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## Note

# Synthesis of a 2-acetamido-2-deoxy-α-D-galactopyranosyl analogue of tunicamycin*†

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The antibiotic tunicamycin[1] shows a wide variety of biological properties attributable to its inhibition[2] of the transfer of 2-acetamido-2-deoxy-D-glucose 1-phosphate from UDP-GlcNAc to dolichol monophosphate. This inhibitory activity may be due to the structural similarity between tunicamycin and the biologically activated 2-acetamido-2-deoxy-D-glucose. It was therefore of interest to synthesise an analogue of tunicamycin containing a 2-acetamido-2-deoxy-α-D-galactopyranosyl moiety, in order to test it as a possible inhibitor against UDP-GalNAc transferase.

The synthesis followed essentially the procedure used for a total synthesis[3,4] of tunicamycin V, by condensation of 1-[(11*R*)-2,3,5,8,9-penta-*O*-acetyl-10-(benzyloxycarbonyl)amino-11-chloro-6,10,11-trideoxy-α-L-*galacto*-D-*allo*-undecodialdo-1,4-furanose-11,7-pyranos-1-yl]uracil[3] (**12**) with an appropriately protected 2-acetamido-2-deoxy-D-galactose. The "aglycon", 2-acetamido-2-deoxy-4,6-*O*-isopropylidene-3-*O*-propanoyl-α-D-galactopyranose (**11**) was prepared by *O*-isopropylidenation of allyl 2-acetamido-2-deoxy-α-D-galactopyranoside (**6**), which was obtained from the readily accessible allyl 2-acetamido-2-deoxy-α-D-glucopyranoside[3] (**1**) in 26% overall yield by the following sequence: acetylation (**1**→**2**), *O*-deisopropylidenation (**2**→**3**), mesylation (**3**→**4**), displacement of the sulfonyloxy groups with an acetate ion (**4**→**5**), and *O*-deacetylation (**5**→**6**).

Reaction of **6** with 2,2-dimethoxypropane and toluene-*p*-sulfonic acid in *N,N*-dimethylformamide gave a mixture of two di-*O*-isopropylidene derivatives **7** and **9**, from which, after acylation, 50% of the propanoyl derivative **8** was obtained. On the other hand, the use of 2-methoxypropene[5] instead afforded selectively **9** that

*Dedicated to Professor Hans Paulsen.

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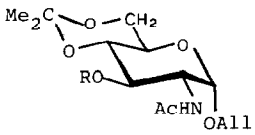
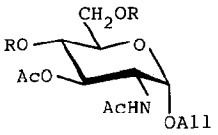


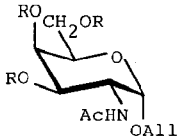
**1** R = H

**2** R = Ac



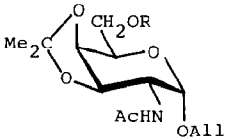
**3** R = H

**4** R = Ms



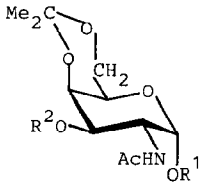
**5** R = Ac

**6** R = H



**7** R = H

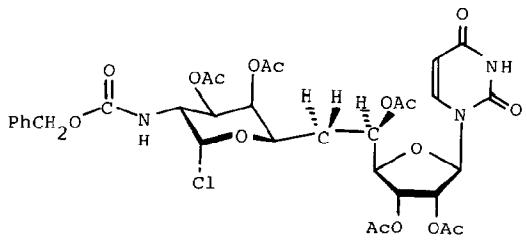
**8** R = CEt (=O)



**9** $R^1$ = All, $R^2$ = H

**10** $R^1$ = All, $R^2$ = CEt (=O)

**11** $R^1$ = H, $R^2$ = CEt (=O)

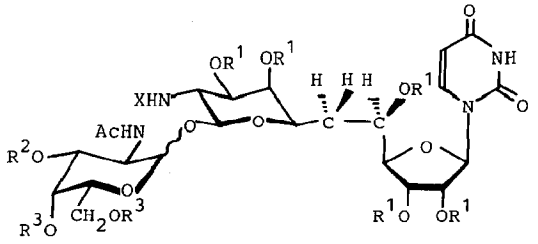


**12**

was successively converted into the propanoyl derivative **10** (92% overall yield). Compound **11** was prepared by deallylation of **10** with selenium dioxide and acetic acid in 1,4-dioxane.

Condensation of **11** and **12** in dichloromethane in the presence of silver carbonate and silver perchlorate at room temperature yielded, after column chromatography, two products **13α** (17%) and **13β** (15%). When the 3-acetate of **11** was used

as the aglycon, separation of two condensates was not feasible. The $\beta,\alpha$ structure of **13α** was deduced from the $^1$H-n.m.r. signal ($\delta$ 4.64, d, $J$ 8 Hz) for H-1 of the substituted GalNAc moiety. The $^1$H-n.m.r. data were in good accord with those of tunicamycin[1]. Therefore, **13β** was tentatively assigned as the $\beta,\beta$ anomer. Compound **13α** was *O*-deacylated with methanolic sodium methoxide (→**14α**) and the product was hydrogenolysed (methanol–Pd black) to give the free base **15α**, which was treated directly with tetradecanoic acid and dicyclohexylcarbodi-imide in dichloromethane at room temperature to give 72% of the amide **16α**. *O*-Deisopropylidenation of **16α** with aqueous 70% acetic acid then afforded the tunicamycin analogue **17α** quantitatively.



| | $R^1$ | $R^2$ | $R^3$ | X |
|---|---|---|---|---|
| **13 α,β** | Ac | CEt (=O) | >CMe$_2$ | COCH$_2$Ph (=O) |
| **14 α,β** | H | H | >CMe$_2$ | COCH$_2$Ph (=O) |
| **15 α,β** | H | H | >CMe$_2$ | H |
| **16 α,β** | H | H | >CMe$_2$ | CCH$_2$(CH$_2$)$_{11}$CH$_3$ (=O) |
| **17 α,β** | H | H | H | CCH$_2$(CH$_2$)$_{11}$CH$_3$ (=O) |
| **18 β** | Ac | Ac | Ac | CCH$_2$(CH$_2$)$_{11}$CH$_3$ (=O) |

The stereoisomer **17β** was obtained likewise from **13β** but, when **16β** was treated with aqueous acetic acid, partial 4,6→3,4 migration of the isopropylidene group occurred to form the more stable five-membered ring, which resisted hydrolysis. Therefore, the product was purified *via* the octa-acetate **18β**, the $^1$H-n.m.r. spectrum (200 MHz) of which supported the assigned structure.

Biological assay showed that **17α** had ~25% of the inhibitory activity of tunicamycin against the transfer of 2-acetamido-2-deoxy-D-glucose 1-phosphate from UDP-GlcNAc to dolichol monophosphate, and there was no detectable difference between inhibition against incorporation of 2-acetamido-2-deoxy-D-glucose and 2-acetamido-2-deoxy-D-galactose. Compound **17α** showed no antiviral or antimicrobial activity.

EXPERIMENTAL

*General methods.* — Melting points were determined in capillary tubes and are uncorrected. Optical rotations were recorded with a Jasco DIP-4 polarimeter. $^1$H-N.m.r. spectra (internal $Me_4Si$) were recorded with a Varian EM-390 (90 MHz) or JEOL FX-200 spectrometer (200 MHz). I.r. spectra were recorded with a Hitachi 225 or Jasco IR-810 spectrophotometer (neat). Mass spectra were recorded with a Hitachi M-80A spectrometer (SIMS). Solutions were concentrated under diminished pressure at <40°. Column chromatography was performed on Wakogel C-300 (Wako Pure Chemical Co. Ltd.), Kieselgel 60 (70–230 mesh, Merck), or Silica Gel 60 K070 (70–230 mesh, Katayama Chemical Co. Ltd.). T.l.c. and preparative t.l.c. were performed on Silica Gel 60 $F_{254}$ (Merck) with detection by u.v. light or by charring with sulfuric acid.

*Allyl 2-acetamido-2-deoxy-α-*D*-galactopyranoside* (**6**). — Allyl 2-acetamido-2-deoxy-4,6-*O*-isopropylidene-α-D-glucopyranoside[3] (**1**, 22 g) was acetylated conventionally with acetic anhydride–pyridine, and the solid crude 3-acetate **2** (18 g, 73%) was treated with aqueous 70% acetic acid (170 mL) for 50 min at 40° to give the syrupy diol **3** (15 g, 100%). Crude **3** (10.2 g) was mesylated in the usual way to give the syrupy dimesylate **4** (15.5 g, 100%), which was treated, without purification, with sodium acetate (116 g) in aqueous 95% acetic acid (130 mL) for 24 h at 140°. Acetic anhydride (100 mL) was then added and, after 2 h, the mixture was processed in the usual way. Column chromatography (1:20, ethanol–toluene) of the product gave the syrupy 3,4,6-triacetate **5** (5.9 g, 45%), a portion (5.7 g) of which was treated with methanolic M sodium methoxide (6 mL) in methanol (110 mL) for 0.5 h at room temperature. The solution was neutralised with Amberlite IR-120B ($H^+$) resin, filtered, and concentrated, and the product was recrystallised from ethanol to give **6** (3.0 g, 79%) as prisms, m.p. 171.5–172°, $[\alpha]_D^{22}$ +201° (*c* 1, methanol), $R_F$ 0.28 (5:1 chloroform–ethanol).

*Anal.* Calc. for $C_{11}H_{19}NO_6$: C, 50.57; H, 7.33; N, 5.36. Found: C, 50.72; H, 7.19; N, 5.34.

*Allyl 2-acetamido-2-deoxy-3,4-*O*-isopropylidene-6-*O*-propanoyl-α-*D*-galactopyranoside* (**8**). — To a suspension of **6** (2.74 g) in tetrahydrofuran (26 mL) were added 2,2-dimethoxypropane (6.40 mL) and toluene-*p*-sulfonic acid (0.21 g) with ice-cooling. After 14 h, the mixture was neutralised with Amberlite IR-400 ($HO^-$) resin and concentrated. Column chromatography [Kieselgel 60 (200 g), 50:1 chloroform–ethanol] of the residue gave an amorphous mixture (3.11 g) of **7** and **9**.

To a solution of the mixture (2.51 g) in pyridine (23 mL) was added propanoic anhydride (1.06 mL) with ice-cooling. The mixture was stirred for 14 h at room temperature, 4-dimethylaminopyridine (54 mg) was added, and stirring was continued for 20 h. The mixture was concentrated, chloroform (40 mL) was added to the residue, and the solution was washed with saturated aqueous $NaHCO_3$ (40 mL × 2) and brine (40 mL × 2), dried ($Na_2SO_4$), and concentrated. Recrystallisation of the residue from toluene gave **8** (50% based on **6**) as white

needles, m.p. 133–134°, $[\alpha]_D^{23}$ +166° (*c* 1, chloroform), $R_F$ 0.34 (10:1 toluene–ethanol); $\nu_{max}^{KBr}$ 3430 (NH), 1725 (C=O), 1645 and 1525 $cm^{-1}$ (NHCO). $^1$H-N.m.r. data (90 MHz, $CDCl_3$): $\delta$ 1.14 (t, 3 H, *J* 8.7 Hz, propanoyl $CH_3$), 1.32 and 1.56 (2 s, 6 H, $CMe_2$), 2.01 (s, 3 H, Ac), 2.35 (q, 2 H, *J* 8.7 Hz, propanoyl $CH_2$), and 4.81 (d, 1 H, $J_{1,2}$ 3.0 Hz, H-1).

*Anal.* Calc. for $C_{17}H_{27}NO_7$: C, 57.13; H, 7.61; N, 3.92. Found: C, 57.25; H, 7.46; N, 3.92.

*Allyl 2-acetamido-2-deoxy-4,6-*O*-isopropylidene-α-*D*-galactopyranoside* (**9**). — To a solution of **6** (104 mg) in *N,N*-dimethylformamide (1.5 mL) were added 2-methoxypropene (58 μL) and toluene-*p*-sulfonic acid (3.0 mg) with ice-cooling. The mixture was stirred for 4 h with ice-cooling, 2-methoxypropene (20 μL) was added, and stirring was continued for 1.5 h. Sodium carbonate (100 mg) was added, stirring was continued for 2 h, and the mixture was then filtered and concentrated *in vacuo*. Column chromatography [Silica Gel 60 K070 (8 g), ethyl acetate] of the residue gave amorphous **9** (118 mg, 99%), m.p. 95–99°, $[\alpha]_D^{20}$ +139° (*c* 1.1, chloroform), $R_F$ 0.13 (ethyl acetate); $\nu_{max}^{CHCl_3}$ 3560 (OH), 3450 (NH), 3000 ($CH_2$), 1670 and 1505 $cm^{-1}$ (NHCO). $^1$H-N.m.r. data (90 MHz, $CDCl_3$): $\delta$ 1.46 (s, 6 H, $CMe_2$), 2.01 (s, 3 H, Ac), 4.94 (d, 1 H, $J_{1,2}$ 3.3 Hz, H-1), and 5.76–6.13 (m, 2 H, NH and allyl CH).

*Anal.* Calc. for $C_{14}H_{23}NO_6$: C, 55.80; H, 7.69; N, 4.65. Found: C, 55.72; H, 7.54; N, 4.36.

*Allyl 2-acetamido-2-deoxy-4,6-*O*-isopropylidene-3-*O*-propanoyl-α-*D*-galactopyranoside* (**10**). — To a solution of **9** (320 mg) in pyridine (3.0 mL) were added propanoic anhydride (231 μL) and 4-dimethylaminopyridine (13 mg) with ice-cooling. The solution was stirred for 52 h at room temperature and then concentrated, chloroform (20 mL) was added to the residue, the solution was washed with saturated aqueous $NaHCO_3$ (20 mL) and brine (20 mL), dried ($Na_2SO_4$), and concentrated. Column chromatography [Kieselgel 60 (5 g), 10:1 toluene–ethanol] of the residue gave **10** (350 mg, 92%), which was recrystallised from toluene–hexane (4:1) to afford material with m.p. 131–133°, $[\alpha]_D^{15}$ +161° (*c* 1.1, chloroform), $R_F$ 0.38 (10:1 toluene–ethanol); $\nu_{max}^{KBr}$ 3320 (NH), 3000 and 2950 ($CH_2$), 1735 (C=O), 1645 and 1545 $cm^{-1}$ (NHCO). $^1$H-N.m.r. data (90 MHz, $CDCl_3$): $\delta$ 1.12 (t, 3 H, *J* 7.8 Hz, propanoyl $CH_3$), 1.41 and 1.46 (2 s, 6 H, $CMe_2$), 1.93 (s, 3 H, Ac), 2.35 (q, 2 H, *J* 7.8 Hz, propanoyl $CH_2$), 4.69 (m, 1 H, H-2), 4.97 (d, 1 H, $J_{1,2}$ 3.3 Hz, H-1), and 5.11 (dd, 1 H, $J_{2,3}$ 10.8 Hz, $J_{3,4}$ 3.5 Hz, H-3).

*Anal.* Calc. for $C_{17}H_{27}NO_7$: C, 57.13; H, 7.61; N, 3.92. Found: C, 57.14; H, 7.50; N, 3.81.

*2-Acetamido-2-deoxy-4,6-*O*-isopropylidene-3-*O*-propanoyl-α-*D*-galactopyranose* (**11**). — A mixture of **10** (3.42 g), selenium dioxide (1.65 g), acetic acid (0.82 mL), and 1,4-dioxane (34 mL) was heated under reflux for 30 min, then cooled to room temperature, and filtered. Toluene (30 mL) was added to the filtrate and the mixture was concentrated. Column chromatography [Kieselgel 60 (70 g), ethyl acetate] of the residue gave amorphous **11** (1.70 g, 56%), m.p. 160–162°, $[\alpha]_D^{21}$

+123° (*c* 1, chloroform), $R_F$ 0.23 (ethyl acetate); $\nu_{max}^{KBr}$ 3440 and 3360 (OH and NH), 3000 and 2950 ($CH_2$), 1725 (C=O), 1650 and 1535 $cm^{-1}$ (NHCO), $^1$H-N.m.r. data (90 MHz, $CDCl_3$): $\delta$ 1.12 (t, 3 H, *J* 8.4 Hz, propanoyl $CH_3$), 1.41 and 1.43 (2 s, 6 H, $CMe_2$), 1.96 (s, 3 H, Ac), 2.38 (q, 2 H, *J* 8.4 Hz, propanoyl $CH_2$), 4.62 (ddd, 1 H, $J_{1,2}$ 3.3, $J_{2,NH}$ 9.3, $J_{2,3}$ 10.5 Hz, H-2), 5.28 (d, 1 H, $J_{1,2}$ 3.3 Hz, H-1), and 5.92 (d, 1 H, $J_{2,NH}$ 9.3 Hz, NH).

*Anal.* Calc. for $C_{14}H_{23}NO_7$: C, 52.99; H, 7.31; N, 4.41. Found: C, 53.18; H, 7.36; N, 4.17.

*1-[(11S)-11-*O*-(2-Acetamido-2-deoxy-4,6-*O*-isopropylidene-3-*O*-propanoyl-α-*(**13α**)* and -β-*D*-galactopyranosyl)-2,3,5,8,9-penta-*O*-acetyl-10-(benzyloxycarbonyl)-amino-6,10-dideoxy-α-*L*-galacto-*D*-allo-undecodialdo-1,4-furanose-11,7-pyranos-1-yl]uracil (**13β**).* — To a solution of **12** (207 mg) and **11** (169 mg) in dichloromethane (3.5 mL) was added molecular sieve 4A (300 mg), and the suspension was stirred for 40 min at room temperature. Silver carbonate (308 mg) and silver perchlorate (33.6 mg) were then added under argon in the dark at room temperature. The mixture was stirred for 3 h, dichloromethane (2 mL), $NaHCO_3$ (0.1 g), NaCl (0.1 g), and water (4 mL) were added, and the mixture was filtered. Dichloromethane (30 mL) was added to the filtrate, and the organic layer was washed with water (20 mL), dried, and concentrated. Column chromatography [C-300 (25 g), ethyl acetate, 50:3 ethyl acetate–ethanol] of the residue and further chromatography [C-300 (12 g), 30:1 chloroform–ethanol] of the fractions containing products with $R_F$ 0.24 and 0.10 (ethyl acetate) gave **13α** (47.9 mg, 17%) and **13β** (40.8 mg, 15%).

Compound **13α** had m.p. 144–148°, $[\alpha]_D^{17}$ +74° (*c* 2.1, chloroform); $\nu_{max}^{KBr}$ 3420 (NH), 3000 and 2940 ($CH_2$), 1750 and 1695 $cm^{-1}$ (C=O). $^1$H-N.m.r. data (200 MHz, $CDCl_3$): $\delta$ 1.15 (t, 3 H, 7.4 Hz, propanoyl $CH_3$), 1.39 and 1.45 (2 s, 6 H, $CMe_2$), 1.91, 1.98, 2.09, 2.10, 2.14, and 2.21 (6 s, 18 H, 6 Ac), 2.39 (q, 2 H, *J* 7.4 Hz, propanoyl $CH_2$), 4.64 (d, 1 H, $J_{10',11'}$ 8.0 Hz, H-11'), 5.75 (d, 1 H, $J_{5,6}$ 8.0 Hz, H-5), 6.06 (bd, 1 H, *J* 9.7 Hz, acetamido NH), 7.10 (d, 1 H, $J_{5,6}$ 8.0 Hz, H-6), 7.31 (s, 5 H, Ph), and 9.16 (bs, 1 H, uracil NH).

*Anal.* Calc. for $C_{47}H_{60}N_4O_{23}$: C, 53.81; H, 5.76; N, 5.34. Found: C, 53.68; H, 5.80; N, 4.83.

Compound **13β** had m.p. 145–146°, $[\alpha]_D^{19}$ +13° (*c* 0.99, chloroform); $\nu_{max}^{KBr}$ 3410 (NH), 1740 and 1695 $cm^{-1}$ (C=O). $^1$H-N.m.r. data (200 MHz, $CDCl_3$): $\delta$ 1.14 (t, 3 H, *J* 7.2 Hz, propanoyl $CH_3$), 1.41 and 1.47 (2 s, 6 H, $CMe_2$), 1.94, 2.05, 2.06, 2.11, 2.14, and 2.20 (6 s, 18 H, 6 Ac), 2.39 (q, 2 H, *J* 7.2 Hz, propanoyl $CH_2$), 4.64 (d, 1 H, *J* 10.8 Hz) and 4.66 (d, 1 H, *J* 10.3 Hz) (H-11' and H-1''), 5.73 (d, 1 H, $J_{5,6}$ 8.0 Hz, H-5), 5.90 (bd, 1 H, *J* 8.6 Hz, acetamido NH), 7.06 (d, 1 H, $J_{5,6}$ 8.0 Hz, H-6), 7.34 (s, 5 H, Ph), and 9.35 (bs, 1 H, uracil NH).

*Anal.* Found: C, 53.42; H, 5.51; N, 5.08.

*1-[(11S)-11-*O*-(2-Acetamido-2-deoxy-4,6-*O*-isopropylidene-α-*D*-galactopyranosyl)-10-(benzyloxycarbonyl)amino-6,10-dideoxy-α-*L*-galacto-*D*-allo-undecodialdo-1,4-furanose-11,7-pyranos-1-yl]uracil (**14α**)*.* — A solution of **13α** (11.6 mg) in methanolic 0.1M sodium methoxide (1 mL) was stirred for 1 h at room temperature,

then neutralised with Amberlite IR-120B ($H^+$) resin, and concentrated. Column chromatography [Kieselgel 60 (1 g), 3:1 chloroform–methanol] of the residue gave **14α*** (8.6 mg, 99%) as a white powder, m.p. 172–174° (dec.), $[\alpha]_D^{21}$ +99° (*c* 1.5, methanol), $R_F$ 0.19 (3:1 chloroform–methanol); $\nu_{max}^{KBr}$ 3420 (OH and NH), 1685 and 1525 $cm^{-1}$ (NHCO). $^1$H-N.m.r. data (200 MHz, $CD_3OD$): δ 1.39 and 1.45 (2 s, 6 H, $CMe_2$), 1.86 (s, 3 H, Ac), 4.56 (d, 1 H, $J_{10',11'}$ 8.0 Hz, H-11′), 5.02 and 5.17 (ABq, 2 H, *J* 13 Hz, benzyloxycarbonyl $CH_2$), 5.07 (d, 1 H, $J_{1'',2''}$ 3.0 Hz, H-1″), 5.70 (d, 1 H, $J_{5,6}$ 8.0 Hz, H-5), 5.85 (d, 1 H, $J_{1',2'}$ 5.0 Hz, H-1′), 7.31 (s, 5 H, Ph), and 7.94 (d, 1 H, $J_{5,6}$ 8.0 Hz, H-6).

*1-[(11S)-11-*O*-(2-Acetamido-2-deoxy-4,6-*O*-isopropylidene-α-*D*-galactopyranosyl)-6,10-dideoxy-10-(tetradecanoyl)amino-α-*L*-galacto-*D*-allo-undecodialdo-1,4-furanose-11,7-pyranos-1-yl]uracil* (**16α**). — A suspension of **14α** (30.6 mg) and Pd black (~50 mg) in methanol (2 mL) was shaken under hydrogen (3.5 kg/$cm^2$) for 2.2 h at room temperature. The catalyst was collected, the filtrate and the washings were combined, and the resulting solution of **15α** was used directly.

To a stirred solution of tetradecanoic acid (25.6 mg) in diochloromethane (1 mL) was added dicyclohexylcarbodi-imide (30.7 mg) at room temperature. After 5.5 h, the above solution of **15α** was added, and the mixture was stirred for 15 h and then concentrated. Column chromatography [C-300 (8 g), 4:1 chloroform–methanol] of the residue gave **16α** (24.5 mg, 72%) as a white powder, m.p. 205–208° (dec.), $[\alpha]_D^{23}$ +86° (*c* 1.2, methanol), $R_F$ 0.59 (5:1 acetonitrile–water); $\nu_{max}^{KBr}$ 3430 (OH and NH), 2940 and 2880 ($CH_2$), 1680 and 1550 $cm^{-1}$ (NHCO). $^1$H-N.m.r. data (200 MHz, $CD_3OD$): δ 1.40 and 1.46 (2 s, 6 H, $CMe_2$), 2.01 (s, 3 H, Ac), 4.49 (d, 1 H, $J_{10',11'}$ 8.2 Hz, H-11′), 4.99 (d, 1 H, $J_{1'',2''}$ 3.4 Hz, H-1″), 5.69 (d, 1 H, $J_{5,6}$ 8.0 Hz, H-5), 5.83 (d, 1 H, $J_{1',2'}$ 4.3 Hz, H-1′), and 7.92 (d, 1 H, $J_{5,6}$ 8.0 Hz, H-6).

*1-[(11S)-11-*O*-(2-Acetamido-2-deoxy-α-*D*-galactopyranosyl)-6,10-dideoxy-10-(tetradecanoyl)amino-α-*L*-galacto-*D*-allo-undecodialdo-1,4-furanose-11,7-pyranos-1-yl]uracil* (**17α**). — A mixture of **16α** (7.9 mg) and aqueous 70% acetic acid (1 mL) was stirred for 40 min at 42°, and then concentrated to give **17α** (7.5 mg) as a white powder, m.p. 212–214° (dec.), $[\alpha]_D^{24}$ +35° (*c* 0.6, methanol), $R_F$ 0.43 (5:1 acetonitrile–water); $\nu_{max}^{KBr}$ 3410 (OH and NH), 2920 and 2850 ($CH_2$), 1665 and 1540 $cm^{-1}$ (NHCO). $^1$H-N.m.r. data (200 MHz, $CD_3OD$): δ 2.04 (s, 3 H, Ac), 4.59 (d, 1 H, $J_{10',11'}$ 9.2 Hz, H-11′), 4.97 (d, 1 H, $J_{1'',2''}$ 3.3 Hz, H-1″), 5.71 (d, 1 H, $J_{5,6}$ 8.4 Hz, H-5), 5.93 (d, 1 H, $J_{1',2'}$ 5.0 Hz, H-1′), and (d, 1 H, $J_{5,6}$ 8.4 Hz, H-6). Mass spectrum: *m/z* 819 ($M^+$ + 1) and 841 ($M^+$ + Na).

*1-[(11S)-11-*O*-(2-Acetamido-2-deoxy-4,6-*O*-isopropylidene-β-*D*-galactopyranosyl)-10-(benzyloxycarbonyl)amino-6,10-dideoxy-α-*L*-galacto-*D*-allo-undecodialdo-1,4-furanose-11,7-pyranos-1-yl]uracil* (**14β**). — Compound **14β**, obtained

*Because of the small amounts of compounds, **14α**, **16α**, **17α**, **14β**, **16β**, **18β**, and **17β**, it was not possible to obtain elemental analyses. Each compound was shown to be homogeneous by chromatography and characterised by n.m.r. spectroscopy.

(82%) from **13β** as described for **14α**, had m.p. 178–180° (dec.), $[\alpha]_D^{23}$ +1.3° (*c* 1.6, methanol), $R_F$ 0.39 (5:1 acetonitrile–water); $\nu_{max}^{KBr}$ 3400 (OH and NH), 1680 and 1530 $cm^{-1}$ (NHCO). $^1$H-N.m.r. data (90 MHz, $CD_3OD$): δ 1.37 and 1.45 (2 s, 6 H, $CMe_2$), 1.94 (s, 3 H, Ac), 5.71 (d, 1 H, $J_{5,6}$ 8.1 Hz, H-5), 5.87 (d, 1 H, $J_{1',2'}$ 3.5 Hz, H-1'), and 7.96 (d, 1 H, $J_{5,6}$ 8.1 Hz, H-6).

*1-[(11S)-11-*O*-(2-Acetamido-2-deoxy-4,6-*O*-isopropylidene-β-*D*-galactopyranosyl)-10-amino-6,10-dideoxy-α-*L*-galacto-*D*-allo-undecodialdo-1,4-furanose-11,7-pyranos-1-yl]uracil* (**15β**) *and 1-[(11S)-11-*O*-(2-acetamido-2-deoxy-4,6-*O*-isopropylidene-β-*D*-galactopyranosyl)-6,10-dideoxy-10-(tetradecanoyl)amino-α-*L*-galacto-*D*-allo-undecodialdo-1,4-furanose-11,7-pyranos-1-yl]uracil* (**16β**). — To a stirred solution of tetradecanoic acid (47 mg) in dichloromethane (1 mL) was added dicyclohexylcarbodi-imide (45 mg) at room temperature. After 5.5 h, to the mixture was added a methanolic solution of **15β**, obtained from **14β** (51 mg) as for the preparation of **15α**, and the mixture was stirred for 2 days and then concentrated. Column chromatography [C-300 (14 g), 4:1 chloroform–methanol] of the residue gave **16β** (35 mg, 63%) as a white powder, m.p. 213–214° (dec.), $[\alpha]_D^{20}$ −2.5° (*c* 1.1, methanol), $R_F$ 0.50 (5:1 acetonitrile–water); $\nu_{max}^{KBr}$ 3400 (OH and NH), 2930 and 2860 ($CH_2$), and 1670 $cm^{-1}$ (NHCO). $^1$H-N.m.r. data (90 MHz, $CD_3OD$): δ 1.41 and 1.48 (2 s, 6 H, $CMe_2$), 1.96 (s, 3 H, Ac), 5.71 (d, 1 H, $J_{5,6}$ 8.1 Hz, H-5), and 7.98 (d, 1 H, $J_{5,6}$ 8.1 Hz, H-6).

*1-[(11S)-11-*O*-(2-Acetamido-3,4,6-tri-*O*-acetyl-2-deoxy-β-*D*-galactopyranosyl)-2,3,5,8,9-penta-*O*-acetyl-6,10-dideoxy-10-(tetradecanoyl)amino-α-*L*-galacto-*D*-allo-undecodialdo-1,4-furanose-11,7-pyranos-1-yl]uracil* (**18β**). — A solution of **16β** (15 mg) in aqueous 70% acetic acid (1 mL) was stirred for 1 h at 40° and then concentrated. A solution of the residue in dichloromethane (0.5 mL) and pyridine (0.5 mL) was treated with acetic anhydride (0.05 mL) for 2 days at room temperature. The mixture was then concentrated and preparative t.l.c. (15:1–40:1 chloroform–ethanol) of the residue gave **18β** (16 mg, 80%), as a white powder, m.p. 112–114°, $[\alpha]_D^{24}$ −3.6° (*c* 0.8, chloroform), $R_F$ 0.27 (20:1 chloroform–ethanol); $\nu_{max}$ 3360 (NH), 2930 and 2860 ($CH_2$), 1750 (C=O), 1680 and 1545 $cm^{-1}$ (NHCO). $^1$H-N.m.r. data (200 MHz, $CDCl_3$): δ 1.96–2.20 (m, 27 H, 9 Ac), 4.69 (d, 1 H, *J* 9.3 Hz) and 4.81 (d, 1 H, *J* 8.7 Hz) (H-11' and H-1''), 7.14 (d, 1 H, $J_{5,6}$ 8.6 Hz, H-6), and 9.03 (bs, 1 H, uracil NH).

*1-[(11S)-11-*O*-(2-Acetamido-2-deoxy-β-*D*-galactopyranosyl)-6,10-dideoxy-10-(tetradecanoyl)amino-α-*L*-galacto-*D*-allo-undecodialdo-1,4-furanose-11,7-pyranos-1-yl]uracil* (**17β**). — A solution of **18β** (14 mg) in methanolic 0.1M sodium methoxide (1 mL) was stirred for 45 min at room temperature, then neutralised with Amberlite IR-120B ($H^+$) resin, and concentrated to give **17β** (8.1 mg, 85%), as a white powder, m.p. 200–205° (dec.), $[\alpha]_D^{23}$ +7° (*c* 0.4, methanol), $R_F$ 0.47 (5:1 acetonitrile–water); $\nu_{max}^{KBr}$ 3400 (OH and NH), 2930 and 2855 ($CH_2$), and 1630 $cm^{-1}$ (NHCO). $^1$H-N.m.r. data (200 MHz, $CD_3OD$): δ 1.97 (s, 3 H, Ac), 5.71 (d, 1 H, $J_{5,6}$ 8.7 Hz, H-5), 5.88 (d, 1 H, $J_{1',2'}$ 4.0 Hz, H-1'), and 7.97 (d, 1 H, $J_{5,6}$ 8.7 Hz, H-6). Mass spectrum: *m/z* 841 ($M^+$ + Na).

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