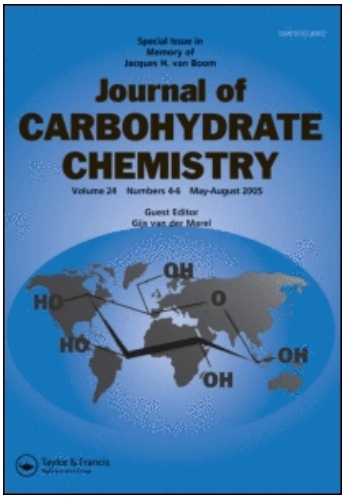

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PREPARATION OF 3-AMINO-3-DEOXY-2,4,5,6-TETRA-*O*-METHYL-D-ALTRONIC ACID HYDROCHLORIDE, A PRECURSOR IN THE PREPARATION OF A CHIRAL β-POLYAMIDE (NYLON 3 ANALOG)

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ABSTRACT

3-Amino-3-deoxy-2,4,5,6-tetra-*O*-methyl-D-altronic acid hydrochloride was prepared from methyl 3-azido-3-deoxy-4,6-*O*-benzylidene-α-D-altropyranoside in seven steps. The key intermediate in this synthesis was the 3-acetamido-3-deoxy-2,4,6-tri-*O*-methyl-D-*altrono*-1,5-lactone which could be transformed, in one step, into methyl 3-acetamido-3-deoxy-2,4,5,6-tetra-*O*-methyl-D-altronate. However, attempts to open the 3-azido-3-deoxy-tri-*O*-methyl (or *O*-benzyl)-D-*altrono*-1,5-lactone intermediates gave a mixture of products, mostly, α,β-unsaturated carbonyl compounds. The 3-amino-3-deoxy-2,4,5,6-tetra-*O*-methyl-D-altronic acid could be transformed into the corresponding β-lactam, (3*S*,4*R*)-3-methoxy-4-(D-*erythro*-trimethoxypropyl) azetidine-2-one, which was further polymerized by anionic ring-opening polymerization giving poly[(2*S*,3*R*)-2-methoxy-3-(D-*erythro*-trimethoxypropyl) propanamide], a chiral nylon 3 analog.

INTRODUCTION

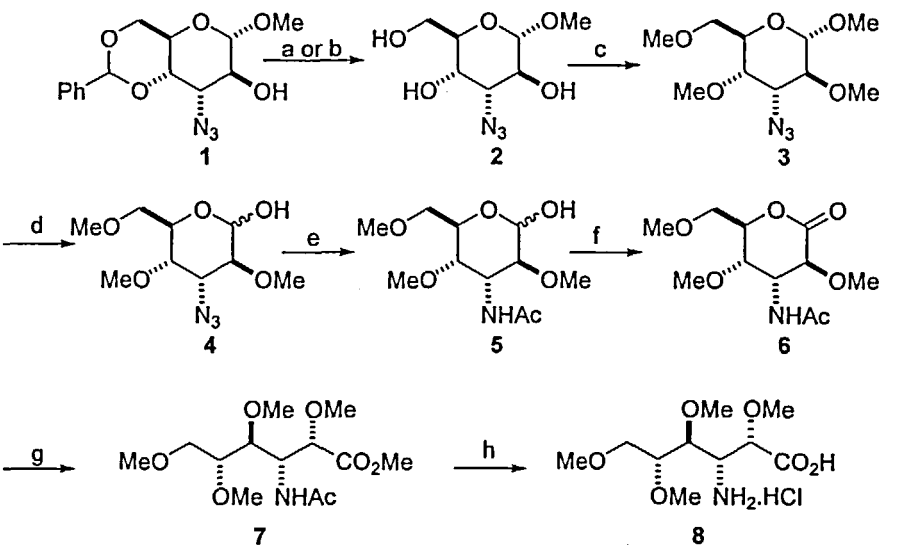
In previous papers we described the synthesis of some derivatives of 2-amino-2-deoxy (and 6-amino-6-deoxy)-D-gluconic acid[1,2] which were precursors of the

corresponding stereoregular α- and ω-polyamides.[3] The increasing interest that is being focused on enantiomerically pure β-amino acids[4] and β-polyamides[5-8] led us to accomplish the synthesis of an *O*-protected 3-amino-3-deoxy-D-aldonic acid which could be further transformed into active monomers for polymerization reactions.

Synthetic polymers containing carbohydrates in the main chain are considered, with steadily increased interest, as a new type of polymeric material[9] due to their potential as biodegradable and biocompatible materials useful for medical applications. Several contributions on the synthesis of polymers derived from carbohydrate monomers have been achieved.[10-16] The presence of stereocenters in the repeating unit makes it possible to adjust the physical properties by controlling the tacticity as well as studying the effect of chirality on biological activity.[17]

RESULTS AND DISCUSSION

We now describe the preparation of 3-amino-3-deoxy-2,4,5,6-tetra-*O*-methyl-D-altronic acid hydrochloride (**8**) and its conversion into the β-lactam, (3*S*,4*R*)-3-methoxy-4-(D-*erythro*-trimethoxypropyl)azetidine-2-one (**9**), which was further polymerized by



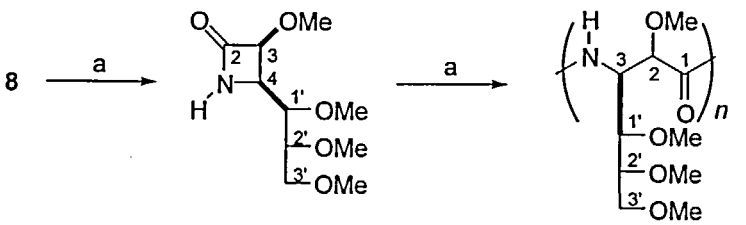
(a) 7:1 TFA-H_2O; (b) concd HCl, acetone; (c) MeI, KOH, DMSO; (d) 5:1 4M HCl-MeCN; (e) Thiolacetic acid, py; (f) DMSO, Ac_2O; (g) MeI, KOH, THF; (h) 4M HCl.

Scheme 1

anionic ring-opening polymerization. Our synthetic strategy to obtain **8** started with the methyl 3-azido-3-deoxy-4,6-*O*-benzylidene-α-D-altropyranoside (**1**)[18] which, in the best of our approaches (Scheme 1), was transformed into the 3-acetamido-3-deoxy-2,4,6-tri-*O*-methyl-D-*altrono*-1,5-lactone (**6**). Opening of this lactone by treatment with methyl iodide in the presence of potassium hydroxide in tetrahydrofuran gave the open chain methyl ester **7**, from which the amino acid **8** was obtained. However, in other approaches, attempts to open 3-azido-3-deoxy-2,4,6-tri-*O*-methyl (or *O*-benzyl)-D-*altrono*-1,5-lactone under similar conditions did not lead to the corresponding open chain methyl esters; instead, complex mixtures of products, mostly α,β-unsaturated carbonyl compounds, were formed.

Hydrolysis of the benzylidene group of **1** to give **2** (Scheme 1), followed by per-*O*-methylation (**3**) and subsequent hydrolysis of the methyl altroside group afforded **4** (68% overall yield, after purification). Reduction of the azido group was accomplished with thiolacetic acid[19] to give the 3-acetamido-3-deoxy derivative **5** (80%), which was oxidized with dimethyl sulfoxide-acetic anhydride to lactone **6** (75%). Opening of the lactone ring and methylation of HO-5 were carried out in one step with methyl iodide-potassium hydroxide-tetrahydrofuran[1,2] to afford the methyl ester **7** (84%). The methyl ester and the *N*-acetamido groups of **7** were hydrolyzed with 4M hydrochloric acid to give the amino acid hydrochloride **8** (98%).

Treatment of **8** (Scheme 2) with sodium hydrogen carbonate and methanesulfonyl chloride in acetonitrile[20] afforded the β-lactam **9** in a 50% yield. Ring-opening



9 **10**

(a) 1. EDPA, MeCN; 2. MsCl, $NaHCO_3$, MeCN; (b) KO^tBu, CH_2Cl_2

Scheme 2

polymerization[21] of this β-lactam was carried out in pure dichloromethane using 4-methyl-4-phenyl-1-*tert*-butoxycarbonylazetidine-2-one as the initiator and potassium *tert*-butoxide as the catalyst under an inert atmosphere, for 2 days, at room temperature. The optically active polyamide **10** was obtained as a colorless, powdery, amorphous solid, soluble in water and a variety of organic solvents including chloroform in accordance with the behavior found for other stereoregular polyamides containing stereocenters in the main chain.[3,15b] The inherent viscosity of polymer **10** measured in DMSO, at 25 °C, was 0.9 dL/g. The weight-average molecular weight (M_W) estimated by GPC was 10,500 with a polydispersity (M_W/M_n) of 1.59.

In conclusion, we describe the preparation of the new β-amino acid 3-amino-3-deoxy-2,4,5,6-tetra-*O*-methyl-D-altronic acid hydrochloride (**8**), which was transformed into the β-polyamide **10**, through the β-lactam **9**, by ring-opening polymerization. This new carbohydrate-based polyamide can be considered as a new type of chiral nylon 3 analog.

EXPERIMENTAL

General methods. Chemicals were all used as purchased from the Aldrich Chemical Co. Solvents were dried and purified, when necessary, by appropriate standard procedures. Melting points are uncorrected. Optical rotations were measured at 20 ± 5 °C (5-cm cell). TLC was performed on Silica Gel 60 F_{254} (Merck) with detection by UV light or charring with sulfuric acid and flash column chromatography with Silica Gel 60 (230-400 mesh, Merck). Elemental analyses were determined in the Microanalysis Laboratories at the Universidad Complutense de Madrid. Inherent viscosity measurements were determined in DMSO solutions with a semimicroviscometer at a temperature of 25.0 ± 0.1 °C. Gel permeation chromatography (GPC) studies were carried out using a PLgel3 m Mixed "E" column (Polymer Labs). HPLC grade THF was used as the eluent at a flow rate of 1 mL.min^{-1}. Chromatograms were analyzed using four poly(methyl methacrylate) calibration standards (ranging from 400 to 29,400 g.mol^{-1}). FT IR spectra were recorded for films or KBr discs. NMR chemical shifts are reported as parts per million downfield from tetramethylsilane. MS were recorded on a Kratos MS80RFA instrument equipped with a combined EI-CI source. HRMS (EI. 70 eV) were taken on the same instrument with resolution 10,000.

Methyl 3-azido-3-deoxy-α-D-altropyranoside (2). *Method a):* A solution of methyl 3-azido-3-deoxy-4,6-*O*-benzylidene-α-D-altropyranoside (**1**, 3.7 g, 12.0 mmol) in 7:1 CF_3COOH-H_2O (24 mL) was stirred at room temperature for 30 min. The solution was concentrated to dryness (< 30 °C) and the residue was treated with dichloromethane (150 mL). The organic solution was extracted with H_2O (200 mL x 3) and the aqueous solution concentrated to an oil. Flash-column chromatography (10:1 CH_2Cl_2-MeOH) of this residue afforded the title compound as a colorless oil (2.6 g, 99%); $[\alpha]_D$ +97° (*c* 1.98, methanol); IR: 2115 cm^{-1} (N_3); ^1H NMR (Me_2SO-d_6, 500 MHz), δ 5.49 (d, 1 H, *J* 4.6 Hz, OH), 5.25 (d, 1 H, *J* 5.5 Hz, OH), 4.58 (dd, 1 H, $J_{OH,6}$ 5.3, $J_{OH,6'}$ 5.9 Hz, OH-6), 4.38 (d, 1 H, $J_{1,2}$ 4.4 Hz, H-1), 3.81 (dd, 1 H, *J* 3.3, *J* 8.1 Hz, H-3), 3.63-3.55 (m, 4 H, H-2, H-3, H-6, H-6'), 3.45 (m, 1 H, H-5), 3.24 (s, 3 H, OCH_3); ^{13}C NMR (Me_2SO-d_6, 50 MHz), δ 101.45 (C-1), 71.56/68.95 (C-2/C-5), 65.09 (C-4), 63.58 (C-3), 61.39 (C-6), 55.27 (OCH_3); MS (CI): *m/z* 188 $(M\text{-}OCH_3)^+$.

Anal. Calcd for $C_7H_{13}N_3O_5$: C, 38.36; H, 5.98; N, 19.17. Found: C, 37.98; H, 6.00; N, 19.34.

Method b): A solution of **1** (0.29 g, 0.94 mmol) in acetone (26 mL) containing concentrated HCl (0.25 mL) was boiled for 30 min. The resulting reddish solution was cooled and neutralized with lead (II) carbonate. The suspension was filtered through diatomaceous earth and the filtrate concentrated to give an oily residue (0.2 g) which was purified as described in method a) to give **2** (0.15 g, 74%).

Methyl 3-azido-3-deoxy-2,4,6-tri-*O*-methyl-α-D-altropyranoside (3). To an ice-cold solution of **2** (0.71 g, 3.24 mmol) in dimethyl sulfoxide (9 mL) was added freshly powdered KOH (1.15 g, 20.6 mmol) and the suspension was stirred for 10 min, methyl iodide (0.9 mL, 14.7 mmol) was added and the mixture was then stirred vigorously at room temperature overnight. After quenching with H_2O (50 mL) the mixture was extracted with dichloromethane (90 mL x 4) and the organic extracts were dried (anhydrous $MgSO_4$) and concentrated. The residue was purified by flash-column chromatography (1:1 diethyl ether-light petroleum) to give the title compound as an oil (0.84 g, 99%); $[\alpha]_D$ +114° (*c* 1.23, dichloromethane); IR: 2105 cm^{-1} (N_3); ^1H NMR ($CDCl_3$, 500 MHz), δ 4.66 (d, 1 H, $J_{1,2}$ 1.8 Hz, H-1), 4.03 (t, 1 H, $J_{2,3}$ 4.3, $J_{3,4}$ 4.1 Hz, H-3), 3.98 (dt, 1 H, $J_{4,5}$ 8.7, $J_{5,6}$=$J_{5,6'}$ 3.5 Hz, H-5), 3.65 (dd, 1 H, H-4), 3.61 (d, 2 H, H-

6, H-6'), 3.43 (dd, 1 H, H-2), 3.46, 3.45, 3.42, 3.41 (4s, each 3 H, OCH_3); ^{13}C NMR ($CDCl_3$, 125 MHz), δ 98.99 (C-1), 78.46 (C-2), 74.61 (C-4), 71.56 (C-6), 67.19 (C-5), 57.95 (C-3), 59.25, 58.42, 57.70, 55.48 (4 OCH_3); MS (CI): *m/z* 230 $(M\text{-}OCH_3)^+$.

Anal. Calcd for $C_{10}H_{19}N_3O_5$: C, 45.97; H, 7.33; N, 16.08. Found: C, 46.20; H, 7.17; N, 15.92.

3-Azido-3-deoxy-2,4,6-tri-*O*-methyl-α,β-D-altropyranose (4). A solution of **3** (3.0 g, 11.5 mmol) in 5:1 4M HCl-acetonitrile (80 mL) was heated at 85 °C overnight. The solution was concentrated to dryness and the residue was extracted with dichloromethane (100 mL) and treated with solid $NaHCO_3$ (4.5 g). The suspension was filtered, and concentrated to give a syrup (2.54 g, 89%) which was purified by flash-column chromatography (3:2 diethyl ether-light petroleum). The title compound was isolated as a colorless oil [2g, 70%; α:β ratio 44:56 (NMR)]; $[\alpha]_D$ +60° (*c* 1.65, dichloromethane); IR: 2114 cm^{-1} (N_3); ^1H NMR ($CDCl_3$ + D_2O, 500 MHz), δ 4.98 (bs, 1 H, H-1α), 4.84 (d, 1 H, $J_{1,2}$ 1.8 Hz, H-1β), 4.20-4.00 (m, 4 H), 3.75 (m, 1 H), 3.60-3.24 (m, 7 H), 3.47 (s, 3 H, OCH_3), 3.38 (3s, each 3H, OCH_3), 3.32, 3.31 (2s, each 3 H, OCH_3). ^{13}C NMR ($CDCl_3$, 125 MHz), δ 92.16 (C-1α), 91.24 (C-1β), 78.64 (C-2β), 78.31 (C-2α), 74.65 (C-4α) 74.55 (C-4β), 72.20 (C-5β), 71.57, 71.50 (C-6α/6β), 67.05 (C-5α), 59.10, 59.05 (2 C), 58.18, 58.00, 57.59, 57.50, 57.17 (C-3α/3β/6 OCH_3); MS (CI): *m/z* 230 $(M\text{-}OCH_3)^+$.

Anal. Calcd for $C_9H_{17}N_3O_5$: C, 43.72; H, 6.93; N, 16.99. Found: C, 43.43; H, 6.74; N, 16.74.

3-Acetamido-3-deoxy-2,4,6-tri-*O*-methyl-α,β-D-altropyranose (5). To an ice-cold solution of **4** (1.67 g, 6.76 mmol) in pyridine (3 mL, 37 mmol), thiolacetic acid (3 mL, 42 mmol) was added dropwise, under stirring and the mixture was stirred at room temperature overnight, then concentrated. The residue was purified by flash-column chromatography (first 1:1 ethyl acetate-light petroleum; then ethyl acetate, and finally 30:1 ethyl acetate-MeOH) to give **5** as a syrup [1.42 g, 80%; α:β ratio 10:1 (NMR)]; $[\alpha]_D$ +52° (*c* 1.26, dichloromethane); IR: 1656, 1533 cm^{-1} (Amide I and II); ^1H NMR ($CDCl_3$, 500 MHz), α anomer: δ 6.85 (d, 1 H, $J_{NH,3}$ 9.8 Hz, NH), 5.97 (bs, 1 H, OH), 5.19 (bs, 1 H, H-1), 4.81 (ddt, 1 H, $J_{2,3}$=$J_{3,4}$ 3.3, $J_{1,3}$ 1.1 Hz, H-3), 4.03 (ddd, 1 H, $J_{4,5}$

9.9, $J_{5,6}$ 2.2, $J_{5,6'}$ 7.4 Hz, H-5), 3.67 (dd, 1 H, $J_{6,6'}$ 10.2 Hz, H-6), 3.52 (dd, 1 H, H-6'), 3.43-3.30 (m, 2 H, H-2, H-4), 3.27 (s, 6 H, 2 OCH_3), 3.20 (s, 3 H, OCH_3), 1.86 (s, 3 H, $NHCOCH_3$); β anomer: δ 6.65 (d, 1 H, $J_{NH,3}$ 7.0 Hz, NH), 6.15 (bs, 1 H, OH), 4.85 (bs, 1 H, H-1), 4.47 (dt, 1 H, $J_{2,3}$=$J_{3,4}$ 3.3 Hz, H-3), 3.75-3.10 (m, rest of the protons); ^{13}C NMR ($CDCl_3$, 50 MHz), α anomer: δ 170.22 ($NHCOCH_3$), 91.73 (C-1), 78.04 (C-2), 72.26 (C-4), 72.07 (C-6), 65.75 (C-5), 58.62, 57.51, 56.76 (3 OCH_3), 43.91 (C-3), 23.15 ($NHCOCH_3$); HRMS (EI) Calcd for $C_{11}H_{21}NO_6$: 263.1363. Found: 263.1387.

Anal. Calcd for $C_{11}H_{21}NO_6$: C, 50.18; H, 8.04; N, 5.32. Found: C, 50.09; H, 8.08; N, 5.01.

3-Acetamido-3-deoxy-2,4,6-tri-*O*-methyl-D-*altrono*-1,5-lactone (6). A solution of **5** (0.56 g, 2.12 mmol) in dry dimethyl sulfoxide (6.5 mL, 92 mmol) and acetic anhydride (4.36 mL, 46.1 mmol) was stirred at room temperature overnight. The mixture was diluted with water (15 mL), extracted with dichloromethane (30 mL x 4), dried (anhydrous $MgSO_4$), and concentrated first at 40 °C/15 mm Hg, then at 1 mm Hg. The residue was purified by flash-column chromatography (30:1 ethyl acetate-2-propanol) to give **6** as a white solid (0.4 g, 75%); mp 95-97 °C; $[\alpha]_D$ -44° (*c* 1.17, dichloromethane); IR: 1735 (C=O lactone), 1651, 1546 cm^{-1} (Amide I and II); ^1H NMR ($CDCl_3$, 200 MHz), δ 6.29 (d, 1 H, $J_{NH,3}$ 8.4 Hz, NH), 4.79 (ddd, 1 H, $J_{2,3}$ 10.6, $J_{3,4}$ 3.5 Hz, H-3), 4.51 (dt, 1 H, $J_{4,5}$ 3.0, $J_{5,6}$=$J_{5,6'}$ 4.1 Hz, H-5), 4.00 (d, 1 H, H-2), 3.67 (t, 1 H, H-4), 3.50 (m, 2 H, H-6, H-6'), 3.43, 3.36, 3.32 (3s, each 3 H, OCH_3), 1.98 (s, 3 H, $NHCOCH_3$); ^{13}C NMR (50 MHz), δ 169.90, 168.92 (C-1/$NHCOCH_3$), 77.00 (C-4), 76.02 (C-5), 75.24 (C-2), 71.39 (C-6), 59.02, 57.35, 57.16 (3 OCH_3), 47.38 (C-3), 22.77 ($NHCOCH_3$); HRMS (EI) Calcd for $C_{11}H_{19}NO_6$: 261.1207. Found: 261.1200.

Anal. Calcd for $C_{11}H_{19}NO_6$: C, 50.57; H, 7.33; N, 5.36. Found: C, 50.40; H, 7.34; N, 5.21.

Methyl 3-acetamido-3-deoxy-2,4,5,6-tetra-*O*-methyl-D-altronate (7). To a solution of lactone **6** (0.51 g, 1.95 mmol) in dry THF (13 mL) was added freshly powdered KOH (0.43 g, 7.8 mmol), 18-crown-6 (3 mg) and MeI (0.43 mL, 3.57 mmol). The mixture was stirred at room temperature for 7 h, then diluted with CH_2Cl_2 (100 mL). The suspension was filtered on diatomaceous earth and the solvents were removed

under reduced pressure. The resulting oily residue was treated with a saturated solution of HCl in ethyl acetate (50 mL) for 30 min. The solution was concentrated to dryness and the residue (0.8 g) was purified by flash-column chromatography (first 20:1 CH_2Cl_2 -MeOH, then 1:1 CH_2Cl_2 -MeOH). The title compound was isolated as an oil (0.5 g, 84%); $[\alpha]_D$ +17° (*c* 1.63, methanol); IR: 1747 (C=O ester), 1656, 1535 cm^{-1} (Amide I and II); ^1H NMR ($CDCl_3$, 200 MHz), δ 5.81 (d, 1 H, $J_{NH,3}$ 9.8 Hz, NH), 4.33 (dt, 1 H, $J_{2,3}$ =$J_{3,4}$ 1.8 Hz, H-3), 4.11 (d, 1 H, H-2), 3.75-3.20 (m, 4 H, H-4, H-5, H-6, H-6'), 3.66 (s, 3H, $COOCH_3$), 3.44, 3.40, 3.36, 3.32 (4s, each 3 H, OCH_3), and 1.89 (s, 3 H, $NHCOCH_3$); ^{13}C NMR (50 MHz), δ 171.34, 169.48 (C-1/NHCOCH$_3$), 81.23, 79.03, 77.96 (C-2/C-4/C-5), 71.34 (C-6), 60.15, 58.90, 58.25, 57.83 (4 OCH_3), 52.08 (C-3), 22.98 (NHCOCH$_3$); MS (CI): *m/z* 308 $(M+H)^+$.

Anal. Calcd for $C_{13}H_{25}NO_7$: C, 50.80; H, 8.20; N, 4.56. Found: C, 51.01; H, 8.09; N, 4.38.

3-Amino-3-deoxy-2,4,5,6-tetra-*O*-methyl-D-altronic acid hydro-chloride (8). *Method a):* A solution of **7** (0.22 g, 0.73 mmol) in 4M HCl (5 mL) was heated at 80-90 °C for 24 h. The solution was concentrated and coevaporated with toluene to give a semisolid residue which was purified by flash-column chromatography (9:2:1 ethyl acetate-MeOH-H_2O) to give the title compound as a solid (0.2 g, 98%); mp 163-164 °C (dec.); $[\alpha]_D$ –40° (*c* 0.87, methanol); IR: 1595 (C=O acid); ^{13}C NMR (D_2O, 50 MHz), δ 178.80 (C-1), 81.69, 81.35, 79.86 (C-2/C-4/C-5), 70.54 (C-6), 60.93, 59.10, 58.18, 57.50 (4 OCH_3), 54.71 (C-3).

Anal. Calcd for $C_{10}H_{22}ClNO_6$: C, 41.74; H, 7.71; N, 4.87. Found: C, 42.08; H, 7.80; N, 5.01.

Method b): A solution of **15** (0.025 g, 0.086 mmol) in methanol (1 mL) was stirred with 10% Pd/C (3 mg) for 2 h under a hydrogen atmosphere. The suspension was filtered through diatomaceous earth and the solution concentrated to dryness. The residue was purified by flash-column chromatography (ethyl acetate) to give a compound (0.022 g, 97%) that was identified as methyl 3-amino-3-deoxy-2,4,5,6-tetra-*O*-methyl-D-altronate, according to the following data: IR: 3420, 1630 (NH_2), 1750 cm^{-1} (CO ester); ^{13}C NMR ($CDCl_3$, 50 MHz), δ 170.74 (C-1), 81.24, 78.23, 77.64 (C-2/C-4/C-5), 69.82 (C-6), 59.80, 59.16, 58.60, 57.65 (4 OCH_3), 54.32 (C-3), 52.45 (COOCH$_3$). The above

compound was treated with 4M HCl (2 mL) at room temperature for 5 days, then concentrated. The residue was treated with light petroleum to give **8** as a solid (0.024 g, 93%).

(3*S*,4*R*)-3-Methoxy-4-(D-*erythro*-trimethoxypropyl)azetidine-2-one (9). A suspension of the amino acid **8** (0.12 g, 0.42 mmol) in dry acetonitrile (18 mL) containing ethyldiisopropylamine (74 μL, 0.42 mmol) was stirred for 10 min. A mixture of $NaHCO_3$ (0.2 g, 2.52 mmol) and methanesulfonyl chloride (64 μL, 0.84 mmol) in acetonitrile (2 mL) was added, and the new mixture was heated at 80 °C overnight. The resulting suspension was cooled, filtered on diatomaceous earth, and concentrated to dryness to give a residue (0.1 g). Flash-column chromatography (3:1 ethyl acetate-light petroleum) of the residue afforded **9** (0.05 g, 50%) as an oil; $[\alpha]_D$ –54° (*c* 0.74, CH_2Cl_2); IR: 3279 (NH), 1744 cm^{-1} (Amide); ^1H NMR ($CDCl_3$, 200 MHz), δ 6.17 (bs, 1 H, NH), 4.53 (dd, 1 H, $J_{3,NH}$ 2.85, $J_{3,4}$ 4.3 Hz, H-3), 3.71 (dd, 1 H, $J_{4,1'}$ 8.8 Hz, H-4), 3.60 (dd, 1 H, $J_{1',2'}$ 2.8 Hz, H-1'), 3.65-3.30 (m, 3 H, H-2', H-3'a, H-3'b), 3.53 (s, 3H, OCH_3), 3.41 (s, 6H, 2 OCH_3), 3.32 (s, 3 H, OCH_3); ^{13}C NMR ($CDCl_3$, 50 MHz), δ 167.96 (C-2), 85.14 (C-3), 81.31 (C-2'), 78.07 (C-1'), 70.63 (C-3'), 55.08 (C-4), 59.34, 59.05, 58.83, and 58.16 (4 OCH_3); MS (FAB): *m/z* 256 $(M+Na)^+$.

Anal. Calcd for $C_{10}H_{19}NO_5$: C, 51.49; H, 8.21; N, 6.00. Found: C, 51.20; H, 8.35; N, 5.89.

Poly[(2*S*,3*R*)-2-methoxy-3-(D-*erythro*-trimethoxypropyl)propanamide] (10). To a solution of **9** (0.05 g, 0.21 mmol) in dichloromethane (1.4 mL) were added 1-*tert*-butoxycarbonyl-4-methyl-4-phenylazetidine-2-one (1 mg) and potassium *tert*-butoxide (1.2 mg), and the mixture was stirred under argon at room temperature for 2 days. The residue was diluted with dichloromethane (10 mL) and added dropwise to diethyl ether (200 mL) with stirring. The precipitated white solid was filtered off, washed with diethyl ether, and dried to give **27** (0.04 g, 80 %); $[\alpha]_D$ -52.5° (*c* 0.69, CH_2Cl_2); η_{inh} 0.9 dL/g (Me_2SO); M_W 10,500, M_n 6,600, M_W/M_n 1.59 (GPC); IR: 1650, 1545 cm^{-1} (Amide I and II); ^{13}C NMR ($CDCl_3$, 50 MHz), δ 172.05 (C-1), 81.99 (C-2), 77.63 (C-1'), 72.43 (C-3'), 61.14, 59.26, 59.24, 58.28, 57.85 (4 OCH_3 and C-2'), 50.88 (C-3).

Anal. Calcd for $(C_{10}H_{19}NO_5 \cdot 0.5\ H_2O)_n$: C, 49.58; H, 8.32; N, 5.78. Found: C, 49.20; H, 7.88; N, 6.34.

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