)), 1.47, 1.42, 1.31, 1.30 (4 s, 2 C(CH_3)$_2$), 0.92, 0.90 (2 s, 2 SiC(CH_3)$_3$), 0.20, 0.17, 0.15, 0.13 (4 s, 2 Si(CH_3)$_2$).

(+)-*tert*-Butyldimethylsilyl 5-[*N*-(Benzyloxycarbonyl)-amino]-6-*O*-(*tert*-butyldimethylsilyl)-5-deoxy-2,3:7,8-di-*O*-isopropylidene-α-D-*erythro*-L-*allo*-octofuranoside ((+)-24α) and *tert*-Butyldimethylsilyl 5-[*N*-(Benzyloxycarbonyl)-amino]-6-*O*-(*tert*-butyldimethylsilyl)-5-deoxy-2,3:7,8-di-*O*-isopropylidene-α-D-*erythro*-L-*allo*-octofuranoside (24β). The acid **23** (1.0 mmol) obtained above was dissolved in toluene (10 mL), and then Et_3N (0.7 mL, 5 mmol, 5 equiv) and $N_3PO(OPh)_2$ (0.26 mL, 1.2 mmol, 1.2 equiv) were added and the mixture was stirred at 20 °C under Ar atmosphere for 2 h. $PhCH_2OH$ (1 mL, 10 mmol, 10 equiv) was added and the solution heated to 100 °C overnight. After the reaction was finished (TLC, petroleum ether/EtOAc 6:1), the solvent was evaporated and the residue was purified by FC (silica gel 60 g, petroleum ether/EtOAc 6:1). The first fraction gave 570 mg of α-furanoside (+)-**24α**; the second fraction gave 56 mg of the β-furanoside **24β**. Total yield was 92%.

Data of (+)-**24α**: ^{1}H NMR (250 MHz, $CDCl_3$) δ 7.35 (m, HC arom), 5.42 (s, HC(1)), 5.18, 5.10 (2 d, ^2J = 12, CH_2Ph), 5.0 (d, ^3J = 9.5, NH), 4.82 (d, ^3J = 6.0, HC(2)), 4.58 (d, ^3J = 6.0, HC(3)), 4.48 (d, ^3J = 2.2, HC(6)), 3.96 (ddd, ^3J = 8.5, 6.5, 2.2, HC(7)), 3.88 (s, HC(4)), 3.82 (dd, ^3J = 9.5, 0.6, HC(5)), 3.72 (m, 2 H, $H_2C(8)$), 1.48, 1.40, 1.32, 1.25 (4 s, 2C(CH_3)$_2$), 0.92, 0.90 (2 s, 2 SiC(CH_3)$_3$), 0.12, 0.15 (2 s, 2 Si(CH_3)$_2$); $[\alpha]^{25}_D$ = +46.2° (*c* = 10.0 g/dm^3, $CHCl_3$).

Data of **24β**: ^{1}H NMR (250 MHz, $CDCl_3$) δ 7.36 (m, HC arom), 5.27 (d, ^3J = 4.0, HC(1)), 5.20 (d, ^3J = 10, NH), 5.12, 5.10 (2 d, ^2J = 12, CH_2Ph), 4.72 (dd, ^3J = 7.0, 2.5, HC(3)), 4.58 (dd, ^3J = 7.0, 4.0, HC(2)), 4.08–3.75 (m, 6 H, HC(4), HC(5), HC(6), HC(7), $H_2C(8)$), 1.53, 1.39, 1.33, 1.29 (4 s, 2 C(CH_3)$_2$), 0.92, 0.90 (2 s, 2 SiC(CH_3)$_3$), 0.18, 0.15, 0.13, 0.12 (4 s, 2 Si(CH_3)$_2$).

5-[*N*-(Benzyloxycarbonyl)amino]-5-deoxy-2,3:7,8-di-*O*-isopropylidene-α,β-D-*erythro*-L-*allo*-octofuranose (25). A solution of (+)-**24α** and **24β** (374 mg, 0.55 mmol) in THF (5 mL) was cooled to 0 °C. Bu_4NF (1 M solution in THF, 2.2 mL, 2 equiv) was added and the solution stirred at 0 °C for 2 h and at 20 °C for another 2 h. The solvent was evaporated and the residue was purified by FC (silica gel 20 g, petroleum ether/EtOAc 1:2) to give **25** (colorless oil, 99%), which contained two isomers, of which the α-isomer predominated: ^{1}H NMR (250 MHz, $CDCl_3$) δ 7.35 (m, HC arom), 5.48 (s, HC(1)), 5.40 (d, ^3J = 10, NH), 5.15, 5.10 (2 d, ^2J = 12, CH_2Ph), 4.80, 4.68 (2 d, ^3J = 6.0, HC(3), HC(2)), 4.18 (d, ^3J = 10.5, HC(4)), 4.15–3.70 (m, 5 H, other H), 1.45, 1.38, 1.32, 1.30 (4 s, 2 C(CH_3)$_2$).

(−)-1,5-Dideoxy-1,5-imino-2,3:7,8-di-*O*-isopropylidene-D-*erythro*-L-*allo*-octitol ((−)-26). A mixture of **25** (246 mg) and 10% Pd–C (250 mg) in EtOAc (5 mL) was stirred at 20 °C under H_2 atmosphere for 24 h. The mixture was filtered through Celite and the Celite pad washed with MeOH. The solvent was evaporated and the residue was purified by FC (silica gel 20 g, CH_2Cl_2/MeOH 8:1) to give 138 mg (83%): colorless oil; ^{1}H NMR (360 MHz, MeOD) δ 4.52 (dd, ^3J = 6.0, 3.5, HC(3)), 4.29–4.10 (m, 3 H, HC(2), HC(7), HC(8)), 3.96 (dd, ^2J = 8.5, ^3J = 5.5, HC(8)), 3.83 (dd, ^3J = 10.0, 3.5, HC(4)), 3.82 (dd, ^3J = 8.5, 1.5, HC(6)), 2.95 (dd, ^3J = 10.0, 1.5, HC(5)), 2.93 (dd, ^2J = 13.5, ^3J = 5.5, H_αC(1)), 2.59 (dd, ^2J = 13.5, ^3J = 7.5, H_βC(1)), 1.56, 1.43, 1.40, 1.37 (4 s, 2 C(CH_3)$_2$); $[\alpha]^{25}_D$ = −27.7° (*c* = 3.7 g/dm^3, $CHCl_3$).

(−)-Trifluoroacetic Acid Salt of 1,5-Dideoxy-1,5-imino-D-*erythro*-L-*allo*-octitol ((−)-27-CF_3COOH). An amount of 100 mg (−)-**26** was stirred with 2 mL of CF_3COOH/H_2O (8:1) at 20 °C for 5 h. The solvent was evaporated to give 110 mg (100%): colorless foam; ^{1}H NMR (250 MHz, D_2O, CH_3CN as internal standard) δ 4.25 (t, ^3J = 2.5, HC(3)), 4.15 (d, ^3J = 6.0, HC(6)), 4.03 (ddd, ^3J = 11.0, 5.5, 2.5, HC(2)), 3.92 (dd, ^3J = 11.0, 2.5, HC(4)), 3.84 (m, 2 H, HC(7), HC(8)), 3.69 (dd, ^2J = 11.5, ^3J = 5.5, H'C(8)), 3.59 (d, ^3J = 11.0, HC(5)), 3.29 (dd, ^2J = 11.5, ^3J = 5.5, HC(1)), 3.21 (dd, ^2J = 11.5, ^3J = 11.0, HC(1)); $[\alpha]^{25}_D$ = −13.4° (*c* = 9.6 g/dm^3, H_2O).

(−)-1,5-Dideoxy-1,5-imino-D-*erythro*-L-*allo*-octitol ((−)-27). (−)-27·CF_3COOH (108 mg, 0.32 mmol) was deposited on Dowex 50 WX8 (H^+ form) and washed with H_2O, MeOH, and finally 2 N NH_3-H_2O to give a solution of (−)-**27**. The solvent was evaporated and lyophilized to give 71 mg (100%): white solid; mp 205 °C dec; ^{1}H NMR (360 MHz, D_2O, CHD_2CN as internal standard) δ 4.17 (t, ^3J = 2.5, HC(3)), 3.92 (dd, ^3J = 8.0, 1.0, HC(6)), 3.84 (dd, ^2J = 10.5, ^3J = 3.5, HC(8)), 3.78 (m, HC(7)), 3.70 (ddd, ^3J = 10.5, 5.0, 2.5, HC(2)), 3.63 (dd, ^2J = 10.5, ^3J = 6.0, H'C(8)), 3.62 (dd, ^3J = 10.5, 2.5, HC(4)), 2.93 (dd, ^3J = 10.5, 1.0, HC(5)), 2.86 (dd, ^2J = 12.5, ^3J = 5.0, HC(1)), 2.68 (dd, ^2J = 12.5, ^3J = 10.5, H'C(1)); ^{1}H NMR (250 MHz, pyridine-d_5) δ 5.9 (d, ^3J = 4.0, HC(6)), 4.74 (t, ^3J = 2.5, HC(3)), 4.49 (m, 2 H, HC(7), HC(8)), 4.26 (dd, ^3J = 10.0, 2.5, HC(4)), 4.17 (dd, ^2J = 10.0, ^3J = 4.5, H'C(8)), 3.96 (ddd, *J* = 10.0, 5.0, 2.5, HC(2), 3.79 (d, *J* = 10.0, HC(5)), 3.43 (dd, ^2J = 10.0, ^3J = 10.0, H_βC(1)), 3.22 (dd, ^2J = 10.0, ^3J = 5.0, H_αC(1)); ^{13}C NMR (62.9 MHz, pyridine-d_5) δ 75.9, 73.9, 71.0, 70.5, 70.45 (5 d, ^1J(C,H) = 140–150, C(2), C(3), C(4), C(6), C(7)), 64.3 (t, ^1J(C,H) = 140, C(8)), 56.3 (d, ^1J(C,H) = 135, C(5)), 46.3 (t, ^1J(C,H) = 135, C(1)); $[\alpha]^{25}_D$ = −27.3° (*c* = 3.0 g/dm^3, H_2O).

(−)-(1*S*,2*R*,6*R*,7*R*,8*S*,8a*S*)-1,2,6,7,8-Pentahydroxyindolizidine ((−)-28). An amount of 40 mg of (−)-**27** (0.18 mmol) was dissolved in 1 mL of anhydrous pyridine. Ph_3P (188 mg, 4 equiv, 0.7 mmol) and CCl_4 (36 μL, 2 equiv, 0.35 mmol) were added and the solution was stirred at 20 °C for 3 h. A volume of 50 μL Et_3N (0.35 mmol, 2 equiv) was added and the mixture stirred at 20 °C overnight. A volume of 0.5 mL of MeOH was added, the solvent was evaporated. The residue was deposited on a column of Dowex 50 WX8 (H^+ form). The column was washed with MeOH, with H_2O, and finally with aqueous 2 N NH_3. The solvent was evaporated and lyophylized to obtain 30 mg (82%): white solid; mp 175 °C dec; ^{1}H NMR (360 MHz, D_2O, pyridine-d_4 as internal standard) δ 4.43 (ddd, ^3J = 8.0, 6.0, 2.5, HC(2)), 4.25 (dd, ^3J = 6.0, 3.5, HC(1)), 4.14 (t, ^3J = 3.0, 3.0, HC(7)), 3.89 (dd, ^3J = 10.5, 3.0, HC(8)), 3.84 (ddd, ^3J = 10.0, 5.0, 3.0, HC(6)), 2.92 (dd, ^3J = 11.0, 2.5, H_αC(3)), 2.90 (dd, ^2J = 11.0, ^3J = 5.0, H_αC(5)), 2.69 (dd, ^2J = 11.0, ^3J = 8.0, H_βC(3)), 2.46 (dd, ^3J = 10.5, 3.5, HC(8)), 2.32 (dd, ^2J = 11.0, ^3J = 10.0, H_βC(5)); ^{1}H NMR (250 MHz, pyridine-d_5) δ 4.65 (m, 3 H, HC(1), HC(7), HC(8)), 4.50 (ddd, ^3J = 7.5, 6.5, 2.0, HC(2)), 4.25 (ddd, ^3J = 10.0, 5.0, 2.5, HC(6)), 3.26 (dd, ^2J = 10.0, ^3J = 2.0, H_αC(3)), 3.18 (dd, ^2J = 10.0, ^3J = 5.0, H_αC(5)), 2.84 (dd, ^3J = 9.5, 4.0, HC(8a)), 2.80 (t, ^2J = ^3J = 10.0, H_βC(5)), 2.56 (dd, ^2J = 11.0, ^3J = 7.5, H_βC(3)); ^{13}C NMR (62.9 MHz, D_2O, pyridine-d_5 as internal standard) δ 73.0, 71.0, 70.7, 69.1, 68.3 (5 d, ^1J(C,H) = 145–150, C(1), C(2), C(6), C(7), C(8)), 66.4 (d, ^1J(C,H) = 130, C(8a)), 61.1, 52.4 (2 t, ^1J(C,H) = 140, C(3), C(5)); $[\alpha]^{25}_D$ = −70.0° (*c* = 8.4 g/dm^3, H_2O).

(−)-(1*S*,2*R*,6*R*,7*R*,8*S*,8a*S*)-1,2,6,7,8-Pentaacetoxyindolizidine ((−)-29). An amount of 15 mg of (−)-**28** was dissolved in pyridine/Ac_2O (2:1). A catalytic amount of DMAP was added and the mixture was stirred at 20 °C for 16 h. The solvent was evaporated and 2 mL of H_2O was added. The solution was alkalized with K_2CO_3 and extracted with CH_2Cl_2. The combined organic layers were dried ($MgSO_4$) and the solvent was evaporated. The product was purified by FC (first with petroleum ether/EtOAc 1:1, then pure EtOAc) to obtain 22 mg (27%) of white solid. It was recrystallized from EtOAc/hexane: colorless solid; mp 150–151 °C; ^{1}H NMR (250 MHz, C_7D_8) δ 5.76 (t, ^3J = 3.0, HC(7)), 5.41 (dd, ^3J = 6.5, 4.5, HC(1)), 5.27 (dd, ^3J = 10.0, 3.0, HC(8)), 4.91 (ddd, ^3J = 10.0, 5.0, 3.0, HC(6)), 4.90 (ddd, ^3J = 8.0, 6.5, 2.5, HC(2)), 2.79 (dd, ^2J = 10.5, ^3J = 2.5, H_αC(3)), 2.75 (dd, ^2J = 10.0, ^3J = 5.0, H_αC(5)), 2.47 (dd, ^3J = 10.0, 4.5, HC(8a)), 2.17 (t, ^2J = ^3J = 10.0, H_βC(5)), 2.14 (dd, ^2J = 10.5, ^3J = 8.0, H_β-C(3)), 1.85, 1.83, 1.75, 1.68, 1.61 (5 s, 5 Ac); $[\alpha]^{25}_D$ = −19.5° (*c* = 2.1 g/dm^3, $CHCl_3$).

(−)-5-*C*-(Benzyloxycarbonyl)-5-deoxy-2,3:7,8-di-*O*-isopropylidene-β-D-*threo*-L-*talo*-octofuranose ((−)-31β). A mixture of $PhCH_2OH$ (15.1 mL, 0.15 mol, 60 equiv), anhydrous CsF (11.1 g, 72.9 mmol, 30 equiv), and anhydrous CCl_4 (93 mL) was stirred at 20 °C for 40 min. It was then cooled to 0 °C and (−)-**30**[17] (805 mg, 2.43 mmol) was added. After stirring at 0 °C for another 20 min (TLC: petroleum ether/Et_2O/CH_2Cl_2 2:3:2), ice–H_2O (100 mL) was added and the organic phase was collected. The aqueous phase was extracted with EtOAc (30 mL, five times). The combined organic extracts were dried ($MgSO_4$) and the solvent was evaporated. $PhCH_2OH$ was distilled off under vacuum. The ^{1}H NMR spectrum of this crude product showed a 44:1 mixture

of (−)-31 and epimerized ester (−)-38. The residue was separated by FC (silica gel 120 g, petroleum ether/Et_2O/CH_2Cl_2 2:3:2) to give 968 mg (91%) of (−)-31 as a colorless solid which contains mainly β-furanose (β/α 4.3:1). Recrystallization from CH_2Cl_2/Et_2O gave pure β-furanose (−)-31β: mp 129–130 °C; ^{1}H NMR (250 MHz, $CDCl_3$) δ 7.42 (m, HC arom), 5.37 (d, ^3J = 4.0, HC(1)), 5.28, 5.10 (2 d, ^2J = 12.0, CH_2Ph), 4.46 (dd, ^3J = 6.0, 1.5, HC(3)), 4.57 (dd, ^3J = 9.0, 1.5, HC(4)), 4.53 (d, ^3J = 6.0, HC(2)), 4.02–3.85 (m, 3H, HC(6), HC(7), HC(8)), 3.78 (dd, ^2J = 7.5, ^3J = 6.5, H'C-(8)), 3.19 (d, ^3J = 4, HOC(1)), 3.01 (t, ^3J = 9.0, HC(5)), 2.53 (d, ^3J = 8.0, HOC(6)), 1.48, 1.42, 1.31, 1.30 (4 s, 2 $C(CH_3)_2$); $[\alpha]^{25}_D$ −3.6° (c = 7.2 g/dm^3, $CHCl_3$).

(−)-*tert*-Butyldimethylsilyl 5-*C*-(Benzyloxycarbonyl)-6-O-(*tert*-butyldimethylsilyl)-5-deoxy-2,3:7,8-di-*O*-isopropylidene-β-D-*threo*-L-*talo*-octofuranoside ((−)-32). A mixture of (−)-31 (950 mg, 2.17 mmol) and 2,6-lutidine (1.51 mL, 13.0 mmol, 3 equiv) in anhydrous CH_2Cl_2 (15 mL) was cooled to 0 °C. *Tert*-butyldimethylsilyl trifluoromethanesulfonate (1.50 mL, 6.5 mmol, 1.5 equiv) was added and the solution was stirred at 20 °C for 5 h. It was poured into brine (20 mL) and extracted with CH_2Cl_2 (20 mL, four times); the organic extracts were dried ($MgSO_4$) and evaporated. The residue was separated by FC (silica gel 120 g, petroleum ether/EtOAc 6:1) to give 1.40 g (97%) of (−)-32 as a colorless oil which contains mainly the β-furanoside (−)-32β (α/β 1:6): ^{1}H NMR (250 MHz, $CDCl_3$) of the β-furanoside δ 7.36 (m, HC arom), 5.31 (s, HC(1)), 5.18, 5.12 (2 d, ^2J = 12, CH_2Ph), 4.88 (dd, ^3J = 6.0, 2.0, HC(3)), 4.45 (dd, ^3J = 9.5, 2.0, HC(4)), 4.42 (d, ^3J = 6.0, C(2)), 4.18 (m, 2 H, HC(6), HC(7), 4.0, 3.70 (m, 2 H, $H_2C(8)$), 2.90 (m, HC(5)), 1.47, 1.34, 1.30 (3 s, 12 H, 2 $C(CH_3)_2$), 0.89, 0.87 (2 s, 2 $SiC(CH_3)_3$), 0.10, 0.09, 0.08, 0.05 (4 s, 2 $Si(CH_3)_2$); $[\alpha]^{25}_D$ = −5.5° (c = 7.9 g/dm^3, $CHCl_3$).

***tert*-Butyldimethyl 6-*O*-(*tert*-Butyldimethylsilyl)-5-*C*-carboxy-5-deoxy-2,3:7,8-di-*O*-isopropylidene-β-D-*threo*-L-*talo*-octofuranoside (33).** A solution of (−)-32 (1.40 g, 2.1 mmol) and 10% Pd–C (150 mg) in EtOAc (15 mL) was stirred under H_2 atmosphere at 20 °C for 1.5 h. The solution was filtered through Celite (rinsing with EtOAc). The free acid 33 was obtained after solvent evaporation: ^{1}H NMR (250 MHz, $CDCl_3$) of the major β-furanoside δ 5.35 (s, HC(1)), 4.90 (dd, ^3J = 6.0, 2.0, HC(3)), 4.48 (d, ^3J = 6.0, H-C(2)), 4.38 (dd, ^3J = 10.0, 2.0, HC(4)), 4.28 (dd, ^3J = 6.5, 6.0, HC(6)), 4.24 (ddd, ^3J = 7.5, 6.5, 6.0, HC(7)), 4.02 (dd, ^2J = 8.5, ^3J = 6.5, H'C(8)), 3.75 (dd, ^2J = 8.5, ^3J = 7.5, HC(8)), 2.86 (dd, ^3J = 10.0, 6.0, HC(5)), 1.46, 1.42, 1.33, 1.29 (4 s, 2 $C(CH_3)_2$), 0.90, 0.89 (2 s, 2 $SiC(CH_3)_3$), 0.14, 0.13, 0.12 (3 s, 12 H, 2 $Si(CH_3)_2$.

(−)-*tert*-Butyldimethylsilyl 5-[*N*-(Benzyloxycarbonyl)-amino]-6-*O*-(*tert*-butyldimethylsilyl)-5-deoxy-2,3:7,8-di-*O*-isopropylidene-β-D-*threo*-L-*talo*-octofuranoside ((+)-34β) and *tert*-Butyldimethylsilyl 5-[*N*-(Benzyloxycarbonyl)amino]-6-*O*-(*tert*-butyldimethylsilyl)-5-deoxy-2,3:7,8-di-*O*-isopropylidene-α-D-*threo*-L-*talo*-octofuranoside ((+)-34α). The crude acid 33 (2.1 mmol) obtained above was dissolved in toluene (20 mL). Et_3N (1.47 mL, 10.8 mmol, 5 equiv) and $N_3PO(OPh)_2$ (0.54 mL, 2.52 mmol, 1.2 equiv) were added and the mixture was stirred at 20 °C under Ar atmosphere for 3 h. $PhCH_2OH$ (2.1 mL, 21.0 mmol, 10 equiv) was added and the solution was heated to 90 °C overnight and then to 105 °C for another 2 h. After the reaction was finished (TLC, petroleum ether/EtOAc 6:1), the solvent was evaporated and the residue was purified by FC (silica gel 160 g, petroleum ether/EtOAc 6:1) to give 1.12 g of β-furanoside (−)-34β as a colorless liquid and 200 mg of α-isomer (+)-34α as a colorless solid. Total yield: 92%.

Data for (−)-34β: ^{1}H NMR (250 MHz, $CDCl_3$) δ 7.33 (m, 5 H, HC arom), 6.26 (d, ^3J = 10.0, NH), 5.37 (s, HC(1)), 5.14, 5.05 (2 d, ^2J = 12, CH_2Ph); 4.76 (dd, ^3J = 1.0, 2.0, HC(4)); 4.52 (dd, ^3J = 6.0, 1.0, HC(3)), 4.31 (d, ^3J = 6.0, HC(2)), 4.02 (ddd, ^3J = 8.5, 7.5, 6.0, HC(7)), 3.70 (ddd, ^3J = 10.0, 8.0, 2.0, HC(5)), 3.68 (dd, ^3J = 8.0, 6.0, HC(6)), 3.63 (dd, ^2J = 8.5, ^3J = 7.5, HC(8)), 3.51 (dd, ^2J = ^3J = 8.5, H'C(8)), 1.45, 1.36, 1.30, 1.26 (4 s, 2 $C(CH_3)_2$); 0.90, 0.88 (2 s, 2 $Si(C(CH_3)_3$), 0.15, 0.14, 0.12, 0.10 (4 s, 12 H, 2 $Si(CH_3)_2$); $[\alpha]^{25}_D$ = −27.4° (c = 11.2 g/dm^3, $CHCl_3$). Data of (+)-34α: mp 91–93 °C; ^{1}H NMR (250 MHz, $CDCl_3$) δ 7.35 (m, HC arom), 5.70 (d, ^3J = 9.5, NH), 5.30 (d, ^3J = 4.0, HC(1)), 5.13, 5.08 (2 d, ^2J = 12.0, CH_2Ph), 4.60 (dd, ^3J = 7.0, 3.0, HC(3)), 4.42 (dd, ^3J = 7.0, 4.0, HC(2)), 4.36 (ddd, ^3J = 7.5, 6.5, 4.5, HC(7)), 4.28 (dd, ^3J = 3.0, 2.0, HC(4)), 4.0 (ddd, ^3J = 9.5, 5.0, 2.0, HC(5)), 3.92 (dd, ^2J = 7.5, ^3J = 6.0, HC(8)), 3.76 (t, ^2J = ^3J = 7.5, H'C(8)), 3.69 (dd, ^3J = 5.0, 4.5, HC(6)), 1.54, 1.41, 1.33, 1.32 (4 s, 2 $C(CH_3)_2$), 0.92, 0.88 (2 s, 18 H, 2 $SiC(CH_3)_3$), 0.12, 0.11, 0.08 (3 s, 12 H, 2 $Si(CH_3)_2$); $[\alpha]^{25}_D$ = +9.5° (c = 7.8 g/dm^3, $CHCl_3$).

(+)-1,5-Dideoxy-1,5-imino-2,3:7,8-di-*O*-isopropylidene-D-*threo*-L-*talo*-octitol ((+)-35). A solution of (−)-34β and (+)-34α obtained above (1.2 g, 1.76 mmol) in THF (10 mL) was cooled to 0 °C, and Bu_4NF (1 M solution in THF, 10.5 mL, 3 equiv) was added. The mixture was stirred at 20 °C for 16 h; the solvent was evaporated and the residue filtered through a short column (silica gel 60 g, petroleum ether/EtOAc 1:2) to give the corresponding octofuranose as a colorless oil. After the addition of 10% Pd–C (700 mg) and EtOAc (10 mL), it was stirred at 20 °C under H_2 atmosphere for 13 h. The mixture was filtered through Celite (rinsing with EtOAc). The solvent was evaporated and the residue was purified by FC (silica gel, 60 g, first EtOAc, then CH_2Cl_2/MeOH 8:1) to give (+)-35 as a colorless solid, which was recrystallized from EtOAc/petroleum ether to give 418 mg (78%): colorless solid; mp 104–106 °C; ^{1}H NMR (250 MHz, $CDCl_3$) δ 4.48 (ddd, ^3J = 7.0, 7.0, 4.0, HC(7)), 4.05 (m, 4 H, HC(8), HC(2), HC(3), HC(4)), 3.89 (dd, ^2J = 8.5, ^3J = 7.0, H'C(8)), 3.55 (dd, ^3J = 8.5, 4.0, HC(6)), 3.40 (d, ^2J = 15.5, HC(1)), 2.96 (dd, ^2J = 15.5, ^3J = 3.5, H'C(1)), 2.64 (br s, OH), 2.37 (dd, ^3J = 8.5, 1.0, HC(5)), 1.58, 1.43, 1.39, 1.36 (4 s, 12 H, 2 $C(CH_3)_2$); $[\alpha]^{25}_D$ = +52.8° (c = 10.2 g/dm^3, $CHCl_3$).

Salt of Trifluoroacetic Acid and 1,5-Dideoxy-1,5-imino-D-*threo*-L-*talo*-octitol (36·CF_3COOH). (+)-35 (167 mg, 0.55 mmol) was kept with 5 mL of CF_3COOH/H_2O (8:1) at 20 °C for 18 h. The solvent was evaporated to give 185 mg (100%) of pure salt: colorless foam; ^{1}H NMR (250 MHz, DHO = δ 4.85 as reference) δ 4.41 (ddd, ^3J = 3.0, 2.0, ^4J = 1.5, HC(4)), 4.25 (dddd, ^3J = 3.0, 2.5, 2.0, ^4J = 1.5, HC(2)), 4.08 (dd, ^3J = 8.0, 2.5, HC(6)), 3.88 (ddd, ^3J = 6.0, 6.0, 2.5, HC(7)), 3.84 (dd, ^3J = 3.0, 3.0, HC(3)), 3.72 (d, 2 H, ^3J = 6.0, $H_2C(8)$), 3.54 (dd, ^2J = 14.0, ^3J = 2.5, HC(1)), 3.46 (dd, ^3J = 8.0, 2.0, HC(5)), 3.29 (dd, ^2J = 14.0, ^3J = 2.0, H'C(1)).

(+)-1,5-Dideoxy-1,5-imino-D-*threo*-L-*talo*-octitol ((+)-36). The salt obtained above (185 mg, 0.55 mmol) was deposited on Dowex 50 WX8 (H^+ form, 10 g, 200–400 mesh) and washed with H_2O with MeOH, and finally with aqueous 3 N NH_3 to provide the solution of (+)-36. The solvent was evaporated and lyophilized to give 118 mg (96%): colorless foam; mp 150 °C dec; ^{1}H NMR (360 MHz, D_2O, CH_3CN as internal standard) δ 4.16 (t, ^3J = 1.0, HC(4)), 3.96 (dd, ^3J = 1.0, 2.0, HC(2)), 3.91 (td, ^3J = 6.0, 1.5, HC(7)), 3.75 (dd, ^3J = 9.0, 1.5, HC(6)), 3.69 (d, ^3J = 6.0, 2 H, $H_2C(8)$), 3.68 (d, ^3J = 1.0, HC(3)), 3.12 (dd, ^2J = 14.0, ^3J = 2.0, HC(1)), 2.78 (dd, ^2J = 14.0, ^3J = 1.0, H'C(1)), 2.75 (dd, ^3J = 9.0, 1.0, HC(5)); $[\alpha]^{25}_D$ = +20.7° (c = 8.1 g/dm^3, H_2O).

(−)-(1*R*,2*R*,6*S*,7*S*,8*R*,8a*S*)-1,2,6,7,8-Pentaacetoxyindolizidine ((−)-37). DEAD (60 μL, 0.38 mmol, 1.2 equiv) was added dropwise to a mixture of (+)-36 (71 mg, 0.31 mmol), Ph_3P (99 mg, 0.38 mmol, 1.2 equiv), and pyridine (anhydrous, 1.5 mL) at 0 °C under Ar atmosphere. The mixture was stirred at 0 °C for 1 h (control by ^{1}H NMR) and quenched with ice–H_2O (5 mL). The H_2O layer was extracted with CH_2Cl_2 (5 mL, four times). The aqueous phase was evaporated and coevaporated with pyridine and toluene to yield the crude (+)-4 as a slightly yellow foam. It was dissolved in anhydrous pyridine (2 mL) and Ac_2O (1 mL). A catalytic amount of DMAP was added and the mixture was kept at 20 °C overnight. Most of the solvent was evaporated and ice–H_2O (4 mL) was added. The mixture was extracted with CH_2Cl_2 (4 mL, twice). The aqueous phase was alkalized with K_2CO_3 to pH = 12 and extracted again with CH_2Cl_2 (3 mL, four times). Combined organic layers were dried ($MgSO_4$) and evaporated. The residue was purified by FC (silica gel 10 g, petroleum ether/EtOAc 1:1 first and then pure EtOAc) to obtain pure 119 mg (90%): colorless solid; mp 186–187 °C; ^{1}H NMR (360 MHz, $CDCl_3$) δ 5.34 (ddd, ^3J = 4.0, 2.0, ^4J = 1.0, HC(8)), 5.27 (m, 2 H, HC(1), HC(6)), 5.11 (ddd, ^3J = 8.0, 4.0, 2.0, HC(2)), 4.91 (t, ^3J = 4.0, HC(7)), 3.21 (dd, ^2J = 13.0, ^3J = 2.5, $H_\beta C(5)$), 3.11 (dd, ^2J = 11.0, ^3J = 2.0, $H_\beta C(3)$), 2.77 (dd, ^3J = 11.0, 8.0, $H_\alpha C(3)$), 2.47 (dd, ^3J = 8.5, 2.0, HC(8a)), 2.42 (dd, ^2J = 13.0, ^3J = 2.5, $H_\alpha C(5)$), 2.20, 2.16, 2.08, 2.05, 2.00 (5 s, 5 AcO); $[\alpha]^{25}_D$ = −24.7° (c = 6.5 g/dm^3, $CHCl_3$).

(−)-5-*C*-(Benzyloxycarbonyl)-5-deoxy-2,3:7,8-di-*O*-isopropylidene-β-D-*threo*-L-*allo*-octofuranose ((−)-38). A mixture of $PhCH_2OH$ (0.72 mL, 7.0 mmol, 6 equiv) and CsF (534 mg, 3.5

mmol, 3 equiv) in anhydrous DMSO (5 mL) was stirred at 20 °C for 30 min. (−)-**30** (387 mg, 1.17 mmol) was added and stirred at 20 °C for another 12 min. Ice–H_2O was added, and the solution was extracted with EtOAc (10 mL, five times). The combined organic extracts were dried ($MgSO_4$) and the solvent was evaporated. ^1H NMR showed that the crude contains only the completely epimerized ester. The residue was purified by FC (silica gel, 60 g, petroleum ether/Et_2O/CH_2Cl_2 2:3:2) to give 435 mg (85%): colorless solid; contains mainly the β-furanose form; mp 92–94 °C; ^1H NMR (250 MHz, $CDCl_3$) δ 7.38 (m, HC arom), 5.45 (d, ^3J = 3.0, HC(1)), 5.24, 5.16 (2 d, ^2J = 12, CH_2Ph), 4.65 (d, ^3J = 11.0, HC(4)), 4.59 (s, 2 H, HC(2), HC(3)), 4.25 (ddd, ^3J = 7.0, 7.0, 5.0, HC(7)), 4.0 (m, 2 H, HC(6), HC(8)), 3.95 (d, ^3J = 3.0, HOC(1)), 3.81 (dd, ^2J = 8.0, ^3J = 7.0, H'C(8)), 3.06 (d, ^3J = 8.0, HOC(6)), 2.85 (dd, ^3J = 11.0, 4.0, HC(5)), 1.48, 1.39, 1.30, 1.27 (4 s, 2 $C(CH_3)_2$); $[\alpha]^{25}_D$ = −2.6° (*c* = 8.0 g/dm³, $CHCl_3$).

(−)-*tert*-Butyldimethylsilyl 5-*C*-(Benzyloxycarbonyl)-6-*O*-(*tert*-butyldimethylsilyl)-5-deoxy-2,3:7,8-di-*O*-isopropylidene-β-D-*threo*-L-*allo*-octofuranoside ((−)-39B) and (+)-*tert*-Butyldimethylsilyl 5-*C*-(Benzyloxycarbonyl)-6-*O*-(*tert*-butyldimethylsilyl)-5-deoxy-2,3:7,8-di-*O*-isopropylidene-α-D-*threo*-L-*allo*-octofuranoside ((+)-39α). A mixture of (−)-**38** (370 mg, 0.84 mmol), 2,6-lutidine (0.59 mL, 5.1 mmol, 3 equiv), and anhydrous CH_2Cl_2 (8 mL) was cooled to 0 °C, and then *tert*-butyldimethylsilyl trifluoromethanesulfonate (0.58 mL, 2.58 mmol, 1.5 equiv) was added. After the solution was stirred at 20 °C for 2 h, it was then poured into brine (20 mL) and extracted with CH_2Cl_2 (20 mL, four times). The combined organic layers were dried ($MgSO_4$), evaporated, and purified by FC (silica gel, 40 g, petroleum ether/EtOAc 6:1) to give 480 mg of the β-furanoside (−)-**39β** and 45 mg of the α-furanoside (+)-**39α**. Total yield: 93%.

Data of (−)-**39β**: colorless solid; mp 107–109 °C; ^1H NMR (250 MHz, $CDCl_3$) δ 7.35 (m, HC arom), 5.41 (s, HC(1)), 5.35, 5.05 (2 d, ^2J = 12, CH_2Ph), 4.67 (dd, ^3J = 11.5, 1.0, HC(4)), 4.50 (dd, ^3J = 6.0, 1.0, HC(3)), 4.44 (d, ^3J = 6.0, HC(2)), 4.13 (dd, ^3J = 7.0, 1.8, HC(6)), 4.02 (m, 2 H, $H_2C(8)$), 3.47 (td, ^3J = 9.0, 9.0, 7.0, HC(7)), 2.38 (dd, ^3J = 11.5, 1.8, HC(5)), 1.49, 1.37, 1.31, 1.23 (4 s, 2 $C(CH_3)_2$), 0.91, 0.86 (2 s, 2 $SiC(CH_3)_3$), 0.14, 0.13, 0.12, 0.09 (4 s, 2 $Si(CH_3)_2$); $[\alpha]^{25}_D$ = −15.1° (*c* = 5.3 g/dm³, $CHCl_3$).

Data of (+)-**39α**, colorless oil; ^1H NMR (250 MHz, $CDCl_3$) δ 7.38 (m, HC arom), 5.25, 5.06 (2 d, ^2J = 12.5, CH_2Ph), 5.16 (d, ^3J = 4.0, H-C(1)), 4.57 (dd, ^3J = 7.0, 3.0, HC(3)), 4.50 (dd, ^3J = 9.0, 3.0, HC(4)), 4.49 (dd, ^3J = 7.0, 4.0, HC(2)), 4.22 (ddd, ^3J = 7.5, 7.0, 8.0, HC(7)), 4.06 (dd, ^3J = 7.5, 2.5, HC(6)), 4.03 (dd, ^3J = 7.0, ^2J = 8.0, HC(8)), 3.62 (t, ^2J = ^3J = 8.0, HC(8)), 2.44 (dd, ^3J = 9.0, 2.5, HC(5)), 1.56, 1.40, 1.32, 1.30 (4 s, $C(CH_3)_2$), 0.93, 0.86 (2 s, 2 $SiC(CH_3)_3$), 0.13, 0.12, 0.11, 0.09 (4 s, 2 $Si(CH_3)_2$; $[\alpha]^{25}_D$ = +31.7° (*c* = 6.7 g/dm³, $CHCl_3$).

(−)-*tert*-Butyldimethylsilyl 6-*O*-(*tert*-Butyldimethylsilyl)-5-deoxy-5-*C*-(methoxycarbonyl)-2,3:7,8-di-*O*-isopropylidene-β-D-*threo*-D-*allo*-octofuranoside. A mixture of (−)-**39β** + (+)-**39α** obtained above (5.5 mg, 0.008 mmol) and 3 mg of Pd–C (10% Pd) in EtOAc (2 mL) were stirred under H_2 atmosphere for 2 h and then filtered through Celite. The solvent was evaporated, and the residue was dissolved in $CHCl_3$ (1 mL). Excess of CH_2N_2 (solution in ether) was added and the mixture kept at 20 °C for 10 min. The solvent was then evaporated to obtain 4.7 mg (97%): colorless oil; ^1H NMR (250 MHz, $CDCl_3$) δ 5.41 (s, HC(1)), 4.63 (dd, ^3J = 11.5, 1.0, HC(4)), 4.50 (dd, ^3J = 6.0, 1.0, HC(3)), 4.46 (d, ^3J = 6.0, HC(2)), 4.10 (m, 3 H, HC(6), $H_2C(8)$), 3.74 (s, OCH_3), 3.52 (m, HC(7)), 2.38 (dd, ^3J = 11.5, 1.0, HC(5)), 1.49, 1.40, 1.33, 1.32 (4 s, 2 $C(CH_3)_2$), 0.92, 0.89 (2 s, 2 $SiC(CH_3)_3$), 0.15, 0.14, 0.13, 0.11 (4 s, 2 $Si(CH_3)_2$); $[\alpha]^{25}_D$ = −5.0° (*c* = 0.2 g/dm³, $CHCl_3$).

(−)-*tert*-Butyldimethylsilyl 5-[*N*-(Benzyloxycarbonyl)-amino]-6-*O*-(*tert*-butyldimethylsilyl)-5-deoxy-2,3:7,8-di-*O*-isopropylidene-β-D-*threo*-D-*allo*-octofuranoside ((−)-40β) and *tert*-Butyldimethylsilyl 5-[*N*-(Benzyloxycarbonyl)amino]-6-*O*-(*tert*-butyldimethylsilyl)-5-deoxy-2,3:7,8-di-*O*-isopropylidene-α-D-*threo*-D-*allo*-octofuranoside ((+)-40α). A solution of (−)-**39β**, (+)-**39α** (495 mg, 0.74 mmol), and 10% Pd–C (50 mg) in EtOAc (8 mL) was stirred under H_2 atmosphere at 20 °C for 22 h. The solution was filtered through Celite (rinsing with EtOAc). The solvent was evaporated and the residue dissolved in toluene (8 mL). Et_3N (0.52, 3.7 mmol, 5 equiv) and $N_3PO(OPh)_2$ (0.19 mL, 0.89 mmol, 1.2 equiv) were added and the mixture was stirred at 20 °C under Ar atmosphere for 2 h. $PhCH_2OH$ (0.77 mL, 7.4 mmol, 10 equiv) was added and heated to 100 °C overnight. After the end of the reaction (control TLC, petroleum ether/EtOAc 6:1), the solvent was evaporated and the residue was purified by FC (silica gel, petroleum ether/EtOAc 6:1) to give 440 mg of β-furanoside (−)-**40β** and 25 mg of α-furanoside (+)-**40α**. Total yield: 92%.

Data of (−)-**40β**: colorless oil; ^1H NMR (250 MHz, $CDCl_3$) δ 7.38 (m, HC arom), 5.42 (s, HC(1)), 5.14 (d, ^3J = 10.0, HNC(5)), 5.13 (s, 2 H, CH_2Ph), 4.77 (dd, ^3J = 6.0, 1.0, HC(3)), 4.53 (d, ^3J = 6.0, HC(2)), 4.0 (dd, ^3J = 11.0, 1.0, HC(4)), 3.9–4.1 (m, 3 H, HC(6), $H_2C(8)$), 3.52 (ddd, ^3J = 11.0, 10.0, 1.5, HC(5)), 3.50 (m, HC(7)), 1.45, 1.43, 1.42, 1.38 (4 s, 2 $C(CH_3)_2$), 0.94, 0.90 (2 s, 2 $SiC(CH_3)_3$), 0.16, 0.15, 0.14, 0.13 (4 s, 2 $Si(CH_3)_2$; $[\alpha]^{25}_D$ = −36.7° (*c* = 6.3 g/dm³, $CHCl_3$).

Data of (+)-**40α**: colorless oil; ^1H NMR (250 MHz, $CDCl_3$) δ 7.36 (m, HC arom), 5.35 (d, ^3J = 10.0, NH), 5.30 (d, ^3J = 2.5, HC(1)), 5.18, 5.08 (2 d, ^2J = 12.5, CH_2Ph), 4.56 (dd, ^3J = 2.5, 5.0, HC(2)), 4.55 (dd, ^3J = 5.0, 1.5, HC(3)), 4.0 (dd, ^3J = 10.0, 1.5, HC(4)), 4.05–3.92 (m, 3 H, HC(6), $H_2C(8)$), 3.50 (m, HC(7)), 3.34 (t, ^3J = 10.0, HC(5)), 1.52, 1.46, 1.32, 1.31 (4 s, 2 $C(CH_3)_2$); 0.93, 0.91 (2 s, 2 $SiC(CH_3)_3$), 0.15, 0.14, 0.13 (3 s, 12 H, 2 $Si(CH_3)_2$); $[\alpha]^{25}_D$ = +12.8° (*c* = 11.7 g/dm³, $CHCl_3$).

(+)-1,5-Dideoxy-1,5-imino-2,3:7,8-di-*O*-isopropylidene-D-*threo*-D-*allo*-octitol ((+)-41). A solution of (−)-**40β** and (+)-**40α** (430 mg, 0.63 mmol) in THF (5 mL) was cooled to 0 °C. After Bu_4NF (1 M solution in THF, 2.5 mL, 2 equiv) was added, the mixture was stirred at 0 °C for 2 h and at 20 °C for another 4 h. The solvent was evaporated and the residue was purified by FC (silica gel 20 g, petroleum ether/EtOAc 1:2) to give a colorless oil which was mixed with 10% Pd–C (250 mg) in EtOAc (5 mL) and stirred at 20 °C under H_2 atmosphere for 36 h. The mixture was filtered through Celite (rinsing with MeOH). The solvent was evaporated and the residue was purified by FC (silica gel 20 g, CH_2Cl_2/MeOH 8:1) and recrystallization from EtOAc/CH_2Cl_2 to give 130 mg (68%): colorless solid; mp 153–154.5 °C; ^1H NMR (250 MHz, $CDCl_3$) δ 4.49 (dd, ^3J = 6.0, 4.0, HC(3)), 4.25 (dt, ^3J = 7.0, 3.5, HC(7)), 4.20 (ddd, ^3J = 6.0, 7.0, 5.5, HC(2)), 4.07 (dd, ^2J = 8.5, ^3J = 6.5, HC(8)), 3.94 (dd, ^2J = 8.5, ^3J = 7.5, H'C(8)), 3.84 (br m, ^3J = 9.0, 9.5, 4.0, HC(4)), 3.79 (dd, ^3J = 3.5, 2.5, HC(6)), 2.96 (dd, ^2J = 13.0, ^3J = 5.5, HC(1)), 2.76 (dd, ^3J = 9.5, 2.5, HC(5)), 2.74 (dd, ^2J = 13.0, ^3J = 7.0, HC(1)), 2.27 (d, ^3J = 9.0, HOC(4)), 1.54, 1.44, 1.388, 1.386 (4 s, 2 $C(CH_3)_2$); $[\alpha]^{25}_D$ = +4.8° (*c* = 6.7 g/dm³, $CHCl_3$).

(+)-Trifluoroacetic Acid Salt of 1,5-Dideoxy-1,5-imino-D-*threo*-D-*allo*-octitol ((+)-42·CF_3COOH). (+)-**41** (89 mg) was stirred with 2 mL of CF_3COOH/H_2O (8:1) at 20 °C for 8 h. The solvent was evaporated to give 99 mg (100%): colorless foam; mp 145–148 °C, 200 °C dec; ^1H NMR (250 MHz, D_2O, CH_3CN as internal standard) δ 4.23 (dd, ^3J = 2.5, 1.0, HC(6)), 4.22 (t, ^3J = 2.5, HC(3)), 4.00 (ddd, ^3J = 11.5, 5.5, 2.5, HC(2)), 3.92 (ddd, ^3J = 6.5, 5.5, 2.5, HC(7)), 3.88 (dd, ^3J = 11.0, 2.5, HC(4)), 3.72 (dd, ^2J = 12.5, ^3J = 5.5, HC(8)), 3.68 (dd, ^2J = 12.5, ^3J = 6.5, HC(8)), 3.49 (dd, ^3J = 11.0, 1.0, HC(5)), 3.26 (dd, ^2J = 12.0, ^3J = 5.5, HC(1)), 3.22 (dd, ^2J = 12.0, ^3J = 11.5, HC(1)); $[\alpha]^{25}_D$ = +11.0° (*c* = 7.1 g/dm³, $CHCl_3$).

(+)-1,5-Dideoxy-1,5-imino-D-*threo*-D-*allo*-octitol ((+)-42). The salt (+)-42·CF_3COOH obtained above (98 mg, 0.29 mmol) was deposited on Dowex 50 WX8 (H^+ form, 5 g, 200–400 mesh) and washed with H_2O, with MeOH, and finally with aqueous 4 N NH_3 to provide a solution of (+)-**42**. The solvent was evaporated and lyophilized to get 65 mg (99%) of pure (+)-**42**: white solid; mp 65–68 °C, 195 °C dec; ^1H NMR (360 MHz, D_2O, CD_2HCOCD_3 as internal standard) δ 4.13 (t, ^3J = 2.5, HC(3)), 3.96 (dd, ^3J = 5.5, 1.5, HC(6)), 3.83 (ddd, ^3J = 5.0, 4.0, 5.5, HC(7)), 3.68 (ddd, ^3J = 11.5, 5.0, 2.5, HC(2)), 3.66 (dd, ^2J = 12.0, ^3J = 4.0, HC(8)), 3.62 (dd, ^2J = 12.0, ^3J = 5.0, H'C(8)), 3.60 (dd, ^3J = 10.0, 2.5, HC(4)), 2.86 (dd, ^2J = 12.5, ^3J = 5.0, HC(1)), 2.83 (dd, ^3J = 10.0, 1.5, HC(5)), 2.71 (dd, ^2J = 12.5, ^3J = 11.5, H'C(1)); ^{13}C NMR (62.9 MHz, D_2O, CD_2HCOCD_3 as internal standard) δ 73.5, 72.0, 68.5, 68.4, 68.3 (5 d, ^1J(C,H) = 140–150, C(2), C(3), C(4), C(6), C(7)), 62.3 (t, ^1J(C,H) = 142, C(8)), 55.0 (d, ^1J(C,H) = 135, C(5)), 43.7 (t, ^1J(C,H) = 138, C(1)); $[\alpha]^{25}_D$ = +52.2° (*c* = 4.6 g/dm³, $CHCl_3$).

(+)-(1*R*,2*R*,6*S*,7*S*,8*R*,8a*R*)-1,2,6,7,8-Pentahydroxyindolizidine ((+)-43). A mixture of (−)-**46** (81 mg, 0.2 mmol) and saturated NH_3/MeOH solution (2 mL) was kept at 20 °C for 8 h. The solvent was evaporated and the residue was deposited on Dowex 50 WX 8 (H^+ form, 200–400 mesh, 5 g). The column was washed with MeOH, with H_2O, and finally with aqueous 4 N NH_3 to give 40.3 mg (100%) of pure (+)-**43**: colorless solid; mp 188 °C dec; ^1H NMR (360 MHz, D_2O, CH_3CN as internal standard) δ 4.19 (ddd, ^3J = 7.0, 5.5, 4.0, HC(2)), 4.09 (t, ^3J = 3.0, HC(7)), 4.08 (dd, ^3J = 4.0, 3.0, HC(1)), 3.80 (ddd, ^3J = 10.5, 5.5, 3.0, HC(6)), 3.79 (dd, ^3J = 10.5, 3.0, HC(8)), 3.53 (dd, ^2J = 10.5, ^3J = 7.0, H_αC(3)), 2.93 (dd, ^2J = 10.5, ^3J = 5.0, H_αC(5)), 2.63 (dd, ^3J = 10.5, 4.0, HC(8a)), 2.39 (t, ^2J = ^3J = 10.5, H_βC(5)), 2.23 (dd, ^2J = 10.5, ^3J = 5.5, H_βC(3)); ^{13}C NMR (62.9 MHz, D_2O, CH_3CN as internal standard) δ 76.8, 76.4, 71.4, 67.7, 66.4 (5 d, ^1J(C,H) = 140–150, C(1), C(2), C(6), C(7), C(8)), 63.9 (d, ^1J(C,H) = 130, C(8a)), 59.9, 50.9 (2 t, ^1J(C,H) = 140, C(3), C(5)); $[\alpha]^{25}_D$ = +44.7° (*c* = 8.1 g/dm^3, H_2O). Anal. Calcd for $C_8H_{15}NO_5$ (205.21): C, 46.82; H, 7.37. Found: C, 46.65; H, 7.28.

(1*R*,2*R*,6*S*,7*S*,8*R*,8a*R*)-6,7,8-Triacetoxy-1,2-epoxyindolizidine (45). When (+)-**42** was treated with PPh_3 and CCl_4 in pyridine, Et_3N, and then Ac_2O/pyridine, a mixture of **45** and (−)-**46** was obtained from which **45** could be isolated by column chromatography on silica gel in 4–10% yield: ^1H NMR (360 MHz, $CDCl_3$) δ 5.68 (t, ^3J = 2.5, HC(7)), 5.02 (ddd, ^3J = 10.0, 5.0, 2.5, HC(6)), 4.92 (dd, ^3J = 10.0, 2.5, HC(8)), 3.62 (d, ^3J = 3.0, HC(2)), 3.56 (d, ^3J = 3.0, HC(1)), 3.35 (d, ^2J = 11.0, H_αC(3)), 3.04 (dd, ^2J = 10.0, ^3J = 5.5, H_αC(5)), 2.82 (d, ^3J = 10.0, HC(8a)), 2.62 (d, ^2J = 11.0, H_βC(3)), 2.61 (t, ^2J = ^3J = 10.0, H_βC(5)), 2.16, 2.05, 2.0 (3s, 3 OAc).

(−)-(1*R*,2*R*,6*S*,7*S*,8*R*,8a*R*)-1,2,6,7,8-Pentaacetoxyindolizidine ((−)-46). DEAD (68 μL, 0.43 mmol, 1.2 equiv) was added slowly to a mixture of (+)-**42** (80 mg, 0.36 mmol), Ph_3P (112 mg, 0.43 mmol, 1.2 equiv), and pyridine (anhydrous, 1.5 mL) at 0 °C under Ar atmosphere. The mixture was stirred at 0 °C for 1 h (controlled by ^1H NMR) and then quenched with ice–H_2O (5 mL). The aqueous layer was extracted with CH_2Cl_2 (5 mL, four times). The aqueous phase was evaporated and coevaporated with pyridine and toluene to yield the crude (+)-**43**, as a slightly yellow foam. It was dissolved in anhydrous pyridine (2 mL) and Ac_2O (1 mL). A catalytic amount of DMAP was added and the mixture was kept at 20 °C overnight. The solvent was evaporated and ice–H_2O (4 mL) was added. The mixture was extracted with CH_2Cl_2 (5 mL, twice). The aqueous phase was alkalized with K_2CO_3 to pH = 12 and extracted again with CH_2Cl_2 (5 mL, four times). The combined CH_2Cl_2 layers were dried ($MgSO_4$) and evaporated. The residue was purified by FC (silica gel 10 g, petroleum ether/EtOAc 1:1) first and then preparative TLC ($CHCl_3$/MeOH 20:1) to obtain 120 mg (81%) of pure (−)-**46**: colorless oil; ^1H NMR (360 MHz, $CDCl_3$) δ 5.58 (t, ^3J = 3.0, HC(7)), 5.30 (d, ^3J = 5.0, HC(1)), 5.05 (ddd, ^3J = 11.0, 5.5, 3.0, HC(6)), 5.02 (dd, ^3J = 10.0, 3.0, HC(8)), 4.96 (dd, ^3J = 7.5, 6.0, HC(2)), 3.70 (dd, ^2J = 10.0, ^3J = 7.5, H_αC(3)), 3.05 (dd, ^2J = 10.0, ^3J = 5.5, H_αC(5)), 2.88 (dd, ^3J = 10.0, 5.0, HC(8a)), 2.48 (dd, ^2J = 10.0, ^3J = 11.0, H_βC(5)), 2.32 (dd, ^2J = 10.0, ^3J = 6.0, H_βC(3)), 2.16, 2.12, 2.09, 2.04, 2.0 (5 s, OAc); $[\alpha]^{25}_D$ = −15.3° (*c* = 7.5 g/dm^3, $CHCl_3$).

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Supplementary Material Available: IR, ^{13}C NMR, and MS spectral data, further optical rotation values as well as elemental analyses of new compounds (−)-**3**, (+)-**4**, **8**, (+)-**9**, (+)-**10**, (+)-**12**, (+)-**13**, (+)-**14α**, (−)-**14β**, (−)-**18**, **19**, (−)-**20**, (−)-**21**, (+)-**22**, (+)-**24α**, **24β**, **25**, (−)-**26**, (−)-**27**, (−)-**28**, (−)-**29**, (−)-**31β**, (−)-**32**, **33**, (+)-**34β**, (−)-**34α**, (+)-**35**, (+)-**36**, (−)-**37**, (−)-**38**, (−)-**39β**, (+)-**39α**, (−)-**40β**, (+)-**40α**, (+)-**41**, (+)-**42**, (+)-**43**, **45**, and (−)-**46** (24 pages). This material is contained in libraries on microfiche, immediately follows this article in the microfilm version of the journal, and can be ordered from the ACS; see any current masthead page for ordering information.